

The Future of Energy in the Atlantic Basin

Eloy Álvarez Pelegry and Paul Isbell
Editors

Center for Transatlantic Relations
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List of Abbreviations

AAC	Atlantic Arc Commission
ABC	Brazilian Cooperation Agency
ABI	Atlantic Basin Initiative
AEF	Atlantic Energy Forum
AfDB	African Development Bank
AFRAS	Africa-South America Summit
ANP	National Petroleum Agency (Brazil)
APEC	Asia-Pacific Economic Cooperation Conference
ATN	Atlantic Transnational Network
AU	Africa Union
bbl	barrels (of oil)
bcf	billion cubic feet
bcm	billion cubic meters
bd	barrels per day
b/d	barrels per day
Bimep	Biscay Maritime Energy Platform
BIOCOM	Bioenergy Company of Angola
bn	billion
BNDES	National Bank for Social and Economic Development (Brazil)
BP	British Petroleum
BRICs (or BRICS)	Brazil, Russia, India, China and South Africa
BtL	biofuels-to-liquids
BTU	British Thermal Unit
CAF	Comunidad Andino de Fomento (Latin American Development Bank)
CAPEX	capital expenditures
CEO	Chief executive officer
CFLs	compact fluorescent lights
CHP	
CIMA	Sugar and Ethanol Interministerial Council (Brazil)
CNG	Compressed natural gas
CNOOC	Chinese National Offshore Oil Company
CNPE	National Council for Energy Policy (Brazil)
CO ₂	carbon dioxide
COM	Council of Ministers (EU)
CPLP	Community of Portuguese Language Countries
CSIS	Center for Strategic and International Studies
CtL	coal-to-liquids
CTR	Center for Transatlantic Relations

DDGS	dried distiller grains
DRC	Democratic Republic of Congo
DRN	New and Renewable Energy Resources Division (Brazil)
DSM	demand-side management
EC	European Commission
EE	energy efficiency
EHS	Environmentally Harmful Subsidies
EIA	Energy Information Agency (US)
EISA	Energy Independence and Security Act (US)
ETI	Extractive Industries Transparency Initiative
E&P	Exploration and Production
EPA	Environmental Protection Agency (US)
ESCOs	private energy services companies
ETS	Emissions Trading Scheme (EU)
EU	European Union
EU-28	European Union of the 28
EUA	Emissions Unit Allowance (EU ETS)
EVE	Basque Energy Agency
FAME	Fatty Acid Methyl Esters (EU)
FAEE	Fatty Acid Ethyl Esters (EU)
FDI	Foreign Direct Investment
FIESP	Federation of Sao Paulo Industries (Brazil)
FQD	Food Quality Directive (EU)
FT	Fischer-Tropsch (technology)
G7/8	Group of Seven (Eight)
GDP	Gross Domestic Product
GEA	Global Energy Assessment (IIASA)
GEF	Global Environmental Facility
GHG	greenhouse gases
GPS	Global Petroleum Survey (Fraser Institute)
GtL	gas-to-liquids
GW	gigawatt
hl	hectaliter
HRT	private Brazilian oil and gas company
HVO	hydrogenated vegetable oil
IBSA	India-Brazil-South Africa dialogue
IEA	International Energy Agency
IMF	International Monetary Fund
IIASA	International Institute of Applied Systems Analysis
ILUC	indirect land-use change
IOCs	International (private) oil (and gas) companies
IPI	Tax on industrial products (EU)
IPP	Independent power project

IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan (South Africa)
JHU	Johns Hopkins University
kWp	kilowatt peak
LAC	Latin America and the Caribbean
LDCs	Least Developed Countries
LEDs	light-emitting diodes
LNG	liquefied natural gas
LPG	liquid petroleum gas
LTO	Light tight oil
mbd	million barrels per day
mbdoe	million barrels per day of oil-equivalent
MGDs	Millennial Development Goals
MEND	Movement of the Emancipation of the Niger Delta
MMBtu	millions of British Thermal Units
Mn Million	thousand millions, or billions
MP	provisional measure (medida provisoria, Brazil)
Mt	million tons
mtoe	million tons of oil-equivalent
mntoe	million tons of oil-equivalent
MS	Member States (EU)
MW	mega-watts
MWh	Megawatt hours
MRE	Ministry of Foreign Relations (Brazil)
NATO	North Atlantic Treaty Organization
NCCR	National Climate Change Response (South Africa)
NGOs	Non-Governmental Organization
NOCs	National (state) oil (and gas) companies
NRETs	Non-conventional renewable energies
oe	oil-equivalent
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
Orkestra	Basque Institute for Competitiveness
PANER	National Action Plan on Renewable Energy (EU)
PCTI	Plan for Science, Technology and Innovation (Basque Country, Spain)
PIESA	Power Institute for East and Southern Africa
PIS/COFIN	Social Integration and Finance of Social Security (EU)
PPAs	power purchase agreements
PPP	purchasing power parity
PV	photovoltaic cells/panels (solar power)

R\$	Brazilian currency, the real
R&D	research and development
RED	Renewable Energy Directive (EU)
REFTTs	Renewable energy feed-in tariffs
RES	Renewable energy systems
RFS	Renewable Fuel Standard (US)
RGGI	Regional Greenhouse Gas Initiatives
SA	South Africa (Republic of)
SADC	Southern African Development Community
SAIS	School of Advanced International Studies (JHU)
SAPP	Southern African Power Pool
SENER	Secretariat of Energy (Mexico)
SE4All	Sustainable Energy for All Initiative (UN)
SET	Strategic Energy Technology Plan (EU)
S&P	Standard and Poor's
SPRI	Regional Development Agency of the Basque Country (Spain)
TAREA	Tanzanian Renewable Energy Association
tcf	trillion cubic feet
tcm	trillion cubic meters
TRR	technically recoverable resources
TPP	Trans-Pacific Trade Partnership
TTIP	Transatlantic Trade and Investment Partnership (US-EU)
TWh	Tera-watt hours
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
U.S.	United States
US\$	United States dollar
USD	United States dollar
WHO	World Health Organization
Wp	watt peak
ZOPACAS	South Atlantic Peace and Cooperation Zone

Preface

It is a pleasure and privilege for me to offer these brief reflections on the publication of this book, *The Future of Energy in the Atlantic Basin*. One of the book's origins was an interesting seminar of the same name that took place in Bilbao in October of 2013. That seminar was the result of the fruitful and ongoing collaboration between the Center for Transatlantic Relations at Johns Hopkins University SAIS and the Energy Chair of Orkestra-The Basque Institute of Competitiveness.

If the origin of the book can be traced back to the above-mentioned seminar, from a conceptual and historical point of view—and from the Spanish, Basque and European perspectives—this book should be considered the by-product of a vocation, a way of life. A vocation for the Atlantic world because throughout much of history we have been a society looking to, and very much engaged with, the Atlantic space. It would be wise to acknowledge our history and to recognize this background.

In this respect, I believe that the key issue with regard to the Atlantic is that of values. I believe that one of these Atlantic values is freedom, although another is a willingness to change and to promote and drive economic and social progress.

In order to highlight the content of this book, I modestly refer to two great thinkers: Raymond Aron and Hans Morgenthau.

According to Raymond Aron: “it is essential to accept the past in order to foresee the future.” The Atlantic world was once a place where natural resources were the key to the development of a productive economy. But crucial as well was the construction of a space for freedom and the creation and development of public institutions that allowed for, and facilitated, a society of opportunities (along with the provision of goods and services covered by a legal system lending certainty to the compliance of contracts). Today the Atlantic world faces a similar challenge, although it is now more focused on Africa. In my view, a promising future for Europe depends on Africa's successful development.

On the other hand, my admired Hans J. Morgenthau once said that “the world is the result of the strengths of human nature” and that “comprehension of a minor evil should be delivered before the comprehension of the absolute good.” (Incidentally, Morgenthau could give many good lessons to Europeans today!) In my view, the Atlantic world should be a place where societies overcome their fears of other values and civilizations. Individual interests should turn into general interests, and institutions should be built to guarantee freedom. Only then will the various communities that constitute today’s Atlantic world become productive economies with vital opportunities available for all to enjoy.

The Atlantic world has a promising future—and we need to believe so. If we take into account the multiple changes registering across the global landscape, including China’s growing leadership role at the global level, these facts oblige us more than ever to keep an eye on the importance of the consolidation of the Atlantic world.

Now that the Eurasian vision and the role of the Pacific Basin have so much impact on international society, the Atlantic world demands its own recognition. Its citizens should now call for the design and implementation of policies to develop the full potential of the Atlantic Basin.

I would like to conclude by thanking the Atlantic Basin Initiative, in the persons of Dan Hamilton, the Executive Director of the Center for Transatlantic Relations at Johns Hopkins University SAIS and his JHU colleague, Paul Isbell, the CAF Energy Fellow, along with the Energy Chair of Orkestra (the Basque Institute of Competitiveness), in the persons of Eloy Álvarez Pelegry and Macarena Larrea. This is the team made it possible for this book to be published.

I believe that you will find this book to be relevant. In any event, it will no doubt provide good food for thought.

Emiliano López Atxurra
Chairman of Sponsor Committee
Energy Chair of Orkestra
Basque Institute of Competitiveness

We are on the cusp of fundamentally changing the way energy is produced, distributed and traded across the entire Atlantic space. Over the next 20 years the Atlantic is likely to become the energy reservoir of the world and a net exporter of many forms of energy to the Indian Ocean and Pacific Ocean basins. The Atlantic is setting the global pace for energy innovation and redrawing global maps for oil, gas, and renewables as new players and technologies emerge, new conventional and unconventional sources come online, energy services boom, and opportunities appear all along the energy supply chain.

Not only has the global center of gravity of energy supply recently moved into the Atlantic world, the basin's multi-faceted energy space—and energy seascape—has been at the epicenter of numerous energy revolutions in recent years: the shale revolution, the offshore revolution and the low-carbon revolution. The single most important structural supply side factor in the slide in oil prices over the last year from over US\$100 a barrel to below US\$60 (where it is now, roughly speaking) has been the boom in Atlantic energy supply generated for the global market by these Atlantic revolutions.

In that context, this book (the first in a series on Atlantic Basin energy) is a timely addition to the ongoing analysis of the global energy scene. It analyzes the currently global energy contexts in Atlantic terms and reveals the potential for pan-Atlantic energy cooperation across the full, complete Atlantic Basin, both north and south. This book on the future of energy in the Atlantic Basin also coincides with the birth of the Atlantic Energy Forum—the first pan-Atlantic mechanism for transnational energy cooperation—which is now in its second year.

In any event, we hope that the new perspectives revealed by our authors will enrich current efforts at energy policy making and long term strategy in the Atlantic Basin.

Daniel S. Hamilton
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Johns Hopkins University SAIS

Introduction

Eloy Álvarez Pelegrý and Paul Isbell

The Origin and Nature of the Book

It has been a pleasure and a challenge to edit this anthology on the future of energy in the Atlantic Basin. This book has only come to fruition as the result of a fortunate joint initiative between the Atlantic Basin Initiative of the Center for Transatlantic Relations (CTR) at Johns Hopkins University's School of Advanced International Studies (SAIS) in Washington, D.C. and the Energy Chair of Orkestra, the Basque Institute of Competitiveness at the University of Deusto (Bilbao, Spain). In June 2013, CTR and Orkestra agreed to organize a seminar in Bilbao in October 2013 to explore the potentials of this new Atlantic framing for energy concerns. Following that successful and very suggestive seminar, the various participants were invited to contribute chapters, based on their seminar presentations, to this book. We also invited other colleagues who could not attend the Bilbao seminar to contribute chapters on a range of Atlantic energy concerns not dealt with directly in the seminar.

The topics covered in this volume span a wide array of themes, some widely considered current—in the sense that they have already received broad attention and consideration—and others less so. The shale and offshore revolutions are just some of the more well-known changes that are re-shaping the energy worlds of the Atlantic space. But there are also new trends in energy access, cooperation and reform in the Southern Atlantic. Finally, the all-important non-state energy perspectives of the private sector, international bodies, NGOs and sub-state actors also shed some light on the tantalizing prospect of pan-Atlantic transnational energy governance.

The selection that follows also includes coverage of the main types of energy (oil, gas, renewables, biofuels, etc.) in the Atlantic Basin, as

well as particular sub-regional focuses. A conscious editorial emphasis has been placed upon the Southern Atlantic, and Africa in particular, so as to help overcome a deep-seated habit to conflate the Atlantic with the North Atlantic. The authors themselves come from all around the Atlantic Basin—from Africa, Latin America, North America, and Europe—and from varying backgrounds and professions, including representatives of the private sector, world-class energy analysts and specialists, energy scholars, and other energy practitioners.

For this reason, the book also captures a diversity of energy conceptualizations. Some authors focus on the function of energy as an economic good which is generated in and distributed through the market, and the purpose of which is to provide as cheap an input as possible to economic activity and well-being. Others frame their analysis around energy as a strategic good—some from the perspective of energy short or energy long sovereign nation-state actors (i.e., net importers versus net exporters), others from the point of view of consumers without access to modern forms of energy or energy services. Still others reveal energy as the primary target in the pursuit of profit and/or geopolitical influence. This last perspective seems to be shared by large parts of the energy industry which views energy as a kind of hybrid good—something between an economic good and a strategic good, or a convenient (or inconvenient) and often opportunistic (or inopportunistic) blending of both realities.

As a result of this diversity of energy perspectives, this anthology offers a multi-dimensional view of energy concerns in the Atlantic Basin, along with a multiplicity of narrative styles and analytical approaches.

At a moment when global energy scenarios continue their most recent and surprisingly abrupt chain of shifts and transformations—from a perceived energy horizon of tightening shortage and heightening geopolitical competition just a few years ago to one of growing abundance and the destabilizing energy price declines that have followed, first in gas, and more recently in oil—this book proposes to analyze afresh, within a novel Atlantic Basin regional framing, many of the same energy issues, concerns, trends, and dynamics that we have long contemplated from our more traditional national, historical-regional, or global perspectives.

Why Atlantic Energy?

The Counter-Intuitive Atlantic

To focus a contemporary energy discussion on the Atlantic world may feel counter-intuitive. After all, ever since the energy crises of the 1970s, the countries of the Atlantic have been generally perceived—and have perceived themselves—to be energy short and, as a result, terminally dependent on the Middle East, Central Asia, and the former Soviet Union. These were the world's traditional net exporting regions of the 20th century, of the global energy map of the Cold War epoch. These parts of central Eurasia—that Great Crescent of hydro-carbon reserves that for so long served as the heavy center of gravity of the world energy supply—have dominated the attention and framing of most global energy analyses and discussions. This view is still pervasive today, even though global energy supply and demand have gone through continuing and profound structural change over the last 40 years. As the following chapters reveal, the strategic value of Atlantic Basin energy is on the rise, while the strategic value of the Great Crescent is on the decline, at least in relative terms, and this key global shift is projected to deepen over at least the coming generation.

The apparent counter-intuitiveness of our Atlantic focus is nevertheless understandable—perhaps even more so for some in the South, although not exclusively, as both European and American foreign policy establishments appear to operate largely within Cold War, 20th century framings which inevitably focus on Eurasia). We must recognize that, since the world wars, the Atlantic has generally meant the North Atlantic (the U.S., Canada, and Europe) and transatlantic relations have meant formal and informal relations between and among the nation-state members of the North Atlantic Treaty Organization (NATO).

Meanwhile, the Southern Atlantic¹ has been, more often than not, forgotten in transatlantic discussions—much as the Eurasian heartland of the realist geopolitical tradition and its critical rimland neighbors in

1. In contrast to the conventional term “South Atlantic,” the Southern Atlantic is meant to be that part of the Atlantic Basin (or Atlantic world) south of NATO. In this sense, the Southern Atlantic contains the South Atlantic within it, extending this geographic term into a broader geopolitical term which includes Mexico, Central America and the Caribbean, along with North Africa, Morocco and the rest of Atlantic Africa not strictly part of the South Atlantic.

the Middle East and Asia (i.e., the Great Crescent mentioned above) are all too frequently, even obsessively, remembered—at least within transatlantic foreign policy circles. And if many in the Northern Atlantic are beginning to remember the Southern Atlantic in recent years (with the coalescence of Global South consciousness and the formation of the BRICs), it is typically with a note of panic as we perceive that the Asians (and the Chinese in particular, or even other Eurasians like the Russians or the Iranians) are beginning to penetrate what some now clearly see as the vulnerable, or attractive, underbelly of the West.

In any event, it is true that most observers, both lay and expert, still do not tend to think of the Atlantic Basin as a distinct, coherent and potentially unifying space upon their mental maps. Furthermore, the emergence of the Pacific Basin in the late 1980s sparked a cyclical discourse over the decline of the West, giving rise to a conceptual rivalry over whether the new century would be ultimately proclaimed the Pacific Century or rather, simply, the Asian Century. The former would imply that the net effect of post-Cold War globalization would be a long term shift in the center of gravity of global power from the Atlantic to the Pacific Basin. North America would still remain the dominant protagonist, via its Pacific projection, but such a shift would imply that Europe would now find itself increasingly less relevant in geopolitical terms.²

On the other hand, an Asian Century would imply that globalization would produce a structural shift in relative global power and influence from the geographic and historical West to the East, regardless of whether this would be the result of a relative decline of the West or a rise of the rest. In both cases, however, the Atlantic Basin slips out of view, as the focus of attention shifts to Asia-Pacific, the geographical antipodes of the West. This book hopes to demonstrate that, at least in terms of energy, the countries of the Atlantic nevertheless have ample reasons for re-focusing their key strategic priorities within their own ocean basin system, regardless of how the global media may initially dub the current century.

2. See for example, Emilio Lamo de Espinosa, "Un mundo post-europeo" in *Europa despues de Europa*, Madrid:Academia Europea de Ciencias y Artes, 2010.

The Role of Mental Maps and Data Categories and Framings

If the most recent shifts on our mental maps for energy have followed the globalizing media's portrayal of the rise of Asia and the Pacific during the age of globalization, a number of ingrained patterns of perception from the Cold War past also continue to obscure from our view the Atlantic Basin as a single coherent, strategically significant and potentially unifying space. First, most of our official, open-source international data tends to be framed in either conventional national or global categories. Most of this data is prepared at the national governmental level and then collected, aggregated and categorized by our international institutions. These organizations overwhelmingly date from the post-World War II and Bretton Woods epoch and still tend to reflect the conceptual structures of the Cold War, colonial, and early post-colonial realities. These conceptual structures, however, are also found embedded in the (seemingly innocuous) categories of the data produced by these same international and regional institutions.

When these international institutions do present the data beyond the standard national or global categories, more often than not the data is cast in two broad alternative intermediate frames. The first is a North-South frame which organizes the aggregate data around the advanced industrial market democracies of the North (or of the West, the OECD, or the G7/8, etc), on the one hand, and around the emerging markets, along with the rest in the South (or of the developing and transitioning worlds). This focus on the rich-poor divide has a strong tendency to abstract the discussion from the actual relevant geography of the map. This tendency can be seen in the recent BRICs media categorization and geopolitical formation, and the resulting new use of aggregate BRICs data.

On the other hand, the second intermediate framing that is also commonly used in a broad range of databases is geographic, but it suffers from a faulty geographic because it has become arbitrary. Many international data sources fall back to the continental categories as a default mode for grouping national data regionally (North America, Africa, South America, East Asia, etc.). Furthermore, some traditional regional organizations continue to keep alive other conventional usages that reinforce the boundaries of the mental map around historically or geopolitically-defined regions like Latin America or Europe

and Eurasia or Southeast Asia, and a long etcetera. While the standard continental landmass groupings are ostensibly geographic, they tend to distort the mental map in their own way by focusing on the globe's landmasses and marginalizing the oceans and their role (stemming from the ingrained assumption that land is the central organizing geographic principle of human political economy and geopolitics).

This emphasis on the national and global categories—when mediated by either economic categories abstracted from the map or supposedly geographic categories which actually marginalize the sea—allows for much of the changing regional (or other sub-global) dynamics to be lost. Indeed, most international organizations, regional trade agreements and transnational bodies of all types—along with the data flows associated with and generated by their activities and concerns—are almost always framed upon a land-based, terrestrial, continental (or sub-continental) focused conception of *region*, which more often than not represents the legacies of technological realities—and the corresponding geopolitical scenarios they projected in their dialectical interaction with a much more slowly changing geography—which are now increasingly part of the past.

In large part this is because such 20th century framings cast a blind eye to the sea, anchored as they in a terrestrial-continental projection of the mental map which degrades (or at least unconsciously discounts) the evolving values and functions of the seas and the ocean basins in local, regional and global human political economy and the global physical system of the biosphere. As might be expected, then, there are only a few international groupings (and therefore relatively few sources of data and data categorization) that have grown up around the world's major bodies of water, the seas and the ocean basins.

The global seascape—constituted of the four major ocean basins (the Atlantic, Pacific, Indian, and Arctic Basins) along with tributary seas and sub-basins (Mediterranean, Black, Baltic, Red, Persian, Caribbean, etc.)—covers the dominant part (75%) of the surface of the planet, connecting all of the terrestrial continental bodies and enveloping all of the world's islands by sea. The seascape is also the multi-dimensional strategic space through which passes an overwhelming and increasing share of the international transportation of

consumer goods, energy and other raw materials and commodities (not to mention the nascent sub-sea economies emerging from below).

As a result, most policy and market analysis tends to take shape around the geographical and conceptual categories through which the data itself is presented: almost always continental, or at least landmass-based. This introduces an inherent inertia into the configuration of our mental maps—just as most market analyses tend to remain behind the curve—making the introduction of new framings feel counter-intuitive, or even clashingly artificial.

Similar dynamics are at play in the energy industries and across the energy world more broadly. Conventional, historical groupings, like OPEC and the IEA, reflect the same North-South, Developed-Developing country divide, only they date from a time when this divide also roughly represented the economic and geopolitical fault line between net energy importing and net exporting countries, between net consumers and net producers. But the changes in Atlantic and global energy which constitute the focus of this book are making such a mental map obsolete, as one-time net importers across the Atlantic world are fast transforming into net exporters, and as new energy sources—each with its own unique if shifting map—penetrate, however haltingly and irregularly, into national, regional and global energy mixes.

Compounding all of the inertias outlined above, the energy industry itself is bound in the short- and middle run by a relatively complex web of references and conventions—like benchmark prices, market hubs, regulatory models, investment decision price assumptions, and contract formulas. Such conventional benchmarks and practices, including industry standards and rules of thumb, change only infrequently, over the same long time frames relevant for energy production and infrastructure projects themselves (which also tend to have high-up-front capital costs and relatively long commercial lifetimes). Even then, such conventions change only if underlying circumstances (supply, demand, price) have changed enough in the meantime to justify a shift in traditional strategy and conservative practice in a highly path dependent sector.

Therefore, even in the best case scenario, necessary changes in conceptual framings, data categories, and analytical focus only arrive slowly, and with a conservative lag, during which time the increasingly

outmoded conventions continue to frame public policy, energy industry analysis and institutional data. This has been one of the defining features of the conceptual interregnum in which the energy world has found itself since right before it was surprised by the last sharp rise in the price of oil and gas (2003–2008) up until now (2015), just after the world has been surprised yet again, only this time by an even sharper fall in the global price of oil.

From an analytical point of view, continuing to assess ongoing changes in the global energy political economy with such increasingly outmoded lenses only risks leaving more and more of the emerging global dynamics out of clear focus, or even simply out of view. This might explain why—during this interregnum in which global energy dynamics are not as clear as they once had seemed—there is widespread recognition and consciousness, for example, of a shale revolution in the U.S., of the deep offshore pre-salt oil finds (and controversies) in Brazil, of an energy boom unfolding in Africa (or of a possible oil curse still to come in large parts of that continent), and even of the ongoing energy dependency crisis in Europe (or of its faltering yet stubborn low carbon revolution), but nearly no awareness at all of an Atlantic energy renaissance that is profoundly re-drawing the global energy map and challenging the notion that global power is shifting irrevocably from West to East.

Projecting an Atlantic Energy Space

A new primary focus on the broad Atlantic space—and then upon the ocean basins and their changing role as new key spaces within the mechanics and dynamics of globalization—would begin to remedy the increasingly deficient vision generated by most traditional data categories and analytical framings. Without an Atlantic Basin category—or some other innovative framings like it which cut across traditional continental and sub-continental definitions—most international energy data as it is currently produced and disseminated will not conveniently reveal the full range and depth of the broader pan-Atlantic—as opposed to conventionally-understood national or sub-regional—dynamics, to say nothing of their potentially unique geopolitical and governance implications.

It goes without saying that these implications could be significantly at odds with those still being gleaned from the traditional definitional framings. On the other hand, through a re-mapping of current data categories, we can at least test the hypothesis that the Atlantic Basin now offers a more coherent and justifiable regional framing than many of those currently on conventional offer.

Yet there is an even more compelling motive to justify the conceptual and data remapping of the global energy scene that would be implied by the introduction of such a pan-Atlantic category, and to apply a particular Atlantic Basin projection to such a map. In recent years, as the global recession sent globalization and global governance on a path toward crisis and fragmentation, and as surprising energy shifts threatened to redraw the global geopolitical map, a nascent Atlantic Basin (or pan-Atlantic) consciousness has begun to take shape. This is evidenced in the ongoing work of the Eminent Persons Network of the Atlantic Basin Initiative, a growing vanguard body spearheading a new Atlantic movement.

These former and current political leaders (ex-presidents and ministers), CEOs, and multinational entrepreneurs, world-class technocrats, and strategic thinkers from all points Atlantic have already come to the conclusion that the century in course will be as much Atlantic as it will be Pacific or Asian. From an investigation of the strategic horizon they have identified a number of issue and flow vectors—including energy, commerce, sustainable development, human and maritime security, the ocean itself, and common Atlantic values—that reveal uniquely Atlantic dynamics, risks and opportunities. They have declared that a New Atlantic Community should be pursued by public, private, and civil society agents from across the entire Atlantic space, and that the historical divisions between the North and South Atlantic are now long obsolete.³

3. See the Eminent Persons Group of the Atlantic Basin Initiative, "A New Atlantic Community: Generating Growth, Human Development and Security of the Atlantic Hemisphere: A Declaration and Call to Action," a white paper of the Atlantic Basin Initiative, Center for Transatlantic Studies, School of Advanced International Studies, Johns Hopkins University, March 2014. See: <http://transatlantic.sais-jhu.edu/events/2012/Atlantic%20Basin%20Initiative/Atlantic%20Basin%20Initiative>

In June of 2013, the leaders of the Atlantic Basin Initiative (ABI) embraced the Atlantic energy renaissance and acknowledged its impact in re-shaping the global energy map, including the epoch-marking shift of the global center of gravity for energy supply into the Atlantic space. Recognizing the Atlantic Basin as the most energy interdependent region in the world, these Atlantic leaders issued the Luanda Declaration, calling for efforts at pan-Atlantic energy cooperation, the creation of an Atlantic Energy Forum, and the drafting and adoption of an Atlantic Charter for Sustainable Energy. Then, in November of 2014, the Atlantic Energy Forum was created under the auspices of the ABI and with the backing and support of a range of private energy and energy-related companies and a number of international and regional political, economic and energy institutions, including the African Development Bank (AfDB) and the African Union (AU), along with the Latin America Development Bank (CAF) and the Regional State Governments of Veracruz, Quintana Roo, and Sao Paulo.⁴

The Bilbao Seminar of October 2013, and the transnational pan-Atlantic energy collaboration to which it has made a significant contribution, has produced what we feel is a unique book which at least in part responds to the call of the Luanda Declaration. We hope it can also inform and engage the new Atlantic Energy Forum's agenda for exploring and exploiting pan-Atlantic energy possibilities.

Structure and Contents

To aid analytical clarity, we have arranged the book into three parts. "Part One: the Atlantic Basin on the Evolving Global Energy Map" groups together those chapters that deal with recent and ongoing trends in Atlantic and global energy, including conventional and unconventional fossil fuels, renewable energies, biofuels, and regional and global energy trade flows (see the chapters by Isbell, Augé, and Bravo). "Part Two: Spotlight on the Southern Atlantic" brings together the chapters focused on Africa (Thorne and Felten, Fakir et al.) and Latin America (Cote and Langevin, Budebo, Manzano), covering renewable energy, oil and gas, regional energy integration and energy

4. See the Atlantic Energy Forum (<http://www.atlanticenergyforum.org/>).

policy and reform. “Part Three: Other Atlantic Energy Perspectives” incorporates chapters on the evolving view on European energy policy of the private sector (Salle), the sub-state level of Atlantic dynamics (Larrea and Alvarez), and the emerging role of the Atlantic energy seascape (Isbell).

While some of our authors incorporate this new Atlantic Basin perspective more deeply into their analysis than others, each provides a penetrating glimpse at an essential aspect of the newly coalescing Atlantic energy world, along with an analysis of the implications for both the broader global system and for various Atlantic actors. Even those who make no explicit reference to an Atlantic energy revolution or renaissance, an Atlantic Basin energy system or pan-Atlantic cooperative frameworks still cast their analysis in a manner consistent and compatible with such an Atlantic perspective, and they all provide important insights to be incorporated as raw material for its further elaboration.

In the first chapter, “The Atlantic Basin and the Changing Energy Global Flow Map,” Paul Isbell points out that only in recent years has the full potential force of the Atlantic energy renaissance—and the underlying structural changes it has unleashed—become perceptible. The Atlantic revolutions in shale, offshore revolution, and low carbon energy, have made the Atlantic Basin self-sufficient in energy. The historic East-to-West global net energy flows have been reversed in the last few years to become net Atlantic energy exports to Asia-Pacific, and by 2035 the Atlantic Basin will provide about one third of the total Asian demand call on global energy supply. Furthermore, despite the emergence of China and the Pacific Basin, the Atlantic energy space remains the most highly interconnected on the global energy flow map, suggesting much potential for pan-Atlantic energy cooperation. This will be needed, according to author, if the new pan-Atlantic risks posed by the Atlantic revolutions in shale and the offshore—the coalescing Atlantic energy seascape—are to be successfully addressed and their opportunities harnessed.

Chapter Two deals with the African hydrocarbons boom and its impact on Atlantic Basin energy and energy relations with the extra-Atlantic. Benjamin Augé points out that this African (and more broadly speaking Southern Atlantic) energy boom has often been pio-

neered by so-called junior companies, smaller firms often run by geologists who formerly worked for the so-called majors (the larger companies that invest the most in the upstream), but who tend to exhibit more risk appetite, particularly in deep offshore exploration, for example, than their larger counterparts. Auge examines the uniquely Atlantic development of the mirror theory which geologically points from one discovery in the deep offshore on one side of the Southern Atlantic to the discovery of twin deposits on the other, strengthening the already deepening energy linkages across this part of the Atlantic energy space. Yet, the shale revolution has rearranged internal Atlantic energy flows, allowing for growing exports to Asia from the Southern Atlantic. Until now no political vision has been developed to help the nations of these continents to work together in order to profit from each other experiences. Perhaps, the necessary relationship between consumers and producers should be replaced by another type of political development based on new partnerships. For Augé there is an urgent necessity of dialogue.

In the third chapter, Manuel Bravo reviews the biofuels scene in the Atlantic Basin, the region which dominates the global market and industry. The author presents the basic characteristics and relative advantages of first and second generation biofuels and then turns his attention to the three relevant sub-regions of the Atlantic Basin that are central to global biofuels in terms of supply, demand, and infrastructure. Brazil and the United States are rivals for the lead in both production and exportation of ethanol, while Europe is a leading producer of biodiesel, and a leading biofuels consumer as well. Brazil exhibits comparative advantage in its sugar cane variety of ethanol, although a number of African countries could become significant producers in the future. Bravo analyses the differences between these three Atlantic biofuels poles in government policy and intervention, in regulatory environments and in strategies for developing biofuels technology in the future. There is much potential for pan-Atlantic cooperation in biofuels to set global standards.

Chapter Four, “The Dynamics and Paradoxes of the Atlantic Energy Renaissance,” analyzes the potential for the three Atlantic energy revolutions (shale, offshore and low carbon) to break the dependence of Europe on the Middle East, Central Asia and Russia—the one Atlantic Basin anomaly of significant extra-regional energy dependency. Nearly

two-thirds of the world's estimated shale resources (gas and oil) are found in the broader Atlantic world, while similar levels of global off-shore production take place in the Atlantic Basin, particularly in the Southern Atlantic. These growing Atlantic sources not only have made much of the Arctic hydrocarbons potential irrelevant, they have also helped to undermine the Atlantic's low carbon revolution—particularly since the global recession began in 2008—making the Atlantic Basin's global lead in fossil fuel subsidies that much more onerous for the renewables sector and leaving the Basin, for the first time in a generation, on a path of economic re-carbonization.

Part Two opens with Thorne and Felten's chapter "Africa's Energy Scenario and the Sustainable Energy for All (SE4All) Initiative." This chapter not only brings the discussion back to the Southern Atlantic, it also puts the focus on Africa's electricity scene in general and the prospect for providing modern energy services to all, as proposed by the United Nations "Sustainable Energy for All" Initiative. This global initiative aims at three global objectives by 2030: (1) ensuring universal access to modern energy services, (2) doubling the share of renewable energy in the energy mix, and (3) doubling the global rate of improvement in energy efficiency. While Thorne and Felten stress the relevance of biomass consumption and use in Africa (including more efficient burners and stoves), they also advocate the development of renewable energies, particularly in mini hydro, solar photovoltaic, and the development of off-grid or mini-grid technologies. The authors also bring attention to the necessity of capacity building, technology transfer and support for the technological and infrastructure development of the energy system. In this respect, the Atlantic Basin and the Atlantic Basin Initiative may play a role in the contribution to more progressive universal access to modern energy services in Africa.

The sixth chapter by Saliem Fakir, Manisha Gulati, Louise Scholtz and Ellen Davies, "South Africa, Africa's Energy Future and Regional Economic Integration—Energy as a Way to Power Change," focuses on the role that South Africa can play across the continent as a key leader in the construction of a sustainable modern energy economy in Africa. South Africa accounts for nearly thirty percent of the continent's primary energy production and has higher levels of access to modern energy sources than the rest of the continent. Traditional biomass, for example, accounts for only 15% of the energy mix compared

with 47% across Africa. South Africa has nearly ninety percent of the proven coal reserves in the continent, and has the greatest installed capacity and production of electricity in sub-Saharan Africa. In this respect South Africa has a key role to play in supporting a more integrated or regional approach to energy supply in the Southern African region (and the energy integration experiences in other parts of the Atlantic Basin can be useful for improving the development of power pools in Africa). Certainly South Africa has an important role, at pan-African level, in the integration and development of international and transnational energy linkages within and across the Southern Atlantic. However, South Africa faces its own challenges, including shortcomings in its energy strategy, policies and universal energy access program. But the country's energy reserves, key skills in areas related to energy, know-how in the modernization of energy systems, experience in managing large grids and electrification systems and the increasing role of renewables in the South African energy mix suggests that there is a good basis upon which South Africa might play a role in the development of new international energy cooperation mechanisms, in Africa and across the Atlantic Basin.

Cote and Langevin underline Africa's growing links to the Latin American rim of the Atlantic Basin (particularly Brazil) in Chapter Seven, "Brazil and Africa: Integration and Development through Expanding Energy Linkages." As the authors point out, Africa—if counted as a single trade partner—is Brazil's forth commercial partner only behind China, the U.S., and Argentina. Brazil's initial energy linkage to Africa began with its own search for national energy security through Petrobras exploration and production activities in West Africa. Brazil also played a contributory role in the founding and administration of the South Atlantic Peace and Cooperation Zone in 1986. Subsequently, after President Luiz Ignacio Lula da Silva took office in 2003, the Brazilian government has been active with programs to structure its south cooperation with Africa. A number of bilateral and multilateral cooperation projects have been developed in energy, financed in part by BNDES, the Brazilian State Development Bank. Brazil's large state-owned companies in hydrocarbons, biofuels and electricity (along with a growing range of private energy firms) are heavily involved in Africa. The authors believe that Brazil might collaborate with the U.S. and Europe on cooperation with Africa. Col-

laboration makes sense but sour political relations between Brazil and its northern neighbors restrict and undermine cooperation. Therefore, the Atlantic Basin Initiative and the Atlantic Energy Forum may have a role to play as a framework to facilitate energy trade and investment and for developing specific initiatives in energy access, renewable development and biofuels.

Gabriel Budebo addresses the issue of energy reform in Mexico in Chapter Eight, “The Mexican Energy Reforms.” He begins by analyzing the previous Mexican energy reform of 2008. This reform did manage to differentiate the functions of Pemex as an operator from those of the state and the regulators. However, the practical results of the 2008 reform were limited. It did not increase production efficiency or oil revenue in the interest of the country and it proved incapable of creating conditions leading to innovation, cost savings or the capacity to exploit reservoirs with lower relative profitability. Budebo also addresses the most recent 2014 reforms, particularly the issues of intergenerational balance and the potential weakening of Pemex. In his view there are three essential principles for achieving effective hydrocarbons reform. First, the sector must be opened to competition, with the state-owned company (Pemex) participating in the new framework. Secondly, Pemex should not be allowed to be critically weakened by the reforms. The State must play a more active role as an energy policy designer and be supported by strong regulatory bodies. Furthermore, according to Budebo, future prices of oil will not be forever increasing, given the shale gas and tight oil revolution, and the progress and effects of declining cost curves in renewables energies. Therefore, the present value of future cash-flows from the hydrocarbon industry must take into account these premises.

In Chapter Nine, “Managing Hydrocarbon Assets: A Comparison across the Atlantic,” Osmel Manzano attempts to determine whether or not hydrocarbons resources are being managed appropriately in Latin America and Africa. He considers hydrocarbons resources as assets, and examines the way these assets are managed. Such financial management can be analyzed using a model in which it is assumed that an asset is managed optimally when its opportunity costs equal the profits obtained from the use of the asset plus the expected change in its value. In a simplified way, Manzano conducts this analysis by observing the evolution of oil production and prices, taking into

account the opportunity cost of investment in oil, from a study sample of nineteen countries (eight in Africa and eleven in Latin America). Two different periods are identified in the chapter: 1980–1993 and 1993–2010. In the first period returns on oil extraction were around 11–15%; however, in the second period they were negative. In the first period the optimal management strategy would have suggested moving forward production and postponing any investment contracts. In this period, Latin American countries fared better. However, after 1993, the optimal strategy would have been to allow investment in long-term projects to develop future production; and African countries performed better. Therefore, Latin American was closer to an optimal strategy between 1980 and 1993, while African countries have had a more optimal strategy since 1994.

Part Three involves energy views from unique Atlantic perspectives. In Chapter Ten, Carlos Sallé assesses European energy policy and strategy to 2020 within the context of the Atlantic Basin from the private energy sector perspective. He analyses the factors that have driven changes in the energy landscape and may explain the negative results. Despite the EU's well-known 20-20-20 targets, Sallé points out that the EU has not appropriately designed its renewables and energy efficiency policy, particularly given how they interact with the design of the Emission Trading Scheme (ETS), to which coherent adjustments have not been forthcoming. Furthermore, other changes—including the significant penetration of renewable energy in Europe, the economic crisis, the development of shale and other unconventional fossil fuels, and the Fukushima nuclear accident—have conspired to work against EU energy strategy, leading to a loss of competitiveness, a weakening of investment and supply security and an erosion of European climate change leadership. To overcome such vulnerabilities, the author recommends environmental tax reform, the creation of a carbon price signal, the rationalization of electricity tariffs, and a further push to truly integrate the European energy market.

Larrea and Álvarez address the Atlantic Basin energy landscape in Chapter Eleven from the perspective of the Basque Country (an autonomous region of Spain). A distinctive aspect of the energy strategies in the Basque Country is the clear connection between energy planning, energy-related industries, and the region's innovation and technology strategies. This approach to Basque internationalization

policy may explain why the Basque country is particularly open, in terms of energy, and closely related to Europe and to the Atlantic Basin regions and countries (with which it trades some 60% of its total). In recent decades the Basque Country has transformed its energy sector, which has contributed to the development of considerable gas and electricity infrastructure. Competitive energy prices, along with security of supply, are particularly important for the Basque economy, given its dependence on energy-intensive industrial sectors and on energy imports to supply them. In this regard, energy companies have a rather diversified mix of import sources, among which the Atlantic Basin plays an increasingly important role, especially in gas. It is also possible that the Basque Country could produce unconventional gas, particularly if Atlantic Basin companies can engage in technology transfer and best-practices exchanges with their Basque counterparts. Finally, given the significant infrastructure development in gas, the region has the potential to develop into an Iberian gas hub.

Finally, in Chapter Twelve, Paul Isbell analyzes the increasing strategic significance of the global seascape in general and of the Atlantic energy seascape in particular. Multiple shifts are overlaying to turn the Atlantic energy seascape into a key region for the global map. The Atlantic energy renaissance—much of which has been driven by the expansion of offshore energy—has shifted the center of global energy supply from the Middle East, Central Asia, and Russia (the Great Crescent) into the Atlantic Basin (while the center of global demand has moved from the Atlantic to Asia). Furthermore, the historic East-to-West global energy flows of the Cold War have dried up and been reversed, reflecting growing Atlantic autonomy in energy, generating more intra-Atlantic energy flows and changing the flow circuits of Atlantic energy transport. Finally, at the same time, the center of gravity of human political economies in general are shifting from the landmasses into the ocean basins.

Comments on the Recent Decline in Oil Prices

Most of the chapters in this book were written by the summer of 2014, when oil prices were around \$100/bbl, and submitted in September 2014, when the recent decline in oil prices was only beginning. As a result, some reflect a point of view that is pre-price decline; how-

ever, the editors have attempted to eliminate obsolete references or claims which would now be inconsistent, irrelevant or simply incorrect. However, it is possible that some of these pre-price decline references remain. Therefore, the entire book should be read taking this into account.

Nevertheless, the Atlantic energy renaissance is not dependent on oil prices at or above \$100/bbl. Although a long period with prices at their current levels—around \$50-\$60/bbl—would price out much of the Atlantic Basin's new potential supply from the market, it is far more likely that prices will actually stabilize within a higher range, somewhere between \$60 and \$80/bbl, over the next year or two.

This was the range to which the growing consensus of market opinion—back in the spring and summer of 2014—foresaw the price eventually softening. What was unforeseen was the timing and abruptness of the fall, and the extent of what appears to be a noticeable overshoot. The analysis in Chapter One, for example, assumed relatively stable mid-term prices around \$80/bbl. Furthermore, this level, if perceived to be a relatively stable long-term band, would be high enough to support most of the Atlantic Basin's recently discovered potential.

Finally, it is also important to note that the growing supply in global energy markets which have led to downward pressures on prices, both in oil and gas, has been coming nearly exclusively from the broad Atlantic space. In other words, the Atlantic energy renaissance has produced a boom in supply (and expected supply) which is, at the margin, almost exclusively responsible, on the supply side, for the recent collapse in oil prices which in turn threaten to economically marginalize some of the more relatively expensive forms of newly identified Atlantic energy supply. This upper fringe of more expensive Atlantic energy supply typically only includes the most recent finds in unconventional and offshore fossil fuels or renewable energy technologies which are still pending crucial innovative breakthroughs.

In other words, the underlying structural change has been the Atlantic energy renaissance, while the recent price collapse has been its short-to-mid-term cyclical effect. Furthermore, at mid-to-long-term prices of \$80/bbl, the center of gravity of global energy supply remains in the Atlantic worlds.

Part I

**The Atlantic Basin
on the Global Energy Map**

Chapter One

An Introduction to the Future of Energy in the Atlantic Basin

Paul Isbell

The Atlantic Energy Renaissance

A new Atlantic Basin is emerging, and energy is one of its principal driving vectors.¹ Indeed, an Atlantic energy renaissance has already been underway, unobtrusively, for nearly a generation. Only in the past few years, however, has the full potential force of such an underlying structural strategic change become perceptible.

New players and technologies have recently emerged to notably alter both the Atlantic Basin and global energy maps, as new conventional and unconventional fossil fuel sources and new alternative low carbon energies come online—and as opportunities for pan-Atlantic energy cooperation begin to emerge. This transformation of the Atlantic energy space is now unfolding across sectors and segments, among public and private actors, and all along the energy value chain. Most importantly, this Atlantic energy renaissance is emanating from both the old North and South Atlantics—not just from the United States, where it has been most loudly trumpeted for its assumed potential to finally secure national energy independence.

In the Northern Atlantic, the shale revolution is indeed radiating out from an increasingly less import-dependent North America.² As

1. Along with economic (trade, investment, and finance), human security, sustainable development, ocean/marine, and other cultural and governance dynamics. For more on these other Atlantic drivers, see the Eminent Persons Group of the Atlantic Basin Initiative, “A New Atlantic Community: Generating Growth, Human Development and Security of the Atlantic Hemisphere: A Declaration and Call to Action,” a White Paper of the Atlantic Basin Initiative, Center for Transatlantic Studies, School of Advanced International Studies, Johns Hopkins University, March 2014. See: <http://transatlantic.sais-jhu.edu/events/2012/Atlantic%20Basin%20Initiative/Atlantic%20Basin%20Initiative>.

2. Elizabeth Rosenberg, et al., *Energy Rush: Shale Production and U.S. National Security*, Center for a New American Security, February 2014, and Center for Strategic and International Studies (CSIS), *New Energy, New Geopolitics: Balancing Stability and Leverage*, April 2014.

recently as early 2013, the International Energy Agency (IEA) expected the United States to overtake Russia in 2015 as the leading producer of natural gas, and to overtake Saudi Arabia in 2017 as the world's leading producer of oil. However, the latter is happening this year, in 2014, and the former is about to occur. By 2019, the IEA projects the United States will be producing over 13.1 million barrels per day (mbd)³. Already, the United States has become a major net exporter of refined petroleum products.⁴ Meanwhile, natural gas production is up 40% in the United States since 2005. In 2012, shale gas accounted for 37% of U.S. natural gas supply, up from only 2% in 2000⁵. By 2040, upwards of 50% of U.S. natural gas production will be unconventional.⁶

The implications have quickly rippled across the Atlantic energy space to Europe, where displaced U.S. coal has been backing out renewable energy and competing downward, to some extent, the price of Russian gas for Europeans.⁷ The paradoxical result, at least so far, has been a relative undermining of Europe's vital role in the parallel low carbon revolution, which it has led for two decades from its position in the northern Atlantic. This recent Atlantic Basin dynamic has intensified the energy dilemmas perceived by the EU—whose member states are, on the one hand, relatively import-dependent (particularly on Russia, Central Asia, and the Middle East),⁸ but also, on the other hand, relatively environmentally conscious (particularly of climate change, but also of the potential dangers of fracking).

3. Grant Smith, "U.S. Seen as Biggest Oil Producer after Overtaking Saudi Arabia," Bloomberg, July 4, 2014. (<http://www.bloomberg.com/news/2014-07-04/u-s-seen-as-biggest-oil-producer-after-overtaking-saudi.html>).

4. Energy Information Administration (EIA), "U.S. Petroleum Products Exports Exceeded Imports in 2011," (March 7, 2012), <http://www.eia.gov/todayinenergy/detail.cfm?id=5290> (EIA 2012b).

5. Steven Mufson, "Shale Gas Reshaping the U.S. Industrial Landscape," *Washington Post*, November 15, 2012.

6. Center for Strategic and International Studies (CSIS), *New Energy, New Geopolitics: Balancing Stability and Leverage*, April 2014 (CSIS, 2014).

7. Steven Mufson, "Turning the Tankers Around," *Washington Post*, December 9, 2012, p. G1. (Mufson 2012).

8. Directorate-General for Energy, "Key Figures," Market Observatory for Energy, European Commission, June 2011. (EC, 2011) and British Petroleum, *Annual Statistical Review of Energy* (Database) 2013 (BP 2013a).

However impressive the shale revolution in the Northern Atlantic has been, the deep-water offshore boom in the Southern Atlantic preceded this North American contribution to the Atlantic energy renaissance, and continues to rival it. Catalyzed by pre-salt discoveries in Brazil (by themselves potentially as high as 50 to 200 billion barrels) and the development of the deep offshore in Angola and elsewhere in the Gulf of Guinea and along the West Africa Transform Margin, the offshore revolution has embraced nearly all of Africa and most of Atlantic Latin America.⁹

Over the last decade, investment in offshore oil exploration and production (E&P) has generated something akin to a Southern Atlantic oil ring with offshore E&P on the rise from Namibia to Morocco in the East, and from Argentina to the Gulf of Mexico in the West. Of the 210 billion U.S. dollars in expected capex investment in global offshore hydrocarbons between 2011 and 2015, over 80% will take place in the Atlantic, and over two-thirds of that in the Southern Atlantic. Already, Southern Atlantic offshore oil reserves (130bn barrels) dwarf those of the Arctic (90bn barrels).¹⁰ In fact, the Southern Atlantic could become the key new region at the margin for increases in global oil production, as well as the most critical regional supplier of oil at the margin to Asia-Pacific (see more on this below).

At the same time, through its myriad public, private, and civic actors, the Atlantic Basin is currently spearheading (however insufficiently) global technological and governance efforts to provide sustainable, low emissions energy access for all (as in the United Nations SE4All Initiative), and to avoid the worst aspects of climate change (as in the United Nations Framework on Climate Change Convention's goal of defending the 2-degree guardrail). The first full blooming of the low carbon revolution has unfolded within the Atlantic Basin, where two-thirds of renewable energy generation now takes place and where a similar share of global installed renewable capacity is currently located. Although much of this has been deployed in the Northern Atlantic, renewable energy is now finding more fertile terrain in Latin America and Africa,

9. Paul Isbell, *Energy and the Atlantic: The Shifting Energy Landscapes of the Atlantic Basin*, Washington, D.C.-Brussels, The German Marshall Fund, 2012. (Isbell 2012a).

10. IFP Energie Nouvelle, "Panorama 2012: A Look at Offshore Hydrocarbons," 2012 (IFP Energie Nouvelle 2012).

where global institutions and the regional development banks are now placing the priority for their low carbon, energy access, and sustainable development goals. Nevertheless, continued growth of low carbon energy has been at least partially undermined by the recent boom in unconventional fossil fuels. Indeed, business-as-usual projections see Atlantic Basin oil accounting for nearly two-thirds of the growth in global oil production to 2030, even as the Atlantic is now projected to de-carbonize its energy mix at a slower rate than the rest of the world, particularly the Asia-Pacific region.¹¹

The Shifting Global Energy Flow Map and the New Atlantic Center of Gravity

The Atlantic energy renaissance is not occurring in a vacuum; nor is it completely free of contradictory tendencies. The sometimes competing or colliding energy revolutions of the Atlantic energy renaissance—shale, offshore, low carbon—have contributed to a redrawing of the global energy map. In stark contrast to the expectations of the reigning conventional wisdom—still adhering to a once valid, but now increasingly obsolete, global energy map of the past—the Atlantic energy renaissance is now beginning to challenge the long-held assumption that the global center of gravity for energy supply, particularly in the fossil fuel realm, would remain firmly rooted for the foreseeable future in the Middle East, Central Asia, and Russia—what we call the Great Crescent on our new global geopolitical, governance, and energy maps. As Atlantic hydrocarbon reserves and production continue to increase over the coming decades, and as Asian energy demand continues to grow, the respective centers for global energy supply and demand are shifting, such that global energy flows will continue to be significantly altered.

In strategic terms, the Atlantic energy renaissance is emblematic—even part and parcel—of a number of deeper, globally-reaching tectonic shifts now convulsing the global energy flow map. These global—but also Atlantic shaped and Atlantic shaping—trends include:

11. Based on projections from British Petroleum, *Energy Outlook 2035* (Database) 2015 (BP 2015) and own elaboration.

A westward shift in the global center of gravity for energy supply into the Atlantic Basin, driven by recent, significant expansion in Atlantic energy resources—in particular, shale in the Northern Atlantic and offshore oil and gas in the Southern Atlantic. The Atlantic world already holds over 40% of proven global reserves of petroleum, and upwards of two-thirds of broader (not yet economical) oil resources (including unconventional oil and the deep offshore). The Atlantic also contributes 46% to daily oil production. This share is projected to rise to 49%—as over two-thirds (71%) of the projected growth in global oil production from 2010 to 2035 will take place in the Atlantic Basin.¹²

Beyond 2030, gas will begin to replace oil within the global energy mix and upon the global energy seascape—and by 2050 gas will have almost completely displaced oil to account for 80% of globally traded energy, with most of it transported across the global energy seascape.¹³ Because the Atlantic Basin is potentially even more central on the future gas map than oil—with two-thirds of the world's estimated shale gas reserves and nearly half of all technically recoverable gas resources (TRR)—future Atlantic gas production will extend and reinforce the supply-side of currently emerging West-to-East global energy flow circuits (and lending momentum to the overall seascape centers of gravity now slipping into the Atlantic Basin; see Chapter Twelve).¹⁴

An eastward shift in energy demand into the Asia-Pacific region (but also into the Great Crescent). This trend has been—and continues to be—driven by: (1) structural declines in Atlantic Basin energy demand (from reduced energy intensity and enhanced energy efficiency stemming from economic maturity and technological change); and (2) structural increases in Great Crescent and Asia-Pacific demand, (in part the product of an ongoing, decades-long, eastward shift in the center of gravity for manufacturing output from the northern Atlantic to Asia-Pacific). Nevertheless, global energy demand is projected to more than double by 2050. For its part, the Atlantic Basin will slip from contributing 45% of global energy demand in 2010 to only 39%

12. British Petroleum, *Energy Outlook 2035* (Database) 2015 (BP 2015).

13. IIASA GEA Model Projections Database, 5013, 2014 (<http://www.iiasa.ac.at/web-apps/ene/geadb/dsd?Action=htmlpage&page=about>) (IIASA, 2014).

14. Energy Information Agency (EIA), “Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States” June 2013 (EIA, 2013).

by 2050. Meanwhile, the relatively energy short extra-Atlantic region, particularly Asia-Pacific, is set to increase its contribution to global energy demand from 55% in 2010 to 61% in 2050.¹⁵

A continual drying up of the traditional post-World War II pattern of net westward global energy flows and their subsequent reversal to become net eastward—or Asia-bound—global energy flows (or West-to-East flows). This is due to the fact that the traditional, historical pattern of Atlantic Basin demand depending on surplus Great Crescent supply is continuing to evaporate. Over time, the Atlantic Basin will become increasingly energy autonomous—in net terms—and Atlantic energy exports, at the margin, will increasingly flow eastward, bound for Asia-Pacific.

These shifts in global energy flows represent a transformation of what could be called the Traditional-Cold War global energy map into the newly emerging global energy flow map of the 21st century. On the Cold War map of the past, for nearly half a century the Northern Atlantic was highly dependent on the Great Crescent for westward energy flows—both land-based and seaborne, but principally and increasingly the latter—with the Strait of Hormuz and the Suez Canal representing the key chokepoints on the map, although with time a growing flow moved out of the Persian Gulf eastward to an early emerging Asia-Pacific, lending the Straits of Malacca their increasing relative strategic significance.¹⁶

15. IIASA GEA Model Projections Database, 2013, 2014 (<http://www.iiasa.ac.at/web-apps/ene/geadb/dsd?Action=htmlpage&page=about>) (IIASA, 2014).

16. More than 17mbd of oil pass through the Straits of Hormuz, at the mouth of the Persian Gulf—meaning 17 million barrels of oil every day. This is equivalent to 35% of all seaborne oil trade, and nearly 20% of globally produced oil (BP2013a, EIA 2012). More than 85% of it is now going to Asia (India, China, Japan and South Korea), and by 2035 nearly all of it will be Asia-bound. Well over 75% of the oil moving through Hormuz daily also passes through the Strait of Malacca in Southeast Asia. Approximately 15mbd pass through Malacca daily—including the bulk of the Hormuz oil and some additional flows coming from West Africa around the Cape Passage on their way to the Far East. The shut-down of either of these straits—or both—would take more oil off the market than is currently produced by Saudi Arabia (perennially around 9mbd-10mbd). The pipeline links between the Gulf countries and the Mediterranean or Red Sea are minimal—at most 4mbd of spare capacity (EIA 2012)—and would take years and many billions of dollars to build new sufficient excess pipeline capacity capable of fully backing up the Strait of Hormuz.

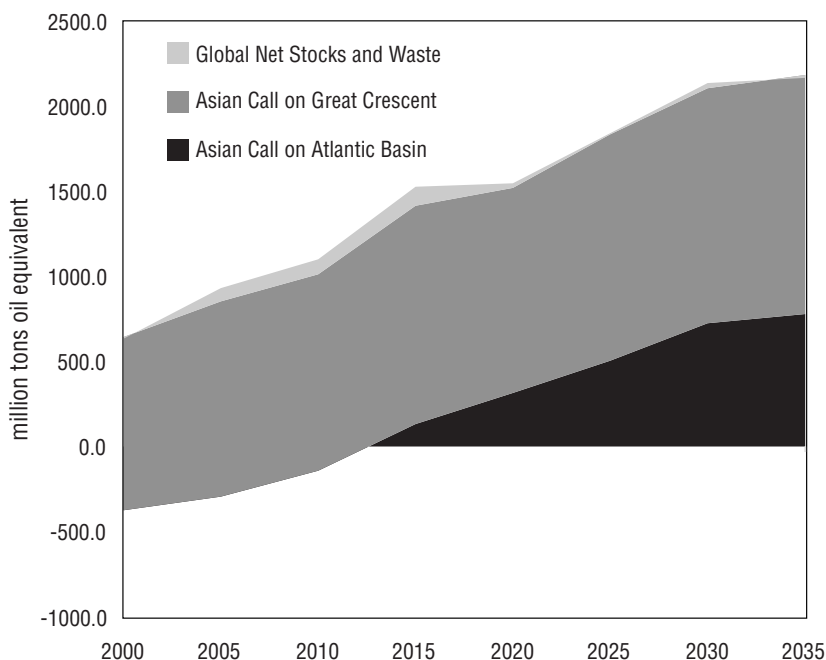
In stark contrast, on the newly emerging global energy flow map, Asia-Pacific is increasingly dependent, at the margin, on eastward (or at least Asia-Pacific bound) seaborne oil and gas flows out of the Atlantic Basin—and increasingly out of the Southern Atlantic. The majority of these growing energy flows follow a flow circuit out of the Southern Atlantic, around the Cape of Good Hope and across the Indian Ocean Basin to India, through Southeast Asia and its multiple straits, and into the contested rim land seas of the Pacific (i.e., the South and East China Seas). While the Hormuz-Malacca energy flow circuit remains crucial, so too now becomes the Cape Passage and the East African sea lanes, while the Suez Canal loses in relative global strategic importance (See Part Three: The Emergence of the Seascape).

The bottom line, in strategic terms, is that seaborne oil and gas flows will increasingly reverse their overall net direction (Emerson 2014)—from Cold War East-to-West flows to the new 21st century West-to-East flows. As a result, the Atlantic Basin (with the Southern Atlantic potentially playing a key role) will become the strategic hydrocarbons supplier-region at the margin for growing energy consumption in Asia-Pacific.

In this regard, it is striking to note that only a decade ago, nearly all projections of global energy supply and demand (whether from the IEA, the EIA, OPEC or the World Energy Council) foresaw increasing global energy demand at the margin being met entirely by the Middle East (and, in particular, by Saudi Arabia). Yet today, in stark contrast, the Atlantic Basin already supplies a growing portion of that same total, now increasingly concentrated in the Asia-Pacific region—and by 2035 the Atlantic Basin is projected to provide over one-third (see Figure 1). Nothing could more synthetically and emblematically reflect the reality of the Atlantic energy renaissance—both its causes and its effects—than this singular and dramatic shift in the global energy flow map.

This refers to all traded energy, including oil, gas and coal, in million tons of oil equivalent annually. 50 million tons of oil (equivalent) annually is equal to approximately one million barrels a day of flow (or 1mdoe). 500mntoe = 10mbdoe, roughly.

Figure 1. Absorption of the Asian Call on Global Energy by region, Atlantic vs Great Crescent, 2000–2035



Source: *BP Energy Outlook 2035*, January 2015 and author's own analysis.

A New Projection of the Global Energy Flow Map

Provoked by the many of the empirical realities of the Atlantic energy renaissance mentioned above, this analysis of Atlantic energy has been conducted by re-projecting the world map, in general, and the global energy flow map, in particular, into three major regions: (1) the Atlantic Basin, (2) the Great Crescent, and (3) Asia-Pacific.

In this projection, the Atlantic Basin includes Africa, Latin America and the Caribbean, North America, and Europe, incorporating these four Atlantic continents in their entirety, along with their ocean and islands. The Great Crescent groups together the traditional 20th century suppliers of hydrocarbons: Russia, Central Asia (or the ex-Soviet Union), and the Middle East—a region which arcs in a great crescent from Southwest Asia across the northern half of the Asian continent.

Asia-Pacific is already a standard regional categorization—in contrast to the two other new units of analysis—and is comprised of what are commonly referred to as the sub-continental regions of South Asia, Southeast Asia, and East Asia, together with the islands of the Indian and the Pacific oceans, including Australia and New Zealand.

Such an Atlantic Basin projection provides a strategic cartographic tool with which to nudge our currently reigning geopolitical and energy maps away from their overwhelmingly national, continental, and land-based focuses and framings—which allow us to easily see the shale revolution in the U.S., but not necessarily an Atlantic energy renaissance—and towards a more universally-applicable and more fully-fledged ocean basin projection of our global mental maps—one more in line with the emerging characteristics on the actual map (like the emerging Atlantic energy seascape). What the Atlantic Basin projection can reveal (and the current maps cannot) is the totality of the Atlantic energy renaissance, as opposed to just one of its component dynamics (like the Brazilian pre-salt, or African energy boom, or the recent setbacks of renewable energy in Europe, or the shale revolution in the U.S.).

Starting with the same existing national and regional energy data from the same standard international sources (the International Energy Agency, the Energy Information Agency, British Petroleum, and other public and private sources), this Atlantic Basin projection re-cuts (or re-groups) these data into new regional categories, or units of analysis. Much as a new cartographic projection of the world map takes the same data—the geographical and positional facts of the planet—used in previous projections of the map, but then reveals a new world by altering the formulas of its framing and focus, this new Atlantic Basin projection—the equivalent of a new geopolitical cartographic projection of global geopolitical and energy flow maps—reveals a fresh vision of the strategic horizon, spotlighting strategic trends—like the Atlantic energy renaissance—which cannot be readily identified on the currently predominant and land-dominated versions of our global geopolitical and energy maps—simply because their focus and framing do not allow for it.

Furthermore, the Atlantic Basin projection also allows us to map the empirical realities of the Atlantic energy renaissance in their true

global context. In other words, not only does the Atlantic Basin projection allow us to perceive the totality of the Atlantic energy renaissance more clearly than our currently dominant global framings, but it also reveals that the global center of gravity for energy supply is shifting into the Atlantic Basin and that the center of gravity of the global energy seascape is also beginning to overlay with the Atlantic energy seascape. Therefore, the Atlantic Basin projection also begins to reveal the logic and potentials of pan-Atlantic energy cooperation. Such trends and potentials simply cannot be identified clearly on the strategic horizon using the framings of our currently predominant maps (real and mental).

Towards an Ocean Basin Projection

In the end, however, even this Atlantic Basin projection leaves two of its three major regions to be defined primarily by their landmasses (the Great Crescent and Asia-Pacific), and thus still ignores the increasingly binding, connecting, generating and re-generating seas (i.e., the Indian, Pacific, and Arctic oceans) between their landmasses. As a result, this projection only fully captures the potentials of one of the emerging ocean basin regions (the Atlantic Basin and its potential for pan-Atlantic energy cooperation). The partial exception would be Asia-Pacific, which comprises various landmasses separated (and therefore connected) by various seas (unlike the Great Crescent which is comprised of contiguous landmasses), and therefore constitutes something of a hybrid terrestrial-maritime region. As a result, this Atlantic Basin projection (essentially half ocean-basin-based, and half landmass-based) does capture the key maritime trends on the energy seascapes along the maritime rim lands of the Great Crescent and Asia-Pacific (for example, the all-important Hormuz-Malacca energy flow circuit).

However, the ocean basins are not just increasingly the spaces of binding dynamics in trade and other material flows like energy, their seas are also rapidly becoming conceptual binders as well. In fact, the ocean basins are on their way to representing the most relevant geo-economic and geopolitical configuring frames of ongoing globalization, both its promise and its peril. This Atlantic Basin projection therefore remains only partial, demanding a more complete ocean-

basin-based cartographic re-mapping of the strategic horizon. Such an ocean basin projection would likely reveal what might be the actual pattern of globalization that has been unfolding for the last 30 years or more through the material expressions of certain dominant initial tracks of ocean-basin based regional cooperation—trade in the Pacific Basin (as in APEC and TTP), energy in the Atlantic Basin (as in the Atlantic Energy Forum of the Atlantic Basin Initiative), security (in its multi-faceted expression) in the Indian Ocean Basin, and ecological and maritime security in the Arctic (as in the agenda of the Arctic Council). While the Atlantic Basin projection reveals the potentials of ocean basin regional cooperation in the Atlantic Basin, an ocean basin projection would reveal the potentials (or lack of them) for ocean basin-based regional cooperation in the other basin regions, as well, including the Indian Basin, the Pacific Basin, and the Arctic Basin.

However, producing an ocean basin projection of the global geopolitical and energy flow map is a task that lies somewhere and sometime beyond the constraints of this paper. It would require an even deeper re-cutting of current data to account for a number of geographical realities of the world's ocean basins. Continental data categories would need to be split between the ocean basins and their shores. This raises the question of how to accurately reflect basin positioning of dual basin countries (with coastlines on more than one ocean basin, like the U.S., South Africa, or Indonesia; and of land-locked countries). Therefore, an ocean basin projection implies a much larger data and methodological challenge than does the Atlantic Basin projection.

Yet even this partial, modified projection of our dominant global maps offered here, the Atlantic Basin projection, still problematizes not only the notion of the Asian century and the foreign policy formulations of the pivot, but also the strategic horizon of the very industry—hydrocarbons—upon which rests the currently emerging global energy flow map. The future ocean-basin map of the future could reveal much more—perhaps even the stepping-stone, labyrinthine pathway through the geopolitical jungle to effective and sustainable global governance. Still, even by partially correcting the framing and the focus, assessing recent changes on the global energy flow map through the lens of a pan-Atlantic perspective reveals a startlingly new picture.

Chapter Two

The African Hydrocarbons Boom: Its Impact on Atlantic Basin Energy and Energy Relations with the Non-Atlantic World¹

Benjamin Augé

Over the past decades the oil sector has changed drastically, thanks to geologists who placed their trust in the potential of new zones that had long remained underexplored. The increase in the price of Brent crude after 2003 (rising from \$28/bbl to \$94/bbl by 2008, and then climbing to \$110/bbl in 2012) helped oil firms raise funds to explore new regions and allowed them to take more risks. This relatively high price level resulted from several geopolitical disruptions which continue to have global repercussions. These have included: (1) the Iraq war; (2) rising tensions with Iran over its nuclear program; (3) Venezuela's massive strike in 2006 and its long-term effects; (4) the wave of violence since 2006 in Nigeria's Niger Delta; (5) recurring terrorist attacks in Saudi Arabia; and (5) Hurricane Katrina in 2005, among others. In any case, the seemingly-secular rise in the price of oil in the past decade reflects, to a large degree, a thirst for oil in emerging countries, particularly in China and India. By 2012, the worldwide market was demanding 10 million more barrels per day of oil (mbd) than it had a decade earlier, bringing total global oil demand to its current level of 90 mbd.

Editor's note: this chapter was written when oil prices were around \$100/bbl—before their recent decline. Although a long period with prices at their current levels—\$50-\$60/bbl—would price out of the market much of Africa's new potential supply—the central subject of this chapter—it is likely that prices will actually stabilize within a higher range, somewhere between \$70 and \$80/bbl. This level would be high enough to support most of Africa's recently discovered potential. The remainder of this chapter should be read taking this into account.

1. This chapter is the product of several field trips in Africa since 2007 on which the author conducted hundreds of interviews with different types of actors: oil executives, ministers, NGO's, political party members in power or from the opposition, journalists, academics, ministers, advisers, etc. The limited bibliography, apart from the Energy Information Administration and European Commission figures, can be explained by the forward-looking issues explored. Geologists are pioneers, and academic researchers have no other choice than to follow them.

Not only did the higher barrel price provide new funds to the majors who have operated in Africa since before the independence era of the 1950s-70s, but it also paved the way for the entry of new kinds of companies, a trend which has significantly accelerated African hydrocarbons exploration since 2003. The first new type of actor is the so-called junior—a small or medium sized company, often founded by ex-major executives or geologists with a pioneering mindset. Another driving force behind African exploration has been the state-owned firms (and in some cases even private companies) coming from countries that have traditionally not invested significantly in Africa—Brazil, Russia, China, India, Malaysia, South Korea, Indonesia, Thailand, and Japan. While the goal might be the same for all such actors (majors, juniors, local, and foreign state firms)—that is, finding, producing and selling the precious crude—their strategies remain quite different.

- Oil majors—the one-time sisters: ExxonMobil, Royal Dutch Shell, Chevron, BP, and, by some counts, Total—have invested billions of dollars in countries with which they are familiar (Nigeria, Angola, Gabon, Congo, Equatorial Guinea, Chad, etc.) without taking on too much new additional African risk.
- On the contrary, the juniors—small and often midsized firms, like Tullow Oil and Marathon, among others—have pioneered and unlocked new and previously unknown or shunned terrains: in Mauritania and Namibia, at the margins of Atlantic Africa's rich oil littoral; in Sierra Leone, Liberia, Ghana, and other small countries along the West Africa Transform Margin; and in East Africa (Uganda, Tanzania, and Mozambique), a region once forgotten by the hydrocarbons industry.
- Other outside oil companies—particularly (but not exclusively) state-owned firms from Asia—have merely developed basins that had already been discovered but which had not yet been deemed politically safe or economically profitable, at least not when the barrel price was too low to justify investment in landlocked fields in places like Sudan and Niger.

In this regard, Tullow Oil represents a unique case. Formed in 1985 by Irish accountants and geologists, this company has subsequently taken great risks, allowing it to discover the first-ever commercial oil in Ghana, Uganda, and Kenya. State firms and majors rushed in to

purchase equity at high prices on the same blocks where this junior (now considered a mid-cap) had made the discoveries. Indeed, a whole class juniors like Tullow are now assuming the first risk by digging underexplored areas. When they make successful discoveries they call upon the majors to gain access to the larger financial resources needed to develop the reserves.

For their part, the majors have increasingly acted like banks and developers whereas juniors have behaved as pioneers and the principal explorers in Africa and in certain areas of Latin America—trends which I discuss in this chapter. In the end, all of the actors mentioned above—majors, juniors and other state-owned firms from Asia—tend to work together. An emblematic example can be found in Uganda, where in 2010 Tullow selected the French major, Total, and the state-owned Chinese firm, the China National Oil Offshore Corporation (CNOOC), to develop a 1.7 billion barrel project in the Lake Albert area. Today, more than 40 countries in Africa (out of a total 54) are currently in exploration, thanks to hundreds of firms eager to find new oil.

Oil discovery has always had immense local and national consequences, but it can also significantly influence the international crude oil market. Discoveries can depress the oil price, but then can also help a country to become energy independent. This may not be a major concern for countries that have only a limited demand for oil; however, when the state in question is the biggest oil and gas consumer on the planet, the implications can be numerous. The gigantic shale oil and gas discoveries in the United States helped the country—which consumes 18.5 mbd—to increase its oil production by 2 mbd between 2005 and 2012 and simultaneously boost its gas output by 170 billion cubic meters.²

As the U.S. gradually depleted its conventional oil and gas reserves at the end of the last century, the country engineered a complex strategy to guarantee that its enormous energy demands could be secured. One part of this strategy, particularly after September 11th, was to increasingly rely on the supplier countries of Atlantic Africa's Gulf of Guinea. This chapter examines the direct implications of America's unconventional discoveries of oil and gas on Africa, in both economic

2. BP *Statistical Review of World Energy* 2013.

and diplomatic terms, and attempts to forecast where these spare hydrocarbons might go in the future.

Oil discoveries on the American side of the Atlantic Basin can have direct implications for Africa or Europe—the old world littoral of the Atlantic Basin—in terms of crude supply; but there is also an Atlantic rationale that has recently come to increasingly drive oil exploration. A million years ago, Africa and Latin America used to belong to one single continent; only recently did geologists start to explore this historical fact. Now that oil companies found oil on one side of the Atlantic basin, they are keener to explore the other side as well. This phenomenon—the mirror image theory—will also be analyzed in this chapter. The two shores of the Atlantic Basin are becoming increasingly interconnected, and the relevant actors are gradually coming to understand the need to work together in light of the mutual benefits that such deepening energy cooperation would bring. This development has so far been driven primarily by private entities, but it might be time for political bodies to consider designing a coherent strategy that would benefit all parties involved in the energy space of the Atlantic Basin.

The Impact of U.S. Shale Gas and Oil on Hydrocarbon Exports from the Gulf of Guinea

The United States has always been particularly preoccupied its energy security. Following the first petroleum shock of October–December 1973, Henry Kissinger, as President Richard Nixon’s Secretary of State, became the driving force behind the creation of the International Energy Agency (IEA). Based in Paris as part of the Organization for Economic Cooperation and Development (OECD), the IEA has been—and continues to be—shaped to represent the oil importing nations as a self-conscious counterbalance to the weight of the Organization of Petroleum Exporting Countries (OPEC), created by the Persian Gulf, the Maghreb and Venezuela in 1960. In 1971, the United States had reached its then-historical peak in oil production, and Kissinger was well aware that his country would be in need of crude from the Persian Gulf, Canada, Mexico, and Venezuela. Controlling the oil output in most OPEC states was impossible due to the nationalizations of the 1970s (and of 1938 in Mexico), but the IEA was

tasked with avoiding market shortages that would automatically increase the price of the crude and directly impact American and other IEA member economies.

Forty years after Kissinger's move, the United States faces a very different situation as it suddenly finds itself on the way to possibly becoming energy independent in the future and almost certainly a net exporter of gas. Shale gas has allowed the U.S. to produce roughly 40 additional billion cubic meters per year since 2010 and to double its reserves from 4.7 trillion cubic meters in 1992 to 8.8 trillion cubic meters in 2012. On the oil side of the equation, the increase of reserves and production has been less spectacular, but significant in any case: extending from 30 to 35 billion barrels from 2002 to 2011, with a daily production increase from 6.9 million barrels in 2005 to 10 million barrels in 2013.³ All these figures will surely rise in the coming years, but the long-term pace of the increase in oil and gas production capabilities in the United States still remains unclear. (Much will depend, however, on how high or low global oil prices finally settle.) Nonetheless, shale oil and gas have already had a significant impact on the other side of the Atlantic Basin in Africa.

The Consequences of U.S. Shale Gas for Africa

One project in particular to suffer a major setback due to recent hydrocarbon exploration by the United States has been Angola Liquefied Natural Gas (LNG). Angola is the second largest producer of oil in Africa (1.8 mbd), but in terms of gas the country also lags behind Nigeria, which has exported gas as a commodity on the international market since 1999. For a number of years after the conclusion of the civil war in Angola in 2002, no company wanted to take on the additional risk to invest in a significant onshore plant to liquefy the associated gas of the offshore oil blocks. But in 2008, Chevron created the Angola LNG Company with the help of Sonangol (Angola), ENI (Italy), BP (United Kingdom), and Total (France). The plant, located in Soyo (Zaire Province in the north) was commissioned in 2013, with its first shipment sold to Brazil. However, the output of Angola LNG was initially intended to be sold entirely to the Mississippi Pascagoula terminal in the U.S.—at least until the shale gas boom occurred.

3. BP Statistical Review of World Energy 2014.

Sonangol U.S., the affiliate of Angola's national utility, had purchased 20% of the Pascagoula terminal to secure its position, but in 2011 the decision was taken to sell its shares to its partners El Paso and GE Energy Financial Services.⁴ The difficulty for Angola LNG since then has been to find long-term customers willing to accept a contract similar to the one the consortium had secured with Pascagoula terminal. This has not yet happened (as of the fall of 2014) and Angola LNG is selling its cargos one by one under spot contracts. Such contracts are profitable in terms of price because Asian buyers are willing to pay a higher price per British Thermal Unit (BTU) than U.S. customers, but there is no certainty with respect to volume. So far, Angola LNG has only managed to sell a couple of cargos to China, Malaysia, India, and Latin America (Uruguay and Brazil). Given that North America might become an energy exporter, all of the new regasification terminals are currently requesting permission from the U.S. government to convert into liquefaction plants (as in the case of Pascagoula) for the export of LNG.

One other consequence of these additional capacities in the United States has been the delay of greenfield LNG projects. Two cases from Nigeria—Brass LNG and OK LNG—are emblematic. Backed by Total, ConocoPhillips, and the Italian ENI, together with NNPC, the Nigerian national oil company, Brass LNG in Bayelsa state, has been plagued with political problems in the Niger Delta—where militants have been putting the sector at risk since the mid-1990s and where the Movement of the Emancipation of the Niger Delta (MEND) has been on the rise since 2006. MEND's campaign managed to shrink the production of the country by a third in 2009, before an amnesty helped the area return to normal production—even though none of the militant demands were met.

This decade-long atmosphere of physical insecurity and uncertainty in the legal regime—combined with the new additional supply capacities coming out of North America—are not conducive to large-scale investments in Nigeria. After the withdrawal of Chevron from Brass LNG in 2006, ConocoPhillips decided to sell all of its Nigerian interests in 2012, including its 17% share in Brass LNG. Although this project was launched under the Olusegun Obasanjo presidency in the 1990s, it is unlikely to reach a final investment decision in the near

4. *Africa Energy Intelligence*, no. 663, 11/16/2011.

future. The same is true for OK LNG. Even if global demand for LNG is growing, further gas development in Nigeria—with gas reserves of 182 trillion cubic feet, the largest in Africa— could be delayed as long as the Maghreb, Russia, and the internal market are able to supply European needs.

The only other gas exporter in Western Africa (apart from Nigeria and Angola) is Equatorial Guinea. Nevertheless, that country is now experiencing difficulties in finding enough gas for a second liquefaction train. Only one train of 5.2 million tons of LNG per year has been operational since 2007. The shale revolution is now endangering the project, at least in the short term.

Consequences of U.S. Shale Oil for Africa

With regards to African crude exports to the United States, there have been major changes since the exploitation of unconventional shale oil reserves on American soil, particularly the so-called light tight oil (LTO) of the now famous Bakken Shale in North Dakota. For several decades the main African exporters of oil have been Nigeria and Angola. Based on figures from the U.S. Energy Information Administration (EIA), Angola sold to the United States an average of 397,000 b/d from 1993 until 2010. Between 2010 and 2013, however, this figure fell to 326,000 b/d and for the year of 2013, it was only 233,794 b/d, the lowest volume in 20 years. Between 1993 and 2010 Nigeria exported 850,000 b/d to the United States. But from 2010 to 2013, this average volume fell to 761,000 (again a level not registered in more than 20 years) and then even more precipitously in 2013 to only 441,000 b/d. The same declining trajectory can be found in other African suppliers of crude (Algeria, Libya, Republic of Congo, Gabon, and Equatorial Guinea). In 2013, there were roughly one million barrels per day of African crude available on the international market that a decade ago would have been sold in the United States. This one million barrels per day of Africa oil that was once bound for the U.S. but is now heading out to other destinations might soon become 2mbd if the trend continues at this pace and the United States stops buying crude from Africa altogether. Less than a decade ago, in 2007, before the gas and oil shale boom, the United States imported 2.66 mbd from 14 African states.⁵

5. Calculations obtained based on figures given by the U.S. Energy Information Administration.

This significant shift in the structure of supply and demand in the international oil market has two main consequences for Africa. First, some African countries, particularly Nigeria, have grown afraid that the end of Washington's energy dependency will reshape its relationship with former economic partners. U.S. involvement in Africa intensified as a result of energy security concerns, and particularly after 9-11, when a more diversified range of suppliers was actively pursued in order to reduce its dependency on Persian Gulf states. Political leaders and government officials in Nigeria are worried that American companies—Exxon and Chevron, in particular—might not invest as much as they had previously planned before the shale revolution.

These worries are understandable. Some American majors have effectively begun to divest from Nigeria—not because of shale or other unconventional opportunities in the United States, but rather because of the country's weak security and decrepit rule of law. To illustrate this point, the two majors, as well as other private companies (including Cobalt, Anadarko, Conoco, and Marathon) have drastically increased their investments in other African countries and are all active in the Gulf of Mexico and in America's onshore.

The State Department might see the political situation in African oil producer states somewhat differently, however, and perhaps will begin to feel less of a geopolitical imperative to be as diplomatic as it has in the past regarding democracy and freedom of speech in certain African countries. Nigeria could still remain a special case, given its weight in the African economy (some 25% of Africa GDP with 170 million inhabitants, one quarter of the continental population) and its ongoing political fragility, still more than evident in the simmering situation in the Niger Delta and the increasingly explosive activities of Boko Haram in the North. Both situations will continue to demand cautious handling. But Angola, Algeria, Equatorial Guinea, Congo, and Gabon—none of which, as yet, are exemplary democratic states—could face a less flexible relationship with the United States in the near future.

The second main consequence of shale oil development in the United States regards the resulting spare capacities of oil and gas in Africa. Who will now buy these new volumes no longer consumed in the North American market? Asian economies—China and India, in

particular—have increased their demand by 8mbd since 2002⁶ and are already importing most of the new cargo available from the Gulf of Guinea, together with other Atlantic countries like Brazil (which is nevertheless reducing its imports from Atlantic Africa as its own domestic production from the Santos and Campos basins expand).

But what about European countries that are closer to African producers and that have refineries capable of treating light oil produced in the Gulf of Guinea? Figures from the European Commission's Energy Directorate can give an idea: the percentage of African imports of total crude exports to the 27 members of the European Union was 20.7% (2009), 20.1% (2010), 17.3% (2011) and 24% (2012). In 2013, this percentage may have declined for one reason: Libya's output contracted by a factor of five within a year. However, while traders in both Geneva and London see a clear tendency for European refineries to increase their crude purchases from Africa, Asia might remain the main buyer of the extra capacities. Nevertheless, traders claim that they face difficulties in selling their crude cargos that went to the United States for the last two years. Consequently, their margins have decreased drastically. It is difficult to predict whether or not this problem will continue over the longer run to impact the level of production in Africa. All such trends remain to be confirmed.

As for gas, new available capacities in Africa might be negligible in comparison with crude oil. Algeria and Libya have always sold most of their output to the European Union through pipelines. Algeria had been selling relatively small quantities of liquefied gas to the United States since the 1960s thanks to the Arzew and Skikda plants (commissioned in 1964), but nothing has been traded since 2007 due to local production weaknesses and a significant rise in local consumption. For Nigeria, which began its operation in 1999 with NLNG (six trains), most of its gas is already going to Europe and Asia, and so is the only liquefaction train in Equatorial Guinea.

The U.S. oil and gas shale boom will clearly reshape relationships with African hydrocarbon producing countries, but it is highly improbable that American firms will divest from this continent. African energy can be very profitable and still has an enormous unex-

6. BP *Statistical Review of World Energy* 2013.

ploited potential. Asia seems to be occupying the space increasingly vacated by the United States.

The “Mirror Image Theory:” Links Between Oil Discoveries in Africa and Latin America

Because Africa and Latin America once belonged to the same geographic landmass, a number of countries on opposite side of the Atlantic Basin—particularly in the south—have similar geologies, despite the fact that they are separated by thousands of miles today. This has recently led oil firms to buy blocks on the opposite side of Atlantic when they make discoveries on one side of the basin or the other. This strategy—known the “Mirror image theory”—is a quite recent development, but examples are beginning to mount.

Namibian-Brazilian Offshore Links

The first occurrence of mirror image exploration on the other side of the Atlantic Basin took place in Brazil. Since 2006, the large discoveries in the Lula field—along with the other huge discoveries (Libra, Carioca) in the pre-salt Santos and Campos basins, off the coast of Rio de Janeiro, Sao Paulo, and Vitoria) have been driving exploration efforts in Namibia. The similarities between the Orange, Walvis, Namibe, and Lüderitz fields in Namibia and Brazil’s offshore pushed junior firms to enter the southern African country and to boost their interests in countries that are currently opening up the deep offshore like Gabon and the Republic of Congo.

Prior to that discovery, Namibia had not been completely terra incognita for oil and gas exploration. Chevron discovered the Kudu gas field in 1974, but its size (1.4 trillion cubic feet) was not significant enough to incentivize commercialization at a time when gas was not considered to be an asset. After Namibia’s independence from South Africa in 1990, the country tried to promote its offshore capacity, and new oil companies bought licenses through several bid rounds since 1991. But even when a major like Shell entered the country no significant reserves were discovered over the next two decades, as Namibia suffered from the weak price of oil in the late 1990s.

A new impetus for exploration came after the findings in Brazil that pushed former Petrobras executives to secure—in 2008—ten blocks in Namibia through their entity HRT Oil&Gas. The enthusiasm for pre-salt exploration in Namibia has recently driven majors to re-enter the offshore. Petrobras was the first one to enter Namibia in 2009, followed by BP on the same block (2714A) in 2011. In 2012, the British firm increased its exposure in the country by accumulating shares in four more blocks: 2512A, 2513A, 2513B and 2612A. The last major to give another chance to Namibian geology was Shell, which secured equities in blocks 2913A and 2914B in February 2014.

A petroleum system has been proven to exist in Namibia, but that does not mean that oil companies are necessarily going to find oil in commercial quantities. Apart from Kudu, which has enough gas to empower an electricity plant of 800 MW in Walvis Bay, the existence of viable Namibian basins still remains uncertain. The three wells drilled in the Walvis and Orange basins by HRT in 2013 have disappointed, but that does not mean the exploration will stop. Shell's 2014 move and Chevron's involvement demonstrate this country might remain a hot spot for oil and gas exploration for the next couple of years. Brazil has an undeniable role in this new opportunity provided to Namibia.

Jubilee Discovery Fosters Positive Developments in Latin America

Another recent example in support of the mirror image theory occurred in Ghana, in the offshore of the West Africa Transform Margin). The discovery of the Jubilee field in 2007 by the British company Tullow Oil and the American juniors, Kosmos Energy and Anadarko, unlocked this country which had previously produced only a very small quantity of crude. The reserves found at Jubilee—around one billion barrels of recoverable oil—are among the largest that have been discovered in the region for years. The field was put in production in December 2010 and has produced roughly 100,000bd since then. Other significant finds discovered after Jubilee have included Tweneboa, Ntomme, and Enyenra which will produce 80,000bd by 2015–2016.

In Sierra Leone, the continuation of the petroleum trends of Ghana in the east helped Anadarko and Tullow to discover the Venus, Mer-

cury, and Jupiter fields in 2009, 2010 and 2011. This petroleum system, called the Liberian basin, has also caught the attention of larger companies. Chevron took three blocks in Liberia in 2010 (where Italian behemoth ENI joined in 2012) and two more blocks in Sierra Leone. In 2013, Exxon managed to take the lead on block 13 in Liberia.

Called by geologists the “transform margin,” these new discoveries—running from Ghana to Sierra Leone and perhaps in future all the way to Guinea—have stimulated exploration on the other side of the Atlantic Basin in Latin America. Indeed, a new impetus has been given to explorations in Guyana, French Guiana, and Suriname—taking place in geological locations exactly analogous to those in offshore Ghana, Liberia, and Sierra Leone—only they are on the other side of the Atlantic Basin. These two regions, which geologists have called the Equatorial Atlantic Basin, were once joined hundreds of millions of years ago, much as were Namibia and southern offshore Brazil.

After its discoveries in Ghana—once Tullow Oil could secure additional funds based on its new reserves—this junior decided to invest more money in the offshore acreages of French Guiana, which the company had acquired in 2006 (as part of the purchase of the Australian company, Hardman Resources). Enthused by the Ghana finds, majors like Total and Shell have farmed into Tullow’s block at Guyane Maritime, leading to the *Zaedyus* discovery in September 2011.

These new successes (along with the African offshore discoveries previously mentioned) pushed Tullow to purchase stakes in neighboring countries in Latin America. After having taken up the operatorship in Suriname’s block 47, in 2013, the British junior took two new blocks in offshore Suriname with Japanese Inpex (license 31) and Norwegian major Statoil (license 54). Tullow was also joined by Kosmos Energy (the other firm active in Jubilee finds) and in 2011 secured the blocks 42 and 45, managing to attract Chevron as co-investor in 2012. Other American firms like Murphy and Apache did the same and won bids in Suriname. In the north, Tullow also acquired the Kanuku offshore block in Guyana (a former Dutch and then a British colony) in July 2013, alongside the Spanish company, Repsol.

They are not alone, as Anadarko (another stakeholder in the Jubilee field) was already present in this area with Exxon. The African findings also provoked Brazil to license blocks in its northern off-

shore, in the Foz de Amazonas Basin, which borders French Guiana and its Zaedyus find. Brazil has been the last country to offer licenses in this region because it has taken time to gather data to promote new blocks, and because Brazilian authorities were busy with all the other discoveries in the Santos and Compos basins in the southern part of its offshore. In the Foz de Amazonas basin, the French major Total won five blocks alongside BP in May 2013. In contrast to the previous experience in all other states in Brazil, the two companies had to pay a high signature bonus (\$270 million) to authorities in order to secure the blocks.⁷

These two shores of the Atlantic basin are still relatively underexplored. Many drilling campaigns will take place in Ghana, Liberia, Sierra Leone, and Guinea in the upcoming years; the same goes for French Guiana, Suriname, Guyana, and north Brazil. Those regions, which share the same geographical lineage, remain underexplored. Nevertheless, their oil exploration fate has taken on a common trajectory in the last ten years.

The Falkland Effect on South Africa

Last but not least, another example of the mirror image theory is coming from the petroleum system discovered recently in the Falkland/Malvinas Islands near the southern Argentine shore. The recent discoveries in the Malvinas/Falklands offshore has had major consequences for the eastern offshore area of South Africa because the two zones used to be joined in the past. The offshore of this archipelago under the sovereignty of United Kingdom has been under exploration (seismic and well drillings) since the end of the 1990s by majors such as Shell or Hamerada Hess.

However, discoveries were far too miniscule to develop the reservoirs at a time when the price of oil was barely \$10/bbl. The new era of oil exploration began in 2003 and was associated with a far more robust crude price in New York and London, which helped some new companies—particularly British juniors such as Falkland Oil and Gas Limited, Desire Petroleum, and Rockhopper Exploration—to reprocess data from the past and to acquire new data in Falklands off-

7. *Africa Energy Intelligence*, no. 717, February 25, 2014.

shore. This led to the discovery of Sea Lion by Rockhopper in 2010 (293 million barrels oil equivalent) and other successful drilling campaigns, which attracted bigger companies such as Noble Energy, Edison, and Premier Oil that farmed in several blocks in 2012.

To develop the Sea Lion prospect in the northern basin, Premier Oil has been in competition with well-known mid-cap companies such as Anadarko⁸ and other American firms like Murphy Oil or Hess. The winner, Premier Oil, accepted to pay \$722 million to develop the field and give \$231 million to Rockhopper.⁹ The final investment decision will be taken in early 2015. In July 2012, Noble Energy assumed control (alongside Edison, owned by the French major power firm EDF) of the blocks in the Falklands southern offshore, owned by junior Falkland Oil & Gas. Several seismic and well drillings are planned for 2014 and 2015, and are expected to amount to a total profit of \$420 million.

This exploratory success in the Falkland/Malvinas Islands has driven some companies to take a corresponding interest—following the mirror image theory—in the eastern part of the South African offshore. Two geological events have put the South African offshore in the spotlight in the last five years. The first one is Anadarko and ENI's enormous Mozambique gas discovery (almost equivalent to Nigeria's reserves) in the northern offshore in 2010. This discovery unlocked the offshore of South Africa, which had been relatively underexplored compared to many other African countries. The second determining geological aspect comes from the Falkland/Malvinas Islands, where the Sea Leon field was discovered and attracted a number of mid-sized companies.

As in other part of the Atlantic Basin offshore, junior companies have typically been the ones to make the first moves and to bid for exploratory rights from the South African authorities.¹⁰ Impact Oil & Gas (a firm based in London and headed by the British geologists who followed the oil history of the Falkland Islands) managed to obtain a formal agreement in March 2012 for the Tugela blocks in South Africa (close to Durban city). Less than a year later, ExxonMobil took 75%

8. Also active in Ghana, Sierra Leone, Liberia and Guyana.

9. <http://www.rockhopperexploration.co.uk/rockhopper/about.html>.

10. <https://www.impactoilandgas.co.uk/NewsDetails.aspx?id=5>.

of the Tugela blocks and became its operator. Additionally, in 2013 the French major, Total, took the operatorship of the block 11B/12B (across from Port Elizabeth).

Once again, the Falkland Island discoveries played a role in the rationale for the investment. According to the company's Senior Vice President of Exploration, Marc Blaizot, the "acquisition in this extensive frontier exploration asset demonstrates our determination to establish ourselves in new plays. South Africa's deep offshore, in particular the Outeniqua Basin, is one of the few remaining under-explored offshore regions in Africa. Recent discoveries in the Falkland Islands (Malvinas Islands) together with prospects identified on the block offer us very promising opportunities."¹¹

Petroleum Actors of the Equatorial Atlantic Margin Play and the Southern Atlantic Basin

In terms of actors in the oil sector, the mirror image geology has clearly paved the way for Atlantic Basin firms. Brazilian companies like Petrobras and HRT have quickly caught on to the potential of Namibia as a result of the previous discoveries in the Santos and Campos basins. Petrobras also took up several blocks in northern Angola and Gabon, given that the geology of the Lula field, unveiled in 2006, is similar in its pre-salt characteristics to the offshore zones of those countries. Furthermore, North American investors in Africa's southern offshore have been very proactive in securing blocks. Exxon and Chevron have operated in Angola for decades, long before the mirror image theory became popular. But they have invested in new areas since this concept has taken root (in Liberia, Sierra Leone, and Guyana). Some mid-cap companies from the United States have been pioneers in this quest. Anadarko and Kosmos Energy, for example, discovered Jubilee in Ghana in 2007, and at the same time entered the new oil plays of Latin American nations such as Suriname and Guyana.

But the real driving force has been Tullow Oil. This British junior took the chance very early on to unlock the two sides of the Atlantic Basin by securing blocks without delay. The story of this small company—the first to understand the geological implications of the

11. <http://total.com/en/media/news/press-releases/20130930-Total-Acquires-Offshore-Exploration-Interests-in-South-Africa>.

mirror image theory—is also wrapped up with that of the South African offshore and Impact Oil & Gas. Thanks to its rapid decision-making practices, Tullow rushed into South Africa after the findings in the Falklands, and the major Exxon profited from the licenses of Impact Oil and Gas a year later. This trend has also been observed in Namibia by HRT Oil & Gas from Brazil, another driving force, in this regard. The company has been joined by the majors, shortly after its initial moves in Namibia.

The African actors seem relatively quiet in this new Equatorial Atlantic Margin play (Ghana, Sierra Leone, Liberia-North Brazil, French Guiana, Suriname, and Guyana). The Angolan state company Sonangol is the sole African actor to have taken blocks in Brazil based on an agreement with Petrobras (which has explored in Angola since 1979).

In summary, the Atlantic Basin remains the sphere of Western or Atlantic companies, with juniors acting as mavericks, later to be joined by majors when successful. At least as far as these new offshore opportunities and basins are concerned, where the mirror image theory has played a catalytic role, no companies from Asia have entered Namibia, Ghana, Liberia, Sierra Leone, South Africa, or in the other mirror image play, countries on the Latin American side of the Atlantic.

Conclusion

The energy market has long been globalized, but increasingly one can see consequences of significant oil and gas discoveries in diverse and disparate locations. This chapter has sought to explain why the Atlantic Basin is an appropriate framework for thinking about hydrocarbons among the Atlantic continents of North America, South America, Africa, and Europe. These regions are already interconnected via private and state firms' visions of geological similarities. But up until now, however no political vision has been developed to help the nations of these continents to work together so that they might profit from each other's experience and common geological ancestry. The same companies are taking blocks on both sides, but states may be missing out on an opportunity to learn from more experienced countries. Some African and Latin American regions have no track

record in hydrocarbon discoveries and are struggling to propose balanced guidelines and contracts that both attract firms and are profitable for the state.

The examples presented and analyzed in this chapter—the Southern Atlantic sub-basin between Brazil and Namibia and the Falklands/Malvinas and South Africa, and the Equatorial Atlantic Margin sub-basin between Ghana, Liberia, Sierra Leone, French Guiana, Suriname, Guyana, and North Brazil—are the first in what could be, no doubt, a very long list. We can easily foresee many other discoveries in these regions that will help to unlock the other side of the Atlantic Basin. It has become necessary to foster a wide regional political debate on these matters, especially after the U.S. oil and gas shale boom, an unexpected development that could drastically change U.S. relationships with African states in the short term. U.S. energy independence might not be achieved for many years, but the country's declining external energy dependency on the countries of the Gulf of Guinea (Nigeria, Angola, Equatorial Guinea, Congo, and Gabon) and the Maghreb is already visible. The necessary political relationships between consumers and producers must be buttressed by another type of political dialogue based on a new Atlantic Basin partnership, one that cannot lead to a political vacuum. The Atlantic Basin is the now the location of a significant percentage of global oil and gas production, but it is also remains an important place of consumption. The need for dialogue is urgent.

Chapter Three

Biofuels and the Atlantic Basin

Manuel Bravo

Biofuels are produced from biomass—organic matter derived from plants or animals. Any form of bioenergy—whether derived from solid, liquid or gaseous fuels—is considered a biofuel. Solid biofuels are as old as civilization: they have been exploited since the man found fire and are still used today for heating or cooking in many communities. Liquid biofuels, such as olive oil or whale oil, were used for lighting until the 19th century when they were replaced by fossil fuels.

In this chapter, however, the term *biofuel* will refer to liquid or gaseous fuels produced from biomass and used principally in transportation. Indeed, the first automobiles were built to run on biofuels—bioethanol in the case of Ford's Model T, while Diesel's engine was designed to run on vegetable oil. However, ever since the beginning of 20th century biofuels have been marginalized by more abundant and cheaper fossil fuels.

During the Second World War bioethanol was used mainly in Europe where it was blended with petrol (gasoline) to reduce dependence on imported oil. As a result of the abundance of cheap oil after the war, biofuels lost their economic appeal until the first oil crisis in 1973–74, when high oil prices and fuel shortages attracted the interest of many governments. At that time, Brazil started to produce bioethanol from sugarcane in earnest, and in the U.S. its production from corn began. Large amounts of money were spent on research and development to improve existing production processes and to develop new ones based on lignocelluloses. Ever since, biofuels have also been used as an octane improver for gasoline and to reduce engine emissions (as in the United States) and as alternative fuels blended with fossil fuels in order to reduce dependence on imported oil.

The fastest growth in biofuels production has occurred over the last 20 years. This renaissance has been supported by new policies and

legislation which have been driven by security of supply concerns and by desires to improve rural economies and reduce external energy dependence. More recently, biofuels have been seen, particularly in Europe, as an option for reducing CO₂ emissions from the transportation sector in line with Kyoto commitments.

Biofuel Use in Transportation Sector

Transportation is one of the largest final energy-consuming sectors of the global economy, accounting for 28% of primary energy consumption in the U.S.,¹ and 22% in the EU-28.² Furthermore, petroleum (or oil) products represent more than 93% of total energy consumed in transportation. Although in OECD countries the energy consumed in transportation is on the decline, in the non-OECD countries (with higher economic and population growth, and less mature transportation sectors), energy consumption in transportation is increasing at an average annual rate of 2.2% (see Figure 1).³ In addition, not only is transportation growth closely linked to economic growth; it is also the sector with the fewest alternative energy sources. It is therefore not surprising that governments have begun to look to indigenous biofuels as a tool for ensuring fuel supply and reducing dependence on foreign oil. Liquid biofuels also have certain characteristics favoring their use as an alternative transportation fuels.

Biofuel Prices

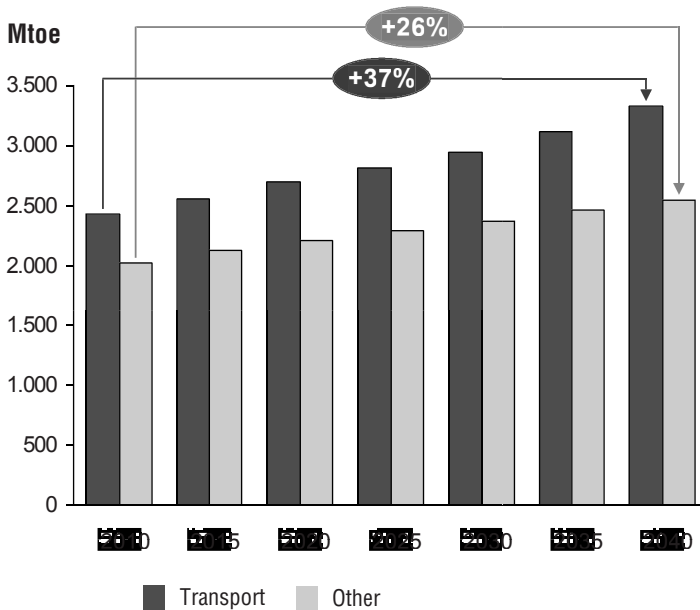
Biofuels are currently more expensive than their fossil based counterparts (see Figure 2). Sugarcane ethanol produced in Brazil has lower production costs than corn starch-, wheat- or rye-based ethanol, and its price is therefore close to the gasoline market price. Market prices for biodiesel, however, are higher than for diesel oil (and are likely to continue to be), at least during the coming decade. As a result, the substitution of fossil fuels in transportation by renewable fuels will

1. EIA, *Monthly Energy Review*, U.S. Energy Information Administration, February 2014.

2. Eurostat (Statistical Office of the European Community) *Energy Statistics*, 2014.

3. EIA, *International Energy Outlook*, U.S. Energy Information Administration, 2013.

Figure 1. Global Liquid Fuels Consumption



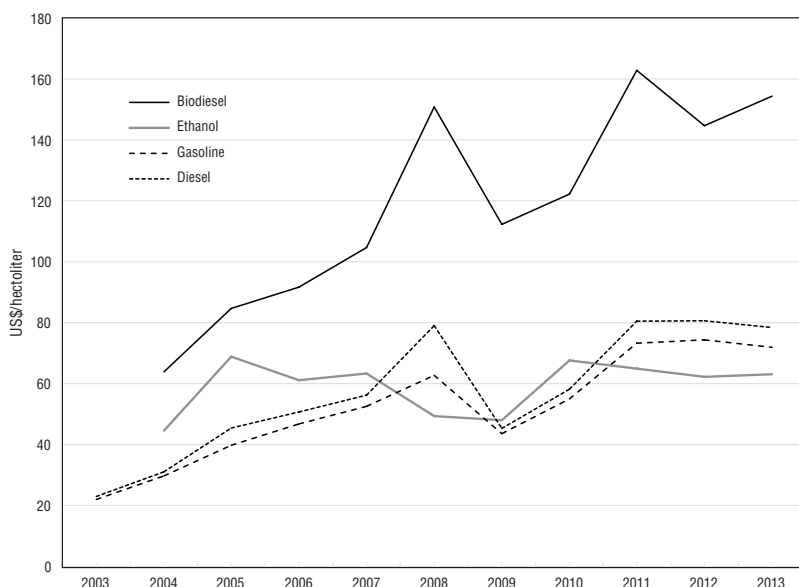
Source: EIA, International Energy Outlook, U.S. Energy Information Administration, 2013.

continue to require the support of biofuel mandates (given that significant increases in oil prices are not foreseen).⁴

Given that the current mandate targets in the three largest biofuel markets (Brazil, U.S., and EU) and elsewhere will have to be predominantly met, over the coming decade, by ‘first generation’ biofuels produced from food crops, such crops will still experience significant additional demand. This additional demand—strengthening the currently increasing global demand for food—will contribute to higher agricultural commodity prices (although by how much is still a matter of debate). Price increases for such commodities will not only depend on the evolution of oil prices, but also on the interactions between different crops and livestock markets, world regions and response to

4. This chapter was written in the late summer and early fall, when the recent dramatic fall in oil prices—from over U.S.\$100/bbl in the summer of 2014 to below U.S.\$50/bbl by the winter of 2015—was only just getting under way.

Figure 2. Price Evolution of Main Biofuels and Corresponding Oil Products, US\$/hectoliter (hl), 2003-2013



Source: OECD-FAO Agricultural Outlook 2013; Energy Information Administration.

price signals by consumers and producers, and yield increases stimulated by higher prices.

Modelling studies, mainly focused on EU biofuel demand (where biodiesel represents the highest contribution), forecast the most significant price increase for oil seeds and vegetable oils (with increases by 2020 in the range of 8% to 36 %) and cereals (with the majority of studies projecting price increase of about 8%).

Atlantic Basin Dominance in Global Biofuels

While current world production of biofuels (both ethanol and biodiesel) accounts for only about 2%-3% of the global market for transportation fuel, over the past decade global ethanol production has more than quadrupled and biodiesel production has grown by a factor of 15. Some 40 countries have now mandated obligatory use of biofuels as a blending component in transportation fuel to reduce the

consumption of petroleum-based fuels like gasoline and diesel, and to establish the market and investment horizon for biofuels. Most of these countries are located in the Atlantic Basin. Total global absolute output of biofuels is projected to triple by 2035.

Over 85% of global biofuels production (and most consumption) takes place within the Atlantic Basin. The only other biofuels producers are in Southeast Asia, where production has focused mainly on biodiesel and rising transportation fuel demand has easily swamped Asian supply. As a result, the Atlantic's current dominance in biofuels will be extended indefinitely into the future, as most expected future biofuels production will continue occurring within the Atlantic Basin.

The evolving Atlantic Basin biofuels system consists primarily of (1) U.S. production of corn-based ethanol and soybean based biodiesel; (2) Brazilian production of sugarcane-based ethanol; and (3) EU production of various grain-based biodiesels. The U.S. is world's largest biofuels producer, consumer, and exporter, followed by Brazil as the second largest producer and exporter, and by Europe as the world's 2nd largest consumer of biofuels. Brazil and the United States together account for 87% of total global production. U.S. biofuels have traditionally been far more heavily supported and protected than their Brazilian sugarcane-based counterparts, although recently U.S. import tariffs and domestic subsidies have been relaxed. While most global biofuels production is consumed domestically within the original national production markets, almost all (nearly 90%) of biofuels trade takes place within the Atlantic Basin.

Brazil

Brazil is an efficient producer of ethanol and biodiesel. The country's biofuels policy is to promote their use in the internal market and the opening of export markets for both products. Current development of Brazil's biofuels industry dates back to the 1970s when the government initiated the Proalcool Plan and explored the possibility of blending ethanol in gasoline as a way to reduce dependence on imported petroleum.⁵ The plan was so successful that by the end of the decade 90% of the car fleet was using biofuel.

5. L. Van der Velde, *Biocombustibles (II): La UE y Brasil*, GEIC, 2010.

Later, oil discoveries by Petrobras—together with the high sugar prices and the precipitous drop in oil price during the mid-1980s—brought a temporary halt to the Brazilian biofuel industry. From 2000 on, however, with oil prices more favorable, Brazilian biofuel policy was again reactivated. Two important elements contributed to this renaissance: the development of flex-fuel engines (a technology that allows for the utilization of high grade biofuel blends) and the international movement towards the reduction of CO₂ and other greenhouse gas (GHG) emissions, as agreed in the Kyoto protocol and subsequent international accords (a development implying improved competitiveness for biofuels).

Brazil is the leading supplier of primary energy from renewable sources which contributed more than 42% to the country's primary energy mix in 2012. Final energy consumption in 2013 was 244 million tons of oil equivalent (Mtoe)—equal to approximately 5 million barrels a day of oil—3.2 % higher than in 2012. The industrial and transport sectors are the largest consumers, sharing 35% and 31% of the energy mix, respectively. Renewable energy's share of final energy consumption is close to 26%.

Transport sector consumption was 74.1 Mtoe in 2012 and is expected to grow at an average annual rate of 3% (with a gasoline-diesel ratio of 0.7). Biofuel's share of transport fuel consumption reached 17.8% in 2012 with the largest share corresponding to bioethanol (37%) (see Figure 3).

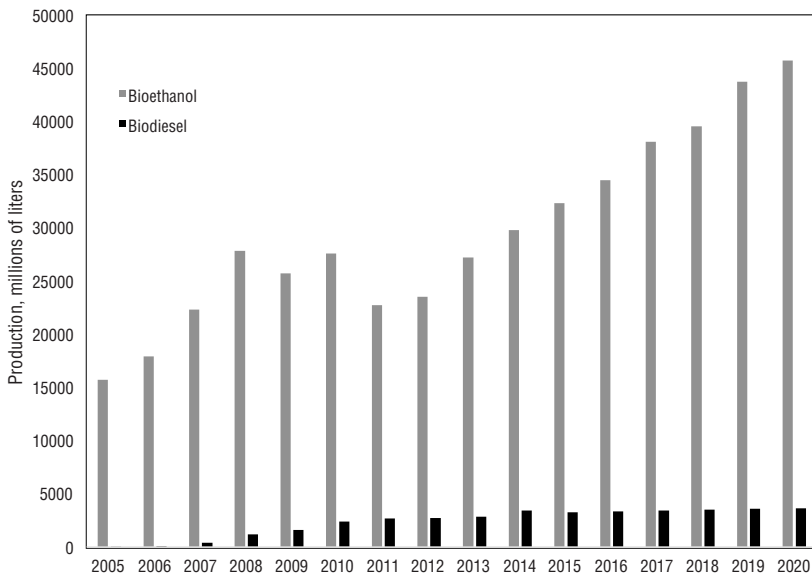
Bioethanol in Brazil

Sugarcane is practically the exclusive feedstock for ethanol production in Brazil. The government monitors the production chain and its sustainability, diverting residues to electricity production and regulating the percentage of ethanol blended into gasoline. Ethanol production depends on decisions made by individual mills to produce sugar and/or ethanol.⁶

Sugarcane production is expected to reach 640 Mt in the 2013-14 growing period (with total reducing sugar content in the range 48-52%). Total estimated ethanol production for 2014 is projected to be

6. USDA, "Brazil Biofuels Annual Report," *Foreign Agricultural Service: Gain Report*, 2013.

Figure 3. Brazilian Biofuels Production, bn liters, 2005–2020



Source: OECD-FAO: Agricultural Outlook 2014-2023.

28.9 billion liters, with total installed production capacity coming to 40.7 billion liters.

Biodiesel in Brazil

The domestic production and consumption of biodiesel is regulated by the government according to the biodiesel mandate that requires all diesel fuel to have a 5% biodiesel blend. The National Council for Energy Policy (CNPE) studied the possibility to increase this blend requirement to 7% (biodiesel content of diesel), although no decision has been yet taken.

Although there are a large number of materials that can be used for biodiesel production, soybeans represent more than 70 % of total biodiesel feedstock, followed by animal fat. Biodiesel production plants must be authorized by the government; Brazil has 69 plants authorized to produce biodiesel with total production capacity of 8 billion liters per year. Based on diesel demand and projections, biodiesel

consumption figures for 2013, along with those forecasted for 2014, are 2.8 and 2.9 billion liters, respectively.

The biodiesel market price remains regulated by the government through a public auction system that determines the price to be received by the producers. Producers are not allowed to change at the auctions; therefore, they must find ways to control their feedstock supply and other production costs.⁷

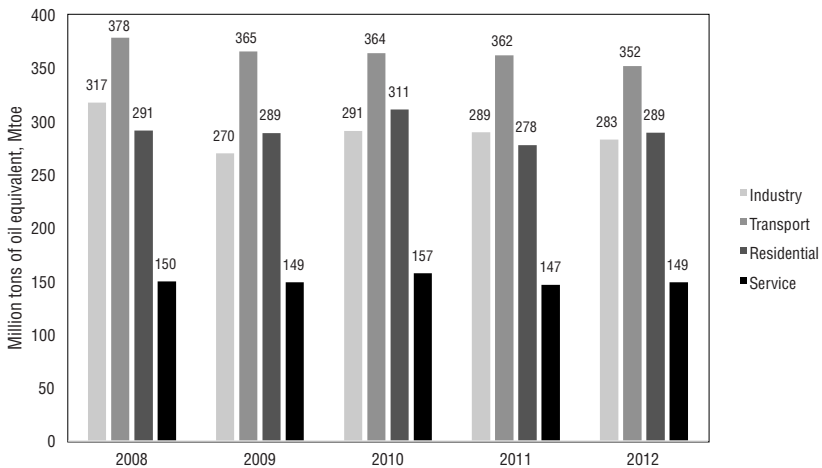
Support policies and programs

Brazil has established and developed a number of support policies for biofuels blending, production, distribution and use.

- **Support programs for bioethanol**
 - *Ethanol use mandate.* According to MP (Medida Provisoria) 532 of April 2011, the percentage of ethanol blended in gasoline can vary between 18% and 25%. As of February 2013, however, in view of the higher sugar cane crop and expected higher ethanol availability, the Sugar and Ethanol Interministerial Council (CIMA) increased the percentage of ethanol blended in gasoline to 20%–25% (and recently a further rise to 27% has been considered).
 - *Tax incentives for ethanol flex cars.* Lower taxes have been established for ethanol flex- fuel cars compared to gasoline cars, especially in the realm of the IPI (Tax on Industrial Products).
 - *Tax incentives for ethanol fuel.* Through MP 613, in May 2013 PIS/COFIN (Social Integration and Finance of Social Security) reduced federal taxes applied to ethanol to practically zero.
- **Support programs for biodiesel**
 - *Production incentives.* The public auction system for biodiesel production gives preference to producers with the Social Fuel Stamp, which provides incentives for poorer farmer in depressed areas.
 - *Biodiesel import tariff.* The import tariff applied to biodiesel is 14%.
- **Advanced biofuels.** At the moment, Brazil has no commercial production of advanced biofuels. In 2013 the National Bank for Social and Economic Development (BNDES) announced a credit line of 1 billion R\$ (Brazilian *reais*) to fund agricultural research and development in the ethanol sector, mostly for investments in advanced biofuels. Currently, Brazil has three

7. *Ibid.*

Figure 4. EU-28 Energy Consumption by Sectors



Source: EUROSTAT: EU Energy Statistics.

advanced biofuel plants are being planned: (1) Raizen's 40mn liter cellulosic ethanol project in Sao Paulo state; (2) GranBio-API's 80mn liter cellulosic ethanol and biobutanol project, Sao Miguel dos Campos in Alagoas state; and (3) Solazyme-Bunge's 100,000 ton renewable oil project in Moema in Sao Paulo state.

EU

Although European energy consumption is falling at a 1% average annual rate (see Figure 4), the EU is each year more dependent on energy imports. Transportation is the sector with the highest energy consumption and greenhouse gas (GHG) emissions. In addition, European transportation is also a highly dependent on imported oil. It is therefore not surprising that the EU has attempted to promote the use of biofuels as a means to reduce external energy dependence, increase farmer incomes and reduce GHG emissions.

The framework for EU biofuel policy laid out in the Directive 2003/30/EC. This EC directive promotes the use of biofuels and other renewable fuels to replace gasoline and diesel for transportation in each member state. The directive sets up indicative targets for bio-

fuel contribution to the gasoline and diesel blends—2% and 5.75 %, on and energy basis, respectively—in each member state market. It also established that the biofuel blends with petrol and diesel should comply with the corresponding European standards and that blends exceeding the limit value of 5% should be marked at the pumps.

EU Policy and Plans

In 2007, the European Council adopted an ambitious set of energy and climate change objectives to be reached in 2020:

- A 20% reduction in GHG emissions (compared with 1990).
- A 20% improvement in energy efficiency (compared with a business as usual scenario).
- A 20% share of renewable energy in the European final energy mix. Within this share, a specific target of 10%—to be achieved by all Member States (MS)—was also set for renewable energy's contribution to the transportation sector's energy mix.

This set of objectives it is called the 20/20/20 strategy. The Energy and Climate Change Package consists of a group of new and amended regulations and directives that lay out the obligations considered necessary for achieving the objectives of the 20/20/20 strategy. The Renewable Energy directive (RED), which is part of the package, entered into force in June 2009 and had to be transposed into MS legislation by December 2010.⁸

The RED establishes a common European framework to promote the supply of energy from renewable resources. It sets mandatory targets for each MS for the overall share of energy from renewable resources in gross final energy consumption. It also set the general obligation to achieve a 10% share (on an energy basis) for renewable energy in the transportation mix and established sustainability criteria for biofuels.

Biofuels must comply with the sustainability criteria laid down in article 17 of RED to be eligible for financial support, or to count towards the EU renewable energy contribution target. All biofuels

8. Directive 2009/28/EC of the European Parliament and the Council on the promotion of the use of energy from renewable sources, O.J. L140/16.

must comply with the following sustainability criteria, whether they are produced in EU or imported:

- Biofuel GHG emissions savings must be least 35% currently. However, beginning in 2017 biofuels will need to register 50% GHG saving when compare with petroleum-based fuels. As of 2018, GHG emission savings must be at least 60% for biofuels produced in installations that begin production on or after January 1, 2017.
- Biofuels must not be made from raw materials obtained from land with high biodiversity value (such as primary forest or wooded land, areas designated as natural protection or for the protection of rare, threatened or endangered ecosystems).
- Biofuels cannot be made from raw materials produced on high carbon stock land, such as wetlands or peat lands.

The agricultural raw materials produced within the EU must be produced in accordance with the requirements for good agricultural and environmental conditions laid down in the common rules for direct support schemes for farmers under the Common Agricultural Policy.

The Fuel Quality Directive (FQD) complements the RED, sets specifications for gasoline and diesel fuels containing biofuels (a mirror of the sustainability criteria contained in RED) and adds the specifications that ethanol and FAME (biodiesel) must comply with in order to be blended with gasoline and diesel. The maximum amount of biofuels allowed in fuel blends is 10% for ethanol in gasoline and 7% for FAME in diesel.⁹

GHG Emissions

According to RED, GHG emissions must be calculated by life cycle emissions following the methodologies described in RED annex V. The annex defines the GHG emissions default values for different raw materials and production pathways. Emissions from indirect land use change (ILUC) are not included.

9. Directive 2009/30/EC of the European Parliament and the Council amending directive 98/70 as regards the specification of petrol, diesel and gasoil and introducing a mechanism to monitor and reduce greenhouse gas emissions, O.J. L140/88.

Certification of Sustainability

Since the entire biofuels production and supply chain has to be sustainable, the sustainability of biofuels needs to be checked by MS or through the voluntary schemes that have been approved by the European Commission (EC). The EC has currently recognized 19 voluntary schemes that apply in the all MS.¹⁰

Indirect Land Use Change (ILUC)

The RED calls for ILUC to be taken into consideration when calculating GHG emissions saving values for ‘first generation’ biofuels. In October 2012 the EC published a directive proposal amending the RED and FQD directive.¹¹ The proposal is being debated by the European Parliament and the Council and both institutions adopted reports on the first reading.

The amendments proposed by the EC are:

- Increasing the GHG saving threshold for new installations to 60% from July 2014.
- Including ILUC factors in the reports of fuel suppliers and MS.
- Limiting to 5% the amount of food crop-based biofuels that can count towards the 10% target for renewable energy in the transport sector by 2020.
- Providing market incentives for biofuels with no indirect land use change emissions or for ‘second generation’ biofuels produced from biomass that does not require additional demand for land.

The main difference between the European Parliament and Council reports is found in the minimum threshold level for first generation biofuels and in the target for the introduction of advanced biofuels.

10. http://ec.europa.eu/energy/renewables/biofuels/doc/sustainability_schemes/voluntary_schemes_overview.pdf

11. Proposal COM (2012) 595, for a directive of the European Parliament and the Council amending directive 98/70/EC on the quality of petrol and diesel fuels and directive 2009/28/EC on the promotion the use of energy from renewable sources, http://ec.europa.eu/clima/policies/transport/fuel/docs/com_2012_595_en.pdf.

European Biofuels Production

Reducing GHG emissions in the transportation sector is a principal motive behind the EC mandate introducing biofuel/fossil fuel blends as transportation fuels. Therefore, the evolution of the European biofuel industry is linked to the evolution of fuel consumption in transportation and to the resulting fuel specifications adopted. There are certain barriers, however, that determine (even limit) the demand for the different types of biofuels:

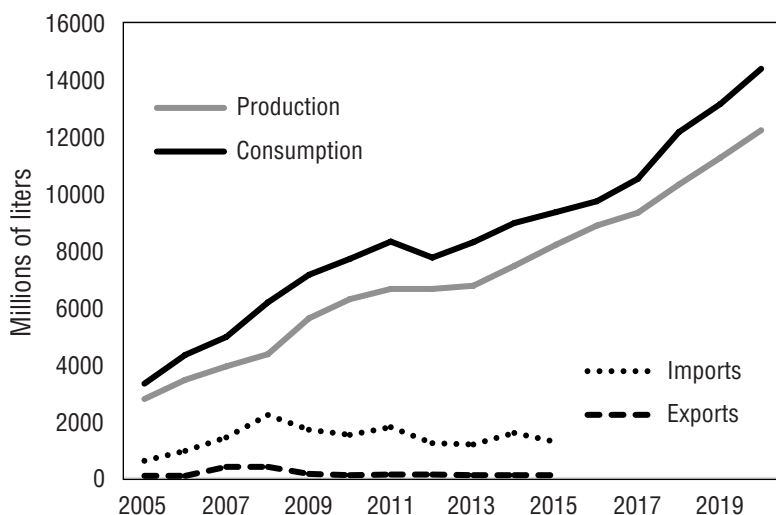
- The maximum biofuel concentration allowed by fuel specifications: 10% for bioethanol, 7% for FAME (there are no limits for HVO; see annex)
- The implementation of the regulation 443/2009¹² setting emission performance for passenger cars and regulation 511/2011¹³ that set emission performance for light commercial vehicles
- The different market spread of transport fuels: in the EU, the ratio of gasoline/diesel consumption is 0.5, but in the U.S. it is about 3.0
- The reduction in transportation fuel consumption during the last five years, in particular for gasoline
- Adjustment of blending mandates by the ILUC directive proposal

Bioethanol in the EU

The European bioethanol industry has experienced a continuous increase in production since 2005. However, economic recession and lack of a stable legislative framework temporarily undermined consumption and the deployment of further production capacity. Growing production is expected in Germany and the UK due to growing domestic markets, but production in all other MS is forecast to remain stagnant. Figure 5 presents the historical evolution of ethanol production and consumption in the EU, along with forecast to 2020. However, because the growth of the domestic bioethanol market is reach-

12. Regulation 443/2009 of the European Parliament and the Council, of 23 April 2009, setting emission performance standards for new passenger cars.

13. Regulation 510/2011 of the European Parliament and the Council, of 11 May 2011, setting emission performance standards for new light commercial vehicles.

Figure 5. EU-28 Bioethanol Balance*

*2013 provisional value; 2010–2020 forecast values.

Source: OECD statistical data.

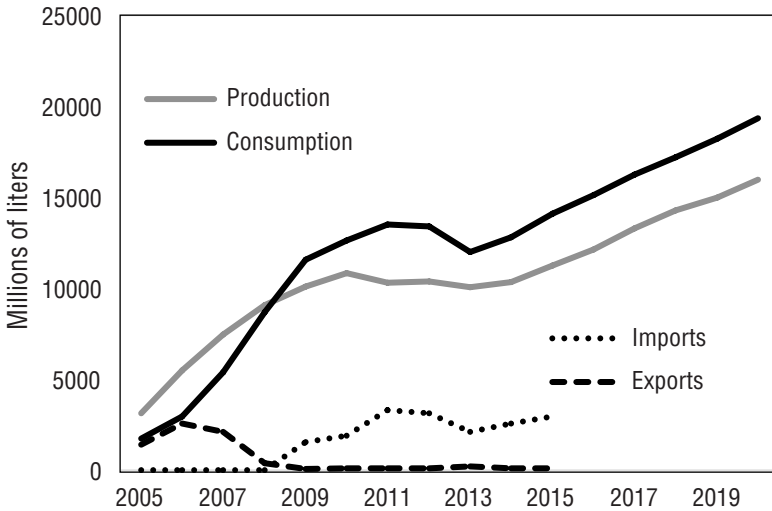
ing its limits, these OECD forecasts for European bioethanol production and consumption could be considered to be too optimistic.

Biodiesel in the EU

The EU is the world's largest biodiesel producer. Biodiesel is the most important biofuel in the European market on an energy basis and accounts for more than 80% of the European biofuels market. Biodiesel production in 2012 did not match its maximum production level from 2010, although production did increase over 2011 (see Figure 6 below). However, in 2013 production fell again because domestic producers had to face competition from 'dumped' biodiesel imports. In August 2012, an antidumping complaint resulted in the imposition of import duties in December 2013 for a five year period in order to restore the level playing field.

European biodiesel production is driven by domestic consumption and competition from imported biodiesel. Germany, the Netherlands and France are Europe's national production leaders. European pro-

Figure 6. EU-28 Biodiesel Balance*



*2013 provisional value; 2010–2020 forecast values.
Source: OEE statistical data.

duction capacity has increased to 26 billion liters (the estimated amount required to comply with the RED contribution target). The estimated capacity utilization rate in 2013 was about 50%. Double counting measures in some MS and reduced mandates in Spain have had a negative impact on demand and production. First generation biodiesel is suffering competition from HVO biodiesel and those obtained from hydrogenated used cooking oil and animal fat, which can be blended at higher rates (see the annex for a discussion of these second generation biodiesel fuels. Adoption of the ILUC directive will reinforce this competition by favoring the introduction of biodiesel produced from waste oils and animal fats.

The United States

Increasing dependence on foreign oil, the desire to boost rural economies and climate change concerns have been the motivating fac-

tors behind the U.S. effort to promote the use of biofuels as an alternative to petroleum-based fuels in the transportation sector. This interest in biofuel promotion triggered the development of policies, at both the state and federal levels, to support biofuel production and use. Such policy measures have fostered a significant expansion of biofuels production (more than 600%) since 2000. These policy measures have included (although some have already expired):

- Tax credits to lower the cost to end users
- Import tariffs to protect domestically-produced ethanol from foreign imports of cheap ethanol
- Loans and loan guarantees to facilitate the development of production and distribution infrastructure
- Research grants to promote the development of new technologies
- Minimum blending mandates to create a market for biofuels.

The Renewable Fuel Standard (RFS)

The Renewable Fuel Standard (RFS) sets the mandatory minimum volume of biofuels to be blended in transportation fuels. The RFS was established by the Energy Policy Act of 2005. This initial RFS (known as RFS1) mandated that a minimum of 4 billion gallons of biofuel be used in the gasoline supply in 2006, and that this minimum rise to 7.5 billion gallons by 2012.

In 2007, the Energy Independence and Security Act (EISA) superseded and expanded RFS1 in quantities and time horizons, increasing the mandate to 36 billion gallons by 2022 (RFS2). In addition to the gasoline minimum, RFS2 extended the mandate to other transportation fuels, including diesel fuel for off-road use and marine fuels.¹⁴ RFS2 supports the U.S. biofuel industry by creating a mandatory market for biofuels, independent of its cost, thereby providing an indirect incentive for investing in the construction of new plants and in development new technologies.

14. B.D. Yacobucci, "Renewable Fuel Standard (RFS): Overview and Issues," *Congressional Research Service*, March 2013.

In addition to expanding the RFS1 mandate, RFS2 has other major distinctions with respect to RFS1. It includes four biofuel categories, each with a specific blending volume and GHG emissions savings threshold:

- *Total renewable fuels.* The total renewable fuel mandate grew to 36 billion gallons by 2022. Biofuels must have a minimum life-cycle GHG emission of 20% compared with conventional fuel in order to fulfil the mandate. Bioethanol produced from corn qualifies for the mandate; however, the volume of corn ethanol that can be blended is capped at 13.8bn gallons in 2013, increasing to 15bn gallons by 2015, and capped at that level thereafter.
- *Advanced biofuels.* Biofuels must have life-cycle GHG emission savings of at least 50% to qualify for this category. The mandate for this category grows from 2.75bn gallons of ethanol equivalent in 2013 to 21bn gallons by 2022. This category includes biomass-based biodiesel, biofuels produced from non-corn feedstock, and Brazilian sugarcane ethanol. Cellulosic biofuels, including those produced from non-starch parts of the corn plant are also included.
- *Cellulosic and agricultural waste-based biofuels.* These are biofuels derived from cellulose, hemicellulose and lignin (see annex). They must reduce life-cycle GHG savings by at least 60% to qualify. They include cellulosic ethanol as well as biofuel produced through the biomass-to-liquid processes (see annex). The mandate should grow from 100mn gallons in 2010 to 16bn gallons in 2022. (RFS mandates for this category were lowered for 2010, 2011 and 2013)
- *Biomass-based biodiesel.* This category includes any diesel fuel produced from any biomass (including algae) including ester and non-ester biodiesels. The life-cycle GHG savings must be at least 50% to qualify for this category. The EPA established a mandate of 1.28bn gallons.

RFS2 is a mandate that limits the inclusion of corn-starch ethanol and promotes the use of higher GHG emission-saving biofuels. Any volume of corn-based ethanol blended in excess of the cap set is not credited towards the annual RFS. Thus any renewable biofuel that meets the GHG savings requirement for cellulosic or biomass-based

Table 1. Volumes Established (in mn or bn gallons) to Determine 2013 and 2014 EPA RFS2 Standards

2nd Generation Categories	2013		2014	
	Set Volume	Proposed %	Set Volume	Proposed %
Cellulosic biofuel	14 mn gal	0.008%	17 mn gal	0.010%
Biomass-based diesel	1.28 bn gal	1.12%	1.28 bn gal	1.16%
Advanced biofuel	2.75 bn gal	1.60%	2.20 bn gal	1.33%
Renewable fuel	16.55 bn gal	9.63%	15.21 bn gal	9.20%

Source: Environmental Protection Agency.

biodiesel is also valid for meeting the advanced biofuels requirement, and any volume of cellulosic biofuels or biomass-based diesel exceeding their individual mandates counts against the advanced biofuels volume mandate. Similarly any renewable fuel that meets the requirement for advanced biofuels is also credited toward the overall total renewable fuel requirement. Under the Energy Independence and Security Act of 2007, the Environmental Protection Agency (EPA) is required to set the annual standards under the RFS2 program for the following year based on gasoline and diesel projections from the Energy Information Administration (EIA) (see Table 1).

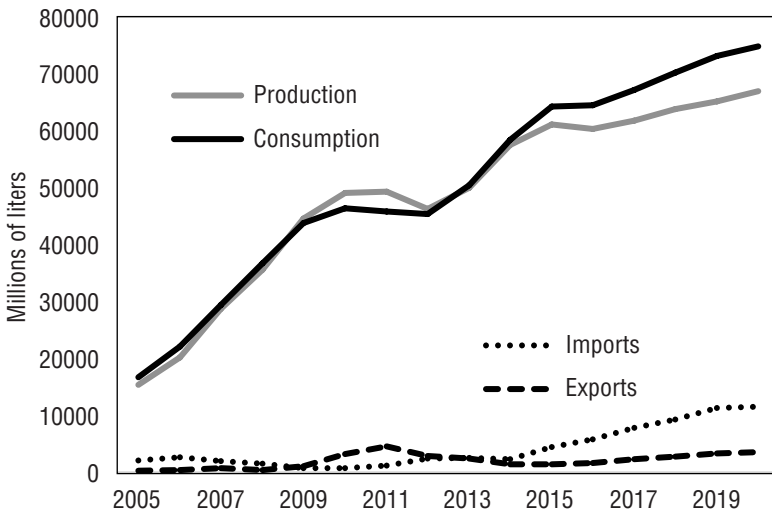
Bioethanol in the U.S.

The U.S. has been blending ethanol into gasoline since the late 1970s, mainly as an additive to gasoline to improve combustion emissions, especially in metropolitan areas. The development of the current U.S. biofuels industry, however, has essentially taken place since 2000. Ethanol represented little more than 1% of gasoline fuel at the time, but it reached 10 % of domestic gasoline consumption by 2011. Still, consumption of ethanol in high ethanol content (more than 50%) gasoline blends (E85) accounts for less than 1% of all ethanol produced for motor fuels.¹⁵

Ethanol is consumed as E10, a blend of 10% ethanol and 90% gasoline, by volume. Only a small volume—less than 1%—is consumed in higher blends (E-85) which can only be used by Flex-fuel

15. EIA, "Biofuels Issues and Trends," U.S. Energy Information Administration, October 2012.

Figure 7. U.S. Bioethanol Balance*



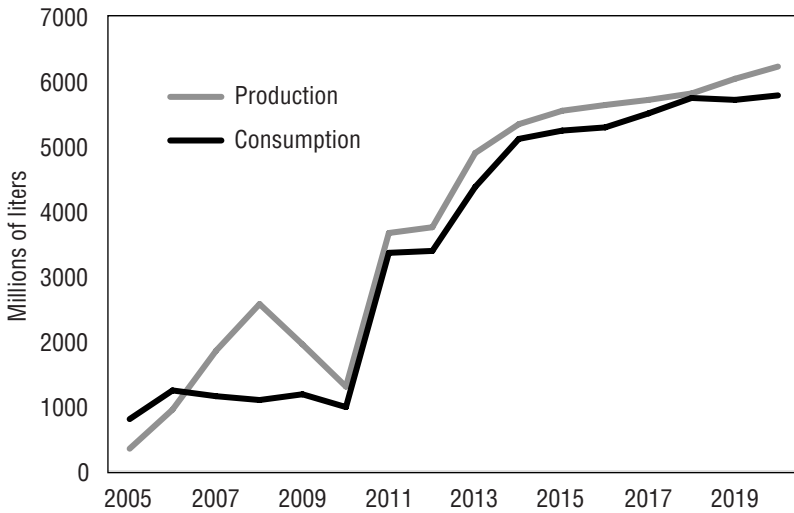
*2013 provisional value; 2010–2020 forecast values.
Source: OECDE statistical data.

vehicles. E10 was the maximum blend allowed for use in conventional vehicles until 2011, when EPA approved the use of 15% (E15) in all light duty vehicles from models after 2001. However outlet retail liability issues and automobile manufacturer warranties, which were not addressed by the approval, has held back consumer demand for E-15.

Ethanol consumption reached 12.9bn gallons (see Figure 7), above the conventional biofuels mandate for that year.¹⁶ The average concentration of ethanol in gasoline for 2011 was 9.6%, but it grew slightly to 9.7% in 2012 and has remained constant since.¹⁷ The implication is that ethanol consumption has reached a practical limit—known as the ethanol “blend wall.” Difficulties in expanding the market for E-15, together with weaker consumption will limit ethanol demand, especially for corn ethanol. As a result, U.S. trade

16. *Ibid.*

17. *Ibid.*

Figure 8. U.S. Biodiesel Production and Consumption, bn Liters*

*2013 provisional value; 2010–2020 forecast values.

Source: OECD statistical data.

with Brazil, the other major bioethanol producer, shifted during 2010 and 2011 as the U.S. became a net exporter of fuel ethanol. As in the case of the EU, the OECD projections to 2020 presented in Figure 7 could be too optimistic.

Biodiesel in the U.S.

Commercial production of biodiesel began in 2001—when 9mn gallons were produced primarily from soybean oil—and it has grown quickly ever since. Growing by 2% from 2012, biodiesel made up less than 3% of U.S. diesel fuel consumption in 2013. As a result, the biodiesel industry still has room to grow without major changes in the existing vehicle fleet—given that it is still below the 5% (by volume) threshold approved for use in all diesel engines. The U.S. has been exporting more biodiesel than it imports, although that could change in the coming years as more biodiesel is consumed in the domestic market in order to comply with RFS2 regulation.¹⁸

After declining in 2010, biodiesel consumption grew to 3.3bn liters in 2011 and 4.4bn liters in 2013 (see Figure 8). Biodiesel's share of all diesel fuel consumed in transportation peaked at 2.7% in 2013. Meanwhile, U.S. biodiesel production fell in 2010 to 1.3bn liters, 34% lower than in 2009, partly due to the expiration of the biodiesel tax credit at the end of that year. A reinstatement of the credit at the end of 2010, retroactive from the beginning of 2010, passed at the end of 2010, allowed the biodiesel production to recover in 2011. Demand for biodiesel also increased in 2011 and after as fuel blenders needed an increased volume of 1.2bn gallons of biomass-based biodiesel to comply with RFS2 mandates.

Conclusion

Future Development

Biofuels can replace fossil-based fuels without major changes to current vehicles or the distribution chain. This simple conclusion summarizes the entire discussion about the need for alternative energy for transportation. Nevertheless, specific energy content of biofuels—particularly that of ethanol—is still lower than for their fossil counterparts; but vehicle engines can still be run efficiently with biofuels or biofuel blends (a 10% maximum in both the EU and U.S., where strict exhaust pipe emissions control standards are maintained). Such a conclusion implies that environmental concerns have not been the major driving force behind their development. It was not a desire to reduce greenhouse gas emissions reduction from transportation that triggered the biofuel mandates; rather it was a process of political and strategic decisions to reduce dependence on imported crude oil. Today, however, biofuel policies have also become focused on the reduction of greenhouse gas emissions from transportation, particularly across the Northern Atlantic.

Biofuel support policies in these three Atlantic biofuel markets (Brazil, the EU and U.S.) respond to different strategies and implementation programs. Whereas Brazil seeks to consolidate the ethanol market and to make ethanol an internationally recognized alternative

18. *Ibid.*

to hydrocarbon fuels, the U.S. promotes the production of ‘second generation’ biofuels, adapting mandates yearly to adjust to changes in foreseen production. For its part, the EU is more focused on the sustainability of the biofuel feedstock. Finally, Africa is nearly absent from the budding biofuels realities, yet it is no doubt the sub-region of the Atlantic Basin with the greatest production potential.

Brazil is the second largest ethanol producer after the U.S. Brazilian ethanol has the highest CO₂ life cycle reduction (more than 60%) and for this reason it faces a strict requirement from the U.S. (as well as from some EU countries) to comply with RFS mandates and standards. Following Brazil’s example, other Latin American countries have begun ethanol production and established ethanol blending mandates (E5 in Argentina and Uruguay, for example, and E8 in Colombia (E8). This trend will further develop a South American market for ethanol. Furthermore, although Brazil is now self-sufficient in crude oil, liquid fuels consumption has surpassed liquid fuels production since 2007, while economic growth continues to drive up transportation fuel consumption. As a result, ethanol demand is likely to increase still further in Brazil.

In contrast with Brazil, the U.S. transportation fuels market—an even larger market for ethanol than in Brazil—is now on the decline. As mentioned above, U.S. consumption is close to the ethanol blending wall. Therefore, if new engines prove incapable of accepting a 15% ethanol blend with gasoline, excess production capacity of first generation ethanol will build-up, with exportation as the only alternative.

The situation is quite different on the other side of the Atlantic. The EU is the world’s largest diesel consumer. The EU transportation fuel market is, therefore, the largest biodiesel market globally. Nevertheless, this market is already on the decline. In addition, EU soil is not especially appropriate for the cultivation of the crops needed for oil extraction (except for rapeseed which has low yields). As a result, feedstocks for biodiesel production have had to be imported and the cultivation of oil crops abroad promoted by granting special import tariff benefits (allowed for under GSP clauses of WTO) to developing countries and by applying EU sustainability standards to their production as well. For this reason, sustainability aspects of the RED started

to be required and the 10% biofuel target in transportation fuel by 2020 was replaced by 10% renewable energy.¹⁹

On the other hand, the biodiesel industry in Brazil is still incipient; production costs remain too high for its biodiesel to compete in international markets. Diesel consumption in Brazil constitutes some 60% of all liquid fuels consumption, and the 5% blending mandate introduced in 2010 will create a large internal market with production regulated by the government. The situation is different in Argentina. After the EU imposed anti-dumping tariffs on Argentine biodiesel, the blending mandate in Argentina was increased from 8% to 10% and electric power plants were required to run on B10.

Other countries in the Atlantic Basin have also promoted biofuels. As a stimulus for domestic production, South Africa has approved a 2% biofuel blending mandate for all transportation liquid fuels. Furthermore, given that large stretches of the West African coast are appropriate for sugarcane cultivation, many African states are beginning to seriously consider biofuels production. This in turn will provide Brazilian producers with the opportunity to further expand the global ethanol market by developing biofuel production projects in the countries of Atlantic Africa.

The Possibility of Pan-Atlantic Cooperation in Biofuels

Biofuels offer many potential vectors for transnational collaboration within the Atlantic Hemisphere. Biofuels can diversify transportation energy supplies; contribute to mitigate greenhouse gas emissions; generate new markets for agricultural commodities, strengthen export income; attract investment; and enhance local industrial capacities. Because biofuels are located at the complex scientific and policy nexus of energy, agriculture, land-use, climate change and sustainable development, much could be gained by deepening collaboration and sharing good practice across the Atlantic space.

Nascent cooperation is already under way. Africa also holds enormous biofuel potential, which Brazil is exploring together with its African partners, supporting extensive agricultural R&D in Africa

19. Directive 2009/28/EC of the European Parliament and the Council on the promotion of the use of energy from renewable sources, O.J. L140/16.

focused on both foodstuffs and commodities as well potential biofuels production and export. Brazil and the U.S. have also been collaborating on biofuels R&D, biofuels assistance to Latin-American, Caribbean and Africa countries, and consultative discussions aimed at designing a standardized international commodity regime for biofuels.

These collaborative ventures offer an initial foundation for broader pan-Atlantic cooperative engagement that would include the EU—the Basin's most important net biofuels importer—as well as additional African, North and Latin American countries.

An Atlantic biofuels initiative could usefully address (1) the international effort to create an effective commodity regime for biofuels; (2) collaboration in the realm of biofuels research, development, investment, production, distribution and regulation, particularly regarding second- generation cellulosic biofuels technology; (3) the potential distortions of, or risks posed by, large-scale public support and/or use of biofuels, to food security, the environment, economic development and trade; (4) rationalization and standardization of current biofuel statistics, which is plagued by inconsistencies. Pan-Atlantic agreements in these areas would not only advance this industry across the Atlantic Basin, they could form the core of global approaches.

Annex

Table 2 shows the characteristics oil-based transportation fuels along with those of potential alternative fuels that can be produced from biomass.²⁰ Biofuel liquids are the closest to petroleum fuels in terms of energy content per unit volume. Another favorable characteristic of liquid biofuels is their blending flexibility with petroleum fuels, which facilitates their partial and progressive incorporation into existing petroleum-based fuel stocks and their feasible utilization within the existing liquid fuel distribution infrastructure. However, with the exception of synthetic fuels derived from biomass and hydrogenated vegetable oils, liquid biofuels should not face difficulties complying with the instability and physical specifications required in order to be

20. A. Schäfer, J.B. Heywood, H.D. Jacoby and I.A. Waitz, *Transportation in a Climate Constrained World*, MIT Press, 2009.

Table 3-2. Characteristics of Transport Fuels

Fuel	C/H ratio	Energy content MJ/l	Energy content MJ/kg	CO ₂ emissions (gCO ₂ /MJ)	Density (kg/l)	Octane number	Stoichiometric ratio air/fuel (kg _{air} /kg _{fuel})	Flammability limit fuel/air (vol%)
Gasoline	0.54	32.2	44.3	73	0.745	85-98	14.8	0.6-8.0
Diesel	0.55	35.5	43.0	74	0.835	-	14.5	0.6-7.5
Ethanol	0.33	21.3	26.8	71.4	0.794	98-117	9.0	3.5-16
Methanol	0.25	19.9	-	69.8	0.793	-	6.5	5.5-26
ETBE	-	27.2	36.3	71.3	0.75	100-117	13.0	1.4-10.0
MTBE	-	26.1	35.1	71	0.745	100-115	13.0	-
FAME	0.5	32.8	36.8	75	0.89	-	13.8	-
Metane								
CNG (248 bar)	0.25	10.4	50	55	0.208	120	17.2	5.0-15.0
LNG	0.25	21	50	55	0.420	120	17.2	5.0-15.0
Hydrogen								
CH ₂ (345 bar)	0	2.8	120	0	0.023	60	34.3	4.0-77
LH ₂	0	8.5	120	0	0.0708	60	34.3	4.0-77

 Source: A. Schäfer, J.B. Heywood, H.D. Jacoby and I.A. Waitz, *Transportation in a Climate Constrained World*, MIT Press, 2009

blended with current oil-based fuels while ensuring that can be safely used by existing vehicle fleet.

Bioethanol is already being blended with gasoline (up to 10% by volume). Higher blending shares, however, would require changes in current distribution infrastructure and adaptation of vehicle fleet. In this regard, new flexible fuel (or flex-fuel) vehicles, capable of operating with pure gasoline or with a gasoline blend of up to 85% ethanol.

Tighter blending specifications and other relevant constraints are applied to biodiesel-diesel blends. Biodiesel-diesel blends of up to 8% biodiesel (by volume) can be distributed and used by current fuel and vehicle infrastructure, and do not require special marking at the pump. Blends with higher biodiesel shares of up to 20 to 30% can be used by truck fleets and off-road vehicles (although they do require specific blending and distribution systems).

Classification of Biofuels

Biofuels are commonly divided into the categories of first and second generation biofuels. Typically, this will depend on when the production technology in question was developed, however, it is possible for the same biofuel to be classified differently, based on the type of oil product that it substitutes, or on the relative maturity of the technology. The most common classificatory distinction is between conventional and advanced biofuels, a different based on the relative maturity of technology.²¹

Conventional biofuels include those produced by well-established technologies that are already producing biofuels commercially. Such conventional biofuels—also referred to as first generation biofuels—include starch- and sugar-based ethanol, biodiesel produced from vegetable oils, and biogas derived from anaerobic digesters. The raw materials most extensively used among first generation processes include: sugarcane (Brazil), sugar beet (Europe), and starch- containing grains like corn (U.S.) or wheat (Europe) for bioethanol; and oil seeds, like rapeseed (Europe), or soybeans and crops like palm oil (Africa) for biodiesel.

21. International Energy Agency (IEA), *Technology Roadmap: Biofuels for Transport*, 2011.

Advanced biofuels—commonly known as second or third generation biofuels—refer to those production technologies based on biomass feedstocks that do not compete with food supplies (a widespread concern with respect to many first generation contexts) and that are presently at the research, pilot or demonstration stage. Production of bioethanol from cellulosic biomasses, hydrogenated vegetable oil (HVO), oils based on animal fats, biomass to liquids (BTL)-produced diesel, bio-synthetic methanol, or gas are all classified as advanced biofuels. Technologies now at the R&D stage—like algae-produced biodiesel or diesel biofuels produced from sugars by biocatalysts—are also included in this group.

Conventional biofuels

Bioethanol. Production of ethanol by fermentation of sugars has been a well-known process for thousands of years. Today the fermentation process has been researched and improved upon. New yeast strains, more ethanol resistant, have been developed, and fermentation efficiency is now close to the theoretical value (or potential level). Similarly, efficiency of ethanol concentration and dehydration processes have been improved and new processes developed.

In the case of sugar-to-ethanol, sucrose is extracted directly from sugar crops (sugar cane or sugar beet) and then fermented into ethanol. The ethanol is recovered, concentrated and dehydrated. The production process from starch (polymer of chain and branched glucose units) requires an additional step: the hydrolysis of starch into glucose. It therefore requires more energy than does the sugar route.

The fermentation and ethanol recovery, concentration and dehydration stages are almost identical, regardless of whether the ethanol is produced from sugar crops or starchy grains. Both processes generate valuable by-products. In the case of sugar cane, the fiber left after the juice extraction is used to generate heat and electricity for fermentation and ethanol concentration. With corn and other starchy crops, dried distiller grain (DDGS) is produced, and then sold as livestock feed.

Bioethanol production costs are dominated by feedstock costs. Since conversion efficiency of the fermentation and ethanol concentration is approaching its theoretical value, the cost reduction possibilities for conventional bioethanol are very limited.

Biodiesel. Biodiesel is produced from raw vegetable oils derived from rapeseed, soybean or palm, as well as from used cooking oils. Vegetable oils are triglycerides, compounds formed by the combination (esterification) of one molecule of glycerin and three molecules of a fatty acid. Fatty acids are straight chain organic acids with 8 to 18 carbon atoms.

To make biodiesel, glycerin has to be separated from the fatty acid and replaced by methanol or ethanol, this process (trans-esterification) takes place by mixing the oil with methanol or ethanol under alkali or acid catalyst. Each molecule of oil gives three molecules of biodiesel (Fatty Acid Methyl (FAME) or Ethyl (FAEE) esters and glycerin. Esterification with methanol is more efficient, cheaper and has better fuel properties; therefore FAME is the more widespread commercial biodiesel. During the biodiesel production process conditions must be controlled to minimize or avoid the presence of free fatty acids, mono- and di-glycerides, glycerin or methanol to achieve a product that meets stringent fuel standards.

The production cost of biodiesel is also dominated by the feedstock price, which is 5 to 10 times higher than the other operating costs. Taking the high and low feedstock costs between 2009 and 2012 would yield a cost per liter between 0.8 to 1.2 US\$/liter for soy bean-based biodiesel in the U.S. and 0.67 to 1.4 US\$/liter for rapeseed base biodiesel in Europe.²²

The cost for methanol is the main non-feedstock operating cost for biodiesel production. The cost of fuel for process heat is also important, although it remains much lower than that of methanol. The revenue from glycerin produced as a byproduct is dependent on the market price for this product, and typically falls in the range between 0.01 to 0.06 US\$/liter of biodiesel.

Biogas. Biogas is produced by anaerobic digestion of organic waste with high moisture content such as animal manure, sewage sludge, agricultural waste, etc. Anaerobic digestion is a naturally occurring process, and can provide an effective means for treating industrial,

22. IRENA, *Road Transport: The Cost of Renewable Solutions*. International Renewable Energy Agency (2013).

agricultural and municipal waste streams in continuously operated digesters.

Biogas is a mixture of methane and carbon dioxide with other minor constituents such as nitrogen, ammonia and hydrogen sulfide. Biogas is often used to produce heat and electricity, but it can also be upgraded to transportation fuel by removing carbon dioxide and hydrogen sulfide.

Biobutanol. Butanol is a primary alcohol with 4 carbon atoms which was produced by fermentation of sugars until 1950-60 when the fermentation was replaced by petrochemical processes with lower production costs. Butanol has higher energy content than ethanol and is less hygroscopic, for this reason it has raised growing interest as a bio-fuel, since it can be mixed with gasoline at higher concentrations than ethanol.²³

Biobutanol can be produced through anaerobic fermentation of sugars by clostridium strains, (mainly *Clostridium acetobutylicum*). Ethanol production plants can be easily revamped to the production of butanol, therefore it can be included within conventional biofuels. Although butanol is not yet commercialized, production facilities are under development and research on new and genetic engineered strains with higher production efficiency has attracted growing interest.

Advanced biofuels

Advanced biofuels are those produced from a diversity of feedstocks that do not compete with food supplies and through processes that are being developed to meet the fuel quality standards and the level of sustainability now required. The term is applied to biofuels produced from ligno-cellulosic or cellulosic biomass, non-food crops and industrial waste and residual streams.

Cellulosic ethanol. Bioethanol can be produced from ligno-cellulosic biomasses through the biochemical or chemical conversion of their cellulose and hemicellulose components into fermentable sugars; however, the biochemical conversion route appears to be the cheapest

23. E. Rajchenberg-Ceceña, J. A. Rodríguez-Ruiz, K. Juárez López, A. Martínez Jiménez, S. Morales Arrieta: *Bio-tecnología* 13 (3) (2009).

option. The sugars are then fermented to ethanol following the same steps as those for conventional ethanol.

The Biochemical Production Route to Bioethanol Requires Two Additional Steps with Respect to the Conventional Production Route:

- **Pretreatment:** this step is designed to prepare the ligno-cellulosic feedstock for further processing, allowing for the exposure of the cellulose and hemicellulose to the hydrolytic activity of enzymes or microorganisms—neither a simple nor a cheap task, given the strong bonds of celluloses and hemicelluloses to lignin.
- **Hydrolysis and lignin separation:** cellulolytic enzymes (cellulases) seem to be cheapest and more efficient, and give better yields. After hydrolysis, the separation of lignin allows for the fermentations of the sugars produced.

Total production costs of a cellulosic bioethanol plant are dominated by investment costs, indicating more complicated processing needs for ligno-cellulosic ethanol than for conventional varieties. Data for recently operational, under construction or planned advanced bioethanol plants have investments cost ranging from 1.5 to 4.5 US\$/liter year of capacity, two to six times higher than conventional ethanol plants. However, unlike conventional units, these plants are first of class units. Therefore substantial reductions in investment costs can be expected once these technologies are more developed.²⁴

Advanced biodiesel. Several process are already commercially viable (or at development stage) to produce liquid biofuels similar to diesel or kerosene. They are fully blendable with fossil fuels, can be distributed through existing infrastructure, and are compatible with current vehicle engines. The main production routes for advanced biodiesel production start from vegetable oil, animal fats and ligno-cellulosic biomass. These include:

- **Hydrogenated vegetable oils (HVO):** The catalytic hydrogenation of vegetable oils or animal fats is a well-known process and can produce high quality biodiesel. There are several demonstration and large scale plants in Finland, Singapore and

24. IRENA, op. cit.

Rotterdam. Similarly, the oils can be hydrogenated mixed with petroleum fractions in oil refineries to produce a mixture of biodiesel and diesel.²⁵ The HVO process could also be grouped among conventional first generation biofuels in those production cases that use virgin vegetable oils as the feedstock.

- **Thermochemical processes:** The thermochemical route to biodiesel includes those processes that involve thermal conversion of a ligno-cellulosic feedstock into liquid fuels, synthesis gas or bio-oils by pyrolysis or gasification processes.

The main routes for thermochemical diesel production are:

- *Biomass-to-liquids* (BtL): This is a similar process to the production of liquid fuels from coal (CtL). It includes biomass pretreatment, gasification with oxygen at high temperature (850 °C) to produce synthesis gas, purification of syn-gas and Fischer-Tropsch conversion to biodiesel.
- *Fast pyrolysis*: In this process biomass is rapidly heated in the absence of air at temperature within the range 400–600 and then quickly cooled to 100 °C to obtain bio-oil and bio-char, vapors and gases. Bio-oil can then be refined into biodiesel. Pyrolysis allows using biomass with larger particle size than gasification, saving pretreatment costs. Fast pyrolysis is an energy intensive process with a products distribution depending on how fast the biomass is heated and cooled.

There are not many commercial-scale plants in operation for advanced biodiesel production. As a result, capital expenditure and operating cost are yet to be determined with a minimum degree of confidence. The current cost estimates for commercial-scale vary with technology. Hydrogenation of animal fats and used cooking oil seem to have the lowest capital costs (in the range of 0.5 to 0.8 U.S.D./liter year of production capacity). From the thermochemical processes the fast pyrolysis is estimated to have capital costs around 1 US\$/liter year of production capacity. BTL processes are significantly more expensive, with estimated capital costs of around 3.5 US\$/liter year of capacity.²⁶

25. International Energy Agency, *Technology Roadmap: Biofuels for Transport* (2011).

26. IRENA, *Road Transport: The Cost of Renewable Solutions*. International Renewable Energy Agency (2013).

Chapter Four

**The Dynamics and Paradoxes
of the Atlantic Energy Renaissance¹**

Paul Isbell

The Shale Revolution

A significant transformation of the Atlantic Basin energy space has been under way for years now, but it has passed largely unnoticed, even in North America, where the focus on the shale revolution and its supposed promise to deliver national energy independence has tended to obscure from view the broader Atlantic energy renaissance, along with its own unique implications, risks, and opportunities. While the shale revolution has conceptually overrun former concerns of peak oil, it has also been cast through an overly rigid strategic focus—or geopolitical projection—that frames the potential of shale resources almost exclusively as a means to regain previously eroded economic competitiveness and global geopolitical influence, conceived of nearly entirely in national terms.

Exporting the Shale Revolution across the Northern Atlantic

At best, the potential of the shale revolution has been thought of in bilateral or transatlantic terms. If North America is now on track to become a significant net energy exporter over the next two decades, its transatlantic partners in Europe remain, by and large, highly dependent on the Great Crescent. Over half of the hydrocarbons consumed in the EU are supplied by Russia and the Middle East.² More than

1. This article has been derived—with significant updating and alteration suffered along the way—from an earlier analysis conducted for a scientific article submitted to the Atlantic Future research project of the European Commission. See: <http://www.atlanticfuture.eu/contents/view/an-atlantic-energy-renaissance>

2. Directorate-General for Energy, “Key Figures,” Market Observatory for Energy, European Commission, June 2011. (EC, 2011), British Petroleum, *Annual Statistical Review of Energy* (Database) 2013 (BP 2013a).

21% of all the EU's oil imports came from the Middle East in 2011, and some 50% of imports came from the Russia.³ In 2011, the EU imported three-quarters of its total gas consumption (448bcm).⁴ Around 35% of these imports—more than a quarter of total European gas consumption—was supplied by Russia.⁵

Although in the years since 2011 Europe's oil dependence on the Middle East has declined somewhat (mainly due to the imposition of trade sanctions on Iran), more recently-cited levels of Russian gas imports into the EU, reported in the context of the Ukrainian crises of 2014, have them as high as 130 bcm in 2012 and 162 bcm in 2013, reaching 30% of total EU gas consumption (Clingendael 2014, based on Gazprom data)⁶.

However, these levels of dependence on Russian gas for the EU as a whole are relatively modest enough to obscure the fact that in Central and Eastern Europe this external dependence on Russia is far higher (given that the northwestern and southwestern flanks of Europe basically do not consume Russian gas). Eastern European dependence on Russian gas is currently around 70% (on average as a sub-region). This is double the overall EU dependence ratio on Russian gas, and more or less the current level of Asia's external dependence on Middle East oil.

In the case of some of the smaller Eastern European and Baltic countries—typically (although not always) with economies in which gas makes up a relatively high share of the primary energy mix, and where fear of and antipathy towards Russia often can still be palpably felt, the relationship is one of near-total dependence on Russia. As a result, Europe tends to perceive an energy security risk as nearly inherent in its relationship with its eastern neighbor, even in the face of the traditional counter-argument that Russia is even more dependent on the EU as an essential export market for its gas.⁷

3. EU oil imports from the Middle East in 2011 accounted for 15% of all EU oil consumption (13mbd). Oil imports from Russia (4mbd) provided for 35% of total EU oil consumption. (BP 2013a).

4. In 2011, the EU imported 335bcm of a total 448bcm consumed. (BP 2013a).

5. Russia supplied 117bcm of gas to the EU in 2011. (EC 2011).

6. In addition, the EU is also dependent on Russia for 30% of its coal imports, while half of all Russian coal exports go to the EU.

7. Almost all Russian gas goes West in pipes; 50% to 70% to EU; the rest to Belarus, Ukraine, Caucasus, Turkey, and the Balkans. (BP 2013a).

This makes Europe an increasingly energy-dependent outlier within an increasingly autonomous Atlantic Basin energy space. Despite this, the shale revolution remains stalled in Europe. A number of obstacles continue to stand in its way over the near-to-midterm.⁸ These include: (1) economic uncertainties over the cost competitiveness of European shale basins; (2) legal and market barriers stemming from the distinct subsoil property rights regimes in Europe;⁹ (3) environmental anxiety over potential local pollution and water contamination; and (4) ongoing political opposition from the environmental movement and the EU low carbon political economy.¹⁰

This high level of energy dependence on the EU's problematic eastern land flanks casts a strategic spotlight on the aging traditional pipeline infrastructure, deployed in an increasingly compromised geographic and geopolitical pattern across the energy landscape of Central and Eastern Europe, which continues to tie Europe to the Great Crescent energy suppliers. In light of the Ukrainian crisis and the ongoing turmoil in the Middle East, there has been much renewed transatlantic discussion over the potential to reduce Europe's depend-

8. The same could be said of the southern Atlantic, where the potential in unconventional hydrocarbons is large. This is particularly true in Mexico, Argentina and South Africa—Atlantic countries where low carbon, environmental, and other local interests are beginning to resist the spread of shale gas but where energy reforms would also be required to generate more sustainable increases in gas production.

9. The shale revolution in the U.S. has been able to spread so rapidly because individual landowners also have property rights over the subsoil and its resources. They are able to sub-contract rights, or not, on their own decision immediately, and independent of any public policy debate. In Europe (indeed, in most of the rest of the world) this is not the case and the state generally controls subsoil rights. The implication is that shale companies will not be able to negotiate multiple independent agreements independent of public policy perceptions and ultimate state policy. This adds to the investor uncertainty already generated by the other barriers standing in the way of shale production in Europe.

10. Chief among the obstacles to—and risks associated with—further shale gas expansion will be the potential impact of fugitive emissions of methane on the ultimate carbon footprint of gas, which conventional wisdom assumes is 50% that of coal and 67% that of oil. Methane, the principal component of natural gas, is also a greenhouse gas which is potentially, if not typically, released with shale gas production (depending on geology and local regulation and safety controls). Because methane has approximately 34-times more heat-trapping capacity than carbon dioxide, the issue of fugitive emissions is the pivot upon which turns at least half of the shale revolution's ultimate rationale—to serve as a lower-carbon bridge fuel. For a fuller discussion of the risks and opportunities posed by the shale gas revolution, see Paul Isbell, *Energy and the Atlantic: The Shifting Energy Landscapes of the Atlantic Basin*, Washington, D.C.–Brussels, The German Marshall Fund, 2012. (Isbell, 2012a), pp. 76–98.

ence on the Great Crescent—and particularly Russia—by importing of liquefied natural gas (LNG) from the United States.

The idea of exporting the shale revolution to Europe—literally, by liquefying shale production and shipping it across the Atlantic—has been seized upon by many as a political project with which to renovate the strategic relevance of the transatlantic relationship. There have been calls for more collaborative action from the U.S.-EU Energy Council, and to include an energy chapter in the expected Transatlantic Trade and Investment Partnership (TTIP).

Nevertheless, U.S. LNG exports to Europe face opposition from a strange bedfellow alliance of large industrial and chemical companies (that would like to keep gas prices in the United States as low as possible to provide cheap energy and feedstocks) together with environmentalists (intent on blocking the development of hydrocarbons altogether). Perhaps more importantly, a number of Northern Atlantic energy analysts have also recently questioned the underlying economic rationale of U.S. LNG exports to Europe. The cost structure of Russian gas appears to be low enough to at least limit the potential for diversifying Europe's gas imports away from Russia in the immediate near-term. Nor is it entirely clear that U.S. LNG exports will ultimately be able to compete on cost with Russian gas in Europe (even if liquefied from relatively cheap shale gas), given the large up-front capital costs that would be required, both in the United States (for liquefaction) and in Europe (for regasification and for more European gas interconnections, particularly between Spain and France).¹¹

Despite these uncertainties, a number of efforts have commenced to boost U.S. gas exports to Europe. Indeed, a huge re-directional infrastructure shift is underway in the U.S., as regasification (import) plants are being reconverted into liquefaction (export) plants. In 2007, 30 U.S. projects were waiting for import approval; today, 30 are waiting for export approval, mainly along the Gulf of Mexico and the

11. For a skeptical assessment of the prospects for exporting LNG from the U.S. to Europe, see Tim Boersma and Geert Greving, "Why Russian Natural Gas Will Dominate European Markets," Brookings Opinions, February 24, 2014 (<http://www.brookings.edu/research/opinions/2014/02/24-russian-natural-gas-european-markets-boersma-greving>) (Boersma and Greving, 2014) and Andreas Goldthau and Tim Boersma, "The 2014 Ukraine-Russia Crisis: Implications for Energy Markets and Scholarship," *Energy Research & Social Science*, Volume 3, September 2014, pp. 13–15 (Goldthau and Boersma, 2014).

Atlantic coasts of North America. Cheniere plans to export LNG to Europe from its Sabine Pass facility by the end of 2015, while export approval has been granted to five other LNG export projects to begin production after 2016.

This first wave of projects alone could allow for some 9bcm a day of exports by the end of the decade, making the United States an overall net natural gas exporter by 2021. By 2025, the United States could be exporting as much as 40bcm of LNG a day (nearly 30% of current production levels)—if the entire application pipeline is eventually approved and executed. Although the United States is still importing about 8% of its gas consumption (mainly from Canada), by 2040 net export capacity will be about 12%.¹²

Successful conclusion of the TTIP would facilitate this process, as U.S. legislation grants automatic export approval of gas to countries that have signed a free trade agreement with the United States. (Otherwise, gas exports must obtain government approval, while crude exports remain banned.) But the crisis in the Ukraine has provoked discussions over the possibility of including specific energy chapters in the currently-under-negotiation TTIP, and debates over their potential contents.

A Pan-Atlantic Vision of Europe's Strategic Energy Horizon

It remains unlikely that any rapidly-conceived transatlantic effort to reduce European dependence on the Great Crescent would make much progress very rapidly in the short run—and this will be particularly true if such an effort remains exclusively northern Atlantic. Nevertheless, over the middle-run of 10 to 15 years out (between 2025 and 2030), the EU's dependencies on the Great Crescent could be strategically reoriented, even if not completely eliminated. But for such a strategic thrust to have any chance at sustainable success, even in the long run, it will require a deep inclusion of Atlantic partners from the Southern Atlantic.

12. Center for Strategic and International Studies (CSIS), *New Energy, New Geopolitics: Balancing Stability and Leverage*, April 2014 (CSIS, 2014)

A pan-Atlantic vision of a strategy to reduce European dependence on Russia based upon the broader possibilities of replacing these land-based energy import flows into Europe with seaborne flows from other parts of the Atlantic Basin—including the Mediterranean and broader Africa, Latin America, and the Caribbean, as well as North America—would offer a greater range of strategic options than would a purely Northern Atlantic crisis response. This is because many of the possibilities of the Atlantic energy renaissance are coming from the Southern Atlantic, where energy policy models and international energy politics are, in general, more fluid in the current dynamics than anywhere else in the world.

Although much African oil is already heading east to Asia, and a large portion—although not all—of U.S. gas exports will eventually go there as well, in the future much of Europe's flattening hydrocarbons demand could be met more cheaply—and more politically sustainably—by imports from Atlantic partners in Africa, Latin America, and North America. Much of future Atlantic Basin energy production potential has not yet been committed, politically or economically, to consumers in Asia-Pacific. Moreover, the majority of oil flows from Africa and Latin America to China that have captured headlines over the last decade were political products stemming from the international geopolitical adjustment to the end of the post-Cold War unipolar moment. While this adjustment has allowed for the first unencumbered expression of the longed-for emergence of the global South, the latter is not yet a consolidated or rigid feature on the current geopolitical map, leaving the future flow circuits of much of future Atlantic energy in a state of strategic fluidity and possibility.

Therefore, to take the most significant and outlier case, even if much of Venezuela's oil output over the middle run is already in hock to China, most of the future potential production of the Southern Atlantic (to be explored more below) has either not yet been assigned, or has at least been notionally assigned to energy companies (principally, the IOCs and smaller private companies, along with many Southern Atlantic NOCs, like Petrobras, Pemex, and Sonangol, among others) which could serve as credible private and public sector conduits for future intra-Atlantic energy shipments to Europe.

Indeed, it is only by including the Southern Atlantic squarely within Europe's strategic energy map that we can begin to see that it is precisely Southern Atlantic energy potential that would allow for an Atlantic Basin energy system (more below) to both provide Europe with a important strategic alternative to the Great Crescent energy imports, but also provide an increasing percentage share of the strategic energy barrel at the margin to economic and political energy consumers in Asia-Pacific in the future.

Beyond the enormous potential of the Southern Atlantic fossil-fuel and renewable energy offshore (to be explored in the following section), both Latin America and Africa also offer significant onshore shale gas possibilities. Currently, nearly all shale gas production takes place in North America, but other Atlantic Basin actors are likely to begin producing sometime before 2025. In particular, Argentina (with 802tcf, the third largest national shale gas reserves after the U.S. and China) and Mexico (545tcf) are both likely to begin shale production before other countries in the extra-Atlantic (with the possible exception of China).¹³

First, large gas infrastructures (including field development, pipelines and international interconnections) already exist in these two Atlantic Basin countries, although in some instances they are now in the early stages of decay. Meanwhile, their national trade balances, once in surplus on the strength of hydrocarbons exports, now contribute to a deficit (or increasingly close to a deficit, in the case of Mexico), as investment and production have languished over the last decade. Still, with so much gas infrastructure already in place and with large shale reserves in the ground, there will be growing economic incentive to invest in sufficient infrastructure upgrading to take advantage of the shale potential.

Furthermore, both countries are ripe for energy policy reform. Indeed, Mexico has recently adopted an energy sector reform program and is currently attempting to effectively implement it. In Argentina, energy sector reform will become possible once the coming presidential election clears the fog from that country's strategic horizons. So

13. Energy Information Agency (EIA), "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," June 2013 (EIA, 2013)

large is the potential upside for shale gas to enhance national economic competitiveness in countries like Argentina and Mexico (assuming reliable environmental sustainability)—and even to unleash a national economic renaissance—that a successful evolution of reform in Mexico, with subsequent development of unconventional hydrocarbons, could serve as sufficient inducement for the various rival interest groups in Argentina to resolve decades-long policy distortions, juridical uncertainty, and reform deadlock—once the critical, if controversial and multiple, Kirchner legacies are sorted out and absorbed by the Argentine body politic.

In Africa, shale possibilities which are large in relation to national consumption stand out in Morocco, Algeria, and South Africa, although in each case there are either political barriers or other strategic options which will probably push back shale development into the future. Morocco is pursuing renewable energy; Algeria places priority on its already large conventional gas reserves; and South Africa is currently pursuing conventional gas supplies—both onshore and offshore—in East Africa, where significant hydrocarbons resources have finally appeared on the horizon. Nevertheless, all of these Southern Atlantic shale possibilities—more immediate or more distant—contribute still further to the tangible possibility of an increasingly geopolitical significant—and potentially fungible and unified—Atlantic energy space in the coming future.

The Atlantic Offshore Revolution

The Northern Atlantic Offshore

Offshore oil and gas production has also long been well established in Northern Europe, particularly in the North Sea production zone—the site of one of the earliest antecedents to the Atlantic energy renaissance—where Norway, the UK, and the Netherlands, in that order, are the major producers. Today, however, the U.S. Gulf of Mexico is the most developed offshore oil-and-gas region in the world. Following the 2010 Deepwater Horizon disaster, the Gulf offshore has recovered, and is now poised for strong growth. Furthermore, the Mexican Gulf offshore—which in large part includes the extensions of producing or promising deposit formations on the U.S. side of the maritime border—will be one of the primary beneficiaries

of a successful implementation of the energy reforms of the Pena Nieto government.

Meanwhile, a number of Atlantic oil companies have high hopes of discovering significant offshore oil in other parts of the Northern Atlantic (like Northeast Canada), or along the mid-rift frontier of the Atlantic seascape—from the Mexican Gulf to the Moroccan offshore—between its two sub-basins (like Cuba or the Canary Islands), although no major finds (with the possible exception of Greenland) have occurred so far.

The Southern Atlantic Offshore

In the Southern Atlantic, Brazil is likely to emerge over the coming decade as a significant oil exporter with the potential capacity to pump as much as much 4 to 5mbd from a growing amount pre-salt deep water reserves.¹⁴ Although BP reports Brazil's proved oil reserves at only 15bn barrels in 2012, most international estimates put the likely eventual total at between 50bn and 100bn barrels, while many Brazilian estimates have them between 100bn and 200bn barrels, the majority of it in deep offshore pre-salt formations.

Furthermore, as the Rand Corporation reported in 2012, geologists estimate that the Gulf of Guinea's oil and gas reserves, already among the richest in the world, are roughly triple (180bn bbl) current proven totals (which BP put at 57bn bbl in 2012).¹⁵ Successful Brazilian offshore exploration, together with discoveries off Ghana, have spurred a deep offshore exploration boom (and in many cases, like Ghana, Angola, and Brazil, a production boom as well) all along the Atlantic coasts of South America and Africa—from Surinam and Guyana to Argentina, from Morocco to Namibia.¹⁶

Moreover, a Southern Atlantic Oil Ring is now forming, stimulated by the enticing (and increasingly verified) Mirror Theory.¹⁷ Geolo-

14. See Isbell, 2012a.

15. See: http://www.rand.org/content/dam/rand/pubs/technical_reports/2012/RAND_TR1144z4.pdf

16. See Isbell, 2012a.

17. See Benjamin Auge in Chapter Two, along with Tim Ridout, "The Atlantic Mirror: The South Atlantic Basin as a Future Energy Hub," German Marshall Fund of the U.S., October 21, 2013. (Ridout, 2013) and Justin T. Stolte, "Testing the Atlantic Mirror Theory," *Oil & Gas Journal*, April 2013 (Stolte, 2013).

gists have posited—in part based on our increasing understanding of the drivers of continental drift—that the Brazilian deep offshore deposits geologically mirror deep water formations along the lower (North-South) coast of the Gulf of Guinea (e.g., offshore Angola) and that the Surinam-Guyana basins mirror the offshore of Ghana and the rest of the West Africa Transform Margin farther to the west (off the coast of the Ivory Coast, Liberia, Sierra Leone, Guinea, Senegal, and Gambia) where over 5bn bbl have been discovered in only 5 years of exploration, according to the Gwondana Oil Corporation, with a 65% drilling success rate.¹⁸

The Strategic Significance of the Atlantic Basin Offshore

The fastest growing segment of the hydrocarbon market is the offshore—a reflection of the ongoing shift in relative strategic significance from the energy landscape to the seascape. Two-thirds (58mbd) of the world's oil production (86mbd) occurs onshore, while 33% (28mbd) comes from offshore (approximately 20mbd from shallow waters and some 8mbd in the deep offshore).¹⁹ Offshore oil's share of global oil production has more than doubled since 1980—from less than 15% to nearly one-third today—rising in absolute daily production terms from 8.9mbd to 28mbd in 2010.²⁰ Since then, offshore oil production has accounted for all of the net increase in global oil production (+20mbd, from 66mbd to 86mbd), as onshore production has fallen from a peak in 1970 of over 60mbd and now appears to have entered a period of stagnation and decline.²¹

Of the current global offshore oil production, over 60% is produced in the Atlantic Basin (see Figure 1). The Southern Atlantic, meanwhile, accounts for three-fifths of all Atlantic offshore oil, and is likely to see its share rise still further as a result of the Brazilian pre-salt deposits coming into production.²²

18. See http://www.gondwanaoil.com/?page_id=79.

19. Infield Energy Analysts, "Subsea Market Watch 2014-2018," Subsea White Paper, 2014 (Infield, 2014).

20. IFP Energie Nouvelle, "Panorama 2012: A Look at Offshore Hydrocarbons," 2012 (IFP 2012), and BP 2013a.

21. Infield, 2014.

22. Meanwhile, a growing share of wind production is also taking place offshore, while other forms of marine energy (wave, tidal, current etc.) are now on the midterm horizon (Holthus, 2012b; IPCC 2011). According to the IEA: "Current world electricity demand is 17,500

Figure 1a. Offshore Oil Production by Major Region, % of Global Total, 2012

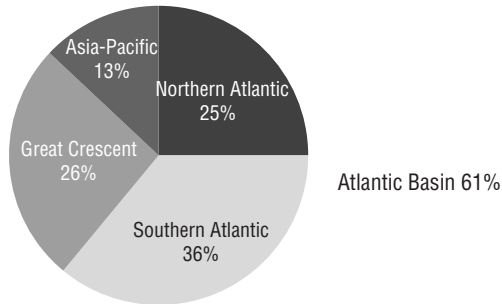
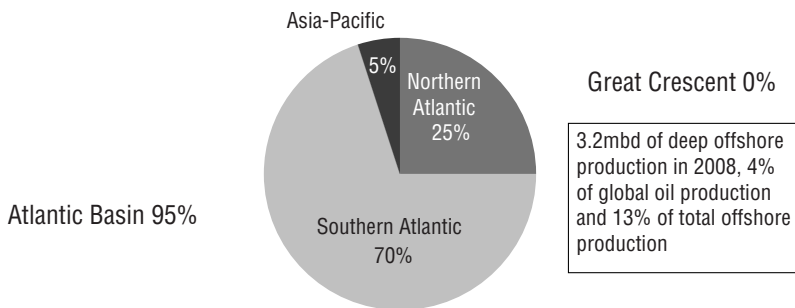


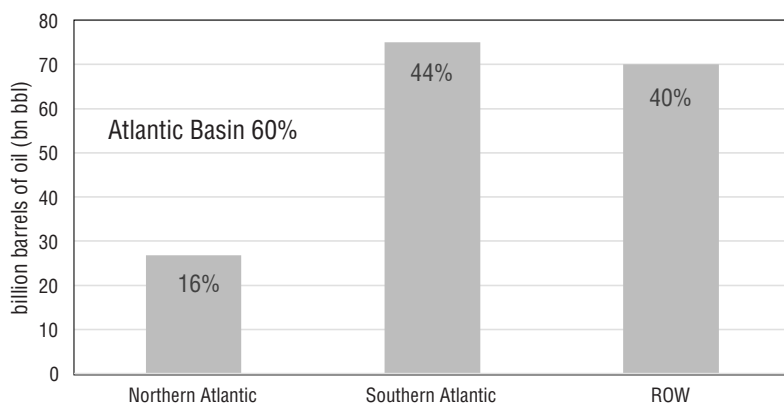
Figure 1b. Deep Offshore (> 1000 meters) Oil Production by Major Region, % of Global Total, 2008



Source: IFP Energie Nouvelle, "Panorama 2012: A Look at Offshore Hydrocarbons," 2012.

Because offshore oil accounted for 20% (or 280bn bbl) of the remaining global proven reserves in 2010 (and for 25% of offshore gas, or 470bn barrels of oil equivalent), offshore hydrocarbons are widely considered to be a non-negotiable imperative for oil companies, even despite multiple technological challenges. The reality is that global offshore offers three times as much potential oil as the Arctic

TWh. There is the potential to develop 20,000-80,000 TWh of electricity generated by changes in ocean temperatures, salt content, and the movement of tides, currents, waves and swells. These technologies are proven." However, the IEA goes on to point out that "... there are siting and environmental issues. Ports, coastal waters, and the open sea are divided into fishing permit areas and shipping routes. *To capitalize on this energy source, international collaboration is necessary.*" See: <http://www.iea.org/techinitiatives/renewableenergy/ocean/>.

Figure 2. Offshore Oil Discoveries, by Major Region, bn bbl and % of Global Total, 1995–2012

Source: Deutsche Bank and Wood Mackenzie.

(280bn bbl versus 90bn bbl), while the Atlantic Basin offshore alone holds two-thirds more. As we will see further below, just the Southern Atlantic offshore (approximately 130bn bbl of reserves, and 50bn in the ultra-deep offshore) offers more than comparable magnitudes of petroleum than those believed to exist beneath the Arctic seabed.²³ Indeed, already the Atlantic offshore has made the speculative hydrocarbons of the Arctic largely irrelevant.

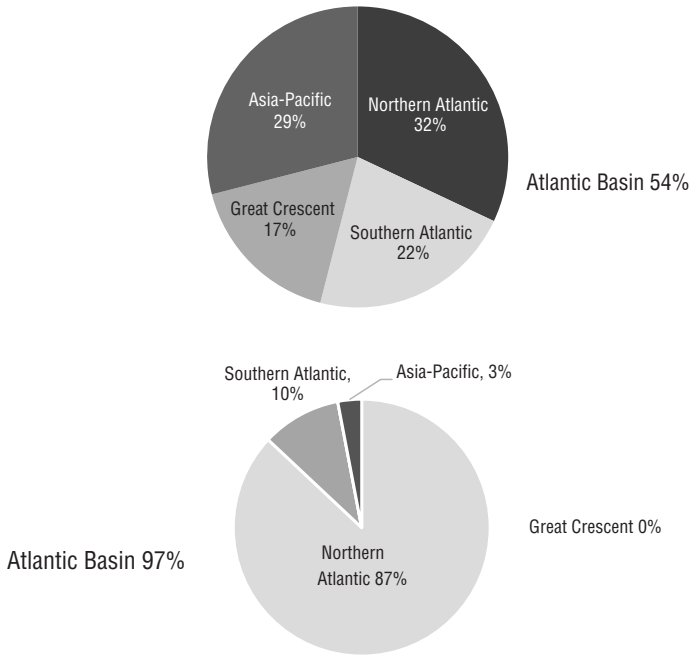
Deep offshore oil reserves (discovered in water depths greater than 1000m) were estimated in 2008 to come to 72bn bbl—approximately 25% of total offshore oil reserves (280bn bbl) or some 5% of total global petroleum proven reserves. Of the 450 oil fields worldwide in the deep offshore, 82% are located in the Atlantic Basin—and 44% are in the Southern Atlantic (see Figure 2). Over 90% of the total 72bn bbl of global deep offshore oil reserves are held by four Atlantic Basin countries (the U.S., Brazil, Angola and Nigeria).²⁴

Current offshore gas production accounts for some 27% of total global gas production. Over half (54%) of this global offshore gas production occurs in the Atlantic Basin (see Figure 4). Furthermore, while

23. IFP 2012.

24. *Ibid.*

Figure 3. Offshore and Deep Offshore Gas Production, by Major Region, % of Global Total, 2012



Source: IFP Energie Nouvelle, "Panorama 2012: A Look at Offshore Hydrocarbons," 2012.

the Atlantic Basin's reserves of deep offshore gas in waters greater than 1000m deep amount to only 23% of the total, its share of deep offshore gas production is currently 97% (see Figure 3)—although it only accounts for 2% of global gas production. Australia, the world's largest deep offshore gas reserve holder with 40% of the global total, is likely to increase its production share in the future.²⁵

Offshore Hydrocarbons Investment in the Atlantic Energy Seascape

Offshore Oil Investment. Investment in offshore oil production is now over U.S.\$100bn annually, accounting for one-fifth of all global investment in oil exploration and development worldwide.²⁶ Of all

25. *Ibid.*

26. *Ibid.*

CAPEX investment spending on offshore oil projected to take place in 2012-2018, 61% will be invested in the Atlantic Basin, as will 93% of all projected global CAPEX in the ultra-deep offshore during the same period. An updated projection by Infield Systems now sees the Atlantic Basin's share of total offshore (subsea) CAPEX in 2014-18 rising to 83%.²⁷

Deep Offshore Oil and Gas Investment. Between 2011 and 2015, new reserves of oil and gas to be developed in the deep and ultra-deep offshore were estimated at 28bn bbl.²⁸ Such developments will require investment of U.S.\$210bn in subsea pipelines and flow systems (38%), subsea completions (36%) and platforms (20%) in order to bring 1,300 subsea wells in to operation. This total is 60% higher than the previous period 2006–2010.²⁹ As a result, in the future deep and ultra-deep offshore developments are likely to provide the majority of growth in offshore oil and gas production. More than 80% of this combined investment in deep offshore oil and gas is projected to take place in the Atlantic Basin (see Figure 4), and over two-thirds of this Atlantic share will be destined for the Southern Atlantic. Furthermore, 75% (or U.S. \$150bn) of this deep offshore hydrocarbon investment planned for 2011-2015 will be undertaken by just six Atlantic Basin oil companies (in descending order with the size of investment): Petrobras, Total, Chevron, BP, Shell, and ExxonMobil.³⁰

The Atlantic Basin Low Carbon Revolution at the Strategic Crossroads

Until the implications of the shale and offshore revolutions became apparent, the low carbon revolution, particularly in the Northern Atlantic, was spearheading the early Atlantic energy renaissance. Renewable energy has become even more highly concentrated in the Atlantic Basin than are the traditional fossil fuels. Considering the basin's collective installed capacities for solar (77% of the world total), wind (64%) and geothermal (59%), Atlantic renewables (also known

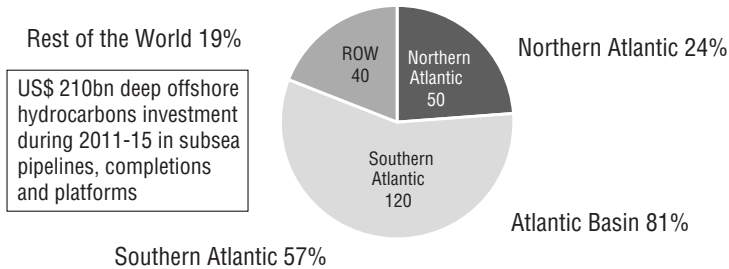
27. Infield, 2014.

28. IFP, 2012.

29. Infield, 2014.

30. IFP, 2012.

Figure 4. Deep Offshore Hydrocarbons Investment by Major Region, U.S.\$bn and %, 2011-2015



Source: IFP Energie Nouvelle, "Panorama 2012: A Look at Offshore Hydrocarbons," 2012.

as NRETs, or non-conventional renewable energy technologies) constitute roughly two-thirds of the world's total installed renewable electricity capacity. In terms of generation and consumption, the Atlantic accounts for more than 75% of total global modern renewable energy (BP 2013a). But despite this apparent impressive Atlantic dominance in non-conventional renewable energy technologies, the Atlantic Basin's current lead in the roll-out of modern renewables remains either insufficient, irrelevant, or unsustainable.

The Shale Revolution and Renewable Energy in the Northern Atlantic

For the two decades preceding the financial crisis of 2008, renewable energies faced an increasingly favorable policy and commercial landscape. But a combination of abrupt pressures and constraints coming from shifting global trends colliding with the worst global economic crisis since the Great Depression generated a political backlash against climate change policies, and a market whiplash against low-carbon energy that has significantly undermined renewable energy rollout.

State policies and business models put into place during the decade prior to the Great Recession and the Shale Revolution by Northern Atlantic public and private sector actors to accelerate the deployment of low carbon technologies have since been either reversed or effectively neutered by the energy market impact of cheap U.S. gas and the political discourse it has produced. Indeed, the energy policy environ-

ment of the northern Atlantic has recently been turned on its head by the cumulative effect of a number of policy and market reversals.

First, there was the so-called death of U.S. cap-and-trade legislation in the fall of 2009 and winter of 2010. Then came an inundation of Chinese solar panels onto the global solar market, just as Northern Atlantic investment community made a risk-averse turn with respect to renewable energy. After that, came the Euro crisis and the reversal of much European state support for renewables (the dramatic, retroactive reduction of support in Spain being perhaps the most significant and emblematic European case). And then the full effects of the shale revolution in the United States were felt across the Atlantic Basin. This slowing effect on the trajectory of renewable energy has been underway for more than five years now as the result of the downward pressure not just on the structure of global gas prices, but also, in market-linked fashion (via the substitution effect), on the price of coal—the very fuel that gas is supposed to be a bridge away from. In the end, these recent changes in the energy policy environment have contributed to a re-carbonization of the Atlantic Basin energy trajectory.

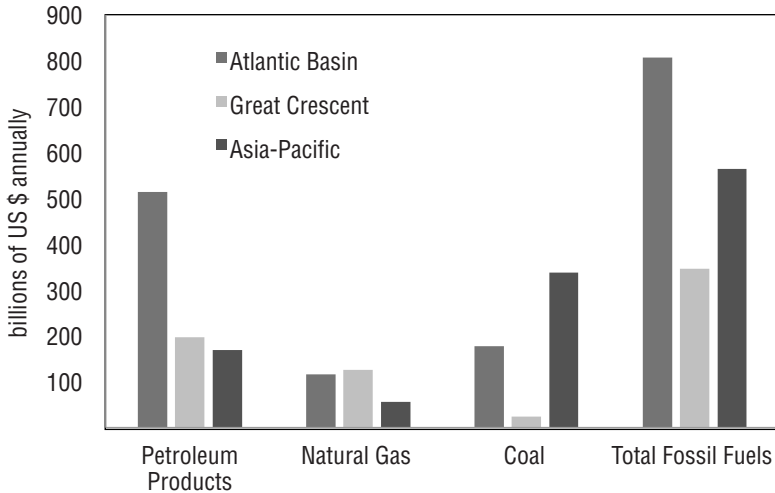
Another perverse dynamic still at play in the Atlantic Basin energy space is that between lingering, if rapidly disappearing, cost differentials between renewable energies and fossil fuels, on the one hand, and a lopsided public subsidy advantage for fossil fuels, on the other. Such levelized cost (or LCOE) differentials have recently all but evaporated in the Northern Atlantic, while in the Southern Atlantic they have fallen to only U.S. \$0.12/kWh and U.S. \$0.06/kWh for grid-connected solar and wind power, respectively.³¹ At the same time, recent studies suggest that the societal benefits of NRETs in the Southern Atlantic (including the avoided costs of carbon emissions and particulate pollution, along with additional economic benefits in terms of improved balance of payments and net job creation) could be as high as two to four times more than these levelized cost differentials.³²

However, the economic, technological, and market trends now swinging in favor of low carbon energies are more than nullified by a

31. Walter Vergara et al., “Societal Benefits of Renewable Energy in Latin America and the Caribbean,” IDB Technical Note, January 2014 (<http://publications.iadb.org/handle/11319/6034?locale-attribute=en>) (Vergara, et al, 2014).

32. Vergara, et al, 2014.

Figure 5. Global Fossil Fuel Energy Subsidies, by Fuel and by Major Region, 2011



Source: International Monetary Fund, *Energy Subsidy Reform—Lessons and Implications*, 2013
<http://www.imf.org/external/np/pp/eng/2013/012813.pdf>.

Note: These are post-tax fossil fuel subsidies, including both direct subsidies and indirect tax expenditures and exemptions, represented in U.S. dollars value.

level of public support for—or subsidization of—fossil fuel use that is more than five times greater than the level of state support for renewable energies worldwide (101bn U.S. dollars). Post-tax public subsidies to fossil fuels worldwide amounted to 1.7 trillion U.S. dollars last year,³³ while direct subsidies for fossil fuels (not including indirect support from tax breaks and exemptions) alone came to 544bn U.S. dollars in 2012.³⁴ Figure 5 reveals the level of fossil fuel subsidies in the Atlantic Basin, compared with other major regions in 2011.

The Atlantic Basin provides 58% of all post-tax subsidies to oil (513bn U.S. dollars of 807bn U.S. dollars globally) and 47% of all fossil subsidies worldwide (806bn U.S. dollars of 1.7tn U.S. dollars). The Great Crescent is the largest subsidizer of gas (42%—126bn of 299bn

33. International Monetary Fund, *Energy Subsidy Reform—Lessons and Implications*, 2013
<http://www.imf.org/external/np/pp/eng/2013/012813.pdf>. (IMF 2013).

34. IEA *World Energy Outlook 2013*, IEA, Paris, 2013 (IEA 2013).

U.S. dollars—and 20% of all fossil subsidies), while Asia-Pacific accounts for 63% of global coal subsidies (338bn U.S. dollars of 539bn U.S. dollars) and for 33% of all fossil fuel subsidies globally.

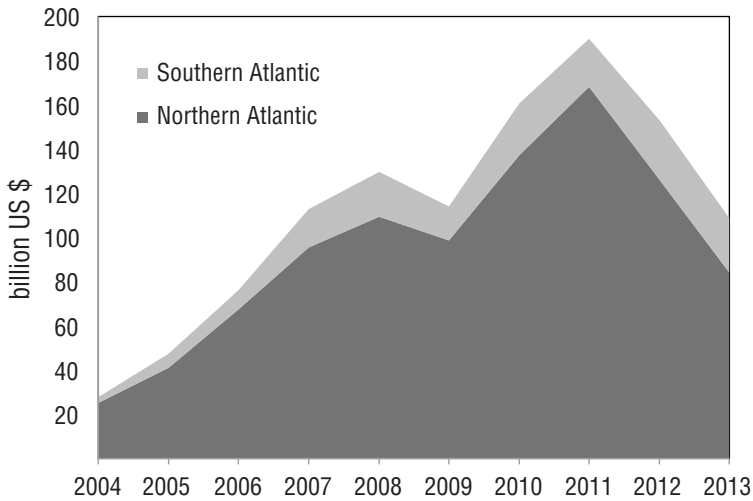
Only three Atlantic Basin countries—the United States, Venezuela, and Mexico—figure in the top ten (with the United States at the top), and only six are in the top fifteen (including Egypt, Canada, and Algeria). Given the outsized share of the United States in total global fossil fuel subsidies (502bn U.S. dollars of 1.7tn U.S. dollars), it is clear that the fossil character of the Atlantic Basin—in relative global terms—is being sustained by the Northern Atlantic, and by North America in particular.

The overall impact of these manifold recent reversals for low carbon energy in the Atlantic Basin is manifesting itself now in terms of (1) lagging investment in renewable energies; (2) a re-carbonization of the Atlantic Basin energy mix; and (3) a loss of global leadership in terms of low carbon deployment.

Investment in renewable energy in the Atlantic Basin is now at its lowest level (U.S.\$104bn in 2013) since 2006, when such Atlantic investment was 75bn U.S. dollars a year—and 75% of the global total. Today, Asia-Pacific renewable energy investment accounts for more than 49% of the global total, compared with only 48% in the Atlantic Basin. Nevertheless, over the same period, renewable energy investment in the Southern Atlantic remained steady, at approximately U.S. \$20bn a year (see Figure 6).

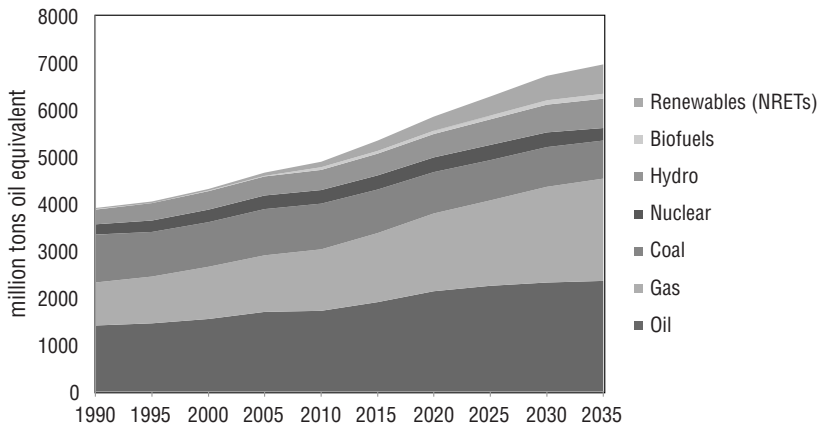
Furthermore, while the Atlantic Basin remains the leader in most relevant low carbon categories, modern renewable energy continues to contribute only a small share of the Atlantic Basin energy mix. Although the share of NRETs (solar, wind, geothermal, etc.) is expected to rise in the future, BP's business-as-usual projection foresees their contribution to the basin's energy mix—nearly 3.5% today—to be only 7.3% by 2030 (although it is true that NRETs will grow faster than any other energy source). Traditional conventional renewable energies (nuclear, hydro, biofuels) will maintain their share of around 16% of the total Atlantic Basin energy mix to 2030; over the same period, the share of fossil fuels will fall, but only from 81% today to 77% by 2030 (See Figure 7).

Figure 6. Atlantic Basin Renewable Energy Investment, Northern vs Southern Atlantic, Billion U.S. Dollars, 2004-2013



Source: *Renewable Energy Status Report 2014*, REN21 (2014) and own-elaboration.

Figure 7. Atlantic Basin Primary Energy Mix, Historical and Projections, 1990–2030



Source: *BP Energy Outlook 2030*, January 2013.

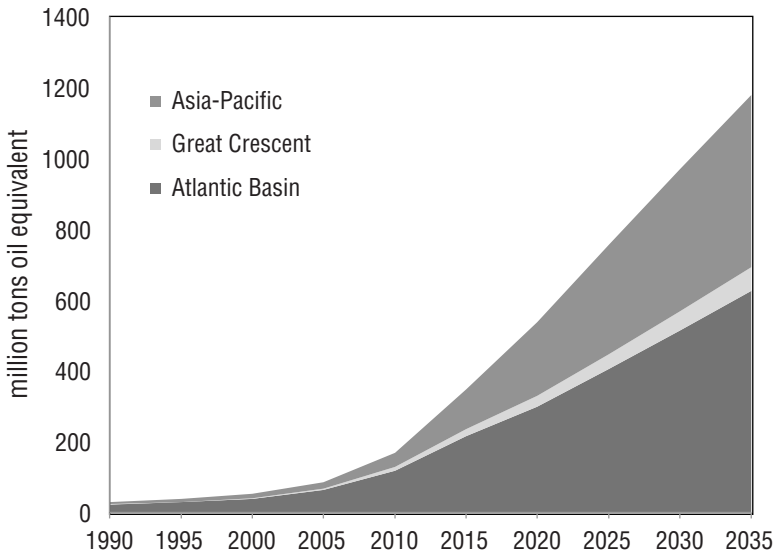
Although the Atlantic Basin energy mix was slightly less fossil fuel-intensive (82%) in 2010 than the rest of the world's, by 2030, according to the business-as-usual projection, the fossil fuel intensity of the world's energy mix will have fallen six percentage points (to 81%), compared with a decline of only five percentage points in the Atlantic, implying that the Atlantic Basin is now expected to de-carbonize its energy mix at a slower rate to 2030 than the rest of the world. So much for the Atlantic Basin's low carbon leadership—at least according to business-as-usual for another 15 years.

It is also to be expected that Asia-Pacific will continue to erode Atlantic Basin predominance in the basic categories of renewable energy consumption and production capacity—as low carbon technologies logically, and necessarily, expand across Asia to provide increasingly cheap renewable energy more closely to the rising centers of global demand. Already Asia-Pacific has increased its share of global renewable energy production from less than one-fifth in 1990 to more than one-third today; by 2030, according to our business-as-usual projection, Asia-Pacific will contribute 41% of all renewable energy production, cutting much of the Atlantic Basin's prior lead (54% in 2030, down from 79% in 1990; see Figure 8). Although this follows BP business-as-usual projection, it does reveal that under current configurations and conditions, low carbon roll-out is now far more intensive in Asia-Pacific than in the Atlantic Basin.

From the perspective of renewable energy producers and international climate change leaders, the crucial question remains how countries from both the Northern and Southern Atlantic strategically integrate the exploitation of shale gas—a short or medium-term solution—with an intensified deployment of low carbon energy, which is a solution to a longer-term problem but a transnational imperative, nonetheless. For should the shale revolution finally manage to spread beyond North America, it could contribute even more than it already has to the market and political undermining of renewable energy deployment. This is one of the central potential paradoxes of the Atlantic energy renaissance.

In short, a supreme expression of the contradictions generated by the shale revolution has been the recent paradoxical reversal of the respective trends in the so-called emissions gap to 2020 on both sides

Figure 8. Renewable Energy Production, by Region, Historical and Projections, 1990-2030



Source: *BP Energy Outlook 2030*, January 2013.

of the Northern Atlantic. On the one hand, the United States can now claim that it will achieve the (admittedly weak) goal of reducing U.S. greenhouse gas emissions to 17% below the 2005 level by 2020 (even though it never formally committed, in a binding way, to these goals at the Copenhagen Climate Summit, given that the Senate had not, and would not, adopt the House's Waxman-Markey Bill which incorporated these national commitments).

However, Europe now finds itself in the uncomfortable position of burning more and cheaper coal, which raises emissions—placing the EU's 20-20-20 objectives in danger across the board—and placing downward pressure on the price of Russian gas sold to Europe, which constrains the pace of renewables deployment and reinforces, again paradoxically, Europe's most notably extra-Atlantic energy dependency. While this dynamic has not yet taken hold in the Southern Atlantic, it could easily be catalyzed by not just shale gas but also by the already underway offshore revolution unfolding in the Southern Atlantic.

The Offshore Revolution and the Sustainable Energy Access for All in the Southern Atlantic

In the Southern Atlantic, over half the population lives beyond the reach of the energy grid. Under the auspices of the UN's sustainable Energy for All initiative, Africa faces an opportunity to leap-frog a generation of (possibly inappropriate) technological development by pursuing a more flexible sustainable development model based on distributed energy services provided by local energy services companies through smaller-scale off-grid and mini-grid solar electricity technologies and through the provision of improved biomass technologies (see Thorne and Felten in Chapter Five).

Distributed forms of solar energy are already competitive with other grid-based electricity sources—even without subsidies or further public support—demonstrating the marginal superiority of the low carbon revolution with respect to the post-Millennium sustainable development goals over its hydrocarbon contemporary rivals, the shale and offshore revolutions. At the same time, however, the offshore revolution has presented the countries of the South with at least a new tempting opportunity to attempt to transform projected increases in hydrocarbons revenue from the offshore into the longed-for authentic seeds of both sustainable development and the low carbon revolution.

The potential problem is that the Southern Atlantic hydrocarbons boom could easily unleash the opposite and reinforce financial, economic, and political distortions within Southern Atlantic economies (i.e., Dutch Disease and the corruption of state institutions and enterprises) and inject corrosive influences upon the very body politic itself (i.e., the multi-faceted oil curse), leaving such countries unfit to receive global green and climate funds—even if the developed countries of the Northern Atlantic and Asia-Pacific make good on their current pledges (100bn U.S. dollars a year from 2020 to developing countries). Inevitably, then, this same offshore boom grows within itself the seeds of a premature abortion of the low carbon revolution in the Southern Atlantic.

The ultimate effect of the latter scenario would be to sink the UN's SE4All Initiative, along with its objectives (extensions of the Millennial Goals), at least in the Southern Atlantic. Certain hydrocarbon exporters in the Southern Atlantic—Mexico, Brazil, and Angola (along

with other potential energy exporters, like Morocco)—must continue to exercise their leadership within the Atlantic Basin energy space by reforming their energy policies, regulatory regimes, and even their political economies, so as to make them compatible with the managed avoidance of Dutch Disease, the oil curse, and a successful policy integration of the hydrocarbons boom—both shale and the offshore—with the pressing imperative (theirs and ours) of sustainably achieving low emissions energy access for all.

Part II

Spotlight on the Southern Atlantic

Chapter Five

Africa's Energy Scenario and the Sustainable Energy for All (SE4All) Initiative

Steve Thorne and Jeff Felten

The Millennium Development Goals (MDGs) launched in 2000 are coming to an end in 2015. While tangible gains have been achieved, there is an understanding that some inputs to the MDGs, previously overlooked, but recognized as cross-cutting, need to be emphasized post-2015 in order to increase the gains. The global backdrop of a changing climate has focused on the emissions of greenhouse gases (GHGs) and impacts of this on climate change. Along with the deforestation, fossil fuel combustion is the main source of GHGs in Africa, focusing attention on the largest global resource sector, energy, and on the opportunities and implications of energy use. The development of this sector, dominated by the traditional policy paradigm of supply security since the 1970's oil crises, and characterized by a large, centralized, dirty and hidden energy system, is starting to fray at the edges. Despite the use of coal, oil and natural gas being consumed at unprecedented rates, a new paradigm is emerging, characterized by being smaller, increasingly decentralized, cleaner and more transparent—and most importantly, by a focus on services, rather than fuels and technologies.

The emerging paradigm comes into sharp focus in Africa where fossil lock-ins have thus far been avoided due to underdevelopment, where access to modern energy services are limited and where climate impacts are the most severe. This fecund continent of vast underutilized natural resources, resilient, but predominantly very financially poor people, has the potential to do energy differently. Despite the recent location of reserves of fossil fuels, a range of international economic instruments may provide sufficient incentives to inspire national leadership in order to catalyze a more sustainable energy trajectory.

Imagine spending 30 hours per week fetching wood from forests that keep moving further away—carrying 10 to 20 kilograms over many kilometers—through wind and rain or the sun beating down on your head; just to cook your food. Imagine having to breathe in smoke for the 3 to 4 hours you spend cooking every day. Imagine what your eyes feel like after being exposed to smoke particles, day in and day out, year after year. Imagine being a young woman in Africa. (Source: Restio Energy)

An international United Nations-lead initiative, Sustainable Energy for All (SE4All), aims to inspire this leadership and leverage the resources to make it happen. This will, however, be extraordinarily difficult in light of the rapid rate of economic growth and ramping up of a spate of exploitable oil and natural gas reserves on the African continent.

Introduction

The world has finally come to realize the fundamental importance of adequate and affordable modern energy as a precondition for economic growth, development and poverty alleviation. Today, some 1.3 billion people globally live without access to electricity. This means they are forced to live without electric lighting in their homes, while their health centers are unable to refrigerate vaccines, their schools have no computers, and local businesses cannot pump water for irrigation or grain mills.

Twice that number of people, 2.6 billion, lack access to clean cooking facilities. For most of these people, cooking requires hacking down trees with a daughter and starting fires by rubbing stones.

The United Nation's Secretary General has called for Sustainable Energy for All (SE4All) by 2030, and the European Union, the United Nations Development Program (UNDP), the Global Environmental Facility (GEF), the African Development Bank, and the U.S. Power Africa program, along with numerous bilateral, multilateral and non-governmental donors, have generously committed support to this initiative, paving the way for larger private and public investments. SE4ALL aims to achieve three simple, but very challenging, global objectives, all by 2030:

Table 1. Energy Indicators for Selected Sub-Saharan African Countries Relevant to SE4All¹

Country	Access to electricity % 2008–2012 ¹	kWh/capita			Renewable energy % ²
		1998–2002	2003–2007	2008–2012	
Angola	26.2	207	230	248	2.20
Congo, Dem. Rep.	11.1	98	104	95	2.87
Congo, Rep.	37.1	142	152	145	2.37
Cote d'Ivoire	47.3	202	210	210	1.67
Ghana	60.5	267	276	298	6.37
Kenya	16.1	149	147	156	7.37
Namibia	34.0	1,740	1,576	1,479	7.37
Nigeria	50.6	127	121	136	0.43
Senegal	42.0	164	196	195	0.60

1. Access and consumption source: World Bank (www.data.worldbank.org/indicator); Budget sources: www.cia.gov/library/worldfactbook, www.indexmundi.com, www.africaneconomicoutlook.org, www.pwc.com/ghana-budget2013, www.statehousekenya.go.ke/economy/budget2009-2012, www.ener-gystar.gov.index/togo, www.worldbank.org

2. Excluding biomass.

- Ensuring universal access to modern energy services;
- Doubling the share of renewable energy in the energy mix; and
- Doubling the global rate of improvement in energy efficiency.

While these objectives will be difficult to achieve in much of sub-Saharan Africa, it is crucial to firstly define these objectives and understand that countries begin the race at different starting points. On the basis of Rapid Gap Analyses at the country level, the next step African countries undertake includes the development of action agendas and investment prospectuses designed to stimulate the domestic public and private investments required to achieve modern energy access, improve efficiencies and introduce more renewables. By March 2014, 83 countries had opted in to SE4All, of which 42 were in Africa.

Universal Access to Modern Energy Services

Access to modern energy refers to electricity for lighting—in the very least—and, typically, also clean fuels and/or technology for cooking. Africa is predominantly rural, yet rural electrification rates in sub-

Saharan Africa average only 16%. Ghana, for example, has one of the highest electrification rates in sub-Saharan Africa, but even that is not enough to supply energy to the 20,000 Lake Volta island communities. Many national power companies are insolvent, unable to expand or even efficiently maintain their current networks. The Tanzanian power company (TANESCO) owes independent power producers hundreds of millions of dollars. And where grid lines exist, consumers find it difficult to pay the connection fees.

In Africa, policy directions which pursue cost recovery pull in different directions from those that pursue equity (access and affordability). This lack of resources results in an inability to extend access to those who actually need it, while often providing subsidized access to those who do not need the subsidy. The general decay of infrastructure that follows erodes reliability, financial and technical efficiencies. Many countries in Africa have dealt with this challenge and many more are still facing it and taking on painful and mostly incomplete power sector reforms. In 2010, African state-owned electricity utilities operated with deficits equivalent to 1.4% of sub-Saharan Gross Domestic Product (GDP), according to the International Monetary Fund (IMF).

The absence of grid power, however, is conducive to alternative opportunities: the markets for off-grid solar photovoltaic (PV) technology and solar lanterns with light-emitting diodes (LEDs) are booming. Soon Africa will see the emergence of small energy supply companies, operating micro-grids in villages, generating power from biomass waste or small hydro sites, and most interestingly selling services rather than consumption of energy. Small energy systems providers have tried out many models (triangulating users, micro finance and technology providers for purchase of systems, rentals and hire purchases schemes), but more recently they have attempted to reduce the transactions costs through rural energy utilities (combining finance and technologies), making use of developing mobile money schemes and offering fee for service, an approach that has been somewhat successful.

Depending on whether you live in a rural or urban area, cooking fuels in sub-Saharan Africa depends primarily on firewood or charcoal (a wood derivative). Both are biomass and, thus, theoretically, represent a renewable form of energy (assuming equivalent biomass re-

Country Default Values of Fraction of Non-renewable Biomass

Angola	97	Liberia	97
Benin	81	Madagascar	72
Burkina Faso	90	Malawi	81
Burundi	77	Mali	73
Cape Verde	89	Mauritania	85
Chad	92	Mauritius	100
Comoros	100	Mozambique	91
Djibouti	100	Niger	82
DR Congo	90	Rwanda	98
Equatorial Guinea	68	Senegal	85
Eritrea	97	Sierra Leone	95
Ethiopia	88	Sudan	81
Gambia	91	Togo	97
Guinea	96	Uganda	82
Guinea-Bissau	85	UR Tanzania	96
Lesotho	98	Zambia	81

Source: CDM EB 67 Annex 22 11th May 2012.

growth, which is not that common—see the box above on Non-Renewable Biomass default factors for Africa). Simply put, trees are still not typically re-planted and forest management is universally insufficient.

Charcoal, in particular, is a vast business, comparable to agriculture in many countries and informally employing millions of people across the continent. The charcoal market in Kenya is valued at more than 200 million dollars annually, and in Tanzania it is the third largest contributor to GDP and almost entirely informal and out of reach of revenue services. Alternatives to wood fuels (electricity, liquefied petroleum gas [LPG], biomass, and briquettes) are generally more expensive or inaccessible due to undeveloped markets. Wood fuel stoves with improved efficiency have been introduced and promoted in most countries, sometimes successfully, such as the Fourneaux Nansu in Benin, Sewa in Mali, or the Jiko in Kenya.

However, there is a significant opportunity to produce and consume wood fuels sustainably through participatory forest management, nurseries and tree planting, more efficient kilns for wood-to-charcoal conversion, and sustainable charcoal certification. Formalization of the sector, along with enhanced policies, policy instruments, legal frameworks and regulation, could also provide greater revenue to governments. Though difficult to achieve, it seems more realistic to expect future African families to cook with sustainable wood fuels in efficient stoves rather than with electricity or LPG. LPG usage was nearly universal in Dakar until very recently; however, most households switched back to charcoal when the LPG subsidies were removed. Similarly, the World Bank reports back-switching to charcoal from electricity and gas in response to poor reliability and high prices in Tanzania.¹

Doubling the Share of Renewable Energy in the Energy Mix

The second SE4All objective—doubling the quantity of renewables in the energy mix—also requires defining, and understanding, the wide spectrum of starting points, from which African countries depart. Clearly, the unsustainably produced and consumed wood fuels used for cooking throughout Africa cannot be considered to be renewable energy. *But perhaps they should be considered renewable if the processes were reinvented into sustainable formal sectors.* Large hydropower installations (such as the 200MW Manatali Dam shared by Mali, Mauritania, and Senegal) exist across the continent; however, given their socio-economic impacts, both positive and negative, it is unlikely that the SE4All effort will build another 100 large-scale dams across Africa. Although this might contribute to increasing lower carbon (rather than fossil fuel-based) electricity supply in Africa, given the potential environmental and social impacts of large-scale hydroelectric power, it is unlikely to be considered by SE4All as sustainable or even renewable.

Instead, SE4All could support the development of thousands of run-of-the-river hydropower projects for rural mini-grids and decentral-

1. From 2001 to 2007, the proportion of households in Dar es Salaam using charcoal as their primary energy source has increased from 47% to 71%. Use of liquefied petroleum gas (LPG) has declined from 43% to 12%. In other urban areas, the share of households using charcoal for cooking remained at 53%, while the share of fuelwood use increased from 33% to 38%. The use of electricity for cooking is below 1%. *Environmental Crisis or Sustainable Development Opportunity*, World Bank Report and Policy Note, 2009.

ized electrification. Furthermore, the doubling of renewable energy should be coupled with the aim of universal access to electricity. In this sense, a focus on small-scale off-grid solar solutions might make more sense than a more traditional focus centering overwhelmingly on large-scale and centralized grid-based access solutions to be favored by Africa's national power companies. Such a distributed renewables focus would mean that most of rural Africa could eventually be provided with power by small, private energy service companies (ESCOs) that generate electricity from biomass, hydro, solar and wind resources. These micro village grids will provide electricity in the volumes required by value-adding agri-businesses, powering irrigation, processing mills and cold storage, fostering the economic growth and development that Africa so badly needs and keeping much of the revenue in local economies. Other larger renewable energy electrification projects will, nevertheless, connect to main grids.

Doubling the Rate of Improvement of Energy Efficiency

The objective of doubling energy efficiency requires a baseline and a unit of measurement. However, in many sub-Saharan Africa countries, it may be easier to save 100 MW of power through energy efficiency rather than through adding 100 MW of renewable electricity. Tanzania has added almost no renewable energy to its power mix over the last decade, while Ghana saved 124 MW in 2007 by replacing 6 million incandescent light bulbs with compact fluorescent lights (CFLs). The South African electricity utility—through Demand Side Management (DSM) and a “Standard Offer”—reduced power consumption by more than 3 GW in just 3 years (between 2010 and 2012) at just over US\$ 600/kW. Nevertheless, their spokesman suggested this was a disappointing, if significant, outcome. In response, standard offer efficiency subsidies there have been withdrawn. The fact of the matter is that few utilities like demand management interventions—unless demand shortages threaten.

In addition to lighting, other widespread opportunities to improve energy efficiency include upgrading antiquated cogeneration installations, improving maintenance of power plants and grid networks to reduce losses, and improving maintenance of thermal performance in structures, along with heat pumps to decrease the use of air conditioning, water, and space heating. Improved cookstoves, successfully intro-

duced and marketed, will also be major contributors to energy efficiency savings and improved respiratory health, as would improved kilns for wood-to-charcoal conversion. There are a multitude of industrial interventions that are possible, such as efficient boilers and variable speed drives—but in all cases energy management is the most powerful contributor to improving efficiency.

Though renewable energy feed-in tariffs (REFITs) and other tools have been developed as incentives for renewable energy power projects, few such incentives are in place to promote energy efficiency. In fact, in many African countries Ministries and government officials do not pay their electricity bills and, therefore, do not feel the financial pain of energy inefficiency. The same is true for most foreign diplomats and development workers in Africa (who often run multiple freezers, refrigerators and air conditioners 24 hours per day). The opportunity is present, therefore, to improve energy efficiency simply through awareness raising, energy audits, incentives to offset verified energy reductions for both suppliers and users, carbon market mechanisms, independent regulation based on least-cost principles, capacity building and monitoring in the public sector. Businesses are most sensitive to energy efficiency, but many lack the technical knowledge to become more efficient, lack the financing to implement measures, and plan on very short payback periods for retrofits and new construction. There are, however, some notable exceptions in Africa in which energy efficiency is world class. For example, some breweries target energy per volume of beverages.

The SE4All initiative is timely, and critical, for Africa's growth and development, but it must be implemented with skill, wisdom and transparency. Many countries will require energy sector policies and reforms (i.e. REFITs, new tendering schemes for renewable additions to grids, establishment of rural energy agencies, etc.), capacity building in both the public and private sectors (without ignoring the financial sector), technology transfer and technical support in deploying new renewable technologies, simple and low-cost financial instruments (including targeted preferential credit, loan guarantees and grants) and affirming demonstration projects in order to meet SE4All's commendable objectives. Each country should first develop a SE4All Action Agenda that rests on good participative processes that facilitate informed decision-making—and hence ownership—by bene-

ficiaries (such as the European Union's Best Practices Guide for Policy Makers and Energy Planners, or similar planning tools for broad consultation and buy-in) before moving onto the development of Investment Prospectuses.

Africa could learn relevant lessons from the trajectories of those countries exhibiting a track record of getting it right. Allegedly, Tanzania's primary energy mix today (along with a number of other African countries with a near 90% primary energy contribution from biomass) is comparable to the one of the United States in the 1850's. Therefore, examples in Asia and across the southern Atlantic in Latin America could be utilized in order to propel Africa's energy systems forward. Particularly salient examples are the ones which boast an abundance of traditional biomass resources in the energy sector that have been modernized and made more efficient in achieving modern energy access that is cleaner, right sized, efficient and sustainable.

Ensuring Universal Access to Modern Energy Services

Access to modern energy has been typically defined as an electricity connection in the household and use of non-solid fuels. Although convenient, this definition does not encompass standalone off-grid solutions and isolated mini-grid solutions. Nor does it capture important aspects of availability (time and duration), reliability, quality (voltage) and affordability of supply from the grid as well as legality of connection. On the cooking solutions side, this definition does not capture the use of solid fuels in advanced cookstoves. Further, this household focused definition ignores the importance of access to energy for community institutions, such as schools, health clinics and community centres, and for productive purposes, including micro-mini enterprises, essential for socio-economic development.²

Under the Sustainable Energy for All initiative, the target of Universal Access to modern energy services by 2030 has become a priority Sustainable Development Goal of the international development agenda. It is an ambitious goal that will require commitment from a

2. *Consultation on Global Tracking Framework: Proposed Methodology for Global Tracking of Energy Access, November 2012*. World Bank/ESMAP World Health Organization (WHO), International Energy Agency (IEA), Global Alliance for Clean Cookstoves (The Alliance).

Table 2. Electricity Access Rates* in Africa, 2012

	Population without electricity (millions)	Electrification rate %	Urban electrification rate %	Rural electrification rate %
Africa	622	43	68	26
North Africa	1	99	100	99
Sub-Saharan Africa	621	32	59	16

*Not to be confused with "access to modern energy services."

Source: IEA, World Energy Outlook, 2014.

broad array of stakeholders and significant amounts of funding. The SE4All Finance sub-committee estimates the achievement of the universal access goal will require \$45 billion per year to 2030, up from the current \$9 billion per year currently (mostly in sub-Saharan Africa, South and South East Asia and Pacific. The Global Climate Fund (GCF), which is set to serve as the centerpiece of efforts to raise \$100bn a year by 2020 for climate finance, has a crucial catalyzing role to play in this effort. Given the limitations of public finance, it is argued that significant private finance will need to be leveraged as a complement. This presents a significant challenge as it is the concentrated and relatively well off who have access to modern energy services—not those who are poor and disparate in location. The low-lying fruit in Africa has already been picked; what remains on the tree does not easily lend itself to the making of markets, or that too would have been done by now.

Where national data is available, the International Energy Agency publishes figures for electrification rates by region, country, urban and rural sectors. Table 2 summarizes the aggregated data for Africa.³

In North Africa, power access is virtually universal. In sub-Saharan Africa, however, the average figure is a low (32%), with Mauritius (100%), and South Africa (85%) at the higher end of the range. At the lower end (essentially the African Least Developed Countries) are Malawi (9%) and Uganda (15%), Ethiopia (23%), and Tanzania (24%).⁴

3. The database shows detailed data on urban and rural electrification collected from industry, national surveys and international sources.

4. IEA World Energy Outlook 2011.

Access to electricity is constrained throughout sub-Saharan Africa, but the constraint is most prominent in rural areas in the least-developed countries (LDCs). Such areas are difficult to supply power to through traditional grid solutions: they are typically geographically remote; transmission and distribution lines present expensive investments; and the ultimate consumers are relatively poor and limited in their ability to pay for consumption. Therefore, there is insufficient return on investment for African power companies that are already financially stressed. Lessons can certainly be learned from the telecommunications industry as to how it successfully built markets in such rural locations. A further complication for developing and particularly LDCs is that replacing fiscal revenues from fossil fuels with renewables or even energy efficiency may not be popular with treasuries.

References to services, including energy and other public services and providers, can be found in national constitutions, bills of rights, and energy policies throughout sub-Saharan Africa. Occasionally, these policies also include specific targets. But physical access to modern energy is only part of the economic growth and sustainable development equations. *The ways in which people and their productive activities connect to, afford and effectively utilize the energy are critical considerations in ensuring modern energy access sustainability.*

Energy is needed as a precondition for rural development, powering value-adding activities such as irrigation pumps, food and minerals processing equipment, cold storage and other food preservation activities, etc. This economic development improves the ability of the local population to consume other, and more, goods and services, including energy services, which in turn contributes to further development. So, while physical access can be achieved using public money, energy consumption beyond a poverty tariff quantity of supplied energy presents a challenge to the economic sustainability of utilities.

With sub-Saharan Africa growing, primarily as a result of mineral, energy, forestry and other extracted commodities, bilateral and multilateral donors, along with international private capital, demonstrate an increased interest to stimulate the deployment of power distribution infrastructure. Foreign development assistance plays a decisive role in supplementing national initiatives. At present, many countries have agencies dedicated to rural energy/electricity access (sadly, their focus

often does not incorporate traditional biomass). For its part, the SE4All initiative, through its regional and thematic hubs and High Impact Opportunity clusters, aims to enable accelerated access that avoids large-scale fossil fuel technology lock-ins and improves efficiency in generation, transmission/transportation, and distribution and use.

Other than the thematic Hubs for Decentralized Energy Access (UNDP), Energy Efficiency (UNEP RIso) and Renewable Energy (IRENA), there are thematic Hubs for Capacity Development (TERI) and Communications and Knowledge Management (World Bank) including some 50 High Impact Opportunity clusters. Furthermore, three Regional Hubs have also been established in the regional public banks (African Development Bank, Asian Development Bank and the Inter American Bank) to facilitate and coordinate national Action Agendas and Investment Prospectus.

SE4All: Roles, Definitional Issues, and Monitoring

National trends of increasing (or decreasing) energy access provide insight into the implementation of national developmental policies, institutional mobilization, leadership and budgetary priorities. Thus, the definition of access underpinning the numbers at each national level is important. Improved cook stove ownership and use is not systematically tracked in most countries, except in a few carbon financed projects or occasional cross-cutting, one-off, sample-based surveys. These surveys, however, do not reveal trends, but rather penetration levels at a particular moment in time. Furthermore, the definition or standard interpretation of what constitutes an efficient, advanced, or improved cook stove still requires agreement.

In a recent meeting with the Permanent Secretary of the Ministry of Energy and Minerals in Tanzania, he acknowledged that published access figures include national grid, mini-grid, stand-alone generators, solar systems, and solar lanterns. The combination of all of the above results in an access figure of 18.4% (November 2012) the reported figure is now increased to 24% according to IEA 2014.

Table 3. The Tier System of Measuring Electricity Access on the Supply Side as Interpreted by CIF

Attributes	Tier 0	Tier1	Tier 2	Tier 3	Tier 4	Tier 5
Peak available (Weq)	-	>1	>50	>500	>2000	>2000
Duration (hrs)	-	>4	>4	>8	>16	>22
Evening supply (hrs)	-	>2	>2	>2	>4	>4
Affordability	-	-	Yes	Yes	Yes	Yes
Formal (legality)	-	-	-	Yes	Yes	Yes
Quality (voltage)	-	-	-	Yes	Yes	Yes
Global tracking for SE4All	No	Basic	Advanced			

Table 4. The Tier System on the Demand/Service Side

Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
-	Task lighting and phone charging	General lighting and TV and fan	Tier 2 and any low-power appliances	Tier 3 and any medium power appliances	Tier 4 and any high power appliances

Source: <https://www.climateinvestmentfunds.org/>

Access in the context of SE4All refers to households, livelihoods, public institutions and productive uses. Faced with this complexity, the World Bank and IEA through ESMAP have pioneered a multi-tier framework to support SE4All that focuses on major attributes of energy supply across energy sources, and includes aspects of performance with respect to: quantity and quality of supply, duration, reliability, affordability, legality, convenience and health and safety.

Included above is the Climate Investment Funds (CIF) interpretation of the ESMAP's tier approach to assessing energy access. The approach, while comprehensive, demands considerable emphasis on measuring and monitoring for assessing baselines and tracking progress (see Tables 3 and 4).

The Tier system for non-electric energy uses (mostly for cooking and heating) has been elaborated and qualifies the technologies and fuels in relation to a range of attributes including: capacity, duration/availability, quality, affordability, convenience and health/safety. The tier rating for the household is calculated by applying the lowest of the tier ratings across all attributes.

Technically improved cook stoves (ICS) and advanced cook stoves (ACS) are capable of wood savings of up to 60%, and over the longer-term, it will be important to aim for more ambitious targets. The additional health benefits of ACS make their introduction an important aspiration.

An International Standards Organization workshop agreement (ISO, 2012) identified four performance tiers for cook stoves depending on their efficiency, environmental and health impacts: Tier 0 includes to unimproved traditional cooking methods; Tier 1 relates to measurable improvements; Tier 2 substantial improvements; Tier 3 currently achievable technology for biomass stoves; Tier 4 stretch goals for targeting ambitious health and environmental outcomes.

An on-going review by the World Bank ACCES Project of the status of clean cook stoves in sub-Saharan Africa (SSA) shows how different types of available stove perform compared to these tier levels. (ACCES (African Clean Cooking Energy Solutions Initiative), 2014) The majority of ICS used in Sub-Saharan Africa today operate at Tier 1 level. However, the report stated that more advanced versions have substantially better performances, and can potentially perform close to those of kerosene or LPG stoves.

In terms of potential wood savings, the performance of the tiers is estimated by ACCES as shown in Table 5.

In addition to electricity and cooking solutions, similar attributes for tier levels are in place for access to electricity for productive and public uses.

Other Definitions of Energy Access

The International Energy Agency's definition, though blunt, is simpler to apply and less onerous to monitor: access to modern energy services is defined as household access to electricity and to clean cooking facilities. The latter is defined as access to clean cooking fuels and stoves, including advanced biomass cook stoves and biogas systems. (International Energy Agency, 2010).

The Practical Action Group (2013) has developed the concept of Total Energy Access, which they define as households, enterprises and community services having sufficient access to the full range of energy

Table 5. Cook Stove Efficiency Ratings for Proposed ISO Tiers

Proposed ISO Tier	Illustrative stove type	Efficiency
Tier 0	3-stone fire	<15%
Tier 1	ICS	>15%
Tier 2	Rocket stove	>25%
Tier 3	Forced draft	>35%
Tier 4	LPG	>45%

Source: World Bank ACCES Project.

supplies and services that are required to support human social and economic development.

SE4All Initiative: Value-Added Energy Services in Africa

The SE4All Africa Hub in the African Development Bank (AfDB) is designed to facilitate SE4All activities on the continent and provide some process and output cohesion and quality, as well as input cohesion such as with the recently established EU-funded SE4All Technical Assistance Facility, The U.S. Power Africa initiative, and the numerous Chinese and Nordic country energy infrastructure projects. It aims to contribute to enabling policy, legal frameworks and favorable environments for the private sector to supply clean modern energy that is transported and utilized more efficiently. The SE4All Hub and facilities will provide technical assistance capacity building for public and private sector actors, including financial institutions. The Initiative could also offer dedicated clean energy finance and grant funding for demonstration projects. In some countries, SE4All may be applied to strengthening and augmenting existing initiatives that target access, efficiency and renewables. In other countries, policy and policy instruments may need to be built up from scratch.

The SE4All Africa hub based at the AfDB will, in turn, facilitate the development of Action Agendas and Investment Prospectuses for the 83 (of which 42 are in Africa) countries that have opted into SE4All and have completed their rapid assessment gap analyses, that have examined existing policies, policy instruments and initiatives baseline to enable the SE4All 2030 goals.

If energy access strategies are designed around minimum energy service levels (i.e. a lighting = solar lantern and cooking = an improved cook stove), many existing value chains will deliver effectively and

Table 6. Access to Energy Services: Range of Energy Sources and Technologies in Africa

Energy services	Energy sources	Access technologies
Lighting	Hydropower, biomass, wind, and solar	Grid, mini-grid, solar PV, solar lanterns and LEDs
Cooking and water-heating	Electricity, LPG, briquettes, sustainable wood fuels	Improved cook stoves
Communications media and amplification	Hydropower, biomass, wind and solar	Grid, mini-grid, solar PV, solar lanterns and LEDs
Food preservation (refrigeration)	Hydropower, biomass, wind and solar	Grid and mini-grid
Food preservation (drying)	Hydropower, biomass, wind and solar	Grid, mini-grid, CHP and solar driers
Food processing	Hydropower, biomass, wind and solar	Grid and mini-grid
Water pumping	Hydropower, biomass, wind and solar	Grid, mini-grid and solar pumps
Transportation	Biodiesel or bioethanol	

Source: J. Felten, Camco 2013.

potentially at the lowest cost. Through bottom-up consultations with the targeted energy access beneficiaries on service and technology options, increased project ownership can be achieved and willingness to pay can be measured, while ensuring sustainability for the SE4All initiatives.

Key to achieving efficiency of energy use and sustainability is providing energy at cost-reflective prices while avoiding systemic subsidies. Consumers use energy most efficiently when they feel the cost. This does not mean that universal access cannot be achieved in economically poor areas. The cost of clean energy technology is forever falling as a result of technological learning, and new lower cost technologies are constantly being manufactured and reaching economies of scale. Also, development actors are skilled at inventing creative ways to facilitate access to the poor, through microfinance and informed technology receptivity programs, for example.

Energy access *for productive uses* requires special consideration, given its critical role in economic growth and sustainable development. It is these productive consumers of electricity that represent the anchor clients for grid extensions, the nucleus of mini-grids, and markets for other energy services. Productive activities create jobs and generate community-wide income, making power more affordable for the population as a whole, including households, public, social and cultural institutions.

Numerous sources could generate productive clean energy, but one of the cheapest and most technically robust can be found in agricultural residues (also known as biomass waste). Investigations of decentralized, least-cost solutions will be a priority in advancing access, and in particular low carbon access with renewables, which are abundant in Africa.

A key challenge for the SE4All will be to devise sustainable and bankable strategies and projects that deliver energy access to poor, remote and sparsely populated rural areas, where income is low and markets for modern energy do not exist. Specialists will have to assist national and subnational governments, private sector associations and their members, communities, and others to design, finance and implement access programs. Specialists' key skill sets should include policy development and processes, business development, finance, marketing,

technology transfer, training, project implementation, and monitoring and evaluation.

Doubling the Share of Renewable Energy in the Energy Mix

The fact that Africa's energy infrastructure is so relatively underdeveloped presents a tremendous opportunity. Going forward, sub-Saharan Africa does not have to follow the same (or similar) industrial revolution development model (based on a large, centralized, dirty and hidden energy system) that developed economies rely on. Africa could build its energy sectors around more sound business models that are less dependent on imported and polluting fossil fuels. Africa can build energy sectors based on decentralized power generation and distribution (often referred to as distributed power), exploiting its own indigenous renewable energy sources and, thereby, reducing transmission losses, creating jobs and augmenting income in rural areas. However, if this was to happen, the fiscal holes left behind by reduced fossil fuel tax income to Africa governments (a large proportion of fiscal revenue in Africa) would have to be filled and the rent seeking associated with large infrastructure projects would have to be overcome.

The SE4All objective of doubling the share of renewable forms of energy in the global energy mix will be primarily met in two ways:

- Electricity will increasingly be supplied using renewable energy sources, which would replace fossil fuels;
- Households and institutions will increasingly cook with renewable energy sources, which would replace unsustainable wood fuels.

Electricity with Renewables

Different forms of renewable energy are available throughout the world, each with its own advantages and limitations. Solar PV is perhaps the most expensive renewable energy technology, but it can be deployed almost anywhere in Africa, in rural areas far away from any grid network. Small and mini-hydro developments generate volumes of reliable power capable of powering agri-business equipment such as grain mills and cold storage, but not every African village is situated

near a river. Evidently, it would be counterproductive to install 1MW of solar panels in a mountainous temperate zone where a timber industry would generate a great deal of biomass waste. Biomass boiler systems are much more reliable and cost-effective.

Solar and Wind. Solar and wind energy resources are somewhat similar in their capacities. Solar PV does not work in the rain, and wind turbines remain motionless when the wind is not blowing. For this reason, both are usually coupled with storage technologies (batteries), so that consumers can have access to power even in the absence of sunlight or wind. The batteries add considerably to the cost of using solar and wind energy and are the weak points of these systems.

On the other hand, solar PV and wind systems have the potential to be deployed in far away off-grid rural areas. This frees the consumer from having to rely on any power provider. In fact, the owner of the solar home system, for example, is simultaneously a power producer and consumer. He/she can never consume more power than her system has generated, and must keep that in mind or damage the solar system.

The use of solar PV technology in Africa is more widespread than wind power technology, but wind power is deployed in large grid-connected projects, such as the 300MW Lake Turkana Wind Power Project in Kenya. The entire sub-Saharan market for solar PV (excluding the newly booming South African Independent Power Projects - IPP market) can be approximated at less than 40MW annually. According to the IEA, solar-installed capacity has increased from less than 80 MW in 2010 (mainly small-scale PV) to around 125 MW in 2013 (including some larger plants). Solar projects including a 15 MW one in Mauritania and a 33 MW one in Burkina Faso are currently under construction.

Table 7 provides examples of potential markets for solar PV technology in Africa.

For example, the capacity of PV panels imported into Tanzania has been growing exponentially between 2005 and 2012, increasing from 100 to 2336 kWp (kilowatt peak). In the period between 2009 and 2013, the retail price dropped from 6.30 dollars/Wp to 1.67 dollars/Wp (watt peak).⁵ Table 8 shows trade of PV capacity in Tanzania

5. Dr. Matthew Matimbwe, Director of TAREA, personal communication November 24, 2013, states that prices in November 2013 had reached 1.50 dollars/Wp.

Table 7. Potential Solar Markets in Africa

No.	Market	End user	System size	Supplier	Beneficiary
1	Social Services	Schools, health facilities, government offices	400Wp - 1.3kWp	Importer/wholesaler	Government, rural population
2	Business	big business, like hotels, telecom, horticulture, mines	300kWp - 3MW	Importer/wholesaler or project developer	Private business
3		SMEs, like village markets, irrigation	1 - 30kWp	Project developer	SME and rural community
4		Fishermen and their co-ops	220Wp	Wholesaler/retailer	Fisherman
5	Households	Rural, off-grid homes	50-200Wp	Wholesaler/retailer	Rural families
6		Village grids	10-30kWp	Project developer	Rural community
7		Urban grid-connected doing net metering	1,000-5,000kWp	Importer/wholesaler or retailer	National grid, system owner
8	The Poor	Rural families of modest means buying or renting lanterns	0.5 - 2Wp	Retailer or credit union or lantern-renting station	rural household
9	Utilities	Utility buying from solar IPP	20MW - 50MW	International project developer	National grid

Source: Jeff Felten, Camco 2013.

between 2005 and 2012. The Tanzanian Renewable Energy Association (TAREA) reported prices in November 2013 at 1.50 dollars/Wp. Only time will show whether this is as a result of technological learning or the dumping of Chinese surplus.

Hydro and Biomass. Like solar and wind renewable energy resources, hydro and biomass energy are also similar in their capacities. The principle difference is that the embodied energy in the biomass and water in the reservoir (or run-of-the-river) is the storage, and, therefore, batteries—typically the weakest component in other types of renewable systems—are not required.

Hydro and biomass power technologies have existed since the industrial revolution, and are, thus, very mature technologies. They can generate high volumes of reliable power. Therefore, they are well suited to supplying electricity to mini-grids in order to allow rural industries to meet their energy requirements, such as irrigation equip-

Table 8. Solar Panels Capacity Traded (imported) in Tanzania 2005–2012

Year	Capacity in kWp
2005	100
2006	206
2007	285
2008	638
2009	1161
2012	2336

Source: Tanzanian Renewable Energy Association (TAREA), 2013.

Note: figures rounded to nearest kilowatt digit

ment, drying, processing, cold storage, etc. This advantage is of critical importance because, in the absence of rural industry, African villages fail to develop, and remain poor. Hydro and biomass power plants can also, theoretically, provide electricity 24 hours a day, 365 days a year.

A 30kWp village mini-grid powered by biomass waste (i.e. rice husks, maize cobs, cashew shells, etc.) can cost as little as 40,000 dollars to develop, whereas a similarly sized village grid using solar PV technology would likely cost four times as much. In addition to solar panels, the other major difference in project costs comes from batteries, which would be required for a solar mini-grid. But hydro and biomass technologies also have their obvious limitations. A hydropower plant requires water and a waterfall or gradient of some kind. A biomass power plant requires sufficient quantities of agricultural waste or sustainable supplies of woody biomass.

Cooking with Renewables

As electricity under the SE4All initiative will increasingly deploy renewable energy sources, so, too, will the kitchens of Africa.

The SE4All initiative ultimately imagines a world where all households and institutions cook with renewable, biomass, electricity and compressed natural gas (CNG) or LPG. This may be possible in the long-term future. However, it is likely that small African businesses will develop markets (both rural and urban) for alternatives to the current unsustainable use of woody biomass and charcoal fuels as has been seen in the highly differentiated kerosene value chains on the

continent. Small and medium industries producing briquettes from agricultural waste are emerging in many countries. These businesses produce local value-added biomass-based alternatives to charcoal and firewood, allowing consumers to continue with their cultural culinary habits, while adding value to previously unused waste streams that require the introduction of appropriate and affordable fabrication technologies.

Other small businesses are marketing biogas systems that digest waste and transform it into methane. The methane can then be lit, creating a flame that can boil water and cook meals. Though biogas technology was originally developed for rural uses to exploit animal manure as feedstock, new technologies are suitable for urban settings as well, using food and other biodegradable wastes. Development aid from the Netherlands has historically been at the forefront of biogas technology dissemination.

Ethanol gel made of sugar processing waste and other starches (like cassava in Mozambique) is another clean energy alternative for cooking and is being vigorously explored, but questions could arise around real and perceived threats to food security.

However, the most likely future renewable energy alternative to the current use of unsustainable wood fuels would be sustainable wood fuels. Wood fuels are biomass, and as such, they are by definition a renewable form of energy when the biomass resource is not depleted by harvesting. The problem lies in the fact that charcoal is currently neither produced, nor consumed in a sustainable way: forests are not managed; trees are not re-planted; wood is processed into charcoal using the least efficient methods; and the sector is almost entirely informal and unregulated. The biomass deficit in most African countries is increasingly rapidly threatening this massive informal energy sub-sector, the livelihoods of those that live off the forests, biodiversity and top soils. Lessons from Brazil and other Latin American countries may assist in turning the biomass energy sub-sector into a sustainable business opportunity in the future.

Strategies to sustainably replace unsustainable wood fuels should be integrated with landscape restoration projects, in line with the Bonn Challenge (like 20x20 Initiative in Latin America), and catalyzed and

coordinated through the regional development banks in the Southern Atlantic (ie, the IDB and the AfDB).

Renewable Energy, Public Institutions, and Private Companies

Ideally, government and the private sector play complementary, albeit different, roles in the development and uptake of renewable energy technologies. In theory, the government facilitates an enabling environment for business, and then business delivers good quality and low-cost clean energy products and services to consumers.

The government can enable by simplifying procedures, such as offering standardized small power purchase agreements (PPAs) or by exempting renewables from taxation. The government can do this by providing incentives, such as renewable energy feed-in-tariffs (REFITs) or project grant funding from rural energy funds. Alternatively, it can do this by requiring mandates—for example, insisting that a percentage of the energy consumed by industry comes from renewables, or that all schools and health centers use briquettes instead of charcoal for cooking and solar water heaters for warm water. Businesses then operate in this enabled environment. Stimulated by government facilitation, incentives and mandates, companies are asked to create business models that deliver clean energy products and services in profitable and sustainable ways (generating income and creating jobs along the way).

Since their roles are different, it is not surprising that the capacity-building needs of the public and private sectors are different as well. Governments need to know strategic options, best practices and policy design and legal frameworks that induce clean energy business development. Businesses need exposure to different business models and technologies, (often) business management training and access to low-cost and easily accessible financing. But most of all, business needs certainty in the environment it operates: “long, load, and legal” has been the request from businesses worldwide for energy markets in new and risky environments, according to Chatham House climate finance researchers.

This highlights the importance of a country's financial sector in the development of clean energy. Banks and other financial institutions

have capacity-building requirements specific to their sector. They need assistance in developing financial products and services that are profitable for them in areas with which they are familiar and which can offer returns, but at the same time, they need to be helpful to the clean energy businessman or woman. They may also need assistance finding those clean energy clients and learning about the financial resilience of the sector in order to lend efficiently and reduce transaction costs.

The SE4All initiative must keep these different needs of government, business, and the financial sector in mind when designing training programs for human skill development and institutional capacity-building. Africa can certainly learn from other countries and particularly those with similar socio-economic and resource realities, like Africa's partners across the Atlantic in Latin America and the Caribbean, which are farther along this process of enabling clean energy.

Doubling the Global Rate of Improvement in Energy Efficiency

Energy efficiency is a powerful and cost-effective way for achieving sustainable development. It should be considered as a key to the path towards increased energy security because it breaks the link between economic growth and rising energy demand. The result is that national economies become more competitive. Energy efficiency is also a cost-effective way of lowering CO₂ emissions and local pollutants and improving bottom lines of enterprises.

In spite of its relevance and potential benefits in African countries, policy makers pay little attention to energy efficiency and few countries have developed energy efficiency strategies. This is primarily because efficiency is a reluctant add-on for most utilities who concentrate on adequate and stable supply before efficiency. However, short-term efficiency measures are introduced during supply crises.⁶

6. In South Africa, efficient lamps, solar water heaters, and negotiations with large energy users to reduce demand (by 10%) were amongst the strategies employed to achieve improved efficiency.

South Africa's electricity utility, Eskom, achieved 3GW of savings efficiency during the last three years (more generation capacity than most countries in Africa) at a cost of 549 U.S. dollars/kW. At the same time, it enthusiastically promoted more supply, despite facing a potential bill of more than a trillion rands for a 9.6GW nuclear plant at a cost of 12,400 U.S. dollars/kW. So when we hear Eskom's spokesman, Andrew Etzinger, who knows efficiency issues well, lamenting the less than expected efficiency savings, we wonder what is going on. What is really inhibiting greater achievements in system efficiency? South Africa has subsequently removed the efficiency rebate, and in the process, destroyed opportunities for many ESCO start-ups.

Source: Business Day, September 7, 2012 and Mail and Guardian, March 23, 2012 included in <http://www.helio-international.org/Thorne-Energy%20reforms-CF2.pdf>.

Note: South Africa has subsequently removed the efficiency rebate, and in the process, destroyed opportunities for many ESCO start-ups.

The SE4All objective of doubling the rate of efficiency of the use of energy globally will be achieved through reduced energy consumption per unit of service and more efficient supply and consumption of wood fuels particularly in Africa.

Efficiency and Electricity

The concept of energy efficiency (EE) has not been addressed in any systematic long-term way in sub-Saharan Africa (with perhaps the exception of Ghana), other than on the supply side of electricity generation, transmission, distribution, oil refining, and off-grid power systems. Generally, however, African power companies have struggled to provide quality services and cost recovery. This can be blamed in part on technical and management inefficiencies, but also on political interference in regulation and on tariff setting. Such political intervention, while typically justified on the compelling grounds of equity, tends to undermine the financial sustainability of energy companies.

On the demand side, one of the most successful energy efficiency initiatives has been implemented by the Ghanaian government. It saved 124MW in 2007 by replacing six million incandescent light bulbs with CFLs. The South African electricity utility, Eskom, through Demand Side Management (DSM), reduced power consumption by more than 3 GW (see text box), but this was an emergency

peak demand saving measure utilizing short-life technologies. Some multinational companies, such as SABMiller⁷ and Kempinski Hotels, have undergone energy audits and implemented EE improvement projects and are world leaders in their footprint endeavors. The United Kingdom's Department for International Development (DfID) has done the same in several African countries within their diplomatic missions. Most companies in Africa that rely on electricity are required to have parallel back-up (mainly) diesel generators to utilize in the event of outages, so their interest in energy efficiency should be easy to stimulate, to avoid the costs of parallel stand-by electricity systems.

African energy intensity per capita is low compared to the global average (although South Africa is an exception), while energy intensity per unit of GDP is high. Both of these figures are linked not only to the underdeveloped power sectors in Africa, but also to the nature of African economies, which are dominated by energy-intensive primary and extractive industries (i.e., mining, oil, and gas), with limited value-added service industries contributing to local GDP.

Africa has relatively small, but rapidly growing markets for energy-utilizing technologies. Compounded by weak standards, leaky customs and low public awareness, it has become a dumping ground for second hand and sub-standard inefficient equipment and vehicles, putting further pressure on already strained energy systems. For example, the introduction of low quality CFLs can undermine market penetration of efficient lighting solutions. Some countries have implemented energy efficiency standards for appliances (and, in some cases, vehicles) such as air conditioners and refrigerators. However, enforcement of these standards has suffered in light of national Bureaus of Standards that are understaffed, under-trained and under-resourced.

Renewable energy associations have multiplied around the continent and have in many cases been instrumental in the removal of tariffs on imported clean energy technologies, the enforcement of minimum standards, the design of energy access financial instruments and codes of practice for their members.

7. SABMiller has 63 plants across Africa and places much value on promoting and achieving intensity benchmarks of 8 to 11 kWh/hectoliter (Greenfield and retrofits) as a contribution to their brand.

Traditionally, energy policy in Africa has focused on supply options, and, thus, is unlikely to alter efficiency in the absence of:

- Policy instruments that value highly and reward efficiency improvements;
- Empowered public utility commissions that demand efficiency for cost recovery and environmental reasons;
- Enforcement of the least-cost energy planning regulatory principle;⁸
- Dedicated energy departments that drive efficiency policy implementation rather than feeble cross-cutting intentions in over-worked and under-capacitated ministries;⁹
- Regulatory instruments that provide sufficient incentive for utilities and users to promote and invest in efficiency; and
- A cadre of trained and accredited auditing and verification professionals.

Efficiency and Cooking

Energy efficiency is partly dependable on technology, but much of its success will depend upon behavior patterns and management changes that are commonly considered, a major determinant in achieving efficiency and moderating demand. Ironically, it is the energy poor that have good management skills in abundance. Amongst the energy poor, energy is typically managed well as a necessary survival strategy within the stark constraints of the fuels and appliances people have access to. Planners and implementers of energy systems would be well-positioned to harness this behavioral attribute of the African poor, as their populations gain access to modern energy services, through sustainable energy pricing and access to efficient lighting and other efficient technologies.

When it comes to biomass, African governments have not managed to adequately formalize a sector that will continue to dominate the energy balances of most sub-Saharan African countries for the fore-

8. Least-cost energy planning is an international principle applied to energy regulation, by which selections of supply and demand resources can be selected and priced to achieve the delivery of energy services at the lowest cost to an economy.

9. Many African Ministries of Energy have a Renewable Energy Section, however energy efficiency sections are unheard of.

seeable future. The IEA estimates that biomass still accounts for 60% of the primary energy mix, and more than 80% in the sub-region use it for cooking. The quest for modernization in many countries has neglected biomass as an energy subsector, despite possibilities for the sustainable utilization of Africa's enviable forest resources. Efficiency saving opportunities in the biomass/domestic energy value chain exist at the transformation stage, with efficient kilns for wood to charcoal conversion, and at the consumption stage, with improved cook stoves.

What is clear in Africa is that modern energy is relatively expensive, but it is becoming less so. The leadership is promoting investments in large centralized energy supply, but not small, decentralized and efficient systems. The potential for efficiency in Africa is large, but almost entirely neglected in favor of securing supply. To harness the opportunity that energy efficiency represents, fundamental policy changes and policy instruments that reward verified efficiency gains are necessary. The SE4All Facility will concentrate on energy efficiency policy and regulatory instruments in assisting Africa policymakers to achieve modern energy/low-carbon economies.

Development partners, who value energy efficiency in their strategies, have been at a loss as to how to assist in achieving a valuable process to introduce efficiency measures with possibilities of success. The daunting prospect of multi-sectoral interventions and limited institutional capacity has reduced energy efficiency to something that would be nice to have. The energy regulators have a fundamental role to play in this regard.

Efficiency, Public Institutions and Private Companies

Energy efficiency can be addressed in different ways by the public and private sectors. African governments and foreign diplomatic and development partner missions can have a major impact on the efficient energy consumption in their countries simply by creating awareness amongst staff, conducting energy audits (and perhaps carbon footprinting exercises), implementing energy saving recommendations, monitoring and evaluating. This process is continuous and cyclical (and must be transparent and applied to all). When one cycle of audit, recommendation, implementation and evaluation ends, another cycle must begin. Additionally, energy efficiency in the public sector is

frequently simpler than in the private sector because it involves replacing inefficient appliances (such as lights) and behavioral change (such as turning off the space heaters or the air conditioning).

Energy efficiency in the private sector requires broader technical knowledge of such appliances as boilers, motors, pumps, and condensers. Supposedly, the private sector has a greater incentive to implement energy efficiency solutions than the public sector, as inefficiency negatively affects profits. However, energy efficiency in the private sector requires greater knowledge transfer as well as low-cost and accessible financing tools for EE projects.

Learning from Best Practices in Similar Socioeconomic Conditions

Across the southern Atlantic from sub-Saharan Africa, the Latin America and the Caribbean (LAC) region has in the past faced similar problems in achieving modern energy services access for its populations and for their productive activities. Particularly applicable to sub-Saharan Africa would be the Latin American experience with modern renewable biomass-based energy generation and gaining access to modern energy services. The enabling policies for such Latin American and Scandinavian transformations, which have allowed biomass to play a major role in modern energy economies, may provide policy pointers and should be studied in Africa.

Too many sub-Saharan African countries neglect sustainable biomass energy policy implementation simply because it is considered to be a primitive, last-resort form of energy and an abundant resource for the poorest. However, as the non-renewable biomass fractions estimations in the table above suggest, biomass energy will hit an availability wall unless forestry, energy, natural resources and subnational governmental authorities can implement and enforce policy and strategies that will result in a sustainable biomass energy services future. The key to sustainable biomass transition will be to project a path for the transformation from traditional to modern biomass including power generation and cogeneration, efficient cook stoves, afforestation and reforestation strategies, utilization of agricultural and other biomass residues, briquetting, etc.

These bridges are already available in the energy sector, certainly between Brazil and the African Lusophone countries, such as Angola and Mozambique. But such transnational energy cooperation revolves more around oil and gas. However, the deepening BRICS agenda has already strengthened trade links between BRICS partners and Angola: China, Brazil and South Africa are all among Angola's top trade partners. When it comes to sustainable energy, linkages are likely to grow and could be further catalyzed by south-south (or southern Atlantic) cooperation in achieving low emissions energy access for all, with transatlantic policy platforms (for example, a new Atlantic Energy Forum, which is currently being established under the auspices of the Atlantic Basin Initiative) also facilitating the exchange.

Chapter Six

South Africa, Africa's Energy Future, and Regional Economic Integration: Energy as a Way to Power Change

Saliem Fakir, Manisha Gulati, Louise Scholtz, and Ellen Davies

South Africa is a dominant economy in Africa's economic landscape, but other fast growing economies in Africa could challenge that status. South Africa's economy accounts for a quarter of total gross domestic product (GDP) in Sub-Saharan Africa and is the largest national investor on the continent. Its investments permeate a number of Africa's economic sectors and extend beyond traditional southern African markets, into the west, east and central parts of Africa.

Given the size of the South African economy, its demand for energy is significant, and it has a significant advantage in terms of installed capacity of megawatts (MW) and electricity access. Growing demand for energy, especially from southern African economies, could lead the region to play an influential role in shaping energy geopolitics and intra-regional trade relations. Growing demand for energy is forcing South Africa to look both inward to secure electricity supply and outward to diversify its supply of petroleum.

The question, therefore, is how South Africa can play a positive role in greater Africa in order to achieve the key imperatives of energy availability, accessibility, and affordability, while ensuring that the resultant economic growth and social development benefits the average African. It is against this backdrop that this chapter will explore the role that South Africa can play in Africa's energy future.

Overview of South Africa's Economic Role in Africa

As one of the two largest economies in Africa (with a 2013 GDP of \$322.6 billion), South Africa is an influential economic player on the continent. The significance is more pronounced in the southern

African region: in 2012, the South African economy was more than three times the size of Angola's, the second largest economy in the Southern African Development Community (SADC) region.¹ South Africa, as the most industrialized country on the continent, has one of the most diverse economies in Africa. Its strong financial services sector serves much of the continent, and it is the trade and investment gateway to Africa for many hedge and private equity funds.

South Africa is also the largest African investor on the continent. By 2008, South African companies had invested \$8.5 billion in the sub-continent, and it is the only African country to be featured in the top 20 investors in Africa, ranking fifth overall.² South African Foreign Direct Investment (FDI) in Africa has occurred beyond traditional Southern African markets, into west, east and even central Africa, in most cases with considerable success. While most FDI from outside Africa focuses on oil and gas, South African firms are branching out - moving beyond mining to a diverse range of activities such as brewing, telecommunications, retail, shipping and banking services.³ In doing so, South African companies contribute to the diversification of African economies and to a reduction in their dependence on primary sector industries. Clean energy also provides new growth and development opportunities, not only for South Africans, but also for the region, an aspect that is discussed later in this chapter.

However, sustained growth and development requires adequate and reliable sources of energy, and in this respect, Africa falls woefully short despite its rich endowment with a variety of energy sources from coal, gas and oil to large-scale hydro-power.

Africa's Energy Situation

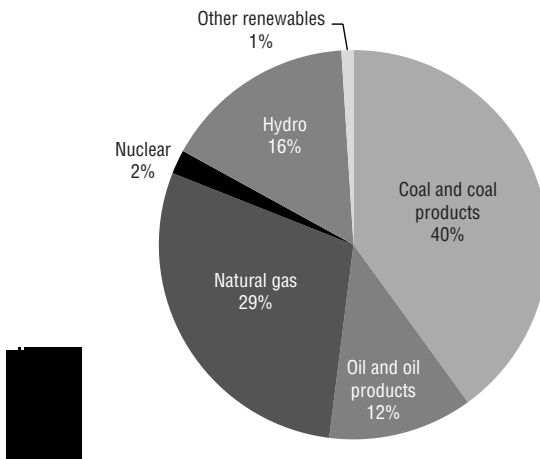
The African continent makes up 15% of the world's population, but only accounts for 5% of primary energy use. In terms of per capita

1. The World Bank. 2014. World Bank Country Data. [Online] Available at: <http://data.world-bank.org/country/south-africa>.

2. UNCTAD. 2013. *Economic Development in Africa Report 2013. Intra-African Trade: Unlocking Private Sector Dynamism*. United Nations, New York and Geneva.

3. Leon, T. 2004. "Africa's Economic Future: SA's Role in Promoting Development." Speech by the Leader of the Opposition, Parliament in SA at the Council on Foreign Relations Washington, D.C.

Figure 1. African Power Generation by Fuel Type in 2009.



Source: IEA Database in Irena, 2012.

energy consumption, Africans consume one third of the global average. However, if we exclude the use of traditional biomass, per capita energy consumption in Africa is as low as one sixth of the global average.⁴

This low per capita consumption is closely related to Africa's limited generation capacity. In 2011, it was estimated that the continent had only 147 GW of installed generation capacity, an amount China installs in one to two years.⁵ Of these 147 GW, the vast majority is generated by fossil fuels. Figure 1 shows that in 2009, 81% of power generation in Africa came from coal, gas, and oil, with 2% generated from nuclear, 16% from hydro, and only 1% from other renewables (including solar, wind, biomass, and geothermal). Although expanded renewable programs in some African countries may have changed the picture somewhat, fossil fuels still continue to dominate the African power generation mix.

The two biggest energy challenges facing the African continent are electricity supply and access. Access to electricity in Africa is particularly low. In 2009, it was estimated that 587 million people in Africa lacked access to basic electricity services. However, access levels across

4. *Ibid.*

5. *Ibid.*

the continent as well as between urban and rural areas differ substantially. Countries in North Africa, for example, are almost entirely electrified, whereas in sub-Saharan Africa, it was estimated that only 35% of urban populations had access to basic electricity services in 2009. In rural parts of sub-Saharan Africa, access is much lower, with less than 20% of rural areas electrified in 2009. Access Levels also differ substantially within sub-Saharan Africa. In South Africa, for example, 83% of urban areas and 57% of rural areas were electrified in 2010, a figure substantially higher than the sub-Saharan average.⁶ Table 1 depicts the percentage of people in sub-Saharan African countries living without electricity access.

Discrepancies between electricity access across the continent are also reflected in estimated electricity consumption. On average, per capita electricity consumption across Africa is 620kWh. However, in sub-Saharan Africa (excluding South Africa), per capita electricity consumption is more than three times lower, at only 153 kWh. When contrasted to the average per capita global consumption of 2,730kWh, electricity consumption across the continent and particularly in sub-Saharan Africa's levels are very low.⁷ This energy deficit is striking, given the rich energy endowments of the continent. This also hinders further potential for economic development in Africa.

Lack of access to a reliable supply of electricity places a major burden on African economies, especially on countries in sub-Saharan Africa. Daily power outages are experienced in 30 of 48 countries in sub-Saharan Africa. Many companies and citizens, therefore, rely on diesel generators at great financial costs. Power outages are estimated to cost some sub-Saharan countries between 1 and 5% of their GDP.⁸

Studies suggest that to meet Africa's demand, an additional 250 GW of capacity will be needed by 2030. This will require substantial investment. Globally, an estimated 34 billion USD (in addition to base line investment) is needed per year to ensure universal access by 2030. An estimated 60% of this is needed in Africa alone. With African government's limited financial resources and pressing development needs,

6. *Ibid.*

7. *Ibid.*

8. *Ibid.*

Table 1. Share of Population Living without Electricity Access per Country in sub-Saharan Africa.

Seychelles	3.0%	Mali	72.9%
Cape Verde	6.0%	Swaziland	73.0%
South Africa	14.7%	Togo	73.4%
Ghana	28.0%	Zambia	74.0%
Botswana	34.0%	Cote d'Ivoire	74.2%
Equatorial Guinea	34.0%	Tanzania	76.0%
Gabon	39.9%	Ethiopia	76.7%
Sao Tome and Principe	41.3%	Mauritania	79.2%
Senegal	45.5%	Guinea-Bissau	80.0%
Cameroon	45.9%	Kenya	80.0%
Djibouti	50.0%	Rwanda	83.2%
Nigeria	55.0%	Burkina Faso	83.6%
Zimbabwe	60.0%	Uganda	85.2%
Mozambique	61.0%	Madagascar	85.3%
Gambia	64.7%	Niger	85.6%
Congo	65.0%	Guinea	87.9%
Sudan	65.0%	Burundi	90.0%
Eritea	68.1%	Democratic Republic of Congo	91.0%
Sub-Saharan Africa	68.2%	Malawi	91.0%
Angola	70.0%	Sierra Leone	95.0%
Namibia	70.0%	Chad	96.3%
Benin	71.6%	Central African Republic	97.5%
Lesotho	72.0%	Liberia	98.4%

Source: UNDP and WHO, 2009; ECREEE for West Africa in IRENA, 2012.

Note: data for West African Countries refer to 2010.

this level of investment can only be achieved through public-private partnerships.⁹

South Africa's Energy Sector vis-à-vis Africa

Although South Africa faces its own energy challenges, it is clear from the data that it is ahead of most of its African counterparts, and

⁹. *Ibid.*

especially countries in sub-Saharan Africa, in terms of energy generation and access. The following section will explore South Africa's energy landscape in more detail.

South Africa is a key player in Africa's energy space: it accounts for 21% of Africa's primary energy use and just over 27% of Africa's primary energy production.¹⁰ In 2011, 40,000 MW of the 147 GW of generation capacity in Africa came from South Africa.¹¹ This capacity assumes greater importance when viewed in the Sub-Saharan context. When South Africa's generation capacity is excluded from sub-Saharan Africa totals, the generation capacity of 48 countries drops significantly from 68 GW to 28 GW.

South Africa is also one of the few countries in Africa with high levels of access to modern energy sources. Biomass share in total primary energy supply for the continent is 47%, while for South Africa it only accounts for 15.4%. South Africa is also the main power market in Southern Africa, estimated to account for two-thirds of power generation in the Southern African region by 2030.¹²

About 88% of Africa's proven coal reserves are found in South Africa, and South Africa is overly dependent on coal that generates 71% of its energy and 90% of its electricity. South Africa's abundant coal reserves during the Apartheid and sanctions busting era were used to convert coal into liquid fuels. This was enabled by SASOL, a privately-owned company based in South Africa, through its pioneering of the Fischer-Tropsch (FT) conversion technology for synfuels production in what is called coal-to-liquids (CTL). FT technology can also be used to convert gas to liquids (GTL).

This has made South Africa less dependent of foreign imports. Synthetic fuels production is a technology proving to be crucial in global gas markets. SASOL is investing 20 billion USD in the United States to tap into the U.S. gas markets.¹³ Other innovations in technology are

10. Eberhard, A., Rosnes, O., Shkaratan, M. and H. Vennemo. 2011. *Africa's Power Infrastructure. Investment, Integration and Efficiency*. Foster, V. and Briceno-Garmendia, C. (series eds) The World Bank, Washington DC.

and IRENA 2012.

11. *Ibid.*

12. *Ibid.*

13. Sasol U.S. 12 March 2012. Sasol Announces Largest Manufacturing Investment in Louisiana History, Creating more than 7,000 Direct and Indirect Jobs. Louisiana Economic Development

being pioneered using dry-cooling methods for coal plants (since they use a lot of water for cooling and carbon capture and storage technologies to sequester carbon dioxide, given that South Africa is one of the major emitters of greenhouse gases per capita terms in the world.¹⁴

South Africa has also undertaken significant reforms that have attempted to make electricity affordable to the poor¹⁵ while at the same time undertaking a large-scale grid-based electrification program, premised on a technically strong utility. These initiatives have been instrumental in supporting increased access to electricity.¹⁶ Urban electricity access has risen from 30% in 1994 to 83% in 2010, and rural access has risen from 12% to 57% over the same period.¹⁷ This is a significant achievement in a continent where energy access remains one of the biggest challenges.

South Africa has a growing clean energy market, attracting significant foreign and local investment. It has the largest clean energy sector on the continent and ranks 9th overall in the world.¹⁸ Over the past five years (from 2008 to 2013), South Africa's clean energy market experienced the fastest growth internationally, with an average annual growth rate of 96%.¹⁹ In 2013, 4.9 billion USD was invested in renewable energy in South Africa—3 billion USD in solar and 1.9 billion USD in wind.²⁰ Investment in this sector is expected to grow with the revising of the country's Integrated Resource Plan (IRP)²¹, thereby achieving a possible 17 GW of additional solar and wind by 2030.²²

Press Release. Sasol. [Online] Available at: http://www.sasollouisianaprojects.com/news.php?action=submit&story_id=50&type=P.

14. National Treasury. 2010. Reducing Greenhouse Gas Emissions: The Carbon Tax Option. National Treasury of the Republic of South Africa, Pretoria.

15. Davidson, O. and Mwakasonda, S. A. "Electricity Access to the Poor: A Study of South Africa and Zimbabwe." Available from <http://www.afrepren.org/project/gnesd/esdsi/erc.pdf>

16. *Ibid.*

17. International Renewable Energy Agency (IRENA). 2012. *Prospects for the African Power Sector: Scenarios and Strategies for Africa Project*. Abu Dhabi.

18. The PEW Charitable Trusts. 2014. *Who's Winning the Clean Energy Race? 2013*. The PEW Charitable Trusts.

19. *Ibid.*

20. *Ibid.*

21. The IRP is an electricity planning tool that the government uses to project long-term energy mix options that can guide ministerial determinations for installed capacity over a 20-30 year period. It also provides for a price-path for electricity.

22. *Ibid.*

Simultaneously, South Africa has an energy efficiency program, specifically aimed at four sectors: industry and mining, commercial and public buildings, residential and transport, all of which seek to reduce final energy demand by 12% by 2015. This initiative is part of South Africa's attempt to reduce greenhouse gas (GHG) emissions by 34% by 2020 and 42% by 2025 as per its commitment under the United Nations Framework Convention on Climate Change (UNFCCC). Initiatives on the energy efficiency front include an industrial energy efficiency program, tax incentives and rebates, energy use through efficient practices and an appliance labelling program. The need to reduce the carbon intensity of the grid has produced a unique feature in the IRP—it is one of the few plans in the world that include an implicit carbon budget for electricity energy mix decisions.

Finally, South Africa is part of one of the few energy integration schemes on the continent, the Southern African Power Pool (SAPP). The underlying political and economic force behind the evolution of SAPP, which was established in 1995, has been South Africa's desire to meet future increases in demand by importing low-cost hydropower from its northern neighbors. The efficacy and effectiveness of SAPP will be discussed in more detail in the section below.

Role at Southern African Level

In the previous section detailed how South Africa will be a key player in supporting a more integrated or regional approach to energy supply, particularly in the Southern African region, where energy access and reliable, affordable supply of electricity remains a key challenge. The following section shall examine South Africa's role in Southern Africa's energy landscape.

South Africa, by means of Eskom, is by far the largest electricity market in southern Africa with the electricity systems of neighbouring countries such as Botswana, Lesotho, Namibia and Swaziland developed as derivatives of the South African network. In the past, these countries have all been net importers of electricity from South Africa. South Africa still exports about 5% of its electricity production to neighboring countries—such as Botswana, Namibia, and Swaziland. This asymmetry of power is clearly illustrated in Table 2.

Table 2. South Africa's Trade in Electricity from April 1, 2005 to March 31, 2011.

Trading Partner	Imports (in gigawatt-hours)	Exports (in gigawatt-hours)
Botswana	0	15.334
DRC	1.815	0
Lesotho	109	420
Mozambique	64.927	58.454
Namibia	105	11.551
Swaziland	0	4.866
Zambia	677	683
Zimbabwe	282	1.259

Source: Information provided by Eskom.

The data clearly shows the vulnerability of these countries to electricity shortages in South Africa which result in rolling blackouts that negatively impact their economies.²³ A regional approach using market mechanisms will go a long way in addressing these electricity shortfalls and in reducing expenditure on wasteful projects, to the benefit of electricity consumers and economies in the region²⁴.

But not only would a more regional approach benefit South Africa's neighbors; it would also help South Africa face its own challenges. It is under increasing pressure to look for alternatives to its "climate unfriendly coal-fired power stations."²⁵ To achieve its commitments to reduce GHG emissions under the UNFCCC framework, South Africa has developed a comprehensive climate change mitigation and adaptation strategy, in the form of the National Climate Change Response (NCCR) White Paper.²⁶ The NCCR recognizes that the greatest emission reduction will have to come from its energy generation and

23. Asami Miketa, A. and Merven, B. 2013. *African Power Pool: Planning and Prospects for Renewable Energy*, International Renewable Energy Agency (IRENA).

24. De Vos, D. 2014. Electricity: "Africa's Secret Weapon for Economic Unity," *Daily Maverick* (online), 7 April. Available at <http://www.dailymaverick.co.za/opinionista/2014-04-07-electricity-africas-secret-weapon-for-economic-unity/#.U0qLNZAaJOw>

25. Scholvin, S. 2014. South African Energy Policy: Constrained by Nature and Path Dependency, *Journal of South African Studies*, 40:1, 184-202. Available at: <http://dx.doi.org/10.1080/03057070.2014.889361>.

26. DEA. 2011. National Climate Change Response White Paper. Department of Environmental Affairs (DEA), Pretoria.

use. The South African Government is, therefore, eager to diversify its energy supply and is increasingly looking at the possibility of unlocking potential shale gas reserves in South Africa. At present, however, economic and feasibility studies must still be undertaken, and successful exploitation will require significant investment in infrastructure.²⁷ There are regional options such as the availability of significant conventional gas resources off of the eastern shores of southern Africa that could be exploited. Recent discoveries in the northern Rovuma basin of Mozambique estimate 180 Trillion cubic feet (Tcf) of recoverable gas reserves.²⁸ In Tanzania, estimates in 2013 predicted 18 Tcf in recoverable reserves with another 20 Tcf still to be discovered.²⁹ As exploration continues, these numbers will continue to rise .

The regional gas reserves provide an opportunity for South Africa to reduce its dependency on coal and its resultant GHG emissions. South Africa could turn to neighboring countries with gas and oil reserves. Both Mozambique and Namibia have offshore gas fields, which South Africa can exploit. At present, PetroSA has already entered into an agreement with Mozambique's state-run Petromac to look at its new gas finds.

The South African Shanduka Group (a private black empowerment firm) will develop a 117 MW gas-fired power station near Maputo. 85% of the output from this station will be sold to Eskom, and the remainder will be taken up by Electricidade de Mozambique. South Africa has, however, not been as successful in ensuring cross-border cooperation with respect to oil.³⁰ Furthermore, other private firms (in addition to the Shanduka Group) are exploring opportunities to access gas for power generation. For instance, SASOL, which has existing pipelines from Mozambique, could be a strong player in the regional gas market for gas finds that are yet to be monetised. SASOL's new strategy is to decrease coal consumption and to switch to gas as an energy source and for conversion to liquid fuels and other products.

27. Hedden, S., Moyer, J.D. and Rettig, J. 2013. Fracking for Shale Gas in South Africa: Blessing or Curse? *Africa Futures Paper*: 9.

28. Fruhaf, A. 2014. Mozambique's LNG Revolution: "A Political Risk Outlook for the Rovuma LNG Ventures." OIES Paper: NG 86. Oxford Institute of Energy Studies.

29. Ledesma, D. 2013. *East Africa Gas—Potential for Export*. Oxford Institute for Energy Studies.

30. Scholvin, S. 2014.

Hydropower also provides opportunities for South Africa, and the broader region. Scholvin highlights the “odd complementarity of varying natural conditions and different stages of economic development” in southern Africa that builds a sensible case for cooperation across borders. South Africa has a high demand for electricity, but has a low hydropower potential, while in neighboring states—Angola, Mozambique, Zambia and the Democratic Republic of the Congo (DRC)—there is potential for hydropower coupled with low electricity demand.³¹ However, finalizing projects that ease cross-border transport is difficult as the failure of the Westcor power project, which was meant to link the DRC’s hydropower station at the Inga Dam to South Africa, demonstrated given the complexities of the terrain, financing and political sovereign issues. Although there was an agreement between Eskom and the operator from the Power Institute for East and Southern Africa (PIESA) that the project was “technically feasible..., they had the impression that discrepancies in national legislation and political quarrels over how to distribute the revenues made the project fail.”³²

In this regard the Cabora Bassa on the Zambesi River is the only project that has begun, illustrating some of the challenges of cross border electricity provision. Initially it was expected that the plant would transmit its maximum load of 2,025 megawatts to Gauteng—the major economic province of nine provinces in South Africa.

However, the war that raged in Mozambique during the 1890’s and 1990’s made transmission lines ‘easy targets’ for anti-government guerrillas; as a result, regular electricity generation only resumed in 1998. Given the eventual success of the scheme and the potential of other hydropower schemes such as Kariba Dam on the Zambia—Zimbabwe border, the Kafue Gorge Dam in Zambia and near Ruacana on the Angola—Namibia border, the question is raised whether Eskom will continue to be a net exporter of electricity in the region, where Mozambique has been the exception given the imports from

31. *Ibid.*

32. Draper, P. and Scholvin, S. 2012. “The Economic Gateway to Africa? Geography, Strategy and SA’s Regional Economic Relations,” Briefing Paper No 121, South African Institute of International Affairs: Johannesburg.

Cabora Bassa. However, South Africa's own growing demand will make it a net importer, rather than exporter of energy, in the future.

The extent to which South Africa could benefit from the rest of the region is clear from the figures supplied by Eskom, illustrating that Mozambique and Zambia could transmit another 5,000 and 1,000 MW respectively to South Africa. It is expected that Angola and the DRC would be able to supply 20,000 MW to the region after 2025, which would make a substantial contribution to satisfying regional demand.³³ Projects like Cabora Bassa are the result of long-term bilateral agreements and the dominant examples of regional electricity supply. In this regard, it is pointed out that as long as trade is limited to the surpluses from this and similar projects, one cannot speak of a functioning power pool, which requires an operational market mechanism for trading electricity.³⁴

It has been argued that at the heart of South Africa's reluctance to fully realize the potential of the region's hydropower lie its large coal reserves. This suggests that only an energy crisis would provoke South African business and government to pursue the benefits potentially offered by the region's oil, gas and hydropower³⁵. This raises the question of whether or not South Africa and the Eskom monopoly are actually interested in maximizing the potential that SAPP holds in deepening regional energy integration.

It also raises the question whether SAPP has been successful in deepening regional integration. Although it is institutionally more effective than people think, there has been limited cross-border trading to date. This is largely the result of the dominant position of South Africa *vis-à-vis* electricity generation capacity in the region. This situation is exacerbated by Eskom, which represents South Africa in front of the body.³⁶ To date, it has been guilty of promoting its own generating assets even in instances where it has not been in the best interests of either the region or South Africa. This is inconsistent with common practice in the rest of the world, where new technologies

33. Scholvin, S. 2014.

34. De Vos, D. 2014.

35. Scholvin, S. 2014.

36. Asami Miketa, A. and Merven, B. 2013.

have made it possible to restructure electricity on a regional basis, and retail sales of electricity are no longer seen as natural monopolies.³⁷

In SAPP, energy demand is expected to grow by 4.4% per year to 2040³⁸. To meet this demand, an additional 129 GW capacity will be required between now and 2040 (PIDA, 2011).³⁹ In terms of the current SAPP plan, the funding required for medium to long term projects alone (until 2025), is somewhere around 83 billion USD for an additional 57,000 MW. This will more than double the current regional generating capacity and would also require regional transmission investments of approximately six billion USD. Investments to meet 2040 demand predictions will be larger. South Africa can play a pivotal role in ensuring the economy (or effectiveness, or efficacy) of these regional electricity projects, if it were perceived as a serious buyer of electricity and provided the initial base load demand.

South Africa, can also play a key role in developing cleaner sources of energy. These sources can meet its own needs and help other countries in the region move towards cleaner energy sources. The successful introduction of the Renewable Energy Independent Power Producers Bidding Program in South Africa supports the view that South Africa can “[lead the] way for countries throughout Africa to capitalize on their natural energy resources and attract private sector investment.”⁴⁰ However, some commentators are more pessimistic: pointing out that renewables have “remained no more than marginal, contributing less than 1% of the electricity used in South Africa.”⁴¹

Others openly question South Africa's commitment, given its continuing investment in large scale coal fired plants, such as Kusile and Medupi, the third and fourth largest coal fired power plants in the world, respectively.⁴² In addition, South Africa has been reluctant to enter into energy contracts with IPP's based in neighboring countries

37. *Ibid.*

38. PIDA, 2011

39. *Ibid.*

40. Nott, G. SA's "Energy Success Story Could Spark a Chain Reaction across Africa." Available at: <http://www.werksmans.com/legal-briefs-view/sas-energy-success-story-could-spark-a-chain-reaction-across-africa/>.

41. Scholvin, S. 2014.

42. Winkler, H. and Marquard, A. (2009). Changing Development Paths: From an Energy-Intensive to Low-Carbon Economy in SA. *Climate and Development*. 1(47-65).

on the basis that the unit cost would be too high. This will continue to affect the process until the size of the African energy systems are extended to enable the scale required to bring energy costs down. It is here, in bringing down costs, that South Africa could play an important role.⁴³

To conclude: there are compelling reasons for energy integration on a comparable level to South Africa. It is in the region and South Africa's interest to pursue high rates of economic growth. Electricity supply constraints are a significant hurdle to future growth, but a regional approach using a combination of market and other mechanisms will go a long way in addressing present electricity challenges in the region. However, while "technical constraints such as the reliability and security of the existing grid and its expansion" pose challenges, the "biggest constraint is where national utility monopolies like Eskom feel threatened by the available market mechanisms and choose not to use them."⁴⁴ This view is supported by Miketa and Merven (2013), who argue that there is little evidence that South Africa is engaging in the long-term planning that is required or forging strategic relationships with its energy rich neighbors.⁴⁵ However, it is imperative for South Africa's decision-makers to confront the extent to which Eskom's self-interest is preventing South Africa from maximizing its position as geopolitical core and a gateway to southern Africa.⁴⁶ Unless this issue is addressed, few things will change in the near future.

Role at Pan-African Level

The above section illustrates that provided it possessed the political will; South Africa could play a significant role in developing an integrated regional energy system in southern Africa. It is also clear that this would have huge benefits not only for the region, but for South Africa as well. However, this is potentially restricted by on-going suspicions within Africa about South Africa's intentions on the continent.

43. Scholvin, S. 2014.

44. De Vos, D. 2014.

45. Asami Miketa, A. and Merven, B. 2013.

46. Draper, P. and Solvin, S. 2012.

South Africa is rumoured to promote “national economic interests, rather than more sectoral and geographically balanced economic growth within SADC”. Unfortunately, many old-guard African leaders are resentful of South Africa as an assertive relative “newcomer.”⁴⁷ The following section shall explore the role South Africa can play at a pan-African level.

South Africa faces its own challenges and shortcomings in its energy strategy and policies, and in its universal energy access program. Many have raised doubts as to these policies performance and relevancy. At the same time, South Africa faces a skill shortage in many sectors in its own economy. Nevertheless, the fact remains that South Africa boasts a high level of industrialization and therefore a wealth of experience in private sector interactions. It also has a large amount of institutional knowledge in bilateral and multilateral organizations, and international agencies and advanced levels of energy planning. South Africa has furthermore instituted policies and programs evaluated by review and evaluation mechanisms and that are adjusted to changing conditions. Sketched below are some suggestions on how South Africa can maximize its dominant position in the African energy landscape to address the energy needs of the continent.

South Africa's experience in managing large grids and electrification systems can be useful to other African countries that want to expand grid access and availability to its population and large industries. Additionally, the country's post-Apartheid success with near universal grid access is a remarkable achievement. This is more than an engineering feat. It is an catalyst for innovative payment and cost recovery systems. This know-how can be used within the African Union's program to expand electricity and other energy infrastructure in Africa. Cross-border sharing at the state-to-state level exists, but has the potential to be significantly reinforced if South Africa adopts a more strategic view and works constructively with other African governments.

Demand for know-how and modernization of energy systems will grow provided that in the next 35 years, the rate of urbanization in

47. Bond, P. 2010. *SA: Foreign Policy after Mandela and Mbeki*. Available at: <http://www.africafiles.org/printableversion.asp?id=23682>

Africa is significant. By 2050, Africa's urban population is expected to triple from an estimated 414 million urban dwellers in 2011 to 1,265 million by 2050.⁴⁸ The United Nations predicts that in 2050, more than half of Africa's population will be living in urban areas.⁴⁹ Service backlogs and the cost of the services are likely to be significant. Finding efficient and effective delivery mechanisms that are also affordable will be imperative.

The increased exploitation of energy reserves and development of related projects will require key skills in areas such as project development, procurement processes, contract negotiation and management, and risk analysis. These skills will become particularly important, especially with the increased involvement of the private sector in the continent's energy sector. South Africa can, therefore, contribute to capacity development in other African countries, particularly in smaller and less resourced countries. In doing so, it would also help reduce the transaction costs of energy projects and programs on the continent. One can observe this trend today. An already large portion of South Africa's technical, engineering and planning expertise also extends beyond South Africa's borders.

The increasing role of renewables in the South African energy mix and in future gas is leading South Africa to develop some experience with modular utility scale technologies. Renewables—an intermittent source of energy—require experience with grid capacity and systems management. By 2030, renewable energy from South Africa's grid is expected to reach 6%-7% of the energy mix—about 19GW. The volume has potential to be higher provided that other sources—such as coal and nuclear—do not become part of the energy mix. By then, South Africa's system operator and IPPs would have gained substantial working experience with various renewables technologies such as photovoltaics (PV), wind, and concentrated solar power (CSP) that would not be only of value for neighboring states, but also for the African region as a whole.

In the long term, South Africa could play a role in supporting and encouraging the creation of regional and continental electricity mar-

48. DESA. 2012. *The World Urbanization Prospects: The 2011 Revision. Highlights*. The Department of Economic and Social Affairs of the United Nations (DESA), Washington DC.

49. *Ibid.*

kets for economic growth and human development for the entire African continent. Regionally integrated approaches to energy development, in particular for large-scale energy sector projects, would make both the energy and the economic market large enough to incentivize investments in the energy sector and facilitate the development of diverse energy resources for the benefit of the entire continent. South Africa's economy is so large that it could serve as an anchor client for a well-integrated energy and economic system that can improve the efficacy of many projects.

Also critical for this development is South Africa's ability to interconnect with neighboring countries in order to provide an alternative supply source for countries, which have small energy markets or are dependent on sources such as hydropower and are affected by nature, in addition to enabling smaller countries to pool risk together. The latter would make the development of a country or a region's power projects more attractive to both domestic and international investors, as well as to bilateral and multilateral lenders.

South Africa would be well-served to capitalize on green growth strategies using the transformation of its own energy sector. They can do this by basing their development strategy in both electricity and liquid fuels. This interest is evident in a number of areas: energy efficiency, less carbon intense grid by scaling up renewables at utility and non-utility scale, smart-grids, and the production of biofuels for motor vehicles and the aviation industry. These require new financing incentives and tools. In addition, their large-scale production is likely to bring down costs. This has already been proven for the renewables IPP bids that the South African government has run for the last three rounds. The link between energy transformation and green growth presents valuable lessons and experience relevant to the rest of the continent. Presently, South Africa is a pioneer in a hostile environment.

Conclusion

This chapter has shown that because of South Africa's strong presence in Africa's economic and energy landscape, it can play a significant role in Africa's energy development. It has also illustrated that increased collaboration with South Africa would have significant ben-

efits not only for Africa and southern Africa in particular, but for South Africa as well. Unlocking Africa's energy access to its unserved population would promote further economic development, growth and integration. South Africa can play an important role in this, but such an initiative would require vision, long-term thinking and an enlightened self-interest.

It is also apparent that for this to happen, strong political will on the part of the South African government is needed to address the Eskom monopoly and to foster the potential of a regional energy system. Unless this will is present, South Africa's role in Africa's energy landscape will be limited to acting as the African voice in the international community, assisting in technology and skills development and providing guidance in the development of successful energy programs. While this level of involvement will undoubtedly be beneficial for the African continent, it will not contribute to a wider set of gains, both for Africa and South Africa that a committed integrated regional energy approach would bring.

Chapter Seven

Brazil and Africa: Integration and Development through Expanding Energy Linkages

Chris Cote and Mark S. Langevin

Over a half century ago, then Brazilian President Jânio Quadros wrote in the pages of *Foreign Affairs*:

As to Africa, we may say that today it represents a new dimension in Brazilian policy. We are linked by our ethnic and cultural roots and share in its desire to forge for itself an independent position in the world today... I believe that it is precisely Africa that Brazil can render the best service to the concepts of Western life and political methods. Our country should become the link, the bridge, between Africa and the West, since we are so intimately bound to both peoples.¹

Quadros' vision to bring Brazil and Africa into close orbit took some time to mature as a foreign policy principle, but by the end of President's Luiz Inácio Lula da Silva term in office (2003-2011) it was clear that Brazil—Africa engagement was expanding rapidly.

President Lula's Foreign Minister, Celso Amorim, summarized the numerical dimensions of this engagement:

As result of the political priority attributed to the African continent in Brazilian foreign policy, the number of Brazilian resident embassies in Africa has more than doubled, now covering 39 out of the 53 countries... not only has political dialogue with African countries improved vigorously, but also trade between the two margins of the Atlantic has expanded fivefold ever since—from US\$5 billion in 2002 to US\$26 billion in 2008. Taken as a single country Africa would appear as Brazil's fourth commercial partner, only behind China, the United States and Argentina, ahead of traditional partners such as Germany and Japan.²

1. Jânio Quadros, "Brazil's New Foreign Policy." *Foreign Affairs*, Vol. 40, Issue 1, October 1961:19-27.

2. Celso Amorim, "Brazilian Foreign Policy under President Lula (2003-2010): An Overview," *Revista Brasileira de Política Internacional*. Vol. 53. 2010:234.

While Brazil was slow to bring about Quadros' vision of Africa-Brazil relations, the nation's solidarity with and interest in Africa now parallels the national defense policy's strategic emphasis on the "Blue Amazon" and the South Atlantic basin as a regional security sphere. Two Brazilian analysts, Abdenur and Souza Neto, argue that Brazilian national defense policy has recently changed in significant ways, including: (1) a newly emerging transregional focus on both South America and West Africa; (2) the adoption of a more precautionary defense posture relative to the South Atlantic given the massive off-shore pre-salt hydrocarbon reserves, the country's export driven growth model and its dependence on safe and secure sea lanes; and (3) not only reviving the historic links between South America and Africa, but also developing a broader regional security strategy that emphasizes shipbuilding and the building up of naval forces.³ Towards these ends, Wiesebron reports that Brazil is currently investing in the modernization of its naval fleet, including the nuclear powered Submarine Force, for deployment in the South Atlantic; and

Because of that, Brazil is expanding its cooperation with the countries of West Africa; it is about supporting African countries so that the South Atlantic is the South Ocean, without the presence of "the North," or at least that this very presence does not jeopardize the interests of the South in general and Brazil in particular.⁴

Clearly, Brazil is busy implementing a South Atlantic development and security strategy, founded upon expanding regional South American integration efforts, but aimed toward providing a broader South Atlantic regional alliance to promote and accelerate deepening economic interdependence between Brazil, South America, and Africa. Currently, this transregional development is fueled by Brazilian foreign policy and through the agricultural and energy sectors, where economic and organizational linkages are quickly multiplying behind a number of Brazilian government initiatives and private sector

3. Adriana Erthal Abdenur and Danilo Marcondes de Souza Neto, "Brazil's Maritime Strategy in the South Atlantic: The Nexus between Security and Resources," in Felix Dane, ed., *Brazil Emerging in the Global Security Order*. Rio de Janeiro: Konrad-Adenauer-Stiftung, 2013:182-183.

4. Marianne L. Wiesebron, "Blue Amazon: Thinking: The Defense of Brazilian Maritime Territory," *Brazilian Journal of Strategy and International Relations*, Vol. 2, No. 3. Jan-June 2013:117-118.

investments. Currently, the agricultural and energy sectors, along with a quickly multiplying number of economic and institutional linkages—all driven by Brazilian foreign policy—fuel this transregional development.

Brazil's initial energy linkage to Africa began in earnest through its own search for national energy security developed by Petrobras' exploration and production activities in West Africa, especially Angola. Yet, today Brazilian government agencies, Petrobras and Eletrobras, and private sector firms are planning, launching, and administering a growing number of projects to achieve energy security and anchor economic development in a select set of African countries. These linkages, largely built from Brazil to Africa, weave together a transregional energy and development strategy that tends to incorporate a growing number of South American and African nation-states.

These linkages may expand and deepen to eventually compose a future foundation for collective energy security among Brazil and its South American and African partners, but it is not certain whether such efforts will be limited to the South Atlantic or become incorporated into a broader Atlantic basin project that ties together the North and South Atlantic through supply and demand exchanges along with a developing "governance space."⁵ For now, it is important to explore and examine these linkages to better understand whether Brazil can construct a bridge that deepens economic development by increasing energy production and consumption in Africa. Given these unfolding linkages, as well as Brazil's South Atlantic-centered defense and foreign policy framework, can Africa-Brazil cooperation become an essential building block to an Atlantic basin-wide energy community, or will it instead hinder this opportunity? Moreover, has President Dilma Rousseff advanced the broad, active engagement of the prior Lula government with Africa or has her administration adopted a more incremental approach to building a bridge to Africa through energy-related linkages?

5. Paul Isbell argues, in *Energy and The Atlantic: The Shifting Energy Landscape of the Atlantic Basin*. German Marshall Fund of the United States. 2012:21; that "the Atlantic Basin could turn out to be the ideal space within which the Atlantic's many energy economies begin to abandon the chimera of "national energy independence" and pursue instead—through a conscious framing of energy policy and a deliberate recasting of energy relations within the basin—an ultimately more sustainable, and therefore pragmatic, 'collective energy security.'"

This chapter explores these questions through an examination of Africa-Brazil energy linkages to identify possible answers and outcomes. The chapter proceeds through four sections, including: (1) Brazilian government policies and programs that initiate, support and frame energy related linkages; (2) hydrocarbons; (3) biofuels; and (4) electricity generation and transmission.

Brazilian Government Policies and Programs

Brazil's engagement with Africa is founded upon its South Atlantic collective security vision, but framed by its efforts to deepen structural and institutional horizontal cooperation between itself, South America and Africa. Towards this end, the Brazilian government has established and advanced an expanding set of policies and programs to structure its "South-South Cooperation"⁶ with Africa since former President Lula took office in 2003. The construction of this inter-continental, South Atlantic regional development bridge began under prior administrations, first with the military government in 1973 and largely carried out through the operations and investments of Petrobras, then a fully state-owned oil and gas company, in Angola. Subsequently, Brazil also played a contributory role in the founding and administration of the South Atlantic Peace and Cooperation Zone (often referred to as ZOPACAS) in 1986. Yet, it was not until the Lula government set out to implement a broad set of bilateral and multilateral cooperation projects in agriculture, energy, health, and workforce development, among other activities, that Africa-Brazil cooperation could be understood through a strategic lens.

Under Lula's administration, and subsequently under his successor President Dilma Rousseff, the Brazilian government established and instituted Africa-Brazil cooperation policies and programs, most of which are coordinated by the Ministry of Foreign Relations (MRE),

6. Carolina Milhorance summarizes Brazil's "South-South Cooperation" as essentially a horizontal effort to structure cooperative relations between governments and private sector actors integrated within policies and programs that enhance comparative advantages through the integrated development of human resources and organizations through both investments and trade. "A Política de Cooperação do Brasil com África Subsaariana no Setor Rural: Transferência e Inovação na Difusão de Políticas Públicas," *Revista Brasileira de Política Internacional*, Vol. 56, No. 2, 2013:7.

implemented through its division, the Brazilian Cooperation Agency (known as ABC), and often financed by the government development bank, the *Banco Nacional de Desenvolvimento Econômico e Social* or BNDES. Although there are expanding cooperative activities between African and Brazilian private sector firms and civil society organizations, these are all made possible through the diplomatic engagement between the Brazilian foreign ministry and its bilateral counterparts and regional international governmental organizations.

For example, soon after former President Lula took office in early 2003, his government spearheaded the founding of the IBSA Dialogue Forum between Brazil, India and South Africa to coordinate deeper South-South cooperation between these three large and developing nations and expand such cooperation to smaller developing nations in Africa, Asia, Latin America and the Caribbean. President Lula followed up this initiative with successive trips to a growing list of African countries, adding presidential diplomacy to his government's efforts to engage African counterparts through both bilateral and multilateral dialogue and formal agreements for development cooperation.

Aside from IBSA, the Brazilian government engagement intensified through the Community of Portuguese Language Countries (known as the CPLP in Portuguese), established in 1996 to coordinate dialogue and cooperation between the former Portuguese colonies, in particular Brazil and the primarily Portuguese-speaking African countries of Angola, Cape Verde, Guinea-Bissau, Mozambique, and São Tomé and Príncipe. Through the CPLP, Brazil participated in a number of activities across a broad spectrum of issues, mostly with a focus on AIDS-HIV, public health, and education. Through the CPLP and under Brazilian leadership, Brazil's oil and gas regulatory agency, the *Agência Nacional de Petróleo* or ANP, provided technical assistance to São Tomé and Príncipe to develop a regulatory and auction regime for its hydrocarbon reserves. Brazil also intensified cooperative energy-related activities in Angola and Mozambique, including the promotion of biofuel production.

In addition to Brazil's engagement through IBSA and the CPLP, the Brazilian government played an instrumental role in the convocation of the first Africa-South America Summit (AFRAS) in Nigeria in 2006. While the first AFRAS summit was largely symbolic, it did serve

to crystalize Brazil's vision of a deepening South-South dialogue and cooperation between the continents of Africa and South America. Aside from these three multilateral initiatives, the Brazilian government is also active in a number of regional African multilateral forums, including the African Union, the Southern Africa Development Community the Economic Community of West African States, and the New Partnership for Africa's Development, among others. Taken together, the Brazilian government's participation in and occasional leadership of these multilateral organizations and forums serves as a key pillar in its geopolitical strategy to assert Brazil's national interests in the South Atlantic. But this institutional engagement also facilitates and amplifies the horizontal developmental cooperation between Brazilian government agencies and private sector firms with their counterparts in Africa, especially, but not limited to the members of the CPLP. This cooperation has led to increasing international trade between Brazil and a growing list of African countries as well as Brazilian direct foreign investment, including a growing portion in the areas of biofuel production and power generation and distribution.

Since the 1990s the Brazilian government has provided favorable financing through BNDES to Brazilian exporting firms. In 2008 the Brazilian government expanded export-promotion efforts by launching the African Integration Program to stimulate Brazilian exports to Africa through both tax subsidies and financing. Overall, international trade between Brazil and Africa has quickly grown in the past decade from just over \$4 billion in 2000, to nearly \$26 billion by 2008; and Brazil is the only developing country that holds a negative trade balance with Africa overall.⁷ Brazilian direct private investment in Africa has also grown over the past decade to reach an estimated \$10 billion.⁸ This economic interdependence is still modest in comparative perspective, but it does reflect Brazil's strategy of fomenting a deeper structural connection with the African continent that parallels its South-South cooperation strategy. Growing trade and investment coupled with extensive governmental cooperation has created a solid foundation for Brazil to establish significant energy linkages with Africa across the energy matrix.

7. Milhorange (2013:9).

8. *Ibid.*

The Brazilian government has achieved modest success in advancing energy-based linkages that develop through government facilitation, dialogue, formal agreements, technical assistance, financing through BNDES, and the facilitation of private sector investment in a growing list of African countries. For example, the Ministry of Foreign Relations (MRE) counts on its New and Renewable Energy Resources Division (DRN) to develop energy-based cooperation with African nations while the MRE administered Brazilian Agency for Cooperation (ABC) directs programs and projects. In the case of bio-fuel development, ABC coordinates and administers cross-cutting projects aimed at implanting sugarcane cultivation for ethanol refining in several select African countries. ABC works with Brazil's Agricultural Research and Extension Agency, known as EMBRAPA, to conduct feasibility studies and provide technical assistance to African governments and producers. Currently, EMBRAPA provides much of this assistance through its offices in Ghana and Mozambique.

Once the Brazilian government has developed programs and projects and through cooperative, bilateral agreements with such African countries as Angola, Mozambique and the Sudan, then BNDES provides Brazilian private sector firms and the state-controlled Petrobras with financing through its foreign direct investment credit line. Bio-fuel production has been and continues to be a focus of this BNDES loan program since its establishment in 2005.⁹ This government facilitation and BNDES financing has led a modest, but growing, list of Brazilian companies to internationalize their operations in Africa, including the state-controlled Petrobras (oil, gas and biofuels) and Eletrobras (electricity) as well as the private firms Odebrecht (construction and infrastructure), Vale (mining), and Dedini (capital goods for sugar/ethanol refining).

Hydrocarbons

Brazil's oil and gas linkages with Africa have weakened since 2013. Petrobras, not long ago a growing player in offshore drilling in Angola, Gabon, and other West African countries through its Atlantic

9. Sergio Schlesinger, "Cooperação e Investimentos Internacionais do Brasil: A Internacionalização do Etanol e do Biodiesel." FASE. 2012.

Project, has sharply cut back its investment in the region. In June 2013, the oil giant's international arm sold half of its shares of exploration and production holdings in six African countries to the finance vehicle BTG Pactual, owned by the São Paulo investor André Esteves, for \$1.525 billion—less than a third of the price it had hoped to sell its Nigerian assets for months earlier.¹⁰ The two companies now co-own a joint venture for exploration and production in Angola, Benin, Gabon, Namibia, Nigeria, and Tanzania. These assets reportedly have a total of 140 million barrels of proven reserves.¹¹ The sale to BTG Pactual and joint venture represent Petrobras' strategy of pulling back from its international investments in order to concentrate investments and new operations in its rapidly expanding Brazilian operations in the pre-salt blocks.

Petrobras' explorations off the coast of West Africa made geologic sense. The continental shelves east of Brazil and West Africa formed together before the continents broke apart. Geologists believe that the same geologic formations that make the pre-salt so promising also exist off the coast of Angola and in the Gulf of Guinea.¹² The work Petrobras had already accomplished on the pre-salt gave it a leg up in developing these blocks as well. But the enormity of the pre-salt has forced the Brazilian company to concentrate its efforts at home. The huge reserves in the pre-salt 300 kilometers off the Brazilian coast are an all but certain path to enormous wealth for the country. Yet many challenges need to be overcome before Petrobras draws any oil from its wells. The ultra-deep wells require new technology to drill through the salt layers and the high seas present stabilization difficulties. Local-content requirements will further postpone yields.¹³ To meet all these

10. Jeb Blount, "UPDATE 2-BTG Pactual Snaps up Petrobras Africa Stake for \$1.53bln." *Reuters*, June 14, 2013, accessed at: <http://www.reuters.com/article/2013/03/27/petrobras-nigeria-idUSL3N0CJ8WC20130327>. According to Blount and Reuters, Petrobras wanted 5 billion dollars for the Nigeria assets alone.

11. Rodrigo Orihuela and Peter Millard, "Petrobras Sees Dutch Tax Advantage for African Operations," *Bloomberg*, September 26, 2013, accessed at: <http://www.bloomberg.com/news/2013-09-25/petrobras-sees-dutch-tax-benefits-for-african-operations.html>.

12. REPSOL, "Gondwana's Oil," accessed at: http://www.repsol.com/es_en/corporacion/prensa/newsletter/petroleo-gondwana.aspx.

13. Mercopress, "Brazil Conditions Any Future Oil Pre-Salt Bidding to Local Industry Capacity to Supply Equipment And Services," December 26, 2013, accessed at: <http://en.mercopress.com/2013/12/26/brazil-conditions-any-future-oil-pre-salt-bidding-to-local-industry-capacity-to-supply-equipment-and-services>.

demands, Petrobras, an experienced deep-water driller, has become overburdened, in terms of both human resource capacity and debt.¹⁴

The fields will take some time to meet the high expectations set by President Lula. Petrobras and its partners currently produce approximately 360,000 barrels per day (bpd) from the pre-salt, much less than originally forecast;¹⁵ the company estimates this production will rise by 2.1 million bpd by 2020.¹⁶ Meanwhile, investors are wringing their hands impatiently. Petrobras stock prices have fallen from a New York Stock Exchange all-time high of \$51.33 on November 27, 2009¹⁷ to a low of \$10.86 on March 14, 2014.¹⁸ As a result, Petrobras has focused its investments and operations closer to home and taken steps to reduce its foreign holdings, including in Africa. In another cost-saving move, Petrobras moved its Africa headquarters in 2013 to the Netherlands, which shares a double-taxation agreement with Brazil. Petrobras will pay a 25% tax rate, significantly lower than it would pay in Brazil, the United States, or another country without such an agreement.¹⁹ Taken together, these efforts demonstrate Petrobras' commitment to explore the pre-salt reserves while also assuaging its disappointed private stockholders who hold a large, but minority stake in this state-controlled company.

Some private Brazilian oil companies, barred from operatorship or a majority stake in pre-salt blocks at home, have availed themselves of

14. See Mark S. Langevin, "The Petrobras Debt Challenge," BrazilWorks Briefing Paper, January 2014, accessed at: <http://www.brazil-works.com/wp-content/uploads/2014/01/The-Petrobras-Debt-Challenge-pages.pdf>.

15. Petrobras, "Operational Highlights: Monthly Crude Oil and Natural Gas Production in Brazil and Abroad," March 6, 2014, accessed at: <http://www.investidorpetrobras.com.br/en/operational-highlights/production/monthly-crude-oil-and-natural-gas-production-in-brazil-and-abroad/monthly-crude-oil-and-natural-gas-production-in-brazil-and-abroad.htm>.

16. Petrobras 2013—2017 Business Plan. March 19, 2013:12, accessed at: <http://www.investidorpetrobras.com.br/en/presentations/2013-2017-bp-presentation.htm>.

17. NYSE: November 27, 2009, Petroleo Brasileiro Petrobras SA Stock. Retrieved through Google Finance at: <https://www.google.com/finance?q=NYSE%3APBR&sq=Petrobras&sp=1&ei=8sEoU8DJJs2O6wH4Kg>.

18. NYSE: March 14, 2014, Petroleo Brasileiro Petrobras SA Stock. Retrieved through Google Finance at: <https://www.google.com/finance?q=NYSE%3APBR&sq=Petrobras&sp=1&ei=8sEoU8DJJs2O6wH4Kg>.

19. Rodrigo Orihuela and Peter Millard, "Petrobras Sees Dutch Tax Advantage for African Operations." *Bloomberg*. September 26, 2013, accessed at: <http://www.bloomberg.com/news/2013-09-25/petrobras-sees-dutch-tax-benefits-for-african-operations.html>.

the similar geology of Africa's continental shelf. So far, they have not found success across the Atlantic. In a five month span in 2013, HRT, owned by a former Petrobras geologist, has come up empty in three drilling attempts in Namibia,²⁰ where it owns ten blocks.²¹ (It has had bad luck at home, too.)²² Odebrecht, the Brazilian construction firm, has a minority stake in an offshore Angolan block, where the operator Maersk oil recently has had success. Petra Energia, another Brazilian exploration and production firm, has expressed interest in expanding its business to Africa, but without any report of success.²³

In a rare case of the linkage moving west, from Africa to Brazil, Angola LNG, a partnership between Sonangol and affiliates of Chevron, Total, BP, and ENI delivered 160,000 cubic meters of liquefied natural gas to Rio de Janeiro in July 2013. Brazil, an importer of natural gas, does not demonstrate much interest in gas exploration and production opportunities in West Africa.²⁴

Petrobras might play a bigger role in Africa's petroleum exploration and production in ten years, after it has achieved forecasted production levels in its own pre-salt fields, diminished its debt burden, and satisfied investors with growing revenues that outpace costs. If it does revisit West Africa, it will likely come back with cutting-edge drilling technology that could significantly reduce production costs for such national oil companies as Angola's Sonangol. In the meantime, Petrobras' presence in Africa is dwindling and it is yet to be seen whether Brazil's smaller private firms can flourish at home and invest abroad with success. While Brazil's firms have seen small success offshore, the work of Odebrecht, Vale, and other large firms onshore—in hydropower, biofuels, coal and electricity generation—constitute Brazil's deepest energy linkages across the South Atlantic.

20. "Brazil's HRT: Third Offshore Namibia Oil Well Comes Up Dry," *Wall Street Journal*, September 10, 2013, accessed at: <http://online.wsj.com/article/BT-CO-20130910-703841.html>.

21. "Brazil's HRT Completes Purchase of BP Stake in Offshore Oil Field," *Wall Street Journal*, January 9, 2014, accessed at: <http://online.wsj.com/article/BT-CO-20140109-704492.html>.

22. Chris Cote and Mark S. Langevin, "The Recent Development of Brazil's Private Petroleum Companies," BrazilWorks Briefing Paper. September 2013, accessed at: <http://www.brazil-works.com/wp-content/uploads/2013/10/Brazils-Private-Petroleum-Producers-Final.pdf>.

23. Ibid.

24. Angola LNG, "First Angola LNG Cargo Delivered." July 24, 2013, accessed at: <http://www.angolalng.com/Project/FirstAngolaLNGCargoDelivered.htm>.

Vale, the Brazilian mining giant, has extended its reach across southern Africa, with work in Mozambique, Angola, and South Africa, where it has planned to invest \$12 billion from 2011 to 2016, mostly in iron-ore and copper.²⁵ Indeed, Vale is betting big in Mozambique. In Moatize, Mozambique, an area on the Zambezi some 600 kilometers northwest of the port city Beira, Vale has undertaken a major coal project, now entering an expanding second phase. The 2014 annual costs at Moatize constitute more than a quarter of Vale's project execution line on its 2014 budget.²⁶ The company began production there in 2011 and now will invest \$761 million more—production totaled 1.444 million tons of thermal coal for 2013. According to a Vale quarterly report,

The ramp-up of the first phase of the Moatize coal project is being temporarily restricted by the existing limitations of the logistics infrastructure—railway and port—which do not allow for utilization of the mine nominal capacity of 11 million tons per year... The conclusion of the Nacala corridor project will eliminate the above mentioned logistics bottleneck.²⁷

A portion of the mined coal, sufficient for the production of 300 million liters of fuel per month, will remain behind in Moatize where Vale plans to build a coal-to-diesel plant.²⁸ The company expects to sell half in the Mozambique market and use the rest for its own operations. The coal not intended for diesel is being shipped by rail for export to South Asia.²⁹ Vale's productive investment in Mozambique reflects a more traditional, extractive industry based approach to foreign direct investment in Africa. However, the combined infrastructure investments by such Brazilian firms as Vale and Odebrecht,

25. Keith Campbell, "Vale Now Active in Southern, Central, and West Africa." *Mining Weekly*. September 2, 2011, accessed at: <http://www.miningweekly.com/article/brazilian-major-now-active-in-southern-central-and-west-africa-2011-09-02-1>.

26. Keith Campbell, "Vale Announces 2014 Investment Plans for Mozambique." *Mining Weekly*. December 13, 2013, accessed at: <http://www.miningweekly.com/article/global-mining-major-announces-2014-investment-plans-for-mozambique-2013-12-13>.

27. Vale, "Vale 2013 and 4Q13 Production Report," 2013, accessed at: [http://www.vale.com/EN/investors/Quarterly-results-reports/Quarterly results/QuarterlyResults/PREPORT4T13_i.pdf](http://www.vale.com/EN/investors/Quarterly-results-reports/Quarterly%20results/QuarterlyResults/PREPORT4T13_i.pdf).

28. Campbell, "Vale Now Active in Southern, Central, and West Africa."

29. Roberto Magno Iglesias and Katarina Costa, "O investimento direto brasileiro na África," Textos CINDES, No. 27, December 2011:20, accessed at: <http://www.iadb.org/intal/intalcdi/pe/2012/09905.pdf>.

including the Nacala airport³⁰ and the Beira port (still in the negotiation phase)³¹ in Mozambique promise to propel development in coming decades. Yet, it may be in biofuels production and electricity generation and transmission that Brazilian energy linkages with Africa best represent the Brazilian government's vision of a South-South cooperation model that delivers up sustainable development in the longer run.

Biofuels

Brazil, a world leader in sugarcane-based ethanol production, envisions a strong biofuel industry as a path to fuel and electricity generation in Africa. The push to create an international biofuels market is centered in Africa, where similarities between West Africa's soil quality and Brazil's fertile *Cerrado* provide a strong starting point for extensive cooperation and shared practices. Transferring training, experience, and technology to its African partners, Brazil is planting the seed for a strong biofuels industry to grow in the near future. Like in the United States, the European Union, and Brazil, many African countries are looking to cut high fuel costs by adding ethanol to the mix. For example, Tanzania currently imports ethanol from Brazil "as one of several ways to cut the cost of gasoline and reduce petroleum consumption."³² Domestic production of biofuels also addresses issues of energy access and rural job opportunities, both major obstacles to development.

Brazil is signatory to several multilateral agreements with the United States and the European Union, which raise Brazil's visibility and increase potential financing. In 2007 the United States and Brazil signed a memorandum of understanding on biofuels cooperation.³³ The second tenet of the agreement stated that, in regard to third countries, "the Participants intend to work jointly to bring the bene-

30. Odebrecht, "An Agreement in Benefit of Mozambique," May 26, 2011, accessed at: <http://www.odebrecht.com/en/press-room/news?id=15777>.

31. *Ibid.*

32. FIESP, Eletrobras and the African Development Bank, "Energy Markets in Africa," 2011:141, accessed at: <http://www.fiesp.com.br/arquivo-download/?id=2463>.

33. Mark S. Langevin, "Energy and Brazil-United States Relations," in Renata de Melo Rosa and Carlos Federico Domínguez Avila, eds., *América Latina no Labirinto Global: Economia, Política e Segurança- Volume 2*. Editora CRV, Curitiba, 2012:99-124.

fits of biofuels to select third countries through feasibility studies and technical assistance aimed at stimulating private sector investment in biofuels.”³⁴ Brazil also joined forces with the European Union in an agreement in 2008 to promote biofuels development in Africa.³⁵ Brazil also participates in biofuels-related technical workshops with India and South Africa.

Brazil extended its biofuels reach in 2008 when it signed an agreement with six countries—Benin, Burkina Faso, the Ivory Coast, Mali, Niger, Senegal, Togo, and Guinea Bissau—through the West African Economic and Monetary Union. Agreements outside of this union are with Angola, Ghana, Mozambique, and Sudan.³⁶

Unlike partnerships in other energy sectors, where private or public-private firms handle the bulk of business, various government ministries will do the heavy lifting for biofuels, at least at the training and technology transfer level. The wide-ranging effort is led by several ministries, including the Ministries of Agriculture, Foreign Affairs, and Mines and Energy. Embrapa, the agricultural and livestock research arm of the Ministry of Agriculture, has opened offices in Ghana and Mozambique since 2008, from which it supplies on the ground technical expertise.³⁷ Additional technical support comes from the Ministry of Foreign Affairs through its administration of *Pró-Renova*, a BNDES-funded mechanism supporting renewable energy development that, as part of its purview, provides training and exchange programs.³⁸ These efforts, like other foreign initiatives, are coordinated through the Brazilian Agency of Cooperation, part of the

34. “Memorandum of Understanding Between the U.S. and Brazil to Advance Cooperation on Biofuels,” U.S. Department of State, March 9, 2007, accessed at: <http://www.state.gov/p/wha/rls/158654.htm>.

35. Ministério de Relações Exteriores (MRE), “Terceira Cúpula Brasi-União Européia—Declaração Conjunta.” October 6, 2009, accessed at: <http://www.itamaraty.gov.br/sala-de-imprensa/notas-a-imprensa/2009/06/terceira-cupula-brasil-uniao-europeia-declaracao>.

36. FIESP, Eletrobras, and the African Development Bank, 2011.

37. For more analysis of Embrapa in Africa and agricultural extension and research cooperation see Lúcia Cabral and Alex Shankland, “Narratives of Brazil-Africa Cooperation for Agricultural Development: New Paradigms?” Future Agricultures. CBAA Working Paper, March 2013.

38. Isaias Albertin de Moraes and Rodrigues Bessa Mattos, in “Cooperação Brasil—África em Biocombustíveis durante o Governo Lula: Uma Parceria para o Desenvolvimento,” *Revista Conjuntura Austral*, Vol. 3 no. 13, August–September 2012, write in Footnote 7, p. 60, that “In 2009 and 2010, a technical team composed of representatives of the Ministries of Agriculture and Foreign Relations and Embrapa held seminars such as “Agroecological Zoning: Instrument

Ministry of Foreign Affairs, and financed by BNDES, the Brazilian National Development Bank.

Implementation and production are largely left to African governments and the private sector. Odebrecht, the seemingly omnipresent construction and agribusiness giant, announced that it will invest \$220 million, with the Angolan companies Damer and Sonangol, in a \$400 million dollar consortium, Bioenergy Company of Angola, known as BIOCOM, in sugarcane for biofuels production in northern Angola.³⁹ It is the country's largest renewable energy project. Sugar production through BIOCOM is forecast for 225,000 tons in 2014, 15% of which (33,750 tons) will be used for ethanol production.⁴⁰ BIOCOM has projected 30 million liters of ethanol to produce 160,000 megawatt hours of bioelectricity annually.⁴¹ Other Brazilian companies, primarily producers of equipment, also stand to benefit from deepening cooperation. Dedini, a São Paulo-based capital goods manufacturer, sold Sudan the plant it uses to produce 65 million liters of ethanol from sugarcane each year.⁴²

Africa-Brazil biofuel linkages are framed by bilateral and multilateral government agreements that create a nexus of international partnerships that support feedstock cultivation and biofuel production. This nexus has attracted investment and triggered technology transfer, especially in the case of Dedini that hopes to build ethanol refineries throughout Africa, but it is not yet apparent whether sufficient interest and investment is available to significantly expand biofuel production

for public policy planning in the agricultural phase of the sustainable production of biofuels," in Botswana, South Africa, Angola, Zambia, Tanzania, Zimbabwe, and Mozambique. In 2010 there were seminars about "Biofuels Public Policy," in the ECOWAS countries and seminars for "Development and Innovation in the Biofuels Industry," in Kenya, Uganda, Tanzania, Ethiopia, Sudan, and Mozambique."

39. Ministério de Desenvolvimento, Indústria e Comércio Internacional (MDIC), "Oportunidades de Negócios e Investimento em Serviços - Brasil e Angola," 2008:19, accessed at: http://www.mdic.gov.br/arquivos/dwnl_1257766509.pdf.

40. Colin McLelland and Manuel Soque, "Odebrecht-run Biocom seeks Angola Sugar Self-Sufficiency," *Bloomberg*, July 25, 2013, accessed at: <http://www.bloomberg.com/news/2013-07-24/odebrecht-run-biocom-seeks-angola-sugar-self-sufficiency.html>.

41. African Development Bank, "Angola: Perfil do Sector Privado do País," 2012:65, accessed at: <http://www.afdb.org/fileadmin/uploads/afdb/Documents/Evaluation-Reports/Angola%20-%20Private%20Sector%20Country%20Profile%20-%20Portuguese%20Version.pdf>.

42. "KSC introduces biofuel for cars in Sudan for the first time," *Sudan Tribune*, April 19, 2013, accessed at: <http://www.sudantribune.com/spip.php?article46293>.

and consumption relative to hydrocarbon based fuels in the coming decade. The relative success of Brazil in promoting biofuels in Africa depends increasingly on national regulatory frameworks, including mandated transportation blend ratios that invite greater local and foreign direct investment in this emerging production chain.

Electricity Generation and Transmission

Sub-Saharan Africa, where Brazil has the strongest energy linkages, suffers from dismal electrification rates (59.9% in cities and 14.2% in rural areas),⁴³ compounded by an unreliable grid and high costs. 585 million people in sub-Saharan Africa are without electricity. To give an example, the World Bank ranked the quality of Mozambique's electricity supply 111th out of 140 countries.⁴⁴ Blackouts are common. The countries of this region need investment in both electricity generation and transmission. Improving Sub-Saharan Africa's electricity grid has become a popular foreign investment project. The European Union's Alliance for Rural Electrification, the United States' Power Africa, and China's infrastructure investment all aim to bring electricity to rural Africa. And there is certainly the need—Sub-Saharan Africa is the largest and most energy-poor region in the world.

Brazil is active in power generation in Africa, primarily through large private companies participating in the development of hydroelectric dams. Brazil's depth of experience with hydropower makes it a useful participant in transferring knowledge to African construction and operation. Several projects stand out.

- Odebrecht is the most active electricity generation construction from Brazil involved in Africa. It started building the Capanda hydroelectric dam in Angola in 1982 with a planned capacity of 520 MW—the company left because of civil war, but the Brazilian government loaned Angola money to finish the project.⁴⁵

43. International Energy Agency, "Access to Electricity," 2011, accessed at: <http://www.worldenergyoutlook.org/resources/energydevelopment/accesstoelectricity/>.

44. World Bank, "Africa Competitiveness Report 2013," 2013:175, accessed at: <http://www.worldbank.org/content/dam/Worldbank/document/Africa/Report/africa-competitiveness-report-2013-main-report-web.pdf>.

45. Gerhard Seibert, "Brazil in Africa: Ambitions and Achievements of an Emerging Regional Power in the Political and Economic Sector," Instituto Universitário de Lisboa, Centro de

Odebrecht is also repairing the four initial turbines of Cambambe Dam on the Kwanza River which have a capacity of 45 MW each. The company will expand the dam, adding four new turbines, to increase total output capacity by 700 MW.⁴⁶ The Laúca Hydroelectric Dam will have a production capacity of 2,067 megawatts, four times larger than the Capanda Dam.⁴⁷ The Gove Dam, in the Huambo region of Angola, will have a production capacity of 60 MW and provide electricity to 3 million inhabitants of Huambo.⁴⁸

- The Brazilian construction firm Camargo Corrêa is constructing the 1500 MW Mphanda-Nkuma hydroelectric dam on the Zambezi River in Mozambique.⁴⁹ It estimates 20% of the electricity will flow into the Mozambique grid.⁵⁰ The Mozambique Electricity Company expects the project to come online in 2018.⁵¹
- Eletrobras, a state-controlled and publicly-traded company, has struggled with overseas activities, but has launched several projects in Africa. In 2012 Eletrobras announced that a 350 MW project in Angola was under review with an initial cost estimate of \$700 million. José da Costa Carvalho Neto, President of Eletrobras, reported that his company would partner with a local company to take on the project, but that planning would take two to five years.⁵² Carvalho Neto also announced a 1,500 MW

Estudos Africanos, p. 10 (publication date not available), accessed at: <http://www.nai.uu.se/ecas-4/panels/1-20/panel-8/Gerhard-Seibert-Full-paper.pdf>.

46. Chris Dalglish, Sharon Jones, and Scott Masson, "Cambambe Dam Project Phase 2: Environmental and Social Due Diligence, Final," Report Prepared by SRK Consulting for HSBC Bank, March 2013:7, accessed at: http://www.miga.org/documents/Cambambe_Dam_ESDD.pdf.

47. Macauhub.com, "Brazilian Company Odebrecht Selected to Build New Hydroelectric Facility in Angola," June 22, 2012, accessed at: <http://www.macauhub.com.mo/en/2012/06/22/brazilian-company-odebrecht-selected-to-build-new-hydroelectric-facility-in-angola/>.

48. Odebrecht, "En Angola, AH de Gove realiza etapa fundamental el proyecto," Odebrecht Noticias, February 2012, accessed at: <http://odebrechtnoticias.com.br/ON4/home/?p=5240>.

49. Seibert, *op. cit.*

50. Mphanda Nkuwa, "Enquadramento," accessed at: <http://www.hmnk.co.mz/pt/go/enquadramento-proyecto>.

51. Electricidade de Moçambique E.P., "Executive Exchange on Developing an Ancillary Service Market: Overview of Mozambique Electricity Sector: Opportunities and Challenges," p.12, accessed at: <http://www.usea.org/sites/default/files/event-/Mozambique%20Power%20Sector.pdf>.

52. "Eletrobras estuda construção de usina em Angola—presidente," *Reuters Brasil*, May 3, 2012, accessed at: <http://br.reuters.com/article/topNews/idBRSP8420A820120503?pageNumber=1&virtualBrandChannel=0>.

hydroelectric dam project in northern Mozambique was under consideration.⁵³ Eletrobras is working within a consortium of Chinese and South African companies.⁵⁴

Although hydropower development is an easy choice for electricity generation in river-rich Southern Africa, some areas may be relying too heavily on water for their electricity needs and thereby expose themselves to shortages during droughts. Strengthening (or in some cases creating) regional power grids will help hedge against local energy shortages and issues of intermittent generation or transmission interruptions. Diversification of electricity sources is another useful hedge, but energy-hungry countries will continue to exploit hydropower's larger, more efficient scale and to generate low-carbon electricity as a direct avenue to development.

There are few current Brazilian contributions to Africa's electricity transmission infrastructure. In 2011 Camargo Corrêa built the 200 kilometer Uíge-Maquela do Zombo transmission line, which provides over 250,000 people with electricity.⁵⁵ Initial plans to extend the line are unconfirmed. Eletrobras announced in late 2012 that studies were underway for two new transmission lines. The transmission lines would each run 1,500 kilometers. One would connect to the South African Power Pool, and the other would supply electricity to Mozambicans.⁵⁶ In total, they would carry 1,500 to 2,000 MW of electricity. Eletrobras expects the project to begin in 2015.⁵⁷

53. Vladimir Platonow, "Projeto de internalização da Eletrobras prioriza investimentos na África e na América do Sul," Agência Brasil, April 18, 2012, accessed at: <http://memoria.ebc.com.br/agenciabrasil/noticia/2012-04-18/projeto-de-internacionalizacao-da-eletobras-prioriza-investimentos-na-africa-e-na-america-do-sul>.

54. Ruderico Ferraz Pimentel and Victor Magalhães Feleppa, "Internationalization of a Brazilian State-Owned Power Company: Comments from the Eletrobras Case," Eletrobras, 2013:13, accessed at: http://www4.fsa.ulaval.ca/files/content/sites/fsa/files/sections/La_recherche/chaieres_recherche/Stephen-A.-JARISLOWSKY/ActesHEI/papers/Internationalization%20of%20a%20brazilian%20state%20owned%20power%20company,%20comments%20from%20the%20eletrobras%20case.pdf.

55. Macaclub.com, "Electricity Transmission Line Inaugurated in Angola," June 23, 2011, accessed at: <http://www.macaclub.com.mo/en/2011/06/23/electricity-transmission-line-inaugurated-in-angola/>.

56. Vladimir Platonow, "Projeto de internalização da Eletrobras prioriza investimentos na África e na América do Sul," Agência Brasil, April 18, 2012, accessed at: <http://memoria.ebc.com.br/agenciabrasil/noticia/2012-04-18/projeto-de-internacionalizacao-da-eletobras-prioriza-investimentos-na-africa-e-na-america-do-sul>.

57. André Magnabosco e Luciana Collet, "Eletrobras pode ser parceria da State Grid na África," *Exame*, February 7, 2014, accessed at: <http://exame.abril.com.br/negocios/noticias/eletrobras-pode-ser-parceira-da-state-grid-na-africa-2>.

One way to continue to rely on hydropower but avoid vulnerability to droughts is through an extended regional grid. Brazil has considerable experience in developing regional (multi-country) grids in South America and its know-how could come into use in Africa. A joint report by the African Development Bank, the Federation of São Paulo Industries (FIESP), and Eletrobras, devotes one section to power integration—strengthening the interconnectivity of four regional power pools in Africa.⁵⁸ The report identifies four areas important to successful power integration: legal and regulatory frameworks, planning and operating systems, trade, and capacity building. Eletrobras could use its experience with each of these categories to facilitate a smoother integration in Africa, especially the Southern Power Pool. The countries Brazil operates most heavily in—Angola and Mozambique—are relatively power poor and so stand to benefit from stronger regional integration and a smoother distribution of electricity. The main objectives of the Southern African Power Pool are, according to the report:

- Improve the reliability and security of the existing regional power system;
- Facilitate grid expansion and integration with non-member countries;
- Increase electricity access in rural areas;
- Develop a competitive energy market; and
- Foster a short-term energy market by facilitating trade in surplus power not contracted under existing agreements.⁵⁹

This report serves as a blueprint for deepening power generation and transmission based linkages as well as a formative experience with respect to expanding such cooperative and integrating efforts throughout energy poor Africa. While the plan focuses on international transmission integration, it sets a foundation for further national and international investments in power generation and gives all stakeholders more incentive to work out the distribution related bottlenecks to insure that expanding regional grid integration translates into affordable electricity for millions of African families and

58. FIESP, Eletrobras, and the African Development Bank, 2011:146–169.

59. *Ibid.*, p. 160.

enterprises. This sensible plan holds out the promise of making Brazil's pragmatic approach to its energy linkages in Africa increasingly successful.

An Evolving Approach

Critics have argued that these initiatives and investments, while bringing projects and infrastructure backed by lots of cash, do too little to address governance issues - dooming them to the same failures of past projects. China, a larger financier in Africa than Brazil, is backing development projects with huge sums of money, filling "a void left by the West," but is criticized for perhaps "neglecting issues of governance, fairness, and sustainability."⁶⁰ While not as well-endowed as China, Brazil purportedly brings something different to the table—a commitment to South-South cooperation and development forged through a shared culture and history.

Brazil has a long way to go before it proves to be a different kind of partner in Africa than China and other foreign investors. With the exception of biofuels and power generation and transmission, most energy linkages are resource extraction projects. The other energy projects that have been supported or undertaken by Brazilian firms have supplied electricity to mining projects and left only the surplus for local distribution. Brazil has highlighted the dismal electrification rates as a reason for cooperation, but the Brazilian government and the private sector have yet to tackle this issue through a systematic, region wide effort; either alone or with other partners such as the European Union or United States. Given Brazil's own successful rural electrification program, *Luz para Todos*,⁶¹ one might expect greater Brazilian leadership to spearhead a more intensive approach to rectifying energy poverty in Africa.

60. Yun Sun, "China's Aid to Africa: Monster or Messiah?" Brookings Institution, February 2014, accessed at: <http://www.brookings.edu/research/opinions/2014/02/07-china-aid-to-africa-sun>.

61. See María F. Gómez and Prof. Semida Silveira, "The Brazilian Electrification Program LPT (Light for All)—What Lessons Have Been Learnt?" *Renewable Energy for Development*. Stockholm Environment Institute, Vol. 23, No. 1. 2010:1-2; and Alexandra Niez, "Comparative Study On Rural Electrification Policies In Emerging Economies: Keys to Successful Policies," International Energy Agency Information Paper, March 2010:19-33.

If Brazil's legacy in Africa remains confined to creating a foundation for successful biofuels programs in a dozen countries, the continent will be better off for its contribution. Ethanol and biomass have made a useful contribution to the fuel mix in other economies, created rural jobs and, in some cases, provided a cleaner source of electricity.

However, Brazil's engagement with Africa promises more and deeper energy linkages across sectors and countries, especially Sub-Saharan Africa and in particular the Portuguese speaking nations. If indeed Brazil's global leadership and pivotal role in coordinating South Atlantic regional security, rather than exclusive efforts aimed at boosting the profits of many of Brazil's leading firms, depend upon the economic and social success of its neighbors across the South Atlantic, then Brazil will need to devote greater attention and investment to distinguish its role in pushing forward the economic development of Africa.

President Rousseff has reined in the ballooning presence that President Lula sought in Africa. She has decided to focus Brazil's strategy in Africa on high impact projects that demonstrate mutual advantage rather than the sense of debt that her predecessor conveyed.⁶² In other words, Brazil shouldn't be everywhere in Africa, just where its companies can do best. She has emphasized that the finance is for Brazilian companies, not for the projects themselves:

As long as it's extremely advantageous for Brazilian companies, we'll finance them. It's different than financing the project. We finance the companies. And they, with that money, sell their products, produce more here in Brazil. We gain, and they gain too, because they're going to have their infrastructure.⁶³

Stolte places President Rousseff's remarks in commercial perspective:

62. Instituto Lula, "Brazil Wants Cooperation Based on Mutual Advantage and Shared Values, Says Dilma in Africa," June 5, 2013, accessed at: <http://www.institutolula.org/eng/?p=421#.Ux8-ej9dU4o>.

63. Government of Brazil, "Dinheiro para obras no exterior sai do BNDES para empresas e não prejudica ações no País (translated from the original in Portuguese by the authors)." Entrevista com Dilma Rousseff, Portal Brasil, February 18, 2014, accessed at: <http://www.brasil.gov.br/economia-e-emprego/2014/02/dinheiro-para-obras-no-exterior-saem-do-bndes-para-empresas-e-nao-prejudicam-acoes-no-pais-diz-dilma>.

The dynamic growth of African economies despite the global economic and financial crisis has led Brazil to look to the continent as a promising market for its goods and services, especially manufactured or semi-manufactured products, as it can offer “tropicalized technology” to meet the demands of developing countries.⁶⁴

Brazil’s promise to contribute to African development is contingent upon its national interest in supplying growing consumer and industrial markets. Therefore, it is likely that its development cooperation, including many energy linkages, will expand in parallel to increases in trade and investment.

Brazil’s evolution to a more practical and limited approach to its engagement with Africa does not preclude programmatic expansion in the future, but for now Africa-Brazil energy linkages fall short of the more ambitious vision promoted by former President Lula. Lula’s desire to humanize Brazil’s relations with Africa offers a compelling vision that inspires and could eventually play a more profound role in shaping energy linkages and African economic development in the future.⁶⁵ For now, however, President Rousseff and Brazilian policymakers must contend with slow growth at home and a sluggish global economy that restricts government initiatives and may prove to slow Brazilian private sector activities in Africa. These limits may force Brazil to reach out to North Atlantic partners, primarily the European Union and United States, to amplify the reach of BNDES loans to Africa as well as Brazilian technical assistance on such pressing issues as the challenge of achieving energy security or the promise of biofuels in Africa. Current agreements with these North Atlantic partners do exist, but have yet to deliver noteworthy results. This suggests that a new dialogue between Africa, Brazil and other international partners may be necessary to recast Brazil’s engagement in order to intensify and expand beyond the current set of Africa-Brazil energy linkages.

One way to extend the influence of Brazil’s approach beyond BNDES’ financial capabilities is to add third-party support, where

64. Christina Stolte, “Brazil in Africa: Just Another BRICS Country Seeking Resources?” Chatham House Briefing Paper, November 2012:7.

65. Instituto Lula, “Lula defende investimento brasileiro no África durante seminário em Brasília,” May 22, 2013, accessed at: http://www.institutolula.org/lula-encerra-seminario-sobre-relacoes-brasil-africa/#.Ux8_-j9dU4o.

developed countries foot more of the bill while Brazil bolsters the project with its technical knowledge and political legitimacy. Agreements with other countries, including the United States and the European Union, are in place but have yet to see major progress. Hence, Brazil's more pragmatic approach to Africa-Brazil cooperation under President Rousseff may lead to rethinking such multilateral efforts if the politics of South Atlantic security and development can be resolved.

The Political Chess of an Atlantic Basin Energy Initiative

The three major players of the Atlantic Basin—the United States, the European Union, and Brazil—are all eager to invest in Africa. Collaboration makes sense. Instead, sour political relations between Brazil and its northern neighbors restrict and undermine cooperation.

For its part, Brazil views the alliance between its North Atlantic neighbors with caution. In August 2013, Brazil's foreign minister Antonio Patriota told the United Nations Security Council,

We are still concerned that NATO may be seeking to establish partnerships outside of its defensive zone, far beyond the North Atlantic, including in regions of peace, democracy, and social inclusion that do not accept the existence within that space of weapons of mass destruction.⁶⁶

Recent revelations of espionage by the United States, the U.S. snub of the 2010 Iran nuclear deal Brazil brokered with Turkey, and the Obama administration's refusal to openly support Brazil's aspiration for a permanent seat on the UN Security Council have all distanced Brazil from the United States.⁶⁷ The Brazilian government's professed need to defend strategic offshore oil reserves and South Atlantic sea lanes has only compounded Brazil's mistrust of the North Atlantic powers. Therefore, any Atlantic basin initiative that promises to work

66. As quoted by Abdenur and Souza Neto (2013:174), *op. cit.*

67. For more on the Brazil-U.S. bilateral relationship see Chris Cote and Mark S. Langevin, "Does Brasilia Matter? A Close Look at Rhetoric and Reality in Washington," BrazilWorks Briefing Paper, Oct. 17, 2013, accessed at: <http://www.brazil-works.com/wp-content/uploads/2013/10/Does-Brasilia-Matter-Oct-17.pdf>.

toward Africa's energy security would necessarily require a formal recognition of Brazilian leadership in the South Atlantic.

On principle, Brazil would embrace many of the goals advanced by an Atlantic Energy Forum, as proposed in "A New Atlantic Community," which would: "(1) facilitate and develop Atlantic Basin energy trade and investment; (2) improve energy efficiency, energy access, environmental protection and corporate social responsibility in Atlantic energy sectors; and (3) draft an Atlantic Charter for Sustainable Energy that defines the terms of joint or coordinated Atlantic Basin action in a broad range of areas." Those proposing such a forum and community also seek to create an "Atlantic Action Alliance for Renewables Deployment and the Reduction of Energy Poverty," and establish a "Cooperative Atlantic Biofuels Initiative."⁶⁸ In many ways Brazil shares such a multilateral approach to advancing sustainable energy security, whether at home or abroad. However, in the current geopolitical climate, Brazil would hesitate to join and ratify another multilateral initiative that does not explicitly recognize its leadership in the South Atlantic.

Certainly a more limited and practical approach to creating an Atlantic Basin energy community, including efforts to reach agreement on international commercial standards and best practices (yet short of creating a governance space), would invite Brazil's active participation without limiting its independent path with respect to its engagement with Africa and existing energy linkages. If Brazil obtains measurable success in boosting African economic development through energy-related cooperation in the coming decade, then it is more likely to engage and even lead a more formal Atlantic Basin-based multilateral energy initiative thereafter. However, if Brazil's contribution to African development and energy security remain modest—falling short of the tall dreams of past leaders—Brazil would resist accepting a secondary role in a new joint effort, leaving an Atlantic Basin energy community without one of its strongest potential members.

68. Atlantic Basin Initiative, *A New Atlantic Community: Generating Growth, Human Development and Security in the Atlantic Hemisphere*, Center for Transatlantic Relations, Johns Hopkins University, February 2014, accessed at: <http://transatlantic.sais-jhu.edu/events/2014/Atlantic%20Basin%20Initiative%20White%20Paper.pdf>.

Chapter Eight

Reform in the Mexican Hydrocarbon Industry: An Overview of Required Principles

Mario Gabriel Budebo

The 2008 energy reform represented the first change in legislation on hydrocarbons in more than 70 years in Mexico, with the exception of the partial opening of the gas transportation market and the failed reform in petrochemicals legislation.

One of the greatest benefits of this 2008 reform was that it made society—specifically, political stakeholders—aware that the problem in the hydrocarbon industry was much more complex than the mere regulatory and budgetary limitations imposed on *Petróleos Mexicanos* (the Mexican state hydrocarbons company, also popularly known as PEMEX). From this perspective, an important outcome of the reform was the breaking of the widespread assumption that hydrocarbons constituted a closed topic, one not subject to discussion.

Other benefits included progress in making a distinction between the functions of PEMEX as an operator, on the one hand, and the State and the regulators, on the other. Accordingly, Pemex was assigned the fundamental role of generating value. In addition, PEMEX was given the power to use results-based remuneration contracts, making it possible for third parties to participate in hydrocarbon production, rather than only providing services to PEMEX. The constitutionality of this measure was upheld by the Supreme Court of Justice of the Nation.

PEMEX was also given powers which had previously been imposed by external legislation or regulation. The company was excluded from the Public Works Law and the Procurement Law and therefore allowed to design its own procurement system. PEMEX was allowed to establish performance-based compensation systems for its staff; it was also given the authority to define the company's organization and structure without the need of Congressional approval.

However, the practical results of the 2008 reform were much more limited than expected. Despite the heightened regulatory powers of the State in relation to the company as a result of the reform, certain decisions were left in the hands of PEMEX (e.g., sourcing for the areas subject to the new contractual system, the speed with which such areas would be put to tender, and the contractual terms of these agreements). This would prove to hinder its ability to make a significant change in the dynamics of the country's production. Furthermore, although the new contractual system generated greater efficiency as a result of its production-based remuneration, it is still characterized by limitations typical of so-called service contracts. Such limitations make it difficult to attract the best available technology and generate interest among private companies in assuming the immense geological and financial risks associated with highly complex deposits (such as the deep water offshore, for example).

The principal limitation of the 2008 reform which undermined its potential to increase production, efficiency and, ultimately, oil revenue in the interests of the country, was the impossibility of creating conditions conducive to innovation, cost savings and the exploitation of reservoirs with lower relative profitability. This limitation was the result of the restriction against modifying the Constitution, and therefore, the impossibility of creating competitiveness in the hydrocarbon industry. In other countries with oil-producing potential—such as Brazil, Norway, Colombia and Peru, among others—this competitive environment has proven to be the main underlying strength of those national systems when it comes to converting the hydrocarbon industry into a driver for economic development and social progress.

Areas of Debate to be Resolved with the 2014 Hydrocarbon Reform

The premise underlying the restriction against altering the Constitution has been shaped by a number of factors, chief among them the balance of forces among the interests associated with a company of such size and weight in the national economy.

But putting aside these political economy issues (which nevertheless must be fully taken into account when negotiating any new

reform), the constitutional restriction has also been built upon false premises which, if not discussed openly, threaten to once again eliminate the great opportunity for Mexico to create progress and wellbeing for this and future generations, an opportunity whose magnitude no other identified reform is capable of generating.

There have been at least two false premises which have limited deep changes in the industrial organization of the hydrocarbon industry in Mexico.

The first is related to the intergenerational balance of exploitation. Based on this principle, some claim that accelerated exploitation of hydrocarbon resources in the subsoil brings a negative impact on future generations for the benefit of the present. It is clear that this premise is fundamentally false, for at least three reasons, each presented below.

The Shale Gas and Shale Oil Revolutions and Their Effect on Price

Technological changes in the exploitation of hydrocarbon resources in shale over the last five or six years alone have substantially altered the geopolitics of petroleum and gas, as well as future expectations regarding the price for these resources. The idea of a steady rise in hydrocarbon prices has been increasingly called into significant question.

In fact, it is enough to observe the effect which the accelerated increase in shale gas production in the United States and Canada has had on gas prices in North America. The tremendous amount of technically recoverable shale gas resources (which represent three times the proven reserves of conventional wet gas in the United States) suggests that the price of this hydrocarbon will remain relatively low for long periods and that committing to expectations of steadily rising prices is a mistake. Although the future of shale gas exploitation in Europe is uncertain, development of these resources in Asia, particularly China, only points in the same direction in terms of the effect on prices.

The shale oil phenomenon is even more recent. Recent studies have demonstrated the global potential of this resource and exploitation is already underway in the United States. Based on the experience with shale gas and recent shale oil production, in combination with

current efforts being made around the world in the area of energy efficiency, which is affecting demand, it is reasonable to anticipate lower prices for crude oil in upcoming years. Indeed, the dramatic price drop from August 2014 to the present has underlined the inherent uncertainties involved when projected the short and long-term future of the oil price.

***Technological Progress in Alternative Energies
and the Future of Fossil Fuels***

The growing awareness of the negative effects of climate change has led a great many countries to establish public policies which encourage research and development of technological advances in exploiting alternative energies (non-fossil). Many countries have set up programs providing significant subsidies, based on the principle of the existence of positive externalities associated with replacing certain fuels with others.

Even if such subsidies are now being reduced, the result has been a substantial reduction in the cost of electricity generation based on renewable sources such as wind and photovoltaic power. There have also been significant advances in transport technology associated with hybrid mechanisms and production of biofuels.

It is clear that the current low price of gas and oil pose challenges in the development of these technologies. Nevertheless it is highly unlikely that progress on renewable sources will halt. Therefore, it is crucial to think about the value fossil-based energy sources will have in the long term.

***Availability of Instruments to Make
Temporary Wealth Permanent***

If the previous two arguments were not enough to call into doubt the imperative for intergenerational management of hydrocarbons resources, there is no question that the ability to use public policy instruments to channel temporary revenue from petroleum and gas into boosting the potential growth rate of the economy will necessarily make it possible to move beyond this position.

In fact, insofar as resources deriving from the exploitation of hydrocarbons are used to generate permanent wealth, the argument that there is an intergenerational imbalance in the exploitation of these resources disappears.

As long as oil revenue deriving from crude oil and gas extraction is allocated for physical and human investment, the potential for generating wealth for the country increases permanently, making it possible to transform this finite wealth into permanent benefits, for this and future generations in the country. The experience of Norway, which transformed its petroleum industry, generating substantial increases in production, demonstrate the potential of public resources used to increase the country's public infrastructure and human capital, and therefore its growth rate.

Weakening the Company

The second false premise regarding an aggressive hydrocarbon exploration and exploitation policy is that it inevitably would weaken the state-owned company.

Recent experiences in two Latin American countries—the 1997 energy reform in Brazil and the more recent reform in Colombia (which allowed their state-owned companies to compete in the local petroleum market alongside other private companies, both domestic and foreign)—have clearly demonstrated that a properly opened hydrocarbons sector leads to growth for the state-owned company in both the domestic and foreign markets.

The other lesson to be learned from these experiences is that competition and a competitive market encourages the development of a very important local industry with the potential to become a service export industry.

Resistance to opening up the industry often comes from a weakness in the State's power to exercise control over the state-owned monopoly, the weakness of regulatory institutions and the time required for these to attain the capabilities necessary to tackle the challenge. The fact is that insofar as this challenge can be faced efficiently, there would be no reason to let an opportunity pass which would mean tak-

Figure 1. Market Capitalization, Petrobras and Ecopetrol (US\$ mn)

Source: Author-compiled.

ing advantage of the potential for economic growth and the strengthening of the state-owned company.

The evidence is that countries similar to Mexico—such as Brazil, Colombia and, more recently, Peru—have been able to overcome the institutional challenge, successfully attracting investment and growth, while at the same time managing to strengthen their state-owned company, at least in terms of market capitalization (see Figure 1). This would suggest that the premise against opening up the industry—that it would endanger the survival of the state-owned company—is false, and that using these reasons to reject a reform that would make competition in the sector possible deprives the country of opportunities for development and progress.

Principles Of Petroleum Reform

In this chapter, the appropriate principles for a comprehensive hydrocarbons reform are analyzed in light of relevant international experiences.

The most recent reform finally approved in Mexico ascribes to most of these principles. As such, the 2013-2014 Mexican energy reform has the potential to be deep and transformative. An analysis of

this recent reform in light of these principles will be undertaken in the section that follows. Here we deepen the analysis of these principles further.

As has been implied above, optimal reform of the hydrocarbon industry would be based on at least three fundamental principles:

- Openness to competition, with the state-owned company participating;
- Strengthening the state-owned company so that it is in a position to compete within the new industrial organization;
- Strengthening the State as an energy policy designer, along with the effectiveness of its regulatory bodies.

Exploration and Production

Openness to Competition, with the State-Owned Company Competing

The most powerful force for generating efficiency and innovation in any sector of the economy—and the hydrocarbon industry is no exception—is competition. And the key to ensuring that an industry open to competition generates benefits for the broad society is adequate and appropriate regulation.

The idea that a single company (public or private) can tap by itself all of the potential of an industry in the interests of society challenges not only the principle of optimum company size, but also the prospect for a proper balance between the regulator and the sole company. This imbalance prevents an alignment of interests between the company and society. This expresses itself in the quality of products and services, discriminatory practices, lack of transparency and inefficiency, among other disadvantages.

In this regard, extreme care must be taken in choosing the type of industrial organization. It is one thing for PEMEX to be free to join forces with other companies, domestic or foreign, and in this way share the risks and financial costs. But it is quite another to only allow third parties to participate in hydrocarbon exploration and exploitation activities through partnerships with PEMEX. A reform of this type would have a limited scope and would represent a waste, not only

of political capital, but also of the capacity to develop the great potential of hydrocarbons in Mexico.

Like any other company, PEMEX faces limitations on its management capacity, apparent in the company's implementation capabilities and financial limitations. If the reform was to require PEMEX to be a partner, whether as an operator or not, in every exploration and exploitation project, the financial and management limitations typical of any company would restrict the potential expansion of production and generation of oil revenue.

In addition, decisions regarding what areas to exploit under partnership schemes, how fast and under what terms to do so, would inevitably be filtered through PEMEX (if they are not decided entirely by that company), leading to a situation similar to the 2008 reform.

Furthermore, under this institutional arrangement, there would be no incentives for PEMEX to exploit to full potential those lines of low relative profitability for the company. As a result, Mexico could fall behind other countries in a key resource like shale gas.

Based on the successful experiences of countries such as Colombia, the need for third parties to be allowed to enter the sector—without necessarily being obligated to do so together with the state company (while leaving that possibility open). In this regard, the two relevant alternatives have been and remain:

- production sharing agreements between the State and private companies,
- a concession scheme.

For either of these options—in order to maximize the value of the national resources over time, rather than just short-term revenue collection for the State—it is critical that the mechanisms used to assign areas of operation derive from a competition-based scheme in which the payment to the State (by the private companies, or PEMEX) and the minimum investment commitment are both taken into consideration.

Regardless of which method the State decides to employ to exploit the nation's public resources, this method must apply equally to

PEMEX and to third parties (with a suitable transition scheme for areas which are already under exploration/exploitation). For either of these two alternatives (and in fact, for partnerships as well), the Constitution had to be modified. Any reform not revising this legal code would have found its scope completely limited.

Another change considered essential in order for this new industrial organization to function properly would be the opening of the seismic survey market. Allowing private companies to invest in obtaining geological information which makes it possible to identify the country's oil-producing potential leads to an acceleration in knowledge of our oil wealth. This, in turn, provides more and better resources with which to manage the country's energy policy. Naturally, as in other Latin American countries that have reformed their petroleum industry, the State must always be entitled to this information, just as the private company should be able to use it under a regulated regime in order to recover its investment, thus encouraging development of this activity.

Strengthening PEMEX

In accordance with the described new industrial organization for the exploration and production sector, PEMEX should be given various tools to enable it to deal with competition and emerge stronger, following the experience in several of the Latin American countries mentioned above.

Round Zero. It has been proposed that the State should establish a period during which PEMEX could select a number of areas in which it has a strategic interest and proven implementation capacity within a reasonable period of time.

Open access to participating in any area of operation. Like any other company that wants to participate in the Mexican market, PEMEX should not face any restrictions with regard to areas where it would be allowed to operate, whether it competes alone, or as part of any consortium it might consider advisable to join or to which it is invited by other companies.

PEMEX's decision to participate in a given area should be made exclusively by its corporate administration.

Deregulation. It was essential to undertake a comprehensive review of the regulation PEMEX is subject to in order to give the company the necessary tools to deal with competition. The aspects to be changed should include: budget and indebtedness control processes; regulation on salaries and performance-based compensation; internal control; and a revision of the Law on the Responsibilities of Civil Servants applicable to PEMEX personnel.

Corporate governance. It was critical to reconsider how the State is represented within PEMEX. Although it must oversee its assets, this should not be done by civil servants who have a potential conflict of interest between government control or regulatory decisions and defending the interests of shareholders—interests which are sometimes opposed.

In addition, it is crucial that we redefine the independence of professional directors. As in any other company, the main value of including these professionals in the PEMEX board lies in their independence. The limitations imposed on these board members (eg, the requirement that they be government officials or full-time civil servants confirmed by the Senate) undermine this principle of independence.

Solution to the pension problem. The debt faced by PEMEX for the pensions of retired workers and current employees with pension rights imposes a burden which will severely limit the company's growth and borrowing capacity in the future, particularly under the new industrial organization.

It is essential to move to a system which makes it possible to fund pensions over the course of the employee's working life and which limits the actuarial cost of current contingencies. Due to the magnitude of the problem, the State must be involved in the solution. However, this should be made dependent on achieving certain reform goals in time, in order to prevent delays by stakeholders.

Capacity to obtain capital in financial markets. One of the most important aspects of strengthening the state-owned company is its capacity to obtain resources in capital markets in a healthy, sustainable fashion. As in the case of changes which create competition in the sector, the opportunity for PEMEX to grow faster based on capital

obtained from institutional investors and the public requires constitutional reform.

It is believed that—as in the case of Colombia—a share issue prior to placing securities on the market could result in significant support for the reform among the general population.

Certain assumptions must be considered with regard to such a securities issue: control of the company being retained by the State and financial rights being granted to third parties, but not necessarily corporate rights.

Strengthening the State

To handle the new institutional arrangement, the State will require specific powers allowing it to ensure the proper functioning of the sector and the capacity to manage the country's energy policy. This issue is analyzed in light of the positive experiences of various countries which have carried out adequate reforms of their hydrocarbon industry.

Centralization of geological information and Periodic Area Plan. The 2008 reform allowed the State access to certain information from PEMEX, as well as use of certain systems, through the Secretariat of Energy (SENER) and the National Hydrocarbons Commission. However, this is completely insufficient for the proposed institutional arrangement. In addition, insofar as PEMEX holds information for areas other than those in which it operates, this would create a clear barrier to access for the sector.

In this regard, the architects of this necessary institutional arrangement should consider it essential to establish an appropriate transfer scheme for this information including some of the (including some of the key information processing systems) to the State. This geological information would provide the State with the tools required to accurately assess the country's oil-producing potential; to define the areas to be opened to concessions (or production sharing agreements, as applicable); and to determine the speed which this process should be carried out, the materiality of the areas and the contractual terms to be used. With such information, the State would also need to issue a periodic plan (a five-year plan, for example) to facilitate corpo-

rate planning and to offer a degree of certainty with respect to the areas that will be put up for tender.

On the other hand, PEMEX should be able to hold on to the information (and associated systems) pertaining to the areas in which the company continues to operate, as well as those which are defined as part of Round Zero (as discussed above).

Capacity to contract for seismic surveying. One of the key changes provoked by what would be a more open and decentralized exploration and production system would be the positive effects on the generation and interpretation of seismic information. The importance of opening up this sector to competition in this regard has already been discussed above. However, it is imperative that the State also have and retain the technical and financial capacity to contract for seismic surveying and interpretation in those areas believed to have potential—or which might have particular strategic import for the country—even if private companies have expressed no interest. This seismic surveying contracting tool becomes an essential guide for energy policy.

Technical and safety regulation. This area has been the responsibility of the National Hydrocarbons Commission since 2008. This realm should be reinforced, in accordance with the new industrial organization, so that it encompasses both PEMEX and private companies.

Powers to regulate aspects of new areas of operation. It will be imperative to grant the State and its regulatory bodies the necessary powers and the human capital required to competently open the defined areas of operation to tender, establish payment schemes for any concessions, determine the minimum investments required, and authorize in the case of withdrawal of concessions, among others.

State financial vehicle. Another instrument which the State (in other hydrocarbon producer countries) has reserved for itself—to better manage the country's energy sector—is the possibility of holding a financial interest in the various consortia. This instrument can also serve as an alternative mechanism for capturing economic rent on behalf of the State, particularly when specific characteristics of certain projects prevent the tax system from capturing rents efficiently. Under such a mechanism, the State could set up a financial vehicle for the sole purpose of managing shareholding positions in the consortia

selected. This would require only a small staff which should not be granted authority to engage in oil-related operations.

Industrial Processing, Transport and Distribution

In the following section, we distinguish between two sectors:

- Refining, and transport associated with the resulting products, and
- Gas processing and the petrochemicals industry, as well as transport of these products.

Refining

In theory, opening up crude oil extraction to third parties would indicate that the downstream processes will also be open for competition. However, in this area the system for managing the retail price of gasoline and diesel fuel are considerations that should taken into account.

The optimal solution for refining (opening or no, and how much) is closely linked to the same decision with respect to managing the retail prices of gasoline and diesel fuel. If a policy decision is taken to deregulate gasoline and diesel fuel prices (or to establish a target subsidy), then it would also be ideal to open the refining market to third parties, and to establish a free market for retail sales to the public.

With regard to the transportation of gasoline and diesel fuel between the refinery, storage terminals and service stations, the 2008 reform made some progress in granting the Secretariat of Energy powers to define the point at which first-hand sales take place, and therefore, the moment when the exclusive rights of the State petroleum industry end. However, as a transition scheme, SENER's regulation still grants certain powers to PEMEX which in practice limit a complete opening. This, however, can be resolved through executive action.

Gas Processing and the Petrochemicals Industry

Within the gas market, we should distinguish between liquefied petroleum gas (LPG) and natural gas. The LPG situation is similar to

that of gasoline: due to the subsidy applied to the final price (which must currently be absorbed by PEMEX Gas and Petroquímica Básica), the options facing both LPG and gasoline are the same.

Likewise, if the natural gas exploration and production sector is opened to competition, then it would be appropriate to open up the entire gas chain, including downstream activities like natural gas processing and the petrochemicals industry. In fact, it would make little sense to force gas producers to deliver all of their production to PEMEX (under a regulated scheme), as this would imply that PEMEX could ultimately come to represent a bottleneck for natural gas processing and petrochemical production. In addition, the benefits of downstream competition obviously would be lost by limiting this part of the market to a single producer.

A reform of natural gas regulations to bring about a genuine opening of the gas transport market (midstream), together with a change allowing third parties to compete with PEMEX in the processing of gas, would give Mexico an extraordinary boost in competitiveness, making possible accelerated industrial development.

Furthermore, the possibility of private companies vertically integrating the entire petrochemicals chain, competing with PEMEX in this market (and eliminating the distinction between basic and secondary petrochemicals), would lead Mexico to become a global leader in petrochemical production. This is due to the considerable availability of raw materials—crude oil and, particularly, gas—which would be augmented still further with upstream reform, and the relative advantage of low gas prices in North America.

Reform of the gas and petrochemical processing industries would make it necessary to revise the provisions covering the transportation of natural gas and (basic)petrochemicals. This second issue is resolved as soon as the distinction between the two types of petrochemicals is eliminated and the industry is opened up to free participation.

In order to enable greater supplies of natural gas to be transported efficiently to points of demand, the natural gas regulations need to be modified to open the distribution market to third parties; to create the position of system manager, separate from that of carriers; and to establish a new capacity purchasing system.

Complementary Measures

Any reform of the hydrocarbons framework would require both taxation and budgetary changes.

Tax Measures

Adapting public finances to remove PEMEX as a residual adjustment instrument. Regardless of the tax rates that PEMEX might be subject to, in order to be suitably prepared to compete from a position on par with that of other players, the company must stop serving as a residual adjustment instrument for public finances. Rather, this issue is that drawing profits above those captured through taxes and fees is done by means of dividends. This will require adjustments to the country's tax system if the State is to achieve the greater flexibility it will need in order to do without this adjustment instrument for public finances.

Allocation of core exploitation areas to PEMEX (Round Zero) to ensure minimum domestic production at start-up. This will require developing a plan for PEMEX production (see the mention above of the Round Zero) capable of maintaining current revenue levels as new production is incorporated into the market from private companies entering the Mexican industry.

Extending the tax system to the entire industry and adapting rates and tax bases. The tax system (which includes fees and royalties) must be extended to apply equally to all players in the industry, including PEMEX. To the extent that a transition begins towards a competitive industry under concession schemes or production sharing agreements with the State, there will be adequate incentive to achieve cost efficiency. This will make it possible to gradually eliminate the cost cap system (which distorts investment decisions), without the risk of weakening the tax base, as currently occurs under the current industrial organization.

Along with revising and expanding the tax base, tax rates for fees must be modified under the new open market to ensure that all oil revenue is obtained for the benefit of the nation, while at the same time guaranteeing an internationally competitive tax system which attracts the required international investment.

Tax system for unconventional resources. Since 2005, the tax system applicable to petroleum-related activity has been updated, distinguishing rates and tax bases, and depending on the type of deposits and nature of the hydrocarbon. This has been appropriate, as the oil revenue to be obtained is different in each of these situations.

However, given that production of unconventional resources (shale gas and shale oil) has not yet begun in Mexico, by the time of the most recent 2014 reform (see the next section), the tax system had not yet considered the specific characteristics of these type of deposits. Such a change will be essential in order to determine and obtain the associated oil revenue and to make the sector competitive.

Budgetary Measures

A reform of the magnitude proposed is unprecedented in the country's history. As in the cases of Norway, Brazil and Colombia, among others, transforming the petroleum industry into one which allows competition will translate into significant production increases, as well as a substantial increase in public revenue.

As indicated earlier in this chapter, employing these additional resources for current expenditures as opposed to investment represents a drawback in terms of intergenerational imbalance and a wasting of the opportunity to transform the finite wealth associated with hydrocarbons into permanent wealth, thereby increasing the country's potential economic growth. Therefore, a key element of the proposed petroleum reform is the creation of principles and institutions with which this and upcoming generations will enjoy the wealth generated.

Using the oil revenue. After the type of industrial organization to be chosen, how the increased public resources will be used is the most important issue regarding reform. Mechanisms and institutions must be created to guarantee the rational use of resources, allocating them to items which increase the country's growth potential on a permanent basis. Rules should be established which precisely set out the items to which these resources will be allocated. A special fund should be established in order to manage resources over time, avoiding the consequences of the so-called "Dutch disease."

Central to this design will be the issue of the institutions responsible for overseeing compliance with these principles and rules, ensuring that determinations are not vulnerable to electoral (or other forms of domestic) politics.

Evaluation of the Recent 2014 Energy Reform in Mexico

In July and August of 2013, three different initiatives proposing energy amendments to the Mexican Constitution were presented to Congress. The Executive Branch, on the one hand, and the PRD and PAN opposition parties, on the other, each presented their respective initiatives after a long period of public discussion on the matter. An additional and intense discussion took place afterward, resulting in the approval of a Constitutional Reform on December 12, 2013. Following that, nine new Laws and twelve amendments to existing legislation were presented by the Executive Branch for approval by the Mexican Congress. Such Laws, modified in Congress, had been approved by August 11th 2014.

Finally, by October 2014, 25 pieces of Executive Branch Secondary Legislation were published in order to establish the detailed legislation required for a proper understanding and implementation of the new rules.

All this has been done in a record time, a positive development that lends a clear signal to markets as to the commitment of the Mexican Government to the transformation of the hydrocarbons sector. On the other hand, the rapidity of the passage of constitutional amendment and the related reform legislation raises certain doubts as to the ability of the relatively new regulators to successfully implement such reforms.

Failure to properly implement the reforms could easily undermine these positive results at the legislative level. However, leaving aside issues of implementation (just now under way), the aim of this section is to evaluate the approved changes in the light of the premises discussed previously in this chapter. In general terms, the 2014 reform reflects such principles, at least to a very large degree.

Exploration and Production, with the State-Owned Company Competing

The opening of the market for third parties to compete along with Pemex was clearly achieved by the 2014. A major point of discussion that resulted in a very positive outcome is related to the regulatory process that was established in order for Pemex to farm out its initially assigned areas (under the so called Ronda Cero). Such new rules avoid the possibility by Pemex of capturing its potential competitors by freely offering joint ventures in relevant areas of exploitation to the big international players in the market.

On the other hand, the menu of contract types now available for the State to employ for the exploitation of hydrocarbon resources is broad enough to give sufficient flexibility to the Government. At the same time, the inclusion of profit sharing contracts (along with production sharing and licenses) provides future Mexican government, less inclined to an open hydrocarbons market, with a tool to limit private participation. Nevertheless, excepting the Round Zero, PEMEX and private companies are to be treated equally—a dispensation of key importance to a well operating market.

Finally, the seismic survey market was widely opened by the 2014 reforms. The relevant geological information was also required to be transferred by Pemex to the State. At least on paper this requirement gives a significant guarantee for fair competition.

Strengthening PEMEX

In this terrain, the results of the most recent reforms were not as impressive or as thorough. On the one hand, PEMEX was given some additional autonomy and a better corporate governance structure. At the same time, no restrictions have been applied to the state company's ability to participate in future bidding processes, or to join forces with other oil companies for Round 1 and future rounds—a development which could potential undermine the competitive advantages of an open market.

The 2014 reforms also granted PEMEX was also granted a generous scheme by which the Federal Government absorbs a significant part of

the pension liabilities of the company, provided there is an internal PEMEX effort to reduce the present value of such commitments.

Nevertheless it is fair to say that dependence of PEMEX on the General Budget is still significant. Furthermore, deregulation resulting from the reforms is only partial, while the total limitation on the company capacity to raise capital in the stock market (Mexican or international) was maintained. These issues must be addressed in the near future, if PEMEX is to be able to compete on equal terms with its peers, and to finance its growth on competitive and flexible terms.

Strengthening the State

The 2014 reform did reflect this principle in a very significant way. The reform not only strengthened the Ministry of Energy's ability to design and execute energy policy, it also gave it new attributions to impose sanctions on sector players (particularly Pemex) using practices designed to limit competitive conditions.

As mentioned earlier, the reforms provided a very strong mandate to the State to obtain not only all the geological information in the possession of PEMEX, but also to gain access to all PEMEX contracts for the management of geological and statistical information in general.

The reform also established a State obligation to publish a five year plan for bidding rounds, strengthening its ability to resist forces opposing the reform which, as can be imagined, are not at all minor.

Regulators were also significantly strengthened. On the one hand, a new constitutional figure was created for energy regulatory bodies. Such a move would significantly improve the regulator's technical autonomy from the Administrative Branch of Government, and from PEMEX. On the other hand, changes in budgetary sufficiency were incorporated so that no Ministry can reduce its budget without the proper justification and approval by Congress. A new regulator was also created for oil related environmental issues, so as to avoid conflicts of interest and competing objectives in regulation.

Industrial Processing, Transport and Distribution

Changes in this front were far more reaching than expected. Not only did the 2014 reform achieve a full opening of the refining and gas processing industries; it also established a very specific calendar for allowing imports and for deregulating public energy prices. However, a mandate to design focalized subsidies in certain products was determined, potentially undermining the credibility of the price liberalization.

Nevertheless, it is fair to say that—in a crude oil price environment such as the current one, and viewing gasoline prices as a way to compensate for diminished oil revenues—this particularly legal mandate (focalized subsidies) might have to be adjusted in the future. However, a legislative change approved by Congress would be, in principle, required.

Opening of the transportation, storage and distribution markets in all fuel segments was incorporated by the reforms. This change will certainly bring private investment in to the industry and generate much higher efficiency.

Finally, vertical disintegration in the natural gas market was secured by the 2014 reforms, a very important change. The transfer of natural gas pipelines from PEMEX to another state company was mandated by the reform. However, despite this clearly positive outcome, the manager of the transport system can still be owner of the pipelines, a possibility which runs against the principles of competition in such markets.

Finally vertical separation of other pipelines (oil, etc) was not included in the reform. This lack of reform will continue to limit the efficiency of these markets.

Tax and Budgetary Measures

Important changes were approved on this front. Taxation on the upstream (the most relevant market segment in this regard) was set by the 2014 reforms in a flexible way, one that is framed by the newly accepted the bidding processes. Although this reduces, to some

degree, the capacity of the State to secure oil revenues, it achieves a much more important objective: the flexibility to attract more competitors to the bidding rounds so as to improve the chances of success in the first tenders.

But better or worse, the 2014 hydrocarbons reforms did not usher in a comprehensive tax reform capable of reducing the State's dependency on PEMEX's revenues while also granted the State company more autonomy. The political obstacles to such a liberal reform apparently remain too formidable.

One of the most significant changes wrought by the reforms relates to the use of future additional revenues. On this front, a Special Fund was created in the Central Bank with independent members outweigh government representatives. The objective of this Fund is to define how excess revenues would be used in the coming years, in order to avoid political pressures to divert such resources to current expenditures.

Chapter Nine

Managing Hydrocarbon Assets: A Comparison Across the Atlantic

Osmel Manzano

Oil and gas continue to be relevant commodities in global markets. In spite of recent gains in efficiency, the world still requires almost one barrel of oil to generate 1,000 dollars of Gross Domestic Product (GDP).¹ Consequently, oil and gas will continue to constitute a key aspect of the policy agendas of consumer countries.

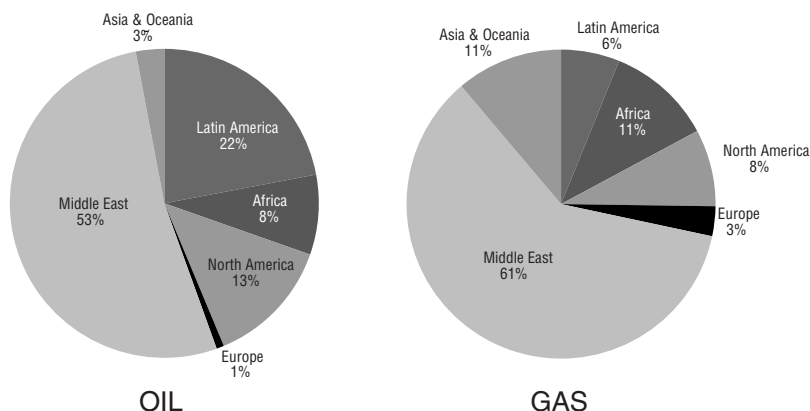
But oil and gas are particularly relevant sectors in producer countries. As a result of the unequal distribution of hydrocarbon reserves around the world, only a limited number of countries boast a relevant share of oil production. However, despite the continued prominence of the Middle East and Russia in the hydrocarbon sphere, the Atlantic energy renaissance (including the offshore revolution) has recently begun to lend the Southern Atlantic energy space increasing strategic relevance along with an important and growing share of global hydrocarbons reserves (see Figure 1). African and Latin American countries now have 30% of global oil reserves and 18% of global gas reserves.²

Given this share of world reserves, hydrocarbons in Africa and Latin America form an important share of economic activity across the Southern Atlantic space.³ According to the World Bank (see foot-

1. World Bank, *World Development Indicators* (Washington, DC, 2014). The precise number is 0.98 barrels per 1,000 dollars of world GDP. World GDP is measured in dollars with equal purchasing power parity (PPP) across countries.

2. For purposes of this chapter, the southern Atlantic includes Guatemala and Mexico. The broad, political Atlantic Basin (also known as the Atlantic space) has 44% of global oil reserves while the Southern Atlantic (i.e., Latin America and Africa, or the Southern Atlantic space) has 30%. These figures are based on Energy Information Administration (various years).

3. However, it should not be expected that because a country has an important share of the reserves of a non-renewable resource that the sector will represent a relatively higher share (or not) of the domestic economy. That outcome would be determined by the development pattern of each country. This is a discussion that goes beyond the scope of this chapter. See Lederman, D. and W. Maloney, *Natural Resources and Development: Neither Curse nor Destiny*. (Stanford: Stanford University Press and the World Bank, 2007); and van der Ploeg, F., "Natural Resources: Curse or Blessing?" *Journal of Economic Literature* 49(2): 366–420, for a complete discussion on the issue of development and resource abundance.

Figure 1. Oil and Gas Reserves

Source: Energy Information Agency (various years)

note 1), energy exports constituted some 17% (un-weighted average) of their GDP in the period from 2003 to 2012.⁴ For a quarter of these countries, however, that share was more than 30%. As a result, oil and gas provide around 50% of fiscal revenue for these countries.⁵

In view of this strategic relevance of hydrocarbons for these Latin American and African countries, it is a valid question to ask whether or not these resources are managed appropriately. To answer that question requires that a number of other questions must be answered previously. First, it is important to note that resource reserves represent an asset. Therefore, the first question is whether the asset is being managed in a financially sound way. A second question pertains to the management and distribution of the proceeds or revenues from these assets. This latter question has driven the recent push towards transparency and a better management of the rents from the sector.⁶

4. This average is for Algeria, Angola, Argentina, Bolivia, Brazil, Cameroon, Chile, Colombia, Ecuador, Egypt, Gabon, Guatemala, Libya, Mexico, Nigeria, Peru, Tunisia, Trinidad and Tobago, and Venezuela. All of these countries lie in the southern part of the broad Atlantic space and all but two form part of the Atlantic Basin.

5. For a simple average that includes Algeria, Angola, Bolivia, Cameroon, Ecuador, Egypt, Gabon, Libya, Mexico, Nigeria, Trinidad and Tobago and Venezuela, fiscal revenues from the oil sector represented 55% of total revenues. See IMF (2012).

6. See Andrés Meija, "The EITI: Impact, Effectiveness, and Where Next for Expanding Natural Resource Governance?" *U4 BRIEF* May 2014, No 6 (U.S. Anti-Corruption Resource Centre); and Humphereys, M., J. Sachs and J. Stiglitz, *Escaping the Resource Curse* (Columbia University Press, 2007) for a review of the evidence and policy recommendations on the management of resource rents.

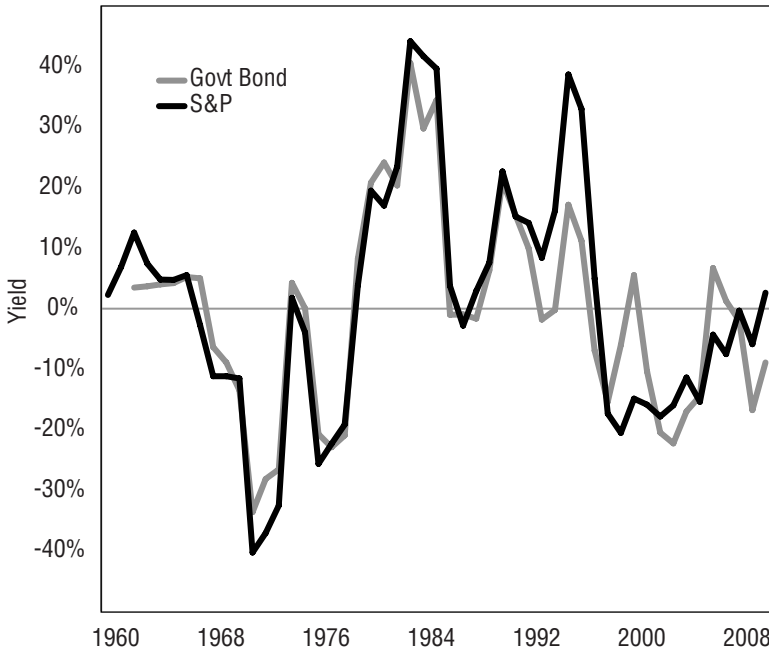
The chapter that follows focuses on the first question—that of hydrocarbon asset management. This by no means implies that the two issues—financial management and revenue management—are independent. As explained in Humphreys et al. (2007), poor rent management might hamper asset management by generating opposition to the resource development. Likewise, under certain conditions poor asset management might exacerbate poor rent management if competition for fewer resources intensifies rent-seeking behavior. The first of these potential causal links will be considered when assessing the oil asset management performance of different countries across the southern swath of the Atlantic space.

Non-Renewable Resources as Assets

Hydrocarbons are assets which, in the case of most oil producing countries of the Atlantic space, are owned (at least partially) by the State, representing the citizens. From a financial point of view, the state is responsible for overseeing how the return of that asset compares to its opportunity costs. A state's decision to extract the resource from the ground should be based on whether the return on such economic activity is higher than the return from waiting for a higher price in the future.

Such financial management can be analyzed using a simple arbitrage model in which it is assumed that an asset is managed optimally when its opportunity costs equal the profit obtained from the use of the asset in question plus the expected change in the value of that asset. As explained in more detail in the appendix, this analysis can be simplified by observing the evolution of oil production along with the evolution of oil prices, relative to the opportunity cost of resources invested in oil.

But what is this opportunity cost and what should represent it? We propose using the interest rate of government bonds to represent this opportunity cost. If the expectation is that oil prices will rise in the future at a higher rate than the interest rate, oil should be kept in the ground and, therefore, for the perspective of the owner of the asset to issue debt at that interest rate to compensate of any lost revenue. Simi-

Figure 2A. Excess Return of Extraction in Ten Years

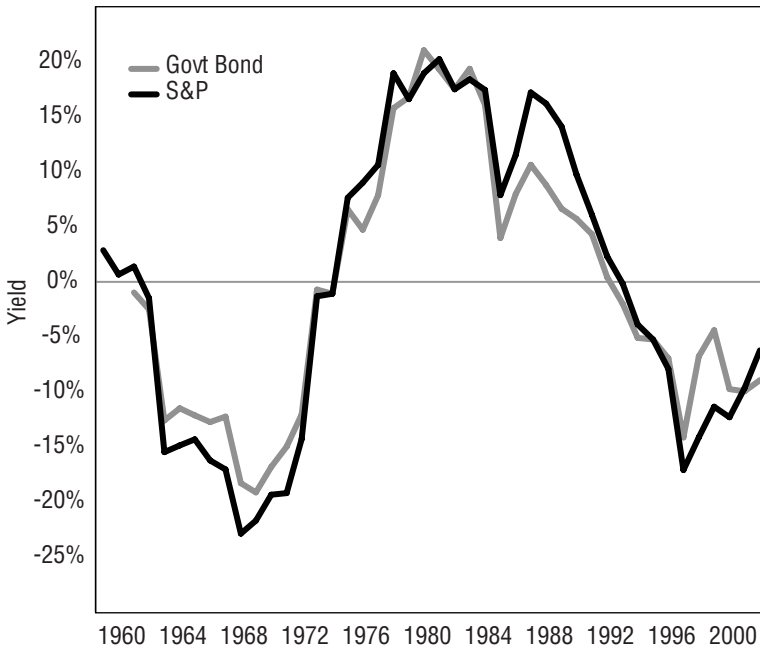
Source: Own calculation using IMF data (International Monetary Fund, *International Financial Statistics*, Washington, DC, 2014).

larly, if oil prices are not expected to increase, the opposite action would be optimal.⁷

In Figures 2a and 2b, the evolution of the opportunity cost of oil production is presented by using proxy returns with ten and three year horizons, respectively. The figures present the return of a U.S. government bond and the return of Standard and Poor's 500 index (S&P) as alternative financial instruments to be used as opportunity cost benchmarks for comparison with the return of oil assets. In this context, then, the important take-away from these two figures is that the

7. In this regard, data availability becomes an obstacle. The ideal interest rate would be the annual marginal interest rate. However, many developing countries did not issue bonds until the 1990s. In addition, only limited information is available on the rates of new debt issued prior to the 1990s. An alternative option is to use the average interest rate. However, even in this case data is not always available.

Figure 2B. Excess Return of Extraction in Three Years



Source: Own calculation using IMF data (International Monetary Fund, *International Financial Statistics*, Washington, DC, 2014).

two lines exhibit similar trends and that if one is above zero, then so is the other, and vice versa. This means that there are no significant differences in using one or the other benchmark.

In general, on the ten-year horizon the analysis shows that until 1963, it was better to extract (including the investment to extract); then, from 1964 to 1976, postponing production was optimal; afterwards and until 1993, it was optimal to extract. Finally, after 1993 and at least until 2003, it was optimal to wait.

The analysis at the three-year horizon suggests similar trends, although with more volatility: until 1964, it was more optimal to extract oil rather than to wait for 3 years; after that and until 1979—though there is a peak in 1974—postponing extraction was optimal; after that and until 1997, it was optimal to extract (with a couple of years where there were troughs). Finally, in the years leading up to 2010, it was optimal to wait.

Reviewing Asset Management in the Southern Atlantic

Given this conceptual framework, we now move on to examining Latin American and African countries' performance, using sample data from 19 countries, 8 of which are in Africa and 11 in Latin America.⁸ These are the countries that have been producing oil for a longer and more continuous time.

The focus of this analysis remains solely on the production of oil. Gas has only recently become a global commodity that will eventually have a single reference price. However, this has not been the case in earlier years to the present. Therefore, gas production does not yet lend itself to such a method long-term asset performance measurement.

Furthermore, this analysis compares the evolution of production and the evolution of the excess return to extraction, using ex-post returns and the ex-post average growth rate of production for the equivalent period. For example, for 1980, we use the excess return of the Treasury bond yield with a three-year maturity with respect to the evolution of prices (which serves as the variable representing return on production/extraction) between 1980 and 1983. That excess return will be compared to the growth rate of production between 1980 and 1983. Using data spanning the period from 1980, the analysis allows for an evaluation of short-run management with three-year returns from 1980 until 2010, and of long-run management with ten-year returns from 1980 to 2003.

Looking at Figures 2a and 2b there are two clear periods to evaluate. During the first period (from 1980 until 1993) returns to extraction were positive on average—in a statistically significant way—both at the ten-year and the three-year horizon. During the second period (from 1993 until 2010) the opposite was true.⁹ Therefore, we will compare policy from these two periods.

8. The countries in Africa are: Algeria, Angola, Cameroon, Egypt, Gabon, Libya, Nigeria, and Tunisia. The countries in Latin America are: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Peru, Trinidad and Tobago, and Venezuela.

9. From 1980 to 1993 the annual returns to extraction were on average 15.5 and 11.3% at the three and ten-year horizon respectively. These return are significant at the 1% level. From 1993 to the end of the sample the annual returns to extraction were on average -5.8 and -7.3% at the three and ten-year horizon respectively. These returns are significant at the 1% and 5% respectively.

After analyzing the data, I draw policy evaluations based on the conclusions.

Theoretically and logically, if a positive return to extracting oil today—compared to extracting it in three years—is expected, then more oil today than in three years will/should be extracted. Therefore, the first variable to analyze is whether production today compared with production in three (or ten) years has the same sign as the returns in that period.

However, this production decision might be affected by geology, unexpected outside events, or other exogenous factors. Therefore, there could be a case in which the country moved in the right direction (in terms of its production decisions) even though the sign of the production variable might not be correct (ie, correspond to that of excess returns to extraction). For that reason, correlations of the two variables—the returns to extraction and production growth—are calculated over a longer period of time (ie, at the three-year and ten-year horizon benchmarks).

Since these two characteristics are statistical variables, I could calculate an index based on the probability that the hypothesis we want to test is true. This index will measure from zero to one. For the sign of production growth we can test whether or not it is in line with the returns to extraction. A value of 0 will imply that with 0% of probability the sign is the correct one. A value on 1 will imply that with a 100% probability the sign is the correct one.

In a similar way, the correlations between production and returns could be tested as to whether or not they carry the expected sign. A value of 0 will imply that with 0% of probability the sign is the correct (ie, optimal) one. A value of 1 implies that with a 100% probability the sign is aligned with the optimal.

Finally, a composite index, combining both of those described above, can be calculated. This composite index could be interpreted as a score: the higher the value, the closer the country is to an optimal financial management of its oil assets.

The results are summarized Table 1, which presents the analysis at the three-year and ten-year horizons. For each horizon, the set of variables for the two periods is shown and for each period the index

for level, correlations and the composite of both is presented. The overall observation is that different countries exhibit different indices.¹⁰ Some extreme cases will serve to help clarify the results presented in the table.

Between 1980 and 1993, at the three-year horizon, Colombia has a value of 0 in level. That means that with a 0% probability the sign of production growth was in line with the sign of returns. In that period the optimal decision was to bring forward production. Colombian production grew constantly until 1987, but then grew in a less steadier way until 1993. On average, production each year was 24.3% lower than 3 years later. Statistically, this means that with a 0% of probability was the sign of production growth in the same direction than the sign of returns. In addition, these fluctuations in production were not aligned with the fluctuations of returns. The correlation was of -0.63, which is in the correct direction with only a 1% probability. Consequently, Colombia has a total composite index of 0.01.

Between 1993 and 2003, at the ten-year horizon, Angola has a value of 1 in “index for level.” That means that with a 100% probability the sign of production growth was in line with the sign of returns. In that period the optimal decision was to allow for investment for production to grow instead of contracting investment and production in the present. Until 2008, Angolan production grew. Production then contracted until 2011, and has been around the same level ever since then. On average, production each year was 54% lower than 10 years later. Statistically, this means that with a 100% of probability production has the same sign than returns. In addition, the fluctuations in production were aligned with the fluctuations of returns. The correlation was of 0.39, which is, with a 86% probability, in the correct direction. Consequently, Angola has a total composite index of 1.86

Once the mechanics behind each number are clearly understood, some generalized facts come into view. The first is that indices in correlations are higher than indices in levels. This might reflect that dynamics of the sector. Given the high level of inertia generally characteristic of oil infrastructure, it might be more difficult to shift from a

10. Espinasa, Ramon, Sergio Guerra Reyes, Osmel Manzano, and Roberto Rigobon, “A Micro-Based Model for World Oil Market,” paper presented at 2011 International Energy Workshop, Stanford University.

Table 1. Policy Implications from Correlations

Country	3 year Policy						10 year policy					
	80-93			94-10			80-93			94-03		
	Index for level	Index for Correlation	Total	Index for level	Index for Correlation	Total	Index for level	Index for Correlation	Total	Index for level	Index for Correlation	Total
Mexico	0.10	0.88	0.97	0.50	0.31	0.81	0.00	1.00	1.00	0.12	0.03	0.15
Argentina	0.03	0.99	1.03	0.50	0.00	0.50	0.00	0.99	0.99	0.00	0.01	0.01
Bolivia	0.42	1.00	1.42	0.50	0.91	1.42	0.00	1.00	1.00	1.00	0.05	1.05
Brazil	0.00	0.11	0.11	0.52	0.04	0.56	0.00	0.40	0.40	1.00	0.10	1.10
Chile	1.00	0.05	1.05	0.48	0.11	0.59	1.00	0.37	1.37	0.00	0.72	0.72
Colombia	0.00	0.01	0.01	0.51	0.12	0.63	0.00	0.00	0.00	0.70	0.56	1.26
Ecuador	0.02	0.72	0.74	0.50	1.00	1.50	0.00	0.17	0.17	1.00	0.16	1.16
Guatemala	0.33	0.90	1.22	0.50	0.04	0.54	0.00	1.00	1.00	0.04	0.03	0.08
Peru	1.00	0.19	1.19	0.49	0.30	0.79	1.00	0.98	1.98	0.00	0.83	0.83
Trinidad and Tobago	1.00	0.68	1.68	0.49	0.74	1.23	1.00	1.00	2.00	0.01	0.17	0.18
Venezuela	0.08	0.98	1.05	0.50	0.60	1.10	0.00	0.47	0.47	0.00	0.27	0.27
Algeria	0.07	0.73	0.80	0.50	0.85	1.35	0.00	0.43	0.43	1.00	0.21	1.21
Angola	0.00	0.06	0.06	0.51	0.85	1.36	0.00	0.00	0.00	1.00	0.86	1.86
Cameroon	0.44	0.05	0.48	0.49	0.67	1.16	1.00	0.00	1.00	0.00	0.80	0.80
Egypt	0.00	0.14	0.14	0.49	0.01	0.50	0.30	0.00	0.30	0.00	0.59	0.59
Gabon	0.00	1.00	1.00	0.49	0.61	1.10	0.00	0.01	0.01	0.00	0.81	0.81
Libya	0.56	0.95	1.51	0.48	0.66	1.14	0.01	0.24	0.25	0.26	0.22	0.49
Nigeria	0.30	0.85	1.15	0.50	0.56	1.06	0.00	0.26	0.26	1.00	0.03	1.03
Tunisia	0.99	0.43	1.43	0.49	0.72	1.21	1.00	0.01	1.01	0.00	0.82	0.82
Average	0.33	0.56	0.90	0.50	0.48	0.98	0.28	0.44	0.72	0.38	0.38	0.76
LAC	0.36	0.59	0.95	0.50	0.38	0.88	0.27	0.67	0.94	0.35	0.27	0.62
Africa	0.30	0.53	0.82	0.50	0.61	1.11	0.29	0.12	0.41	0.41	0.54	0.95

Source: Author's estimation.

regime of expanding production to one of contracting production, even if the returns change. However, the pace of development could be affected and this might explain why correlations exhibit higher indices.

A second observation is that indices at the three-year horizon are higher than at the ten-year horizon. Again this also might reflect the particular characteristics of the oil markets. Long-term projections are difficult to make. Therefore, long-run plans might be based upon assumptions regarding profitability and expected bounds for oil prices, but not necessarily on how oil prices and interest rates will move in each year.

A third observation is that indices after 1993 (94-03 and 94-10) are higher than indices leading up to 1993 (80-93). Again, this might also be due to the fact that before 1993 the optimal management strategy would have suggested to move forward production and postpone any long-term project. Given the nature of oil production, this can often be a difficult and challenging task. Interestingly, OPEC countries had high scores at the three-year horizon in this period because they were implementing quotas. Therefore, production was falling as quotas became smaller in order to try, unsuccessfully, to keep prices higher. However, such a policy was not done while at the same time investing for longer horizons and therefore, the strategy might not have been optimal in for that time framework

Given all these stylized facts, how do the regions of the Southern Atlantic space compare? Independent of the time horizon, African countries on average had lower indices than Latin American countries in the first period, but then exhibited higher indices than LAC in the second period. In other words, between 1980 and 1993, when the optimal management strategy would have suggested to move production forward, Latin American countries fared better. However, after 1993, when the optimal strategy would have been to postpone production, African countries performed better. Therefore, Latin American management strategy was closer to an optimal strategy between 1980 and 1993, while African countries have had a better strategy after 1994.

Oil Institutions and Asset Management Across the Southern Atlantic Space

How can the pattern of behavior presented in the previous section be explained? Given that most countries—and in particular, the African countries—do not have enough data to formally test these changes, only some stylized facts, that might lead to a hypothetical explanation, can be formulated.

When focusing on the past decade, the Global Petroleum Survey of the Fraser Institute can be used to explain the challenges in investments in the oil sector.¹¹ This is a survey of representative agents of the oil sector on investment conditions in different oil producing countries (or regions, in the case of Canada and the United States). The survey explores a wide range of issues from taxation and regulation to the quality of geological information. Interestingly, on average the regions are not that different. The average value of the index for Latin America is 75.05 (where the higher the number the worse the business environment for the oil sector) and the average position in the index will be 113 (out of 147 oil provinces).¹² In Africa the average value is 71.94 (actually better than Latin America) but the average position is 121. This difference points out the heterogeneity of institutions between and within these regions.

In this regard, the present analysis further explores the correlations between different key questions on the Fraser GPS survey and the indices described and analyzed above. Three variables become relevant in their relationship with the indices: the quality of the tax system, the quality of government regulation and the certainty of that regulation. Each of these variables is assigned the percentage of GPS respondents that answered that the institutional variable in question (i.e., tax system, regulation, certainty) does not deter investment.

Table 2 presents the correlations between the different indices (calculated and presented in the previous section) and the institutional variables linked to the Fraser Institute GPS survey responses. Because

11. Fraser Institute, *Global Petroleum Survey*. (Canada: Fraser Institute, 2007 and subsequent years).

12. Oil provinces are based on national and local rules. Since in some countries, oil regimes have also a component based on local regulations, federal countries might have more than one oil province.

Table 2. Correlations between Institutions and Indices

	Three Year			Ten Year		
	Index for level	Index for Correlation	Total	Index for level	Index for Correlation	Total
Tax System	-	-**	-**	-	+	+
Compliance with Regulation	+	-	-	-	+	+
Reg. Certainty	-	-*	-*	-*	+	+

*, **, *** significant at the 1%, 5% and 10% level, respectively. Author's estimation.

the survey was undertaken in 2007, only the second period (94-10) is analyzed. For simplicity, only the sign and the significance level are presented. The correlations with the highest level of significance are those between the index for correlation -between returns to extraction and production—and the institutional variables related to compliance with regulation and regulatory certainty over the ten-year horizon.

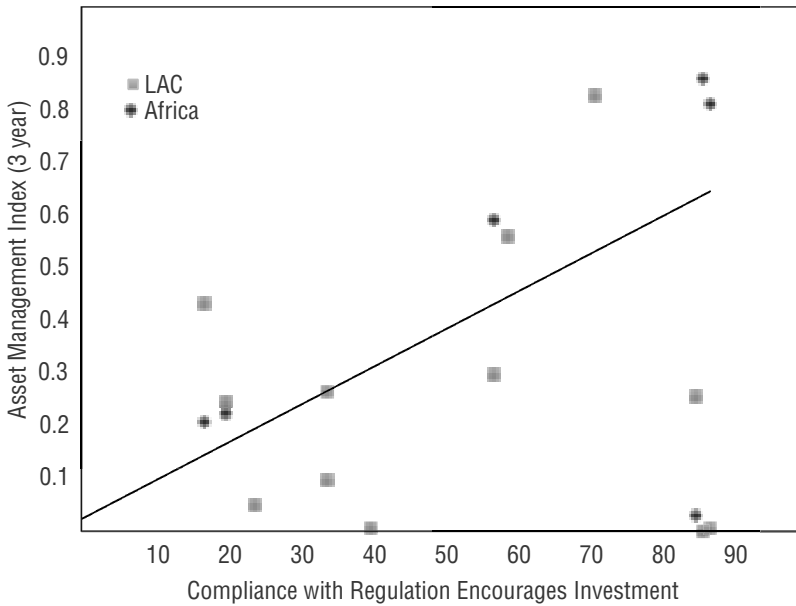
These positive correlations imply that those countries where the issues of compliance with regulation and regulatory certainty are not viewed as impediments to investment (and might even encourage it) are also those countries where production changes are closer to the optimal response to changes in the return to extraction.

Figure 3 further illustrates this correlation. The horizontal axis measures the percentage of respondents that expressed that compliance with regulation does not deter (or even encourages) investment. The vertical axis measures the value of the index of correlation at the ten-year horizon.

To illustrate, Figure 3 reveals that, in Gabon, 87% of respondents expressed that compliance with regulations does not deter (or even encourages) investment. On the other axis, the index for correlation for Gabon is 0.81, placing Gabon at the green point in the upper right corner of the graph. At the opposite corner of the graph, in Algeria only 17% of those surveyed expressed that the compliance with regulations does not deter (or even encourages) investment, while its correlation index is only 0.21.

A similar case could be constructed with respect to regulatory certainty. Furthermore, (although only at the 10% level) there is also a positive correlation between a positive perception of the tax system

Figure 3. Compliance with Regulations and Resource Management

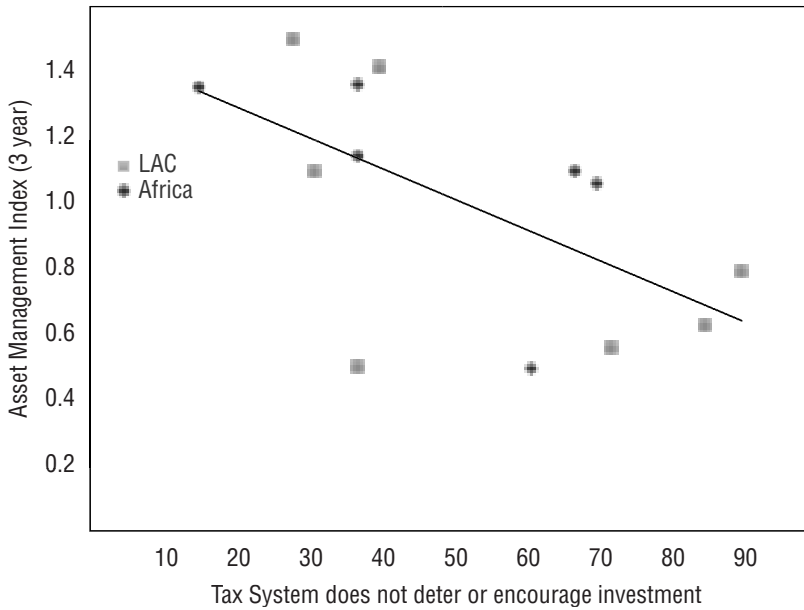


Source: Author's estimation.

and the correlation between production and returns to extraction (see Figure 4). Consequently, at the 10% level, positive perceptions of the national institutions seems to be related to better management of the resource base.

However, the Table 2 also reveals that there are some negative correlations between institutions—in particular, the perceived effect of the tax system upon investment—and optimal responses for the three-year horizon. These imply that at the shorter-term horizon less favorable views of the tax system are negatively correlated with the correlations between return to extraction and production changes closer to the optimal response. This correlation is illustrated in Figure 4. The horizontal axis measures the percentage of respondents that expressed that the tax system does not deter (or even encourages) investment. The vertical axis measures the value of the total composite index for the three-year horizon.

Figure 4. Tax and Resource Management



Source: Author's estimation.

Figure 4 reveals that, in Peru, 90% of respondents expressed that the tax system does not deter (or even encourages) investment. On the other axis, the index for correlation is 1.18. This makes Peru the red point on the farther right-hand side of the graph. At the opposite (or NW) corner of the graph, in Algeria only 15% of those surveyed expressed that the tax system does not deter (or even encourages) investment while the index is 1.35.

These results revealed in Figures 3 and 4 seem to suggest that better perception of the relevant national institutions in oil producing countries in the Southern Atlantic space tend to generate *optimal responses to changes in the return to extraction in the long run*. However, worse perception of these institutions—at least of the tax system—tend to generate optimal responses to changes in the return to extraction in the short run. Therefore, therefore the broad conclusion would be to suggest that better institutions allow for long term planning and

management of the oil resource, while inferior institutions tend toward short run planning and management of oil resources.

Looking at institutions, in terms of taxes, the average percentage of investors who responded that taxes do not deter or even encourage investment is similar in Africa and Latin America (48%). However, there is more dispersion in Latin America, at the individual nation level, with the lowest and the highest share of respondents considering taxes not to be an obstacle.

In terms of compliance with regulation, a higher percentage of those surveyed in Africa (59%) answered that it does not deter investment than in Latin America (33%). In this case dispersion is higher in Africa. Finally, the percentage of investors that do not consider the issue of regulatory certainty to be a deterrent to investment (or even consider it a positive influence) is higher in Africa than in Latin America (39% versus 28%). There is more national dispersion across Latin America, as well. Therefore, in spite of the low average, the best performers in terms of regulatory certainty can be found in Latin America (Colombia and Peru). This average is pulled down by the presence of some poor performers (Ecuador and Venezuela).

Mutual Lessons for Best-Practices Across the Southern Atlantic

These results also suggest that there are lessons to be learned across the Southern Atlantic. On average, African countries have generated less perception of regulatory uncertainty, better perception with respect to the obstacles implied by regulation, and a similar superior perception of the tax system. Remarkably, this broad conclusion stands in spite of the fact that, when looking at general institutional indicators (such as the institutional variables of the World Bank), African countries tend to rank lower than their Latin American counterparts.

Table 3 presents the average for each Southern Atlantic continent with respect to each set of institutional variables. The first part of the table present the results of the Fraser Institute's 2007 Global Petroleum Survey indicating the share of firms that consider that taxes and regulatory uncertainty are not deterrents to investment in the oil sector. The second part presents the average value of some selected gen-

Table 3. Performance of Oil Institutions in the Southern Atlantic Space

Institutions	Africa	Latin America
Oil Institutions		
Tax system does not deter Investment	49%	49%
Regulation compliance does not deter Investment	59%	33%
Regulatory Uncertainty does not deters Investment	39%	28%
General Institutions		
Control of Corruption	-0.77397	-0.27427
Government Effectiveness	-0.65158	-0.18037
Regulatory Quality	-0.72554	-0.03298
Rule of Law	-0.73292	-0.51115

Source: World Bank (2013) and Fraser Institute (2007).

eral institutional variables for each region coming from the World Bank's Worldwide Governance Indicators for 2013. The lower the value, the worse the perception of the institutions (in both sections). Perceptions of oil institutions in Africa are as good as, or better than, in Latin America despite the fact that, in general, African institutions rank worse.¹³

Important lessons can be extrapolated from these results regarding how to generate an adequate environment for a specific sector. For example, Cameroon has already made advances in opening its oil sector by attracting oil companies to develop marginal and deep-water offshore fields. To this end, the national oil company signed two production-sharing agreements in 2005 and 2006.¹⁴ Cameroon is also an Extractive Industries Transparency Initiative (EITI)-compliant country, and published 11 years of fiscal data in 2011.¹⁵

Furthermore, of all African and Latin American producing countries (and including those beyond the sample of countries considered in this study), only two Latin American countries are EITI-compliant while another two are candidates. On the other hand, 17 African

13. See World Bank, *Worldwide Governance Indicators* (Washington, DC, 2013). This result is in line with Balza, Espinasa and Jimenez (2014) that shows that that oil sector performance depends primarily on sector-specific institutions, and, to a lesser extent, national institutions.

14. OECD, "Cameroon Study Report." *African Economic Outlook*, AfDB/OECD, 2007.

15. Extractive Industries Transparency Initiative (EITI), *Cameroon 2011 EITI Report*, (Norway: EITI 2011).

countries are EITI-compliant and another four are candidates. This push toward transparency has accompanied a boom in the extractive sector in Africa.

In addition, this commitment to transparency is not necessarily related to better financial management. As explained in Schaechter et al., there are no significant differences in the use of fiscal rules between Africa and Latin America.¹⁶ In any case, there is more use of them in Latin American. Therefore, it seems that a commitment to an open management of resource revenues lends credibility to previously-implemented reforms and could support, and provide for sustainability of, future institutional and reform commitments.

Still, the lessons could be mutual—given that some Latin American countries rank higher as oil management performers—with lessons to be learned in Africa from the best-practices of the LAC region. As explained before, Colombia and Peru rank high in investors perspectives. As documented by Balza and Espinasa, the positive performance of the oil sector in these two countries could be explained by the institutional arrangement in those countries.¹⁷ There, the state exercises its monopoly property rights through indirect control of production by means of a National Oil Regulatory Agency which administers the oil bearing lands on behalf of the state owner. The agency opens up the territories with hydrocarbon potential for development by oil companies both national and international, and both privately and state-owned. The territories to be developed are auctioned off through a bidding process and awarded on the basis of different parameters, among others: the government take, the investment and production over and above minimum levels set up by the agency and the content of local goods and services over and above a set minimum. Therefore, the institutions are set in a way that the different roles that the state may have in the oil sector are separated and managed independently. This setting has a positive impact on performance.

16. Schaechter, Andrea, Tidiane Kinda, Nina Budina, and Anke Weber, “Fiscal Rules in Response to the Crisis—Toward the ‘Next-Generation’ Rules. A New Dataset.” IMF Working Paper WP/12/187 (Washington, DC: International Monetary Fund, 2012).

17. Balza, Lenín H. and Ramón Espinasa, “Oil Sector Performance and Institutions: The Case of Latin America.” *IDB Technical Note IDB-TN-724* (Washington, DC: IDB Publications, 2015).

In such cases, it is difficult to disentangle the role of general intuitions from that of sector institutions. Therefore, the case of Latin American countries might highlight the importance of general institutions across the Southern Atlantic.

Conclusion

In Africa and Latin America, hydrocarbons represent an important share of economic activity. Therefore, whether or not these resources are managed correctly presents a valid question and represents a national imperative. Nevertheless, answering that question—and meeting that imperative—requires several steps, one of which is to examine whether or not the asset is being managed in a financially sound way.

This chapter has focused on that question. From a financial point of view, the owner of the asset—in this case the State—should examine how the return on that asset compares to its opportunity costs. Current extraction decisions should be based on a return on such activity that is higher than the return from leaving it in the ground in expectation of a future higher price.

The observations made in this chapter reveal some stylized facts. Even if extraction rates might not be at the expected levels (given returns to extraction), shifts over time do have a correlation to those returns in line with the optimal response. Secondly, at the three-year horizon production seems to be closer to the optimal response than at the ten-year horizon. Both of these results could be in line with the particularly characteristics of oil exploitation (which involved much greater levels of uncertainty over longer time horizons).

In addition to those observations, in the period after 1993 production levels and shifts are closer to the optimal strategy. This is a period in which production should have been postponed into the future. Production strategies seem to align themselves better in a context of expansion of demand that over time generates increasing prices.

Finally, there are some clear regional differences. African countries on average had lower indices than Latin American countries in the

first period, but moved to higher indices—expressing better perceptions of their oil institutions—in the second period.

Most countries (in particular, African countries) fail to provide enough data to formally test the variables that could explain the differences in the relationship between production changes and returns across countries and time. However, some stylized facts can be based on the correlation between these relationships and investor perceptions.

Countries with better investor perceptions of the tax system, regulation compliance and regulatory certainty tend to have long-term reactions to oil extraction consistent with its return. However, in the short-run, at least with respect to taxes, the opposite is true. Therefore, it appears from these results that better institutions allow for long term planning and management of the resource, while inferior institutions lead to short run planning and management of the resource.

African countries have generated less perception of regulatory uncertainty than their Latin American counterparts—and a similar perception of the tax system. Consequently, there are lessons to be learned across the Atlantic. Moreover, in addition to highlighting the importance of an adequate institutional framework, these results open the door for future research on the specific channels to these correlations.

Appendix

Optimal Use of a Resource Asset

To perform such analysis, I use a simple arbitrage equation, similar to equation (1).¹⁸ The equation states that the assets' opportunity costs (rV) should be equal to the profit obtained from that asset (π) plus the expected change in the value of the asset (\dot{V}):

$$rV = \pi + \dot{V} \quad (1)$$

The equation can be rearranged as follows:

18. This view is a restatement of the traditional model of exploitation of a non-renewable resource, developed originally in Hotelling, "The Economics of Exhaustible Resources," *Journal of Political Economy* 39:137–175, 1931.

$$r = \frac{\pi}{V} + \frac{\dot{V}}{V} \quad (2)$$

For the oil sector, π/V is basically a function of the extraction rate; e , and V/\dot{V} are a function of the expected change in oil prices, \hat{p} . Therefore, when rearranged for the oil sector, equation (2) can be written as:

$$e = f(r, \hat{p}) \quad (3)$$

This equation implies that the extraction rate should be equal to a function of the opportunity cost and the expected change in oil prices. In a simpler form:

$$e = f(\hat{p} - r) \quad (4)$$

Is this simplification always valid? Firstly, since V/\dot{V} depends on net income, this means the ratio depends on more than expected changes in prices. The expected change in value will also depend on the expected evolutions on costs, in particular how technological change will help reduce costs.¹⁹ Therefore, V/\dot{V} could be underestimated by \hat{p} .

Secondly, both π/V and V/\dot{V} depend on the evolution of reserves. Reserves can only be estimated after the beginning of a project. As a consequence, the incorporation of the revised reserves calculation will cause e to change. In addition, any deviation of the reserves from their expected value at the beginning of resource production will affect the value of V .

For the purpose of this analysis, I am going to assume the simple linear specification of equation (4) and compare the evolution of the left hand side of equation (4) with the production evolution. How should they move? Both π and V are based on net income. If oil production decisions are based on profit maximization,²⁰ if $\hat{p} - r$ increases, it is optimal to postpone production until its net income is higher. Therefore, extraction should fall. On the other hand, if it falls, it is optimal to extract more today.

19. However, in the context of the recent spike in oil prices, it could also include the expectations on the inflation in oil services. However, since we are looking at a 10-20 years horizon, this issue becomes less relevant.

18. Heal, Geoffrey, "The Optimal Use of Exhaustible Resources." *Handbook of Natural Resource and Energy Economics, Volume III*, Chapter 18, North Holland, 1993.

Estimation of the Indices

Oil prices from the International Financial Statistics (IMF, various years) are used to determine the return of oil extraction. In particular, the price of the Brent crude is used. I compare the future change of prices with the equivalent yield of the U.S. Treasury bond. In other words, the future change of prices in three years was compared to the yield of a three-year bond (the same exercise was performed on a ten-year horizon). Bond yields were also taken from the International Financial Statistics.

Production figures were taken from the Energy Information Agency (EIA, various years). I estimated the future annual growth rate of production for each year. In other words, I took the average growth rate of production for the following three years. I estimate a similar indicator for ten years. Since I am using future changes, for ten years the last point is 2003 and for three years, it is 2010.

For these variables the average for each period was calculated and based on the standard deviation it was tested whether or not the sign was the expected one. The probability that the null hypothesis was true was used as the index for level.

In a similar way, the correlations between the returns and the growth rate were used for each period and horizon. Using the Fisher transformation, the correlations were tested on whether they were of the expected sign. The probability that the null hypothesis was true was used as the index for correlation.

Institutions

The Global Petroleum Survey was used to measure the quality of the institutions governing the oil sector (Fraser Institute, 2007). With regards to the tax system, the question whether the tax system presents a deterrence to investment was used.

With regards to the regulation system, the question whether the regulation uncertainty discourages investment was used. Similarly to Figures 3 and 4, rationality is based on the value of the correlation between returns to extraction and production. For Figures 5 and 6, speed of adjustment is defined as the multiplication of the signs of the correlation of returns and production and the correlation of the ratio

of production to returns to extraction and returns with the absolute value of the latter. The relations in Figures 3, 4, 5 and 6 are all greater or equal to 0.75 (when using the Fisher transformation and a significance level used was 10%).

Part III

**Transnational Perspectives on Energy
in the Atlantic Basin**

Chapter Ten

The Energy Policy of Europe in the Context of the Atlantic Basin: A Business Vision

Carlos Sallé

The European Union (EU) has established competitiveness, security of supply and environmental sustainability as the pillars of its energy policy and the axes around which its energy policy instruments turn.

In March 2007 the European Council adopted the so-called “20-20-20” targets, which committed European energy policy to three objectives: to reduce greenhouse gas (GHG) emissions by 20%, to achieve a 20% share for renewable energy within final energy consumption, and to improve energy efficiency by 20%—all by 2020. The origins of these objectives are to be found context of early 21st century Europe, where concerns about economic growth and competitiveness had been displaced by the pursuit of a prosperous economy, with climate change and environmental sustainability positioned as increasingly priority challenges to be addressed within an ambitious policy framework.

However, the world has changed significantly since these goals were adopted in 2007. The European economy has been depressed by an unprecedented crisis over the last five years, renewable energy has acquired a leading role in the European electricity sector, major European competitors (such as the United States) have developed highly competitive energy supply sources from non-conventional fuels (i.e., shale gas), and the Fukushima accident has caused a number of governments to doubt the role of nuclear energy in their electricity mix. Furthermore, in addition to these changes in the economic and political arena, the dynamics of the 20-20-20 objectives and the interactions between them have created inefficiencies throughout the entire European economy.

This chapter analyzes European experience and its implications in the aftermath of the 2007 policy changes, and it assesses the capacity of European energy policy to adapt to the newly unfolding context. Based on this analysis, concrete proposals and recommendations are offered.

The chapter is structured into five main areas:

- The first describes the main elements of the European energy strategy for 2020.
- The second describes the main drivers of change in the current global energy scene.
- The third analyzes the impact of environmental changes on the results of the European strategy for 2020.
- Finally, the fourth and fifth sections make concrete proposals to meet the new challenges posed to the European energy model.

Empirical Evidence Regarding the 20-20-20 Goals

The European position in the global energy model is conditioned on its fossil resource shortage and its positioning as global leader in the fight against climate change, with the underlying objective of initiating a change of the EU economic model towards an economy that is less dependent on energy and carbon dioxide (CO₂).

The regulatory framework for energy and environmental affairs in Europe has in recent years been defined by the 20-20-20 targets to be attained by the year 2020, as follows:

- A 20% reduction in greenhouse gas emissions (GHG) from 1990 levels.
- Raising the share of final energy consumption supplied by renewable resources to 20%; including raising the use of renewable energies in the transport sector to 10%.
- 20% improvement in primary energy consumption compared to baseline scenario, via energy efficiency.

In order to achieve these goals, on the one hand, various European Directives have been passed¹ and, on the other, the member states have developed regulatory instruments both at internal level and with the objective of transposing these EU Directives.

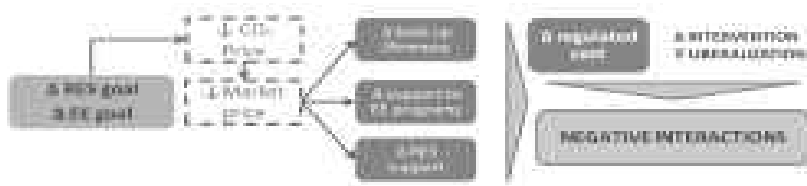
The empirical evidence has shown interactions among 20-20-20 policy goals (some of them very negative). When the objectives of 2020 were established in 2007, it was impossible to foresee the full extent of the current economic crisis which affects such important variables as the energy demand, emissions reduction and, consequently, the emissions trading scheme (ETS) allowance price. As it may be seen in Figure 1, all these economic factors and the interaction of three simultaneous goals (energy efficiency-EE, renewable energy systems—RES, and CO₂) have contributed to the reduction of both CO₂ and electricity market prices, which has increased the need of support for renewables and energy efficiency policies in comparison to the original forecast.

Massive RES penetration has exacerbated the “missing money” problem suffered by conventional generators, making even more important and urgent the introduction of capacity remuneration mechanisms to counteract the negative effect of the market and regulatory failures present in the current market design. The former elements have increased regulated costs, which have reached a very important share on total cost across EU electricity systems. The bigger the share of regulated cost in the electricity system, the greater is the risk from government intervention, which jeopardizes liberalization processes. It should not be forgotten that such an extensive government role comes with a political cost, in terms of transferring cost to final prices, which explains the reluctance of governments to tackle this issue.

In general terms, by making agents’ remuneration increasingly dependent on regulated mechanisms (and less on the market), both in the field of generation and trade, a growing bias towards interventionism is introduced, moving in the opposite direction of the European directives on liberalization.

1. Emissions Trading Directive (2003/87/EC), as amended by Directive 2009/29/EC, Directive on the Promotion of the Use of Energy from Renewable Sources (2009/28/EC) and the recently passed Energy Efficiency Directive (2012/27/EU).

Figure 1. Negative Interactions among 20/20/20 Policy Goals



Source: own elaboration.

Faced with such a situation, in which the CO_2 price is considerably low, the auctioning rules for the EU ETS have been amended in order to allow for the postponing of the auctioning of a particular number of emissions (this is referred to as “back-loading” in EU jargon). By implementing this postponement strategy (which is practically equivalent to changing the slope of the curve for maximum emissions allowed in the early years at the expense of increasing the maximum emissions allowed at the end of the period 2014–2020), the European Commission seeks to restrict the offering of emissions allowances in short-term auctions, thus raising the short-term price. It will then offer more allowances at the end of the period, when demand is expected to have recovered. Assuming that the effect of this increase in emissions as a result of back-loading at the end of the period will be more than offset by the aforementioned increase in demand, the CO_2 price will go up or at least remain stable.

Notwithstanding, back-loading is only a short-term measure that should be complemented by structural measures to consolidate the improvements introduced since the beginning of EU ETS and lay the foundations for reducing emissions in the long term.

The World Has Changed Since 2007: Some Remarks on the Electricity Sector

Since 2007, the world has changed dramatically and energy policy has not yet adapted to the challenges that have arisen. Some of the distinctive elements that constitute the new global framework are shown below:

Box 1. Climate and Energy Policy Framework 2030 Targets proposed by the European Commission for 2030

Experience with the current 2020 framework proves that while European and national targets can drive action by the member states on environmental and energy policies, they have not always ensured market integration, cost-efficiency and undistorted competition. Based on this experience, the European Commission (EC) proposed on January 22, 2014 a framework of energy and climate objectives applicable beyond 2020 and up to 2030. The EC aims at achieving several goals with this proposal: reduce greenhouse gas emissions, provide flexibility for member states to define a low carbon transition appropriate to their specific circumstances (follow a cost-efficient approach which responds to the challenges of affordability and competitiveness), improve security of the EU's energy supplies and sustainability, and reduce EU dependence on energy imports and enhance investor certainty.

One of the keystones of the EU's energy and climate policy for 2030 is a new reduction target for domestic GHG emissions of 40% compared to 1990, to be shared between the ETS and non-ETS sector. The non-ETS target would be allocated among member states. To achieve the overall 40% target, the sectors covered by the EU ETS would have to reduce their emissions by 43% compared to 2005. Emissions from sectors outside the EU ETS would require a reduction of 30%. An increased level of energy savings of approximately 25% is consistent with the CO₂ goal. This effort would be shared equitably between the member states.

Regarding renewable energy, the Commission proposes an objective of increasing the European level for renewable energy of at least 27% of the EU's energy consumption by 2030 with flexibility for member states to set national objectives.

The role of energy efficiency in the 2030 framework will be further considered in a review of the Energy Efficiency Directive due to be concluded later in 2014.

Some of main challenges that face the EC framework proposal for 2030 are related to the development of instruments sets to achieve it efficiently. Moreover, it should be taken into account that the current 2030 proposal is still under discussion, and the final version could be very different from initial drafting.

- *Economic crisis:* The crisis has had two main consequences. On the one hand, energy demand has been reduced, with a consequent revenue decrease. On the other hand, financing capacity of firms has deteriorated. Both aspects have had a particularly negative impact on the electricity sector, harming economic viability of power facilities and limiting the capacity to tackle new invest-

ments. This situation has been worsened by the increasing interventionism of governments.

As a general consideration, it should be noted that experience has shown that during periods of economic boom, costs items not related to supply have been introduced into the electricity tariff. These costs have created upward pressure on electricity tariffs, which are very difficult to pass to final consumer prices especially in periods of economic crisis. In some countries, such as Spain, this phenomenon has created a tariff deficit, which governments have attempted to correct by adjusting remuneration frameworks to various activities (distribution, renewables, etc.).

- *Non-conventional fuels deployment* (for example shale gas deployment in the United States) has created a new global reality, in which borders between consumers and producers have been blurred, thus, changing the competitive position of several important economies such as United States.
- *Massive renewable penetration in electricity mix*: It is necessary to consider two issues. First, the need for firm capacity (that with a high probability of being available whenever needed) has not changed. Second, since renewable generation has close to zero variable costs (wind, sun, etc.), it displaces conventional production with high variable costs (gas, coal). This inevitably results in a reduction of the average spot price (not in the final price that has to recover all cost and subsidies), which has obvious implications for the economic sustainability of conventional generation. Indeed, conventional generation revenues will be reduced not only because of the lower operating hours (lower production from being displaced by renewables), but also because of the reduction in prices obtained in the market.
- With this in mind, a fall of over 40% in the price of solar panels since 2010 has led some parties to make the case that electricity generated from residential solar photovoltaic (PV) installations has become—or is fast becoming—competitive with electricity generated from fossil fuels.² This has introduced into the present regulatory debate the phenomenon of the “distributed generation.” According to K. Rábago, traditional “net metering”

2. International Energy Agency, *World Energy Outlook 2013*. Paris, 2013.

approaches that have been adopted in past decades, have been proven unsustainable in the long-run because they do not ensure that the electricity system recovers the full cost and discourages energy efficiency, thereby providing erroneous signals to the market regarding the economic viability of the facilities that were already mentioned.³ This situation requires thorough assessment from policymakers on access tariff design to ensure, on the one hand, the full recovery and fair allocation of system costs avoiding free riding by passing on some costs and, on the other hand, allowing distributed generation when its deployment is efficient for the system as a whole.

- *Fukushima accident*: The Fukushima accident has questioned the role of nuclear energy in electricity generation mix in many countries all over the world. One important example on this regard is the change in German policy.

It seems that the EU has failed to firmly respond to this weakness of the European energy policy. In fact, the EU has delayed its adaptation to this new situation, which has had negative consequences:

Loss of Competitiveness in the Global Framework

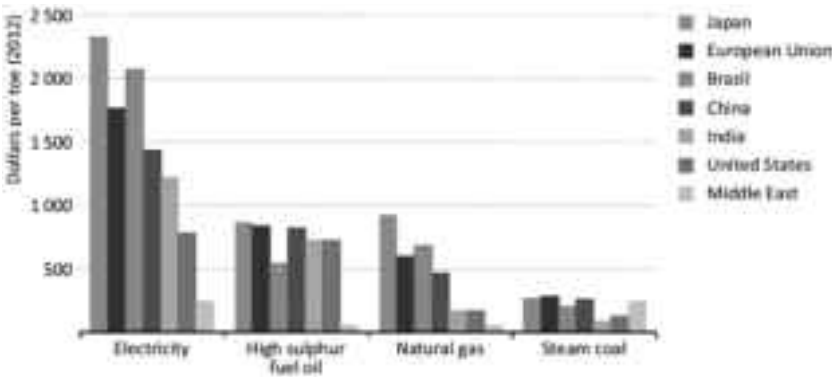
Final electricity prices in Europe increased by almost 40% between 2005 and 2012, while in the United States, the prices remained constant.

On average, in 2012, industrial consumers in the EU paid more than double the price for electricity procured by companies based in the United States. Gas market prices are even more overwhelming since European industrial consumers, on average, paid four times the price of their U.S. counterparts.

One of the main drivers of the reduction of natural gas prices that face U.S. consumers is the so-called “non-conventional fuel revolution,” particularly that of shale gas. Since 2008, the production of tight and shale gas has increased by about 19%, bringing annual production to 25 trillion cubic feet (tcf) in 2012 (up from the 21 tcf reached in 2008.) As seen in Figure 3, the IEA forecast shows that shale gas deployment will be consolidated in the long run, until becoming the

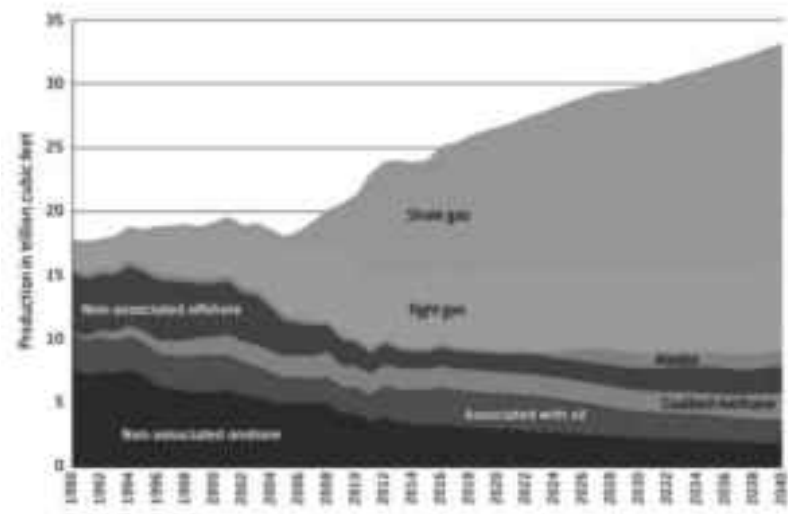
3. K. Rábago, “The Value of Solar Tariff: Net Metering 2.0,” *The ICER Chronicle*, December 2013, pp. 46-49.

Figure 2. Industrial Energy Prices Including Tax by Fuel and Region, 2012



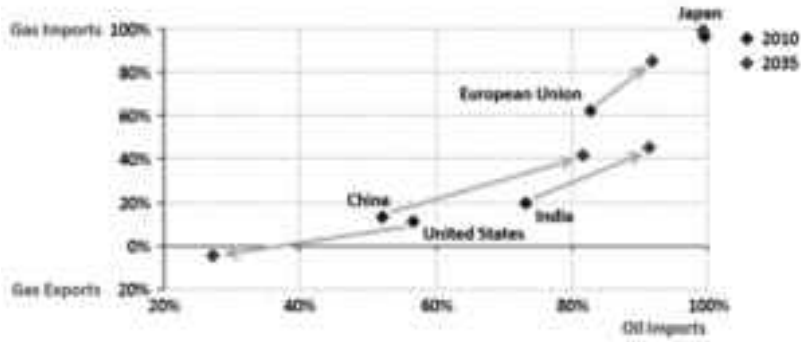
Source: World Energy Outlook 2013, IEA.

Figure 3. U.S. Natural Gas Production in Trillion Cubic Feet



Source: Annual Energy Outlook 2013 Early release, U.S. Energy Information Administration.

Figure 4. Current Status and Future Development of Energy Dependence



Source: International Energy Outlook 2013, IEA.

main component of the U.S. gas production mix. Paying prices well below the EU lowest price has allowed U.S. industries to change their global position from marginal producers to one of the lowest cost producers in the world.⁴

Beyond the positive impact on gas and electricity bills for domestic and industrial consumers, one of the most evident effects of shale gas development in the United States has been the decrease of dependence on imported energy, as Figure 4 illustrates. This contrasts with the expected evolution of dependence on the other economic blocs, where the dependence on conventional energy resources will increase significantly and which is particularly noteworthy for the outlook in Europe and Japan, where imports will represent over 80% and almost 100% of their needs for natural gas and oil respectively.

Another relevant consequence of the energy cost reduction is that energy price disparities are creating a comparative advantage in favor of U.S. manufacturers. According to the 2012 European Competitiveness Report, the increase in energy costs is the dominant driver for relocating production activities abroad. According to the Energy Prices and Cost report made by the European Commission:

4. European Commission, *Taxation Trends in the European Union*, 2013 edition. Brussels.

regional prices disparities increase the risk of reducing production levels and investment in higher priced countries and bring changes in global trade patterns, in particular affecting industries that have a high share of energy cost and are exposed to international competition because their production is easy and relatively cheap to transport.⁵

This view is supported by IEA's analysis in the 2013 World Energy Outlook, which demonstrates that persistently high energy price disparities can create important differences in economic structure over time and have deep effects on investment, production and trade patterns, which are nowadays measurable with difficulty. For now, higher prices have resulted only in a loss of competitiveness,⁶ although in the long run, this could lead to a loss of EU industrial market share unless EU industries' energy efficiency gains allow for overcoming price gaps.

Nonetheless, competitiveness analysis is very complex and requires the consideration of indicators, which inform how energy prices and energy use affect production decisions. Energy costs, energy productivity and energy intensity are such indicators which can be analyzed. In the electricity sector, the complexity of price competitiveness is remarkable considering that "[e]nergy is becoming relatively expensive in Europe,"⁷ despite the fact that energy wholesale price has collapsed due to the low demand, high renewable production and low CO₂ prices. A large proportion of the loss of competitiveness in Europe comes from taxes and charges on electricity prices that are not related to energy supply and, in many cases, account for nearly 50% of the final price. A clear example of this can be seen in Spain, where the lack of competitiveness of electricity tariff originates in the fact that 50% of the final electricity price in 2012,⁸ corresponds to costs not related to supply (RES & Combined Heat and Power—CHP support, autonomous coal support, islands generation, annual recovery of tariff deficit generated in the past, etc.).

5. European Commission, *Energy Prices and Costs Report*. Brussels, 2014.

6. Europe still remains the largest export region for energy intensive goods in 2011, according to the *Energy prices and costs report* of the European Commission, Ibid.

7. G. Zachmann & V. Cipollene, "Energy competitiveness," in R. Vengeler, *Manufacturing Europe's Future*, Belgium: Bruegel, 2013, pp. 139-160.

8. This percentage increased in 2012 and 2013 due to measures taken to control tariff deficits.

Figure 5. Mapping Political/Regulatory Risk across Europe for Power Generation Utilities



Source: Exane BNP Paribas estimates.

Security of Supply and Investments Under Risk

This consequence has been particularly relevant for the electricity sectors across Europe, where in recent years most governments have adopted measures that are contrary to regulatory consistency and orthodoxy, ignoring that these two elements are key to allowing for investments in networks and power generation. These measures have been undertaken in a context of crisis and profound paradigm overhaul, characterized by an increasing pace of renewable energy⁹ and the many related aspects linked to this phenomenon.¹⁰

Nevertheless, Europe is characterized by different levels of political and regulatory risk (as seen in Figure 5). Countries with opened regulatory reform processes tend to have a higher risk level.

9. It is remarkable that some of these regulatory reforms have adjusted supports to all renewable technologies, with an important negative impact on their economic viability and on the perception of investors on RES market perspectives.

10. W. Hogan, "Electricity market design: Coordination, Pricing and Incentives," ERCOT Energized Conference. John F. Kennedy School of Government, Harvard University, 2008.

When focusing on the European regulatory debate on electricity market challenges, one of the hottest topics is the increasing pressure on the economic viability of the conventional generation activity in a situation of depressed demand, increasing share of renewables and depressed CO₂ prices. All these factors exacerbate the “missing money” problem created by well-known market and regulatory failures, as they make conventional generators increasingly dependent on some scarcity prices that for different reasons (price cap on wholesale prices, market exit barriers on generators, regulatory intervention at price peaks, etc.) the market ultimately does never deliver. The former distortions prevent the market from efficiently allocating resources. But the damage is two-fold: (1) they hurt economic sustainability of the facilities that are already established,¹¹ and (2) they discourage potential investors who would have to face low investment returns. According to Hogan, “[a] variety of market rules for spot markets interact to create *de jure* or *de facto* price caps. The resulting missing money reduces payments to all types of generation.”¹²

Already in 2006, Joskow anticipated the risks for supply security in the U.S. market derived from the missing money problem:

there are a number of market imperfections and institutional constraints that have the effect of keeping wholesale prices for energy and operating reserves below their efficient levels during hours when prices should be very high and provide insufficient net revenues to support the capital costs of an efficient portfolio of generating facilities . . . If this situation is allowed to persist it will in turn lead to underinvestment in generating capacity and to higher rates of power supply emergencies and involuntary rationing (black-outs). These problems have been exacerbated in the U.S. by instability in the wholesale market designs and market rules that characterize these wholesale markets (continuing reforms of the reforms), uncertain commitments by government policymakers to liberalization (calls for re-regulation), and an incomplete transition to a stable retail competition framework. At least some of these

11. “About 40% of the current thermal capacity is a risk of closure due to economic reasons,” according to “The Crisis of the European Electricity System, Diagnosis and Possible Ways Forward,” published by Commissariat général à la stratégie et à la prospective, Paris, January 2014.

12. Hogan, *op. cit.*

problems are likely to characterize competitive electricity markets in some other countries. That's the bad news. The good news is that these problems can be fixed with appropriate reforms to wholesale and retail market designs and credible government commitments to market liberalization.¹³

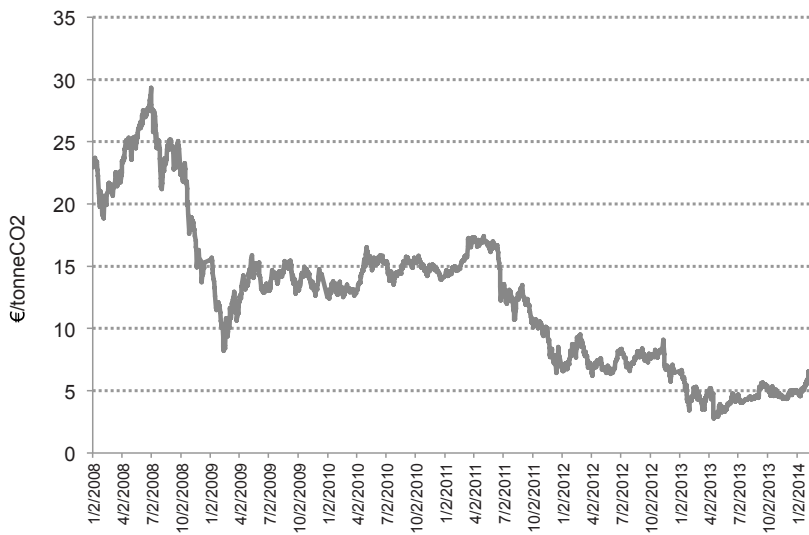
In the European context, massive penetration of renewable energy has had relevant consequences for electricity markets. Due to renewable technologies having almost no variable cost, conventional energy generation, with higher variable cost, has seen its market share reduced, depending even more on peak prices produced (wholesale market prices of peak hours should be high enough to allow cost recovery). This is particularly worrisome with regards to revenues for those plants that work a limited number of hours. Additionally, that reduces the reasonable expectation of cost recovery and weakens the main economic signal to the entrance of new generation capacity.

Weakening of the Signals to Fight Against Climate Change and the Loss of European Leadership in Tackling Climate Change

Despite the fact that the emissions allowance market is working smoothly (bear in mind that the emissions target is being met and that the price is in keeping with the basic factors), many analysts claim that the price of CO₂ in the European market has fallen so low, and at the same time shown such a high level of volatility, that it is not providing an incentive for the investments required for the decarbonisation of the economy (since January 2013, the price of the Emission Unit Allowance (EUA) has remained mostly below 5 Euro/ton CO₂).

The Emissions Allowance Trading Scheme (EU ETS) has proven to be effective in bringing down emissions, a goal that is achieved due to the structure of the regulatory instrument (cap & trade). However, the economic crisis and its consequences on productive activity and demand in the economy, together with the interaction with the measures put in place to achieve the other two objectives (RES and EE), have contributed towards plummeting prices per ton of CO₂ and, therefore, weakened one of the main drivers contemplated by the regulator: a technological shift towards a low-carbon economy, which is

13. P. Joskow, "Competitive Electricity Markets and Investment in New Generating Capacity," AEI-Brookings Joint Center Working Paper No. 06-14, pp. 1-74, 2006.

Figure 6. Emission Unit Allowance (EUA) Prices in the European Market

Source: Bloomberg.

the second main goal (albeit implicit), for which this framework was defined.

Apart from industrial sectors, the difficulty in achieving reductions in emissions in the non-ETS sectors, particularly in transport and construction, is also remarkable. In these sectors, the lack of concrete commitments for stakeholders and the technological difficulties in introducing low-carbon technologies undermine progress towards the decarbonisation of the economy beyond the 2020 horizon. In this regard, taxation could play an important role, creating the signals through the appropriate internalization of environmental cost in prices.

At the European level, the role of environmental taxation is significant. During times of economic crisis, environmental taxes have gained relevance in EU taxation frameworks as evidenced by the fact that their revenues correspond to 2.4% of GDP and to 6.17% of all revenues from total taxation and social contribution.¹⁴ However, an

14. European Commission, 2013, *op. cit.*, Annex A, tables 66 and 67, pp. 237-238.

important weakness of the EU taxation framework is the lack of coordination between the energy and environmental taxation. The basic framework, Directive 2003/96/EC, is currently immersed in a profound debate, as the EC has noticed some malfunctions: there is no clear price signal on CO₂ emissions and energy content, nor strong incentives for the development and usage of alternative energy; industries within the European market for emission rights (ETS) are taxed twice, and there are differences in taxation schemes among EU member states.

In 2011, the Commission issued a proposal for a directive that is being considered. The impact assessment accompanying this proposal for a revised directive, drawn by the European Commission, acknowledges the need for tax harmonization at the European level in order to prevent distortion of the internal market due to the current situation of so many different taxes and concepts in each member state. At the national level, there is a similar problem, leading to a scenario that might be described as pseudo-environmental taxation.

In the Spanish context, there has also been an alarming lack of coordination between the central government and the autonomous regions, which has led to contradictory messages in the various legislations. On the one hand, the existence of different taxes in different regions has led to a disruption in the single market and in the revenue transfers between the autonomous regions. Rather than applying an environmental logic, revenue logic has been applied, which means that the regions have been setting up taxes and charges in facilities already installed in their territories, regardless of their environmental impact, instead of preventing the creation of others that might create more pollution.

Proposals for the Sustainability of the Electricity Sector

The significant challenges faced by the European electricity sector require, from a global point of view, an environmental tax reform, and from a sectoral perspective, a deep reform that will increase cost transparency and provide predictability. Some detailed propositions are described below:

- ***Develop an Environmental Tax Reform:*** A proposition could be to tax more polluting energy sources to finance the development of renewable energies, based on the outcome of environmental impact studies.¹⁵
 - Tax rates should be set according to the environmental damage generated by each energy source, thus allowing the internalization of the costs generated by the energy consumption in the price signal. This will contribute to improving the profitability of many energy efficiency measures.
 - The role played by each energy sector in funding energy and environmental policies should be taken into account. In this regard, the reform of environmental taxation should focus on the transport sector (which accounts for 40% of final energy consumption), so that its economic contribution towards funding policies in this field is increased (ex. renewable energy).
 - A Reform of the Environmental Harmful Subsidies (EHS) framework should be conducted (i.e. subsidies for those sectors that promote the use of polluting or energy-intensive products or processes) to allocate the use of this economic instrument to those sectors under carbon leakage risk.
- ***Structural measures to stimulate CO₂ price signal:*** These measures will allow for the consolidation of the improvements that have been introduced since the Emissions Allowance Trading Scheme began and for the establishment of the foundations for reducing emissions in the long term. Some of the main measures are summarized below:
 - Set post-2020-2030 targets at the earliest possible opportunity to provide certainty to investments. This intervention will unilaterally increase carbon and energy prices to 2020, but it is unlikely that there would be a significant impact on investment decisions without visibility of the longer term carbon price.
 - Bring forward the announcement of the widening of ETS sector coverage. It would make sense to extend the scope of the EU ETS to other sectors including economy-wide fuel consumption. To achieve reductions in emissions in the diffuse sectors, particularly in transport and construction, is crucial. In these sectors, the lack of concrete commitments for stakeholders and the technological difficulties in introducing low-carbon technologies damage progress towards the decarbonisation of the economy beyond the 2020 horizon. An EU ETS framework extension to these sectors will improve the efficiency of the scheme as an

15. Ex. Cost Assessment for Sustainability Energy System (CASES) or “External Costs of Energy” (ExternE).

efficient market mechanism. If the EU ETS is to be extended to all final fuel consumers, it would be important to coordinate these measures with fuel tax measures in order for the combination and interaction of each measure to reflect the external cost.

- Avoid intervention in CO₂ markets to manipulate price when governments perceive that such an intervention exceeds what they consider acceptable under political considerations.
- ***Removal from electricity tariff of all cost items not related to supply:*** In this regard, the energy consumer bill must reflect the market-based cost of energy and cannot be a vehicle for financing other policies. In addition, the postponement of the return of costs, leading to tariff deficit, should not be allowed. The large share of non-energy related price components arising from other policies, such as RES support schemes or other taxes and levies, conceal the competitive element of the energy price. The current high level of taxes and charges, which in some cases represent more than 50% of customer end-prices, are nullifying the achievements of market integration and of price convergence between member states.
- Access tariffs should only reflect costs directly related to the transport of energy (transmission, distribution) in order to eliminate distortions in the competitiveness of industrial and domestic electricity consumers. Currently, a large volume of charges to finance environmental, energy and social policies increase final electricity prices, undermining their competitiveness compared to hydrocarbon prices. Ultimately, it has a negative impact on the electrification of the economy, which is recognized as an important trend to advance the sustainability of the energy model, especially for the transport sector (ex. electrification of freight transport by promoting rail, electric vehicle, etc.).
- Beyond these problems in the field of competitiveness between energy sources, the efficient deployment of net metering and self-consumption will require as a prior requirement a thorough assessment from policy-makers on tariffs structure and charges included in final electricity cost to ensure an efficient full recovery and fair allocation of system costs (avoiding free riding by bypassing the payment of all the costs) and, at the same time, allowing the deployment of distributed energy if this is efficient by itself and not based in the abovementioned by-passing of costs.
- ***Support sectors at risk of carbon leakage:*** Since it is important to avoid *ex-post* government intervention when energy prices increase due to the internalization of CO₂, should an international agreement not be reached in climate change issues, addi-

tional measures must be introduced to secure the competitiveness of EU industries with a risk of carbon leakage, due to the unfair competition of those products which are intensive in the use of energy produced by competitors in countries without compromises in reduction of CO₂. This support should use revenues from CO₂ auctions and provide free emission rights to compensate, in conformity with the state aid guidelines, industries at risk of carbon leakage.

- ***Keep going forward with the integration of energy markets at the EU level:*** It is a fundamental tool for a competitive, secure and sustainable energy supply. The current level of interconnection infrastructure is not sufficient to achieve this goal (ex. difficulties in developing infrastructure electricity interconnection between France and Spain). An increase in interconnection capacity would also help to meet efficiently RES goals since it would reduce the episodes, in which electricity produced by RES plants is wasted.
- ***Develop a set of measures to tackle the missing money problem:*** Remarkably, current outdated and ineffective climate policy in Europe has endangered the credibility and leadership built up in the EU over the years in international climate negotiations.

Conclusion

Taking into account the analysis developed in this document, some general reflexions on EU policy and regulatory principles are a good way to conclude. They are structured below around three general guidelines:

- ***Harmonize EU taxation and efficiency in energy policy instruments and goals:***
 - Europe must harmonize its energy policies and taxation to adapt them to the new situation.
 - In the field of environmental tax reform, charges and rates on energy sources (not just electricity) should be based on their environmental impact.
 - On the other hand, energy policy design should set as one of its priorities the achievement of goals in an efficient way.

- **Base regulation on principles of good regulation:** Regulatory uncertainty should be reduced (long term goals, less intervention, etc.) to allow for investments.¹⁶
- Regulation must provide reasonable prospect for companies, allowing them to recover the costs incurred to provide the service. Besides, regulations must be conducive to an environment, in which firms have incentives to develop their business efficiently. To meet these requirements, regulations must be predictable and transparent.
- Independence and good practices in the regulator activity are key. Some of the elements to meet this goal are the following:
 - Independence of the regulator from the regulated companies and the government (administrative, financial and skills resources);
 - Effectiveness in meeting its objectives;
 - Efficiency (mechanisms of cost-benefit analysis);
 - Transparency (previous public consultations with agents, access to the disclosure and communication procedures);
 - Predictability of the sector regulator (participation of different stakeholders and a regulatory compliance calendar).
- Some of the most important “principles of good regulation” could be introduced as amendments in the constitutions of EU member states.

Importantly, the regulatory risk has relevant consequences for the whole economy. Following Serrano Calle,¹⁷ it should be highlighted some of the main negative impacts derived from a regulation framework not based on principles of good regulation:

- Worse credit ratings and higher financial cost;
 - Programmed disinvestments;
 - Loss of build infrastructure quality (incentives to invest in operating infrastructures could be weakened if there are not enough regulatory signals);
 - Reduction of future investment levels;
 - Relocating a part of the economic activity.
- **Use liberalization as a main principle in sector organization:** Intermediate models between the regulated and liberalized ones

16. S. Serrano Calle, “El riesgo regulatorio en el sector energético, índice de evaluación de la calidad regulatoria energética (ICRE),” Madrid: Escuela de Organización Industrial (EOI), 2013; C. Sallé Alonso, “Los principios de buena regulación en el sector eléctrico,” In L. M.-S. Fernando Becker Zuazua (coord.), *Tratado de Regulación*. Madrid: Editorial Aranzadi, 2009, pp. 211-256.

17. Serrano Calle, 2013, *op. cit.*

do not usually lead to efficient results mainly motivated by the effects on markets and agents that have the intervention of the administration. That is why it is important to avoid the use of regulated tariffs, supporting liberalization both in wholesale and retail markets. This system must be complemented with a relevant supervision by the competition authorities and should take into account support (from public budgets) to vulnerable consumers due to fuel poverty.

Chapter Eleven

The Emerging Atlantic Basin Energy Landscape and the Basque Perspective

Macarena Larrea Basterra and Eloy Álvarez Pelegrý

Long before the tiny Iberian fleet had arrived in the Americas in late 1492, the Atlantic Basin played an important role in the global economy. But once Columbus landed in La Española, this ocean basin began to bear an increasing amount of economic transactions with these New World lands.

Some 500 years later, the Atlantic Basin is more interconnected than ever. Transatlantic linkages and alliances—north-south (Europe-Africa), east-west (Europe-North America, and Latin America-Africa), and diagonal linkages (North America-Africa and Europe-Latin America) have been forged and progressively deepened among the Atlantic world's sub-regions. Taking into account both weaknesses and strengths—in a context in which China plays not only an increasingly important role in the Pacific, but also a growing one as well in the Southern Atlantic—these interrelations generate opportunities and threats in several domains, including the economy, energy, geopolitics and society.

Nevertheless, no Atlantic Basin (meaning pan-Atlantic) collaborative mechanisms or cooperation frameworks yet exist. There is not yet anything like the Asia-Pacific Economic Cooperation (APEC) in the Pacific or the Arctic Council in the Arctic Basin. One of the only exceptions, at least so far, is the Atlantic Basin Initiative (a public-private network dedicated to producing tangible benefits for the Atlantic people through the deepening of pan-Atlantic collaboration, cooperation and transnational governance, and the striving toward the construction of a New Atlantic Community),¹ along with the Atlantic Energy Forum (AEF), a recently established offshoot of the ABI.

1. Eminent Persons Group of the Atlantic Basin Initiative, *A New Atlantic Community: Generating Growth, Human Development and Security in the Atlantic Hemisphere: A Call to Action*, 2014, Center for Transatlantic Relations, School of Advanced International Studies (eds), Johns Hopkins University, Washington, DC.

The Basque Country, a historical and autonomous region of Spain, has long been a regional political economy oriented predominantly toward, and integrated with, the broader Atlantic Basin. As such this part of Europe may have much to gain from an international strategy that is informed by the ongoing emergence of an Atlantic Basin world and community. The Basque Country might also benefit from the further development of these nascent pan-Atlantic structures mentioned above, particularly the Atlantic Energy Forum.

The rest of this chapter provides an overview of the Basque Country, its regional and international economic context, and its positioning within an Atlantic Basin framework. The first part of the chapter includes a summary of the main contours of the Atlantic Basin concept, particularly with respect to energy and trade, with certain reference to terms and concepts that analysts and experts are now developing within a nascent pan-Atlantic studies community.²

The second part focuses primarily on the Basque Country as an open territory, concentrating on issues such as international trade, the evolution of the establishment of Basque companies in foreign countries, and other aspects related to migratory movements. It also analyzes the institutional development of the territory in terms of its internationalization strategy, including its participation in different forums and initiatives.

Given that energy is a key factor in economic competitiveness—as an input, as a technology, and as a business activity that plays a key driving role in the Basque economy—the second part focuses primarily on the energy activity and its related industries, such as the electrical equipment business. Finally, the chapter offers some conclusions and reflections on the potential development of the Basque Country within the framework of the Atlantic Basin concept and the Atlantic Basin Initiative.

An Overview of the Atlantic Basin

The Atlantic Basin can be considered from the point of view of two main perspectives.³ The first could be called the broad Atlantic Basin.

2. For example, the Atlantic Future Research Project of the European Commission.

3. Paul Isbell, “La energía en el Atlántico y el horizonte estratégico,” *Revista CIDOB d’Afers Internacionals*, Septiembre de 2013, no. 102-103, 73.

This more political conception of the Atlantic Basin incorporates all four coastal continents of the Atlantic Ocean in their entirety, including those countries with no Atlantic coastline (i.e., Peru and Chile, Tanzania and Kenya, etc) along with those countries of the Mediterranean Basin which, for the purposes of this analysis, is considered to be a sub-region of the broader Atlantic (or Western) world.⁴

The second, more geographically narrow conception could be called the geo-economic Atlantic Basin. This more specific regional scaling would embrace only those countries with an Atlantic coastline and those landlocked countries directly linked to (or integrated with) the Atlantic Basin, such as Paraguay. In order to develop this concept, some have considered introducing the concept of the dual basin country to describe countries like Canada, the United States, Mexico, Colombia, and South Africa (among others), which have coastlines in at least two different oceans basins.⁵

One of the main challenges that the Atlantic Basin must face is the fact that relations are still established principally within each of its constituent continental regions instead of between them, and across the Atlantic seascape.⁶ In this regard, Africa is the place where intra-regional (meaning intra-African) exports and cooperation are less developed. In contrast, in Europe, most exports are sent inside the European continental territory. However, central and south America are more dependent on Atlantic exports than any other Atlantic continental territory.

Developed nations usually import natural resources, food and vehicles (cars and other components for car construction) and export refined crude oil, vehicles, and other manufactured goods. Developing countries usually export natural resources and import refined crude oil, cars and other manufactured goods.⁷

According to Ruano (2013), in the period between 2000 and 2011, total trade between Atlantic Basin continental regions increased by about 126%. However, the distribution is not homogeneous among

4. Indeed, the Mediterranean is incorporated into both of these Atlantic Basin conceptualizations.

5. Isbell, 2013, *op. cit.*

6. Ayuso, A., & Viilup, E. (2013, Septiembre de 2013). Introducción: una nueva mirada al Atlántico. *Revista CIDOB d'Afers Internacionals*, n 102-103, 7.

7. Ruano, L. (2013, Septiembre de 2013). El comercio en la cuenca del Atlántico, 2000-2012: una visión panorámica. *Revista CIDOB d'Afers Internacionals*, n 102-103, 101.

these regions. For instance, North America-Europe trade accounts for about 32% of total intra-Atlantic Basin trade,⁸ and North America-Latin America another 32%. Business transactions between Europe and Africa, and Europe and Latin America represent 17% and 12%, respectively, of total intra-Atlantic trade. Lastly trade between North America and Africa (6%) and between Latin America and Africa (only 1.8% of total Atlantic commercial transactions) can be considered negligible.

In addition to commercial relations, energy is an increasingly important topic in the region, particularly given the ongoing Atlantic energy renaissance.⁹ This renaissance has been the result of several recent energy developments including, (1) shale gas revolution in the United States (which has the potential to turn the country into a future gas exporter);¹⁰ (2) the recent boom in the Atlantic Basin offshore; (3) the evolution of developing countries such as Brazil, where new consumers have entered the market with new energy needs; (4) the reform of the oil and gas sector in Mexico;¹¹ and (5) the development of renewable technologies in the EU, North America, and, increasingly, others in the Southern Atlantic. China is also becoming an important energy buyer from the Atlantic Basin. As a result, Asia, Russia, and the Middle East will have to improve productivity and competitiveness to face the new challenges posed by the Atlantic Basin's development as an international energy producer.

Proven oil reserves and production in the political Atlantic Basin now represent well over 40% of world's reserves. The volume of proven oil reserves has increased both in absolute and relative terms during recent years. The proven oil reserves of the narrow geo-economic Atlantic represent today more than one third of global reserves and total oil production.¹²

8. The concept Intra-Atlantic trade considers the total volume of commerce among the Atlantic regions that is North, Central and South America, Europe and Africa. These figures should be taken into account with prudence.

9. Eminent Persons Group of the Atlantic Basin Initiative, 2014, *op. cit.*

10. The U.S. shale gas revolution implies considerable geopolitical consequences: it has already, as it displaces decision making forums from the Middle East to the Atlantic Basin.

11. The energy reform in Mexico develops incentives for foreign investment in the sector that among others will develop technology improving efficiency.

12. Paul Isbell, *Energy and the Atlantic: The Shifting Energy Landscapes of the Atlantic Basin*, German Marshall Fund of the US, Washington, DC and Brussels, 2012, and Isbell, 2013, *op. cit.*

The Atlantic Basin hosts only 11% of worldwide conventional gas reserves and produces around 27% of total conventional gas. In contrast, 67% of technically recoverable shale gas reserves are in the political Atlantic Basin and 59% in the geo-economic Atlantic. Practically all unconventional gas production is located in North America. It is expected that Argentina and Mexico will begin their production in the medium-term, even before other countries such as China.¹³

The relative predominance of the Atlantic Basin in the world energy context can also be observed in biofuels production: more than 90% of total biofuels production comes from the broad Atlantic Basin (and 67% from the geo-economic Atlantic).

The political Atlantic generates 48% of total global electricity (34% in the geo-economic Atlantic). The Atlantic Basin not only represents the largest hydroelectric region; it is also where most nuclear electricity is produced. Renewable technologies are also concentrated in the Atlantic Basin with around two thirds of global renewable installed capacity. Solar and wind play an important role.¹⁴

Together, biofuels production and renewable electricity make an important contribution towards a low carbon economy in the Atlantic. This trend is accompanied by the development of greenhouse gas markets on both sides of the Atlantic (i.e., the European Union Emissions Trading Scheme: EU-ETS; the Regional Greenhouse Gas Initiative: RGGI; MEXICO₂, etc.).

Within this framework, the Atlantic Basin is in the process of reducing its external dependence. Furthermore, the Atlantic Basin will likely become the world's energy reservoir in the future and export to the Indian and Pacific Basins.¹⁵

The Basque Country

The Basque Country is a regional autonomous community located on Spain's north coast and bordering France. With a population of

13. Isbell, 2013, *op. cit.*

14. Isbell, 2013, *op. cit.*

15. Eminent Persons Group of the Atlantic Basin Initiative, 2014, *op. cit.*

about 2.2 million people according to 2012 statistics,¹⁶ the Basque Country's economy has developed an international approach over time, due in part to its geographical location bordering the sea.

This 7,234 km² territory has historically been open not only to foreign trade, but also to foreign cultures. For example, during the Middle Ages, the Port of Bilbao served as the outlet to Europe for goods from the Castilian plateau, as well as the entry point into Europe for many Atlantic Basin and South American colonial goods.¹⁷ Later, in the 19th century, the modernization of the steel industry opened new markets in France and the United Kingdom, which in turn had an impact on architecture and many other aspects of lifestyle.

Today, the territory's international approach focuses on how to solve the main economic problems, consequences of the long global economic crisis. Competitiveness of industrial processes that promotes exports and emigration are some of the instruments that the Basque government is promoting despite the fact that overdependence on exports brings with it the risk of vulnerability from the volatility of international markets.

A Rather Open Economy

The structure of the Basque economy has evolved over time. In this regard, industry¹⁸ and energy activities that were of great importance in the development of the territory during the 19th and 20th century have seen their weight and role in the 21st century decline from 25.8% in 2005 to 21.3% in 2012, much in line with the general trend of developed countries.

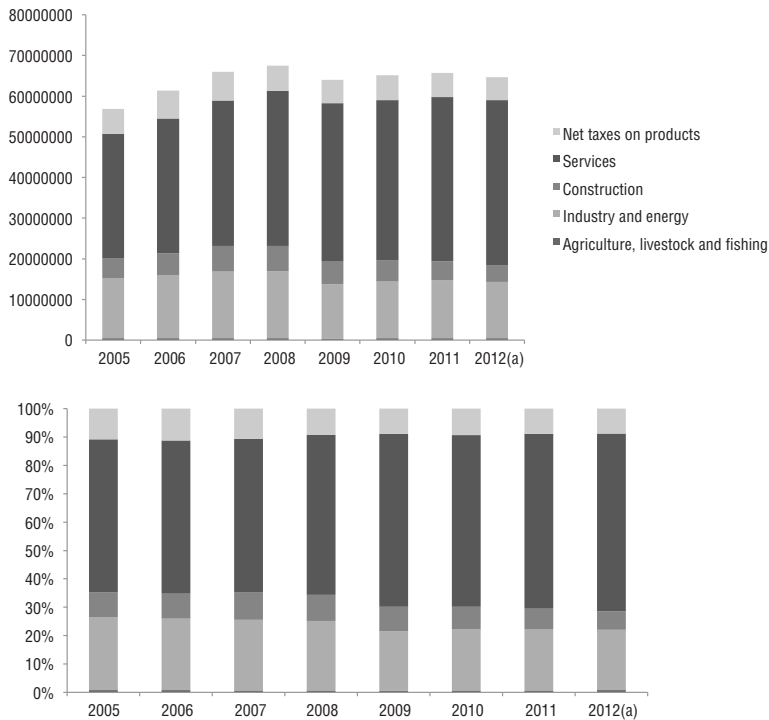
Noticeably, international trade plays an important role in the Basque economy: exports and imports came to 36 billion euro in 2012, which represents 55.7% of the GDP (with an average level of 54% in the period from 2005 to 2012).

16. Eustat (2014a), *Población de la C.A. de Euskadi por grandes grupos de edad cumplida, sexo, ámbitos territoriales y período*.

17. Autoridad Portuaria de Bilbao. *La historia*, 2011.

18. The Basque Country industry has a cluster model, mainly based on business, knowledge and government.

Figure 1. Gross Domestic Product of the Basque Country by Components (thousand €) 2005–2012.^a



Note: a = summary; Supply and demand in current prices (in thousands of Euro)

Source: own analysis from Eustat, 2014e, *Producto interior bruto de la C.A de Euskadi por componentes. Oferta y demanda. Precios corrientes (miles de euros). 2005-2012(a)*.

Exports and imports exhibit an increasing trend since 2001 (excluding 2009 and 2013, years which formed exceptions to this general trend). It is important to take into account that in 2010 and 2011, companies adopted international trade as a tool against the relative stagnation of internal demand (which grew in those years by only 0.5% and 0.2%, respectively). During those years, exports grew at an average annual rate of 16.5%.

As can be observed in Figure 2, in 2013, 93% of the Basque Country's exports to the 12 main destinations were sent to Atlantic Basin countries, especially to European nations (52%). Brazil, Mexico and the United States represented around 11.5% of total Basque exports.

Figure 2. Main Exporters and Importers to and from the Basque Country in 2013 (in Thousands of Euro).

Exports by country of destination			Imports by country of origin	
1	France	3,416,371	Russia	2,503,051
2	Germany	2,936,574	Germany	1,863,554
3	USA	1,434,869	France	1,600,086
4	United Kingdom	1,204,430	Mexico	999,366
5	Italy	921,209	China	809,677
6	Portugal	810,140	USA	794,340
7	Belgium	664,935	Italy	782,791
8	Netherlands	583,311	United Kingdom	522,793
9	China	493,574	Netherlands	454,779
10	Brazil	455,181	Ireland	445,081
11	Mexico	424,994	Colombia	379,612
12	Australia	405,092	Belgium	363,626
12 main destinations		13,750,682 67.9%	12 main origins	11,518,758 73%
Main exports to the Atlantic Basin countries		12,852,016 63.5%	Main imports from the Atlantic Basin countries	7,826,417 49.6%
Total exports		20,242,038	Total imports	15,792,061

Source: Own analysis from Eustat, 2014f, *Ranking de las exportaciones de la C.A. de Euskadi por países (miles de euros) 2013 (p)*

In 2012, exports from the Basque Country were mostly sent to European countries (61.2%); however, 22.6% of total Basque exports were sent to other Atlantic regions. Latin America received 10.4%¹⁹ of Basque exports and North America received 7%, with the United States as the major destination. Africa's purchases were only 5.3% of exports.²⁰

It should be noted that Basque exports have at present a more balanced mix of clients than a decade ago when European purchases amounted to 70.6%. Exports to Asia and Latin America have increased

19. Brazil (2.2%) and Mexico (2%).

20. Cámara de Álava, 2014. *Resultados del Comercio Exterior del País Vasco en 2012 y perspectivas para 2013*.

by around 3.5 points in both cases. Africa's purchases have also increased considerably by 2 points.

The main goods exported by the Basque economy in 2013²¹ include: (1) those related to base metals and articles of base metal manufacturing (especially iron and steel products); (2) the automotive industry (including vehicles, car accessories, tires, etc.); and (3) oil products (such as petroleum oils or oils obtained from bituminous minerals and petroleum coke). This export structure has not changed significantly during the last decade, but has exhibited an increasing trend in most of the tariff classifications (except in 2009, an outlier year).

As far as imports are concerned, they come from a somewhat more diversified mix. Furthermore, Russia is the origin of 15.85% of total Basque imports as the result of Basque purchases of Russian oil. In 2008, Basque imports reached a peak of 20.1 billion euros. Although imports then declined by 21%, since 2013 they have remained quite stable. In any case, it is significant that during the 1990's, total imports fluctuated between 4 and 7 billion euros annually, and most came from European countries (France, United Kingdom, Germany and Italy).²² Mexico was an important origin of Basque imports and continues to be relevant today (occupying the fourth position in the 2013 ranking). Russia's key role became noticeable around 2004, when its Basque imports of Russian goods reached more than 1.25 billion euros.

Moreover, energy products (mainly oil and gas) represented around 35% of total imports in 2013, followed by iron and steel products (including scrap for electric iron making furnaces) and automotive goods.²³

The degree of openness of the economy should not only be analyzed by taking into account foreign trade figures but investments as well. Basque companies have also made an effort to establish themselves in other countries, developing facilities that employ local staff. Basque investments in other countries represent around 7.5% of total Spanish outward investment. It is mainly located in Europe and Amer-

21. Eustat (2014b), *Comercio exterior*.

22. These four European countries provided 48.5% of total Basque imports.

23. Eustat (2014b), *Comercio exterior*.

ica (90%). Asia and Africa play a marginal but slowly increasing role. However, investment figures in economic value do not follow a standardized pattern over time. In the energy field, most of the investment is done by the gas and electricity sectors (7.5% of total investments).²⁴

These establishments can be either commercial or productive. According to the figures, it has been more common for Basque entities to establish themselves commercially.²⁵ Nonetheless, productive establishment has a greater impact, as it may contribute to technology transfer and social development.

More than 250 Basque companies have relocated production of goods and services to other countries. Some of them have employed joint ventures (around 33%) and others have no partners in the country of destination. 36% are located in America, 43% in Europe and 20.5% in Asia. Other Basque companies have chosen commercial deployment as an instrument for internationalization, which means that they do not produce within the country in question, but rather establish offices to foster the importation of their goods and services produced in Spain. Some 400 companies have developed themselves commercially outside of Spain.²⁶

Mexico hosts approximately 130 of these Basque companies (69 with production facilities, 33 with commercial offices and 24 offering services). Such Basque economic interests will benefit from the free trade accords of the Pacific Alliance (Chile, Colombia, Mexico and Peru, with Panama present as an observer) and from the Trans Pacific Partnership (a strategic pan-Pacific grouping including North America and Asian countries in addition to Pacific Latin America). This latter agreement will allow Basque companies located in Mexico to gain access to low cost production locations in Asia, such as Vietnam.²⁷

For example, major electrical goods producers have exclusively located their facilities in Europe and America, as Figure 3 reveals.

24. S.G de Inversiones Exteriores. (2015). *Inversión extranjera en España e Inversión Española en el Exterior*.

25. Departamento de Desarrollo Económico y de Competitividad. (2014). *Catálogo industrial y de exportadores del País Vasco*.

26. This figure does not include Basque companies in France and Portugal.

27. Lozano, A. "Norteamérica ofrece grandes oportunidades de negocio incluso más allá de sus fronteras," *Empresa XXI*, April 1, 2014, pp. 39.

Figure 3. Worldwide Distribution of the Main Basque Electrical Capital Goods Producers.



Source: Larrea Basterra & Marcoartu Basterra, 2013.

Over the last decade, Asia and the Pacific have become important markets. In order to become—or remain—competitive on a global scale, companies have, as a result, established themselves in those regions. On the contrary, because of the size of most Basque companies—small in comparison to some of their main competitors—they have restricted their expansion to countries like India, China and Australia. Russia and Central Asia are still mainly unknown territories with respect to Basque economic activity.

Last but not least, the Basque Country also attires foreign investment in the territory, whose main origins are Europe and America (90%). Nonetheless, American investment comes principally from the north. Africa also plays a marginal role that together with the data from South America can be considered coherent with their developing situation and need for investments in their own territories. European investment in the Basque Country has grown during the last five years. Once again, in the energy field, gas and electricity have received more investments than oil.²⁸

Although internationalization may be a positive strategy, it is not enough. Companies should develop concrete strategies to position

28. S.G. de Inversiones Exteriores, 2015, *op. cit.*

themselves properly in the global market. In this regard, it would be optimal for Basque companies to develop products with high technology content in order to differentiate themselves from competitors and to attract new business, and with fresh technology and research investment.²⁹ However, it should be underlined that research and development (R&D) creates neither products, nor markets, *per se*; this also requires design and development, as well as additional measures.

The Basque internationalization strategy. One of the central objectives of the Basque government is to support and foster Basque economic and business networks. In this view, the Basque business network serves as a tool for improving Basque industrial competitiveness, along the stages of an advanced manufacturing strategy. Such a strategy is conceived and designed to stimulate Basque companies to produce more value-added, to design and produce more innovative products and processes by incorporating technologies convergent with the traditional activities, and to promote new innovative models of human resources management. This strategy is expected provide a boost to Basque economic internationalization.

According to the Statute of Guernica,³⁰ the Basque government has only limited competence or role in foreign affairs. However, the Basque government has an internationalization strategy that builds on four main lines of action. In principle, the Basque Country aims to develop the external network of SPRI (the Regional Development Agency of the Basque Country, see below); to coordinate the Basque government, the SPRI, the Chambers of Commerce³¹ (one for each province), and the Provincial Councils (one for each province) to develop specific policies for internationalization and to promote human capital development.³²

29. Orkestra-Basque Institute of Competitiveness, *Resumen ejecutivo en inglés del informe de competitividad del País Vasco 2013*, Orkestra-Basque Institute of Competitiveness (Ed.), San Sebastián, 2013.

30. Known as the Estatuto de Guernica in Spanish.

31. The Chambers of Commerce organize periodically what could be called trade missions.

32. The Basque Government has developed working grants for young people such as the Global Training Program or the Internationalization grants (BEINT) program developed by the SPRI. The objective of such programs is to offer an opportunity to work outside Spain, usually in Basque companies, as well as to acquire knowledge that could be useful in the future in the Basque Country. North America, Europe, and Asia are among the main destinations.

The Regional Development Agency of the Basque Country (SPRI) is a public company that was originally created to facilitate the industrial reorganization which the Basque Country faced during the 1980s. However, SPRI now works as an agency for entrepreneurial development. It depends on the government and aims to promote the economic development of Basque companies in order to create wealth and welfare for its citizens. During recent years, it has established commercial offices around the world.

SPRI has organised its network into five operative areas: (1) Africa and Middle East; (2) Latin America; (3) Asia and Oceania; (4) Europe; and (5) North America. SPRI's global presence is actually even wider than the figure map above suggests, given that the company has a local consulting network which extends its presence to more than 70 countries. However, only half of these countries are located in the geo-economic Atlantic Basin. Nevertheless, it should be noted that SPRI is now developing an Asian network that could include Indonesia, Malaysia, Thailand, and Vietnam.³³

The Basque government's executive branch has a General Secretariat for Foreign Action. Among other mandates, the General Secretariat represents the territory in forums and institutions where regional participation is accepted, including: the Atlantic Arc Commission,³⁴ the European Committee of the Regions,³⁵ the Aquitaine-Basque Country Euro region, the Atlantic Transnational Network,³⁶ the Atlantic Arc Cities, and the Pyrenees Working Community

33. Asociación Española de Agencias de Desarrollo Regional. *Aumenta el apoyo de SPRI a las empresas vascas en Asia*, 2014.

34. The Atlantic Arc Commission is one of the six Geographical Commissions within the Conference of Peripheral Maritime Regions of Europe, and its action is part of a more general framework. Fisheries, transport and renewable marine energies are among the Atlantic Arc Commission's areas of interest.

35. The Committee of the Regions is an advisory body representing local and regional authorities in the European Union.

36. The Atlantic Transnational Network (ATN) is a platform for cooperation of civil society in the Atlantic Area. Officially formed on September 19, 2003, this transnational network is composed of Economic and Social Councils of the Atlantic Area regions and in the case where such institutions don't exist, by analogous regional organizations. It has established a permanent cooperation with the Atlantic Arc Commission (AAC) of the Conference of Peripheral Maritime Regions. The network's main objective is the development of cooperation between the civil society in order to influence European policies towards the Atlantic coast.

(Comunidad de Trabajo de los Pirineos).³⁷ In spite of their names, most of these forums are Europe-oriented. The Basque executive also organizes trips for other heads of the government to visit places of interest in the territory.

Additionally, the Basque government has delegations to promote Basque interests in Madrid; in Brussels (where the Basque Country can participate in the Committee of the Regions); in Mexico, Argentina, Colombia, Chile, and in the United States. The delegations to the United States are uniquely tasked with economic activities and migratory flows.

Migratory flows. During the last decade, migratory movements have increased. In 2012, the number of Basque residents who emigrated was 20,848,³⁸ a number that increased to 23,328 in 2013,³⁹ mainly due to the economic situation. According to Eustat statistics, around 6,000 of these emigrants leaving the Basque Country in 2012 were foreigners. The main destinations of such migration were the Americas (41.3%, but particularly South America) followed by Europe (33.6%) and Africa (20%).

From 1997 to 2007, the number of immigrants increased from 1,666 to 28,648. However, by 2014 this figure had fallen by 47% to 14,883. In the 1990s, around 30% of immigrants came from Europe (especially the Portuguese and French), followed by Central and South America (Cubans and Brazilians), and Africa (with a 20% share and mainly from Morocco).

Years later, by 2012, Central and South America had become the main geographical origin for foreign migration and represented 34% of total immigrants (from Colombia, Nicaragua, Bolivia, and Venezuela), followed by Africa (29%). European immigrants reached 21% of total immigrants (mostly from Romania).⁴⁰

37. The Pyrenees Working Community (born in 1983 and supported by the European Council) aims to provide the Pyrenees area with a cross-border cooperation framework similar to other existing structures along other international national European borders.

38. INE (Spanish National Institute of Statistics), *Migraciones exteriores. Serie 2008-2012. Resultados definitivos. Flujo de emigración con destino al extranjero por comunidad autónoma, año, sexo, grupo de edad y país de destino (agrupación de países)*, 2014.

39. Ibid. In 2008 there were 9,249 emigrants. This implies increase of 60% in past five years.

40. Eustat, 2014c, *Migraciones externas de extranjeros en la C:A de Euskadi por territorio histórico, clase, sexo, nacionalidad y período*, 2014.

As a consequence, around 8%-9%⁴¹ of Basque citizens are foreigners, mainly coming from Colombia, Ecuador and Peru (18%), the Maghreb (15%), Western Europe (12%), Romania and Eastern Europe (10%), and Brazil, Venezuela, and other Latin American countries (16%).⁴²

In 1994, the Basque government passed the Law on the Relation with Basque Groups and Centers outside the Basque Country. These groups and centers are instruments for cohesion, conservation of Basque culture and promotion of Basque groups abroad.

Basque emigrants are located primarily in the Americas and in Europe. These territories, concentrated in the broader political Atlantic Basin, form the natural expansion zone of Basque agents. This geographical distribution of Basque emigration, however, does not include the African continent.

Energy in the Basque Country

The Basque government's strategy considers energy as a competitiveness driver.⁴³ Even though the territory depends almost entirely on external sources of energy, the Basque government has been responsible for the energy domain since it became an autonomous region in Spain in the early 1980s.⁴⁴ In 2012, it published the third Basque Energy Strategy 3E-2020, within the context of the Business Competitiveness Plan (2010-2013) and the Science, Technology and Innovation Plan (PCTI 2015). The Basque government considers the Atlantic Basin to be a new potential energy framework offering opportunities in the emergent scenario.⁴⁵

This energy strategy has established an inventory of goals, as well as a list of guidelines that have been designed in order to achieve these goals. The strategy's core is to foster energy efficiency and saving poli-

41. More than 175,000 residents come from abroad.

42. Eustat, 2014d, *Población de origen extranjero en la CAPV*; Eustat, 2014a, op. cit.

43. Tápia, A. *Arantzazu Tápia Forum Europa Discurso* (Gobierno Vasco ed.), 2013.

44. As a consequence of the Statute of Autonomy, the Basque Government faces certain constraints in the energy field and therefore focuses on the promotion of energy R&D, via the Basque Energy Agency (EVE), and the development of energy policy and planning. It is also able to support the infrastructures developments, facilitate authorization procedures, and offer opinion and expertise to the Ministry when it develops new laws and rules.

45. Tápia, op. cit.

cies, to develop new technologies to reduce dependence on oil, and to facilitate the evolution toward low carbon energy. In order to accomplish these objectives, the transport sector should make an effort to advance electricity and gas, as a replacement for oil and oil products—today the principal energy inputs used in transport.

Since the 1990s, total energy consumption in the Basque Country has grown by more than 25%. Electricity and gas, in particular, have notably transformed the structure of both primary and final energy consumption. Despite these changes, however, oil consumption still remains important because of its direct relationship to the transport sector.

The structure of energy consumption (or the energy mix) in the Basque Country is similar to that in Germany. Electricity, renewable energies and gas have increased their weight. However, even coal consumption has recently fallen; fossil fuels in general have gained prominence. These developments could strengthen the Basque interest in exploring the unconventional gas resources of the territory. All these changes have been accompanied by the development of new infrastructure in oil, gas, electricity and other forms of low carbon energy—as has been occurring in the Atlantic Basin. These shifts bring benefits to companies in the form of job creation, investment and, perhaps, even a more competitive energy sector overall.

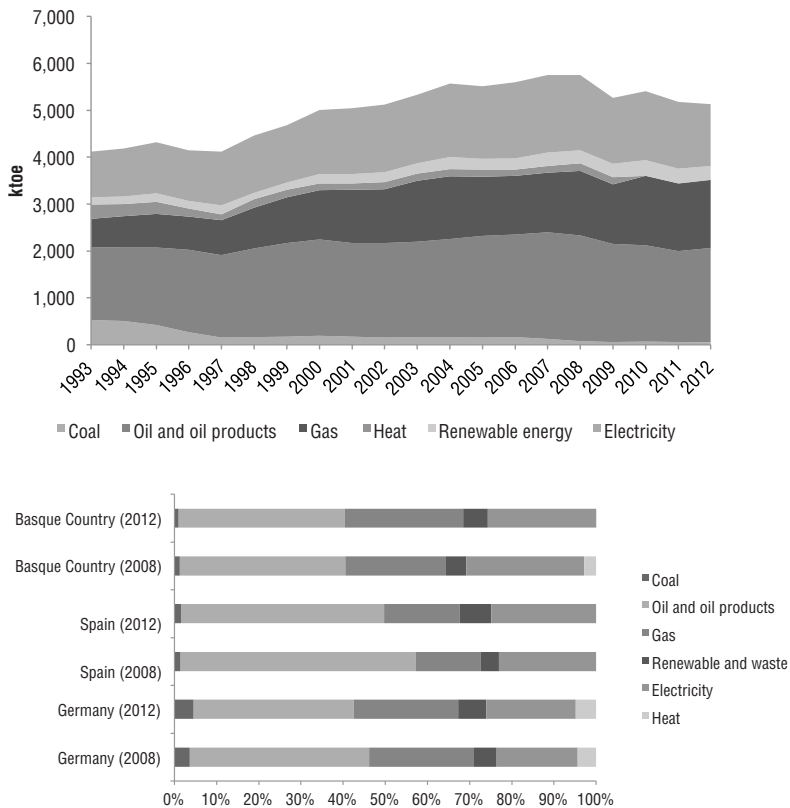
In the Basque economy, industry consumes more energy than any other sector, but pays less for each ton of oil equivalent (toe). Nonetheless, at the Spanish national level (and both in Germany and at the level of the EU), transport is the largest energy consuming sector.

Industry consumes more than 40% of total energy in the Basque Country, followed by the transport sector. This could imply that the Basque economy specializes in energy intensive sectors. As a consequence, energy prices are a key issue with respect to the formulation of industrial and energy policies.

Oil, gas, and electricity. At Muskiz the Basque Country has a refinery that contributes around 10% of the Spanish national storage capacity for oil and oil products, along with 15% of distillation and refining capacity.⁴⁶

46. (Foro de la Industria Nuclear Española, 2013).

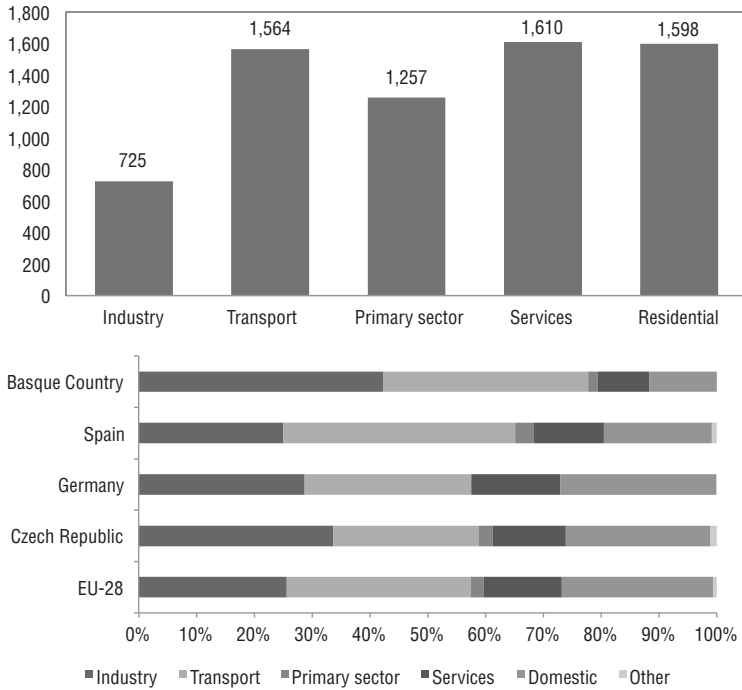
Figure 4. Evolution of Final Energy Consumption in the Basque Country and a Comparison with Spain and Germany.



Source: Ente Vasco de la Energía (EVE) *Energía 2009. País Vasco, datos energéticos*, 2010; Eurostat, 2014b, op. cit.; EVE, 2013b, *Datos energéticos 2012*.

The Basque Country imported half of its total oil imports in 2010 and 2011 from Russia (followed by the Middle East). In 2012, however, imports from these areas—Russia and the Middle East which, together with Central Asia constitute what has been called the Great Crescent—fell significantly as they were progressively displaced by oil imports from sources in the Atlantic Basin, including Mexico, Colombia, and Brazil. At the Spanish national level, however, the figures are quite different: Russia represents only around 15% of Spanish oil imports; together with the Middle East, these Great Crescent sources barely reach 50% of total Spanish oil imports. In any event, Middle

Figure 5. Energy Consumption and Energy Cost by Sector, 2012 (€/MWh).



Source: Own analysis from EVE, 2013b, *op. cit.*

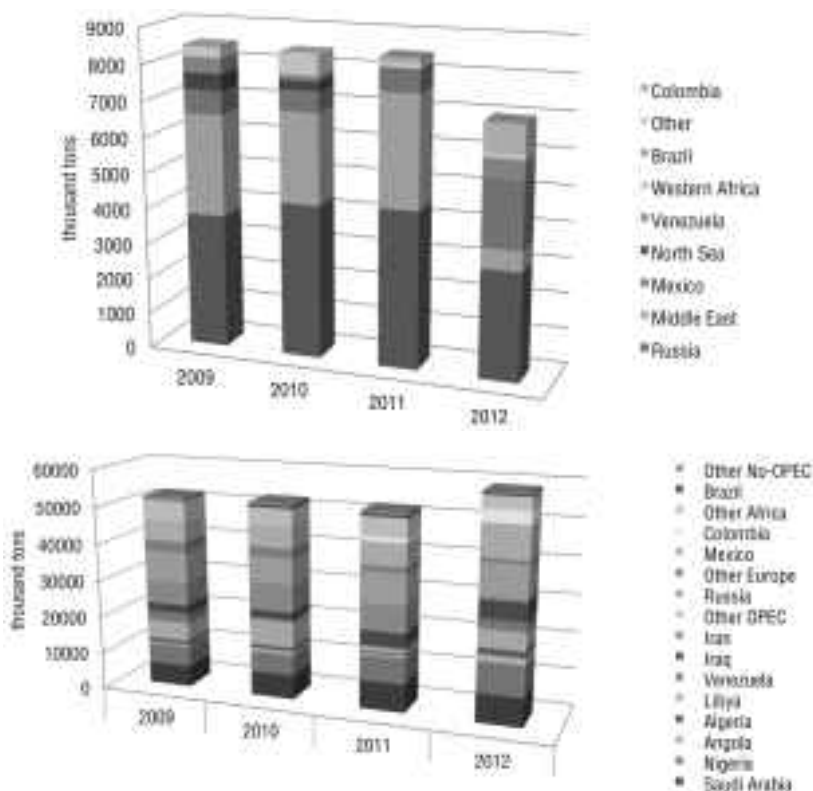
Eastern imports are larger than those from Russia. However, in both the Basque and Spanish cases, oil imports from Atlantic American countries are on the rise.

In the 1990s, the Basque government developed new infrastructure for gas. Therefore, the infrastructure to meet gas requirements is already present: from storage facilities to a regasification plant; from transport and distribution grids to international interconnections with France.⁴⁷

Natural gas resources from Gaviota—the only conventional natural gas reservoir in the Basque territory—have already been exploited.

47. Improving and developing further new gas interconnections could help to create a gas market in the Iberian Peninsula.

Figure 6. Crude Oil Origins. Basque Country and Spain.



Source: Own analysis from Petronor, 2013, *Informe anual 2012*. Muskiz; Petronor, 2012, *Informe anual 2011*. Muskiz; and CORES, 2014a, *Informe estadístico anual*, 2013. Madrid.

When the gas was exhausted, the empty Gaviota gas reservoir was converted into a storage facility. Now, however, there is potential for exploiting unconventional (mainly shale) gas in the Basque region. Estimates⁴⁸ of recoverable unconventional gas in Spain are as high as 2,026 bcm (71 tcf), including shale gas (1,977 bcm), tight gas and coal bed methane.

Recent studies confirm that the Basque portion of the Cantabrian Basin exhibits suitable geological characteristics for hosting shale gas

48. ACEIP, G. *Evaluación preliminar de los recursos prospectivos de hidrocarburos en España*. Madrid, 2013.

exploration. Prospective resources in the Basin are placed around 1,084 bcm—55% of total estimated Spanish shale gas.⁴⁹ Exploration for these resources—at both the regional and national level—could follow the development lead of a partner industry, fostering technology transfer, for example, from the U.S. leaders in this field.

At present, all gas must be imported; nevertheless, the Basque Country has a quite diversified mix of LNG imports.⁵⁰

As can be observed in Figure 7, the national origin on these LNG imports have changed considerably in the last few years. Peru has recently become an important source—to the detriment of Norway, Algeria, and others. In 2013, over 90% of total Basque LNG came from the Atlantic Basin (in geo-economic terms). However, at national level LNG imports came from a more diversified mix of sources, with Middle Eastern countries representing a higher percentage than in the Basque case. LNG imports from the Atlantic Basin reach approximately 45% of total LNG imports.

With respect to electricity, the Basque Country has only limited power generating capacity within its territory⁵¹ (combined cycles and renewable energies), as it essentially takes the electricity from the Spanish electricity system. However, the Basque Country is interconnected with France, where new power projects in this area are foreseen for the future. One of these projects—designed to improve security of supply in collaboration with France—is the development of submarine electricity interconnection in the Bay of Biscay.

Energy price competitiveness. Natural gas has become, together with electricity, the principal energy source for the Basque Country's energy-intensive industry. As such, energy prices play a key role in the evolution of Basque industrial competitiveness.

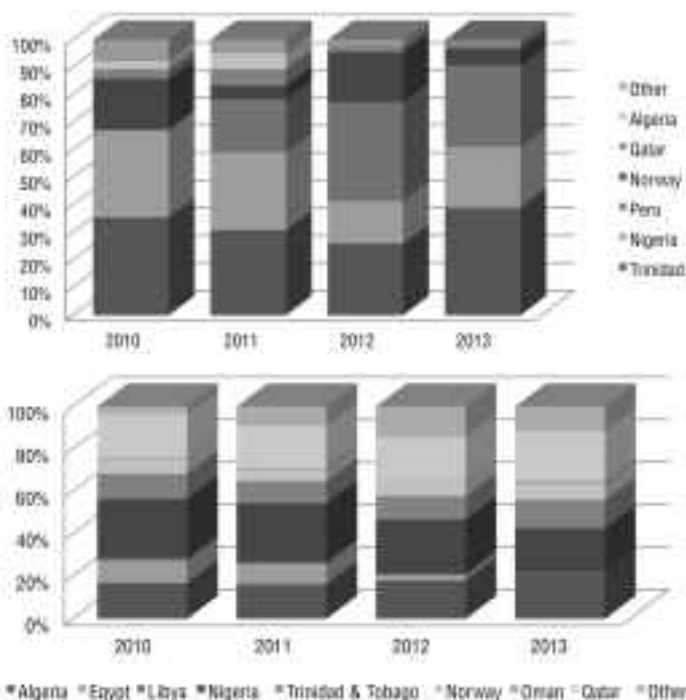
Even if appears that the industrial sector benefits from lower energy costs, when compared to other countries, the reality is often different. A Basque industry—like its Spanish counterpart—faces

49. *Ibid.*

50. LNG = liquefied natural gas.

51. Local Basque power generation capacity is around 3,000 MW. Combined cycle gas plants represent 66.3% of total capacity, while renewable technologies make up around 13%. The rest of Basque power capacity is thermal.

Figure 7. Origins of LNG Imports, Basque Country and Spain.



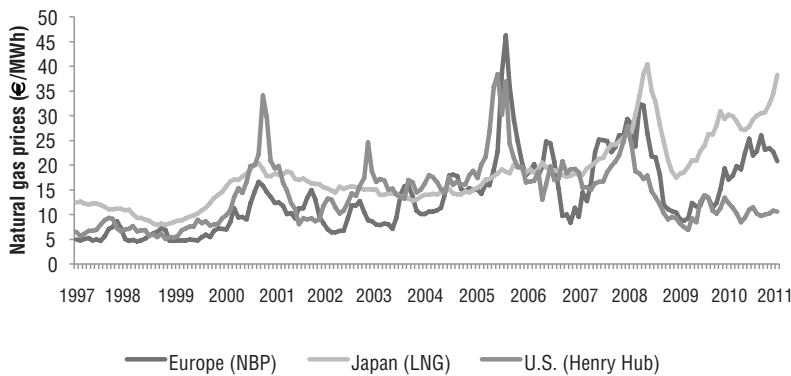
Source: Own analysis from BBG, 2014, *Bahía de Bizkaia Gas ha sido la segunda planta más utilizada del sistema gasista español en el 2013*; and CORES, 2014b, *Procedencia del gas natural licuado*.

higher gas prices than an American equivalent.⁵² But these prices are below German and French prices—and above those borne by industry in the United Kingdom.⁵³ Basque and Spanish electricity prices are equal to the European average, above French and Finnish prices but below Italian and Irish prices.⁵⁴ This is particularly important for Basque industry, given that the region is a significant energy consumer that competes globally in business and economic terms. In addition, Basque and Spanish electricity consumers face a large tariff deficit of approximately 30 billion Euros.

52. Georis, V., & Van Driessche, L. La compétitivité des sites belges de Solvay affectée par l'électricité trop chère, *L'Echo*, martes 30 de octubre, 2012, pp. 28.

53. Eurostat, 2014c, *op. cit.*

54. Eurostat, 2014a, *op. cit.*

Figure 8. Natural Gas Price Evolution in Various Markets.

Source: Own analysis from Sia partners & GRT Gaz, 2013, Evolution of the prices of natural gas in the main market zones, and Remy, 2014, *How to Establish a Proper Working Gas Hub?* Bilbao: Huberator.

The Basque energy sector has a higher productivity than the economy as a whole and presents attractive unit labor costs compared with other Basque economic sectors and with the national energy sector.⁵⁵ However, energy prices depend not only on the capacity of energy companies to offer low(er) costs, but also on many other influential factors, such as energy policy and foreign policy.

Gas prices are largely framed by long-term contracts and indexed, or linked, to oil prices. In order to cushion the impact of crude oil prices upon those of gas, and to ameliorate potential energy insecurity, gas supply should be flexible and competitive. The development of a gas market in the Iberian Peninsula—the Iberian Gas Hub⁵⁶—is an important instrument for augmenting security and optimizing competitiveness. Figure 8 shows the evolution of natural gas prices across different markets.

The United States benefits from the lowest gas prices (10 Euros per MWh) while Japan experiences the highest (nearly 40 Euros). These price differences will probably continue as a consequence of the U.S. shale gas revolution. Some European countries have already cre-

55. Orkestra-Basque Institute of Competitiveness, 2013, *op. cit.*

56. The Iberian Gas Hub is located in Bilbao, the largest city in the Basque Country.

ated regionally organized markets (or hubs), which will probably be strengthened by the EU gas target model framework. These markets foster non-discrimination and interoperability, and are adapted, as much as possible, to the customers changing needs; they provide liquidity, depth, competition and price transparency.

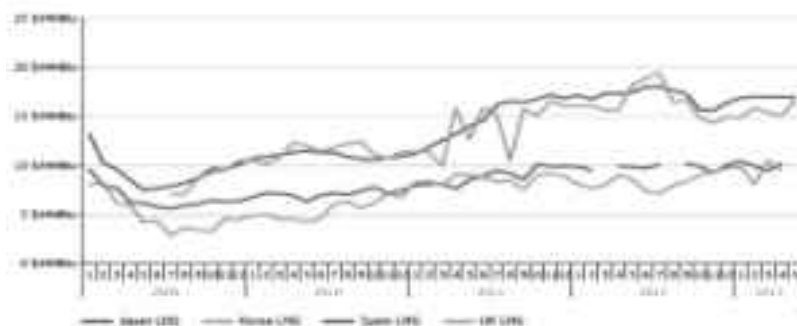
This development has been accompanied by a strong correlation among gas prices within those hubs. This could mean that a hub could improve gas price competitiveness for industry, as it will lead to similar prices in the market.

In the meantime, Spanish prices are much higher than North American or even European prices, where gas markets have developed during the last decade. In the summer of 2014, for example Spanish LNG prices were approximately US\$9.70/MMBtu, as opposed to US\$3.27 and US\$3.73 in the United States, or US\$6.59 in the UK, where there is an important market.⁵⁷

Recent Spanish government measures make it easier to use regasification plants as foreign companies gas storage facilities, and the conflict between Russia and Ukraine will possibly contribute to fostering the development of Spain as a logistics center, thereby facilitating competition with other markets such as the United Kingdom and Belgium.

In parallel with gas penetration since the 1990s, infrastructure improvements and the expansion of gas distribution networks have also developed. Transmission and distribution grids cover 3,700 km, and provide, together with the rest of facilities developed (regasification plant, gas storage, port terminal, etc.) provide an excellent base for further development in the territory. In this regard, the finalization of the Bilbao-Treto gas pipeline—which allows for the linkage with the Santander-Burgos network, thus promoting and ensuring gas supply in the Cantabrian strip—will interconnect different regasification plants and, most importantly, consolidate the Basque regasification plant as the main gas inlet of the Atlantic arc. Such conditions are ideal for the expansion of the Iberian Natural Gas Hub.

57. Federal Energy Regulatory Commission, 2014, *World LNG Landed Prices, Estimated August 2014*.

Figure 9. LNG Price Evolution.

Source: Thompson-Reuters Waterborne, Eurostat Comext, European Commission, 2013, *Quarterly Report on European Gas Markets. Second Quarter 2013*. Brussels.

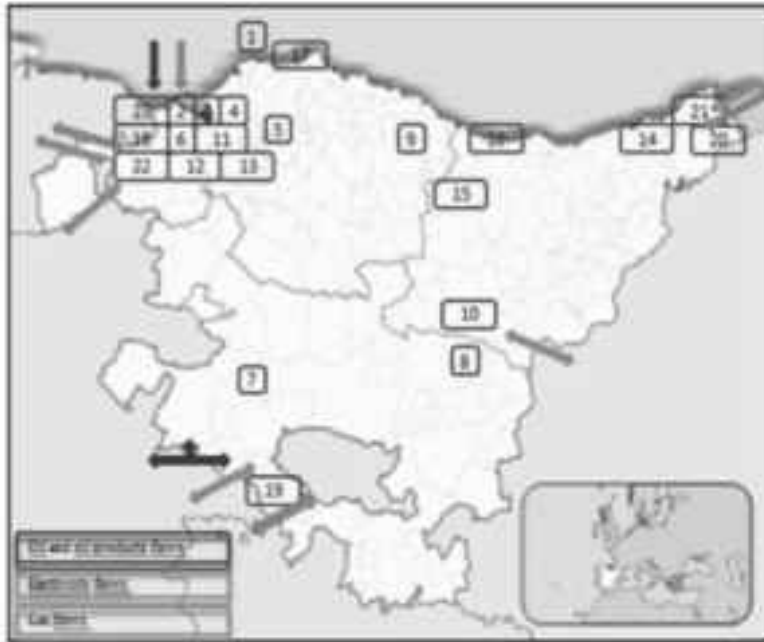
The Energy-Related Industry

Energy is a competitiveness driver for the Basque economy. This should be considered from two main perspectives: the first perspective is that energy is an important input for the Basque economy; the second is that over time, the Basque economy has developed an industrial sector directly related to energy.

The Basque territory has developed significant oil, gas and electricity infrastructure during the past two decades, some of which are shown in the next figure. Such infrastructure has including power generating facilities (BBE, Santurce IV, Boroa, wind facilities in Píz, Elgea, etc.), port terminals (BBG), transport and distribution networks, storage facilities (Gaviota) and international connections (with France). First, this has allowed for greater diversification and balance in the Basque energy mix. In addition, such infrastructure greatly benefits Basque industrial companies that have faced challenges in promoting intensive investment, know-how, technology, R&D and job creation, among others.

The Basque government has developed a technology and corporate development strategy (energiBasque) to link the 3E-2020 strategy and the Plan for Science, Technology and Innovation (PCTI), in an attempt to articulate a comprehensive strategy to position the Basque

Figure 10. Energy Infrastructure Developed in the Basque Country Since 1990.



1. This figure does not consider transmission and distribution grids development.
2. (1) Gaviota; (2) BBG; (3) BBE; (4) Iberdrola s Santurce IV; (5) Boroa; (6) Wind facility at Bilbao Port; (7) Wind facility Badaia; (8) Wind facility Elgea-Urkilla; (9) Wind facility Oiz; (10) Wind facility Elgea; (11) Zabalgarbi; (12) BioArtigas; (13) Biogarbiker, S.A.; (14) BioSanMarkos, S.A.; (15) Biosasieta, S.A.; (16) Mutriku; (17) BIMEP; (18) Biofuels; (19) Bionor Transformación; (20) International Interconnection Irún-Biriatou; (21) International Interconnection Spain-France; (22) CLH; (23) Petronor
- Source: Álvarez Pelegry, E. et al.; 2013, La transformación del sector energético vasco. Aspectos relativos a la competitividad. Bilbao.

Country as a knowledge center and a reference in industrial development. The energiBasque strategy is based both on the European SET-Plan⁵⁸ and PANER.⁵⁹

58. The SET Plan is the foundation of European energy and climate policy. It considers that energy technologies are essential in fight against climate change and to secure energy supply, and provides a roadmap for coordinated research in the development of cleaner, more efficient and cost effective low carbon energy technologies, and their introduction into large scale markets. The Set Plan also describes coordinated actions and efforts, and establishes a range of technologies with high development potential (see the next table), and budgetary estimations

According to a list of criteria (including market maturity, the existence of driving companies, the coverage of the value change, and others), the *energiBasque* strategy focuses on eight strategic areas: wind power, solar thermal and marine power (renewable energies), electric vehicle and smart grids (electricity areas), energy storage, hydrocarbons, and energy efficiency in buildings (cross areas).⁶⁰

According to the SET-Plan, choosing the appropriate strategic energy policy depends on the presence of indigenous agents along the value chain for that particular area in the Basque Country. This key element has its advantages and disadvantages. If the principal consumer stops buying, the supply chain must be able to bear that burden. On the other hand, having a leader company can help the others to follow its steps in the process of internationalization.

The Basque territory has three universities, ten business units for R&D, two large technology corporations, five centers of international competition, and a large multi-technology research center. They all support the promotion of the above-mentioned areas of the *energiBasque* strategy. Each of these centers is also accompanied by manufacturing and engineering companies, some of which have already internationalized their activities (i.e., the main electrical goods producers and engineering companies). Despite the relatively small size of the market, these companies nevertheless try to compete in a globalized market. To a certain extent, they define an energy cluster.

In the wind energy supply chain, for example, there are more than 80 companies that offer their products and services for developing wind facilities, both onshore and offshore. These include companies that also work in marine energy, due to the synergies that exist between the wind and the sea.⁶¹ Marine projects, for instance, involve

for investments. When choosing some energy technologies, the SET Plan considers not only the costs but also the potential of the technologies to reduce greenhouse gas (GHG) emissions and to meet energy demand at any time.

59. Directive 2009/28/EC of the European Parliament and of the Council of 23 April on the promotion of the use of energy from renewable sources provides that each Member State develop a National Action Plan on Renewable Energy (PANER) to achieve the national targets set in the Directive.

60. The SET-Plan road map establishes many other areas: geothermal power, cogeneration, fission, hydropower, biofuels, etc., as well as those areas chosen by the *energiBasque* strategy.

61. In the Basque Country, the Basque Energy Agency (EVE) is promoting the Bimep (Biscay Maritime Energy Platform) project. *Bimep* is designed to test and demonstrate prototype

different agents, including private companies (manufacturers and engineering) and public authorities, each with different responsibilities and tasks.

The group of entities that work on the thermo-solar supply chain is smaller. In this field, the role of engineering companies could be further highlighted. Approximately 40 companies work on smart grids, manufacturing technical goods with often a very high technological component. It should be noted that the ratio of R&D expenditure to sales for largest Basque electrical equipment companies is quite similar to that of the four main international competitors. The performance of the companies working on electric vehicle development and energy storage should also be considered.

In any event, the Basque territory's energy cluster has maintained a stable return on assets and a positive return on equity, in spite of the economic crisis. The ratio of personnel costs to number of employees has even increased.

Figure 11 shows the status of exports from these Basque energy and oil and gas clusters, according to the Porter classification and with respect to three variables.⁶² The first is the total volume of regional exports, represented by the size of the blue spheres. The second is the change in market share, tracked on the horizontal axis; when a sphere is located to the right of the average for the Basque Country's market share (represented by the dashed lines) this means that sub-cluster has evolved positively. Finally, the vertical axis offers information on the market share of each activity. If the sphere is above the average for the territory, then it has performed positively as well.

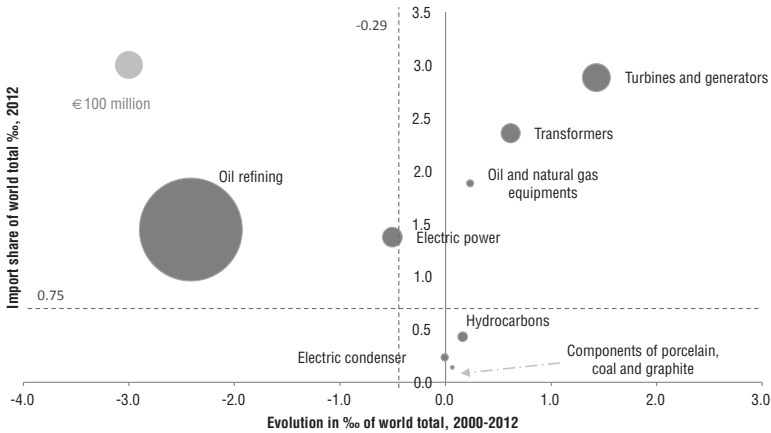
According to Figure 11,⁶³ most energy activities have a considerable market share, above the Basque average (0.75‰), with the exception of hydrocarbons, electric condensers and porcelain, coal, and graphite components, which have nevertheless evolved positively during the last decade. Manufacturing equipment for oil, gas, and electricity (especially turbines, generators, and transformers) appear to be

devices for harnessing ocean energy in terms of their safety, and economic and technical viability, prior to their full-scale commercial development. EVE, 2013a, *op. cit.*

62. Porter, M. E. "The Economic Performance of Regions," *Regional Studies*, 2003, pp. 549-578.

63. This figure does not include the extraction sub-cluster due to its reduced size.

Figure 11. Exports from Basque Country Energy Sub-Clusters Compared to World Exports



Source: Own analysis from Comtrade (United Nations), and Inland Revenue.

active clusters within the framework of the international market; in these clusters, the evolution has been favorable and global market share has been higher than the Basque average.

Despite the large size of the oil refining activity (i.e., volume of sales), the cluster has slipped in terms of market share, probably due to the overall declining trend. In 2012, the Basque market share of refining activity dropped from an average of 3% during the last six to seven years to less than 1.5%. However, because data is not yet available for 2013 and 2014, it is still unclear whether this decreasing trend will continue or not.

Finally, there are possibilities to take advantage of technological innovation in developed and developing countries. Basque companies should try to benefit from technological developments in other countries (i.e., the United States in the shale gas field) and—once more Basque companies become international and establish themselves in developing countries—to collaborate with the development of the energy sectors in development countries, particularly in the Southern Atlantic.

Conclusions

The Basque Country is economically embedded within, and oriented toward, the Atlantic Basin (including the Mediterranean) even if, during the last decade, Basque agents have attempted to enter new markets and capitalize on opportunities in Asia.

According to exports and imports statistics, the Atlantic Basin is an important and natural market for the Basque Country, particularly the European Union and the Americas (North, Central and South). Moreover, Basque companies have developed production facilities and service offices in these territories as well.

The Basque government has developed a range of economic strategies, including an economic internationalization strategy and an energy strategy. The internationalization strategy aims for Basque companies to go abroad and helps them as far as its competences allow. It also represents citizens and companies in different forums and institutions, where sub-nation-state regions are invited to participate.

Basque energy activities have been internationalized both in terms of resources and industrial activity. The Basque economy depends on industrial sectors that are significant energy consumers. As a result, price and security of supply are key factors impacting upon Basque economic competitiveness. In order to meet energy requirements, the territory imports most of its energy because it lacks natural resources. In this regard, the energy companies operating in the territory come from a diversified range of countries. But the Atlantic Basin plays an increasing role in Basque energy, particularly in the realm of gas.

Related to energy prices, the transformation process during these last two decades has been fostered by the development of infrastructures in oil, gas and electricity.

The energy infrastructure developments of the past two decades in oil, gas, and electricity have benefitted the territory enormously by contributing to the growth of the Iberian Gas Hub. The broader and deeper markets implied by these energy infrastructures can offer more competitive prices that will benefit Basque industrial consumers and producers.

Furthermore, as a result of the international gas crisis that has been the by-product of the Ukraine-Russia conflict, and the broader Basque energy infrastructure developments of the past two decades—in particular, the Iberian Gas Hub—Europeans are likely to consume an increasing amount of Atlantic gas. This future trend is likely to be even stronger if Basque (and Spanish) shale gas is finally sufficiently explored, produced and consumed.

In order to develop this unconventional fossil fuel energy source, the Basque Country and its companies should attempt to participate in technology transfers—which can contribute with industrial development and knowledge—from countries that have already begun to exploit shale gas.

The Basque government has also developed an interesting technological energy strategy that focuses on eight principal energy areas, or sub-sectors, including wind energy and thermo-solar, and involves a number of internationally renowned companies. To help stimulate the development of these sub-sectors, it has also engaged the collaboration of two technological centers, three universities and a number of manufacturing companies, among other entities.

This energy-related industrial sector has also undertaken efforts to internationalize not only through exports and imports, but also by investment in production centers abroad. This strategy has been underpinned by considerable investments in R&D.

In summary, the Basque Country is an Atlantic-oriented sub-state territory, where the autonomous regional government has developed strategies in internationalization, energy, and technology to support the development of private sector companies, particularly manufacturers, to the benefit of the wider Basque citizenry. Therefore, the Atlantic Basin Initiative has the potential to foster relations among regions in economic and energy terms, to develop markets and to improve competitiveness. This appears to be particularly true of the Basque Country.

Chapter Twelve

The Emergence of the Atlantic Energy Seascape: Implications for Global Energy and Geopolitical Maps¹

Paul Isbell

The Rise of the Global Seascape

The Atlantic offshore revolution is just one of the many expressions—one of the most dramatically visible—of a deeper reconfiguration of the global geopolitical and energy flow maps that has been unfolding since the end of the Cold War. The rise of the seascape and the emergence of the blue economy is a driving dynamic behind the various revolutions and counter-revolutions of the Atlantic energy renaissance. In fact, the strategic emergence of the global seascape reflects a long-term shift in relative geoeconomic and geopolitical significance (and transnational governance potential) away from the traditional geopolitical and energy landscapes and increasingly into the sea—the next great resource frontier and transnational governance challenge.

Over time, technological innovation has deepened the economic division of labor, pushing the dividing line of productive specialization beyond the unit of the household, then beyond the locally-confined market of the village, then past the boundaries of regional and national economies, and finally, now, even beyond the terrestrial, continental land frontiers of the global political economy itself to stretch more exhaustively across—and more penetratingly into—the global seascape. Over the past two decades, the increasingly rapid rate, and intensifying reach, of technological innovation has opened the sea

1. This chapter has been derived—with significant alteration suffered along the way—from an earlier analysis conducted for a scientific article submitted to the Atlantic Future research project of the European Commission. See: <http://www.atlanticfuture.eu/contents/view/an-atlantic-energy-renaissance>

depths and allowed for the mapping of their unique and largely unknown spaces, systems and topographies. Today the seascape represents a key space not just for the movement of people, goods, and military forces across the surface of the sea, but also for the exploration, mapping, exploitation, stewardship, and governance of its depths and floors—with its consequent implications for the global geopolitical and energy flow maps.

Transportation and commerce have, and continue to be, typically more efficiently undertaken by sea. Over 90% of physical merchandise trade (by volume, and nearly three-quarters by value) takes place via marine transport along the world's sea lanes (including two-thirds of the global oil trade, one-third of the gas trade, and the large majority of other global material flows, which together are expected to triple by mid-century).² Already some 5% of global GDP—or 3 trillion U.S. dollars annually—is generated from marine and coastal industries, while some 40% of the world's population depends directly upon marine and coastal biodiversity.³ Furthermore, the role of the oceans in the maintenance of species diversity and of coastal ecosystem services, and in the absorption of carbon dioxide, is also critical, and—given the deplorable state of oceans in general and their rapid rate of deterioration—it will demand more and more intensive transnational collaboration.⁴

2. Total global seaborne trade has increased since 1970 at an average annual rate of 3.1% and is expected to double yet again by 2030 (UNCTAD 2012). Since the mid-19th century, it has increased 400-fold in cargo volume terms, reaching nearly 1.5 trillion tons of seaborne cargo per capita annually. See Martin Stopford, "How shipping has changed the world & the social impact of shipping" *Global Maritime Environmental Congress SMM Hamburg*, September 7, 2010. (Stopford 2010).

3. See Marcia Stanton, "The Worth of the Deep Blue," *Namib Times*, April 27, 2013 (<http://www.namibtimes.net/forum/topics/the-worth-of-the-deep-blue>) (Stanton 2013), and Global Ocean Commission, "Petitioning Ban Ki-moon: Help secure a living ocean, food and prosperity—propose a new agreement for high seas protection" September 2014 (<https://www.change.org/en-GB/petitions/ban-ki-moon-help-secure-a-living-ocean-food-and-prosperity-propose-a-new-agreement-for-high-seas-protection-in-september-2014>) (GOC 2014).

4. See Paul Holthus, Xavier de la Gorce, and Anne-François de Saint Salvy, "Fisheries: A Resource in Crisis", in Richardson et al, *The Fractured Ocean: Current Challenges to Maritime Policy in the Wider Atlantic* (Washington, D.C.: German Marshall Fund of the United States and the OCP Foundation), 2012 (Holthus 2012a) and Paul Holthus, "Marine Natural Resources Extraction", in Richardson et al, 2012 (Holthus, 2012b).

“How inappropriate to call this planet Earth, when it is quite clearly Ocean” wrote the British writer, Arthur C. Clarke, referring to the fact that few are aware that nearly three-quarters of the planet’s surface is covered by water, and that this same salt water constitutes 96% of the planet’s living space by volume.⁵ Largely as a result of having always lived predominantly upon the continental landmasses, even fewer among us have fully registered this relative shift in the center of gravity of the human political economy and our geopolitics into the seas. Nevertheless, as the center of economic and geopolitical gravity continues its modern shift from the land to the sea, our actual energy, geo-economic, geopolitical, and governance maps (independent of reigning mental maps) are increasingly marine-centered and ocean basin-based.

Furthermore, this relative shift from the land to the seascape today is far more profound than that announced in the first part of the 20th century by Alfred Thayer Mahan and Julian Corbett. In that earlier historical context, the advent of petroleum and the modern naval ship allowed sea power to overtake land power in relative terms, as navies could then influence the rim lands of Eurasia more effectively than during the earlier maritime ages of sail and steam. That relative shift in the historical technological edge between modes of land and sea transportation made obsolete the earlier claim by Halford Mackinder, the original geopolitical theorist, that the railroad ultimately implied that any power in control of the Eurasia heartland would easily dominate the entire landmass of Eurasia, and thus the world. But the subsequent relative overtaking of rail by sea transport in the early 20th century offset the influence of the once more dominant land-based railroad and facilitated a more feasible containment of the land-locked Eurasia heartland (most of what is today Russia and Central Asia and much of the Middle East) through the application of sea power to the rim lands of the supercontinent.

Despite that shift—theorized by Nicholas Spykman and *de facto* articulated in practice by George Kennan, and declared epoch-shap-

5. “How inappropriate to call this planet Earth when it is clearly Ocean,” quoted in James E. Lovelock, “Hands Up for the Gaia Hypothesis,” *Nature*, Volume 344, Number 6262, 8 March 1990 (p. 102); also: “... As science-fiction author Arthur C. Clarke noted, ‘it is inappropriate to call this planet Earth when it is quite clearly Ocean,’” as quoted in “Oceans: The Blue Frontier,” *Nature*, 469, 12 January 2011 (pp. 158-159).

ing in its own day—the Eurasian heartland has continued to be considered the pivot of history—something like a middle earth on the predominant geopolitical projection of our global maps—just as it did back when Mackinder first made the claim in 1904, just before the railroad and land power lost their relative edge to maritime transport and sea power. Today strategic priorities are still focused on the heartland and rim lands of the supercontinent, even as seascape emerges in relative strategic terms.

This tectonic slippage of relative strategic significance from the global landscape into the seascape has continued at an accelerated pace since the first half of the 20th century, and is now far more profound than it was in the world war and interwar years when Mackinder's heartland and land power gave way to Mahan's sea power and Spykman's rim lands. Today, the seascape embraces not just secondary trade, naval power, and the strategic balance of power (as it did at the time of the dying British Empire), but increasingly significant aspects of very material base of the expanding global economy itself—energy and a plethora of other raw materials, foodstuffs, pharmaceuticals, biotech products, and maritime transportation and security. The key geopolitical implication is that the strategic significance of the Eurasian heartland has now dissolved into the sea—and into the energy seascape of the Atlantic Basin.

The Atlantic Energy Seascape and the Changing Global Energy Flow Map

Today the long-building strategic shift to the seascape is approaching an inflection point, as accumulating layers of new strategic significance now overlap across the Atlantic Basin. These cumulative overlays are over-determining certain tectonic ruptures in the underlying global geopolitical and energy flow maps and giving rise to new interlocking global centers of gravity within the Atlantic Basin.

Atlantic as the Center of Gravity of the Global Seascape

Atlantic Basin dominance along the burgeoning frontier of offshore oil and gas E&P (explored in Chapter Four) is complemented and buttressed by the Atlantic's clear lead in the maritime transport of

global energy flows along the global seascape. Nearly 40% of the global total of tradable energy—and three-quarters of the world's actually traded energy—is transported via the global seascape.⁶ Furthermore, intra-Atlantic (or Atlantic Basin) energy flows—75% of all Atlantic Basin global energy flows—make up nearly two-thirds (42mbdoe) of total maritime energy transportation on the global seascape (63mbdoe).⁷ We estimate that total Atlantic Basin global energy flows (including both intra- and extra-Atlantic energy trade) constitute over three-quarters of the total use of the global seascape for the transportation of global energy flows.⁸

Therefore, putting together both offshore energy and maritime energy transport, the Atlantic Basin clearly dominates the global energy seascape, accounting for, all told, about two-thirds of all global maritime energy stocks and flows. Because of this outsized role for the Atlantic Basin in the global energy seascape, much of the entire world's sea, ground and air transportation (which rely nearly completely on oil and gas, an increasing amount of which is coming from the Atlantic) will depend in the short- and medium run directly upon the efficiency, productivity and security of the Atlantic energy seascape—and, increasingly into the future, the Southern Atlantic seascape. As more energy comes out of the Atlantic energy seascape, more energy will also be transported along the seaborne flow circuits of the Atlantic Basin, underlining its rising relative strategic significance as a seascape, compared to both the global energy landscape, in general, and to the other ocean-basin energy seascapes, in particular. In this sense, the center of gravity of the global energy seascape has shifted into the Atlantic Basin.

6. Tradeable energy is energy which could feasibly be traded, but which may or may not be actually traded (internationally, across borders) in any given year (much primary biomass would therefore not qualify). Total tradeable energy produced globally amounted to 222 million barrels a day of oil equivalent (mbdoe) in 2012 (against a total global energy production of 250mbdoe). Actual total traded energy came to 84mbdoe globally. Based on British Petroleum, *Annual Statistical Review of Energy* (Database) 2013 (BP 2013a) and own-elaboration.

7. Based on annual national bilateral trade data from UNCOMTRADE International Trade Statistics Database, 2014 (<http://comtrade.un.org/>) (UNCOMTRADE, 2014).

8. Intra-Atlantic energy trade is international energy trade whose flow circuit begins and ends in the Atlantic Basin. Extra-Atlantic energy trade is made up of either imports into the Atlantic Basin from the extra-Atlantic (i.e., the rest of the world beyond the Atlantic Basin) or of Atlantic exports to the extra-Atlantic.

The Role of the Atlantic Energy Seascape upon the Changing Global Geopolitical and Energy Flow Maps

Along with the increasingly significant shift of the center of gravity of the global energy seascape into the Atlantic Basin is another underlying tectonic shift stemming from the Atlantic energy revolutions—the swapping of positions between the relative centers of gravity of both global energy supply and demand between the Atlantic Basin and Eurasia. This epochal change of globalization has produced a dramatic reversal in the dominant overall directional patterns of global energy flows. The historic switch from predominantly East-to-West flows to West-to-East flows (and even more so, to Atlantic Basin-to Asia-Pacific flows) is also the principal driver behind the currently unfolding transformation in the relative balance between East-West and North-South global maritime flows upon the global map.

On the traditional Cold War energy flow map, maritime flows moved, in general, along an East-West axis vector. Energy flow circuits in particular relied on sea lanes that were punctuated by the strategic energy chokepoints that characterize the rim land geography of Eurasia and the security dynamics of its East-West energy flow circuits—the Straits of Malacca, the Strait of Hormuz, the Strait of Bab el Mandeb, the Suez Canal, the Straits of Bosphorus and the Dardanelles, the Straits of Denmark and Gibraltar, and the inner seas of East Asia (and the passages between). These predominantly East-West global maritime energy flows (the Hormuz-Malacca flow circuit from East Asia to Western Europe being its main artery) relied primarily upon the low latitude inter-basin passages, leaving the high latitude inter-basin passages (the Arctic and Cape passages) in the merely complementary role of handling the spillover or other ancillary traffic.

From here on, however, the initial and intermediate corridors of all such seaborne flows following flow circuits leading from the Atlantic Basin to Asia-Pacific will increasingly shift, over time, from their current East-West orientation—through the low latitude canals—to a North-South flow following longer stretches of north-south Atlantic sea lanes before turning into the high latitude inter-basin passages (the Cape and Arctic passages) to move towards Asia-Pacific.

This will occur because of a confluence of now-shifting flow circuit constraints and enablers. First, even the enlarged and/or refitted Panama and Suez canals will increasingly come to represent bottlenecked chokepoints—once the enlarged Asia-Pacific bound capacity of Panama and the still spare eastward capacity of Suez are absorbed over the years to 2030 by increasing Atlantic Basin energy flows to Asia-Pacific. Secondly, international shipping traffic—which has grown 400-fold since the mid-19th century and tripled in the last ten years—is expected continue its upward growth, doubling again by 2030, and tripling by 2050.⁹ Such an increase in volume can be expected to outstrip even the enlarged capacity of the low latitude inter-basin passages by 2030, and possibly before. Thirdly, and given these anticipated trends in volume and patterns of maritime flows, shipping and marine-related technology have, and will continue, to evolve such that the largest seaborne vessels—which already cannot pass through the canals and tend to carry bulk and dry cargoes (i.e., raw materials)¹⁰—will increasingly to be pushed, even during the period up to 2030, to the high-latitude passages to reach Asia-Pacific from the Atlantic, particularly through the Cape Passage in the South, but also even through the Arctic's Northern Route (as the latest enhanced weatherization technology allows more and more ships to effectively use this Arctic route, even in its current state).¹¹

The first of these high-latitude inter-basin passages—the rising Southern Passage—flows south out of the Southern Atlantic and through the Cape Passage, along the northern reaches of the Southern Ocean, and into the Indian Ocean. The other is the emerging Northern Route, which flows north from the northeast Atlantic and into the Arctic Ocean along the northern stretches of Russia.

Ever since the Portuguese first rounded the Cape of Good Hope, the traditional mediating ocean basin between markets and destina-

9. UNCTAD, *World Economic Situation and Prospects*, UN: New York, 2012. (UNCTAD 2012), and Stopford 2010.

10. See Armando Marques Guedes, "Geopolitical Shifts in the Wider Atlantic: Past, Present, and Future," in Richardson et al, *The Fractured Ocean: Current Challenges to Maritime Policy in the Wider Atlantic* (Washington, D.C.: German Marshall Fund of the United States and the OCP Foundation), 2012 (Marques Guedes 2012).

11. Juha Käpylä & Harri Mikkola, "Arctic Conflict Potential: Towards an Extra-Arctic Perspective," Finnish Institute for International Affairs, Briefing Paper 138 (2013) (Käpylä & Mikkola, 2013).

tions in the Atlantic and Asia-Pacific—given the enormous breadth of the Pacific Basin, and the traditionally impassable nature of a frozen Arctic—has been the Indian Ocean, which progressively displaced the old land-based Eurasian silk road. As climate change melts the Arctic icecap, however, the Arctic Ocean becomes a potential new rival—or at least a complement—to the Indian Ocean as a mediating basin between the Atlantic world and Asia.¹²

But for a number of reasons, the Arctic Basin is not likely to displace the strategic significance of the Indian Ocean as a mediating basin—the absolute strategic significance of which will continue grow—or even rival for strategic significance the other East-West low latitude energy flow circuits that are lined with straits and canal chokepoints, particularly those of the Hormuz-Malacca energy flow circuit. At least in the near-to-mid-term—even with ongoing climate change—the ultimate, inherent limitations of the Arctic on most economic activities, together with the likelihood that most Arctic oil and gas will be economically marginalized by the Southern Atlantic offshore revolution (see Chapter Four) will prevent Arctic Basin global energy flows—both those originating from Arctic production and those potentially passing through from the Atlantic Basin to Asia-Pacific—from ever contributing more than marginally to the total of global seaborne energy flows.¹³

This does not mean, however, that the Bering Strait, long a strategic hard power passage, could not become for the first time a strategic energy chokepoint. The emergence of a new rival, strategic eastward energy flow to Asia-Pacific from Arctic Russia—where most of the projected, if limited, hydrocarbon production in the Arctic is expected to take place—would point to this development.

Furthermore, and as a result of all of the factors analyzed above, maritime traffic of all types, but particularly of Atlantic Basin global energy flows (both intra- and extra-basin bound) will become increasingly dense in the North-South directions, particularly along the

12. For an optimistic appraisal of the future potentials of the Arctic, see Scott Borgerson, “The Coming Arctic Boom: As the Ice Melts, the Region Heats Up”, *Foreign Affairs*, July/August 2013, pp. 76-89.

13. For a more circumspect analysis of the near and mid-term future of the Arctic, see K  py   & Mikkola, 2013.

western and eastern seaboard of the Atlantic. This is because Atlantic Basin energy flows will rely increasingly on maritime flow circuits through the high latitude passages to reach growing markets in Asia-Pacific as they are increasingly boxed out of the East-West inter-basin energy flow circuits. The low latitude canals—while continuing to accommodate their newly expanded maximum capacity throughputs over the short to middle run—will come to represent over the middle to long run, both a gauntlet of strategic bottleneck chokepoints and a shrinking share of global energy flows over time.

These projected changes in maritime trends within the Atlantic energy seascape also reinforce the rapidly growing relative strategic significance of the Southern Atlantic—and of the Southern Ocean around Antarctica. Such shifting trends on the strategic horizon—in which the Southern Atlantic gains more than anywhere else on the global map in relative strategic terms, and in which the Indian Ocean Basin remains the most significant in absolute terms—serve as harbingers for rising future investments in transportation, communications, and port facilities, in addition to energy, in the southern reaches of the Atlantic. They might also serve as a call for pan-Atlantic energy cooperation.

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