Introduction

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The purpose of this book is to stimulate the activity and effectiveness of the Jean Monnet Network on Atlantic Studies, to explore the current state and future directions of the nexus between energy and transportation in the wider Atlantic world, and to identify the implications for the European Union and other Atlantic actors.

The book draws on the collaboration, research and analysis of a number of colleagues from around the Atlantic Basin. They come from both the member institutions of the Network and beyond. Most have worked previously on issues pertinent to Atlantic energy, and have collaborated with the EU's *Atlantic Future* project, or with the Center for Transatlantic Relations' *Atlantic Basin Initiative*, or with one of the other wider Atlantic projects that have been undertaken in recent years by a number of public, private and academic entities around the Atlantic and now also contribute to what has become a budding epistemic and policy community in the New Atlantic—the wider Atlantic or the Atlantic Basin. The authors also come from a range of professions (academics, think tank analysts, development specialists, public and private sector practitioners) and they have made diverse types of contributions to the Jean Monnet Network project's research and analyses (chapters include academic, analytical, policy, and exploratory strategic pieces).

The book attempts to draw an initial, analytical Atlantic map of the nexus between energy and transportation—and of their potential co-transformations—highlighting the strategic terrains of the maritime realm, ongoing economic globalization and global value chains, multi-sector technological transformation, climate change, development and governance. The book also builds upon (and modifies) insights from previous work undertaken within the context of the Atlantic Future project and the Atlantic Basin Initiative.

In Chapter One, R. Andreas Kraemer lays out the current contexts, trends and outlooks in energy and transportation across the wider Atlantic and on each of the Atlantic continents, and concludes that energy and transportation are now engaged in an interdependent process of co-transformation which is moving principally in the direction of more renewable energy in the energy matrix and more electrification in general, but particularly in transportation.

In Chapter Two, Martin Lowery and Michael Leitman analyze three nascent trends and potential lines of action—the democratization of energy, the dynamic grid, and the broader electrification of the economy—which together could contribute to an economically beneficial and emissions-reducing transformation of the energy and transportation sectors of the Atlantic Basin. They propose an alternative business model, the energy cooperative, as a potential vehicle for contributing to the transformation.

Part Two is dedicated to energy and land transportation in the Atlantic Basin. In Chapter Three, Eloy Álvarez Pelegry, Jaime Menéndez Sánchez, and Macarena Larrea Basterra present empirical data on the recent evolution of alternative vehicles and fuels in European passenger transportation (focusing on electric and gas vehicles) and they analyze their future trends. On the basis of their original study of passenger mobility in the Basque country, they conclude that electric vehicles and hybrids (with some contribution from gas vehicles) represent the overall best options for decarbonizing the European passenger transportation sector.

In Chapter Four, Lisa Viscidi and Rebecca O'Connor present the panorama for energy and transportation in Latin America and the Caribbean (LAC), placing the focus on passenger and public transportation. They highlight the potential for more vehicle fuel efficiency, quality and emissions standards to reduce greenhouse gas GHG and air pollutant emissions in LAC, as well as the need to maintain investment in public and urban transportation, and to encourage electric vehicle penetration, if the region is not to experience more than a doubling of transport emissions by 2050.

In Chapter Five, Roger Gorham analyzes the expanding carbon footprint of African transportation and reviews the broad policy options available to African decision-makers and other relevant actors, along with the many of the barriers to their successful application. He identifies a number of potential modal shifts (reform of the private informal bus sector, more public urban transportation, improvements to last-mile connectivity through use of ICT applications and sharing platforms, a potential shift of freight from road to rail) along with smart motorization policy to reduce the fleet's average age, as policy areas with decarbonization potential in the short to middle run.

Part Three is dedicated to energy and transportation in the maritime realm of the Atlantic Basin. In Chapter Six, Jordi Bacaria and Natalia Soler-Huici bring our discussion of Atlantic energy and transportation, and of their decarbonization nexus, into the maritime realm. They trace the history of the expansion of the shipping industry, and of maritime GHG and air pollutant emissions, and analyze their various drivers (including the declines in shipping costs, containerization of manufactured goods trade, increases in shipping volume and vessel size, improvements in ship design and efficiency, the ongoing development of global value chains, among others). They evaluate the history of the regulation of maritime emissions by the International Maritime Organization, balanced against projected trends in maritime emissions growth, and propose Atlantic Basin cooperation, led by the European Union, to reduce maritime emissions at a faster rate in the Atlantic.

In Chapter Seven, João Fonseca Ribeiro focuses on the strategic potential of port-cities as policy fulcrums for the decarbonization of energy and transportation in the Atlantic Basin, and not only in the maritime realm. He maps out the various integrated sustainable growth strategies of both the EU and the African Union in energy, transportation, infrastructure, maritime affairs and climate change, emphasizing the importance of such strategy and policy integration, and highlighting their impact upon, and the integrated role they envision for, port-cities. After analyzing current trends affecting port-cities, and offering a vision of the strategic and policy paths port-cities might pursue, he proposes pan-Atlantic cooperation—again possibly spearheaded by Europe—among Atlantic Basin port-cities for the greening of maritime energy, transportation, and climate change infrastructures.

The Shifting Atlantic Energy Renaissance: From Unconventional And Offshore Oil To Low Carbon Energy

Only a few years ago, as the last oil price cycle enjoyed its peak—a plateau of $95–$110 per barrel that lasted from 2010 to 2014—an Atlantic energy renaissance took shape in the form of a boom in unconventional and offshore oil and gas. During that time, the shale revolution of North America was paralleled and accompanied by a unique new Atlantic oil ring that was also emerging in the deep offshore, particularly in the Southern Atlantic (if largely unnoticed by many American and European observers).

It was noted at the time that, as a result of such a sudden and clear preeminence taking root on the frontiers of what had traditionally been known as difficult or expensive hydrocarbons—and not just in the U.S. or the Hemisphere of the Americas, but also across the wider Atlantic space—the center of gravity for global energy supply had begun to shift out of the Great Crescent (comprised of the Middle East, Central Asia and Russia) and into the Atlantic Basin (Europe, Africa, Latin America and the Caribbean, North America and the maritime realm of the Atlantic Ocean). At the same time, the center of gravity for global energy demand was shifting from the Northern Atlantic to Eurasia—but particularly East Asia.[1].

After long decades during which many Westerners (or Atlantics) felt compromised in economic, geopolitical, and security terms by their oil import dependency, the wider Atlantic region, taken as a whole, had rapidly become energy autonomous. Indeed, large parts of the basin—especially North America and the Southern Atlantic—appeared on the verge of becoming important exporters at the margin to the oil-import dependent East, the oil demand of which was now beginning to outstrip the capacity of the Middle East to supply it, at least as long as the Atlantic world remained oil import dependent in net terms.

Putting aside, for the moment, the various possible interpretations, then and now, of the geopolitical significance of an Atlantic energy renaissance—against the backdrop of the Pivot to Asia and the belief in an Asian or Pacific Century—the debate over the usefulness of energy as a geopolitical lever or over significance of the weighting of the energy variable within the equation of geopolitical power, the important issue to note with respect to energy and transportation is that any such Atlantic energy renaissance had been based on a technological revival of fossil fuels, and sustained by a relatively high oil price. As a result, the energy horizon of Atlantic Basin that emerged during the period of the last oil price peak was one centered around (and implicitly assuming) continued and sustained fossil fuel relevance, if not centrality.

As an extension of this horizon, the predominant view of the future of Atlantic transportation assumed the maintenance of the status quo's traditional fossil-liquids-based transportation system, and its infrastructure base and marketing networks around the world. This fossil-liquids transport system serves internal combustion engine vehicles, run on liquid derivatives of fossil fuels (mainly gasoline and diesel), principally on roads (and to a much lesser extent rail), along with the equivalent fossil-liquid-powered ships and jet planes in the maritime and aviation spheres and their respective infrastructures (ports and airports).

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1. See Paul Isbell, "An Introduction to the Future of Energy in the Atlantic Basin," in Paul Isbell and Eloy Alvarez Pelegry (eds.), *The Future of Energy in the Atlantic Basin* (Washington, D.C., Center for Transatlantic Relations, JHU SAIS, 2015).

In part this was because, at that time, feasible alternatives to the current fossil-liquids transportation system did not emerge clearly. The fuel switching options available to transport were generally constrained to fossil fuels—compressed natural gas (CNG), liquefied natural gas (LNG) and liquid petroleum gases. The only other obvious liquid alternative to gasoline or diesel are biofuels. While they are compatible in certain percentages with the current liquids-based transportation infrastructure, biofuels are only economically viable and environmentally suitable in certain countries of the Southern Atlantic (like Brazil and some Atlantic African countries) and Southeast Asia, and even then, not as a comprehensive alternative capable of fully displacing fossil fuels in transportation.

The most comprehensive alternative—electrification, if in conjunction with LNG, and possibly renewable energies (RE)-generated synfuels including biogas—would require a large-scale transformation of the underlying infrastructure configuration: the transportation and manufacturing and fossil liquids industries and infrastructures would need to be transformed or displaced by the progressive and widespread electrification of the transportation sector and supported by significant RE penetration in the generation mix.

Until recently, this has always been viewed as too far away in the future to be seriously considered, particularly given the growing perception of fossil abundance that came with the first phase of the Atlantic energy renaissance. During the last high oil price cycle, the power over mind-sets, across continents, countries and classes, of the long-standing centrality of the fossil fuel industry, epitomized and symbolized by the automobile and the truck, remained intact and largely dominant. Renewable energies, already showing enormous promise and basically begging for rollout support and capacity investment, were still considered too expensive and too unreliable by enough people in many places. What passed for a common sense, real world consensus still provided support for the fossil-dominated energy reality of the global map. Meanwhile, the ships of the maritime realm, even more so than the planes and jets of the airspace, remained largely at the margins of the consciousness of a land-centered, continentally-focused global public.

But the horizon for the Atlantic energy renaissance, and the future of transportation, have both rapidly and radically shifted since the great oil price collapse of 2014-2016 (which established the current price plateau of around $45 to $55 a barrel). Much of the deep offshore oil of the Atlantic Basin was suddenly pushed back beyond the horizon by prices below $50 (most Atlantic offshore oil required an oil price of at least $70-$80 to be economical to produce). Even the shale sector experienced significant consolidation and a slowing of production. However, despite the lower prices, renewable energy continued to boom. As costs continued to fall, decarbonization of the power sector proceeded apace. In the wake of the Paris Agreement, attention has turned to the next major sector in line: transportation.

For the first time in the history of fossil energy, the return of a sustainable upward cycle in oil price has been put into serious doubt. The last upward cycle of the oil price (roughly from 2004 to 2014) not only began to kill off demand and to overstimulate production of more high-cost oil and gas (i.e., in the offshore), it also provided support to renewable energy which, together with scattered if growing state facilitation and backing, and ongoing RE and battery cost declines, has been minimally sufficient for the sector to become established and to begin to challenge the growth of fossil fuels. Not only did oil demand fall in cyclical terms; it also began to structurally disappear. With the passing of just a decade, attention has shifted from the controversy over peak oil (a projected imminent peak in global supply) to a discussion over the timing of the arrival of peak demand.

Today the Atlantic energy renaissance has transformed from a story about emerging Atlantic Basin dominance in fossil fuel supply (and its geopolitical implications) to one about the growing realities and potentials of renewable energy, alternative fuels and electrification in transportation, dynamic grid transformation, and the emergence of new business market and regulatory models, along with the establishment and exchange of Atlantic best practices. This book explores the nature of this shift in the Atlantic energy renaissance and its intersection with Atlantic transportation, the bastion of oil. The incumbency of oil in transportation is far more central and structurally influential than the market power and infrastructural hold of any of the fossil fuels in any other sector, making its transformation the key climate change challenge.

Transportation As the Key to the Low Carbon Transition

During the last decade, as a nascent low carbon economy began to take shape around the world, the bulk of decarbonization efforts have concentrated on renewable energy rollout within the electricity sector. As a result, and considering projected policy, technology and cost trends foreseen within the Paris Agreement, the prospects for decarbonizing the world's power sectors by mid-century are, depending on the scenario considered, now relatively optimistic. Nevertheless, without a corresponding decarbonization effort in the multi-modal and multiply-segmented global transportation sector, defending the 2-degree guardrail of the Paris Agreement is probably out of reach.

As the group of eight multilateral development banks (MDBs) maintained in a joint statement on the eve of the Paris accord: "Actions to reduce greenhouse gas emissions and stabilize warming at 2 degrees Celsius will fall short if they do not include the transport sector." Near complete decarbonization of transportation will almost certainly be necessary to achieve the even more ambitious target of 1.5 degrees C.

The transportation sector burns nearly two-thirds of the oil consumed each day around the world and represents 27 percent of all energy used globally. As a result, transportation now accounts for one-quarter of all energy-related CO_2 emissions and over 15 percent of *total global* GHG emissions (including F-gases and emissions from the land sectors). Furthermore, transportation is growing more quickly—around 2 percent a year—than all other energy demand sectors. As a result, the transport sector is the fastest growing source of GHG emissions, with a projected 70 percent increase by 2050.

As the second largest total GHG source after the power sector (31 percent), transportation is basically on par with the emissions produced by the land sectors—collectively known as AFOLU emissions (agriculture, 10.5 percent of total global GHG gases in 2015, and forestry and land-use, 6 percent). This makes transportation the new central arena in the decarbonization of the world's energy economy. Such an emissions profile also clearly implies that forest protection and the restoration of degraded lands are also key strategic supports to the global decarbonization effort on the land side of the GHG equation. In addition, beyond the transportation and land-use sectors, the next major strategic area of action will be the development of blue ecosystems services as the sustainability lever for the growth of the blue (or ocean) economy. Indeed, energy and transportation, agriculture, forestry and land-use, and the broader maritime realm are all positioned for major co-transformation.

Overlapping Energy, Transportation, and ICT Co-Transformations

The transformations now underway in energy, transportation and information and communications technology (ICT) (including smart phones, social media, automation, internet of things, etc) have long developed along largely separate tracks with different rhythms and patterns. Nevertheless, there has been mutual interaction among different pairs of this trilogy of sectors. Energy and transportation infrastructure have reinforced each other for a century and continue to mutual depend on each other (see R. Andreas Kraemer, Chapter One). The ICT revolutions have fed transportation volume and shaped its structural and modal evolution both on land and at sea. Global transportation, in turn, is being transformed in a structural fashion by both the ongoing push of economic globalization and the shifting development of global value chains—both of which are stimulated by ICT advances—and by the nearly-universal global consensus that the sector must be decarbonized (see Jordi Bacaria and Natalia Soler-Huici, Chapter Six).

In their current transformative stages, however, these revolutions are beginning to integrate with each other at their common intersection. The synergistic result is a growing movement in the direction of (1) an increasingly electrified world of (2) increasingly distributed low carbon energy production, incorporating (3) prosumer economic participation in generation and the provision of storage (and other ancillary) services to the grid, and (4) integrated by ICT applications and related technological advances for effecting efficient market transactions and technical clearings in (5) an increasingly interactive and electricity based energy and transportation system.

Because of the numerous potential synergies presented by the overlapping of these global transformations, their current intersection appears to structurally favor renewable energies, electricity, and electrification of transportation more than any other energy, energy carrier, or transport infrastructure. As a result, these co-transformations are also contributing to further transform both the automobile industry and the multimodal transportation network, enabling deeper electric vehicle (EV) and electricity penetration, in both freight and passenger transportation, in both the maritime and terrestrial transportation realms (see R. Andreas Kraemer, Chapter One).

This is not to say that the future of energy and transportation is to be electric, only that a large part of the land-based (and some of the maritime) systems easily could be. As the authors of this volume either explicitly acknowledge or implicitly accept, a largely (if not completely) electrified world probably would not be the worst of possible futures, at least not in the wider Atlantic. Nevertheless, there is also a range of other approaches, independent of electrification, which offer the potential to reduce emissions in the transportation sector.

Transportation Contexts and Trends in the Atlantic Basin

Transportation is a segmented sector supporting and binding national, continental, and global economies. The sector is split by function between passenger and freight transportation, and is segmented by mode of transport: (1) road; (2) rail; (3) ship; and (4) air. Although both passengers and freight can conceivably move by all transportation modes, certain types of transport demand are more dominant within certain modes than others. For example, 60 percent of global transport demand is passenger transportation, which is growing at a rate of 1.5 percent annually on average, and such growth is projected to continue 2040. Most of this transportation demand is still focused on roads. This is particularly true of Europe, where the road segment accounted for 82.5 percent of the total EU passenger transport in 2012 (see Eloy Álvarez Pelegry, et al, Chapter Three). The same is basically as true for Latin America and Africa, where private demand for light-vehicle passenger vehicle travel are poised to boom—unless such projected future demand is shifted successfully to public transportation which uses higher capacity road and rail vehicles. The global vehicle fleet numbers approximately 1.2 billion today, around 95 percent are light-duty passenger cars. That number is expected to hit 2 billion by 2035. Clearly, efficient and low-carbon transformation of road passenger light duty vehicle traffic is a key priority on all the Atlantic continents.

However, freight and cargo transportation are also significant and growing, particularly in the Southern Atlantic. Freight traffic can be divided into bulk/dry goods (including solid energy, like coal), liquid energy (like oil and LNG) and container traffic (principally manufactured goods, and which can easily travel on different modes). Freight transport in non-OECD will grow by 30 percent from 2015 to 2040. More than half of the growth of the world's freight transportation energy use will come from non-OECD countries. Freight traffic is still predominantly undertaken by heavy-duty road vehicles (i.e., trucks), at least on land, but maritime cargo has also increased significantly in recent decades and continues to do so (see Jordi Bacaria et al, Chapter Six). On the other hand, rail transport could take on a greater role, as part of a mode shift to cut transportation costs and overall freight transport emissions, if only in certain regions under particular circumstances (see Roger Gorham, Chapter Five; and João Fonseca Ribeiro, Chapter Seven).

The four land-based energy and transportations systems of the Atlantic world have each been configured within the respective possibilities created, and limits imposed, by the concrete geographies and specific economic and technological histories of their corresponding continental spheres. As such, they are quite distinct from each other, and relatively independent and autonomous (see R. Andreas Kraemer, Chapter One). Yet they have all been shaped and are increasingly linked by the maritime energy and transportation space of the Atlantic Basin (see Jordi Bacaria and Natalia Soler-Huici, Chapter Six, and João Fonseca Ribeiro, Chapter Seven).

Northern Atlantic land-based transportation sectors are relatively mature: in the U.S. and Europe, where fuel economy and vehicle emissions standards have had a long and relatively effective history, oil demand and emissions have levelled, and efficiency has risen. Indeed, in Europe and the U.S., the growing if nascent (and not completely exclusive) trend, in large part stimulated by these very vehicle and fuel standards, is toward electric vehicles in passenger mobility and LNG in road-based (i.e., heavy-duty vehicles) and maritime freight transport (see Álvarez Pelegry et al, Chapter Three and Fonseca Ribeiro, Chapter Seven). Although EVs still only comprise about 1 percent of the light-duty vehicle fleet in the Northern Atlantic and Asian economies, the EV market is poised at an inflection point, propelled forward by the rapid development of new influencing factors.

Collapsing renewable energy prices and lower battery costs are driving the energy and transportation co-transformations. Renewable electricity generation has fallen more than 50 percent in the last decade and a similar reduction is forecast for the next ten years. The story is the same with respect to the costs of battery storage: McKinsey projects that battery prices will fall from $383/kWh in 2015 to $197/kWh in 2020, to $163/kWh in 2025, and to as low as $150/kWh in 2030 (see Álvarez Pelegry et al, Chapter Three). The home solar complexes (solar roof panels—even elegant tiles—together with electric vehicles and home battery and charging facilities) now being promoted by Tesla (and highlighted by R. Andreas Kraemer in Chapter One) represent a key infrastructure nexus that can drive the electrification of the passenger transportation sector, particularly in the U.S. and Europe.

In Europe, integrated policies are in place to promote alternative transportation fuels and the strategic expansion of broader continental transportation infrastructures (along with the specific infrastructures for electric and compressed natural gas vehicles, and LNG facilities for cargo transport included in the TEN-T EU transportation corridor and infrastructure strategy), thus removing one of the principal barriers to the rapid expansion of EVs and electrification of transport more broadly. The EU's integrated energy, transport and climate strategies also incorporate the broader maritime realm, and maritime transport in particular, as well as the crucial land/sea-energy/transportation interfaces of the port-cities, in an overarching climate and green growth strategy to meet the objectives of Europe's 20-20-20 program and the Paris Agreement (see Álvarez Pelegry et al, Chapter Three and Fonseca Ribeiro, Chapter Seven).

In North America, the principal transportation policies focus on fuel efficiency standards (including a mandatory target of 36mpg by 2025, along with the only existing targets in the world for heavy freight vehicles). Furthermore, gas continues to displace coal in the generation mix and renewable energies (REs) now dominate new capacity additions. States and cities have become the principal promotors and facilitators of the uptake of REs in the generation mix, and even of public transportation. Electrification of transportation is also proceeding apace, increasingly in a sustainable self-generating way, as costs of both renewables and batteries continue to fall, and as new EV models penetrate the market (see R. Andreas Kraemer, Chapter One; and Eloy Álvarez Pelegry et al, Chapter Three).

Meanwhile, in the Southern Atlantic of Latin America and Africa, much of the land-based transportation demand which accompanies economic development—which the U.S. and Europe have already experienced—has not yet taken place. But without a change in energy, transportation and other related policies and practices, a massive increase in transport demand is on its way in the Southern Atlantic, along with the significant increase in all types of emissions (GHGs and air pollutants like NOx and SOx) that will come with it. Furthermore, in both of these continents, fuel efficiency, quality and emissions standards are either weak or non-existent, and they are undermined by significant imports of second-hand vehicles from the advanced economies which are older, dirtier and less efficient (see Lisa Viscidi and Rebecca O'Connor, Chapter Four; and Roger Gorham, Chapter Five)

In Latin America and the Caribbean region, where urbanization rates are high (85 percent) and growing, much passenger transportation already takes place via public transportation networks. More than one-third of all Latin Americans rely on the use of public transportation on a daily basis, but in many cities this number is higher than 50 percent (Bogota, Medellin, Lima and Quito) and in some cases, like Mexico City and Panama City, more than two-thirds (see Lisa Viscidi and Rebecca O'Connor, Chapter Four). However, with continued economic growth the private transportation fleet is mushrooming as the middle class continues to expand (and as last-mile connectivity continues to be a challenge for public transportation), driving demand for light-duty vehicles. The region has the fastest growing motorization rate in the world, around 4.5 percent a year. Motorization has nearly doubled from 2000—from 100 vehicles per 1000 inhabitants to 170. The LAC regional fleet is expected to triple to more than 200mn vehicles in 2050, according to business as usual projections.

Meanwhile Africa generates only 3 percent of global CO_2 emissions and only 4 percent of transport-related CO_2 emissions. This is low by global standards but still a concern for the future given that the intensity of transport-related CO_2 emissions relative to economic output is high; therefore, as African economies continue to grow, transport emissions will rise faster in Africa than in other world regions (see Roger Gorham, Chapter Five). Also, the proportion of CO_2 emissions than come from transport is higher than in most other regions. Transport emissions are growing faster than any other source of emissions in Africa. The current and expected dynamics of transport emissions in LAC is similar to those of Africa, if somewhat less acute.

This situation is the result, on the one hand, of a still high level of energy poverty—most people in Africa (65 percent to 75 percent) do not have access to electricity or clean cooking fuels, let alone to private vehicle transportation—and, on the other hand, to the current predominance of the informal private bus sector in the passenger transportation sphere. Anywhere from 36 percent to 100 percent (with a median of 86 percent across a group of 20 African cities) of all road-based passenger transport was carried by paratransit vehicles, mainly minivans and small buses (see Roger Gorham, Chapter Five). This dominant mode share is characterized by market weakness and informalities, along with an aging, inefficient and dirty fleet, making it a challenge to effectively reform even as it holds much potential for improving economic efficiency and last-mile connectivity with public transportation, and reducing emissions. Compounding such barriers and problems are the previously mentioned realities that Africa (and to a lesser extent LAC) is a technology taker in the energy and transportation sectors, and that vehicle inefficiencies and emissions leak from the Northern Atlantic into Africa in the form of poorly regulated second-hand vehicle imports.

In the realm of freight transportation infrastructure, and of multi-modal linkages between land and maritime transport, Africa has attempted to follow Europe's lead, in its own way, to map out a transportation corridor and infrastructure strategy (both terrestrial and maritime), consistent with long term development goals, the post-Millennium goals and the decarbonization of transport. This integrated continental strategy is manifested in the African

Union's Agenda 2063, the 2050 Africa's Integrated Maritime Strategy, and the Program for Infrastructure Development in Africa (PIDA). Nearly $30 billion is being invested by the multilaterals, regional instruments and other donor countries, within this strategic framework, in ten major transport corridors and in port expansion projects in more than 10 Africa countries (see Fonseca Ribeiro, Chapter Seven). But in Africa trade and customs restrictions rival the lack of transport infrastructures as the major barrier to more intra-African trade.

Policy Approaches to the Decarbonization of Atlantic Transportation

Given these distinct states of economic and transportation development across the wider Atlantic space, it is useful to view the different Atlantic continents and maritime sphere through the lens of the EASI framework (developed by the Africa Transport Policy Program; see Roger Gorham, Chapter Five). This analytical framework provides for a policy-based decomposition of the sources of CO_2 growth and consists of four layers, or angles, of approach—(1) Enable; (2) Avoid; (3) Shift; and (4) Improve—that may be utilized for increasing the efficiency, and reducing the emissions, of the transportation sector in each continental sphere of the Atlantic Basin.

The Enable component is grounded in the quality and resilience of the institutions of governance, regulation, and policy. This is the foundational realm of the state (and its various subnational instances) which can contribute to (or undermine) the transformation of transportation and its decarbonization. It determines the ability of governments and governance systems to organize themselves in a manner than can generate CO_2 emissions savings via the other methods of approach (i.e., to avoid future transport demand, to shift transport demand from one mode to another, and to improve the vehicles, and fuels/modes of propulsion, involved in each mode). Broadly speaking, the Enable component is stronger in the Northern than in the Southern Atlantic; and it is also relatively more effective in Latin America than in Africa.

The Avoid approach engages land-use, urban and transportation planning in order to avoid future individual passenger demand altogether. Generally speaking, this can be achieved through the design and development of dense, compact multi-use urban environments capable of relying on high volumes of public transport, mass transit and non-motorized transportation (e.g., bicyles and walking). The Avoid approach is most suitable in European urban settings (and to a lesser extent North America), but this is tougher to achieve in the dynamic, highly unregulated demographic and economic patterns (and imperfect markets) of Africa where cities tend to sprawl in a way that fails to capitalize upon the positive aggregating economic effects that cities in the North have generally produced (See Roger Gorham, Chapter Five) LAC falls somewhere between the Northern Atlantic and Africa with respect to the short-term viability of such an Avoid approach.

The Shift approach incorporates the realm of multi-modal transportation infrastructure, policy, and reform. In the area of passenger mobility this typically involves a shift of passenger traffic from lower occupancy private light duty vehicles (the road passenger transport mode) to the higher occupancy vehicles of public transportation and mass transit, (including bus rapid transit, metros and light rail). With respect to freight transport, this could also involve shifting cargo traffic from truck transportation on roads to railroad transport. This is generally more feasible as an approach in the Northern Atlantic, where infrastructure exists and capital for its further development is more available, markets are less imperfect, regulatory regimes are more established, and a history of urban planning is more entrenched. However, the Shift approach is also already well-developed in LAC and could be applied in Africa with appropriate financing, planning, attention to emerging technologies, smart regulation, and targeted market intervention (see Roger Gorham, Chapter Five).

Finally, the Improve approach focuses on improving the quality of transportation vehicles (cars, trucks and ships, for example) and/or their fuels. This can be achieved through appropriate policy and regulatory standards which mandate higher fuel efficiency and quality, and lower emissions. The response of the energy and automotive sectors in the face of obligatory standards could stimulate the production and marketing of lower emissions vehicles and fuels, and even, perhaps, the electrification of transportation.

Such Improve techniques are now more than evident in the more mature energy and transport economies of the Northern Atlantic continents. In part this is because the less mature transportation systems in the Southern Atlantic are technology takers (as Kraemer points out in Chapter One) and as such are dependent on the technological improvements in vehicles and fuels developed elsewhere. But they are also often dependent on these same foreign markets, typically in the Northern Atlantic or Asia, for their supplies of vehicles and fuels as well. Therefore, the Southern Atlantic paradoxical serves as a sink accumulating the leakage from more advanced economies of typically older, less efficient and higher-emitting vehicles which, once retired from the markets of Europe and North America by technological improvements and increasingly stringent vehicle and fuel standards, leak into the Southern Atlantic, where they are sold as cheaper secondhand vehicles, far more accessible to the middle classes, and the masses aspiring to middle class status in Africa's cities, which are growing at the fastest rates in the world (see Roger Gorham, Chapter Five).

Despite the structural barriers that face the Southern Atlantic with respect to energy and transportation transformation, including the leakage of second-hand vehicles from the Northern Atlantic and Asia, weaker regulatory regimes and enforcement, and the role of the informal market, some interesting opportunities present themselves at this juncture, particularly to Africa but also to Latin America. These opportunities take the form of technological and organizational leapfrogging and can be clearly grasped from the developing context of two other technological and policy realms impacting upon the energy-transportation nexus in the Atlantic Basin: (1) the changing nature and potentials of the dynamic electric grid, particularly with respect to energy and transportation, and the various new business, market, system and regulatory models that are emerging to shape and engage such a modernized and transformed grid; and (2) the maritime realm of energy and transportation, and the port-cities which serve as the geographic, strategic and policy interfaces of land and sea transportation, the key enablers of global value chains, and the environmental stewards of the blue economy.

The Changing Nature and Potentials of the Electric Grid

The electric grid was once the specialized and relatively stable terrain of engineers, public utilities, and regulators. For most of the last century, the grid in its various national and regional forms remained highly centralized, handling one-way flows of electricity (traditionally generated from coal, nuclear, hydro and oil, but with time also gas, and more recently REs) from central power stations, through the transmission networks and distribution systems, to the end-user. The most interesting aspect of the traditional centralized grid model was the long-running attempt to resolve its ongoing and changing regulatory challenges, and to maintain fair and stable balance between producers and consumers.

However, possibilities for a more dynamic grid are emerging. Multiple new horizons have been opened up by new and interlocking technological developments in energy, transportation and ICT and related sectors, many of which enable demand side measures (DSM) to efficiently manage two-way flows of energy and data, on much more flexible and linked grids (including microgrids), and with much more effective storage capacity, a higher amount of distributed energy generation, less need for investment in (and management of) transmission systems, higher overall efficiency and quality, and increasingly lower energy and transportation emissions (see Lowery and Leitman, Chapter Two),

There is potential for major grid modernization and transformation all across the wider Atlantic space, and in many parts of the Southern Atlantic this presents itself in the form of enormous leapfrog potential with respect to both the utility-centric, centralized grid model and to continued use of fossil fuels in transport and their accompanying infrastructures.

In Northern Atlantic, this would imply upgrading and modernizing an already mature and complex grid to accommodate a changing, increasingly low carbon energy mix. In LAC, where there is nearly universal access, the challenge is to adapt the existing grids to harness additional low emitting technologies so that further economic development and increased per capital electricity consumption does not result in significant increases in GHGs. In Africa, where electricity access is still highly limited, grids are not fully deployed in rural areas, and where national grids do exist, they tend to function poorly, and their reach is limited. Distributed RE-powered microgrids (possibly administered through ESCOS, energy services companies, or through energy cooperatives) could facilitate a leapfrogging of an entire infrastructural stage in development. A largely non-grid reality could evolve into microgrids and then into a network of microgrids.

Within this context of potential grid transformation, new models of energy generation and distribution have begun to emerge in the Atlantic Basin, primarily in the Northern Atlantic, but they also hold much promise for the South.

First, there has been the development of distributed energy resource systems (DERs) which are characterized by small scale generation and a closer positioning to the centers of demand. When connected to other grids DERs provide for significant resilience and demand-side management possibilities which reduce the need for transmission line planning and investment, and the political opposition that often comes with it.

The efficiency of both connected grids and microgrids will depend on managing two-way flows of data and power. An agile fractal grid would be able to isolate sections of a distribution system for protection purposes and to provide a reliably continuous flow of power from DERs when central station power is not available. Such an integration of the potentials of DERs and microgrids leads to a more resilient grid, which overlaps with climate change adaptation priorities. Grid resiliency would be even further enhanced by the progressive electrification of transport. Distributed energies, particularly renewables, microgrids, and ICT-supported platform, sharing and prosumer market and business models in energy, transportation and related sectors, along with further development of EVs, could drive such grid modernization.

Second, there is also the growing energy cooperative movement. Energy cooperatives are strongest and most widespread in North America and Europe, but they are expanding in Latin America and show much promise for Africa (see Lowery and Leitman, Chapter Two). Energy cooperatives in North America have grown out of the older commons model of rural electrification that was born in the 1930s and later spread. Cooperatives are now abetted by ICT and other related technologies. Some analysts see the convergence of these multiple technological and market trends as giving rise to a new energy commons in an increasingly zero-marginal cost society. Under such a perspective, cooperatives could become an alternative organizing principle and business model for the modernized and transformed dynamic grid, with the potential to stimulate renewables and transport electrification, and to facilitate technological leapfrogging, particularly in Africa (see Lowery and Leitman, Chapter Two; and João Fonseca Ribeiro, Chapter Seven).

The energy cooperative model—in which consumers of energy are also potentially owner/ producers as well as providers of energy storage and other ancillary services to the grid—overlays particularly well with the emerging trend toward distributed energy (as in community solar development) and the introduction of more flexible microgrids within and beyond the reach of national electricity grids. The cooperative model also dovetails very well with the more overarching trends generated by the mutual co-transformations of energy, transportation, ICT and related technological realms mentioned earlier: including the democratization and prosumerization of energy; the electrification and multi-modalization of transportation; and innovative ways of engaging the dynamic grid (see Lowery and Leitman, Chapter Two).

The cost and emissions synergies generated by the overlapping co-transformations in energy and transportation, in the broad ICT and technological realm, and in manufacturing and trade, are creating an interlocking set of policy and economic incentives pressing toward the prosumerization and democratization of energy production, the development of microgrids powered by distributed renewable energies (sometimes in combination with gas, hydro, or diesel), and the progressive electrification of transportation and the broader economy. This dynamic grid modernization and transformation would stimulate new market, business, system and regulatory models for the energy and transportation sectors capable of generating economic efficiency and emission reduction gains.

Any such transformative modernization of conventional centralized electricity grids would also force a redefinition of the function and role of what have traditionally been known as utilities. With the prosumerization of energy generation, use and trade, utilities could become distribution system operators (DSOs) and provide only grid management services, allowing and facilitating consumers to choose among multiple wholesale power and energy service suppliers. Alternatively, utilities could become more consumer-centric, offering or facilitating the same innovative energy services, in competition with other third-party providers (i.e., ESCOs).

The Maritime Energy and Transportation Realm in the Atlantic Basin

The Atlantic maritime realm is partially obscured by long-term terrestrial blinders that produce a widespread distorting mental map effect known as sea blindness—a generalized relative lack of consciousness of the sea and the realities and developments of the maritime realm. The Atlantic is no different than the other ocean basin regions in this regard.

One result of this blind spot in our policy and regulatory perspectives is that the Atlantic Ocean is in danger of becoming a potential sink for the leakage of air-borne emissions like GHGs and air pollutants from the continental reach of land-focused national and regional legislative and regulatory jurisdictions. This leakage is similar in effect to the earlier-mentioned leakage of second-hand (older, less-efficient, dirtier and higher emitting) vehicles from the Northern Atlantic into the Southern Atlantic vehicle sink. In this regard, the seas and oceans remain a vulnerable sink for pollution and emissions leakages from land-based regulatory regimes (see Jordi Bacaria and Natalia Soler-Huici, Chapter Six; and Fonseca Ribeiro, Chapter Seven).

While the land-based emissions regime is firmly under control of the UNFCCC process and the Paris Agreement, the maritime emissions regime has been delegated to the International Maritime Organization. This intergovernmental global organization has proceeded more slowly than land-based national policy and regulatory jurisdictions with respect to regulation of maritime air pollutants (which negatively affect the air quality of port-cities and coastal hinterlands), but especially of maritime GHG emissions (which affect the entire world by undermining the progress and effectiveness of land-based emissions reductions efforts framed by the UNFCCC and the Paris Agreement). (See Fonseca Ribeiro, Chapter Seven)

The maritime realm has undergone enormous transformation and growth in the last century, driven in large part by the globalization of the economy, the expansion of international trade, the boom in maritime transport and, more recently, the deepening and constantly shifting development of so-called global value chains. These trends, in turn, have been fed by a reduction in maritime transport costs, brought on by the continued increase in the size of ships, improvements in ship design and efficiency, and the containerization of much of merchandise trade in manufactured goods. All of this has contributed to an explosion in maritime trade and transport (see Jordi Bacaria and Natalia Soler-Huici, Chapter Six). Although the Atlantic Basin currently transports less maritime cargo than the other major ocean basins, much future maritime transport demand is poised come from Southern Atlantic economies.

In the second phase of post-Cold War (or post-Wall) globalization, global value chains have become interdependent with trade and transportation volumes, patterns, routes and modal systems. The more fragmented production is distributed throughout a geographically disperse value chain, the more intermediate goods comprise that value chain and, therefore, the more container transportation will be required. Expanding, deepening and shifting global value chains (GVCs) will continue to exert a trend toward increasing VKT (or vehicle kilometers traveled) of freight transportation as gross domestic product (GDP) rises. This has given rise to a paradox of carbon-efficient maritime transport: although maritime transportation is the least carbon-polluting transportation mode by unit of cargo transported, the overall increase in maritime transport demand—driven by falling costs and the development of global value chains based on multiplying types of intermediate goods—ends up pushing up overall maritime emissions, and at faster rates. Globalization, through global value chains and expanded trade and transportation, generates the externality of increasing the aggregate emissions from the maritime realm which is still only insufficiently regulated (see Jordi Bacaria and Natalia Soler-Huici, Chapter Six).

This challenge is compounded by the fact that the decarbonizing options available for maritime transport energy are less obvious and less diverse than those available for land-based transportation. Currently, LNG is the leading maritime fuel alternative to the use of bunker fuels (fuel oil) given that some gas infrastructure already exists, LNG is also relatively abundant and offers some air pollution and emissions reduction gains (see Joao Fonseca Ribeiro, Chapter Seven).

But as a result of deepening global value chains, an increasingly important mutual dependency has developed between terrestrial and maritime (and even air) transportation systems. The transport of merchandise trade in one of these systems often depends on, or conditions, the transport volumes and types in the other. International trade depends on the efficient functioning of both. Therefore, progressive movement toward renewable energy and the electrification of land transportation can facilitate and stimulate the progressive greening of maritime transportation through the provision of clean energy to ships while at shore in port (and even on approaches and departures).

In this emerging context of heightening mutual relevance and dependency between the terrestrial and maritime trade and transportation systems the role of the port-city takes on new salience. Port-cities serve as the geographic and modal interfaces for terrestrial and maritime transport, and as such become the strategic fulcrum and the integrated policy and regulatory platforms for the energy, transportation, ICT, manufacturing, trade and climate change co-transformations (see João Fonseca Ribeiro, Chapter Seven).

The port-city is an appropriate and effective level of governance for stemming regulatory leakages of emissions from the land into the sea, and it can act a lever for reducing both terrestrial and maritime emissions. As the natural nodes of influence over the blue growth of the Atlantic Ocean, port-cities can also serve as the economic and technological platforms for the sustainable development and governance of the blue (or ocean) economy.

But maritime transport and port-cities are increasingly subject to transformative pressures—including the trend toward deep water ports (as ship size continues to rise) and the ongoing deepening and shifting of GVCs (which intensifies competition between ports). The result can often be an antiquated and decaying port-city. Even when a port relocates, a port-city mismatch in policy and planning can lead to a long-term decline of the urban area around the old port and a lack of economic and regulatory integration between the new port and the city.

Cities are already increasingly acting as strategy and policy protagonists in the effort to reduce GHG emissions and air pollutants. They are increasingly interacting with each other in cooperative networks, sharing best practices, lessons learned and even new applicable models. There is room for coastal cities, and for Atlantic port-cities in particular, to further engage such efforts at transnational cooperation.

The potential synergistic effects on overall efficiency, emissions and growth stemming from a transformation of port-cities would be large, given their unique capacity to guide and implement integrated continental, regional and national strategies in overlapping energy, transportation, climate and maritime policy terrains. Strategically aligned and renovated, green port-cities could serve as catalysts for a progressive (if partial) greening of the maritime realm, as facilitators of improved multi-modal transportation systems linking ports with continental hinterlands, and as integrated policy agents and regulators for smart green and blue growth.