Chapter 2
Energy and Environmental Policy and Economic Development

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Abstract The Stockholm Declaration of 1972 first officially recognized the call for worldwide Sustainable Development. Almost fifty years after that, the world has its greatest opportunity to pursue this goal. Environmental policy and energy policy are key tools for achieving sustainable development as there are a fair (and growing) number of worldwide experiences that show that the focus on environmentally-responsible practices can boost growth. Developing countries are those to get the most benefits, as they are the most affected by environmental threats. In light of the latter, this chapter revisits the theoretical perspectives on micro and macro system on economic development and environmental policy. The case of Europe is stressed as an example of successful integration of the latter into overall policy action. The chapter then discusses the role of Sustainable Energy Technologies (SET) and other alternatives as core elements of a sustainable and economic growth driven framework, and analyzes Portugal context within the European Union as a case study. Lastly, this chapter identifies challenges and opportunities for Mexico to build an integrated energy and environmental policy framework that supports development considering the tension this creates with the policy standpoint of the country's current administration.

Abbreviations

ASEA	Agency for the oil and gas sector (Mexico)
CEL	Clean Energy Certificates (Mexico)

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CFE	Federal Electricity Commission (Mexico)
CIT	Carbon Intensive Technologies
CNH	National Hydrocarbon Commission (Mexico)
CRE	Regulatory Energy Commission (Mexico)
ENE	National Energy Strategy
EU	European Union
GHG	Greenhouse Gases
IMO	International Maritime Organization
MIBEL	Iberian Electricity market
PEMEX	Mexican Oil State Company
PNAC	National Program for Climate Change
PNAE	National Energy Efficiency Action Plan (Portugal)
PNALE	National Plan for the Allocation of Emission Allowances
PV	Photovoltaic
R&D	Research and Development
SCE	National System of Certification of Energy and Air Quality in Buildings
SDG	United Nations' Sustainable Development Goals
SET	Sustainable Energy Technologies
SGCIE	Management System of Intensive Energy Consumption

1 Introduction

In 1987, fifteen years after the Stockholm Declaration of the United Nations that was a pioneer in acknowledging the effects of human activity on the environment, the World Commission on Environment and Development made an urgent call to create a global agenda for change. The response came in the form of the popular Report of the World Commission on Environment and Development; Our Common Future, led by Gro Harlem Brundtland. The so-called "Brundtland Report" aimed to create a long-term agenda for action that could fulfil the goals and aspirations of the world community. But more importantly, this Report also put forward, arguably, the most accepted definition of sustainable development to date: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

This is precisely the departure point of this chapter, since sometimes it is quite clear that there is a tension between fulfilling "present needs" without compromising "future needs", particularly when the quality of life of a society is not high. For those countries that have not reached high levels of development, environmental policy appears as a stark restriction on economic growth. Yet, most often this is false economy, because not aligning their energy requirements with their environmental limits could, in many cases, actually hamper their economic growth.

This chapter thus seeks to throw light on how countries can effectively escape such a trap by considering a systemic approach to sustainable development that makes salient the relevant policy trade-offs that arise when environmental and energy policy are not aligned to foster economic growth.

In the first part, the chapter revisits theoretical perspectives on micro and macro systems on economic development and environmental policy, with emphasis on the literature that has analysed the economic and environmental interactions of developed and developing countries in relation to economic growth. The second part of the chapter is an overview of the historical evolution of the interaction between energy and environmental policy, with stress on the specificity of the latter as key to successfully integrate it into overall policy action, particularly in Europe. The third part of the chapter presents the trade-offs that prevail in fostering economic growth when considering environmental policy in a sustainability framework. The role of Sustainable Energy Technologies (SET) as a core element of such strategy is discussed in depth, as well as different policy alternatives for integration of environmental and energy policy as enablers of economic growth. The fourth part of the chapter introduces best practice for environmental and energy policy integration, within the policy framework of the European Union, with Portugal, particularly, as a relevant case study. Finally, the fifth part of the chapter discusses an emerging economy case: Mexico's dramatic structural rearrangement of 2010s in environmental and energy policy. This part provides insight into how environmental and energy policy are intertwined into facilitating (or obstructing) a sustainable approach towards economic growth.

2 Micro and Macro System Perspectives on Economic Development and Environmental Policy

In the context of contemporary energy and environmental policy, the relationships of interests are those that describe the processes and factors that lead to economic growth. For this reason, in this section, we briefly describe the relevant studies in this field and use them to build a systemic representation of key policy trade-offs.

In this regard, the pioneering work of Austrian economist Joseph Schumpeter (1934) has provided some of the basic systemic concepts that can be used for describing economic growth in an era of accelerated technological change and innovation. Schumpeter places entrepreneurial activities and technological change at the centre of economic evolution. In his view, the economy is changed through innovation waves of "creative destruction" that transform the existing means of production and trade, eliminating the need for some services in the economy, and at the same time creating new ones. These ideas have been very influential in contemporary policy perspectives on economic development and environmental policy and place this field of study at the intersection of economic and natural systems.

Theoretical perspectives on development can be divided into three groups. The first group comprises studies that focus on understanding the role of markets and industries in shaping growth patterns; we defined these as micro-behaviour models. The second group includes studies that focus on understanding growth at the country level; we refer to these as macro-behaviour models. Finally, the third group consists of studies that have specifically focused on studying the economic and environmental interactions of developed and developing countries in relation to economic growth. In reality, these perspectives are closely linked as they use similar concepts and methods, but for the benefit of the present argument it is more suitable to describe them separately.

The micro-behaviour models of growth are primarily focused on dynamic change at industrial levels. For these models, economic development can be understood as the result of the interaction of economic agents through dynamic mechanisms such as research and development (R&D), learning by doing, economics of scale and social learning. For example, Nelson and Winter (1982) focus on understanding the influence of firms' R&D strategies, and of innovation characteristics for shaping industries' long-term structure (i.e. degree of concentration, productivity). Dosi (1988) argues that knowledge needed for developing an innovation which can be ultimately commercialized in the market, is accumulated through several dynamic processes, such as R&D, knowledge spillovers across technologies and companies, and learning by doing in the market. Dasgupta and Stiglitz (1980) incorporate the role of the market structures (i.e. monopoly, oligopoly, perfect product competition, R&D competition), while including the risk profiles of a firm's R&D strategies in their game theory model of industrial development. Their results show that free competition in products only produces suboptimal levels of R&D, while competition on R&D produces research in excess. Finally, Arthur's model (1989) of competing technologies shows that the initial conditions in technology competition can be determinant in shaping growth trajectories. He demonstrates that early random events in technology competition can favour inefficient technologies in the beginning of technological races. This initial advantage can be extremely difficult to overcome, and it can lead to market domination by inefficient technologies in the longer term.

The macro-behaviour models of interest include research studies that specifically concentrate on the dynamics of economic change at a country level. Romer's model (1990) of endogenous technological change is among the pioneering works in this field. His model expands the one-sector neoclassical model by explicitly allowing economic agents to make R&D investment decisions. As a result, economic growth in his model is powered by technological change. His model is one the first models to provide a modelling framework to the empirical findings of Robert Solow (1957), and it is considered to have provided the building blocks of endogenous growth theory.

The models developed by Silverberg and Verspagen (1994) consider a broad system boundary when analysing economic change at a country level. Their model series takes into account several processes of economic change and growth that have been observed empirically, including the co-existence of concurrent technologies and the firm's heterogeneous behaviour. Their analysis shows that firms with higher R&D investment fluctuations tend to fail in the market faster than firms that have a more stable R&D strategy.

Aghion and Howitt (1992) developed an endogenous growth model in which vertical innovations, generated by a competitive research sector, are the engine of economic growth. Their model describes firms as agents that are motivated by the prospect of monopoly gains that can be captured when a successful innovation is patented. However, these gains are lost once a superior innovation is developed. In this model, technological change and growth are closely linked; the rate of growth is positively correlated with the size of innovations, the size of the skilled labour force, and the productivity of research.

In addition to the micro and macro behaviour-oriented models, there are other relevant studies that focus on the dynamics of the economic and environmental interactions of developed and developing countries.

Fernandes and Kumar (2007) use a macroeconomic dynamic model to study the welfare implications of the technological investment choices that poor and rich countries face in light of their trade interactions. Their analysis shows that there are cases in which rich countries have developed economic incentives to improve a poorer country's technology because this can yield positive welfare gains derived from better terms-of-trade with the poorer region, and from greater specialization in sophisticated goods. Lempert et al. (2006) use a system dynamics model to study the economic, demographic and environmental challenges of global sustainability.

In this study, technological change is represented by the rate at which economic development decouples from environmental pollution. They analyse the performance of different static and adaptive policies under a wide range of scenarios (5200) and show that each policy is associated with different trade-offs for the North and South, which is one of the most critical aspects of coordination between these regions. Acemoglu et al. (2009) introduce endogenous technical change in a growth model with environmental constraints and limited resources. Their model considers an economy in which only one good is produced by combining the inputs of two sectors. One of these sectors uses technologies that pollute the environment and deplete resources rapidly, while the other sector uses technologies that are more environmentally efficient. Their analysis shows that it is possible to direct technological change in the direction of clean technologies, while achieving economic growth by implementing a combination of both carbon taxes and research subsidies. They also consider the role of developed and developing countries and show that if clean sectors are substituted for the dirty sectors, policy changes in the North may be enough to avoid global environmental disaster. Silverberg and Verspagen (1995) extend their endogenous growth model to analyse the dynamics of the interaction between multiple countries. In their model, countries can interact through technology transfer and behavioural imitation. Howitt (2000) also has extended his earlier Schumpeterian growth model into a multi-country version. In this model, countries are only connected through technology transfer. Their simulation and analysis show that countries that engage in R&D activities converge to parallel growth trajectories, while countries that do not invest in R&D stagnate.

This review of the relevant models that have been used to study economic growth at an industry level and at an international level is very useful to define and understand pertinent system relationships to be considered in current environmental policy debates. Figure 1 presents a system diagram that captures some of the ideas discussed in the previous paragraphs. Under this conceptualization, competition for R&D

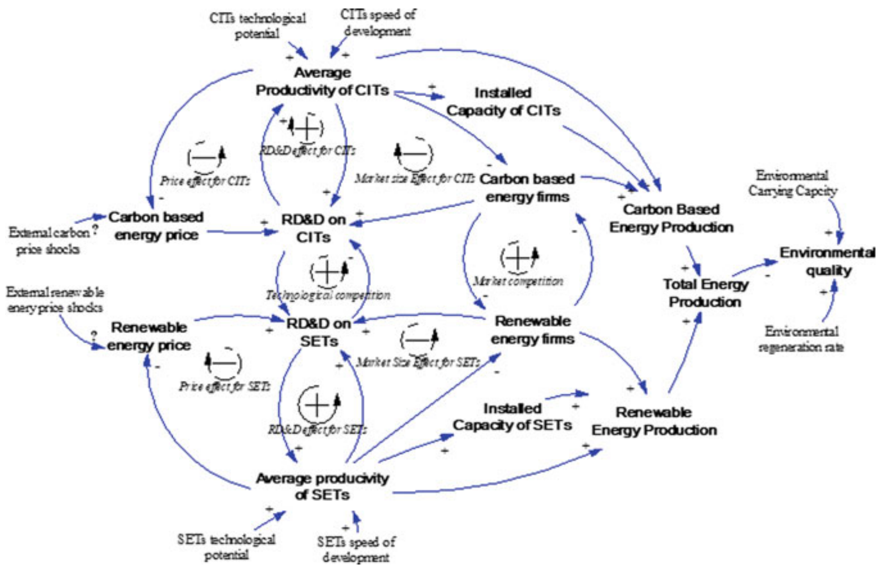

Fig. 1 Regional SETs' diffusion system diagram. *Notes* The links between each variable represent the direction in which a variable influences the other. The cardinality of each link specified is as follows: a positive cardinality indicates that the two variables change in the same direction (e.g. if one variable decreases the other also decreases), a negative cardinality indicates that the two variables change in opposite directions (e.g. if one variable increases the other decreases)

resources and for market power is the central force that directs technological change towards Carbon Intensive Technologies (CITs), or Sustainable Energy Technologies (SETs). We show three feedback loops which are central for supporting the development and penetration of a given technology, these are: The price effect; the R&D effect; and, the market size effect. The evolution of each technology's productivity plays an important role in changing the price of the energy being produced with that technology, and also in creating incentives for investing in its R&D and in the creation of new firms that use this technology for energy production. The productivity of each technology is a function of its technological potential and of its rate of development. The technological potential refers to the marginal increase in productivity per incremental innovation, and the speed of development refers to the frequency at which these innovations occur. The energy mix produced using CITs and SETs impacts directly the environmental quality of the region, for example, quantity of greenhouse gases emitted per unit of energy produced. Finally, the initial state of this system is such that SETs are behind CITs in terms of productivity and market share. Therefore, the diffusion of SETs in this system occurs only when SETs are able to capture sufficient R&D resources and market power to make the price, R&D, and market feedback loops work for their benefit.

3 A Short History of Energy and Environmental Policy

Environmental policy encompasses a wide variety of rules, laws, and regulations regarding the use of environmental assets (including energy flows) by humans and externalities on the environment caused by human activities. We structured the history of environmental policy in five phases: Pre-industrialized; industrialization; growing environmental awareness; sustainability focus; and, integration.

The pre-industrial phase describes the set of mechanisms, rules and norms to protect and control the environment, set before the industrial revolution. Environmental policy during those times entirely focused on avoiding direct consequences of the scarcity of environmental assets on the continuation of societies, but also on reducing environmental damage that lead to human welfare decline within the immediate environmental limits (Kraft 2017; Yoffee and Cowgill 1991). For instance, there is evidence of waste disposal rules in the Roman Empire (Gray 1940), forest-harvesting quotas in the Greek empire (Hughes and Thirgood 1982), sanitation norms in the Aztec city of Tenochtitlan (León 1992), hunting restrictions in colonial America (Andrews 2006) and natural protected areas in South Asia and the Americas (mainly related to the areas' sacred designation). Energy use and consumption relied mainly on muscle power by humans and animals, and on traditional biomass (as discussed in Chap. 1, Sect. 1.1); therefore, there was not a specific energy policy. Instead, energy flows were discussed under the norms for agriculture and forestry (Harris 2013).

The industrialization phase characterizes the efforts made by early industrialized societies in the nineteenth and early twentieth centuries. The focus on environmental policy did not change drastically from the previous phase, i.e., it still focused on direct consequences and damage within the immediate environmental limits,[1] the scale of those limits grew as urban societies and its technological base became more complex and connected to each other (Kraft 2017). Moreover, industrialisation led to a radical change in manufacturing processes, which in turn put more pressure on environmental assets (Andrews 2006). Also, during this phase, the first two official natural protected areas worldwide were legally recognized: one, in the island of Tobago and the other, in the United States (WHC 2019; Kraft 2017). Particularly, energy policy consisted mostly of allocating the ownership of natural energy resources among the industries that extracted, transformed, and marketed them for securing supply and meeting domestic demand (Colmenares 2008; Stiftung 2014).

The growing environmental awareness phase describes the arising consciousness about environmental threats from within and outside the immediate environmental limits by modern societies. This occurred from around the mid-twentieth century until the early 1970s, and the rising activism by society and governmental actors as a response to these perceived threats (Kraft 2017). Formal economy-wide policies were set, which were self-contained and included several policy instruments for its implementation and enforcement. For example, the Clean Air Act in 1956 in the UK

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[1] The immediate environment refers to an area of natural environment within which a certain society lives and performs most of its activities. Particularly, the immediate environment provides **direct** environmental services to the particular society (e.g., sanitation, air cleansing, and water provision).

and the Air Pollution Control Act in 1955 in the U.S. were the first legislation to approach the increasing pollution problem in big cities (Muskie 1968; Sanderson 1961) Also, the first Environment Action Program of the European Council was crafted in 1973 and included product and environmental quality norms (Hey 2005). Moreover, during this phase, some of the most important environmental protection organizations were funded, e.g. the World Wide Fund for Nature in 1961, and Greenpeace in 1971 (Greenpeace 2019). Therefore, this phase marks the beginning of modern environmental policy and governance (Andrews 2006). On the flip side, the Arab Oil Embargo of 1973 put emphasis on the fundamental role of energy use in economic growth (Hoffman and Jorgenson 1977; Manne et al 1979) [1] and on the need for reducing oil dependence for energy security concerns (Stiftung 2014), but also on mechanisms to foster energy efficiency in industry, particularly in the chemical industry as presented in Chap. 3. Due to the latter, energy policy expanded its focus to setting market rules for the energy sector, specifically on trade tariffs, taxation, and oil commodity prices (Hartnett 1991; Bamberger 2003). It also extended to research and the development of alternative energy sources and energy-saving strategies (Solorio and Jörgens 2017; Stiftung 2014).

During the sustainability focus phase (1980s and early 1990s), there was a change of focus for environmental policy due to a worldwide awareness of the natural limits of growth related to the scarcity of non-renewable natural resources (Hey 2005) [the example for copper is presented in Chap. 1], and also on the related economic, social and intergenerational issues. Environmental policy represented one of the most important tools to fulfil the recommendations for sustainable development of the 1987 Brundtland report (Keeble 1988). Moreover, climate change concerns, arising in the early 1990s, required further specialisation of environmental policy and became one of its central considerations. Thus, the evolution of environmental policy became more complex as it needed to balance counteracting forces, such as, economic progress, growth of material consumption, energy security, emissions reduction, international cooperation, and political control (Kraft 2017). During this phase, the first United Nations Climate Change Conference took place in 1995, where the foundations of the Kyoto Protocol were established (Stiftung 2014; Oberthür and Ott 1999). Energy policy kept a market-based orientation, mainly focusing on enhancing market efficiency through liberalisation, competition, and privatisation (Helm 2005; Pearson and Watson 2012; Tenenbaum et al. 1992). Policy for the promotion of renewable energy technology attracted more attention, but had little success (Hey 2005). In addition, despite the main focus on energy, policy at that time was not on concerns about climate change and energy-related environmental impact (Fells and Lucas 1992; Jackson 1992), this market-oriented approach induced better quality of policy instruments for reducing GHG emissions (Pollitt 2012).

Finally, the integration phase refers to the trend of complete integration of environmental and sustainable development objectives into all areas of policymaking, including non-environmental sectoral policy, during the last two decades (Lafferty and Hovden 2003). This integration also includes a better coordination between individual environmental policies (EU 2019a) and the full realignment of energy policy to other environmental policies (Pearson and Watson 2012)—see Sect. 5. Despite this, the fact that such integration has only occurred partially, especially in Europe, it has therefore made slow progress so far (Nilsson 2005). Environmental policies have become less ambitious than their predecessors, but more specific in terms of implementation and enforcement to increase their chances of success (Hey 2005; EU 2019a). During this phase, energy policy has deepened its focus on climate change, even fossil-related policy (Murray and King 2012; Van de Graaf and Verbruggen 2015). In this regard, policies for the development and promotion of renewable energy, and for the regulation of residential and industrial energy consumption and efficiency have been issued in most countries that signed the Paris Agreement (Braun and Glidden 2014; Meckling et al. 2017; Solorio and Jörgens 2017).

[1] The Arab Oil Embargo also boosted the field of energy-economic modelling (Miller and Blair 2009; Manne et al 1979).

4 Trade-Offs in Inducing Growth Through Environmental Policy and Sustainability

In response to several multi-lateral agreements, a large set of counties have defined national energy and environmental policies to face common challenges, such as Climate Change. The objectives of these strategies are to prepare nations for future Climate Change, and to reduce the Greenhouse Gas emissions (GHG) of their economies in order to induce economic growth (CICC 2007).

The diffusion of Sustainable Energy Technologies (SETs) is a core element of these strategies. The assumption is that SETs have the potential for protecting a nation's natural resources, reducing GHG emissions, and fostering the creation of new environmentally sustainable market niches. However, although the intent of these policies seems to balance correctly the economic, environmental, and social concerns, in reality, it is still a contentious issue of how to achieve the right balance between protecting the environment, and enhancing equitable economic growth and social development. This has raised concerns about an individual nation's capacity for successfully achieving these multiplicities of goals.

Future prospects are also challenging. The rate of economic and demographic growth of developing economies is expected to continue rising over the following decades, and this will increase the pressure on their natural resources and the vulnerability of their populations to Climate Change.

Social factors are especially important when considering the developmental trajectories of developing countries in the context of environmental policy. In contrast to developed nations, developing countries are undergoing a process of transformation in which their public institutions, as well as their citizens' economic values, are being established as a direct consequence of the maturation progress of their democracies. The outcome of these transformations is highly uncertain, and history provides various examples where unexpected transformations can take place in developing countries (e.g. the Arab spring, China's vigorous economic growth).

There are three dimensions to these social factors that seem to be the most relevant for environmental policy and for stabilising these countries' greenhouse gas emissions: (a) population growth, (b) economic growth, and (c) consumers' preferences. In particular, these dimensions are more relevant in emerging markets, such as China, India, and Brazil.

The population growth of developing countries is an important consideration in this context. Population growth increases these countries' energy demands, which may result in higher greenhouse gas emissions. However, it also increases the potential economic value of their energy markets which increases the attractiveness of these markets for developers of SETs and CITs. Nevertheless, it is not clear if the populations of these countries will continue growing in the coming decades. Experience in some developing countries suggests that deviations can occur. For example, the growth path of Mexico's population drastically changed during the 80s because of the implementation of family planning policies which contributed to stabilising Mexico's growing population. However, recently Mexico's birth rate has steadily grown, making it uncertain whether the population of Mexico will remain at stable levels, or will continue growing in the coming decades. China offers another interesting example. In this case, the one child policy successfully stabilised China's population, but current concerns about the fiscal burden of China's aging population may incentivise Chinese policy makers to encourage population growth in the coming decades.

The economic growth path of developing countries is perhaps more relevant than their population growth. Especially when considering the future economic growth of emerging economies such as China, Brazil and India. Over the last decade there has been ample speculation regarding the economic prospects of these countries. However, recent economic events show that the economic dynamisms of these economies may be diminishing. For instance, the sustained rapid economic growth of emerging economies may allow them to adopt SETs more rapidly because their consumers and firms will have more resources to invest on cleaner energy sources. Economic growth may also help these countries develop their local human capital, which can also support the adoption of more advanced SETs. In contrast, economic growth is also strongly correlated with growth in energy demand which can rapidly increase the usage of CITs and result in higher greenhouse gas emissions for these countries. As has been presented in Chap. 1, as discussed by Smil (2017) and White (2007).

The evolution of consumers, firms, and policy makers' preferences in developing nations is another important factor for determining the success of environmental policy. In particular, it is unknown to what extent these actors will become environmentally conscious, which can have a significant impact in their technology adoption decisions.

Although each country faces its particular conditions for the successful diffusion of SETs, generally, policy alternatives to foster its diffusion face two major challenges for their large-scale success. First, many of these technologies need to be diffused in mature industries in which dominant technologies already exist. Such is the case of the automobile and fuel industries, in which the internal combustion engine is the dominant technology. The internal combustion engine has been improved to such an extent that it has become a cost-effective mobility solution for a vast number of consumers. Therefore, the use of vehicles with internal combustion engines is deeply rooted in the preferences and practices of car manufacturers, fuel suppliers, and consumers. Similar complexities can be found in other fields in which SETs are intended to be diffused, such as electricity production. Secondly, SETs are highly sophisticated technologies that need advanced human capital, and advanced institutional and innovation systems to foster their development. Even in the case of wind energy, which is one of the most mature SETs, the technical complexities of the technology have influenced the creation of new firms and institutional arrangement to steer its diffusion. For example, Shell tried over several decades to become a wind energy developer, but it failed to do so while other newly created firms, such as Iberdrola, have become global leaders in the field. In addition, not all countries have been successful in developing the adequate institutional and innovation arrangements for wind energy. Germany and Denmark are well known success stories, while The Netherlands has fallen behind these countries, in spite of having started the first diffusion of wind energy (Jacobsson 2000, pp. 635–639).

Thus, competition with incumbent technologies and the sophistication of SETs are two important factors to consider when seeking to use environmental policy as a lever of economic development.

Many countries are implementing a mixture of policies aimed at strengthening the development and diffusion of SETs and inducing growth (IEA 2011). In general terms, these strategies can be grouped in two main categories; these are: hybridization strategies and market niche management strategies. Hybridization strategies consist in achieving first the diffusion of an intermediate technology between the incumbent carbon intensive technology and the radical sustainable energy technology. The diffusion of the hybrid technology can create sufficient institutional and economic inertia, and technological learning to foster a more cost-effective second phase transition towards the radical technology. Market niche management strategies are aimed at creating controlled competition environments for SETs, through the implementation of targeted policy incentives aimed at strengthening the competitive position of SETs, while maintaining economic growth inertia. It can also be carried out through the deployment of regional policy experiments that can enhance the adoption of SETs in specific regions, and to scale diffusion afterwards to larger regions. In general, market niche management strategies aim at creating an environment in which policy makers can learn more about the economic challenges of SETs, without being negatively affected by competing against mature incumbent technologies, or causing unintended economic consequences (Raven 2007).

In addition, for many countries, technology transfer is another important strategy, needed for the successful diffusion of SETs in their territories. Technology transfer can provide developing countries with the means to catch up on advanced economies in the diffusion of SETs. The dilemma is to find an approach to technology transfer that is cost effective for both technology developers and technology adopters (OECD 2009, pp 19–20). This is particularly important because if SETs' technology transfer is enhanced vis-à-vis CITs, emerging economies could potentially leapfrog advanced economies' SETs diffusion rates.

Table 1 provides a qualitative assessment of these policy alternatives. It is clear that the analysis remains at a very abstract and general level. Nevertheless, it shows that these alternatives could be complementary to each other, and that their importance to enhance economic growth will vary across regions.

The types of carbon regulation policies and the timing of their implementation represent an important strategic issue for developed and developing countries in the context of environmental policy, growth and the stabilisation of greenhouse gases. In principle, it is expected that countries will carefully consider the national and international economic stakes of implementing these types of policies. However, political and economic stakes, as well as the democratic and governance differences among developed and developing countries make it extremely difficult to realistically estimate the course of action that developed and developing countries will follow regarding the implementation of carbon regulations in their economies. Differences in regulation systems among developed and developing countries are important factors that can determine the economic and political feasibility of cooperation in environmental policy (Mattoo and Subramanian 2013).

For the case of developed nations three aspects are the most relevant: the national regulation of their economies' carbon intensity; the regulation of their trade flows' carbon intensity; and, the timing of their regulatory changes. For instance, if developed nations decide to continue supporting carbon regulation in their economies, and developing countries decide not to do so, it might be possible that this regulatory difference creates pollution havens for firms, rather than to continue pursuing a low-cost carbon intensive production strategy.

Table 1 Environmental policies and growth

Alternatives	SETs diffusion rate	Economic cost	Long term orientation
Hybridization	**Low**-Two phases required, supported by lengthy market process	**Low**-Cost of implementation is shared mainly by consumers and firms, some incentives from government	**High-**Requires commitment for several decades
Market niche management	**Medium**-Successful experiments have the potential of rapidly scaling up	**High**-Need to invest heavily on market incentives to protect SETs	**Medium**-Successful implementation in small scale environment, does not guarantee success in large scale
Technology transfer	**High**-Diffusion depends on successful adaptation of existing technologies	**Unknown**-Economic cost may vary depending on the investment needed in R&D and property rights	**Low**-It creates no endogenous capacity in developing countries to support SETs

This can have serious negative consequences for developed nations in terms of their economic competitiveness against developing countries, but also an unknown environmental impact (Mattoo and Subramanian 2013). As a result, it is likely that developed countries will also attempt to implement a border carbon tax to regulate flows from more carbon intensive economies. It is also unknown if this will be possible because the implementation of such trade regulations is extremely controversial considering current World Trade Organization's standards and regulations. Finally, developed nations can choose to implement these policies in the near term or to act later in the future when more information regarding climate change and the economic progress of developing countries becomes available.

For the case of developing nations, the set of options available is more constrained. For most developing countries (especially for emerging nations) their exports to developed countries play an important role in their economic development models (Mattoo and Subramanian 2013). Therefore, developing countries have higher stakes in choosing to implement local carbon regulation systems. For instance, if developed nations implement both border and local carbon regulations, there might also be an economic incentive for developing countries to implement local carbon regulations to continue trading with developed nations. However, the economic cost of implementing these policies for developing countries may also surpass the potential trade gains.

Developed and developing countries, through their finance and science ministries, will define over the coming years the type of support that they will grant to environmental policies. Individual countries are more concerned with technology creation policies, such as direct R&D investments, technology subsidies, or advancement market commitments that can incentivize firms to use SETs for energy production. Since there are technology spill-overs across countries and trade among their energy and technology firms, it is expected that the technology policy actions of one region will also have a technological impact on other regions.

Although, their decisions seem to be the same, the decision context differs. Governments and firms in developed countries have already invested greatly in the R&D of critical SETs, such as solar panels, wind turbines, and other critical CITs. As a result, most of the firms that are leading these technology sectors are native to these types of countries (Susman 2008). Success for developed countries implies the ability to transform their R&D and fiscal investments into new firms and markets for these technologies, while also reducing their economies' greenhouse gas emissions.

Developing countries have not invested in these technologies at the same level, and, as a result, critical SETs are external to them. Therefore, these countries will likely need to import these technologies from developed countries, which can be expensive for some of them or which can result in a failure to diffuse these technologies in their economies due to lack of native technical capacities (Ramanathan, 2002). More importantly, developing countries' first priority seems to be to achieve economic development in the most cost-effective way, which implies using mature and cheap CITs for satisfying their economic development energy needs (Mattoo and Subramanian 2013). Therefore, for developing countries it is important to decide which type of technologies their environmental policies will support (i.e. SETs or

CITs). These individual country decisions will be made in a complex trade and technological environment. The interconnection of these countries will likely bring surprises to their individually cantered objectives.

5 Best Practices: The European Union Policy Framework

The European Union has developed some of the most sophisticated energy, and environmental policies worldwide since the 1990s (Andersen and Liefferink 1999). Nowadays, EU environmental policy framework represents the standard of quality, completeness, integration and overall alignment to sustainable development objectives (Haigh 2015). The construction of this framework has required innovative governance to achieve convergence of countries, with previously narrow national environmental policies, towards the most advanced member states; as well as, to reach acceptance of supranational policy directives by individual governments (Bondarouk and Mastenbroek 2018). Moreover, the successful negotiations of the former Kyoto Protocol and the recent Paris Agreement have confirmed the global EU leadership in international climate policy (Hey 2005; Oberthür and Groen 2017).

Nevertheless, the EU environmental policy framework is not without drawbacks and challenges. For example, incomplete compliance by member states has caused a halt to EU policy-making and, instead, led to multiple amendments to existing policies (Börzela and Buzogány 2019, Scanlan et al. 2013).Renewable energy and energy efficiency policy, instead of promoting green growth, has affected competitiveness mainly because of rising costs of climate measures, economic distortions brought about by environmental taxes and exemptions, and high energy prices driven by ambitious short-term renewable goals (Ekins and Speck 1999; Helm 2014; Slominski 2016). Furthermore, the over-focus on climate change objectives has caused a passive policy dismantling in other policy areas such as clean air and water protection policies, which have been relegated in the environmental policy agenda since 2010 (Steinebach and Knill 2017). The internal energy market (i.e. a unified cross-border energy market system) has not materialised mainly due to energy security concerns, such as ownership of natural resources, protection of national energy companies and mistrust between member states, and due to incompatibility issues of physical infrastructure (Eikeland 2011; Helm 2014). In addition, emission reduction trends were mainly caused by de-industrialization and slow growth rather than by the direct effect of environmental policy (Helm 2014).

EU environmental policy framework

The EU environmental policy's legal basis rests in four articles in the Treaty of Functioning of European Union, which establish EU's competency in all areas of environment policy (Fig. 2) within five policy levels (Hey 2005, EU 2019a).

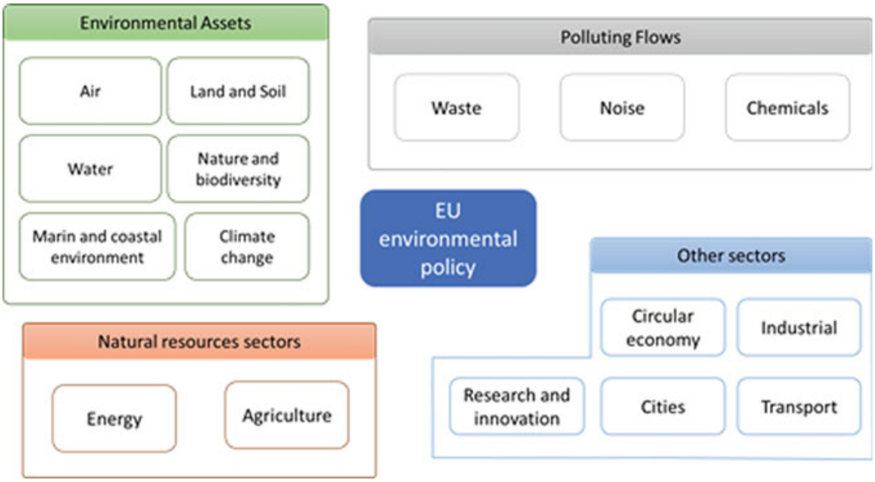

Fig. 2 Areas of EU Environmental Policy. *Source* EU (2019b). *Note* Figure of our own making and own classification

(1) The Environment Action Programme, the highest order policy, establishes nine priority objectives, such as ecological resilience and low carbon growth, and defines strategic initiatives and implementation considerations.
(2) Horizontal Strategies define detailed sustainable development pathways to reach all priority objectives. For example, the Europe 2020 strategy.
(3) International environmental cooperation aligns EU policy under international agreements and aims to maintain EU global leadership in environmental policy.
(4) Environmental impact assessment and public participation establishes the obligations on environmental responsibility for economic sectors and public rights in environmental decision-making.
(5) Implementation, enforcement and monitoring consists of specific policy instruments, contained in hundreds of directives, regulations and official decisions. At this last level, supranational policy is transposed into national policy for implementation.

As shown in Fig. 2, EU environmental policy framework covers most, if not all, environmentally relevant areas for sustainable development. Notably, it still requires further evolution to address current and future challenges regarding, for example, compliance, policy integration, state-level governance, emission transfers through trade and over-regulation (IEA 2014). Nevertheless, it remains the most advanced and flexible framework worldwide to approach global and regional environmental threats.

EU energy policy

EU energy policy is key for fulfilling climate change objectives and international commitments, as well as for guaranteeing economic security, geopolitical stability and sustainable growth in the EU bloc for the long run (Goldthau and Sitter 2015; Szulecki et al. 2016). It is centrally planned by the EU, though it is flexible in respect of member state sensitivities about decision-making on national energy mix, and energy resources ownership (Herweg 2017; IEA 2014).

This policy has the following objectives (EU 2019c).

1. A functioning internal energy market and interconnected energy networks;
2. Security of energy supply;
3. Improvements in energy efficiency and savings;
4. De-carbonization and transition towards a low-carbon economy;
5. Development of alternative energy technologies within the internal energy market; and
6. Research, innovation, and competitiveness.

Furthermore, it defines targets, support schemes, safety standards, monitoring procedures, market rules and financing mechanisms in the field of Energy efficiency, Renewable energy, Fossil energy, Nuclear energy, Energy security, Markets and consumers and Energy infrastructure (IEA 2014; Kanellakis et al. 2013). In addition, the implementation of such a complex policy framework leads to lower compliance than for other environmental policies (Herweg 2017). Nevertheless, there have been successful cases among member states; specifically, the case of Portugal is described below, as it can provide insights on how to successfully integrate advanced energy policy into underdeveloped energy governance settings.

Example of successful compliance to EU energy policy :Portugal 1995–2010

Portugal is an energy success story of the EU as it transitioned from a mostly fossil to a mostly renewable power sector, and significantly diversified its primary energy mix in less than 15 years (Guevara and Rodriguez 2016). To do so, it gradually transformed its energy policy for complete compliance with the EU and proposed other policy instruments that helped EU's energy policy to better adapt for the domestic settings (Guevara and Domingos 2017).

By 1995, two main energy policies were in force: The Regulation on Energy Management, and the Energy Program. These policies lacked a roadmap for their implementation and did not set specific targets on energy efficiency and renewable primary energy share. Notably, in 1998, the country received for the first-time natural gas from a recently opened distribution network in Northern Africa.

Aligned with rising climate concerns, the national Climate Change Commission was created in 1998 and the National Strategy of Climate Change, issued in 2001 (ENAC), included general measures on energy supply and consumption without specific targets. Portugal ratified the Kyoto protocol in 2002, in which the country, as part of the EU, was allowed to increase its GHG emissions by 27% compared to 1990 due to its lower economic development than other member states.

The 2003 energy regulation resolution established a target of 39% share for renewable electricity generation by 2010, with a non-conventional renewable generation capacity of 4.68 GW (more than 10 times the 2001 capacity) due to an estimated investment of 5 billion euros (10^9 euros). Moreover, this resolution outlined the liberalisation of the energy market (aligned to EU Directives 2003/54/EC and 2003/55/EC), the concretization of the Iberian Energy Market, and support schemes for rational energy use. In addition, this resolution led to the total liberalisation of fuel prices to final consumers as of January 2004 (ENMC 2016).

Furthermore, after two years of public discussion, the National Program for Climate Change (PNAC) was launched. The PNAC set the following energy objectives: 8.6% less losses in the transformation and distribution of energy, an increase to 18% cogeneration for power generation, 1,300 GWh energy savings in direct demand, deployment of 3.75 GW renewable generation capacity, and the introduction of natural gas to Madeira Island. Furthermore, the government between, 2003 and 2005, increased the targets for renewable generation capacity (Maranhão de Abreu 2006). It also put pressure on quality and cost improvements in energy utilities and services, on implementation of the Iberian Electricity Market, and on liberalisation of natural gas and electricity markets.

A National Energy strategy was issued in 2005 (ENE, aligned to EU Directive 2001/77/EC). This strategy was extensive: it considered a regulatory framework for competition in the electricity sector; an energy efficiency action program; carbon and energy taxation schemes; licensing simplification for renewable projects; support for research and development on energy diversification, energy efficiency and carbon capture and sequestration; and programs for public awareness and evaluation of the ENE. Moreover, the National Plan for the Allocation of Emission Allowances was issued in 2005 (PNALE), which set measures for emission license trading, aligned to the EU Directive 2003/87/EC, and proposed the creation of the Portuguese Carbon Fund to support projects in energy efficiency and renewable sources (Carvalho et al. 2014).

In 2006, policies for a National Electric System, and a National Natural Gas System structure and operation were launched, in accordance with EU directives 2003/54/EC and 2003/55/EC, respectively. As of September 2006, the energy market established that all consumers can purchase electricity from the supplier of their choice, with independent distribution system operators, thereby meeting the requirement of EU directive 2003/54/EC (ERSE 2009a). However, the natural gas market was not able to meet the requirements of the EU directive 2003/54/EC; instead, the Ministers' Council determined the schedule for later compliance (ERSE 2009b).

In that year, the Portuguese Carbon Fund was created; a new version of the PNAC was launched; the EU Directive 2003/30/EC on the promotion of renewable fuels for transport was implemented; and the National System of Certification of Energy and Air Quality in Buildings (SCE) was created (in line with EU Directive 2002/91/EC).

The Iberian Electricity market (MIBEL) started operating in 2007 (Carvalho et al. 2014). The MIBEL structures the operation of the joint market, establishes a single price, enhances transparency and free competition, removes entry barriers, and promotes economic efficiency (Domínguez and Bernat 2007). A similar joint market for natural gas was discussed (IEA 2016).

The National Energy Efficiency Action Plan 2008–2015 (PNAE, aligned to EU Directive 2006/32/EC) defined measures to achieve the EU target of 10% savings in direct energy use by 2015. The PNAE included measures and programs for the promotion of rational energy use in the residential and service sectors and complements the PNAC and ENE measures for the industrial and public sectors. In the same year, the Management System of Intensive Energy Consumption (SGCIE) was launched (aligned to EU Directive 2006/32/EC), which required from energy intensive industries a strategic plan for rational energy use and imposed on them compulsory energy auditing. Moreover, EU Directive 2006/32/EC on energy end-use efficiency and energy services was transposed, which established an energy saving target of at least 9% by 2016 and was related to other policies such as the PNAE, the SCE and the SGCIE.

Finally, in 2010, the ENE was updated (EU Directive 2009/28/EC), which extended the planning period to 2020. The 2010 ENE highlighted the contribution of other renewable sources besides wind generation, and increased support for research and development activities. Also, the first version for public discussion of the National Renewable Energy Action Plan (PNAER), and the Energy Efficiency Fund were released in that year.

6 Mexico's Position

Mexico's current environmental and energy institutional frameworks have been largely shaped over the course of the 2010s decade.[2] Driven by market liberalisation reforms and by an ambitious agenda of international investment attraction, in just a six year-span Mexico allowed for private participation in its energy sector and adhered to both the Paris Agreement and United Nations' Sustainable Development Goals (SDGs).[3] It was precisely during this period that article 25 of Mexico's Constitution was amended to include the concept of promotion of "sustainable development" as one of the State's roles in the economy.

Such grand task entailed a complete institutional rearrangement of the environmental and energy sector that included, but was not limited to: a new law of climate change, a sectorised institute for the environment and climate change, the creation of independent regulatory energy agencies and independent system operators for natural

[2] Environmental concerns were first included in the National Plan of Development in 1983 (CITA), and some advances were established during the next couple of decades. However, such efforts were isolated and did not constitute a strategic central element of Mexican policy. One of the first long run measures that tried to incorporate environmental concerns with energy planning was attained during Felipe Calderon's presidential term under the National Strategy of Energy. It was a yearly publication that spanned actions to be carried out for the next 15 years in order to foster the energy trilemma: energy security, energy transition and energy efficiency. However, the document was eradicated in Enrique Peña Nieto's second year at office never to return again.

[3] This period comprehends the six years from the promulgation of the General Law of Climate Change to the last year of Peña Nieto's presidential term, which de facto was the last year of full implementation of energy reform advances.

gas and electricity networks, a brand new environmental and industrial safety regulatory agency for the oil & gas sector (ASEA), and the legal definition of “clean energy”.

The environmental objectives of the country are best summarised by the General Law of Climate Change, which establishes a commitment towards cutting Greenhouse Gas (GHG) emissions 30% by 2030 and 50% by 2050 with respect to its baseline. This implied a major challenge, insofar as Mexico, despite representing only 1% of total global GHG emissions, has an energy portfolio that relies heavily on hydrocarbons.

For that matter, several instruments had been developed to attain this goal. Some of the instruments have been complementary, like the instauration of a Cap and Trade system operated by Mexico2 and the Clean Energy Certificates program (CEL, by its acronym in Spanish) operated by the Regulatory Energy Commission (CRE). However, the underlying objectives of Mexico’s 2013 energy reform and environmental commitments seem to be misaligned shall they both aim towards a sustainable model. On the one hand, there is an ambitious goal of to reduce GHG emissions, but on the other there is also the vision (and fiscal revenue requirement) to revamp oil & gas production back to 2.5 million barrels per day by 2024.

Mexico’s new administration’s energy policy has also complicated matters of alignment with respect to the previous environmental commitments on several trenches.[4] Firstly, GHG emissions reduction would come in part from the increasing use of renewable energy in electricity generation. But this in turn depended on the continuation of key infrastructure for electricity transmission projects that would allow more remote renewable sources to be incorporated into the grid, as well as on the follow up of tender processes that generated incentives for new investments.[5] President Lopez Obrador’s administration cancelled both.

In second place, the independence of regulatory agencies is cornerstone to preserve the framework for incentive mechanisms to shift the energy use portfolio from fossil fuels to non-fossil sources. As it turns out, on 28 October 2019, the Ministry of Energy presented an agreement through which the rules that established the criteria to assign and acquire CEL were modified. The accepted modification, of which CRE has been supportive despite international astonishment, basically eroded the additionality criterion that laid out the basis for CEL to promote new investments

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[4] The starkest of them comes from the fact that in the Nation’s Project 2018–2024, President López Obrador’s political platform as a candidate, the energy vision is called “Oil Program”, with a strong stance in favor of increasing oil and gas and fuels production. But others include the increase in coal purchases for CFE’s generation plants and the constant public declarations of high officials from CFE and CENACE (grid’s ISO) that renewable sources are both expensive and inefficient.

[5] Peña Nieto’s administration created three tender processes with more than 40 firms participating with a total 9 thousand million USD investment for generation capacity, of which more than 90% was renewable. The average price of the last tender reached a worldwide record-breaking level of $20.57 USD/MWh.

on (cheaper) renewable energy projects.[6] Without such instruments, it would prove really hard for Mexico to fulfil the mark of 35% renewable generation by 2024.

Third, one of the flagship projects of the current administration is the construction of a new refinery in Paraíso, Dos Bocas, Tabasco. While it is true that Mexico has, in the last decade, lost its status of energy net exporter to become a net importer, the project presents at least two major flaws relevant to our discussion. On the one hand, the mere existence of a new refinery would represent a net increase in GHG emissions by 2030.[7] On the other hand, the technical assessment with respect to the environmental impact of the refinery, although approved by ASEA, it is incomplete because it does not reveal the full extent of the territory the project comprises nor the exact coordinates where it would be located.[8]

Last but not least, because of lack of a long run energy policy, Mexico faces a scenario where perverse incentives might be triggered to go back to fossil fuel (and more costly) electricity generation. In January 2020, the new regulation of the International Maritime Organization comes to place, by which a limitation of 0.5% sulfur specification for bunker fuel needs to be met (IMO 2020). Mexico is an exporter of fuel oil, but its current refineries configuration would certainly not allow the country to meet IMO 2020 in time. In order to not waste the product, it might be tempting for Mexico's public electricity utility, Federal Electricity Commission (CFE), to use such product for its own plants.

While not flawless, the institutional framework created over this decade in Mexico for a more encompassed energy and environmental policy seemed to be on a right path. Nevertheless, only one year after the most radical shift in economic policy in the past four decades, the joint fulfillment of energy and environmental goals in order to establish a sustainable paradigm is jeopardized.

As other countries, Mexico faces the challenge to balance its short run needs with its long run aspirations. There are technological game changers that lie ahead to speed up fossil-fuels phasing out, like the evolution of the electricity storage industry (i.e. batteries), electromobility, smart grids, and distributed generation. Yet, the major

[6] Basically, the incentive-based mechanisms were designed to promote new investments in clean energy (mainly from solar PV and wind generation plants) by giving them market advantage with respect to older more expensive and dirtier generation plants. The mechanism aimed to create an environment where firms with the latter central plants (mainly CFE) would have to buy certificates from the former (mainly new investments), thus giving recent clean energy projects a competitive advantage that would allow the addition of new (clean) energy sources that might have not occurred otherwise.

[7] According to the Mexican Center of Environmental Law (CEMDA), if the new refinery initiates its operation by 2022, the annual CO_2 equivalent output would rise to 2.16 million metric tons which would imply a total output of 17.3 $MtCO_2$ equivalent by 2030, thus jeopardizing the Nationally Determined Contributions under the United Nations Framework Convention on Climate Change (CEMDA Bulletin No. 33/19).

[8] While ASEA's argument about not providing full information about the refinery project is based on grounds of industrial protection for PEMEX in an open market setting, there is genuine concern about the independence of ASEA's environmental impact assessment given that the new Executive Director lacks professional experience in both environmental and industrial security fields, but is a close former collaborator of Mexico's President.

threat for a country like Mexico, given its current status of electricity coverage, cost and grid reliability is to focus on such opportunities without exploring first the low-hanging fruit: the strategic expansion of its transmission network. Even if the technological adoption of batteries comes earlier than expected, Mexico's energy transition largely depends on the capacity to connect generation hubs with consumers, a matter that batteries on its own will not resolve.

The sector in Mexico with the highest contribution to GHG emissions is transport. In this respect too, Mexico faces a wide array of challenges should it create opportunities for massive electromobility. Yet, once a more robust transmission network is addressed, infrastructure of distribution and of electric service stations, as well as new business ventures for public transport must be the at the top of priorities for public policy.

Another element that must be revisited in aligning energy and environmental policy and goals is the role of private investment in the energy sector. According to the Ministry of Energy, Mexico's installed capacity of solar PV reported an increase by a factor of 11 during the 2012–2018 period, due to private participation and cumulative investments of 9 billion USD stimulated by the energy reform. The financial health of CFE does not seem to allow the company for big new renewable energy projects from public investment.[9]

Finally, one of the major characteristics of President López Obrador's administration is the lackluster place environmental concerns occupy in his agenda. While several efforts, as claimed in this section, were pushed by the Mexican government throughout the 2010s decade, the main challenge for a comprehensive environmental policy in the country is still related to the weak recognition that negative environmental impacts in Mexico represent economic costs (Serra 2017).

7 Mexico's Future

As stated in the previous section, Mexico's energy policy implemented by the current administration moves in the opposite direction of global trends in general and of its institutional framework in particular, as envisioned by 2013's energy reform.

SARS-CoV-2 pandemic is still unfolding at the time of writing this book, so there are no reliable forecasts to characterise the extent of lower than expected demand for oil and gas. Even so, and despite no change in fundamentals have been observed in the hydrocarbon's markets, it seems that the safe bet is to pursue a decisive agenda of energy transition in a country with premier renewable resources and highly vulnerable to climate change like Mexico. Furthermore, while President López Obrador has made it clear that no further private investments in the energy sector will be allowed

[9] CFE's financial statements report a deterioration on the Operational Balance that closed 2015 from $2.1 billion USD to 2019–$820 million USD. Net total debt in 2019 accounts for $1 billion USD. And, while total investment increased from an average of $1.67 billion USD during the period of 2015–2018 to $2.5 billion USD in 2019, most of resources were devoted to maintenance of coal, combined cycle and thermal generation plants.

in his administration, it seems not plausible he will amend any piece of the legal architecture of the energy reform, specially not after July 1st, 2020, when USMCA came into effect.

These elements provide quite a good recipe for a brighter and greener future for Mexico. What potential directions would lead to it? The very first step is to reinstate the mechanisms of market development for crude oil, natural gas, fuels, and wholesale electricity. It might seem contradictory to advocate the rehabilitation of bidding rounds for oil and gas while also pushing a sustainable paradigm. Yet, a competitive market for oil and gas might provide greater social gains than a state-monopoly model driven by a financially fragile and unregulated PEMEX. It could also set free fiscal resources to devote towards very needed infrastructure in the electricity sector, namely transmission and distribution. In the electricity sector, renewed tenders for long term energy purchase will not only represent investment flows produced by energy transition projects aligned with Mexico's overall environmental policy, but also might translate into lower prices for end use consumers, namely industry, commerce, agriculture and residential users of electricity.

The second step in the process is to allow regulators to proceed their mandate with autonomy and technical capabilities, as described in the law. Otherwise, anti-competitive behavior of PEMEX and CFE in their respective realms will accrue in deadweight loss. With the energy reform, market development required sharp and precise regulatory instruments to provide certainty for investors and ensure more efficient results in favor of consumers. Before being captured by López Obrador's energy policy and political objectives, both Regulatory Energy Commission (CRE) and National Hydrocarbons Commission (CNH) were on track to become tip of the spear amongst regional regulatory bodies in the energy industry; sustainable energy policy requires to recover such institutions as they were envisioned by law.

Another major element to reactivate are energy infrastructure plans, particularly regarding natural gas and electricity networks. The world is leaning towards both industries as the steering wheel of the economy. Mexico has enormous potential to generate clean energy from both renewable sources and natural gas, yet it faces road-blocks to implement new infrastructure projects, especially in vulnerable and indigenous communities. An adequate consultation mechanism with strong enforcement must be placed to ensure the coexistence of millennial cultures with a market-driven energy industry, and Canada's experience with First Nations' population could serve as a guide for best practices. Furthermore, infrastructure plans should characterize long-term uncertainties so as to establish resilient networks to foster energy security for the country by responding to global trends and unexpected shocks.

An additional element that must be resolved within the energy policy sphere that creates externalities on Mexico's environmental policy is the use of fossil-fuel subsidies. If compared to Middle East countries, Mexico's proportion of energy subsidies with respect to its Gross Domestic Group is quite small (circa 0.5%, IEA 2016). However, they convey misguidance for both producers and consumers and result not only in detriment of energy transition by producing an artificial advantage of fossil over renewable sources, but also in higher GHG emissions due to higher consumption. Moreover, even with the market liberalisation of fuels, the Ministry of Finance (SHCP by its acronym in Spanish) has placed price controls on gasoline and diesel through fiscal stimulus. This hinders adequate signals in a market with a consumption that produces the largest share of Mexico's GHG emissions.

Finally, Mexico has placed a heavy burden on its national energy companies, PEMEX and CFE. Not only it is expected of them to satisfy domestic demand and develop grand infrastructure projects, some of which are not profitable, but also to produce revenue and stand as the stronghold of economic development. This might have partially worked in the distant past, but it is certainly not attainable in the current energy landscape.

8 Conclusions

This chapter describes the complexity of building an environmental and energy policy framework that works for achieving economic growth and sustainable development by any nation. It highlights the main theoretical and empirical findings regarding the binomial environmental policy - growth and, based on them, suggests a sustainable path for a relevant emerging economy, i.e., Mexico.

The design of a successful environmental policy in encouraging economic growth must consider:

- The degree of substitution between carbon-intensive and sustainable energy technologies;
- A balanced environmental tax/subsidies basket;
- The configuration of the physical infrastructure for managing energy and other natural resources;
- Investment in R&D with management of competition for resources and market power;
- The socio-political context set by the incumbent government and other directly involved actors;
- An adequate timing for policy design and implementation;
- The growth, preferences and environmental consciousness of the population;
- A long-term implementation strategy for changing conditions;
- The level of development and growth path of the economy;
- The current structure of non-environmental policy; and
- Other social priorities such as health, security and well-being.

Particularly, the diffusion of sustainable energy technologies, which entails technology development and penetration to existing markets, is an indispensable condition for greener growth. To achieve so, energy policy must understand and balance the necessary price, R&D and market size conditions for such diffusion. An adequate path consists of directing an initial penetration in mature industries, in which dominant technologies already exists; while advancing human capital and institutional/innovation systems that foster the development of new firms and markets for these technologies.

Moreover, beyond growth, the integration of environmental policy is the only path that can bring a sustainable future. Therefore, the desired environmental policy framework should be flexible to allow coordination between individual environmental policies and realignment of other policy areas to environmental objectives.

Mexico's case, as exemplified by the mismatch between environmental and energy policy rearrangements of 2010s decade, represents a potential failure in the adoption of a hybrid model of SET. The most cost-effective way to introduce renewable energy and cleaner technologies to foster economic growth in Mexico was through market-based incentives, i.e. through lengthy market development processes. Yet, political disruption and a different agenda of economic development in Mexico upon the arrival of a new administration misaligned environmental and energy agendas, thus placing high risk on attaining a sustainable paradigm for the country.

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