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# Energy Transitions and the role of the EU ETS: The case of Greece

by

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# Energy Transitions and the role of the EU ETS: The case of Greece

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## Abstract

Major energy transitions are associated not only with fundamental transformations of the energy sector but also with multidimensional changes in societies. Existing energy systems are heavily implicated for climate change. This paper investigates the prevalent high-carbon energy systems in capitalism and their ongoing transformations, with a special focus on Greece. Furthermore, it explores whether the EU ETS created considerable incentives for effective and socially fair transitions to low-carbon systems. Empirical data reveals the enduring high-carbon composition of gross inland energy consumption in Greece while evidence on gross electricity generation by fuel discloses the limited penetration of renewable energy sources (RES) since 1990. The neoliberal design of ETS at the EU level and its poor workings did not really induce investments in low carbon technologies. RES support policies have been more significant. However, both have adverse distributional effects, especially on working people since the latter bear the cost of transition for the most part. Effective and fair low-carbon energy transitions need radical social transformation.

Key words: Political Economy, energy, climate change, EU Emissions Trading System, Greece

JEL Classification: B5, P1, Q4, Q5

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**Energy Transitions and the Role of the EU ETS: The Case of Greece**

## Introduction

Major energy transitions are associated not only with fundamental transformations of the energy sector but also with multidimensional changes in societies. They involve shifts in primary energy sources and energy technologies. At the same time, they affect broad changes in economic processes, technologies, and political and cultural aspects of social life, albeit variegated at different times and different places (Altvater, 2006; Huber, 2009; Kern and Markard, 2016; Smil, 1994).

Starting at the beginning of the industrial revolution in the mid-nineteenth century, fossil fuels grew to play a central role in capitalist economies in modern times. The dominance of fossil fuels has been the outcome of the historical development of capitalism and was grounded in the benefits that they brought to it. At the same time, fossil energy generates several contradictions and negative effects, although different for different social subjectivities. They are heavily implicated, for instance, for greenhouse gas emissions (GHG) and climate change. Their many adverse effects instigate today various economic, political and ecological tensions and conflicts over the control and use of fossil fuels, leading to the transition to a new energy system. This transition is shaped and fostered by the modus operandi of contemporary capitalism (competition, profit maximization and accumulation, and class conflict), by multiple social struggles and by state intervention. In particular, the current transition occurs under the influence of Neoliberalism which has increased the use of markets in the form of extended commodification, privatization and financialization to address energy and climate issues. The EU Emissions Trading System (EU ETS), under focus in this paper, is a market-based instrument to mitigate climate change.

The European Union (EU) has established two Frameworks of Energy (2020 Energy strategy, and 2030 Energy strategy) and is developing a third one (Energy Roadmap 2050). The ongoing 2020 Energy Strategy defines the EU's energy priorities between 2010 and 2020. It aims at: reducing greenhouse gases by at least 20% from 1990 levels; increasing the share of renewable energy in the EU's energy mix to at least 20% of consumption; and improving energy efficiency by at least 20%.

Within the 2030 Energy Strategy, EU countries have agreed to the following objectives to be met by 2030[1]: (i) a binding EU target of at least a 40% reduction in greenhouse gas emissions by 2030, compared to 1990. EU ETS sectors need to cut GHG emissions by 43% and non-ETS by 30% from 2005 levels; (ii) a binding target of at least 32% share of renewable energy in final consumption in the EU, with an upward clause by 2023; (iii) an energy efficiency increase of at least 32.5%, with an upward clause by 2023; (iv) the completion of the internal energy market by reaching an electricity interconnection target of 15% between EU countries by 2030, and by pushing forward important infrastructure projects.

Since fossil fuels are heavily implicated for environmental degradation and climate change, EU energy strategy clearly interacts with environmental and climate policy, all influencing energy transition. In particular, the EU ETS, the leading EU climate policy, belongs to the Kyoto Protocol (KP) flexible mechanisms and applies to the high-carbon energy sector, energy-intensive industrial firms and part of the aviation sector. Creating a carbon market, the EU attempts at providing incentives to capitalist firms for a least-cost transition to a low-carbon economy (Vlachou, 2014).

This paper aims at investigating the transformation of the Greek energy system in progress with a special focus on the role of the EU ETS, from the standpoint of a critical political economy, inspired by Marx. In the next section, we discuss theoretical issues of energy transitions in capitalism to ground the emergence of contemporary EU energy and climate policy under Neoliberalism. In the third section, we analyze the transformation of the Greek energy system in view of energy mix, energy dependency, carbon structure, climate sustainability, and changes in demand. In the fourth section, we inspect the factors which shape the ongoing energy transition with a special focus on the role EU ETS. The analysis reveals that for the transformation, especially in electricity, the impact of RES policies and entry was more important than that of the EU ETS. However, these decarbonizing endeavors, closely tied with privatizations and deregulations under the framework of EU internal market, have been costly and socially unfair. In the last section, some concluding remarks are offered.

[1] "The 2030 climate and energy framework" at https://ec.europa.eu/clima/policies/strategies/2030_en. "Electricity interconnection targets" at https://ec.europa.eu/energy/topics/infrastructure/electricity-interconnection-targets_en#eu-interconnection-targets. Both accessed March 9, 2020.

## 2. Energy Transitions and Capitalism: Theoretical Issues

Capitalist firms rely on natural resources and conditions for the production of value and surplus value (Resnick and Wolff, 1987; Vlachou, 2002; 2005). In particular, climate conditions sustain natural resources and conditions that are needed by capitalist firms in requisite quantities and qualities for their profit-making activities in contemporary capitalism. Nevertheless, land and natural resources have been transformed into private assets through a historical process which generated a condition of existence for labor power as a commodity and of capitalism, for that matter (Marx, 1991, Vol. III, 753–4). As Marx indicated, "landed property presupposes that certain persons enjoy the monopoly of disposing of particular portions of the globe as exclusive spheres of their private will to the exclusion of all others" (ibid., 752).

Given ownership of land and natural resource reserves, capitalist producers have to pay the landowners a share of the surplus value extracted by them, in order to gain access to the productive use of reserves; this "is known as ground-rent, irrespective of whether it is paid for agricultural land, building land, mines, fisheries, etc." (ibid., 755–6).

For capitalist production, access to high-quality supplies of energy and other natural resources or access to advantageous natural conditions may also confer advantage over competitors. This advantage becomes a source of revenue in the form of differential rent, which is part of the surplus value extracted by producing capitalists, and is appropriated by resource-owners or by producing capitalists as excess profits, if resource owners and capitalists are the same person (Harvey, 1999; Vlachou, 2002; Konstantinidis and Vlachou, 2017).

Humans use natural resources and conditions to satisfy their socially and historically determined needs (such as food or heating). In particular, climate conditions and energy sustain human life and, for that matter, they provide elements which are necessary for the reproduction of labor power. It follows that nature, energy and climate, in particular, participate in the determination of the value of labor power of workers in capitalist firms (Marx, 1991, Vol. I, 274–276; Vlachou, 2002; 2005).

Following Marx, natural conditions enter the determination of value in capitalism, as the value of any commodity is shaped by regulating conditions of production: these are the average or generalized conditions of production in industry (Marx 1991, Vol. I, 129–130) and the least favorable natural conditions for primary sectors (Marx 1991, Vol. III, 779–797). Consequently, ecological problems such as climate change and depletion of fossil fuels, as well as measures to contain them, result in changes in costs of production, prices, profits and rents, albeit to variegated extents, and thus have economic ramifications for various actors (Vlachou, 2002; 2005).

Fossil fuel energy plays a central role in powering economic and social activities of capitalism. This position is historically and socially shaped, making them integral to the generalization, stabilization and expanded reproduction of capitalist social relations. In the development of capitalism, fossil fuels became the dominant energy source because they offer specific benefits to capitalist production and circulation. At the same time, however, the use of fossil fuels gives rise to contradictions and adverse impacts, paving the way to an energy regime change (Huber, 2009; Smil, 1994; 2010; Solomon and Krishna, 2011). Let us first discuss briefly the benefits of fossil energy for capitalism.

The *differentia specifica* of capitalism is labor power, bought as a commodity and consumed productively so that it creates value greater than its own exchange value, giving rise to surplus value. In their effort to maximize surplus value, capitalists continuously change the technical and organizational aspects of production and circulation to overcome physical and social limitations and constraints to the scale of production and productivity, and therefore to surplus value.

The industrial revolution signifies a major energy transition to coal, used as a motive power in steam-engine, that conferred a lot of advantages to capitalism as first evidenced by the shift from manufacture to factory (Marx, 1991, Vol. I, 494–499). Industrial machines powered by fossil energy set production "free" from the limitations of human strength, as Marx observed (Marx, 1991, Vol. I, 497). At the same time, the factory production was associated with a dramatic subjugation of the workers to capital control, as the latter were not only excluded from the means of production but they also lost their work skills and were deprived of control over the production process (Marx, 1991, Vol. I, chapter 15).

Fossil fuels confer locational and mobility advantages for capital when compared to other preexisted motive forces in manufacture (horse power, wind and water power). Although water-power preponderated in manufacture, it had its own limitations — above all was essentially locational (Marx, 1991, Vol. I 497–499). Coal and fossil fuels, in general, can be transported, nowadays all over the globe. Along similar lines, Altvater (2006, 41) observes that "in contrast to solar radiation, which changes its intensity between day and night and with the rhythms of the seasons, fossil energy can be used 24 hours a day and 365 days a year with constant intensity … Fossil energies can be stored and then consumed without reference to natural time patterns, in accordance only with the time regime of modernity and a timetable that optimizes profits… Moreover, fossil energy allows for the extreme *acceleration* of processes, the '*compression* of time and space'... In other words, it allows for an increase in productivity" (Altvater, 2006, 41). Moreover, as Smil (1994) noted, coal is a highly concentrated source of energy, unlike wood or crop-waste. Given its high "energy density" and the underground reservoir of the fuel, coal did not involve the use of large areas of land for harvest, as steam-engines powered by timber would entail. Land-saving was important in Britain in the context of 17th and 18th century (Huber, 2009).

With coal, the siting of industrial production is not primarily driven by the local availability of energy resources; energy availability turns out to be only one factor among others, such as labor power availability and cost, for the location of industries. Fossil fuels permitted the concentration of production along with concentration of workers in urban centers, giving rise to "agglomeration economies" and competition-driven innovation and change. Consequently, based on concentrated labor power, large industrial capitals generate an increasingly flexible and mobile labor force employed at low wages (always under the constant pressure of the reserved army of unemployed) to thrive upon it (Marx, 1991, Vol. I, 499; Altvater, 2006; Huber, 2009; Malm, 2013).

Under competition, technological change enabled by and contributing to energy shifts (from coal to oil, to natural gas, to electricity) increased energy efficiency, mobility and, flexibility of industrial capitals, reducing energy cost. When oil entered the scene in the early 20th century, it deeply transformed heating, transport (first with the use of automobiles and later with aviation) and industrial processes, affecting the '*compression* of time and space' and the further internationalization of capital. The shift to electricity (powered mostly through fossil fuel combustion) profoundly transformed not only industrial production, but also household life organization (Smil, 1994; 2010). The use of electricity in industrial production sustained a remarkable development of productive forces and production scale, as evidenced in Fordist "mass production" assembly lines (Aglietta, 1979). This transformation was characterized by dramatic increases in the flexibility and efficiency of power transmission in industrial production (Huber, 2009). By increasing the scale, the time schedules and the speed of production of industrial capitals, these energy shifts resulted in cost reductions, increases in productivity and in surplus value produced.

Not only production but also the circulation of commodities (notably transportation) and consumption in capitalism were powered by fossil fuel energy. Extended reproduction of capitalist production results in increased volumes of commodities that need ever-expanding markets for exchange at global level. Moreover, expanding large-scale industry gives rise, *ceteris paribus,* to an increasing search for natural resources and raw materials at global scale. Spatial and temporal barriers to commodity exchange are continuously removed through dramatic transformations in the means of transport in combination with shifts in energy that powers them (Altvater, 2006; Harvey, 1999; Huber, 2009). The shift to oil ('the perfect transportation fuel'), which is 'denser' and liquid and thus easy and cheap to transport, increased further flexibility in transportation and reduced the cost of transport (Huber, 2009).[2] It thus allows for the price convergence of tradable commodities and market integration at international scale, enlarging the terrain of capitalist competition. In short, through revolutions in the means of transport combined with the use of fossil energy, spatial and temporal barriers to commodity exchange have been removed, decreasing the cost and increasing the flexibility of transport, while, at the same time, markets are being integrated, raising capitalist competition and profitability.

Energy "is constitutive in the social production of urbanization and the infrastructures that make modern life possible" (Huber, 2015; 331). In particular, fossil fuels have added flexibility to consumption. Transport fueled by oil or electricity changed the geographies of home and work for the people. The energy consumption of households are shaped, among other things, by cultural/social values and associated feelings attached to life practices such as, for instance, automobility and driving (ibid). Fossil-fueled electrification of households stirred the development of various appliances which changed the organization of domestic life, reduced the cost of labor reproduction, and freed time from household activities (Altvater, 2006). At the same time, it

[2] Huber (2015, 331), using Mitchell's instruction "follow…the oil", observes that the networks of pipelines, tankers, refineries, and other modes of distribution not only transport oil but also become conduits of the social and financial power embedded in the material substance". The same applies to natural gas and electricity infrastructures.

brought about an increased individualization of social life which would tend to increase the cost of life and give rise to feelings of personal isolation and discontent.

The intensive use of fossil energy in capitalism, however, gives rise to significant contradictions and adverse effects. In particular, fossil fuels are generated by natural processes, not by production proper. In this sense, they are exhaustible resources with implications for sustainable development, although their scarcity is historically and socially constructed (Vlachou, 1994). Importantly, as natural resource bases, their reserves are unevenly distributed globally. Energy extraction relates to "an uneven and scattered geography of "holes" (Huber, 2015, 329). Regions and countries short of fossil fuel reserves tend to import them to power their economic activities. The private ownership of natural resources gives rise to battles for access to and control of them.[3] In existing capitalism, access to ample and low-cost fossil energy is an important element to profitability. Intense capitalist competition (involving production, circulation and distribution of value and surplus value) form fossil energy prices in national and/or world markets via which access to fossil energy is acquired (Bina, 1985; Vlachou, 2002). Moreover, as "energy underpins the basic concepts of social life —food, mobility, consumption, and the geographies of home and work"— energy production significances become basic elements of national development plans and of associated narratives for building national aspirations, identity and (eventually) consensus; and it is these narratives that often rationalize dispossession and environmental destruction of local societies (see also Huber, 2015, 328, 330).

Violent modes of control of fossil resources were also exercised in the 20th century (Klare, 2002; 2004). Geopolitical conflict over them results in wars and wealth transfers (Vlachou, 2001). Establishing fossil energy security (with respect to reserves, pipe lines, routes of oil tankers, refineries and storage facilities) for capitalist countries and unions (such as EU) proves to be competitive and conflict prone (Altvater, 2006).[4]

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[3] "Tracing social relations and commodities back to the source of extraction reveals social displacement and dispossession… Yet, while energy extraction necessarily entails the physical displacement of populations, communities who remain in place also suffer the slow violence of landscape destruction, water contamination, and livelihood disruption…the energy underpinning our lives is often made possible through violence — to both human and non-human populations" (Huber 2015, 330).

[4] Altvater (2006, 51) observes: " 'Oil security' is one of the priorities of the US and other powerful oil consuming countries or blocs, such as the EU. …. 'Oil security' has several dimensions: first, the strategic control of oil territories; second, the strategic control of oil logistics (pipe lines, the routes of oil tankers, refineries and storage facilities); third, influencing the price of oil by controlling supply and demand on markets; and fourth, determining

On the other hand, energy shortages and increasing energy prices jeopardize profitable production and value realization for capitalist firms that use energy as an input. They may lead to energy poverty for low income households, instigating working people's opposition. In the context of uneven capitalist development, increases in fossil energy prices may also lead to sluggish development for importing countries, especially less developed ones, giving rise to international conflict. To counteract import dependence and to safeguard energy security, the development of indigenous resources and the diversification of fossil energy suppliers may possibly emerge as main aspects of a way out (Vlachou, 2001; 2002).

The combustion of fossil fuel produces many emissions that are harmful to capitalist firms and to life on earth. Negative environmental effects, including climate change, will (at least in part) register as increases in costs, values, and prices, resulting in changes in profits, rents, and wages in capitalism (Vlachou, 2002). Carbon taxes and carbon trading such as the EU ETS are policy responses, among others, to these costs, albeit shaped by the dominant forces in modern capitalism (Vlachou, 2014; Vlachou and Konstantinidis, 2010).

Increasing exhaustibility of fossil fuels, limited access and control over fossil reserves, production and transportation, and intensification of nature's degradation due to fossil energy can instigate various conflicts and tensions between energy suppliers and users and between pollution/GHG emitters and their various victims. For instance, people affected by increasing energy prices and limited access to energy supply, as well as by pollution and climate change, struggle to protect their living conditions and income. Capitalist companies that suffer from pollution clash with polluting firms. Unstable supply and increasing energy prices bring about cost increases for capitalist buyers, leading them to push for new less expensive and more safe sources of energy. These multiple struggles give rise to national and international energy, climate and environmental policies. In particular, the inter-capitalist struggle or competition among capitals and the struggles taken up by the working and ecological movements play an important role in the shaping of energy and environmental regulation and, for that matter, of access to nature (see also Vlachou, 2004). In the international arena, uneven access and control over fossil fuels and historical accountability for climate change feeds the conflict over energy and climate issues

the currency in which the price of oil is invoiced. When we consider the many strands in a complex strategy of oil security or 'oil imperialism' the formula of 'blood for oil' seems much too simple. Yet it is essentially correct."

between developing countries and developed ones (Altvater, 2006; Klare, 2004; Vlachou, 2001; Vlachou and Konstantinidis, 2010).

The state is called upon by social agencies to secure natural conditions and to mediate conflicting claims over natural resources. By performing various processes, the state, as we understand it, secures multiple conditions for the completion and renewal of the circuit of capital and, more generally, the reproduction of capitalism as a class society (Resnick and Wolff, 1987; Vlachou and Maniatis, 1999). The state (and quasi-state institutions like the EU) may establish policies to ensure the continuous availability of energy at low prices for capitals' profitability, and to reduce import dependency in view, for instance, of oil embargos (Solomon and Krishna, 2011). It may introduce environmental instruments, such as command-and-control measures, emissions taxes, pollution permits and abatement subsidies, to discipline economic activity that generates climate change (Vlachou, 2005). The direction of state climate and energy policies is largely an outcome of struggles waged by working people and capital and their *relative strength* over access to global natural resources and conditions, at the national and international level (Vlachou, 2004; 2014; Vlachou and Konstantinidis, 2010).

The ongoing transition from fossil fuels to mostly renewable energy coupled with energy efficiency is stirred by various reactions and measures to deal with exhaustibility, increasing energy costs, energy poverty, energy security, climate change and the deterioration of the environment (Vlachou, 2004; Vlachou and Konstantinidis, 2010). Such a transition attempts at developing appropriate technologies, stimulating proper investments and creating appropriate institutions towards a green capitalist development (Fouquet and Pearson, 2012). Often presented as a "Green New Deal", the ongoing transformation molds a capitalism that would expand "at a more socially and environmentally sound basis"; however, "the explicit goal of *most* of these "Green New Deal" proposals is to save capitalism, not to promote a transition towards a genuinely different socioeconomic system" (McCarthy, 2015, 7).

The current energy transition occurs under the influence of Neoliberalism (Harvey, 2006; Fine and Saad-Filho, 2014; Konstantinidis and Vlachou, 2017). The latter shapes the energy and climate policies instituted by EU and its member-states, one of which is Greece.

*EU Energy and Climate Policy under Neoliberalism*

The ascendancy of neoliberal capitalism has been attributed by many radical scholars to the crisis of the 1970's associated with slow-down in profits, stagflation and fiscal crises. It has spread the use of markets, commodification, privatization and financialization to address, among other things, climate and energy issues, albeit in variegated ways across countries and country unions. While it was initiated first in the United Kingdom and the United States, Neoliberalism spread globally through competition and the increased internationalization of capital. Financial markets and, in particular, Washington institutions (the World Bank and IMF) played a major role in this process, by enforcing neoliberal policies as conditionalities for aid or debt relief to countries close to default (Harvey, 2006; Fine and Saad-Filho, 2014; Konstantinidis and Vlachou, 2017).

Within the European Community, neoliberal imperatives were inscribed in the Single European Act of 1986 for the creation of a Single Market and the Maastricht Treaty of 1992 for the transition to the Economic and Monetary Union and the adoption of a single currency in 1999 — Greece introduced the euro in 2001. The completion of the single market had important implications for deregulation and privatizations in Europe. Huge markets in equipment, infrastructure and services opened up to suppliers and investors from other countries. In the energy sector, the prioritization of the EU internal energy market reduced state policies in the sector and imposed privatizations of publicly-owned energy companies. While protracted, deregulation and privatizations in the energy sector in Greece between 1991-2009 were the result of such EU-wide neoliberal restructuring; at the end of the day, they were justified by the disciplinary force of the capitalist market competition. Since the eruption of the Greek crisis, public debt and austerity programs have been used as a vehicle for furthering the neoliberal transformation of Greek society through harsh 'internal devaluation', and privatizations and deregulation of the energy sector (Vlachou and Maniatis, 1999; IEA, 2014; Verde, 2008; Konstantinidis and Vlachou, 2017).

With respect to climate policy, the Kyoto Protocol (KP) to limit climate change, which came into being in 1997 with the support of EU, inscribed Neoliberalism — especially by founding the flexible mechanisms to achieve GHG reductions under the pressure of dominant interests. The EU ETS, the principal climate policy of EU, belongs to the KP flexible mechanisms (Ikwue and Skea, 1994; Vlachou, 2014; Vlachou and Konstantinidis, 2010).

The EU ETS was instituted by Directive 2003/87/EC. It established an integrated market for greenhouse gas (GHG) emissions permits at the EU level. It was rationalized in terms of cost-effectiveness and flexibility to meet the EU GHG reduction targets. The price of emissions allowances would provide polluters with incentives to invest in free- or low-carbon technologies and energy efficiency (Vlachou, 2014). EU ETS has been running for three trading periods since 2005. With limited ability to shape it, Greece is required to follow the EU policy in energy and climate issues.

Energy and climate policy in EU concretizes our understanding of energy transitions in capitalism presented above. The key features of the energy structure in EU are: (a) high dependence on fossil fuels which raises energy and climate sustainability issues; (b) import dependency combined with limited diversification of external energy supplies and limited cross-border transportation capacity with implications for security; (c) ageing electricity generation capacity, inadequate back-up generation and transmission capacity to accommodate high shares of variable renewable energy with implications for sustainability prospects in power systems; (d) declining oil refining capacity for years with implications for competitiveness and security, albeit a restructuring is *en route*; (e) inadequate interconnections for the completion of internal electricity and gas markets with implications for competitiveness and security (celebrated goals of the internal energy market); and (f) relatively high cost and prices of energy raises concerns about competitiveness (when compared, for instance, to the US) and real income of consumers, on the demand side (EC, 2010; IEA, 2014; Helm, 2014; Vlachou and Pantelias, 2015). This condensed account shows nonetheless the problems and the tensions generated by the existing energy structure and shaping the ongoing change. As the EU is a class-based union of unevenly developed capitalist countries, the restructuring would not be an evening-out and class-neutral process (Konstantinidis and Vlachou, 2017; 2018; Vlachou and Pantelias, 2019).

Three major objectives of energy and climate policy have been proclaimed by EU: (1) economic competitiveness to ensure the provision of energy at affordable prices; (2) security of supply to ensure the reliable provision of energy; and (3) energy and environmental sustainability through decreasing GHGs, pollution and fossil fuel dependence (EC, 2010; IEA, 2014; Helm, 2014; Vlachou and Pantelias, 2015). It is claimed by the EC that they are better achieved in the long run via an EU-wide approach instead of national schemes: "A European approach is expected to result in lower costs and more secure supplies when compared to individual national schemes. With a common energy market, energy can be produced where it is cheapest and delivered to where it is needed”[5]. The key policy areas asserted by EC to achieve the energy goals are the following: (i) completion of internal energy market via building oil and gas pipelines, power lines and common rules; (ii) boosting EU domestic energy production, including renewables, to reduce import dependency; (iii) energy security strategy for the supply of gas and oil; (iv) emissions reductions; (v) promotion of renewables; (vi) promoting energy efficiency; (vii) safety regarding nuclear waste and the operation of offshore oil and gas platforms. Several instruments have been used at the EU and national level to implement energy and climate strategies for “a more sustainable, competitive and secure energy system”. These include directives (such as 2001/77/EC, 2003/30/EC, 2009/28/EC for RES) and institutional mechanisms; market-based measures such as EU ETS, carbon and energy taxes, feed-in-tariffs and other subsidies for electricity from renewables (RES-e); direct measures such priority dispatching RES-e, and emergency oil stocks; national financial support policies and subsidies for energy efficiency and RES-e, support for research and development in energy and industrial innovation; and investment in back-up generation and infrastructure to complete the internal energy market and to accommodate the integration of variable RES (EC, 2011; IEA, 2014; 2017; Vlachou, 2014; Vlachou and Pantelias, 2015). Shaped under the influence of dominant capitals, pulled and pushed by international intra-capitalist competition, these instruments require, depending on the case, smaller or bigger state involvement – one cannot miss here the inconsistencies of the neoliberal dogma with respect to state involvement (Vlachou and Pantelias, 2019; Konstantinidis and Vlachou, 2018).

In reality, EU energy and climate policies tend to incorporate several elements of nonhuman nature into the circuits of capital (Vlachou, 2014; Vlachou and Pantelias, 2017b; Konstantinidis and Vlachou, 2018). In particular, climate and energy issues are increasingly seen as an opportunity of change and growth, thus resulting into an ‘early-mover advantage’ when firms compete in international markets (Porter and van der Linde, 1995; Costa-Campi et al., 2018). The policies for the transition to a low carbon economy might offer an opportunity for growth for the highly competitive industrial firms of the United States and of advanced EU countries. Germany, for instance, has set off to establish a competitive advantage in low-carbon technologies, especially

[5] EC, “2050 Energy Strategy” https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy, last accessed May 26, 2019.

in wind and solar energy (EC, 2017). As for the EU as a whole, "the EU priorities for the global low carbon technology market are renewable energy including energy storage, efficiency in buildings and industry, sustainable transport and carbon capture and storage/use…Compared to the rest of the world, the EU is highly specialized in research and innovation in renewables and energy efficiency in buildings, and has increased its specialization in renewable fuels, bioenergy, batteries and e-mobility" (Tagliapietra et al., 2019, 952). Competitive advantage entails R&D activities: "competitive advantage in particular sectors is often accompanied by high innovation and technological change in these sectors. For example, countries that are specialized in patenting in a certain low-carbon sector are also specialized in exporting in this sector" (ibid.). In Germany, for instance, 752 companies and research organizations based in Germany filed 3,156 patents in low-carbon energy technologies in 2013, accounting for 48% of the EU total; the filed patents concentrated on sustainable transport (40%), followed by efficient systems (21%), and renewables (21%) (EC, 2017, 20). At the same time, due to uncertainties involved and the high cost of energy technologies and infrastructures, the state is often called upon by the business side to facilitate the transition, especially by financially supporting R&D and investments in RES and infrastructure[6].

## 3. The Transformation of the Greek Energy Sector

The Greek energy system is characterized by a high-carbon structure and it is thus heavily implicated for the GHG emissions of the country. Before the 1973 energy crisis, the energy sector was heavily dependent on imported oil. The 1973 oil embargo, the significant oil price increases in 1974 and 1979 and the instability of the world oil market created oil security problems, inflation, economic stagnation and foreign exchange problems in Greece as oil imports absorbed a high portion of foreign exchange revenues from exports (Zolotas, 1975). The electricity generation capacity, in particular, which was controlled by the state, became inefficient and obsolete in those circumstances. As a result, an energy shift was initiated by the energy sector (and capitalist firms in other sectors) away from imported oil to domestic energy sources (lignite, hydropower and other renewable energy sources (RES)). As was the case with other energy-dependent countries, the

[6] "private investment in the EU focuses mainly on batteries and e-mobility, renewable energy technologies and energy efficiency in industry. Renewable fuels and integrated and flexible energy systems attract larger fractions of public investment" (Tagliapietra et al., 2019, 952).

Greek government undertook initiatives to enable this shift. Under the pressures of market forces and governmental action, the Public Power Corporation (PPC) of Greece became a major vehicle for this change. Founded as a public enterprise in 1950, PPC achieved the electrification of the whole country and has been a defining factor of Greece’s economic development after WWII (Tsotsoros, 1995). It had entirely undertaken the electricity sector in the country. By the early 1990’s, it had become a vertically integrated company in the production of lignite, and the production, transmission, and distribution of electricity; it was the largest public firm in Greece. As a result of the energy shift, the share of lignite generation and hydropower in electricity production increased from 53% in 1974 to 79% in 1995. However, this restructuring required significant funds, a portion of which had to be borrowed by PPC (Vlachou, 2001; Vlachou and Maniatis, 1999, 164).

During the last thirty years, the energy sector in Greece has undergone several waves of deregulation and privatizations as part of (i) EU efforts to create an internal energy market, with a focus on integrating electricity and natural gas markets, and (ii) Greece’s efforts to fulfill the criteria for entry to the Eurozone and to comply with its statutes afterwards. The first EC Internal Energy Market Directive 1996/92 was transposed into Greek legislation by the Law 2773/1999 and spurred a number of changes in the Greek energy market. At the beginning of 2001, PPC was transformed into a stock company and listed on the Athens and London exchange, while 16% of PPC’s shares became available to private investors. In the years that followed, PPC sold another 32.88% of its shares so that by 2011 the Greek state owned 51.12% of company’s shares (IEA, 2006; 2011).

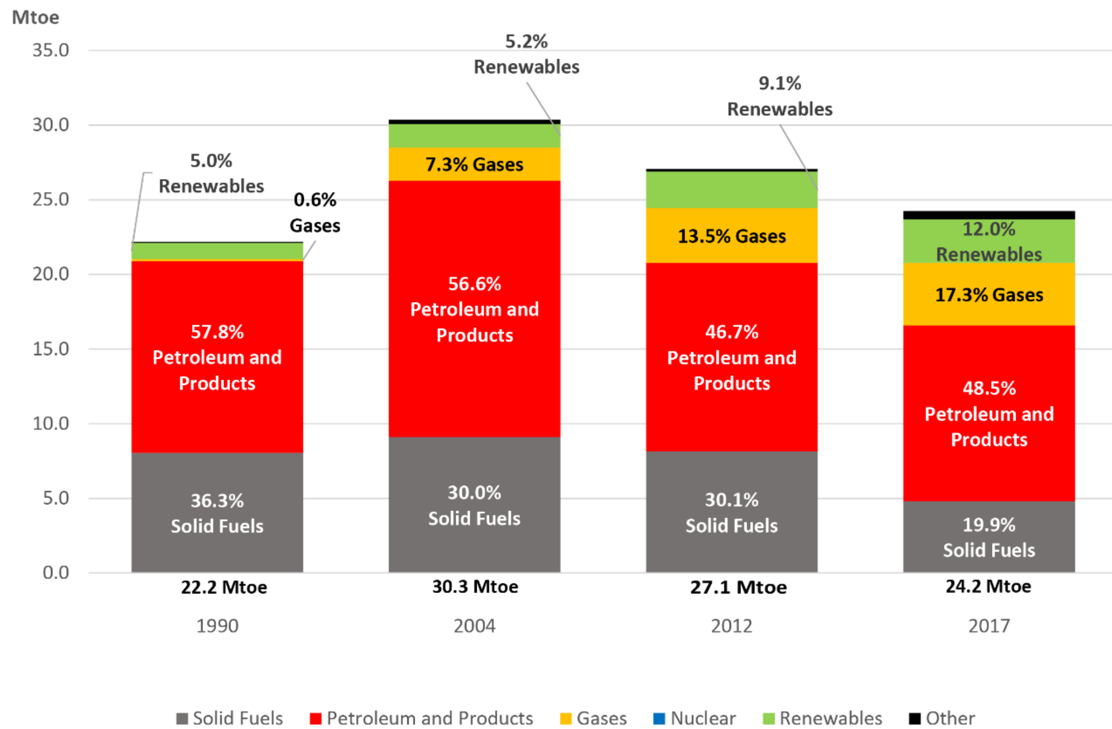
The next stage of market liberalization was initiated by the second EU Directive on the Internal Electricity Market (2003/54/EC) which was transposed into Greek legislation by the Law 3426/2005 and established a common EU electricity market framework (IEA, 2006; 2011). Law 4001/2011 transposed into national law the third EU Internal Energy Market Directives (2009/72/EC and 2009/73/EC) which aim at completing the opening of electricity and natural gas markets to private capital and competition. This third stage of electricity liberalization directives instigated a new wave of deregulation and privatizations mediated by the adjustment programs forced on Greece as conditionalities (inscribed in *Memoranda*) for debt relief packages (IEA, 2011).

As a result of the entry of private investors into power generation, the PPC's share of installed generation capacity (including RES and cogeneration held by private owners) fell from 90% of the market in 2005 to 60.3% in 2014, mostly due to increased private wind and solar production, followed by gas-fired generation (RAE, 2008, 40; 2015, 28). The further privatization of the PPC was a persistent proposal on the part of lenders. In 2011, the Greek government committed to reducing its ownership in PPC from 51% to 34% of assets (IEA, 2011, 24). In July 2014, the Samaras government passed by Law 4273/2014 the split of the PPC into two companies with a 70-30 breakdown of assets: the "small PPC" law, aimed at creating a smaller company holding quite attractive assets such as newest lignite-fired plants and hydropower ones. After the national elections of 2015, the SYRIZA government announced that it would not go ahead with the privatization of "small PPC" (Konstantinidis and Vlachou, 2018). In fact, this privatization was replaced by the NOME-type auctions to be discussed below. These privatization schemes responded to complaints raised by private investors who asserted that they could not profitably enter into the wholesale and retail markets because PPC held a competitive advantage grounded in the exclusive use of low-cost lignite and hydropower energy sources.

In the last thirty years, Greece was still in a process of moving-away from imported oil and replacing it by domestic energy sources. However, besides energy security and cost efficiency, issues of environmental destruction, climate change and exhaustibility became of concern. Overall, energy transformation has not produced dramatic changes in the mix of fuels. It seems, however, that the shift has been accelerated in the last 15-20 years. Several factors have been shaping this change. During the period 2000-2010, Greece has followed the RES Directives 2001/77/EC and 2003/30/EC of the EU, among other actions. In 2010, Greece designed and submitted to EC for approval a National Renewable Energy Plan (NREAP) in the scope of the new RES Directive 2009/28/EC and went on in pursuing it (YPEKA, 2010). An important feature of this new RES policy framework (Law 3851/2010) was that the non-binding targets for 2010 for biofuels and electricity from RES were replaced by a binding target: Greece committed to increase the share of RES in gross final energy consumption from 6.9% in 2005 to 18% in 2020 (according to Directive 2009/28/EC). To achieve this target, the share of power from RES was set at 40% of total electricity generation, the share of RES in heating and cooling at 20%, and the share of RES in transport at 10% in 2020. According to the compliance scenario of NREAP, to reach a 40% share in electricity generation required RES capacity to increase to 13,3 GW by 2020 (from almost 2.9

GW in 2005) and to be allocated as follows: 7.5 GW for wind (56.6%); 2.2 GW for PVs (16.6%); 250MW for concentrating solar (1.9%); 2951 MW (22.2%) for hydro of which 255 MW for small hydro, excluding pumping (1580 MW); 250MW of bioenergy (1.9%); and 120 MW for geothermal (0.9%) (YPEKA 2010, 101–2). We turn now to the changing structure of the energy sector in the last three decades, with a special focus on exploring whether recent changes have been stimulated by the EU ETS.

Figure 1. Gross Inland Consumption by type of fuel in Greece for selected years, in Mtoe and percentages (%) of total.




Note: "Other" category consists of Electricity and Waste(non-renewable). Electricity category derives from net electricity imports.
Source: European Commission, Directorate-General for Energy (2019), "Energy datasheets: EU28 countries" (last update 10/04/2019), https://ec.europa.eu/energy/en/data/energy-statistical-pocketbook

Primary energy consumption in Greece is still clearly dominated by fossil fuels, albeit their share has been decreasing in the last decades. According to official data (presented in Figure 1), gross inland consumption (consumption of primary energy) from fossil fuels has decreased from 94.7% in 1990 to 93.9% in 2004, 90.3% in 2012, reaching 85.7% in 2017 (European Commission, 2019b).[7] During this period, the composition of fossil fuels' consumption shows a shift from solid fuels (mainly lignite) and oil to natural gas.

During the period 1990-2017, the share of RES in gross inland energy consumption increased from 5% in 1990, to 5.2% in 2004 to 12% in 2017, showing a considerable shift from fossil fuels to RES. Biofuels and renewable waste is steadily the dominant mode of RES, although their share in gross inland energy consumption from RES decreased from 80.9% in 1990 to 40.7% in 2017. On the other hand, the share of solar and wind energy increased significantly, while the share of hydro fell.

The global economic crisis of 2008 and the following prolonged Greek debt crisis have been inscribed on the trend of the Greek energy consumption. Since 1990, gross inland energy consumption has been steadily rising up till 2008 when the trend was reversed following a downward path almost continuously: from 30.35 Mtoe in 2004 dropped to 24.23 Mtoe in 2017.

The energy import dependency of Greece is quite high, indicating prolonged energy security issues for the country (IEA, 2017).[8] It amounted to 61.9% in 1990, 72.3% in 2004, 65.8% in 2012 and reached 71.1% in 2017 (European Commission, 2019b). With the exception of solid fuels, energy import dependency is almost complete in all types of fossil fuels. Natural gas is totally imported, mostly from Russia. In terms of oil, Greece is almost completely dependent on imports to cover its domestic demand as well as to support its increased exports of refined oil products to other countries.[9] In short, lignite and RES are the two important domestic sources of energy in Greece from 1990 to 2017.

Final energy consumption reflects changes in the structure of the economy and in household life. It was steadily increasing between 1990 and 2004 but it decreased between 2004 and 2017 by 18%, mainly due to the economic crisis. Fossil fuels are dominant in final energy consumption, although their share has been declining from 75.5% in 1990 to 63.3% in 2012 to

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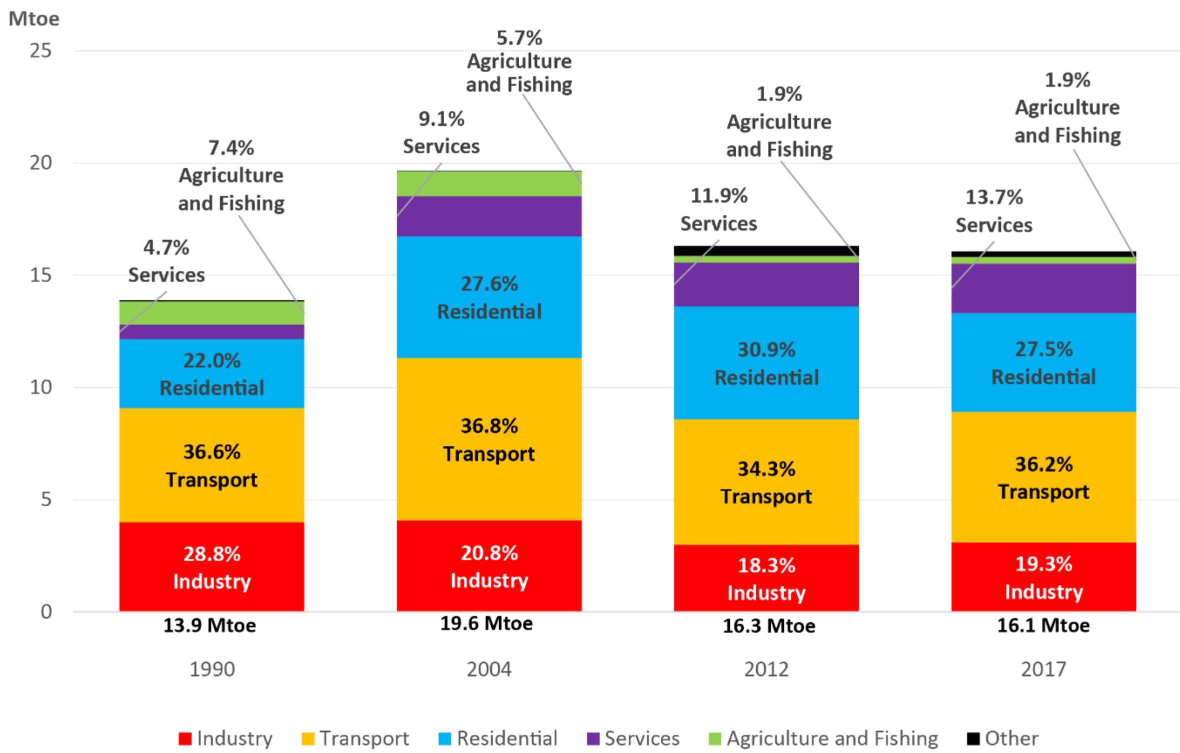
[7] The years 2004 and 2012 were selected for this discussion because 2004 preceded the inauguration of the EU ETS in 2005 and 2012 was the end year for the second running period of the scheme. In this way, the reader gets a hint of the possible association of the changing structure of energy sector with the EU ETS.

[8] Energy import dependency is an indicator that shows the percentage of domestic energy needs of a country which are met by imports. It is calculated according to the following formula: (Net Energy Imports) / (Gross Inland Energy Consumption + international maritime bunkers).

[9] Greece increased its refining output of its four domestic refineries in recent years; the net exports of oil products has grown fivefold from 2011 to 2016 (IEA, 2017, 32).

60.5% in 2017. Petroleum and oil products are the leading fuels, largely due to their use in transport. On the other hand, there is an increasing use of electricity in final consumption; its share increased from 17.6% in 1990 to 28.9% in 2017. The share of RES in final energy consumption increased from 6.9% in 1990 to 10.3% in 2017 (European Commission, 2019b). During this period the dominant type of RES are the solid biofuels and renewable waste, although their share is declining (European Commission, 2019b).

Figure 2. Share of each sector in total Final Energy Consumption in Greece for selected years (in percentages).




Source: European Commission, Directorate-General for Energy (2019), "Energy datasheets: EU28 countries" (last update 10/04/2019), https://ec.europa.eu/energy/en/data/energy-statistical-pocketbook

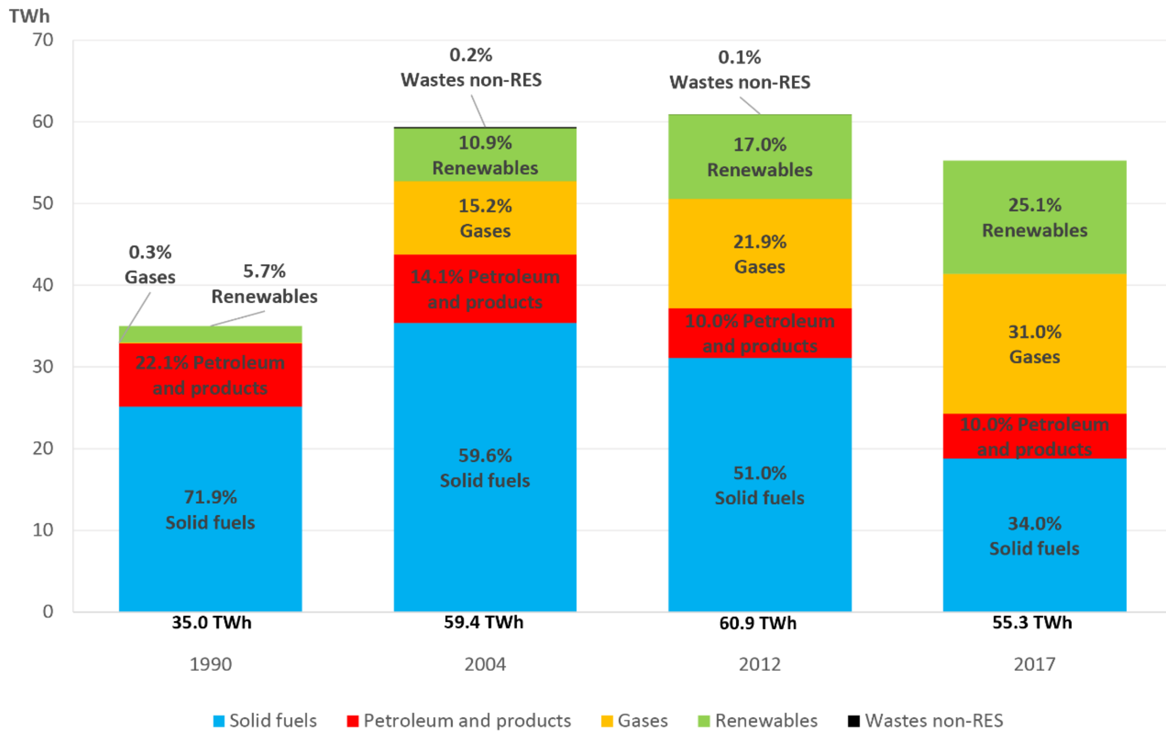
The amount of energy that each sector of the economy consumes as an end-user provides a useful insight into the connection between energy transition and the changing Greek economy. Based on official data (European Commission, 2019b), the leader in final energy consumption of Greece is stably the transport sector (see Figure 2). The residential sector also holds a significant share which reached 27.5% in 2017. The share of the industrial sector shows a declining trend from 28.8% in 1990 to 20.8% in 2004, to 18.3% in 2012 (the last drop was mainly due to crisis);

it increased slightly to 19.3% in 2017. The agricultural sector exhibited also a decline: its share dropped from 7.4% in 1990 to 1.9% in 2017. The share of services increased from 4.7% in 1990 to 13.7% in 2017. This picture matches the long structural change that has been taking place in the Greek economy as evidenced by the sectoral mix of gross value added (GVA): the persistent decreasing importance of industry and agriculture and the relatively rising significance of transport, real estate, trade and accommodation and food service activities (related to tourism) in the Greek economy. [10]

Since the current EU climate change and energy policy, including EU ETS, has specifically targeted the electricity sector, we inspected the changing structure of the electric power sector in Greece. Electricity generation is characterized by a high-carbon energy mix. As mentioned above, in the 1970s, there was a shift to lignite-fired and hydro generation to replace the oil-fired one. As a result, solid fuels accounted for 71.9% and RES for 5.7% of the gross electricity generation in 1990. As Figure 3 shows, fossil fuels in total accounted for 94.3% of electricity generation in 1990; their share dropped to 88.9% in 2004 and continued declining to 82.9% in 2012, reaching 75% in 2017, but it is still quite high. Overall, the importance of oil and solid fuels has decreased in electricity generation since 2004. Having signed an interstate agreement with Soviet Union since 1987 for the procurement of natural gas, Greece introduced natural gas into its energy sector, starting from electricity, in the mid-1990s (Vlachou, 2001). The share of natural gas in electricity generation reached the level of 15.2% in 2004 and increased to 21.9% in 2012 and to 31% in 2017. The contribution of renewables in electricity generation has increased from 5.7% in 1990, to 10.9% in 2004, to 17% in 2012 and to 25.1% in 2017. In sum, electricity generation shifts from solid fuels and oil to natural gas and RES in the last two decades; natural gas is imported in its entirety but RES are a domestic source of energy. We shall examine below this restructuring with a focus on the role of EU ETS.

[10] Based on data drawn from Eurostat, on-line database, "Gross value added and income by A*10 industry breakdowns", last update 12.07.2019, [nama_10_a10]. Table can be provided upon request.

Figure 3. Gross Electricity Generation in Greece by fuel for selected years , in TWh and percentages (%) of total




Notes: *Gases* include *Natural gas* and *manufactured gas.*
*Solid fuels* include: Solid fossil fuels, peat and products, oil shale and oil sands.
The category *other* was left out as the amount was negligible.

Source: European Commission, Directorate-General for Energy (2019), "Energy datasheets: EU28 countries" (last update 10/04/2019), https://ec.europa.eu/energy/en/data/energy-statistical-pocketbook

## 4. The EU ETS and the Transformation of the Power Sector

The EU ETS is characterized by EU itself as the cornerstone of its climate policy. It is a cap-and-trade system launched on January 1, 2005. The participating countries are the member-states of EU and since 2008 three additional countries are included: Iceland, Liechtenstein and Norway. EU ETS has been running for three trading periods (2005–2007, 2008–2012, and 2013–2020) and it is planned to run for a fourth period (2021–2030). At its onset, EU ETS covered mainly $CO_2$ emissions from large stationary installations. Under the scheme an upper *limit* or *cap* is set to the total of quantity of GHG emissions that are allowed to be emitted by installations covered by the system. Subsequently an equal amount of EU Allowances (EUAs) to emit are created and are allocated for free or auctioned via market exchanges to the participating installations. Each installation is then obliged to measure and report its annual emissions and then surrender an equal amount of EUAs to these emissions for compliance. Each participating installation decides about the amount of emissions it creates (or the level of abatement it undertakes) in terms of economic efficiency and engages in EUAs trading. In the case, for instance, that the installation produces less emissions than the amount of EUAs allocated to it, it can sell these permits to other companies that are experiencing a deficit of allowances at the prevailing price. In addition to EUAs, ETS installations are able to surrender international KP credits such as: Certified Emission Reductions (CERs) that are created by Clean Development Mechanism(CDM) projects or Emission Reduction Units (ERUs) that are created by Joint Implementation(JI) projects. Each installation that fails to surrender the required amount of EUAs or international KP credits is obliged to pay a fine, which does not relieve, however, the participating installation from its initial obligation for compliance (Vlachou, 2014; Vlachou and Pantelias, 2017a,b).

EU ETS covers over 11,500 installations that are responsible for almost 45% of the GHG emissions in EU. The system covers the power and heat industry as well as energy intensive sectors and since 2012 domestic air flights.[11] The initial allocation of EUAs to participants was mainly *free of charge* in the first and second trading period. In the third trading period (2013–2020), auctioning became the default method of allocation within the ETS, albeit exceptions were granted for competitiveness reasons (justified by the fear of carbon leakage). The only sector that since 2013 receives just about no free allowances is the power sector, with a few exceptions. The remaining sectors are planned for gradual transition to auctioning. It is estimated that about 57% of the allowances will be auctioned during the third period. Carbon prices increase the cost of high-carbon fuels to the competitive advantage of low-carbon fuels, advancing the transition to a low-carbon energy system. (Vlachou and Pantelias, 2017a,b).

During its operation in the first and second period, ETS demonstrated a huge surplus of EUA allowances. This was mainly the result of an over-allocation of allowances, the use of additional international KP credits permits and the insensitivity of the system toward (asymmetrical) effects in the demand caused by economic crisis. The above led to declines in the price of carbon and the collapse of the market. As an answer, EU legislated adjustments to be

[11] Significant sectors such as transportation, building, agriculture that were excluded from the EU ETS, are now subject to the Effort Sharing legislation, that is, national targets of each Member State that will collectively lead to a reduction of 10% in total EU emissions from these sectors by 2020 and 30% by 2030 (EC, 2019a).

applied in the third period: an EU-wide cap declining annually by 1.74%; the measure of *back-loading* that postponed certain amount of the auctions of the years 2014–2016 to reduce surpluses in the short-run; and the permanent market stability reserve from 2019 design to balance the demand and supply of allowances in the market by increasing or decreasing allowances to be auctioned. Since EU ETS legislation allowed the unlimited "banking" of allowances from 2008 onwards, the transfer of EUAs from one period to the next was possible. This, however, meant that surpluses created in the second period were carried over and still haunt the ETS in the third period. The resulting low prices and the volatility in the market discouraged investment in low-carbon/emission reduction projects (Vlachou, 2014; Vlachou and Pantelias, 2017a,b).

The workings of EU ETS in Greece gave rise to similar outcomes observed at the EU level. There was an over-allocation of allowances leading to an EUAs surplus. Hard-hit by the crisis, non-combustion (industrial) activities, experienced high surplus of allowances. Belonging to the "combustion of fuels" activities, electricity production is singled out as the biggest emitter among the ETS-liable activities in the country. Primarily responsible for GHGs in the country, the electricity sector experienced a shortage of allowances due mainly to the lignite-fired generation in the mainland and to the oil-fired generation in the islands of PPC, still the major power producer in Greece (Vlachou and Pantelias, 2019). Since the Greek power generation is a strategic sector for the ongoing energy transition, we turn to carefully investigating its structural change with a focus on driving factors.

In the high-carbon electricity sector, EU ETS gave rise to significant cost increases especially in the third period (2013–2020). For instance, the cost of compliance to ETS for PPC amounted to €1.1 billion from 2010 to 2016. In 2017, PPC's expenditure for $CO_2$ allowances amounted to €141.6m (PPC, 2019a, 11).

After a decision of RAE, the cost of $CO_2$ allowances bought for compliance was pass-through to the tenders made by the electricity generating companies in the Day Ahead Market since 1-1-2013 (with a transitional stage from 1-6-2011 to 31-12-2012). Based on data kindly provided by PPC, we have calculated the average cost of compliance to ETS for PPC per MWh generated by thermal power plants for the years 2013-2016 (of the third trading period). The cost ranges from 12.2% to 19.4% of the average system marginal price (SMP), which (SMP) reflects the variable cost in the wholesale electricity market. To a great extent, power price increase is being reimbursed to industrial firms vulnerable to leakage risks, financed from revenues received from EUAs auctions (Vlachou and Pantelias, 2019).

Then again, as was the case with the EU as a whole, carbon prices have not created a strong incentive for the penetration of renewables in the Greek power sector up till 2017 (IEA, 2014; 2017). Nevertheless, investments in RES capacity have been increasing during the period 2004-2017, based on data from the Eurostat. Total net RES capacity (including large hydro) increased from 3594 MW to 8686 MW. The increase was 12.5% in 2004–2007, 54.6% in 2008–2012, and 13.2% in 2013–2017. The increase in PVs capacity (inclusive of PVs on roofs) was impressive: from almost nil in 2004, the installed capacity reached 2606 MW in 2017. Quite impressive was also the expansion of wind capacity: from 470 MW in 2004 climbed to 2624 MW in 2017 (an almost five-fold increase). On the other hand, the hydro capacity (inclusive of large hydro) was almost stagnant: from 3099 MW in 2004 increased to 3392 MW in 2017.[12]

The greening of electricity was mainly the result of generous support measures for renewables such as priority dispatching, generous feed-in-tariffs (FiT) and long-term contracts for RES electricity (RES-e) purchase (RAE, 2016; IEA, 2017). The case of FiT for photovoltaics (PVs) is enlightening for the period 2005–2017. Remuneration for electricity production was set by Law 3468/2006 in 2006 as follows in terms of kWp (kilo Watt peak - PV's nominal power): for PVs ≤100 kWp the tariff was €450/MWh in mainland (mostly appealing to farmers to develop PV in their farm lands); for PVs >100 MWp the tariff was €400/MWh in mainland; in non-interconnected islands, the tariff was €500/MWh for PVs ≤100 kWp and €450/MWh for PVs >100 kWp. These FiTs were readjusted every year (YPEKA, 2010, 77–78; IEA 2011, 96–97). For comparison, the average wholesale electricity price in Greece for the years 2007–2009 was €69/MWh (IEA, 2017, 95). These FiT are quite generous when compared to relevant cost data provided by the EC.[13]

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[12] Eurostat database, "Electricity production capacities for renewables and wastes"[nrg_inf_epcrw], Last update: 24-02-2020, accessed 05.04.2020.

[13] In particular, it was reported by EC that the cost of electricity generated from PVs was €140-430/MWh in 2005 and it was projected to reach €55-260/MWh in 2030 (under the assumption of €20-30/t$CO_2$). For comparison, the cost of electricity generated from coal was reported at €30-50/MWh in 2005 and projected to reach €45-70/MWh in 2030 (under the assumption of €20-30/t$CO_2$). For electricity generated from natural gas, the cost was at €35-70/MWh in 2005 and projected to reach €40-95/MWh in 2030 (under the assumption of €20-30/t$CO_2$) (EC, 2007, 26).

These support measures made the entry of private investors quite profitable but unduly increased the price of electricity while the country was in the middle of a severe recession, as we argue below. As the result of the generous incentives, the national target of 2,200 MW of cumulative installed photovoltaic (PV) capacity for 2020 was achieved as early as the end of 2013. Such an overshooting was not unique to Greece as other EU countries reached the 2020 target quite early, indicating a poor design of EU-wide PV policy (IEA, 2014).

Realizing the cost-burden of the FiT scheme, the Greek government stipulated (Law 3851/2010) the gradual reduction of the tariffs for PVs (YPEKA, 2010). Planned to be effective from the mid of 2010, FiT had to reach €260,97/MWh for PVs >100 kWp and €293.59/MWh for PVs ≤100 kWp in the mainland; and €293.59/MWh irrespective of capacity level in non-interconnected islands, by August 2014. It was further stipulated that, from 2015 and hereafter, the FiT of PVs would be associated with the average system marginal costs (ASMC) of the previous year.[14] For comparison, the wholesale price (SMP) for 2015 was €52.4/MWh (LAGIE, 2018, 25).[15] In addition, Roinioti and Koroneos (2019, 37) provided the following estimates of the levelized cost (LCOE) of various electricity generation options of the Greek interconnected system (mainland) for 2015: lignite €55/MWh, CCGT (Combined-cycle Gas Turbine) €87/MWh, small hydro €80/MWh, wind €91/MWh, and PV €203/MWh.

In fact, the generous Greek support system was poorly financed by a RES tax, resulting in an accumulated RES account deficit, which peaked at around € 550 million in 2013 in the course of a severe economic crisis (RAE, 2016, 55).[16] The government was then forced to revise the Law 3851/2010 by the Law 4254/2014 which retroactively recalculated downward the FiT

[14] In particular, for the year n as of year 2015, FiT is calculated as $1.3ASMC_{n-1}$ for PVs >100 kWp and as $1.4ASMC_{n-1}$ for PVs ≤100 kWp; and as $1.4ASMC_{n-1}$ irrespective of capacity level in non-interconnected islands.

[15] It should be noted that the average SMP was officially considered quite low, not reflecting the energy cost of production. RAE (2013, 26) points in 2013: "Most crucially, wholesale prices remained relatively low, but in no way reflective of the full energy production cost. Their levels are suppressed due to significant amounts of compulsory quantities, including mandatory hydro, plants' minimum operational levels, and renewables, which currently constitute a fast escalating component, with the rate of penetration of photovoltaic panels, in particular, rising exponentially. Nevertheless, the deviation between the depressed wholesale price levels (SMP) and the high feed-in-tariffs applied for renewable electricity reimbursement has created a sustained and continually increasing (not temporal, but structural) debt in the Renewables Account."

[16] According to RAE (2013, 5) "Simultaneously, the large (and widening) gap between the – depressed - wholesale price levels (SMP) and the high feed-in-tariffs reimbursed to renewables, created a sustained and ever growing debt in the Renewables Account managed by the Market Operator, LAGIE SA. The deficit of this RES account reached €400 million at the end of 2012, further reducing the liquidity of the Market Operator and, hence, its ability to pay conventional generators, importers and renewable producers in 2012."

remuneration for existing PV and other RES installations holding purchase contracts. The government also set taxes on revenues and time limits in the completion of RES investments to slow-down their penetration (RAE, 2016, 32). During 2012–2014, the licensing of new PV installations was suspended. The FiT program closed at the end of 2015 to be followed by a Feed-in-Premium (FiP) above the electricity market price (IEA, 2017). The objective is to gradually integrate RES into the electricity market, providing market-based state operating aid (RAE, 2018).

In 2016, the Greek government took decisive initiatives to fully eliminate the deficit by the end of 2017 and keep the special RES account annually in balance onwards (RAE, 2017, 9). These included increases in the RES duty (established by now as a special levy on air pollutant emissions with the acronym ETMEAR) on final consumers; imposing of a new 2€/MWh levy on lignite; a special energy charge on electricity suppliers (and channeling part of the revenues from auctions of EUA permits to the RES account (IEA, 2017; IEA, 2014; Vlachou and Pantelias, 2019).

Table 1. Electricity sales volume, ETMEAR unit charge and ETMEAR revenues per consumer category in Greece, 2016.

| **Consumer Category** | | **Electricity sales**[1] | | **ETMEAR charge**[2] | **Revenues from ETMEAR** | |
|---|---|---|---|---|---|---|
| | | MWh | % | Euro/MWh | million Euro | % |
| **High Voltage (HV)** | | 8,187,698 | 16.0 | 2.41 | 19.73 | 2.1 |
| **Medium Voltage (MV)** | > 13GWh | 1,919,859 | 3.8 | 2.48 | 4.76 | 0.5 |
| | < 13GWh | 9,027,738 | 17.6 | 10.12 | 91.36 | 9.9 |
| **Agricultural MV** | | 387,431 | 0.8 | 10.12 | 3.92 | 0.4 |
| **Agricultural LV** | | 2,058,738 | 4.0 | 10.69 | 22.01 | 2.4 |
| **Residential LV** | | 16,767,368 | 32.8 | 24.87 | 417.00 | 45.3 |
| **Other Uses LV** | | 12,806,320 | 25.0 | 28.21 | 361.27 | 39.3 |
| **Total** | | 51,155,152 | 100 | - | 920.05 | 100 |

Sources
1. Regulatory Authority for Energy(RAE) 2017, RAE Decision No 1.101/2017.
2. European Commission (EC) 2018, State Aid SA.52413 (2018/NN), C(2018) 8884 final, Brussels 18.12.2018.

ETMEAR is unfairly shouldered by households while it is quite low for the energy intensive industry (the high voltage (HV) customers). Based on data available by EC (2018) and RAE (decision no 1101/2017 of 22.12.2017), we have calculated in Table 1 the share of each customer category in the ETMEAR revenue for the year 2016: the HV industrial companies accounted for 16% of total electricity consumption and contributed 2.15% to ETMEAR revenues, paying a charge of €2.41/MWh; in contrast, low voltage (LV) households accounted for 32.8% of total consumption and contributed 45.3% to ETMEAR revenues, paying a charge of €24.87/MWh.

In 2017, the target year for eliminating the deficit, ETMEAR contributed 42.4% to the financing of RES account; energy charge on suppliers contributed 19.7%, and revenues from auctions of EUA permits 7.2%. By the end of 2017 the RES special account had a surplus of € 42.5 million (RAE, 2018, 104).

Discontent with increases in electricity payments (associated with unclear calculation of charges and levies, including climate and RES ones) has been mounting as economic depression escalated (RAE, 2016, 74). Electricity bills also rose due to imposed charges upon final consumers in order for the state to be able to finance social programs to combat energy poverty amidst the crisis (Vlachou and Pantelias, 2019).[17] Energy poverty was a harsh consequence of crisis but also deepened by the increased electricity charges, including ETMEAR ones.

Moreover, the greening of electricity via ETS and RES policy intermingles with the negative effects of crisis on the sector and, particularly, on the PPC. The decline of electricity demand and the ill-designed (and socially unfair) penetration of renewables contributed to the economic deterioration of the PPC since they led to a fall in lignite-fired generation (and thus to the underutilization of its lignite plants) owned by PPC, and to a reduction in PPC's revenues.[18] In

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[17] In particular, the Greek government initiated since January 1, 2011 a new program offering low-tariff electricity to vulnerable households. The "Social Residential Tariff" as it is called, had 608,714 residential customers as beneficiaries in 2015, with a total consumption of 2,236,691 MWh of energy (RAE, 2016, 71). The cost of this program is pass-through to the final customers through the electricity bills in a form of cross-subsidy among consumers.

[18] RAE portrays similar problems for the wholesale power market (picturing actually PPC as the biggest power producer in the whole market): "Still, severe liquidity problems and credit risk issues, which started to emerge in early 2011, escalated in 2012. This crisis escalation partially reflected the deepening economic recession, which reversed the demand growth trend prior to the crisis and rendered a surplus of capacity, something that challenged severely the financial viability of the new plants and the prospects of recovery of the large investments made. Moreover, the liquidity crisis unveiled the internal inconsistencies of policies that the Greek State had implemented regarding retail and renewables tariffs. Although appealing in the context of social policy and renewables growth respectively, these policies, interpreted as revenue streams, led to large deficits. Costs were not correctly reflected or adequately transferred across the value chain… Simultaneously, consumers' debts (unpaid electricity bills) escalated to 1.3 billion (estimated value) at the end of 2012, due to the severe economic recession and the incorporation, from autumn 2011 onwards, of a very substantial property tax into the electricity bill, which bulged its total amount." (RAE, 2013, 25–26).

particular, generation from lignite-fired plants fell from 35.4 TWh in 2004 to 31.1 TWh in 2012, to 18.8 TWh in 2017 (see Figure 3). Beyond this, the Greek crisis effects, interwoven with climate and energy policies, contributed to the economic decline of the PPC in additional ways. First, there was an increase of unpaid electricity bills in Greece, and with the PPC being the dominant supplier of electricity, this translated to a huge accumulation of debt towards PPC. The total overdue receivables (customer's debt towards the company) of PPC amounted to 2.44 billion euro by the end of 2018 (PPC, 2019b, 12). Instead of disconnecting the service, after large mobilizations of people against such action in 2011, the state-regulated PPC initiated adaptable debt settlements of accumulated electricity debt with its customers. This, however, created liquidity problems for PPC and limited ability to self-finance its transition to green sources of power and increased energy efficiency. The obvious contradictions imprudently strengthened the longstanding neoliberal calls for privatization, expedited by the adjustment programs.

The third Economic Adjustment Program of Greece, which started in August 2015, introduced further reforms in the energy market, inter alia, the reduction of PPC's share in retail to 50% by the end of 2019 via an alternative mechanism named *NOME auctions* (IEA, 2017, 67). The purpose of these auctions was to facilitate the entrance of new independent electricity suppliers in the retail market by giving them access to PPC's generation from lignite and hydro plants at low price, in the name of creating market competition.[19] As expected by critics and the PPC, NOME auctions resulted in economic damages for PPC.[20] It has been reported that in 2018, for instance, the damage of PPC from NOME amounted to €151.6 million (PPC, 2019a, 10). At the end of August 2019, the new Minister of the Environment and Energy of the New Democracy

[19] The quantity to be auctioned amounts to 1200MW of baseload lignite and hydro-electric generation. The auctions are organized on an annual or quarterly basis for each year, for four years 2016-2020 (RAE 2018, 66). At the auction of 7.2.2018, the reserve price was €32.05/MWh and the purchase price for most of 17 byers was €41.25/MWh; at the auction of 18.4.2018, the reserve price was the same and the purchase price it was €42.0/MWh. In comparison, the 2018 average annual SMP which was €60.4/MWh. The auction prices were drawn from LAGIE http://www.lagie.gr/fileadmin/groups/EDSHE/FEP/AuctionResults/20180207_PurchaseOrdersFinalClassificationTable_Auction2018A01.pdf
http://www.lagie.gr/fileadmin/groups/EDSHE/FEP/AuctionResults/20180418_PurchaseOrdersFinalClassificationTable_Auction2018A02.pdf (last accessed, April 3, 2020)

[20] PPC was forced to sell power at prices lower than the average SMP to its competitors. At the auction of 7.2.2018 (mentioned in the previous footnote), for instance, the total product quantity for sale was 400 MWh/h (total volume 3,504,000 MWh) and the major byers were: Protergia (90Mwh/h), HRON (60Mwh/h), NGR (55Mwh/h), Elpedison (40Mwh/h), ELTA (40Mwh/h),and Watt+Volt (90Mwh/h), as reported by the energy press: https://energypress.gr/news/sta-4145-eyromwh-ekleise-i-timi-sti-simerini-dimoprasia-nome-poies-posotites-pire-kathe-paihtis, (last accessed, April 3, 2020)

government, K. Hatzidakis, stated that through NOME auctions PPC lost €600 million to its competitors, by selling electricity at prices lower than its cost, in the last four years (Hatzidakis, 2019). Shockingly, the observed increase in electricity exports in 2018 was mainly attributed to export of quantities acquired by third private parties through NOME at low prices, and exported for profit at the expense of PPC (PPC, 2019a, 10).

In short, decreased demand, the penetration of RES, idle capacity, ETS compliance cost, unpaid bills and the required further privatization have serious implications for PPC's revenues, its ability to service debt payments and for its profitability. With PPC's share price failing, any privatization attempts of company's assets would be a sell-off, reminiscent of "primitive accumulation". While the biggest power firm in the country, PPC's condition has been weakened by so many complex energy and social factors, shaped in part within the neoliberal EU context, undermining the firm's potential to transform its electricity structure into a low-carbon one for the country.

Looking at the broader picture in Greece, the real path of the energy transition has been characterized by high costs, social unfairness and poverty, "grabbing" of natural resources and public assets, and the destruction of the public power corporation.

## 5. Concluding Remarks

Climate change is deeply grounded in the historically-specific patterns of fossil-powered capitalist development. Fossil fuels shaped many important processes of capitalism by providing freedom from physical constraints, greater energy efficiency, locational and mobility advantages, concentration of production in urban centers, increased flexibility and mobility of labor force, cost reductions, and increased productivity — all enhancing profitability. At the same time, they contributed to serious environmental problems and face exhaustibility, which result in costs increases, geopolitical conflicts, and poverty of many sorts. Such contradictions generate conflict and social change which drive the ongoing energy transition. There is a need for an extensive restructuring of the existing energy system, production, transport, and other social activities in order to achieve climate and energy sustainability. The current transition signifies a capitalist restructuring with the help of national and international policies such as the EU ETS and RES support policies.

Up till now, the EU ETS has not really challenged the fossil fuel basis of the contemporary capitalism in EU and Greece, in particular. It has been environmentally ineffective and distribution–wise unfair. The economic crisis gave rise to old and new risks for the ETS. The surpluses that were exacerbated by the economic recession, the volatility of carbon prices and the accompanied financial risks, all undermined long-term investments in low carbon technologies very much needed for a low-carbon society.

Transition to low carbon energy by increased RES penetration is in the making. Even mainstream authors tend to recognize that this shift has been costly, socially-unfair and full of uncertainties. "Ambitious renewable energy promotion in some countries has resulted in significant uptakes of the renewables. However, the cost of the support policies tends to create a trade-off between sustainability and affordability objectives. Higher electricity prices arising from subsidies can have negative [impacts] on both households and industrial consumers, affecting social welfare and industrial competitiveness." (Costa-Campi et al., 2018, 585).

Being locked-in within the uneven capitalist development in EU, Greece is obligated to follow EU-wide neoliberal climate and energy policies designed under the influence of the dominant class interests in the EU. Highly in debt and under harsh austerity programs of neoliberal orientation, Greece cannot genuinely design its transition to sustainable development (hopefully of a socialist orientation) according to its own needs, resources and timetables. Greece was not given the necessary time and resources badly needed for the country to exit the crisis and to start a sustainable transition. On the contrary, a vast misallocation of scarce resources takes place in Greece, at the expenses of the under-privileged, by following EU-wide ill-designed climate and energy policies such as the ETS, RES/PV penetration policies, deregulation and privatizations in the energy sector.

In Greece, an extensive transformation of the energy system, production and social activities is needed. Ecological and climate sustainability from a socialist perspective will need to include transition to renewables and greater energy efficiency. It needs to be combined with a socialist transformation of Greek society through the actions of a strong radical collective subjectivity. This transformation should take into account the need of Greece to exit the crisis, its limited means, its potentials and workable timetables. The recent struggles of Greek people against austerity programs and the dominant national and EU business interests have failed; crucial natural conditions and resources are drawn into the circuits of private capitals (Konstantinidis and Vlachou, 2018). Nonetheless, a strong radical collective subjectivity could emerge as people draw lessons from their experiences, forming an eco-socialist vision and acting upon it.

References


Aglietta, Michel. 1979. *A Theory of Capitalist Regulation: The U.S. Experience*. London: Verso.

Altvater, Elmar. 2006. "The social and natural environment of fossil capitalism." In *Coming to terms with nature*, edited by Leo Panitch and Colin Leys. Socialist Register 2007, 37–60. London: Merlin.

Bina, Cyrus. 1985. *The Economics of the Oil Crisis: Theories of Oil Crisis, Oil Rent, and Internationalization of Capital in the Oil Industry*. London: The Merlin Press.

Costa-Campi, María Teresa, Tooraj Jamasb, and Elisa Trujillo-Baute. 2018. "Economic analysis of recent energy challenges: Technologies, markets, and policies." *Energy Policy* 118: 584–587.

EC (European Commission) . 2007. "An energy policy for Europe." *Communication from the Commission to the European Council and the European Parliament. COM(2007) 1 final*, 10.1.2007.

———. 2010. "Energy 2020 – A Strategy for Competitive, Sustainable and Secure Energy." *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions. COM(2010) 639 final*, November 10.

———. 2011. *Energy Roadmap 2050: Impact Assessment and Scenario analysis*. SEC (2011) 1565 final, December 15. At https://ec.europa.eu/energy/sites/ener/files/documents/roadmap2050_ia_20120430_en_0.pdf

———. 2017. *Commission Staff Working Document – Energy Union Factsheet Germany*. SWD(2017) 389 final, November 23.

———. 2018. "State Aid SA.52413 (2018/NN) – Greece, Reduced contribution to financing of support for electricity from renewable sources (RES) and high-efficiency cogeneration (HECHP) for energy-intensive users (EIUs)." C(2018) 8884 final, December 18.

———. 2019a. "Effort sharing: Member States' emission targets." Accessed July 16. https://ec.europa.eu/clima/policies/effort_en#tab-0-0.

———. 2019b. "Energy datasheets: EU28 countries, last update 10 April 2019." Accessed https://ec.europa.eu/energy/en/data/energy-statistical-pocketbook.

———. 2019c. *European Economy Institutional Paper 116 – Enhanced Surveillance Report: Greece*, Luxembourg: Publications Office of the European Union.

———. 2020. *European Economy Institutional Paper 123 – Enhanced Surveillance Report: Greece*, Luxembourg: Publications Office of the European Union.

European Parliament and Council of the European Union. 1996. *Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity*. Official Journal L 027.

Fine, Ben and Alfredo Saad Filho. 2014. "Politics of neo-liberal development: Washington Consensus and post-Washington Consensus." In *The Politics of Development: A Survey,* edited by Heloise Weber, 154–166. London: Routledge.

Fouquet, Roger, and Peter J G Pearson. 2012. "Past and prospective energy transitions: insights from history." *Energy Policy* 50: 1–7.

Hatzidakis, Kostis. 2019. "Briefing the Committee for Production and Trade of the Greek Parliament by the Minister of the Environment and Energy on the efforts of the Government and the Management of PPC for improving the economic situation of the corporation," August 19, https://www.hellenicparliament.gr/Vouli-ton-Ellinon/ToKtirio/Fotografiko-Archeio/#cee78f80-c706-46ea-994b-aab900d1c0c4 and https://energypress.gr/news/hatzidakis-amesi-katargisi-nome-den-tha-ypohoriso-stis-vryxelles-me-nomo-megalyteri-eyelixia

Harvey, David. 1999. *The Limits to Capital*, London: Verso.

———. 2006. *Spaces of Global Capitalism.* London: Verso.

Helm, Dieter. 2014. "The European framework for energy and climate policies." *Energy Policy* 64: 29–35.

Huber, Matthew. 2009. "Energizing historical materialism: fossil fuels, space and the capitalist mode of production." *Geoforum* 40 (1): 105–115.

———. 2015. "Theorizing Energy Geographies." *Geography Compact* 9 (6): 327–338.

IEA (International Energy Agency). 2006. *Energy Policies of IEA Countries: Greece 2006 Review*. Paris: IEA.

———. 2011. *Energy Policies of IEA Countries: Greece 2011 Review*. Paris: IEA.

———. 2014. *Energy Policies of IEA Countries: The European Union 2014 Review*. Paris: IEA.

———. 2017. *Energy Policies of IEA Countries: Greece 2017 Review*. Paris: IEA.

Ikwue, Tony, and Jim Skea 1994. "Business and the genesis of the European Community carbon tax proposal." *Business Strategy and the Environment* 3 (2): 1–10.

Kern, Florian, and Markard Jochen. 2016. "Analysing energy transitions: Combining insights from transitions studies and international political economy." In *The Palgrave Handbook of the International Political Economy of Energy*, edited by Van de Graaf, T., Sovacool B.K., Ghosh A., Kern, F. and Klare M.T, 291–318. London: Palgrave Macmillan.

Klare, Michael. T. 2002. *Resource Wars: The New Landscape of Global Conflict.* New York: Metropolitan books.

———. 2004. *Blood and Oil: The dangers and consequences of America's growing petroleum dependency*. London: Hamish Hamilton.

Konstantinidis, Charalampos, and Andriana Vlachou. 2017. "Appropriating nature in crisis-ridden Greece: The rationale of capitalist restructuring, Part 1." *Capitalism, Nature, Socialism* 28 (4): 48–61.

———. 2018. "Appropriating nature in crisis-ridden Greece: Deepening neoliberal capitalism, Part 2." *Capitalism, Nature, Socialism* 29 (2): 108–121.

LAGIE (Hellenic Electricity Market Operator). 2018. *Monthly Report for Spesial Acoount for RES and CHP*. LAGIE: December.

Malm, Andreas. 2013. "The origins of fossil capital: From water to steam in British cotton industry." *Historical Materialism* 21 (1): 15–68.

Marx, Karl. 1991. *Capital: A Critique of Political Economy*. New York: Penguin Books.

———. 1976. *Capital*: *A Critique of Political Economy*. Volume I. trans. Ben Fowkes. New York: Penguin Books.

McCarthy, James. 2015. "A socioecological fix to capitalist crisis and climate change? The possibilities and limits of renewable energy." *Environment and Planning N* 47 (12): 2485–2502.

Porter, Michael E., and Claas van der Linde. 1995. "Toward a New Conception of the Environment-Competitiveness Relationship." *Journal of Economic Perspectives* 9 (4): 97–118.

PPC (Public Power Corporation S.A). 2019a. *Financial Report (January 1st 2018 – December 31st 2018)*. Athens: PPC S.A.

———. 2019b. *Financial Results 2018 – Presentation to the Analysts*. Athens: PPC S.A.

RAE (Regulatory Authority for Energy). 2008. *2008 National Report to the European Commission.* Athens: RAE.

———. 2013. *2013 National Report to the European Commission.* Athens: RAE.

———. 2016. *2016 National Report to the European Commission*. Athens: RAE.

———. 2017. *National Report 2017 – Regulation and performance of the electricity market and the natural gas market in Greece, in 2016.* Athens: RAE.

———. 2018. *National Report 2018 – Regulation and performance of the electricity market and the natural gas market in Greece, in 2017.* Athens: RAE.

Resnick, Stephen. A., and Richard D. Wolff. 1987. *Knowledge and Class: A Marxian Critique of Political Economy.* Chicago: University of Chicago Press.

Roinioti, Argiro and Christopher Koroneos. 2019. "Integrated life cycle sustainability assessment of the Greek interconnected system." *Sustainable Energy Technologies and Assessments* 32: 29–46.

Smil, Vaclav. 1994. *Energy in World History*. Boulder, Co: Westview Press.

———. 2010. *Energy Transitions: History, Requirements, Prospects*. Oxford: Praeger.

Solomon Barry D., and Karthik Krishna. 2011. "The coming sustainable energy transition: History, strategies, and outlook." *Energy Policy* 39 (7): 7422–7431.

Tagliapietra, Simone, Georg Zachmann, Ottmar Edenhofer, Jean-Michel Glachant, Pedro Linares, and Andreas Loeschel. 2019. "The European union enegy transition: Key priorities for the next five years." *Energy Policy* 132: 950–954.

Tsotsoros, Stathis. 1995. *Energy and development in the Postwar period. The power public Corporation 1950–1992* (In Greek). Cent. Neohell. Res. Natl. Hell. Res. Found. 52 (in Greek).

Verde, Stefano. 2008. “Everybody merges with somebody—the wave of M&As in the energy industry and the EU merger policy.” *Energy Policy* 36 (3): 1125–1133.

Vlachou, Andriana. 1994. “Reflections on the ecological critiques and reconstructions of Marxism.” *Rethinking Marxism* 7 (3): 112–128.

———. 2001. *Environmental and Natural Resource Economics*. Athens: Kritiki (in Greek).

———. 2002. “Nature and value theory.” *Science & Society* 66 (2): 169–201.

———. 2004. “Capitalism and ecological sustainability: the shaping of environmental policies.” *Review of International Political Economy* 11 (5): 926–952.

———. 2005. “Environmental Regulation: A value-theoretic and class-based approach.” *Cambridge Journal of Economics* 29 (4): 577–599.

———.2014. “The European Union’s Emissions Trading System.” *Cambridge Journal of Economics*, *38* (1): 127–152.

Vlachou, Andriana, and Charalampos Konstantinidis. 2010. “Climate change: The political economy of Kyoto flexible mechanisms.” *Review of Radical Political Economics* 42 (1): 32–49.

Vlachou, Andriana. and Thanasis Maniatis. 1999. “Paving the Road to Privatization: The Case of the Public Power Corporation in Greece.” In *Rethinking Democracy and the Welfare State*, edited by John Milios, Louka Katseli, and Theodore Pelagidis, 146–175. Athens: Ellinika Grammata.

Vlachou, Andriana, and Georgios Pantelias. 2015. “The disturbing embeddedness of the EU’s Emissions Trading System (EU ETS) in high-carbon European economies.” Paper presented at the 6th Annual Conference in *Political Economy* of the International Initiative for Promoting Political Economy (IIPPE) on *Rethinking Economics: Pluralism, Interdisciplinarity and Activism*, held at The University of Leeds, U.K., September 9-11, 2015.

———. 2017a. “The EU’s Emissions Trading System, Part 1: Taking Stock.” *Capitalism Nature Socialism* 28 (2): 84–102.

———. 2017b. “The EU’s Emissions Trading System, Part 2: A Political Economy Critique.” *Capitalism Nature Socialism* 28 (3): 108–127.

———. 2019. “Climate under neoliberalism: The EU Emissions Trading System in crisis-ridden Greece.” Working Paper 05-2019, Department of Economics, Athens University of Economics and Business.

YPEKA (Ministry of Energy, Environment and Climate Change). 2010. *Greece: National Renewable Energy Plan in the scope of Directive 2009/28/EC*. Athens.

Zolotas, Xenophon. 1975. *“The Energy Problem of Greece.*” *Archives of Studies and Lectures* 28, Athens: Bank of Greece (in Greek).