TRANSrisk
TRANSITION PATHWAYS AND RISK ANALYSIS FOR CLIMATE CHANGE POLICIES

TRANSITIONS PATHWAYS AND RISK ANALYSIS FOR CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGIES

D3.2 Context of 15 case studies:

Greece: Solar Power, Buildings, and Micro-Generation & Storage

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1 COUNTRY CASE STUDIES: THE ENABLING ENVIRONMENT FOR SUSTAINABILITY

During the last decade, there has been increasing interest in PV generation in Greece. This is a result of the high solar potential in the country as well as the Feed in Tariffs that encouraged new investments. However, the Greek photovoltaic sector has vastly shrunk in recent years, mainly due to the changes in the regulatory framework and the incentives mechanism. Part of the Greek case study, therefore, will explore the potential for the PV market (in terms of perspectives, energy prices and their impacts on investments, financial schemes, etc.), as well as the current policy framework, in order to survey the key drivers in the solar power sector towards a decarbonised Greek economy by 2050.

Additionally, the existing building stock in Greece, which is predominantly of poor performance and consequently in need of renovations, provides significant room for further decarbonisation. The case study, as a result, will also give attention to the required renovation work, focusing mainly on investments in solar power generation, solar heating and cooling, and insulation measures.

Finally, the case study aims to explore pathways towards a low carbon energy system that is based on the notion of prosumers (i.e. consumers that also generate power) and the diffusion of micro-generation and storage (both thermal and electrical) in the residential sector. Specifically, the effect of different pathways for demand management technologies and the appropriate market mechanisms will be simulated and assessed.

1.1 Research questions for the Greek case study

Given the general context of the country (as discussed in the next section), the overarching research questions for the Greek case study are summarised below.

1 **How can Greece move towards a more efficient use of energy resources to support sustainable growth?**
   a. What can be done to reduce primary energy demand (across all sectors)?
   b. Which areas should we primarily focus on?

2 **What is the role of renewables towards decarbonisation?**
   a. What is the minimum penetration of renewables in energy consumption and the power generation mix, in order to achieve a transition to a low carbon economy, also considering the national potential in solar (and wind) power?
   b. What is the cost of renewables and who absorbs it?
   c. What is the cost of GHG emissions savings associated with solar power compared to other alternatives?

3 **How can further development of the Greek solar market be achieved?**

a. What caused the institutional failure of the past that, combined with the adverse fiscal environment, contributed to the suspension of the remarkable boom of the Greek solar market (2011-2013)?

b. In this context and considering the current shutdown of new investments, how can further development of the domestic solar market be incentivised?

4 **Which policies can drive a transition pathway for the power system that is based on the notion of consumers generating, storing and consuming clean energy locally?**

5 **With regard to energy efficiency, which policy instruments can promote the desired transition pathway(s) in the building sector?**

6 **What would be the socio-economic consequences of switching from coal sources (and mainly lignite-fired power plants), which currently account for about half of the power generation mix, to renewable energy sources (with emphasis on solar power)?**

a. What are the risks and uncertainties associated with the corresponding policy options?

b. On promoting micro-generation and storage at the residential sector, how could potential costs and benefits be distributed to both the consumers and the power market actors?

1.2 Introduction to the general context

Most of the information provided in this section stems from both preliminary desk research and the results of intensive stakeholder engagement (see section 2.5, stakeholder engagement, for further details on the number and type of stakeholders contacted).

1.2.1 Policy overview

Greece is part of the EU delegation that signed the Paris Agreement. The EU has set itself a long-term goal of reducing greenhouse gas (GHG) emissions by 80-95% when compared to 1990 levels by 2050, with a reduction of 80% to be achieved domestically as laid down in the EU roadmap (EC, 2011a) for moving to a competitive low-carbon economy in 2050. To achieve this long-term target cost-efficiently, the EU should aim to reduce its domestic emissions by 40% and 60% by 2030 and 2040, respectively. The target for 2030 is part of the Energy and Climate Package for 2030 and was adopted in 2014 by the European Council (EC, 2014). Greece is part of the EU and therefore in bond to adopt the European targets at least in the medium term.

Greece adopting the EU 2020 targets means a total reduction of 4% until 2020 relative to 2005 GHG emission levels (EC, 2009). According to the EU Directive 2009/28/EC, Greece has to achieve a target of 18% renewable energy (RES) penetration in gross final energy consumption by 2020, although the target has been amended to 20% (Law 3851/2010); the specific trajectory for achieving it was presented in the 2010 National Renewable Energy Action Plan (NREAP) (MEECC, 2010). The overall target is broken down further into sub-targets of 40% RES in the power generation mix, 20% RES in final energy consumption for heating and cooling, and 10% RES in final energy consumption for transport until 2020 (Figure 1). The long term EU targets until 2050 have not been translated into national reduction targets yet, although the visualisation of the future energy system—as indicated by three basic energy policy scenarios—has been summarised in the 'Greek Energy Roadmap to 2050' document (YPEKA, 2012; EKDDA, 2012). This roadmap shows that Greece's plan to reduce greenhouse gas emissions focuses on maximising the penetration of renewables into the electricity generation mix using all commercially available technologies, increasing the use of biofuels in transportations, improving energy efficiency in the building sector accompanied by large penetration of renewable energy in buildings, and developing decentralised production units and smart grids. By focusing efforts towards these directions, as well as reducing dependence on energy imports and reinforcing the protection of final consumers, Greece could potentially achieve a 60 – 70% reduction of GHG emissions by 2050.

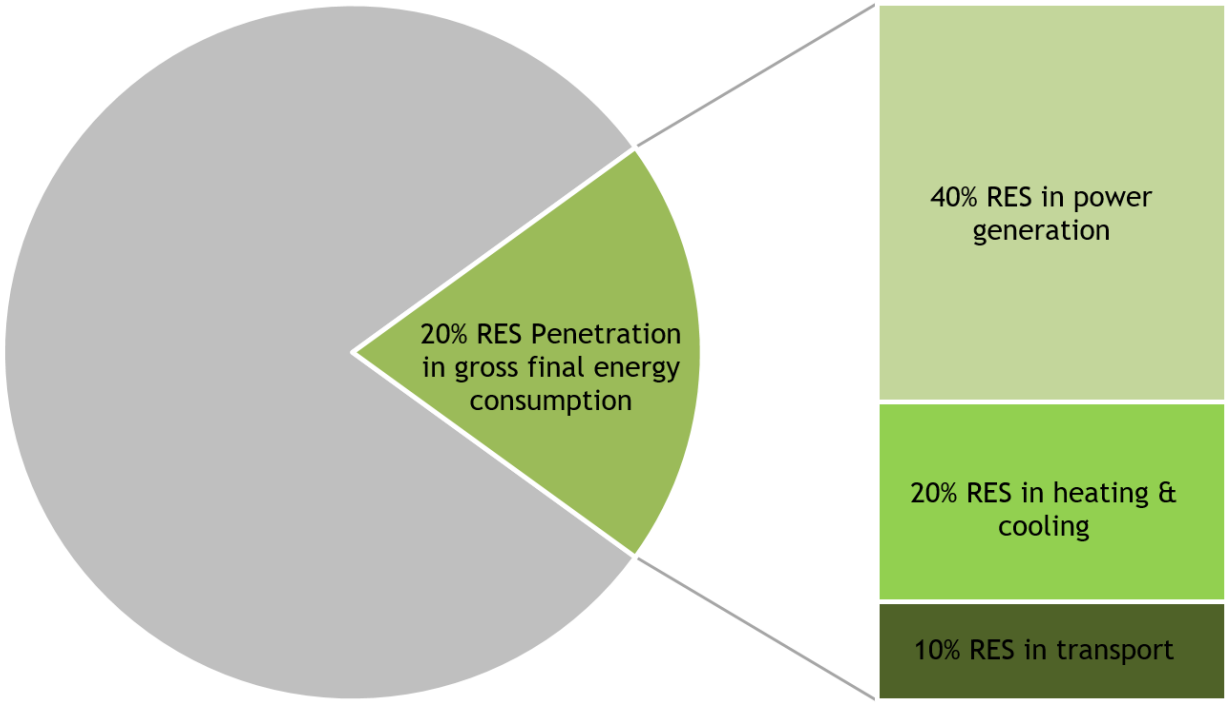


Figure 1 National RES penetration targets for 2020

Source: MEECC, 2010

The national institutional framework includes full harmonisation with EC directives regarding energy efficiency, power market operation and renewable energy share in primary energy consumption.

1.2.2 Natural resources and environmental priorities

Natural resources in Greece: potential and constraints of resources

The Greek energy sector is still largely dependent on fossil fuels, most of which are imported. Primary energy supply in Greece is the most carbon-intensive among the IEA member countries, because of its strong reliance on oil and lignite (IEA, 2011). However, Greece has a large potential for wind and solar energy and is rightly determined to increase their use.

Following the significant decrease in energy consumption since 2008 due to the recession, primary energy production in Greece too seems to have fallen (Figure 2). Figure 3 shows that, despite the large penetration of renewables in the power generation mix, primary energy production is still largely dependent on fossil fuels and specifically lignite, sources of which can be found in abundance and are to a large extent exploited.

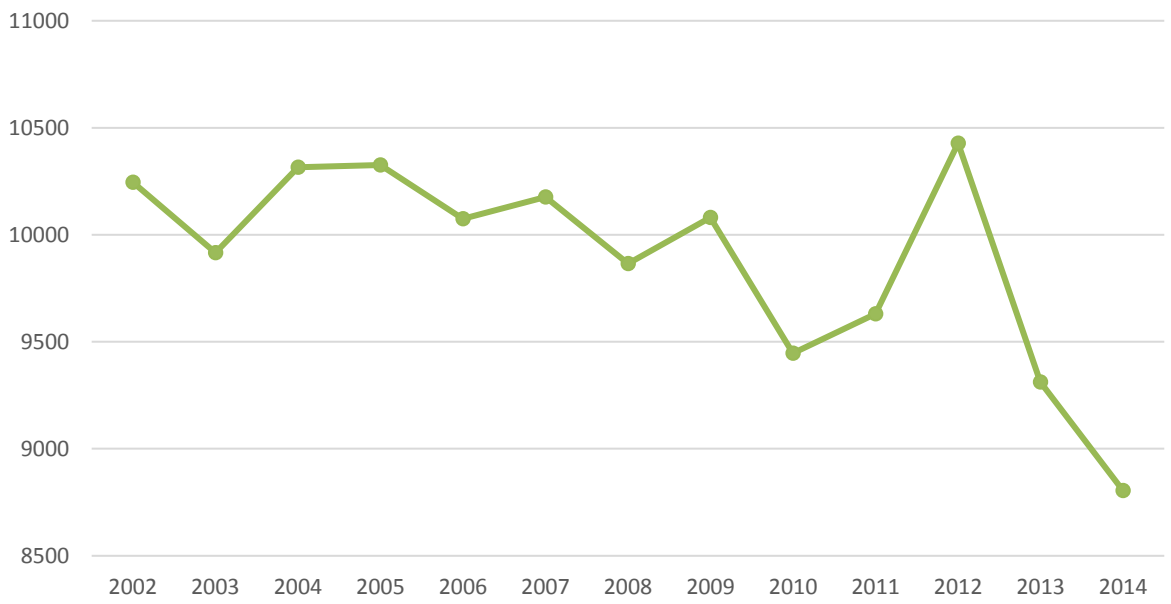


Figure 2 Primary energy production in Greece (kTOE), 2002 - 2014

Source: Eurostat, 2016a

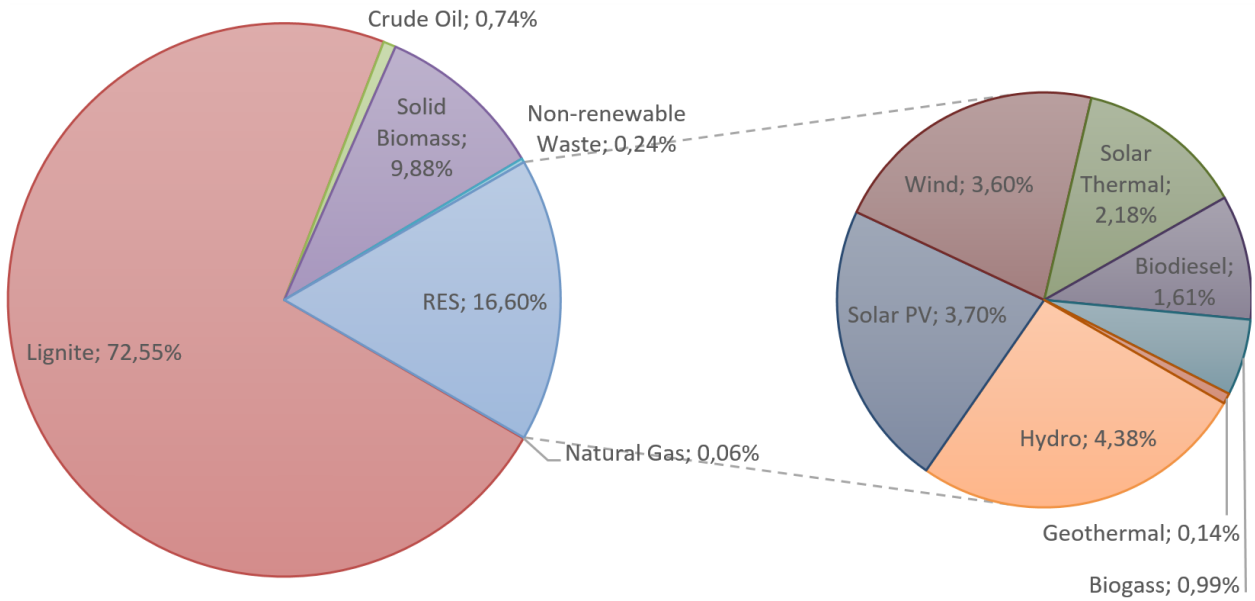


Figure 3 Primary energy production in Greece by source, 2014

Source: IEA, 2015

The Greek electricity sector is peculiar in that it consists of the interconnected continental system and of the non-interconnected stand-alone grids in the islands, where electricity demand is catered to by oil-fired plants and, to a smaller extent, by RES facilities (approximately 85/15%) (Boel, 2015).

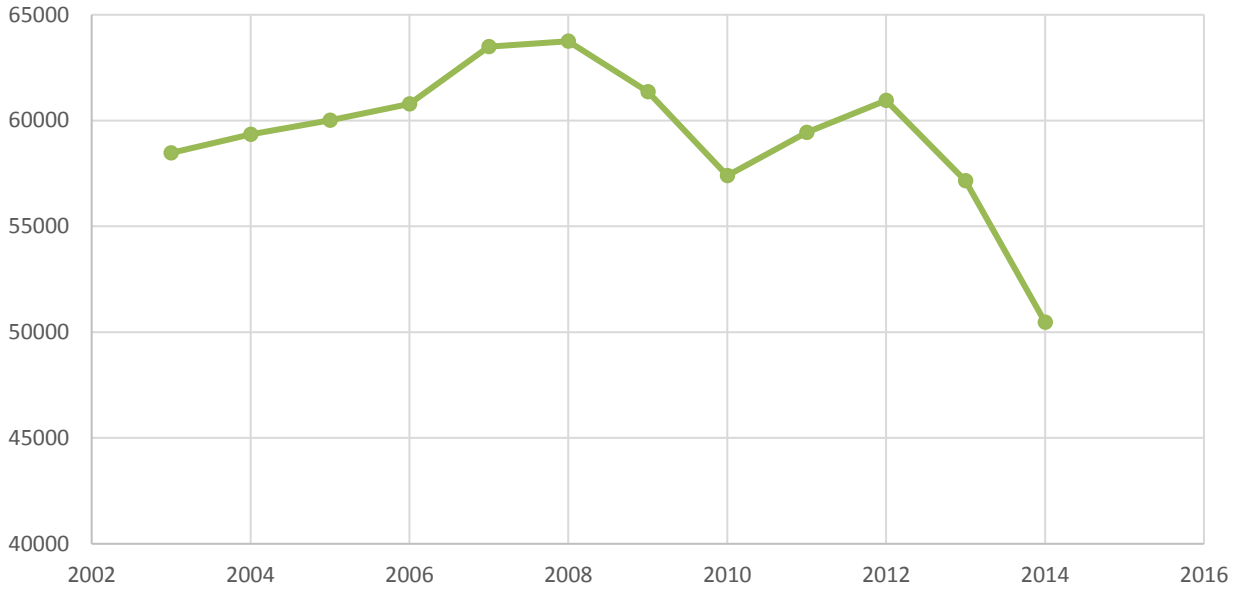


Figure 4 Gross electricity generation in Greece (GWh), 2003 - 2014

Source: Eurostat, 2016b

As seen in Figure 4, in 2014, gross national electricity generation was 50.4 TWh. This corresponds to a decrease of around 21.8% compared to the situation before the beginning of the economic recession (61.4 TWh in 2009) (Eurostat, 2016b). In 2014, gross electricity generation was shared between lignite (46.1%), natural gas (19%), oil (9.5%), hydro power (9.4%) and other renewables (15.9%) (World Bank, 2016). With regard to other renewables, this can be further broken down to photovoltaics (7.05%), wind (6.91%), small hydro (1.29%) and biomass (0.38%) (HELAPCO, 2015a). In 2015 wind power's share in the electricity generation mix increased to 8.37% (HELAPCO, 2016a) with all the other renewable energy sources remaining at the same levels.

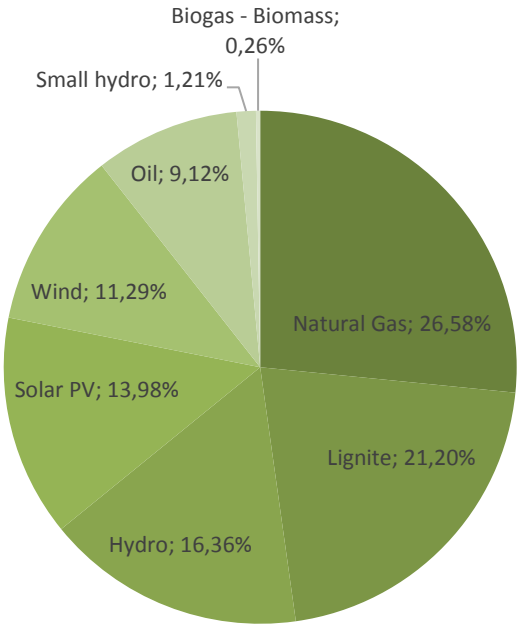


Figure 5 Installed capacity of electricity generation plants in Greece (MW), 2015

Source: Boel, 2015

The Greek electricity system is interconnected with Bulgaria, the Former Yugoslav Republic of Macedonia (FYROM), Albania, Turkey (400kV/150kV AC lines) and Italy (400kV DC submarine cable). These interconnections are mostly used for importing power to Greece, with the exception of the one with Albania which is mainly used for exports (IEA, 2011). According to data provided by ENTSO-E (2015), Greece's electricity exchanges consists mainly of imports, with 88% (11091GWh) of the total exchange accounted for by imports and 12% (1,473 GWh) by exports. Total transfer capacity of interconnection lines reaches around 15% of current peak demand in Greece (IEA, 2011).

Greece consumes 1.6% of the total EU consumed energy, according to the Eurostat 2013 Statistics. The highest energy consuming EU countries are Germany, France, Italy and the UK which altogether consume 56.5% of the EU-consumed energy (19.1%, 15.3%, 10%, and 12.1% respectively) (Eurostat, 2013).

Final energy consumption in Greece was 15,574 ktoe in 2014, mainly shared between the transportation, residential and industrial sectors (Eurostat, 2016b), as can be seen in Figure 6.

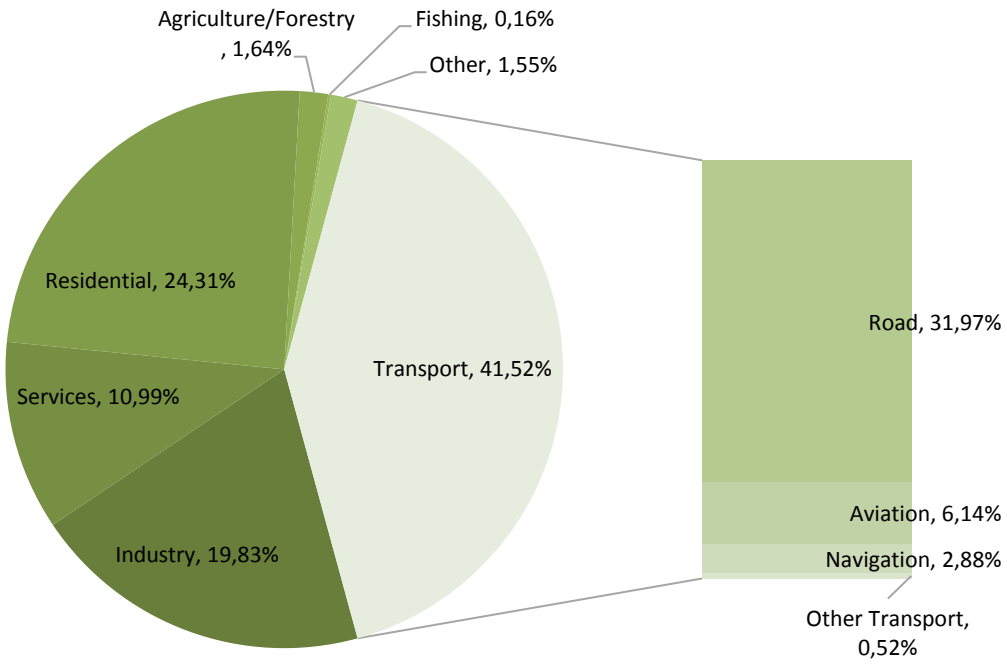


Figure 6 Final energy consumption by end user group in Greece, 2014

Source: Eurostat, 2016b

With regard to carbon emissions in Greece, Figure 7 shows that the largest contribution comes from electricity and heat production, followed by transportation and industry (manufacturing and construction). In 2013, CO_2 emissions in Greece were shared between electricity and heat production (60.33%), transportation (23.66%), industry (8.17%), buildings and services (6.46%) and other sectors (1.38%) (IEA, 2013).

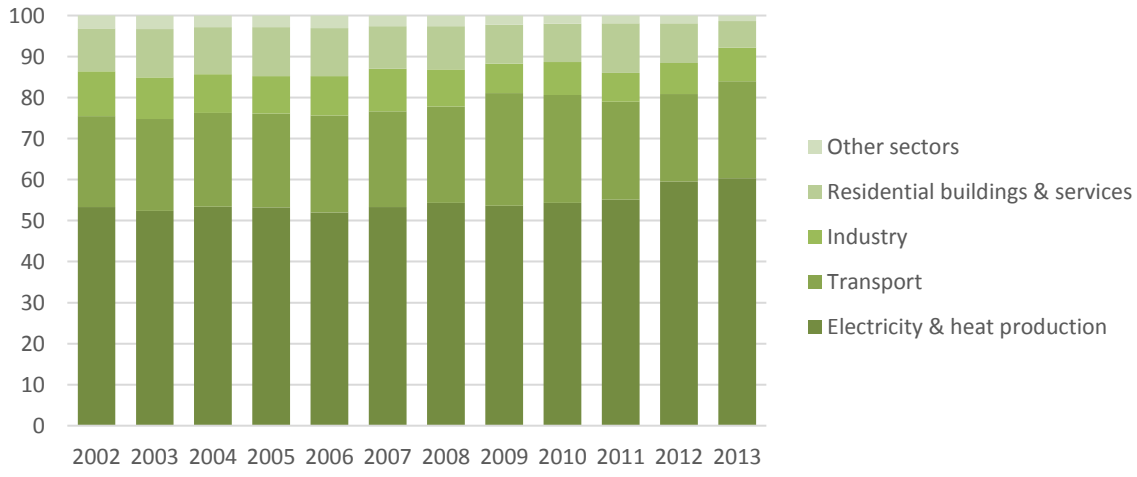


Figure 7 CO_2 emissions by sector in Greece, 2002 - 2013

Source: IEA, 2013

In Figure 8, we can see that carbon emissions per capita have significantly decreased after 2008, due to the overall, absolute decrease of carbon emissions (IEA, 2013). This change primarily stems from the negative economic growth and industry activity in the country during the recession, as well as the remarkable development of renewable energy sources (especially with regard to solar power) during the period 2011-2013.

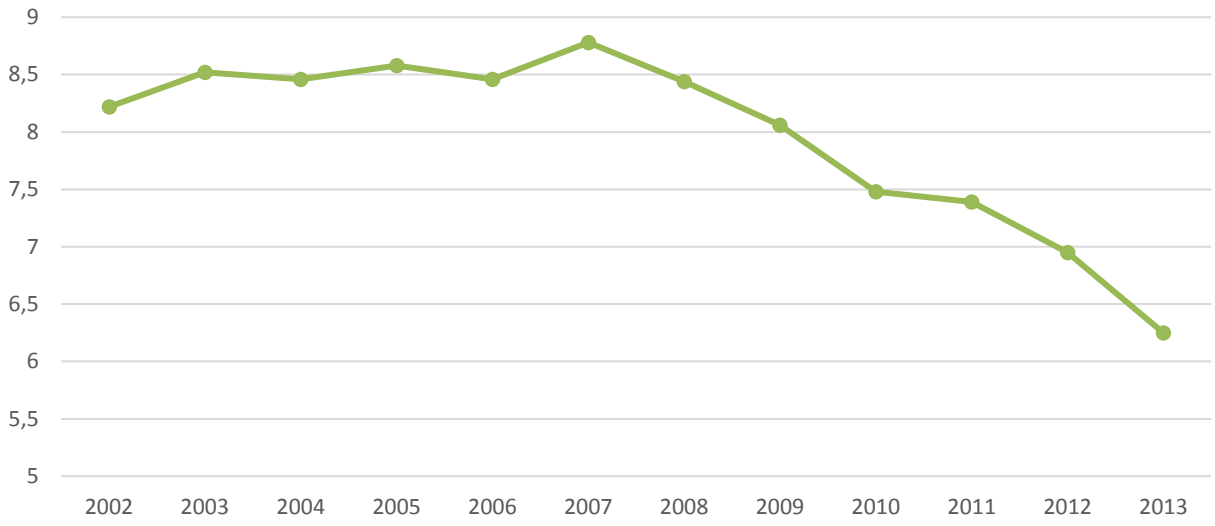


Figure 8 Carbon emissions per capita (tCO_2)

Source: IEA, 2013

Vulnerability to natural events (risk)

The country's environmental conditions may be described by increasing coastal areas stress, by expanding differences between touristic areas and the rural hinterlands, serious resources interdependencies, high susceptibility to pollution, and the sensitivity of the water-soil equilibrium (Skondras et al., 2011).

The soils of Greece are extremely vulnerable to erosion, desertification and salinisation with resulting problems in developing also the water resources (reservoir sedimentation, stream bed stability, etc.) (Skondras et al., 2011). Greece has predominantly a rocky coast (70%). A minor part of the country's coastline is characterised by sandy beaches and dunes as well as wetlands and lagoons. These softer parts currently experience a high rate of erosion: over 20% of the total coastline is currently under threat. (Policy Research Corporation, n.d.; MEECC, 2014).

Furthermore, the role of tectonics is especially important in tectonically active zones, as it can counterbalance the relative sea level rise (SLR) when there is a tectonic uplift, or conversely, amplify the SLR when there is tectonic subsidence. The 'high risk' coastal areas of Greece include the deltaic areas of many Greek rivers and gulfs. Apart from long-term SLR predicted to reach 0.25 to 1m by 2100, other climate phenomena capable of causing coastal erosion are the anticipated increase in storminess and the frequency of storm surges. The impacts of storm surges include: flooding of coastal areas; destruction of coastal infrastructure; coastal erosion; and

intrusion of salt water in lagoons, river, etc. (MEECC, 2014). However, with regard to coastal flooding, the risk is rather limited as tidal ranges are relatively small in the Mediterranean area. Greece has not experienced any severe floods from the sea in the past and Sea Level Rise (SLR) is estimated to be only in the range of 0/+1 mm/year (Policy Research Corporation, n.d).

Coastal zones and islands are additionally threatened through drought, creating additional water management problems, especially in summer when increasing tourism causes a strong, seasonal services and infrastructure demand. The Greek islands and the region of Thessaly may especially experience increasing periods of drought due to a reduction of summer precipitation. In the Nestos and Mornos Basins the most significant impacts of droughts refer to stream flow reduction and the reduction in agricultural production (MEECC, 2014). Climate change will result in a need for additional water storage facilities in order to sufficiently capture precipitation during the winter months (Policy Research Corporation, n.d.). Wastewater management problems proliferate with the expanding urban population during the summer and effluents are deteriorating the quality of coastal waters (Skondras et al., 2011).

Moreover, water systems are vulnerable to climate change due to an overall decrease in aquifer infiltration and recharge, as a result of:

- decreased rainfall;
- increased salinity of coastal and subsea aquifers;
- higher pollutant load concentrations in coastal water bodies and the sea;
- faster degradation of deltaic regions, in cases where degradation has already begun as a result of transversal dam construction upstream; contamination or drainage of coastal wetlands;
- amplification of the desertification phenomenon as a result of water deficits; and
- droughts determined by social factors such as population changes, population shifts, demographic characteristics, technology, government policies, environmental awareness, water use trends, social behaviour, level of water development and/or exploitation, and water availability (MEECC, 2014).

Greece also has well recognised ‘ecological problems’ due to frequent forest fires (Skondras et al., 2011). Forest ecosystems will suffer from the combined effect of reduced precipitation and increased temperatures during hot and dry periods, while facing a higher risk of devastation from wildfires. Global warming is expected to affect both the number of summer wildfires and total burned area. Forests in southern continental Greece and Crete are expected to be most affected (MEECC, 2014).

Environmental priorities

Integration of environmental concerns in sectoral policies is needed to achieve cost-effective environmental protection and sustainable development in a country facing economic recession like Greece. Thus, the environmental reform necessitates increased involvement of different stakeholders (industry, environmental NGOs, local authorities etc.) in implementing environmental policies. Recommendations of policymakers with regard to strengthening the

country's environmental performance include broad actions in the energy, buildings (including services), transport, industry, and agriculture sectors.

Investment in environmental infrastructure has been a major aspect of Greek environmental policy, however progress should be made towards stimulating the uptake of more energy-efficient technologies in power plants. Today, lignite is largely exploited for electricity production, as it is present in abundance in Greece and using it improves energy independence. As a result, CO_2 emissions emitted by lignite stations have increased, although decommissioning of old coal-lignite plants is expected, based on commitments at the EU level and especially the EU Large Combustion Plants Directive. According to our stakeholders, it is of vital importance that growth in the use of natural gas (e.g. for power supply and household appliances) and renewables (e.g. in the islands) be encouraged, through further exploitation of the high potential in solar power, wind power and energy from waste. Predictions suggest that an increase in wind and, to a greater extent, PV projects may occur during 2016, as the bidding process for solar power projects of 50MW has already opened. A boost to PV installations through auctions (target for new projects of 750MW until 2020) is also anticipated.

Reform of the entire energy sector (production, distribution and transport of electric power), and liberalisation of the electricity market remain a challenge, while concepts like decentralisation, interconnection of islands, Crete and mainland Greece, or with neighbouring countries are highly under discussion. Drawing from the stakeholder engagement workshop (see Section 2.5) and in order to achieve such formulations, net metering, smart grids and energy management systems facilitating electricity storage as well as training of skilled personnel should be given high priority.

Energy efficiency improvement can be achieved by strengthening enforcement of the building codes. Implementation of national legislation and funding could promote energy saving by focusing on the exploitation and optimisation of Building Management Systems, building insulation, new RES such as geothermic, heat pumps for solar heating and cooling and photovoltaics. The total determination of building energy performance, through either indirect studies (before manufacture or during use) or direct measurements, can lead to significant energy gains (ISO 50001, LEED). In the above framework, the establishment of a national observatory, an overall change of the user's culture and major investments in saving and new production technologies could reduce energy consumption of buildings, while at the same time providing a boost to the construction industry, which has declined in recent years.

As far as urban living is concerned, proper disposal of municipal solid waste remains a challenge, although efforts have begun recently to address it and industries continue to develop infrastructure for waste water treatment and solid waste disposal.

Finally, efforts have been made to modernise public transport and manage traffic, contributing to controlling air emissions. However, based on Greek stakeholders' input, economic instruments should be better used to promote development and utilisation of biofuels, electric and hybrid cars, while the state should also provide incentives for the domestic industry to adopt production processes that minimise effluent and emissions.

It should be noted that the national environmental priorities do not emphasise agriculture activities. Efforts to reduce wastewater from agricultural resources (e.g. from excessive use of fertilisers), however, are underway.

1.2.3 Economic priorities

Greece Status Quo - Future economic priorities and expectations

The fact that the GDP of Greece has been severely declining, since the beginning of the economic recession in 2009, hinders the prediction of the national future economic evolution. The following figure depicts the evolution of the Greek GDP from 2000 to 2015. A simple autoregressive integrated moving average (ARIMA) model has been superimposed to provide a short-term projection (World Bank, 2015).

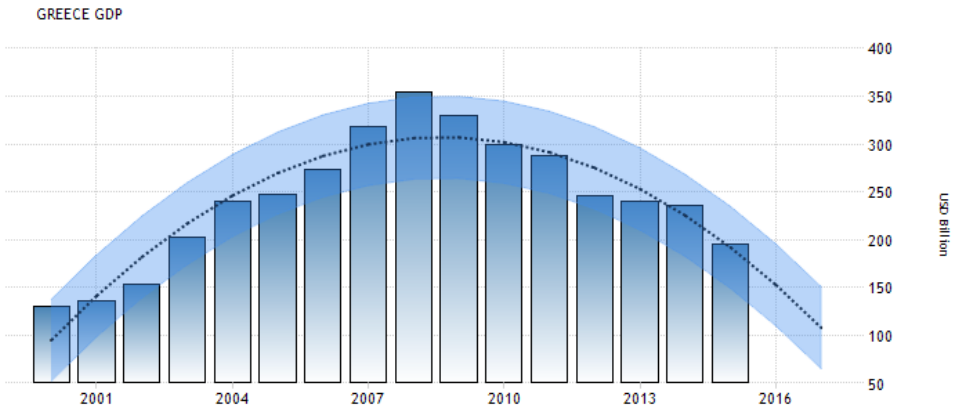


Figure 9 The evolution of Greek GDP 2000-2015

Source: World Bank, 2015

Generally long-run growth depends on three factors: a) labour force developments; b) capital accumulation; and c) total factor productivity (TFP). In the face of significant demographic challenges, which imply a decline in working-age population over time[1], and investment rates, which relied on external financing, (and hence unsustainable under current conditions) TFP will be the main driver of growth.

The Bank of Greece in its **"Monetary policy report 2015-2016"** (Bank of Greece, 2016) states that the submission and approval of the new investment law is expected to contribute to the development of a stable taxation framework for innovative and outward-oriented businesses, and the proper use of the Greek specialised personnel. Specifically, the draft law under consultation is envisaged to:

[1] Demographic projections suggest that working age population will decline by about 10 percentage points by 2060.

- Provide fast track procedures and a 12-year stable tax regime for large investment projects that create new jobs.
- Limit the eligible investment plan threshold for small enterprises (EUR 150,000) and set an upper limit of 5 million euro per investment, however the advance of the subsidy is reduced to 50% and is attributed under stringent conditions.
- Bestow special supporting scheme for investment in areas with particularly significant migratory flows.
- Provide the possibility to support capital risk through an equity fund with own or borrowed funds. Also, the types of aid include the subsidy costs of employment, created for a specified period.

With regard to the **real estate market**, which is dwindling since 2008, it is estimated that the tax burden on real estate will continue to discourage construction activity in 2016. Conversely, in other constructions, especially in infrastructures, it is estimated that there is a gradual restoration of the rate of implementation of projects, supported significantly by the European fund flows (Bank of Greece, 2016).

However, the Bank of Greece (BoG) is optimistic and states the stabilisation of the real estate market and its recovery depend on: the prospects of recovery of the Greek economy, the boost of business and households confidence; the improvement of the financing conditions from the banking system; the reduction of bureaucracy; the integration the cadastral work; and the formation of a stable fiscal institutional framework.

As far as **employment** is concerned, the BoG expects that during 2016 and onwards, the rate of deceleration of employment will fall. Further falls in unemployment, and particularly youth unemployment and long term unemployment, and the increase of employment rates will depend on the stabilisation of the economic climate and economic activity, and the implementation of structural changes with a gradual return of the economy to growth. In this context, it is important to implement actions for the improvement and extension of active employment policies and training programs increasing their efficiency in parallel. In addition, actions to reduce the undeclared, uninsured labour, in order to ensure the pension system and the efficient labour market (EC, 2016). Active employment policies and the training programs of OAED (Manpower Employment Organisation) can also help towards this direction with the appropriate design and targeting and the proper use of the available, mainly European, resources (OAED, 2016d).

Towards the improvement of the **international competitiveness** of Greece, the BoG states that the restoration of normality in the business environment in general, and particularly of business financing, will enhance the feasibility of productive investments to expand and diversify capacity in internationally tradable sectors, further enhancing the extroversion of the old and new export business.

In summary, global forecasts for the Greek economy show an **economic recovery**, starting from the second half of 2016 and continuing in the years 2017 and 2018. For 2016, a modest reduction

of GDP of 0.3% is expected, while a growth of 2.5% and 3% is foreseen for 2017 and 2018 respectively. The projections are based on the assumption that the completion of the evaluation in the first half of 2016 will bring, from the second half of 2016, significant positive effects on the liquidity of the financial system, reducing uncertainty and improving the economic climate. This will bring important implications for the development of key components of domestic demand. It is also based on the assumption that the accommodative monetary policy by the ECB will continue.

In its own survey for the medium-term modelling of the GDP evolution, the International Monetary Fund (IMF) forecasts a long-term annual GDP increase of 1.25% until 2060 (IMF, 2016).

European impact to Greek economic priorities

Beyond the country, BoG expects that the stabilisation of capital flows from the **EU structural programs**, the amount of which reached 2.3 euros billion in 2015, will boost both the infrastructure and innovative entrepreneurship. At the same time, it states that the market is positively reacting to the inflow of investments as part of the European Fund for Strategic Investment (EFSI - known as the Juncker package). 42 projects have been pre-selected with a total budget of 5.4 billion Euros, while funding has already been approved for the first project of a Greek company, worth 15 million euro.

The **Annual Growth Survey 2016** (EC, 2015c) validates the already established European and Members States economic and social priorities, but confirms that policy efforts need to be strengthened to set the recovery on a sustainable path, unlock investments, strengthen the adjustment capacity of EU Member States, foster productivity and accelerate the process of convergence. In this light, the Commission proposes to focus efforts on the three following priorities for 2016, which significantly impact the Greek economy:

- **Re-launching investment** – (i) the progress made on mobilising private and public investments and the selection of the strategic projects under the Investment Plan for Europe need to be accompanied by an improved investment and regulatory environment at the national as well as the European level; (ii) the Banking Union needs to be completed to reinforce financial stability in the Euro area and beyond; work on the Capital Markets Union needs to be accelerated, so that companies have access to increased and more diversified sources of funding and the financial sector can fully support the real economy; stocks of debt holding back financing and investment decisions also need to be addressed; (iii) investment priorities must go beyond traditional infrastructure and extend to human capital and related social investment.
- Pursuing **structural reforms** to modernise the EU economies – (i) reforms must be based on effective coordination between the Member States and aim at higher productivity and upward convergence; (ii) labour market policies need to balance flexibility and security considerations; a particular focus should be on tackling youth and long term unemployment, (iii) more integrated and competitive product and services markets should stimulate innovation and job creation.

- **Responsible fiscal policies** – (i) there is a need to continue to support growth and equity friendly fiscal consolidation in many countries, (ii) tax systems need to address disincentives to employment creation and be made fairer and still more effective, (iii) social protection systems should be modernised to efficiently respond to risks throughout the lifecycle.

The **European Public Affairs** (2014) also confirmed that growth is the primary aim for EU and subsequently for Greece, stating that it is considered to be the necessary element for triggering jobs, political stability, and the correction of social imbalances, with the subsequent reinforcement of European cohesion. With the **EU2020 Strategy** as a backdrop, Greece considers the "right balance between fiscal solidity and an effort to boost growth" as the catalyst towards the achievement of this priority. This midpoint could be achieved by increasing the lending capacity of the European Investment Bank, with an emphasis on financing SMEs, which are key for generating new jobs.

As part of the **Europe 2020 initiative**, the concept of **Research and Innovation Strategy for Smart Specialisation** is highlighted, so that Greece nationally and regionally focuses on strengthening specific categories of investments that will give competitive advantage to the economy. This is a localised approach which takes into account the specificities of different geographical areas in respect to their characteristics, their potential and the path they need to follow to achieve economic development.

Finally, the **Research and Innovation Strategy for Smart Specialisation 2014-2020 (GSRT, 2015)** links research and innovation to economic development in new ways, such as entrepreneurial discovery and prioritisation after close cooperation with local authorities. It additionally aims to reorganise traditional sectors through switching to high added value activities, new markets or value chains. On top of that, it aims to modernise existing business through the adoption and diffusion of new technologies, to achieve diversification through new technologies and to develop new economic activities through innovation. New forms of innovation are explored such as open and user-friendly innovation, social innovation and innovation in services.

1.2.4 Societal priorities perspective on climate change

As of January 2016, the population of Greece was estimated to be 10,933,457 people, of which around a third lives in the Athens area (estimated at 3.75 million) and more than a million in the Thessaloniki area (IEA, 2011; World Population Review, 2016; UN, 2015a; UN, 2015b; Countrymeters, 2016). According to Eurostat, the largest urban zone of Athens is among the eight most populated areas in the European Union, while noting that the true numbers are in fact higher, given that undocumented immigrants and refugees have not been taken into account (Bank of Greece, 2011a). It should be noted that 33% of the Greek population lives in coastal cities, towns or villages situated within 2 km of the sea, while 12 of the country's 13 former Administrative Regions are coastal: the country has extensive coastlines (13,676 km), with 113 m of coast for every km^2 (compared with a global average of only 4.5 m/km^2) (Bank of Greece, 2011a; World Atlas, 2015). Several (mainly) urban regions and transport networks are located within the distance of influence from this coastline. Moreover, Greece's largest urban centres with the highest number

of movements/trips, such as Piraeus, Thessaloniki, Patras, Heraklion, Volos and Kavala, are situated in coastal zones, while large part of the mainland is mountainous and sparsely populated (Bank of Greece, 2011a; IEA, 2011; World Population Review, 2016; UN, 2015a; UN, 2015b). As a result, climate change is expected to affect a significant part of the Greek population.

Moreover, due to its geographical position Greece has been used as a gateway to Europe by a large number of immigrants, including Syrian refugees in the midst of the ongoing Syrian Civil War. However, due to international agreements (e.g. the Dublin Regulation), refugees end up staying in Greece, adding to the numbers of the population that are most vulnerable to both climate change and climate change related policies (UNHCR, 2016; CRS, 2016).

Additionally, the country's vulnerability to climate change increases as the elderly, considered to be among the most vulnerable groups to climate change, comprise a growing number of the Greek population (EC, 2015a). In 2015, approximately 27% of the Greek population was aged over 65 (OECD average 15%) with 4.3% of the population over 80 (OECD average 4%) (OECD, 2016a; Eurostat, 2015; HelpAge International, 2015). Greece has one of the world's most rapidly aging populations, and by 2050 it is estimated that the number of over-60s will have risen to 40.8 percent of the population (HelpAge International, 2015).

Education in Greece remains, over time, the major factor for reducing inequality and poverty. Educational inequalities seem to be much more closely linked to economic inequalities than other demographic and socioeconomic factors (occupation, age, household size and composition, area of residence, gender, etc.) (Bank of Greece, 2014). In particular, 68% of adults aged 25-64 have completed upper secondary education, less than the OECD average of 76%. Regarding educational attainment, 80.5% of the labour force has at least a secondary education in Athens, while this share is only 61% in Central Greece (OECD, 2016b). The early school leaving rate was 9% in 2014, with Greece performing significantly better than the EU average (11.1%). The early school leaving rate dropped by 5.3% during the economic recession, from 14.3 % in 2007. However, the national average masks significant variation between geographical areas, types of schools and social groups (EC, 2015b).

Greece has experienced a severe recession over the last seven years (beginning in 2009): amongst the EU 27 Greece has the third highest proportion of its population at risk of poverty or social exclusion with only Romania and Bulgaria above it (Eurostat (ilc_peps01)). The median income has also fallen during the crisis, e.g. a 8.3% drop between 2013 and 2014, while the at-risk-of-poverty rate has increased (Bank of Greece, 2014; OECD, 2016c; Eurostat (ilc_peps01)). Apart from leaving a significant part of the population at the fringe of society, faced with labour market, social and healthcare exclusion and thus more vulnerable to climate change and climate mitigation actions (Bank of Greece, 2011a; Matzarakis, 2007), this appears to affect the way in which Greek citizens perceive the seriousness of climate change (Papoulis et al., 2015): poverty and income inequalities create major barriers to stricter implementation of environmental policies, mainly due to the uncertainty surrounding their outcomes and, particularly, when the consequence on different income groups is unknown or when environmental policies addressing certain labour-intensive activities are perceived as constituting a threat to employment. Moreover, the political

acceptability of increasing prices for basic necessities in order to incorporate environmental costs will always be a problem (Schaper, 1997; MFA, 2008; Macintosh & Wilkinson, 2015).

Papoulis et al. (2015) examined the public perception of climate change in a period of economic crisis. The main results show that Greek citizens are aware of environmental problems and climate change and also believe that the environmental quality of Greece is quite poor. They believe they are fairly well informed about climate change. However, the current economic crisis in Greece has reversed the progress made in the past concerning the awareness of climate change. In 2008, nine in ten Greek citizens considered climate change as the ultimate global problem and ranked an economic downturn as the fourth most serious problem (38%) (EC, 2008a). Trends were reversed in 2013: the economic situation was classified as the second most serious problem (87%), with climate change as the third (53%) (EC, 2013). Also, Greek citizens appear to have very low confidence in public authorities and big enterprises to deal with climate change, considering state and industry to be mainly responsible for environmental degradation, as opposed to their high level of trust in scientific and environmental organisations (Papoulis et al., 2015).

Literature shows that the vast majority of Greek citizens (93%), like European citizens (86%), stress the importance of responsibility at the individual level to protect the environment (Lorenzoni & Pidgeon, 2006; EC, 2008b; Bank of Greece, 2011b; OECD, 2010). However, they do not show great willingness to participate in individual actions against climate change (only 37.6% of the population) (Papoulis et al., 2015). According to Eurobarometer, the most popular individual action that respondents undertook in 2007 to tackle environmental problems was recycling (Greece: 32%, EU: 59%), reduction in energy consumption (Greece: 38%, EU: 47%) and water saving (Greece: 39%, EU: 37%) (EC, 2007). Only 9% of Greek citizens reported having used their car less in 2007 (EC, 2007), while in 2011 only one in five (21%) reported having used environmentally friendly alternative ways of transportation instead of their cars (EC, 2011b). Of course, these numbers are expected to have changed during the ongoing recession, but primarily due to the decrease in income and the increase in fuel prices (Chita & Zervas, 2014) given the consequent lower awareness of climate change.

Societal perception of actions against climate change is mainly observed in renewable energy investments, mostly concerning the installation of wind and photovoltaic parks. The installation of wind power parks was stopped because of citizens' demonstrations in many Greek islands (e.g. Crete, Skyros, Kefallonia, Tinos) and mountain areas (e.g. Pieria mountains, Lakonia region). Local municipalities and citizens find no benefit from these renewable investments, supporting the opinion that they are environmentally, financially, socially harmful, as well as a threat to areas of religious, historical and archaeological significance. Common arguments against wind turbines, in particular, are that wind parks are visible from archaeological sites, close to residential areas and livestock installations, and thus negatively impact the surrounding natural environment and demote agricultural and tourist activities, especially alternative forms of tourism or tourism on Greek islands, repealing the gentle Aegean features. Citizens object that investments like wind and solar parks do not aim to cover the energy needs of the respective region, but in contrast serve the interests of large companies and contractors, rather than offering benefits to the local community.

To express their opposition citizens are not limited to claims only at institutional level but have organised many and diverse actions in extra-institutional level: appeals, resolutions, petitions, press releases, meetings, events, screenings, interventions in local government processes, marches, protests, social media posts, documents, posters, banners posts, spray slogans in the streets, activism actions, solidarity actions, mountaineering trips, and concerts.

Concluding from the above, climate change actions are perceived to affect the local economies of island and mountainous areas, causing the redefinition of the functioning and sustainability of companies, especially in the tourist sector.

During the TRANSrisk stakeholder workshop that took place in Athens, on the 25th of October 2016 (see Section 2.5 for more information), experts also expressed some concerns with regard to the changes necessary for the energy system: given the economic crisis as well as the growing energy poverty in Greece, electricity should remain affordable, a fact that should also be considered when planning the desired low-carbon transition of the energy system.

1.2.5 Politics of energy development priorities

At the moment, the Greek parliament consists of 8 political parties occupying 296 of the 300 parliamentary seats. Percentages of each party are depicted in the following figure; it must be taken into account that 16.67% (i.e. 50 parliamentary seats) are by default attributed to the first party.

By reading the Greek parties' positions on energy and climate change, it is clear that in general they all acknowledge the threat of climate change and are in favour of tackling it through the promotion of renewable energy sources (RES) and rational energy use. However, there are some differentiations regarding societal impacts, energy security, and exploitation of fossil fuels. Regarding fossil fuels, in particular, some parties support total independence from coal, while most pursue its exploitation (indicatively, the right-wing parties frame fossil fuels exploitation as a means to abolish the austerity measures imposed by the memoranda of understanding that Greece has signed over the past six years).

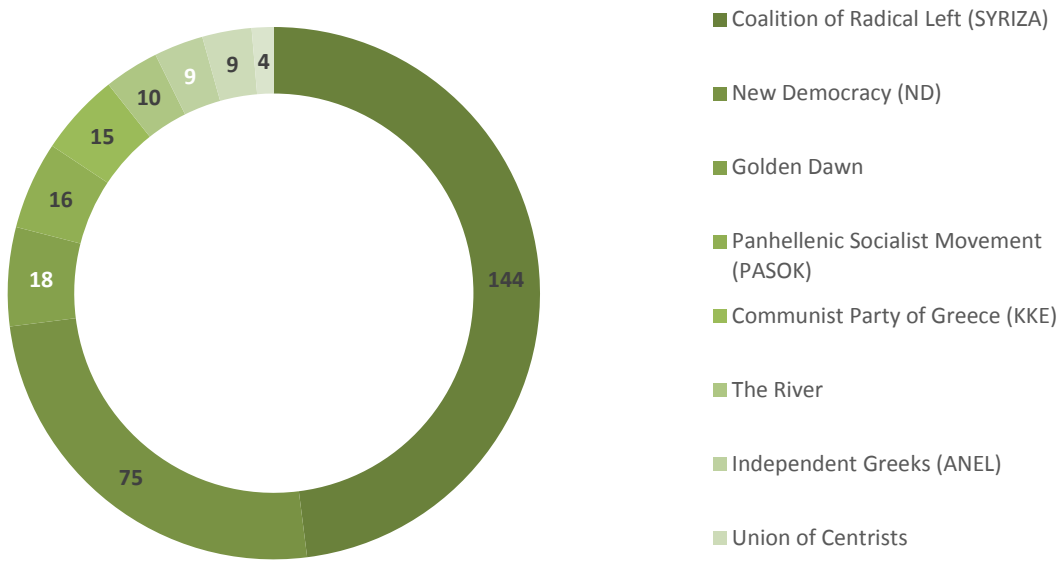


Figure 10 Political Parties' representation in the Parliament (seats)

Source: Hellenic Parliament, n.d.

However, the Greek political scene is quite unstable, which was reflected by the high abstention levels in the last election — on September 20, 2015 — which was above 43% (YPES, 2015), as well as the fact that in less than a year six Members of Parliament have already been removed from the parties they were elected with (Hellenic Parliament, n.d.) of which four still remain as independent MPs in the Parliament.

Drawing from the stakeholder interviews that took place within the context of TRANSrisk, the collected experts' perceptions point out that there is no differentiation among political parties regarding the promotion of RES and mitigation of climate change: everyone appeared to be in favour of the former as a means to achieve the latter. Political positions differ on the level of fossil fuels exploitation. Moreover, stakeholders consider that political parties' priorities are of socio-economic nature and focus on the confrontation of the economic crisis rather than sustainable energy and climate change per se. Furthermore, they admit that the political scene is quite unstable, while the framework for investments has been changing so quickly that people's faith in politicians' consistency has been dramatically reduced, potentially affecting societal acceptance of policies and use of incentives towards the direction of enhancing RES diffusion. Finally, according to stakeholders, policy making in general seems to be carried out rather trivially and in a short-term way without clear and solid strategy, mainly driven by negotiations with the troika and commitments to the memoranda.

In conclusion, every political party seems to support RES promotion and climate change mitigation efforts. Nevertheless, in practice climate change mitigation is at the bottom level of political priorities in Greece, unless it is intertwined with socio-economic benefits that revolve around the goal of reducing the extent and mitigating the impact of austerity measures. With regard to the

exploitation of fossil fuels, five out of the eight parties currently represented in the Parliament appear to be in favour, two are against, and one refrains from referring to it.

1.2.6 Conflicts and synergies of priorities

Based on the fact that the country's GDP has declined by about 23% since the beginning of the recession back in 2009 (Hellenic Statistical Authority, 2015), projections of this indicator have proven difficult and inaccurate, adding significant uncertainty to the socioeconomic trajectories that drive foresight analyses. This unfavourable economic environment, along with the limited capital liquidity and deterioration of the creditworthiness of the Greek economy, have already led to reduced clean energy investments.

Additionally, economic activities that are linked to natural resources, due to their direct dependence on the natural environment, are facing a broad range of challenges and problems (see e.g. Ford et al., 2010; 2011; Sauchyn & Kulshreshtha, 2008). Directly dependent upon the climate are the production activities related to forests and water ecosystems, like agricultural activities and the fisheries sector. The coastal systems, where a considerable share of the population and production activities is concentrated, face considerable capital losses. Mining is also among such activities, since sustainable development has resulted in reduced lignite mining activity causing several lost jobs in the field (Bank of Greece, 2011a).

Due to the recession and the negative GDP growth rate, electricity demand has declined as well. In the meantime, and despite both the country's potential for RES deployment and the national decarbonisation goals, new lignite-fired power plants are planned to be constructed. The system of fixed price remuneration (i.e. Feed-In Tariffs), which exclusively had been implemented in the aim of promoting renewable energy projects in Greece, led to an excessive burden to the Operator (LAGIE, 2014) and subsequent charges to the final consumers. Market-oriented support schemes (Feed-In Premiums) are currently being promoted, while FITs are gradually being phased out.

Aside from the recession, two other significant problems that Greece is currently dealing with are the refugee crisis and political uncertainty, which constitute adverse conditions imposing high risks in the policy agenda. Another critical topic to be addressed is energy poverty in the country. Specifically, the fuel poverty indicators for 2012, among people at risk of poverty, are 47.6% for inability to keep home adequately warm, 54.4% for arrears on utility bills, and 21% for dwellings with leakages & damp walls (BPIE, 2014).

1.3 The Human Innovation System Narrative

1.3.1 Overview of the development of the case study focus

Greece has undoubtedly large potential in electricity generation from renewable energy sources (RES-E), and specifically solar and wind energy (Tigas et al., 2015); this potential comprises favourable weather conditions and adequate uncultivated land (HELAPCO, 2016a). This potential constitutes an important factor for realising 2050 decarbonisation targets. Although the country got a late start in developing the domestic PV market, the latter quickly reached high levels in just three years, from 2011 to 2013 (EPIA, 2014), which resulted in Greece ranking among the top countries in the world for solar power share (more than 7%) in electricity demand (EPIA, 2015). However, despite NREAP projections (MEECC, 2010) for continuous annual growth, this remarkable boom was suspended by the adverse fiscal environment, leading to a complete shutdown of new solar energy: the Greek PV market shrank to 1.5% and 1% of its 2013 size during 2014 and 2015 respectively (HELAPCO, 2015a; 2016a).

As a result, there is significant scope for effectively reducing carbon emissions via the deployment of large- and small-scale photovoltaic projects in Greece, given the fact that the majority of GHG emissions derive from the mostly-fossil-fuel-driven power sector (followed by the transport sector). However, aside from the Greek debt crisis and the past legislative failure to support new solar power projects, other challenges should be tackled, including the enhancement of transmission networks, grid interconnection (between mainland and the islands), smart grid development and the adoption of a more distributed generation system (Tigas et al., 2015).

Part of the Greek case study, therefore, aims to explore the potential for the solar market (perspectives, energy prices and their effect on investments, financial schemes, etc.), as well as the current policy framework, in order to survey the key drivers in the solar power sector (conditions, incentives, policies) that could assist progress towards a decarbonised Greek economy by 2050.

In the building sector, apart from the electricity generation from building-integrated photovoltaics—which, as of 2015, account for about 21% of the PV total installed capacity (HELAPCO, 2016a)—there is room for further decarbonisation. The residential sector accounts for about 25-30% of the final energy consumption (CRES, 2015). The existing building stock in Greece is predominantly of poor energy performance and, consequently, in need of significant renovation work: 58.4% of the buildings in Greece were constructed before 1980 (YPEKA, 2014; 2015; ELSTAT, 2011a), as can be seen in the figure below (Figure 11). This case study, therefore, will also give attention to building renovation packages, namely investments in solar PV systems, solar heating/cooling and insulation measures.

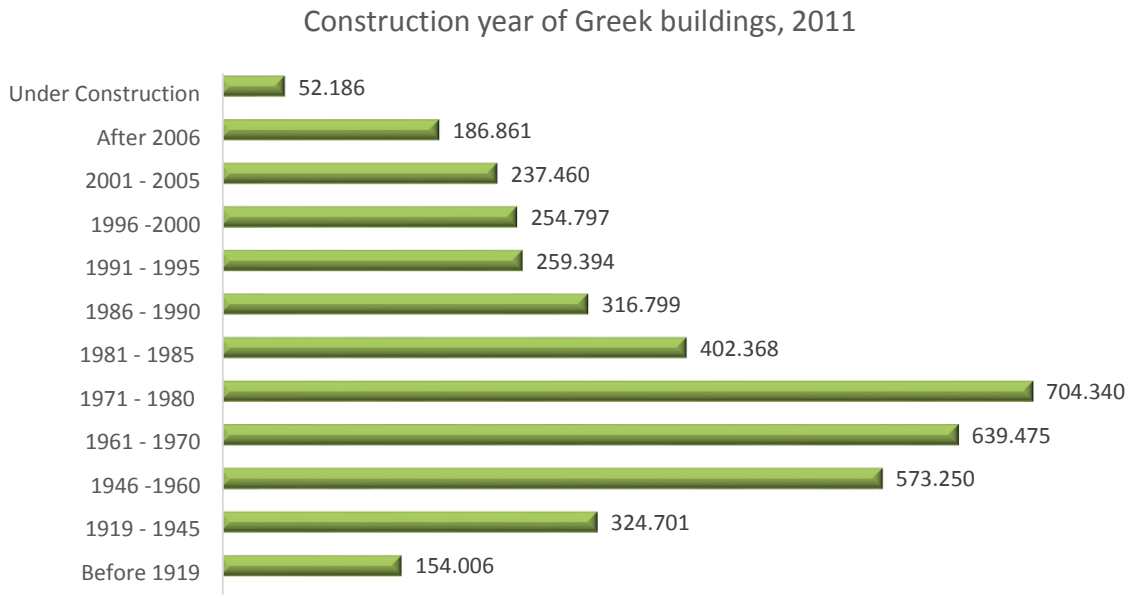


Figure 11 Year of construction of Greek buildings, according to 2011 census

Source: ELSTAT, 2011a

Finally, the case study explores pathways towards a low carbon energy system that is based on the diffusion of micro-generation and storage (both thermal and electrical) in the residential sector. The European Industrial Initiative on electricity grids (part of the SET-Plan's roadmaps) calls for engaging the active participation of customers in energy markets. To this end, the effect of different pathways for demand-side management technologies and the appropriate market mechanisms will be explored.

Electricity generation from solar power

Law 3468/2006, incorporating Directive 2001/77/EC, was the first piece of legislation to pave the way for investments in photovoltaic plants, changing Greek energy policy dramatically by stipulating the Feed in Tariff system of RES energy pricing. In April 2007, the Ministry of Development presented the first phase of the Photovoltaic Stations Development Program, which was devised by RAE (Regulatory Authority for Energy) and through which the basic principles for the construction of PV plants in Greek territory was laid, covering a total capacity of 640 MWp for stations connected to the system and 200 MWp for plants connected to the Network of Non-Interconnected Islands.

In January 2009 Law 3734/2009 introduced the first considerable decrease of Feed in Tariffs, amending Law 3468/2006. In particular, the ceiling of 840 MWp, informally set by RAE, as well as the power distribution cap that would be applied for old applications and would lead to cancellation of thousands of projects, were removed. By the first quarter of 2009, RAE had granted a total of approximately 300 MWp in production licenses and exemptions, covering the Greek territory excepting the interconnected islands (e.g. the Ionian, Sporades, etc.). Law 3734/2009 communicated the intention of the Ministry of Development to prepare a joint ministerial decision

(together with the Ministry of Environment, Planning and Public Works) to provide special incentives for the installation of photovoltaic systems in buildings (residential consumers and commercial/industrial applications) (HELAPCO, 2009).

In June 2010, a new law on RES, namely Law 3851/2010, was passed, through which significant changes regarding the licensing of photovoltaic systems took place. Subsequently, a series of Ministry Decisions amended previous regulations for photovoltaics installations, mainly regarding urban planning, thus changing the investment landscape.

The national target for the share of renewable energy sources in the gross electricity consumption was set to at least 20% by 2020. With regard to photovoltaics in particular, the installation of 1500 MWp by 2014 and of a total of 2200 MWp by 2020 was compiled as a national goal (HELAPCO, 2011).

The most important contribution of Law 3851/2010 was to simplify some of the old licensing procedures. Under the new legislation, the issuance of a Decision for Environmental Conditions Approval is the most important prerequisite to achieve the Connection (to the grid) Offer (Giannini et al., 2015). The role of the Regulatory Authority of Energy (RAE) was invigorated, as it became the authority for RES license issuance instead of the Ministry of Environment and Climate Change. In particular, no longer is a production license or any other certification decision (known as an "exception") required for photovoltaic systems up to 1 MWp. For PV power systems over 1 MWp a production license must be obtained, which is now issued by RAE. Furthermore, no environmental permits are required for systems installed in buildings and organised industrial areas.

The installation of photovoltaic systems is no longer subject to planning permission procedures, but to the approval to implement small-scale construction work by the Urban Planning Authority. Regarding photovoltaic systems installed in buildings of up to 100 kWp, work approval is also not required, but suffices a simple notification to the Network Operator (DEDDIE) informing that the system installation is routed. This favourable regulation is related to the domestic sector and the small and medium sized systems installed in business buildings.

Furthermore, Law 3889/2010 (Bulletin of Government Gazette A182/14.10.2010), article 29, amended certain provisions (article 20) of Law 3468/2006. The Law 4001/2011 (Bulleting of Government Gazette A179/22.08.2011), revised the framework of the Greek energy market (electricity, gas, hydrocarbons, gas & oil pipelines, renewables, mining etc.), while the Ministerial Decision YAPE/F1/14810 issued the Regulation of Electricity Generation Licenses for RES & CHP plants.

In 2013, the new annual installed capacity of the Greek photovoltaic market exceeded the threshold of 1,000 MW, thus achieving the national indicative target for 2020 seven years earlier. However, the market showed a lack of progress due to the deficit of LAGIE and a series of inhibitory regulatory actions taken from mid-2012 onwards. Apart from the significant reductions in guaranteed sale prices of electricity (fixed-price feed-in-tariffs/FiTs), the most important regulation—as far as investments are concerned, was the licensing process suspension for new photovoltaic systems imposed in August 2012 (Ministerial Decision YAPE/F1/2300/oik.16932 &

2301/16933 & 2302/16934 & 2303/16935) which remained in force until April 2014 (Law 4254/2014). (HELAPCO, 2014, 2015b). The Ministry of Energy and Climate Change issued further amendments to the FiTs of PV systems, inducing more than a 40% reduction in ground-mounted and rooftop installations. The new FiTs were valid from June 1, 2013 and applied retrospectively to P/V stations installed since February 2013 (Ministerial Decision YAPE/F1/1289/9012 & 1288/9011).

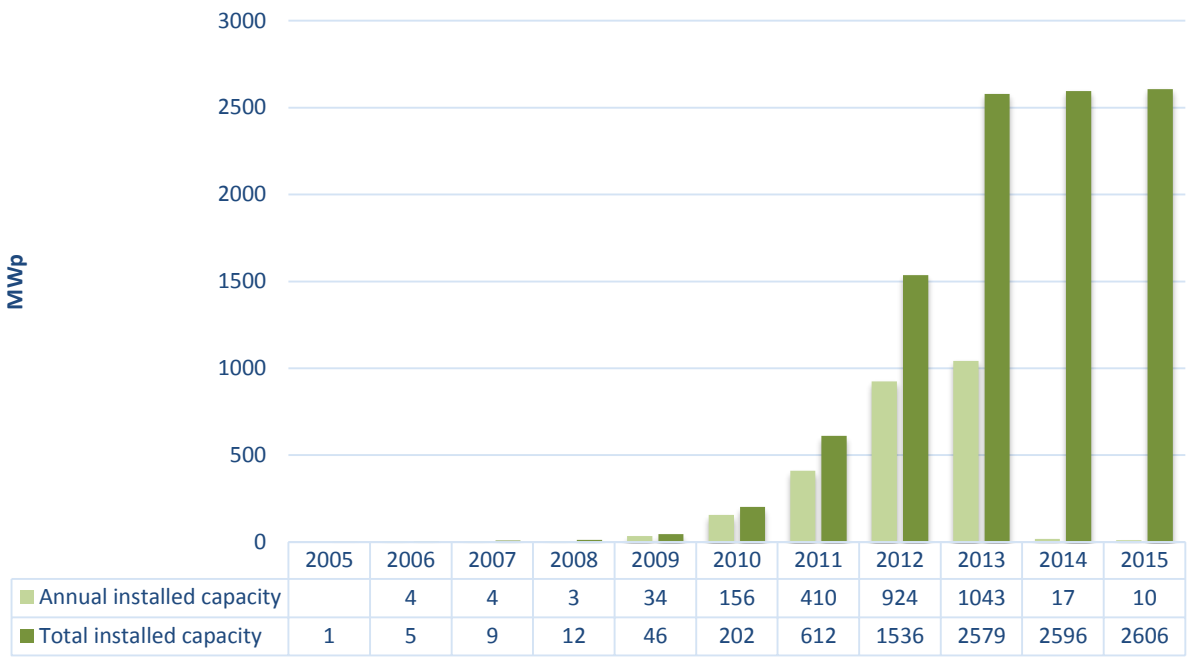
Another inhibitor for investments in photovoltaics was the implementation of a special solidarity surcharge of 25% - 42% for RES producers, on the sales' price from July 1, 2012 to June 30, 2014 (Law 4093/2012 and Law 4152/2013). The above surcharge affected operating stations and those set to operate hereinafter, except for photovoltaic plants of the Special Programme for the Development of Photovoltaic Systems in buildings (HELAPCO, 2013). In addition, the "Transition Tax of Security Supply" on the income from electricity production, adopted in November 2013, constituted an undue burden to photovoltaics and RES (Law 4203/2013).

Through Ministerial Decision No. 3791/2013, 'Standard Environmental Commitments for renewable energy projects" were established, which standardised and simplified the environmental licensing of photovoltaic projects.

In 2014, the Greek photovoltaic market shrank and stagnated, with new installations constituting about 1.5% of the 2013 market. Two measures that possibly had a negative impact on the market were the suspended licensing of new projects that ran for 20 months and the low compensation set for the electricity produced by photovoltaic systems from 2015 onwards, which did not result in sustainable investments.

Under Law 4254/2014, the total power level of PV stations, which were set in test or connection mode after January 1, 2014 and the energy output of which would be compensated by the existing feed-in tariffs, amounts to 200 MWp per year up to 2020 (HELAPCO, 2015b).

In 2015, the shutdown of new photovoltaic installations persisted (the market size was only 1% of that of 2013, see Figure 12) while job losses in the PV industry continued. The main causes of this were the delay in adopting the new institutional framework in 2015 (which prevented the development of medium and large projects) and the imposition of capital controls (which influenced the installation of small self-production systems). Nevertheless, in 2015, PV accounted for 7.1% of the country's electricity needs, placing Greece in the second place worldwide, regarding the contribution of PV to total electricity consumption. This is mainly attributed to the development of the previous years (HELAPCO, 2016a).



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Annual installed capacity		4	4	3	34	156	410	924	1043	17	10
Total installed capacity	1	5	9	12	46	202	612	1536	2579	2596	2606

Figure 12 The Greek solar market

Source HELAPCO, 2016a

After three years of recession and lack of sufficient incentives for the photovoltaic market development, Greece has—since August 2016—a new institutional framework for the support of RES, which allows the gradual restart of the photovoltaic market in the country (HELAPCO, 2016b). The law provides for implementation of a new support structure for RES and CHP projects in Greece compatible with the EU Guidelines on State aid for environmental protection and energy for the period 2014 – 2020. It also aims for a gradual integration and participation of RES and CHP projects in the electricity market on an optimal cost-benefit basis for society. A number of Ministerial Decisions are expected that will add further detail on how the new regime will function in practice (Watson Farley & Williams, 2016).

The building sector

In Greece, the first measure regarding energy saving in buildings was the regulation concerning buildings' thermal insulation adopted in 1979 (FEK 362D/1979). This regulation sets the thermal insulation requirements and the measures to be taken in order to ensure good thermal insulation in building construction. According to the regulation, the country is divided into three zones, namely A, B and C, on the basis of which construction products coefficients (e.g. the thermal coefficient) are defined.

Subsequently, Directive 1993/76/EEC contributed to limiting carbon emissions by improving energy efficiency (SAVE), through measures adopted by the Ministerial decision 21475/4707/1998. Additional Directives, like the 2002/91/EC and its revision in Directive 2010/31/EU, introduced new perspectives to buildings' energy efficiency. Law 3661/2008, in compliance with Directive 2002/91/EC "on the energy performance of buildings", is applied both in buildings of the tertiary

(services) and the residential sector, but was since amended by Law 3851/2010. Law 3661/2008 distinguishes five main themes: definition of minimum energy performance requirements and the method for calculating energy performance (Article 3) of new and existing buildings (Articles 4 and 5), issue of energy performance certificate (Article 6), inspections to boilers and air-conditioning systems (Articles 7 and 8), provision of qualified and accredited energy inspectors (Article 9). Article 8(1) of Law 3855/2010 "Measures to improve energy efficiency in end use, energy services and other provisions" provides for the gradual implementation of an energy management system to all central and general government agencies.

EU Regulation No. 244/2012 supplemented Directive 2010/31/EU on the energy performance of buildings by establishing a comparative methodological framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and construction products. Directive 2006/32/EC, which among others repealed Directive 93/76/EEC, provided guidance on energy efficiency in end-use and energy services. This Directive was also repealed by Directive 2012/27/EU, which provides for energy efficient renovations in at least 3% of buildings owned and used by the government, requires that governments buy only energy efficient buildings, and that countries plan long-term national strategies for building renovations. Law 4342/2015, in compliance with Directive 2012/27/EU, provides a framework of measures aiming to contribute to the Union's 2020 overarching objective for a 20% improvement in energy efficiency. It paves the way for further energy efficiency improvements beyond that date, as well as energy efficiency targets for 2020 including measures for their promotion and rules aiming at overcoming the energy market failures that impede efficiency in the supply and use of energy.

Additionally, through Law 3734/2009, FEK 8A and Ministerial Decision 12323/CC175/2009, FEK 1079B, a Special Program for the Development of Photovoltaic Systems in buildings and especially in buildings' roofs and facades was developed, which was then amended by a series of Ministerial Decisions. Amendments to the Special Programme for buildings relate to significant reductions in the price of electricity injected from rooftop photovoltaic systems into the network, compared to previous billings. Article 8(3)(f) of Ministerial Decision D6/B/oik.5825/09.04.2010 'Adoption of Regulation on the Energy Performance of Buildings' and law 3851/2010, Article 10(3), provide new arrangements for domestic hot water from solar thermal systems and complements Law 3734/2009 aiming at nearly zero energy buildings. In 2014, Ministry Decision RESEL/A/F1/oik. 24461, FEK 3583B, set net metering, through which PV holders, and auto producers in general, are no longer paid for the energy produced, since this energy is compensated by the energy consumed annually in the producer's residence.

The Adoption of the Regulation on the Energy Performance of Buildings (KENAK), according to the Joint Ministerial Decision 5825/2010, set a milestone in national energy efficiency policy. The Energy Performance of Buildings sets the principles and defines the terms and conditions for improving the energy efficiency of buildings. The purpose of the energy efficiency regulation is to reduce conventional energy consumption for heating, cooling, air conditioning, hot water and lighting while ensuring comfortable conditions in the interiors of buildings. Additionally, the Special Service of Energy Inspectors (Ε.Υ.ΕΠ.ΕΝ.) is constituted (Presidential Decree 72/2010, Presidential Decree 100/2010) and further Technical Guidelines are delivered by the Technical

Chamber (TEE) mainly concerning national parameter specifications for calculating the energy performance of buildings and issuing the energy performance certificate (Ministerial Decision 17178/2010). Law 4122/2013, in compliance with Directive 2010/31/EU on the energy performance of buildings, redefines the minimum energy performance requirements already existing in KENAK. It stipulates that from January 1, 2021 and onwards, all new buildings must be nearly zero energy buildings (January 1, 2019 for public sector buildings).

Micro-generation and storage at the residential sector

During the period 2008-2013, i.e. the period of strong fiscal incentives for investments in PV power, a total amount of approximately € 5 billion was invested. For the year 2013, despite the economic recession, the momentum was sustained due to the attractive feed-in tariff (FIT) contracts that certain developers were still holding, while, as explained in the previous sections, the installed capacity additions during 2014 and 2015 collapsed to 10 MW and 6 MW (Figure 13).

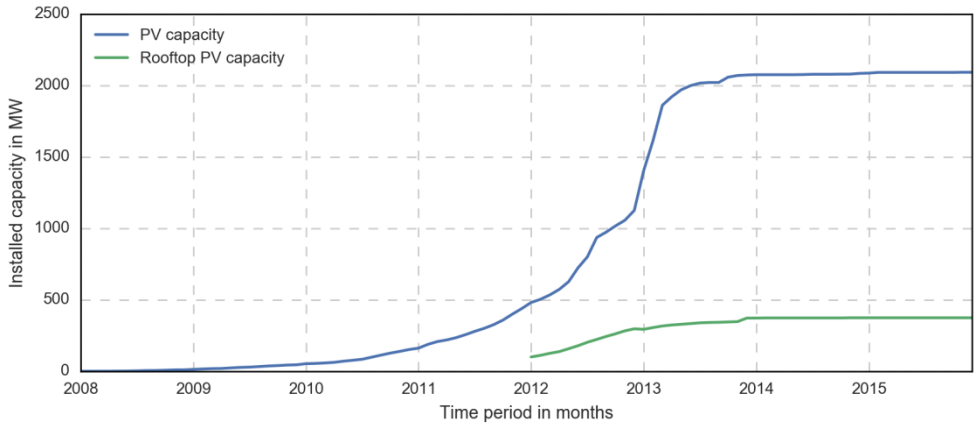


Figure 13 Evolution of installed PV capacity in Greece

The sharp drop in new installations was mainly the result of a freeze on the receiving and processing of new applications for PV systems from August 2012 until April 2014. Furthermore, the reduction in FIT rates has also been influential on the stagnation of the PV power market in Greece. As indicated earlier, the FIT support scheme was cut by 12.5% to 0.292 €/kWh for solar coming online from February 2012 and generating more than 100 kilowatts. Later on, Greece cut FIT rates by roughly 44% for solar photovoltaic (PV) plants installed after February 1st, 2013. The effect of the subsidy cuts is depicted in Figure 14 which presents the evolution of the generation-weighted (in €/MWh) monthly average PV power price.

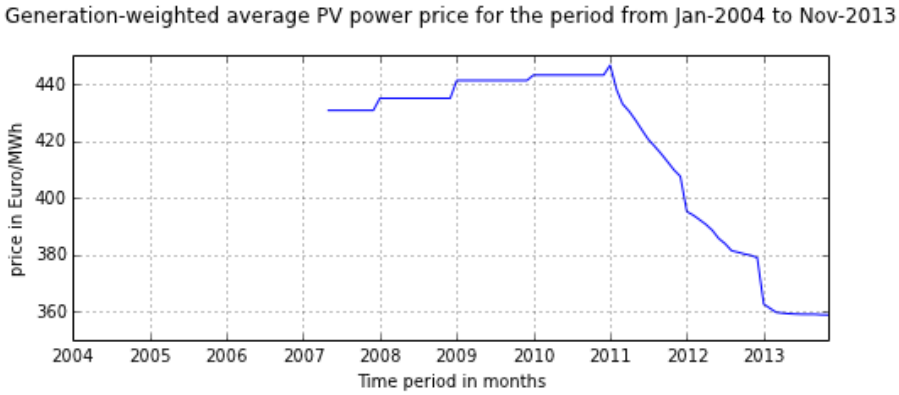


Figure 14 Weighted monthly average power price of PV RES-E

On the 30th of December 2014, the Greek Ministry of Environment, Energy and Climate Changes issued the Decision on Establishment of RES Production Units of Self-producers with Energy Offsetting in execution of Article 14A of Law 3468/2006. The decision regulates the terms and conditions for development of PV systems which would cover the needs of self-producers. The Greek net-metering scheme (active as of May 2015) is applicable to all solar PV systems that aim for self-consumption, and thus expands to both rooftop and ground-mounted systems. The upper limit for residential net-metering PV installations in Greece's mainland grid is set at 20 kW. However, in commercial applications where the required load exceeds 20 kW, the new scheme allows for net-metering of installations that exceed the 20 kW limit and reach up to half the power consumption of the consumer. In this case, net-metering systems can reach up to 500 kW.

The main features of the Greek PV net-metering scheme are:

- It concerns fixed photovoltaic systems, which are installed on the same or an adjacent surface area (owned or co-owned) with the consumption facilities that they feed (i.e. virtual net metering is not supported), and are connected to the grid.
- The PV systems can be mounted on buildings or on free land or other structures, according to current civil construction legislation.
- Energy compensation for net-metering owners will be taking place on an annual basis.

The first stage of net metering applications began in May 2015, when the Hellenic Electricity Distribution Network Operator (HEDNO) started accepting applications for PV systems to connect to the low voltage grid. According to the Hellenic Association of Photovoltaic Companies (HELAPCO), this round of net metering applications attracted about 1,000 applications, mainly for commercial and business PV systems, the majority of which have a capacity of between 25 KW to 50 KW. The first Greek net metering system was connected to the grid in September 2015 and regarded an 85 KW rooftop PV installation at a factory inside the city of Volos.

The combination of decentralised power generation with power storage is particularly important for Greece since it can potentially increase the grid's hosting capacity for RES. For the mainland case, the time-consuming grid-connection procedures due to the limited absorption capacity of the grid have been a major barrier for PV deployment in Greece since 2006. For the case of the

non-interconnected islands, the TILOS Horizon 2020 project[2] has found that the Greek island of Tilos could boost the share of renewables in its energy mix to over 80% by installing a battery storage system.

The latter case is particularly interesting since power generation in Greek non-interconnected islands relies mainly on diesel. As a result, the non-interconnected islands' energy cost is, on average, up to three times higher than in the mainland. The extra cost is not paid exclusively by islanders, as public subsidies to power the islands' diesel generators are paid evenly by all of Greek electricity consumers via their electricity bills.

Based on the aforementioned, the net metering scheme in Greece is an opportunity for setting up the regulatory environment and market conditions necessary to realise a transition pathway for the power system that is based on the notion of consumers generating, storing and consuming clean energy locally. To this end, the TRANSrisk project is an opportunity to quantify the costs and benefits that are associated with this pathway, as well as to derive effective policies that can support and accelerate the realisation of this pathway and appropriately distribute the costs and benefits amongst the consumers and the power market actors.

The relevant policy developments are closely related to the issue of self-consumption, as well as to the notion of consumers becoming active participants in the power market. In particular, the policy framework must be updated to support market designs that both support the realisation of the transition pathway under study and be compatible with the EU Electricity Directive 2009/72/EC and the EU Target Model for electricity markets.

1.3.2 TIS life cycle value chain: a cradle to grave analysis

The Greek case study focuses on energy production and management in two main energy forms, electrical (both on the national and the residential level) and thermal (mainly on the residential level as a substitute to electrical energy). Consequently, it begins at the electrical and thermal demand in dwellings and explores the chain back to the primary energy sources. Focus will be attained in photovoltaic systems (PVs), heating and cooling systems from solar energy, buildings insulation measures, thermal and electrical micro-generation and storage systems.

Integrated Value Chain

(i) *Energy resource and raw materials*. In this step of the value chain the following products and services are incorporated: extraction of raw materials to be used in the production of solar panels, solar heating & cooling systems, and insulation materials. In Greece, there are a large number of companies extracting materials used in the aforementioned products. Specifically, the most significant mineral is bauxite which is used in aluminium products such as boilers, panel frames, window frames, as well as some insulation products (i.e. rock mineral wool).

[2] http://www.tiloshorizon.eu/

Moreover, another significant mineral is petroleum which is used for the production of expanded, as well as extruded polystyrene insulation products.

(ii) *Power generation*. Energy conversion technology systems include the photovoltaic process on the one hand, and the conversion of solar energy to thermal energy stored in heated water, as well as the reduction of heat exchange between the inside and outside of a house/building which is achieved by insulation products on the other. In a wider perspective, electricity in Greece is produced by thermal power plants and other RES, while thermal energy is also produced by CHP power plants.

(iii) *Processing transportation*. In Greece the transportation of raw materials, as well as products involved in the studied sectors, from the extraction to the retail market is mainly done by road transport either by the producers' own fleet or by third party logistics companies. Beyond the retailers, the products are either transported by the installers' trucks or the end users' own vehicles.

(iv) *Storage*. Electrical energy storage in Greece is not very widespread at both large and small scales (Table 1). Currently there are only two open loop hydro pumped systems with a total power of 699 MW in operation. Moreover, the first ever production license for a Hybrid Station consisting of a Wind Turbine, a PV plant and a battery station in Greece was issued by RAE on March 13, 2016. The station's storage capacity is 0.8 MW (which satisfies approximately 80% of the island's peak demand) the guaranteed power capacity is 0.4 MW. Its installation is expected to start in Q2 2017 within the framework of the TILOS Project. Regarding the storage of thermal energy there are no large-scale facilities in Greece, however there are many applications at the residential level such as water boilers and buildings insulation.

(v) *Distribution to end users*. In Greece electrical energy is delivered to the end users through the distribution grid operated by HEDNO. Regarding the distribution of thermal energy, it is implemented mostly at residential level in areas where there are CHP power plants nearby.

(vi) *End users*. Energy end users are either households or companies mainly located in Greece. The end users are mainly energy consumers, but there is a small number of energy "prosumers". As energy imports exceed energy exports the number of end users outside the Greek system is insignificant.

(vii) *Decommissioning*. On the residential level, dismantling of the implemented technology applications is generally combined with the installation of a new one, and the installers perform the application's dismantling. In larger scales, power plants are dismantled either on update (refurbishment, reconstruction, upgrade, etc.), or in case there is a change of use on the occupied land. In these cases, the dismantling is done by either installers or general construction companies.

(viii) *Reclaiming land and waste handling*. Land used in PV plants is generally in good shape and does not need any further redevelopment. Residential level applications do not have significant impact on land use. Waste handling is done either by reversing the products' supply chain, or by individuals that roam the streets collecting disposed products and taking them to scrap metal recycling facilities.

(ix) *Facilitating services & infrastructure*. There are plenty of institutions facilitating the installation or maintenance of photovoltaics, solar heating and cooling, and insulation systems. Analytical display of these institutions is provided in the system maps included in Section 2.4.

The solar power sector

In Greece, the solar energy exploitation conditions are among the most favourable in Europe, as the total solar energy received per square meter, during a whole year, ranges between 1,400 and 1,800 kWh. It should be noted that a PV system produces, on average, 1,200-1,650 kWh/kWp per annum in Greece. The following figure illustrates the total annual solar energy produced per surface (kWh/m^2) and the total annual energy produced by PVs (kWh/kWp) in the country.

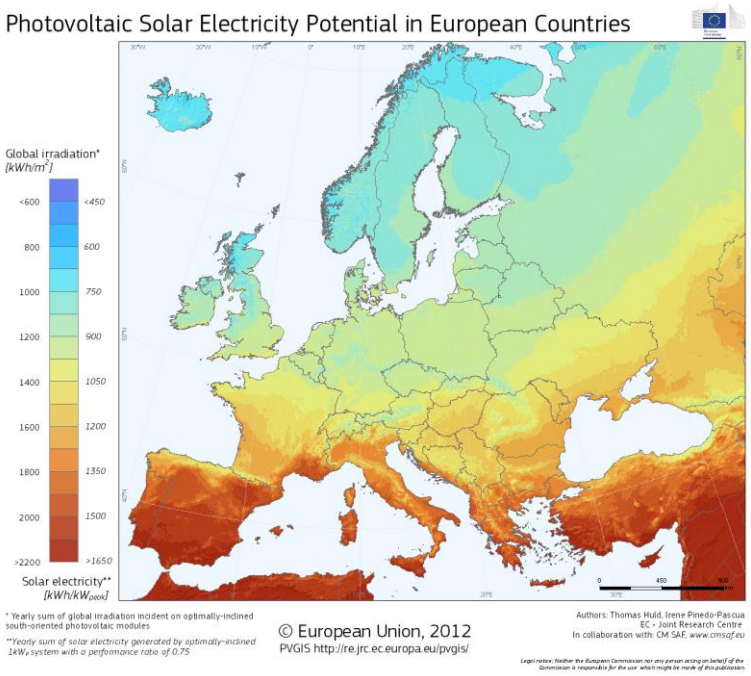


Figure 15 Solar radiation and solar electricity potential in European Union

Source: Huld et al., 2012

In 2015, production from PV covered 7.1% of the national electricity demand. Moreover, Greece was ranked 2nd, for the third time in a row, at a global level in terms of PV share in the total energy demand. New PV installations, however, were equal to just 10.3 MW, during the previous year, 1.5M Wp of which were PV systems with net-metering. In addition, the total installed PV capacity was equal to 2,605.6 MW, of which 2,230.1 MW were PV plants of more than 10 KWp, at the end of 2015. Ground-mounted PV plants account for 2,066MW, representing 79.3% of the total installed capacity in Greece (HELAPCO, 2016a).

The ground-mounted PV panels of 2,066 MW cover a surface of approximately 12.4 km^2. However, regarding the total surface covered by this capacity (taking also into consideration the gaps between the solar arrays and the perimeter safe distance from land boundaries), this is estimated

to be approximately equal to 40 km^2. Comparatively, the area occupied by the lignite power stations and mines, according to the Public Power Corporation, is equal to 253 km^2, i.e. 6.3 times greater than the area covered by PVs. In addition, according to ELSTAT, agricultural land amounts to 36,800 km^2 in Greece, of which 31,700 km^2 are also cultivatable. This means that PVs commit 0.1% of Greek agricultural land or 0.03% of the total area of Greece. It should also be noted that the agricultural land that is left uncultivated is 125.5 times greater than the area covered by photovoltaic systems (HELAPCO, 2016a).

Until recently, 5 national companies were producing solar PV panels, namely "Heliosphera", "Solar Cells Hellas", "Silcio/Piritium", "Exel Group" and "Stibetherm". Today, no company produces solar PV panels in Greece.

An indicative list of designers-installers and companies operated in the fields of supply and installation of PV systems has been developed and kept up to date by the Centre for Renewable Energy Sources and Saving (CRES). Enterprises and professionals who appear in the list have accepted the minimum specifications and safety requirements for the installation and operation of PV systems according to the "Guidelines for the installation of PV systems in buildings"[3].

During the operational phase of a solar power plant, managers for operation, maintenance and service are responsible for securing the uninterrupted and efficient operation of the solar PV project, the expansion of its lifetime and the recording of historical data (production and events). Moreover, these managers conduct operation and maintenance reports for the solar power plant owner, as well as reports for insurance companies (compensation claims).

Battery banks may be used in solar PV systems on roof-tops in order to store excess electricity produced by solar panels, to be consumed during periods of lower or no electricity production. Storage facilities that are in operation or planned to be in the future in Greece, in order to store electrical energy (that is not directly distributed to the power grid) at a wide-level, are presented in the following table.

[3] http://www.cres.gr/kape/pdf/odigos_pv_systimaton.pdf

Table 1: Storage facilities in Greece

Name	Place	Technology	Power (kW)	Duration (HH:MM)	Status	Date
Sfikia Pumped Hydro Power Station	Sfikia-Veria, Imathia	Open-loop Pumped Hydro Storage	315,000	n/a	Operational	Jan 01, 1985
Thisavros Hydro Power Plant	Paranesti, Drama	Open-loop Pumped Hydro Storage	384,000	n/a	Operational	Jan 01, 1996
TILOS (Technology Innovation for the Local Scale Optimum Integration of Battery Energy Storage)	Tilos Island, Prefecture of Dodecanese, Aegean Sea	Sodium-nickel-chloride Battery	800 (wind) and 160 (solar)	3:00	Contracted	Jul 01, 2017
Hydro Pumped Storage Amfilochia	Amfilochia, Aitoloakarnania	Closed-loop Pumped Hydro Storage	587,800	1200:00	Announced	
Amari Pumped Hydro Hybrid Project	Rethymnon and Lassithi, Crete	Closed-loop Pumped Hydro Storage	50,000	n/a	Announced	

Source: DOE - Global Energy Storage Database, 2016

When a specific solar panel or cell fails, the ruined product is recycled and replaced by a new one. The products involved in the aforementioned process include the panels, the inverters, other automation and control equipment, as well as the general electrical materials (cables, fuses, switches, etc.).

In May 2014, the Joint Ministerial Decision 23615 was established regarding the recycling of electric waste, including inter alia photovoltaics. Its purpose was to harmonise the national legal framework with Directive 2012/19/EC.

The Krannich Solar group is one of the official recycling stations of the European Organisation of "PV Cycle". The owners of the PV systems may deliver their used panels for recycling at branches of the Krannich Solar group in Europe that have been defined as collection points. This process is free of cost and is funded by the companies-members of the Organisation. Subsequently, "PV Cycle" is responsible for receiving these photovoltaic panels from the collection points and

concentrating them into recycling centres in which the dismantling and recycling of the panels takes place. The land on which the plant had been installed can return to its previous use.

The building sector

The buildings' dimension incorporates the use of three technologies so as to transform solar energy to electrical and thermal energy.

The first one refers to the transformation of the solar energy to electricity and is more or less the same as the solar power dimension presented above. However, in this case photovoltaics are installed on buildings' rooftops so instead of land to claim there is the rooftop to restore. Also, small scale batteries could be involved in case the building is not connected to the electricity grid. The installed capacity of PVs on rooftops is equal to 540 MW, with a share of 20% of the total PV installed capacity in Greece (HELAPCO, 2016a). According to CRES, as many as 1,704 enterprises are active in the design & installation of PV systems on buildings.

The second technology of the buildings' dimension refers to the transformation of solar energy directly to thermal, either for hot water, or for space heating and cooling. According to ELSTAT, more than one third of the Greek population (35.76%) uses solar energy for hot water (ELSTAT, 2016b), while there is also a negligible amount (0.21%) of population using solar energy for heating (ELSTAT, 2016c). Moreover, based on the Greek Solar Industry Association (EBHE, n.d.) the relevant industry has an annual turnover of about €300 million and ensures 3,500 full time jobs. EBHE was founded in 1979 and currently has 23 permanent members that produce solar thermal products in their own factories. The installation of solar thermal systems is legally defined by Instruction 3/2003 Ministry/D/Directorate no. 1945/134/17.01.2003, entitled "Installation of solar water heaters".

The third and last technology, namely building insulation, is introduced so as to resist the heat exchange between the inside and outside of the building, and to keep the thermal comfort of the buildings at an acceptable level. Companies operating in the Greek building renovation industry are divided into two main categories, the ones that are related to thermal insulation in masonry and those related to thermal insulated window frames. Regarding the former and according to the Hellenic Association of Insulation Companies (PSEM), there are 23 companies active in the production of insulation products, 32 in the commerce of these products, and 48 in the installation of insulation in buildings. However, with regard to the latter, there is also a majority of unlisted companies. Regarding the latter, the market of window frames is dominated by aluminium products (75%), while PVC and wood frames account for 14% and 11%, respectively. In Greece, there are about 10-15 major aluminium window frames producing companies, approximately 250-350 retailers that are also installers, and there are numerous unlisted installing companies (estimated to be about 1,500).

1.3.3 Enabling environment: policy mixes in the socio-economic system

The table below summarises the EU priorities and the corresponding EU and Greek national policies that are relevant to the Greek solar power and building sectors. The background, context and impact of the policies is extensively analysed in Section 2.3.1. The majority of national climate- and energy-related policy instruments stem from the harmonisation of the Greek legislation system with the corresponding EU directives.

Table 2: EU Environmental priorities and corresponding EU and national policies in the Greek solar power and building sectors

EU environmental priorities	Greek National Policies	EU Directive Reference
1. "Limit carbon dioxide emissions by improving energy efficiency (SAVE)"	Limiting CO_2 emissions, by setting measures for improving buildings energy efficiency [M.D. 21475/4707/1998]	SAVE Directive
2. "Substantially reduce natural resource use"	Special Consumption Tax [Law 3336/2005]	Energy Taxation Directive
3. "Promotion of electricity produced from renewable energy sources in the internal electricity market"	Electricity generation from RES and HECHP [Law 3468/2006]	Electricity from RES Directive
4. "Energy performance of buildings"	Measures for limiting energy consumption in buildings [Law 3661/2008] Energy performance of buildings [Law 4122/2013]	Energy Performance Of Buildings Directive
5."Promotion of cogeneration based on a useful heat demand in the internal energy market"	Promotion of cogeneration of two or more useful forms of energy [Law 3734/2009]	Promotion of Cogeneration Directive
6. "Promotion of the use of energy from renewable sources"	Acceleration of RES diffusion for climate change mitigation [Law 3851/2010] Promotion of the use of energy from renewable energy sources [Law 4062/2012]	RES Directive
7. "Common rules for the internal market in electricity and repealing Directive 2003/54/EC"	For the operation of Electricity and Natural Gas markets [Law 4001/2011]	Common Rules of Electricity Market Directive
8. "Energy efficiency"	Energy efficiency [Law 4342/2015]	Energy Efficiency Directive
9. "Guidelines on State aid for environmental protection and energy 2014-2020"	New support framework for RES power and HECHP power plants [Law 4414/2016]	Environmental Protection And Energy Guidelines

Other national policy instruments that are either directly or indirectly related to the Greek case study dimensions are presented in the table below. The legislative framework offering incentives for the protection of the environment consolidates a stable national environmental policy strategy, which contributes to attracting domestic and foreign investments into the RES industry. In addition, more targeted legislation, such as laws regarding the protection and improvement of air or water quality and measures regarding waste management, indirectly promotes the diffusion of renewables as well as energy efficiency, in the direction of reducing conventional and hazardous

pollutants produced by coal-fired and other non-renewable power plants; and limiting energy consumption across all sectors (buildings included). Legislation on the protection of biodiversity is also included: the contribution of renewables to climate change mitigation is intertwined with the efforts towards maintenance of healthy ecosystems. However, specifically with regard to solar power, the development of large-scale solar parks may have significant impacts on ecosystems and biodiversity.

Table 3: Greek policy instruments that directly or indirectly impact the solar power and building sectors

Policy themes	Greek National Policy Instruments			
Energy Climate	Limiting CO_2 emissions, by setting measures for improving buildings energy efficiency [M.D. 21475/4707/1998]	Electricity generation from RES and HECHP [Law 3468/2006]	Installation of RES units by auto producers with energy offsetting [M.D. RESEL/A/F1/oik. 24461/2006]	Measures for limiting energy consumption in buildings [Law 3661/2008]
	Promotion of cogeneration of two or more useful forms of energy [Law 3734/2009]	Special Program for the Development of Photovoltaic Systems in buildings [M.D. 12323/CC175/2009]	Technical Instructions for Energy Performance of Buildings [M.D. 17178/2010]	Energy Inspectors of buildings, boilers and heating and air conditioning systems. [P.D.100/2010]
	Acceleration of RES diffusion for climate change mitigation [Law 3851/2010]	Financing Environmental Interventions, Green Fund, Ratification of Forest Maps [Law 3889/2010] Environmental licensing of «Strategic Investments» [Law 3894/2011]	For the operation of Electricity and Natural Gas markets [Law 4001/2011] Environmental licensing [Law 4014/2011]	Regulation of Electricity Generation Licences for renewable energy (RES) and high efficiency heat and power (CHP) [M. D. YAPE/F1/14810]
	Promotion of the use of energy from renewable energy sources [Law 4062/2012]	Annual tax of conservation right for possessing electricity production licence [Law 4152/2013]	Energy performance of buildings [Law 4122/2013]	Standard Environmental Commitments for renewable energy projects [M.D. No. 3791/2013]
	Renewable Energy issues regulations [Law 4203/2013]	Re- setting pricing data regarding operating RES and CHP power station	Energy efficiency [Law 4342/2015]	New support framework for RES power and

		[Law 4254/2014]		HECHP power plants [Law 4414/2016]
Air	Measures for improving air quality [M.D. 14122/549/E.103/2011]			
Waste/ resource use	(Non-hazardous) waste management [M.D. 50910/2003]	Special Consumption Tax [Law 3336/2005]	Criminal Law Protection of the Environment - Waste production and management framework [Law 4042/2012]	
	Measures and terms for landfills of waste [M.D. 29407/3508/2002]	Regarding Electric and Electronic Equipment Waste [P.D. 117/2004]		
Water	Water Protection and Management [Law 3199/2003]			
Biodiversity	Biodiversity conservation [Law 3937/2011]	Approval of the 2014-2029 National Strategy on Biodiversity and of the 5-year Action Plan [Ministerial Decision 40332/26.8.2014]	Environmental upgrade and private urban development - Sustainable housing development Forest Law [Law 4280/2014]	Hoc committee for preparing draft bills related to a) legislative framework for the natural environment and b) the national management and administration system of protected areas and the natural environment [M. D. 29491/20.7.2015]

1.3.4 Enabling environment: government institutions

The key government institutions that are involved in formulating, influencing or implementing policies in the Greek solar power and building sector are presented in the following energy framework chart (Figure 16). Most of the included government departments are directly involved in formulating or implementing energy and climate policy in Greece, i.e. are closely related to the Regulatory Authority for Energy (RAE), while others (e.g. the Ministry of Education, Research and Religious Affairs and the Ministry of Infrastructure, Transport and Networks) simply supervise research institutions that are involved with research and innovation in this area. RAE is the link between the government and the regulatory authorities for electricity (market, network and transmission operators) and natural gas.

With regard to regional or local governments (such as municipalities and local authorities), although their role is currently limited in terms of influencing or implementing national policies

at the local level, they are included in the energy framework chart as they are to some extent involved in sustainable energy action plans. However, according to stakeholders, this role must be enhanced in the future, for the purpose of promoting the desired low-carbon transitions.

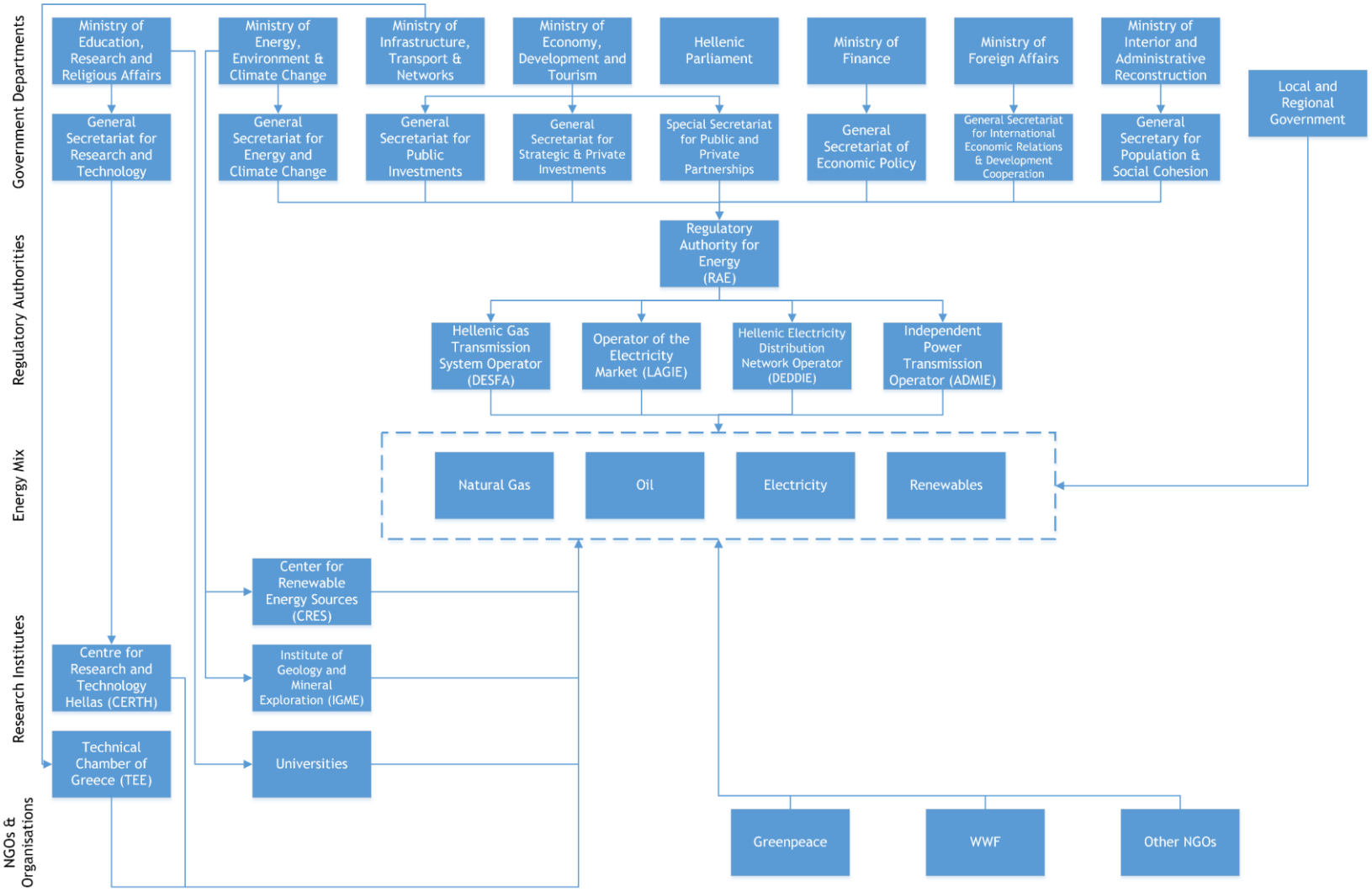


Figure 16 Major institutions in the energy framework in Greece.

1.4 The Innovation System map

The system maps for the Greek solar power and building sectors, as generated by MATISE and edited by yEd, are presented in the following figures. These system maps were created after mobilising stakeholder knowledge and expertise, during a stakeholder engagement workshop that took place on the 25th of October, at the National Technical University of Athens.

With regard to the solar power sector (Figure 17), the role of Research & Development (R&D) is characterised as of paramount importance for the extended PV deployment, including, among others, the development of storage facilities and the technological improvement of raw material and components of PV infrastructure, e.g. for achieving e.g. greater capacity factors. In addition, the fixed level of electricity tariffs has been identified as a considerable barrier against sell-consumption via PV development in the distribution network.

Moreover, the lack of funding capital, as a result of the current economic recession, has had negative effects on further solar PV diffusion. In particular, financial institutions, and mainly banks, have reduced their funding contribution in financing RES investments, leading to limited new solar PV projects during the last 3 years.

Furthermore, a critical issue that has to be examined is the way in which the grid costs will be distributed among the electricity customers in the future, especially in case of extensive net-metering implementation. Specifically, as the number of prosumers increases, fewer customers will have to pay more for the grid. Media and NGOs have been identified as additional key stakeholders in the sustainable transformation of the energy system and the promotion of the current policies towards additional PV technology expansion.

Considering the Greek building sector (Figure 18), a focal point of the TIS is the “Power end-users”, who are the ones taking the decisions regarding building renovations. Consequently, they decide if they will apply energy efficiency technologies, as well as if they will become prosumers by producing electricity from RES. “Power end-users” are the ones that will both initiate the building renovation market and also modify the way that the electricity distribution network operates. In doing so, they are motivated through supportive policies such as the “Energy Efficiency at Household Buildings Program”, which enabled investments through “Financial Institutions”. However, the application of the policy framework was quite problematic: “Financial Institutions” were involved in the scheme as evaluators which created obstacles and bureaucracy. Moreover, the media appear to have had a negative impact to the framework by presenting the payment needed for building evaluations as “another tax by the state”. Additionally, the lack of certified installer registry raises questions regarding the quality of the provided services and diminishes trust in certified work. Moreover, regarding the implementation of KENAK, a lot of bad examples of buildings’ assessments have been observed making its contribution controversial, if not negative.

The need for a communication and engagement strategy in order to correctly inform consumers on why they are paying and what benefits their payments entail is highlighted. It is worth mentioning that consumers in general do not believe that there is a way to influence the energy market and their electricity bill. That is because, until recently, there was only one retail electricity supplier. Also, the role of the media is quite important towards the alternation of the Greek solar PV and buildings sectors.

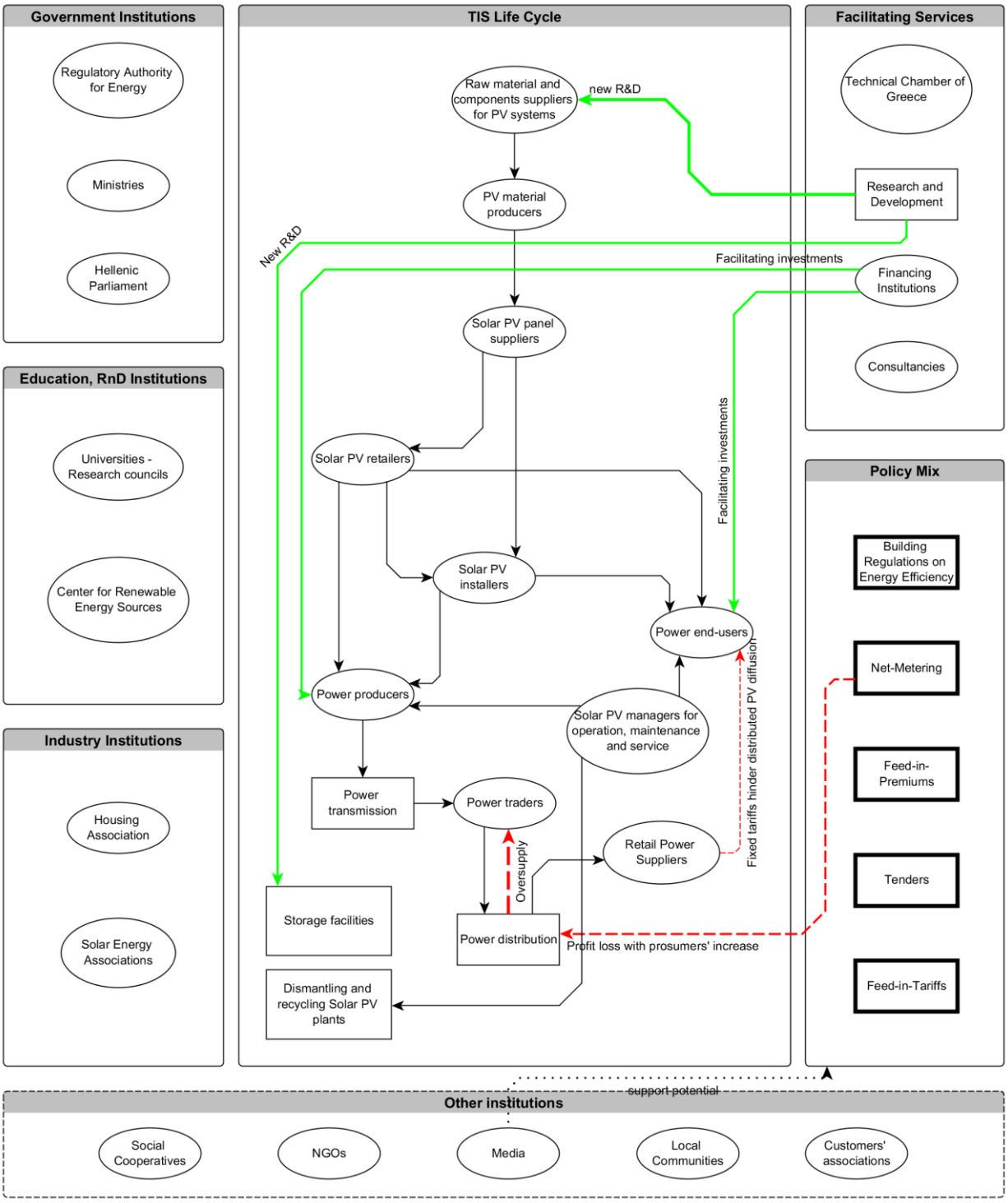


Figure 17 The Greek Solar Power system map, as compiled through secondary research and a stakeholder engagement workshop

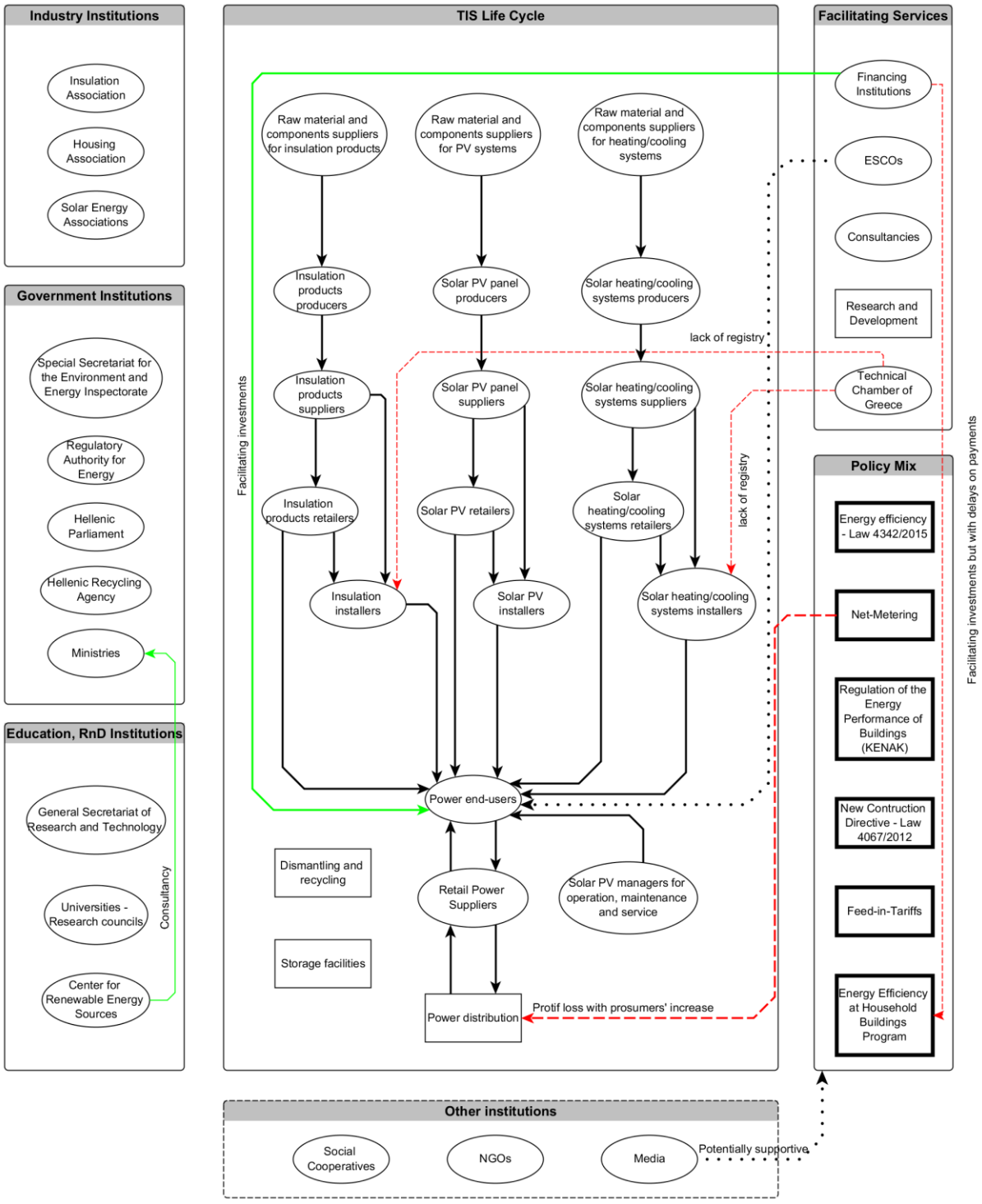


Figure 18 The Greek Building Sector system map, as compiled through secondary research and a stakeholder engagement workshop

1.5 Stakeholder engagement

The stakeholder engagement comprised twenty-one semi-structured interviews and one stakeholder workshop that NTUA and UPRC conducted with generalists and case-study experts. Stakeholders were drawn from a large number of groups, including regulatory authorities, government bodies and consultancy institutions, industry associations and networks, academic and research institutions, environmental NGOs, power generating companies, financing institutions and industry. The interviews were conducted during July, August, September and October of 2016, while the stakeholder engagement workshop took place at October 25, 2016. More information on the stakeholders that participated in TRANSrisk, in the aim of this deliverable, can be found in Section 2.5.

Table 4: Stakeholder Engagement

Type of stakeholder	Position in the organisation	Economic sector	Type of engagement	Month and year contacted
1. Business	Director	Energy	Interview	July 2016
2. Association	Chairman	Energy	Interview	July 2016
3. Business	Director	Energy	Interview	July 2016
4. Utility	Director	Energy	Interview & Workshop	July 2016 & October 2016
5. Association	General Manager	Energy	Interview & Workshop	July 2016 & October 2016
6. Research Organisation	Chairman	Energy	Interview	July 2016
7. Consultancy / Business	General Manager	Energy	Interview	July 2016
8. Business	Engineer	Energy	Interview	August 2016
9. Consultancy / Business	General Manager	Construction	Interview	September 2016
10. Association	Adviser / Freelancer	Energy	Interview	September 2016
11. Utility	Director	Energy	Interview	September 2016
12. Research	Engineer	Energy Policy	Interview	September 2016
13. Research / Consultancy	Member of BoD	Energy	Interview & Workshop	September 2016 & October 2016
14. Business	Manager	Energy	Interview & Workshop	September 2016 & October 2016

15.	Business	Manager	Energy	Interview & Workshop	September 2016 & October 2016
16.	Consultancy	Consultant	Energy / Financing	Interview & Workshop	September 2016 & October 2016
17.	Utility	Engineer	Energy	Interview & Workshop	September 2016 & October 2016
18.	Research	Testing Engineer	Energy	Interview & Workshop	October 2016
19.	Research / Consultancy	Director / Strategist	Energy	Interview	October 2016
20.	Academic / Research	Researcher	Energy	Interview	October 2016
21.	Business	Vice President	Energy	Interview	October 2016
22.	Research / Consultancy	Freelancer	Energy	Workshop	October 2016
23.	Utility	Engineer	Energy Policy	Workshop	October 2016
24.	Consultancy	Freelancer	Energy	Workshop	October 2016
25.	Academic / Research	Lecturer / Researcher	Energy	Workshop	October 2016
26.	Academic / Research	Lecturer / Researcher	Energy	Workshop	October 2016
27.	Academic / Research	Lecturer / Researcher	Energy	Workshop	October 2016
28.	Academic	Lecturer	Social	Workshop	October 2016
29.	Academic / Research	Researcher	Energy /Economics	Workshop	October 2016
30.	Academic / Research	Researcher	Energy / Environment	Workshop	October 2016
31.	Academic / Research	Researcher	Energy / Environment	Workshop	October 2016
32.	Academic / Research	Researcher	Energy Policy / Economics	Workshop	October 2016
33.	Academic / Research	Researcher	Energy Policy / Economics	Workshop	October 2016
34.	Consultancy / Research	Researcher	Energy Policy	Workshop	October 2016
35.	Academic / Research	Researcher	Energy Policy / Economics	Workshop	October 2016

36. Academic / Research	Researcher	Energy Policy	Workshop	October 2016
37. Academic / Research	Researcher	Energy / Environment	Workshop	October 2016
38. Academic / Research	Researcher	Energy Policy	Workshop	October 2016

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