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Improving the energy efficiency of buildings as a growth driver of the Greek economy

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TABLE OF CONTENTS

TABLE OF GRAPHS

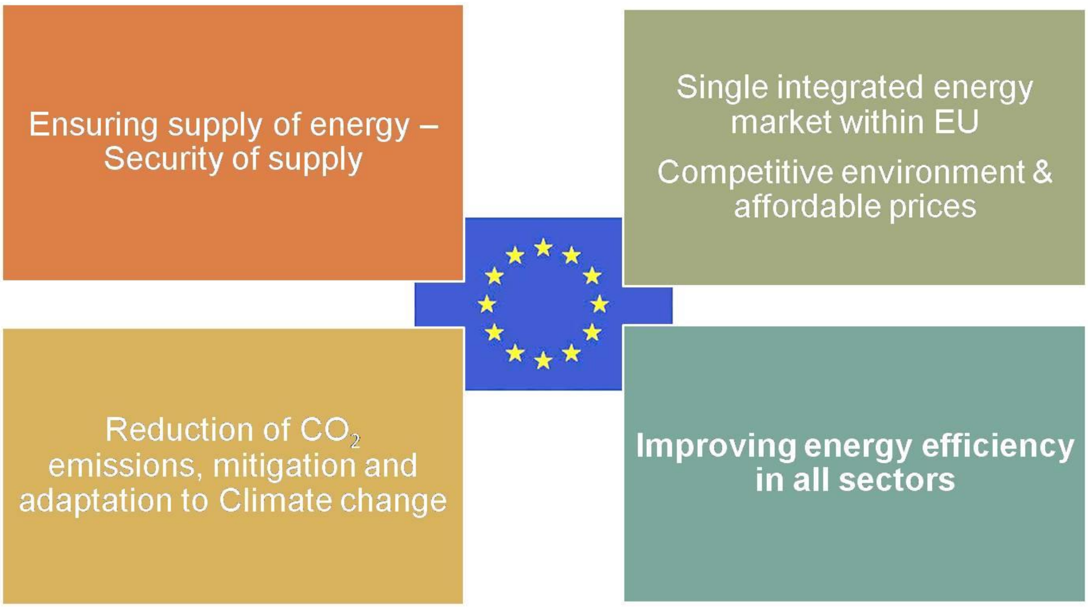
TABLE OF TABLES

SUMMARY

This study examines the impact on the Greek economy from the accelerated implementation of energy efficiency and energy saving measures in buildings, as foreseen in the relevant national and European law. The analysis shows that, in addition to the positive impact on environmental and energy indicators, the resource utilization and the mobilization of funds for energy efficiency will have a potentially significant effect on GDP, employment and public revenues.

Improving energy efficiency is a central pillar of the European Union (EU) Energy Policy, as it can support its individual objectives, and in particular energy security for all consumers (industry, businesses and households), limit CO_2 emissions thus supporting necessary structures to mitigate the effects of climate change.

Figure 1: European Energy policy objectives



Source: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union

In particular, improving energy efficiency is necessary to reduce greenhouse gas emissions by 80-95% by 2050 compared to 1990 levels. The EU Energy and Climate Roadmap, which is among the foundations of the energy policy, lists as its main objective the reform of the energy systems of the Member States. In this context, upgrading the energy performance of buildings is expected to bring significant benefits for the environment and for the economics of households and other related stakeholders.

The relevant Greek legislative framework for the promotion of energy efficiency includes Law 3855/2010[1], which harmonized with the EU Directive 2006/32/EC, as well as Law 4422/2015[2]. The overall energy savings target for 2014-2020 are foreseen for 3,332.7 ktoe (33.8 TWh), which will mainly derive during the 2016-2018 and 2019-2020 periods (19.5TWh and 15.8

[1] Law 3855/2010, Measures to improve energy end-use efficiency, energy services and other provisions

[2] Law 4342/2015, Energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing the Directives 2004/8/EC and 2006/32/EC

TWh, respectively). Achieving the foreseen objectives is mainly structured around the implementation of relevant measures and actions in public buildings, the creation of an information system for monitoring the improvement of energy efficiency, the financial support of technological investments that promote research in energy saving, the application of tax exemptions for energy saving interventions and the development of an energy management system in the public sector.

Despite the undoubted benefits of improving energy efficiency in buildings, the need for high initial investment in the implementation of advanced technological solutions seems to be a major barrier for the Greek households[3]. Studying the residential sector has shown that Greece has not yet fully exploited the potential benefits associated with improving energy efficiency, while the reduction in energy consumption achieved is more related to the reduction of disposable income and economic activity and less to the implementation of energy efficiency upgraded systems for housing. This is confirmed by the results of a previous study of IOBE, showing that few households have implemented all the measures available to improve energy efficiency. Similar conclusions derive from the annual reports of the Ministry of the Environment and Energy, where it is noted that most of the housing stock has significant deficiencies associated with their very low energy efficiency. Consequently, most of the buildings concerned are classified in low and medium energy classes.

Calculation of the economic impact of energy upgrading activities on the basis of an input-output model shows that investments in energy upgrading of buildings exhibit strong multiplier effects on the Greek economy. Every €1 million of investment in energy upgrading of buildings in 2018 increases the Greek GDP by €1.4 million by cumulatively on net terms[4]. In addition, employment is augmented by a maximum of 40 thousand jobs. Furthermore, implementing the activities foreseen in the Strategic Investment Planning for the energy efficiency upgrade of the building stock of the tertiary sector[5] can bring an additional 0.4 percentage units to the growth rate and increase employment by an extra 24,700 jobs. According to the results of the economic analysis, governmental support of energy efficiency in buildings, besides the considerable positive environmental impact, can generate significant economic benefits at a time when stimulating economic activity and employment growth is a main social demand.

Towards the achievement of the above objectives, State should provide additional incentives for households to accelerate investments in energy upgrading of buildings. A tax-credit proportionate to the level of the cost of energy upgrading activities could also contribute significantly.

[3] The Household Savings II program, which is co-funded by the EU, aims at the provision of financial facilitations and consequently in removing the relative obstacles for the upgrade of energy performance of residential buildings. The program, which was launched in February 2018, is expected to support the achievement of national energy savings targets in residential buildings.

[4] Taking into account both the positive economic impact of stimulating investment in energy upgrading of buildings and the negative economic impact of reducing energy expenditure on energy-related goods

[5] See Decision ΥΠΕΚΑ ΔΕΠΕΑ/Γ/οικ. 185497, ΦΕΚ Β 3004, 31-12-2015, YPEKA 2014, "Report of a long-term strategy for the mobilization of investments for the renovation of residential and commercial buildings, public and private, national building stock"

Taking into account the multiplying effects of investments related to the improvement of the energy footprint of buildings, it appears that the negative impact on public revenues caused by the up-mentioned tax deduction is partly or wholly counterbalanced by the positive effect on public revenues from the stimulation of economic activities from these additional activities. For example, we estimated that if a 20% tax deduction for renovation works mobilizes private investments of the amount described in the ambitious housing upgrades scenario, then public revenues increase, in aggregate terms, over the first six years of implementation[6]. However, an aggregate fiscal gap is emerging from 2026 onwards, rising to 4% of the aggregate cost of renovation interventions in 2030.

[6] The aggregate additional public revenues due to the stimulation of economic activity exceed the aggregate loss of tax revenues due to the tax deduction for each year in the period 2018-2025

INTRODUCTION

The sustainable use of energy along with the development of renewable energy sources and the reduction of greenhouse gas emissions have been recognized as key pillars of the European Union's (EU) energy and climate policy,. The main expression of this policy are the directives 2012/27/EU and 2013/12/EU on energy efficiency (EED), as well as the Directive 2010/31/EU on Energy Performance of Buildings (EPBD)[7]. The EED includes a set of rules and obligations for the Member States that should achieve an indicative target for energy efficiency by 2020[8], while the DEPB sets more specific targets for energy efficiency requirements for the building sector[9].

The building sector, that is responsible for a large share of the final energy consumption (around 40%) in the EU, is recognized as one of the sectors with significant potential on energy savings at relatively low cost, given the characteristics of the building stock in terms of quality and age. The main measures suggested by the EPBD include the mandatory introduction of energy performance certificates that should be issued before the purchase or renting of buildings, requirements for the construction of new "almost zero-energy" buildings by the end of 2020 (for public buildings by end 2018), renovation obligations for older buildings, mandatory inspections of central heating and cooling systems, or other measures having equivalent effect, and the definition of financial support measures for similar actions.

In the same way, the EED requires from the Member States to define building renovation strategies, as part of the National Energy Efficiency Action Plans, according to which the public sector will annually renovate at least 3% of the total area of owned and used buildings. At the same time, for the 2014 – 2020 period, it imposes an annual aggregate energy saving target for the distribution and retail energy companies, which is equal to 1.5% of the average annual energy sales to final consumers during the 2010-2012 period.

From the above, and taking under consideration that the appropriate financial instruments promoting energy efficiency improvement actions are established at EU level, it appears that there is a considerable room for growth of the energy efficiency sector in Greece. Moreover, the age[10] and the technical characteristics of the existing Greek housing stock, (i.e. such as insulation[11]), necessitate large-scale interventions to save energy in buildings such as thermal insulation, upgrade of heating-cooling systems, replacement of window frames etc. These interventions, when implemented, they will contribute significantly to the domestic economic

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[7] This Directive was amended in July 2018 by Directive 2018/844/EU

[8] Reduction in energy consumption by 20% compared to the projected energy consumption by 2020 without the implementation of additional energy efficiency measures

[9] As these policies have a long-term perspective, under the proposed new energy and climate policy framework for the period up to 2030 (November 2016), the energy efficiency targets are expanded by providing for an additional 30% reduction in energy consumption

[10] According to the Census of Buildings (ELSTAT, 2011), the houses in Greece in 2011 amounted to a total of 6.4 million. Of these, the largest part (1.4 million buildings) was built in the 1970s. In the 2000s, 986 thousand buildings were built, roughly as many as in the past decades of the 1980s and 1990s. The majority of buildings (about 55%) are over 30 years old (built before 1981)

[11] Only 9% of the buildings built after 2001 (7.8% for buildings after 2006) has no insulation systems, when 2/3 of the buildings built before 1981 and 41.5 % of the buildings built between years 1981-1990 did not have any kind of insulation. Overall, although some improvements in the insulation of buildings is evident, especially after 1991, most of today's building stock lacks necessary elements that increase their energy footprint considerably

activity, supporting the Greek constructions, a sector that has suffered huge losses during the economic crisis of recent years.

The purpose of this study is to examine the benefit for the Greek economy from the accelerated implementation of energy efficiency and energy saving actions in buildings, as foreseen in the relevant national and European legislative framework. The exploitation of resources and the mobilization of funds, besides having significant effect in the environmental and energy footprint of the buildings, may be related with potentially considerable impact on GDP (i.e. increase of investments, reduction of imports), employment (generation of new jobs) and in public revenues.

The study is structured as follows: The **first chapter** presents the environmental, social and economic benefits of improving energy efficiency. The **second chapter** provides an overview of the European energy efficiency policy with emphasis on the building sector and the **third chapter** examines the current situation in the field of energy efficiency of the building stock in Greece. The economic impact of implementing energy saving interventions in buildings is analyzed in **chapter four**, while the **fifth chapter** summarizes the conclusions of the analysis and includes suggestions for the policy makers.

1. THE BENEFITS OF ENERGY SAVINGS

Adopting the principles of sustainable development leads to a more rationalized use of natural resources, that can be obtained from improving efficiency. The development of systems of smaller energy footprint is a primary objective of the existing European and national policies for transition towards a zero carbon economy, in line with the principles of sustainable development.

In recent years, the issue of energy efficiency is put high in the agenda of all relevant stakeholders (policy makers, industry, etc.), mainly because of the concerns about the impact of energy production on climate change, and also on other negative externalities that affect the environment and society. Improving energy efficiency leads in reductions in the GHG and fewer energy costs in various production processes[12].

The benefits of improving energy efficiency are not limited only to climate protection but also to the economic activity, the natural environment and, more generally, life quality. According to the International Energy Agency (IEA)[13], the benefits of improving energy efficiency can be classified in five categories:

- Enhancement of the energy systems security
- Economic growth and progress
- Social development
- Environmental sustainability
- Improving welfare

This chapter presents the main benefits from upgrading energy systems and improving energy efficiency, which belong to the above categories. Their impact is greatly affected by the size of investments in the parameters that determine energy efficiency[14]. It is noted that in many cases the benefits extend to more than one category.

[12] Economics of Energy Efficiency, Encyclopedia of Energy, Vol. 4, Elsevier 2004
[13] Capturing the Multiple Benefits of Energy Efficiency, IEA 2014
[14] The macroeconomic and other benefits of energy efficiency, European Commission 2016

Graph 1.1: The multiple benefits of energy saving

Source: IEA, 2014.

1.1 Strengthening the security of the energy system

The level of energy efficiency affects all the individual components that determine the safety of existing energy systems (cost, fuel imports, network infrastructure, etc.).

As most of the energy demand is covered by the combustion of fossil fuels, it is obvious that low energy efficiency increases the need for fuels, the imports from producer countries and overall the energy costs, which is related with the geographic availability of these fuels. Consequently, improving energy efficiency reduces dependence on fossil fuels and other pertinent elements affecting their supply (e.g. price changes), enhancing security of energy supply and facilitating consumers' access to energy.

In contrast, high energy efficiency is usually translated into smaller and more sustainable distribution energy systems. The creation of the necessary infrastructure does not require high cost and high risk investments, while saved funds can be used in other investments and/or to reduce the cost of the provided services, with direct benefits for the industrial and trade competitiveness, as well as for the disposable income of households.

1.2 Economic growth and progress

Improving energy efficiency is a strategic goal for economic growth. Limiting consumption of fossil fuels to produce energy, as a result of improving energy efficiency, leads to a reduction in household and business spending on energy purchase and greenhouse gas emission permits (in specific sectors). Since energy cost is a key element of the industry's operating costs, its reduction creates competitive advantages, which can be further translated into greater resilience to external challenges, increased investments (research and development, transport networks, entry into new markets), and overall, results in higher added value for the economy.

In addition, investing in infrastructure that improves energy efficiency, as long as it does not displace other investments, contributes positively to the rate of economic growth. For example, in the EU it is estimated that similar investments may, under certain conditions, increase GDP from 1.3% to 4.4% depending on the time period, the Member State and the energy efficiency levels of the energy systems[15].

1.3 Social development

Improving energy efficiency has a positive impact on employment, especially in the energy-intensive sectors and the sectors related with the construction of equipment and materials relevant to energy efficiency. Employment of these sectors in the EU was estimated at around 900 thousand jobs in 2010. When the employment of the auxiliary sectors are taken into account, then employment is assessed at 2.4 million jobs or about 1% of total employment in the EU. Implementation of the European energy policy may triple the relevant jobs by 2030.

Energy poverty is another important social aspect affected by energy efficiency. Today, over 1/7 of the world's population has no access to electricity, while 11% of the population in Europe fails to enjoy adequately heated housing at affordable costs. Energy poverty and the relevant inequalities appear to be significant both in the developed and in the developing countries. In these cases, lower income social groups face increased energy costs due to residing in low-energy efficiency buildings and use of old electrical appliances. Improving energy efficiency reduces their demand for energy. Consequently, power distribution networks can cover a larger part of the population at more affordable prices, while savings from households budget can be used for other major needs (e.g. education).

1.4 Environmental sustainability

Energy production is an activity with significant environmental impact on air, soil, water resources and biodiversity. Moreover, as already mentioned, energy production is the main source of GHG causing climate change, which is linked to economic, social and cultural challenges at a global level[16]. More generally, improving energy efficiency reduces anthropogenic pressure on natural ecosystems that may arise from the extraction and exploitation of rare natural resources, while limiting human intervention in ecosystems of high importance for regulating climate (e.g. arctic ecosystems and tropical forests), while under specific conditions, it slows down phenomena such as oceans acidification.

Smaller demand for fossil fuels, due to energy savings, has a direct impact on air quality. This limits the release of air pollutants (SO_2, PM, NO_x) from transport, industry, electricity generation and households. The impact of the polluted atmosphere on human health is important and multidimensional. According to the World Health Organization (WHO), air

[15] Assessing the Employment and Social Impact of Energy Efficiency, Cambridge Econometrics, 2015
[16] https://ec.europa.eu/clima/change/consequences_en

pollution is responsible for about 4.2 million premature deaths per year and diseases that are intensified in urban environments (cardiovascular diseases, lung cancer, inflammations). Of these, 600 thousand occur in Europe[17], while 90% are registered in low-income countries[18]. Total health expenditure in China's highly urban areas is between 25-83 billion USD or 1.1-3.3% of GDP[19]. In Europe, more than 90% of the inhabitants of large urban areas have been exposed to significant concentrations of a major pollutant[20].

1.5 Improving welfare

Energy efficiency offers a wide range of technological and other solutions that can be used to reduce energy consumption, reduce GHG emissions, save financial resources and improve welfare in general.

Improving energy efficiency is important for improving everyday living conditions. For example, upgrading a heating system of an industrial unit, leads to better working conditions for employees and in lower operating costs. The application of new lighting technologies in workplaces (e.g. LED technology) improves safety and, consequently, employee productivity.

Implementing energy saving measures in economies based on the production and export of fossil fuels reduces local demand, increasing the quantities available for sale (exports).

Household disposable income is also positively affected. Increased energy savings could, under specific conditions, lead in the reduction of the energy unit cost and the overall contraction of the relevant costs. As a result, the unspent financial resources can be used to cover other households' needs, improving the standard of living and well-being.

Finally, implementing measures that improving energy efficiency could positively affect the value of real estate (industrial and residential). In developed economies, it has been observed that households and enterprises are willing to pay a higher price for the purchase of a residential and/or industrial building with higher energy efficiency[21].

[17] (OECD, 2015)
[18] http://www.who.int/airpollution/ambient/health-impacts/en/
[19] World Bank and SEPA, P. R. China, 2007
[20] https://www.eea.europa.eu/media/newsreleases/air-pollution-still-causing-harm
[21] Bonifaci & Copiello, 2015

2. OVERVIEW OF THE EUROPEAN UNION ENERGY EFFICIENCY POLICY

2.1 Introduction

The European Union's (EU) energy and climate policy aims at the uninterrupted and sustainable energy supply of all European citizens. This objective is materialized through the following objectives:

- Ensuring supply and security of supply for all consumers (firms and households).
- Creating competitive conditions for the operation of energy companies and the achievement of affordable energy prices.
- Limiting CO_2 emissions and creating the necessary structures to mitigate the effects of climate change.
- Improving energy efficiency in all sectors.

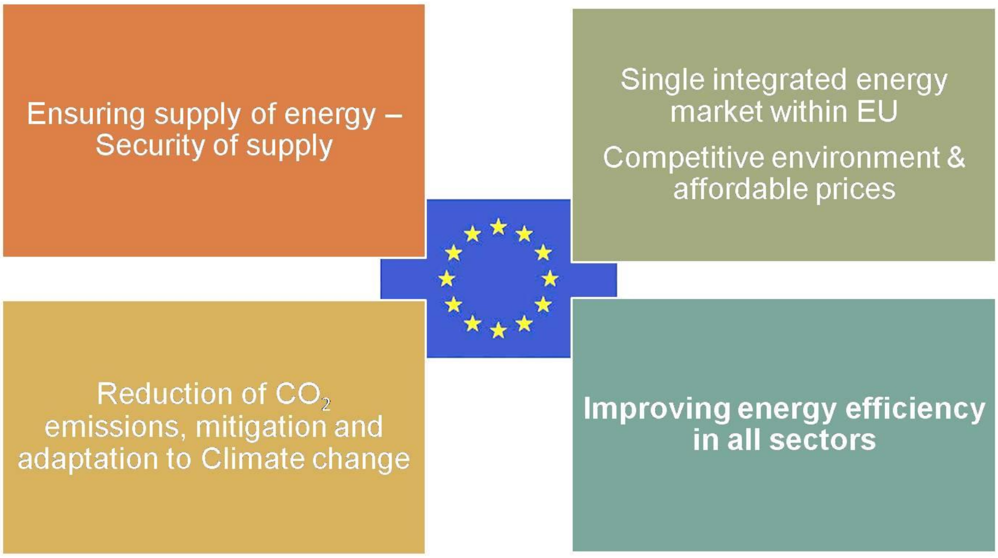
Achieving the EU's policy objectives requires the creation of the Energy Union, which is the first step in ensuring stable energy supply at affordable prices for households and firms, job creation and economic growth broadly in the EU. Increased competition supports further the affordable energy prices among energy companies operating in Europe, through the free movement of goods and services, which, combined with the implementation of new technological solutions and upgrading of existing infrastructure are promoted by the Energy Union. The integration of the internal energy market is another institution supporting the achievement of the objectives of the European strategy, which aims at protecting consumers and at the same time ensuring adequate interconnections between Member States. For this to be achieved, it is necessary to remove the institutional and commercial barriers and rationalize pricing policies that increase the competitiveness of energy companies and improve consumers protection.

Security of energy supply is among the main targets of the EU policy. Today, more than 50% of EU energy needs are covered from imports mainly related to fossil fuels (oil and gas), while several Member States depend on imports from only one supplier (e.g. natural gas from Russia). The need to reduce the dependence of the European economy on other countries for economic and geopolitical reasons has led to the adoption of short-term measures implemented in 2014-2015 but also to other medium- and long-term measures up to 2030 aimed at improving energy efficiency, increasing energy production within the EU and improving infrastructure to reduce the impact of any possible energy supply disruption.

To ensure a stable energy supply but also reduce the dependence on fossil fuel imports from other countries, EU policy foresees specific measures increasing energy production in the EU, with particular emphasis on the use of renewable energy sources, but also on improving energy efficiency. The shift to a new, lower-carbon economic paradigm is aligned with other EU policies (e.g. climate action policy) that supports the creation of new jobs in the broader environmental industry.

The role of energy efficiency in achieving the foreseen objectives is important. Improving energy efficiency generates benefits in various dimensions (economy, society, environment and climate). This improvement is largely dependent on the size of the relevant investments, which are linked with a positive impact on various macroeconomic elements (employment, value added). At the same time reducing the relevant energy costs of enterprises and households, affect their competitiveness and disposable income, respectively. Energy security of networks benefits from the ability to serve demand easier. At the same time, improving efficiency is an important tool for reducing energy poverty .

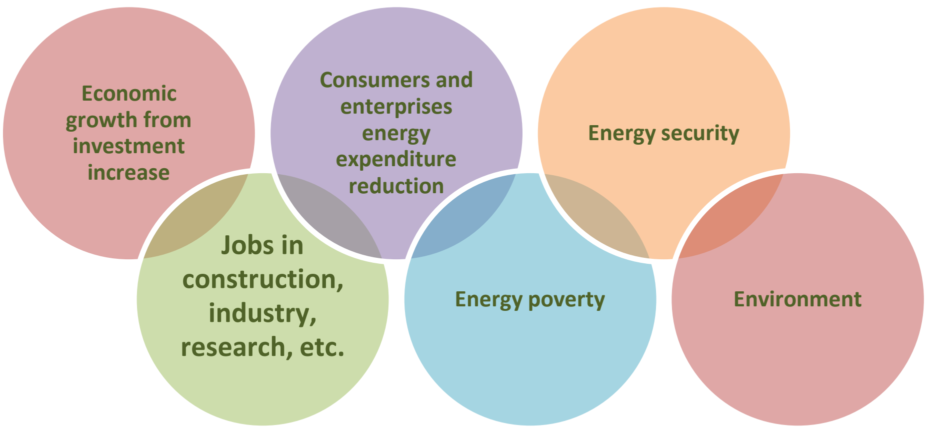
Graph 2.1: The targets of EU energy policy



Source: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union

For the achievement of the foreseen objectives, the legislative framework takes into account the contribution of new technologies, the existing energy efficiency improvement measures and the need to upgrade existing infrastructures. The use of these tools not only improves energy efficiency in the EU, but also improves labor skills, boosts employment and supports growth and exports. In addition, energy policy supports the transition to a sustainable, low carbon and environmentally friendly economy.

Graph 2.2: The benefits of improving energy efficiency



Source: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union

2.2 Elements of the EU energy policy

The implementation of effective energy strategies requires long-term planning and commitment from all Member States implementing actions that will not only reduce the impact on climate and the environment but will also transform energy policy into a pillar supporting the development of the European economy broadly. This is highlighted as the main goal of the Juncker investment plan[22]. Besides the above, it is now clear that the cost for the European economy of not taking comprehensive measures, both in the medium and long term, is extremely high[23].

In addition, EU aims to reduce GHG emissions by about 80-95% of the 1990 levels by the year 2050. As the energy sector contributes decisively to GHG emissions, the Energy Roadmap for 2050, expressed in energy strategies for 2020 and 2030, is geared towards reforming energy systems to achieve EU policy objectives. The way forward for achieving the objectives of the EU strategy involves transforming the EU energy system, redesigning energy markets, mobilizing investors and, finally, involving consumers and the general public in policymaking.

Thus, improving energy efficiency is at the heart of policies for 2020 and 2030. The role of buildings and residences both in energy saving and in energy production (from renewable energy sources - RES) is crucial. In particular, it is proposed to intensify energy saving measures in buildings, transport and electrical/electronic products, where there is still great potential for improving energy efficiency. In addition, it is of great importance to expand the use of new technologies that stimulate consumer behavior such as smart meters and other types of home automations. As the improvement of energy efficiency requires extensive investments both for the renovation of existing building stock and for the adoption of new techniques of industrial design for products, it is necessary to facilitate access to funding for all involved stakeholders. The crucial importance of access to capitals and the provision of financial incentives to improve energy efficiency is also widely recognized in the EU policy.

2.3 The EU's institutional framework for energy efficiency

2.3.1 Energy strategy 20-20-20 and energy efficiency

The quantitative objectives of the EU 2020 energy strategy are: a) to reduce greenhouse gas emissions by at least 20% compared to 1990 levels, b) to increase the share of renewable energy sources to 20% of energy consumption (at minimum) and (c) achieve energy savings of 20% (or more) overall in the EU, compared to projected energy consumption by 2020 without the implementation of additional energy efficiency measures (non-binding target). In addition, in all Member States, 10% of the energy used in the transport sector must derive from renewable sources.

The objective of improving energy efficiency by 2020 is extremely important as it related to the extent of the necessary adjustments to achieve the remaining energy policy objectives.

[22] Investment plan for Europe: The Juncker Plan, available at https://ec.europa.eu/commission/ /priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan_en

[23] http://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:52011DC0885&from=EN

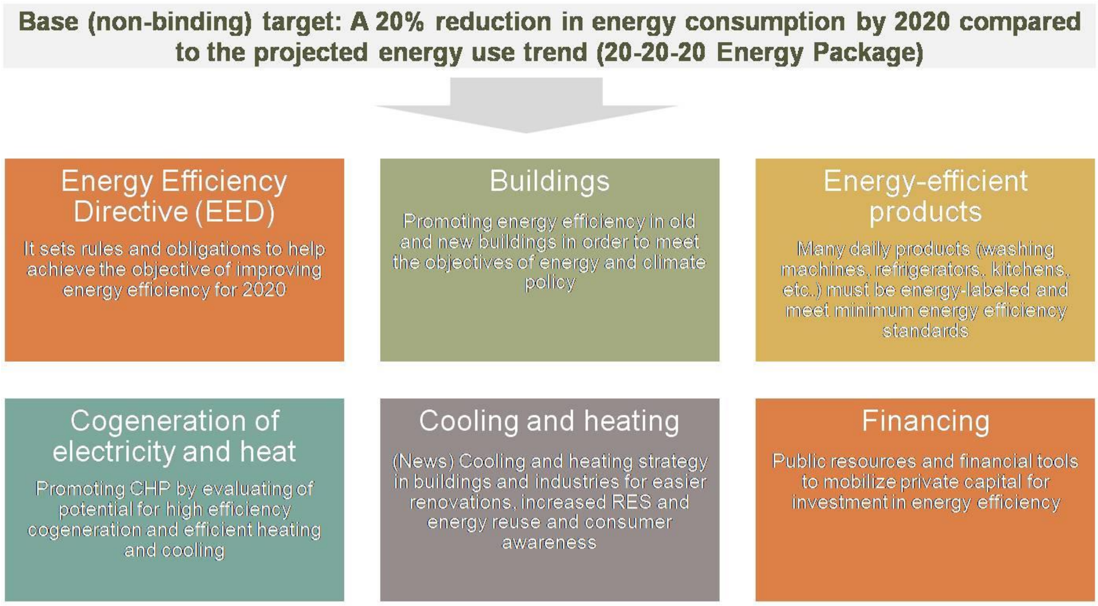
The EU strategy, through implementation of relevant policies sets quantitative targets, rules and obligations to support the achievement of the foreseen energy efficiency results (Chart 2.3).

Energy efficiency of building stock is important for limiting energy consumption and protecting climate. For this reason, energy policy is extended to both old and new buildings.

Another pillar of the strategy is related with the energy efficiency of various electrical and electronic devices. The strategy foresees the use of specific labeling for informing consumers about the energy efficiency of market products and the establishment of a minimum energy efficiency level.

In addition, EU is promoting policies for cogeneration of electricity and heat, and cooling/heating in buildings. The exploitation of the potential of cogeneration, as well as the use of renewable energy technologies in the cooling and heating sector, along with the raising public awareness is considered as very significant.

Graph 2.3: EU energy efficiency policy



Source: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2020-energy-strategy

In particular, the achievement of energy efficiency policy objectives is directly and indirectly supported by:

- Directive on energy efficiency (2012/27/EU), which replaced Directive 2006/32/EU on energy end-use efficiency and energy services
- Directive on the energy performance of buildings (2010/31/EU)
- Institutional framework for products that sets minimum energy efficiency standards
- CO_2 emission standards for vehicles
- Increase funding through European funds and programs
- Promoting smart energy meters
- Emissions Trading Scheme

Improving energy efficiency can be achieved both through implementing relevant measures in the existing infrastructures (e.g. public and private buildings) and by innovating in the design of electrical products towards lower energy consumption (e.g. eco-design). Improving energy has immediate benefits for the environment and climate protection, as natural resource use is rationalized, while GHG emissions are reduced. In addition, improved energy efficiency leads to lower production costs from the more efficient use of energy and from the limited purchase of GHG emission rights for the sectors participating in the European Emissions Trading Scheme. The above elements affect the competitiveness of European industry and enterprises, generating benefits to employment and the economy in general, in line with the "Investment Plan for Europe"[24].

To achieve this, the EU is in the process of implementing measures, such as:

- Annual reduction of national energy sales by energy suppliers by 1.5%
- Improving the energy efficiency of buildings used by central governments and restoring at least 3% of total public buildings annually
- Mandatory use of energy certificates for the sale and/or rental of buildings
- Adoption of minimum energy efficiency levels and labeling for different electrical products and devices
- Preparation of National Energy Efficiency Plans every three years by Member States
- Use of about 200 million smart electricity meters and 45 million fuel meters
- Establishment of internal energy audits in large enterprises at least every 4 years
- Consumers' access in historical and current consumption data
- Improving knowledge and awareness of energy efficiency improvements - EU guidelines have already been issued

Mobilizing financial resources is a key prerequisite for supporting the energy efficiency policy. Based on EU estimates, achieving the energy efficiency targets by 2020 requires a total cost of €100 billion[25]. Towards this direction, many support programs and initiatives that can mobilize both public and private funds have been developed to support the relevant investments. In particular, having recognized the importance of the building stock for achieving the 2020 Strategy, but also for improving the European economy more broadly, the EU has increased the amount of public resources available to improve energy efficiency. For the 2014-2020 period, the European Structural and Investment Funds allocates €18 billion for energy efficiency projects, €6 billion for renewable energy in buildings and about €1 billion for the installation of smart energy grids. In addition, an additional €10 billion are expected to be mobilized from national public and private funds.

The European Investment Bank, in cooperation with the European Commission and the Climate action of the LIFE programme has created the "Private Finance for Energy Efficiency" financing tool (PF4EE) from 2015, which aims to address limited access to adequate and affordable commercial finance for energy efficiency investments.

[24] https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan_en
[25] https://ec.europa.eu/energy/en/funding-and-contracts

Text Box 2.1: Key points of Directive 2010/33/EC on Energy Performance of Buildings

Directive 2010/33/EC establishes the requirements for improving the energy performance of buildings in the EU by setting a common methodology for calculating the energy performance of buildings and describing minimum requirements for the performance of new and old buildings.

The Directive allows to each Member State to set minimum energy efficiency requirements in relation to the general climatic conditions and their long-term economic return. For this purpose, methodologies are described to calculate the cost optimum levels of minimum energy performance requirements.

In addition, emphasis is put on the study of the installation of alternative high-efficiency systems in new buildings, before the start of their construction (e.g. cogeneration systems, heat pumps, etc.). In existing buildings, the Directive foresees the need to meet the minimum energy performance requirements, when they undergo extensive refurbishments.

The Directive also defines nearly zero-energy buildings (highly energy-efficient buildings). In particular, it stipulates that all new buildings used by public authorities after 31/12/2018 should be nearly zero-energy consumption, and by the end of 2020 all new buildings, regardless of their use, should be nearly zero-energy consumption. In any case, Member States are obliged to draw up national plans to increase the number of nearly zero-energy buildings.

Member States shall compile a list with the existing and proposed measures, including financial incentives, and shall ensure that the list is renewed on a three-year basis. Furthermore, they should establish a system for energy performance certification of buildings. The relevant certificate is necessary for the construction, sale and rental.

Finally, the Directive describes in detail the technical specifications for the inspection of the heating and air conditioning systems, but also the establishment and operation of the independent control system.

The purpose of the PF4EE tool is to fund, through the existing banking system, projects that support the implementation of national action plans improving energy efficiency of Member States through the financial system. At the beginning of 2018, the European Investment Bank allocated a total of €480 million for all Member States[26]. So far investments have taken place in the Czech Republic, Spain, France, Belgium, Italy, Portugal and Germany.

In addition, innovation and related investments in energy management projects are supported by the European Regional Development Fund, Horizon 2020, NER 300, LIFE Climate Action, Eco-innovation program and the Connecting Europe program.

[26] http://www.eib.org/products/blending/pf4ee/index.htm

Graph 2.4: Examples of European pilot projects aiming at improving the energy efficiency and autonomy of buildings

Sources: https://interreg-med.eu/, http://www.smartpvproject.eu/, https://goo.gl/KpY1D9, https://goo.gl/kKstVC

Protecting consumer rights and achieving high safety standards is also an important priority of the 2020 strategy. Creating internal competition-enhancing structures leads to the removal of any barriers faced by consumers when changing their energy supplier.

Another pillar of the strategy concerns the transformation of the European energy system and its support for energy technology and innovation. In this context, the 2020 strategy foresees the implementation of a strategic Energy and Technology plan, related to the development of low-carbon technologies and the increasing their penetration.

Finally, a very important factor is the establishment of good relations between Member States and non-EU energy suppliers (e.g. Norway and Russia), as well as non-EU transport countries (e.g. Ukraine). As the EU's dependence on energy imports is significant, securing mutual relations with energy partners is essential for the competitiveness of European industry and enterprises and thus for the European economy. In addition, experience from the crisis in Ukraine in 2013 has shown that concerted action is needed, at European policy level, to ensure unimpeded and sustainable access to energy. In this context, the 2020 strategy also foresees the entry and participation of countries neighboring to Member States in the internal energy market.

Table 2.1: The key points of the EU Energy Efficiency Directives

Directive on Energy Efficiency (2012/27/EU)	Directive on the energy performance of buildings (2010/31/EU)

• **National energy efficiency action plans** every three years and annual progress reports
• **National policy for buildings renovation**
  • Building stock description
  • Formulation of major policies for promoting renovations
  • Estimation for energy savings from renovations
  • Annually renovation of 3% of the total area of state owned buildings in 2014-2020
• **Compulsory**
  • Energy companies need to achieve annual energy savings of 1.5% of final energy consumption
  • Alternative policy measures (taxes, financial incentives, arrangements, voluntary agreements, education and information, etc.)
• **Public procurement** of energy-efficient buildings, products and services
• **Empowering consumers** with tools that allow for better energy management
• Incentives and obligations for companies to carry out **energy audits**
	• **Establishment of an energy efficiency certification system**
	  • Obligation to issue energy performance certificates in new construction, sales and rental of buildings
	• **Inspection of cooling and heating systems** or measures of equivalent effect
	• **Nearly zero energy consumption** in all new buildings by 31 December 2020 (2018 for public buildings)
	  • Member States are drawing up national plans to increase the number of nearly zero-energy buildings.
	  • These plans may include objectives differentiated according to the category of the building.
	• **Definition of minimum energy performance requirements** for new buildings, large-scale renovations of buildings and reconstruction of building components (ceilings, cooling-heating systems, insulations, etc.)
	• Compilation of a list of **financial incentives and financing tools** for improving energy efficiency of buildings

Text Box 2.2: Key elements of Directive 2012/27/EC

According to the Directive 2012/27/EU, each Member State is required to set an indicative national energy efficiency target for 2020 based on primary or final energy consumption or on primary or final energy savings or on energy intensity. In addition, the directive sets strategies for achieving the 20% energy efficiency target by 2020. Specifically:

i. The EU's overall energy consumption target should not exceed 1.474 mil. toe of primary energy or 1.078 mil. toe of final energy.

ii. Member States are required to adopt a long-term strategy to mobilize investments to renovate the national building stock (housing, commercial buildings, public and private). In particular and as of 1/1/2014, Member States should renovate 3% of the total floor area of the buildings occupied by the central public administration. The renovation must take into account the minimum energy requirements of Directive 2010/31/EU.

iii. Public procurement drives central services purchases for energy-efficient products, services and buildings, provided that this is consistent with economic efficiency and sustainability.

iv. Each Member State shall set up an energy efficiency obligation scheme that ensures that energy distributors and retailers achieve an aggregate saving target, which is set at 1,5% of their annual energy sales volumes to final energy consumers in relation to the average of the last three years before 2013.

v. Member States shall make possible to carry out energy audits for both households and small and medium-sized enterprises, submitted by energy inspectors. For large businesses, the energy audit obligation is set at least once every four years.

vi. Individual meters are available to final consumers of electricity, gas, district heating/cooling and hot water, if this is economically feasible.

vii. In cases that consumers do not have smart meters, Member States shall ensure that pricing information is accurate and based on actual consumption. In addition, final consumers are given access to historical consumption data on demand, while consumers receive their consumption bills free of charge.

viii. In addition, the Directive encourages the implementation of programs aimed at raising households awareness and improving energy use through the adoption of specific measures (e.g. tax incentives, access to loans and subsidies, demonstration projects, etc.)

It is now clear that achieving the long-term energy policy objectives is largely based on improving energy efficiency. In this context, the role of buildings has been recognized, as well as the need to change the design of products in order to operate in conditions of optimal energy efficiency during their life cycle.

In particular, for the building sector, the strategy foresees the introduction of clearer requirements for feasibility studies before constructing new buildings, increasing the integration of high technology (e.g. smart meters, automation, electric vehicle chargers) and improving information of users through the design and implementation of interactive smart systems. These measures are included in the revision of Directive 2010/31/EU which entered into force in July 2018 (2018/844/EU) and provides for:

- Adoption of long-term strategies for the upgrading of buildings of Directive 2012/27/EC on energy efficiency
- Establishing clearer requirements for carrying out feasibility studies before constructing new buildings
- Improvement of provisions for the inspection of heating/cooling systems
- Increase of automation levels
- Promotion of e-mobility systems (e.g. electric vehicle chargers in private and public buildings)
- Renewal of tracking indicators (e.g. Smartness indicator)
- Improving the supply of information to stakeholders (consumers, investors, etc.)

With regard to eco-design, the EU's institutional framework recognizes the need for the industry to study relevant practices as a means of promoting product competitiveness, while reducing the need for energy consumption.

2.3.2 The 2030 framework for the climate and energy

The adoption and implementation of the 2020 policy by the Member States has brought the EU to the right path for reducing greenhouse gases, increasing the use of renewable energy sources and improving energy efficiency compared to 2008 levels. According to Eurostat, in the sector of environmental goods and services, the implementation of the 2020 policy has a direct positive impact on the macroeconomic figures of the European economy, as it has supported the maintenance of over 4.2 million full-time jobs in the environmental industry[27] despite the difficulties of the financial crisis.

A divergence of 2 percentage points from the achievement of the targets[28] is expected in 2020. Therefore, more efforts are necessary, notably at the implementation level of the existing legislative framework by the Member States. In particular, it is necessary to strengthen the implementation of the directives on energy efficiency and energy efficiency of buildings and to expand the implementation of regulations on energy efficiency of products. Also, to link energy policy with EU economic growth is necessary to limit uncertainty among investors and other stakeholders of the broader energy sector[29]. In this context, the 2030 strategy was based on the experience of implementing the 2020 strategy, setting even more ambitious targets for the year 2030.

More specifically, the quantitative targets of the 2030 strategy are:

- Reduction of greenhouse gases by 40% compared to 1990 levels
- At least 32% of the energy consumed should derive from renewable sources
- Energy savings of 32.5% compared to the business as usual scenario[30]

The first legislative initiative under way in the field of energy and climate policy was the amendment of the Energy Savings Directive in buildings (2018/844/EU), as mentioned in the previous section.

The 2030 policy sets the foundations for simplifying the energy consumption calculations. This affects positively final consumers, who are able to easily quantify their consumption, assessing the sustainability of possible investments. It also supports decision making priorities of policy makers of the Member States. It also revises the requirements for Member States 'annual reports on the achievement of energy saving targets, while the Member States' national action plans should have been prepared before 2020 in order to have the necessary time to select specific and effective actions for the period 2020-2030.

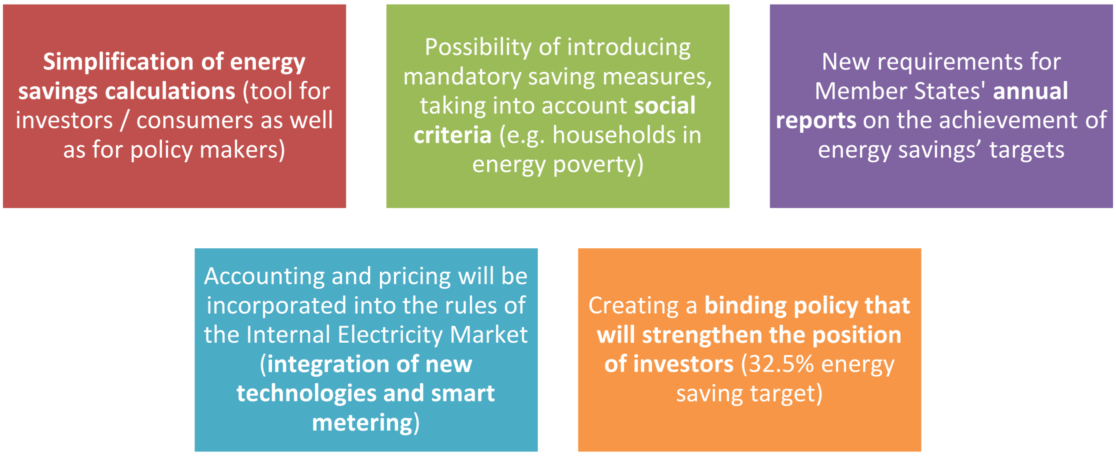
[27] The environmental industry includes all sectors that the main or a significant part of their main activity is aimed at developing and producing products and services that record, prevent, limit or correct the results of anthropogenic effects on the natural environment, and in particular on water, air and soil (OECD, 1994)

[28] https://ec.europa.eu/energy/sites/ener/files/documents/2014_eec_ia_adopted_part1_0.pdf

[29] https: //ec.europa.eu/energy/sites/ener/files/documents/20130702_green_paper_2030_consulation_results__0.pdf

[30] In November 2016, the European Commission proposed a revision of the Energy Efficiency Directive (EED) as part of the clean energy package. The purpose of the revision is to adapt the EED to 2030 by setting a 30% binding target for energy efficiency. The Commission has also proposed simplifying parts of the text in order to facilitate implementation at national level. In June 2018, the European Commission, the European Parliament and the European Council reached agreement on adopting an EU energy saving target of 32.5% (compared to the projected trend) with an upward trend for the revision in 2023.

Graph 2.5: Elements of the new energy efficiency policy framework towards 2030



Source: European Commission.

2.4 Progress towards achieving the EU's energy efficiency target

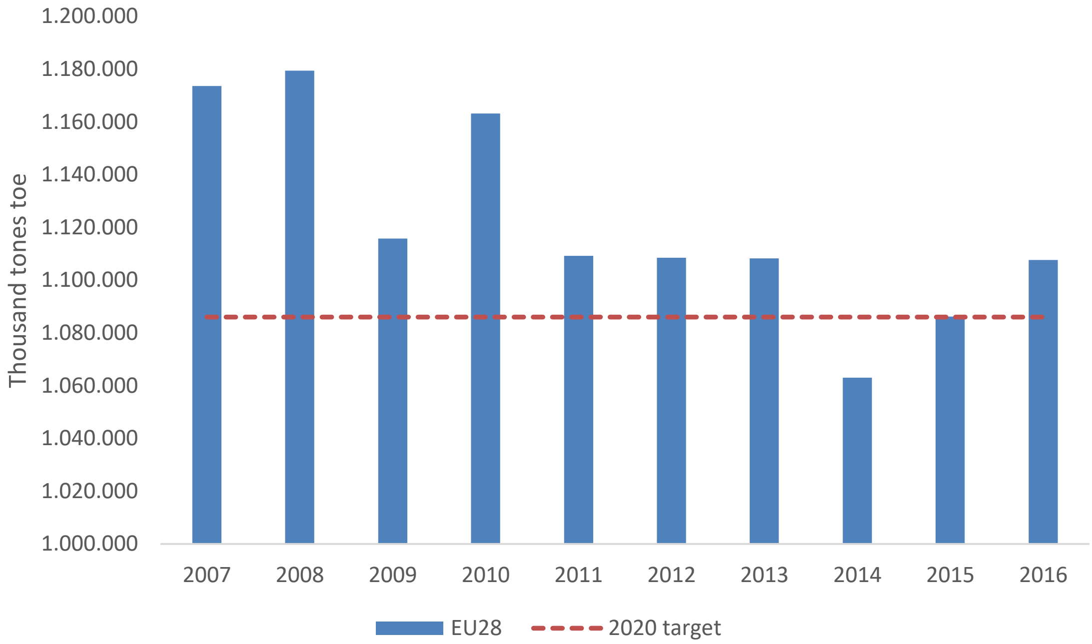
In 2016, the year with the most recent energy data available, primary energy consumption at the EU level increased in relation to the previous year, mainly due to the worst weather conditions and the strengthening of the economic growth rate. As a result, the distance from the primary energy consumption target for 2020 reached 4 percentage points. Similarly, final energy consumption was 2 percentage points above the target (1.108 Mtoe) (Graph 2.6)[31]. However, there are strong indications of decoupling economic growth from energy consumption, especially after 2008, as a result of energy efficiency policies (Graph 2.7)[32].

The contribution of the residential sector in the achievement of the European energy saving targets results from the study of energy consumption figures for European households for the period 2000-2015. Looking at the relevant data, it appears that energy-saving actions offset the impact of the increase in consumption (Graph 2.9).

[31]http://ec.europa.eu/eurostat/documents/2995521/8643581/8-05022018-BP-EN.pdf/1338cf55-5c91-4179-a6ca-808675e40bbd

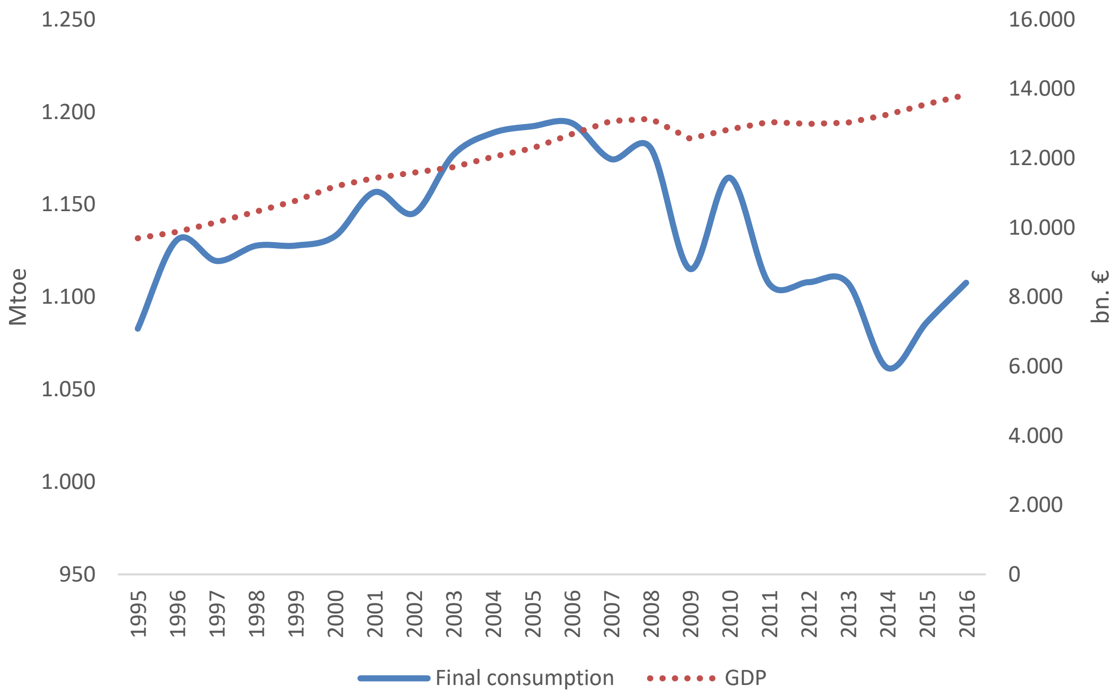
[32] https://ec.europa.eu/energy/sites/ener/files/documents/2014_eec_communication_adopted_0.pdf

Graph 2.6: Final Energy Consumption in the EU28



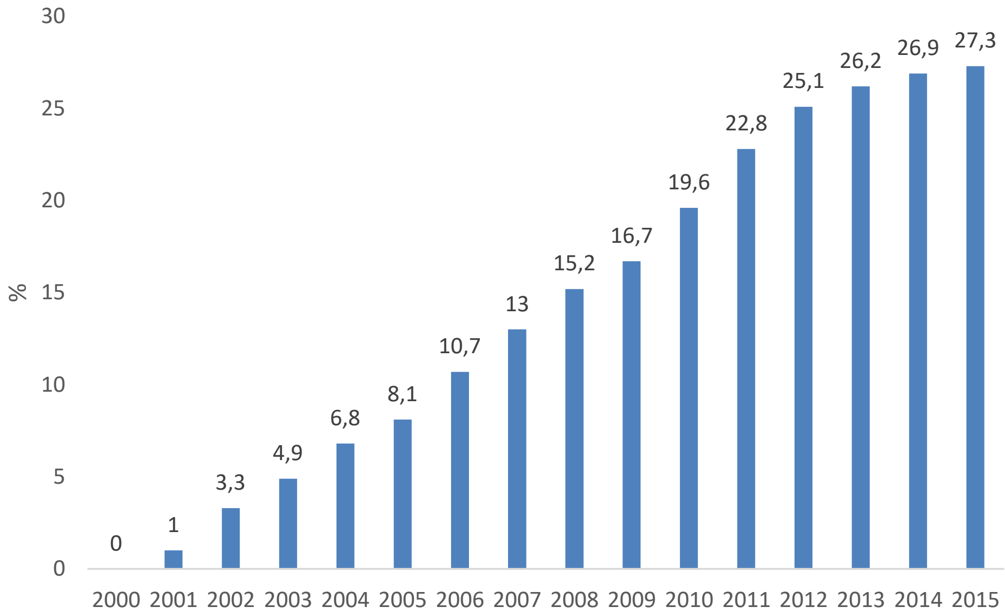
Source: Eurostat.

Graph 2.7: Relation between GDP and final energy consumption, EU28



Source: Eurostat.

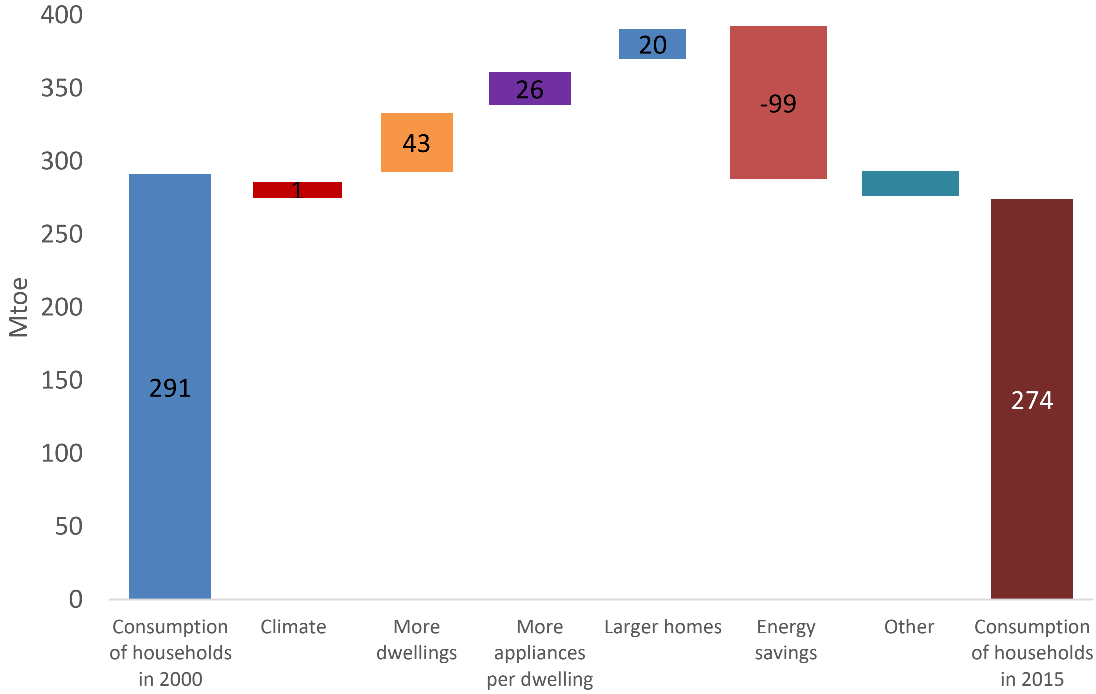
Graph 2.8: Benefits of improving energy efficiency in the residential sector in the EU28



Source: Odyssee-Mure.

In total, household energy consumption in the EU was lower in 2015 compared to 2000. Factors such as more and larger houses, as well as the largest number of electrical appliances per house, are estimated to have boosted energy consumption (Graph 2.9). However, energy savings were remarkable and ultimately reduced household energy consumption.

Graph 2.9: Analysis of household energy consumption change, EU28



Source: Odyssee-Mure.

3. ENERGY EFFICIENCY IN GREEK BUILDINGS IN GREECE: CURRENT SITUATION

3.1 The national legislation

The EU Energy and Climate policies for 2020 and 2030 set out the broader framework and calls on the Member States for implementing policies and actions to support the achievement of the foreseen objectives. In Greece, the basic legislation on energy efficiency includes: a) Law 3855/2010, "Measures to improve energy end-use efficiency, energy services and other provisions", which is the harmonization with the Directive 2006/32/EU and b) Law 4342/2015 "Energy efficiency, amending Directives 2009/125/ EC and 2010/30/ EU and repealing Directives 2004/8/EC and 2006/32/EC".

In March 2018, in line with Directive 2012/27/EU, the fourth National Energy Efficiency Action Plan (NEEAP)[33] was adopted. The NEEAP includes measures and actions in all areas of final energy consumption. Taking into account the energy needs of Greece, the national indicative quantitative energy saving target and other macroeconomic parameters, the NEEAP assesses the energy savings targets, the required budget and the necessary sources of funding for the implementation of relevant actions to support the improvement of energy efficiency and limiting energy consumption. It is essentially a national policy tool for monitoring the course of Greece, which is presented and approved by the European Commission.

The third NEEAP, adopted in December 2015, set the strategy for reaching the 2020 targets. The plan outlines all the methodological parameters taken into account for assessing the target of energy efficiency, final energy consumption and overall energy savings. To improve the efficiency of buildings, the NEEAP described specific actions related to electricity consumption for lighting and cooling/heating.

More specifically, the overall energy savings target for the period 2014-2020 is 3,332.7 ktoe (33.8 TWh), which have been allocated over the periods 2016-2018 and 2019-2020 (19.5 TWh and 15.8 TWh respectively). The NEEAP describes specific projects and measures that create the necessary structures to achieve the targets. These concern the monitoring and support of the pilot implementation of energy efficiency improvement projects in public buildings, the creation of an information system to monitor the improvement of energy efficiency, the financial support of technological investments in energy saving and research, the implementation of tax exemptions for energy saving interventions, development of an energy management system in the public sector and so on.

Achieving the national strategy goals is also supported by the implementation of selected policy alternatives outlined in the NEEAP and is expected to deliver energy savings of around 902 ktoe. Of these, 600 ktoe derived from upgrades to buildings and households through programs such as "Home Saving – Εξοικονομώ Κατ’ Οίκων" (70 thousand households).

[33] There were three National Energy Efficiency Action Plans (NEEAPs) in 2008, 2011 and 2014 that mapped the situation in Greece and proposed targets for energy savings and final consumption for 2010, 2016 and 2020 respectively. In addition, they examined practices of high value added for implementing measures that would lead to the achievement of the selected energy savings targets.

Table 3.1: Energy consumption and national energy efficiency targets

	2007	*2009*	*2011*	*2015*	*2020**	*Target difference by 2007*
Gross Domestic Energy Consumption (Mtoe)	*31,5*	*30,5*	*27,8*	*24,4*	*25,4*	*-19%*
Primary Energy Consumption (Mtoe)	*30,7*	*29,6*	*26,9*	*23,7*	*24,7*	*-20%*
Total final energy consumption (Mtoe)	*22,1*	*20,5*	*18,9*	*16,5*	*18,4*	*-17%*

***(Indicative national target in the framework of Directive 2012/27/EE)**

Source: National Action Plan for Energy Efficiency, 2015 και 2018.

The new "Home Saving II" program, which was launched in March 2018 and is funded by the National Strategic Reference Framework (NSRF) 2014-2020, is expected to support the achievement of further energy saving targets in households.

In addition, the NEEAP provides the implementation of an energy management system in 4,000 buildings, the broader energy upgrading of residential and commercial buildings, and more actions to educate and raise citizens' awareness on energy efficiency improvements and reducing energy consumption.

Achieving national targets in the building sector requires, under the 2010/31/EU Directive, an annual renovation of at least 1.5% of the building stock by 2020 and around 4% by 2050. In addition, a renovation is required for about 120 thousand m^2 of buildings occupied by public utilities per year by 2020. By 2050 all buildings must have zero or minimal energy consumption combined with maximum RES utilization.

In particular for public buildings, the Ministry of the Environment and Energy published a list of 82 heated/cooled buildings of the central public administration with a useful area of more than 500m^2, which will be subject to extensive renovations in line with the relevant directive. The implementation of the "Home Saving I & II" programs in public buildings has contributed to energy savings of 2,500 ktoe and a reduction in CO_2 emissions of 10.1 thousand tons per year. According to the new NEEAP (March 2018), the strategy for the renovation of public buildings is being updated, while a dedicated platform for recording and managing the energy features of public buildings is planned; this is expected to be operational in 2018.

The update of the Greek Building Energy Efficiency Regulation (KENAK) to the standards of European and national energy efficiency policy is one of the key policy measures for the renovation of the Greek building stock and the introduction of specifications for the construction of new buildings. The new KENAK, replacing the previous 2010 edition, was published in July 2017. Its implementation started on 27/11/2017, following the approval of the technical instructions of the Technical Chamber of Greece (ΦΕΚ Β 4003/17.11.2017). The delay in publishing and implementing has led to corresponding delays in the implementation of NSRF programs that are related to energy (the "Home Saving" program).

Table 3.2: Horizontal policy measures and policy measures to renovate buildings

Horizontal Policy Measures (2014 – 2024)	Further Policy Measures for buildings renovation	Further Policy Measures for public buildings renovation
Home Saving	Building Energy Efficiency Regulation (since 2010)	Integrated Design of Local Authorities and covenant of mayors (since 2009)
Home Saving I & II to local authorities	Mandatory installation of solar thermal systems in new households (since 2011)	Energy saving interventions in public buildings (from 2010)
Energy upgrading of households	Energy upgrading of social housing (from 2011)	Energy efficiency improvement in school buildings (from 2011)
Energy upgrading of public buildings (from 2011)	Mandatory installation of solar thermal systems in tertiary buildings (since 2011)	Mandatory replacement of all low energy efficiency bulbs in the public sector (since 2006)
Implementation of the ISO5001 system in the public sector	Aid to small and medium-sized enterprises in manufacturing, tourism, commerce, services (since 2013)	Energy managers in public and broader public sectors' buildings (from 2014)
Energy upgrading to commercial buildings through Energy Services Business		Energy upgrading of public buildings (since 2018)
Education and training actions		Portfolio Fund under the name "Infrastructure Fund" - Projects for the Energy Upgrading of Public Buildings (since 2018)
Development of smart energy measurement systems		

Source: NEEAP 2015 και 2018.

Text Box 3.1: The new "Home Saving II" program

In February 2018, a joint ministerial decision was signed on the new "Home Saving" program, which is expected to subsidize with € 250 million interventions of €500 million in energy saving (available from the NSRF 2014-2020). In the new program, the co-funding rate is shaped according to social and income criteria, based on 7 income categories. In any case, the budget of each application may not exceed €25 thousand, including VAT.

Interventions include the replacement of window frames, the installation of shading systems, the installation of thermal insulation in the building shell, the upgrade of the heating and hot water systems.

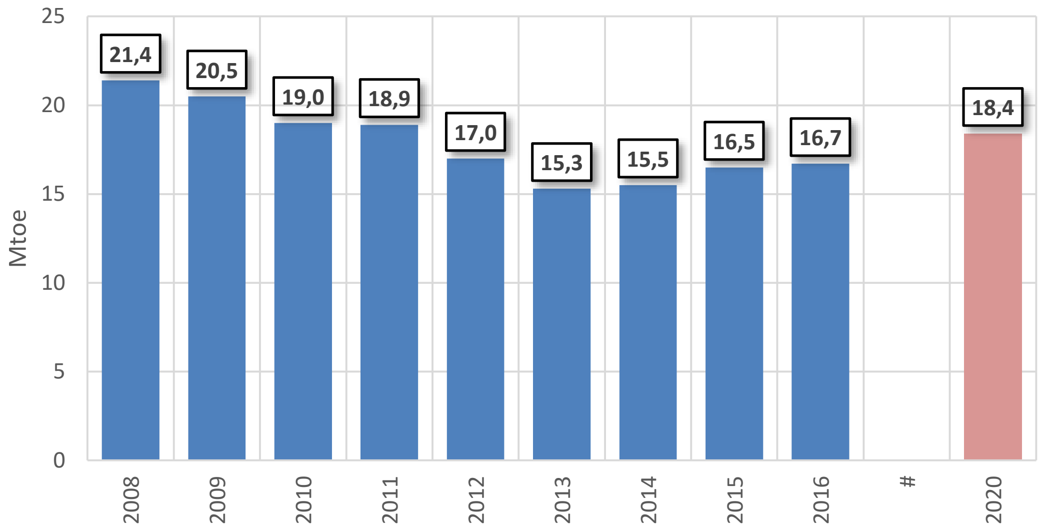
Individual Income	Family Income	% of subsidy	Increase of subsidy per each protected member	Maximum % of subsidy
~ €10.000	~ €20.000	60	5	70
€10.000-€15.000	€20.000 - €25.000	50	5	70
€15.000 - €20.000	€25.000 - €30.000	40	5	70
€20.000 - €25.000	€30.000 - €35.000	35	5	70
€25.000 - €30.000	€35.000 - €40.000	30	5	50
€30.000 - €35.000	€40.000 - €45.000	25	5	50
€35.000 - €40.000	€45.000 - €50.000	0	0	0

3.2 Overview of the current situation in Greece

Total final energy consumption in Greece was reduced in the period 2008-2013, but since then, it exhibits an upward trend (Graph 3.1). In 2016, final energy consumption was lower than in 2008, but this appears increased in the 2013-2015 period. It is worth noting that in contrast to the EU, Greece is experiencing very little decoupling between energy consumption and economic activity (Graph 3.2). These two figures evolve in parallel during the first period of the economic recession (2008-2013), when GDP was reduced by 26.3% and final energy consumption by 28.5%. Subsequently, in the 2014-2016 period, the loss of domestic product is slowing down (-0.5%), while final energy consumption is rising by about 8%.

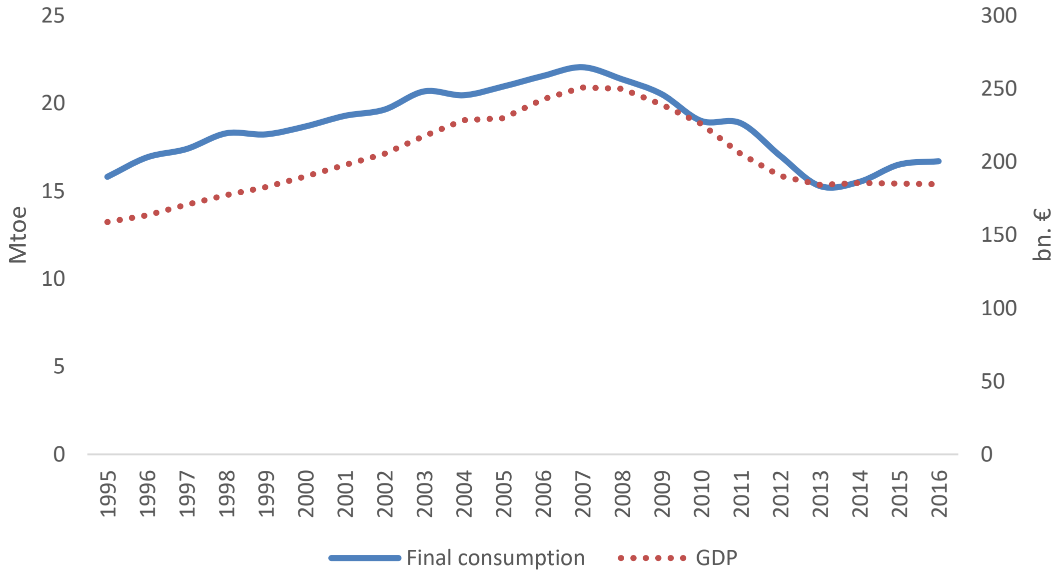
By examining the composition of final energy consumption per sector in Greece over time, a decline in demand in all sectors from the beginning of the economic crisis (2008) to 2013 is evident (Graph 3.3). Since then, consumption has increased slightly, but remained at lower levels compared to the 2000-2008 period. Transport is the sector with the highest energy consumption - about 40% of final energy consumption in Greece for the period 2010 to 2016 (Graph 3.4). The household and services sectors follow, accounting for about 37% of final energy consumption. The reduction of the households' disposable income and the significant decline in turnover of services led to a reduction of their annual consumption, which was more intense during the period 2010-2013.

Graph 3.1: Final energy consumption, Greece



Source: Eurostat.

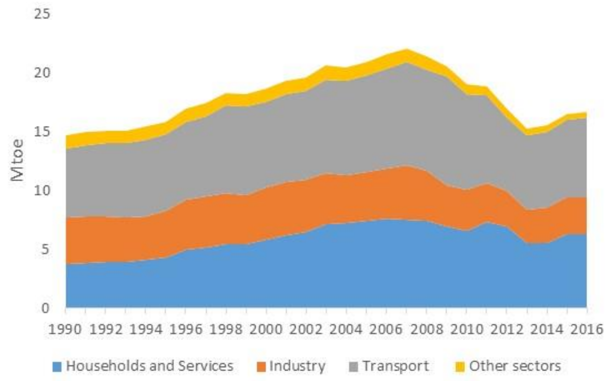
Graph 3.2: Final energy consumption (left-hand axis) and GDP (right-hand axis), Greece



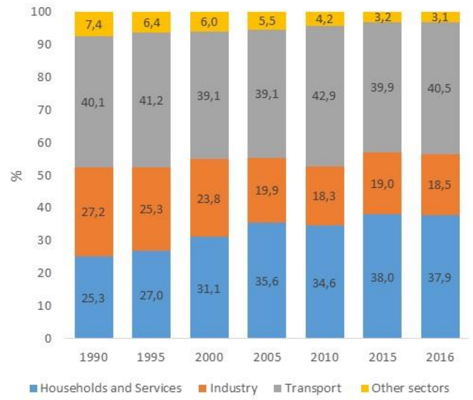
Source: Eurostat.

In the next years, the domestic sector increased significantly its share of energy consumption, which was close to 38%. Manufacturing, where the impact of the economic crisis was stronger during the period 2010-2013, ranked third (18.5% of total of final consumption but well below the domestic sector), with the consumption being reduced at an average annual rate 5.0%. Finally, the rest of the sectors (primary, constructions, etc.) were significantly limited during the study period, resulting in only 3.1% of the final energy consumption.

Graph 3.3: Final energy consumption by sector (in Mtoe), Greece



Graph 3.4: Structure of final energy consumption by sector (%), Greece



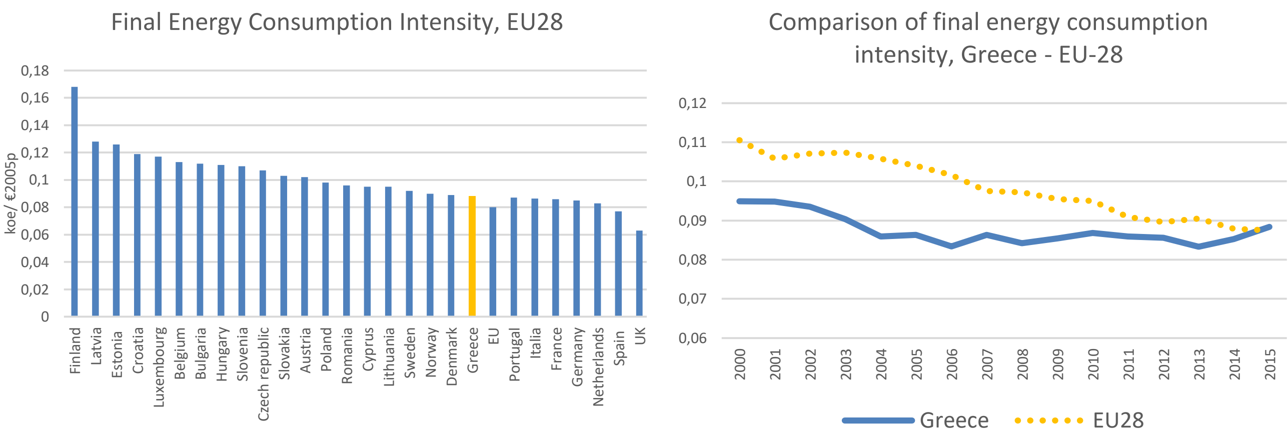
Source: Eurostat.

In the ranking of the final energy intensity index[34] for the year 2015, Greece is close to the European average and eleventh among the 28 EU Member States (Graph 3.5). However, the review of the relevant indicator over time shows a significant lag from the European average with almost a constant performance in the period 2000-2015. In addition, from 2013 onwards, the relevant index for Greece exhibits an increasing trend, whereas the EU average is decreasing. This performance can be related to the low implementation rates of energy efficiency measures implemented in Greece, in comparison to the achievement of targets the other EU Member States.

A more detailed analysis of the household sector, a sector with an extremely important role in achieving national policy goals, depicts that Greece has not exploited all the potential benefits associated with improving energy efficiency, so far. In particular, the rate of improvement in energy efficiency in Greece was significantly below that of the EU until 2010. After that, there are some indications of convergence and energy efficiency in Greek households seems to be stable with some increasing trends, mainly during the 2013-2015 period. However, according to data related to the existing situation of the building stock presented in the next section, there are indications that the reduction in energy consumption achieved to date is more related to the reduction in energy demand and less to the implementation of energy upgrade systems for households (Graph 3.7).

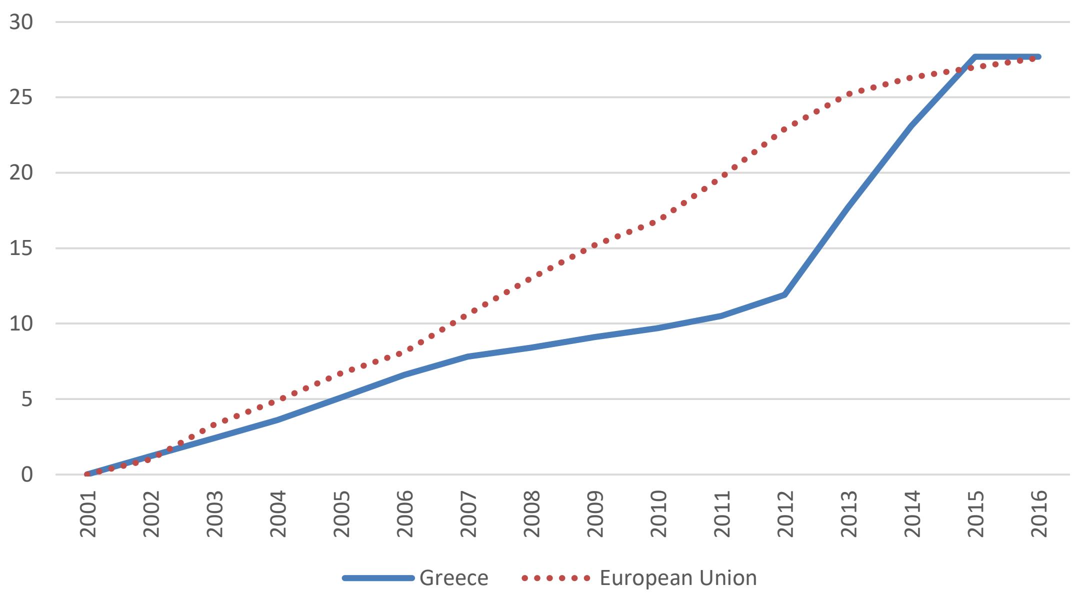
[34] The energy intensity ratio correlates the magnitude of energy needs with a country's GDP. Higher index values are associated with high demand for energy for a particular production and low energy efficiency rates.

Graph 3.5: Final energy consumption intensity, EU28, 2015 and comparison of Greece with EU-28



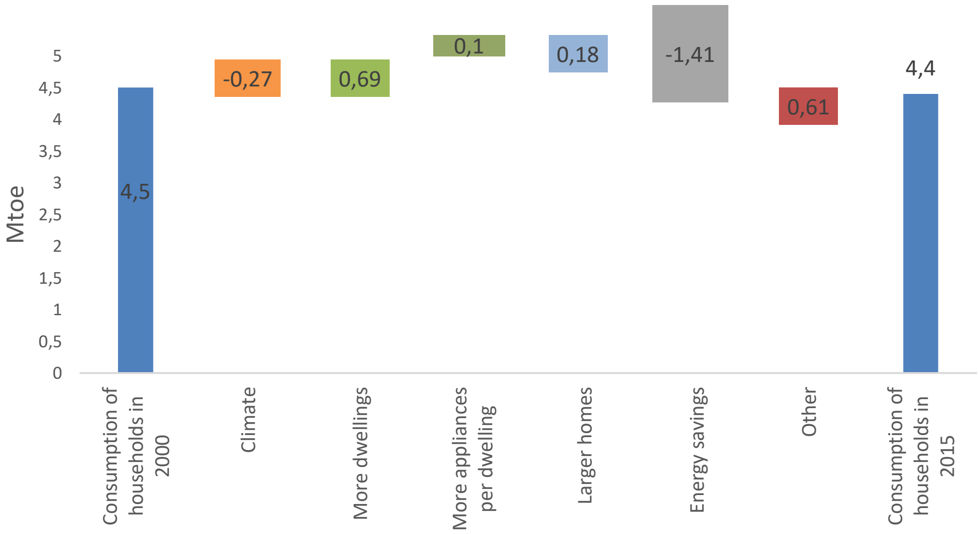
Source: Odyssee-Mure, H2020.

Graph 3.6: Comparison of energy efficiency in households, Greece - EU28



Source: Odyssee-Mure, H2020.

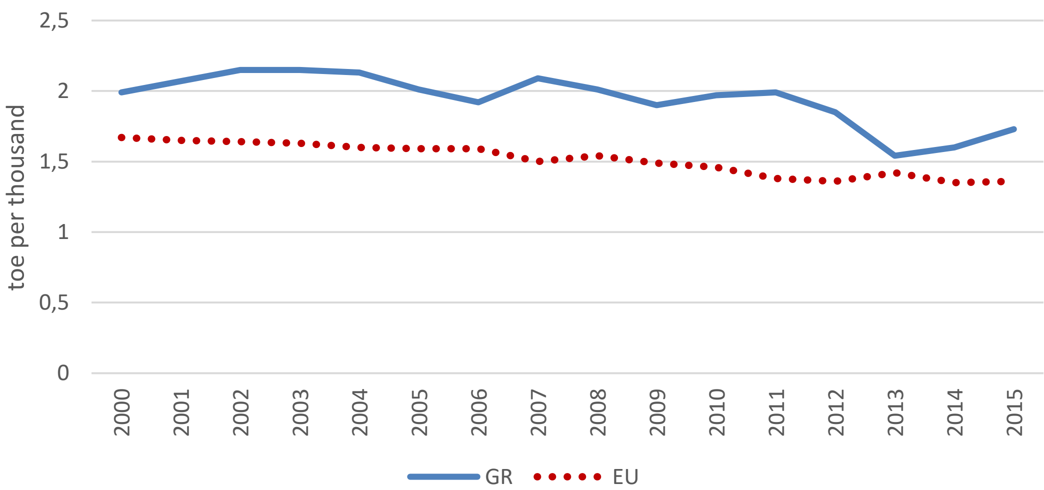
Graph 3.7: Analysis of energy consumption change in households, Greece 2000-2015



Source: Odyssee-Mure, H2020.

The ineffective implementation of energy saving policies in households is also evident in the comparison of consumption figures after EU climate adaptation. Greek households consistently consume more energy compared to the EU average, with a difference between 8.4% and 35% in the period 2000-2015. It is noted in recent years the gap between Greek and European households is growing again (Graph 3.8).

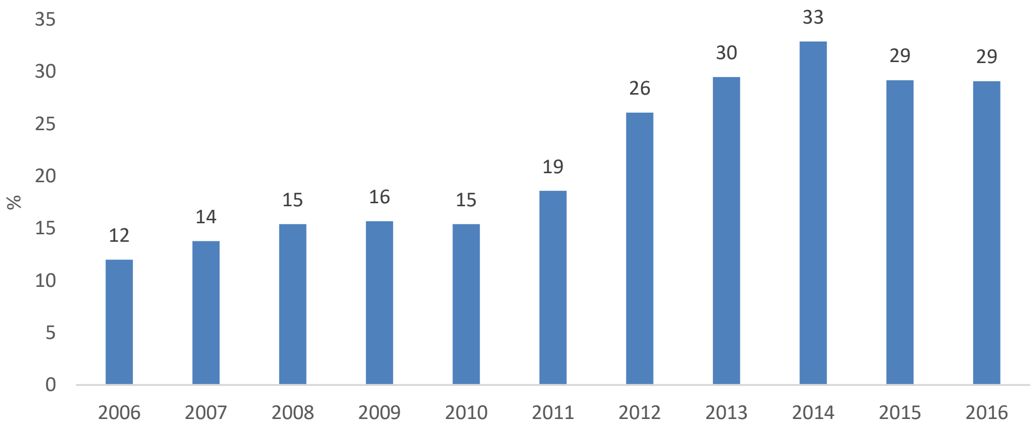
Graph 3.8: Energy consumption per household, data adjusted to climate



Source: Odyssee-Mure, H2020.

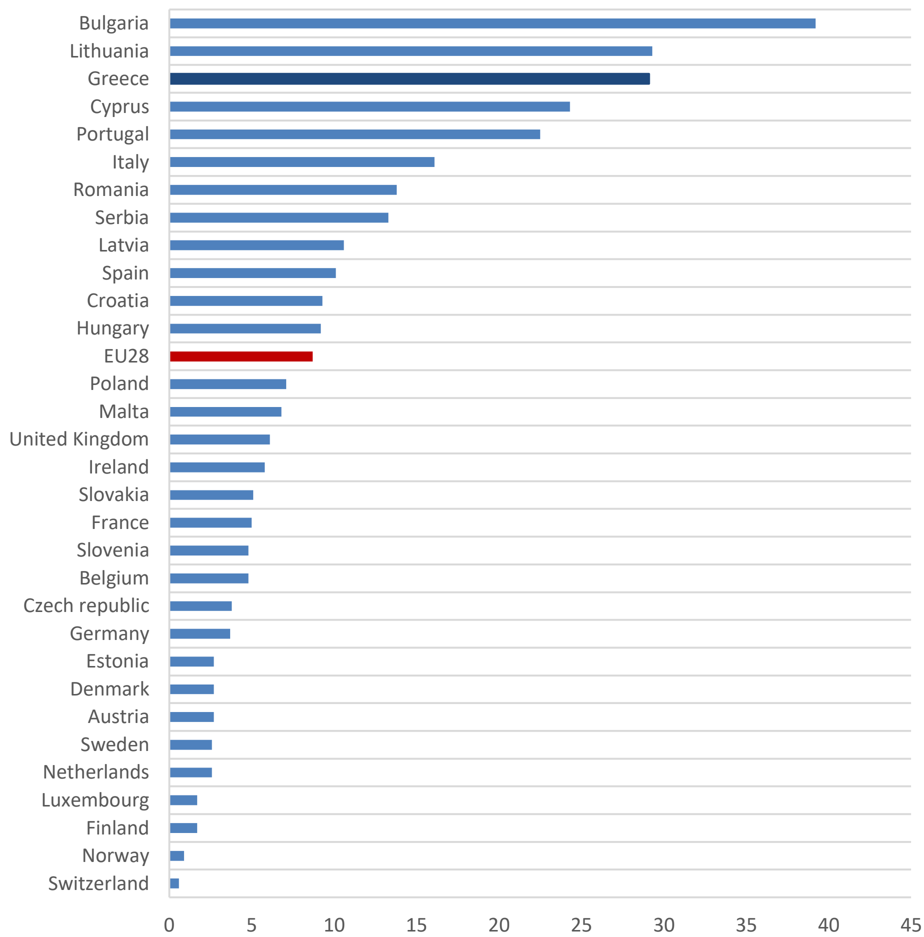
The lag in improving energy efficiency is also linked to socio-economic factors. The long-lasting economic crisis, which significantly affected the household disposable income and consequently investments in energy upgrading measures, led to a significant increase in the proportion of households that were not adequately heated. Indicatively, Greece ranks 3rd among the countries with the highest percentage of households without access to adequate heating, following Bulgaria and Lithuania (2016), and is significantly below the European average. As a result, the role of improving energy efficiency is even more important as it leads to meeting the heating needs, using less energy and therefore reducing the household expenditure.

Graph 3.9: Percentage of population with inadequate heating in Greece



Source: Eurostat.

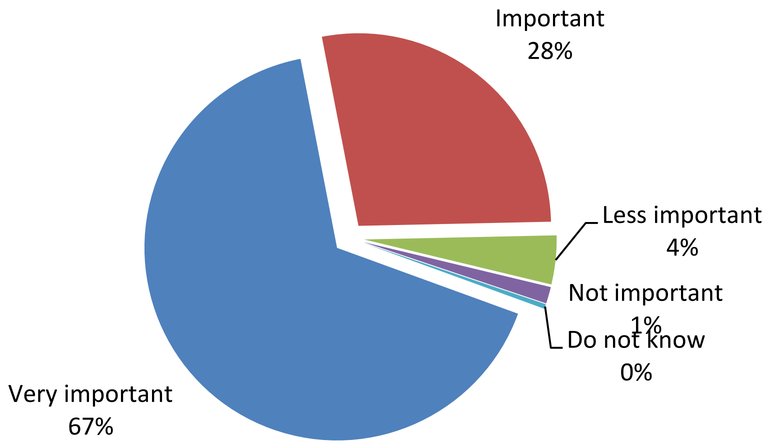
Graph 3.10: Percentage of population with inadequate heating, EU28, 2016



Source: Eurostat.

According to a survey carried out by IOBE among Greek households in 2012[35], most of them are significantly affected by high energy prices and therefore consider energy saving to be very significant (Graph 3.11).

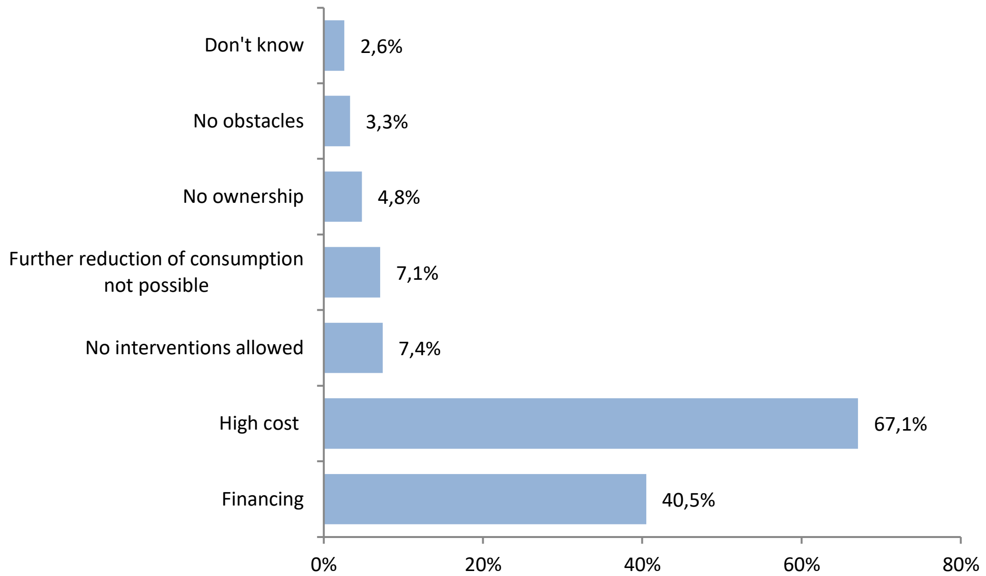
Graph 3.11: Significance of energy savings for Greek households



Source: IOBE, 2012

However, the high cost of interventions (Graph 3.12) is recognized as the most important limiting factor for energy saving interventions in households, as noted by 67.1% of respondents in the sample. The second limiting factor is related to the limited funding, since 40.5% of the sample, are not in a position to implement energy saving interventions.

Graph 3.12: Obstacles to the implementation of energy saving interventions in households



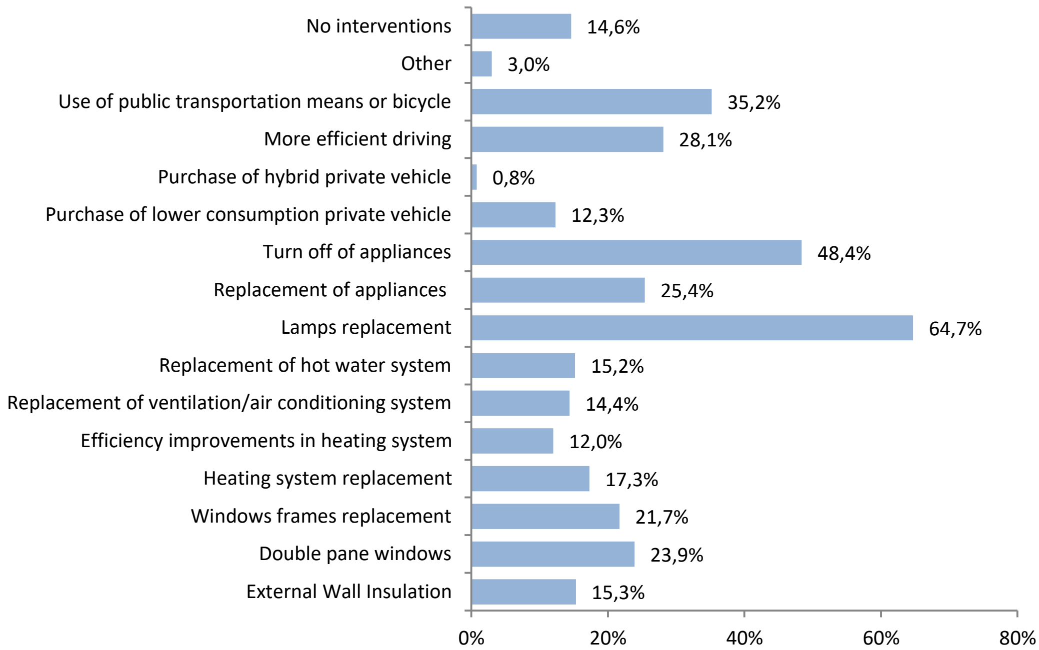
Source: IOBE, 2012.

[35] Presentation of the current situation regarding the use of energy by final consumers and the potential of energy saving in Greece, IOBE 2012

In the same survey, just 7.1% of respondents mentioned that all necessary measures have already been taken to save energy within the household and therefore there is no possibility of further reducing energy consumption. This finding reinforces the view that there is considerable untapped potential in the residential building sector.

Among households that have already implemented energy-saving interventions, most (24%) have installed double pane windows and (22%) have replaced window frames (Graph 3.13). Fewer (15%) have insulated the outer shell and improved the heating system (12%).

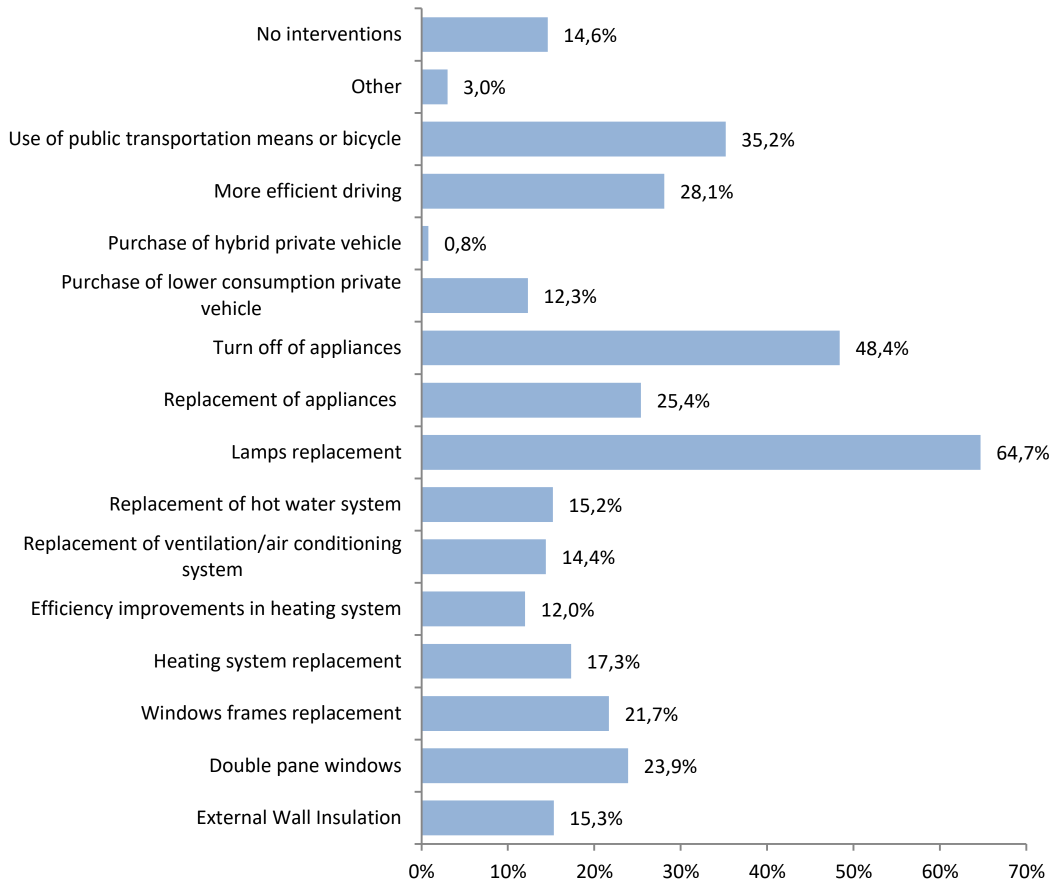
Graph 3.13: Interventions carried out over the last 3 years in households



Source: IOBE

A characteristic of household's inertia that was intensified by the economic crisis and the reduction in disposable income, is the fact that while most households (83%) recognize the need for energy saving interventions, the overwhelming majority (72%) say they do not intend to implement any action for the energy upgrading of their home (Graph 3.14).

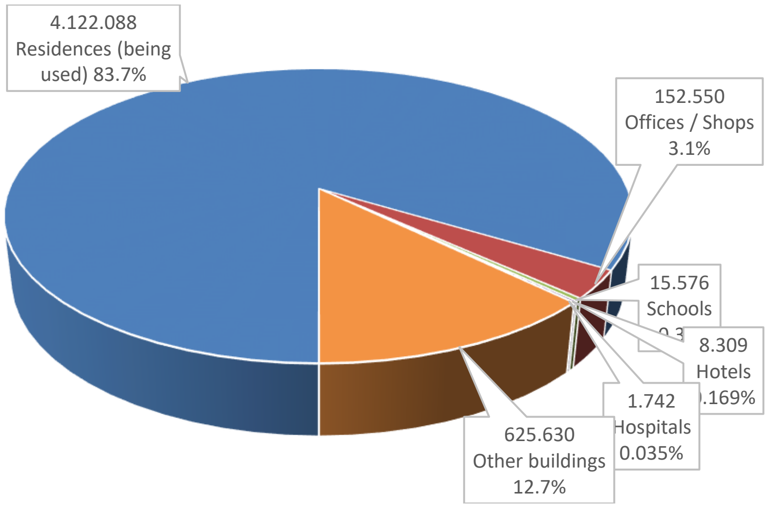
Graph 3.14: The type of intervention that households plan to implement



Source: IOBE

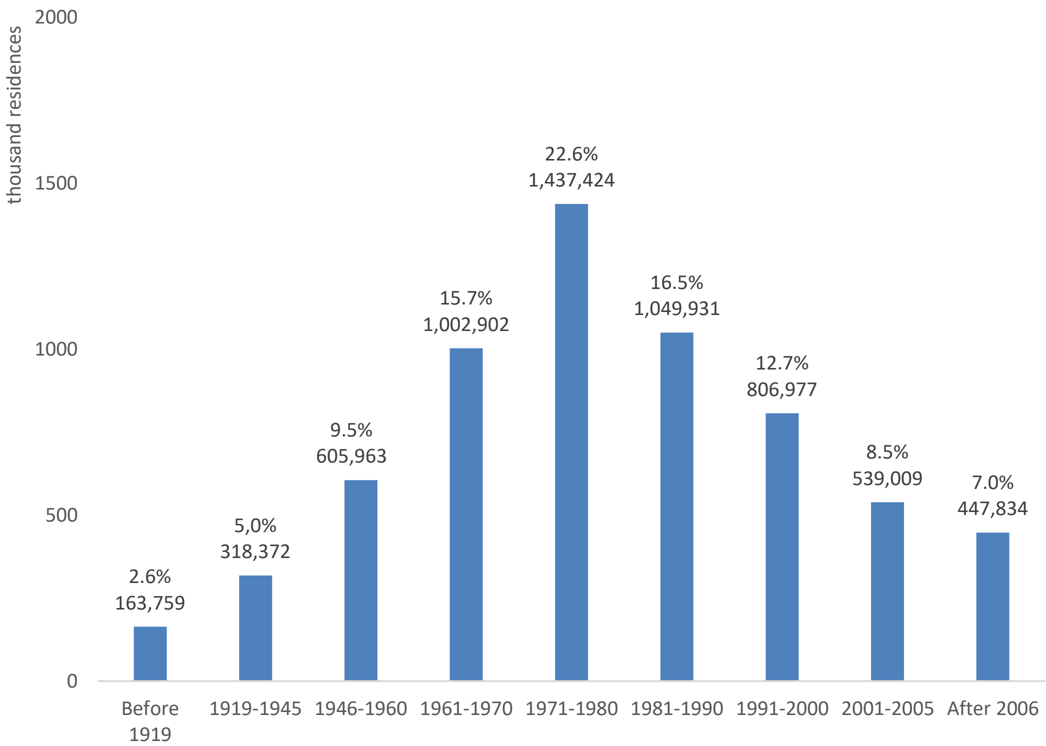
Considering the particular characteristics of the Greek building stock and especially of the households, it emerges that the need for effective implementation of the national policy and energy upgrading is intense. Indicatively, housing accounts for 83.7% of the 4.9 million available buildings in the country, according to the latest building inventory conducted in 2011 (Graph 3.15). The majority of households (55%) were built before 1980, when the requirements for heat insulation were non-existent. Consequently, it is not surprising that about half of the houses (3 million) have absolutely no thermal insulation (Graph 3.16). As the minimum requirements for thermal insulation of new homes improve over time, newer buildings exhibit better energy efficiency (Graph 3.17). Thus, some 3.4 million households have some kind of insulation, only 86 thousand of which have integrated systems including double glass panes, insulation of exterior walls and other measures.

Graph 3.15: Number and composition of buildings, 2011



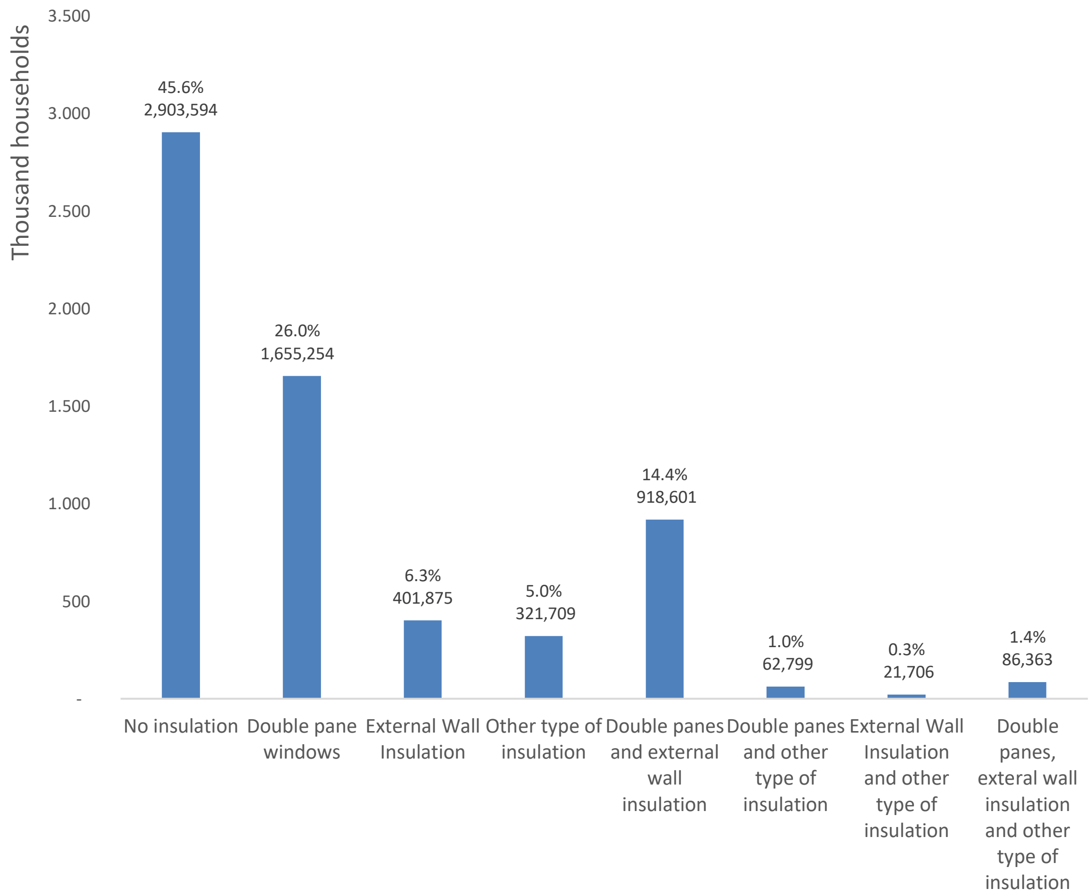
Source: Ministry of Energy, Environment and Climate Change - Report of a long-term strategy for the mobilization of investments for the renovation of residential and commercial buildings, public and private, national building stock, December 2012, See Ministerial Decision announced in the national gazette B 3004, 31-12-2015.

Graph 3.16: Households built by construction period



Source: ELSTAT - Population - housing census 2011.

Graph 3.17: Households by insulation category



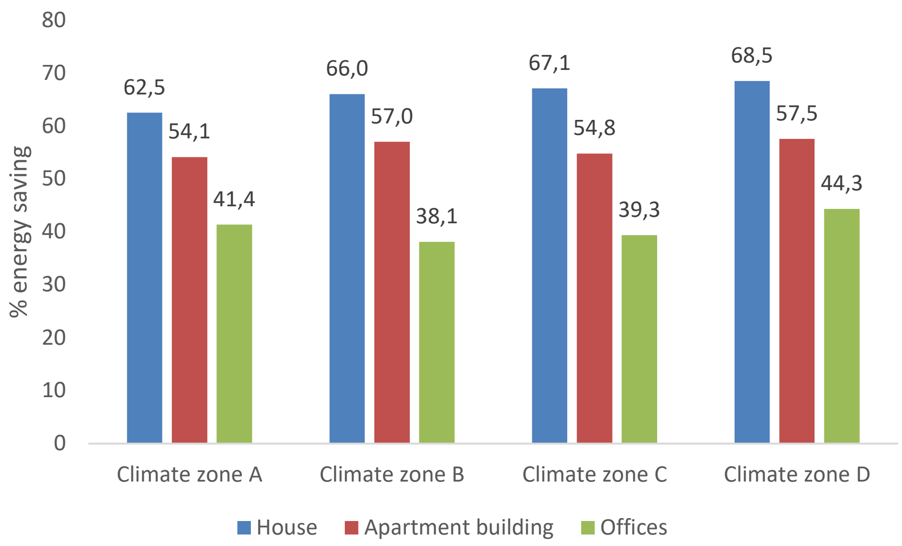
Source: ELSTAT - Population - housing census2011.

The low performance in the field of energy efficiency is also underlined in the Annual Energy Performance Report for Buildings of the Ministry of Environment and Energy[36], where it is noted that most of the buildings inspected in 2017 (59.7%) are classified in the lower energy classes (E- H). On the contrary, only 2.7% of the buildings were classified in the highest categories (A-B), while 37.6% are in categories (C-D). When examining residential buildings, it appears that 66.8% is classified to low categories (E-H), 20.6% to medium (C-D) and only 2.5% to high (A-B). According to the annual reports for the period 2015-2017, there are no significant changes in the classification of residential buildings at any energy class level.

As a result, it is evident that since the majority of residential buildings belong to medium and low energy classes (97.4%), the adoption of energy upgrading measures is expected to have a significant positive effect on the achievement of national energy efficiency targets. To that point, the lag between the energy efficiency of buildings inspected until 2017 and the energy efficiency resulting from the full implementation of KENAK specifications is very high (Graph 3.18). Depending on the type of building and the climate zone, it would be possible to consume 38% to 68% less energy, a figure that also depicts the high energy savings potential of buildings in Greece.

[36] Building Energy Performance Certificates: Statistical analysis for 2017, YPEN

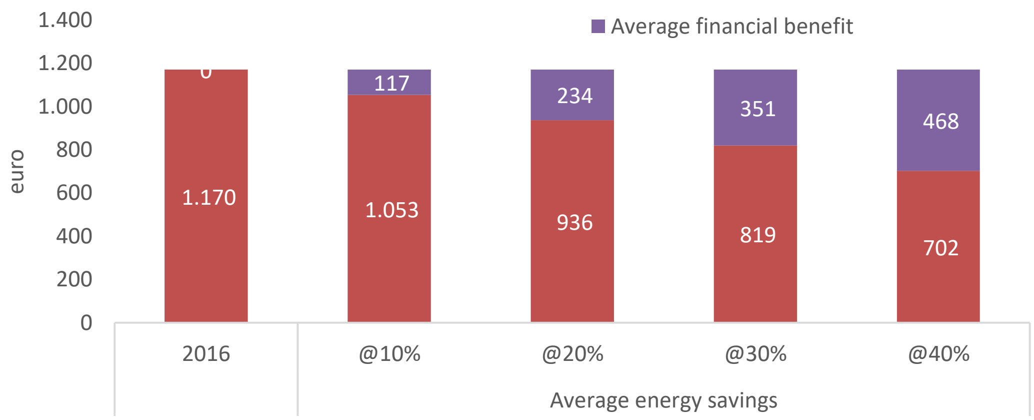
Graph 3.18: Percentage of energy savings by applying the KENAK specifications by building type and climate zone



Source: Building Energy Performance Certificates: Statistical analysis for 2017, YPEN.

The reduction of energy bills for households, depending on the percentage of energy savings, can be particularly significant on an annual basis (Graph 3.19). Indicatively, for an average household that spent €1,170 on the purchase of energy products in 2016[37], 40% energy savings mean a reduction in energy expenditure of €468 per year.

Graph 3.19: Average energy expenditure per household for different energy savings rates



Source: Analysis IOBE.

Providing incentives for the upgrading of households and other buildings can contribute significantly in improving energy efficiency. The implementation of the "Home Saving" program, by June 2016, resulted to 52,000 funding applications, of which 83% replaced window frames and 54% installed thermal insulation. The new “Home Saving II” program (see

[37] Elements of ELSTAT, Family Budget Survey

Text Box 3.1), which was launched in February 2018, is expected to boost the implementation of energy efficiency improvement measures on about 13 thousand households.

However, is underlined that the implementation of the energy strategy is a major challenge. Despite the undeniable benefits, energy upgrading requires a high initial investment from the households for a benefit that is expected to return gradually over a period of time[38]. Taking into account the reduction in disposable income due to the economic crisis, sourcing the initial investment capital is a challenge for the most of the Greek households. The involvement of financial institutions and the provision of bank loans to households, as part of the "Home Saving II" program, are positively evaluated. However, it is necessary to keep track of the progress of the implementation of the program and the intensity of specific actions in order to maximize the untapped potential in residential buildings.

[38] Energy efficiency: A compelling global resource, McKinsey, 2010

4. ECONOMIC EFFECTS FROM THE IMPLEMENTATION OF ENERGY SAVINGS MEASURES IN BUILDINGS

4.1 Introduction

This chapter presents the calculation of the economic impact of a series of interventions to save energy in buildings. In particular, the economic impacts of the four scenarios of energy upgrading interventions on buildings, proposed in the most recent study by the Ministry of Energy for the enhancement of the energy efficiency of buildings in Greece, are being examined[39]. Three scenarios are under consideration concerning energy upgrading interventions in households and a scenario of such interventions in tertiary sector buildings. For each of these scenarios of energy upgrading interventions, the respective subsequent effects on the Greek economy are calculated on an annual basis for the period 2018-2030. In particular, the contribution of the implementation of each scenario to the increase in Greece's Gross Domestic Product (GDP), the stimulation of employment and the increase of government revenue from taxes and social security contributions are calculated. The analysis identifies both the direct effects on the Greek economy of the implementation of each scenario and the subsequent economic effects that arise through the interactions of the energy upgrading activities of buildings with the various sectors of the Greek economy. For each scenario, the net effects of scenario implementation on the economy are estimated, identifying the economic benefits of increasing investment in energy upgrading of buildings, while taking into account the negative economic effects of lower final spending on energy, due to the reduced energy consumption of buildings.

The calculation of the net economic impact of the energy upgrading activities of buildings is based on an input-output model for the Greek economy. The results of the analysis show that investments in energy upgrading of buildings have strong multiplier effects on the economy. Every €1 million investment in energy upgrading of buildings increases altogether, on net terms[40], the Greek GDP by €1.4 million, employment by 37 jobs and government revenue by €0.5 million in 2018. The implementation of investments in the energy upgrading of households, as provided for by the planning of the Ministry of the Environment and Energy, can increase the growth rate of the Greek economy by up to 0.7 percentage points and can boost employment by up to 40.000 jobs. In addition, the implementation of the investments in the strategic planning for the upgrading of tertiary sector buildings can bring additional growth rate increase of up to 0.4 percentage points and employment increase by up to 24.700 jobs. The results of the analysis make clear that institutional support for building energy upgrading activities, in addition to the great environmental benefits it can bring, can simultaneously deliver very significant developmental benefits, at a time when economic and employment stimulation is a top priority in Greece.

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[39] See Decision ΥΠΕΚΑ ΔΕΠΕΑ/Γ/οικ. 185497, ΦΕΚ Β 3004, 31-12-2015, YPEKA 2014, "Report of a long-term strategy for the mobilization of investments for the renovation of residential and commercial buildings, public and private, national building stock"

[40] Hereinafter, net effects are always mentioned, unless otherwise noted. Net impacts arise taking into account both the positive economic impact of stimulating investment in energy upgrading of buildings and the negative economic impact of lower energy expenditure on energy products.

4.2 Overview of the methodology

The overall assessment of the impact of a productive activity on the national economy takes into account both the direct and consequential economic effects of the activity. The implementation of energy upgrading interventions in buildings contributes directly to the national economy, generating value added[41], creating jobs and generating revenue for the state in the form of taxes and insurance contributions.

In addition, energy upgrades in buildings indirectly stimulate economic activity in many sectors of the Greek economy, as the contractors carrying out these operations use products of various sectors as inputs. In addition, the increased economic activity of suppliers of energy upgrading contractors stimulates economic activity in industries producing inputs from these suppliers, and so on. The aggregate effect of these interactions is the indirect contribution of the energy upgrading activities of buildings to the Greek economy.

Also, energy upgrading activities, by providing income to the professionals and workers performing them, cause an increase in consumer demand and hence further stimulation of domestic economic activity. Similarly, multiplier effects also appear along this path of economic interactions, as this stimulation of economic activity causes a further increase in income, thus a further increase in consumer demand, and so on. The aggregate effect of this type of interactions is called the induced contribution of energy upgrading activities to the Greek economy.

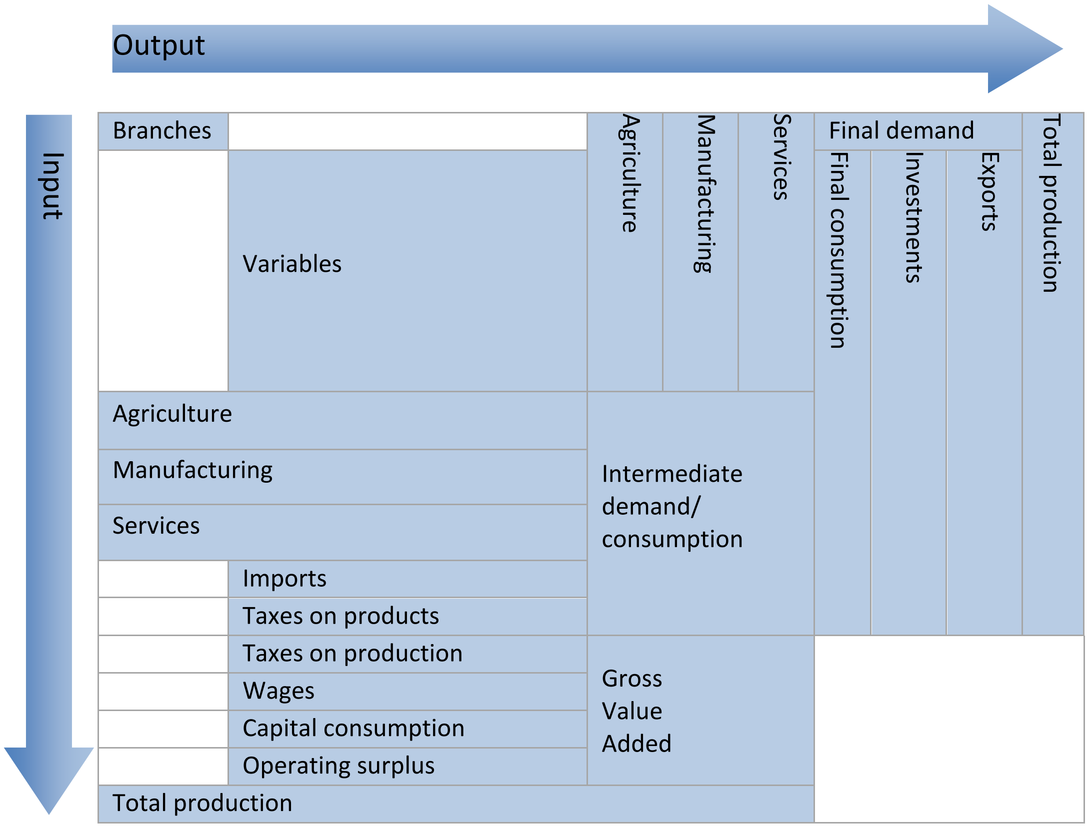
For the calculation of the overall economic footprint of energy upgrading activities, all these effects are quantified in an economic analysis based on an input-output model. The input-output method was developed by the Russian-American economist Wassily Leontief, who received the Nobel Prize in Economics in 1973 for his work[42]. The economic analysis using an input-output model is based on the latest available statistics for the sectoral structure of the Greek economy.

The figures of the sectoral structure of the economy have the following structure: Economic activity in Greece is classified in 63 branches (e.g. chemical products, telecommunications, basic metallurgy, fishing, construction, etc.). For every branch/sector there are figures for the gross value of the output of the sector in a given year and the quantities, in terms of value, of inputs used to produce this output (products of other industries, imports) and of the labor used. There is also detailed information on the amount of taxes and insurance contributions paid during the production process of each product. In addition, there is a breakdown of the final uses of the product of each sector (final consumption by private agents and government, stocks, use for capital formation, exports), as well as data on the import uses of each industry. These statistics are presented in a standard form in the input-output tables for the Greek economy. The structure of a typical input-output table in a simplified form for a three-branch economy is shown in Graph 4.1.

[41] Value added of a productive activity is the difference between the value of the final result (product/service) of the activity and the cost of the goods used as inputs to produce this final result

[42] See also Wassily W. Leontief, Input-output Economics, Second Edition, Oxford University Press, 1986

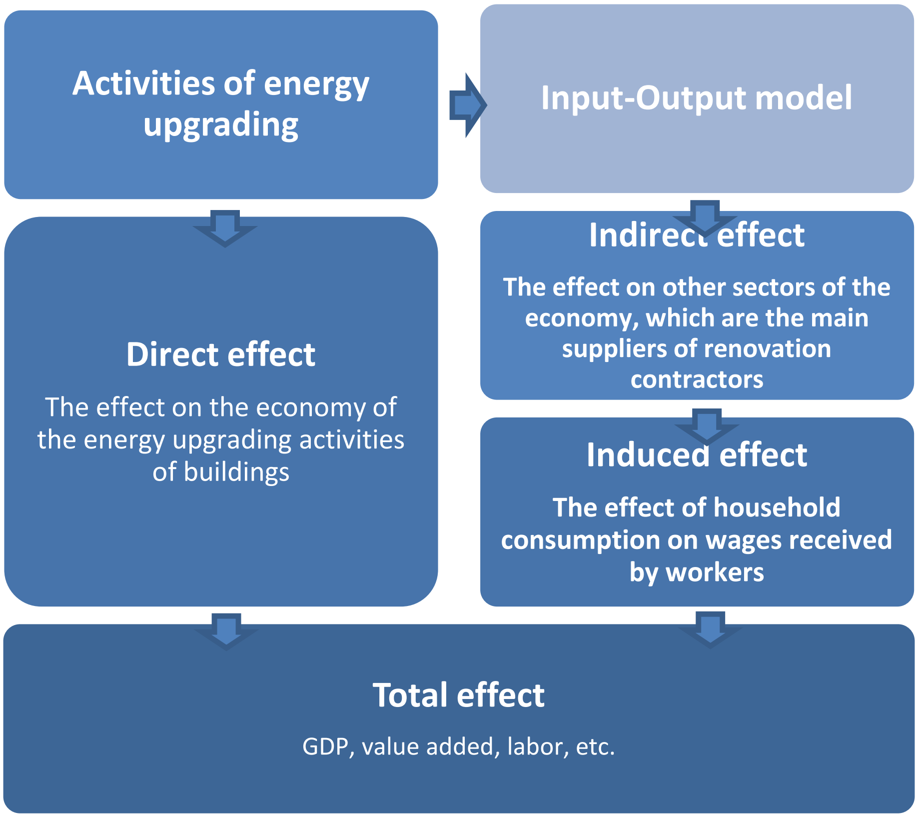
Graph 4.1: Structure of input-output table



The economic analysis in the context of an input-output model is based on certain assumptions. The most important of these assumptions concerns production technology, which is considered to be constant: it is considered that in order to produce a single product unit in one sector, other products (inputs, labor, etc.) are required in fixed proportions, irrespective of the level of total production of the industry. It is also considered that both consumer preferences and prices in the economy remain constant and that there are no restrictions on the productive capacity of branches the economy. Under such a model, the production of each industry is determined by the demand for its product.

Based on these assumptions, the amount of each input required, as well as the wages offered, etc., per unit value of the final product of the industry can be calculated for each branch. Based on the per-unit of production requirements of each industry, the respective subsequent requirements of its immediate suppliers can be determined, and so on. Similarly, the subsequent effects of each sector's activity on consumer demand can be determined and the subsequent stimulation of economic activity from the increase in consumption. By following this approach, the indirect, induced and eventually total economic effects of the activity of any branch of the economy can be calculated. In this way, the economic effects of an exogenously induced increase in energy upgrading activities in the Greek economy can be calculated (Graph 4.2).

Graph 4.2: Direct, indirect and induced economic effects



By the same method, the negative economic impacts from the reduction in consumer spending on energy goods (liquid, solid and gaseous fuels and electricity) can be calculated, due to the energy savings generated by upgrading interventions in buildings. The net economic impacts of energy upgrading investments are calculated by taking into account both the positive effects of increased investment expenditure on energy upgrades (the gross economic impact of such investments) and the negative effects of lower energy expenditure due to energy savings in buildings. The methodology used to calculate the economic impacts of the energy upgrading of buildings is described in detail in Appendix[43].

4.3 Scenarios of energy upgrading interventions in buildings

This section presents the characteristics of some scenarios for implementing energy upgrading interventions in buildings as defined in the relevant Ministry of Environment and Energy (YPEN) report. In the next sections, the economic impacts of applying each scenario will be presented. In each scenario, the type and number of renovated buildings is determined for each year in the period 2018-2030 and for each degree of renovation intensity (renovation that brings energy savings of 20%, 40%, etc.)

The YPEN study estimates for each scenario the cost of new energy upgrades for each year in the period 2018-2030. By combining various options for energy saving interventions, based on bibliography and on the basis of market surveys, the study estimates the cost, on average,

[43] For more details on the model and the input/output tables, see Eurostat, Manual of Supply, Use and Input-Output Tables, 2008 edition, ISSN 1977-0375 http://ec.europa.eu/eurostat/web/ /products-manuals-and-guidelines/-/KS-RA- 07-013, as well as Ronald E. Miller, Peter D. Blair, Input-Output Analysis: Foundations and Extensions, Second Edition, Cambridge University Press, 2009.

of a new investment in the energy upgrading of buildings, which results in energy savings of 1 kWh per year. This average cost is estimated for each building class separately. In particular, the study of the Ministry results in the following values for the investment cost per unit of energy saved per year: 1€/kWh for houses, 1.2€/kWh for school buildings and 1.5€/kWh for offices, hospitals and hotels[44]. Based on the average cost per unit of energy saved and the total annual energy savings for each building class under each scenario, the corresponding total annual expenditure for new energy upgrading activities in each year is shown for each scenario. This investment expense for new energy upgrades is stimulating economic activity in the country, generating subsequent economic results, which will be presented in next sections, examining three scenarios of energy upgrades in households and a scenario of energy upgrades in tertiary sector buildings.

Based on the characteristics of each scenario of energy interventions, the annual reduction in energy expenditure resulting from the reduction of energy consumption in buildings due to their energy upgrading is also calculated for each scenario and for each year in the period 2018-2030. For each scenario, the total additional saved energy is calculated for each year, over the savings of the corresponding base scenario. Based on ELSTAT data on household energy consumption[45] and household expenditure[46], the average expenditure per unit of energy consumed for thermal uses[47] is calculated at 868 €/toe. Considering this average energy price for thermal uses over a period of time (constant in real terms), and based on yearly energy savings, the reduction in consumer expenditure on energy goods per year is calculated for each scenario[48]. The reduction in energy consumption also has multiplier economic effects that are taken into account when calculating the net economic effects from the implementation of each scenario.

It is worth emphasizing that any investment in energy upgrading of buildings brings benefits of energy savings for many years after the upgrading. Therefore, the energy savings achieved in a given year are the aggregate savings from the upgrading interventions implemented in that year and in all previous years. A corresponding cumulative effect is also the reduction in the cost of energy goods in any given year.

4.3.1 Scenarios of energy upgrading interventions in households

Taking into account the strategic planning of the state for the energy upgrading of the country's building stock, as reflected in the YPEN study, three scenarios of energy upgrading interventions will be examined. Graph 4.3 summarizes the main features of each scenario of residential interventions.

[44] 11.630 €/toe for houses, 13.953 €/toe for school buildings and 17.445 €/toe for offices

[45] See ELSTAT, Research on Household Energy Consumption, 2011-2012

[46] See ELSTAT, Family Budget Survey (EEA) 2016

[47] Expenditure on thermal uses was considered to cover solid, liquid and gaseous fuels, district heating and part of the expenditure on electricity used for space heating and cooling and for the production of hot water (a total of 17.3% of the electricity consumed by households, according to ELSTAT data - see Energy Consumer Survey for Households, 2011-2012).

[48] For the calculation of the decrease in energy expenditure by the tertiary sector, in the corresponding scenario, it was considered that the average expenditure on energy products for thermal uses by the tertiary sector is also equal to 868 €/toe, fixed in real terms, similarly to households.

Graph 4.3: Scenarios of energy upgrading interventions in homes

Base Scenario	Conservative scenario (Scenario 2 of YPEN study)	Ambitious scenario (Scenario 3 of YPEN study)	Target Scenario (Scenario 5 of YPEN study)
• There is no incentive • The rate of energy renovations is assumed to be constant at the level of 2014 • Rate of residential renovations constant: 0.37% of the housing stock per year • Average degree of energy savings constant: 25%	• Small-scale residential renovations • Rate of housing renovations: from 0.73% to 2.26% of the stock per year • Average degree of energy savings: from 27.2% to 31.5%	• More extensive residential interventions • The rate of renovations of the building stock is rising rapidly • Rate of house renovations: from 1.28% to 2.92% of the stock per year • Average degree of energy savings: from 45.1% to 51.3%	• It is sufficient to achieve the objectives of the 3rd NEEAP • Rate of housing renovations: from 1.49% to 2.20% of the stock per year • Average degree of energy savings: from 40.7% to 41.5%

4.3.1.1 Base residential scenario

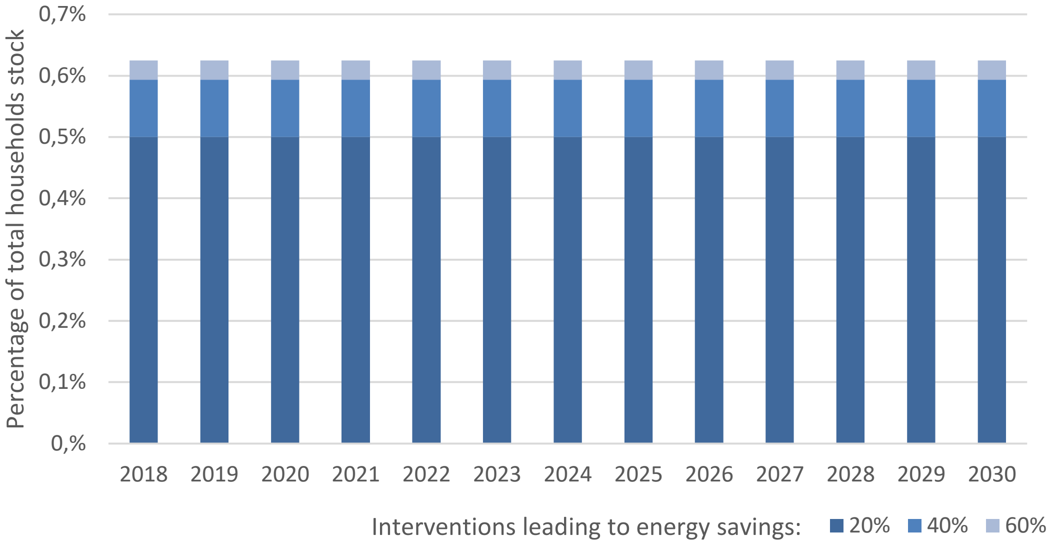
In the base residential scenario[49] there is no incentive for the energy upgrading of housing in Greece. It is assumed that the rate of energy renovations is stable at the level of 2014. In particular, it is estimated that a total of 25,000 households are annually renovated, most of which are upgraded to achieve 20% energy savings, while some are upgraded to a greater extent, so as 40% and 60% energy savings are achieved[50]. Graph 4.4 shows the number of households as a percentage of the total house stock in the country[51], upgraded per year and for each level of energy upgrades under the base scenario. For example, the cost of these interventions in 2018 is €196.5 million. Base scenario interventions lead to total energy savings of 17ktoe per annum from new house renovations that take place each year, leading to a €15.1 million reduction in energy expenditure, 1 million per year by these new renovations in real terms (2018 prices).

[49] The base housing scenario of this study corresponds to Scenario 1 of the YPEN study

[50] 20,000 residences (0.50% of the total housing stock) are upgraded to achieve 20% energy savings, 3,725 residences (0.09% of the stock) are upgraded to achieve 40% savings and 1,265 residences (0.03% of the stock) are upgraded to achieve 60% energy savings

[51] The total housing stock in Greece was considered to be equal to 4,000,000 households

Graph 4.4: Base Residential Scenario - Renovated houses per year and per degree of energy upgrading



Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015

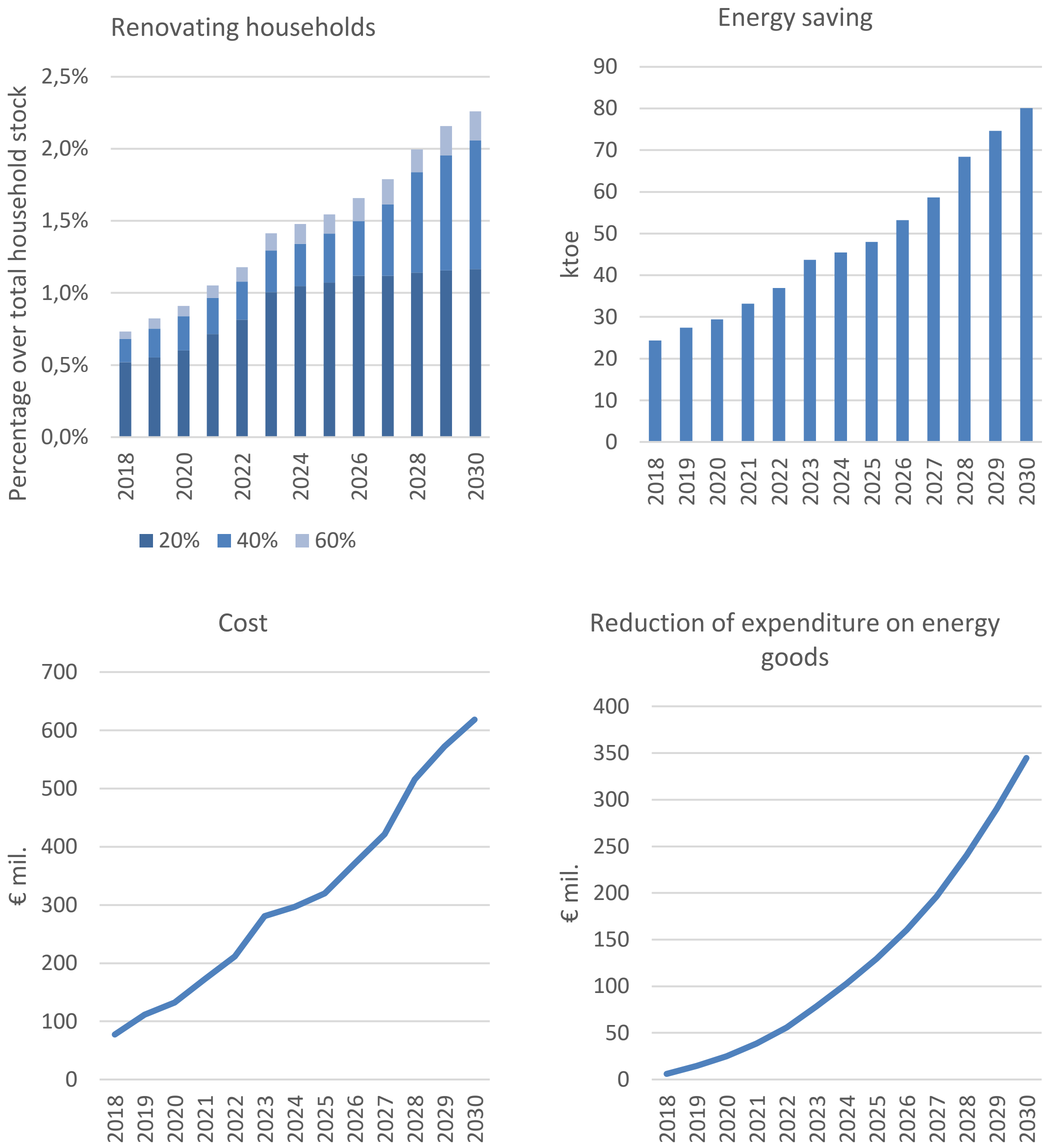
4.3.1.2 Conservative residential scenario

In the conservative scenario[52] the number of renovated households increased from 0.73% of all households in 2018 to 2.26% in 2030, with a gradual increase in the rate of higher intensity renovations (Graph 4.5 and Table 6.1 in Appendix). The average degree of energy savings under this scenario ranges from 27.2% to 31.5%. Under the conservative scenario, the annual energy saved from new renovations is increased from 24 ktoe in 2018 to 80 ktoe in 2030, with the annual cost of these energy upgrades increasing from €78 million to €620 million in the same period. The annual reduction in energy expenditure under this scenario in relation to the base scenario starts at €6 million in 2018 and rises to €345 million in 2030[53].

[52] The conservative scenario of this study corresponds to Scenario 2 of the YPEN study

[53] As mentioned above, the reduction in expenditure on energy goods in any given year results from the energy savings from building upgrades in the given year and in all previous years (aggregate savings)

Graph 4.5: Conservative residential scenario - Renovated homes per year, energy savings from new renovations, new renovations' costs and expenditure reduction for energy products due to saving, per year

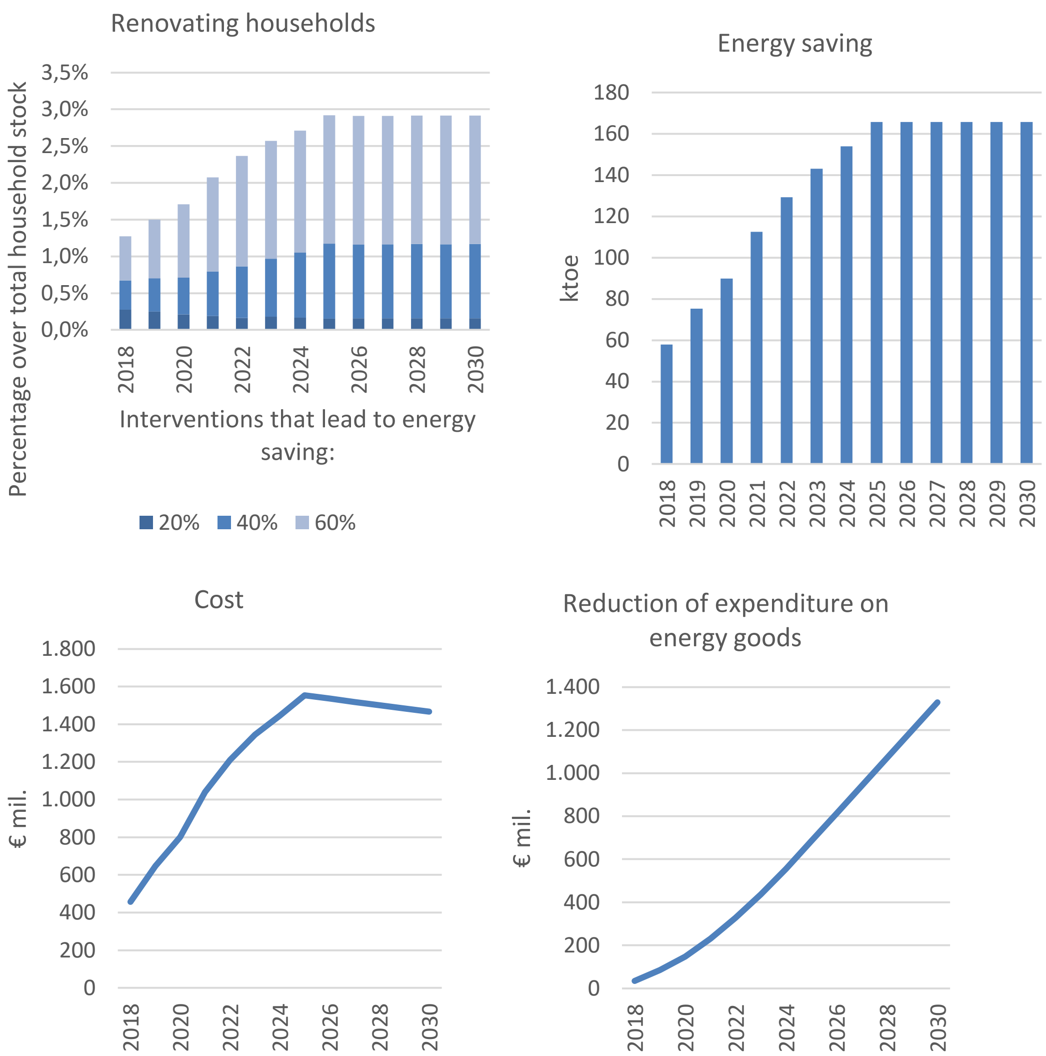


Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015.

4.3.1.3 Ambitious residential scenario

In the ambitious scenario[54] the incentives for energy upgrading of households are much stronger so that the number of renovated households is rising rapidly, starting at 1.28% of all households in 2018 and reaching 2.92% in 2030 (Graph 4.6 and Table 6.2 in the Appendix).

Graph 4.6: Ambitious residential scenario - Renovated homes per year, energy savings from new renovations, new renovations costs and expenditure reduction for energy products due to saving, per year



Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015.

In addition, upgrading interventions are on average more intense and the intensity of renovations is also rising rapidly, with the average degree of energy savings under the ambitious scenario rising from 45.1% to 50.9% in the period 2018-2030. Under this scenario, the total annual energy savings from new renovations will increase from 58 ktoe in 2018 to nearly 166 ktoe in 2025, a level that remains until 2030, with the annual cost of energy upgrading interventions following a similar course, rising from €457 million in 2018 to €1.5

[54] The ambitious scenario of this study corresponds to Scenario 3 of the YPEN study.

billion in 2025 (at 2018 prices). The annual decrease in energy expenditures compared to the base scenario is rising from €35 million in 2018 to €1.3 billion in 2030.

4.3.1.4 Target residential scenario

In the residential target scenario[55] the number of renovated homes is initially higher than in the ambitious scenario, at 1.49% of all households in 2018, but it is increasing at a slower pace, reaching 2.20% of the total in 2030 (Graph 4.7 and Table 6.3 in Appendix). Upgrading interventions are on average lower in intensity than in the ambitious scenario, with the average level of energy savings ranging from 41% to 42% throughout the period 2018-2030.

Graph 4.7: Target residential scenario - Renovated homes per year, energy savings from new renovations, new renovations costs and expenditure reduction for energy products due to saving, per year

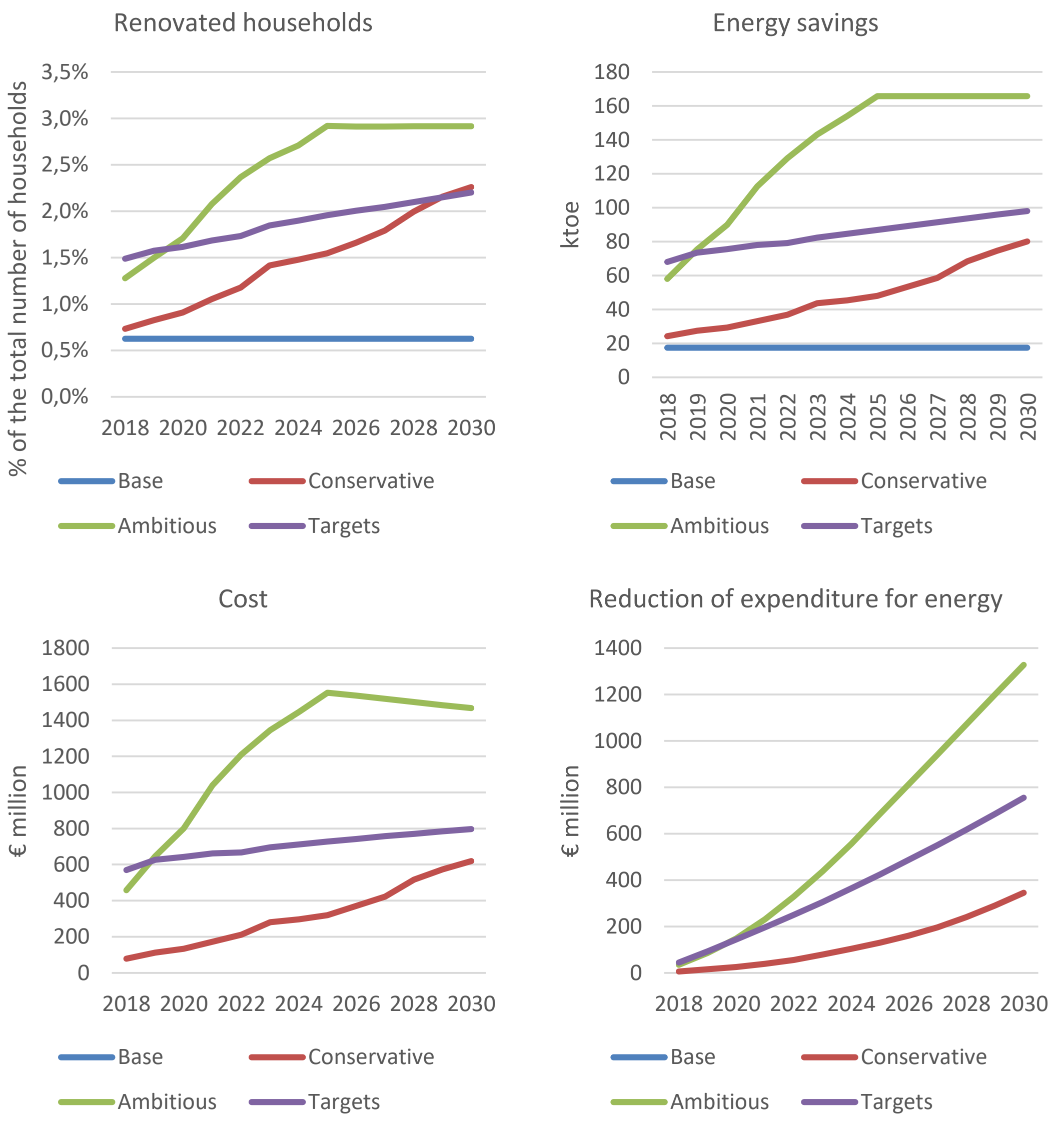
Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015.

Under the target scenario, the total annual energy savings from the new renovations of each year starting from 68 ktoe in 2018 will increase to about 98 ktoe in 2030 and the annual

[55] The target scenario of this study corresponds to Scenario 5 of the YPEN study

renovation costs will increase from €570 million to approximately €800 million for the same time period (at 2018 prices). The reduction in energy expenditures per year, in relation to the base scenario, is increasing from €44 million to €755 million in this period. The residential target scenario is designed to achieve the energy efficiency targets set out in the 3rd National Energy Efficiency Action Plan, regarding households. Graph 4.8 summarizes the main features of the three scenarios of energy upgrade interventions in households.

Graph 4.8: Residential energy interventions scenarios - Renovated homes per year, energy savings from new renovations, new renovations costs and expenditure reduction for energy products due to saving, per year for each scenario

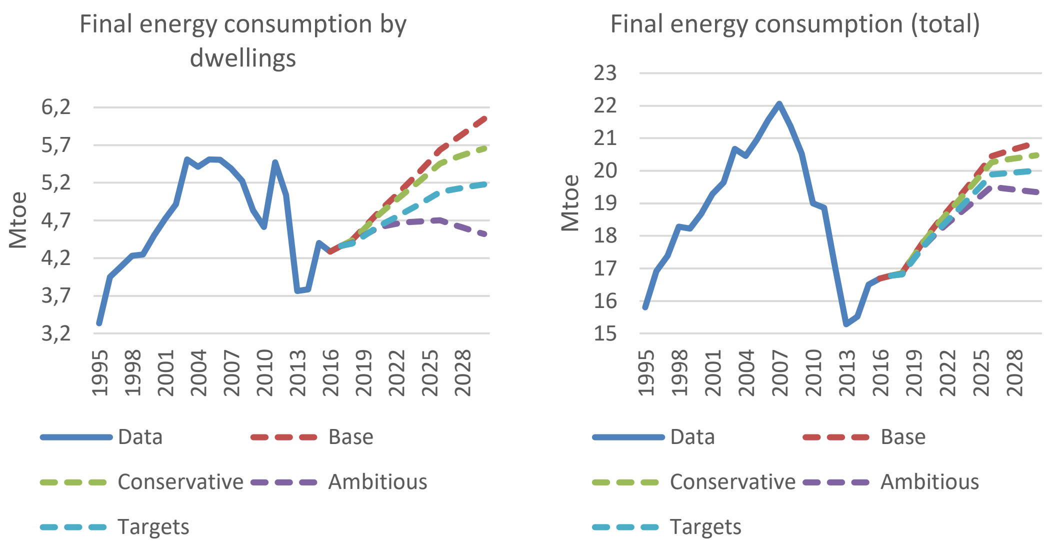


Source: YPEN, «Long-term strategy report ...» ΦΕΚ Β 3004, 31-12-2015.

Assuming that without policy measures, both final energy consumption in households and total final energy consumption in the country will evolve in line with the country's GDP[56], Graph 4.9 depicts the result of the energy savings achieved with each scenario.

[56] See Appendix

Graph 4.9: Final energy consumption of homes and total final energy consumption, data (1995-2016) and projections (2017-2030) per scenario



Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015, Eurostat, IMF estimations, IOBE.

4.3.2 Intervention scenarios in tertiary sector buildings

Tertiary sector buildings include offices, shops, school buildings and buildings used by educational institutions, hospitals and hotels. The base scenario for energy upgrading interventions in tertiary sector buildings and a scenario of greater interventions in these buildings, which is designed to achieve the targets set in the 3rd National Energy Efficiency Action Plan, is presented below.

4.3.2.1 Base scenario for tertiary sector buildings

In the base scenario for buildings in the tertiary sector, no incentive is given for the energy upgrading of these buildings, and it is considered that the rate of energy renovations in such buildings is constant at the level of 2014. In particular, 1,085 offices and shops are considered to be renovated annually, 47 hospitals, 250 hotels and 444 schools, most of which (80% of renovated buildings) are upgraded to achieve 20% energy savings, while some are upgraded to greater extent[57]. The intervention cost of the base scenario for tertiary sector buildings at 2018 prices is €212 million. Interventions of this scenario lead to a total energy saving of 13 ktoe per year, from the new renovations that take place each year, with the corresponding reduction in the expenditure for energy products from these new renovations reaching €10.9 million.

4.3.2.2 Target scenario for tertiary sector buildings

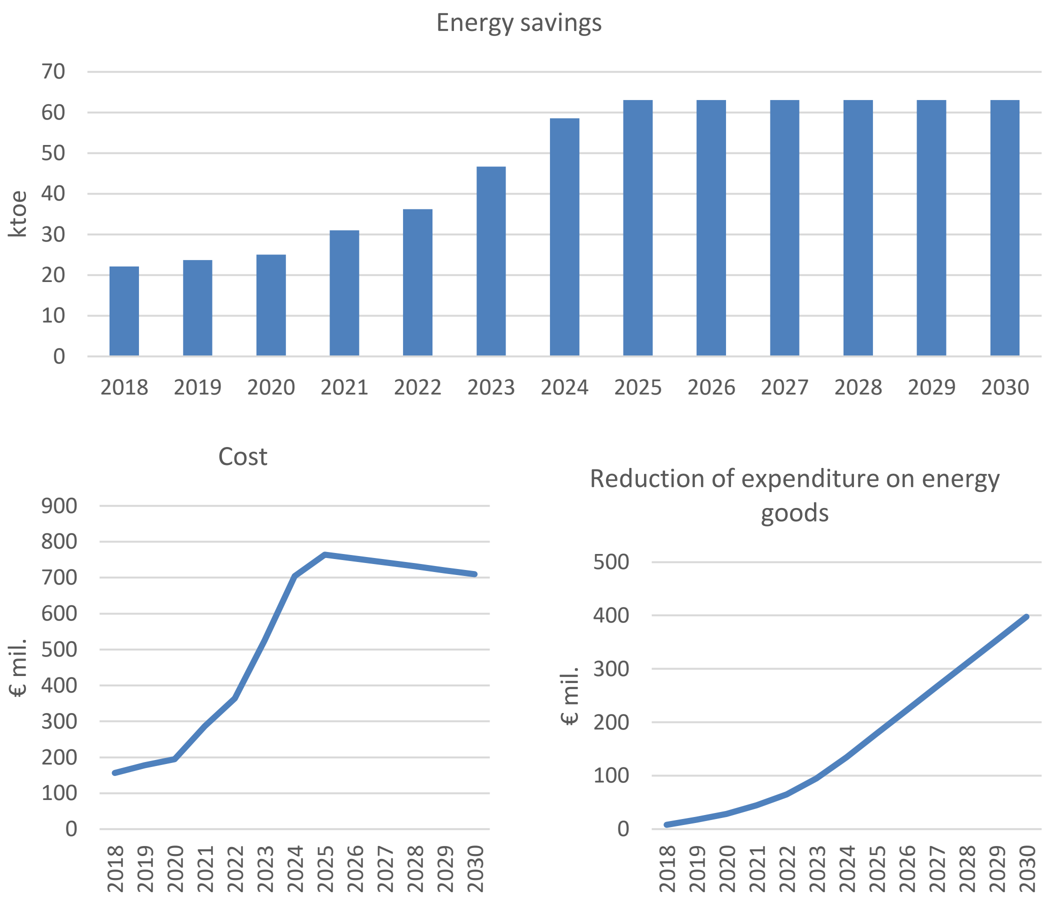
The target scenario for tertiary sector buildings[58] is designed to achieve the energy efficiency targets set out in the 3rd National Energy Efficiency Action Plan for tertiary sector buildings.

[57] In 15% of renovated buildings 40% energy savings are achieved and 5% of renovated buildings achieve 60% energy savings

[58] The target scenario for tertiary sector buildings in this study is is the aggregation of the four sub-scenarios of energy upgrades in tertiary sector buildings discussed in the YPEN study (the sum of the four discrete scenarios for offices, schools, hospitals and hotels).

Under this scenario, the number of renovated buildings in each category per year is not much higher than in the base scenario, but upgrading interventions are on average more intense, resulting in annual energy savings from new renovations starting from 22 ktoe in 2018 and reaching 63 ktoe in 2025, remaining at this level by 2030 (Graph 4.10 and Table 6.4 in the Appendix).

Graph 4.10: Target scenario for tertiary sector buildings - Energy savings from new renovations, new renovations costs and expenditure reduction for energy products due to saving, per year



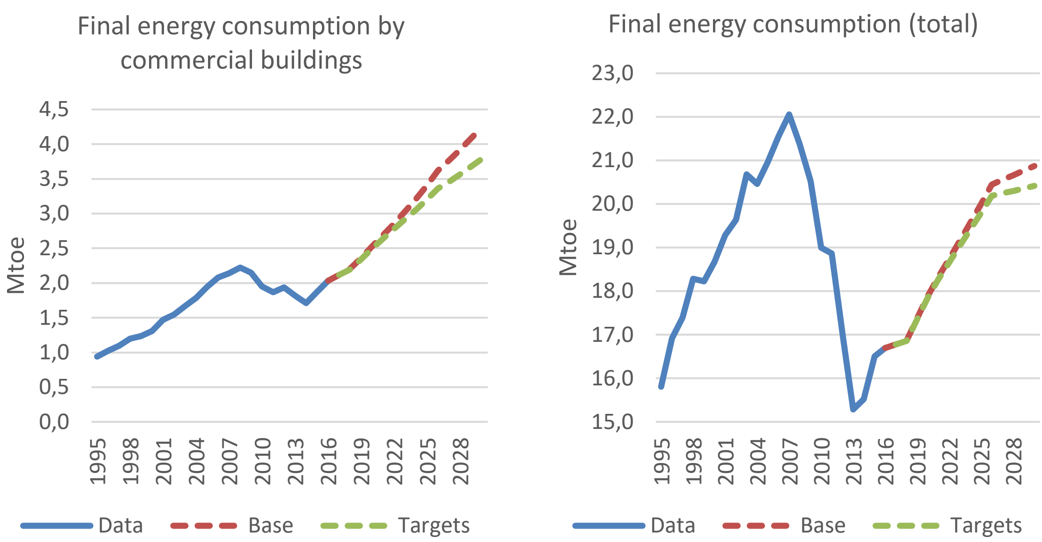
Source: YPEN, «Long-term strategy report ...» ΦΕΚ Β 3004, 31-12-2015.

Accordingly, the annual cost of new renovations, starting at €157 million in 2018, is increased to €760 million in 2025, in 2018 prices, while the annual decrease in energy expenditure compared to the base scenario starts from €8 million and reaches €400 million over the same period.

Assuming that without policy measures both final energy consumption in the tertiary sector and overall final energy consumption in the country will evolve in line with the country's GDP[59], Graph 4.11 illustrates the result of the energy savings achieved with the target scenario for tertiary sector buildings.

[59] See Appendix

Graph 4.11: Final energy consumption of tertiary sector (commercial) buildings and total final energy consumption, data (1995-2016) and projections (2017-2030)



Source: YPEN, «Long-term strategy report …» ΦΕΚ Β 3004, 31-12-2015, Eurostat

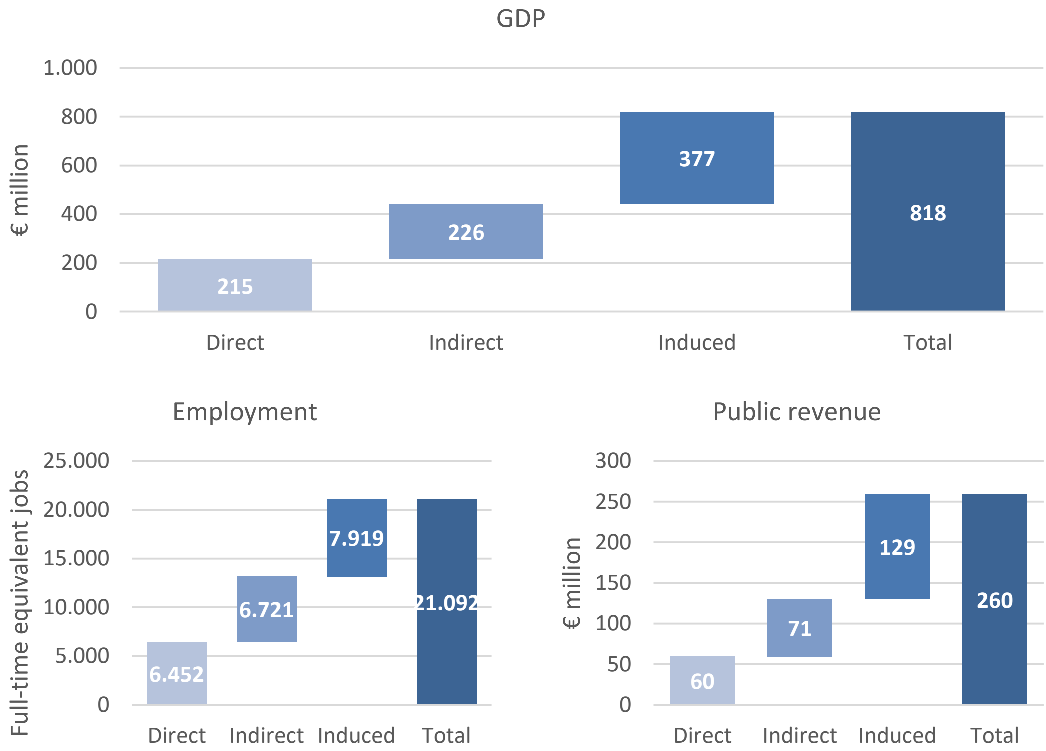
4.4 The economic footprint of energy upgrading activities of buildings

This section presents the net multiplier effects of the energy upgrading activities of buildings on the Greek economy for the years 2018-2030. In particular, the multiplier effects from the implementation of each scenario of energy upgrading interventions in buildings, as these scenarios were presented in the previous section, are calculated for each year in that period, taking into account both the positive economic effects of the increase in investments for energy upgrades, as well as the negative economic effects of reducing consumer expenditure on energy goods. The results of the economic analysis show that investments in the energy upgrading of buildings have strong multiplier effects on the Greek economy. Enhancing energy upgrading activities boosts overall economic activity in the country, thus boosting growth and the creation of new jobs. Stimulating economic activity in turn has a strong positive impact on government revenues, from direct and indirect taxation, as well as employers' and employees' social security contributions.

It is characteristic that the materialization of the energy renovations of residential buildings of the target scenario in 2018, involves activities costing €570 million, while directly contributing €215 million to Greece's GDP[60], and causes total GDP growth of €818 million (Graph 4.12), an effect that reaches 0.43% of Greek GDP. That is, for every €1 of investment in energy upgrading of buildings, a total of €1.4 is added to Greece's GDP.

[60] All figures are given in net terms, unless otherwise noted

Graph 4.12: Target scenario for housing in 2018 - Net effect on GDP, employment and government revenues



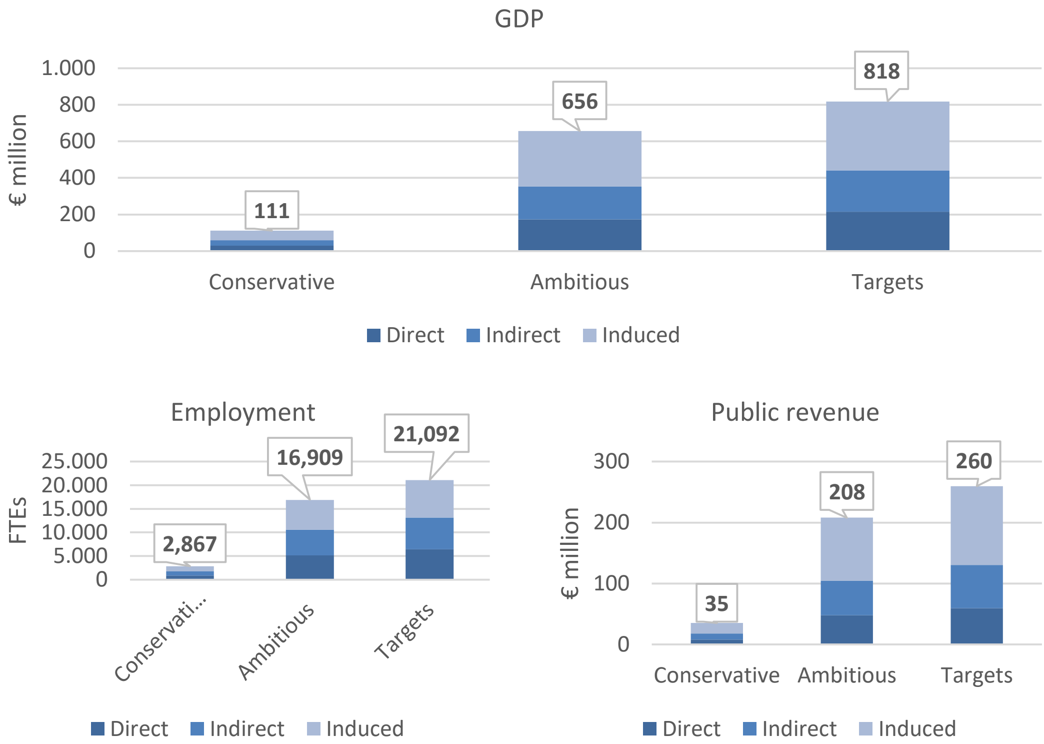
Source: Input-Output model IOBE, Eurostat.

Accordingly, the application of the residential target scenario in 2018 increases employment in the country by a total of 21,000 full-time equivalent jobs (FTEs), suggesting that for every €1 million of investment in energy renovations of buildings, 37 full-time jobs are generated in total in Greece. Also, the implementation of the target scenario results in an increase in government revenues from taxes and insurance contributions of €260 million in 2018, so a total of €0.5 is added for every €1 of investment in the energy upgrading of buildings to government revenues. Consequently, if the residential target scenario is financed solely by government funds, it is estimated that the final net burden is only €310 million[61] for 2018. The final net government burden is almost half the cost for energy upgrading investments.

The achievement of the target scenario initially had stronger economic effects, both in comparison with the conservative scenario and the ambitious scenario (Graph 4.13). Under the target scenario the net economic effects initially increase and then follow a declining path (Graph 4.14).

[61] The cost of subsidized energy upgrading works in the residential target scenario is €570 million. This does not include the cost of work performed apart from the subsidy (energy renovations of households in base scenario). The net government burden arises from the cost of subsidized activities (€570 million), subtracting the overall impact on government revenues (€260 million) for 2018

Graph 4.13: Scenarios for housing interventions - Net economic effects on GDP, employment and government revenues per scenario in 2018

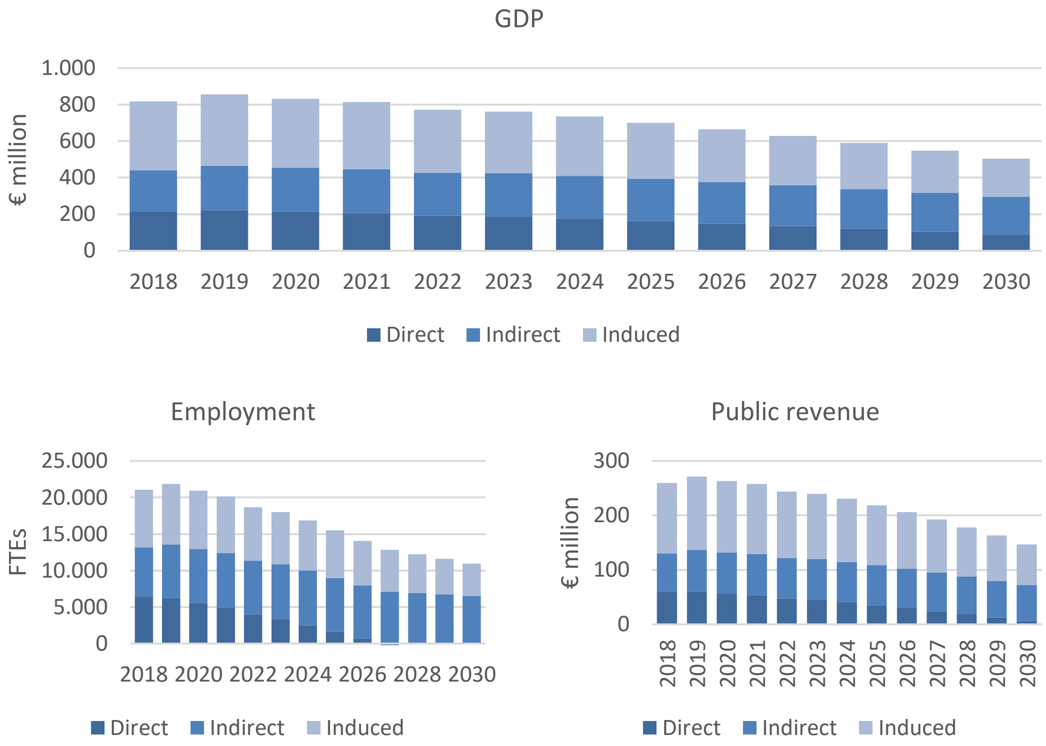


Source: Input-Output model IOBE, Eurostat.

As investment in energy renovation of households under the target scenario increases, the overall gross effect on GDP is growing due to these investments, reaching €1.2 billion in 2030. Similarly, gross effects on employment increase, reaching 31,700 jobs and government revenues reaching €390 million in 2030. At the same time, however, energy savings are increasing, resulting in a decreasing household spending on energy goods. This reduction in consumer spending has also an impact on the economy. The net result of these processes is an increase in the net overall impact on GDP in the first year of the scenario, reaching €860 million in 2019, and then a gradual decrease of this impact to €500 million through 2030 (Graph 4.14). The picture of the net overall effects on employment and government revenues is similar.

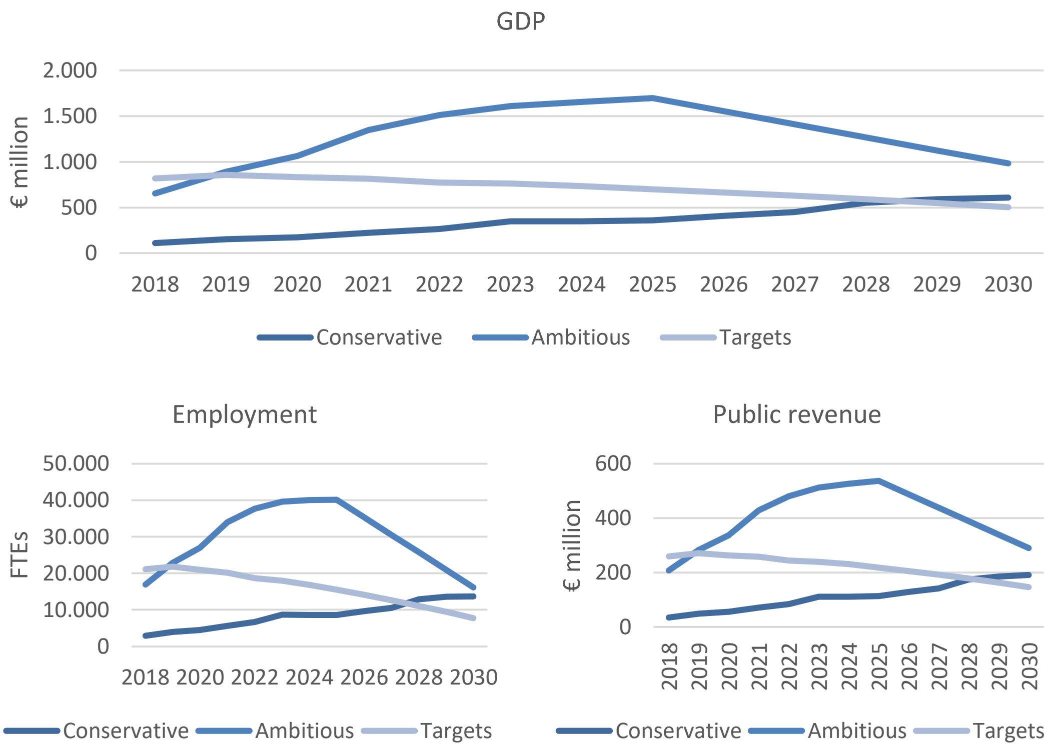
A little different picture is presented by the economic effects under the ambitious scenario. In this scenario, investments in the energy upgrading of buildings up to the year 2025 are increasing at a much faster rate than in the target scenario, with very strong positive economic effects in the early years of the scenario. As a result, net effects on GDP, employment and government revenues are increasing until the year 2025. In the following years, on the one hand the slight decrease in investment expenditure and on the other the effects of the decreasing consumer expenditure on energy goods, lead to a gradual decrease in the net economic effects of the ambitious scenario. However, the ambitious scenario has stronger net economic impacts than the target scenario for the years 2019-2030, lagging behind the target scenario only in the year 2018.

Graph 4.14: Target scenario for households - Net effects on GDP, employment and government revenues, 2018-2030



Source: Input-Output model IOBE, Eurostat.

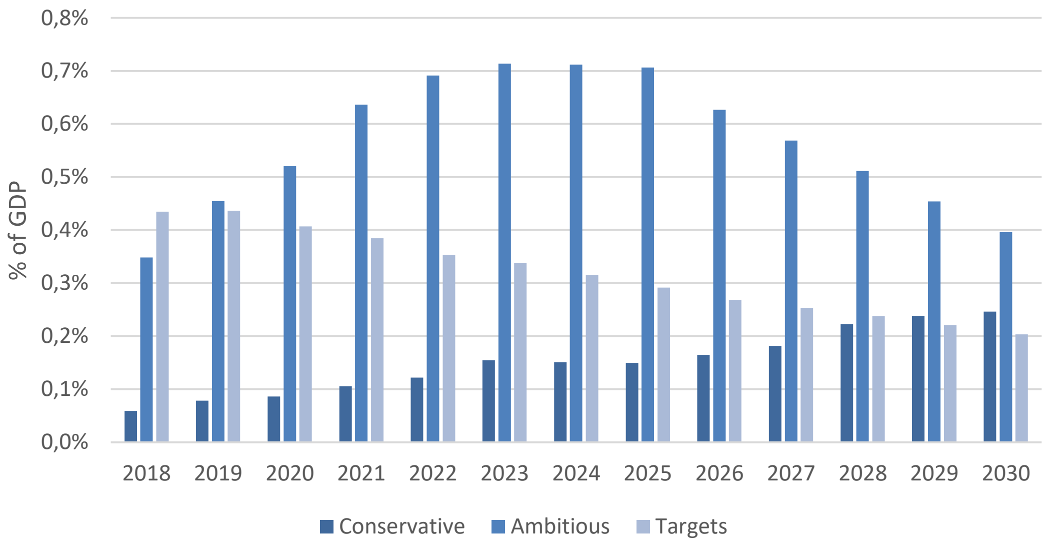
Chart 4.15: Household intervention scenarios - Total net effect on GDP, employment and government revenue per scenario 2018-2030



Source: Input-Output model IOBE, Eurostat.

Chart 4.16 shows the effects of residential energy upgrading scenarios on GDP as a percentage of the total GDP of Greece. Investments in the energy upgrading of buildings under the ambitious scenario can boost the GDP growth rate by up to 0.7 percentage points, while under the target scenario these investments boost growth by up to 0.44 percentage points.

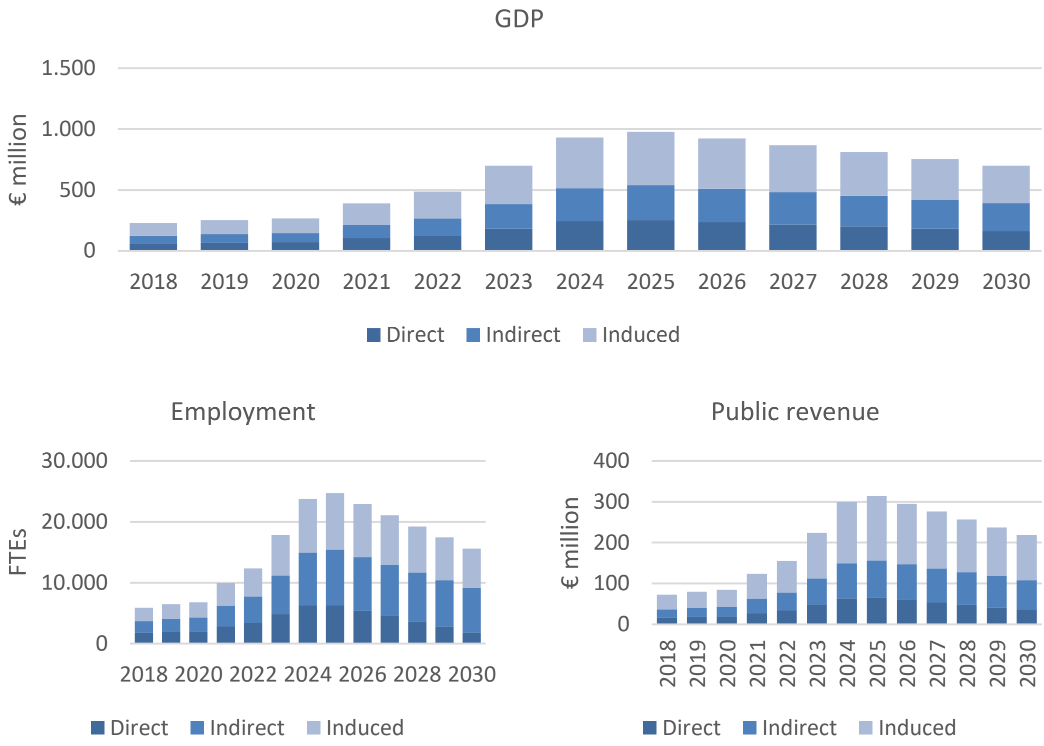
Chart 4.16: Household intervention scenarios - Net overall impact on GDP, as a percentage of GDP, per scenario 2018-2030



Source: Input-Output model IOBE, Eurostat.

Significant benefits for the Greek economy can also be achieved by energy-related investments in tertiary sector buildings. Indeed, the implementation of the scenario for tertiary sector buildings is boosting the country's GDP by €228 million in 2018, with an increase to €980 million in 2025 (0.41% of GDP) and then decreasing to €700 million in 2030. Similarly, with these interventions in tertiary sector buildings, a total of 5,900 full-time jobs are created in 2018, rising to 24,700 in 2025, with annual government revenues strengthened in total by €72 million in 2018 and €310 million in 2025.

Chart 4.17: Target scenario for tertiary sector buildings - Net effects on GDP, employment and government revenues, 2018-2030



Source: Input-Output model IOBE, Eurostat.

4.5 Conclusions

The results of the economic analysis highlight the importance of the multiplier effects of the energy upgrading activities of buildings on the Greek economy. The implementation of the energy upgrades of the residential target scenario, as described in the strategic planning of the YPEN[62], shows a net overall impact on GDP of €800 million during the first six years of the scenario's implementation, which is decreasing in the following years, but without dropping below €500 million by 2030. These effects correspond to an increase in the rate of growth of the Greek economy by about 0.4 percentage points in the first years of the scenario. Respectively, the implementation of the residential target scenario leads to the creation of about 20,000 full-time jobs per year in the first years of the scenario and generates a boost of the annual government revenue by €250 million.

With the implementation of the ambitious scenario of housing energy improvements, the benefits to the economy are much greater. Under this scenario, the overall net effect on GDP amounts to €1.7 billion in 2025, boosting the growth rate of the Greek economy by 0.7 percentage points. The impact on employment exceeds 40,000 jobs, while the impact on government revenue reaches €540 million.

[62] See Decision ΥΠΕΚΑ ΔΕΠΕΑ/Γ/οικ. 185497, ΦΕΚ Β 3004, 31-12-2015, YPEKA 2014, "Report of a long-term strategy for the mobilization of investments for the renovation of residential and commercial buildings, public and private, national building stock"

Significant economic benefits can also be obtained by implementing energy upgrading interventions in tertiary sector buildings, such as the target scenario for such buildings in the strategic planning of YPEN. The implementation of these interventions leads to a boost of the country's GDP by €228 million and employment by 5,900 jobs in 2018, effects that increase to €980 million and 24,700 jobs in 2025, respectively.

In the context of an integrated institutional intervention for the energy upgrading of the country's building stock, the target scenarios for residential and tertiary buildings could be combined, providing incentives for interventions in all types of buildings. In such a case, the growth rate in the country would be increased by as much as 0.72 percentage points, while employment would be increased by up to 40.600 jobs in 2025. In the case of a combined implementation of the ambitious residential scenario with the target scenario of the tertiary sector, the benefit in terms of increased growth rate of the Greek economy would reach 1.1 percentage points, while the employment benefit would reach 64.800 additional jobs in 2025.

The economic importance of energy upgrading activities is reflected in the high values of the relevant macroeconomic multipliers. For every €1 of investment in energy upgrading of buildings, a total of €1.4 is added to the Greek GDP, and a total of €0.5 is added to the state's revenue. For each €1 million of investment in energy upgrading, a total of 37 jobs are created in Greece.

In the case that energy upgrading investments in buildings are covered entirely by public funds, taking into account the total economic benefit from the realization of these investments, the final net cost of these activities is significantly less than their "nominal" initial cost. Indeed, taking into account the effects of energy upgrading investments on government revenue, the final net government burden for each scenario of interventions is about half the initial "nominal" investment cost.

5. POLICY RECOMMENDATIONS

Although energy saving interventions in buildings entail a positive private economic benefit, factors such as the subjective, and possibly "myopic", assessment of the feasibility and efficiency of these interventions by households and the limited resources available often prevent investment by households. This is the case at a time when Greece does not seem to have "disconnected" the consumption of energy from the course of economic activity. Achieving national targets for energy savings is mainly the result of the economic crisis rather than the effort to improve energy efficiency. Thus, combined with the energy status of the stock of buildings and the extremely low investment rate in new houses, the potential for energy savings in buildings is high. It would therefore be desirable from the state side to provide additional incentives to remove barriers to the implementation of energy saving interventions.

As has been extensively analyzed in the previous chapters, investments in the energy upgrading of buildings, in addition to the environmental benefits they bring, help to stimulate economic activity and in particular contribute to the strengthening of the construction industry. Constructions belong to the sectors that have suffered the most losses during the crisis in recent years and therefore any effort to strengthen the construction activity, in addition to the economic benefit and the jobs it can offer, supports the maintenance of the know-how of the labor force, which has tended to decline in recent years, with particularly worrying implications for the future adequacy of the workforce for the implementation of high quality projects. In addition, constructions have a low degree of import dependence, are labor-intensive and have a strong presence in the peripheral regions of Greece, making them a growth factor with strong multiplier effects on the Greek economy.

According to the above, incentives by the state for the energy upgrading of buildings can prove to be of particular importance: if such incentives succeed to mobilize the interest of citizens, they will lead to stimulating economic activity and employment, with significant environmental benefits, including the significant reduction of greenhouse gas emissions in the building sector and a reduction in the consumption of imported fuels.

Offering tax incentives could mobilize private resources to invest in energy upgrading of buildings. It is especially important that a large part of private savings in Greece is now in the form of cash held by households. These savings are economically inert. Therefore, the provision of tax incentives could potentially mobilize additional dormant financial resources, a process that is equal to an extrinsic shock to the economy and causes multiplier effects with the mechanisms mentioned in the previous chapter.

An appropriate tax incentive could be the offering of a tax deduction, proportionate to the amount of the expenditure of energy renovation activities for buildings. Assuming that such an incentive would encourage private investors to use dormant savings to finance energy upgrading works and taking into account the multiplier effects of such investments, the negative impact on public revenues due to tax deduction will be counterbalanced partly or wholly, by the positive effect on public revenues due to the stimulation of the economic activity by the investments in the energy upgrading of buildings.

For example, if a tax deduction of 20% of renovation costs mobilizes private investments of the amount described in the ambitious residential scenario, then public revenue in the first years of the measure is slightly increased (around €12 million, or 3% of the renovation costs). However, this positive fiscal effect is gradually mitigated. From 2023 onwards, the final impact on annual government revenue is negative[63]. In aggregate terms, the tax deduction leads to increased public revenues over the first six years of the measure (aggregate additional public revenues due to the stimulation of the economic activity exceeds the aggregate loss of tax revenue due to tax deduction for each year in the period 2018-2025). However, an aggregate fiscal gap is emerging from 2026 onwards, rising to €560 million in 2030, or 4% of the aggregate cost of renovation interventions.

Assuming that the 20% tax deduction on the cost of energy upgrades is not sufficient to mobilize the private resources needed for the renovations provided for by the ambitious scenario, but a 50% tax deduction on the expenditure would be required for this purpose, the state would have lost revenue by applying such a measure, from the first year of implementation of the measure, with this fiscal gap steadily increasing. However, the loss of public revenue from the 50% tax deduction on renovation expenditure corresponds to 27% of this expenditure in the first year of the measure, reaches 30% of the expenditure in aggregate terms in 2024, and does not exceed 34% of the aggregate expenditure in 2030. The ultimate loss of public revenue is significantly less than the amount offered as a tax deduction, precisely because of the positive effects on public revenues resulting from the stimulation of economic activity brought about by the renovation works. The following tables present the financial results over time for different levels of tax deduction and different assumptions as to whether each tax deduction mobilizes sufficient private resources to implement the investments provided for in each of the three scenarios for energy upgrades of households.

In order to ensure the effectiveness of the tax deduction measure, it is important that the discount covers the broadest range of tax obligations of citizens beyond the income tax (e.g. ENFIA). It would also be important for the beneficiaries of the tax deduction to be able to pass on any deduction balance they are entitled to in subsequent tax years if the tax credit they are entitled to is greater than their tax obligations in the year of investment. In these ways the tax credit will be an incentive for more households, especially for low-income households, which often have even more urgent needs for energy upgrading their homes.

It is worth noting that incentives on the part of the state, such as the tax deduction for energy upgrades in households, may bring additional financial benefits. In fact, the transactions that will be made in the context of the implementation of the measure between households and upgrading workshops will be legally recorded (transactions for which the legal documents will be issued), bringing to light a part of the economic activity that would otherwise belong to the underground economy, along with the consequent benefits that this entails, both in terms of corporate income tax and indirect taxation (VAT).

[63] The stimulation of the economic activity by the energy upgrading renovations is becoming smaller over time, as energy savings entail a reduction in economic activity in the energy production branches.

Table 5.1: Annual budget surplus(+)/shortage(-) per scenario, per tax deduction rate, which mobilizes private investments for renovations at the level of each scenario and per year, in absolute terms (€ million) and as a percentage of the corresponding annual cost of energy upgrading interventions.

		Tax exemption 20%		Tax exemption 30%		Tax exemption 40%		Tax exemption 50%	
	Year	€ mil.	% of interventi on cost	€ mil.	% of interventi on cost	€ mil.	% of interventi on cost	€ mil.	% of interventi on cost
Conservative scenario	2018	2	3%	-6	-7%	-13	-17%	-21	-27%
	2019	2	2%	-9	-8%	-20	-18%	-32	-28%
	2020	1	1%	-12	-9%	-25	-19%	-39	-29%
	2021	1	1%	-16	-9%	-34	-19%	-51	-29%
	2022	0	0%	-21	-10%	-42	-20%	-64	-30%
	2023	-1	0%	-29	-10%	-57	-20%	-85	-30%
	2024	-3	-1%	-33	-11%	-63	-21%	-92	-31%
	2025	-7	-2%	-39	-12%	-71	-22%	-103	-32%
	2026	-9	-2%	-46	-12%	-83	-22%	-120	-32%
	2027	-13	-3%	-55	-13%	-97	-23%	-139	-33%
	2028	-16	-3%	-67	-13%	-119	-23%	-170	-33%
	2029	-21	-4%	-78	-14%	-135	-24%	-193	-34%
	2030	-27	-4%	-89	-14%	-151	-24%	-213	-34%
Ambitious scenario	2018	12	3%	-34	-7%	-79	-17%	-125	-27%
	2019	11	2%	-53	-8%	-118	-18%	-183	-28%
	2020	8	1%	-72	-9%	-152	-19%	-232	-29%
	2021	6	1%	-98	-9%	-202	-19%	-306	-29%
	2022	-2	0%	-123	-10%	-244	-20%	-365	-30%
	2023	-13	-1%	-148	-11%	-282	-21%	-416	-31%
	2024	-25	-2%	-169	-12%	-314	-22%	-458	-32%
	2025	-41	-3%	-196	-13%	-352	-23%	-507	-33%
	2026	-61	-4%	-215	-14%	-369	-24%	-522	-34%
	2027	-83	-5%	-234	-15%	-386	-25%	-538	-35%
	2028	-104	-7%	-254	-17%	-404	-27%	-554	-37%
	2029	-125	-8%	-273	-18%	-421	-28%	-570	-38%
	2030	-146	-10%	-292	-20%	-439	-30%	-586	-40%
Target scenario	2018	15	3%	-42	-7%	-99	-17%	-156	-27%
	2019	9	1%	-53	-9%	-116	-19%	-179	-29%
	2020	2	0%	-62	-10%	-126	-20%	-190	-30%
	2021	-4	-1%	-70	-11%	-136	-21%	-202	-31%
	2022	-11	-2%	-78	-12%	-145	-22%	-212	-32%
	2023	-19	-3%	-89	-13%	-158	-23%	-228	-33%
	2024	-26	-4%	-97	-14%	-169	-24%	-240	-34%
	2025	-35	-5%	-108	-15%	-181	-25%	-254	-35%
	2026	-44	-6%	-119	-16%	-193	-26%	-267	-36%
	2027	-54	-7%	-130	-17%	-205	-27%	-281	-37%
	2028	-64	-8%	-141	-18%	-218	-28%	-295	-38%
	2029	-74	-9%	-152	-19%	-231	-29%	-309	-39%
	2030	-84	-11%	-164	-21%	-244	-31%	-324	-41%

Table 5.2: Aggregate budget surplus(+)/shortage(-) per scenario, per tax deduction rate that mobilizes private investments for renovations at the level of each scenario and per year in absolute terms (€ million) and as a percentage of the corresponding aggregate cost of energy upgrading interventions.

		Tax exemption 20%		Tax exemption 30%		Tax exemption 40%		Tax exemption 50%	
	Year	€ mil.	% of intervention cost	€ mil.	% of intervention cost	€ mil.	% of intervention cost	€ mil.	% of intervention cost
Conservative scenario	2018	2	3%	-6	-7%	-13	-17%	-21	-27%
	2019	4	2%	-15	-8%	-34	-18%	-53	-28%
	2020	5	2%	-27	-8%	-59	-18%	-91	-28%
	2021	6	1%	-43	-9%	-93	-19%	-142	-29%
	2022	6	1%	-65	-9%	-135	-19%	-206	-29%
	2023	5	1%	-93	-9%	-192	-19%	-291	-29%
	2024	2	0%	-127	-10%	-255	-20%	-383	-30%
	2025	-5	0%	-165	-10%	-325	-20%	-486	-30%
	2026	-14	-1%	-211	-11%	-409	-21%	-606	-31%
	2027	-27	-1%	-266	-11%	-506	-21%	-745	-31%
	2028	-42	-1%	-333	-11%	-625	-21%	-916	-31%
	2029	-63	-2%	-411	-12%	-760	-22%	-1.108	-32%
	2030	-90	-2%	-501	-12%	-911	-22%	-1.321	-32%
Ambitious scenario	2018	12	3%	-34	-7%	-79	-17%	-125	-27%
	2019	23	2%	-87	-8%	-197	-18%	-308	-28%
	2020	31	2%	-159	-8%	-350	-18%	-540	-28%
	2021	37	1%	-258	-9%	-552	-19%	-846	-29%
	2022	35	1%	-380	-9%	-796	-19%	-1.211	-29%
	2023	22	0%	-528	-10%	-1.078	-20%	-1.627	-30%
	2024	-3	0%	-697	-10%	-1.392	-20%	-2.086	-30%
	2025	-44	-1%	-894	-11%	-1.743	-21%	-2.593	-31%
	2026	-105	-1%	-1.109	-11%	-2.112	-21%	-3.115	-31%
	2027	-188	-2%	-1.343	-12%	-2.498	-22%	-3.653	-32%
	2028	-291	-2%	-1.597	-12%	-2.902	-22%	-4.207	-32%
	2029	-416	-3%	-1.870	-13%	-3.324	-23%	-4.777	-33%
	2030	-562	-4%	-2.162	-14%	-3.763	-24%	-5.363	-34%
Targret scenario	2018	15	3%	-42	-7%	-99	-17%	-156	-27%
	2019	24	2%	-95	-8%	-215	-18%	-335	-28%
	2020	27	1%	-157	-9%	-341	-19%	-525	-29%
	2021	23	1%	-227	-9%	-477	-19%	-727	-29%
	2022	12	0%	-305	-10%	-622	-20%	-939	-30%
	2023	-7	0%	-394	-10%	-780	-20%	-1.167	-30%
	2024	-33	-1%	-491	-11%	-949	-21%	-1.406	-31%
	2025	-69	-1%	-599	-11%	-1.130	-21%	-1.660	-31%
	2026	-113	-2%	-718	-12%	-1.323	-22%	-1.927	-32%
	2027	-167	-2%	-847	-12%	-1.528	-22%	-2.208	-32%
	2028	-231	-3%	-988	-13%	-1.746	-23%	-2.503	-33%
	2029	-305	-4%	-1.141	-14%	-1.977	-24%	-2.812	-34%
	2030	-389	-4%	-1.305	-14%	-2.220	-24%	-3.136	-34%

6. APPENDIX

6.1 Methodological notes

The economic analysis to determine the economic footprint of the energy upgrading activities of buildings includes the calculation of updated input-output tables for domestic production in Greece and the use of imports based on the latest available input/output tables available, published by Eurostat for the Greek economy, and the use of the updated tables to calculate the direct, indirect and induced effects of energy upgrading activities in Greece's economy. For the calculation of the net effects of energy upgrading activities, both the positive effects of increased investment expenditure for energy upgrades (the gross economic effect of such investments) and the negative effects of the reduction in energy expenditure, due to energy savings in buildings are taken into account.

6.1.1 Input-output tables update

This section describes the methodology for updating input-output tables for the years 2018 to 2026[64]. Initially, estimates were made for gross output, value added and employment by industry, and for household consumption, government, fixed capital formation, exports and other figures for the years 2017-2026, using statistics on these figures from the national accounts. For each such economic variable, a first order autoregressive model was evaluated using statistics for the period 2000-2016[65], on the basis of which the forecasts for the values of the variables in the years 2017-2026 were estimated.

For each of the years 2018 to 2026, the following procedure was followed. The national symmetric input-output table for domestic production in Greece for the year in question was constructed by updating the input-output table data for 2010, as published in a standardized form by Eurostat[66], using the aforementioned financial forecasts for the year in question. The input-output table for domestic production presents the sectoral structure of Greek production, categorized in 63 sectors of economic activity[67].
For each year's table, the figures for the sectoral structure of gross production value (output), value added, net operating surplus[68], consumption of fixed capital, taxes on production, labor

[64] For the years 2027-2030, up-to-date input-output tables were not constructed as there was insufficient data on which the forecasts could be based. The analysis of economic impacts for the years 2027-2030 was made using the input/output tables for the year 2026

[65] See Eurostat - National Accounts aggregates by industry (up to NACE A * 64) [nama_10_a64] http://ec.europa.eu/eurostat/data/database?node_code=nama_10_a64 and GDP and main components (output, expenditure and income) nama_10_gdp]
http://ec.europa.eu/eurostat/data/database?node_code=nama_10_gdp

[66] See symmetric input-output tables for Greece: http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/methodology/symmetric-input-output-tables (tables for Greece, NACE Rev. 2, Greece_suiot_130124.xlsx, worksheets dom10, imp10)

[67] The classification of economic activity in Greece by Eurostat is done according to the NACE Rev. 2 statistical classification and includes 64 branches of economic activity. However, the 'CPA_U - Offshore Services' sector is not included in the sectoral analysis of Greek production, as published by Eurostat, encoded in the relevant input/output tables due to the lack of sufficiently detailed relevant statistical data. This sector is not taken into account in the analysis to determine the economic impacts of the energy upgrading activities of buildings. Excluding this industry has no impact on the accuracy of the calculations

[68] The net operating surplus of a branch is equal to the total revenue of the economic units in the industry, by deducting the expenditures for disposals (by imports and domestic suppliers), payroll, depreciation of fixed assets (consumption of fixed capital) and taxes (on production and on products)

costs, net employee compensation and total intermediate consumption of each branch of the economy were updated on the basis of the forecasts for the year under review. Data on total household, non-profit organizations and government consumption as well as figures for total gross fixed capital formation, total inventories, total exports, imports and product taxes for the year under review were also updated. The individual intermediate consumption of domestically produced goods in each sector, the sectoral use of inputs and the corresponding taxes on products, as well as the sectoral structure of household, non-profit institutions and government consumption, and the sectoral structure of exports were calculated on the basis of the corresponding total intermediate consumption and total uses for the year under review and the respective percentages of the individual uses over the total, as derived from the input-output table for the year 2010.

The change in inventories in the year under review was assumed to be entirely domestic stocks. The amount of total use of imported products for gross fixed capital formation and the corresponding taxes on products were determined in such a way that the difference between the total use of products in the economy (total and intermediate uses) and the total use of domestic products equals the sum of total imports and total taxes on products. The sectoral structure of gross fixed capital formation was calculated on the basis of the total use of domestic products used for gross fixed capital formation in the year under review and the respective percentages of individual (per branch) product uses over the corresponding total domestic use for fixed capital formation in 2010. The sectoral structure of inventory change was calculated in the same way.

Subsequently, adjustments were made to the specified quantities of certain sub-uses, so that the total use for each branch is equal to the gross production value of the industry, in order to ensure symmetry of the input-output table for the year under review. The amount of the adjustment (quantity added or removed) for each individual use (partial intermediate consumption or end-use of domestic products, import use or product tax) was determined by solving an optimization problem (quadratic programming) under the following constraints. Adjustments leave the total use of domestic products for each branch unaffected, ensure symmetry of the input-output table, ensure that the total intermediate use and use for household consumption for each branch does not exceed industry output and is calculated to minimize the sum of the percentage changes in each use and to minimize the deviation of the sectoral structure of total intermediate use of domestic products from the corresponding structure in 2010.

The input-output table for the use of imports is calculated by allocating the total use of imports of each intermediate consumption and each end-use, as derived from the calculation of the table for domestic production, in the sub-sectors, based on the respective proportion of imports of each sector (column) to the total import consumption for that use, as reflected in the import input/output table for 2010.

6.1.2 Calculation of economic effects

Based on the input-output tables for domestic production and imports, the total economic impact of the energy upgrading activities of buildings can be calculated. The calculation of the economic impact is based on estimates of the total cost per year of the building renovation activities of each scenario (estimates of the total annual cost of energy upgrading activities) as given in the "Long-term strategy report on the mobilization of investments for the renovation of the residential and commercial, public and private, national stock buildings" by YPEN and estimates for the reduction of the expenditure for energy products due to the energy savings in buildings.

6.1.2.1 Input-Output Model

The calculation of the economic effects of the energy upgrading activities of buildings using the input-output model is as follows:

Initially, the gross economic effects of investments in energy upgrading of buildings are calculated. The direct impacts of energy upgrading activities on the economy include the gross output value of energy upgrading activities covering both the value of the materials and equipment and the value of the installation services (gross value of production), the respective value added of these activities, the employment in energy upgrading activities and other relevant variables.

The following procedure is used to calculate the indirect effects. The domestic input-output table for the year at hand is used to calculate the quantities of domestic inputs required to produce one unit of each product and to build the corresponding direct requirements table for Type I Leontief. Table A has dimensions [63 x 63] (one line and one column per sector/branch of economic activity). Each element in Table A expresses the quantity, in terms of value, of the product of the corresponding row in the table required to produce one unit of product in the corresponding column of the table:

$$A = [\alpha_{i,j}]\ with\ i,j = 1,2,\dots,63\ \text{ and } \alpha_{i,j} = \frac{input\ use\ i\ by\ sectorj}{production\ value\ of\ sector\ j}$$

Using Table A, the Leontief table for indirect effects (Leontief type I) is calculated as:

$$L_A = (I - A)^{-1}$$

The L_A table can be used to determine the effects on the economy as a whole of an exogenous increase in demand in one or more sectors of the economy. It is worth noting the following:

If T is the column vector [63 x 1] of total industry demand for each sector, W is the column of demand for intermediate consumption in the economy and F is the column of final demand in the economy, assuming that household consumption is included in the final demand:

$T = [t_{i,1}]\ with\ i = 1,2,\dots,63$ and $t_{i,1}$= total demand for the product i

$W = [h_{i,1}]\ with\ i = 1,2,\dots,63\ and\ w_{i,1}$demand for goods i for intermediate consumption

$F = [f_{i,1}]\ with\ i = 1,2,\dots,63\ and\ f_{i,1}$= demand for goods i for final consumption

Then it holds that:

$$W + F = T$$

By construction of table A, it also holds that:

$$A \cdot T = W$$

It follows that:

$$T = L_A \cdot F$$

The latter equation allows the calculation of indirect effects on the overall output of the economy from an external shock to final demand.

To determine the (gross) indirect effects of energy upgrading activities on the economy, using the Leontief L_A table, the impact on total output is calculated by an increase in final demand in the Constructions sector equal to the annual expenditure on energy upgrading activities, as estimated for each scenario and for the year under review in the YPEN report.

The calculation of the (gross) induced effects of energy upgrading activities follows a similar process. The Leontief table for indirect and induced effects (Leontief type II) is being constructed, taking into account the domestic consumption of households combined with wages offered by each sector[69]. Gross indirect and induced effects of energy upgrading activities are calculated, using this Leontief table, as the economic result of an increase in demand in the Constructions sector equal to the total cost of an energy upgrading activity.

It is noted that for the calculation of income taxes it was considered that the average tax rate for labor income is 22.3% and the average corporate tax rate for corporate profits is 6.3%, according to the latest available national accounts data by Eurostat[70].

Then, indirect and induced effects from the reduction in energy consumption are calculated with the same method.

Initially, for each scenario and for each year, the corresponding reduction in household expenditure on energy products resulting from the reduction of energy consumption in buildings due to their energy upgrading is calculated. For each scenario and each year the total additional saved energy is calculated, above the savings of the corresponding base scenario, as derived from the construction of the scenarios in the YPEN report. Using household energy consumption data from the ELSTAT Household Energy Survey for 2011-2012, as well as household expenditure from the ELSTAT Household Budget Survey (HBS) for 2016, the average household expenditure per unit of energy consumed for thermal uses is calculated. Expenditure on thermal uses was taken to cover the costs of solid, liquid and gaseous fuels, the costs of district heating, as well as part of the cost of electricity used for heating and cooling and hot water production (a total of 17.3% of electricity consumed by households, according to ELSTAT[71]). Based on these data, the average household expenditure per unit of energy consumed for thermal uses is calculated as 868 €/toe. Considering this average energy

[69] Within this approach, households are also treated as a sector that uses inputs to produce a 'product', labor. Labor in turn is used as an input from the rest of the economy
[70] See Eurostat, Main national accounts tax aggregates [gov_10a_taxag], data for 2015
[71] See p. ELSTAT, Survey on Household Energy Consumption, 2011-2012

price for thermal uses over a period of time constant in real terms, and based on year-on-year energy savings, the reduction in consumer expenditure on energy goods per year is calculated for each scenario[72]. Next, on the basis of the aforementioned data on energy consumption and relevant household expenditure, the expenditure on energy goods is shared in the three sectors of economic activity, according to the NACE Rev.2 classification: Electricity and Natural Gas Division (code D35), Mining Sector (C19) and Forestry / Wood Industry (A02, concerns firewood and other solid fuels). When allocating the cost savings to the three sub-sectors, the part of the expenditure related to imported energy goods is deducted, as shown by the input-output tables for 2010, so only the part of reduced expenditure corresponding to domestically produced energy goods is taken into account for the calculation of the economic effects.

Next, the indirect and induced economic effects of reducing energy expenditure are calculated for each scenario and year as the impact on total output from a reduction in final demand for domestically produced energy goods.

The net indirect and induced effects of building upgrading activities arise by deducting the effects by the energy consumption reduction from the gross effects of energy upgrading of buildings.

[72] For the calculation of the reduction of energy expenditure by the tertiary sector, in the corresponding scenario, it was considered that the average expenditure on energy products for thermal uses by the tertiary sector is also equal to 868 €/toe, fixed in real terms, similar to households

6.2 Characteristics of energy saving scenarios in buildings

Table 6.1: Conservative residential scenario - Renovated homes per year and per degree of energy upgrading, energy savings from new renovations and new renovation costs per year

	Renovated houses (% of total housing stock)			Energy savings	Cost of new renovations
Year	20%	40%	60%	ktoe	€ mil.
2018	0,52%	0,16%	0,05%	24,3	77,6
2019	0,55%	0,20%	0,07%	27,4	111,6
2020	0,60%	0,24%	0,07%	29,4	132,5
2021	0,72%	0,25%	0,09%	33,2	172,5
2022	0,81%	0,26%	0,10%	37,0	211,8
2023	1,01%	0,29%	0,12%	43,7	281,0
2024	1,05%	0,29%	0,14%	45,5	296,8
2025	1,07%	0,34%	0,14%	48,0	319,8
2026	1,12%	0,38%	0,16%	53,2	371,0
2027	1,12%	0,49%	0,18%	58,6	421,6
2028	1,14%	0,70%	0,16%	68,4	516,0
2029	1,16%	0,80%	0,20%	74,6	572,6
2030	1,17%	0,89%	0,20%	80,1	618,8

Table 6.2: Ambitious residential scenario - Renovated homes per year and per degree of energy upgrading, energy savings from new renovations and new renovation costs per year

	Renovated houses (% of total housing stock)			Energy savings	Cost of new renovations
Year	20%	40%	60%	ktoe	€ mil.
2018	0,28%	0,40%	0,60%	58,0	457,2
2019	0,25%	0,45%	0,80%	75,3	646,6
2020	0,21%	0,50%	1,00%	89,9	799,8
2021	0,19%	0,61%	1,28%	112,6	1.039,9
2022	0,16%	0,70%	1,50%	129,2	1.209,7
2023	0,18%	0,79%	1,60%	143,1	1.344,5
2024	0,17%	0,88%	1,66%	154,0	1.445,5
2025	0,15%	1,02%	1,75%	165,8	1.553,3
2026	0,16%	1,00%	1,75%	165,8	1.536,0
2027	0,16%	1,01%	1,75%	165,8	1.518,7
2028	0,16%	1,01%	1,75%	165,8	1.501,5
2029	0,16%	1,01%	1,75%	165,8	1.484,3
2030	0,16%	1,01%	1,75%	165,8	1.467,0

Table 6.3: Target residential scenario - Renovated homes per year and per degree of energy upgrading, energy savings from new renovations and new renovation costs per year

	Renovated houses (% of total housing stock)			Energy savings	Cost of new renovations
Έτος	20%	40%	60%	ktoe	€ εκατ.
2018	0,44%	0,55%	0,49%	68,0	570,3
2019	0,44%	0,58%	0,56%	73,5	626,7
2020	0,44%	0,58%	0,60%	75,6	642,3
2021	0,49%	0,58%	0,62%	78,0	662,3
2022	0,52%	0,61%	0,60%	79,1	667,4
2023	0,60%	0,66%	0,59%	82,5	695,9
2024	0,59%	0,70%	0,61%	84,7	711,9
2025	0,59%	0,75%	0,61%	86,9	727,5
2026	0,60%	0,80%	0,61%	89,2	742,5
2027	0,60%	0,86%	0,59%	91,4	756,9
2028	0,60%	0,91%	0,59%	93,6	770,8
2029	0,60%	0,95%	0,60%	95,9	784,3
2030	0,60%	1,00%	0,60%	98,0	797,2

Table 6.4: Target Scenario for tertiary sector buildings - Energy savings from new renovations and new renovation costs per year

	Energy savings	Cost of new renovations
Year	ktoe	€ mil.
2018	22,1	156,5
2019	23,7	178,0
2020	25,0	194,8
2021	31,0	286,5
2022	36,2	364,1
2023	46,7	525,3
2024	58,5	704,7
2025	63,1	764,2
2026	63,1	753,3
2027	63,1	742,5
2028	63,1	731,6
2029	63,1	720,8
2030	63,1	709,9

6.3 Financial analysis result tables - Net effects

The following tables (Table 6.5 to Table 6.11) show the net economic effects per scenario and per year. Net impacts arise by deducting the effects of reducing energy expenditure on energy savings from the effects of investment in energy upgrading of buildings.

Table 6.5: Household intervention scenarios - Net direct, indirect and induced effects on GDP, per scenario and per year (€ million)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	29.2	30.8	51.3	172.3	181.5	302.4	214.9	226.4	377.2
2019	40.2	43.5	70.5	233.1	251.9	408.2	223.0	242.5	391.4
2020	45.5	50.5	79.8	275.5	305.0	483.0	214.0	240.9	377.5
2021	57.4	64.8	101.0	346.6	391.2	610.0	206.1	241.0	367.5
2022	67.9	78.3	119.8	385.1	445.9	680.6	191.8	234.6	345.9
2023	88.7	103.3	156.0	405.8	484.4	719.9	185.9	237.5	338.2
2024	87.5	106.1	156.8	409.9	508.0	740.1	174.4	235.2	325.4
2025	88.6	111.2	160.0	413.5	531.0	752.7	162.0	231.5	307.3
2026	99.6	127.4	181.0	367.0	502.9	683.9	148.8	227.6	289.5
2027	108.9	142.5	199.5	320.8	474.4	615.7	135.0	223.0	271.1
2028	133.2	174.3	244.0	274.6	446.0	547.5	120.4	217.9	251.5
2029	140.7	189.6	260.6	228.4	417.7	479.3	105.1	212.2	230.8
2030	142.6	199.8	268.0	182.2	389.2	411.1	88.9	206.0	208.8

Table 6.6: Household intervention scenarios - Net direct, indirect and induced effects on employment, by scenario and per year (equivalent full-time jobs - FTE)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	877	914	1,077	5,172	5,388	6,349	6,452	6,721	7,919
2019	1,146	1,314	1,486	6,639	7,614	8,612	6,278	7,327	8,257
2020	1,223	1,546	1,688	7,432	9,347	10,214	5,576	7,377	7,982
2021	1,477	2,016	2,135	8,950	12,168	12,893	4,895	7,490	7,766
2022	1,663	2,452	2,531	9,344	13,959	14,374	4,011	7,334	7,305
2023	2,116	3,266	3,291	9,091	15,301	15,188	3,362	7,494	7,136
2024	1,883	3,374	3,307	8,247	16,142	15,610	2,522	7,467	6,863
2025	1,700	3,544	3,377	7,301	16,912	15,886	1,640	7,365	6,485
2026	1,781	4,068	3,820	4,813	16,045	14,437	715	7,255	6,111
2027	1,784	4,548	4,211	2,385	15,127	12,997	-214	7,103	5,722
2028	2,178	5,564	5,152	-44	14,209	11,556	-1,182	6,934	5,309
2029	2,015	6,050	5,500	-2,471	13,292	10,118	-2,189	6,750	4,871
2030	1,645	6,372	5,657	-4,900	12,374	8,678	-3,236	6,547	4,407

Table 6.7: Household intervention scenarios - Net direct, indirect and induced effects on government revenue, by scenario and per year (equivalent full-time jobs - FTE)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	8.1	9.6	17.6	47.7	56.8	103.6	59.5	70.9	129.2
2019	10.9	13.7	24.2	63.2	79.2	140.5	60.2	76.3	134.7
2020	12.1	15.9	27.7	73.3	96.2	167.6	56.3	76.0	130.9
2021	15.0	20.5	35.4	91.0	123.8	213.7	52.7	76.3	128.7
2022	17.5	24.8	42.3	99.2	141.2	240.3	47.4	74.3	122.1
2023	22.7	32.8	55.4	102.3	153.5	255.8	44.4	75.3	120.2
2024	21.8	33.8	56.0	100.5	161.8	264.3	39.7	74.9	116.2
2025	21.5	35.4	57.3	98.3	168.8	269.7	34.8	73.6	110.1
2026	23.7	40.5	65.0	82.2	159.7	245.8	29.6	72.3	104.0
2027	25.5	45.2	71.7	66.3	150.7	221.2	24.2	70.8	97.4
2028	31.1	55.4	87.7	50.4	141.6	196.7	18.6	69.2	90.4
2029	32.0	60.2	93.6	34.5	132.6	172.2	12.7	67.4	82.9
2030	31.2	63.4	96.3	18.6	123.6	147.7	6.5	65.4	75.0

Table 6.8: Household intervention scenarios - Net total effects on GDP (€ million), employment (FTE) and government revenue (€ million), per scenario and per year

	GDP			Employment			Public revenues		
Year	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target
2018	111.3	656.1	818.4	2,867	16,909	21,092	35.3	208.1	259.6
2019	154.2	893.2	856.8	3,947	22,865	21,862	48.8	282.9	271.2
2020	175.8	1,063.6	832.4	4,457	26,993	20,935	55.7	337.1	263.2
2021	223.2	1,347.9	814.5	5,628	34,011	20,151	70.9	428.4	257.7
2022	266.1	1,511.6	772.2	6,647	37,677	18,650	84.7	480.8	243.9
2023	348.0	1,610.0	761.6	8,673	39,580	17,993	110.9	511.6	239.9
2024	350.5	1,657.9	734.9	8,564	40,000	16,852	111.6	526.5	230.9
2025	359.9	1,697.3	700.8	8,621	40,099	15,489	114.1	536.7	218.5
2026	408.0	1,553.8	665.9	9,669	35,295	14,080	129.2	487.6	205.9
2027	450.9	1,410.9	629.1	10,543	30,508	12,612	142.4	438.2	192.4
2028	551.6	1,268.1	589.8	12,894	25,722	11,061	174.2	388.8	178.1
2029	590.9	1,125.4	548.0	13,566	20,939	9,431	185.9	339.4	163.0
2030	610.4	982.6	503.7	13,675	16,152	7,718	191.0	289.9	147.0

Table 6.9: Household intervention scenarios - Net total effects on GDP, employment and government revenue as a percentage of total GDP, employment and government revenue in the country respectively, per scenario and per year

	GDP			Employment			Public revenues		
Year	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target
2018	0.06%	0.35%	0.43%	0.07%	0.39%	0.49%	0.05%	0.30%	0.37%
2019	0.08%	0.45%	0.44%	0.09%	0.51%	0.48%	0.07%	0.39%	0.37%
2020	0.09%	0.52%	0.41%	0.09%	0.57%	0.44%	0.07%	0.44%	0.35%
2021	0.11%	0.64%	0.38%	0.11%	0.69%	0.41%	0.09%	0.54%	0.33%
2022	0.12%	0.69%	0.35%	0.13%	0.74%	0.37%	0.10%	0.59%	0.30%
2023	0.15%	0.71%	0.34%	0.17%	0.75%	0.34%	0.13%	0.61%	0.28%
2024	0.15%	0.71%	0.32%	0.16%	0.74%	0.31%	0.13%	0.60%	0.26%
2025	0.15%	0.71%	0.29%	0.15%	0.72%	0.28%	0.13%	0.60%	0.24%
2026	0.16%	0.63%	0.27%	0.17%	0.61%	0.24%	0.14%	0.52%	0.22%
2027	0.18%	0.57%	0.25%	0.18%	0.53%	0.22%	0.15%	0.47%	0.21%
2028	0.22%	0.51%	0.24%	0.22%	0.44%	0.19%	0.19%	0.42%	0.19%
2029	0.24%	0.45%	0.22%	0.23%	0.36%	0.16%	0.20%	0.36%	0.17%
2030	0.25%	0.40%	0.20%	0.24%	0.28%	0.13%	0.20%	0.31%	0.16%

Table 6.10: Target scenario for tertiary sector buildings - Net direct, indirect and induced effects on GDP (€ million), employment (FTE) and government revenue (€ million) per year

	GDP			Employment			Public revenues		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	60.1	62.8	105.2	1,830	1,865	2,208	16.7	19.7	36.0
2019	65.9	70.3	114.8	1,917	2,127	2,422	18.0	22.1	39.5
2020	69.3	75.5	120.8	1,930	2,315	2,555	18.6	23.8	41.9
2021	101.2	110.9	176.2	2,777	3,452	3,724	27.1	35.1	61.7
2022	126.0	139.8	219.3	3,372	4,381	4,632	33.4	44.3	77.4
2023	181.5	201.8	314.1	4,833	6,384	6,626	48.1	64.0	111.6
2024	241.2	270.2	419.6	6,337	8,596	8,851	63.6	86.0	149.9
2025	251.6	287.4	439.2	6,298	9,166	9,269	65.4	91.3	157.3
2026	233.8	275.7	412.8	5,395	8,812	8,713	59.4	87.6	148.3
2027	216.1	264.0	386.2	4,507	8,433	8,152	53.5	83.8	138.8
2028	198.3	252.3	359.6	3,620	8,055	7,591	47.5	80.1	129.2
2029	180.6	240.5	333.0	2,732	7,677	7,030	41.5	76.4	119.7
2030	162.9	228.8	306.4	1,845	7,298	6,468	35.6	72.7	110.1

Table 6.11: Target scenario for tertiary sector buildings - Net total effects on GDP, employment and government revenues per year as absolute values and as a percentage of total GDP, employment and government revenue in the country respectively

	GDP		Employment		Public revenues	
Year	€ mil.	%	FTEs	%	€ mil.	%
2018	228.1	0.12%	5,904	0.14%	72.4	0.10%
2019	251.0	0.13%	6,466	0.14%	79.6	0.11%
2020	265.6	0.13%	6,800	0.14%	84.4	0.11%
2021	388.3	0.18%	9,953	0.20%	123.9	0.16%
2022	485.1	0.22%	12,384	0.24%	155.1	0.19%
2023	697.4	0.31%	17,844	0.34%	223.7	0.27%
2024	931.0	0.40%	23,784	0.44%	299.5	0.34%
2025	978.1	0.41%	24,733	0.44%	314.1	0.35%
2026	922.3	0.37%	22,920	0.40%	295.3	0.32%
2027	866.2	0.35%	21,093	0.36%	276.1	0.30%
2028	810.2	0.33%	19,266	0.33%	256.8	0.28%
2029	754.1	0.30%	17,439	0.30%	237.6	0.25%
2030	698.1	0.28%	15,611	0.27%	218.3	0.23%

6.4 Economic Analysis result tables - Gross effects

The following tables (Table 6.12 to Table 6.18) show the gross economic effects per scenario and per year. Gross effects are the effects of investments on energy upgrading of buildings, without taking into account the economic impact of reducing energy expenditure on energy savings.

Table 6.12: Household intervention scenarios - Gross direct, indirect and induced effects on GDP, per scenario and per year (€ million)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	31,0	31,8	53,9	182,8	187,4	317,8	228,0	233,8	396,4
2019	44,7	46,0	76,8	258,8	266,3	445,2	250,8	258,1	431,5
2020	53,1	54,7	90,7	320,2	330,0	547,2	257,1	264,9	439,4
2021	69,1	71,3	117,8	416,4	429,9	709,9	265,2	273,8	452,1
2022	84,8	87,6	144,0	484,4	500,7	822,6	267,2	276,2	453,8
2023	112,5	116,4	189,9	538,4	556,9	908,9	278,7	288,3	470,4
2024	118,8	123,2	201,3	578,8	600,0	980,5	285,1	295,5	482,9
2025	128,1	132,7	216,4	622,0	644,2	1.051,1	291,3	301,7	492,3
2026	148,6	153,9	251,4	615,1	637,1	1.040,8	297,3	307,9	503,1
2027	168,8	174,9	285,7	608,2	629,9	1.029,0	303,1	313,9	512,8
2028	206,6	214,0	349,6	601,2	622,7	1.017,3	308,7	319,7	522,3
2029	229,3	237,5	388,0	594,4	615,6	1.005,7	314,1	325,3	531,4
2030	247,8	256,6	419,2	587,4	608,4	994,0	319,2	330,6	540,2

Table 6.13: Household intervention scenarios - Gross direct, indirect and induced effects on employment, by scenario and per year (equivalent full-time jobs - FTE)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	972	947	1.132	5.724	5.580	6.672	7.140	6.961	8.323
2019	1.383	1.394	1.621	8.008	8.076	9.393	7.762	7.827	9.104
2020	1.633	1.680	1.918	9.853	10.140	11.571	7.911	8.142	9.292
2021	2.120	2.223	2.489	12.773	13.400	15.004	8.135	8.534	9.555
2022	2.598	2.751	3.041	14.837	15.719	17.373	8.186	8.671	9.584
2023	3.445	3.687	4.008	16.478	17.641	19.175	8.530	9.131	9.925
2024	3.637	3.924	4.246	17.709	19.111	20.681	8.722	9.412	10.185
2025	3.918	4.237	4.568	19.026	20.576	22.182	8.911	9.637	10.389
2026	4.545	4.926	5.307	18.812	20.393	21.969	9.094	9.857	10.619
2027	5.164	5.597	6.030	18.601	20.164	21.722	9.270	10.049	10.826
2028	6.320	6.851	7.380	18.389	19.934	21.475	9.441	10.234	11.025
2029	7.013	7.602	8.189	18.178	19.706	21.229	9.606	10.413	11.218
2030	7.579	8.215	8.850	17.967	19.477	20.982	9.764	10.584	11.402

Table 6.14: Household intervention scenarios - Gross direct, indirect and induced effects on government revenue, per scenario and per year (€ million)

	Conservative scenario			Ambitious scenario			Target scenario		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	8,7	10,0	18,5	51,4	58,7	108,8	64,2	73,2	135,8
2019	12,5	14,4	26,4	72,3	83,7	153,2	70,0	81,1	148,5
2020	14,8	17,2	31,5	89,1	104,0	189,8	71,5	83,5	152,4
2021	19,2	22,5	41,3	115,6	135,9	248,7	73,6	86,5	158,4
2022	23,5	27,7	50,8	134,3	158,5	290,5	74,1	87,4	160,2
2023	31,2	36,9	67,5	149,2	176,4	323,0	77,2	91,3	167,2
2024	32,9	39,2	71,9	160,4	190,9	350,1	79,0	94,0	172,4
2025	35,5	42,1	77,5	172,3	204,6	376,5	80,7	95,8	176,4
2026	41,2	48,9	90,3	170,4	202,4	374,0	82,4	97,8	180,8
2027	46,8	55,5	102,6	168,5	200,1	369,8	84,0	99,7	184,3
2028	57,2	68,0	125,6	166,5	197,8	365,6	85,5	101,5	187,7
2029	63,5	75,4	139,4	164,6	195,5	361,4	87,0	103,3	191,0
2030	68,6	81,5	150,7	162,7	193,3	357,2	88,4	105,0	194,1

Table 6.15: Household intervention scenarios - Gross total effects on GDP (€ million), employment (FTE) and government revenue (€ million), per scenario and per year

	GDP			Employment			Public revenues		
Year	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target
2018	116,7	688,0	858,2	3.050	17.976	22.424	37,1	219,0	273,1
2019	167,4	970,3	940,5	4.397	25.478	24.693	53,4	309,2	299,7
2020	198,4	1.197,4	961,5	5.231	31.564	25.345	63,5	382,9	307,5
2021	258,2	1.556,2	991,1	6.833	41.177	26.224	83,0	500,1	318,5
2022	316,4	1.807,7	997,2	8.391	47.929	26.441	102,1	583,3	321,8
2023	418,9	2.004,2	1.037,3	11.139	53.295	27.585	135,6	648,6	335,7
2024	443,4	2.159,3	1.063,5	11.807	57.500	28.320	144,0	701,4	345,4
2025	477,2	2.317,3	1.085,3	12.723	61.784	28.937	155,1	753,4	352,9
2026	553,9	2.292,9	1.108,3	14.778	61.175	29.570	180,4	746,7	360,9
2027	629,3	2.267,1	1.129,9	16.792	60.486	30.145	205,0	738,3	368,0
2028	770,3	2.241,3	1.150,6	20.551	59.798	30.700	250,8	729,9	374,7
2029	854,7	2.215,6	1.170,8	22.804	59.114	31.238	278,3	721,5	381,3
2030	923,6	2.189,8	1.190,0	24.644	58.425	31.751	300,8	713,1	387,6

Table 6.16: Household intervention scenarios - Gross total effects on GDP, employment and government revenue as a percentage of total GDP, employment and government revenue in the country respectively, per scenario and per year

	GDP			Employment			Public revenues		
Year	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target	Conserv.	Ambit.	Target
2018	0,06%	0,37%	0,46%	0,07%	0,42%	0,52%	0,05%	0,31%	0,39%
2019	0,09%	0,49%	0,48%	0,10%	0,57%	0,55%	0,07%	0,42%	0,41%
2020	0,10%	0,59%	0,47%	0,11%	0,67%	0,54%	0,08%	0,50%	0,40%
2021	0,12%	0,73%	0,47%	0,14%	0,84%	0,53%	0,11%	0,63%	0,40%
2022	0,14%	0,83%	0,46%	0,17%	0,94%	0,52%	0,13%	0,71%	0,39%
2023	0,19%	0,89%	0,46%	0,21%	1,01%	0,52%	0,16%	0,77%	0,40%
2024	0,19%	0,93%	0,46%	0,22%	1,06%	0,52%	0,17%	0,80%	0,40%
2025	0,20%	0,96%	0,45%	0,23%	1,10%	0,52%	0,17%	0,84%	0,39%
2026	0,22%	0,92%	0,45%	0,26%	1,06%	0,51%	0,19%	0,80%	0,39%
2027	0,25%	0,91%	0,46%	0,29%	1,05%	0,52%	0,22%	0,79%	0,39%
2028	0,31%	0,90%	0,46%	0,36%	1,03%	0,53%	0,27%	0,78%	0,40%
2029	0,34%	0,89%	0,47%	0,39%	1,02%	0,54%	0,30%	0,77%	0,41%
2030	0,37%	0,88%	0,48%	0,43%	1,01%	0,55%	0,32%	0,76%	0,42%

Table 6.17: Target scenario for tertiary sector buildings - Gross direct, indirect and induced effects on GDP (€ million), employment (FTE) and government revenue (€ million) per year

	GDP			Employment			Public revenues		
Year	Direct	Indirect	Induced	Direct	Indirect	Induced	Direct	Indirect	Induced
2018	62,6	64,2	108,8	1.960	1.911	2.285	17,6	20,1	37,3
2019	71,2	73,3	122,6	2.206	2.224	2.586	19,9	23,1	42,2
2020	78,0	80,4	133,3	2.400	2.469	2.818	21,7	25,3	46,2
2021	114,7	118,4	195,6	3.519	3.691	4.133	31,8	37,4	68,5
2022	145,8	150,7	247,6	4.466	4.731	5.229	40,4	47,7	87,4
2023	210,4	217,6	355,1	6.439	6.893	7.492	58,3	68,9	126,2
2024	282,2	292,5	478,0	8.634	9.317	10.082	78,2	93,1	170,7
2025	306,0	316,9	517,1	9.361	10.123	10.913	84,8	100,7	185,2
2026	301,7	312,4	510,4	9.227	10.002	10.775	83,6	99,2	183,4
2027	297,3	307,9	503,1	9.094	9.858	10.620	82,4	97,8	180,8
2028	293,0	303,4	495,7	8.961	9.714	10.465	81,2	96,4	178,1
2029	288,6	298,9	488,4	8.828	9.570	10.309	79,9	95,0	175,5
2030	284,3	294,4	481,0	8.695	9.426	10.154	78,7	93,5	172,9

Table 6.18: Target scenario for tertiary sector buildings - Gross total effects on GDP, employment and government revenues per year, as absolute figures and as a percentage of total GDP, employment and government revenue in the country respectively

	GDP		Employment		Public revenues	
Year	€ mil.	%	FTEs	%	€ mil.	%
2018	235,6	0,13%	6.156	0,14%	75,0	0,11%
2019	267,2	0,14%	7.016	0,16%	85,1	0,12%
2020	291,6	0,14%	7.688	0,16%	93,3	0,12%
2021	428,7	0,20%	11.344	0,23%	137,8	0,17%
2022	544,1	0,25%	14.427	0,28%	175,6	0,22%
2023	783,1	0,35%	20.824	0,40%	253,4	0,30%
2024	1.052,7	0,45%	28.034	0,52%	341,9	0,39%
2025	1.140,0	0,47%	30.397	0,54%	370,7	0,41%
2026	1.124,5	0,45%	30.003	0,52%	366,2	0,39%
2027	1.108,3	0,45%	29.571	0,51%	360,9	0,39%
2028	1.092,2	0,44%	29.140	0,50%	355,7	0,38%
2029	1.076,0	0,43%	28.707	0,50%	350,4	0,38%
2030	1.059,8	0,43%	28.275	0,49%	345,1	0,37%

6.5 Forecasts for the evolution of final energy consumption of housing, the tertiary sector and the economy as a whole

Forecasts for the future evolution of final energy consumption in households were based on the following method. Using statistics on final household energy consumption and GDP for Greece by Eurostat[73] for the period 1995-2016, and considering that the rate of change in final energy consumption in households in Greece is proportional to the rate of growth of the country's GDP, the following econometric model was estimated:

$$EHGR_t = C_1 + C_2 * YGR_t$$

where:

$EHGR_t$ is the year-to-year percentage change in the final energy consumption of households in Greece in year t

YGR_t is the rate of economic growth in Greece (percentage change in the country's GDP from year to year) in year t

C_1 , C_2 are the constant parameters to be estimated

Parameters of model C_1 and C_2 are estimated using the least squares method based on the 1995-2016 statistics on energy consumption and GDP. The parameters' values were calculated as follows:

C_1 = -0.00247

C_2 = 0.76605

Using forecasts by the International Monetary Fund on the rate of growth of the Greek economy[74] in the next few years, as well as IOBE estimates, based on the above econometric model, forecasts were made for the rate of change in the final energy consumption of households for the years 2017- 2030, which also resulted in forecasts for the amount of energy consumption of households in this period.

The same method resulted in forecasts for final energy consumption by the tertiary sector and the economy as a whole.

[73] See also Eurostat, Simplified Energy Balances - annual data [nrg_100a] for energy consumption and [nama_10_gdp] for GDP

[74] See IMF, Datasets, World Economic Outlook (October 2017) http://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD

For final energy consumption by the tertiary sector, the following model was estimated:

$$ESGR_t = C_3 + C_4 * YGR_t$$

where:

$ESGR_t$ is the percentage change from year to year in final energy consumption in the tertiary sector in Greece in year t

and the parameter values resulted:

C_3 = 0.01273

C_4 = 0.50209

While for the final energy consumption in the economy as a whole the model we estimated was:

$$ETGR_t = C_5 + C_6 * YGR_t$$

where:

$ETGR_t$ is the year-to-year percentage change in total final energy consumption in Greece in year t

and the parameter values resulted:

C_5 = 0.03187

C_6 = 0.91449

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