



Energy Service, Ministry of Energy, Commerce and Industry

Long-term Strategy for Building Renovation

April 2020

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1. Introduction

The Energy Union and the framework of policy for energy and the climate, with 2030 as time-scale, establish ambitious commitments for further reduction of greenhouse gas emissions by at least 40% until 2030 as compared with 1990, increase of the percentage of consumption of energy from renewable sources and energy saving corresponding to the level of the Union's aspirations, in order to reinforce its energy security, competitiveness and sustainability. Buildings are at the heart of the energy efficiency policy, as they account for almost 40% of the final energy consumption at Union level and 30% at national level. With a view to facilitating the cost-effective conversion of existing buildings to high energy efficiency buildings, leading to a decarbonised building stock, each Member State must prepare every three years a Long-term Strategy for the Renovation of the national building stock.

In accordance with Article 2a of the Directive on the Energy Performance of Buildings (Directive 2010/31/EU and Directive 2018/844/EU), the Long-term Strategy for the Renovation of the national building stock, both public and private, intended for residential or other purposes, should encompass at least the following:

- a) An overview of the national building stock based, as appropriate, on statistical sampling and the expected percentage of renovated buildings in 2020.
- b) The determination of cost-effective approaches to renovations relevant to the building type and the climate zone, taking in consideration possible appropriate activation signs during the building's life cycle, per case.
- c) Policies and actions to stimulate cost-effective deep renovations of buildings, including staged deep renovations, as well as to support targeted cost-effective measures and renovations, for example by adopting an optional building renovation passport system.
- d) An overview of the policies and actions relating to the worst performing parts of the national building stock, dilemmas due to conflicting interests and market failures, as well as description of the national actions which contribute to the mitigation of energy poverty.
- e) Policies and actions related to all public buildings.
- f) An overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as to improve skills and education in the construction and energy efficiency fields.

- g) A substantiated estimate of the expected energy saving and broader benefits, among other things in terms of health, safety and the quality of air.

Homes in Cyprus are estimated to account for 18% of the final energy consumption, whereas commerce, hotels and services, i.e. mostly office buildings, account for another 12%. The different political, economic and social conditions that prevailed for many years did not favour the implementation of energy-saving measures in building construction, resulting in the creation of a particularly energy-intensive building stock. The first organised effort to implement energy-saving measures in buildings was made in 2004 through the grant schemes of the Fund for Renewable Energy Sources (RES) and Energy Saving (ES), whereas the implementation of mandatory measures in new buildings and buildings larger than 1.000 m² undergoing major renovation took place for the first time in 2007 upon the adoption of the 'Regulation of the Energy Performance of Buildings (Minimum Energy Performance Requirements) Decree of 2007'. The absence of thermal insulation, as well as of sufficient protection from the sun during summer months, have negative effects in the economy and the environment, are detrimental to people's health, reduce employee productivity in workplace buildings, and, in general, downgrade the overall quality of life. Deep renovations of buildings provide an opportunity to resolve many of these problems, since the energy-saving potential is huge, as 91% of all the buildings were built before the establishment of the minimum energy performance requirements.

The Long-term Strategy for Building Renovation uses quantitative and qualitative indicators to stress the problems caused by the energy status of the building stock to date, as well as the opportunities offered by an increased mobilisation of investments in the field of deep renovations. It identifies the parties involved, the obstacles they come across and how these can be overcome. On the basis of the above, the roadmap with measurable indicators of progress by 2050 is presented.

The Long-term Strategy for Building Renovation is an evolution of the Strategy for Mobilising Investment in the Field of Building Renovation, which was issued in 2014 and revised in 2017. As in the previous cases, the Long-term Strategy for Building Renovation was drawn up following consultation with the stakeholders. The consultation was carried out through the statutory Advisory Committee for Monitoring the Application of the Regulation of the Energy Performance of Buildings Law, comprising 22 organisations and bodies, including engineers, architects, building contractors, technical building system installers, land developers, universities, consumer associations and public sector departments involved in the building sector. In addition, feedback was received from additional stakeholders through a questionnaire, the presentation of which took place in a dedicated workshop. Also, the views recorded at meetings and workshops on issues related to the energy upgrading of buildings, which were organised by the Energy

Service of the Ministry of Energy, Commerce and Industry, as well as other agencies, were taken into consideration. Specific interest groups, such as employers' organisations, financial institutions and private organisations whose primary objective is to carry out research in the energy sector, participated in these meetings and workshops. Details of the public consultation are recorded in Annex I. The exchange of views between the Ministry of Energy, Commerce and Industry and the parties involved in building renovation was in itself an opportunity to exchange knowledge and come up with new ideas.

The public consultation process, as well as the studies leading to the preparation of the Long-term Strategy for Building Renovation, confirm that speeding up the rate of implementation of renovation is in line with the energy and environmental targets of Cyprus. The aim is to ensure the energy upgrading of the building stock in cost-optimal ways for the owner, while at the same time maximising economic, environmental and social benefits for the country.

2. Review of the national building stock

In Cyprus there are 431,059 residential buildings and more than 30,000 non-residential buildings. Almost half of the residential buildings are single-family houses. The building stock of Cyprus is relatively new, as most buildings were built in 1980-2000. As a result of the simultaneous absence of any policy measures for the construction of these buildings, most of the existing buildings have a low energy efficiency rating. This is reflected in the final energy consumption of the building sector, which rose dramatically from the late 1990s onwards, with a slight drop in 2013 due to the economic crisis. The review of the existing building stock is broken down into homes (residential buildings), non-residential buildings and public buildings and is based on statistics available by the Statistical Service of Cyprus and the technical reports titled 'Building Stock in Cyprus and Trends to 2030' and 'An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050', prepared by the Joint Research Institute (JRC) and GIZ respectively. These reports were drawn in the context of technical assistance provided by the European Commission to the Ministry of Energy, Commerce and Industry.

2.1 Homes

There are approximately 300,000 homes used as permanent dwellings. It is noted that approximately another 78,000 homes are used as country or tourist dwellings, meaning that they are typically seasonally used, thus consuming less annual energy than permanent dwellings. There are also another 54,000 empty homes, meaning that they are available for sale or rent and that some of them are abandoned.

Almost half of the homes that are used as permanent dwellings are single-family houses, while almost a quarter of them are apartments. The rest of them are designated as 'other types of homes', such as terraced houses, two-family houses and homes in mixed-use buildings.

ΤΥΠΟΣ ΚΤΙΡΙΟΥ ΣΤΟ ΟΠΟΙΟ ΒΡΙΣΚΕΤΑΙ Η ΚΑΤΟΙΚΙΑ	ΚΑΘΕΣΤΩΣ ΚΑΤΟΙΚΗΣΗΣ					
	Σύνολο	Κατοικημένη ως συνήθης τόπος διαμονής	Κενή κατοικία	Χρησιμοποιείται ως εξοχική/δεύτερη κατοικία	Χρησιμοποιείται ως τουριστικό διαμέρισμα/ κατοικία	Για κατεδάφιση/ Άλλη χρήση
Σύνολο	431.059	297.122	54.651	71.942	6.146	1.198
Μονοκατοικία	172.944	129.268	12.949	28.090	1.959	678
Διπλοκατοικία	59.050	48.743	4.597	5.344	247	119
Σπίτια σε συνεχή δόμηση	32.893	18.004	4.883	8.922	859	225
Βοηθητικό σπίτι	8.993	6.457	1.809	679	2	46
Πολυκατοικία	123.557	72.072	24.254	24.729	2.418	84
Κατοικία σε κτίριο μεικτής χρήσεως	32.530	22.215	6.066	3.589	618	42
Κτίριο άλλου τύπου	1.092	363	93	589	43	4

Πηγή : Στατιστική Υπηρεσία Κύπρου

TYPE OF OCCUPANCY

TYPE OF BUILDING IN WHICH THE HOME IS LOCATED	Total	Occupied as a usual place of residence	Empty home	Used as country/ second home	Used as tourist apartment/ home	Intended for demolition/ other use
Total	431,059	297,122	54,651	71,942	6,146	1,198
Single-family house	172,944	129,268	12,949	28,090	1,959	678
Two-family house	59,050	48,743	4,597	5,344	247	119
Terraced houses	32,893	18,004	4,883	8,922	859	225
Auxiliary house	8,993	6,457	1,809	679	2	46

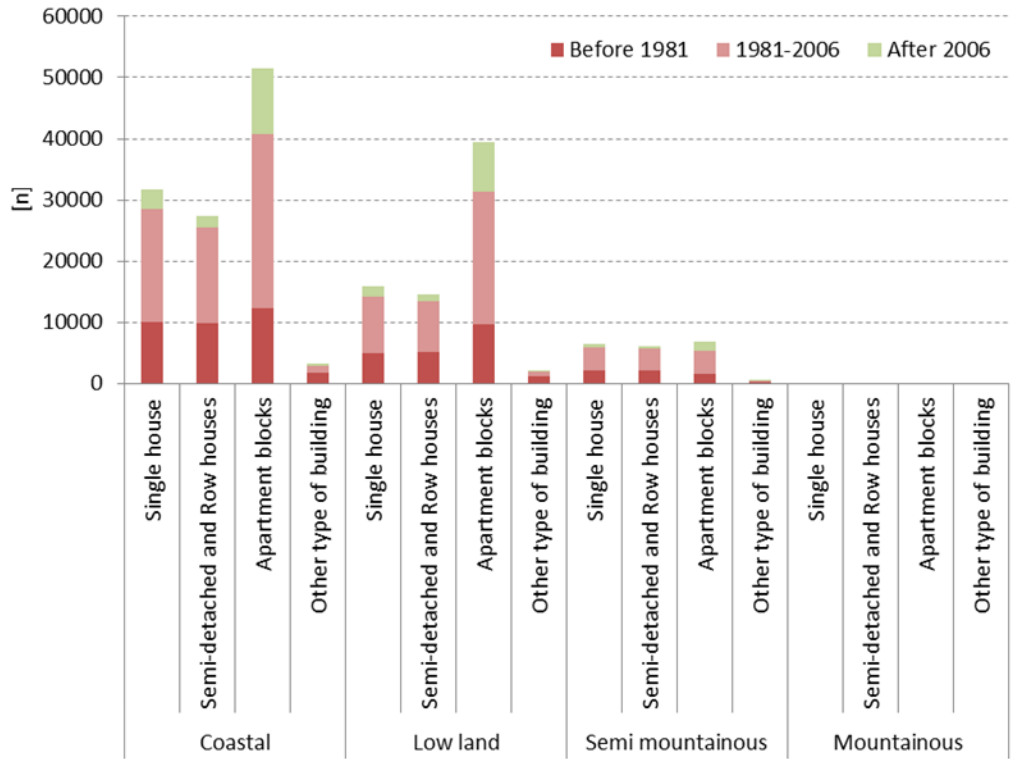
Multi-apartment building	123,557	72,072	24,254	24,729	2,418	84
Home in a mixed-use building	32,530	22,215	6,066	3,589	618	42
Other type of building	1,092	363	93	589	43	4

Source: Statistical Service of Cyprus

TABLE 2.1: HOMES PER TYPE OF BUILDING AND TYPE OF OCCUPANCY

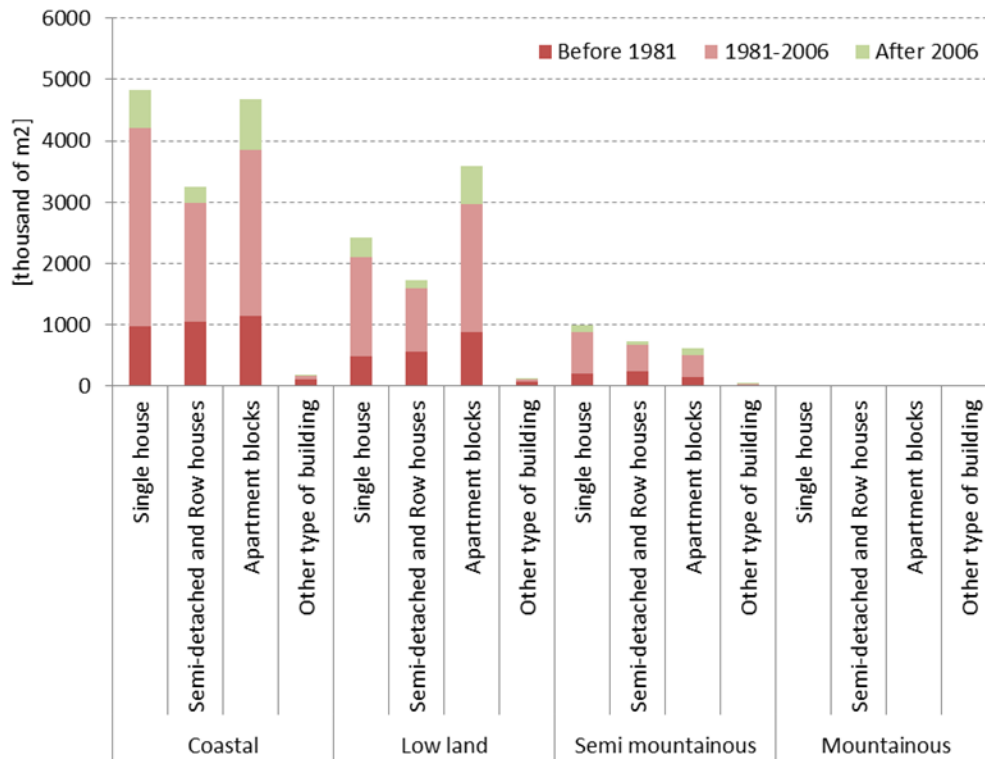
The above table provides a brief picture of the homes in terms of the type of building and type of occupancy, as these were recorded by the survey of the Statistical Service, which was performed in the context of the population census in 2011.

In terms of geographical distribution, 78% are located in coastal and lowland areas where the largest urban centres are also located. Ninety percent (90%) of multi-apartment buildings and 62% of two-family houses or terraced houses are located in urban areas.



GRAPH 2.1: NUMBER OF HOUSES PER TYPE, METEOROLOGICAL ZONE AND CONSTRUCTION PERIOD - URBAN AREAS¹

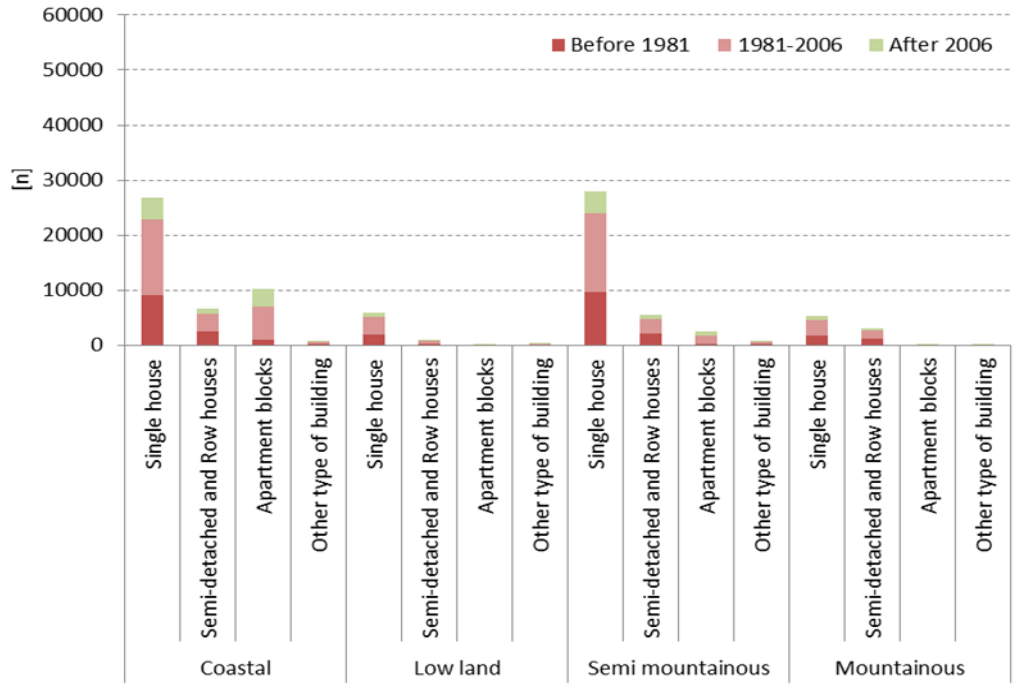
¹ Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.



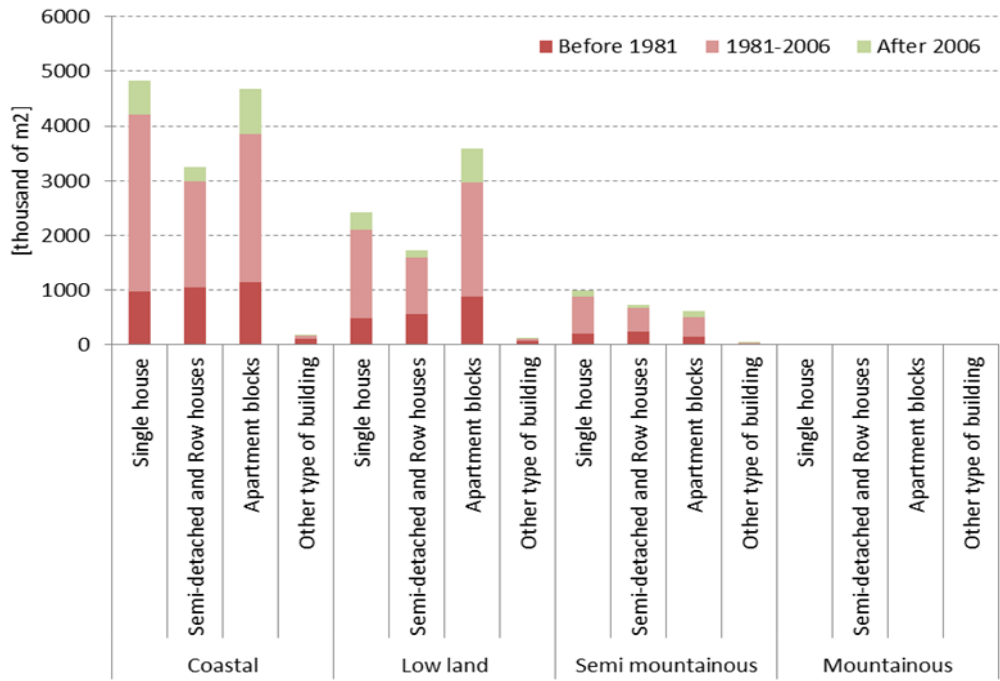
Graph 2.2: Number of houses per type, meteorological zone and construction period - Urban Areas²

Graphs 2.1 and 2.2 show the number and the floor area, respectively, per type of house, the meteorological zone and the construction period for urban areas.

² Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.



GRAPH 2.3: NUMBER OF HOUSES PER TYPE, METEOROLOGICAL ZONE AND CONSTRUCTION PERIOD - RURAL AREAS³



Graph 2.4: Number of houses per type, meteorological zone and construction period - RURAL AREAS³

³ Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

Graphs 2.3 and 2.4 show the number and the floor area, respectively, per type of house, the meteorological zone and the construction period for rural areas.

The meteorological zones referred to are those defined in the Calculation Methodology of the Energy Efficiency of Buildings as follows:

- a) Coastal (Zone 1)
- b) Lowland (Zone 2)
- c) Semi mountainous (Zone 3)
- d) Mountainous (Zone 4)

The size of the homes constructed tends to change in the course of time. The floor area of single-family houses and multi-apartment buildings appears to be larger in newer buildings. However, as far as apartments are concerned, the trend in terms of floor areas is to become smaller.

Type of home	Period of construction	Floor area (m ²)	Volume (m ³)	No. of Floors	Surface of door and window frames (m ²)	Surface of exterior walls (m ²)	No. of households
Single-family house	Before 1970	132.1	396.3	1	10	188.4	1
	1971-1990	151.2	453.6	1	17.9	148.8	1
	1991-2007	141.4	424.0	1	22.1	155.6	1
	After 2008	202.2	606.6	2	43.3	276.6	1
Two-family house	Before 1970	265.4	796.2	1	20	342	2
	1971-1990	300.2	900.7	1	30.9	231.6	2
	1991-2007	302.4	900.7	2	38.8	297.6	2
	After 2008	302.8	908.4	2	35.7	319.2	2
Terraced houses (more than two)	Before 1970	718.5	2155.5	1	92.1	801	3
	1971-1990	842.7	2528.2	1	89.2	802.5	3
	1991-2007	1001.6	3004.8	1	127.1	921.6	3

Type of home	Period of construction	Floor area (m ²)	Volume (m ³)	No. of Floors	Surface of door and window frames (m ²)	Surface of exterior walls (m ²)	No. of households
	After 2008	1335.5	4006.4	1	169.5	1228.8	4
Multi-apartment building	Before 1970	345.4	1022.6	3	62.3	380.3	3
	1971-1990	690.8	2072.4	3	133	916.8	6
	1991-2007	690.8	2072.4	3	133	916.8	6
	After 2008	861.4	2181.7	4	164	1064	8

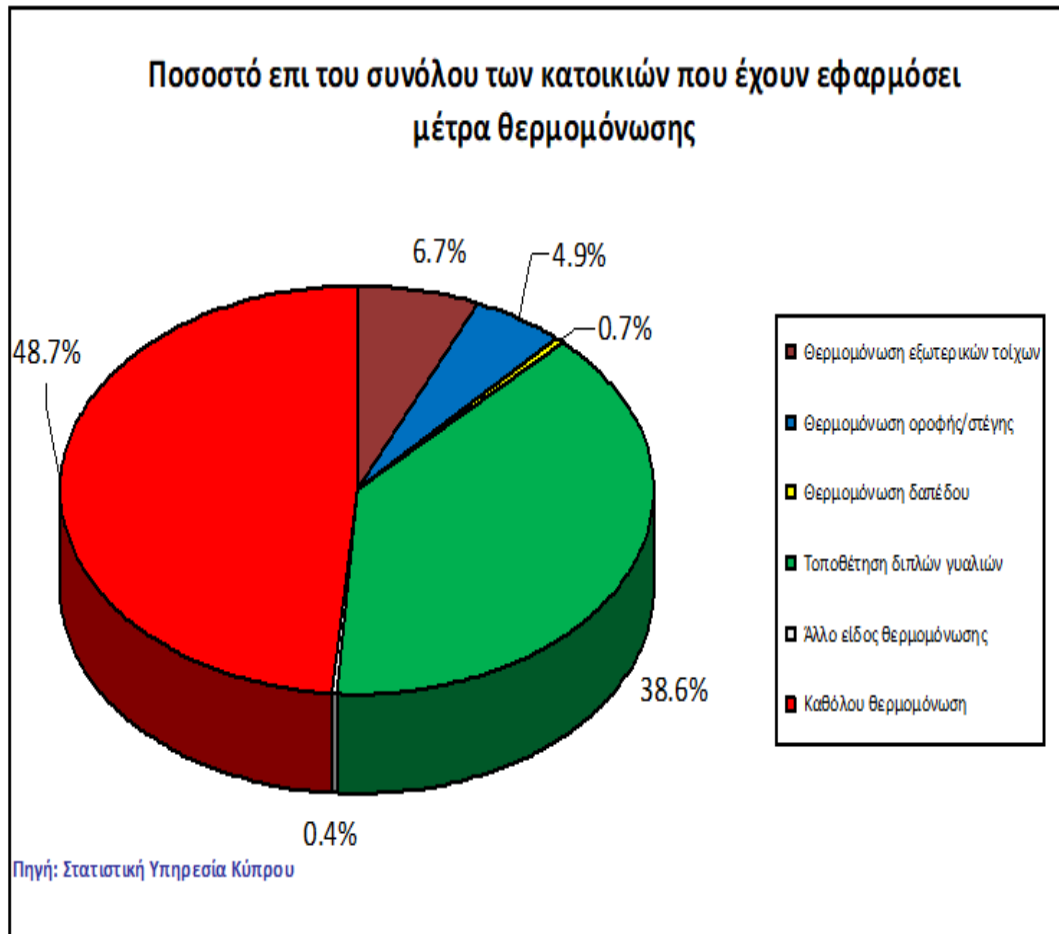
TABLE 2.2: CHARACTERISTICS OF TYPICAL HOMES PER TYPE AND PERIOD OF CONSTRUCTION⁴

The share of the residential sector in the final energy consumption has rapidly increased during the 1995-2013 period, from 14.1% in 1995 to 18% in 2013. Electricity consumption has increased by 150% during the same period mainly due to the installation of air-conditioners and the increasing number of household appliances. However, the annual energy consumption per home has been reduced since the beginning of 2000 from 1.16 Tons of Oil Equivalent (TOE) to 0.85 TOE in 2013. At the same time, the share of the residential sector in energy consumption remains stable from 2013 onwards. This can be partly attributed to the improvement of building energy efficiency with the implementation of the Directive on building energy efficiency since the end of 2007.

Forty per cent (40%) of homes in Cyprus were erected before 1981 and 54% of them were erected between 1981 and 2006, i.e. the vast majority of homes were constructed when there were no minimum energy performance requirements in force. A very poor to medium energy efficiency rating can be assigned to most homes, as in the absence of legislative measures, no energy-saving measures were generally taken during the construction. Some homeowners took individual energy-saving measures afterwards, taking advantage of the grant schemes implemented by the Fund for RES and ES and then of the 'Save & Upgrade' programme for renovation that will significantly improve energy efficiency. Given that the buildings that were renovated during the 2015–2020 period were mostly implemented through the 'Save & Upgrade' programme, the percentage of renovation in the residential sector for this period is not expected to

⁴ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

exceed 0.5% (more details on the ‘Save & Upgrade’ programme are cited in paragraph 4.2.2). Therefore, these interventions did not significantly change the overall energy picture of the residential sector. Based on available statistics, no energy-saving measures have been taken in 49% of the homes, and some form of thermal insulation has been used on the building envelope only in 12% of the homes. The situation is a bit better in terms of door and window frames, where more than 38% of the homes have double glazing.



Ratio of homes, out of the total number of homes, with thermal insulation measures

Thermal insulation on exterior walls

Thermal insulation on ceiling/ roof

Thermal insulation on floor

Double glazing installed

Other type of thermal insulation

No thermal insulation

GRAPH 2.5: PERCENTAGE OF BUILDINGS WITH THERMAL INSULATION

Graph 2.5 shows thermal insulation measures in the entire residential sector based on a survey of the Statistical Service on final energy consumption in households. Although the survey was carried out in 2009 on the basis of what is mentioned above, the picture of the residential sector in terms of thermal insulation measures has not changed.

The primary energy product used in the residential sector is grid electricity, as this accounts for almost half of the final energy consumption, followed by heating oil and liquefied gas, which are the most important energy products after electricity (see Table 2.3 for that purpose).

As regards renewable energy sources (RES) systems in homes, solar energy for hot water production is the most widely used system, accounting for 19% of the final energy consumption. This is primarily due to the fact that there are solar water heaters installed for hot water production in 91% of the homes. However, there is no information available on the age or performance levels of these systems. For heating purposes, heat pumps are widely used, as well as biomass and geothermal heat pumps to a lesser extent. It has been estimated that 31% of the energy consumption for heating and cooling purposes is covered by RES in 2018. Photovoltaic systems have been installed on homes since 2004, initially with subsidised rates for the electricity generated and then by offsetting the electricity consumed against that generated. There are currently more than 15,000 photovoltaic systems installed on homes.

Fuel	Electricity	Heating oil	Kerosene	LPG	Biomass	Solar heaters	Geothermal	Total
Final energy consumption (TOE)	127,557	51,545	9,807	42,450	8,559	57,678	1,551	299,146

TABLE 2.3: TOTAL ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR PER TYPE OF FUEL⁵

In a typical home, most of the energy is consumed by the air-conditioning and heating systems, provided that thermal comfort conditions are ensured in the home. The most

⁵ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

widespread heating system in single-family houses is a central heating system with an oil boiler, as opposed to apartments, in which independent air-conditioners are used for heating. Independent air-conditioners are the most common air-conditioning system used in summer months in all types of homes. However, half of the homes do not have any central heating system installed, and 18% of the homes do not have an air-conditioning system installed, which, in combination with the lack of thermal insulation in most homes, means that a large part of the households have settled for average to poor thermal comfort conditions. Tables 2.4 and 2.5 provide in detail the types of heating and air-conditioning systems respectively per type of home.

Heating system	Fuel	Single-family house	Two-family houses and terraced houses	Apartments	Other types of houses
Central heating system with an oil boiler	Oil	41% (27%)	35% (25%)	17% (5%)	23% (9%)
Central heating system with a condensing boiler	Oil or liquefied gas	0% (0%)	0% (0%)	0% (0%)	0% (0%)
Oil stove	Oil	2% (2%)	2% (2%)	2% (1%)	1% (2%)
Central heating system with a liquefied gas boiler	Liquefied gas	3% (3%)	1% (2%)	0% (1%)	0% (1%)
Liquefied gas heater	Liquefied gas	11% (17%)	11% (19%)	9% (13%)	28% (21%)
Heat pump	Electricity	4% (3%)	4% (2%)	5% (2%)	0% (2%)
Heat pump with a ground source heat exchanger	Electricity	0% (0%)	0% (0%)	0% (0%)	0% (0%)
Independent air-conditioners	Electricity	17% (17%)	23% (19%)	35% (42%)	14% (19%)
Independent high-efficiency air-conditioners	Electricity	4% (4%)	6% (5%)	9% (11%)	4% (5%)
Electric heater	Electricity	8% (10%)	9% (12%)	11% (15%)	20% (29%)
EAC storage heaters	Electricity	2% (1%)	3% (1%)	6% (1%)	0% (0%)
Fireplace	Biomass	4% (13%)	3% (12%)	1% (2%)	1% (3%)
No or other heating equipment	N/A	3% (2%)	2% (2%)	5% (8%)	7% (9%)

TABLE 2.4: HEATING SYSTEM PER TYPE OF HOME IN URBAN AREAS, AND IN RURAL AREAS IN PARENTHESES⁶

⁶ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

Air-conditioning system	Fuel	Single-family house	Two-family houses and terraced houses	Apartments	Other types of houses
Central system with a heat pump	Electricity	4% (4%)	4% (4%)	5% (5%)	0% (0%)
Central system with a ground source heat exchanger	Electricity	0% (0%)	0% (0%)	0% (0%)	0% (0%)
Independent air-conditioners	Electricity	62% (62%)	62% (62%)	61% (61%)	65% (65%)
Independent high-efficiency air-conditioners	Electricity	16% (16%)	16% (16%)	15% (15%)	16% (16%)
No or other air-conditioning equipment	N/A	18% (18%)	18% (18%)	18% (18%)	18% (18%)

TABLE 2.5: AIR-CONDITIONING SYSTEM PER TYPE OF HOME IN URBAN AREAS, AND IN RURAL AREAS IN PARENTHESES⁷

Table 2.6 shows the estimated energy demand per type of home and construction period. As energy demand takes no account of the technical system used, this table indicates how efficient the building envelope is in terms of thermal insulation per construction period.

⁷ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

	Year of construction	Space heating (kWh / m ² / year)	Space cooling (kWh / m ² / year)	Hot water (kWh / m ² / year)
Single-family house	Before 1981	54	72	23
	1981–2006	40	54	18
	After 2006	36	50	15
Two-family houses and terraced houses	Before 1981	59	58	23
	1981–2006	43	44	18
	After 2006	39	40	15
Apartments	Before 1981	45	105	23
	1981–2006	33	84	18
	After 2006	30	76	15
Other types of houses	Before 1981	56	53	23
	1981–2006	41	41	28
	After 2006	37	38	15

TABLE 2.6: TYPICAL ENERGY DEMAND PER TYPE OF HOME⁸

2.2 Non-residential buildings

There are around 30,000 non-residential buildings, including those of the public sector, which a total floor area of 9 million square metres. In terms of the use of these buildings, the most populous ones in number of accommodation facilities are offices, retail sales facilities and dining establishments. However, the largest category of buildings in terms of floor area is that of hotels and accommodation facilities, with a total floor area of 2 million square metres. Table 2.7 shows the total number and floor area for non-residential buildings.

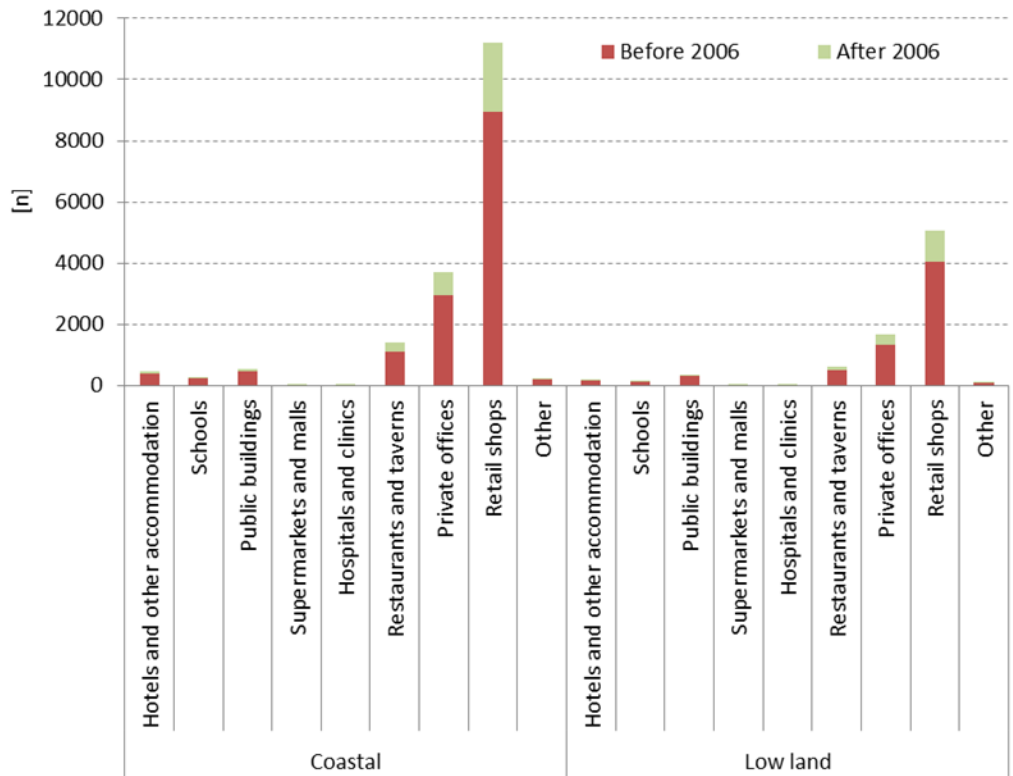
⁸ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

	Total floor area (m²)	Number of accommodation facilities	Average floor area (m²)
Hotels	2,094,134	766	2,734
Private offices	1,665,000	11,100	150
Public buildings	1,886,370	1,087	1,735
Retail sales facilities (stores)	1,080,000	18,000	60
Hospitals and clinics	485,898	83	17,354
Hypermarkets and department stores	280,396	67	4,185
Restaurants	179,360	2242	80
Airports	119,600	2	59,800
Junior and Senior High Schools and Technical Schools	613,546	144	4,261
Primary education schools	453,755	325	1,396
Child care centres	96,376	419	230

TABLE 2.7: FLOOR AREA AND NUMBER OF ACCOMMODATION FACILITIES PER TYPE OF NON-RESIDENTIAL BUILDING⁹

Just like in the residential sector, 83% of the buildings used for the provision of services or other business purposes were constructed before adopting any minimum energy performance requirements. The vast majority of non-residential buildings are located in coastal and lowland areas of the country (meteorological zones 1 and 2).

⁹ Source: Economidou, M. (2016). *Report on the current status of the energy services market and proposals for measures to promote EPC in the public and private sector — JRC Technical Reports.*



GRAPH 2.6: NUMBER OF NON-RESIDENTIAL BUILDINGS IN COASTAL AND LOWLAND AREAS¹⁰

Graph 2.6 shows the number of buildings per type, dividing them in buildings constructed before and after 2006.

¹⁰Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

The non-residential sector covers energy needs using electricity, as it covers 77% of the consumption. Table 2.8 provides the energy consumption of the sector per energy product.

Fuel	Electricity	Heating oil	Kerosene	LPG	Biomass	Solar heaters and heat recovery	Total
Final energy consumption (TOE)	149,214	24,612	2,050	42,450	4,905	10,380	203,285

TABLE 2.8: TOTAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR PER TYPE OF FUEL¹¹

The technical systems installed in tertiary sector buildings are different depending on the type of building. The most common heating system used in hotels is a central heating system with a boiler, while in offices, stores and hypermarkets it is a central heating system with a heat pump. The majority of tertiary sector buildings use a central air-conditioning system. Relevant data are presented in Tables 2.9 and 2.10.

¹¹ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

	Fuel	Hotels	Private offices	Retail sales facilities (stores)	Hospitals and clinics	Hypermarkets and department stores	Restaurants
Central heating system with an oil boiler	Oil	43%	41%	12%	31%	11%	28%
Central heating system with a condensing boiler	Oil or liquefied gas	2%	1%	0%	1%	1%	0%
Central heating system with a liquefied gas boiler	Liquefied gas	10%	4%	2%	4%	1%	3%
Heat pump	Electricity	40%	44%	75%	61%	81%	36%
Heat pump with a ground source heat exchanger	Electricity	0%	1%	0%	1%	2%	0%
Independent air-conditioners	Electricity	3%	6%	8%	0%	8%	18%
Independent high-efficiency air-conditioners	Electricity	1%	1%	1%	0%	1%	5%
No or other heating equipment	N/A	1%	0%	0%	0%	0%	0%

TABLE 2.9: HEATING SYSTEM PER TYPE OF BUILDING IN NON-RESIDENTIAL BUILDINGS¹²

¹² Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports.*

	Fuel	Hotels	Private offices	Retail sales facilities (stores)	Hospitals and clinics	Hypermarkets and department stores	Restaurants
Central system with a heat pump	Electricity	62%	54%	75%	68%	88%	42%
Central system with a ground source heat exchanger	Electricity	0%	1%	0%	1%	2%	0%
Independent air-conditioners	Electricity	24%	22%	8%	9%	0%	28%
Independent high-efficiency air-conditioners	Electricity	4%	3%	1%	2%	0%	5%
No or other air-conditioning equipment	N/A	10%	20%	16%	20%	10%	25%

TABLE 2.10: AIR-CONDITIONING SYSTEM PER TYPE OF BUILDING IN NON-RESIDENTIAL BUILDINGS¹³

¹³ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports.*

Table 2.11 shows the estimated energy demand per type of building.

	Year of construction	Space heating (kWh / m ² / year)	Space cooling (kWh / m ² / year)	Hot water (kWh / m ² / year)	Lighting (kWh / m ² / year)
Hotels	Before 2006	65	268	40	55
	After 2006	45	183	28	50
Private offices	Before 2006	87	203	5	45
	After 2006	59	138	4	40
Retail sales facilities (stores)	Before 2006	41	194	5	105
	After 2006	28	132	4	95
Hypermarkets and department stores	Before 2006	33	470	1	105
	After 2006	23	321	1	95
Restaurants	Before 2006	142	285	214	85
	After 2006	97	194	146	80

Table 2.11: Energy demand per type of building in non-residential buildings¹⁴

2.3 Buildings owned by and/or used by the public sector

For buildings owned and/or used by the public sector, even though they are part of the buildings of the tertiary sector, a specific review of the building stock for this sector is necessary due to their exemplary role in the field of energy performance of buildings. It is noted that ‘public buildings’ are not determined in the Directive on Energy Performance of Buildings or in the Regulation of the Energy Performance of Buildings Law and the Law on Energy Efficiency.

¹⁴ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

For the purposes of this text, reference to public buildings has to do with buildings used by central government authorities and sub-central contracting authorities as set out in Annex I of the Law of 2016 on Regulating Public Procurement Procedures and Related Matters. Public schools and educational institutions are presented separately in the following tables because they are used differently than public buildings.

Public buildings are typically used as offices and follow a similar age distribution with private sector buildings, which results in low energy efficiency. This is confirmed by the Energy Performance Certificates issued for these buildings.

The local government in the area controlled by the Republic of Cyprus consists of 30 municipalities and 350 communities. Most of the municipalities and larger communities only have one building used for administrative purposes and events. Larger municipalities, however, own several buildings intended for providing services to the general public, as well as other types of buildings, such as libraries and sports centres.

During the 2018-2019 school year, in total 272 kindergartens, 331 primary schools and 134 secondary education schools operated. The responsibility for the implementation of projects consisting in the construction of new schools and the maintenance and expansion of existing ones lies with the Technical Services of the Ministry of Education, Culture, Sports and Youth. Most schools were erected before 2006. Almost all schools use a central heating system with a boiler for heating in the winter, while, typically, there is no air-conditioning in most classrooms.

As regards public universities, the University of Cyprus, which is the largest public university, owns the highest number of buildings, most of which were erected in the campus in recent years. The Cyprus University of Technology is housed mainly in historic buildings and rented ones in downtown Limassol, whereas the Open University of Cyprus is housed in a building in Nicosia. Public universities operate technical departments that are responsible for the maintenance and smooth functioning of their building facilities.

Relevant data are presented in Tables 2.12 and 2.13.

	Total floor area (m²)	Number of accommodation facilities	Average floor area (m²)
Public buildings	1,886,370	1087	1735
Primary schools	453,755	325	1396
Junior and Senior High Schools and Technical Schools	613,546	144	4261
Child care centres	96,376	419	230
Higher education	222,404	N/A	N/A

TABLE 2.12: NUMBER AND FLOOR AREA PER TYPE OF BUILDING OF THE PUBLIC SECTOR¹⁵

	Year of construction	Space heating (kWh / m² / year)	Space cooling (kWh / m² / year)	Hot water (kWh / m² / year)	Lighting (kWh / m² / year)
Public buildings	Before 2006	49	44	5	42
	After 2006	34	30	4	37
Schools	Before 2006	35	55	7	35
	After 2006	24	37	5	30

TABLE 2.13: ENERGY DEMAND PER TYPE OF BUILDING OF THE PUBLIC SECTOR¹⁵

¹⁵ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports.*

3. Cost-optimal approaches to building renovation

The calculation of cost-optimal levels of minimum energy performance requirements, as made for the first time in 2013 and repeated every five years on the basis of Article 5 of the Directive on the energy performance of buildings, offers an opportunity to look into the most cost-optimal building renovation methods, also taking into account the initial capital expenditure and the operating cost over the life cycle of the building. Moreover, cost-optimal approaches have been examined through technical studies elaborated on behalf of the Ministry of Energy, Commerce and Industry. This chapter sets out cost-effective and technically practical measures for improving the energy performance of buildings.

3.1 Results of the calculation of cost-optimal levels of minimum energy performance requirements

The results of the second calculation of cost-optimal levels, carried out in 2018, showed that for buildings undergoing major renovation, higher minimum energy performance requirements should be introduced than the class B requirement currently in force, but lower than the requirements for Nearly Zero-Energy Buildings (NZEBs). It should be noted that the definition of NZEB is the same for new and existing buildings. More specifically, the economically optimal thing to do is to upgrade residential buildings undergoing renovation, to energy class A and non-residential buildings to energy class B+.

Furthermore, according to the calculation, individual measures providing a high economic benefit to the life cycle of a building are:

- a. thermal insulation in roof
- b. heat pumps for heating
- c. biomass boilers
- d. high-efficiency air-conditioners
- e. LED lighting
- f. photovoltaic systems

The above-mentioned results relate to the economically optimal solution from the investors' point of view rather than the broader macroeconomic perspective and they are based on a number of assumptions with the following being the most important:

- a. the building's life cycle was set at 30 years for homes and public buildings and at 20 years for other buildings;
- b. the discount rate was set at 5% for homes and at 11% for buildings of the tertiary sector;
- c. the average annual rate of increase is 1.5% for electricity prices and 1.2% for oil products.

Annex II gives examples of cost-optimal, over the life cycle of a building, combinations of energy-saving measures that can be implemented as part of a deep renovation, based on the results of the calculations concerned. Please note that these examples reflect the cost of energy and materials at the time when the calculations were made, i.e. in 2018, and the energy consumption level reflects the average potential use. Therefore, the examples give a general picture, as the energy-saving interventions and the installation of RES systems in buildings must be assessed in relation to the data specific to each case.

The costs indicated in the examples below relate to the additional cost of a scheduled major renovation, as the minimum energy performance requirements are only triggered then. Moreover, the implementation of the combination of measures listed below may entail other benefits, in addition to energy saving, such as the beautification of façades, the improvement of thermal comfort and the increase in the value of the building when sold or leased. These benefits have not been quantified as financial revenues for the investor and have not been taken into account when calculating the cost-optimal levels.

3.2 Signs in the building life cycle increasing its likelihood of renovation

During the life cycle of a building, there are signs that trigger major renovation. The most common are:

- a. When it is transferred to a new owner;
- b. When it is leased to a new tenant;
- c. When a structural upgrade is performed;

d. When there is a change of use and/or additions

Change of use and/or additions seem to be the sign that will most likely lead to a major renovation in line with the public consultation preceding the preparation of the Long-term Strategy for Renovation, where the interested parties replied to the Energy Service's questionnaire (Annex I). It was noted that when replying to the questionnaire, most people had residential buildings in mind. The likelihood of the same sign triggering a major renovation may vary depending on the type of building. For example, a new owner of a home is very likely to proceed with renovation, but this is not the case with the change of ownership in a hotel unit, where renovations are primarily driven by competition in the tourism sector. In some buildings, such as shops in areas with high commercial demand, there are no triggers.

Renovations are related to energy upgrades through minimum energy performance requirements. However, the implementation of the requirements alone does not ensure that the energy-saving potential of the cost-optimal levels is fully exploited. For this reason, when there is a scheduled renovation or a renovation that is triggered by the reasons mentioned above, synergies with energy-saving measures that will lead to economies of scale should be examined.

4. Policies and actions for cost-effective deep renovation of buildings

The policies and measures to stimulate the renovation of existing buildings can be broken down into legislative measures, incentives, training measures and information measures. An analysis of the current state of play is provided below, and the relevant obstacles along how to overcome them are identified.

Some of the measures mentioned below concern actions targeting individual building elements, such as inspections of the heating and air-conditioning systems and requirements for technical systems. However, they can be the trigger for deep renovation or be part of a gradual renovation.

4.1 Legislative measures

4.1.1 Minimum energy performance requirements for existing buildings

The minimum energy performance requirements for existing buildings must be applied when they undergo major renovation and when elements of their envelope are replaced or retrofitted. The first Decree on the minimum energy performance requirements, issued in 2007, provided for the mandatory energy upgrading of buildings with a floor area of more than 1,000 m² undergoing major renovation. The minimum requirements were amended in 2009, adding the requirement for issuing energy performance certificates with a minimum class B for buildings with a floor area of more than 1,000 m² undergoing major renovation. A new decree was adopted in December 2013, reducing the U-values by 15% for buildings with a floor area of more than 1,000 m² undergoing major renovation, while for the first time requirements for elements of the building envelope were placed, which are retrofitted or replaced irrespective of the size of the building. As of 1 January 2017, all buildings undergoing major renovation must be classified under energy-efficiency class B. If the energy upgrading to that minimum level is not technically and/or financially feasible, a study should be prepared to explain why.

The new minimum energy performance requirements will be implemented on 1 July 2020. These will require all residential buildings undergoing major renovation to be of energy class A, and all other buildings to be of energy category B+. The new requirements have been developed on the basis of the results of the calculation of cost-optimal levels of minimum energy performance requirements carried out in 2018, as well as the views of all parties involved in the consultation that preceded the relevant Advisory Committees.

		Minimum energy performance requirements Decree of 2007 (RAA 568/2007) In effect from 21/12/2007	Minimum energy performance requirements Decree of 2009 (RAA 446/2009) In effect from 01/01/2010	Minimum energy performance requirements Decree of 2013 (RAA 432/2013) In effect from 11/12/2013	Minimum energy performance requirements Decree of 2016 (RAA 119/2016, RAA 376/2016) In effect from 01/01/2017	Minimum energy performance requirements Decree of 2020 (RAA 121/2020) In effect from 01/07/2020
Major renovation	Walls and load-carrying structure	0.85 W / m ² K only for buildings with a floor area of more than 1,000 m ²	0.85 W / m ² K only for buildings with a floor area of more than 1,000 m ²	0.72 W / m ² K only for buildings with a floor area of more than 1,000 m ²	-	-
	Ceiling and exposed floors	0.75 W / m ² K only for buildings with a floor area of more than 1,000 m ²	0.75 W / m ² K only for buildings with a floor area of more than 1,000 m ²	0.63 W / m ² K only for buildings with a floor area of more than 1,000 m ²	-	-
	Overlying floors in closed non-air conditioned spaces	2.0 W / m ² K only for buildings with a floor area of more than 1,000 m ²	2.0 W / m ² K only for buildings with a floor area of more than 1,000 m ²	2.0 W / m ² K only for buildings with a floor area of more than 1,000 m ²	-	-
	Frames	3.8 W / m ² K	3.8 W / m ² K only for buildings with a floor area of more than 1,000 m ²	3.23 W / m ² K only for buildings with a floor area of more than 1,000 m ²	-	-
	Maximum shade	-	-	0.63 only for buildings with a floor	-	-

		Minimum energy performance requirements Decree of 2007 (RAA 568/2007) In effect from 21/12/2007	Minimum energy performance requirements Decree of 2009 (RAA 446/2009) In effect from 01/01/2010	Minimum energy performance requirements Decree of 2013 (RAA 432/2013) In effect from 11/12/2013	Minimum energy performance requirements Decree of 2016 (RAA 119/2016, RAA 376/2016) In effect from 01/01/2017	Minimum energy performance requirements Decree of 2020 (RAA 121/2020) In effect from 01/07/2020
	factor for frames			area of more than 1,000 m ²		
	Minimum energy efficiency class in the Energy Performance Certificate	-	B only for buildings with a floor area of more than 1,000 m ²	B only for buildings with a floor area of more than 1,000 m ²	B for all buildings	A for residential buildings B+ for non-residential buildings
Building elements that are replaced or installed subsequently	Walls and load-carrying structure	-	-	0.72 W / m ² K for all buildings	0.4 W / m ² K for all buildings	0.4 W / m ² K for all buildings
	Ceiling and exposed floors	-	-	0.63 W / m ² K for all buildings	0.4 W / m ² K for all buildings	0.4 W / m ² K for all buildings
	Overlying floors in closed non-air-conditioned spaces	-	-	2.0 W / m ² K only for buildings with a floor area of more than 1,000 m ²	-	-
	Frames	-	-	3.23 W / m ² K for all buildings	2.9 W / m ² K for all buildings	2.25 W / m ² K for all buildings
	Maximum shade factor for frames	-	-	0.63 for all buildings	-	-
	Minimum energy efficiency class in the Energy Performance Certificate	-	-	-	-	-

TABLE 4.1: MINIMUM ENERGY PERFORMANCE REQUIREMENTS FOR EXISTING BUILDINGS

4.1.2 Energy Performance Certificates

Issuing an Energy Performance Certificate is a reliable way to evidence the energy status of an existing building and to record proposals for its upgrade. It must be presented to the would-be buyer or tenant, while a copy must be provided to the new tenant or buyer. Also, the energy efficiency class of a building must be indicated in commercial advertisements when the building is offered for renting or sale. Therefore, with the information it provides, the Energy Performance Certificate is a tool to trigger renovation at the point of the life cycle of a building when it is sold or leased to a new tenant. To date, 59,432 Energy Performance Certificates have been issued. However, only 10.6% of all those issued, relate to existing buildings, which can lead to the conclusion that the issuance of an Energy Performance Certificate for the purposes of sale or renting is low. This can be attributed to the following reasons:

- a) no legislation in force to associate the energy performance certificate with the deed of sale or rental;
- b) no information on the energy performance certificate provided to would-be buyers or tenants of buildings;
- c) would-be buyers or tenants of buildings, owners and real estate professionals find it difficult to 'translate' the data shown on the energy performance certificate into building operating costs;
- d) relatively low value added to the selling or rental price that the building owner can secure due to its high energy efficiency rating.

The above obstacles have not allowed the Energy Performance Certificate to gain full momentum as an indicator that affects the value of properties and, ultimately, fostering the energy upgrading of existing buildings. Aiming at the bigger promotion of Energy Performance Certificates among the public, from 2015 onwards financing incentives were associated with the issuance of Energy Performance Certificates, such as in the case of the 'Save & Upgrade' programme, while they have been included in informative campaigns organised by the Ministry of Energy, Commerce and Industry.

In order to further improve the role of Energy Performance Certificates during selling or renting, the increase of inspections in 2020 has been planned in order to implement the Law in commercial advertising.

The Ministry of Energy, Commerce and Industry has decided to proceed with the revision of the methodology for calculating the energy performance of a building, used for the issuance of Energy Performance Certificates. The project started in December 2018 with the signature of a contract with the University of Cyprus and is scheduled to be completed in 2021 with the issuance of a software simulating the new methodology. The revised methodology will be developed on the basis of the new standards that have been prepared by the European Committee for Standardisation (CEN) in the context of mandate M/480 of the European Commission and in Directive 2010/31/EU and its amendment, Directive 2018/844/EU. The aim is to address problems and gaps observed by the implementation of the existing methodology, to include new technologies and to improve the way that the energy status of the building is recorded in the Energy Performance Certificate and its accompanying recommendations. This improvement is expected to lead to greater energy saving, as the Energy Performance Certificate is used as an indicator of compliance with the minimum energy performance requirements for major renovations, as well as of achievement of saving in financial and other incentives.

Further measures to strengthen the Energy Performance Certificate in the real estate market are recorded in the National Energy and Climate Action Plan, as one of the instruments for Cyprus to achieve the 2030 climate objectives and the vision of a decarbonised building stock by 2050. These measures are the revision of the existing legislative framework for the sale and renting of buildings and the link between Energy Performance Certificates and financial and fiscal incentives.

4.1.3 Inspection of heating and air-conditioning systems

The mandatory periodic inspection of air-conditioning and heating systems is yet another measure that can contribute towards the energy upgrading of existing buildings. The inspection of air-conditioning and heating systems aims to improve the energy efficiency of the systems by means of the recommendations submitted by the inspector.

The inspection of air-conditioning systems is carried out by air-conditioning system inspectors and the inspection of heating systems is be carried out by inspectors of

heating systems. In all cases the inspector must hand over an inspection report to the owner of the building, which must record the inspector's recommendations for improving the performance of the system and/or part of it.

To date, the examination centres, approved by the Energy Service, have certified 70 heating system inspectors and 78 air-conditioning system inspectors, and 315 inspections of heating systems with a boiler and 305 inspections of air-conditioning systems have been performed.

Directive 2018/844/EU increases the limit of nominal capacity of the system to be inspected to 70 kW, instead of 20 kW for heating and 12 kW for air-conditioning, as it is today. Furthermore, under the new Directive, inspections may be replaced by the installation of a system of automation and control or by an energy performance contract or by the assignment of the operation of the system to a system operator or network operator. This revision essentially recognises the low impact that inspections have had so far on energy saving and how they can be replaced by more effective measures, such as electronic monitoring of the operation of the system and under certain conditions by energy audits and energy suppliers. However, the Directive extends the scope of inspections to all heating systems (currently only heating systems with a boiler are inspected) and ventilation systems, when combined with heating and air-conditioning systems.

The implementation of alternative measures in terms of inspections will provide building owners with more flexibility in order to implement the optimal measures per case. The inspections currently in place and below the 70 kW threshold are planned to be maintained in the law as optional. Public and private resources have been invested in the development of inspections of smaller heating and air-conditioning systems and their continuation on a voluntary basis can yield even small energy savings. Also, they can assist in the implementation of other measures, such as energy control and energy performing contracting.

With a view to modernising and improving inspections, the process of reviewing the method of inspecting heating and air-conditioning systems on the basis of the new standards adopted by CEN has started. In addition, digitising the register of system inspectors is ongoing, which should facilitate quality control, as well as controlling the enforcement of the legislation on inspections.

4.1.4 Technical system requirements for existing buildings

In order to further improve the energy efficiency of heating and air-conditioning systems in existing buildings, a provision was adopted in 2015 and 2013, respectively, for the periodic checking, adjustment and functioning of these systems. Two guides that have been issued for each system describe the works and controls to be carried out by the installers of technical systems. The aim is to ensure that appropriate measures are taken for the maintenance of heating and air conditioning systems, so that they function with the best energy-efficiency possible.

In addition, for new systems installed in existing buildings and for the existing system being upgraded, energy-efficiency requirements were set in 2016. In addition to air-conditioning and heating systems, the requirements also cover hot water and large ventilation systems. The implementation of these systems is mandatory insofar as this is technically, functionally and economically feasible.

These requirements are explained in detail in two Guides:

- a. In the Guide of Total Performance Requirements for Technical Systems Installed or Upgraded in Buildings and Building Units used as Homes, for buildings and building units used as homes;
- b. In the Guide of Total Performance Requirements for Technical Systems Installed or Upgraded in non-Residential Buildings and Building Units, for non-residential buildings and building units.

The systems covered in the Guides are:

- a. heating systems with a boiler in order to heat spaces and produce hot water
- b. sub-floor heating
- c. mechanical ventilation
- d. heat pumps
- e. cooling systems
- f. solar panels for the production of hot water
- g. hot water pumps
- h. hot water and radiation heaters
- i. hot water production systems
- j. central air-conditioning units

- k. air Management Units
- l. insulation of pipework and ducts
- m. water rotating plants and water pumps in heating and air-conditioning systems.

Directive 2018/844/EE amends the definition of technical systems by extending the scope of requirements to lighting, automation and control systems and to on-site power generation systems. The Ministry of Energy, Commerce and Industry has signed a contract with Frederick University for consulting services in the revision of the two Guides of Total Performance Requirements for Technical Systems. The contract will be completed in 2020.

4.1.6 Energy Services: Energy Auditing and Energy Performance Contracting

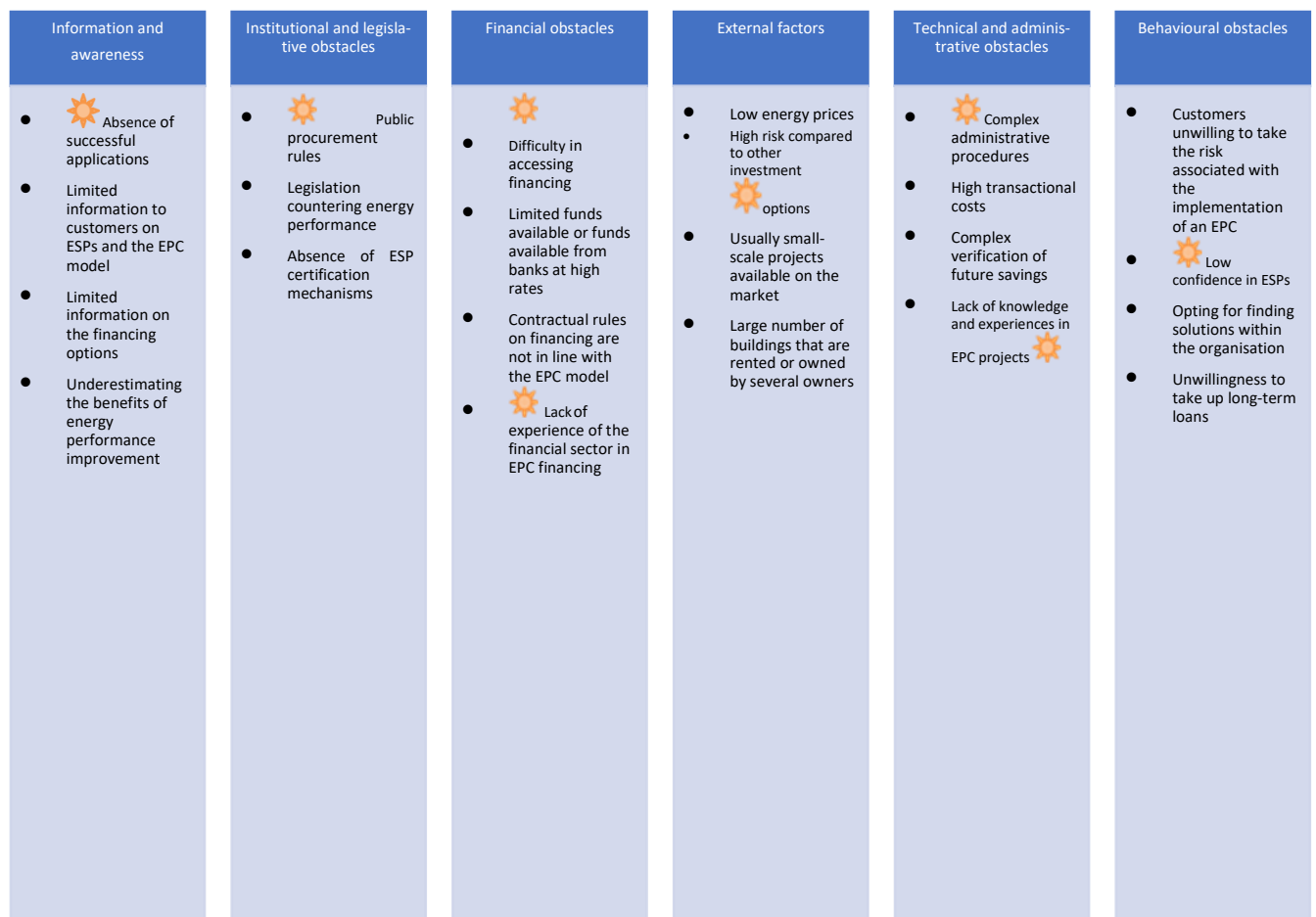
Energy auditing of buildings, as carried out by authorised energy auditors, offers a more holistic approach than that offered by the three other independent experts in the field of the energy performance of buildings (Qualified Experts, Air-Conditioning System Inspectors and Heating System Inspectors), as it must be based on updated and measurable operating data regarding energy consumption in the building and must include a detailed overview of the characteristics of that consumption. The training and authorisation of energy auditors started in the second half of 2013.

Periodic energy audits are mandatory for large undertakings, every four years. At the same time, a sponsorship scheme is in place to promote energy audits for Small and Medium-sized Enterprises (SMEs). The scheme aims at promoting the performance of energy audits in the areas where they perform their financial activity and where energy is consumed (buildings, industrial installations and processes, agricultural installations and transport).

The regulations on Energy Service Providers (ESPs) were issued In April 2014, to increase confidence in energy audits among stakeholders, as well as to offer an alternative way of financing energy-saving measures resulting from energy audits, by means of Energy Performance Contracting (EPC).

To date, there are 55 Energy Auditors and 12 ESPs that can operate in the buildings sector. However, the level of activity of energy auditors and ESPs is very low. This may be due to a lack of confidence on the part of end users in the process and to a lack of

know-how and experience on the part of ESPs. Given the relatively small size of the market and the lack of access to financing, the development of the energy services market remains stalled. JRC's report, 'Report on the current status of the energy services market and proposals for measures to promote EPC in the public and private sector', records the obstacles encountered in the development of energy services. These are broken down into the following themes: information and awareness, institutional and legislative obstacles, financial obstacles, external factors, technical and administrative obstacles, and behavioural obstacles. Graph 4.1. illustrates the obstacles mentioned in this study, while the obstacles which are, in accordance with GIZ's study 'An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050', the most essential ones, are marked with an asterisk in order to be resolved as a matter of priority.



GRAPH 4.1: OBSTACLES TO THE IMPLEMENTATION OF ENERGY SERVICES¹⁶

¹⁶ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

To overcome the obstacles referred to above, the following measures are under way:

- a. Development of a methodology and software for the qualitative control of Energy Audits. The aim of this measure is to increase and to better target the qualitative control, which will in turn improve the market's confidence to energy controls and, by extension, the EPCs based on them.
- b. Implementation of online services for the electronic management of all the registers kept by the Energy Service, including the registers of Energy Auditors and Energy Service Providers. The objective is to speed up administrative procedures and ease access to companies and other organisations that are interested in the market of energy audits and ESPs.
- c. Preparation of standard public tender documents for the selection of Energy Service Providers with the objective of signing Energy Performance Contracts with the state and the wider public sector. The objective is to create standardised documents, together with a short, step-by-step, procedure to be notified subsequently to the Authorities, both of the central government and the wider public sector, in order to facilitate the implementation of such projects. It is expected that the documents will help to increase the use of Energy Service Providers to implement energy-efficiency projects in the public sector.

4.2 Incentives

Failure to ensure renovation financing is, according to the questionnaire answered by stakeholders during the public consultation, the biggest obstacle to the energy upgrading of buildings (Annex I). They also consider that public grant schemes are the most important tool for increasing energy renovation.

The incentives are designed to ease this obstacle. However, the success of the incentives is largely determined by the savings achieved. In accordance with Directive (EU) 2018/844, the financial measures for energy-efficiency improvements in the renovation of buildings should be linked with targeted or achieved savings, as these are identified by one or a combination of the following criteria:

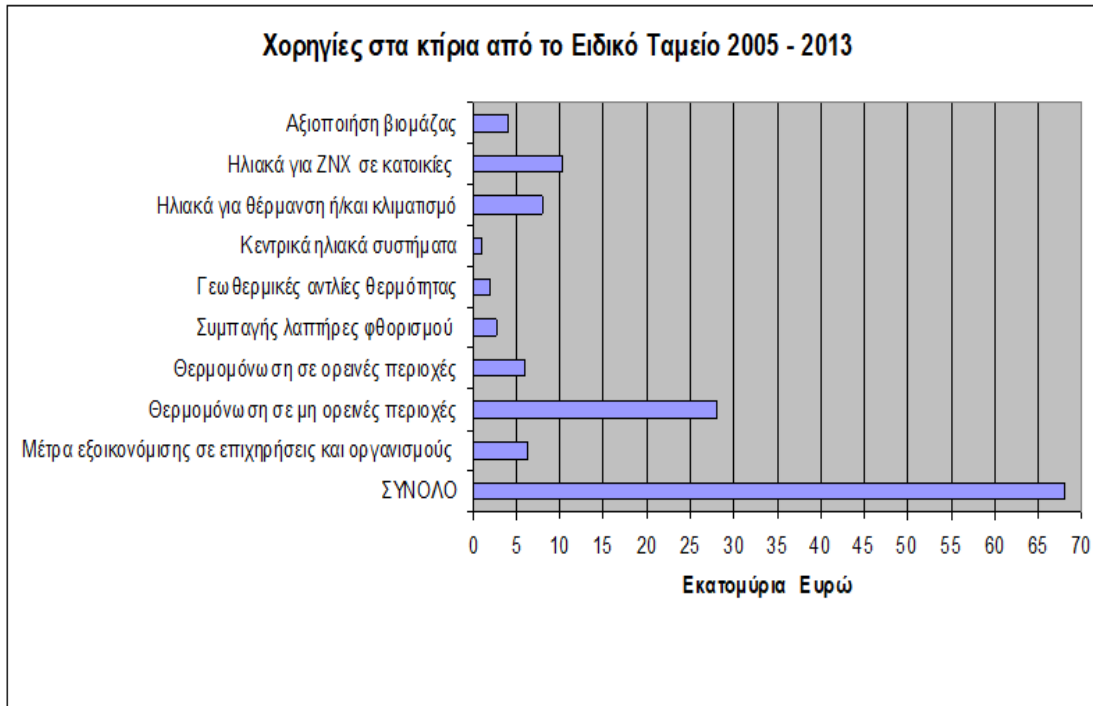
- a. The energy performance of the equipment or the material used for the renovation, where the equipment or the material used for the renovation should be installed by a person responsible for the installation, with an appropriate level of certification or qualification;
- b. With the comparison of Energy Performance Certificates prior to and after the building renovation;
- c. With the results of the energy audit;
- d. With the use of standard prices in order to calculate energy-saving;
- e. With the use of another, relative to the above and transparent, method.

The above criteria are already implemented in many financial incentives, such as the 'Save & Upgrade' programme and Order 1 of 2014 of the Ministry of Interior, which are recorded in points 4.2.2 and 4.2.3 respectively.

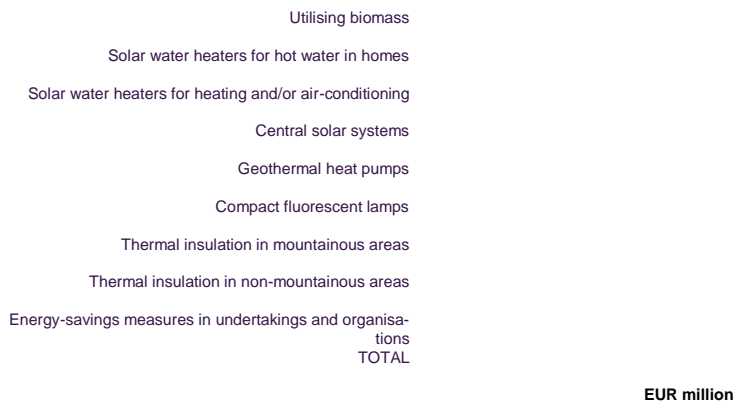
4.2.1 Renewable Energy Sources (RES) and Energy Saving (ES) Schemes

The Fund for RES and ES was created in 2003 in order to finance investments in energy performance improvement measures and renewable energy sources' systems. The Fund derives its income from imposing an energy fee per kWh of electricity consumed on all final consumers. From February 2004, when the grant schemes of the Fund were put in place, to the end of 2013, a total of €100 million was granted for investments in energy performance and RES measures to households, businesses and the public sector. An estimated €67 million of the expenses for 2004-2013 were given as a grant to the building sector, in investments, such as thermal insulation, windows and installation of RES systems for air-conditioning and heating.

Since the minimum energy performance requirements were put in force in 2008, the Fund kept subsidising energy-saving measures only for existing buildings and RES systems intended for heating and cooling in new and existing buildings. The energy saving to be included in the life cycle of buildings through the implementation of measures financed by the Fund is estimated to reach 1 million tons of oil equivalent (TOE).



Grants to buildings from the Special Fund 2005–2013



GRAPH 4.2: GRANTS TO BUILDINGS FROM THE FUND FOR RES AND ES 2005–2013

In 2019, the Fund for RES and ES operated the following schemes:

- a. Grant Scheme for encouraging the use of Renewable and Energy Sources and Energy Saving in Homes. The project comprises four categories: a) thermal insulation of roofs c) thermal insulation of roofs with a photovoltaic system c) installation of a photovoltaic system) installation of a photovoltaic system for vulnerable consumers. The first three categories relate exclusively to existing homes. The scheme had a

total budget of €24.5 million financing part of the cost of implementing the measures of thermal insulation and installation of the photovoltaic system.

- b. Grant scheme for the promotion of energy audits in Small and Medium-sized Enterprises (SMEs). The Scheme aimed at promoting the performance of energy audits in the areas where they carry out their economic activity and where energy is consumed, including buildings. The scheme had a total budget of €200,000, exclusively financing the cost of carrying out the energy audit.

The Ministry of Energy, Commerce and Industry has announced that the Grant Scheme for encouraging the use of Renewable Energy Sources and Energy Saving in homes will be made available again in 2020.

4.2.2 'Save & Upgrade'

The 'Save & Upgrade' programme finances renovation of homes and buildings owned or used by SMEs, which had requested a building permit before 21 December 2007. The programme is expected to finance the renovation of 2,100 homes with €20.4 million and 164 SMEs' buildings with €8.7 million. It is co-financed by the Union's Cohesion Fund (CF) for households and the European Regional Development Fund (ERDF) for SMEs.

The project provides financial support for a package of measures that will upgrade the building to a minimum level of energy efficiency. The eligible costs include thermal insulation of the envelope, windows, high-efficiency technical systems, lighting and RES for heating, cooling and hot water. A larger subsidy is awarded to buildings that are renovated into NZEBs and to vulnerable consumers' homes. The following tables cite more data in terms of the renovation cost and savings for 2014–2018.

Year	Scheme name	Number of applications submitted	Number of applications approved/included to date	Total grant for projects included	Applications paid until 31/12/2019	Amount of payment until 31/12/2019
2014–2016	'Save & Upgrade for Businesses' programme	164	128	€8,698,946	95	€6,260,515
2015–2016	'Save & Upgrade for Homes' programme (1st Call)	1139	990	€10,286,014	947	€9,006,678
2018	'Save & Upgrade for Homes' programme (2nd Call)	1230	859	€9,166,645		

TABLE 4.2: 'SAVE & UPGRADE' PROGRAMME IN TIME PERIODS

INVESTMENT CATEGORY	CALL	NUMBER OF APPROVED APPLICATIONS RELATED TO NZEBs	AVERAGE m2 OF HOME	AVERAGE INVESTMENT COST	AVERAGE ANNUAL ENERGY SAVING, KWH/YEAR (COMPARISON OF THE INITIAL WITH THE FINAL ENERGY PERFORMANCE CERTIFICATE)	SAVING INDICATOR A: (KWH/1000 EUROS OF INVESTMENT)	SAVING INDICATOR B: (KWH/M2 OF HOME)
NZEB	A	84	167	37000	65574	1772.27	392.66
NZEB	B	74	200	47500	75248	1584.17	376.24
INVESTMENT CATEGORY	CALL	NUMBER OF APPROVED APPLICATIONS	AVERAGE m2 OF HOME	AVERAGE INVESTMENT COST	AVERAGE ANNUAL ENERGY SAVING KWH/YEAR (COMPARISON OF THE INITIAL WITH THE FINAL ENERGY PERFORMANCE CERTIFICATE)	SAVING INDICATOR A: (KWH/1000 EUROS OF INVESTMENT)	SAVING INDICATOR B: (KWH/M2 OF HOME)
ALL CATEGORIES	A	990	159	25682	52844	2057.63	332.35
ALL CATEGORIES	B	859	154	26958	52800	1958.60	342.86

TABLE 4.3: 'SAVE & UPGRADE' PROGRAMME PER CALL

4.2.3 Scheme for the production of electricity from RES for own consumption

The installation of photovoltaic systems in buildings started in 2005 with grants from the Fund for RES and ES. Reduced photovoltaic prices and increased electricity tariffs have turned the development model for these systems to methods associating production with consumption. The first offsetting programme (net metering) started in 2013. Up until the end of 2015, it was possible to install a photovoltaic system only in homes with a maximum capacity of 3 kW. In December 2015, the programme was revised to include all types of buildings and to increase the maximum permissible capacity of the photovoltaic system to 5 kW.

The programmes of electricity offsetting (net-metering), bill offsetting (net-billing) and auto-production offer the ability to all consumers to cover part of or their total needs in electricity through photovoltaic systems and/or other RES systems. The systems are installed on the roof of the premises they serve or on the ground within the same land parcel or on an adjacent plot.

The installation of such systems is carried out within the framework of the 'Project for electricity from Renewable Energy Sources for own consumption', covering:

- a. installation of photovoltaic systems using the measuring offsetting method (net-metering), with a capacity of up to 10 kW for all consumers (residential and non-residential/commercial consumers);
- b. installation of RES systems (photovoltaic systems, units of biomass/biogas use etc.), with a capacity from 10 kW up to 10 MW, using the billing offsetting method (net-billing) in commercial or industrial premises and public buildings;
- c. installation of photovoltaic systems and systems of biomass/biogas use, with a capacity from 10 kW up to 10 MW, using the method of auto-productions in commercial or industrial premises and public buildings.

Up until February 2020, 15,907 photovoltaic systems have been installed, with a total capacity of 58,596 MW, in homes and commercial premises, in the net-metering category. In the category of net-billing and auto-production, 152 systems with a total capacity of 10,127 MW have been installed.

Following a proposal made by the Minister of Energy, Commerce and Industry to the Council of Ministers residential buildings will also be eligible for net-billing.

The above schemes play a catalytic role in the increase of RES in the existing buildings, where their installation, either as part of a renovation, or as an individual measure, is an important element in the effort being made to decarbonise the building stock.

4.2.3 Order 1 of 2014 of the Minister of Interior

Another incentive is Order No 1 of 2014, as issued by the Minister of Interior on the basis of the Town and Country Planning Law. In accordance with the Order, in the case of new buildings and buildings undergoing renovation, it is possible to increase the building rate by 5% for energy class A buildings, and at least 25% of their total energy needs will be covered from renewable energy sources, i.e. at least two of the criteria laid down for NZEBs should be met. From 2014 to April 2020, certificates have been provided confirming that the requirements of the Order have been met for 950 developments, for 187 of which the owners signed a contract with the local planning authority in order to proceed with the construction or renovation of the building. It is noted that a significant increase in the interest in the use of the incentive is gradually observed. It is stated that in 2019, the Energy Service issued certificates that the criteria of the Order were met for 482 developments, as compared with 160 in 2018.

The Ministry of Energy, Commerce and Industry in cooperation with the Department of Town Planning and Housing has submitted recommendations for the revision of the Order by the Minister of Interior. The aim is for this incentive for the construction or renovation of buildings to exceed the requirements in force for NZEBs.

4.2.4 Reduced V.A.T. rate for building renovations

A reduced V.A.T. rate is applied since 2015 (5% instead of 19%) for building renovations for which at least three years have passed from the first date of occupancy. The reduced rate applies to all saving measures related to the building envelope and installation of photovoltaic systems. This measure combined with grant schemes, such as the 'Save & Upgrade' programme and the schemes of the Fund for RES and ES, helps to reduce renovation costs.

4.2.5 Financing tool

However, ensuring maximum investment requires a higher share of private financing and solutions that are based on market mechanisms. Therefore, energy upgrading projects must meet the different criteria that are mandatory for financing from the financial sector, and the banking sector must also become acquainted with the concept of energy upgrading of existing buildings. The technical report entitled 'Financing energy efficiency in buildings in Cyprus', as prepared by the JRC for the Ministry of Energy, Commerce and Industry, provides an analysis of the existing incentives and an assessment of their cost and energy effectiveness, also proposing a roadmap for a transition to financing measures that are more based on market mechanisms. Greater mobilisation of private capital is very important, in accordance with the report, and proposals for improving the situation are being made.

The 'Fund of Mutual Funds' is one of the proposals adopted. On 18 December 2018, the Council of Ministers decided to set up a fund to implement a loan scheme for energy efficiency and RES (Decision No 86,411). The Fund has an initial capital of €40 million, coming from the Cohesion Fund, the European Regional Development Fund and national contributions. Another amount of €40 million has been added to the Fund by the Government from a loan guaranteed by the European Investment Bank. The 'Fund of Mutual Funds' is designed to provide loans to households, SMEs and local authorities that will invest in energy efficiency and RES projects. These loans will be made available through commercial banks. It is expected to be operational in 2020.

4.2.6 Business4Climate

The 'Business4Climate' initiative was developed as a pilot by the Cyprus Employers and Industrialists Federation (OEB), in co-operation with the Cyprus University of Technology to offer the required support in terms of scientific knowledge, and the Department of Environment. The aim of the initiative is to voluntarily commit companies that are not part of the Emission Trading Scheme, and to help them take action to reduce carbon emissions. The initiative was officially launched in September 2018 and provides Cypriot businesses from all economic fields with the necessary tools to determine greenhouse

gas emissions from their activities and to compile an Action Plan for each business aiming at the reduction of these emissions.

The proposal was submitted and financed by Climate-KIC, through the Regional Innovation Scheme of the European Institute of Innovation and Technology (EIT).

The 'Business4Climate' initiative is based on the following steps

- a. Signing of a voluntary declaration by businesses for the reduction of greenhouse gas emissions by more than 8% by 2030.
- b. Seminars by the initiative's partners on the development of skills for the personnel of businesses.
- c. Development of an online tool for businesses, assisting in the preparation of the report of gas emissions for reference year 2017.
- d. Development of a template for the submission of an Action Plan for the reduction of greenhouse gas emissions for businesses. The Action Plan may be submitted by the business within a year from the date of signature of the declaration.
- e. Progress monitoring by a monitoring group. Progress reports (or a revised Action Plan) should be submitted by the business every two years.

The benefits of the initiative are considerable and multiple for businesses, as the reduction of greenhouse gas emissions will result from the reduction of energy consumption and the more rational management of resources, leading to a reduction in their operating costs.

The financing by Climate-KIC for the implementation of the 'Business4Climate' initiative was completed on 31 December 2018. Up to now, 64 Cypriot businesses from various fields of economic activity have been voluntarily committed. In 2019, it was considered that additional incentives are needed for the participation of enterprises in the initiative, with a view to stepping up efforts to reduce emissions by 2030. The Department of Environment is preparing a scheme to mobilise businesses following a relevant decision made by the Council of Ministers, dated 28/08/2019 (Decision No 88,020). It is expected that the grant scheme will be operational in 2020. The Scheme is financed by state resources deriving from the revenues of the Emissions Trading Scheme. The total budget for all Grant Schemes for Actions Contributing to the Reduction of Greenhouse Gas Emissions (including the above), which are mentioned in

the decision of the Council of Ministers dated 28 August 2019, amounts to €13.5 million for the 2020–2022 period.

The grant scheme will aim to reduce greenhouse gas emissions from the commercial and industrial activity of businesses and will target the financing of enterprises that have been shown to reduce greenhouse gas emissions through the implementation of actions related to the adoption of one and/or several measures mentioned in the Template of the Action Plan. Businesses that will manage to reduce their emissions, will receive as a grant the current price of carbon permit (tCO_{2eq}) for every tCO_{2eq} that has been reduced, related to the reference year, 2017, and up to 2030, from the date of implementation of the measure for the reduction of the emissions.

Some of the energy-saving measures that can be implemented by the businesses participating in 'Business4Climate' are the renovation of buildings where they are housed and individual measures for energy-saving in the buildings where they are housed, such as thermal insulation of roofs, thermal insulation of walls, replacement of frames, replacement of the lighting system, replacement of air-conditioning systems, installation of external fixed or moving shades, installation of a solar panel system for the production of hot water, installation of a central solar panel system for space heating and/or cooling, installation of a biomass boiler for space heating or production of hot water, installation of a system to recover the energy emitted.

It is estimated that the cumulative energy saving during the last use from the implementation of the said measure for the 2021–2030 period will amount to about 15,200 TOE, without taking into account that other businesses will also possibly participate in the future.

4.3 Information measures

4.3.1 Information campaign of the public on energy performance issues

The information campaign of the public on energy performance issues was carried out during the 30.10/2019–08.12.2019 period. The costs of implementing the campaign amounted to almost €165,000. An important part of this campaign concerned homes

and business buildings and was addressed to all the citizens of the Republic, emphasising on the 20–65 age group.

The main actions of the campaign were:

- a. Billboards on main highways, buses and malls;
- b. Creation of a static website of the Energy Service providing information related to energy performance issues (consumers and SMEs), with a capacity of expansion at a 2nd phase in order to include the Energy Service's entire website;
- c. Creation and broadcasting of radio spots;
- d. Creation and broadcasting of TV spots;
- e. Promotion of the Energy Service's social media (Facebook and Twitter);
- f. Online advertisements;
- g. Print advertisements in the press.

4.3.2 Energy-saving tool

The online energy-saving tool has been set up to help citizens to easily identify the costs and benefits from different energy-saving and renewable energy sources measures they may receive.

The tool offers a range of functions to users for estimating energy consumption and proposes ways to save energy. It includes, in particular, options for

- a. Building energy upgrading: Depending on the use of energy and the construction elements of each home, users can easily identify potential energy-saving measures in their own home, with an indication for the expected energy saving and the improvement of the levels of thermal comfort offered by each measure. In addition, advice on the ways of rational use of energy is provided on a case-by-case basis.
- b. Electrical appliances: It is possible to calculate money and energy saving in the event of replacement of the existing household electrical appliances with more energy-efficient ones. There are eight categories of electrical appliances, including lamps.
- c. Renewable Energy Sources Systems: Depending on the energy consumption in each home, a photovoltaic system of appropriate capacity is suggested. In addition, depending on the needs for hot water, the size of solar collectors in order to fulfil

the needs is suggested. Indicative figures for money saving due to reduced electricity tariffs are provided.

- d. Cars: Two cars can be compared and calculations are made for the benefits from replacement, in terms of the reduction in consumption and the fuel cost, as well as in terms of the reduction in carbon dioxide emissions.

The tool was prepared in the framework of technical assistance provided to Cyprus by the European Commission to increase public information on the benefits of energy-saving measures. It was carried out with the cooperation of the Energy Service, the Austrian Environmental Bureau and the Cyprus Energy Agency and funded by the Structural Reform Support Service of the European Commission.

It is posted online at EnergySavingsTool.cea.org.cy. There is also a relevant link for the tool at the Energy Service's website, which was prepared in the framework of the information campaign of the public (www.energy.gov.cy). The tool addresses the public for information purposes and the results it produces are indicative.

4.4 Research and innovation in the field of energy performance of buildings

In line with the National Energy and Climate Action Plan, in the effort to reduce carbon emissions, research and innovation can play an important role. Although it is difficult to implement important technological developments just from the research carried out in Cyprus, the existence of a critical number of researchers on issues such as energy efficiency, renewable energy sources and fuels can speed up:

- a. The demonstration and development of new technologies in Cyprus;
- b. The implementation of innovative measures in accordance with the particular conditions of the Cypriot market;
- c. The development of expertise for innovative services related to technologies for low carbon dioxide emissions.

Particularly in the area of the energy performance of buildings, significant work has been carried out in recent years by universities and other research institutions in the field of energy upgrading of existing buildings. The Energy Service supports such initiatives, mainly by issuing opinions on policy issues, as well as on the dissemination of

the results. Moreover, the results of these projects are also used as feedback to improve the existing arrangements and incentives relating to the energy upgrading of existing buildings. Following are some of these research projects

- a. The Cyprus Energy Agency is a partner in the 'VIOLET' (preserve traditional buildings through Energy reduction) project, which is co-financed by the EU's European Regional Development Fund (ERDF) and has a duration of 5 years (2017-2021). More specifically, the project aims to foster and develop policies for strengthening the energy performance of traditional buildings, also including parallel actions for reducing carbon dioxide emissions and preserving their cultural heritage. 'VIOLET' encourages the application of integrated design for the energy upgrading and protection of traditional buildings, with a view to making sure that they are properly restored and preserved, as they will remain financially viable for ongoing use at reduced energy operating costs. There are 6 partners in the project, from Romania, Germany, Spain, the Netherlands, France and Cyprus, with a total budget of €1.3 million.

- b. The Novel integrated approach for seismic and energy upgrading of existing buildings (SupERB) project aims at developing a holistic and innovative methodology for the optimal simultaneous upgrading of existing buildings, in terms of both seismic resistance and energy efficiency, taking into account the economic, technical, geographic and environmental factors. The simultaneous improvement of safety against seismic loading and energy efficiency in buildings made of reinforced-concrete and load-bearing walls, which constitute the major part of the southern European building stock, is the biggest challenge. The project is financed by the Research and Innovation Foundation, in the framework of the Restart 2016 – 2002 programme and has a duration of three years (2019–2022).

- c. The Cyprus Employers and Industrialists Federation (OEB) participates in the European Hotels4Climate programme, the aim of which is to facilitate the reduction of greenhouse gas emissions in the hotel sector in Greece and Cyprus. The actions of the project include, inter alia:
 - Assessment of the current situation of the hotel sector in Cyprus and Greece with regard to energy use, energy saving and greenhouse gas emissions and the selection of good practices;

- Development of skills and training for the staff of the hotel sector on issues of reduction of greenhouse gas emissions and energy saving;
- Creation of an online base for the exchange of information between the hoteliers concerned;
- Thematic visits to good hotel practices in Greece and Germany for 10 representatives of hotel units from Cyprus;
- Networking opportunities with financial institutions, interested bodies and hotel executives.

The project is financed by German Funds for the Climate and started on 1 October 2019 to be completed within 23 months.

d. The Cyprus Employers and Industrialists Federation (OEB) participates in the European 'SMEmPower Efficiency' programme, the general aim of which is to support SMEs in the implementation of European Directive 2012/27/EU on energy efficiency. In particular, the project is based on a holistic framework aimed at helping SMEs to improve the skills and competences of their staff, by developing special training programmes for Energy Managers, as well as to undergo energy audits and, above all, to take action and implement the proposed energy-saving measures. The actions of the project include, inter alia:

- Development of a free certified education and training programme aimed at training the executives of SMEs, who deal with energy issues in their business (5 ECTS, level 6 of the EQF);
- Development of an electronic energy management platform, as well as of 2 specialised energy analysis tools (Monitoring & Targeting, Measurement & Verification), which will be accessible by professional engineers free of charge;
- Pilot implementations for energy-saving measures in businesses/industries;
- Development of an advanced training manual;
- Workshops that will bring SMEs in contact with the representatives of financial institutions to explore ways of financing energy efficiency projects.

The project started on 1 September 2019 and will be completed on 30 August 2022.

4.5 New measures and actions

4.5.1 Energy-Efficiency Obligation Scheme

In 2020, the framework of operation of the energy-efficiency obligation scheme for energy distributors is expected to be established, which are defined as Obligated Parties to achieve part of the national mandatory cumulative target for energy-saving at end-use.

According to national planning, as this is reflected in the National Energy and Climate Action Plan, the energy-efficiency scheme will contribute to the 2030 national mandatory target by 41.1% or about 100 ktoe.

The energy-efficiency obligation scheme includes measures, which should be implemented by the Obligated Parties, in order to improve energy-efficiency in residential, commercial and industrial facilities, as well as vehicles. In particular, the measures are divided into awareness-raising and technical measures. Awareness-raising measures concern actions for behavioural change and rational use of energy by final consumers, while technical measures relate to intrusive operations such as, for example, thermal insulation of the building envelope, replacement of technical systems, etc.

It is estimated that the implementation of the obligation scheme for energy distributors for the 2020–2030 period will lead to investments of €150 million, which, however, are not all related to the building sector. Further details on the Energy-Efficiency Obligation Scheme are set out in Chapter 3.2 and Annex 4 of the National Energy and Climate Action Plan.

4.5.2 Anti-seismic building upgrading

In most of the buildings built when there were no minimum energy performance requirements, there were also no seismic safety requirements. Therefore, the vast majority of existing buildings are insufficient, both in terms of energy efficiency, but also in terms of seismic resistance. The combination of the two is two-way, as a structural

upgrade of the building will activate its energy upgrade, while a renovation to improve the building's energy efficiency can reveal the inadequate shielding of the building against earthquakes.

In accordance with the proposed amendment of the Regulation of the Energy Performance of Buildings Law, for purposes of addressing issues related to intense seismic activity, prior to major renovation, the owner of a building or a building unit, the building permit of which was issued before 1994, must appoint a suitable designer, who will prepare a report on the valuation of the load-bearing structure in accordance with the Eurocodes in force as regards the status of the structural bearing of the building and its estimated remaining life, accompanied by any recommendations concerning its structural strengthening. This provision was made following public consultation with the stakeholders. It aims to provide adequate information to the building owner at the appropriate time by allowing more complete technical and financial planning.

4.5.3 Special character buildings

Buildings that have been designated as listed or ancient monuments are exempted from the obligation to issue an Energy Performance Certificate when they are available for sale or renting. In addition, they are exempted from the obligation to observe minimum energy performance requirements if their compliance with them would substantially alter their character. In Cyprus, there were 7,000 buildings designated as listed or ancient monuments in 2018. However, this number has a small but gradual increase, with around 70 buildings a year being designated as listed, while an average of 350 of them are being renovated each year.

For the best use possible of the energy-saving potential of buildings that have been designated as listed or ancient monuments, the proposed amendment of the Regulation of the Energy Performance of Buildings Law includes the following:

- a. The ability to exclude these buildings from the issue of an Energy Performance Certificate when they are available for sale or renting ceases to exist;
- b. Non-implementation of the minimum energy performance requirements is possible only after adequate documentation that it alters their character or appearance in a non-acceptable way.

The above amendments in the legislative framework aim to increase the measures of energy efficiency in listed buildings through energy certification, as well as to urge those

involved in such renovations to find technical solutions that will improve the building's energy performance without violating its character.

4.5.4 Proposals for the 2021–2027 planning period of the European Structural Funds

In the framework of the 2021–2027 planning period, the Ministry of Energy, Commerce and Industry, taking into account the importance of energy upgrades, has submitted to the competent national authority (Directorate General for European Programmes, Coordination and Development) the following proposals

- a. Energy upgrade of homes to NZEBs. The proposal has a budget of €40 million, while with the contribution of private funds the total expenditure in renovations will amount to €80 million. It is estimated that with this proposal about 1,600 homes will be renovated.
- b. Implementation of energy-saving measures in SMEs. The proposal has a budget of €15 million, while with the contribution of private funds total investments will amount to €30 million. Eligible costs will be building renovations and targeted energy-saving measures. It is estimated that this proposal will implement at least 100 renovations.
- c. Implementation of energy-saving measures in municipalities and communities. The proposal has a budget of €15 million, while with the contribution of funds from municipalities and communities total investments will amount to €30 million. Eligible costs will be building renovations and targeted energy-saving measures.

The above proposals are recorded in Chapter 3.2 of the National Energy and Climate Action Plan.

4.5.5 Green tax reform

As mentioned in paragraph 2.2.1i of the National Energy and Climate Action Plan, the Green Tax Reform is the most important additional policy worth considering, for Cyprus to meet its climate targets by 2030 and to move towards a zero-carbon footprint economy by 2050. The green tax reform will include carbon pricing in sectors outside the Emissions Trading Scheme of the Cypriot economy. Such a reform can indeed further stimulate investments in energy-efficiency and RES measures. Particularly in the building sector where the cost of emissions today is not transferred to private investment. In September 2019, the Minister of Finance announced that a green tax

reform would be put to consultation in 2020, with a view to the adoption of the relevant legal framework and the implementation of such a reform in 2021.

4.5.6 Installation of 'smart' electricity meters

The Operator of the Distribution System plans to install 400,000 'smart' electricity meters by January 2027. Meters will provide real-time information on electricity consumption and generation, helping final consumers to optimise their energy use. Furthermore, this information can be particularly useful for building owners and investors, in order to implement, during the renovation, cost-optimal energy-saving and RES measures.

5. Policies and actions relating to the worst performing parts of the national building stock, dilemmas due to conflicting interests and which contribute to the mitigation of energy poverty

Buildings for which an application for a building permit has been submitted before 21 December 2007 are typically the buildings with the lowest energy performances, since before this date there were no minimum energy performance requirements. Recognising that this is part of the building stock with the largest energy-saving capacity, the 'Save & Upgrade' programme and the thermal insulation programmes of the Fund for RES and ES exclude the financing of buildings for which a building permit has been submitted after 21 December 2007.

In low energy efficiency buildings, it is more difficult to implement an energy upgrade when one or more of the factors listed below coexist:

- a. The energy end user bears energy costs, but cannot decide to implement energy efficiency improvement measures, e.g. in rented homes and commercial premises.
- b. The energy end user does not bear the energy costs, and therefore has no economic incentive to reduce consumption, e.g. hotel guests.
- c. There are several owners or tenants and it is necessary to obtain consent from all of them to implement energy upgrading measures, e.g. in multi-apartment buildings.

- d. The building's uses and/or users keep changing either due to its type or due to its location, such as stores on commercial roads the tenants of which change often or homes that are rented out on a temporary basis. In these cases, the duration of the use of the building is not long enough or is uncertain, thus not securing the pay-off of the initial capital expenditure.
- e. Households that are in the spectrum of energy poverty.

The main problems arising from these factors and ways to mitigate them are analysed below.

5.1 Buildings rented and buildings owned by several owners

As regards a certain percentage of the building stock, the parties involved are discouraged from making energy performance investments as all or part of the resulting benefits will not be enjoyed by the party bearing the initial investment costs.

Tenants and/or owners of apartments are a category representing approximately 60% of the total homes of the building stock and they are highly likely to face these challenges. This is mainly due to:

- a. The different levels of understanding of the benefits of energy efficiency between joint owners;
- b. The different incentives and priorities between joint owners;
- c. The different levels of credit ranking and income between joint owners;
- d. Organisational issues associated with the collective decision-making process.

Rented homes represent 24% of all homes. The implementation of energy upgrading measures in these homes may be prevented by the fact that the investment cost borne by the building owner results in benefits for the tenant alone. There is a similar problem with tertiary sector buildings. Despite the data from the commercial sector being insufficient, we do know that the renting of buildings as offices, points of sales of products and dining facilities constitutes a widespread practice in Cyprus.

	Used by owners	Rented out	Other
Single-family houses	35.9%	6.9%	2.9%
Apartments, two-family houses, mixed use buildings	33.1%	17.5%	3.7%
Other types of houses	0%	0.1%	0%

TABLE 5.1: RATIO OF HOMES THAT ARE USED BY THEIR OWNERS AND RENTED OUT

The technical report titled 'Split incentives and energy efficiency in Cyprus', as prepared by the JRC for the Ministry of Energy, Commerce and Industry, provides an analysis of the roadblocks to the energy upgrading of buildings due to the current structure of the real estate market. To overcome the roadblocks, the technical report cites examples of successful policies and measures implemented in other countries, as well as proposals for measures that can be implemented in Cyprus. The measures proposed are the following:

- a. Strengthening the implementation of the role of Energy Performance Certificates by implementing better mechanisms to audit their quality, imposing stricter penalties for those violating the relative legislation and improving the methodology for calculating energy performance;
- b. Fostering the installation of energy meters in each apartment so that owners have accurate consumption information;
- c. Promoting policies for simplifying the decision-making process for buildings owned by several owners;
- d. Providing financing incentives, particularly for multi-apartment buildings and buildings rented;
- e. Implementing voluntary deals between owner and tenant to share the cost and the benefit that will result from an energy upgrade;
- f. Gradual introduction of minimum energy performance requirements in rented buildings;

g. Certification of installers of building elements.

Some of the above measures have already been adopted, such as the revision of the methodology for calculating the energy performance and the creation of a registry of installers of technical systems and small-scale RES systems. In addition, the 'Save & Upgrade' programme attempted to give solutions to the obstacles that prevent the energy upgrading of buildings rented and those owned by several owners. Buildings that were rented could also be included in the plans. In the case of SMEs, the SME that was using the rented building, was the applicant and beneficiary, regardless of whether it owned or rented it. In the case of homes, rented buildings could also be included, but the application could be filed only by the owner. Moreover, there was special provision for including a multi-apartment building in the plan, whereby a management committee was the applicant and beneficiary of the grant. However, the number of such buildings in the 'Save & Upgrade' programme was limited.

On the basis of the replies to a questionnaire sent by the Energy Service to the stakeholders, they consider the implementation of minimum requirements for buildings rented (Annex I) to be a more effective measure. However, this requires further measures to strengthen Energy Performance Certificates in the real estate market, as referred to in paragraph 4.5.2. The negative effects of the measure, such as the increase in rent prices, should be assessed.

5.2 Energy poverty

In 2018, 21.9% of the population reported that they were unable to have a warm house in winter, while 12.2% were unable to pay the energy bills in time due to financial difficulties.

On the basis of Directive 2009/72/EC, each Member State defines the concept of vulnerable customers which may refer to energy poverty and, inter alia, to the prohibition of disconnection of electricity for such customers at times of crisis. According to the Regulation of the Electricity Market Law, energy poverty may relate to the status of customers who may be in a difficult situation due to their low income, as shown by their tax returns, combined with their professional status, family situation and specific sanitary conditions, and, therefore, are unable to meet the costs of reasonable electricity supply needs, as these costs represent a significant part of their disposable income.

Under the above Law, a Decree of the Minister of Energy, Commerce and Industry, which sets out energy poverty, the categories of vulnerable electricity consumers and the measures to protect such consumers, was entered into force in 2015.

Today, measures to protect vulnerable electricity consumers include

- a. The right to submit an application to be included in special household tariffs by EAC with Code 08. This tariff is about 20% lower than the regular household tariff.
- b. The measure of non-disconnection or reconnection of electricity at times of crisis for those of the vulnerable consumers who fall under the Decree and face serious health problems.
- c. The provision of economic incentives, depending on the available budget, for the installation of a home photovoltaic system using the 'net-metering' method.
- d. The provision of economic incentives, depending on the available budget, for the energy upgrade of their homes through the 'Save & Upgrade' programme. This plan provides for a higher grant rate (75% instead of 50% for other consumers) for the energy upgrading of their home. In addition, grants are given for the implementation of individual energy-saving measures.

The total number of beneficiaries of the above measures, i.e. vulnerable consumers, is 52,645, representing 5.8% of the population. According to the questionnaire answered by stakeholders during the public consultation, state grant schemes for individual thermal insulation measures are considered to be the most effective measure to help low-income households (Annex I). However, it should be acknowledged that some of the energy poor live in rented buildings and/or multi-apartment buildings, which makes it difficult to use any state grants.

It has been decided to extend the categories of vulnerable electricity customers and to introduce income criteria for those categories that were beneficiaries for inclusion in the special tariff measure with Code 08, for the measure of special tariff to be applied to consumers mostly in need.

6. Policies and actions related to all public buildings

The exemplary role of public buildings in the sector of energy performance is underlined through a series of legislative measures. These are:

- a. The obligation to annually renovate 3% of the total floor area of buildings owned or used by central government authorities, so as to meet minimum energy performance requirements, or to take other measures bringing about equal energy-saving in these buildings;
- b. From 1 January 2019 all new public buildings should be NZEBs, i.e. two years earlier than the rest of the buildings;
- c. Central government authorities should buy and lease only high energy-efficiency buildings;
- d. For public buildings with a usable floor area of more than 250 m², Energy Performance Certificates need to be issued, which should be posted at a position prominent for the public.

Besides legislative measures, there are other actions aiming to improve the energy efficiency of public buildings. The most important policies and actions are presented below.

6.1 Action Plan for the energy upgrading of buildings owned and used by the central government

Article 5 of Directive 2012/27/EC provides that Member States are obliged to annually renovate 3% of the total floor area of the buildings owned and used by central government authorities or to select an alternative approach, including deep renovations and measures to change the behaviour of users, in order to achieve equivalent energy saving by 2020.

Cyprus has opted for the alternative approach as it provides more flexibility in implementing effective energy-saving measures. The annual energy saving that should be achieved for the 2014-2020 period, has been calculated at 3.31 GWh or 0.285 ktoe. The annual target was estimated assuming that 3% of the public building will be renovated from energy class E to energy class B. Primary energy consumption prior to

and after the renovation is considered to be the one calculated for a typical building, as this has been set in the calculation of the cost-optimal levels of minimum energy performance requirements. A relevant report has been submitted to the European Commission, which mentions and quantifies the measures to be taken.

By virtue of the Decision of the Council of Ministers of 14 April 2016, a Committee was set up for Upgrading the Energy Performance of Buildings used by Central Government Authorities. The Committee comprises representatives of the Directors of the Energy Service of the Ministry of Energy, Commerce and Industry, the Department of Public Works, the Department of Electrical and Mechanical Services and the Directorate of Control of the Ministry of Transport, Communications and Works. It is charged with the planning of the implementation of energy-saving measures based on the technical data and funds available. For the renovation of buildings owned and used by central government authorities, €20 million have been secured from European and Structural Funds for the 2014-2020 period, as the main objective of the Committee is to fulfil the obligation of Article 5 of Directive 2012/27/EC.

The same approach will be followed for the 2021-2030 period, but the annual energy-saving target has been recalculated on the basis of the changes to the central government building stock. These are:

- a. Renovation of three buildings to at least energy class B, while one more is expected to be completed in 2020. These buildings have been removed from the list of buildings to be renovated;
- b. Two new office buildings have been constructed to replace existing buildings and have been removed from the list;
- c. Hospitals and health centres have been removed from the list, given that they have fallen under the administration of the State Health Services Organisation (SHSO) instead of the Ministry of Health. SHSO is an organisation, independent from the central government, and was set up in the context of the recent public health sector reform.

The following table shows the central government buildings, the total floor area and the energy saving that could be achieved if 3% of the total floor area was renovated annually. The new annual energy-saving target for the 2021-2030 period is 1.31 GWh or 0.11 ktoe.

Type of building	Number of buildings	Primary Energy prior to the renovation (kWh / m ² year)	Primary Energy after the renovation (kWh / m ² year)	Total floor area (m ²)	Estimated energy saving (GWh)
Offices	93	332	177	210,042	32.55
Education buildings	17	96	50	52,200	2.4
Other	41	332	177	57,369	8.89
Total	151			318,831	43.85
Annual energy saving to be achieved in order to be equivalent to annual renovation of 3% of the total floor area					1.31

TABLE 6.1: ESTIMATION OF THE ENERGY-SAVING TARGET IN BUILDINGS OWNED AND USED BY THE CENTRAL GOVERNMENT

The above savings target is only part of the full energy saving potential that could be achieved in central government buildings. In the theoretical scenario that all buildings owned and used by central government will be renovated into NZEBs, annual energy saving is estimated to be 2.2 GWh or 0.189 ktoe. The technical and economic aspects of this calculation have not been taken into account, but they serve as a reflection on future policy measures in view of the 2050 targets.

Type of building	Number of buildings	Primary Energy prior to the renovation (kWh / m ² year)	Primary Energy after the renovation (kWh / m ² year)	Total floor area (m ²)	Estimated energy saving (GWh)
Offices	93	332	71	210,042	54.32
Education buildings	17	96	24	52,200	3.76
Other	41	332	71	57,369	14.97
Total	151			318,831	73.55
Annual energy savings that can be achieved by means of annual renovation of 3% of the total floor area into NZEBs					2.2

TABLE 6.2: ESTIMATION OF ENERGY SAVING FROM THE RENOVATION OF BUILDINGS OWNED AND USED BY THE CENTRAL GOVERNMENT INTO NZEBs

The target for the 2021–2030 period is scheduled to be implemented mainly through the following measures:

- a. Deep renovation: the Ministry of Energy, Commerce and Industry and the Department of Electrical and Mechanical Services are preparing a proposal to the Directorate General for European Programmes, Coordination and Development, which is competent for the European Regional Development Fund and the Cohesion Fund, in order to secure funds for the 2021–2027 period;
- b. Individual measures: Measures identified as being more optimal in terms of cost-efficiency, as well as measures that can be combined with maintenance works will be carried out by the Department of Public Works and the Department of Electrical and Mechanical Services and are financed mainly from national resources;
- c. Behavioural measures: The Energy Saving (ES) Officer, appointed in each public building, will be responsible for recording energy consumption and promoting energy efficiency mainly by means of behavioural and information measures. He/she plays a central role in changing the behaviour of civil servants towards a more rational use of energy.

6.2 Energy Saving Officers in public buildings

Since 2011, the institution of ES Officers has been applied on a voluntary basis. Then, following a decision made by the Council of Ministers (Decision No 80,534) in 2016, after a joint proposal made by the Ministry of Transport, Communications and Works and the Ministry of Energy, Commerce and Industry, ES Officers should be appointed in all public buildings. ES Officers must collect and monitor energy and other data related to the use of energy in public buildings and supply/channel the relevant information to the Department of Public Works, the Department of Electrical and Mechanical Services and the Energy Service.

As part of the implementation of the institution, the ES Officer must complete and send to the Energy Service, on an annual basis, the Report on Energy Consumptions and Actions. The report includes, inter alia, energy data of the building, electricity and/or oil consumptions, and the electrical machinery of the building.

A notable and successful example of the implementation of the ES Officer is the building in which the Department of Fisheries and Marine Research and the Nicosia/Kyrenia

Agricultural District Office are located. This is a rented building, which, following invitation of the ES Officer, has been inspected by representatives of the Energy Services and energy-saving measures (zero-cost, as well as technical interventions) were proposed. In co-operation with the ES Officers of the two Departments, the building's deep energy renovation by the owner and its conversion to an energy class A building became possible. The renovation works were completed in early November 2018.

6.3 Renting and purchase of high energy-efficiency buildings by the central government

In accordance with the Law on Energy Performance, central government authorities buy and rent only high energy-efficient buildings, if this is consistent with cost-effectiveness and economic feasibility, wider sustainability, technical suitability and adequate competition. A relevant circular on the issue has been issued by the Treasury of the Republic of Cyprus.

The Ministry of Finance has requested offers for the purchase of buildings that will replace the leased buildings occupied by central government authorities. It is expected that this measure will, at least in part, change the current situation where the central government is a lessee in several low energy-efficiency buildings.

6.4 'SYNERGEIN' and 'STRATENERGY' projects

In the framework of the submission of proposals of the Interreg V-A GREECE-CYPRUS 2014–2020 co-operation programme, the Managing Authority of the Programme approved the implementation of the Co-operation for Energy Saving in Public Buildings of the Trans-National Arc Greece-Cyprus (SYNERGEIN) project and the Strategic Cross-border Co-operation & Capitalisation of a Common Approach for the Energy Saving in Public Buildings (STRATENERGY) project. The two projects concern the promotion of energy saving in the municipalities, communities and organisations of the wider public sector in the Programme's cross-border cooperation area, by developing tools for use by these bodies, as well as by implementing demonstration projects for energy saving. It is noted that these projects are co-financed, with the European Regional Development Fund contributing 85% and 15% coming from national resources of Greece and Cyprus.

SYNERGEIN's goal is the overall strengthening of the Programme's cross-border co-operation area for the implementation of ES works in public buildings, taking into account all of their aspects (management, data collection, planning, monitoring, financing) in the framework of 'total energy planning' at a local level. The common trans-border approach organises the ES framework (data collection, planning, monitoring) and directly supports 'total energy planning' solutions in the aforementioned organisations, which saves time and resources during the elaboration of preliminary studies, while speeding up the maturation process of projects for financing.

The implementation of the project in Cyprus will involve energy upgrades to the Town Halls of the Municipalities of Aglantzia, Lakatamia and Geri, as well as to the multifunctional centre of the Community of Pano Polemidia. The Ministry of Energy, Commerce and Industry is the main beneficiary of the project with a budget of €955,337, while the total project budget for all partners amounts to €2,095,877. The Nicosia Development Agency (ANEL), the Centre for Renewable Energy Sources and Saving of Greece (CRES), the Regional Development Fund of Crete, the Municipalities of Rhodes and Chersonisos also participate in the partnership. The project is due to be completed in 2020. Information on the energy-saving measures to be carried out in each building in Cyprus, the expected annual energy saving, as well as the category in which the Energy Performance Certificate of each building is classified prior to and after the energy upgrade, is given in the following table.

S/N	Organisation	Building	Energy-saving measures to be implemented	Energy Performance Certificate category (prior to the upgrade)	Energy Performance Certificate category (after the upgrade)	Expected annual primary energy saving based on the Energy Performance Certificate in kwh
1	Municipality of Aglantzia	TOWN HALL	Thermal insulation of the roof, replacement of air-conditioners, installation of a shading system	E	B	273,785

S/N	Organisation	Building	Energy-saving measures to be implemented	Energy Performance Certificate category (prior to the upgrade)	Energy Performance Certificate category (after the upgrade)	Expected annual primary energy saving based on the Energy Performance Certificate in kwh
			on windows, installation of a photovoltaic system.			
2	Municipality of Lakatamia	TOWN HALL	Thermal insulation of exterior walls, thermal insulation of the roof, replacement of frames, replacement of the air-conditioning system, installation of LED lamps.	E	B	535,294
3	Municipality of Geri	TOWN HALL	Thermal insulation of exterior walls, thermal insulation of the roof, replacement of frames, replacement of the air-conditioning system, installation of LED lamps.	F	B	430,917
4	Community of Pano Polemidia	MULTIFUNCTIONAL CENTRE OF PANO POLEMIDIA	Thermal insulation of exterior walls, thermal insulation of the	G	A	1,284,982

S/N	Organisation	Building	Energy-saving measures to be implemented	Energy Performance Certificate category (prior to the upgrade)	Energy Performance Certificate category (after the upgrade)	Expected annual primary energy saving based on the Energy Performance Certificate in kwh
			roof, replacement of frames, replacement of the air-conditioning system, installation of LED lamps, installation of a photovoltaic system.			
Total expected annual primary energy saving based on the Energy Performance Certificate in kwh						2,524,978

TABLE 6.3: BUILDINGS TO BE UPGRADED IN CYPRUS IN THE FRAMEWORK OF IMPLEMENTATION OF THE 'SYNERGEIN' PROJECT

The main objectives of the STRATENERGY project are to implement new, additional to SYNERGEIN, mature strategic projects in public buildings, to finalise a common framework for strategic and operational planning of public sector bodies for 2030 in order to integrate energy saving into their building stock and to maximise results through a pilot application using modern specialised IT applications/methodologies for decision support and for broadening the common framework in coherence with the relevant policies.

In the framework of implementation of the project, in Cyprus, the Town Halls of the Municipalities of Geroskipou, Agios Dometios, Sotira and Athienou, the headquarters of the Sewerage Board of Limassol, the Limassol Municipal Art Gallery and a building of the Cyprus University of Technology will be renovated. The Ministry of Energy, Commerce and Industry is the main beneficiary of the project with a budget of €1.68 million, while the total project budget for all partners amounts to approximately €3.72 million. The project is due to be completed in early 2021. The Nicosia Development Company

(ANEL), the Centre for Renewable Energy Sources of Greece (CRES), the Region of Crete, the Municipality of Thira, the Municipality of Samos, the Municipality of Kos and the Association of Greek Regions also participate in the partnership. Information on the energy saving measures to be carried out in each building in Cyprus, the expected annual energy saving, as well as the category in which the Energy Efficiency Certificate of each building prior to and after the energy upgrading is classified, is given in the following table.

S/N	Organisation	Building	Energy-saving measures to be implemented	Energy Performance Certificate category (prior to the renovation)	Energy Performance Certificate category (after the renovation)	Expected annual primary energy saving based on the Energy Performance Certificate in kwh
1	Municipality of Limassol	LIMASSOL MUNICIPAL ART GALLERY	Thermal insulation of the roof, replacement of frames, installation of external shading systems on windows, installation of LED lamps, replacement of the air-conditioning system.	C	B	528,703
2	Municipality of Agios Dometios	TOWN HALL	Thermal insulation of the roof, replacement of frames, installation of LED lamps, replacement of the air-conditioning system.	G	B	1,820,837
3	Municipality of Geroskipou	TOWN HALL	Thermal insulation of the roof, thermal insulation of exterior walls, replacement of frames, installation of LED lamps, replacement of the air-conditioning system.	D	B	170,756
4	Municipality of Athienou	TOWN HALL	Replacement of frames, installation of LED lamps, replacement of the air-conditioning system, installation of a photovoltaic system, installation of a heat	D	B	401,105

S/N	Organisation	Building	Energy-saving measures to be implemented	Energy Performance Certificate category (prior to the renovation)	Energy Performance Certificate category (after the renovation)	Expected annual primary energy saving based on the Energy Performance Certificate in kwh
			recovery system.			
5	Municipality of Sotira	TOWN HALL	Thermal insulation of the roof, replacement of frames, installation of external shading systems on windows, installation of LED lamps, replacement of the air-conditioning system, installation of a photovoltaic system.	D	B	500,344
6	Cyprus University of Technology	BUILDING OF FORMER POPULAR BANK - LIMASSOL	Thermal insulation of the roof, thermal insulation of external walls, replacement of the air-conditioning system, installation of a photovoltaic system.	D	B	454,590
7	Sewerage Board of Limassol / Amathous	PRIVATELY OWNED HEADQUARTERS	Replacement of frames, installation of LED lamps, replacement of the air-conditioning system.	D	B	332,871
Total expected annual primary energy saving based on the Energy Performance Certificate in kwh						4,209,206

TABLE 6.4: BUILDINGS TO BE RENOVATED IN CYPRUS IN THE FRAMEWORK OF IMPLEMENTATION OF THE 'STRATENERGY' PROJECT

6.5 Public schools

The Ministry of Education, Culture, Sports and Youth has concluded an agreement with the Electricity Authority of Cyprus (EAC) for the installation of photovoltaic systems for measurement offsetting with a total capacity of 4 MW and the thermal insulation of the roof in public school buildings. The project should contribute to:

- a. The saving of state financial resources;
- b. The production of additional electricity, also outside the hours of operation of school units;
- c. The effective and rational production and consumption of electricity;
- d. The achievement of the targets set by the European Union to its Member States, in terms of production of energy from renewable sources;
- e. The protection of the environment and the reduction of pollutants and greenhouse gas emissions;
- f. The fulfilment of the harmonising and exemplary role of public buildings in the field of energy;
- g. The cultivation of energy and environmental conscience of students, and, in particular, their familiarisation with RES technologies.

The agreement was signed in November 2019 and the projects are due to be completed in 2021. This measure is due to be implemented in 430 schools.

Furthermore, the Ministry of Education, Culture, Sports and Youth, in co-operation with the Cyprus Energy Agency and the Pedagogical Institute (Environmental and Sustainable Development Education Unit), has secured financing of €500,000 from the European Commission and the Horizon 2020 programme for the implementation of technical assistance, titled PEDIA (Promoting Energy Efficiency & Developing Innovative Approaches in schools). PEDIA aims to define a long-term strategy for the upgrading of public school units into NZEBs. It adopts approaches and solutions to limit technical, administrative and legal challenges, which are often faced by projects of energy upgrading of school buildings and aims at their total energy upgrading. In particular, technical assistance will include

- a. The selection and study of 25 school units that will undergo deep energy upgrading, in order to become nearly zero-energy school buildings, with multiple benefits besides the economic ones, such as the installation of modern systems and 'green'

technological solutions, beautification of the school space, qualitative improvement of the school's technical operations, as well as upgrading of the learning quality. The selection of schools and what is related to the school's building programme will be done in accordance with defined criteria and with the close co-operation of the Technical Services of the Ministry of Education, Culture, Sports and Youth. The expenditure for the energy upgrading of the buildings has been calculated at €7.5 million in a time schedule of five years (2022–2027) that will be required for the completion of the works.

- b. Development of methodology and criteria for the determination of priorities in terms of the gradual energy upgrading of school buildings.
- c. Pilot implementation of the international standard for Energy Management ISO 50001 in 5 schools, which will offer to the Ministry of Education, Culture, Sports and Youth an integrated tool of energy management, which has been tested in local conditions and the particularities of public schools in Cyprus. The successful pilot action and the extension of the implementation of this standard will, gradually and in the long run, enable more efficient energy management, as well as further improvement of the energy efficiency of all school units.

Technical assistance is expected to start on 1 September 2020 and will last for 5 years.

7. Promoting smart technologies and well-connected buildings and communities

The promotion of smart technologies and well-connected buildings and communities constitutes a main pillar for the digitisation of the energy sector. The main and most important feature of 'smart' systems is that they can communicate and exchange information in a digital environment to optimise building performance and energy use. The implementation of smart systems in buildings and the interconnection between them in energy communities improves the flexibility of the energy system, as the regulations and measures so far only concerned the generation and use of energy. In addition, the collection of data through the digitisation of the building sector is expected to help implement more targeted energy saving and RES measures in the renovation process, as well as to better integrate new technologies, such as electro-mobility and energy storage.

7.1 Smart readiness indicator for buildings

The smart readiness indicator for buildings will be used to measure the ability of buildings to use information, communication and electronic system technologies, in order to adapt the operation of buildings to the needs of the tenants and the grid and to improve the energy efficiency and overall performance of buildings.

The objective of the smart readiness indicator for buildings is to raise the awareness of building owners and tenants on the value of automation and electronic monitoring of technical building systems and to inspire confidence in tenants about the actual savings that can be achieved thanks to these new enhanced operations.

On the basis of Directive 2018/844/EU, the European Commission is going to proceed with the issue of a delegated act with which a common system for rating the smart readiness of buildings will be established. The rating of the smart readiness of buildings must be based on an assessment of a building or building unit as regards its ability to adapt its operation to the needs of the tenants and the grid, and to improve its energy efficiency and overall performance. In particular, its calculation methodology will be based on three basic operations as regards the building and its technical systems:

- a. the ability to maintain the levels of energy efficiency and the operation of the building by adapting energy consumption, for example through the use of energy from renewable sources;
- b. the ability to adapt the way of operation of the building to the needs of the tenants, taking into account simultaneously user-friendliness, the maintenance of healthy climatic interior conditions and the ability to inform in terms of energy consumption;
- c. the flexibility of a building in terms of the total demand for electricity, including its ability to enable participation in active and passive, as well as direct and indirect response to demand, in terms of the grid, for example through flexibility and load transfer.

In 2020, after consulting with stakeholders, the European Commission will also proceed with an implementing act specifying the technical details for the effective implementation of the system and clarifying the supplementary relation of the system to Energy Performance Certificates. In addition, two technical studies have been

elaborated on behalf of the European Commission for the definition of the smart readiness indicator for buildings and its calculation methodology.

The implementation of the system for assessing the smart readiness indicator for buildings by the Member States is optional. The bill amending the Regulation of the Energy Performance of Buildings Law enables the Minister of Energy, Commerce and Industry to issue a Decree, with which he will be able to determine issues regarding the common assessment system of the smart readiness indicator and which will not be covered by the delegated act to be issued by the European Commission.

7.2 Energy communities

In accordance with Directive 2018/2001/EU on the promotion of the use of energy from renewable sources, Member States must ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community. They must, in addition to their participation, retain their rights or obligations as final customers without being subject to unjustified or discriminatory conditions or procedures that would prevent their participation in a renewable energy community. In the case of private undertakings, their participation is allowed provided that it does not constitute their primary commercial or professional activity.

At the same time, in accordance with Directive 2019/944/EU on the internal market for electricity, Member States must provide for an enabling regulatory framework for citizen energy communities. A citizen energy community is defined as a legal entity that:

- a. Is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises;
- b. Has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to local areas where it operates rather than to generate financial profits;
- c. May engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders.

The provisions of the aforementioned Directives, with their adaptation in national legislation, will form a favourable framework for the implementation of energy-saving and RES measures in groups of buildings, the owners of which will participate on a voluntary basis in an energy community.

A number of workshops have been held in Cyprus on this subject, and exchange of ideas and information on best practices with other Member States took place. During the workshops it was noted that the implementation of the new obligation stemming from the Directives requires the development of new tools and the introduction of new interactive technologies and new concepts that will inform and induce the final consumer to actively participate in the energy community.

At local government level, the Municipalities of Nicosia, Paphos and Aradippou have developed initiatives to transform them into smart cities. Many of the actions they are planning do not completely fall into the energy sector, but provide for the development of applications and infrastructure through a package of advanced digital services that can be used in the future by energy communities.

Furthermore, in 2019, the Commissioner of Mountain Regions prepared the National Strategy for the Development of the Mountain Communities of the Troodos area, which includes depiction of the existing energy situation of the specific area and measures for its improvement. These measures include the energy upgrading of private and public buildings, energy visits to households for their information and awareness, and pruning and green waste collection with a view to their energy recovery. The total indicative cost for the implementation of the proposed measures for the 2019–2030 period is estimated at €4,940,000. This initiative is the first structured energy design in a large geographical area, for Cyprus, which includes 115 communities.

8. Improvement of skills and education in the construction field and the field of energy performance

The training of all the professionals involved in the energy performance of buildings, in the energy upgrading of existing buildings in particular, is a fundamental measure to increase energy renovation. Professionals engaging in the design of buildings and of technical building systems, including RES systems, and installers of building elements that affect energy performance are the most important players.

8.1 Independent experts on energy performance issues

Through legislative regulations, independent experts have already been created, whose mission is to offer, in an objective and independent way, advice on the energy improvement of a building in its entirety or regarding its individual elements. These legislative regulations ensure a satisfying level of knowledge of the experts through requirements related to qualifications, experience, training and exam success.

Independent experts	Qualifications
Qualified Expert on homes	<ul style="list-style-type: none"> (a) Architect, Civil Engineer, Mechanical Engineer, Electrical Engineer, Chemical Engineer, Environmental Engineer (Member of the Technical Chamber of Cyprus) (b) At least 1 year of proven experience in the building sector or in energy issues or in technical building systems (c) Exam success
Qualified Expert on non-residential buildings	<ul style="list-style-type: none"> (a) Architect, Civil Engineer, Mechanical Engineer, Electrical Engineer (Member of the Technical Chamber of Cyprus) (b) At least 3 years of proven experience in the building sector or in energy issues or in technical building systems (c) Exam success
Heating System Inspector	<ul style="list-style-type: none"> (a) Mechanical engineer (Member of the Technical Chamber of Cyprus) (b) At least 3 years of professional experience in studies, contracting, maintenance of building heating systems (c) Exam success

Independent experts	Qualifications
Air-Conditioning System Inspector	<ul style="list-style-type: none"> (a) Mechanical engineer (Member of the Technical Chamber of Cyprus) (b) At least 3 years of professional experience in studies, contracting, maintenance of building air-conditioning systems (c) Qualification certificate for category I, management of fluorinated gases, issued by a certification body
Energy Auditor A	<ul style="list-style-type: none"> (a) Engineer registered at the Technical Chamber of Cyprus (b) At least 3 years of documented professional experience in energy audits of buildings and/or industrial installations or in energy issues and, in particular, issues of energy saving/improvement of energy efficiency in buildings and/or industries and/or in the design and/or the operation of complex electromechanical facilities in buildings and/or industries (c) Attendance of a training programme (d) Exam success
Energy manager	Attendance of a training programme

TABLE 8.1: QUALIFICATIONS OF INDEPENDENT EXPERTS IN THE FIELD OF ENERGY PERFORMANCE OF BUILDINGS

Designating Qualified Experts as the parties responsible for calculating the energy efficiency rating of buildings and issuing energy performance certificates and making recommendations in 2009 was an opportunity for providing architects, as well as civil, mechanical and electrical engineers with training on the energy performance of

buildings. Despite the absence of any provision on training in the qualifications for qualified experts, the Energy Service organised dozens of training seminars to prepare the parties concerned for the relevant examination. The seminars intended for qualified experts concerning homes lasted for 16 hours and covered topics relating to legislation, energy efficiency calculation and cost-optimal measures for improving the energy performance of buildings. Since 2016, the Cyprus Energy Agency has been approved by the Energy Service as an evaluation body for candidate Qualified Experts. So far, 16 training seminars for candidate qualified experts have been organised.

Building energy inspectors must necessarily attend and successfully complete, following an examination, an 80-hour long theoretical and practical training session. Training sessions are conducted by organisations authorised by the Energy Service. These organisations include a partnership between the University of Cyprus and the Cyprus Energy Agency, as well as the Frederick University.

Training activity on technical building system issues is also offered. The Cyprus Energy Agency and the Frederick University, which have been approved by the Energy Service as evaluation bodies of Heating System Inspectors, have organised 7 training sessions in total on this topic.

In 2016, the legal framework for Energy Managers was created by a Decree of the Minister of Energy, Commerce and Industry. In accordance with the legislation, any organisation and company may designate one of its executives as Energy Manager, provided that he/she will attend a training programme approved by the Energy Service. The Energy Manager is responsible for monitoring energy use issues in the business or the organisation in which he/she works and for planning and monitoring actions to increase energy efficiency and reduce energy consumption. Unlike the above independent experts, the Energy Manager is a member of the business or the organisation promoting energy efficiency through its hierarchy and structures. In particular, in small enterprises with no resources for the purchase of external services by Energy Inspectors and/or large investments, the Energy Manager can help with changing the mentality in terms of energy use and other low-cost measures. A research carried out by the Cyprus Employers and Industrialists Federation (OEB) in the context of the implementation of the European programme 'SMEmpower Efficiency' in January 2020, where 32 businesses participated, has shown that:

- a. 7 businesses have a designated Energy Manager;
- b. 15 businesses do not have a designated Energy Manager, but a member of the staff of the business is responsible for energy issues;
- c. 10 businesses do not have a designated Energy Manager.

Thus, 69% of the businesses that participated in the research have a person dealing with energy issues.

The training of Energy Managers is carried out in training organisations designated by the Energy Service, which, after attending the training session, provide trainees with a relevant certificate of attendance of the training programme. Until April 2020, the programme that has been approved is the European Energy Manager – EUREM seminar, organised by the Cyprus Energy Agency, and three training sessions have been carried out.

8.2 Installers

As regards building element installers, professional education and training is provided to them through initial and ongoing training programmes. The average technical and professional training provided by Technical Schools also includes branches directly associated with the energy performance of buildings, such as mechanical engineering, electrical engineering and construction.

However, in order to achieve the building energy efficiency targets, a sufficient number of reliable installers should be available. The register of installers has been created by the Cyprus Energy Agency with the aim of ensuring certain minimum quality levels for the installation of systems and their energy efficiency. Quality assurance is expected to gradually increase the confidence of building owners to the technical personnel working in the field of technical systems and small-scale RES systems.

In the case of technical system installers, natural persons are entered in the Register as installers, if, among others things, they have relevant certificates of qualification for specified categories, as shown in Table 8.2.

S/N	Categories	Required Certificates for Professional Qualifications issued by the Professional Qualifications' Certification Body for the level of specialised craftsman and are in force.
1.	<p><u>Category A:</u></p> <p>Installers of technical equipment for heating systems</p>	<p>I. Construction Industry, Professional Qualification 'Central Heating Systems' (Level 4)</p> <p>II. Construction Industry, Professional Qualification 'Plumbing' (Level 4)</p>
2.	<p><u>Category B:</u></p> <p>Installers of technical equipment for air-conditioning and ventilation systems.</p>	<p>i. Construction Industry, Professional Qualification 'Plumbing'. (Level 4)</p> <p>ii. Construction Industry, Professional Qualification 'Cooling and Air-Conditioning Systems'. (Level 4)</p>
3.	<p><u>Category C:</u></p> <p>Installers of technical equipment for hot water production systems.</p>	<p>Construction Industry, Professional Qualification 'Plumbing' (Level 4)</p>

TABLE 8.2: QUALIFICATIONS OF TECHNICAL BUILDING SYSTEM INSTALLERS

Legal entities are also included in the register as technical system installers, provided that they have at least one registered installer in their resources or have contracted with at least one natural person installer. During the registration of a legal entity as an installer, the category or categories of the systems for which the installer is authorised to perform relevant work is/are determined, depending on the categories of the installers (natural persons) that it employs or has contracted with.

The Register of Technical Building System Installers includes 37 limited liability companies and 3 natural persons registered.

In addition, in the framework of the 2015 Regulations on the Promotion and Encouragement of the Use of Renewable Energy Sources (Certification of Installers of Small-Scale Renewable Energy Sources Systems), the Energy Service proceeds with the certification of small-scale RES system installers and their registration in the register of

technical system installers. The certification relates to the following categories of RES system installers:

- a. Category A: Biomass boiler and heater installers
- b. Category B: Heat pump installers
- c. Category C: Solar photovoltaic system installers
- d. Category D: Solar thermal system installers

Registration at the register of installers certifies the professional competence for installers of RES systems with a nominal capacity of up to 30 kW. Sixty four (64) installers in the category of photovoltaic systems and 25 in the category of solar thermal systems have been entered in the register.

Before registering, the persons concerned must attend a training programme by an authorised body and pass an exam organised by an authorised examination organisation. The Energy Service has so far authorised six training providers and four examination organisations to organise training and examination programmes at regular intervals.

The certification of installers is voluntary. However, in the framework of certain support programmes or grant schemes, it is required that RES systems are installed by certified installers. For example, in accordance with the provisions of the 'Support Scheme for Electricity Production from Renewable Energy Sources (RES) for own consumption' the installations of photovoltaic systems for measurement offsetting (net-metering) and billing offsetting (net-billing) with a capacity of up to 30 kW should be performed by certified installers, who are registered at the register of photovoltaic system installers.

9. Estimate of energy saving and broader benefits

Renovating the existing building stock will undoubtedly lead to savings in energy and funds for investors provided that it is implemented in a cost and technically optimal way. However, it is important to assess the benefit of renovation for society in general, e.g. for the competitiveness of the Cypriot economy, employment, social cohesion and the environment. The resulting benefits are dependent upon the quantity and quality of the renovation projects to be implemented in the following years. The relevant benefits are listed below, along with some estimates for 2030, 2040 and 2050.

9.1 Estimate of energy saving

The targets of Cyprus for the 2021–2030 period in the energy sector are:

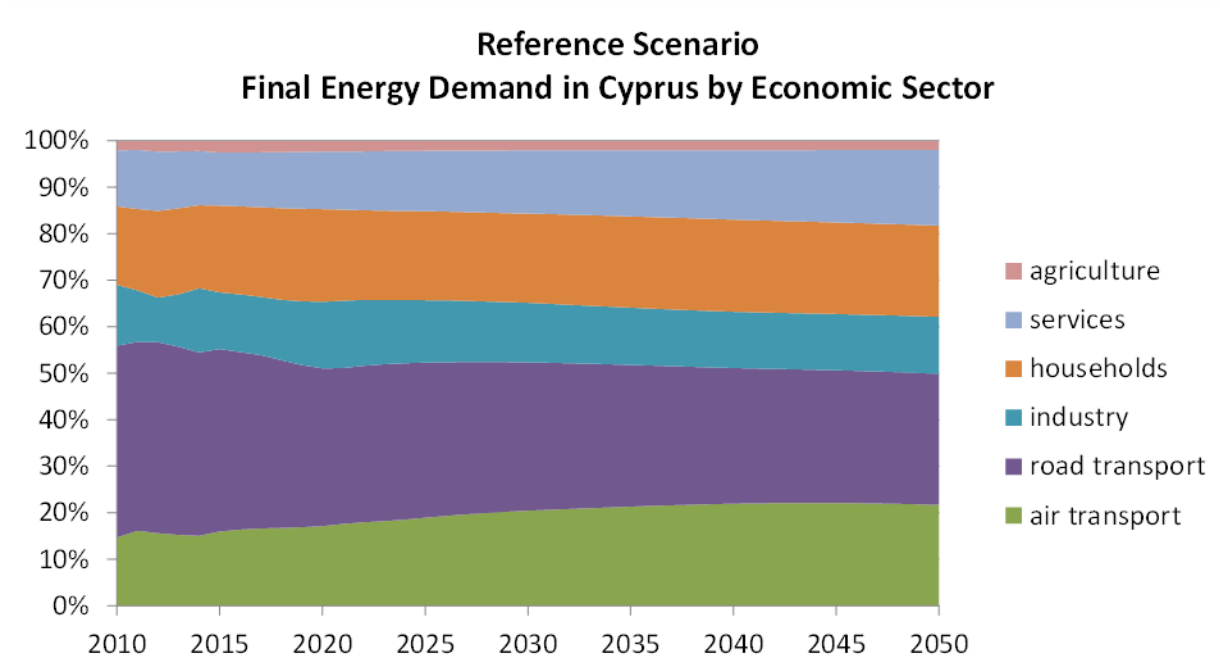
- a. Final energy consumption of 2 million TOE in 2030, representing a 13% reduction in final energy consumption in relation to the respective forecast of the European Commission for Cyprus in 2007;
- b. Primary energy consumption of 2.5 million TOE in 2030, representing a 17% reduction in final energy consumption in relation to the respective forecast of the European Commission for Cyprus in 2007;
- c. Cumulative energy saving of 243.04 ktoe for the 2021–2030 period;
- d. A percentage of 23% RES in final energy consumption;
- e. A percentage of 26% RES in final electricity consumption;
- f. A percentage of 39% RES in heating and cooling;
- g. A percentage of 14% RES in transportation.

According to the National Energy and Climate Action Plan, buildings will have the most important contribution to achieving the cumulative target of energy saving by 2030. In addition, based on the scheduled measures and policies recorded in the National Energy and Climate Action Plan, an increase in the installation of RES systems in buildings is provided for in order to achieve RES targets. See below the measures which were included in the National Energy and Climate Action Plan and which will be implemented during the 2020–2030 period, and which are at the same time included in chapters 4 and 6 as they mainly target or are exclusively about buildings.

- a. Energy-Efficiency Obligation Scheme,
- b. Fund of Mutual Funds,
- c. Business4Climate,
- d. Grant Scheme for the energy upgrading of homes in the framework of the 2021 – 2027 planning period,
- e. Grant Scheme for the implementation of energy performance measures in SMEs in the framework of the 2021 – 2027 planning period,
- f. Grant Scheme for the implementation of energy performance measures in municipalities and communities in the framework of the 2021-2027 planning period,

- g. Renovation of public buildings in the framework of the 2021-2027 planning period,
- h. Renovation of public buildings in the framework of European Territorial Co-operation Programmes,
- i. Schemes of the Fund for RES and ES,
- j. Revision of the scheme for the production of electricity from RES for own consumption,
- k. Revision of Order 1 of 2014 of the Minister of Interior,
- l. Installation of 'smart' electricity meters.

It is estimated that the building sector will continue to have the same fixed share in energy consumption as it has today up to 2050. Given that the new buildings to be introduced into the building stock will now be NZEBs, a major contribution to the national energy saving and RES targets can only come from the renovation of buildings.



GRAPH 9.1: FINAL ENERGY CONSUMPTION BY SECTOR – REFERENCE SCENARIO ¹⁷

¹⁷ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

The forecast given in the study titled 'An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050', prepared by GIZ, has been adopted as a reference scenario for final energy consumption in the National Energy and Climate Action Plan. In Graphs 9.2 and 9.3 the forecast for the building and tertiary sectors is presented for purposes of comparison with five other scenarios that were elaborated in the framework of other studies. More specifically, these forecasts stem from the following studies:

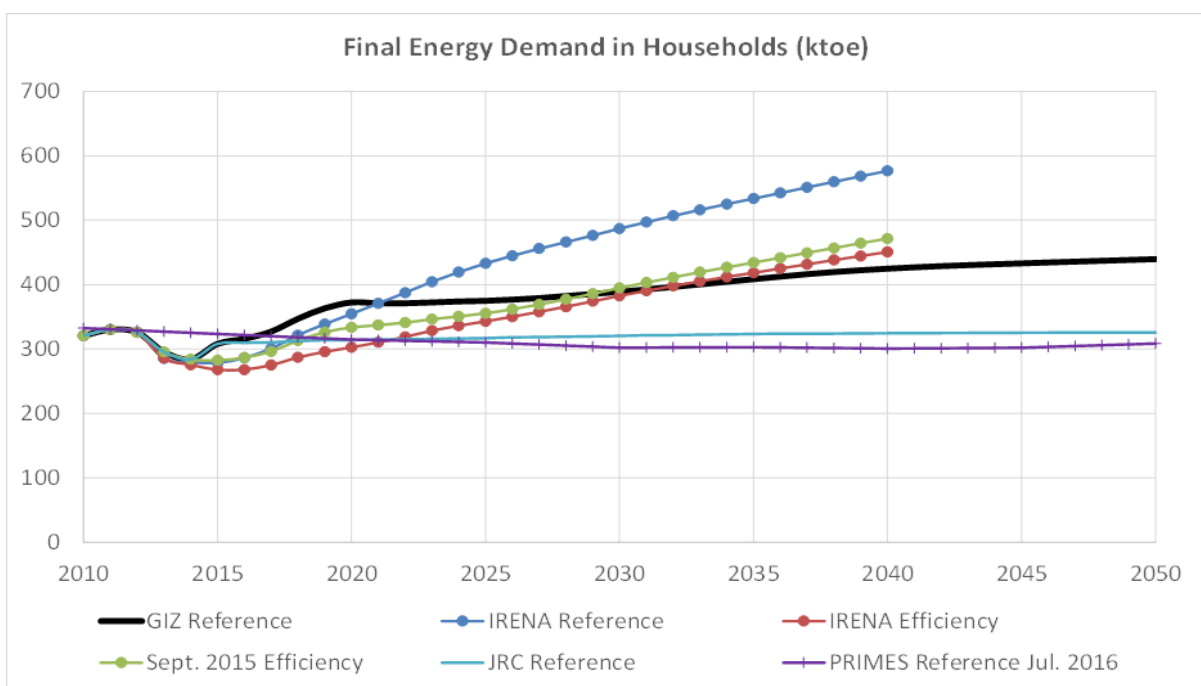
- a. The forecasts of the International Renewable Energy Agency (IRENA) in 2015 for Cyprus, regarding two scenarios: the reference scenario and the scenario with increased energy performance (IRENA. (2015). Renewable Energy Roadmap for the Republic of Cyprus. Abu Dhabi: IRENA);
- b. A study elaborated by the Cyprus University of Technology on tax reform and the policy on energy and the climate (Zachariadis, T. (2015, November). How Can Cyprus Meet Its Energy and Climate Policy Commitments? The Importance of a Carbon Tax)¹⁸;
- c. The reference scenario for a study elaborated by JRC for the Ministry of Energy, Commerce and Industry on the analysis for the potential of high-energy cogeneration in Cyprus (Santamaria, M., Kavvadias, K. & Jakubcionis, M. (2016). Cost-benefit analysis for the potential of high-efficiency cogeneration in Cyprus. JRC Science Hub);
- d. The estimations of the European Commission for Cyprus, which were made using the PRIMES model.

When comparing the different forecasts, we should take into account that they have some significant differences. First, they have a different base year, i.e. the last year for which real data were available. The IRENA forecasts used 2013 as base year, while the forecast of the Cyprus University of Technology study uses the 2014 energy balance as a starting point. The PRIMES forecasts also used 2013 as base year. The study elaborated by GIZ uses 2015 as base year, i.e. 2016 is the first year of forecast. A second major difference lies in the different assumptions of macroeconomic and oil prices used in the various studies examined here. The IRENA and JRC studies were based on the European Commission's and national authorities' macroeconomic forecasts of spring 2014 and the International Energy Agency's oil price forecasts of autumn 2013, prior to the significant drop in oil prices observed in 2014-2016. The PRIMES forecasts used macroeconomic forecasts in early 2015 and oil price forecasts reflecting the recent drop in oil prices. The forecast of the study prepared by GIZ is based on national macroeconomic forecasts of

¹⁸ In the Graphs it is mentioned as SEPT. 2015 Efficiency

autumn 2016, which show higher economic growth, as well as on the oil price forecasts of the International Energy Agency for autumn 2016, which are significantly lower than the ones for 2013¹⁹.

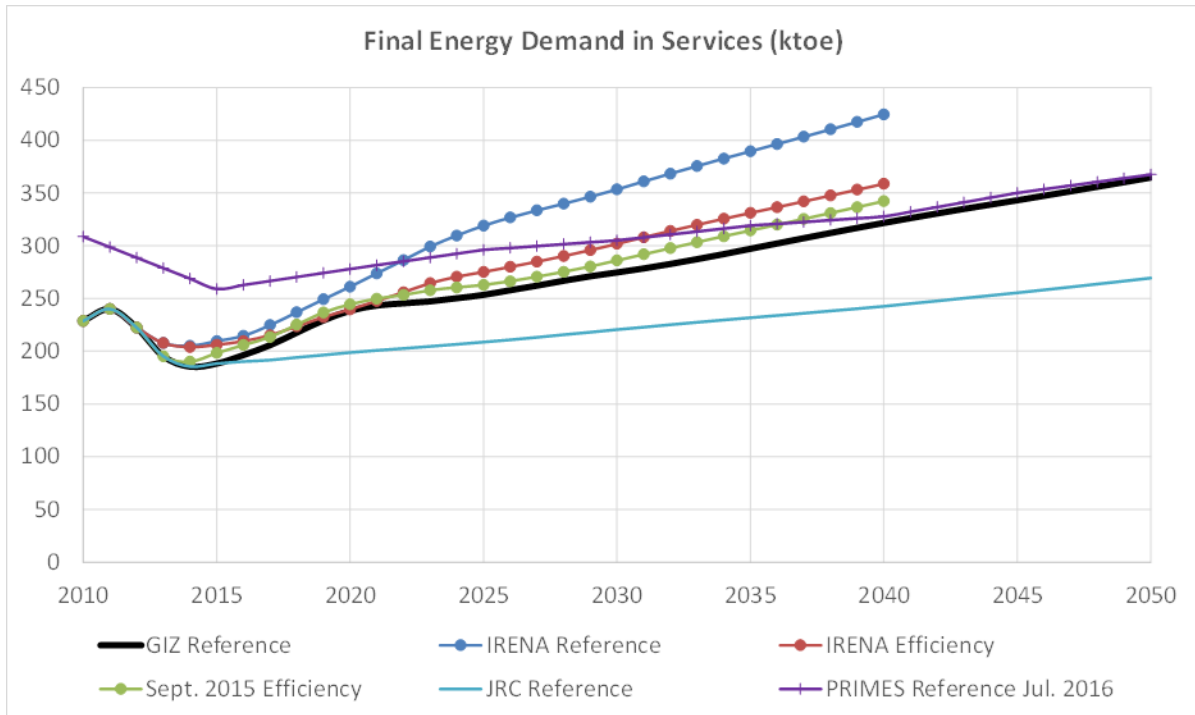
However, as shown in Graph 9.3, in all scenarios the energy consumption of the tertiary sector manifests a continued increasing trend up to 2050. The same applies for three of the six scenarios of the residential sector, as only the scenarios estimated by the PRIMES model and the JRC study show stabilisation of energy consumption (Graph 9.2). Finally, six scenarios from five different studies confirm that current policies and measures will increase energy consumption across the entire building sector for the next 30 years.



GRAPH 9.2: FINAL ENERGY CONSUMPTION IN HOMES²⁰

¹⁹ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

²⁰ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050



GRAPH 9.3: FINAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR ²¹

The study titled ‘An energy efficiency for Cyprus up to 2020, 2030 and 2050’, prepared by GIZ, provides an estimate of the energy saving potential of the building sector and how its exploitation can change the trends mentioned above. Two scenarios, the ‘max technical potential’ scenario and the ‘realistic’ energy-saving scenario are considered.

The ‘max technical potential’ for energy saving for the building sector is defined as the amount of current energy consumption that will be saved by upgrading the existing building stock in NZEBs as defined in national legislation. The scenario is without financial constraints, both public and private, and does not incorporate any of the policy implementation problems or the market response. It is characteristically stated that only for homes €15 billion would need to be invested, while taking into account the workforce that will be required makes the implementation of this scenario unlikely. Therefore, this scenario is intended to serve as an indicator and not as an alternative energy policy scenario.

The ‘realistic’ scenario concerns the economically viable potential, which is a percentage of the maximum potential. It is defined as the amount of energy saving that can be achieved if the measures that are more cost-effective are implemented, as there are some economic constraints which in reality limit the funds available that directly or indirectly finance renovations. It is estimated that in the 2020 – 2030 period

²¹ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

approximately €800 million will be required for the 'realistic' scenario. The following tables provide the energy saving that will be achieved in the building sector by implementing the two scenarios.

	Current consumption (ktoe)	Max technical potential for energy saving		Realistic energy-saving potential	
		Future consumption (ktoe)	Saving	Future consumption (ktoe)	Saving
Heating	123	32	73.7%	114	7.2%
Cooling	42	8	80.3%	38	9.9%
Hot water	68	68	0%	68	0%
Lighting and appliances	63	34	55%	60	3.9%
Total	299	145	51.3%	283	5.2%

TABLE 9.1: MAX TECHNICAL POTENTIAL AND REALISTIC ENERGY-SAVING POTENTIAL IN THE HOUSING SECTOR

It should be noted that in the case of hot water, the final energy consumption appears unchanged in both scenarios, as a large part is already covered by solar thermal energy. However, in conventional fuels, the 'maximum technical potential' and the 'realistic' scenario result in energy saving of 75% and 18.9 % respectively.

	Current consumption (ktoe)	Max technical potential for energy saving		Realistic energy-saving potential	
		Future consumption (ktoe)	Saving	Future consumption (ktoe)	Saving
Electricity	149	39	73%	137	8.4%
Heating oil	27	0	100%	25	6%
LPG	12.9	25	-115%	12.1	6%
Kerosene	2	0	100%	2	0%

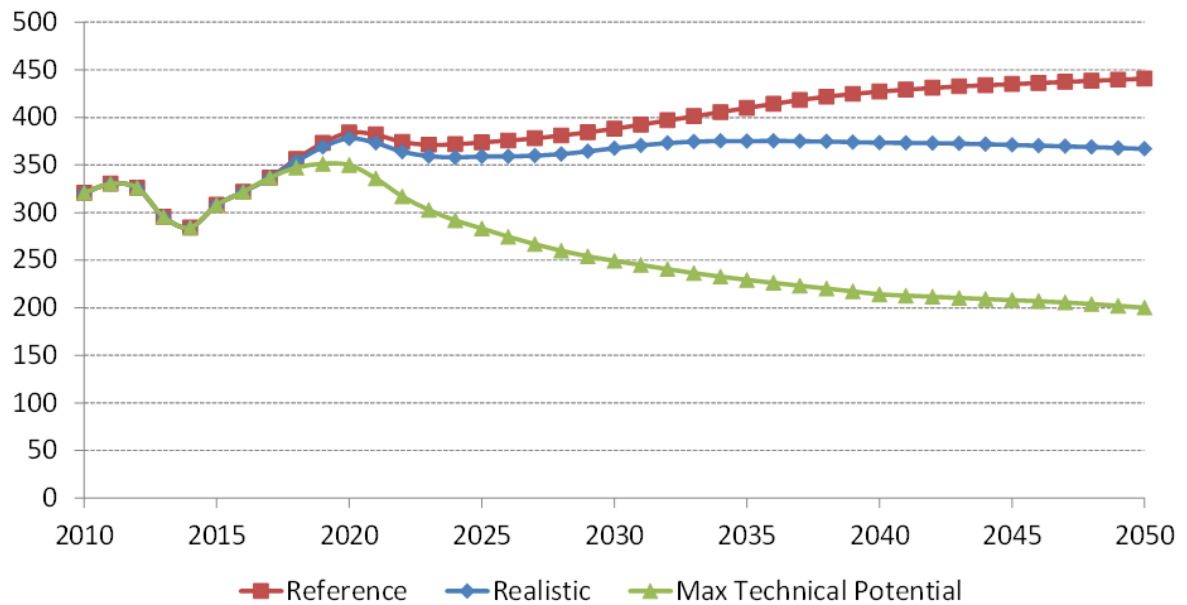
LFO	0.1	0	100%	0.1	0%
Biomass	4.9	1.9	60%	4.8	0%
Total	192	68	64.7%	183	6%
Solar and heat recovery	10.3	14	-35.1%	13.1	-29.3%

TABLE 9.2: MAX TECHNICAL POTENTIAL AND REALISTIC ENERGY-SAVING POTENTIAL IN THE TERTIARY SECTOR

The 'max technical potential' scenario will lead to a significant drop in energy demand for the next 30 years in the residential and tertiary sector as shown in Graphs 9.4 and 9.5.

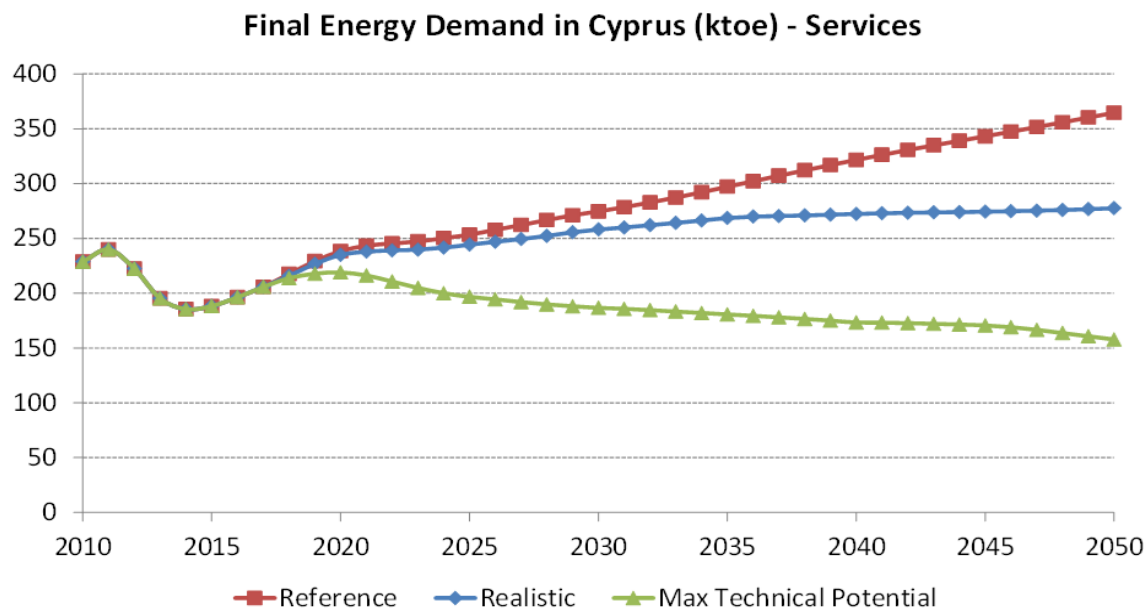
The 'realistic' scenario shows for the residential sector that its implementation will stabilise energy demand by 2030 and is expected to continue until 2050 despite the economic growth foreseen (Graph 9.4). However, this scenario does not prevent an increasing trend in energy demand for the tertiary sector (Graph 9.5).

Final Energy Demand in Cyprus (ktoe) - Households



GRAPH 9.4: FINAL ENERGY CONSUMPTION IN HOMES – REFERENCE, REALISTIC AND MAX TECHNICAL POTENTIAL SCENARIOS²²

²² Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050



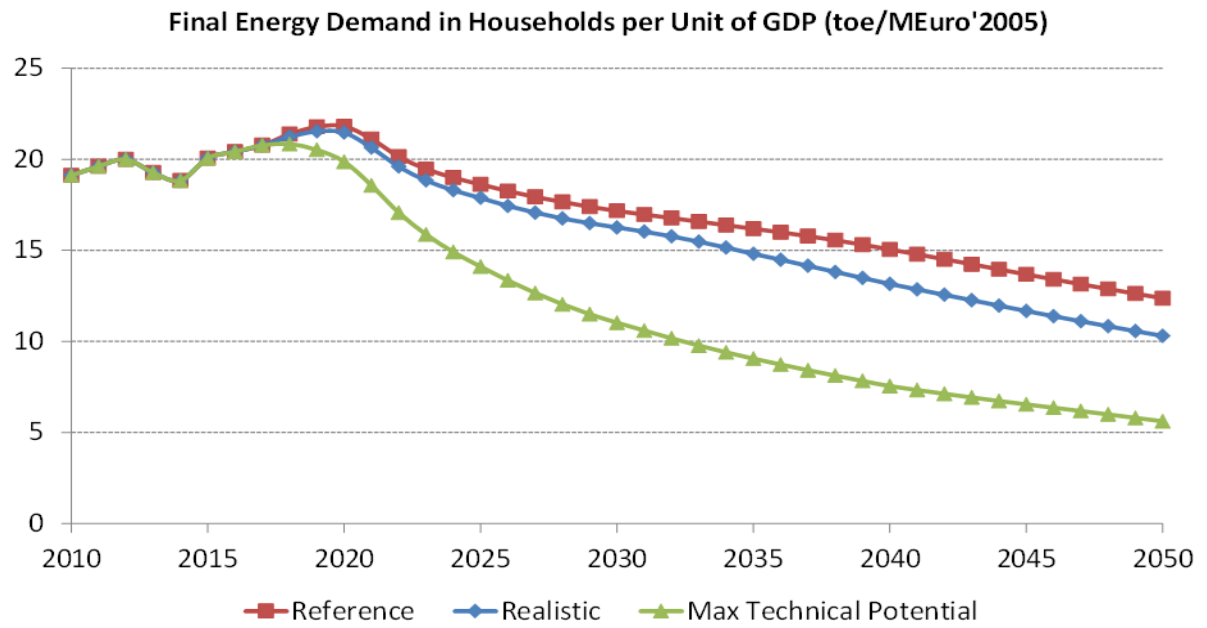
GRAPH 9.5: FINAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR – REFERENCE, REALISTIC AND MAX TECHNICAL POTENTIAL SCENARIOS²³

9.2 Estimate for economic benefits

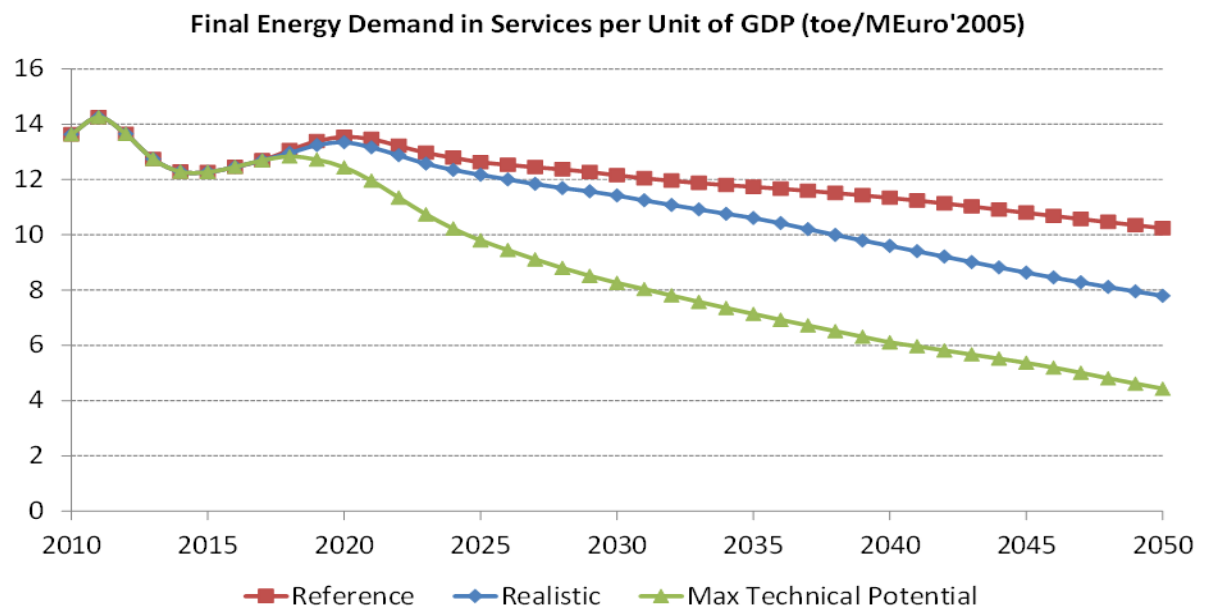
The heavy dependence of the energy system on imported oil products, combined with the low energy efficiency of many households and businesses, exposes the economy to changes in international oil prices. The energy upgrading of the building stock will help decouple economic growth from conventional fuels. By implementing the ‘realistic’ scenario, energy intensity in buildings, i.e. energy consumption per unit of the Gross Domestic Product (GDP), is expected to be halved by 2050 (Graphs 9.6 and 9.7). Of course, new buildings that will be NZEBs, will make a bigger contribution to this development than renovations.

The reduction of energy intensity in homes can reach almost 70% in the housing sector and exceed 75% in service rendering buildings, as calculated by the ‘max technical potential’ energy upgrading scenario (Graphs 9.6. and 9.7).

²³ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050



GRAPH 9.6: FINAL ENERGY CONSUMPTION IN HOUSEHOLDS PER UNIT OF GDP – REFERENCE, REALISTIC AND MAX TECHNICAL POTENTIAL SCENARIOS²⁴



²⁴ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

GRAPH 9.7: FINAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR PER UNIT OF GDP – REFERENCE, REALISTIC AND MAX TECHNICAL POTENTIAL SCENARIOS²⁵

It is estimated that the investments to be made for energy upgrades during the period of 2020–2030 will increase GDP by 0.25%. This increase, albeit modest, is favourably compared with other investments of the energy sector, such as electricity storage technologies and improving energy efficiency in the industry.

At a household level, the average energy expenditure is €3,100 per year or 10.6% of the household income. An increase in the energy efficiency of buildings will release funds for households to purchase other services and products, which will have a multiplying benefit for the economy in general. As regards undertakings, a reduction in energy consumption will significantly improve their viability, which is particularly true for undertakings for which the energy costs of their building facilities represent a large part of the operating costs.

According to a survey carried out by the Cyprus Employers and Industrialists Federation (OEB) in January 2020, in the framework of the implementation of the European programme SMenpower efficiency, 53% of SMEs believe that a business's electricity bill is big and 66% intends to invest in the next three years in energy-saving measures, mostly by using equity capital. The strengthening of sustainability and competitiveness through the improvement of the energy performance of buildings can become more imperative in some sectors, such as businesses in the hotel and catering sectors, from which most of the energy consumption results.

9.3 Estimate for environmental benefits

In Cyprus, 18% of greenhouse gas emissions are due to buildings. Therefore, the energy upgrading of buildings is one of the elements contributing to the achievement of the objective of reducing emissions by 24% by 2030. In homes, the thermal insulation of the roof and the replacement of old boilers with heat pumps, as well as the cogeneration of heating electricity in buildings such as hospitals and hotels, are assessed to be among the most cost-effective measures for decarbonisation of the non-ETS (Emissions Trading Scheme) sector. It is estimated that the implementation of the 'realistic' scenario in the building sector will lead to the removal of over 40 thousand tons of CO₂ by 2030.

²⁵ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

Reduced energy consumption in buildings, apart from its contribution towards combating climate change, also reduces the emissions of other polluting gases, such as SO₂, NO_x and small particles produced by power plants and heating systems. These emissions have a negative impact on the environment and public health. In Cyprus, according to the European Environment Agency, the exposure of the population to high concentrations of the above gases in the atmosphere has led to 850 premature deaths in 2016.

9.4 Estimate for social benefits

One's home represents their social status. Inadequate and poor living conditions contribute towards social exclusion, and give rise to constant safety and health concerns. The World Health Organisation has recognised that the number of deaths caused by defective building design and construction in European countries is higher than the number of deaths caused by road accidents. Energy-efficiency laws and incentives may not target health and safety issues in buildings, but energy upgrading, by improving thermal comfort conditions, will unavoidably improve the quality of indoor areas and living conditions. Based on the questionnaire answered by stakeholders during the public consultation, it was considered that the improvement in thermal comfort conditions is, at the same time with money saving, the most important reason for the upgrade of buildings (Annex I)

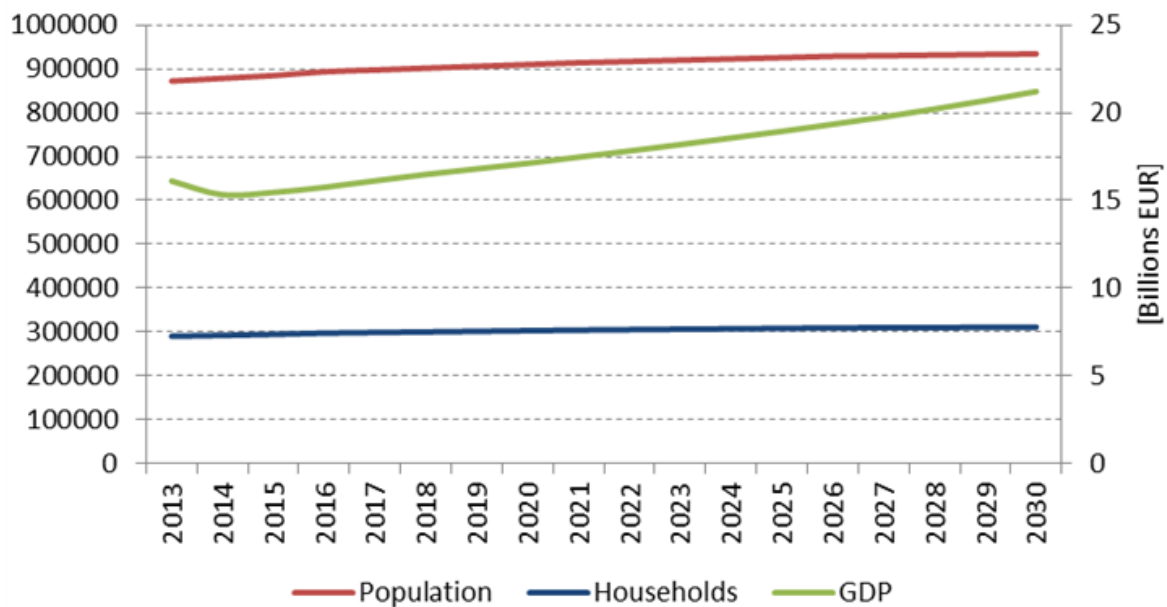
10. 2030, 2040 and 2050 Roadmap

It is estimated that by 2030, for the implementation of energy upgrades in the residential sector foreseen in the 'realistic' scenario, as described in paragraph 9.1, €450 to €550 million for residential buildings and €335 million for tertiary sector buildings will be required. These amounts are the combination of public and private funds and are the same as the energy saving estimates recorded in the scenario of the planned policies and measures of the National Energy and Climate Action Plan (PPM scenario). This scenario consists of a set of new measures, added to the existing measures and policies (WEM Scenario) to implement the 2030 national energy and climate targets.

The technical report titled 'Building Stock in Cyprus and Trends to 2030', prepared by JRC for the Ministry of Energy, Commerce and Industry, provides an estimate on how the building stock will be formed in Cyprus by 2030 in case the policies in the energy

efficiency of buildings do not change. This assessment is based on assumptions which, inter alia, relate to the following:

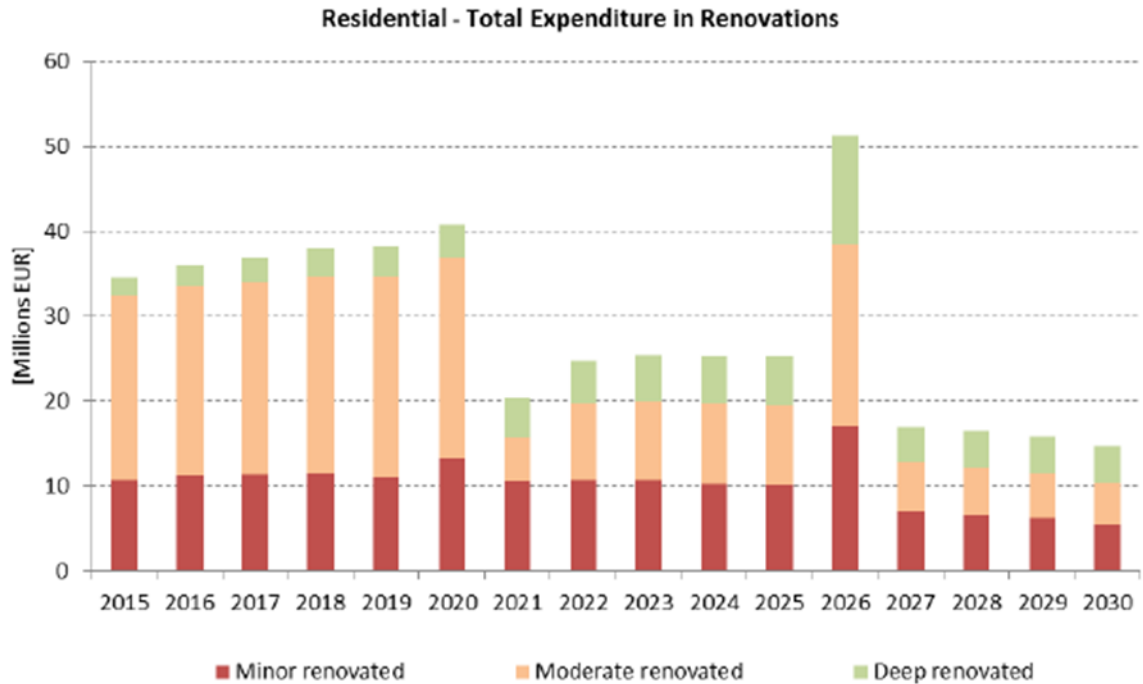
- a. The increase of the population and the Gross Domestic Product (GDP);
- b. The annual erection and demolition of buildings;
- c. The prices for energy and their progression;
- d. The intentions of investors based on the available capitals and the amortisation time;
- e. The available technologies and their cost.



GRAPH 10.1: ESTIMATE FOR THE PROGRESSION OF POPULATION, HOUSEHOLDS AND THE GDP BY 2030²⁶

Graph 10.1 provides a forecast for the changes in population, households and the GDP by 2030.

²⁶ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030, JRC Technical Reports*.

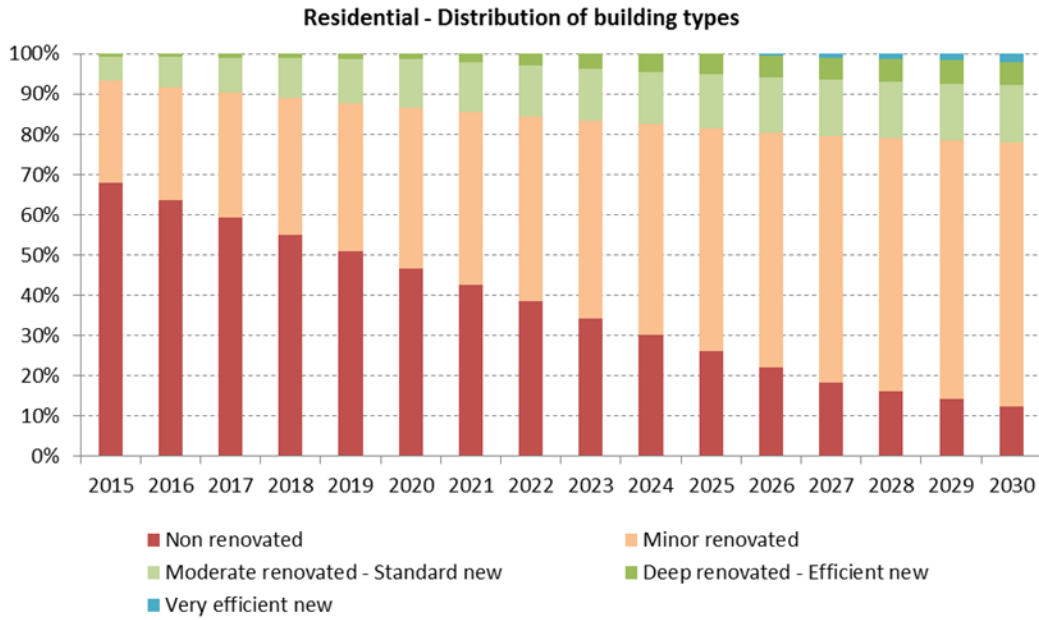


GRAPH 10.2: ESTIMATE OF EXPENDITURE FOR RENOVATIONS IN THE RESIDENTIAL SECTOR BY 2030²⁷

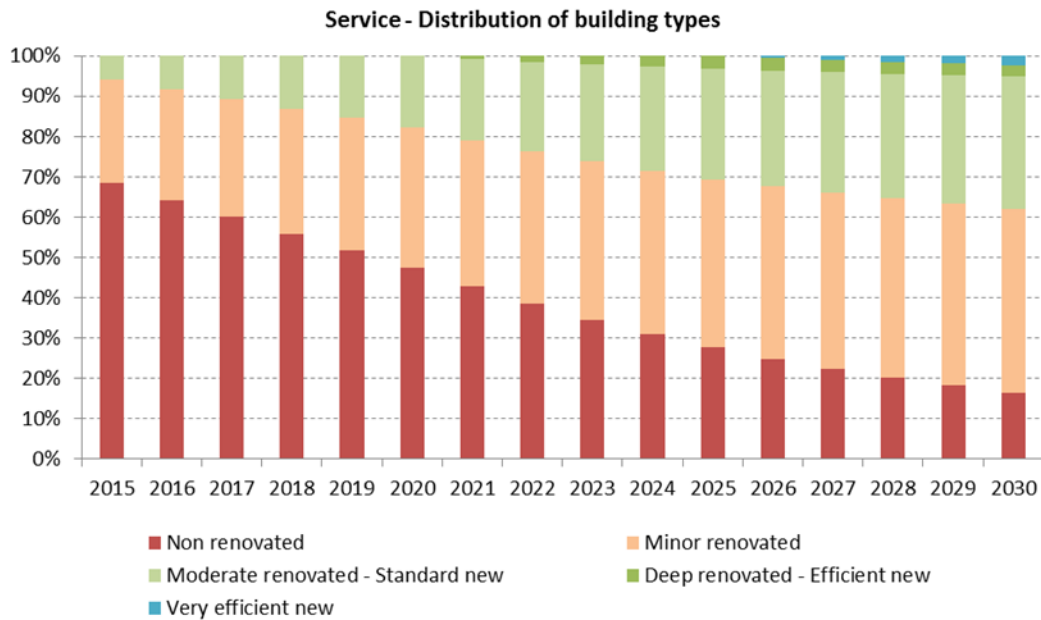
Graph 10.2 records the forecasts for the investments to be made in home renovations per year up to 2030. Renovations are divided into small, medium and deep. Small renovations concern the implementation of individual energy-saving measures, while medium and deep renovations relate to the combination of measures, with deep renovations leading to energy saving of more than 60%.

On the basis of the above, a base scenario has been created on how the building stock will be formed up to 2030 in terms of its energy efficiency. In accordance with this scenario, by 2030, more than 20% of homes (Graph 10.3) and approximately 35% of non-residential buildings (Graph 10.4) will be in good condition in terms of energy. A very small percentage of buildings will be high energy-efficiency buildings.

²⁷ Source: GIZ (2017), An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050



GRAPH 10.3: ESTIMATE FOR THE PERCENTAGE OF HOMES THAT WILL BE RENOVATED BY 2030 ²⁸



GRAPH 10.4: ESTIMATE FOR THE PERCENTAGE OF TERTIARY SECTOR BUILDINGS THAT WILL BE RENOVATED BY 2030

²⁸ Source: Zangheri, P. (2016). *Building Stock in Cyprus and Trends to 2030*, JRC Technical Reports.

Particularly for the household sector, taking into account economic and technical constraints, it is realistic to say that approximately 33,000 homes will be renovated by 2030. This forecast assumes that only one out of 6 homes will undergo deep renovation. On the basis of the study prepared by GIZ, the buildings estimated to undergo energy upgrading, are indicatively broken down by construction period, as follows:

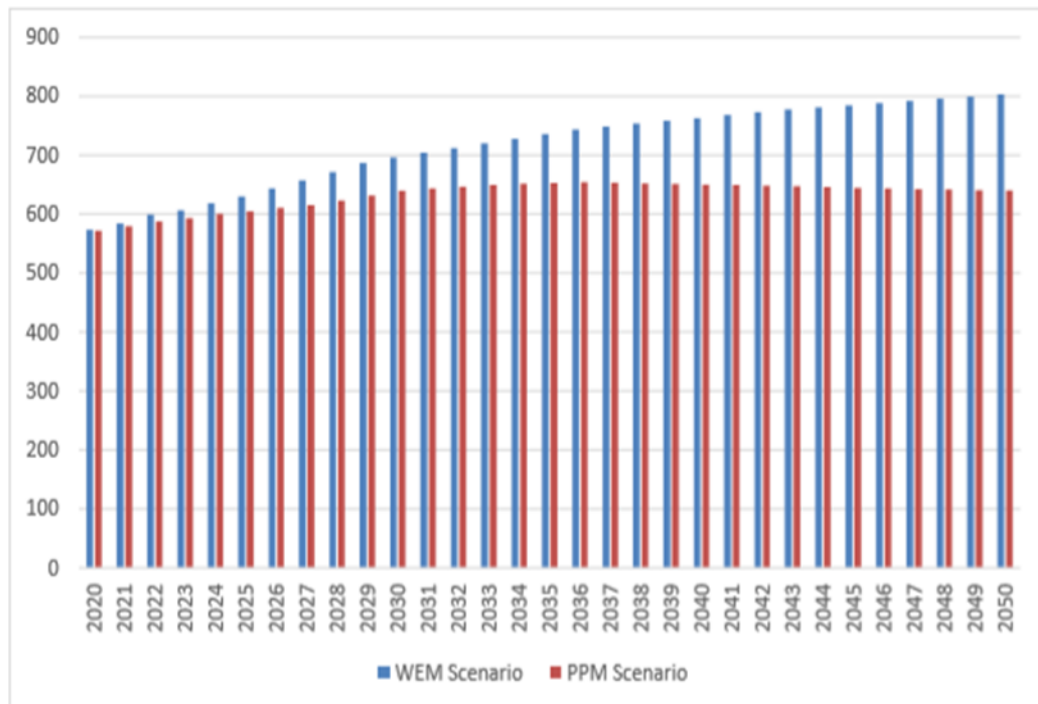
- a. 4% renovation of buildings constructed before 1970 (1,635 homes);
- b. 9% renovation of buildings constructed during the 1971–1990 period (10,250 homes);
- c. 20% renovation of buildings constructed during the 1991–2007 period (21,200 homes);
- d. 1% renovation of buildings constructed from 2008 until today (315 homes).

However, if energy-saving interventions, which are cost-optimal, would be implemented, this would result in them being implemented in a larger number of homes, between 43,000 and 79,000, with more likely 63,000 houses that could proceed with a combination of energy interventions by 2030. On an annual basis, this translates into an average annual figure of about 5,000 households. Around 25% of these are expected to proceed only with the replacement of lighting, electronic devices with more efficient ones, and with the installation of solar systems for hot water. With this assumption, an average of about 3,700 households could make significant energy upgrades every year, representing approximately 1% of the existing housing stock.

In terms of the tertiary sector, the total number of buildings to undergo energy upgrading, i.e. some type of intervention will be implemented, is estimated to be around 10,000 by 2030, with an average number of about 800 buildings per year. Approximately 30–40% of this annual number is expected to proceed with energy upgrades at a relatively low expenditure and with a shorter amortisation period. It is considered that around 400 buildings will implement a more integrated type of energy upgrade entailing higher investment costs.

In both the residential and tertiary sectors, the ‘realistic’ scenario contributes to the reduction of energy consumption by 2050 and is included in the scenario of the proposed measures and policies of the National Energy and Climate Action Plan. Graph 10.5 compares the scenario of the existing measures, policies and actions (WEM scenario) and the scenario with the proposed measures (PPM scenario) by 2050. It is

noted that this comparison is made under the assumption that the same expenditure for renovations that was estimated for the period up to 2030 will also continue for the 2030–2050 period. As a result, the renovation rate will not change after 2030. This assumption should be reassessed in subsequent studies in order to obtain the new data in the energy and building sectors.



GRAPH 10.5: COMPARISON OF THE WEM SCENARIO AND THE PPM SCENARIO FOR THE FINAL ENERGY CONSUMPTION OF THE BUILDING SECTOR BY 2050

Table 10.1 shows energy consumption by implementing the ‘realistic scenario’ for 2030, 2040 and 2050. It also refers to energy saving in relation to the reference scenario (or a scenario with the existing policies and actions in line with the National Energy and Climate Action Plan) for these years. Total energy consumptions with the implementation of the ‘realistic scenario’ also constitute indicative milestones in the building sector for 2030, 2040 and 2050, as their implementation is part of a wider plan, as this is recorded in the National Energy and Climate Action Plan.

Year	Final energy demand (ktoe)			Saving in relation to the WEM scenario (ktoe)
	Homes	Tertiary sector buildings	Total	
2030	373	266	640	56
2040	373	277	650	112
2050	361	279	640	163

TABLE 10.1: INDICATIVE MILESTONES IN THE BUILDING SECTOR FOR 2030, 2040 AND 2050

11. Conclusions

The drawing up of the Long-term Strategy for Building Renovation was based on the available statistical data, technical studies and the feedback received from stakeholder through the public consultation that preceded it, as well as other meetings and consultations carried out in the framework of European programmes. The most important conclusions that can be drawn are:

- a. The building stock remains energy-intensive. The changes that were brought about in the building sector by minimum energy performance requirements and aids are important, but they have influenced only a small percentage of buildings existing today, resulting in the total picture not being significantly differentiated in terms of energy consumption.
- b. When carried out in the framework of planned renovation, building renovation in high energy-efficiency buildings (from B+ to NZEB) is the cost-optimal solution in the life cycle of the building from the investor's side.
- c. Points in the building's life cycle, such as its sale, change of use and seismic upgrade can also trigger its energy upgrade. In order to strengthen the chances for building owners to proceed with energy upgrade of the buildings at these points, appropriate synergies should be developed between them.
- d. In the cases where the energy upgrade is not carried out in the framework of a scheduled renovation, then the level of ambition in terms of energy saving is reduced, as the cost-benefit ratio for the owner is differentiated. However, there are important macroeconomic and social benefits that are underestimated. Benefits, such as the improvement of the purchasing power of households, the competitiveness of enterprises and tackling energy poverty, have not been quantified so far. Quantifying them would make the cost-benefit ratio for energy-

saving investments more favourable. Future studies should highlight these issues in order to better design policies and actions.

- e. Policies and actions that are being implemented for years should be revised in order to become more effective, while it has been shown that other actions and policies also need to be strengthened. Strengthening of the Energy Performance Certificates in the real estate market seems to be the most important action.
- f. The 'realistic' scenario for the energy upgrading of buildings is annual renovation of 1% of the entire building stock. This scenario takes into account economic and technical limitations. This rate, combined with the construction of new buildings that will now be NZEBs, will make a significant contribution to reducing energy intensity in the sector and will stabilise energy consumption over time. However, in order to achieve an ambitious target leading to an exemption for the entire building stock from carbon dioxide emissions by 2050, the annual renovation rate should be tripled. This scenario appears to be unrealistic today, but the revision of policies and actions, which takes into account the macroeconomic, social and environmental benefits, should aim to increase the largest rate of renovation possible. In particular, in the residential sector, energy upgrades seem to be motivated to a large degree by reasons not only concerning money-saving and to which greater emphasis should be put.

The Long-term Strategy for the Renovation of Buildings should not be seen as a mere recording of the problems and potential of renovations, but as a first step and a springboard for helping building owners, investors and professionals in the sector to join forces in an effort that will ensure maximum economic and other benefits for all the parties concerned. The improvement of the legal, economic and social framework governing the energy upgrading of buildings, on the basis of the conclusions set out above, should be the intended result.

Annex I: Public Consultation

In order to shape the Long-term Strategy for the Renovation of Buildings in the best way possible, a public consultation preceded it, involving the following

- a. Presentation of the Long-term Strategy for the Renovation of Buildings to the Advisory Committee for Monitoring the Application of the Regulation of the Energy Performance of Buildings Law. Presentation and discussion of the matter at the Committee meeting on 26 February 2020.
- b. Presentation of the Long-term Strategy for the Renovation of Buildings to stakeholders at a one-day meeting organised by the Cyprus Employers and Industrialists Federation (OEB) on 19 February 2020.
- c. Collection of stakeholder views, from 12 February 2020 until 17 March, through a targeted questionnaire. Annex Ia presents the results of the questionnaire.
- d. Views formed during technical committee meetings and roundtable discussions in the framework of European programmes, in which the Energy Service participated. More details of these meetings are set out in Annex Ib.

Annex Ia: Questionnaire to stakeholders

Questionnaire in the framework of the public consultation carried out for the elaboration of the Long-term Strategy for the Renovation of Buildings

Name

Organisation that you represent or position/status

1. Which do you think is the biggest obstacle to the energy upgrade of existing buildings?

- (a) The failure to secure funding
- (b) The lack of trained personnel in the construction sector
- (c) The lack of information on the benefits resulting from the energy upgrade of the building
- (d) The low energy prices
- (e) Other

2. What, in your opinion, is the most important reason for the energy upgrade of existing buildings?

- (a) Climate Change
- (b) Saving money
- (c) The increase in a building's value
- (d) The improvement of thermal comfort
- (e) Other

3. What is the most important tool to increase renovations that will improve the energy performance of existing buildings?

- (a) Energy Performance Certificates
- (b) Energy Performance Contracting
- (c) State grant schemes

- (d) Favourable loans
- (e) Other

4. What is the most effective measure to help households with low incomes, which are unable to keep their homes warm in winter and cool in summer?

- (a) State grant schemes for deep renovation
- (b) State grant schemes for individual thermal insulation measures
- (c) State grant schemes for the installation of photovoltaic systems
- (d) Energy price subsidisation
- (e) Other

5. What is the most effective measure to improve the energy performance of rented buildings?

- (a) Determination of minimum energy performance requirements for rented buildings, such as the requirement for a minimum class in the Energy Performance Certificate
- (b) Financing or other incentives to those renting high energy efficiency buildings
- (c) Voluntary agreements between owner and tenant to share the costs and benefits that will result from an energy upgrade
- (d) Incentives to group renovations in rented buildings belonging to the same owner
- (e) Other

6. When is an energy upgrade more likely to take place in a building?

- (a) When it is transferred to a new owner
- (b) When it is leased to a new tenant
- (c) When structural upgrade is performed
- (d) When there is a change of use and/or additions
- (e) Other

7. Which type of building did you have in mind while answering the questionnaire (not related to question 4)?

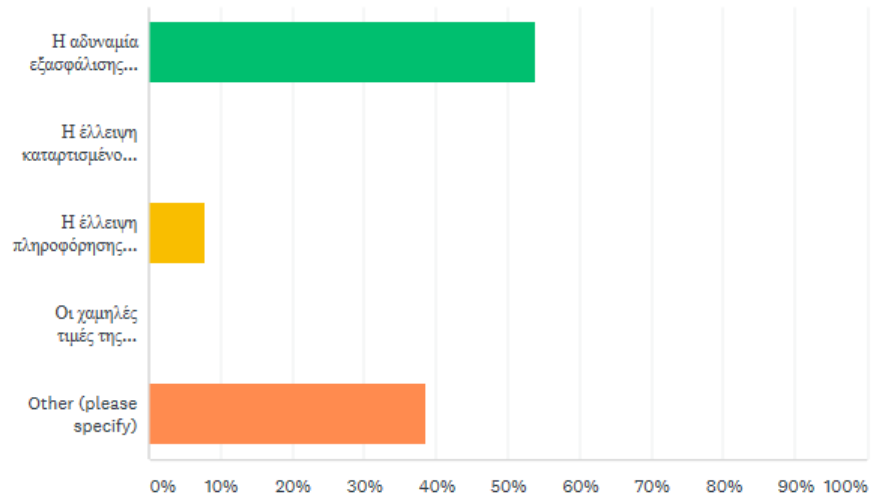
- (a) Home
- (b) Office buildings
- (c) Public buildings
- (d) Hotels
- (e) Other

8. Other comments and suggestions

RESULTS

Ποιο νομίζετε ότι είναι το μεγαλύτερο εμπόδιο για την ενεργειακή αναβάθμιση των υφιστάμενων κτιρίων;

Answered: 13 Skipped: 0



Which do you think is the biggest obstacle to the energy upgrade of existing buildings?

Answered: 13 Skipped: 0

The failure to secure...

The lack of trained...

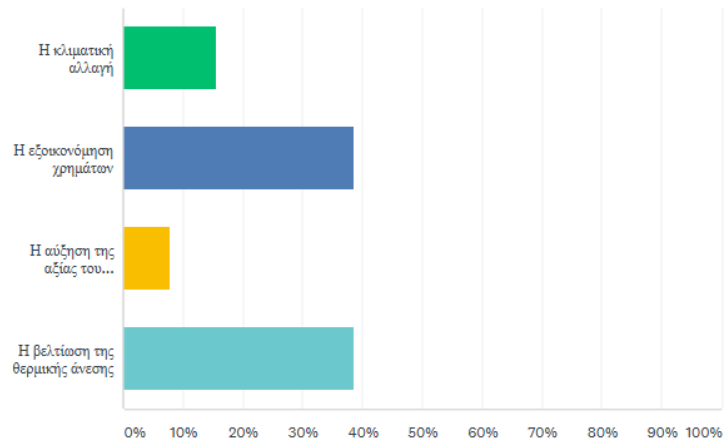
The lack of information...

The low energy prices

Other (please specify)

Ποιος είναι για εσάς ο πιο σημαντικός λόγος για ενεργειακή αναβάθμιση των υφιστάμενων κτιρίων;

Answered: 13 Skipped: 0



What, in your opinion, is the most important reason for the energy upgrade of existing buildings?

Answered: 13 Skipped: 0

Climate Change

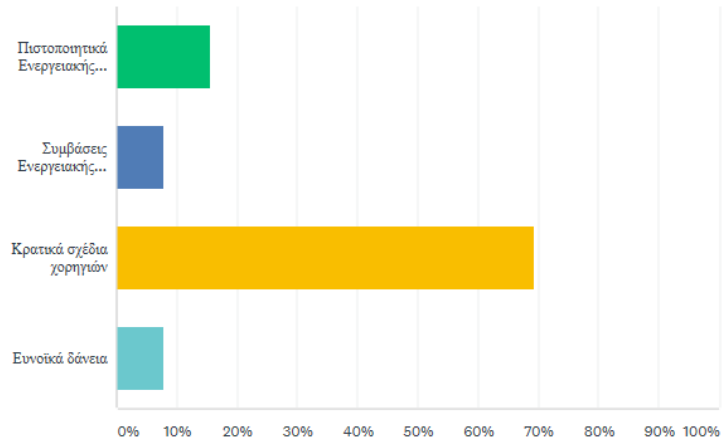
Saving money

The increase in a...

The improvement of thermal
comfort

Ποιο είναι το πιο σημαντικό εργαλείο για αύξηση των ανακαινίσεων που θα βελτιώσουν την ενεργειακή απόδοση των υφιστάμενων κτιρίων;

Answered: 13 Skipped: 0



What is the most important tool to increase renovations that will improve the energy performance of existing buildings?

Answered: 13 Skipped: 0

Energy Performance Certificates

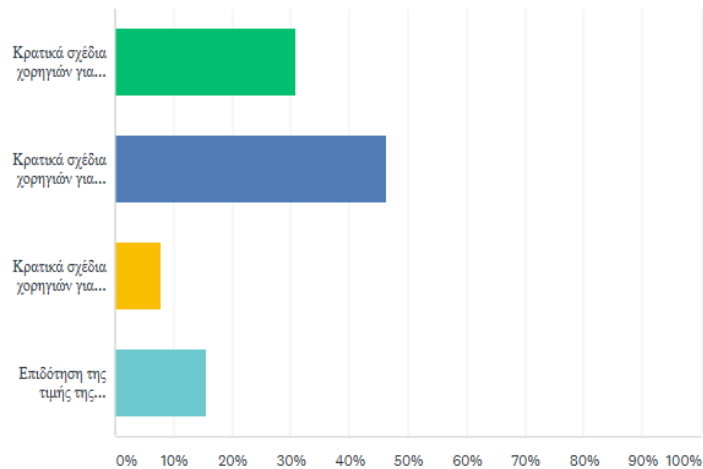
Energy Performance Contracting

State grant schemes

Favourable loans

Ποιο είναι το πιο αποτελεσματικό μέτρο για να βοηθηθούν νοικοκυριά που έχουν χαμηλό εισόδημα και αδυνατούν να έχουν ζεστά σπίτια τον χειμώνα και δροσερά το καλοκαίρι;

Answered: 13 Skipped: 0



What is the most effective measure to help households with low incomes, which are unable to keep their homes warm in winter and cool in summer?

Answered: 13 Skipped: 0

State grant schemes for...

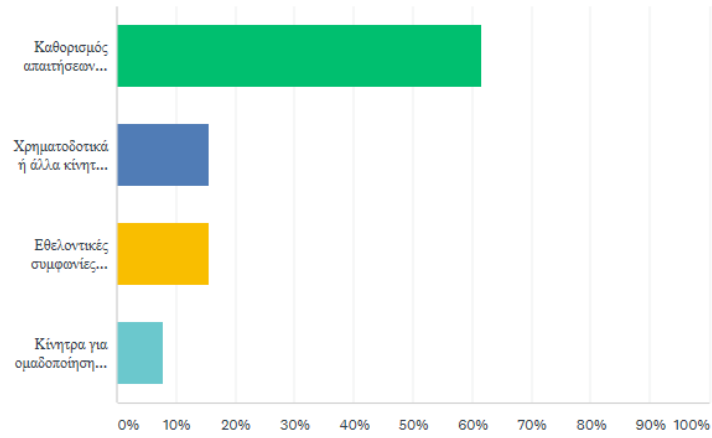
State grant schemes for...

State grant schemes for...

Energy price subsidisation

Ποιο είναι το πιο αποτελεσματικό μέτρο για να βελτιωθεί η ενεργειακή απόδοση των κτιρίων που ενοικιάζονται;

Answered: 13 Skipped: 0



What is the most effective measure to improve the energy performance of rented buildings?

Answered: 13 Skipped: 0

Determination of minimum...

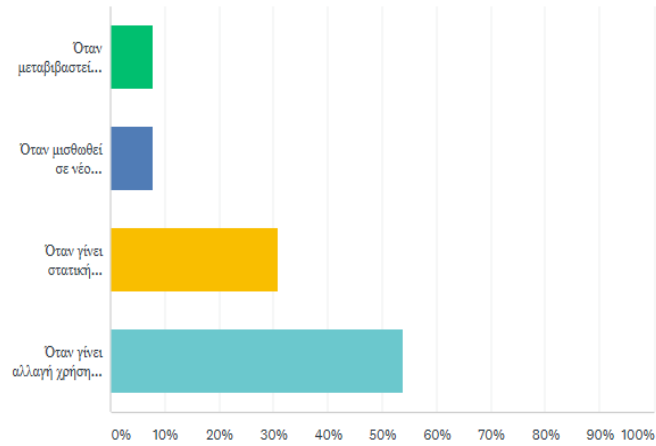
Financing or other incentives...

Voluntary agreements...

Incentives to group...

Πότε μια ενεργειακή αναβάθμιση είναι πιο πιθανό να ενεργοποιηθεί σε ένα κτίριο;

Answered: 13 Skipped: 0



When is an energy upgrade more likely to take place in a building?

Answered: 13 Skipped: 0

When it is transferred...

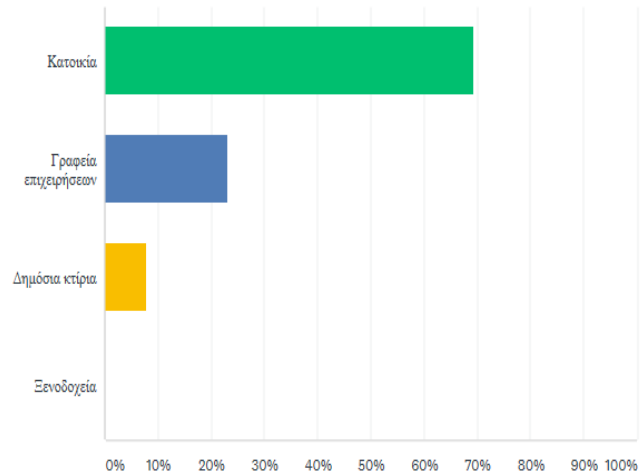
When it is leased to a
new...

When structural...

When there is a change of
use...

Ποιο τύπο κτιρίου είχατε υπόψη κατά την απάντηση του ερωτηματολογίου (δεν αφορά την ερώτηση 6);

Answered: 13 Skipped: 0



Which type of building did you have in mind while answering the questionnaire (not related to question 6)?

Answered: 13 Skipped: 0

- Home
- Office buildings
- Public buildings
- Hotels

Annex Ib: Meetings of advisory or technical committees of European programmes and roundtable discussions in which the Energy Service participated

1. Business4Climate+ Stakeholders business brunch/event, 19 December 2018, OEB
2. 5 meetings of the VIOLET programme Technical Advisory Team, organised by the Cyprus Energy Agency between February 2017 and December 2019
3. Roundtable discussion in the framework of the Hotels4Climate programme, 13 January 2020, OEB
4. 1st workshop in Cyprus - Roundtable discussion of 'SMEmPower efficiency' project 'Challenges and prospects of promoting energy managers in Cypriot businesses' 26 February 2020, OEB

Annex II: Examples of cost-optimal, over the life cycle of a building, combinations of energy-saving measures that can be implemented as part of a deep renovation, as shown from the results of these calculations

1) Renovation of a single-family house constructed in 2003 into a NZEB

General building information

- Location: Nicosia
- Usable floor area of 172 m²
- Two floors
- Three bedrooms

Technical characteristics of the building prior to any intervention:

- Roof: Tile roof, no thermal insulation ($U= 3.39\text{W}/\text{m}^2\text{K}$)
- Pillars/beams: Concrete, no thermal insulation ($U=3.33\text{W}/\text{m}^2\text{K}$)
- Walls: Typical 20 cm brick ($U = 1.39\text{W}/\text{m}^2\text{K}$)
- Frames: Aluminium frames with double glazing, no thermal break system ($U= 2.46 \text{ W}/\text{m}^2\text{K}$)
- Shading: No external moving shades
- Heating system: Central heating system with radiators and an oil boiler with an efficiency rating of 80%
- Air-conditioning system: Independent air-conditioners with a cooling efficiency rating of 2.6
- Hot water system: The same oil boiler as that used for heating, and solar panels
- Lighting: Compact fluorescent lamps
- Energy efficiency class in the Energy Performance Certificate: D

Energy-saving measures and initial cost:

- ✓ Installation of 8 cm thick thermal insulation on the roof ($U=0.33\text{W}/\text{m}^2\text{K}$)

- ✓ Installation of 7 cm thick thermal insulation on the walls, pillars and beams (U=0.25W/m²K)
- ✓ Replacement of frames with frames with double glazing and a thermal break system (U=1.68W/m²K and low - e)
- ✓ Replacement of boiler with a heat pump
- ✓ Replacement of air-conditioners with high-efficiency ones
- ✓ External moving shades
- ✓ Replacement of lamps with LEDs
- ✓ Installation of a photovoltaic system with a capacity of 5 kW
- ✓ Additional cost in relation to the scheduled renovation = €34,070

Energy consumption for:	Before renovation (kWh / m ² year)	After renovation (kWh/ m ² year)
Heating	43	5
Air-conditioning	101	20
Hot water	10	2
Lighting	17	13
Production of electricity from RES	0	38

Table II.1: Renovation of a house into a NZEB

2) Renovation of a multi-apartment building constructed in 2006 into an energy class A building

General characteristics

- Location: Limassol
- Usable floor area of 2,192 m²
- Four floors

- Four three-bedroom apartments and a one-bedroom apartment per floor

Technical characteristics of the building prior to any intervention:

- Roof, no thermal insulation ($U=3.39 \text{ W/m}^2\text{K}$)
- Pillars/beams: Concrete, no thermal insulation ($U=3.33\text{W/m}^2\text{K}$)
- Walls: Typical 20 cm brick ($U=1.38\text{W/m}^2\text{K}$)
- Frames: Aluminium frames with double glazing, no thermal break system ($U=2.46 \text{ W/m}^2\text{K}$)
- Shading: No external moving shades
- Heating system: Central heating system with radiators and an oil boiler with an efficiency rating of 80% for the three-bedroom apartments and independent air-conditioners with an efficiency rating of 1.9 for the one-bedroom apartments
- Air-conditioning system: Independent air-conditioners with a cooling efficiency rating of 2.6
- Hot water system: The same oil boiler as that used for heating and solar panels for the three-bedroom apartments and electric resistance and solar panels for the one-bedroom apartments
- Lighting: Compact fluorescent lamps
- Energy efficiency class in the Energy Performance Certificate: D

Energy-saving measures taken:

- ✓ Installation of 7 cm thick thermal insulation on the roof and the pilotis ($U=0.38 \text{ W/m}^2\text{K}$)
- ✓ Installation of 7 cm thick thermal insulation on the walls, pillars and beams

($U=0.33 \text{ W/m}^2\text{K}$)

- ✓ Replacement of air-conditioners with high-efficiency ones for heating and cooling
- ✓ Replacement of lamps with LEDs
- ✓ Installation of a photovoltaic system with a capacity of 10 kW
- ✓ Additional cost in relation to the scheduled renovation = €121,688

Energy consumption for:	Before renovation (kWh / m ² year)	After renovation (kWh/ m ² year)
Heating	12	0.64
Air-conditioning	102	24
Hot water	5	0.63
Lighting	19	13
Production of electricity from RES	0	9

Table II.2: Renovation of a multi-apartment building into an energy class A building

3) Renovation of an office building into a NZEB

General building information

- Location: Nicosia
- Usable floor area of 1,922 m²
- Four floors

Technical characteristics of the building prior to any intervention:

- Roof: No thermal insulation ($U = 3.39 \text{ W/m}^2\text{K}$)
- Pillars/beams: Concrete, no thermal insulation ($U = 3.33 \text{ W/m}^2\text{K}$)
- Walls: Typical 20 cm brick ($U = 1.39 \text{ W/m}^2\text{K}$)
- Frames: Aluminium frames with single glazing ($U = 5.8 \text{ W/m}^2\text{K}$)
- Shading: No external moving shades
- Heating system: Independent air-conditioners with a heating efficiency rating of 1.9

- Air-conditioning system: Independent air-conditioners with a cooling efficiency rating of 2.6
- Hot water system: Electrical instantaneous water heater
- Lighting: Compact fluorescent lamps
- Energy efficiency class in the Energy Performance Certificate: D

Energy-saving measures and initial cost:

- ✓ Installation of 15 cm thick thermal insulation on the roof ($U=0.19 \text{ W/m}^2\text{K}$)
- ✓ Installation of 12 cm thick thermal insulation on the walls, pillars and beams ($U=0.21 \text{ W/m}^2\text{K}$)
- ✓ Replacement of frames with frames with double glazing and a thermal break system ($U=1.68 \text{ W/m}^2\text{K}$ and low - e)
- ✓ High-efficiency heat pump
- ✓ Replacement of air-conditioners with high-efficiency ones
- ✓ External moving shades
- ✓ Installed lighting power under 10 W / m^2
- ✓ Installation of a photovoltaic system with a capacity of 20 kW
- ✓ Additional cost in relation to the scheduled renovation = €67,530

Energy consumption for:	Before renovation (kWh / m ² year)	After renovation (kWh/ m ² year)
Heating	21	2
Air-conditioning	101	14
Ventilation	0	3
Hot water	0	0
Lighting	48	14
Production of electricity from RES	0	17

Table II.3: Refurbishment of offices into a NZEB

4) Renovation of a hotel constructed in 1987 into an energy class B+ building

General building information

- Location: Paphos
- Usable area of 4,831 m²
- Five floors
- 116 bedrooms

Technical characteristics of the building prior to any intervention:

- Roof: No thermal insulation ($U = 3.39 \text{ W/m}^2\text{K}$)
- Pillars/beams: Concrete, no thermal insulation ($U = 3.33 \text{ W/m}^2\text{K}$)
- Walls: Typical 20 cm brick ($U = 1.39 \text{ W/m}^2\text{K}$)
- Frames: Aluminium frames with single glazing ($U = 5.8 \text{ W/m}^2\text{K}$)
- Shading: No external moving shades

- Heating system: : Central heating system with radiators and an oil boiler with an efficiency rating of 80%
- Air-conditioning system: Independent air-conditioners with a cooling efficiency rating of 3.2
- Hot water system: The same oil boiler as that used for heating with solar panels
- Lighting: Compact fluorescent lamps
- Energy efficiency class in the Energy Performance Certificate: C

Energy-saving measures and initial cost:

- ✓ Installation of 7 cm thick thermal insulation on the roof ($U=0.38 \text{ W/m}^2\text{K}$)
- ✓ Installation of 7 cm thick thermal insulation on the walls, pillars and beams ($U=0.33 \text{ W/m}^2\text{K}$)
- ✓ Replacement of frames with frames with double glazing and a thermal break system ($U=1.1 \text{ W/m}^2\text{K}$ and low - e)
- ✓ Replacement of boiler with a heat pump
- ✓ Installation of a photovoltaic system with a capacity of 20 kW
- ✓ Additional cost in relation to the scheduled renovation = €108,280

Energy consumption for:	Before renovation (kWh / m ² year)	After renovation (kWh/ m ² year)
Heating	46	3
Air-conditioning	114	80
Ventilation	0	7
Hot water	82	17
Lighting	33	33
Production of electricity from RES	0	11

Table II.4: Renovation of a hotel into an energy class B+ building

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