An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050

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List of abbreviations

CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CUT	Cyprus University of Technology
EAC	Electricity Authority of Cyprus
EE	Energy Efficiency
EED	Energy Efficiency Directive (2012/27/EU)
EPBD	Energy Performance of Buildings Directive (2010/31/EU)
EPC	Energy Performance Certificates
ESCO	Energy Service Company
ETBE	Ethyl *tert*-butyl ether
ETS	Emission Trading System
GDP	Gross Domestic Product
IRENA	International Renewable Energy Agency
JRC	Joint Research Centre
KTH	Royal Swedish Institute of Technology
LPG	Liquefied Petroleum Gas
MECIT	Ministry of Energy, Commerce, Industry and Tourism
NEEAP	National Energy Efficiency Action Plan
NZEB	Nearly Zero Energy Buildings
RES	Renewable Energy Sources
SME	Small and medium-size enterprise
TREMOD	Transport Emission Model
TSO	Transmission System Operator
2EMRS	Energy Estimation Model for Residential Sector

I Executive

Energy Efficiency Potentials

The energy efficiency potential in Cyprus is significant in the various end-use sectors and still remains largely untapped. A bottom-up analysis of the energy savings potentials in the household, service and industry sectors - that have not been covered through other sector studies within the overall framework of this technical assistance – revealed considerable long-term remaining **maximum (theoretical) saving potentials** compared to the existing sectoral consumption in the amount of

- Household sector: 51.3%
- Service sector 64.7%
- Industry sector: 34% (electricity), 5% (oil and gas)

An **economically viable potential**, which takes into account real-world financial constraints to implementing energy efficiency measures that would be cost-efficient revealed significantly lower numbers of savings compared to the existing consumption for the period until 2030:

- Household sector: 5.2%
- Service sector 6% (+2.4% of electricity savings because of energy efficient upgrade of the street lighting infrastructure)
- Industry sector: 6.2% (electricity) and 0.5% (oil and gas).

Modelling Results

On the basis of the bottom-up analysis, a Maximum Technical Potential and Realistic Scenario have been modelled in addition to the Reference Scenario, which reflects the current set of policies adopted by the Cyprus government:

Compared to the evolution of the Reference Scenario, the **Maximum Technical Potential Scenario** foresees energy savings in the **household sector** that may reach **36% by 2030 and almost 55% by 2050**. In the **services sector**, the corresponding savings compared to the evolution of the Reference Scenario are **32% in 2030 and 57% in 2050**, whereas similarly in **industry** they reach **20% by 2030 and 21.5% by 2050**. Potential savings, compared to the evolution of the Reference Scenario, under the Maximum Technical Potential Scenario are markedly lower in agriculture (with savings of 11% in 2030 and 23% in 2050) as well as in road transport (with just 2% savings in 2030 and 13% in 2050), where no significant behavioural or infrastructure changes have been assumed which might allow a better organisation of freight logistics, or an increased use of public transport modes. However this scenario is not integrating any policy or market considerations, is a run-free scenario from public and private budget constraints and is meant to serve as an indicator and not as an alternative energy policy scenario.

Following a different trajectory, but by integrating market and policy parameters in its structure, the **Realistic Scenario** foresees a gradual and slow-pace improvement in the intensity of energy use. Compared to the Reference Scenario, modest but likely energy savings are projected in **households** (**5.3% in 2030 and almost 17% in 2050**), whereas the corresponding savings are somewhat higher in the **service sector** up to **2030 (around 6%)** and increase gradually afterwards to reach **24% by 2050**. **Industrial** energy savings are even lower – **3.3% by 2030 and 7% by 2050**, focusing mainly on reduction in the consumption of electricity due to investments in automations and more efficient motors, compressed air systems and lighting. Under this scenario, an assessment of the cost-effectiveness of the different Energy Efficiency interventions is performed in order to illustrate the optimum mix of these interventions. This is done on the basis of their cost efficiency and affected number of end-users as well as to their attractiveness for the end-users and also from a macroeconomic perspective.

Overall, the expected expenditure for energy efficiency interventions for the household and service sector until 2030, in order to meet the targets resulted out of the realistic scenario, amount to almost 850 m€ and this is translated to a mean weighted ratio of annual investments at the level of around 0.33% of the estimated GDP over the 2018-2030 period.

Policy Recommendations

To exploit the considerable potentials in the different sectors the main barriers preventing a broader uptake of energy efficiency measures - limited financial support on the one hand and interest of final consumers on the other – shall be adequately addressed by the government in the post 2020 period.

The regulatory framework shall be further adjusted in order to establish a secure, consistent and market-oriented framework for energy efficiency interventions mainly targeting the building sector and to a less extent the transport sector. The still embryonic state of the energy service market in Cyprus can be attributed to a underdeveloped regulatory framework. More emphasis should be put on issues related to standardisation of energy services provided, the performance of such services and their procurement and operation in the public sector.

It is evident from the analysis provided in the context of this study, that the existing energy saving potential should be approached on a cost-efficient investment basis and to allow, even incentivise, the best performing interventions and instruments to scale-up.

The existing regulatory provisions with regard to the building code, Energy Performance Certificates, as well as energy audits for non-SMEs should be further enhanced in terms of monitoring processes and increased market value in order to create a sustainable regulatory framework for Energy Efficiency. In this context, the enhancement and extension (both also in time) of an obligation scheme for energy suppliers is proposed in order to increase relevance of the foreseen energy efficiency interventions on the market and to allow for the integration of these measures as new market mechanisms under a competitive framework. Though, the structure of the domestic energy market currently does not leave big room for competition among energy suppliers, considering the anticipated changes especially in the electricity market the introduction of such energy efficiency obligations can be expected to foster and accelerate the establishment of a functioning national energy service market.

The low-hanging fruits in terms of energy efficiency interventions still are not fully exploited and further emphasis should be given to awareness, training and information activities that would allow the fairly easily achievement of some significant energy savings.

Therefore, the adoption of national ***post-2020 energy efficiency sectoral targets***, which could be expressed in various ways or indexes, is proposed in order to drive the uptake of the domestic market for energy efficiency interventions and mechanisms in the various sectors, creating at the same time market confidence and security of expectation that the achievement of these targets is going to be monitored and is prioritised by the State. While the adoption of such sectoral targets could be very beneficial in order to achieve a sustainable national energy efficiency market, linking and underwriting the achievement of these targets with specific policy instruments (regulatory and financial) should be carefully planned and assessed. A continued active role of the public sector is expected to be required in order to achieve the envisaged energy savings targets, though, with a different mix of policy instruments compared to the current situation.

A balanced mix of ***mandatory obligations*** as well as ***voluntary targets*** for the various energy consumers and suppliers should be introduced. This needs to be done in a way that while going beyond the minimum mandatory instruments currently foreseen under the EED not to create market failures or uneven burden for some end-users or market participants. The instrument of energy audits especially for non-SMEs should be exploited far more in the future in both the service and industry sector and to be directly linked with any kind of state financial support.

Any regulatory market barrier should be addressed as efficient and as fast as possible in order not to witness market bottlenecks or lock-in effects. For this reason mainly ***capacity building*** measures for various stakeholders groups (e.g. building installers, energy managers, lawyers, bankers) should be timely planned and implemented. The introduction of ***standardised tools and procedures*** as well as the development of electronic databases, registries and communication platforms are also considered key instruments for the successful tackling of the existing mainly market-related barriers.

However, the most sever barrier for the achievement of the planned savings is the limited available budget for such kind of interventions. The private sector has been accustomed to be responsive only when a significant public subsidy is available, while the public sector tends to request full upfront capital coverage. For this reason, the transition to a ***more market-oriented financial support scheme***, will be definitely a challenge and a careful planning along with the mobilization of the appropriate financial and market instruments will be required. Government support will continue to play a vital and indispensable role in the achievement of the targeted energy savings and as such the appropriate new energy efficiency financing instruments should be deployed and be in operation as soon as possible. The aim from the side of the State should not be to reduce its overall share in the support of the energy efficiency interventions, but mainly to drive the public financial resources to more cost-efficient support instruments and types of energy efficiency interventions with a higher leverage.

The establishment of a dedicated ***energy efficiency revolving fund*** is proposed in the context of this study allowing the sustainable medium-term design of national support schemes for energy efficiency interventions. The success or not of this proposed fund is closely associated with the involvement and cooperation with the ***domestic banking sector*** and for this reason the active and direct participation of the latter sector should be thoroughly discussed and ultimately guaranteed before the launch of support programmes under this Fund. The governance and administration of this fund should be equally transparent and independent from external state budget obligations and the usage for energy efficiency investments should be therefore safeguarded.

In this context the possibility of additional inflows to this fund should be assessed and considered, mainly in the framework of carbon/green taxes, however without jeopardizing the existence of an initial capital for the medium-term fund operation. The capital for the fund operation is overall proposed to be allocated from the national Cohesion and Structural funds under the next programming period, however, by also integrating some foreseen and previously allocated budget elsewhere under the current programming period as an early kick-starter facility.

Benchmarking assessment and analysis in order to support the efficient planning and distribution of public funds is essential and to this end the current data set of specific energy consumption data for various end-use sectors needs to be systematically broadened and detailed. Market surveys and wider participation of market associations in the various national energy efficiency schemes (e.g. voluntary agreements) and exploitation of data collected by the energy managers of the public buildings and the stock of issued energy building certificates in the framework of dedicated Information System databases and platforms are proposed to be one of the first administrative driven actions for the next period.

In the **household/residential sector**, while not undermining the acceleration of new building requirements (i.e. deep renovations leading to nZEB consumption), any new instrument shall be designed to be cost-attractive as well as implementable in market terms. Programmes with a fast market uptake (i.e. roof insulation, heat pumps, solar thermal) allowing both comprehensive and stand-alone interventions shall be priorities. Linking these types of interventions in the household sector to the proposed Energy Efficiency Obligation Schemes is generally proposed in order to bridge the regulatory and financial gaps and to allow an upscale of the deemed beneficiaries.

In the **service sector** targeted sub-sectors for tailored initiatives are proposed to be the tourism and the industry food, diary, tobacco sector, while as far as the public sector is concerned emphasis should be given to hospitals and energy efficiency upgrade of street lighting. Since the latter is primarily under the responsibility of municipalities and communes, targeted schemes would need to be designed to empower and/or support local government to programme, procure and implement such measures, while a priority should again be given to the mobilisation of private capital through light energy performance contracting. Overall for the building sector, pilot actions should be also supported under the next period but under a specific market strategy that would foresee and anticipate the replication of these interventions and/or the uptake of various market mechanisms.

As far as concerns the agricultural sector the focus should be mainly given to higher penetration of RES systems for heating and cooling, achieving relative significant savings in terms of primary energy use and avoided cost of imported fuel, while also the adoption and support of an energy audit scheme could allow the identification of some significant cost efficient energy saving potential that could be addressed under tailored design national programmes either for specific sub-sectors (e.g. wineries) or agricultural process activities (e.g. greenhouses, drying). Given the poor knowledge on RES and energy efficiency potentials and technologies along the agricultural value chain all measures will need to be accompanied by awareness raising and training activities.

The transport sector, while exhibits a reference high potential for savings, due to existing and persistent modal shift patterns and overall infrastructure constraints is expected to perform quite modestly in terms of energy savings in the decade up to 2030. Action should focus on modifying the vehicle taxes to accelerate the penetration of higher efficient cars and light commercial vehicles, soft measures to promote a modal shift towards public, e-mobility and other alternative transport modes. To accelerate the uptake of e-mobility public funding the charging infrastructure and/or other regulatory measures for the set-up of charging infrastructure to enable the development of a free and competitive market must be considered, however only after a certain satisfactory level of cost-efficiency for these infrastructure investments is reached.

II Situation analysis

II.I Introduction

As stipulated in the Terms an analysis on the current situation on energy efficiency has been carried out for the household, services and industry sector. Transport sector (road and maritime transport) and agriculture (greenhouses and animal sector) have been covered by separate studies within the overall technical assistance and are thus not featuring in this report.

Methodologically the analysis is based on a literature review complemented by discussion with ministry representatives and feedback from other stakeholders. Apart from the last National Energy Efficiency Action Plan (NEEAP) for Cyprus from 2014 main written sources used are the outcomes from different studies from the Joint Research Centre under Administrative Agreement SI2.211494 "Support to Cyprus in tis obligation in the framework of Directive 2012/27/EU (cogeneration), Directive 2012/27/EU (renovating Cyprus national building stock) and Directive 2010/31/EU (nearly-zero energy buildings)", data and publications from the ODYSSEE-MURE project and other literature.

The report focuses mainly on the regulatory framework and financial incentive schemes which also represent the main policy instruments used by the Cyprus government up to now. Whereas the household sector is presented in a separate chapter Service and Industry sector have been combined in one single chapter since most policy measures are targeting the business sector as a whole. Least attention has so far been devoted to the industry sector, which however can partly be explained by the small share of industry in Cyprus compared to other economies.

II.II Household Sector

According to data from the Statistical Service of the Ministry of Finance the household sectors accounts for 19% of the final energy consumption and another 13% to commerce, hotels and services, i.e. mainly office buildings (Ministry of Energy, Commerce, Industry and Tourism, 2014). The building stock comprises of 431.059 residential buildings and 85.198 non-residential buildings. Of the residential buildings almost half are single-family houses and 22% apartments (Hadjinicolaou, 2015). The majority of dwellings (67%) are occupied by their owners and a large part (78%) is located in the coastal and low land areas (Zangheri, 2016).

The building sector is expected to play a key part in the achievement of the national targets for 2020 covering almost 98% of the energy saving target (BUILD UP Skills Project, 2012). The potential is huge since 91% of all buildings

(94% of residential buildings 83% in the service sector) were built before the introduction of mandatory energy performance requirements and 50% do not have any kind of thermal insulation (Hadjinicolaou, 2015) (Zangheri, 2016).

The share in final energy demand of the housing sector has been increasing rapidly over the last 10-16 years: From 14.1% in 1995 to 17% in 2000 up to 18% in 2013 (Kitsios, Kakouris, & Zachariadis, 2015). Electricity consumption has gone up by 150% in the same period mainly due to the installation of air conditioners and increasing number of home electric appliances (Kitsios, Kakouris, & Zachariadis, 2015).

Cyprus did not have any mandatory building performance requirements until 2007. Since then the requirements have been tightened twice and it is assume that a new building consumes around 50% less energy than a similar building that was built before the implementation of energy performance requirements (Hadjinicolaou, 2015).

Unit consumption of dwellings has dropped since the early 2000 from 1.16 toe/dw in 2000 to 0.85 toe/dw in 2013. Typical single-family houses are slightly more efficient (200 kwh/m²) than office buildings (250 kWh/m²). This can be partly attributed to improved energy performance of buildings with the introduction of the EPBD in 2008 mainly affected by the reduced use of heating systems due to economic reasons. Same goes for electricity consumption that has been falling to 2010 kWh/dw in 2013 after reaching a peak in 2007/2008 with 5600 kWh/dw (Kitsios, Kakouris, & Zachariadis, 2015).

II.II.I Regulatory measures

Legislative activity in Cyprus in the Household Sector has focused on transposing the relevant EU legislation into primary and secondary legislation, namely the Energy Labelling Directive (2010/30/EU), the Energy Service Directive (2006/32/EU) and its repelling Energy Efficiency Directive (2012/27/EU), and the Energy Performance of Buildings Directive (2010/31/EU).

Energy Performance of buildings

The law on Energy Efficiency of Buildings (No. 210(I)/2012) is the main legal act for transposing the requirements from the EU Performance of Buildings Directive (2010/31/EU) into Cypriot Law. A first law regulating the performance of buildings was adopted in 2006 (No. 142(I)/2006) with amendments in 2009 (No. 30(I)/2009) and a recent update in 2012 (No. 210(I)/2012) to include new requirements concerning qualified experts for the inspections of boilers and air-conditioning systems.

Specific performance requirements have been set by ministerial decree, which have subsequently been tightened in 2009, 2013, and 2016 and are set as follows (Hadjinicolaou, 2015):

Table II.1: Evolvement of energy performance requirements in Cyprus

Minimum Energy Performance Requirement	Since January 2010 (GAA 446/2009)	Since December 2013 (GAA 432/2013)	Since January 2017 (GAA 119/2016)	Since August 2014 (GAA 366/2014) – NZEB requirements
Energy class of the EPC	B or better for all new buildings and buildings lager than 1,000 m^2 that undergo major renovations.	B or better for all new buildings and buildings larger than 1000 m^2 that undergo major renovations	B or better for all new buildings and buildings that undergo major renovations	A for all new buildings and buildings that undergo major renovations
Maximum U-value for walls part of the building envelope in contact with the external environment (W/m².K)	0.85	0.72	0.4	0.4
Maximum U-value for roofs and floors in contact with the external environment (W/m².K)	0.75	0.63	0.4	0.4
Maximum U-value for windows and doors in contact with the external environment (W/m².K)	3.8	3.23	2.9	2.25
Maximum mean U-value for all buildings elements in contact with the external environment (W/m².K) – not including roofs and floors	1.3 for residential 1.8 for non-residential	1.3 for residential 1.8 for non-residential	-	-
Minimum percentage of primary energy consumption to be covered by RES	Installation of solar water heater for the production of DHW in new residential buildings and provision of the future installation of RES that produce electricity in all new buildings	In additional to 2010 requirement at least 3% of primary energy consumption to be covered by RES for new non-residential buildings	At least 25% of primary energy consumption to be covered by RES for new single-family residential buildings, 3% for new multi-family residential buildings, and 7% for non-residential ones.	At least 25% of primary energy consumption to be covered by RES

Maximum shading factor	-	0.63	0.63	-
Mean installed capacity for lighting in non-residential buildings (W/m^2)			10	10
Maximum annual primary energy consumption ($kWh/m^2/a$)			-	100 for residential 125 for non-residential
Maximum annual energy need for space heating ($kWh/m^2/a$)			-	15 for residential

Requirements and characteristics of nearly-zero energy buildings (NZEB) have as well been set by ministerial decree in 2014 requiring U-values for energy class A, a maximum consumption of primary energy and at least 25% of the demand to be covered by RES. This requirement applies for new and existing buildings (Hadjinicolaou, 2015).

Inspections

The implementation of minimum energy performance indicators is foreseen to be verified by MECIT through appointed inspectors on a random basis. According to the law these inspectors have the right to enter any building and construction site. In case of non-compliance first a written warning is issued and if the non-compliance persists a legal procedure is activated.

Inspections are being carried out though - due to shortages in personnel - not on at the desired scale.

Energy Performance Certificates

Directive 2010/31/EU on the energy performance of buildings requires Member States to introduce Energy Performance of Building Certificates (EPCs) to be issued for buildings at the time of construction, sale or renting or when undergoing major renovation. It has been transposed through a series of laws and regulations with the Law on Energy Efficiency of Buildings (No. 210(I)/2012) as the main legal act.

The EPC scheme has undergone a revision in 2013. On the one hand a new energy class B+ has been introduced to provide an extra incentive for property developers and building owners since most new buildings since 2009 have been constructed in energy class B and rarely in class A. Furthermore the recommendations in the report became more detailed since it now has to cover both individual measures and combination of measures. Furthermore, the report must give for every building element an indication of the relative efficiency vis-àvis the minimum requirements. Part of the revision has also been the possibility for issuing administrative fines of up to 30,000 EUR for non-compliance with EPC issuance (Hadjinicolaou, 2015:222). In 2014 MECIT has commenced a campaign to check on how EPC have been displayed when renting and selling. These included visits to offices of real estate agents and property developers, conducting seminars with associations of real estate professionals and property owners (Hadjinicolaou, 2015).

Though compliance levels have improved for EPCs in residential buildings from 2010 to 2013 EPC issuance remains at low levels. EPCs for existing buildings amount to only 7% of all EPC issued by 31/12/2013 (Ministry of Energy, Commerce, Industry and Tourism, 2014) and have only slightly increased since then though no official data on the ration of EPC issued for existing buildings is currently available.

In its Strategy for encouraging investments in the renovation of buildings MECIT stated in 2013 that many potential buyers and sellers keep ignoring its existence, though mandatory, during the transaction and don’t take into account the thermal performance during the transaction (Ministry of Energy, Commerce, Industry and Tourism, 2014).

Apart from legislative gaps connecting the EPCs with the sales documents and rental agreement this is attributed to insufficient information on the EPC to interested buyers or tenants and the difficulty of interested buyers or tenants as well as professionals in the real estate market to “translate” the data included in the EPC into building operating cost (Ministry of Energy, Commerce, Industry and Tourism, 2014). Furthermore, an EPC is required only at the time of construction, sale or renting of a building and thus excludes the largest part of the building stock which is owned by residents.

Energy Labelling

EU Directive 2010/30/EU on the “indication by labelling and standard product information of the consumption of energy and other resources by energy-related products” also known as EU Labelling Directive requires that different - mainly household - appliances must carry an energy label, which is standardised and also must be given to the consumer. The same applies for mail order catalogues (European Union, 2010).

The EU Energy Labelling Directive has been transposed in Cyprus national law through a series of separate ministerial decrees covering all required appliances. Trainings by MECIT were offered to suppliers and importers. Market surveillance is performed by authorized inspectors at several distribution sites. Inspections are also performed at several online selling points. Surveillance primarily takes the form of visual inspections. In case of doubt laboratory measurements might be carried out (ODYSSEE-MURE, 2014).

According to information by MECIT and other stakeholders consumers seem to be well aware of the labels. Compliance is improving though due to staff shortages market surveillance can only be performed on a limited scale.

The label proves to be a highly effective instrument to influence investment decisions towards energy efficient appliances when it comes to replacing broken equipment. Consumers in Cyprus at present however rarely replace old inefficient equipment when it is still functional although savings might be considerable and payback times attractive.

II.II.II Financial Incentive Schemes

Financial incentives have been provided through two grants schemes to private consumers. Both schemes have not been handing out grants since early 2016 due to a shortage of funds. Both schemes are expected to significantly contribute to the Article 7 target under the EED reaching a combined 48% of the cumulative final energy savings target (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

Special Fund for RES and EE

With Law 33(I)/2003 a Fund has been set up in 2004 to promote Renewable Energy Sources and Energy Savings. Law 33(I)/2003 was replaced by law 112(I)/2013. However, the articles related to the fund have all been adopted and transposed also in the new Law. The fund is financed by a levy of 1.00 ct. per kilowatt hour on electricity consumption for all final consumers. The fund has been subsidizing individual energy efficiency measures, cogeneration and renewable energy installations such as:

1) Thermal insulation and double glazing;
2) Off grid connected PV systems up to 30 kW;
3) Replacement of solar thermal systems for domestic water;
4) Solar thermal systems for space heating or space heating & cooling;
5) Geothermal heat pumps.

The fund is managed by the Fund Managing Committee consisting of representatives from MECIT, Ministry of Finance, DG for European Programmes, Coordination and Development, Cyprus Scientific Technical Chamber, and the Accountant General of Cyprus.

The grant scheme proved to be immensely popular and the budget was gradually increased over time and nearly 10% of the Cypriot residential buildings stock benefitted from the programme. In total around 100 million EUR investments had been allocated between 2004 and 2013 around half of it for energy efficiency investments (Economidou, Financing energy efficiency in buildings in Cyprus, 2016). 52% of the grants disbursed accounted for the household sector, 17% for the non-residential sector and the remainder unknown (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

An estimated 1 million toe had been saved with measures implemented with subsidies from the Special fund by 2013 (Ministry of Energy, Commerce, Industry and Tourism, 2014). However the design and impact of the fund has been criticised for different reasons (Economidou, Financing energy efficiency in buildings in Cyprus, 2016)

- Being a single non-holistic grant-based scheme the Fund has been weak in promoting comprehensive retrofit projects and buildings benefitting from the scheme were exposed to lock-in effects.
- Since the largest recipient group were homeowners with traditionally strong purchasing power is suspected that the scheme has attracted many free riders. Household income was only considered for subsidies for PV installations and impact on low income households can generally be considered as weak. The same goes for SMEs and multi-family buildings.

The effect on job creation, financing savings and stimulation of the wider renovation market remains unclear (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

The fund is currently in debt due to avoidance costs for RES producers which are paid by the fund. It has not handed out any subsidies since 2013. To rebalance the fund the levy on electricity has been increased from 0.5 ct. to 1 ct. per kWh as of March 2013 which would create additional revenues 0.5 million EUR per month from March 2017 onwards for the fund.

Given the considerable investments required and the need for deep retrofitting for reaching the national efficiency targets a review of the current scheme and a combination with other instrument is to be considered.

I SAVE I UPGRADE

To account for some of the shortcoming of the grant scheme from the Special Fund a new scheme “I SAVE I UPGRADE” has been set in place following a more holistic approach. It provides support grants for packaged measures that meet certain energy performance conditions (e.g. 40% energy savings or minimum class B).

For residential buildings a 50% grant (75% for vulnerable groups) is provided with a funding cap of 15,000 EUR per building or 10,000 per apartment. For renovations to NZEB levels 75% subsidies with a cap of 25,000 EUR are granted. Individual measures are also subsidised for vulnerable households with a funding cap of 2,500 EUR.

For non-residential buildings the funding cap is set at 200,000 EUR per unit with a grant intensity of 50%. The subsidy increases to 75% for NZEB buildings while the funding cap of 200,000 remains (ODYSSEE-MURE, 2013).

An Energy Performance Certificate, techno-economic study as well as expected energy savings from the measure are obligatory for both groups and need to be conducted by an energy auditor or qualified expert. For buildings with a useful floor area above 1000 m² an energy audit or energy management systems must be established (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

For the period of 2014 – 2020 a total budget of 15.3 million EUR for SMEs and 16.5 million EUR for households has been allocated. The majority of the funds are provided by the EU Cohesion Fund with co-financing from national resources. MECIT has been charged with the administration and management of the programme.

With regard to the household sector the I SAVE I UPGRADE scheme has been much more successful in tackling comprehensive renovation, direct involvement of actors of the energy efficiency supply chain, promoting Energy Performance Certificates, extending the scheme to apartment owners and extending the list of eligible measures though some challenges remain.

The equivalence of energy class B and 40% savings is not always achieved especially with regard to buildings of energy class G, F, E and lower band and non-comprehensive refurbishments could lead to lock-in effects. Also administrative procedures for reviewing applications take time due to limited infrastructure and capacities (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

No second call for the popular programme for households has been opened yet. It is expected that the market is deferring investments in expectation of new subsidies. It is also evident that especially for the household sector the remaining funds do not suffice for meeting the demand of the market.

Apart from reviewing the current scheme with regards of shortcomings mentioned and in view of the significant investments needed to meet the national energy efficiency targets additional resources would need to be mobilized to continue the existing schemes and other financing options with a higher leverage should be explored.

Net-Metering Scheme for residential photovoltaic systems

In 2013 a net metering scheme was introduced for the promotion of small residential photovoltaic systems. This scheme supported the installation of small PV systems with power up to 3 kW in 5,000 households. The total allowed installed PV capacity under that scheme was 15 MW. The beneficiaries of this scheme are separated in the two following categories (ODYSSEE-MURE, 2014):

- Small PV installation in households with low incomes as specified by the decree RAA 218/2013 of the Ministry of Energy, Commerce, Industry and Tourism. In this category, a grand of 900 EUR per installed kW is provided with maximum amount 2,700 EUR per system. The total capacity for this category is 6 MW i.e. 2,000 households.

- In the second category are included all the households that not eligible for grants according to the above directive. No grant is provided for these installations. The total capacity in this category is 9 MW, i.e. 3,000 households.

In 2016, 2040 grants with a volume of 5,486,360 EUR were allocated to households with low incomes exceeding the target (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

II.II.III Awareness raising

Directive 2012/27/EU on energy efficiency obligates member states in Article 17 to ensure that "information on available energy efficiency mechanisms and financial and legal frameworks is transparent and widely disseminated to all relevant market actors". "Members States shall, with the participation of stakeholders, including local and regional authorities, promote suitable information, awareness raising and training initiatives to inform citizens on the benefits and practicalities of taking energy efficiency improvement measures" (European Union, 2012).

Apart from information effects resulting from the introduction of Energy Performance Certificates and Energy Labels MECIT has been engaged in the following activities:

Publications

MECIT has produced a number of publications on Energy Efficiency to different target groups which are analysed and presented in more detail in Deliverable 4.1. Most of the publications have been designed for energy specialist such as engineers or architects as intermediaries but there are also a few targeting consumers such as an Energy Labelling Guide, and Energy Saving Guide, a guide for zero-cost measures in the households and workplace and materials for schoolchildren. The effect of publications to raise the awareness on energy efficiency among end-consumers in different sectors of the economy, however, seems to have been limited.

Fairs

At the International trade fair of Nicosia MECIT is every year hosting a special stand of the governmental energy department providing info, catalogues etc. on energy efficiency, RES and particularly promoting the governmental financial support schemes. The fair is visited by a minimum of 200,000 people which is about a quarter of Cyprus' total population (ODYSSEE-MURE, 2011).

Advertisements

To promote the Grant Scheme and RES Special Fund two kinds of newspaper ads had been produced and published in different print media[1] over a period of three month in 2009 but not any more since then (ODYSSEE-MURE, 2011). More focus have been put on TV and radio spots in recent years where 1 TV and 5 radio spots on different energy efficiency measures have been produced and free airtime provided by the stations.

Social media

MECIT is maintaining a Twitter and Facebook account and also having a YouTube channel featuring different information on energy related topics.

Traffic and likes on all social media channels remains however limited so far and through these communication channels the targeted audience is not reached to a satisfactory degree.

It is acknowledged by MECIT that awareness raising activities have been limited so far and additional efforts need to be undertaken in the upcoming years to flank the legislative and financial measures with awareness raising activities and other soft measures in the future.

[1] Phileleptheros, Politis, Simerini, Alitheia, Haravgi, Machi, Antilogos, Pontiki, Sunday Mail

II.III Service and industry sector

The services sector has seen a significant rise in the share of energy consumption having almost doubled its value added to the Cypriot economy from the mid-1990s to 2011-2012 and also electricity consumption has roughly doubled in 2009 compared to the mid-1990s which can be explained by high use of air conditions and expansion of the tourism sector which constitutes together with the financial sector the biggest consumers in the service economy (Kitsios, Kakouris, & Zachariadis, 2015). However the energy consumption in the services sector receded in recent years and was only a mere 27% higher in 2013 compared to 2000.

The share of the industry sector in the overall energy consumption has in contrast been declining throughout the last two decades. Following the financial crisis of the post-2009 period, the two subsectors that remained strong (construction and cement industry) have also experienced a substantial decline due to the decrease in demand for new houses (to be used either as main residences or as holiday houses). However, these subsectors are expected to rebound if the national economy reverts to a sustainable growth path. Final energy demand has declined even further as a result of both the drop in economic activity and progress in energy efficiency measures (Kitsios, Kakouris, & Zachariadis, 2015).

II.III.I Regulatory measures

The minimum energy performance requirements set by the law on Energy Efficiency of Buildings (No. 210(I)/2012) and supplemented by various ministerial decrees as presented in section II.II.I apply to buildings in the service sector alike. In this sub-chapter hence only regulations specifically targeting the service sector are presented.

Heating, Ventilation and Air Conditioning

Complementing the Law on Energy Efficiency of Buildings (No. 210(I)/2012) a series of decrees have been passed 2011 - 2015 on:

- Mandatory inspections of heating (>20 kW) and air conditioning (>12 kW) systems
- Efficiency and size of heating, cooling, hot water and large air conditioning systems
- Requirements for installing certified heat pumps and solar thermal equipment as well as performance requirements for biomass heaters and boilers

Energy audits

Article 8 of the EED requires Members States to promote high-quality energy audits in their territories and ensure that their large enterprises are subject to regular energy audits at least every four years. The EED differentiates between the requirement for Member States to promote and encourage the use of energy audits in small and medium-sized enterprises (SMEs), households and other small end-users, and the requirement for Member States to oblige large enterprises to carry out regular energy audits (European Union, 2012).

Cyprus has fully implemented the requirements from article 8 mandating non-SMEs to perform regular energy audits as well as setting up an energy auditor's registry including registration procedure, necessary qualification (ODYSSEE-MURE, 2015).

However, since Cyprus has only very few companies falling under the definition of a non-SME, the effect of the regulation has so far been limited. According to MECIT and business associations only a very limited number of SMEs has carried out energy audits in the past or introduced an environmental management system. Concerns were also raised by business representatives about the limited number and level of qualification of the existing auditors.

MECIT is currently preparing a new regulation to further encourage the uptake of energy audits for SMEs.

Ecodesign

Cyprus has fully transposed the Ecodesign Directive 2009/125/EU into national legislation by law No. 17(I)/2011 on Setting of Ecodesign Requirements for Energy-related Products.

Energy efficiency requirements have been set for hot water pumps, air conditioners and comfort fans, industrial fans, household dishwashers, household washing machines, circulators, electric motors, refrigerators and freezers, TVs, external power supplies, lighting products in the household and service sector, simple set-top boxes, stand by and off mode electric power consumption of household and office equipment. Since there are no domestic manufacturers of such product in Cyprus market surveillance covers imported products only which mainly come from Europe or Asia.

The Ministry of Energy, Commerce, Industry and Tourism has issued information leaflets for the main provisions of the eco-design Law for the consumers and the trading/importing companies (ODYSSEE-MURE, 2015).

Combined Heat and Power

The national Law for the Promotion of Combined Heat and Power Generation 174(I)/2006 has been amended for transposing the article 14 and a number of paragraphs of Article 15 of the Directive 2012/27/EE.

II.III.II Incentive schemes

Fund for RES and EE

The Fund for RES and EE presented in more detail in chapter II.II.II has been open to the private sector and public institutions alike.

The following interventions were eligible (Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016):

1) Any energy efficiency technology, which can achieve a 10% primary energy savings;
2) Central solar thermal systems for domestic water;
3) Central solar thermal systems for space heating/cooling;
4) Geothermal heat pumps;
5) Biomass investments;
6) Combined heat and power systems for non-profitable organizations;
7) Geothermal heat pumps for space heating/cooling for non-profitable organizations.

The maximum grant volume was 50,000 EUR. Typical investments included waste heat recovery, efficient motor/inverters, efficient boilers, thermal insulation, lighting systems, ballasts, energy management systems, controls etc. (Kitsios, Kakouris, & Zachariadis, 2015).

For CHP a 30% grant with a maximum of 160,000 EUR for plants up to 1 MW is paid. A feed in tariff equal with the national utility company cost of avoidance is guaranteed. For high efficiency CHP plants the same feed in tariff applies. The utility company is obliged to buy all high efficiency CHP electricity with a limit of 11 MWel (ODYSSEE-MURE, 2014). For cogeneration a minimum efficiency requirements for investments are an annual efficiency coefficient of the CHP system of at least 65% and, particularly for the case in which a combined cycled technology is used, of at least 75%. In the case of self-producers of the service sector, the annual efficiency coefficient was set to 60% (ODYSSEE-MURE, 2014).

In contrast to private consumers the grant scheme has been less popular among business. Only 5% of applications to the Fund were for non-residential buildings while for about 5% a distinction between service and residential building was not possible. Only 17% of the overall investments of around 100 million EUR between 2004 and 2013 both for renewable energy systems and energy efficiency have been directly allocated to the non-residential sector while for 31% of the overall funds the sector is unknown (Economidou, Financing energy efficiency in buildings in Cyprus, 2016) so the overall numbers might be higher.

Co-and tri-generation measures were the least popular interventions covering only 0,16% of the disbursed budget and the system obviously proved to be ill-suited to attracted investment into these capital intensive measures. Most popular were building envelope insulation (56%), lighting systems (7%), and electrical equipment (23%), air conditioning systems (10%) and energy management systems (2%) (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

I SAVE I UPGRADE

In the I SAVE I UPGRADE scheme presented in more detail in section II.II.II 15.3 million EUR which constitute a bit less than half of the overall budget for the period 2014 – 2020 have been allocated to SMEs. For non-residential buildings the funding cap is set at 200,000 EUR per unit with a grant intensity of 50%. The subsidy increases to 75% for NZEB buildings while the funding cap of 200,000 remains (ODYSSEE-MURE, 2013).

An Energy Performance Certificate, techno-economic study as well as expected energy savings from the measure are obligatory and need to be conducted by an energy auditor or qualified expert. For buildings with a useful floor area above 1000 m² an energy audit or energy management systems must be established. (Economidou, Financing energy efficiency in buildings in Cyprus, 2016; Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016).

As in the previous scheme the participation of SMEs remains low and the first call for applications has been open for more than two years without all funds being exhausted. Though it is in principle possible to finance the renovation with third party funds the scheme also failed so far to involve ESCOs and thus boosting the market for Energy Performance Contracting (Economidou, Financing energy efficiency in buildings in Cyprus, 2016; Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016).

II.III.III Energy Service Contracting

Legal framework

The Cyprus government has adopted a number legal acts to regulate the establishment and work of ESCOs with the main legislative measures being the law on energy efficient end use and energy service and regulation 210/2014 (Economidou, Financing energy efficiency in buildings in Cyprus, 2016; Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016):

- Operation conditions, registration terms and licensing of ESCOs
- Duties of the Energy Auditors Committee in relation to energy service providers
- Type of energy services provided and the minimum provisions to be included in the contract

- Steps to be followed by energy service providers to confirm increasing energy and financial benefits
- Stipulations on conducting the audit and evaluation of the energy services provided

Model contracts and tender documents have been issued in October 2014 by the Electrical and Mechanical Services Department after a public consultation process in July 2014. They include the legal framework, EPC definition, methodologies (shared or guaranteed savings, variable contract term), applications, details on the technical and financial capacities of the operator, and main provisions of the contract. The laws and regulations are presented in detail in (Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016).

Cyprus thus complies with article 18 and other relevant articles of the EED and has created the necessary regulatory framework conditions for ESCO companies operating in Cyprus.

By 2016 there were 19 ESCO companies officially registered in the country, all of them offering services in category A (buildings, ports, airports, street lighting) and B (industrial installations and processes, agricultural installations) and none in category C (transport) (Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016).

Potential for ESCOS

The potential for ESCO development has been cited in a recent JRC report as promising given the poor performance level of the Cypriot buildings stock and high energy prices. The market development potential is deemed high with a focus on street lighting, large hotels, hospitals and service buildings in general. Around two-thirds of the total non-residential floor area – in buildings over 1000 m² - is assumed to be addressable by ESCOs which constitutes more than half of the non-residential building stock (Economidou, Financing energy efficiency in buildings in Cyprus, 2016).

Current market penetration

The ESCO market in Cyprus is still in an embryonic state with a current market penetration of ESCOs being close to zero. Two buildings in the public sector (Central Offices of the Department of Public Works and the Central Offices of the Department of Electrical and Mechanical Services) which are of G and D energy class respectively have been selected as pilot project though technical assessments have been delayed repeatedly and the tender has not been opened yet. A pilot tender for Street Lighting a tender has been opened in early 2017 though no contract has been awarded at the end, since not a single final offer was submitted[2].

Existing barriers

No in-depth study on the absence of ESCO activities have been conducted for Cyprus. Possible explanation cited by an EU project in 2012 included the missing expertise and experience of ESCOs and the lack of trust among end-users in the procedure. Furthermore, the small market, high interest rates constitute other factors (Maxoulis, 2012) which coupled with the economic downturn inhibited the development of the market. Given the obvious market failures and the lack of positive examples and success stories public sector engagement will needed in the future to stimulate the market and showcase benefits of ESCO concept in practice as discussed in more detail in (Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016).

[2] Overall it should be mentioned that any induced complexity of the technical proposal and understanding of the evaluation procedure can be a major barrier up to the point of non-shown (no participation in the tender call) for the interested companies.

Moreover, the introduction of a new mechanism (i.e. Energy Performance Contracting) at such a demanding project, though easy in terms of planning and supply-installation, but with a high upfront cost is presenting high perceived risk from the private sector's perspective and is raising explicable concerns on the future respect of the contractual terms.

II.III.IV Other measures

Trade fairs

Trade fairs are used for outreach activities to promote energy efficiency and renewable energy activities both by government institutions as well as industrialist associations.

At the International trade fair of Nicosia MECIT is every year hosting a special stand for governmental energy department providing info, catalogues etc. for energy efficiency, RES and particularly promoting the governmental financial support schemes. The fair is visited by a minimum of 200,000 people which is about a quarter of Cyprus' total population.

The Cyprus Employers Industrialists Federation (OEB) with 4,500 members is organizing three-day Energy Fairs SAVENERGY hosting around 100 local and foreign traders, manufacturers, importers of energy efficiency/RES technologies. Typical technologies demonstrated are solar thermal applications, PV, small wind, hybrid / electric cars, heat recovery systems, electric demand management systems etc. (ODYSSEE-MURE, 2011).

Trainings

Specialised trainings targeting industry engineers, energy managers and plant managers are organized by different stakeholders such as MECIT, Cyprus Employers Industrialist Federation (OEB), Cyprus trade and industrial chamber (KEBE), Cyprus professional engineers chamber (ETEK), and Cyprus Energy Agency (CEA).

Competitions

MECIT is organizing annual competitions for energy saving projects in the service sector, industry and households. A special committee decides annually for the best and most innovative investments in energy efficiency improvement in companies, households to be awarded based on standard criteria.

Publications

MECIT has produced a number of publications targeting mainly energy specialist such as engineers or architects as intermediaries. From the interviews conducted with various stakeholders it can be concluded that these specialised publications are well acknowledged.

III Energy efficiency potentials

III.I Introduction

Given the missing comprehensive overview on existing energy efficiency potentials in the Cypriot economy and the lack of a previous studies in that field the technical assistance project has carried out an assessment of firstly the overall existing theoretical and secondly a from the macroeconomic point of view economically viable energy efficiency potential for the (a) household, (b) services and (c) industry sector. In the following sections the methodology applied in order to estimate these potential are described.

Each sector exhibits different characteristics regarding energy related behaviour, available technologies for energy production and use, energy demand profile, and fuel substitution possibilities. Based on these specific characteristics and in order to obtain technically robust and plausible results, three different methodologies, one for each sector, were followed. This potential was used as a benchmark in order to formulate the assumptions of the Maximum Technical Potential Scenario of our study.

III.II Household sector

III.II.I Methodological approach

The maximum (theoretical) energy saving potential for the residential building sector is defined as the amount of the current energy consumption that will be saved if the existing residential building stock is upgraded to nearly zero energy buildings, with regard to the provisions of: (a) 366/2014 decree of the Republic of Cyprus (envelope requirements), and (b) guidelines on the minimum energy efficiency of the technical systems in the household sector published by the Energy Service of MECIT.

The economically viable potential, which is a fraction of the maximum potential, is broadly defined as the amount of energy savings that can be attained if the more cost-efficient measures are implemented given some real-world financial constraints that limit the funds available for directly or indirectly supporting renovations of residential buildings.

The energy saving potential has been derived in both cases with the aid of the 2EMRS model (Energy Estimation Model for Residential Sector). The 2EMRS model, which was developed and validated by Cyprus University of Technology's (CUT) Energy and Environmental Economics and Policy Research Group (3EP), can be categorised as a simplified dynamic bottom-up algorithm. Using technical and physical input parameters, the model estimates the final heating and cooling energy consumption of the existing residential building stock of Cyprus. Figure III.1 illustrates the schematic presentation of the 2EMRS calculation algorithm.

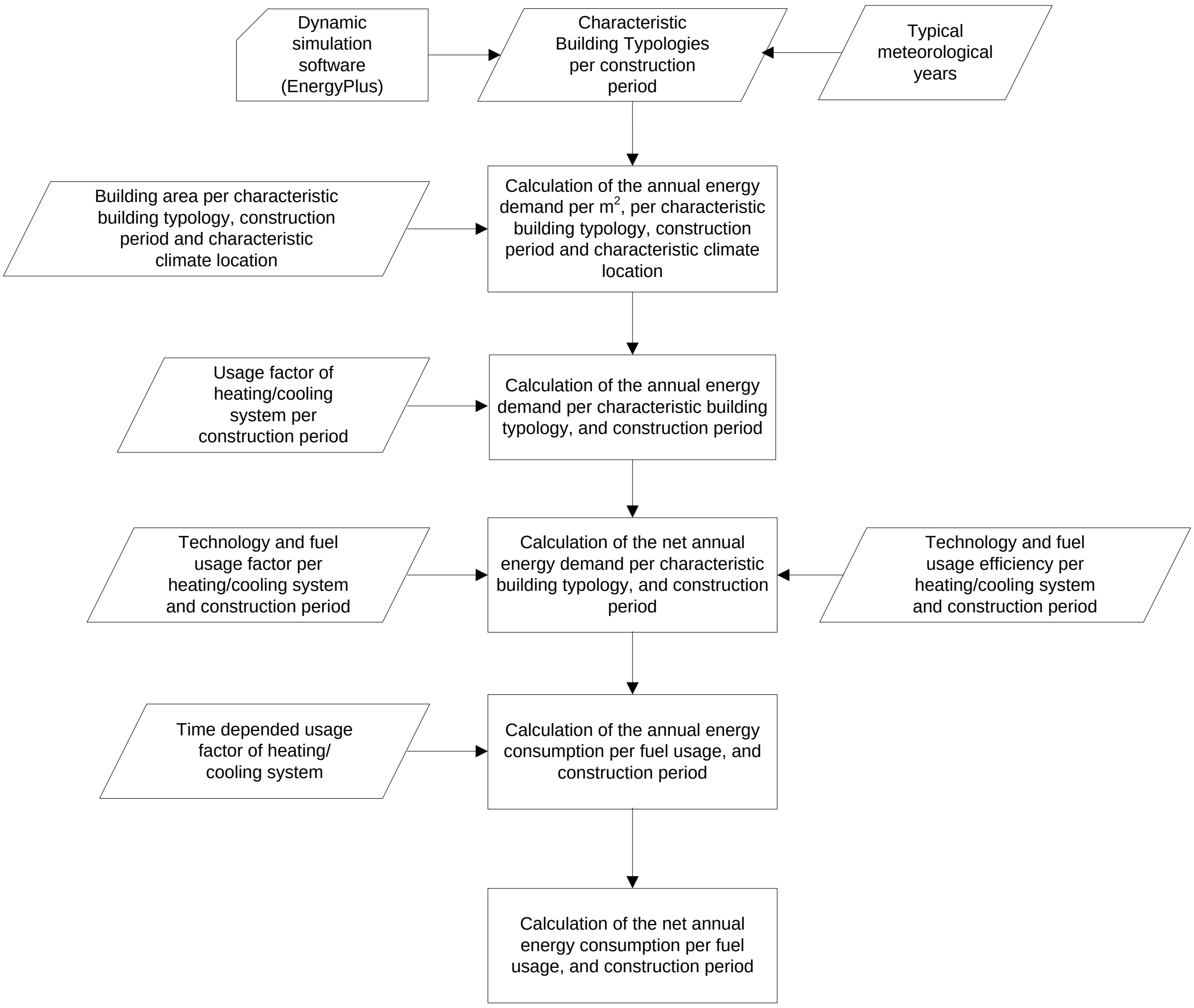


Figure III.1: Schematic presentation of the 2ERMS calculation algorithm

The following paragraphs present the main input parameters of 2ERMS.

Characteristic building typologies

The characteristic building typologies that the 2ERMS model takes into consideration were developed after a detailed analysis of the statistics of building construction permits per district and area provided by the Statistical Service of Cyprus. This analysis indicates 84 characteristic building typologies based on building type, construction period and climatic area. The main characteristics of the building typologies are presented in Table III.1.

Table III.1: Main characteristics of the characteristic building typologies

Building Type	Constru-ction Period	Area [m²]	Volume [m³]	No. of floors	No. of dwel-lings	Win-dow area [m²]	Exter-nal wall area [m²]	No. of hous e-holds
Single-family building	Before 1970	132.1	396.3	1	2	10.0	188.4	1
	1971-1990	151.2	453.6	1	2	17.9	148.8	1
	1991-2007	141.4	424.0	1	2	22.1	155.6	1
	2008-	202.2	606.6	2	1	43.3	276.6	1
Building with two housing units	Before 1970	265.4	796.2	1	2	20.0	342.0	2
	1971-1990	300.2	900.7	1	2	30.9	231.6	2
	1991-2007	302.4	907.2	2	2	38.8	297.6	2
	2008-	302.8	908.4	2	1	35.7	319.2	2
Building with more than two housing units	Before 1970	718.5	2155.5	1	2	92.1	801.0	3
	1971-1990	842.7	2528.2	1	2	89.2	802.5	3
	1991-2007	1001.6	3004.8	1	2	127.1	921.6	3
	2008-	1335.5	4006.4	1	1	169.5	1228.8	4
Multi-family buildings (apartment blocks)	Before 1970	345.4	1022.6	3	2	62.3	380.3	3
	1971-1990	690.8	2072.4	3	2	133.0	916.8	6
	1991-2007	690.8	2072.4	3	2	133.0	916.8	6
	2008-	861.4	2181.7	4	1	164.0	1064	8

Typical meteorological years

The typical meteorological years are climate files, which are needed for the dynamic simulation of the characteristic building typologies using the EnergyPlus software. These files were extracted from Meteonorm Software for the three reference climate regions (hot, moderate and cold) of Cyprus. The hot climate region represents the southern coastal areas of the island

(Limassol climate file), the moderate climate is characteristic for the mainland areas (Nicosia climate file), while the cold region represents the mountainous areas of the island (Saittas climate file).

Usage factor of heating and cooling system per construction period

This factor accounts for the percentage of the spaces in which heating/cooling system is not installed per construction period. The factor was retrieved by data of the Statistical Service of Cyprus and for the heating operation is equal to 2.4%, 2%, 1% and 4.3% respectively, while for the cooling operation it is equal to 19.2% for all construction periods.

Technology and fuel usage efficiency per heating/cooling system and construction period

The efficiency figures of the fuel-based heating and cooling system for all construction periods are shown in Table III.2. They were considered based on the study on the minimum energy performance requirements and cost optimal levels of the buildings in Cyprus which was performed by MECIT under the provisions of the article 5 of Directive 2010/31/EC. It is worth mentioning that for efficiency values of some systems that are not included in this study, the indicative ones from the EN 15316-4-X Standards were applied.

Table III.2: Characteristic efficiency values of heating and cooling systems.

Fuel	Heating/Cooling system	Efficiency
Electricity	Heat pump for heating	320%
	Heat pump for cooling	250%
	Any other	100%
Diesel	Central boiler	80%
	Stove	70%
Kerosene	Central boiler	80%
	Stove	70%
LPG	Central boiler	80%
	Stove	70%
Biomass	Central boiler	80%
	Stove	70%
	Fireplace	30%

Time dependent usage factor of heating/cooling system

This correction factor takes into consideration the actual use of the heating and cooling system on a daily basis. The factor was estimated based on the results of the final energy consumption survey of households performed by the Statistical Service of Cyprus in 2009. The time dependent usage factor remains the same for all building typologies and heating/cooling system types and is equal to 61.1% and 26.3% for heating and cooling operation, respectively.

Based on 2EMRS runs, the following two Sections describe the approach followed and the results obtained from the assessment of the theoretical and economically viable potential respectively.

III.II.II Theoretical potential

This potential was estimated in terms of percentage reduction in: (a) heating energy consumption, (b) cooling energy consumption, (c) energy consumption for domestic hot water production and (d) electricity consumption for lighting and appliances (white goods), assuming the energy upgrade and retrofitting of the building envelope stock and the gradual penetration of the following interventions for the existing building:

- High efficiency heat pumps for cooling in all buildings
- 90% High efficiency heat pumps + 10% high efficiency boilers for heating in multi-family buildings, located in urban and rural areas
- 80% High efficiency heat pumps + 20% high efficiency boilers for heating in single family buildings located in urban areas
- 50% High efficiency heat pumps + 50% high efficiency boilers for heating in single family buildings located in rural areas.

For electric heat pumps a heating efficiency of 600% and a cooling efficiency of 650% were considered. For the high efficiency boilers, which burn LPG, a thermal efficiency of 96.5% was assumed.

This analysis was based on:

- results of the "Energy Estimation Model for Residential Sector - 2EMRS" that was developed by CUT in the frame of this study; and
- the findings of the JRC report "Cost benefit analysis for the potential of high efficiency cogeneration of heating and cooling in Cyprus (Santamaria, Kavvadias, & Jakubcionis, 2016)that was conducted in 2016.

Heating

Table III.3 illustrates the results on the maximum (theoretical) energy saving potential for heating in the household sector based on the results of 2EMRS model.

Table III.3: Maximum energy saving potential for heating in the residential sector.

Construction period of buildings	Current final energy consumption [toe]					
	Electricity	Gas oil	Kerosene	LPG	Biomass	Total
< 1970	4,630.87	3,550.12	1,789.34	9,898.46	1,301.73	21,170.52
1971-1990	8,063.11	16,925.78	2,951.40	17,623.56	3,305.12	48,868.98
1991-2007	7,092.87	24,190.85	4,120.10	11,371.46	3,282.23	50,057.50
2008-now	1,447.47	617.78	319.92	739.12	357.15	3,481.44
Sum	*21,234.32*	*45,284.53*	*9,180.76*	*39,632.61*	*8,246.24*	*123,578.45*
	Final energy consumption of the maximum (theoretical) energy saving scenario [toe]					
< 1970	978.03	-	-	3,962.32	-	4,940.35
1971-1990	2,890.57	-	-	9,983.34	-	12,873.91
1991-2007	3,025.48	-	-	10,370.85	-	13,396.33
2008-now	285.11	-	-	971.93	-	1,257.04
Sum	7,179.18	-	-	25,288.45	-	32,467.63
	Reduction in heating final energy use [%]					
< 1970	78.9%	100.0%	100.0%	60.0%	100.0%	76.7%
1971-1990	64.2%	100.0%	100.0%	43.4%	100.0%	73.7%
1991-2007	57.3%	100.0%	100.0%	8.8%	100.0%	73.2%
2008-now	80.3%	100.0%	100.0%	-31.5%	100.0%	63.9%
Sum	66.2%	100.0%	100.0%	36.2%	100.0%	73.7%

Cooling

Table III.4 illustrates the results on the maximum (theoretical) energy saving potential for cooling in the household sector based on the results of the 2EMRS model.

Table III.4: Maximum energy saving potential for cooling in the household sector.

Construction period of buildings	Final energy	Saving	
	Current situation	Maximum (theoretical) energy saving scenario	
	Electricity	Electricity	
< 1970	6,012.97	1,115.37	81.5%
1971-1990	18,371.41	3,122.29	83.0%
1991-2007	16,535.47	3,493.12	78.9%
2008-now	1,256.67	557.68	55.6%
Sum	42,176.52	8,288.47	80.3%

Domestic Hot Water

The estimation of the maximum energy saving potential for domestic hot water production was based on the findings of the JRC study on the building sector. This study indicates a possible potential of 75% savings. The mentioned level of energy savings in terms of DHW usage, refers to the savings on the conventional fuels for DHW which represent currently around 15% of the total energy consumption for DHW. Therefore if the 75% savings of the current conventional fuel usage for DHW are achieved then this will lead finally to 2050 to a ratio of consumption for DHW at the level of 4%/96% for conventional fuel versus solar thermal from a ratio of 16%/84% currently observed. Based on this and taking into consideration the results of CYstat's household energy consumption survey, the maximum (theoretical) energy saving potential of fuels for domestic hot water production was estimated and is shown in Table III.5. The conventional fuel savings for DHW arises from the coverage of these end-use needs by domestic solar thermal systems.

Table III.5: Maximum energy saving potential for hot water production in the household sector.

	Final energy consumption [toe]						
Fuel	Electricity	Gas oil	Kerosene	LPG	Biomass	Total (conv. fuels)	Solar Thermal
Current situation	927.40	6,260.00	626.00	2,817.00	313.00	10,943.40	57,678
Max	684.32	-	-	2,054.25	-	2,738.57	65,883
Saving	26.2%	100.0%	100.0%	27.1%	100.0%	75.0%	*-14.2%*

Lighting and Appliances

The estimation of the maximum energy saving potential for lighting and appliances was based on individual analysis performed using Dialux software on characteristic reference buildings of the building stock of Cyprus. This simulation analysis indicates a possible potential of 55% savings. Based on this and taking into consideration the results of CYstat's survey on household energy consumption, the maximum (theoretical) energy saving potential for lighting and appliances was estimated and is shown in Table III.6 below.

Table III.6: Maximum energy saving potential for lighting and appliances in the household sector.

	Final energy consumption [toe]		Saving (%)
	Current situation	Max potential	
Electricity	63,218.54	34,770.20	55.0%

Overall maximum theoretical potential

Total final energy savings in the household sector are summarised in Table III.7 below:

Table III.7: Theoretical energy saving potential in the household sector.

	Final energy consumption [toe]							
Fuel	Electricity	Gas oil	Kerosene	LPG	Biomass	Solar	Geother mal	Total
Current situation	127,557	51,545	9,807	42,450	8,559	57,678	1,551	299,146

Max potential	50,922	-	-	27,343	-	65,883	1,628	145,776
Savings	*60.1%*	*100.0%*	*100.0%*	*35.6%*	*100.0%*	*-14.2%*	*-5.0%*	*51.3%*

III.II.III Economically viable potential

Based on the modelling analysis that led to identification of the maximum energy saving potential, it turned out that the following non-prioritised energy interventions should be mainly considered in order to improve the energy efficiency of the current residential building stock:

(a) Insulation of the horizontal elements (roof, ceiling, etc.)

(b) Insulation of the vertical elements (reinforced elements, masonry)

(c) Installation of shading devices

(d) Installation high efficiency windows (frame and glasses)

(e) Installation of LED lighting bulbs

(f) Use of high efficiency heat pumps

(g) Use of solar thermal collectors

(h) Use high efficiency boilers (in rural areas)

The JRC study on "Building stock in Cyprus and trends to 2030" (Zangheri, 2016) has shown that under a scenario which assumes policies recognised as particularly appropriate for Cyprus, the total expenditure in renovations is foreseen to account for about 450-500 million EUR until 2030. This is demonstrated in Figure III.2. Based on direct communication of the study team with MECIT, this level of expenditures, compromising both private and co-financed interventions, is considered by national energy authorities as a challenging but realistic prospect for the period up to 2030 and was therefore adopted in this analysis.

The average intervention cost of a deep renovation (i.e. leading to a nZEB class) per average dwelling (i.e. weighted average after considering single family, two-families and multi-family buildings) is estimated at about 65,000 EUR, meaning that an equivalent number of just 7,700 buildings in the household sector could be fully upgraded with this amount until 2030.

Obviously, the consideration that only deep renovations could or should be implemented in the household sector -while also non-realistic in pure technical and market-related terms- is also non-optimal in cost efficiency terms, since the combination with other Energy Efficient (EE) interventions will increase both the total achieved savings and the affected households, keeping simultaneously stable the overall budget expenditure.

More specifically, considering that the ratio of energy saving/intervention cost of some specific individual measures is higher than the ratio of integrated deep renovation to nZEB and taking in consideration a mix of the (a)-(h) previously illustrated energy efficiency interventions, a higher number of affected buildings for the same available total amount of expenditures could be targeted. Therefore, considering indicative nominal savings per investment and their cost and a mean mix of single interventions along with deep renovations it results that on average around 33000, assuming that only 1 out of the 6 affected dwellings will undergo a deep renovation, dwellings can be expected to be renovated under the realistic scenario. This would include all different building typologies: single-family house up to multi-family blocks of flats.

This buildings stock that undergoes a kind of energy efficiency upgrade and improvement, after considering some market related characteristics and stakeholders opinion, could be indicatively allocated per construction period as following:

- 4% renovation of the building stock constructed before 1970 (1,635 dwellings);
- 9% renovation of the building stock constructed during 1971-1990 (10,250 dwellings);
- 20% renovation of the building stock constructed during 1991-2007 (21,200 dwellings); and
- 1% renovation of the building stock constructed from 2008 up to now (315 dwellings).

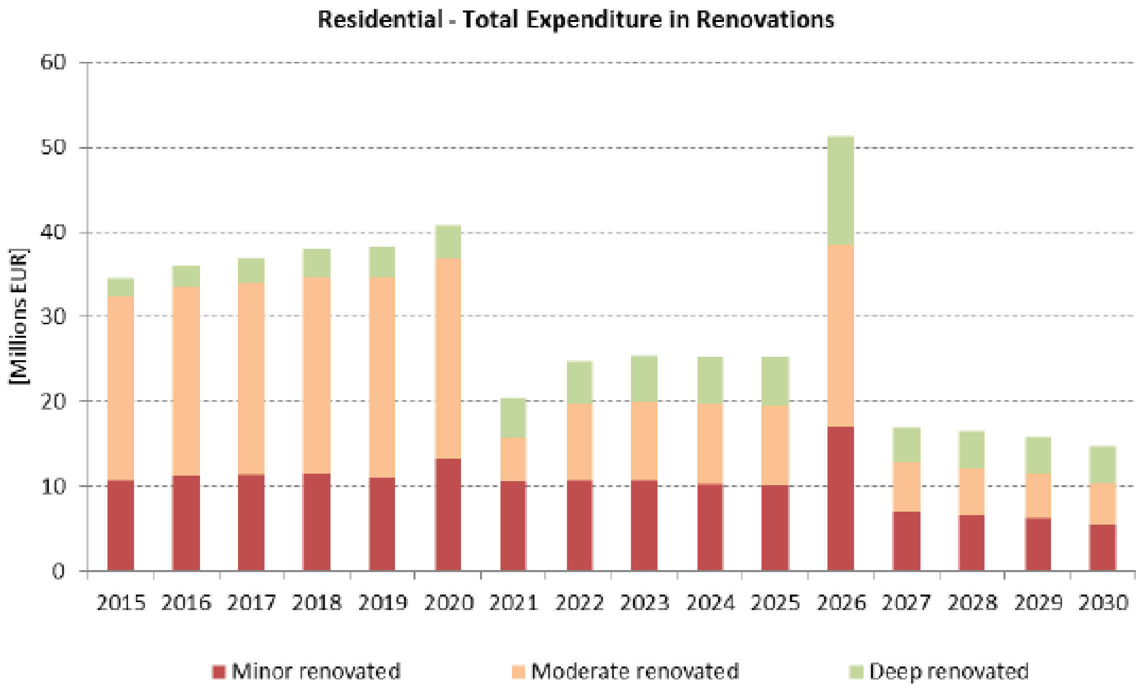


Figure III.2: Annual expenditure in refurbishment activities on the residential building stock of Cyprus until 2030 according to Policy Scenario 1 of Zangheri (2016).

Using these assumptions, CUT's "Energy Estimation Model for Household Sector - 2EMRS" leads to calculations of energy savings by end use. Tables III.8 and III.9 display the calculated savings for space heating and space cooling respectively, adapted to the energy balance of Cyprus for year 2015.

Table III.8: Estimated economically viable energy saving potential for space heating until 2030.

Construction period of buildings	**Current final energy consumption [toe]**					
	Electricity	Gas oil	Kerosene	LPG	Biomass	Total
< 1970	4,630.87	3,550.12	1,789.34	9,898.46	1,301.73	21,170.52
1971-1990	8,063.11	16,925.78	2,951.40	17,623.56	3,305.12	48,868.98
1991-2007	7,092.87	24,190.85	4,120.10	11,371.46	3,282.23	50,057.50
2008-now	1,447.47	617.78	319.92	739.12	357.15	3,481.44
Sum	*21,234.32*	*45,284.53*	*9,180.76*	*39,632.61*	*8,246.24*	*123,578.45*
	Final energy consumption of the realistic energy saving scenario [toe]					
< 1970	4,861.65	3,408.12	1,717.76	9,678.62	1,249.66	20,915.81
1971-1990	8,325.81	15,402.46	2,685.78	17,035.77	3,007.66	46,457.48
1991-2007	7,061.81	19,352.68	3,296.08	11,401.80	2,625.79	43,738.16
2008-now	1,552.03	611.60	316.72	742.53	353.58	3,576.46
Sum	*21,801.29*	*38,774.85*	*8,016.34*	*38,858.73*	*7,236.69*	*114,687.91*
	Reduction in heating final energy use [%]					
< 1970	-5.0%	4.0%	4.0%	2.2%	4.0%	1.2%
1971-1990	-3.3%	9.0%	9.0%	3.3%	9.0%	4.9%
1991-2007	0.4%	20.0%	20.0%	-0.3%	20.0%	12.6%
2008-now	-7.2%	1.0%	1.0%	-0.5%	1.0%	-2.7%
Sum	*-2.7%*	*14.4%*	*12.7%*	*2.0%*	*12.2%*	*7.2%*

Table III.9: Estimated economically viable energy saving potential for space cooling until 2030.

Period	Final energy consumption [toe]		Savings [%]
	Current situation	Realistic energy saving scenario	
	Electricity	Electricity	
< 1970	6,012.97	5,817.06	*3.3%*
1971-1990	18,371.41	16,998.99	*7.5%*
1991-2007	16,535.47	13,927.00	*15.8%*
2008-now	1,256.67	1,249.68	*0.6%*
Sum	*42,176.52*	*37,992.74*	*9.9%*

As regards energy savings for domestic hot water consumption, these were calculated based on the assumption that up to 12,000 buildings will upgrade their conventional hot water production system by a solar thermal system. The individual savings for the solar thermal system were estimated through the simulation of a 4 m^2 selective surface solar collector combined with a 200 L storage tank using the f-chart method on the typical climate conditions of Cyprus. This simulation indicates a production of 2,000 kWh/a (172 kgoe/a). On the basis of these results, Table III.10 presents the calculated energy savings.

Table III.10: Estimated economically viable energy saving potential for hot water production.

	Final energy consumption [toe]						
Fuel	Electricity	Gas oil	Kerosene	LPG	Biomass	Total	Solar Thermal
Current situation	927.40	6,260.00	626.00	2,817.00	313.00	10,943.40	*57,678*
Realistic	1,132.58	4,952.38	403.42	2,233.74	157.28	8,879.40	*59,742*
Saving	*-22.1%*	*20.9%*	*35.6%*	*20.7%*	*49.8%*	*18.9%*	*-3.6%*

Finally, the energy savings for lighting and appliances was calculated based on the assumption that up to 12,000 buildings will upgrade their lighting system and appliances. Especially for lighting, the individual savings per household are assumed to amount to 55% of the existing energy consumption based on the results of the simulation using the Dialux software. Table III.11 presents the calculated energy savings for this end use category.

Table III.11: Estimated economically viable energy saving potential for lighting and appliances.

	Final energy consumption [toe]		Saving
	Current situation	Realistic potential	
Electricity	63,218.54	60,762.11	*3.9%*

As a result, Table III.12 illustrates the overall economic energy saving potential for the household sector.

Table III.12: Estimated economically viable energy saving potential for the household sector.

	Final energy consumption [toe]							
Fuel	Electricity	Gas oil	Kerosene	LPG	Biomass	Solar	Geothermal	Total
Current situation	127,557	51,545	9,807	42,440	8,559	57,678	1,551	299,146
Realistic potential	121,689	43,727	8,420	41,092	7,394	59,742	1,582	283,646
Saving	*4.8%*	*15.2%*	*14.1%*	*3.2%*	*13.6%*	*-3.6%*	*-2.0%*	*5.2%*

Additionally, if the foreseen budget is channelled to a relatively higher number of multi-family rather than to single-/double-family buildings then while more households could be reached in absolute numbers the same total savings are going to be achieved per type of intervention. This is further analysed and described in the relevant section III.V.

III.III Service sector

III.III.I Methodological approach

The maximum (theoretical) energy saving potential for the service sector is defined as the amount of the current energy consumption that can be saved if the existing service building stock is upgraded to nearly zero energy buildings, in line with the provisions of: (a) 366/2014 decree of the Republic of Cyprus (envelope requirements), and (b) guidelines on the minimum energy efficiency of the technical systems in the non-residential sector published by the Energy Service of MECIT.

The economically viable potential, which is a fraction of the maximum potential, is broadly defined as the amount of energy savings that can be attained if the more cost-efficient measures are implemented given some financial constraints that limit the funds available for directly or indirectly supporting renovations of commercial buildings.

The following two sections describe the modelling approach followed and the results obtained from the assessment of the theoretical and economically viable potential respectively.

III.III.II Theoretical potential

This potential was estimated in terms of percentage reduction in: (a) heating energy consumption, (b) cooling energy consumption, (c) energy consumption for domestic hot water production and (d) electricity consumption for lighting and appliances, assuming the gradual penetration of high efficiency heat pumps and boilers. In this context, the III.13 indicates the penetration of the aforementioned technologies for heating and cooling and was used in the analysis. Moreover, demand side management/demand response measures were considered.

Due to the significant diversity of building types, pattern uses, equipment etc., as well as the lack of an adequate existing model, this analysis was performed with the aid of:

- in-situ visits of CUT personnel and interviews with the energy managers of large facility owners, such as banks, hotels and office blocks;
- interviews with directors of energy management companies;
- data provided by local companies that are highly involved with the design, construction and maintenance of facilities;
- data provided by MECIT retrieved by previous analysis of the Service sector;
- the findings of the JRC report "Cost benefit analysis for the potential of high efficiency cogeneration of heating and cooling in Cyprus (Santamaria, Kavvadias, & Jakubcionis, 2016)that was conducted in 2016.

A further improvement that should be taken into account is the replacement of all street lighting, whose consumption currently accounts for 4.9% of electricity consumption in the service sector. According to technical information collected during the study, due to the different type of lights used in different types of lighting, this replacement will lead to savings of:

- 55% for municipal lighting
- 48% for community lighting
- 42% in public lighting.

Taking also into account that, according to data from the Cyprus Energy Agency, 32% of all electricity consumption is due street lights in communities, and that the rest is mainly consumed by municipalities, electricity savings of 50% are assumed, which correspond to 2.4% savings in the total electricity consumption of the service sector.

Table III.13 presents some main operation characteristics of equipment used for heating, cooling and hot water production by subsector of the service sector. Out of this equipment, electric heat pumps were considered an efficiency of 600% for heating and 650% for cooling and hot water production; high-efficiency boilers were assumed to burn LPG with a thermal efficiency of 96.3%; and electric heaters for hot water production were assumed to have an efficiency of 99%.

Tables III.14 and III.15 give further background information that was provided by MECIT on the basis of the above mentioned JRC study; these data were then combined with all other available information and adapted to the energy balance of Cyprus for year 2015.

The resulting maximum energy saving potential is a result out of a model analysis performed for the scope of this study, which was based on the information provided for the:

a) Operation characteristics of equipment used in different subsectors of the service sector
b) energy consumption of the various subsectors of the service sector

Table III.16 summarises and presents the results on the maximum (theoretical) energy saving potential for the service sector per fuel, including the potential savings from the above mentioned improvements in street lighting.

Table III.13: Operation characteristics of equipment used in different subsectors of the service sector.

Subsector	Operating hours per day	Heating		Cooling	Hot water				
		Heat pump	Boiler	Heat pump	Solar	Heat pump	Boiler	Electric	Recovery
Hotels and Lodges (3* and higher & other)	24 h	75%	25%	100%	20%/30 %	25%/30%	20%/40 %	-/-	35%/-
Private Offices	9 h	80%	20%	100%	-	-	-	-	-
Retail markets, Shopping malls, Shopping centres	11 h	90%	10%	100%	-	-	-	100%	-
Health facilities (Public & Private)	24 h	73%	20%	100%	10%/5%	40%/20%	30%/55 %	10%/10%	10%/10 %
Restaurants and Leisure	11 h	90%	10%	100%					
Public Buildings	9 h	95%	5%	100%					
Kindergarten (Public & Private)	9 h	95%	5%	100%	-/-	-/-	-/20%	100%/80%	-
Secondary Education (Public	9h	95%	5%	100%	-/-	-/-	-/20%	100%/80%	-
Primary Education (Public & Private)	9h	95%	5%	100%	-/-	-/-	-/20%	100%/80%	-
University	13 h	85%	15%	100%	35%	35%	30%	-	-
Airports	24 h	100%	-	100%	-	-	-	100%	-
Sport facilities	13 h	-	100%	100%	40%	60%			
Other	9 h	80%	20%	100%	-	-	-	100%	-

Table III.14: Background information on energy consumption of subsectors of the service sector – current situation.

Subsector	Heating - Diesel	Heating - LPG	Heating - Electricity	Cooling	HW - Diesel	HW - LPG	HW - Electricity	HW - Solar	Lighting etc
	Final energy consumption - Current situation [MWh/a]								
Hotel and Lodges									
3-stars and higher	24.223	5.992	23.585	135.138	44.749	2.295	3.825	10.072	87.840
other	13.190	3.277	12.862	60.624	26.544	1.311	2.212	5.980	37.685
Secondary Education									
Public	15.968			2.025	1.795		1.012		7.040
Private	5.323			6.948	598		337		2.347
Primary Education									
Public	14.050			1.782	1.579		891		6.195
Private	1.696			2.214	191		108		748
Kindergarten									
Public	1.975			250	222		125		871
Private	1.369			1.787	154		87		604
Universities	17.232			11.661	3.021				35.769
Public Buildings	17.729		86.399	69.607					162.416
Sport Facilities	365			168	8.181				2.175
Airports			5.373	5.566			1		22.990
Shopping malls	1.482			16.800	78				14.880

Shopping centres			5.444	26.800			287		23.693
Hospitals									
Public	6.931		20.116	10.477	63.700				35.783
Private	10.139			20.278	7.605				12.674
Restaurants			23.209	46.417			34.813		127.647
Private Offices	20.254		47.260	118.153					185.658
Retail markets	4.752		19.008	71.280					142.560
Other	3.246		3.246	10.820	4.328				21.640
Sum	*159.922*	*9.269*	*246.502*	*618.795*	*162.743*	*3.606*	*43.698*	*16.052*	*931.214*

Table III.15: Background information on energy consumption of subsectors of the service sector – savings potential.

Subsector	Heating - Diesel	Heating - LPG	Heating - Electricity	Cooling	HW - Diesel	HW - LPG	HW - Electricity	HW - Solar	Lighting etc
	Final energy consumption - Theoretical Potential [MWh/a]								
Hotel and Lodges									
3-stars and higher	-	17.883	8.611	37.570	-	7.923	1.467	20.983	39.528
other	-	11.501	5.538	16.854	-	16.651	1.850	12.027	16.958
Secondary Education									
Public	-	392	1.197	359	-	-	2.382	-	-
Private	-	233	709	1.231	-	490	1.906	-	1.056
Primary Education									
Public	-	332	790	274	-	-	2.096	-	2.788
Private	-	71	169	340	-	75	292	-	336
Kindergarten									
Public	-	49	148	44	-	-	295	-	392
Private	-	34	103	317	-	50	193	-	272
Universities	-	1.308	1.190	2.380	-	790	896	887	16.096
Public Buildings	-	9.494	28.952	12.333	-	-	-	-	73.087
Sport Facilities	-	185	-	34	-	-	566	2.454	653
Airports	-	-	622	1.548	-	-	1	-	6.897
Shopping malls	-	74	107	3.683	-	-	60	-	6.696

Shopping centres	-	999	1.442	5.109	-	-	287	-	10.662
Hospitals									
Public	-	10.142	6.511	2.913	-	14.883	7.766	9.555	16.102
Private	-	1.971	1.265	5.637	-	3.257	752	855	5.703
Restaurants	-	4.940	7.135	8.848	-	-	34.813	-	57.441
Private Offices	-	21.810	14.002	20.935	-	-	-	-	83.546
Retail markets	-	3.724	5.379	13.588	-	-	-	-	64.152
Other	-	1.492	958	1.917	-	-	3.279	-	9.738
Sum	-	86.634	84.828	135.913	-	44.119	58.901	46.762	412.104

Table III.16: Theoretical energy saving potential in the service sector.

Fuel	Final energy consumption [toe]		Savings
	Current situation	Maximum efficiency	
Electricity	149,214	39,724	*73.4%*
Gas oil	24,612	-	*100.0%*
LPG	12,024	25,881	*-115.2%*
Kerosene	2,050	-	*100.0%*
Light fuel oil	100	-	*100.0%*
Biomass	4,905	1,962	*60.0%*
Sum	*192,905*	*68,095*	*64.7%*
Solar & Recovery	10,380	14,020	-35.1%

III.III.III Economically viable potential

Based on the analysis that led to identification of the maximum energy saving potential as well as the review of the existing literature, the following non-prioritised energy interventions should be the considered in order to improve the energy efficiency of the current service (service) building stock:

(a) Insulation of the horizontal elements (roof, ceiling, etc.)
(b) Installation of shading devices
(c) Insulation of the vertical elements (reinforced elements, masonry)
(d) Use high efficiency windows (frame and glasses)
(e) Installation of LED lighting bulbs
(f) Use of high efficiency heat pumps
(g) Installation of Building Energy Management Systems (BEMS)

Moreover, specific energy efficiency interventions could be considered for specific sub-sectors of the service sector that relate to different energy demand profiles and type of energy end-uses. In particular the following interventions could be additionally considered for:

Hotels and Lodges as well as Health facilities, Shopping malls and centres:

(a) Heat recovery from cooling systems
(b) Installation of solar thermal collectors

(c) Use of solar cooling

(d) Use of CHP

The JRC study on "Building stock in Cyprus and trends to 2030" (Zangheri, 2016) has shown that under a scenario which assumes policies recognised as particularly appropriate for Cyprus, the total expenditure in renovations is estimated to about 7.5-8.0 million EUR until 2030. This is demonstrated in the bottom graph of Figure III.3. Conversely, under a basic scenario which includes the policy measures already in force, the total expenditure in renovations is limited to less than 5 million EUR, as shown in the top part of Figure III.3.

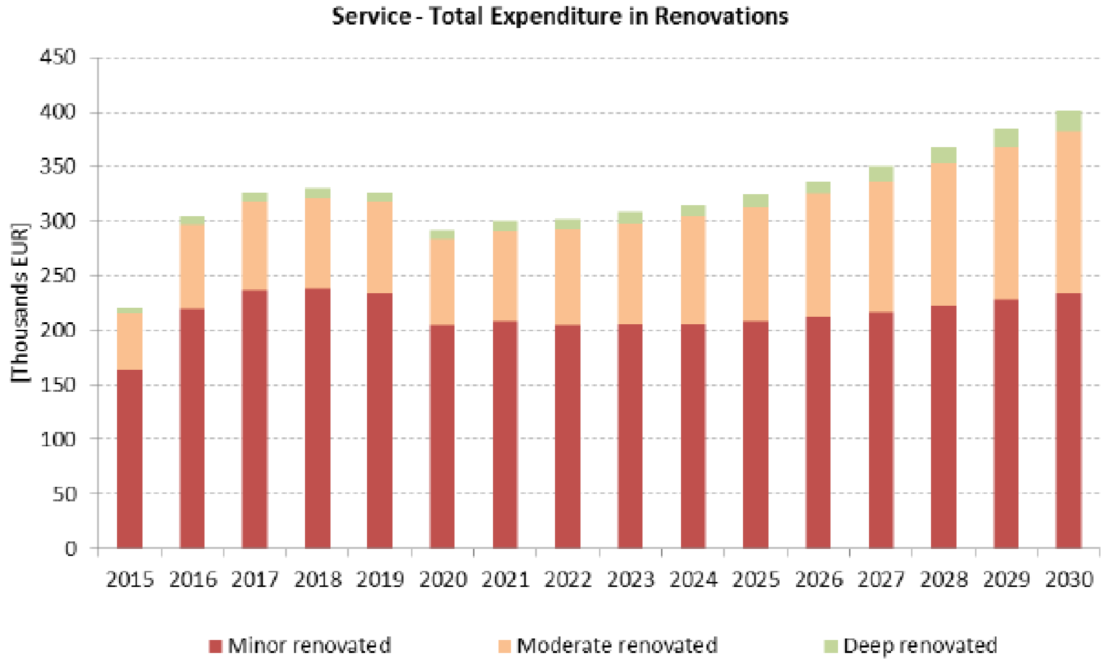
Such an extremely low expenditure amount and budget for energy efficiency measures in the service sector, would lead to relative low savings and to largely untapped energy efficiency potential in the specific end-use sector.

Considering the current and foreseen expenditures during the period until 2020, it was assumed as realistic that an average annual total expenditure for energy efficiency interventions for both public and private buildings in the service sector of around 20-30mil EUR should be seen as realistic for the period until 2030 if an appropriate mix of instruments and policies are in place.

Based on direct communication of the study team with MECIT, due to the lack of available data the estimation of the realistic potential for energy renovations in the service sector is very uncertain. Taking into consideration the potential for specific measures that was mentioned by consultants, energy managers and owners of specific commercial facilities during meetings that were held in the frame of this study and by applying an energy efficient mix of interventions on the basis of an annual budget of around 25 mil EUR a resulting figure of about 6% of energy savings has been resulted until 2030, which was considered as realistic both in economic and market terms.

On top of this, an additional amount of electricity savings at the range of 2.4% were assumed for the same period, in order to take into account the foreseen replacement of all street lighting within the next period and for sure before 2030, as explained in the previous section describing the theoretical energy saving potential in the sector. The cost for this intervention in street lighting is adding to the previous estimation of budget expenditure and is contributing to an estimated mean annual increase of the foreseen budget at around 1-2 mil€ (i.e. overall budget of around 20 mil€[3]).

[3] In line with the proposal by the Cyprus Energy Agency to EEEF on the EE upgrade of the street lighting consumption in Cyprus.



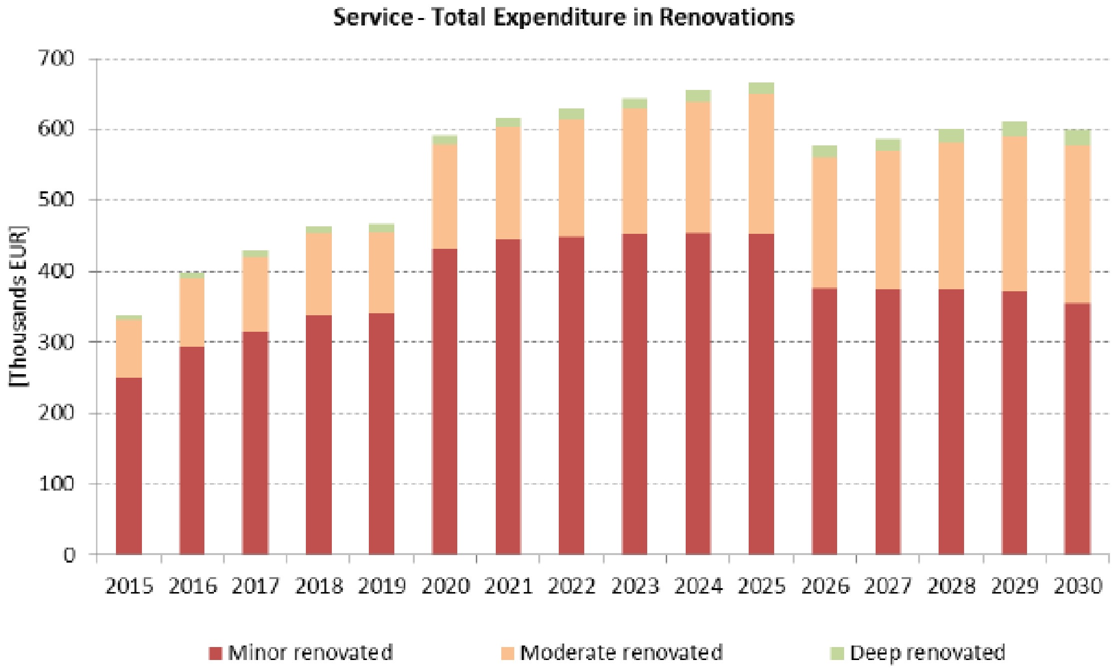


Figure III.3: Annual expenditure in refurbishment activities on the commercial building stock of Cyprus according to Policy Scenario 0 (top) and Scenario 1 (bottom) (Zangheri, 2016)

The following table illustrates the overall economic energy saving potential for the service sector until 2030.

Table III.17: Estimated economically viable energy saving potential for the service sector.

	Final energy consumption [toe]							
Fuel	Electricity	Gas oil S 0.1%	Kerosene	LPG	Biomass	LFO S≤1%	Solar	Total
Current situation	149,884	27,064	2,360	12,959	5,108	851	10,179	208,405
Realistic potential	137,294	25,440	2,218	12,181	4,801	800	13,166	195,900
Saving	*8.4%*	6%	6%	6%	6%	6%	-29,3%	6%

III.IV Industry sector

III.IV.I Methodological approach

The maximum (theoretical) energy saving potential for the industrial sector is defined as the amount of the current energy consumption that can be saved if industrial plants upgrade and/or replace their equipment and install high efficiency equipment that is available in the market.

The economically viable potential, which is a fraction of the maximum potential, is broadly defined as the amount of energy savings that can be attained if the more cost-efficient measures are implemented in line with the industry's economic capabilities and investment plans.

The following two sections describe the modelling approach followed and the results obtained from the assessment of the theoretical and economically viable potential respectively.

III.IV.II Theoretical potential

This potential was estimated in terms of percentage reduction per fuel (electricity, heavy fuel oil, gas oil) on the following individual consumers: (a) cement industry, (b) food and beverages, (c) mining, (d) water supply, (e) plastics (f) building material industry, (g) pharmaceutical and cosmetic industry. Moreover, demand side management/demand response measures were considered.

Due to the significant diversity of industries, pattern uses, process and equipment use, as well as the lack of existing data, the analysis was based on:

- in-situ visits of CUT personnel and interviews with the energy managers of the plants;
- data provided by local companies that are highly involved with the design, construction and maintenance of industrial equipment.

It was assumed that the substitution of industrial equipment with more efficient one will be implemented until 2030. After this year, further technological improvements were assumed, mainly regarding the introduction of advanced automation systems that enable further energy savings. For the longer run, further very energy efficient technologies were assumed to penetrate gradually.

Under this assumption for the theoretical potential the overall coefficient of performance of heating, cooling and electricity use in the industry sector is considered to be highly improved and that also improvements in the energy related processes could result to reduced energy demand.

Based on the above information sources, the maximum theoretical energy saving potential was assessed to be 34% for electricity and 5% for fuel oil and gas oil.

III.IV.III Economically viable potential

Based on the analysis that led to identification of the maximum energy saving potential, the following non-prioritised energy interventions have been considered in order to improve the energy efficiency of the industrial sector:

(a) Use of high efficiency electric motors

(b) Use of inverters

(c) Installation of automations

(d) Use of heat recovery systems

(e) Installation of LED lighting bulbs

(f) Installation of energy efficient compressed-air systems

(g) Use of CHP

As agreed during meetings between MECIT and the study group, the economic potential for the industrial sector is defined as *"the amount of the current energy consumption that will be saved if industrial plants upgrade and/or replace their equipment and install high efficiency one which is available in the market based on their economic capability/plans"*.

Based on this assumption, and taking into account the results of consultation meetings with energy managers of specific industrial units, the realistic energy saving potential for the industrial sector until 2030, is estimated to be 6.2% in the consumption of electricity and 0.5% in the consumption of fuel oil and gas oil.

The table that follows, illustrates the overall economic energy saving potential for the industry sector until 2030

Table III.18: Estimated economically viable energy saving potential for the industry sector.

	Final energy consumption [toe]								
Fuel	Electricity	Gas oil S 0.1%	Kerosene	LPG	Biomass	LFO S≤1%	HFO S>1%	Heating form CHP	Total
Current situation	59,425	14,056	1,375	5,890	11,924	15,660	3,584	175	112,089
Realistic potential	55,740	13,986	1,375	5,890	11,924	15,582	3,584	175	108,256
Saving	*6.2%*	*0.5%*	-	-	-	*0.5%*	-	-	*3.4%*

III.V Overall potential and sectorial ranking with regard to cost effectiveness

The previous sections provide a methodological approach for the estimation of the theoretical potential in the relevant end-use sectors (i.e. household, service, industry) as well as the adaptation of this potential into an economically viable one, considering both the amount of available expenditure that could be driven for such measures and interventions as well as some market related constrains that should be further assessed in order not to have lock-in effects and/or market failures. The latter should be mainly assessed in relation to the capacities of the service providers and construction companies to perform a certain number of annual interventions as well as to the anticipated payback periods for the different end-use sectors.

The industry sector should be seen as the most inelastic in terms of energy demand, followed by the service sector and the household sector. The decision for energy efficiency interventions in the industry sector is driven in absolute terms by cost savings and as such very low payback periods are envisaged and are prerequisite in order to proceed to these types of interventions.

On the contrary, both the service and household sector encompass different energy demand profiles and concurrent energy saving potential that relate not only to cost savings but also to improvement of the living/working conditions and asset value increase of the affected premises.

Another parameter that should be considered is that for both the industry and service sector, the conclusion of the foreseen interventions should have minimum and limited time impact in relation to their everyday activities, since the energy related cost effectiveness could be reduced or even counterbalanced if it would lead to revenues losses due to reduced production or provision of services.

As far as the household sector is concerned, the available absolute annual budget for such kind of energy-related interventions is the major decisive factor, which finally dictates the mix of the realised actions.

In terms of the cost effectiveness of the individual measures per end-use sector the following elements and parameters should be assessed and evaluated from the individuals' perspective:

- The nominal index of total investment to achieved annual (new) savings
- The absolute categorization and weighting of the interventions in terms of needed investment

- The payback period[4] of the specific interventions and or the Net Present Value[5] of the different energy efficiency interventions and investments.

While from central state policy perspective the cost effectiveness should be also evaluated and assessed in relation to the following parameters:

- The avoidance cost index that relates to the average cost in EUR for each kWh energy saved over the lifetime of the measure[6]
- The avoided fuel import cost annually and for the lifetime of the investment[7]

The ranking of the proposed interventions on the basis of these parameters could assist on the policy design of the energy efficiency measures in order to promote the implementation of the interventions with the highest cost-effectiveness and to address cost-related entry barriers that could cancel or delay the implementation of these interventions.

III.V.I Building sector

Households

The energy efficient interventions in the household sector, have to be first inner categorised but also to be weighted in terms of the residential premise type (i.e. single, double or multi-family buildings), since this induces other cost parameters but also administrative considerations that should be taken into account.

Table III.17 presents the categorisation of the proposed interventions for the two main types of residential premises and their overall related comparison. It has to

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[4] For the calculation of the payback period an estimation of the evolution of the electricity tariffs and the supply cost of the other fuels should be assumed.

[5] For the calculation of the Net Present Value an applicable discount rate should be considered, which could be taken either from the end-user side (higher) or from the societal aspect (lower).

[6] The avoidance cost is a benchmarking index that can be used to rank the overall cost efficiency of the various energy saving interventions, considering their anticipated lifetime savings. The index is calculated by inserting as nominator the initial investment cost by EE intervention and as denominator the annual foreseen savings times its lifetime in years per each measure. This indicator can also be used reversely in order to indicate the threshold compared with the mean cost of energy supply that the intervention makes sense.

[7] The avoided fuel import cost index considers the cost savings in terms of primary fuel savings per fuel and per each EE intervention annually and also over the lifetime of the intervention. In order to allow benchmarking analysis this should be calculated by assuming the same initial investment for all different EE interventions and then to assess their ratio of total cost savings due to the avoided fuel imports over this fix initial investment.

be highlighted that all these indexes are indicative and resulting from the savings per intervention are assumed on the basis of independent interventions and do not consider a number of interventions to be realised for the same premise/building. Moreover the presented values are the mean resulting values by considering the independent interventions to be implemented in different building stock categories in relation to their period of construction. Further information concerning the nominal savings and cost per energy efficiency intervention in the building sector are provided in Annex B.1.

Table III.19: Categorisation of proposed interventions by property type (mean values)

	Individual houses			Multi apartment buildings			Lifetime[8] (yrs)
	weighted effort in inv. cost[9]	**inv. cost per new annual savings (EUR/kWh)**	**avoidance cost (EUR/kWh)**	**weighted effort in inv. cost**	**inv. cost per new annual savings (EUR/kWh)**	**avoidance cost (EUR/kWh)**	
deep renovation (to nZEB)	30	5.1	0.17	23	4.3	0.14	30
roof insulation	2	0.6	0.02	1	0.4	0.01	30
façade insulation	10	7.7	0.26	5	3.3	0.11	30
ground level insulation				1	4.5	0.15	30
upgrade of window frames	9	9.8	0.33	8	5.2	0.17	30
electronic appliances and lighting	3	2.1	0.21	5	1.8	0.18	10
heat pump	5	1.1	0.07	5	1.3	0.09	15
solar thermal	1	0,6	0,03	2	0,6	0.03	20
mean index	***10,792 EUR***	***3.0***	***0.12***	***22,459 EUR***	***2.3***	***0.10***	
Weighted investment cost per annual savings (EUR/kWh) under proposed mix of interventions		***1.8***			***1.8***		
Overall mean avoidance cost (EUR/kWh)			***0.11***				

The comparison of the foreseen independent interventions reveals firstly that the measures implemented at the level of multi-family buildings are more cost-

[8] Lifetime per EE intervention in terms of delivering stable annual energy savings, without the need of a new investment.

[9] The weighted effort index is a qualitative index aiming to compare and identify the level of upfront investment needs that are needed for various EE interventions and should be used in order to evaluate the relative easiness or difficulty of one intervention versus the others in the initial decision for their implementation. The index is calculated by rounding the result of the ratio consisting by the cost per EE intervention and the lowest cost among the EE interventions under comparison.

efficient (around 30%) and secondly that targeted measures are far more cost efficient than comprehensive interventions (e.g. deep renovation and upgrade of window frames against roof insulation and heat pumps). Additionally, interventions like electronic appliances and lighting as well as solar thermal have close impact factors for both types of residential buildings.

On the basis of the performed analysis, marginal allocation of the available resources in favour of multi-family buildings and to best cost performing interventions should be aimed at the level of energy policy measures.

Considering a realistic mix of energy efficiency interventions in terms of the characteristics of the building stock, market constraints, societal behaviours, as well as the constraints for the annual and cumulative available expenditures for these measures (i.e. around 450-550 milEUR of total budget until 2030 for the household sector) the total anticipated savings[10] are calculated on the basis of the cost-effectiveness analysis.

[10] It has to be noted that the targeted savings are directly related to the mix of interventions that is going to be finally implemented as well as to the type of affected buildings. On the basis of a sensitivity analysis with different mix of market realistic interventions, variations of around ±15% in terms of the final savings could result, while for different types of buildings the variations in terms of the final energy savings could go up to ±40%. It is therefore essential that a monitoring scheme of the affected final end-users and implemented types of interventions to be in place in order to drive the focus in special interventions and/or types of buildings that will allow achieving the mean presented savings until 2030.

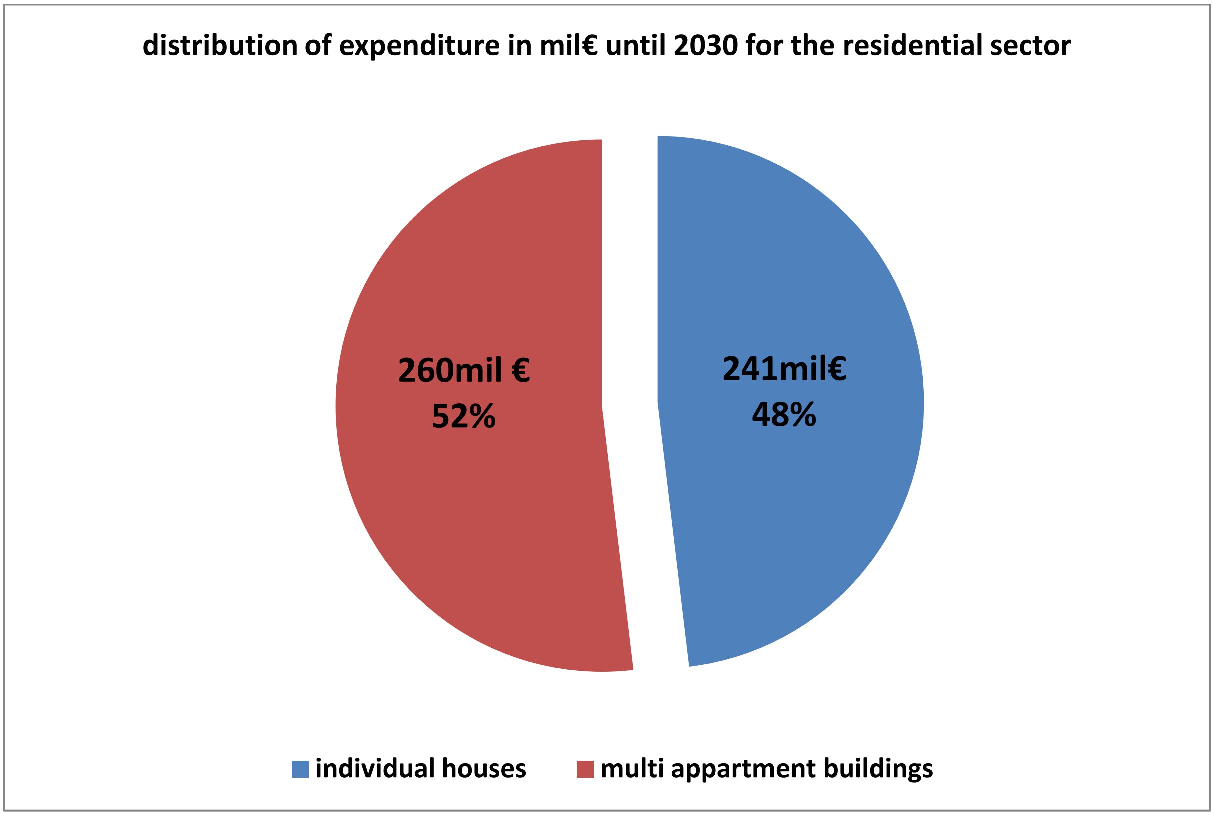


Figure III.4: Allocation of expenditures from the cost-effectiveness analysis

The analysis reveals that bigger focus should be given to interventions in multi-family buildings, which have the best cost-efficiency per measure. However, considering the difficulties in implementing comprehensive interventions in multi-family buildings, the physical barriers that could exist in many of these types of existing buildings, and past experiences that have illustrated low participation in the framework of state supported financial programmes, the allocated resources should be at the end almost be equally balanced among individual and multi-family buildings.

Evidently, the analysis suggests that emphasis should be given on measures that have the best performance per invested Euro and are most easily to be adopted and implemented by the households (e.g. lighting and electronic appliances). Almost 35% of the total budget should be aimed for interventions in relation to the replacement of lighting equipment and electronic appliances with the most energy efficient ones, while only about 15% of the total budget is proposed to be allocated for deep renovations in the household sector.

Roof insulation and installation of heat pumps are among the measures with the highest cost-efficiency and as such targeted measures should be designed for their promotion and to facilitate their adoption, which will consider a mix of such types of cost efficient interventions that will translate to light or medium building renovation at the end but which will achieve an overall significant improvement of the energy consumption under an optimum investment level.

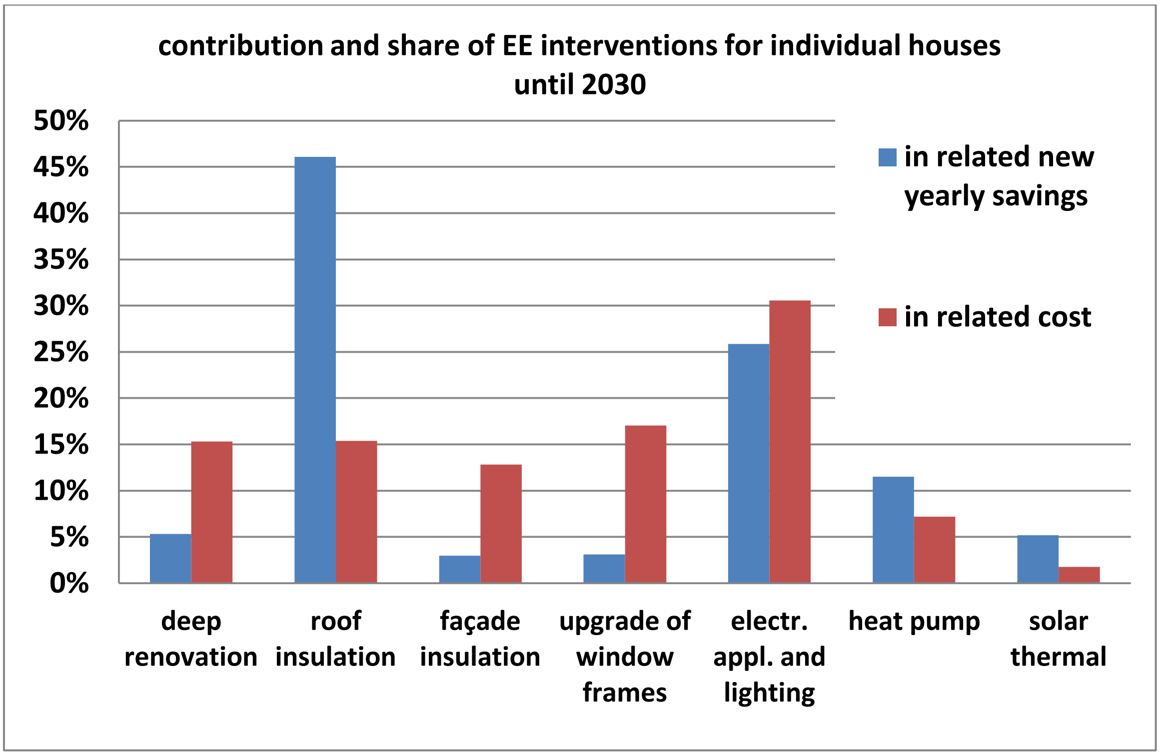


Figure III.5: Share of energy efficiency interventions for individual houses

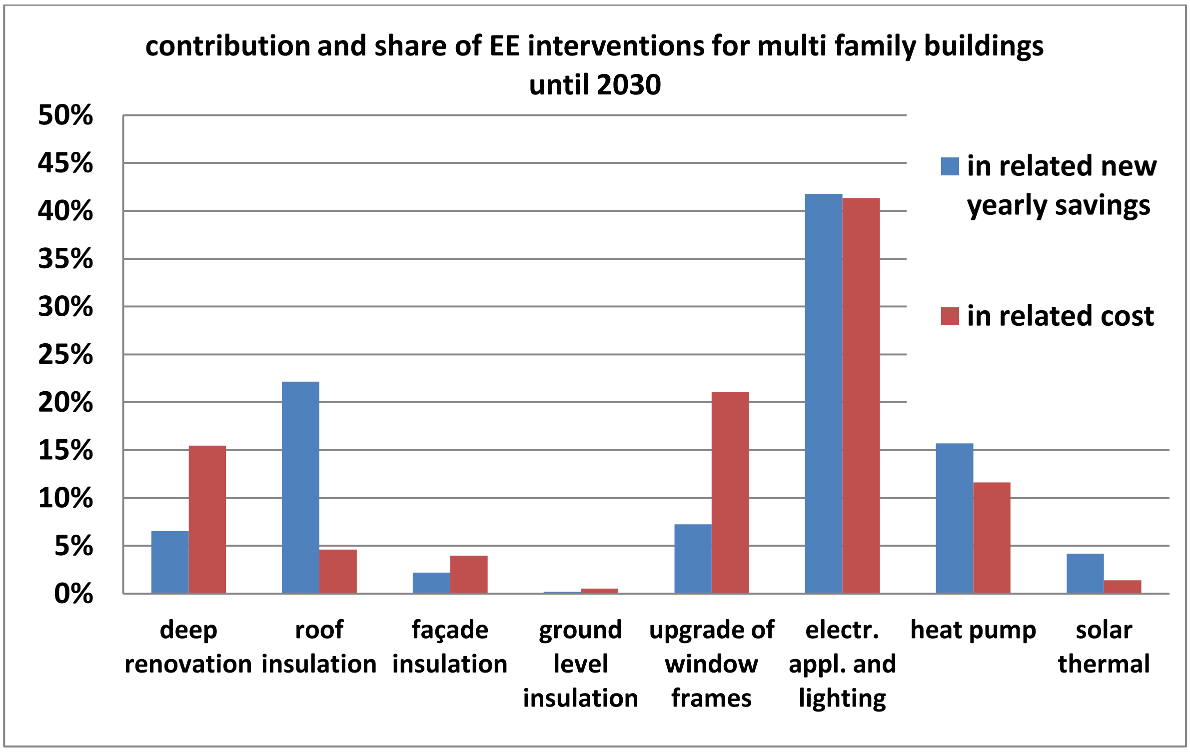


Figure III.6: Share of energy efficiency interventions for multi-family buildings

This optimum cost-efficient distribution of interventions will result in a possible range of affected households between 43,000 and 79,000, with a most likely number in the range of around 63,000 households that could proceed to a mix of energy interventions until 2030. On an annual basis this translates to a mean number of close to 5,000 households that could be upgraded energetically, however with around 25% of this to be allocated to households that are expected to proceed only to renovation and substitution of their lighting equipment and of their electronic appliances to the most energy-efficient ones and/or to the installation of solar thermal systems. Nevertheless, with this distribution of energy efficient interventions and having a threshold for the cumulative total budget until 2030, on average around 3,700 households could be targeted annually for significant energy interventions, a figure that is also representing around 1% of the existing number of households.

The cumulative savings for the household sector, assuming a linear implementation of interventions and expenditure, result to around 1,879 GWh until 2030, with a total avoidance cost of 0,09EUR/kWh. Table III.18 presents the resulting cumulative savings for the suggested mix and list of interventions on the basis of their cost-effectiveness and market-related considerations.

Table III.20: Cumulative savings by intervention

household sector	final new yearly savings in 2030 (GWh)	cumulative savings until 2030 (GWh)	total avoided cost (EUR/kWh)
total	**250**	**1879**	**0.09**
heating	100	702	0.07
cooling	71	494	
lighting/appliances	73	621	0.19
DHW	13	91	0.03
lifetime savings (GWh)			**5765**

Service sector

The assessment of the cost effectiveness of the anticipated energy efficient measures in the service sector is performed using the same methodology like the one for the household sector. Results are similar since the majority of the measures have been repeated matching to a high degree the energy savings impact simulated previously for multi-family buildings. It is highlighted that the following presented values are primarily based on an analysis of a typical office building and thus should be considered as indicative.

The mean annual expenditure is projected to be around 26 m EUR until 2030, with a total expenditure of almost 335 m EUR. On this basis an optimal share of interventions is suggested mainly considering the investment versus savings index as well as various market constraints that prohibit either a wider implementation of specific measures (i.e. heCHP) or induce a threshold in terms of amount of interventions (i.e. heat pumps and solar thermal).

Table III.21: Categorisation of energy efficiency interventions in the service sector (mean values)

EE interventions until 2030	service sector		
	weighted effort in inv. cost	**inv. cost per new annual savings (EUR/kWh)**	**avoidance cost (EUR/kWh)**
deep renovation (to nZEB)	23	4.3	0.14
roof insulation	1	0.4	0.01
façade insulation	5	3.3	0.11
upgrade of window frames	8	5.2	0.17
electronic appliances and lighting	5	1.8	0.18
heat pump	5	1.3	0.09
solar thermal	2	0.6	0.03
heCHP	7	2.2	0.11
mean index	**25.268 EUR**	**2.3**	**0.10**
cumulative savings until 2030 (GWh)		**1411**	
lifetime savings (GWh)		**3671**	
final new yearly savings in 2030 (GWh)		**186**	
Weighted investment cost per annual savings (EUR/kWh) under proposed mix of interventions		**1.6**	
Weighted avoidance cost (EUR/kWh) under proposed mix of interventions		**0.09**	

The assessment of the cost effectiveness for the service sector reveals that again the focus should be given on easy to be installed interventions, which achieve the best performance in terms of cost-efficiency, while the most comprehensive ones are ranked lower in terms of cost efficiency.

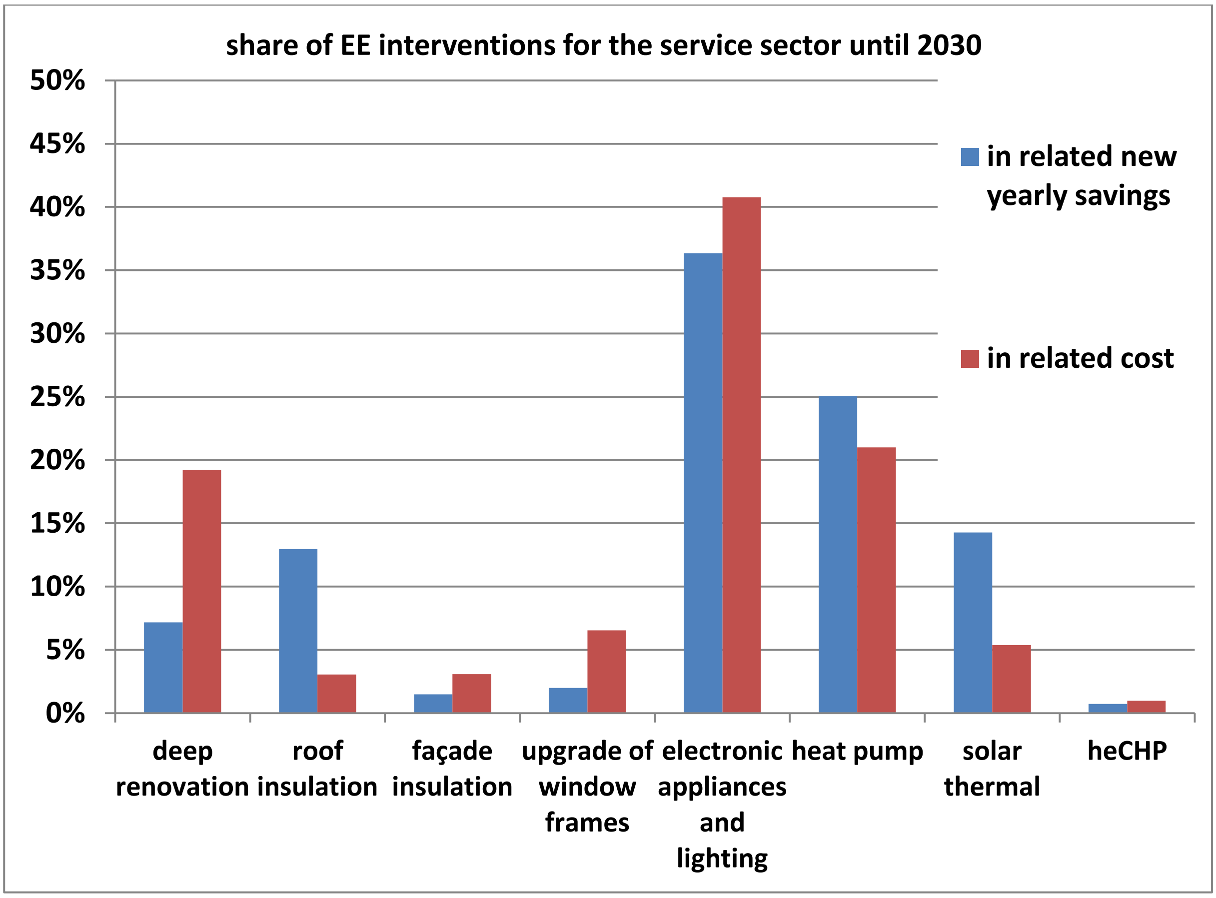


Figure III.6: Share of energy efficiency interventions in the service sector

The overall avoidance cost is in the same range with the one of the household sector for the suggested mix of interventions and the total number of affected buildings is estimated to around 10,000 until 2030, resulting to an average annual number of approximately 800 buildings for which some kind of intervention should be foreseen. Similarly around 30-40% of this annual number is expected to proceed only to the least expensive intervention with the shortest payback period and around 400 buildings annually are considered that will implement a more comprehensive type of interventions and/or one involving higher investment cost.

Investment needs

Overall for both the housing and the service sector the proposed structure of investment and resulting expenditures from all different sources is amounting to almost 840 m EUR until 2030 (additional expenditure for the upgrade of the street lighting infrastructure should be also considered at around 20-25 m€), with a rather balanced budget distribution of 3:2 respectively. The weighted effect of the savings is almost the same, on the basis of the suggested mix and number of interventions per sector, resulting in a marginally higher contribution of the service sector in relation to its share in the overall budget.

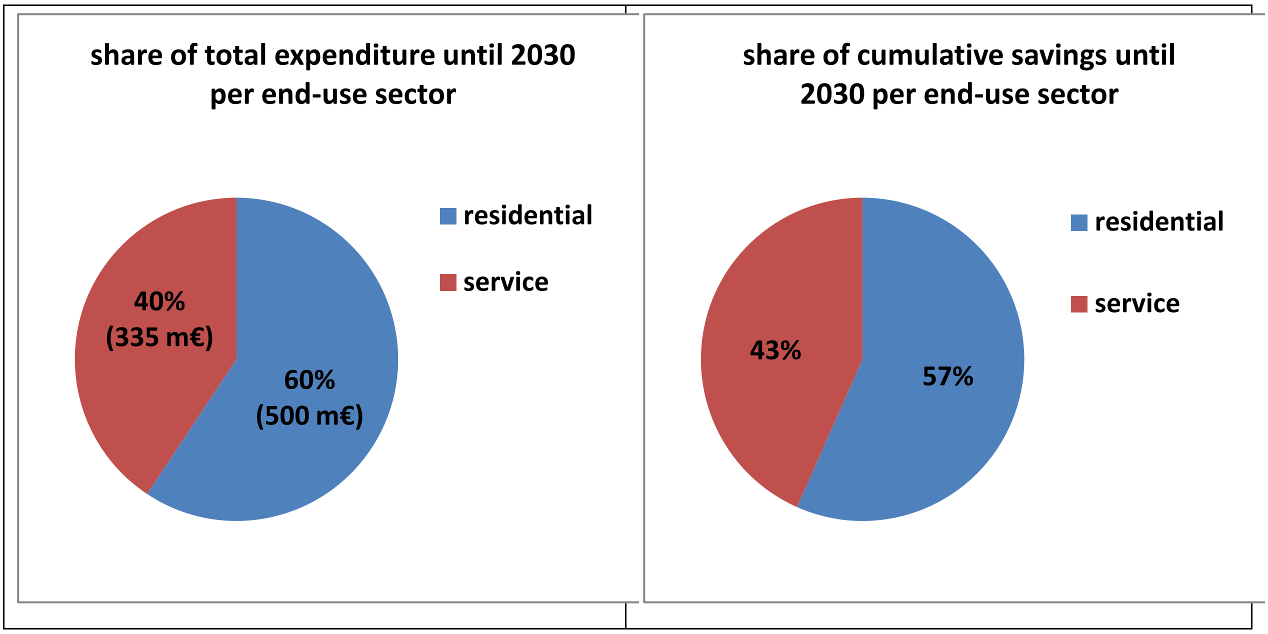


Figure III.7: Shares of estimated expenditures and savings per end-use sector

It has also to be stressed out that these expected savings are to be achieved with a mean weighted ratio of annual investments at the level of **0.33% of the GDP over the 2018-2030 period**, which is overall assessed as realistic considering the macroeconomic projections, while the list of the proposed measures in terms of suggested interventions per type of buildings results to the same avoided cost index for the household and service sector and thus overall index for avoided cost in the building sector (i.e. 0.09 EUR/kWh).

In order to achieve the optimum distribution of both achieved annual savings as well as of overall avoidance cost, the distribution of the number of interventions per proposed and foreseen energy efficiency measure was performed. This was done taking into account the nominal cost efficiency index per measure and the weighted effort in investment cost as well as market consideration issues and the overall technical complexity factor. Annex B.2 provides the suggested mix of interventions. The presented mix of these interventions is only one out of the many scenarios of different mix of interventions that could lead to the same level of energy savings at the end of 2030, with the same scale of budget. In this sense it should be approached only as an indicative proposed plan mainly serving to indicate where the emphasis and focus should be placed in terms of policies and support schemes.

Finally, an important index in order to evaluate the overall effectiveness of the proposed measures is the avoided cost of imported fuel due to the induced savings by the referred measures, while other social related indexes in terms of affected households per nominal amount of investment as well as the weighted need for public budget intervention are also relevant and important.

Moreover, from the end-user perspective the economic/financial attractiveness of the intervention is crucial. The most appropriate indexes in order to assess the level of financial attractiveness are the simple payback period and the Net Present Value (NPV) of the different interventions.

It has also to be highlighted that as far as the net benefit in terms of avoided cost of imported fuel is concerned, the resulting savings from the no-use of indigenous natural gas for power generation are also contributing to this index due to the additional equivalent net benefits from the relevant sales abroad, which result from the amount of natural gas that would be shifted for export (before foreseen for internal use).

On the basis of the performed analysis in relation to the cost-effectiveness of the different energy efficiency interventions, the previously proposed mix of energy efficiency interventions until 2030 can be further justified and even to unlock further public and private budget for the high performing interventions.

Evidently, from the values presented in the table that follows, the intervention in relation to the roof insulation over-performs in comparison with the other analysed energy efficiency interventions, while also the installation of heat pumps and solar thermal systems achieve quite positive indexes in terms of financial attractiveness and effectiveness from a macro-economic perspective. However, it should be mentioned here that all the presented indexes are based on some common assumptions in terms of nominal savings and initial investment cost per intervention, which however can both vary to a lower or higher extent per specific building/household. Nevertheless, the relative performance, as presented here, could and should be used for the assessment of the different energy efficiency interventions and therefore to drive the available financial resources to the best performing interventions and for the buildings with the highest potential for energy savings (see sensitivity analysis in the graph that follows). In this direction, the design and adoption of the most appropriate policy measures and market mechanisms that could foster the deployment and upscaling of these best performing energy efficiency interventions is essential.

While the focus is proposed to be placed on the planning and supporting of mainly combination of specific energy efficiency interventions in the building sector, comprehensive ones should also be kept under the various support schemes, however with stricter criteria for eligibility and anticipated savings (e.g. buildings of low energy class) and also possibly combined with societal characteristics (e.g. households under energy poverty conditions), in order to achieve increased awareness and to allow the overall uptake of the domestic market in terms of energy efficiency interventions in the building sector.

Additionally, the establishment of new public budget inflows for energy efficiency interventions should be envisaged and as such the implementation of a carbon tax for service sectors (and more broadly for those sectors that are not subject to the EU Emissions Trading System) should be further assessed and evaluated since it could offer substantial economic incentives that would make EE investments more attractive, and would also provide revenues that would finance the most cost-effective interventions.

Lastly, the elaboration of a **dedicated study on the macro-economic benefits of the various energy efficiency interventions**, also considering job growth indexes could further enhance the task for the identification of the most appropriate and beneficial energy efficiency interventions in relation to the Cypriot economy.

Table III.22: Financial attractiveness, avoided cost of imported fuel and societal indexes for various energy efficiency interventions

END-USE EE MEASURES	simple payback period (yrs)	*NPV with different discount rates (k€)*		ratio of effectiveness in terms of avoided (imported) fuel cost per invested mil€ (over the lifetime)	Public budget efficiency index (scale of private investment leverage) :1-5
		5%	*8%*		
deep renovation (to nZEB)	*>20*	*-18.4*	*-23.3*	*0.65*	*1*
roof insulation	***3.6***	***10.2***	***6.7***	***5.77***	*3*
window frames	*>20*	*-8.6*	*-9.5*	*0.46*	*2*
heat pumps	***5.2***	***6.9***	***4.5***	***1.31***	*4*
Lighting & appliances	*8.6*	*-0.3*	*-0.8*	*0.60*	*5*
solar thermal	***4.9***	***1.9***	***1.2***	***3.18***	*4*

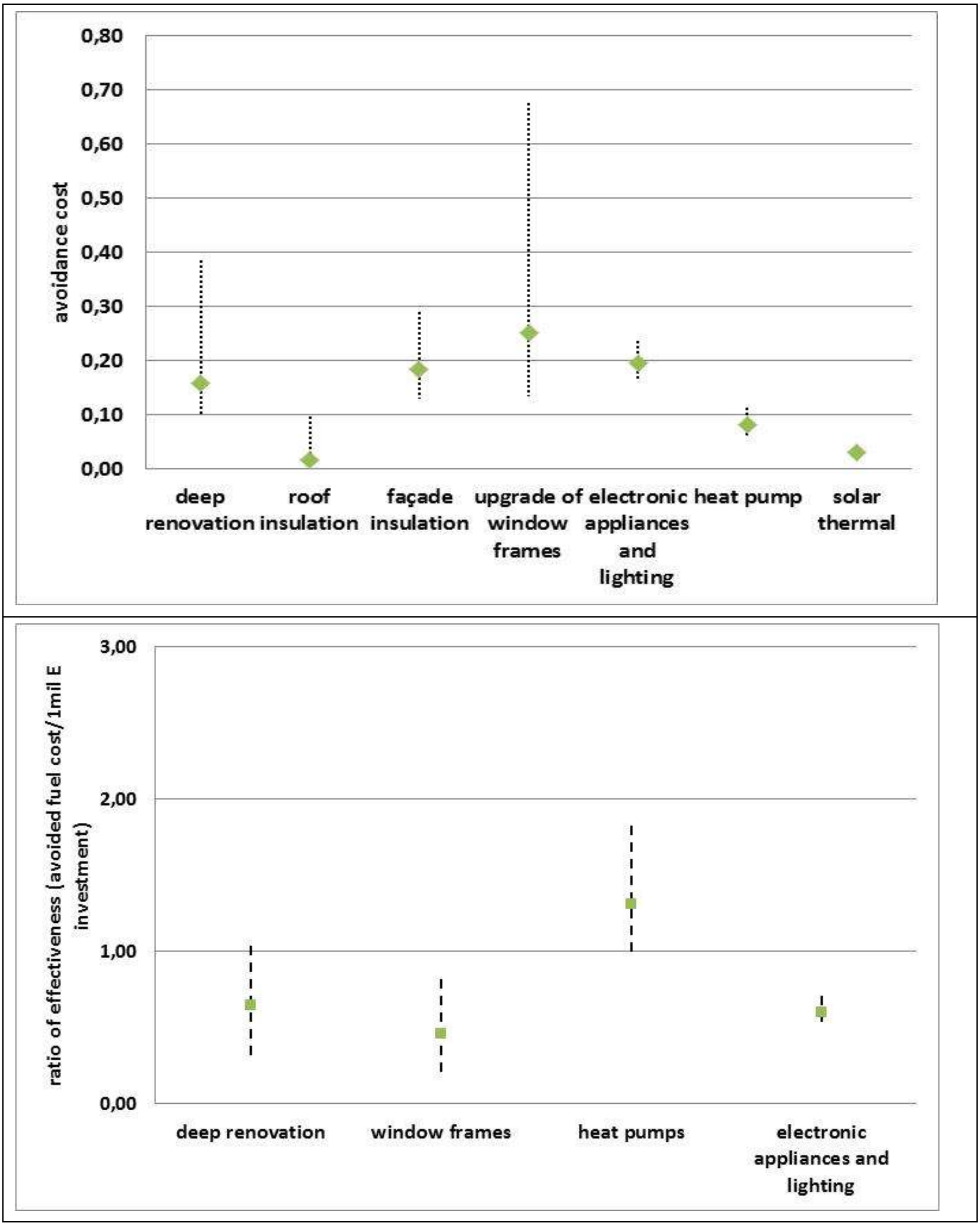


Figure III.8: sensitivity analysis of various energy efficiency interventions in terms of avoidance cost and ratio of effectiveness in terms of avoided (imported) fuel cost per invested mil€ (over the lifetime)

III.V.II Industry sector

The final energy consumption in industrial sector accounts for 225 Mtoe (2015) that is equal to 13.5% of the total final energy consumption. The table below illustrates the share of the final energy consumption per subsector.

Table III.23: Share of final energy consumption per subsector.

Subsector	[%]
Mining and quarrying	2.0 %
Water supply	7.7 %
Food, beverages and tobacco	18.3%
Textiles	0.2%
Wood	0.2%
Paper and pulp	1.2%
Chemicals	2.9%
Plastic products	1.4%
Non-metallic minerals, *of which:*	60.5%
Cement industry	55.4%
Basic metals	2.9%
Machinery and equipment	0.2%
Other industry	2.5%

Based on the conducted discussions with the market stakeholders and in particular with the energy managers of various industrial plans the following list presents the cost-effective measures for the industry sector ranking from the higher to the less cost-efficient.

(a) Heat recovery
(b) Installation of CHP
(c) Use of high efficiency electric motors
(d) Use of inverters
(e) Installation of energy efficient compressed-air systems
(f) Installation of automations
(g) Installation of LED lighting bulbs

However, no generic assumptions could be performed for the adaptation of specific measures at the level of each industrial plant due to the not comparable industrial processes, constraints in relation to the accessibility of the sites and equipment and the daily load profile. The identification of both the energy saving potential as well as the most cost efficient interventions require an on-site inspection and analysis and therefore only the overall above provided classification of the proposed measures could be presented. Moreover the rationale for the implementation of some of these measures is directly related to the overall cost of fuel supply and the applied electricity tariffs and always a site specific cost benefit analysis need to be performed whereas in contrast to the buildings sector the most decisive factor is the short payback period.

IV Evolution of final energy consumption by 2050

IV.I Introduction

This chapter presents the mathematical specification of the model used in the frame of this study for performing forecasts of final energy demand for the Republic of Cyprus. The model has been used for similar studies in the past, most notably for the preparation of an update of the 3rd National Energy Efficiency Action Plan that was submitted to the European Commission in spring 2014 (MECIT, 2014) and for the development of a renewable energy roadmap for Cyprus with the aid of the International Renewable Energy Agency (IRENA, 2015).

The subsequent sections outline the overall assumptions that were included in the implementation of the model as well as on assumptions and policies considered in the individual sectors.

IV.II Model description

The forecast model calculates future annual energy consumption in each major economic sector of Cyprus (agriculture, cement industry, other industry, households, services, road passenger transport, road freight transport and air transport) as a function of future macroeconomic variables and energy prices. It also calculates fuel shares in each sector, depending on technology costs (investment, operation, maintenance and fuel costs), the penetration potential of various technologies and technical constraints for the uptake of new technologies, and allows computing future final energy consumption by sector and fuel.

Final energy demand, by economic sector and year, is the sum of demand for substitutable energy and demand of non-substitutable electricity. The former denotes all final energy forms that are used in various sectors and uses (including a fraction of electricity consumption), which may be substituted by other energy forms in the future. The latter denotes use of electricity in appliances and for lighting purposes, where electricity does not compete with other fuels and therefore all future energy needs for these uses will continue to be covered by electricity in the foreseeable future; non-substitutable electricity follows its own dynamic path in the model.

$$EN_{i,t} = E_{i,t} + ELCNS_{i,t} \quad (1)$$

where

EN final energy demand (in ktoe) in sector *i* and year *t*,

E final substitutable energy demand (in ktoe)

$ELCNS$ final demand for non-substitutable electricity (in ktoe)

Final demand for substitutable energy is calculated with the following formula:

$$E_{i,t} = E_{i,t-1} \cdot\ 1 - eff_{i,t} \ \cdot \left(\frac{A_{i,t}}{A_{i,t-1}}\right)^{\alpha} \cdot \left(\frac{ap_{i,t}}{ap_{i,t-1}}\right)^{\beta_1} \cdot \left(\frac{ap_{i,t-1}}{ap_{i,t-2}}\right)^{\beta_2} \cdot \prod_{r=2}^{7} \left(\frac{ap_{i,t-r}}{ap_{i,t-r-1}}\right)^{\varphi\left(\frac{r}{n}\right) \cdot \gamma}$$

(2)

where

eff exogenous energy efficiency improvement in sector *i* and year *t*

A economic activity variable that is relevant for sector *i*; Table IV.1 presents the different economic sectors included in the model and the corresponding activity variable of each sector

ap average energy price in sector *i*; this is the weighted average of fuel prices used in this sector; in order to avoid unnecessary simultaneity problems in solving the model, *ap* is calculated every year on the basis of the fuel shares of the previous year

$\varphi(r/n)$ polynomial distributed lag with *n=5*. It is applied to the long-term elasticity of energy demand with respect to prices of years *t-3* to *t-7* in order to simulate a 'parabolic' price effect: the long-term effect of energy prices is less pronounced for recent price developments (e.g. of years *t-3* and *t-4*), is stronger for prices of intermediate years and fades slowly in later years, so that the price developments of years *t-8* and before do not affect today's energy demand at all. It is calculated as follows:

$$\varphi\left(\frac{r}{n}\right) = \frac{6\ \ n+1-r\ \ r}{n\ \ n+1\ \ \ n+2}$$

(3)

Table IV.1: List of economic sectors covered in the energy demand model and the corresponding economic activity variable.

Sector	***Activity variable***
Agriculture	Value added of agriculture, forestry and fishing
Cement industry	Value added of cement industry
Other industry	Value added of all industry except cement industry
Households	Private consumption
Services	Value added of service sector
Road passenger transport	Private consumption
Road freight transport	Gross Domestic Product
Aviation	Gross Domestic Product

As regards the exponents of equation (2), α is the assumed income elasticity, β_1 and β_2 are short-term price elasticities, and γ is the long-term price elasticity. These elasticities vary by sector and year but indices *i* and *t* are omitted here for brevity. Table IV.2 presents the income and price elasticities used in the model. Income elasticities are assumed to decline gradually after 2020 for all economic sectors, as a result of saturation in the use of energy-consuming appliances and equipment. It is assumed, however, that this saturation will not involve major behavioural changes of energy consuming firms and citizens; therefore, the drop in the value of income elasticities is assumed to be modest over the forecast period.

Table IV.2: Elasticities currently used in the model.

Sector	***Income elasticity up to 2020***	***Income elasticity in 2050***	***Short-term price elasticity***	***Long-term price elasticity***
Substitutable energy forms in:				
Agriculture	0.7	0.6	-0.15	-0.60
Cement industry	0.7	0.6	-0.20	-0.80
Other industry	0.7	0.6	-0.20	-0.80
Households	0.7	0.6	-0.15	-0.60
Services	0.7	0.6	-0.20	-0.80

Road passenger transport	0.9	0.8	-0.10	-0.40
Road freight transport	1.1	0.9	-0.10	-0.40
Aviation	1.2	1.0	-0.05	-0.20
Non-substitutable electricity in:				
Agriculture	0.8	0.7	-0.15	-0.60
Cement industry	0.9	0.8	-0.10	-0.40
Other industry	0.9	0.8	-0.10	-0.40
Households	1.1	0.9	-0.10	-0.40
Services	1.1	0.9	-0.05	-0.20

Turning back to the average energy price *ap* of equation (2), this is calculated as follows:

$$ap_{i,t} = \sum_{j} W_{i,j,t-1} \cdot p_{j,t} \qquad (4)$$

where

W the share of consumption of fuel *j* in sector *i* in year *t-1* over total fuel consumption of that sector and year

p end-user price of fuel *j* in year *t* (in constant EUR per toe). For future years, this is calculated with the following formula:

$$p_{j,t} = p_{j,t-1} + ppa_j \cdot\ p_{oil,t} - p_{oil,t-1}\ + r_{j,t} \qquad (5)$$

where

p_{oil} the international crude oil price in a given year (in constant EUR per toe), according to an exogenous oil price forecast – usually adopted from a forecast of an international organisation such as the International Energy Agency or the US Dept. of Energy's Energy Information Administration; since up to now all fuels used in Cyprus are petroleum products, the crude oil price is decisive for the evolution of their end-user prices

ppa coefficient (derived through a simple statistical estimation) expressing the pass-through of a change in international crude oil prices to retail fuel prices in Cyprus

r adjustment coefficient that may be used to account for e.g. changes in fuel taxation from a year onwards as a result of a policy change, imposition of carbon taxes etc.

The fuels/energy forms j considered in the model are: gasoline, automotive diesel, aviation kerosene, gas oil, light fuel oil, heavy fuel oil, liquefied petroleum gas (LPG), pet coke, biomass, biofuels, electricity, solar energy, geothermal energy and hydrogen. Obviously, not all fuels are relevant for all economic sectors – for example, pet coke has historically been used only in the cement industry in Cyprus. In the road transport sector (passenger and freight) there is a further breakdown to hybrid technologies – hybrid gasoline vehicles and hybrid diesel vehicles.

Turning to equation (1), final demand for non-substitutable electricity is calculated with the following formula:

$$ELCNS_{i,t} = ELCNS_{i,t-1} .\ 1 - eff_{i,e,t} \cdot \left(\frac{A_{i,t}}{A_{i,t-1}}\right)^{\alpha_e} \cdot \left(\frac{pelc_{i,t}}{pelc_{i,t-1}}\right)^{\beta e_1} \cdot \left(\frac{pelc_{i,t-1}}{pelc_{i,t-2}}\right)^{\beta e_2} \cdot \prod_{r=2}^{7}\left(\frac{pelc_{i,t-r}}{pelc_{i,t-r-1}}\right)^{\varphi\left(\frac{r}{n}\right).\gamma_e}$$

(6)

where $pelc$ is the retail price of electricity in sector i and year t.

The exponents of equation (6) denote elasticities in the same manner with the corresponding ones of equation (2) which are shown in Table IV.2.

Focusing now on the consumption of substitutable energy, it is necessary to compute for each future year the fuel/technology shares in final energy demand by sector. For equipment that survives from the previous year, final energy demand by sector and fuel is calculated as follows:

$$\overline{E_{i,j,t}} = E_{i,j,t-1} .\ 1 - eff_{i,t} \cdot \left(\frac{A_{i,t}}{A_{i,t-1}}\right)^{\alpha} \cdot \left(\frac{ap_{i,t}}{ap_{i,t-1}}\right)^{\beta_1} \cdot \left(\frac{ap_{i,t-1}}{ap_{i,t-2}}\right)^{\beta 2} \cdot \prod_{r=2}^{7}\left(\frac{ap_{i,t-r}}{ap_{i,t-r-1}}\right)^{\varphi\left(\frac{r}{n}\right).\gamma} \cdot \frac{LF_{i,j} - 1}{LF_{i,j}}$$

(7)

with notations similar to those of equation (2), and LF the lifetime of typical energy-using equipment in sector i using fuel j.

Summing up over all fuels j in a given sector i, one can obtain total final energy consumption in this sector from equipment that has survived in year t from previous years. In most cases, this sum will not be equal to the sector's total substitutable energy use $E_{i,t}$ as computed by equation (2). The difference between the two is:

$$NEW_{i,t} = E_{i,t} - \sum_{j}\overline{E_{i,j,t}}$$

(8)

If NEW is positive, which is the normal case in times of economic growth and rising energy use, this means that total demand for substitutable energy in this sector cannot be satisfied by surviving equipment alone, hence new equipment has to be installed to fill this gap:

$$\text{If } NEW_{i,t} > 0 \text{ then } \mathrm{E}_{i,j,t} = \overline{\mathrm{E}_{i,j,t}} + s_{i,j,t}.NEW_{i,t} \quad (9)$$

where s denotes the share of fuel/technology j in that sector's new energy-using equipment.

On the other hand, if NEW is negative, which may occur in case of an economic recession or a strong reduction in energy use for other reasons, an adjustment of the calculated fuel-specific energy consumption is necessary in order to equate it with the sector's total substitutable energy use $E_{i,t}$:

$$\text{If } NEW_{i,t} \le 0 \text{ then } \mathrm{E}_{i,j,t} = \mathrm{E}_{i,j,t-1} \frac{\mathrm{E}_{i,t}}{\mathrm{E}_{i,t-1}} \quad (10)$$

The fuel/technology share s of equation (9) is calculated with the aid of the following formula, which involves an implicit cost minimisation:

$$s_{i,j,t} = w_{i,j,t} \frac{\left(\frac{d_i.e^{d_i LF_{i,t}}}{e^{d_i LF_{i,t}} - 1}.CC_{i,j,t} + FC_{i,j,t} + \frac{\left(VC_{i,j,t} + \frac{p_j}{eff_{i,j,t}} \right)}{CONV_{i,j,t}} \right)^{\eta}}{SUM_{i,t}} \quad (11)$$

with $$SUM_{i,t} = \sum_j w_{i,j,t} . \left(\frac{d_i.e^{d_i LF_{i,t}}}{e^{d_i LF_{i,t}} - 1}.CC_{i,j,t} + FC_{i,j,t} + \frac{\left(VC_{i,j,t} + \frac{p_j}{eff_{i,j,t}} \right)}{CONV_{i,j,t}} \right)^{\eta} \quad (12)$$

where

CC capital costs of technology j (in constant EUR per installation)

FC fixed operation & maintenance costs of technology j (in constant EUR per year)

VC variable operation & maintenance costs of technology j (in constant EUR per appropriate unit depending on the sector)

d real discount rate used for energy investment decisions in sector i; in line with values assumed in the most recent European Commission's energy forecasts (European Commission, 2016), the following discount rates are used: 7.5% for the energy-intensive cement industry; 9% for the rest of the industry; 14% for households; 11% for services, agriculture and private transport; and 9.5% for freight and air transport.

eff 'efficiency' factor depending on sector (e.g. fuel consumption in litres per 100 kilometres for cars and trucks or in kilograms per hour for boilers etc.)

$CONV$ appropriate conversion factor, depending on sector, in order to convert variable and fuel costs to the same unit with annualized capital and fixed maintenance costs – e.g. kilometres travelled per year for vehicles, hours of operation of boilers per year etc.)

w technology 'maturity factor' – a figure taking any non-negative value, expressing the potential of a given fuel/technology j to penetrate the market in that sector; e.g. $w = 0$ for coal in industries other than cement industry because historically there has been no coal use in these sectors in Cyprus; or $w = 1$ (a relatively high figure) for hybrid vehicle technologies that may be promoted in the near future.

Equation (9) implies that the fuel/technology with the lowest annualised costs (comprising investment, operation & maintenance and fuel costs) will gain the highest share in new energy-using equipment. The relative advantage of the cheapest technology is largely determined by the substitution elasticity η of equations (11) and (12). The higher η is (in absolute terms) the higher are the shares of the cheapest technologies – and correspondingly the lower the shares of the most costly technologies. For $\eta \rightarrow -\infty$, the computed shares correspond to those of an optimization algorithm, i.e. the cheapest technology gets the full share of the market. We currently use $\eta = -1$ across all sectors, in order to allow for many technologies to have a share in the market since real-world market shares are not determined by annualized costs alone but by a number of other factors that are not accounted for in the model's equations.

Calculating $\overline{E_{i,j,t}}$ from equation (7), $NEW_{i,t}$ from equation (8) and (if applicable) $s_{i,j,t}$ from equation (11), it is possible to compute annual energy demand by sector and fuel $E_{i,j,t}$ from equation (9) or equation (10). By definition, due to the adjustments made before, total sectoral non-substitutable energy consumption computed in equation (2) is equal to the sum of fuel-specific sectoral consumption – i.e. $E_{i,t} = \sum_j E_{i,j,t}$. If non-substitutable electricity consumption from equation (6) is added to it in line with equation (1), this leads to the calculated total annual energy consumption by sector $EN_{i,t}$ for each future year.

Due to the recursive form of the model's equations, a forecast can start from any year t – the base year – using energy, macroeconomic and price data from official sources, and proceed year by year until 2040 with the use of the formulae described above. When data for a more recent year t' becomes available, that year can become the base year, and the forecast starts from year $t'+1$ onwards. This makes it easy to update national energy forecasts when new base year data are available.

IV.III Reference scenario/impact of current policies

IV.III.I General assumptions

Macroeconomic and oil price development

As explained in Section IV.II, the forecast model relies on exogenous assumptions on the evolution of macroeconomic variables and international oil prices. This Section outlines the projections of these variables, which were used throughout the study, i.e. in all scenarios that will be described in Chapter IV.

As regards the macroeconomic development, an official forecast was provided to the study team by the Ministry of Finance of Cyprus in October 2016. According to this, the economy of Cyprus is assumed to follow a path of sustained growth, starting with growth rates of real GDP of 2.7-2.8% per year and gradually slowing down to annual growth of around 2.3% from 2030 onwards. Private consumption is assumed to grow at a slower pace than GDP in the short and medium term because it has been hit less by the economic downturn of recent years and has remained at relatively higher than expected levels.

The contribution of each major economic sector to GDP (which is based on assumptions of the study team) is assumed to remain essentially constant. The GDP share of industry, which was around 13% in the mid-1990s, fell to 10% in 2005 and to 7% in 2014-15, is assumed to rebound slightly, reaching a share of 8% in the longer term. A stronger rebound is expected in the construction sector, whose share plunged from 11% to just over 4% during the years of the financial crisis, and is assumed to gradually revert to 8.5% in 2030 and 9% by 2050. The contribution of agriculture, around 2% today, is assumed to slightly decline to 1.7% in the long term. Finally, the service sector is assumed to keep its dominant role in the economy and continue contributing by more than 80% to national economic output. Table IV.3 and Figure IV.1 summarise these macroeconomic assumptions.

Table IV.3: Assumptions on the evolution of GDP, private consumption and sectoral GDP shares in Cyprus.

	Actual values in 2015	*Forecast of real growth rates (average over each period)*			
	(m EUR)	*2016-2020*	*2020-2030*	*2030-2040*	*2040-2050*
GDP	15 355	2.8%	2.5%	2.3%	2.3%
Private consumption	10 376	2.1%	2.2%	2.3%	2.3%
Sectoral GDP shares	*Actual in 2015*	*2020*	*2030*	*2040*	*2050*
Agriculture	2.0%	2.0%	1.9%	1.8%	1.7%
Industry	7.1%	7.6%	8.4%	8.1%	8.0%
Construction	4.2%	5.6%	8.5%	8.8%	8.9%
Services	86.6%	84.8%	81.2%	81.3%	81.3%

Source: Values of 2015 based on national accounts from Cyprus Statistical Service (last updated on 14 October 2016). GDP forecast based on projections of the Ministry of Finance of Cyprus in October 2016. Future sectoral GDP shares are assumptions of the study team.

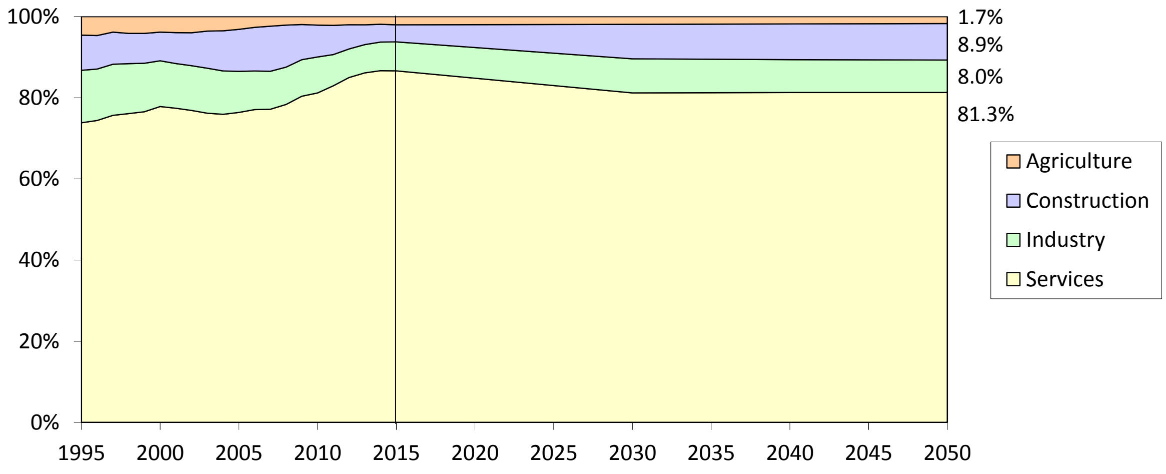


Figure IV.1: Historical evolution (1995-2015) and assumed future development of sectoral GDP shares in Cyprus.

The energy system of Cyprus is almost entirely dependent on oil products, hence retail fuel prices – in the absence of changes on energy taxes – will change in the future in line with the evolution of international crude oil prices. The latter are assumed to develop in line with the central scenario

("New Policies Scenario") of the International Energy Agency's (IEA) World Energy Outlook 2016, which was published in November 2016 (International Energy Agency, 2016).According to the IEA's forecast, crude oil price is expected to rebound from its current quite low levels of $40-50 per barrel, and reach $79 per barrel in 2020 (at constant prices of year 2015), with a further increasing trend in later years, to $111 in 2030 and $124 in 2040. For the purpose of this study we extrapolated IEA's trend up to 2050, which leads to a crude oil price of $137 per barrel (at 2015 prices). We assumed for the entire forecast period that the exchange rate between the euro and the US dollar will remain constant at 1.11 USD/EUR, which is the average exchange rate of year 2015 according to Eurostat.

Electricity needs

Aggregate final electricity demand was calibrated so as to be in line with the latest official electricity forecast for the period 2016-2025 that was prepared by the Transmission System Operator (TSO) and approved by the Cyprus Regulatory Authority for Energy in 2016. The latest projection was published in March 2016 (Transmission System Operator Cyprus, 2016) but more recent data were also provided by the TSO. As this forecast is about electricity generation and not final consumption, it is necessary to know the TSO's assumptions about auto-consumption of power plants and the assumptions of the Electricity Authority of Cyprus (EAC) about transmission & distribution losses. The study group, with the aid of MECIT, obtained such information from the TSO. Sectoral shares of electricity demand have also taken into account the following information:

- Preliminary results from the preparation of the revised National Renewable Energy Action Plan that was conducted by MECIT for the period up to 2020;
- Results of the JRC study conducted for MECIT about useful energy demand forecasts for heating and cooling up to 2050;
- Relevant results from scenarios run with the Osemosys model by MECIT with the assistance of the Swedish Royal Institute of Technology (KTH).

It should be noted that the Reference Scenario presented here does not fully adopt the above results, but insights from these forecasts were used in order to formulate a realistic Reference Scenario up to 2050.

TSO publicised two electricity projections in March 2016: one as a baseline – assuming no energy efficiency measures are taken by the government – and a second one assuming that energy efficiency measures up to 2015 are implemented over the forecast period. Although the latter forecast is theoretically in line with the Reference Scenario described in this report, we adopted the TSO's baseline projection up to 2020 and then assumed a gradual convergence towards the second projection of TSO for the period 2021-2025. The reason for this adjustment is that, according to preliminary information obtained by MECIT, some of the measures described in the previous paragraphs have been less effective than initially planned. As a result, it is expected that the energy savings expected to be actually realised until around 2020 are lower than those foreseen by MECIT some years ago.

Other general assumptions

New energy-intensive infrastructure projects that may affect energy consumption in Cyprus (such as marinas, casino resort, desalination plants etc.) are implicitly assumed to affect future energy demand to the extent that they will affect economic growth as well. No special provisions were made for them in the Reference Scenario. It should be noted that the same approach is followed by TSO in its long-term electricity forecast.

Furthermore, measures related to power generation implicitly assumed for the reference scenario (although not directly taken into account) were the following:

- Energy efficiency improvements in the transmission and distribution of electricity.
- Decommissioning of Dhekelia's old steam turbine units in 2024 and decommissioning of Dhekelia's ICE units in 2030-2031.

Finally, here is a list of measures which were not considered in the reference scenario:

- Use of natural gas in power generation and in end uses
- Electrical interconnection of Cyprus with other countries
- Construction of a LNG terminal in Cyprus

IV.III.II Household sector

Assumptions

As a general rule, the Reference Scenario includes all relevant policies and measures that have already been implemented or are officially planned to be adopted by the government of Cyprus in the near future. The timeline of implementation of these measures (and the energy savings they will bring about) is consistent with MECIT plans.

Policies considered

In the household sector the measures considered in the Reference Scenario comprise:

- The implementation of the Energy Labelling Directive (2010/30/EC).
- The implementation of the Energy Efficiency Directive (2012/27/EU) and more specifically:
    - Implementation of measures for the achievement of the obligatory target for energy savings at end use level by 2020, as set by article 7 of the Directive (including, amongst others, the continuation up to 2020 of financial incentives for renovating households). No additional post-2020 measures are assumed.
    - Energy efficiency information and education measures.
- The implementation of the Energy Buildings Directive (2010/31/EC) and more specifically:
    - Regular inspections of central heating systems with boiler and air-conditioning systems in large buildings.
    - The implementation of new, more stringent minimum energy performance requirements by 2017 as an intermediate step towards NZEB.
    - Requirements in energy performance, operation, adjustment and control of technical building systems installed in existing buildings.
    - The requirement to issue energy performance certificates for sale and rent of buildings and apartments.

Results

Figure IV.2 shows the forecast of final energy demand in households according to the Reference Scenario and compares it with earlier Reference Scenarios in order to enable a better understanding of the underlying trends. For this purpose, the forecast of this study is compared with earlier forecasts carried out by CUT in the recent past, as well as with the baseline forecasts provided by the European Commission (2016) and the

Commission's Joint Research Centre (JRC) in the frame of a recent study conducted for MECIT (Santamaria, Kavvadias, & Jakubcionis, 2016). More specifically, we compare the current forecast with the following five ones:

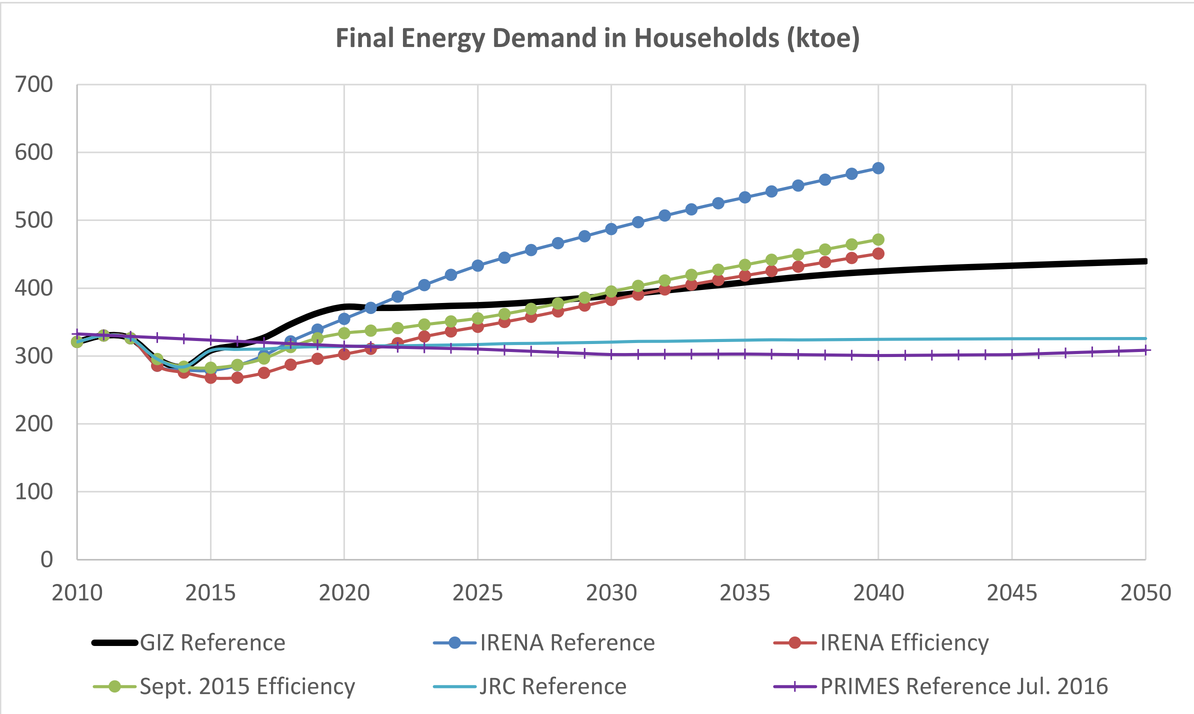
- The projections of the 'Reference Scenario' and the 'Energy Efficiency Scenario' of the renewable energy roadmap study carried out with the support of the International Renewable Energy Agency in 2014 (IRENA, 2015).
- Updated projections of the IRENA study's 'Energy Efficiency Scenario' with more recent macroeconomic and oil price assumptions, as of September 2015, which were used to assess the effects of a carbon tax on the energy system of Cyprus (Zachariadis, How Can Cyprus Meet Its Energy and Climate Policy Commitments? The Importance of a Carbon Tax, 2015)
- Baseline scenario projections of the JRC study mentioned above.
- The most recent Reference Scenario forecasts adopted by the European Commission (as of July 2016), which were carried out mainly with the PRIMES model (European Commission, 2016).

When comparing the different forecasts, one has to keep in mind some major differences between them. First, they have a different base year, i.e. the last year for which actual data were available. The IRENA forecasts used 2013 as a base year, while the September 2015 forecast included the 2014 energy balance as a starting point. The PRIMES projections also used 2013 as a base year since they included all information available by Eurostat in February 2015 (European Commission, 2015:18). The current study uses 2015 as a base year, i.e. 2016 is the first forecast year. The JRC projections shown in Figure 4 were adjusted in order to have 2015 as a base year too.

A second important difference lies in the different macroeconomic and oil price assumptions used in the various studies reviewed here. The IRENA and JRC studies relied on macroeconomic forecasts of the European Commission and national authorities as of spring 2014, and on oil price forecasts of the International Energy Agency of autumn 2013 – before the significant drop in oil prices that was observed in 2014-2016. PRIMES projections used macroeconomic forecasts of early 2015 and oil price forecasts that accounted for the recent drop in oil prices. Compared to those, the model runs of our study rely on national macroeconomic forecasts of autumn 2016, which show higher economic growth throughout the forecast horizon, and on IEA oil price projections of autumn 2016, which are markedly lower than those of 2013. As a result, due to the combination of higher growth and lower energy prices, the current forecast shows – in all sectors except services – a stronger rebound in energy demand between 2016 and 2020 compared to the IRENA forecast.

In order to control for the differences in base year and GDP assumptions and put the forecasts in perspective, the bottom part of Figure IV.2 illustrates projections of final energy intensity (energy demand per unit of GDP) by sector, normalised to year 2015. Moreover, it includes energy intensity data of the last twenty years (1995-2015) for which these data can be assumed to be known with reasonable accuracy.

This comparison shows that the household sector, which has demonstrated quite stable energy demand per unit of GDP during the last twenty years, is expected to exhibit a declining energy intensity post-2020. This decrease is projected to be modest and clear, slightly stronger until the mid-2030s, but still quite clear thereafter and until 2050. In general, the post-2020 evolution is similar to that forecast by PRIMES and in the JRC study. Although this implies a significant drop in household energy intensity, at levels that have not been observed in the past, this seems to be plausible in light of the adoption of the NZEB legislative requirements for all new household buildings in the future. The future improvements in energy intensity will also be due to a continuation of the historic trend of decoupling between economic output and energy use thanks to overall technological progress, and also due to the slightly rising energy prices as a result of the modest increase in international oil price.



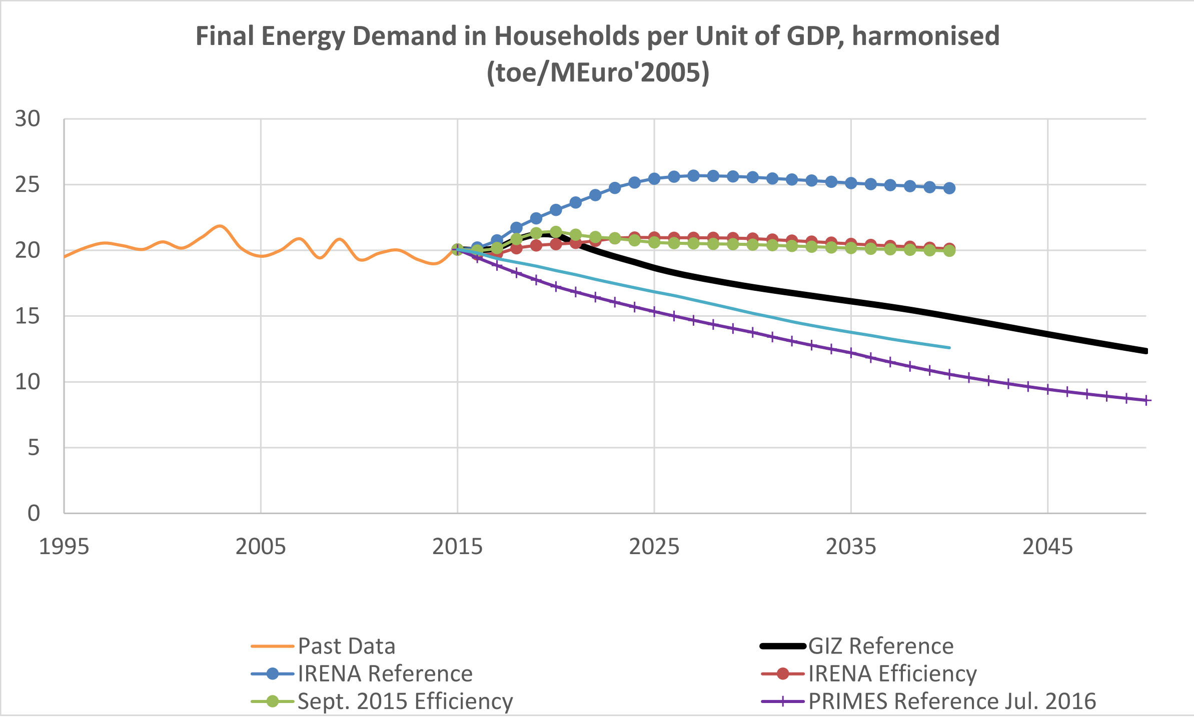


Figure IV.2: Final energy demand in households in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

Figure IV.3 presents the projected evolution of fuel shares in final energy demand in households according to the Reference Scenario. It shows the basic trends for further electrification and a modest increase in the (already quite high) share of solar thermal uses (mainly for water heating), coupled with a declining share of petroleum products such as gas oil and LPG.

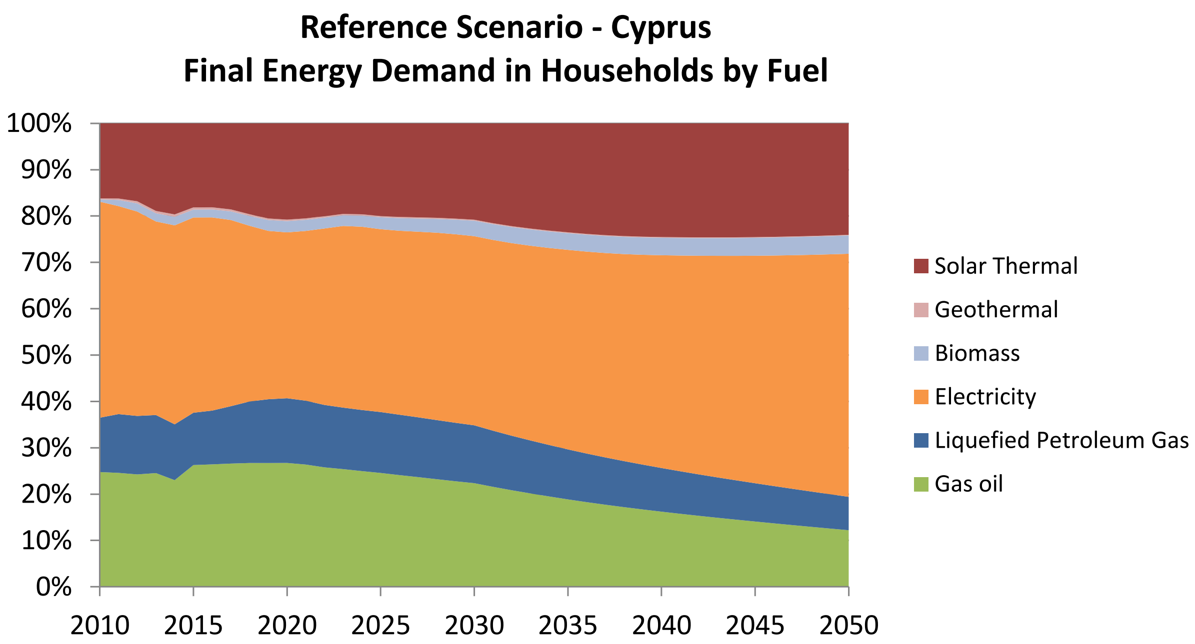


Figure IV.3: Projected evolution of fuel shares in household energy demand in Cyprus according to the Reference Scenario.

IV.III.III Service sector

Assumptions

The Reference Scenario includes all policies and measures that are relevant for the service sector and have either been implemented or are officially planned to be adopted by the government of Cyprus in the near future.

Policies considered

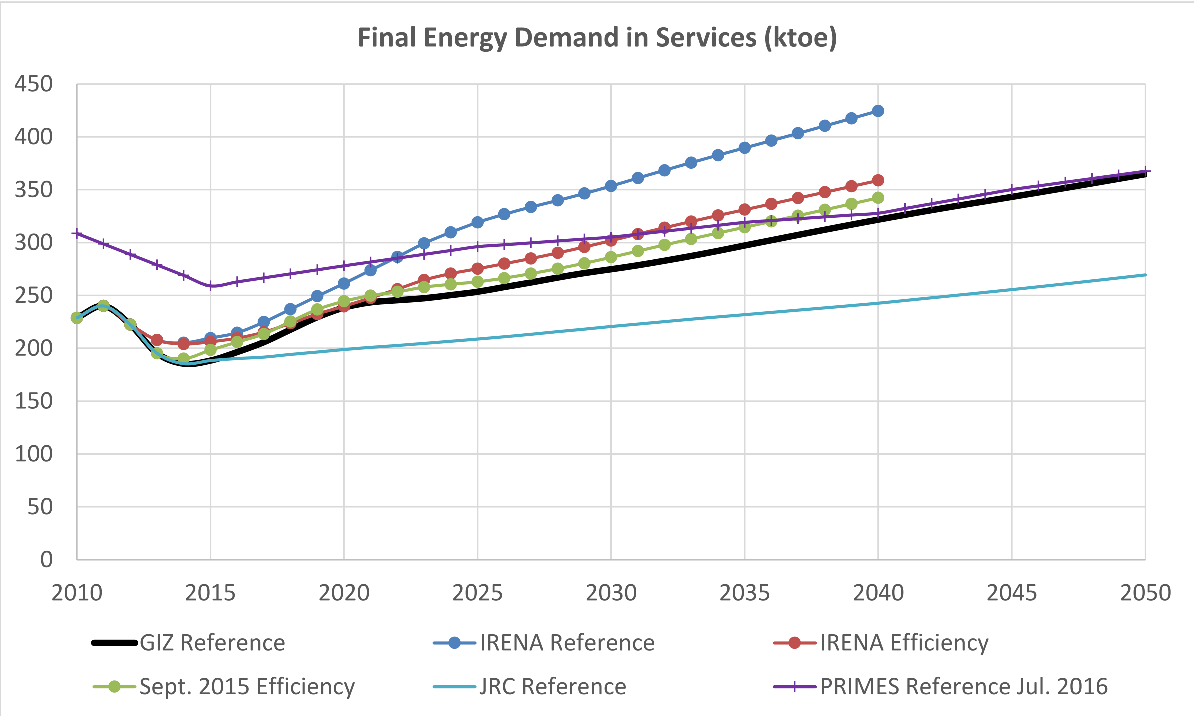
In the service sector the measures considered in the Reference Scenario are the following:

- The implementation of the Energy Labelling Directive (2010/30/EC).
- The implementation of the 'Energy Efficiency Directive' (2012/27/EU) and more specifically:
  - Renovations and other measures of upgrading energy efficiency in buildings owned and used by the central government. Such measures are planned to be implemented until 2020 but essentially discontinue after 2020 in this Scenario.
  - Implementation of measures for the achievement of the obligatory target for energy savings at end use level by 2020, as set by article 7 of the Directive (including, amongst others, the continuation up to 2020 of financial incentives for renovating buildings owned and used by SMEs). No additional post-2020 measures are assumed in this Scenario.
  - Energy efficiency requirements on purchasing by public bodies
  - Energy efficiency measures in street lighting
  - Obligation for energy audits for non-SMEs
  - Energy efficiency information and education measures.
- The implementation of the Energy Buildings Directive (2010/31/EC) and more specifically:
  - Regular inspections of central heating systems with boiler and air-conditioning systems in large buildings.
  - The implementation of new, more stringent minimum energy performance requirements by 2017 as an intermediate step towards NZEB.
  - Requirements in energy performance, operation, adjustment and control of technical building systems installed in existing buildings.
  - The requirement to issue energy performance certificates for sale and rent of buildings and apartments.

Results

Figure IV.4 presents the projections for final energy demand in services according to the Reference Scenario and compares it with earlier studies in order to enable a better understanding of the underlying trends. The individual studies, as well their major differences from this one, have been explained in the previous Section on households.

In the service sector, which has demonstrated fluctuating but relatively stable energy demand per unit of GDP during the last twenty years, it is expected that energy intensity will start declining after 2020. This decrease is projected to be modest and clear throughout the forecast horizon and until 2050. In general, the post-2020 evolution is similar to that forecast by PRIMES and in the JRC study. Although this implies a significant drop in energy intensity, at levels that have not been observed in the past, this seems to be plausible in light of the adoption of the NZEB legislative requirements for all new buildings in the future, as well as due to investments in energy efficient equipment in different subsectors such as hotels, restaurants and offices. The future improvements in energy intensity will also be due to a continuation of the historic trend of decoupling between economic output and energy use thanks to overall technological progress and small structural changes in the economy, and also due to the slightly rising energy prices as a result of the modest increase in international oil price.



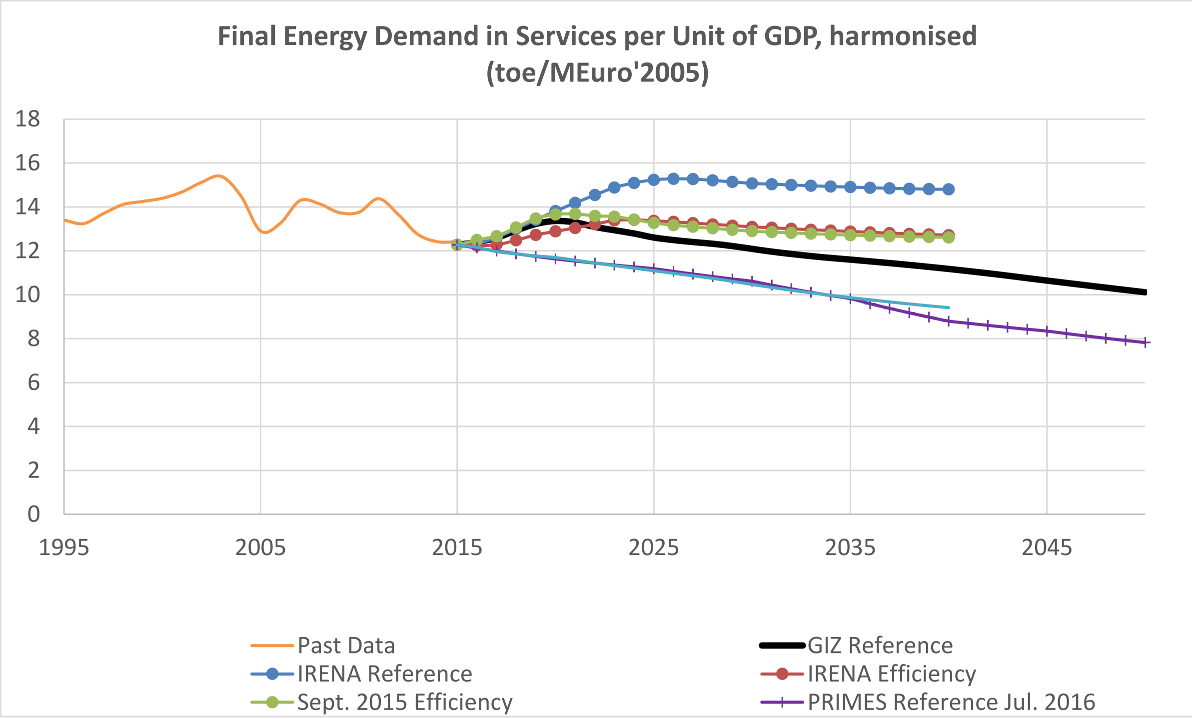


Figure IV.4: Final energy demand in services in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

Figure IV.5 presents the projected evolution of fuel shares in final energy demand in services according to the Reference Scenario. It shows that electrification is projected to continue and the contribution of solar energy will rise, especially after 2030, gaining share from petroleum products such as gas oil and LPG.

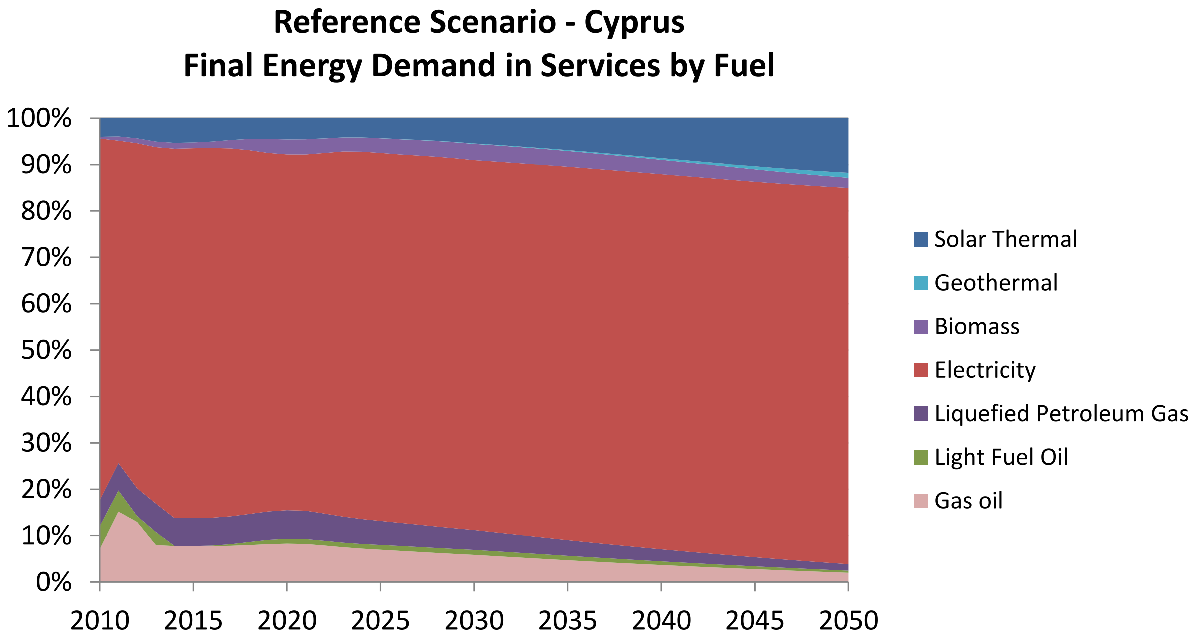


Figure IV.5: Projected evolution of fuel shares in service energy demand in Cyprus according to the Reference Scenario.

IV.III.IV Industry sector

Assumptions

As in the other sectors, the Reference Scenario includes all policies and measures that are relevant for the industrial sector and have either been implemented or are officially planned to be adopted by the government of Cyprus in the near future.

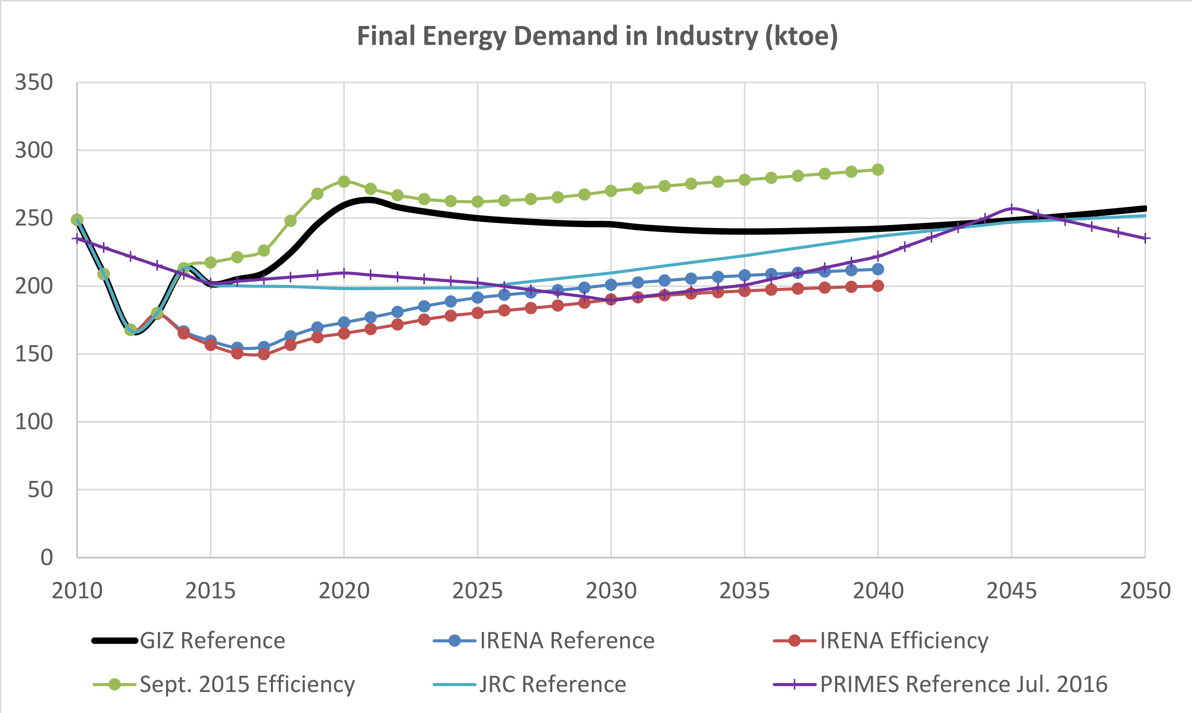
Policies considered

There has admittedly been limited attention to improving the energy efficiency of industrial processes or equipment. The policies taken into account in this sector are those foreseen in the Energy Efficiency Directive (2012/27/EU) as well as the training of industry engineers and energy managers as outlined in Section II.III.IV. Furthermore, some modest industrial investments in automations or replacement of electric motors or compressed-air systems with more energy efficient ones are assumed.

Results

Figure IV.6 illustrates the forecast of industrial energy consumption (top graph) and energy intensity (bottom graph) up to 2050, also in comparison to earlier forecasts for which more information was provided in the Household Section of this Chapter.

The Reference Scenario foresees a variation in the energy intensity of industry that is similar to that of the other sectors, i.e. an increase up to 2020 and a modest decline afterwards. Both PRIMES and JRC study forecasts do not include an increase in intensity for the 2016-2020 period but then project a slower improvement in energy intensity until 2040. The projection of the Reference Scenario of this study is probably more realistic since it accounts for the existence of low oil prices at least until 2020, which would tend to keep energy intensity at the same or slightly higher levels than those of years 2013-2015. It should also be stressed that the strong drop in industrial energy intensity in the past twenty years is somewhat misleading: Intensity is expressed here, for reasons of uniformity and data availability, as final energy consumption divided by total GDP and not – as would be more appropriate – divided by industrial production or industrial value added. Since the share of industry in national GDP has been constantly declining, as shown in Figure IV.1, the intensity indicator used here decreases strongly. Our assumption is that the share of industry in total economic output will not continue its strong decline, hence it is reasonable to expect a future evolution in industrial energy intensity similar to that shown in Figure IV.6. In the longer term the intensity improvement may slow down a bit, in the absence of additional energy saving policies in this sector.



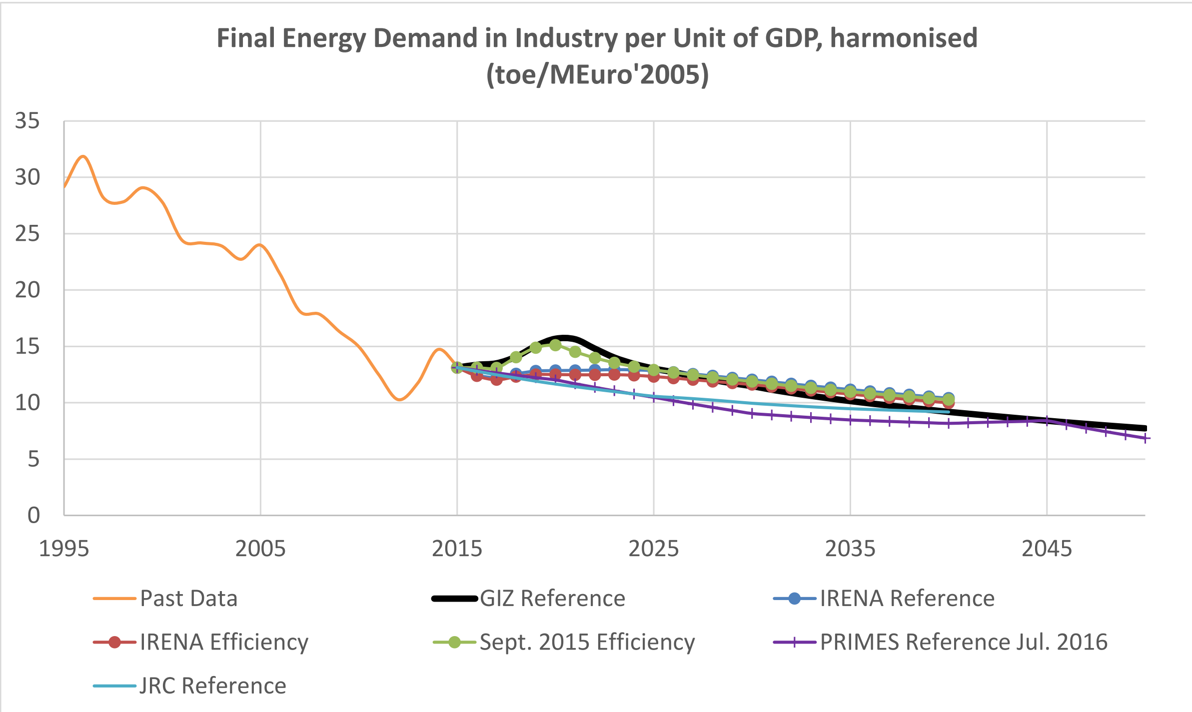


Figure IV.6: Final energy demand in industry in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

Figure IV.7 shows the projected evolution of fuel shares in final energy demand in industry according to the Reference Scenario. The basic trend is further electrification and a declining contribution of petroleum products. Some solar thermal uses are also forecast to appear in the industrial sector over the longer term.

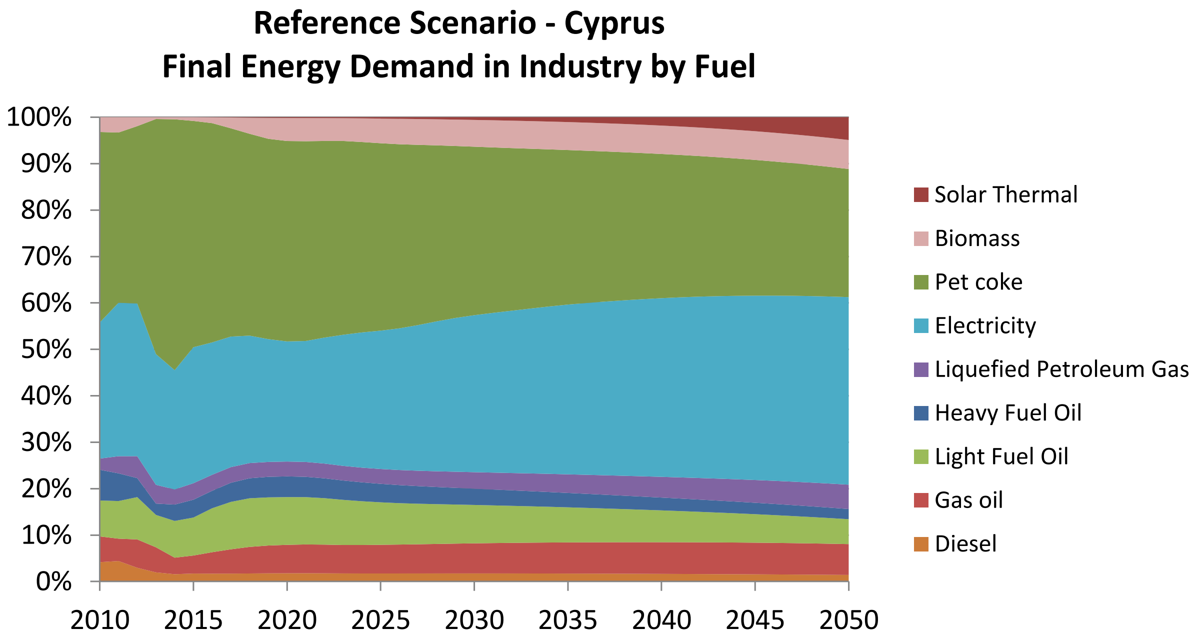


Figure IV.7: Projected evolution of fuel shares in industrial energy demand in Cyprus according to the Reference Scenario.

IV.III.V Transport sector

Assumptions

The Transport Reference Scenario was built on latest data availability and aligned with Cyprus policies. Other reference scenarios, such as those of the latest National Energy Efficiency Action Plan (MECIT, 2014), of the Renewable Energy Roadmap (IRENA, 2015) and of the European Commission (2016) were taken into account for comparison. The input parameters considered for the Reference Scenario of transport are summarised in table IV.4.

Table IV.4: Input parameters for the reference scenario on transport.

Parameters	Data source or assumption
Basic economic data (GDP, Population etc.)	Official forecasts by Cyprus economic ministry
Total transport activity (number of vehicles, mileage)	Projections according to the European Commission's Reference Scenario 2016
Fuel efficiency	Implementation of CO_2 regulation, fuel efficiency trend projection for all vehicle classes according to the TREMOD Reference Scenario
Modal split	Share of private/public motorized transport, non-motorized transport remains constant compared to previous trends
Average vehicle size	Remains constant compared to previous trends
Vehicle occupancy rate	Remains constant compared to previous trends
Share of alternative fuel vehicles	Limited penetration of e-vehicles (past trends) and LPG No CNG, LNG or hydrogen vehicles
Biofuels	10% RES will not be reached, no bioethanol is used Biodiesel blend according to MECIT proposal
Renewable energy in electricity in the future	As provided by MECIT modelling results

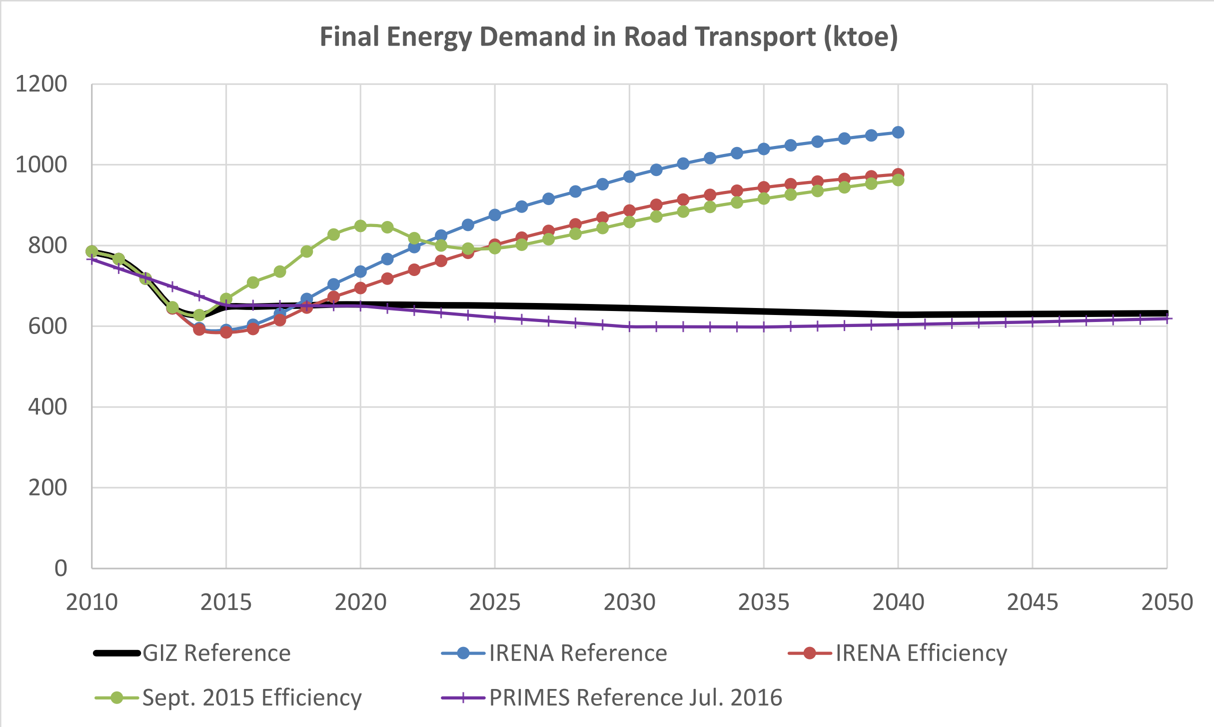
Policies considered

The legal policy framework considered in the transport Reference Scenario includes:

- EU regulations for CO_2 emissions from cars (443/2009) and vans (510/2011) until 2020. Additional assumptions were considered to take into account the differences between type approval and real world fuel efficiency.
- The Fuel Quality Directive (2009/30/EC), setting a minimum of 6% reduction in GHG intensity by 2020 for road transport fuels, as well as the requirement of Directive 2009/28/EC to achieve a 10% renewable energy share in road transport by 2020 was taken into account, but their fulfilment was not part of the Reference Scenario.
- Regulations 715/2007, 595/2009 and 582/2011 concerning Euro regulations for passenger cars and light commercial vehicles.
- Indirect Land Use Change Directive (iLUC)(EU 2015/1513) Cap of 7% on the contribution of biofuels produced from 'food' crops (1st generation) by 2020
- Directive 2014/94/EU on the deployment of alternative fuels infrastructure (DAFI)

Results

As regards road transport, where we have adopted the projections carried out under Work Package 5 “Technical Assistance in order to assess and formulate recommendations for the promotion and penetration of alternative fuels in the transport sector” of this technical assistance, a continuous decline in energy intensity is foreseen for both passenger and freight transport, as is evident in Figure IV.8. This is not due to the introduction of alternative fuelled vehicles or the increased use of public transport modes, as the Reference Scenario does not include such assumptions. The improvement in energy intensity should entirely be attributed to technological improvements in the fuel economy of conventional powertrains. The forecast results in a higher share of diesel powered passenger cars in 2050 (Figure IV.9), and hence an increased share of diesel fuel in total energy consumption, and a slight increase in the use of biofuels. Electrification is foreseen to proceed very slowly, so that electricity consumption in transport is projected to remain at negligible levels (less than 0.1% share of road transport energy use) up to 2050.



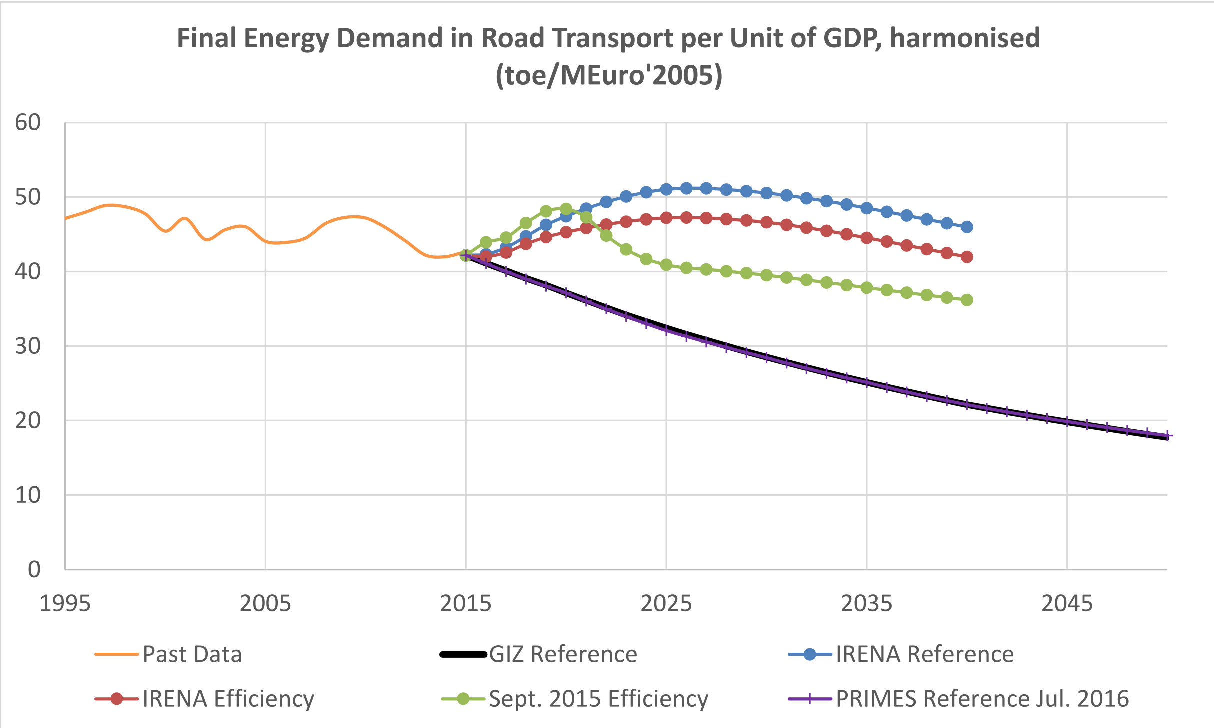


Figure IV.8: Final energy demand in road transport in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

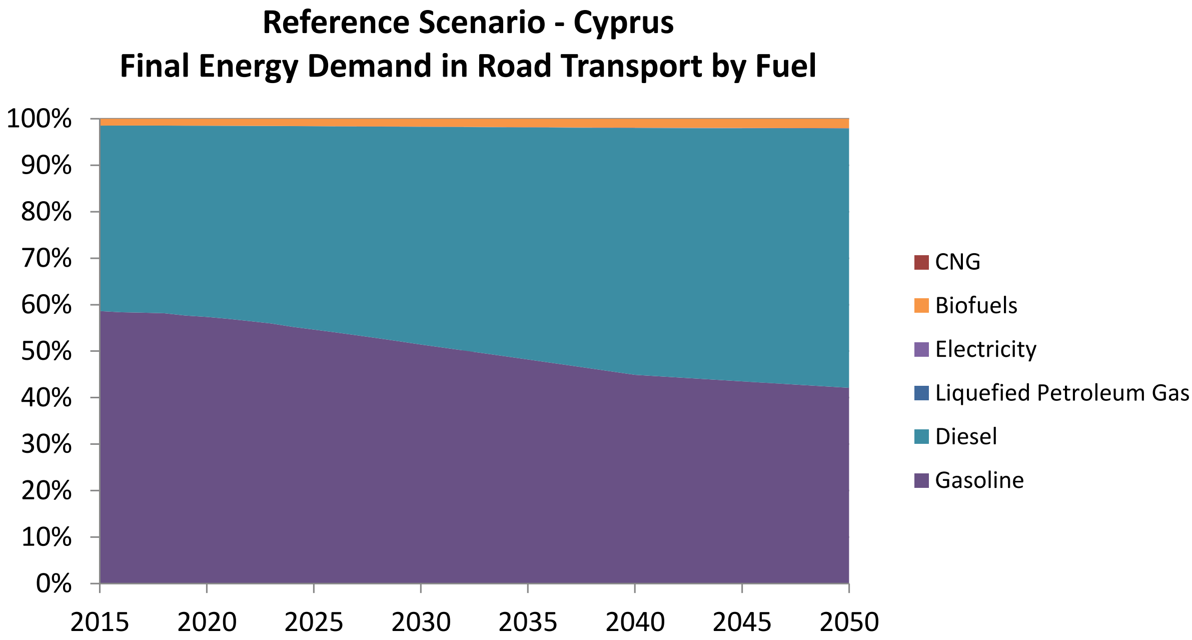
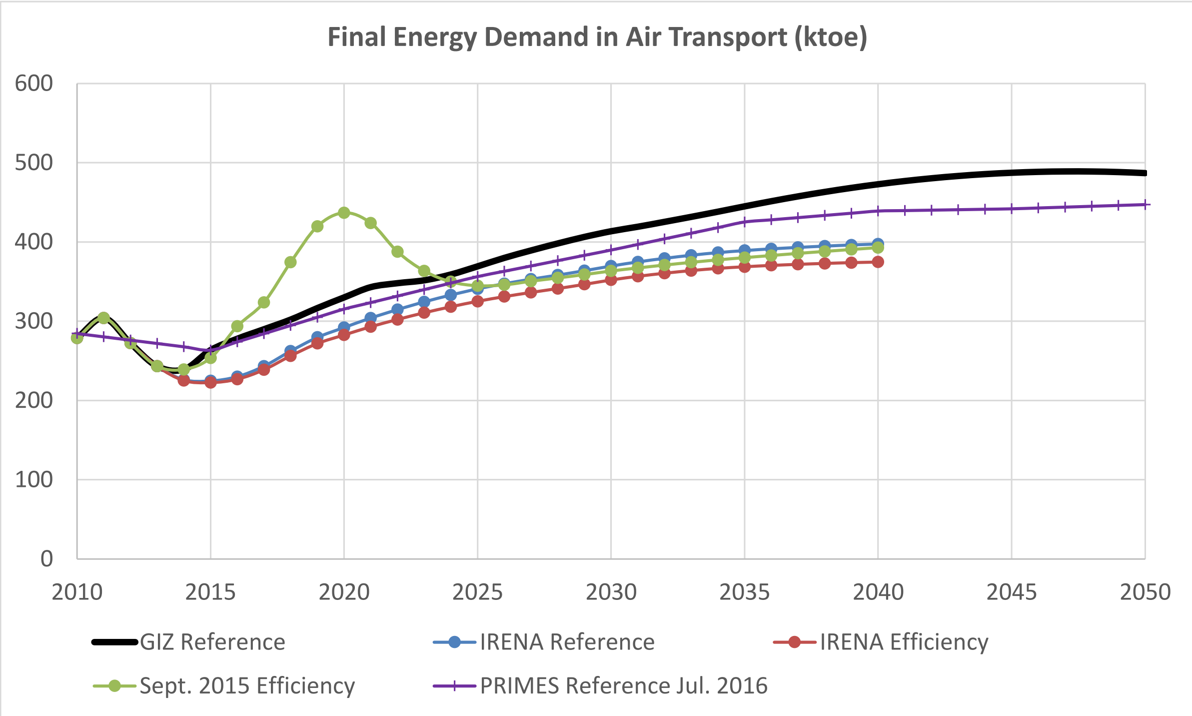


Figure IV.9: Projected evolution of fuel shares in road transport energy demand in Cyprus according to the Reference Scenario.

Finally, as shown in Figure IV.10, air transport is projected to continue its declining energy intensity after 2025, in line with the corresponding assumptions and projections of PRIMES. This will lead to an increased fuel demand, which however shows signs of saturation after the mid-2030s. All energy needs are projected to be met by aviation kerosene; no other fuel is expected to enter the aviation sector up to 2050.



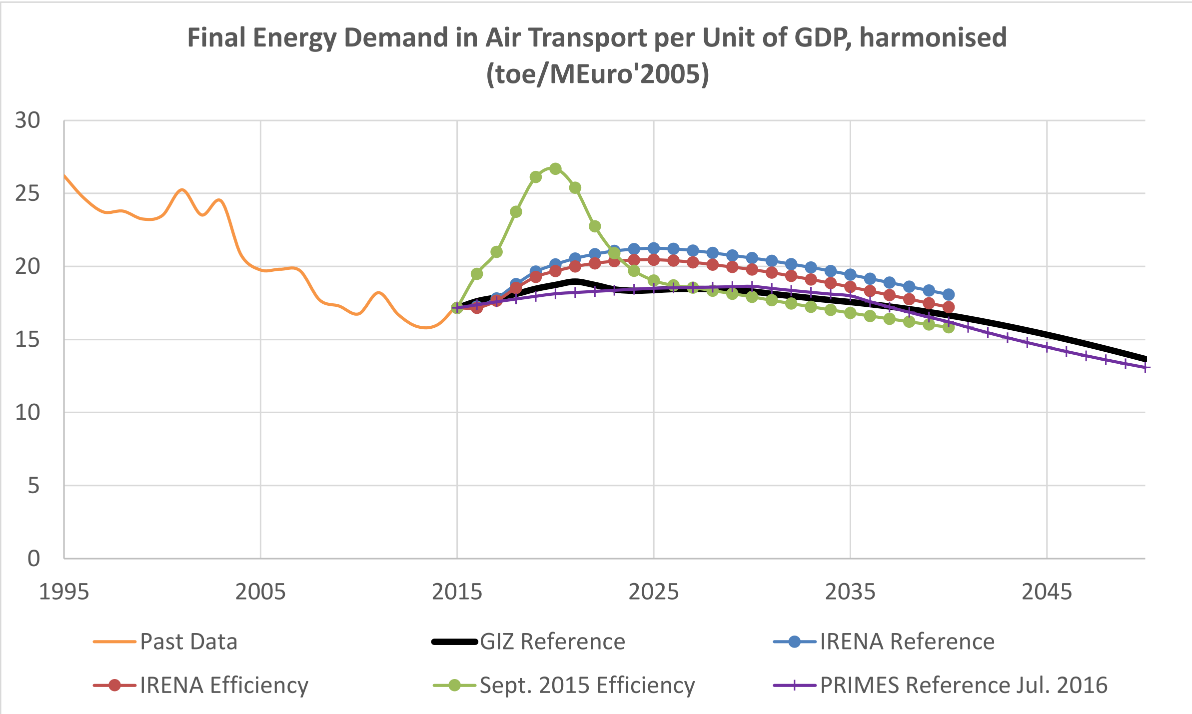


Figure IV.10: Final energy demand of air transport in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

IV.III.VI Agricultural sector

Assumptions

In line with the broader definition the Reference Scenario, it was assumed that agriculture continues with policies and measures that have either been implemented or are officially planned to be adopted.

Policies considered

In the absence of specific targets for the energy performance of agricultural installations, it was assumed that the agricultural sector will undergo a small and relatively slow modernisation process in the equipment and machinery used (off-road vehicles, generators, pumps), in line with overall energy policies of Cyprus.

Results

Figure IV.11 shows the projected evolution of energy use in agriculture according to the Reference Scenario, and compares it with that of three earlier scenarios: The projections of the 'Reference Scenario' and the 'Energy Efficiency Scenario' of the renewable energy roadmap study of 2014 (IRENA, 2015); and updated projections of the IRENA study's 'Energy Efficiency Scenario' with more recent macroeconomic and oil price assumptions, as of September 2015 (Zachariadis, 2015). Because of the different starting point of the earlier forecasts, they missed the increase in observed energy consumption of year 2015. Low oil prices, which are assumed to persist up to around 2020, contribute to a relatively high agricultural energy demand up to that year; form the next decade onwards energy consumption drops or remains essentially stable, which – because of continuously increasing economic output of agriculture in line with the macroeconomic assumptions explained in Section IV.III.I– implies a continuously declining energy intensity of the sector.

Moreover, as Figure IV.12 illustrates, fuel shares in the agricultural sector are expected to remain almost constant in the short and medium term. After 2030, an increased contribution from biomass and solar energy is projected, to the detriment of petroleum products such as gas oil and LPG.

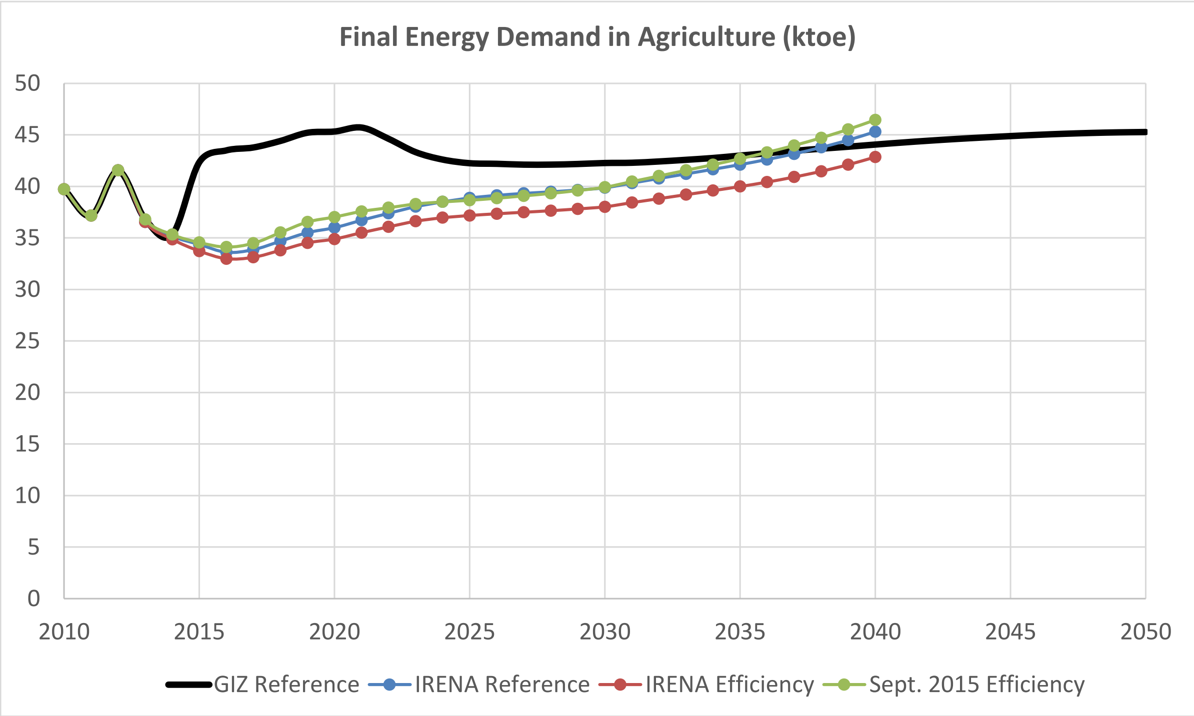


Figure IV.11: Final energy demand in agriculture in Cyprus according to the Reference Scenario (thick black line), and comparison with other recent projections.

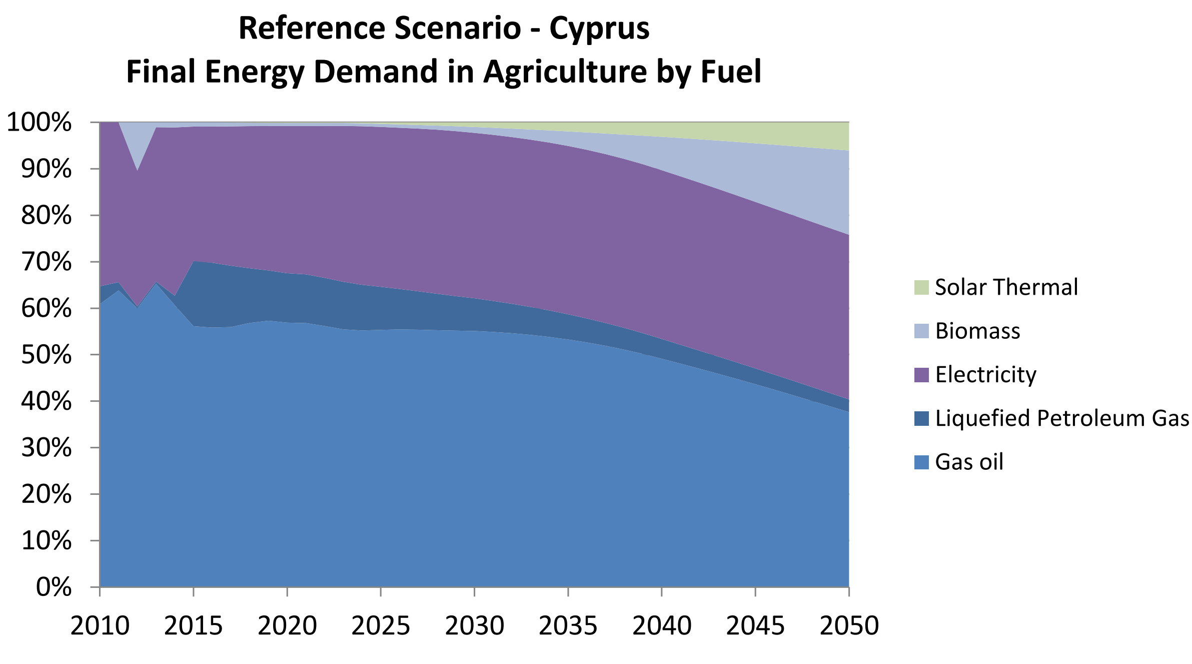
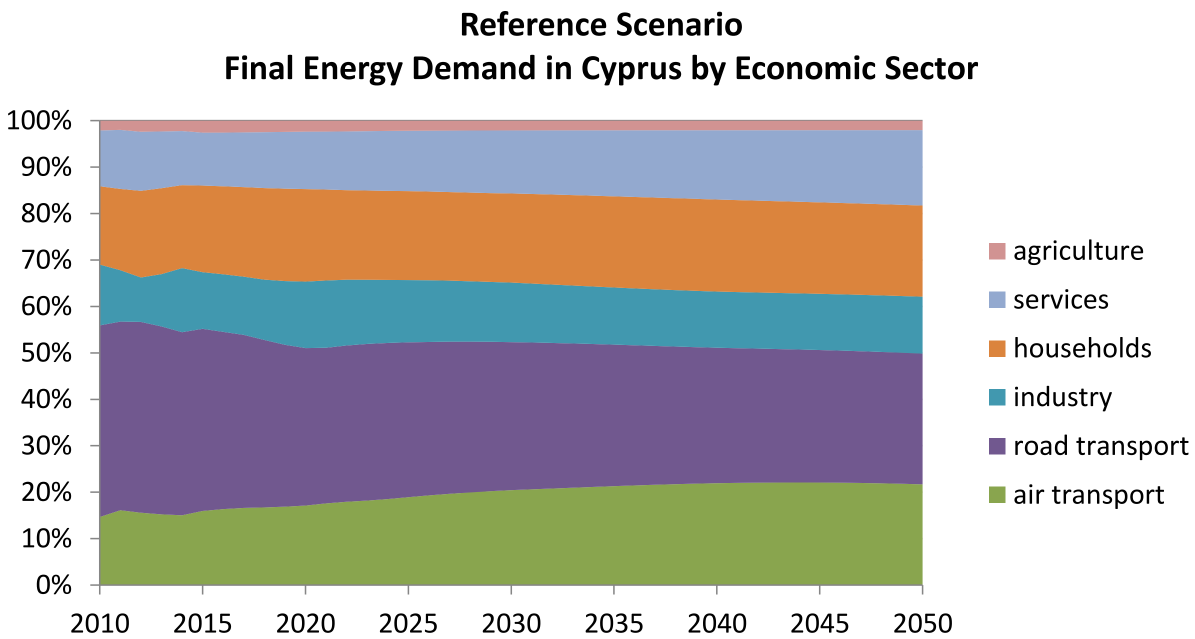


Figure IV.12: Projected evolution of fuel shares in agricultural energy demand in Cyprus according to the Reference Scenario.

IV.III.VII Aggregated results for the Reference Scenario

Bringing together the forecasts of individual sectors which were described in the previous Sections, Figure IV.13 presents the projected evolution of the sectoral and fuel shares in final energy demand according to the Reference Scenario. As no substantial changes in the economic structure of Cyprus are assumed, sectoral shares are expected to remain roughly at the pre-crisis levels with a partial exception of industry whose share in the economy is assumed to remain low. As regards fuel shares, a further electrification of the economy is projected, along with the gradual penetration of solar thermal (especially in services), biofuels (in road transport) and biomass (in all sectors but mainly in agriculture). Electrification in transport is projected to evolve slowly throughout the forecast period. The shares of electricity by sector and year are displayed in Figure IV.14.



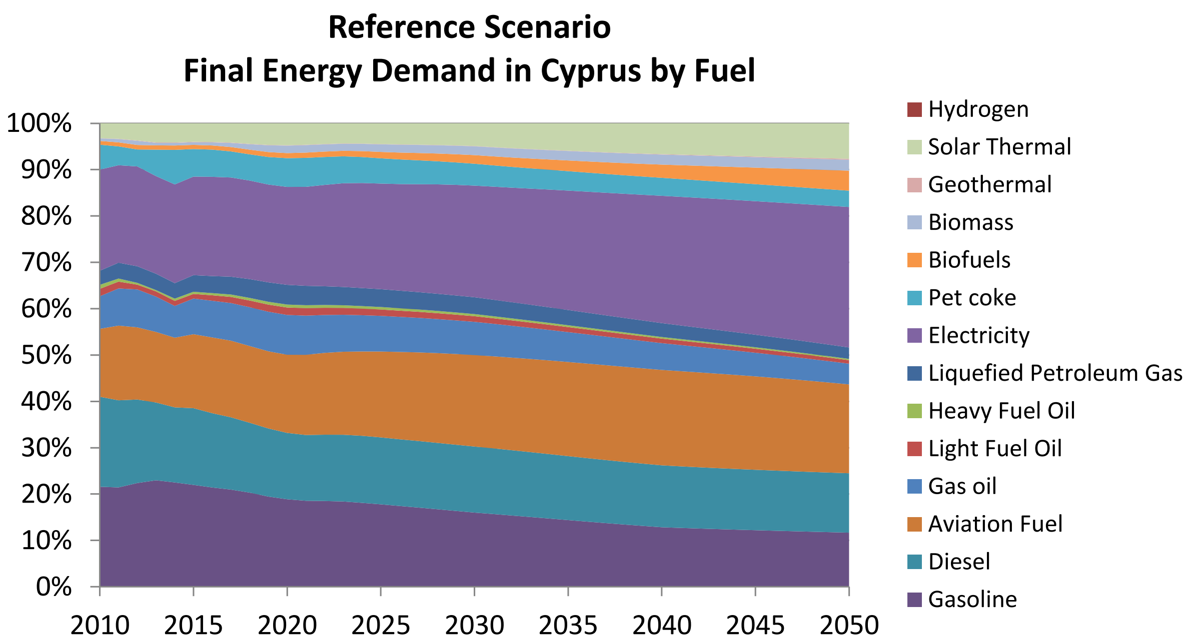


Figure IV.13: Projected evolution of sectoral and fuel shares of final energy demand in Cyprus according to the Reference Scenario.

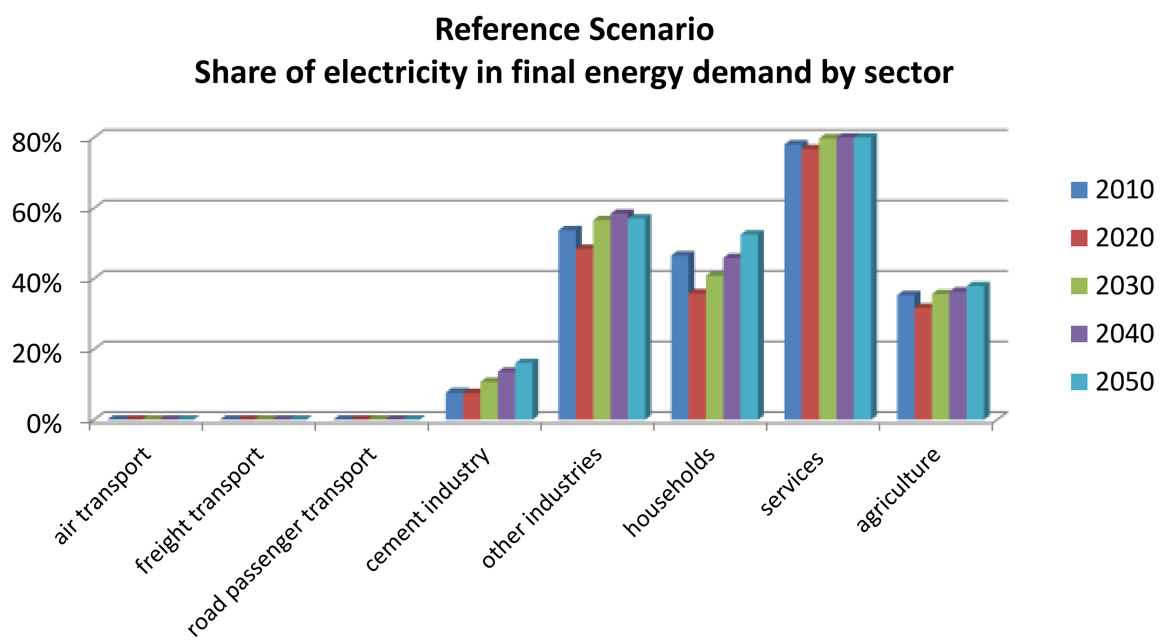
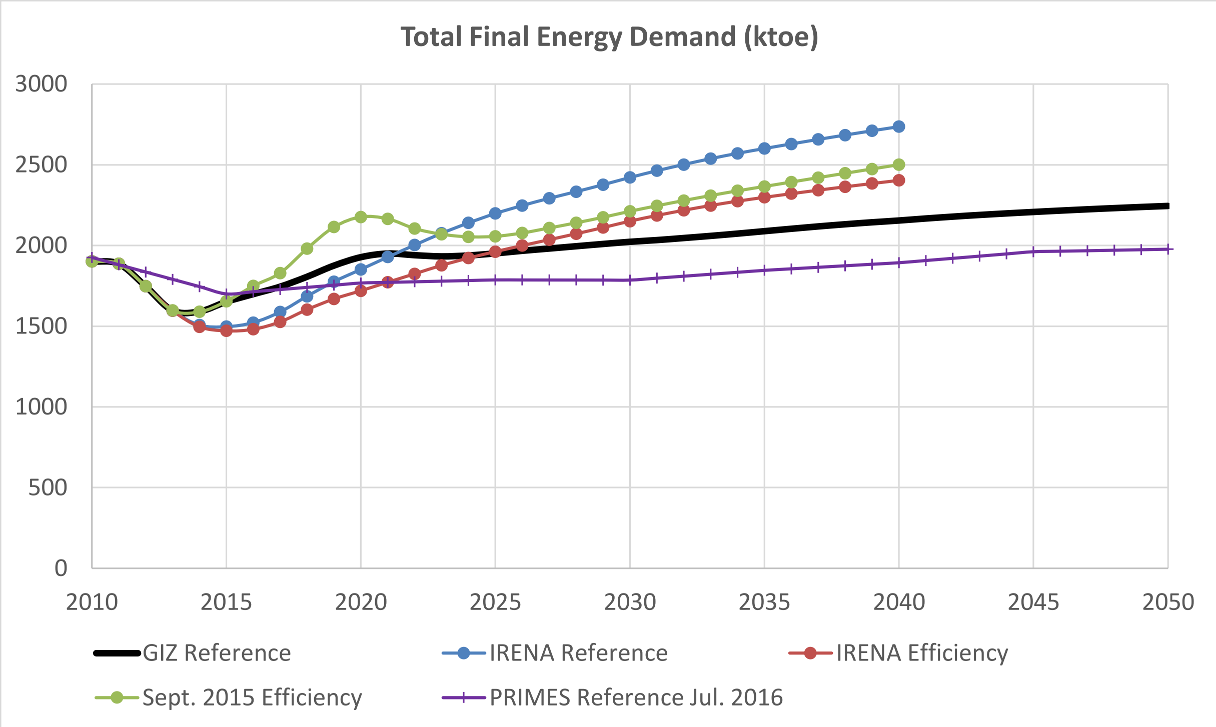


Figure IV.14: Projected evolution of the share of electricity in each main economic sector of Cyprus according to the Reference Scenario.

Figure IV.15 shows the forecast of final energy demand according to the Reference Scenario in absolute terms, and a comparison with earlier

Reference Scenarios as explained in the previous Sections. In order to control for the differences in base year and GDP assumptions and put the forecasts in perspective, the bottom part of Figure IV.15 illustrates projections of final energy intensity (aggregate energy demand per unit of GDP) normalised to year 2015, along with energy intensity data of the 1995-2015 period.

The comparison shows that aggregate energy intensity is expected to resume its historic declining trend after 2020. During the period 2013-2020, i.e. during the financial crisis and the rebound of the economy, energy intensity shows some signs of stabilisation or even a small increase. Technically, this trend is largely driven by the official forecast of electricity demand which, as explained above, comes from the Cyprus TSO for the period 2016-2025. It should be noted that TSO forecasts in recent years have successfully captured the fluctuations of electricity demand during a period characterised by high uncertainty – including years of strong economic recession followed by a faster-than-expected recovery of the national economy. The temporary stagnation or increase of energy intensity can be explained partly by the existence of low energy prices in 2014-2020 and partly by the slowdown of the renewal of energy-intensive capital stock (machinery, buildings and vehicles) as a result of the economic and financing constraints faced by firms and households during these years. In fact, it seems that the increase in energy intensity in 2014-2020 counterbalances the stronger-than-usual drop in intensity of years 2011-2013. After 2030, despite the absence of strong additional energy saving measures but thanks to the diffusion of very low energy buildings and fuel efficient vehicles, the Reference Scenario foresees a continuation in energy intensity improvements, at a similar rate with that of the 2020-2030 period.



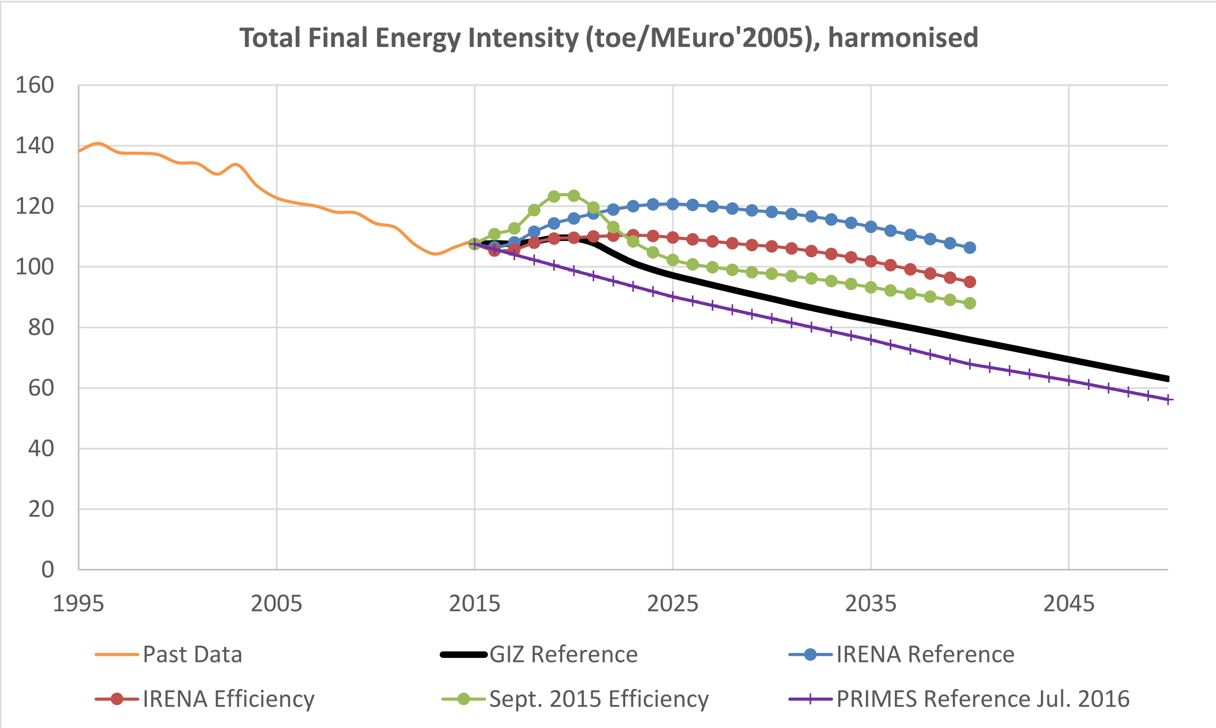


Figure IV.15: Final energy demand in Cyprus according to the Reference Scenario, and comparison with other recent projections in absolute terms (upper graph) and in harmonised energy intensity terms (bottom graph).

IV.IV Maximum Technical Potential Scenario

The findings of the bottom-up analysis with regard to the maximum theoretical energy saving potential in Cyprus, which were described in detail in Chapter III of this report, were adapted to the official energy statistics of year 2015 and were then used to develop the Maximum Technical Potential Scenario of this study. The following Sections describe the assumptions made specifically per sector.

This model analysis is not coupled with any policies or measures and should not be approached as a policy scenario, since it is not integrating at all the expenditure volume as well as the market capability to respond. On the contrary this scenario should act merely as an indicator of the existing potential and therefore to evaluate in qualitative market terms the possibility to achieve a smaller energy saving potential if the appropriate measures and support schemes are adopted and by expecting a market realistic impact factor[11].

IV.IV.I Household sector

Assumptions

Theoretically, if sufficient financial resources and human capital are available, it should be possible to refurbish all residential building stock in order to explore its maximum energy saving potential within a short period of time – even within a decade. In the long run, after these refurbishments are completed, the remaining further technological improvements would mainly involve the introduction of advanced automation systems and the use of very highly efficient technologies that would enable further energy savings.

However, a fast and thorough investment in renovations of residential buildings would require an unprecedented mobilisation of financial and human resources, of the order of around 15 billion EUR or about the

[11] Meaning that while a cap of the available expenditure should be placed in order that the projections to be as much as possible market realistic, even the provision of this constraint cap should expect in order to be fully absorbed that should target a small to medium percentage of the possible beneficiaries. Moreover the purchasing power of the end-users is always the most-critical element for the success factor of any foreseen policies and under this scenario this parameter is not assessed at all.

country's current annual GDP. These resources are highly unlikely to exist over a period of a few years. Moreover, a small fraction of these renovations should rather be considered as technically unrealistic even in the long run.

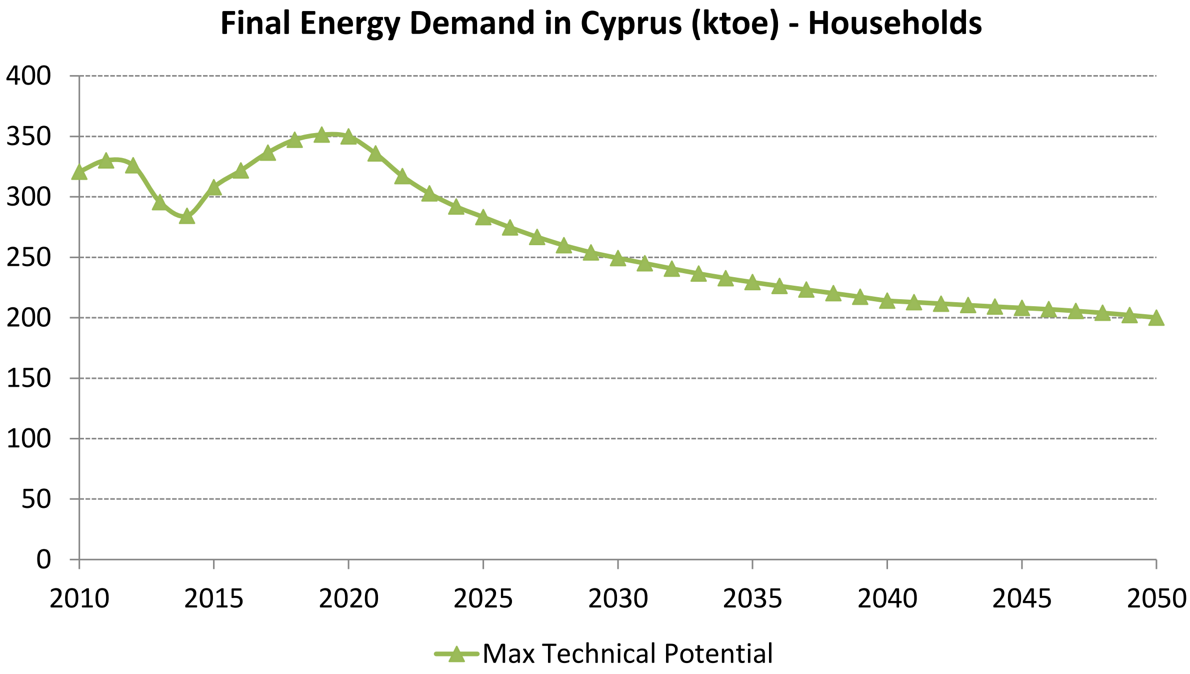
Therefore, in the Maximum Technical Potential Scenario it was assumed that the theoretical potential will be realized by 95% in the household sector; in other words, we assumed that one in twenty residential building renovations will not be practical to be implemented. As far as the rate of these renovations/replacements is concerned, we assumed that they will take place at a gradual rate in order to be in line with renovation / refurbishment rates that are technically and financially ambitious but realistic. For residential buildings the necessary investments were assumed to take place until 2040. For the rest of the forecast horizon up to 2050, some further technological improvements were assumed due to the introduction of automations or other highly efficient technologies that may exist in the coming decades. In order to allow a benchmarking for the achievement of the maximum technical potential, this would require about 18,600 residential buildings to be affected, if deep renovations are foreseen, for each year from 2018 to 2040, at an investment cost of around 648 mil €/year.

Policies considered

The main policy considered was the mobilization and investment of public funds in order to mobilise adequate private funds that would enable the renovation of 95% of the existing residential building stock to nearly-zero energy buildings.

Results

Figure IV.16 presents the projected final energy consumption and energy intensity of households up to 2050, and Figure IV.17 shows the fuel mix of the sector according to the Maximum Technical Potential Scenario. A significant decrease in household energy needs is forecast in this scenario, resulting from an even stronger decline in energy intensity – which is expected to fall to one third of today's levels by 2050.



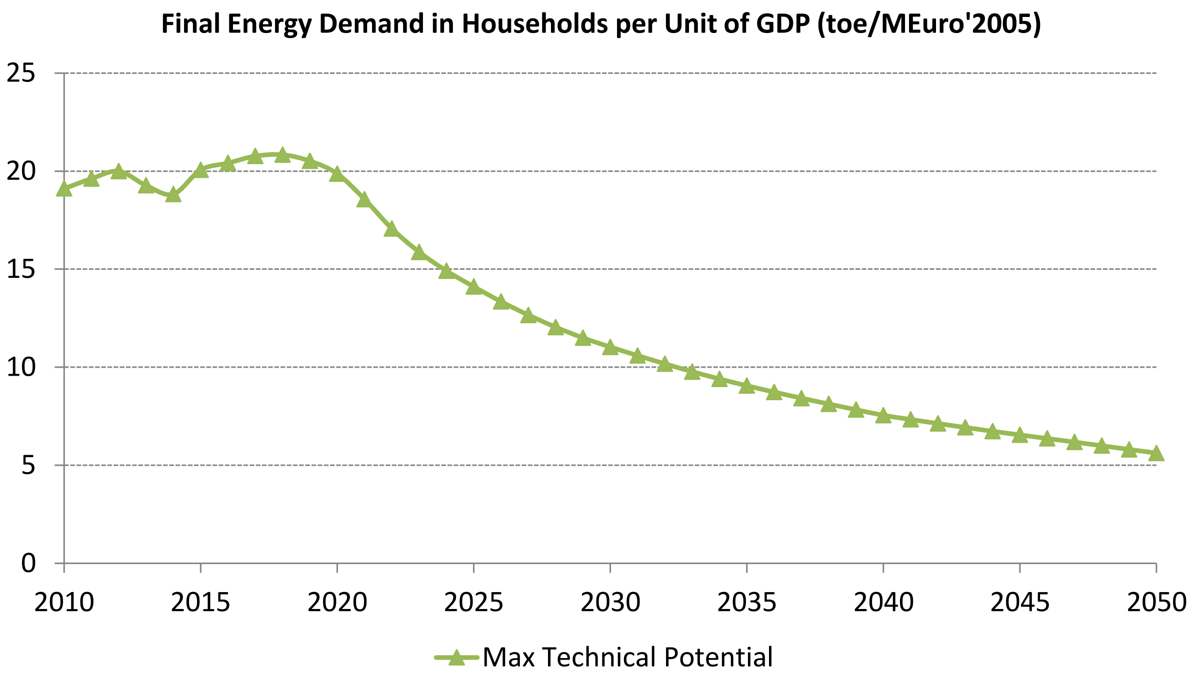


Figure IV.16: Final energy demand and energy intensity in households according to the Maximum Technical Potential Scenario.

In line with the methodology and the assumptions for deriving the maximum theoretical potential for energy savings in Chapter III, the share of gas oil and biomass gradually diminishes in residential buildings, whereas electricity and LPG gain shares, although the use of these energy forms declines in absolute terms because of the strong implementation of energy efficient buildings, equipment and appliances. As a result, the only fossil fuel to be used in buildings by 2050 is projected to be LPG; all other household energy needs are projected to be covered by electricity and solar-generated heat – plus a very small fraction of biomass in the service sector. Despite this electrification trend, the share of electricity in total energy consumption declines between today and 2050, especially in the service sector; this is a result of the improvement in the energy efficiency of electric heating (heat pumps), lighting and appliances, which is expected to be considerably stronger than the improvements in LPG-fired boilers used for heating and hot water production.

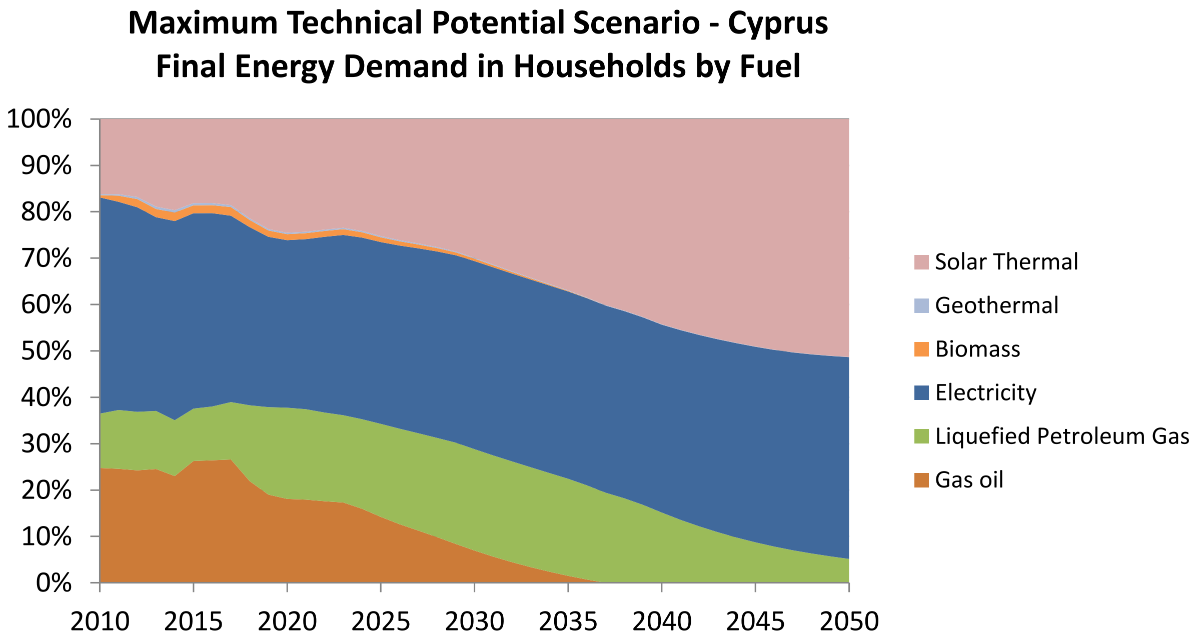


Figure IV.17: Fuel shares in household energy demand according to the Maximum Technical Potential Scenario.

IV.IV.II Services sector

Assumptions

As already laid out in chapter IV.IV.I if sufficient financial and human capital would be available a refurbishment of all commercial buildings stock and replacement of the associated appliances and equipment could be realised within a relatively short time of 5-6 years up to a decade. In the long run, after these refurbishments are completed, the remaining further technological improvements would mainly involve the introduction of advanced automation systems and the use of very highly efficient technologies that would enable further energy savings.

However, a fast and thorough investment in renovations of buildings and equipment would require an unprecedented mobilisation of financial and human resources, of the order of ten (10) billion Euros (two thirds of the country's current annual GDP) which are highly unlikely to exist; moreover, a small fraction of these renovations should rather be considered as technically unrealistic even in the long run. Therefore, in the Maximum Technical Potential Scenario it was assumed that this maximum potential will be realized by 90% in the service sector; in other words, we assumed that one in ten service sector building renovations will not be practical to be implemented. As far as the rate of these renovations/replacements is concerned, we assumed that they will take place at a gradual rate in order to be in line with renovation / refurbishment rates that are technically and financially ambitious but realistic. For commercial buildings the necessary investments were assumed to take place until 2040. For the rest of the forecast horizon, some further technological improvements were assumed.

In order to have – as in the household sector – a benchmarking index, the achievement of the savings until 2040 translates to an annual needed investment cost of around 409 mil € for the period 2018-2030.

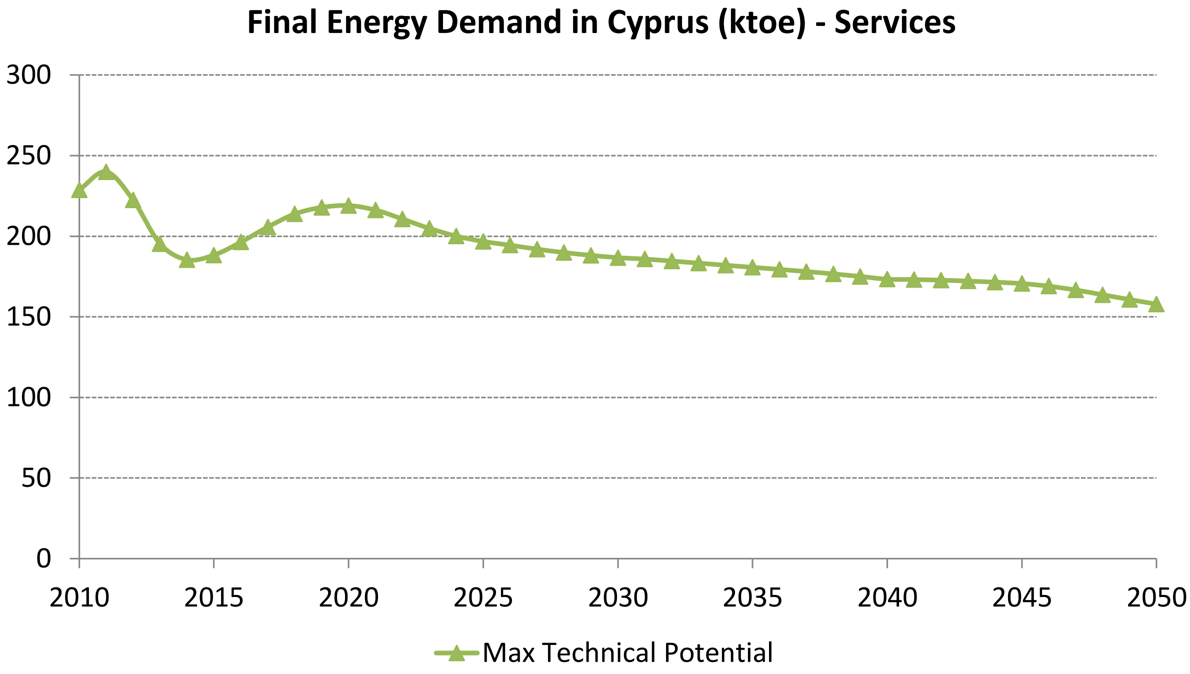
Policies considered

The main policy considered was the mobilization and investment of public funds in order to mobilise adequate private funds that would enable the renovation of 90% of the existing building stock of the service sector to nearly-zero energy buildings, and to replace equipment, lighting and appliances with modern very efficient ones.

Results

Figure IV.18 presents the projected final energy consumption and energy intensity of services up to 2050, and Figure IV.19 shows the fuel mix of the sector according to the Maximum Technical Potential Scenario. After some rebound in the current decade, energy needs are forecast to drop substantially throughout the forecast period, with energy intensity falling to one third of today's levels.

In line with the methodology and the assumptions for deriving the maximum theoretical potential for energy savings in Chapter III, the share of gas oil gradually diminishes in the service sector, whereas electricity and LPG gain shares, although the use of these energy forms declines in absolute terms because of the strong implementation of energy efficient buildings, equipment and appliances. As a result, the only fossil fuel to be used in this sector by 2050 is projected to be LPG; all other service energy needs are projected to be covered by electricity and solar-generated heat – plus a small fraction of biomass. Despite this electrification trend, the share of electricity in total energy consumption declines substantially between today and 2040; this is a result of the improvement in the energy efficiency of electric heating (heat pumps), lighting and appliances, which is expected to be considerably stronger than the improvements in LPG-fired boilers used for heating and hot water production.



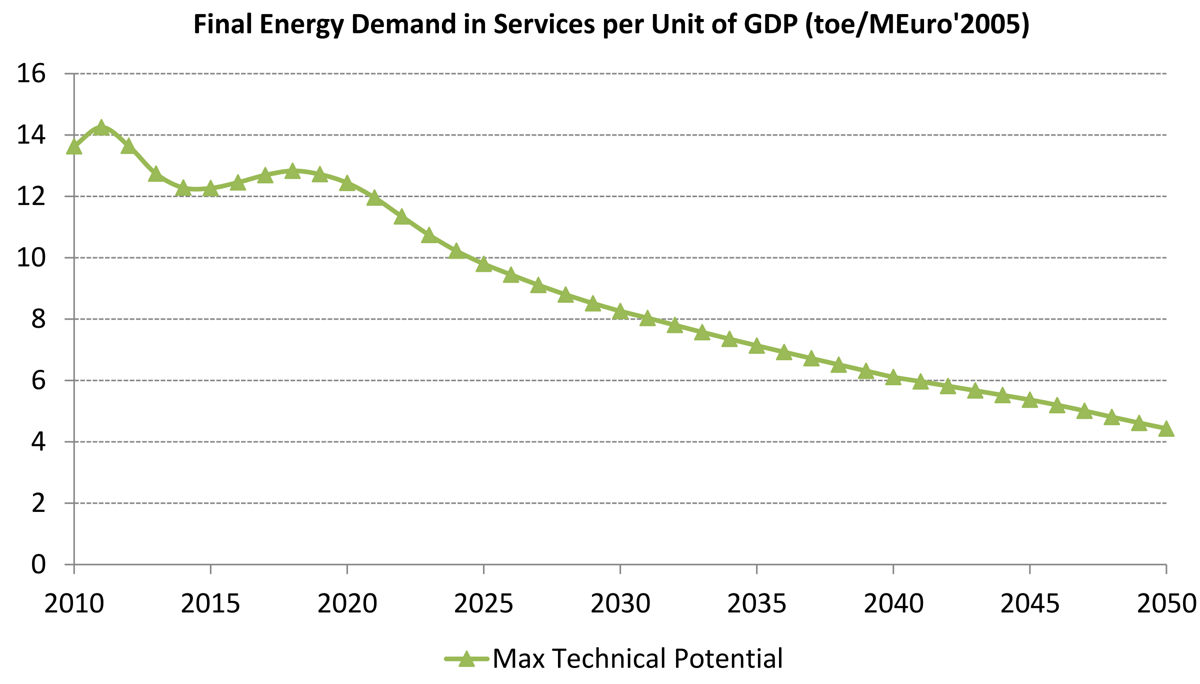


Figure IV.18: Final energy demand and energy intensity in services according to the Maximum Technical Potential Scenario.

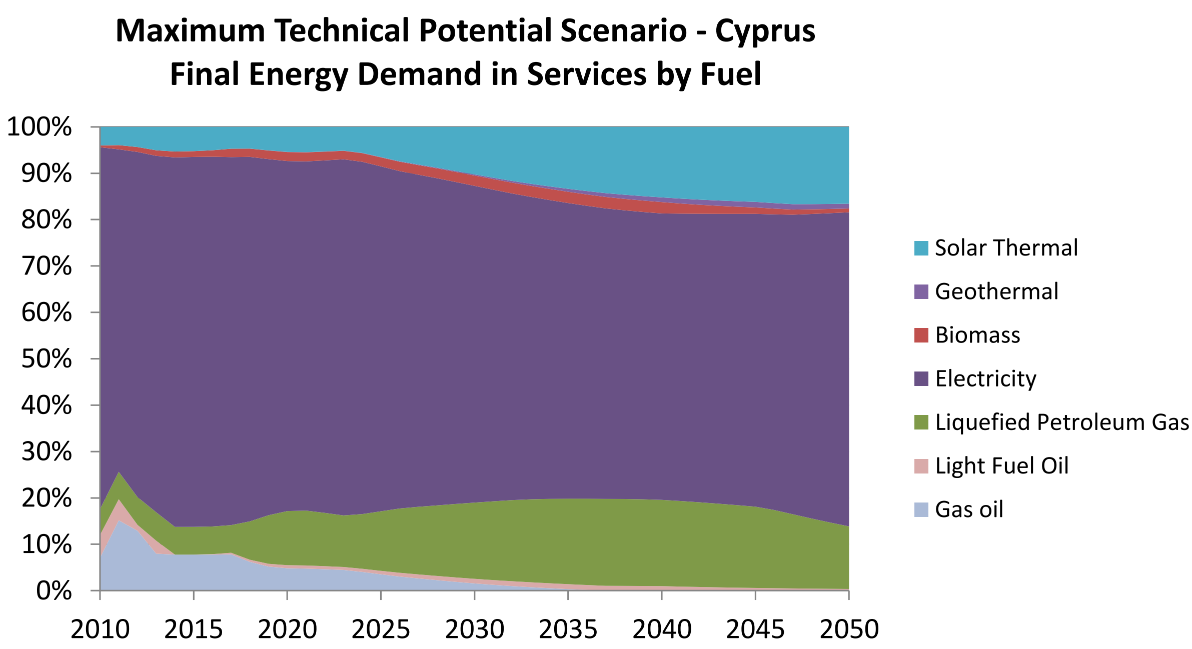


Figure IV.19: Fuel shares in service energy demand according to the Maximum Technical Potential Scenario.

IV.IV.III Industry sector

Assumptions

Assuming the availability of ample financial resources and human capital, it should be possible to replace a significant part of the existing industrial equipment in order to explore the sector's maximum energy saving potential within a few years. In the long run, after these refurbishments are completed, the remaining further technological improvements would mainly involve the introduction of advanced automation systems and the use of very highly efficient technologies that would enable further energy savings.

However, a fast and thorough investment in such renovations of industrial equipment would require high financial resources, which are highly unlikely to be available in either the public or the private sector; moreover, a small fraction of these investments should be considered as unrealistic even in the long run. Therefore, in the Maximum Technical Potential Scenario it was assumed that this maximum potential will be realized by 93% in the industrial sector – meaning that one in fifteen industrial equipment replacements will not be practical to be implemented. As far as the rate of these renovations/replacements is concerned, we assumed that they will take place at a gradual rate in order to be in line with replacement rates that are technically and financially ambitious but realistic. For the industrial sector, it was assumed that the total energy saving potential can be exploited until the year 2030, and then some further technological improvements with the deployment of highly efficient equipment and appliances were assumed up to 2050.

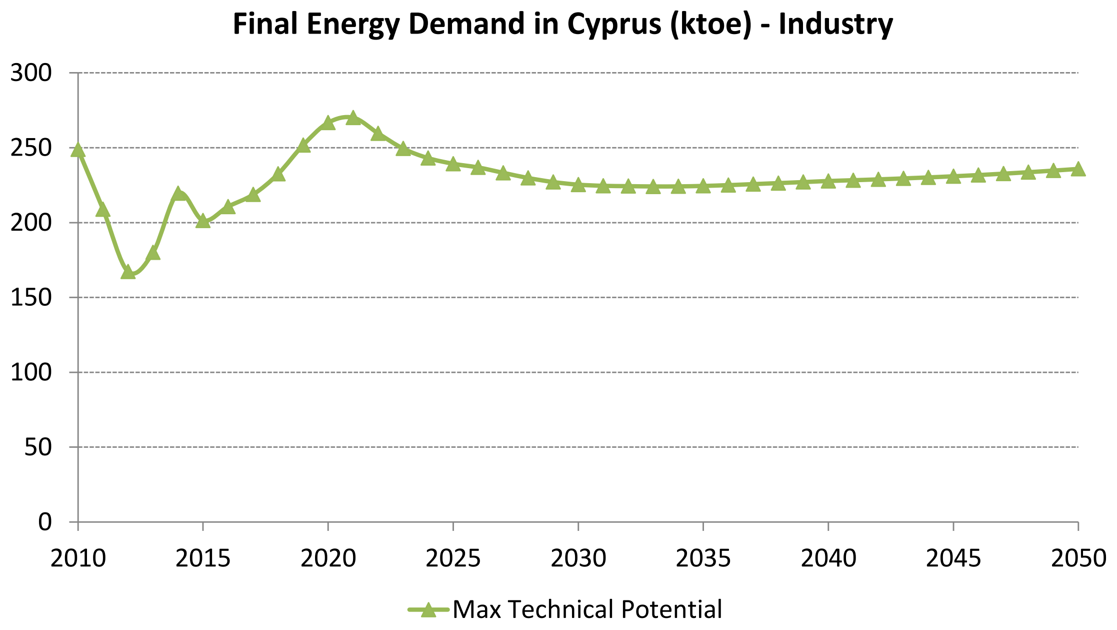
Policies considered

The main policy considered was the mobilization and investment of public funds in order to mobilise adequate private funds that would enable the renovation of 93% of the existing industrial equipment (compressed-air system, motors, inverters etc.) with modern very efficient one.

Results

Figure IV.20 presents the projected final energy consumption and energy intensity of the industrial sector up to 2050, and Figure IV.21 shows the fuel mix of the sector according to the Maximum Technical Potential Scenario. Despite the considerable improvement in energy intensity, which is projected to be at half of today's levels by 2050 and markedly lower than that of the Reference Scenario, energy use is expected to start rising again – albeit at low growth rates – after the mid-2030s when all major energy efficiency investments foreseen in this scenario will have been accomplished.

Due to the diversity of activities and end uses in the industrial sector, almost all fuels will continue to be used in the future, even in this scenario. The growth in electrification will be counterbalanced by the significant improvement in the energy efficiency of electricity-intensive industrial processes.



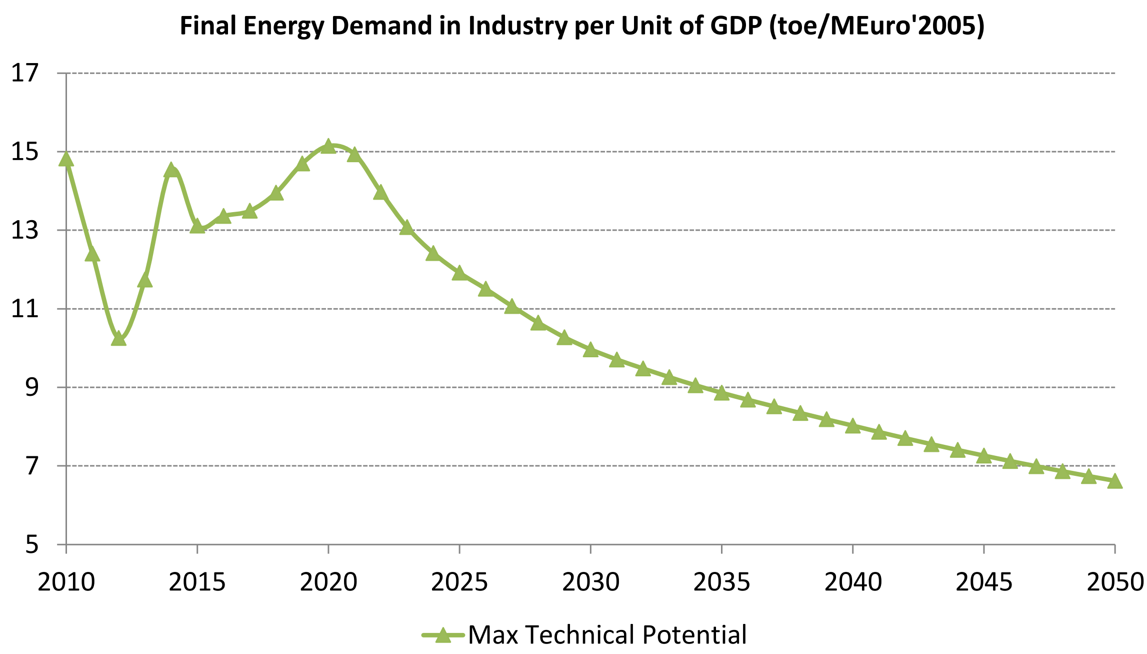


Figure IV.20: Final energy demand and energy intensity in industry according to the Maximum Technical Potential Scenario.

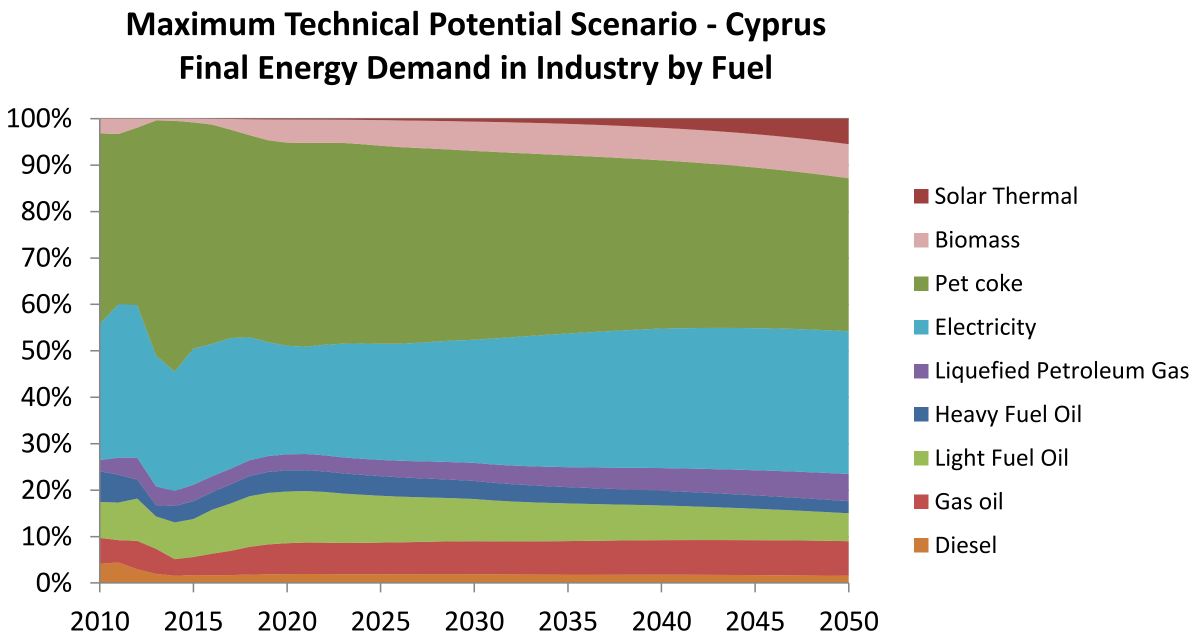


Figure IV.21: Fuel shares in industrial energy demand according to the Maximum Technical Potential Scenario.

IV.IV.IV Transport sector

Assumptions

In addition to the assumptions of the Reference Scenario, some further measures improving the fuel efficiency of motor vehicles were assumed. These are outlined below. In line with assumptions made for other economic sectors in this Scenario, no changes in transport activity, public transport infrastructure and behavioural aspects were considered. This means that the modal split in both passenger and freight transport was kept constant with that of the Reference Scenario. Assumptions about policies to enable the penetration of alternative fuels such as biodiesel, bioethanol, CNG and electricity are explained in detail in the report of Work Package 5 of this study.

Policies considered

Apart from the policies that were taken into account in the Reference Scenario, three additional measures were considered:

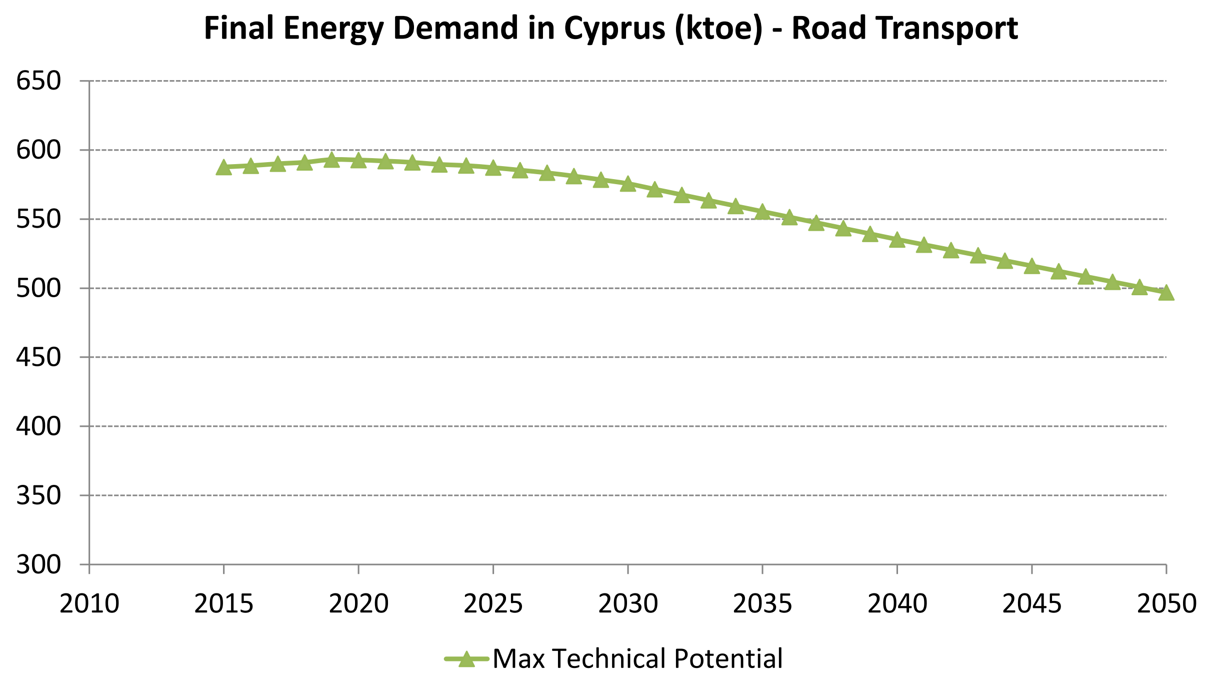
- A strengthening of the legislation on CO_2-based taxation of new cars, which was assumed to take place shortly before 2020. With the current tax system, whose implementation started in 2014, the share of low-CO2 cars (<120 g/km) in first registrations has increased substantially. As a result, the average CO_2 emissions of new cars have dropped from 158 g/km in 2012 to 130 g/km in 2015. A part of this is due to overall technical progress in cars, but a part is due to the changes in the tax system. Currently, both the one-off registration tax and the annual circulation tax paid for newly registered cars are primarily based on CO_2 emissions. Cars with emissions < 120 g/km pay zero custom-tax. It is foreseeable that, due to technical progress, the emissions class for which a zero tax is paid moves downwards, to less than 95 g/km (which is the CO_2 emission target standard imposed at EU level for 2020). If such a change is implemented, it is expected to lead to an increase in the share of very-low-CO_2 cars, which can lead to a reduction of the average CO_2 emissions and fuel consumption of new cars by 5-10%.
- As regards in-use cars, in addition to periodic tests that each car undergoes every two years, it was assumed that the Transport Ministry strengthens random roadside inspections of cars. As a result, a number of cars will have to undergo some more serious maintenance work; in this Scenario it was assumed that this can improve on-road fuel economy of all cars by 2% in the short term and by up to 5% up to 2050.

- In freight transport, it is very challenging to implement measures to improve the energy efficiency of trucks. It was therefore assumed that roadside inspections will cause some small improvement in fuel consumption in the medium and long run. The current taxation system for trucks, which slightly differentiates tax levels according to the age and Euro emission standards of each truck, provides a negligible economic incentive for the purchase of more efficient trucks, and is unlikely to change soon.

Results

Figure IV.22 shows that energy intensity of road transport is projected to decline very substantially over the coming decades, thanks mainly to technical progress in the fuel efficiency of new cars and trucks. As shown in the Reference Scenario, this evolution is in line with that foreseen by the study of the European Commission (2016) with the aid of the PRIMES model; the Maximum Technical Potential Scenario results in somewhat lower energy intensity compared to the Reference Scenario due to the implementation of the additional policies outlined in the previous paragraphs. Despite the sustained economic growth assumed in this study, total energy demand of road transport is expected to peak around 2020 and then start decreasing continuously.

As is evident from Figure IV.23, this Scenario forecasts a sizeable penetration of alternative fuels, starting after 2025 and rising considerably until 2050. Compressed Natural Gas and electricity (primarily in passenger cars and to a lesser extent in light and heavy trucks) are projected to reach 12% and 8% of total energy consumption in 2050, respectively. The use of biofuels is expected to peak around 2020, with their share reaching 5% of total road transport energy demand; they will consist mainly of biodiesel but also some amounts of bioethanol (ETBE).



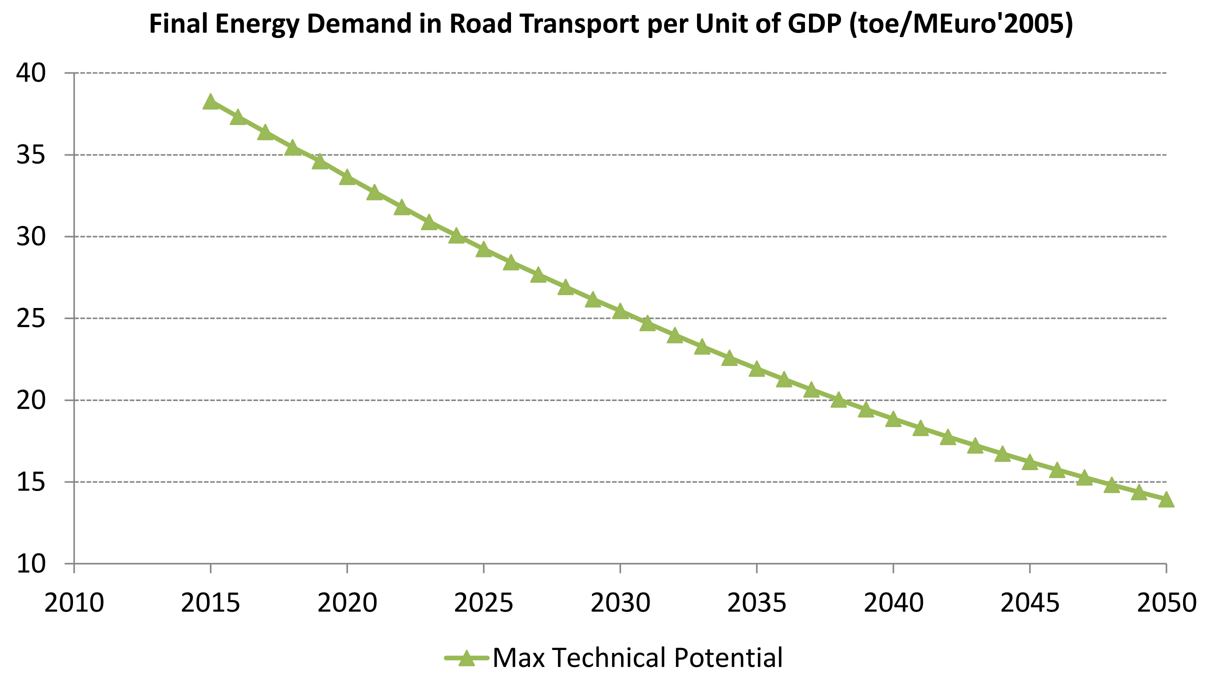


Figure IV.22: Final energy demand and energy intensity in road transport according to the Maximum Technical Potential Scenario.

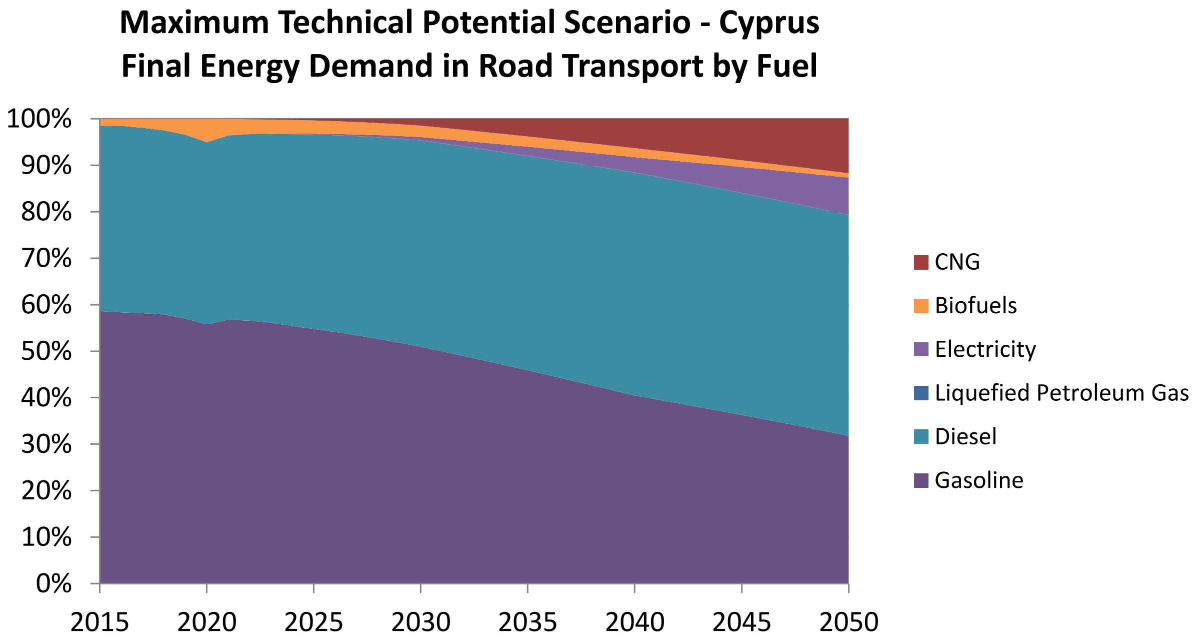


Figure IV.23: Fuel shares in road transport according to the Maximum Technical Potential Scenario.

IV.IV.V Agricultural sector

Assumptions

The technical potential for energy efficiency improvements in agriculture seems to be relatively limited – e.g. in comparison to the corresponding one in buildings – especially since the available potential for co-generating heat and power from animal waste has largely been exploited in Cyprus, with 14 biomass/biogas plants already operating in Cyprus with a total capacity of around 10 MW (Zachariadis and Hadjikyriakou, 2016). Therefore, this scenario assumes mainly an extensive modernisation of the available stock of equipment and machinery used in agriculture.

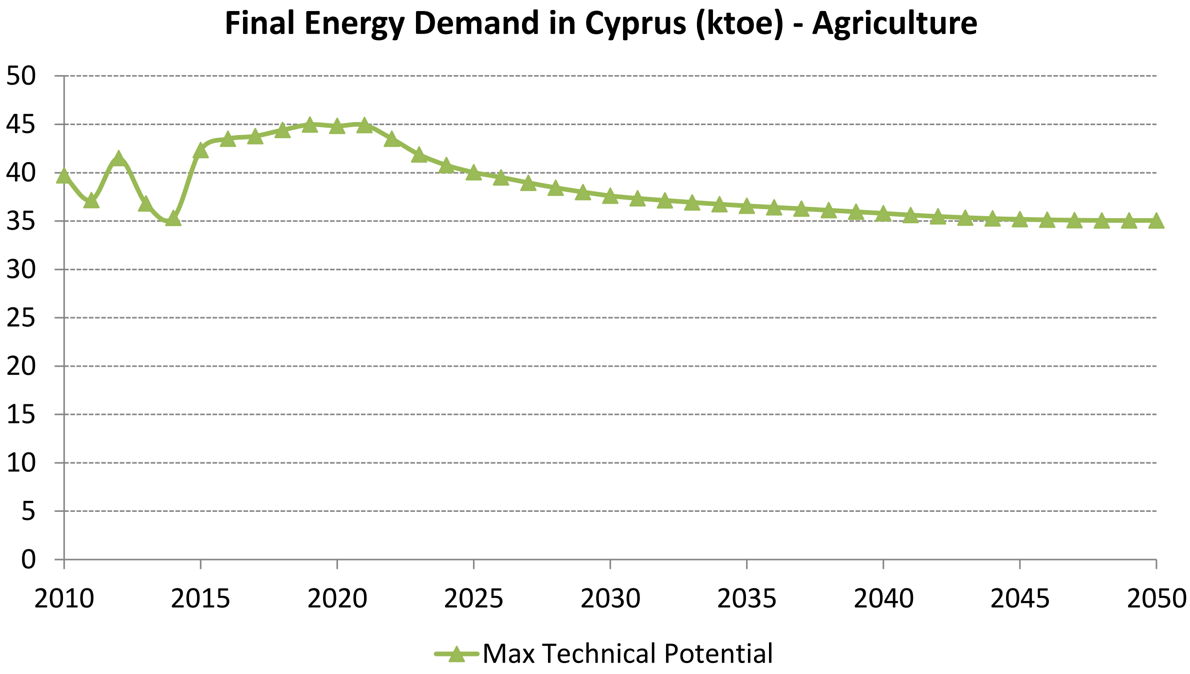
Policies considered

The main policy considered was the investment of public funds that could to mobilise the corresponding private funds in the agricultural sector which would enable the substitution of old machinery (off-road vehicles, generators, pumps) with modern very efficient one.

Results

Figure IV.24 presents the projected final energy consumption and energy intensity of agriculture up to 2050, and Figure IV.25 shows the fuel mix of the sector according to the Maximum Technical Potential Scenario. Energy intensity is expected to drop substantially, starting from today's situation. As a result, final energy demand of the sector is projected to fall, especially after 2020 – in contrast to demand in the Reference Scenario where the falling intensity was not enough to counterbalance economic output growth and therefore agricultural energy consumption continued to increase even up to 2050.

Due to the diversity of activities in the agricultural sector (open-air and greenhouse farming, with and without irrigation, animal breeding etc.), most fuel types will continue to be used in the future even in this scenario, with a large part of fossil fuels to be replaced by biomass over the years. The share of electricity is expected to remain stable or even fall slightly in the long term due to the significant improvement in the energy efficiency of electric equipment.



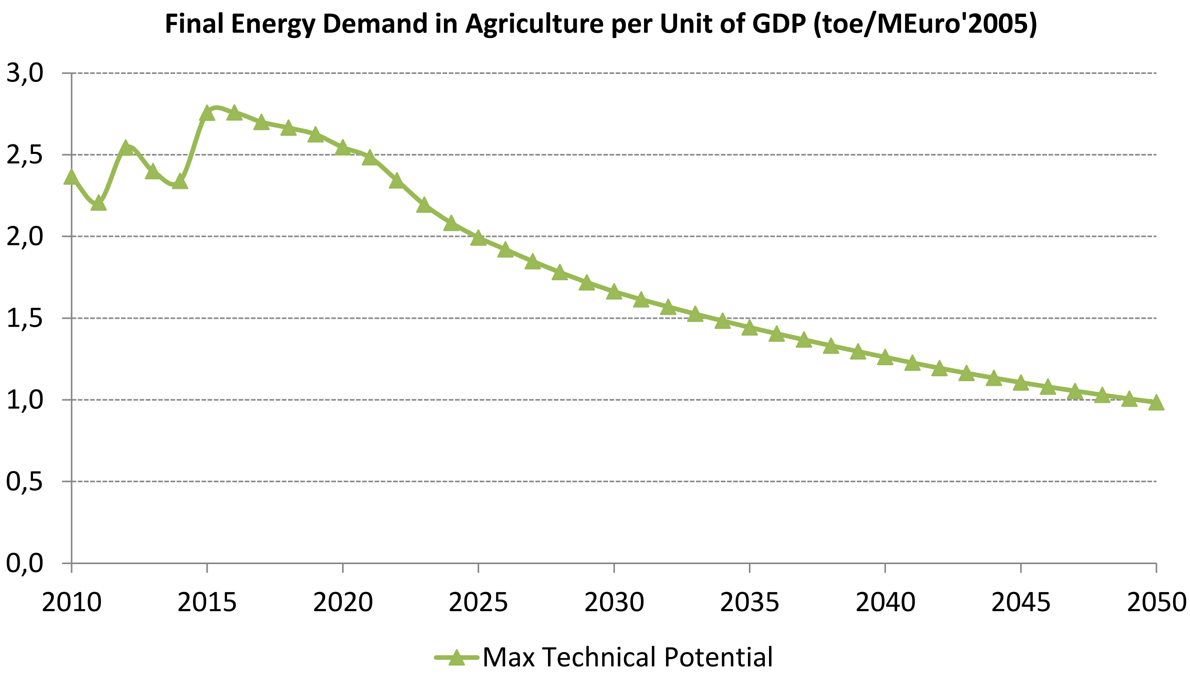


Figure IV.24: Final energy demand and energy intensity in agriculture according to the Maximum Technical Potential Scenario.

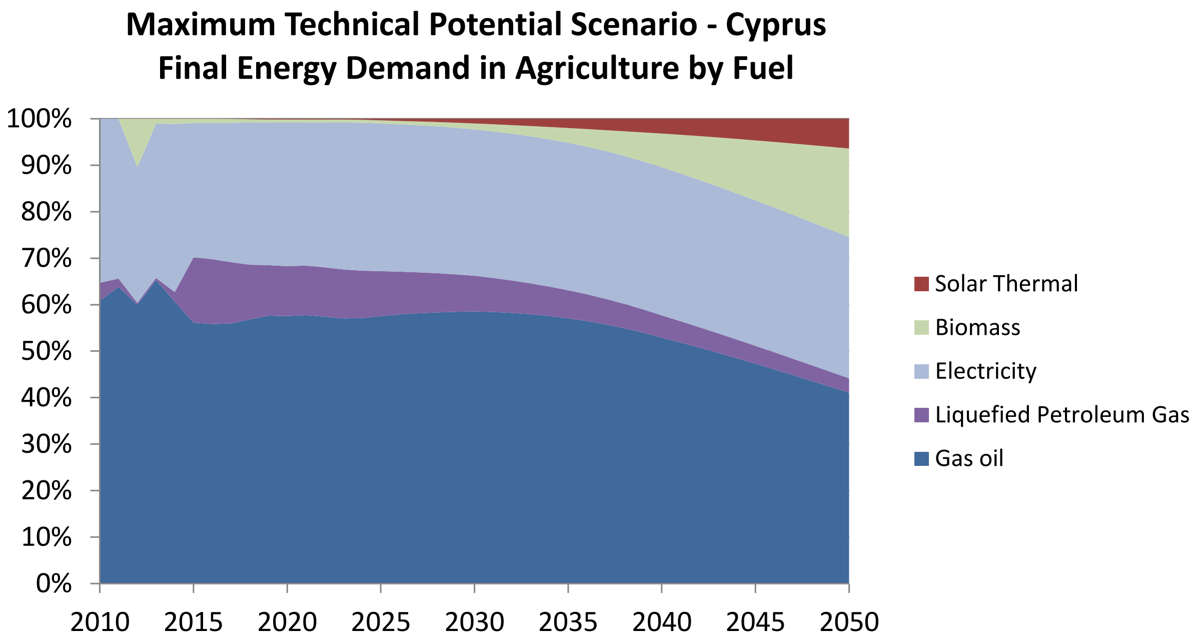


Figure IV.25: Fuel shares in agricultural energy demand according to the Maximum Technical Potential Scenario.

IV.V Realistic Scenario

The findings of the bottom-up analysis with regard to the economic energy saving potential in Cyprus, which were described in detail in Chapter III of this report, were adapted to the official energy statistics of year 2015 and were then used to develop the Realistic Scenario of this study. The following Sections describe the assumptions and results per sector.

IV.V.I Household sector

Assumptions

Based on the analysis presented in Chapter III, it was assumed that the following energy interventions will have priority in order to improve the energy efficiency of the current residential building stock:

(a) Insulation of the horizontal elements (roof, ceiling, etc.)
(b) Insulation of the vertical elements (reinforced elements, masonry)
(c) Installation of shading devices
(d) Installation of high efficiency windows (frame and glasses)
(e) Installation of LED lighting bulbs
(f) Use of high efficiency heat pumps
(g) Use of solar thermal collectors
(h) Use of high efficiency boilers (in rural areas)

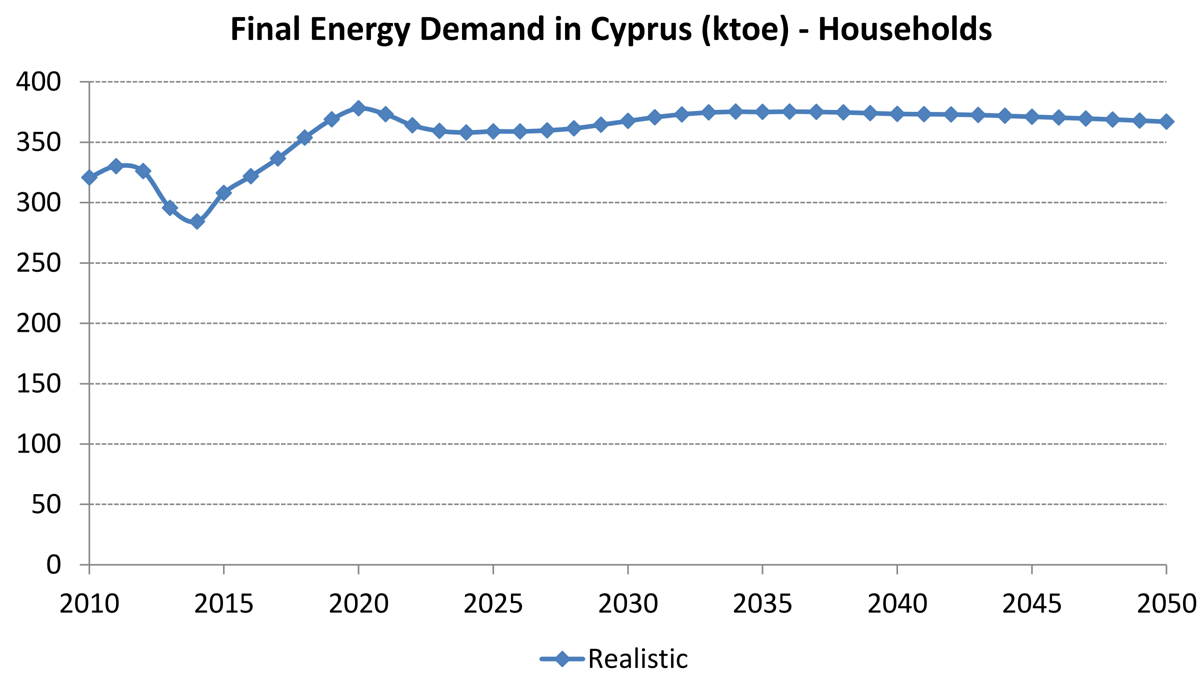
Policies considered

Based on the analysis of Zangheri (2016) and further calculations described in Chapter III, it was assumed that total expenditures of the order of 500 million EUR will be made for renovations in the household sector of Cyprus up to 2030, and similarly modest expenditures in the period 2030-2050. These financial resources will be devoted to investment grants, provision of credit lines, and education/information campaigns.

Results

Figure IV.26 presents the projected final energy consumption and energy intensity of households up to 2050 according to the Realistic Scenario. After some modest increase in energy intensity up to 2020, which however will be lower than in the Reference Scenario, a continuous decline in intensity is projected, especially in the decade 2020-2030, when the economic energy saving potential will be exploited with an expenditure of about 500 million EUR. As a result, annual energy needs are expected to remain essentially constant up to 2030 in spite of the strong economic growth. After 2030, the improvements in energy intensity continue at a similar pace because of the assumption on a continuation of the same level of expenditures, hence energy consumption is projected to remain constant or even start declining from around 2040 onwards, also due to further increasing energy prices. In short, the Realistic Scenario shows that exploiting the economic potential for energy savings in the household sector may be sufficient to stabilise household energy demand up to 2050 despite the projected strong economic growth; on the other hand, these measures are far from sufficient to ensure a path towards serious energy savings and strong decarbonisation, as is the EU target for 2050.

Figure IV.27 shows the fuel mix of the household sector according to the Realistic Scenario results. The evolution of fuel shares is similar to that of the Reference Scenario, with a somewhat faster decline in the importance of gas oil and biomass.



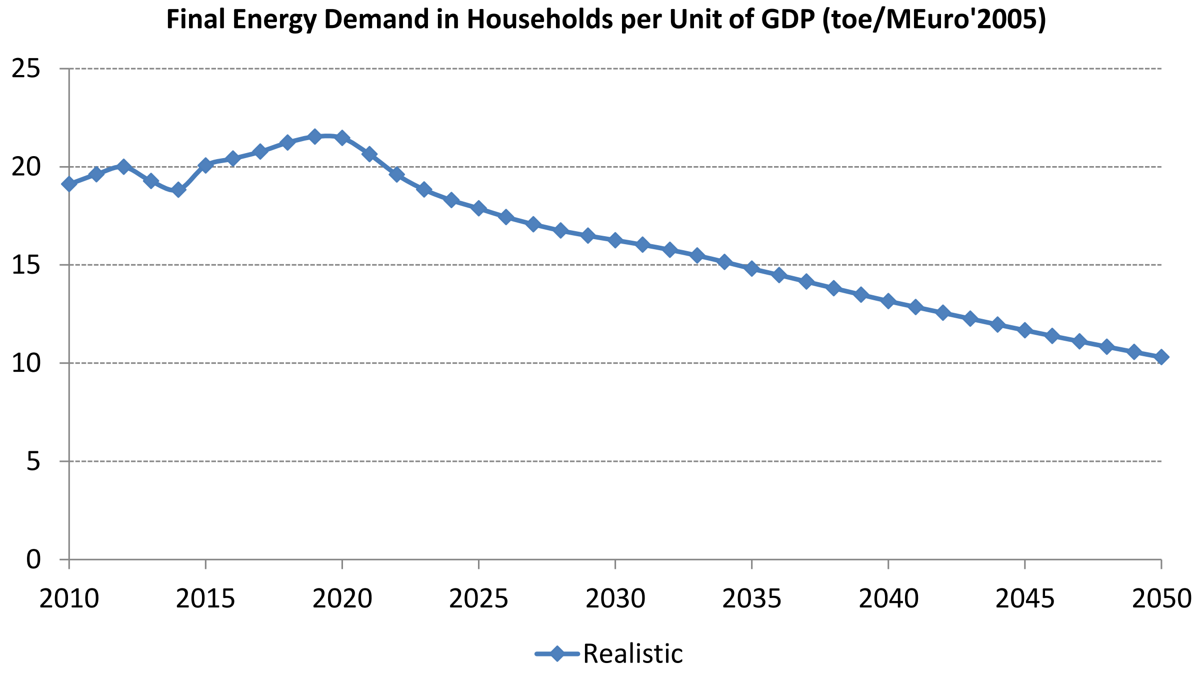


Figure IV.26: Final energy demand and energy intensity in households according to the Realistic Scenario.

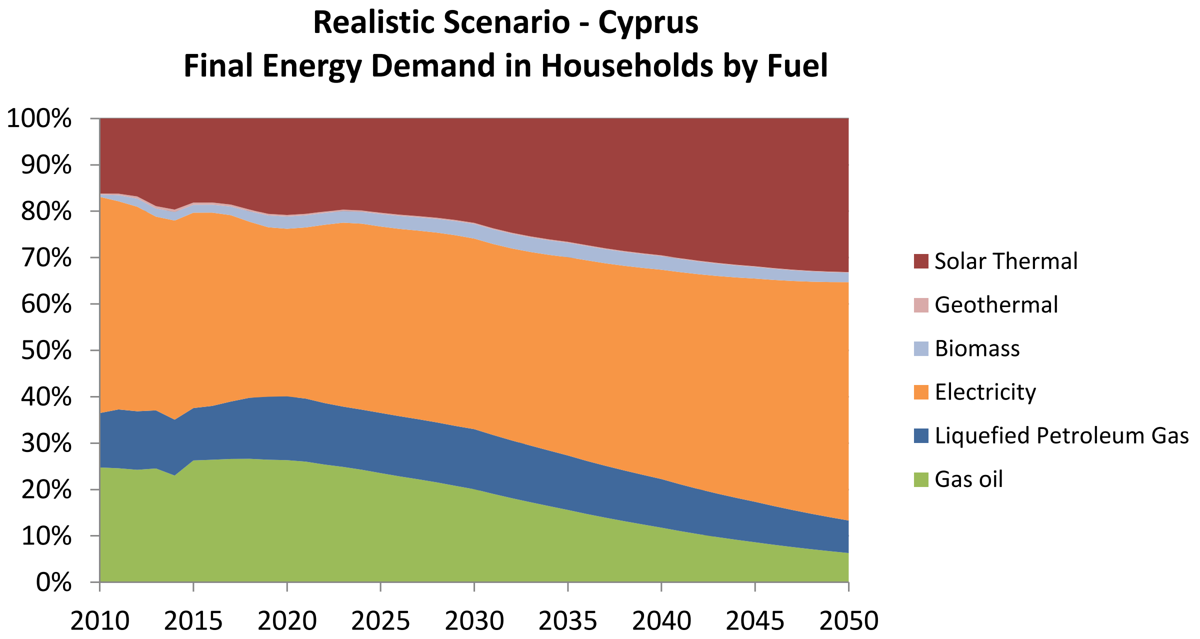


Figure IV.27: Fuel shares in household energy demand according to the Realistic Scenario.

IV.V.II Services sector

Assumptions

Based on the analysis presented in Chapter III, it was assumed that the following energy interventions will have priority in order to improve the energy efficiency of the current stock of buildings and equipment in the service sector:

(a) Insulation of the horizontal elements (roof, ceiling, etc.)

(b) Insulation of the vertical elements (reinforced elements, masonry)

(c) Installation of shading devices

(d) High efficiency windows (frame and glasses)

(e) Installation of LED light bulbs

(f) Use of high efficiency heat pumps

(g) Increased use of solar thermal collectors

(h) Use of high efficiency boilers for preparation of hot water and process heat

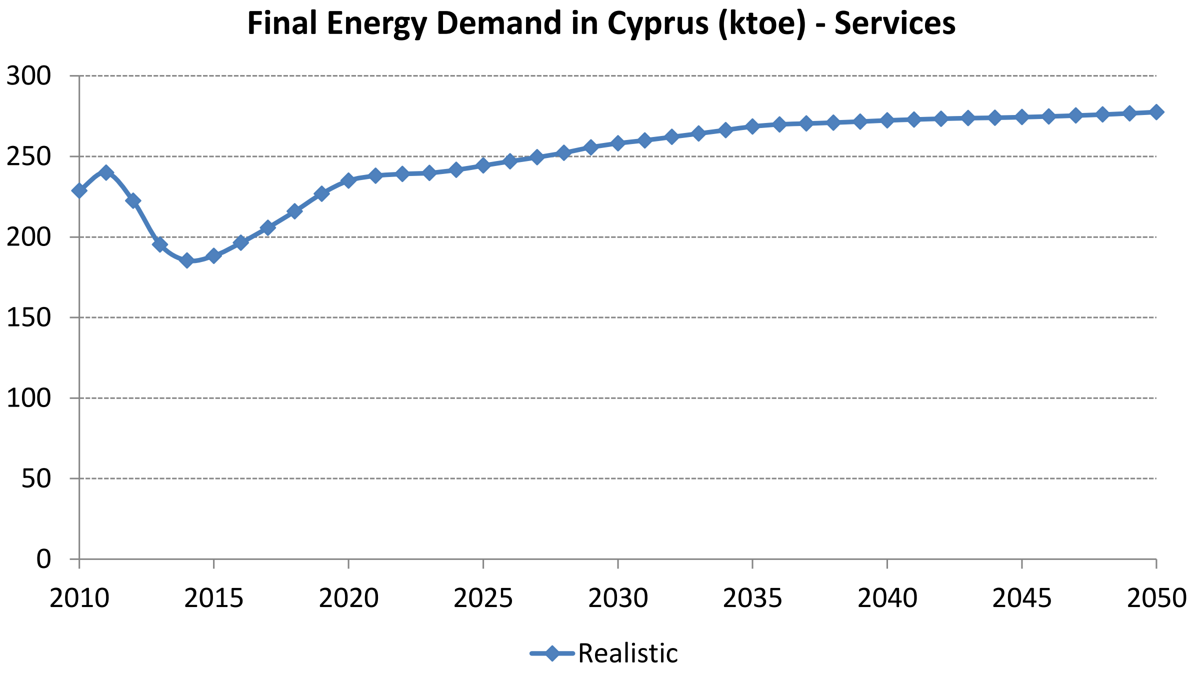
Policies considered

Based on the analysis of Zangheri (2016) and further calculations described in Chapter III, it was assumed that total expenditures of the order of 8 million EUR will be made for renovations in the service sector of Cyprus up to 2030, and similarly modest or slightly increasing expenditures in the period 2030-2050. These financial resources will be devoted to investment grants, provision of credit lines, and education/information campaigns.

Results

Figure IV.28 presents the projected final energy consumption and energy intensity of households up to 2050 according to the Realistic Scenario. After some modest increase in energy intensity up to 2020, which however will be lower than in the Reference Scenario, a continuous decline in intensity is projected. The improvement is attributed to the estimation of a mean annual mobilization rate of investments around 25mil€, resulting to a cumulative investment expenditure of around 300-350mil€ until 2030. After 2030, the improvements in energy intensity continue at a somewhat faster pace because of the assumption that equal funds will be made available during that period integrating also some improvement of the cost-efficiency ratio per intervention; hence energy consumption is projected to remain almost constant from around 2040 onwards, so that persistent economic growth is counterbalanced by increased energy efficiency in this sector. In short, the Realistic Scenario shows that exploiting the economic potential for energy savings in the service sector will not be sufficient to stabilise energy demand in the medium term; and in any case these measures are far from sufficient to ensure a path towards serious energy savings and strong decarbonisation, as is the EU target for 2050.

Figure IV.29 shows the fuel mix of the service sector according to the Realistic Scenario results. The evolution of fuel shares is similar to that of the Reference Scenario, with a somewhat faster decline in the importance of gas oil and light fuel oil.



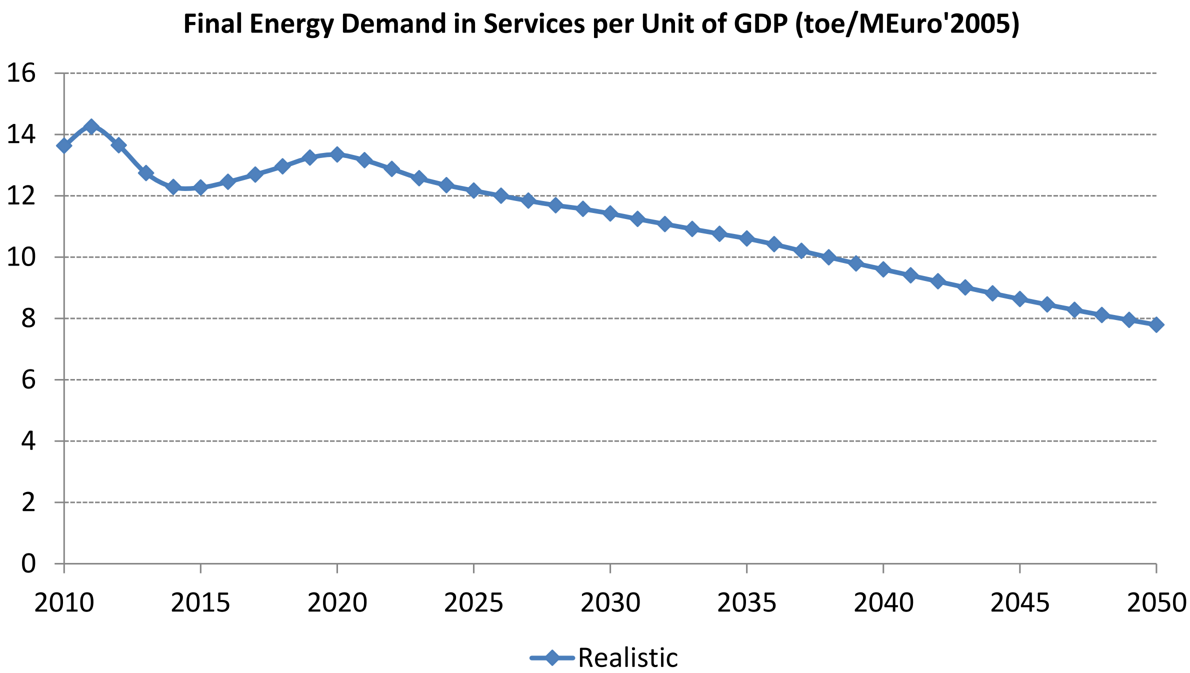


Figure IV.28: Final energy demand and energy intensity in services according to the Realistic Scenario.

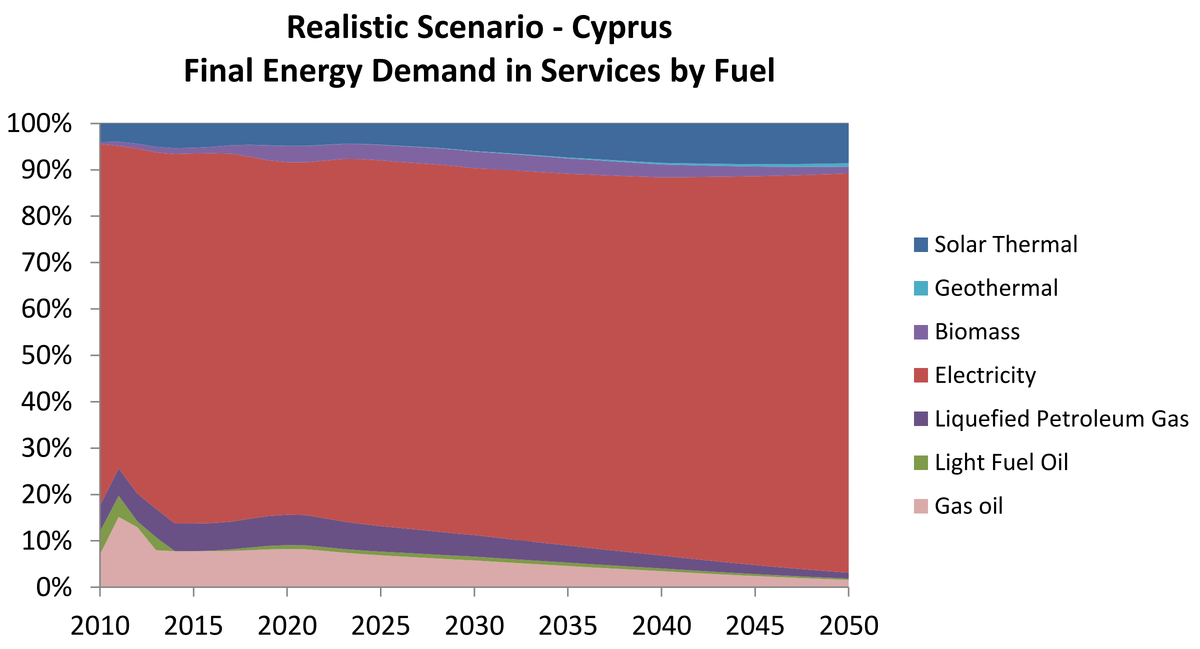


Figure IV.29: Fuel shares in service energy demand according to the Realistic Scenario.

IV.V.III Industry sector

Assumptions

Based on the analysis of Chapter III, the following energy interventions were assumed to have priority in the industrial sector:

(a) Replacement with high-efficiency electric motors

(b) Use of inverters

(c) Use of automations

(d) Heat recovery

(e) Installation of LED lighting bulbs

(f) Installation of energy efficient compressed-air systems

(g) Installation and use of CHP in industrial plants

Policies considered

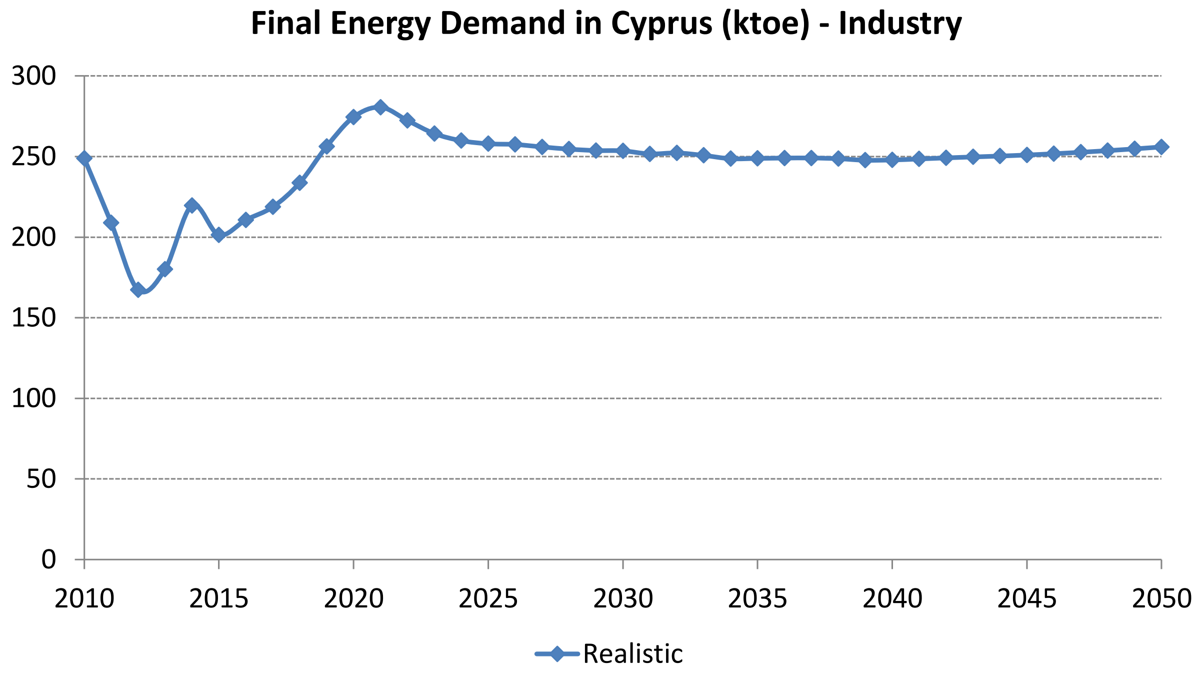
As explained in Chapter III, the economic energy saving potential for the industrial sector was defined as the potential energy savings that are attainable if industrial plants upgrade or replace their equipment and install high efficiency one which is available in the market based on their economic capability. It is expected that some of the financial resources required for these upgrades will come from indirect support from authorities such as provision of credit lines and education/information campaigns.

Results

Figure IV.30 presents the projected final energy consumption and energy intensity of the industrial sector up to 2050, and Figure IV.31 shows the fuel mix of the sector according to the Realistic Scenario.

Industrial energy savings are even lower than those projected for the household and service sectors in this Scenario. They will be sufficient to stabilise industrial energy demand over the long run, due to a falling energy intensity that outweighs increased economic output – but they will be far from sufficient in fulfilling the long-term decarbonisation goals of Cyprus.

Energy savings are primarily expected to occur due to the reduced consumption of electricity thanks to investments in automations and more efficient motors, compressed air systems and lighting. As a result, the share of electricity in total energy demand is projected to be lower compared to the Reference Scenario.



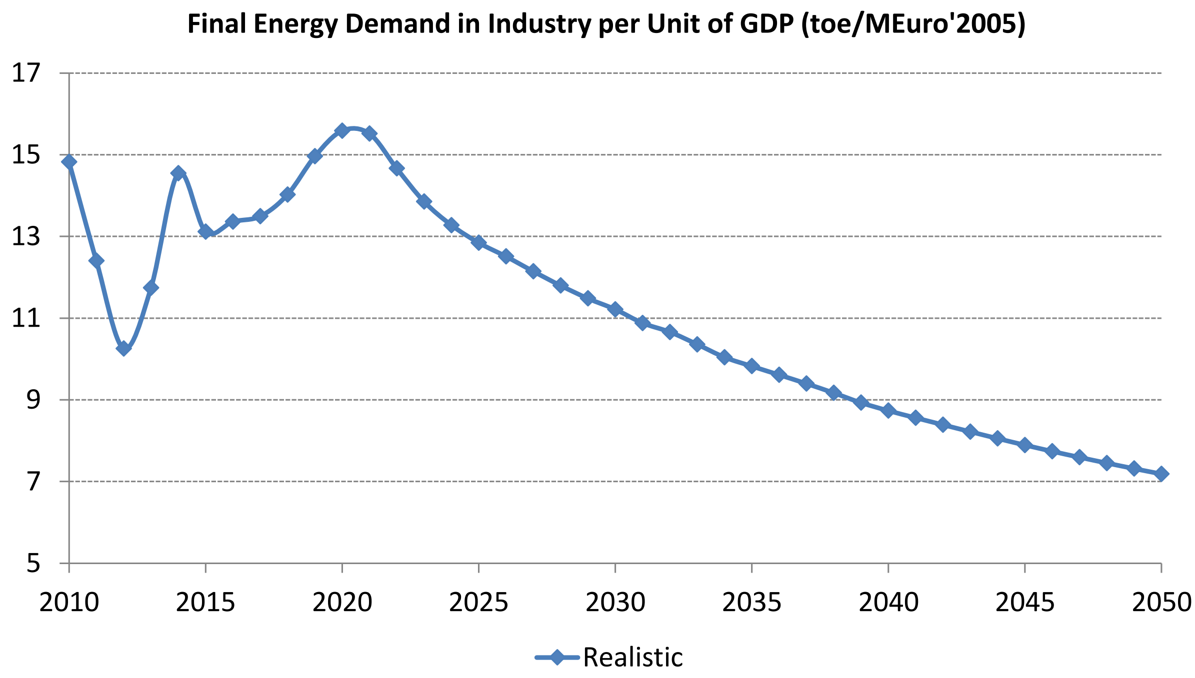


Figure IV.30: Final energy demand and energy intensity in industry according to the Realistic Scenario.

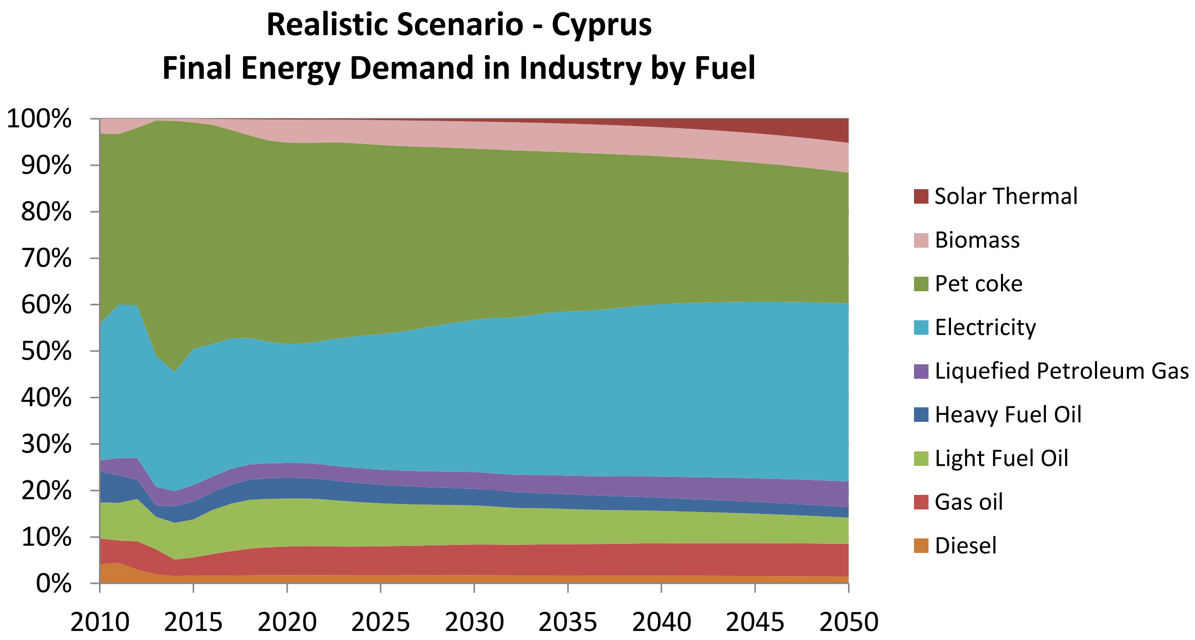


Figure IV.31: Fuel shares in industrial energy demand according to the Realistic Scenario.

IV.V.IV Transport sector

Assumptions

In addition to the assumptions of the Reference Scenario, some further measures improving the fuel efficiency of motor vehicles were assumed, similar to those of the Maximum Technical Potential Scenario. In line with assumptions made for other economic sectors in this Scenario, no changes in transport activity, public transport infrastructure or behavioural aspects were considered. This means that the modal split in both passenger and freight transport was kept constant with that of the Reference Scenario. Assumptions about policies to enable the penetration of alternative fuels such as biodiesel, bioethanol, CNG and electricity are explained in detail in the report of Work Package 5 of this study.

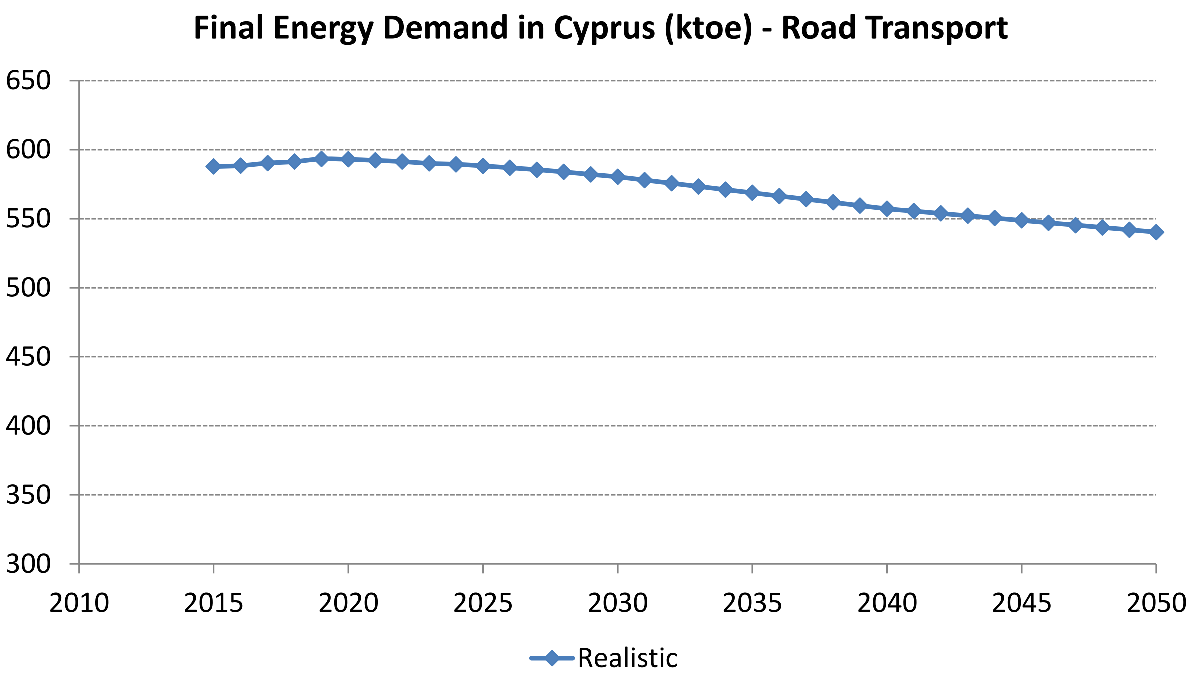
Policies considered

The limited policy interventions that were considered in the Realistic Scenario are similar to those described for the Maximum Technical Potential Scenario in Section IV.IV.IV, but with a slower implementation rate.

Results

Figure IV.32 shows that energy intensity of road transport is projected to decline very substantially over the coming decades, thanks mainly to technical progress in the fuel efficiency of new cars and trucks. As shown in the Reference Scenario, this evolution is in line with that foreseen by the study of the European Commission (2016) with the aid of the PRIMES model; the Realistic Scenario shown here results in a slightly lower energy intensity compared to the Reference Scenario due to the implementation of the additional policies explained above. Despite the sustained economic growth assumed in this study, total energy demand of road transport is expected to remain almost stable by 2020 compared to 2015, and then start decreasing continuously.

As shown in Figure IV.33, the Realistic Scenario forecasts a sizeable penetration of alternative fuels, starting after 2025 and rising considerably until 2050. The main fuel to gain share is Compressed Natural Gas (primarily in passenger cars and to a lesser extent in light and heavy trucks), with its share reaching 18% of total energy consumption in 2050. The use of biofuels is expected to peak around 2020, with their share reaching 4% of total road transport energy demand, and then recede to 2% in 2050; they will consist mainly of biodiesel but also some amounts of bioethanol (ETBE) to be used in cars, light trucks and two wheelers. Electrification of the vehicle fleet is expected to remain at low levels in the Realistic Scenario, reaching only 3.3% of total energy demand of road transport in 2050.



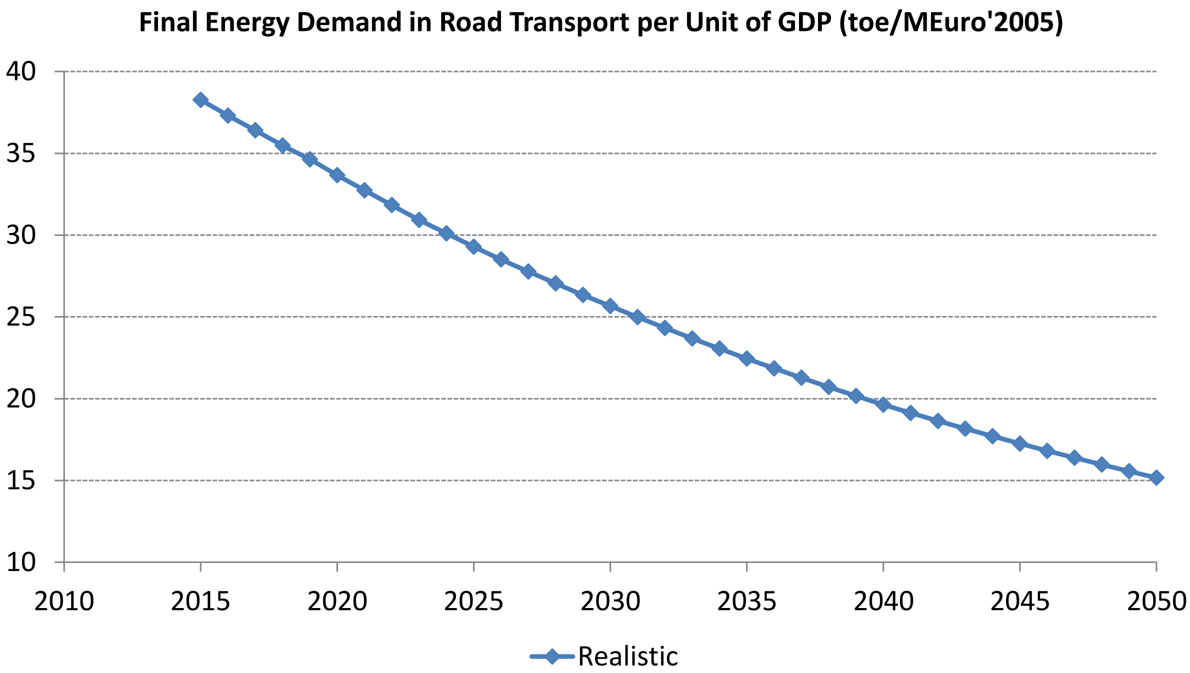


Figure IV.32: Final energy demand and energy intensity in road transport according to the Realistic Scenario.

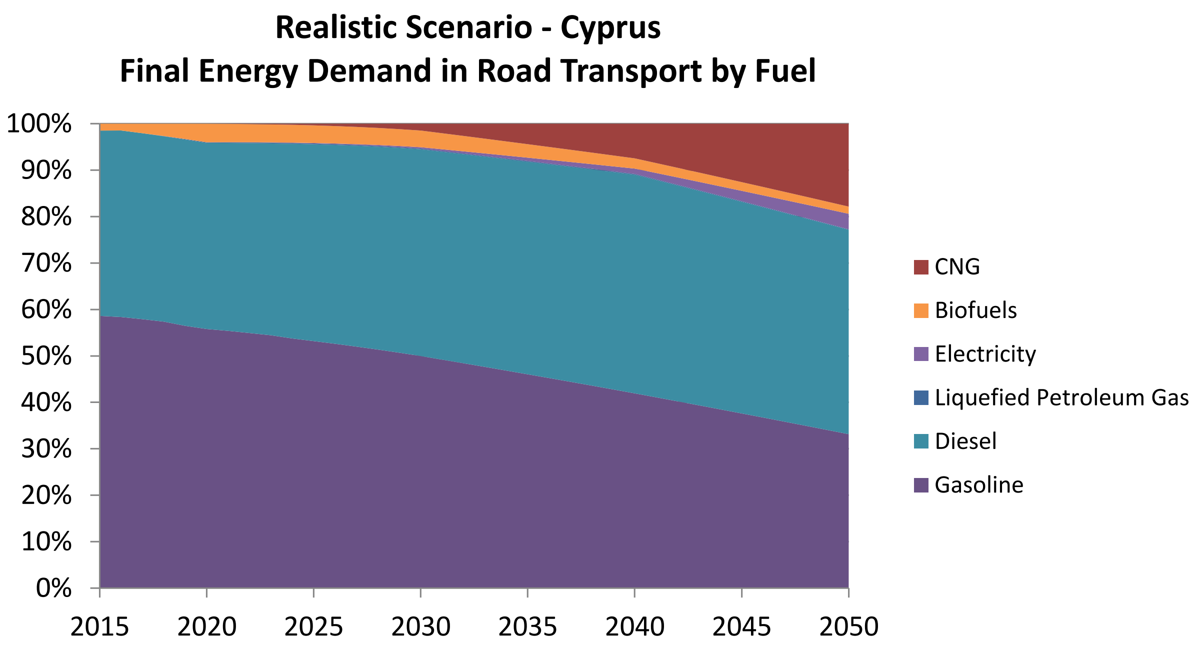


Figure IV.33: Fuel shares in road transport according to the Realistic Scenario.

IV.V.V Agricultural sector

Assumptions

The technical potential for energy efficiency improvements in agriculture seems to be relatively limited – e.g. in comparison to the corresponding one in buildings – especially since the available potential for co-generating heat and power from animal waste has largely been exploited in Cyprus, with 14 biomass/biogas plants already operating in Cyprus with a total capacity of around 10 MW (Zachariadis and Hadjikyriakou, 2016). Therefore, this scenario assumes mainly a limited modernisation of the available stock of equipment and machinery used in agriculture, in line with the economic capabilities of economic agents who are active in this sector.

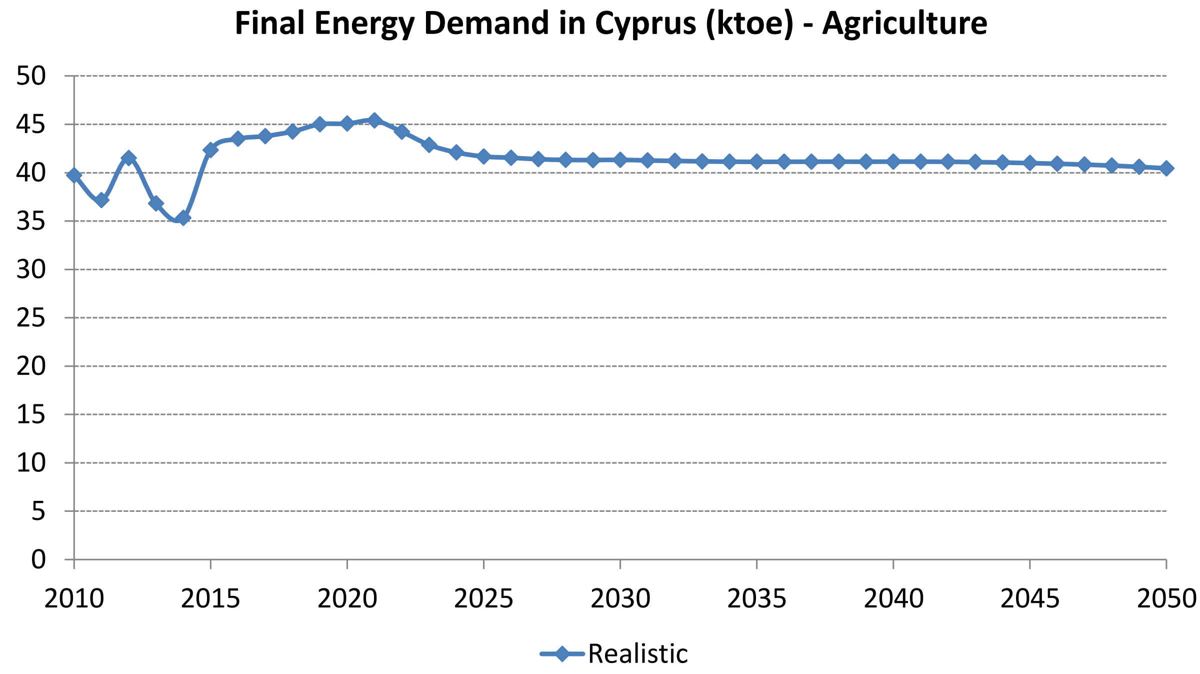
Policies considered

The main policy considered was the direct or indirect support of the government which would enable the substitution of old machinery (off-road vehicles, generators, pumps) with modern efficient one. This support could take the form of grants, credit lines and education campaigns.

Results

Figure IV.34 presents the projected final energy consumption and energy intensity of agriculture up to 2050. Energy intensity is expected to drop slightly faster than in the Reference Scenario, thus leading to a stabilisation of agricultural energy needs up to 2050 despite the assumed growth in the economic output of the sector.

Figure IV.35 shows the fuel mix of the agricultural sector according to the Realistic Scenario results. The evolution of fuel shares is similar to that of the Reference Scenario, since little is expected to change in this sector between the two scenarios.



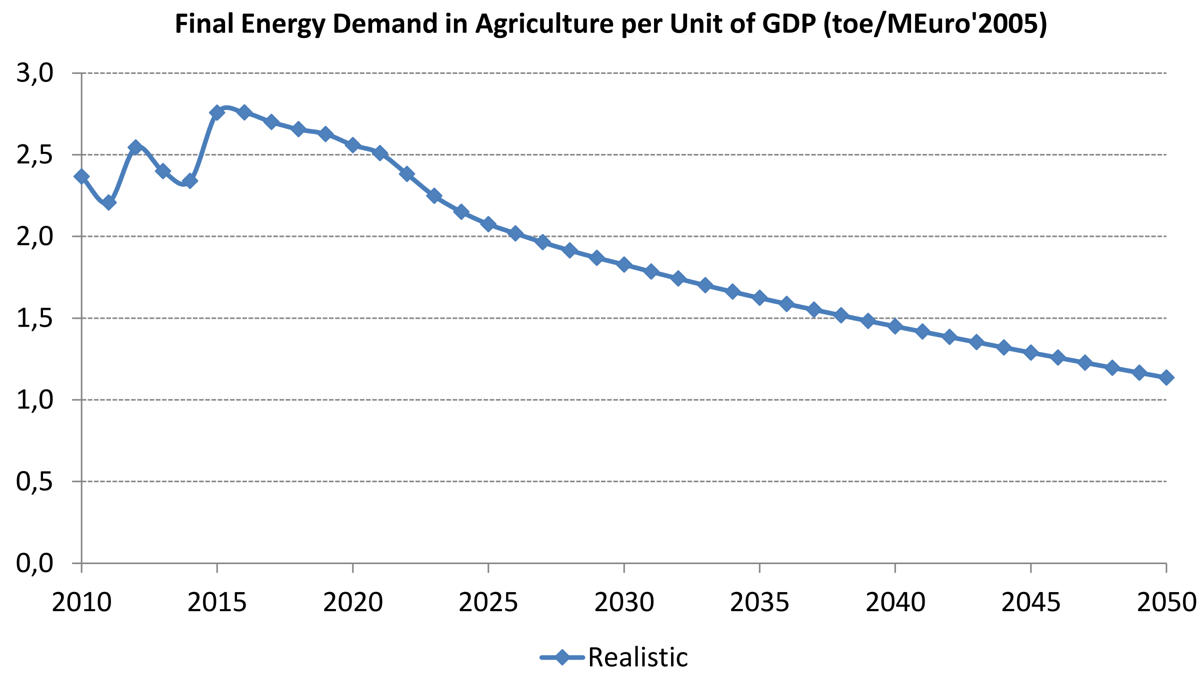


Figure IV.34: Final energy demand and energy intensity in agriculture according to the Realistic Scenario.

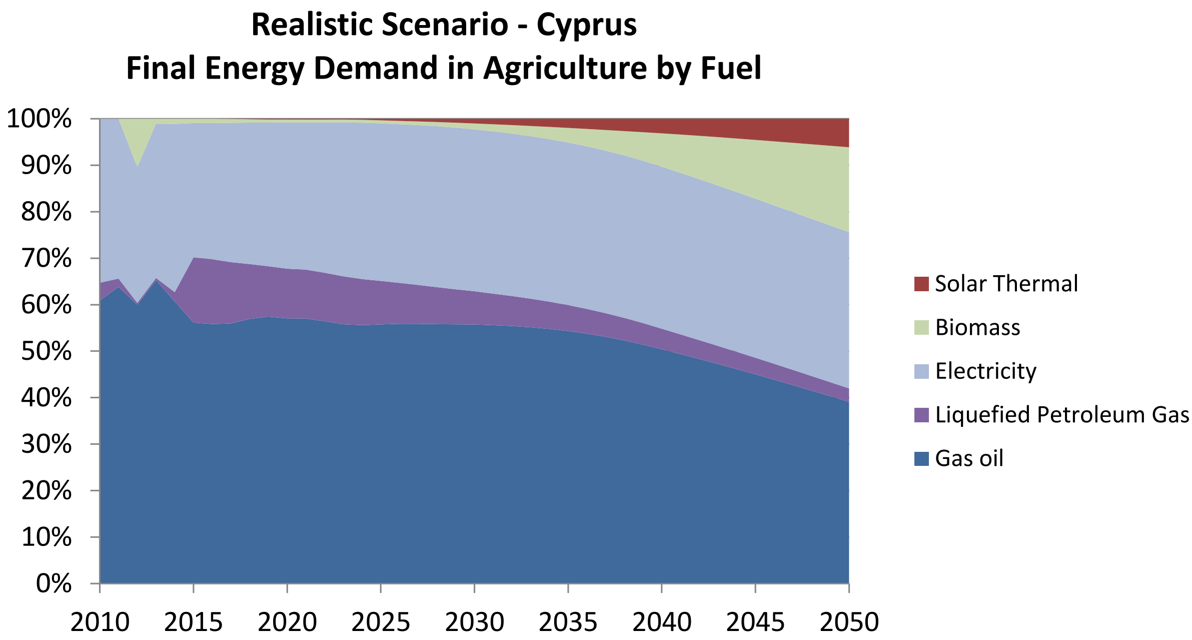


Figure IV.35: Fuel shares in agricultural energy demand according to the Realistic Scenario.

IV.VI Comparison of the Three Scenarios

This Section provides a comparative overview of the forecasts resulting from the three scenarios of this study. To illustrate the differences, Figures IV.36 to IV.42 bring together the individual results shown in the previous Sections and present a comparison of the projected evolution of final energy demand and final energy intensity in the main economic sectors of Cyprus. What follows is an outline of the main findings of this comparison.

In aggregate terms, a strong decoupling between energy consumption and economic output is foreseen throughout the forecast period. Overall, compared to the evolution of the Reference Scenario, the Maximum Technical Potential Scenario foresees energy savings in the household sector that may reach 36% by 2030 and almost 55% by 2050. In the services sector, the corresponding savings are 32% in 2030 and 57% in 2050, whereas in industry they reach 20% by 2030 and 21.5% by 2050. Potential savings are markedly lower in agriculture as well as in road transport, where no significant behavioural or infrastructure changes have been assumed which might allow a better organisation of freight logistics, or an increased use of public transport modes.

Following a different trajectory, the Realistic Scenario foresees a small or modest improvement in the intensity of energy use. Compared to the Reference Scenario, and in accordance with the assumptions explained in the previous Sections, modest energy savings are projected in households (5.3% in 2030 and almost 17% in 2050), whereas the corresponding savings are somewhat higher in the service sector up to 2030 (around 6%) and increase gradually afterwards to reach 24% by 2050. Industrial energy savings are even lower – 3.3% by 2030 and 7% by 2050, focusing mainly on reduction in the consumption of electricity due to investments in automations and more efficient motors, compressed air systems and lighting.

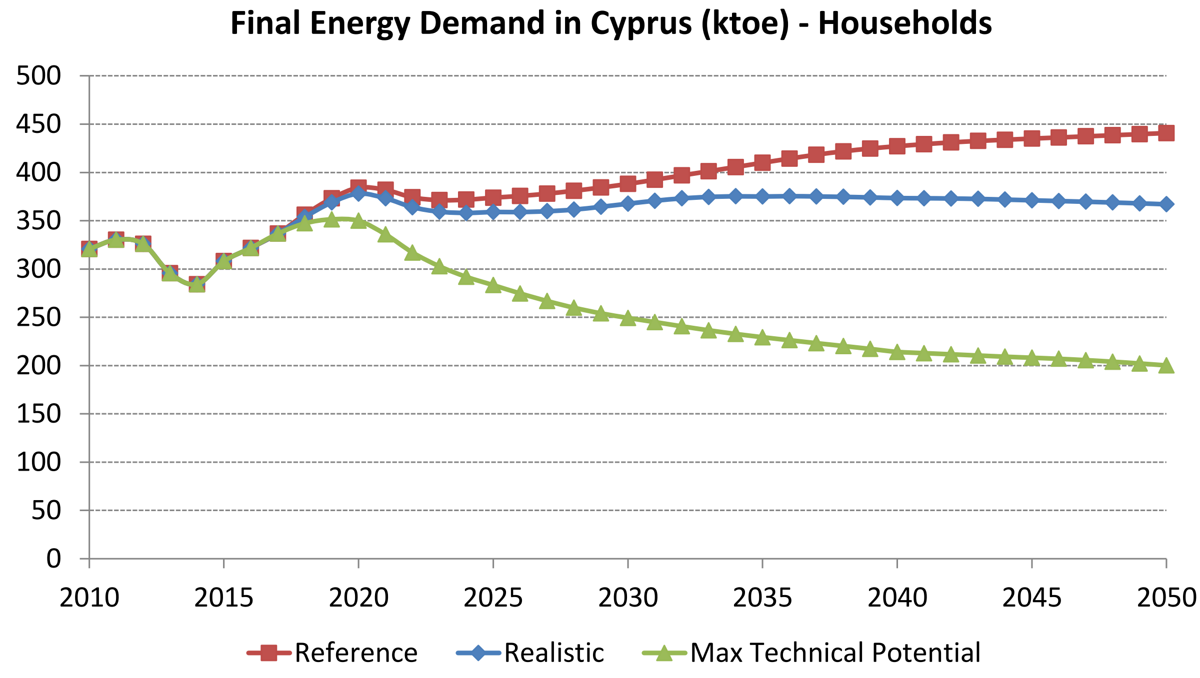
Finally, agricultural energy use is projected to evolve smoothly, without substantial improvements in energy intensity in the Reference Scenario. The Maximum Technical Potential Scenario foresees energy savings of 11% and 23% in 2030 and 2050 respectively due to the use of more efficient equipment and machinery, whereas the Realistic Scenario projections are for energy savings of just over 2% in 2030 and 11% in 2050.

The evolution of the shares of each fuel or energy form is not repeated in this Section as it has been presented in detail in the corresponding sections of each scenario. However, it is worth recapitulating some of the main findings:

The Maximum Technical Potential Scenario, in line with what was outlined in the definition of its assumptions, projects that the shares of gas oil and biomass gradually diminish in the household and service sector, whereas electricity and LPG gain shares, although the use of these energy forms declines in absolute terms because of the strong implementation of energy efficient buildings, equipment and appliances. As a result, the only fossil fuel to be used in these two sectors by 2050 is projected to be LPG; all other energy needs of buildings and processes are projected to be covered by electricity and solar-generated heat – plus a very small fraction of biomass in the service sector. The share of electricity in total energy consumption declines between today and 2050, especially in the service sector; this is a result of the improvement in the energy efficiency of electric heating (heat pumps), lighting and appliances, which is expected to be considerably stronger than the improvements in LPG-fired boilers used for heating and hot water production. CNG-powered and electric vehicles are forecast to penetrate road transport, accounting for up to 20% of the sector's final energy demand in 2050.

On the other hand, in the Realistic Scenario the evolution of fuel shares is similar to that of the Reference Scenario, with a somewhat faster decline in the importance of gas oil and biomass (in the household sector) and gas oil and light fuel oil (in the service sector). Only in transport can one observe a significant difference between Reference and Realistic scenarios, due to the considerable penetration of CNG-powered vehicles in the latter scenario – which dominates among alternative fuels, thus leaving fewer shares in electric vehicles.

The most important finding of the analysis presented in these Chapters seems to be that Cyprus can substantially increase the energy productivity of its economy, especially in the household and service sectors which account for a large part (30%) of the country's final energy needs and for the major portion of electricity consumption (around 80% in 2015). However, in order to achieve a transition to a low-carbon economy, apart from reducing the carbon footprint of power generation, it is imperative to reduce the energy needs of road transport very substantially. Without a drastic implementation of policies that can reduce the energy intensity of motor vehicles and enable the penetration of low- or zero-carbon fuels, it is not possible for Cyprus to meet the EU's long-term decarbonisation target of 80-95% reduction in greenhouse gas emissions by 2050.



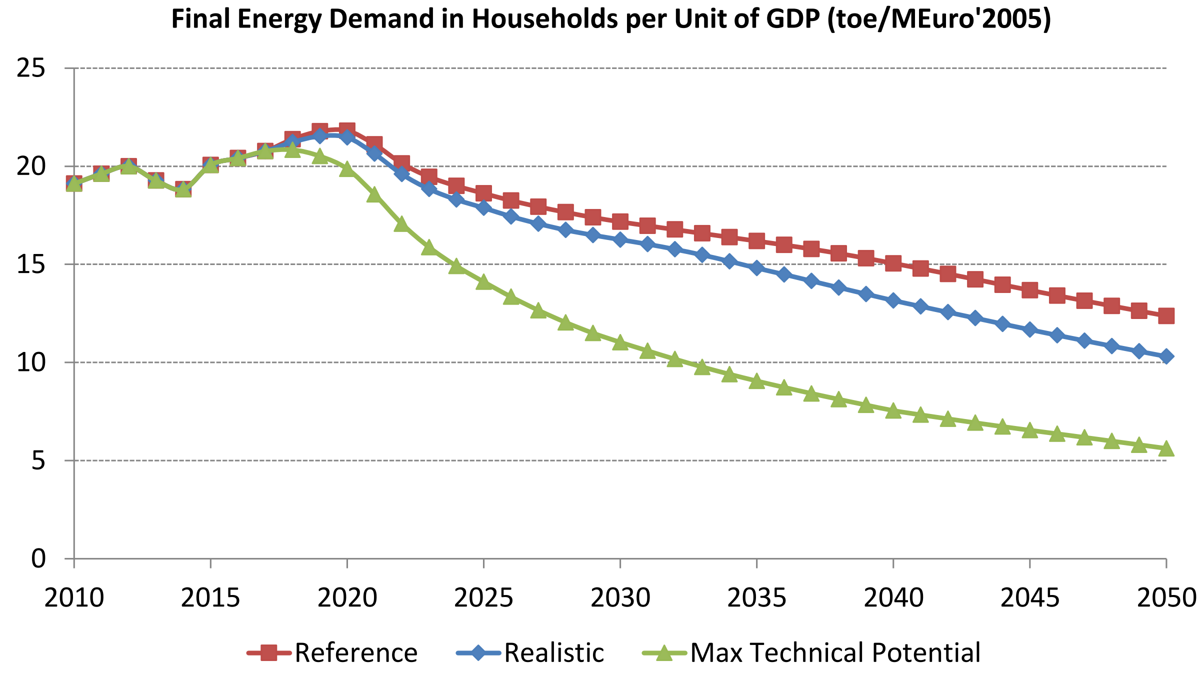


Figure IV.36: Final energy demand and energy intensity in households according to the three scenarios of this study.

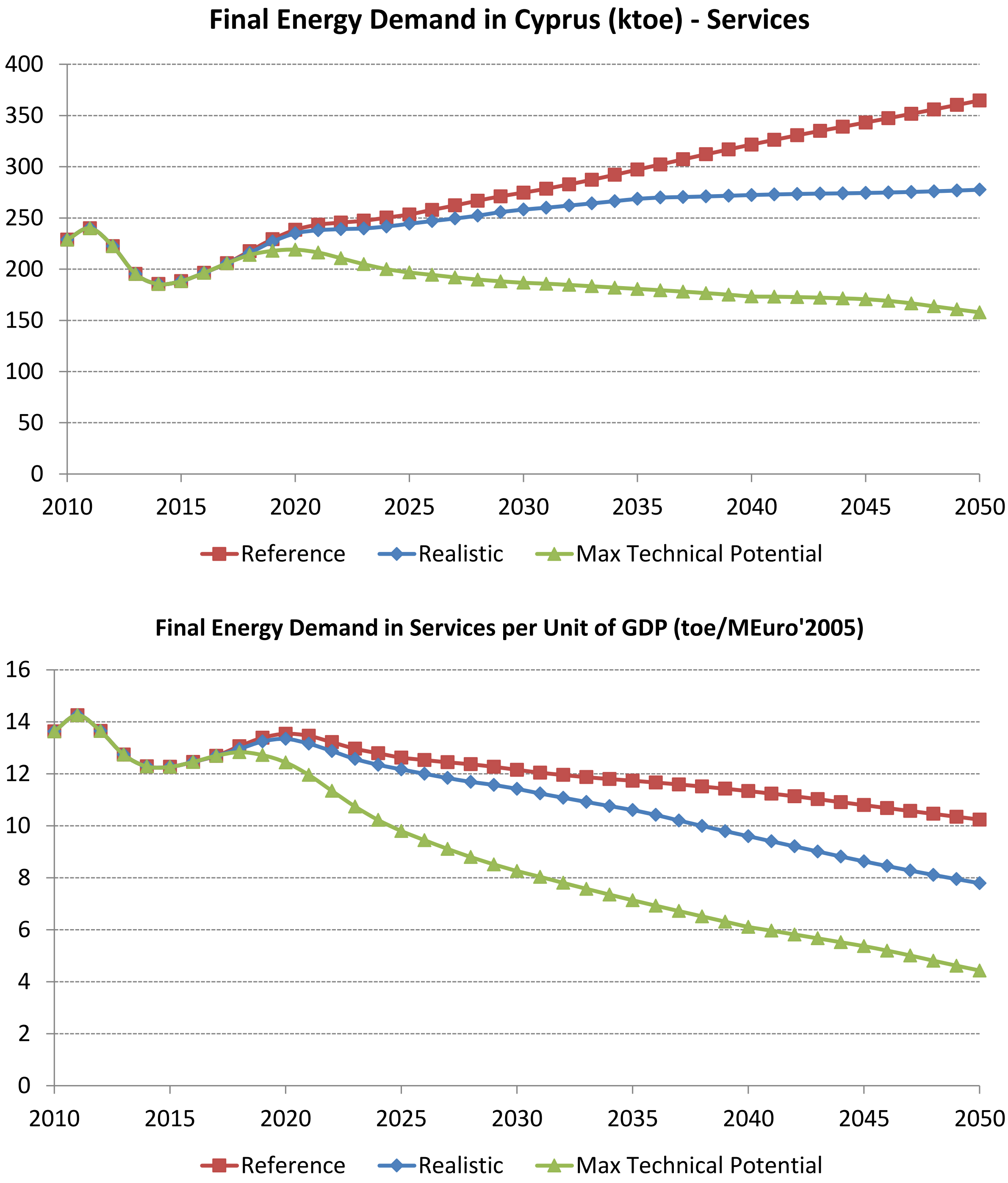
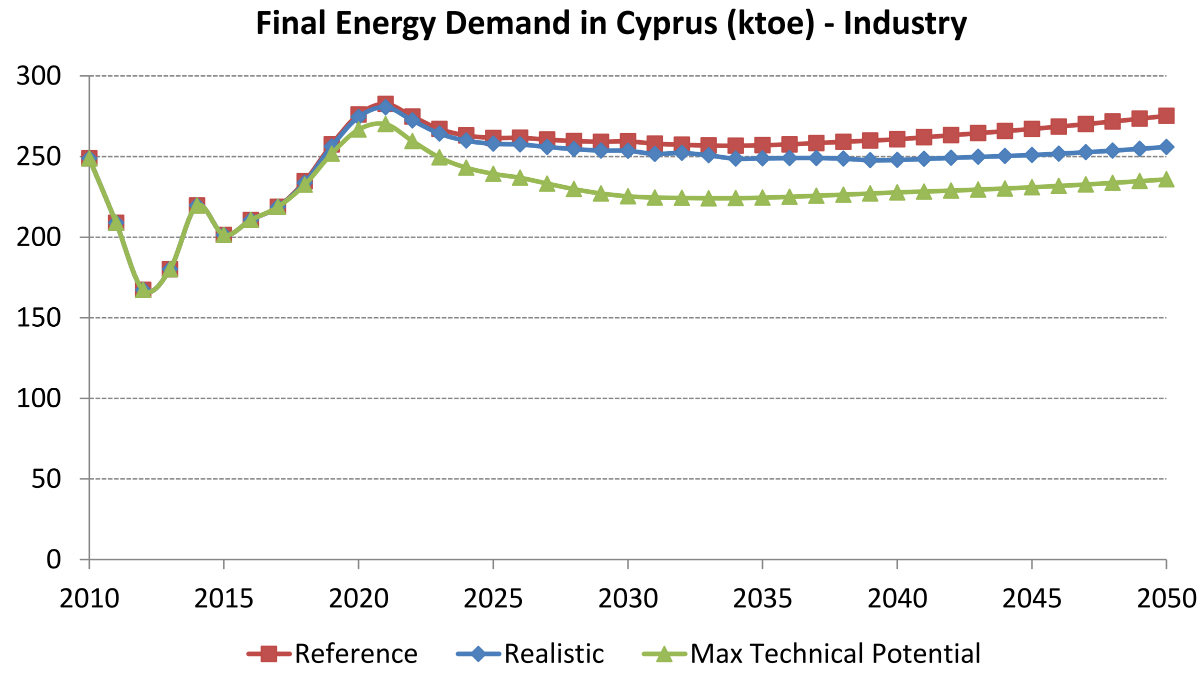


Figure IV.37: Final energy demand and energy intensity in services according to the three scenarios of this study.



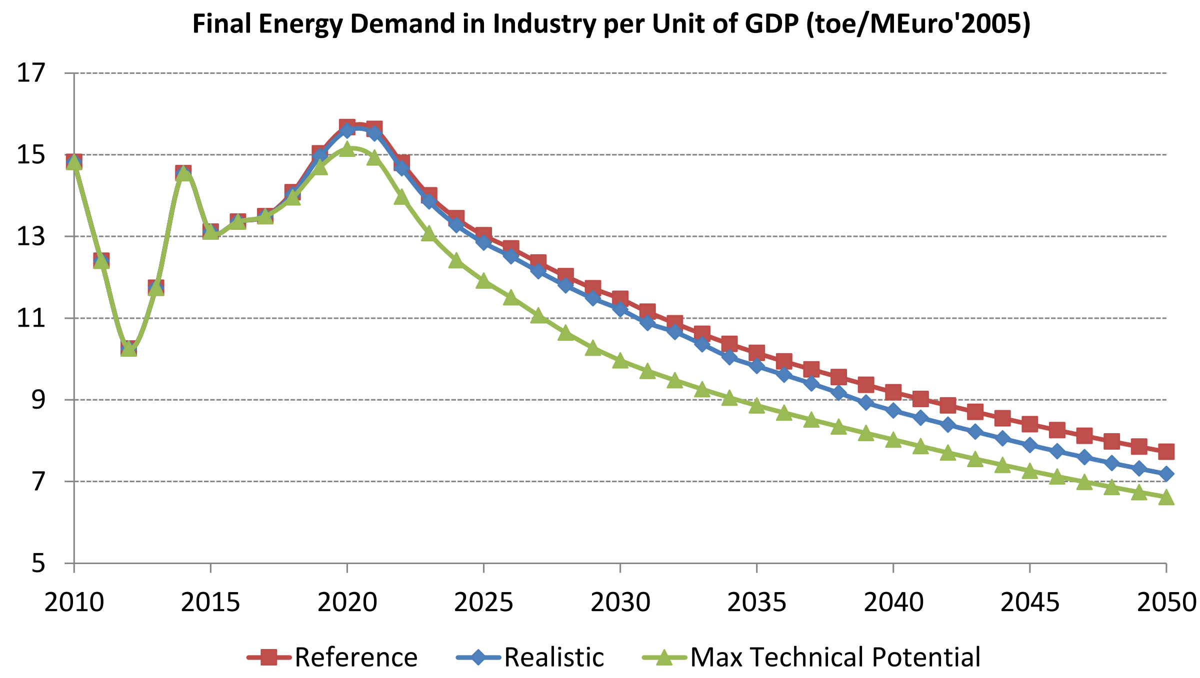
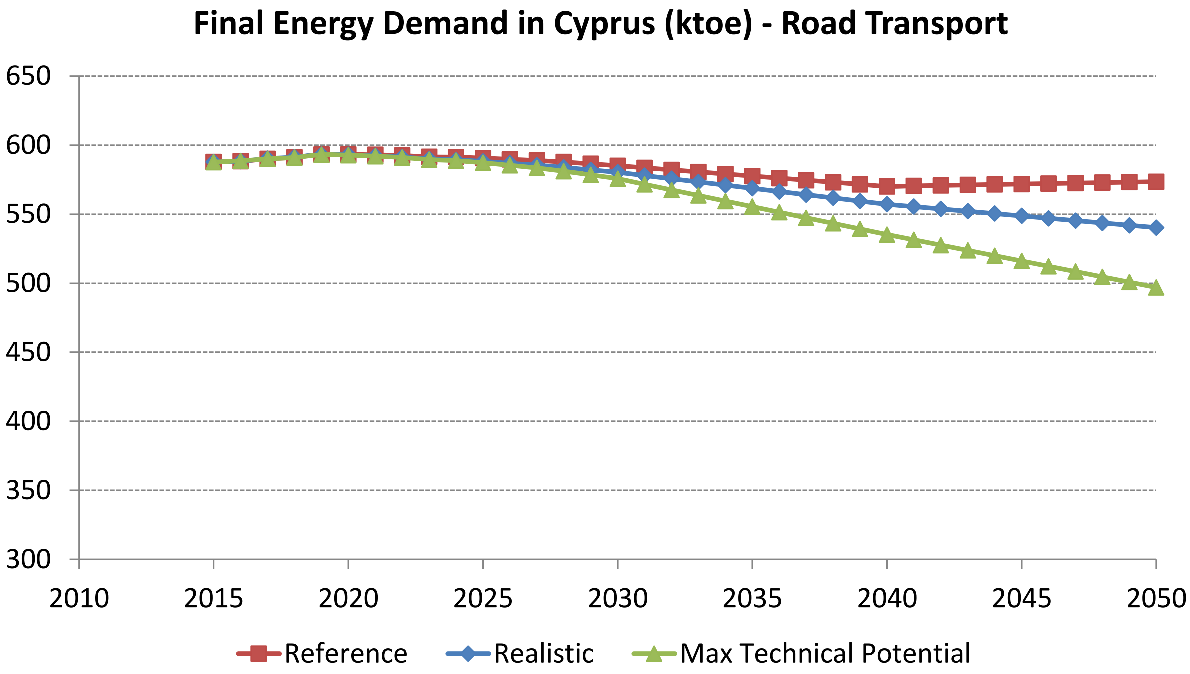


Figure IV.38: Final energy demand and energy intensity in industry according to the three scenarios of this study.



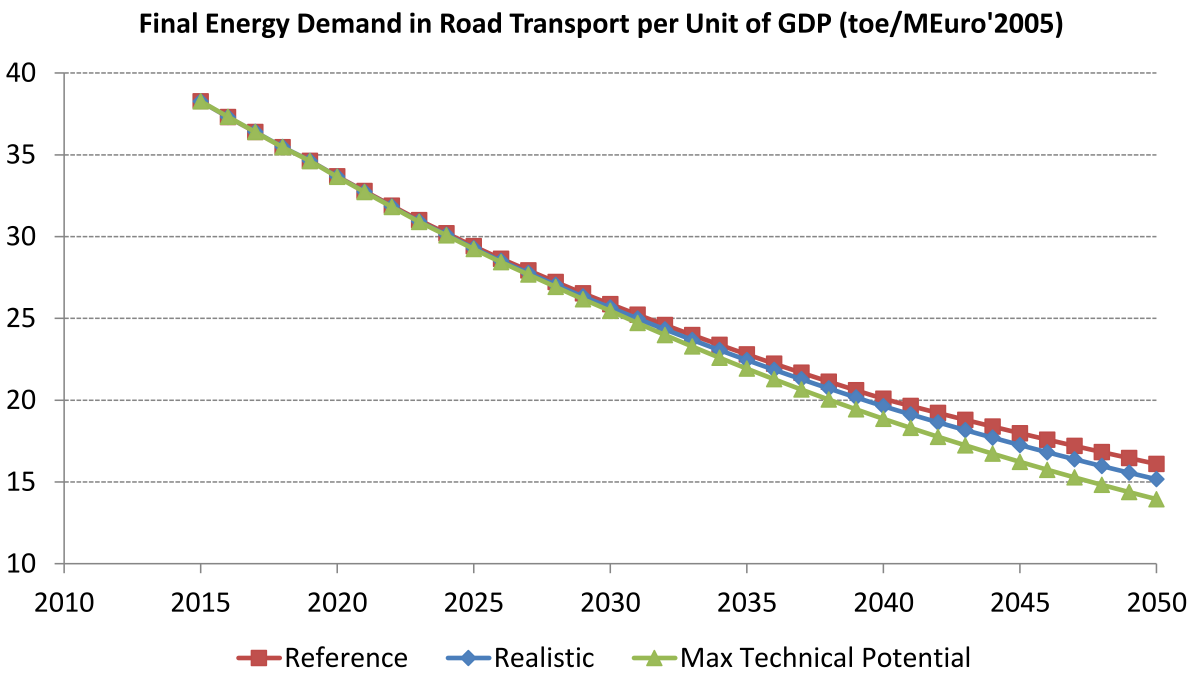
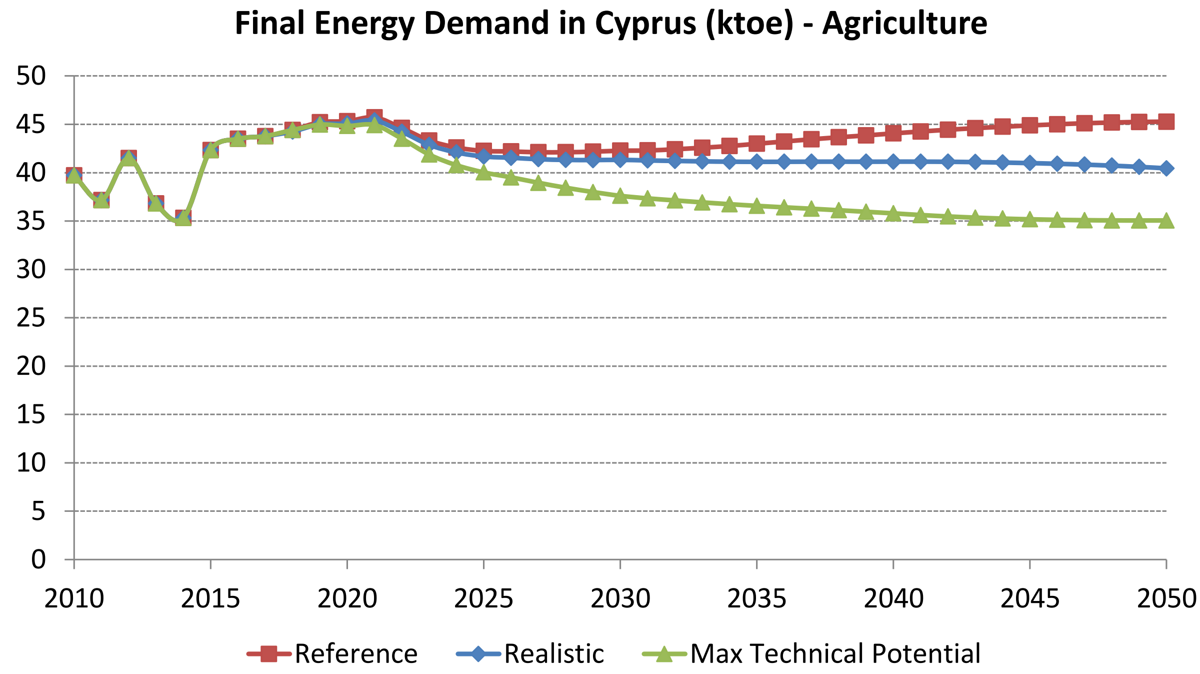


Figure IV.39: Final energy demand and energy intensity in road transport according to the three scenarios of this study.



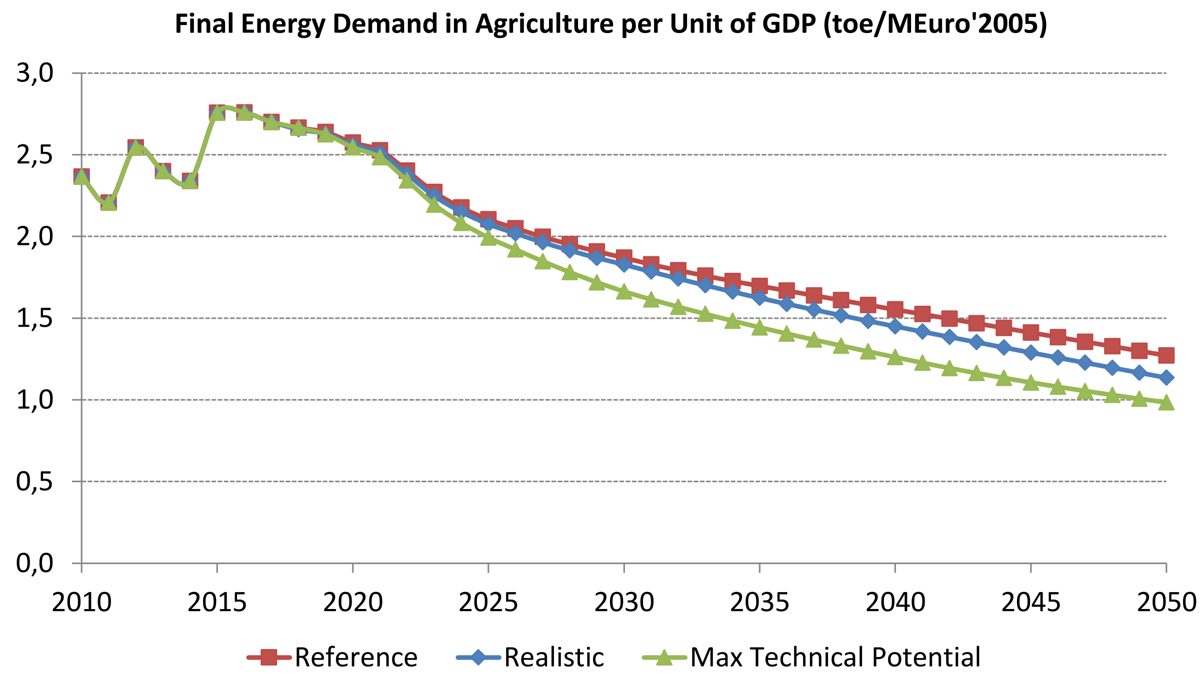
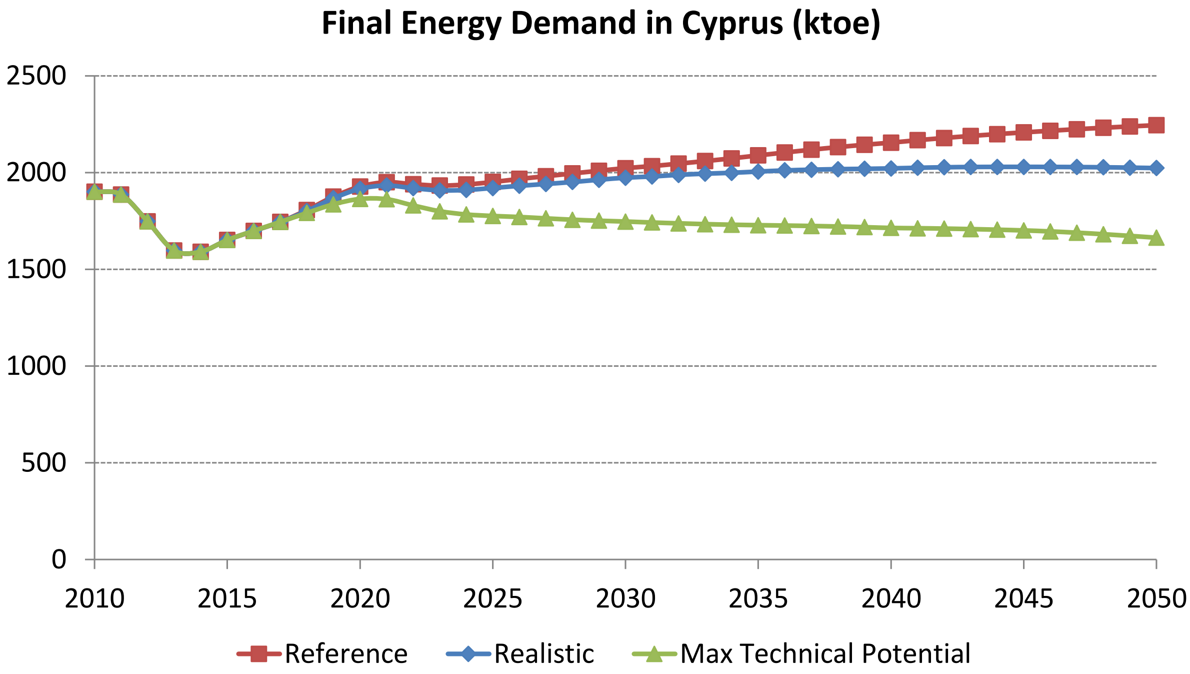


Figure IV.40: Final energy demand and energy intensity in agriculture according to the three scenarios of this study.



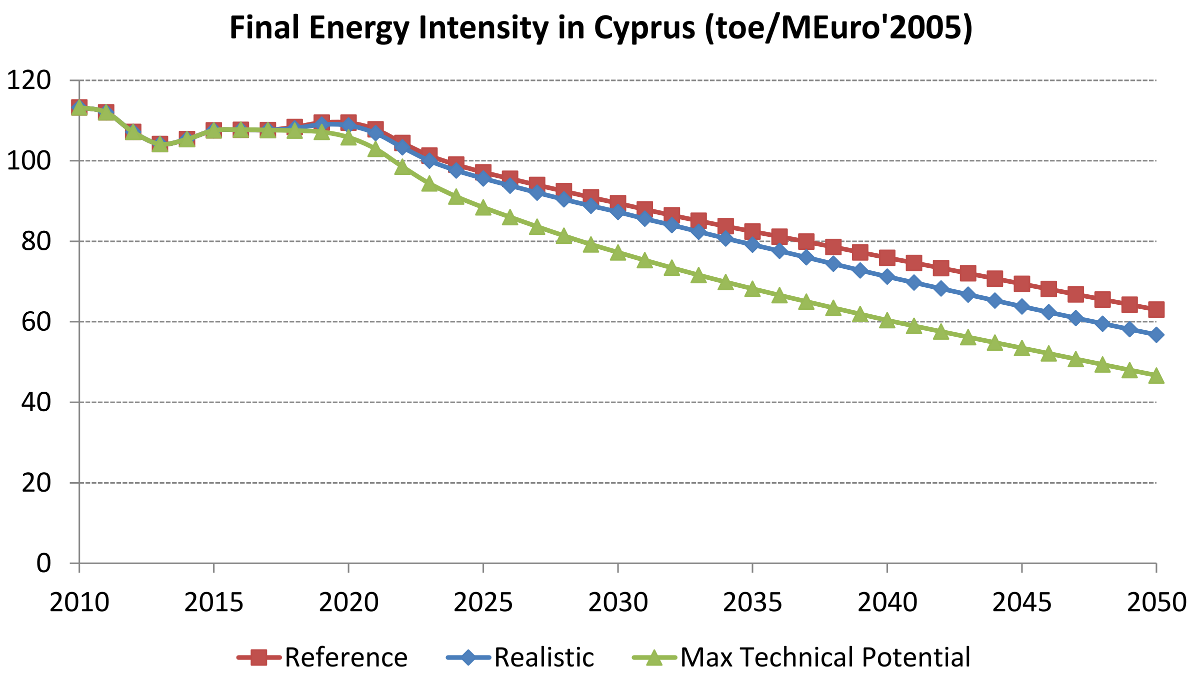


Figure IV.41: Aggregate final energy demand and energy intensity in Cyprus up to 2050, according to the three scenarios of this study.

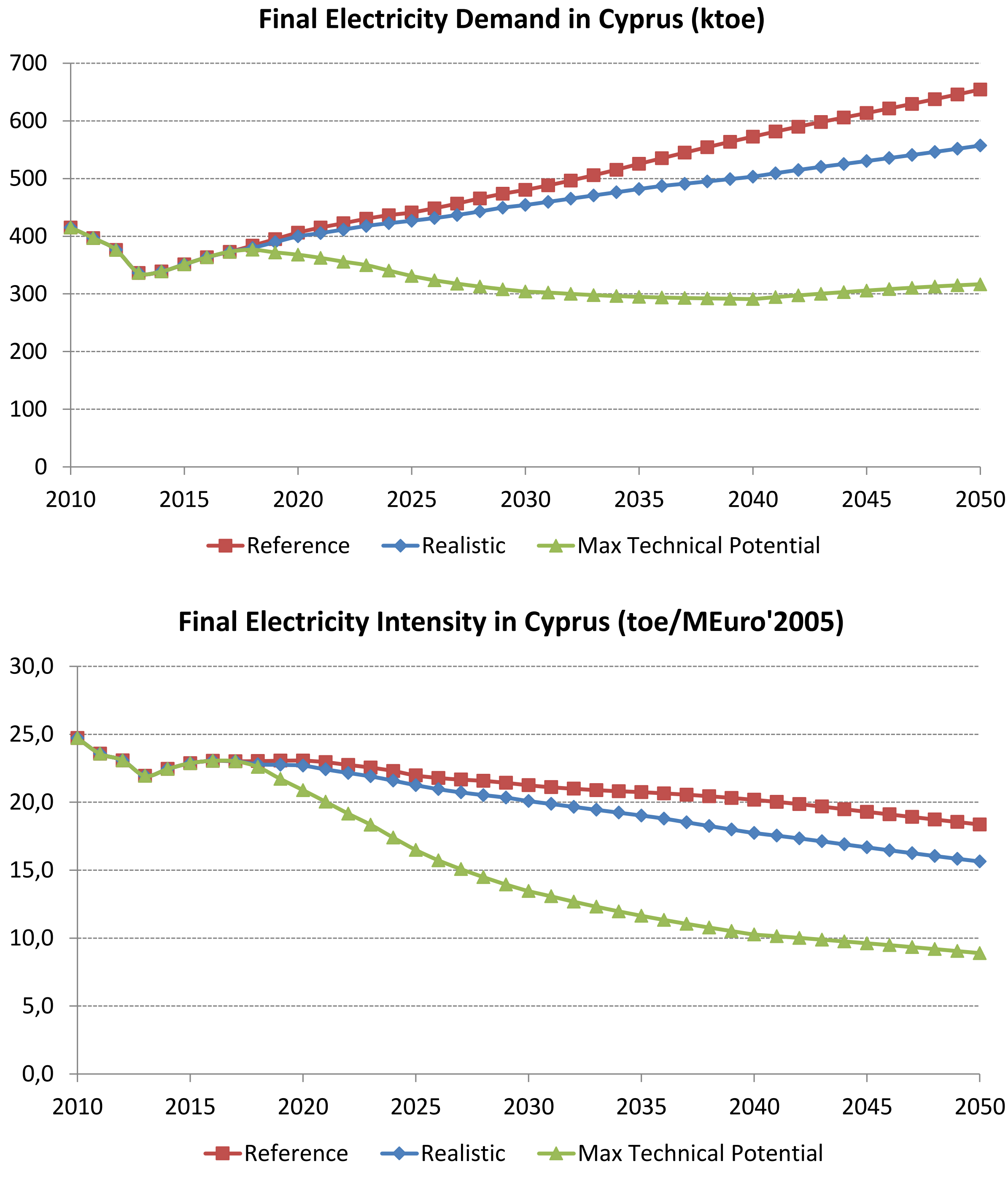


Figure IV.42: Aggregate final electricity demand and electricity intensity in Cyprus up to 2050, according to the three scenarios of this study.

IV.VII Proposed post 2020 energy efficiency objectives

The national post 2020 energy efficiency objective and targets should be decided on in a timely manner in order to allow for an appropriate planning, involvement of the various market actors but also the implementation of new policies, measures and most importantly financing instruments. The latter ones will be needed to achieve a higher level of energy savings, the improvement of the energy intensity indexes as well as the enhancement of the country's energy security.

The reference scenario presented in the previous chapter is based on a mix of policies With Existing Measures (WEM) that performs quite effectively in anticipated and projected energy savings in the various sectors, which are mainly illustrated in the strong improvement of the energy intensity index.

However, the WEM based scenario fails in the long term to stabilise the absolute energy demand in Cyprus and a small but steady annual increase of overall demand is observed for the whole 2020-2050 period. In this context, considering the overall benefits and advantages resulting from the implementation of cost-efficient measures in terms of increased available expenditure for other economic activities, reduced dependency from imported fuels and improvement of living conditions, further effort With Additional Measures (WAM) is proposed in order to tap a degree (the most cost optimum and realistic to be implemented) of the detected maximum technical potential for energy savings.

The key challenge for the national energy efficiency strategy is to ensure an effective scaling up the energy efficiency interventions

The realistic scenario integrates the WAM approach and puts emphasis on the distribution and expenditure allocation per energy efficiency measure in order to achieve some key national energy savings goals in the medium and long term.

However, different energy policy challenges are present in the context of the WAM approach since the projected savings under the realistic scenario, though achievable under different mixes of energy efficiency interventions, require the early adoption of various measures that will allow both the design and implementation of the most efficient energy efficiency mechanisms and incentives on time. In the following sections of this chapter a more detailed analysis and elaboration of the proposed post 2020 measures is presented in order to act as a tool for policy design, decision-making and implementation by the Cypriot authorities in relation to the national energy efficiency policy framework. Moreover, some overall high-level recommendations are highlighted in the paragraphs that follow in order to set-up the main policy directions and pillars of policy interventions that should be enabled and considered for the establishment of a sustainable national energy efficiency policy framework. Continuity in the design and implementation of policies as well as in the support market mechanisms should be one of the main policy objectives and principles for the decision makers and therefore the appropriate governmental structures must ensure that this principle will be respected and followed.

Moreover, a high level of coordination and collaboration is required among the different public and private actors in order to identify and unlock the benefits resulting from the implementation of a high number of energy efficiency interventions in Cyprus and to allow coordinated actions for their achievement. Horizontally, effective coordination mechanisms between MECIT as the coordinating ministry and other line ministries such as Communication and Works, Education and Culture and - very importantly - Finance has to been ensured. Vertically, improved coordination and integration of municipalities and communes into policy design and implementation including design of tailored support schemes to local governments should be considered. This task can only be achieved with a clear mandate and support from the highest political levels.

Emphasis should be put not only on developing new energy efficiency policies, especially in end-use sectors with limited until now attention in the energy policy formulation (i.e. primarily referring to the transport, industry and agriculture sectors and secondary to the service sector), but to further enhance and improve the performance of existing ones, aiming to better integrate energy efficiency considerations. Moreover, the policy design and implementation must allow a gradual market transformation in various end-use sectors, especially in the buildings sector and the energy service market, which will be able to support and to unlock various public or private energy efficiency investments. In a medium-term perspective this holds especially true also for the transport sector. Because of the anticipated market transformations, the appropriate market mechanisms and supportive policies (e.g. regulation and support schemes) should be integrated in the policy formulation and to be implemented at the appropriate time.

The impact of the existing energy efficiency national regulatory framework in terms of energy savings have delivered to some extent what has been projected, though it is believed that these measures could deliver higher savings and more is expected and projected under the WEM scenario for the post 2020 period in terms of achieved savings from the existing measures[12]. In other words, further effort in terms of policies and measures, should be given so that the already adopted EE policies and regulations, especially in the building sector, deliver the anticipated and forecasted savings.

Additionally, under the existing support schemes, for which the allocated budget is expected to be fully absorbed, the number of affected consumers and as of consequence to total energy savings will be limited. This is attributed to the strong subsidy-nature of the various support schemes, as well as to the rather limited allocated total budget.

The benefits in terms of economic productivity, energy security, social welfare and economic growth should be highlighted more strongly and the prioritisation of energy efficiency should be kept as high as possible, especially in the prospect of the new national economic growth opportunities that are expected to be developed with the hydrocarbons exploitation in the post 2020 period.

The adoption of both qualitative and quantitative medium and long term energy efficiency targets is proposed to the Cypriot government in order to allow both planning and commitment to the most cost-efficient energy saving policies and measures. In this context and considering both the energy saving potential and the characteristics of the Cypriot economy, the adoption of sectoral or even sub-sectoral energy efficiency targets should be aimed and is therefore proposed under this study. The adoption of sectoral targets will assist in the formulation of targeted policy interventions as well as implementation of support schemes, while also allowing a more efficient monitoring of the performance of the various energy efficiency measures and policies.

Moreover, attention should be given considering the immaturity of the local energy service market, to the avoidance of lock in effects and stranded assets because of late or even non achieved market transformations.

Nevertheless, the aimed savings should always consider the insularity element of the national economy and end-use consumption, as well as the climate conditions that induce a different baseline of possible energy

[12] For the period after 2030, a continuation in energy intensity improvements is also expecting because of the diffusion and continuous market impact of existing measures. The energy intensity rate of improvement is assumed the same with that of the 2020-2030 period.

efficiency interventions compared to other countries. The target should be always translated to lower levels of energy intensity as well as to energy consumption per inhabitant, however, by considering the energy consumption impacts of the tourism sector.

Therefore, the **main objectives and targets for the post 2020** national energy efficiency strategy are proposed to be related to:

- ***Stabilisation of the national energy demand by 2030 achieving a reduction of overall demand in the following years that would lead to lower absolute values by 2050.***
- ***Stabilisation of the national energy demand for households by 2030 and reduction of the absolute levels of finally energy consumption in the period up to 2050.***
- ***Reducing the growth rate of final energy consumption in the service sector and allowing only marginal increases for the 2030-2050 period.***
- ***Achieving stabilised energy consumption in the industry sector by 2030.***
- ***Target a mean renovation rate of between 1-1,5% of the building stock until 2050.***
- ***An overall target of final energy consumption savings in the buildings sector (household plus service sector) of 20% until 2050 compared to the Reference Scenario (WEM) projections.***
- ***Attaining a significant share of the maximum technical potential (MTP) for energy savings in the final energy demand of around 40% by 2050, with a minimum 30% share of the MTP for every end-use sector.***
- ***Mobilize financial instruments effective to trigger mean annual energy efficiency investments at a minimum level of 0.5% of the GDP for the period until 2050.***

IV.VII.I Sectoral policies

Baseline

A number of energy efficiency policies and measures have been implemented in Cyprus up to now, the majority following the transposition of the relevant EU regulations. The impact of the economic crisis has, however, prohibited or delayed the update of new market mechanisms and the adoption of innovative financing instruments.

Public awareness on the potentials and possibilities of energy efficiency interventions is still assessed at medium levels and also other soft measures like demand response and the deployment of smart meters is only planned for the upcoming years.

Lack of sufficient public funding and limited private investment combined with limited awareness and capacities has resulted to lower levels of achieved energy savings in line with the initial expectations.

Moreover, lack of disaggregated data at various end-use sectors like service and industry as well as the national modal shift patterns, prohibit the planning of comprehensive but tailored measures with vertically described processes (i.e. from administration down to recipients' level as well as the evaluation of existing ones. For this reason the conduction of ***statistical market surveys*** and the introduction of a systematic ***monitoring system*** for the energy savings, under a comprehensive database should be key priority for the policy decision makers and initiatives towards this direction are recommended to be taken before 2020.

Financial priorities

Scale up energy efficiency investments for augmented net financial benefits to the national economy

The key challenge for the national energy efficiency strategy is going to be the identification of viable ways for scaling up energy efficiency investments in the various sectors and to increase the confidence of the involved parties for the multiple benefits and cost savings that arise from these types of interventions.

The volume of the available private expenditure for energy savings interventions seems to be directly correlated with the presence or not of public financial support and thus the absolute number of affected end-users remains at rather moderate numbers.

In this context the use of new financing instruments that would allow both a more efficient use of the available resources and a higher participation from the private sector and consumers is necessary for achieving the scaling-up of the energy efficiency interventions. In this context the structure and operation of state and private energy efficiency investment loan facilities, will allow the creation of a sustainable energy efficiency investment framework. Dedicated financial support tools will encourage the adoption of standardised interventions and verification process of their savings.

The formation of a dedicated **Energy Efficiency Fund** is overall proposed, however an ex-ante assessment of its administrative cost, revenues structure, intermediaries profile and operation characteristics should be performed in order to evaluate the necessity of a totally independent Fund or the integration of these credit facilities within existing financial structures. Nevertheless, the main concept of this fund is proposed to remain the re-allocation of support for energy efficiency interventions under a budget-revolving process, providing instruments either directly to the end-users or to credit intermediaries.

The mobilisation of private financing for energy efficiency interventions should be further encouraged through training events and promotion of standardised methodologies in order to assist in the de-risking of the various energy efficiency investments and in this context both the banks and the insurance companies have to undertake their role and responsibilities for improving the risk profiles of the various energy efficiency investments. The adoption of a scheme of **state guarantees** for energy efficiency investments directly financed by the private credit sector could allow a higher participation from the local banks but it is obvious that reference energy efficiency investments at local level are still missing and more emphasis should be given to this direction.

Regulatory and market-related priorities

The public-private partnership scheme should be further enhanced and promoted especially for **lighthouse energy efficiency projects** that are considered essential for the market maturity and scale-up of energy efficiency interventions.

The standardisation of the evaluation process for suggested energy efficiency measures that are eligible under a state support scheme, is also proposed as a key instrument in order to allow for the identification and planning of the most cost-efficient support structures and the wide adoption of **energy audits** and/or of energy management systems like ISO 50001 that can effectively lead in this direction.

Other instruments like **voluntary schemes** could be considered, in order to overcome early-entry barriers for the participation of mainly commercial end-users in the service sector and to some extent also in the industry sector. Though, since these schemes have previously never been applied in Cyprus, considerable efforts in building trust among the different parties of the scheme would be required by the government. If these schemes would be coupled with other market provisions and/or obligations (e.g. nZEB, the **EED obligation scheme** or auto-consumer schemes) they could facilitate the implementation of energy efficiency measures by the participants and enhance the overall performance of the proposed policies.

Moreover, while energy efficiency measures and interventions are not clearly considered in various market sectors in which energy is not a core business, they are finally also “integrated” and embedded in some extent on their balance sheets. Even for these cases more effort in terms of policies and identification of benefits are needed to make these businesses prioritise energy efficiency and implement corresponding measures. Sectors like real estate and tourism as well as industry should be targeted in order to allow a shift in prioritization of energy efficiency as a core dimension of their activities and to facilitate the adoption of energy efficiency interventions from their side.

The tax regime and the framework of energy price subsidies should also be carefully assessed and the adoption of dedicated energy efficiency taxes could be considered in the cases of neutral or even positive net impact on the level of consumers and/or national economy[13]. However a transparent tax flow regime and the support of the most cost efficient energy saving measures should always be ensured. It is strongly proposed, though, that an ex-ante analysis and assessment of any new energy tax should be conducted before the adoption and implementation of such an instrument, including an impact analysis on the consumers’ compliance capacity.

The improvement of technology in various types of interventions will continue to result in lower investment costs per amount of saved energy and therefore the attractiveness of these interventions will become much higher in the medium to long term. However, coordinating effort will be required in order to structure and operate the most appropriate administrative forms of the new financing programmes and to identify key end-use subsectors, whereas tailored planning of interventions should be considered.

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[13] Such a tax structure has been proposed by CUT-team to MECIT, in the context of previous activities and it relates to the establishment of a carbon tax for the non-ETS sectors (Zachariadis, How Can Cyprus Meet Its Energy and Climate Policy Commitments? The Importance of a Carbon Tax, 2015).

New energy efficiency mechanisms that reduce end-use transaction costs and facilitate the scale-up of energy efficiency interventions, like smart metering, on-bill finance, energy leasing and energy savings insurance should be considered by all the relevant market actors and therefore encouraged and supported by the state. This is especially import when considering the reform of the national electricity market that is expected to be completed until 2020 and which will create new opportunities for the adoption of new market schemes.

Identification of barriers and required prior actions

Need for the mobilisation of new financing instruments that would allow state revolving financing and better access to finance: aim for overall reduction of the currently identified financial barriers.

Governance priorities and objectives

The perceived quantitative objective should result to an annual rate of renovated buildings of not less than 1% for the 2020-2050 period, while the necessary annual investments for achieving and attaining this renovation rate are modelled to be less than 0,5% of the mean annual GDP for this period and to this end such an amount on annual basis should be considered and be driven for energy efficiency investments.

The implementation of the energy efficiency policies to follow for the post 2020 period should also be drawn after a comprehensive evaluation of the outcomes and impacts from past and on-going measures and moreover, emphasis should be also given to the capitalisation of synergies between policy measures (i.e. energy audits) and financing programmes.

The identification of the performance of existing energy efficiency regulatory schemes as well as revealing the energy efficiency potential in various end-use sub sectors is essential for the targeted planning of new instruments and regulatory interventions if needed. In this direction the development of a specific Information System should be considered. Such a system would allow for the assessment and evaluation of the various energy efficiency policies and measures and the enhancement of the disaggregated energy consumption profiles data and equipment used by the various end-users.

Data shall be obtained from dedicated market surveys and exploitation of the information provided by energy audits and/or energy management systems. This system should be further enhanced by systematic monitoring of savings achieved from the implementation of various measures also as part of the EED art.7 obligations. This should include a clear definition of the data collection process and obligation of data providers such as the proposed Energy Efficiency Fund, municipalities, projects implemented by other line ministries such as the Ministries of Education and Public Works, etc.

Development of a mechanism for monitoring and assessing the effectiveness of energy efficiency policy measures

Overall a balance of legislative interventions, financial support schemes and market initiatives should be envisaged with a coordinated and comprehensive approach allowing flexibility in the anticipated efforts per sector to allow steering on the basis of ex-post analysis of past measures.

Especially in sectors like households but also services, the transition from conventional state support schemes in the form of grants to other types of financing instruments (e.g. loans, guarantees) and mobilisation of market mechanisms (e.g. energy services), will require a learning phase and this should be aimed to be fully accomplished in the medium-term. However, even in the short-term the initiation of this process should not be further delayed and in order to avoid failures and lock-in budget effects the simultaneous presence of other assistive market mechanisms (e.g. energy services) should be secured.

Moreover, is proposed to attempt the more cost intensive measures to be back-loaded in time scale in order to allow both market maturity and exploitation of less cost intensive energy saving potential.

The implementation of energy efficiency measures in buildings can create multiple economic and social benefits and priority should be given to measures that result in a net profit at the macro-economic level.

The efficiency improvements will also improve social outcomes, by contributing to a reduction in consumers' energy bills, reducing any energy poverty trends and increasing the sustainability of the energy supplier's market.

A critical element for the successful implementation and performance of the new energy efficiency policies and measures is the as much as possible detailed identification and analysis of the existing barriers that prohibit the best performance of the currently implemented energy efficiency policies-measures and the resulting design of dedicated interventions that would allow the uplift of those barriers and the avoidance of creating new ones under newly launched energy efficiency policies.

Table IV.5: Summary of proposed actions for policy interventions for enhancing the performance of the national energy efficiency framework

Area of policy intervention	Barrier	Prior action
Energy Buildings Certificate	No integration in the building's asset value. Lack of aggregated and unitary information out of the existing Energy Building Certificates for consideration on the design of policies. Lack of understanding of the Energy Performance Certificate and implication of unfavourable energy classes among buyers and tenants	Promotional events with real estate agents. ISP for aggregated information. Making provision of the Certificate mandatory for notarisation of any property transaction
ESCO market	Lack of modelled contracts and standardised procedures for M&V. Lawyers' involvement on contractual clauses and enforcement of contracts. Lack/unsystematic consumption monitoring in public building to assess the viability of the business case. Limited confidence between contractual parties.	Development of public model contracts. Enhancement of ESCO registry's features. Targeted training events for all stakeholders (banks lawyers, public procurers, SMEs, ESCOs). Application of Code of Conduct. Public-Private ESCO. Pilot public EnPC projects Bundling of projects to decrease transaction costs. Promotion of ISO 50001 and energy consumption monitoring to facilitate selection of potential ESCO projects Involvement of intermediaries/facilitators (e.g. Energy Agencies, local development

		agencies)
Public buildings	Insufficient disaggregated data.	(re) training of energy managers and track regular monitoring. Dedicated ISP for energy use
Private energy sector initiatives	Knowledge gaps Incentive schemes are not taken up/matching the need so business sector Lack of access to finance No incentive and no market maturity of some technologies/sectors	Legislation for obligating parties with long horizon. Schemes for PPPs. Energy efficiency networks and voluntary schemes. Demand response operational framework. Adjust existing support schemes Awareness raising and capacity building in sectors with high savings potential (e.g. tourism)
Private Banking Sector	Lack of knowledge and trust.	Development of de-risking tools like state guarantees and insurance products. EE fund with different financing instruments. Awareness and training measures for credit and risk officers
Energy audits	Lack of (adequately) trained professionals. Lack of incentives beyond mandatory usage.	Guideline for energy audits and training events. Hybrid financial instrument for SMEs that undergo an energy audit. Certified auditors. Energy managers for industry. Consider extending the audit obligation to non-SMEs or linking an audit certificate to subsidies

		Energy Efficiency Networks
Green Public Procurement, EPC Tenders	Evaluation criteria and process. Restraining/complex O&M clauses. Profit sharing clause. Public accounting rules. Lengthy procedures for signing agreement (ref public buildings).	Integrate cost efficiency criteria. Allow/foresee/promote competitive dialogue. Typical O&M contracts. Public procurement rules.
Consumers/ End-Users	Low level of engagement on EE issues	Auto-consumption schemes. Awareness and educational activities/campaigns. Energy (carbon) taxes or tax rebates.

Household sector

In the household sector the focus should be kept on energy efficiency interventions in the existing building stock, ensuring the appropriate enforcement and monitoring of the EPBD and national energy related requirements for new buildings.

However, it is proposed that at least in the initial phase the focus of the national policies that consider forms of support, to be mainly driven to specific combination and mix of energy efficiency interventions that attain the highest cost-effectiveness. The eligible interventions under these schemes should, though, lead to an **overall improvement of the energy performance of the affected residential buildings**. Special care should be given to targeting these support schemes equally to multi-family buildings, since this is a segment of the building stock in which energy efficiency interventions achieve maximum cost-efficiency and which has not been addressed effectively under previous schemes. Moreover, the high degree of occupancy of the apartments by the owners eliminates the split incentive effects and allows a more straightforward design of policy interventions.

Strengthening the market impact of **the Energy Performance Certificate** should be another priority, especially in the context of the new obligation for the nZEBs, in order to integrate in the building's asset value its energy performance and to further incentivise the professionals of the sector (e.g. real estate agents-developers) to seek for a higher energy performance of their assets.

On the basis of the analysis of aggregated data in relation to the profiles of residential consumption and the characteristics of the existing building stock (e.g. insulation & window frame types, heating and cooling equipment, actual values of energy consumption, etc) specific measures must be launched that will target:

- Specific categories of buildings (construction period, type of household)
- Isolated interventions (e.g. roof insulation, heat pumps)

able to deliver the maximum savings with the best ratio of investment.

Though, the any public financing scheme is not going to be sufficient for sizable overall energy savings in the residential sector if it is not accompanied by a high leverage of private financing. Emphasis should thus be given to measures and policies that will combine non-bureaucratic schemes with substantial private financial participation. Such policies could become attractive only if are related to short payback periods and to interventions that do not inherent any market constraints.

The role of the private energy sector could be essential for the energy efficiency interventions in the residential sector, especially if an **obligation scheme** is established covering different type of energy suppliers. Under such a framework the adoption of fast-delivering and easy to be implemented interventions will be most definitely aimed at, without though sacrificing the overall sustainability of the energy efficiency market. The latter can be safeguarded if the obligation scheme will have a clear and transparent medium to long term framework. Such an obligation scheme could also be a catalyst for the uptake of the domestic energy service market as well as the adoption of more innovative market mechanisms (e.g. on bill financing)

At the same time the public sector should be resilient enough in order to adjust and respond to measures taken by the private sector in order first to differentiate and second to bridge the gap if the latter is observed and needed. In this context no competitive public supported measures should be planned and the overlapping of the different incentives should be kept at the minimum possible levels.

Soft measures along with regulatory additions should be also planned to allow the most efficient organisation and operation of self (auto)-consumption schemes in relation also to final energy savings as well as for the initiation of demand response incentives and behavioural induced savings. Especially for the self-consumption schemes, attention should be given in order not to allow discriminatory behaviour against vulnerable consumers and to avoid negative overall impacts to the network charges budget.

The operation of the proposed **Energy Efficiency Revolving Fund** will be a clear challenge for the household sector especially in the initial period. A transition mechanism could be adopted that would allow a mix of grants-loan-private contribution, varying either by the household's purchase power and/or the type of the energy efficiency intervention. Nevertheless this Fund could be also mobilised under private sector's initiatives in order to allow the scale-up of the number of beneficiaries and/or provide de-risking instruments (i.e. guarantees) for types of interventions or providing loan instruments to the obliged parties.

Additionally, the public administration could enhance the performance of private operated and supported energy efficiency mechanisms through dedicated training events, IS Platforms and list of certified energy installers and/or auditors. Experiences taken from similar initiatives under EU programmes (e.g. BUILD UP SKILLS WE-QUALIFY for the installation of thermal insulation) should be used to the maximum degree possible in order to allow the roll-out of interventions at a massive scale.

Deep renovations should be carefully planned and supported, possibly only linked with welfare and societal criteria (e.g. vulnerable households, mountainous areas) versus specific combination and mix of energy efficiency interventions that should attain higher importance and support especially the ones that lead to high energy performance class.

Moreover, comprehensive refurbishment of residential buildings, when a public support scheme is in place in the form of a subsidy, should be limited only to buildings with low energy performance class and of specific construction period in order to maximise both the energy savings but also the cost effectiveness of the applied scheme.

New promotional activities for energy efficiency household appliances, which are proposed to be further enhanced by integrating smart linkage to other schemes and mechanisms (e.g. auto-consumption, smart-meters) should be also foreseen, aiming to tap the energy saving potential that still exists because of the usage of non-energy efficiency devices and lighting equipment. Overall awareness activities should be planned and implemented in the next period targeting especially the households, which are further elaborated in the GIZ study "A proposal for an Energy Efficiency Awareness Campaign in Cyprus".

Lastly but not least, **training** and light **certification schemes** for building installers should be planned in order to increase first the transparency and the credibility of the proposed energy efficiency interventions and to second to assist in the de-risking of the investments from financial perspective.

Table IV.6: Ranking intensity of effort in different time intervals for a number of policy intervention areas in the household sector up to 2050 (intensity grade x-xxx)

Measure	2020-2030	2030-2040	2040-2050
Deep renovation schemes	x	x	xx
Support for combined EE interventions	xxx	xx	xx
Information and awareness raising on EE equipment (labelling) and professionals training/certification	xxx	x	x
Enable prosumers schemes	xx	xx	xx
Energy service market (through obligation schemes)	xx	x	x
EE revolving Fund	xxx	xxx	xxx

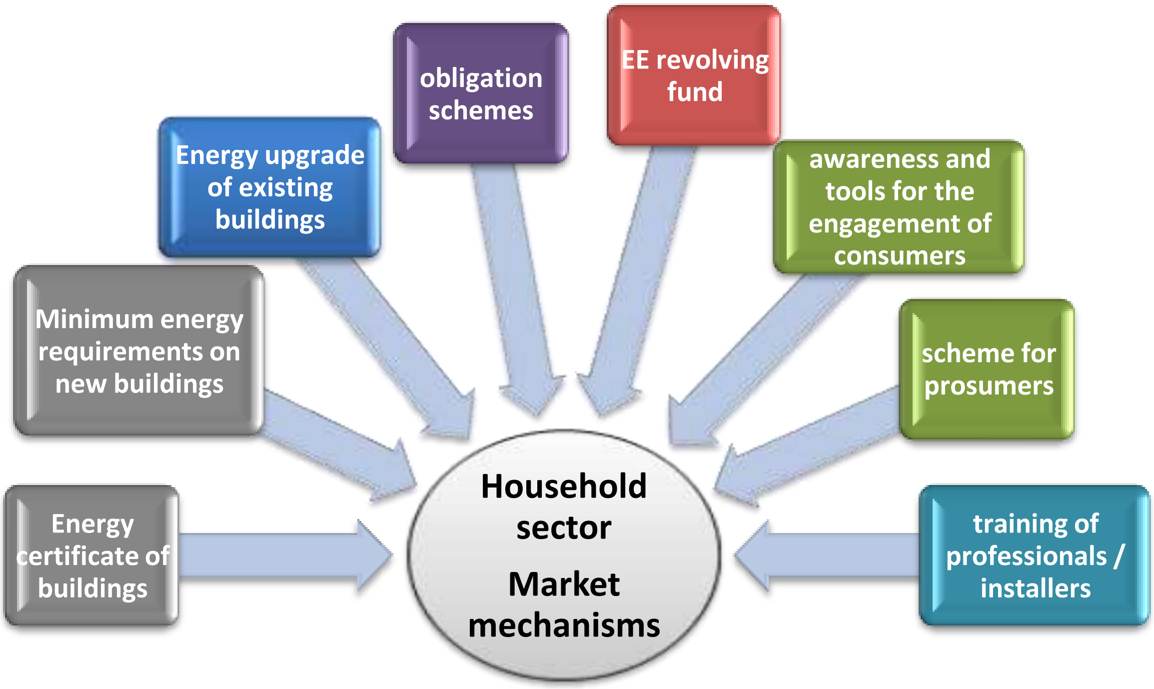

Figure IV.42: Overview of policies for the household sector

Service sector

The achievement of energy savings in the service sector is going to be a considerable challenge, especially in private buildings considering the up to now limited interest for any energy efficiency interventions.

However, the potential for energy savings is extremely high in almost all the different subsectors and as such an appropriate mix of policies and incentives could unlock this potential and to translate it into savings.

The suggested approach refers to the establishment of the appropriate framework that would allow standardised procedures for the verification of the savings in relation to the use of financial instruments as well as the activation of the domestic **energy service market** that is a key factor for the achievement of energy savings in the service sector.

Especially for public buildings the appointed **energy managers** should be further activated in order to allow for an accurate identification of excess consumption and optimum planning of targeted interventions. Moreover, in the context of other EU initiatives (e.g. Covenant of Mayors) and with regard to the planned municipal reform which would give more autonomy and financial resources to local governments, the development of and support for the implementation of local action plans could be foreseen. Implementation shall be ensured (i.e. if market and fiscal barriers are removed) to a considerable share through **energy performance contracting** and with the support of the **Energy Efficiency Fund**. The continuation of only grant-based instruments for public buildings is proposed to be gradually limited down only to comprehensive type of interventions (i.e. NZEB).

As far as the private segment of the service sector is concerned, the timely implementation of **energy audits** also for SME - as to be promoted with the upcoming new regulations prepared by MECIT - and **energy management systems** should be the first priority since this is believed to as the catalyst for the permanent engagement of the sector in the energy efficiency improvement of its energy consumption. Complementary efforts in further enhancing the competence levels of pool of existing class B auditors might be needed.

Table IV.7: Prioritisation and types of measures by subsector

Service sector						
Ranking of priority	**Private buildings / facilities**	**Types of interventions**	**Tools**	**Public buildings / facilities**	**Types of interventions**	**Tools**
1	Hotels	Building cell, lighting, BEMS, solar thermal & cooling, heat pumps , recovery	Energy audits, ISO50001 Energy managers & EE networks	Hospitals (including private)	Building cell, heCHP, BEMS, lighting, recovery, heat pumps	Energy audits, ISO50001, Energy managers
2	Shopping malls	Building cell, HeCHP, lighting	Energy audits, ISO50001, Energy managers	Public buildings	Building cell, lighting, BEMS, heat pumps, IT	Energy audits, ISO50001, Energy managers
3	Banks	Building cell, BEMS, IT, heat pumps, lighting, recovery	Energy audits, ISO50001, Energy managers	Sport centers	RES heating and cooling, lighting, heat pumps,	Energy audits, Energy managers
4	Restau-rants	Building cell, Heat pumps, lighting & equipment, solar thermal		Schools (including private)	Building cell, lighting, RES heating, heat pumps	Energy managers, Energy audits
5	Retail market	Building cell, heat pumps, lighting				
6	Hyper-markets	Building cell, heat pumps Lighting,	Energy managers			
7	Offices	Building cell, heat pumps, lighting, IT	Energy audits			
8	Airports	Building cell, lighting, BEMS , heat pumps	Energy audits, ISO50001, Energy managers			

In subsectors with added social value and of high visibility (e.g. hotels, shopping malls) the adoption of **voluntary schemes** could be beneficial in order to achieve overall energy savings per sub-sector and to introduce the energy savings in their corporate social responsibility identity. Especially the tourisms sector, which is driven by increasing environmentally concerned travellers but also in light of the requirements from international tour operators can be expected to be receptive to such initiatives. This sector should also be encouraged to engage in peer-learning activities in designing and implementing saving measures through energy efficiency networks that proved to be highly effective in other Member States.

Such voluntary schemes could be foreseen to be eligible for support under the energy efficiency fund in order to increase the market visibility, build capacities but also not to create financing barriers. Similarly, the role of the local energy service market could be important in this pillar, though with lower relevance compared to the public buildings sector.

Of outmost importance is, however, the establishment of an accurate energy usage profile and stock of energy installations & equipment in the various sub-sectors of the service sector, since the lack of such data prohibits the planning of central policies and support for targeted measures that achieve the best cost efficiency ratio. In this context the launch of ***sectoral surveys*** on energy consumption and equipment is critical in order to allow the planning of tailored-made energy efficiency measures and interventions that consider the different energy profiles of the various sub-sectors of the service sector.

Additionally, an identification of the different existing barriers for proceeding to energy efficiency interventions should be performed in consultation with the market stakeholders in order to reveal - besides the financial and technical ones - if fiscal and regulatory ones are also present. The table that follows presents a comprehensive overview of the possible barriers for potential energy saving opportunities, as referred by previous studies[14], which could link to barriers that also applicable for the Cypriot case.

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[14] Study on Energy Efficiency and Energy Saving Potential in Industry from possible Policy Mechanisms. ICF, 2015.

Table IV.8: Taxonomy of barriers to energy efficiency and Energy Saving Opportunities

Origin	Area	Barriers
External	Market	Energy price distortion
		Low diffusion of technologies
		Low diffusion of information
		Market risks
		Difficulty in gathering external skills
	Government / politics	Lack of proper regulation
		Distortion in fiscal policies
	Technology/service providers	Lack of interest in energy efficiency
		Technology suppliers not updated
		Scarce communication skills
	Designers and manufacturers	Technical characteristics not adequate
		High initial costs
	Energy suppliers	Scarce communication skills
		Distortion in energy policies
		Lack of interest in energy efficiency
	Capital suppliers	Cost for investing capital availability
		Difficulty in identifying the quality of the investments
Internal	economic	Low capital availability
		Hidden costs
		Intervention related risks
	Organisational behaviour	Lack of interest in energy efficiency
		Other priorities
		Inertia
		Imperfect evaluation criteria
		Lack of sharing the objectives
		Low status of energy efficiency
		Divergent interests
		Complex decision chain
		Lack of time

		Lack of internal control
	Barriers related to competences	Identifying the inefficiencies
		Implementing the interventions
	Awareness	Lack of awareness or ignorance

Source: Study on Energy Efficiency and Energy Saving Potential in Industry from possible Policy Mechanisms. (ICF consulting, 2015)*. Reference to Cagno et al,2012.*

Similar to the residential sector, the service sector also hides a number of low-hanging fruits in terms of energy savings, which should be first exploited and mainly are related to behavioural aspects (linked to automated and intelligent control systems) with extremely short payback periods (e.g. less than 2 years), while also another group of interventions in most of the cases is also relevant that relates to short-medium payback periods of up to 5 years. The table that follows also presents a list of reference best practices in the service sector with short to medium term payback period.

Table IV.9: List of best practices and opportunities for energy efficiency interventions in the service sector

References of the best cost efficient interventions in the service sector	
Variable speed drives-HVAC	Occupancy controls-sensors
LED technology-lighting	Demand controlled ventilation
Overnight cooling	Optimise building management systems
Natural cooling techniques	Intelligent control systems
Exhaust air heat recovery	Temperature setback and scheduling
Energy efficient equipment	Insulation of equipment, pipes, etc.

Source: Study on Energy Efficiency and Energy Saving Potential in Industry from possible Policy Mechanisms. (ICF consulting, 2015)

Especially for the private service sector the element that increases the weighting factor of any pre-identified barrier is the level of perceived risk for the implementation of specific energy efficiency intervention and this risk can be further broken down to a technical, commercial and financial one. The way that these risks are going to be addressed and mitigated is essential for the optimum implementation of a measure but most importantly for the uptake of similar interventions from a large number of recipients.

From another perspective any identified risk can also be the driver for the scaling up of the interventions in the service sector (i.e. if addressed properly by a structural measure). The table that follows groups a number of referred risks[15] and links them with structural changes that could serve as drivers for the uptake of energy savings in the tertiary sector, with relevance to the Cypriot case.

Table IV.10: proposed structural policies to mitigate risk consideration for a number of energy efficiency interventions in the service sector

Risk categories	Structural drivers for successful policies
Technical	
Engineering design	*Certified companies , certified installers, energy audits, ISO50001*
Implementation	*Model contracts – Standardised Contractual Terms and Liability Arrangements*
Operation and Maintenance	*Standardised Measurement and Verification tools and protocols, ISO50001*
Commercial	
Procurement	*Competitive Dialogue, Model Contracts*
Counterparty	*Standardised Contractual Terms and Liability Arrangements, State Guarantees*
Financial	
Expected returns	*Link Light-Basic Energy Performance Contracting with financing tools, Establish EE Insurance Schemes*
Financing structure	*Mobilise soft loans and state guarantees*

With regard to public buildings, though many of the challenges, barriers and technological opportunities for energy efficiency interventions remain the same like in the private service sector, the fundamental difference is related to the budget element. As far as public buildings are concerned the list of solutions to achieve significant levels of energy efficiency improvements are narrowed to only two: One is direct financing from national schemes (CSF 2014-2020,2021-). The other one is outsourcing of the cost of intervention

[15] As also found in the Study on Energy Efficiency and Energy Saving Potential in Industry from possible Policy Mechanisms (ICF consulting, 2015).

through an Energy Performance or Energy Supply Contract. In this regard the uptake of the Energy Service Market is of crucial importance since a sustainable rate of energy efficiency upgrades in public buildings cannot only be supported by state funds/budget. As stated in the beginning of this chapter the energy managers can constitute a highly valuable instrument for the identification of the most appropriate interventions and most suitable public buildings to undergo such a refurbishment. In this context a dedicated Information System Platform (ISP) on the energy infrastructure and consumption should be developed and performance indexes should be developed in order to identify both the specific energy saving potential as well as the ranking and prioritizing among the different typical public building categories.

In order to foster the uptake of the ESCO market in Cyprus for the public buildings different pathways could be mobilised (pilot projects, soft loan facility for ESCOs, etc.), though only after addressing some identified current barriers in the context of public procurement and accounting rules that do not allow the optimum exploitation of this market mechanism and discourage any initiative in the field. The already developed ESCO registry is proposed to be enhanced significantly, by developing model contracts, code of conduct and an M&V methodology and the tender of some lighthouse EPC projects in the public sector – once the above-mentioned barriers have been addressed properly - should be launched as soon as possible. Large[16] municipal authorities could also play a pivotal role in the uptake of the Energy Service Market in Cyprus and is recommended to provide direct technical assistance and financial support to them for the preparation of tenders, especially when buildings are grouped (e.g. schools, communal buildings, sport centres etc.).

Considering the above mentioned issues, an intermediary structure for facilitating the contractual terms and the technical evaluation of the proposed projects could be established. Such a structure could facilitate the growth of the local ESCO market and the launch of the first projects. It needs, however be carefully designed in order first to have the technical and legal competence to be actively engaged and to play the role of the (widely-accepted) facilitator and second not to give the ground for inducing new delays in the tendering and/or negotiating process of such projects.

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[16] In terms of population and ownership of building stock (m^2) and energy infrastructure.

Table IV.11: Kickstarter administrative actions for the uptake of the ESCO market in Cyprus[17]

Framework	Technical-Operational	Market
Train lawyers	M&V standardized scheme	Public financing mechanisms
Tax treatment and public debt issues	Public buildings database with disaggregated baseline energy consumption	Intermediate body

Since generally the scheme of a public (or public-private) ESCO in Cyprus is not widely recommended, due to the market characteristics (limited and localised potential in terms of number of public end-users, possible market distortion of competition) and given the non-developed technical capacities from public organisations, such an intermediary structure would be more light and could be much more efficient considering the characteristics of the Cypriot ESCO market. If properly designed and structured with the participation of the appropriate organisations (e.g. CEA, OEB), it could actively facilitate the uptake of the local energy service market not only for public buildings/infrastructures but also for the private sector.

The JRC study (Economidou, Report on the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector, 2016), has also identified a list of existing barriers that prohibit the growth of the local ESCO market. The figure that follows presents this list of documented barriers in that study, having highlighting the ones that are seen as essential and prior actions needed to allow the uptake of the national EnPC/ESCO market.

[17] Considering the discussions held on the workshops organized by the GIZ team for the scope of this study on the 26-27 of April 2017, in Nicosia-Cyprus.

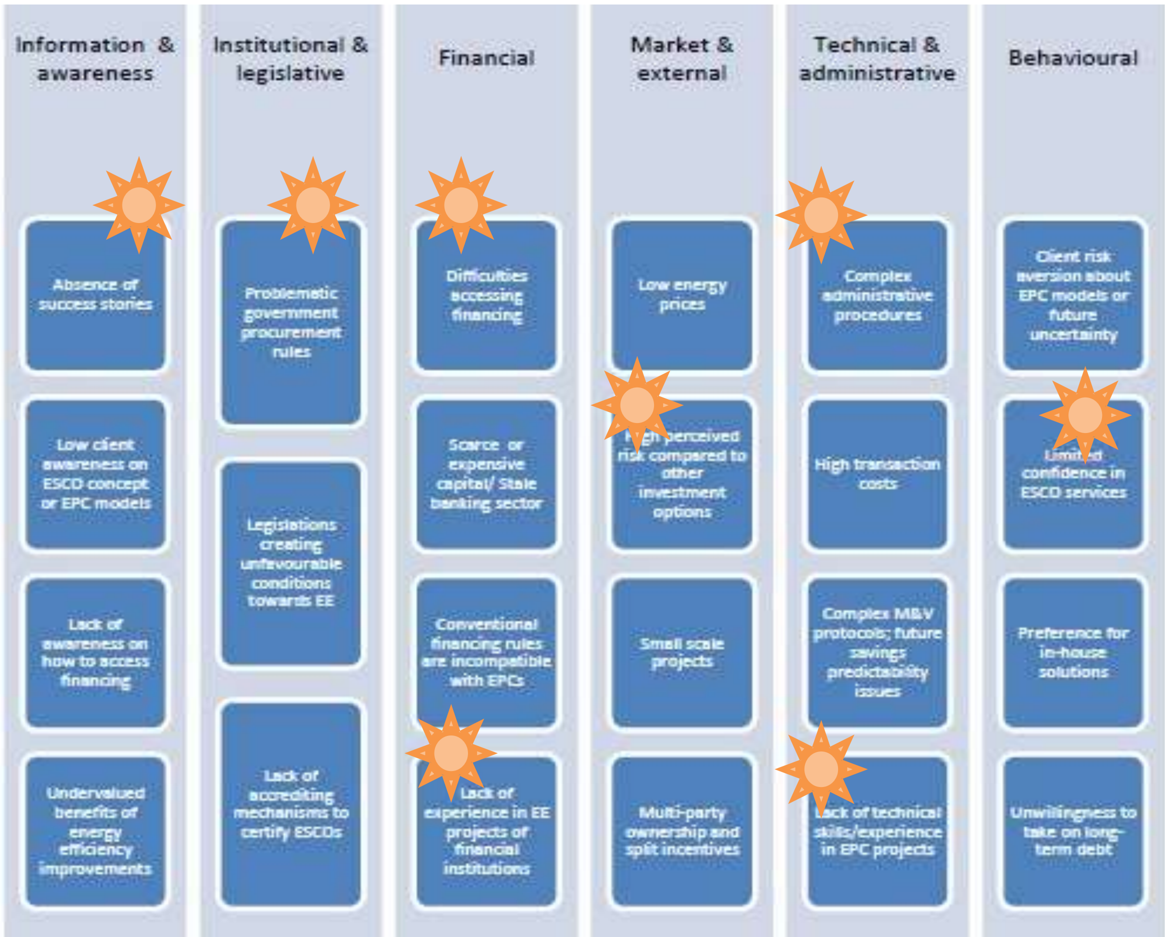

Figure IV.43: Barriers that should be prioritised for the uptake of the energy service market in Cyprus (reference to page 17 of the JRC Report on "the current status of the Energy services market and proposal for measures to promote EPC in the public and private sector)

The implementation of an obligation scheme could also have beneficial effect for achieving energy savings in the service sector and to overall drive the growth of the local energy service market. Moreover such a market obligation could also allow the fast adoption of new market mechanisms, either directly provided by the obliged parties (e.g. on-bill financing) or from the credit institutes (e.g. lease contracts) to various type of energy consumers (i.e. households, SMEs).

Additionally, the energy efficient upgrade of street lighting should be accelerated as much as possible and the tackling of procurement barriers identified in past efforts[18] as well as the adoption of dedicated loan facility

[18] For example the future launch of such a new tender mechanism should be done under an as much as possible equal risk-sharing structure among the private and

could act as catalyst to the achievement of these fast-performing energy savings that also have positive impact at the state budget.

Table IV.12: Ranking intensity of effort in different time intervals for a number of proposed policy intervention areas in the service sector up to 2050

Measure	2020-2030	2030-2040	2040-2050
Deep renovation schemes	x	x	xx
Support for specific EE interventions and RES heating and cooling	xx	xxx	xx
Energy audits (SMEs)	xxx	x	x
Energy Services /ESCOs (focus on both public and private buildings)	xxx	x	x
Voluntary schemes (specific subsectors)	xx	x	x
Energy managers (focused on specific subsectors)	xxx	x	x
EE revolving Fund	xxx	xxx	xxx

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public stakeholders and by also providing adequate and standardised information that is sufficient to create a transparent benchmarking for all the potential interested companies. The award criteria should also be clear and transparent in a way that the comparison among the different offers could be performed easily, while also the contractual payment terms should be simple and free of legal risks

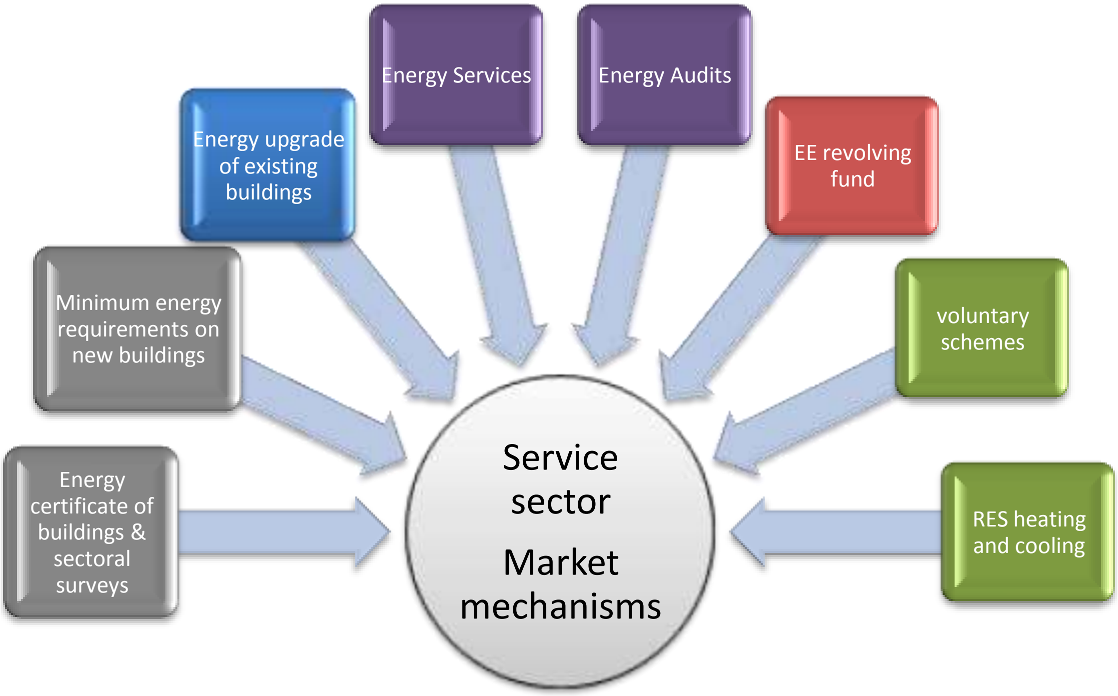

Figure IV.44: Overview of policies for the service sector

Industry

Requirements for large industries to either conduct an energy audit or to implement an energy or environmental management system ISO50001/ISO14001 have to be monitored and assessed. Energy audits also in SMEs should be encouraged and promoted and adequate support schemes are proposed to be considered in combination with financial instruments that target comprehensive energy efficiency interventions.

Under such an audit policy and obligation scheme, the relevant governmental services will collect a lot of new data relating to final energy consumption in the industry and the relevant potential for energy savings. This could be used in order to give potential investors a realistic picture of the energy efficiency market in this sector and to design future energy efficiency policies for the industry.

While the performance of the EU ETS is directly correlated to the overall necessity for the industries to undertake energy efficiency measures in the future, the support for auto-consumption schemes, implementation of heat recovery systems and the wider operation of high efficiency Combined Heat and Power (heCHP) systems could be aimed independently especially with increasing retail fuel prices.

Nevertheless the industry sector exhibits the least elasticity in terms of its energy profile and as a matter of fact any intervention will be always adjusted and tailored to the specific installation/industry and any governmental support scheme should have enough flexibility to accommodate the different types of energy efficiency interventions.

Surprisingly, the full potential of energy savings by easy to be implemented energy interventions (i.e. heat recovery, automations, etc.) is not fully known among the various stakeholders of the industry sector and it is expected that the energy audit scheme would increase the energy efficiency awareness level and to reveal easy to be installed measures with short payback periods.

Similarly the presence of either a trained energy managers or an Energy Management System (EMS) would allow the uptake of several energy efficiency interventions in the industry sector.

Table IV.13: Suggested energy efficiency interventions in the industry sector linked with instruments to address existing barriers

Intervention	Barrier to be addressed	Instruments to be enabled
Heat recovery	Lack of knowledge. Limited information of technology solutions. Lack of specialized installers.	Information events, energy audit, energy manager, EMS, ESCOs, EE Fund
Installation of heCHP	Lack of knowledge. Worst payback periods vs other auto-consumption schemes	Information events, energy audit, energy manager, EE Fund
Use of high efficiency electric motors	Perceived risk for new installations on core activities	Information events, energy manager
Installation of energy efficient compressed-air systems and use of inverters	Limited awareness & information.	Information events, energy audit, energy manager, EMS, ESCOs
Installation of automations	None – limited awareness & information	Energy audit, energy manager, EMS
Installation of LED lighting bulbs	None – limited awareness & information	Energy manager, EMS

Moreover, access to the proposed Energy Efficiency Fund should only be allowed with caution for the industry sector in order not to interfere with the ETS framework but also in order not to act as a disincentive for performing interventions, otherwise meaningful and planned, without public support.

A central policy decision could be made with regard to the tax regime of the fuel supply to the industry. An additional environmental related tax could be used as an inflow for the Energy Efficiency Fund and to be allocated for interventions in the industry sector.

Lastly, like in the proposal for the service sector, voluntary agreements could be launched in specific industrial sectors (e.g. with high social perspective and national added value-like food beverage tobacco industry) that would allow the formulation of central and coordinated interventions to the (participating) industries under preferential financing conditions and for measures with low payback period. Similarly, energy efficiency networks in the industry could be considered and kick started with support from the Energy Efficiency Fund or other schemes.

While the industrial sector should be considered under the planning of the national energy efficiency policies it cannot be treated per se like the other end-use sectors. The adoption of energy efficiency measures by the industries could be secured only if disincentives are regulated or the incentives/profits are high enough. The targeted usage of the Energy Efficiency Fund towards industries that have undergone an energy audit and are applying for the implementation of the most cost-efficient suggestions resulting from the audit along with the requirement for installing a permanent Energy Management System (EMS) could be a format for a holistic approach to this sector.

The adoption of an additional obligation for EMS is also proposed but in a later stage, after the evaluation of the operation of the energy audit scheme and after considering the specific and special energy profiles of the different sub-sectors of the industry (also in terms of annual energy consumption and total value of industry’s annual energy bill). Alternatively, an obligation for an energy manager could also be foreseen with a central monitoring system of achieved savings[19]. Centrally organised training events for energy managers of industries could be organised and supported with the collaboration of both the state and the relevant associations (e.g. OEV) aiming to increase the knowledge and awareness on the available technological solutions and to allow a dissemination of best practices in a sector with a high level of introspection in providing data on energy consumption.

From a regulatory perspective, any barrier for the implementation of new technological solutions that improve the energy performance/energy intensity of the industrial processes should be uplifted and in this context monitoring of the Best Available Technologies (BAT) should be performed, disincentives or competition with other schemes should be avoided (auto-consumption vs heCHP), and a dissemination of their performance should be also centrally planned (i.e. in the context of annual energy efficiency events for the industrial sector) with the cooperation of OEB.

[19] Analysed extensively in the Study on Energy Efficiency and Energy Saving Potential in Industry from possible Policy Mechanisms (ICF consulting, 2015).

Table IV.14: Ranking intensity of effort in different time intervals for a number of proposed policy intervention areas in the industry sector up to 2050

Measure	2020-2030	2030-2040	2040-2050
Energy audits	xxx	xx	xx
Tax regime	xx	xx	xx
Energy Management Schemes	xx	xxx	xxx
Auto-consumption schemes	xx	xx	xx
heCHP	xxx	xx	xx
Heat recovery	xxx	xx	x
Voluntary schemes / EE Networks	xx	x	x
Dissemination Activities	xx	xx	xx
EE revolving Fund	x	x	x

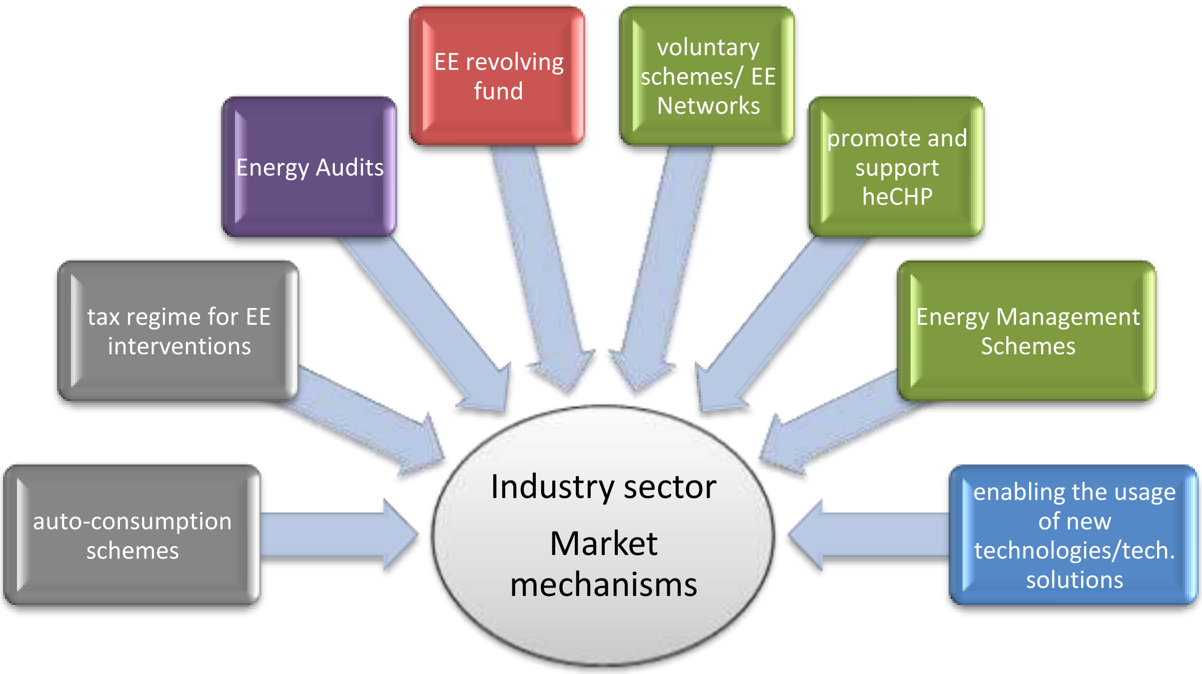

Figure IV.45: Overview of policies for the industry sector

Transport

In order to reduce the GHG emission targets by 2030 and afterwards the improvement of energy efficiency is a key target for Cyprus together with the use of RES. Therefore, supporting policies to foster energy efficient technologies ("Improve") or to strengthen more efficient or non-motorized transport modes ("Shift") can play a significant role.

As shown in the scenarios developed in ifeu Study Penetration of alternative fuels in Cyprus road and maritime sectors (Heidt, Jamet, Lambrecht, Bergk, & Allekotte, 2017) light duty vehicles (including passenger cars and light commercial vehicles) contribute to more than three quarter of the energy consumption of Cyprus road transport. Therefore, the measures and policies target in priority this vehicle group. Supporting policies to increase the energy efficiency for public bus and heavy good transports are first mentioned but should be considered more in details in a second step.

While emphasis should be also put on the establishment of a transparent e-mobility framework and the adoption of policy measures and market mechanisms that would allow and foster this transition, attention should be given in order not to over-incentivise not yet mature and competitive market structures and not to allocate the currently high early adaptation costs to the state budget.

Awareness initiatives along with capacity building/training activities should also be considered for exploiting some of the low-hanging fruits for energy savings in the transport sector. Compared to other end-use sectors tax instruments could be employed more intensively and strategically for transport.

In the text that follows some proposed key policy interventions for the transport sector are highlighted[20] and are further analysed in the context of experiences from abroad.

Modification of vehicle taxes based on energy efficiency

Vehicle taxes are used by most countries. Taxation levels taking into account average CO2 emissions or fuel consumption can help making energy efficient technologies economically more attractive to end users e.g. hybrid or e-cars. There are several international examples displaying different vehicle tax systems and their effects. The tax policy applies to several vehicle taxes in EU countries: registration, ownership, company car tax, annual motor vehicle tax or VAT.

[20] Full analysis is provided in the dedicated study of this TA project (Heidt, Jamet, Lambrecht, Bergk, & Allekotte, 2017).

Modification of vehicle taxes based on energy efficiency
Aim: Accelerate the penetration of energy efficient vehicles (cars and LCVs)
Current situation: In the past both registration taxes of new cars and annual circulation taxes were partly calculated on the basis of a car's direct CO_2 emissions as monitored by the EU CO_2-legislation for car manufactures. Due to the tax system in Cyprus, the share of new cars with less than 120 g CO_2/km increased from 18% to 45% between 2013 and 2015. However, the share EVs was only ~ 0.3%.
Description of the policy: Cyprus vehicle tax system could be modified in terms of a further push of energy efficient or low CO_2 vehicles and especially alternative fuels such as full EVs or hybrids. The vehicle tax classification and the level and type of tax exemptions and additional taxes still have to be defined, e.g. based on experiences from other countries. A combined push-pull policy such as the French Bonus Malus System is seen in favor in terms of cost-neutrality according to the polluter pays principle.
Stakeholders & partnerships: The implementation of vehicle taxes occurs at the level of federal government, i.e. the ministry of transport and the ministry of finance.

If the vehicle tax system in Cyprus is to by modified, two main aspects must be carefully designed: the type and the level of the tax exemption (equivalent to subsidising) and the target group.

The level of the tax has to compensate (partly) the incremental costs. In the specific case of electric cars, incremental investment costs as estimated for this study can range between ~4,000 and ~14,000 € depending on the car size. Tax exemptions and subsidies in other countries are usually lower (ICCT, 2016). According to (Christodoulou & Clerides, 2012) who studied the taxations of vehicle purchase in Cyprus, a feebate[21] similar to a bonus malus adding up to the existing system would reduce emissions (maximum by 23.7% for a taxation of 60€ per g with a pivot point at 120g CO_2/km) but consumer and producer's welfare would decrease. Replacing the current system by a new tax based on emissions would have a lower emission reduction but would increase welfare. In both cases the policies are designed as cost neutral. Based on the economic situation in Cyprus, using a system of feebate could enable giving sufficient tax exemptions to energy efficient cars such as EVs by taxing less energy efficient vehicles. The level and type of tax exemptions and additional taxes can be adapted according to the reaction of the market.

Second the target group must be studied, as taxes on company cars registration may have a high potential e.g. in the Netherlands more than

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[21] A feebate program is a self-financing system of fees and rebates that are used to shift the costs of externalities produced by the private expropriation

90% of EVs are registered by companies (ICCT, 2016). Therefore working on a lowered company car taxes or tax reduction on vehicles for companies may be a powerful instrument.

Regulating the operation of e-charging infrastructure

Together with the question of the construction of the infrastructure arise the question of the operation of the new charging points. Even though the EU foresees a private operation in the long term, the current low return on investments requires the involvement of the public sector. Several new roles are also developed with the new infrastructure:

- The Distribution System Operators (DSO) - operating, ensuring the maintenance of and, if necessary, developing the electricity distribution system in a given area
- The e-Mobility Provider (EMP), providing charging services such as charging cards, possibly combined with electricity supply to end consumers
- The Charging Station Operator (CPO) – operating and ensuring the maintenance of the charging stations (possibly also building the infrastructure)

Concerning deployment models for electro-mobility, a general framework can be found in the Directive on the deployment of alternative fuels infrastructure (DAFI) (2014/94/EU). It states that the build-up and operation of charging points should be developed as a competitive market with open access to all parties interested. Currently the general limited profitability of e-infrastructure because of high investments costs and unclear business models requires a cooperation of the public and private sector. Nevertheless a tendering process is also an option to open competition for the service. The DSO involvement can follow two different approaches:

- The DSO is in charge of developing EV charging infrastructure and metering, contracting out the commercial and technical operation of the assets to a market player e.g. in Austria
- The DSO is in charge of developing EV charging infrastructure and metering and is also the technical operator of the assets. Billing services are provided by a third party i.e. the commercial operator e.g. in Ireland

If the DSO is the owner and operator of the assets a clear exit strategy toward a competitive framework should be planned from the beginning. Ultimately when a business case is achieved, the DSO can remain the owner of the assets until the costs are recovered or they can sell their assets for a residual cost. In a fully liberalised e-mobility market, the role of e-mobility providers (EMP) and charging point operators (CPO) could be redefined. This is for example the situation in Austria, where vertically integrated EMPs and CPOs offer their services [Eurelectric, 2016]

In parallel is necessary to develop smart grids to cope the electrification of the vehicle fleet to manage electricity demand (currently under the responsibility of DSOs) and the development of V2G (Vehicle-to-Grid) dealing with network congestion management issues. Other business opportunities are summarized in the table below.

Table IV.15: Underlying business opportunities in the development of the charging infrastructure (Ecofys, 2014)

Future Services	Underlying (business) opportunities
Flexibility services	Congestion management, temporal and spatial matching of supply and demand, change consumption pattern
Infrastructure provision for electric vehicles	Demand management, utilize electricity storage capacity of electric vehicle, congestion management
Energy efficiency services	Reduce energy consumption, environmental awareness through visualising environmental impacts
Ownership & management of metering equipment	Utilize economies of scope and economies of scale in smart meter roll-out, standardisation smart meters
Data handling	Utilize economies of scale in data collection and management, cooperation with ICT/telco sector

In parallel the question of restricted access systems need to be addressed. For example Portugal has embarked on a nationwide EV charging system integrating access, equipment, billing and payment together. The system called Mobi.E covers the entire country. In contrast London has developed the SOURCE London system designed on a regional basis. While discussions are being undertaken to expand the operation to other areas in the United Kingdom, at the moment EV users need to register with different agencies to use the publicly accessible charging points across the country (ICCT, 2016)

Regulating the operation of e-charging infrastructure
Aim: Enabling a free and competitive market to develop profitable business models
Current situation: In Cyprus the only operator is the Electric Authority of Cyprus (EAC**)**
Description of the policy: Shifting to a competitive market will require regulation and a strategic positioning of public entities. Overall there are 4 basic activities to consider in the context of charging infrastructure: the provision of the infrastructure (asset), the provision of electricity to the charging points, the provision of e-mobility services (e.g. charging card and possibly selling electricity to the end user). Once the economic viability of the infrastructure will be achieved, the next step will consist in reaching a fully competitive market.
Stakeholders & partnerships: Several new stakeholders are entering the emerging market of charging infrastructure operation. The roles are still being defined and vary from one country to another depending on the model in place. Both a "full" DSO model and public tendering model are currently in place in Europe.

The charging infrastructure market is meant to be a competitive one in the next years, but the lack of profitable business models requires the involvement of the public sector and public entities e.g. currently a "full" DSO model is currently in use in Cyprus as EAC owns and operates the entire charging infrastructure. A best case for business models could be to offer all-in-one services package e.g. infrastructure providers offer charging stations and vehicle renting or leasing together with maintenance. As in other EU countries the phase out of the monopolistic situation towards a competitive market should be discussed and defined together with the DSO. The role of CPOs and EMPs will also gain importance in the future, when e-mobility achieves better economic records, and a sound regulation environment should encourage this change. In order to define the best model for Cyprus, a workshop is recommended to bring all the different stakeholders and potential new actors together and discuss the possible model e.g. open or restricted access, business modes, opening to the competition, private and public investments, and give a first impulse to this highly complex regulating issue.

Funding of public e-charging infrastructure

The availability of the fuelling or charging infrastructure is a central element to give drivers of e-vehicles the same liberty and convenience as with conventional vehicles. A regulatory framework for the construction of this infrastructure is already given by the DAFI. However, the implementation is the task of the Member States. As there are yet few experiences with business models[22], public funding plays an important role in the initial construction of the infrastructure[23].

Funding of alternative fuel infrastructure
Aim: Support the coverage of alternative fuel infrastructures
Current situation: There are actually 26 charging points. The network was established by the DSO Cyprus Electricity Authority (EAC).
Description of the policy: Depending on the technology, which is favored in the future e.g. natural gas or electro-mobility; the corresponding infrastructure should be made available. In the case of e-mobility, the number of charging points needs to increase to achieve the same coverage as refueling stations (currently app. 300) while taking into account that more stations would be required as charging a e-cars takes longer than refueling conventional cars. The main constraint is represented by the available budget. To foster the uptake of e-mobility, both AC and DC charging points would need to be built. Infrastructure funding needs to be designed in accordance with possible business models. Funding can be provided through a tendering process
Stakeholders & partnerships: Funding policies have to involve the federal government. Cooperating with local governments is highly recommended in order to avoid regional incoherence and to ensure homogeneity. The private sector has also a role to play in the construction of the infrastructure and the design of business models.

Several deployment models of e-infrastructure can be considered depending on the financial situation of the state. Parallel to private funding are several EU funds available, while regions and cities can attribute a share of their budget to the development of e-infrastructure (eventually the budget comes from the federal level). Examples of available funds for Cyprus are:

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[22] Newly BMW, Volkswagen, Ford and Daimler plan to build about 400 next-generation (350 kilowatt) charging stations costing 200,000$ each in Europe that can reload an electric car in minutes instead of hours, making it quicker that Tesla's super chargers. The fastest chargers in widespread use on the continent so far are Tesla's, which has installed over 1,800. At 120 kW, they still need half an hour to fully charge a car (with an autonomy of 270 km) [Reuters, 2017]

[23] In Germany the BMVI (German Transport Ministry) has defined a path for the development of alternative infrastructure in its national strategic framework "Nationaler Strategierahmen" (NSR) in the context of the directive on the DAFI. Besides founding the R&D for hydrogen and fuel cells technologies the major investment is dedicated to electro-mobility: the government designed a funding program of 300 M€ to: a)Equip all rest areas equipped with refuelling stations with DC charging stations, b) Develop a network of 5,000 DC and 10,000 AC stations by 2020.

The funding planned within the German national strategic framework is used through public tendering, thus enabling the private sector to build and operate the infrastructure according to their expertise.

- Grants from the TEN-T Network mainly through the CEF: Connecting Europe Facility
- European Structural and Investment Funds especially the EU's European Regional Development Fund, which funded the NSR network in the North Sea region[24] and the Cohesion Fund.
- The European energy efficiency fund, which attributed a €30 million senior funding to the Bolloré project in France (e-car sharing scheme in Paris)

Nevertheless, the mobilization of direct national public funds for e-infrastructure should be also assessed in terms of market maturity for e-vehicles and the allocation of such funds without the presence of a self-sustainable market for e-vehicles should be overall avoided or at least be prioritised as a medium-term impact policy measure for the transport sector.

Coordinate the creation of a one stop shop for e-mobility

Financial incentives for alternative fuel vehicles and a developed infrastructure is not sufficient to ensure that users will en masse and durably adopt the new technology. Insufficient or inexact information can hinder its uptake. Important information for end-users includes overview of vehicles available for purchase (manufacturers and models) and their performance data, refuelling network, the corresponding costs (fuel, maintenance, tax, …). as well as practical experiences from other users. The "one-stop" shop concept enables providing reliable information on all topics related to alternative fuels, e.g. electric-mobility, CNG or LPG.

The UK provides information on electric cars, charging infrastructure and EV incentives through a dedicated website: Go Ultra Low - a joint government and car industry campaign - including calculators and guidance on the Plug-In Car grant. Frontrunners of e-mobility such as the Netherlands provide information on incentives, vehicle registration statistics and charger location on its platform: Nederland elektrisch in partnership with private actors, NGOs and organisations.

In parallel there are also multiple platforms allowing users to find the nearest charging point, for example www.openchargemap.org, a global public registry of electric vehicle providing non-commercial, non-profit service hosted and supported by a community of businesses, charities, developers and interested parties around the world. Through the website

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[24] The e-mobility North Sea Region (NSR) project was designed to create favourable conditions to promote the common development of electric mobility in the North Sea Region in order to foster current and future developments, paying attention to links with both freight and logistics.

and the app users can provide peer review, edits, additions, comments, photos and promote the service to other users.

The one stop shop concept is also applied in the context of the TEN-T corridors to ease train path management and exchange on information by providing one single point of contact allowing applicants to request and receive answers regarding infrastructure capacity for international freight. A European platform for e-mobility is the Initiative for Cleaner Vehicles in Urban Europe, offering e.g. web tools for TCO analyses of e-cars and other information. (http://icvue.eu/)

Coordinating the creation of a one stop shop for e-mobility
Aim: Fostering the dissemination of information for users and ensure free-access to information
Current situation: Currently the only actor in the field of e-infrastructure EAC provides a map of the available charging stations (non-interactive), a user manual, and technical info as well as billing information on its website. No or few information related to e-vehicle use (availability, handling, costs) is currently available.
Description of the policy: The federal government together with regional entities should coordinate the development of a “one-stop shop” for e-mobility. Additional information can include interactive maps for charging stations (including GPS coordinates, current occupancy and price), information on vehicle purchase and operation. A central coordination enables coordinating and centralizing information and gathering the relevant stakeholders. The platform can also be used to communicate on policy agendas together with governmental authorities.
Stakeholders & partnerships: Next to the infrastructure operators, it is crucial to involve the car industry (manufacturers, sale and renting companies) into providing all necessary information to alternative fuel vehicle users. In this context relying on local knowledge and specificities of region is of relevance and enables bundling capacities and knowledge. The tourism industry can also play a role in disseminating information.

The creation of a one stop shop for e-mobility in Cyprus could be based on the current information service of the DSO and be supplemented by additional information based on international examples. For example a section:

- Policy agenda: with all goals and currently running policies and measures
- Statistics: with relevant and easy to understand data on alternative fuel penetration
- Vehicle: with an overview of available models, vehicle performance or leasing possibilities
- Infrastructure: with an explanation of the restricted access system i.e. e- charging card and an interactive map
- TCO analysis: to calculate the costs of running alternative vehicles
- Incentives: with all grants and funding available

Quality management and awareness raising campaign for public transport

Next to technical measures, the so called "shift" measures to foster the use of public transport modes are an important element in an energy efficiency strategy. Shift measures require the funding of the necessary infrastructure in the first place. Nevertheless shifting is also correlated with behavioural changes, it requires good campaigning. If public transport and soft modes, e.g. walking and bicycle, have to be favoured, it is important to convey both their advantages as well as a positive image. Today buses in Cyprus are predominantly used by low-income users and owning a car is part of a social recognition. This negative image must evolve.

There are several materials available on the design of such promotion campaigns such as the training material developed in the context of e-atomium project[25]. An interesting case study is displayed by Civitas: the city of Usti nad Labem in the Czech Republic. A status analysis revealed three main issues acting negatively of the share of public transport (PT):

- Deficits in the quality of offered services;
- Lack of served areas; and
- Limitations in covering passenger needs

PT promotion was therefore aiming at designing its PT offer to the needs of the users, supporting a good image for PT and attracting passengers and strengthening its usage by:

- Highlighting advantages of public transport compared to individual motor transport;
- Improving provision of information about transport services
- Public events to promote local PT services to residents. During these events, people were able to compare the services provided in the past and the improved once. They participated in knowledge and effort competitions for prizes, discussions and workshops about PT services Improving accessibility of services by providing targeted information to passengers
- Promoting campaign activities in local media
- Education of children for all primary school children in the city by the Municipal Police

[25] e-Atomium is a training project funded through the STEER programme which is part of the European Commission's Intelligent Energy Europe programme and will be implemented in Belgium, France, Ireland, Italy, The Netherlands and the United Kingdom. The aim of e-Atomium is to strengthen the knowledge of local / regional managing agencies in the transport field and to accelerate the take up of EU research results in the field of local and regional transport.

Through a research study and a survey the city mapped out directional relationships and transfer links. The majority of PT connections have been optimised, the operating times adjusted to correspond with school time, opening hours of offices, businesses and services in the city, arrivals and departures of trains and working hours in factories. Intervals of individual connections were set to better correspond with each other. Some lines were cancelled or replaced. Selected lines were guaranteed to operate by low-floor trolleybuses to enable transportation of disabled passengers. Moreover purchase of new and modern low-floor buses and trolleybuses (incl. providing wifi connection) was favoured together with better maintenance of vehicles and stations.

Quality management and awareness raising campaign for public transport
Aim: Motivating citizens to use public instead of individual transport modes
Current situation: Public transport in Cyprus currently includes urban and regional busses. They have a low share in the modal split in comparison to private modes, e.g. passenger cars. In the future, the construction of a tramway line in Nicosia is planned.
Description of the policy: Information campaigns for public transport in cities will be carried out under the participation of bus operators and citizens. Benefits of public transport versus private transport modes should be highlighted. At the same time, potentials for improvement of public transport are surveyed to better invest in public transport according to user's needs. The measure can show synergies to other policies, e.g. using B100 or electric busses.
Stakeholders & partnerships: Ministry of transport, city governments, public transport companies and citizens.

Information campaigns for public transport in cities will be carried out under participation of bus operators and citizens. At the same time, potentials for improvement of public transport are surveyed to better invest in public transport according to user's needs.

The promotion of public transport has synergies with policies for using RES and improving energy efficiency of busses, e.g. funding B100 or electric busses as well as the refuelling and charging stations.

Table IV.16: Ranking intensity of effort in different time intervals for a number of policy intervention areas in the transport sector up to 2050 (intensity grade from low to high: x-xxx)

Measure	2020-2030	2030-2040	2040-2050
Modification of vehicle taxes based on energy efficiency	**xxx**	**xx**	**x**
Funding of public e-charging infrastructure	**xx**	**x**	**x**
Regulating the operation of e-charging infrastructure	**xxx**	**xx**	**x**
Coordinate the creation of a one stop shop for alternative fuels	**xxx**	**xx**	**xx**
Quality management and awareness raising campaign for public transport	**xxx**	**xx**	**xx**

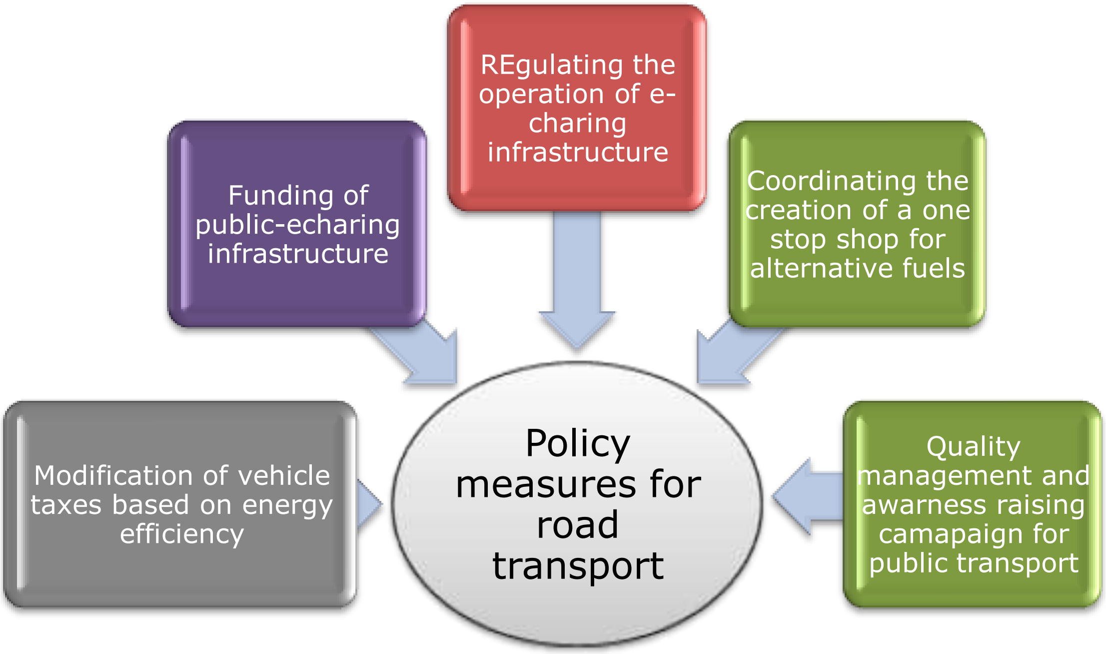


Figure IV.46: Overview of policies for the transport sector

Agriculture

Energy efficiency potentials in the agricultural sector have remained largely untapped so far. There is also no clear overview of the potentials with regard to different consumers (buildings, motors, lighting etc.) and the exemplary audits conducted in the animal and agricultural sector part of the technical assistance by GIZ for the greenhouse and animal sector (Mohamed, Markou, Balafoutis, Papdakis, Michael, & Janssen, 2017) (Markou, Balafoutis, Mohamed, Papadakis, Michael, & Janssen, 2017)would need to be detailed with further analysis. No data is available on other sectors such as for instance crop farming. Collecting disaggregated data through **statistical market surveys** and including the agricultural sector into a comprehensive monitoring system of energy savings will be mandatory to design tailor made policies and support schemes for farmers

The promotion of **energy audits** especially in the animal and greenhouses sector would also improve the data situation and increase awareness among the farmers. These audits should also include **indirect energy** consumed through fertilisers or feedstock where significant savings potentials have been identified.

Soft measures on building capacities and raising the awareness for energy efficiency and available technologies among the governing institutions and along the agricultural value chain is deemed necessary in the upcoming years with a view of current awareness levels. Adequate information products need to be developed and made available on all levels. Taking advantage of the decentralised network of agricultural extension officers of the Ministry of Agriculture and the Agricultural Research Institute as established intermediaries should be considered.

Energy efficiency and renewable energy should also be linked to dedicated agricultural programmes on national and EU levels such as the **Rural Development Programme (RDP)** and energy audits be promoted as a good agricultural practice in these frameworks. The installation of co- and **trigeneration** technologies should be considered wherever economically viable and an enabling framework created for an uptake of these technologies.

Especially in the agricultural sector energy efficiency measures shall be examined together with **renewables** in an integrated approach given the vast opportunities from solar, wind and biomass in different combinations.

Table IV.17: Ranking intensity of effort in different time intervals for a number of proposed policy intervention areas in the agricultural sector up to 2050

Measure	2020-2030	2030-2040	2040-2050
Capacity building/dissemination	xxx	xx	x
Energy audits	xx	xx	xx
Integration of EE into agricultural programmes	xx	xx	xx
EE revolving Fund	x	x	x
Combination with RES	xxx	xxx	xxx
Co- and Trigeneration	x	xx	X

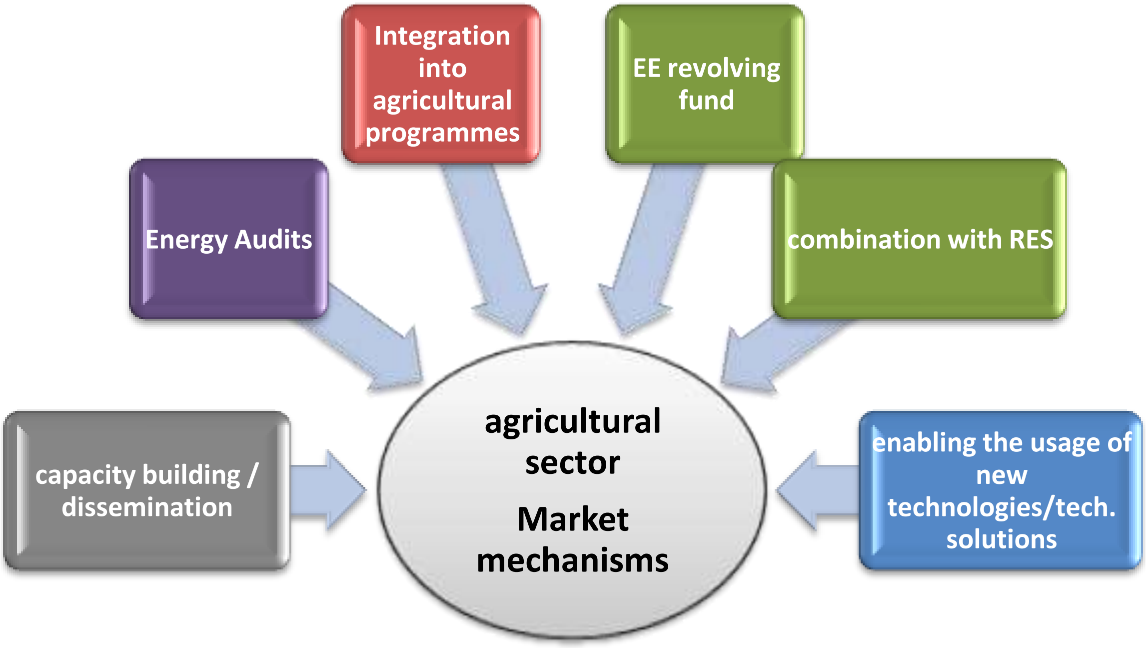


Figure IV.47: Overview of policies for the agricultural sector

IV.VII.II Structure of financing instruments for the post 2020 period

The further elaboration of the proposed flow of expenditures per type of financial instrument is essential for the timely implementation of the proposed measures in order to achieve the anticipated/modelled energy savings.

However, mainly considering that:

- These expenditure flows are related to specific figures of public budget amount for energy efficiency interventions until 2030 and that
- The range of leverage ratio between private and public finance can vary significantly,

the inclusion of any specific quantitative targets can lead to a misleading perception of the allocation of future budget lines. Therefore the below mentioned graphical representation of the necessary budget for energy efficiency interventions should be seen on a more qualitative perspective, which however at some extent is integrating also some specific recommendations for quantative targets mainly related to the overall threshold of cumulative investment that should be foreseen for the period until 2030.

The presented qualitative assessment also includes policy targets that could be set by MECIT for the optimum usage of the expenditures required in order to meet the targeted energy savings.

As presented in the sectoral analysis the main pillars for the mobilisation of the amount of energy efficiency interventions necessary for achieving the 2030 targets under the realistic (WAM) scenario are:

- The adoption of national policies, with mandatory as well as voluntary nature
- The development of the energy service market through various instruments
- The establishment of a core financing instrument able to allow the uptake and support of this high number of foreseen interventions.

The mobilisation of the current available/allocated budget from the 2014-2020 programming period to new financing instruments seems to be almost unrealistic and not easy to be administrated considering the time constraints. However, having in mind the n+2 provision under the national programmes the late adoption in 2018 of a new financial instrument, could be high beneficial, as it could serve as the first transition to a completely new structure of energy efficiency financing in Cyprus. This would also allow for the identification of some early barriers that should be efficiently addressed as soon as possible and for sure before the scaling up of the new financing instruments.

In the initial phase and until 2022 is proposed the emphasis to be put in two main axes:

i. the support of energy efficiency lighthouse projects in the public sector and
ii. the development of hybrid financing instruments that consider subsidies along with soft loans for the private sector

The identified legislative and regulatory barriers in relation to public procurement and the operation of the energy service market especially in the public sector should be addressed in time, based on the recommendations and experiences provided to the MECIT in the context of this and others studies.

Moreover, the mix of the available energy efficiency financing instruments should be adaptable to the national economic growth situation and as such an initially more conservative and at later stage more aggressive market approach should be adopted and is ultimately recommended.

The risk of having a market failure due to immaturity or lack of supporting structures (i.e. procurement rules, technical personnel, M&V standards and methodologies, contractual clauses) is high and the negative impact of such a situation could delay or even defer energy efficiency investments for a long time period. For this reason setting up intermediary structures could prove to be highly efficient to facilitate the uptake of specific market instruments and mechanisms, like the energy service market.

In order to plan the future allocation of the available state budget as well as to design the right instruments that would allow an escalating leverage ratio of private budget vs public support an overall quantification of the needed state budget should be first performed. Considering that for the transport and the agricultural sector no specific budget estimations have been performed the overall foreseen numbers are mainly related to the necessary investments for the residential, service and service sector on an aggregated level.

Under this approach, the estimated cumulative budget needed for energy efficiency investments until 2030 is at the level of 1bil€ (all end-use sectors included). Considering that at maximum around 10-15% of these anticipated savings could be achieved with soft national policies and measures, which are not requiring any (or marginal) direct public aid support (e.g. campaigns, trainings, awareness events, new regulations for energy audits etc.) the remaining cumulative public budget that should be driven for energy efficiency investments in the period 2018-2030 is estimated at the level of 150-170mil€ (≈12mil€/yr) in order to achieve the forecasted savings[26]. This requires and translates to a structural change in the formulation of the public budget lines for the flow of this state budget, meaning from currently only provided direct grants and subsidies to allocate and shift around 80% of the public budget for loans and guarantees. This structural amendment of the balance among the different types of public support will result to a substantial improvement of the performance index that considers the energy savings per provided/spent euro compared with the current situation under the existing national energy efficiency support schemes.

Definitely, the most challenging element is going to be the proposed and needed shift from a traditional state subsidy aid scheme to a more market competitive one, with a small share of direct aids and a much higher share of soft loans and/or guarantees (i.e. translated to privilege financing terms). The inner ratio among the various end-use sectors between direct aid and loan facility shares should also be different, keeping a relatively higher share of direct aid to the residential sector and to the public service sector.

The graphs that follow, present such a core representation of the different shares by sector and the effort that should be given in terms of the financing structure for the achievement of the planned/targeted energy efficiency savings until 2030 in the building sector. They are meant to serve as a roadmap for the detailed structure and ex-ante assessment of the new financing instruments. Nevertheless, the proposed Energy Efficiency Fund is a critical element under these set of recommendations since it achieves to contribute up to 40% of the overall needed public support in terms of the revolving funds and as a consequence to ensure a better sustainability of the scheme and to significant lesser extent of allocated public budget for the achievement of the targeted energy efficiency savings.

[26] Considering that an EE revolving fund is established. Annex C presents a modelled case for the structure of such a fund.

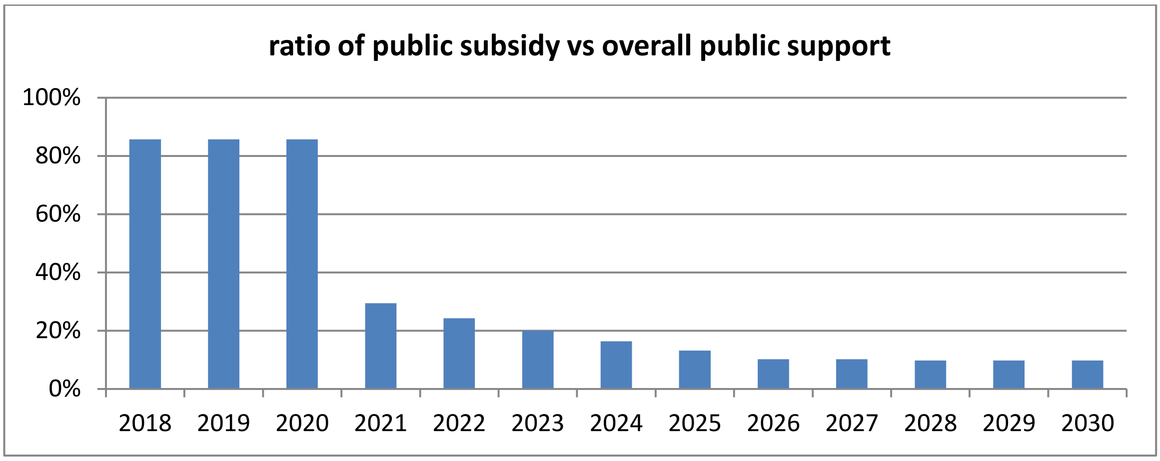


Figure IV.46: Recommended evolution of the public subsidy index in terms of public support share for energy efficiency interventions until 2030

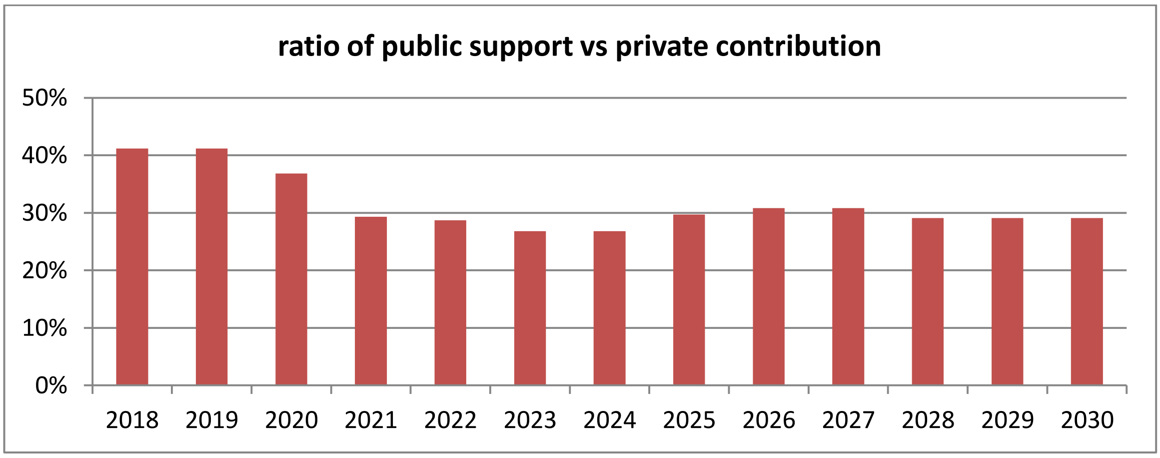


Figure IV.47: proposed evolution of the ratio between public and private contribution for the achievement of the 2030 energy efficiency savings under the WEM scenario.

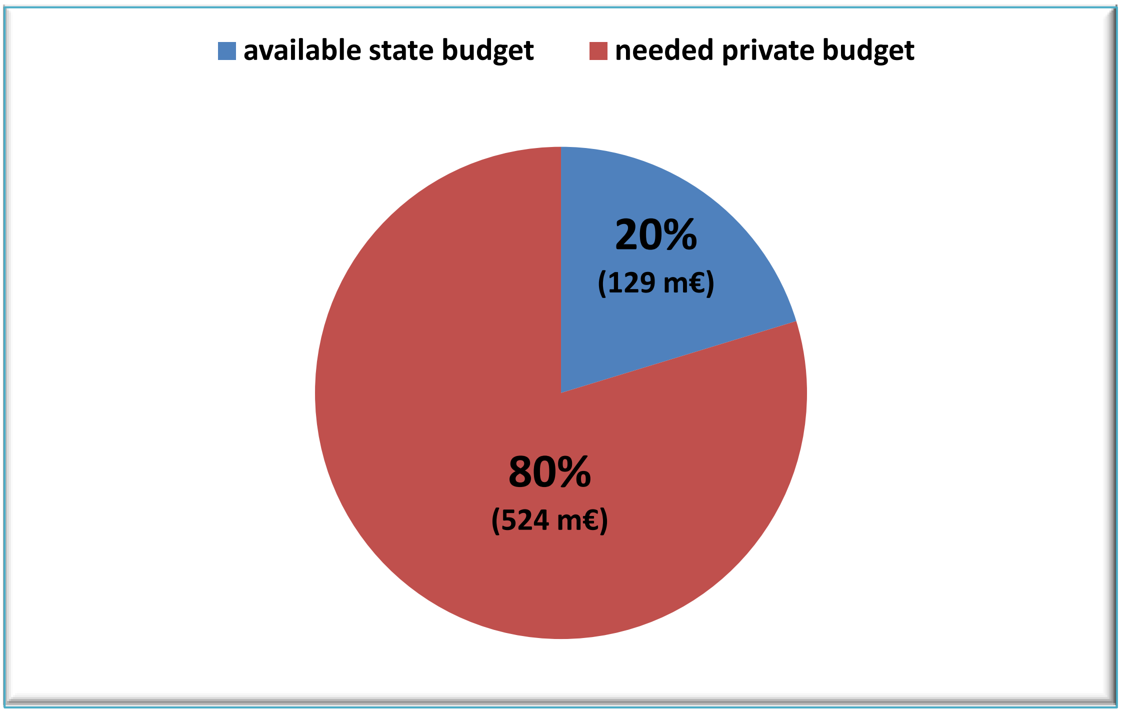


Figure IV.48: distribution of estimated cumulative budget until 2030 under national energy efficiency support schemes.

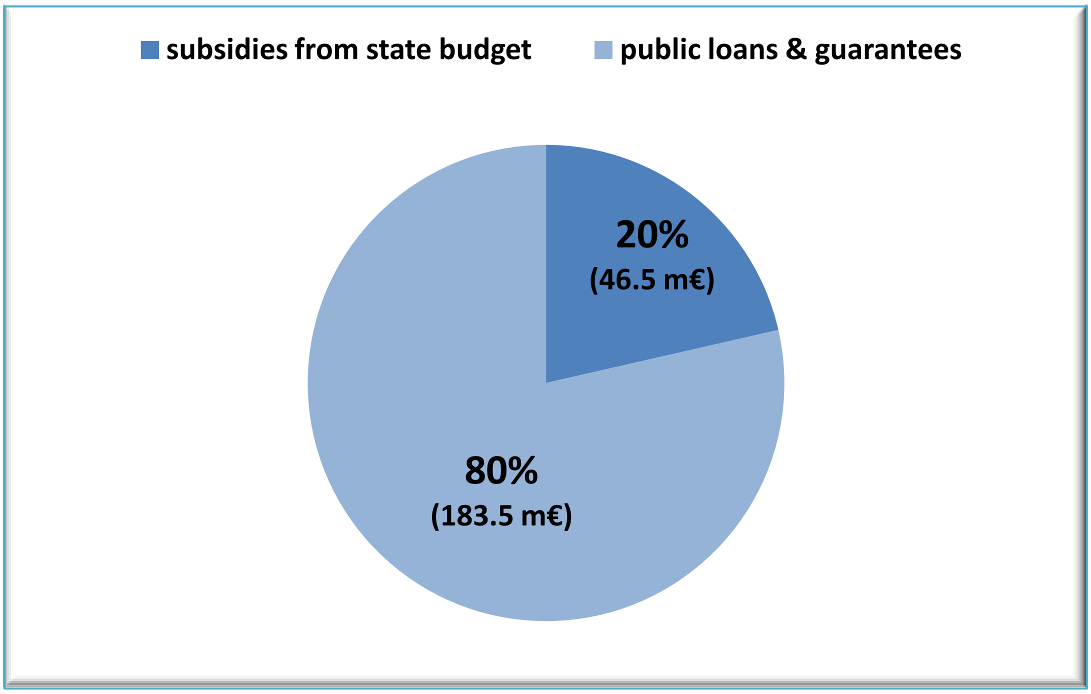


Figure IV.49: recommended distribution of support instrument allocation under the public aid support scheme.

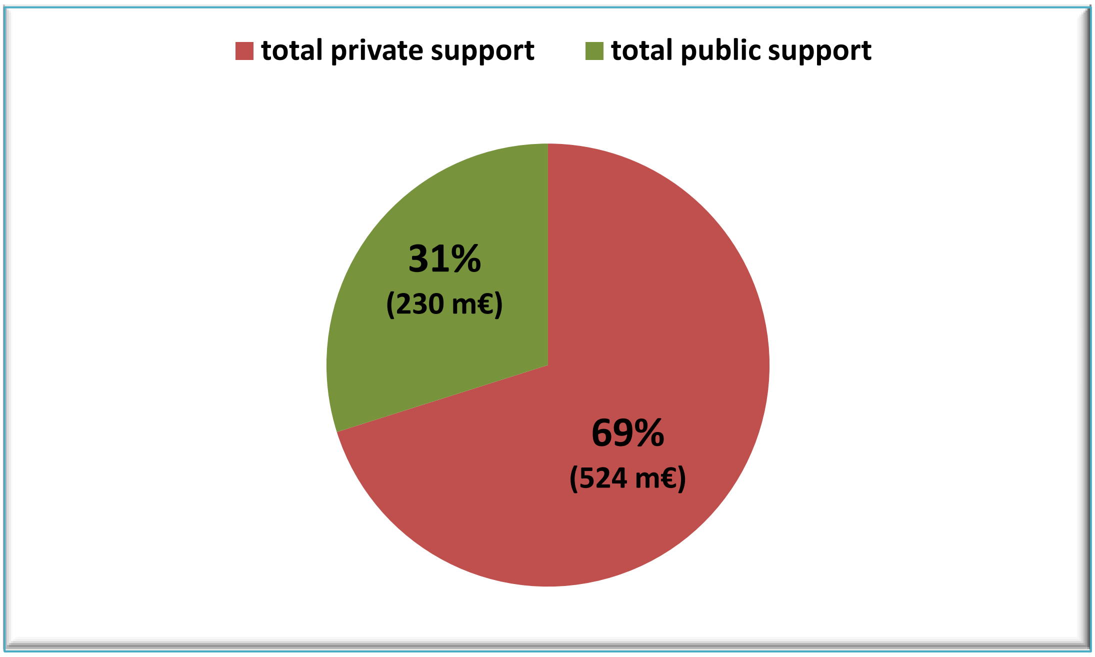


Figure IV.50: proposed distribution and overall leverage ratio among private and public support for energy efficiency interventions until 2030.

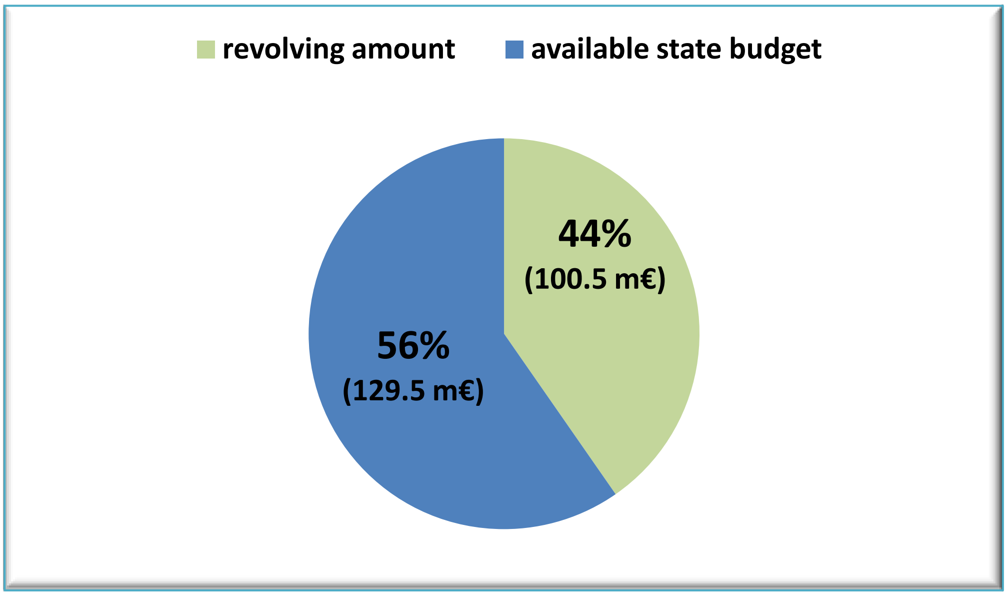


Figure IV.51: estimated distribution of the inflows for the public support until 2030 under the operation of an energy efficiency revolving fund.

V Recommendations for further developing the regulatory environment and support schemes

The energy saving potential in Cyprus, while it is quite significant in various end-use sectors, has not yet been adequately exploited mainly due to limited financial support on the one hand and interest of final consumers on the other.

The regulatory framework should thus be further adjusted in order to establish a secure, consistent and market-oriented framework for energy efficiency interventions mainly targeting the building sector and to a less extent the transport sector. The still embryonic state of the energy service market in Cyprus can be attributed to a underdeveloped regulatory framework. More emphasis should be put on issues related to standardisation of energy services provided, the performance of such services and their procurement and operation in the public sector.

It is evident from the analysis provided in the context of this study, that the existing energy saving potential should be approached on a cost-efficient investment basis and to allow, even incentivise, the best performing interventions and instruments to scale-up, which however translate to comprehensive energy efficiency upgrades.

The existing regulatory provisions with regard to the building code, Energy Performance Certificates, as well as energy audits for non-SMEs should be further enhanced in terms of monitoring processes and increased market value in order to create a sustainable regulatory framework for Energy Efficiency. In this context, the enhancement and extension of an obligation scheme for energy suppliers is proposed in order to increase relevance of the foreseen energy efficiency interventions on the market and to allow for the integration of these measures as new market mechanisms under a competitive framework. Though, the structure of the domestic energy market currently does not leave big room for competition among energy suppliers, considering the anticipated changes especially in the electricity market, the introduction of such energy efficiency obligations can be expected to foster and accelerate the establishment of a functioning national energy service market.

The low-hanging fruits in terms of energy efficiency interventions still are not fully exploited and further emphasis should be given to awareness, training and information activities that would allow the fairly easily achievement of some significant energy savings.

Therefore, the adoption of national ***post-2020 energy efficiency sectoral***

targets, which could be expressed in various ways or indexes, is proposed in order to drive the uptake of the domestic market for energy efficiency interventions and mechanisms in the various sectors, creating at the same time market confidence and security of expectation that the achievement of these targets is going to be monitored and is priorities by the state. While the adoption of such sectoral targets could be very beneficial in order to achieve a sustainable national energy efficiency market, linking and underwriting the achievement of these targets with specific policy instruments (regulatory and financial) should be carefully planned and assessed. A continued active role of the public sector is expected to be required in order to achieve the envisaged energy savings targets, though, with a different mix of policy instruments compared to the current situation.

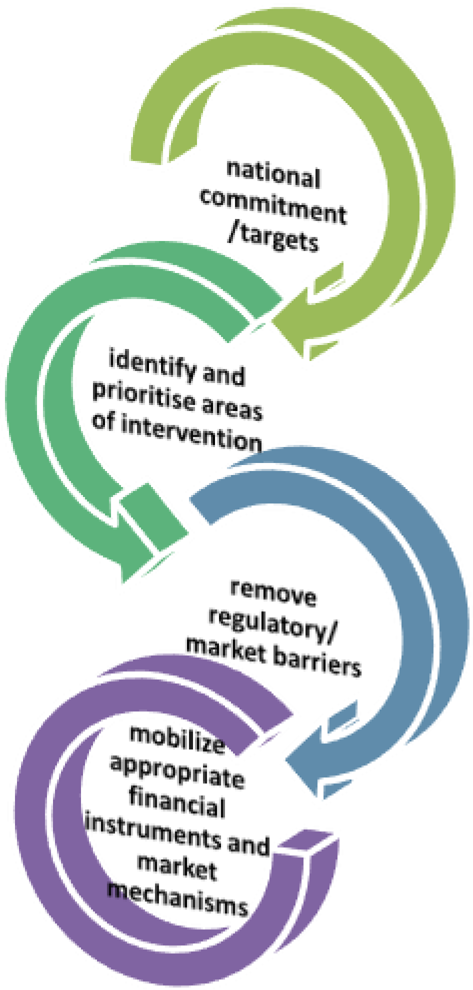


Figure IV.52: comprehensive policy action plan for implementation of energy efficiency policy measures.

A balanced mix of ***mandatory obligations*** as well as ***voluntary targets*** for the various energy consumers and suppliers should be introduced. This needs to be done in a way that while going beyond the minimum mandatory instruments currently foreseen under the EED not to create market failures or uneven burden for some end-users or market participants. The instrument of energy audits especially for non-SMEs should be exploited far more in the future in both the service and industry sector and to be directly linked with any kind of state financial support.

Any regulatory market barrier should be addressed as efficient and as fast as possible in order not to witness market bottlenecks or lock-in effects. For this reason mainly ***capacity building*** measures for various stakeholders groups (e.g. building installers, energy managers, lawyers, bankers) should be timely planned and implemented. The introduction of ***standardised tools and procedures*** as well as the development of electronic databases, registries and communication platforms are also considered key instruments for the successful tackling of the existing mainly market-related barriers.

However, the most sever barrier for the achievement of the planned savings is the limited available budget for such kind of interventions. The private sector has been accustomed to be responsive only when a significant public subsidy is available, while the public sector tends to request full upfront capital coverage. For this reason, the transition to a ***more market-oriented financial support scheme***, will be definitely a challenge and a careful planning along with the mobilization of the appropriate financial and market instruments will be required. Government support will continue to play a vital and indispensable role in the achievement of the targeted energy savings and as such the appropriate new energy efficiency financing instruments should be deployed and be in operation as soon as possible. The aim from the side of the state should not be to reduce its overall share in the support of the energy efficiency interventions, but mainly to drive the public financial resources to more cost-efficient support instruments and types of energy efficiency interventions with a higher leverage.

The establishment of a dedicated ***energy efficiency revolving fund*** is proposed in the context of this study allowing the sustainable medium-term design of national support schemes for energy efficiency interventions. The success or not of this proposed fund is closely associated with the involvement and cooperation with the ***domestic banking sector*** and for this reason the active and direct participation of the latter sector should be thoroughly discussed and ultimately guaranteed before the launch of support programmes under this Fund. The governance and administration of this fund should be equally transparent and independent from external state budget obligations and the usage for energy efficiency investments should be therefore safeguarded.

In this context the possibility of additional inflows to this fund should be assessed and considered, mainly in the framework of carbon/green taxes, however without jeopardizing the existence of an initial capital for the medium-term fund operation. The capital for the fund operation is overall proposed to be allocated from the national Cohesion and Structural funds under the next programming period, however, by also integrating some foreseen and previously allocated budget elsewhere under the current programming period as an early kick-starter facility.

Benchmarking assessment and analysis in order to support the efficient planning and distribution of public funds is essential and to this end the current data set of specific energy consumption data for various end-use sectors needs to be systematically broadened and detailed. Market surveys and wider participation of market associations in the various national energy efficiency schemes (e.g. voluntary agreements) and exploitation of data collected by the energy managers of the public buildings and the stock of issued energy building certificates in the framework of dedicated Information System databases and platforms are proposed to be one of the first administrative driven actions for the next period.

In the **household/residential sector**, while not undermining the acceleration of new building requirements (i.e. deep renovations leading to nZEB consumption), any new instrument should be designed to be cost-attractive as well as implementable in market terms. Programmes with a fast market uptake (i.e. roof insulation, heat pumps, solar thermal) allowing both comprehensive refurbishment through stand-alone interventions should and must be priorities. Linking these types of interventions in the household sector to the proposed Energy Efficiency Obligation Schemes is generally proposed in order to bridge the regulatory and financial gaps and to allow an upscale of the deemed beneficiaries.

In the **service sector** targeted sub-sectors for tailored initiatives are proposed to be the tourism and the industry food, diary, tobacco sector, while as far as the public sector is concerned emphasis should be given to hospitals and energy efficiency upgrade of street lighting. Since the latter is primarily under the responsibility of municipalities and communes targeted schemes would need to be designed to empower and/or support local government to programme, procure and implement such measures while a priority should again be given to the mobilisation of private capital through energy performance contracting.

Overall for the building sector, its economic role and contribution to Cyprus GDP and employment has to be further investigated and assessed in order to identify and prioritize the Energy Efficiency interventions with the highest positive economic and job growth impact. Such an analysis will bridge the findings from the cost-effectiveness analysis with the ones for the whole impact in the national economy and will allow the available funds to be further fine-tuned and driven to the overall optimum energy policy measures and interventions.

Especially for the different possibilities of building renovation strategy (i.e. deep, light, medium) end-use profiles and criteria should be considered and integrated under the national programmes and the allocation of the public funds should consider the overall attained benefits under these renovation strategies.

The figure that follows highlights some of the renovation benefits in addition to energy savings.

Source European Parliament PE 587.326-2016

Figure IV.53: benefits of renovation in addition to energy savings.

As far as concerns the **agricultural sector** the focus should be mainly given to higher penetration of RES systems for heating and cooling, achieving relative significant savings in terms of primary energy use and avoided cost of imported fuel, while also the adoption and support of an energy audit scheme could allow the identification of some significant cost efficient energy saving potential that could be addressed under tailored design national programmes either for specific sub-sectors (e.g. wineries) or agricultural process activities (e.g. greenhouses, drying). Given the poor knowledge on RES and energy efficiency potentials and technologies along the agricultural value chain all measures will need to be accompanied by awareness raising and training activities.

The **transport sector**, while exhibits a reference high potential for savings, due to existing and persistent modal shift patterns and overall infrastructure constraints is expected to perform only modestly in terms of energy savings in the decade up to 2030. Action should focus on modifying the vehicle taxes to accelerate the penetration of higher efficient cars and light commercial vehicles, soft measures (possibly in combination with support schemes) to promote a modal shift towards public, e-mobility and other alternative transport modes. To accelerate the uptake of e-mobility public funding the charging infrastructure and/or other regulatory measures for the set-up of charging infrastructure to enable the development of a free and competitive market should be considered, however only after a certain satisfactory level of cost-efficiency for these infrastructure investments is reached.

VI Annex A: Long-Term evolution of Primary Energy Demand in Cyprus

The following section provides an outlook of primary energy demand in Cyprus, combining the final energy demand projections described in Section IV of this report with projections for the power generation sector which were conducted in the frame of another study that was performed by CUT for MECIT and is annexed to this report for informative purposes only.

To compute primary energy demand per year, the calculations below utilise the projections of final energy demand presented in this report for all fuels *except electricity*. The projections of final *electricity* demand presented in this report are then converted to primary energy demand, using the power generation mix (and the associated efficiency figures) assumed in the power generation study, which was based on the OSEMOSYS (Open Source Energy Modelling System) model, a cost optimization tool used for long-term energy planning, which is currently applied by MECIT and KTH (the Swedish Royal Institute of Technology) for a quantitative analysis of the Cypriot energy system (Taliotis, Howells, Partasides, & Gardumi, 2017). The sum of final non-electricity demand and primary energy input for power generation constitutes (in the case of Cyprus) the Primary Energy Consumption of the country[27].

IThe three scenarios on final energy demand that were described in Section IV of the main report of this study had to be combined with the scenarios that were considered in the MECIT/KTH study mentioned above. That study formulated the following scenarios for electricity supply in Cyprus:

- Scenario S1 assumes that natural gas will become available for use in the electricity supply sector of Cyprus by the beginning of 2019 via an LNG regasification facility. This means that the supplied gas does not necessarily originate from the domestic gas reserves, but could be from any potential supplier.
- Scenario S2 assumes that natural gas will only be available from 2024 onwards; in other words, it is assumed that no imports of natural gas will take place, and that this fuel will be used only after it becomes possible to exploit domestic gas reserves.
- Finally, in Scenario S3, natural gas does not become available in the energy system of Cyprus at any point in time within the model horizon. New conventional thermal power plant installations continue to rely on HFO and diesel.

[27] This figure is equivalent to the term “Gross Inland Consumption” used by Eurostat and “Primary Energy Demand” used by the International Energy Agency.

Comparing these with the scenarios considered for final energy demand, and after consultation with MECIT, the following approach was considered to be reasonable:

- The Reference Scenario of this study was combined with power generation scenario S3; this is in line with the regular definition of a Reference Scenario by the government of Cyprus: it assumes that natural gas will never enter the energy system of Cyprus.
- Both the Realistic Scenario and the Maximum Technical Potential Scenario of this study were combined with power generation scenario S1 (natural gas from 2019 onwards); this is in line with what was considered by the government of Cyprus as a realistic policy option by the time of this writing (spring 2017).

It has to be underlined that the combination of the Realistic Scenario of final energy demand and the power generation scenario S1 has also been used as the "Energy Efficiency Scenario" for the 4th National Energy Efficiency Action Plan (NEEAP) submitted by MECIT to the European Commission in May/June 2017. In a similar fashion, the combination of an older version of the Reference Scenario of final energy demand with the power generation scenario S3 has been used as the "Reference Scenario" of the 4th NEEAP.

The table on the next page presents the forecast of major energy figures for the three scenarios of this study. The graphs illustrate the projections of energy inputs for power generation and total primary energy consumption respectively. Due to the higher electricity demand and the lower efficiency of thermal power generation, the Reference Scenario projects a higher evolution of primary energy inputs for electricity production. However, even in the Reference Scenario, despite the steadily rising final demand of electricity that was shown in the results of Section IV of the main report, primary energy consumption stabilizes in the longer term – at least up to 2040 – thanks to the improving penetration of renewable electricity which improves the overall efficiency of power generation. This evolution is clearer in the other two scenarios, where the penetration of renewable electricity is combined with the penetration of natural gas from 2019 onwards. After 2040, the OSEMOSYS results imply a stagnation in the efficiency of power generation because already installed thermal power plants will continue operating, and the RES share in electricity supply is projected to remain essentially stable between 2040 and 2050. Coupled with a continuously increasing final demand for electricity, primary energy use in power generation is forecast to start rising again after 2040, which outweighs many of the reductions in final energy demand of other fuels. Therefore, total primary energy consumption is expected to increase in the Reference Scenario, stabilize in the Realistic Scenario and drop at a slower rate in the Maximum Technical Potential Scenario. It is clear that such a development over the long term is not sufficient for decarbonizing the energy system of

Cyprus.

It has to be reminded that the Reference Scenario of this study is different from the Reference Scenario of the 4th NEEAP (presented in a different Annex) because the latter assumes by definition no implementation of energy efficiency policies and measures after 2010 – whereas the Reference Scenario of this study assumes no further implementation of measures after 2015.

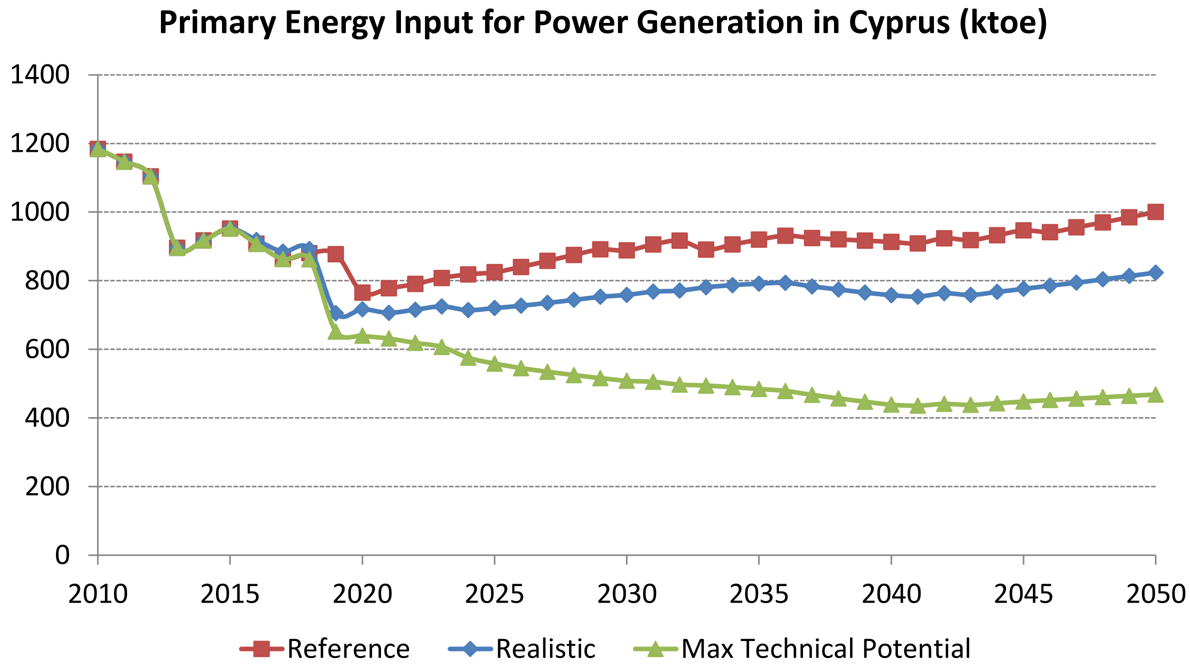
Primary energy consumption forecasts for the three scenarios of this study.

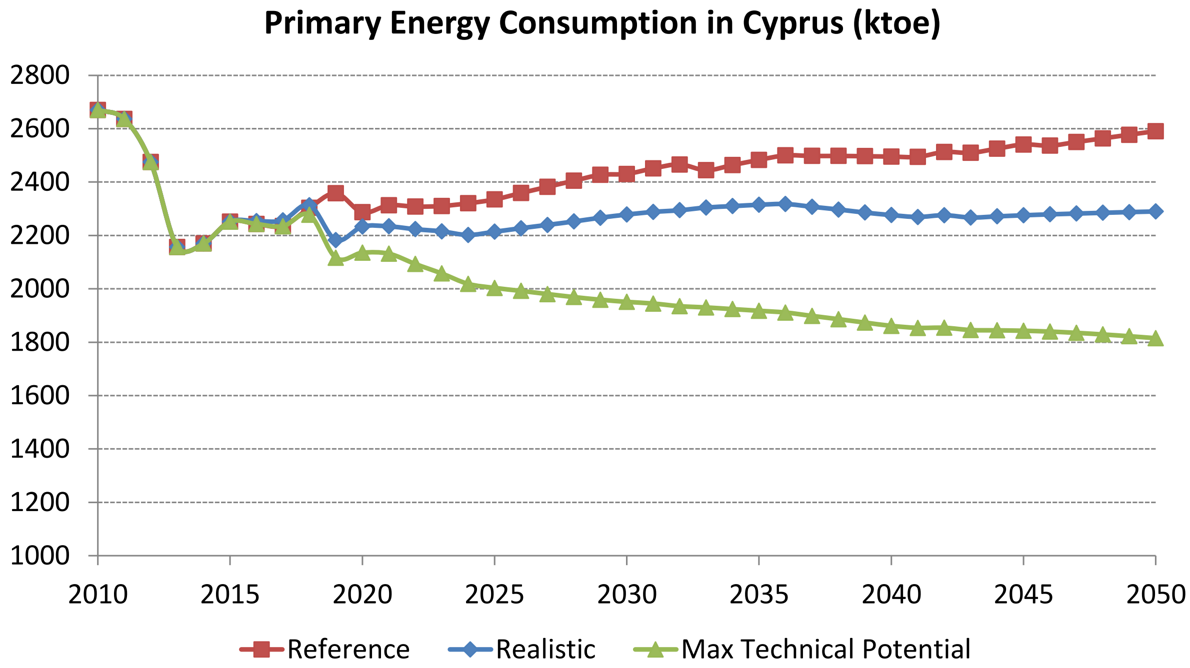
Reference scenario	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Final energy consumption	1901	1886	1747	1597	1591	1651	1928	1951	2023	2089	2155	2208	2245
Final electricity consumption	415	397	376	336	339	351	406	441	480	525	573	614	654
Final non-electricity consumption, *of which:*	1486	1490	1371	1261	1252	1300	1522	1510	1542	1563	1582	1594	1591
Industry	176	140	112	129	163	142	205	184	172	163	160	161	164
Households	171	182	182	172	162	178	247	226	230	233	231	221	210
Services	50	73	57	45	38	38	55	52	56	58	62	65	69
Agriculture	26	24	29	25	23	30	31	28	27	27	28	29	29
Road Transport	785	766	718	646	627	648	654	651	645	637	628	630	632
Air Transport	279	304	272	243	239	263	330	369	413	445	473	487	487
Primary energy input for power generation	1184	1147	1104	896	918	952	765	825	888	920	913	947	1000
Primary energy consumption	**2670**	**2637**	**2475**	**2157**	**2170**	**2252**	**2287**	**2335**	**2431**	**2483**	**2495**	**2541**	**2591**

Maximum Technical Potential Scenario	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Final energy consumption	1901	1886	1747	1597	1591	1651	1864	1776	1747	1728	1714	1701	1663
Final electricity consumption	415	397	376	336	339	351	368	331	304	295	291	306	317
Final non-electricity consumption, *of which:*	1486	1490	1371	1261	1252	1300	1496	1445	1443	1433	1423	1395	1347
Industry	176	140	112	129	163	142	204	179	166	160	159	160	163
Households	171	182	182	172	162	178	224	172	148	137	127	120	113
Services	50	73	57	45	38	38	54	50	59	66	66	63	51
Agriculture	26	24	29	25	23	30	31	27	26	25	24	24	24
Road Transport	785	766	718	646	627	648	653	646	630	601	572	540	508
Air Transport	279	304	272	243	239	263	330	369	413	445	473	487	487
Primary energy input for power generation	1184	1147	1104	896	918	952	639	559	508	484	439	448	468
Primary energy consumption	**2670**	**2637**	**2475**	**2157**	**2170**	**2252**	**2135**	**2003**	**1951**	**1918**	**1861**	**1843**	**1815**

Realistic Scenario	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Final energy consumption	1901	1886	1747	1597	1591	1651	1916	1920	1974	2005	2022	2030	2023
Final electricity consumption	415	397	376	336	339	351	400	427	454	482	503	530	557
Final non-electricity consumption, *of which:*	1486	1490	1371	1261	1252	1300	1516	1494	1520	1524	1518	1499	1466
Industry	176	140	112	129	163	142	204	183	171	161	156	156	158
Households	171	182	182	172	162	178	241	215	217	215	205	192	178
Services	50	73	57	45	38	38	56	52	54	53	50	44	39
Agriculture	26	24	29	25	23	30	31	28	27	27	27	27	27
Road Transport	785	766	718	646	627	648	653	648	638	623	608	593	577
Air Transport	279	304	272	243	239	263	330	369	413	445	473	487	487
Primary energy input for power generation	1184	1147	1104	896	918	952	717	720	759	791	758	776	824
Primary energy consumption	**2670**	**2637**	**2475**	**2157**	**2170**	**2252**	**2233**	**2214**	**2278**	**2315**	**2276**	**2276**	**2290**

Forecast of primary energy inputs for power generation and total primary energy consumption in Cyprus up to 2050.





VII Annex B: Update of National Energy Forecasts for the Republic of Cyprus to be used in the 4th National Energy Efficiency Action Plan

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May 2017

1. Introduction

This note presents an update of the national energy forecasts for the Republic of Cyprus that were carried out with the latest version of the 3EP/CUT energy forecast model. These forecasts are intended to be used by national authorities in the submission of the updated National Energy Efficiency Action Plan to the European Commission.

Since the last submission of these Action Plans in year 2014, both the macroeconomic environment of Cyprus and the EU-wide regulatory environment in energy issues have changed considerably. In the macroeconomic front, after the dramatic events of March 2013 and the requirements for fiscal adjustment as well as downsizing and restructuring of the domestic banking sector in order to attain sustainable levels of public debt in the medium term, an economic and financial adjustment programme for Cyprus was agreed between the national authorities and the Troika (European Commission, European Central Bank and International Monetary Fund). The adjustment programme assumed a strong contraction of the national economy in years 2013-2014 – mainly due to significant decreases in private and public consumption as well as fixed investment – and a slow rebound of economic growth from 2015 onwards. This macroeconomic outlook, which had been incorporated in the revised NEEAP of 2014, turned out to be too pessimistic since the economy of Cyprus experienced a slower-than-predicted economic recession and a faster recovery. The current NEEAP update takes into account the revised economic outlook which leads to higher growth rates in the future.

As far as the regulatory environment is concerned, following the EU's "Energy Efficiency Directive" (2012/27/EU), a number of policies and measures have been implemented for energy-efficiency-oriented renovations in the existing building stock – with specific obligations for governmental buildings – and for specific energy savings to be attained by energy distributors or retail energy sales companies. Moreover, some national initiatives have materialised in recent years, mainly focusing on grants for energy renovations in residential and commercial buildings.

The national energy forecast model that was used for the 4th NEEAP calculates future annual energy consumption in each major economic sector of Cyprus (agriculture, cement industry, other industry, households, services, road passenger transport, road freight transport and air transport) as a function of future macroeconomic variables and future energy prices. Simultaneously it calculates fuel shares in each sector, depending on technology costs (investment, operation, maintenance and fuel costs), the penetration potential of various technologies and technical constraints for the uptake of new technologies, and allows computing future final energy consumption by sector and fuel.

2. Macroeconomic and oil price assumptions

Table 1 presents the basic macroeconomic assumptions up to the year 2020 that have been used in this study. Economic output declined substantially in 2013 and less in 2014, but started growing again in 2015. Aggregate indicators, i.e. GDP and private consumption for 2017-2018 are in line with the European Commission's macroeconomic forecasts[28]; for subsequent years national growth forecasts were used, as provided to us by the Finance Ministry of Cyprus in November 2016. According to the projections of the Cypriot Ministry of Finance, the economy of Cyprus is assumed to follow a path of sustained growth, with real GDP growth rates of 2.7-2.8% per year up to 2020. Private consumption is assumed to grow at a slower pace than GDP in the short and medium term because it has been hit less by the economic downturn of recent years and has remained at relatively higher than expected levels.

The contribution of each major economic sector to GDP is assumed to remain essentially constant. The GDP share of industry, which was around 13% in the mid-1990s, fell to 10% in 2005 and to 7% in 2014-15, is assumed to rebound slightly – to 7.6% by 2020 and to higher shares in the coming decades. A stronger rebound is expected in the construction sector, whose share plunged from 11% to just over 4% during the years of the financial crisis, and is assumed to revert to 5.6% in 2020 with an increasing long-term trend. The contribution of agriculture, around 2% today, is assumed to remain at the same level up to 2020. Finally, the tertiary sector is assumed to keep its dominant role in the economy and continue contributing by more than 80% to national economic output.

The energy system of Cyprus is almost entirely dependent on oil products, hence retail fuel prices – in the absence of changes on energy taxes – will change in the future in line with the evolution of international crude oil prices. The latter are assumed to develop in line with the central scenario ("New Policies Scenario") of the International Energy Agency's World Energy Outlook 2016, which was published in November 2016[29]. According to the IEA's forecast, crude oil price is expected to rebound from its current quite low levels of $40-50 per barrel, and reach $79 per barrel in 2020 (at constant prices of year 2015), with a further increasing trend in later years. We assumed for the entire forecast period that the exchange rate between the euro and the US dollar will remain constant at 1.11 USD/EUR, which is the average exchange rate of year 2015 according to Eurostat.

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[28] European Commission, *European Economic Forecast – Autumn 2016*. Institutional Paper 038, Brussels, November 2016, ISSN: 2443-8014. https://ec.europa.eu/info/publications/economy-finance/european-economic-forecast-autumn-2016_en

[29] International Energy Agency, *World Energy Outlook 2016*. Paris, France, ISBN: 978-92-64-26495-3. http://www.worldenergyoutlook.org/publications/weo-2016/

3. Energy efficiency scenarios

To simulate the effect of energy efficiency measures on national energy consumption, the two available scenarios from earlier national Action Plans ('reference' and 'additional energy efficiency' scenario respectively) have been updated. The two scenarios contain different assumptions with regard to the implementation of energy efficiency measures in the various sectors of the Cypriot economy. Such measures include:

- Actions taken as a result of mandatory compliance with EU legislation, such as the 'Energy Services Directive' (2006/32/EC), the Directive on labelling and standard product information of the energy consumption by energy-related products (2010/30/EC), the Directive on energy performance of buildings (2010/31/EC), and the recent Energy Efficiency Directive (2012/27/EU); and
- Additional national measures such as subsidies for energy efficiency and renewable energy investments by households and firms.

More specifically:

- The Reference Scenario assumes that no additional measures – at EU and national level – are implemented after 2010. In other words, Directives adopted in year 2010 (the Energy Labelling Directive 2010/30/EC and the Energy Buildings Directive 2010/31/EC) and national subsidies up to the year 2010 are assumed to take effect, but no post-2010 actions are included. It has to be noted that this scenario is not identical with the corresponding 'reference scenarios' that were used in the 2nd and 3rd NEEAPs of Cyprus (in 2011 and 2014 respectively) because this scenario incorporates the latest macroeconomic developments described in Section 2 of this note.

- The Additional Energy Efficiency Scenario assumes that further energy efficiency measures are adopted in the post-2010 period, such as a continuation of national subsidies for investments in energy saving technologies, the implementation of the 'Energy Efficiency Directive' at EU level, and some modest adoption of further legislation on near-zero energy buildings later in this decade. More specifically, implementing the Energy Efficiency Directive 2012/27/EU leads to the following measures up to 2020:

    - Renovations and other measures of upgrading energy efficiency in buildings owned and used by the central government.

    - Implementation of measures for the achievement of the obligatory target for energy savings at end use level by 2020, as set by article 7 of the Directive (including, amongst others, the continuation up to 2020 of financial incentives for renovating household and buildings owned and used by SMEs).

    - Energy efficiency requirements on purchasing by public bodies

    - Energy efficiency measures in street lighting

    - Obligation for energy audits for non-SMEs

– Energy efficiency information and education measures.

As far as the industrial sector is concerned, there has been limited attention to improving the energy efficiency of industrial processes or equipment in Cyprus in recent years. The policies taken into account in the Additional Energy Efficiency Scenario for this sector are those foreseen in the Energy Efficiency Directive (2012/27/EU) as well as training of engineers and energy managers of industrial plants. Furthermore, some modest industrial investments in automations or replacement of electric motors or compressed-air systems with more energy efficient ones are assumed.

As regards transport, the Additional Energy Efficiency Scenario assumes a continuation of the same trends on transport activity and modal split, but additional roadside inspections for passenger cars and trucks which can lead to some small improvements in the fuel economy of on-road motor vehicles. Moreover, a strengthening of national CO_2-based vehicle taxation is also assumed to take place in 2019, which can somewhat accelerate the adoption of new low-carbon cars in the vehicle stock. Available information from national transport authorities was used in order to arrive at these assumptions.

Final electricity demand in the 'additional energy efficiency scenario' was calibrated so as to be in line with the latest official electricity forecast for the period 2016-2025 that was prepared by the Transmission System Operator (TSO) and approved by the Cyprus Regulatory Authority for Energy in 2016. The latest projection available during the model runs of this study was published in March 2016[30] but more recent data were also provided by the TSO. As this forecast is about electricity generation and not final consumption, it is necessary to know the TSO's assumptions about auto-consumption of power plants and the assumptions of the Electricity Authority of Cyprus (EAC) about transmission & distribution losses. The study group, with the aid of the Ministry of Energy, Commerce, Industry and Tourism (MECIT), obtained such information from the TSO. Sectoral shares of electricity demand have also taken into account preliminary results from the preparation of the revised National Renewable Energy Action Plan that is currently conducted by MECIT for the period up to 2020[31].

New infrastructure projects that may affect energy consumption in Cyprus (such as marinas, casino resort, desalination plants etc.) are implicitly assumed to affect future energy demand to the extent that they will affect economic growth as well. No special provisions were made for them in the scenarios presented in this note. It should be kept in mind that the same approach is followed by the national TSO in its long-term electricity forecast.

As regards the fuel shares in each end-use sector, for both scenarios described above, the energy model calculates with dynamic recursive equations – for each future year – the allocation of final energy demand among different fuels. For this purpose, the uptake of different technologies/fuels by sector is simulated, based on each technology's costs as well as on the

[30] See http://www.dsm.org.cy/nqcontent.cfm?a_id=2990&tt=graphic&lang=l2

[31] Taliotis K., Howells M., Partasides G. and Gardumi F. (2017), Cost-optimal scenario analysis for the Cypriot energy system. Unpublished report conducted under grant VC/2015/0004 of the European Commission, Report DESA/17/4, royal Institute of Technology, Stockholm, Sweden.

technically exploitable potential of each technological option. For this purpose, detailed technical information was obtained from the Cyprus Energy Service and the Cyprus Institute of Energy on the basis of earlier specialised sectoral studies and data collected in the frame of national grant schemes for investments in energy efficient and renewable energy technologies. In principle it was assumed that no drastic changes in the fuel mix of final energy consumption will take place until 2020, apart from some shifts towards renewable energy forms (including biomass and biofuels) to ensure compliance with related EU legislation.

The two scenarios were implemented as follows:

– For the Reference Scenario, we followed the same trend in energy intensity that was foreseen in the Reference Scenario of the previous (3rd) NEEAP and adapted the evolution of energy consumption up to 2020 in line with the most recent actual energy consumption data and the latest economic growth forecasts up to 2020. This is a reasonable approach as the NEEAP Reference Scenario is by definition a counterfactual scenario that cannot be implemented today, because it assumes that there were no new energy efficiency policies adopted after 2010. On the other hand, this approach ensures a meaningful comparison between this and the Additional Energy Efficiency Scenario.

  This approach, however, was not straightforward because, apart from economic growth forecasts that changed between the time of the previous NEEAP and today, there has also been a revision of official national GDP figures of the past. We therefore constructed an energy intensity index, and made sure that the harmonised Reference Scenario follows the same relative evolution in energy intensity with that of the 3rd NEEAP's Reference Scenario.

– The Additional Energy Efficiency Scenario was derived from a recent study conducted for MECIT by GIZ and 3EP/CUT, which was funded by the European Commission and the German Ministry for Economy and Energy.[32] The third scenario of that study, which was designated as 'realistic scenario', was designed in agreement with MECIT, in order to comply with the requirements for the Additional Energy Efficiency Scenario of this NEEAP. It contains the assumptions about energy policies by sector which were described in the previous paragraphs. In the frame of this project a separate detailed study was conducted for the transport sector of Cyprus[33]; results of that study have been incorporated in our forecasts as well.

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[32] Vougiouklakis Y., Struss B., Zachariadis T. and Michopoulos A. (2017), A draft energy efficiency strategy for Cyprus up to 2020, 2030 and 2050. Deliverable 1.1. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, May 2017. Project funded by the European Commission Structural Reform Support Service under grant agreement SRSS/S2016/002 and by the German Federal Ministry of Economy and Energy.

[33] Heidt C., Jamet M., Lambrecht U., Bergk F. and Allekotte M. (2017), Penetration of alternative fuels in Cyprus road and maritime sectors. ifeu – Institut für Energie- und Umweltforschung Heidelberg. Project funded by the European Commission Structural Reform Support Service under grant agreement SRSS/S2016/002 and by the German Federal Ministry of Economy and Energy.

4. Power Generation

The electricity sector is not modelled explicitly by our energy model in its current form; however, the model's projections for final electricity demand by sector and scenario are combined with those of studies conducted by MECIT for the power generation sector, and fuel inputs for power generation are then calculated on the basis of appropriate assumptions. More specifically, electricity demand forecasts of our model have been fed into OSEMOSYS (Open Source Energy Modelling System), a cost optimization tool used for long-term energy planning, which is currently used by MECIT and KTH (the Swedish Royal Institute of Technology) for a quantitative analysis of the Cypriot energy system.

As regards fuel inputs in power generation, in line with the definition of the two scenarios in previous versions of the NEEAP, the Reference Scenario assumes that natural gas will not penetrate in power generation of the country until 2020, whereas the Additional Energy Efficiency Scenario was calculated by assuming that natural gas will enter the market in 2019, as foreseen by national authorities in early 2017.

Thermal efficiency of power generation in the case with natural gas was calculated on the basis of earlier official forecasts of the Cyprus Energy Regulatory Authority. Overall thermal efficiency of non-renewable power plants is forecast to increase considerably thanks to the introduction of natural gas form 2016 onwards. Most of the power generation in year 2020 will take place in natural gas fired combined cycle gas turbine (CCGT) power plants. A considerable fraction of electricity will be produced by renewable energy sources, and only a tiny fraction of fuel oil and diesel oil will be used.

For the case of no natural gas penetration (i.e. in the Reference Scenario), it was assumed that the thermal efficiency of non-renewable power plants will improve slightly over the years. This may happen because all newly built power plants in Cyprus use the CCGT technology. Even though their utilisation will not be as high as in the case of natural gas (because in the absence of natural gas they have to operate with more expensive diesel oil and plant operators will prefer to use cheaper fuel oil burning power plants more intensively than CCGT plants), and despite a somewhat lower thermal efficiency of these plants when they operate on diesel oil instead of natural gas, still they will improve the average thermal efficiency to some extent, so that a gradual increase of average efficiency up to 40% in 2020 seems to be justified.

5. Results

Table 2 shows the procedure followed in order to adapt the previous Reference Scenario forecast to both the actual national energy data up to 2015 and the revised macroeconomic forecast up to 2020 as explained above. Table 3 presents the energy demand forecasts up to the year 2020 according to the Reference Scenario and the Additional Energy Efficiency Scenario, separately for the economic sectors falling under the 'heating and cooling' category (households, cement industry, rest of industry, services and agriculture) and for the transport sectors (road passenger, road freight and air transport). In the lower part, Table 3 presents the resulting energy savings that are used in the updated (4th) National Energy Efficiency Action Plan of Cyprus.

When comparing these projections with the forecast of the 3rd NEEAP (submitted in 2014), two points stand out. First, it turns out that Cyprus might attain slightly higher energy savings than those foreseen in the 3rd NEEAP, both in absolute and in relative terms. The current forecast leads to savings in national energy consumption of 397 ktoe in 2020, or 15% compared to the Reference Scenario. In contrast, the 3rd NEEAP projected savings of 375 ktoe in 2020, amounting to 14.5% of the Reference Scenario of that time. In absolute terms, primary energy consumption in the Additional Energy Efficiency Scenario is slightly higher than in the 3rd NEEAP. This is a combined effect of three changes:

- The faster-than-expected economic recovery of Cyprus, which has led to upwards revised GDP growth forecasts and hence to corresponding higher projections of energy demand especially in the buildings sectors (residential and services);

- The projected improvement in the energy intensity of the transport sector thanks to the successful implementation of CO_2 emission standards at EU level and the additional adoption of national legislation for CO_2-based vehicle taxes, which has led to a faster-than-expected reduction of the CO_2 levels of newly registered cars since 2014. This leads to comparatively lower energy demand in road transport;

- The stronger improvement in the efficiency of power generation, mainly as a result of a faster penetration of renewable electricity production than foreseen in the 3rd NEEAP. This in turn leads to lower primary energy needs in the electricity supply sector.

In other words, primary energy consumption in 2020 is forecast in the 4th NEEAP to remain at almost the same level with that of the 3rd NEEAP (2233 ktoe vs. 2201 ktoe respectively) because the expected increase in energy demand due to stronger economic growth is counterbalanced by lower energy intensity of road transport and power generation.

Energy savings, in both absolute and relative terms, are somewhat higher in the 4th NEEAP compared to the 3rd NEEAP, mainly because the improvements in the efficiency of power generation in the current Reference Scenario (which assumes that no natural gas will be used at least up to 2020) are not as strong as in the Additional Energy Efficiency Scenario. As a result, the difference between primary energy inputs for power generation between the two scenarios is larger than before, which becomes especially pronounced from 2019 onwards, when natural gas is expected to be used for producing a large fraction of total electricity in the Additional Energy Efficiency Scenario.

A second observation is that, similarly to the Additional Energy Efficiency Scenario of the 3rd NEEAP, almost half of the total savings (127+93 = 220 ktoe or 56%) are forecast to come from energy saving measures in end-use sectors and the other 44% (175 ktoe) from additional savings in primary energy consumption due to the use of natural gas in power generation.

Figure 1 illustrates the projected evolution of primary energy consumption up to 2020 for the two scenarios considered.

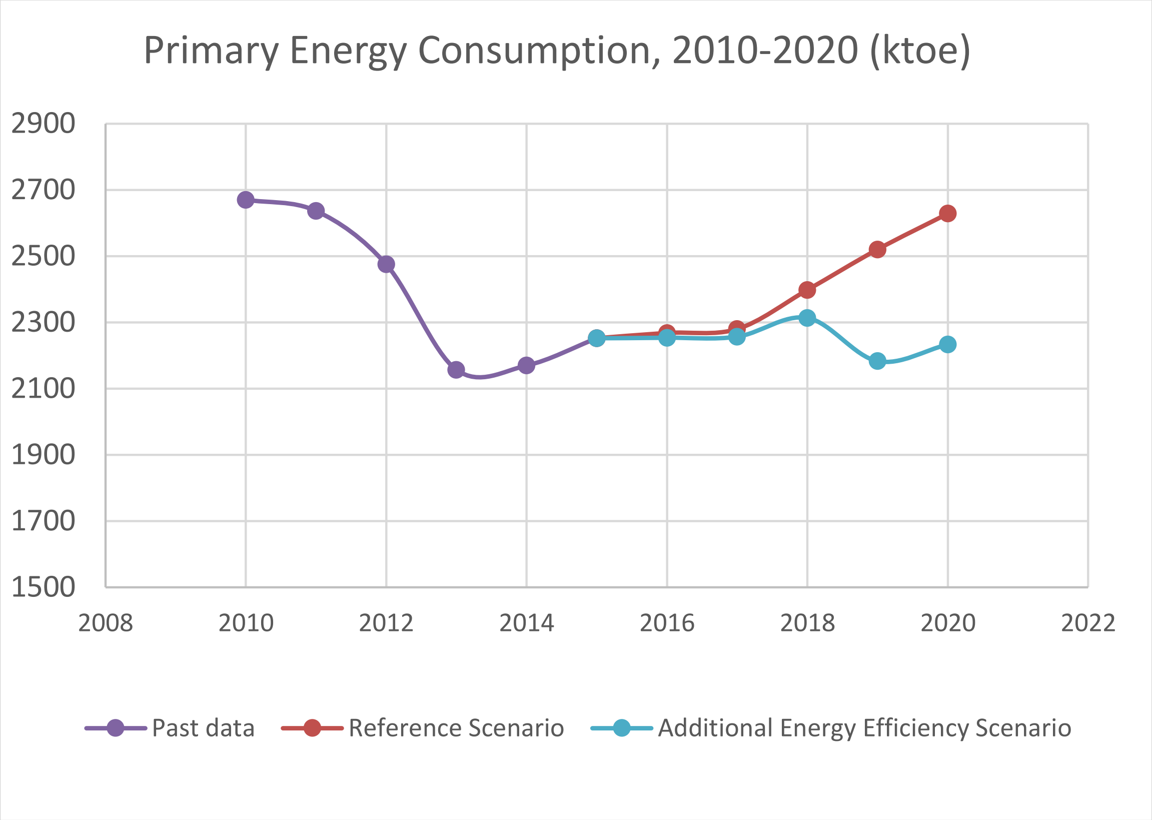

Figure 1: Projected evolution of primary energy consumption in Cyprus up to 2020 for the two scenarios considered in the 4th NEEAP.

Table 1: Macroeconomic assumptions for Cyprus as of March 2014.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Real GDP (mio Euros at 2005 prices)	16784	16838	16307	15336	15101	15355	15769	16211	16665	17131	17611
Annual growth rate of GDP:	*1,3%*	*0,3%*	*-3,2%*	*-6,0%*	*-1,5%*	*1,7%*	*2,7%*	*2,8%*	*2,8%*	*2,8%*	*2,8%*
Real private consumption (mio Euros at 2005 prices)	10967	10894	10750	10117	10186	10376	10584	10817	11055	11287	11513
Annual growth rate of private consumption:	*3,3%*	*-0,7%*	*-1,3%*	*-5,9%*	*0,7%*	*1,9%*	*2,0%*	*2,2%*	*2,2%*	*2,1%*	*2,0%*
Sectoral shares of GDP:											
Agriculture	2,1%	2,2%	2,0%	2,0%	1,9%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Industry	8,9%	7,7%	7,0%	7,0%	7,1%	7,1%	7,2%	7,3%	7,4%	7,5%	7,6%
Construction	7,8%	7,2%	6,0%	4,9%	4,4%	4,2%	4,5%	4,8%	5,1%	5,4%	5,6%
Services	81,2%	83,0%	85,0%	86,1%	86,7%	86,6%	86,3%	85,9%	85,5%	85,2%	84,8%

Source: For years 2010-2016, official national accounts, Statistical Service of the Republic of Cyprus (as of October 2016).

For years 2017-2020, assumptions regarding GDP and private consumption from European Commission's (see footnote 1) and national macroeconomic forecasts; sectoral GDP shares are author's own estimates.

Table 2: Procedure to adapt the Reference Scenario of the 3rd NEEAP to the data and macroeconomic forecasts of the 4th NEEAP.

Reference Scenario of 3rd NEEAP (2014)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Final non-electricity consumption for heating and cooling	424	421	405	371	349	345	350	366	387	410	432
Final non-electricity consumption in transport	1070	1077	992	902	828	819	831	868	923	972	1012
Final electricity consumption	415	397	392	362	346	352	364	387	416	444	471
Primary energy input for power generation	1194	1146	1097	1011	940	936	950	989	1041	1091	1132
Primary energy consumption	2688	2643	2494	2284	2118	2100	2131	2223	2351	2473	2575
Final energy intensity (toe/Meuro'2005)	126,4	124,8	120,7	117,4	114,9	113,3	113,4	116,2	121,0	125,7	129,5
Final energy intensity index (2010 = 100)	100,0	98,7	95,5	92,9	90,9	89,6	89,7	91,9	95,8	99,5	102,4
Final non-transport energy intensity (toe/Meuro'2005)	55,6	53,9	53,8	52,7	52,5	52,1	52,4	54,0	56,3	58,8	61,1
Final non-transport energy intensity index (2010 = 100)	100,0	96,9	96,9	94,8	94,4	93,8	94,3	97,2	101,3	105,8	109,9
Final electricity intensity (toe/Meuro'2005)	27,5	26,1	26,5	26,0	26,1	26,3	26,7	27,8	29,1	30,6	31,8
Final electricity intensity index (2010 = 100)	100,0	95,2	96,4	94,7	95,1	95,8	97,3	101,1	106,1	111,4	115,9
Final transport energy intensity (toe/Meuro'2005)	70,8	70,9	66,9	64,8	62,4	61,2	61,0	62,2	64,7	66,9	68,4
Final transport energy intensity index (2010 = 100)	100,0	100,2	94,5	91,5	88,2	86,4	86,1	87,8	91,4	94,5	96,6
Primary energy intensity (toe/Meuro'2005)	177,9	174,1	168,3	164,0	159,7	156,9	156,3	159,3	164,9	170,2	174,1
Primary energy intensity index (2010 = 100)	100,0	97,8	94,6	92,2	89,7	88,2	87,9	89,5	92,7	95,7	97,9

Table 3: Forecast of national energy demand in Cyprus in the two scenarios and breakdown of energy savings by sector.

4th NEEAP

Final energy demand for heating and cooling (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	838	816	757	708	725	740					
Reference scenario						740	763	807	864	926	987
Additional energy efficiency scenario						740	772	805	848	897	933

Final energy demand in transport (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	1063	1070	990	890	866	911					
Reference scenario						911	932	973	1036	1097	1149
Additional energy efficiency scenario						911	926	940	954	970	983

Final electricity demand (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	415	397	376	336	339	351					
Reference scenario						351	367	392	424	459	492
Additional energy efficiency scenario						351	364	373	380	390	400

Final energy demand (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	1901	1886	1747	1597	1591	1651					
Reference scenario						1651	1695	1780	1900	2023	2136
Additional energy efficiency scenario						1651	1699	1745	1801	1867	1916

Primary energy input for power generation (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	1184	1147	1104	896	918	952					
Reference scenario						952	940	892	923	956	985
Additional energy efficiency scenario						952	918	885	892	705	717

Primary energy consumption (ktoe)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Past data	2670	2637	2475	2157	2170	2252					
Reference scenario						2252	2268	2280	2398	2520	2628
Additional energy efficiency scenario						2252	2254	2257	2313	2183	2233

Savings in 2020 primary energy consumption between Reference Scenario and Additional Energy Efficiency Scenario

	(ktoe)	(%)
Savings in heating and cooling	55	5,5%
Savings in transport	165	14,4%
Savings in final energy consumption	220	10,3%
Savings in power generation	268	27,2%
Total savings in primary energy consumption, of which:	**395**	**15,0%**
due to savings in final non-electricity consumption	*127*	
due to savings in final electricity consumption	*93*	
due to the use of natural gas in power generation	*175*	

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