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Ex post evaluation and policy implementation in the building sector

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Executive summary

Key messages

- Energy consumption for heating and cooling in the building sector has been steadily decreasing in the EU. This has been achieved by numerous policies and measures implemented by Member States aimed at improving energy efficiency buildings.
- Union policies, such as the Energy Efficiency Directive and the Recast of the Energy Performance of Buildings Directive, have been an important driver of national policies and measures in Member States.
- Member States use a mix of different instrument types to improve energy efficiency in buildings, although regulations, financial and information measures are most common. The evidence suggests that the complexity of the policy mix increases over time, as more and more PaMs are implemented.
- The EEA PaM database also suggests that the instrument mix has changed and that recent PaMs are relatively more frequent regulations and economic instruments, whereas older policies and measures tend to be more fiscal and information instrument types.

Introduction and objectives

Buildings account for about 40 % of total final energy consumption and around 60 % of electricity consumption in the EU-28 in 2015. This makes the buildings sector the largest energy end-use sector, followed by transport (33 %), industry (25 %) and agriculture (2 %) (Eurostat, 2017). A significant part of this energy consumption is for heating and cooling of residential buildings and buildings in the services sector.

Improving the energy efficiency of buildings has been recognized as a cost-efficient measure to reduce energy consumption and greenhouse gas emissions and therefore has been the objective of national and Union policies and measures. In this study, the effectiveness and coherence of these policies and measures are evaluated. More specifically, it is assessed which policies and measures have been implemented to improve energy efficiency, what the effect was of these policies and measures on energy consumption and to what extent the policy mix is coherent.

To address these research questions, evidence is drawn from three data sources:

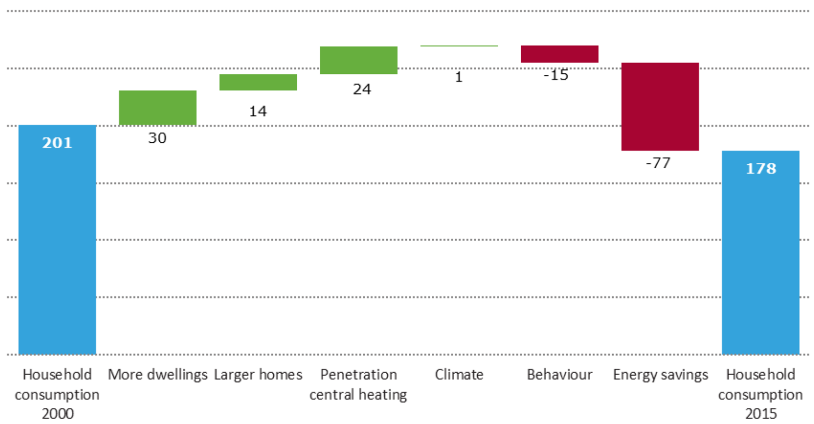
- databases on policies and measures, primarily the EEA PaM database and the MURE database;
- a wider literature search, and;
- six country case studies, were the policies and measures of Bulgaria, Cyprus, the Czech Republic, France, the Netherlands and Sweden are looked at in greater detail.

Results and discussion

Energy consumption for heating and cooling in the building sector has been steadily decreasing in the EU. These reductions in energy consumption have been achieved by improvements in energy efficiency. These gains from energy efficiency improvements counteract forces that increase energy consumption such as increased population size, dwelling size and, for the services sector, economic growth (example for households, Figure S.1).

To achieve these energy savings as a result of improvements in energy efficiency, Member States have implemented numerous policies and measures aimed at improving energy efficiency buildings. There are clear differences among Member States in the number of implemented policies and measures (Figure S.2). These policies and measures constitute a large part of climate mitigation measures (EEA PaM database). To improve energy efficiency in buildings different instrument types are used such as information, research and education measures; taxes; voluntary instruments such as cooperation agreements; and plans and strategies. The dominant and most frequently used instrument types are economic incentives and regulations (EEA PaM database). The case studies show that policies and measures also target different actors: building professionals, owners or tenants of buildings, energy suppliers, local or national authorities, and financial institutions.

Figure S.1 Waterfall plot of the change in household energy consumption for space heating between 2000 and 2015 in the EU (in Mtoe).



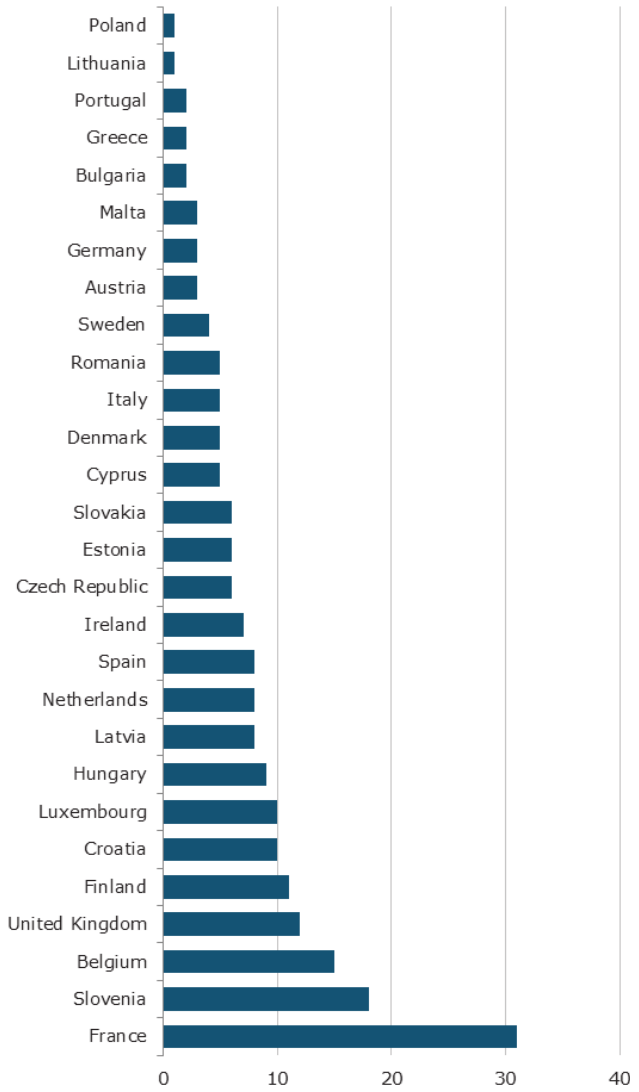
Source: Odyssee, 2017.

While policy action to improve energy efficiency of buildings has in some Member States a long history, the EEA PaM database shows that Union policies have been an important driver of national policies and measures in Member States. This includes the transposition of EU legislation into national legislation, such as the case for the Recast of the Energy Performance of Buildings Directive. Other policies and measures have been implemented to achieve the energy efficiency targets under the Energy Services Directive or the Energy Efficiency Directive.

The reporting requirements under this Union policy framework implies that information on policies and measures are reported on, e.g. in the context of the National Energy Efficiency Action Plans or the Monitoring Mechanism Regulation. This increases the transparency, although quantitative information on individual policies and measures is not always available. For example, *ex post* evaluations of individual policies and measures in the EEA PaM database and the MURE database is scattered and incomplete. This does not allow a complete analysis of the impact of energy efficiency policies on energy savings and greenhouse gas emission reductions.

Considering the multilevel or polycentric governance of energy efficiency policy (and climate mitigation in general) and the number of national policies on energy efficiency in buildings, this provides an interesting case to look at the policy mix. In policy mixes different instrument types are combined to achieve the same objective. These policy mixes are considered to be more effective than single instrument types. Different instrument types interact with one another and can have a positive, neutral or negative impact on its effectiveness. Therefore evaluation of individual measures is more complicated. In cases with a more extensive policy mix a holistic approach in evaluation could therefore be more appropriate. Additionally, there are several barriers for improving energy efficiency in buildings that a policy mix needs to address.

Figure S.2 Number of existing energy efficiency policies and measures in the buildings sector in Member States.



Source: EEA PaM database

Analysis of policies and measures show that individual Member States use a mix of instrument types. These are not used in isolation, but often in combination with other instrument types. The instrument types that are most often combined are regulation and economic instrument types. These are also the most frequently used instrument types by the Member States. There are however also differences among Member States. For example, France has implemented for several target groups a mix of instrument types that includes economic incentives, regulations, fiscal measures, and information and education campaigns. In the Netherlands, there are relatively few combinations of financial and regulation instrument types, but rather combinations of financial and information. In other Member States looked at in the case studies, Bulgaria, the Czech Republic and Sweden, combinations of financial and regulation policies are most frequently combined. This partially reflects also the difference in the number of policies and measures in the different Member States, which are high in France.

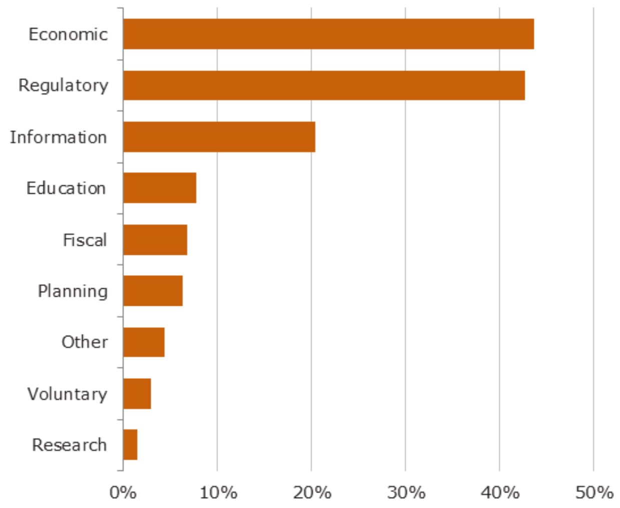
In most case studies, the complexity of the policy mix increases over time. More new instrument types are implemented with time. This is the case in the United Kingdom and Finland (Kern et al., 2017) and also in the case studies France, Bulgaria, the Czech Republic and Cyprus. For the Netherlands' household sector and the Swedish services sector this seems not so conclusive as it appears that several policies and measures have ended and replaced by other policies and measures.

The EEA PaM database also suggests that the instrument mix has changed and that recent PaMs are relatively more frequent regulations and economic instruments, whereas older policies and measures tend to be more fiscal and information instrument types (Figure S.3).

Because of the different market failures and political constraints in the built environment, an ideal policy package should target all relevant actors, establish mechanisms to overcome actor-specific barriers and guarantee a reinforcement of the different instrument among each other. Crucial ingredients includes a holistic policy roadmap, proper infrastructure and funding, proper energy prices, minimum performance standards prepared by education and training of the different market actors, tackling information deficits and giving financial incentives to realize a broad market introduction of low energy buildings.

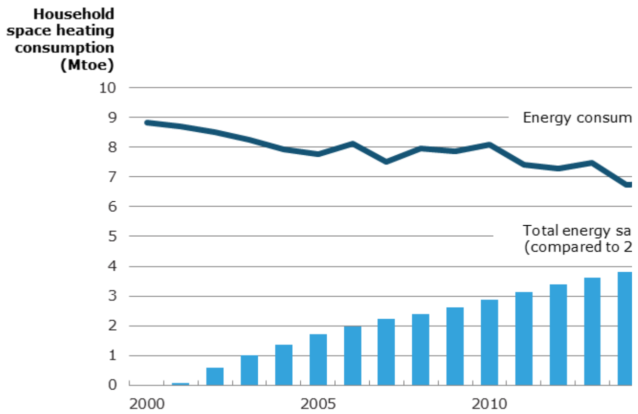
The case studies show that countries with more individual PaMs also have a more complex policy mix, but the relationship is not perfect. The dominance of financial and legislative instrument types is evident in almost all target groups in the case studies. These can have a mutually neutral or negative impact on the effectiveness of the policy mix. In the case studies, combinations are also used of instrument types that have a complementary impact, such as financial instruments and information campaigns. Taxes are not included in the policy mix of all case studies, although it could have a reinforcing impact on the effectiveness of all other instrument types.

Figure S.3 Share of instrument types of energy efficiency policies and measures in the EU-28 (in %).



Source: EEA PaM database

Figure S.4 Household energy consumption for heating (line) and cumulative energy savings from energy efficiency improvements from 2000 (bars) in the Netherlands (in Mtoe).



Source: Odyssee, 2017.

The Netherlands improved the energy efficiency in buildings between 2000 and 2015 (Figure S.4). Looking at policies, it seems that the long term strategies that the Netherlands developed helps them in setting-up a coherent and effective policy mix in the buildings sector.

Conclusions and recommendations

The influence of Union policy and the implementation of increasing numbers of national policies and instruments warrant more holistic evaluations of policy mixes. This is still not done frequently.

Policy databases such as the EEA PaM database and the MURE database can contribute to this. In fact, these databases already offer an accessible and comprehensive overview ended, existing, and planned policies and measures. Comparison of the MURE and EEA PaM database shows however differences in completeness and comprehensiveness of information. This is because of differences in scope (only energy efficiency measures or all climate mitigation measures) and reporters, resulting for example in policies and measures grouped and named differently. There is still room for improvement in how information on energy and climate policies and measures is reported. More integrated reporting is needed on policies and measures. The new Governance regulation of the Energy Union could already be a step in this direction, but it also required an integrated reporting system at Member State level on climate and energy measures.

From an evaluators perspective not all information is available in the databases. Information on *ex post* impact of policies and measures on indicators, energy savings or greenhouse gas emission reductions is particularly missing. For individual measures this information helps to better understand its importance and give an indication of how important interaction effects could be in case of overlapping measures.

1 Introduction

1.1 Background

Buildings account for about 40 % of total final energy consumption and around 60 % of electricity consumption in the EU-28 in 2015. This makes buildings the largest energy end-use sector, followed by transport (33 %), industry (25 %) and agriculture (2 %). In some countries, such as Estonia, Croatia and Hungary, buildings represent even more than 45 % of final energy consumption in countries (Eurostat, 2017). For the EU-28 as a whole, around two thirds of the energy consumption of buildings is for residential buildings (Odyssee-MURE, 2015). Therefore, reduction of energy consumption and the increased use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union's energy dependency and greenhouse gas emissions.

The current core Union policies aimed at reducing energy consumption in buildings are (EC, 2016) the Energy Performance of Buildings Directive (EPBD), the Energy Efficiency Directive (EED), and several product regulations laying down minimum energy performance standards and putting energy performance information on labels (Ecodesign and Energy Labelling). Figure 1.1 indicates the timeline of these key EU legislations and their predecessors (BPIE, 2014).

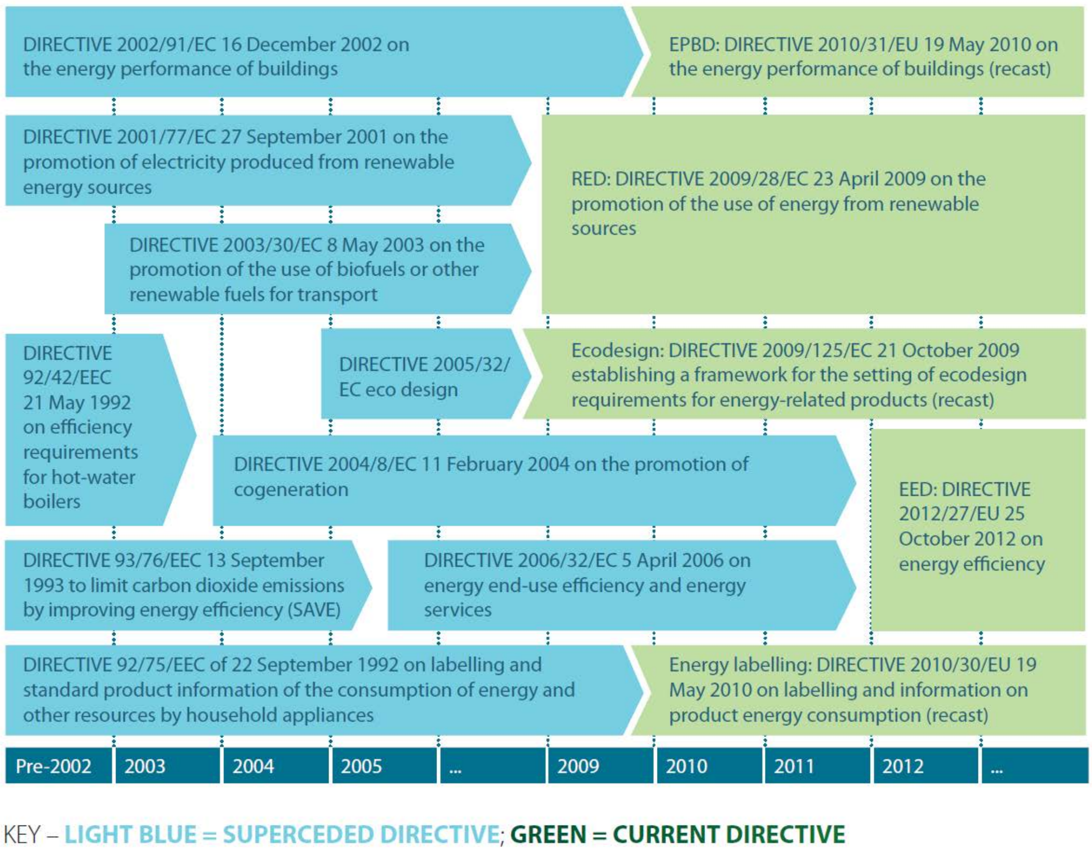
On 30 November 2016 the European Commission presented a new package of measures to keep the European Union competitive as the clean energy transition changes global energy markets, in the so-called 'winter package'. One of the central pillars is to put 'energy efficiency first', which is reflected in the launching of new and innovative energy efficiency measures. These measures focus on:

- Setting the framework for improving energy efficiency in general;
- Improving energy efficiency in buildings and stressing the importance of renovation;
- Improving the energy performance of products (Ecodesign) and informing consumers (energy labelling);
- Financing for energy efficiency with the smart finance for smart buildings proposal1.

The 'winter package' recognizes that the building stock still provides a large potential for energy savings. This includes both new and existing buildings, although the tighter minimum energy performance requirements and the high compliance rates of new buildings (typically above 80 %), means that the largest saving potential remains mostly in the existing buildings stock (EC, 2016). This explains why many studies have a forward looking perspective, with recommendations for future policy developments. A retrospective perspective is also needed to understand if and how policies have contributed to energy efficiency in buildings. Moreover, while studies on single instruments are valuable, it is important to consider the wider context in which instruments are designed and implemented (Kern et al., 2017).

[1] http://europa.eu/rapid/press-release_MEMO-16-3986_en.htm

Figure 1.1 Timeline of key EU legislation for energy use in buildings.



Source: BPIE, 2014.

1.1.1 Objectives

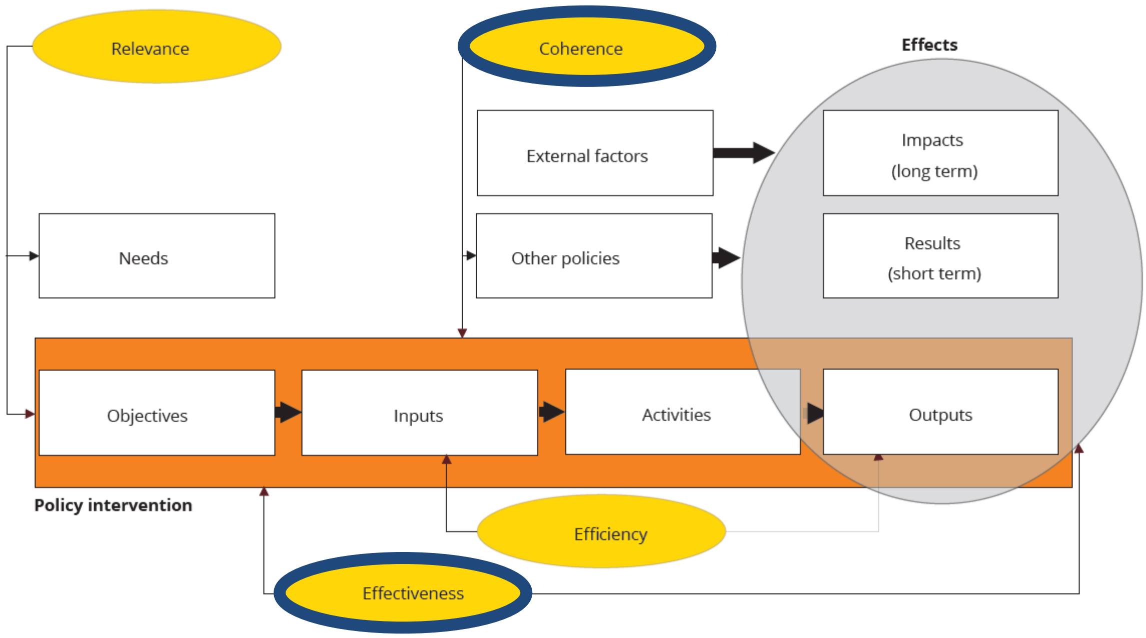
In this report, a partial *ex post* evaluation of building energy efficiency policies and measures (PaMs) in the domain of heating and cooling is performed. In this analysis, a building is defined as a roofed construction having walls, for which energy is used to condition the indoor climate in the households and services sector. This means that all PaMs improving the energy efficiency of heating and cooling in buildings (including sanitary hot water) are considered. Considering that Union policies improving energy efficiency in buildings is important, the considered PaMs will mainly be linked to the Union policies EBPD, EED, and - to a lesser extent – the Ecodesign and Energy Labelling Directives. The analysis is however not limited to only those PaMs that have been implemented in response to Union policies; all relevant PaMs within the Member States (which are documented in international literature or databases) are considered.

The *ex post* evaluation of national energy efficiency policy mixes is focused on the coherence and effectiveness of implemented policy packages. In the evaluation of coherence a distinction is made between external (to what extent is the intervention coherent with other interventions) and internal (to what extent is the intervention coherent internally) coherence. As the evaluation comprises a set of different individual instruments to improve building energy efficiency, coherence is limited to the internal coherence of the set of instruments e.g. how different energy efficiency policy instruments interact with one another and how these policy instruments address different barriers and actors. It does not cover external coherence with Union policies or with policies with an objective outside the scope of the analysis (e.g. reducing energy poverty).

Box A1.1. Policy evaluation by the EEA.

Policy evaluation is of particular relevance to the European Environment Agency (EEA) and in the current multi-annual framework programme this evaluation tradition is even being strengthened, as highlighted in the 2015 report "Environment and climate policy evaluation". The EEA report not only clarifies what EEA understands under *ex post* evaluation, it also provides a conceptual framework that helps structure and guide evaluations (Figure 1.2). This framework represents the relevant elements of each policy intervention, from the societal needs that trigger the intervention to the long term impacts that are generated, and links these to the typical *criteria* that are evaluated: *effectiveness, efficiency, relevance* and *coherence*[2]. Evaluations for the European Commission additionally cover the *added value of EU intervention* (EC, 2017). This framework is also used as guidance in this evaluation of energy efficiency policy in buildings.

Figure 1.2 Policy evaluation framework.



Source: EEA, 2016a.

1.2 Methodology and scope

While the above criteria provide a useful framework to structure an evaluation, reformulating these criteria into specific evaluation questions is needed. These evaluation questions can be generic or context dependent. In this paper following five questions linked to the evaluation of coherence and effectiveness of PaMs are considered:

[2] Value added of an intervention at a certain level of governance, e.g. what is additional value of an EU intervention compared to national/regional/local action, is often also considered a criteria.

Criteria	Evaluation questions
Implementation	Which policies have Member States implemented to improve energy efficiency in buildings? To what extent have these policies been implemented in response to Union policies?
Effectiveness	Has policy intervention resulted in energy efficiency improvements ? How is the relationship between improvements in energy efficiency and the national policies within a Member State?
Coherence	To what extent are national policy mixes for energy efficiency in buildings coherent?

As indicated in the table, one part of the effectiveness assessment look closer to the actual implementation within the member states (implementation status), while the last two questions evaluate the relationship between objectives and outputs (in this context, improvement of efficiency). To answer these questions, evidence is drawn from multiple sources, namely:

1. PaM databases and related information, more specifically the EEA PaM database, the Odyssee-MURE database and information contained in the National Energy Efficiency Action Plans (NEEAPs).
2. Existing literature on energy efficiency evaluation. This is complemented with quantitative data on energy efficiency indicators (EEA indicator assessment, EU Building stock observatory).
3. The analysis is complemented with a more detailed and comprehensive analysis of six case studies of Member States' policy mixes, to verify and complete the guiding principles of designing a coherent and effective policy mix to improve the energy efficiency of buildings. To this end an excel file was compiled to collect relevant information on national energy efficiency policies from the different case studies. This excel file was shared with Member States to check for completeness and accuracy and to ask for any additional national information that could be relevant.

2 Implementation of energy efficiency PaMs

Which policies have Member States implemented to improve energy efficiency in buildings?

To improve energy efficiency in buildings, all Member States have implemented a significant number of different PaMs. In some Member States there is already a long tradition in energy efficiency policies in buildings, so PaMs have been superseded, revised and strengthened throughout the years. The evidence shows that most frequent instrument types are regulations, economic instruments (such as subsidies and grants) and information. This is supported by both the EEA PaM and MURE database. The most active period within the Member States for implementation of PaMs differs between the data source. In the MURE database there is a larger share of PaMs starting in the period 2000-2015, whereas in the EEA PaM database more PaMs started on average later and most single PaMs started even after 2010.

To what extent have these policies been implemented in response to Union Policies

Already since the nineties, has the EU implemented buildings energy efficiency policies linked to heating and cooling. An important step was the introduction of the EPBD in 2002 having far-reaching impact on owners, operators and developers of all buildings. However, in many Member States national policies were already in place. Studies show that in the recent decade national energy efficiency policies have increasingly been influenced by Union policies, like the recast of the EBPD, Energy Services Directive and the EED (for example EC, 2016). This is in line with the EEA PaM database: in total 71 % of all single PaMs promoting energy efficiency in buildings, have been implemented in response to the EPBD, the Energy Services Directive and/or the EED. Other Union policies have been a driver as well, such as the Effort Sharing Decision, but these have been less important. Besides EU legislation, also the promotion of Energy Services Companies (ESCOs) by multiple EU and international institutions, like the European Investment Bank, influence the professional landscape of energy efficiency in buildings.

2.1 Which policies have Member States implemented to improve energy efficiency in buildings?

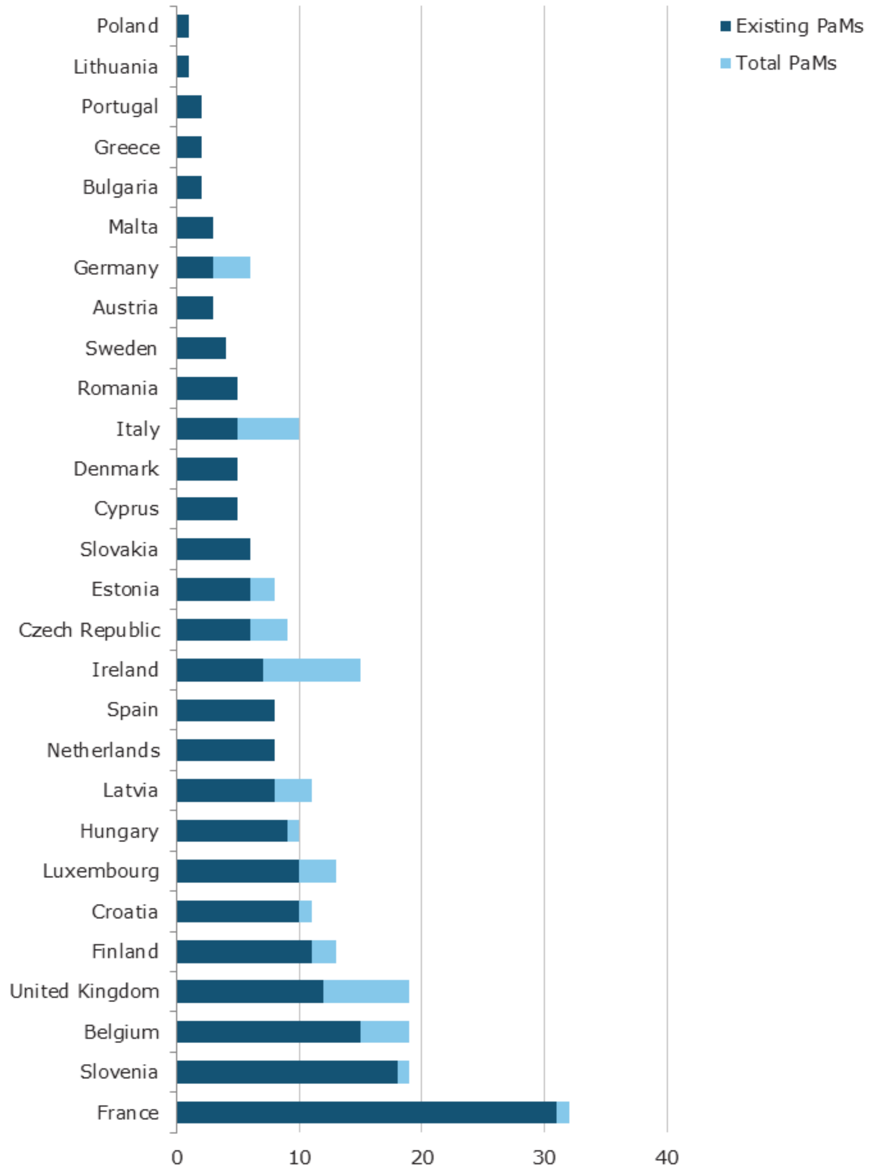
2.1.1 PaM database

Member States are required to report biennially on their climate change mitigation PaMs in the context of the Monitoring Mechanism Regulation. This information is aggregated into a PaM database and data viewer (EEA, 2017a). This PaM database covers all relevant sectors (energy supply, energy consumption, transport, industrial processes, agriculture, land use and land use change, and waste). In this analysis, all PaMs were selected with the objective ‘efficiency improvements of buildings’, the characteristics of these PaMs are presented below. The analysis of the number of PaMs in the EEA database can be used to understand general trends in the characteristics of buildings energy efficiency measures. It is worth remembering that reporting is done by individual Member States and therefore there are inherent differences in the completeness and the level of detail that is provided for each PaM, although this is improving every reporting cycle.

The database contains few existing PaMs[3] improving efficiency of buildings for the Member States Bulgaria, Greece, Lithuania, Malta, Poland, and Portugal, which could be due to reporting several individual instruments as one single PaM. For example, a single PaM in the EEA PaM database could include several financial instruments. On the other side of the spectrum, Belgium, Croatia, France, Finland, Luxembourg, Slovenia, and the United Kingdom reported the most individual PaMs (Figure 2.1).

[3] Existing means not expired (planned, adopted, implemented) and starting no later than 2017.

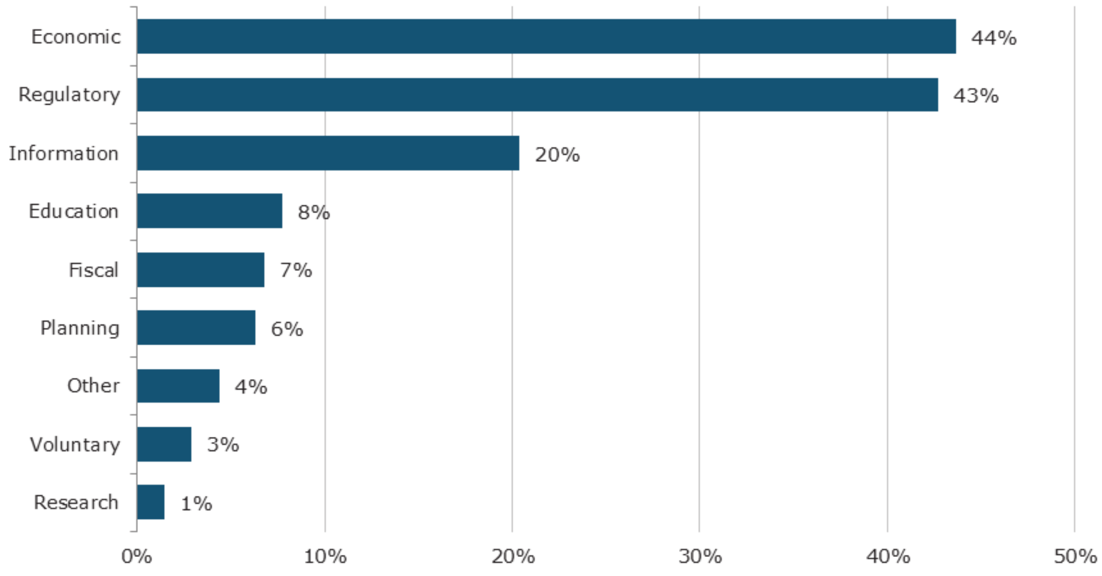
Figure 2.1 Number of single PaMs linked to the objective 'improvement of energy efficiency in buildings' for all Member States (dark blue: only existing PaMs and light blue: all PaMs).



Source: EEA, 2017a.

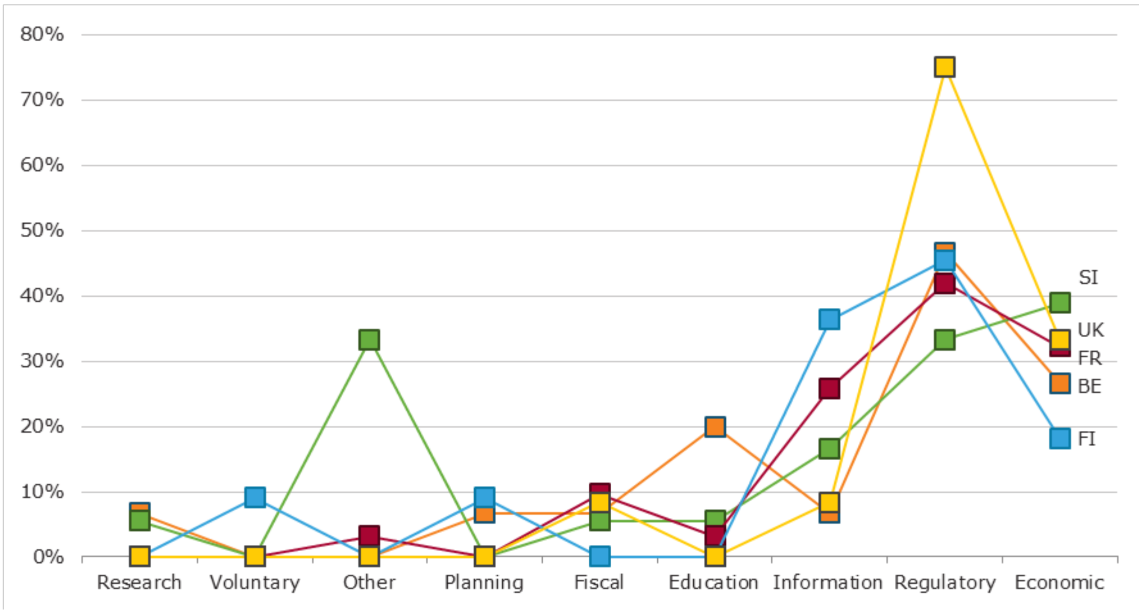
Existing PaMs that improve efficiency of buildings are by far mainly regulatory and/or economic policy instruments (Figure 2.2). Economic instruments are all instrument types that provide a financial incentive to the target group such as a grant or a loan. It excludes however fiscal stimuli, such as a tax or tax rebate, which are considered fiscal instrument types. More than 40 % of reported existing PaMs are regulatory and/or economic (in some cases in combination with other instrument types). This is because these are considered very effective instrument types and are often directed towards different groups. The third most frequently used instrument type is information. Education scores relatively better as an instrument type, compared to climate PaMs in other domains. Fiscal policy instrument types have a relatively low share. There are differences among Member States. The five countries with the most existing energy efficiency PaMs in buildings, France, Belgium, Slovenia, Finland and the United Kingdom, illustrate these differences (Figure 2.3). However, economic, regulatory and information instrument types are for almost each of these countries the dominant instrument types.

Figure 2.2 **Share of PaMs per instrument type linked to the objective 'improvement of energy efficiency in buildings' for EU-28 (% compared to total).**



Source: EEA, 2017a.

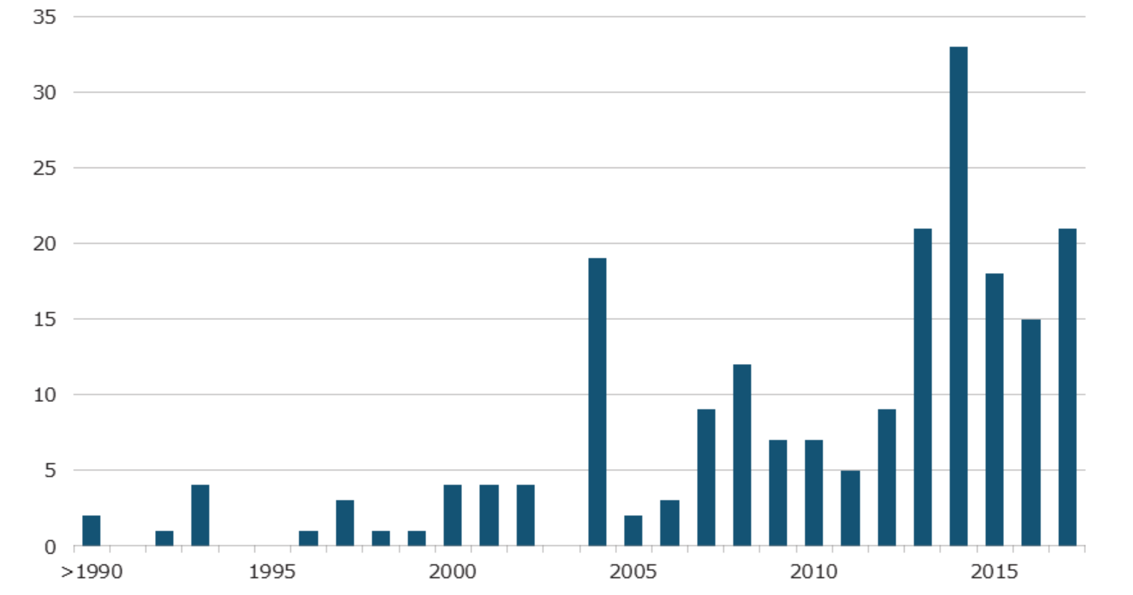
Figure 2.3 **Share of PaMs per instrument type linked to efficiency in buildings for the five Member States with the most existing PaMs.**



Source: EEA, 2017a

Concerning the implementation period of energy efficiency PaMs for buildings, there are two PaMs that started before 1990, respectively 1960 (Sweden) and 1970 (Slovenia; Figure 2.4). These are both building regulations implemented very early and since then revised frequently. Similarly, other EU Member States implemented building regulations, including regulations on energy efficiency, early on that are not included in the PaM database. It illustrates that energy efficiency measures for buildings have already a considerable history in many EU Member States, a history that is not always captured by the PaM database (and other databases and information sources, such as the NEEAPs) that focusses more on recent climate PaMs. Old and expired climate PaMs are not always reported by Member States, nevertheless it is required by the EU MMR. Concerning the existing PaMs there is an overall increasing trend of the number of PaMs that have been implemented to improve energy efficiency in building sector. Apart from this general trend, in 2004[4], 2008 and 2014 there appears to be a peak in the implementation of policies (Figure 2.4). This is very consistent with the results obtained for all climate related PaMs (Dauwe et al., 2017).

Figure 2.4 Number of single existing PaMs linked to improved energy efficiency of buildings, per start year.

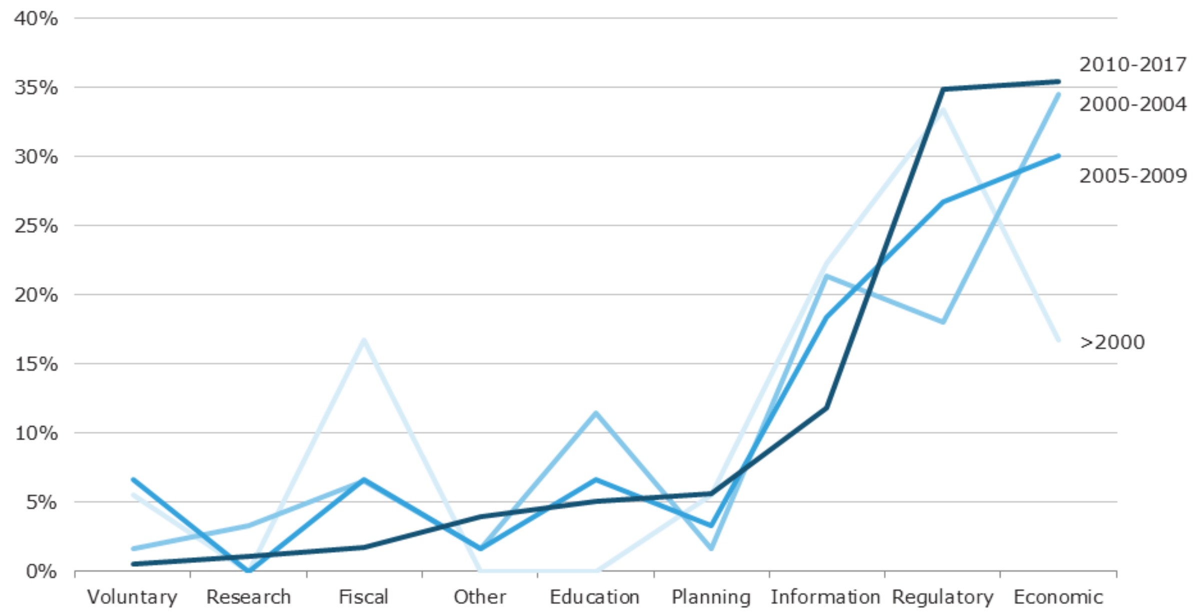


Source: EEA, 2017a.

The share of the different instrument types could also be linked to the starting year of the PaM. This analysis shows that the result for the most recent PaMs (starting between 2010-2017) corresponds most with the pattern in Figure 2.5. PaMs that were implemented earlier, tended to have a higher share of fiscal and information policy instruments and less regulatory and economic. This is especially the case for PaMs starting before 2000.

[4] 2004 is mostly related to the reporting of one Member State that had for many PaMs starting year 2004.

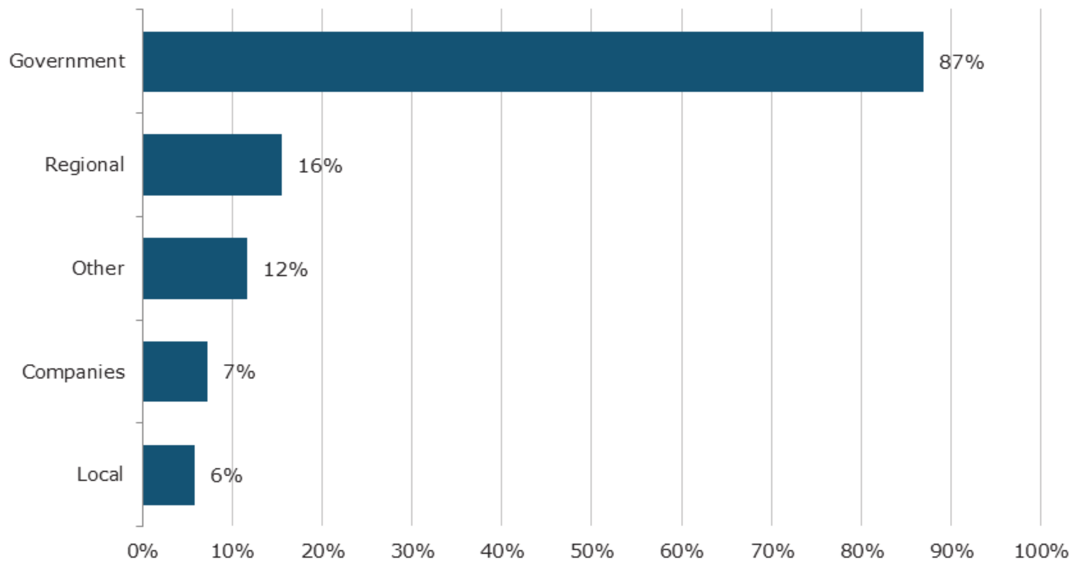
Figure 2.5 Share of all single PaMs linked to improved energy efficiency of buildings, per instrument type.



Source: EEA, 2017a.

The vast majority of PaMs linked to energy efficiency improvement of buildings are implemented by national governments: 87 % of existing PaMs have been implemented by the national government, either alone by the national government or together with another entity type (Figure 2.6). This is very similar to the distribution among entity types for all climate PaMs. Other entities involved are companies as the dedicated state owned company Motiva in Finland or KredEx in Estonia. Other entity types are for example the Sustainable Energy Authority of Ireland, the National Energy Efficiency Authority in Croatia and Eko sklad (public environmental fund) of Slovenia.

Figure 2.6 Share of single existing PaMs linked to improved energy efficiency of buildings, per entity type.



Source: EEA, 2017a.

2.1.2 MURE database

PaMs are aggregated per sector in the MURE database (Odysee-MURE, 2017). To make sure that the selected PaMs fall within the scope of this analysis, *i.e.* improve energy efficiency of buildings, following search criteria were used for the targeted end-use:

- households: “hot water”, “room cooling”, “room heating” or “total fuel consumption”;
- tertiary: “space heating” and “total fuel consumption”;
- industry: “space heating”[5].

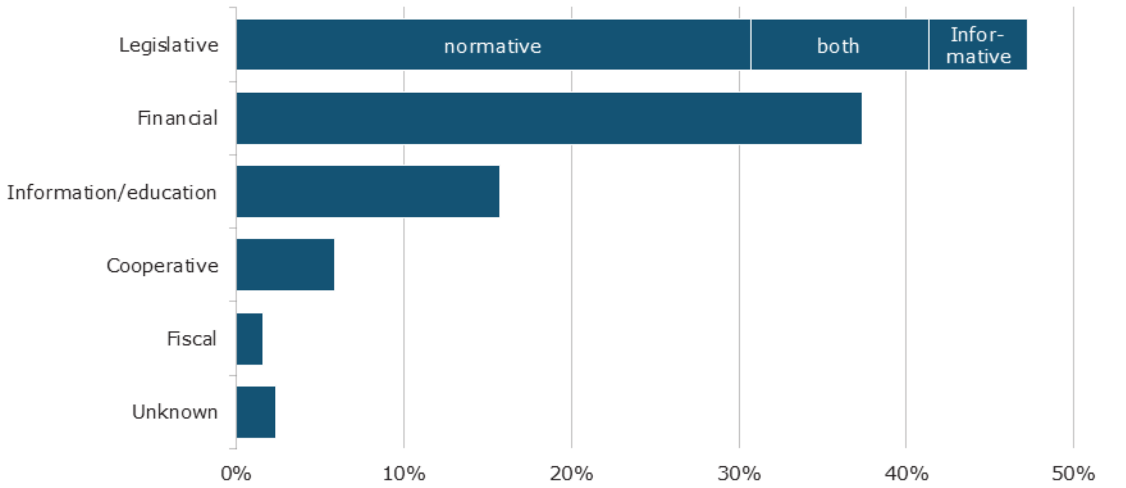
Only PaMs from EU-28 Member States were included in the analysis and, to have a similar approach as in the EEA PaM database, expired PaMs were excluded. This resulted in 254 different PaMs: 149 in the household, 92 in the tertiary and nine in the industrial sector) (Odyssee-MURE, 2017). Because information is grouped per sector, there could be some duplication of information as PaMs that affect for instance the residential and tertiary sector could be included twice. Most of the selected PaMs from the MURE database were legislative and/or financial (Figure 2.7)[6]. This aligns well with the outcome of the EEA PaM database. The relative importance of information/education/training instruments is also evident from the MURE database. In the MURE database, there are less fiscal PaMs than cooperative PaMs (such as voluntary agreements), which is not evident from the EEA PaM database.

Box A2.1. The MURE policy database.

The MURE (Mesures d'Utilisation Rationnelle de l'Energie) database aggregates information on national energy efficiency PaMs. The information on energy efficiency PaMs is based on information included in the NEEAPs. The database is searchable online based on the characteristics of the PaMs: the affected sector, the instrument type and the targeted end-use. A description and quantitative of qualitative information on the impact of the PaMs is also included. The database is part of the H2020 funded Odyssee-MURE project that also includes a database on quantitative energy efficiency indicators.

The database is accessible via the link http://www.measures-odyssee-mure.eu/.

Figure 2.7 Share of PaMs per instrument type linked to energy efficiency in buildings.

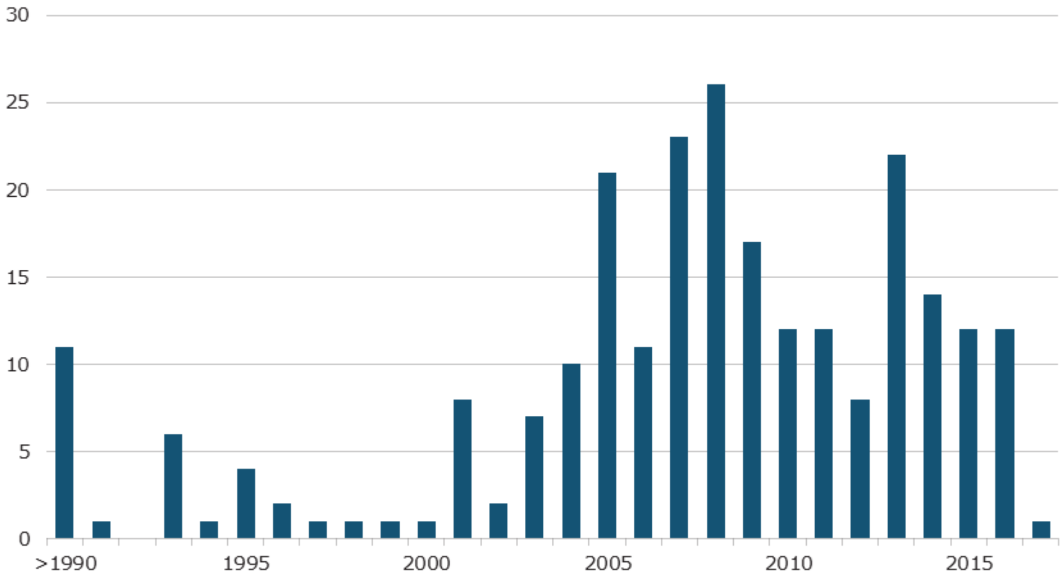


[5] While energy efficiency in industry is not part of the scope of this analysis, PaMs targeted at increasing the energy efficiency of buildings in the industrial sector have been included in this assessment.
[6] More explanation on the types of measures in the MURE database is given in the Annexes.

Source: Odyssee-MURE, 2017; own analysis.

The analysis of the start year of PaMs included in the MURE database shows a different pattern than for the EEA PaM database (Figure 2.8). In the EEA PaM database, more PaMs are included with a starting date later than 2010. In the MURE database this is different and the starting year of PaMs is more evenly spread between 2005 and 2015. This could be because of differences in how individual PaMs are grouped and reported. Reporters for the information under the MMR and the NEEAPs or Odyssee-MURE could be different, resulting in differences in how information on PaMs is presented and reported.

Figure 2.8 Number of existing PaMs in the MURE database, per start year.



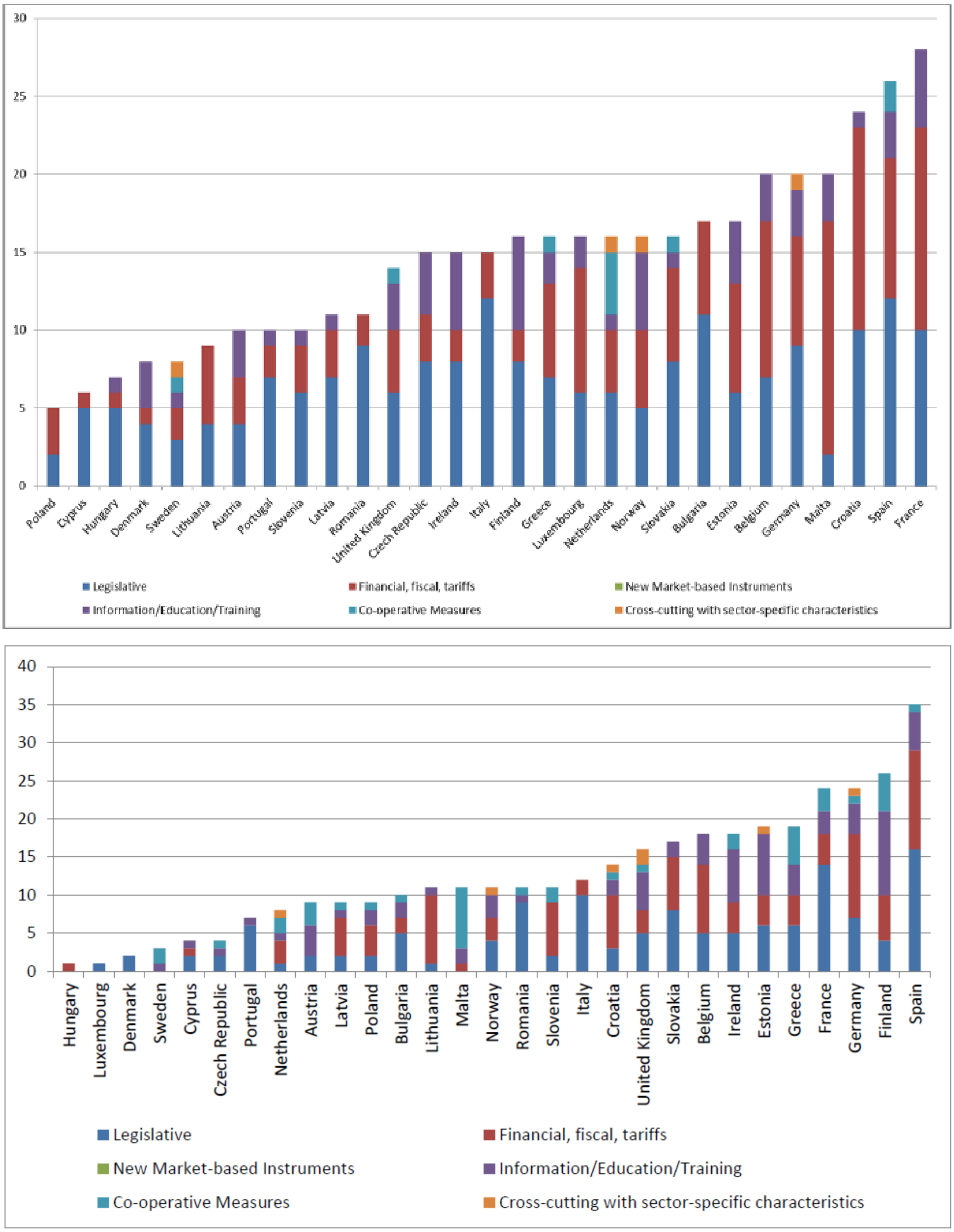
Source: Odyssee-MURE, 2017; own analysis.

2.1.3 Overview from literature

Types of measures in EU-28 countries

Energy efficiency improvements in the building sector are hindered by various barriers, each of which needs to be addressed by different types of measures. It is a common agreement in literature, that developing a balanced policy mix which includes several types of measures is required for effective energy efficiency policies. Moreover, these measures target several sectors or end-users and can be implemented or can be relevant at different stages of the development. The adopted policy mixes by the European Member States vary significantly from country to country, as illustrated for the household sector in Figure 2.9 (Odyssee-MURE, 2015).

Figure 2.9 **Number of measures by type and by country in the household sector (top) and tertiary sector (bottom).**



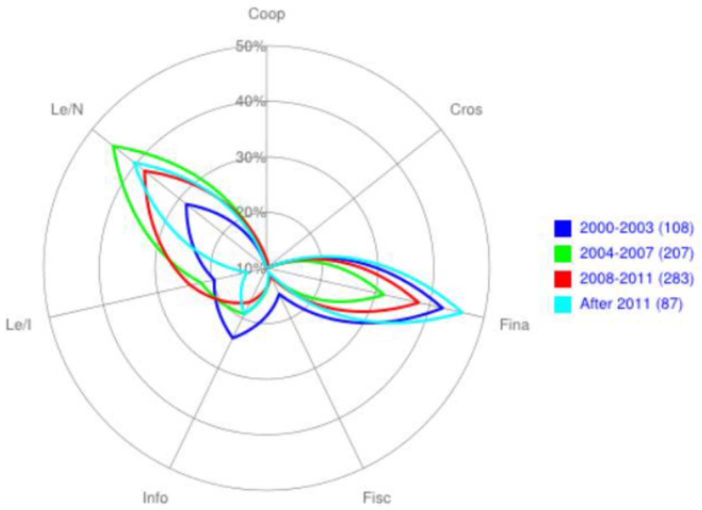
Source: Odyssee-MURE, 2015.

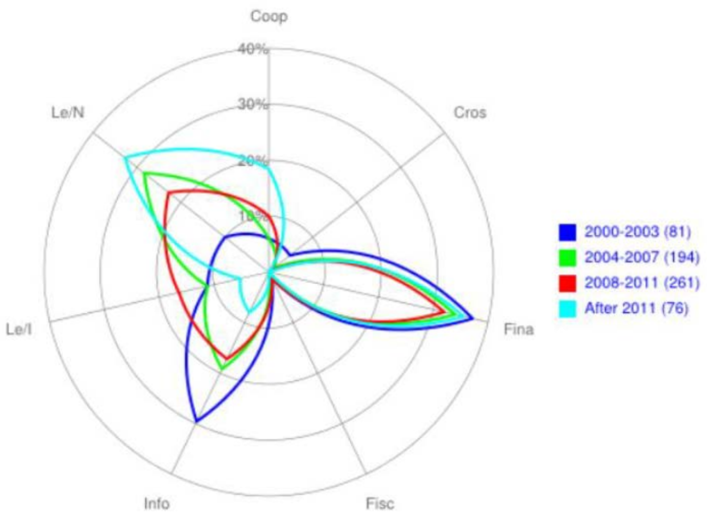
As shown, legislative measures, i.e. regulations, dominate in the household sector (Odyssee-MURE, 2015). A notable exception is Malta where the majority of measures are economic. Legislative measures have a considerable role also in the tertiary sector but unlike in the household sector, their role is not quite as dominant. In the tertiary sector, co-operative measures, typically voluntary agreements, have been implemented too. Energy efficiency laws are a common approach worldwide to consolidate the institutional commitment to energy efficiency (World Energy Council, 2016), because a law gives a more durable status to energy efficiency policies. These laws comprise a legal framework for the adoption of targets or other regulations, such as labelling, minimum performance standards, obligations for large consumers or energy savings obligation for utilities or energy audits.

Economic measures are the second most common type of measures within the Member States. Most countries have also reported at least one information based instrument, but there are a few countries which have not reported measures of this kind. Nevertheless, information and communication are key components of an energy efficiency policy to motivate consumers and inform them about the technical and financial solutions (World Energy Council, 2016). Recently, more targeted modes of information and communications have recently been developed, such as energy efficiency platforms, information centers and their new form of "one stop-shops", and mobile applications. Therefore, to inform households on energy efficiency actions many countries have set up information centers in the main cities to be as close as possible to the consumers.

Figure 2.10 shows the changes in policy mix over time in terms of number of measures: in the recent years the major emphasis has been in financial measures, but also legislative measures have had an important role (Odyssee-MURE, 2015). In the services sector, co-operative measures are growing in importance in the latest years.

Figure 2.10 Measures introduced by type and by period of time for households (top) and tertiary sector (bottom).





Note: Coop = Co-operative measures, Cros = Cross-sectoral measures, Fina = Financial measures, Fisc = Fiscal measures, Info = Information/education/training, Le/I = Legislative/Informative, Le/N = Legislative/Normative, Mark = New market-based instruments; the categories of policy measures are explained in Odyssee-MURE.

Source: Odyssee-MURE, 2015.

Under Article 9 of the EPBD, Member States have to draw up national plans to ensure Nearly Zero Energy Buildings (NZEBs) by 2020. A wide range of PaMs were reported by the Member States in their national plans and NEEAPs[7] (National Energy Efficiency Action Plans) (Ecofys, 2014). Various Member States have PaMs for strengthening building regulations which include tightening energy minimum standards for buildings or the minimum level of renewable energy in housing in place. Other measures which are often used by the Member States are energy performance certification (e.g. certificate provides information about opportunities to improve building energy efficiency or scaled energy certificates), demonstration and pilot projects (e.g. project tenders with the topic “Sustainable home” or pilot projects “Existing nearly zero-energy buildings”) and supervision (e.g. establish an efficient, high-quality system of energy audits or rollout of smart meters). The most prevalent measure for stimulating refurbishment into NZEBs is the implementation of financial support schemes. In the previous Commission progress report of 2013,

[7] Based on the third NEEAPs (2014).

only seven Member States reported specific measures for the refurbishing of existing buildings. This development is very positive and indicates that Member States focus more on the refurbishment of the existing building stock than before (Ecofys, 2014).

Box A2.1. The National Energy Efficiency Action Plans.

The Energy Efficiency Directive, and the preceding Energy Services Directive, requires Member States to prepare every three years a National Energy Efficiency Action Plan (NEEAP). NEEAPs were prepared in 2007, 2011, 2014 and the latest version in 2017. The action plans describe the estimated energy consumption, planned energy efficiency measures, and the improvements Member States expect to achieve. Member States must additionally report the progress towards their national energy efficiency targets on an annual basis.

NEEAPs are available via the link https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans.

Role of Energy Efficiency Obligation Schemes EEOs

Energy saving or efficiency obligation was initiated at the end of the 2000's and is an innovative measure in which energy companies (supplier/retailer or distributor) have a legal obligation to undertake energy efficiency activities with their customers. If this obligation can be met by trading energy saving certificates, this is usually called "White Certificates" (World Energy Council, 2016). As a consequence of the EED (Article 7), there are now several countries in Europe that have implemented or are planning to establish energy efficiency obligation schemes (EEOS): Austria, Bulgaria, Croatia, Denmark, Estonia, France, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Slovenia, Spain and the United Kingdom. The impact of the schemes, but also of the other incentives, is significant, in terms of economic impacts: induced investments, employment, reduced imports and lower expenditures for consumers. Some companies see EEOS as a tool to develop new markets and revenue streams (European Parliament Research Service, 2016). Electricity companies are investigating new revenue streams linked to services. EEOS are seen as encouraging suppliers to adapt their business model from mainly selling electricity to selling services, such as for installations that reduce the energy bill.

The analysis of EEOS and alternative measures (European Parliament Research Service, 2016) illustrates that the residential sector will be responsible for the largest share of the 1.5 % annual energy end-use savings required by the EED. Overall, most measures included in the EEOS focus on implementation of 'low-hanging fruits', in the residential sector, such as efficient light bulbs and roof insulation. EEOS need to be combined with other policy measures, such as publicly funded grants and subsidized loan programmes.

2.1.4 Lessons learned from case studies

Timeline

For all case studies, many PaMs have been implemented after 2005 and this reflects the fact that Union policy is an important driver to implement new policies promoting energy efficiency in buildings, whether it is the (recast of the) EPBD, the Energy Services Directive or the EED. However the cases also show differences among Member States. Some countries have little to no PaMs starting before 2005, such as Bulgaria and Cyprus. The Czech Republic, France, the Netherlands and Sweden on the other hand have several PaMs that started before 2005 and some of these PaMs are still implemented.

Instrument types

In the case studies, Member States have used different instrument types directed at different target groups to improve energy efficiency. The EU outcome on used instrument types, based on the EEA PaM database or literature, typically also holds for the case studies: a dominance of regulation and financial instrument types. There are also some differences. Taxes and fiscal instruments are not used in all case studies, Cyprus, Czech Republic and Sweden (although this could also be a result of incomplete reporting, for example Sweden has a carbon tax), although this only constitutes one or two PaMs where it is reported. Also the importance of information and education measures is different, and is particularly important in Sweden and France.

Target groups

Target groups were aggregated into:

- owner/tenants;
- authorities (local, regional, national);
- financial institutions – covers only financial institutions;
- energy suppliers;
- building professionals;
- other.

In almost all cases are owners/tenants the group that is most targeted by individual PaMs. This is not surprising as this is also the group that is the most diverse and also the group that can have a direct impact on the energy efficiency of buildings by building more efficient new buildings or retrofitting buildings.

2.2 To what extent have these policies been implemented in response to Union policies?

2.2.1 PaM database

In the submitted PaM report, Member States have to specify if the PaM was implemented in response to one or more Union policies. As a consequence it is possible to assess to what extent Union policy was a driver for the implementation of national energy efficiency policies in buildings. As can be expected the most important Union policies were the EPBD and the EED (combined with the Energy Services Directive). Of the exising 206 PaMs, 38 % were implemented because of the EPBD and 24 Member States reported at least one PaM. Only Malta, Portugal, Bulgaria and Croatia did not report a single PaM implemented in response to the EPBD. The EED and/or Energy Services Directive resulted in more national PaMs being implemented, 50 % of all PaMs related to energy efficiency in buildings were reported to be implemented – at least partially - because of it. Three Member States did not report a single PaM implemented in response to the EED: Germany, the Czech Republic, and Luxembourg. There are several reasons why this could be the case. First, PaMs could have been implemented before the Union legislation and contribute to the target but not be implemented because of the EED. Secondly, PaMs could be adjusted because of Union policy but this is not reflected in the PaM reporting, i.e. the PaM is reported as not being implemented because of Union policy.

The Ecodesign and Labelling Directives were less of an incentive to implement policies improving the efficiency of buildings. For only six of the PaMs (3 %) this was a driver of its implementation. One explanation is that the Ecodesign and Labelling Directive is often reported as a separate single PaM by Member States, with as objective improving energy efficiency of appliances.

Apart from these four Union Policies, other Union policies have also been linked to 25 % of the PaMs improving the energy efficiency of buildings. Of these Union policies, the Effort Sharing Decision and the Renewable Energy Directive were by far the most important, although these were in most cases reported in combination with the EED or the EPBD. For a number of PaMs (25 %), Member States reported that these were not related to a Union policy. This is not an insignificant number of PaMs, but only occurred in ten Member States. In contrast to this, in the majority of Member States the EPBD and the EED (together with the Energy Services Directive) was a driver for the implementation of at least one national PaM.

The results from the EEA PaM database indicate that Union policies have been an important incentive in the implementation of new national PaMs. Additionally, while some national PaMs such as building regulations pre-date Union policy, EU action might still have been an important driver for adjustments to existing national PaMs. This might not always be reflected in the reporting of Member States.

2.2.2 MURE database

The MURE database also provides information on whether a national PaM is a transposition of Union policy or not. The MURE database starts from a more stringent approach than used in the EEA PaM database, where all Union policies which resulted in the implementation of national PaMs are reported (e.g. EED, Renewable Energy Directive, Effort Sharing Decision). As a consequence only a small fraction (26 %) is linked to Union policies, notably the EPBD, the Ecodesign or Labeling Directives and the Performance of Heat Generators for Space Heating/Hot Water Directive (92/42/EEC). For all other PaMs it is not reported whether Union policy has been a driver in its implementation.

2.2.3 Overview from literature

EU legislation is a major driver in national PaMs implemented in the household and services sectors which has required massive effort and resources of the Member States (Odyssee-MURE, 2015). Therefore, new measures within the Member States have mainly focused on the implementation of EU legislation, like the implementation of Article 7 of the EED on EEOs, the implementation of Article 9 of EPBD on NZEBs. 71 % of existing PaMs in the EEA PaM database have been implemented because of the Energy Services Directive, EED and/or EPBD. Other examples of EU influence are Energy Service Companies or ESCO's which are widely promoted by the European Commission, the European Investment Bank, the European Bank for Reconstruction and Development and the International Energy Agency, as they provide a framework to encourage private funding to support energy efficiency investments with a minimum role for governments. Article 18 of the EED contains a list of measures that Member States shall adopt in order to promote energy services market, including the ESCO market (World Energy Council, 2016). Concerning the EPBD, Member States agree that the Directive is in line with subsidiarity as it sets a vision and leaves the details at Member States level. However, during the public consultation of the EBPD evaluation, almost half of the respondents think the EPBD has been successful, while about a third believes it has not (Ecofys, 2015). Mentioned reasons were the delayed implementation in Member States, the slow uptake of measures and the low renovation rate. Several respondents also highlight the poor compliance and enforcement of measures while others recognise that the economic crisis in the construction sector has slowed improvements. This indicates that Member States can experience difficulties while implementing the EBPD, affecting the efficiency and effectiveness of national policy mixes.

3 Impact of PaMs on energy savings and GHG emission reductions.

To what extent did energy efficiency improve in buildings?

Data from Odyssee-MURE (2015) and the EPBD evaluation (2016) show that the energy efficiency for heating and cooling has improved since 2000 at the EU level in the household sector as well as in the services sector. Concerning the residential sector, this is mainly linked to the energy efficiency improvement for space heating and electrical appliances. The impact of new buildings on the energy performance of the total stock is however limited, given the small share of new dwellings built every year. Although after 2006, the application date of the EPBD, a clear positive change of trends in the EPBD is observed in the household sector, the economic downturn had a clear impact, which is strongly reflected in the evolution of the energy intensity in the services sector.

How did PaMs contribute to improvements in energy efficiency across Member States?

The EEA PaM and the MURE database provide scattered evidence that energy efficiency policies contributed to energy efficiency in buildings. There are several reasons for this. First is that not for all PaMs quantitative information is available on the ex post impact. Second is that how impact is expressed (e.g. energy (kWh), energy efficiency (GJ/m²), GHG emissions (t CO_2) or output (number of applications)) and how this is calculated can be very different. Finally, it is also very difficult to determine the effectiveness of the individual instruments in a policy mix, due to interactions between the individual policy instruments and the long history of policy intervention.

A top down approach could be more appropriate in this case. Several studies showed that energy efficiency policy can be a strong driver of energy efficiency improvements in the EU. An econometric study of JRC (Bertoldi and Mosconi, 2015) indicates that in the absence of energy policies, energy consumption in EU-28 and Norway would have been approximately 11 % higher in 2013. Apart from policies, there can be several other explanations that drive energy efficiency improvements. These autonomous trends are energy efficiency improvements that occur because of - for instance - technological improvements that are driven by inherent economic processes, increasing energy prices etc. Panel data studies indicate that when financial incentives (private or public) and subsidies are taking into account explicitly, they have a positive impact on the probability to undertake energy efficiency improvements. However, when evaluating their effectiveness, the presence of free-riding turns out to be a problem: a significant number of people would have undertaken the energy efficiency upgrading measures anyway, even without the incentives. These analyses make it clear that it is difficult to get a transparent view on the causal relationship between energy efficiency and the implemented individual policy instruments nor the policy mix as a whole within a Member States.

3.1 To what extent did energy efficiency improve in buildings?

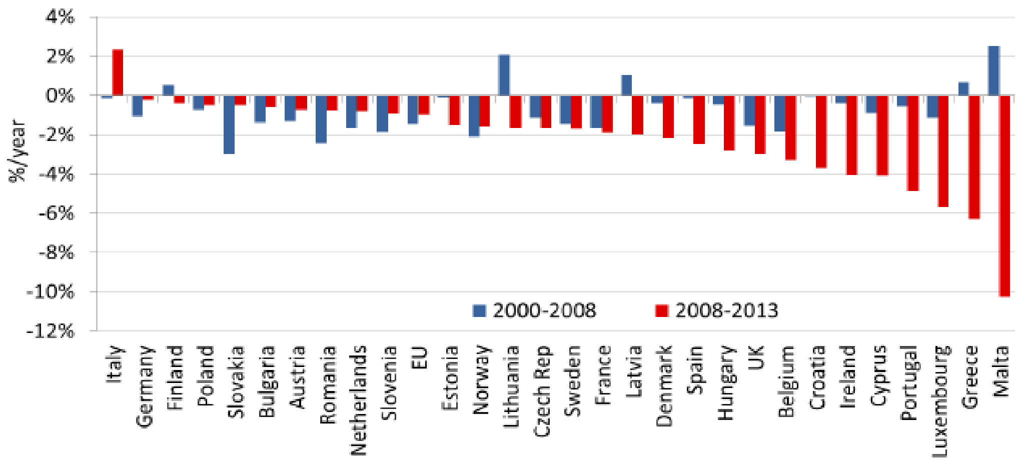
3.1.1 Overview from literature

The next paragraphs describe the historical evolution of energy efficiency in the building sector, mainly linked to heating and cooling, as can be found in literature. A common understanding concerning the effectiveness or outputs/impact of the PaMs for the buildings sector, is that it is very difficult, if not impossible, to determine the effectiveness of the individual instruments in a policy mix, due to interactions between the policy instruments.

Household sector

In the household sector, the energy efficiency has improved by 1.8 % per year at EU level since 2000, thanks to the energy efficiency improvement for space heating (renovation, more efficient new dwellings and heating appliances) and the diffusion of more efficient new electrical appliances (e.g. labels A+ to A++). The household energy consumption per dwelling has been decreasing regularly in most countries since 2000 (1.5 % per year at EU level, Odyssee-MURE, 2015). This trend is explained by energy efficiency improvements driven by various types of policy measures and higher energy prices since 2004 (+64 %) and, since 2008, by the recession (household income at the same level in 2012 as in 2008). The energy efficiency improvement is above the target of 1 % per year requested in the Energy Services Directive over 2008-2016 for all final users, but in line with the new target of 1.5 % per year additional savings included in Article 7 of the EED. The same decreasing trend in household energy consumption is observed in most EU countries, with a very strong reduction since 2008, by above 4 % per year, in some countries (e.g. Ireland, Cyprus, Portugal, Luxembourg and Malta), as illustrated in Figure 3.1 (Odyssee-MURE, 2015). This increase can be explained by the economic recession but also policy intervention.

Figure 3.1 Trend in the household energy consumption per dwelling.

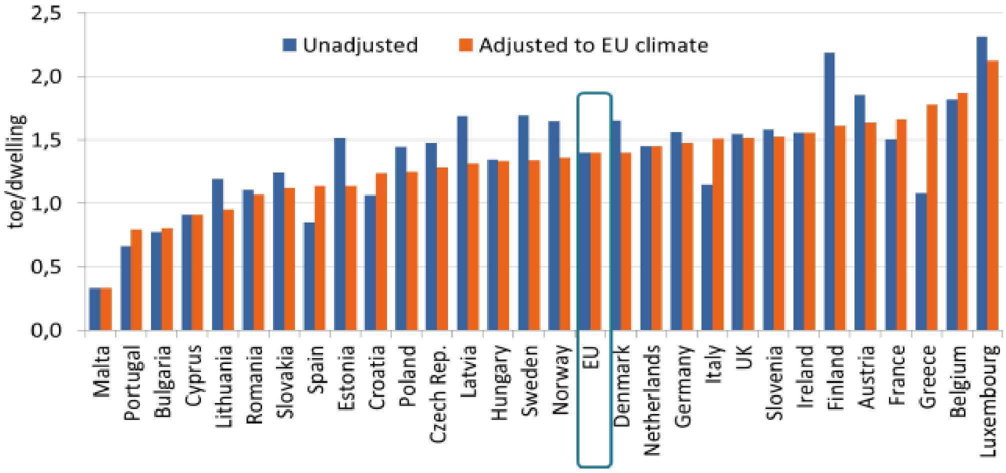


Note: Consumption at normal climate.

Source: Odyssee-MURE, 2015.

A comparison between countries is most relevant if the heating consumption is adjusted to the same climate. After adjustment to the EU average climate, Luxembourg and Belgium turn out to have the highest consumption, at around two toe/dwelling (i.e. 23 000 kWh), compared to 0.8 toe (9 300 kWh) in Portugal and Bulgaria (Odyssee-MURE, 2015) (Figure 3.2).

Figure 3.2 Household energy consumption per dwelling (2012).



Note: Data is climate corrected, except for Malta and Cyprus given their low number of degree days[8].

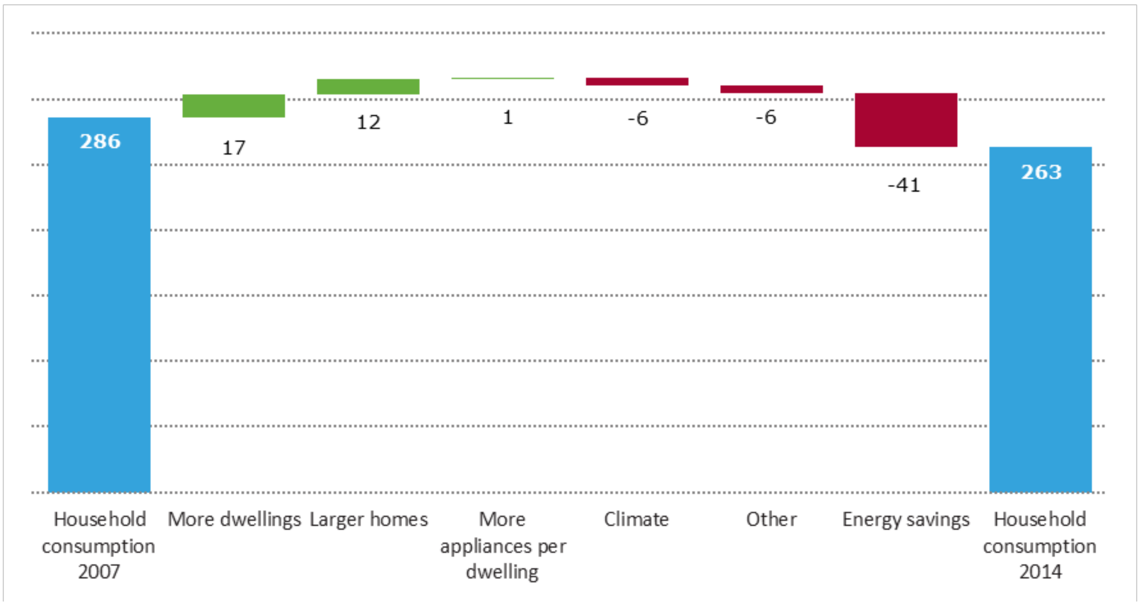
Source: Odyssee-MURE, 2015.

According to building regulations, new dwellings consume now in theory 40 % less than dwellings built before 1990, on average at EU level. The impact of new dwellings on the energy performance of the total stock is however still limited as the annual number of new dwellings built every year corresponds on average to 1.1 % of the dwelling stock (average over 2000-2012). This ratio has even been decreasing since 2009 with the economic crisis. Dwellings built since 1990 now represent 23 % of the total stock (anno 2013) (Odyssee-MURE, 2015). Therefore, standards for new buildings have contributed to reducing the average unit consumption of the dwelling stock in the EU as a whole by 0.5 % per year on average between 1990 and 2014 (EEA, 2016b).

The increasing number of dwellings and appliances contribute to raise the household energy consumption. As indicated, their effect is however counter balanced by the energy efficiency improvements. Without these savings, the energy consumption of households would have been 60 Mtoe higher in 2012 at EU level (Odyssee-MURE, 2015). The evaluation of the EBPD (EC, 2016) estimated that the positive effects of this Directive are energy savings of 48.9 Mtoe up to 2014 compared to the 2007 baseline of the EPBD, of which 41.4 Mtoe in the residential sector (36.6 Mtoe for space heating only). These numbers are in line with the 2008 EPBD Impact Assessment, indicating that the Directive is likely to deliver the expected 60-80 Mtoe energy savings by 2020. These savings were estimated by means of decomposition analysis of the changes of households' consumption between 2007 and 2014 (based on Odyssee database). Figure 3.3 shows the results for the household sector, where the factor 'energy savings' reflects the impact of EU and national energy efficiency policies.

[8] Climatic corrections are done in a linear way on the space heating or cooling consumption on the basis of the ratio between average degree days and the annual degree days.

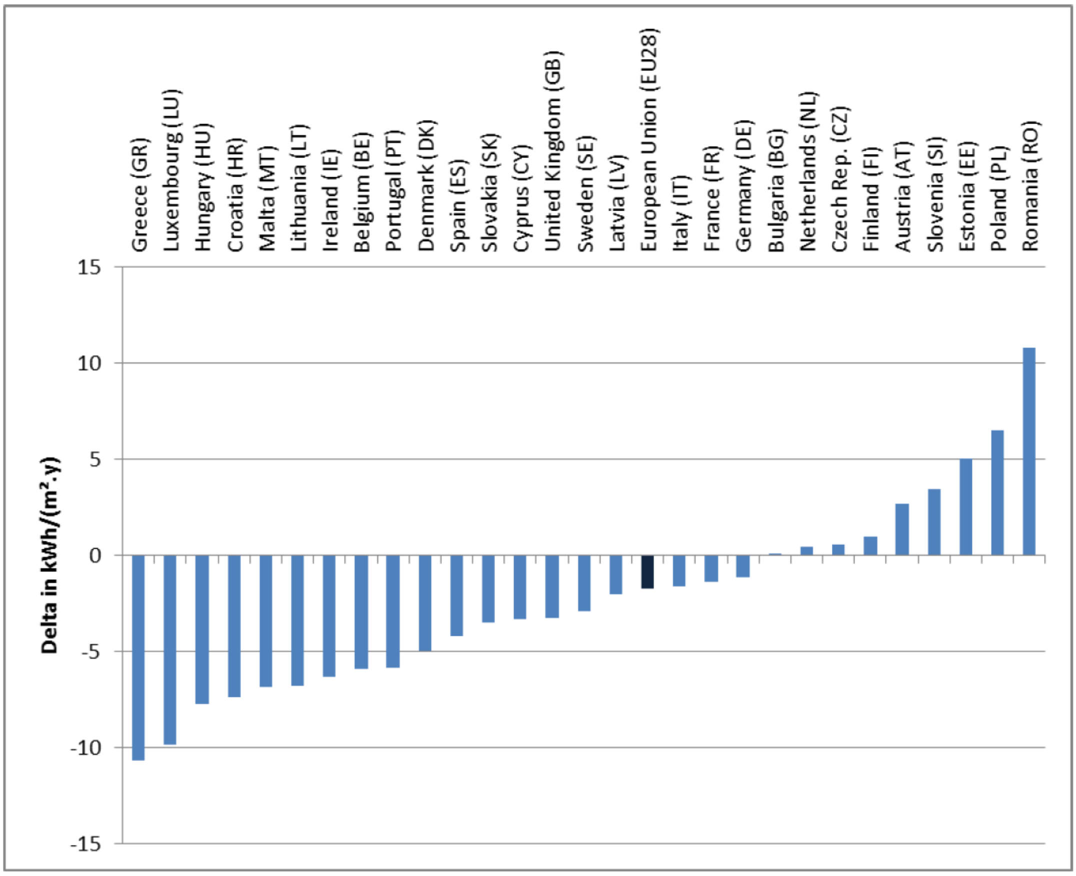
Figure 3.3 Decomposition of the variation of households' consumption 2007-2014 - European Union (in Mtoe).



Source: Odyssee-MURE, 2017.

After 2006, the application date of the EPBD 2002/91/EC, a clear positive change of trends in the energy performance of buildings (final energy consumption per square meter) is observed (Figure 3.4). This observation varies across Europe. The few Member States where an opposite change is observed had seen improving energy performance before 2006 (EC, 2016).

Figure 3.4 Difference in the change of the evolution trend of the annual final energy consumption per square meter in the residential sector, between the trend observed after 2007 and the trend observed before 2006.



Source: EC, 2016.

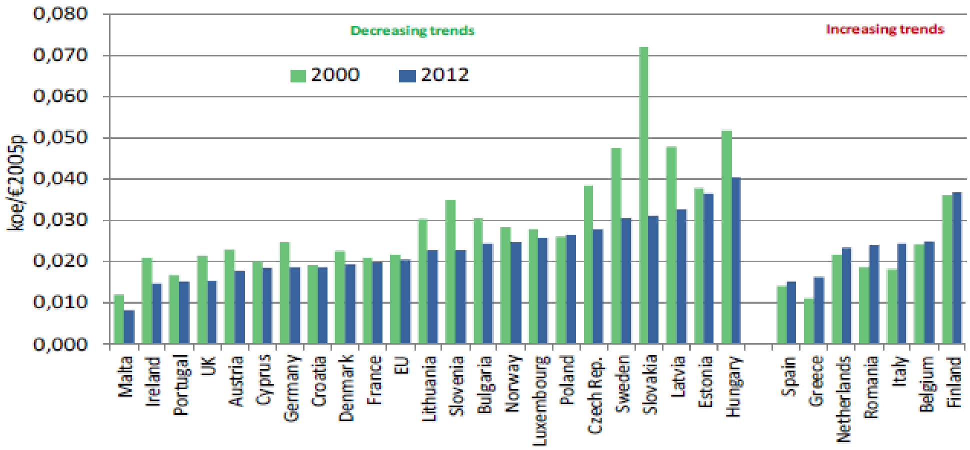
As shown, in most Member States, the trend changed towards delivering more energy savings per square meter per year, meaning that the observed decrease is quicker after 2007 compared to the pre-2006 general trend, sometimes much more significantly than the EU average change of trend (EC, 2016) The EPBD evaluation stresses that, despite the fact that the change of trend seems to coincide in terms of timing with the application of the EPBD, other EU policies working in synergy with the EPBD may have influenced the observed trends, e.g. national measures including those adopted pursuant the Energy Services Directive. On the other side, by requiring the setting of minimum standards, the EPBD is also having an influence on the effectiveness of these other measures. This makes it impossible to precisely segregate and quantify a specific contribution of the EPBD to these savings.

Services sector

In the services sector, energy consumption increased rather rapidly until 2008, by 2.5 % per year between 2000 and 2008 at the EU level; then it has been decreasing since the economic downturn, by 1.5 % per year. But, electricity consumption has continued growing since 2008, albeit at a slower pace (1.1 % per year, against +3 % per year before), despite a very limited economic growth (as expressed in added value, Odyssee-MURE, 2015). This increasing trend observed in almost all EU countries can be ascribed to the increased use of air conditioning in southern European countries, the use of information and communication technology and other office equipment in general (EEA, 2016b).

The energy intensity, i.e. the ratio of energy consumption to value added, has decreased in almost three-quarter of the countries, with a larger reduction for countries which had a high intensity in 2000 (see Figure 3.5). On the other hand, energy intensity has increased in Greece, Italy and Romania (by over 2 % per year).

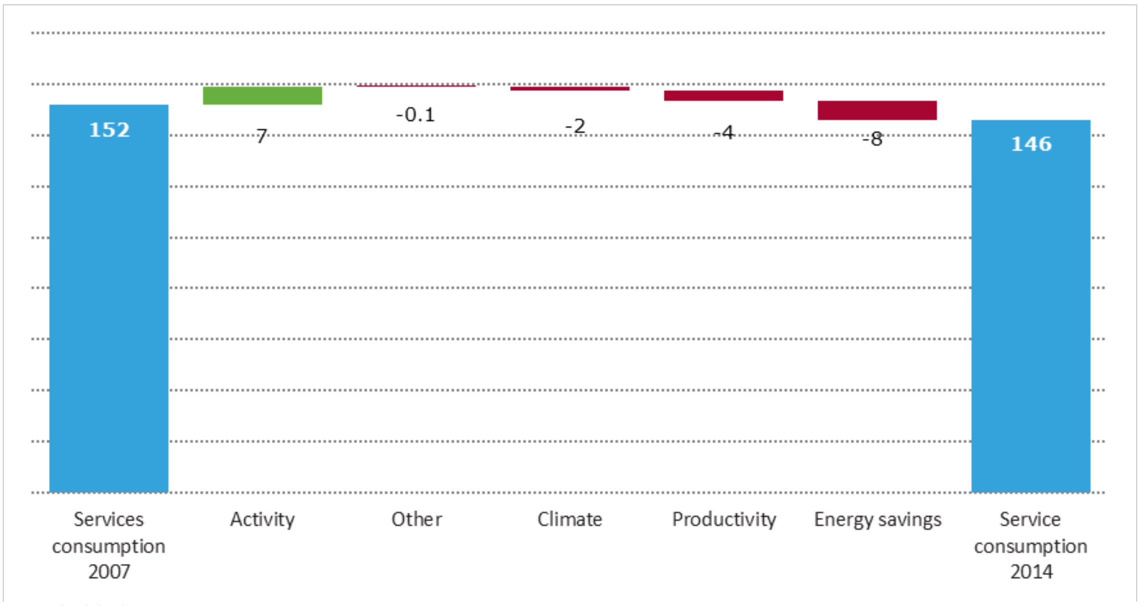
Figure 3.5 Energy intensity in services sector.



Source: Odyssee-MURE, 2015.

The evaluation of the EPBD (Commission, 2016) estimated that the EPBD, amongst others EU policies, resulted in 7.5 Mtoe energy savings in the services sector between 2007 and 2014. Based on the Odyssee database, Figure 3.6 shows that energy savings (mostly from policy intervention) resulted in savings of 8 Mtoe between 2007 and 2014.

Figure 3.6 Decomposition of the variation of services sector consumption 2007-2014 - European Union (in Mtoe).



Source: EC, 2016.

3.1.2 Lessons learned from case studies

Energy efficiency of buildings is improving across the EU-28 and the collected evidence suggests that this is also the case for all case studies. In all the case studies the energy efficiency of buildings, especially in the residential sector, improved either expressed per m² or per dwelling. In Bulgaria, progress appears to have been relatively lower than the EU average, while for the other cases the progress has been similar or better than the EU average.

There are however differences in the outcome on energy consumption. In some countries, energy efficiency improvements appear to have had a positive impact on total energy consumption in buildings. In France, the Netherlands, and Sweden energy consumption for household space heating is decreasing since 2000. For the other Member States, the energy efficiency improvements did not result in notable changes in energy consumption for heating and cooling. This is the case for Bulgaria, Cyprus, and the Czech Republic. The impact of energy savings from energy efficiency are largely or completely offset by increased demand because of increases in building stock or the size of buildings. This is particularly the case for the Czech Republic and Cyprus.

Based on the decomposition data from Odyssee-MURE, top down energy efficiency improvements after 2010 have been slower after 2010 than before 2010 in Bulgaria, Cyprus, Czech Republic and Sweden. In France and the Netherlands energy savings from energy efficiency continue to increase after 2010. Bottom up calculations typically result in higher savings from energy efficiency than top down approaches (from the decomposition analysis).

3.2 How did PaMs contribute to improvements in energy efficiency across Member States?

3.2.1 PaM Database

The EEA PaM database covers quantitative information on the impact of the PaMs on relevant indicators to monitor progress and on *ex post* and *ex ante* GHG emission savings. Information on indicators and *ex post* emission savings are not reported often by the Member States. On indicators, quantitative information is available for 52 single existing PaMs (and 91 indicators), which represent 25 % of all existing energy efficiency PaMs in buildings. These indicators are different among Member States and are in most cases calculated energy or emission savings from implemented measures, the number or total floor area of renovated buildings or the number of applications for a certain PaM.

For 102 single PaMs and 20 grouped PaMs (linked to improved energy efficiency of buildings) *ex ante* emission savings are reported. The total impact on emission savings from these PaMs in 2020 was estimated to be 95 Mt CO_2-eq. from single PaMs and an additional 24 Mt CO_2-eq. from grouped PaMs. This does not mean that these savings are only achieved by energy efficiency improvements in buildings as PaMs, and especially grouped PaMs, could combine the impact of instruments in several (sub)sectors. As the PaM reporting is linked to reporting on GHG emission projections, there is a good link between the implemented and planned PaMs and future trends in GHG emissions.

3.2.2 MURE database

In the MURE database, quantitative estimates of PaMs on energy savings are also included for 82 PaMs[9] or 32 %. This is mostly *ex post* data. As in the EEA PaM database, used methodologies and the counterfactual can be different and this complicates comparing and combining information, between the databases as well as between PaM within a Member State. It is also not possible to easily aggregate information for the EU-28 as this information is presented in separate web pages or pdf files for each PaM.

[9] Not in all cases where the MURE database reports that quantitative data is available is this also the case.

3.2.3 Overview from literature

In the previous paragraphs, it is clearly showed that there are several factors affecting energy consumption for buildings, some increasing the energy consumption (e.g. number of buildings) and others decreasing energy consumption (e.g. energy efficiency improvements or behavioral changes). Energy savings caused by improvements in energy efficiency are the largest contributor to decrease energy consumption in buildings in the EU-28. Apart from policies, there can be several other explanations that drive energy efficiency improvements or the realized energy savings. These autonomous trends are energy efficiency improvements that occur because of - for instance - technological improvements that are driven by inherent economic reasons to reduce (energy) costs, exacerbated by increasing energy prices. The effectiveness of policies or policy packages will be different for different groups of households and home owners, as for each group quite different drivers and barriers may be at play (Laes et al., in press). Owner-occupied single family homes are generally more likely to take up carbon mitigation measures as they are more involved in the choice and design of such measures and have less organizational barriers to consider (e.g. split incentives, collective decision-making and financing).

Econometric and panel data studies exploit the observed heterogeneity in policies in order to investigate how policies and energy prices – including energy taxes – have influenced energy efficiency, together with other determining factors such as household income, population, heating degree days, etc. (Laes et al., in press). Everything else being equal, higher energy prices are found to lead to lower energy demand, higher energy efficiency or lower carbon intensity for the residential sector. However, the corresponding elasticities imply an inelastic demand, meaning that an increase in the energy price leads to a less than proportional fall in energy demand, or a much less than proportional increase in energy efficiency. As can be expected, the studies find that in the long term the price sensitivity is higher, reflecting that people have more options to adapt in the longer term. Nevertheless, also the long-run elasticities point to an inelastic demand. Some studies also include a trend variable capturing factors such as autonomous technological progress, fuel switching or structural effects (for example the preferred indoor temperature or the time spent at home). In Broin et al. (2015) the trend indicates a reduction in space heating energy demand per square meter of 1 % to 2 % per year of which these trend variables would account for a reduction of space heating demand of 0.5 % for Sweden and 0.7 % for the UK. Several studies showed that energy efficiency policy can be a strong driver of energy efficiency improvements in the EU. For example Bertoldi and Mosconi (2015) performed an econometric study, linking data from the MURE database to energy efficiency improvements, and found that in the absence of energy policies consumption in EU-28 countries and Norway would have been approximately 11 % higher in 2013. Filippini et al. (2014) found that financial measures have the highest impact on energy efficiency. Information measures, which contain labelling, surprisingly lead to a lower energy efficiency. The authors point to the rebound effect, associated to a more intensive use of energy-saving equipment, as a possible explanation. Among the regulatory measures, the performance standards of buildings, heating systems and appliances have a positive effect on energy efficiency, but less so than financial measures. The authors refer to the longer penetration time of the regulations as they apply to new buildings. (Broin et al., 2015) found that regulatory policies have an immediate impact from the first year of implementation onwards. This type of measures is found to have a consistent impact over the years. Financial policies only have a small impact in the year of introduction and require a number of years before having a significant impact. No statistically significant impact was indicated for information policies.

When financial incentives (private or public) and subsidies are taking into account explicitly, most of the studies find that they have a positive impact on energy efficiency improvements (Laes et al., in press). However, when evaluating their effectiveness, the presence of free-riding turns out to be a problem: a significant number of people would have undertaken the energy efficiency upgrading measures anyway, even without the incentives. For information policies the quantitative evidence is still limited: panel data studies find no or a negative impact (Laes et al., in press). This finding however does not necessarily imply that information policies are useless as the panel data studies do not allow for a detailed analysis of different types of informational approaches.

It is clear that it is difficult to get a transparent view on the causal relationship between energy efficiency and the implemented individual policy instruments nor the policy mix as a whole within a Member States. Vringer et al. (2016) mentions that well-designed policies can result in substantial energy savings. They indicate that:

- Voluntary agreements can be effective, especially in situations in which regulations are difficult to enact or enforce.
- Labelling, information dissemination and training may increase awareness and improve know-how about energy efficiency measures.
- Government funded research, development and demonstration ultimately will contribute to the development of new energy efficient technologies.
- Implementing minimum efficiency standards can be a very effective strategy for stimulating energy efficiency improvements on a large scale, especially if these are updated periodically.
- Financial incentives may increase the adoption of energy efficiency measures. But financial incentives should be carefully designed, avoiding costly efforts that have little or no incremental impact on the marketplace. One way to avoid this outcome is to provide incentives for newly commercialized technologies, in particular those with high first cost but good prospect for cost reduction as demand grows, production expands, and learning occurs.

3.2.4 Lessons learned from case studies

In their NEEAP, Member States report the impact of energy efficiency improvements on final and primary energy consumption. Some Member States also report the impact of individual energy efficiency PaMs. This makes it possible to look closer to realized *ex post* energy savings (and in some cases even avoided GHG emissions) of PaMs. However, the low availability of *ex post* evaluations and the strong diversity in ways of calculating and expressing savings or efficiency improvements makes any comparison difficult.

Additionally, the top down calculation method for energy savings in the NEEAP is not very conservative. It quantifies energy efficiency improvements since 2007 and multiplies this with relevant activity variables. It is well known that energy efficiency improvements can have impacts on the activity as well, known as rebound effects. For example, the rebound effect results in more km being driven with a more energy efficient car. In the top down calculation methodology of the NEEAPs this effect is added to the energy savings. For buildings the effect on the calculated energy savings is however less important as it is for transport or industry.

The scarce information that is available on the impact of energy efficiency PaMs shows that:

- Bulgaria: in 2016 savings from energy efficiency in buildings (2060 GWh) corresponding to approximately 6 % of total final energy consumption in the residential and services sector[10].
- Cyprus: in 2013 savings from energy efficiency in buildings (measures related to EPBD only) corresponding to approximately 15 % of total final energy consumption in the residential and services sector.
- Czech Republic: in 2014 savings from energy efficiency in households and services (including electricity) corresponding to approximately 8 % of total final energy consumption in these sectors.
- France: in 2014 savings from energy efficiency in buildings corresponding to approximately 10 % of total final energy consumption in the residential and services sector.

[10] As Eurostat data for 2016 is not yet available, the average final energy consumption over the period 2007-2015 is used as comparator.

- The Netherlands: in 2015 savings from energy efficiency in buildings corresponding to approximately 7 % of total final energy consumption in the residential and services sector, when compared to 2007. This increases to 13% when compared to 2000.
- Sweden: in 2016 savings from energy efficiency in buildings corresponding to approximately 20 % of total final energy consumption in the residential and services sector. The impact of measures related to heating only amount to a 10 % share of total final energy consumption.

Comparison among countries is again difficult because of differences in approach (bottom up versus top down estimates), time periods and the scope of the assessment (heating in buildings only to all energy consumption in residential and services sector).

The decomposition analysis of Odyssee does make it possible to have a more consistent overview for each of the case studies. This shows that in 2015 total energy consumption for heating in households would be 60 % (Sweden), 58 % (the Netherlands), 43 % (Cyprus), 40 % (France), 38 % (Czech Republic), and 15 % (Bulgaria) higher if energy efficiency would be at the level of 2000. While evidence is only circumstantial, energy efficiency policy has contributed significantly to this.

4 Coherence of the policy mix

Because of the different market failures and political constraints in the built environment, an ideal policy package should target all relevant actors, establish mechanisms to overcome actor-specific barriers and guarantee a reinforcement of the different instrument among each other. Crucial ingredients to realize effective policy mixes comprises a holistic policy roadmap, proper infrastructure and funding, besides proper energy prices, minimum performance standards prepared by education and training of the different market actors, tackling information deficits and giving financial incentives to realize a broad market introduction of low energy buildings.

Literature evidence shows that in the energy efficiency domain already multiple instrument types are used for the same target group or sub-sector (Rosenow et al, 2016). Union policy is a driver for this, enforcing Member States to implement different instrument types in the energy efficiency domain to comply with Union policies. As can be expected, the case studies show that countries with many PaMs also have a more complex policy mix, but the relationship is not one-to-one. The Czech Republic appears to have less instrument types than Bulgaria although the number of PaMs does not differ much. The dominance of financial and legislative instrument types is evident in almost all target groups. These can have a neutral or negative impact on the effectiveness of the policy mix. In the case studies, combinations are also used of instrument types that have a complementary impact, such as financial instruments and information campaigns. Taxes are not included in the policy mix of all cases, although it could have a reinforcing impact on the effectiveness of all other instrument types.

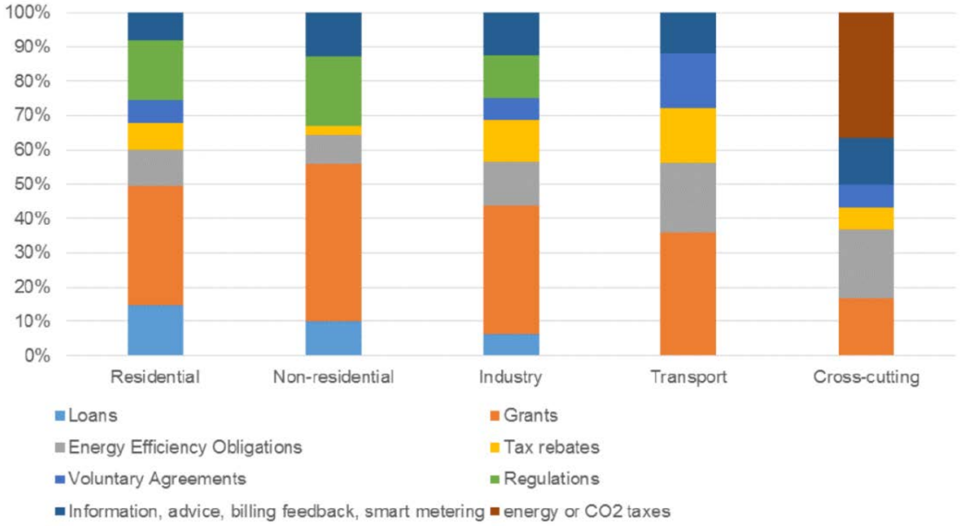
4.1.1 Overview from literature

As the evaluation in this paper comprises a set of different individual instruments to improve building energy efficiency, coherence for this analysis is limited to the internal coherence of the policy mis, e.g. how different energy efficiency policy instruments interact with one another and how these policy instruments address different barriers and actors to achieve the overall objective, namely energy efficiency improvement. It does not cover external coherence with Union policies or with policies with an objective outside the scope of the analysis (for example reducing energy poverty). It has long been recognised that a set of different energy efficiency policies rather than just one single instrument is needed to address a particular policy goal (Rosenow et al., 2017). While energy policy is probably the domain most studied from a policy mix perspective, for energy efficiency this has still been done scarcely in comparison to the evaluation of individual instrument (Rosenow et al., 2017). Moreover, many studies have focused on the interaction of two or more policy instruments, rather than provide an overview of the policy mix in countries or the EU.

The evaluation of coherence is usually based on qualitative data, and needs to take into account the policy-making process, communication and cooperation between authorities, and direct and in-direct effects of related policies (EEA, 2016a). Quantitative data, for example on GHG emission reductions from related policies, can be used to judge the magnitude of the impact and the overlap between policies although this information is largely missing.

Studies looking into the energy efficiency policy mix of the EU and/or individual Member States, mostly focus on the mix of different policy instruments that have been implemented. Rosenow et al. (2016) and Rosenow et al. (2017) looked at energy efficiency policy mixes in the buildings sector (Figure 4.1), which is in line with the findings in section 2.

Figure 4.1 Share of instrument types implemented to improve energy efficiency in different end-sectors in the EU.



Source: Rosenow et al., 2017.

Mixes of different instrument types are considered more effective than a single instrument type as they tackle a variety of barriers. The advantage of such a policy mix is that the different instruments can reinforce each other (Vringer et al., 2016), for example by compensating for the inherent weaknesses of specific instrument types. In a combination of an energy tax and energy labelling system, for example, the tax provides a financial incentive, while labelling ensures a more transparent housing market. Interactions do not always have to be positive though and some combinations of instrument types are expected to have no or a negative impact on the effectiveness. These interaction effects of instrument types have been documented in several sources (see Figure 4.2).

Figure 4.2 Interaction effects of energy efficiency instrument types.

	Energy or CO_2 taxes	Grants	Loans	On-bill finance	Tax rebates	Regulations	Voluntary agreements	Standards and norms	Energy-labelling schemes	Information, advice, billing feedback, smart metering
Energy-efficiency obligations (EEOs)	+	–	–	–	–	0	–	+	+	+
Energy or CO_2 taxes		+	+	+	+	+	+	+	+	+
Grants			–	–	–	0	0	+	+	+
Loans				–	–	0	0	+	+	+
On-bill finance					–	0	0	+	+	+
Tax rebates						0	0	+	+	+
Regulations							–	+	+	+
Voluntary agreements								+	+	+
Standards and norms									+	+
Energy-labelling schemes										+

Source: Rosenow et al., 2016.

To have an understanding of the policy instruments that are combined most often, Rosenow et al. (2016) analyzed combinations of policy instruments (only those additional to energy efficiency obligation schemes) across the building sector. They found that combinations that occurred relatively most were economic instruments (grants and/or loans) with regulations and voluntary agreements.

Kern et al. (2017) showed that in Finland and the United Kingdom more and more building related energy efficiency policies were implemented with time. This means that the policy mix has become increasingly complex, which has an impact on the evaluation of the measures. Increased interaction among policy instruments means that individual evaluation of measures is complex and that a more integrated approach to policy evaluation of the policy mix is more appropriate (Kern et al., 2017).

There is more extensive literature on what the compilation of an ideal policy package should look like, targeting all relevant actors and establish mechanisms to overcome actor-specific barriers (Höfele and Thomas, 2011). The complexities of the building sector require that all members of the value chain act in the right direction. Consequently, barriers and incentives of all relevant actors should be identified so a targeted and coherent mixture of PaMs can be set up.

According to Höfele and Thomas (2011) and Wupertal (2013), following elements should ideally be included in a comprehensive policy package to realize savings in the building sector:

- *A policy roadmap* towards ultra-low-energy buildings should guide policy-making, with a clear timetable and targets. According to the European Insulation Manufacturers Association (Eurima) building a renovation roadmap requires the involvement from all levels of the government, market actors and stakeholder parties (BPIE, 2014). Moreover, a holistic approach - addressing the whole building stock, the whole sector and all relevant issues including technologies, construction, skills, financing, removal of legal and regulatory barriers – is also a prerequisite, besides the integrations of energy performance with broader societal goals (like employment, demographics, …).
- The *infrastructure and funding* for the other policy elements need to be in place;
- *Energy prices* should 'tell the economic and ecological truth';
- *Minimum energy performance standards* (MEPS) for all new buildings and existing buildings undergoing a major renovation, as well as for building components, heating and cooling systems. For new buildings, these standards are the most important policy, however, for existing buildings, it is much more important to accompany MEPS with individual advice as well as financial incentives/financing for meeting the MEPS requirements, since otherwise building owners may wait with major renovations. Preferably, other statutory requirements such as individual metering, energy management for larger buildings, or regular inspections of heating, ventilation, and air conditioning systems should complement the legal framework to ensure energy-efficient operation of the buildings.
  The standards should be created by law and strengthened step by step every three to five years. MEPS reduce transaction costs as well as address the landlord-tenant and developer-buyer dilemma by removing the least energy-efficient building practices and concepts from the market. In order to be effective, compliance with MEPS must be controlled at the local level.
  A step in MEPS regulation should be prepared by *education and training of architects, planners, developers, builders, contractors, lenders and other market actors,* to increase renovation rates, further strengthening of MEPS and ensure high qualitative, energy-efficient buildings;
- The markets should, furthermore, be prepared for strengthening of MEPS regulation through policies tackling the substantial information deficits and financing barriers. These include *building energy performance certificates* (and energy labels for components where useful), showcasing of demonstrated *good practice buildings, advice and financing support for investors, and financial incentives* – such as grants and tax incentives – *for broad market introduction of NZEBs.* For the renovation of existing buildings, these type of measures are crucial in order to first move markets towards very energy-efficient retrofit levels ("deep renovation") and then to trigger energy efficient renovation i.e. to increase the retrofit rate in a member state. To raise the awareness, also individual advice, such as energy audits, should be given to building owners to show what they (or their tenants) can save and what is cost-effective.
  Concerning financial incentives, these instruments are preferably targeted to limit the number of beneficiaries (e.g. low income households, tenants) (WEC, 2016). They should also be restricted to certain types of investments (from a selected list of equipment), with a long payback time but

high efficiency gains (e.g. renewables, co-generation), or to innovative technologies (demonstrative or exemplary investments). Moreover, in areas where the cost effectiveness of technologies is not too high, subsidies should be a temporary measure to mobilize consumers with the objective of a cost reduction for the subsidized technologies. Once the critical mass has been reached, economic incentives can be reduced and even stopped without slowing down the diffusion dynamics (World Energy Council, 2016).

Additional instruments can deal with innovation support through research and development funding, demonstration (including in public buildings), award competitions , etc. The public sector should lead by example through very efficient renovations and ambitious targets for its own buildings.

4.1.2 Lessons learned from case studies

As Kern et al. (2017), the case studies show that the policy mix tends to increase in complexity with time as more and more PaMs are implemented. This is the case for all selected Member States. Only the data from the Netherlands show more dynamism with a significant number of PaMs expired and replaced by other policies. Typically there are more policies directed at the residential sector than at the services sector.

For the analysis of internal coherence, a cross table was made for all case studies of the target audience and the instrument types. This helps identify what kind of instrument types are combined. Combinations of policy instruments are now believed to be more effective than single instruments. Nevertheless, not all instruments are complementary. Theory can thus be used to see whether interactions between instrument types are likely to have a complementary, neutral or overlapping effect.

The strong dominance of legislation/regulation and financial instruments is also reflected in these cross tables, which suggests that both instrument are used for the same groups. Some financial instruments such as loans and grants are not very complementary and therefore having many similar policy instrument types targeted at the same group is not necessarily very effective. Financial and legislation instrument types might also overlap and therefore it can be expected that the outcome is lower due to negative interaction effects. This is mostly the case of the group of owners/tenants in the case studies, for example in Bulgaria, Czech Republic and France. Owners/tenants of buildings are however also often the target group of information and education instruments, which has a positive effect and reinforces the impact of financial and legislative instrument types as well as all other instrument types. Information and education appears to be used for all relevant target groups (but not often for financial institutions and energy suppliers) in all case studies.

Theory suggests that taxes are also complementary with all other instrument types, but are not used explicitly in all case studies as a tool to improve energy efficiency in buildings. As Rosenow et al. (2016) pointed out, countries take very different views on taxation of energy of different types and across different sectors. Using high taxes to stimulate energy efficiency might be politically unacceptable or not in line with other policy goals.

The cross tables for the different case studies show that the number of individual PaMs not necessarily means that a more diverse policy mix is used for specific target groups. France, which has the most individual PaMs of the case studies, also has a more diverse policy mix in the different target groups. Yet for countries with a similar number of PaMs, Bulgaria and the Netherlands appear to have a more complex policy mix than the Czech Republic.

Box 4.1 PaM reporting discrepancies

There are some reporting discrepancies between the EEA PaM database and the MURE database. These inconsistencies vary among the Member States and are concisely described below. There could be several reasons for these inconsistencies: how information is reported and whether different instruments are grouped or not into one single PaM; for the EEA PaM reporting, which is more extensive as it covers all climate mitigation measures there might be a tendency to only focus on the most important PaMs; the timing of reporting is different; and finally the people responsible for reporting might be different.

Bulgaria. The EEA PaM database includes only four PaMs, while the MURE database contains 35 PaMs. The EEA PaM database thus only includes a fraction –albeit the most important - of the energy efficiency PaMs in the building sector.

Cyprus. There is inconsistent reporting of PaMs by Cyprus to different reporting streams. The MURE database contains more PaMs than reported to the EEA under the MMR, but this may be due to grouping of numerous related PaMs for the MMR. There were also some PaMs in the MURE database but which were not in the 3rd NEEAP. As Cyprus is in the process of compiling the 4th NEEAP, this may be due to different reporting timelines.

Czech Republic. There is a broad similarity between the MURE and EEA PaM database. The PaMs in both databases are not exactly the same and some PaMs are exclusively included in either the MURE or EEA PaM database.

France. While both the MURE and EEA PaM database cover a relatively large number of PaMs, there are relatively few that occur in both databases (16 were identified in MURE and EEA database as the same). For the PaMs that are in both the MURE and EEA PaM database, information about the characteristics, such as start year and end year, do not match in all cases.

Netherlands. The MURE database appears more complete as the EEA PaM database. This is related to the fact that reporting is done at different times by different organisations or persons translation differences occur. The Netherlands is improving this: as part of the national system a central database on PAMs is implemented with the intention to have consistent names and lists for various reports.

Sweden. There is a high similarity between the PaMs included in the MURE/NEEAP and the EEA PaM database. All the important PaMs improving energy efficiency of buildings in Sweden appear to be reported similarly in both databases.

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Annexes

Introduction

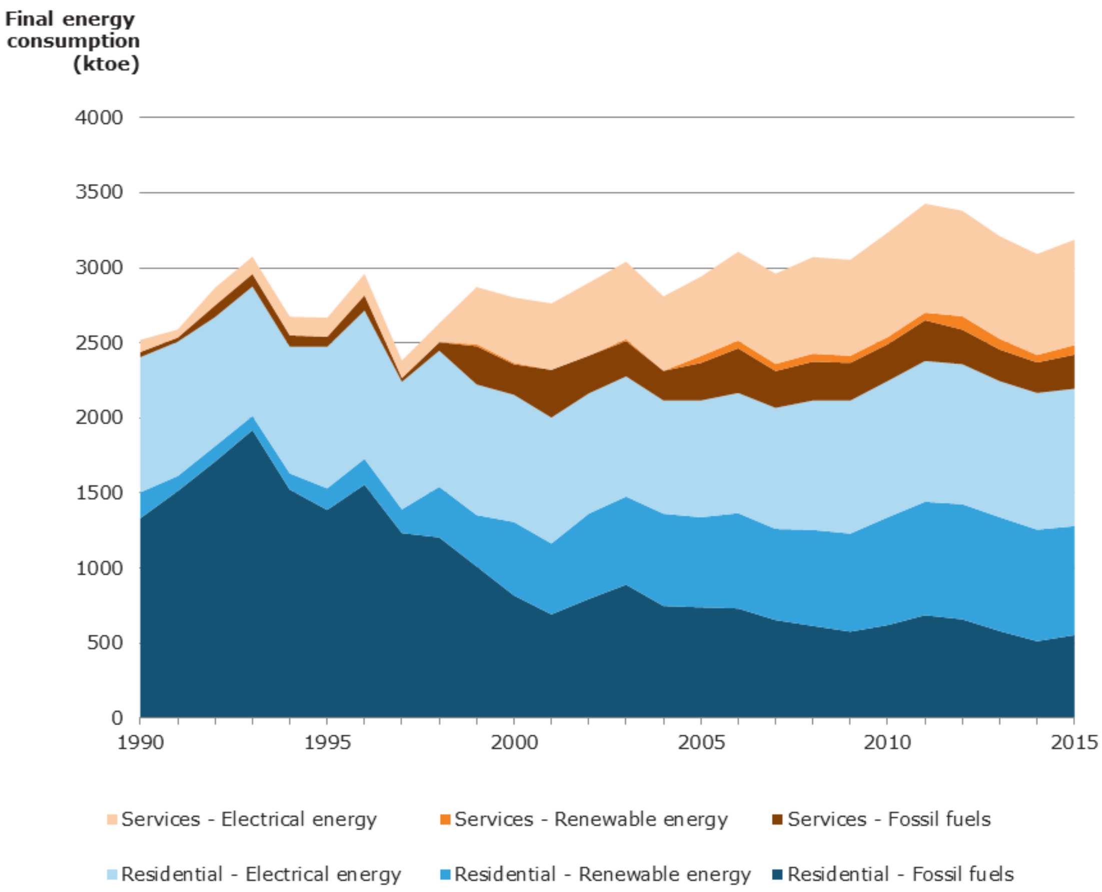
For the assessment of policy instruments in the case studies incentivising energy efficiency in buildings, this review primarily relies on information provided by the Member State through the updated fourth NEEAP, Odyssee-MURE, and under the MMR. While these sources provide the most up to date information on climate policies in Member States, issues regarding data availability limit the scope of any undertaken assessment. Consequently, a full in-depth assessment of policy coherence and their compatibility is outside the scope of this assessment. Instead, this study aims to provide a basic assessment of instruments in the different countries aimed to promote energy efficiency, discussing the current state of energy efficiency in the country, and the need for additional policy evaluation.

## Annex 1.	Bulgaria

Setting the scene: energy consumptions in buildings

According to the most recent census, as at 1 February 2011 there were 3 887 149 residential units in Bulgaria, including 3 839 342 (99 %) in residential buildings, 22 103 (0.6 %) in student hostels, 21 339 (0.5 %) in non-residential buildings, as well as 818 collective housing units and 3 547 (0.1 %) primitive and mobile units. The energy mix of the housing stock is dominated by four sources: biomass, electricity, coal and district heating. The share of electricity in the final energy consumption of Bulgarian households is among the highest in Europe, 39 % compared to an EU-27 average of 30 %. District heating remains the most efficient heating option in cities with developed heat transmission networks, despite the many controversies over the distribution, measurement and reporting of heat in the houses of final users. The service is available in 18 Bulgarian cities; just 16 % of Bulgarian citizens receive district heating services while in some EU Member States this share varies from 23 % to 64 %. Households use 74 % of the heat supplied by district heating companies (Ministry of Energy, 2017a).

**Figure A1.1	Final energy consumption of the residential and services sector in Bulgaria, 1990-2015 (in ktoe).**



Source:	Eurostat, 2017, simplified energy balances

In Figure A1.1, the total final energy consumption of the residential and the tertiary sector is given for the period 1990-2015.

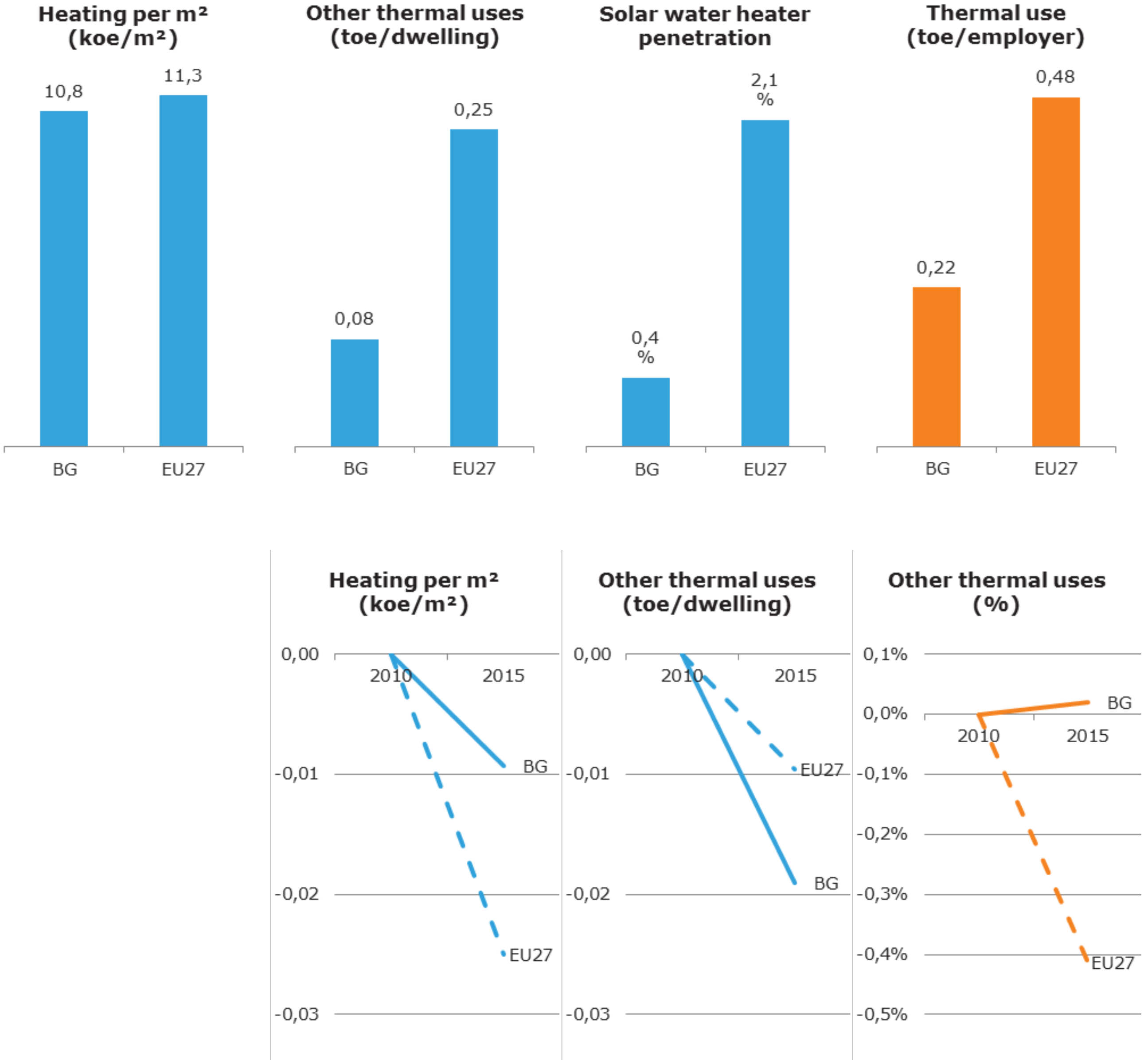
In comparison to other EU countries, the Bulgarian building stock is low-energy-consuming (Odyssee-MURE, 2017a):

- Residential sector: the average consumption for space heating amounts 7.4 koe/m² corrected for climate;
- Services sector: the average consumption per employee is 0.69 toe/employee corrected for climate.

These numbers in comparison to the best and lowest performing countries are illustrated in Figure A1.2. These graphs indicate clearly that the actual consumption for heating in the buildings sector as well as the related energy savings realized between 2000-2015 are high performing compared to other countries and the EU average.

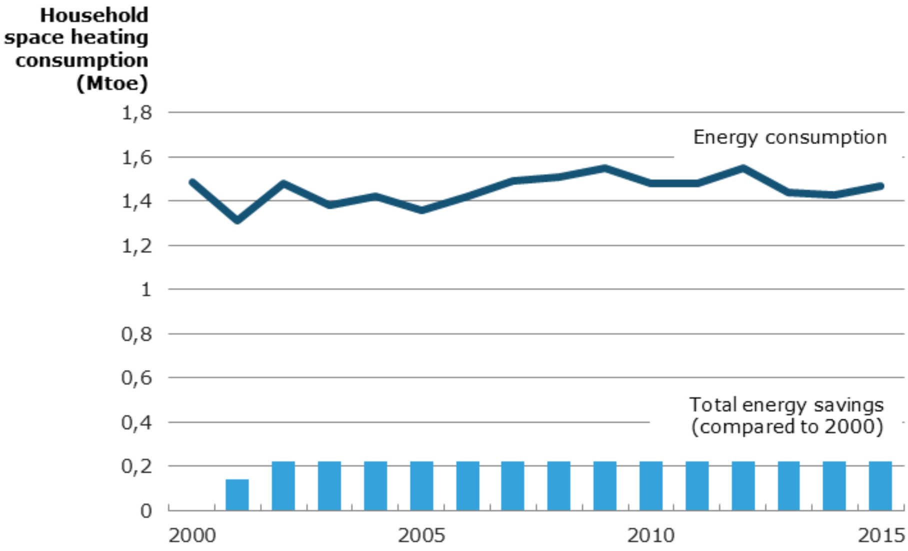
The energy consumption for heating in residential buildings shows a consistent trend in the period 2000-2015 (Figure A1.3). The decomposition analysis quantifying the impact of energy savings on total energy consumption shows that there has been little progress in energy efficiency in residential buildings (Odyssee-MURE, 2017a).

Figure A1.2 Bulgaria positioning within EU concerning the energy efficiency level (in 2000, upper graphs) and progress between 2000 and 2015 (lower graphs) for households (blue) and services sector (orange).



Source: Odyssee-MURE, 2017a, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A1.3 Energy consumption for space heating in households in Bulgaria and estimated energy savings (Mtoe).



Source: Odyssee-MURE, 2017a

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

The legal framework for energy efficiency in Bulgaria is established by the Energy Efficiency Act (ZEE). This Act was implemented in 208 to meet the requirements of the Energy Services Directive, but has since then been amended in response to the recast of the EPBD and the Energy Efficiency Directive. The act provides a clearer definition of the commitments and state support for energy efficiency development and to establish institutional, legislative and financial conditions for the realization of national policy.

The governance framework for the promotion of energy efficiency in Bulgaria is defined by the “Energy Strategy of the Republic of Bulgaria up to 2020”. The Energy Strategy is complemented by the National Energy Efficiency Strategy. At sectoral level, the national savings target has been split between obligated parties, industry, energy traders and owners of public buildings. The governance framework thus addresses different actors and different governance layers (Energy Efficiency Watch, 2013). To achieve the national energy efficiency target Bulgaria has introduced an energy-saving obligation scheme. The energy efficiency obligation scheme (implementation linked to the EED) applies to end suppliers of electricity, heat, natural gas, liquid fuels and sold fuels. To achieve the target under the EED, no alternative measures have been proposed (Ricardo AEA et al., 2016). This does not mean that Bulgaria did not implement additional PaMs to improve energy efficiency of buildings.

Sectoral PaMs

To achieve their energy efficiency target under the Energy Efficiency Directive, Bulgaria opted to only use an Energy Efficiency Obligation Scheme. Additional energy efficiency policies have been implemented to improve energy efficiency further.

A key policy providing a financial incentive to increase energy efficiency is the 'Energy Efficiency and Renewable Sources Fund'. This fund started in 2008 (focusing only on energy efficiency then) based on resources from several entities, including the Global Environment Fund and the Bulgarian and Austrian government. The Fund is operated as a commercially oriented public-private finance facility serving three major roles: lending financial resources, guaranteeing credit and providing technical assistance to enterprises, municipalities and residents. This funding has been used to create a revolving fund which by the end of 2014 has contributed EUR 23.4 million to 170 projects with a total value of over EUR 34.6 million. It has gained international recognition for its innovative approach to EE financing and consulting (CityInvest, 2017). By the end of 2013 its projects expected to have total energy savings of over 95 000 MWh per year (CityInvest, 2017).

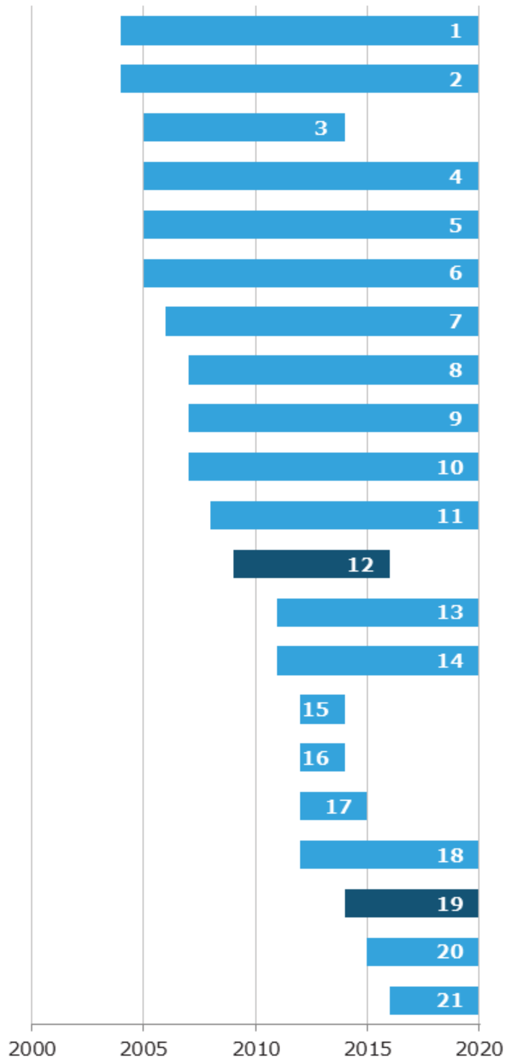
Among the PaMs identified as the most successful in the housing sector, is the National Energy Efficiency Program for Multifamily Residential Buildings renovation. Multi-family residential buildings have been a priority in Bulgaria already for a longer time (Energy Efficiency Watch, 2014).
According to a study of ICF (2015), Bulgaria has a very strong framework for minimum energy performance. The compliance rate could not be determined. Concerning energy performance certificates, Bulgaria has a strong framework.

Time frame

Based on the information about PaMs in the Odyssee-MURE database (Odyssee-MURE, 2017b) and the updated NEEAP from 2017 (Ministry of Energy, 2017b), the following history line is set up (Figure A1.4), illustrating a diversity of measures implemented to realize energy savings in the building sector (heating and cooling). Most of the reported PaMs have been implemented after 2005 and are still in operation. Only a few of the reported PaMs have ended. Both in the residential and services sectors more than 10 PaMs have been implemented. Few cross-cutting PaMs (targeting the residential and services sector or other sectors) have been implemented by Bulgaria.

Figure A1.4 History of PaMs in Bulgaria to improve energy efficiency in buildings (in bold cross-sectoral PaMs).

Residential buildings



1 Bulgarian Energy Efficiency and RES Fund with authorizing it for financing projects with renewable energy sources

2 Minimum Thermal Insulation in Buildings

3 Residential Energy Efficiency Credit Line REECL

4 Update of the requirements for the efficiency coefficient of boilers, working with liquid and/or gas fuel

5 Energy Performance Standard for Buildings

6 Building Tax Exemption

7 National Program for Renovation of Residential Buildings in the Republic of Bulgaria, 2006-2020

8 Update for the requirements and methods for design of the heating, ventilation and air-conditioning

9 Individual billing (multi-family houses)

10 Control Systems for heating regulation

11 Mandatory energy efficiency control for boilers and air-conditioning systems

12 Distribution of energy savings as individual targets for the obligated under Energy Efficiency Law persons – energy dealers

13 Introduction of Directive 2010/32/EU in Bulgarian legislation

14 Stimulating the establishment of association of the owners in the frames of Law for management of the floor property

15 Energy renovation of Bulgarian residential buildings

16 Development of National Plan for increase the number of the nearly-zero energy buildings

17 Support for energy efficiency in multifamily buildings

18 Support for energy audits in multifamily buildings at guaranteed implementation of the recommended measures

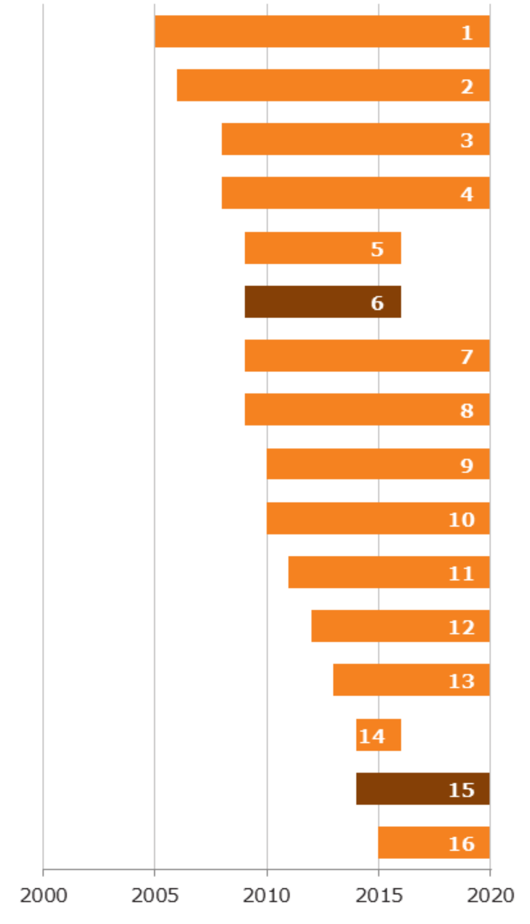
19 Energy Efficiency Obligation Scheme

20 National programme for energy efficiency of multi-family residential buildings

21 Demand Side Residential Energy Efficiency through Gas Distribution Companies in Bulgaria (Project DESIREE GAS)

Figure A1.4 *continued*.

Tertiary buildings



1 Regional Councils on Energy Efficiency

2 National Strategy for financing the building insulation for energy efficiency 2006-2020 - services

3 Mandatory energy efficiency certificates and labels for buildings - Services

4 Mandatory energy efficiency control for boilers and air-conditioning systems - Services

5 Distribution of the National Indicative Target for energy savings as individual targets for the obligated under Energy Efficiency Law

6 Distribution of energy savings as individual targets for the obligated under Energy Efficiency Law persons – energy dealers

7 Mandatory Energy Efficiency Management in buildings and annual reports for its implementation

8 Mandatory Energy Efficiency Programmes for central government and local authorities

9 Financing of energy efficiency projects in municipal buildings by Operational Program Regional Development

10 Instructions (rules) criteria related to green public procurement and select priority categories of products and services

11 Training of governmental and municipal employees for development, implementation and reporting of energy efficiency plans

12 National Plan for Nearly Zero Energy Consumption Buildings

13 Information on the published list of heated and cooled buildings of central government

14 Individual energy saving targets for owners of industrial systems, and government and municipal buildings

15 Energy Efficiency Obligation Scheme

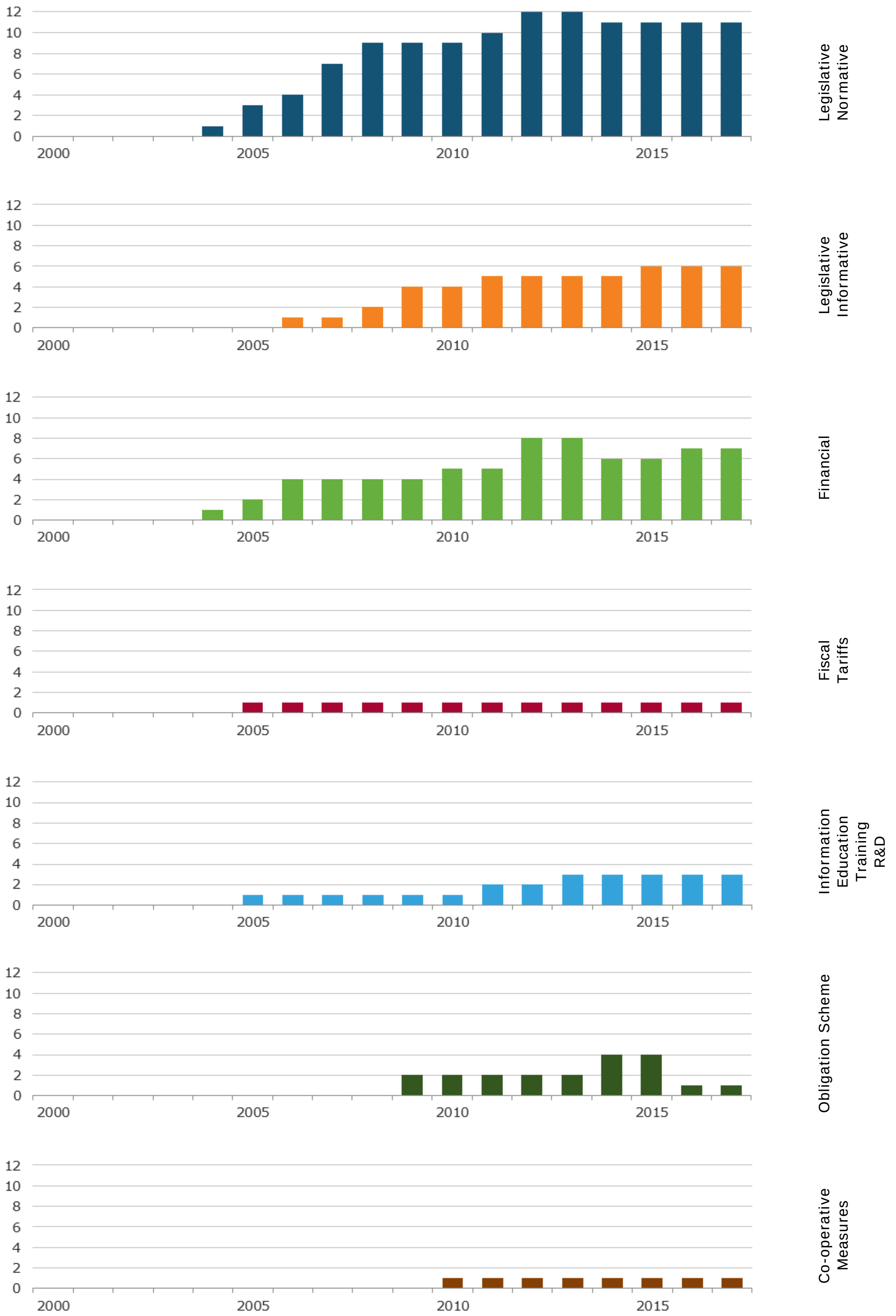
16 Mandatory annual renovation of 5 % of the total area of the central government buildings

Source: Odyssee-MURE, 2017b; Ministry of Energy, 2017b.

Instrument types

Looking closer to the implemented measures in Bulgaria, as depicted in Figure A1.5, we identify over the whole time period a strong dominance of financial, legislative/normative, legislative/informative and obligation schemes; other types of measures are only limited represented in the policy package, like fiscal and information/education/training measures shows that major part of the PaMs are implemented after 2005, which is linked to the accession to the EU in 2007. In the Odyssee-MURE database, updated with the fourth NEEAP submission, 19 out of 35 measures are directly linked to an EU Directive, more specifically to the EPBD, Energy Services Directive and the EED.

Figure A1.5 Evolution of type of PaMs in Bulgaria.



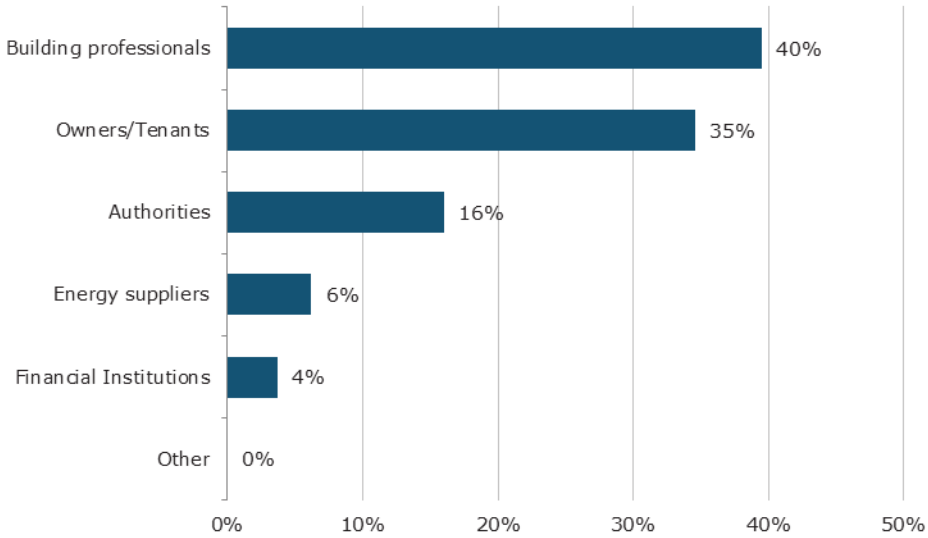
Source: Odyssee-MURE, 2017b; Ministry of Energy, 2017b.

Target audience

Concerning the target audience (Figure A1.6), building professionals, the general public, professional associations, owner-occupiers and local authorities are mainly addressed. Nevertheless the predominance of these five audiences, the graph shows a strong diversity in the target audience over the whole time period.

'Other' target groups are not reported by Bulgaria. This group consists of target groups such as SMEs, students, research organisations and employers/employees.

Figure A1.6 Target audience in Bulgaria.



Source: Odyssee-MURE, 2017b; Ministry of Energy, 2017b.

The impact of PaMs on energy savings and GHG emission reductions.

National evaluation framework

In the *NEEAP*, Bulgaria estimates the impact of energy efficiency policies with a mixture of bottom-up and top-down methods. The top-down method is based on the generic methodology recommended by the European Commission. These calculation are part of the analysis of the energy efficiency situation in Bulgaria drafted by the Agency for Sustainable Energy Development (AUER; Ministry of Energy, 2017b).

The bottom-up calculation method is used to estimate the energy savings achieved as a result of the implementation of specific measures, projects, and programmes included in the NEEAP. This is based on:

- Savings declared by the relevant parties in their annual reports submitted to AUER, as set out in national legislation;
- Data reported by the responsible institutions and managing bodies of operational programmes on economic measures for energy efficiency improvement;
- Data collected by AUER of energy audits and energy efficiency measures.

Verification of the achieved energy savings calculated based on bottom-up methods is regulated by the Ordinance "on the methods of establishing the national energy efficiency target and of determining the overall cumulative target, introduction of a scheme for energy savings obligations, and allocation of individual energy savings targets between obligated parties".

The reporting in the context of the *Monitoring Mechanism Regulation*, provides no details on how PaMs on energy efficiency are evaluated and on the methodologies that have been used.

Ex post *impact of energy efficiency PaMs in buildings*

The *ex post* impact of energy efficiency measures in buildings have been reported in the NEEAP. *Ex post* impacts have been assessed with bottom up assessments. The energy efficiency obligation scheme in Bulgaria resulted in average energy savings of 909 GWH per year (2008-2010), 934 GWH/year in (2011-2013), and 558 GWH/year (2014-2016). These savings are not necessarily achieved only in the building sector. For the building sector, Bulgaria reported energy savings amounting to 2060 GWh in 2016 (Table A1.1). The measures with the largest impact are the obligatory audit and certification of buildings for public servicing and buildings of public administrations.

The report on climate PaMs under the MMR includes an *ex post* assessment of the impact of two energy efficiency policies in the building sector on GHG emissions. The first is the policy “renovation of communal, public and state buildings at the percentage rate required by the Directive 2012/27/EU (built up area over 250 m^2)”. This policy aims to improve the energy efficiency of public buildings. The estimates emission savings in 2014 are 448 kton CO_2-eq. The second PaM is a regulatory and financial incentive to replace inefficient equipment for production of energy with new equipment. This policy resulted in an emission saving of six kton CO_2-eq. in 2013.

Table A1.1 Cross table of target audience and type of PaM in Bulgaria.

Title of the Measure	*Energy savings until 2016, GWh/y*	*Projected effect 2017-2020, GWh/y*
Implementation of measures after an obligatory audit and certification of buildings for public servicing	873.6	388.4[13]
Implementation of energy efficiency improvement measures after an obligatory audit and certification of buildings of public administration	833.2	358.8[13]
Annual renovation of 5 % of the total TFA of all heated and/or cooled state-owned buildings used by public administration	83.9	The evaluation is made annually and is included in the analysis of the implementation of NPDEE
Financing projects of the Energy Efficiency and Renewable Sources Fund in buildings	6.3	The evaluation is made annually depending on the number of financed projects and is included in the analysis of the implementation of NPDEE
Energy efficiency credit line for households	34.1	The evaluation is made annually depending on the number of financed projects and is included in the analysis of the implementation of NPDEE
Implementation of projects under Operational programme 'Regional Development' 2014-2020	140.6	The evaluation is made annually depending on the number of financed projects and is included in the analysis of the implementation of NPDEE
Implementation of projects under the National programme for energy efficiency of multi-family buildings	88.2	924.7

Source: Ministery of Energy; 2017b.

Coherence of the policy mix

The results in the section above show that a variety of instrument types targeting a diverse audience has been implemented in Bulgaria to improve the energy efficiency of buildings. To have a better indication of the coherence of the PaMs package, a cross table of both parameters indicates whether a variety in type of measures also holds true per type of target audience. Table A1.1 shows that the financial and legislative/normative measures are targeted to a rather broad audience, the same holds true for legislative/informative and education/information/training measures although the latter type of PaMs are less frequent implemented.

In the Odyssee-MURE database, a 'Policy Interaction Tool' is available, enabling to characterize interaction of packages (Odyssee-MURE, 2017b). For the buildings sector in Bulgaria, the level of interaction is suggested for the different types of measures, ranging from strong reinforcement, not interacting to a strong overlap. In Table A1.2, this cross table is presented.

Given the high number of legislative/normative measures on the one hand and financial measures on the other hand, there is on average a strong overlap between the implemented PaMs. This implies that the expected savings of the individual PaMs each are likely to decrease.

Table A1.2 Cross table of target audience and type of PaM in Bulgaria.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement	Cooperative measures
Financial Institutions	2	1	1	1	1	0	0
Energy suppliers	2	0	2	0	1	0	0
Authorities	3	4	7	2	1	0	2
Other	0	0	0	0	0	0	0
Building professionals	11	11	4	0	3	0	0
Owners/Tenants	8	13	2	0	2	0	0

Source: Odyssee-MURE, 2017b; Ministry of Energy, 2017b

Conclusions

Which PaMs have been implemented?

Bulgaria has expanded the number of PaMs to improve energy efficiency in buildings. Most of the PaMs identified started after 2005. There is a strong dominance of legislative/normative and informative, financial, and obligation schemes instrument types. The latter being the only instrument selected under article 7 of the EED (Ricardo AEA et al., 2016). Other types of measures are only limited represented in the policy package, like fiscal and information/education/training measures. Concerning the target audience, building professionals, the general public, professional associations, owner-occupiers and local authorities are mainly addressed. Nevertheless the predominance of these audiences, there is a strong diversity in the target audience over the whole time period.

Impact of PaMs on energy savings and GHG emission reductions

Energy consumption for heating and cooling in the residential sector in Bulgaria in the period 2000 to 2015 is quite stable and it appears that little progress has been made in improving energy efficiency of residential buildings compared to the EU as a whole. Energy consumption per dwelling or m² is still below the EU average though. The top down calculations from the Odyssee database also show that changes in energy consumption have only marginally been affected by energy savings, resulting from energy efficiency improvements. This is in stark contrast to the estimated bottom up savings reported by Bulgaria in their NEEAP. For the building sector, Bulgaria reported energy savings amounting to 2060 GWh in 2016 (final energy consumption in the residential and services sector in Bulgaria was 37 066 GWh in 2015[11]).

Coherence of the policy mix

Bulgaria implemented different instrument types to target the same actors. The combination of legislative/normative measures on the one hand and financial measures on the other hand, means there is potentially a strong overlap between the implemented PaMs, reducing the effectiveness of the individual measures in the policy mix.

[11] Data Eurostat not yet available for 2016.

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Annex 2. Cyprus

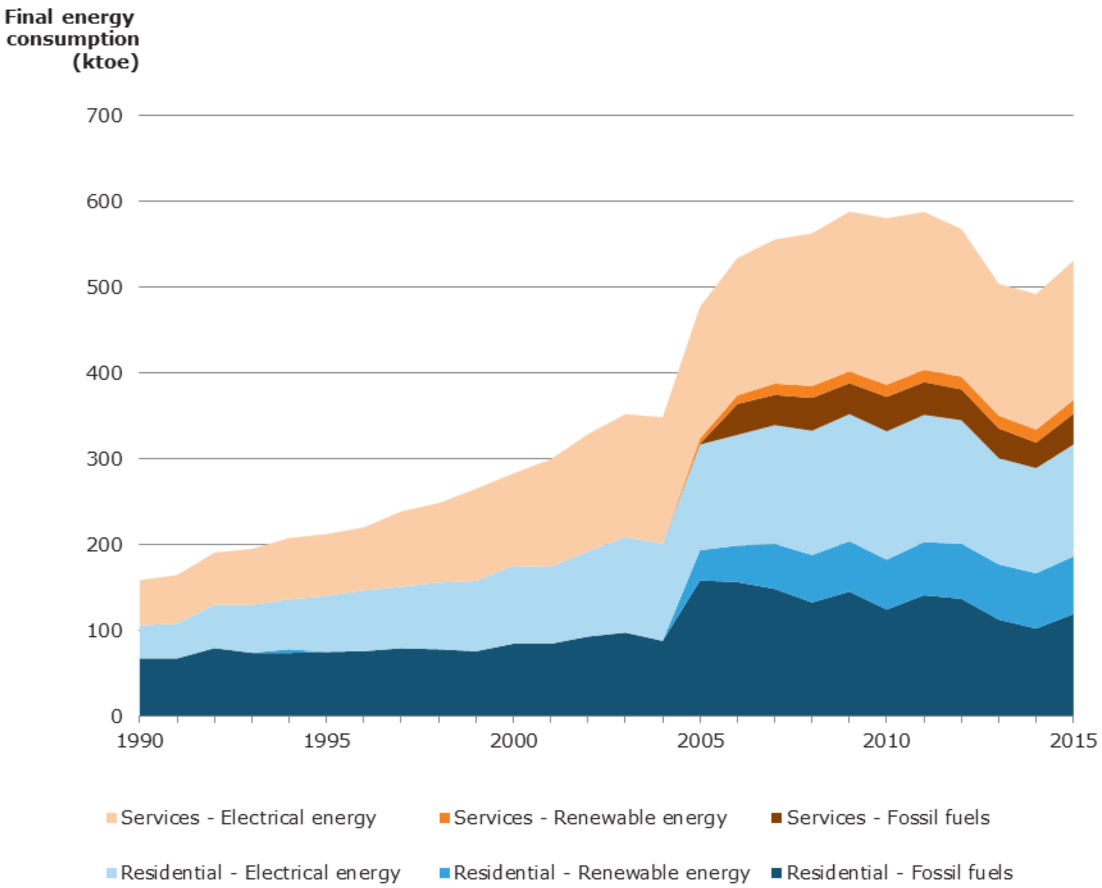
Setting the scene: energy consumptions in buildings

Cyprus has a Mediterranean climate: hot, dry summers and mild, wet winters. Cyprus has four climatic zones defined in the national methodology for the energy performance of buildings: 1) coastal areas, 2) lowlands, 3) low mountainous areas (300m to 600m from seal level) and 4) high mountainous areas (above 600m elevation). Zones 1-3 have similar energy consumption requirements but zone four has significantly higher energy consumption demands. However, only 3 % of the population live in zone four (Cyprus Institute of Energy, 2014).

Cyprus faces a number of energy challenges due to its isolation, size and climate. Cyprus currently has no electricity, oil or gas connecting pipelines with other countries but has a high dependence on imported fossil fuels. The building sector (residential and non-residential buildings) in Cyprus consumes approximately 37 % of national final energy consumption (Cyprus Institute of Energy, 2014).

Energy consumption from buildings (households and services) has almost tripled since 1990 (see Figure A2.1). The dominant fuel consumed in households has changed over the last 25 years. In 1990 petroleum products were most commonly used (64 %), but since then the share of electricity and renewables have increased to 41 % and 21 % respectively in 2015 (Eurostat, 2017d). In 2015, renewable energies contributed 16 % of final energy consumption from buildings (households and services) in Cyprus (Eurostat, 2017e).

Figure A2.1 Final energy consumption of the residential and services sector in Cyprus, 1990-2015 (in ktoe).



Source: Eurostat, 2017e.

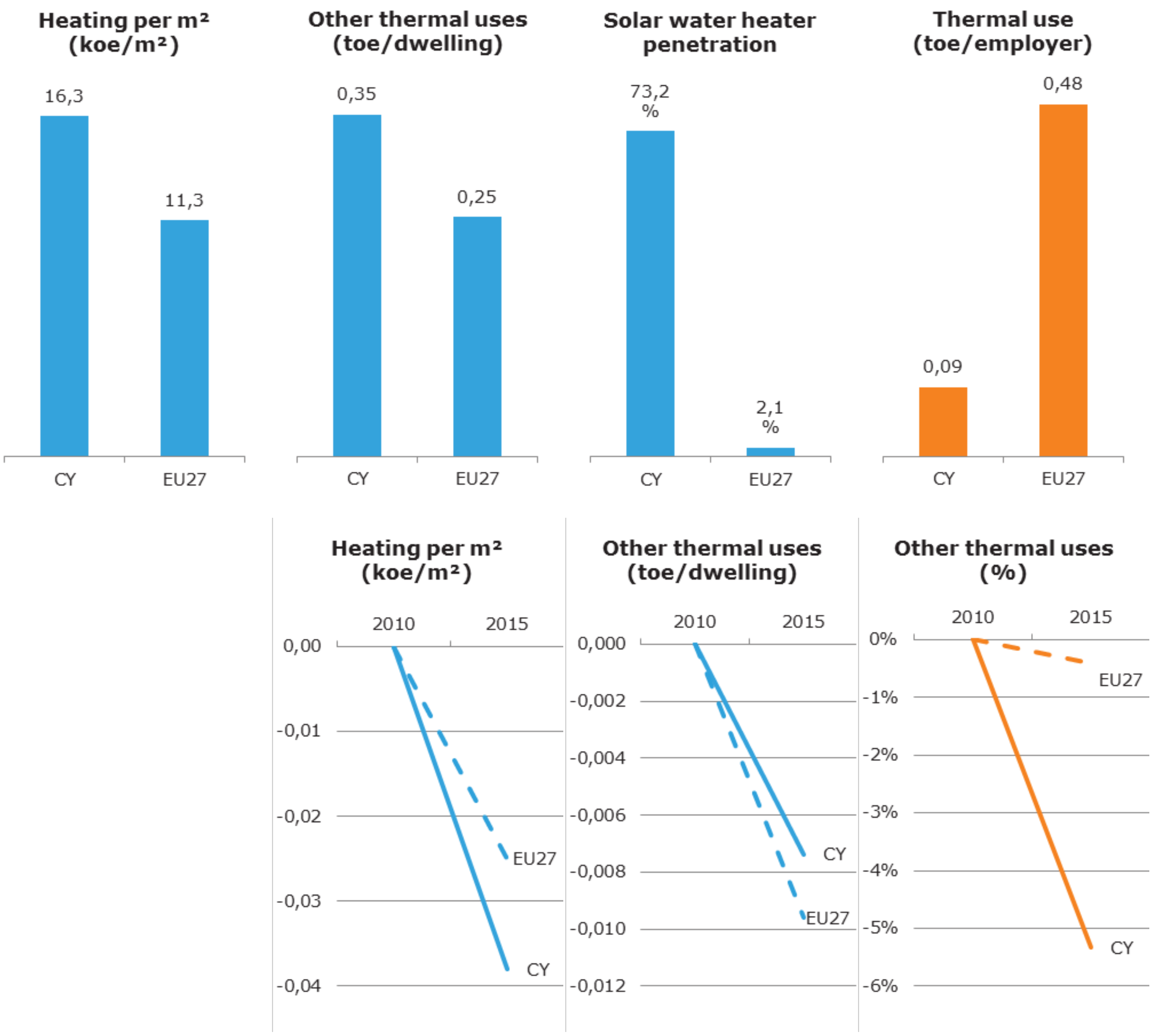
The energy consumption in residential buildings is relatively high (expressed as toe/m², Figure A2.2) compared to the EU average, despite the Mediterranean climate. This can partially be explained by the fact that Cyprus had the largest average size of residential buildings in the EU at 141m^2, compared to the EU-28 average of 96 m^2 (in 2012, Eurostat, 2017a). Cyprus' residential energy consumption per dwelling is among the lowest in the EU, with an average energy consumption of 9 465 kWh per dwelling in 2014 (EU Building Stock Observatory, 2017). Cyprus has the second lowest number of heating degree days in the EU, meaning relatively low energy is required for heating buildings. The energy requirements for cooling in buildings are expected to increase in the future with increasing average temperatures in the Mediterranean, but this will be through electricity consumption rather than oil and gas (CYSTAT, 2009). Cyprus' energy consumption per building (Figure A2.4), across residential and non-residential, is also among the lowest in the EU, with an average of 14 556 kWh per building in 2013 (latest year available) (EU Building Stock Observatory, 2017).

Figure A2.2 shows Cyprus performing well compared to other countries and the EU average for percentage of households with solar water heating; 73 % of dwellings have solar water heaters in Cyprus in 2015, compared to an EU average of 2 %.

Cyprus' building standards are currently in the process of being revised to fulfil EU requirements of Near-Zero Energy buildings. In 2015, 73 % of the population owned their home, 3 % higher than the EU-28 average (Eurostat, 2017c). This has the potential for insulation retrofitting policies to have a considerable impact on residential energy consumption, as home-owners are more likely to invest in improvements to their home rather than those who rent.

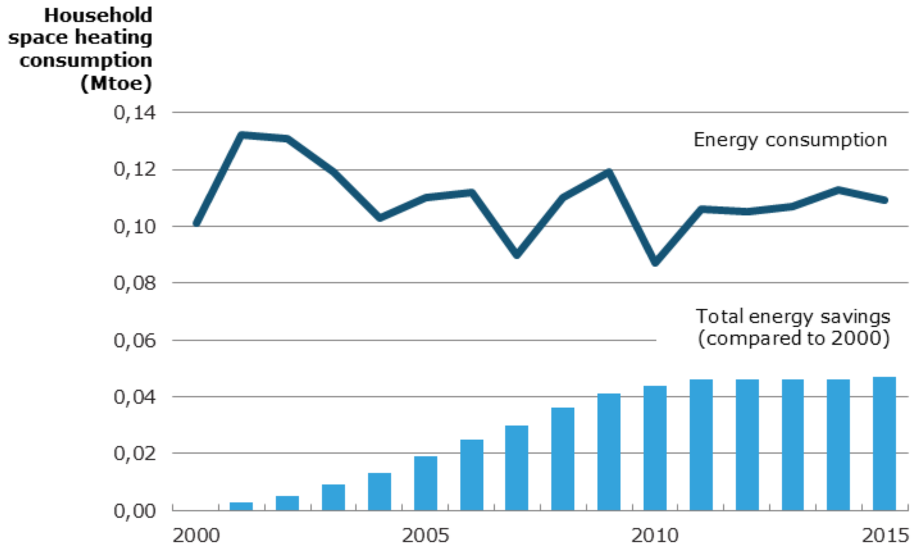
The energy consumption for heating in residential buildings shows a downward trend in the period 2000-2015 (Figure A2.2 and Figure A2.3). The decomposition analysis quantifying the impact of energy savings on total energy consumption shows that there has been progress in energy efficiency in residential buildings, larger than decreases in absolute energy consumption (Odyssee-MURE, 2017a). Progress however appears to have stalled somewhat after 2011.

Figure A2.2 Cyprus positioning within EU: level (2015) and progress (2000-2015) in energy efficiency for households (blue) and services sector (orange).



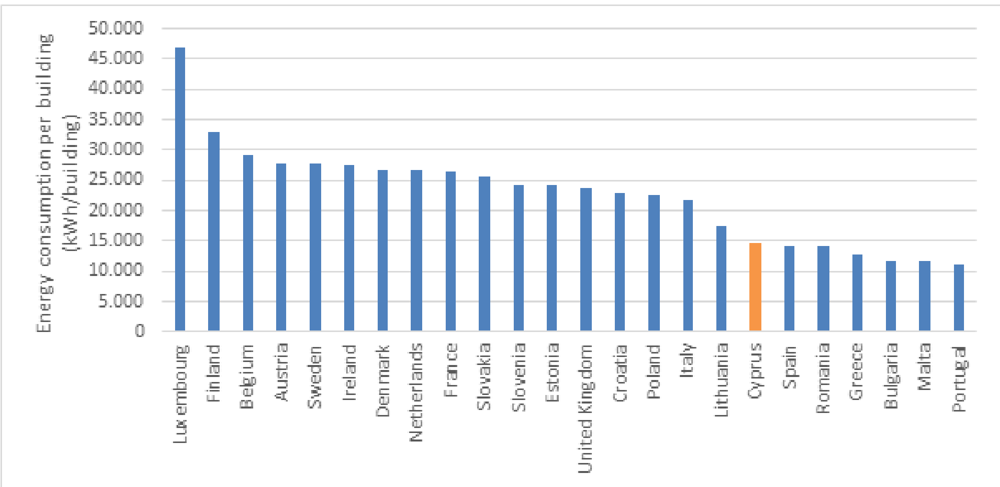
Source: Odyssee-MURE, 2017a, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A2.3 Energy consumption for space heating in households in Cyprus and estimated energy savings (Mtoe).



Source: Odyssee-MURE, 2017a

Figure A2.4 Energy consumption per building.



Source: EU Building Stock Observatory, 2017

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

Prior to Cyprus' accession to the EU in 2004, Cyprus did not have any mandatory building codes on energy efficiency or thermal insulation, which has resulted in a large number of buildings constructed with poor to average energy/thermal performance. In 2015 Cyprus had the fourth highest share of population unable to keep their home adequately warm in the EU (Eurostat, 2017b), likely related to the majority of households lacking central heating (Cyprus Institute of Energy, 2014).

Energy efficiency improvements in Cyprus' building sector are largely being driven by policies resulting from the implementation of EU Directives, but there are several complementary measures. Multiple EU and national policies impact domestic energy efficiency in Cyprus, including the 2010 EPBD and the 2012 EED, the Ecodesign Directive (2009/125/EC), grant schemes of the Special Fund for renewable energy sources and energy saving measures, solar thermal systems, and the distribution of free compact fluorescent (CFL) light bulbs.

Sectoral PaMs

The 3rd NEEAP identifies the installation of proper thermal insulation measures as key for realising potential energy savings in the building sector, as well as improvements to the heating and cooling systems (Cyprus Institute of Energy, 2014). Full implementation of the EPBD is expected to make significant improvements to energy efficiency through the adoption of compulsory thermal insulation regulations for new buildings. In new buildings, the minimal energy performance requirements are estimated to reduce energy consumption by at least 50 % compared to the same building prior to the EPBD (MECIT, 2016).

The grant schemes for implementation of energy savings measures in buildings through the Special Fund for RES and ES were operational between 2004 and 2013. Approximately EUR 67 million was granted in this period for measures such as thermal insulation, energy efficient lighting, energy recovery and renewable energy systems in cooling and heating. The Special Fund for RES and ES was financed through a 0.50 EUR/kWh levy on electricity consumption for all final consumers (Cyprus Institute of Energy, 2014).

Under the Special Fund for RES and ES, the Compact Fluorescent (CFL) lamps campaign ran from 2006 to 2012, distributing six free CFL lamps to households, non-profitable organisations, schools, churches etc. Approximately two million CFL lamps were distributed in this period (Cyprus Institute of Energy, 2014). The CFL lamps save 47 kWh/year from the GLS lamps they were replacing.

A new aid scheme was implemented in 2014 ('Save & Upgrade') to encourage households and SMEs to adopt energy efficiency or RES measures. The provision for participation of qualified experts and energy auditors in the scheme supports a holistic cost-effective approach (Economidou, 2016). The scheme requires the issuance of an Energy Performance Certificate (EPC) and the following of its recommendations. For buildings with usable areas larger than 1 000 m^2 an energy audit is required in addition to the EPC (MECIT, 2016). Cyprus is one of the only countries to provide free training programmes for qualified EPC experts (BPIE, 2014). If qualified experts or companies are found to be in non-compliance with the EPBD, an administrative penalty in the form of loss of accreditation is applied.

Cyprus 'Solar energy for all' net metering programme started in 2013 to promote photovoltaic (PV) installations for meeting the building's own electricity needs. This compliments the promotion of NZEBs as it helps fulfil the obligation for renewable energy production in the building. By 2016, 11 000 PV systems had been installed in buildings (MECIT, 2017).

Implementation of the EED will also bring significant improvements to Cyprus' building sector. As a Mediterranean country, heating and cooling are important, and under Article 14 of the EED Cyprus is amending applicable national legislation.

Under Articles 12 and 17 of the EED, Cyprus has a suite of 12 activities related to consumer information, training and awareness. These include school activities on energy savings, energy efficiency and renewable energy sources. Each public-sector building is appointed an Energy Saving Officer to ensure implementation of energy saving measures, particularly zero-cost measures. Training seminars and information days on energy management and RES are held annually, with the seminars targeting unemployed engineers, and the information days addressed to engineers, hotel owners, municipalities, contractors and the general public.

The EPC aims to inform building owners, occupiers and real estate actors of the energy status and potential improvements of a building. However, it is only required during the construction, sale or rental of buildings. Approximately 78 % of residential dwellings are owned by their occupants (CYSTAT, 2009), meaning EPCs are not frequently used. Even when they are mandatory, their use remains at low levels; between 2010 and 2013 the Land Registry and Surveying Department received 25 652 sales documents, but only 1 244 EPCs were issued (Cyprus Institute of Energy, 2014). The Ministry of Energy is therefore carrying out awareness raising campaigns for the EPCs, particularly focusing on potential buyers and tenants, as they bear the energy costs to which the EPC relates. Administrative fines have since been introduced in cases where there is no EPC during sale or rental. This full implementation of the 'Save & Upgrade' has the potential to improve energy efficiency measures in households.

The EPBD includes a provision under which all new public buildings must be nearly zero energy buildings (NZEBs) by 31st December 2018, becoming applicable to all new buildings by 31st December 2020. NZEBs are buildings in which the very low amount of energy required is covered to a significant extent by RES[12]. The largest aid amount under the 'Save & Upgrade' programme is for buildings undergoing renovations to become NZEBs. Under the initial call of the Save & Upgrade programme an estimated 106 homes will be upgraded to NZEBs.

In recognition that NZEBs are a new concept to both the general public and the construction industry, Cyprus has issued technical and public guidance on NZEBs (MECIT, 2017). Guidance on NZEBs has been included in the training and exams required for qualified engineers, heating system inspectors, air-conditioning system inspectors and energy auditors.

According to a study of ICF (2015), Cyprus has a very strong framework for minimum energy performance. The compliance rate was also very high (more than 85%). Concerning energy performance certificates, Cyprus has a very strong framework, with a very high compliance rate.

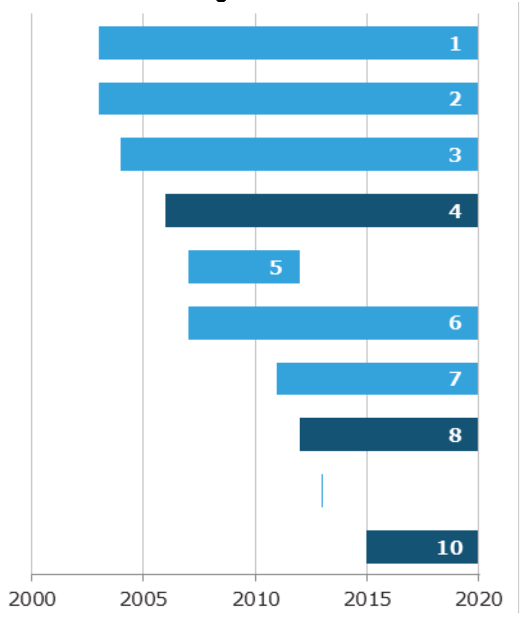
Time frame

Figure A2.5 presents the evolution of building energy efficiency PaMs in Cyprus, as collected by the MURE database. The policies are coloured by sector, and key EU policies are overlaid for reference. This figure illustrates the relatively recent implementation of energy efficiency PaMs in Cyprus. Most PaMs have been implemented after 2005 and few PaMs expired since then. There are also relatively few PaMs in the residential and services sector, less than 10 if discounting the cross-cutting measures.

[12] See EPBD legislation for a complete definition, specific technical requirements and characteristics for NZEBs.

Figure A2.5 History of PaMs in Cyprus to improve energy efficiency in buildings.

Residential buildings



1 Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Governmental financial support schemes for investments in RES/RUE/EE

2 Revised Directive for Labelling of Energy-related Products (Directive 2010/30/EU) - Energy labelling and relevant information of household appliances

3 Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Information, awareness campaigns, workshops , seminars for energy savings

4 **Information, awareness , training policies for energy savings**

5 Scheme for subsidising CFL lamps

6 Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Law for the enegy performance of buildings

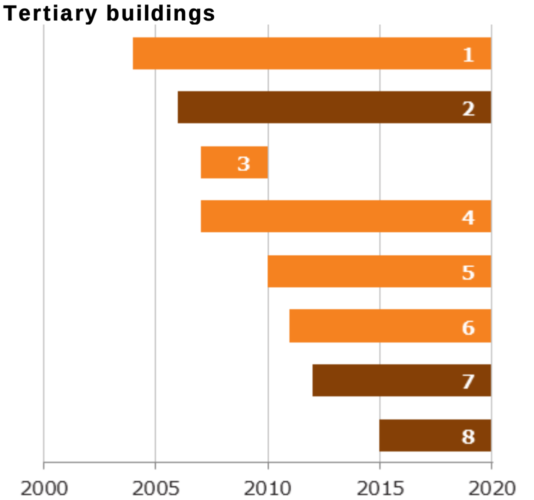
7 Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Efficiency requirements for energy using prodsuts

8 **Energy Audits**

9 Net metering scheme was introduced for the promotion of small residential photovoltaic systems

10 **Program for the Energy Renovation of buildings**

Tertiary buildings



1 Governmental financial support schemes for investments in RES/RUE/EE

2 **Information, awareness , training policies for energy savings**

3 Action plan for green public procurement

4 Energy Performance of Buildings (Directive 2002/91/EC) - Energy performance buildings Regulations

5 Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Information, awareness, training for energy efficiency and RES technologies in buildings

6 Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Eco design requirements for energy related products

7 **Energy Audits**

8 **Program for the Energy Renovation of buildings**

Note: In bold, cross-cutting measures

Source: MURE, 2017; NEEAP3, 2014

Instrument types

Looking closer to the implemented measures in Cyprus, we identify over the whole time period a strong dominance of financial, legislative/normative, and legislative/informative type of measures. Nevertheless, a variety of measures have been implemented in the period 2000-2015, as you can see in Figure A2.6. Some PaMs are categorised as more than one type, for example, the PaM Energy Audits is categorised as both financial and information/education. If these are counted separately, as shown in Figure A2.6., we can see that legislative and financial types are most common in Cyprus. Correlating with the relatively small number of PaMs in Cyprus, some instrument types are missing such as fiscal measures and co-operative measures (although there has been one PaM in the past).

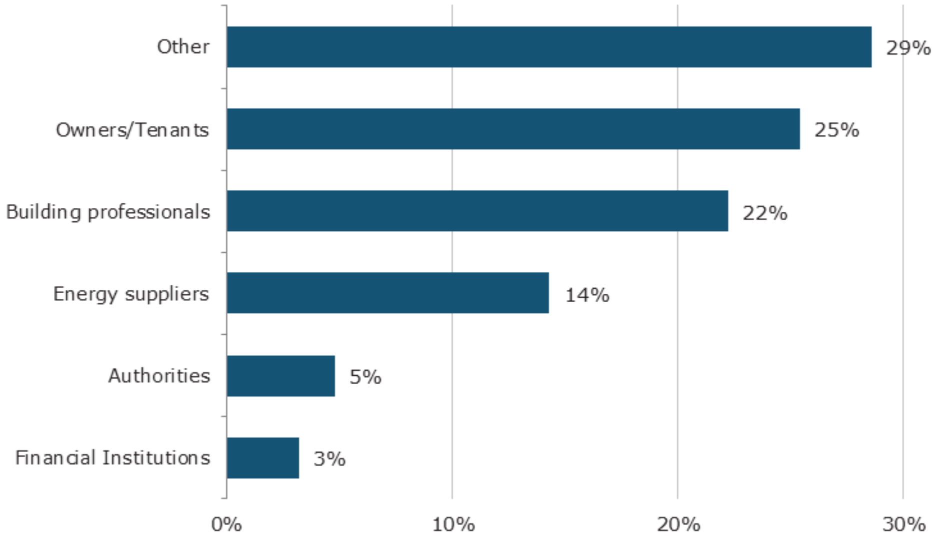
Figure A2.6 Evolution of type of PaMs in Cyprus.

Source: MURE, 2017; Cyprus Institute of Energy, 2014

Target audience

Concerning the target audience, 'other', owners/tenants and building professions are most commonly addressed by Cyprus' building energy efficiency PaMs (Figure A2.7). In the group other employees/employers and trade associations are most frequently reported. This shows that despite the relatively smaller number of PaMs and instrument types, different groups are being targeted.

Figure A2.7 Evolution of target audience in Cyprus.



Source: Odyssee-MURE, 2017b; Cyprus Institute of Energy, 2014

The impact of PaMs on energy savings and GHG emission reductions.

National evaluation framework

Information on how the impact of PaMs was estimated on energy savings was not included in the third NEEAP (Cyprus Institute of Energy, 2014).

Cyprus' technical report submitted pursuant reporting obligations under the Monitoring Mechanism Regulation show that reporting and evaluation of PaMs is done on an ad-hoc basis.

Ex post *impact of energy efficiency PaMs in buildings*

In the third NEEAP energy savings from minimum requirements for the energy performance of new dwellings (transposition of the EPBD) have been estimated (Cyprus Institute of Energy, 2014). This measure resulted in 2012 in a final energy saving of 78 and 7.7 ktoe in the residential and services sector respectively. The grant scheme for energy savings in (existing) dwellings on the other hand resulted in 2012 in savings of only 10.5 and 10.3 ktoe in the residential and services sector.

The report on climate policies and measures under the MMR does not include *ex post* assessments of the impact of energy efficiency policies in the building sector on GHG emissions.

Coherence of the policy mix

The above section indicates that a variety of measures types targeting a variety of audiences have been implemented in Cyprus to improve the energy efficiency of buildings. To have a better indication of the coherence of the PaMs package, a cross table of both parameters indicates whether this variety in types of measures also holds true per type of target audience.

For the buildings sector in Cyprus, the level of interaction is suggested for the different types of measures, ranging from strong reinforcement, not interacting to a strong overlap. Table A2.1 shows that for the most common target audiences, there is indeed a wide spread of PaM types. Given the high number of legislative/normative measures on the one hand and financial and informative measures on the other hand, there is a general tendency of overlap (some to strong overlap) in the implemented PaMs. This implies that the expected savings of the individual PaMs each are likely to decrease. It also highlights the importance of 'soft' information and education-based PaMs.

Table A2.1 Cross table of target audience and type of PaM in Cyprus.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement	Cooperative measures
Financial Institutions	2	0	0	0	2	0	0
Energy suppliers	6	2	1	0	5	0	0
Authorities	3	0	0	0	1	0	0
Other	12	2	0	0	14	0	0
Building professionals	5	7	3	0	6	0	0
Owners/Tenants	5	10	5	0	7	0	0

Source: Odyssee-MURE, 2017b; Cyprus Institute of Energy, 2014

Conclusions

Which PaMs have been implemented?

In response to Union policy, Cyprus has expanded the number of PaMs to improve energy efficiency in buildings, most of which started after 2005. The lack of mandatory insulation building codes in Cyprus pre-EU accession means that full implementation of key EU policies, such as the EPBD and the EED, are expected to deliver significant energy savings.

The number of individual PaMs is relatively small compared to other countries. There is a strong dominance of legislative and financial instrument types. Also information and education instruments cover a high share of instrument types reported by Cyprus. Other types of measures are only very limited or not represented in the policy package, like fiscal, obligation schemes and co-operative measures. Concerning the target audience there appears to be a good mix of instruments targeted at different groups.

Impact of PaMs on energy savings and GHG emission reductions

While final energy consumption in the residential and tertiary sector increased significantly in Cyprus in the period from 1990-2015, evidence from Odyssee-MURE shows that between 2010 and 2015, Cyprus has achieved energy efficiency improvements in line with the average of the EU because of improvements in energy efficiency and behavioural changes. This has not resulted in significant changes in energy consumption due to an increase of the building stock (more buildings) and larger buildings. Surprisingly considering the climatic condition in Cyprus, energy consumption per m² is high compared to the EU average which is caused by the larger homes in Cyprus compared to the EU average. The energy consumption is expected to rise in future as the standard of living improves and the use of air conditioning systems increases.

Coherence of the policy mix

The type of policies related to energy efficiency of buildings in Cyprus are quite well balanced. The regulatory minimum energy performance standards are likely to have the single largest impact on energy efficiency. However, these are supported by economic measures such as the grant scheme for energy saving actions, fiscal measures such as subsidised CFL bulbs, information measures such as energy audits, and awareness measures such as energy managers for every public building.

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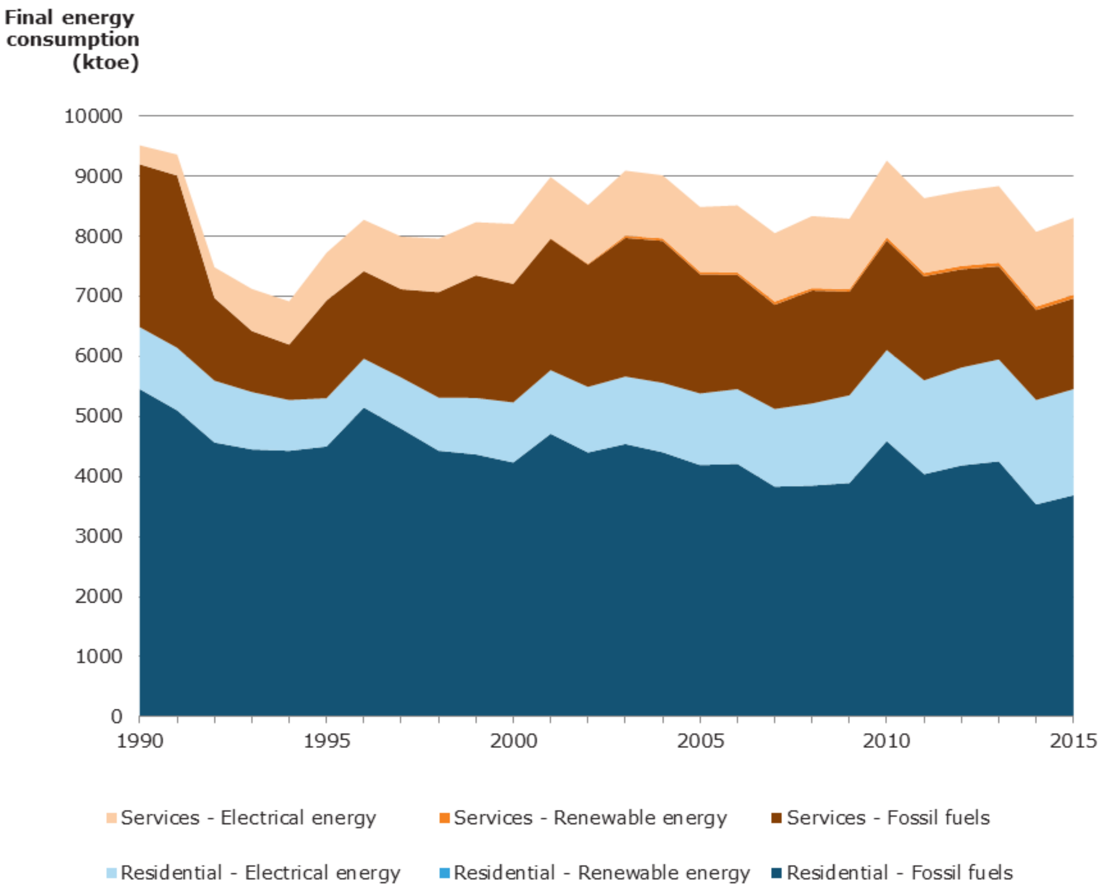
Annex 3. Czech Republic

Setting the scene: energy consumptions in buildings

Energy consumption in the Czech Republic has changed drastically in the last three decades. Up until 1989, the economy was characterised by high energy intensity due to *inter alia* a specialisation in heavy industry, general underinvestment, and state-regulated energy pricing. Although energy efficiency has improved and made great strides catching up with the EU average, the country is likely to experience substantial impacts of rebound effects as economic improvements and rising living standards can lead to increased energy consumption (Ministry of Industry and Trade, 2017b).

Residential housing is the third largest energy consumer in the Czech Republic, following the industry and transport sectors. While industrial energy consumption has decreased greatly since 1990, energy consumption in housing and services has remained stable over time (see Figure A3.1 below).

Figure A3.1 Energy consumption of the residential and services sectors in the Czech Republic, 1990 – 2015 (in ktoe).



Source: Eurostat, 2017, simplified energy balances

With an average energy consumption of 15.900 kWh per dwelling and year, the Czech housing sector consumes more than the EU average (see Figure A3.2 below) (EU Building Stock Observatory, 2017).

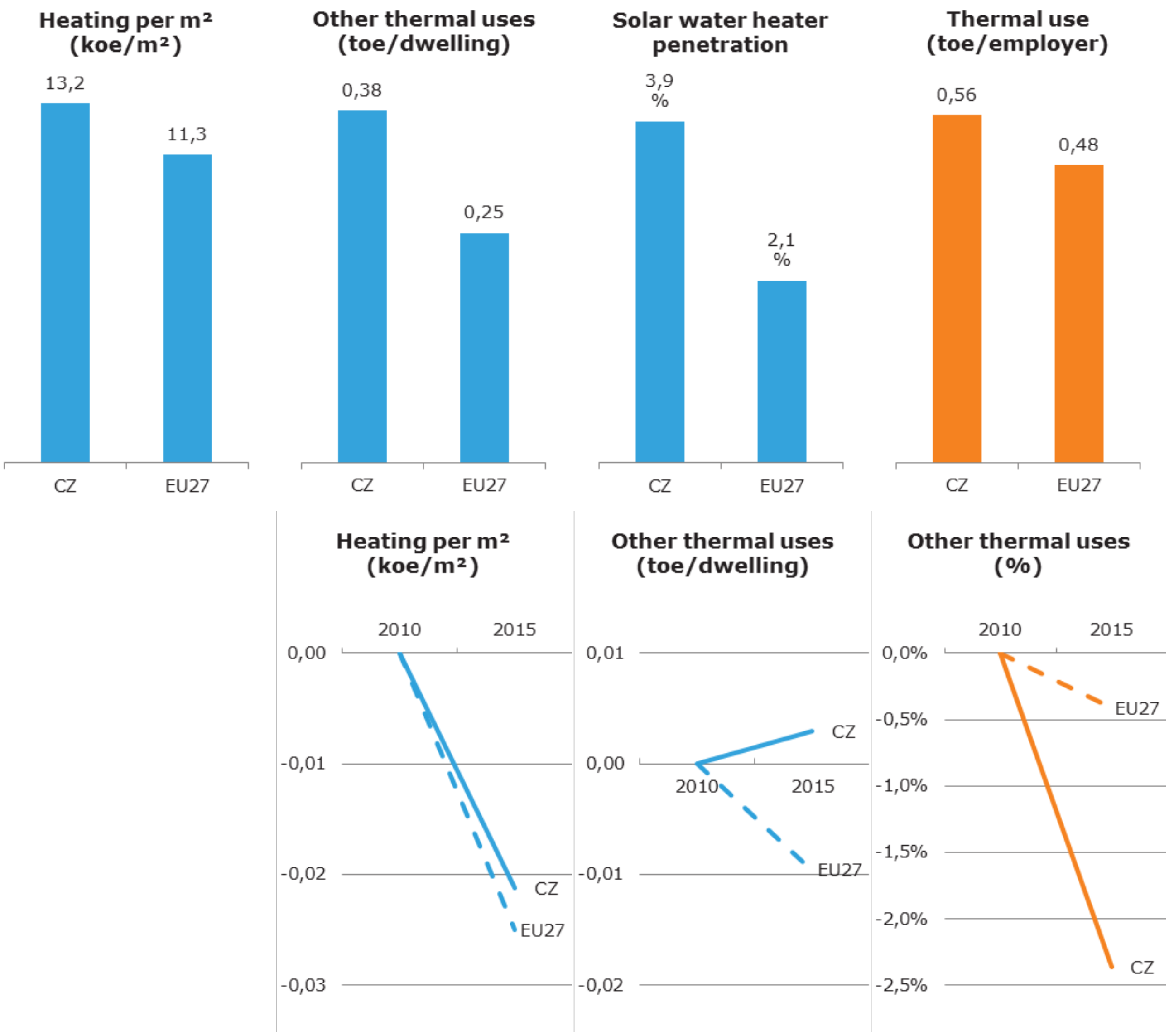
This represents an average consumption of 203 kWh/m^2/year, well above the EU average of 159 kWh/m^2/year (EU Building Stock Observatory, 2017). Several factors contribute to the relatively high energy consumption per square meterage of Czech dwellings (Figure A3.4), but is mainly impacted by smaller dwellings in need of repair (Eurostat, 2015). The majority of residential blocks in the Czech Republic, or nearly 1.2 million flats, were build using prefab technologies between 1954 and 1994 (EC, 2015). Often, technological faults of this type of construction led to low-quality housing featuring poor insulation, water leakages and poor metal structures today affecting structural safety and energy performance. Refurbishment of these dwelling blocks often require substantial financial resources, and to date only 25-30 % of properties have been refurbished (EC, 2015).

78 % of Czech residents own their own properties, with the majority (59 %) having no outstanding mortgage or housing loans. This is well above the EU average, where only 69 % own their properties, and 42 % without any mortgage or housing loans (EU-SILC Survey, 2017).

In the Czech service sector, the growth in energy demand has mainly been attributed to the growth of buildings in this sector, including supermarkets and shopping centres, as well as sports and culture centres (ENVIROS, 2015; Ministry of Industry and Trade, 2014).

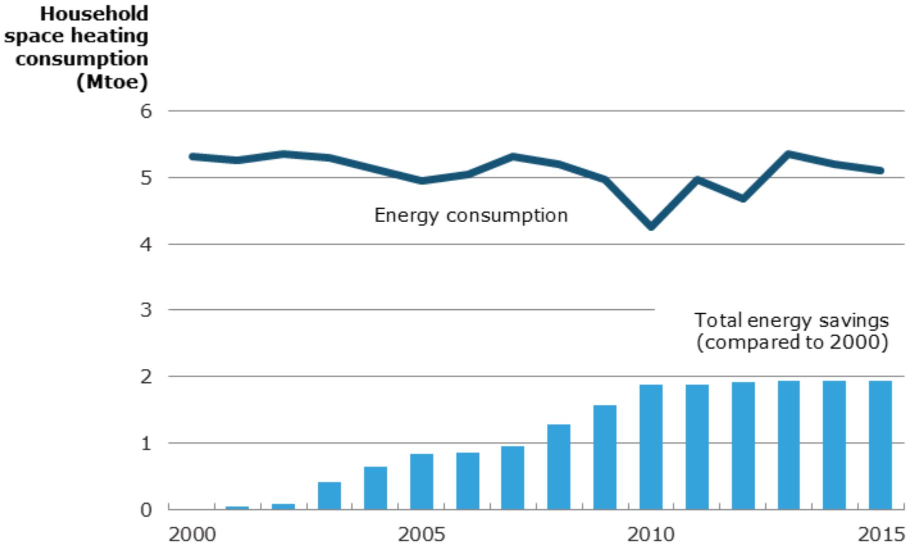
The energy consumption for heating in residential buildings shows a stabilizing trend in the period 2000-2015 (Figure A3.2 and Figure A3.3). The decomposition analysis quantifying the impact of energy savings on total energy consumption shows that there has been progress in energy efficiency in residential buildings, offset by increased demand for heating (Odyssee-MURE, 2017a). Progress however appears to have stalled somewhat after 2010.

Figure A3.2 The Czech Republic's positioning within EU: level (2015) and progress (2000-2015) in energy efficiency for households (blue) and services sector (orange).



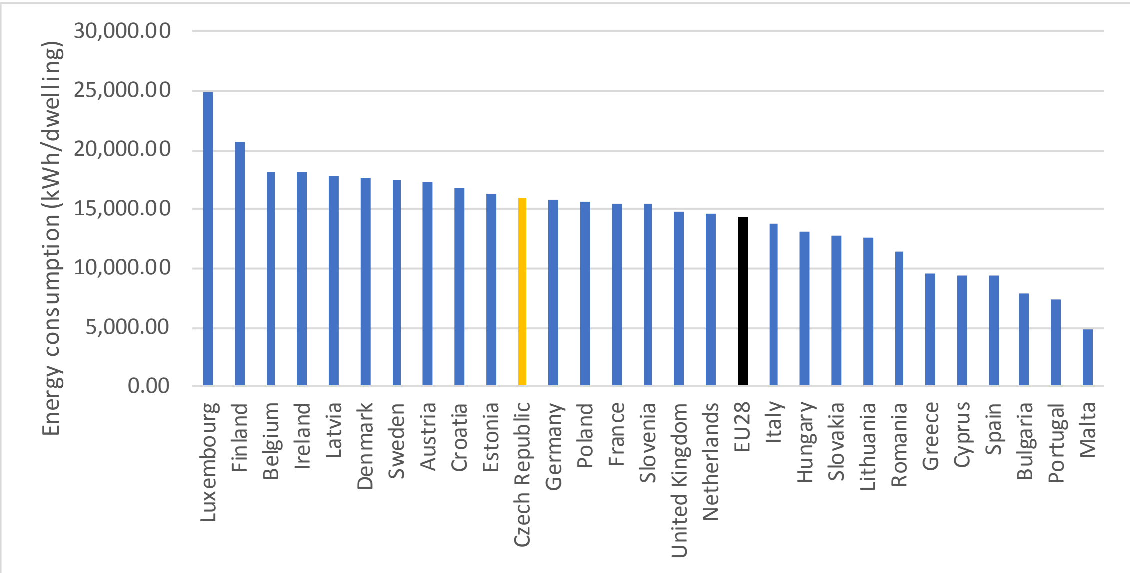
Source: Odyssee, 2017, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A3.3 Energy consumption for space heating in households in the Czech Republic and estimated energy savings (Mtoe).



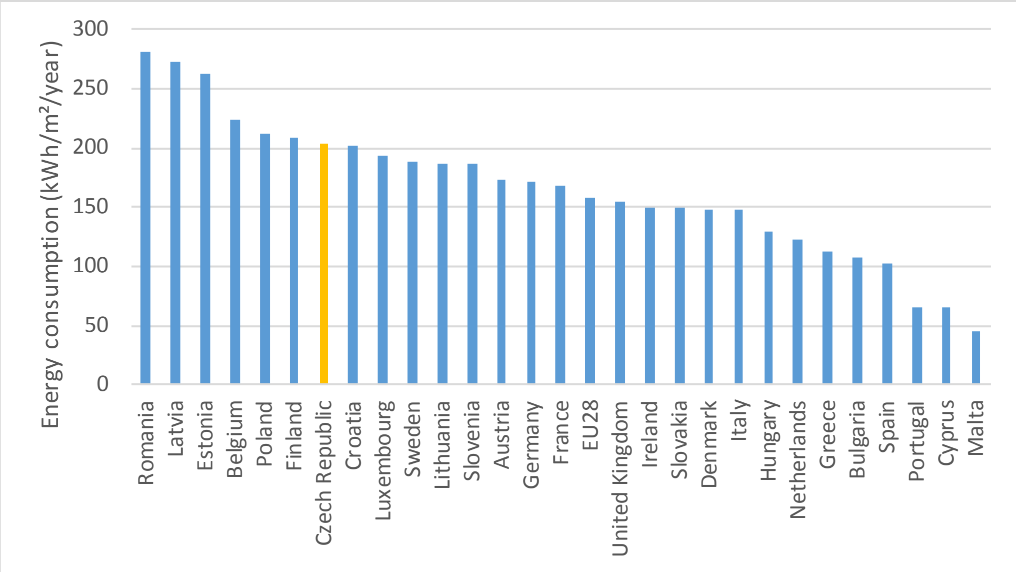
Source: Odyssee-MURE, 2017a

Figure A3.4 Energy consumption per dwelling.



Source: EU Building Stock Observatory, 2017

Figure A3.5 Energy consumption per square-metre and year.



Source: EU Building Stock Observatory, 2017

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

The Czech Republic has developed several current, and past policies aimed to improve energy efficiency in buildings. Apart from national and EU-based normative and legislative regulations such as the EPBD, the country hosts multiple fiscal instruments aimed to subsidise and encourage energy efficiency through refurbishment as well as new-builds.

Based on the historic and present situation, and ambitions to improve energy efficiency in the building environment, the Czech Republic has developed national indicative targets in accordance with Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency, thus amending Directives 2009/125/EC and 2010/30/EU, and repealing Directives 2004/8/EC and 2006/32/EC. Through the targets, the Czech Republic aims to increase energy efficiency by 20 % by 2020, in line with the Union's 2020 target (Ministry of Industry and Trade, 2017).

To improve energy efficiency in buildings, the Czech Republic utilises multiple legislative/normative, informative, cooperative policies, alongside the fiscal instruments that are the primary concern of this assessment, and the country has actively used these kinds of policies for a long time (Ministry of Industry and Trade, 2017). Instruments include national as well as EU policies to improve energy efficiency, national building regulations, NZEB standards and initiatives (e.g. Šance pro budovy), and the European Ecodesign Directive (2009/125/EC). Financial engineering instruments and investment subsidies financed from public funds are expected to be the primary mechanisms. For an overview of all identified policies related to energy efficiency in buildings, see Figure A3.5.

Due to different pressures driving energy demand, and separate trends since 1990, the assessment of fiscal instruments is undertaken separately for instruments in the residential and service sectors.
Sectoral PaMs

The Czech Republic has operated multiple financial and economic policies to improve energy efficiency in the residential sector. Examples of such policies include investment subsidies undertaken through Government Programme B, the Joint Boiler Replacement Scheme, subsidies for the elaboration of energy audits, the Green Savings Programme, and JESSICA.

Whilst suggesting an overarching compatibility of energy efficiency policies, this does not account for other national and international incentives that could have an adverse impact on energy efficiency. For example, incentives to increase economic development in the construction sector as well as improved living standards in general can often lead to the construction of larger dwellings, with a potential increase in energy demand as a result.

Some of the key policies identified include:

- *New Green Savings Programme 2014 – 2020.* Continuation of predecessor programmes (New Savings Programme and New Green Savings Programme 2013). Incentivising energy efficiency improvements through direct investment in measures to reduce energy intensity of buildings (Ministry of Industry and Trade, 2017). Funding amounts of previous rounds of the Green Savings Programme have been in the scale of 25 billion CZK (approximately EUR 1 million) to support heating installations utilising renewable energy sources, as well as investment in reconstructions and new buildings (IEA, 2017).
- *Integrated Regional Operating Programme*. Supports modernizations and refurbishment of living houses. Owners of living houses (any physical or legal body) can obtain advantageous long-term loan with fixed interest covering up to 80 % of the total investment. In terms of energy savings is significant priority axis two of the program and its investment priority 4c "Promoting energy efficiency, intelligent systems energy management and use of energy from renewable sources for public infrastructures, including in public buildings and in housing". Supported measures affecting the energy performance include e.g. insulation of residential building, replacement and refurbishment of windows and doors, passive heating and cooling, shielding, installation of systems controlled ventilation with heat recovery.
- *Renewal of panel homes – PANEL programme/New Panel/PANEL 2013+.* Focuses on investment in the renovation of multi-family buildings through the provision of subsidies to cover the interest on loans, with grants of up to 90 % of the investment. Estimated to have achieved 106.9 TJ in savings between 2014 – 2016, and is expected to contribute to 100 TJ additional savings between 2017 – 2020 (Ministry of Industry and Trade, 2017). The programme is administered by the State Housing Development Fund.
- *Energy Savings Fund.* Proposed policy, expected to achieve savings of 2 600 TJ between 2017 and 2020 (Ministry of Industry and Trade, 2017).

The building savings system in the Czech Republic was originally designed to support the investment of private persons for refurbishment of their property. However, the financial resources of the building savings are not only spent on modernisation or renovation. Based on the dataset in the annual statics of the building savings bank 46 % of the new loans in 2015 were used for refurbishment and modernization
The Czech Republic has operated multiple financial and economic policies to improve energy efficiency in the service sector. Examples of such past policies include investment subsidies undertaken through the Operational Programme Enterprise and Innovation (2007 – 2013), Operational Programme Environment (2007 – 2013), and State programmes on the promotion of energy savings and the utilisation of renewable energy sources (EFEKT).

Nine key policies were identified for the assessment based on their relevance to energy efficiency in the service sector, either by addressing relevant actors in the sector, or construction companies. Of the identified energy efficiency policies, nine policies were found to have directly conflicting policy goals, although some cases of substantial overlap was identified. Whilst suggesting an overarching compatibility of energy efficiency policies, this does not account for other national and international incentives that could have an adverse impact on energy efficiency. E.g. Incentives to increase economic development in other sectors can lead to adverse impacts on energy efficiency.

Some of the key policies identified above include;

- *Operational Programme Environment 2014-2020.* Promotion of energy savings and use of RES. Offers subsidies for environment protection. It comprises promotion of energy efficiency and use of RES mainly in the Commercial/Institutional sector (1A4a). The measure supports energy efficiency improvement and use of RES in public sector.
- *Operational Programme Enterprise and Innovation for Competitiveness (2014-2020).* Financial PaM aiming to provide investment support to increase energy efficiency in industry and improve energy performance of buildings in the business sector. Expected to achieve 9.619 TJ of savings between 2014 – 2020 (Ministry of Industry and Trade, 2017).
- *ENERG Programme.* Pilot financial instrument aimed at supporting the achievement of final energy savings in the small and medium enterprises sector (Ministry of Industry and Trade, 2017). Plugs a gap in the financing of energy saving projects for businesses operating in Prague through its focus on the SME sector in the capital. Expected to deliver 40 TJ of savings between 2014 – 2020 (Ministry of Industry and Trade, 2017).
- *Operational Programme Prague Growth Pole – buildings part.* PaM aiming to improve energy performance of buildings, converting energy intensive municipal buildings in Prague to near-zero energy buildings. Expected to deliver 10 TJ in energy savings between 2014 – 2020 (Ministry of Industry and Trade, 2017).

While the present situation provides multiple routes and tools to promote energy efficiency, issues can arise where property owners and tenants wishing to improve energy efficiency in their building are met by a plethora of options. Although different options can facilitate the promotion of energy efficiency to multiple stakeholders, a more user-focused approach to deliver a one-stop-shop for energy efficiency in the Czech Republic would be more effective.

In the Czech Republic, taxes on energy represented 82 % of total environmentally related tax revenue, compared to 70 % average of OECD and partner economies. Transport is on average taxed the most (12.32 EUR/GJ), compared to fuels used for heating and process purposes (0.28 EUR/GJ) or electricity generation (0.06 EUR/GJ) (OECD, 2016).

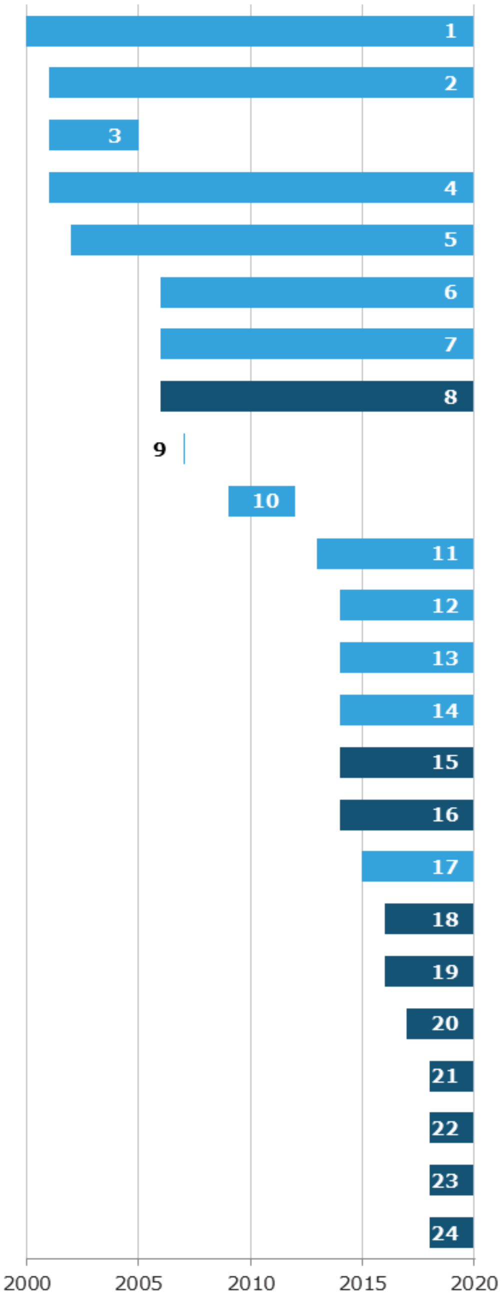
According to a study of ICF (2015, the Czech Republic has a framework for minimum energy performance of medium strength. The compliance rate could not be determined. Concerning energy performance certificates, the Czech Republic has a strong framework, with a very high compliance rate.

Time frame

Based on the information about PaM's in the Odyssee-MURE database (Odyssee, 2017) and the updated NEEAP from 2017 (Ministry of Industry and Trade, 2017), the following history line is set up (Figure A3.6), illustrating a diversity of measures implemented to realize energy savings in the building sector. Both in the residential and the tertiary sector, numerous individual PaMs have been implemented. The NEEAP of the Czech Republic and MURE database also has a relatively high share of - mostly planned - cross-sectoral PaMs.

Figure A3.6 History of PaMs in the Czech Republic to improve energy efficiency in buildings

Residential buildings



1 Support for the modernisation of housing stock by means of building society savings schemes

2 Awareness of energy savings in heat consumption in households

3 Subsidies for elaboration of energy audits in the framework of annual Government Programme for period 2000-2005

4 Renewal of panel houses - PANEL programme/New Panel/PANEL 2013+

5 Energy Performance of Buildings (Directive 2002/91/EC)

6 Energy Performance of Buildings (Directive 2002/91/EC) - Periodic mandatory inspection of boilers

7 Level of heat energy demand according to ESN 73 05 040-2/Z1: 2005

8 Operational Programme Environment 2014 - 2020 (Ministry of the Environment) (Priority Axis 5 - SO 5.1)

9 Investment subsidies in the framework of the annual Government Programme B

10 Green Savings Programme

11 New Green Savings Programme 2013

12 Joint Boiler Replacement Scheme

13 New Green Savings Programme 2014 - 2020

14 JESSICA Programme

15 Strategic Framework for Sustainable Development

16 State programme to promote energy savings (EFEKT 2)

17 Integrated Regional Operational Programme

18 Alternative measures for increasing energy efficiency in Czech industry and in municipalities and regions

19 Reasonable Energy Savings Programme

20 ENERG Programme (Czech- Morovian Guarantee and Development Bank)

21 Programmes supporting research and development

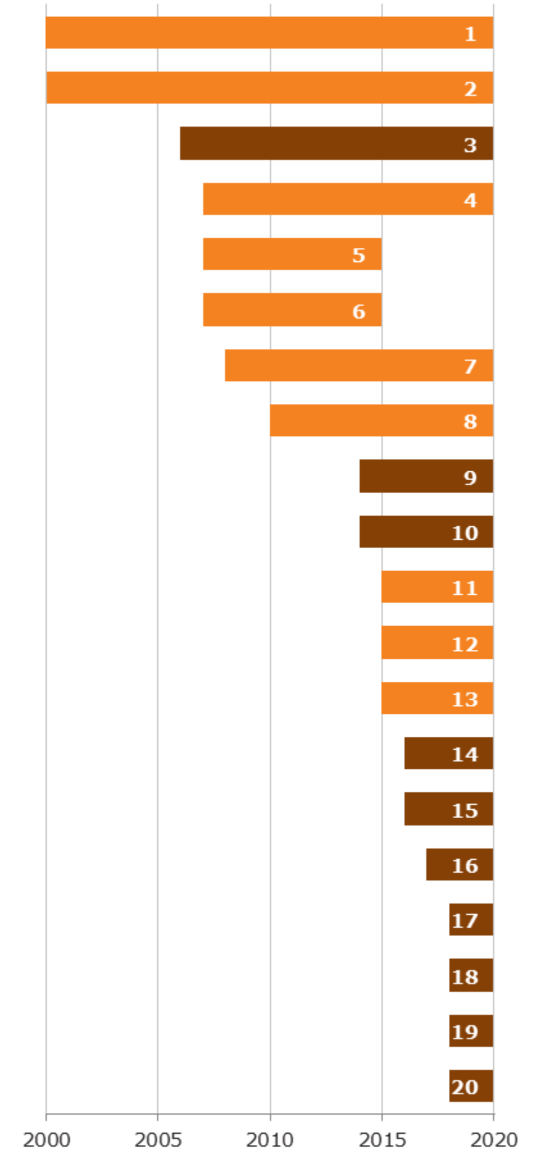
22 Support for the installation of cogeneration units

23 Energy Savings Fund

24 Support for the construction sector in the Czech Republic is improving energy efficiency and environmental protection in line with the EU 2020 environmental strategy

Figure A3.6 *continued*.

Tertiary buildings



1 Energy Performance of Buildings (Directive 2002/91/EC) - Provision of energy services via the EPC method in the tertiary sector and its support

2 State programmes on the promotion of energy savings and the utilisation of renewable energy sources (EFEKT) - investment subsidies

3 Operational Programme Environment 2014 - 2020 (Ministry of the Environment) (Priority Axis 5 - SO 5.1)

4 Summary of measures to increase the energy efficiency of agricultural plants

5 Operational Programme Enterprise and Innovation (2007 - 2013) (commercial services)

6 Operational programme environment 2007 - 2013

7 Ecodesign Directive for Energy-using Products (Directive 2005/32/EC) - Electric energy savings in the area of lighting in the tertiary sector and public lighting

8 Extension of the role of public sector in demonstrating new technologies

9 Strategic Framework for Sustainable Development

10 State programme to promote energy savings (EFEKT 2)

11 Operational Programme Enterprise and Innovation for Competitiveness (2014 - 2020) (commercial services)

12 Operational Programme Prague Growth Pole - buildings part (Prague)

13 Operational programme environment 2014 - 2020

14 Alternative measures for increasing energy efficiency in Czech industry and in municipalities and regions

15 Reasonable Energy Savings Programme

16 ENERG Programme (Czech- Morovian Guarantee and Development Bank)

17 Programmes supporting research and development

18 Support for the installation of cogeneration units

19 Energy Savings Fund

20 Support for the construction sector in the Czech Republic is improving energy efficiency and environmental protection in line with the EU 2020 environmental strategy

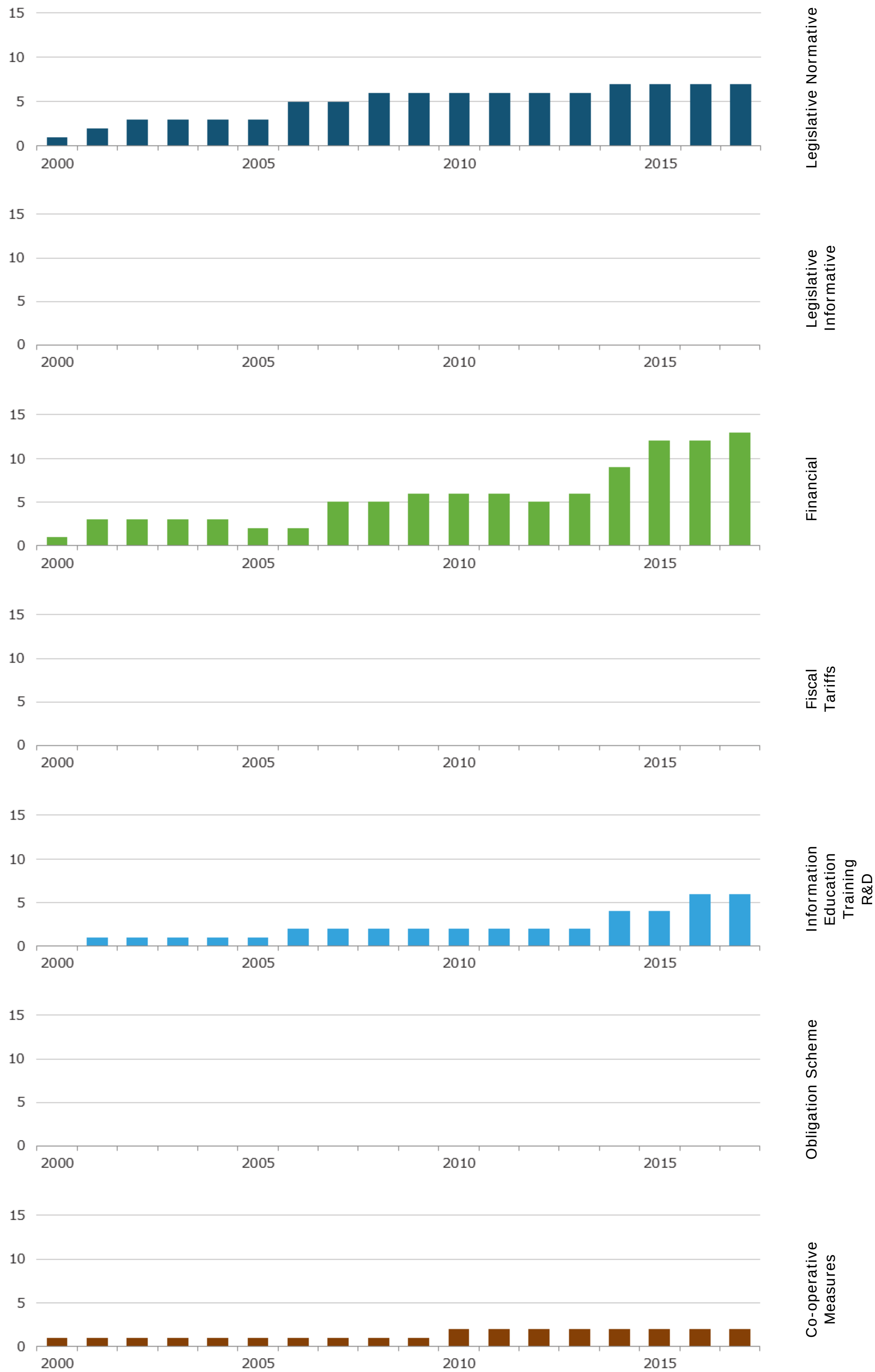
Note: In bold, cross-cutting measures

Source: Odyssee, 2017; Ministry of Industry and Trade, 2017

Instrument types

Looking closer to the implemented measures in the Czech Republic, as depicted in Figure A3.7, identify over the whole time-period a strong dominance of financial policies. Figure A3.7 shows that the majority of the PaMs are implemented after 2001, which is linked to the accession in the EU in 2004. In the Odyssee-MURE database, updated with the fourth NEEAP submission, 12 of the 34 measures are either directly or indirectly linked to an EU Directive, more specifically to the EPBD and the Energy Services Directive. The instrument types are dominated by legislative and financial instruments, with an important contribution also of information and education.

Figure A3.7 Evolution of type of PaMs in the Czech Republic

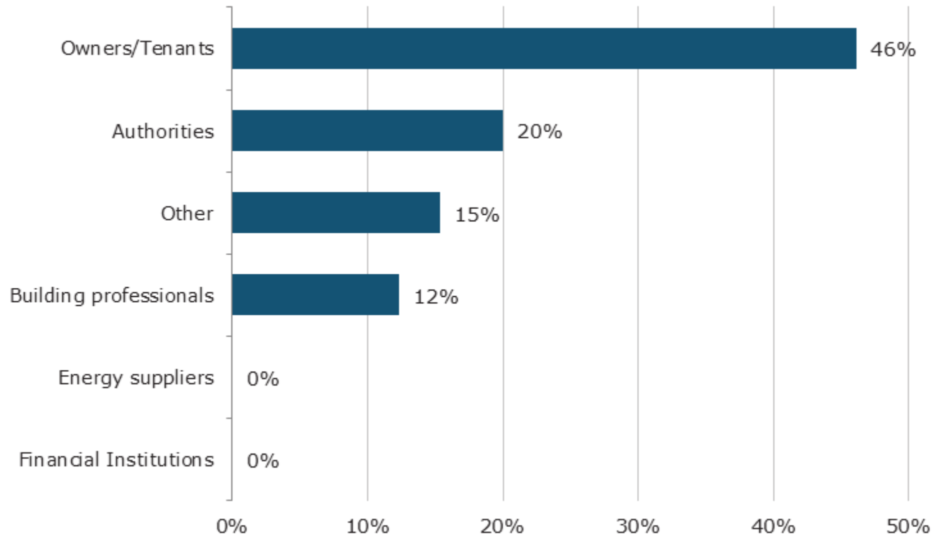


Source: Odyssee, 2017; Ministry of Industry and Trade, 2017

Target audience

Concerning the target audience (Figure A3.8), owner/tenants and authorities are mainly addressed. While the PaMs affect several key target groups, energy suppliers and financial institutions appear completely excluded from policy intervention.

Figure A3.8 Evolution of target audience in the Czech Republic.



Source: Odyssee, 2017; Ministry of Industry and Trade, 2017

The impact of PaMs on energy savings and GHG emission reductions.

National evaluation framework

In the NEEAP, the Czech Republic uses only top-down approaches to estimate improvements in energy efficiency (Ministry of Industry and Trade, 2017). For the evaluation of the impact of specific energy efficiency PaMs, including in the buildings sector, Annex 3 of the Czech Republic's NEEAP provides a detailed description of the applied methodologies, from collection of the data to verification of the information. This applies to a set of 14 PaMs, which are alternative policies under article 7 of the EED[13]. Consistent data collection for each of these support programmes is achieved by a list of specified basic data reporting requirements during registration of applications for financial aid are specified.

The reported information is also verified. For energy savings programmes in buildings, verification will be carried out on a sample of at least 5 % of the supported projects (if energy consumption after project implementation is not monitored for all projects). For energy savings achieved as part of EPC projects and additional measures, energy savings verification will be performed by an independent entity. In the case of energy savings reported from consultancy and awareness-raising, an external review of the

[13] Operational Programme Enterprise and Innovation for Competitiveness 2014-2020, Operational Programme Enterprise and Innovation 2007-2013, Operational Programme Environment 2014-2020, Operational Programme Environment 2007-2013, Integrated Regional Operational Programme 2014-2020, Integrated Operational Programme 2007-2013, EFEKT Programme; Panel Programme, JESSICA Programme, Clean Energy Prague Programme, New Green Savings 2014-2020, New Green Savings 2013, Green Savings 2009-2012, and National Programme Environment.

report from the independent entity will be drawn up, which will determine the savings amount (Annex 3, Ministry of Industry and Trade, 2017).

Ex post impact of energy efficiency PaMs in buildings

According to the fourth NEEAP, the Czech Republic achieved a cumulative energy saving of 27 015 TJ and 7 415 TJ in respectively the household and services sector in the period 2008-2014.

For individual PaMs, those to achieve the energy efficiency target under Article 7 of the EED, individual *ex post* energy savings have been included in the fourth NEEAP. These are:

- The Joint Boiler Replacement Scheme (49.6 TJ between 2014 – 2020),
- the Green Savings Programme (8.7 TJ between 2011 – 2013)
- JESSICA (73.9 TJ saving until 2016)
- Focuses on investment in the renovation of multi-family buildings through the provision of subsidies to cover the interest on loans, with grants of up to 90 % of the investment. Estimated to have achieved 106.9 TJ in savings between 2014 – 2016, and is expected to contribute to 100 TJ additional savings between 2017 – 2020 (Ministry of Industry and Trade, 2017). The programme is administered by the State Housing Development Fund.

The report on climate PaMs under the MMR does not include *ex post* assessments of the impact of energy efficiency policies in the building sector on GHG emissions.

Coherence of the policy mix

The above section indicates that a variety of measures targeting a diverse audience has been implemented in the Czech Republic to improve the energy efficiency of buildings. To have a better indication of the coherence of the PaM package, a cross table of both parameters indicates whether a variety in type of measures also holds true per type of target audience.

Table A3.1 shows that the financial, legislative/normative, and information measures are targeted to a rather broad audience of authorities, building professionals and owners/tenants. So for each of these audiences, the different instrument types appears to be used. Financial instruments are more directed towards the owners/tenants of buildings and authorities than to other target groups. For building professionals regulation instrument types appear more important.

In the Odyssee-MURE database, a 'Policy Interaction Tool' is available, enabling to characterize interaction of packages (Odyssee, 2017). For the buildings sector in the Czech Republic, the level of interaction is suggested for the different types of measures, ranging from strong reinforcement, not interacting to a strong overlap. Seven key policies were identified for the assessment based on their relevance to residential energy efficiency, either by addressing private households, or indirectly through public sector housing. Of the identified energy efficiency policies, no policies were found to have directly conflicting policy goals, although cases of overlap were identified. These cases are largely a result of broad priorities of the PaMs, aiming to improve energy efficiency in the residential sector overall. Of the highlighted policies, 'Support for the installation of cogeneration units', the 'Energy Savings Fund', and the 'Renewal of panel houses – PANEL 2013+' programmes have a national coverage. By comparison, the 'Operational Programme Environment 2014 – 2020', 'New Green Savings Programme 2014 – 2020' and the 'Integrated Regional Operational Programme' have some regional separations, including certain funding streams being available in all regions except Prague (Ministry of Industry and Trade, 2017; Odyssee, 2017).

Table A3.1 Cross table of target audience and type of PaM in Czech Republic.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement	Cooperative measures
Financial Institutions	0	0	0	0	0	0	0
Energy suppliers	0	0	0	0	0	0	0
Authorities	11	3	0	0	3	0	2
Other	9	1	0	0	6	0	0
Building professionals	5	6	0	0	2	0	0
Owners/Tenants	20	11	0	0	8	0	0

Source: Odyssee, 2017; Ministry of Industry and Trade, 2017

Conclusions

Which PaMs have been implemented?

There is a strong dominance of financial and legislative measures, with other types of measures only presenting a limited presence in the policy package. Concerning the target audience, owners/tenants, building professionals, and authorities are mainly addressed, but overall there is a strong diversity in the target audience over the whole time period. Some groups, financial institutions or energy supplies, appear to be missing though.

Impact of PaMs on energy savings and GHG emission reductions

The actual, final consumption for heating in the buildings sector as well as the related energy savings realized between 2010-2015 are slightly below average when compared to other EU countries. The decomposition analysis of the Czech Republic by Odyssee-MURE suggests that energy savings (from energy efficiency improvements) have increased since 2000, but since 2010 there appears to be a stagnation of the progress. According to the NEEAP the Czech Republic achieved an average annual saving of 4 490 TJ per year in the period 2008-2014. The average annual energy consumption the residential and services sector was 412 000 TJ in the same period.

Coherence of the policy mix

Across the different target groups financial, legislative and information instrument types have been implemented. In the group of owners/tenants relatively more financial instruments are provided, while for building professionals more legislative PaMs have been implemented. Given the high number of financial measures, there is on average an overlap between some of the implemented PaMs. This implies that the expected savings of the individual PaMs each are likely to decrease.

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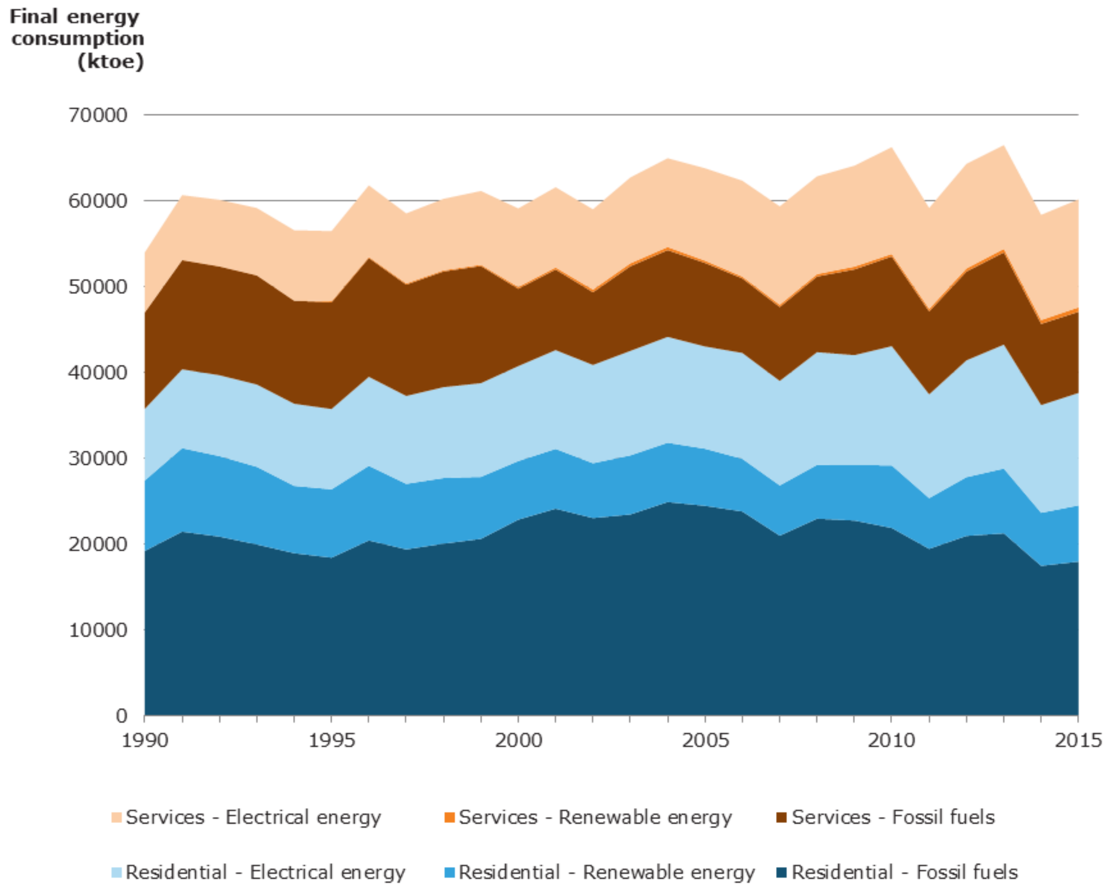
Annex 4. France

Setting the scene: energy consumptions in buildings

In 2013, the French residential stock had about 33.5 million dwellings. More than four out of five dwellings are principal residences, 59 % of which are owner-occupied. In almost four out of five cases (78.5 %), these home-owners live in a single-family home. The remaining 41 % of the principal residences are occupied by tenants, of which 40 % is social housing. The private as well as public rental housing stock mainly concerns collective dwellings: more than three units out of four are apartments. Concerning new dwellings, the share of dwellings constructed between 2001-2012 represent about 10 % of the stock of main residences. The tertiary sector counted in 2012 about 1.459.433 buildings, having a total area of 862.263.687 m² (Ministère de l'Environnement, de l'Energie et de la Mer, 2017).

Figure A4.1 Final energy consumption of the residential and services sector in France, 1990-2015 (in ktoe).



Note: Fossil fuels also includes derived heat and non-renewable wastes.

Source: Eurostat, 2017, simplified energy balances.

The main heating sources are gas (37 % of dwellings) and then electricity (32 %) in the residential park as a whole, and a fortiori in collective dwellings, even more than three quarters of the dwellings are heated by gas or electricity (RenStrat, 2017). In Figure A4.1, the total final energy consumption of the residential as well as the tertiary sector is given for the period 1990-2015. In comparison to other EU countries, the French building stock is rather medium-consuming (Odyssee-MURE, 2017a):

- Residential sector: the average consumption for space heating amounts 10.5 toe/m² corrected for climate;

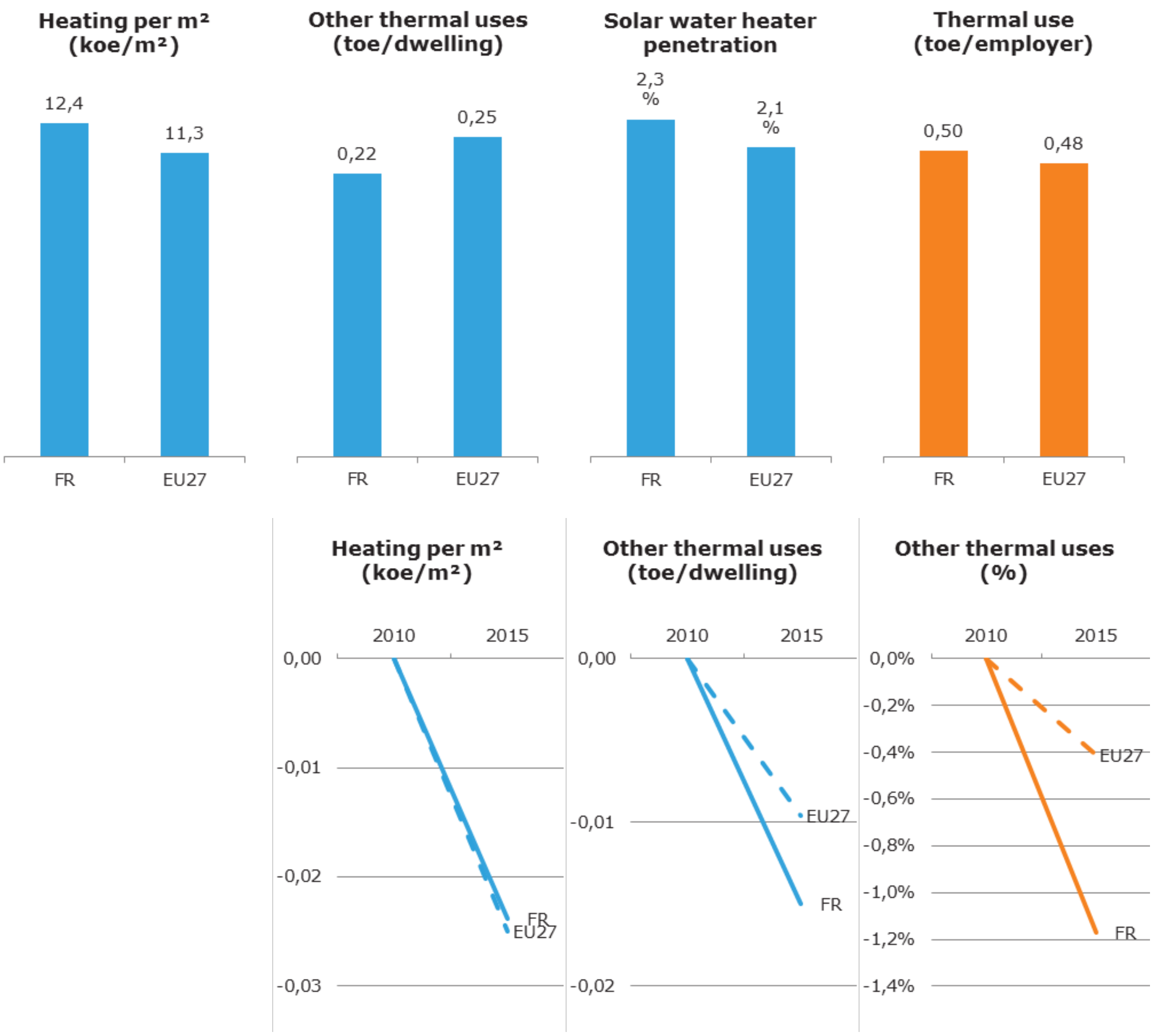
- Services sector: the average consumption per employee is 0.96 toe/employee corrected for climate.

Figure A4.2 indicates that the energy savings for heating between 2000-2015 are comparable to the EU average.

In this respect, the residential and tertiary sector, which accounted for 44.9 % of France's final energy consumption in 2015, represents a major challenge for energy efficiency policies.

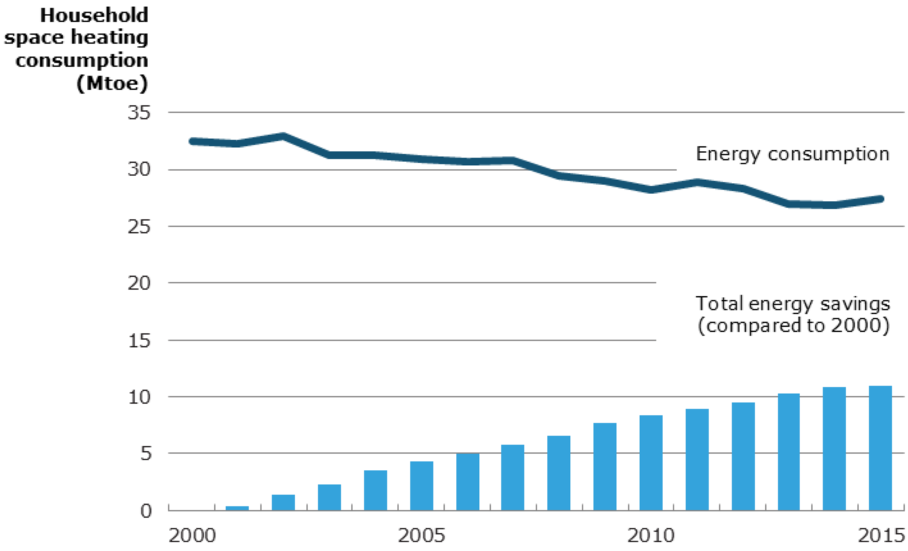
The energy consumption for heating in residential buildings shows a clear and consistent downward trend in the period 2000-2015 (Figure A4.2 and Figure A4.3). The decomposition analysis quantifying the impact of energy savings on total energy consumption shows that there has been continuing progress in energy efficiency in residential buildings, larger than decreases in absolute energy consumption (Odyssee-MURE, 2017a).

Figure A4.2 France positioning within EU: level (2000) and progress (2000-2015) in energy efficiency for households (blue) and services sector (orange).



Source: Odyssee-MURE, 2017a, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A4.3 Energy consumption for space heating in households in France and estimated energy savings (Mtoe).



Source: Odyssee-MURE, 2017a

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

In 2015, France adopted the Law on the energy transition for green growth (LTECV) and its accompanying action plans that aim to allow France to contribute more effectively to the fight against climate change and to the protection of the environment. It also consolidates France's energy independence while offering its citizens and businesses access to energy at a competitive cost (Direction Générale de l'Energie et du Climat, 2017). To provide a framework for the joint action of citizens, businesses, territories and the State, the LTECV sets medium- and long-term targets, for all sectors among which:

- reduce final energy consumption by 50 % by 2050 compared to the 2012 reference, with an intermediate target of 20 % by 2030;
- reduce primary energy consumption of fossil fuels by 30 % by 2030 compared to the 2012 reference.

The LTECV specifically defines objective for the buildings sector, such as:

- achieve a level of energy performance complying with the 'low-energy building' standards for the entire housing stock by 2050;
- combat fuel poverty;
- assert the right for all to have access to energy at an affordable cost with regard to household resources.

Sectoral PaMs

The NEEAP of France identifies following key measures in the residential and services sector:

- The *2012 thermal regulations* which strengthened the energy efficiency requirements of new buildings from 2013 onwards. Apart from setting a maximum primary energy consumption for buildings, it also imposes builders to apply for and submit certifications and declarations of compliance. The item-for-item thermal regulations for existing buildings set minimum performance for those elements of a building that are renovated or replaced.

- Several measures of the LTECV impose a mandatory improvement of the energy performance of existing buildings when major renovation works are carried out. This applies to buildings in the residential and services sector. Prior to the LTECV, this was already initiated in the charter for the energy efficiency of tertiary buildings.
- The energy transition tax credit (CITE) offers a tax credit to the general public for the purchase of energy efficient equipment or building materials. It has been in operation since 2005, but eligible equipment and materials have been continuously revised. The tax incentive has been extended until the end of 2017 at a rate of 30 %. In 2015, it was estimated that the tax credit was used for 150 000 condensing boilers, 21 000 heat pumps, 18 000 heat pump boilers, 160 000 roof insulations, and 65 000 wall insulations (Direction Générale de l'Energie et du Climat, 2017).
- In 2009, France implemented the interest-free eco loan (eco-PTZ). This loan can be used to finance up to EUR 30 000 for the energy efficiency renovation of residential buildings. The loan is available to both owners as landlords. The total number of loans in the period 2009-2015 is 311 260.
- The Housing energy renovation plan (PREH), announced on 21 March 2013, reflects the commitment to renovate 500 000 housing units per year by 2017 (Direction Générale de l'Energie et du Climat, 2017). The PREH contains numerous measures that cover all aspects of renovation: decision-making (points of single contact, thermal renovation ambassadors); financing (energy transition tax credit, interest-free eco-loan and social housing ecoloan, energy savings certificates, implementation of third-party financing); and structuring of the sector so that requests can be correctly and properly answered (training and qualification of professionals). These commitments are reiterated in the LTECV. These long-term programs and plans, indicating a timetable and targets, can guide the policy-making and improves the holistic approach or coherence in the set-up and definition of PaMs (BPIE, 2014).

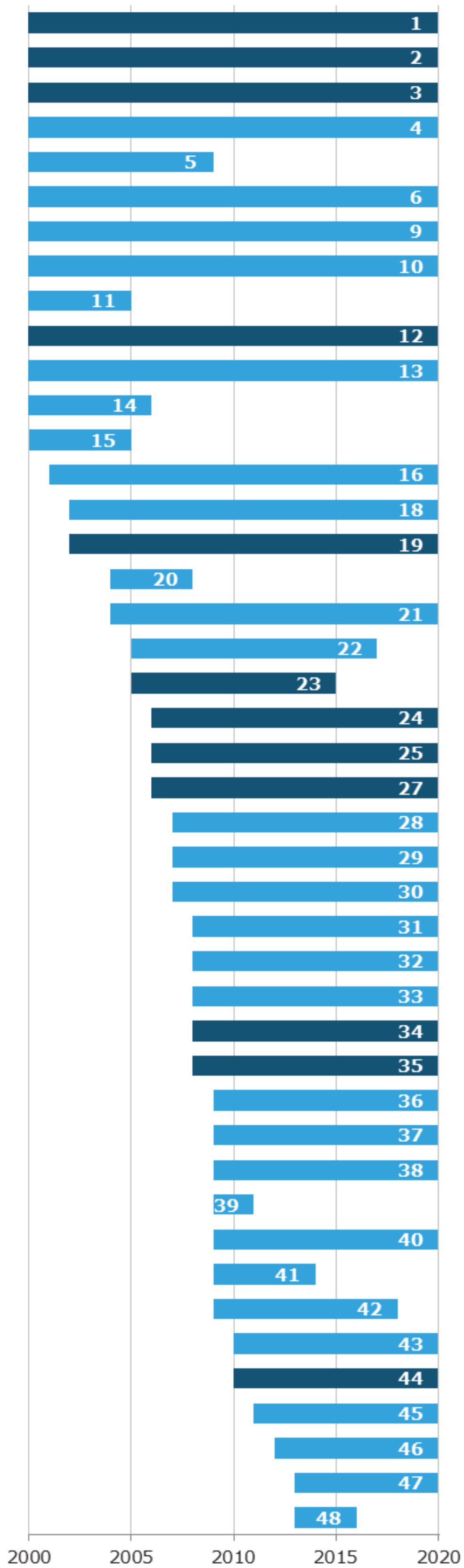
According to a study of ICF (2015), France has a strong framework for minimum energy performance. The compliance rate was high (between 70 and 85%). Concerning energy performance certificates, France has a very strong framework, with a very high compliance rate.

Time frame

France has already a long history of policies dealing with energy efficiency in buildings. Based on the information about PaM's in the Odyssee-MURE database (Odyssee-MURE, 2017b) and the updated NEEAP from 2017 (Direction Générale de l'Energie et du Climat, 2017), a history line is set up in Figure A4.4, illustrating both the long history and an exhaustive list of measures implemented to realize energy savings in the building sector (heating & cooling). This is especially the case for the residential sector. The number of PaMs in the services sector is markedly lower. There are also 12 cross-sectoral PaMs affecting energy efficiency in both the residential and tertiary sector.

Figure A4.4 History of PaMs in France to improve energy efficiency in buildings.

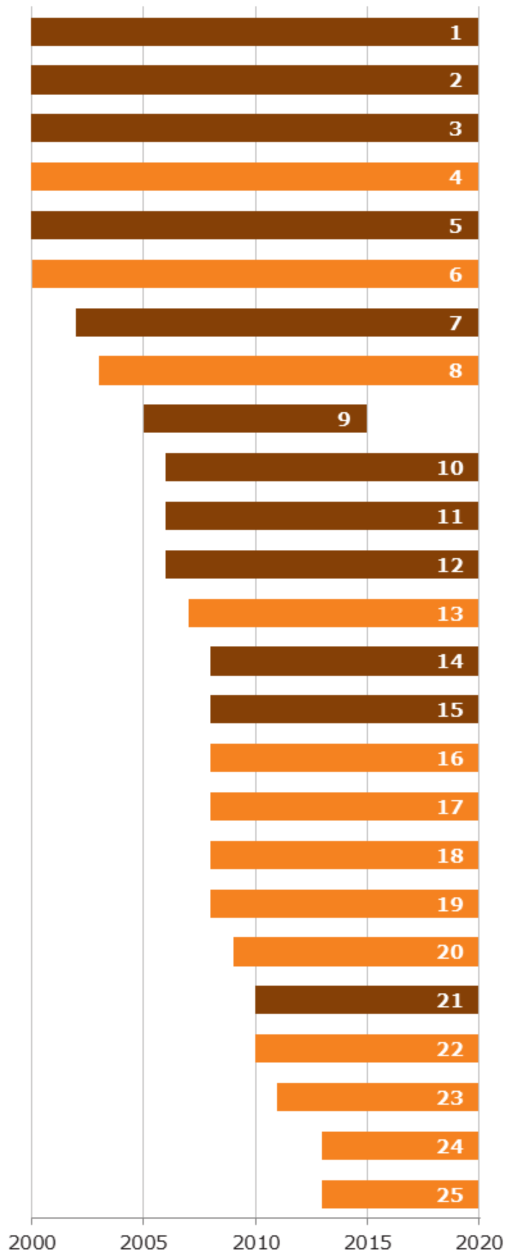
Residential buildings



1	**Tax on energy**
2	**Building codes 1974, 1982, 1989, 2000, 2005, 2012**
3	**Limit to internal temperature**
4	Subsidies for dwellings retrofitting OPAH
5	Subsidies for dwellings retrofitting PALULOS
6	Audits subsidies in buildings
9	Individualised breakdown of heating costs
10	Minimum energy performances of boilers
11	Tax credit for EE materials and RES
12	**Boiler maintenance and periodic control**
13	VAT Reduction to works for EE of housing
14	Subsidies for wood equipment
15	Subsidies for solar equipment
16	Local energy information centres (EIE)
18	Inspections of air-conditioning and reversible heat pump systems
19	**Periodic mandatory inspection of heating / ventilation / AC**
20	Information/advertising campaign "why wait"
21	ADEME energy-saving awareness campaign
22	Energy Transition Tax Credit (CITE) (ex-Sustainable Development Tax Credit)
23	**Research program « l'énergie dans les bâtiments » (PREBAT 1 & 2)**
24	**Energy performance diagnosis**
25	**Energy Saving Certificates (ESC)**
27	**Information and awareness-raising campaigns**
28	CO2-credits for "household" projects
29	High performance label dwellings "label haute performance énergétique" (HPE)
30	Sustainable Development Account
31	Relief from property tax on existing buildings
32	Feasibility study for energy supplies
33	Sustainable building training scheme
34	**Thermal regulation for existing buildings**
35	**Exemplary state process**
36	Thermal regulation and certification in French overseas departments and territories
37	Quality labels for EE works and studies
38	Distribution of energy savings between owner/landlord and tenant
39	Exemption from property tax on existing buildings for BBC dwellings
40	Social housing eco-loan
41	Zero-rated loans for first-time buyers
42	Zero-rated eco-loan "prêt à taux zéro"
43	EE measures to tackle fuel poverty
44	**Measures in favour of Energy Performance Contracts**
45	Targeting of Scellier aid for rental investment towards BBC dwellings
46	Mandatory Energy Performance Diagnosis and audits in co-ownership properties
47	One-stop shop and PRISs (Renovation information service points)
48	Refurbishment plan for housing (PREH)

Figure A4.4 *continued*.

Tertiary buildings



1 **Tax on energy**
2 **Building codes RT 1974, 1982, 1989, 2000, 2005, 2012**
3 **Limit to internal temperature**
4 High environnmental quality of buildings
5 **Boiler maintenance and periodic control**
6 Audits subsidies in buildings
7 **Periodic mandatory inspection of heating / ventilation / AC**
8 Energy efficiency of residential and tertiary buildings - Program OPATB
9 **Research program « l'énergie dans les bâtiments » (PREBAT 1 & 2)**
10 **Energy performance diagnosis**
11 **Energy Saving Certificates (ESC) "Certificats d'Economies d'Energie (CEE)"**
12 **Information and awareness-raising campaigns to improve EE**
13 High energy performance label
14 **Thermal regulation for existing buildings**
15 **Exemplary state process**
16 Reinforcement of local authorities involvement in climate and energy policies – The Cit'ergie programme
17 Thermal Regulations for existing buildings
18 Feasibility study for energy suppliers
19 "Moderning building and cities" programme
20 Energy advisors for local authorities (CEP)
21 **Measures in favour of Energy Performance Contracts**
22 Refurbishment of central government buildings
23 Periodic mandatory greenhouse gas emissions record
24 Mandatory energy audit
25 Charter for Energy Efficiency in buildings of the service sector

Note: In bold, cross-cutting measures

Source: Odyssee-MURE, 2017b; Direction Générale de l'Energie et du Climat, 2017

Instrument types

Looking closer to the implemented measures in France, as depicted in Figure A4.5, we identify over the whole time period a mix of different instrument types. However, it is mainly in the period 2005-2010 that the instrument type mix diversifies. This period corresponds to the implementation of the Energy Services Directive at the EU level. In the Odyssee-MURE database, updated with the fourth NEEAP submission, 17 out of 60 measures are directly linked to an EU Directive, mainly to the EPBD and the EED.

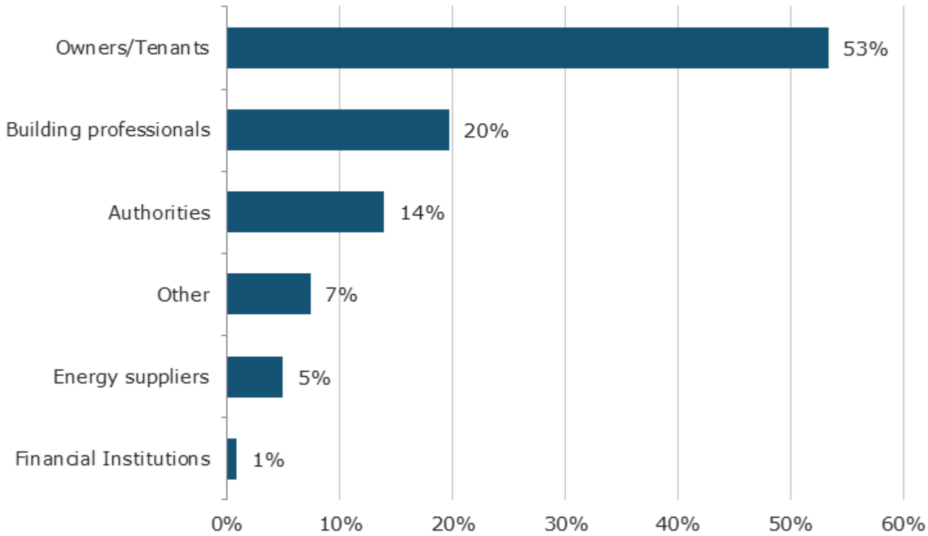
Figure A4.5 Evolution of type of PaMs in France.

Source: Odyssee-MURE, 2017b; Direction Générale de l’Energie et du Climat, 2017

Target audience

Concerning the target audience (Figure A4.6), the group of owner/tenants are clearly mainly addressed by the PaMs. Additionally, also building professionals and authorities are targeted. The least targeted group are financial institutions, as is the case for most other case studies.

Figure A4.6 Evolution of target audience in France.



Source: Odyssee-MURE, 2017b; Direction Générale de l'Energie et du Climat, 2017

The impact of PaMs on energy savings and GHG emission reductions.

National evaluation framework

In the context of the *NEEAP*, the progress made with regard to the targets set by the Energy Services Directive (amounts of energy savings to be achieved in 2010 and 2016), indicators have been calculated based on the top-down methods recommended by the European Commission. These indicators have been calculated with the help of ADEME and Enerdata) project and from the MEEM's statistical service (SOeS).

For the reporting under the *Monitoring Mechanism Regulation*, the DLCES developed a common format for a methodological sheet of evaluation. Each sheet consists of a description of the measure, the method of evaluation (specifying the underlying assumptions, the data used, the definition of the counterfactual scenario and the calculations performed) and of the evaluation results together with an analysis (such as discussion on the consistency of the result's order of magnitude, identification of factors that might influence the result and influence of the other measures). The assessments are carried out by mobilising the most recent statistical data published by the departments in charge of these subjects, and in particular the statistical department of the MEEM (SOeS) which ensures their timeliness. While this report does not cover all PaMs, for the PaMs included information is provided completely, transparently, consistently and accurately.

Ex post *impact of energy efficiency PaMs in buildings*

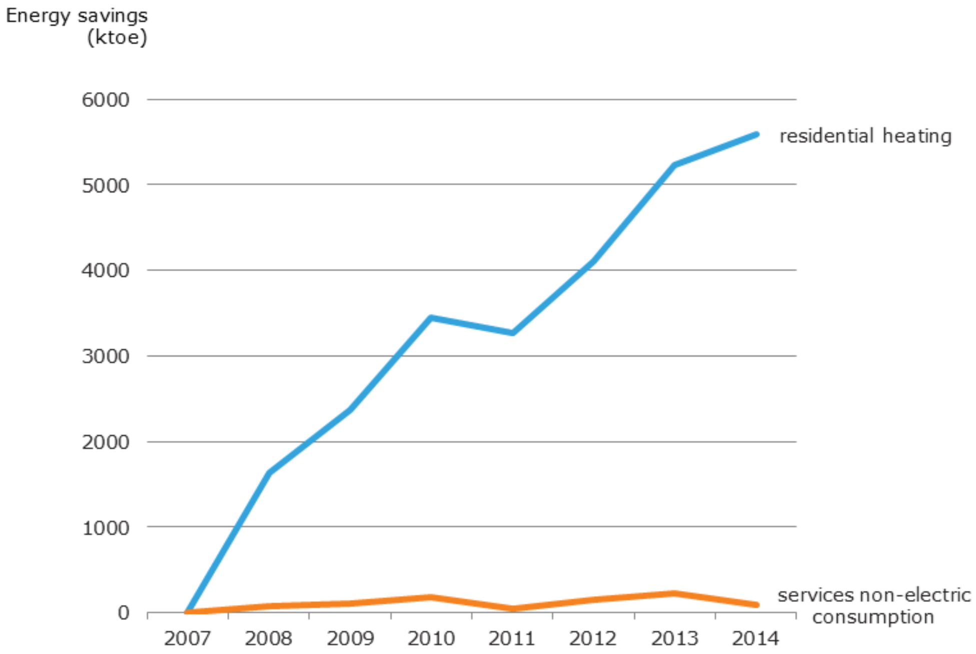
In their NEEAP, France estimated that the energy efficiency in the residential sector resulted in a savings of 6 317 ktoe in 2014 compared to 2007. The largest part of this savings was achieved from heating (5 590 ktoe) (Figure A4.7). It should be noted that the top-down methodology found that energy efficiency for cooling was deteriorating in France between 2007-2014, but was not accounted in the total energy savings. Also in the tertiary sector energy efficiency improvements were calculated between 2007-2014, resulting in energy savings of 636 ktoe. These savings are estimated compared to a reference year, so savings could be the result of policy intervention or autonomous trends, not induced by policy intervention.

France however also assessed the impact of a number of energy efficiency PaMs in a bottom-up approach in their NEEAP and the MMR reporting. This covers the measures that are indicated as the most important measures.

- The Energy Saving Certificate Scheme (certificats d'économies d'énergie) in France's energy efficiency obligation scheme. It sets energy efficiency targets to all suppliers of energy and was created in 2005. The MMR reporting shows that the scheme resulted in a steadily increasing energy and emission savings, starting from 2 and 423 kton CO2-eq. in 2007 to 29.3 TWh and 6 190 kton CO2-eq. in 2015.
- The 2012 Thermal Regulations (Réglementation thermique) strengthened the requirements with regard to the thermal performance of new buildings resulted in a final annual energy saving of 500 ktoe in 2015 and should generate energy savings in the order of 1680 ktoe per year by 2020. It is the main instrument for energy efficiency improvements in new residential buildings. According to the reporting under the MMR, this would result in an estimated emission saving of 1075 kton CO_2-eq.
- The Energy Transition Tax Credit provides private individuals a tax credit for the purchase and installation of the most energy efficient materials or equipment in terms of energy savings (in existing buildings only). This measure resulted in an estimated annual saving of 780 ktoe in 2013 and 930 ktoe in 2016.
- The interest free eco-loan resulted in annual savings in the order of magnitude of 190 ktoe in 2013 and 2016.This loan, available since 2009, is aimed at individual owner-occupiers or landlords in order to finance major renovation work.
- Social housing eco-loans is specifically designed for social housings, offering a loan for energy efficiency renovations at a subsidised fixed rate. It resulted in savings of 350 ktoe in 2013 and 650 ktoe in 2016 annually.
- For the services sector, the key measure in the NEEAP is the implementation of Article 5 of the EED. This is expected to result in savings of 49 ktoe in 2014 and 118 tkoe in 2015.
- The Housing energy renovation plan (Plan de rénovation énergétique de l'habitat – PREH) aims to speed up the renovation of existing housing stock, by relying in particular on the network of Renovation information service points (Points Rénovation Information Services – PRIS) and on improved coordination between existing schemes (energy transition tax credit, interest-free eco-loan, etc.). Fuel poverty is being fought in particular through the actions of the National housing agency (Agence Nationale pour l'Habitat – Anah) and its 'Habiter mieux' (Living better) programme.

These major measures are estimated to achieve about 4.24 Mtoe savings in 2020 (compared to a total final consumption of 60.2 Mtoe in 2015) (Direction Générale de l'Energie et du Climat, 2017).

Figure A4.7 Evolution of energy savings from buildings in the residential and services sector in France (in ktoe).



Source: Direction Générale de l'Energie et du Climat, 2017

Coherence of the policy mix

The above sections indicate that a variety of measures targeting a diverse audience has been implemented in France to improve the energy efficiency of buildings. To have a better indication of the coherence of the PaMs package, a cross table of both parameters indicates whether this variety in types of measures also holds true per type of target audience.

Table A4.1 shows that for most target groups different instrument types have been implemented, for the building professionals this includes all types, but with a dominance of legislation. For the group of owners/tenants there is a strong preference for financial incentives, legislation, fiscal measures, and information. Given the high number of legislative/normative measures on the one hand and financial and informative measures on the other hand, there is a general tendency of overlap (some to strong overlap) in the implemented PaMs. This implies that the expected savings of the individual PaMs each are likely to decrease.

Table A4.1 Cross table of target audience and type of PaM in France.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement	Cooperative measures
Financial Institutions	1	0	1	0	0	0	0
Energy suppliers	4	0	3	0	0	1	1
Authorities	5	2	7	0	4	2	4
Other	1	2	3	0	2	2	2
Building professionals	6	9	4	2	4	2	2
Owners/Tenants	24	23	9	11	17	0	0

Source: Odyssee-MURE, 2017b; Direction Générale de l'Energie et du Climat, 2017

Conclusions

Which PaMs have been implemented?

France has already a long history of policies dealing with energy efficiency in buildings, as well as a big diversity of types of measures implemented.

We identify a strong dominance of financial, legislative/normative, information/education/training, fiscal/tariffs and legislative/informative type of measures. Nevertheless, France has been implementing a variety of measures targeting a variety of audience to improve the energy efficiency of buildings. Focusing on the frequently targeted audience 'general public' still different types of measures have been set up, but concerning the 'building professionals' most of the measures are only legislative/normative.

Impact of PaMs on energy savings and GHG emission reductions

Looking closer to the realized savings (impact) and/or the amount of interventions (output) according to *ex post* evaluations of the individual measures, no concrete conclusions can be taken.

Coherence of the policy mix

The roll-out of long-term programs and plans, like the LTECV and the PREH, can guide the policy-making and improves the holistic approach or coherence of the implemented policy package.

We also see that given the high number of legislative/normative measures on the one hand and financial and informative measures on the other hand, there is a general tendency of overlap in the implemented PaMs. This implies that the expected savings of the individual PaMs each are likely to decrease.

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Odyssee-MURE, 2017a database of energy indicators of EU member states, (http://www.indicators.odyssee-mure.eu/) accessed during July-November 2017

Ministère de l'Environnement, de l'Energie et de la Mer, 2017, Direction de l'Habitat de l'urbanisme et des paysages, 2017, Transposition de l'article 4 de la directive 2012/27/UE, Stratégie à long terme pour mobiliser les investissements dans la rénovation du parc national de bâtiments à usage résidentiel et commercial, public et privé, (https://ec.europa.eu/energy/sites/ener/files/documents/fr_building_renov_2017_fr.pdf)

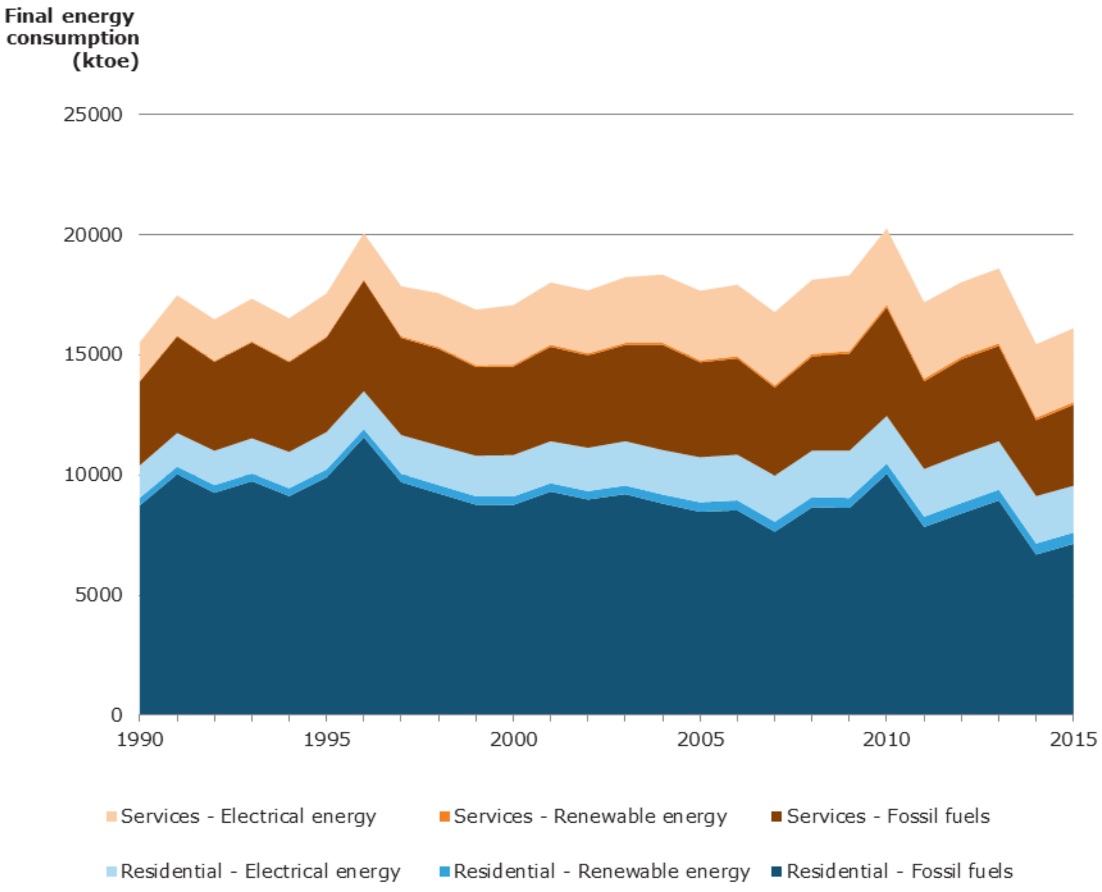
Annex 5. The Netherlands

Setting the scene: energy consumptions in buildings

The housing stock in the Netherlands accounts 7.6 millions of dwellings in the residential sector. In 2015, the number of new built dwellings amounted 48 000 dwellings, which is about 0.5 % of the total stock. An extrapolation of the dutch stock shows that the share of low-energy new dwellings will increase, but even in 2050 the share will only be 20 %. This indicates the large share of the existing stock and therefore, the importance of renovation. In 2015, 55 % of the Dutch stock is owner-occupied, 31 % is available for social tenants and 13.5 % for private tenants. Concerning the utility buildings, the total surface of buildings is estimated at 570 million m². Like the residential sector, the share of new buildings in the total stock is low and even decreasing since 2008 because of the crises (vacancy) (RVO, 2016).

In Figure A5.1, the total final energy consumption of the residential as well as the tertiary sector is given for the period 1990-2015. As indicated in this graph, the main heating sources in the residential as well as in the services sector in natural gas (9.8 Mtoe in 2015 or 61 % of total final consumption).

Figure A5.1 Final energy consumption of the residential and services sector in the Netherlands, 1990-2015 (in ktoe).



Source: Eurostat, 2017, simplified energy balances

In comparison to other EU countries, the Dutch building stock is low-consuming (Odyssee, 2017):

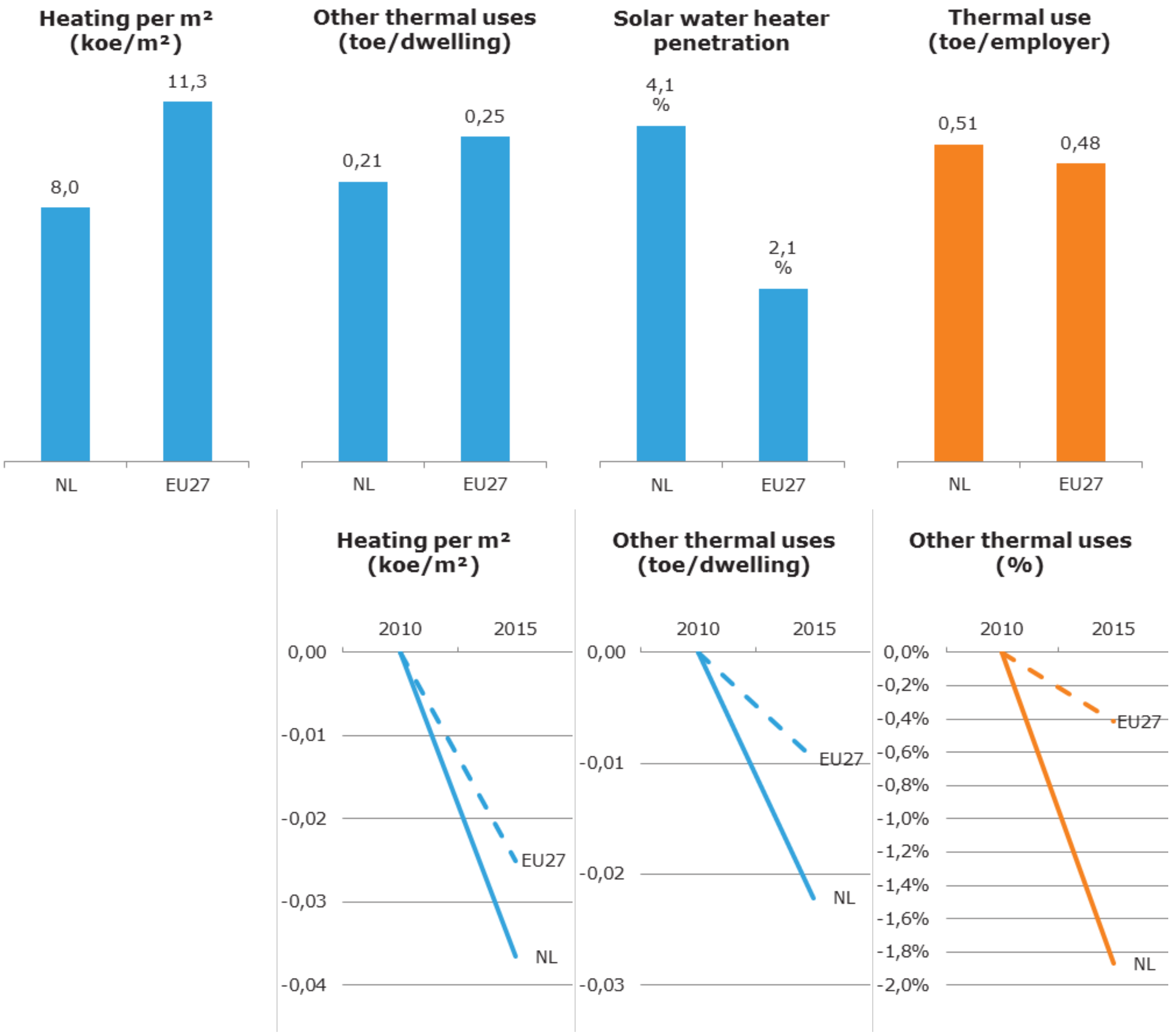
- Residential sector: the average consumption for space heating amounts 6.7 toe/m² corrected for climate;

- Services sector: the average consumption per employee is 0.98 toe/employee corrected for climate.

Figure A5.2 indicates clearly that the actual consumption for heating in the residential sector as well as the related energy savings realized between 2000-2015 are high performing compared to other countries and the EU average.

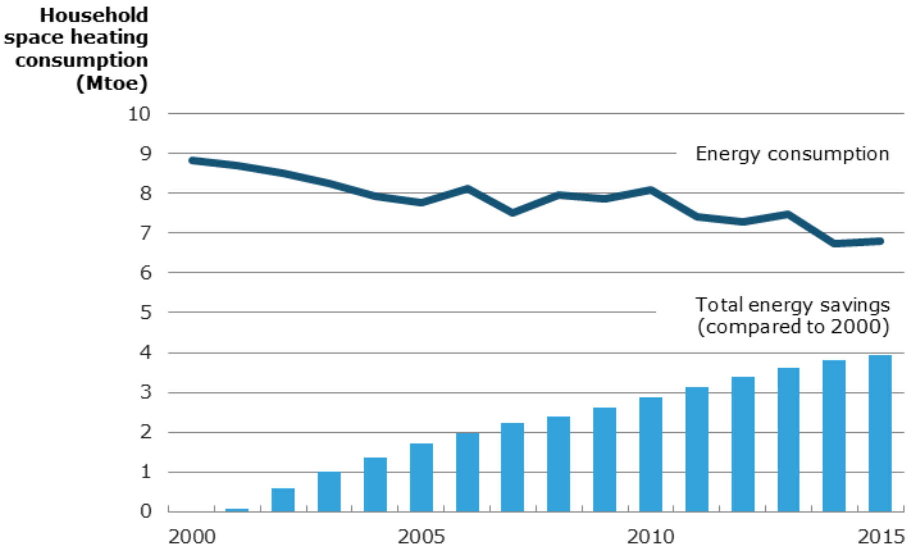
The energy consumption for heating in residential buildings shows a clear and consistent downward trend in the period 2000-2015 (Figure A5.2 and Figure A5.3). The decomposition analysis quantifying the impact of energy savings on total energy consumption shows that there has been continuing progress in energy efficiency in residential buildings, larger than decreases in absolute energy consumption (Odyssee-MURE, 2017a).

Figure A5.2 The Netherlands positioning within EU: level (2000) and progress (2000-2015) in energy efficiency for households (blue) and services sector (orange).



Source: Odyssee, 2017, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A5.3 Energy consumption for space heating in households in the Netherlands and estimated energy savings (Mtoe).



Source: Odyssee-MURE, 2017a

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

Recently, policy measures have been established as part of the Energy Agreement for Sustainable Growth, which includes provisions on both energy conservation and renewable energy sources. The Energy Agreement was established in 2013 and it is expected to save some 100 PJ by 2020, at least 35 % of which to be achieved by 2016 and the reminder 65 % by the end of 2018. Additional measures will be implemented thereafter if the target will be missed. In order to exploit the many opportunities for achieving significant energy savings in the built environment, the Agreement aims at incentivize cooperation between individuals and businesses through a combination of different types of measures, like information provision, awareness-raising, reducing the burden, and funding support (EPRS, 2016).

Besides the Energy Agreement, also an Energy Agenda is adopted in 2016 determining the 2050 long term objectives, among which the renovation strategies (Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017). Having these holistic agreement and long term approaches improves the coherence of the policy package and can guide the policy-making to increase the effectiveness (BPIE, 2014).

A strength of the Dutch approach are its robust transparency and accountability systems. Public communication campaigns about the available measures and their results are regularly undertaken. In addition, an annual progress report and a National Energy Report ensures that the outcomes of the measures are periodically assessed (EPRS, 2016). The annual progress report of 2015 resulted, for instance, in intensifying the energy efficiency policy for buildings in 2016 (eg. obligation of label C for offices) (Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017).

Sectoral PaMs

Already since 1992 the Dutch government has made long-term agreements (MJA) with different sectors to improve energy efficiency. This applies to the sectors industry, services, agriculture and transport. The current long-term agreement will end in 2020. Companies that sign up to this agreement develop a four year energy efficiency plan that includes also buildings.

To provide additional support to the minimum energy performances (see box below) for new buildings, the Dutch government has made a voluntary agreement with relevant stakeholders to promote energy efficiency of buildings further. In 2015, this was superseded by the ZEN agreement (the very energy efficient new buildings agreement). With this voluntary agreement, the government and the construction sector, want to contribute to NZEB and net positive energy buildings.

To specifically address energy efficiency in the rent sector, the Dutch government set targets for the social rent sector and private landlords in a voluntary agreement. To support these targets and government implemented additional PaMs such as subsidies and a loan for energy efficiency investments. This covenant was evaluated in 2016 which showed that while actions had been implemented, the energy savings were still below expectations. The incentives were not sufficient for private landlords. The social rent corporations did improve energy efficiency of their buildings but progress is slow (Vringer et al., 2014).

Minimum energy performances are part of the energy efficiency policy mix since 1995 in the Netherlands for new buildings. Since then these have been regularly revised and strengthened, the last time in 2015. Studies on the cost efficiency of NZEBs are foreseen to be available in 2018. The aim of the Netherlands is to implement this by 2021. For government buildings this applies already in 2019.

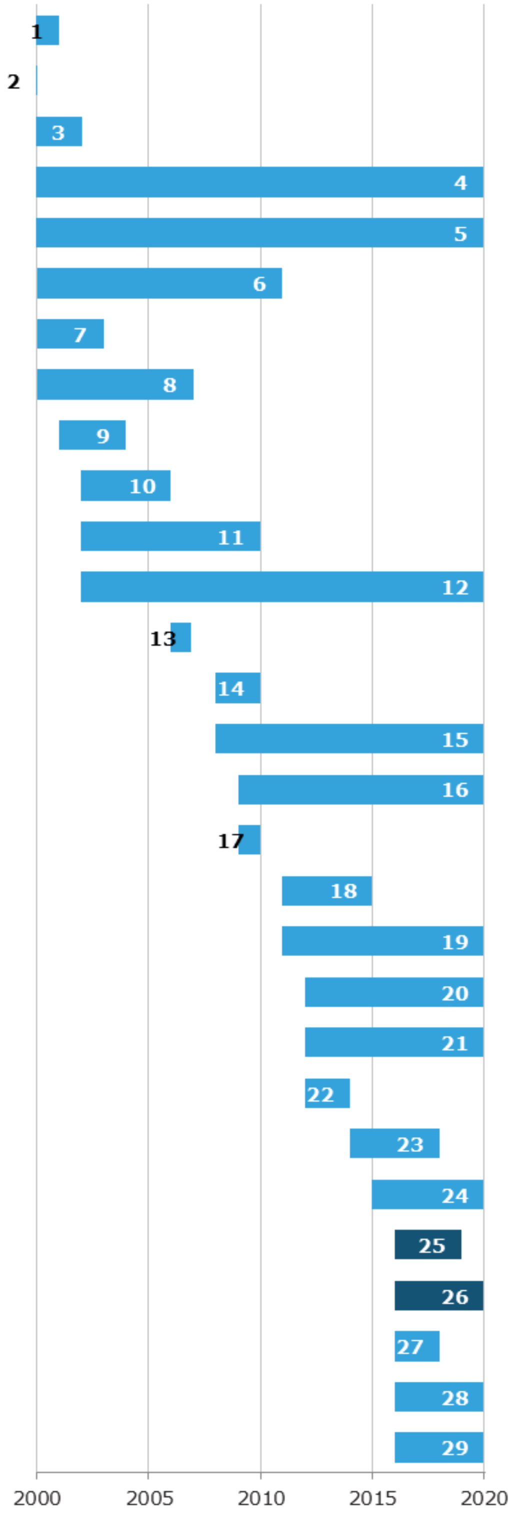
According to a study of ICF (2015), the Netherlands has a strong framework for minimum energy performance. The compliance rate was average (between 55 and 70%). Concerning energy performance certificates, the Netherlands has a strong framework, with a high compliance rate.

Time frame

Based on the information on PaMs in the Odyssee-MURE database (MURE, 2017) and the updated NEEAP from 2017 (Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017), a time line is set up (Figure A5.4), illustrating the long history and the diversity of measures implemented to realize energy savings in the building sector (heating and cooling). Different from other case studies, the time line for the Netherlands shows numerous PaMs that have already expired. Of the 29 PaMs in the residential sector, 15 are still in operation in 2017. These appear to be in most cases financial instruments that have been ended.
In the tertiary sector, where there are much less PaMs, none have expired. Most also are quite recent, suggesting that the Netherlands only recently started to implement policies specifically for buildings in the services sector.

Figure A5.4 History of PaMs in the Netherlands to improve energy efficiency in buildings.

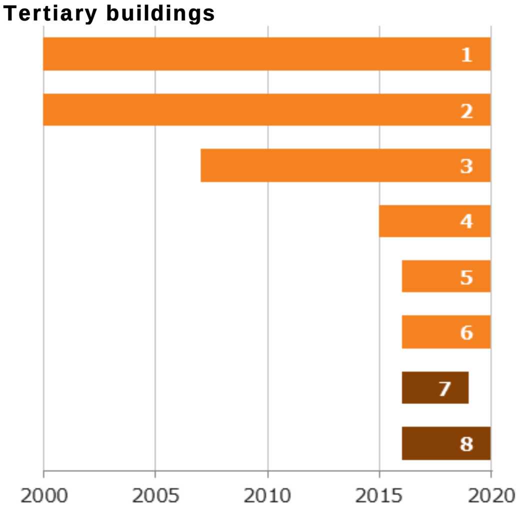
Residential buildings



1	Ecoteams
2	The Enviromental Action Plan (MAP) of the Energy Distribution Sector
3	The Building Decree 1991
4	Energy Performance Standards (EPN)
5	Energy Tax (Energiebelasting)
6	MilieuCentraal, COEN (Consumer & Energy) and HIER campaign
7	Energy Premiums (except renewables)
8	Energy Performance Advice
9	Subsidies sustainable energy within the energy premiums
10	(Temporary) Subsidy scheme on Energy savings for Low Income households (TELI)
11	Compass - Energy-conscious living and working
12	The Building Decree (2002, 2012 onwards)
13	Temporary subsidy scheme Buildings and CO2 reduction
14	Sustainable heat existing houses
15	Energy performance certificate for buildings/ Energy label for houses
16	Reduced VAT rate on labour costs for insulation and glass + maintenance of renovation of residential buildings
17	Customised Advice More with Less
18	Innovation Agenda for the Built Environment
19	Change in the Home Valuation System
20	Covenant Energy Savings Rental Sector
21	Introduction Smart Meters
22	Block by Block approach
23	Incentive energy performance rented sector (STEP)
24	ZEN agreement (zeer energiezuinige nieuwbouw)
25	**Information Campaign 'Energie besparen doe je nu'**
26	**Investment subsidies sustainable energy (ISDE)**
27	Subsidies Energy Savings Own House
28	National Energy Savings Fund
29	Energy Performance reimbursement (EPV)

Figure A5.4 *continued*.

Tertiary buildings



1 Energy Performance of Buildings (Directive 2002/91/EC) - Building Decree and Energy Performance Standard

2 CO2 Reduction Plan

3 Subsidy schemes (IRE, MEI, UKR, Demonstratieprojecten Schoon en Zuinig)

4 Expertise Centre Energy Savings (ECE)

5 Energy performance Inspection (Energie Prestatie Keuring EPK)

6 Premiums energy savings and RES in sports accomadations

7 Information Campaign 'Energie besparen doe je nu'

8 Investment subsidies sustainable energy (ISDE)

Note: In bold, cross-cutting measures

Source: MURE, 2017; Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017

Instrument types

Looking closer to the implemented measures in the Netherlands, as depicted in Figure A5.5, we identify over the whole time period a strong dominance of financial, legislative/normative, and information/education instrument types; other types are only limited represented in the policy package, like fiscal measures and cooperation and voluntary agreements. Figure A5.5 shows that a major part of the PaMs are implemented after 2002, the introduction year of the first important EU Directive linked to heating and cooling of buildings, namely the EPBD. In the Odyssee-MURE database, updated with the NEEAP submission, 18 out of 35 measures are directly linked to an EU Directive, more specifically to the EPBD and the EED.

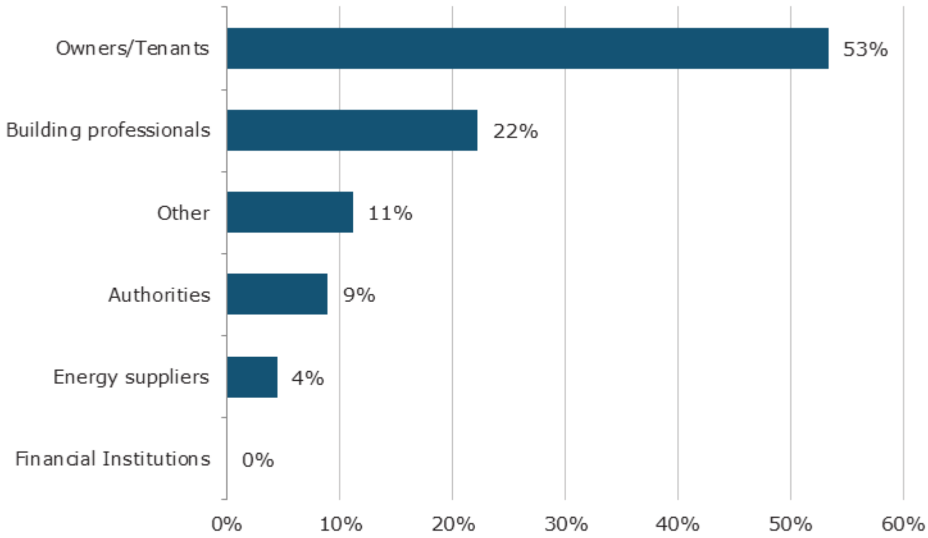
Figure A5.5 Evolution of type of PaMs in the Netherlands.

Source: MURE, 2017; Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017

Target audience

Concerning the target audience (Figure A5.6), owner/tenants are mainly addressed. Over 50 % of PaMs are directed to this group. Also the other groups are the target of policy interventions, except for financial institutions.

Figure A5.6 Evolution of target audience in the Netherlands.



Source: MURE, 2017; Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017

Effectiveness of energy efficiency policies

National evaluation framework

The Netherlands uses top-down approach in the *NEEAP* to estimate energy efficiency savings since 2007. For the bottom-up results included in the NEEAP, no description is provided on the methodology or approach. The results however show that the Netherland account for double counting in their approach.

In the Netherlands, climate policy instruments are monitored with regard to progress and results during their implementation. This is done by various agencies on behalf of the national government. Most energy related instruments are monitored by RVO.nl. They collect and integrate the relevant results for energy and climate related monitoring in close cooperation with all relevant other agencies. These include other governmental implementing agencies as well as specialized sectoral economic expert agencies.

Ex post *impact of energy efficiency PaMs in buildings*

In the Netherlands, the impact of key measures is calculated and reported in the fourth NEEAP. For all residential buildings related measures (excl. electrical appliances) the annual impact of savings are estimated to be between 1400 to 2450 GWh per year in the period 2008-2015. This results in a cumulative energy saving of 15 050 GWh in 2015 compared with 2007.

Tabel 3.3 Jaarlijkse besparingen woningen (bottom-up) (exclusief elektrische apparaten)

	2008	2009	2010	2011	2012	2013	2014	2015
Besparingen woningbouw/jaar (GWh)	1550	1500	1400	2100	1950	2150	1950	2450
- nieuwbouw (GWh)	0	300	250	300	250	400	350	400
- bestaande bouw (GWh)	1560	1200	1150	1800	1700	1750	1600	2050
Totale besparing tov 2007 (GWh)	**1550**	**3050**	**4450**	**6550**	**8500**	**10650**	**12600**	**15050**
Totale besparing tov 2000 (GWh)	13000	14500	15900	18000	19950	22100	24050	26500

The *ex post* impact of individual measures is not reported in the NEEAP. No *ex post* data is reported by the Netherlands on PaMs reported under the MMR. National evaluation of PaMs improving energy efficiency in buildings have been performed in the Netherlands, for example for the block for block programme (RVO; 2014) or the evaluation of the heat law (Haffner et al.; 2016).

Vringer et al. (2016) evaluated the energy efficiency policy in the Netherlands on effectiveness and efficiency. For new buildings, the combination of legal obligation and communication instruments was assessed to be very effective. However, the volume of new buildings is small compared with the number of existing buildings and therefore the most energy must be saved in existing buildings. But the pace of energy saving in existing buildings is deemed slower than needed (Vringer et al., 2016). The existing policy instruments do not stimulate sufficiently energy saving measures on a larger scale.

The report on climate PaMs under the MMR does not include *ex post* assessments of the impact of energy efficiency policies in the building sector on GHG emissions.

Coherence of the policy mix

The above sections indicate that the Netherlands have implemented mostly financial and legislative instruments for a diverse group of actors to improve the energy efficiency of buildings. The general objectives of the Dutch policy is to aim for cooperation between individuals and businesses (EPRS, 2016), therefore there is a preference to target a broad audience with a rather limited number of types of measures.

To have a better indication of the coherence of the PaMs package, a cross table of both parameters indicates whether a variety in type of measures also holds true per type of target audience. Table A5.1 shows clearly that the focus of the Dutch government is on financial measures and information and education that are mostly directed to owner/tenants of buildings. Financial measures are also combined most with legislative measures within the same target group. The exception is the group of owners and tenants where a more diverse set of instruments are applied, including taxes and voluntary agreements.

According to (BPIE, 2014), the Dutch strategy is based around three key principles: informing and raising awareness; facilitating; and financial incentives. The fact that a wider Energy Agreement has been secured with a number of stakeholder bodies is therefore considered a strength.

For the buildings sector in the Netherlands, the combination of legislative/normative measures with financial and informative measures, means there is a general tendency of overlap (ranging from some to strong overlap) in the implemented PaMs (MURE, 2017). This implies that the effectiveness of policies is affected to some extent.

Table A5.1 Cross table of target audience and type of PaM in the Netherlands.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement
Financial Institutions	0	0	0	0	0	0
Energy suppliers	1	0	2	0	0	0
Authorities	2	1	1	0	0	1
Other	2	1	1	0	1	0
Building professionals	6	4	0	0	1	0
Owners/Tenants	41	2	0	4	17	3

Source: MURE, 2017; Minister van Economische Zaken en de Minister van Binnenlandse Zaken en Koninkrijksrelaties, 2017

Conclusions

Which PaMs have been implemented?

The Netherlands' recent experience in energy efficiency is often cited as a prototype of best practices able to establish an innovative, market-leading approach in the household and building sectors (EPRS, 2016).

Impact of PaMs on energy savings and GHG emission reductions

The energy consumption in the Netherlands for heating and cooling of buildings has gone down in recent years (2000-2015), both in absolute and in relative terms. Evidence suggests that these energy savings have been achieved by improvements in energy efficiency that continue until 2015. This is corroborated by evidence from bottom up *ex post* evaluations that show that policy intervention resulted in emission savings in the building sector as a whole. National evaluations of individual measures are available but are not included in either the NEEAP or MMR reporting. Vringer et al. (2016) illustrates though that there is also further room for improvement, especially related to the refurbishment of existing buildings and energy efficiency improvement of non-residential buildings.

Coherence of the policy mix

The Netherlands' experience in energy efficiency is often cited as a prototype of best practices able to establish an innovative, market-leading approach in the household and services sectors. Looking closer to the implemented measures in the Netherlands, we identify over the whole time period a strong dominance of only three types of measures, namely financial, legislative/normative and information/education; other types of measures are only limited represented in the policy package, like fiscal measures and voluntary agreements. On the contrary, the Dutch policy package targets a more broad diversity of target audience: building professionals, the general public, housing associations, landlords and owner-occupiers are mainly addressed. This confirms the general objectives of the Dutch policy to aim for cooperation between individuals and businesses. According to (BPIE, 2014), the Dutch strategy is based around three key principles: informing and raising awareness; facilitating; and financial incentives. The fact that a wider Energy Agreement has been secured with a number of stakeholder bodies is encouraging. What is particularly interesting in the Dutch approach is that the emphasis is less about needing to provide financial support. Rather, it is about a different way of viewing the challenge, and about finding holistic solutions that address the barriers holding back the implementation of cost-effective opportunities.

Further strengths of the Dutch approach are its robust transparency and accountability systems. Public communication campaigns about the available measures and their results are regularly undertaken. In addition, an annual progress report and a National Energy Report ensures that the outcomes of the measures are periodically assessed.

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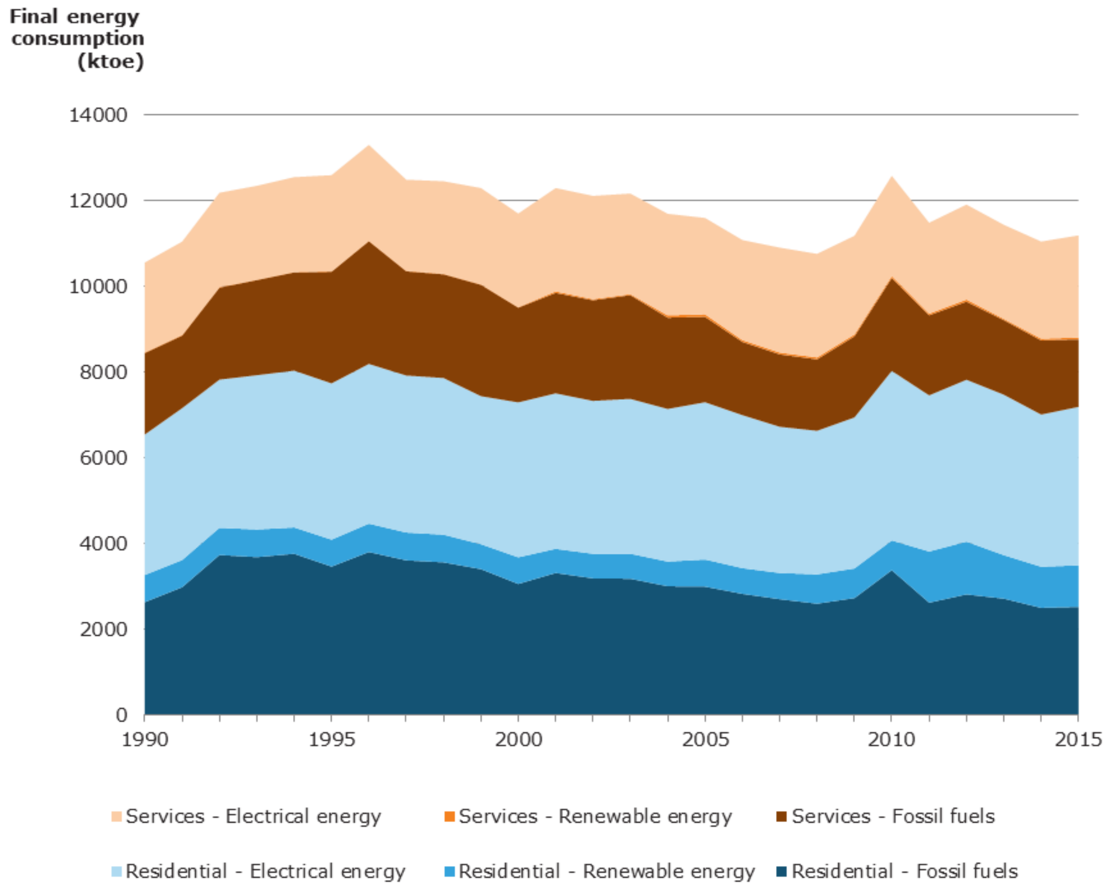
Annex 6. Sweden

Setting the scene: energy consumptions in buildings

Sweden's residential energy consumption is among the highest in the EU, with an average energy consumption of 17.500 kWh per dwelling and year (Figure A6.4) (EU Building Stock Observatory, 2017). The relatively high energy consumption can be attributed to multiple factors such as building standards, a colder climate, and population behaviour.

Since 1990, the energy consumption has remained steady in both the residential and service sectors, with energy efficiency improvements (Figure A6.2) generally offsetting population and economic growth (see Figure A6.1).

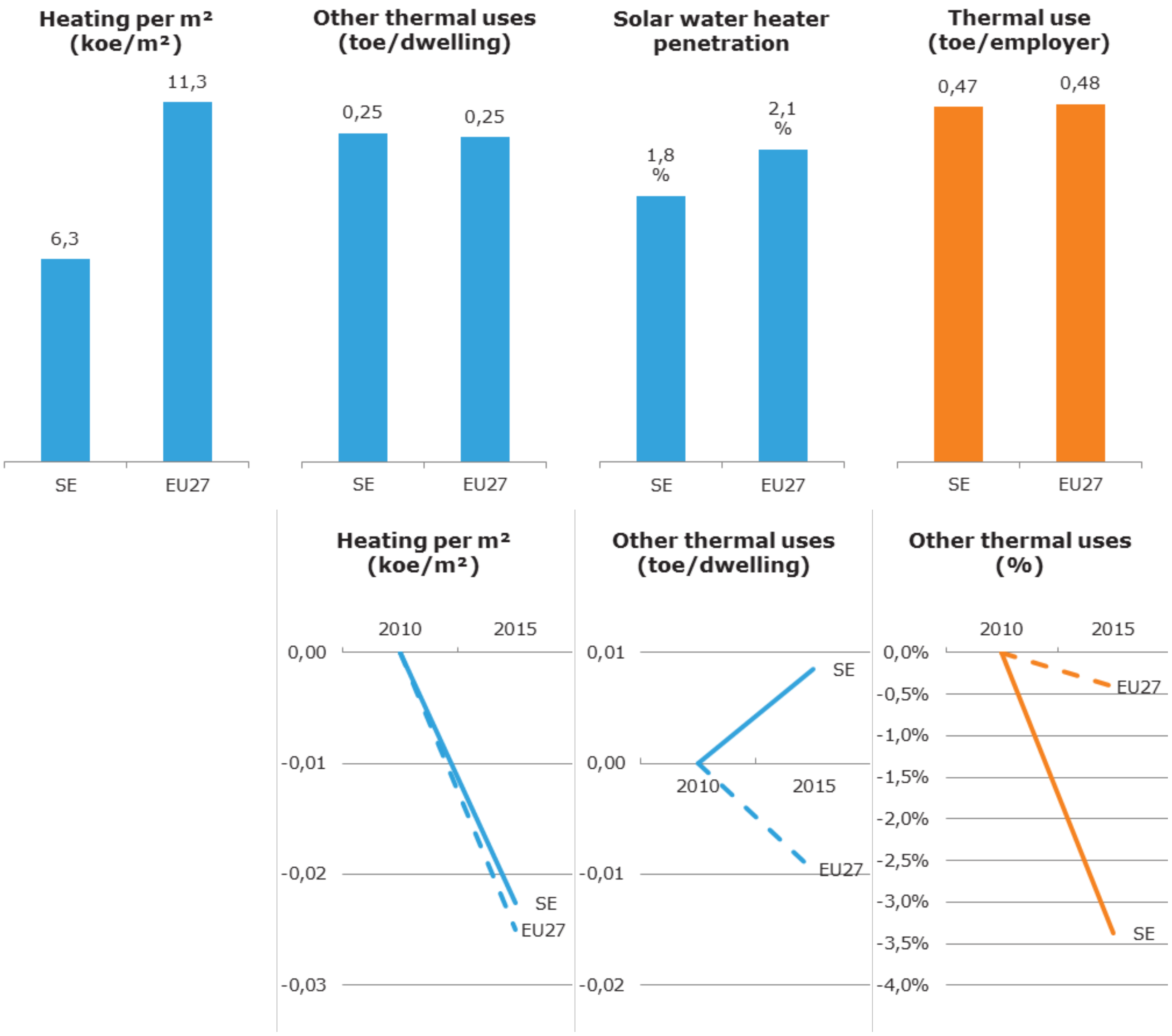
Figure A6.1 Final energy consumption of the residential and services sectors in Sweden, 1990-2015 (in ktoe).



Source: Eurostat, 2017, simplified energy balances

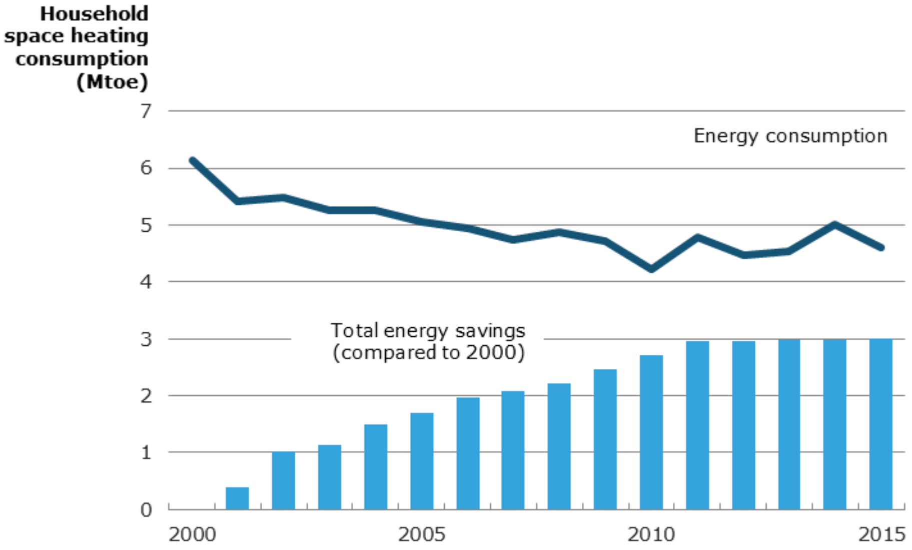
The country's high energy consumption can also be explained by a higher than average dwelling size, and high indoor temperatures. When energy efficiency is compared in terms of square-meterage, Sweden ranks among the 10 least performing countries (Figure A6.5), with an average energy consumption of 187 kWh/m²/year (EU Building Stock Observatory, 2017). The average indoor temperature of 21.2°C in small homes is also above other Member States. Changing behaviours to lowering indoor temperatures presents the largest potential energy efficiency measure (Figure A6.3). It has been estimated that reducing the average indoor temperature to 20°C could reduce domestic energy consumption by 13.3 TWh/year (SEI, 2017).

Figure A6.2 Sweden positioning within EU: level (2015) and progress (2000-2015) in energy efficiency for households (blue) and services sector (orange).



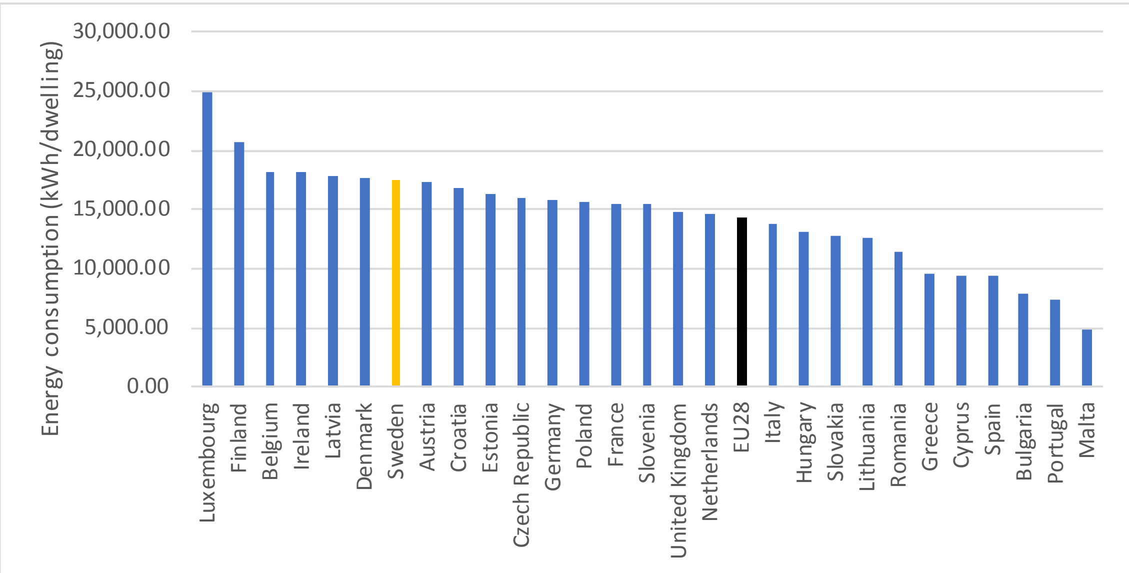
Source: Odyssee, 2017a, http://www.indicators.odyssee-mure.eu/energy-efficiency-scoreboard.html

Figure A6.3 Energy consumption for space heating in households in Sweden and estimated energy savings (Mtoe).



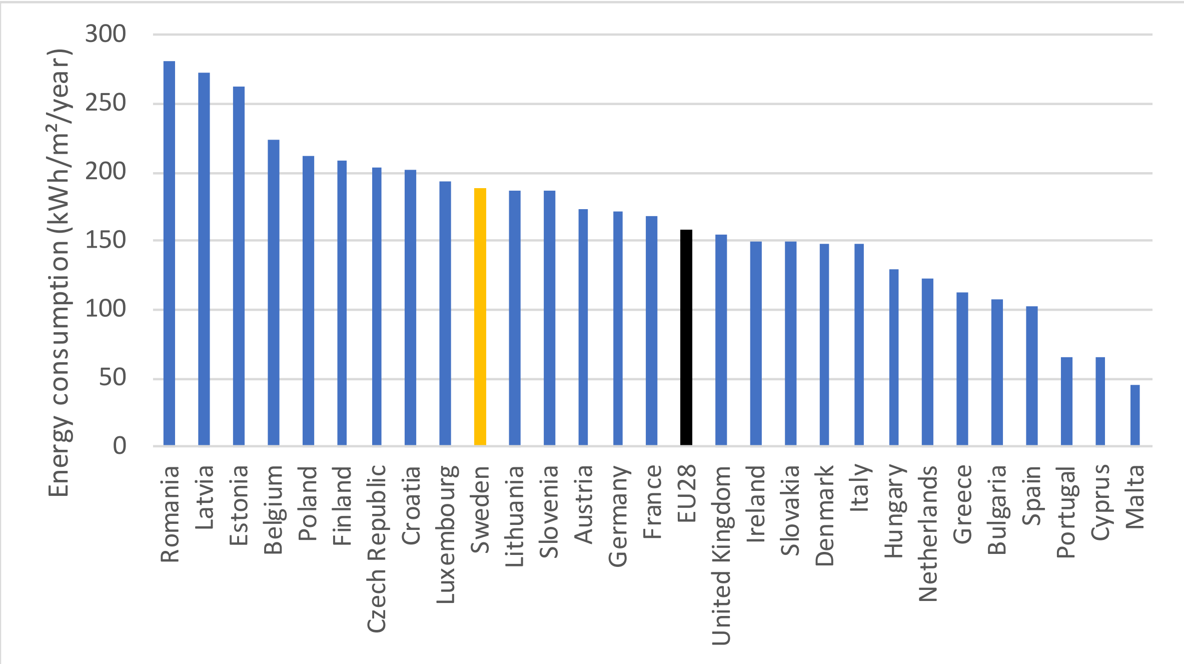
Source: Odyssee-MURE, 2017a

Figure A6.4 Energy consumption per building.



Source: EU Buildings Observatory, 2017

Figure A6.5 Energy consumption per square-metre and year



Source: EU Buildings Observatory, 2017

Implemented PaMs to improve energy efficiency

Description

Horizontal measures

Multiple EU and national policies impact domestic energy efficiency in Sweden, including the 2010 EPBD and the 2012 EED, national building standards (BFS 2015:3), Near-Zero building standards, passive house programmes, testing of energy intensive products, and the national energy and carbon dioxide tax (Odyssee-Mure, 2017a). Energy efficiency improvements are guided by a cross-sectoral target to improve energy efficiency by 20 % by 2020 compared to a 2008 baseline (Regeringskansliet, 2017). The target is based on energy efficiency per unit of GDP in fixed prices (Sweden, 2017).

Swedish building standards are currently in the process of being revised to fulfil EU requirements of Near-Zero Energy building standards. Traditionally, the national building standards have incorporated a gradual variation across the country depending on the nation's four climate zones to account for the varying climatic conditions in the country (BFS 2015:3; Regeringskansliet, 2016).

District heating has played a key role in the Swedish policies related to heating of buildings since the middle of the 20th century. However, the growth of the district heating sector is particularly notable due to the absence of any specific 'district heating policy' guiding the growth of the sector. Instead, district heating schemes have been the direct result of overarching energy and climate policies, and in particular national energy and carbon dioxide taxes are the principal policy instruments applied to improve energy efficiency and reduce greenhouse gas emissions (Swedish Energy Agency, 2015). The effect of the general energy and carbon dioxide taxes has been an overall penalisation of other energy arrangements.

In the Odyssee-MURE database, updated with the fourth NEEAP submission, 7 of the 20 measures are either directly or indirectly linked to an EU Directive, more specifically to the EPBD, the Energy Services Directive and the Ecodesign directive (2009/125/EC).

Sectoral PaMs

In the residential sector, district heating initially grew from the 1940s onwards to the urbanisation following the second World War. Further growth occurred during the 1970s when the large-scale multiple occupancy public housing programme known as 'The Million Programme' (*Miljonprogrammet*) could be connected to district heating during the oil crises (Energiföretagen, 2009).

Swedish municipalities have had a key role in the development of district heating schemes. Through the Swedish 'Planning and building act' (*Plan- och bygglagen*), municipalities are obligated to plan the built environment, and can thus control and develop district heating infrastructure (SFS 2010:900; SEI, 2017). This, combined with the historical state monopoly on energy production led to the district heating networks being operated by municipal energy companies, although there has been a certain privatisation following the deregulation of the energy market in the 1990s. As of today, there are 540 district heating networks in 270 of Sweden's 290 municipalities (Åhman, 2016; Energiföretagen, 2009).

Following the oil crises in the 1970s, environmental legislation and incentives facilitated the transition from conventional fossil fuels to alternative fuels such as biomass and waste. The large tax reforms in 1991 saw the introduction of sulphur-, energy- and carbon dioxide taxes (Swedish Energy Agency, 2006; Carlén, 2014; Åkerfeldt and Hammar, 2016; Åhström et al., 2017).

Through the reliance on municipal district heating schemes, energy efficiency solutions in both the residential and services sectors have benefitted from economies of scale. Similarly, energy efficiency in the residential sector has benefitted from the high proportion of multi-occupancy panel-buildings and apartments connected to district heating, and municipal housing organisations enabling area-wide refurbishment initiatives. However, out of the 870.000 apartments constructed between 1961 and 1975 alone as part of 'The Million Programme', more than a third have not been renovated, and 200.000 apartments are estimated to need refurbishment in the next 10 – 15 years (Energimyndigheten et al., 2012). On average, refurbishing and improving the energy efficiency of such a typical 40-year-old is estimated to approximately EUR 47.200 per apartment (SEK 462.000) (Energimyndigheten et al., 2012).

A readily available domestic production of biofuels, as well as nuclear and hydropower has enabled Sweden to retain low energy prices. Instead, the Swedish government has been able to retain a focus on sustainable domestic energy production, energy security and associated employment opportunities. However, this focus has also reduced the need for energy efficiency improvements, with long payback times as a result (SEI, 2017).

Similar to the situation in the residential sector, the Swedish service sector has retained a high usage of district heating. However, for both residential and service buildings, district heating has seen increasing complementation and competition through the adoption of heat pumps since the 1980s, and more recently through solar energy. Sweden and Switzerland are the two largest adopters of heat pumps per capita (SEI, 2017).

The large investment costs required to develop district heating has also presented a substantial barrier to competition, with district heating often obtaining a monopoly status in the areas where they operate. While enabling substantial reductions of carbon emissions, this situation can reduce pressures that would otherwise lead to energy efficiency improvements.

Quantitatively assessing the impact of Sweden's energy and carbon taxes and their interaction with other policies related to energy efficiency is difficult. Both the energy and carbon taxes have fiscal functions as well as steering effects (Odyssee Mure, 2014). *Ex ante* assessments of the impact of the energy and carbon dioxide taxes estimate an energy saving of 24 PJ between 1990 and 2016 (Odyssee Mure, 2017a).

In the future, Sweden's energy situation is likely to become increasingly problematic. Sweden's reliance on imported waste for district heating purposes and associated overcapacity of EfW incineration plans compared to the domestic waste generation could lock the country into an unsustainable energy system that might become incompatible with EU's energy waste directive (2008/98/EG) and countries' ambition to increase recycling rates. The energy delivery focus through cheap energy supplied by large-scale district heating plants could also prove problematic if energy demand were to decreases as a result of a warmer climate and increasing energy efficiency. A warmer climate will also increase energy demand for cooling, with Stockholm currently operates the largest district cooling system in the country.

Although Sweden has developed some pioneering passive house projects, the overall uptake of energy efficient houses has been limited. Barriers include low public awareness, non-stringent building standards and readily available and cheap low-carbon energy (Person and Grönkvist, 2015; SEI, 2017). The impact of the revised building standards and replacement of the nation's climate zones remain to be seen.

As in the rest of Europe, multiple factors contribute to the limited refurbishment and uptake of most energy efficient buildings in Sweden, for example:

- *Economic* – Different incentives for landowners and tenants, low energy costs, and difficulties raising sufficient capital for refurbishments.
- *Knowledge* – Lack of energy and technology related knowledge especially among smaller landlords. Lack of building managers capable of working with new smart-buildings,
- *Administrative* – Limited enforcement of energy efficiency standards (discussed in greater detail below).

Across Europe, enforcement of energy efficiency standards is generally not considered to be done as strictly as in the case of fire and structural safety standards (Economidou, 2012). In Sweden, procedures have been established to ensure fire, structure and energy efficiency standards, with mandatory enforcements.

If submitted proposals to the local authority are non-compliant with building standards, projects can be refused building permissions. Development of an inspection plan is also mandatory before construction is initiated, and a permit is issued by the responsible local authority once the plan has been completed (GBPN, 2017; Meijer and Visscher, 2017). While inspection plans are mandatory, their strength is somewhat weakened by the regulation's lack of obligatory demands concerning frequency and intensity of site inspections, or what control and inspection methods that should be used (Meijer and Visscher, 2017).

Follow construction, compliance is achieved by measuring actual energy use of the occupied building. Penalties for non-compliance include fines and refusal of permission to occupy (GBPN, 2017). In practice, local authorities' ability to refuse occupancy permits can be limited, especially in the face of housing scarcity, and if occupants have already started living in the building.

Enforcement of energy standards also account for the utilised energy source, with different standards depending on whether the building is connected to district heating, or heat pumps. It remains to be seen how the revised building standards might come to affect this development. However, since the 1940s there has been an overall trend towards declining energy consumption, particularly for single occupancy homes (Swedish Energy Agency, 2012).

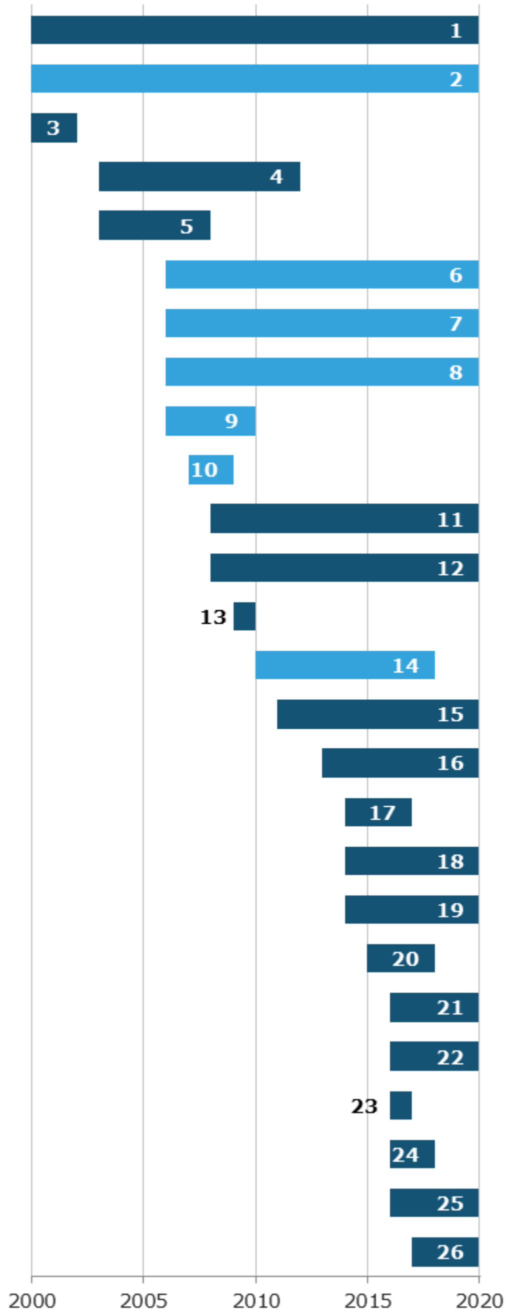
According to a study of ICF (2015), Sweden has a framework for minimum energy performance of medium strength. The compliance rate was high (between 70 and 85%). Concerning energy performance certificates, Sweden has a framework of medium strength, with a very high compliance rate.

Time frame

Figure A6.6 shows that the majority of the current PaMs are implemented after 2006, suggesting a continuous replacement of past policies to keep up with changing legislative demand and new EU legislation since the country's accession to the EU in 1995. The majority of PaMs are still in force. Figure A6.6 makes a differentiation between PaMs specific to the residential or tertiary sector or that are cross-cutting. In Sweden, the cross-cutting measures are clearly an important group of PaMs compared to PaMs that are sector specific.

Figure A6.6 History of PaMs in Sweden to improve energy efficiency in buildings

Residential buildings



1 **Energy and carbon dioxide taxes**

2 Testing and trial of energy intensive products

3 **Programme for reduced electricity use**

4 **Improved statistics for buildings**

5 **Climate Investment Programme (KLIMP)**

6 Building regulations (Planning and building law BFS 2016:13 based on SFS 2011:338)

7 Statute on energy declarations for buildings

8 Energy Performance of Buildings (Directive 2002/91/EC) - Energy efficiency certificates

9 Support for conversion from direct electric systems in households

10 Investments grants for small scale biofuel-fired heating systems and more energy efficient windows

11 **Repair, Conversion, Extension tax deduction**

12 **Ecodesign (Lagen om ekodesign SFS 2008:112)**

13 **Delegation for sustainable cities**

14 Programme for buildings with very low energy use (LÅGAN)

15 **Act on the labelling of energy-related products**

16 **Investment support for grid-connected photovoltaic cells (and for solar hybrid systems)**

17 **Energy Builders (Energibyggare)**

18 **Electricity Act (SFS 2014:270) Adjustments in the electricity act in order to use the grid more effectively**

19 **The Rural Development Programme 2014-2020**

20 **Support for improvements to school premises and outdoor environments beside schools**

21 **Aid for improvement and increases in energy efficiency of rental accomodation**

22 **New glasses (Nya glasögon) -**

23 **Client Skills (Beställarkompetens) - an in depth course following "Energilyftet"**

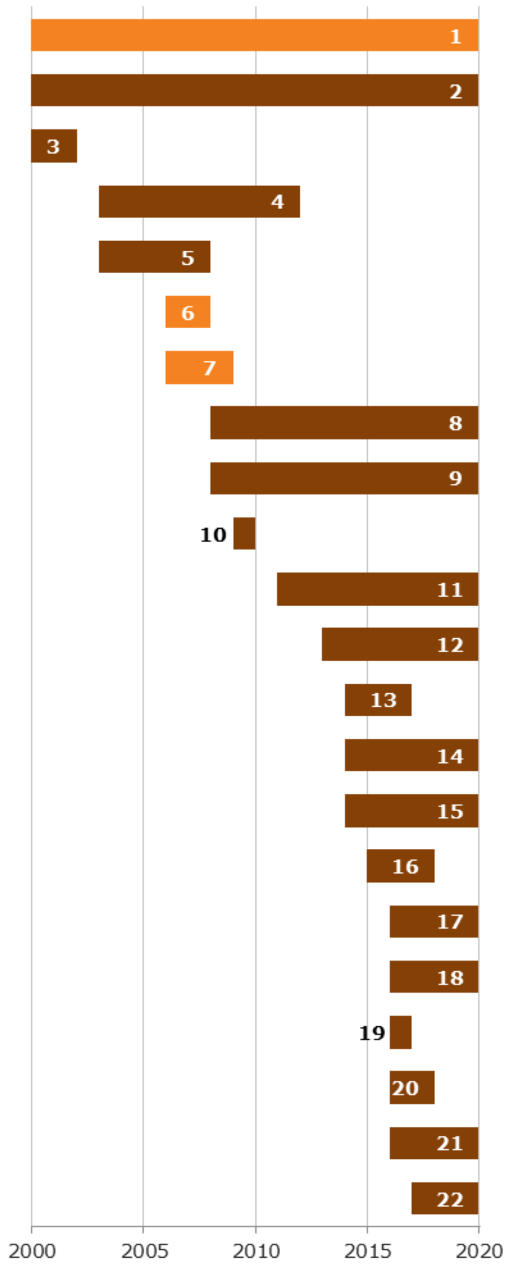
24 **Energy lifting (Energilyftet) - online training course**

25 **Municipal climate and energy advice (Energi- och klimatrådgivningen)**

26 **Sector strategies (Sektorstrategier)**

Figure A6.6 *continued*.

Tertiary buildings



1 Innovation clusters (formerly known as technology procurement groups)

2 Energy and carbon dioxide taxes

3 Programme for reduced electricity use

4 Improved statistics for buildings (Förbättrad energistatistik i bebyggelsen)

5 Climate Investment Programme (KLIMP)

6 Support for energy efficiency, conversion and solar cells in public buildings

7 Grants for solar collecting systems in commercial buildings

8 Repair, Conversion, Extension tax deduction

9 Ecodesign (Lagen om ekodesign SFS 2008:112)

10 Delegation for sustainable cities

11 Act on the labelling of energy-related products (Lag 2011:721 om märkning av energirelaterade produkter)

12 Investment support for grid-connected photovoltaic cells (and for solar hybrid systems)

13 Energy Builders (Energibyggare)

14 Electricity Act (SFS 2014:270) Adjustments in the electricity act in order to use the grid more effectively

15 The Rural Development Programme 2014-2020

16 Support for improvements to school premises and outdoor environments beside schools

17 Aid for improvement and increases in energy efficiency of rental accomodation

18 New glasses (Nya glasögon) -

19 Client Skills (Beställarkompetens) - an in depth course following "Energilyftet"

20 Energy lifting (Energilyftet) - online training course

21 Municipal climate and energy advice (Energi- och klimatrådgivningen, SFS 1997:1322)

22 Sector strategies (Sektorstrategier)

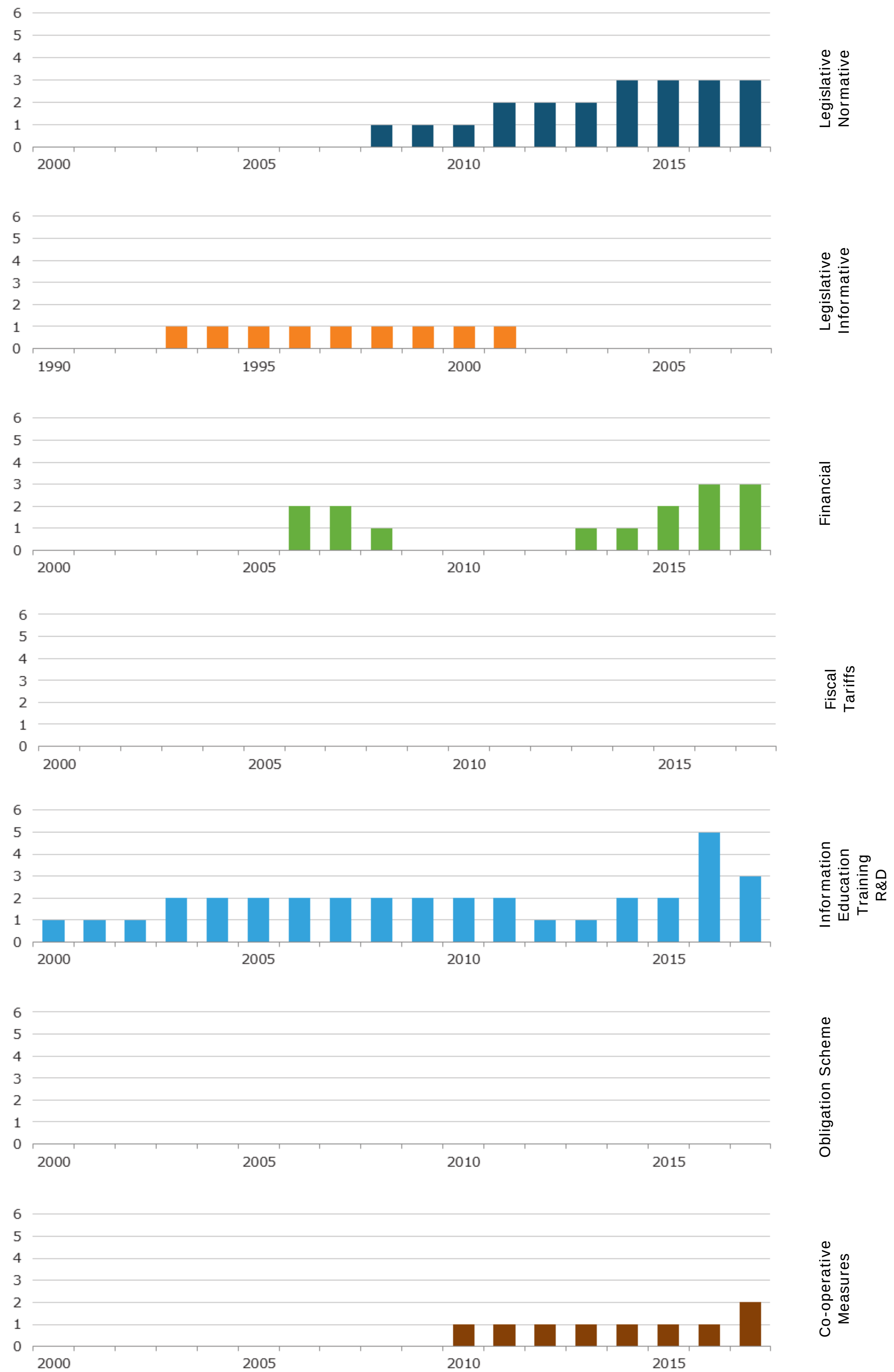
Note: In bold, cross-cutting measures

Source: Odyssee, 2017; Sweden, 2017

Instrument types

Looking closer to the implemented measures in Sweden, as depicted in Figure A6.7, identify over the whole time-period a mixture of primarily legislative/normative, financial and information/education instrument types. After 2010, also cooperative and voluntary agreements become somewhat important. The MURE database does not include any taxes although clearly the energy/carbon tax is. This is however categorised as a legislative measure.

Figure A6.7 Evolution of type of PaMs in Sweden

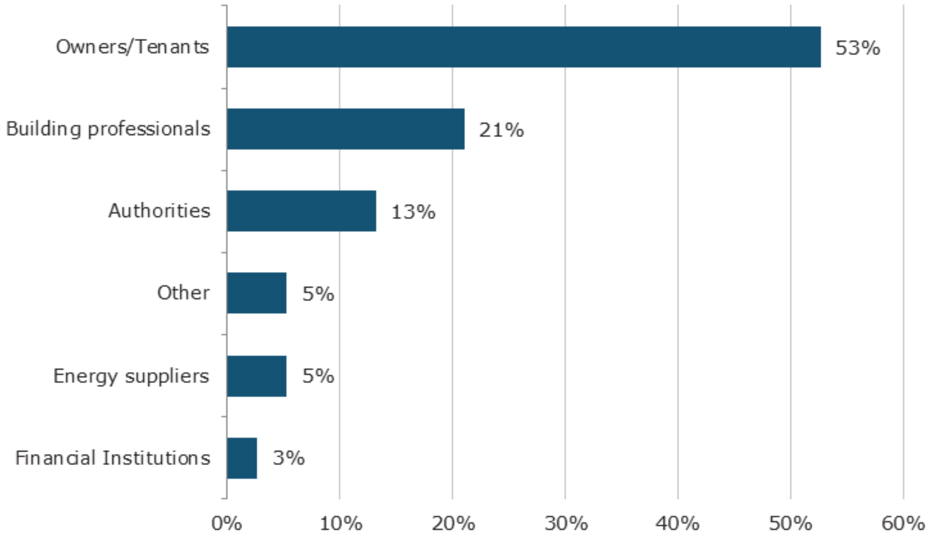


Source: Odyssee, 2017; Sweden, 2017

Target audience

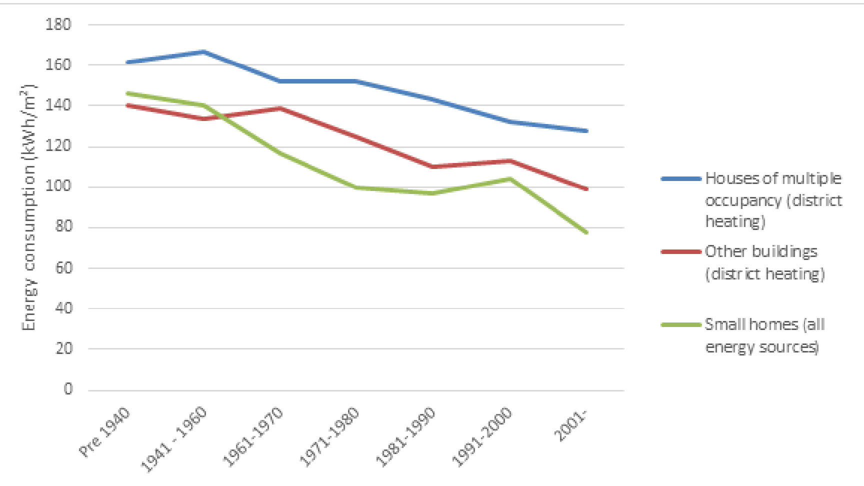
Concerning the target audience (Figure A6.8), owner/tenants, building professionals, and authorities are some of the audiences that are mainly addressed. However, overall the graph shows a strong diversity in the target audience.

Figure A6.8 Evolution of target audience in Sweden.



Source: Odyssee, 2017; Sweden, 2017

Figure A6.9 Energy consumption by construction year and heating system



Source: Swedish Energy Agency, 2012

Effectiveness of energy efficiency policies

National evaluation framework

In the NEEAP, Sweden used the top down approaches proposed by the European Commission to estimate the impact of the energy efficiency measures in buildings. The NEEAP does not include detailed information on *ex post* evaluations of PaMs (Sweden, 2017).

In the reporting under the MMR, also no information is provided on how evaluation of energy efficiency measures is done.

Ex post *impact of energy efficiency PaMs in buildings*

In the Swedish NEEAP, top down methodologies to assess the energy savings from improved energy efficiency in buildings resulted in energy savings of 25.6 TWh in 2014 and 26.6 TWh in 2016 (Sweden, 2017). According to the NEEAP, these energy savings can be largely attributed to two effects:

- The uptake of heat pumps means an increased efficiency in heating;
- The increase in energy prices is an important incentive for households to invest in energy efficiency improvements to the buildings.

Sweden also acknowledges that the top down calculation method is not always the most conservative. In cases where improved energy efficiency also results in an increased use, the method results in higher savings although this mostly applies to transport and industry and less for buildings. The approach also does not take into account autonomous trends, any improvement of energy efficiency is assumed to be caused by policy intervention.

The report on climate PaMs under the MMR does not include *ex post* assessments of the impact of energy efficiency policies in the building sector on GHG emissions.

Coherence of the policy mix

The above graphs indicate that a variety of measures targeting a diverse audience have been implemented in Sweden to improve energy efficiency of buildings (Figures A6.8 and A6.9). To develop a better indication of the coherence of the PaMs package, a cross table of both parameters indicates whether a variety in the type of measures also hold true per type of target audience. Table A6.1 below shows that primarily the legislative/normative and financial PaMs target a broad audience, while legislative/informative and co-operative PaMs are somewhat less frequently implemented.

In the Odyssee-MURE database, a 'Policy Interaction Tool' is available, enabling the characterisation of the interaction of different policy packages (Odyssee, 2017). For the buildings sector in Sweden, the level of interaction is indicated for the different kinds of measures, ranging from a strong reinforcement, or not interacting, to a strong overlap. In the table below, this cross table is presented.

Table A6.1 Cross table of target audience and type of PaM in Sweden.

	Financial	Legislative Normative	Legislative Informative	Fiscal / Tariffs	Information / Education	Voluntary agreement	Cooperative measures
Financial Institutions	0	0	1	0	1	0	0
Energy suppliers	1	1	1	0	1	0	1
Authorities	1	0	1	0	2	0	0
Other	1	0	0	0	1	0	3
Building professionals	5	5	2	0	7	0	2
Owners/Tenants	7	8	8	2	4	0	3

Source: Odyssee, 2017; Sweden, 2017

Conclusions

Which PaMs have been implemented?

The high uptake of district heating in Sweden has not been the result of a specific district heating policy, but is instead the result of events such as the 1970s oil crises, large-scale public housing programmes, and general energy and carbon taxes.

Impact of PaMs on energy savings and GHG emission reductions

Although the residential sector represented 22.7 % of national energy demand in 2015 and the sector has a high average energy consumption compared to other EU Member States (see discussion above), the overall environmental impact is generally considered to be low. This is principally a result of a low carbon intensity of the national electricity grid, and a large uptake of renewable energy in the district heating sector (EC, 2016). Today, Sweden has one of the highest uses of district heating in the EU. In total, the sector heats more than 50 % of all buildings, compared to 6 % in the rest of the EU (SEI, 2017). The role of district heating for the Swedish residential and services sectors is further discussed in greater detail below.

In the Swedish NEEAP (Sweden, 2017), top down methodologies to assess the energy savings from improved energy efficiency in buildings resulted in energy savings of 25.6 TWh in 2014 compared to 2007. This is quite significant when compared to the final energy consumption of 128 TWh in the residential and services sector in Sweden in 2014.

Coherence of the policy mix

Building standards are currently in the process of being revised, and will change from delivered energy to the building, to the building's primary energy. Although district heating schemes continue to have a good cost-competitiveness against other energy sources, it is expected that the future will bring increased competition from other sources such as heating pumps and renewable energy sources such as solar. Enforcement of building standards for new buildings will remain a key priority to reduce energy consumption, but must be coupled with refurbishment of the existing building stock.

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