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Progress in the Implementation of the EU Energy Efficiency Directive through the Lens of the National Annual Reports

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Abstract: Following the adoption of the Energy Efficiency Directive (EED) in 2012, the Member States of the European Union implemented various policies and measures to meet the Directive's requirements, including national energy efficiency targets for 2020. The progress made at national level is tracked through the Annual Reports provided by Member States to the Commission in accordance with the EED Article 24. To provide valuable insights of the actions taken by Member States towards increasing energy efficiency in various sectors of their economies, this paper reviews the assessment of the Annual Reports (AR) submitted since 2013—the year in which the first reports were due—until the latest Annual Reports of 2018. Notably, the implementation status of key EED provisions such as Article 5 on the exemplary role of public bodies' buildings and Article 7 on Energy Efficiency Obligation Schemes (EEOS) is discussed, providing a historical view of the progress made from the inception of the various actions until now. The need of more efforts, in particular with the Article 5 implementation, is identified. The national contributions towards the EU 2020 target are also discussed, including an analysis of the latest energy consumption trends and reasons for which energy consumption remained stable or increased, as given by Member States in their reports. Lessons learned from the EED experience so far are drawn that provide valuable input for the successful implementation of the future requirements under the new Energy Union Governance.

Keywords: EU Energy Efficiency Directive; annual reports; policy update; exemplary role of public bodies; energy efficiency obligation schemes

1. Introduction

Worldwide, energy accounts for about 85% of global CO₂ emissions. This simple data implies an equally simple necessity: the way of producing and using energy must profoundly change in order to meet the climate goals of our societies, as expressed by the long-term objectives of the Paris Agreement [1]. This requires speeding up the deployment and penetration of low-carbon technologies in all end-use sectors, given a greater emphasis on energy efficiency, renewable energy sources and innovation. According to several authors [2–5], this commitment will also bring significant social and economic benefits, such as positive health and well-being impacts, energy poverty alleviation, economic development and job creation, increased industrial productivity and competitiveness, improvement of natural resource management, etc.

In the past decades, this process of paradigmatic transformation was promoted, accompanied and monitored by policy initiatives, at the international, national and local level. All the largest emitter countries (the top ten account for 68% of the world total) implemented programmatic measures [6–10], which have contributed, in a more or less decisive manner, to achieve the first encouraging results [11].

In fact, in the past 40 years, there have been four periods in which CO₂ emission levels were stable or fell respect the previous year, but only the one observed in the last years came in a period of economic growth.

The European Union (EU) has always been one of the entities that has most promoted the introduction of stringent environmental objectives [12]. In this context the Energy Efficiency Directive 2012/27/EU (henceforth the EED or the Directive) [13], adopted in 2012, constitutes a key part of the climate and energy legislative package. It has been designed to stimulate the implementation of energy efficiency improvement measures by Member States based on ex-ante estimates of the existing energy efficiency improvement potential in the EU. All Member States are required to implement policy measures that can improve the efficiency of energy production, distribution and consumption. These requirements aim to achieve the EU energy efficiency target set for 2020 and are now also supposed to contribute to achieving the 2030 energy efficiency target recently established in the amended version of the EED [14]. The EU target set for 2020 corresponds in particular to a 20% reduction in the EU primary energy consumption to be achieved in 2020 compared to primary energy consumption projections for 2020 that were performed through the PRIMES model in 2007. This target implies a primary energy consumption reduction of 370 Mtoe to be realized at the EU level in 2020 and also sets an EU absolute primary energy consumption level of 1483 Mtoe for this year (to be compared with 1853 Mtoe expected by 2007 projections).

To this aim, Member States have been required under EED Article 3 to set indicative (i.e., not mandatory) energy efficiency targets—expressed either in terms of primary or final energy savings, primary or final absolute energy consumption levels or energy intensity reductions—that can overall allow achieving the expected 20% reduction in EU primary energy consumption. Member States have been also requested under EED Article 24 to describe implemented measures and to estimate achieved and expected energy efficiency improvements within National Energy Efficiency Action Plans (NEEAPs) submitted every three years as well as in progress reports (also known as Annual Reports or ARs) submitted every year since 2013. For the latter, Member States have been required to specifically report on their registered recent consumption trends, new or updated policy measures, progresses in the implementation of Article 5, (“Exemplary role of public bodies’ buildings”) and Article 7 (“Energy efficiency obligation schemes”) of the Directive. In particular, as requested by Annex XIV of the EED, Member States have been requested to provide the following minimum information:

- (a) An estimate of various energy-related indicators for two years before (e.g., for 2016 in the Annual Reports of 2018 or AR2018), including a discussion of the reasons if stable and growing energy consumptions were observed.
- (b) Updates on major legislative and non-legislative measures implemented in the previous year (e.g., 2017 in the AR2018), which contribute towards the overall national energy efficiency targets for 2020.
- (c) The total building floor area of the buildings with a total useful floor area over 500 m² and as of 9 July 2015 over 250 m² owned and occupied by the Member States’ central government that, on 1 January, did not meet the minimum energy performance requirements referred to in Article 5(1).
- (d) The total building floor area of heated and/or cooled buildings owned and occupied by the Member States’ central government that was renovated in the previous year (e.g., 2017 in the AR2018) referred to in Article 5(1) or the amount of energy savings in eligible buildings owned and occupied by their central government as referred to in Article 5(6).
- (e) Energy savings achieved two year before (e.g., for 2016 in the AR2018) through the national energy efficiency obligation schemes referred to in Article 7(1) or the alternative measures adopted in application of Article 7(9).

This paper provides a summary of the progress of various actions made from their inception until the latest available year. Next sections discuss the general method adopted and the results

obtained for the four main elements covered by Annual Reports: (i) growing energy consumption; (ii) updates on major legislative and non-legislative measures; (iii) implementation of Article 5; (iv) and implementation of Article 7. Main conclusions are provided in the final section.

2. Method

The European Commission has had the responsibility to assess the annual progress made by Member States in achieving their national energy efficiency targets and in fulfilling the requirements established under the various articles of the Directive. The Joint Research Centre (JRC) of the European Commission has, among others, reviewed and evaluated the information submitted in the Annual Reports.

Points (b) to (e) of Annual Reports were only required since the second Annual Report (that is, AR2014) and in all other subsequent reports. As these points represent the main elements that can give insight on the progress made with the implementation of various provisions of the Directive, our review focuses on the assessment of the Annual Reports submitted over the last 5-year period only; in other words, our analysis covers the Annual Reports of 2014 (AR2014) to 2018 (AR2018). Based on the minimum information from the EED Annex XIV listed above, we can therefore give a historical perspective of the progress made in relation to point (b) in the years from 2013 to 2017, progress linked to points (c)–(d) for the years 2014 to 2017 and progress made with regards to point (e) for the years 2015–2017.

In 2014, during the analysis of the first Annual Reports, it proved necessary to harmonize the information provided by Member States and a common reporting template was developed. Since 2015 it was proposed (never compulsorily) as a guiding tool to share the more relevant information and, as shown in Table 1, in the last 3 years a good number of Member States adopted it as the only tool for sharing data or as a complement to a descriptive report. The last version of the template is shown in Appendix A (Figures A1 and A2).

Table 1. Usage of the AR common reporting template introduced in 2015.

AR Year	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	
2015		x		x				x	x						x					x			x						
2016	x	x		x				x	x	x				x	x	x			x	x	x		x				x		
2017	x	x		x				x	x	x				x	x	x					x		x				x		
2018	x	x		x			x	x	x	x				x	x	x				x	x		x				x		

It should be noted that in several cases, especially when the common reporting template was not available, the interpretation of the shared information has not been trivial. For instance, typical elements of uncertainty were:

- The type of update, the implementing EED article and the main sector(s) affected by the new policy measures reported under point (b).
- The annual requirements and the type of energy savings (e.g., cumulated vs. yearly) achieved under Article 5 (point (d)).
- The type of annual energy savings (e.g., from new measures or from all active measures) reported to address the Article 7 obligation (point (e)).

To overcome these issues, additional sources were considered, such as the National Energy Efficiency Action Plans (NEEAPs) [15,16], the Member States' Notifications regarding Articles 5 and 7 and the ODYSSEE-MURE database [17]. Some Member States were also asked to provide certain clarifications on specific issues.

Since 2013 six Annual Reports for each Member State were analysed [18–20], contributing to the drafting of the last EC's Progress Reports [21–24]. The Annual Reports, as well as the NEEAPs and the Article 5 and 7 Notifications are publicly available on the European Commission's website [25].

All data shown in this analysis (sections below) were extracted or derived from the Annual Reports (almost 200 documents in total) provided by Member States in the past six years.

3. Results and Discussion

3.1. Growing Energy Consumption

According to EUROSTAT statistics [26], in the period from 2005 to 2016, the European Union has reduced its energy consumption. The final energy target for 2020 set by the Article 3 of EED (1086 Mtoe) has been met already in 2014 (1063 Mtoe), but in 2015 and 2016 the final energy consumption increased (1108 Mtoe) and slightly exceeded the 2020 target (corresponding to a gap of 2%).

At national level, since 2005 both the absolute values of primary and final energy consumptions have declined for almost all Member States (the main exceptions are Estonia, Lithuania, Malta and Poland), but it is not possible to say the same looking at the period covered by the analyses included in the Annual Reports. In fact, over the period 2011–2016 only 11 Member States reduced significantly (i.e., more than 1%) their total final energy consumptions (Table 2).

Table 2. Change of Final Energy Consumptions (FEC) over the period 2011–2016 and indication of years in which Final Consumptions (of each sector) has not decreased compared to the previous year.

MS	Total FEC 2016 vs. 2011	Annual Stable/Growing FEC			
		Industry	Transport	Residential	Services
AT	+4%	2012, 2013, 2014, 2015, 2016	2013, 2015, 2016	2012, 2013, 2015, 2016	2014, 2015, 2016
BE	+4%	2012, 2013, 2014, 2015, 2016	2014, 2015, 2016	2012, 2013, 2015, 2016	2012, 2013, 2015, 2016
BG	+4%	2013, 2014, 2015,	2012, 2014, 2015, 2016	2012, 2015, 2016	2015, 2016
HR	−5%	2014, 2015, 2016	2013, 2015, 2016	2015, 2016	2015, 2016
CY	−8%	2013, 2014, 2016	2015, 2016	2015, 2016	2015, 2016
CZ	+1%	2012, 2013, 2015, 2016	2013, 2014, 2015, 2016	2012, 2013, 2015, 2016	2015, 2016
DK	−2%	2014, 2015, 2016	2014, 2015, 2016	2013, 2015, 2016	2012, 2013, 2015, 2016
EE	−1%	2014	2012, 2014, 2015, 2016	2012, 2016	2012, 2014, 2015, 2016
FI	+1%	2014, 2015, 2016	2013, 2015, 2016	2012, 2014, 2016	2012, 2014, 2016
FR	+2%	2015, 2016	2012, 2013, 2014, 2015, 2016	2012, 2013, 2015, 2016	2012, 2013, 2015, 2016
DE	+4%	2012, 2013, 2014, 2015, 2016	2012, 2013, 2014, 2015, 2016	2012, 2013, 2015, 2016	2012, 2013, 2015,
EL	−11%	2013, 2014, 2015	2013, 2014, 2015, 2016	2014, 2015	2012, 2015, 2016
HU	+1%	2012, 2013, 2014, 2015, 2016	2014, 2015, 2016	2015, 2016	2013, 2015, 2016
IE	+6%	2013, 2014, 2015, 2016	2013, 2014, 2015, 2016	2012, 2013, 2015	2012, 2015, 2016
IT	−6%	2014, 2016	2014	2012, 2013, 2015, 2016	2012, 2013, 2015, 2016
LV	−1%	2012, 2014, 2015	2013, 2014, 2015, 2016	2012, 2016	2012, 2014, 2016
LT	+7%	2012, 2014, 2016	2012, 2013, 2014, 2015, 2016	2012, 2016	2012, 2016
LU	−6%	2014, 2016	2016	2012, 2013, 2015	2012, 2013, 2015, 2016
MT	+18%	2012, 2014, 2015	2013, 2014, 2015, 2016	2012, 2013, 2014, 2015, 2016	2012, 2013, 2014, 2015
NL	−4%	2014, 2015, 2016	2015, 2016	2012, 2013, 2015, 2016	2012, 2013, 2015, 2016
PL	+3%	2013, 2014, 2015, 2016	2014, 2015, 2016	2012, 2015, 2016	2012, 2015, 2016
PT	−7%	2014, 2015	2014, 2015, 2016	2016	2012, 2014, 2015
RO	−2%	2014, 2015	2012, 2014, 2015, 2016	2012, 2015, 2016	2012, 2013, 2014, 2015, 2016
SK	−3%	2012, 2013, 2014, 2015, 2016	2013, 2015, 2016	2013, 2015, 2016	2013, 2015, 2016
SI	−3%	2013, 2014, 2015, 2016	2012, 2016	2015, 2016	2013, 2015, 2016
ES	−5%	2014, 2016	2014, 2015, 2016	2012, 2015, 2016	2015, 2016
SE	+1%	2014, 2015, 2016	2013, 2014, 2015, 2016	2012, 2015, 2016	2012, 2014, 2015, 2016
UK	+1%	2012, 2013, 2015	2012, 2013, 2014, 2015, 2016	2012, 2013, 2015, 2016	2012, 2013, 2015, 2016

In addition to the general trends, the analysis of Annual Reports allowed to focus on the evolution in the short-term, by comparing the final consumption values with those of the previous year, for the four main end-use sectors (industry, transport, residential and services). Often this comparison has highlighted increasing (or stable) trends which the Member States were required to explain. Table 2 shows the years in which there was no reduction compared to the previous year for each sector. On average the years associated with a stable or growing trend are the majority for all end-uses and just for few Member States (Croatia, Cyprus, Luxembourg, Portugal, Spain) this picture appears different.

In accordance with Annex XIV of EED, almost all Member States provided explanations in cases where energy consumption remained stable or increased year by year. The main reasons indicated over the period 2011–2016 are summarized in Table 3. In general, they refer mostly to activity growth

(i.e., economy, production, population, employment) and climatic fluctuations, but price effects have also been reported. Rarely the explanations have been supported with in-depth analyses, but the general picture agrees quite well with that one obtained from decomposition analysis, which identifies possible driving factors and their contributions to observed energy consumption trends in the EU [27].

Table 3. More recurrent explanations delivered by Member States overall to justify stable or growing Final Energy Consumptions by end-use sector.

Sector	Explanation
Industry	Economy growth (increase of the Gross Value Added of industry or by the Gross Domestic Product).
	Employment growth. Production growth.
Transport	Activity growth (increase of the total mileage, the flows of passengers and freight or the amount of exports).
	Reduction of the international fuel prices.
	Economy growth (increase of the Gross Domestic Product).
Residential	Vehicles' number growth.
	Increase of the Heating Degree Days (HDD).
	Population growth
	Households' number growth.
	Increase of the disposable income of households.
Services	Increase of electric appliances and electronic equipment of households.
	Decline of international fuel prices.
	Economy growth (increase of the Gross Value Added of services or by the Gross Domestic Product).
	Increase of the Heating Degree Days (HDD).
	Employment growth.
	Reduction of the international fuel prices.

3.2. Updates on Major Legislative and Non-Legislative Measures

Since several articles of the EED encourages Member States to update their existing policy instruments and to implement new measures, it is crucial to monitor constantly this process. For this reason the Annex XIV (Part 1) requires explicitly Member States to report in their Annual Reports updates on major legislative and non-legislative measures implemented in the previous year which contribute towards the overall national energy efficiency targets for 2020.

Coherently with the Annual Report template introduced in 2015, the policy updates were classified according to their legal basis, type of measure and type of update (Table 4). An overview of policy updates based on their legal basis is presented in Figure 1. The number of updates has progressively increased over the years. The Annual Reports of 2014 included just over 100 updates, while the latest Annual Reports of 2018 were close to 400. In the first Annual Reports of 2013, no policy updates were declared as according to EED Annex XIV Part 1 on General framework for Annual Reports, only the second and subsequent reports were required to include the aforementioned points (b) to (e).

As shown in Figure 1, the majority of the updates regarded the implementation of the Energy Efficiency Directive (general transposition and main articles). A few updates of measures stemmed from other directives such as the Ecodesign [28], Energy Labelling [29] and Energy Performance of Buildings [30] Directives, thus highlighting the broad range of EU policy contributing to energy efficiency improvements. In particular, many of the described updates concerned provisions linked with the Energy Performance of Buildings Directive such as energy performance certificates, minimum energy performance requirements and nearly zero energy buildings.

Under the EED, the majority of the concerned measures were claimed under Article 7 (see Figure 1). These were intensified in 2017, as nearly 100 updates concerned either the energy efficiency obligation schemes or alternative measures under Article 7. Updates concerning the general transposition of the EED and the other EED Articles were also reported. In particular: Article 4 on building renovation, Article 5 on the exemplary role of public bodies' buildings, Article 8 on energy audits and energy management systems, Articles 9–11 on metering and billing, Articles 12 and 17 on information and training, and Article 18 on energy services. "Other EED" category includes policies referred to the other EED articles and the quite numerous policies that were not clearly linked to a specific provision of the EED.

Table 4. Categories used to classify the measure updates within the harmonized template.

Category	Classification
Legal basis	General transposition: Energy Efficiency Directive EED
	Energy Efficiency Obligation Scheme Art. 7 EED
	Alternative measure Art. 7 EED
	Renovation roadmap Art. 4 EED
	Exemplary role and purchasing by public bodies Art. 5 and 6 EED
	Public sector renovations Art. 5 EED
	Energy audits in large enterprises Art. 8 EED
	Metering Art. 9 EED
	Billing Art. 10 and 11 EED
	Consumer information, empowering programme, information and training Art. 12 and 17 EED
	Efficiency in heating and cooling (cogeneration, district heating and cooling) Art. 14 EED
	Demand response and efficiency in transformation and distribution networks Art. 15 EED
	Qualification, accreditation and certification schemes Art. 16 EED
	Energy services & performance contracting Art. 18 EED
	Other measures to promote energy efficiency Art. 19 EED
	National Energy Efficiency Fund Art. 19 EED
	Other EED-related measures
Energy performance certificates	
Nearly zero energy buildings	
Minimum energy performance requirements	
Other measures related to the Energy Performance of Building Directive (EPBD)	
Energy labelling	
Ecodesign	
Other	
Regulations and legislative measures	
Market-based instruments (e.g., Energy Efficiency Obligation Schemes)	
Funds, financial measures & fiscal incentives	
Information, knowledge & advice	
Competitions, pilot & demonstration projects	
Market surveillance	
Plans & strategies	
Voluntary agreements	
Other	
Adoption of a new measure, conclusion of agreement, publication of legislation, commencement/enforcement of a measure/programme	
Abolition/termination/completion of measure	
Amendments, implementation or design changes and extension of an on-going measure	
Monitoring information, update on progress or impact assessment results	
Continuation of existing measures/no significant updates	
Drafts, announcements, commitments, planned measures, discussions for a new measure	
Other	

Regarding the policy types, the major part of updates concerned “regulations and legislative measures” followed by “funds, financial measures & fiscal incentives”. About the type of update, the majority of the measure updates concerned “amendments, implementation or design changes and extension of on-going measures”, followed by “adoption of new measures, conclusion of agreements, publication of legislations, and commencement or enforcement of measures and programmes”.

The outcomes of the present analysis stress the need of further harmonization in future reporting obligations. As the reporting template provided for the Annual Reports is of voluntary nature under current EED reporting requirements, not all Member States reported their updates in a structured way, which, at times, rendered it difficult to understand crucial information, such as the type of policy measure and update being described. In 2018, 14 Member States (Austria, Belgium, Cyprus, Denmark, Estonia, Greece, Spain, Hungary, Ireland, Italy, Malta, the Netherlands, Portugal and Slovenia) filled out the template. The ability of this tool to avoid misunderstandings through the use of the template was confirmed by our assessment, demonstrating the need to officially adopt a harmonized reporting approach in the future.

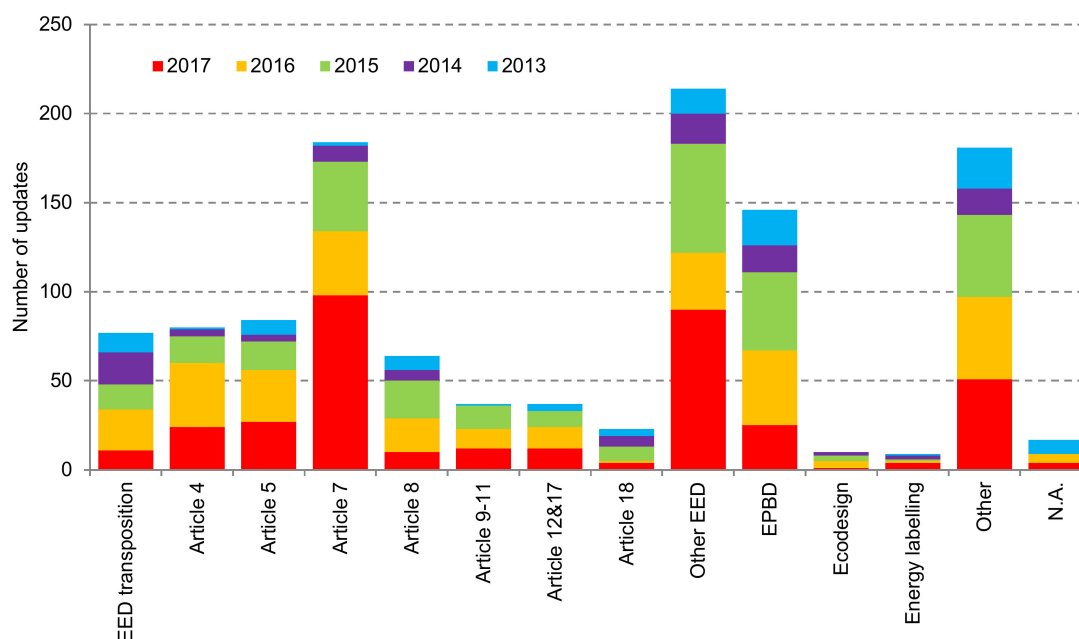


Figure 1. Policy updates by legal basis from 2013 to 2017 reported in the Annual Reports.

3.3. Progress on Article 5 Implementation

Member States were also required (Article 5(1)) to guarantee that the 3% of the total floor area of heated (and/or cooled) buildings owned and occupied by their central government which does not meet minimum energy requirements (set under the Energy Performance of Building Directive) is renovated each year, starting from 1 January 2014. Alternatively, Member States can opt for an alternative approach (Article 5(6)), and achieve equivalent or greater energy savings through the implementation of other cost-effective measures, including deep renovations and measures for behavioral change of occupants.

Tables 5 and 6 provide a summary of the progress communicated by Member States for the period 2014–2017. A color-code system was used in the tables to highlight the level of the annual achievement: green indicates Member States that reached or exceeded the expected savings, yellow represents Member States which fell short of their expected savings by up to 50% and red indicate Member States which fell short by more than half. From Table 3, it can be concluded only Latvia achieved the overall renovation requirement from the reporting period (i.e., 2014–2017).

Table 5. Implementation progress of Article 5 requirement for Member States which chose the default approach (Art. 5(1)). Data are currently under review.

MS	Progress in Terms of Renovated Floor Area [m ²]				Progress in Terms of Ratio Between Renovated Floor Area and Annual Requirement			
	2014	2015	2016	2017	2014	2015	2016	2017
BG	n.a.	72 000	n.a.	28 101	n.a.	28%	n.a.	42%
EE	17 022	56 321	n.a.	40 701	n.a.	184%	n.a.	133%
EL	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ES	306 550	382 581	248 695	302 209	n.a.	132%	90%	110%
HU	n.a.	11 184	n.a.	n.a.	n.a.	85%	n.a.	n.a.
IT	561 090	468 243	559 737	459 045	n.a.	124%	135%	111%
LT	n.a.	24 586	45 559	77 610	n.a.	76%	143%	161%
LU	n.a.	4 281	n.a.	16043	n.a.	124%	n.a.	709%
LV	232 635	136 155	n.a.	136 155	299%	206%	n.a.	227%
RO	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
SI	n.a.	n.a.	11 307	23 514	n.a.	n.a.	49%	102%

Table 6. Implementation progress of Article 5 requirement for Member States which chose the alternative approach (Art. 5(6)). Data are currently under review.

MS	Progress in Terms of Energy Saved from New Measures Implemented in the Reference Year [ktoe]				Progress in Terms of Ratio between Energy Saved from New Measures and Annual Requirement			
	2014	2015	2016	2017	2014	2015	2016	2017
AT	0.318	0.540	0.170	n.a.	54%	92%	29%	n.a.
BE	n.a.	0.465	4.060	n.a.	n.a.	100%	871%	n.a.
CY	0.299	0.295	0.261	0.268	105%	103%	92%	94%
CZ	0.173	0.251	0.170	0.592	51%	74%	50%	176%
DE	n.a.	0.612	n.a.	0.404	n.a.	109%	n.a.	72%
DK	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.	0%
FI	0.759	0.427	n.a.	n.a.	687%	386%	n.a.	n.a.
FR	49.000	118.659	n.a.	120.378	138%	334%	n.a.	339%
HR	0.262	1.466	0.703	0.789	224%	1255%	602%	675%
IE	0.757	0.790	0.054	0.149	470%	491%	34%	133%
MT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
NL	n.a.	2.723	n.a.	n.a.	n.a.	65%	n.a.	n.a.
PL	0.385	0.374	0.468	0.577	103%	100%	125%	154%
PT	n.a.	n.a.	0.035	0.011	n.a.	n.a.	n.a.	n.a.
SE	0.621	1.582	n.a.	n.a.	27%	69%	n.a.	n.a.
SK	0.073	4.709	1.979	4.145	2%	105%	44%	92%
UK	23.388	10.000	2.244	2.089	665%	284%	64%	59%

Given that 2014 was the first year of the implementation, this year was marked insufficient or uncertain progress in most Member States. So, if this year is excluded from the reporting period, the Member States which collectively met their renovation requirements under the default approach in the period 2015–2017 include also Estonia, Spain, Italy and Lithuania. It should be noted that according to the EED Article 5 (3), if a Member State renovates more than 3 % of the total floor area of central government buildings in a given year, it may count the excess towards the annual renovation rate of any of the three previous or following years. For the other countries, it is not possible to draw conclusions due to partial reporting.

In terms of the countries under the alternative approach (Table 5), the collective savings requirement over the period 2014–2017 is met by Belgium, Finland, France, Croatia, Ireland, Poland and the United Kingdom. Cyprus, the Netherlands and Slovakia were short of reaching their requirement on average by 4%, 18% and 20%, respectively. In 2015–2017, Czech Republic also reached its energy savings requirement.

Compared to the initial years of reporting, a higher level of compliance with reporting obligations can be observed in 2017, while 2014 and 2016 have generally been the years with lowest levels of compliance. A number of Member States, however, have still not provided any information on the annual progress made throughout the overall period. These include Greece and Romania under the default approach, and Denmark, Malta and Portugal under the alternative approach. It should be noted that data reported are under review and further clarifications have been requested by the European Commission on the missing data and meaning of some reported values, typically in relation to energy savings claimed under the alternative approach. The most frequent problem in interpreting annual energy saving values relates to whether these savings are only the new savings that have been generated to comply with the 3% obligation for a given year or if they include also savings generated by actions implemented to comply with the 3% obligation of previous years.

3.4. Progress on Article 7 Implementation

As mentioned, Member States have also been required to annually report energy savings achieved two year before (e.g., for 2016 in the AR2018) with the national Energy Efficiency Obligation Scheme (EEOS) adopted in application of Article 7(1) [31] or the alternative measures referred to Article 7(9).

Table 7 provides an overview on the approach used by each Member State to comply with Article 7 (i.e., obligation scheme and/or alternative measures) and the progress made in terms of: (i) savings each year from new actions and from actions already implemented that continue delivering savings in that year, and (ii) ratio of achieved cumulative savings over expected savings for the period 2014–2016.

Generated savings are compared with expected savings by assuming that each Member States is expected to annually generate a constant amount of new savings corresponding to 1.5% of the total energy sales calculated as requested under EED Article 7. If the amount of new savings expected each year is X, the amount of cumulative savings expected in 2014, 2015 and 2016 will hence assumed to respectively be X, $3 \times X$ and $6 \times X$. The linear delivery (taken as reference) assumes therefore that the new actions to be implemented every year (from 2014 up to 2020) have to achieve 1/28 of the total savings requirements to be achieved for 2014–2020. The same color-code system discussed above is also used in this table.

Table 7. Implementation status of Article 7 (final energy values are reported).

MS	Implementation Approach		Total Cumulative Savings Requirement in 2014–2020 under Article 7 [ktoe]	Savings Achieved from New Actions and from Actions Already Implemented that Continue Delivering Savings [ktoe]			Cumulative Savings Achieved over the Period 2014–2016 against Expected Average Savings on the Basis of Linear Delivery [%]
	Obligation Schemes	Alternative Measures		2014	2015	2016	
BE		x	6911	330	545	779	112%
BG	x		1942	29	50	99	43%
CZ		x	4882	50	160	310	50%
DK	x		3841	219	496	758	179%
DE		x	41989	2541	3316	4085	111%
EE		x	610	41	58	184	217%
IE	x	x	2164	71	208	330	131%
EL	x	x	3333	74	134	174	54%
ES	x	x	15979	565	1079	1536	93%
FR	x	x	31384	1410	2192	2887	96%
HR		x	1296	3	21	n.a.	22%
IT	x	x	25502	1298	1399	4565	133%
CY		x	242	2	4	6	24%
LV	x	x	851	8	17	32	31%
LT		x	1004	45	53	86	86%
LU	x		515	0	10	14	22%
HU		x	3680	75	274	292	81%
MT	x	x	67	4	7	8	129%
NL		x	11512	666	1130	3416	211%
AT	x	x	5200	245	637	1026	171%
PL	x		14818	213	1661	3268	162%
PT		x	2532	46	65	94	38%
RO		x	5817	364	337	n.a.	n.a.
SI	x	x	945	18	87	180	141%
SK		x	2284	72	185	n.a.	n.a.
FI		x	4213	561	580	n.a.	529%
SE		x	9114	252	1264	n.a.	n.a.
UK	x	x	27859	1195	2029	2984	104%
EU28			230486	12176	17999	n.a.	n.a.

It can be noted that about half of the Member States have overachieved their cumulative target over the period 2014–2016. Good results achieved by Finland, Austria, Poland, Estonia, Denmark and the Netherlands are to be emphasized. On the other hand, 7 Member States (Bulgaria, Croatia, Cyprus, Latvia, Luxembourg and Portugal) seem to be far away from their savings requirements.

According to complementary calculations provided to the EC under technical assistance [32], it turned out that the large majority of the cumulative energy savings achieved (about 70%) is due to transversal measures that target energy efficiency in two or more sectors. The remaining part focuses mainly on the residential and transport sectors (about 10% each).

As Member States have been required to indicate the type of measures that have generated the claimed savings, it has been possible to produce an overview of the type of measures generating new savings each year. Figure 2 below report therefore the distribution of new energy savings over the various types of measures as generated in 2014, 2015 and 2016.

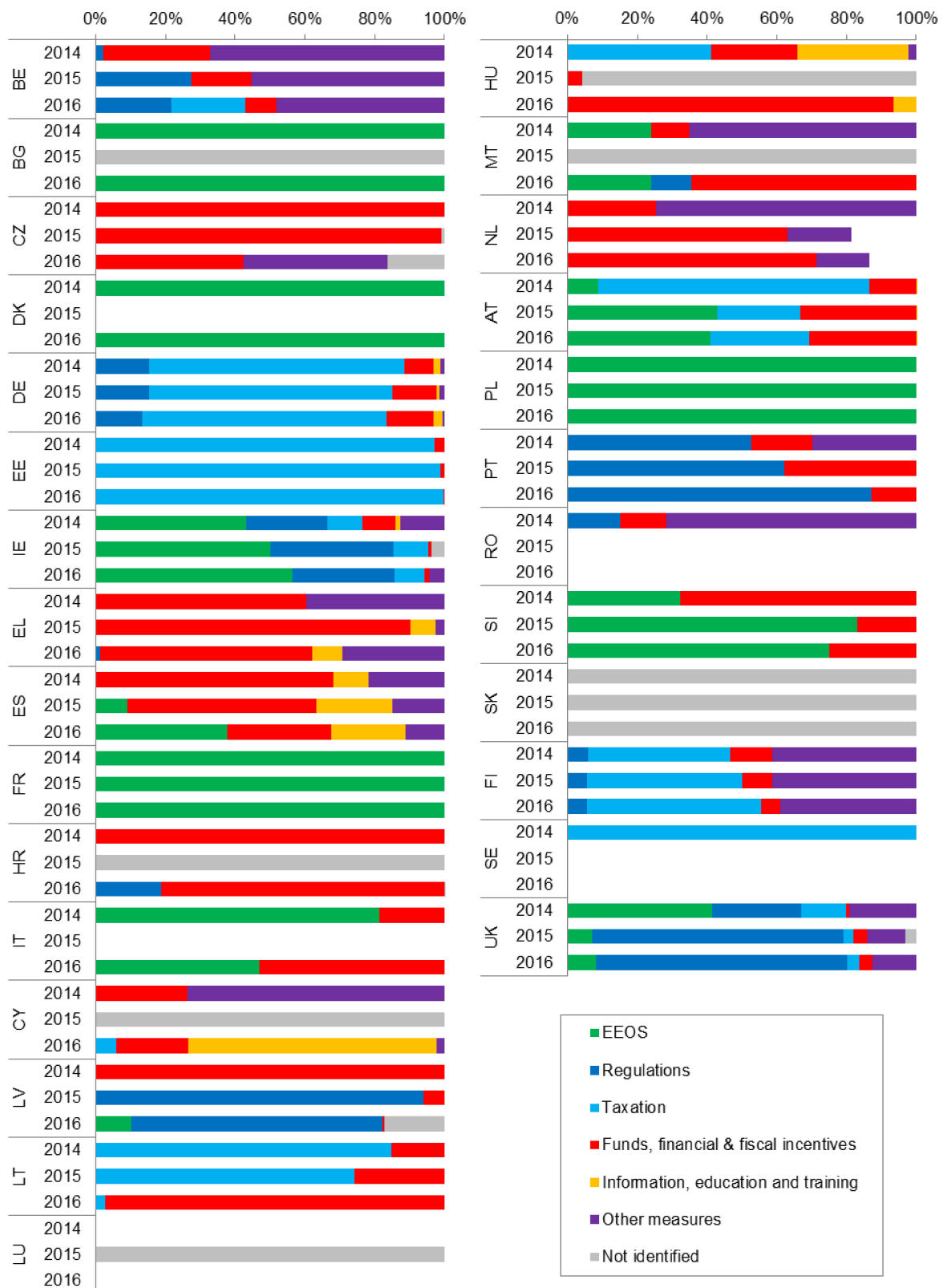


Figure 2. Share of energy savings generated in 2014, 2015 and 2016 by new actions that were implemented in these years, by type of policy measure. The absence of bars means that also total new savings have not been claimed.

The following 12 Member States either partially or fully generated their savings through the implementation of Energy Efficiency Obligation Schemes (EEOSs) (EED Article 7(1)): Bulgaria, Denmark, Ireland, Spain, France, Italy, Latvia, Malta, Austria, Poland, Slovenia and the United Kingdom. It may also be worth noting that savings generated by EEOSs represented almost 41% savings totally claimed under Article 7 savings at the EU level in 2016.

The not exhaustive picture provided by the figure above shows therefore that savings generated through alternative measures (EED Article 7(9)) play a relevant role. The measures falling under the category "Taxation" covered a substantial share (24%) of the total achieved savings over the period 2014–2016, as happening with "Funds, fiscal and financial incentives" measures (18%). Regulatory measures were adopted by nine Member States (Belgium, Germany, Ireland, Croatia, Malta, Latvia, Portugal, Finland and the United Kingdom) generating around 11% of the total savings reported. "Information, education and training" measures used by Austria, Belgium, Cyprus, Germany, Greece and Hungary generated 1.4% of the total saving achieved by actions that were implemented until 2016. Around 10% of total savings was achieved through other measures, as voluntary agreements, public transport public development schemes, etc. The remaining 0.7% could not be associated with any specific measure type.

Variations in the type of measures contributing to claimed new savings under Article 7 over the time period 2014–2016 seem to be noticeable in case of Belgium (where freight transport taxation has started playing a relevant role as of 2016), Ireland and Spain (where the importance of the EEOS in terms of generated new savings seems to increase during the years), Croatia (where regulations for individual heat metering in multi-apartment buildings have been introduced and started making almost 20% of total claimed new savings in 2016), Cyprus (where measures focused on information, education and training have made most of the new savings for the first time in 2016), Latvia (where the EEOS has started generating a significant amount of claimed new savings in 2016), Hungary and Malta (where financial and fiscal measures have generated most or large part of the savings for the first time in 2016), Austria (where savings from taxation measures have been mostly substituted by savings from the EEOS as of 2015), Portugal (where not better specified regulations for the management of energy consumption and the promotion of energy efficiency have become increasingly relevant over the years), Slovenia (where the EEOS makes most of the savings as of 2015) and the United Kingdom (where the relevance of the EEOSs has instead markedly decreased and building regulations have started making most of the savings as of 2015).

Overall, it can be probably concluded that good progress in Article 7 target achievement is being registered. It has however to be generally emphasized that what has made it possible to have a quite clear overview of the situation has been the creation of a sufficiently detailed and understandable report template that the European Commission has made available to Member States to report their progresses under Article 7. As discussed also in other parts of paper, whereas guidance given to Member States has been less clear (e.g., in case of reporting requirements under EED Article 5) the assessment of progresses made results obviously much more difficult.

4. Conclusions

The Energy Efficiency Directive has been one of the key elements of the EU climate and energy legislative package, mandating EU Member States to set 2020 indicative targets on energy efficiency and put in place a number of mandatory policy measures for energy supply, distribution and end-use sectors. The annual reports notified by Member States to the European Commission in accordance with the EED Article 24 constitute the main vehicle through which the progress of implementing key provisions of the Directive can be assessed.

This paper focused on the assessment of the annual reports in the first 5-year reporting period until 2018. Based on this assessment and the historical trends leading to 2016—the year that marks the mid-point between the adoption of the EED in 2012 and the milestone target of 2020—it can be concluded that continued, and in certain cases enhanced, commitment is necessary to keep the EU

on track towards its primary and final energy targets of 1483 Mtoe and 1086 Mtoe, respectively, by 2020. Our assessment has shown that while at national level, both the absolute values of primary and final energy consumptions have declined for almost all Member States since 2005, over the period 2011-2016 only 11 Member States reduced significantly (i.e., more than 1%) their total final energy consumptions. Colder climatic conditions during winter months, economic recovery and growth following the economic recession of 2008, the rise in population and number of households, the increase of passengers and goods transport are some of the reported reasons behind this reversal of trend. The introduction of new and more ambitious national policy actions, as well as strengthening of existing ones in the remaining period leading to 2020, must be considered if Member States are to deliver their fair share of energy savings towards the EU target.

In terms of the implementation status of key Directive provisions, our 5-year assessment has confirmed good progress with regards to the implementation of Article 7, with half of the Member States overachieving their cumulative target over the period 2014-2016. As a result of the implementation of the Energy Efficiency Directive, half of the EU Member States have set an energy efficiency obligation scheme in their national compared with just four Member States (Denmark, France, Italy and the United Kingdom) prior to the adoption of the EED. While design features of these schemes such as type of obligated actors, nature of obligation and ambition of savings vary greatly from country to country, the set-up of obligations on energy suppliers is considered one of the most effective policy measures in energy efficiency and one of the main success stories of this Directive. On the other hand, despite the various reporting gaps identified in our assessment, it can be concluded that meeting the central government renovations requirements or achieving equivalent energy savings under Article 5 may be challenging and increased efforts are therefore needed to step up progress in improving energy efficiency in the public sector. Beyond these two key EED articles, the policy updates reported by Member States enabled the close examination of the progress made in relation to other provisions of the directive, in the form of amendments of existing measures and adoption of new measures as well as conclusion of agreements, enactments of legislations, and enforcement of specific measures and schemes. Our assessment has also identified significant interconnections and synergies with other EU legislations, highlighting the linkages within the overall energy and climate package.

The review of the progress based on the information submitted in the Annual Reports by the Member States has also demonstrated the importance of using a common reporting in the context of the new timeline to 2030 proposed by the new Regulation of the Energy Union and Climate Action [33,34] and the revised Energy Efficiency Directive [35]. The template, introduced in 2015 and subsequently fine-tuned in 2016 and 2017, offered a more structured reporting approach which, for the first time, harmonized the collection process of key information and indicators in energy efficiency policy and thereby reduced the incidence of errors, misinterpretations and subsequent need of clarification requests. However we believe that this monitoring approach can be further improved, by including additional indicators to account the achievements obtained in terms of environmental and socio-economic benefits (e.g., urban pollution, energy poverty alleviation, job creation).

Finally, our assessment has showcased the importance of regular monitoring of the progress made towards the targets and the deployment of econometric modelling and index decomposition analysis that enable the separation of the impact of factors such as economic activity and weather fluctuations on the general energy trends and the isolation of the impact of energy efficiency policy. This is deemed imperative given the nature of the 2030 targets and urgency for stronger, more scientifically-based EU action in the energy and climate agenda.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Additional requirements Article 24 (1), Annex XIV, Part 1 (a) Energy Efficiency Directive

In sectors where energy consumption remains stable or is growing, Member States shall analyse the reasons for it and attach their appraisal to the estimates.

	Main reason 1	Main reason 2	Main reason 3	Please, insert a discussion providing supporting data,
Industry	Please select	Please select	Please select	
Transport	Please select	Please select	Please select	
Households	Please select	Please select	Please select	
Services	Please select	Please select	Please select	
Agriculture (voluntary)	Please select	Please select	Please select	

Additional requirements Article 24 (1), Annex XIV, Part 1 (b) Energy Efficiency Directive

Updates on major legislative and non-legislative measures implemented in the previous year which contribute towards the overall national energy efficiency targets for 2020:

	Type of measure	Legal basis	Type of update	Please, insert explanations or provide a link to an extra/additional document:
Major legislative in the previous year	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
Major non-legislative in the previous year	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	
	Please select	Please select	Please select	

Additional requirements Article 24 (1), Annex XIV, Part 1 (c) Energy Efficiency Directive

Total building floor area [m2] of the buildings with a total useful floor area over 250 m2 owned and occupied by the Member States' central government on 1 January 2018	
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Total building floor area of the buildings with a total useful floor area over 250 m2 owned and occupied by the Member States' central government

Total building floor area [m2] of the buildings which did <u>not meet</u> the energy performance requirements referred to in Article 5(1) on 1 January 2018	
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Additional requirements Article 24 (1), Annex XIV, Part 1 (d) Energy Efficiency Directive

Total building floor area of heated and/or cooled buildings owned and occupied by the Member States' central government that was renovated in the previous year referred to in Article 5(1), or the amount of energy savings in eligible buildings owned and occupied by their central government as referred to in Article 5(6):

Default approach Article 5(1)	
Total building floor area [m2] of buildings renovated in <u>2017</u> as referred to in Article 5(1)	
Amount of energy savings [ktoe] achieved in <u>2017</u> in eligible buildings owned and occupied by their central government due to renovation of buildings as set out in Article 5(1), expressed in primary or final energy	

Alternative approach Article 5(6)	Policy measure (Please, specify the policy measure)	Amount of energy savings [ktoe] achieved in 2016 in eligible buildings owned and occupied by their central government as referred to in Article 5(6)
Alternative measure 1		
Alternative measure 2		
Alternative measure 3		
Alternative measure 4		
Alternative measure 5		
Alternative measure 6		
Alternative measure 7		
Alternative measure 8		
Alternative measure 9		
Alternative measure 10		
Amount of energy savings [ktoe] achieved in <u>2017</u>		
Sum of energy savings [ktoe] achieved in eligible		

Figure A1. Common reporting template (part 1).

Additional requirements Article 24 (1), Annex XIV, Part 1 (e) Energy Efficiency Directive

Energy savings achieved through the national energy efficiency obligation schemes referred to in Article 7(1) or the alternative measures adopted in application of Article 7(9):

Energy savings achieved in 2016 (savings achieved from measures and notified under Article 7(2)(c) and (d) shall not be part of this table)	Policy measure (Please, specify the policy measure)	Savings achieved in 2016 [ktoe]		Total <u>expected</u> savings [ktoe] by 2020 expressed in final energy (voluntary)
		Total annual end-use savings achieved [ktoe] in 2016 (amount of savings from new actions implemented in 2016 and from actions implemented in 2014 or 2015 that continue delivering savings in 2016)	thereof savings achieved [ktoe] in 2016 only from <u>new</u> actions that were implemented in 2016	
EEOS				
Alternative measure 1				
Alternative measure 2				
Alternative measure 3				
Alternative measure 4				
Alternative measure 5				
Alternative measure 6				
Alternative measure 7				
Alternative measure 8				
Alternative measure 9				
Alternative measure 10				
Total savings				

Energy savings achieved in 2016 from supply side measures accounted for under Art. 7 (2)(c)	Policy measure (Please, specify the policy measure)	Total annual savings generated in 2016 [ktoe] from <u>supply side measures</u> (amount of savings from new actions implemented in 2016 and actions implemented in 2014 or 2015 that continue
Measure 1		
Measure 2		
Measure 3		
Total savings		

Energy savings achieved in 2016 from early actions accounted for under Art. 7 (2)(d)	Policy measure (Please, specify the policy measure)	Total amount of savings generated in 2016 [ktoe] from <u>early actions</u> that took place between 31/12/2008 and 31/12/2013 expressed in final energy
Measure 1		
Measure 2		
Measure 3		
Total savings		

Figure A2. Common reporting template (part 2).

References

- Rogelj, J.; den Elzen, M.; Höhne, N.; Fransen, T.; Fekete, H.; Winkler, H.; Schaeffer, R.; Sha, F.; Riahi, K.; Meinshausen, M. Paris Agreement climate proposals need a boost to keep warming well below 2 °C. *Nature* **2016**, *534*, 631–639. [[CrossRef](#)] [[PubMed](#)]
- Kerr, N.; Gouldson, A.; Barrett, J. The rationale for energy efficiency policy: Assessing the recognition of the multiple benefits of energy efficiency retrofit policy. *Energy Policy* **2017**, *106*, 212–221. [[CrossRef](#)]
- Ryan, L.; Campbell, N. *Spreading the Net—The Multiple Benefits of Energy Efficiency Improvements*; Information Paper; OECD/IEA: Paris, France, 2012.
- Heffner, G.; Campbell, N. *Evaluating the Co-Benefits of Low-Income Energy-Efficiency Programmes*; Results of the Dublin Workshop 27–28 January 2011; OECD/IEA: Paris, France, 2011.
- Akella, A.K.; Saini, R.P.; Sharma, M.P. Social, economical and environmental impacts of renewable energy systems. *Renew. Energy* **2009**, *34*, 390–396. [[CrossRef](#)]
- Ringel, M.; Knodt, M. The governance of the European Energy Union: Efficiency, effectiveness and acceptance of the Winter Package 2016. *Energy Policy* **2018**, *112*, 209–220. [[CrossRef](#)]
- Nejat, P.; Jomehzadeh, F.; Taheri, M.M.; Gohari, M.; Majid, M.Z. A global review of energy consumption, CO₂ emissions and policy in the residential sector (with an overview of the top ten CO₂ emitting countries). *Renew. Sustain. Energy Rev.* **2015**, *43*, 843–862. [[CrossRef](#)]
- Liu, Z.; Guan, D.; Moore, S.; Lee, H.; Su, J.; Zhang, Q. Climate policy: Steps to China's carbon peak. *Nature* **2015**, *522*, 279–281. [[CrossRef](#)] [[PubMed](#)]

9. World Energy Council. *Energy Efficiency: A Straight Path towards Energy Sustainability*; World Energy Perspectives—Energy Efficiency Policies; World Energy Council: London, UK, 2016.
10. International Energy Agency (IEA). *World Energy Outlook 2018*; International Energy Agency: Paris, France, 2018.
11. Obama, B. The irreversible momentum of clean energy. *Science* **2017**, *355*, 126–129. [[CrossRef](#)] [[PubMed](#)]
12. Kanellakis, M.; Martinopoulos, G.; Zachariadis, T. European energy policy—A review. *Energy Policy* **2013**, *62*, 1020–1030. [[CrossRef](#)]
13. European Union. Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on Energy Efficiency, Amending Directives 2009/125/EC and 2010/30/EU and Repealing Directives 2004/8/EC and 2006/32/EC. Brussels, 14 November 2012. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0027> (accessed on 1 January 2019).
14. European Union. Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 Amending Directive 2012/27/EU on Energy Efficiency. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.328.01.0210.01.ENG (accessed on 1 January 2019).
15. Economidou, M.; Labanca, N.; Castellazzi, L.; Serrenho, T.; Bertoldi, P.; Zancanella, P.; Paci, D.; Panev, S.; Gabrielaitiene, I. *Assessment of the first National Energy Efficiency Action Plans under the Energy Efficiency Directive*; EUR 28055 EN; European Union: Brussels, Belgium, 2016.
16. Economidou, M.; Labanca, N.; Ribeiro Serrenho, T.; Castellazzi, L.; Panev, S.; Zancanella, P.; Broc, J.; Bertoldi, P. *Assessment of the Second National Energy Efficiency Action Plans under the Energy Efficiency Directive*; EUR 29272 EN; JRC110304; Publications Office of the European Union: Luxembourg, 2018; ISBN 978-92-79-87946-3.
17. MURE (Mesures d’Utilisation Rationnelle de l’Energie) Database. Available online: <http://www.measures-odyssee-mure.eu/> (accessed on October 2018).
18. Economidou, M.; Kona, A.; Bertoldi, P. Implementation of the Energy Efficiency Directive: Progress, challenges and lessons learned. In Proceedings of the ECEEE 2017 Summer Study Proceedings, Toulon, France, 29 May–3 June 2017.
19. Paolo, Z.; Marina, E.; Albana, K. *Analysis of the Annual Reports 2017 under the Energy Efficiency Directive—Summary Report*; EUR 28922 EN; JRC108810; Publications Office of the European Union: Luxembourg, 2017; ISBN 978-92-79-77040-1.
20. Sofia, T.T.; Nicola, L.; Barbara, C.; Agne, T.; Paolo, Z.; Paolo, B. *Analysis of the Annual Reports 2018 under the Energy Efficiency Directive—Summary Report*; EUR 29667 EN; Publications Office of the European Union: Luxembourg, 2018.
21. European Commission. Commission Staff Working Document, SWD(2013) 541 Final. “Progress Report on Energy Efficiency in the European Union Accompanying the Document Report from the Commission to the European Parliament and the Council Progress Report on the application of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services and on the Application of Directive 2004/8/EC on the Promotion of Cogeneration Based on a Useful Heat Demand in the Internal Energy Market {COM(2013) 938 Final}”. 2014. Available online: <https://ec.europa.eu/energy/sites/ener/files/documents/swd-2013-541.pdf> (accessed on 1 January 2019).
22. European Commission. Commission Staff Working Document, SWD (2015) 245 Final. Report from the Commission to the European Parliament and the Council, Assessment of the Progress Made by Member States towards the National Energy Efficiency Targets for 2020 and towards the Implementation of the Energy Efficiency Directive 2012/27/EU as Required by Article 24 (3) of Energy Efficiency Directive 2012/27/EU, COM(2015) 574 Final. Brussels, 18 November 2015. Available online: https://ec.europa.eu/energy/sites/ener/files/documents/2a_EE%20progress%20report%20-%20CSWD%20part%201.pdf (accessed on 1 January 2019).
23. European Commission. Report from the Commission to the European Parliament and the Council, Assessment of the Progress Made by Member States in 2014 towards the National Energy Efficiency Targets for 2020 and towards the Implementation of the Energy Efficiency Directive 2012/27/EU as required by Article 24 (3) of the Energy Efficiency Directive 2012/27/EU, COM/2017/056 Final. Brussels, 1 February 2017. Available online: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52017DC0056> (accessed on 1 January 2019).

24. European Commission. Report from the Commission to the European Parliament and the Council, Assessment of the Progress Made by Member States towards the National Energy Efficiency Targets for 2020 and towards the Implementation of the Energy Efficiency Directive as Required by Article 24(3) of the Energy Efficiency Directive 2012/27/EU, COM(2017) 687 Final. Brussels, 23 November 2017. Available online: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52017DC0687> (accessed on 1 January 2019).
25. Annual Reports and National Energy Efficiency Action Plans. Available online: <https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans> (accessed on 1 October 2018).
26. Eurostat Database. Available online: <http://ec.europa.eu/eurostat/data/database> (accessed on 1 July 2018).
27. Economidou, M. *Assessing the Progress towards the EU Energy Efficiency Targets Using Index Decomposition Analysis*; EUR 28710 EN; JRC106782; Publications Office of the European Union: Luxembourg, 2017; ISBN 978-92-79-71299-9.
28. European Union. Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 Establishing a Framework for the Setting of Ecodesign Requirements for Energy-Related Products (Recast). Available online: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125> (accessed on 1 January 2019).
29. European Union. Directive 2010/30/EU of the European Parliament and of the Council of 19 May 2010 on the Indication by Labelling and Standard Product Information of the Consumption of Energy and Other Resources by Energy-Related Products (Recast). Available online: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0030> (accessed on 1 January 2019).
30. European Union. Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings (Recast). Available online: <https://eur-lex.europa.eu/eli/dir/2010/31/oj> (accessed on 1 January 2019).
31. Fawcett, T.; Rosenow, J.; Bertoldi, P. Energy efficiency obligation schemes: Their future in the EU. *Energy Effic.* **2019**, *12*, 57–71. [CrossRef]
32. Kampman, B.; Nieuwenhuijse, I.; van de Water, S. *Implementation of EED Article 7—Updating the Database*; Publication Code: 19.3R57.005; Technical Assistance for DG Energy: Delft, The Netherlands, 2019.
33. European Commission. Procedure 2016/0375 (COD). Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union, Amending Directive 94/22/EC, Directive 98/70/EC, Directive 2009/31/EC, Regulation (EC) No 663/2009, Regulation (EC) No 715/2009, Directive 2009/. European Commission: Brussels, Belgium. Available online: https://eur-lex.europa.eu/procedure/EN/2016_375 (accessed on 1 January 2019).
34. European Union. Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, Amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and Repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ:L:2018:328:TOC&uri=uriserv:OJ.L_.2018.328.01.0001.01.ENG (accessed on 1 January 2019).
35. European Commission. Procedure 2016/0376 (COD). Proposal for a Directive of the European Parliament And of the Council amending Directive 2012/27/EU on energy efficiency. European Commission: Brussels, Belgium. Available online: https://eur-lex.europa.eu/procedure/EN/2016_376 (accessed on 1 January 2019).

