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Portuguese Plan for Promoting Efficiency of Electricity end-use: policy, methodology and consumer participation

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ABSTRACT

The Portuguese Electricity Demand-Side Efficiency Promotion Plan (PPEC) is a voluntary financial mechanism, under which several entities, among them electric utilities, may submit proposals of measures that contribute to the reduction of electricity consumption or load management. PPEC is of the schemes that provide financial support to the implementation of measures whose results contribute to the commitments made under the Portuguese National Energy Efficiency Action Plan (NEEAP). In the first edition of the PPEC only three energy services were addressed while in the most recent PPEC edition, the sixth, measures addressed nine energy services. Also, the participation of consumers and other agents in cost-sharing has increased, raising the investment in energy efficiency from other actors besides that from the program administrator. PPEC, although a voluntary mechanism, has proven to be a very competitive one, involving an increasing number of sectors of the economy, measures and addressed energy services.

KEYWORDS

Energy efficiency promotion; Electric utilities; voluntary schemes; Portuguese experience; consumer participation; Costs of avoided kWh.

INTRODUCTION

On the grounds of Article 7 of the Energy Efficiency Directive, several European Union Member States (MS) have adopted Energy Efficiency Obligations (EEO) (European Parliament and of the Council, 2012). EEO requires that energy companies meet a savings target of 1.5% of annual sales to final consumers. However, an alternative was available for MS to fulfil their energy savings obligations. This was the road Portugal decided to follow. Among the policy measures taken to achieve the savings target, is the Electricity Demand-Side Efficiency Promotion Plan (PPEC), a voluntary mechanism. Portugal has been implementing PPEC, with a track record of six calls for proposals for energy efficiency measures, since 2007. Under this mechanism, several entities, among them electric utilities, may submit proposals of measures that contribute to the reduction of electricity consumption

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or load management measures. Load management measures are those that allow a reduction of the costs of supply, without necessarily involving the reduction of energy consumption, namely the transfer of consumption from peak to off-peak hours. The proposed measures are evaluated according to a set of criteria, and the best performing ones are selected to be financed with funds raised from all electric energy ratepayers. Several changes to the regulations have been done over the years. Some of the changes were setting mandatory contribution of beneficiaries to the cost of the measures, setting maximum funding limits, and also setting criteria to assess the contribution of the measures to the national energy policy, among others. The number of participating actors has been increasing, as has also the total projected cost of the candidate measures. In last PPEC edition the total cost of the proposed measures accounted to 63 million euros, almost three times the available budget.

The purpose of this paper is to highlight the role of the PPEC mechanism to the national energy policy and in the Portuguese commitments with the EU. Also how the participation has been evolving, highlighting the energy services addressed, the sharing of the costs of the measures among the different agents, the evolution of the program administrator and societal costs of each saved kWh and the expected investments.

PORTUGUESE ENERGY POLICY

In the 2016 Portuguese National Energy Efficiency Action Plan, NEEAP 2016 - the Energy Efficiency Strategy, a new goal regarding a maximum limit of primary energy consumption was set. The actions and targets set for the 2013-2016 period included the energy reductions concerns set to 2020, part of the Directive on Energy Efficiency, Directive n.º 2012/27/EU, from the European Parliament and Council, from October 25. The Government set a 25% reduction in consumption by 2020, based on PRIMES forecasts carried out in 2007, setting the maximum consumption limit at approximately 22.5 Mtoe. This commitment goes a little bit further than the 20% reduction set by Directive on Energy Efficiency. Besides the 25% reduction goal, a specific reduction goal for the State was set to 30% of the primary energy consumption by 2020. The NEEAP 2016 was developed in articulation with the 2020 National Renewable Energy Action Plan, NREAP 2020 - the Renewable Energy Strategy (Council of Ministers, 2013).

The measures that were set in the previous NEEAP, the NEEAP 2008, were analysed and some changes were made in order to cope with the new commitment. Some measures were discarded and others were introduced. The NEEAP 2016 includes ten programmes covering six distinct areas (**Table 1**).

Table 1 – Areas and programmes considered in the NEEAP 2016

	<i>Areas</i>					
	Transport	Residential and services	Industry	State	Behaviour	Agriculture
Programmes	Eco Car	House and Office Renovation				
	Urban Mobility	Building Energy Efficiency System	Intensive Energy Consumption Management System	State Energy Efficiency	Communicate Energy Efficiency	Efficiency in Agricultural sector
	Transport Energy Efficiency System	Solar Thermal				

In Council of Ministers, 2013.

Each programme include, specifically:

- Eco car – measures towards improving energy efficiency of vehicles;
- Urban Mobility – measures to promote the use of the public transportation system and soft modes of transportation;
- Energy Efficiency System for Transport – measures addressing the promotion of railway systems and the energy management of transport fleets;
- House and Office Renovation – measures aiming the improvement of energy efficiency in lighting, home appliances and building retrofits;
- Buildings Energy Efficiency Systems – measures resulting from the energy certification system;
- Solar Thermal – measures addressing the adoption of renewable energy sources in buildings;
- Intensive Energy Consumption Management System – transversal measures in the industrial sector, and the revision of the Portuguese Intensive Energy Consumption Management System (SGCIE - Portuguese acronym for Sistema de Gestão dos Consumos Intensivos de Energia);
- State Energy Efficiency – measures aiming the energy certification of public buildings, as well as the Public Administration Energy Efficiency Programme (ECO.AP), State transport fleets and Public lighting;
- Communicate Energy Efficiency – measures promoting communication and awareness campaigns to disseminate more energy efficient habits and attitudes;
- Efficiency in the Agriculture sector – transversal measures addressing energy efficiency regarding the specificities of the sector.

The projection of the accumulated primary energy savings by 2020, through the measures of the NEEAP2016, is presented in **Table 2**.

Table 2 – Accumulated primary energy savings by 2020 from NEEAP 2016

	<i>Accumulated primary energy savings (toe)</i>	<i>Accumulated primary energy savings (%)</i>
Transports	136 777	11%
Residential and Services	582 727	46%
Industry	261 397	21%
State	253 988	20%
Behaviour	0	0%
Agriculture	40 000	3%
Total	1 274 889	100%

Source: Council of Ministers, 2013

The implementation of the NEEAP will be supported by regulatory measures, fiscal differentiation measures and financial support to the implementation of the energy efficiency measures. PPEC is one of the schemes that may provide financial support to the implementation of measures to be considered to account for the NEEAP targets. Other financial resources are the Energy Efficiency Fund, Fund to Support Innovation, the Portuguese Carbon Fund, and the National Strategic Reference Framework among others.

PPEC is a mechanism, developed by the Portuguese Energy Services Regulatory Authority (ERSE), for the promotion of electric energy efficiency in the demand-side, whose first call for proposals occurred in 2007. However, the existence of stimuli to the involvement of electric utilities in the promotion of energy efficiency at the demand-side dates back to 1998. By then, the costs associated to demand-side projects were included in the revenues from the tariffs applied to all electricity consumers (DR, 1998). This was in force between 1999 and 2001. Changes were imposed by the Tariff regulation of 2001 (DR, 2001), that defined a benefit-sharing scheme of 50% for each part, the utility and the consumers. The participation of the public electricity distributors was mandatory and Demand-Side Management Plans (PGP - Planos de Gestão da Procura, in Portuguese) should be presented every year, between 2002 and 2005. Due to uncertainties regarding the regulatory evolution following the reform of the electricity sector, the PGP was suspended and then replaced by PPEC. Unlike PGP, PPEC is a voluntary scheme where, besides electric utilities, other entities can compete for funds to finance energy efficiency improving measures. The measures proposed are subjected to a competition, leading to the selection of the “best” energy efficiency measures, according to a set of criteria defined in advance.

In its sixth edition, PPEC rules have evolved over the years, motivated either by the experience gained by the regulator with previous editions or by energy policy requirements. With the publication of Ordinance no. 26/2013, of January 24th (DR, 2013), which established new rules for the evaluation criteria and procedures, to be observed in the ranking and selection of the measures submitted to the competitions, it was determined that the assessment of these measures, in addition to being carried out by ERSE, should also be subjected to the appreciation of the Directorate-General for Energy and Geology (DGEG), in order to reflect energy policy criteria.

The evaluation of the measures submitted to PPEC in each call for proposals, that happens every two years, is carried out taking into account two main sets of evaluation criteria, both equally valued, i) evaluation criteria regarding the efficiency of electricity consumption, from the perspective of economic regulation, and ii) evaluation criteria related to energy policy objectives and instruments defined by decision the member of the Government responsible for energy (DR, 2013).

The evaluation criteria set by ERSE depends on the type of the measures: tangible or intangible measures. The intangible measures are those aimed at providing consumers with

relevant information on the efficiency of electricity consumption and its benefits in order to adopt more efficient consumption habits, namely, training actions, information dissemination campaigns and energy audits. On the other hand, tangible measures are measures that address the installation of equipment with energy efficiency performance superior to the market standard or the replacement of energetically inefficient equipment with more efficient ones. Tangible measures must address a consumption segment, Industry and Agriculture, Commerce and Services, and Households. The evaluation of the tangible measures is done taking into account the following criteria a) cost-benefit analysis; b) scale risk; and c) weight of equipment investment in the total cost of the measure. Regarding intangible measures, their evaluation is made taking into account the following evaluation criteria, a) quality of the presentation of the measure, b) ability to overcome market barriers and spill over effect, c) equity, d) innovation, and e) promoters' experience with similar programs. Each criterion has its own weight in the final score on the measure's performance.

The evaluation criteria set by the member of the Government responsible for energy, for the last PPEC call for proposals were a) alignment with the national energy policy and legislation in force, b) alignment with the national energy efficiency policy and legislation in force, c) support for the development and implementation of measures to promote energy efficiency d) diversification of promoters, and e) coordination with other instruments to encourage energy efficiency.

Each PPEC call for proposals has six different competitions: four tenders for tangible measures and two tenders for intangible measures. The tenders for tangible measures go as follows, a) three calls for tender for all promoters, one for each consumption segment (Industry and Agriculture, Commerce and Services, and Households); b) a tender for tangible measures for promoters which are not companies in the electricity sector.

The competitions of intangible measures are a) a tender for all promoters, and b) a tender for promoters who are not companies of the electric sector.

The promoters, the entities that submit proposals of measures and that are responsible for their implementation, may be electric energy traders, operators of electricity transmission and distribution networks, associations and entities that defend consumers' interests, municipal associations, business associations, energy agencies, and higher education institutions and research centres.

Each candidate measure must include in its application a measurement and verification (M&V) plan, defining the methodology for the verification of savings. This M&V plan should be done by entities independent from the promoter. Also, ERSE will carry out audits of various measures, by subset, subject to a budget that will not exceed 1% of the annual PPEC budget.

PPEC participation in the costs of tangible measures must be 80% or less of the total cost of the measure, fostering the participation and responsibility of the promoters and beneficiaries. Also if the budget for the first year of implementation of a tangible measure is less than 25% of the total PPEC candidate cost, the measure is excluded. Some other budget limits are imposed, such as, measures submitted to the competitions for all promoters, with program administrator costs higher than 1/3 of the budget set for their contest and segment; measures of the competitions for promoters who are not companies of the electric sector with candidate costs to the PPEC greater than 1/6 of the budget defined for the respective competition. The Net Present Value (NPV) from the societal perspective is an indicator of the societal value of the measure. A positive NPV is a screening criterion for a tangible measure to be competing in a tender. The NPV is computed according with the following expression:

$$NPV = \sum_{t=0}^n \frac{B_{s_t} - C_{s_t}}{(1+i)^t} \quad (1)$$

Where:

B_{s_t} – Total benefits from the societal perspective associated to the measure in year t ;

C_{s_t} – Total costs from the societal perspective associated to the measure in year t ;

i – Discount rate;

n – Lifetime, in years.

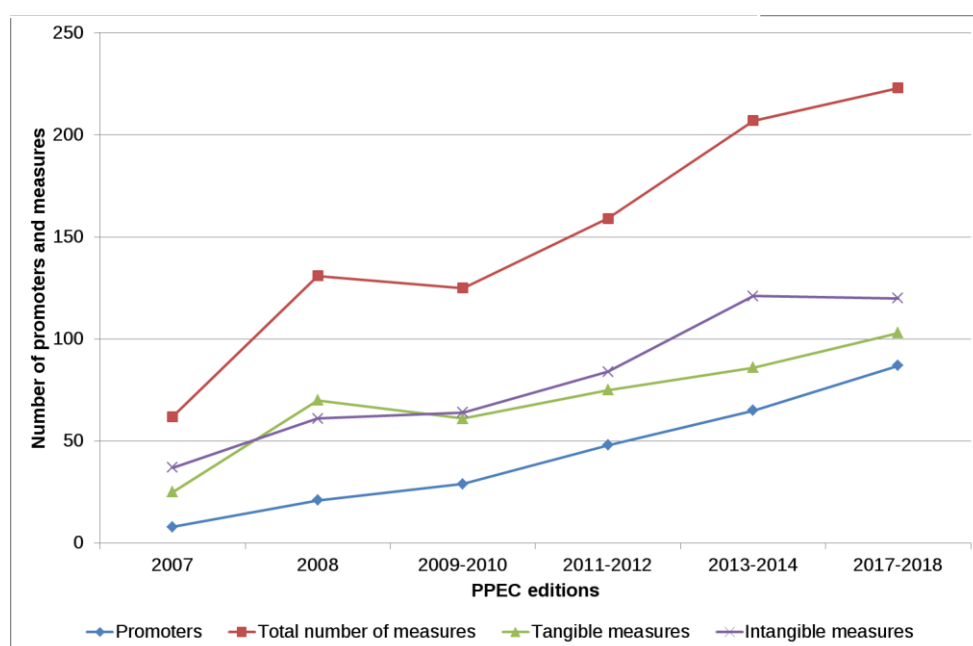
The benefits, from the societal perspective, are the sum of the environmental benefits with the avoided supply costs. The societal costs include the financial costs incurred by the participant consumers, by all electric energy consumers (financed through PPEC), by the promoters or any other entities. The costs and benefits are calculated in an incremental perspective against the market standard technology. Whenever it is considered that the proposed tangible measure does not contribute to the breakdown of market barriers, a free-ridership factor that penalizes the savings announced by the promoter may be applied.

In the next section some results from the six editions of PPEC are presented, with emphasis on the costs sharing and the evolution of the program administrator costs and the societal costs of the measures. The analysis will be presented both for eligible and selected measures. *Eligible measures* are measures that are submitted and accepted into the competition, since they passed the eligibility criteria and *selected measures* are the ones that were selected to be financed. PPEC costs are assumed as the costs candidate to be financed by PPEC budget, similar to the perspective of the costs of the Program Administrator (PA) cost test of the California Standard Practice Manual (CPUC, 2001).

PPEC RESULTS

Costs and Budgets

Generally speaking, the participation in PPEC editions has been increasing from one edition to the following one. The number of promoters has been steadily increasing from 8 in the first PPEC edition to 87 in the last one (**Figure 1**). Also, the number of measures that have been submitted and considered eligible has been increasing. The number of eligible measures rose, from 62 in 2007 to 223 in the last edition, representing an increase of more than 3 times. The increase was sharper from 2007 to 2008, and there was a slight decrease from 2008 to 2009. This decrease was mostly due to a decrease in the number of tangible measures and a reduction in the pace of increase of intangible measures. The 2008 PPEC rules (DR, 2008) came into force in the 2009-2010 edition. This change in the rules could also influence the reduction in the number of eligible measures.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 1 – Evolution of the number of promoters and eligible measures in each PPEC edition.

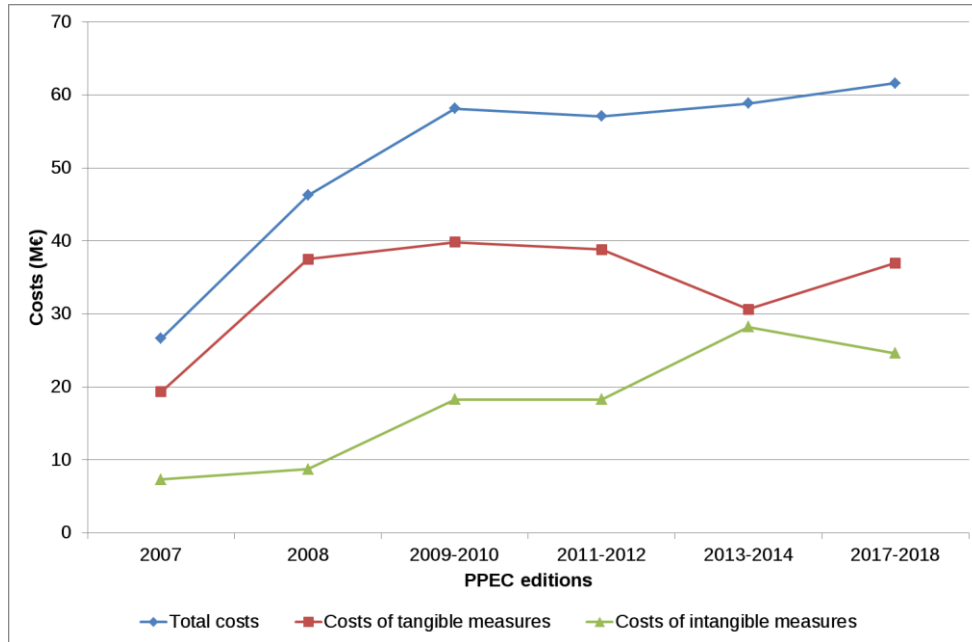
In **Table 3** the allocation of the PPEC funds to each type of measures, consumer segment, and competition. As mentioned before, the tangible measures in the all promoters' competition have distinct budgets, depending on the consumer segment addressed.

Table 3 – Allocation of funds (in millions of euros) by type of measure, consumer segment and competition, to each PPEC edition.

	2007	2008	2009-2010	2011-2012	2013-2014	2017-2018
Tangible measures						
Industry and Agriculture	3	3	5,8	5,8	5,1	7
Commerce and Services	2,5	2,5	4,9	4,9	4,3	4
Households	2,4	2,4	5,3	5,3	4,6	3
Non-Electric Sector Promoters	-	-	2	2	3	4
Total	8	8	18	18	17	18
Intangible measures						
All promoters competition	-	-	1,5	1,5	3	3
Non-Electric Sector Promoters	2	2	3,5	3,5	3	2
Total	2	2	5	5	6	5
Total	10	10	23	23	23	23

Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

The PA costs of the eligible measures increased sharply in the first three editions and remained very similar (**Figure 2**). In the last four editions, the difference between the highest (61.6 M€ in 2017-2018) and the lowest (57 M€, in 2011-2012) is around of 4.5M€, 8% of the lowest value. The main variations were an increase in the cost of intangible measures and a decrease in tangible ones, in the same PPEC edition (the 2013-2014 edition). These variations were probably due to the transfer of one million euros from the tangible measures budget to intangible measures (**Table 3**).

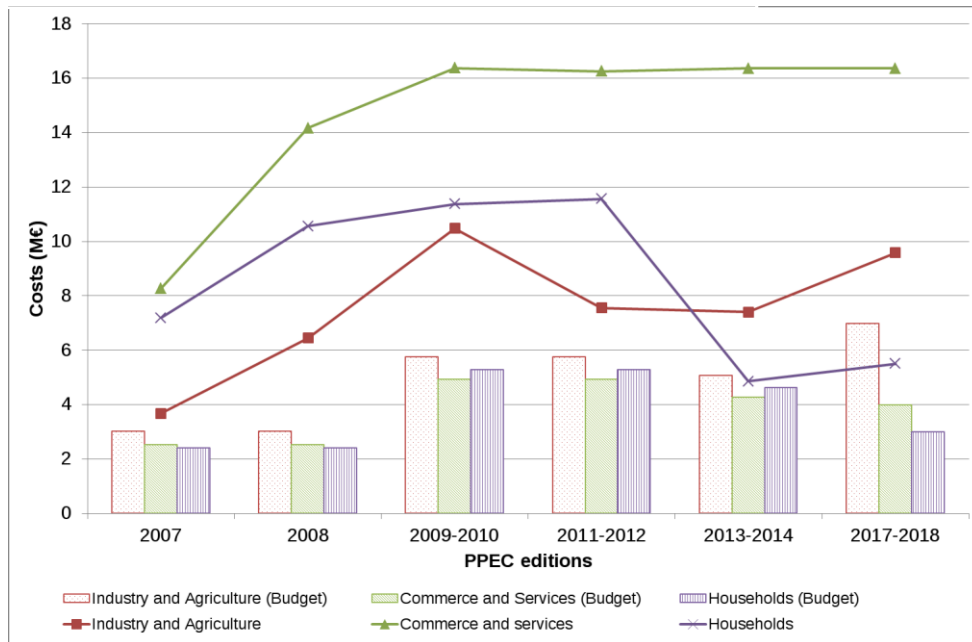


Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 2 – PA costs of the eligible measures throughout PPEC editions.

It is important to have in mind that the first two editions were annual, with a budget of 10 million euros, and the other four were biennial. The biennial editions have a budget of 23 million euros (equivalent to 11.5 million euros/yr). In the first two PPEC editions, tangible measures could have a multiannual implementation period of up to three years. However, only the costs to be spent in the first year were considered to be financed by that edition's budget. For example, for a measure selected in the 2007 edition that had an implementation cost plan for 2007 and 2008, only the costs pertaining to 2007 were financed by the 2007 budget. The costs to be spent in 2008 were to be financed by 2008 budget. Nowadays, only tangible measures with an implementation plan of two years are eligible.

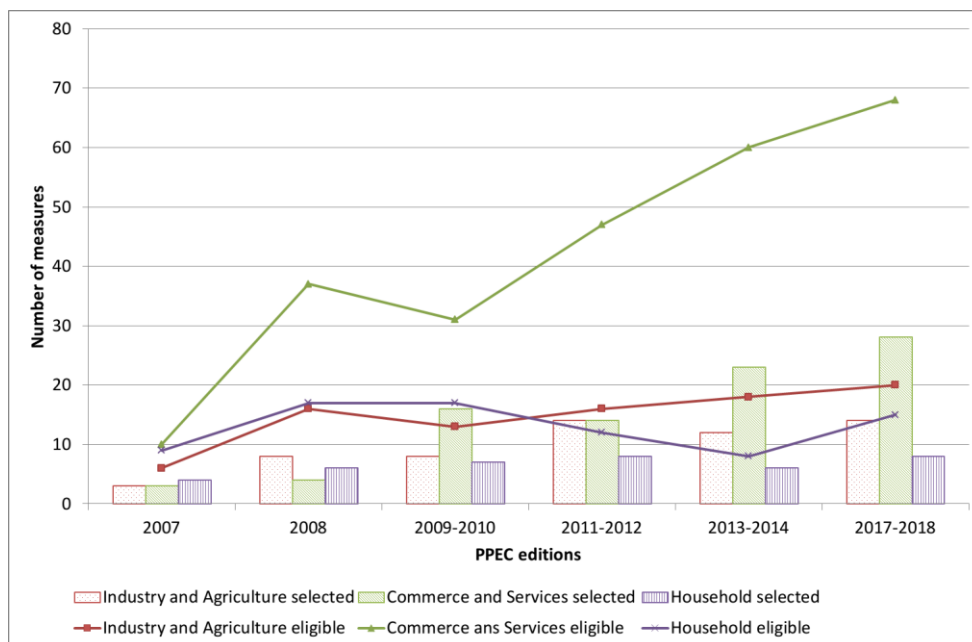
As can be seen in **Figure 3**, although Commerce and Services has not been the consumer segment with the highest budgets, it has been the one with highest PA costs of the eligible tangible measures. Interesting enough is the fact that the PA cost of those measures has been very similar for all biennial editions. The same cannot be said to the PA costs of the measures addressing the other two segments.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 3 – PPEC costs of the eligible tangible measures and corresponding available budget, for each PPEC edition.

Although the PA costs of the measures addressing Commerce and Services have been almost constant over the last four editions, the number of eligible measures in this segment more than doubled for the same editions (**Figure 4**), corresponding to the highest number of measures when compared to the number of those addressing the other two consumer segments. In fact, in the last PPEC edition, nearly 2/3 of the total number of eligible tangible measures addressed the Commerce and Service segment. Regarding the number of selected measures, the Commerce and Services consumer segment is also the one with the highest number of selected measures actually funded by PPEC.

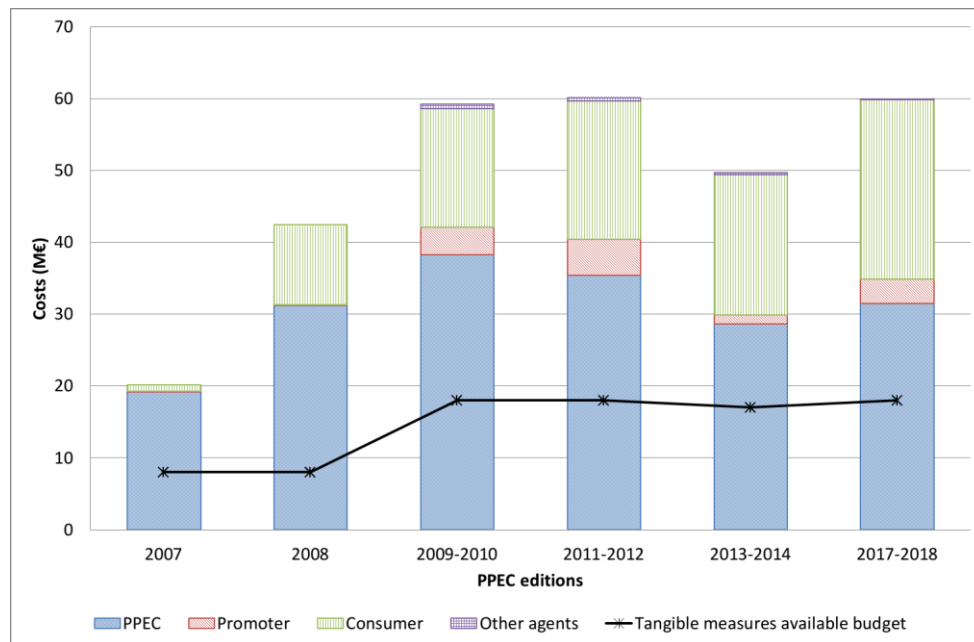


Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 4 - Number of eligible and selected measures by consumer segment in each PPEC edition.

Costs sharing among actors

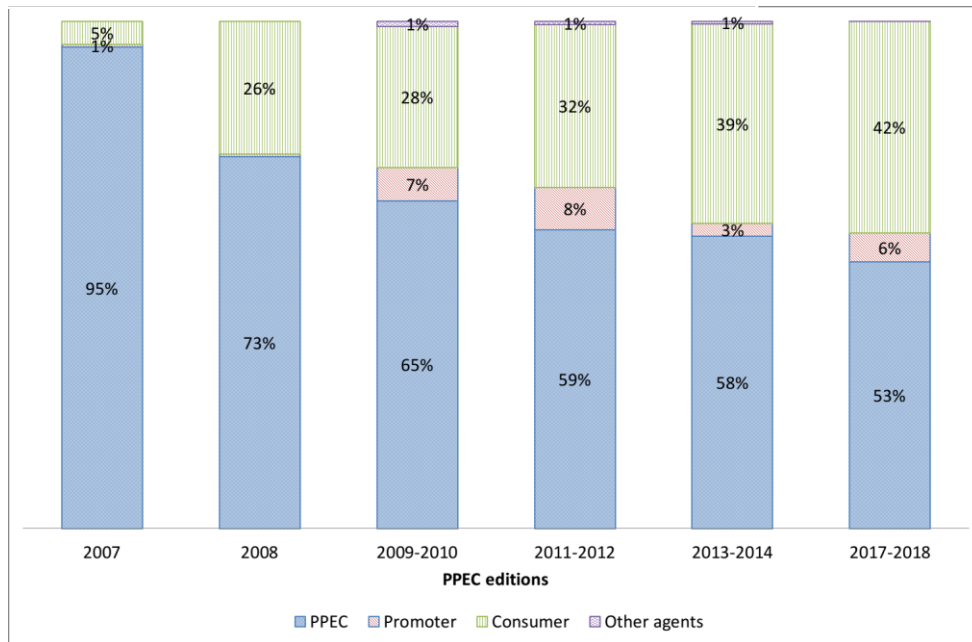
The total cost of a measure, also addressed as the societal cost, can be financed by several agents. Besides the part of the cost of the measures that is financed by PPEC budgets, tangible measures are financed by the promoter, the consumer and/or other agents, such as promoter's partners. Over the time, the societal costs sharing among agents have been changing. In **Figure 5**, it is possible to see the average costs, by agent, of the eligible tangible measures in each PPEC edition.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 5 – Societal costs of the eligible tangible measures and related available budget.

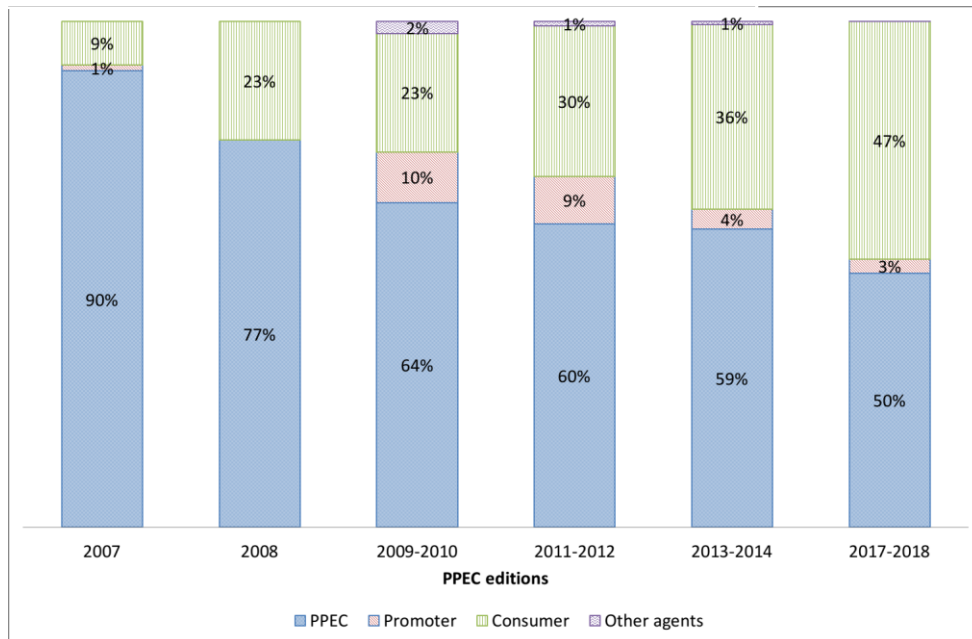
Each agent's average share of the societal costs of eligible measures is presented in **Figure 6**.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 6 – Share of societal costs of the eligible tangible measures in each PPEC edition.

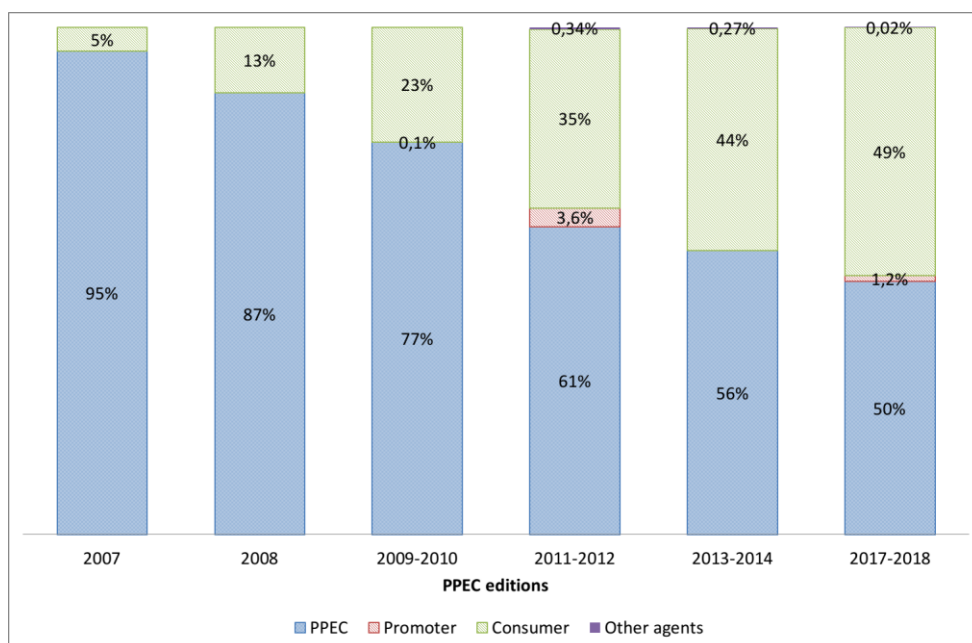
From **Figure 6** it can be seen that the PPEC share in costs has been decreasing. From the 2009-2010 PPEC edition, PPEC costs cannot exceed 80% of societal costs. Nevertheless, the decreasing tendency is probably due to the fact that only PPEC costs are taken into account in the selection procedures. Then, the lower the participation of PPEC funds in each measure costs, the more interesting tends to be the benefit-cost ratio and the probability for the measure to be selected. Promoters are trying to involve beneficiaries and partners in societal costs. The promoter's shares tend to be quite small, which is understandable, since they share the costs but do not share the benefits. If the promoter is an electric utility, the incentive to participate in costs sharing is even smaller, since energy efficiency measures will reduce sales. Also, the participation of partners in costs sharing has been residual or inexistent. The average share of societal costs of the selected tangible measures (**Figure 7**) is quite similar to the costs sharing of eligible measures (**Figure 6**). Since the cost-benefit analysis is made under the perspective of the PA costs, it could be expected that the share of PPEC funds should be less than the share of costs of eligible measures. However, since the Cost-Benefit ratio is not the only criterion, there is no evidence of lower share of PPEC costs in selected measures, when compared to eligible measures.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 7 - Share of societal costs of the selected tangible measures in each PPEC edition.

In the next three figures, societal cost sharing among agents is presented for the selected measures and the three consumption segments: Industry and Agriculture (**Figure 8**), Commerce and Services (**Figure 9**) and Households (**Figure 10**). Regarding PA costs, the measures for Industry and Agriculture follow closely the trend verified for eligible measures (**Figure 6**). It can be seen that the participation of other agents in costs, besides the PA and the beneficiary, is quite small or inexistent.

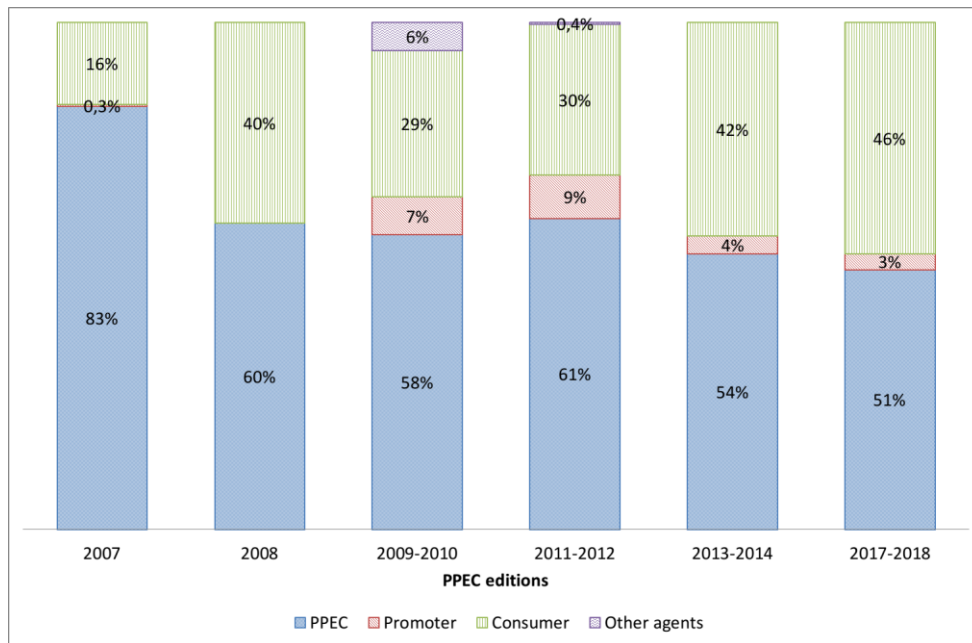


Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 8 – Share of societal costs of the selected tangible measures for the Industry and Agriculture consumption segment, in each PPEC edition.

In the case of the measures addressing the Commerce and Services segment, PPEC relative participation in the costs of the selected measures has been under 61% since the 2008 edition,

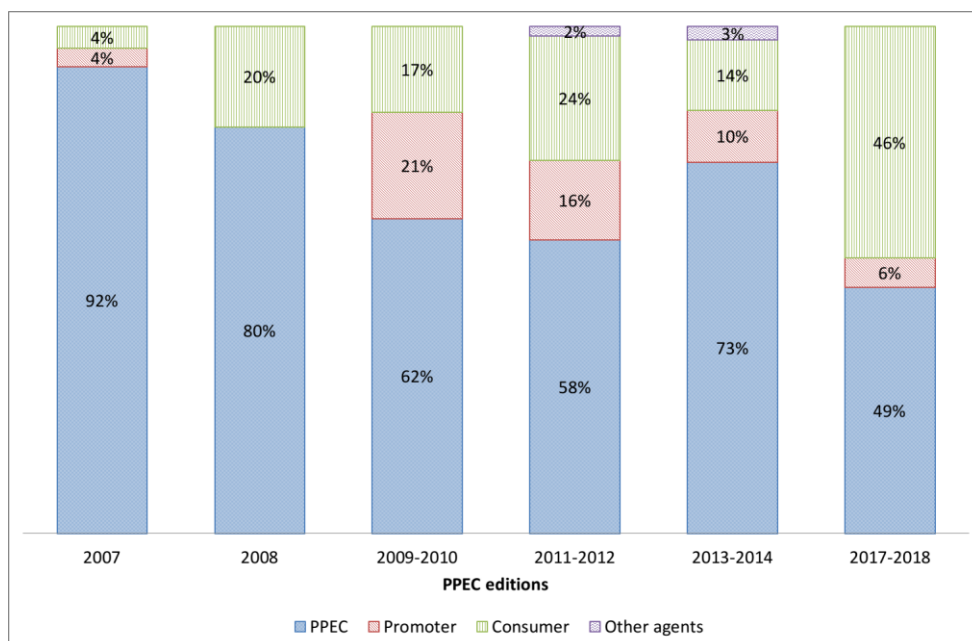
even before the 80% limit was defined. The average participation of the promoters in costs, although very small, is higher than the one verified in the case of the Industry and Agriculture measures.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 9 – Share of societal costs of the selected tangible measures for the Commerce and Services consumption segment, in each PPEC edition.

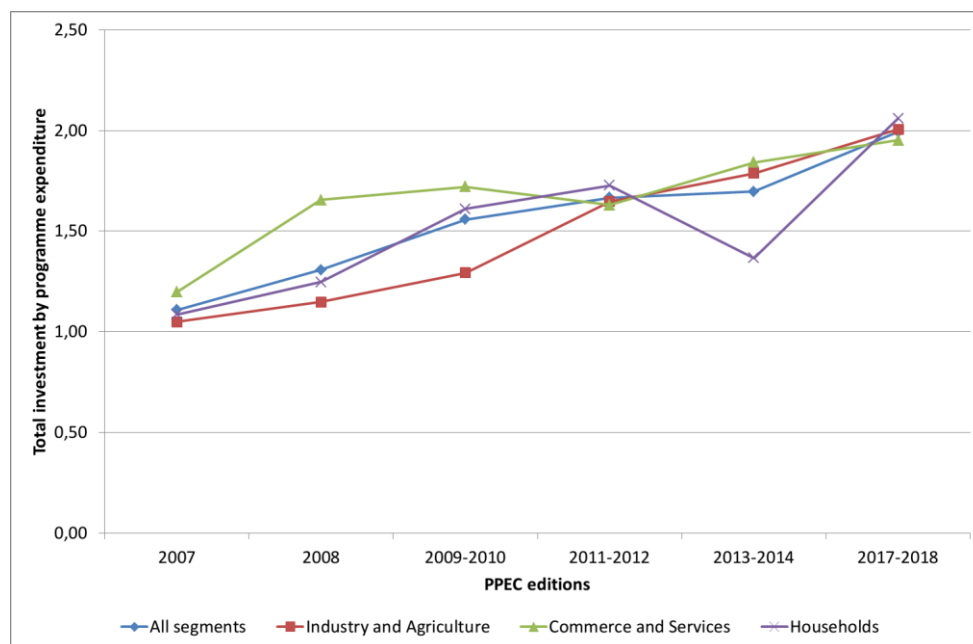
For the Households sector, with the exception of the 2013-2014 edition, the PA share in the societal costs of the measures has also been showing a decreasing tendency. The 73% of PPEC participation in costs, for the 2013-2014 edition, is mostly due to one measure whose PA costs represents 33% of the available budget and 78% of the societal costs. It can also be seen that the promoter’s share in costs is above the one verified in the measures addressing the other two consumer segments.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 10 – Share of societal costs of the selected tangible measures for the Households consumption segment, in each PPEC edition.

In the first PPEC edition, the investment in tangible measures generated by PPEC was 9.2 M€, being 8.3 M€ from the PPEC budget. In the last PPEC edition, the total expected investment is 35.9M€, the participation of the PA reaching 18M€. The expected investment in tangible measures generated by PPEC has increased 3.9 times, from 9.2 M€ in 2007 to 35.9 M€, in last PPEC edition, while the PA costs increased 2.2 times. The existence of a leverage factor (Rohde, 2015) is clear. A leverage factor of 1.0 means that all the investment is made from programme funds. A leverage factor of 2.0 means that only half the investment is made from programme funds. **Figure 11** shows the leverage factors for all selected tangible measures (all segments) and for each segment individually, in each PPEC edition. As can be seen, the leverage factors were, in last PPEC edition, near 2.0 (1.99), meaning that, for each euro invested from the programme funds, an additional ninety-nine cents were invested. In the first PPEC edition, the leverage factor was 1.11. In the Households sector, it is expected that 1.06 € will be invested for each euro from PPEC funds, since its leverage factor is 2.06. The lower leverage factor, of 1.95, was found for the Commerce and Services. Never the less it is very close to the leverage factors found in the other consumer segments. The lower value for the leverage factor found for the Households segment, in the 2013-2014 edition is mostly due to that same measure, identified earlier, with the PA costs being 78% of the societal costs.



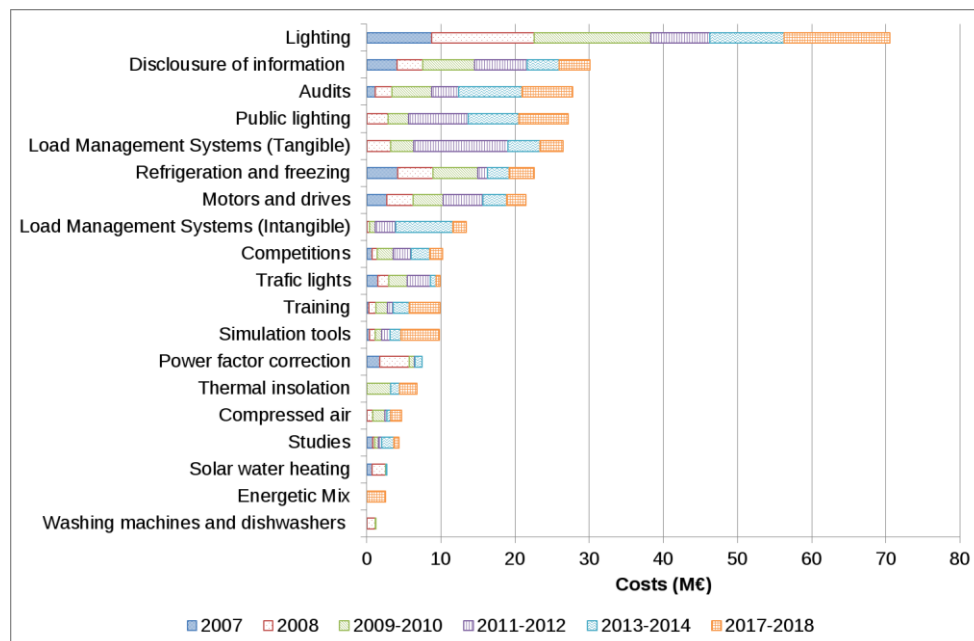
Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 11 – Leverage factors, for each PPEC edition, total and for each consumption segments.

Looking from another perspective, the extra investment caused by each euro invested through PPEC evolved from eleven cents, in the first PPEC edition, to ninety-nine cents in the last edition.

Energy services addressed

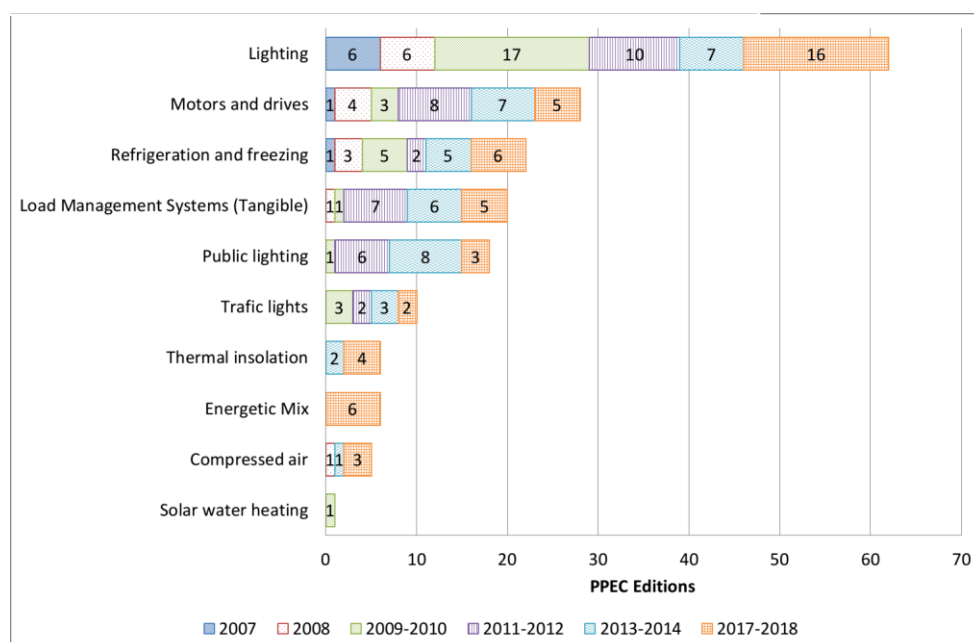
In **Figure 12** the PPEC costs of the proposed measures according to the energy services they address (for tangible measures) and the energy related services (for intangible measures) are presented. As can be seen, the most popular energy service addressed is, by far, lighting, mostly involving technology replacement actions. There are, in fact, three energy services related to lighting: interior lighting (mostly in buildings), public and traffic lighting. In the first three editions, most of the measures proposed a change in technology from incandescent to compact fluorescent lamps (CFL). In more recent editions, the standard of the market was considered the CFL, leading promoters to propose the replacement of existing lighting devices with LED technology based devices. The experience obtained by the promoters in previous editions, made it possible for them to address more energy services, promoting nowadays a more diversified set of measures.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016).

Figure 12 – Costs of the measures by targeted energy services, for each PPEC edition.

Regarding tangible measures, the diversity of energy services addressed and the number of selected measures in each PPEC edition is presented in **Figure 13**. As can be seen, in the first PPEC edition, only three energy services were addressed and the diversity has been increasing since then. Altogether, the number of measure addressing lighting (in buildings, public and traffic) represents almost 51% of the selected measures.



Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

Figure 13 – Number of selected measures, according to each energy services addressed, in each PPEC edition.

From **Table 4** it can be seen that, with the clear exception of the first PPEC edition, the PPEC cost of each saved MWh are very competitive. Comparing the values in **Table 4** with the values in **Table 5**, it is possible to see that due to the very high participation of consumers in costs, generally speaking, the energy services mostly addressed are also the ones with more competitive PPEC costs by saved MWh.

Table 4 – Average PA costs of each avoided MWh of the selected measures in each PPEC edition.

	2007	2008	2009-2010	2011-2012	2013-2014	2017-2018
Compressed air	-	20.36	-	-	29.82	17.14
Energetic Mix	-	-	-	-	-	12.81
Lighting	20.86	6.08	7.93	8.93	13.58	16.68
Load Management Systems (Tangible)	-	10.31	5.50	12.29	18.45	14.11
Motors and drives	10.25	8.29	4.44	6.94	6.57	8.70
Public lighting	-	-	8.95	6.73	6.71	29.06
Refrigeration and freezing	24.25	8.78	2.83	4.84	7.15	16.41
Solar water heating	-	-	4.95	-	-	-
Thermal insulation	-	-	-	-	13.34	13.05
Traffic lights	-	-	39.82	12.51	17.05	9.91

Sources: (ERSE, 2007a, 2007b, 2009, 2010, 2013, 2016), (DGEG e ERSE, 2016).

In more recent PPEC editions, with the investment in LED lamps, the costs of each saved MWh increased. The PA costs of each saved MWh among the selected measures ranged from 8€ to 39€, in last PPEC edition.

Table 5 - Average Societal costs of each avoided MWh of the selected measures in each PPEC edition (in €/MWh).

	2007	2008	2009-2010	2011-2012	2013-2014	2017-2018
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Compressed air	-	28.83	-	-	51.38	39.84
Energetic Mix	-	-	-	-	-	23.78
Lighting	23.99	8.34	12.72	15.15	31.02	32.60
Load Management Systems (Tangible)	-	10.31	10.16	21.33	26.06	22.35
Motors and drives	10.25	9.33	6.17	10.65	10.29	16.41
Public lighting	-	-	11.19	12.10	10.29	56.27
Refrigeration and freezing	24.25	15.45	3.67	6.24	11.30	39.98
Solar water heating	-	-	64.84	-	-	-
Thermal insolation	-	-	-	-	27.84	35.64
Traffic lights	-	-	54.92	20.02	25.04	17.83

CONCLUSIONS

The promotion of energy efficiency at the demand side by electric utilities in Portugal has been in place since 1999. At first with the PGP, where the participation of the regulated utility was mandatory, and then, after 2007, with the PPEC, a voluntary scheme that allows the participation of other promoters not belonging to the electricity sector. The number of promoters over the six PPEC editions increased more than 10 times. Also the number of measures increased 3.6 times, with tangible measures increasing at a slightly higher rate (4.1 times) than intangible measures, although the number of intangible measures is higher than the number of eligible measures in almost every PPEC edition. The program costs of the eligible measures have also been 2.5 to 2.7 times the available budget. So, if one looks either at the number of proponents, the number of measures, or the program costs of the eligible measures, it is safe to say that the PPEC scheme is an effective instrument to foster energy efficiency in electricity consumption.

The consumer participation in costs has been increasing, representing 42% in the case of eligible measures and 47% in the case of the selected measures, in the last PPEC edition. The share of the programs costs, although limited to 80% of the total cost of the measure, represented 53% and 50% of the total cost of eligible and selected measures respectively, in the last PPEC edition.

Looking at the tangible measures, only three energy services were addressed in the first PPEC edition. In last edition, 9 energy services were addressed. The main energy services addressed are related to lighting, whether it is in buildings, public lighting or traffic lighting, representing more than 30% of the available budget, for eligible measures, and more than 40% for the selected measures.

The expected investment caused by PPEC increased near 4 times over the six editions. Also, for each euro invested by PPEC in improving the efficiency in electricity consumption, another euro is invested, by consumers, promoters and other agents.

After the 2009-2010 PPEC edition, CFL were considered the market standard and underwent a depreciation in the valuation of savings, resulting in a reduced number of eligible measures supporting this technology and an increase in the measures addressing LED technology, a more expensive but more efficient one.

As can be inferred from the above, the PPEC scheme is a very effective one, with an increasing number of promoters, from different sectors of the economy. The promoters that have been answering PPEC calls have now experienced teams in the design of new proposals, addressing different energy services and technologies. Also, participation in costs by actors other than the program administrator leads to a greater accountability of these agents in the effectiveness of the measure.

The voluntary nature of this program allows the participation of a larger number of actors, reaching a more diversified number of consumers that become increasingly aware of the

importance of energy efficiency. On the other hand, since it is a voluntary mechanism, projections of energy savings are prone to uncertainty.

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