PROMOTING DEMAND SIDE MANAGEMENT AND ENERGY EFFICIENCY IN PORTUGAL

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ABSTRACT

ERSE, the Portuguese Energy Services Regulatory Authority, has established a mechanism to promote efficiency in electricity consumption called PPEC, which consists of a tender mechanism, by which eligible promoters submit measures to improve electricity consumption efficiency. These measures are selected through technical and economical evaluation criteria presented in this paper.

The benefits for the electricity sector and the environment from PPEC 2008 are much higher than the correspondent costs, up to a factor of 9 in the services segment. From 2007 to 2008, the expected cumulative avoided consumption more than doubled from 390GWh / 144 455 tonCO_2 to 878GWh / 324 794 tonCO_2.

The costs per ton of CO_2 avoided (PPEC 2008: 9,2€/MWh; PPEC 2007: 21,2€/MWh) are much lower than the cost resulting from the implementation of equivalent measures in the supply side, such as the promotion of special regime generation (41,6€/MWh).

INTRODUCTION

The purpose of this paper is to demonstrate the importance of measures to improve electricity consumption efficiency, that act on the demand side, in meeting international and national objectives for CO_2 emissions reduction.

The most effective way to promote energy efficiency is through the definition of tariffs that allow the recovery of costs associated with each and every activity of the electricity sector and by tariff structures and prices that reflect marginal or incremental costs. This methodology is incorporated in the Portuguese electricity tariff code. Nonetheless, environmental externalities not reflected in prices and the existence of barriers to the adoption of efficient behaviours justify the implementation of initiatives to foster energy efficiency.

DEMAND SIDE ELECTRICITY EFFICIENCY PLAN (PPEC)

ERSE has developed a mechanism for promoting efficiency in electricity consumption – "Plano de Promoção de Eficiência no Consumo" (PPEC). PPEC consists of a tender mechanism, by which eligible promoters (suppliers, network operators, consumers' rights associations, energy efficiency agencies, etc) submit initiatives to improve electricity efficiency in the industrial, services and household/residential sectors.

PPEC budget has risen from 20 million Euros for both 2007 and 2008 to 23 million Euros for both 2009 and 2010, representing about 0,2% of final prices charged to consumers each year. Those amounts are supported through the Global Use of System Tariff, paid by all consumers.

Types of measures admissible

PPEC comprises two types of measures:

Tangible – installation of equipment with a level of efficiency superior to standard equipment on the market, therefore producing measurable consumption reductions. In Table 1 some examples of tangible measures are shown, as well as their technical characteristics.

Intangible – disseminating information on energy efficient practices in order to promote a change in behaviours. An example of this kind of measures is energetic audits, information campaigns, seminars and conferences.

Measure	Assumptions
Residential lighting (Fluorescent Compact Lighting 18 W)	- Aimed for the household segment - Useful lifetime: 6 years - Annual consumption reduction: 62 kWh (relative to 75W incandescent light bulb)
Electronic ballasts	- Aimed for the services segment - Useful lifetime: 16 years - Annual consumption reduction: 63 kWh (relative to a ferromagnetic ballast and considering T8 bulbs of 36W)
Electronic speed variator (<=70KW)	- Aimed for the industrial segment - Useful lifetime: 15 years - Annual reduction in consumption: 25%

Table 1. Technical characteristics of tangible measures (examples)

TECHNICAL AND ECONOMIC CRITERIA FOR EVALUATING ENERGY EFFICIENCY MEASURES

The measures are analysed and approved by means of a competitive process and ranked according to pre-established rules, based on a cost-benefit analysis.

Evaluation criteria for energy efficiency tangible measures

In evaluating tangible measures, the first step is to calculate the Social NPV (Net Present Value from a social perspective) as in (1). Measures with a negative NPV are excluded.

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

where:

$B_{S\,t}$ Total benefits from the social point of view in year t

$C_{S\,t}$ Total costs from the social point of view in year t

i Discount rate

n Useful lifetime

The net social benefit (NSB_t) of each measure for each year is given by the following expression (2)

$$NSB_t = B_{S_t} - C_{S_t} =$$
$$= \Delta MgC + B_{Env} - (CM_{part} + CM_{PPEC} + CM_{others}) \quad (2)$$

where:

ΔMgC is the avoided cost of supplying electricity (includes generation, transmission and distribution)

B_{ENV} is the avoided CO_2 emissions

CM_{part}, CM_{PPEC}, CM_{others} are the costs borne by participants, PPEC and other entities.

The tangible measures' ranking process is done individually for each segment: industry, services and households, thus allowing for the funds to be distributed by all segments. Measures with a positive NPV are then ranked according to the following technical and economic criteria:

Benefit-cost proportional analysis (A1) – 40 points (3);

$$P_p = 40 \times \frac{RBC_p}{RBC_{\max}} \quad (3)$$

where the weight of each measure (p) is proportional to its benefit-cost ratio (RBC), calculated in (5), up to 40 points, being 40 points given to the measure with the highest benefit-cost ratio.

Benefit-cost ordered analysis (A2) – 20 points (4);

$$20 - (k-1) \times \frac{20}{n} \quad (4)$$

where:

n is the number of measures

k is the position of the measure in terms of RBC

The RBC is calculated accordingly to the following expression (5):

$$RBC = \frac{\sum_{t=0}^{n} \frac{B_{S\,t}}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_{PPEC\,t}}{(1+i)^t}} \quad (5)$$

where:

RBC Benefit-cost ratio

$B_{S\,t}$ Total benefits from the social point of view in year t

$C_{PPEC\,t}$ Total costs, from the PPEC point of view in year t

i Discount rate

n Useful lifetime

Equity (B) - 4 points

The equity criterion evaluates the measure of equity considering the geographical scope and the way participants and suppliers are selected on the basis of a predefined set of questions.

Presentation quality (C) - 7 points

The presentation quality criterion evaluates the measure in terms of how clearly and objective it is presented and how well its assumptions are justified. It also evaluates the quality of its measuring and verification plan both on the basis of a predefined set of questions.

Scale risk (D) - 10 points

The scale risk criterion evaluates the variation in average costs in each measure as a function of its execution rate (6)

$$IS_C = \left(\frac{CF + \sum_{i=1}^{m} Cv_i}{CF + \sum_{i=1}^{n} Cv_i} \right) - 1 \quad (6)$$

where:

IS_C Scale index

CF Fixed PPEC cost, i.e, does not depend on the number of interventions

Cv_i Unit variable PPEC cost of intervention i

m Number of interventions

n Half the interventions

The best ranked measure receives 10 points and the following are ranked as shown in (7)

$$10 \times \frac{IS_C}{IS_{C\max}} \quad (7)$$

where:

IS_C Sensibility index

$IS_{C\max}$ Maximum sensibility index in all the measures of a given segment

Ability to overcome market barriers and spill over effect (E) - 5 points

The ability to overcome market barriers and spill over effect criterion evaluates measures in terms of its effectiveness in overcoming market barriers to its implementation and its capability in spreading out its effects on the basis of a predefined set of questions.

Innovation (F) - 2 points

The innovation criterion evaluates the degree of uncommonness of a measure and compensates innovative measures for its higher costs relatively to conventional measures on the basis of a predefined set of questions.

Weight of the investment in equipment in the total cost of the measure (G) - 10 points

The weight of the investment in equipment in the total cost of the measure criterion awards measures that maximize the direct investment in equipment rather the administrative or support costs (8)

$$ID = \frac{K}{CT} \quad (8)$$

where:

ID weight of the investment in equipment in the total cost of the measure

K PPEC amount spent on acquiring the equipment

CT total costs

The best ranked measure receives 10 points and the following are ranked as shown in (9)

$$10 \times \frac{ID}{ID_{\max}} \quad (9)$$

where:

ID weight of the investment in equipment in the total cost of the measure

$ID_{\max}$ Maximum weight of the investment in equipment in all the measures of a given segment

Experience in similar programs (H) - 2 points

The experience in similar programs criterion evaluates the degree of relevant experience of the promoter and its partners necessary to the successful implementation of the measure.

In order to maximize the program's score the measures are selected accordingly to the following expression (10). The marginal measure is subject to budgetary cuts in order to meet and fulfil PPEC's budget.

$$\max \sum_{i \in Us} f_i(A1, A2, B, C, D, E, F, G, H, Interv_i) \Big| \sum_{i \in Ap_s} Cost_i^t \le Budget_s^t$$

$$where: \quad Cost_i^t = C_{Fix_i}^{\,t} + Interv_i \times c_{Var_i}^{\,t} \quad (10)$$

Where f_i is the score of measure *i*, from the total measures in segment *s*, considering the number of interventions $Interv_i$ that ensures that the cost restriction is met (the total cost of measures approved in segment *s*, Ap_s, should be comprised in its segment budget for each year *t*). The cost of each measure *i* corresponds to the sum of the fixed cost (C_{Fix}) and the variable cost (c_{Var}).

Evaluation criteria for energy efficiency intangible measures

Intangible measures are ranked according to the following criteria:

Presentation quality – 25 points;
Equity – 20 points;
Ability to overcome market barriers and spill over effect – 31 points;
Innovation – 12 points;
Experience in similar programs – 12 points.

The number of interventions in intangible measures is not variable, however it is considered acceptable that the costs of the marginal measure may be reduced up to 20% to meet the budget frontier.

As demonstrated, measures' evaluation has a metric component as well as a non-metric one. The latter has more weight in the evaluation of intangible measures. The benefit-cost ratio, the scale risk and weight of the investment in equipment in the total cost of the measure, are metric criteria, while the remaining are of a non-metric nature. In order for the non-metric criteria to be objective, a classification matrix was created. A thorough description of the aforementioned matrix is presented in [1].

IMPACTS AND BENEFITS OF THE ENERGY EFFICIENCY MEASURES APROVED BY PPEC

Both PPEC contests held so far were very competitive. In 2008, 131 measures from a diversified array of technologies valued in 46,2 million Euros were submitted to the contest, while only the best measures valuing 9,3 million Euros were approved.

Figure 1 forecast expected measurable impacts for the implementation of PPEC 2007 and PPEC 2008. From 2007 to 2008, the expected cumulative avoided consumption from measures approved more than doubled (390 GWh / 144 455 ton CO_2 to 878 GWh / 324 794 ton CO2). This is the result of the higher benefit/cost ratio of PPEC 2008 compared to PPEC 2007.

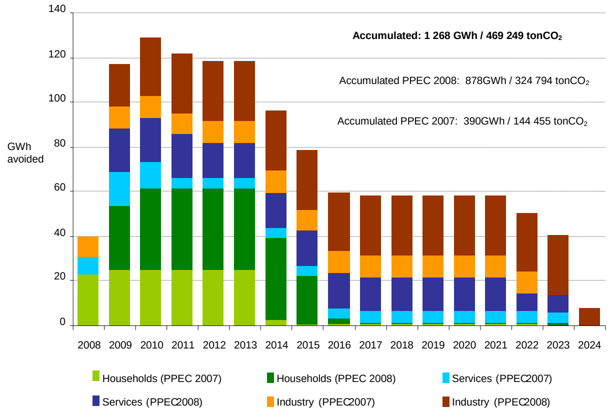

Figure 1. Annual avoided consumption from PPEC 2007 and PPEC 2008 tangible measures

Measures approved in PPEC 2007 have a unit cost of 21,2€/MWh avoided, which compares to a lower value of 9,2€/MWh avoided in the measures approved by PPEC 2008 (Figure 2 and 3).

The measures approved are subject to auditing in order to verify its degree of compliance in terms of costs, objectives and avoided consumption.

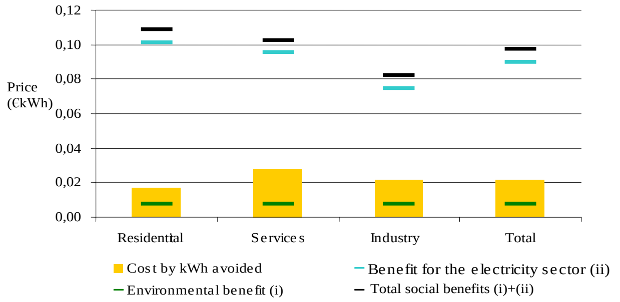

Figure 2. Benefits and costs from PPEC 2007 tangible measures per unit of consumption avoided

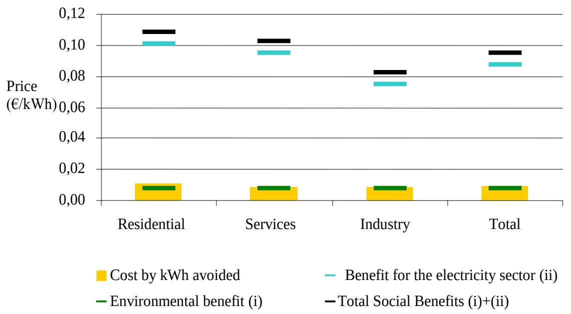

Figure 3. Benefits and costs from PPEC 2008 tangible measures per unit of consumption avoided

In any scenario the unit costs of consumption avoided are significantly lower than the cost resulting from the implementation of supply side equivalent measures, such as the premium given to special regime generation (41,6 €/MWh).

The premium paid to special regime generation is justified by the goal of reducing CO_2 emissions and diversifying sources of supply. Demand side management tools, like PPEC, proves to be competitive and serve the same purposes as special regime generation. Although both solutions have other virtues, it is clear that their assessment should be made in parallel.

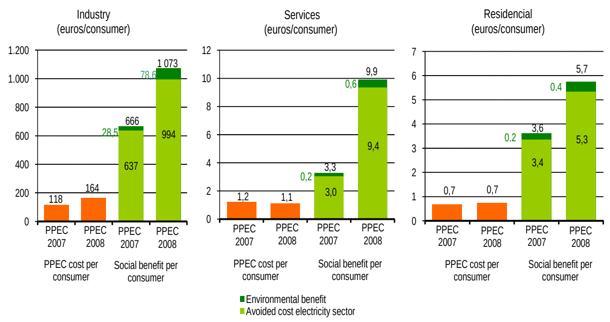

Figure 4. Costs and social benefits per consumer from measures in PPEC 2007 and PPEC 2008

Figure 4 illustrates the cost and the social benefit per consumer estimated for PPEC 2007 and PPEC 2008. The analysis clearly shows that in only one year the efficiency of the measures approved increased. In fact, in any given segment or year, expected benefits clearly outweigh expected costs, up to a factor of 9 in PPEC 2008 – services segment.

CONCLUSIONS

The paper presents 2 years' experience in promoting demand-side management and energy efficiency in the framework of the electricity regulation. The instrument conceived by ERSE to improve electricity efficiency in the demand side is called PPEC – "Plano de Promoção da Eficiência no Consumo". PPEC is a competitive mechanism of selection of energy efficiency measures from the supply side. The technical and economical evaluation criteria used in PPEC is also presented in the paper.

For PPEC 2008, 131 measures valued in 46,2 million Euros were submitted to the contest, knowing that only the best measures worth 11,9 million Euros would be approved. The expected cumulative avoided consumption of tangible measures is 878 GWh representing 324 794 tonCO_2. The expected measurable benefits, of these tangible measures, to be recovered are 71 million Euros, leading to a global benefit/cost ratio of 7,5.

The analysis of the forecasted PPEC impacts encourages the adoption of competitive demand side management tools, such as PPEC, as a regulatory tool to foster energy efficiency in consumption and CO_2 emissions reduction.

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