

Registration and validation of energy saving activities – Practical experiences and cost-effective solutions

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The Italian white certificates market and the measurement and verification of end-use energy efficiency improvements

Marcella Pavan

Head - Energy Efficiency Policy Division

Italian Regulatory Authority for Electricity and Gas ()*

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1. The Context: the Italian tradable white certificates scheme



Main features/1

- ◆ **First** operational tradable white certificates scheme introduced **world-wide**
- ◆ **Legislative framework** introduced in 2001; **regulatory framework** developed throughout 2002-2004 via consultation of all interested parties (plus revision of the legislative framework); **fully operational since January 2005**
- ◆ **Demand driver**: annual primary **energy saving targets** on (major) electricity and natural gas distributors
- ◆ **White certificates serve as an accounting tool** to prove compliance with targets
- ◆ **Supply-side**: white certificates are issued upon verification that the corresponding amount of energy has been saved via the development of **any type of end-use energy efficiency project**



Main features/2

- ◆ **Projects can be developed by/certificates are issued to** obliged distributors, non-obliged distributors, companies controlled by distributors, energy service providers
- ◆ **Certificates are tradable** in a specific marketplace or over the counter
- ◆ **Non-compliant distributors are subject to administrative sanctions**
- ◆ **Obliged distributors can recover part of the costs borne to meet their target** via electricity and natural gas rates
- ◆ **The Electricity and Natural Gas Regulator (AEEG) is in charge of:**
 - defining the **technical rules** for projects design, development and evaluation (i.e. M&V of energy savings) as well as for the issuing of white certificates
 - defining the **economic rules** governing the scheme: sanctions, cost-recovery mechanism, trading rules (jointly with the Electricity Market Operator)
 - **administering and monitoring the system**



The importance of M&V to the system

◆ Within the scheme white certificates:

- serve as an **accounting tool** to prove that the corresponding amount of energy has been saved and to monitor the extent to which the mandatory targets have been met
- have an **economic value**

➔ **You want to be sure that they represent “real” savings**



2. Major Measurement and Verification (M&V) issues



Why M&V rules for energy savings are needed

- ◆ What is “special” about M&V of energy savings?
 - you can not measure energy savings at the meter
 - you have to measure the energy savings via a **comparison of the energy consumption *before* and *after* the project**
 - **in some cases** the “before the project” scenario is not known (data, new installations) and **you need to make assumptions (“project baseline”)**
 - in other cases the “before the project” scenario is known, but **you need to net out** the impact on consumption trends of variables other than those on which the energy saving project have an influence (climatic and working conditions)
 - in other cases **measuring everything is not cost-effective**



Major M&V issues/1

◆ Technical issues:

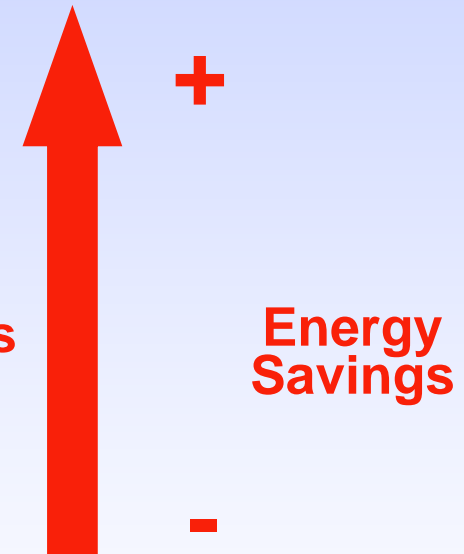
- **baseline setting**: what is the reference scenario? (cf. following slide);
- **additionality** and treatment of (partial) **free-riders**: do we take into account savings that would have been achieved by **project participants** even in the absence of the project (may be at a later date)? If yes, how?
- **adjustments** to take into account changing framework conditions
- impact of different **delivery mechanisms** (e.g direct delivery versus discount bonus)
- [treatment of **free-drivers**: do we take into account – and, if yes, how – positive impact on **non-participants**? And what about extensive positive impacts on **participants**?]



M&V issues/2

◆ Technological baseline setting (options other than the “real” baseline when it is not known):

- average installed
- average sold
- average offered on the shelves
- technology that meets mandatory standards
- average produced
- BAT

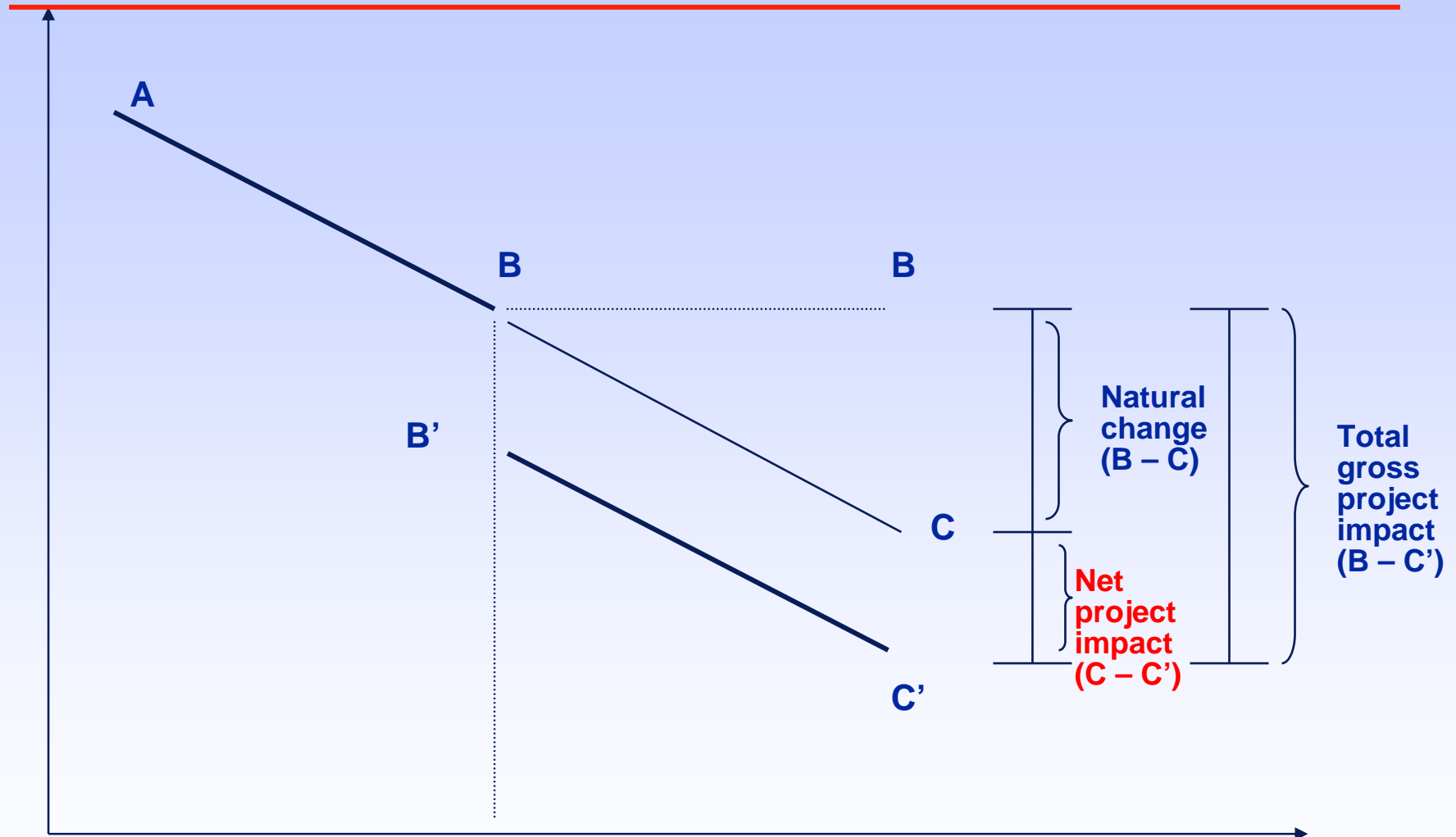


◆ The baseline is dynamic → need for regular updating

◆ You may want to consider only additional savings (cf. next slide)



Additionality



M&V issues/3

◆ Technical issues (cont):

- **technical lifetime**
- **persistence of savings over time:** *coeteris paribus*, the savings produced during the first year(s) of operation may gradually reduce over time (relevant only for ex-ante or partially ex-ante M&V approaches)
- **so called “market transformation” projects e.g. information campaigns, training programs:** do we include them? How do we measure and verify the savings produced?
- **documentation** requirements



Alternative M&V approaches, trade-offs and general criteria

◆ Three main alternative approaches

1. (Ex-post) direct measurement
2. (Ex-ante) stipulated savings (assumptions)
3. Hybrid approaches (e.g. indirect measurement, engineering estimates)

◆ Major trade-off:

- **accuracy vs economic efficiency** (underlying administrative and compliance costs)



3. The AEEG's approach



Guiding criteria

◆ **Project-based mechanism** → **Bottom-up**

◆ **General criteria:**

- **simple and transparent** rules and procedures
 - **certain and reliable** reference framework for operators
 - **promotion of economic efficiency and technological innovation** (baseline setting)
 - **consumers protection** and promotion of **competition**
- **search for a balance between robustness and reliability of savings versus simplicity and cost-effectiveness**

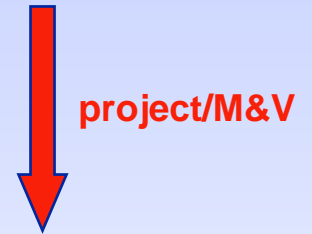
◆ **Regulation is always defined following a thorough consultation** of all interested parties



M&V procedures: AEEG's approach

◆ 3 types of M&V methods:

- 1) **deemed** savings (no on-field measurement)
- 2) engineering **estimates** (partial on-field measurement)
complexity
- 3) energy **monitoring** plans (subject to pre-approval)



◆ **Market Transformation measures** (e.g. information campaigns, training programs) are eligible **only if they are associated to “hard” measures**

- provided they meet specific qualification requirements they entitle the hard measure to a **5% “premium”** on the amount of certified energy savings

◆ **Only additional savings are considered**, i.e. over and above spontaneous market trends and/or legislative requirements



Deemed savings

◆ Main Characteristics:

- **totally ex-ante** (→ certainty of results, limited “risk”)
 - **simplified energy savings calculation** (both for users and AEEG)
 - **limited reporting documentation** to be provided
 - **simplified control and certification** procedures (both for users and AEEG)
-
- ◆ **Suitable for** projects for which expected savings and reasonably well understood and direct measurement would therefore be not cost-effective
 - ◆ For each type of project **a specific amount of saved energy is defined ex-ante for each installed unit (toe/unit/year)**
 - ◆ **Assumptions are made on a number of variables** (e.g. baseline, working conditions and working hours)
 - ◆ **Default factors** are used for: **free-riding** (net-to-gross ratio), **delivery mechanism** and **persistence**
 - ◆ Developed on the basis of **public consultation** on proposals put forward by AEEG; **regularly updated**



Engineering estimates

◆ Main Characteristics:

- **relatively simplified** energy savings **calculation**
 - **reduced reporting documentation** to be provided
 - **simplified control and certification** procedures
- ◆ **Suitable for** projects whose saving impact is quite well understood but varies depending on a limited number of identifiable parameters (e.g. number of working hours).
- ◆ For each type of project a **specific evaluation algorithm** is defined, with pre-defined values for some parameters **while other parameters have to be measured case by case**
- ◆ **Default factor** for net-to-gross ratio
- ◆ **Measurement** of persistence
- ◆ **Developed on the basis of public consultation on proposals put forward by AEEG; regularly updated**



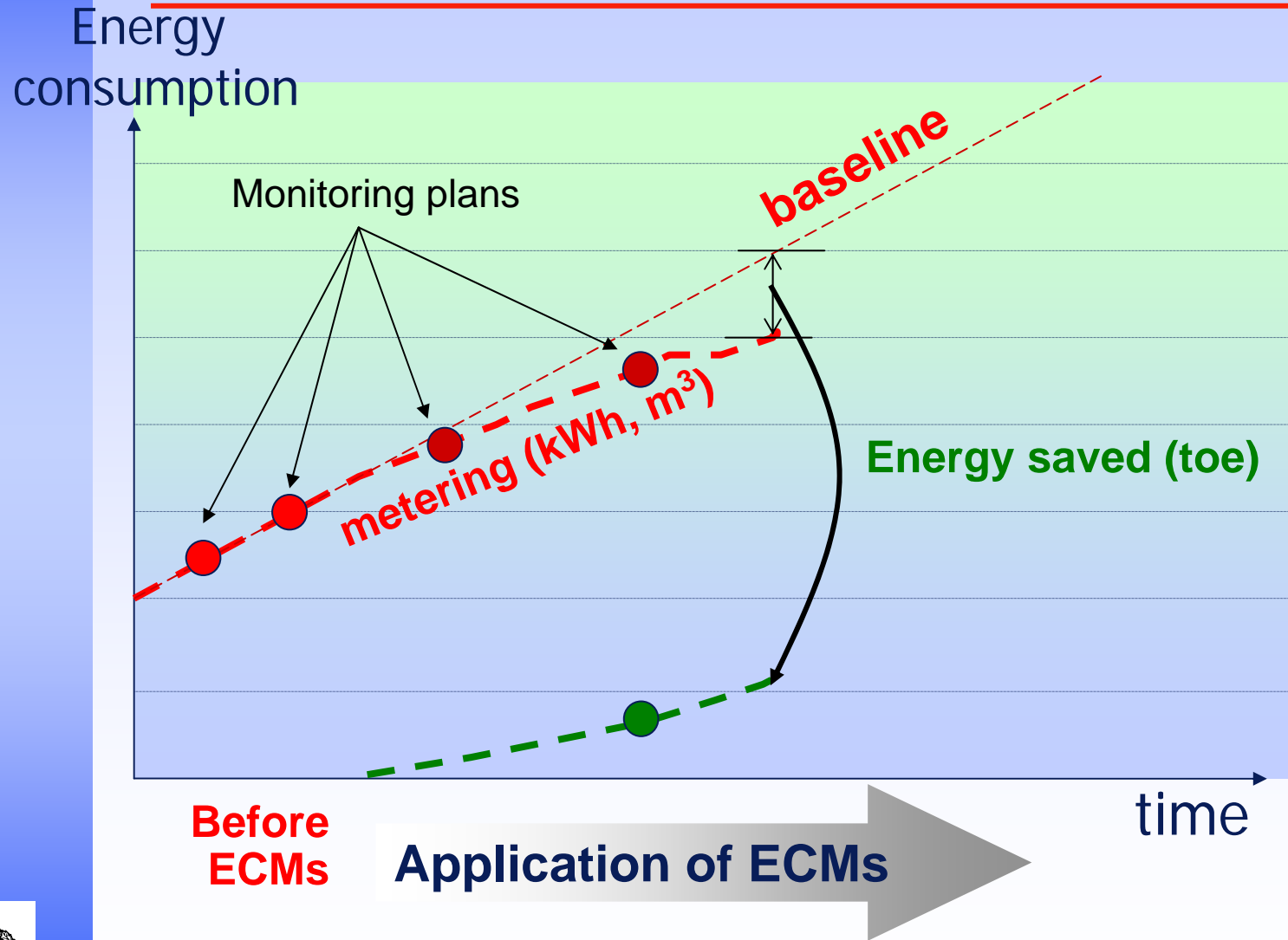
Energy Monitoring Plans/1

◆ Main Characteristics:

- **direct/indirect measurement** of energy usage **before and after the project**
 - **extended documentation** to be provided for *ex-post* validation and certification
 - **extended control and certification** procedures
- ◆ **Suitable for** projects whose energy performance crucially depends on variables and parameters that change from case to case and is therefore less predictable
- ◆ **Methodological proposal** to be developed for each project according to **pre-determined criteria and format** (es.: measured parameters; (possible) calculated parameters and methods of calculation; major assumptions; adjustments; additionality; documentation to be provided)



Energy Monitoring Plans/2



Example of deemed savings calculation/1

◆ Baseline Technology

- incandescent lamp

◆ Efficient Technology

- Class “A” Compact Fluorescent Lamp

◆ Deemed energy savings calculation methodology

$$\text{DEEs} = (\text{Pinc.} - \text{PCFL}) \times \text{h/y} \quad [\text{kWh/year/lamp}]$$

$$\text{DEPs} = \text{DEEs} \times \text{Fel} \quad [\text{toe/year/lamp}]$$

$$\text{where Fel} = 0.22 \times 10^{-3} \text{ toe/kWh}$$



Example of deemed savings calculation/2

◆ Major Assumptions

- **probability** of installation in each room (p)
- number of **working hours** per year per room (h/y)
- **power needed** in each room (P)
- **power difference** between the incandescent lamp ($P_{inc.}$) and the CFL (P_{CFL})

➔ **Weighted average of achievable primary energy savings:**

$$EP_{av.} = (\sum_n EP_n \times p_n) / 100$$

◆ Cf. next slide



Example of deemed savings calculation/3

Case No	Room	Pinc[W]	PCFL [W]	DP [W]	Use [h/year]	DEEs [kWh/y/unit]	DEPs [10 ⁻³ toe/y/unit]	p [%]	DEPs _{prob} [10 ⁻³ toe/y/unit]
1	Kitchen	100	20	80	1200	96	21.12	30	6.34
2	“	75	15	60	“	72	15.84	10	1.58
3	“	60	11	49	“	58.8	12.94	5	0.65
4	Dining/living room	100	20	80	800	64	14.08	20	2.82
5	“	75	15	60	“	48	10.56	5	0.53
6	“	60	11	49	“	39.2	8.62	5	0.43
7	Bath	60	11	49	300	14.7	3.23	10	0.32
8	Bedroom	40	9	31	300	9.3	2.05	10	0.2
9	Outside	100	20	80	2000	160	35.2	5	1.76

→ **Weighted average of achievable primary energy savings:**

$$EP_{med} = (\sum n EP_n \times p_n) / 100 = 14,6 \cdot 10^{-3} \text{ toe/y/unit}$$



Example of eligible energy monitoring plans/1

◆ Direct measurement:

- based on **metered energy consumption** (es.: kWh) before and after the energy efficiency project + adjustments for changed framework conditions + additionality calculation

◆ Indirect measurement:

- based on **calculated consumption**, i.e. on the measurement of the parameters that determine energy consumption (use of average, hypothetical values not allowed)

Example: use of measured (i.e. case-specific) P and measured (i.e. case-specific) working hour to calculate lighting energy consumption:

$$\text{Energy consumption (before and after)} = P \times h$$



Example of eligible energy monitoring plans/2

◆ Continuous measurement vs measurement during limited time periods

- only allowed when continuous measurement is not feasible or is not economic
- Example:
 - industrial energy consumption (dependent from production levels and climatic conditions)
 - pre-project scenario: calculation of a unit consumption index (energy input per unit of output) on the basis of **measured energy consumption during representative time periods** (e.g. 3 weeks in winter, 3 weeks in summer, 3 weeks in spring/autumn)
 - post-project scenario: calculation of the unit consumption index during the same time periods
 - energy saved calculated on the basis of the difference between unit consumption indexes (pre and post project) and of the total production in the current year



APPENDIX



Eligible projects (1)

- ◆ **Rephasing of electric systems**
- ◆ **Electric motors and their applications** (e.g. inverters installation, installation of high efficient industrial motors)
- ◆ **Lighting systems** (public and private: e.g. installation of compact fluorescent lamps, automatic lighting systems)
- ◆ **Reduction of electricity leaking** (e.g. reduction of stand-by losses)
- ◆ **Switching from electricity to other fuels when this produces primary energy savings** (e.g. substitution of electric water heaters with gas water heaters, district heating)
- ◆ **Reduction of electricity consumption for heating purposes** (e.g. installation of more efficient electric heating systems or water heating systems)
- ◆ **Reduction of electricity consumption for air conditioning** (e.g. wall insulation, double glazing, heat pumps)



Eligible projects (2)

- ◆ **High efficient electric appliances** (e.g. installation of A-rated fridges, dishwaters, washing machines)
- ◆ **High efficient office equipment** (e.g. installation of high efficient computers, printers, faxes)
- ◆ **Switching from other fuels to electricity when this produces primary energy savings** (e.g. various types of so-called electro-technologies)
- ◆ **Reduction of primary energy consumption for domestic heating, ventilation and air conditioning system** (e.g. district heating, cogeneration, fuel cells, electric or gas-fuelled heating pumps)
- ◆ **Promotion of end-use technologies fuelled by renewable sources** (e.g. solar systems for water heating, small photovoltaic systems, biomass cogeneration of domestic heating)
- ◆ **Electric and gas-fuelled vehicles**



Deemed savings (1)

Developed so far

- 1) **Compact Fluorescent Lamp**
- 2) **Replacement of electric water heaters with gas water heaters (residential)**
- 3) **Replacement of gas water heaters with more efficient gas water heaters (residential)**
- 4) **Installation of efficient (i.e. 4 stars) gas water heater (residential)**
- 5) **Double glazing (residential, offices, commercial, hospitals, schools)**
- 6) **Wall insulation (residential, offices, commercial, hospitals, schools)**
- 7) **Small PV plants (residential, offices, commercial, hospitals, schools)**
- 8) **Thermal solar for water heating**
- 9) **White goods: fridges, frizers, dishwashers, whashing machines**
- 10) **Low-flow showers' water taps**
- 11) **Low-flow water taps**

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Deemed savings (2)

Developed so far

- 12) High efficiency electric motors (industrial uses)**
- 13) Heat pumps**
- 14) Light-flow regulators (public lighting)**
- 15) Na lamps (public lighting, substitution of HG lamps)**
- 16) Inverter application on hydraulic systems (small)**
- 17) Air conditioning (residential sector)**
- 18) High efficient (4 stars) boilers for condominium**

...and others to come



Engineering estimates

Developed so far

- 1) Energy recovery from natural gas de-compression
- 2) Inverter application on hydraulic systems (big)
- 3) CHP
- 4) District Heating

...and others to come



Supportive documentation in English

- ◆ Pavan., M. – *New trends in energy regulation: the integration of command and control approaches, tariff regulation and artificial markets for demand-side resources*, forthcoming in the proceedings of the 2006 IAEE Conference
- ◆ Pavan, M. - *What's up in Italy? Market liberalisation, tariff regulation and incentives to promote energy efficiency in end-use sectors*, in Proceedings of the 2002 ACEEE Summer Study on Energy Efficiency in Buildings, August 2002
- ◆ Pavan, M. – *Italian energy efficiency obligation and white certificates: measurement and evaluation*, presented at the European Parliament Workshop on “Case studies of current European Schemes for the measurement and evaluation of energy efficiency improvements”, Brussels, 3 March 2005



Contacts

Marcella Pavan
Head - Energy Efficiency Policy Division
Autorità per l'energia elettrica e il gas
Piazza Cavour 5
20121 Milan – ITALY

tel: +39 02 65 565 263/313

fax: +39 02 65 565 230

e-mail: mpavan@autorita.energia.it

WEB Site: <http://www.autorita.energia.it/ee/index.htm>

(in Italian)

