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

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(*) This is not an official document of the 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

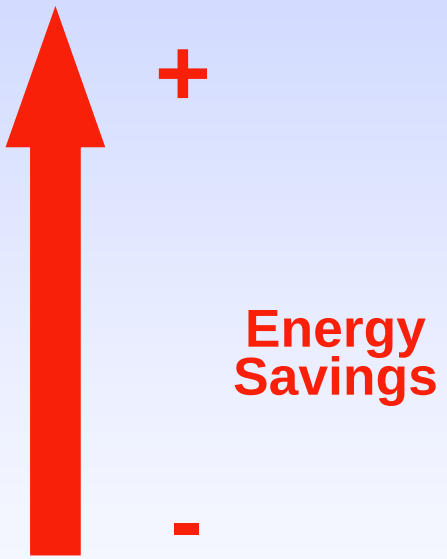
- **What is "special" about M&V of energy savings?**
  - you can not measure energy savings at the meter
  - you have to measure the energy savings via a comparison of the energy consumption *before* and *after* the project
  - in some cases the "before the project" scenario is not known (data, new installations) 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?]**

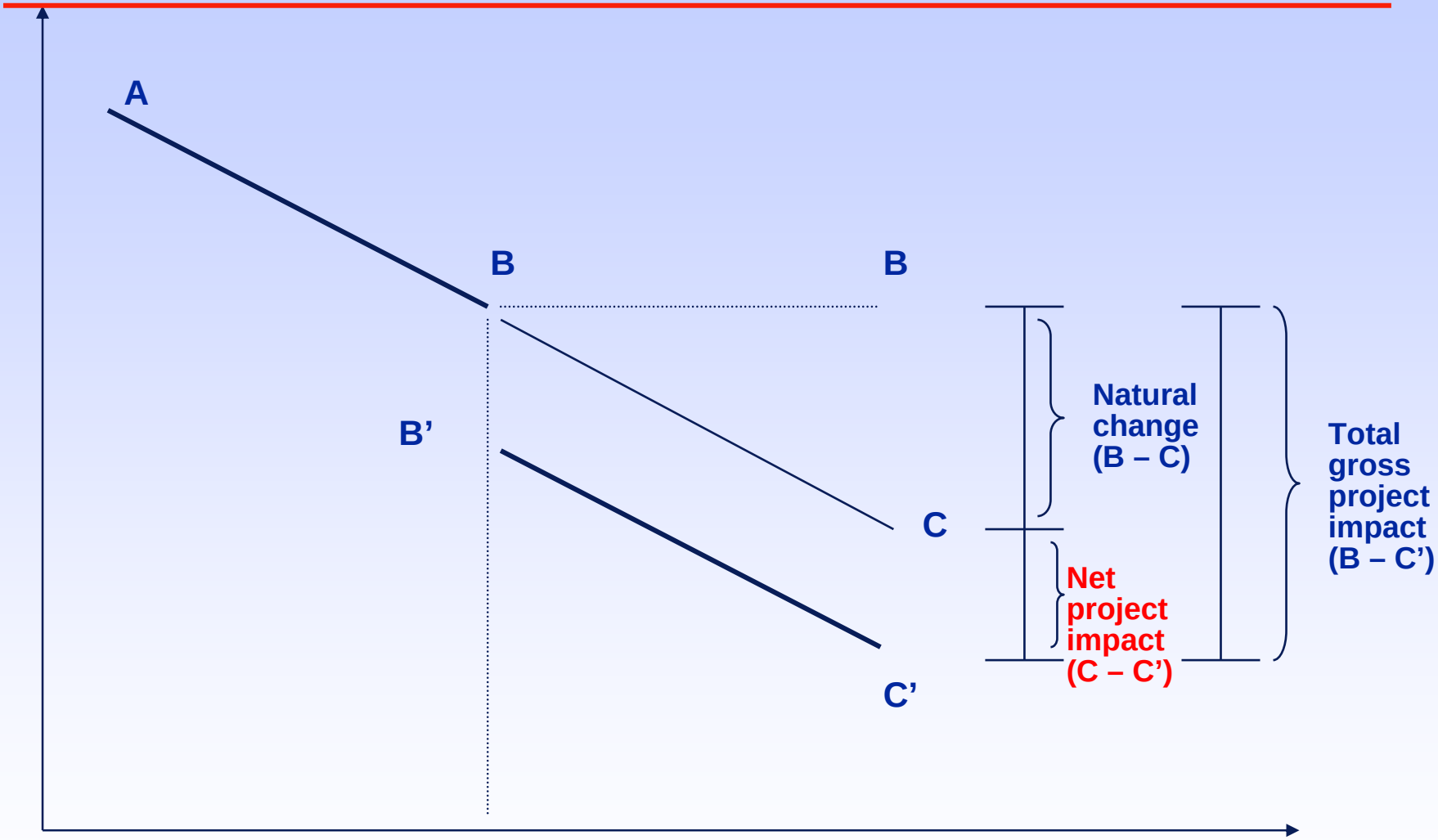
M&V issues/2

- **Technological baseline setting (options other that 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 o 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)

  3) energy monitoring plans (subject to pre-approval)

  complexity ↓ **project/M&V**

- **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**

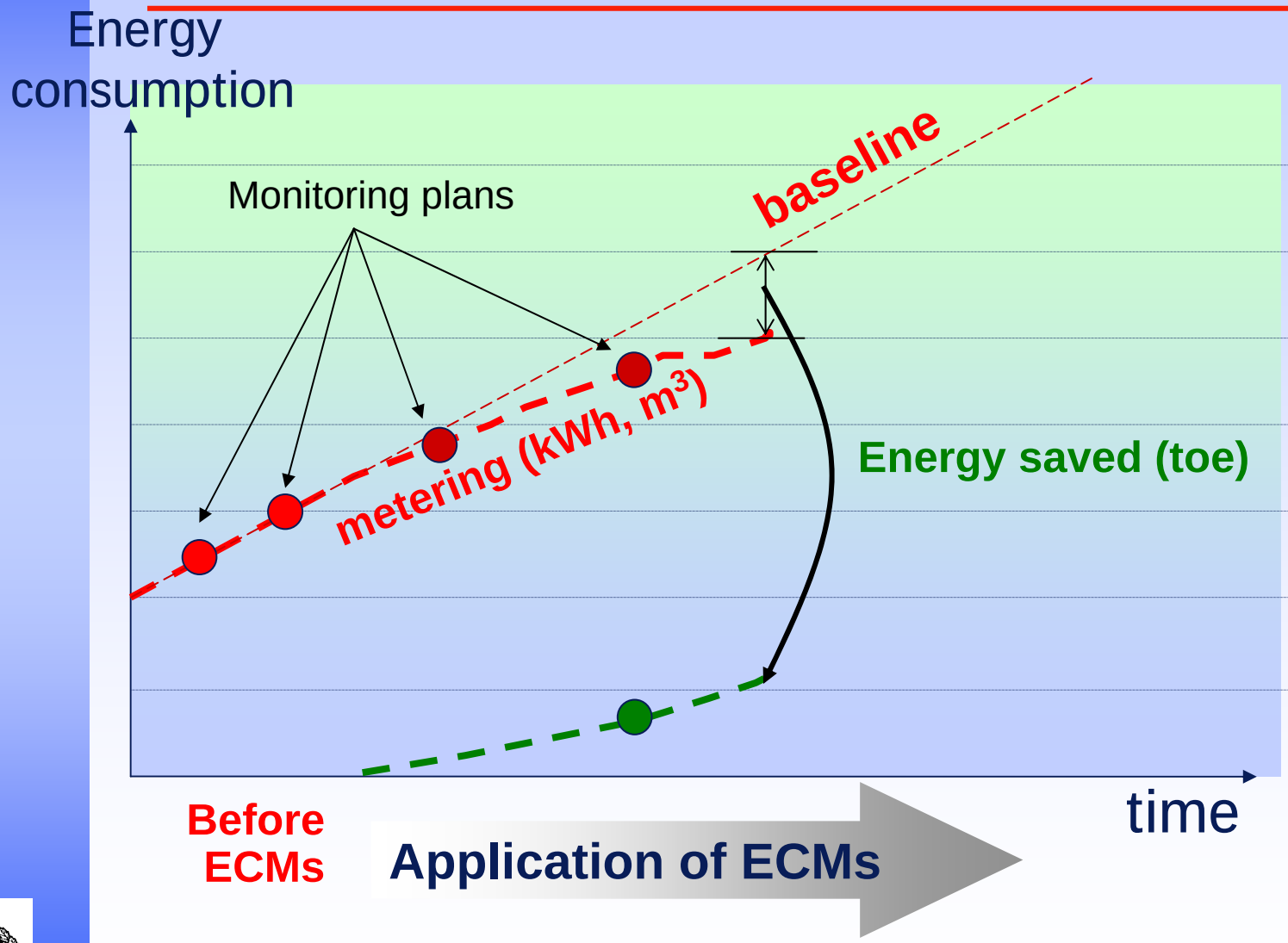
Engineering estimates

- **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**

$DEEs = (Pinc. – PCFL) \times h/y$ [kWh/year/lamp]

$DEPs = DEEs \times Fel$ [toe/year/lamp]

where $Fel = 0.22 \times 10^{-3}$ 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:**

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

- **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 [%]	DEPsprob [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:**

$$EPmed = (\Sigma n\ EPn \times pn)/100 = 14{,}6 \cdot 10\text{-}3\ toe/y/unit$$

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:

    Energy consumption (before and after) = P X 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**

Deemed savings (2)

Developed so far

12) High efficiency electric motors (industrial uses)

13) Heat pumps

14) Light-flow regulators (pubblic lighting)

15) Na lamps (pubblic 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

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(in Italian)