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French Environment & Energy Management Agency

Enerdata

Case studies of energy savings calculation standards in France

IEA-DSM Task XXI: Standardisation of Energy Savings Calculation

3rd Experts Meeting

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Madrid, REE

Energy Savings Calculation (ESC) standards: overview

- Energy saving certificates: the most common and the broadest approach to energy savings calculation in France;

- Other approaches: mostly used by ESCO's and consultants; not widespread yet

  - Measurement of energy consumption and calculation of energy savings resulting from upgrading of building

  - Methods for Energy Performance Contracting

  - Methods for defining the contribution of buildings occupants to the energy saving resulting from energy efficiency investments by the owner: new

  - Official calculation methods of energy performance diagnosis (DPE) (energy efficiency certificates for buildings)➔ not really a method for calculating savings

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Content

- Energy savings certificates
- Case of Compact fluorescent lamps (class A) in the residential sector
- Case of industrial Variable Speed Drive
- Case of retrofit wall insulation in the residential sector

Energy savings obligation and certificates in France (1/2)

- Introduced in July 2006 within an energy saving obligation for energy utilities exceeding a certain volumes of sales, with possibility of trading ("white certificates")

- Energy savings defined as follows in the obligation:
  - In final energy
  - cumulated over the lifespan of the equipment or action;
  - discounted at 4% :both financial (economic value of ESC) and technical discount (gradual decrease in savings)

    ➔ Savings express in kWh cumac

- Concrete implementation of energy saving obligations defined through various government decrees (6 as of September 2010)

Energy savings obligations and certificates in France (2/2)

- First period (3 years) from July 1st 2006 to June 30th 2009 :
  - Obligation for energy suppliers with sales > 400 GWh/year for electricity, gas and heat and 100 GWh/year for LPG and all resellers of heating oil
  - Overall national target 54 TWhcumac over 3 years (cumac = cumulated and discounted) (June 2006-July 2009) (electricity 30.99 TWh, gas 13.93 TWh, heating oil 6.84 TWh, LPG 1.53 TWh and heat 0.69 TWh)
- Second period (officially endorsed in a new law in July 2010; new 3 years period to start in January 2011; transitory period since end of June 2009)
  - Obligation extended to resellers of motor fuels
  - Overall national target 345 TWhcumac over 3 years, of which 255 TWh for the companies having already an obligation over the first period ➔ multiplication by 4.7 compared to the first obligation

White certificates in France: standardisation of energy savings

- Ex-ante evaluation of energy saving (no measurement) for standard operations/equipment
- Existence of standard evaluations by energy saving operations/equipment
- Summary sheets publicly available on Ministry web site and in a printed Memento
- Detailed calculation sheets with all assumptions : restricted access for stakeholders

Type of document	Documents	Date
ATEE guide of standardised energy saving operations (includes the summary sheets by operation and all decrees) (~180 operations)	○"Mémento du Club C2E"	September 2010 (6 th edition)
On line summary sheets by operation on Ministry web site	○ http://www.developpement-durable.gouv.fr/Les-Fiches-d-operations.html	May 2010 (last update) (regular updates)
Technical sheet detailing the mode of calculation of energy savings for selected operations	○Compilation of calculation sheets (unofficial , prepared by ADEME for IEA-DSM Task XXI)	2010

White certificates in France: example of summary sheets for standardised energy savings operations

- Each summary sheet specifies:
  - the conditions of eligibility,
  - the conventional life time
  - the amount of energy savings certificates in final energy expressed in kWh cumac (cumulated and discounted at 4%):
    - example: savings with a freezer of A+ class, saving 50 kWh/year during 10 years are 420 kWh cumac (and not 50*10= 500kWh).

- Example of summary sheet : solar water heater:
  - Eligibility : need of a certification (CSTBat, Solarkeymark) and installation by certified companies (Qualisol).
  - Conventional life time : 15 years.
  - Amount of certificates according to climatic zone
    - H1(North): 2 900 kWh cumac / m2
    - H2 (Centre): 3 500 kWh cumac / m2
    - H3 (South): 4 600 kWh cumac / m2

Standardisation of 182 operations and equipment

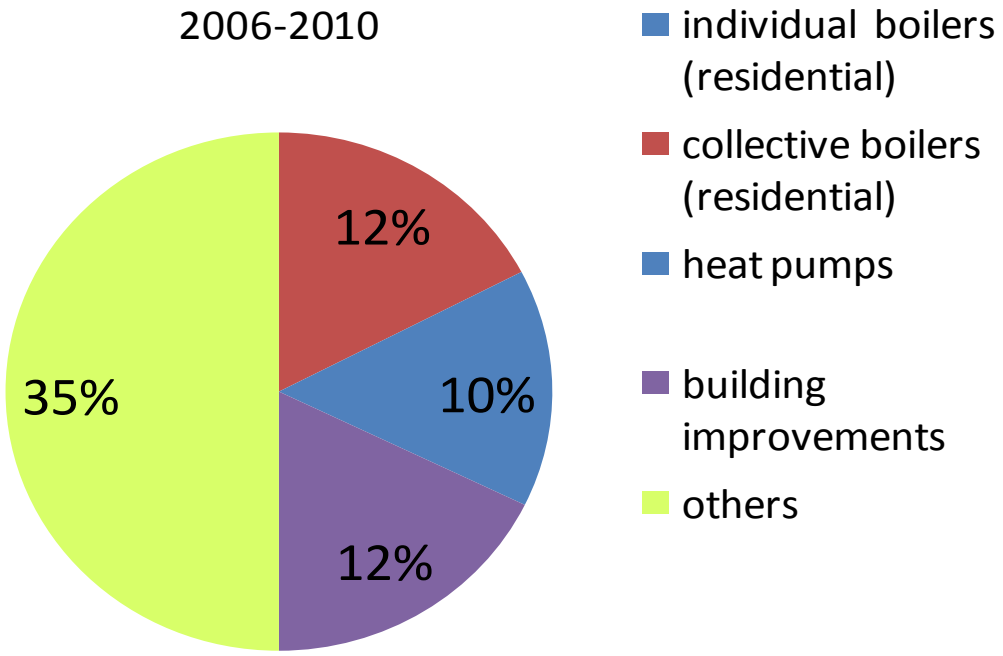
Sector	Number
Residential buildings	**61**
•Envelope	7
•Thermal equipment (eg boilers, water heaters, regulators)	44
•Equipment (e.g. refrigerator, lamps)	8
•Services	2
Tertiary buildings*	**84**
•Envelope	14
•Thermal equipment	51
•Equipment (e.g. lighting)	19
Industry	**22**
•Buildings	9
•Utilities	11
•Envelope	2
Networks	**10**
•Heat & cold	5
•Public lighting	4
•Electricity distribution	1
Transport	**5**

* Separate file for large buildings in many cases

Results by type of standardised measures: overview

Total savings 127 TWh cumac, of which:

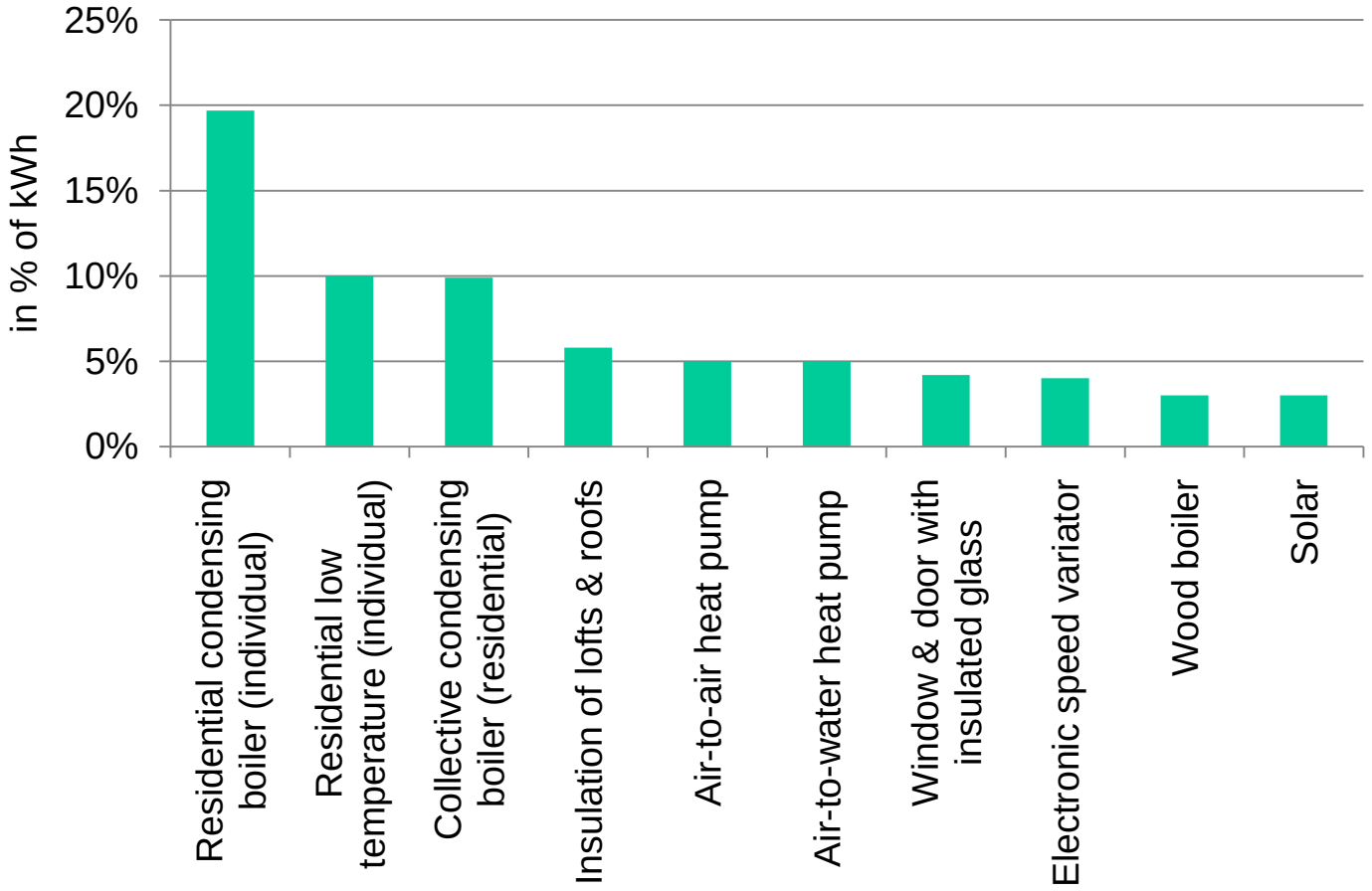
- 122.5 TWh (97%) from standardised operations
- 117.6 from obliged utilities (93%)



Source: MEEDDAT / DGEC, September 2010

Results from 1st July 2006 to 31st July 2010

Results by type of standardised measures: ten most frequent measures



Results from July 2006 to July 2010 (Source: MEEDDAT / DGEC, September 2010)

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Formula used for the calculation of annual gross energy savings : compact fluorescent lamps

Gross savings in year t = $\{n_s \times [1/1000 \times (P_{old} \times h_{old} - P_{new} \times h_{new})]\}$ in kWh

P_{old} = the capacity in W of the (old) bulbs

P_{new} = the capacity in W of the (new) CFL

h = burning hours

n_s = number of CFL units promoted/installed in year t

1/1000 = conversion factor from W to kW

Notes: In red: calculation parameters

energy savings specified per object of assessment, i.e. per lamp installed or promoted

Baseline issues/ gross to net corrections : compact fluorescent lamps

- The baseline used for the energy savings calculations is a market average. It is assumed that on average a CFL replaces in 70% of the case an incandescent lamp and in 30% of the cases a CFL ➔ Baseline incorporated in the gross to net calculation.

- The baseline is static; the discounting (during the lifetime calculation) is considered to somehow take into account a dynamic baseline.

- There is no correction for double counting, free riders, technical interactions, spillover effects or rebound effect.

- Net savings are equal to gross savings multiplied by a coefficient reflecting the market share of the efficient appliance (MSEFF):

  Annual net savings in year t = (1- MSEFF) * gross savings in year t in kWh

Input parameters: compact fluorescent lamps

Annual net savings in year t = (1- MSEFF) *{n_s x [1/1000 x (P_{old} x h_{old} – P_{new} x h_{new})] } in kWh

with:

- MSEEF = market share of the efficient appliance
- P_{old} = the capacity in W of the (old) bulbs
- P_{new} = the capacity in W of the (new) CFL
- h = burning hours

- Parameters Assumptions:
  - MSEEF= 70%
  - P_{old} : 80 W.
  - P_{new} : 18 W.
  - h : 800 h (stable, ie does not change after the replacement

Life time savings: compact fluorescent lamps

- The life time savings are not used for how long savings are accounted for, but for accounting the savings of the CFL promoted in year t.
- Life time of CFL Class A: 7.5 years (6,000 h over lifetime and 800 h/year ➔ 6,000/800=7.5)
- The life time savings are discounted (saving in kWh cumac) with a discount rate of 4% ➔ annual net savings are multiplied by a discount factor, function of the life time and discount rate. This results in the value of 6.626 for the discount factor (LT_{disc}) for CFL.
- Lifetime savings = $LT_{disc} \times n_s \times 34.72 = 6.626 \times n_s \times 34.72 = = n_s \times 230$ kWh
- This 230 kWh is presented as kWh cumac to clarify that this value is cumulated and discounted.

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Formula used for the calculation of annual gross energy savings : industrial Variable Speed Drive

Gross savings in year t = n_s x PCES*h in kWh

PCES = % of energy savings from the installation of VSD

h = operating hours

n_s = power in kW of motors in which VSD units are installed in year t

Notes: In red: calculation parameters

energy savings specified per kW of power rating installed or promoted

Baseline issues/ gross to net corrections : industrial Variable Speed Drive

- The baseline is incorporated in the gross to net calculation: net savings are equal to gross savings multiplied by a coefficient reflecting the market share of the efficient appliance (MSEFF) = gross savings *(1-MSEFF)

  Annual net savings in year t = (1- MSEFF) * gross savings in year t in kWh

- The baseline used for the energy savings calculations is a market average. For specifying the baseline, three types of motors uses are considered: ventilation, pumping and compressed air

- The baseline is static; the discounting (during the lifetime calculation) is considered to somehow take into account a dynamic baseline.

- There is no correction for double counting, free riders, technical interactions, spillover effects or rebound effect.

Input parameters: industrial Variable Speed Drive (VSD)

- Annual net savings in year t = (1- MSEFF) * n_s x PCES*h in kWh

  with:

  - MSEEF = market share of VSD
  - PCES = rate of energy savings from VSD
  - h= operating hours

- Parameters Assumptions:

Application	MSEEF	PCES	Operating hours
Pumping	96.4%	30%	5 091
Ventilation	96.1%	30%	6 148
Compressed air	99.3%	15%	4 709

Application	Baseline market share
Pumping	3.64%
Ventilation	3.86%
Compressed air	0.69%

Life time savings: industrial Variable Speed Drive

- The life time savings are used for accounting the savings of the VSD promoted in year t.
- Life time of VSD: 10 years
- The life time savings are discounted ➔ annual net savings are multiplied by a discount factor, function of the life time (10 years) and discount rate (4%). This results in the value of 8.44 for the discount factor (LT_{disc}) for VSD.
- Lifetime savings = LT_{disc} x n_s x annual savings

  ➔for pumping= 1472 = 8.44 x n_s x 1472= = n_s x 12423 kWh cumac

Application	Life time savings (rounded) (kWh cumac)
Pumping	12400
Ventilation	15000
Compressed air	5900

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Formula used for the calculation of annual energy savings : retrofit wall insulation in the residential sector

- Savings in year t = n_s ESij in kWh

  ESij = unitary energy savings per m2 of insulation materials for climatic zone i and heating fuel j (electricity versus fuels based systems)

- Energy savings specified per m2 of insulation materials installed or promoted

Formula used for the calculation of annual unitary savings : retrofit wall insulation in the residential sector

- $ESij = x\ (U_0-U_t)*\ DD*CC_i*\ 24h*IC/EFF_j/1000$ in kWh

n_s = surface area of insulation materials promoted or installed in year t

U_t = U value after installation of insulation materials)

U_0 = U value before installation of insulation materials (W/ m^2K)

R = thermal resistance of the insulation material (m^2K/W)

DD = Average number of degree days

CC_i = Climatic coefficient of climatic zone i (=1 for average)

IC = Intermittency coefficient and incidental gain

DD = Average number of degree days

EFF_j = Efficiency of heating system j

1/1000 = conversion factor from W to kW

- As $U_t = 1/((1/U_0)+R)$, with R= thermal resistance of the insulation, the formula becomes:
- $ES_{ij} = \{U_0 - (1/[(1/U_0)+R])\}*\ DD*CC_i*\ 24h*IC/EFF_j/1000$

Baseline issues/ gross to net corrections : retrofit wall insulation in the residential sector

- The baseline used for the energy savings calculations is the stock average.
- The baseline insulation coefficient used for external wall is U_o=3.3 W/ m^2K: it corresponds to a non insulated wall.
- The baseline is static; the discounting (during the lifetime calculation) is considered to somehow take into account a dynamic baseline.
- There is no correction for double counting, free riders, technical interactions, spillover effects or rebound effect.
- Annual net savings in year t = gross savings in year t in kWh

Input parameters: retrofit wall insulation in the residential sector

- Annual net savings = n_s x * {U_0 - (1/[(1/U_0)+R])}* DD*CC_i* 24h* IC/EFF_j/ 1000 in kWh/m^2
- Parameters Assumptions:
  - U_0= U value before installation of insulation materials = 3.3 W/m^2.K
  - R = thermal resistance of the insulation material= 2.4 m^2K/W
  - DD = Average number of degree days = 2450
  - IC = Intermittency coefficient and incidental gain = 0.5
  - EFF_j = Efficiency of heating system=95% for electricity and 60% for fuel based heating
  - CC_i= climatic coefficient ➔

Climatic zone i	Climatic coefficient CC_i
Average	1
H1 (cold)	1.1
H2	0.9
H3 (south)	0.6

Calculation of annual savings: retrofit wall insulation in the residential sector

- Annual net savings = n_s x * {U_0 - (1/[(1/U_0)+R])}* DD*CC_i* 24h* IC/EFF_j/ 1000 in kWh/m^2
- Annual net savings in year t for average climate and for electricity

  = ns*{3.3 - (1/[(1/3.3)+2.4])}* 2450*1* 24*0.5/0.95/1000 = n_s x 91 kWh
- Annual net savings in year t for average climate and for fuels

  = ns*{3.3 -(1/[(1/3.3)+2.4])}* 2450*1* 24*0.5/0.6 = n_s x 144 kWh
- Annual net savings in year t by climatic zone and fuel

Climatic zone i	Fuel	Electricity
Average	144	91
H1 (cold)	158	100
H2	129	82
H3 (south)	86	54

Life time savings: retrofit wall insulation in the residential sector

- The life time savings are used for accounting the savings of the insulation retrofit promoted/installed in year t.
- Life time of insulation retrofit : 35 years
- The life time savings are discounted ➔ annual net savings are multiplied by a discount factor, function of the life time and discount rate (4%). This results in the value of 19.4 years for the discounted lifetime (LT_{disc}) for insulation retrofit .
- Lifetime savings = LT_{disc} x n_s x annual savings (rounded) in kWh cumac

Climatic zone i	Fuel	Electricity
H1 (cold)	3070	1940
H2	2500	1600
H3 (south)	1700	1100