IEA DSM Task XXI
Standardisation of Energy Savings Calculations

Technology case application Heat pumps in households;
Summary on calculations (section 2 in the case applications)

1. Formula used

The formulas for calculating the annual energy savings as used in the three countries case applications are developed from a different view:
- the Norwegian based on metered annual electricity use, where the non-heating use is subtracted;
- the Dutch based on the estimated heat demand calculated using a model approach for meeting the heat demand;
- the Italian based on calculations for replacement of conventional water heathers and for new installation using average Coefficient Of Performance (COPs)[1].

Table 1 lists the formulas in a summarised fashion. The country reports hold more details.

Table 1. Issued formulas in the case application per country

Country	Formulas
Norway	$$ES_t = \sum_i \left(CT_{-1,i} - CNH_{-1,i}\right) \cdot \frac{DDn_i}{DD_{-1,i}} - \left(CT_{t,i} - CNH_{t,i}\right) \cdot \frac{DDn_i}{DD_{t,i}}$$ i = household index, $i = 1 \ldots n$ t = time index, specified as follows: $t = -1$ = The last full year before installation of heat pump (ex-ante year) $t = 0$ = The <u>point in time</u> of installation of the heat pump $t > 0$ = Any full year of operation after installation of the heat pump (ex-post year) ES_t = annual net savings in year t in kWh $CT_{t,i}$ = Observed (metered) annual <u>total</u> consumption of electricity (kWh) in year t for household i $CNH_{t,i}$ = Annual consumption for <u>non-heating purposes</u> of electricity in year t for household i (kWh). DDn_i = Normalised annual degree day sum for household i $DD_{t,i}$ = Observed (metered) degree day sum in year t for household i
The Nether-lands	$$ES_t = \sum_i E_{tot,ref} - E_{tot,hp} \quad \text{in GJ (primary energy)}$$ *i = installed heat pumps i= 1.. n* $E_{tot,ref}$ = *Calculated total primary energy use of the building (standard conditions) in MJ/year* $E_{tot,hp}$ = *Calculated total primary energy use of the building (standard conditions) with a heat pump installed, in MJ/year* ES_t = *annual net savings in the year t in primary energy use (MJ/year)*
Italy	$$ES_t = \sum_i E_{ref} - E_{pdc}$$ *i = installed heatpumps i= 1.. n*

[1] The Italian case application is available at the website www.iea.dsm.org as there is no Italian country report

Country	Formulas
	E_{ref} = Energy use in the situation before in the year t in 10^{-3} toe/year
	E_{pdc} = Energy use in the situation after, depending on climate zone en COP in the year t in 10^{-3} toe/year
	ES_t = annual net savings in the year t in 10^{-3} toe/year

source: the individual case applications as included in the country report

2. Parameters

In the Norwegian case application the annual consumption for non-heating purposes (CNH) is estimated based on a default electricity use of 8,000 kWh and an electricity use of 1,000 kWh per household member.

In the Dutch case application the model calculates the total primary energy use based on the energy use of the components of the building and the energy system:

$$E_{tot} = E_{rv} + E_{tap} + E_{hulp} + E_{verl} - E_{pv} - E_{wkk}$$

where

- E_{tot} = Total primary energy usage of building (standard conditions) [MJ/yr]
- E_{rv} = Energy use for space heating [MJ/yr]
- E_{tap} = Energy use for domestic hot water [MJ/yr]
- E_{hulp}= Energy use for pumps/ventilation [MJ/yr]
- E_{verl} = Energy use for lighting [MJ/yr]
- E_{pv} = Energy supply solar panels [MJ/yr]
- E_{wkk} = Energy supply micro-CHP [MJ/yr]

For the calculation of natural gas to primary energy, the energy content of 35.17 MJ/m^3 and for electricity 3.6 MJ/kWh is used.

In the Italian case application a conversion factor of 0.187 toe/MWh from electricity to primary energy is used.

3. Baseline issues

In the Norwegian case application electricity use in the 'before situation' is the baseline, whatever heating system was in place. In the Dutch case application the baseline situation is the heating demand of de dwelling holding the same assumptions as for the energy savings calculations, but with an other heating system then the heat pump. In the Italian case application three different baseline situations are used for a single household: 1) a gas water heather (using $163*10^{-3}$ toe/year); 2) an electric water heater (using $251*10^{-3}$ toe/year); 3) a reference situation for new installations: a national weighted average of the different type of water heaters in use (using $186*10^{-3}$ toe/year).

4. Normalisation

In the Norwegian and Dutch case application the energy use is normalised by Heating Degree Days (HDD). In the Dutch case application the model calculations are also normalised for the heating temperature (18 $^\circ$C) and for a specified number of households members (related to the floor area of a dwelling). In the Italian case application the COPs are related to four climatic zones.

5. Corrections

In the Norwegian case application a subsample of households is used to estimate the impact of "other factors changed" and so estimate the gross savings of the households participating in the programme. But this information was not used for a correction in the calculated energy savings.

So in practise no corrections are conducted.

6. Life time savings applied

In all case applications no life time savings are calculated.