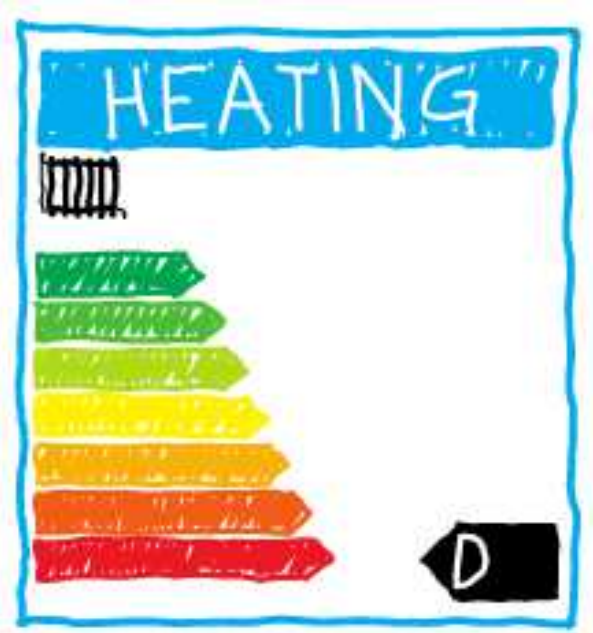
HARP Project – Heating Appliances Retrofit Planning



AN EU ENERGY LABELLING METHODOLOGY FOR EXISTING HEATING APPLIANCES

Diego Menegon

Institute for Renewable Energy, Eurac Research

1st July of 2022, Mostra Convegno Expocomfort, Milan

eurac research

HARP
Heating Appliances Retrofit Planning

Introduction

Definition of an **energy label** for space heating and water heaters **old appliances**. For the appliances that were in the market before the introduction of energy label directive (regulations 811/2013 and 812/2013).

Give the possibility to final user and to professionals to **compare** the old appliance label with the one of a new product.

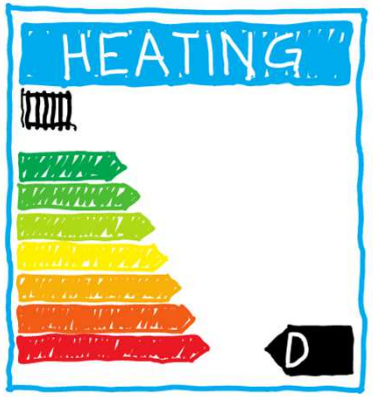
- **Simplified** version for a **common user**
- **Detailed** version for a **professional user**

Introduction

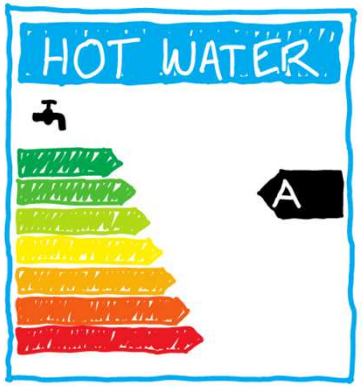
The methodology has been implemented as first step of the HARPa tool.

The labelling proposed in HARP is **voluntary** and its aim is to **inform** the final user about the (in)efficiency of old appliances. Therefore the graphics recalls the official label.

Your existing boiler has an estimated efficiency of 70%, reaching an energylabel class of D.



Your existing gas instantaneous water heater has an estimated efficiency of 83%, reaching an energylabel class of A.



Workflow of the developing of labelling methodologies

1) **Analysis** of the **existing** compulsory and voluntary heating **labelling schemes** in EU countries
2) Development of **harmonized** methodologies with the **EU energy labelling regulations** Reg. 811/2013 (space heating) and Reg. 812/2013 (water heating)
3) Introduction of a **degradation factor** according to the appliance's age defined in cooperation with the heating industry and considering the existence of regular maintenance procedures
4) **Validation** of the methodologies considering the technical data of more than **5.000 appliances** and **laboratory testing** of 5 appliances (space heating and water heaters)

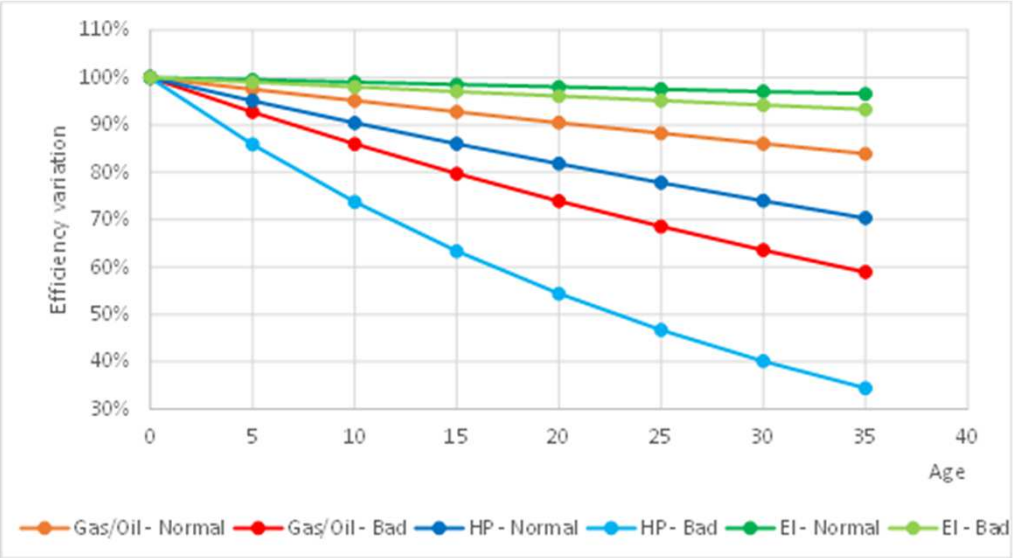
Labelling methodologies for existing heating appliances

EXISTING SPACE HEATERS

$$\eta_s = \eta_{son} \cdot \boldsymbol{C_{age}} - \sum F_{(i)}$$

EXISTING WATER HEATERS

$$\eta_{WH} = \frac{Q_{ref}}{\left(Q_{fuel} + CC \cdot Q_{el}\right) + Q_{cor}} \cdot \boldsymbol{C_{age}}$$



We considered different degradation coefficients for "normal" or "bad" maintenances depending on the appliances typology.

Labelling methodologies for existing heating appliances

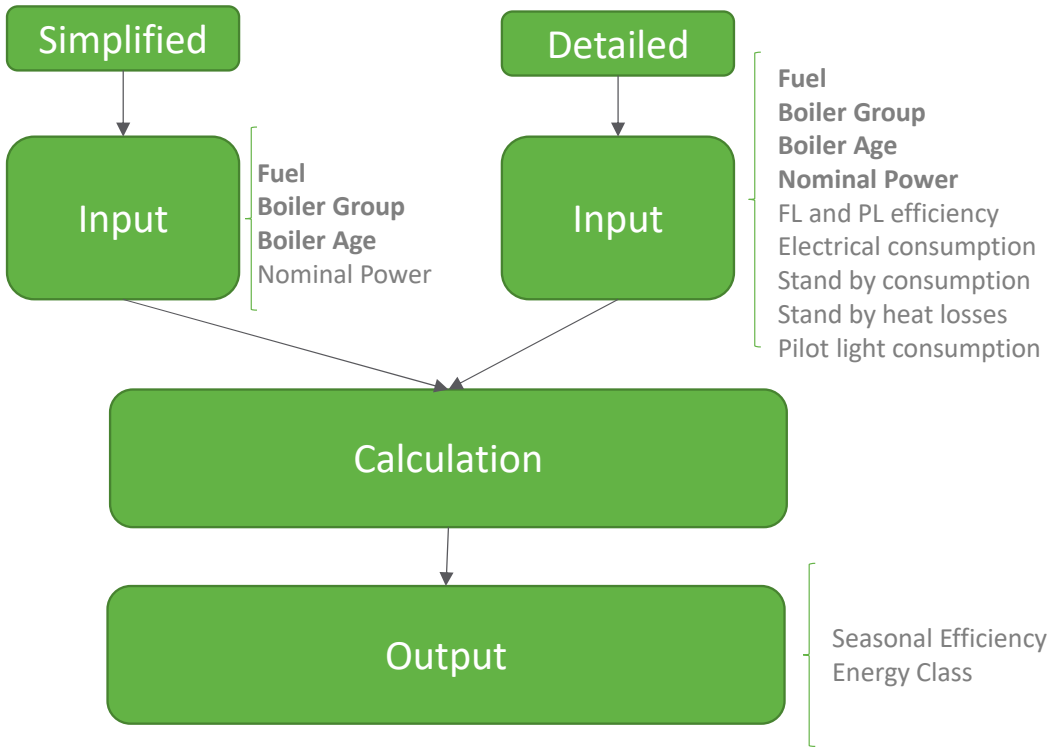
- The final user is not aware of the meaning of the calculation inputs
- For old appliances some values cannot be retrieved from datasheets or appliances books.

The validation of the methodologies considered those limits:

1. For the final user, the inputs are needed to define default values.
2. The selection of default values has been simplified.
3. The default values were selected from EN 15316 and from a market analysis.

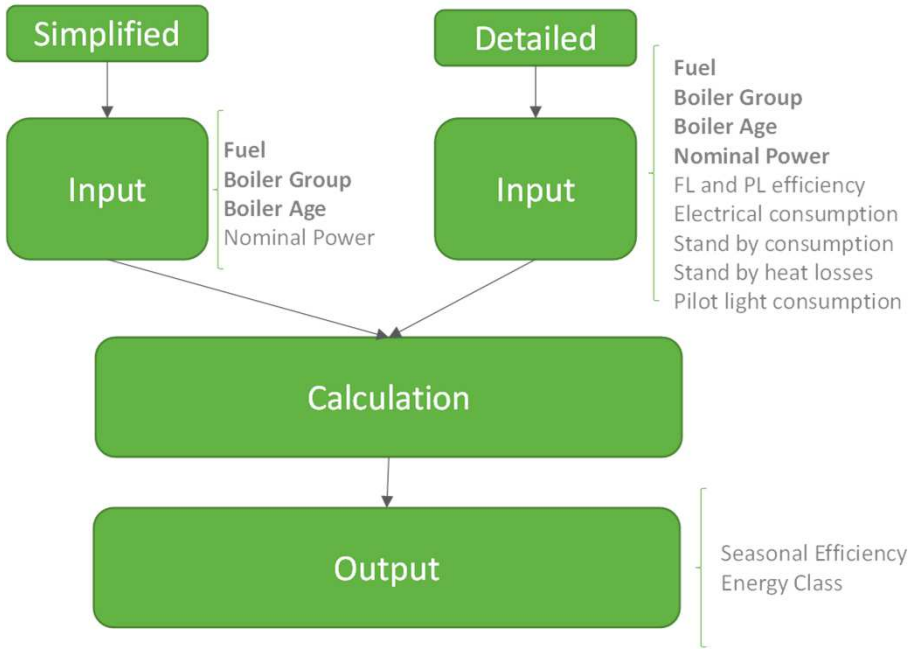
Labelling methodologies for existing heating appliances

SPACE HEATING – data input

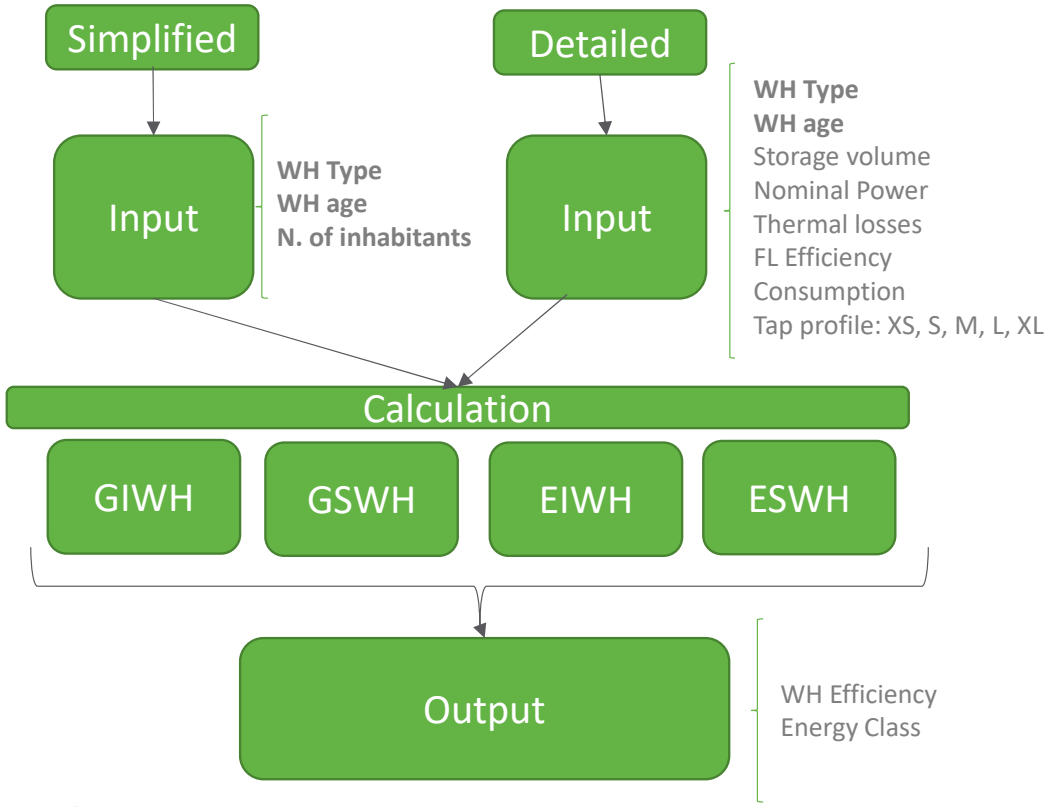


Labelling methodologies for existing heating appliances

SPACE HEATING – data input



WATER HEATING data input



Labelling methodologies for existing heating appliances

SPACE HEATING

The representation is done according to the boilers groups:

- Standard
- Low temperature
- Condensing

The validation regarded:

- about 4600 models
- with construction year from 1972 to 2019
- gas and oil boilers

Labelling methodologies for existing heating appliances

SPACE HEATING

The representation is done according to the boilers groups:

- Standard
- Low temperature
- Condensing

The validation regarded:

- about 4600 models
- with construction year from 1972 to 2019
- gas and oil boilers

WATER HEATING

The appliances considered were:

- Gas storage
- Gas instantaneous
- Electric storage
- Electric instantaneous

The validation regarded:

- 400 appliances models
- Appliances older than 10 years old
- Electric and gas heaters

Average deviation of 3% between the simplified and the detailed calculations

Conclusion

Labelling methodologies for existing space heating appliances and water heaters has been developed.

The methodologies are compliant to EU regulations 811/2013 and 812/2013.

The methodologies considered two versions: a simplified for the final user and a detailed for the professional user.

The validation considered about 5000 appliances and the average deviation between the simplified and the detailed versions is about 3%.

Thank you for your attention!

Dr. Diego Menegon

Eurac Research - Institute for Renewable Energy

Tel +39 0471 055 639 / Fax +39 0471 055 699

diego.menegon@eurac.edu

A.Volta Straße 13/A / Via A. Volta 13/A

39100 Bozen / Bolzano

eurac research

HARP
Heating Appliances Retrofit Planning

Energy Labelling for SH appliances

NEW

$$\eta_s = \eta_{son} - \sum F_{(i)}$$

$$\eta_{son} = 0.85 \cdot \eta_1 + 0.15 \cdot \eta_4$$

OLD

$$\eta_s = \eta_{son} \cdot \boldsymbol{C_{age}} - \sum F_{(i)}$$

$$\eta_{son} = 0.85 \cdot \eta_1 + 0.15 \cdot \eta_4$$

Calculation of seasonal efficiency (that defines the energy class) according to regulation EU 811/2013.

Energy Labelling for new SH appliances

where:

$$\eta_1 = \eta_{30} \cdot \frac{H_i}{H_s}$$

$$\eta_4 = \eta_{100} \cdot \frac{H_i}{H_s}$$

$$P_1 = P_{30}$$

$$P_4 = P_{100} = P_n$$

30 represents the 30% of nominal power

100 represents the full load

H_i, H_s lower and upper heat values

Source: Regulation EU 811/2013 – Annex VIII. Communication 2014/C 207/02
EN 15502-1 c.9.5

Energy Labelling for old SH appliances

Simplified version (default values)

$$\eta_{30} = c_3 + c_4 \cdot \log(P_n)$$

$$\eta_{100} = c_1 + c_2 \cdot \log(P_n)$$

$$P_{stby} = c_5 \cdot (P_n)^{c_6}$$

$$el_{min} = c_{7,P1} + c_{8,P1} \cdot (P_n)^{n_{P1}}$$

$$el_{max} = c_{7,Pn} + c_{8,Pn} \cdot (P_n)^{n_{Pn}}$$

$$P_{SB} = c_{7,SB} + c_{8,SB} \cdot (P_n)^{n_{SB}}$$

$$P_{ign} = 150\ W$$

Detailed version (inputs from professional)

$$\eta_{30}$$

$$\eta_{100}$$

$$P_{stby}$$

$$el_{min}$$

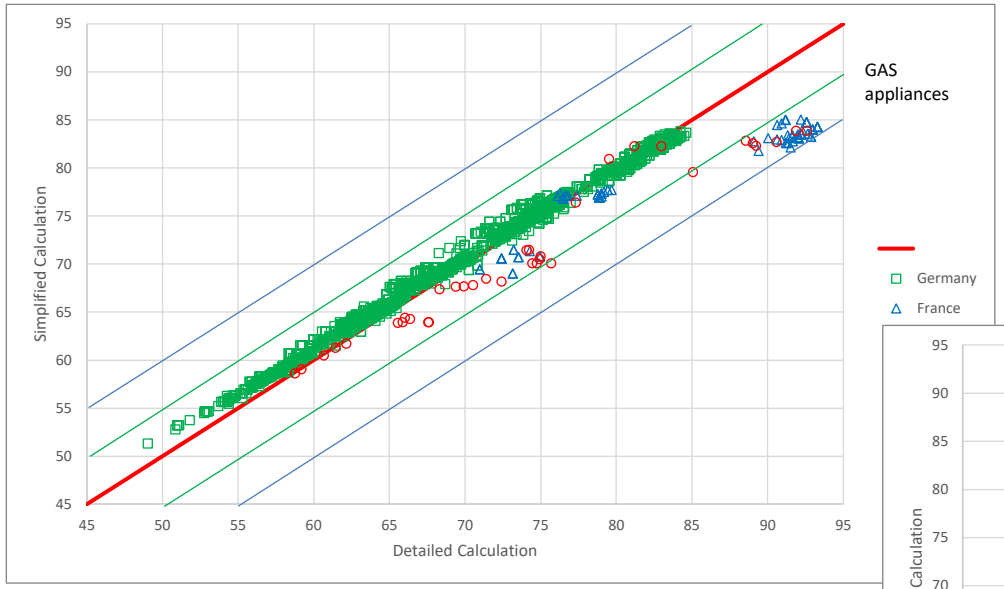
$$el_{max}$$

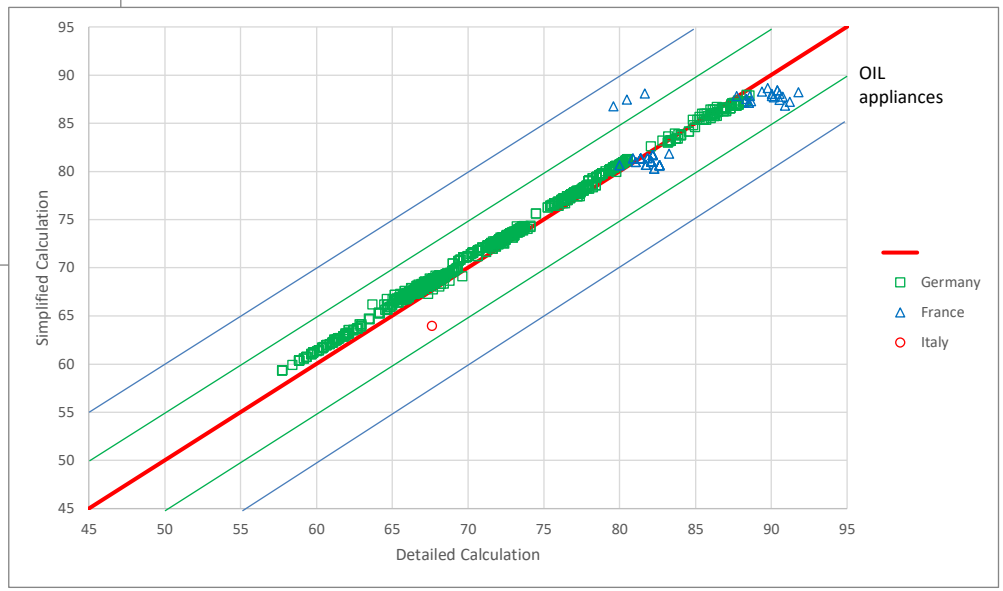
$$P_{SB}$$

$$P_{ign}$$

$$calculation\ of\ \eta_1, \eta_4, \eta_{son}, F(i)\ and\ \eta_s$$

Energy Labelling for old SH appliances





Energy Labelling for water heaters

NEW

$$\eta_{WH} = \frac{Q_{ref}}{(Q_{fuel} + CC \cdot Q_{el}) \cdot (1 - SCF \cdot smart) + Q_{cor}}$$

Calculation of water heater efficiency (that defines the energy class) according to regulation EU 812/2013.

OLD

$$\eta_{WH} = \frac{Q_{ref}}{(Q_{fuel} + CC \cdot Q_{el}) + Q_{cor}} \cdot \boldsymbol{C_{age}}$$

smart = 0
Qref from tapping profile
Qfuel / Qel calculated
Aging Effect

Energy Labelling for old WH appliances

Simplified version – the number of inhabitants defines the tapping profile

	Energy	N° inhabitant
S	2.1 kWh/day	0
M	5.85 kWh/day	1 – 2
L	11.7 kWh/day	3 – 5
XL	19.1 kWh/day	6 – 8
XXL	24.5 kWh/day	9+

Energy Labelling for old WH appliances

Energy losses - values from EN 15316-5:

$$H = \frac{1000}{c_4 \cdot c_5} \cdot (c_1 + c_2 \cdot V^{c_3})$$

$$Q_L = f_{sto,bac,acc} \cdot f_{sto,dis,ls} \cdot \frac{H}{1000} \cdot (\vartheta_{set} - \vartheta_{amb}) \cdot t$$

Where:
V is the volume
H [W/K] is the heat losses coefficient
$\vartheta_{amb}, \vartheta_{set}$ are the ambient and storage temperatures -
c_1, c_2, c_3, c_4, c_5 defined in the standard as a function of WH type

[.. follows ..]

Source: EN 15315-5

Energy Labelling for old WH appliances

[.. continues ..]

$f_{sto,bac,acc}$ represents a factor for the adaption for the calculation time step

$f_{sto,dis,ls}$ represent a factor that considers thermal bridge

Default, monthly or annual calculation $f_{sto,bac,acc} = 1$

$f_{sto,dis,ls} = 1$ no thermal bridge

$f_{sto,dis,ls} = 3$ with thermal bridge

Source: EN 15315-5

Energy Labelling for old WH appliances

Energy losses - values from Datasheet:

$$Q_L = Q_{L,65} \cdot \frac{\vartheta_{set} - \vartheta_{amb}}{\vartheta_{set,test} - \vartheta_{amb}} \cdot t$$

In the datasheet the $Q_{L,65}$ is indicated as 24 hours losses with 65°C of storage.

The correction to ϑ_{set} is done to agree with calculation of EN 15316-5.

Energy Labelling for old WH appliances

ESWH:

$$Q_{el} = \frac{Q_{ref} + Q_{ls}}{\eta}$$

GSWH – from datasheet or default values from EN 15316-4-1:

$$Q_{fuel} = \frac{Q_{ref} + Q_{ls}}{\eta}$$

Energy Labelling for old WH appliances

GIWH – from datasheet or default values from EN 15316-4-1:

$$Q_{fuel} = \frac{Q_{ref}}{\eta_{100} \cdot H_i/H_s} = \frac{Q_{ref}}{\eta_{100}} \cdot \frac{H_s}{H_i}$$

$$Q_{el} = \int P \, d\vartheta = el_{max} \cdot t_{on} + P_{SB} \cdot t_{off}$$

where - default values:

$$\eta_{100} = c_1 + c_2 \cdot \log(P_n)$$

$$el_{max} = c_{7,max} + c_{8,max} \cdot (P_n)^{n_{max}}$$

$$P_{SB} = c_{7,sb} + c_{8,sb} \cdot (P_n)^{n_{sb}}$$

t is time

c_1, c_2, c_7, c_8 defined in the standard as a function of boiler type

Source: elaboration of EN 13203-2

Energy Labelling for old WH appliances