Small scale renewable heating

Heat pumps / Biomass Boilers

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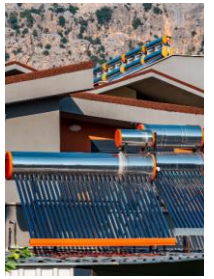
Definition and scope



- Definition

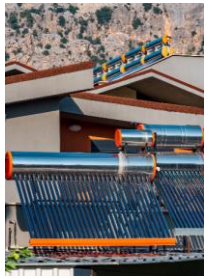
  Small-scale renewable heating technologies are systems that supply central heating without polluting emissions, in this case, to cover the heat demand of buildings and provide domestic hot water

- Scope of the streamSAVE:
  - Measures targeting residential sector and non-residential sector
  - Methodologies prepared for following technologies:
    - Heat pumps for heating and domestic hot water
    - Biomass boilers for heating and domestic hot water

Heat pumps for heating and domestic hot water (DHW)

[residential and non-residential buildings]

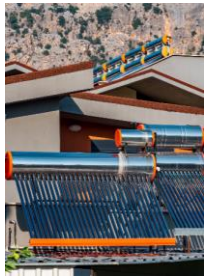
Calculation methodology – Art. 7 Heat pumps



$$TFES = A \cdot (SHD + HWD) \cdot \left(\frac{1}{eff_{baseline}} - \frac{1}{eff_{action}} \right) \cdot f_{BEH} \cdot cf_x$$

TFES	Total final energy savings [kWh/a]
A	Useful floor area of the building or dwelling [m²]
SHD	Area specific heating demand of the building or dwelling [kWh/m²a]
HWD	Area specific hot water demand of the building or dwelling [kWh/m²a]
cf_x	Climate correction factor
$eff_{baseline}$	Conversion efficiency of a reference heating system [dmnl]
eff_{action}	Conversion efficiency of the heat pump [dmnl]
f_{BEH}	Factor to calculate behavioural aspects [dmnl]

Calculation methodology – Art. 7 Heat pumps



Action type	Indicative lifetime (years)
Heat pumps for residential buildings	10 (air-to-air)
Heat pumps for non-residential buildings	15 (air-to-water);
Heat pumps	25 (geothermal)

(Appendix VIII of Commission Recommendation (EU) 2019/1658)

EUR-Lex - 32019H1658 - EN - EUR-Lex (europa.eu)

cf_x	[dmnl]		
	North	West	South
Residential	1.21	1	0.76
Non-Residential	1.16	1	0.70
f_{REH}	[dmnl]		
Residential	0.75		
Non-Residential	Not available		
Lifetime of savings	**[years]**		
Lifetime of savings	10 (air to air) 15 (air to water) 25 (geothermal)		
$eff_{Baseline}$ – reference heating system	[dmnl]		
Residential	0.887		
Non-Residential	0.947		
SHD	[kWh/m² useful floor area a]		
Residential	92.1		
Non-Residential	106.9		
HWD	[kWh/m² useful floor area a]		
Residential	19.2		
Non-Residential	18.1		

Calculation of impact on energy consumption (Art3)

Heat pumps for heating and DHW (residential and non-residential buildings)

$$EPEC = FEC_{Baseline} \cdot \sum_{ec} (share_{ec,Baseline} \cdot f_{PE,ec}) - FEC_{Action} \cdot \sum_{ec} (share_{ec,Action} \cdot f_{PE,ec})$$

EPEC	Effect on primary energy consumption [kWh/a]
FEC	Annual final energy consumption [kWh/a]
$share_{ec}$	Share of final energy carrier on final energy consumption [dmnl]
$f_{PE,ec}$	Final to primary energy conversion factor of the used energy carrier [dmnl]
Baseline	Index for the baseline situation of the action
Action	Index for the situation after the implementation of the action
ec	Index of energy carrier

Calculation of impact on energy consumption

Indicative values for the share of energy carriers for Article 3: Heat pumps

$Share_{ec}$ space heating & domestic hot water preparation		Reference heating system [%]	Heat Pump [%]
Residential	Solids	5%	/
	Liquefied petroleum gases	2%	/
	Gas/Diesel oil	16%	/
	Natural gas	37%	/
	Wood/wood waste	19%	/
	Geothermal energy	0%	/
	District heat	11%	/
	Electricity	9%	100%
	Solar	1%	/
Non-residential	Solids	2%	/
	Liquefied petroleum gases	1%	/
	Gas/Diesel oil	21%	/
	Natural gas	44%	/
	Wood/wood waste	2%	/
	Geothermal energy	0%	/
	District heat	13%	/
	Electricity	18%	100%
	Solar	0.2%	

Overview of cost related to the action

Heat pumps

Indicative costs (excl. taxes or fiscal incentives) for heat pumps and reference heating systems:

[euro2020]	Investment costs (single family house - SFH)	
	SFH existing stock	SFH newly built
District heat	14,731	14,731
Gas condensing boiler	9,223	8,607
Oil condensing boiler	14,615	12,993
Firewood boiler	15,286	no data
Wood pellet boiler	16,655	15,899
Heat pump – air	15,785	12,372
Heat pump – ground probe	25,426	20,002
[euro2020/a]	Variable operational costs	
Costs of reduced fuel input	Energy prices from chapter 1.2.1 of D2.2 (fuel prices before/after for household consumers)	
[euro2020/a]	Fixed operational costs: Maintenance	
District heat	1.15 %	
Gas condensing boiler	1.15 %	
Oil condensing boiler	2.12 %	
Firewood boiler	2.55 %	
Wood pellet boiler	2.62 %	
Heat pump – air	2.35 %	
Heat pump – ground probe	2.25 %	
[euro2021]	Revenues	
	No revenues	
[a]	Lifetime	
Lifetime	10	

Calculation of CO_2 savings

Heat pumps

- Based on Article 7 savings

$$GHGSAV = \left[FEC_{Baseline} \cdot \sum_{ec} \left(share_{ec,Baseline} \cdot f_{GHG,ec}\right) - FEC_{Action} \cdot \sum_{ec} \left(share_{ec,Action} \cdot f_{GHG,ec}\right)\right] * 10^{-6}$$

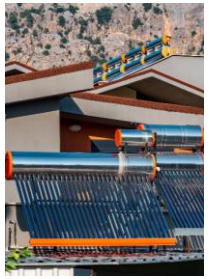
GHGSAV	Greenhouse gas savings [t CO_2e p.a.]
FEC	Annual final energy consumption [kWh/a]
share	Share of final energy carrier on final energy consumption [dmnl]
f_{GHG}	Emission factor of final energy carrier [t CO_2/kWh]
Baseline	Index for the baseline situation of the action
Action	Index for the situation after implementation of the action
ec	Index of energy carrier

f_{GHG}	Greenhouse [g CO_2/kWh]
Emission factor of the reference heating system	158.6

Biomass boilers for heating and domestic hot water (DHW)

[residential and non-residential buildings]

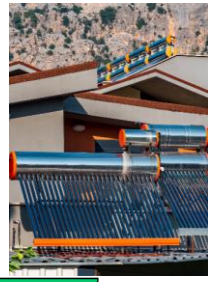
Calculation methodology – Art. 7 Biomass boiler for heating



$$TFES = A \cdot (SHD + HWD) \cdot \left(\frac{1}{eff_{baseline}} - \frac{1}{eff_{action}} \right) \cdot f_{BEH} \cdot cf_x$$

TFES	Total final energy savings [kWh/a]
A	Useful floor area of the building or dwelling [m²]
SHD	Area specific heating demand of the building or dwelling [kWh/m²a]
HWD	Area specific hot water demand of the building or dwelling [kWh/m²a]
cf_x	Climate correction factor
$eff_{baseline}$	Conversion efficiency of a reference heating system [dmnl]
eff_{action}	Conversion efficiency of the biomass boiler [dmnl]
f_{BEH}	Factor to calculate behavioural aspects [dmnl]

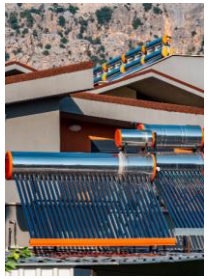
Calculation methodology – Art. 7 Biomass boiler for heating



Indicative calculation values for Article 7 of biomass boilers for heating

cf_x	[dmnl]		
	North	West	South
Residential	1.21	1	0.76
Non-Residential	1.16	1	0.70
f_{BEH}	**[dmnl]**		
Residential (Space heating)	0.75		
Non-residential	Not available		
Lifetime of savings	**[years]**		
Residential	20		
Non-Residential	25		
$eff_{Baseline}$ – reference heating system	**[dmnl]**		
Residential	0.887		
Non-Residential	0.947		
eff_{Action} – biomass boilers	**[dmnl]**		
Biomass boiler	0.920		
SHD	**[kWh/m² useful floor area a]**		
Residential	92.1		
Non-Residential	106.9		
HWD	**[kWh/m² useful floor area a]**		
Residential	19.2		
Non-Residential	18.1		

Calculation methodology – Art. 7 Biomass boiler for heating



eff_{action}	Conversion efficiency
Oil-fired boiler	0,77
Biomass-fired boiler with minimum efficiency	0,75
Biomass boiler (best technology available on the market, estimated from product catalogues/certification schemes)	0,92

(Appendix X of Commission Recommendation (EU) 2019/1658)

EUR-Lex - 32019H1658 - EN - EUR-Lex (europa.eu)

Calculation of impact on energy consumption (Art3)

Biomass

$$EPEC = FEC_{Baseline} \cdot \sum_{ec} (share_{ec,Baseline} \cdot f_{PE,ec}) - FEC_{Action} \cdot \sum_{ec} (share_{ec,Action} \cdot f_{PE,ec})$$

EPEC	Effect on primary energy consumption [kWh/a]
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Calculation of impact on energy consumption (Art3)

Indicative values for the share of energy carriers for heating and DHW preparation for residential and non-residential buildings

Share$_{ec}$ space heating & domestic hot water preparation		Reference heating system [%]	Boiler(biomass) [%]
Residential	Solids	5 %	0 %
	Liquefied petroleum gases	2 %	0 %
	Gas/Diesel oil	16 %	0 %
	Natural gas	37 %	0 %
	Wood/wood waste	19 %	100 %
	Geothermal energy	0 %	0 %
	District heat	11 %	0 %
	Electricity	9 %	0 %
	Solar	1 %	0 %
Non-residential	Solids	2 %	0 %
	Liquefied petroleum gases	1 %	0 %
	Gas/Diesel oil	21 %	0 %
	Natural gas	44 %	0 %
	Wood/wood waste	2 %	100 %
	Geothermal energy	0 %	0 %
	District heat	13 %	0 %
	Electricity	18 %	0 %
	Solar	0.2 %	0 %

Biomass

Overview of cost

Indicative costs (excl. VAT) for biomass boilers and reference heating systems

[euro2020]	Investment costs (single family houses - SFH)	
	SFH existing stock	SFH newly built
District heat	14,731	14,731
Gas condensing boiler	9,223	8,607
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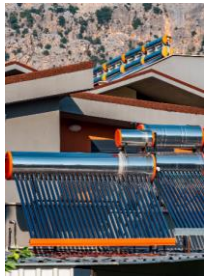
Wood pellet boiler	2.62 %	
Heat pump - air	2.35 %	
Heat pump - ground probe	2.25 %	
[euro2021]	Revenues	
	No revenues	
[a]	Lifetime	
Lifetime	20 - 25	

Calculation of CO_2 savings



- Mainly CO_2 savings, when installing biomass boiler
- Based on Art. 7 savings:

$$GHGSAV = \left[FEC_{Baseline} \cdot \sum_{ec}\left(share_{ec,Baseline} \cdot f_{GHG,ec}\right) - FEC_{Action} \cdot \sum_{ec}\left(share_{ec,Action} \cdot f_{GHG,ec}\right)\right] * 10^{-6}$$

GHGSAV	Greenhouse gas savings [t CO_2e p.a.]
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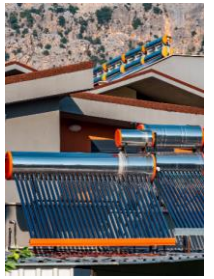
f_{GHG}	Greenhouse [g CO_2/kWh]
Emission factor of the reference heating system	158.6

Questions for discussion



- No savings can be achieved by replacing boilers in non-residential buildings by biomass boilers, based on EU averages. What's the role of biomass boilers in EE programs within countries?
- Importance of having national values to achieve more accurate results in savings calculations.
- Cooling is not covered, due to lack of data availability etc. What information would be crucial here to allow for savings estimations?

Thank you

Get in touch for more information!

Project coordinator - Nele Renders, VITO

All project reports will be available for download on the streamSAVE website www.streamsave.eu

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