Generation systems

J. Vivian

Generation systems

HVAC systems

Generation → Distribution → Emission

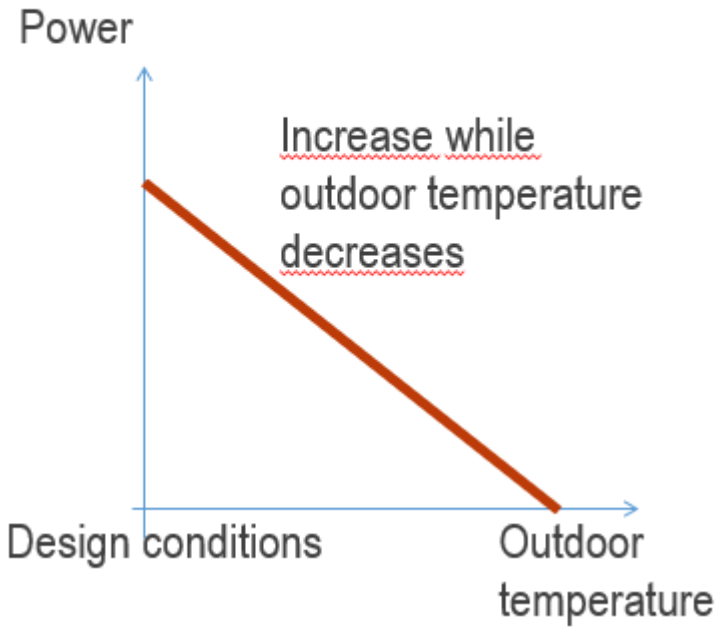
Heating: fossil-fuelled boilers, biomass boilers, heat pumps (air or ground as heat sources)

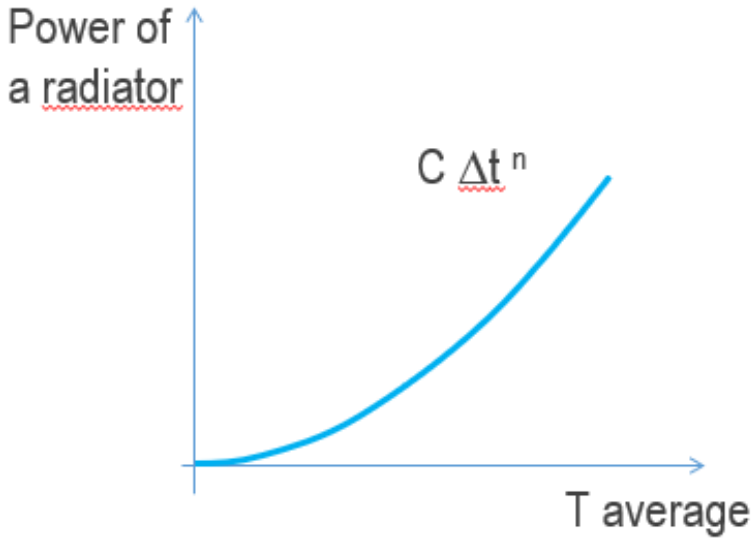
Cooling: chillers (air or ground as heat sinks)

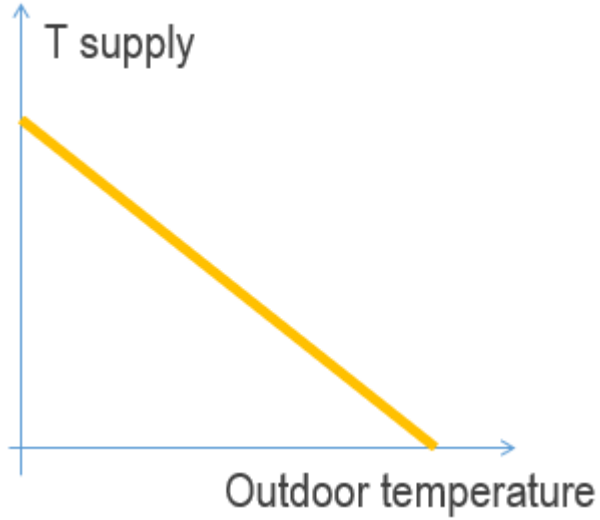
Generation systems

Supply temperature of heat generation systems

$$P = (H_t + H_v)(t_e - t_i)$$







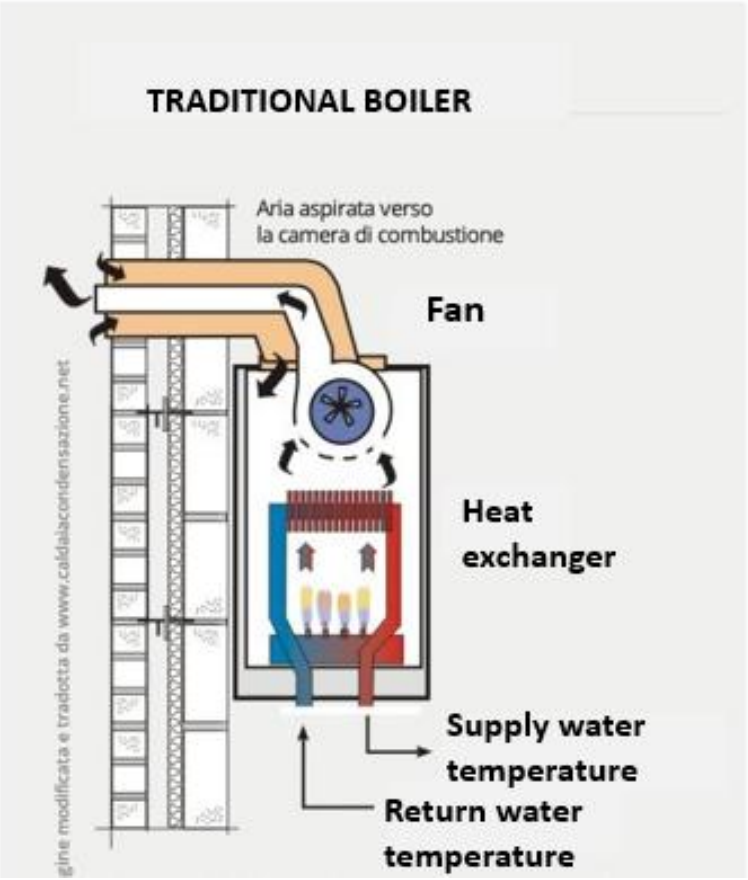
Fossil-fuelled boilers

Basics

Boilers use fossil fuels: **natural gas, LPG, oil**.

The following generation losses are present:

- Combustion losses
- Losses in the envelope
- Chimney losses



Gas boilers

Traditional gas boilers

Boilers technology improved by:

- Increase of insulation of the envelope (reduction of losses)
- Variable-temperature generators with climatic control (weather compensation on supply temperature)
- Use of premix burners (all the combustion air is mixed with the fuel gas before arrival at the flame) → combustion of better quality with lower air excess (15-20%) compared to “Bunsen burners” (40-80%).

Gas boilers

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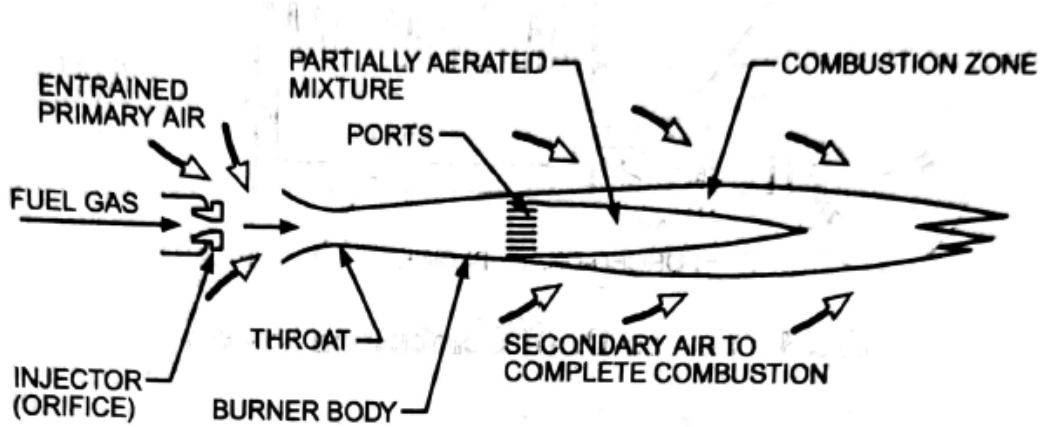


Fig. 1 Partially Aerated (Bunsen) Burner

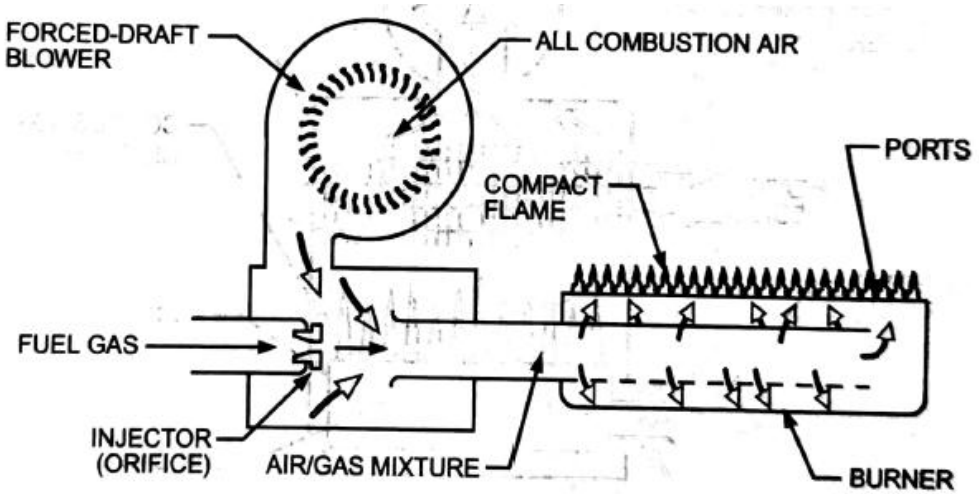


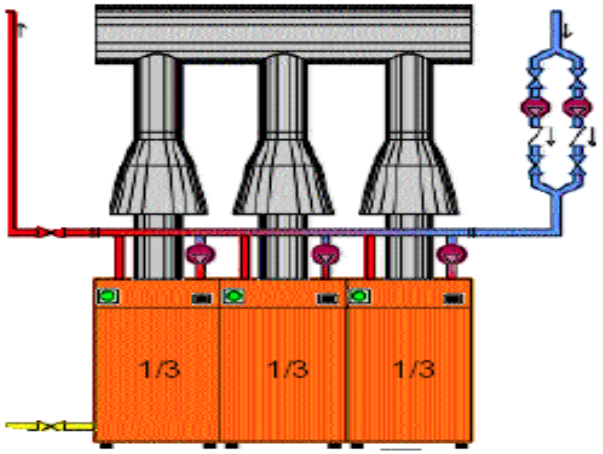
Fig. 2 Premix Burner

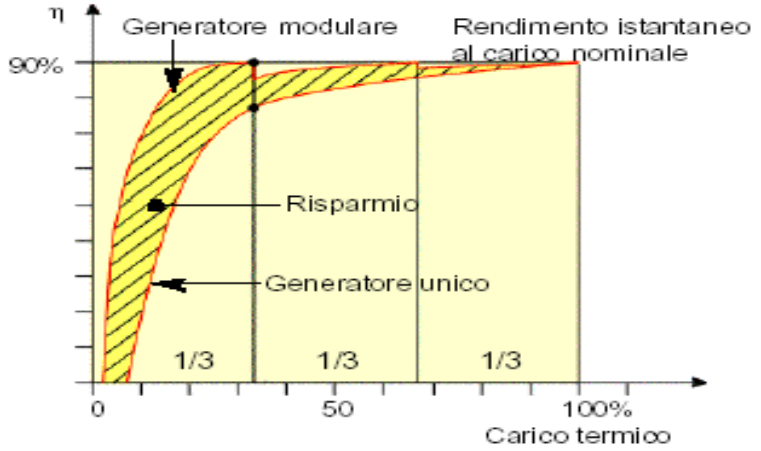
Gas boilers

Traditional gas boilers

Modular boilers in centralized systems are easy to install and:

- allow to reduce the load (thus increase of efficiency);
- are reliable as they can work even when one module is off.

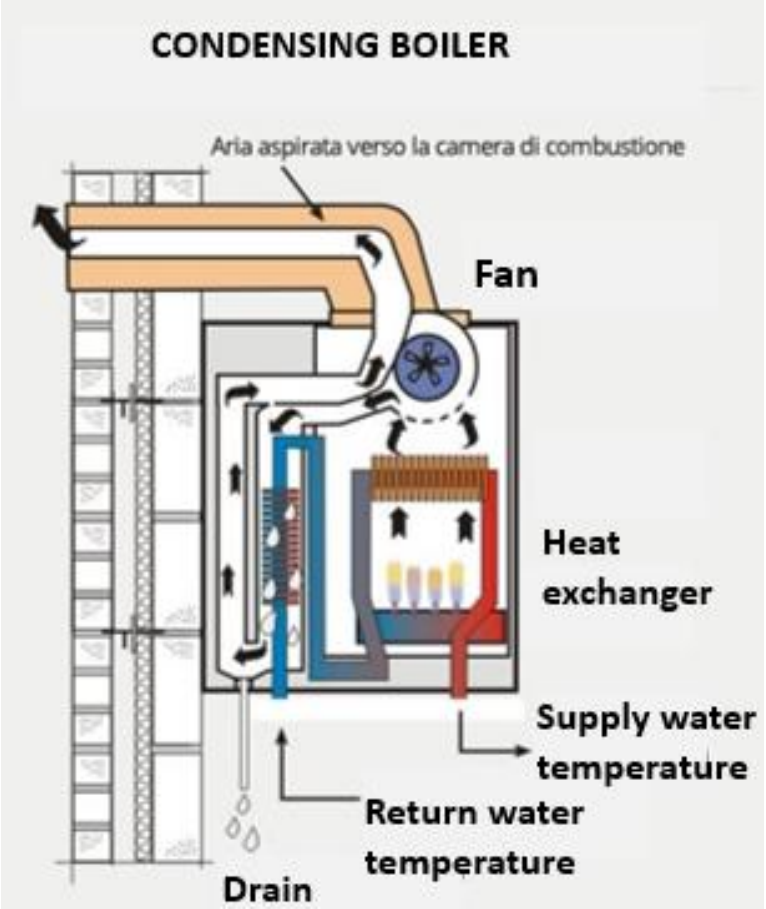




Gas boilers

Condensing gas boilers

The flue gases produced by combustion flow through the primary heat exchanger and then through a second heat exchanger, which pre-heats the return water using the latent heat of the flue gases.



Gas boilers

Condensing gas boilers

The dew point temperature of the flue gases depends on the content of water vapor, which in turn depends on the excess air rate.

At excess air rate of 20%, the dewpoint temperature is around 55.6°C.

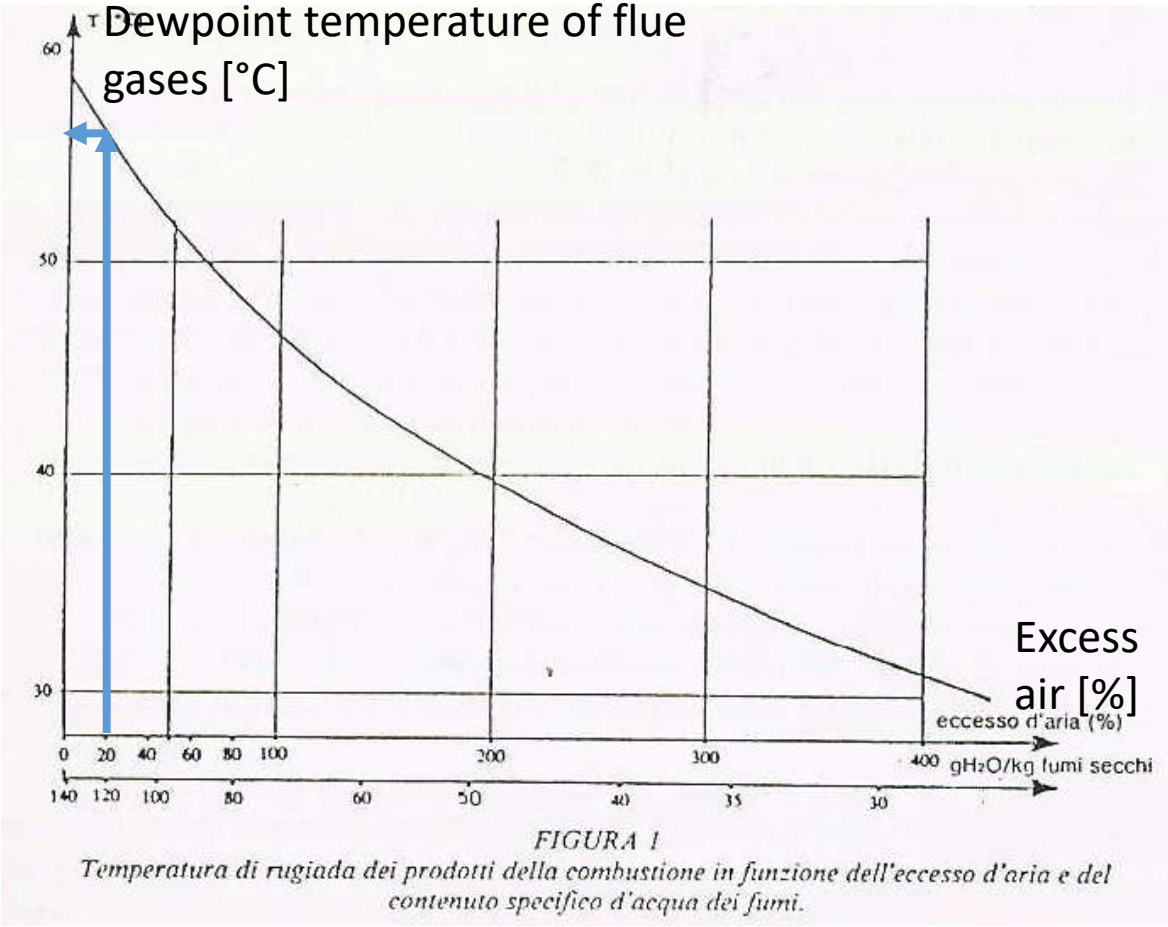


FIGURA 1

Temperatura di rugiada dei prodotti della combustione in funzione dell'eccesso d'aria e del contenuto specifico d'acqua dei fumi.

Gas boilers

Condensing gas boilers

The return water should be not higher than 55°C to condense water vapor in the flue gases (Tse <= Tdp).

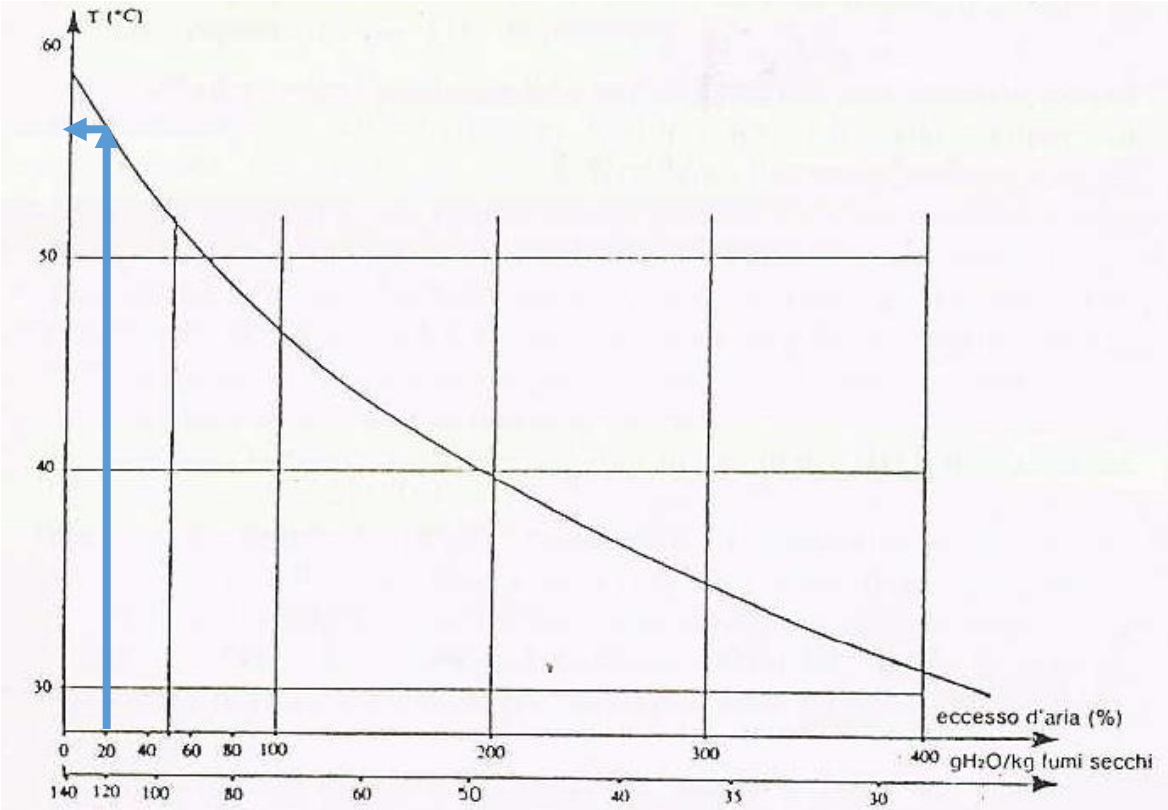


FIGURA 1

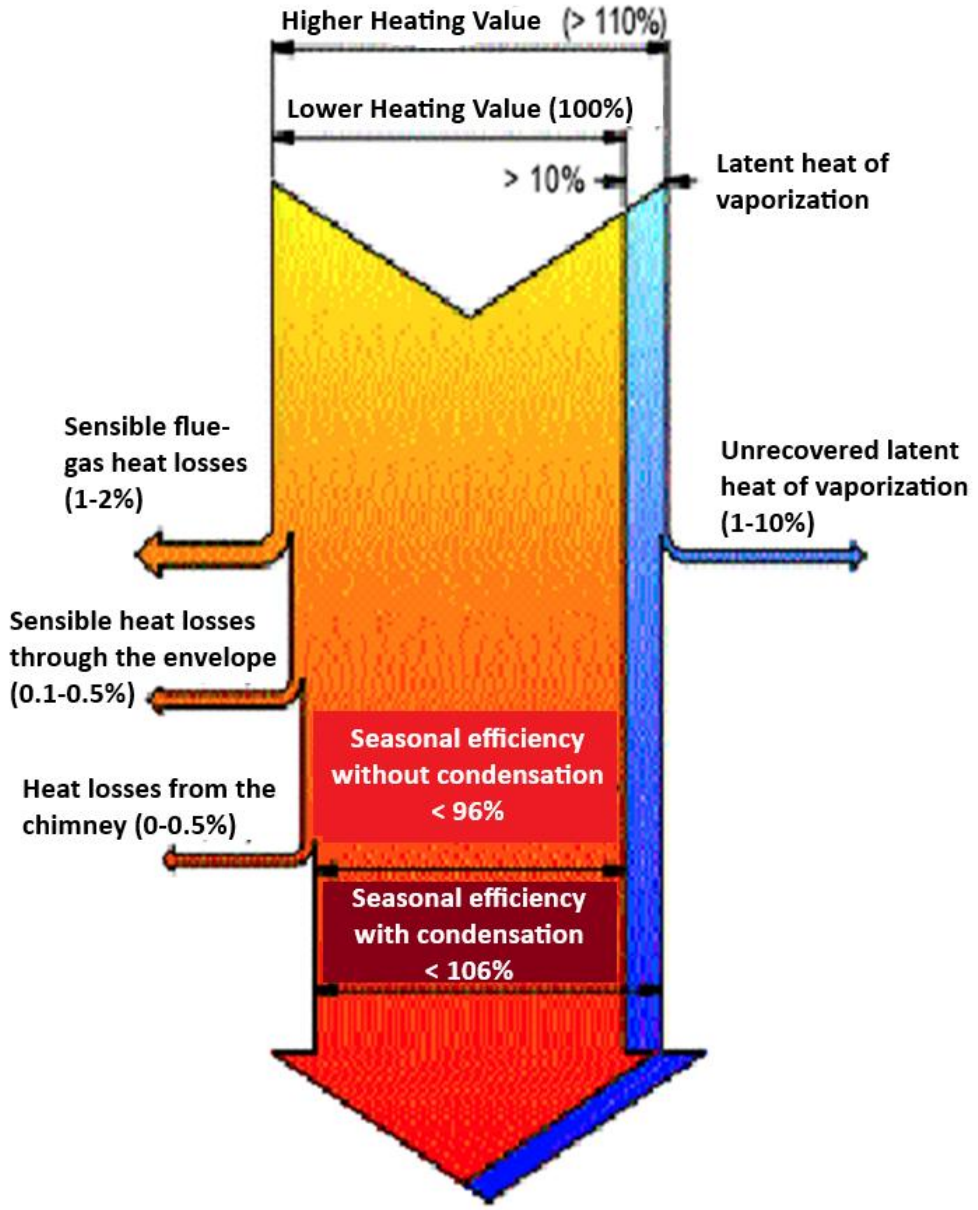
Temperatura di rugiada dei prodotti della combustione in funzione dell'eccesso d'aria e del contenuto specifico d'acqua dei fumi.

Gas boilers

Condensing gas boilers

Efficiency can be higher than 100% if referred to the Lower Heating Value (LHV, or H_0) of methane.

$$\eta = \frac{q}{\dot{m}_c H_0}$$



Biomass boilers

Wood-chips boilers

Wood-chips boilers are used in large plants for heating only or as heat source for CHP units (ORC engines).

Biomass boilers

Wood- and pellet stoves

In residential applications, wood is usually burnt in open fireplaces or in stoves in the form of wood logs or pellet.

Table 3.38 Distribution of wood combustion by technologies

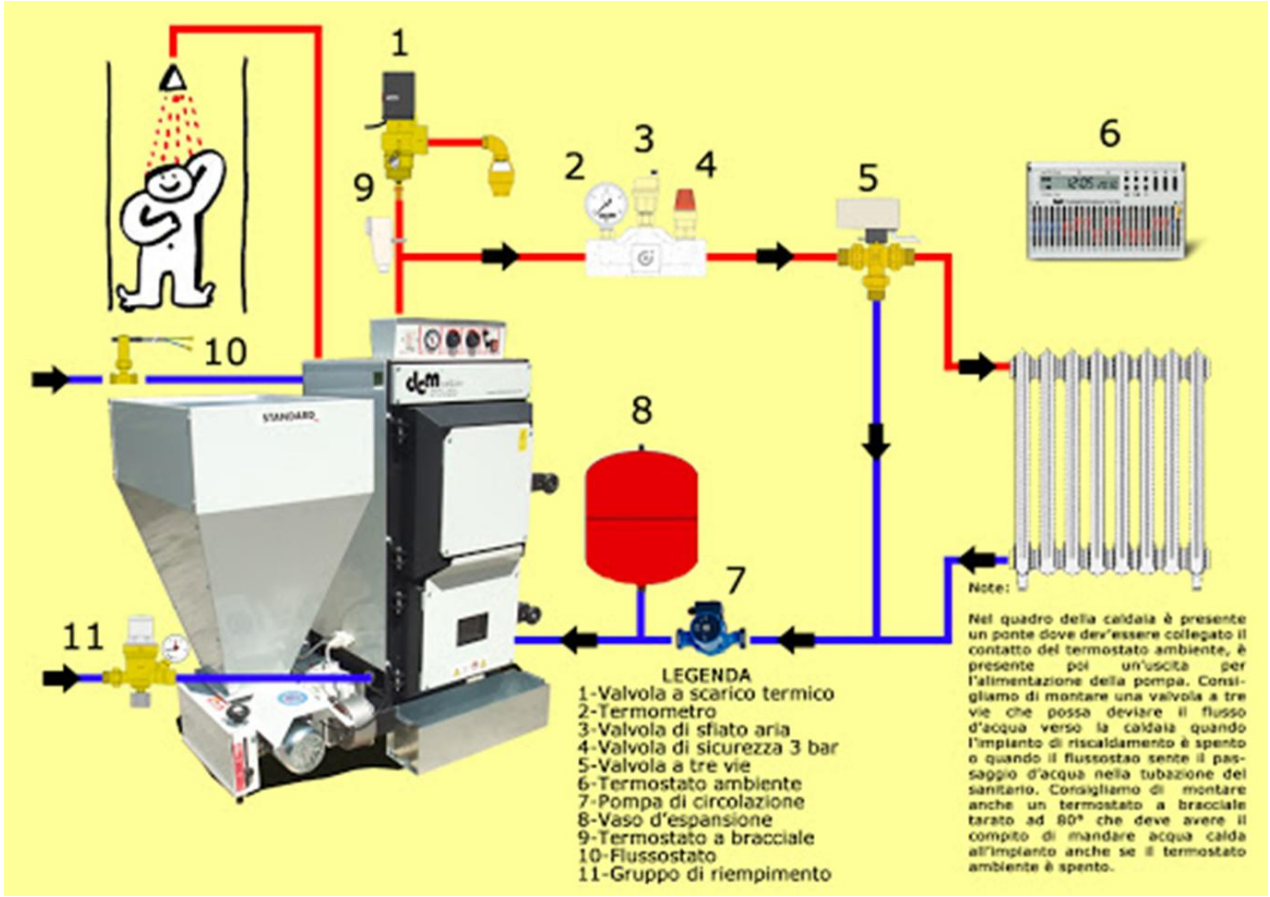
Source: ISPRA

Distribution of wood combustion by technologies	1999	2006	2012	2015	2019	2020-2021	2022
	%						
Fireplaces	51.3	44.7	51.2	49.0	40.3	39.7	40.8
Stoves	28.4	27.6	22.9	21.0	18.4	17.9	18.3
Advanced fireplaces	15.4	20.2	15.8	15.0	19.7	19.5	19.0
Pellet stoves	0	3.1	4.0	9.0	13.6	15.1	14.0
Advanced stoves	4.8	4.4	6.0	6.0	7.9	7.8	8.0

Biomass boilers

Wood- and pellet boilers

In residential applications, wood is usually supplied to the stove in the form of wood logs or pellet.



Biomass boilers

Wood- and pellet boilers

The impact of particulate matter (PM10, PM2.5) on human health is very high.

Consider also these pollutants and not only GHG emissions, especially in highly polluted areas.