Industry decarbonization: The key role of electrification, Focus on industrial heat pumps

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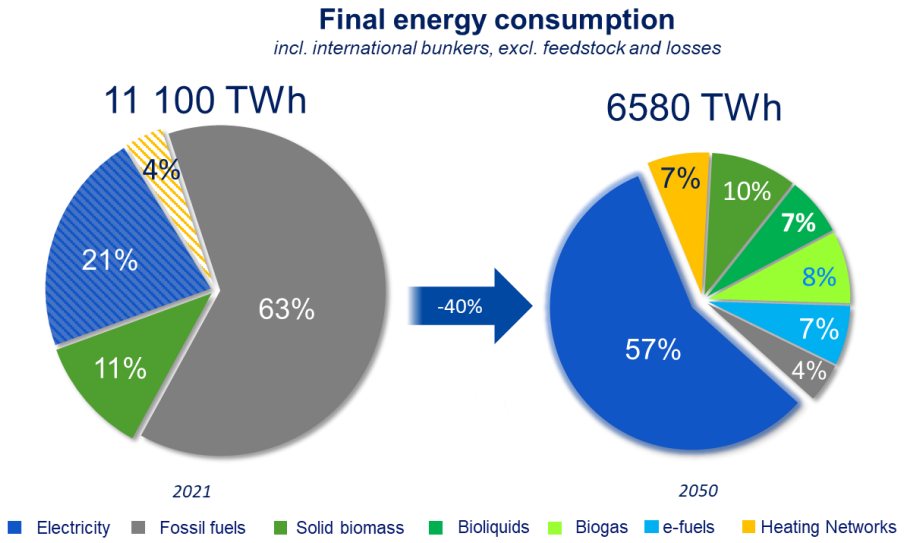
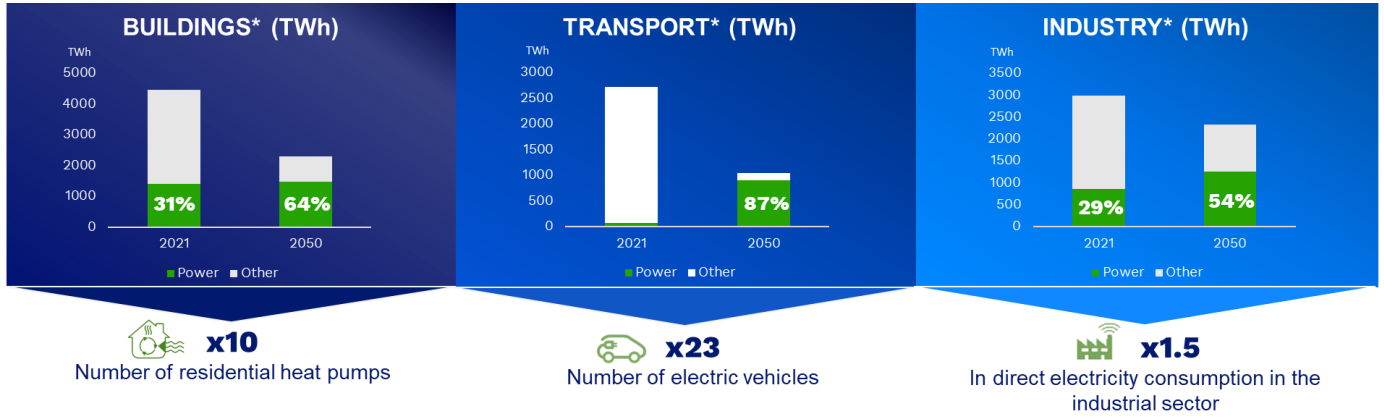
1. Electrification, driver of the decarbonisation of the European industry

Pathway to reach carbon neutrality in Europe by 2050





Scénario Net Zero 2050 | Groupe EDF

Carbon neutrality objective means a deep transformation in the energy demand, by using of fully decarbonised energies and reducting the final energy demand.

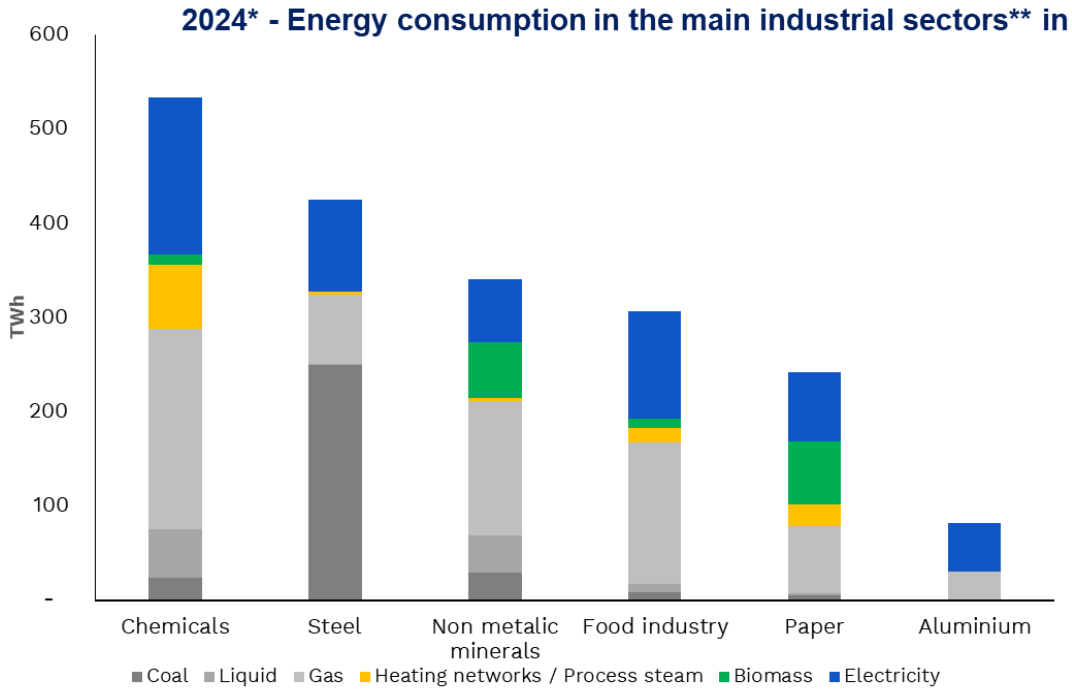
Electrification play a key role in all sectors, with a share of electricity of 57%.

Decarbonized energy vectors such as renewable heat, biofuels, hydrogen, e-fuels, will also play an important role for hard-to-abate targeted uses.

Industry sector represents a cornerstone of this transformation.

*Final energy consumption excl. international bunkers for Transport

Energy consumption in industry



*Source: EDF NZ scenario, excluding Feedstock

** total industry : 2500 TWh & 540 MtCO2

In 2024, six sectors account for:

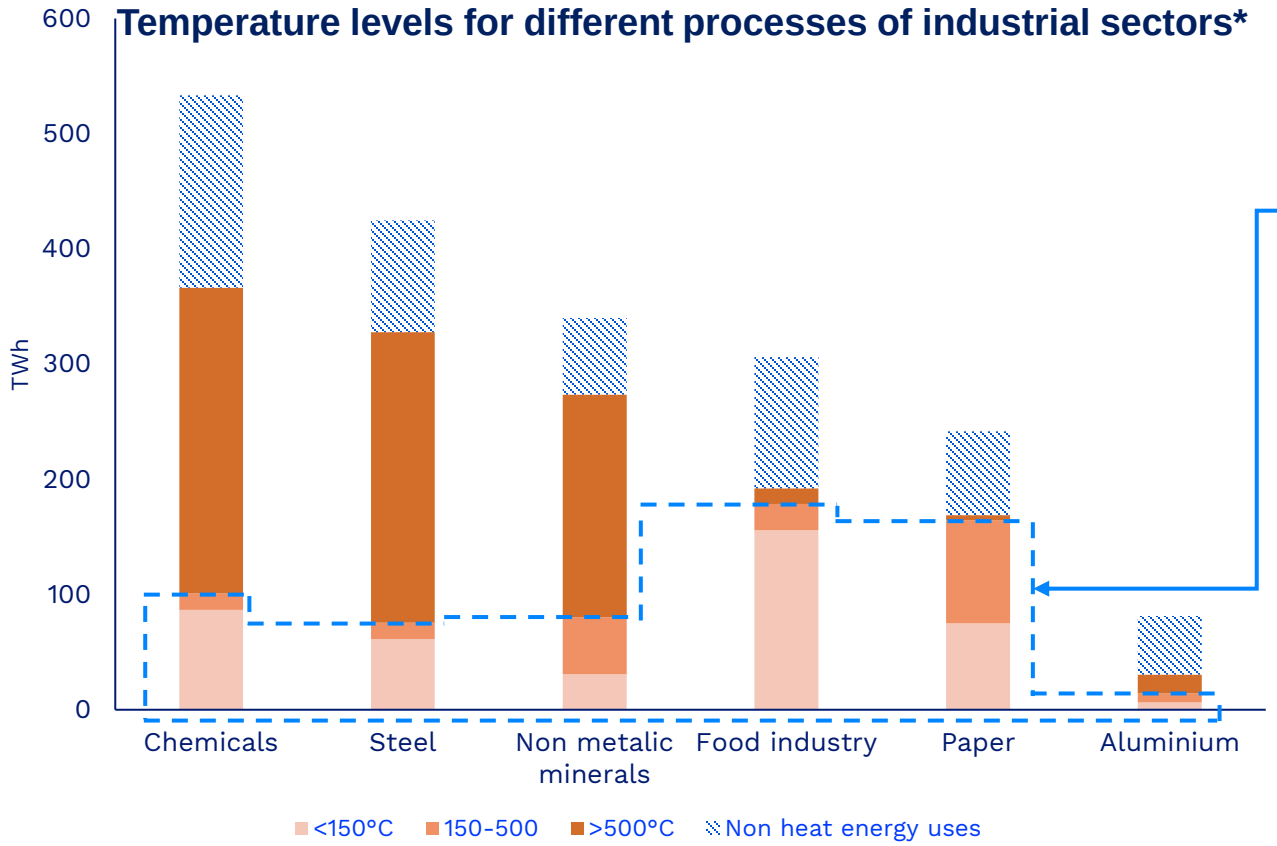
80 % **of the industry's energy consumption**

475 **Mt CO2 emissions**

Today, main industrial sectors continue to rely heavily on gas, liquid fossil fuels and coal, resulting in 475 Mt CO2 emissions per year. **Electrification** is an essential lever to efficiently decarbonize these sectors. However, each industrial process has unique characteristics, determining how easily it can be electrified.

From a technical perspective, the European industry sector* has the potential to be electrified by up to 95%" (* excl. primary materials)

Temperature levels of process : key factor for electrification



LOW HANGING FRUITS

Below 150°C, existing technologies are mature and require only CAPEX support.

Between 150°C and 500°C, most existing technologies are mature but require investment support (CAPEX and OPEX)

The temperature requirements of the different industrial processes are key to determining how **easily the sector can be electrified.** Targeting “low hanging fruits“ processes that are simpler to electrify would result in quick wins toward the **industry decarbonization.**

*Source: EDF NZ scenario

A large panel of mature and promising technologies

Industrial HP (HT & THT)

Mechanical vapor compression (MVC)

Electric boiler

Electrical arc furnace

Resistance furnace

Induction furnace

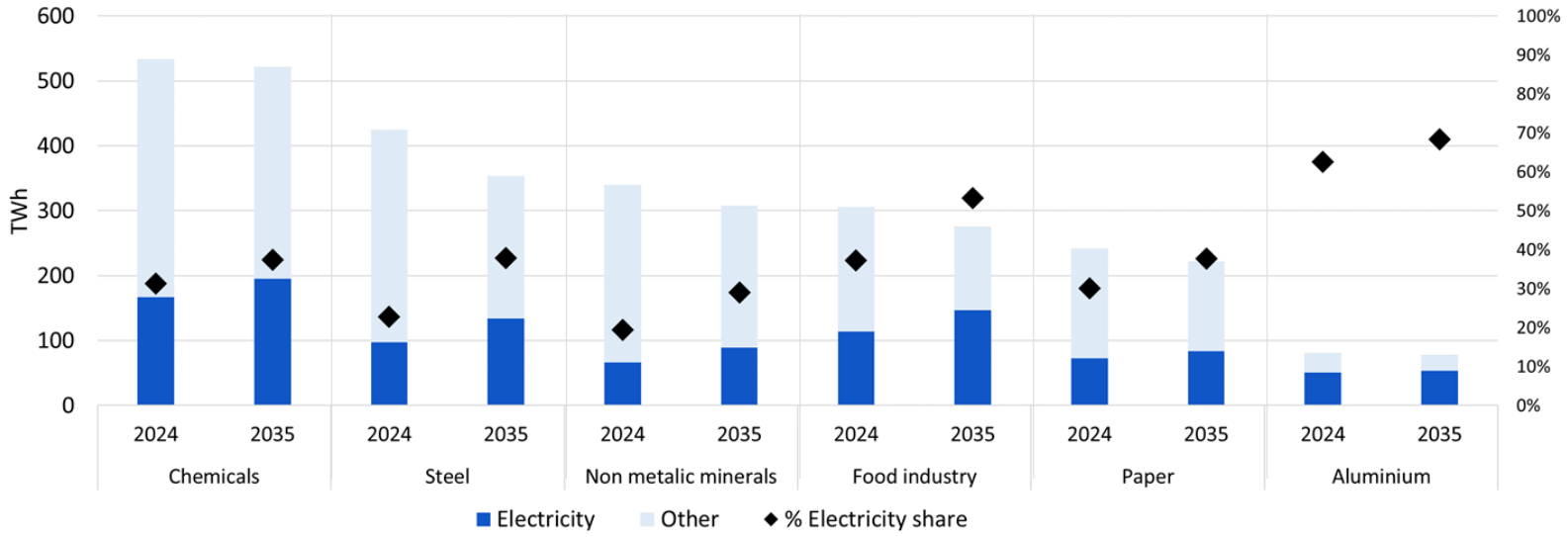
More details on electrical technologies : Direct electrification of industrial process heat – Agora Industry / Fraunhofer ISI

Mature and promising electrical technologies, whether it be furnaces, heat pumps or boilers, are **already available in all sectors and for a large temperature ranges. They represent the most technically and economically efficient solutions for the system** even though some of them temporary require CAPEX and/or OPEX subsidies before becoming competitive in the medium term, as the value of carbon on the EU-ETS is currently too low

For some disruptive technologies, as THT HP or some furnaces, further development and demonstrations are needed.

EDF Net Zero Scenario : Electrification of industry by 2035

Energy consumption in the main industrial sectors in Europe between 2024 and 2035*



** total industry 2035 : 2300 TWh & 460 MtCO2

*Source: EDF NZ scenario

Between 2024 and 2035 :

-10% energy consumption
from 1950 TWh to 1750 TWh

+25% power
from 560 TWh to 700 TWh

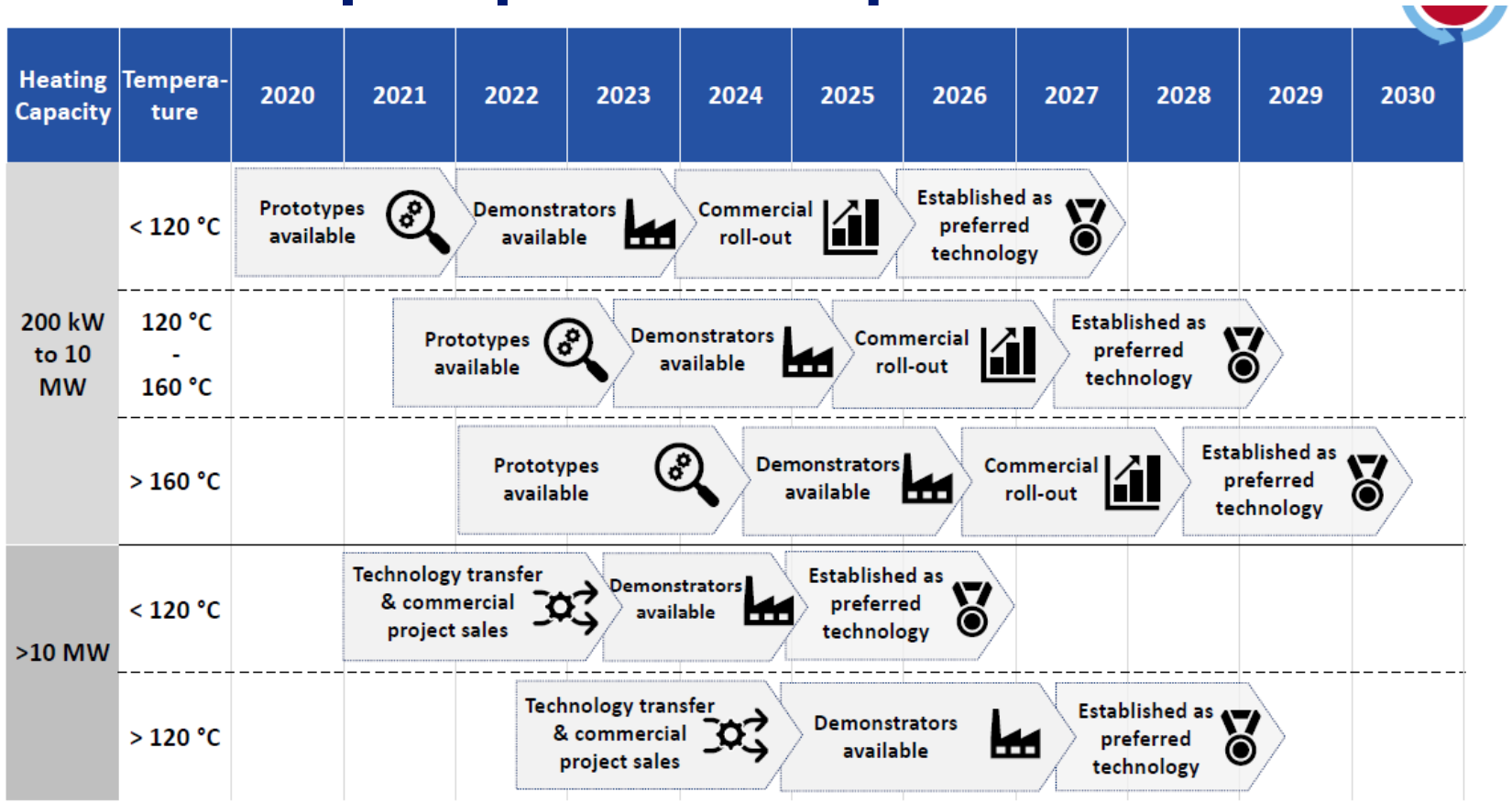
-25% CO2 emissions
from 475 Mt to 350 Mt

Low-carbon electric industrial processes not only reduce carbon emissions but are generally less energy intensive and can be locally produced, **lowering energy costs and enhancing strategic autonomy.**

However, since not all processes can be easily electrified, other energy vectors such as hydrogen, biofuels and heat should be considered for further decarbonisation.

2. Focus on industrial Heat pumps

Industrial Heat pumps roadmap

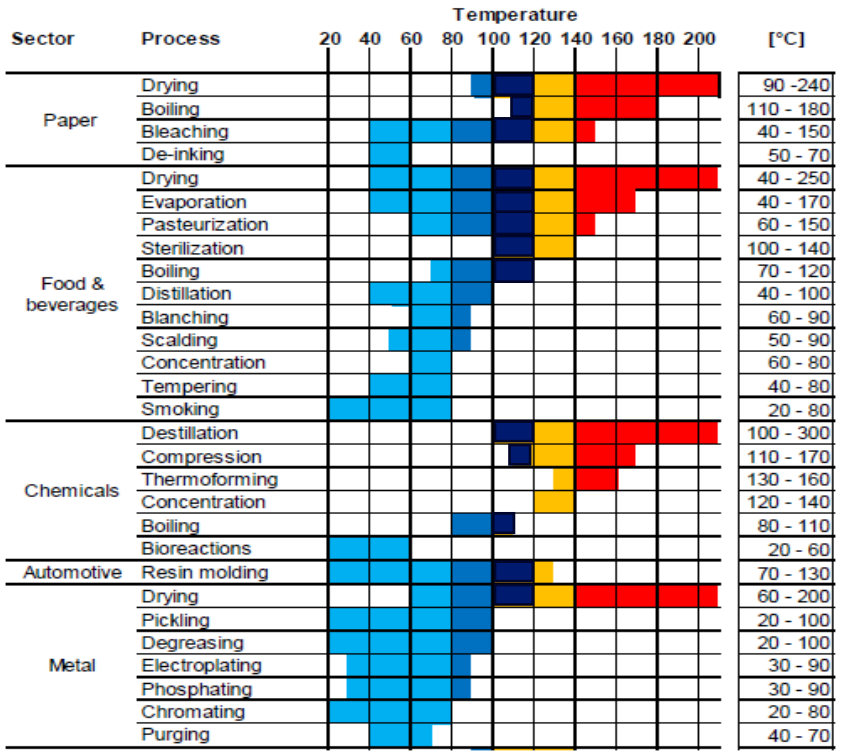


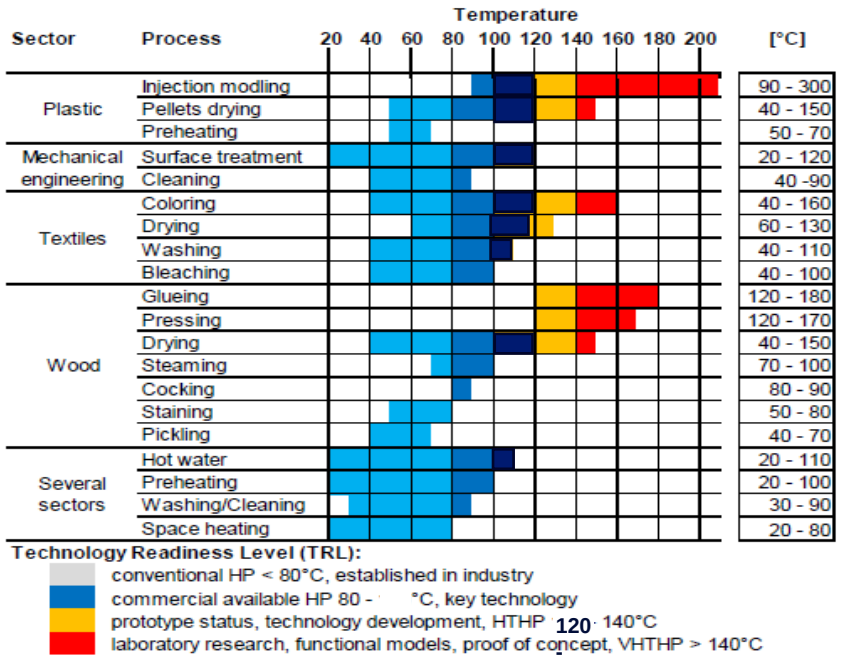
https://heatpumpingtechnologies.org/annex58/

Significant progress has been made in prototype research and demonstrator developments, but further support is ongoing to rapidly advance the technology and bring it to industrial use

Industrial heat needs

Temperature levels of industrial processes and HP technology readiness



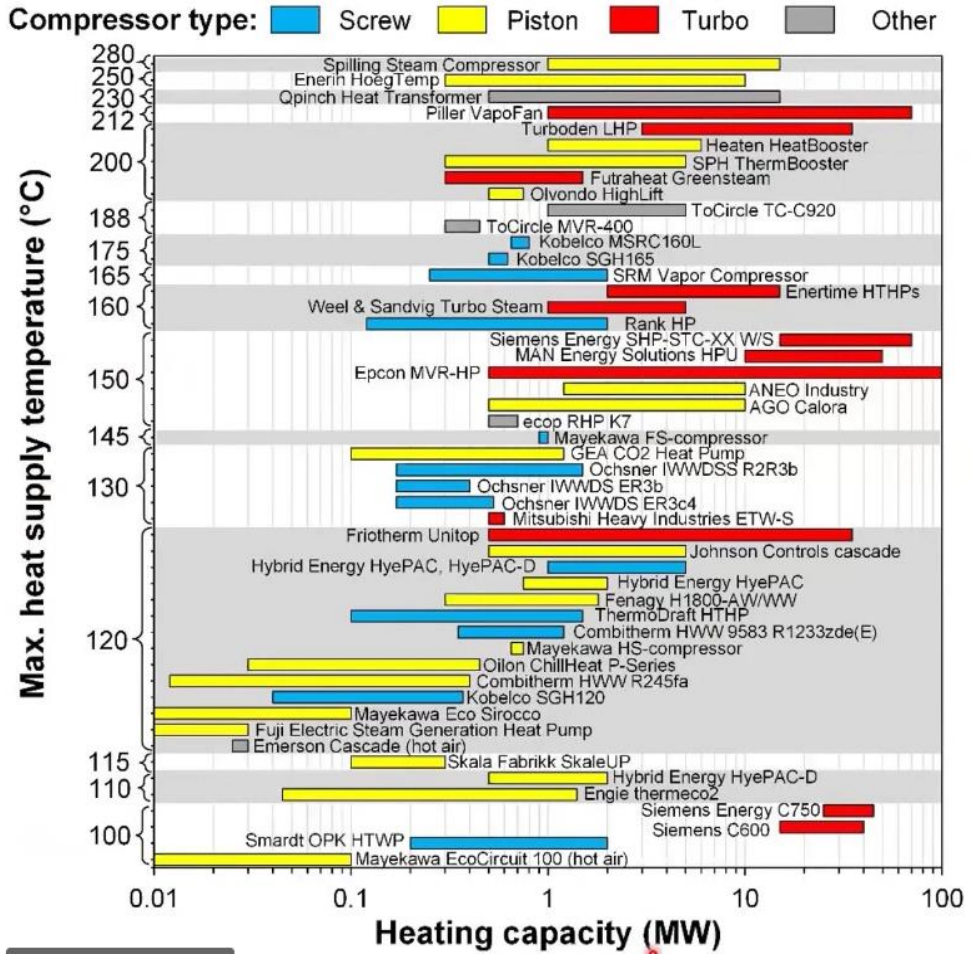


Data sources: Brunner et al. (2007), Hartl et al. (2015), IEA (2014), Kalogirou (2003), Lambauer et al. (2012), Lauterbach et al. (2012), Noack (2016), Ochsner (2015), Rieberer et al. (2015), Watanabe (2013), Weiss (2007, 2005), Wolf et al. (2014)

Heat pumps are already available for **all** industrial sectors, but not for every process (Temperatures above 120 °C). There is still work to be done to cover all industrial processes across all sector

Industrial heat pump technology and CAPEX estimation

Heat pump technologies vary according to heating capacity and delivery temperature.



Source : Cordin Arpagaus et Annexe 58 IEA

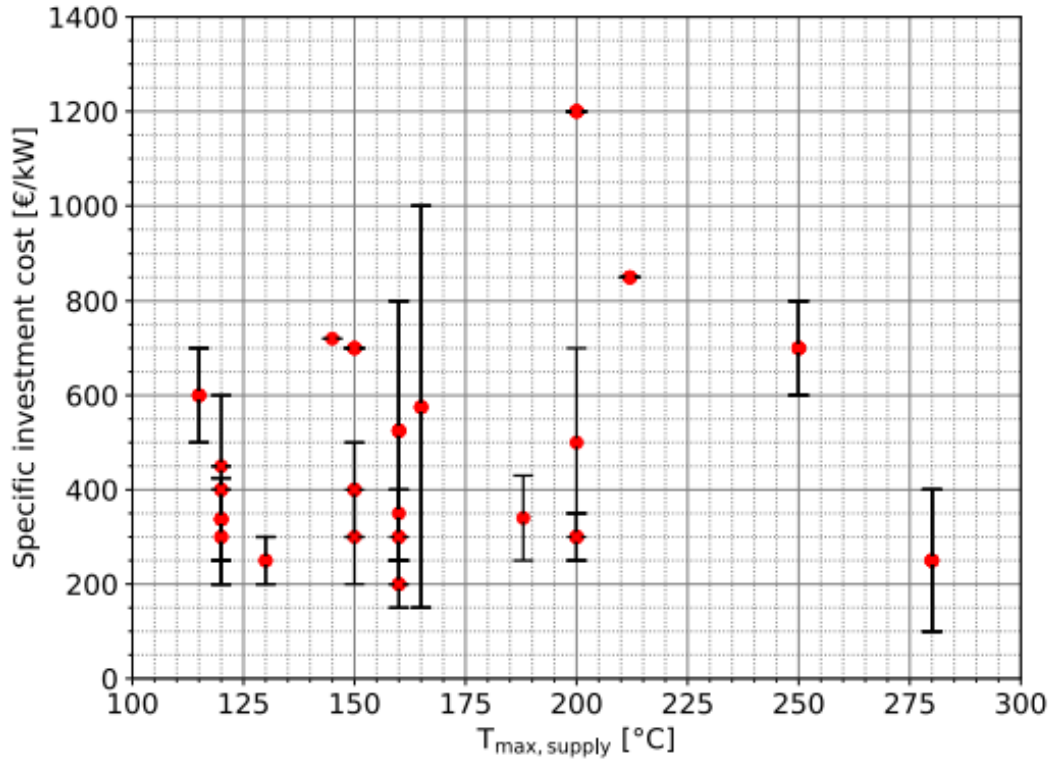
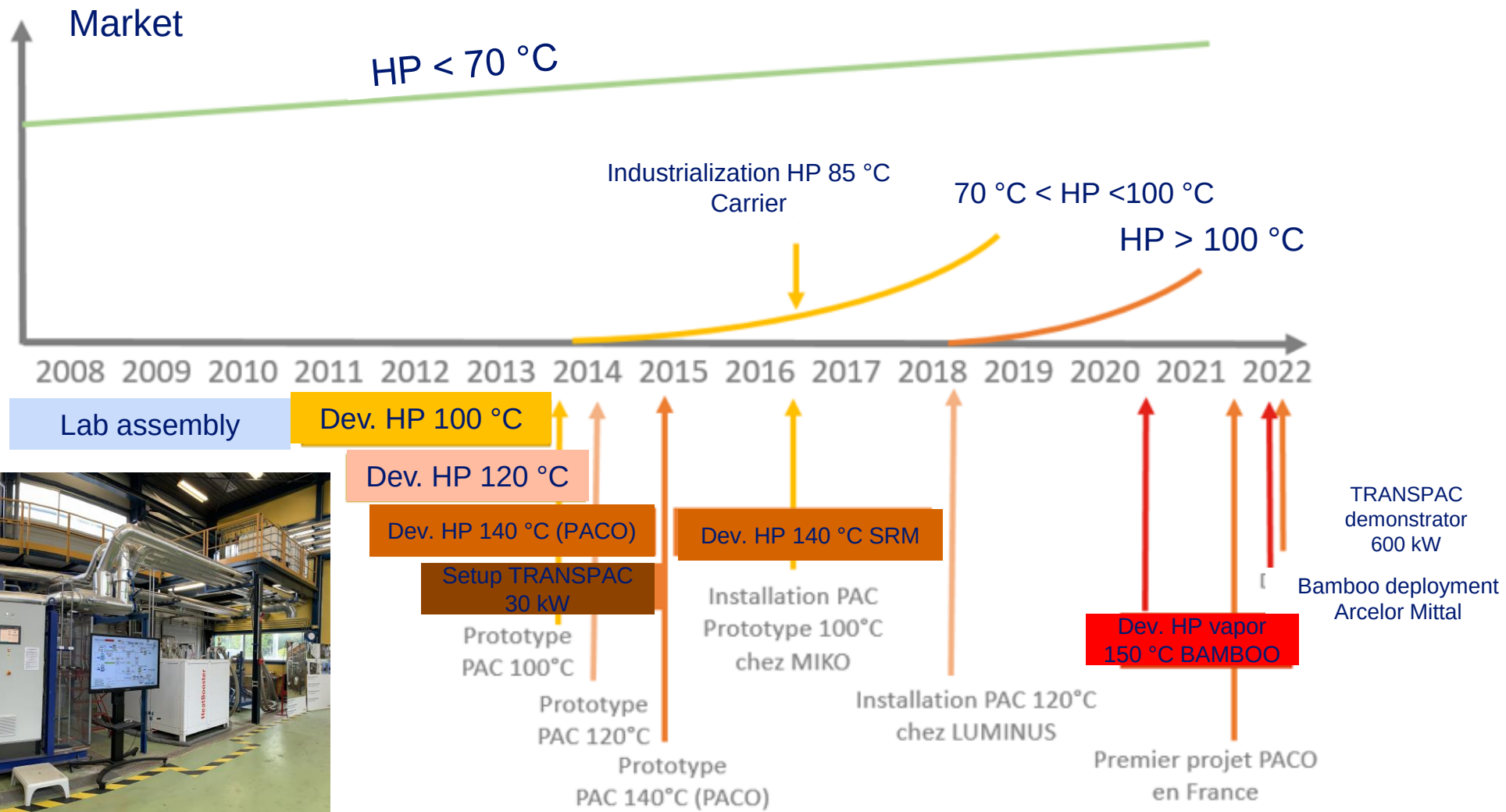


Figure 2-33: Specific investment cost as a function of maximum supply temperature.

Investment costs remain highly uncertain, given that the process has not yet reached full industrial deployment and must be evaluated case by case

EDF R&D – High temperature heat pump research

Different developments have been carried out, leading to industrial demonstrators



Avenue des Renardières, 77250 Écuelles, France

EDF R&D anticipes and prepares demonstrator

demonstrator	TRANSPAC	BAMBOO / Vapeur	PACO
Technologies	Transcritical HP (COP =4 to 6)	Steam HP	PAC natural fluid (water)
Temperature	120°C to 150°C	152°C	130°C
Industry	Paper and cardboard (dryers)	All industries	food, chemistry (stripping)
Demonstration	2022-2023	2022	2013
Partners	Wepa, Dalkia, DFS, Armines, Ademe, compressor manufacturer	AIT, Arcelor Mittal, TGE	JCi, Dalkia
More information	TRANSPAC	BAMBOO	

Several European demonstrators in progress

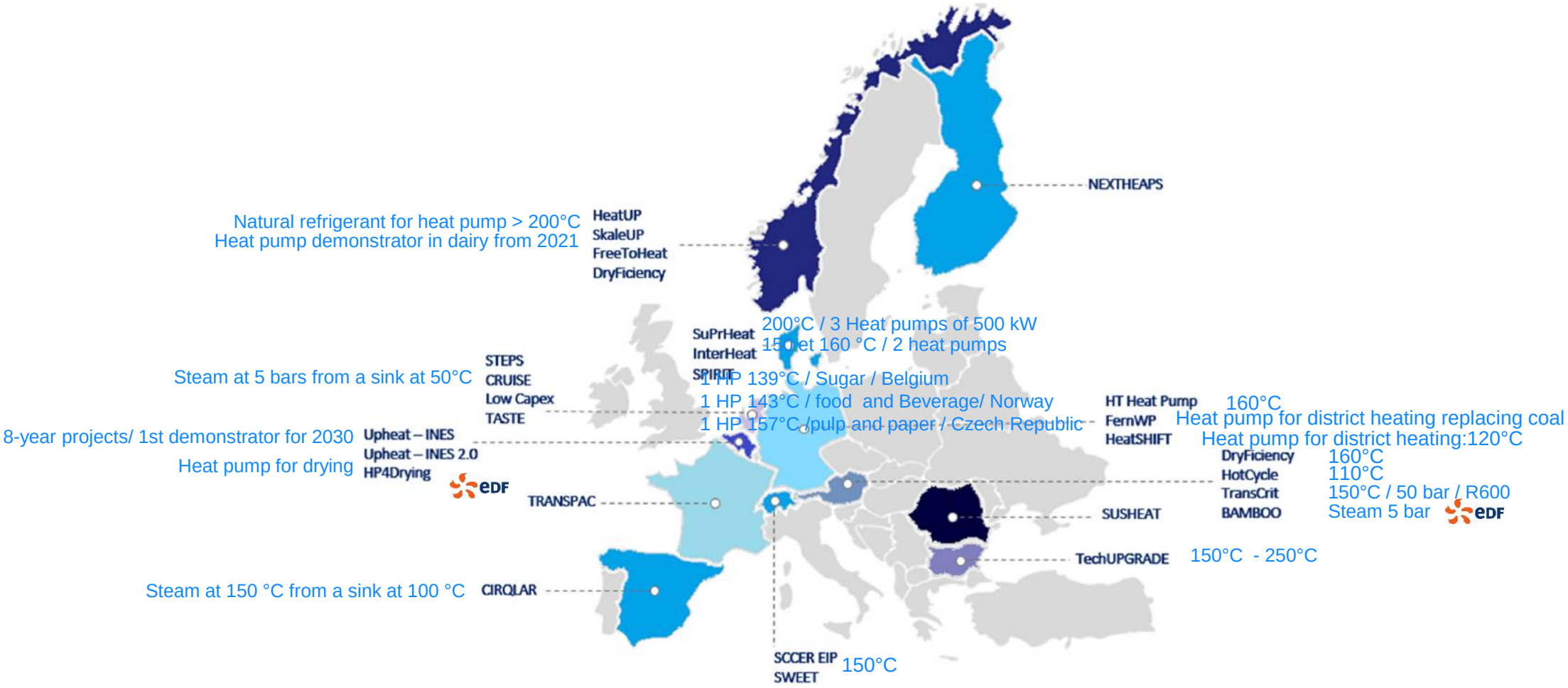


Fig. 8. National projects on the study and development of HTHPs in some European states. Source: self-elaboration based on (I International Energy Agency, IEA., 2023; Fleckl et al., 2017; Geyer et al., 2019).

Merci

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