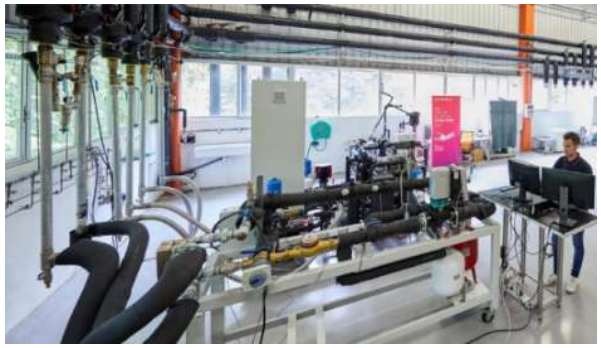
tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Push2Heat

R&D activities on Steam-Generating Heat Pumps



José L. Corrales Ciganda
Researcher

October 21st 2025
OST Webinar on Steam-Generating Heat Pumps

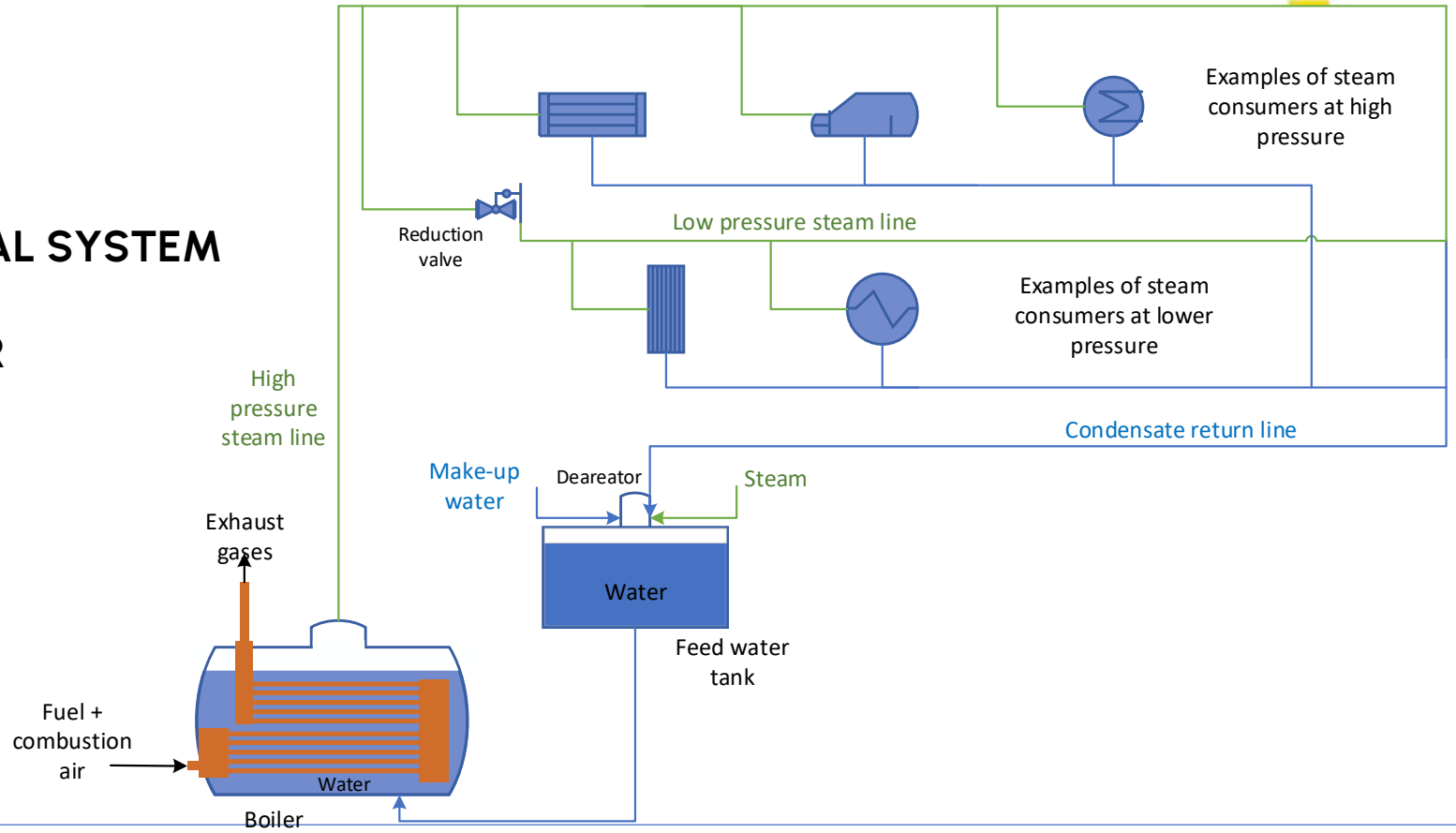
Funded by the European Union

Business as usual:
gas boiler and 2 pressure levels

Push2Heat

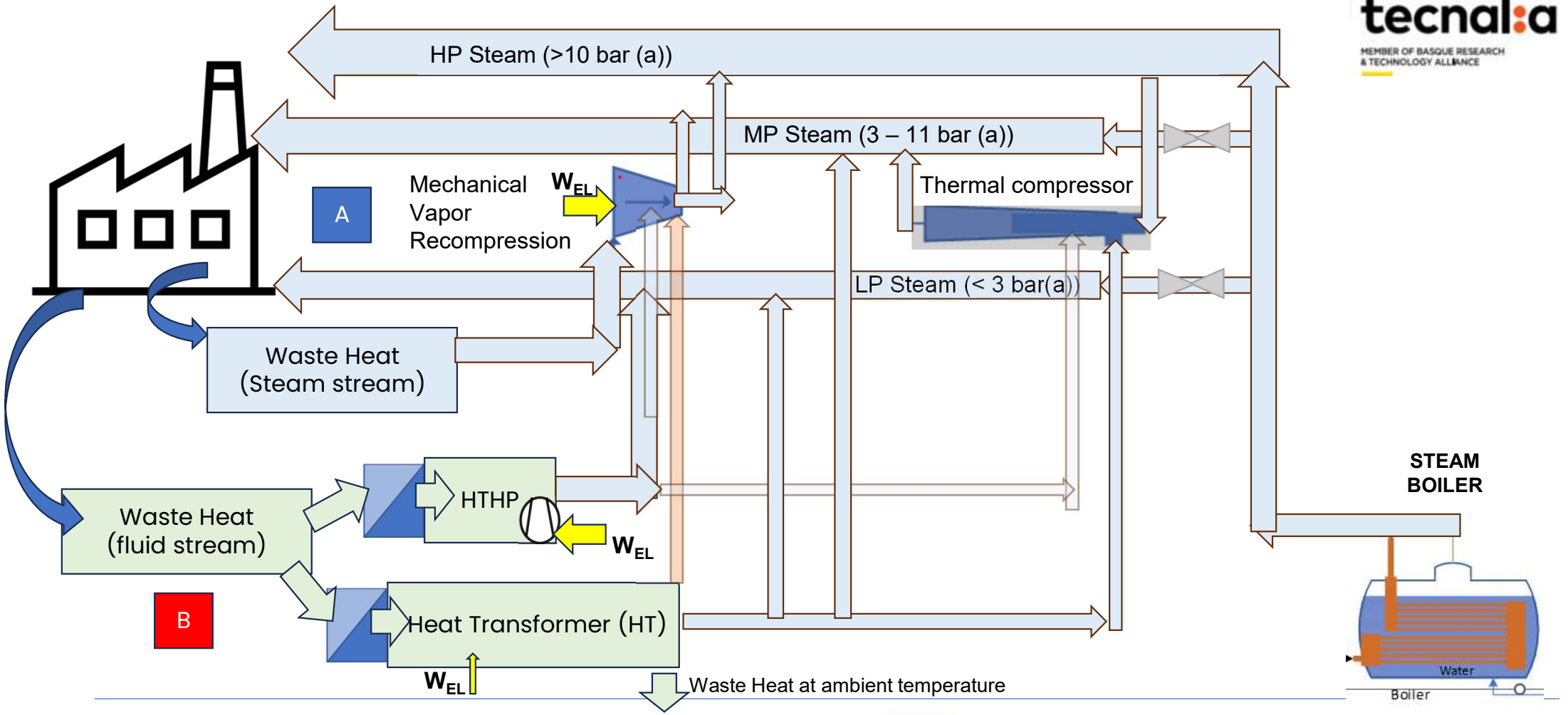
tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

CONVENTIONAL SYSTEM
With
STEAM BOILER



Funded by the European Union

But, how can we recover and upgrade waste heat to produce steam in an industrial site?

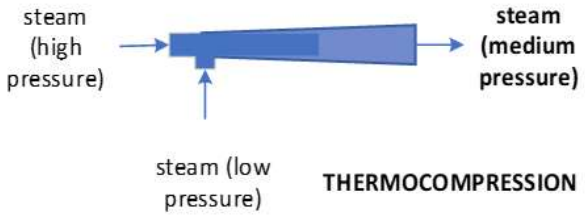


Funded by the European Union

A Steam pressure upgrade technologies

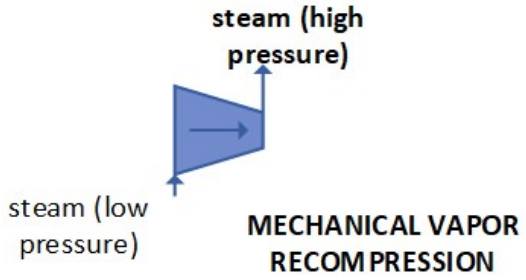
A1 • Thermocompressor (TC)

- \+ Proven and market available technology with different suppliers
- \+ No moving parts, no electric consumption
- − 1 to 4 units of HP Steam per 1 unit of LP Steam are required



A2 • Mechanical vapour recompression (MVR)

- \+ Does not require any supporting HP steam
- \+ Can make use of renewable electricity and be used for flexibility strategy
- − Flexibility and availability for LP steam



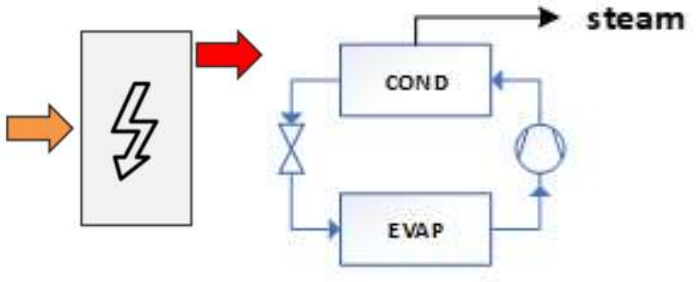
Funded by the European Union

B1

Steam generation with HTHP

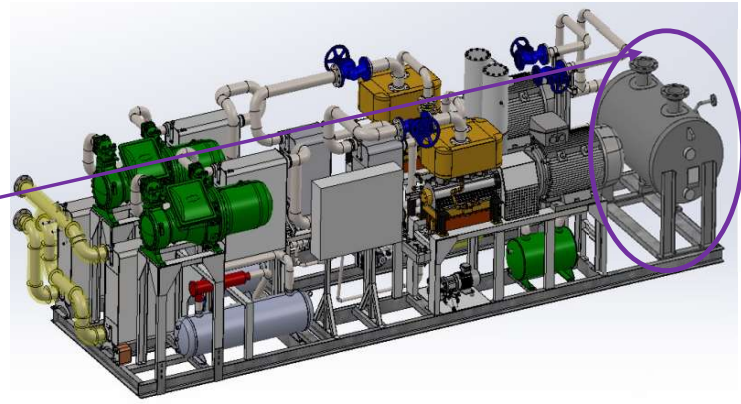
Push2Heat

- + Can recover up to 100% of the waste heat
- + Can make use of renewable electricity and be used for flexibility
- + Increasing number of providers with different technologies



- Depending on the technology, direct steam generation is today possible for pressures up to 10 bar (200C)
- Generation of steam on the condenser requires careful design

  (Shell & plate or others, **R&D required**)
- *Example, SPH Steam-Generating HTHP*
  Push2Heat Demo2 with Shell and Plate Condenser



cascade HTHP, Δtl_{LIFT}>70C, COPel=2.3

- **Alternative: indirect generation using Flashtank**

  + Easier control of the HTHP cycle, operation safety

  - Additional circuit HTHP to Flash Tank penalizes COP

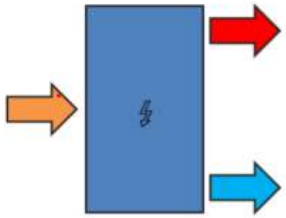
SPH Sustainable Process Heat

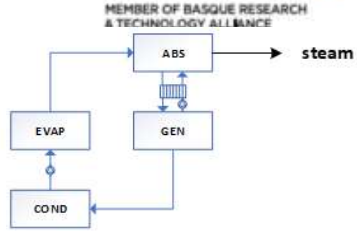
Funded by the European Union

B2

Steam generation with Heat Transformer

+ Very small (COPel>50) electricity consumption
+ Only moving parts are unexpensive small pumps





- **Absorption Heat Transformer (AHT)**:

thermodynamics and working pair limits
+ state-of-the-art SE LiBr/H20 up to 160C => >43 AHT, 134 MW installed worldwide
+ double effect up to 180C => penalizes waste Heat recovery (COPth < 0.35)
- Existing systems for steam generation with Flash Tank **(R&D required)**
For higher sink temperatures => new working pairs (R&D required)

- **Chemical Heat Transformer (Ch-HT)**
Technology based on reversible chemical reactions, room for new developments
(R&D required)

High Temperature Sinks (>220C) and direct steam generation already market available by European Supplier (Qpinch)

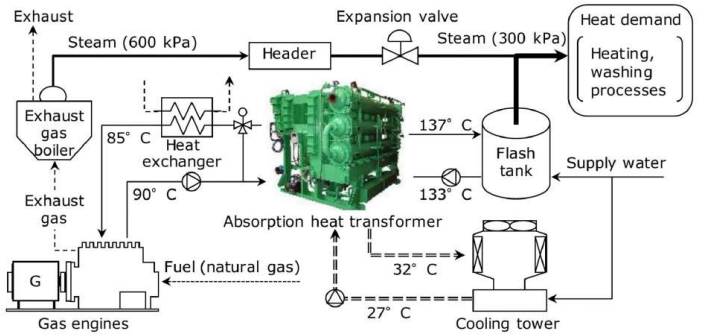


Fig. 5. Absorption heat transformer installed in an industrial plant (Capacity: 150 kW) [39].

Source:
Absorption heat transformer - state-of-the-art of industrial applications
Absorption heat transformer - state-of-the-art of industrial applications - ScienceDirect

Funded by the European Union

B2

Chemical HT for direct steam production

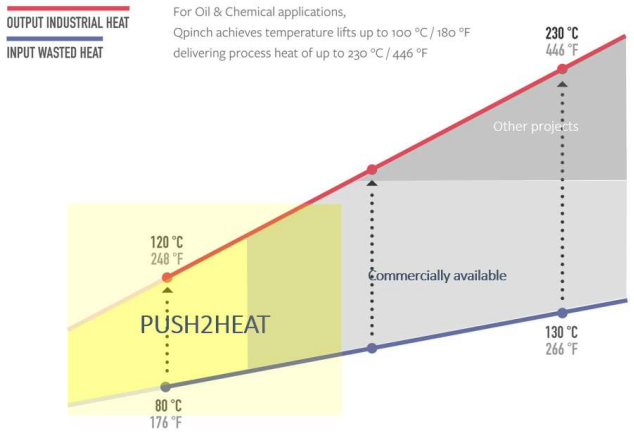
CHEMICAL plant (LDPE) in Antwerp, Belgium

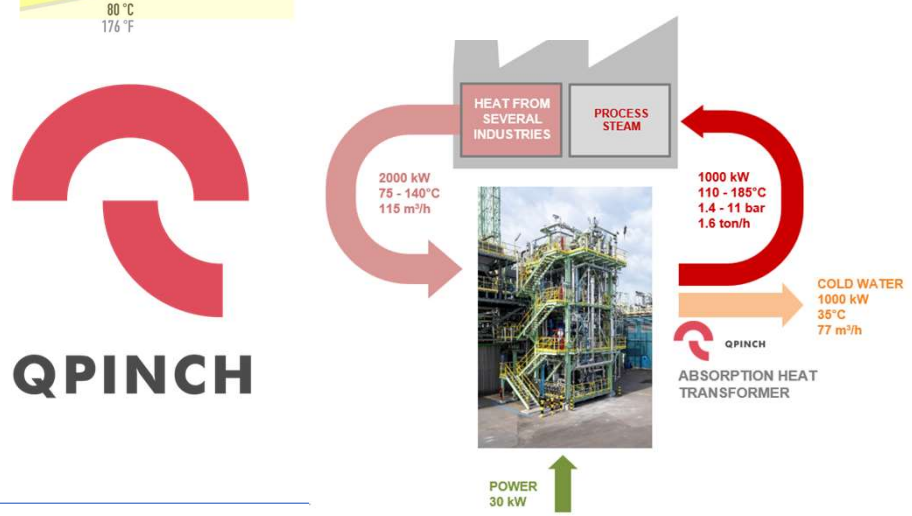
Waste heat source	**Waste heat** between **75-140 ºC: heat from exothermic reactor or LPS vent**
Heat supply	Process heat as **steam at 110-185 ºC** as output of THT

Injection in the low & medium pressure steam net

Steam distribution in client systems:

- **MP → up to 11 bar(a)**
- LP → up to 5 bar(a)
- 1.6 ton/h (1000 kW) nominal capacity

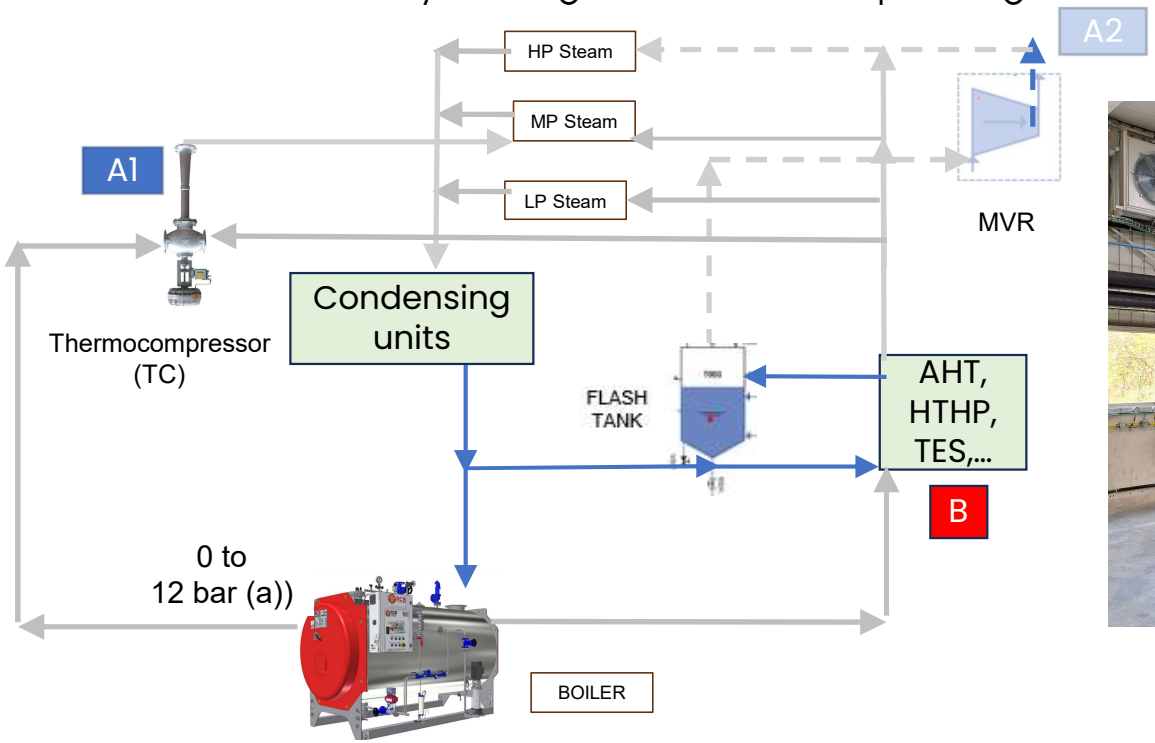




Funded by the European Union

Controlled conditions R&D: Steam test bench in Tecnalias TERMILAB

- Test bench for combining steam-producing heat upgrade technologies
- First tests with HTPHs and AHT developed at Tecnalia, with Flash Tank and Thermocmpressor coupled to Boiler
- Test-bench ready to integrate MVR (under planning)



Steam Test Bench, 50 to 200 kW

(TERMILAB, TECNALIA)

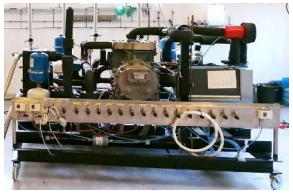
Condensed water

Direct steam or pressurized water

Absorption HT (TECNALIA) **B2**

Cond. water

Direct steam or pressurized water



Piston HTHP (TECNALIA) **B1**

Funded by the European Union

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

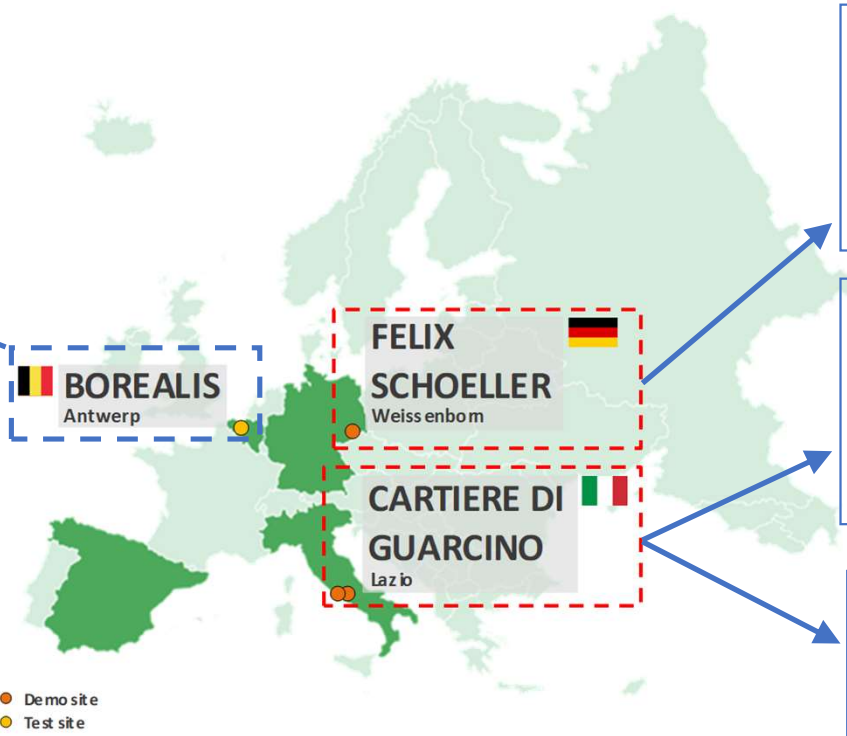
Real conditions R&D: PUSH2HEAT Demo Sites

Push2Heat

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

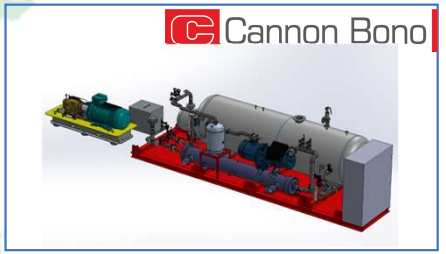
B2

DEMO 4: Ch-HT direct steam production (2 to 11 bar(a))



B1

DEMO 1: steam-gen HTHP (2 bar(a))*
*WH-source = 46ºC



B1 + A2

DEMO 2: HTHP + MVR (6.5 bar(a))

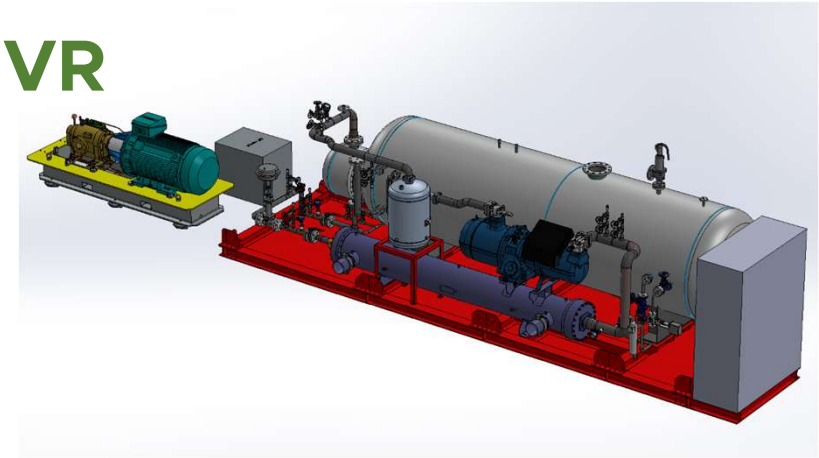
B2 + A1

DEMO 3: AHT + TC (6.5 bar(a))

Funded by the European Union

P2H DEMO 2 – HTHP + MVR

B1 ☒ A2



Push2Heat

Cannon Bono Energia

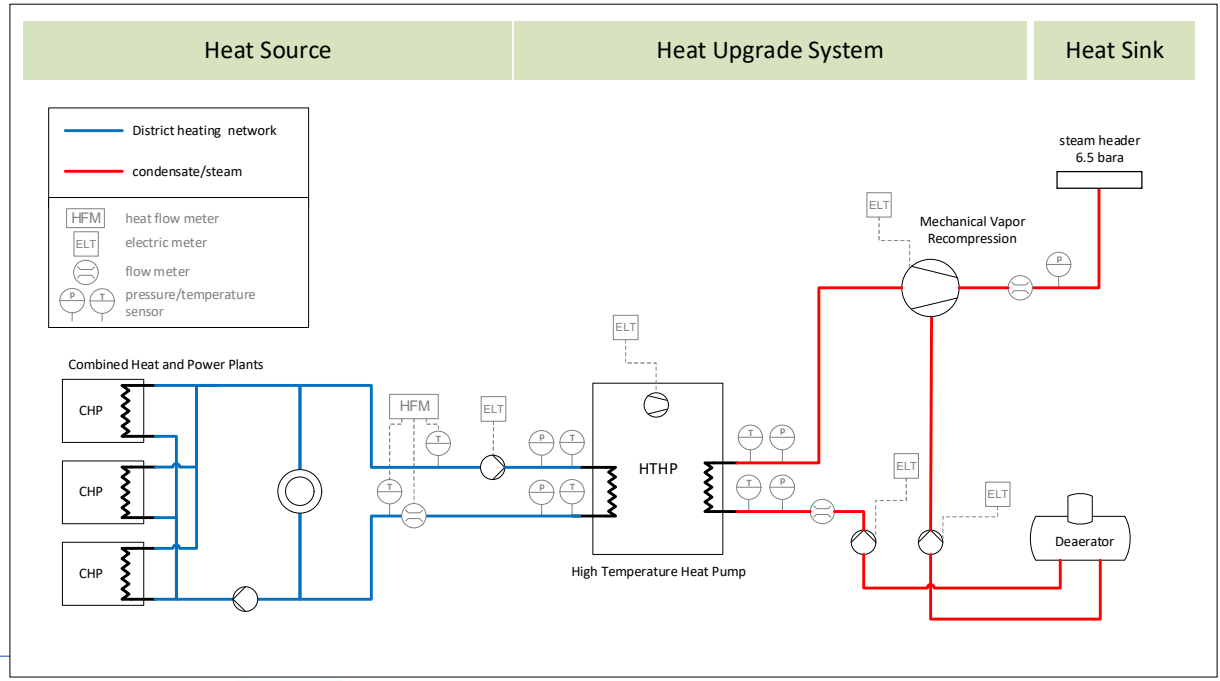
CARTIERE DI GUARCINO

POLITECNICO MILANO 1863

MAIN CHARACTERISTICS

Screw compressor HTHP , R1233zd(E)		
Heat source	90°C / 600 kW	Biomass CHP
HT Heat sink	115.2°C / 744 kW	Steam to MVR
COP / W_{EL}	**5.3** / 144 kW	

HTHP + MVR (COP = 3)		
Suction MVR	1.7 bar(a) / 1180 kg/h	From HTHP
Discharge MVR	6.5 bar(a) / 1310 kg/h	To process
W_{EL}	149 kW	



MAIN R&D CHALLENGES:

- Taylor-made Steam Generator / Refrigerant condenser
- Control of coupled systems
- Supply of Steam at constant pressure level

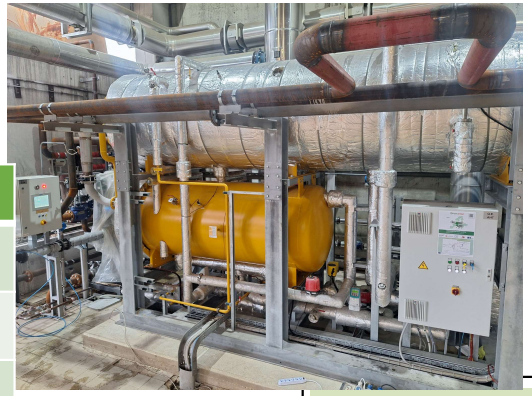
Funded by the European Union

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

P2H DEMO 3 – AHT + Thermocompressor

Push2Heat

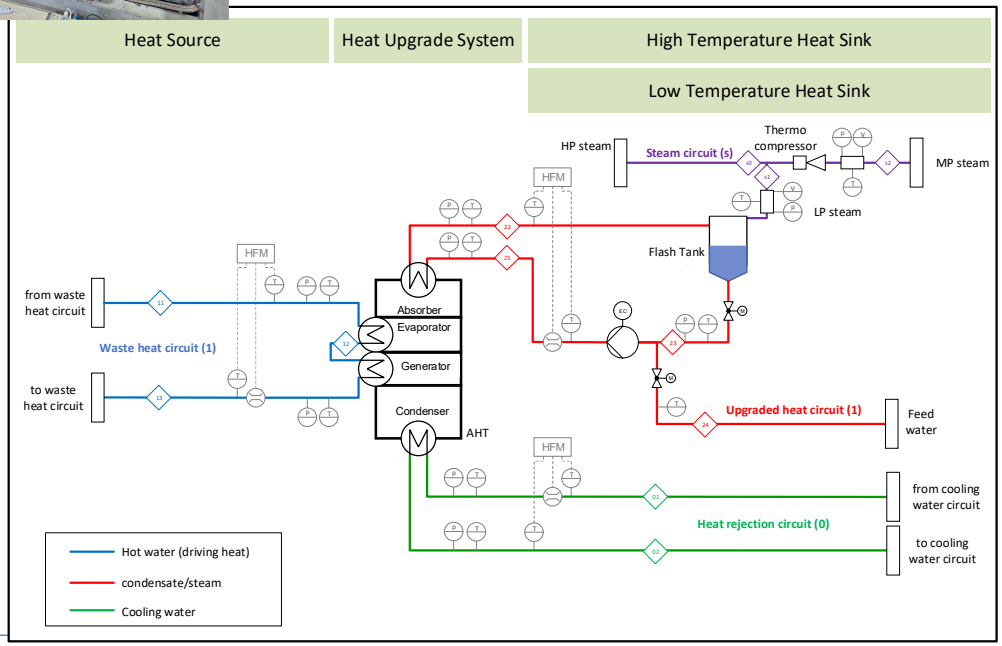
B2 ⊠ A1



MAIN CHARACTERISTICS

SE LiBr/H2O AHT (COP_{EL} = 79 AHT)		
Heat source	90°C / 709 kW	Biomass CHP
HT Heat sink	143°C / 341 kW	Into Flashtank
LT Heat sink	15°C / 368 kW	River cooling

AHT + Flashtank + TC (COP_{EL} > 35)		
In Steam 3.3 bar	540 kg/h	From Flashtank
In Steam 14.5 bar	2046 kg/h	From HP Network
Steam 6.5 bar	2586 kg/h	To Process out



MAIN R&D CHALLENGES:

- Control of AHT for stable TC operation
- Control of complete system for constant steam supply
- Electric consumption minimization

Funded by the European Union

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

tecnalia
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Thanks a lot
Eskerrik Asko
¡Muchas gracias!

For more information:

www.push2heat.eu

joseluis.corrales@tecnalia.com

Funded by the European Union

Push2Heat