Excess Heat Recovery

Driving Circular Economy in Industry and Urban Communities

26 November 2024 | 10:00 - 11:30 CET | Teams webinar

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Push2Heat

SPIRIT

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Agenda

10.00 – 10.10: Welcome and introduction of the projects - **Francesca Genovesi, EHPA**

10.10 – 10.25: Real scale demonstration of a High-Temperature Heap Pump for industrial waste heat valorisation in a paper mill - **Reuven Paitazoglou, Fraunhofer**

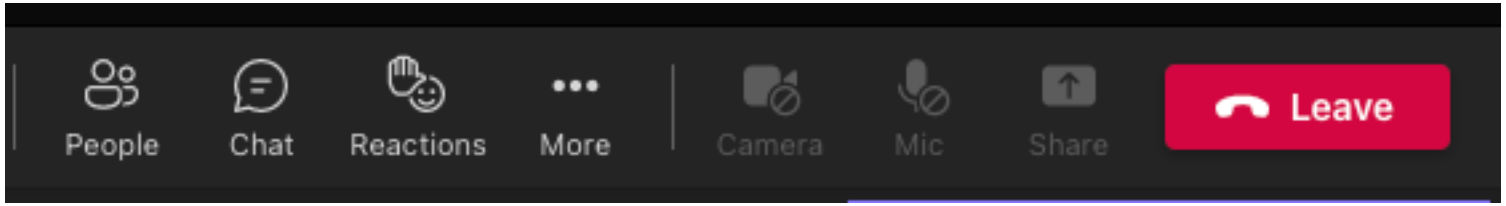
10.25 – 10.40: A Roadmap for Industrial Symbiosis Standardisation for Efficient Resource Sharing - **Lieven Demolder, University of Ghent**

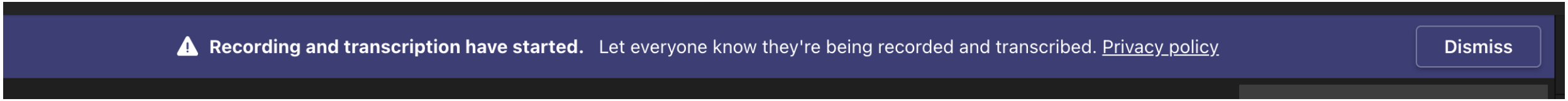
10.40 – 11.10: High Temperature Heat Pumps for steam generation with driving heat from a district heating network - **Laura Alonso Ojanguren, TECNALIA Research and Innovation**

11.10 – 11.25: Q&A

11.25 – 11.30: Closing of the webinar - **Francesca Genovesi, EHPA**

Teams Webinar Platform interactions





Push2Heat

- **Programme**: Horizon Europe
- **Budget:** € 9 739 703,13
- **Duration:** 48 months (Oct 22 – Sep 26)
- **Partners:** 19 from 6 European countries
- **Coordinator:** Tecnalia
- **Demo sites:** 3 in the paper and chemical industries
- **Objectives:**
  - Addressing the technical, economic, and regulatory barriers that prevent heat upgrading technologies to be widely deployed
  - Demonstrating suitable business models for higher market penetration of these technologies

Demonstration Sites

DEMO 1: WEISSENBORN, GERMANY

FELIX SCHOELLER

(PAPER INDUSTRY)

Vapour compression heat pump with piston compressors (SPH)

DEMO 2: GUARCINO, ITALY

CARTIERE DI GUARCINO

(PAPER INDUSTRY)

-Vapour compression heat pump with turbo compressors (ENERTIME)

- Absorption Heat Transformer (BSNOVA)

DEMO 3: ANTWERP, BELGIUM

QPINCH

(CHEMICAL INDUSTRY)

Thermochemical Heat Transformer (QPINCH)

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SPIRIT

Implementation of sustainable heat upgrade technologies for industry

20-21 Sep 2022, SPIRIT Kick-off Meeting, Petten (NL)

Project Overview

- **Programme**: Horizon Europe
- **Budget**: € 11 157 709,78
- **Duration**: 42 months (Sep 22 – Feb 26)
- **Partners**: 17 from 8 EU countries
- **Coordinator**: TNO (NL)
- **Demo sites**: 3 in paper & food sectors
- **Aim**: enable industrial heat pumps to become the reference climate neutral technology for covering heat demand for temperatures up to 160° C by 2030

Demonstration sites

DS 1: Prawn Processing in Norway

Industry: Stella Polaris
Technology: High Temperature Heat Pump, ammonia & pentane in cascade from Mayekawa
Knowledge Provider: Netherlands Organisation for Applied Scientific Research (TNO)

DS 2: Sugar Production in Belgium

Industry : Tiense Suiker
Technology : High Temperature heat pump, Pentane from GEA
Knowledge provider: Danish Technological Institute (DTI)

DS 3: Paper Production in Czechia

Industry: Smurfit Kappa
Technology: Four-cylinder piston compressor from Spilling Technologies
Knowledge provider: German Aerospace Center (DLR)

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META BUILD

ICCS Coordinator

Insitute of Communications and Computer Systems

38 Partners

Participants
+ 2 beneficiaries

13 Countries

Powering the METAmorphosis of BUILDings towards a decarbonised and sustainable energy system

Title

HORIZON EUROPE, RIA – Research and Innovation Action

Funding

6 Austria, Croatia, France, Greece, Italy, Spain

Front Runners

- Electrifying the thermal energy demand of buildings
- Optimising heating and cooling performance

Main Goals

48 Months

01 Jan 2024

31 Dec 2028

Lifetime

7 Spain, Poland, Latvia, Germany, Greece, Bulgaria

Replication Multipliers

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Want to know more about the projects?

Push2Heat

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Scan the code or click here!

Scan the code o click here!

Scan the code or click here !

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Excess Heat Recovery

Driving Circular Economy in Industry and Urban Communities

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Reuven Paitazoglou
Senior researcher at the Fraunhofer IEG

Fraunhofer IEG

Excess Heat Recovery: Driving Circular Economy in Industry and Urban Communities with heat pumps

Real scale demonstration of a High-Temperature Heap Pump for industrial waste heat valorisation in a paper mill

Teams webinar

Reuven Paitazoglou
Fraunhofer IEG
26/11/2024

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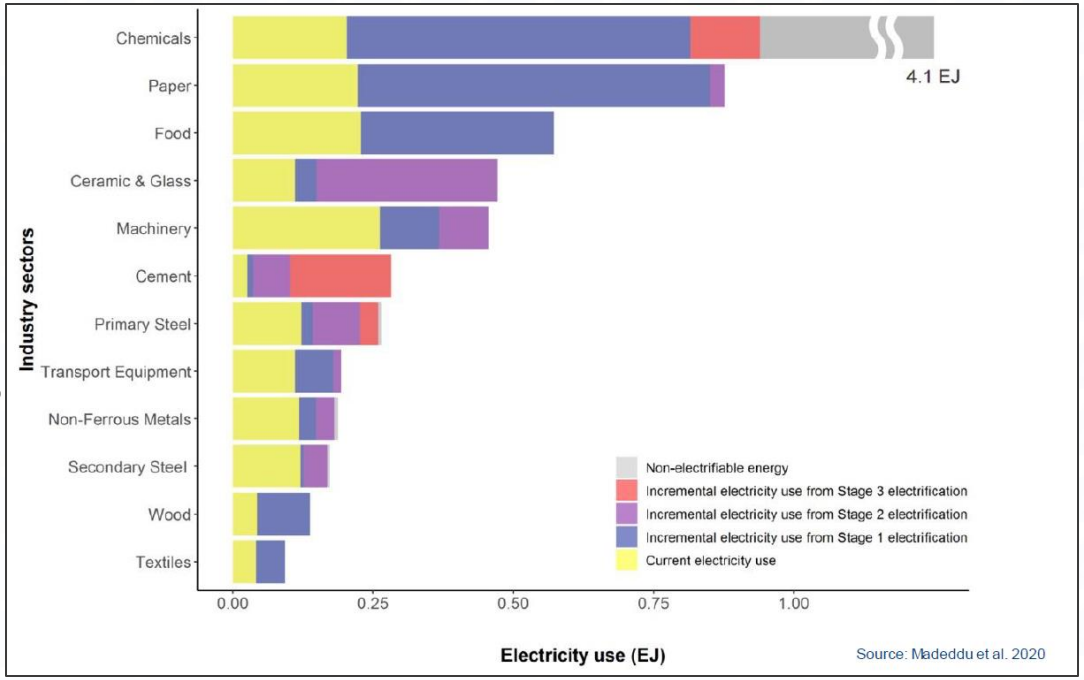
Industrial Decarbonization

- Industrial energy landscape
  - **~75% Heat - Today mainly from fossils**
  - ~25% Electricity - today 50% from fossils

- 37% of the process heat required is **below 200 ºC** (730 TWh/year)

- Available **waste heat** between 40-100ºC is estimated in 220 TWh



Source: Madeddu et al 2020 https://doi.org/10.1088/1748-9326/abbd02

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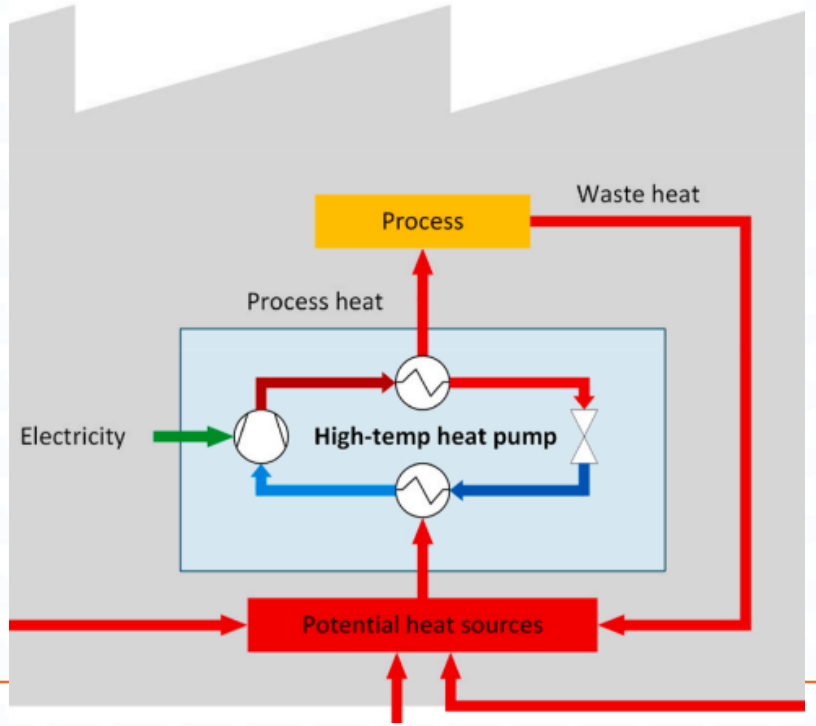

PUSH2HEAT is about:

- Waste heat recovery **40-100 ºC**
- Upgrade with High Temperature Heat Pumps **90-160 ºC**

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PUSH2HEAT main objectives

TECHNOLOGY RELATED OBJECTIVES:

- Optimization of **four heat upgrade technologies**

MARKET/BUSINESS RELATED OBJECTIVES:

- **Pushing forward the market potential, new business models** and actions towards technologies market deployment

Demonstration of four full-scale pilot plants in different industrial applications:

- Waste heat at 40-90 ºC
- Heat supply at 100-160 ºC
- System size: 0,5 to 3 MW

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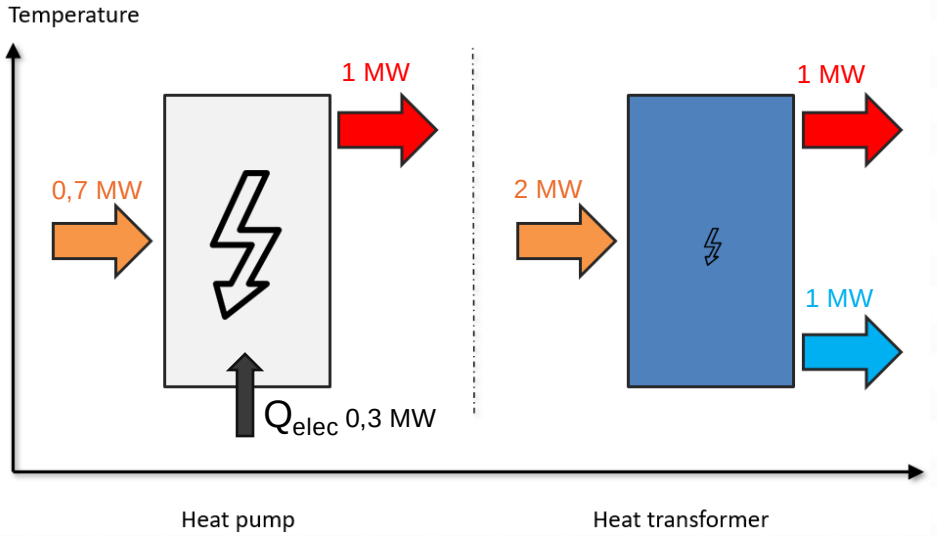
Push2Heat

PUSH2HEAT technologies



PUSH2HEAT Heat Upgrade Technologies

- **Electrically driven HPs**
  - Piston compressor
  - Mechanical Vapour Re-Compression (MVR)
- **Thermally driven HPs**
  - Absorption Heat Transformer
  - Thermochemical Heat Transformer

SPH

to be confirmed

BS Nova

QPINCH

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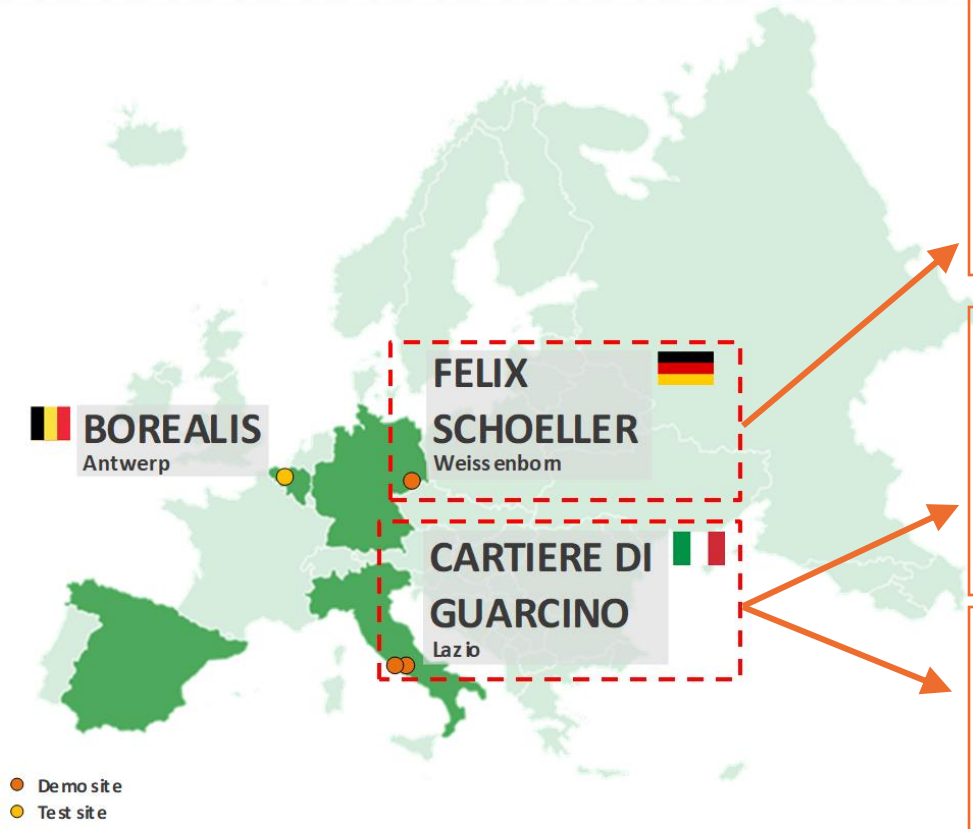
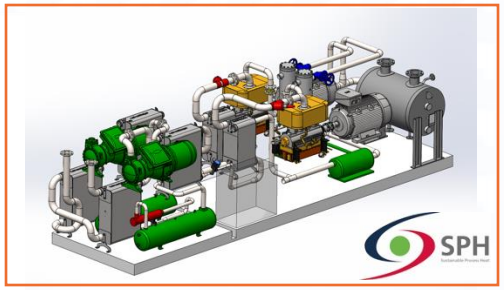
Demo sites & design parameters





Mechanical Vapour Re-Compression (MVR)

to be defined

		Germany Demo 1	Italy Demo 2	Italy Demo 3
Heat Source Parameters				
Thermal capacity	kW_{th}	690	922	700
In-/Outlet temperature evaporator	°C	46 / 41	90 /75	90 /80 (evaporator +generator)
Fluid	-	water/glycol	water	water
Heat Sink Parameters				
Thermal capacity	kW_{th}	1 180	1 700 to 2 000	340 (HT) 360 (LT)
In-/Outlet temperature	°C	90/123 (condenser)	162	142/137 (HT:absorber) 15/21 (LT: condenser)
Steam generation	-	direct	MVR	flash tank
Steam outlet pressure	bara	2.2	6.5	3.3
Fluid	-	inlet: liquid water, outlet: (saturated) steam		
			Thermo-compressor	
Flow rate Pressure motive steam	-	-	-	1.8 t/h 14.5 bara
Flow rate Pressure discharge steam	-	-	-	2.4 t/h 6.5bara
Heat Upgrade System				
Electricity consumption	kW_{el}	517	-	5
Coefficient of Performance (COP)	-	2.3 (kW_{th} / kW_{el})	-	25-35 (kW_{th} / kW_{el}) 0.48 (kW_{th} / kW_{th})

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PUSH2HEAT demo site Weissenborn

- Felix Schoeller GmbH & Co KG (STC) is one the of the biggest groups in Europe dedicated to the production of technical and specialty paper
- The specialty paper factory of the group in Weißenborn is located in the free state of Saxony in Germany. 700 employees on that site are producing around 100 000 t of paper a year
- Yearly energy demands
  - Electricity: 88 GWh_{el}
  - Process heat: 230 GWh_{th} (steam)
- Combined Heat and Power supply system
  - Power generation with 3 gas turbines and 1 steam turbo generator; max rated power 18 000 kW fully supplies the demand of the mill
  - Steam generation with 4 boilers (3 waste heat boilers) with max capacity 145 t/h
- Steam is generated at the pressure levels of 4.5 bar(a) and 8 bar(a)


PM 4 - Weissenborn

Felix Schoeller GmbH & Co.KG

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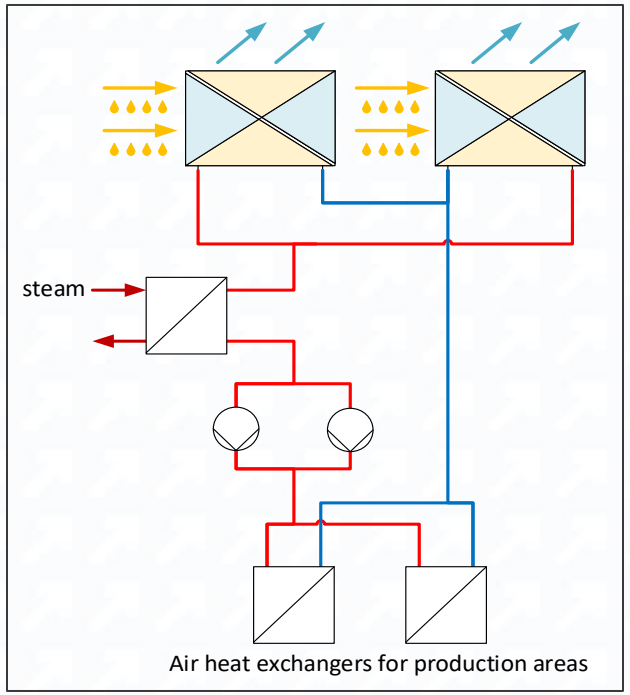
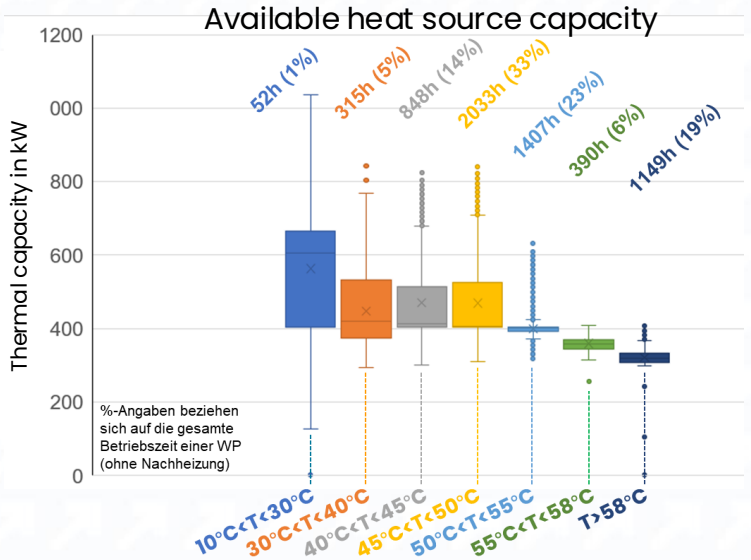
PUSH2HEAT demo site Weissenborn

Heat source

Heat Recovery Circuit from the exhaust air of drying hood

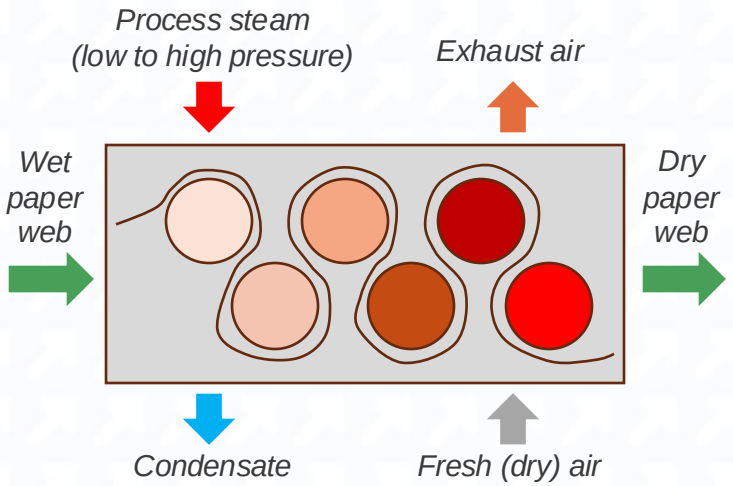


- Heat Recovery system from the **exhaust air of drying hood** serves as heat source for the HTHP
- Heat Recovery circuit operates at **varying temperature levels** of 30-60°C
- Temperature level = f(paper, ambient air conditions)
- Heat Recovery System extended in 2023



Heat sink

- Low pressure dryer cans …up to 4.5 bara
- Direct integration of the steam into production process



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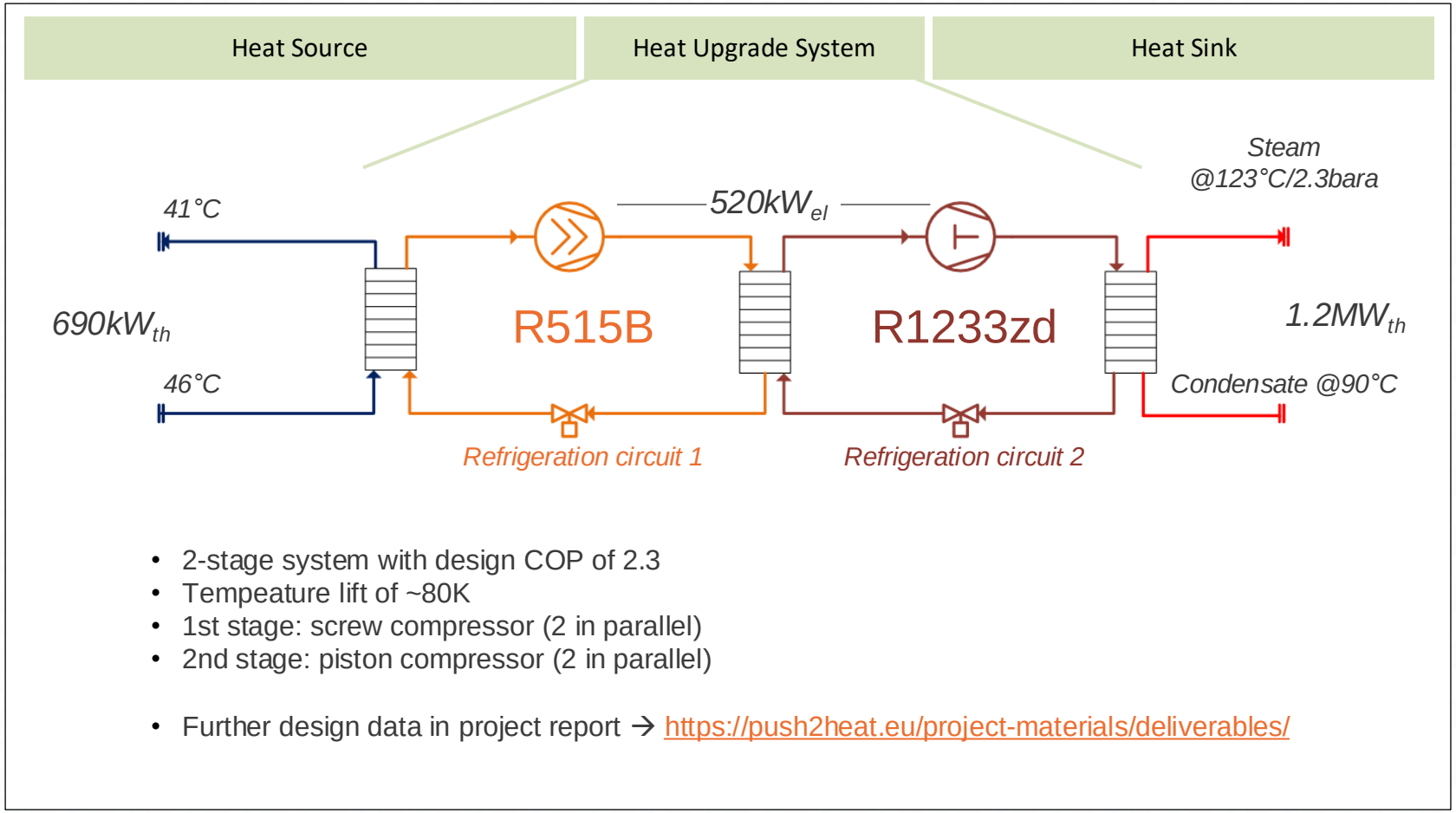
Heat Upgrade System



- 2-stage system with design COP of 2.3
- Tempeature lift of ~80K
- 1st stage: screw compressor (2 in parallel)
- 2nd stage: piston compressor (2 in parallel)

- Further design data in project report → https://push2heat.eu/project-materials/deliverables/

Felix Schoeller GmbH & Co.KG

IEG - HP assemply

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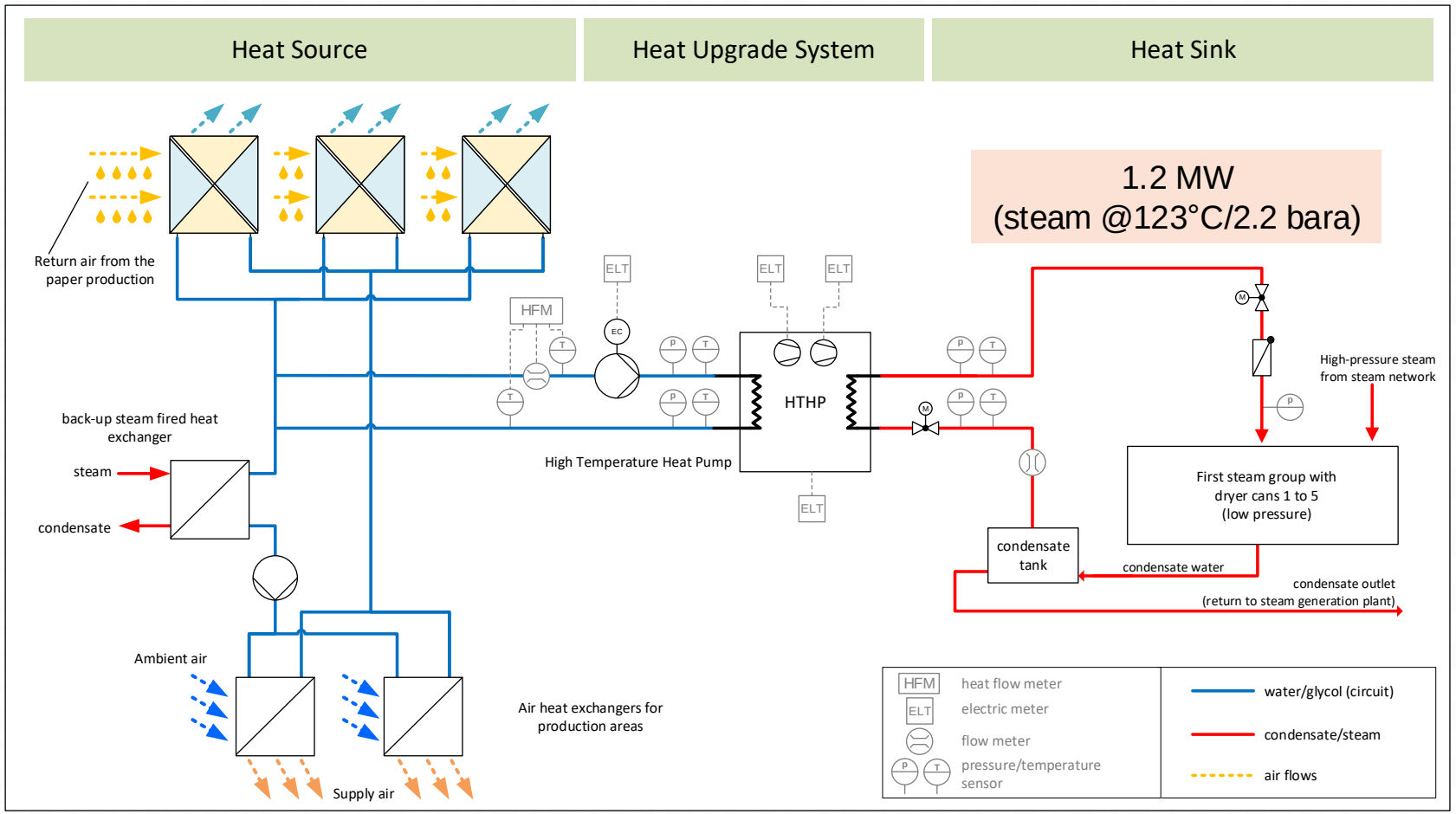
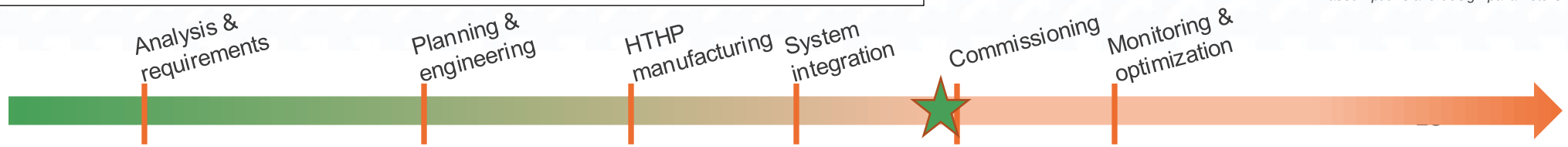
Overview system



Industrial partner	Felix Schoeller GmbH & Co.KG
Sector	Paper Industry
Technology	HTHP with reciprocating piston compressor (SPH), 2-stage system
Expected output*	
Operation hours	4 000 h/a
Heat supply	4 720 MWh/a
Gas savings	453 000 m³/a
CO2 savings	231 t/a
PE savings	2 414 MWh/a
OPEX savings	108 000 €/a
Spec. savings	~23€/(MWh·a)
Commissioning	Q1-Q2 2025

**Values are based on preliminary assumptions and design parameters*

R. Paitazoglou, A. Hanßke, J. Corrales, L. Alonso, T. Toppi, G. Abrami, "Implementation of High Temperature Heat Pumps for heat upgrade and supply of process steam in the industry", High-Temperature Heat Pump Symposium 2024, extended abstract.



Demo site Weissenborn

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Thank you!

Dipl.-Ing. Reuven Paitazoglou

Senior Researcher

Fraunhofer IEG

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Linkedin

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Senior Researcher in Energy & Sustainability, Ghent University

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FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT ELECTROMECHANICAL, SYSTEMS AND METAL ENGINEERING
RESEARCH GROUP ECM (ENERGY & CLUSTER MANAGEMENT)

RISERS

A ROADMAP FOR INDUSTRIAL SYMBIOSIS STANDARDISATION FOR EFFICIENT RESOURCE SHARING

EHPA WEBINAR 'EXCESS HEAT RECOVERY' 13/11/2024

UGENT-FEA-EMSME-ECM

Ir. Lieven Demolder, prof. dr. ir. Greet Van Eetvelde

UGENT-ECM: ENERGY & CLUSTER MANAGEMENT

~INDUSTRIAL SYMBIOSIS (since 1998)

- energy & resource management in
  - industrials parks & sites
  - urban-industrial & cross-sectoral clusters
  - regions, ports, hubs & districts
- interdisciplinary research
  - engineering models
  - legal, economic, spatial, technical and social aspects
- projects eg
  - industrial clustering/management
  - climate/energy symbiosis and circular economy
  - hubs for circularity

MATERIALS
resources, waste, emissions, critical materials, by/side-products, …

ENERGIES
heat/steam, electricity, nuclear, hydrogen, renewable, …

SERVICES
facilitation, infrastructure, logistics, transport, engineering, platforms, …

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Standardisation of Industrial Symbiosis

RISERS builds a roadmap integrating practice, policy and R&I to **promote the standardisation of IS focused on priority synergies and resources for high-impact EU resilience.**

website: risers-project.eu

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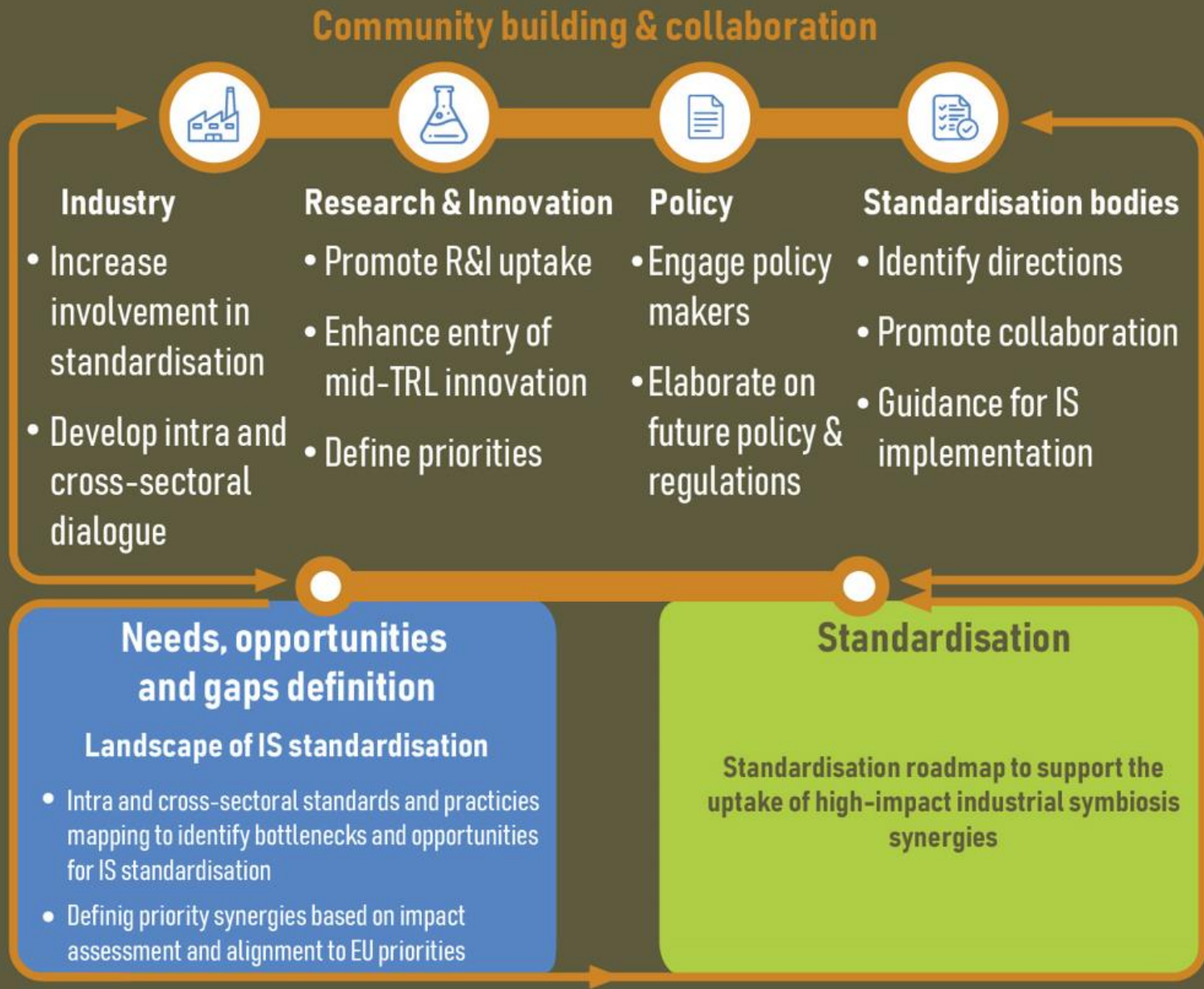
RISERS

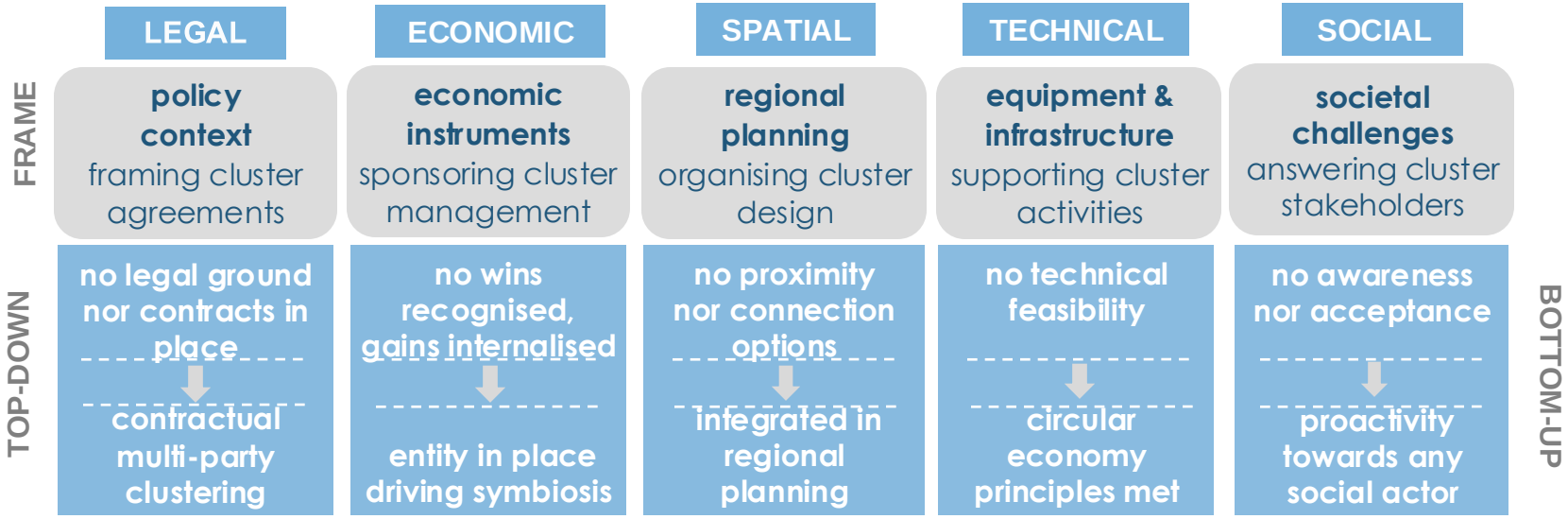
Our Approach

To address the IS standardisation challenges, RISERS uses a methodological approach based on community building and collaboration, definition of needs, opportunities and gaps to develop an IS standardisation framework.



IDENTIFY IS POTENTIAL

> LESTS methodology (Maqbool et al., 2016)



> Engineering suitability (eg need for infrastructure)

> Organisational suitability (eg in line with company goals and strategies)

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RISERS WP3: PRIORITY SYNERGIES

#	MES		Source sector	Sink sector	**Synergy** - base case listed, scope widening in T3.3	PPP impact very high on
2/50	BOF/EAF slag	M	Steel	Cement, various	Recover BOF slag and provide Si, Al, Fe, Ca and Al for clinker raw materials	planet
9/24	Waste heat	E	Various	Urban	Recover heat from process industry and use for urban heating	people
36/46	Plastic packaging	M	Various	Cement, various	Use plastic waste from process industry as raw material in cement industry	planet
38	Waste steel	M	Urban, Various	Steel	Recover waste steel for recycling (secondary steel manufacturing)	planet
35	Energy data	S	Various	Energy	Optimise electricity sourcing and provide flexibility via demand-response	planet
39	Biomass	ME	Urban, Various	Refineries, Various	Produce alternate fuels using Fischer-Tropsch process	planet
13	Waste wood	ME	Pulp & paper	Energy	Recover waste wood from pulp & paper sector to fuel combustion plants	planet
6	Refractory materials	M	Steel	Glass, construction	Recover fly ash and extract mineral products for brick and roof tiles manufacturing	people
New	Textiles	M	Textiles	Various	Produce secondary raw materials from unwearable textile waste	planet
New	EV batteries	ME	Transport	Energy/Minerals	Recover lithium and other rare earth elements, reuse for energy storage	planet

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PRIORITY SYNERGY: WASTE HEAT

TECHNICAL FEASIBILITY

Industrial pilot
Low technical requirements

Growing demand for sourcing energy-intensive industries with waste heat/renewable heat

Waste heat recovery
Industrial/urban heating networks
Production of solar heat
Industrial heatpumps

PPP IMPACT – EU wide potential

Wins in industry
ca. 5-20% ROI, lower OPEX

Environmental gains
ca. -100-300g CO2-eq. /kWh used
total heating demand: ca. 2000 TWh/y in industry

Wins for society
public health benefits due to renewable energy
community integration through PPP investment
job creation and new skill development

REFERENCES

EPOS case watch 03/18 https://www.aspire2050.eu/epos

Scaler synergies outlook,case 91, H2020 www.scalerproject.eu

Industrial heat pumps- overview, EHPA, https://www.ehpa.org/wp-content/uploads/2022/12/Industrial-Heat-Pumps-overview.pdf

TrustEE, H2020, https://www.trust-ee.eu/

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INDUSTRIAL WASTE HEAT: IS PRACTICE

CHRISTEYNS

DuCoop

www.ducoop.be

Exchange of industrial waste heat between a chemistry (soap) factory and newly built residential area in Ghent (BE)

- Recovery of waste heat can cover 70% of the residential heat demand (400 housing units, offices,
- Heat production from decentralized wastewater treatment (using 125 kW aquathermal heat pump)
- Treated wastewater is supplied to the chemistry factory to replace freshwater demand

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DuCoop

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Francisco Mendez-Alva, Hélène Cervo, Gorazd Krese and Greet Van Eetvelde, Industrial symbiosis profiles in energy-intensive industries: Sectoral insights from open databases, Journal of Cleaner Production, Volume 314, 2021, 128031, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2021.128031.

Maqbool , A. S., Piccolo G. E., Zwaenepoel G. E., and G. Van Eetvelde, Cultivating Industrial Symbiosis between Process Industries, Sustainability Conference, Utrecht, the Netherlands, 2016. http://hdl.handle.net/1854/LU-8198557

UGent biblio: https://biblio.ugent.be/

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Laura Alonso
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MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

tecnalia

MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

HTHP FOR STEAM GENERATION WITH DRIVING HEAT FROM A DISTRICT HEATING NETWORK

Laura Alonso Ojanguren

Researcher in Efficient Thermal Energy Systems, TECNALIA

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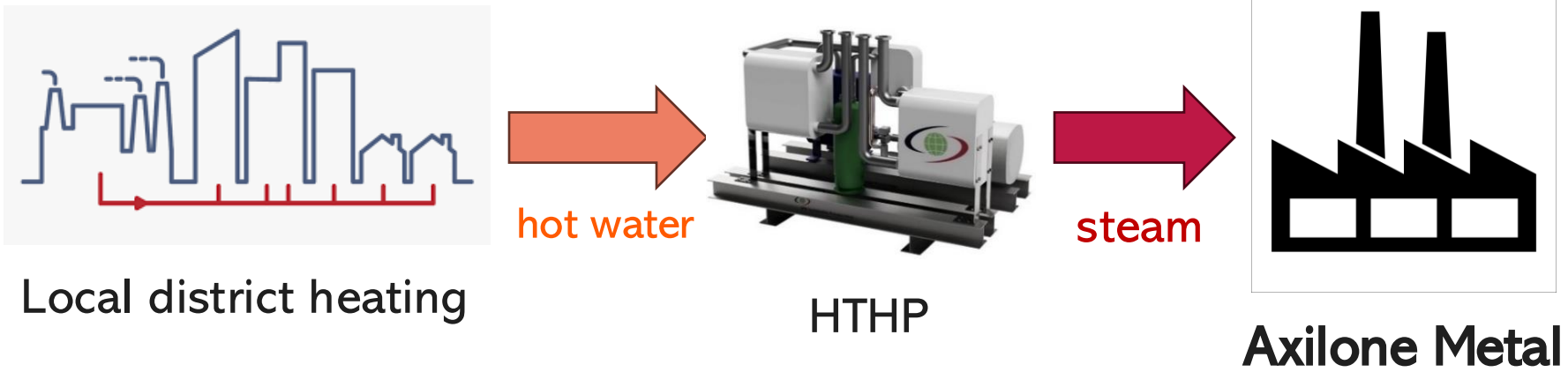
26/11/2024

INTRODUCTION

HTHP installed in a metal processing plant for cosmetic and perfumery caps. Heat from local district heating network.

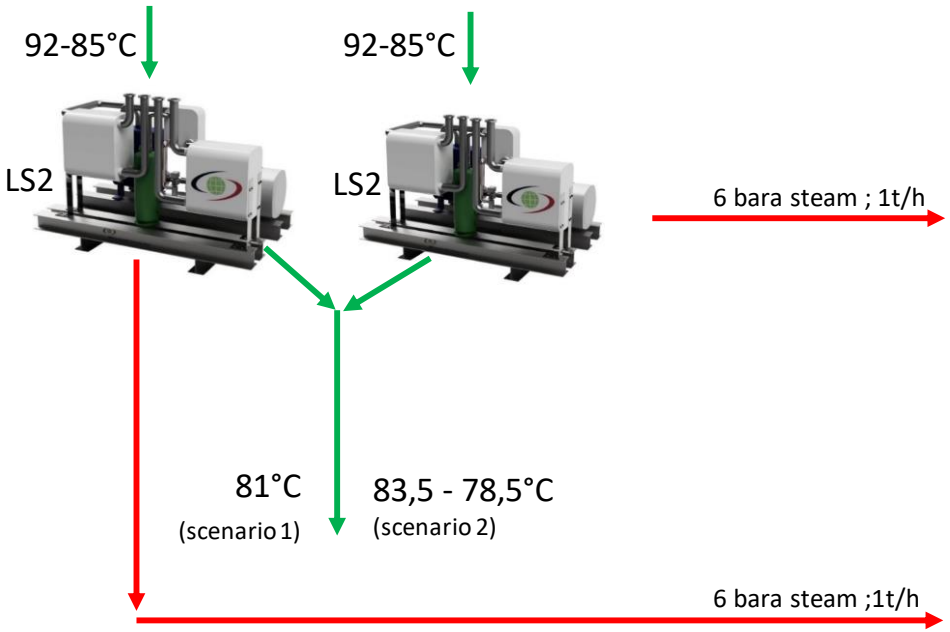
First HTHP generating steam in an industrial process installed in Spain.



HTHP INTEGRATION FOR STEAM PRODUCTION

KEY FEATURES

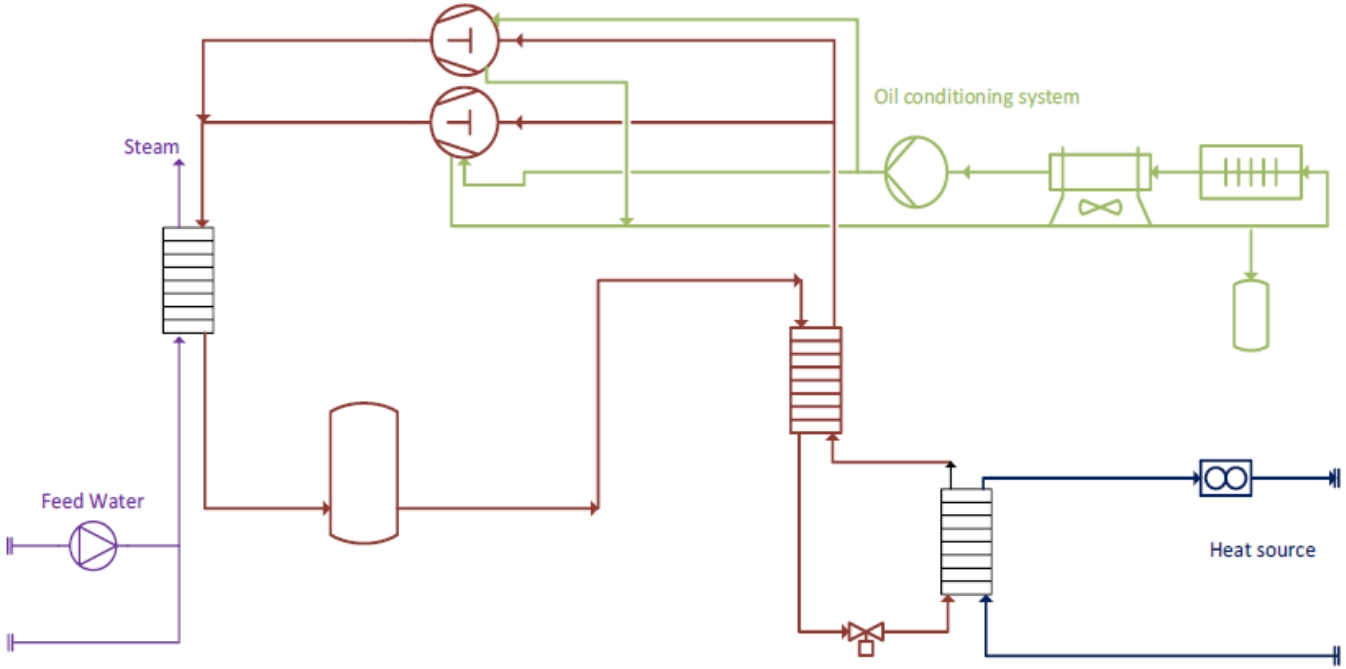
- Heat from the District heating network: input for the HTHP → water at around 88 ºC
- Output upgraded heat for the process in form of steam → 6 bar(a)
- Designed configuration → two LS2 ThermBooster from SPH
- Capacity (each unit):
  - Input heat: 400 kWth
  - Upgraded heat: 635 kWth → ~ 1 ton/h steam
  - Compressor: 240 kWel
- COP = 2.6

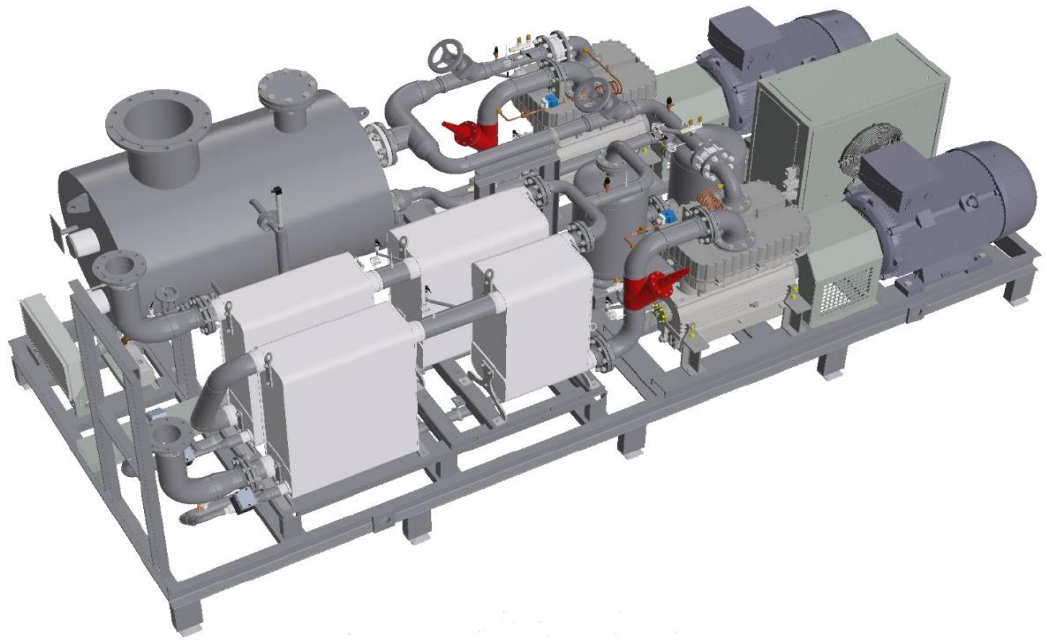


HTHP INTEGRATION FOR STEAM PRODUCTION

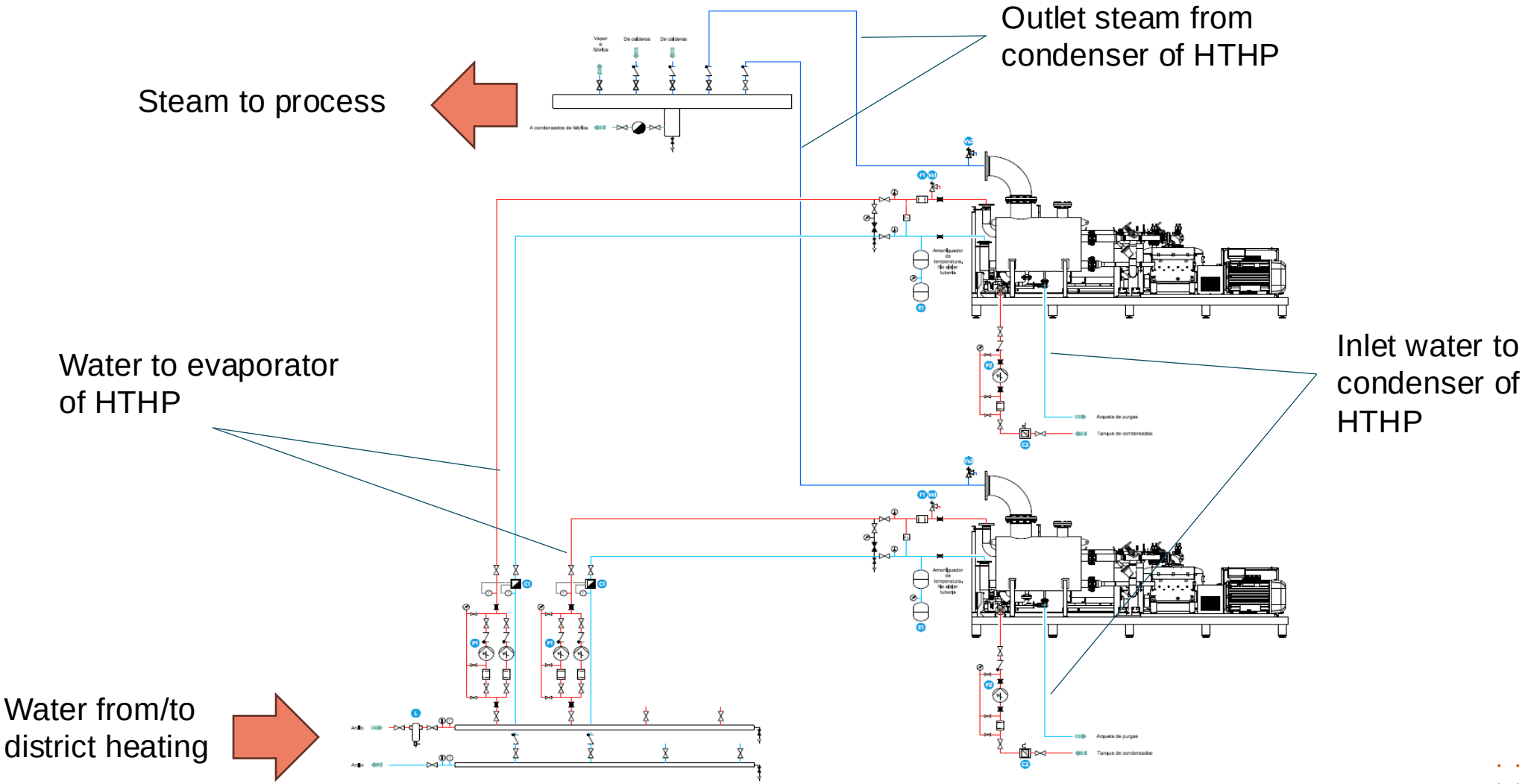
HTHP CONFIGURATION

- 2 SPH Piston Compressors
- Two evaporators
- Condenser – Steam Generator





LAYOUT OF INSTALLATION



KEY PERFORMANCE INDICATORS

	Calculated values
• HTHP Upgraded heat capacity, $Q_{upgraded}$	1 270 kW
• Heat input (source) provided to HTHP, Q_{source}	816 kW
• Coefficient of Performance, COP	2.6
• Thermal energy saving for the plant	13 000 MWh/year
• Electrical energy consumption of the plant due to the HPs operation	4 400 MWh/year
• Primary energy savings	7 000 MWh/year
• CO_2 savings	1 200 ton/year

PLANNING

In the short term:

- Manufacturing → finished
- Testing of HTHPs in SPH facilities → starting soon
- Installation → Q1 / 2025
- Commissioning → Q1 /2025

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Q&A session and Panel discussion

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Lieven Demolder
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Laura Alonso
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