

# Flexible Power Generation – ETN Webinar Series

## Challenges and opportunities in the future energy scenario

*Tuesday, April 20, 2021 • 11:30am – 01:00 pm*

### Performance Untapped Modulation for Power and Heat via Energy Accumulation Technologies

### **PUMP-HEAT**

Speaker: Prof. Alberto Traverso  
University of Genoa, Italy



## Presentation agenda

### Executive Summary

- Introduction – news from the past
- Energy Union – PUMPHEAT role
- PUMPHEAT key achievements
- Question for you



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## Introduction

# How long have we been waiting for the 2020?

01/01/**2000** – Vision 21: Fossil Fuel Options for the Future.  
Washington, DC: The National Academies Press.  
<https://doi.org/10.17226/9862>. Focus on conversion efficiencies.

01/03/**2007** – Launch of the EU 2020 climate & energy package is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020 (emission reduction of greenhouse gases by 20% by 2020 taking 1990 as reference).

14/01/**2014** – Launch of **Horizon 2020** the new European Framework Programme for Research and Innovation 2020



# Introduction Now that we passed the 2020...

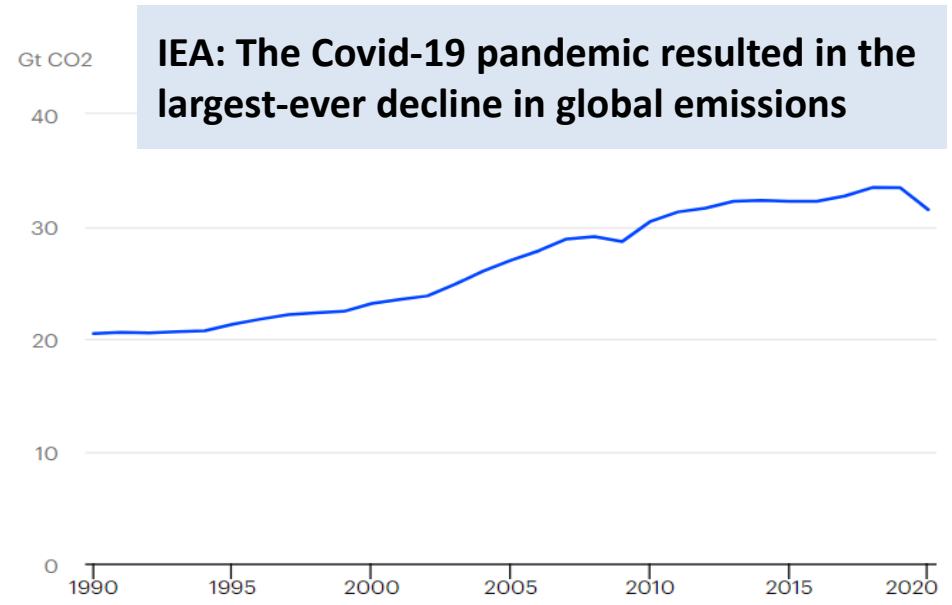
## CO2 global emissions

The collapse of the Soviet Union in 1991 led to a huge drop in greenhouse-gas emissions because the resulting economic crisis => driver for Russia ratification of Kyoto protocol in 2004

Will the Paris 2015 CO2 emission targets (Paris COP21 agreement, subscribed in 2015) be achieved «thanks» to the Covid19?

*The EU has already overachieved its target of reducing greenhouse gas emissions by 20% below 1990 levels by 2020 (...) Total EU-27 greenhouse gas emissions are at their lowest level since 1990 (...) The Commission has therefore proposed to step up Europe's 2030 climate ambition by reducing greenhouse gas emissions by at least 55%.*

Global energy-related CO2 emissions, 1990-2020



*State of the Energy Union, COM/2020/950 final, October 2020*



## Introduction

# How long will we be waiting for the 2030?

# How the 2030 targets will be achieved?

Don't know the global answer

Just outline the PUMPHEAT contribution



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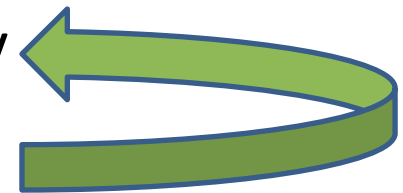
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# Five dimensions of the energy union

1. Security, solidarity and trust
2. A fully integrated internal energy market
3. Energy efficiency
4. Climate action, decarbonising the economy
5. Research, innovation and competitiveness



[https://ec.europa.eu/energy/topics/energy-strategy/energy-union\\_en](https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en)

(published in 2015, updated in 2020)

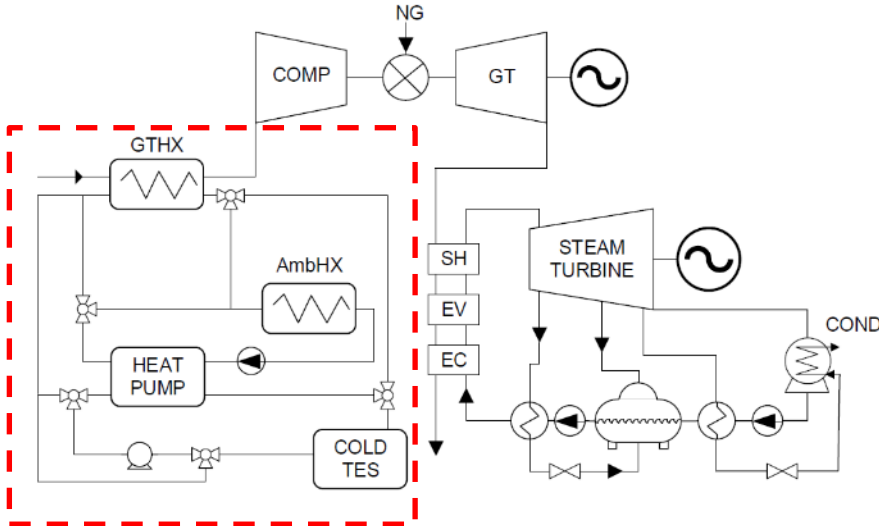




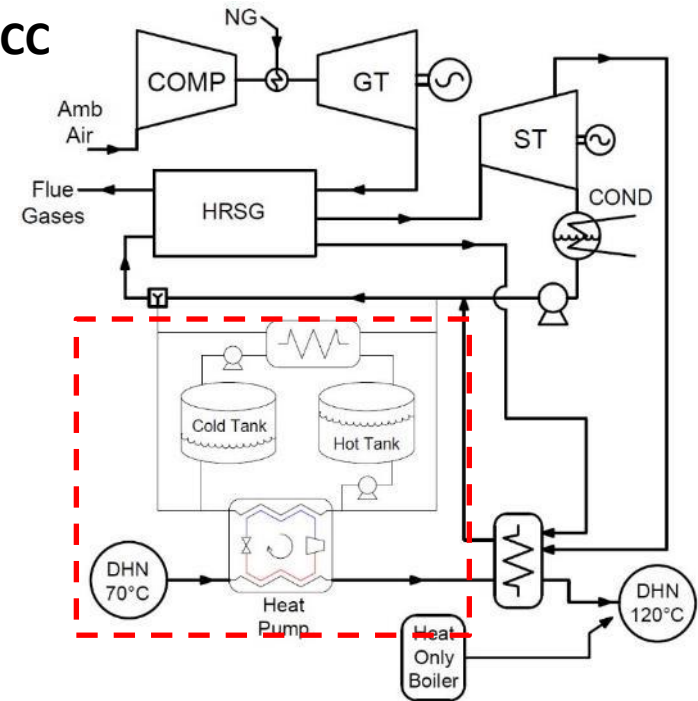
# PUMP-HEAT concept: Power Oriented and CHP Combined Cycle layouts

Heat Pump (HP) and Thermal Energy Storage (TES) integrated with Combined cycles (CC)

## Power Oriented CC



## CHP CC



- Flexibility: Heat Pump (HP) as a *smart electrical load* ( $\Leftrightarrow$  *electrification*)
- Energy efficiency: (i) HP can displace auxiliary boilers (ii) HP can increase the CC average annual efficiency

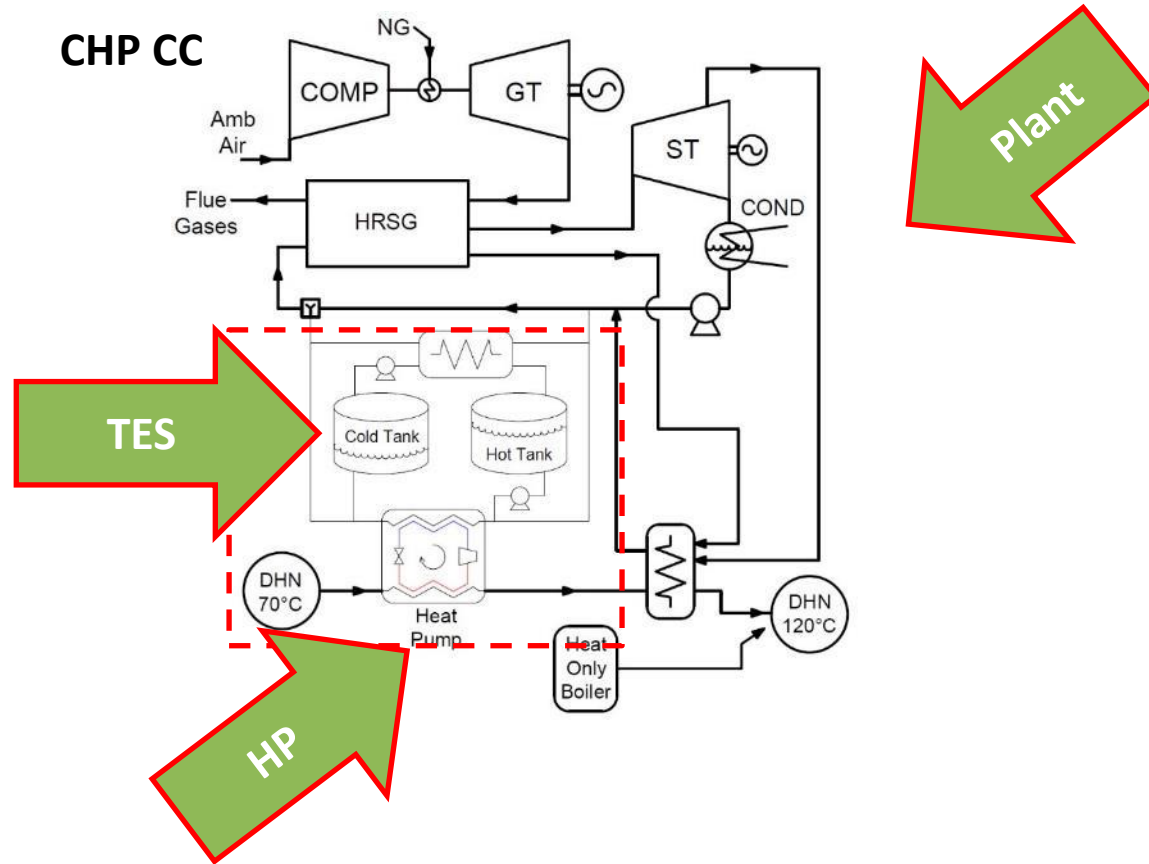
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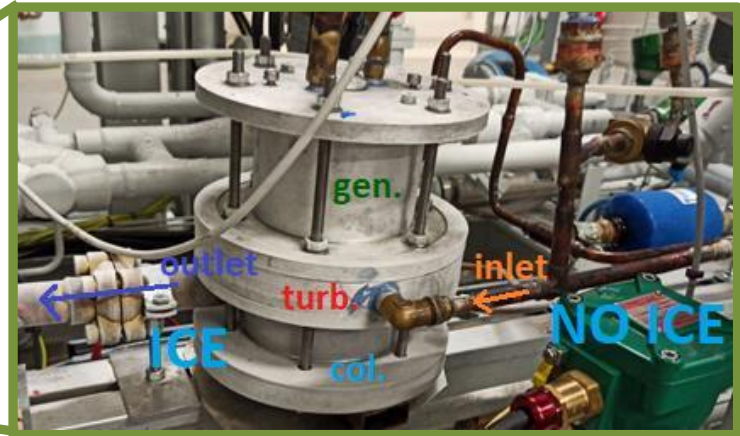
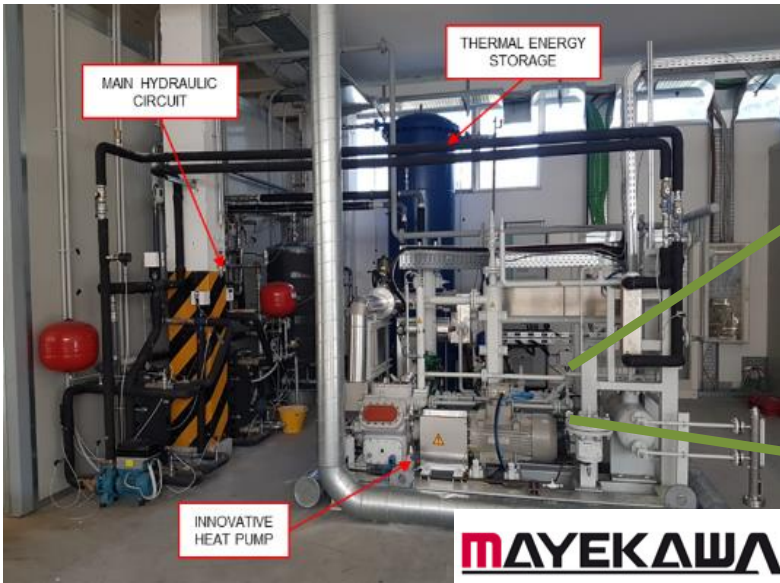
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# PUMP-HEAT key achievements



# R600 Heat Pump with Bladeless expander



## Project Validation site (UNIGE, Italy)

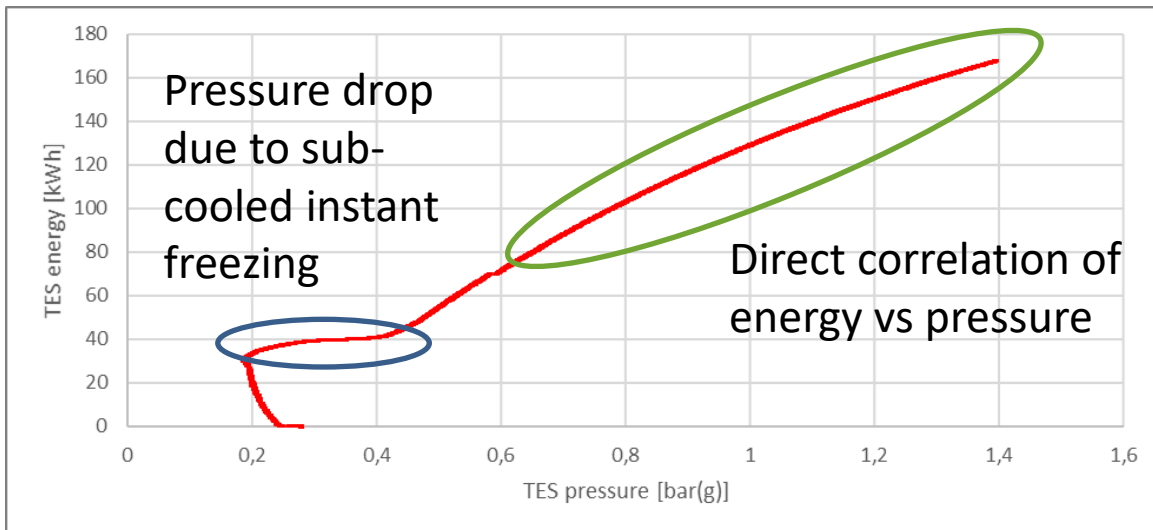
- Natural fluid (R600-butane), Fast response HP, 10 kW<sub>e</sub>
- Bladeless turbine installed on the HP
- Authorisation and safety issues faced and solved
- Initial tests successfully performed at low power (HP<70%) and low speed (turbine <10krpm)



## Cold Thermal Energy Storage - laboratory

### Project Validation site (UNIGE, Italy)

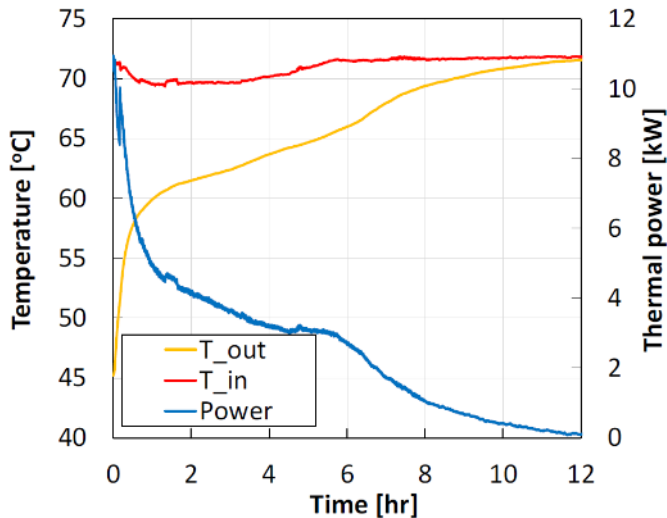
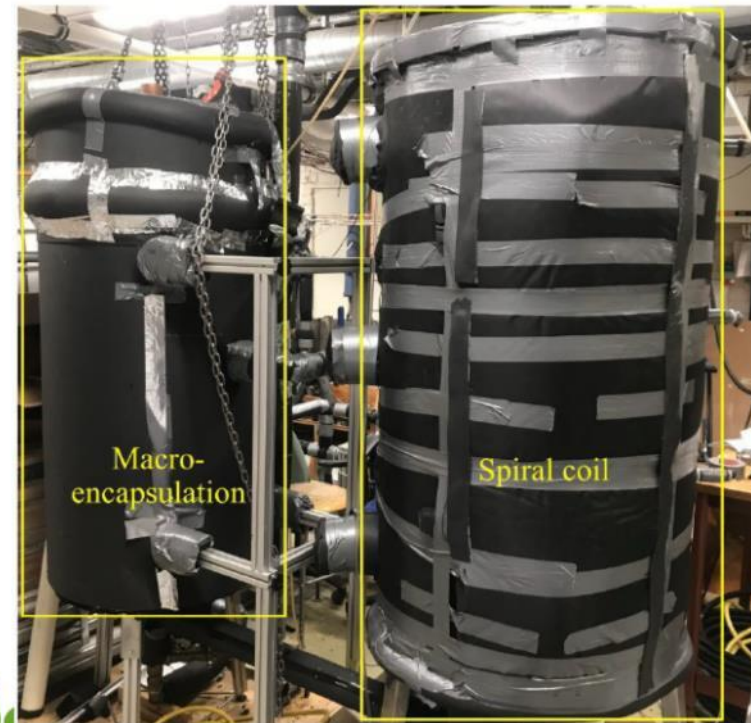
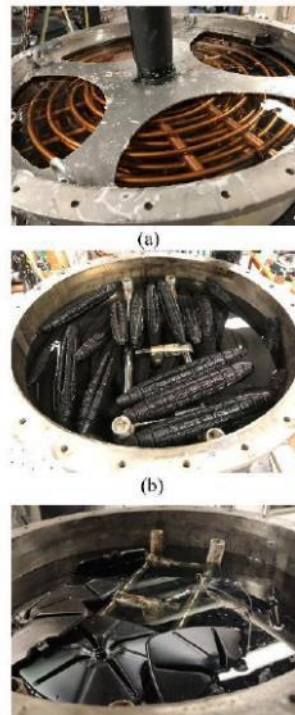
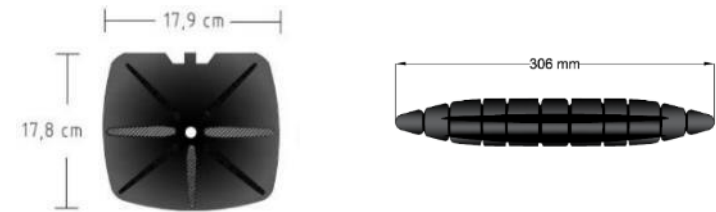
- demineralized water as PCM – around 160 kWh capacity (thermal) – freezing at 0°C
- Pressure sensor installed in order to correlate TES charge status with internal pressure



# Warm Thermal Energy Storage – laboratory

## Project Validation site (KTH, Sweden)

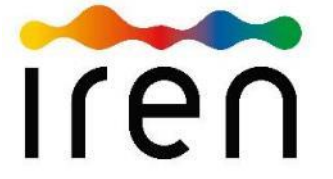
- Two Thermal Energy Storage configurations:
  - Spiral-type heat exchanger
  - Macro-encapsulation
- Several tests performed (discharge of spiral type below)



## PUMP HEAT Demonstration site

### Project demosite (Cogenerative CC of Moncalieri, IREN, Italy)

- Natural fluid (R600-butane), Fast response HP, 150 kW<sub>e</sub>
- Thermal Energy Storage, 700 kWh, PCM freezing in 50-70°C range
- Authorisation and safety issues faced and solved in RELEVANT ENVIRONMENT
- Initial tests on equipment revealed some technical issues, under resolution now



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## Stakeholder questionnaire

Take the opportunity of asking a feasibility study!

Your input is highly appreciated

<https://forms.office.com/r/HHhVbkD6PM>

A screenshot of a Microsoft Forms survey titled "PUMP-HEAT Stakeholders Final Survey". The survey header is teal and contains the PUMP HEAT logo and the title. Below the title, it asks "How PUMP-HEAT solutions can enhance EU Flexibility needs particularly looking at Gas Turbine and Combined Cycle Plants?". The form is marked as mandatory with an asterisk. The first section is "GENERAL INFORMATION" and contains two questions: "1. NAME OF THE INSTITUTION \*" and "2. Type of Institution \*". The first question has a text input field with the placeholder "Inserisci la risposta".

**PUMP HEAT**

### PUMP-HEAT Stakeholders Final Survey

How PUMP-HEAT solutions can enhance EU Flexibility needs particularly looking at Gas Turbine and Combined Cycle Plants?

\* Obbligatoria

#### GENERAL INFORMATION

1. NAME OF THE INSTITUTION \*

2. Type of Institution \*

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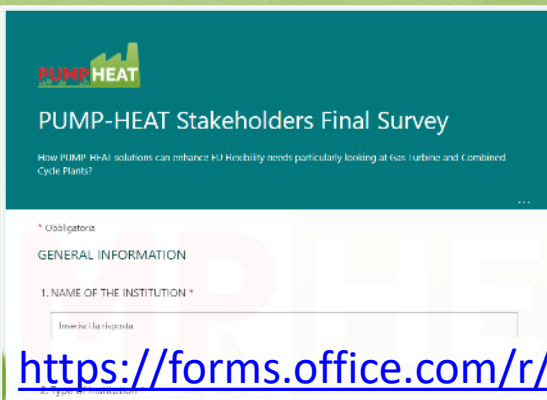
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