

Flexible Power Generation – ETN Webinar Series – 4th episode

PUMP-HEAT

**Innovative concept to increase flexibility of combined cycle power plants
and gas turbines**

Tuesday, January 12, 2020 • 12:00am – 01:00 pm

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

**Speaker: Prof. Alberto Traverso
University of Genoa, Italy**



Presentation agenda

Executive Summary

- Heat Pumps for CC flexibility - PUMP-HEAT project
- WHY heat pumps for CC flexibility
- HOW heat pumps for CC flexibility (PO and CHP layouts)
- Demonstration activities and equipment



Presentation agenda

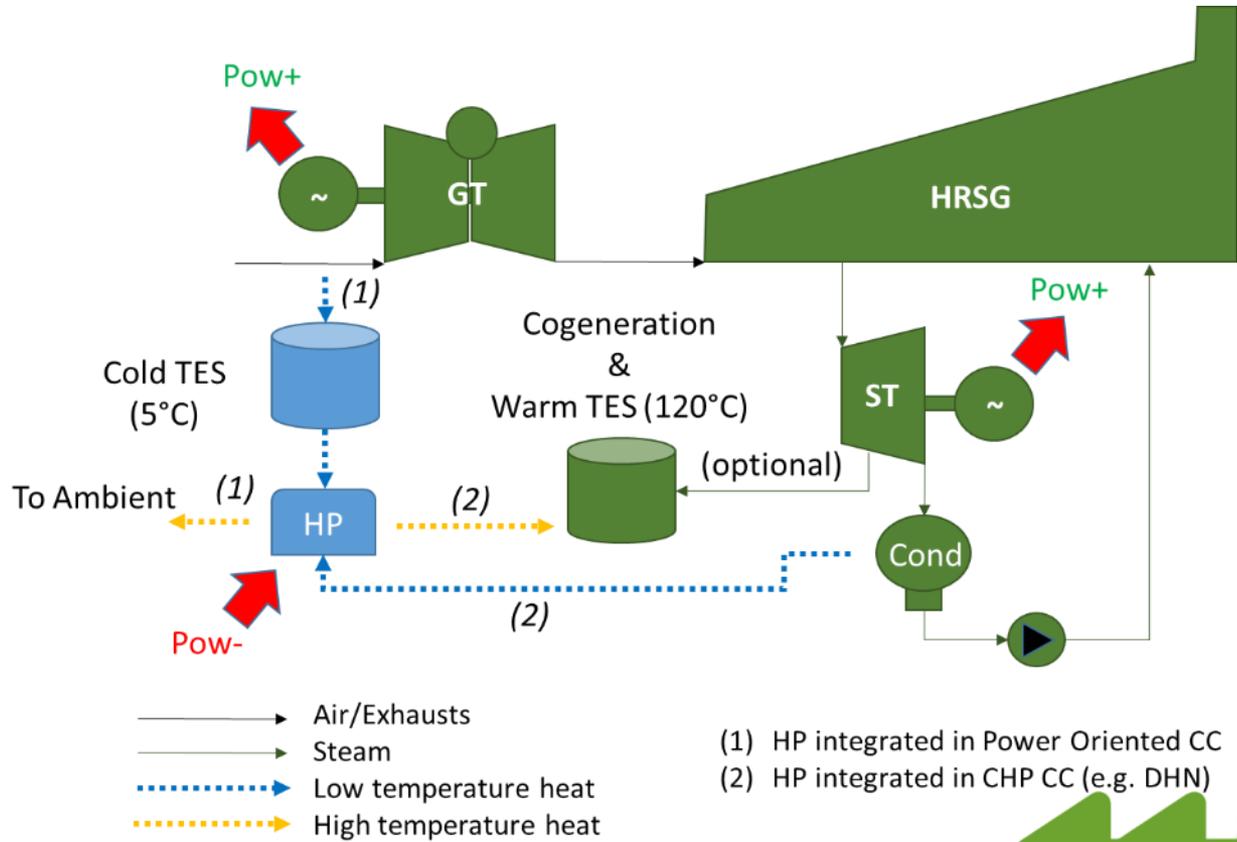
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PUMP-HEAT concept overview

- Heat Pump (HP) as a *smart electrical load*
- HP may allow CC to sell grid services also when the CC is off
- HP will impact on the GT inlet air, reducing P_{min} and augmenting P_{max} as required
- HP can produce useful heat for DHN, displacing auxiliary boilers
- HP will also increase the CC average annual efficiency



(1) HP integrated in Power Oriented CC
 (2) HP integrated in CHP CC (e.g. DHN)

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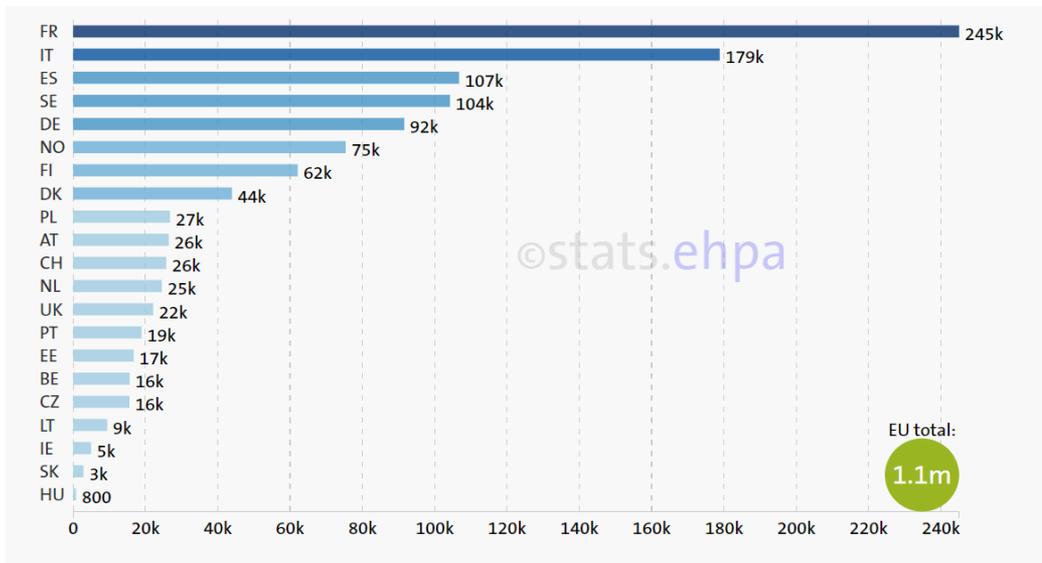
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Why use a Heat Pump for CC flexibility?

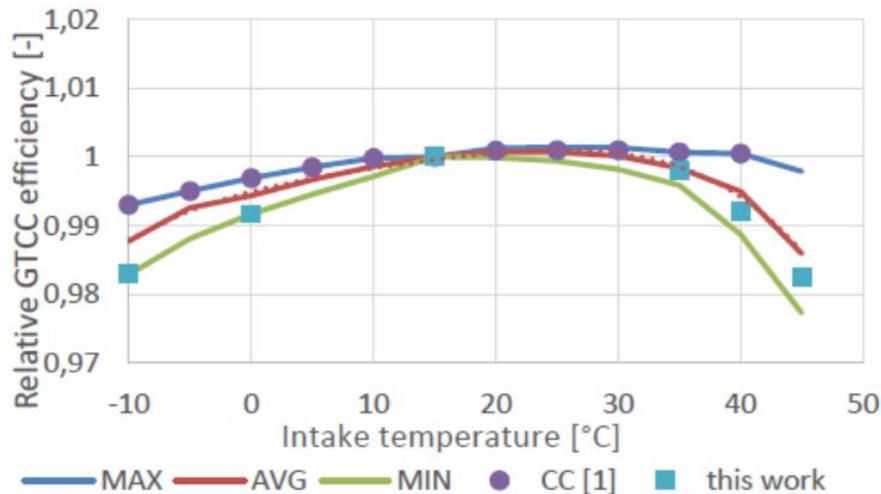
- ✓ To store or to use excess of Renewable production is mandatory in every energy market
Heat pumps enable the **PowerToHeat approach**
- ✓ The Thermal Energy Storage allows to use the heat when is most beneficial to CC profitability
- ✓ In cogenerative applications, the Heat Pump may displace fossil-fuelled auxiliary boilers
- ✓ France and Italy are the largest EU markets for heat pumps



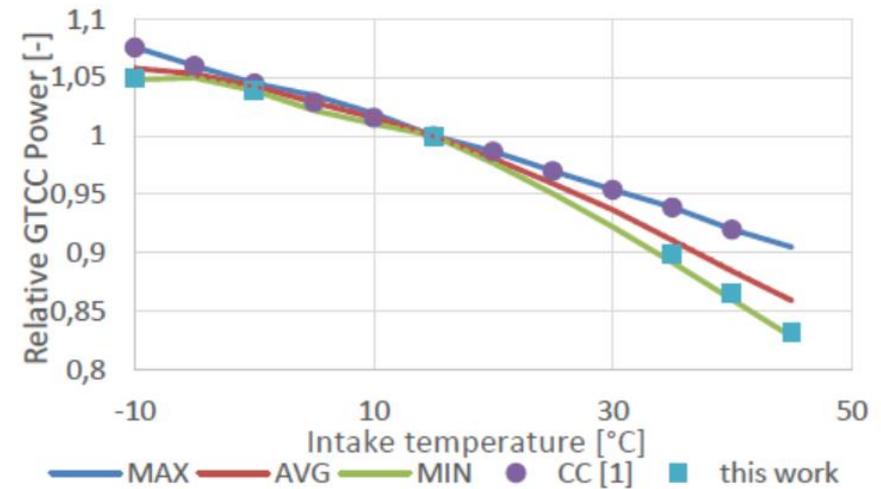
Heat pumps sales in 2019 [EHPA, 2020]

Why use a Heat Pump for CC flexibility?

CCGT Efficiency



CCGT Power



Open literature curves and Authors' calculations were compared with the Combined Cycle correction curves on temperatures for the OEM F Class GT frames (e.g. AE94.3A, GE9F, SGT5 4000F such as simple cycles and AEGT26 such as reheat cycles), extracted by the GT PRO.

Analysis of a Combined Cycle Exploiting Inlet Conditioning Technologies for Power Modulation, ASME TurboExpo 2019, ASME paper GT2019-91541

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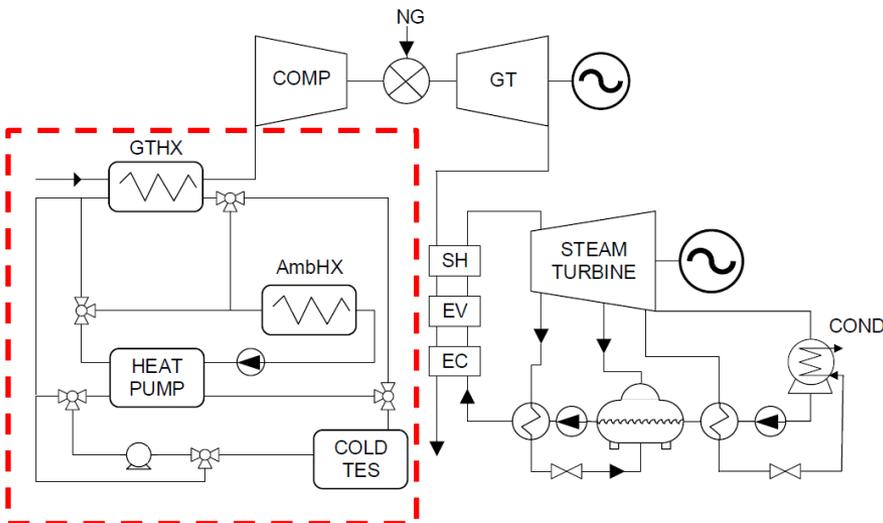
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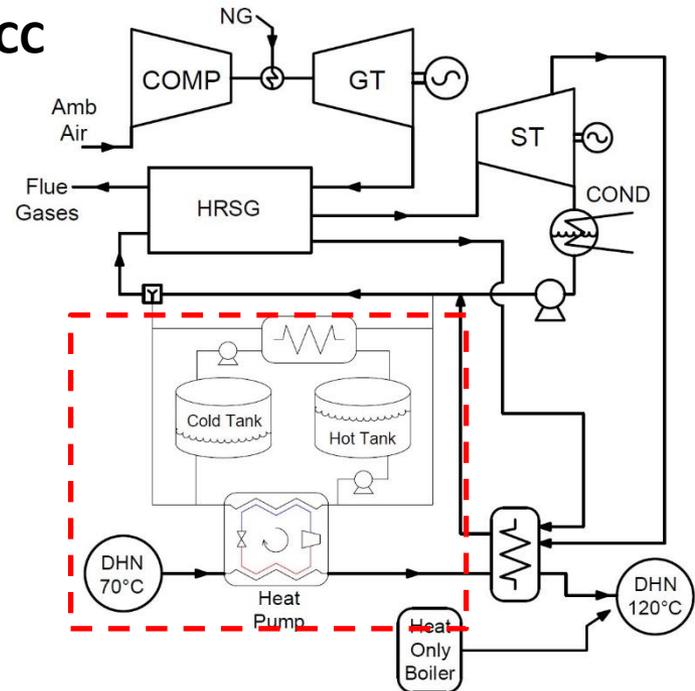


Two Cycle Layouts: Power Oriented and CHP Combined Cycles

Power Oriented CC



CHP CC



Different role of HP+TES System – different role/flexibility offered on the electric market.



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A demonstration-to-market approach, as excellence for Research Innovation Actions

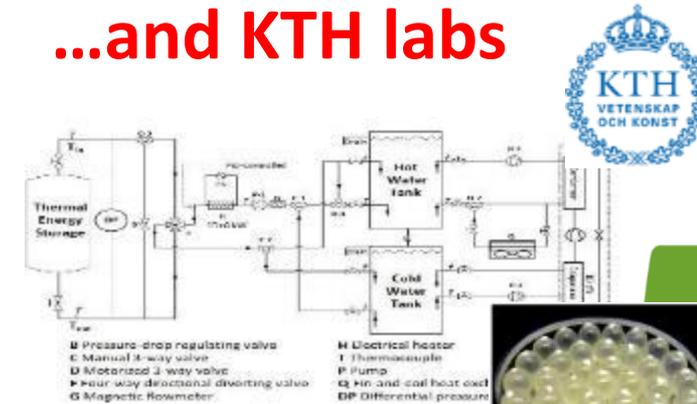
Demonstration at IREN Moncalieri CHP CC (+District Heating)



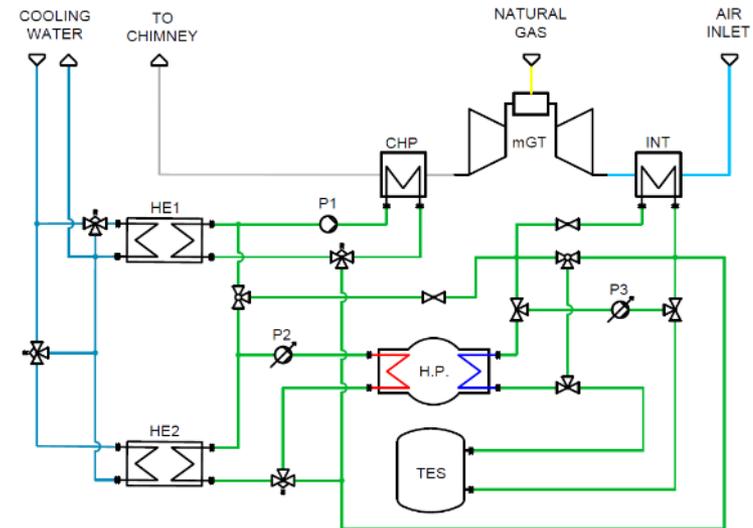
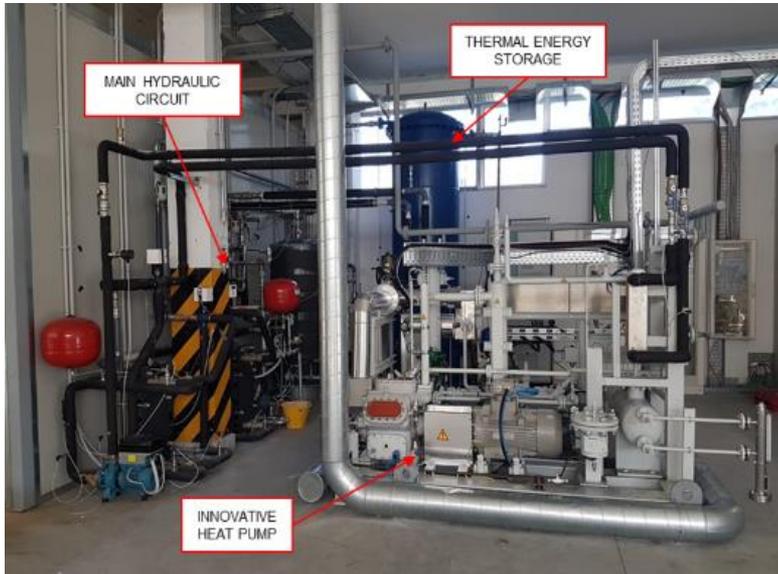
Validation at UNIGE PO layout



...and KTH labs



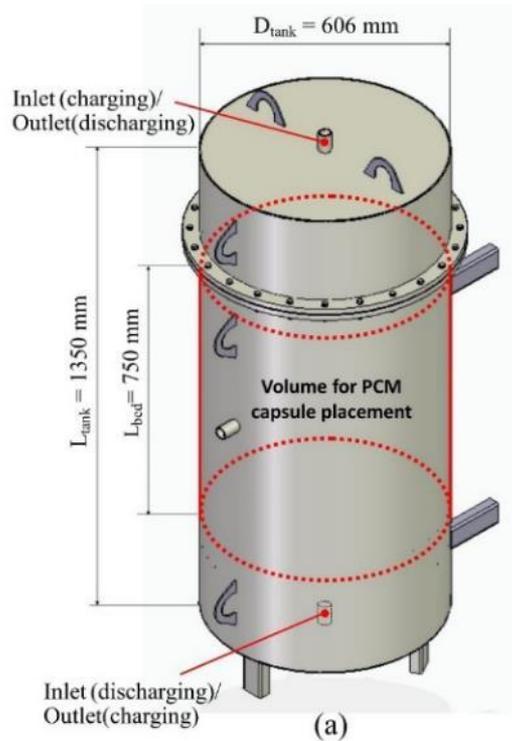
PUMP HEAT Validation site (UNIGE): Power Oriented layout



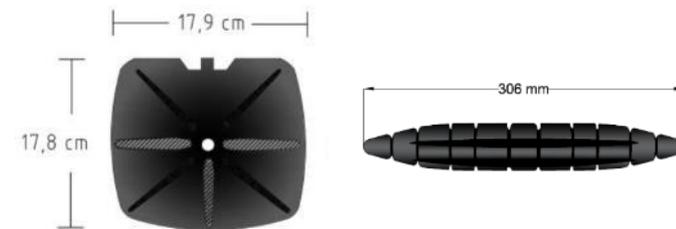
- Project Validation site, placed within Tirreno Power power plant, Savona (Italy)
- 100 kW_e micro gas turbine
- Fast response HP, 10 kW_e
- Cold thermal storage, 100 kWh, T range -5°C to +5°C



PUMP HEAT Validation site (KTH): Warm Thermal Storage



- Two thermal storage configurations:
 - Shell-and-tube heat exchanger
 - Macro-encapsulation
- Volume of tank chamber = 0.2 m³



PUMP HEAT Demonstration site



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- Project Demosite is settled within an IREN facility in Moncalieri power plant (Italy), a 400 MW_e CHP CC
- Fast response HP, 150 kW_e
- Warm Thermal storage, 360 kWh, temperatures up to 120 °C



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