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GUIDELINES FOR AN OPTIMAL INTEGRATION OF WATER-WATER HEAT PUMPS IN LOW-TEMPERATURE DHNs

Lessons learnt from the analysis of three networks in France

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OBJECTIVES AND METHODOLOGY

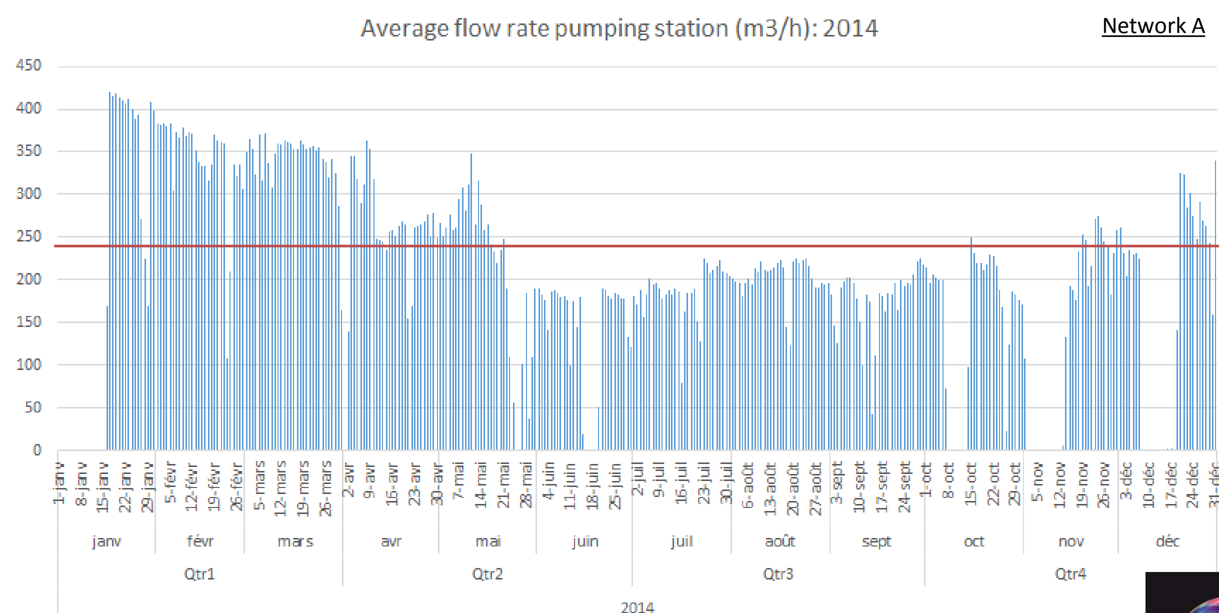
- How to better design, install and operate centralised and decentralised Heat Pumps?
- What economic KPIs need to be considered to design cost-effective installations?

Data from the monitoring system || Business plans, invoices, annual financial reports || Interviews of operators, installers, technicians

	A	B	C
System architecture	Centralized	Decentralized	Decentralized
Heat pumps	2 x 1092 kW_{th} for heating	18 HPs for heating + 18 HPs for DHW + 1 HP for swimming pool. 4640 kW_{th}	13 HPs. In total: 739 kW_{th} for heating + 272 kW_{th} for cooling + 94 kW_{th} for DHW
Back-up	Gas boilers	Gas boilers	Electric resistance
Heat source	Sea water	Geothermal doublet	Rejects from wastewater treatment plant
Number of substations	15	18 + 1 (swimming pool)	5
Temperature (set points)	Forward : 63°C Return: 50 °C	Heating : 36 °C -27/20 °C DWH : 60 °C – 27 °C	Heating : 45 - 26 °C Cooling : 7 °C – 12 °C
HP start-up year	2013	2012-2013	2014

HEAT SOURCE

- The heat source determines the **availability** and performance of the HP
- The availability and **quality** (flow rate, temperatures, water quality) need to be guaranteed
- **Trained** design **engineers** and further sharing of **return of experience** are needed to avoid project weaknesses and to face the peculiar needs of each heat source type
- Complex installations → time consuming **maintainance**
- Not to be underestimated: length and complexity of the **authorisation** process



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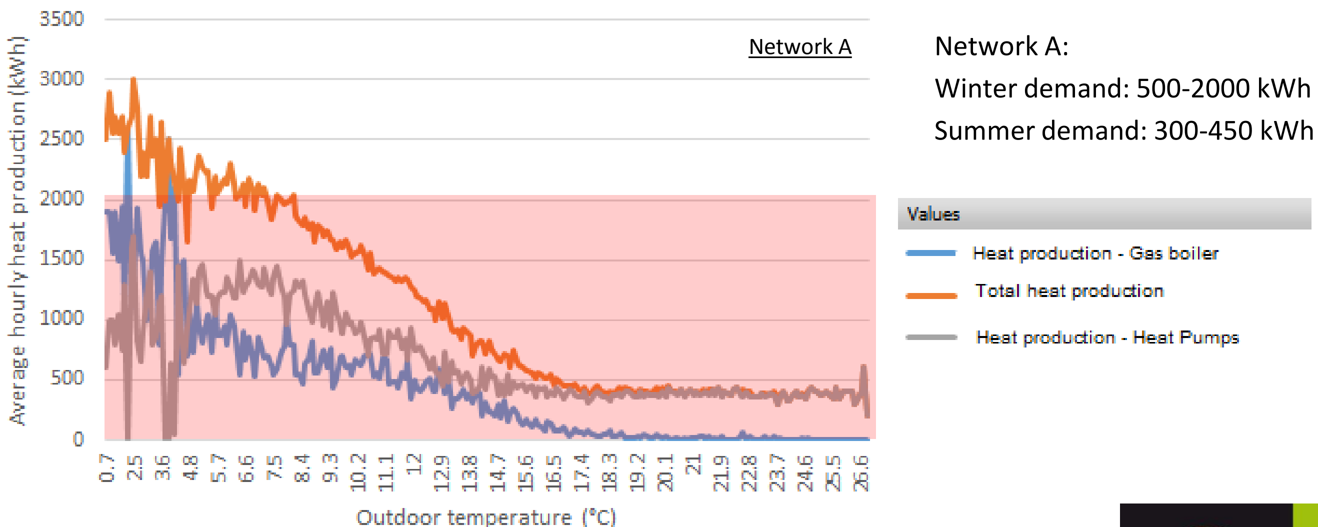
HEAT PUMP SELECTION AND SIZING

Heat Pump selection based on: **heat demand + source / sink temperatures** and **their variations** during the year:

- Thermal capacity: to be chosen to avoid part-load operations and frequent load variations
- **COP**: to be calculated for each heat source and sink temperature → good estimation of the HP **seasonal** performances
- Seasonal COP and HP cover rate often needed to calculate possible **incentives**
- Spring/autumn: most critical operating conditions, with higher demand fluctuations



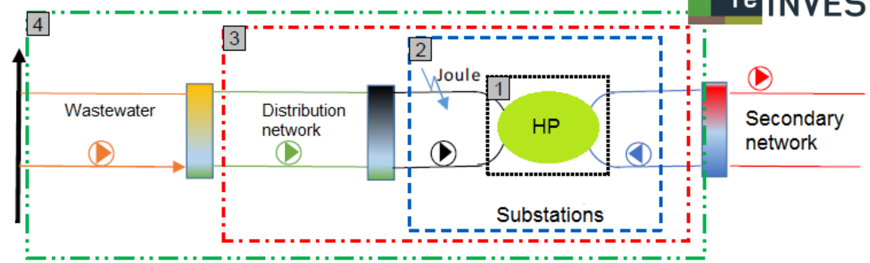
Network A:

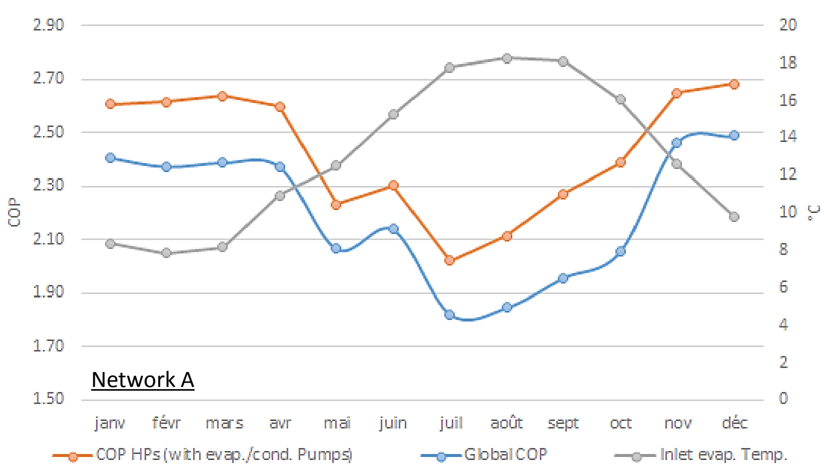
Winter demand: 500-2000 kWh

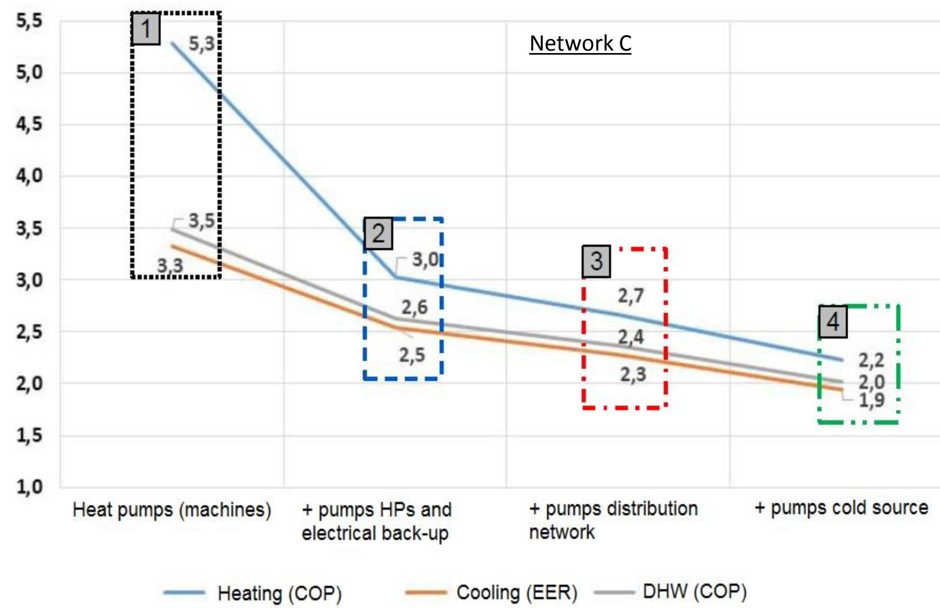
Summer demand: 300-450 kWh

COP: THE IMPACT OF AUXILIARIES

- Significantly higher impact in summer, when the heat production is lower and the HPs work at part-load
- **Due to the high impact on the global COP, the consumption of auxiliaries needs to be taken into account in all the project phases**







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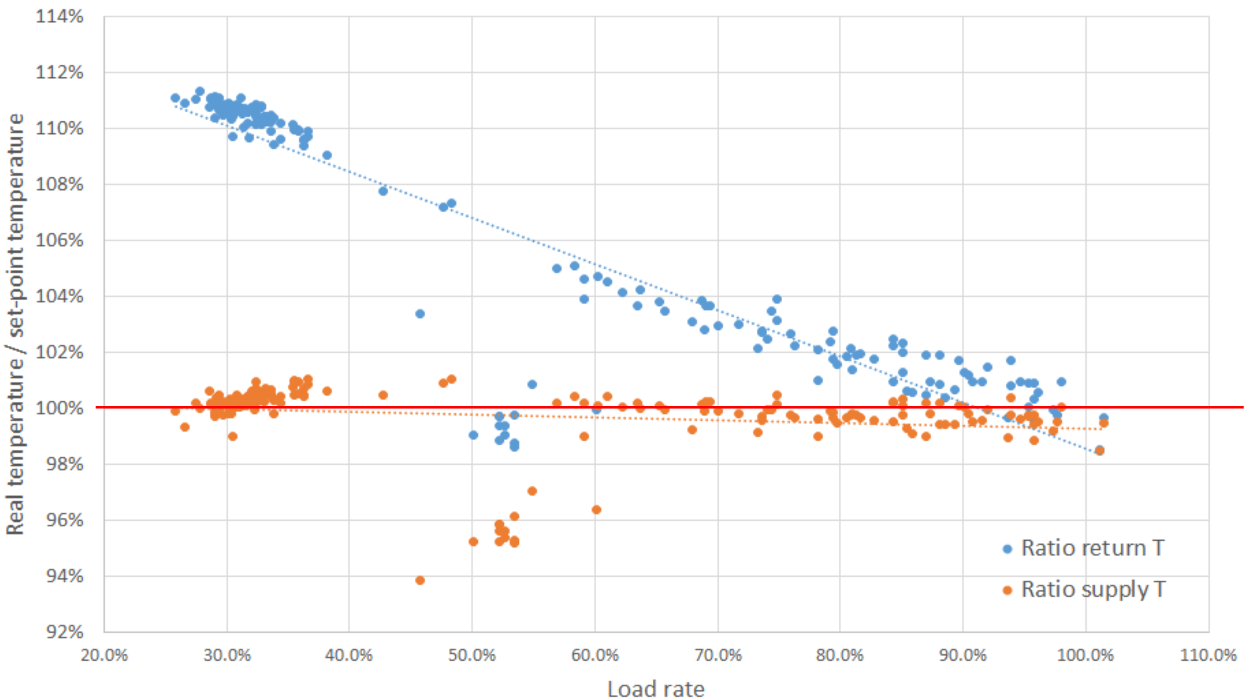
HP SELECTION AND PART-LOAD

Impact of the load rate and return temperature on production temperature:

- Summer: low COP (**economic** and **energy efficiency**), but production temperature maintained thanks to the high return temperature (**contractual engagement**)
- Winter: high COP but, because of the **HPs** not optimally **chosen**, the set-point production temperature cannot be reached

→ Analysis in energy AND temperature needed



Set-points:
Forward : 63°C
Return: 50 °C

Network A

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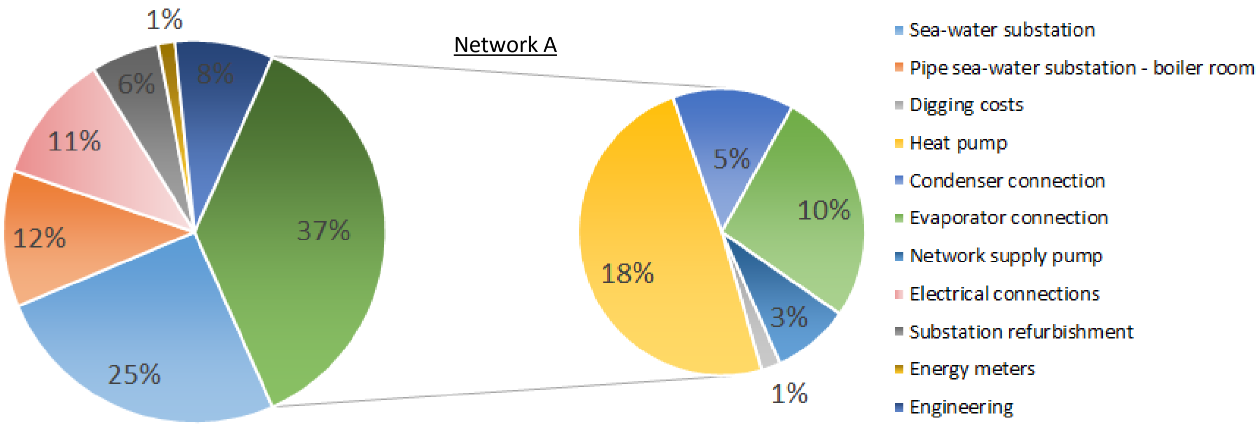
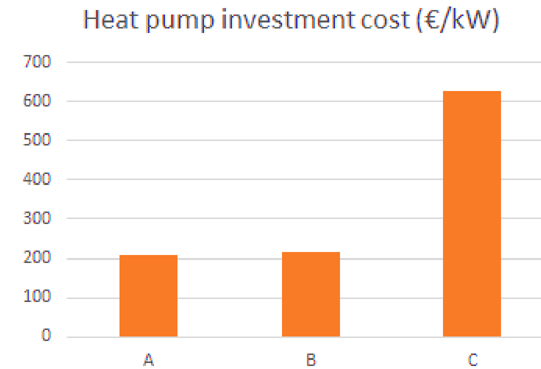
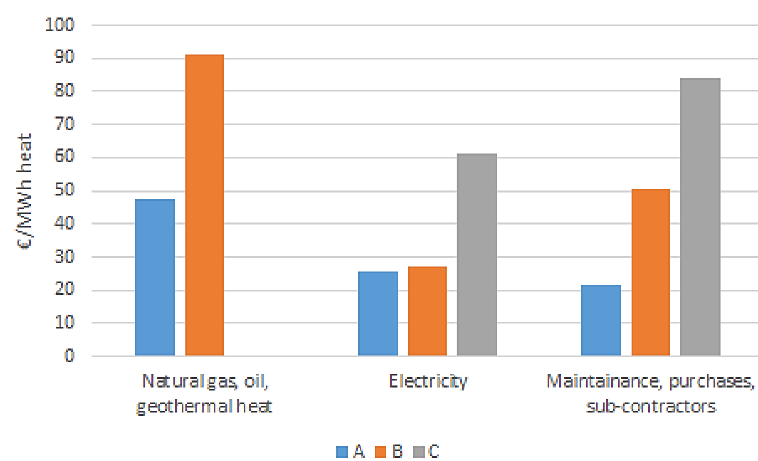
ECONOMIC ANALYSIS

Investment cost:





Operating costs: components of the heat production cost (€/MWh $_{\text{heat produced}}$)



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CONCLUSIONS

- Carefully select and size the heat pumps according to the yearly temperature and heat **demand curves** and **not** based on **maximum values**

- Do not underestimate:
  - the **maintainance** needs of the heat source and of the heat pumps and its impact on the overall performances – especially in decentralised systems
  - the electricity consumption of **auxiliaries** required by the heat pump
  - a continuative **relationship** with the HP provider: several operational issues cannot be detected and resolved at the commissioning
  - the impact of the **network** and the heat source temperatures on the expected performances
  - The importance of **Variable Speed Drives** and **heat storage** for the optimization of the HP's operations

- Invest on the **monitoring system**: good performances of heat pumps rely on an optimised control strategy and on preventive maintainance

THANK YOU

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