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Université Savoie Mont Blanc

Absorption heat pumps in district heating substations: 3 operating modes

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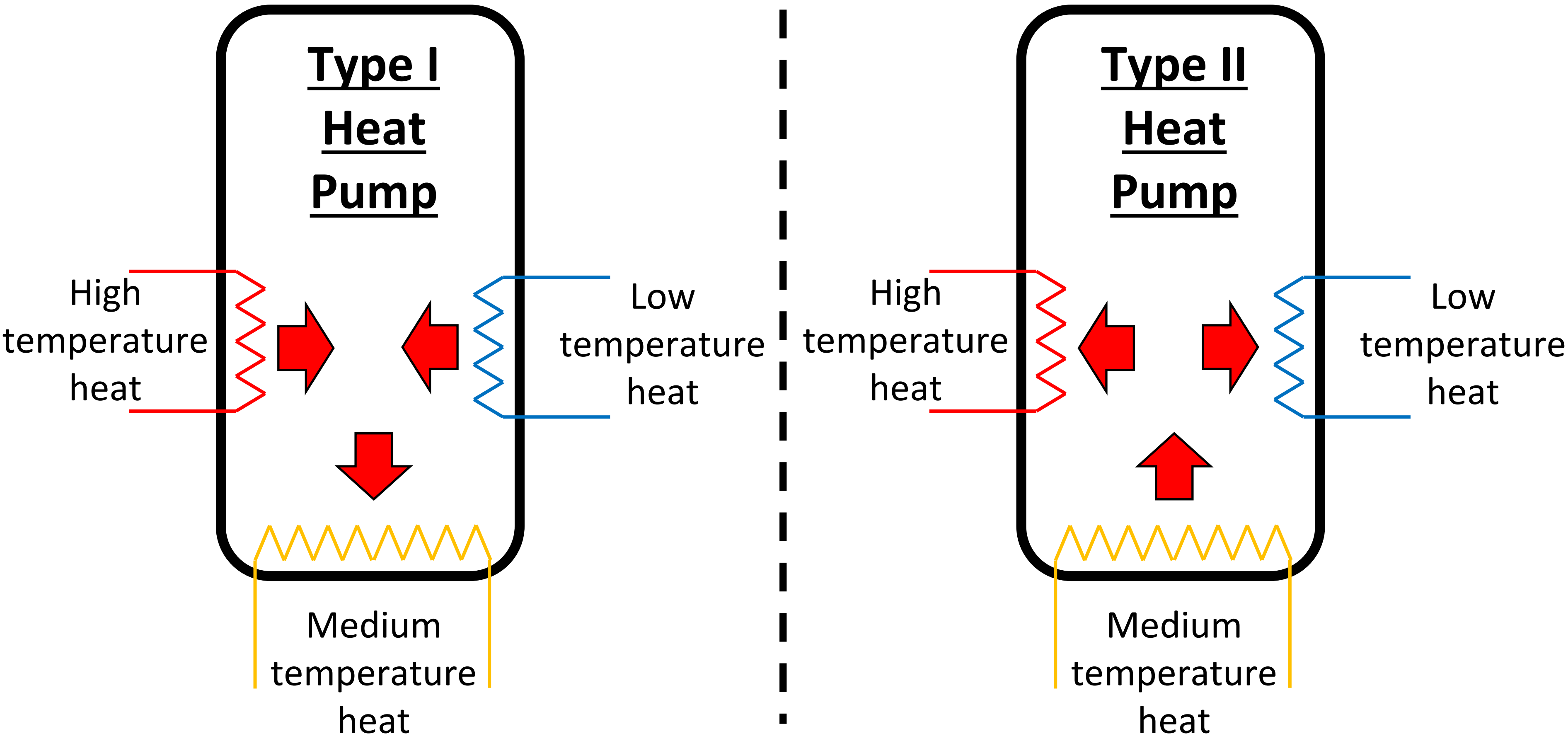
4DH
4th Generation District Heating Technologies and Systems

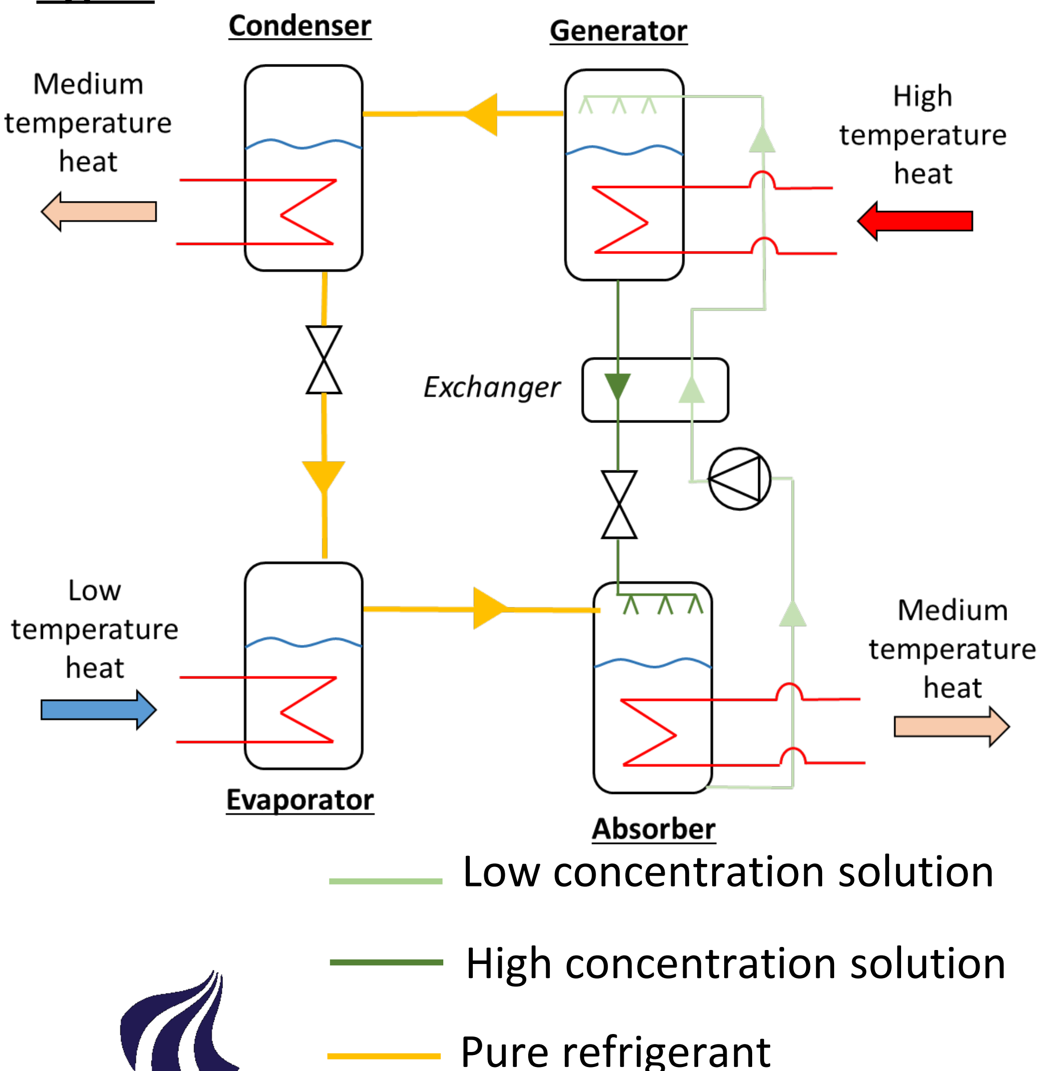
Absorption heat pumps



2 configurations

Absorption heat pumps

Type I



- **Tritherme system**
- **Couple of fluids**
- **4 main components:**
  - **Generator**
  - **Absorber**
  - **Evaporator**
  - **Condenser**

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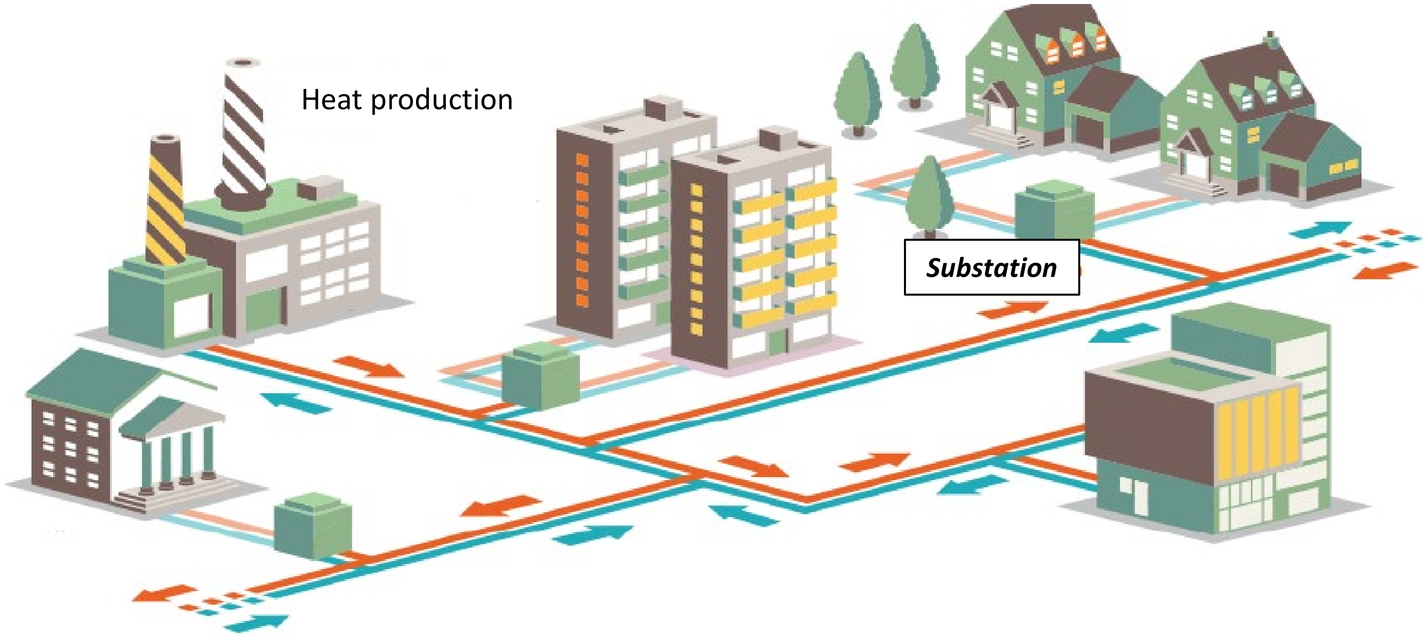
Absorption heat pumps in substations



- In substation of district heating
  - 3 different modes
  - Compare couples

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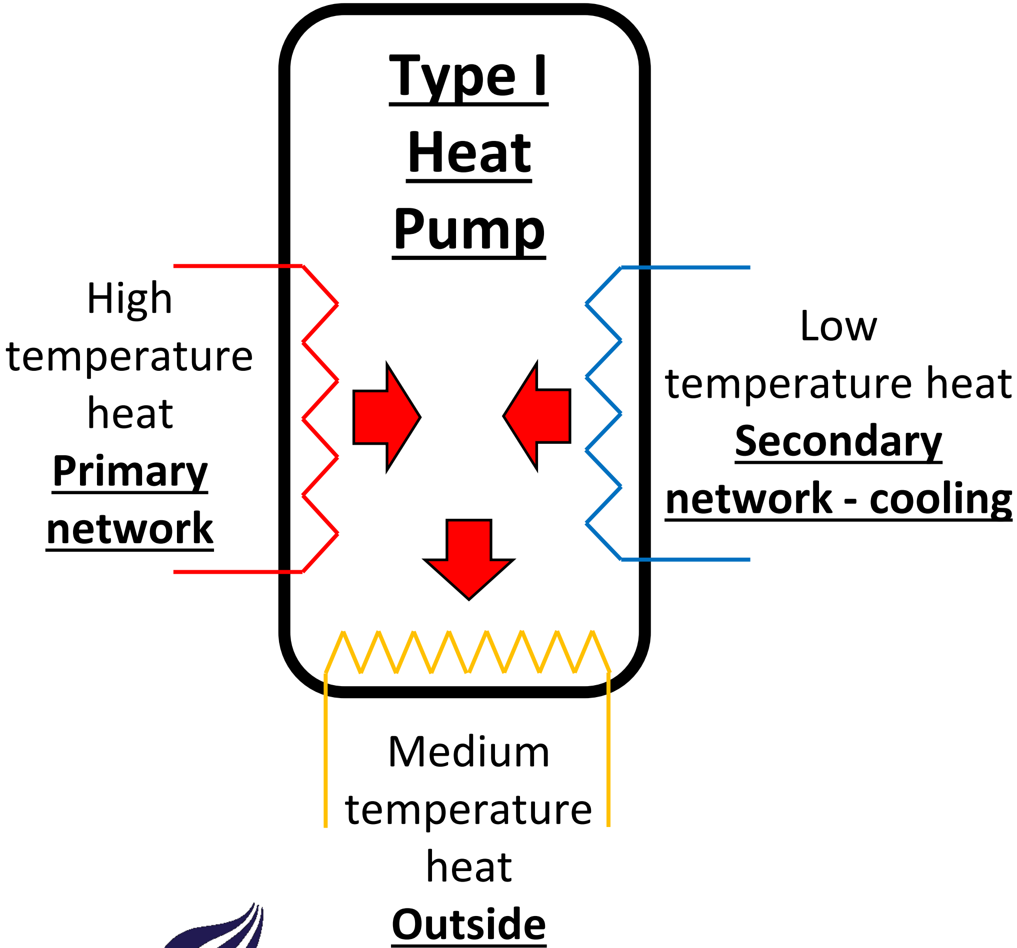
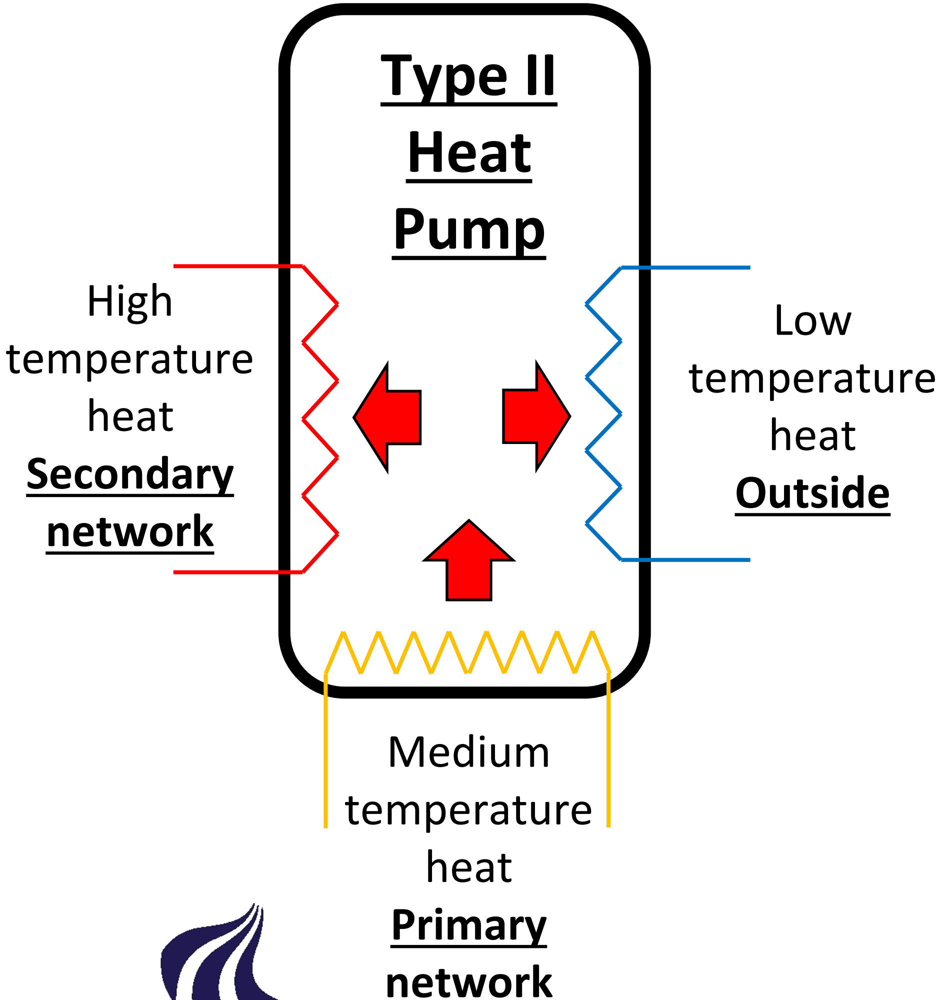
Cooling mode



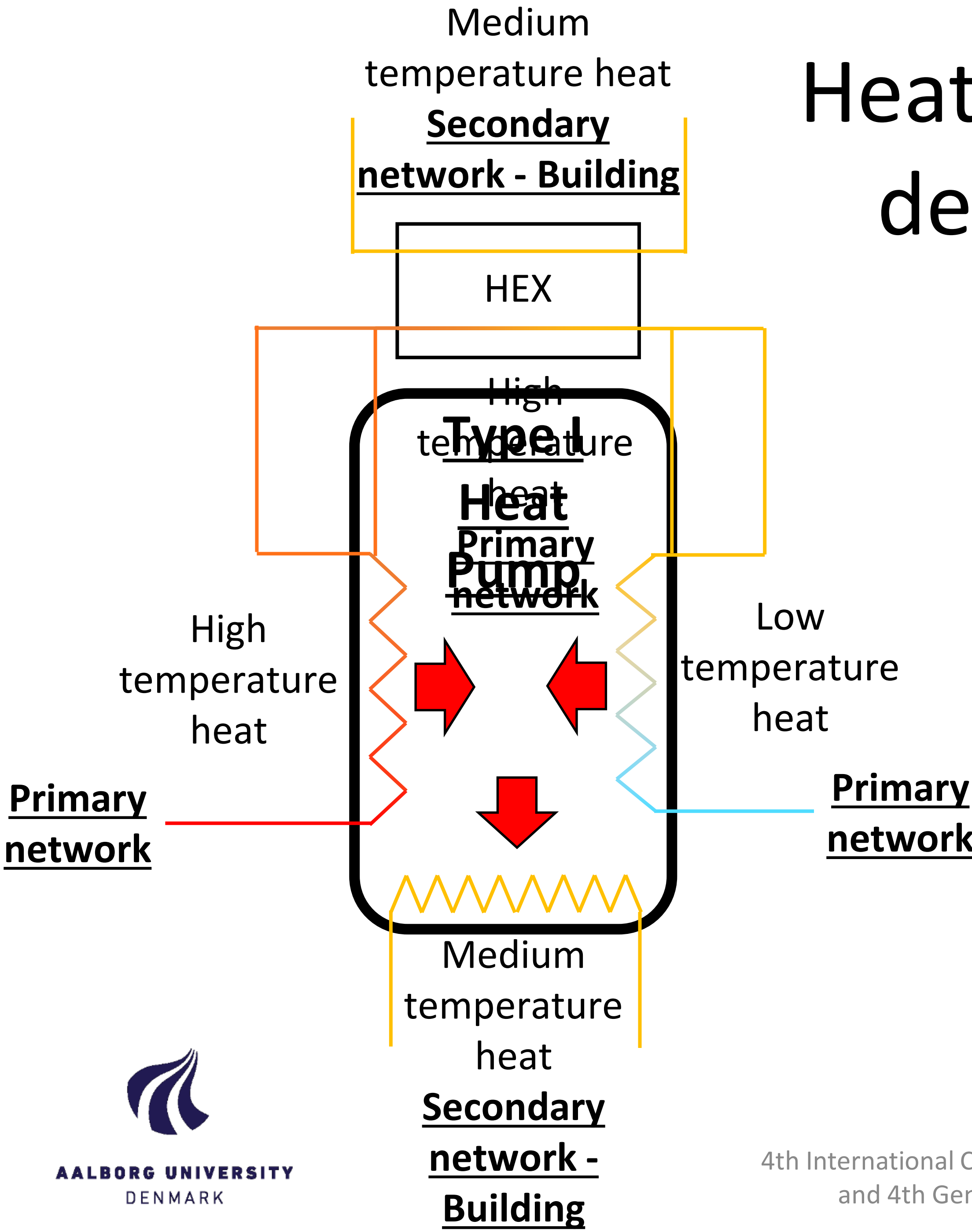
- **Use of district heating in summer for cold production**
- **Recover heat from permanent heat production: waste incinerator, industrial energy waste**
- $COP_{Cold} = \frac{Q_{Low\ temperature}}{Q_{High\ temperature}}$

Upgrade mode



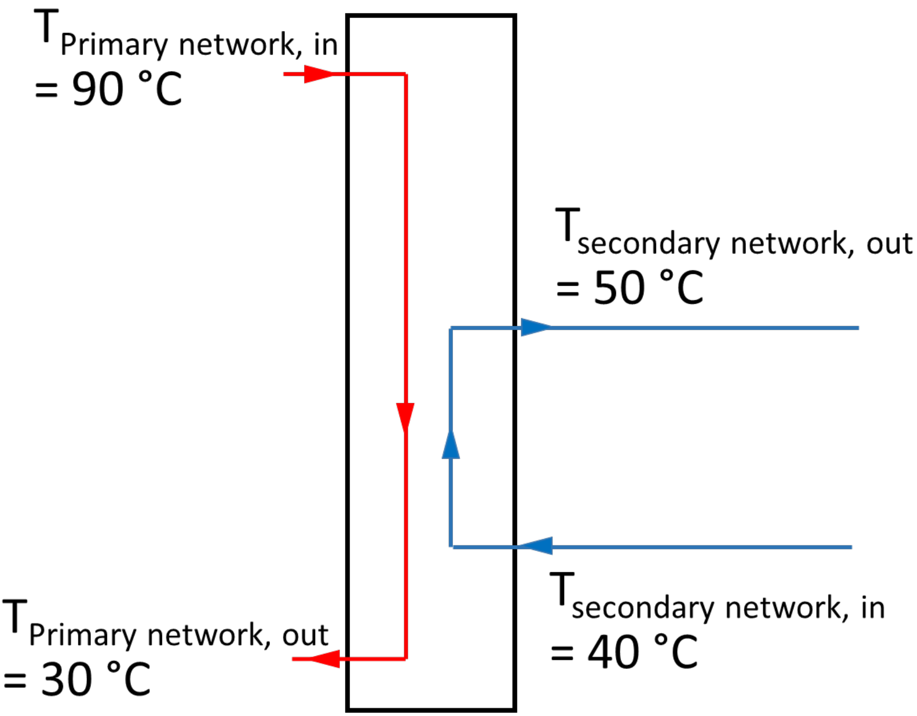
- **Increase the temperature of the primary network in the substation**
- **Local increasing of the temperature to reduce the overall temperature of district heating network**
- $COP_{upgrade} = \frac{Q_{High\ temperature}}{Q_{Medium\ temperature}}$

Heating mode : description



- **Temperature outlet of primary network lower than inlet of secondary network**

Heating mode : advantages



- **Temperature outlet of primary network lower than inlet of secondary network**
- **Reduction of primary flow**
- **Reduction of heat losses**
- **Allow to use low temperature heat sources: solar, industrial energy waste, …**
- $\varepsilon = \dfrac{T_{Primary,in} - T_{Primary,out}}{T_{Primary,in} - T_{Secondary,in}}$

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Model

- **Python non-linear equations solver**
- **Mass, energy and matter balances**
- **5 couples :**
  - **H_2O/LiBr**
  - **H_2O/LiI**
  - **NH_3/H_2O**
  - **NH_3/$LiNO_3$**
  - **NH_3/NaSCN**
- **Hypothesis :**
  - **Pinch of 5 °C**

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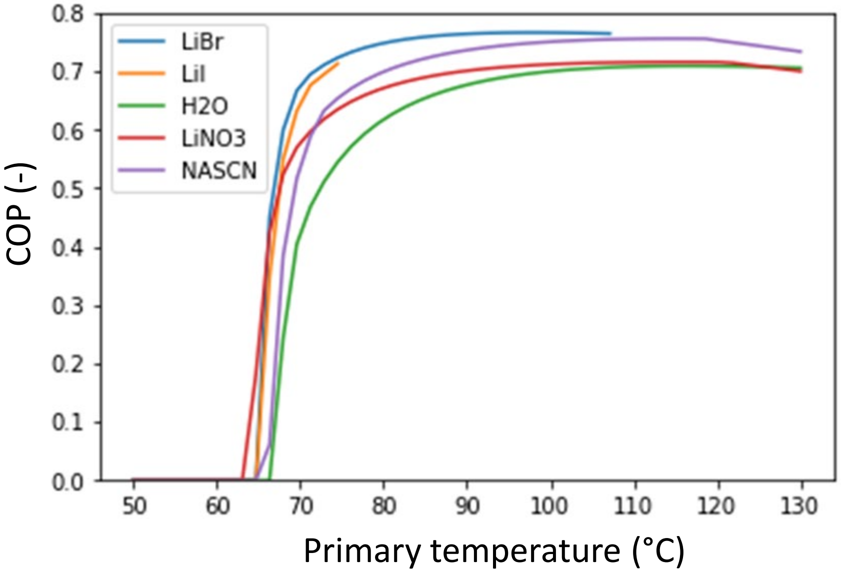
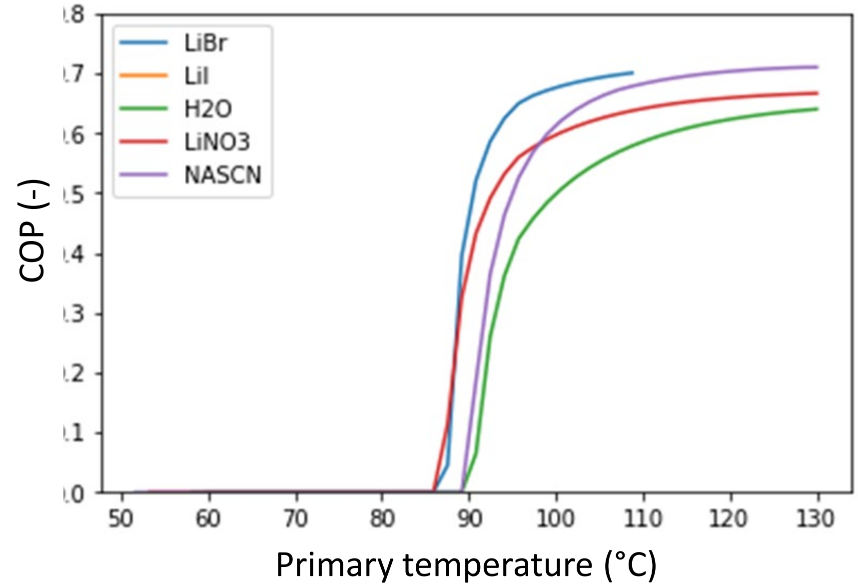
Results : cooling

- **Cooling temperature : 15/10 °C**



Outside temperature : 25 °C



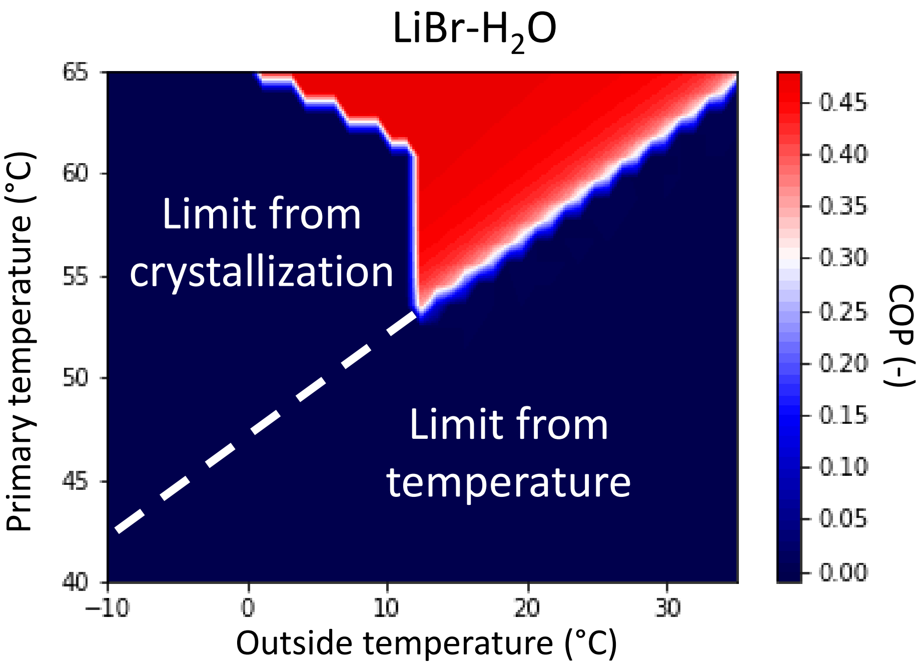
Outside temperature : 35°C

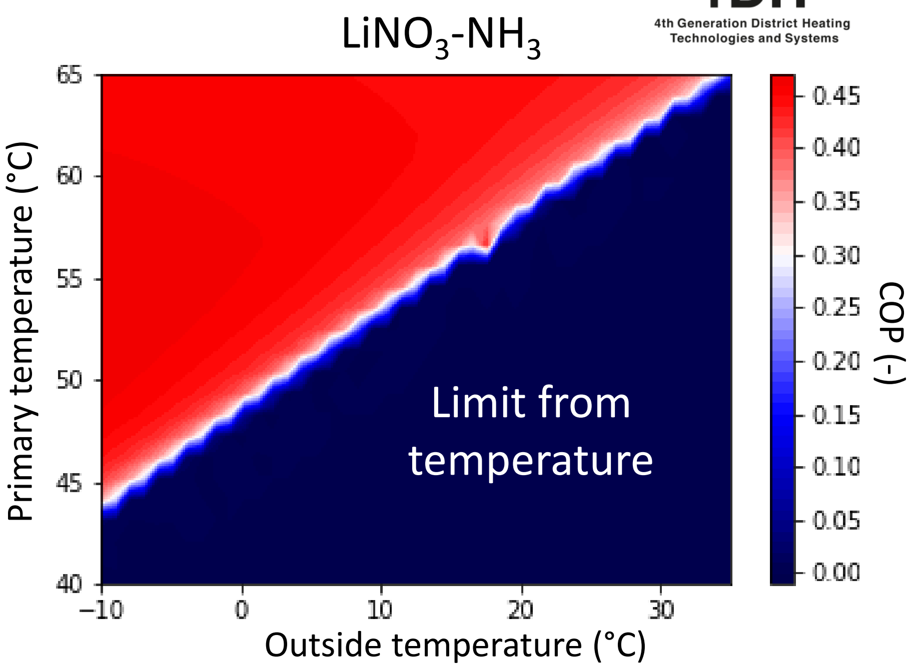
- **High temperature network required**
- **Crystallization risks**

$$COP_{Cold} = \frac{Q_{Low\ temperature}}{Q_{High\ temperature}}$$

Results : Upgrade

- **Secondary temperature : 60/70 °C**

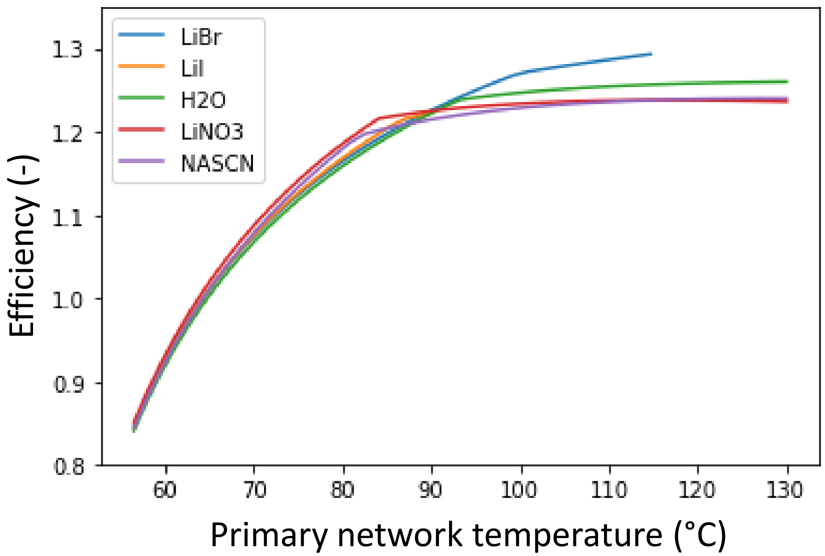




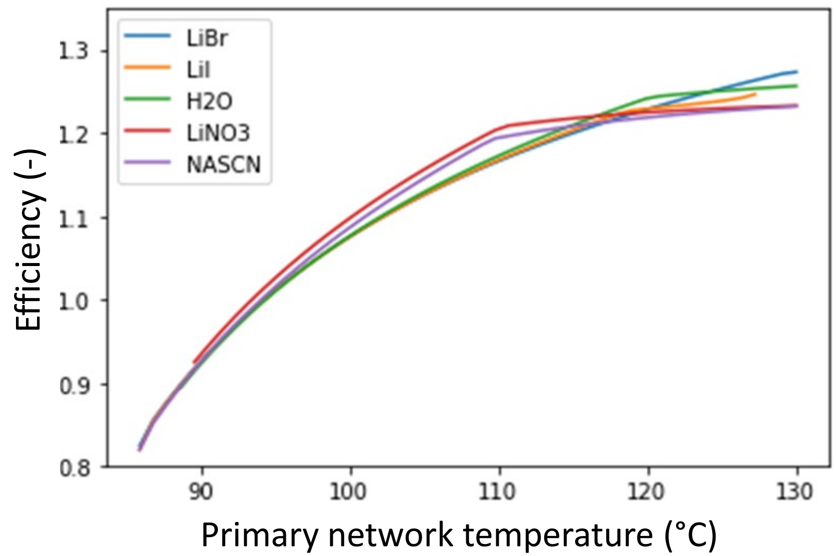
- **Better performances for low outside temperature**
- **Crystallization risks**

$$COP_{upgrade} = \frac{Q_{High\ temperature}}{Q_{Medium\ temperature}}$$

Results : Heating



Secondary temperature (Low temperature heating system) : 30/40 °C



Secondary temperature (High temperature heating system) : 60/70 °C

- **High secondary temperature imply high temperature network for better performances**
- **Close performances**

$$\varepsilon = \frac{T_{Primary,in} - T_{Primary,out}}{T_{Primary,in} - T_{Secondary,in}}$$

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Results

Primary network temperature (°C)	SUMMER (30 °C)		WINTER (10 °C)		
	DHW (60/70)	Cooling (15/10)	LT (30/40)	HT (50/60)	DHW (60/70)
110	Heating (1,17/1,20)	Cooling (X/0,68)	Heating (1,29/1,24)	Heating (1,23/1,22)	Heating (1,17/1,20)
100	Heating (1,08/1,10)	Cooling (0,73/0,67)	Heating (1,27/1,23)	Heating (1,17/1,20)	Heating (1,08/1,10)
90	Heating (0,93/0,93)	Cooling (0,71/0,63)	Heating (1,23/1,22)	Heating (1,07/1,09)	Heating (0,93/0,93)
80	~~Heating~~	Cooling (0,59/0,50)	Heating (1,16/1,19)	Heating (0,93/0,93)	~~Heating~~
70		~~Cooling~~	Heating (1,07/1,09)	~~Heating~~	
60	~~Upgrade~~	~~Cooling~~	Heating (0,93/0,93)		Upgrade (X/0,45)
50	~~Upgrade~~	~~Cooling~~	~~Heating~~	Upgrade (0,46/0,42)	~~Upgrade~~

($LiBr-H_2O$ / $LiNO_3-NH_3$)

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Conclusion and outlooks

- **Different modes**
- **Model to compare the performances of couples**
- **Daily and seasonal switches possible**

- **Improvement of the model**
- **Experimentation**
- **New mode : storage**