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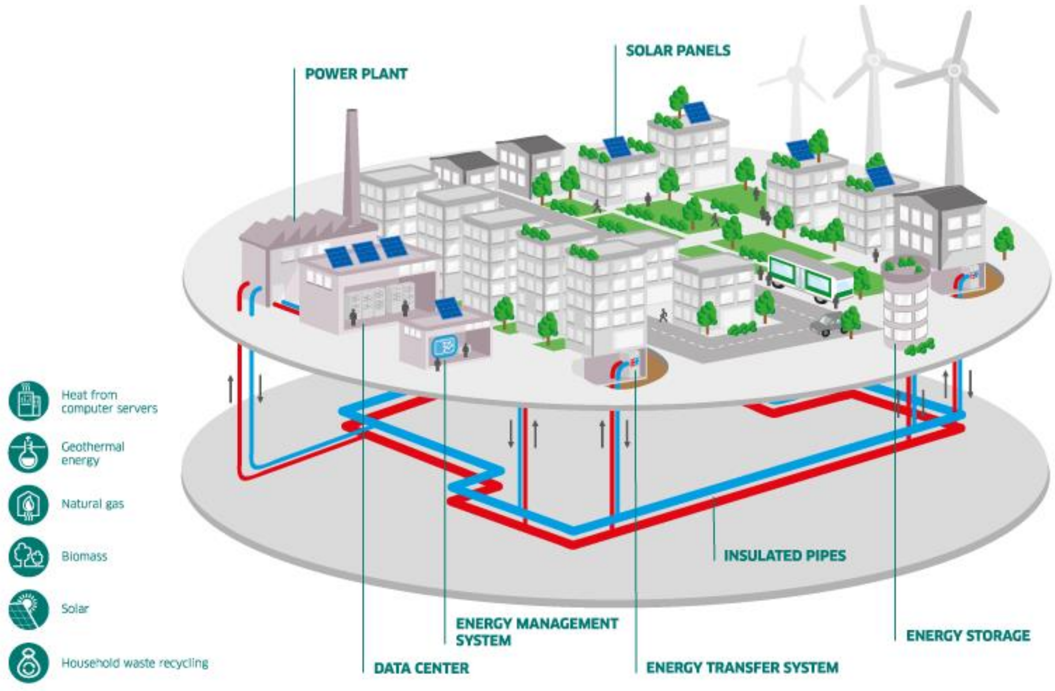
ENGIE

Thermal Storage Integration in a Smart Thermal Grid

RESTREINT | INTERNE | SECRET

AGENDA

1. 4^{th} GENERATION DHC
2. STORAGE SYSTEMS
3. CASE STUDY
4. CONCLUSION



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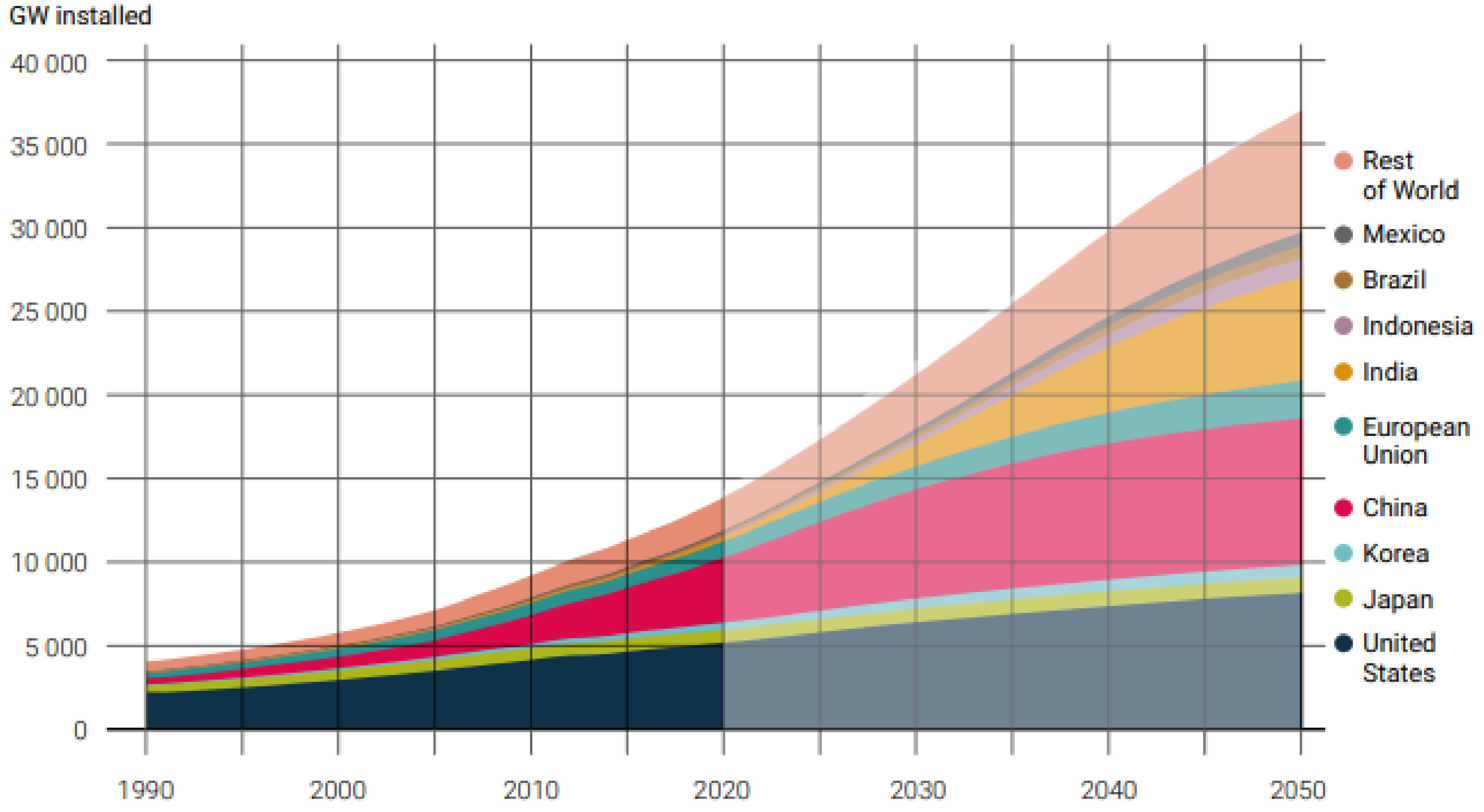
4th Generation DHC

CITIES TREND IN THE FUTURE

COOLING CAPACITY PROJECTIONS



Cooling capacity projections for residential and collercial air conditioning in baseline scenario of IEA Future of Cooling (2018a)

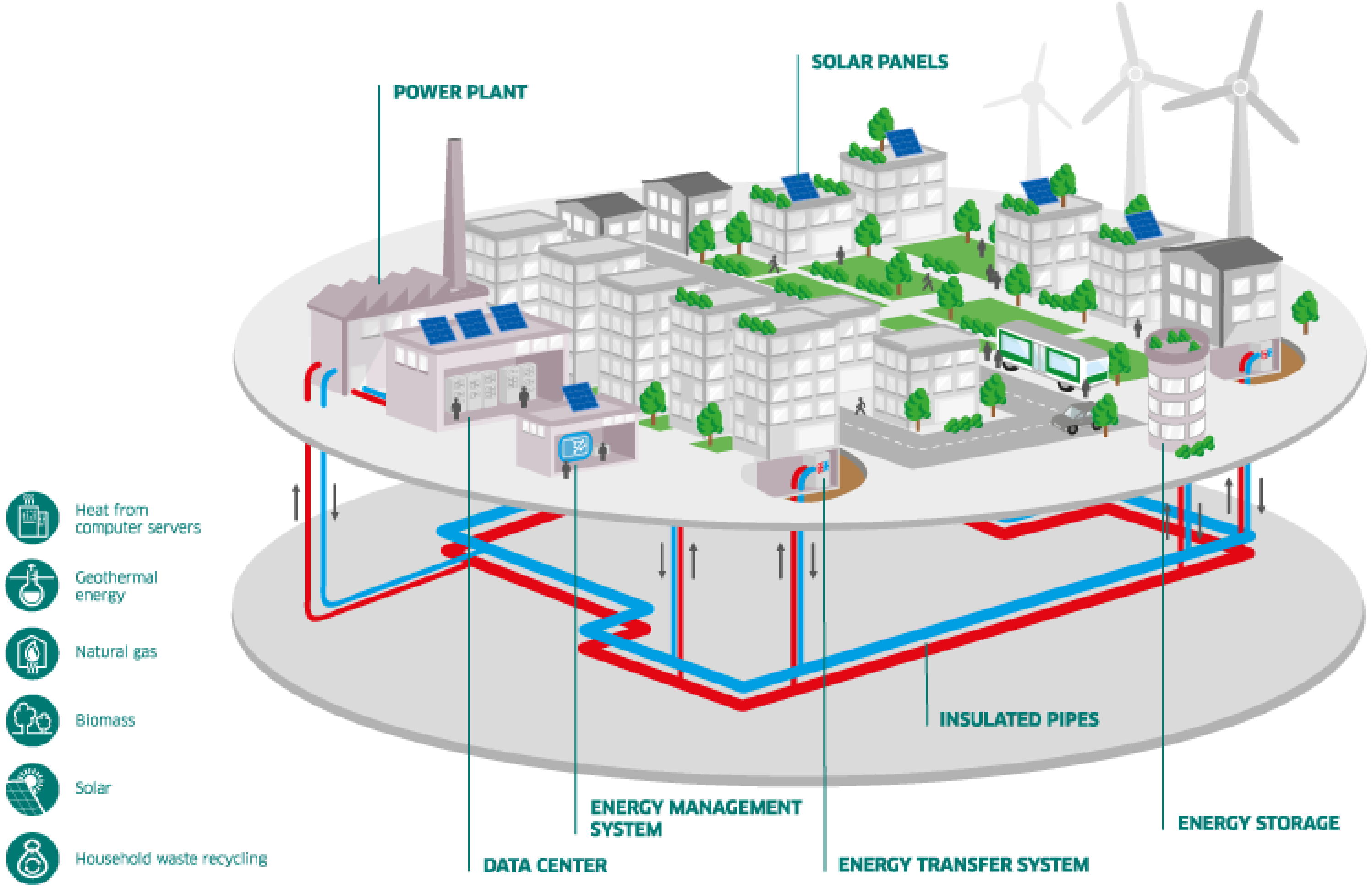
70%
Cities' population by 2050

75%
Energy concentration in cities

70%
Cities' GHG emissions

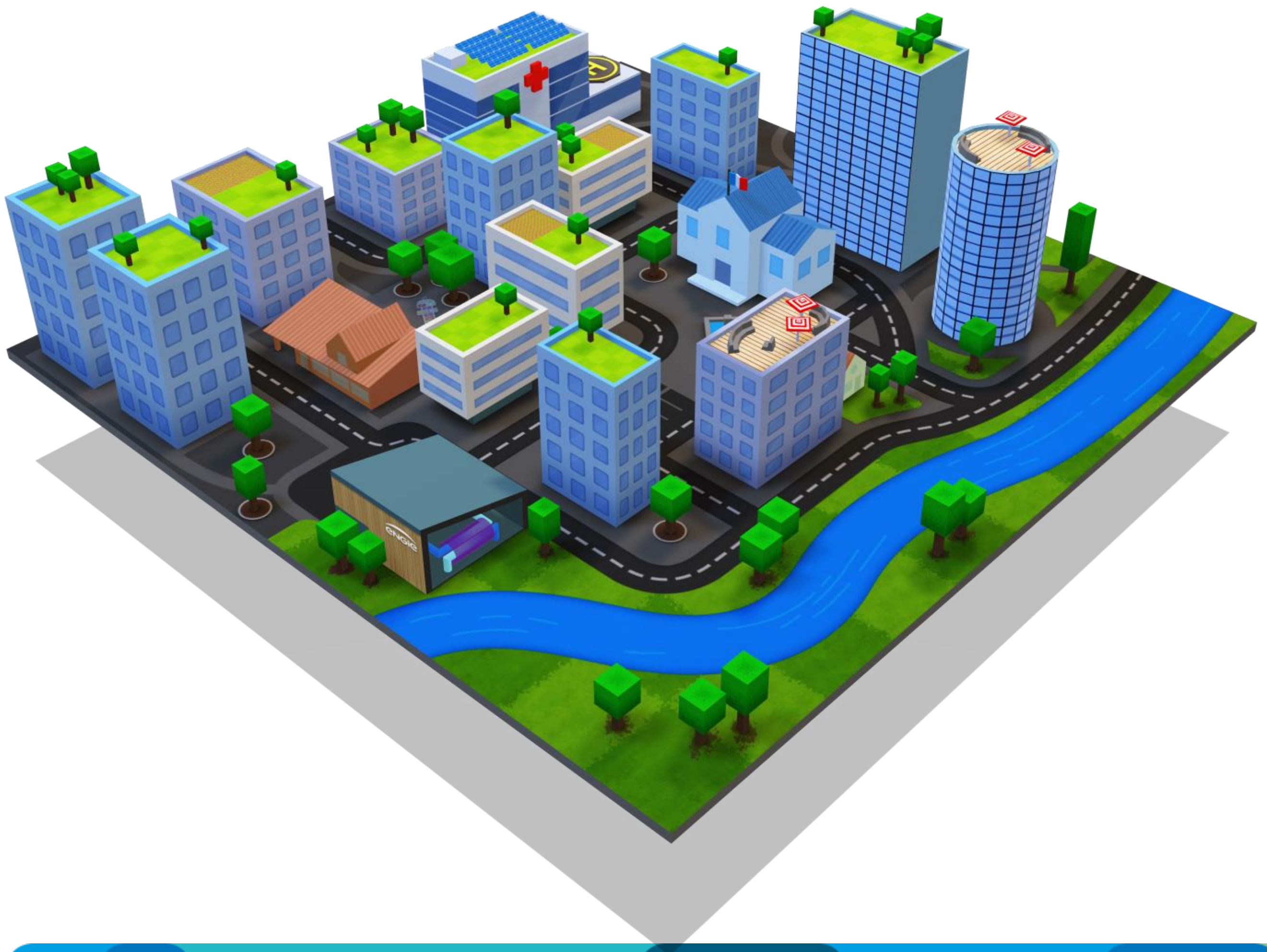
***Before COVID**

DISTRICT SYSTEMS DEFINITION



By definition, a **district energy system** is a well-developed and **highly efficient** infrastructure for distributing **heat** or **cold** generated in a centralized location through a system of insulated pipes

Principle of cooling networks



1. PRODUCTION
2. DISTRIBUTION
3. UTILIZATION

C.O.P. *(Coefficient of Performance)*.
It is the ratio between the cold **energy delivered**
And the **energy consumed** (the energy needed to produce the cold).

Higher C.O.P., higher results in production **performances**
and **energy efficiency**.

Stand-alone installations
Air system

Stand-alone installations
Humid system

District Cooling

Performance of cooling networks

+ 50%
Energy Efficiency

C.O.P. 2
Stand-alone installations
Air system

C.O.P. 3
Stand-alone installations
Humid system

C.O.P. 4
District Cooling

Source : *Étude École des Mines, 2003*

Performance of cooling networks

CO_2 g/KWh

40 ÷ 60

Stand-alone installations
Air system

CO_2 g/KWh

40 ÷ 60

Stand-alone installations
Humid system

- 50%

Carbon Emissions

CO_2 g/KWh

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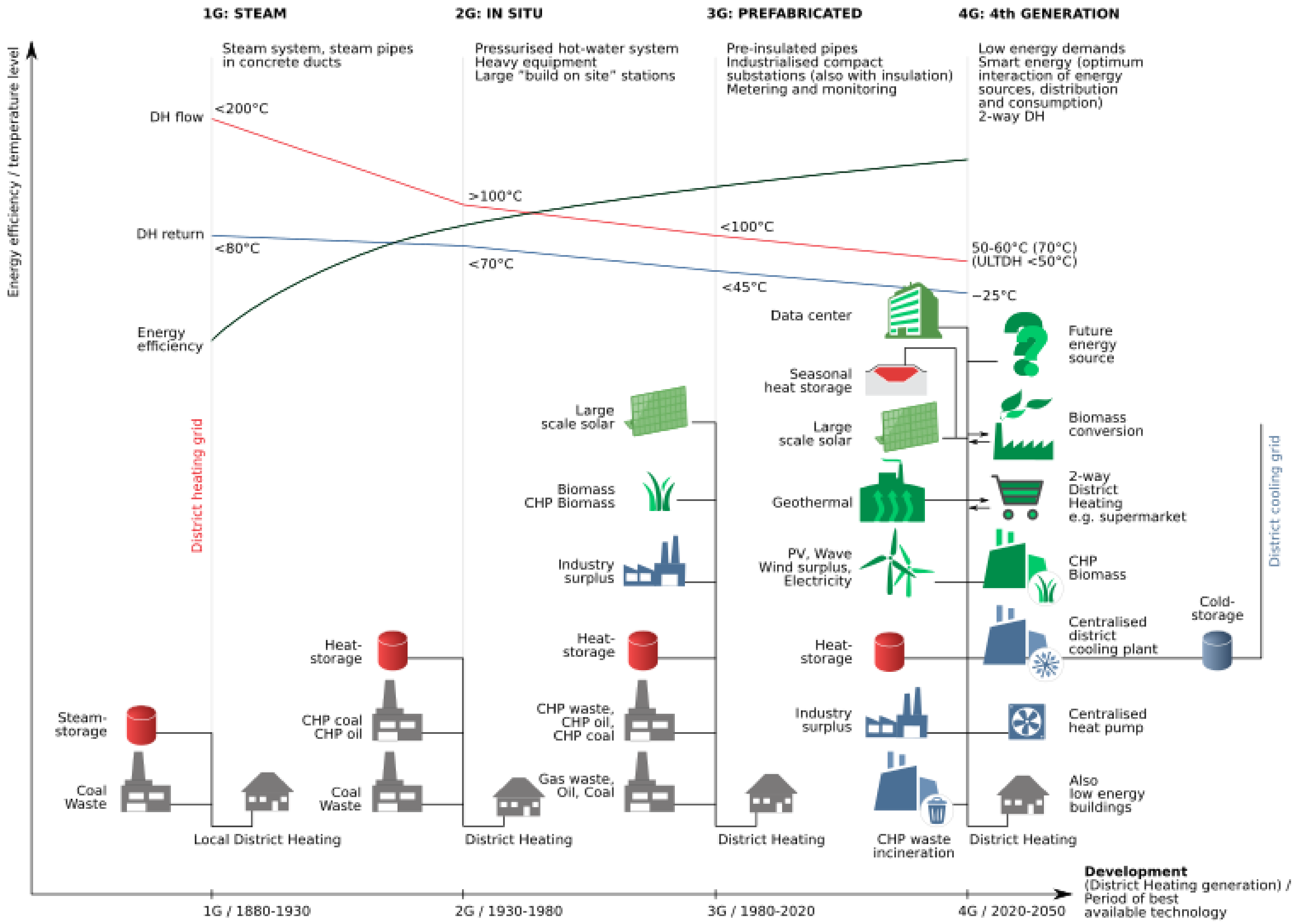
District Cooling

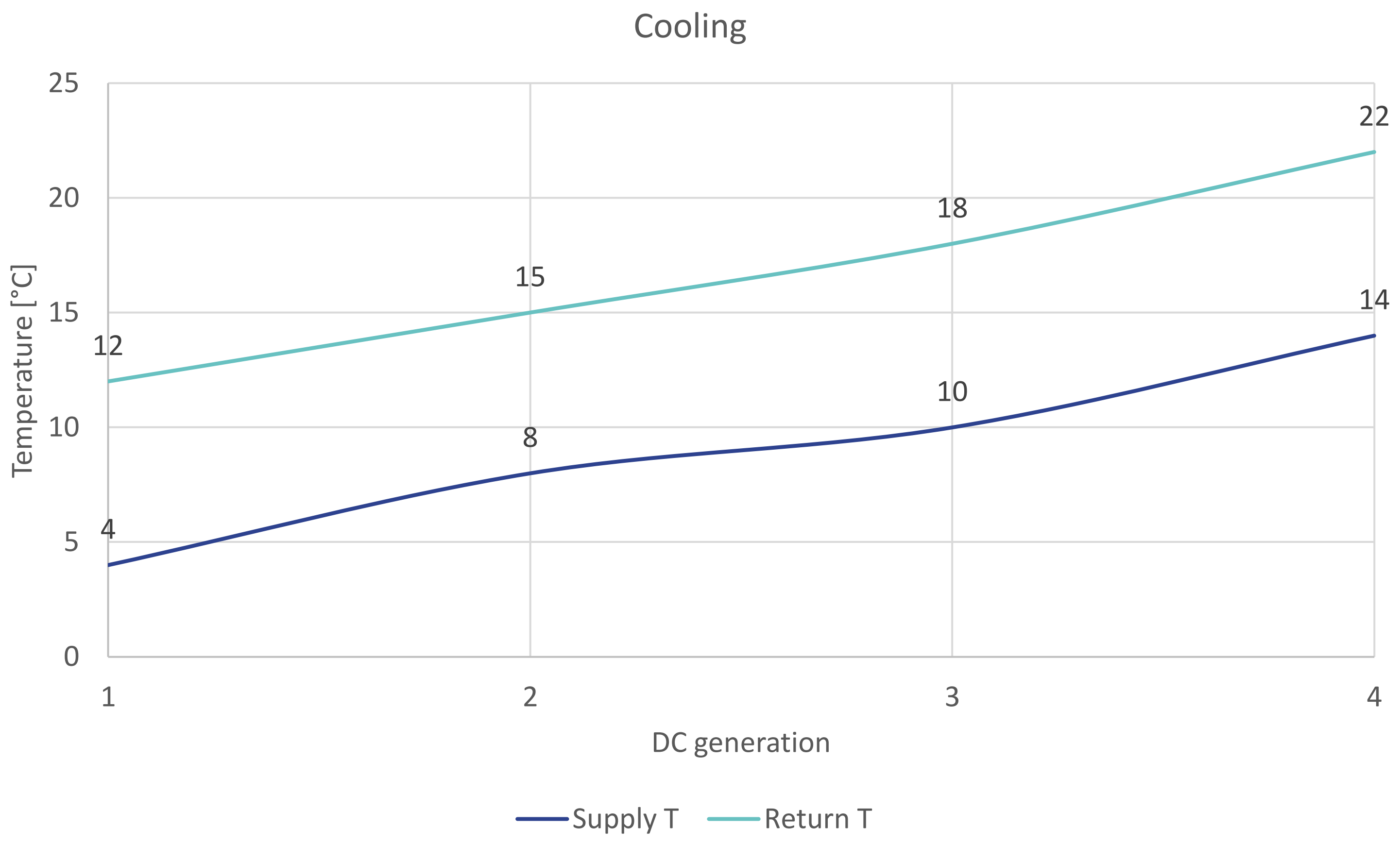
Source : Étude École des Mines, 2003

4TH GENERATION DHC DEFINITION



UNEP

4TH GENERATION DHC DEFINITION



COOLING POTENTIAL CO2 REDUCTION THANKS TO EFFICIENCY MEASURES

210÷460 $GtCO_2e$

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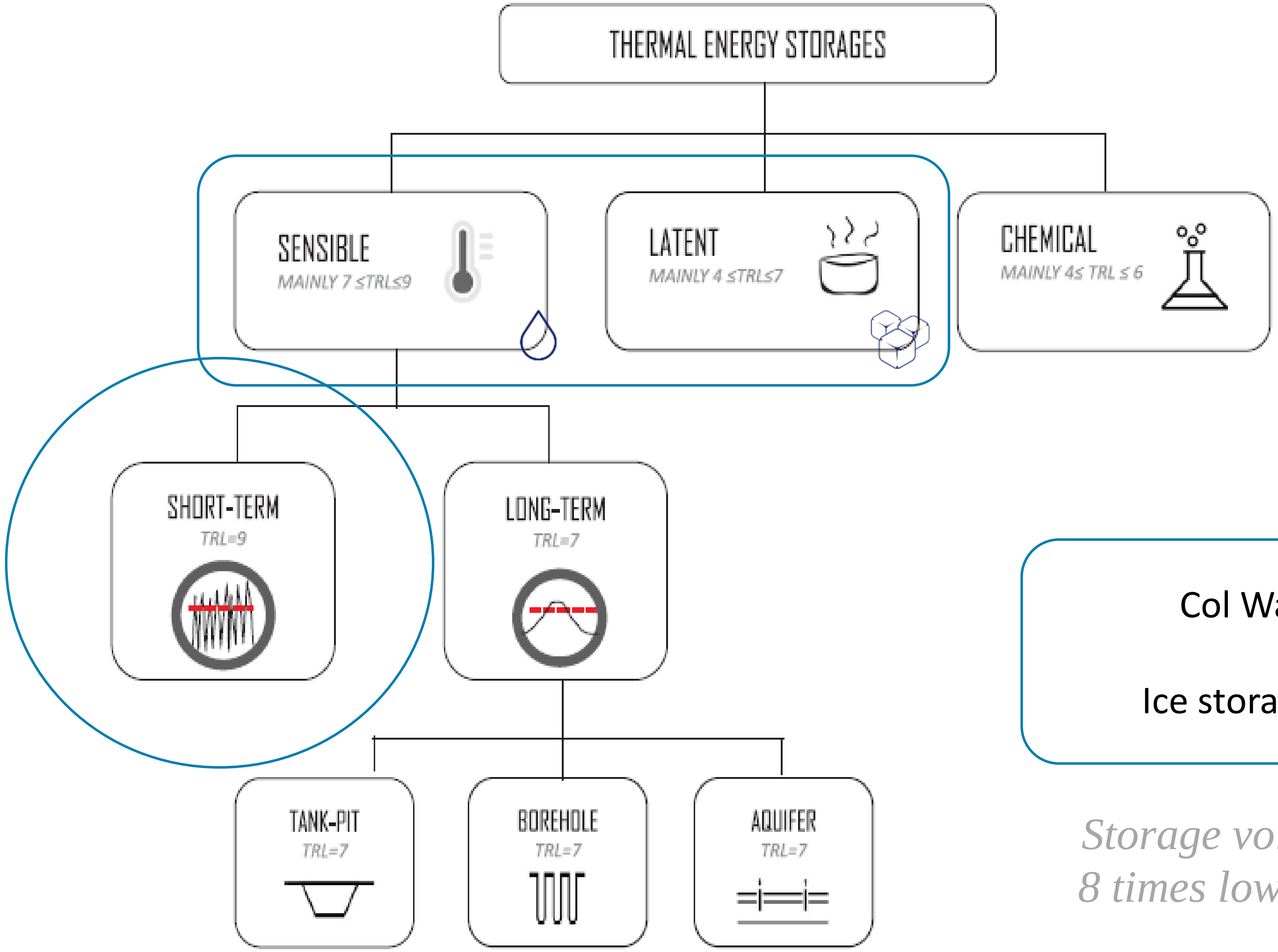
2

Storage Systems

CLASSIFICATION OF STORAGE SYSTEMS

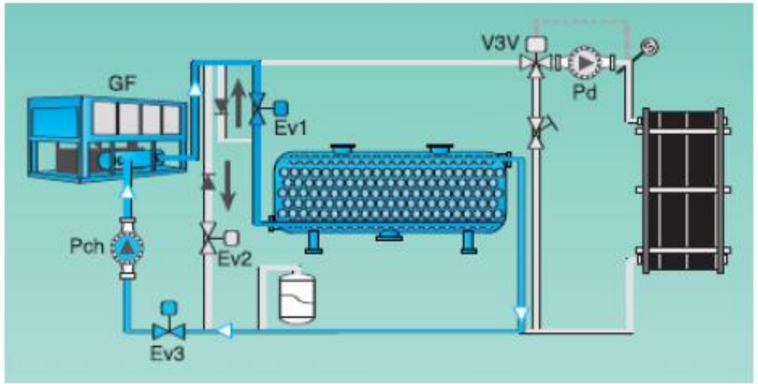


Col Water Storage – tank

Ice storage - Encapsulated Ice

Storage volume of latent storage is 8 times lower than sensible storage

COLD WATER STORAGE VS ICE STORAGE



CAPEX: from 265€ to 1060 €/kW
(John S. Andrepont, 2016)

CAPEX: 1500 €/kW and 250 €/kWh
Efficiency: ≈ 90% (ENEA Consulting, 2012)

TEMPERATURE
5 Vs -6 °C

ICE STORAGE VOLUME
x3

ICE STORAGE CAPEX
x3

3

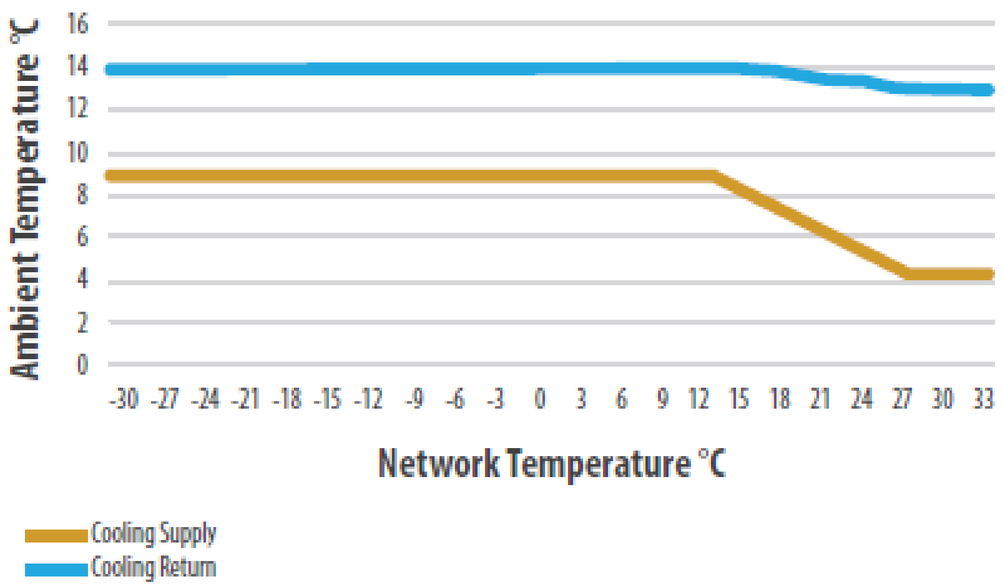
Case Study
Cooling Network

MODUS OPERANDI

	Description Network	Temperature Network
Scenario 1	Without TES	supply 4 °C, return 12 °C
Scenario 2	Cold Water Storage	supply 4 °C, return 12 °C
Scenario 3	Iced Storage	supply 4 °C, return 12 °C
Scenario 4	Without TES HTCD	supply 8°C, return 15 °C
Scenario 5	Cold Water Storage HTCD	supply 8°C, return 15 °C
Scenario 6	Iced Storage HTCD	supply 8°C, return 15 °C

NEMO

Peak demand
160MW



NETWORK DEFINITION

Plant 1
40 MW

Free Cooling
6 MW

Plant 2
130 MW

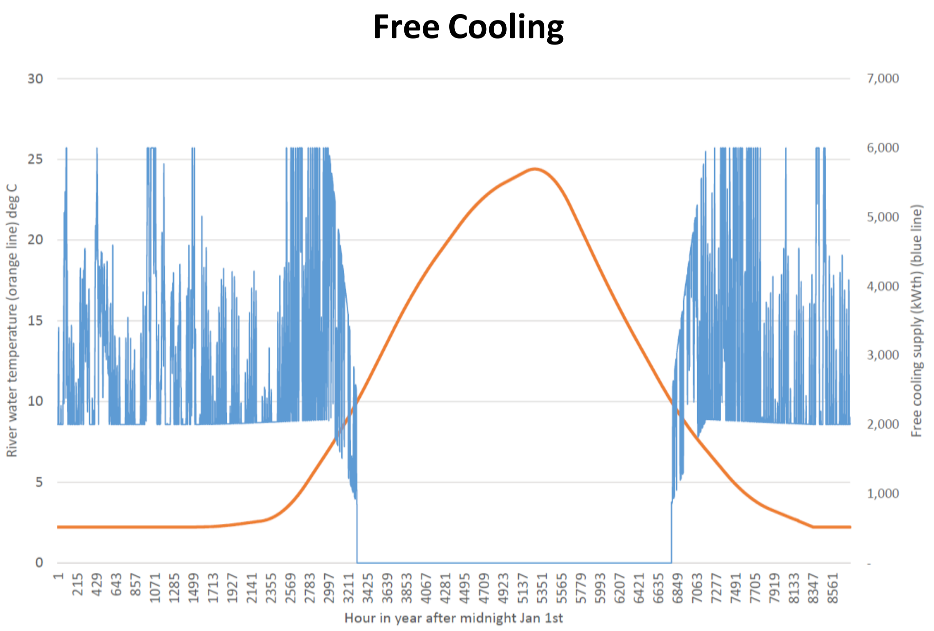
HYPOTHESIS

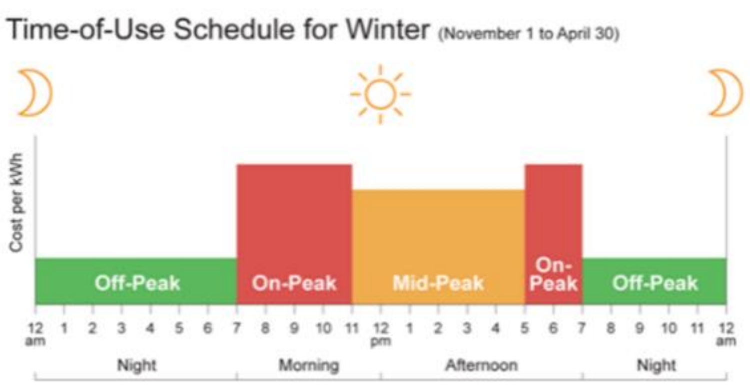
Same network configuration for all simulations

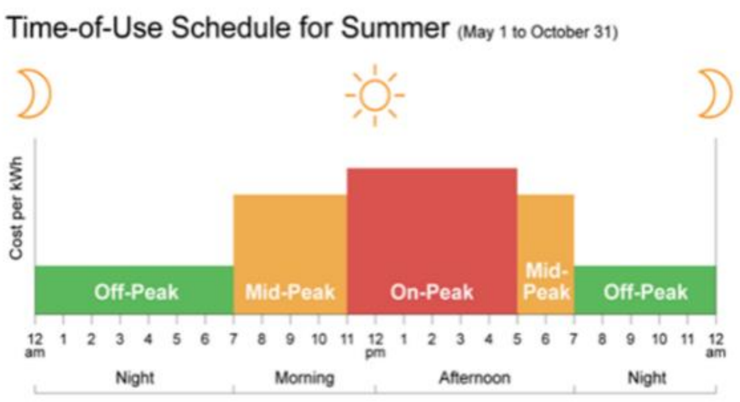
1 Negative chiller in Plant1 and 1 in Plant2

ELECTRICITY PRICE in Plant2

x2,4 Plant1

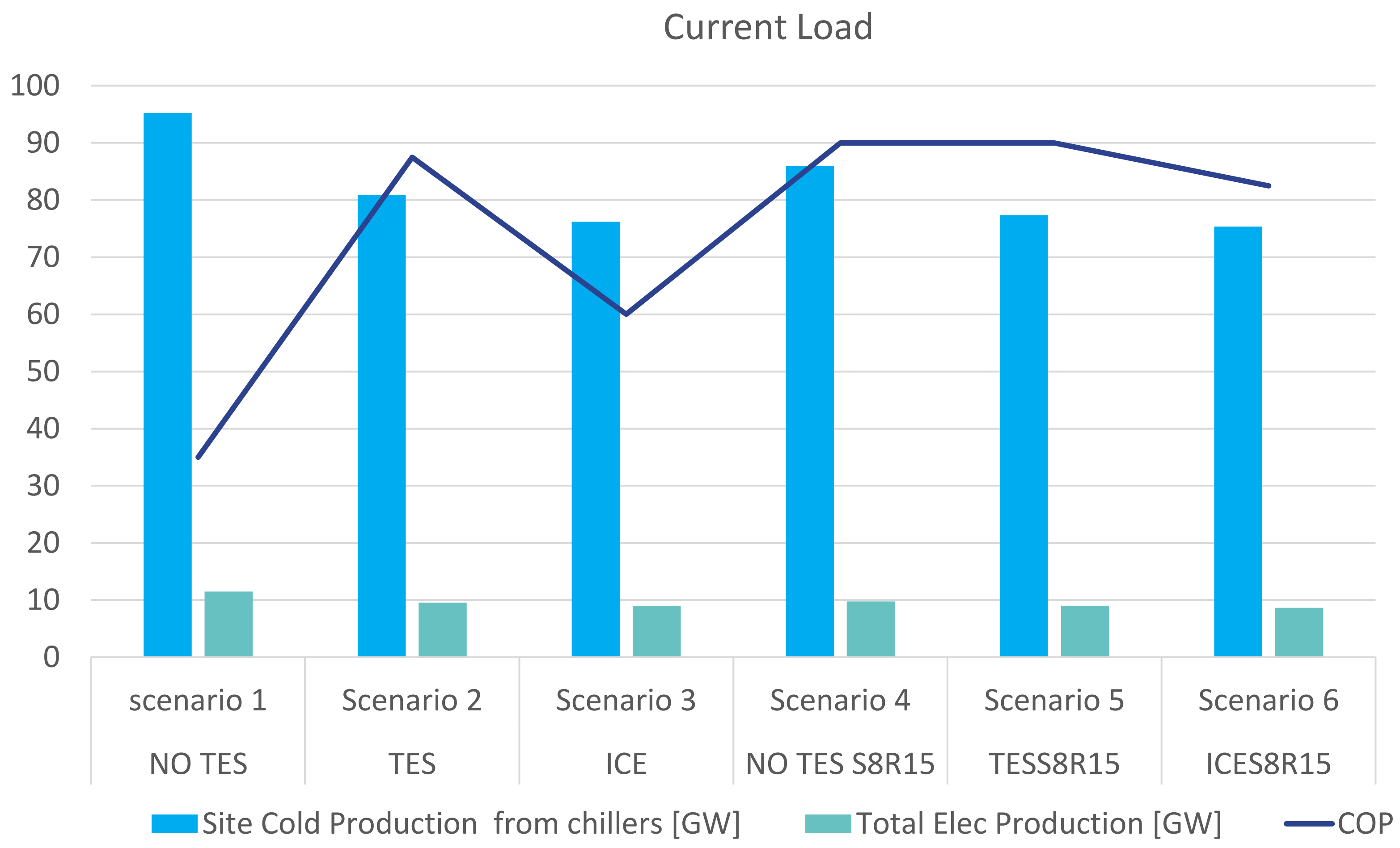


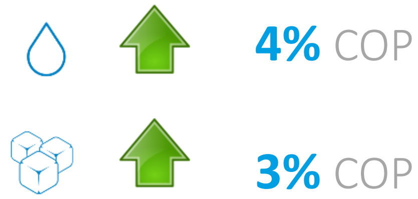




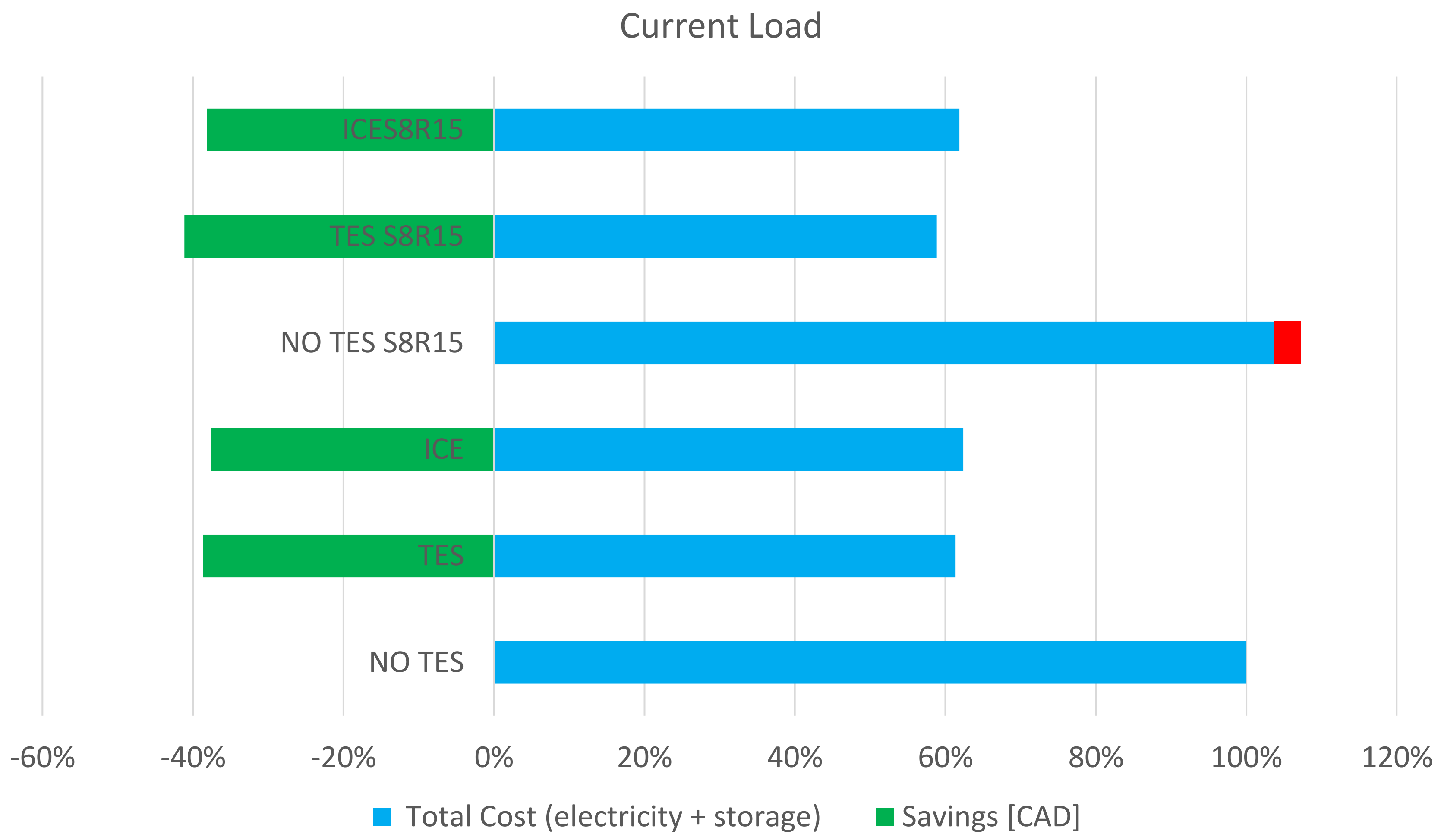
- 42 CAD/MWh
- 60 CAD/MWh
- 87 CAD/MWh

COLD PRODUCTION VS ELECTRICITY CONSUMPTION





OPEX SAVINGS VS NETWORK PERFORMANCES



OPEX savings between **30** and **40%**

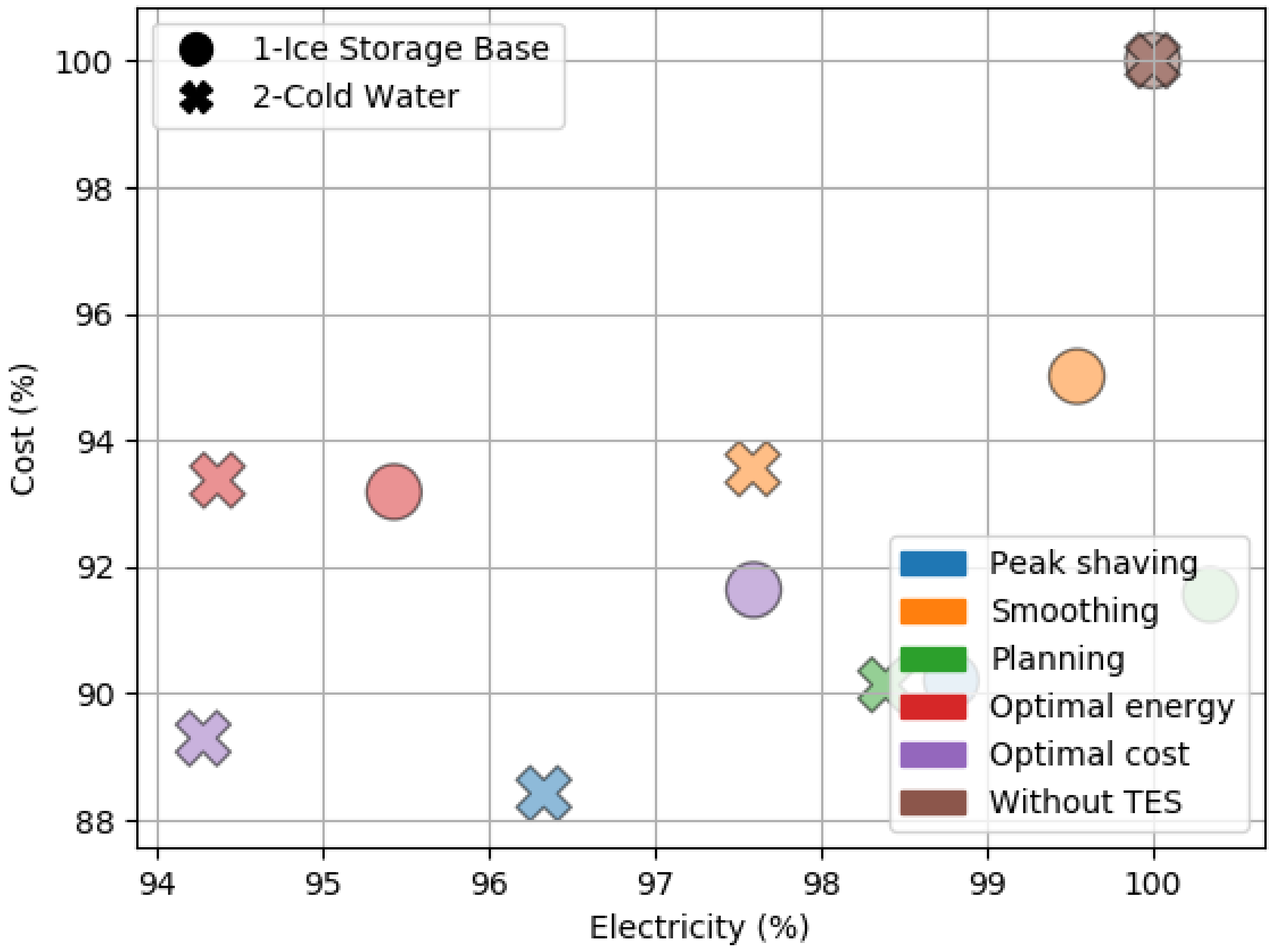
FREE COOLING WITH HIGHER TEMPERATURE NETWORK

	Free Cooling growth
Scenario 1 (w/o TES) Vs scenario 4 (w/o TES S8R15)	+23%
Scenario 2 (TES) Vs scenario 5 (TES S8R15)	+50%
Scenario 3 (ICE) Vs scenario 6 (ICE S8R15)	+18%

Freecooling can be boosted by higher network temperatures

Free cooling simulated with a chiller of nominal COP 10

RESULT - AI ALGORITHM FOR TES



Error around **4%** compared to NEMO

4

Conclusion

CONCLUSION

Up to
+4%

Gains in COP thanks to storage systems

Up to
+50%

Higher utilization of free cooling with high T network

Up to
-40%

Annual OPEX savings thanks to storage flexibility

THANK YOU

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