The role of District Cooling in Accelerating Decarbonization

Bridging performance & zero-carbon ambitions through tailored & integrated decarbonizing solutions

February 2020

Cities are at the forefront of climate change

Highly exposed as well as heavy contributors

- Impacted more and more often by extreme weather events (heat waves, storms, floods…)
- Major sources of greenhouse gas emissions

>50%

of carbon emissions are produced within cities (1)

50%

of the final energy consumption is due to Heating (2)

200 %

Increase in global cooling demand from air conditioning between 2016 et 2050 (3)

70%

of the population is expected to live in Cities by 2050 (4)

1) *UNHabitat, Global report on human settlement 2011, figures based on production of CO2*
2) *Heat Roadmap Europe, 2015*
3) *IEA, The Future of Cooling, 2018*
4) *Bloomberg NEF - Air Conditioning Heats up Electricity Demand*

Heating & cooling : what is at stake for Cities ?

- Energy efficiency
- Financing & savings
- CO2 reduction
- High satisfaction of final customers
- Renewable & local energies
- Integration in the City
- Safety & Resilience
- Reintroduction of the Nature in the City

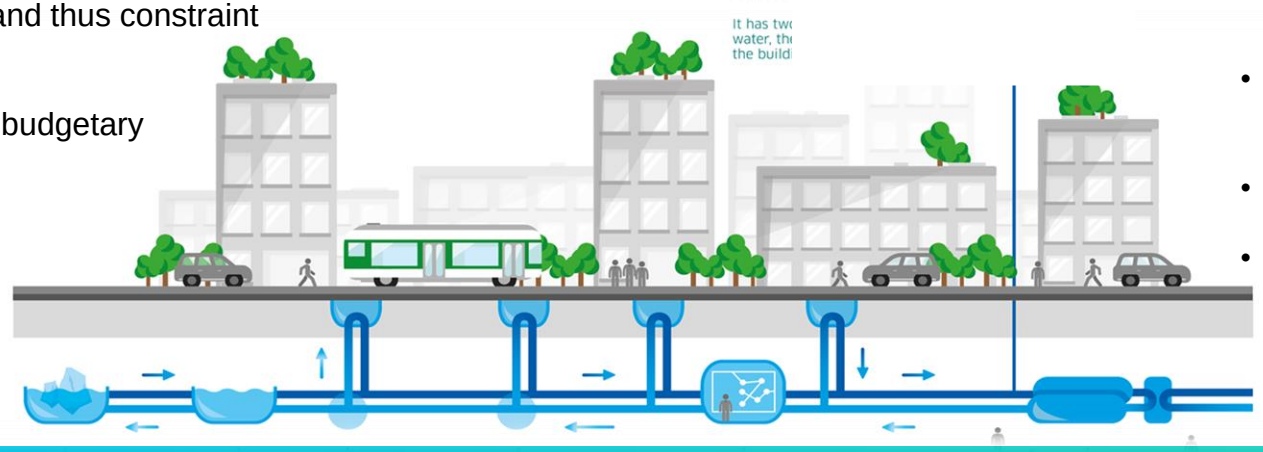
Bridging attractiveness & zero-carbon for Cities via Heating & Cooling networks…

Consuming less resources

- Reducing energy, water, chemicals consumption
- Reducing operating and maintenance costs thanks to pooled equipment versus individual systems
- Reducing energy bills
- Reducing peak demand and thus constraint on the grid
- Financing projects within budgetary constraints

Shifting to green energy

- Being assured of a reliable low carbon energy supply
- Favouring local and renewable energies
- Promoting circular economy
- Coupling energy sector (heat, cold, power)



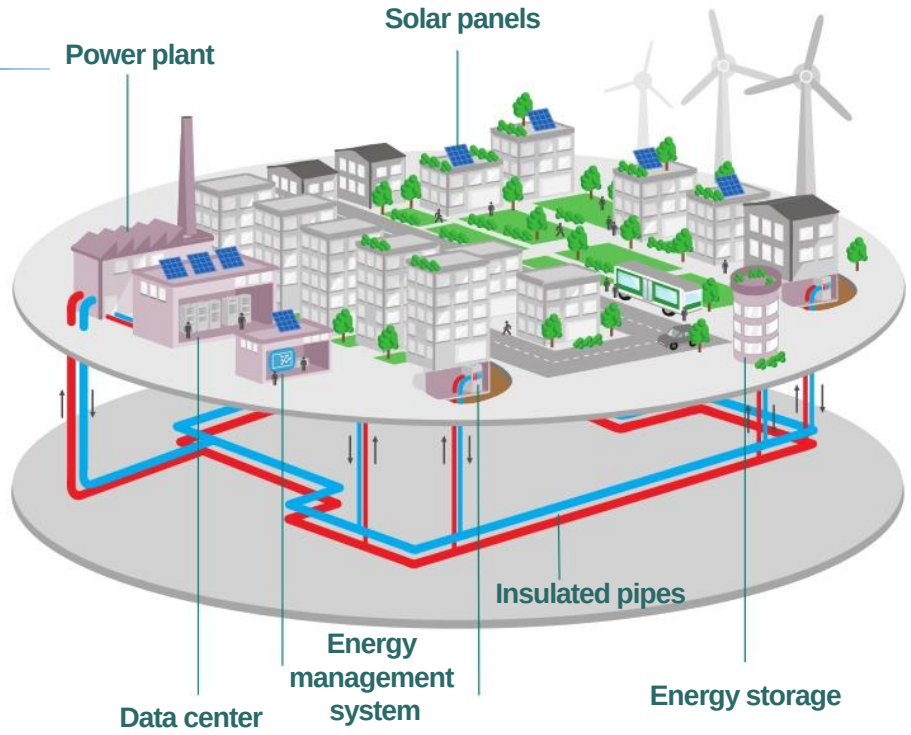
Contributing to better urban spaces

- Ensuring safety of operations
- Maximizing availability and resiliency
- Satisfying end users
- Improving air quality
- Reducing visual pollution caused by individual systems
- Integrating installations in the architectural landscape,
- Vegetalized streets and buildings
- Embarking stakeholders (schools, citizens…)

...a wide range of solutions that can be applied to heating and cooling networks

Consuming less resources

- Best available technologies for boilers, chillers, heat pumps, energy transfer stations, storage, distribution …
- Energy management system, digital monitoring and intelligence optimizing consumptions
- Reduction of energy losses (LTHW Low Temperature Hot Water)
- Reduction of water leakages
- Guaranteed energy performance and savings



Shifting to green energy

- On-site energy production: combined heat & power, cogeneration, biomass, biogas, solar thermal, geothermal, hydrogen …
- Green Power Purchase Agreement including blockchain certification
- Use of Free Cooling when Doable,
- Re-use of local excess heat (industry, data centers…)
- Waste recycling to energy
- Energy storage

Contributing to better urban spaces

- Urban planning
- Green roofs, greenery urban islands
- Protection of biodiversity
- Guaranteed availability
- Safety of installations, security for people
- Reduction of the number of points of emissions and better control
- End-users' satisfaction surveys
- Visitors centers

…DHC as part of Urban Planification Internal ENGIE' set of tools

…WITH APPLICATIONS BRINGING VALUE INTO THE WHOLE DHC VALUE CHAIN…

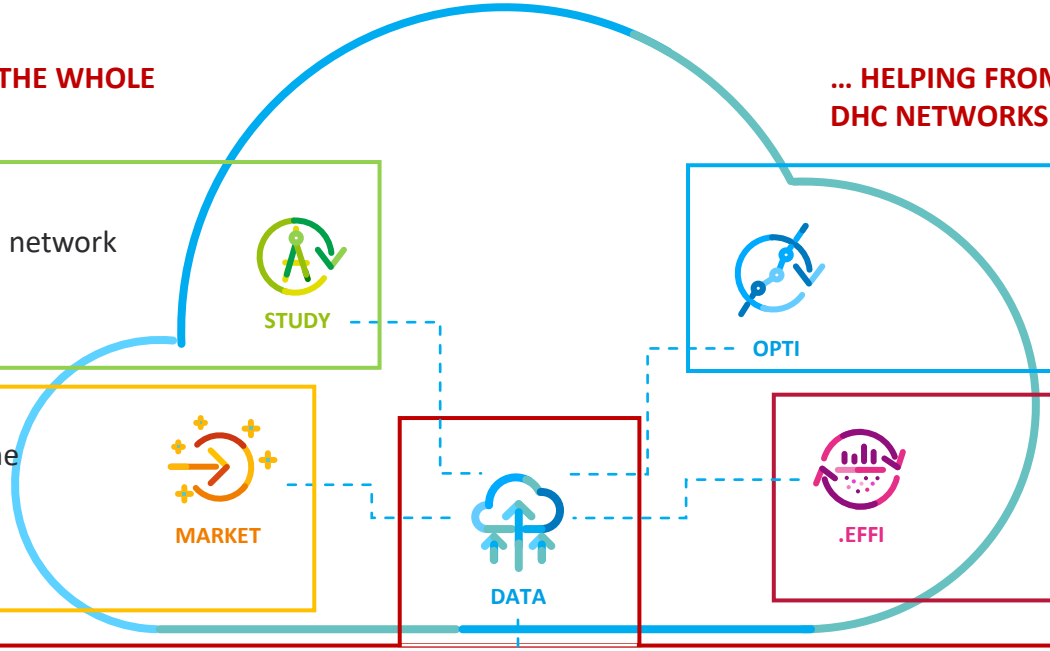
… HELPING FROM THE CONCEPTION TO THE OPERATIONS OF DHC NETWORKS

NEMO.study
To simulate network behaviour and evaluate network performances

NEMO.market
To prospect and design networks based on the territories' acknowledgement

NEMO.opti
To help operational teams to find the optimum level of performances

NEMO.effi
To identify anomalies on the production sites, based on data analysis

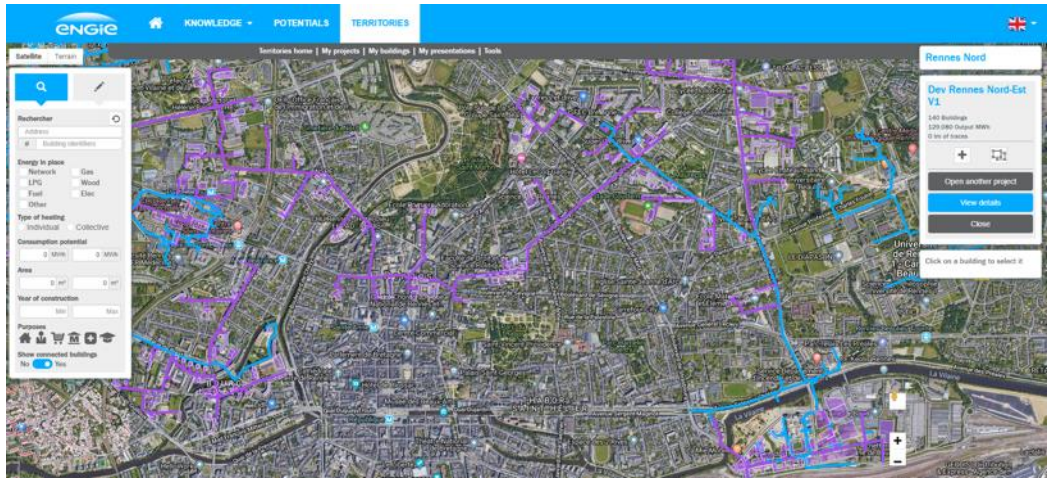


ONE TERRITORY AND ITS SPECIFIC DATA…
Clients, Weather, Networks, Energy Prices, Excess of heat Renewables sources…)

...DHC as part of Urban Planification

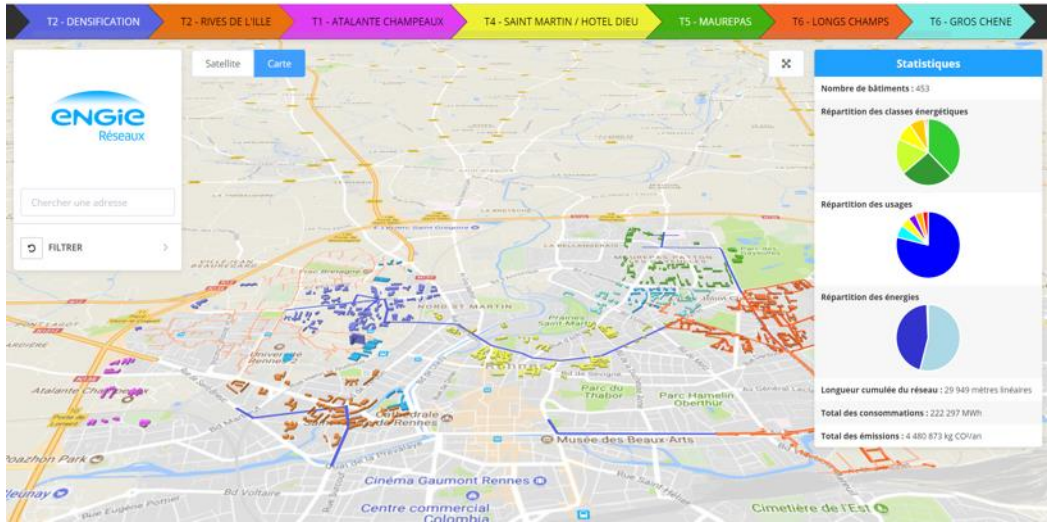
DHC systems are (Upfront) **CAPEX Intensive**. The challenge is to create enough critical mass to justify the investment that makes viable a project.

Planification is key and should be developed with City Authorities, developers, Constructors and real estate managers.



MASTER ENERGY PLAN

- **Prospection** tool for creation, connection or interconnection.
- Scan of the terroritory and local potential (geothermal, solar, free cooling, heat excess, etc.)
- Definition of the Phasing **of a project that is crucial to meet fiancial ratios for investors.**
- **Definition of the Ramp up that may be detrimental to green field projects.**
- **Defitnion of loads profiles, peak demand for each of the buildings to be connected**



KEY BENEFITS

- Help decision makers to viusalize the layout of a network throughout a city,
- Outcomes may be integrated in a broader City MASTER PLAN,
- Help decision makers to maximize the benefits of a District System

CLIMESPACE - PARIS DISTRICT COOLING NETWORK

Climespace, ENGIE subsidiary, the leader in sustainable refreshment in Paris. The system produces 485,000 MWh of cooling energy per year.

CLIENT STAKES

Client identity and activities

- A concession older with the city of Paris since 1991, CLIMESPACE operates and develops the district cooling system of the city of Paris, the largest in Europe and the 11th in the word.
- **Critical clients**
  With highly demanding performance requirements (temperatures, resiliency…)
  - Louvre Museum, Paris
  - Opéra Garnier, Paris
  - Elysée (Presidential residence)
  - Paris Town Hall
  - Data centers …

Client needs

- Connected customers : nearly 700 customers over 6 million m2

PROJECT VALUE PROPOSAL

People

- - 35% of electricity consumption

Planet

- -50 % CO2 emissions
- +50% of energy efficiency
- Peak Demand Management
- Better management of refrigerants and phasing out
- **Green PPA** concluding with a Hydro entity to cover 100% of power needs

Profit

- +50% of energy efficiency
- -65% of water consumption

TECHNICAL ASPECTS

Technical aspects

- 10 cooling plants
- Distribution : 79 km of underground network
- Cooling capacity : 269 MW
- **3 energy storage facilities** : -140 MWh
- Free cooling coming from the Seine river close by to some plants
- 1st European cooling network in # of km and in power installed

Contractual aspects

- Public Service Delegation : Design, build, finance, operate & maintain contract

LONDON QUEEN ELIZABETH OLYMPIC PARK & WESTFIELD STRATFORD CITY

The Energy Center for the Olympic Park & Stratford City, built and operated by ENGIE UK, includes a 3 MW wood chip biomass boiler and Combined Cooling, Heat and Power (CCHP) plant to generate heating, cooling and electricity. Hot and chilled water are distributed through a district energy network to the Olympic Park

CLIENT STAKES

Client identity and activities

- Queen Elizabeth Olympic Park in London is a sporting complex in Stratford. It was built for the 2012 Summer Olympics and the Paralympics
- The Energy Centers provide an efficient low-carbon heating and cooling system across the site for the Games and for the new buildings and communities that form part of the wider Olympic Legacy Project

Client needs

- 75% of area electricity needs covered
- Expected growth for heating : 78 up to 165 GWh in 2030
- Expected growth for Cooling : 44 up to 51 GWh in 2030

PROJECT VALUE PROPOSAL

People

- Eco-friendly environment
- Energy Center with a flexible modular design for future expansions
- Heat trust signatoree (customer protection body)

Planet

- 24% reduction in CO2 emissions
- Efficient use of raw materials & Avoidance

Profits

- 40% savings in energy consumed equivalent to a reduction of 2,900 metric tons of CO2 emitted, compared with conventional CO2 facilities

TECHNICAL ASPECTS

Technical aspects

- 2 integrated Tri generation energy (including CHP, Biomass boilers & **Absorption Chillers**)
- Distribution : 16 km of pipeline
- Cooling & heating capacity :
  - 57 MW : Cooling capacity
  - 92 MW : Heating capacity
- **Thermal Storage**
- Connected residents : 3,000 housing connected

Contractual aspects

- Design, build, finance, operate & maintain contract

DISTRICLIMA - DISTRICT HEATING & COOLING NETWORK

Districlima was Spain's first urban heating and cooling district network. The project was initially located in an urbanistic remodeled area of Barcelona that includes the Cultures Forum 2004 (Besos seafront).
The project encompasses the design, construction and later use, over a 25 years concession of the Forum's production station and energy distribution network.

CLIENT STAKES

Client identity and activities

- Districlima located in Barcelona was formed in 2002 to perform, for the first time in Spain, an urban network of distribution of heat and cold for use in heating, cooling and sanitary hot water

Client needs

- In the case of Barcelona, the first catalyst of change was the celebration of the Barcelona'92 Olympic Games,
- With the "DHC" project a long-term urban, economic and social transformation of more than 200 Ha is undertaken, attracting "20th century industries" that should replace the old factories of the 19th century

PROJECT VALUE PROPOSAL

People

- More space available for business or other uses
- Interoperability of local system

Planet

- Reduction of greenhouse effect gas emission
- **-63%** Fossil fuel consumption reduction
- Significant reduction of leakages and refrigerant discharged into atmosphere
- **Sea Water** as cooling system of chillers.

TECHNICAL ASPECTS

Technical aspects

- 2 Districts Heating & Cooling
- Distribution : **18** km network length
- **Waste to energy system that feeds both heating and Cooling network**
- Cooling & heating capacity :
  - **93** MW : Cooling capacity
  - **62** MW : Heating capacity
- 40Mwh chilled water storage tank and **120MWh ice storage** tanks
- **Absorption Chillers**
- **1 seawater collection station of 5.000 m3/h**
- Connected buildings: **94** Buildings

Contractual aspects

- Design, build, finance, operate & maintain contract

THASSALIA – MARSEILLE DISTRICT HEATING & COLLING NETWORK

Implement a heating and cooling network across the EUROMEDITERRANEE 1 area using thermal energy from the sea marine geothermal energy.

CLIENT STAKES

Client identity and activities

- The Euroméditerranée Public Development Establishment aims to making the Aix-Marseille Provence Metropolis the spearhead of an ideal applicable to the metropolises and cities of Southern Europe and the Mediterranean basin.

Client needs

- Euroméditerranée is building the sustainable Mediterranean city! The sustainable Mediterranean city of tomorrow is a model that takes into account the specific geographical, climatological and cultural characteristics of the Mediterranean.
- It is sustainable, connected and intelligent.

PROJECT VALUE PROPOSAL

People

- 1 whole system all the energy needs of the buildings connected to the network – close to 600,000 m²

Planet

- Reduction of greenhouse gas emissions by approximately 70%;
- Benefits of District Energy System compare to standalone solutions :
  - Electricity use: -40%
  - Greenhouse gas impact: -70%
  - Water use: -65% to -100%
  - Use of chemicals: -80% to -99%

Profits

- Greenfield project
- Reduction of energy primary use and costs associated

TECHNICAL ASPECTS

Technical aspects

- **seawater loop system to produce heat and cold**
- Installed capacity **(Heat Pumps)** : **20 MW** cooling and **18 MW** heating
- A network spanning a length of 3.1 km across the EUROMED
- Total of 44 customers (heating and cooling)
- Air-conditioned surface area of **600,000 m²** (Housings plus Offices)

Contractual aspects

- 35-year concession contract.

Main Recommendations to unlock the DHC Potential

- **Establish national and local potentials and plans for district heating and cooling**: Establishing the tools and having firm processes in place to properly assess the potential for district heating and cooling systems (DHC as part of the urban planification).

- **Increase investments in energy efficiency improvements all along the value chain including in-buildings**

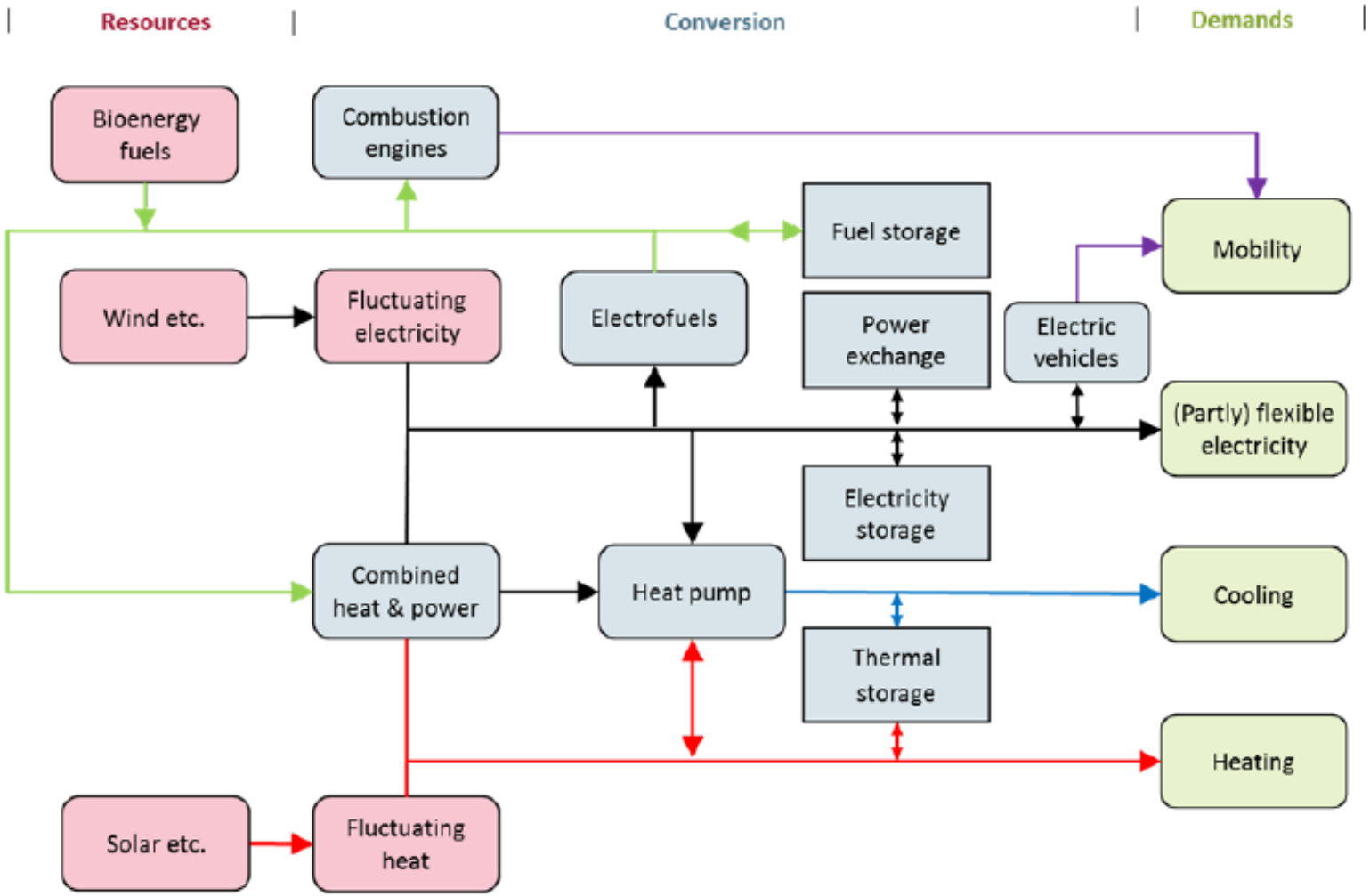
- **Set commitments to deploy actions in liaise with the local level**: Heating and Cooling are local energy demand, and it is important to enable coordination between the national and local levels.

- **Start investigating the potential and role of district cooling:** As cooling is one of the fastest growing of the thermal sectors, the potential to explore the role of using free cooling and higher levels of cold water thermal storage requires investigations to be able to fully understand the potential and role that district solutions for cooling could play on the wider energy system.

- **Ensure a level playing field for a decarbonized energy system:** Markets, investments, regulation, taxes and tariffs need to be adjusted to promote low-carbon technologies and energy efficiency (new business models are needed to take into account, throughout the asset lifetime, the benefits brought by the DC system).

- **Take a system approach:** There is a need to assess the energy transition from an energy system perspective to utilize synergies between sectors and enable the energy value chain effects.

DHC to be deemed as essential infrastructure such as gas, electricity or water distribution lines in dense area



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