Energy Infrastructure in Cities

The reason we do what we do

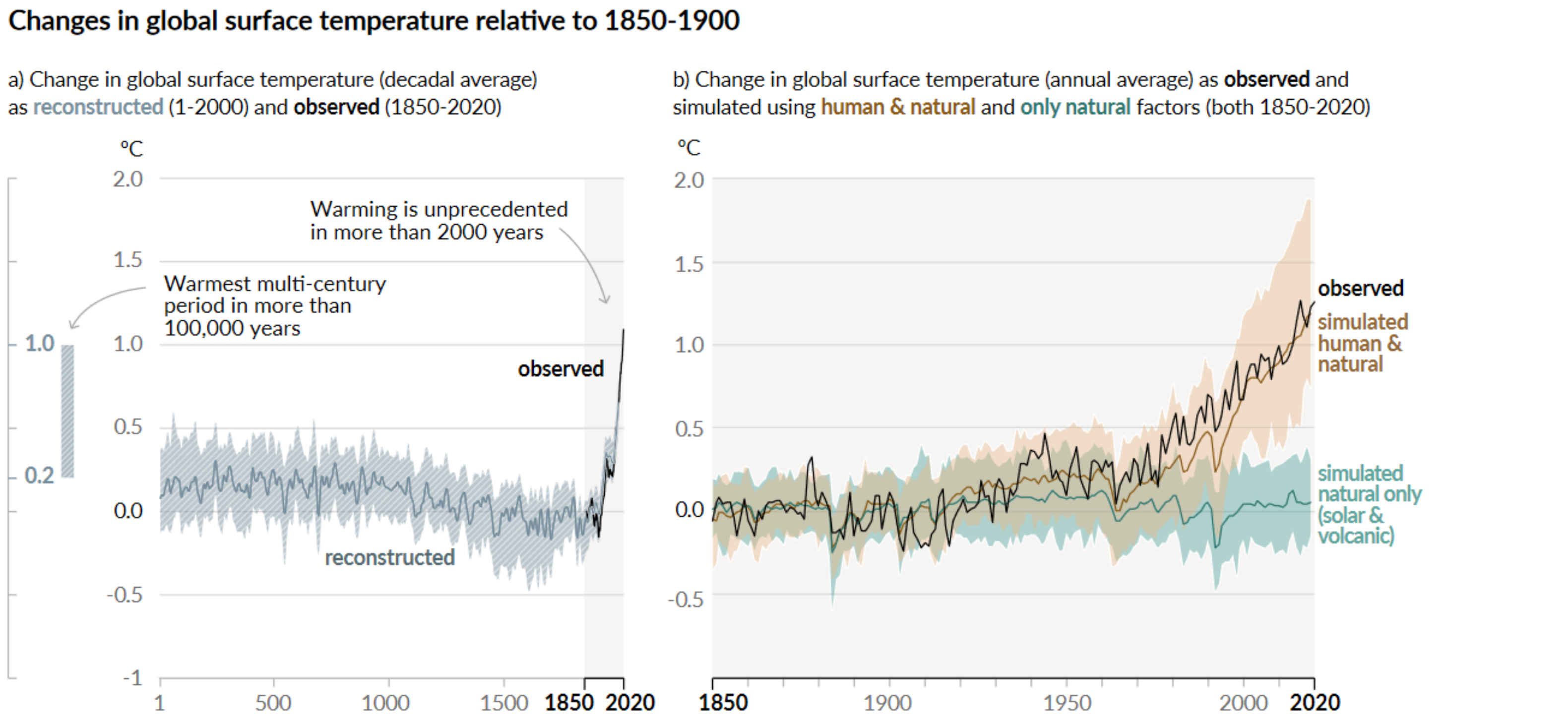
Climate Change

Germany 2021: over 150 dead in floods, over 100 000 evacuated

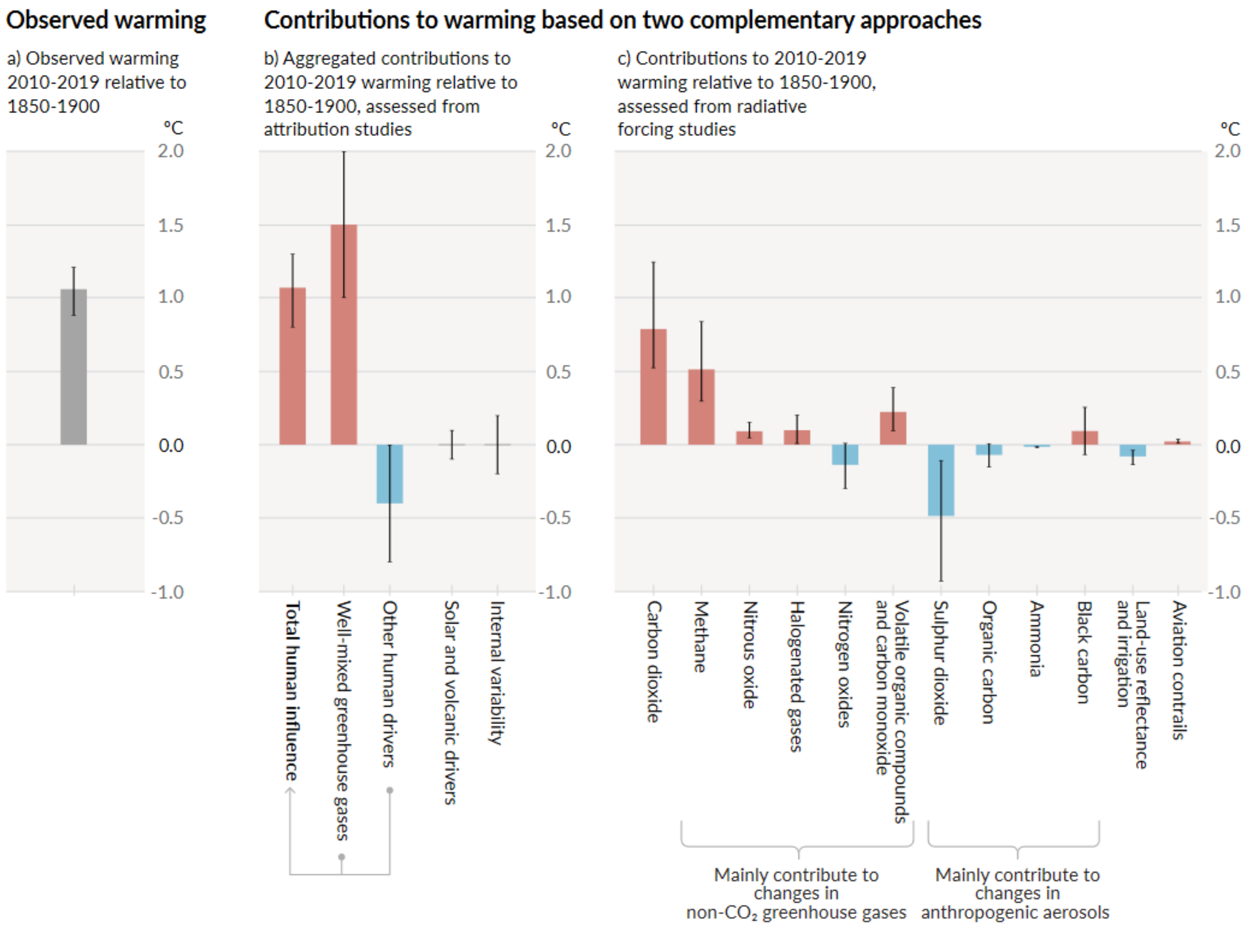
Western US and Canada 2021: over 50 degrees C, fires, over 200 dead, over 200 000 evacuated

IPCC:

It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

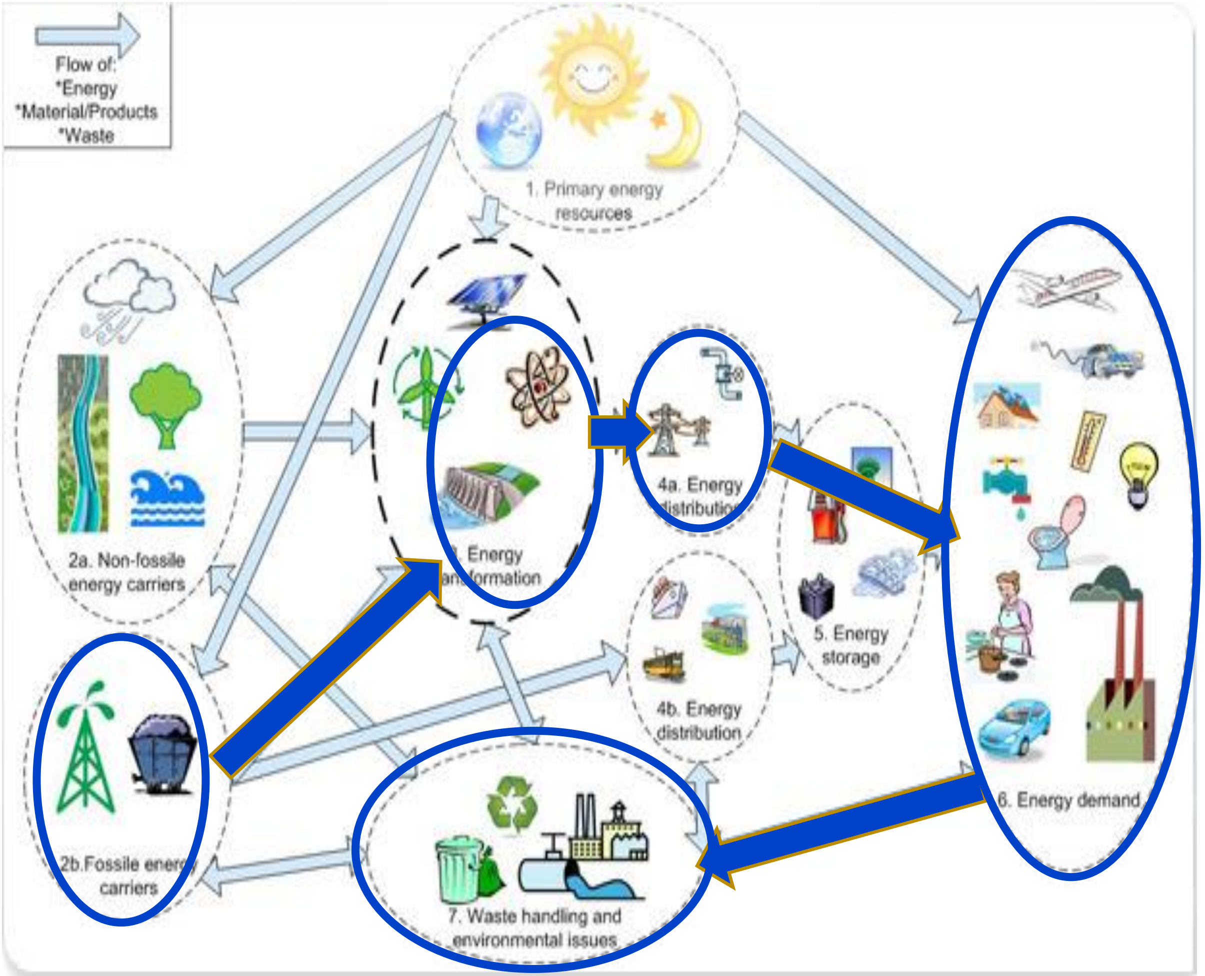


Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling



Energy System

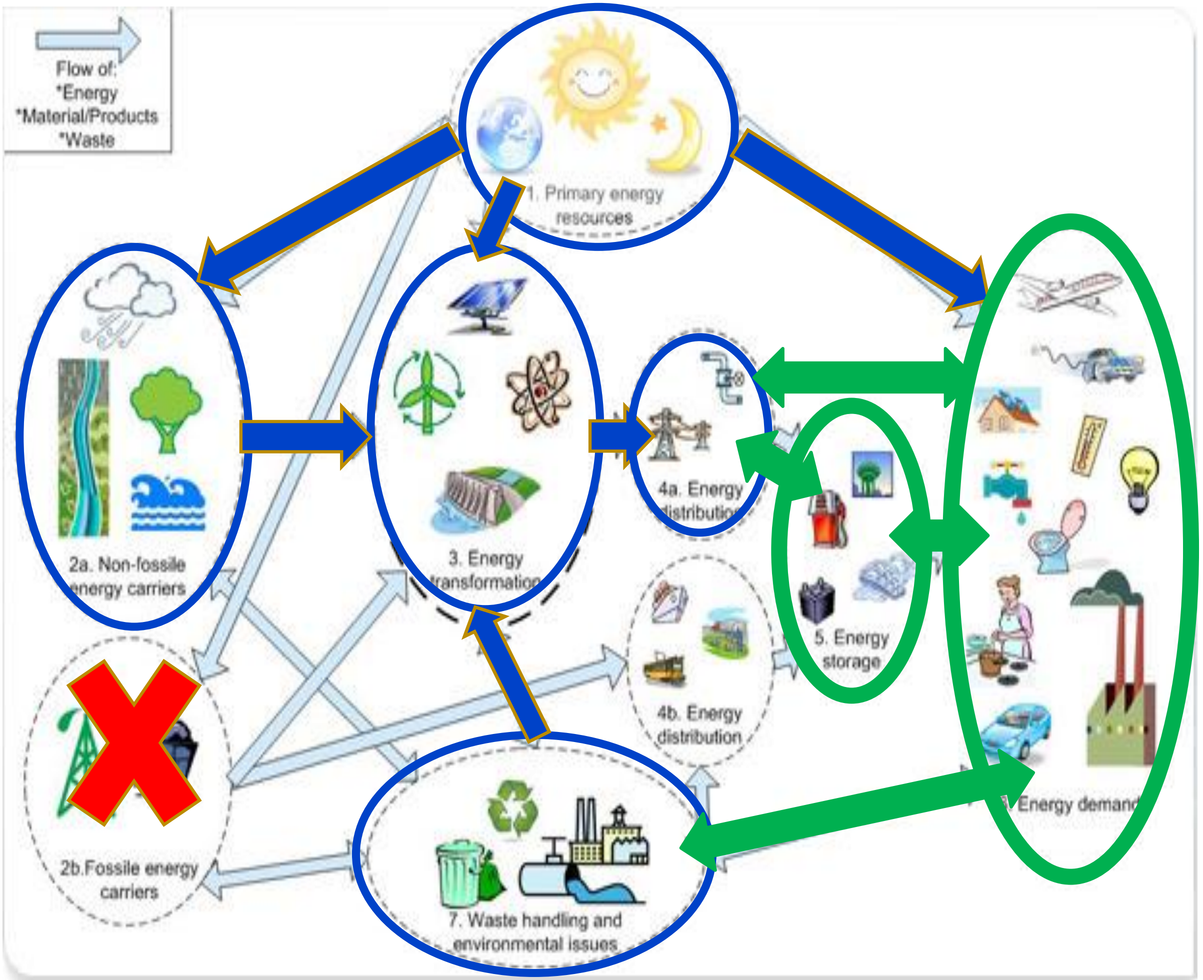
Where do we come from?

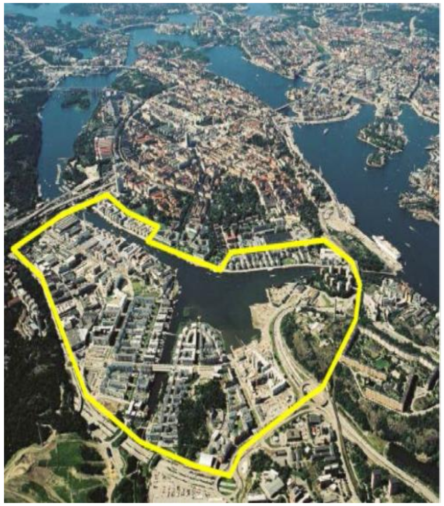


Where do we want to go from here?

Energisystemet

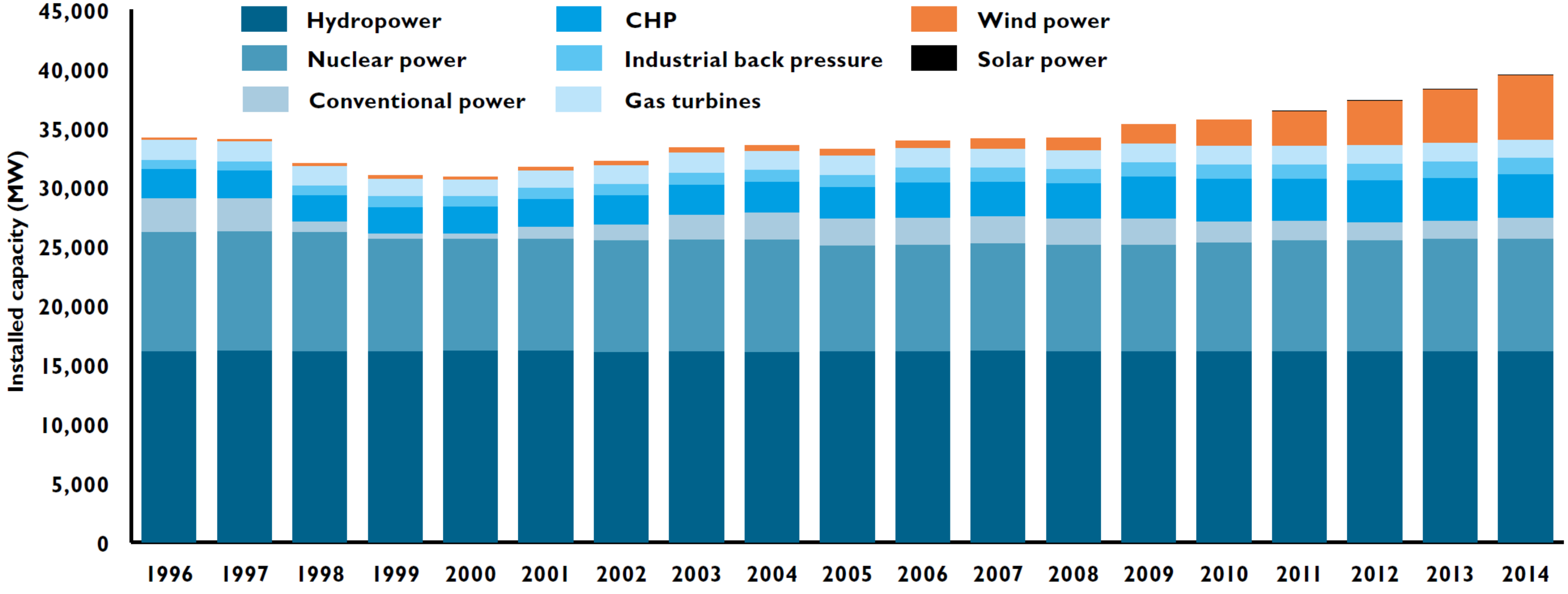
Where are we going to



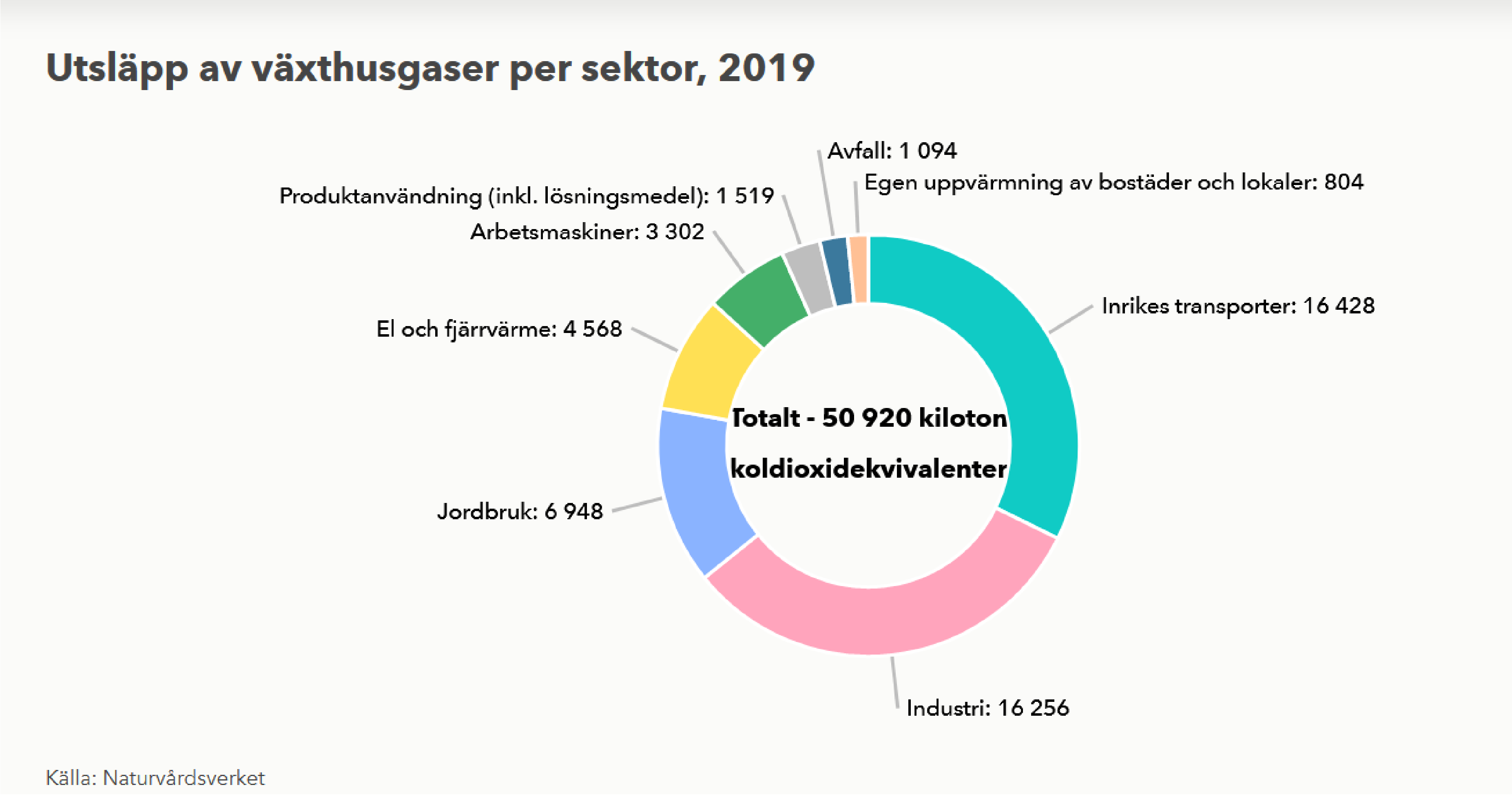


Electricity Production Sweden

Figure 2: Installed capacity of different energy sources 1996–2014, MW. Source: Swedish Energy Agency.



CO2 emissions Sweden



New scenarios for Sweden for 2050
Published 2021-05-21

All scenarios for 2045

Name	Consumption [TWh]	Hydrogen [TWh]	Wind Power [TWh]	Export [TWh]
2020	134	-	27 – 20%	22
Small scale renewables	174	11	82 – 47%	6
Mixed roadmaps	188	16	117 – 62%	21
Electrification planable	266	69	124 – 47%	2
Electrification renewable	286	85	211 – 74%	2

German wind power in 2020: **132 TWh**
≈ size of Sweden + 8 times more densed populated

Electricity Transmission Sweden

Elements of City Energy Infrastructure

- Energy demand units
- Heat and power supply systems
- District heating network
- Power grid
- Gas network

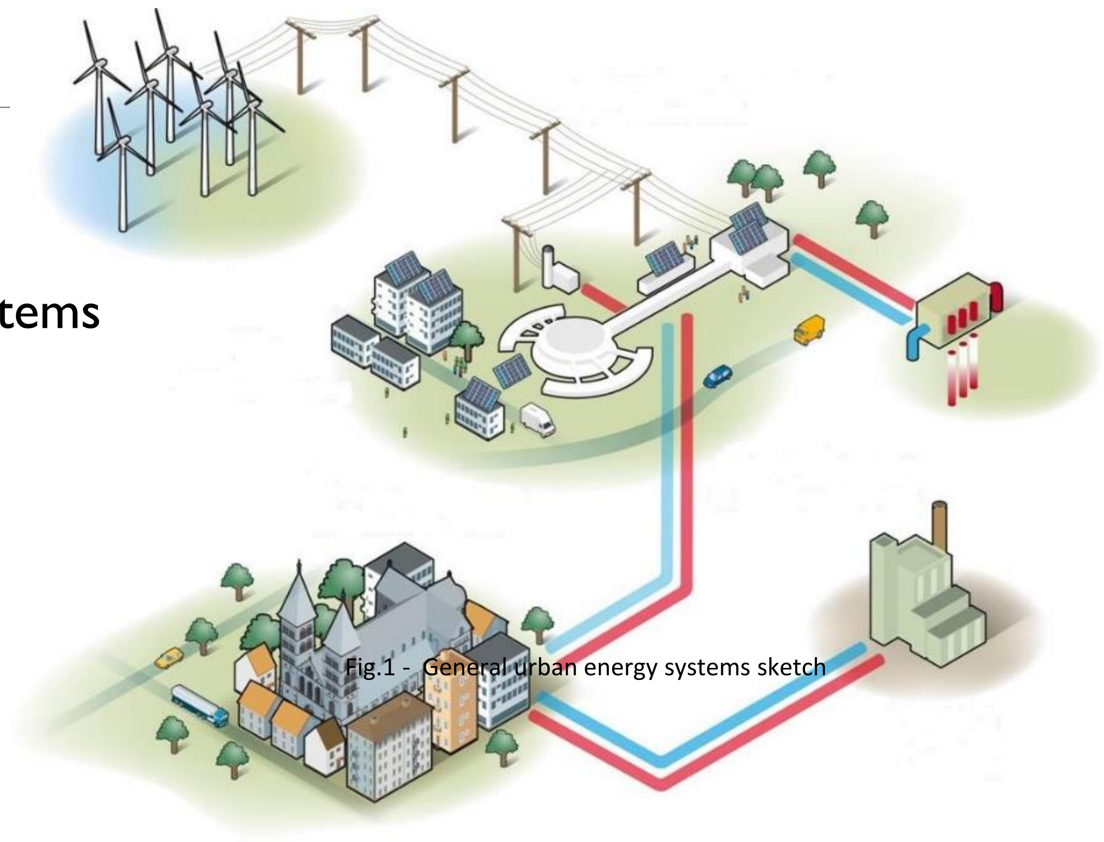


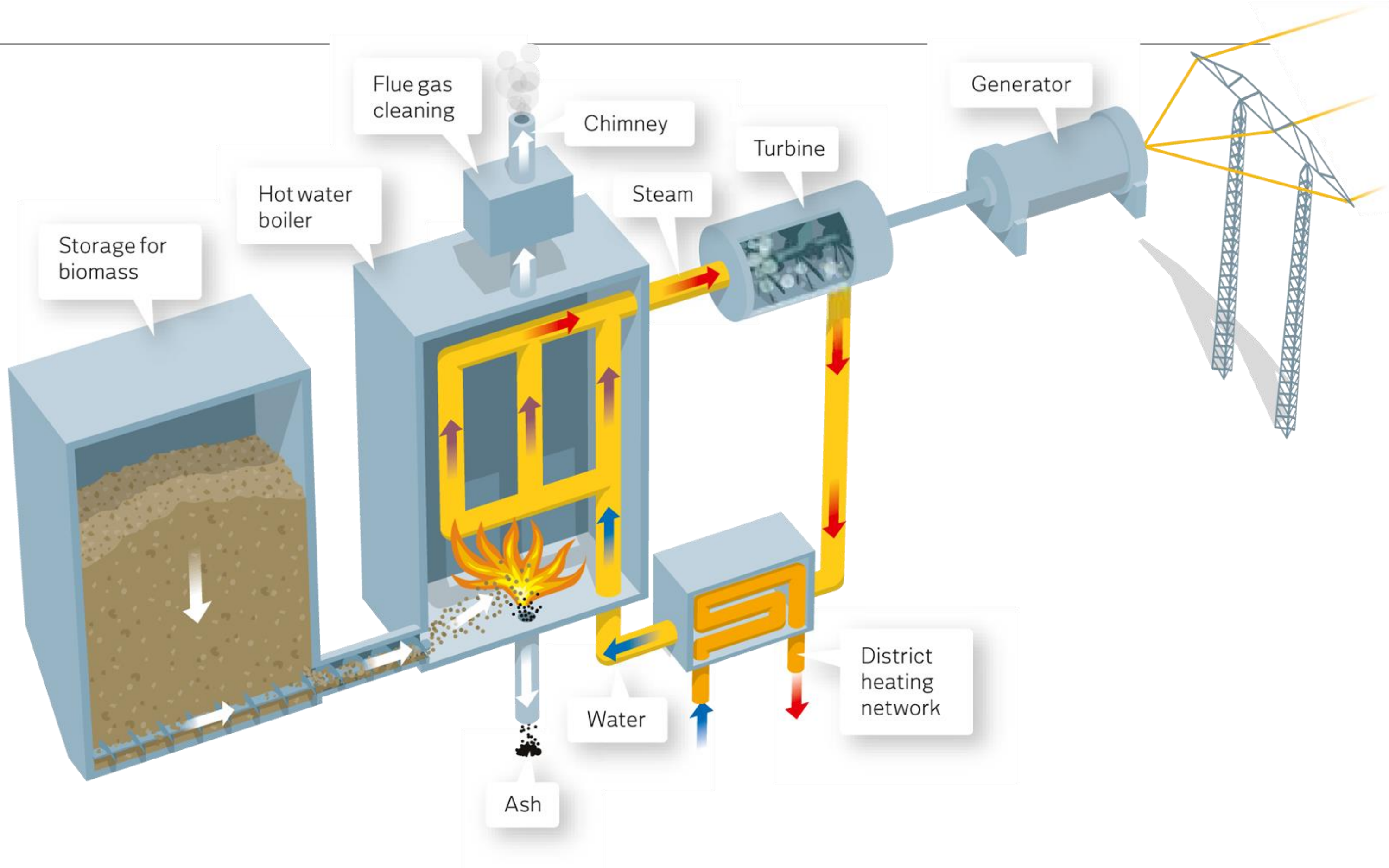
Fig.1 - General urban energy systems sketch

Elements of the City Energy Infrastructure

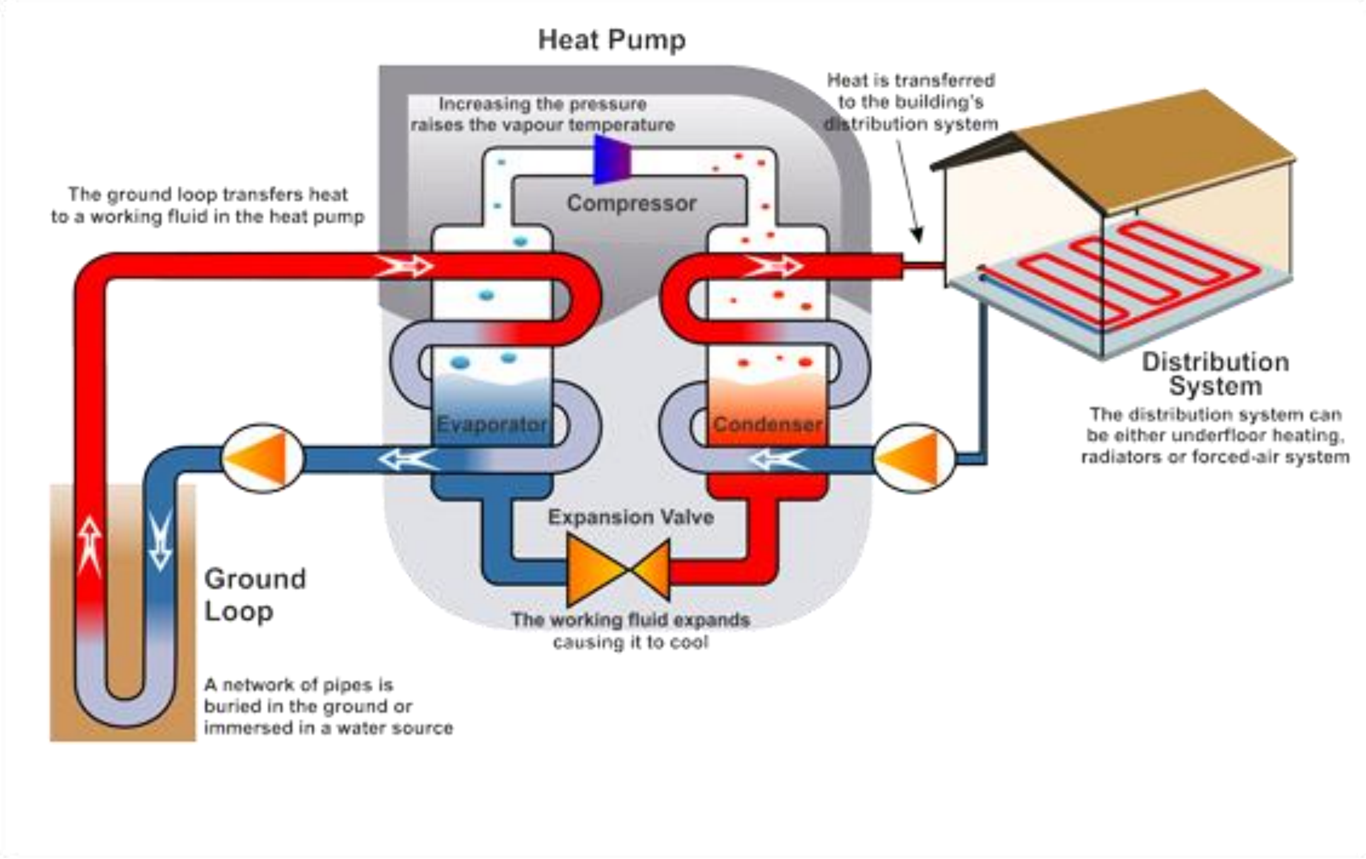
IntegrCiTy environment will be based on the interactions among three energy entities:

- **Energy conversion technologies/infrastructures** – District heating/cooling (DHC) networks, NG distribution grids, low- and medium-voltage electricity distribution grids.
- **Energy resources** – Renewable and non-renewable sources, along with recoverable waste energy (waste heat from industrial applications, waste materials and water flows, urban waste incineration, production of biogas in water treatment plants or other plants), to be considered as a resource, similarly to local storage capacities.
- **Energy demand** – (i) Energy demand of buildings, incl. heating, domestic hot water, cooling and electricity, (ii) energy needs from industrial and tertiary sectors (production processes and application-specific needs), (iii) electric vehicles consumption. Demand loads (i) and (ii) for each energy vector (heating/cooling, NG, electricity)

Examples Production Units Heat and Power



Heat Pump – Working Principle



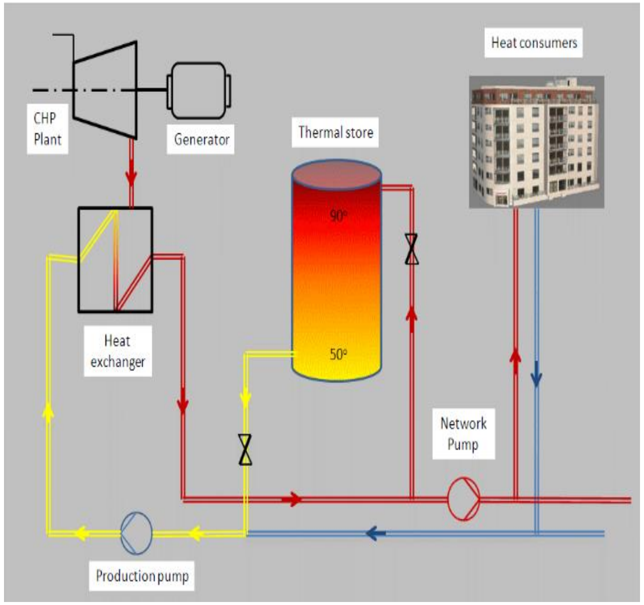
Storage Strategy

ELECTRICITY PRICES DRIVEN

If there is the possibility to store heat…

Two options

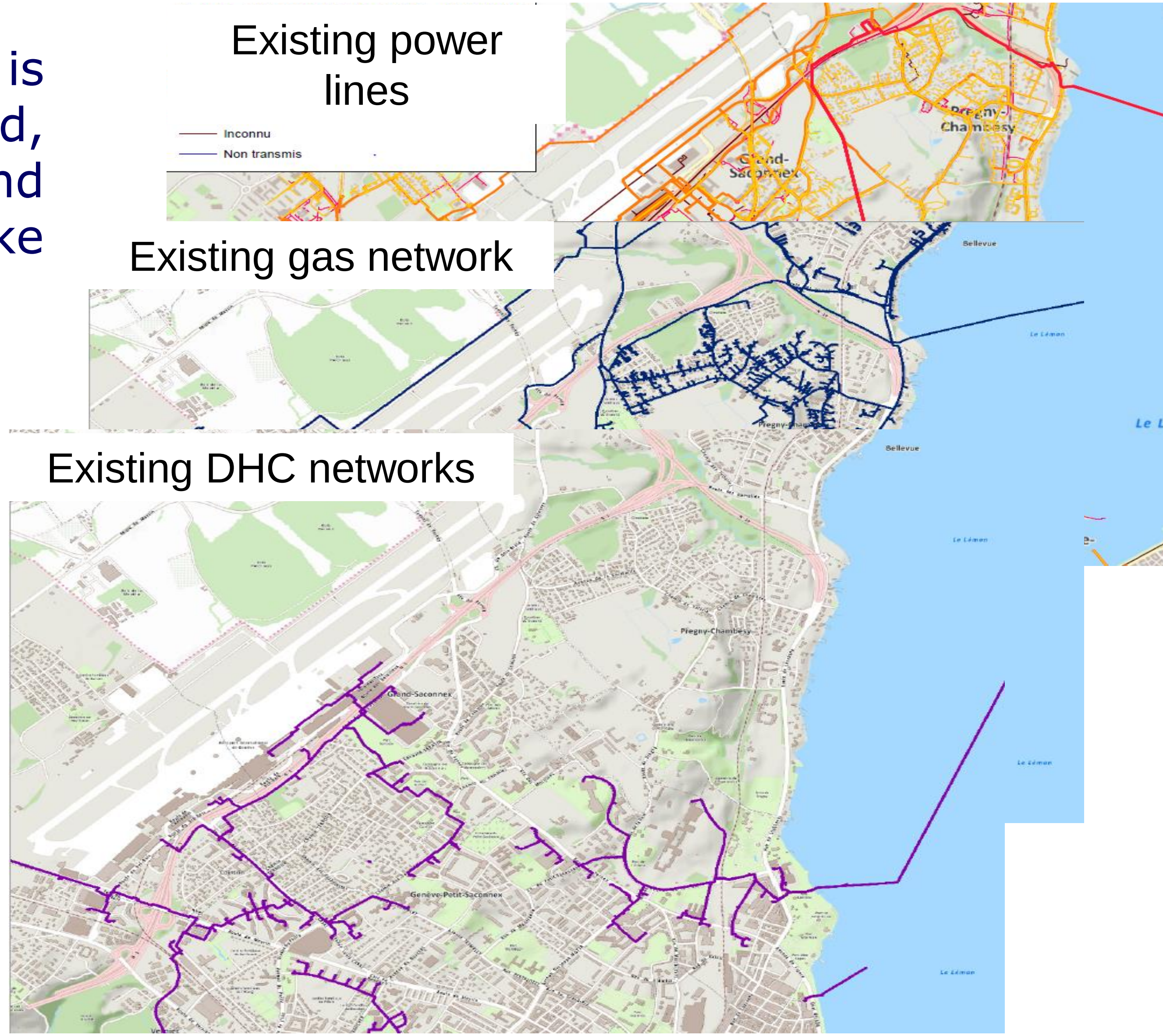
- **High Electricity Prices**
  - **CHP on**
  - Max Electrical Generation
  - The excess of heat is stored in the tank
- **Low Electricity Prices**
  - **CHP off**
  - Some heat is extracted from the tank



Energy networks – Present situation

Energy networks is cities are planned, built, operated and optimized in silo-like fashion

- Electricity distribution
- Natural gas distribution
- District heating and cooling



What are the risks when looking into energy networks as Silos?

Energy networks – Present situation - 2

Without an integrated appoach, the comprehension of the system may not be sufficient as to explore neither synergy opportunities between networks nor relief options.

- Realizing bad investments to spread and/or densify urban energy networks (e.g. reinforcing electric networks to accommodate massive injection renewable production) when alternative and profitable options could be available;
- Insufficient integration of renewable resources, or integration without cost optimization;
- Non-durable or optimal use of existing infrastructure;
- Inadequate decision-making processes regarding new urban energy systems, from both a technological and final customer pricing points of view.

-> an integrated approach is necessary to include inter-network synergies + demand/supply

IntegrCiTy – Overall approach - 1

The EU needs to accelerate innovation in cutting edge low-carbon technologies and innovative solutions, as well as bridge the gap between research and the market. IntegrCiTy project approaches this need :

1. An integrated urban infrastructure simulation platform will be developed and applied as decision-support environment;
2. Selected scenarios carried out by the tool for districts in partner cities shall be implemented by the local energy utilities;
3. Energy networks allow implementing more efficient conversion technologies, as well as renewables (e.g. geothermal, waste or biogas), thus allowing attaining EU's ambitious objectives in terms of long-term energy sustainability;
4. A multi-stakeholder collaboration has been established, including academic institutions, city- and region-level energy authorities, multi-energy utilities, along with an innovative equipment manufacturer and a software start-up company.

IntegrCiTy project

Platform Models

- Energy demand units
- Heat and power supply systems
- District heating network
- Power grid
- Gas network

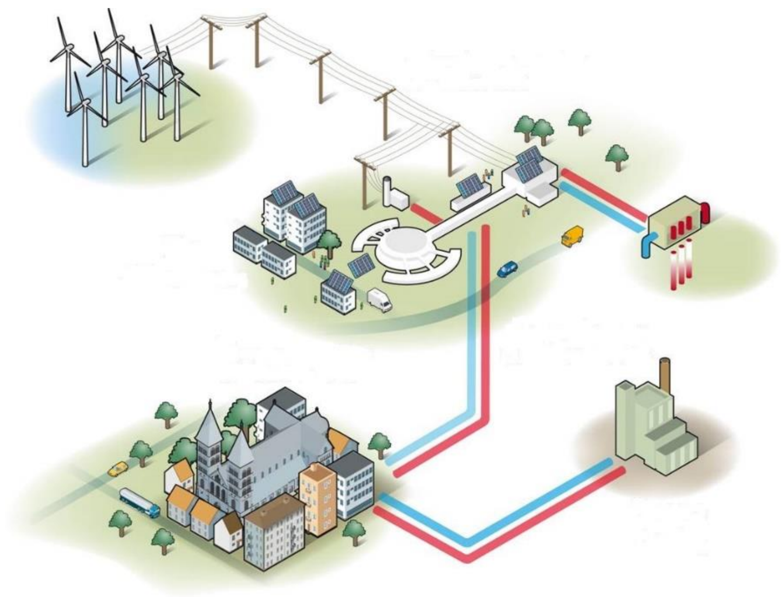
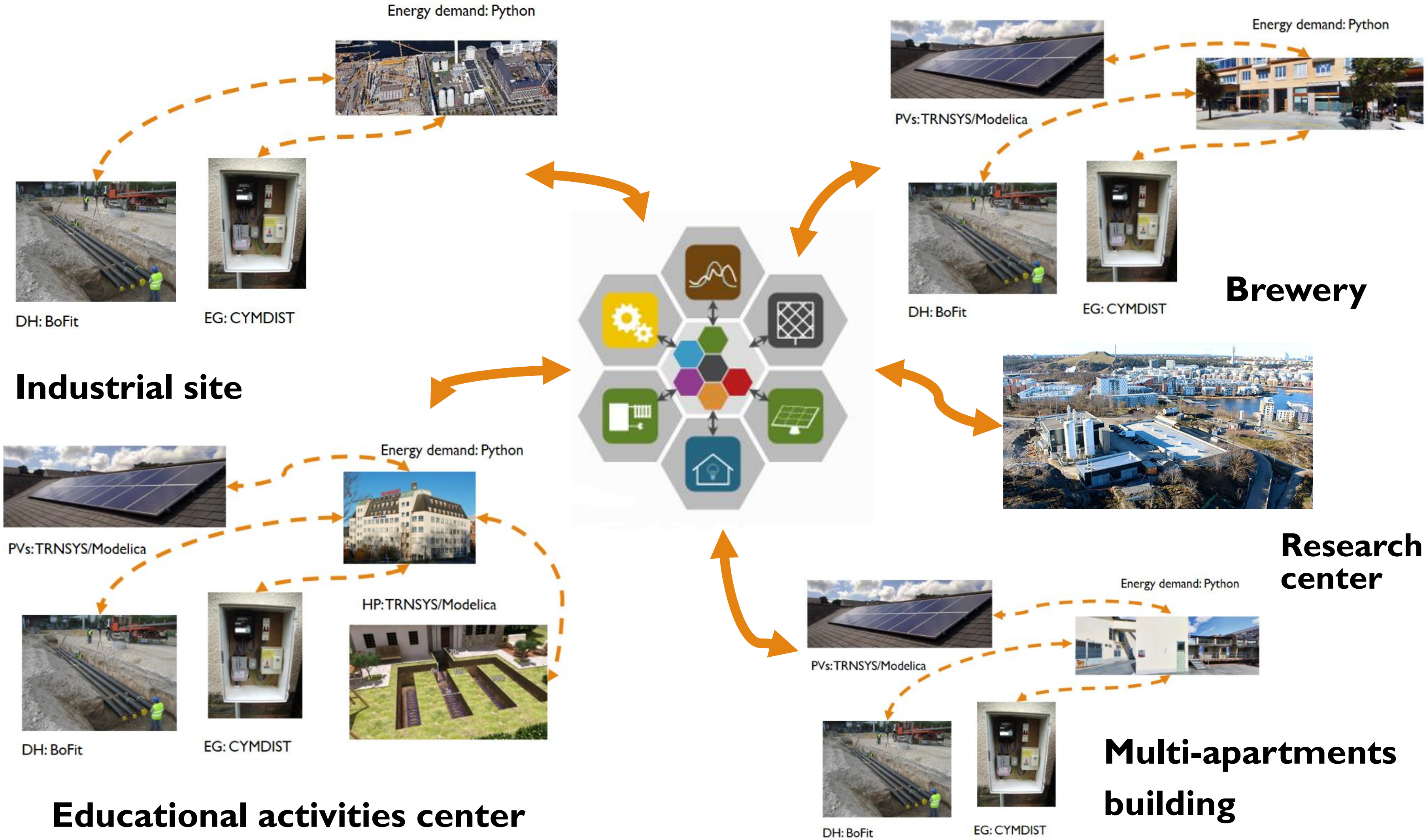


Fig.1 - General urban energy systems sketch

Platform Purposes

- How to reduce **energy consumption**?
- How to shape **peak demand**?
- How to handle **new installed capacity**? (ex. electric cars)
- What is the impact of future scenarios on the **infrastructure demand**?
- Where to allocate the energy supply responsibility in a **distributed system**?
- Are energy **networks interactions** advantageous?

Hammarby Sjöstad simulation



Locally produced and shared energy –
maximizing infrastructure use, minimizing losses

European/Swedish concept of **citizen driven energy communalities**

Energy system is in transition
Energy Communalities shall support
 climate action and energy transition
towards efficient usage locally

There is a need to investigate **social hurdles, redulation and laws, business opportunities, scaling and replicability of the concept**

Locally produced and shared energy –

maximizing infrastructure use, minimizing losses

Pilot Project: two Swedish Districts