INFORSE webinar 07-06-2021

HEAT ROADMAP EUROPE; LOW-CARBON HEATING

JAKOB WORM

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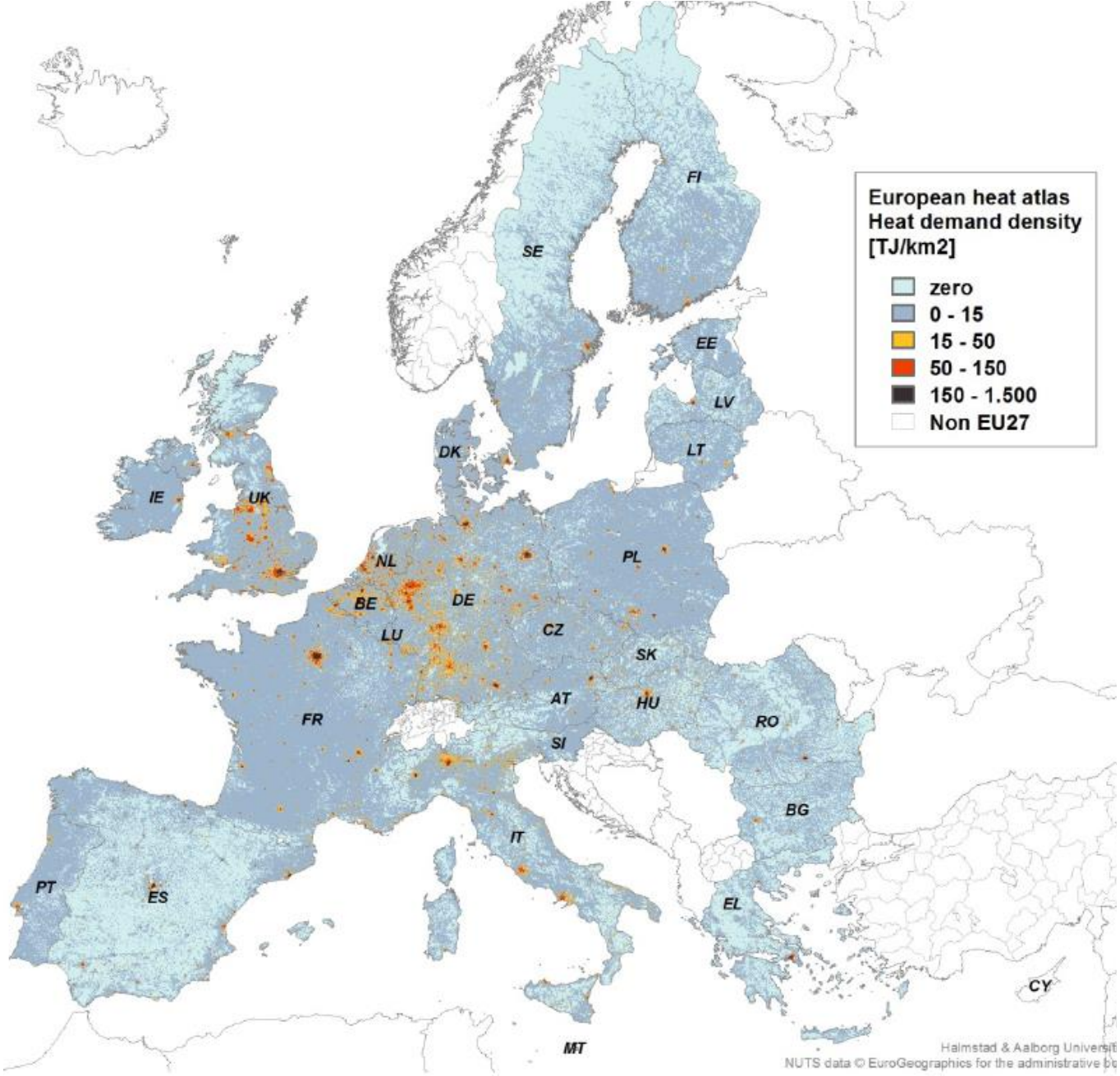
Heat Roadmap Europe

Heat demand



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Industry with waste heat

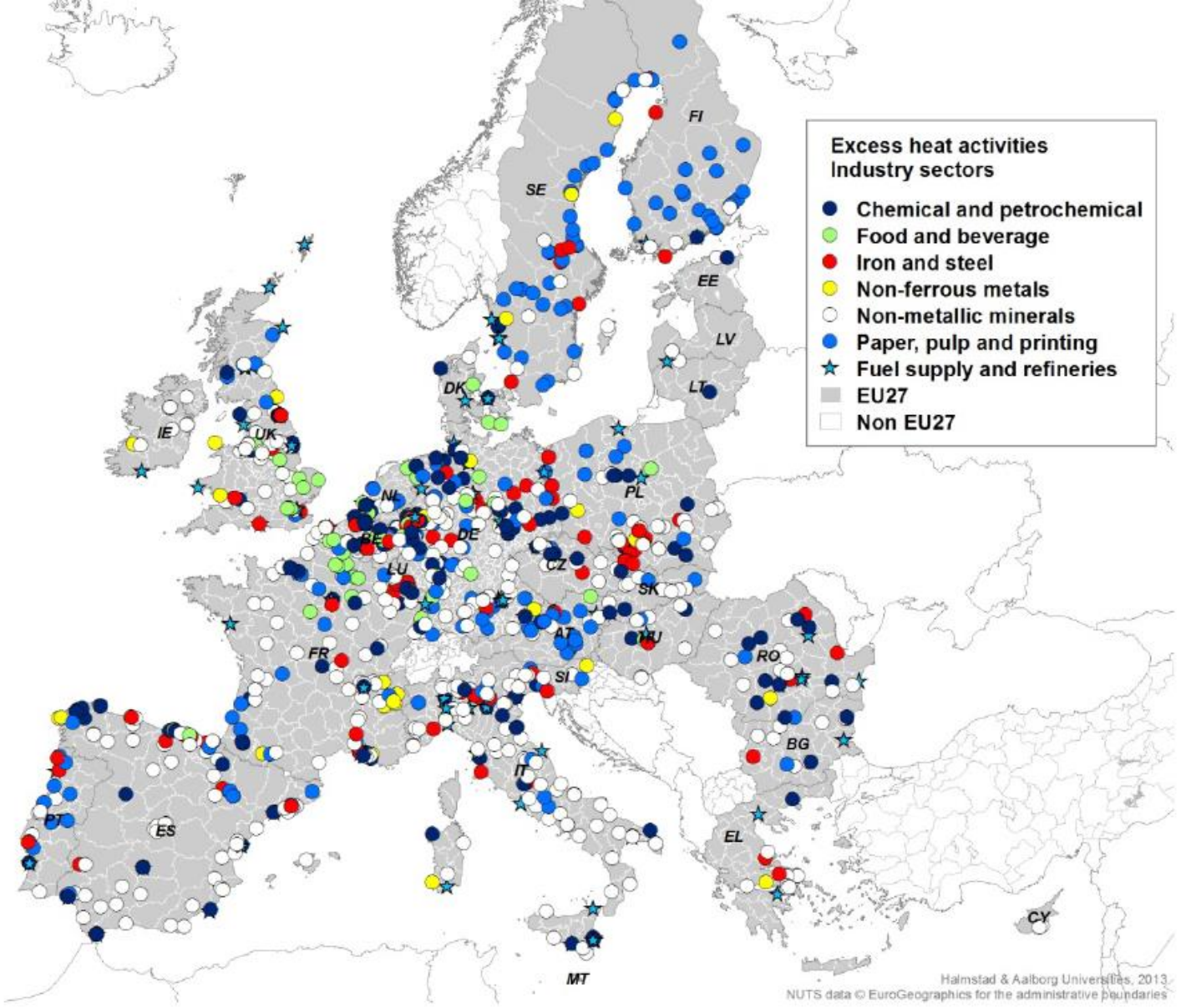

Figure 83: Locations of major energy intensive industries with considerable volumes of excess heat. Source: The E-PRTR database at EEA in Copenhagen.

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Heat Roadmap Europe

Excess heat compared to head demand

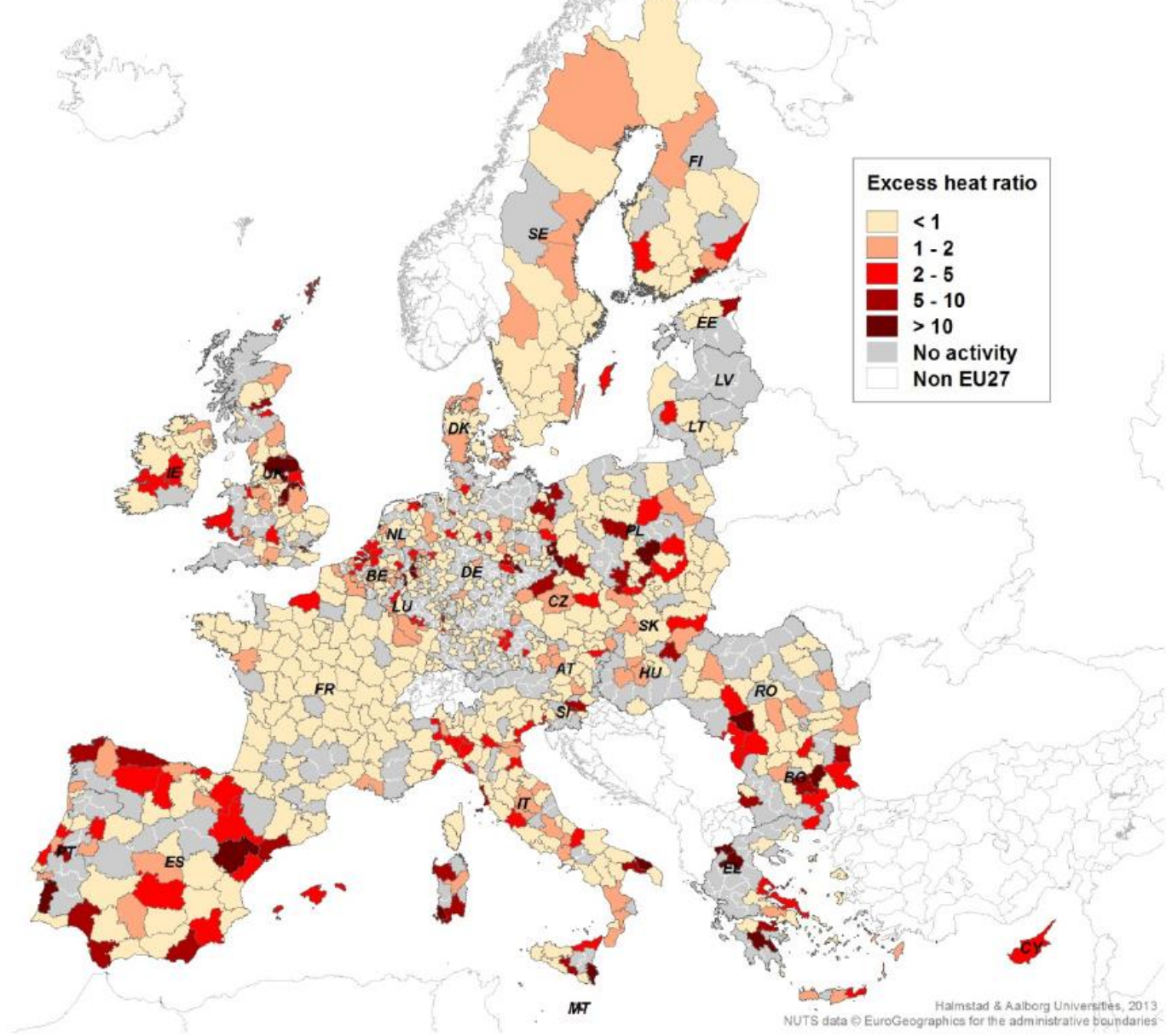

Figure 25: EU27 NUTS3 regions by their excess heat ratio, i.e. their share of excess heat relative their share of low temperature heat demands in residential and service sectors.

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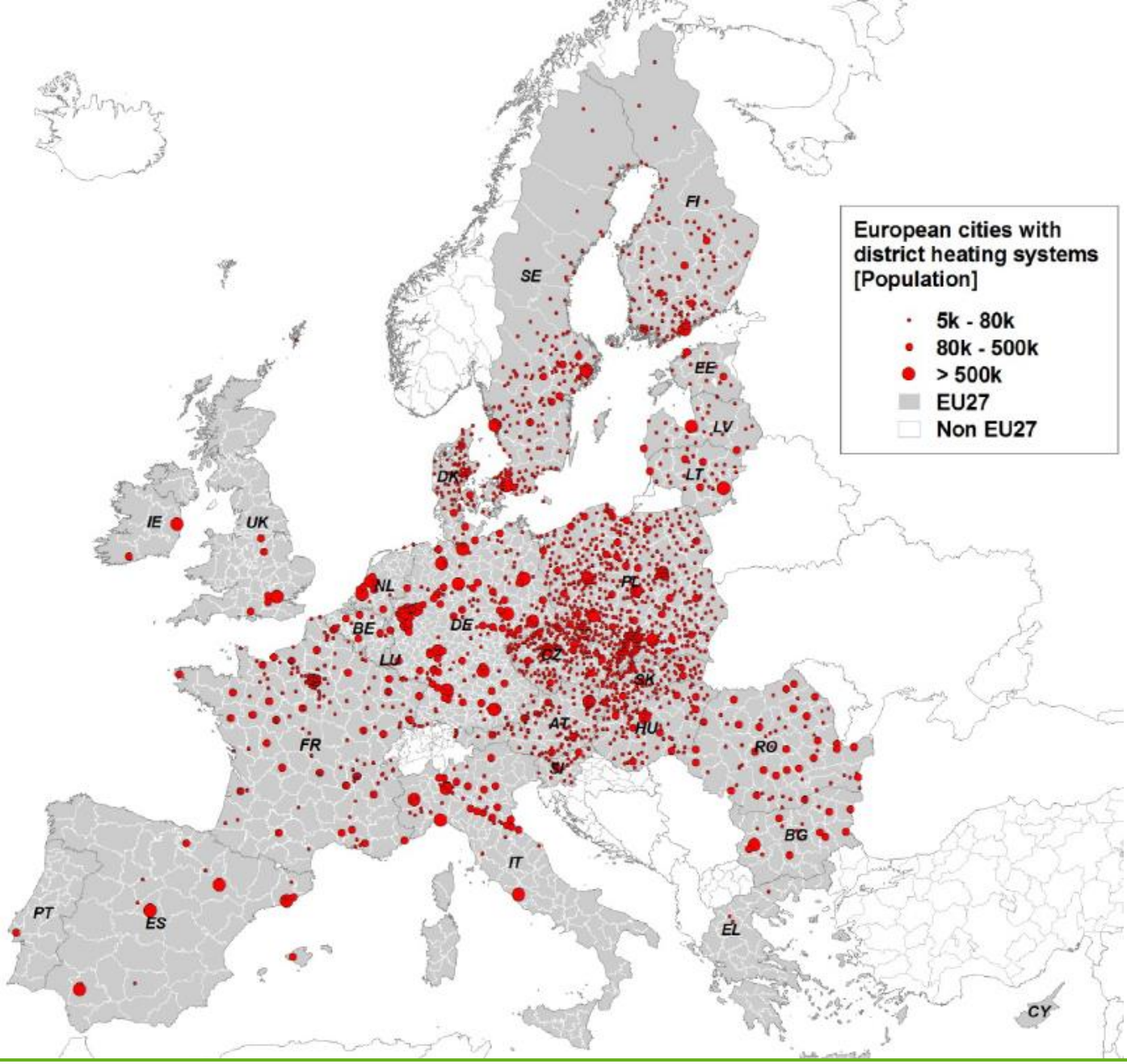
Heat Roadmap Europe

District heating today



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EnergyPLAN

INPUT

Demands
Electricity
Cooling
District Heating
Individual Heating
Fuel for Industry
Fuel for Transport

RES
Wind
Solar Thermal
Photovoltaic
Geothermal
Hydro Power
Wave

Capacities & efficiencies
Power Plant
Boilers
CHP
Heat Pumps
Electric Boilers
Micro CHP

Storage
Heat Storage
Hydrogen Storage
Electricity Storage
CAES

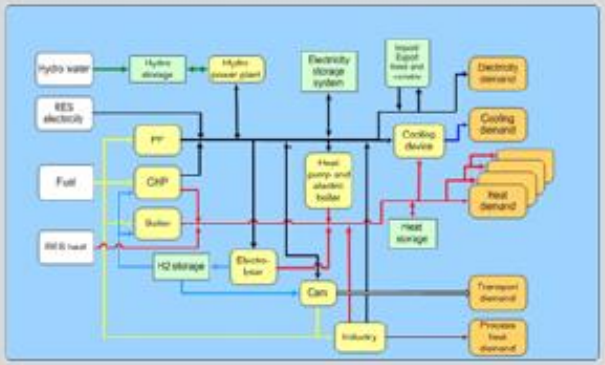
Transport
Petrol/Diesel Vehicles
Gas Vehicles
Electric Vehicles
V2G Electric Vehicles
Hydrogen Vehicles
Biofuel Vehicles

Distribution data
Electricity Demand | District Heating | Wind | Hydro | Wave | Waste
Solar thermal | Photovoltaic | Geothermal | Individual Heating
Industrial CHP | Transportation | Market Prices

Regulation
Technical Limitations
Choice of Strategy
CEEP Strategies
Transmission Cap.
External Electricity Market

Fuel Cost
Types of fuel
CO2 Emission Factor
CO2 Emission Costs
Fuel Prices

Cost
Variable Operation
Fixed Operation
Investment
Interest Rate



Either: **Technical regulation strategies**

1) Balancing heat demand
2) Balancing both heat and electricity demand
3) Balancing both heat and electricity demand (reducing CHP even when partially needed for grid stabilisation
4) Balancing heat demand using triple tariff

Or: **Electricity market strategy**

Market simulation of plant optimization based on business economic marginal production costs.

And: **Critical Excess Electricity Production**

Reducing wind
Replacing CHP with boiler or heat pump
Electric heating and/or bypass

OUTPUT

Results
(Annual, Monthly and Hourly Values)

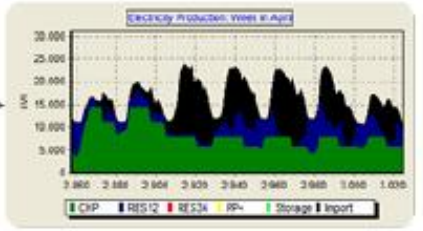
Electricity Production
Electricity Import/Export
electricity Excess Production

Import Expenditures
Export Revenues

Fuel Consumption

CO2 Emissions

Share of RES



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Heat Roadmap Europe (HRE); results

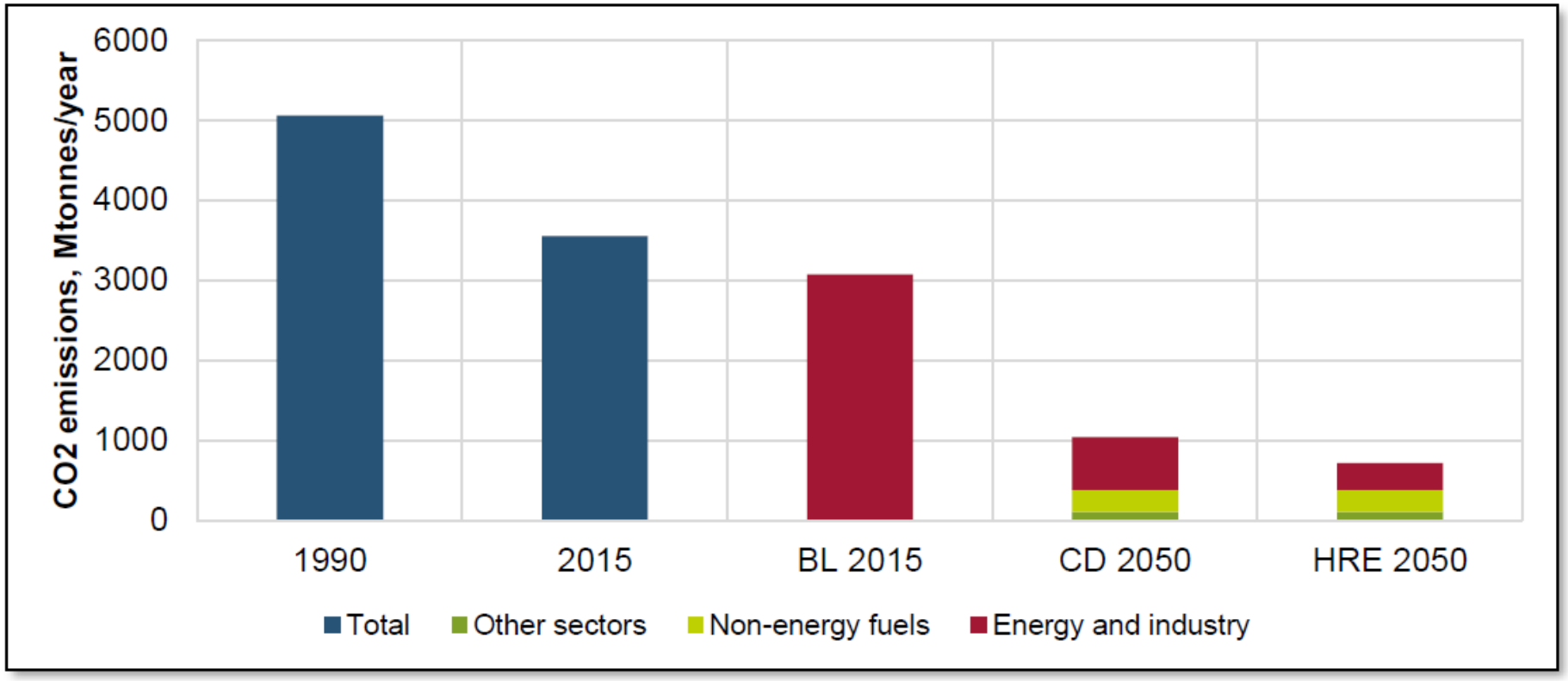

Figure 2. Historical, current and future CO_2 emissions for the 14 HRE4 countries; including the years 1990 [8] (the base year for the Paris Agreement), 2015 and the three 2050 scenarios; i.e. the Baseline (BL) 2050, which represents the development of the energy system under currently agreed policies; the Conventionally Decarbonized (CD) 2050, which represents the development of the energy system under a framework that encourages renewables, but does not radically change the heating and cooling sector; and the HRE 2050, which represents a redesigned heating and cooling system, considering different types of energy efficiency and better integration with the other energy sectors.

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Heat Roadmap Europe (HRE); results

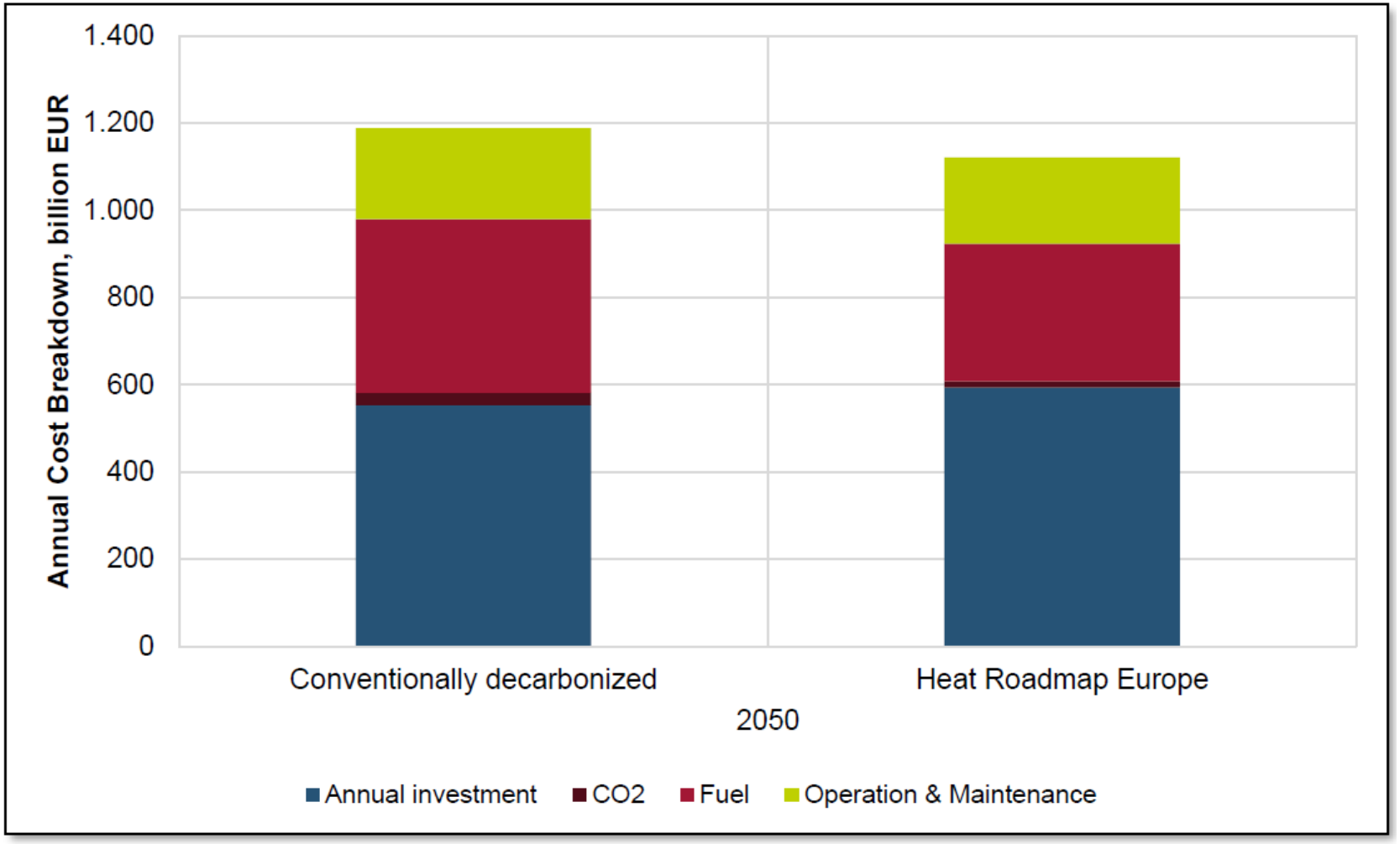

Figure 3. Annual total energy systems costs for the decarbonized 2050 scenarios. The Conventionally decarbonized energy system focusing on increasing the renewable energy penetration and some degree of energy savings reaches an 80% reduction in CO_2-emissions while the HRE 2050 scenarios reaches 86% at a lower cost using deeper renovations and an integrated new energy system design.

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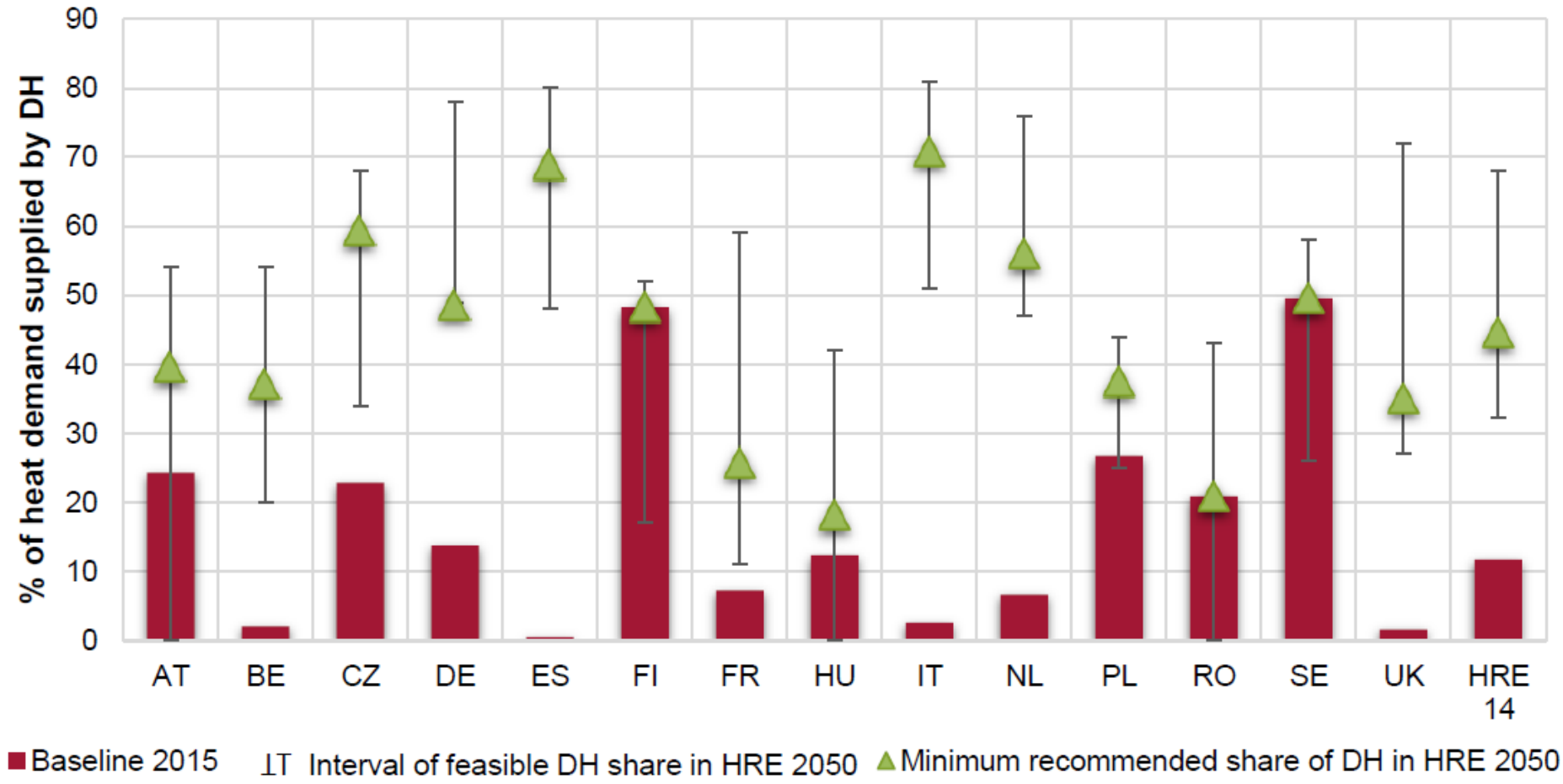
District heating in 2015 and the recommended share in HRE 2050



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Energy system Trends

- Energy supply security
  - Nature gas ?
  - Locale waste heat from powerplants / industries ?
  - Biomasses / wood ?
- Renewable energy DH
  - Future sources; solar and wind
- Community energy supply
  - Local ownership?
  - Benefits for society and every citizen and company?
- Energy efficiency DH systems
  - Best practice technology and management

Strategy

- Choice Awareness
- Radical technological change
  - Technique
  - Knowledge
  - Organisation
  - Product
  - Profit (sustainable local economy)
- Feasibility Studies

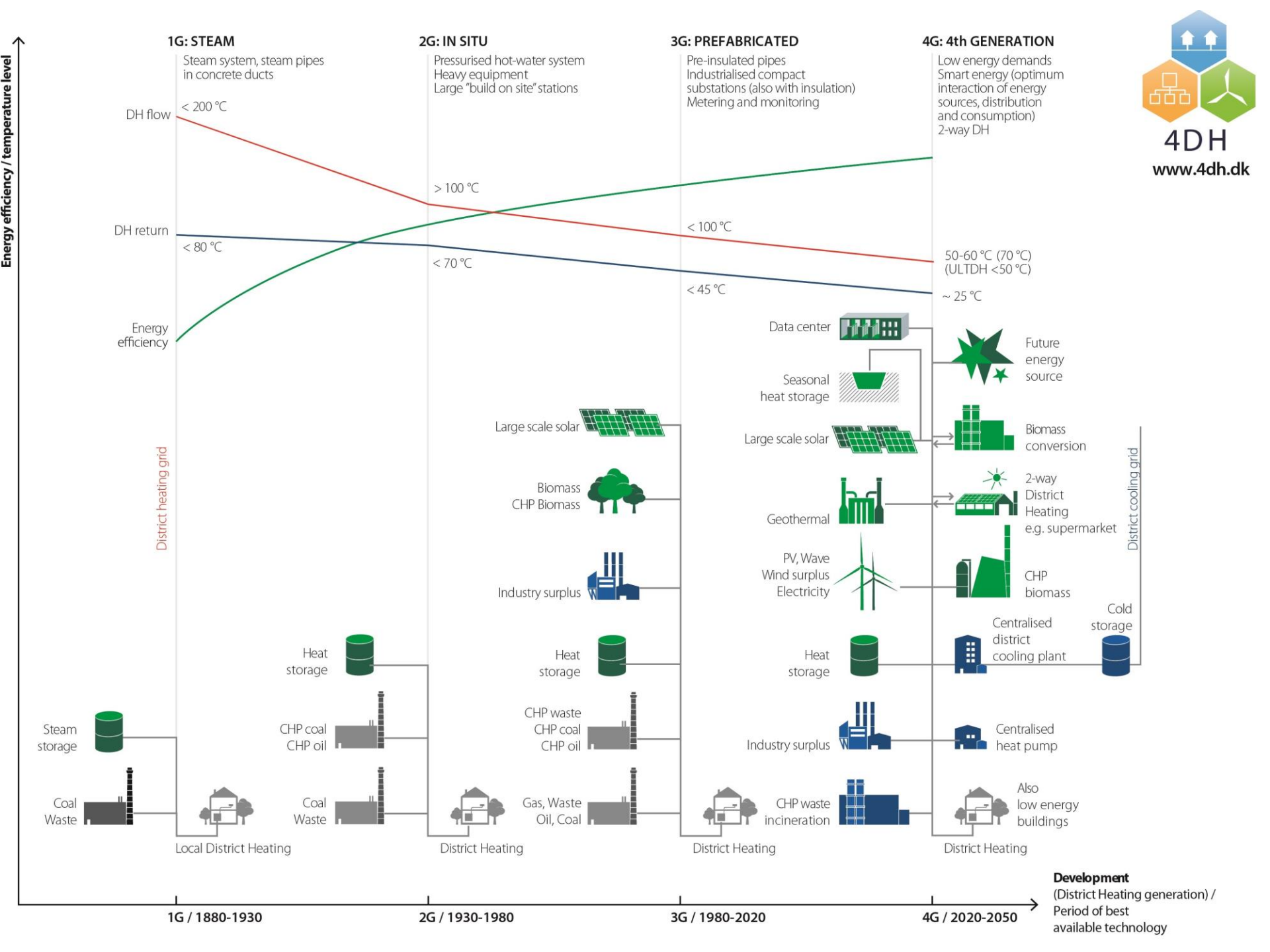
Methodology

1. Design of concrete technical alternatives

2. Feasibility studies based on institutional economics

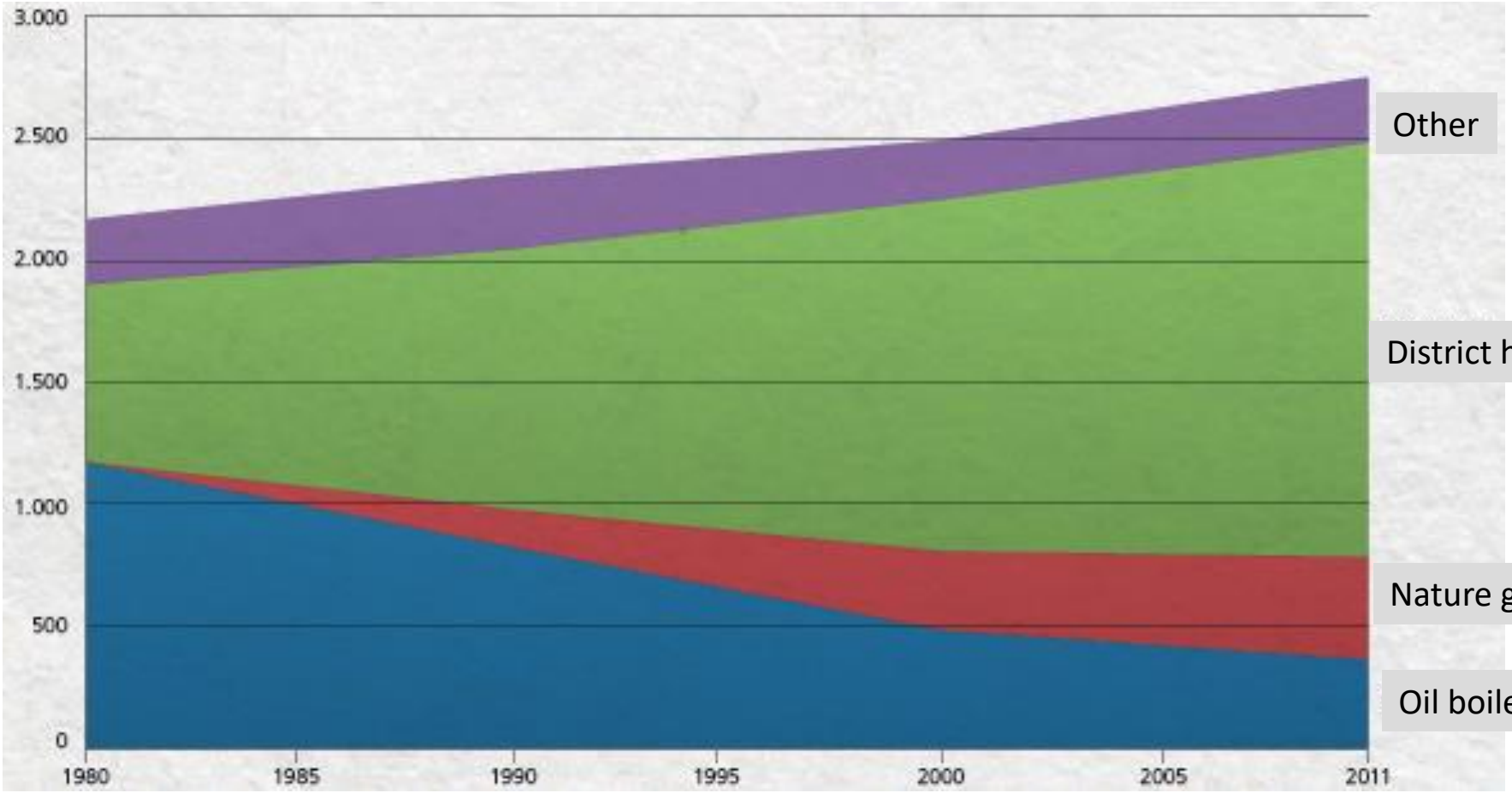
3. Public regulation measures proposals

4. Promotion og new-corporate democratic infrastructure


1G: STEAM
Steam system, steam pipes in concrete ducts
2G: IN SITU
Pressurised hot-water system
Heavy equipment
Large "build on site" stations
3G: PREFABRICATED
Pre-insulated pipes
Industrialised compact substations (also with insulation)
Metering and monitoring
4G: 4th GENERATION
Low energy demands
Smart energy (optimum interaction of energy sources, distribution and consumption)
2-way DH
4DH
www.4dh.dk
Energy efficiency / temperature level
DH flow
< 200 °C
> 100 °C
< 100 °C
50-60 °C (70 °C)
(ULTDH <50 °C)
DH return
< 80 °C
< 70 °C
< 45 °C
~ 25 °C
Energy efficiency
District heating grid
District cooling grid
Data center
Seasonal heat storage
Large scale solar
Future energy source
Biomass conversion
2-way District Heating e.g. supermarket
CHP biomass
Cold storage
Centralised district cooling plant
Centralised heat pump
Also low energy buildings
Large scale solar
Biomass CHP Biomass
Industry surplus
Heat storage
CHP waste CHP coal CHP oil
Gas, Waste Oil, Coal
Geothermal
PV, Wave Wind surplus Electricity
Heat storage
Industry surplus
CHP waste incineration
Steam storage
Coal Waste
Heat storage
CHP coal CHP oil
Coal Waste
Local District Heating
District Heating
District Heating
District Heating
1G / 1880-1930
2G / 1930-1980
3G / 1980-2020
4G / 2020-2050
Development
(District Heating generation) / Period of best available technology

Heating installations in Denmark

(numbers in 1.000 pcs.)



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- Consulting Engineers
- >30 years working with renewable energy
- 40 employees
- Offices in
  - Skørping
  - Aarhus
  - Copenhagen

- District heating
  - Solar thermal
  - Seasonal storages
  - Heat pumps
  - and other renewables
- Energy planning
- Biogas
- Planning of wind and PV farms

Thank you for your attention!

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