

CITIES, 26-27 MAY, 2014

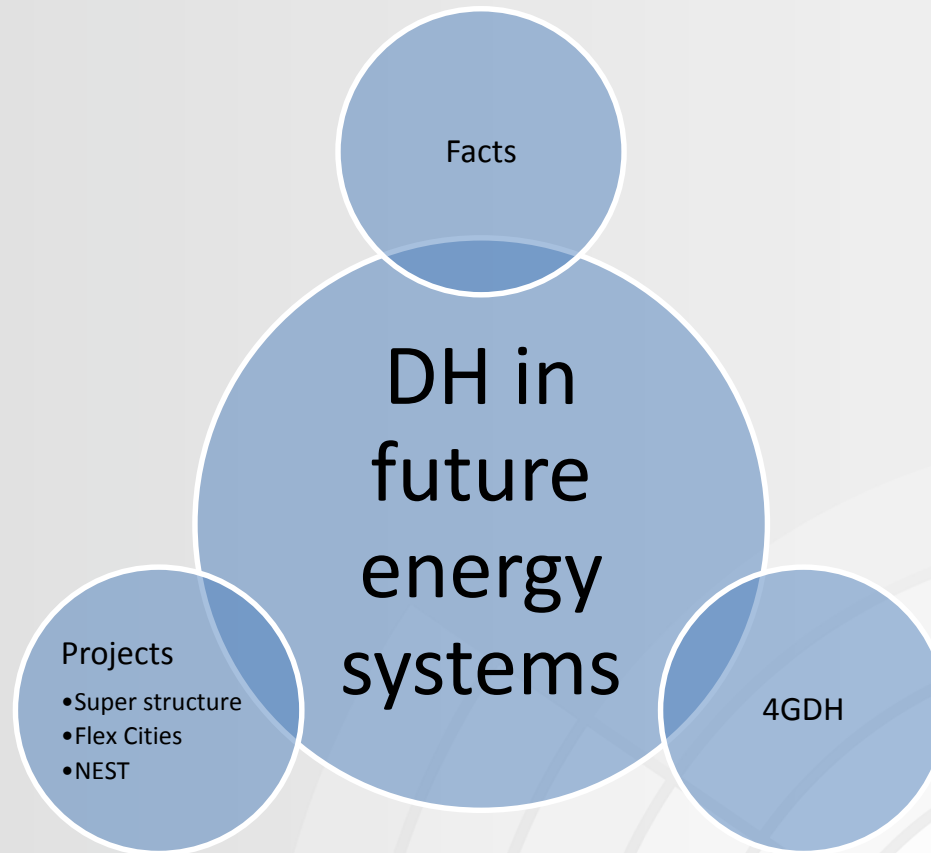
DH IN FUTURE ENERGY SYSTEMS

MORTEN HOFMEISTER
HEAD OF INNOVATION PROJECTS
GRØN ENERGI

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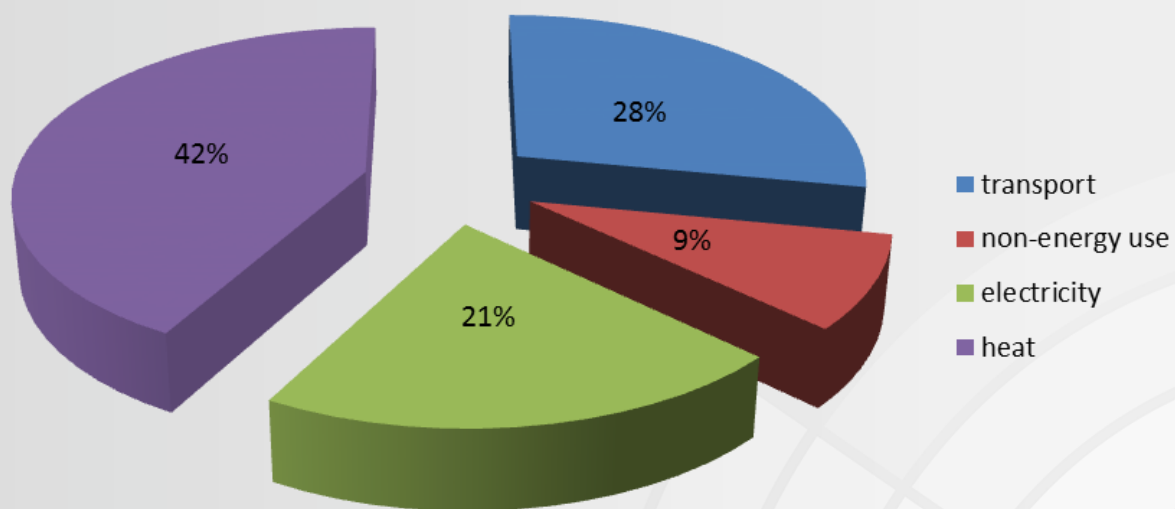


DH IN FUTURE ENERGY SYSTEMS



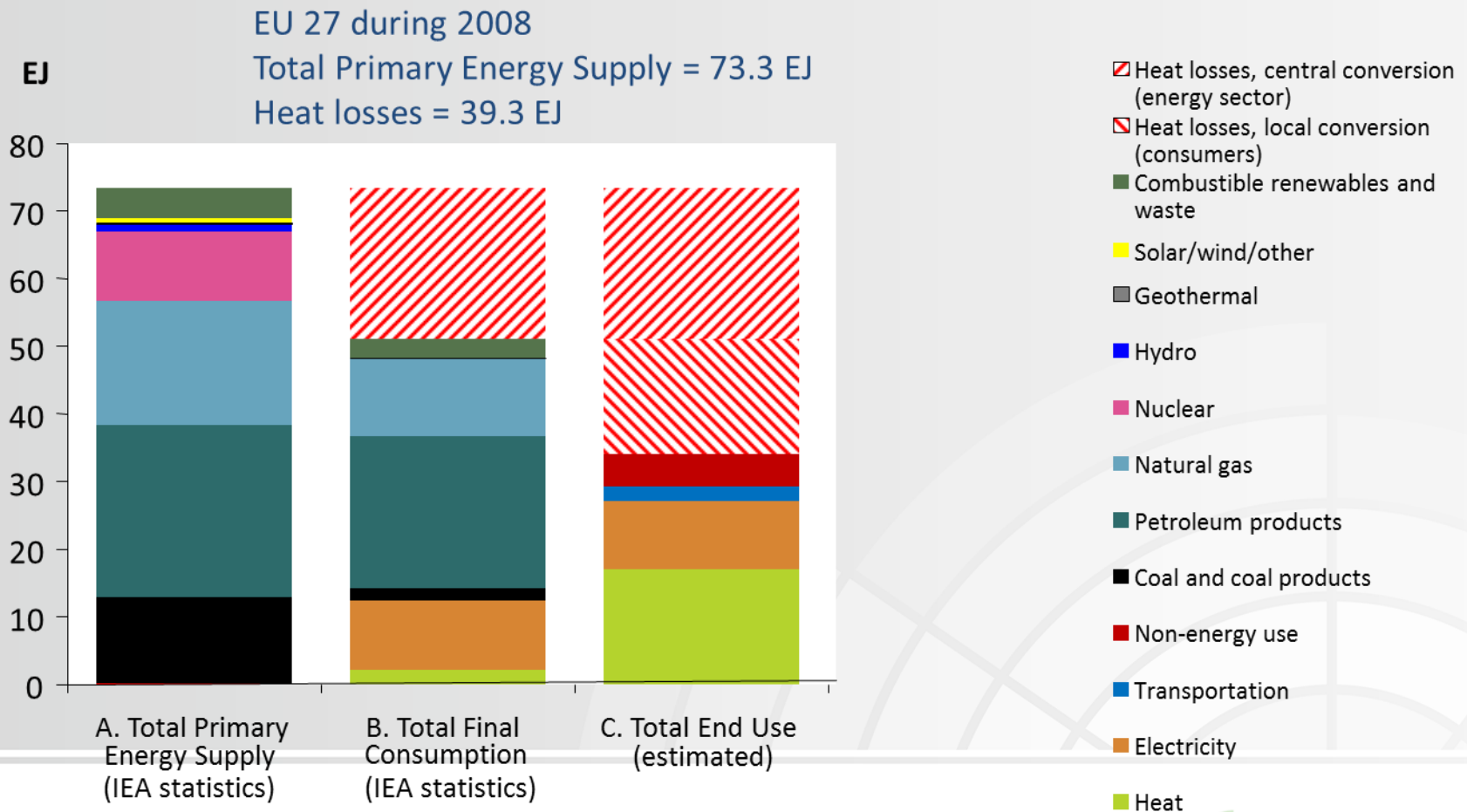
HEAT: THE ELEPHANT IN THE ROOM !

Final energy demand by energy service, 2011 (EU 27)



FACTS

THE EU IS WASTING ENERGY (HEAT)...



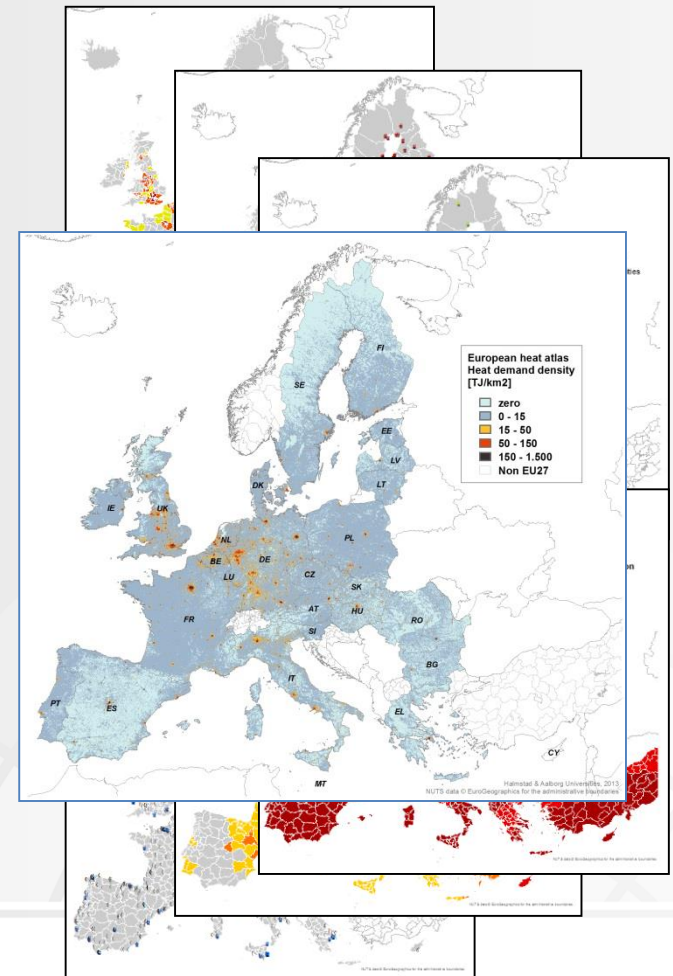
FACTS

Opportunity

- Heat Demand in Urban Areas

MANY ENERGY SOURCES

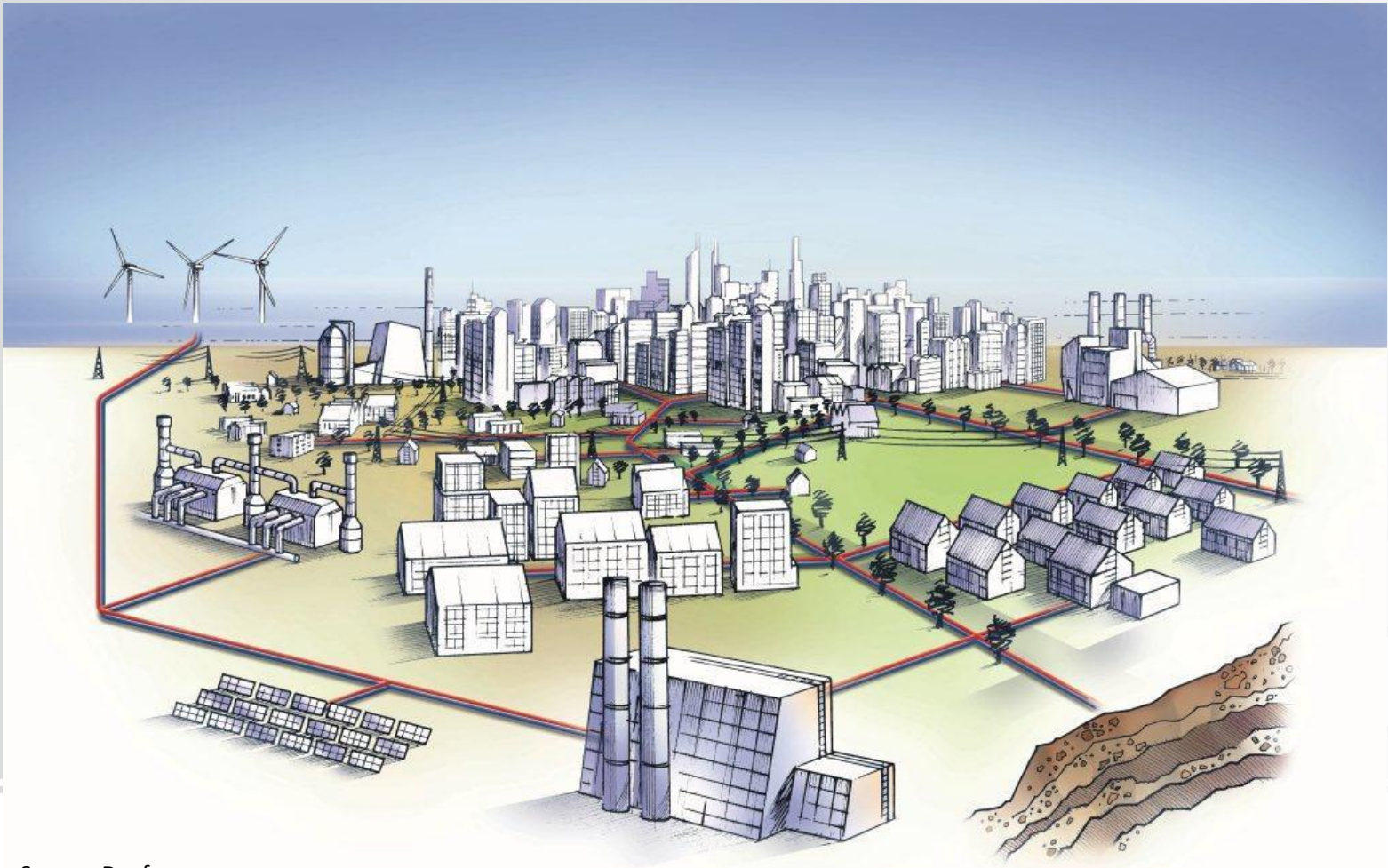
- Power and Heat Generation
- Waste Management
- Industrial waste heat
- Geothermal heat
- Solar Thermal



Source: Heat Roadmap Europe II (2013)

FACTS

DHC – 'FUTURE-PROOF' INFRASTRUCTURES

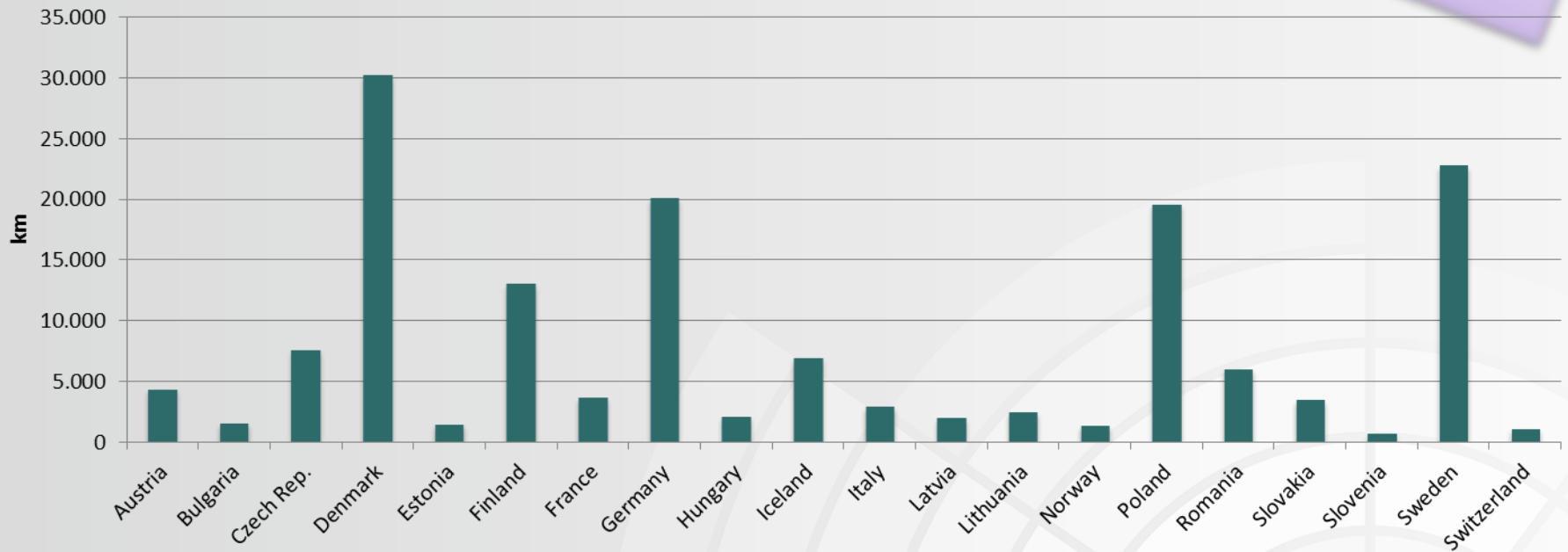


Source: Danfoss

FACTS

Top 3 trench length of DH pipeline system:
Denmark (over 30,000 km), Sweden (nearly 23,000 km) and Germany (over 20,000 km)

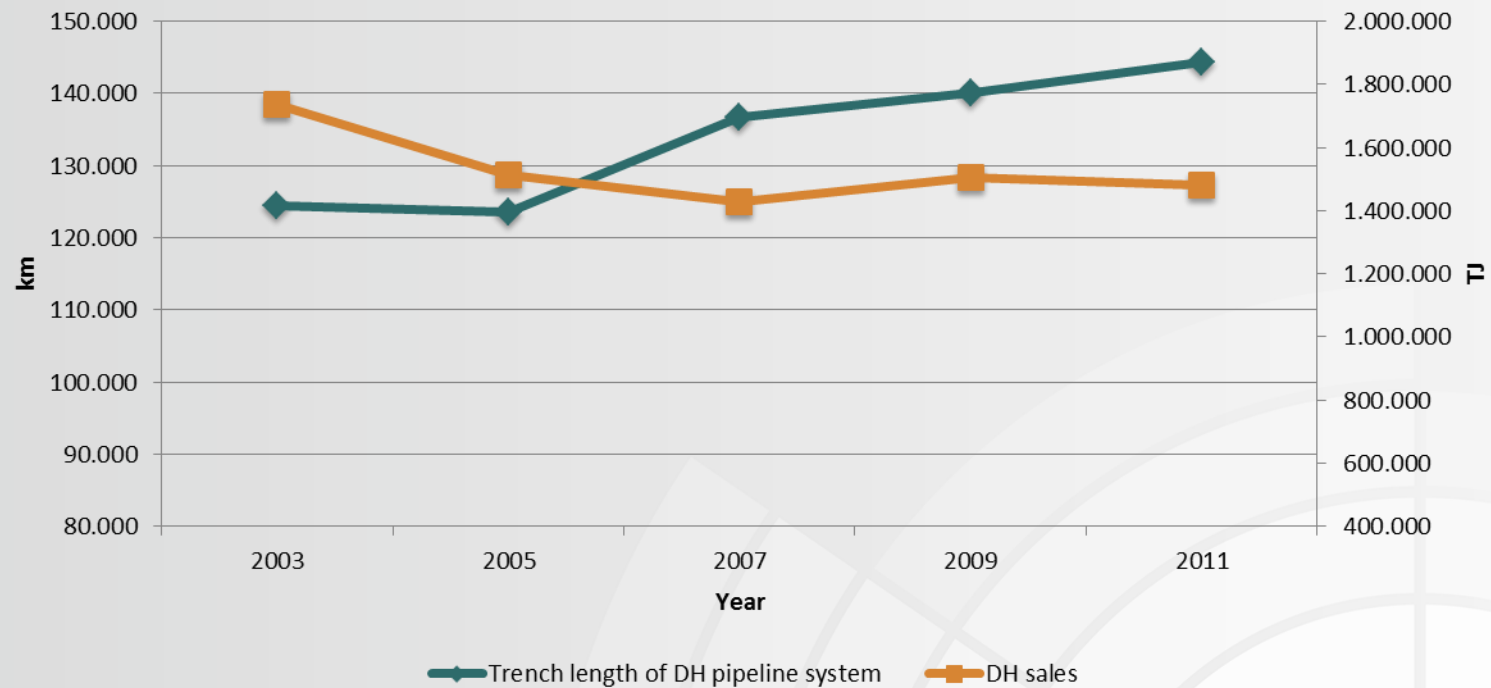
Trench length of District Heating pipeline system in 2011



Source: Euroheat & Power (DHC Country by Country survey 2013)

FACTS

Development of total trench length of DH pipeline system & total DH sales

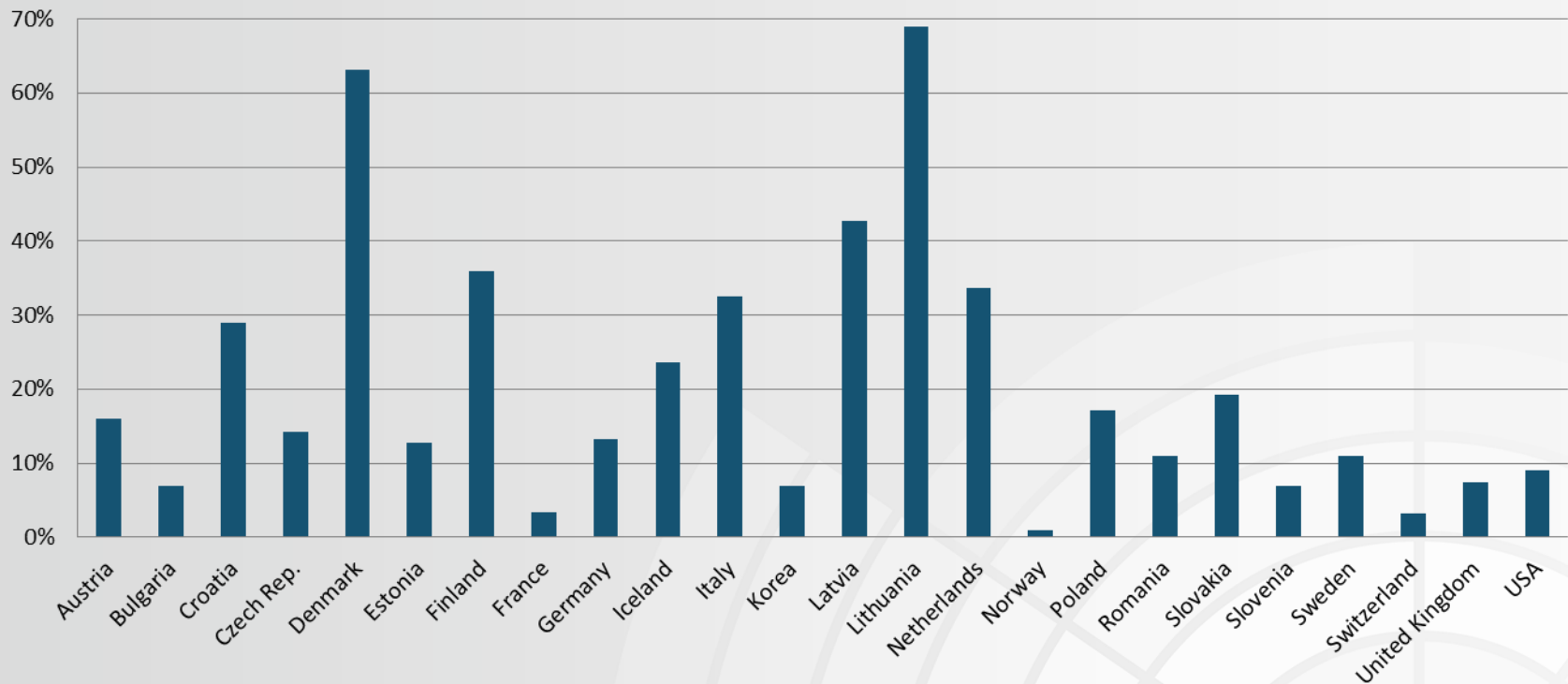


Source: Euroheat & Power (DHC Country by Country survey 2005, 2007, 2009, 2011 and 2013)

FACTS

SHARE OF CHP IN ELECTRICITY GENERATION

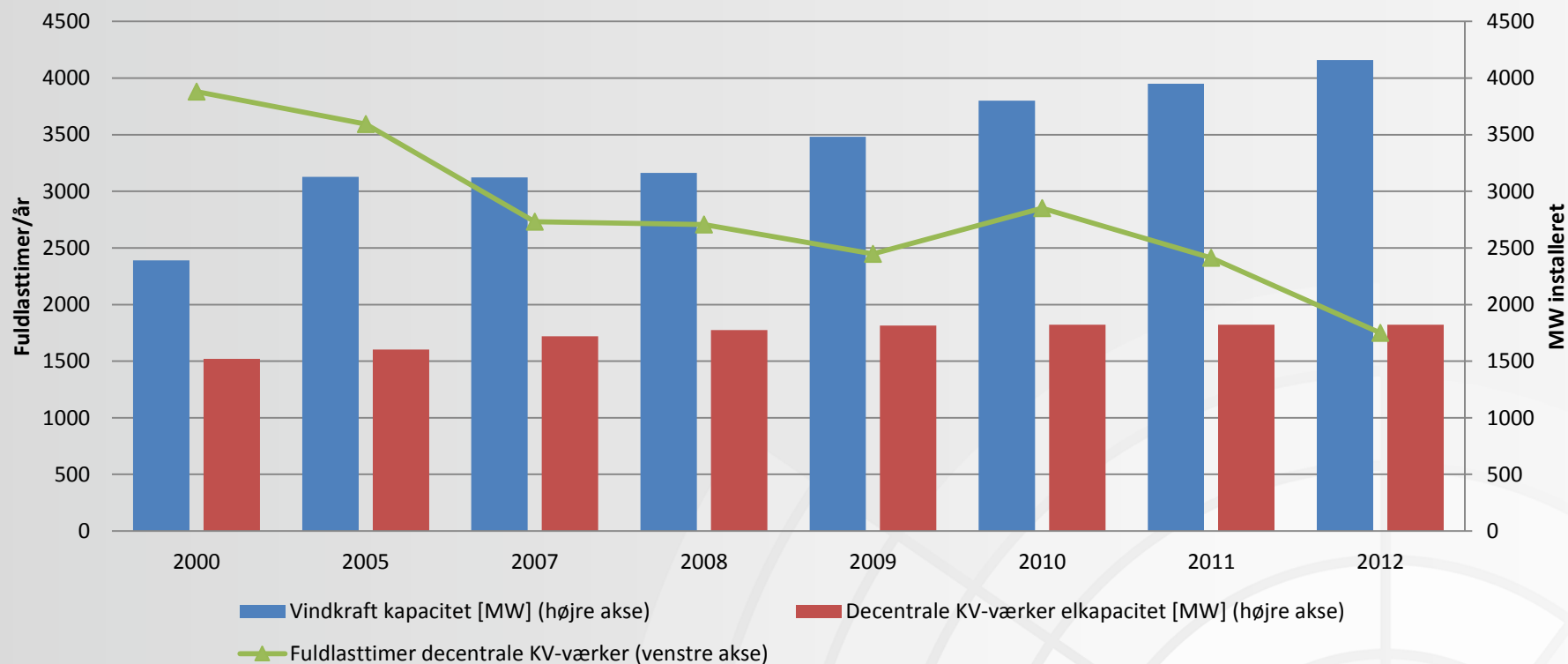
Total share of CHP in national electricity production in 2011



Source: Euroheat & Power (DHC Country by Country survey 2013)

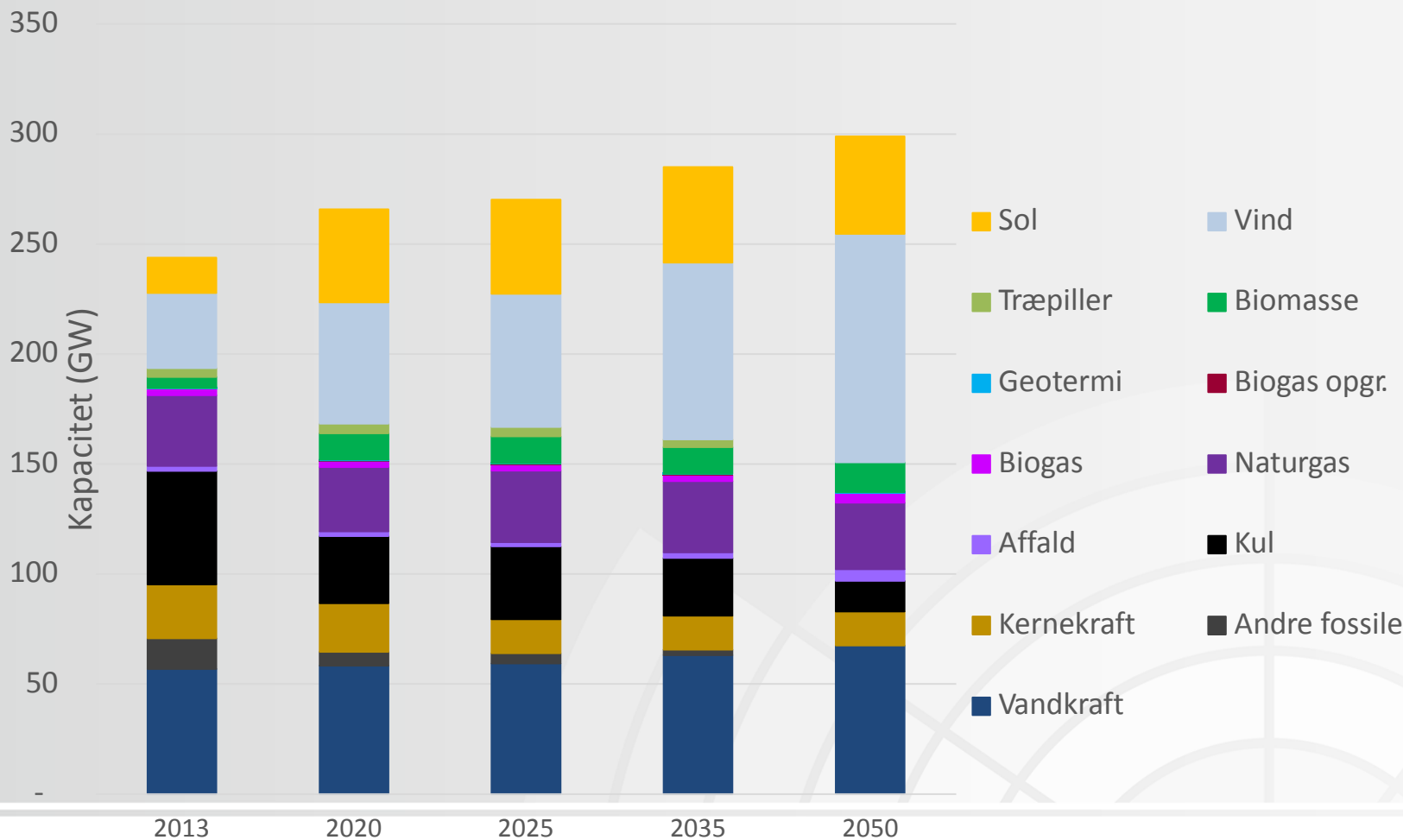
REDUCTION IN CHP-PRODUCTION IN DENMARK

Fulldlasttimer på decentrale værker



Wind and PV increase to more than 40 % of total electricity production in the Nordic countries and Germany

Source: EA Energianalyse, Balmorel-calculations



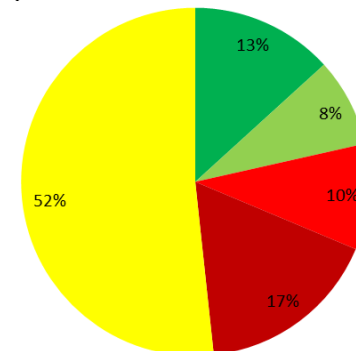


160 phone
interviews May-
October 2013

Result: 600 MWe
gas-CHP may not
be present by
2020

Antal: 297 anlæg
Kap: 1.038 MW

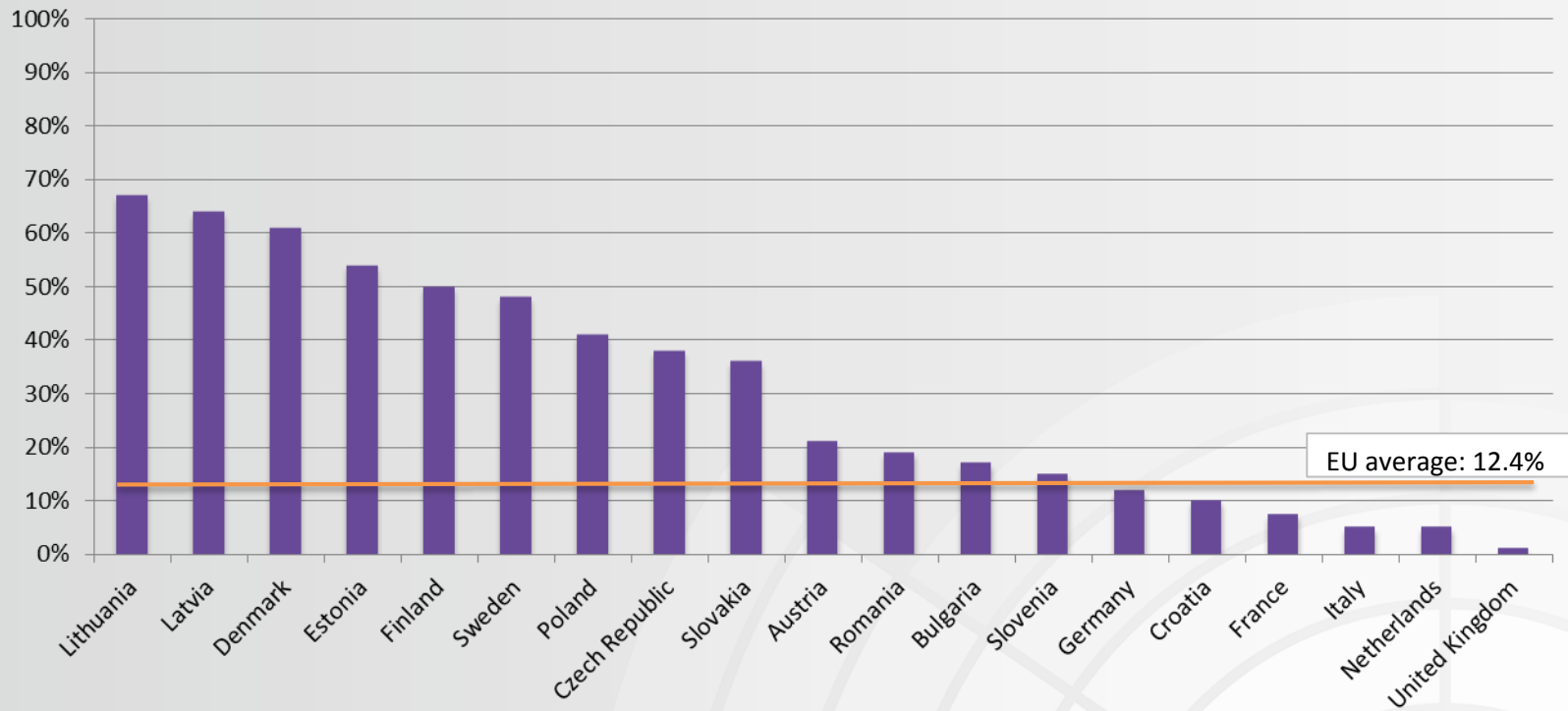
Samlet



- Ja, det har bestyrelsen besluttet
- Ja, men endnu ikke besluttet af bestyrelsen
- Nej, det har bestyrelsen besluttet
- Nej, men endnu ikke besluttet af bestyrelsen
- Ved ikke

FACTS

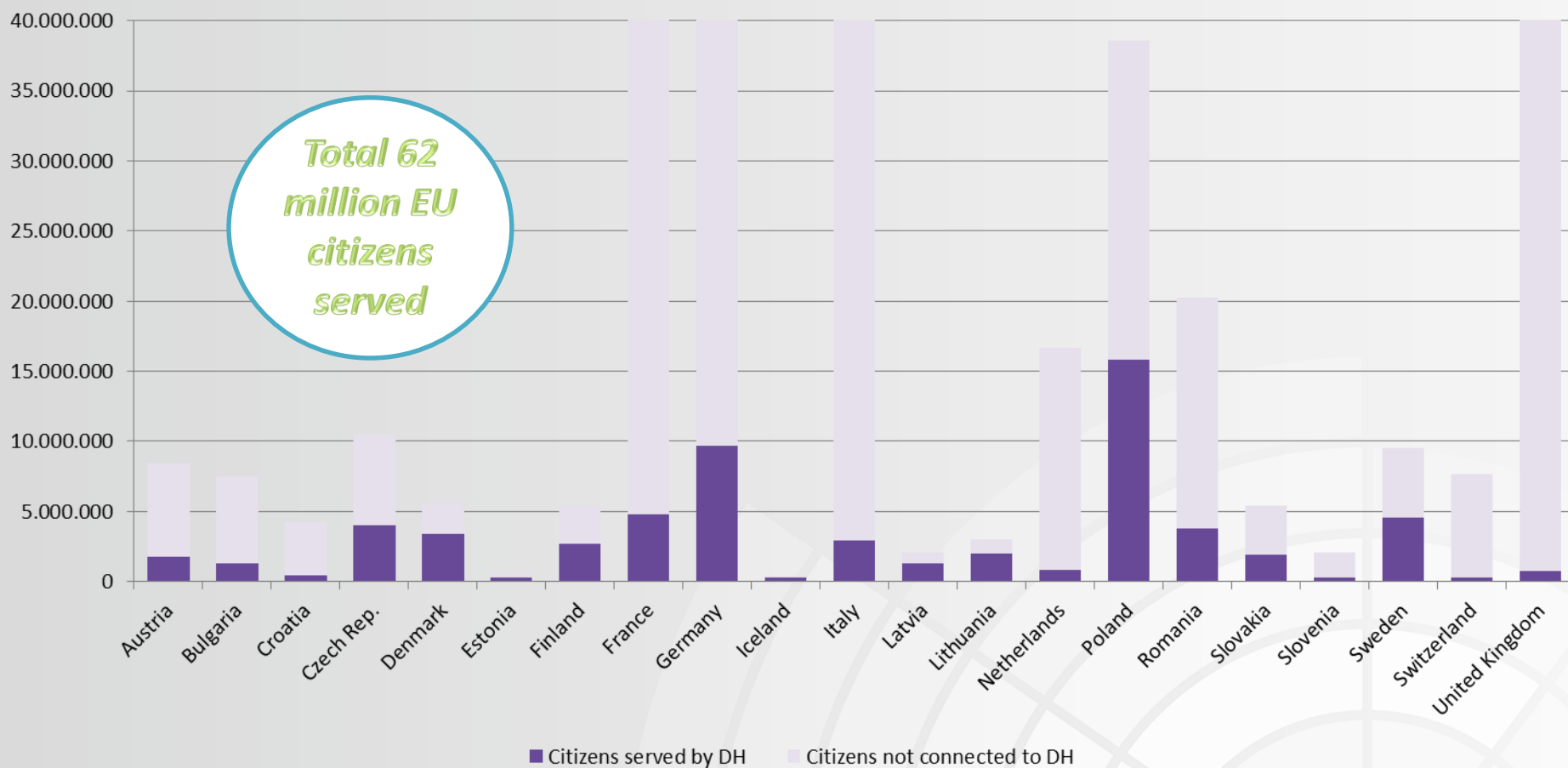
Share of citizens served by District Heating in EU countries (in 2011)



Source: Euroheat & Power (DHC Country by Country survey 2013)

FACTS

Number of citizens served by District Heating (in 2011)



Source: Euroheat & Power (DHC Country by Country survey 2013)

FACTS

50% DH AND CHP

- Decrease primary energy supply and especially fossil fuels and CO2 emissions
- Decrease annual costs of energy in Europe by approximately €14 Billion in 2050
- Create additional 220,000 jobs over the period 2013-2050
- Further integration of RES

LESS FUEL

LESS MONEY

MORE EU JOBS

MORE RE



HEAT ROADMAP
EUROPE 2050

FIRST PRE-STUDY FOR THE EU27



Aalborg University
David Connolly
Brian Vind Mathiesen
Poul Alving Østergaard
Bernard Möller
Steffen Nielsen
Henrik Lund

Halmstad University

Ulrich Persson
Daniel Nielsen
Sven Werner

PlanEnergi
Daniel Trier



EUROHEAT
& POWER

FACTS

SECTOR'S OWN VIEW OF THE FUTURE

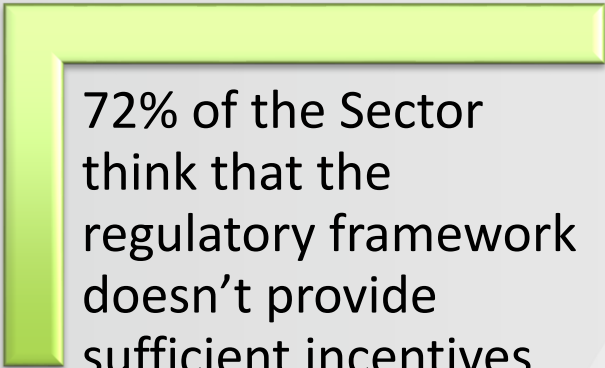
49% of the Sector see their own business growing over the next 5 years

46% of the Sector see their level of investment related to DHC growing over the next 5 years

64% of the Sector have or are involved in investment plans in RES to be realised in the next 5 years

Source: Euroheat & Power (2013 District Heating and Cooling Barometer)

CHALLENGES AHEAD



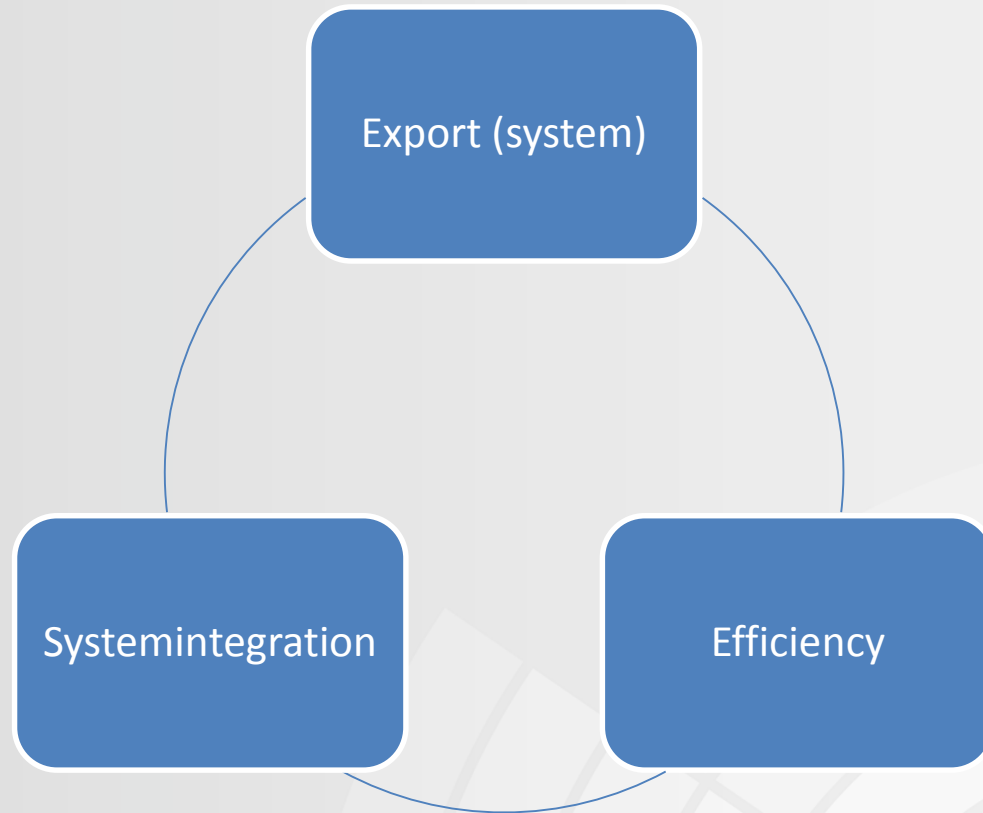
72% of the Sector think that the regulatory framework doesn't provide sufficient incentives to the development of DHC



49% of the Sector believe that R&D in DHC requires more attention/funding in order to keep pace with competing technologies

Source: Euroheat & Power (2013 District Heating and Cooling Barometer)

PRIORITIES OF "GRØN ENERGI"



GENERATIONS OF DISTRICT HEATING – 4GDH

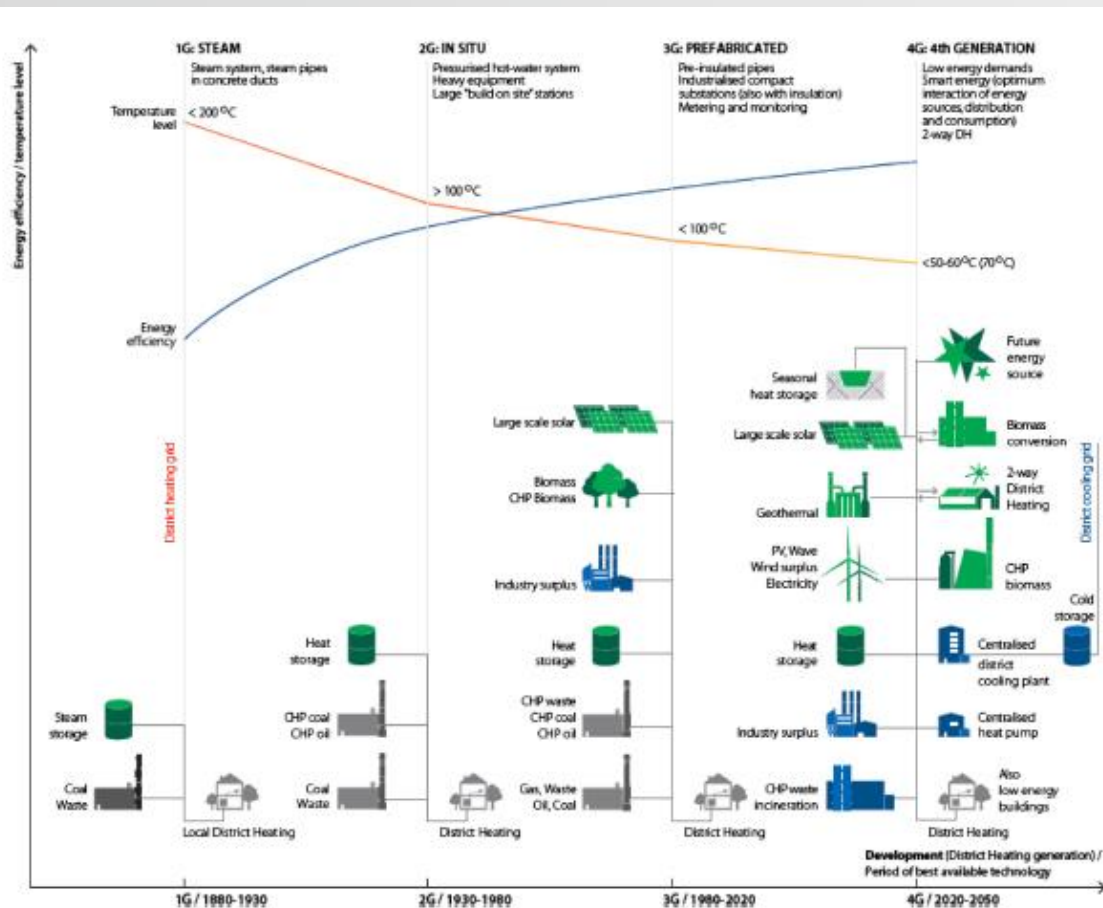


Fig. 2. Illustration of the concept of 4th Generation District Heating in comparison to the previous three generations.

DH's role in future sustainable energy systems requires meeting the challenges:

1. Low temperature DH to old and new buildings
2. Distribute heat with low heat losses
3. Recycle heat from low temperature sources and integrate renewables
4. Integrated part of smart energy systems
5. Suitable planning, cost and motivation structures

Source: Lund H., et al., 4th generation District Heating (4GDH), Energy 2014, <http://dx.doi.org/10.1016/j.energy.2014.02.089>

www.4dh.dk annual conference 18 August 2014

WHAT IS THE OPTIMAL STRUCTURE?



Estimated investments in Eastern Jutland:

Total approx. 2,500 MWth,
cost for each technology:

- CHP: DKK 25 bln
- Solar thermal and storage: DKK 35 bln
- Heat pumps and heat storage: DKK 20 bln

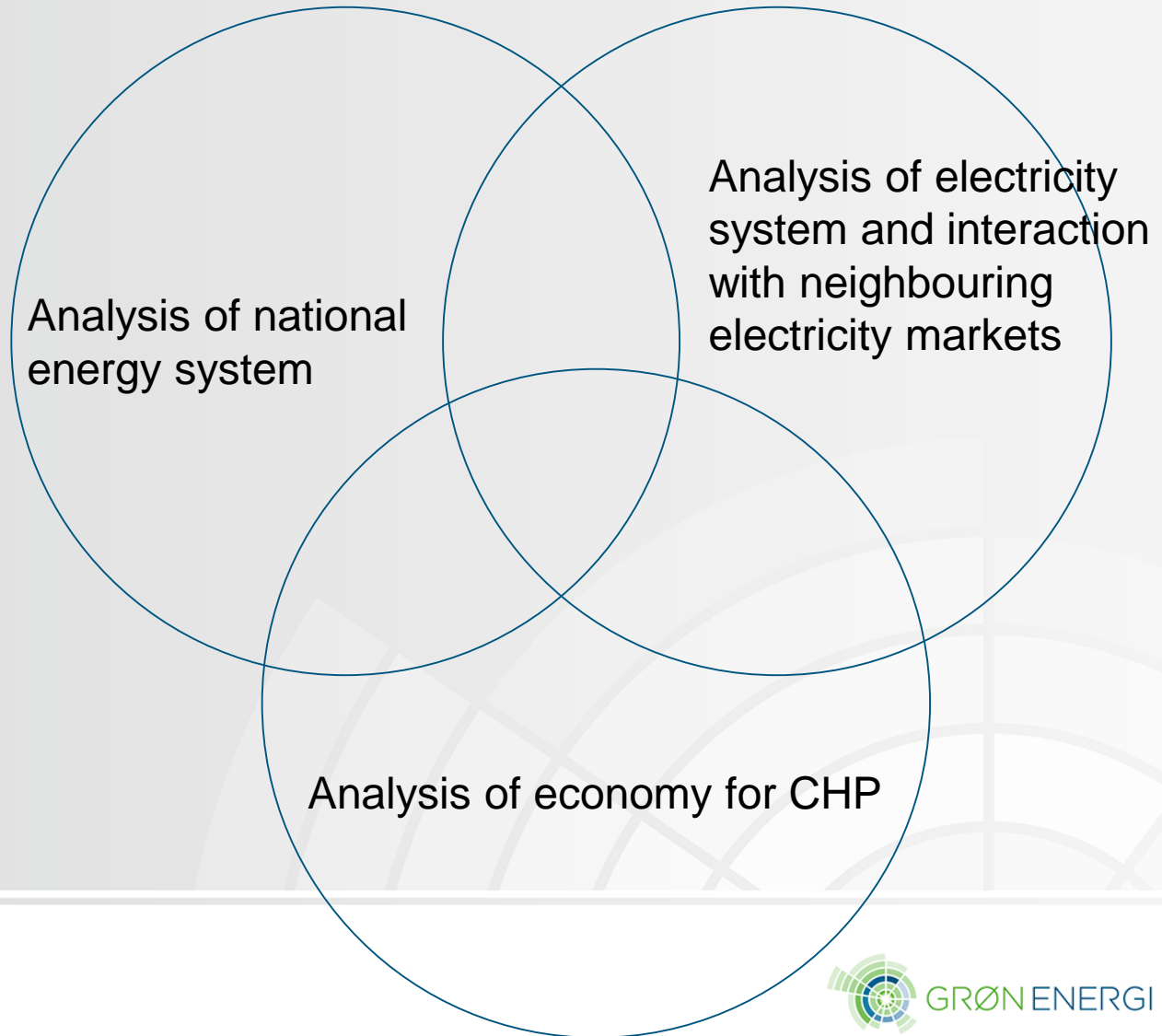
1 % error margin equals
DKK 200-400 million

ENERGY SYSTEM MODELS

Optimise the choice of scenario – not only the scenarios

A lot of choices to be made – CHP, solar, heat pumps, heat storages:

More than 50 decisions
 $2^{50} = 112589990684262$



SUPERSTRUCTURE OPTIMISATION

How to model and optimise investments in the future DH infrastructure

- Remaining technical lifetime for existing production assets
- Establishment and use of transmission pipelines
- Establishment and use of heat storages
- Investments in new heat production capacity
 - Type
 - Size
 - Location
 - Timing

Workshop 24 March 2014

Conclusions:

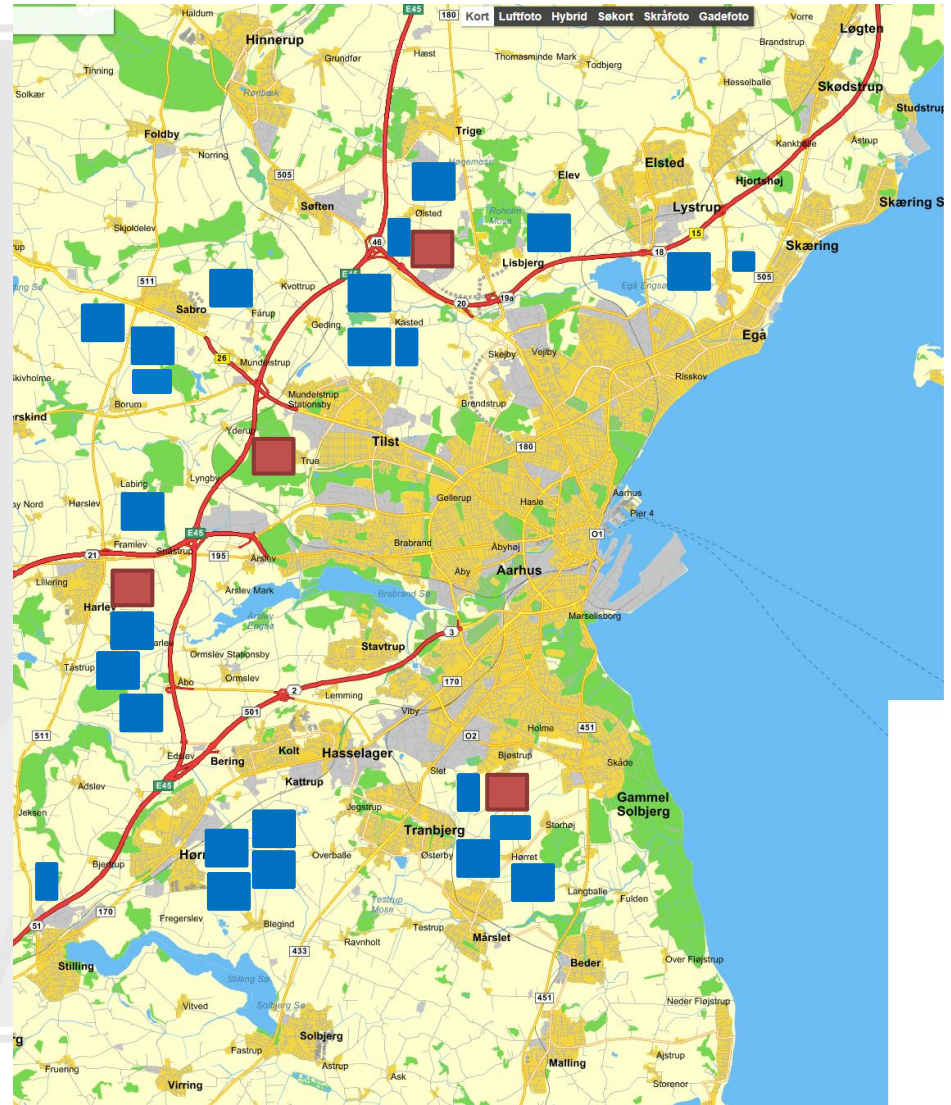
- **No existing model meets the demand of modelling and optimising choice of technology and operation – combined optimisation model and optimisation algorithm**
- **Large DH-grids is a pre-requisite for decentralised production of renewable energy**
- **The link between temperatures in the system and various renewable energy technologies is vital for the efficiency – this requires detailed data (hour)**

SOLAR THERMAL – 100 % IN AARHUS

(NOT A PROJECT – FOR ILLUSTRATION)

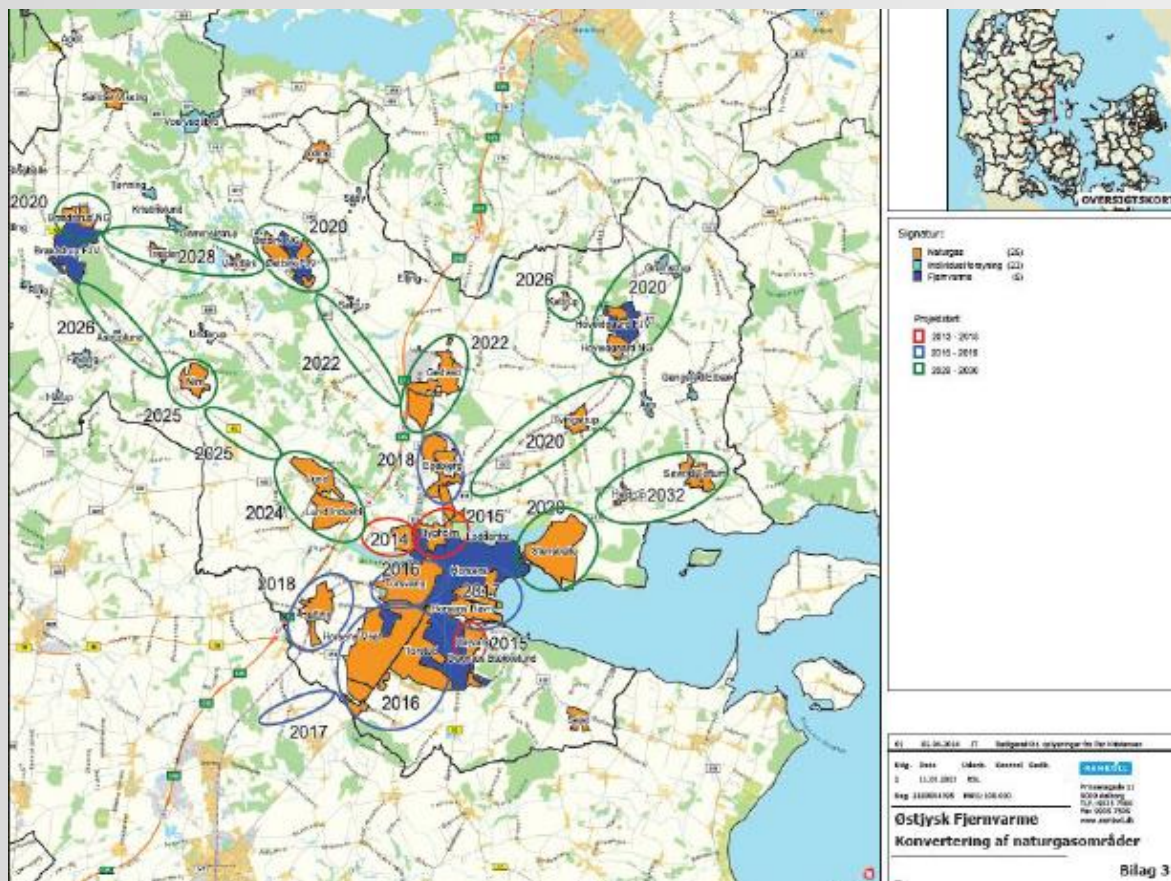
Total investment DKK 12-15 bln

Main challenge is area of 25 km²



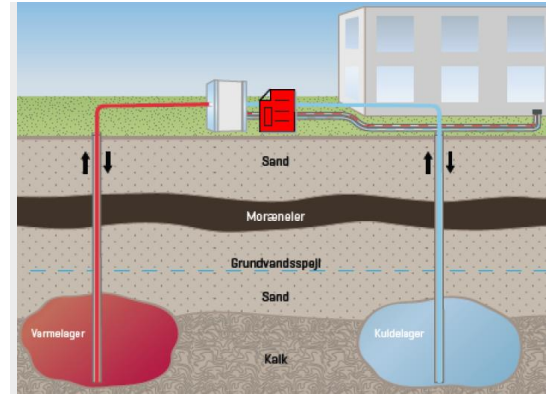
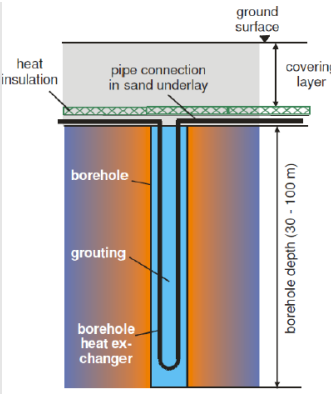
FLEX CITIES PROJECT

CONVERSION FROM NATURAL GAS (ORANGE) TO DH (BLUE)



HEAT STORAGES AND LARGE HEAT PUMPS IN DH IN DENMARK

Potentialet for nye damvarmelagre og borehulslagre er tilsvarende opgjort til 2.800 GWh lagerkapacitet.



Steel tanks
Amount: 284
Cap: 50 GWh

Pit heat storage
Amount: 4
Cap: 13 GWh

Bore hole
Amount: 1
Cap: 630 MWh

Aquiferlagre
Amount: 8 only 1 in relation to DH



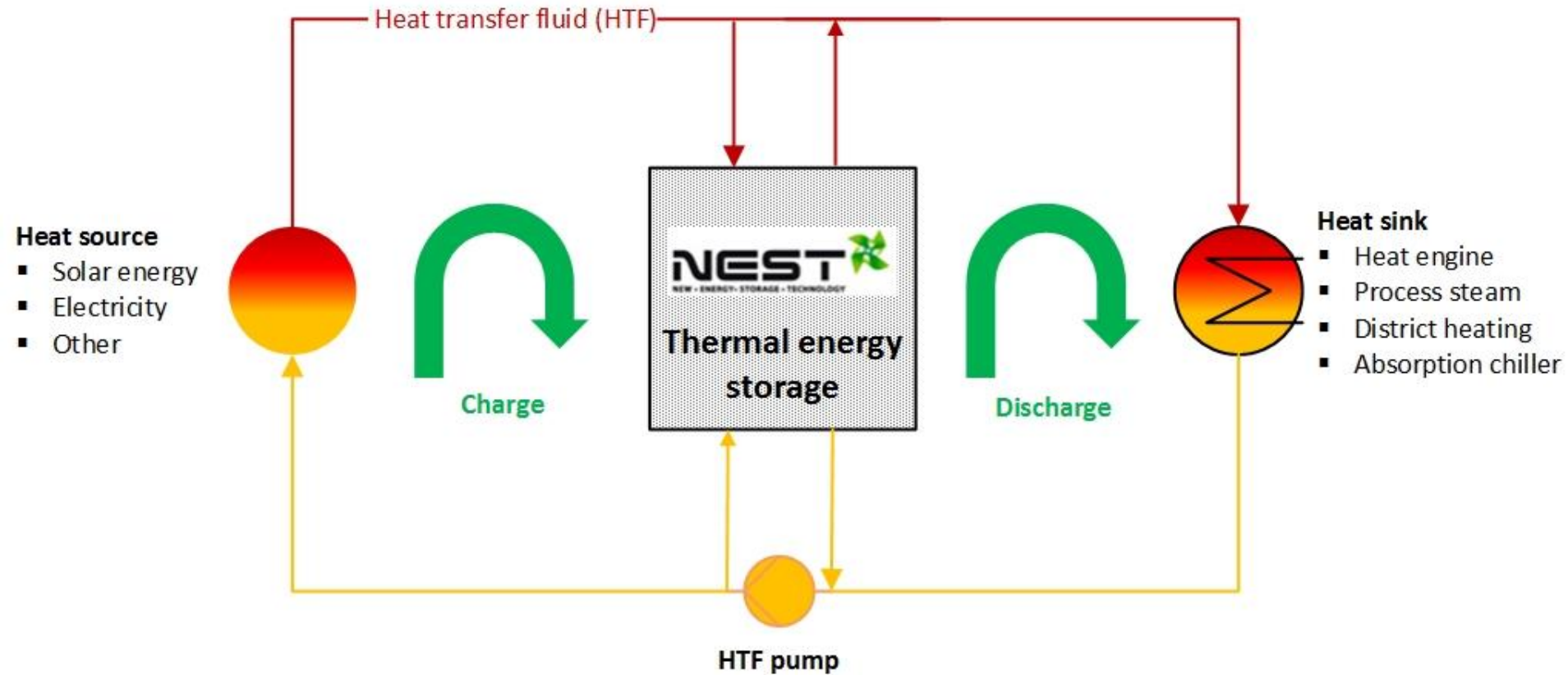
A manual on large scale heat pumps is now elaborated

Electricity heat pumps
Amount: 14
El. power: 17 MW
Heat cap.: 75 MW

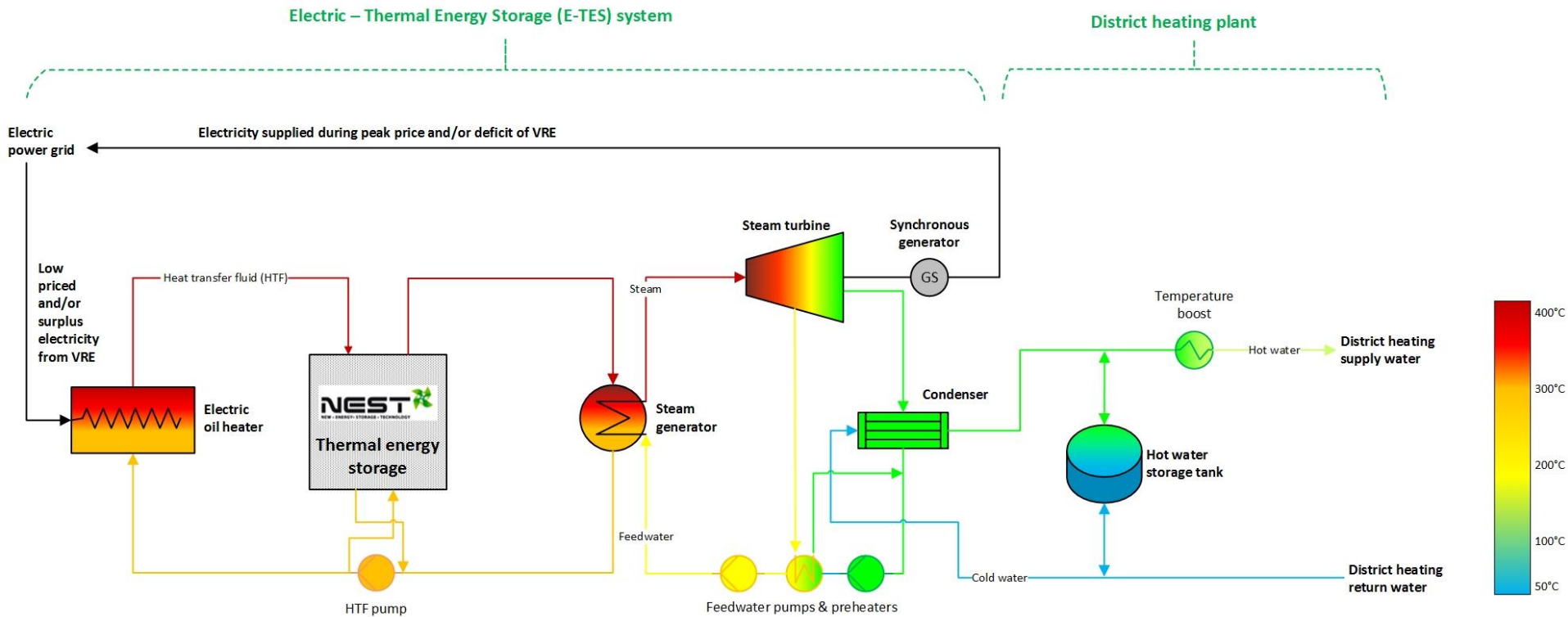
Absorption heat pump
Amount: 18
Cap.: 55 MW

El. boilers
Amount: 37
El. power: 295 MW
Heat cap.: 295 MW

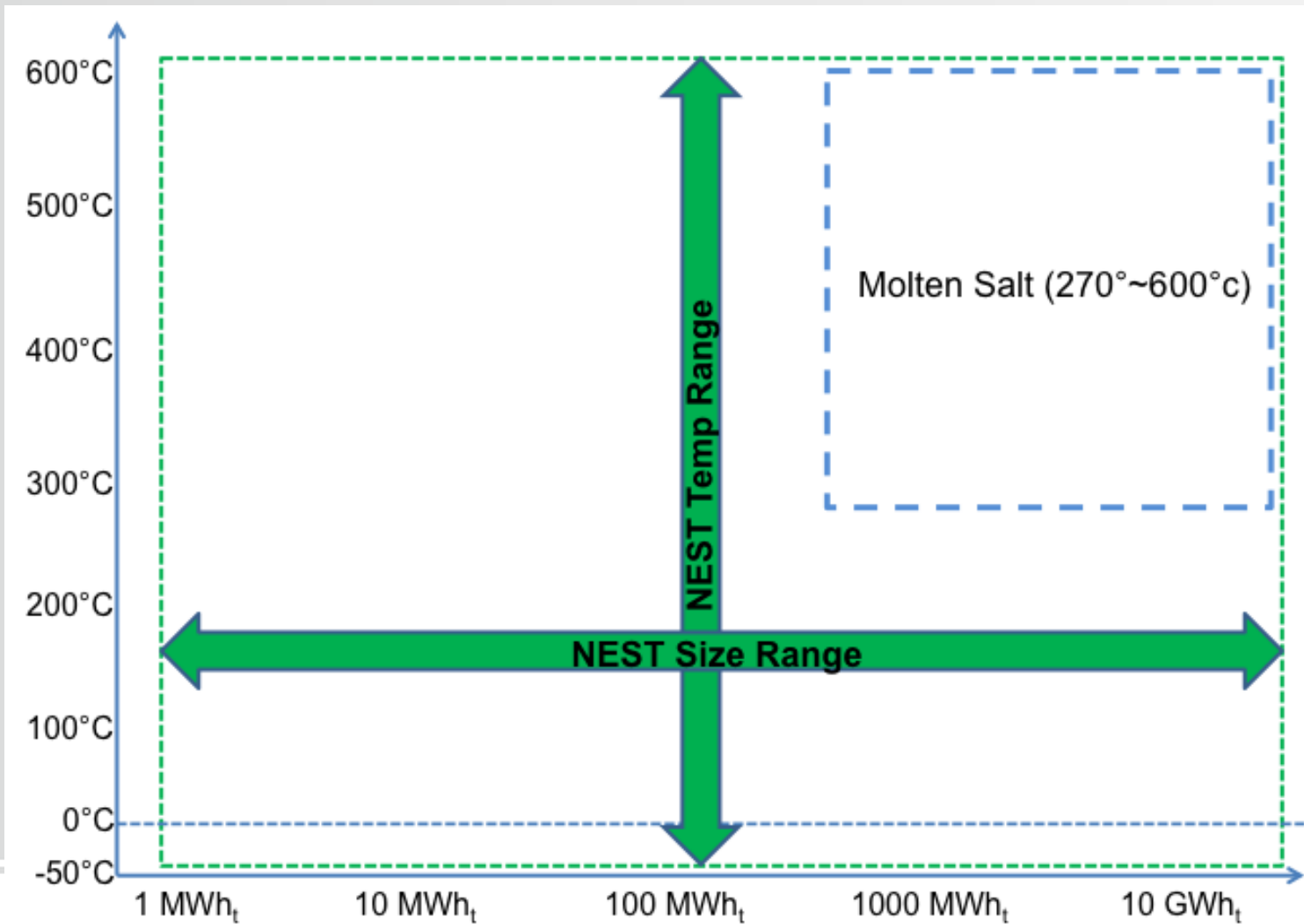
THERMAL ENERGY STORAGE CONCEPT



ELECTRICITY TES SYSTEM FOR CHP PLANT INTEGRATED WITH DISTRICT HEATING SYSTEM



SYSTEM SIZE AND TEMPERATURE RANGE



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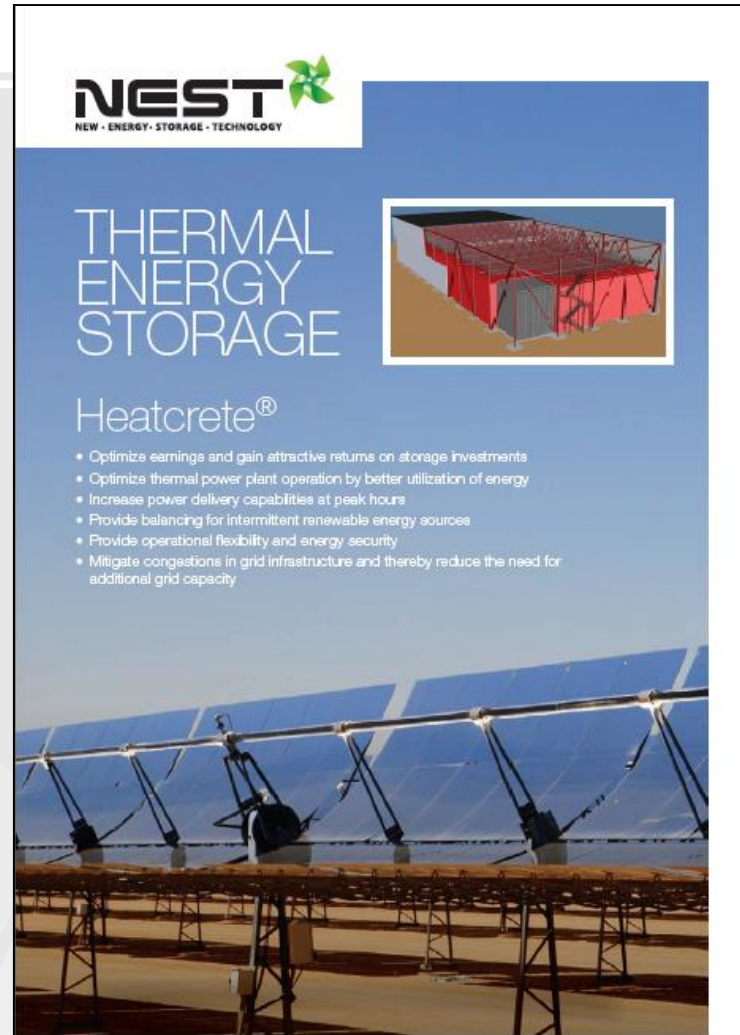
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