

Towards a Low Carbon Energy System in Denmark

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The presentation

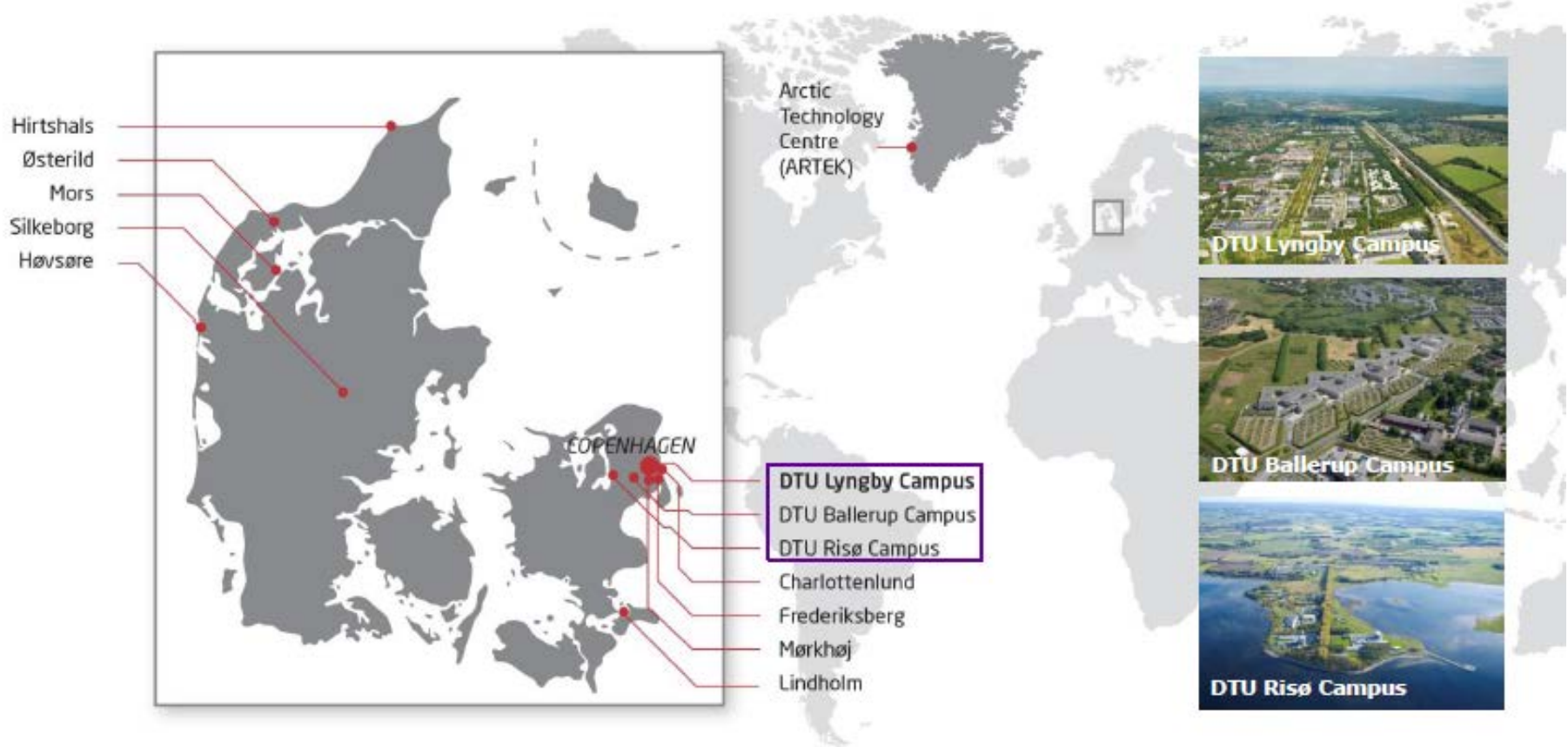
- The Danish aim of becoming fossil fuel free in 2050
- The plans of the new Danish Energy Agreement 2020-2024 in achieving the goal.
- Copenhagen city with 600.000 people aims at being carbon neutral in 2025:
<https://cphsolutionslab.dk/en>

Technical University of Denmark

- DTU employs more than **5,000** faculty and staff, including more than 2,100 assistant professors, researchers, and postdoctoral fellows and over 1,200 PhD students.
- With 1,200 international employees of **88 different nationalities** as many as 35% of the researchers employed at DTU are of another nationality than Danish.
- Research is carried out in **21 Departments** and 19 PhD-schools, for instance in the fields of energy, material and nanoscience, bio- and life science, climate and environment research.
- DTU is ranked among Europe's leading engineering institutions, and the highest ranked engineering university in the Nordic countries.

University locations across the kingdom

- centered in the capital region



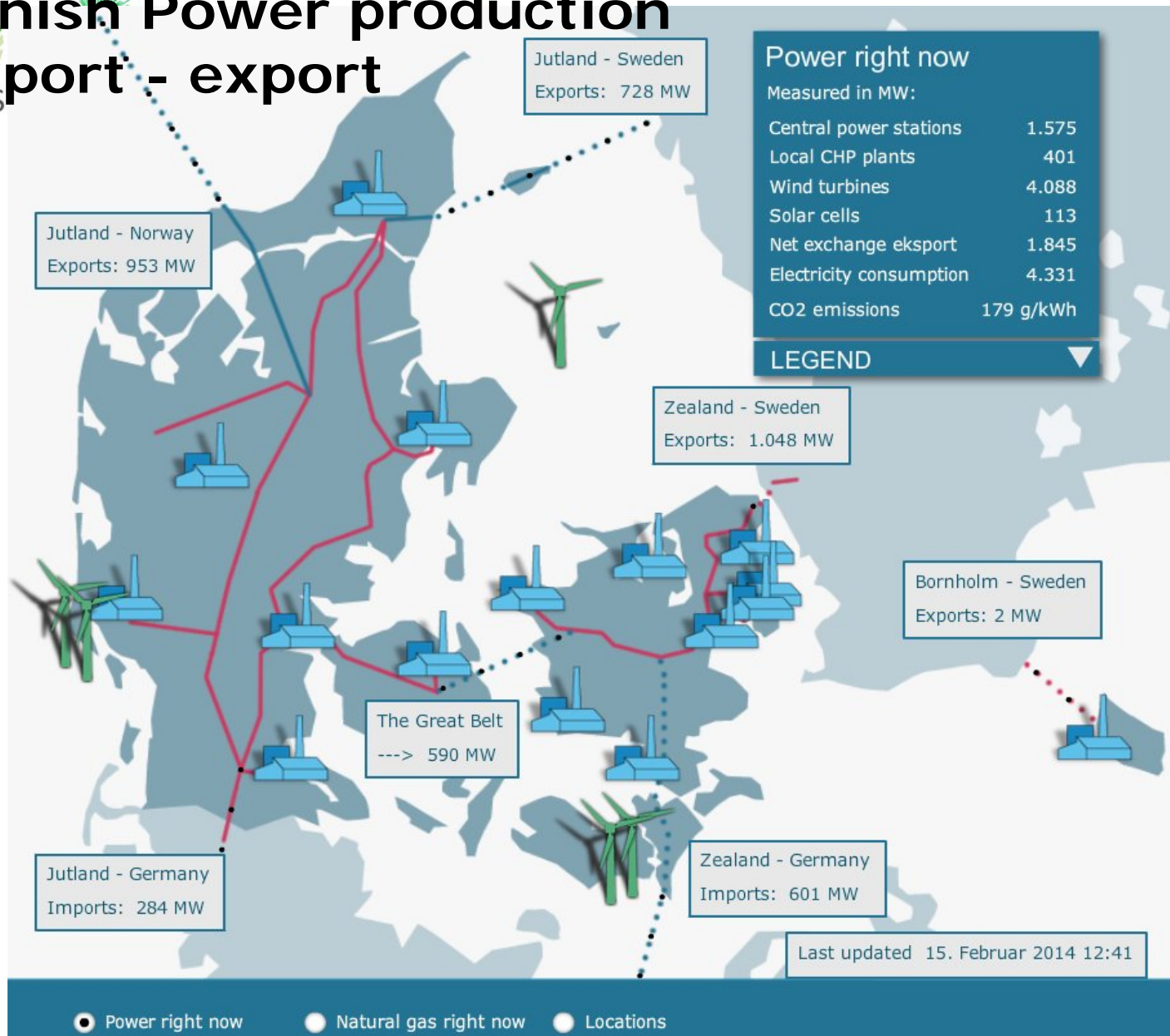
How Copenhagen is doing it

National energy policy
The new Energy Agreement 2020-2024

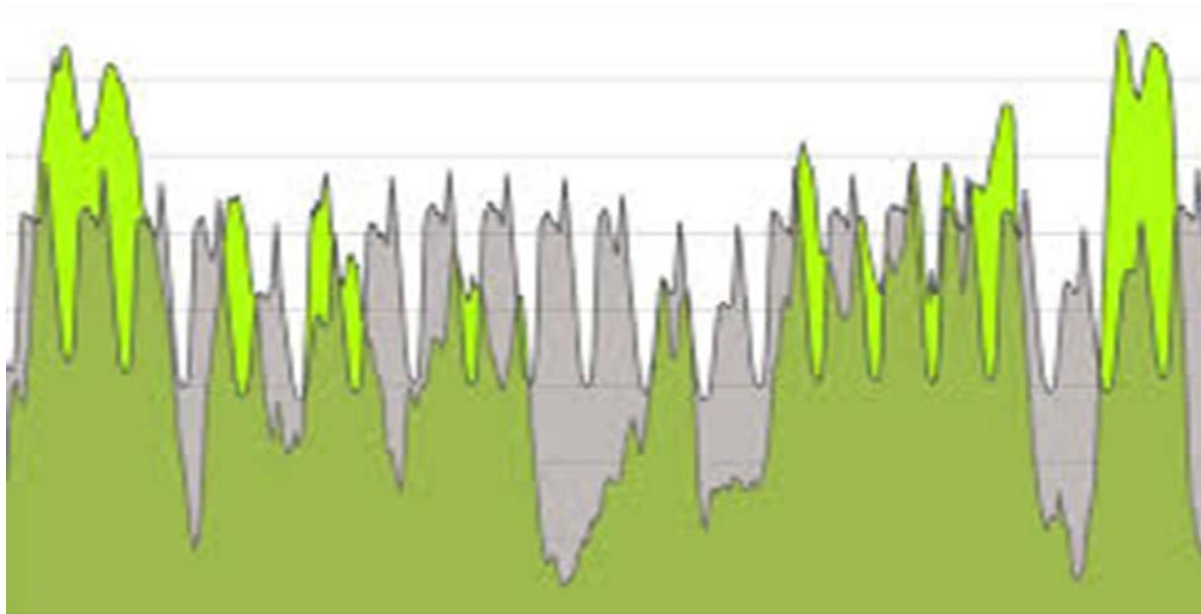
Making the city administration
carbon neutral in itself

65 local projects in Copenhagen

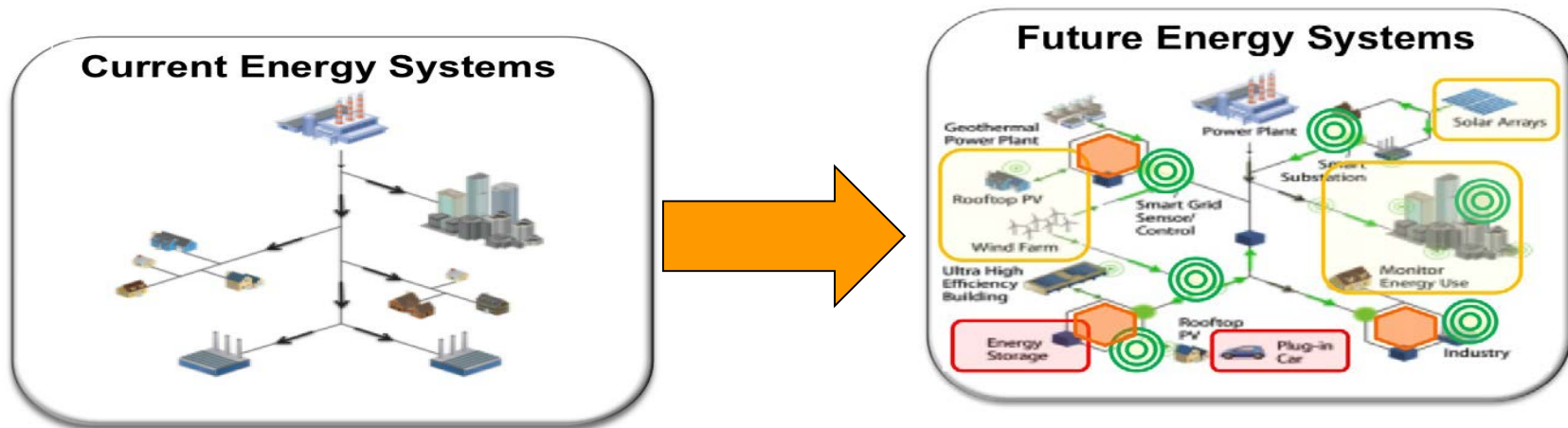
Danish Power production Import - export



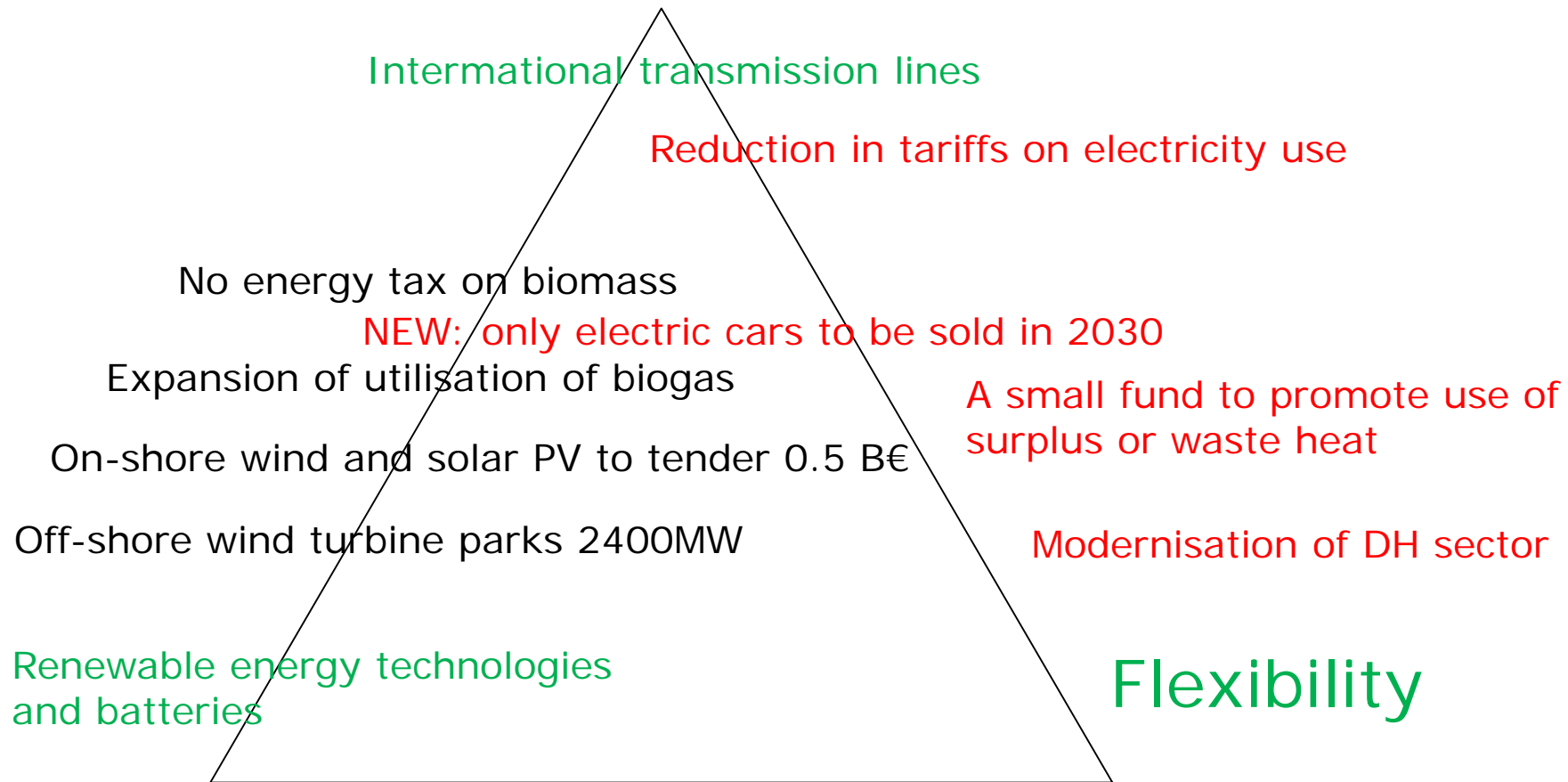
Electricity production (green) and electricity consumption (grey) over **three weeks** in Denmark



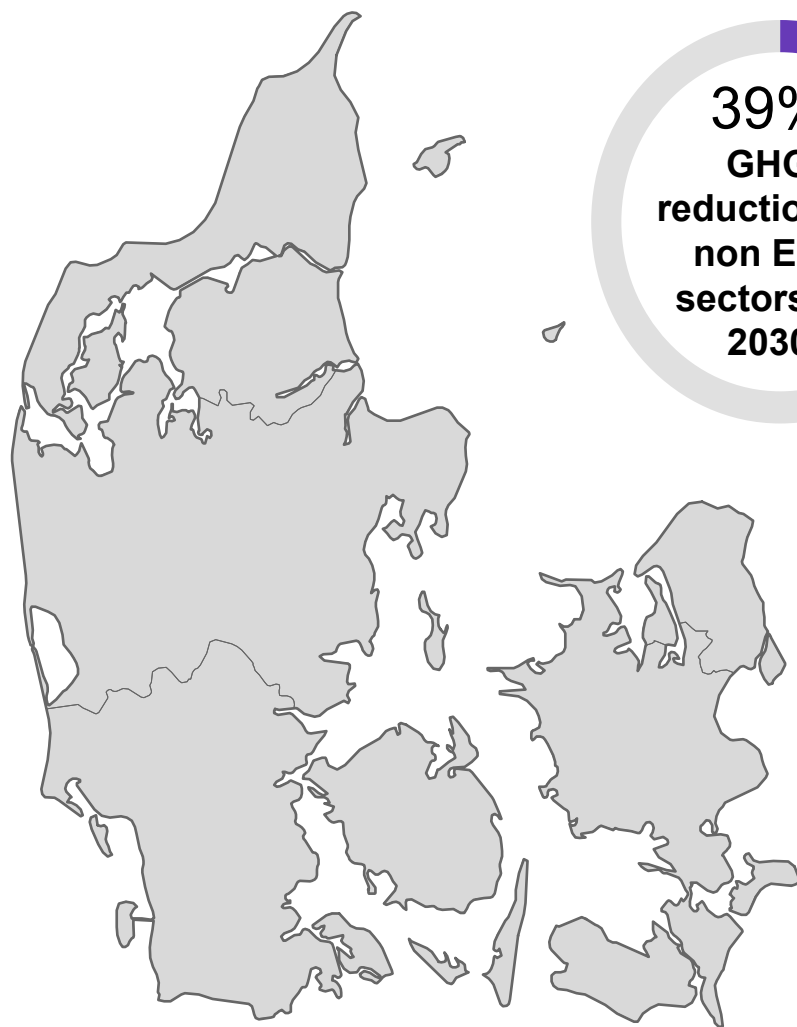
Change towards smart networks and decentral solutions



Major investment decisions in the Energy Agreement 2020-2024



Ambitions and climate targets



39%
GHG
reduction in
non ETS
sectors by
2030

At least
55%
RE-share in
total energy
consumption
by 2030

100%
Green
electricity
by 2030

Target of **net
zero emissions**
in the EU and
Denmark by
2050 at the latest

Key elements of the Danish energy policy

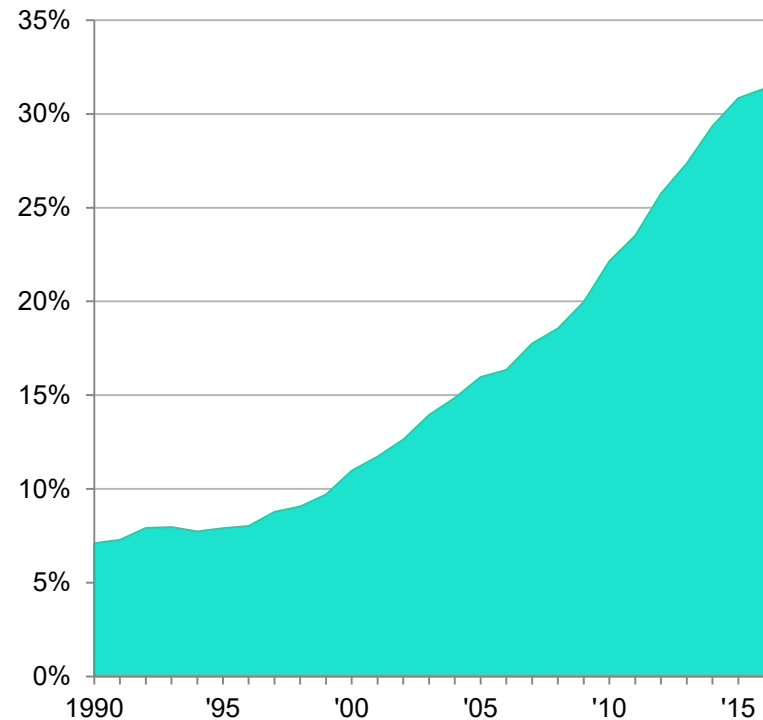
Policy Elements

- Cost-effective renewable energy subsidy schemes
- Energy taxes on fossil fuels
- Support for RD&D (EUDP, etc.)

Energy Policy Agreements

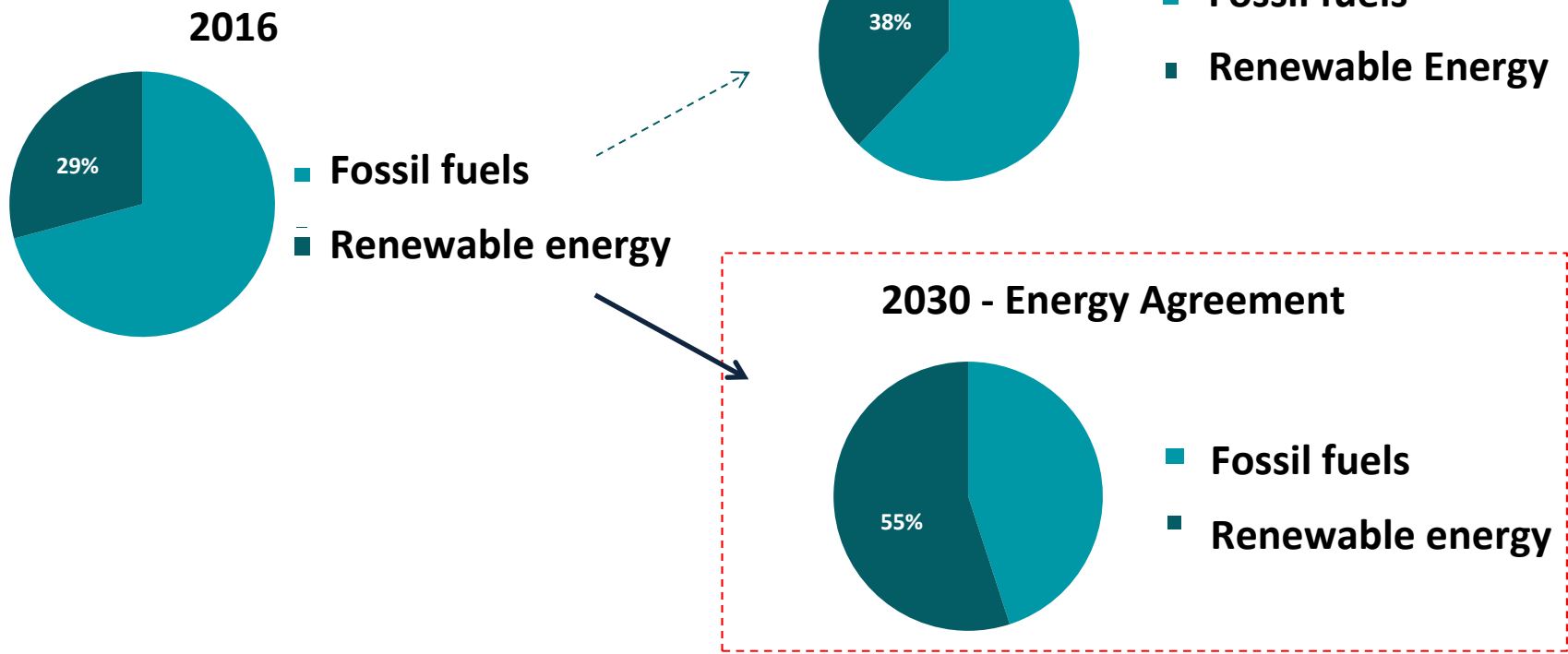
- Broad political consensus
- Long-term energy strategies and agreements
- Dialogue with sector stakeholders
- A stable framework to secure investment graded/bankable renewable energy projects

Renewable energy share of final energy consumption in Denmark

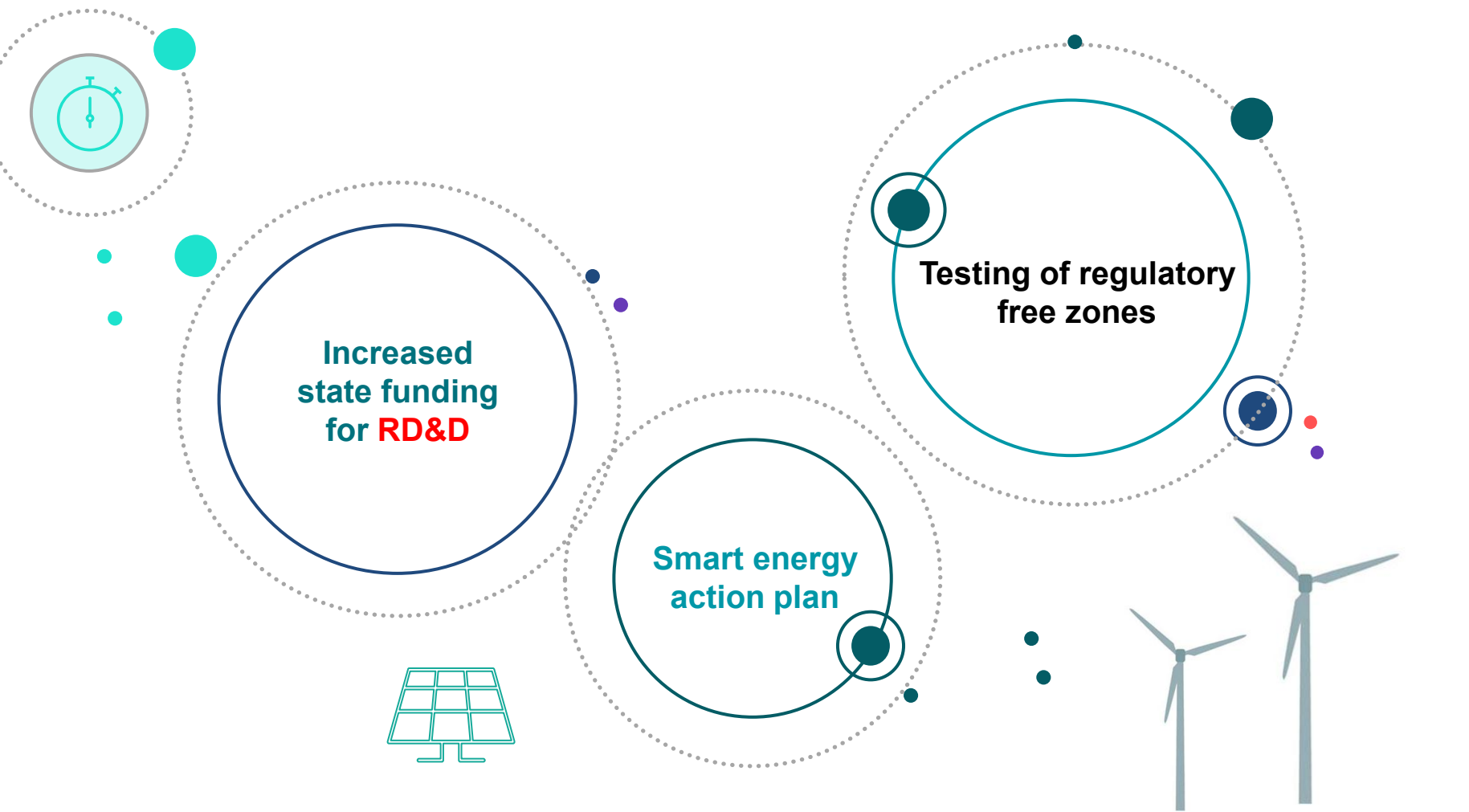


Source: Danish Energy Agency

Energy mix in Denmark – now and in the future



Strengthened energy and climate research



Roles of Danish RE sources in the Energy Agreement 2020-2024 – related to flexibility

	Electricity	Mobility	Heating	Cooling
Wind Power expansion	0-200% supply of DK power use – when the wind is blowing – need to be used	Change to electric cars – charging when the wind is blowing	Use of individual and large heat pumps – to be used when the wind is blowing	Use of individual A/C and large A/Cs – to be used when the wind is blowing
Solar PV expansion	0-50% (2050) supply of DK power use – when the sun is shining	Change to electric cars – charging when the sun is shining	Use of individual and large heat pumps when the sun is shining	Use of individual and large A/Cs - to be used when the sun is shining
Biomass	Used by CHP plants and DH Plants – will be used on ALL coal plants	n/a	Used for heat production at almost all DH (and CHP) plants	

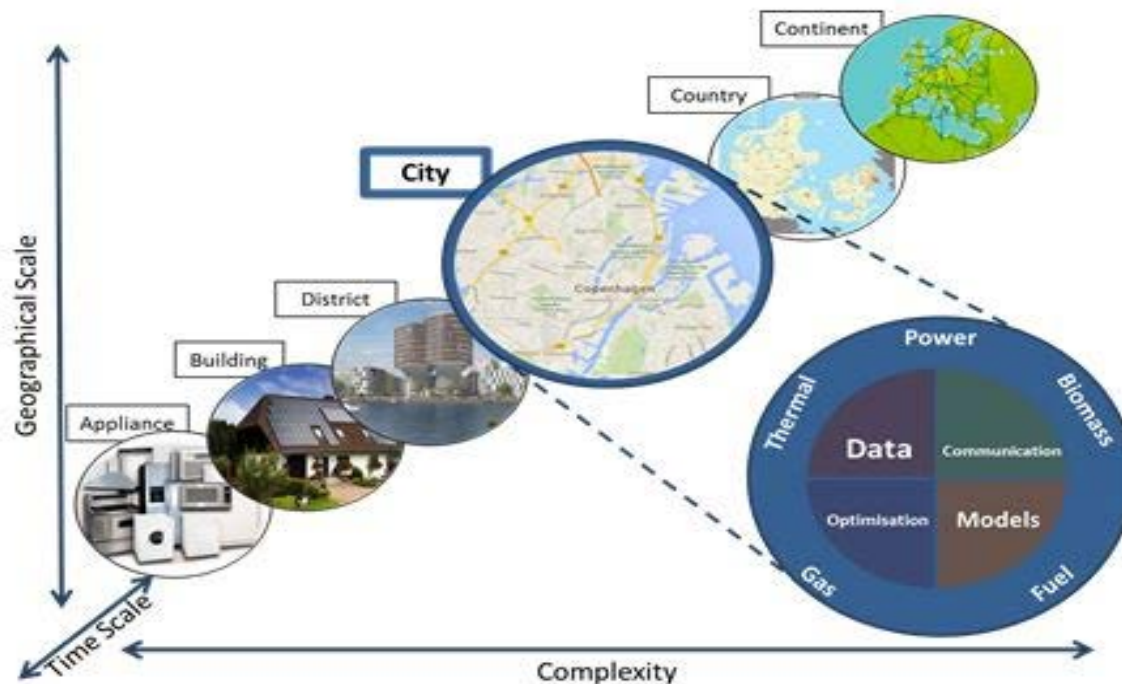
Other important issues in the Energy Agreement – related to flexibility

	Electricity	Mobility	Heating	Cooling
Biogas	Not expected to be able to compete on electricity prices	Upgrading biogas to be used as biofuels	Upgraded to the natural gas quality to national natural gas grid	
Nuclear power phase out in Sweden and Germany	Decreases baseload supply in Sweden (and Denmark)	Will be a challenge to charging EVs without smart charging	Will be a challenge to use heat pumps when without smart control	Will be a challenge to use A/C when without smart control
Expansion of the Trans-mission grids	Trans-mission of power from wind area to consumption area	Without smart charging of EVs - expansion of trans-mission grid is required	Without flexible control of HP - expansion of transmission grid may be required	Without flexible control of A/C - expansion of transmission grid may be required

Centre for IT Intelligent Energy Systems - CITIES

Scientific Objective

To establish **methodologies and ICT solutions** for **design and operation** of integrated electrical, thermal, fuel pathways at all scales.



Centre for IT Intelligent Energy Systems in Cities – Funded by Innovation Fund DK

- 45 partners including
- 5 DTU Departments and AAU
- 35 commercial partners

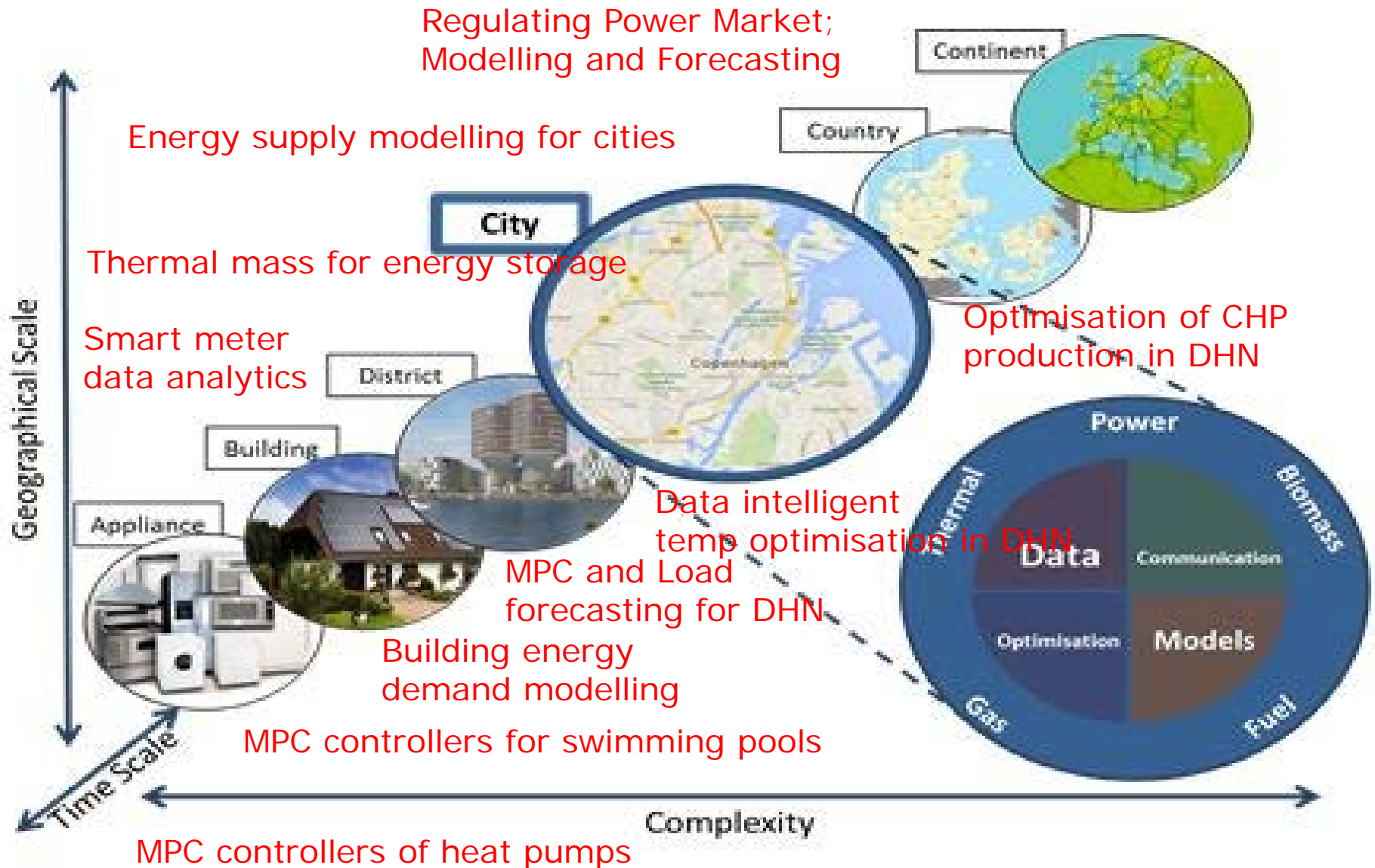
- 2014-2020 (6+1 years)
- Total budget: 75 mio Dkr

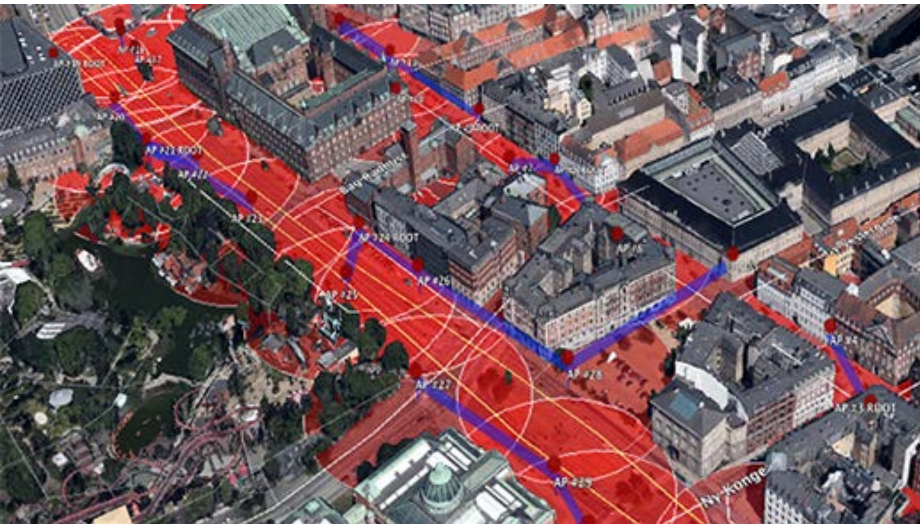
- > 100 journal and conference papers
- > 20 workshops
- > 20 solutions

Key Outcomes

- Modular **forecasting and control models/tools** for a variety of energy system components, including their interactions
- **Market structures** that support energy systems integration (testing in **tariff-free zones**)
- In particular we focus on **Data driven solutions** for optimising energy consumption when wind is blowing and the sun is shining (increasing flexibility in the energy system – at all levels)
- Operational **methods and scenarios** for energy systems integration and management, scenarios towards a fossil free future (Power and heating sectors fossil fuel free in year 2035)

Centre for IT intelligent Energy Systems in Cities - CITIES

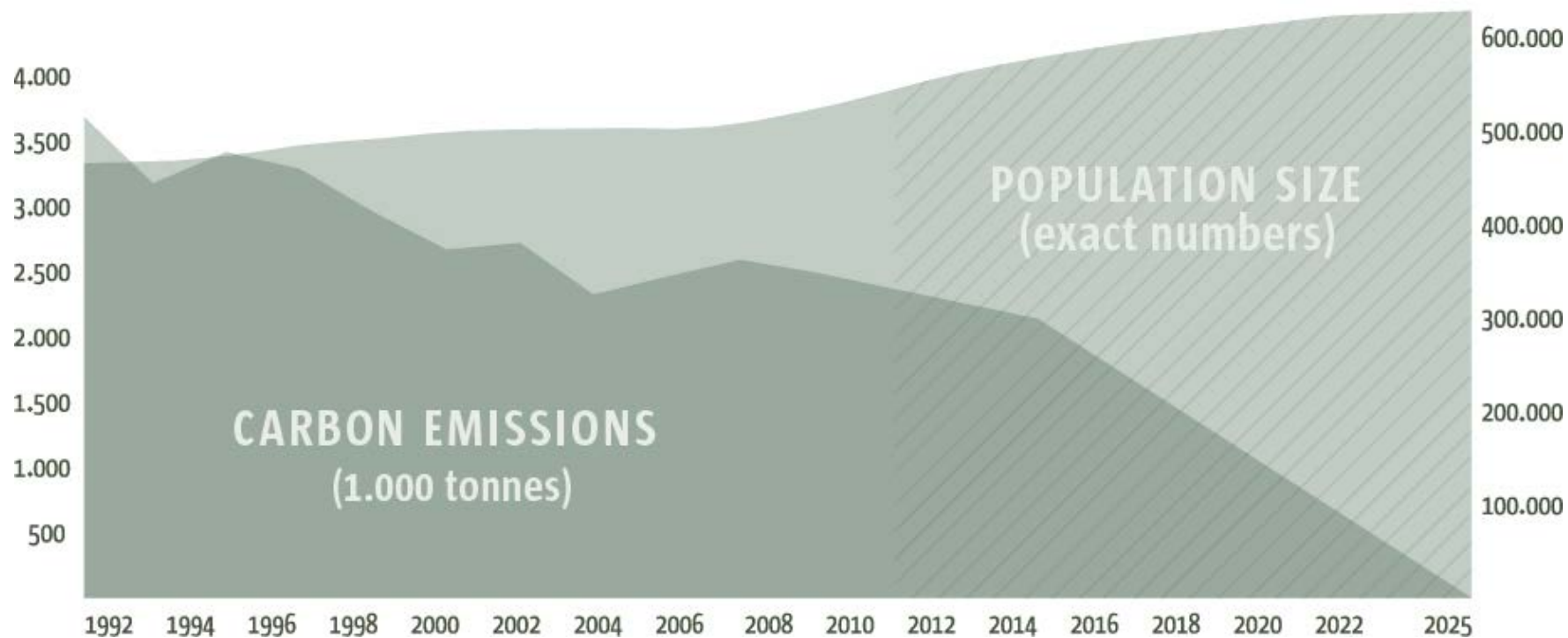




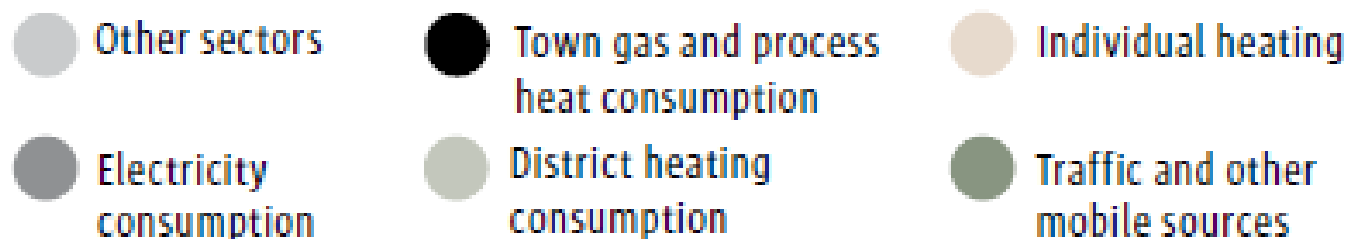
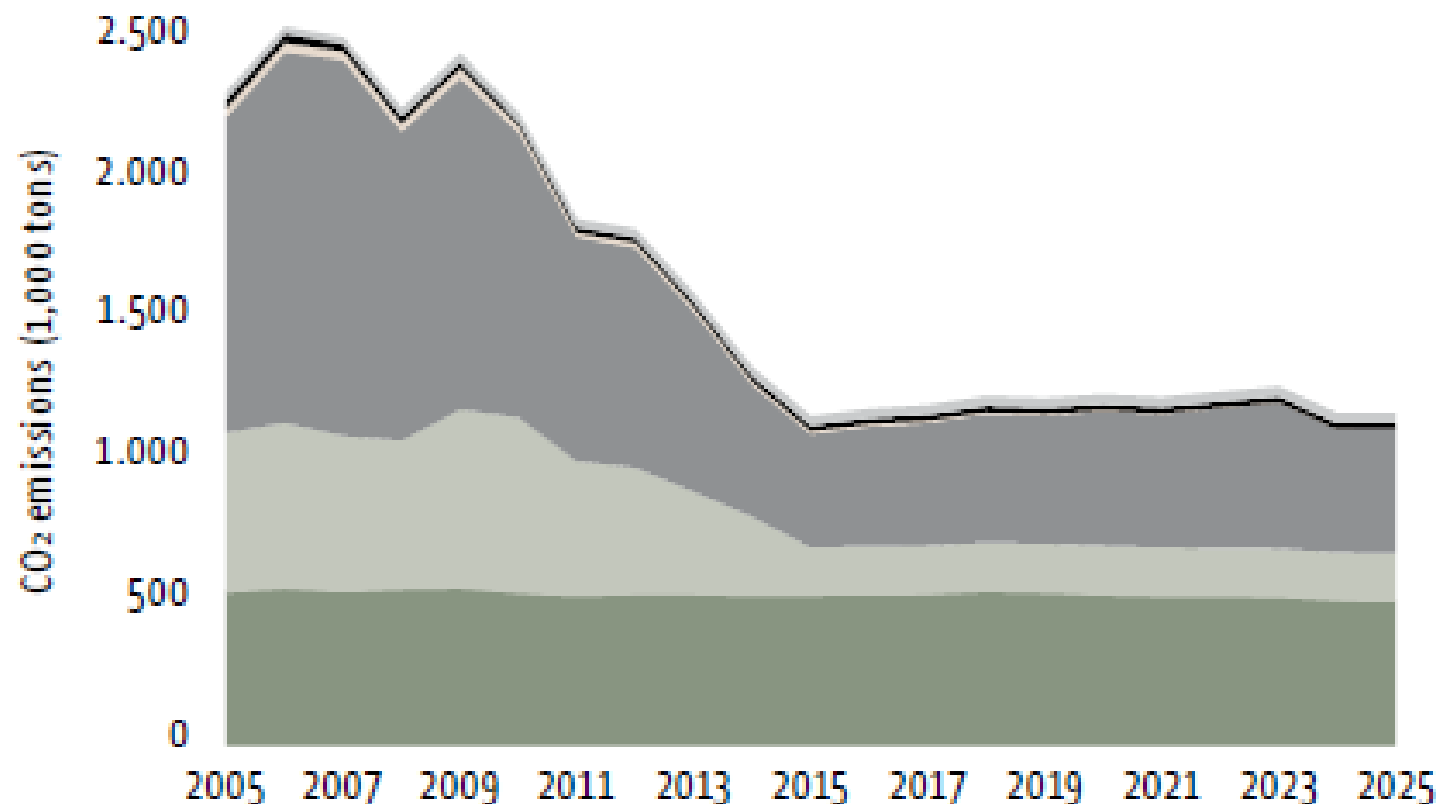
Background and Status of CPH 2015

- Copenhagen City's ambition to become the **world's first carbon neutral capital by 2025**. The current status (as of 2016) is that overall the City is well on track.
- The current climate plan: A total of **2.7 billion DKK (€ 363 million)** public money was agreed for the entire period of CPH 2025, that is, from 2012 to 2025.
- The roadmap for CPH 2025 includes **65 specific projects**, and it includes budgets, time-horizons and desired impact.

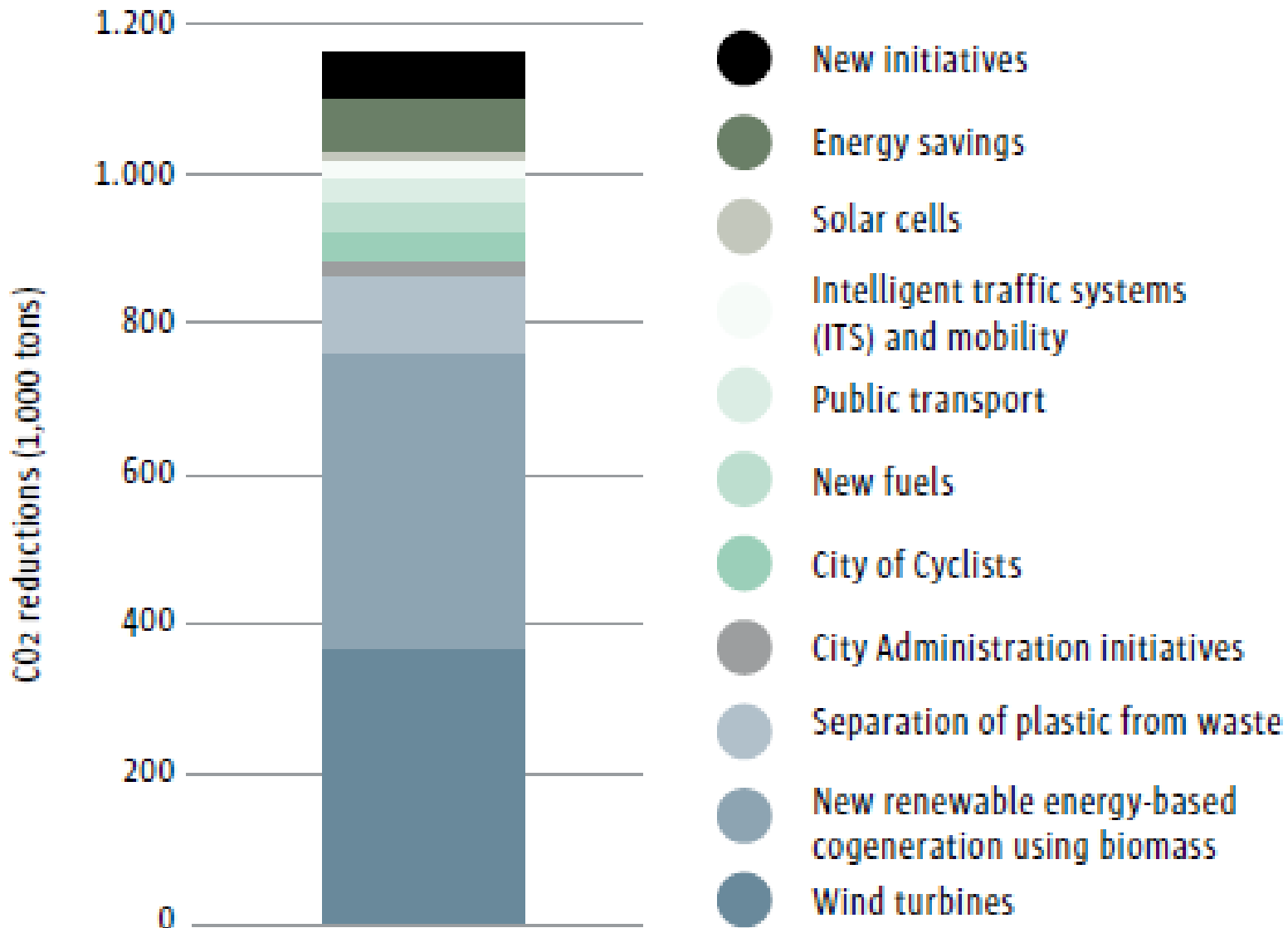
More Copenhageners - less carbon emissions



Development of CO₂ emissions up to 2025 – no further initiatives (CPH Climate Plan 2025)



CO₂ reductions resulting from initiative in the CPH 2025 Climate Plan



Summing up

- Danes need to **use energy** when **the wind is blowing** and/or when **the sun is shining**
- The energy agreement is a **step** towards the Danish political goal of becoming **fossil fuel free in 2050**. BUT
- The agreement is **politically motivated** and not based on sufficient scientific technical as well as economic analysis.
- We need to be able to evaluate the **benefits of an intelligent energy system**, which is not only focussing on providing more RE supply. We are just postponing the real challenge of transitioning to a sustainable energy system for Denmark.
- Copenhagen shows **how divers** the solutions will have to be to make a **full transition** to a sustainable energy system. And need to happen at **all level of society**. The government and the municipalities (Copenhagen) are **relying on each other** to achieve the goal.