LONG TERM INTEGRATED ENERGY PLANNING FOR DISTRICT ENERGY

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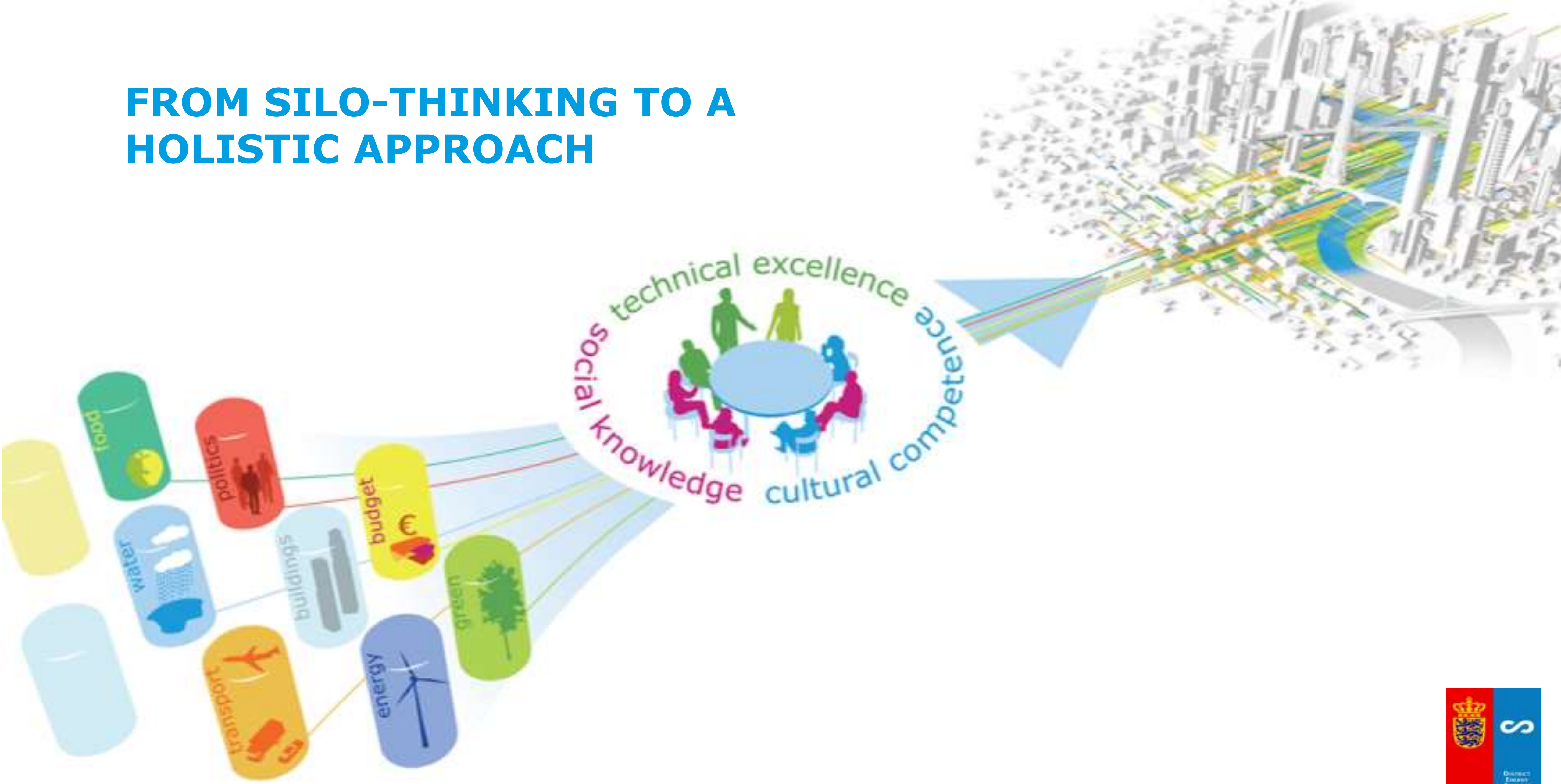
FROM SILO-THINKING TO A HOLISTIC APPROACH



BRIEF HISTORY OF DISTRICT HEATING DEVELOPMENT IN DENMARK

Non-for-profit approach has been key for all district heating and energy planning developments throughout decades!!

- Historically, Denmark has been divided into areas supplied by natural gas, district heating areas and areas supplied by centralized cogeneration plants. This followed the first heat supply act from 1979
- In the 80'ies Denmark established a country wide natural gas network. Therefore, it was politically agreed that the majority of the smaller cogeneration plants should use natural gas.
- Since the update of the heat supply act in 1990 it has been a requirement that a project proposal should be conducted in which different supply scenarios should be assessed.
- About 4-6 years ago it was politically accepted, that that if the socio economy was better than supply from natural gas, district heating could substitute natural gas in these areas.

THE HEAT PLAN DK

- **The Heat Plan DK from 2008 documented that the heating sector in Denmark has reduced the CO_2 emmissions by 50 % since 1980**

- Also the plan gives guidlines to how Denmark can reduce the CO_2 emmissions further by 2021 and to become CO_2 nuetral by 2030:

- The district heating sector to further connect from 46% to between 63% and 70%

- At least 70% of all new build shall be connected to district heating or dezentraælised heatings systems

- The end users further reduces the space heating with 25% and lower the return temperature even more

- District heating production to be with more renewable energy with waste-to-energy, exhaust gas condensation, waste heat, biomass power plants, Biogas CHP, big scale solar heating, geothermal heat and electric boilers and heat pumps to use overproduction of electricity from wind turbines

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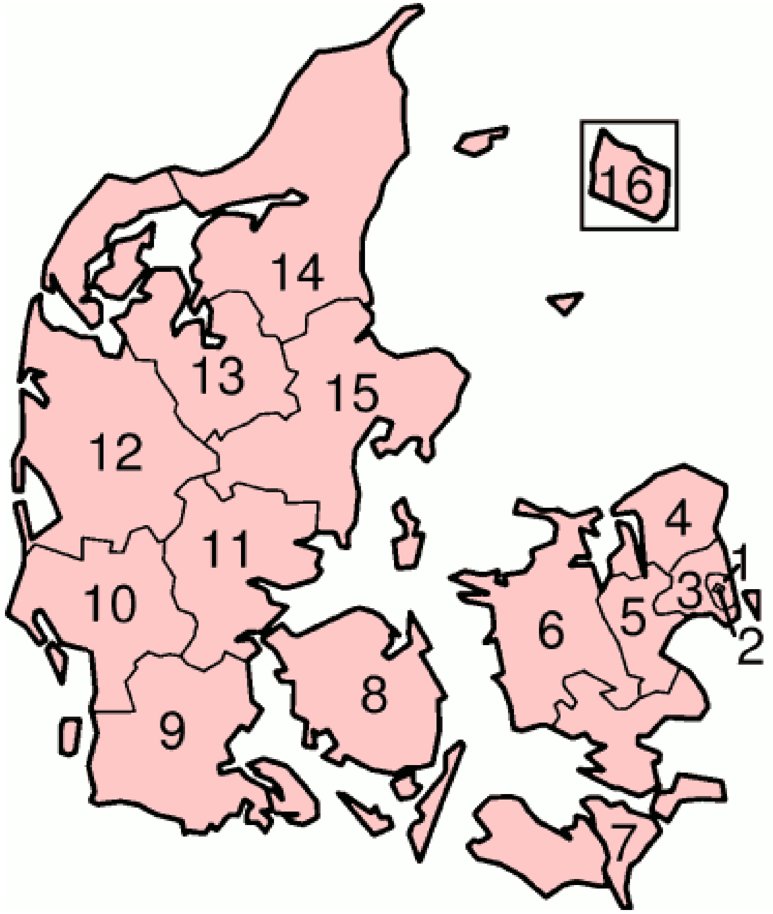
DANISH COMMUNITY PLANNING FOR DISTRICT ENERGY

- ✓ All necessary assumptions regarding choice of fuel (whether natural gas, biomass, other biofuel), necessary capacity of smaller cogeneration plants etc. was given by **the Danish Energy Agency.**

- ✓ **The municipalities** should ensure that all assumptions were followed and that the projects were realized.

- ✓ **A project proposal** is often prepared by a consultant for the local district heating company. After a project proposal is accepted, the district heating company can continue with the plans for the project.



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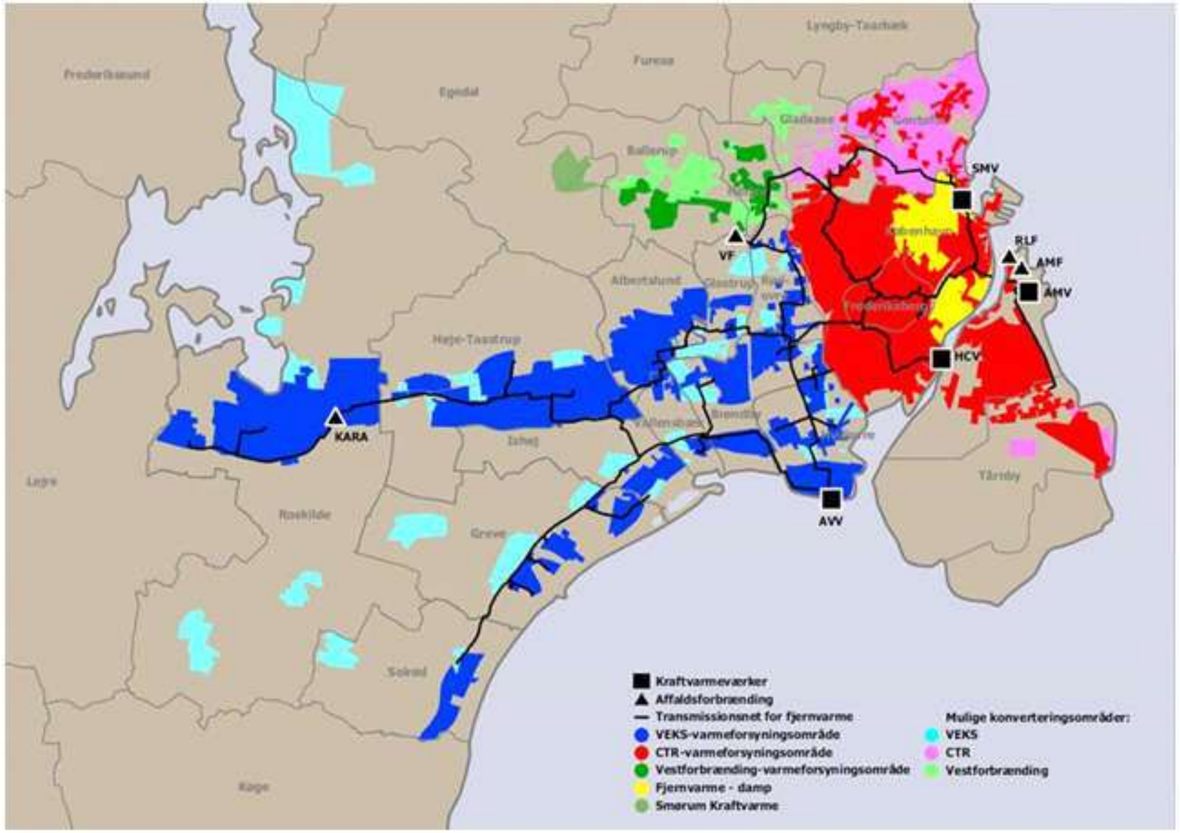
OVERLAPPING COMMUNITIES

- There has always been a good cooperation between the different municipalities

- VEKS and CTR in Denmark was established as a result of the centralized planning in Denmark. The centralized cogeneration should co-produce heat and electricity.

- VEKS should take heat from the new Avedøreværket (from 1988) and CTR should take heat from the new unit at Amagerværket (Unit 3 from 1987)

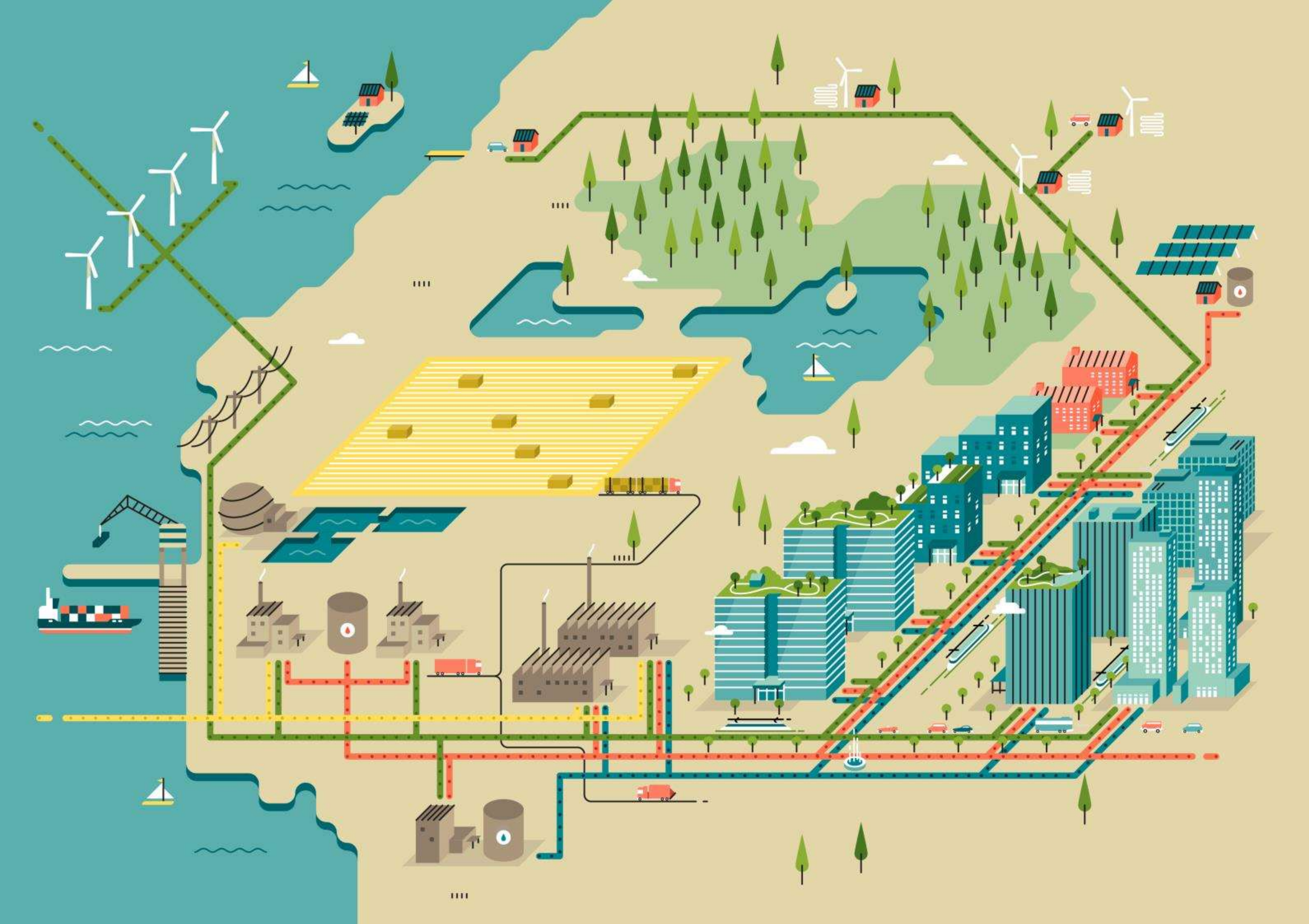


HOW IS DK APPROACHING COOLING?

- Cooling plan Denmark from 2016

- Not yet the same regulations and legislations on district cooling but is often heavily discussed

- Most often district cooling systems is designed with heat pumps either to utilize surplus heat from industries and commercial buildings or to utilize energy source from the sea



- Surplus biomass for CHP plant
- Surplus straw for CHP plant
- Offshore wind farm
- Large building
- Residential building
- Harbour, unloading of biomass
- Wastewater treatment and biogas plant
- Solar heating plant and heat storage
- Distant building w/solar PV
- Outskirt building w/ heat pump, solar PV and wind turbine
- CHP plant fuelled by gas, straw, wood, city waste + heat storage
- District heating/ cooling plant + cold water storage
- Industry with process energy and surplus heat
- Electricity
- District heating
- District cooling
- Gas

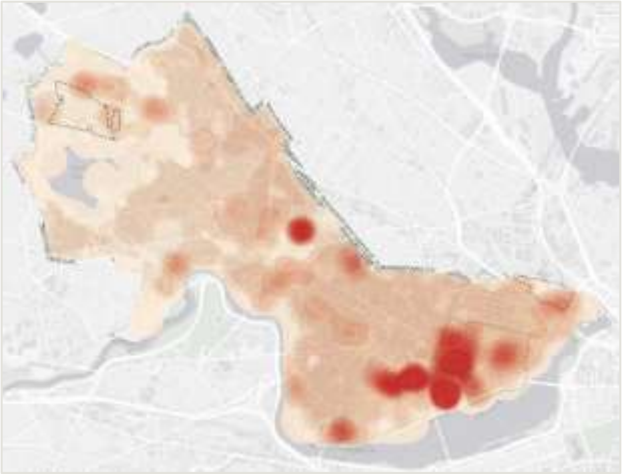
PROCESS: APPROACH TO ENERGY PLANNING "WHERE IT STARTS"

SCOPING ASSESSMENT

- Height, density and orientation of buildings
- Consumption of energy for electricity, heating and cooling
- Daylight and degree day impacts
- Understanding existing infrastructure and other influences

DETAILED ENERGY MODELING

- Using software tools running multiple scenarios



ENERGY SUPPLY STRATEGIES

- Geographic distribution of the heating, cooling and electricity loads of an urban area
- Analyze the costs and benefits of district energy (heating/cooling) against individual systems
- Assess alternative energy supply options such as wind energy, solar, combined heat and power, heat pumps, thermal energy storage, geothermal and many more

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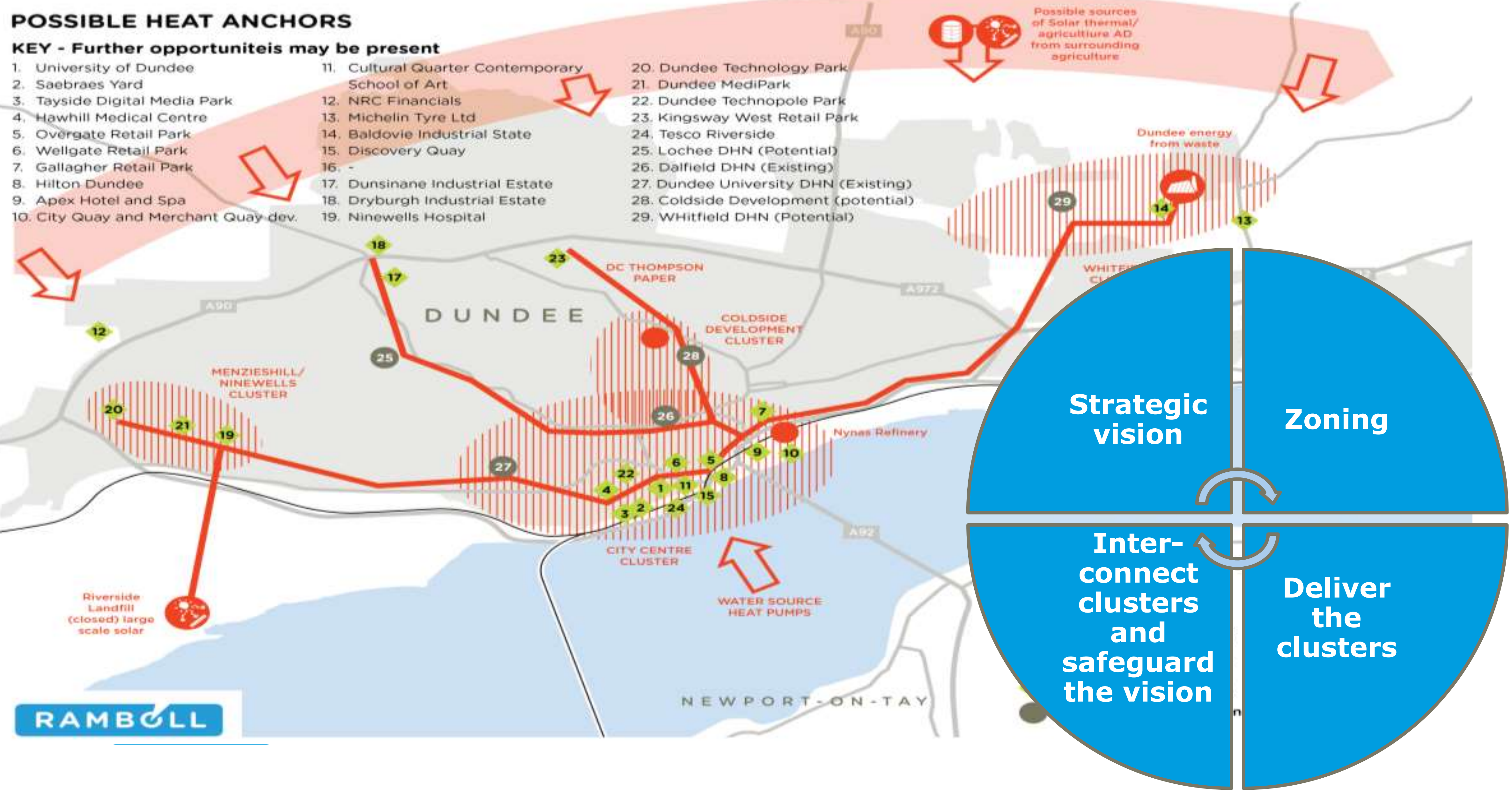
THE EXTENDED PLANNING PROCESS

PLANNING AND DELIVERING DISTRICT ENERGY OVER TIME



IMPORTANT CONSIDERATIONS

- Existing infrastructure and/or planned changes/upgrades to infrastructure
- Immediate needs
- What are the medium and long term goals with respect to energy and GHG emissions
- How can existing infrastructure best be used to achieve those long term goals and/or what is the alternative solution
- Establish a strategic vision for district energy supply supported by an implementation plan that meets the immediate needs of the campus whilst safeguarding for future changes
- Planning must be flexible to account for technology, market and policy changes
- Ownership of the plan must ultimately rest with the campus and stakeholder engagement at all times is critical

KEY RISKS AND OPPORTUNITIES TO BE MANAGED

- **Data Collection**
  - Incomplete Data Sets
  - Data collection and analysis can be difficult and time consuming
  - Appropriate level of data
  - Engagement with the right people for data collection
  - Establish and agree an assumptions base

- **Engagement and Buy-in of key stakeholders**
  - Project Champion
  - Political Issues
  - Technical Assumptions
  - Lost Opportunities
  - Innovative Solutions

CHALLENGES TO BE ADDRESSED AS PART OF PROJECT IMPLEMENTATION

Commercial and Financial

- High investment costs and long development timescales
- Complex stakeholder arrangements

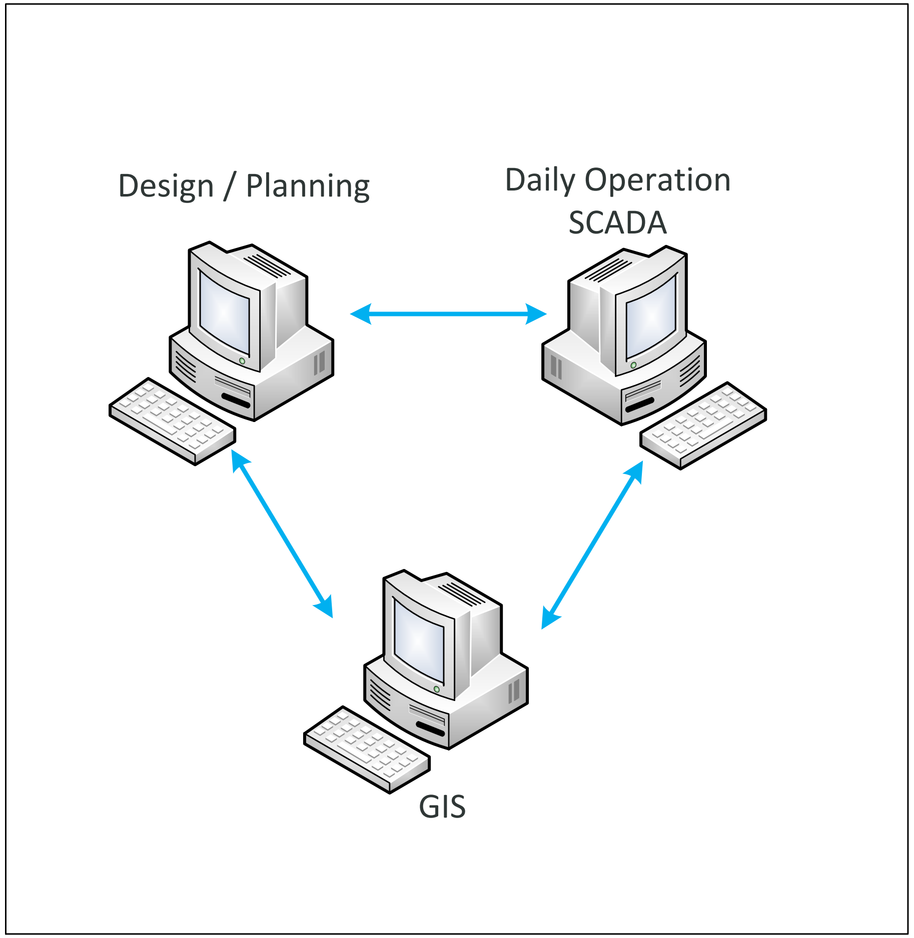
Capacity and appetite to deliver

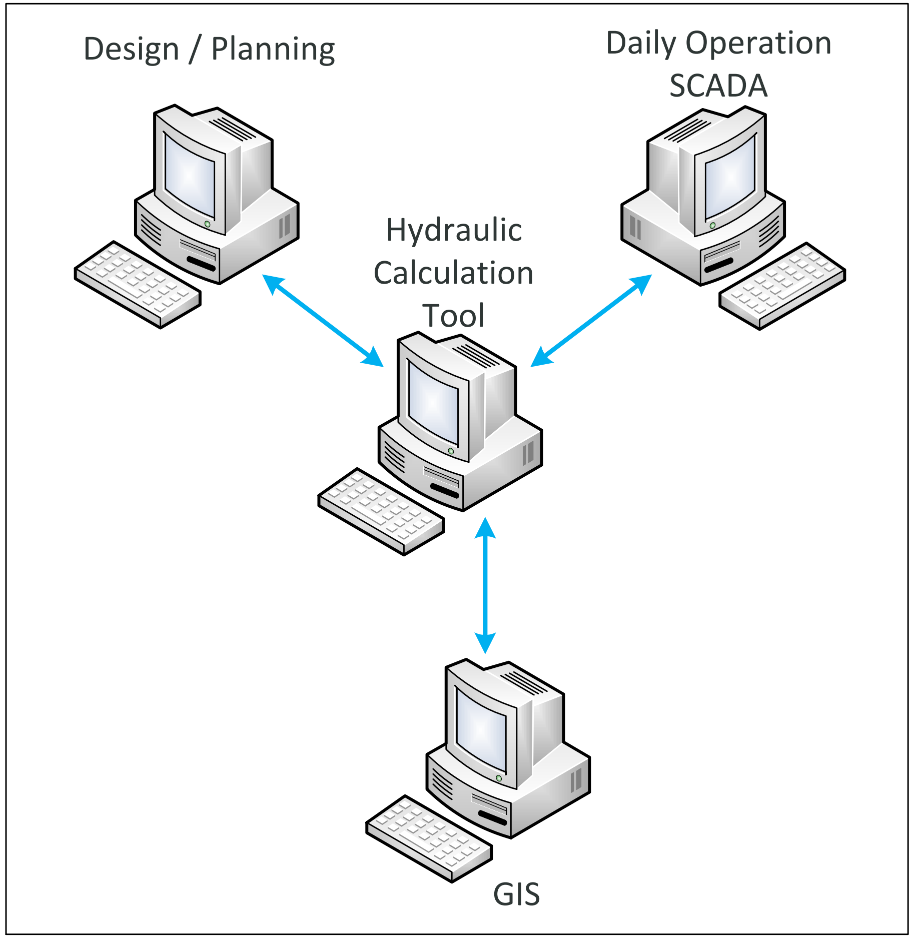
- Internal resources, funds, relevant skills
- Access to finance

Technical challenges

- Retrofitting costs (building temperatures and heating systems)
- Energy demand density
- Existing utilities and grid connection

PLANNING – DESIGN - OPERATION





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PROJECT EXPERIENCE – CITY OF CAMBRIDGE, MA

Challenge

The City formed a Net Zero Task Force and developed 25 year Action Plan to get to Carbon Neutrality by 2050.

Low carbon energy supply was a key component of the plan.

What we do

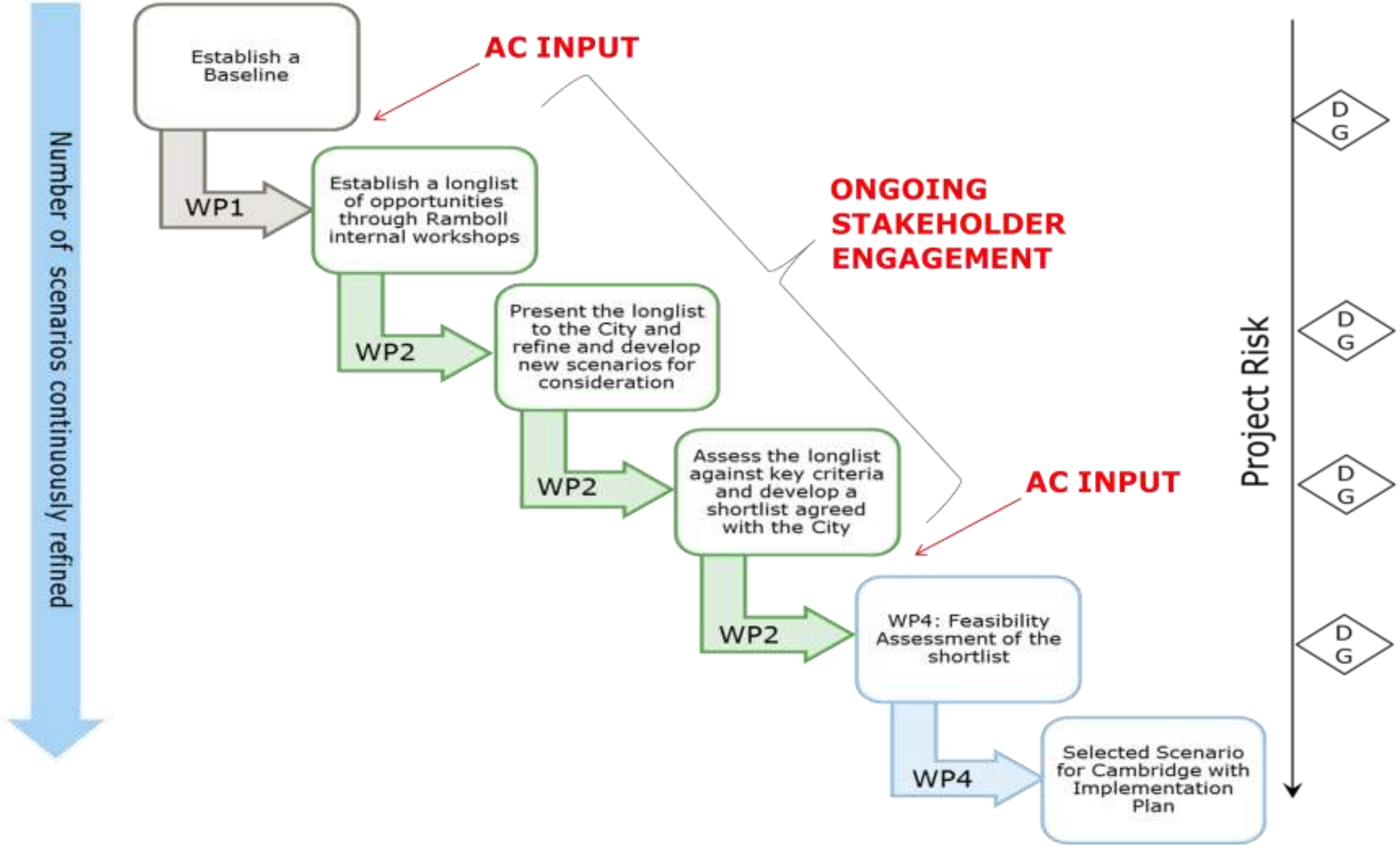
Ramboll provided stakeholder engagement and management of the City's Advisory Committee to steer them through the study.

Other services provided were energy master planning and concept design engineering.

Effect

A mix of local production and utility procurement of renewable energy coupled with electrification of the heating & cooling systems and leveraged with district energy to lower energy costs and reduce GHG's by 80%.

SCENARIO DEVELOPMENT PROCESS – ITERATIVE ENGAGEMENT AND EVOLVEMENT OF SCENARIOS



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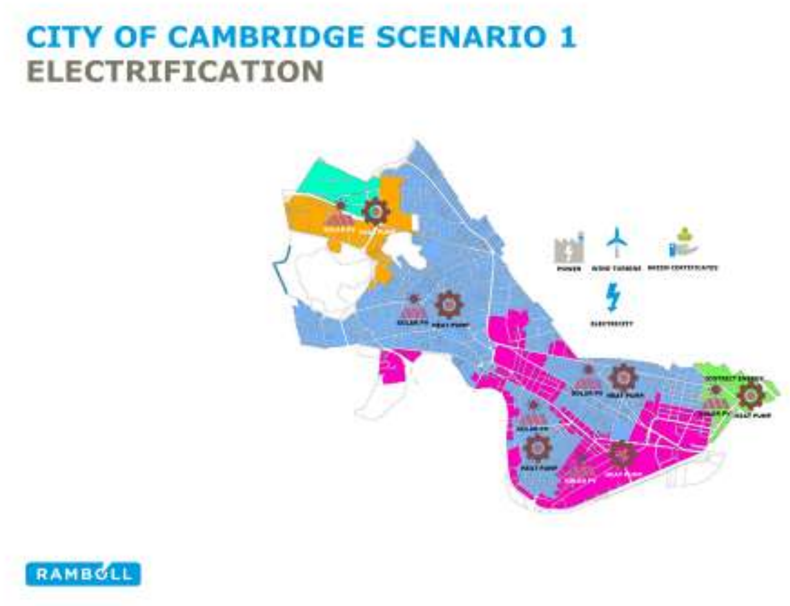

Top Three Scenarios were presented to the City's Advisory Committee:

Scenario 1 – Electrification through heat pumps

Scenario 2 – Electrification with District Energy

Scenario 4 – Local CHP added to District Energy

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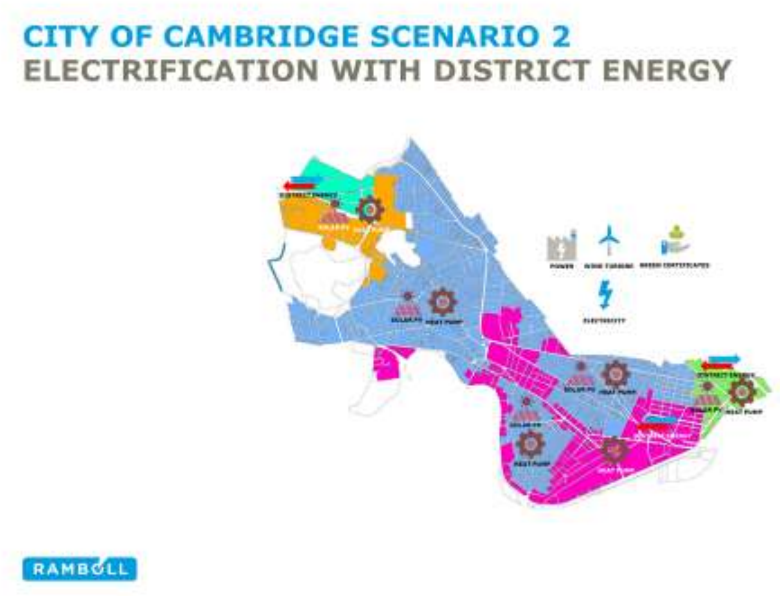

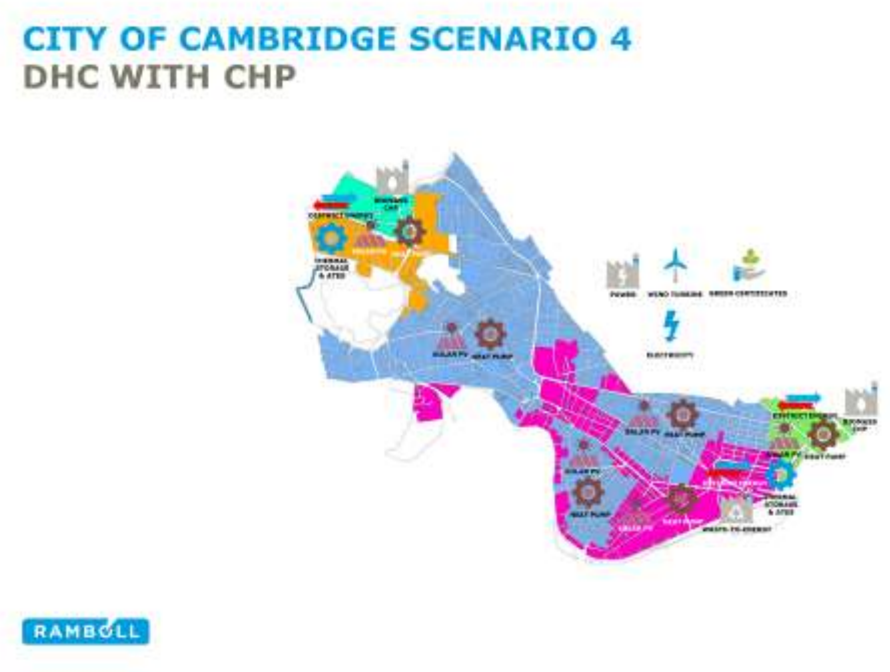

THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

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