



LIST OF CONTENT TASK C

RAMBOLL ENERGY

ANDERS DYRELUND



CONTENT

Network technologies

Energy storage technologies

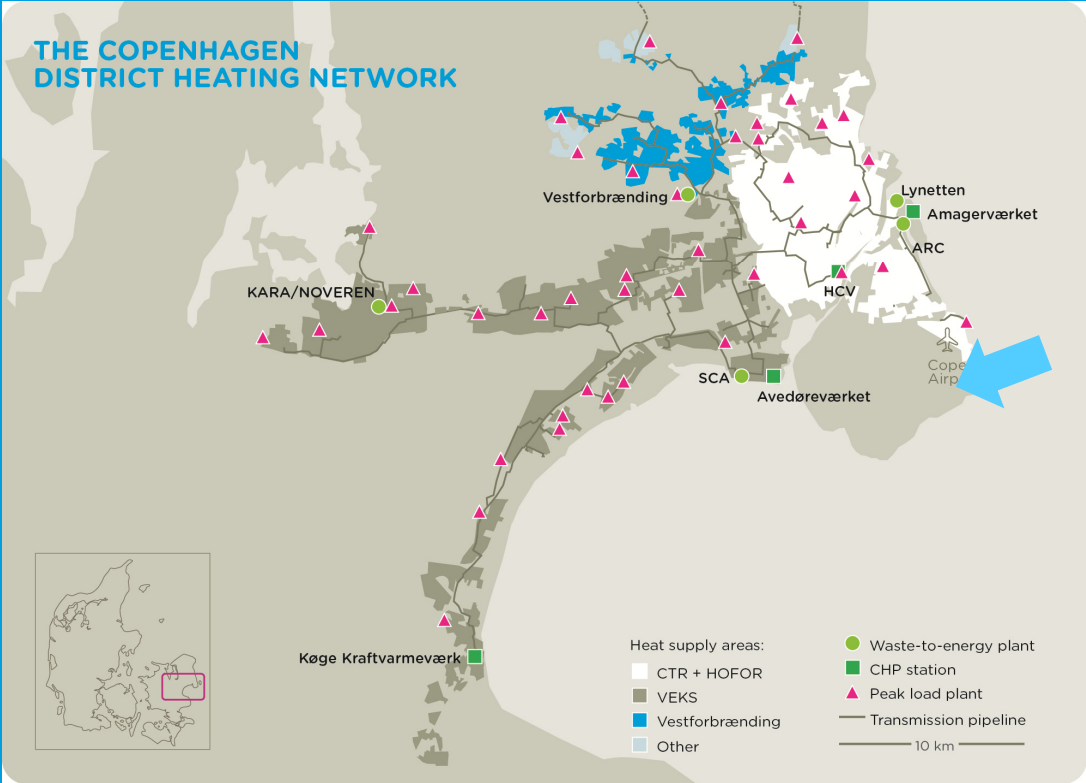
Production and conversion technologies

Automatization, operation and maintenance (new)

Integrated heating and cooling systems for the campuses

Energy price assumptions at the campus or city gate including cost of environmental issues

NETWORK TECHNOLOGIES



NETWORK TECHNOLOGIES

- HVAC systems in buildings for heating and cooling
- Preinsulated DH pipes bonded system low temperature < 110 dgr.C
- Preinsulated DH pipes temperature < 160 dgr.C
- Preinsulated pipes flex pipes < 80 dgr.C
- Steel pipes in concrete tunnels and ducts < 160 dgr.C
- Steel pipes in concrete tunnels and ducts steam
- Preinsulated DC pipes
- PEH-pipes for DC
- No-dig methods and gas pipe technologies
- Pumps, pressure reduction and hydraulic scheme
- Network design strategy to improve resilience
- Water treatment to secure long life time

PIPE TECHNOLOGIES TEMPLATE FOR EACH TYPE

- Description
- Special design criteria
- Reference to norm and standards
- Pipe-table for a variety of dimensions
 - Internal diameter
 - Space required for one pipe and for two pipes, minimum soil cover
 - Normal maximal flow in m/s and m³/h
 - Capacity at a given dT (or steam temperature/pressure)
 - Heat loss per m trench (two pipes) at a given temperature
 - Cost in green field, wide road and densely road

ENERGY STORAGE TECHNOLOGIES



ENERGY STORAGE TECHNOLOGIES

- Hot water Pressurized and pressure less steel tanks for DH hot water
- Cold water storage tanks for DC networks
- Steam storage tanks
- Heat storage pits
- Cold water storage pits
- Gas storages
- Electric batteries

STORAGE TECHNOLOGIES TEMPLATE FOR EACH TYPE

- Description
- Special design criteria
- Reference to norm and standards
- Storage-table for a variety of energy contents
 - Stored energy in MWh
 - Volume in m³ at given dT
 - Space required
 - Capacity at a given dT
 - Efficiency, Heat loss MWh per year at given temperature or losses per load cycle for batteries
 - Investment cost
 - Operation cost

PRODUCTION AND CONVERSION TECHNOLOGIES



PRODUCTION AND CONVERSION TECHNOLOGIES

- Heat exchanger for DH steam to hot water
- Heat exchanger for DH hot water to buildings, directly
- Heat exchanger for DH hot water to buildings, directly
- Oil boiler
- Gas boiler condensing
- Wood chip boiler
- Straw boiler
- Electric heat pumps for DC only
- Electric heat pump for combined DH and DC in two steps
- Absorption heat pump for DC
- Absorption heat pump for DH and DH combined
- Electric boiler

PRODUCTION AND CONVERSION TECHNOLOGIES

- Gas CHP engine
- Dual fuel CHP engine gas/diesel
- Gas turbine
- Gas CC steam CHP
- Biomass CHP

PRODUCTION TECHNOLOGIES TEMPLATE FOR EACH TYPE

- Description
- Special design criteria
- Reference to norm and standards
- Data for selected capacities (curve if possible)
 - Capacity
 - Space required
 - Min/Max load and time to warm up, time from min to max
 - Investment cost
 - Operation cost
 - Life-time

HEATING AND COOLING SYSTEMS



HEATING AND COOLING SYSTEMS BOUNDARY CONDITIONS

- DH and DC grids interconnect all buildings
- Total load profile to the network, hour by hour, GWh/a, MW max.
- Measured return temperature, and monitored need for supply temperature
- Network losses are included in measured values or calculated for new grids

- Campus and city gate prices for:
 - Electricity, fluctuating market prices, markets for capacity, day ahead etc.
 - Gas prices, energy and maximal capacity etc.
 - Other energy prices

HEATING AND COOLING NETWORK SYSTEMS

- Hot water DH <110 dgr.c replaces steam network
- Hot water DH <110 dgr.C replaces individual boilers
- DC network < 8 dgr.C replaces individual chillers

- DH network redesigned to increase resilience of critical buildings
- DC network redesigned to increase resilience of critical buildings

DH HOT WATER AND DC SYSTEMS MIX OF PRODUCTION AND STORAGE TO NETWORKS

- Biomass boiler 4 hour storage tank base load, oil peak,
- Oil CHP engine 8 hour storage tank base load, oil peak
- Gas CHP engine 8 hour storage tank base load, gas peak
- Gas CHP engine 16 hour storage tank, solar heat 20%, gas peak
- Gas CHP engine, 32 hour storage tank, electric boiler, solar 30%, gas peak
- Gas CHP engine, seasonal storage, electric boiler, heat pump, solar 50%, gas peak
- Gas CHP CC, 16 hour DH storage 8 hour DC storage, electric boiler, DH&C heat pump, gas peak
- DH&C heat pump 16 hour DH storage 8 hour DC storage, gas peak

- Etc.etc.

THANK YOU