Oil drove the 20th Century economic boom. Efficient use of renewable energy is the opportunity of our century.

SUSTAINABLE ENERGY IN AN URBANISED WORLD

urban population%
URBANISATION – GREEN OR BLACK GROWTH?

• Black urbanisation:
  • Poorly planned:
    • Congestion? We build a new road
  • Deteriorisation of health and the environment
    • more is less

• Green urbanisation:
  • Holistic planning
    • Congestion? We shift mode
    • Less is more
THE SUSTAINABLE CITY OF THE FUTURE

An eco-friendly city
En miljøvenlig by

A city at the water
En by ved vandet

A vibrant city
En levende by

A city of sustainable mobility
En by med grøn trafik

A city for everyone
En by for alle

A dynamic city
En dynamisk by
Nordhavnen: Copenhagen – the sustainable city of the future

- Five minute city
  - Promotes walking, cycling, and public transport at the expense of cars
  - Mixed use

- CO₂ friendly city
  - Renewable energy
  - District solutions
  - Protection against climate changes

- Intelligent grid
  - Staggered building zone structure
  - Dynamic structure
  - Flexible to adapt to future trends
  - The city will never be perceived as finished

Ramboll
The Lakeside Idea

Sustainability: the last resort!

A development with global significance
International thinking for living differently
Transformative for the region, the City and the southeast lakefront
Connecting Lakeside to the neighborhood and the neighborhood to Chicago
Designed for Living Differently

State-of-the-art urban lifestyle

- Clean next-generation infrastructure
- Community living in an innovation hub
- Live-work-play connected to the lakefront
- A five-minute walk to school, parks, shopping
- Parks that root residents in their neighborhoods
- Connected transit where cars are optional
How to do - energy
Lakeside will set new standards for resource efficient buildings

CREATE A GREEN CODE FOR LAKESIDE

- Designing for High-Performance, Greater Energy Efficiency and Comfort: Maximum limit to heat and cooling loads
- All buildings must connect to district energy systems
- Use low embodied-carbon and resource efficient building materials
- Implement smart user controls, monitoring and feedback
Delivering Next Generation Infrastructure

Building green from scratch

- Advanced infrastructure as a catalyst for development
- A pioneering neighborhood utility company to efficiently operate clean energy systems
- A “living lab” to prototype and promote new technologies
- Reuse water and return naturally cleaned stormwater to the Lake
- Recycle and reuse waste, eliminating waste to landfills

A district energy approach

Conserve, re-use and return water

Waste Prevention

70% Recycling
Reuse
Recycle/Compost
Energy Recovery
Disposal
30% RDF/WTE/Disposal

Getting to zero waste

Connecting with the world and ICT
COPENHAGEN CO2 NEUTRAL BY 2025

- 98% of heat supply by district heating
- Regional “fingerplan” supports high rate of public transport
- Years of tradition of bicyclism
- Good potential for geothermal heat
- Easy access to imported biomass
SMART ENERGY CITY CONCEPT
SMART INTELLIGENT GRIDS AND BUILDINGS

- National power grid

- City-wide district heating grid
  - storage
  - optimal use of CHP and RES

- City district cooling grid
  - storage and optimal free cooling

- National natural gas - biogas grid
  - gas storage,
  - gas to CHP and small houses

Climate Committee
SMART INFRASTRUCTURE IN THE BACK YARD

• Avedøre
  • New power plant site located with respect to the heat market
  • CHP multi-fuel gas, coal, straw, wood pellets
  • CHP with 2x22,000 m³ heat accumulators
  • Waste water treatment plant
  • Wind

• Amager
  • CHP biomass, coal
  • Waste-to-energy
  • Geothermal energi
  • Waste water treatment plant
  • Sludge incineration
Energy

SMART SUPPLY: DISTRICT ENERGY

District energy offers the most affordable, clean, discrete and future proof energy supply.

- Create district energy systems that provide Lakeside with heating, cooling, and power
- Create energy generation facilities that can be phased with the development
- Create a shared network for energy distribution
- Extend the energy network into the adjacent community
FLEXIBLE DISTRICT ENERGY
AQUIFER THERMAL ENERGY STORAGE
A BROWNFIELD DISTRICT ENERGY SYSTEM INTEGRATING WITH ITS NEIGHBOURS
HEATING CO2 EMISSIONS – AN EXAMPLE

- Individual Gas: 23,000 tons of CO2 per year
- District Heat: Biomass Only: 4,000 tons of CO2 per year
- District Heat: Biomass & Cogen: -27,000 tons of CO2 per year
- District Heat: Gas Only: 18,000 tons of CO2 per year
Lakeside is neighbor to the largest solar field in USA. Lakeside can go solar too.

- Buildings will be equipped with – or at least prepared for – solar panels
- A design guide will secure a consistent visual expression of the installations.
- Large solar rooftop installations could net-meter back to the neighborhood utility
- The land to be developed during later phases could be used temporarily for solar fields
Lakeside has excellent wind resources, in particular offshore. We want to be a first mover.

- Wind turbines on the breakwater: the Lakeside landmark
- Initiate a large-scale offshore wind farm project off Lakeside
- With 15 turbines Lakeside would be self-sufficient with electricity
USE LAKEWATER FOR DISTRICT COOLING

The bottom of the lake is a reservoir of cold water which can be used as a free energy source.

- The existing cribs could be used to supply cooling water from the bottom of the lake
- Or, a new long pipe will be extended far out into the lake
- An underground cooling water distribution system will connect to all buildings needing cooling
- The lukewarm return water will be pass through the Lakeside water bodies and help keep outdoor temperatures down, before being returned to the lake.
- Costs of cooling will be dramatically reduced.
AN INTEGRATED URBAN ENERGY SYSTEM
LARGE-SCALE HEAT STORAGE

• Seasonal solar heat storage
  • Takes on big time in DK
  • Competitive with conventional heating

• Seasonal storage in a smart grid:
  • Decoupling CHP from heat demand
BALANCING WIND POWER IN DH SYSTEM

Geothermal
Solar
Heat pump
Wind
Thermal energy storage

CHP heat
COST COMPARISON OF DIFFERENT MEASURES

Energy savings, kWh/m²

- Isolering +200 -> +300 mm
- Mikrovindmøller
- Isolering +100 -> +200 mm
- Solceller
- Solvarmefra lager
- Isolering +100 mm
- Havvindmøller
- Landvindmøller
FAST TRANSFORMATION THROUGH DISTRICT ENERGY: DENMARK

Case A: Moderately improved building envelope and expansion of district heating

- Solar heating (individual)
- Heat pumps (individual)
- Stoves, electricity
- Central heating with natural gas
- Central heating with oil
- District heating

Net heat demand in TWh

Share of combined heat and power production
- Waste, biomass etc.
- Natural gas
- Coal
- Oil
- Share of combined production

Share of fuel/energy to cover 1 unit of heat

Disctrict Heating in TWh
URBAN PLANNING MATTERS!

CO2 emission for new office building

- Commuting
- Electricity
- Heating
- Materials

Individual transport
- Individual heating

Public transport
- District heating

0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000
kg/m2 over 60 år

Ramboll
Linking Lakeside to the Region

Lakeside and Chicago’s Southside can become transit-rich with vibrant and walkable neighborhoods

- Building walkable and bike-able neighborhoods
- Reconnecting the South Chicago Community to the Lake
- Planning for the next generation of vehicles and smart infrastructure - ‘personal rapid transit’
- Implementing fully integrated intelligent transit systems
- Making Lakeshore Drive into a great boulevard promoting a strong sense of community
The City of Copenhagen estimates that it’s cyclists save the city 90,000 tonnes of CO2/year.

The City of Copenhagen aims to have 50% of people cycling to work by 2015.

Only 2% of train users in Copenhagen drive to the train station.

On average, the volume of car transport per employee is 10km less per day if an enterprise is located less than 600-700m from a station...

source: Hartoft-Nielsen 2002

Locating an office near a train station saves 5 times as much CO2 as going from a standard building to passive design.

source: Byernes Rolle i Klimastrategien
Totally Connected, Personally Controlled

CHALLENGE
Integrate technology to expand opportunities

- Provide new ways to educate
- Enhance access to healthcare
- Enable infrastructure and energy systems to reach maximum potential
- Power the neighborhood utility services
- Connect the southeast lakefront community to advanced information technologies
CO2 ækv. opgjort på brændsler

Alle virkemidler

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2015</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vind</td>
<td>-800</td>
<td>-600</td>
<td>-400</td>
</tr>
<tr>
<td>Olie</td>
<td>-200</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Non Energy</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Naturgas</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kul</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Diesel</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Benzin</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Avgas</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Affald</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>