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Going electric – Ambition to create the first electric region in Norway

Torstein Melhus, Director Market
Our mission:

We provide clean energy for a sustainable society - now and in the future
Key facts

Offices **five countries**

**47 owned** hydroelectric power stations in South of Norway

Norway’s **fourth largest** producer of hydroelectric power

Operating revenue (2017): **10.221 million NOK**
Our business

**Hydroelectric power:**
Operating and developing hydropower stations

**Network:**
Operating and developing the power grid

**Energy Management:**
Energy management and trading, flexibility

**Marketing:**
Electricity retailing, electrical engineering services, entrepreneur HV services, venture capital investments, district heating and cooling, EV-charging
Bottom-up revolution

- From central to decentral production
- From analog to digital
- From fossil to renewable
- From manual to machine learning
In our area we have a power surplus of flexible and sustainable hydropower of (aprox.) 13 TWh.

That gives credibility to our ambition of being the first electric region in Norway.
Establish a picture of status and potential in Kristiansand

Status electrification - 2019

Possible areas to electrify - C02 red

Actions/pilots to perform further electrification
OVERVIEW TOTAL ENERGY CONSUMPTION AND EMISSIONS IN KRISTIANSAND

352,578 tons CO2e (2017) – Norwegian Environment agency

Source: SSB, Norwegian Environment Agency, THEMA Consulting Group
CURRENT ELECTRIFICATION RATE IS 68.5% IN KRISTIANSAND AND APPROXIMATELY HALF OF THE REMAINING EMISSIONS HAS POTENTIAL TO BE ELECTRIFIED!

Source: SSB, Norwegian Environment Agency, THEMA Consulting Group
ELECTRIFICATION-RATE PER CATEGORY WITHIN KRISTIANSAND SHOWS THAT TRANSPORT AND CONSTRUCTION MACHINES ARE THE AREAS WITH HIGHEST POTENTIAL TO BE ELECTRIFIED.

**Year 2017**

- **Fossil**
  - Road: 98% electrified
  - Constr. Machines, etc: 100%
  - Sea: 97%
  - Air: 100%
- **Bio and others**
  - Road: 2%
  - Constr. Machines, etc: 0%
  - Sea: 3%
  - Air: 0%
- **Electricity**
  - Road: 0%
  - Constr. Machines, etc: 0%
  - Sea: 0%
  - Air: 100%

**Industry, oil and gas**
- 83% electrified

**Energy supply**
- 87%

*Source: SSB, Norwegian Environment Agency, THEMA Consulting Group, fjernkontrollen.no*

*Statistics underestimates actual energy consumption from ships in harbour, so electrification rate might be lower.*

- **e.g.: Coal anthrasite is used in industry process.**
- **CHP: Power production and waste heat reused (CCS).**
Electric vs fossile fuel

ENERGY EFFICIENCY INCREASES DRAMATICALLY AND VALUE CHAINS WITHIN ENERGY DISTRIBUTION WILL CHANGE

Example category: Road

<table>
<thead>
<tr>
<th></th>
<th>Fossil</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
<td>307,537</td>
<td>4,945</td>
</tr>
<tr>
<td>Fully electrified</td>
<td>97,025</td>
<td>97,025</td>
</tr>
</tbody>
</table>

Energy consumption (MWh)

-68%

Source: SSB, Norwegian Environment Agency, THEMA Consulting Group
“Todays available technology is not the obstacle to solve the climate crisis. For the majority of us it’s about changing our own habits. This might be a painful transformation. But I think we are willing to change our behaviour to make necessary changes.”

Harald Furre, Mayor of Kristiansand

**The Mayor: Electric Kristiansand A political aim**
• We have a surplus of sustainable hydropower – energy is not the obstacle

• We have identified potentials in electrification - mainly about transport

• Conversion of the transport sector from fossil to electricity will:
  • Stop distribution of fossil fuel and replace with –cable/batteries/H2/solar/wind/…
  • Increase demands for fast charging – cars, buses, taxis, trucks, airplanes, ferries……

  • This will put a challenge for capacity on the GRID
    • Intelligence, real-time, prognostics, peak-shaving, aggregation – flexibility
    • Optimization – grid expansions versus smart control and local capacity
    • Digital twins to simulate, integrate and operate areas in true-time with AI
    • Microgrids? to optimize «behind the meter»

• We need to create pilots in many areas – as transport hubs:
  • High peak-power in short periods for charging - fossil fuel is out……
  • Harbour areas, Airports..,
  • Seasonal areas – like the Zoo in summer - *(5,000 cars in daypark 4-8 weeks/year)*
User flexibility
Pilot Engine Trafo in 2015 with Microsoft
Large scale pilot now in Norflex
Kristiansand Harbour: Established Europes largest shore-power 2018
DHC from reuse – helps the power grid

Heating from:
CHP & Glencore
99% re-use wasteheat

Cooling from:
Cold, salt seawater
(intake 150m depth)
### Shore-power to Cruiseships
(8 MW/ship – 5 hrs)

### Transport
Car, bus, taxi, truck …

### Urbanizing

### Electric ferries
Colorline, Fjordcat..

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**Possible pilot - Kristiansand Harbour**

**Microgrid?, Digital Twin, Flexibility market, H2, batteries, GRID:**
- Ideal area to start a pilot, *high peak-load/few hours usage*
- Explore the challenges in capacity need, capacity build in grid, hydrogen as carrier, batteries vs grid, V2G...
- Possible load in city to turn off periodically (aggregation/flexibility market)
- Digital twin virtual model of Harbour (and city) for true time simulation and control

**Goal:**
- Make electrification smart
- Reduce high investments in GRID with few hours use.
- Optimize through digital infrastructure, processing of data in real-time and load-shifting to reduce peak-power
Norway: Focus on electric airplanes for short distance routes

Estimated >10MW charge/plain
From 2025 towards 2030

A challenge for Avinor
A challenge for the grid
Kjevik Airport – possible pilot area – not concluded

Heat/cooling:
- HP with seawater

Local prod:
- Solar/wind
- Batterystorage
- Hydrogen

Parking:
- Multiple charging stations
- Vehicle-to-the-grid (V2G)
- Part of peak-power planning

El- taxi, busses, cityferry, goods transport

El - trucks, trolleys, cars

Electric airplanes

Goal:
Reduce cost and investment in GRID/capacity through optimizing all users, producers and storage in, and around, the area.

Optimization towards grid

Planning of future peak-power demands
- Aggregation, loadshift, balancing
- In true-time connect production hydroturbine and usage Kjevik

Develop tomorrows regional, electric airport
We believe that we can manage the transformation towards a sustainable and electric future.

But - to be able to remove fossile fuel as energy carrier we need:
• Smart solutions for energy distribution and grid capacity planning/balancing
• Electric/hybrid equipment development - planes, ships, trucks, constr.mach.
• Political will and guts to push for behavioural change

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Harald Furre, Mayor of Kristiansand