Technologies enable systemic change

Heli Antila
Fortum – For a cleaner world

Megatrends
Climate change and resource efficiency
Urbanisation
Active customers
Digitalisation, new technologies

Mission
We engage our customers and society to drive the change towards a cleaner world. Our role is to accelerate this change by reshaping the energy system, improving resource efficiency and providing smart solutions. This way we deliver excellent shareholder value.

Vision
For a cleaner world

Strategy
Drive productivity and industry transformation
Grow in solar and wind
Create solutions for sustainable cities
Build new energy ventures
IPCC: Staying below 1.5°C requires “rapid and far-reaching transition” – Fortum calls for an ambitious EU climate strategy

- We need to reach global carbon neutrality by 2050
- The power sector should reduce emissions by 100% well before 2050
- 70-85% of electricity should come from renewables and nuclear will play a bigger role
- We believe electrification will be an enabler for decarbonisation
- We ask for a stable, visionary, and long-term political framework
- Carbon pricing should be the key for reaching carbon neutrality and market mechanisms developed to reward CO₂ removal
Transition towards Solar Economy is ongoing
Comparison

Wind capacity scenario forecasts compared over time

Cumulative installed capacity

Net capacity additions per year

Solar capacity scenario forecasts compared over time

Cumulative installed capacity

Net capacity additions per year

Onshore wind and solar PV have become competitive among new power plants in most regions across the World

Recently announced long-term Power Purchase Agreement contract prices / tariff levels

1 Sources: announcements by the investing companies and IEA report “Renewable Energy Medium-Term Market Report 2015” for US, Brazil, South Africa, Australia and Jordan. Values reported in nominal euros. United States values calculated excluding tax credits. Typical contract lengths are 15-25 years. The prices indicate levels with which investors have been willing to invest, however, they may not describe the actual comparable costs as the bid prices may be reduced by preferential land prices, site exploration cost, targeted low-cost loans etc.

For Sweden the price level at which investors can hedge their renewable production for the next 4 years: average of 2017-2020 electricity (LUL) + elcertificate futures with 29.8.2016 closing prices. In Spain, wind and solar built on market prices with only downside protection mechanisms in case of significant drop in market price. Germany and Netherlands have had merchant bids in offshore where grid connection is provided by TSO.
Battery technology costs have declined faster than estimated before

Target price for Tesla model 3 and GM Bolt battery storages

Source: Bloomberg New Energy Finance, 2016
Renewables demands a new way to look at the energy system

- Energy is a limited resource
- Focus on how much energy is used
- Minimize usage of energy
- Fixed tax
- Support for renewable generation
- Focus on the electricity system
- Focus on national solutions
- Solar PV important in the solar belt
- Baseload will secure the future
- DH is old-fashioned and fossil based

- Energy is an infinite resource
- Focus on when energy is used
- Optimize production capacity
- Variable tax
- Support for flexible generation
- Focus on the energy system
- Focus on regional solutions
- Wind and hydro important in the Nordics
- Baseload loses importance
- DH is smart, sustainable and a complement to renewables
The energy system is becoming more interlinked – and more complex - with electrification and decarbonisation as key drivers

- **Transportation**
  - EV demand and additional grid issues with charging peaks

- **Power**
  - Gas providing more flexibility and peak supply for power sector
  - Gas storages, distribution and transmission constraints
  - CHP electricity during winter times
  - Potential demand increase from heat electrification

- **Gas**
  - Gas supply to power sector
  - Gas storages, distribution and transmission constraints
  - RES integration cost
  - Gas supply to heat sector

- **Heat**
  - Flexibility from heat sector
  - Additional grid constraints for heat electrification
  - Gas providing more flexibility and peak supply for power sector

- **Energy flows**
  - Existing connections
  - Potential new sector couplings

**Key Terms**
- **OCGT**
- **CCGT**
- **P2G**
- **DSM**
- **CHP**
- **Storage**
- **DH net**
- **RES**
- **CCGT**
- **OCGT**
- **CHP**
- **DSM**
- **Storage**
- **DH net**
- **RES**
- **P2G**

**Abbreviations**
- **P2G = Power to Gas**
Consumers in key role!
SmartLiving – end-customer experience

1. Steady indoor climate
2. Decreasing heating costs
3. Shared goals for increasing living comfort

Weather information and forecast
Ecologically optimized production
Machine intelligence

Building owners and residents

Powered by Leanheat
Spring virtual battery Supporting Energy System
14,76 €
157 kWh
Sähkökulutus toukokuun alusta

Kulutus nyt
2,68 kW

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NORMAALI LÄMMITYS

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Fortum Bio2X: Acceleration towards natural resource efficiency
Bio2X is based on fractionation technology: We can transform biomass into multiple sustainable high-value end products

**Raw materials:**
Non-food lignocellulosic biomass

**Forest biomass**

**Agro residues**

**Other plantations**

**Bio2X fractionation technologies**

**Cellulose (40-45%)**
- Cellulose fibers
  - Dissolving pulp for textiles
  - Bleached pulp
  - Brown pulp

**Hemicellulose (25-35%)**
- C6 sugars
  - Polymers, fuels, plastics, chemicals, e.g., PLA, PEF, FDCA

**Lignin (20-30%)**
- C5 sugars
  - Xylose
  - Technical emulsifiers
  - Dietary fibers
  - PLA & furfural

**End products:**
- Bio-resins
- Dispersants
- Polyurethane
Case example: India

Breathing air in Delhi for a day = Smoking 44 cigarettes

Example action:

- Build biorefineries to Delhi’s surrounding countryside
- We could replace over 50% of global cotton production
- Considerably improve air quality and CO₂ levels
Bio2X first step: Fortum participates in joint venture in India to build a bio-refinery based on Chempolis fractionation technology

- Fortum has taken a step forward in its Bio2X programme and established a joint venture together with Numaligarh Refinery Limited (NRL) and Chempolis for building and operating a biorefinery in Assam, India.

- The joint venture will own the biorefinery. Construction work will begin in the autumn of 2018, with the target date for beginning operations at the site set for the year 2020.

- The total investment cost estimate is 160 million euros.

What will we learn from NRL fractionation plant?

- Prove Chempolis core process in ethanol production
- Bamboo sourcing and suitability for processing
- Working and project execution in India business environment
Thank you

Join the change!