

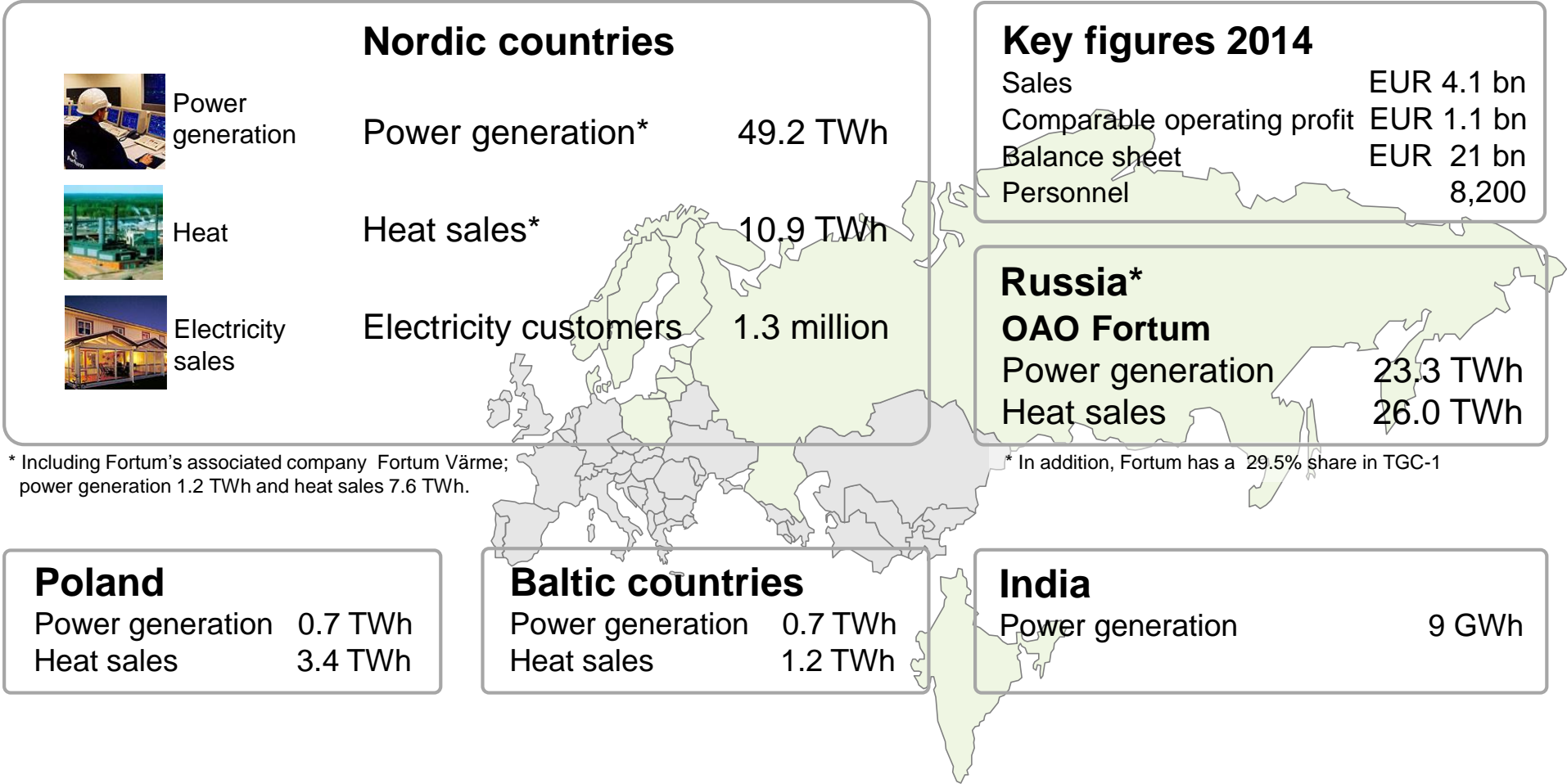


Öljä puusta
Teknologiajohtaja Heli Antila, Fortum

ALUMNIWEEKEND 2015

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- **Fortum briefly**
 - Solar economy
 - Fortum's new bio-oil plant
 - Bio-oil consumption

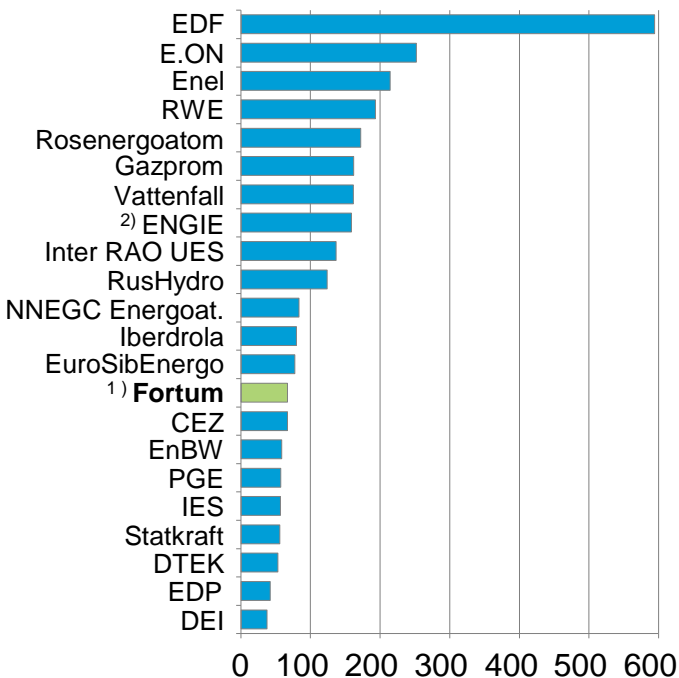
Our current geographical presence



Fortum mid-sized European power generation player; major producer in global heat

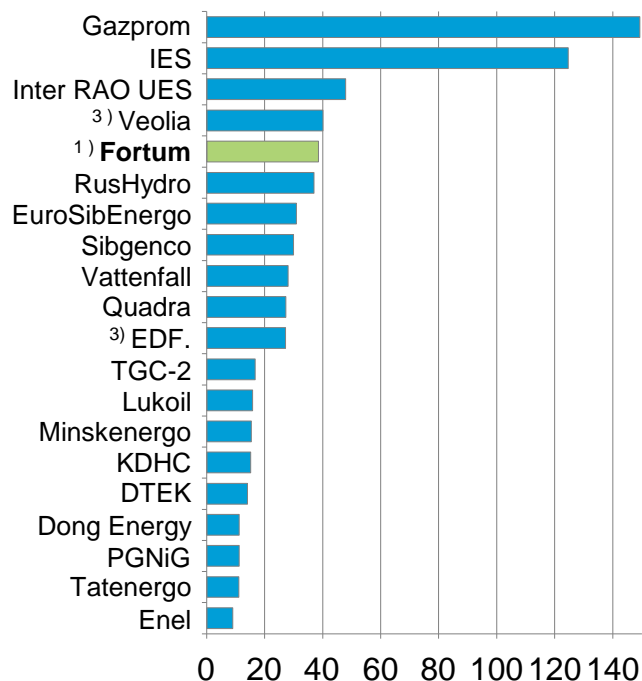
Power generation

Largest producers in Europe and Russia, 2013
TWh



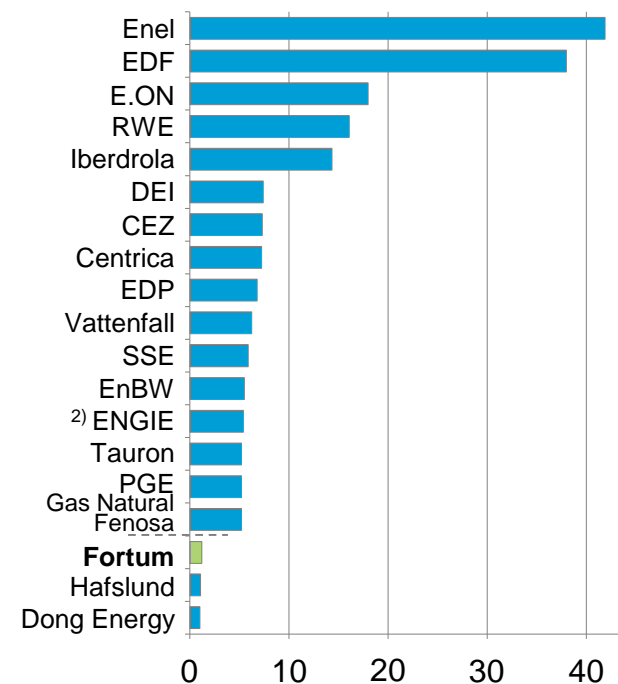
Heat production

Largest global producers, 2013
TWh



Customers

Electricity customers in EU, 2013
Millions



1) Incl. Fortum's associated company Fortum Värme; power generation 1.3 TWh and heat production 8.2 TWh.

2) Formerly GDF SUEZ; 3) Veolia incl. Dalkia International and EDF incl. Dalkia's activities in France

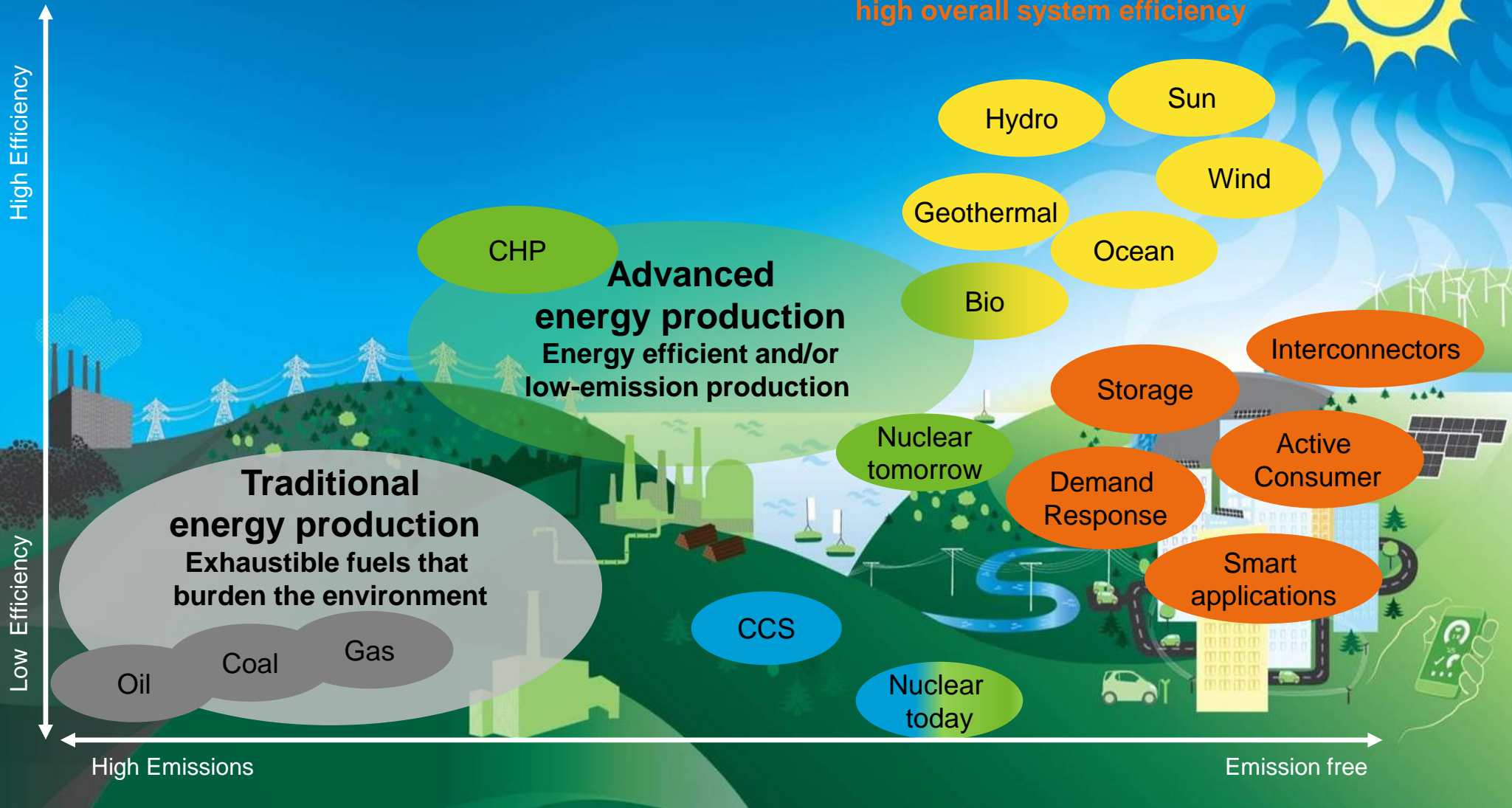
Source: Company information, Fortum analyses, 2013 figures pro forma, heat production of Beijing DH not available.

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Energy is an enabler

Solar Economy

Solar based production with high overall system efficiency



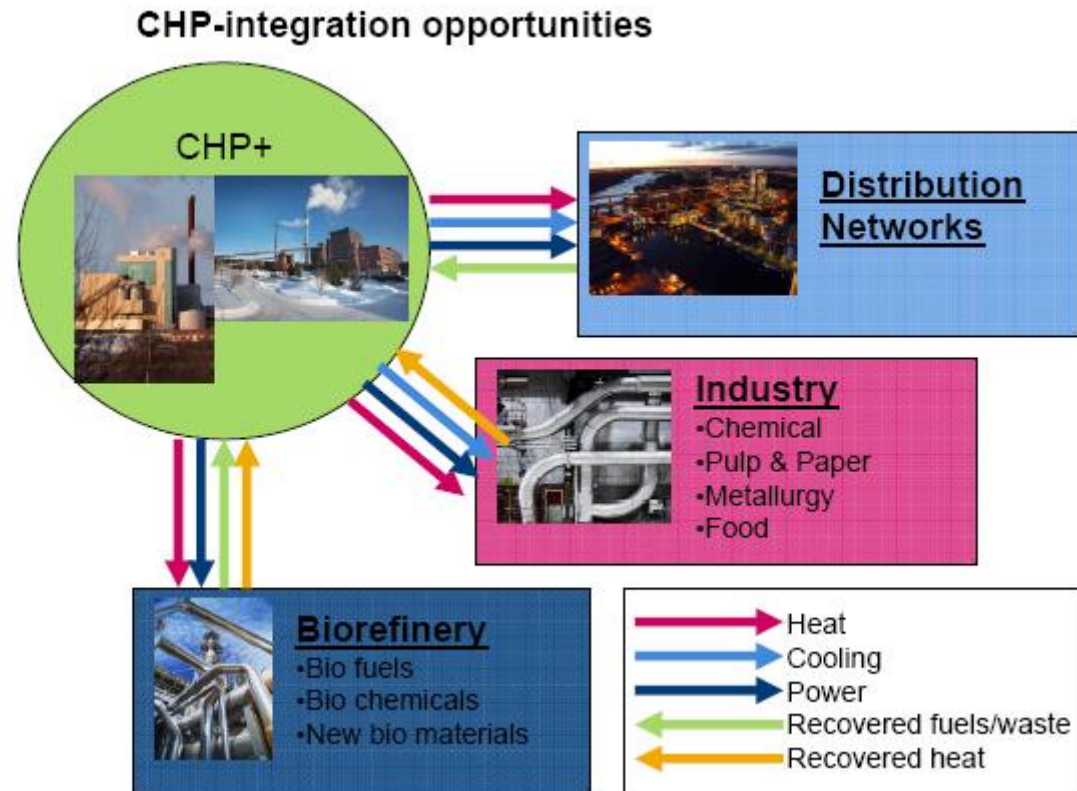
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New CHP+ concepts (Combined Heat and Power)

Integrated production adding value

Key rationale and potential

- CHP is the most efficient way for converting fuels to power and heat
- CHP enables utilization of variety of different fuels, waste and industrial side products
- Stable heat loads enabling better utilization of assets
- New business through wider product range; new products in addition to electricity, heat and cooling
- New sustainable solutions for decreasing emissions by replacing fossil fuels and further improving energy efficiency



The production and usage of bio oil is one route to low-carbon energy production



Fuels of the power plant =
the raw materials of bio-oil

CHP plant

- electricity production
- heat production
- bio-oil production

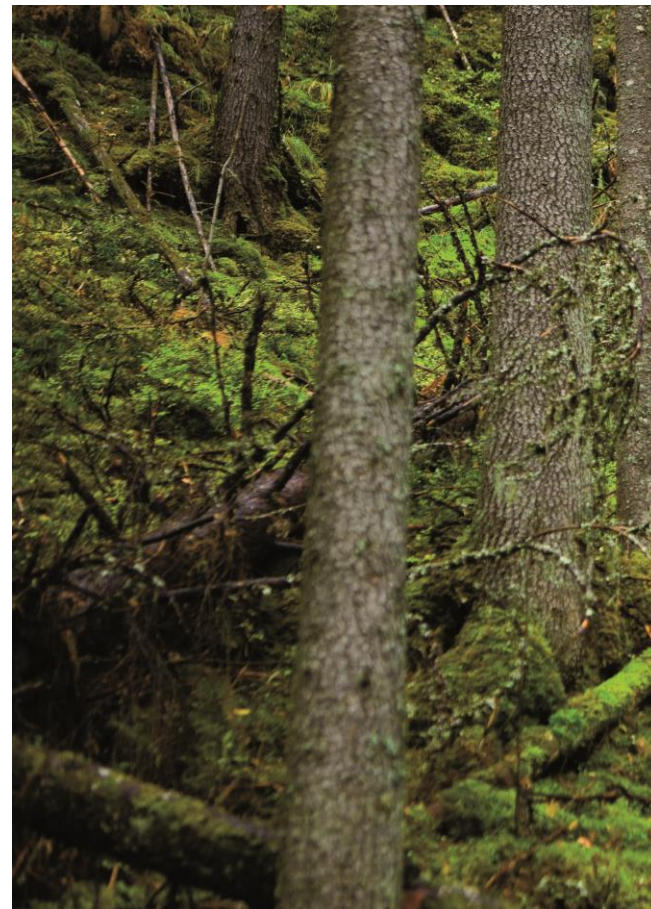
Final consumption of bio-oil

Low-carbon production of heat and steam

Bio-oil production integrated with electricity and heat production is not only highly energy efficient but also progressive alternative because of its investment and operating costs.

Drivers and triggers for new biofuel technology investment

1. Market outlook
 - New business potential – customer demand
 - Savings potential (technology, fuels, O&M...)
 - Political aspects – trends and clear priorities
2. Novelty value - potential for competitive advantage
3. Synergies with existing business
 - Modularity – opportunities to duplicate/integrate to new plants/markets
4. Sustainability
 - Carbon footprint, emissions
 - Public acceptance
5. Partnering opportunities – resources
 - Research
 - Technology provider
6. New technology risks - opportunities for public funding
 - R&D support
 - Innovation funding for demonstration phase



From R&D initiative to investment

Case pyrolysis oil production

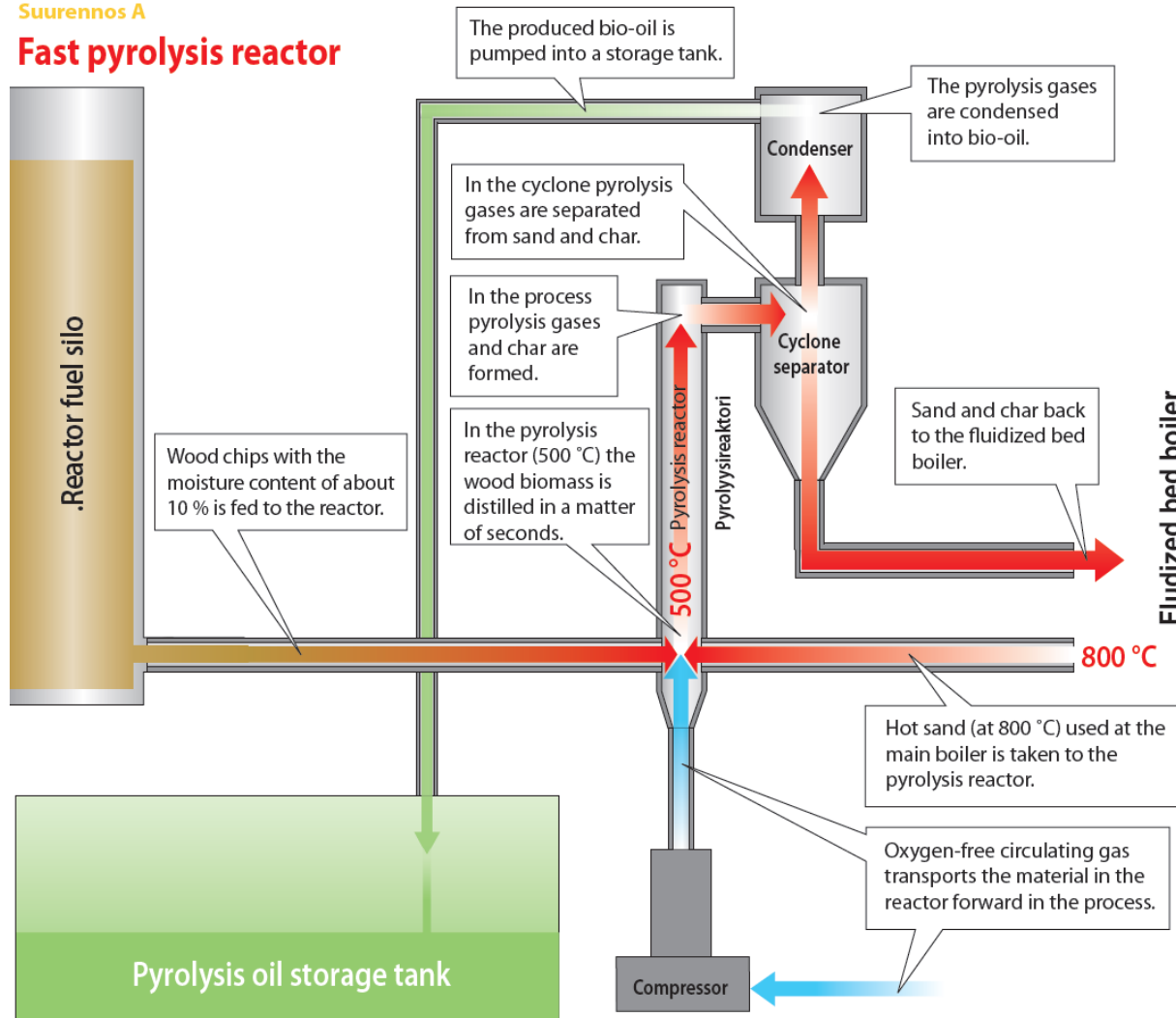
- **First pilot 2001 (“stand alone type”)**
 - Market was not ready (low oil price, no price for CO₂)
- **Feasibility studies 2007- 2008**
 - Market outlook getting more favourable for CO₂ –lean solutions (e.g. EU 20-20-20 targets)
- **Fortum joins R&D consortium with Metso, VTT and UPM in 2009**
 - Strong partners with natural roles, CHP –integrated technology
- **Pilot testing in Metso laboratory supported by VTT, combustion testing in Fortum heating plant 2009 – 2011**
- **Investment decision for a demonstration plant in February 2012**
- **Pyrolysis oil production started in Joensuu at Q4 / 2013**



This is how a CHP integrated bio-oil production works

Suurenos A

Fast pyrolysis reactor



- Fast pyrolysis is a high temperature process in which biomass is rapidly heated in the absence of oxygen
- Steps
 - Drying of biomass (moisture < 10%)
 - Crushing (particle size < 5mm)
 - Fast pyrolysis (high heat transfer rate, controlled temperature, short vapour residence time)
 - Separation of particulates and pyrolysis vapours (cyclone)
 - Rapid cooling of the pyrolysis vapours

From reasearch to production

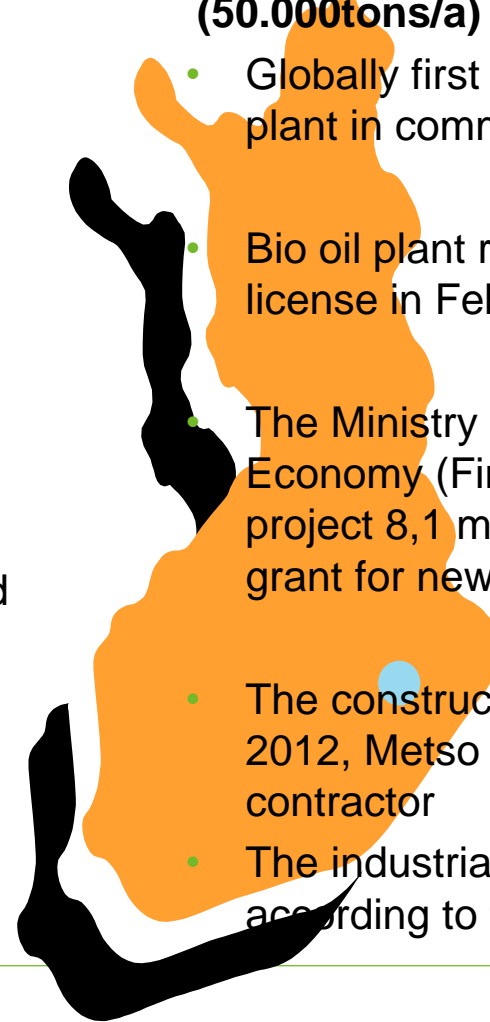
Bio-oil production plant to Joensuu


Eastern Finland is a great location for the first bio-oil plant because:

- Raw material is available in near-by areas:
 - Logging residues
 - First thinning wood
 - By-products of pulp and paper industry
- The plant uses already lots of wood-based fuels
- The current boiler fits for the purpose and Fortum´s district heating operation gives good platform for continuous production
- There is strong knowhow of forestry and bio energy in Eastern Finland

Joensuu demonstration plant (50.000tons/a)

- Globally first CHP-integrated pyrolysis plant in commercial size
- Bio oil plant received an environmental license in February 2012
- The Ministry of Employment and the Economy (Finland) has allocated the project 8,1 million euros of investment grant for new technology
- The construction work started in June 2012, Metso Power as a turn key contractor
- The industrial production of bio oil begun according to the plan in Q4 / 2013



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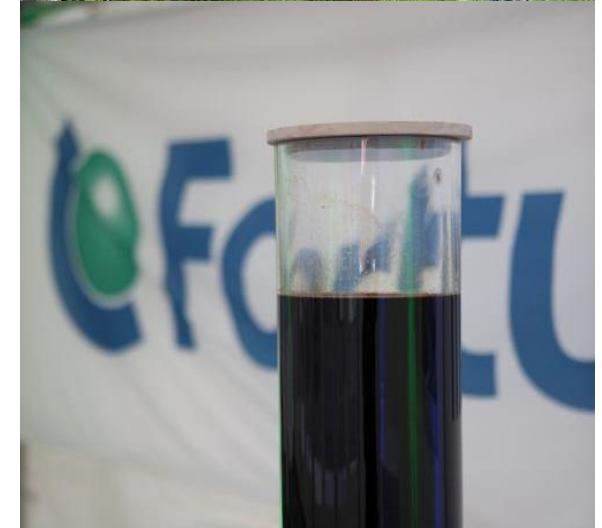
Wood-based bio-oil to replace fossil fuels

- The calorific value of the bio oil is approx. half of the energy content of fossil heating oil
 - Bioenergy in compact form
- Bio-oil is easy to pump
 - Can be used in current boilers
- Bio-oil consists of organic compounds
 - Cannot be blended with fossil heating oils
- In the future -> As a raw material for traffic fuels and green chemicals



Pyrolysis oil – sustainable alternative for fossil oil

- Raw material is local wood-based bio-mass
- By replacing fossil fuels with bio-oil, the carbon dioxide emissions of heat production can be reduced over 90%
- Wood-based bio-oil is practically sulphur-free -> Positive impact on the local air quality
- Planned output of bio-oil is approximately 50,000 tonnes annually:
 - District heating for 10,000 detached houses or for 24,000 medium size apartments
 - Approximately 60,000 tonnes reduction of CO₂ emissions
 - Approximately 320 tons reduction of sulphur dioxide emissions



Future outlook

- First step to replace fuel oils in heat production
- Future applications can be further refining to products with higher market value (e.g. traffic fuels)

Latest news

1.9.2015

- Fortum has delivered its first export batch of bio-oil produced in Finland.
- The bio-oil was tested at E.ON's Karlshamn power plant in Sweden, which is one of the biggest peak-load and reserve power plants in the Nordic countries with a capacity of 1,000 megawatts.
- Based on the test combustion performed at the Karlshamn power plant, bio-oil can replace heavy fuel oil also in bigger power plants.
- E.ON is Fortum's first bio-oil customer outside Finland. Four tanker truckloads, or 160 tonnes, of bio-oil was supplied for the test combustion. In the test combustion, the bio-oil was incinerated at a record output of 175 megawatts. So far bio-oil has been used in smaller heat plants.
- Before Fortum Otso bio-oil has been used in Finland at Savon Voima's heat plant in Iisalmi and at Fortum's heat plant in Joensuu.



A young child with blonde hair is smiling and holding a large, colorful globe of the Earth. The globe is positioned in front of the child, partially obscuring their face. The background shows a sandy area, green trees, and a clear blue sky with some light clouds. The text "Next generation energy company" is overlaid in white on the left side of the image.

Next generation energy company

Twitter @AntilaHeli

Next generation
energy company

