



Heating Large Cities with Biomass

Dr Heli Antila, Chief Technology Officer

Content

- 
- **Fortum briefly**
 - World's most efficient biomass based combined heat and power production (CHP)
 - Towards higher value bio products

Fortum – Forerunner in clean energy

MEGATRENDS

Climate change
Urbanisation
Active customers
Digitalisation, new technologies



VISION

Forerunner in
clean energy

MISSION

We provide customers with energy solutions that improve present and future life, and we deliver excellent shareholder value.

STRATEGY



Drive
productivity
and industry
transformation



Create
solutions
for sustainable
cities



Grow in
solar and
wind



Build new
energy
ventures

MUST-WIN-BATTLES

Put the customer
in the centre

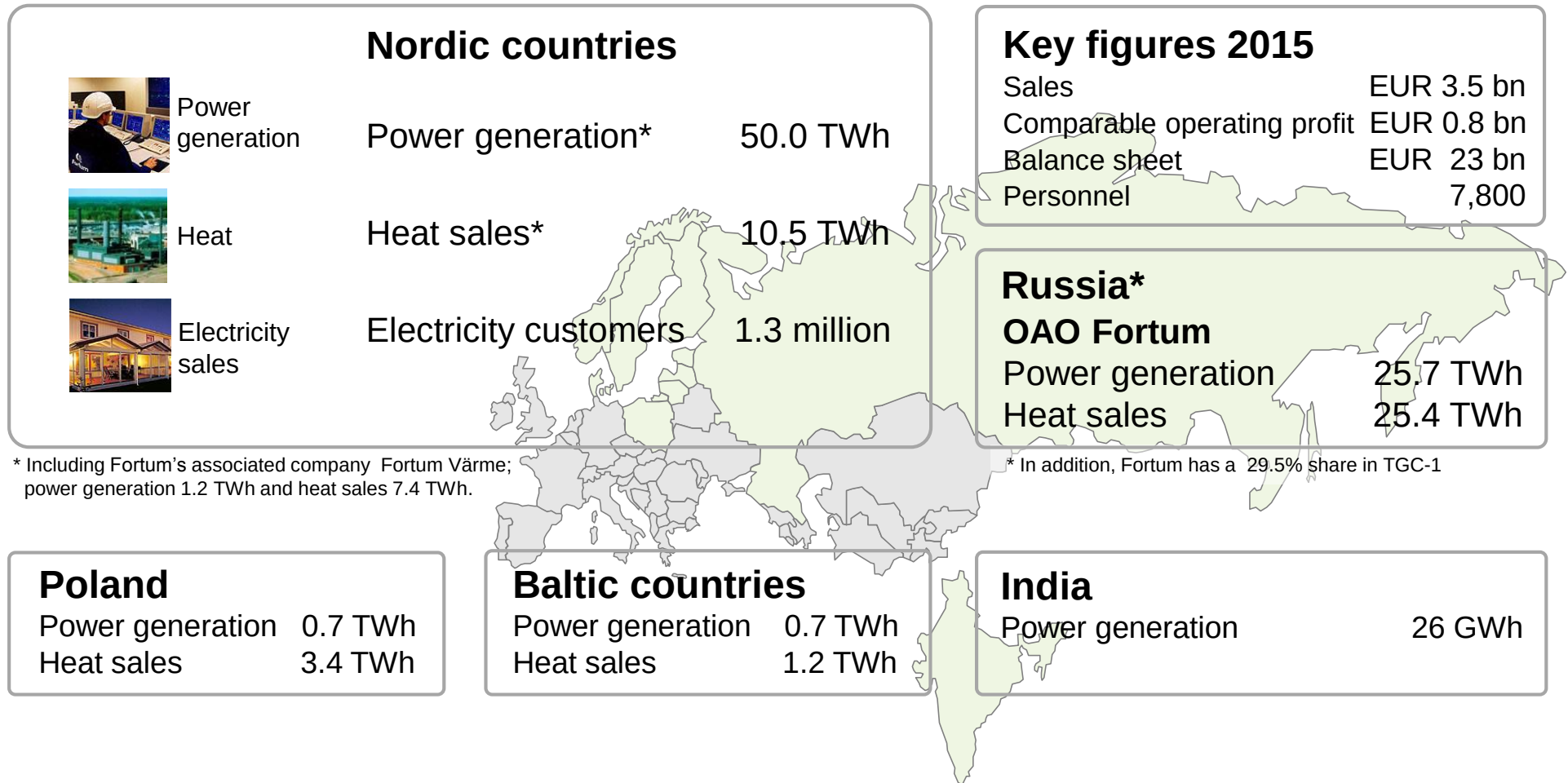
Establish a culture
of speed and agility

Digitalise our business
for maximum scalability

Create value from
market volatility

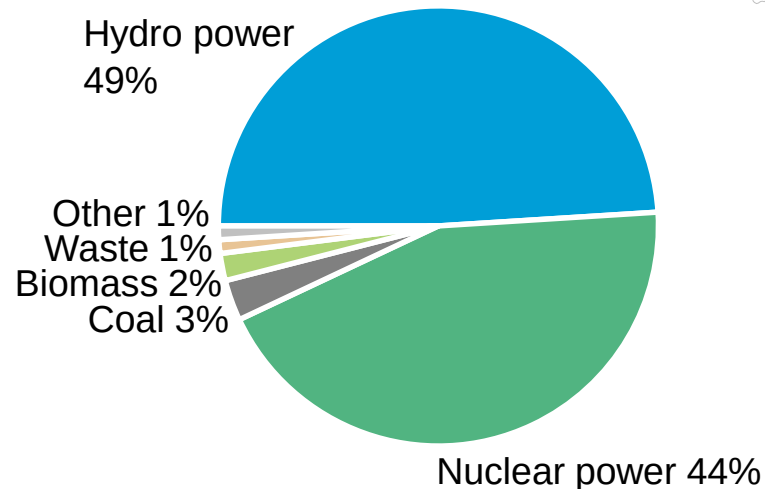
Drive competitive markets
and fair regulation

Our current geographical presence



Fortum's European power generation based on hydro and nuclear power – wide flexibility in heat production

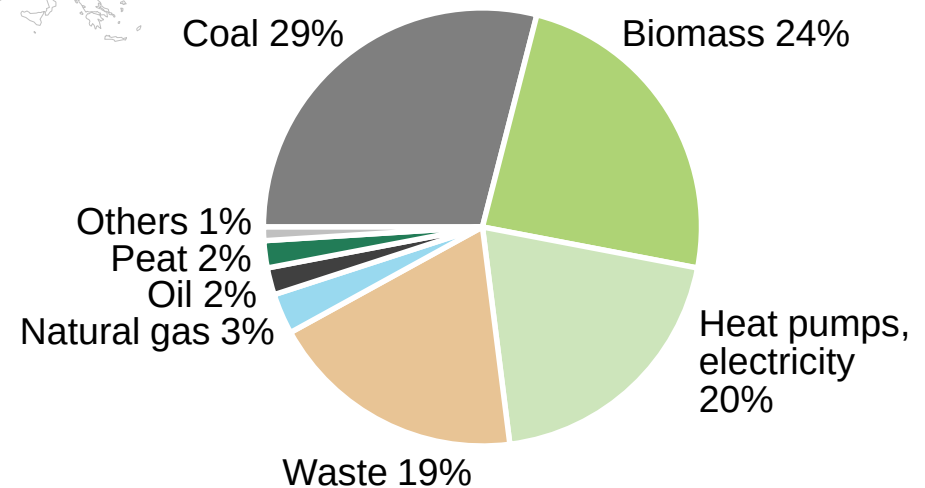
Fortum's European power generation in 2015



European generation 51.3 TWh
(Generation capacity 9,413 MW)



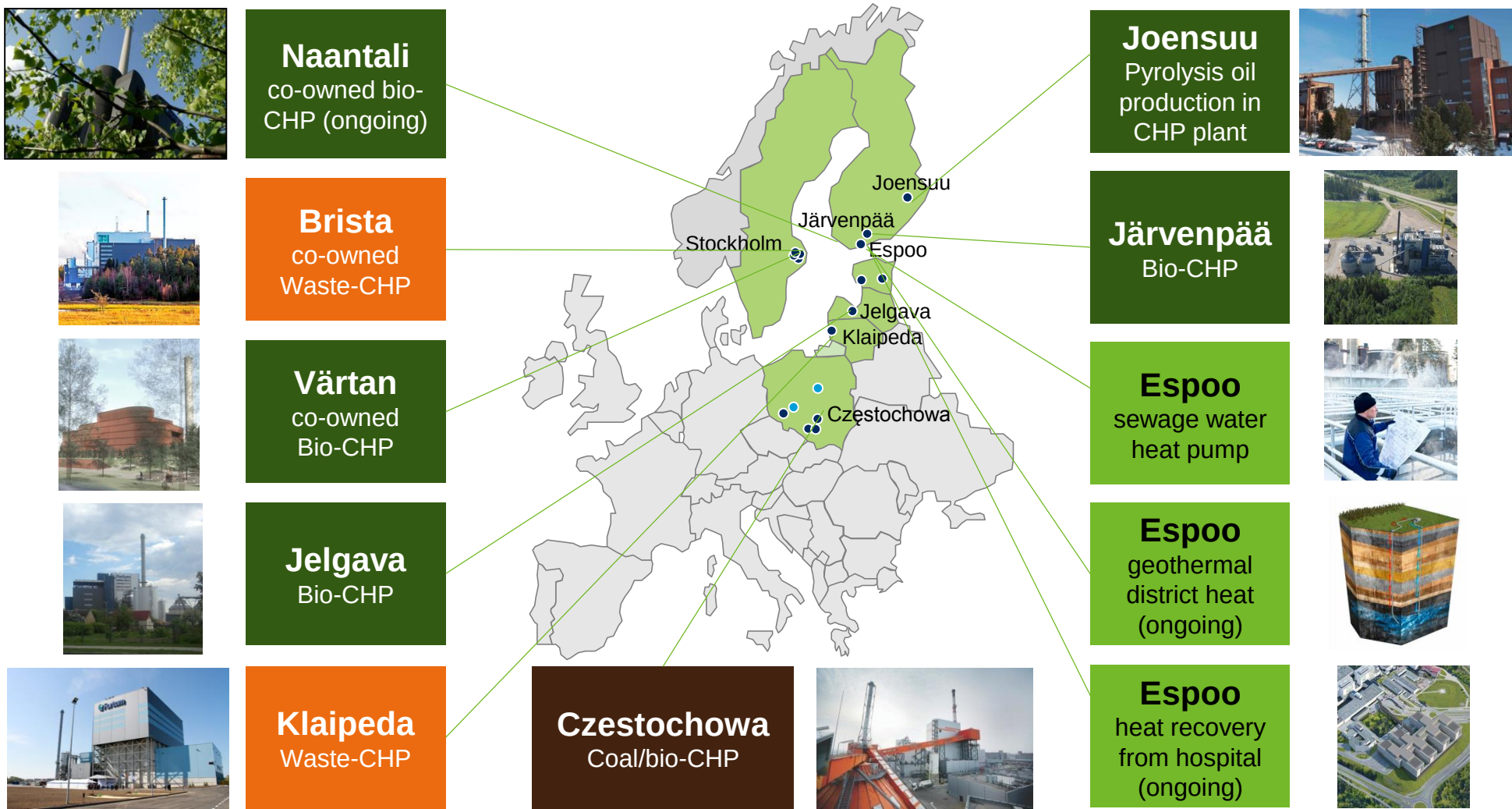
Fortum's European heat production in 2015



European production 13.9 TWh
(Production capacity 7,806 MW)

Incl. Fortum's associated company Fortum Värme; power generation 1.2 TWh (capacity 639 MW) and heat production 7.5 TWh (capacity 3,891 MW).

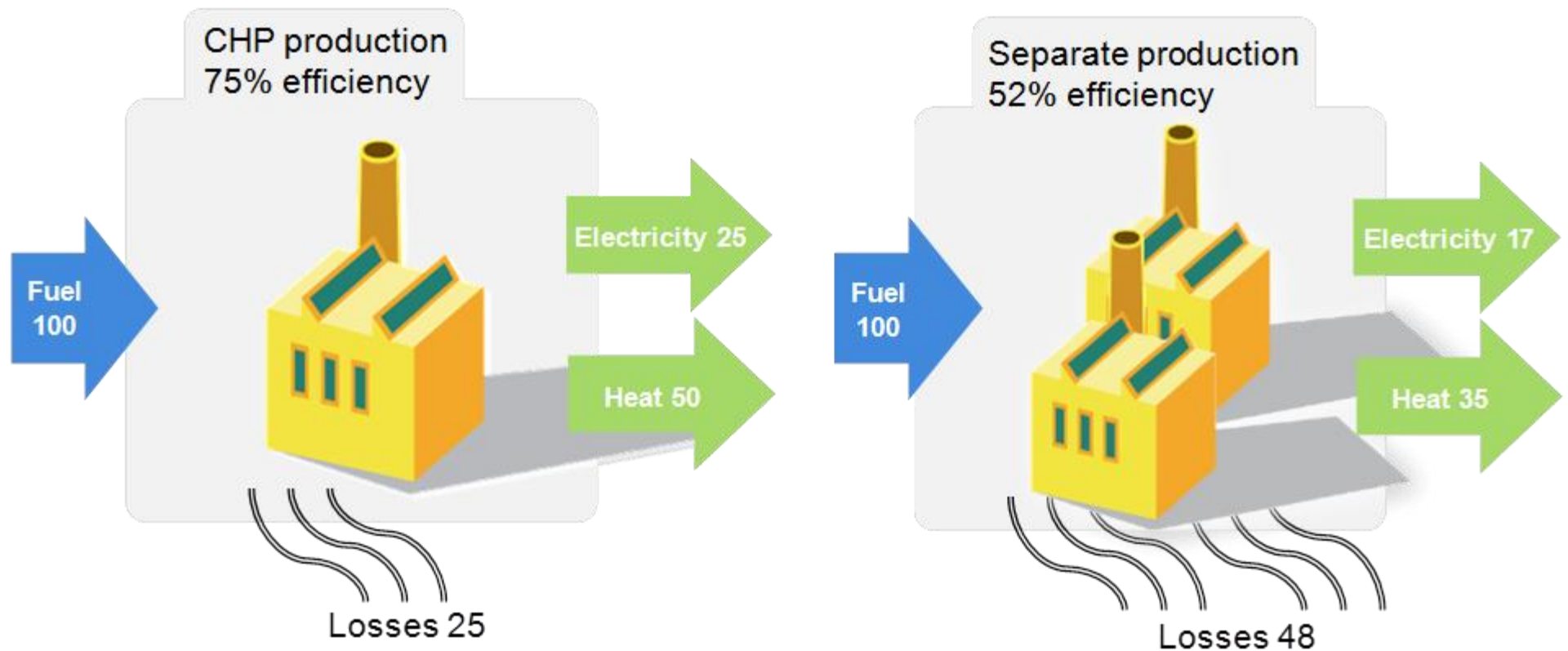
Strong focus on biomass both in present and future business potential – examples of recent investments



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Combined heat and power (CHP) is the most efficient way to produce energy of biomass



Our district heating and cooling facilities in the Stockholm area



Half of Stockholm district heating from local sources



1. Energy from sorted waste from companies and households

2. Waste heat in sewer water, district cooling returns and from server farms

3. Renewable biofuels from the forest industry and sun energy from the sea



Värtaverket in Stockholm

- towards 100 percent renewable and recovered energy

CHP8 – Värtaverket

330 MW CFB, 140 Bar/560°C, 130 MW power, 200+80 MW heat



Construction start Dec 2012
Commissioning Feb 2016
Investment ~500MEUR

Underground fuel storage 55 000 m³



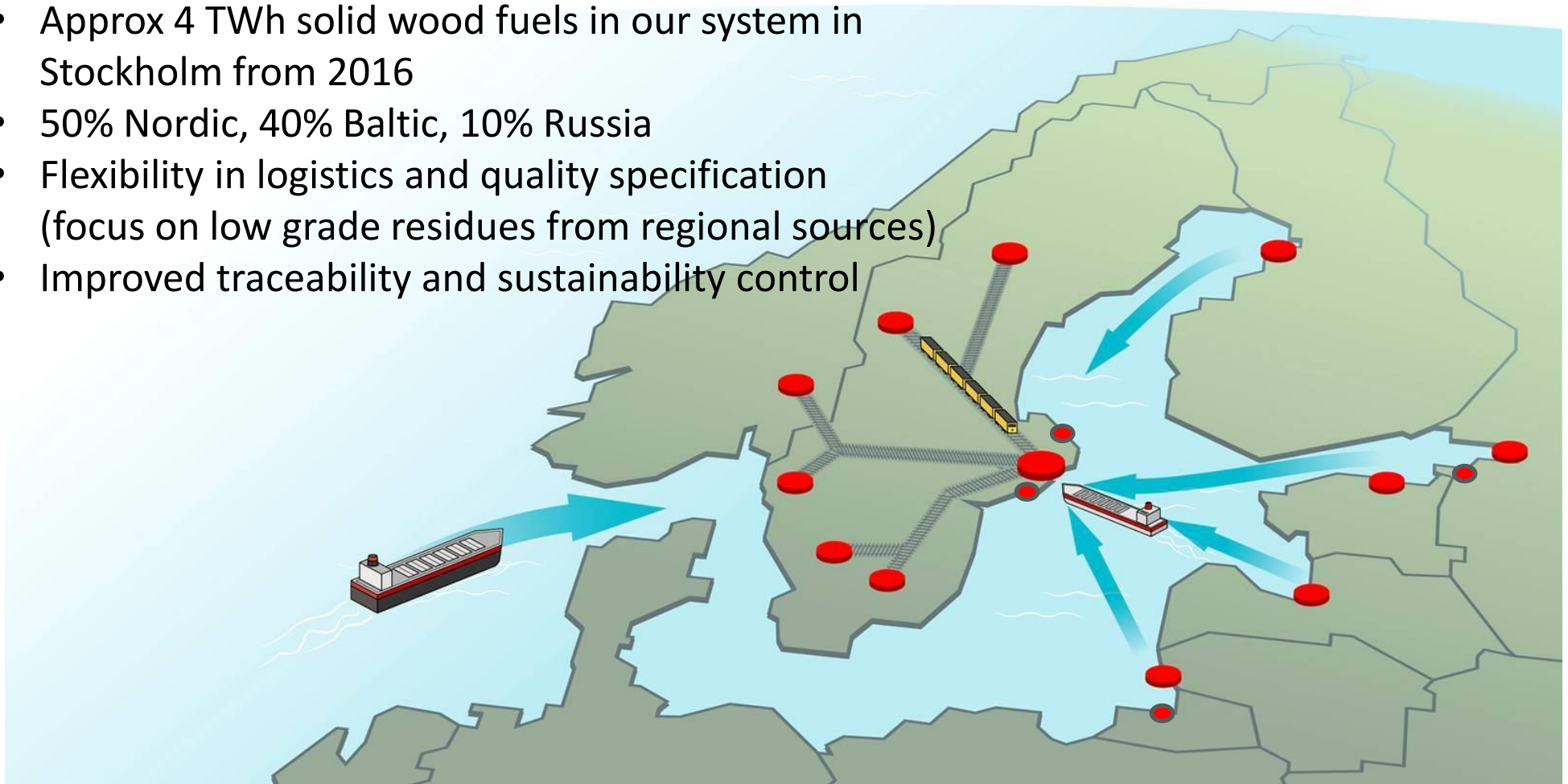


Next generation
energy company



Fuel sourcing from global, regional and local sources

- Approx 4 TWh solid wood fuels in our system in Stockholm from 2016
- 50% Nordic, 40% Baltic, 10% Russia
- Flexibility in logistics and quality specification (focus on low grade residues from regional sources)
- Improved traceability and sustainability control



Rail and vessel logistics

- Train systems with specially designed containers ("high cubic")
 - 26 cars with 3x60 m³ containers gives 4 600 m³ in one set (~2 sets of trains corresponds to one days consumption)
 - Length approx 500 m
- In door container discharge with high capacity (3-4 min/container gives 3-4h per set)
- Based on standard baltic coasters, but also capacity to receive wood chip carriers (WCC) from other continents
 - One coaster per day (12 000 m³) or 2-3 WCC per month (~100 000 m³)
- Typical mix probably 1-2 set of trains per day, 3-4 coasters per weak and 3-4 WCC per year
- Full redundancy: 100% supply by vessel or train
- Permission to receive ~10% by truck

"Fortum Woodtainer"



Baltic coaster 9 000 cbm



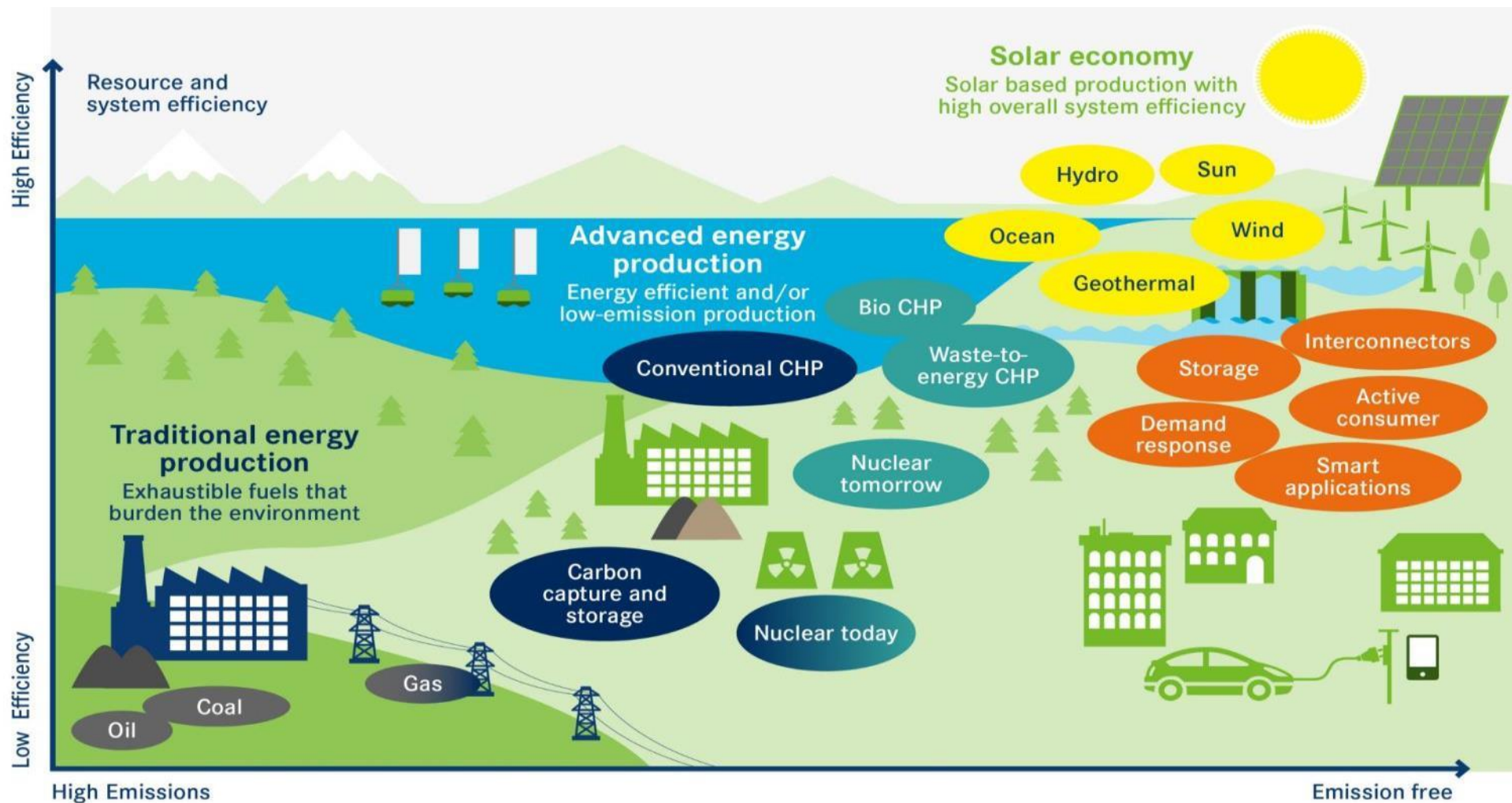
From local to central heating – improved air in Stockholm



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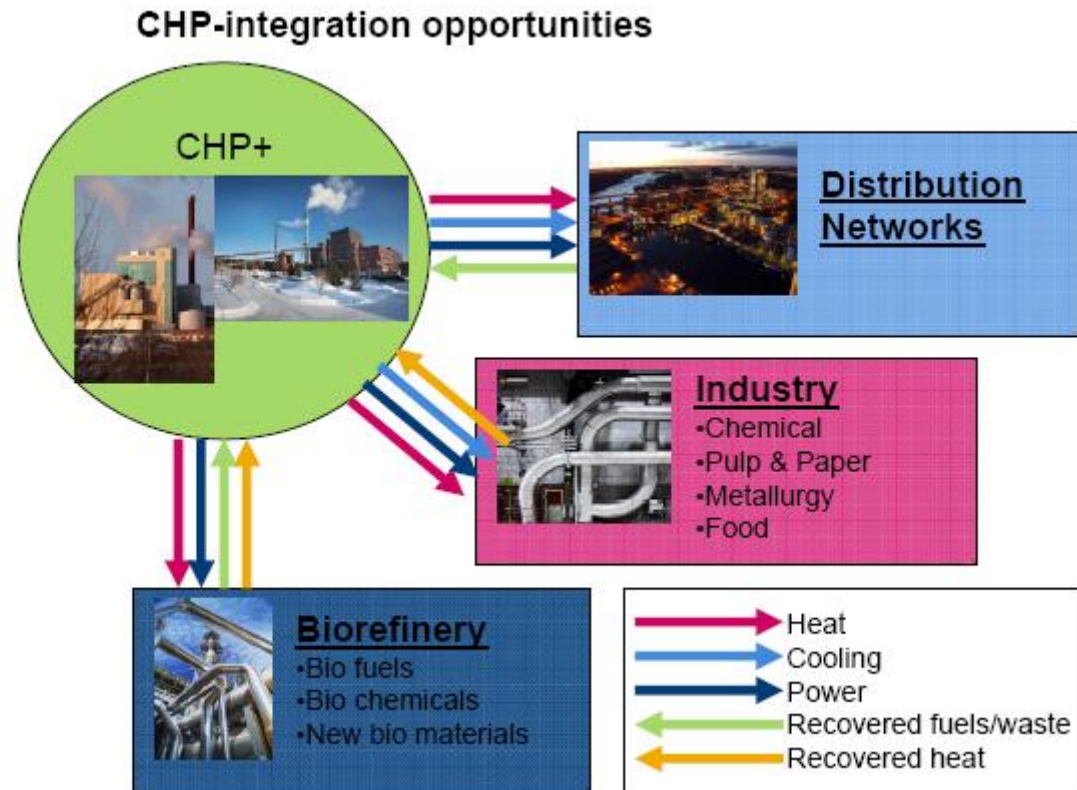
Transition towards Solar Economy is ongoing



1. Case bio-oil: higher value products by utilizing assets more efficiently

Key rationale and potential

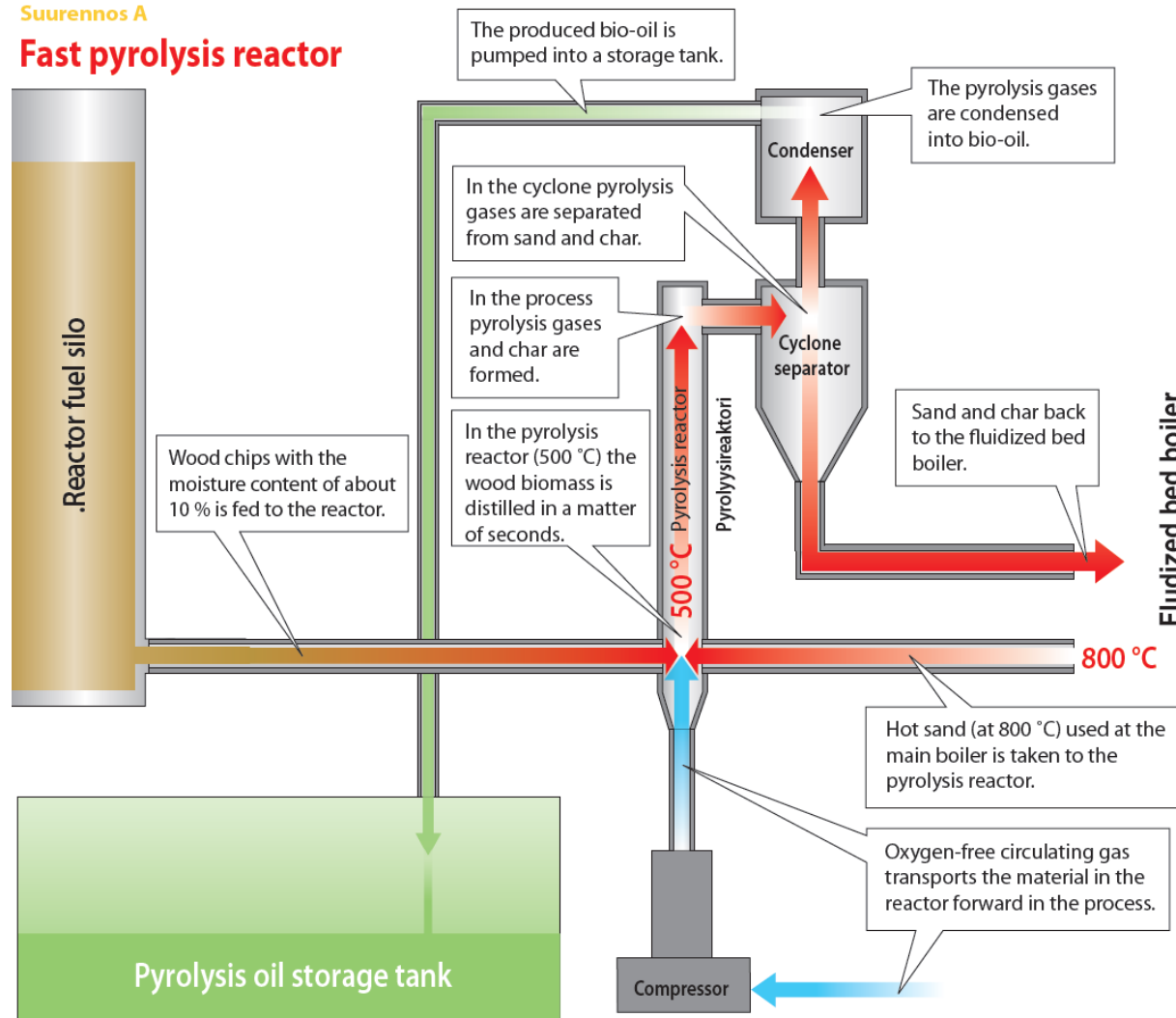
- Bio-oil production integrated with electricity and heat production:
 - highly energy efficient
 - low investment and operating costs.
- Stable heat loads enabling better utilization of assets
- New products by utilizing present assets
- Fortum invested in globally first commercial scale CHP-integrated pyrolysis oil (=bio oil) plant in 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

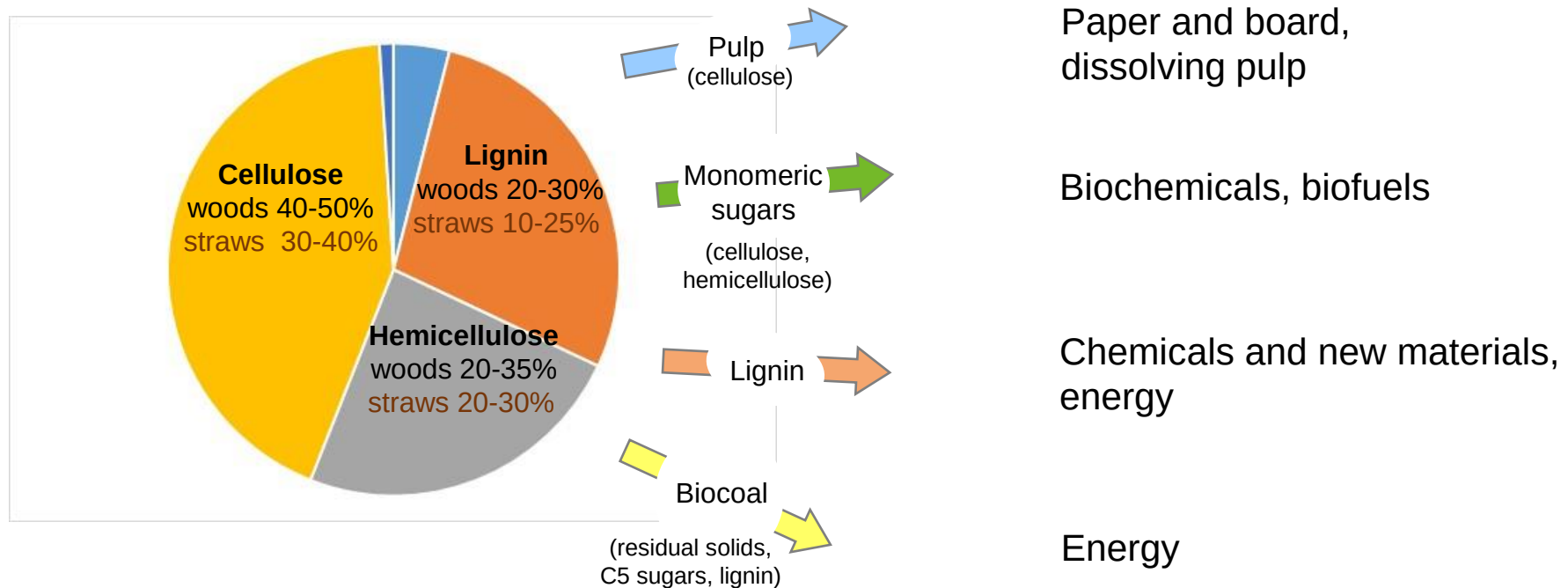
Wood-based bio-oil to replace fossil fuels

- The calorific value of the bio oil is approx. half of the energy content of fossil heating oil
 - Bioenergy in compact form
- 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
- 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



2. Case biorefinery concept: aims to fractionate lignocellulose into its main components for further refining

- We are now evaluating the possibility to build a commercial scale demo plant in the near future using biorefining technology developed by Chempolis Ltd
 - The technology will be used to fractionate lignocellulose into its main constituents with good technical properties and high purity, e.g.:





Thank you

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