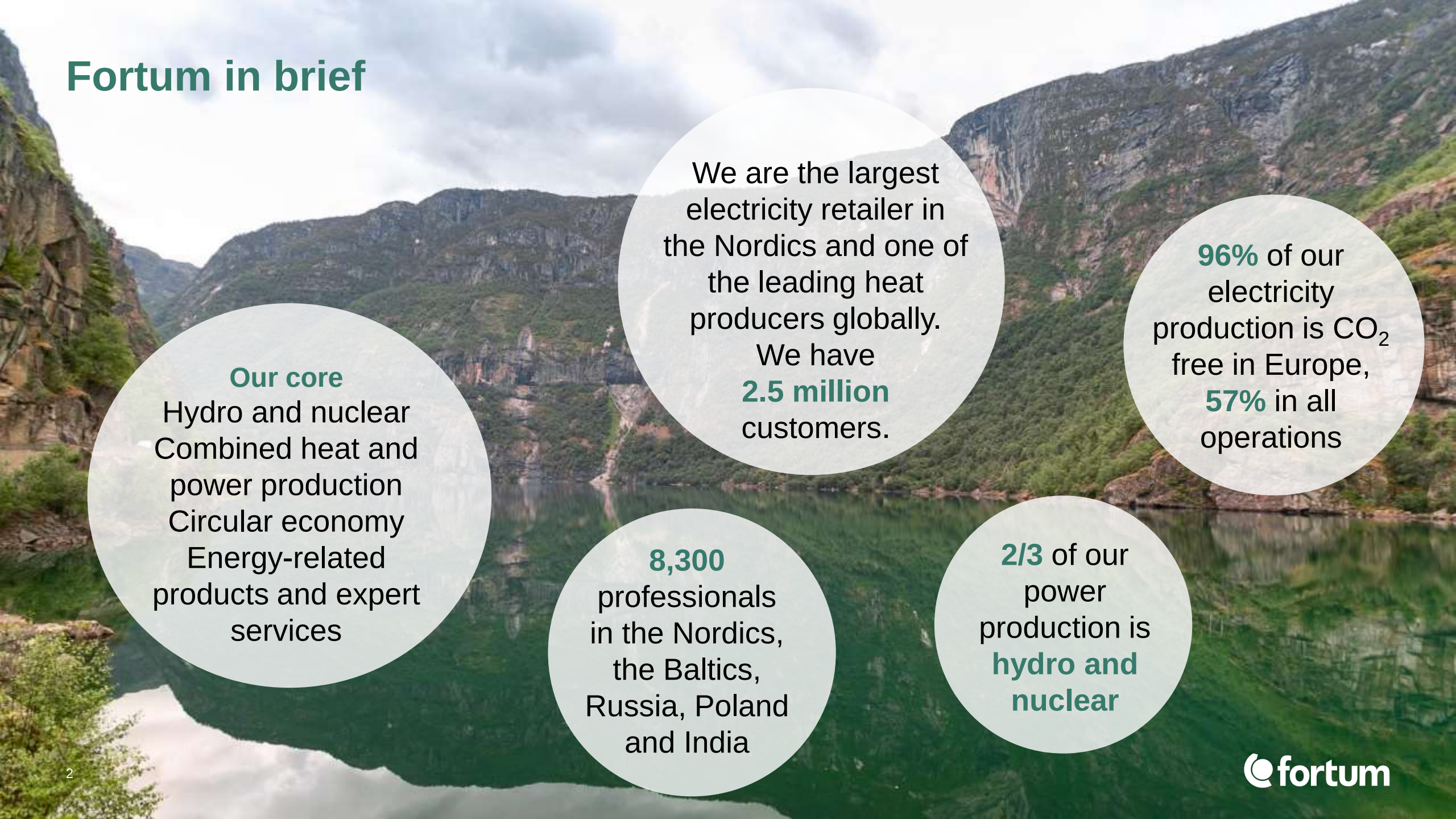
Fortum – Building the Utility of Future

Heli Antila
VP, Biobased Solutions

Fortum in brief



Our core
Hydro and nuclear
Combined heat and power production
Circular economy
Energy-related products and expert services

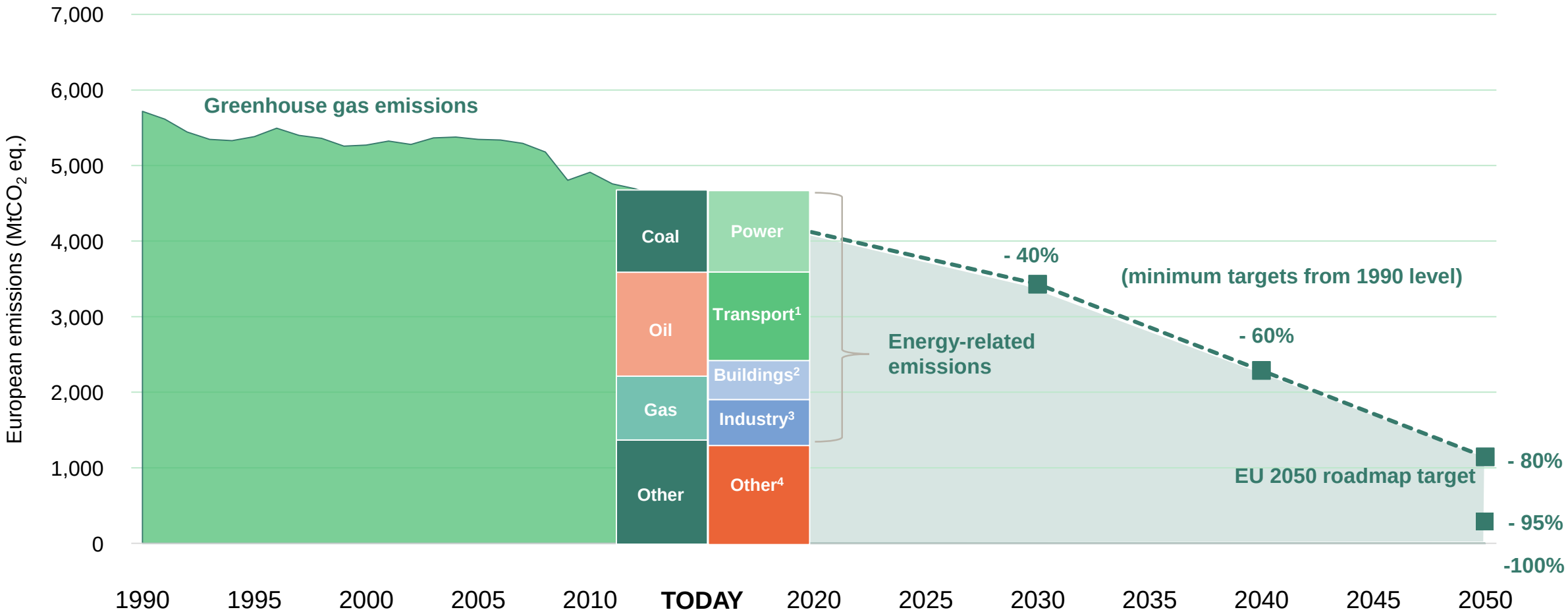
We are the largest electricity retailer in the Nordics and one of the leading heat producers globally. We have **2.5 million** customers.

96% of our electricity production is CO_2 free in Europe, **57%** in all operations

8,300 professionals in the Nordics, the Baltics, Russia, Poland and India

2/3 of our power production is **hydro and nuclear**

Europe needs to eliminate CO_2 emissions to reach climate goals



[1] including international aviation and marine
[2] residential and commercial heating & cooling
[3] iron & steel and chemicals are among the biggest contributors
[4] non-energy related emissions: industrial processes and product use, waste management, agriculture, fugitive emissions
Source: IEA World Energy Outlook 2017, Eurostat, Eurelectric, Fortum Industrial Intelligence

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Decarbonisation will increase electricity demand

Power

Transport

Buildings

Industry

Other

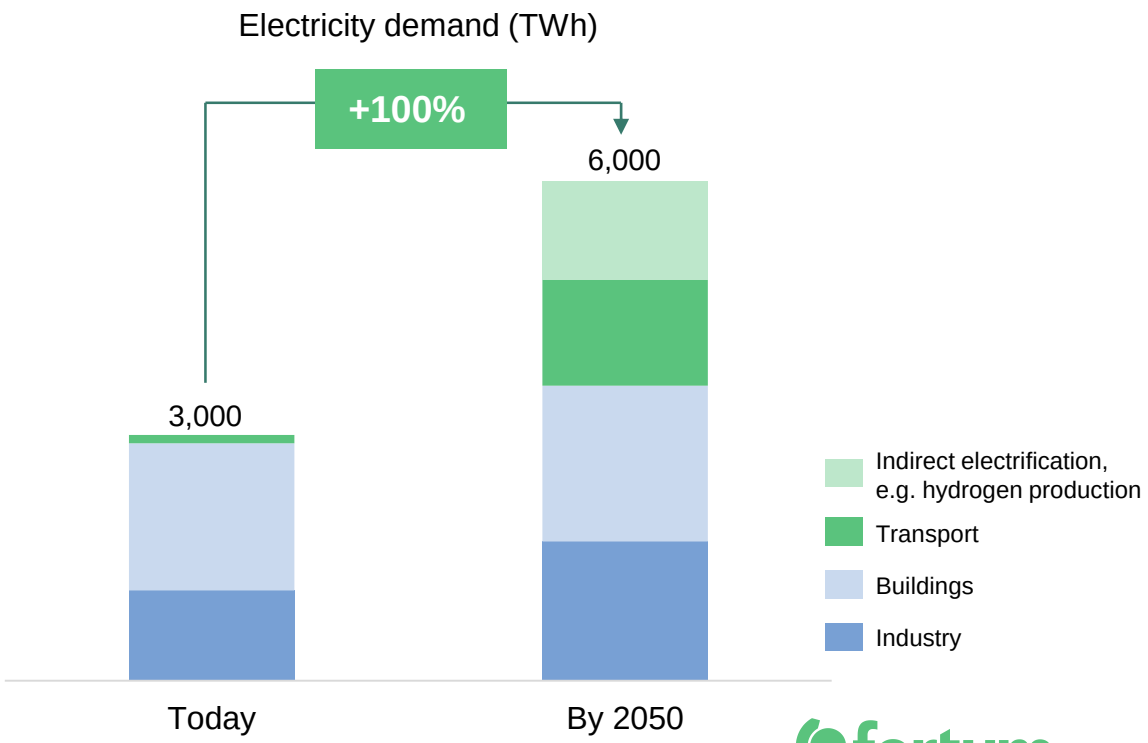
Means to decarbonise via electrification

Electric vehicles, hydrogen

Heat pumps, hydrogen

Electrified processes, hydrogen

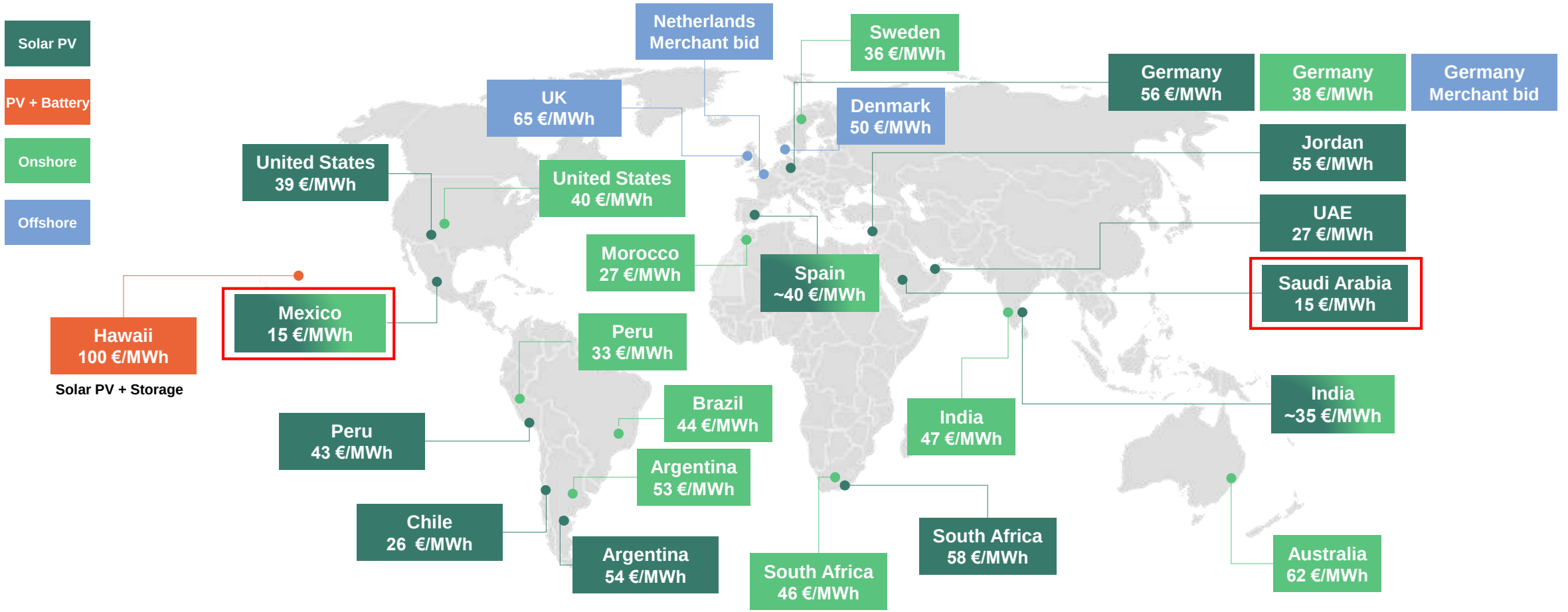
Carbon neutrality could double electricity demand by 2050



Source: Eurelectric study, May 2018, Scenario 3

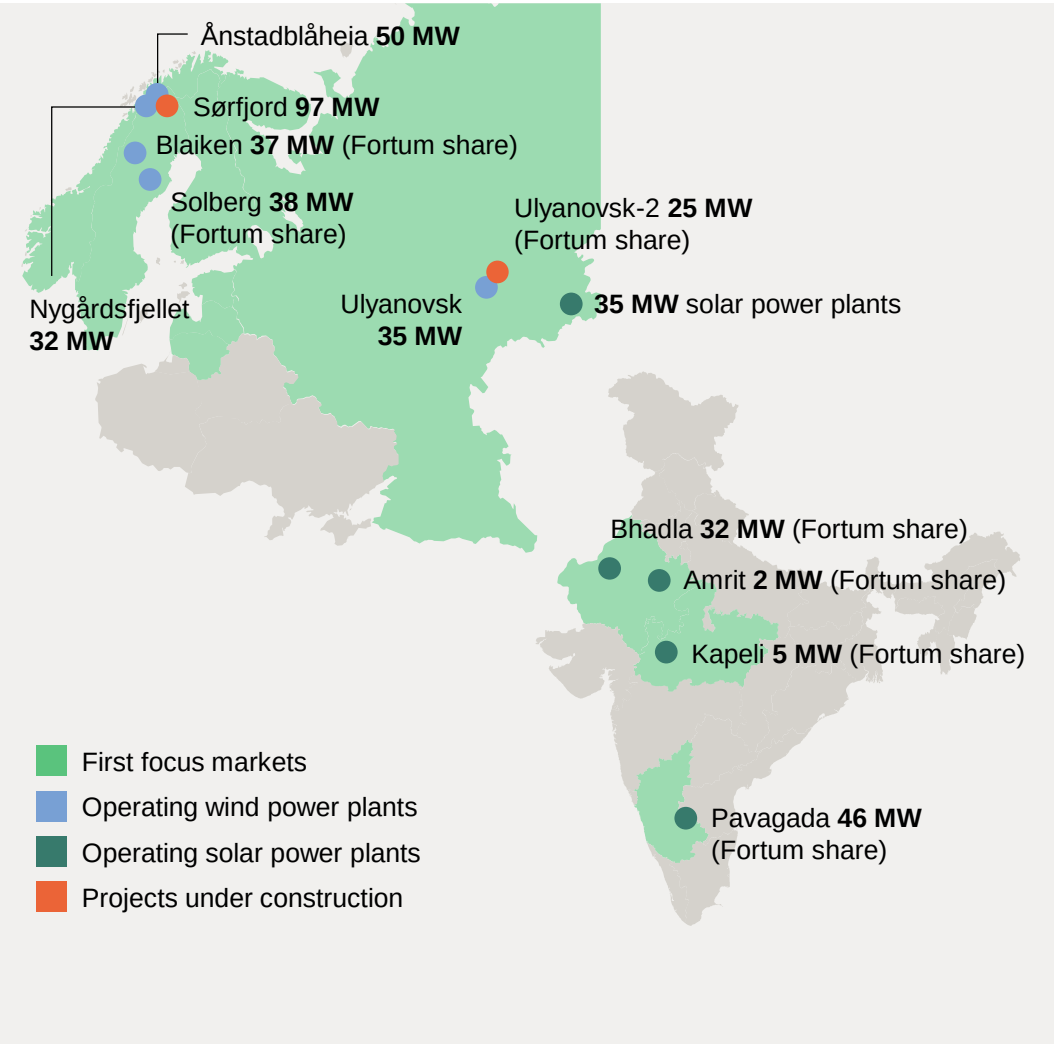
Onshore wind and solar PV have become competitive among new power plants in most regions across the World

Recently announced long-term Power Purchase Agreement contract prices / tariff levels[1]



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 Netherland have had merchant bids in offshore were grid connection is provided by TSO.

Fortum is growing towards gigawatt scale target in solar and wind power production



PORTFOLIO	TECHNOLOGY	STATUS	CAPACITY MW	FORTUM SHARE, MW	SUPPLY STARTS/ STARTED
NORWAY			**179**	**179**	
Nygårdsfjellet	Wind	Operational	32	32	2006 and 2011
Ånstadblåheia	Wind	Operational	50	50	Q4 2018
Sørfjord	Wind	Under construction	97	97	2019
SWEDEN			**323**	**75**	
Blaiken	Wind	Operational	248	37 (15%)	2017*
Solberg	Wind	Operational	76	38 (50%)	2018
RUSSIA			**2 003**	**1 092**	
Bugulchansk	Solar	Operational	15	15	2016-2017
Pleshanovsk	Solar	Operational	10	10	2017
Grachevsk	Solar	Operational	10	10	2017
	Solar	Under development	110	110	2021-2022
Ulyanovsk	Wind	Operational	35	35	2018
Ulyanovsk-2	Wind	Operational	50	25 (50%)	1.1.2019
Rusnano JV	Wind	Under construction	200	100 (50%)	H1 2020
Rusnano JV	Wind	Under development	1 573	787 (50%)	2018-2023
INDIA			**435**	**335**	
Amrit	Solar	Operational	5	2 (46%)	2012
Kapeli	Solar	Operational	10	5 (46%)	2014
Bhadla	Solar	Operational	70	32 (46%)	2017
Pavagada	Solar	Operational	100	46 (46%)	2017
Pavagada	Solar	Under development	250	250	2019
Rajasthan	Solar	Under development	250	250	Q4/2020
TOTAL			**3 191**	**1 931**	
		Under development	1 933	1 147	
		Under construction	597	447	
		Operational	661	337	

*) Blaiken last stage IV inaugurated in 2017. NOTE: Table numbers not accounting; tells the size of renewables projects. All not consolidated to Fortum capacities. All figures in MW and rounded to nearest megawatt. Additionally, target to invest 200 – 400 million euros in India solar and create partnership for operating assets. Under construction includes investment decisions made

BatTwo - Battery/Hydro Hybrid Project

Technical characteristics

Battery system

- 5.0 MW Peak Power
- 6.8 MWh Storage Capacity
- 90% Round Trip Efficiency

Hydropower Station

- Run-off river
- Built in 1990
- 2 x 22 MW Kaplan Generators
- 200 GWh production per year

- Increasing quality of frequency control delivered by Kaplan unit
- Increasing provided reserves making the case financially viable
- Suitable to the future's energy system with low inertia
- Decreased wear and tear prolonging equipment's lifetime
- More flexibility in water planning and less environmental impact of regulation

Join the change

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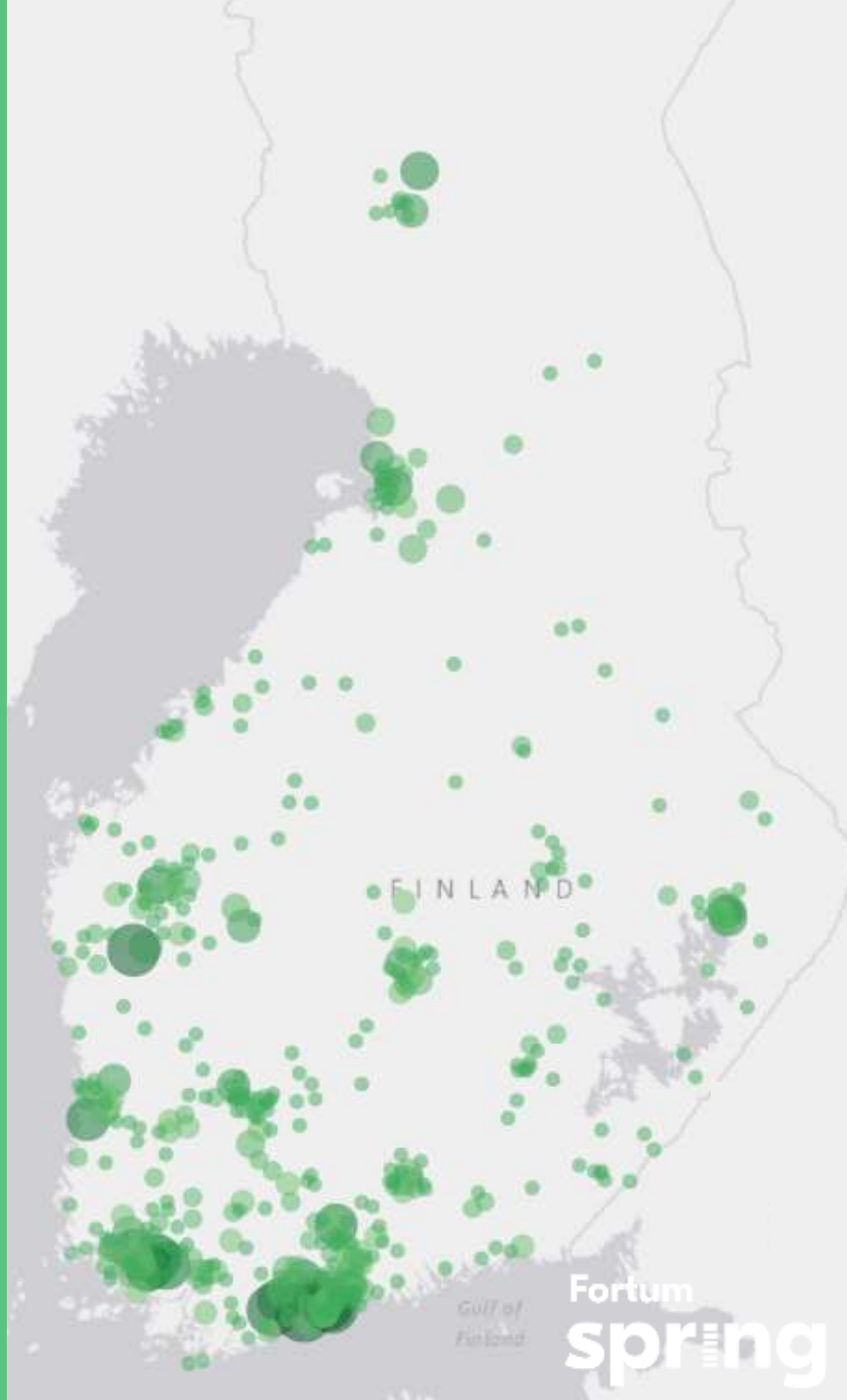
Fortum Spring – In addition to helping residential customers become active parts of the power system, they are offered real time consumption data of their homes and remote control of home appliances

2,000+
Homes measured and steered in real time

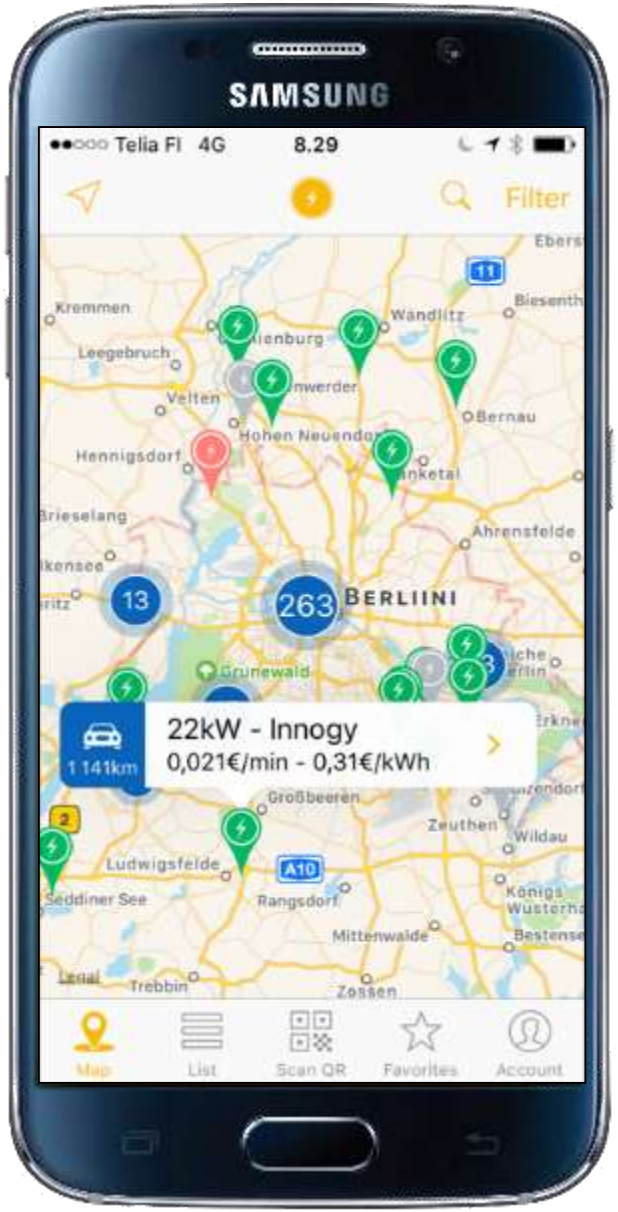
10+ GWh
Flexibility in Finland

173 Million
Measurements daily

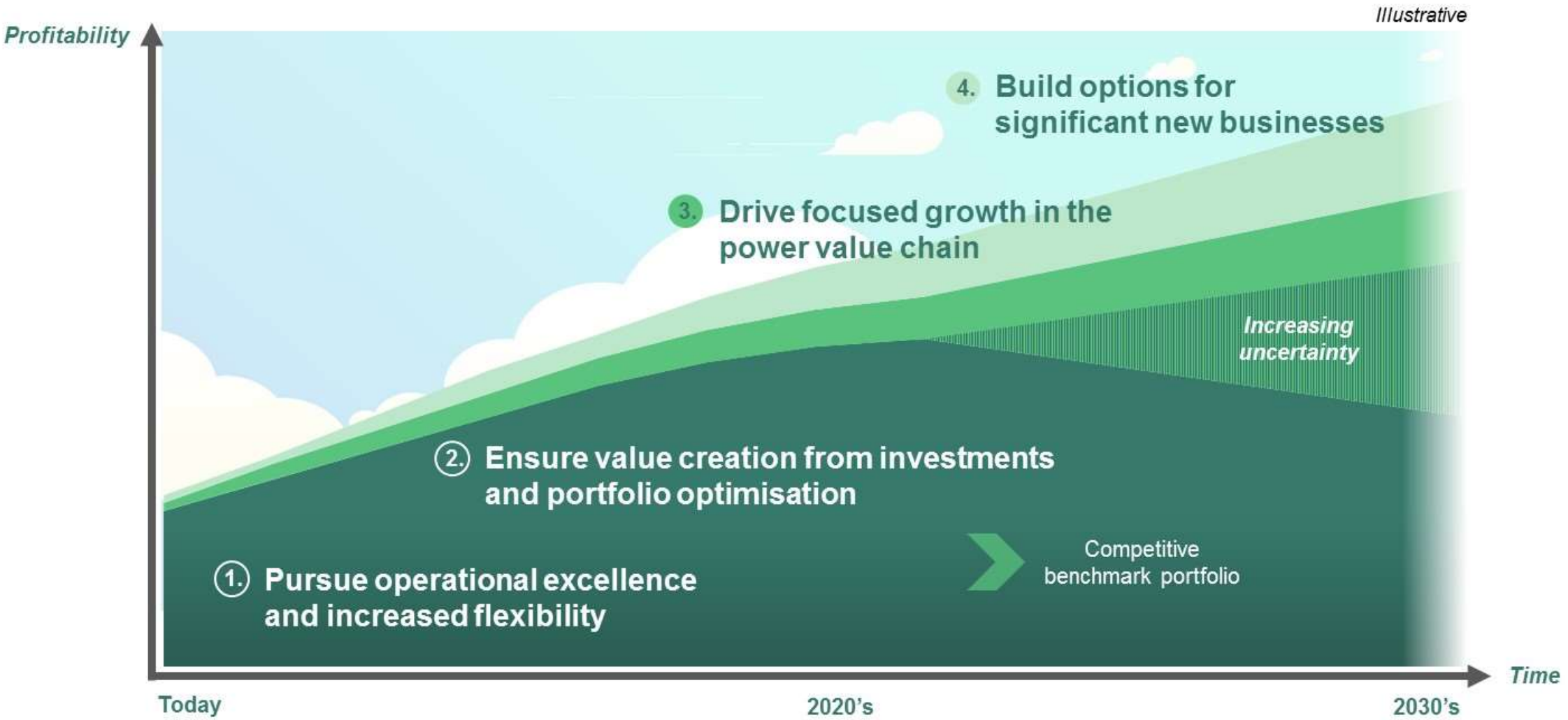


Fortum Charge & Drive and Plugsurfing -making it easy to use electric vehicles

- Fortum Charge & Drive and Plugsurfing join forces to empower drivers to charge wherever they go, even internationally
- Plugsurfing – access to 108,000 chargers across Europe
- Together we are able to better serve the drivers of electric vehicles, car manufacturers, leasing companies and charge point operators



Fortum's vision is even more valid today in updated strategy – *For a cleaner world*



Fortum Recycling & Waste Operations in the Nordics

30 offices/treatment centers

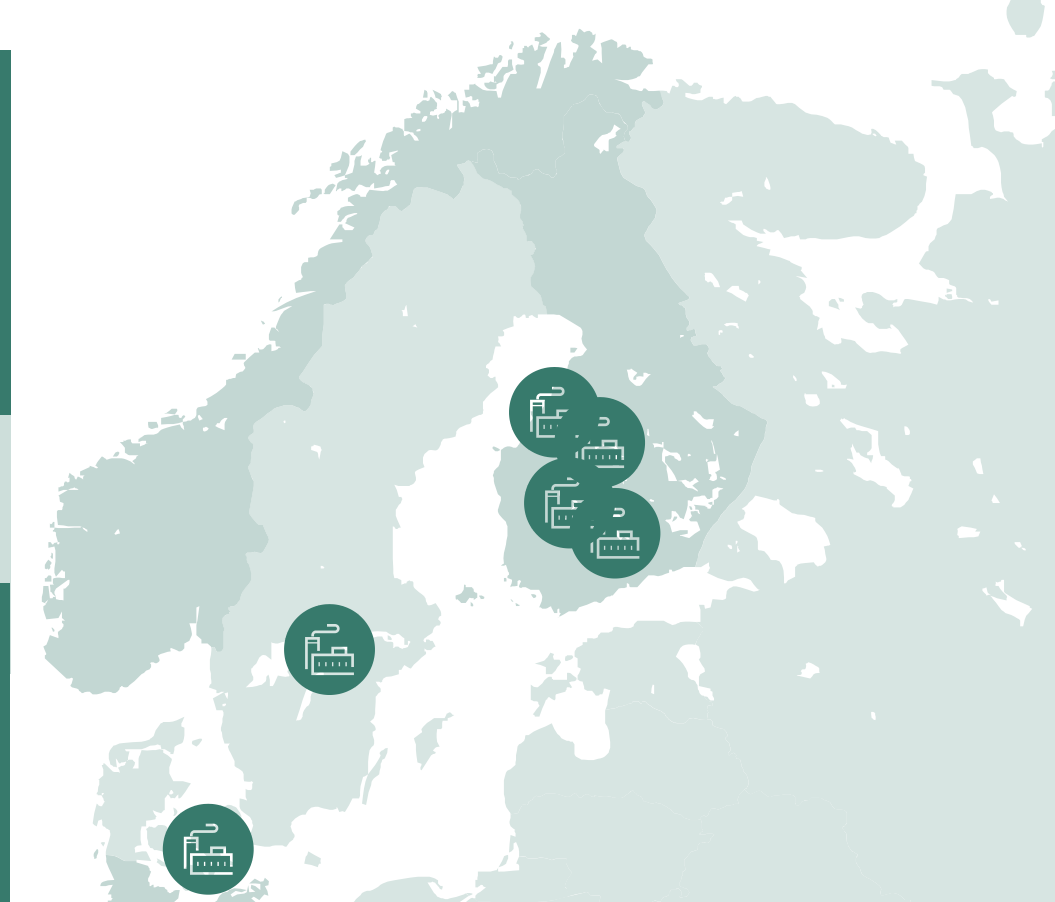
Finland
Sweden
Denmark
Norway

Around 650 employees In the Nordics

Recycling
Refineries to recycle plastics, metals, ash and li-ion battery chemicals

High temperature incineration
In order to treat hazardous waste

Waste-to-Energy
In order to treat municipal solid waste and industrial waste



Finland

Riihimäki
Plastic refinery
High temperature incineration
Two Waste-to-Energy plants
Ikaalinen
Metal recycling
Pori
Ash refinery
Harjavalta (Crisolteg
Li-ion battery recycling plant

Sweden

Kumla
High temperature incineration
Waste-to-Energy Plant

Denmark

Nyborg
High temperature incineration

Plastics recycling from package to a new product

Customers for secondary raw materials

Recycling of materials

End customer

Customer interface owner

On-site operations

Transport

Pre-treatment

Transport

Final treatment

Final disposal

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Fortum Circo granulate

- CIRCO can be used to replace virgin raw materials in the production of plastic products
- Quality of the granulate can be guaranteed because Fortum controls the whole production process from sorting to production
- Circo can be customized for customer's processes and product requirements
- CIRCO granulates recycled for production of
  - HDPE extrusion
  - LDPE film application
  - PP injection moulding applications

Products from CIRCO® and other Fortum recycled plastics

Fortum Bio2X: Acceleration towards natural resource efficiency

Dr Heli Antila
VP, Biobased solutions

Join the change

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Bio2X mission is to produce high-value products from agro-residues and woody biomass to replace fossil and other environmentally detrimental raw materials

In India focus is also to reduce pollution and imports

Breathing air in Delhi for a day = Smoking 44 cigarettes

If all agri biomass burned in fields could be used as raw material :

Build biorefineries to Delhi's surrounding countryside

→ We could replace over 50% of global cotton production

→ Considerably improve air quality and CO_2 levels

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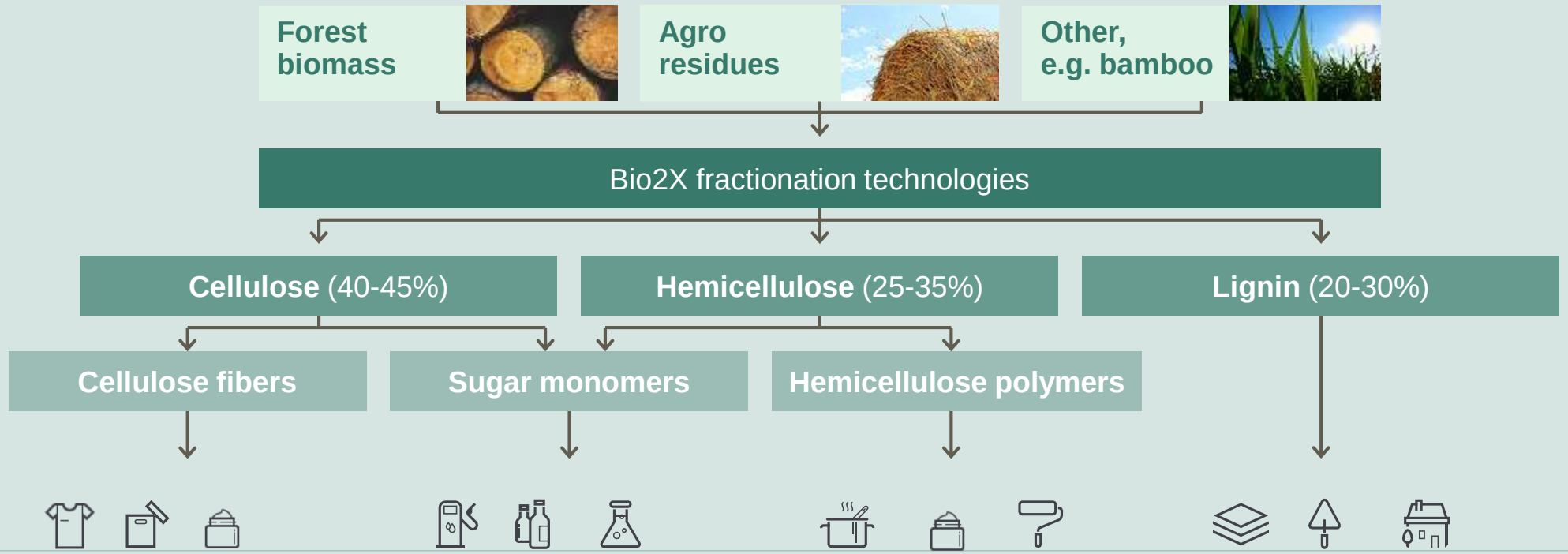
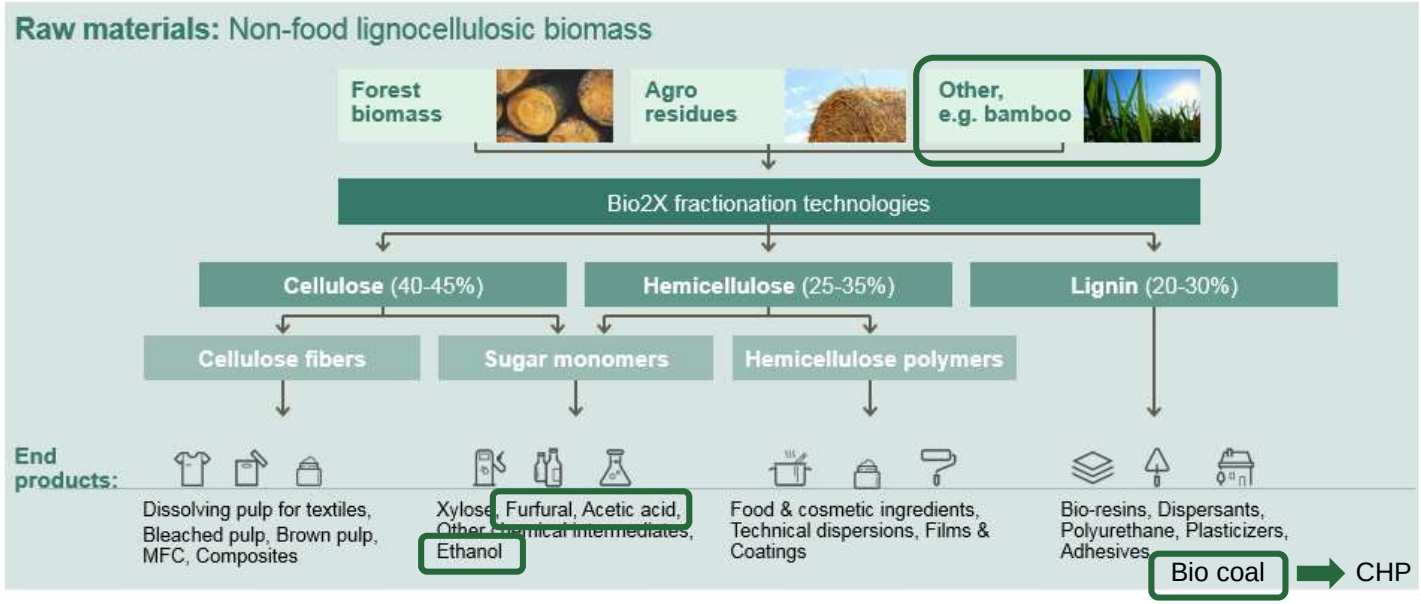
Bio2X fractionation: Transform biomass into multiple sustainable high-value end products

Raw materials: Non-food lignocellulosic biomass



Bio2X case example: Fortum participates in joint venture in India to build a bio-refinery based on Chempolis fractionation technology

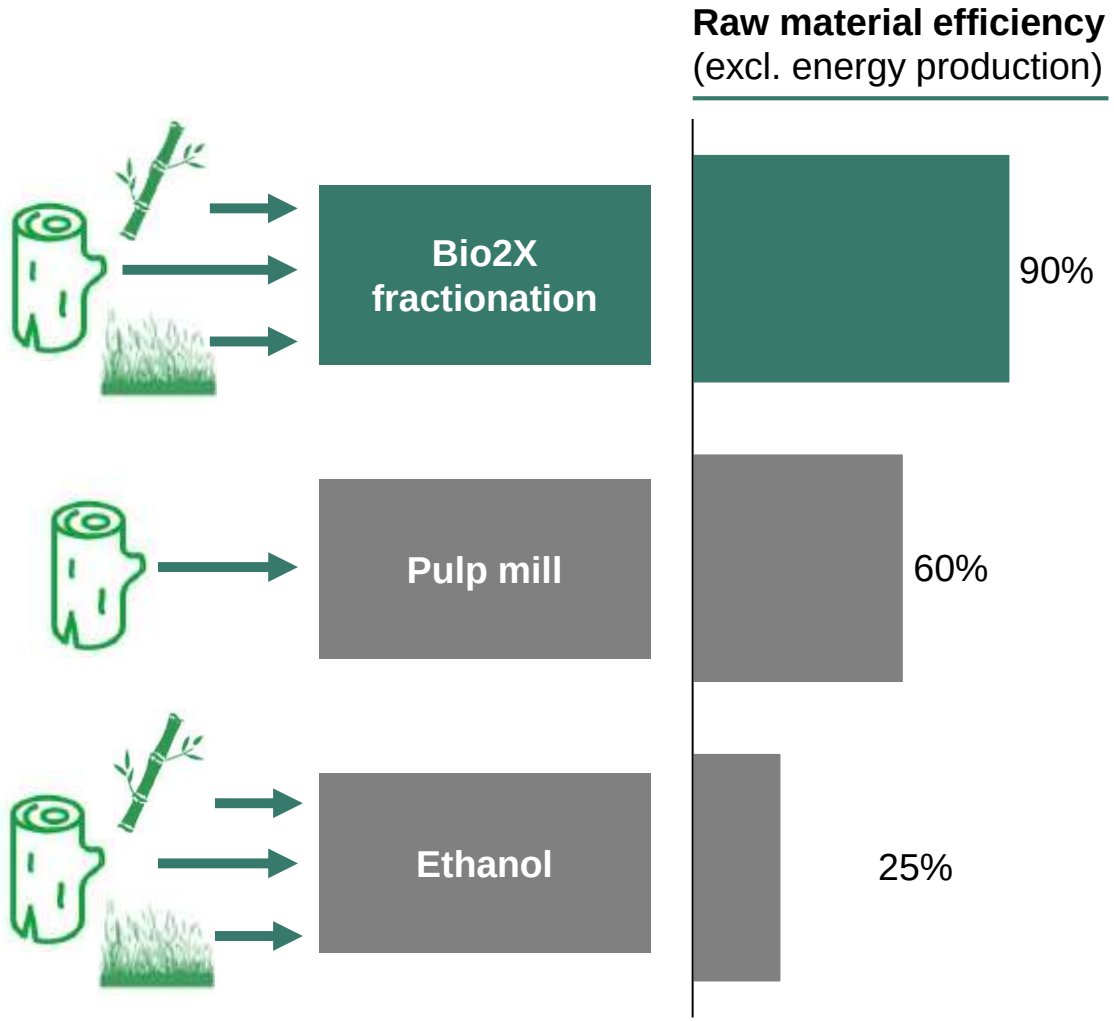


What will we learn from NRL fractionation plant?

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

- **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 2021.**
- **The total investment cost estimate is 160 million euros.**

Bio2X delivers high yield, favorable pricing, small unit size & vast environmental benefits



Technical benefits:

- **Purity of all fractions**, enabling cost-effective production of end-products
- **Optimized properties of all fractions** (vs. conventional pulp mills: only pulp is optimized)
- **Smaller unit size** (e.g., 1/5) with at least the same feasibility as large pulp mills
- **Flexibility in raw material,** e.g., possibility to use **waste** (e.g., straw)
- Ability to **combine best parts of different technologies**

Environmental benefits:

- Possibility to **replace fossil raw materials** in huge variety of products (e.g., viscose & plastics)
- **Lower pollution** (i.e., CO_2) **& reduced water consumption**
- **Reduced land degradation & deforestation** (e.g., wheat is used for food & straw to replace fossil and unsustainable products)

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Fortum Bio2X from demonstration towards commercialization

Research, development and demonstration phase

Commercialization phase

Work done so far at Bio2X

- Competence building
- Piloting with several fractionation technologies using several raw materials
- 10 kg's –scale application development with several downstream partners.

Building the base for strong **ecosystem** concept with key partners

Fractionation: Selected technologies to be up-scaled and piloted (100 kg's).

Product concepts: Bio-components for existing & new applications

Building a demonstration-scale plant with partners (1000 kg's)

Preparing the 1st large investment proposal

Fortum Bio2X

Utilization of straw	Raw materials otherwise considered as waste replace fossil, other non-sustainable and scarce raw materials
Superior material efficiency	Bio2X fractionation technology enables >90% material efficiency thus leaving minimum amounts of waste
High performance and quality	Our outputs are at least on par in performance with materials currently available on the market
Minimized environmental impact	Excellent LCA (life cycle assessment) results proving the process and the outputs are truly sustainable also in large scale
Ecosystem of local production sites	Instead of a global production hub, multiple smaller scale production units ensure access to raw materials (in required volumes) and control over social responsibility issues


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