HYVINVOINTIA SÄHKÖLLÄ

VISIO 2030

Tulevaisuuden energiaratkaisut

Heli Antila
VP, Biopohjaiset ratkaisut

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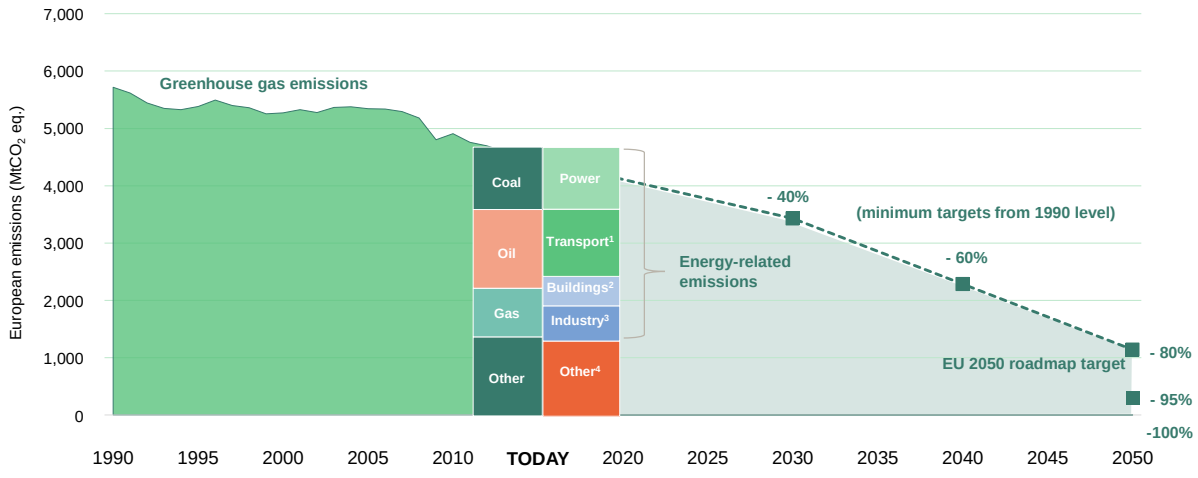
Europe needs to eliminate CO_2 emissions to reach climate goals



[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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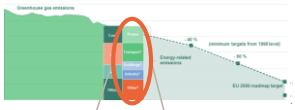
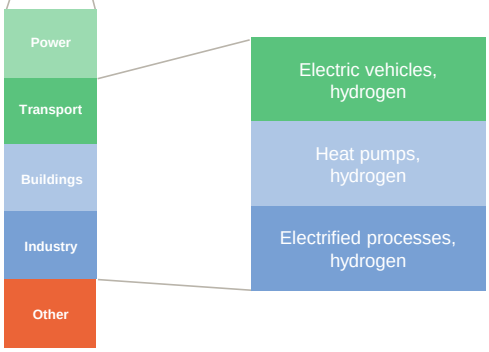
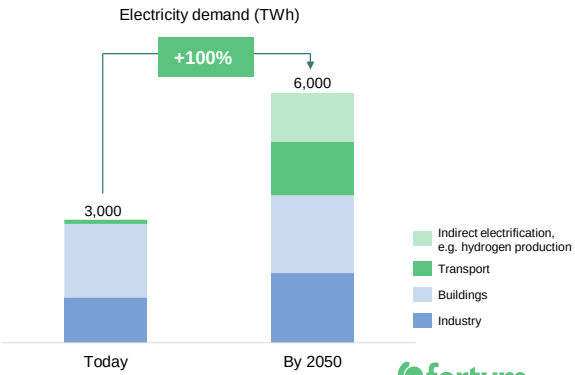
Decarbonisation will increase electricity demand



Means to decarbonise via electrification



Carbon neutrality could double electricity demand by 2050



Source: Eurelectric study, May 2018, Scenario 3

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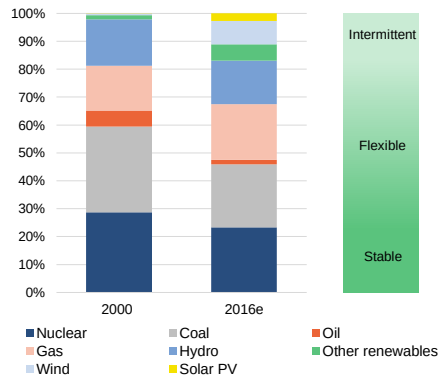
Demand for flexibility is increasing because stable and flexible capacity is being replaced by intermittent generation

European power generation (TWh)



Source: IEA World Energy Outlook 2017

- Higher share of intermittent solar and wind capacity
- Reduced share of flexible coal and oil - partly compensated by increased gas
- Decline of stable nuclear generation
- Coal and nuclear phase-out in Europe will accelerate the shift
- Stable share of flexible hydro production

- **There is a need to increase the share of flexible assets in the European power mix**
- **All sources of flexibility will be needed**
- **… and the value of flexible assets will increase**

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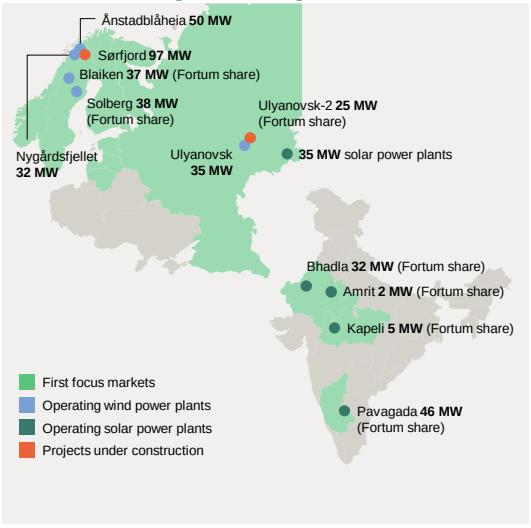
Fortum is growing towards gigawatt scale target in solar and wind power production



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	

6 *) 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

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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

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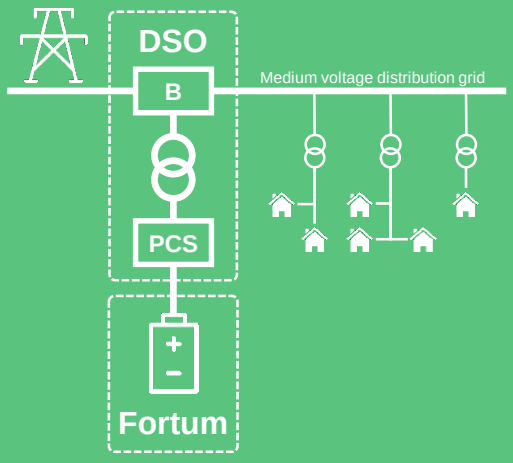


Battery as a service for a distribution system operators

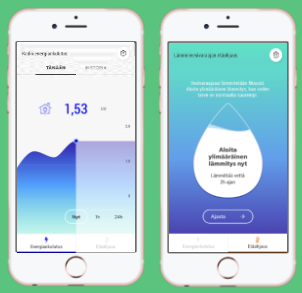
Fortum Spring owns and operates the battery system. Battery capacity is used to offer security of supply services, voltage control and congestion management for the DSO.

During normal operations, the battery system is utilized in the FCR-N markets by Spring, which significantly increases the revenue and allows reasonable service pricing for the DSO.

In case of a distribution failure, the battery system will island a part of the grid and continue supplying electricity to the customers.

Fortum spring

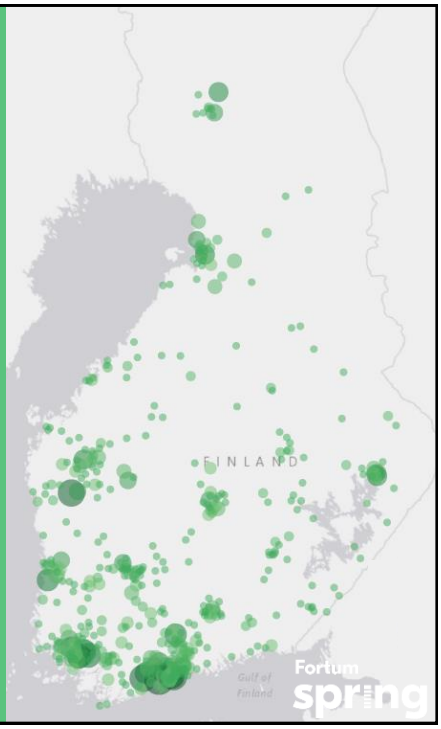
Fortum Spring – In addition to helping residential customers become active parts of the power system, they are offered real time consumption data of their homes and remote control of home appliances



2,000+
Homes measured and steered in real time

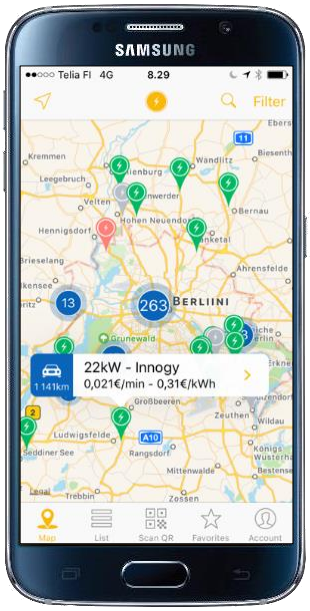
10+ GWh
Flexibility in Finland

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



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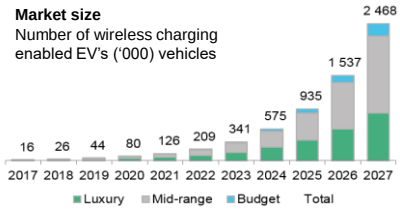
Fortum and the City of Oslo are working on the world's first wireless fast-charging infrastructure for taxis

- The greatest hurdle in the electrification of the taxi fleet is the infrastructure: it is too time consuming for taxi drivers to find a charger, plug in and then wait for the car to charge.
- Fortum in cooperation with the City of Oslo and Momentum Dynamics will build a wireless fast-charging infrastructure for taxis in Oslo, Norway.
- From 2023 onwards, all taxis in Oslo will be zero emission

Market size
Number of wireless charging enabled EV's ('000) vehicles



Market data source: Bloomberg New Energy Finance

Key project characteristics

- Taxis will be able to drive up to the charger and a wireless charging session will automatically start in a place where they would anyway be waiting for new customers
- Wireless induction technology allows for charging up to 75 kilowatts. Charging plates are installed in the ground where taxis are parked and a receiver is installed in the taxi
- Project aims to demonstrate the effectiveness, reliability and performance of the system in all kinds of weather and environmental conditions

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Chandri - Swappable batteries for fleet operators utilizing Light Electric Vehicles (LEVs)

Customer problem

Charging batteries takes a lot of time out of the business day of a taxi and logistic company using LEVs.

Cost of vehicles are high, as the batteries cost a lot.

Range is a problem with on-board batteries.

Customer

Taxi and logistic companies using LEVs

Solution

Battery swapping stations. Fortum owns the batteries. Swapping station behind the people in the picture below.

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Powering Electric Flying (PEF)

- Emissions from aviation currently amount to about 1 Gt of CO2 accounting for almost 3% of total global emissions, but, under a business as usual scenario, they would grow to almost 1.7 Gt by 2040 representing above 4% of global emissions and 14% of the transport sector emissions[1]

Key project characteristics

- Project duration: May 2018 – Aug 2019
- Project includes both practical collaboration with the Helsinki Electric Airplane Association, as well as desktop analysis to study whether this is a market Fortum should be involved in
- Fortum is sponsoring the first serial produced electric airplane in Finland

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[1] IEA, 2016, *Energy Technology Perspectives*

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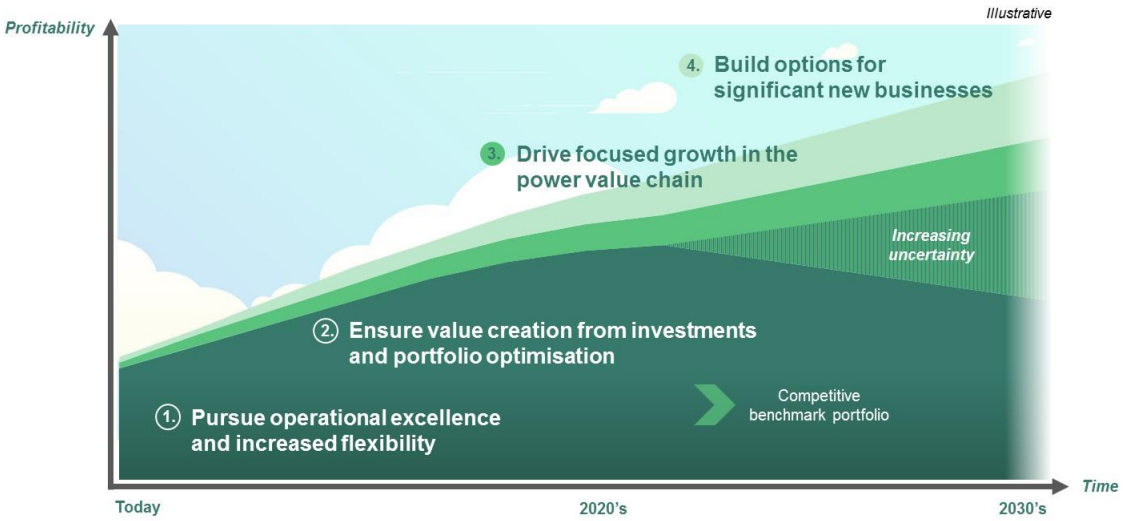
Fortum's vision is even more valid today in updated strategy – *For a cleaner world*



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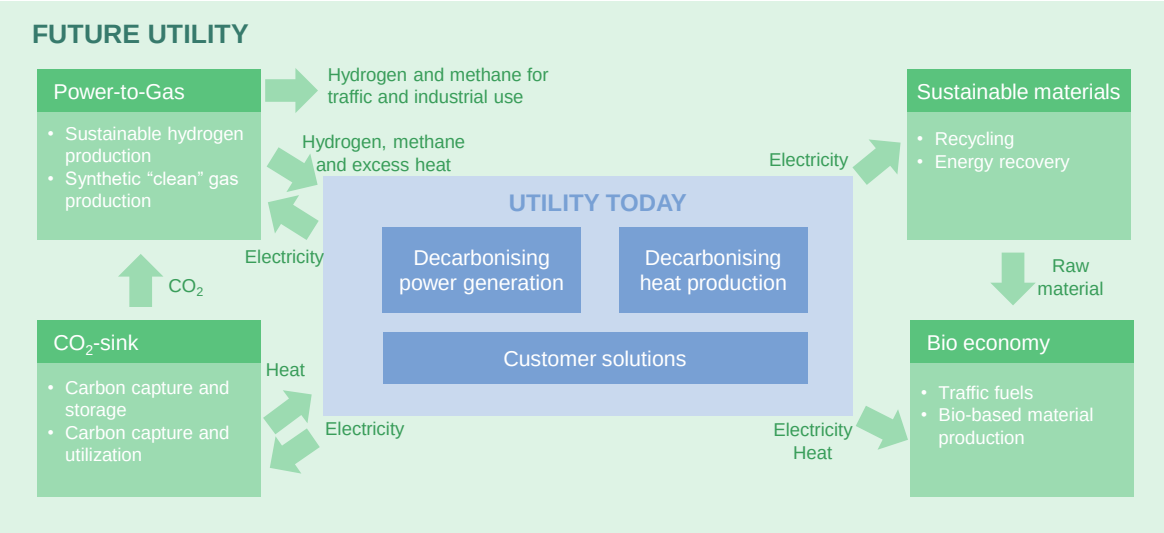
Building the utility of the future



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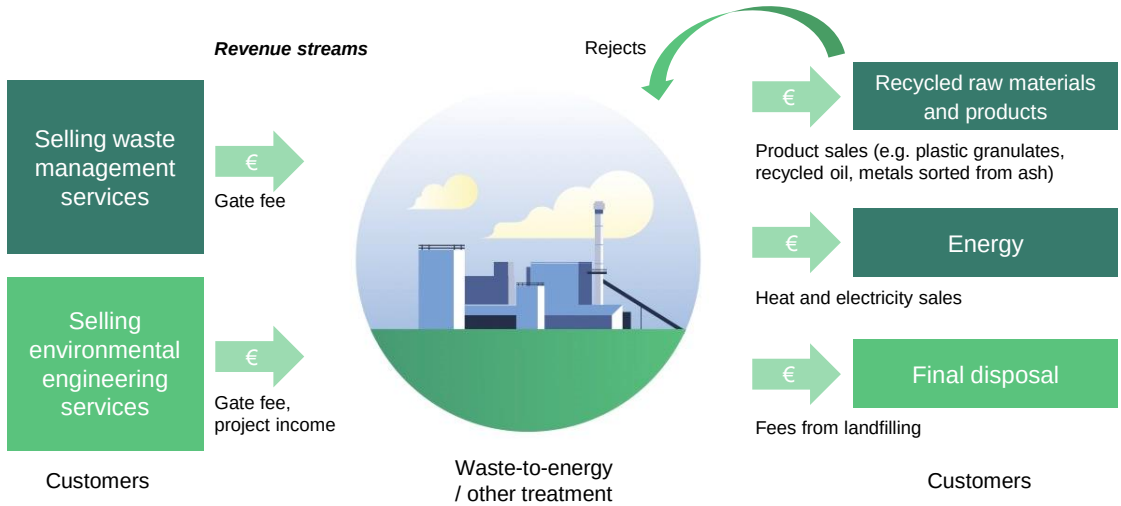
Waste-to-energy is the enabler for starting sustainable material production



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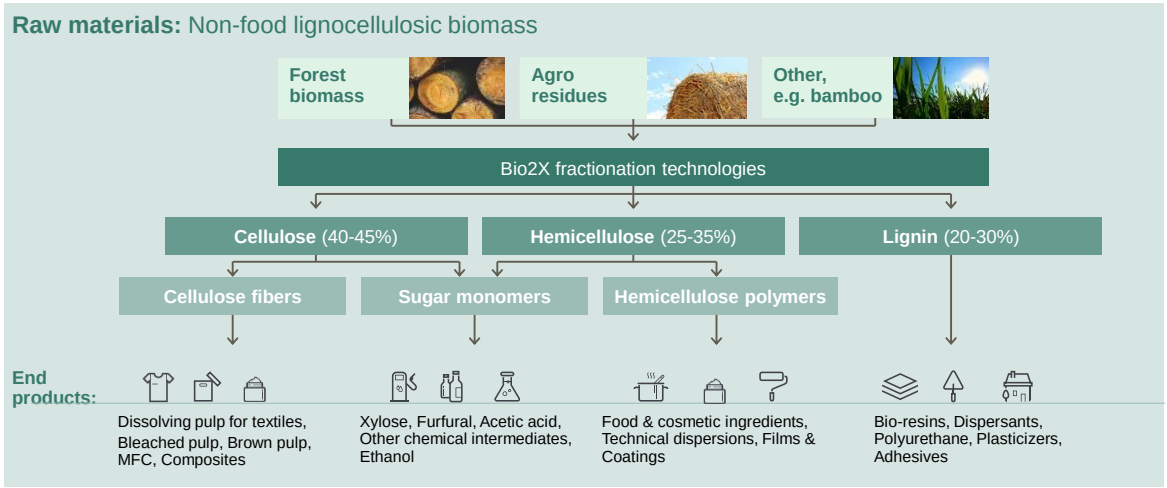
Bio2X fractionation: High biomass resource efficiency for high-value end products

Raw materials: Non-food lignocellulosic biomass



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Thank you
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