

ENERGYWEEK.FI

#ENERGYWEEK

EnergyWeek

Transforming the Energy Landscape

By: VEBIC – Vaasa Energy Business Innovation Centre, University of Vaasa

Vaasan yliopisto
UNIVERSITY OF VAASA

18.3.2025

2025 MARCH 17–20
VAASA, FINLAND

Winner 2026 - Vaasa
EUROPEAN GREEN LEAF
An initiative of the European Commission

EnergyWeek

Agenda

14:30 Welcome

14:35 Antti Majava
Trends of electricity market and energy system in Finland and Nordic countries

14:45 Hannu Laaksonen & Giovanna Pinilla De La Cruz
PEAK project: towards flexible regional energy systems in Ostrobothnia

14:55 Ingvar Kulla
Challenges and Opportunities for rural energy supply and distribution

15:05 Kirsi Spoof-Tuomi
Accelerating the sustainable energy transition with biogas

15:15 Antti Kettu
The Future of Energy: What New Energy requires?

15:30 Panel discussion

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Trends of electricity market and energy system in Finland and Nordic countries



Antti Majava

Specialist, BIOS Research Unit
Managing Director, Käännekohta t&k Oy
Doctoral Researcher, University of Helsinki

Trends of the electricity market and the energy system in Finland and Nordic countries

Navigating resilient pathways for an unforeseeable future

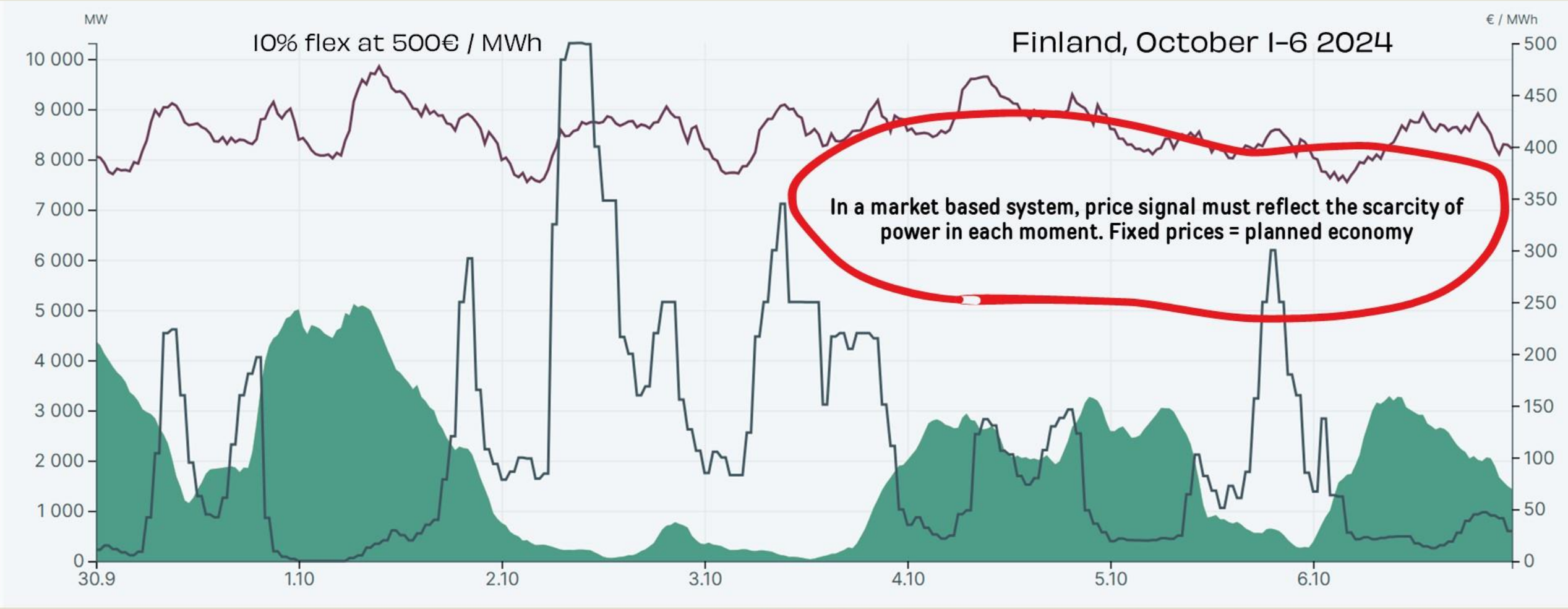
Antti Majava
Vaasa Energy Week 18.3.2025

BIOS research unit

Ylä- ja Itä-Kainuun vihreän siirtymän osaamiskeskus

KÄÄNNEKOHTA T&K

Industry's fixed price contracts and inflexible demand remain unresponsive to price signals



- A volatile market is the basis for investments in flexibility
- Lack of certainty in continuation of volatility is stalling flex investments

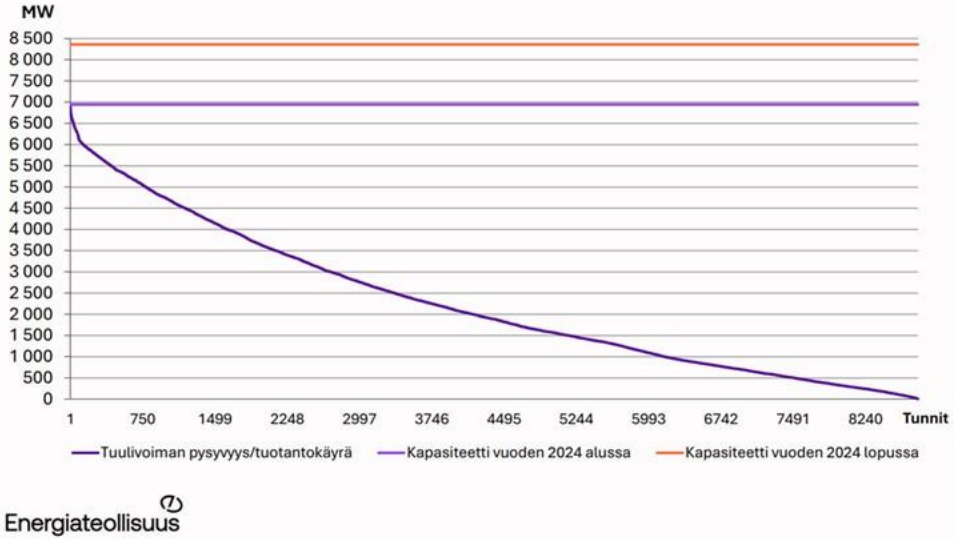
Who will invest in power production, storages and flexibility when:

- Future seems unclear
- Risks are high
- Profitability is weak

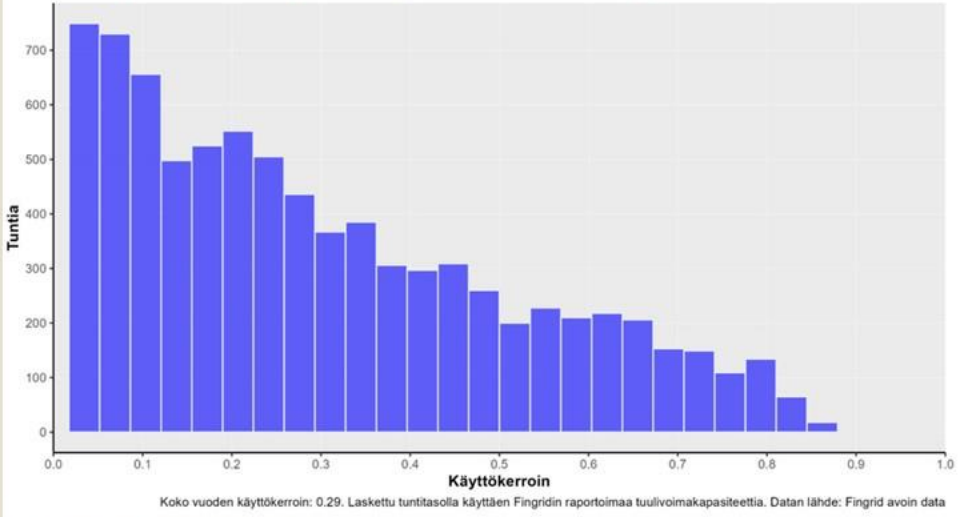
Wind - hardly enough alone

- According to statistics, wind power accounts for approximately 25 % of Finland's annual electricity production. The nominal capacity of wind power at the end of 2024 was around 8,400 MW.
- According to Fingrid's estimate, wind power's share will be around 40% in 2030 and nearly 70% in 2035.
- The highest instantaneous wind power output in 2024 was approximately 7,000 MW, and the highest daily average power output was around 6,000 MW.
- On an annual basis, wind power generation is below 70% of its nominal capacity for 98% of the time.
- The combined capacity factor of Finland's wind power in 2024 was below 0.3, meaning that on average, approximately 2,300 MW of wind power was available.
- On 315 days of the year, the average daily wind power output fell below half of its nominal capacity.
- For 35% of the days in a year, wind power production drops below 6% of its nominal capacity.
- On 10% of the days, the average daily power output remains in the range of 0–6% of nominal capacity. Loss of Load Expectation (LOLE) risk is significantly higher than expected

Windpower duration curve

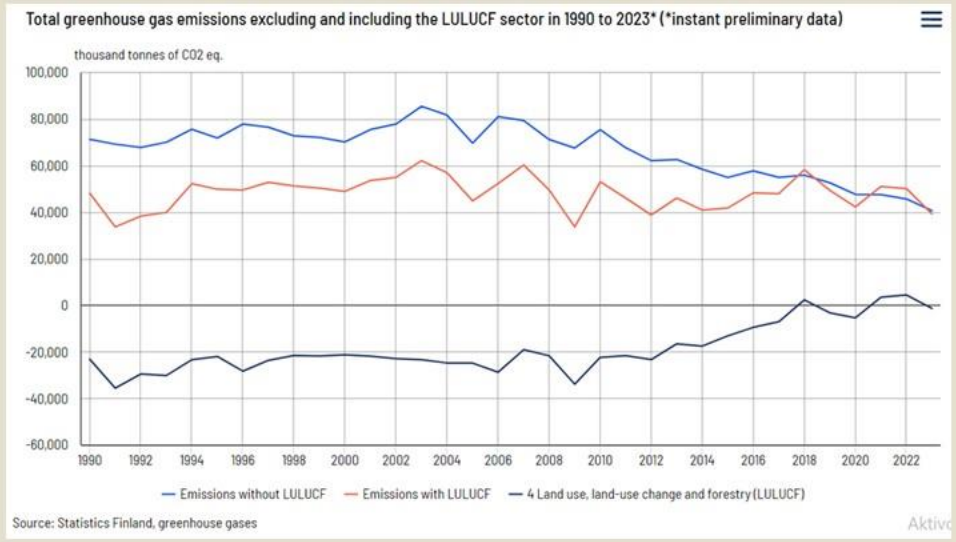


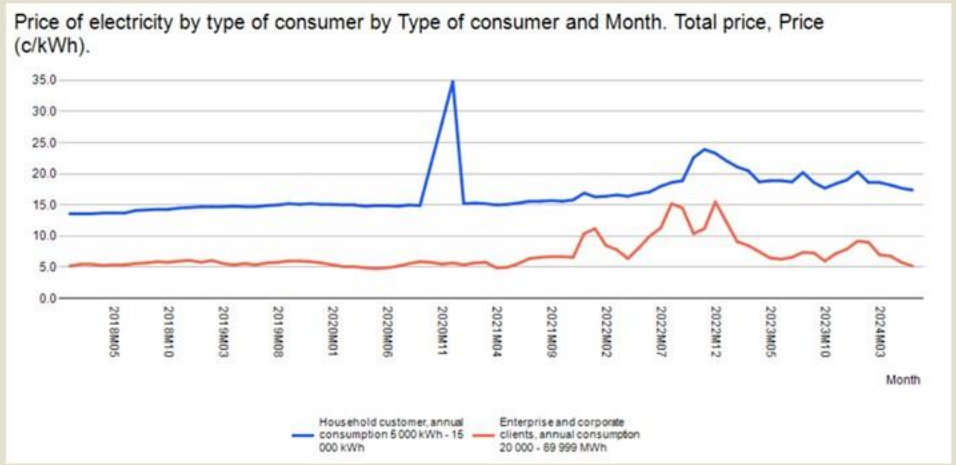
Windpower capacity factor histogram 2024



Suomenilmasto.info

Power sector investments and net emmissions - What went wrong?





Emission cuts are the major driver for the energy transition

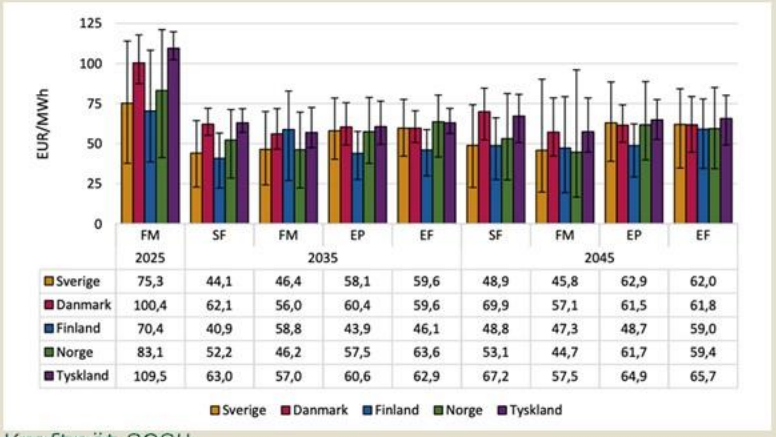
Around 40-50 billion investments in total into emission cuts in Finland. Net emissions (red line) remain still in the 1990's level.

Who is paying the bill? Consumers, industries, or tax payers?

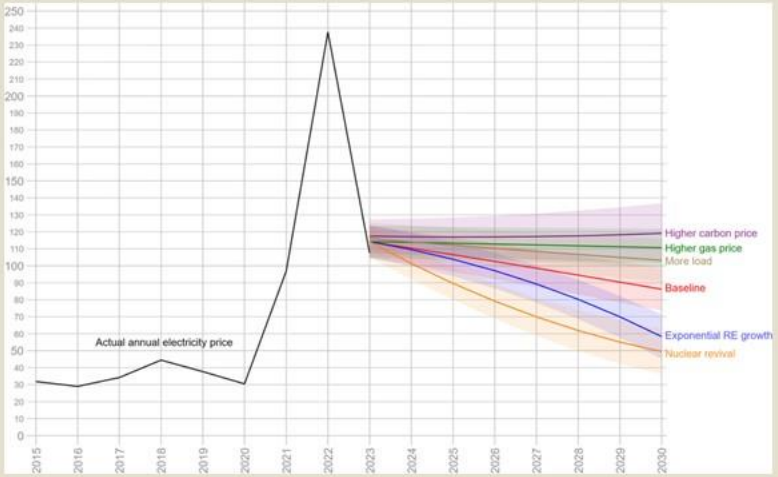
Technology	Added capacity (MW)	CAPEX (rough estimate)
Wind	8500	10 billion €
Nuclear	1600	5,5-8 billion €
Solar	1500	1-2 billion €
Storages	1000-2000 MW	1-3 billion €
Flexibility	2000 MW	1-3 billion
Grid		5 billion (1 billion extra per year)
All	13 000-14 000 MW	20-30 billion €

Cross sectoral planning needed for maintaining emissions reductions and the competitive business environment

Mysteries of electricity price



Kraftnät 2024



Liebensteiner et. AL

Cheapest electricity in Finland
– is it a good or a bad sign?

In most likely scenario Finland is the most expensive...

Germany Challenges Nordic countries in nuclear revival and RE Growth -scenarios.

Electricity market seems unforeseeable for all actors. Weak predictability blocks investments especially in peripheric regions.

Estimates of electricity price for industry 2024-2030

Analyst	Price €/MWh, Finland	Price €/MWh, Germany
Finnish sectoral research insititute	38,5	92,2
Energy market analysts	67	50-110
Steel industry		60 (2024)
International institute		75
AI -estimate	23	

Estimated 2035 LCOE per technology

according to Fingrid's projections

"There ain't no such thing as a free lunch"

Assumptions:

I) Energy produced according to Fingrid's 2035 energy production estimates by type

2) Half of renewable energy production matched to inflexible industrial demand via energy storages

3) LCOE/LCOS based on an assumed learning curve on top of existing technologies

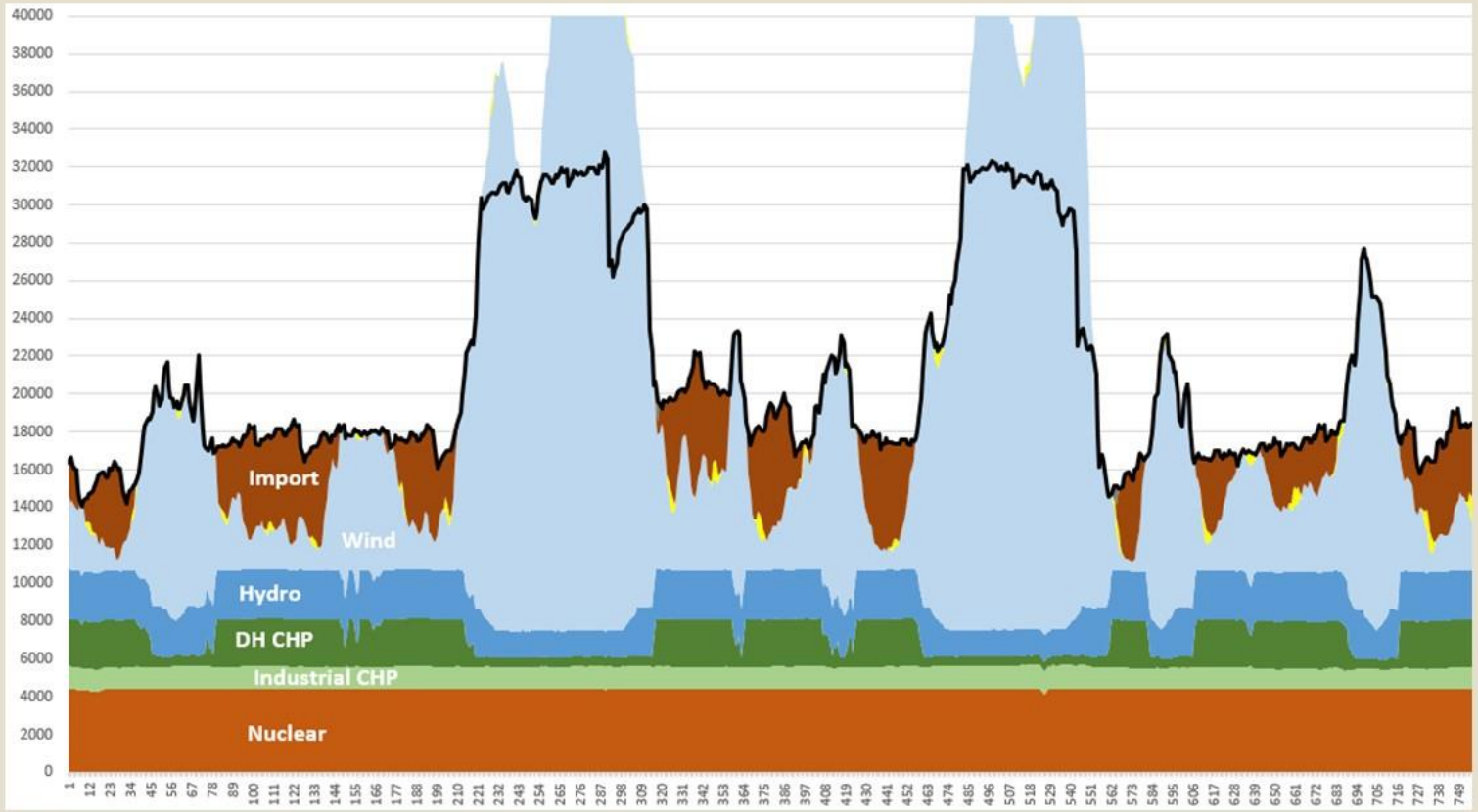
Energy Source	Share of Consumption	Production Costs (LCOE / LCOS)
Windpower	58 % / 101 TWh	40 €/MWh (onshore 30 €/MWh, offshore 55 €/MWh)
Solar PV	9 % / 16 TWh	30 €/MWh
Required Energy Storage	33 % / 58 TWh ((added to electricity costs)	LCOS 100 €/MWh
Total Variable Renewables	67 % / 117 TWh	88 €/MWh
Nuclear power	19 % / 34 TWh	70 €/MWh
Hydropower	8 % / 14 TWh	30 €/MWh
Thermal power	6 % / 10 TWh	80 €/MWh
Total, Other than VRE	33 % / 48TWh	62 €/MWh
Average Production Cost	100 % / 175 TWh	80 €/MWh

Bio + VRE + Energy storage costs roughly the same as nuclear power. Both produce stable carbon free electricity, but one system is centralized, whilst the other is decentralized.

What would enable exceptionally low energy cost for Finnish industry in a long run?
Cheaper Wind vs. higher transmission costs?

A simulation of a winter month energy production in 2035

(According to Fingrid scenarios)

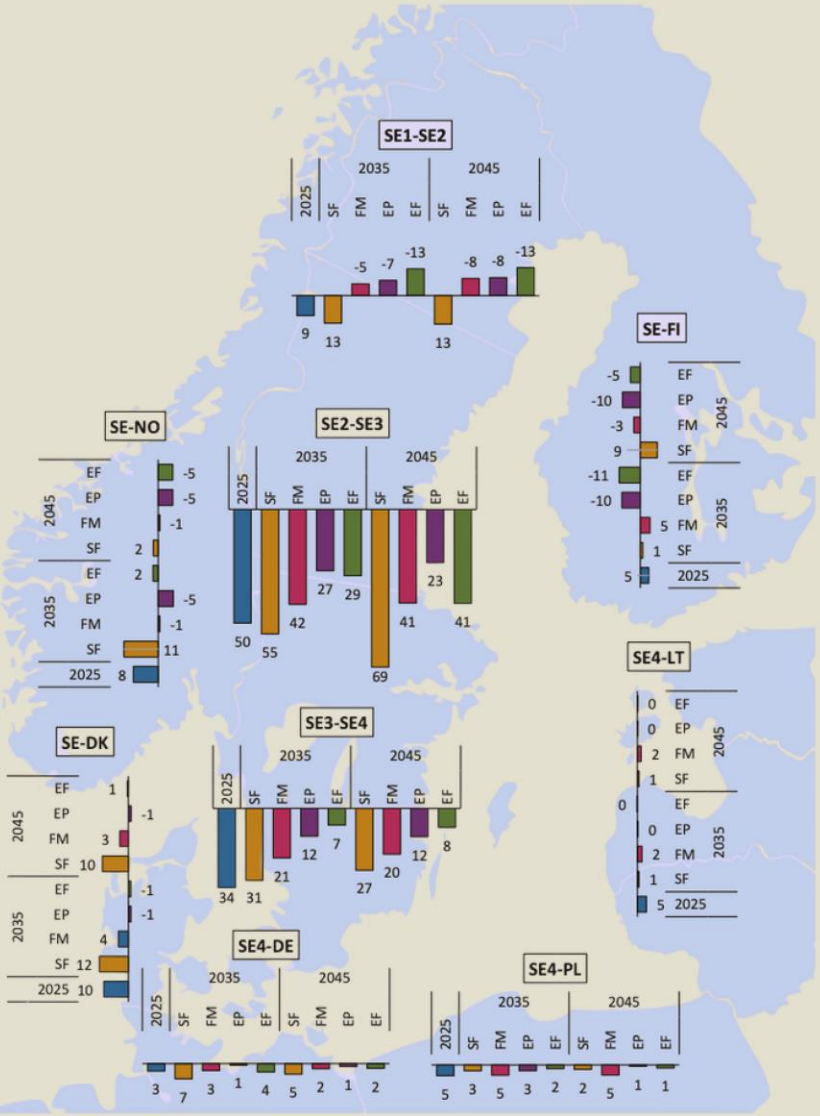


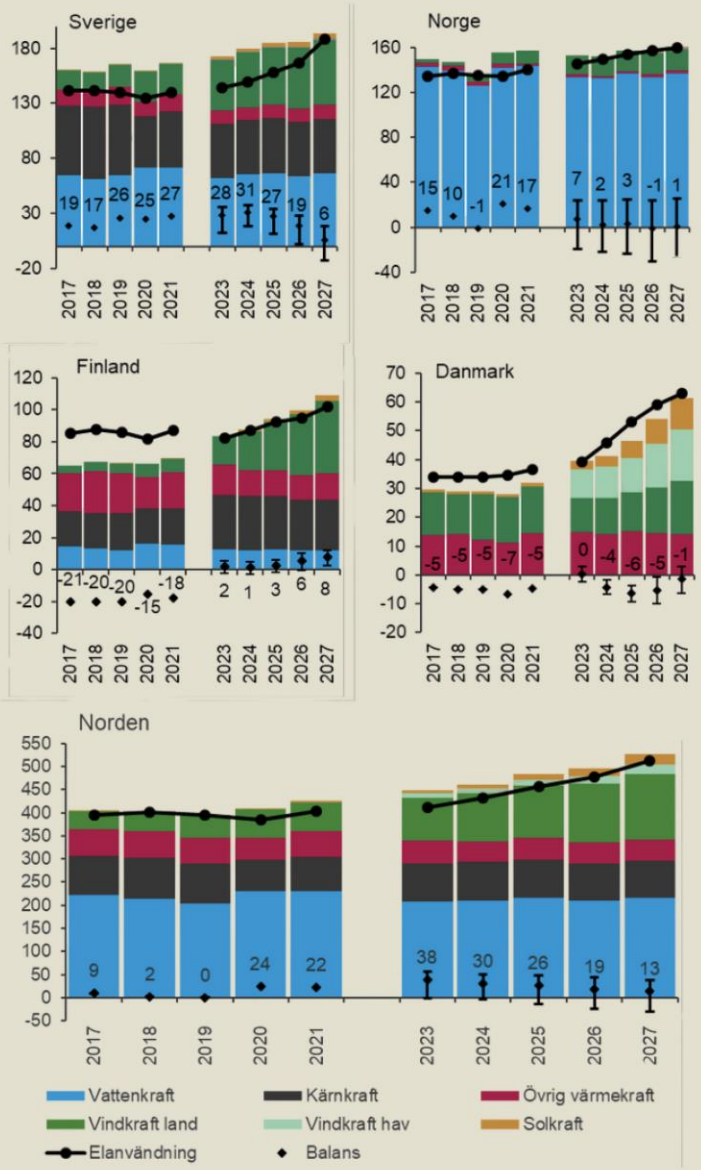
Samuli Rinne , Green Competence Center

- Continuously available power capacity remains at the 2025 level, around 14,500 MW.
- Approximately 1,500 MW of additional consumption can be covered 50% of the time.
- 10,000 MW of consumption can be sustained less than 35% of the time.
- Inflexible hydrogen production and data centers greatly increases the need to import electricity.
- Transmission costs can multiply

Production method	Capacity in 2035 (GW)
Hydropower	3
Onshore Wind Power	30
Offshore Wind Power	7
Solar PV	20
Nuclear	4
Thermal	4
Total	69
Hydrogen production	8
Electric boilers	7

Nordic balance





- Annual balance stays postive, but the marginal decreases
- Hours of negative balance is rapidly increasing
- Finland stays a net energy exporter
- But remains reliant on imported electricity during peak consumption

Percentage of hours in the year with a negative power balance

	Nordics	Denmark	Finland	Norway	Sweden
2030	3 %	14 %	26 %	<1 %	<1 %
2030	-16 GW	-6 GW	-7 GW	2 GW	-10 GW
2040	28 %	24 %	42 %	<1 %	8 %
2040	-38 GW	-10 GW	-13 GW	-3 GW	-10 GW

Key takeaways

1. Industrial demand can't adapt to great variability in energy production; flexibility emerges only + 300 €/MWh prices.
2. Full flexibility on the consumption side is unlikely, because of significant capital costs and reduced production. If hydrogen production and datacenters are hailed as much needed sources of flexible consumption, but the business model and great capital expense costs for the facilities result in actual flexibility provision being unlikely - even a high cost of electricity is more profitable than halting production.
3. To make variable renewable energy production suitable for industrial energy consumption, energy storages on multiple timescales are essential; BESS, PSH, and BIO
4. Nuclear and / or bio power are also a solid facilitators for new industrial carbon free baseload consumption
5. Energy superpower / cheap energy exporter / resource economy - aren't most benefical strategies for Finland
6. Trans-Baltic submarine grid connections can't be solely relied on in current geopolitical climate. Security of supply and reliability of delivery can't depend solely on market logics or importing power.

1. Price signal is not yet dominating the power sector investments
2. Flexibility of demand comes with at a high price
3. Rapid expansion of feasible energy storages, flexible generation and inertia is imperative
4. There is a recognized need for new nuclear
5. Better public-ownership + Nordic and EU-level collaboration needed
6. Actions needed to maintain national reliability & security of supply

BIOS

Antti Majava, 18.3.2025

Ylä- ja Itä-Kainuun vihreän siirtymän
osaamiskeskus

KÄÄNNEKOHTA T&K

PEAK project: towards flexible regional energy systems in Ostrobothnia



Hannu Laaksonen

Professor, University of Vaasa



Giovanna Pinilla De La Cruz

Postdoctoral Researcher, VEBIC – University of Vaasa

PEAK - DEVELOPMENT OF THE REGIONAL ENERGY SYSTEM IN OSTROBOTHNIA

PEAK project: towards flexible regional energy systems in Ostrobothnia

Giovanna Pinilla De La Cruz
Hannu Laaksonen

Co-funded by the European Union

ÖSTERBOTTENS FÖRBUND
POHJANMAAN LIITTO

esse elektro-kraft

Vaasan yliopisto
UNIVERSITY OF VAASA

AKTION ÖSTERBOTTEN

AGENDA

1. Challenges of the energy transition and weather-dependent renewable energy
2. What is PEAK project about and why is it relevant in the current energy landscape?
3. Need for increased flexibility in future power systems
4. Mapping the exploitability of the electricity grid and flexibility resources

Challenges of the energy transition and weather-dependent renewable energy

"Renewables could contribute to two-thirds of total primary energy supply globally by 2050". (IRENA, 2018, 2019)

- As higher shares of variable energy **increase the need for balancing supply and demand.**
- As **variable renewable energy integration** increases, system operations become more **complex: add variability and uncertainty**.

> ***"The security of supply of the system requires sectoral integration and flexibility".*** (TEM, 2021)

IRENA (2019), Global energy transformation: A roadmap to 2050 (2019 edition), International Renewable Energy Agency, Abu Dhabi
IRENA. (2018). Power system flexibility for the energy transition, Part 1: Overview for policy makers. Abu Dhabi
TEM (2021) Sektori-integraatiotyöryhmän loppuraportti

What is the PEAK project about and why is it relevant in the current energy landscape?

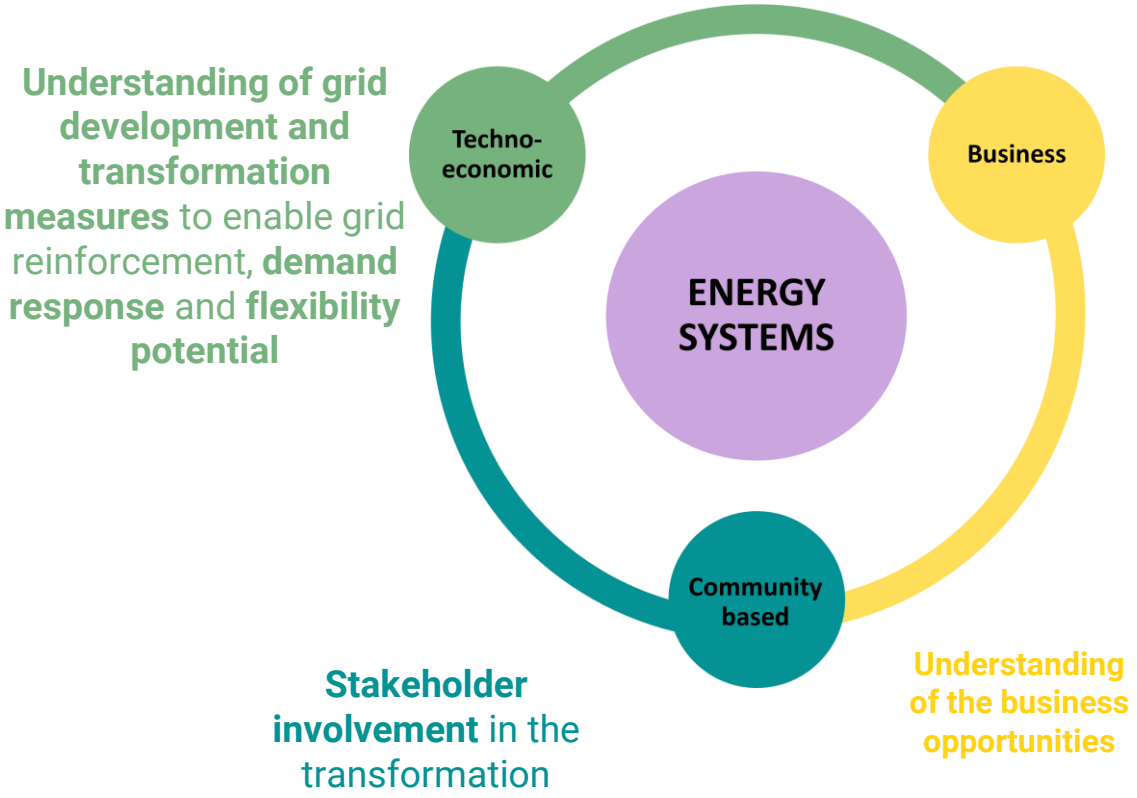
The **PEAK project** focuses on the shift towards carbon-neutral regional energy systems. Our purpose is:

- Generate **new knowledge** to accelerate the transformation and development **of the regional energy system** .
- **Provide information** from **a techno-economic, business and community perspective** to **support decision-making.**
- **Prepare the regional energy systems** for further projects.

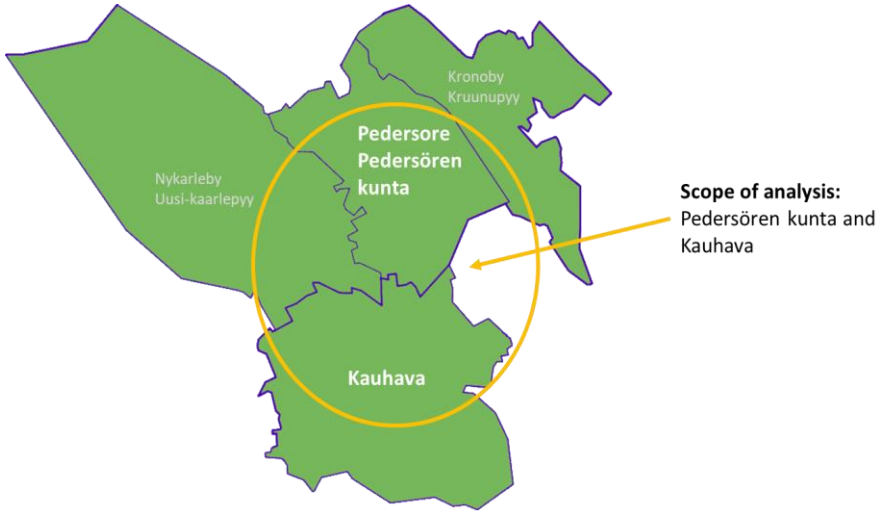


What is the PEAK project about and why is it relevant in the current energy landscape?

- **Project duration:** 1.5.2024 - 30.4.2026
- **Total budget:** 406 353€
- **Target area:** Municipalities in Ostrobothnia, having special analytical focus on the operation area of Esse-Elektro-Kraft ab
- **Beneficiaries:** University of Vaasa, Aktion Österbotten
- **Funders:** JTF/EU, University of Vaasa, Aktion Österbotten, Esse Elektro-Kraft ab



PEAK project - Mapping energy potential



Operational area of Esse Elektro-Kraft

Task 1.1 Mapping energy potential in the area under operation

- Besides the use of hydropower in the area under operation, other renewable energy sources are gaining track in recent times.
- Solar photovoltaic is making significant strides in the region. By 2028, at least two major projects in Kauhava are expected to deliver more than 100 MWp of capacity.
- In the wind power sector, several projects are underway between Pedersöre and Kauhava, at various stages of development.

Renewables Finland. (2024b). Wind Power. Retrieved from https://tuulivoimayhdistys.fi/en/wind-power-in-finland
Motiva Oy. (2024). Solar Power Plants. Retrieved from https://aurinkosahkovoimalat.fi/

Need for increased flexibility in future power systems

Power systems are changing due to

1) **Climate change / Environmental issues**
   - Need **for large-scale integration of renewable, low emission (CO2) energy sources** in HV, MV and LV network
   - Need to **electrify other sectors** (transportation, heating, industrial processes)
   - Need to improve **energy efficiency of the whole energy system**

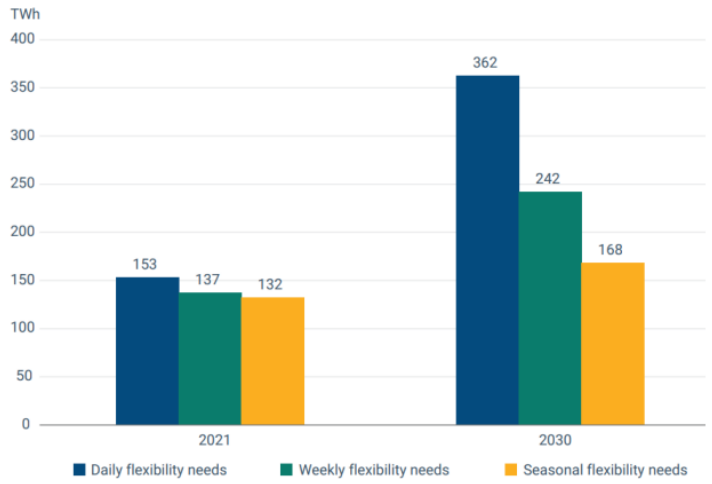
2) **Increasing dependency on electricity**
   - Need to **improve electricity supply reliability, resiliency** and quality

- In order to maintain whole energy system costs and electricity price at competitive level, **increased amount of flexibility is needed from different energy resources, voltage levels (HV, MV and LV) and sectors** (also from electrified transportation, heating and industrial sectors) **to fulfill simultaneously the flexibility needs of** local distribution system operator (**DSO**) and system-wide transmission system operator (**TSO**) **at different time-scales** (e.g. seconds, minutes, hours, days, weeks, seasons)
- **Active (*P*) and reactive power (*Q*) control related flexibility services from distributed energy resources (DER)** (like generation, energy storages, demand response, electric vehicles) **as well as from related sub-systems (**like households, buildings, energy communities/districts, energy/smart villages, different size of microgrids etc.) can e.g. support the power system frequency (TSO service) and local voltage/congestion management or peak shaving at the corresponding voltage level (DSO or TSO service)

Need for increased flexibility in future power systems

Flexibility must double to keep up with renewables (right amount, right time)

Daily, weekly and annual flexibility needs in 2021 and 2030 in Europe

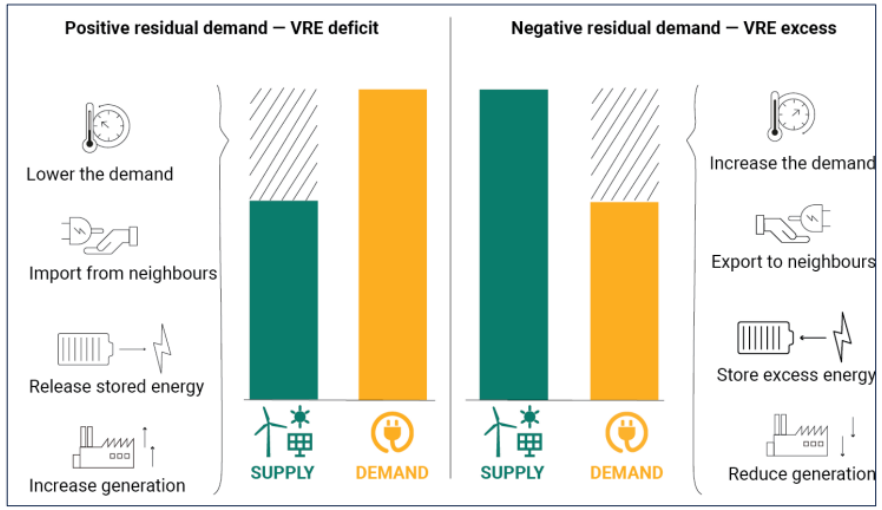


- Increased solar generation requires substantial daily flexibility
- Wind generation mostly requires weekly flexibility
- Increased electrification of heating (via heat-pumps) requires more seasonal flexibility, but it unlocks demand-side flexibility and cheaper thermal energy storage.

Source: ACER-EEA - Flexibility solutions to support a decarbonised and secure EU electricity system

European Environment Agency ACER European Union Agency for the Cooperation of Energy Regulators

Climate-compatible flexibility solutions exist



- Increasingly, home-grown climate-compatible flexibility resources are needed.
- Facilitate the switch to these low-carbon flexibility solutions.

Source: ACER-EEA - Flexibility solutions to support a decarbonised and secure EU electricity system

European Environment Agency ACER European Union Agency for the Cooperation of Energy Regulators

https://help.leonardo-energy.org/hc/en-us/articles/12626019550236--EA21-The-EU-s-big-picture-renewables-flexibility-and-energy-security

PEAK-project – Esse Elektro-Kraft network

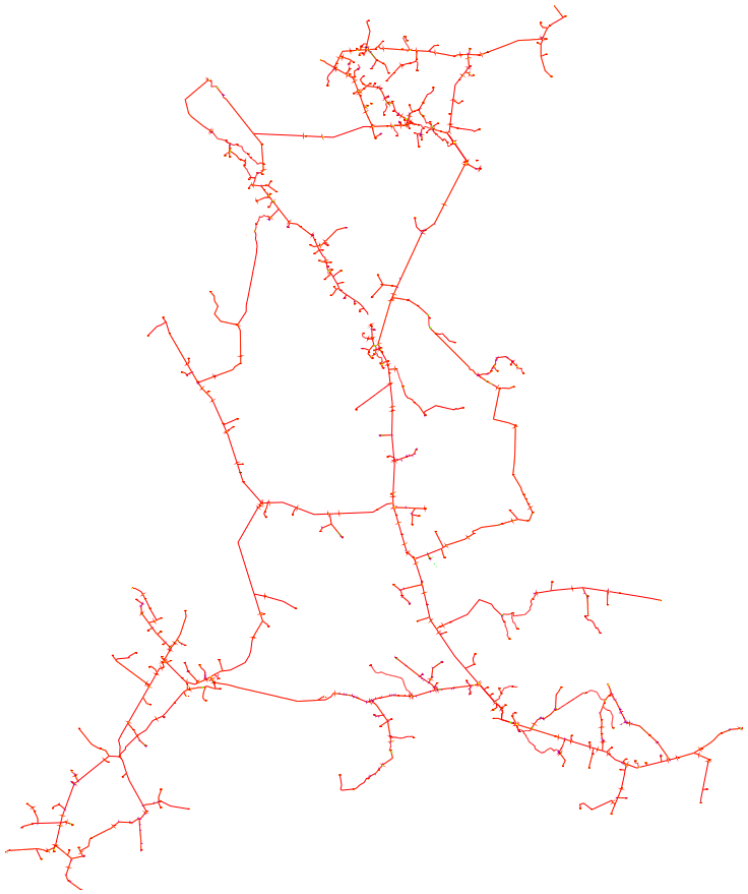
Task 1.2 "Available flexibility potential, future flexibility needs and flexibility & resiliency improvement possibilities"

a) **Identification of the current customer flexibility potential** (controllable loads / demand flexibility) in the different parts of the network

b) **Assessment concerning the impact of the integration of renewable energy sources (like PV) and electric vehicles on the LV and MV distribution network capacity** (lines, distribution transformers) and hence the **potential need for flexibility** (without grid capacity and component upgrade investments)

c) **Identification of potential development needs/flexibility resources like battery energy storage systems (BESSs) integration opportunities and most feasible locations** in the distribution network

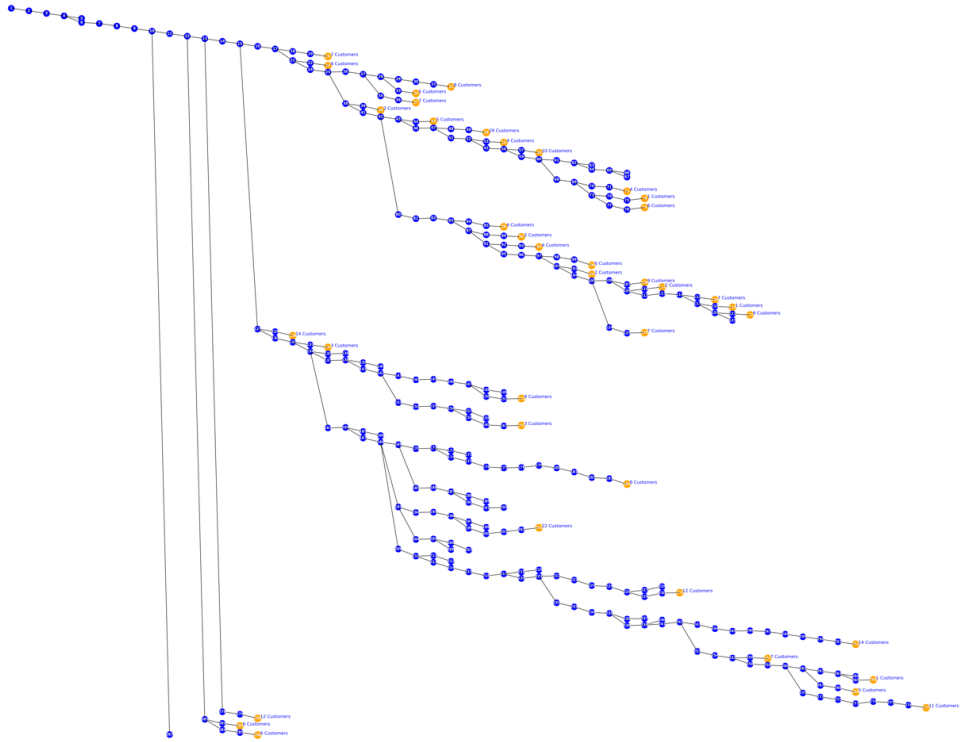
d) **Identification of the potential to improve the reliability and resiliency of the Esse E-K distribution network** through existing/future flexible demand (a), renewable energy generation (b), T1.1), new flexible energy resources like BESSs (c)



PEAK-project – Esse Elektro-Kraft network

Task 1.3 "Techno-economic calculation related to the renewable energy potential and distribution network flexibility/development needs"

- **Carry out a techno-economic calculation by considering the inputs from previous tasks (T1.1) and (T1.2) e.g. local DSO's MV and LV network flexibility & development needs**, so that
  - **Flexible energy resources capabilities** could be fully utilized for
    - *maximized network capacity utilization* (without line or transformer upgrades),
    - *enabling simultaneously PV & EV hosting capacity/integration maximization* as well as
    - *distribution network resiliency and reliability maximization* (e.g. optimal sizing and siting of BESSs)

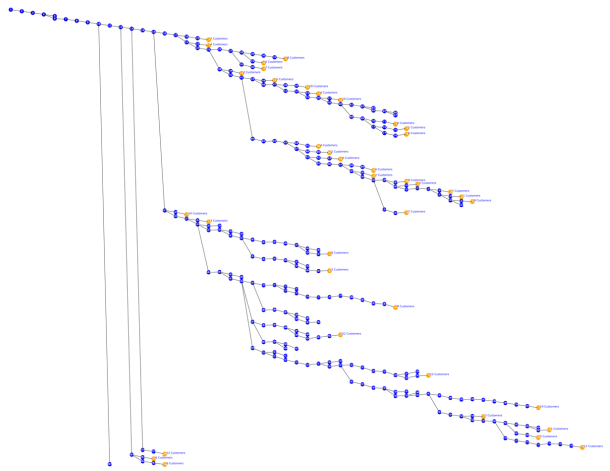


PEAK-project – Esse Elektro-Kraft network

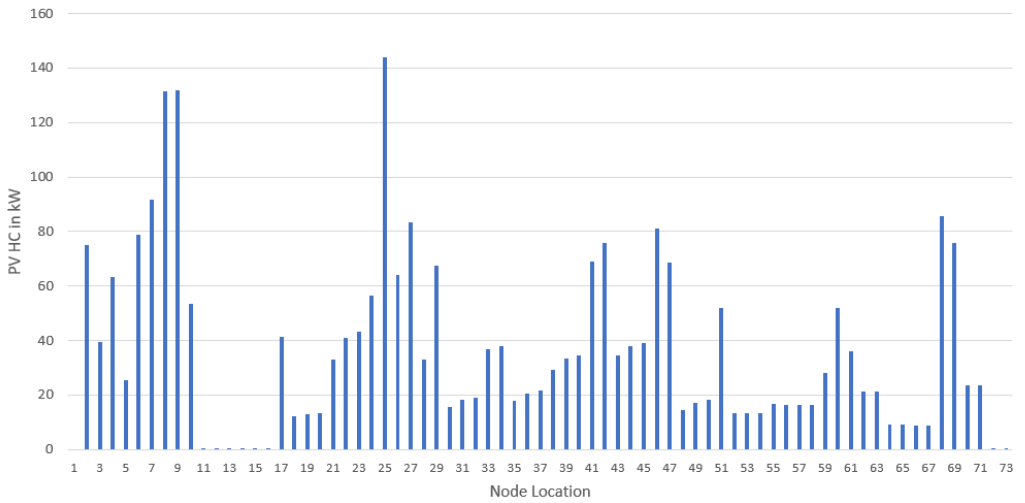
Results example

Studied Network (Section) Information

- Porkholm's 39-Substation Network
- Number of Nodes: 287
- Total Network Length: 55.389 km
- Number of Customers: 286
- Yearly Power Consumption: 1953.112 MWh
- The grid can accommodate substantial PV capacity at select nodes



- The grid can accommodate substantial PV capacity at select nodes
- PV Hosting Capacity Analysis



Node	Capacity in kW
25	143.841003
9	131.8172085
8	131.3521768
7	91.73330156
68	85.73925859

- Total PV generation: 2683.72 kW

PEAK - DEVELOPMENT OF THE REGIONAL ENERGY SYSTEM IN OSTROBOTHNIA

Thank you!

Follow us in our social media channels
@PEAK project in LinkedIn

Co-funded by the European Union

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AKTION ÖSTERBOTTEN

Challenges and Opportunities for rural energy supply and distribution



Ingvar Kulla

Managing Director, Esse Elektro-Kraft

esse elektro-kraft

Challenges and Opportunities for **rural** energy supply and distribution



esse elektro-kraft

Key figures

Turn-over	ab 8 milj euro
Number of employees	13 persons

Owners

Privately owned, ab 350 shareholders

Distribution

Distribution of electricity	52 GWh
Connected users	3800
Total length of distr.grid	1055km
Voltage levels	20kV and 0,4V

Energy production

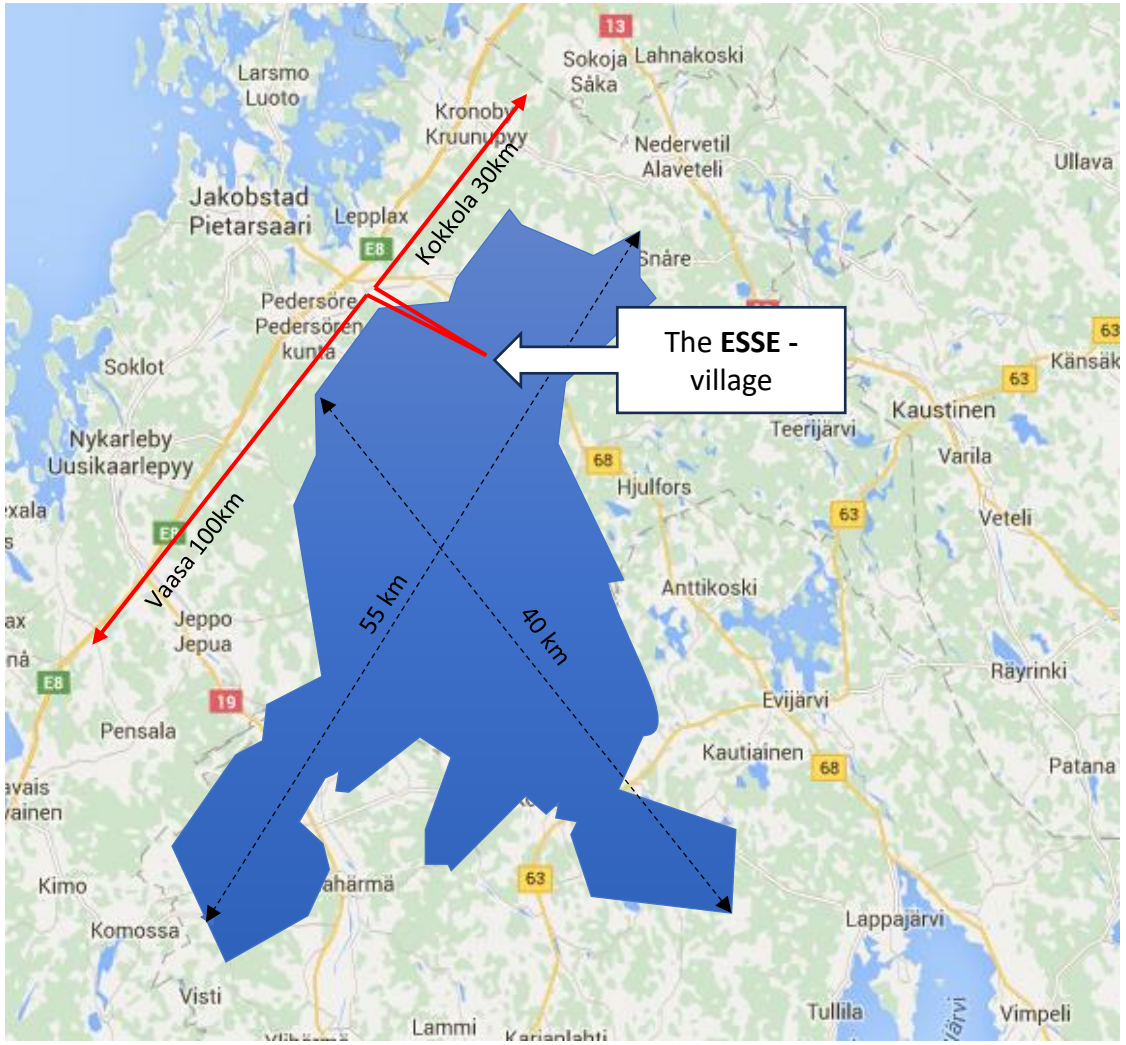
Hydro power	3,7 MW
Solar Power	1,6 MW
+ ´co owned production´	
Total prodcution ab.	53 GWh

Energy storage

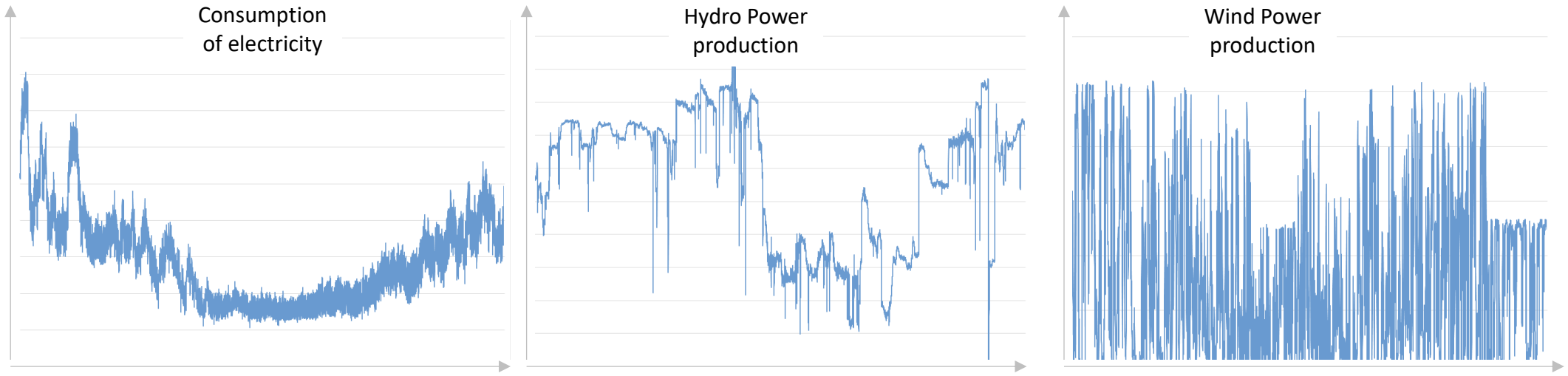
1MW, under construction

Sales and production

Sales of electricity	38 GWh



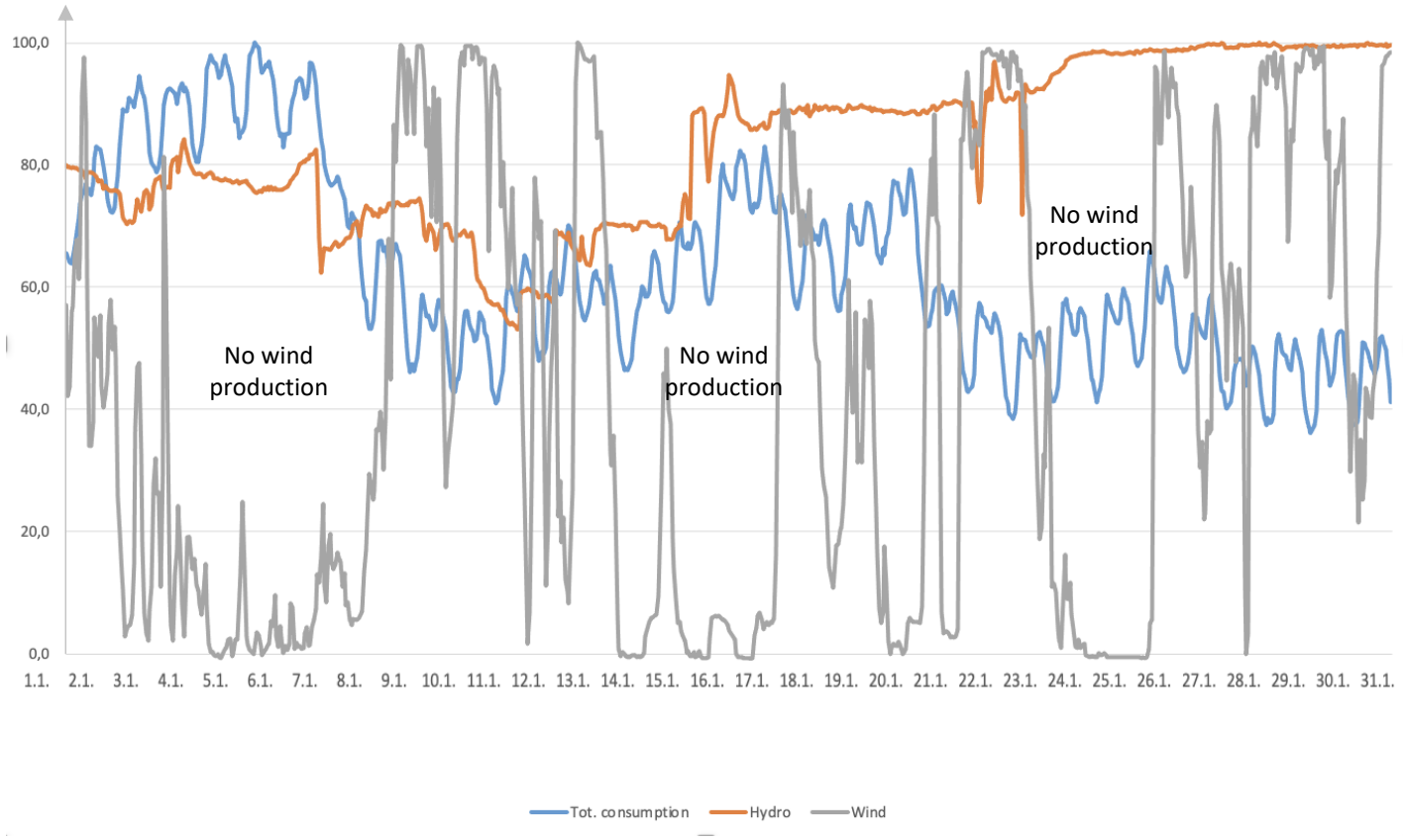
Yearly profiles: 2024



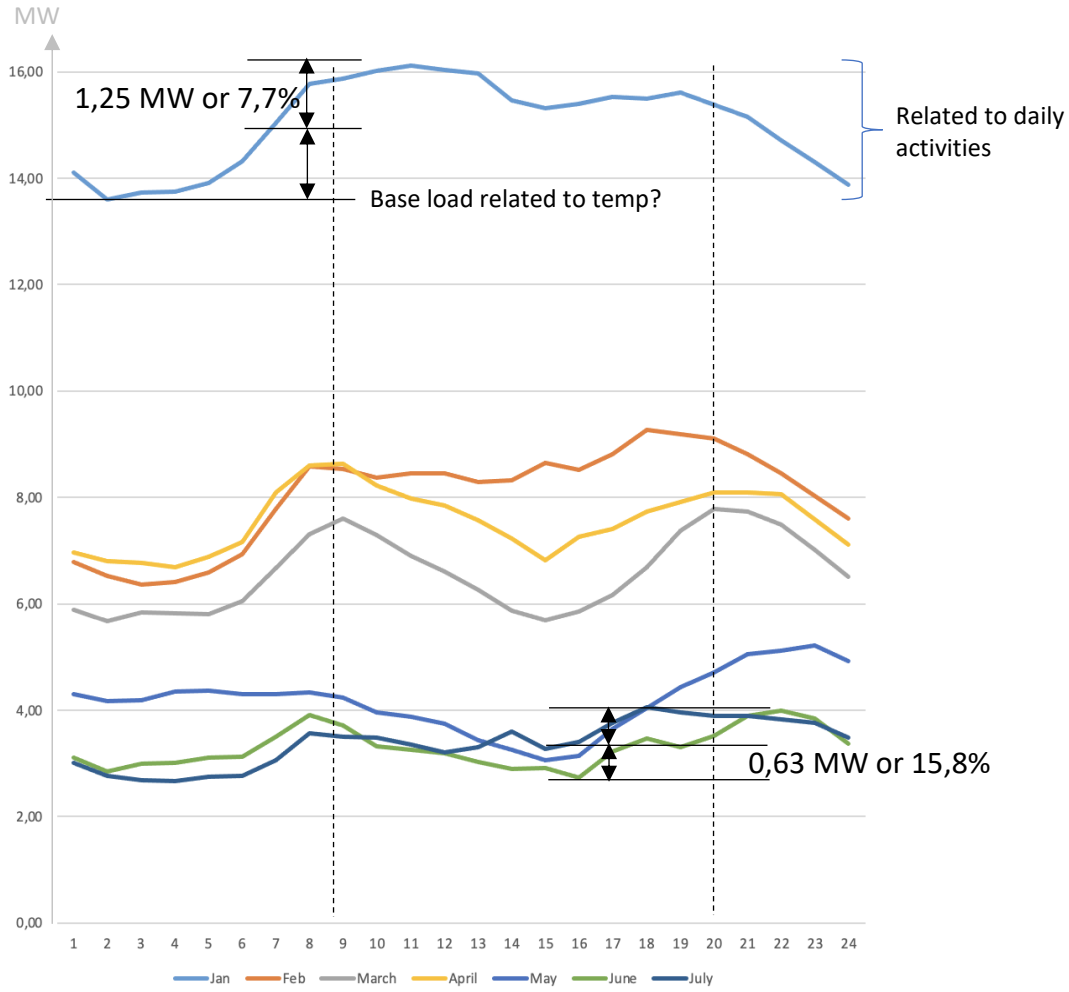
Production portfolio (electricity)	EEK	Finland
Wind Power	43%	24%
Hydro Power	41%	17%

- How can we match RES to consumption?
- How can we meet the **growing** demand from electrification with wind and solar?

Monthly profiles: Jan 2024



Typical **daily user** profiles



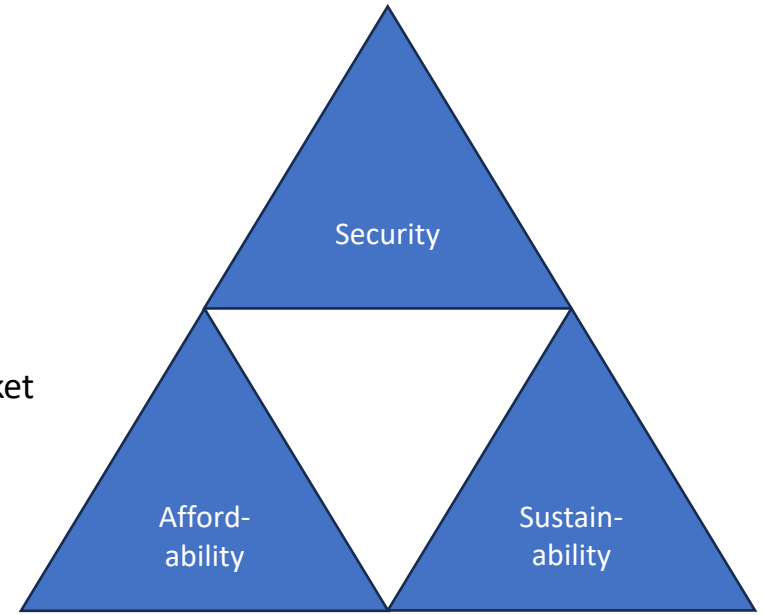
Consumption of electricity

in different sectors	EEK	Finland
Households	41%	28%
Farming (milk, meat)	32%	2%

- Load switching from **hour to hour**, not from day to day or week to week?

Challenges and Opportunities

- Consumption at peak hours and cold temp
- Effects of electrification
- Weather conditions,
  prediction of RES production
- Limitations in distribution



- User flexibiliy, Flexibility market
- Tariffs, pricing mechanisms
- Load shifting, peak shaving
- Large scale energy storage,
  electricity or/and heat
- Sector coupling: electricity
  - district heating - biogas/H2
- Grid investments

- Availiability of RES
- Integration of RES into grids
- Matching RES production to
  consumption (without CO2
  emissions)
- Utilisation of waste heat



esse elektro-kraft

Accelerating the sustainable energy transition with biogas



Kirsi Spoof-Tuomi

Postdoctoral Researcher,
VEBIC – University of Vaasa

DigiBiogasHubs

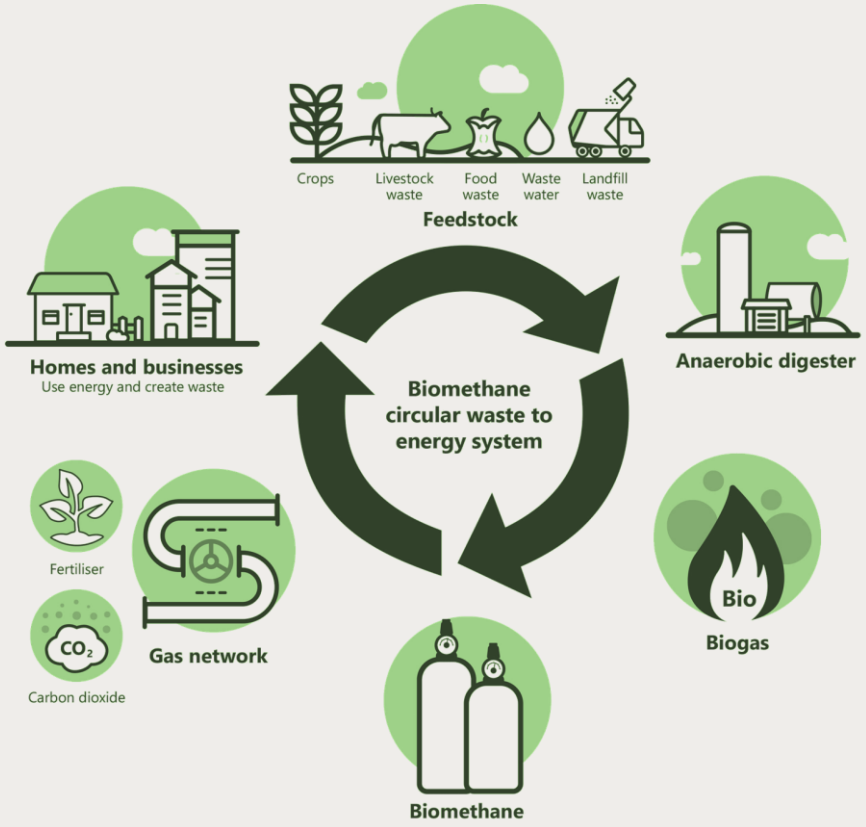
Accelerating the sustainable energy transition with biogas

Kirsi Spoof-Tuomi
University of Vaasa/VEBIC

18.03.2025

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Unlocking the power of biomethane



Modified from:: https://www.powerco.co.nz/

Biomethane

- **ready-to-use, sustainable** solution to accelerate the global energy transition
- **a circular economy** solution that combines energy production, waste management, fertilizer production and greenhouse gas emission reduction

Biomethane: A drop-in solution for the energy system

Biomethane can:

- **Replace fossil-based natural gas in pipelines** without modifications
- **Be used in industrial processes, power generation, and heating systems** just like conventional gas
- **Support heavy transport and shipping** through liquefied biomethane (bio-LNG)



ESL Shipping fuels vessel with drop-in liquefied biogas.
https://www.tradewindsnews.com/gas/esl-shipping-fuels-vessel-with-drop-in-liquefied-biogas/2-1-824495

Strengthening local energy autonomy

Energy independence at regional and national levels

- **Greater control over communities' energy supply** and resilience against global energy price fluctuations
- **Economic opportunities for rural areas**, empowering farmers, waste processors, and municipalities



Figure: iStock

In times of geopolitical uncertainty and volatile fossil fuel markets, **biomethane is not just a cleaner choice—it is a strategic one**.

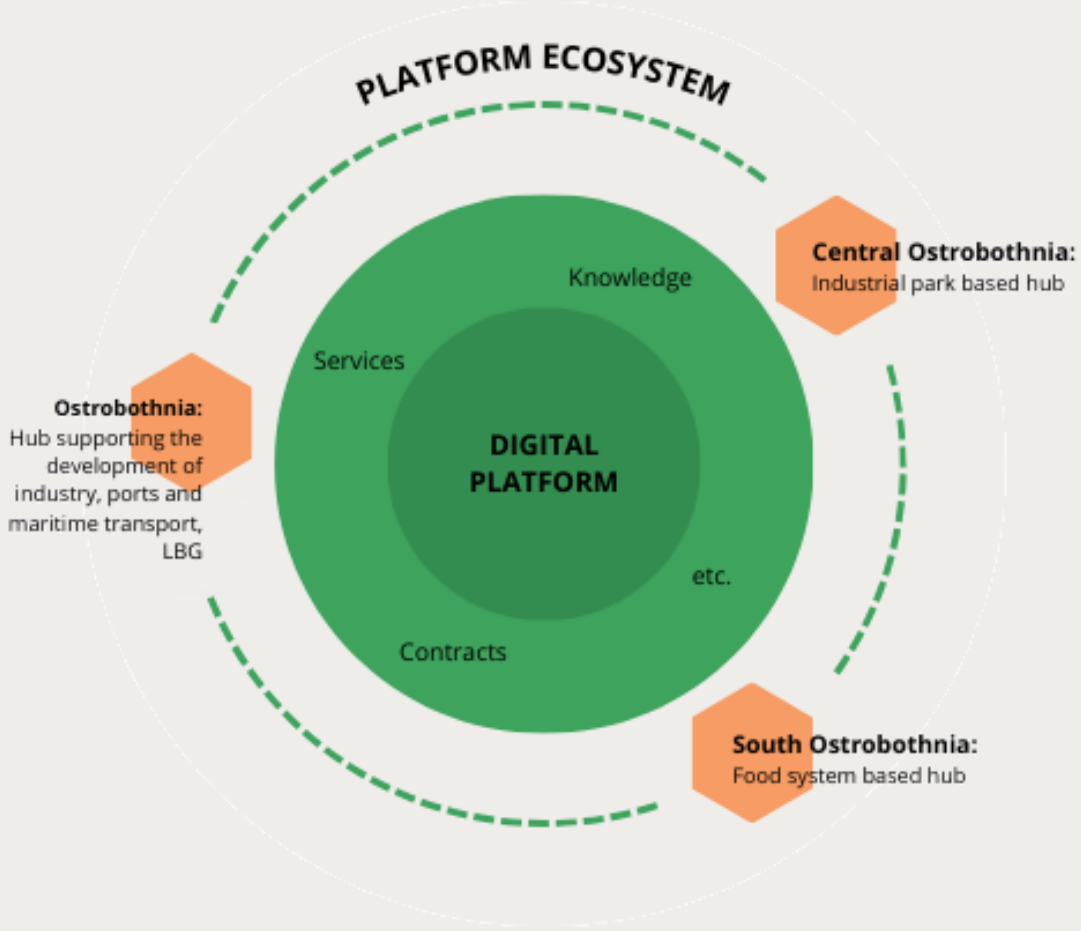
Findings from the DigiBiogasHubs project

DigiBiogasHubs –

Flexible and scalable biogas business through digitally connected biogas Hubs

Ostrobothnia biogas hub:

Hub supporting the development of industry, ports and maritime transport, LBG.



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LBG use potential in Ostrobothnia region

LBG could replace fossil fuels and peat

- in industry 782 GWh/year
- in heavy road transport 144 GWh/year
- in short sea shipping 58 GWh/year
- in district heating and cogeneration electricity production 298 GWh/year







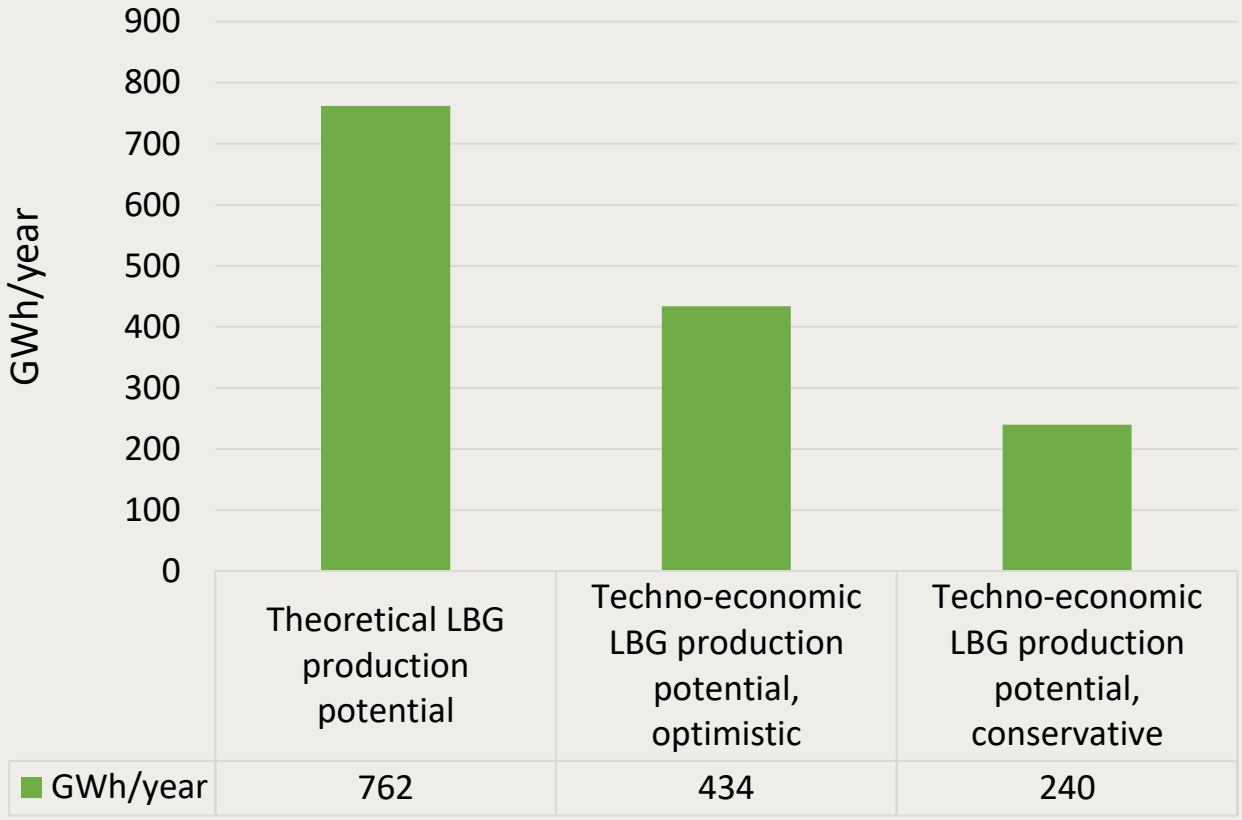


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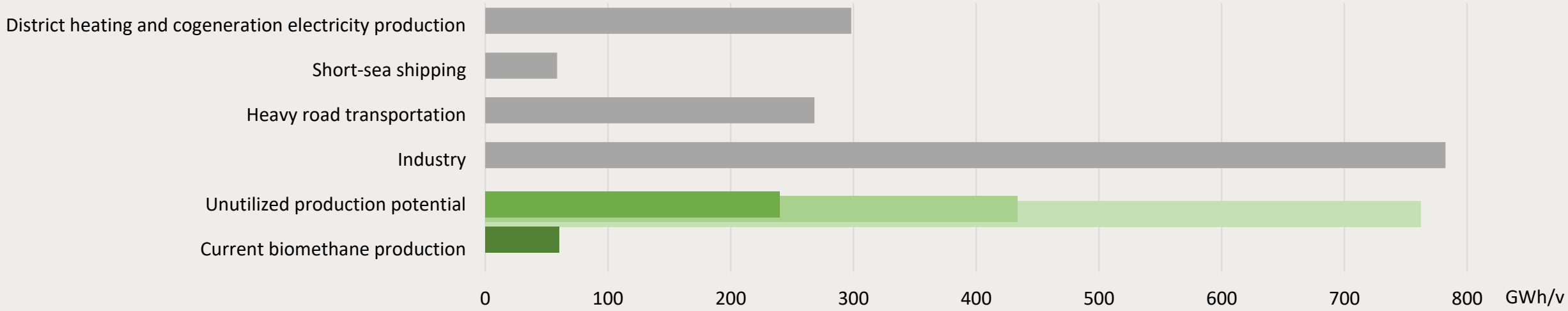
LBG production potential in Ostrobothnia region

Assumption for techno-economic potential:

- collecting radii of biomasses for
  - wet manures 20 km
  - dry manures 40 km
  - field biomass 50 km
- the amount of biomass ending up in biogas production for
  - wet manures 60 % or 80 %
  - dry manures 50 % or 70 %
  - field biomass 20 % or 40 % of the total amount

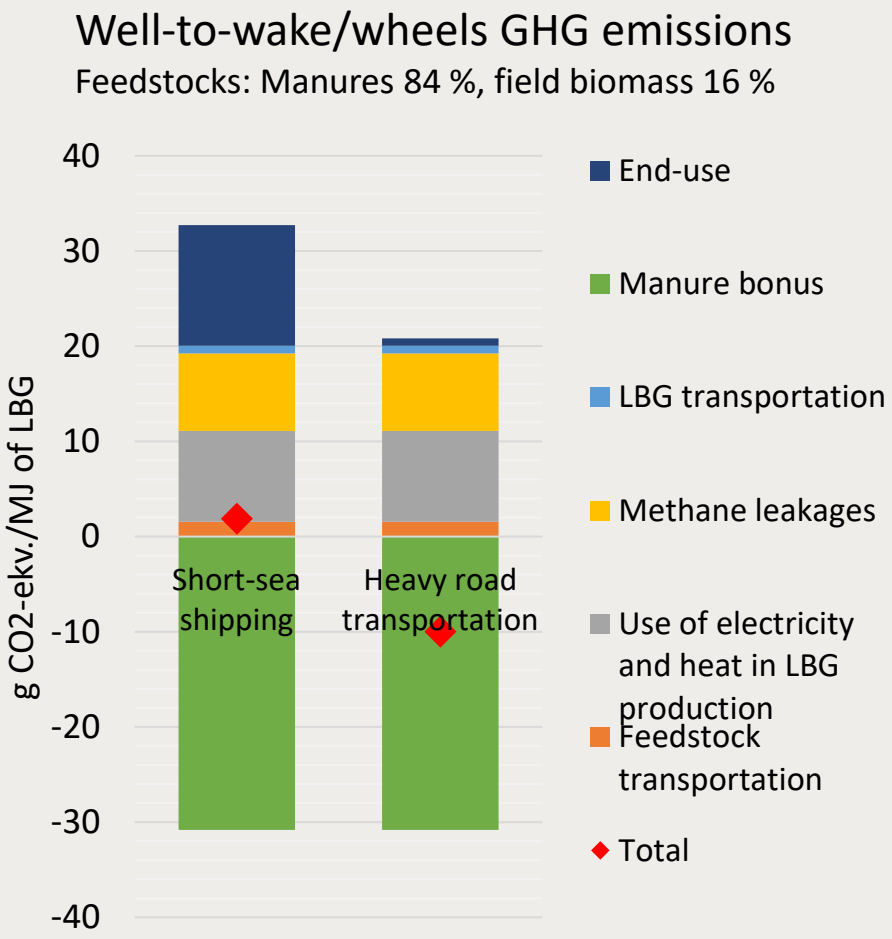


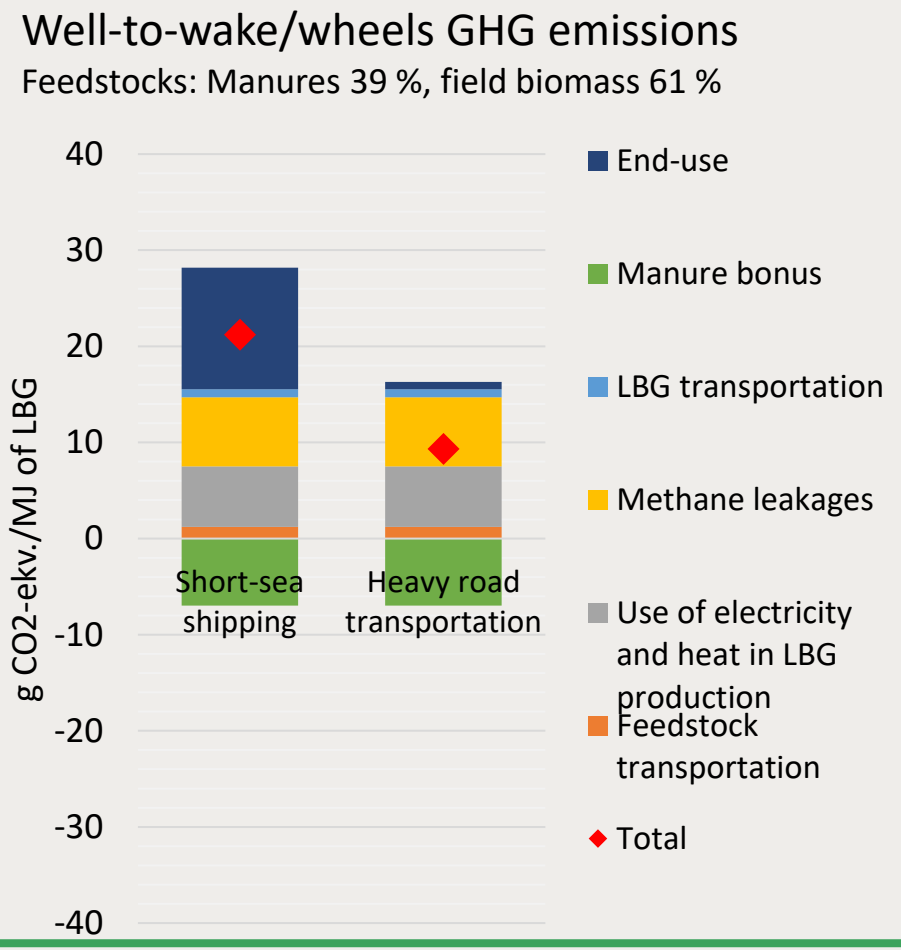
Summary of biomethane production and use potential



	Current biomethane production	Unutilized production potential	Industry	Heavy road transportation	Short-sea shipping	District heating and cogeneration electricity production
Current biomethane production	60					
Use of fossil fuels and peat			782	268	58	298
Techno-economic LBG production potential, conservative		240				
Techno-economic LBG production potential, optimistic		434				
Theoretical LBG production potential		762				

Carbon footprint





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Key takeaways

Biomethane is **not a distant technology—it is here, ready, and deployable today**. By leveraging its compatibility with existing infrastructure and its ability to promote local energy autonomy, we can accelerate the energy transition in a way that is **sustainable, cost-efficient, and resilient**.

The question is not whether biomethane has a place in the future energy system — the question is **how quickly we will embrace it**.



iStock
Credit: Ralf Geithe

Thank you!

Contact: kirsi.spoof-tuomi@uwasa.fi

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The Future of Energy: What New Energy requires?



Antti Kettu

Sales Manager, ABB Oy

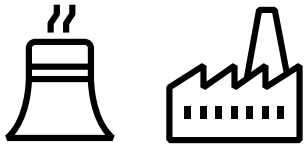


The Future of Energy: What New Energy requires?

ABB Energy Industry – Antti Kettu

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Energy transition



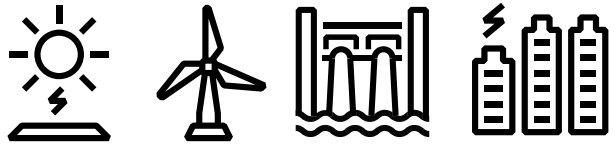
Fossils

Centralized

Predictable

Low volatility

Human



Renewables

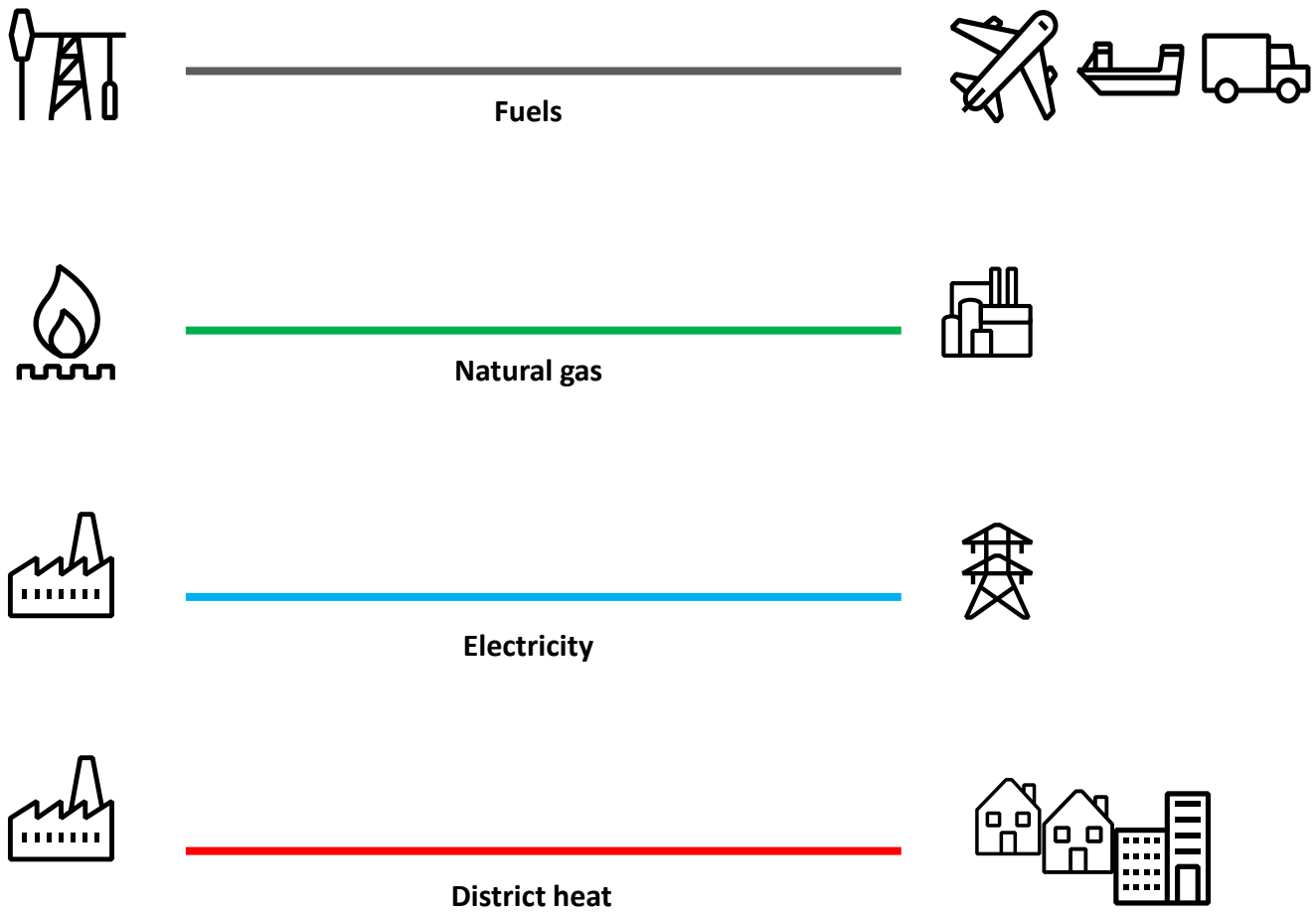
Distributed

Unpredictable

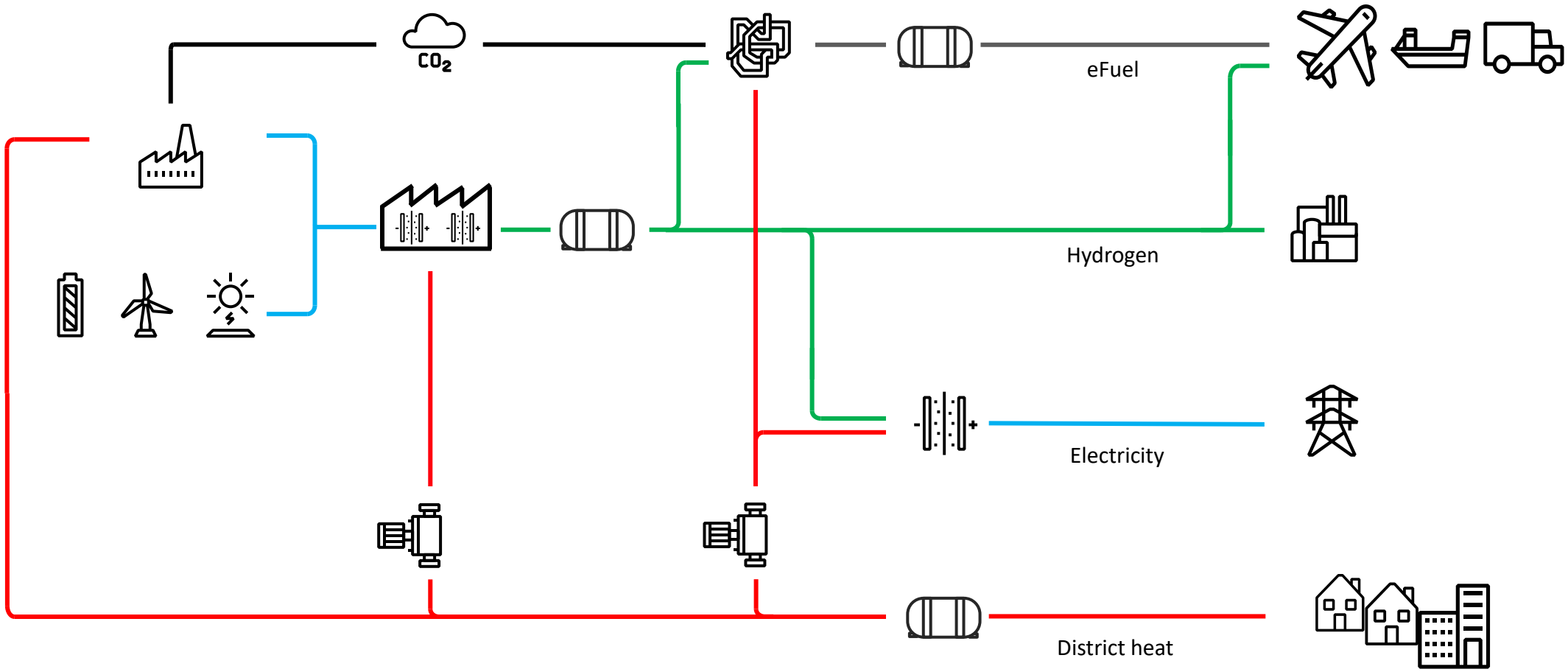
High volatility

Digital

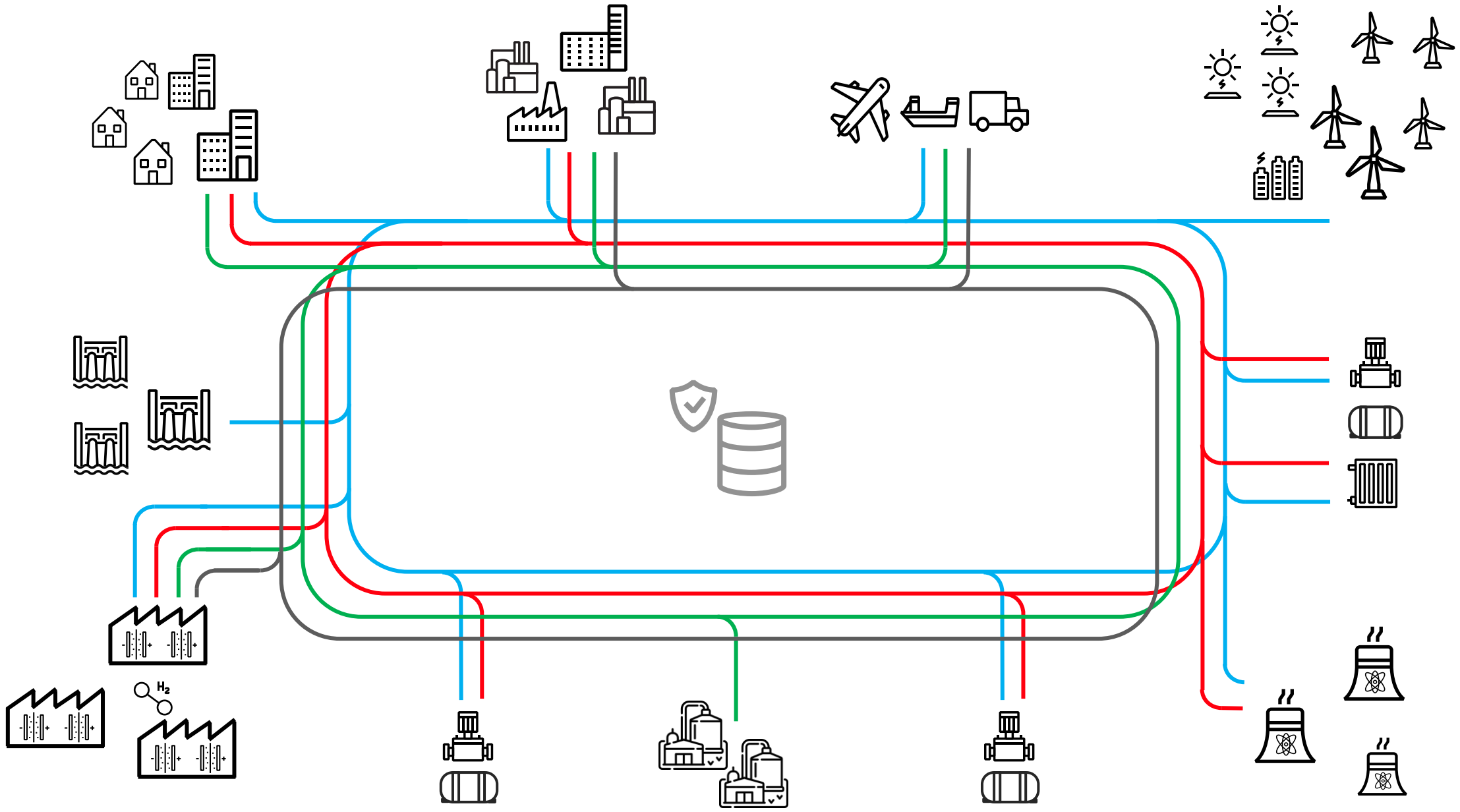
Traditional energy system



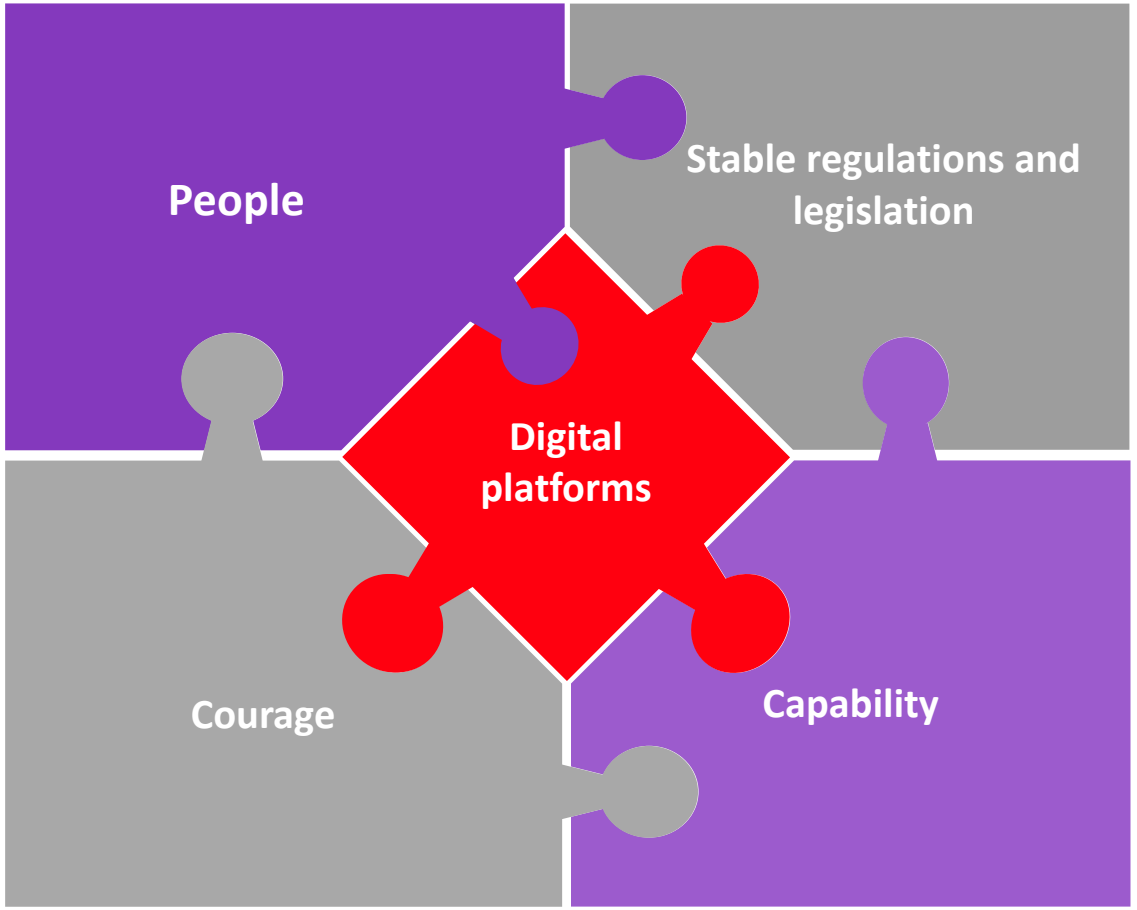
Sector coupled energy system



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H2

What do New energies requires to work?



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Moderators



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Research Programme Manager,
VEBIC – University of Vaasa



Giovanna Pinilla De La Cruz

Postdoctoral Researcher,
VEBIC – University of Vaasa

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Panel discussion:

Transforming the Energy Landscape



Hannu Laaksonen

Professor
University of Vaasa



Ingvar Kulla

Managing Director
Esse Elektro-Kraft



Antti Kettu

Sales Manager
ABB Oy



Christer E. Wik

General Manager
Wärtsilä Finland Oy



Mats Söderlund

Deputy-CEO, CFO, Vice President
EPV



Antti Majava

Specialist, BIOS Research Unit
Managing Director, Käännekohta t&k Oy
Doctoral Researcher, University of Helsinki

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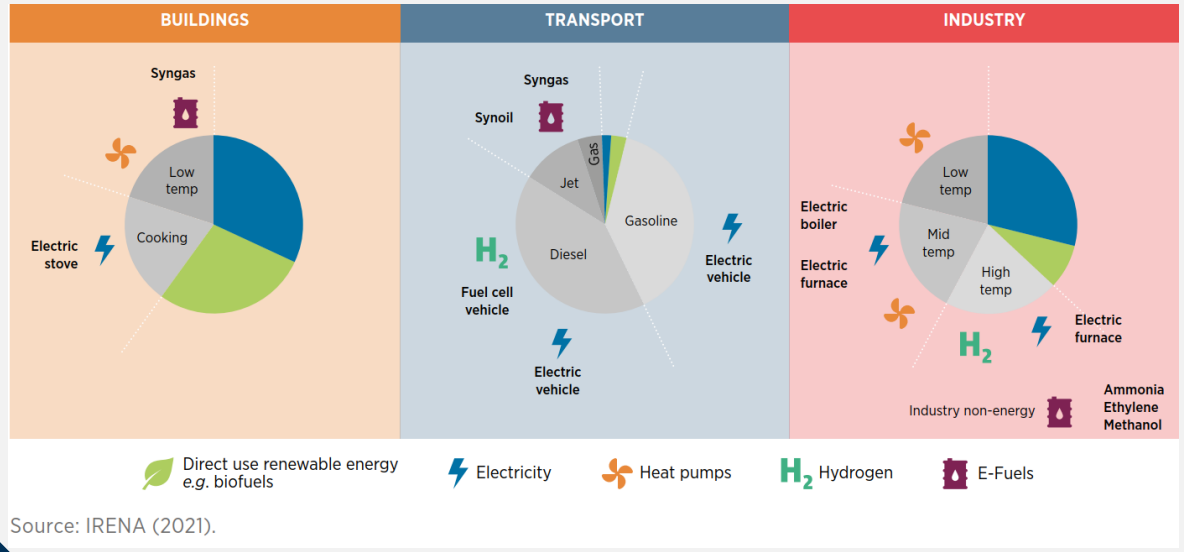
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Sector coupling

"Sector coupling broadly describes an important strategy to optimise the energy system by increasing its flexibility and reliability through direct or indirect use of electricity across applications in end-use sectors, with the aim of accelerating the transformation towards 100% renewable energy" (IRENA, 2022)



Source: IRENA (2021).

IRENA Coalition for Action (2022), Sector coupling: A key concept for accelerating the energy transformation, International Renewable Energy Agency, Abu Dhabi
IRENA Coalition for Action (2021), Companies in transition to 100% renewables: Focus on heating and cooling, International Renewable Energy Agency, Abu Dhabi

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