

# Preconditions for a sustainable energy system and the role of hydrogen for Finland

---

Jukka Leskelä, Finnish Energy  
Future energy solutions 2024  
Lappeenranta 10.9.2024



**What is our vision as  
sustainable energy system ?**

---

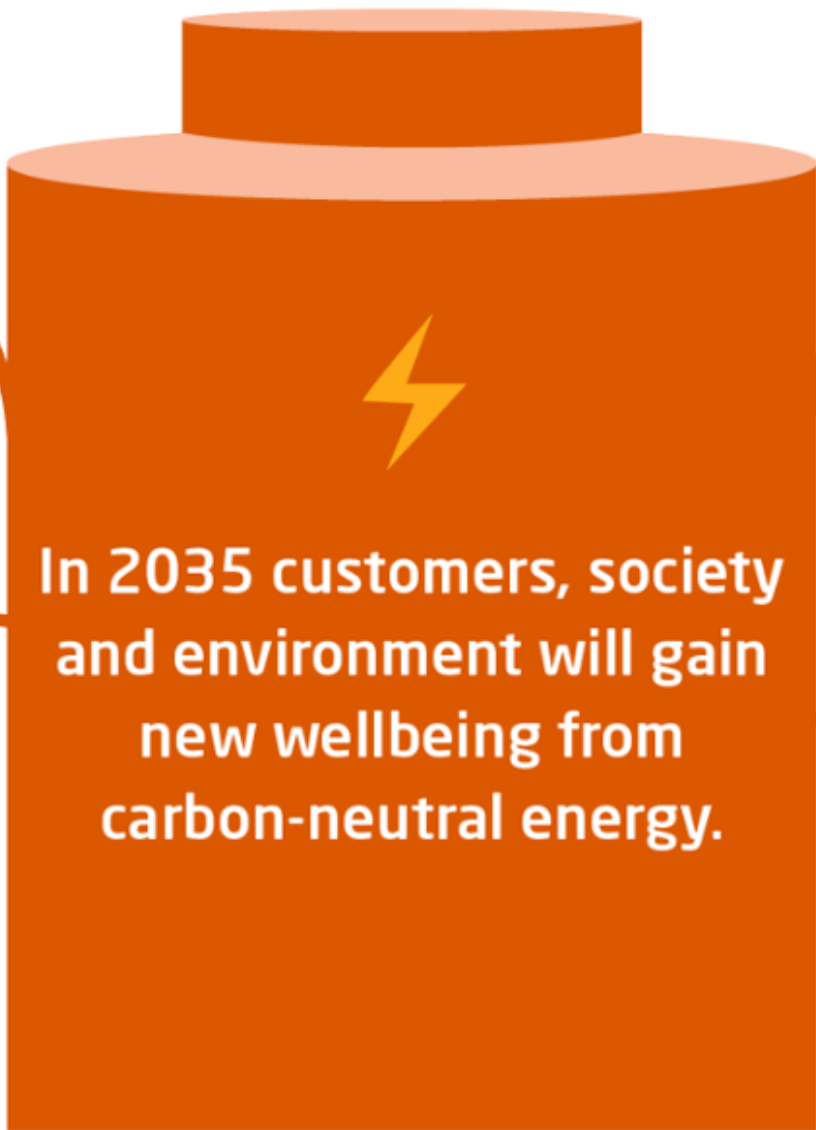




With the new energy system and its services, customers are able to make individual energy choices.



Society trusts in energy that is secure in terms of its supply and maintenance, due to which Finland is competitive and attracts investment.



**In 2035 customers, society and environment will gain new wellbeing from carbon-neutral energy.**



Energy sector that has achieved carbon neutrality has a net positive impact on biodiversity.



Energy investments based on an active market have sensible targets, utilise new technology and deliver prosperity in a cost-effective way.

**Together we will lead society towards a sustainable future.**

# Three jumps to functioning carbon neutral energy system

---



# Triple jump

TOWARDS CARBON-NEUTRAL ENERGY



3.

Reliable and well-functioning new energy system

- Sector integration of energy
- Cooperation with the customer
- Enabling energy networks
- Developing expertise & services

1.

Carbon neutral energy production

- Fossil-free electricity and district heat generation
- Circular economy
- Bioeconomy
- Clean gases

2.

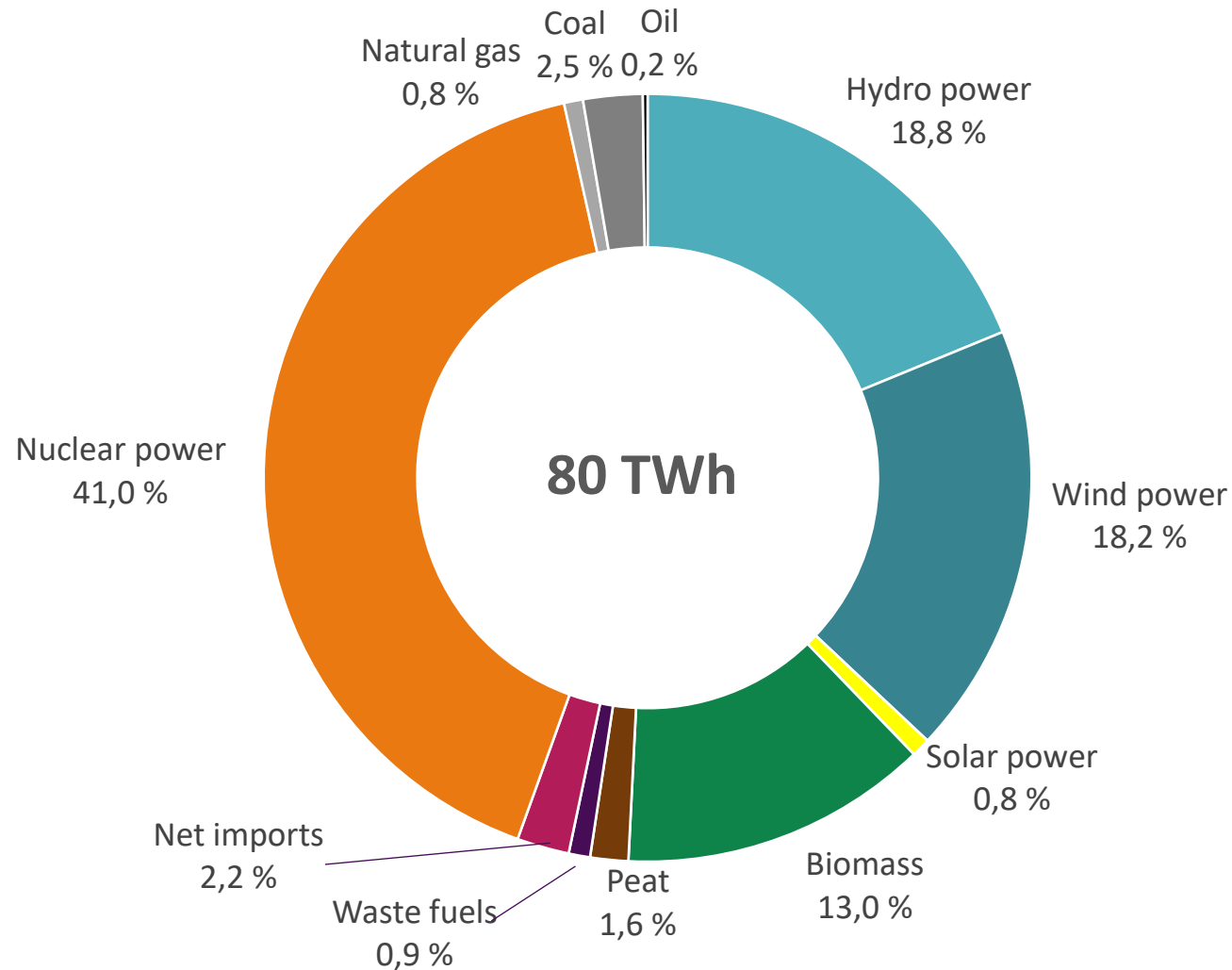
Energy transition in consumption: electrification and hydrogen economy

- Industry
- Transport
- Heating

**What have we achieved and  
where are we now?**

---

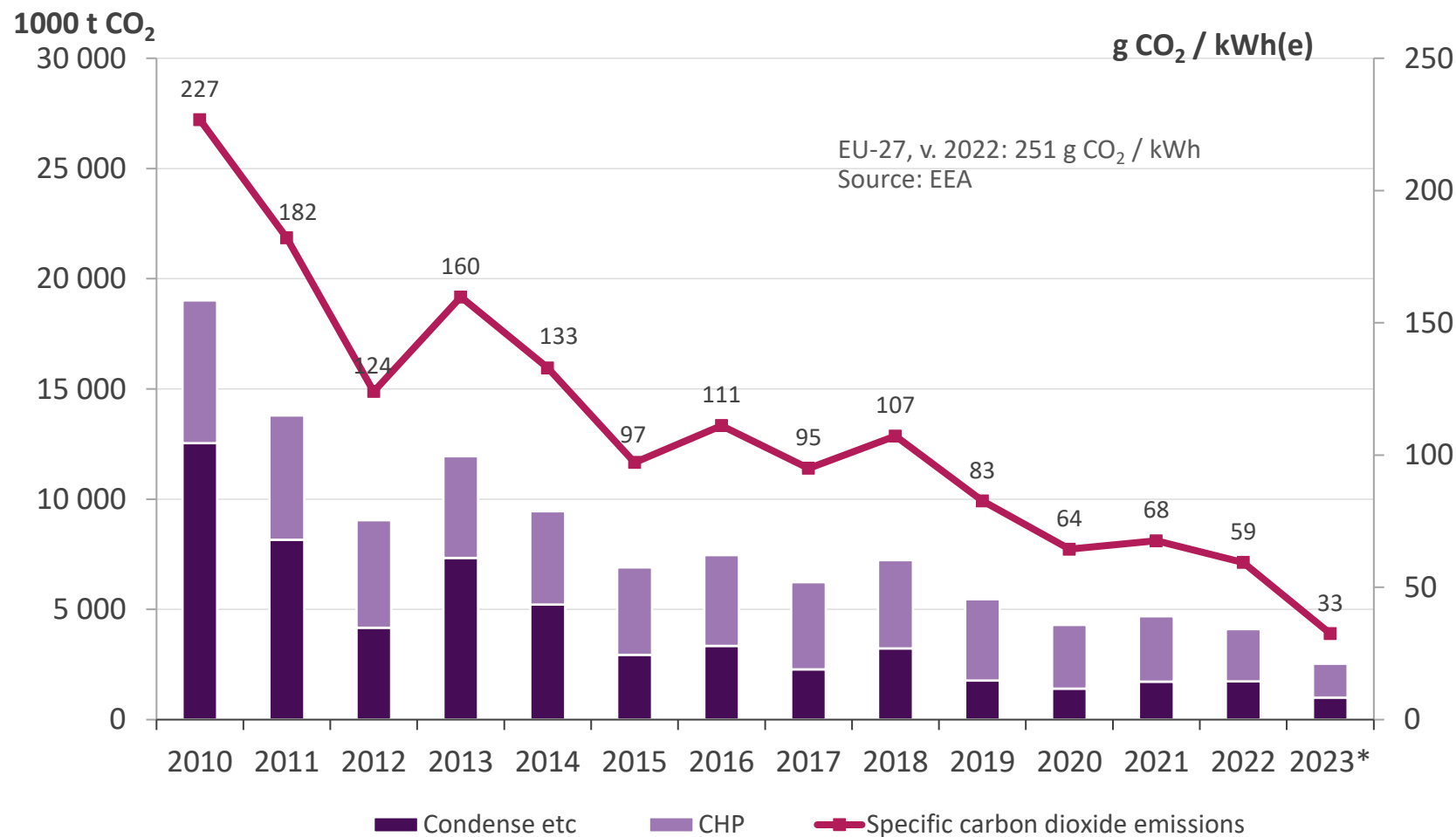
# Electricity by energy source and net imports 2023



## Power generation in 2023:

- Carbon neutral: 94 %
- Renewables: 52 %
- CO<sub>2</sub>-emissions: 33 g/kWh<sub>e</sub>  
(EU average around 220 g/kWh)
  - -87 % since 2010
- Finland used to be the EU's biggest importer of electricity but has now mostly replaced the net imports.

# CO<sub>2</sub>-emissions of power generation -87 % since 2010



CO<sub>2</sub>-emissions of power generation:

- 2.5 Mt in year 2023
- 4.1 Mt in year 2022
- 7.5 Mt in year 2016
- 19 Mt in year 2010

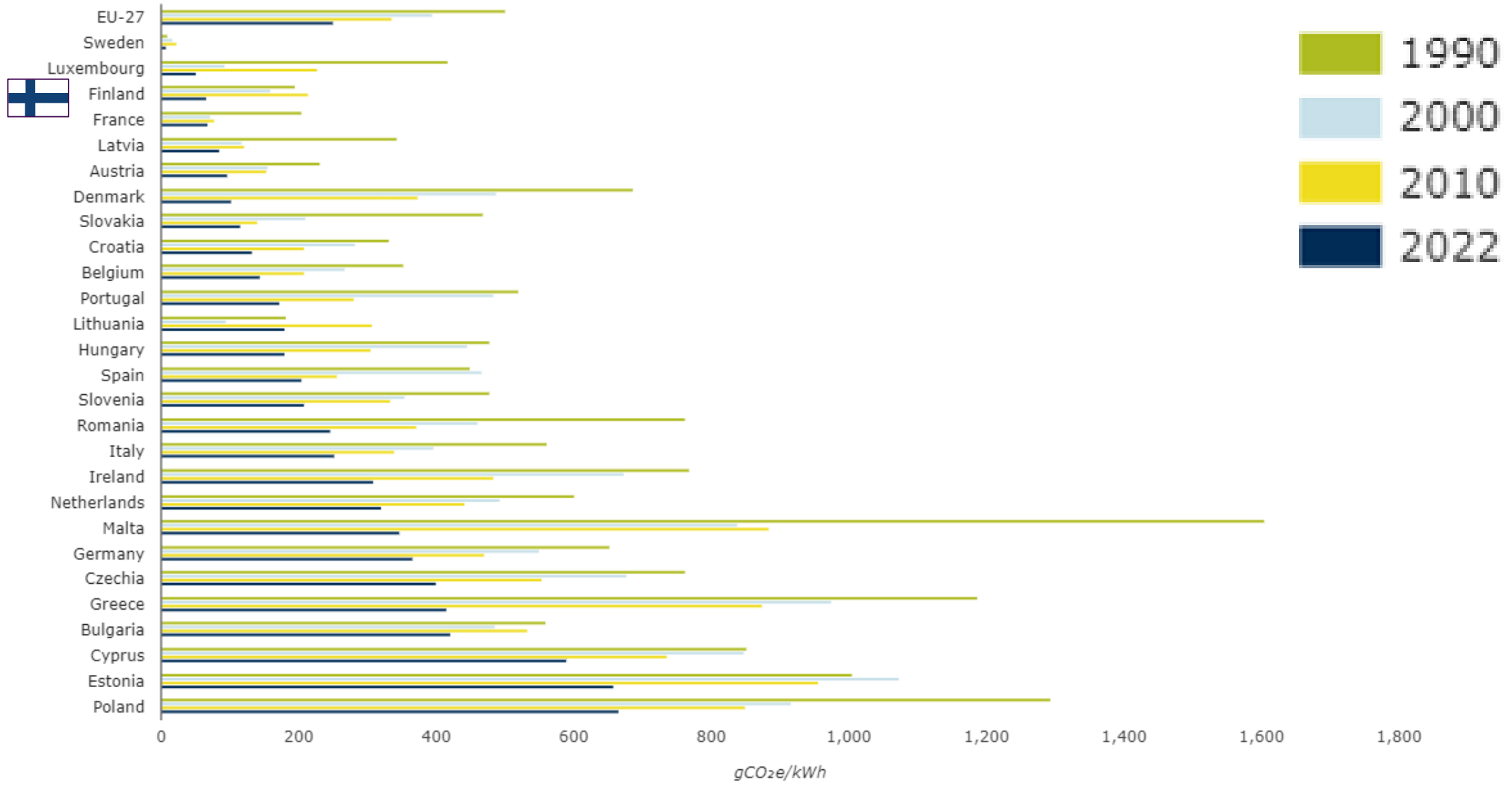
→ 2023 vs. 2022 **-38 %**

→ Emissions **-65 %** in last 5 years

→ Emissions **-87 %** vs 2010

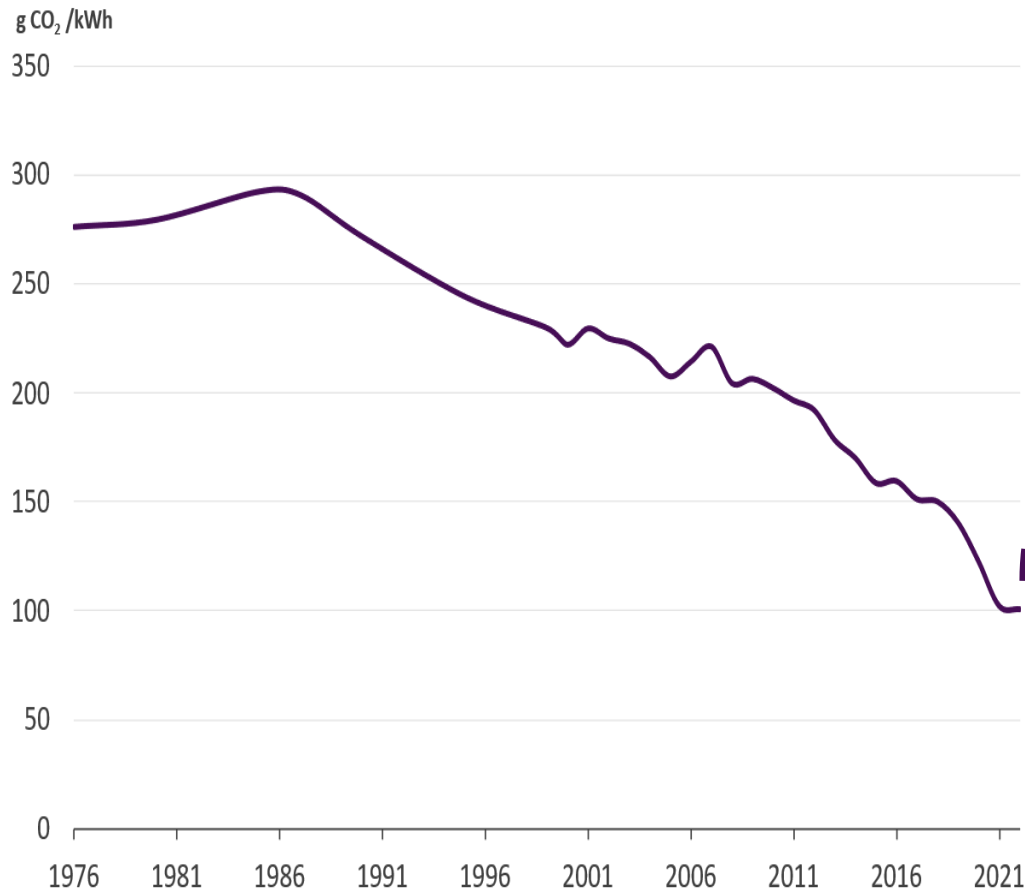


# Power generation emissions in EU countries (gCO<sub>2</sub>/kWh)

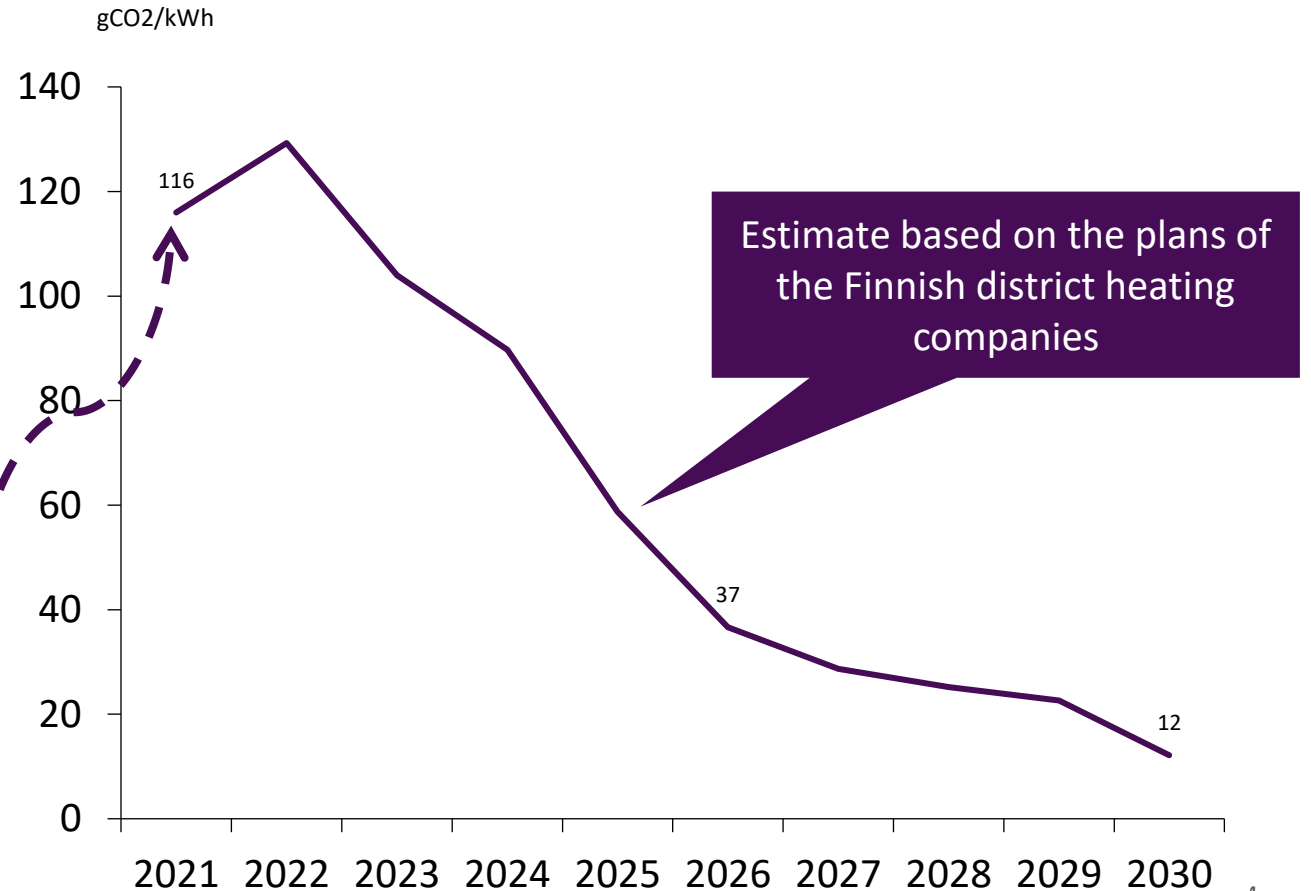


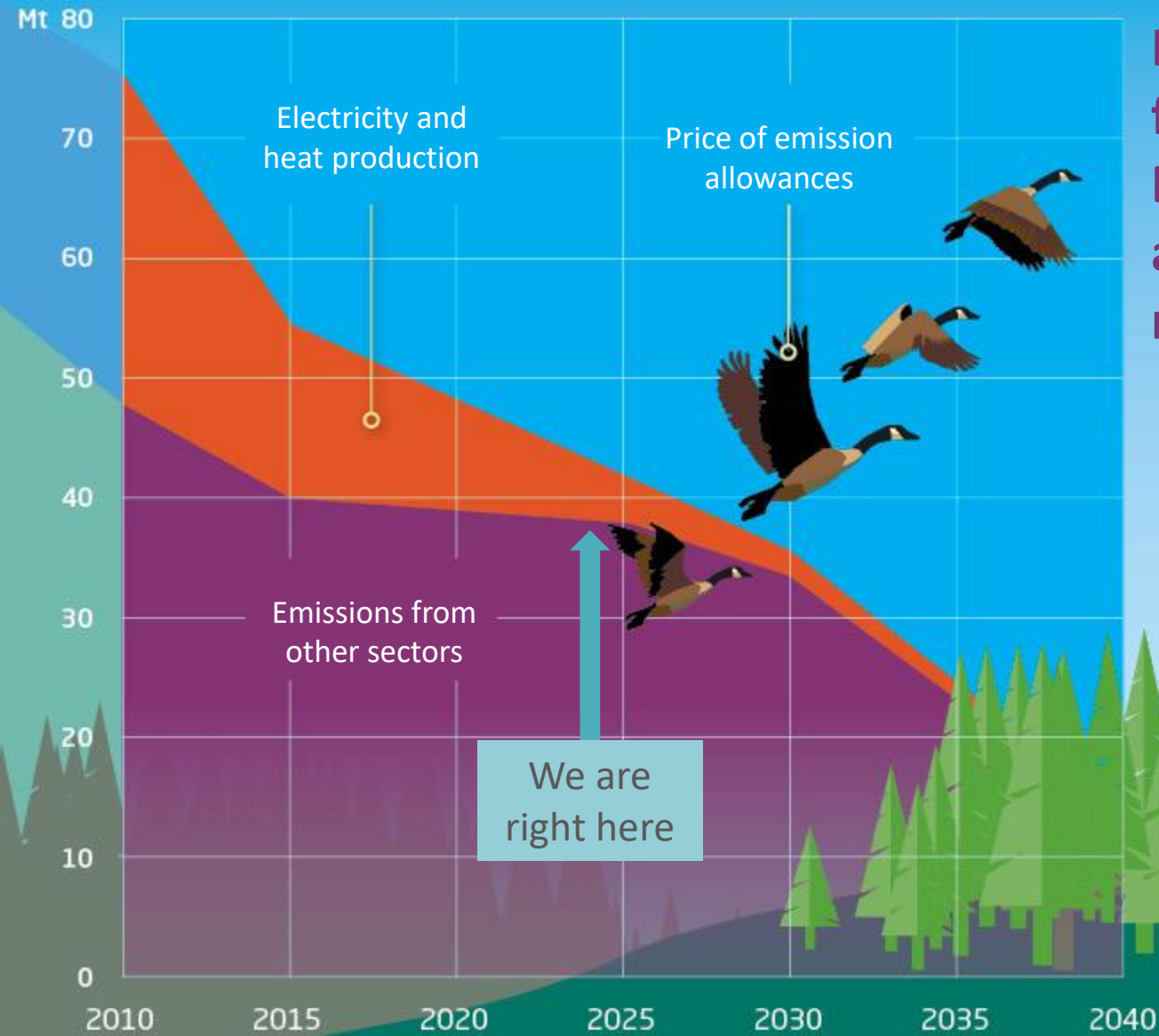
# Emissions of **district heating** in Finland have also dropped and will likely be phased out by 2030

## History of district heating emissions



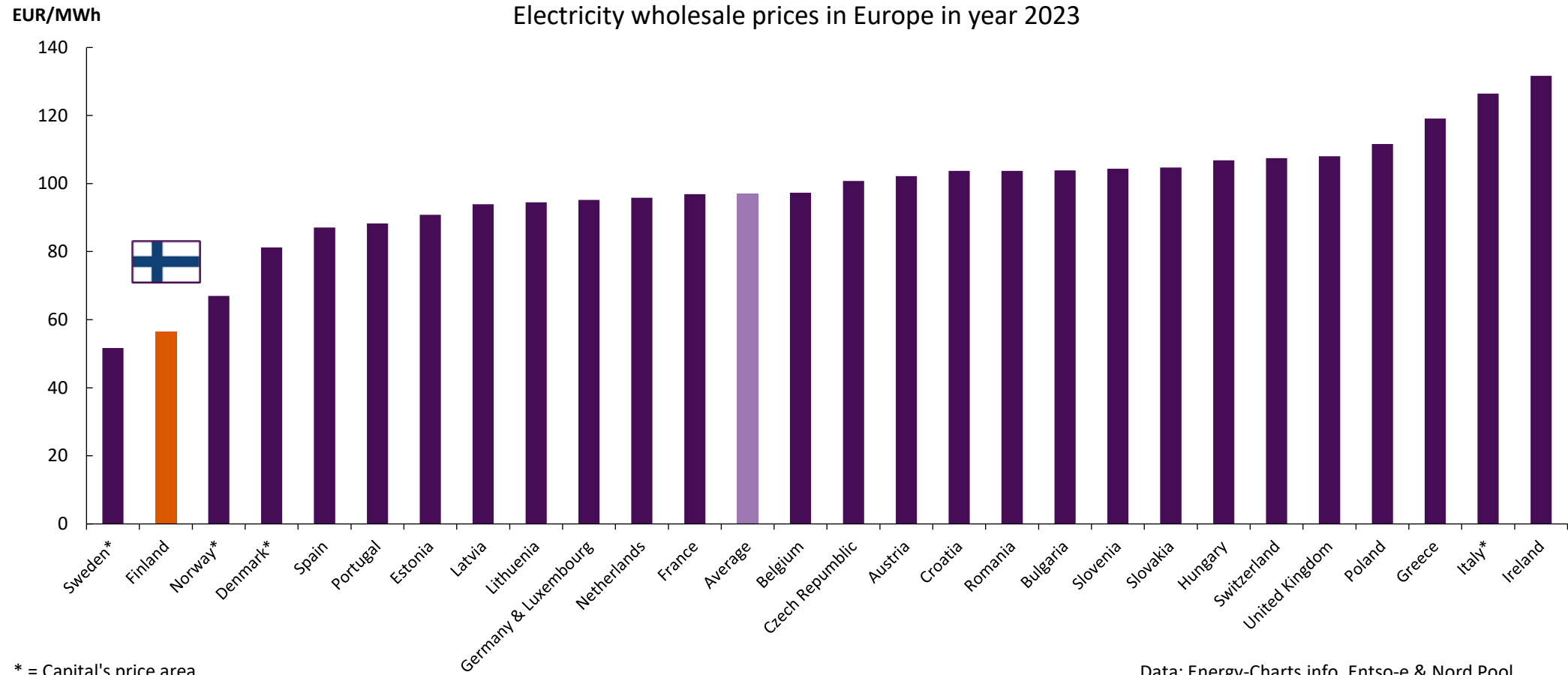
## **Future** of district heating emissions





**Emissions from electricity and heat are falling rapidly**  
**Decarbonisation of transport, industry and agriculture necessary to climate neutrality**

# Countries with lowest emission have the lowest power prices



# Opportunities ahead

---



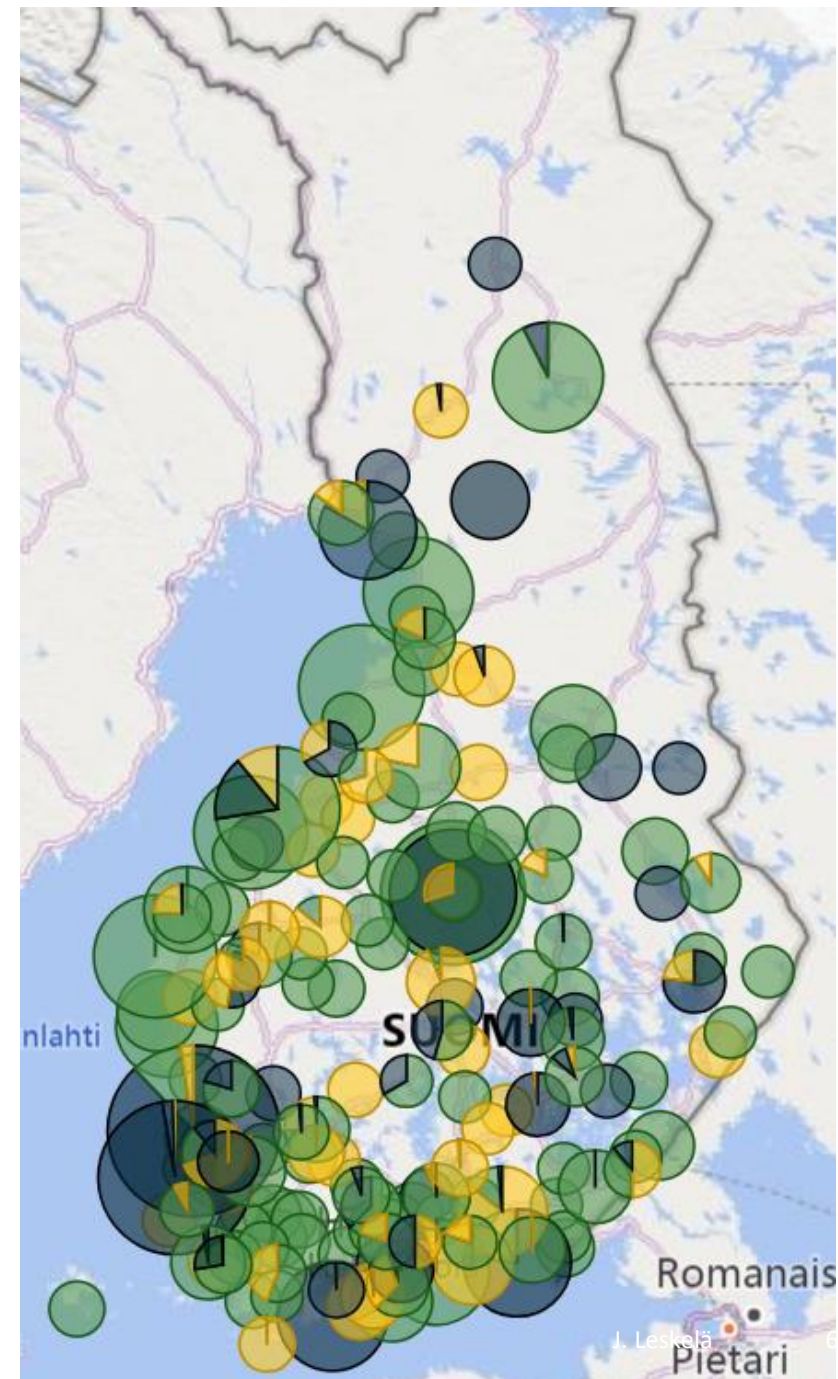
# Opportunities to multiply carbon neutral power capacity

- Huge amount of wind and solar power projects
  - On-shore wind projects under development alone could double or triple Finnish power generation
  - Multiple off-shore wind power projects
  - Industrial scale solar power emerging, tens of GWs in pipeline
- Nuclear power outlook very good
  - "Old" NPPs lifetime extensions agreed, Olkiluoto 3 on production
  - High public and political support to nuclear
  - Large interest on small modular reactors by energy companies and industrial users



# Huge interest for industrial investments based on clean electricity and hydrogen

- There are investment plans for more than 260 billion euros in clean energy, hydrogen and carbon neutral industry in Finland alone.
  - Confederation of Finnish Industries keeps up a data dashboard
    - <https://ek.fi/en/current/news/the-data-dashboard-tracks-finlands-green-investments/>
- This development is business-driven
  - Technology, customers, financiers,...



# Why hydrogen and what is this for Finnish economy?

---







# A Persistent Performer or European Champion of the Energy Transition

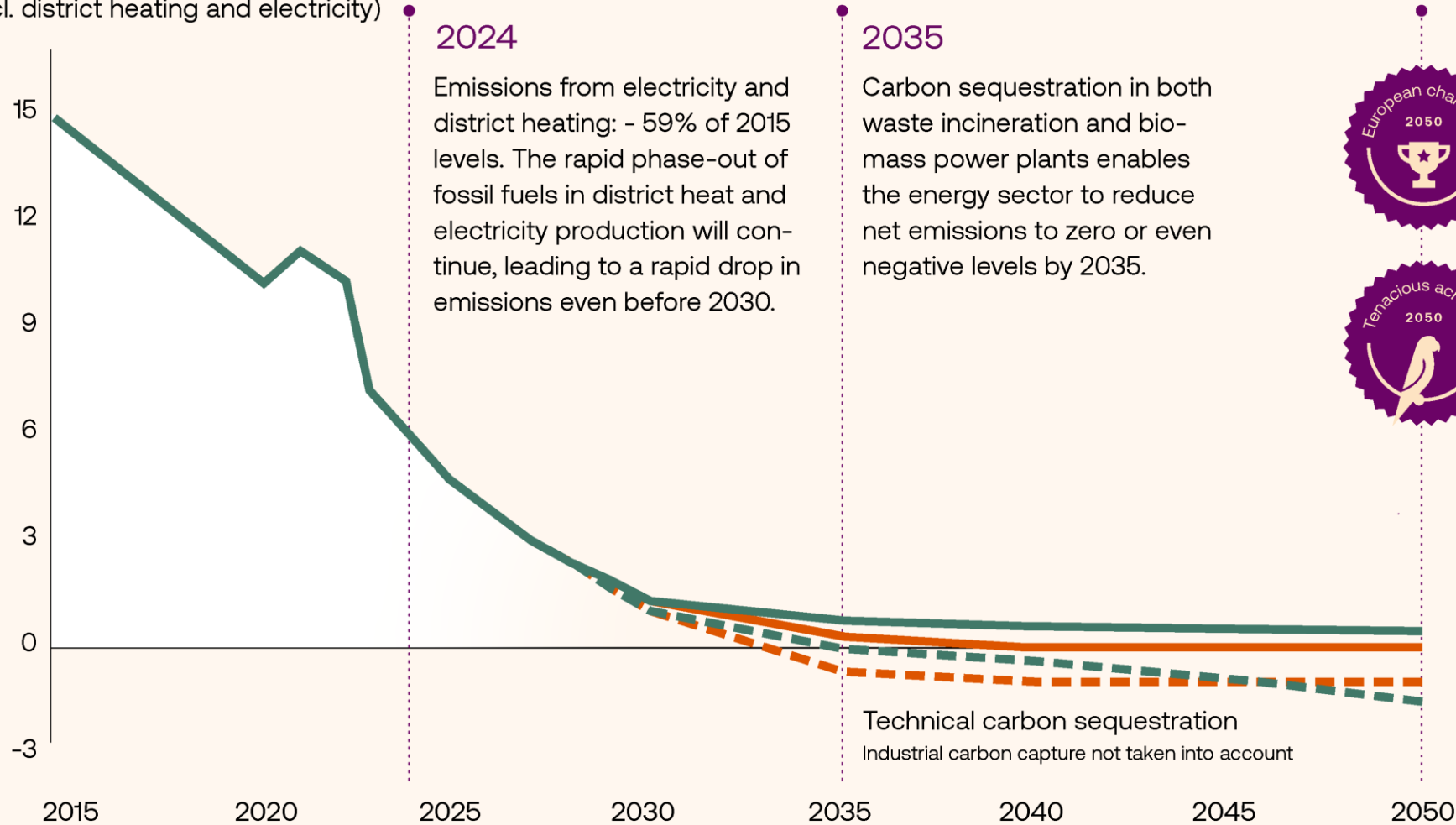
A vision for the energy future  
of a successful Finland



Energiateollisuus

# Emissions fall below zero

Emissions, MtCO<sub>2</sub>  
(incl. district heating and electricity)



2024

Emissions from electricity and district heating: - 59% of 2015 levels. The rapid phase-out of fossil fuels in district heat and electricity production will continue, leading to a rapid drop in emissions even before 2030.

2035

Carbon sequestration in both waste incineration and biomass power plants enables the energy sector to reduce net emissions to zero or even negative levels by 2035.

2050

1 million tonnes of negative emissions and 0 gross emissions.

— Gross emissions  
- - Net emissions



2 million tonnes of negative emissions and gross emissions of 0.4 tonnes.\*

— Gross emissions  
- - Net emissions

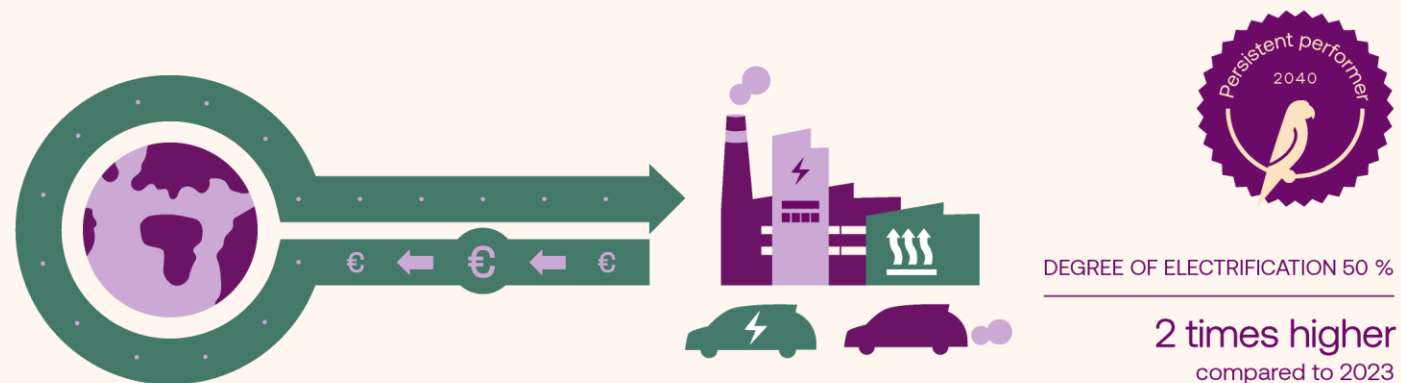
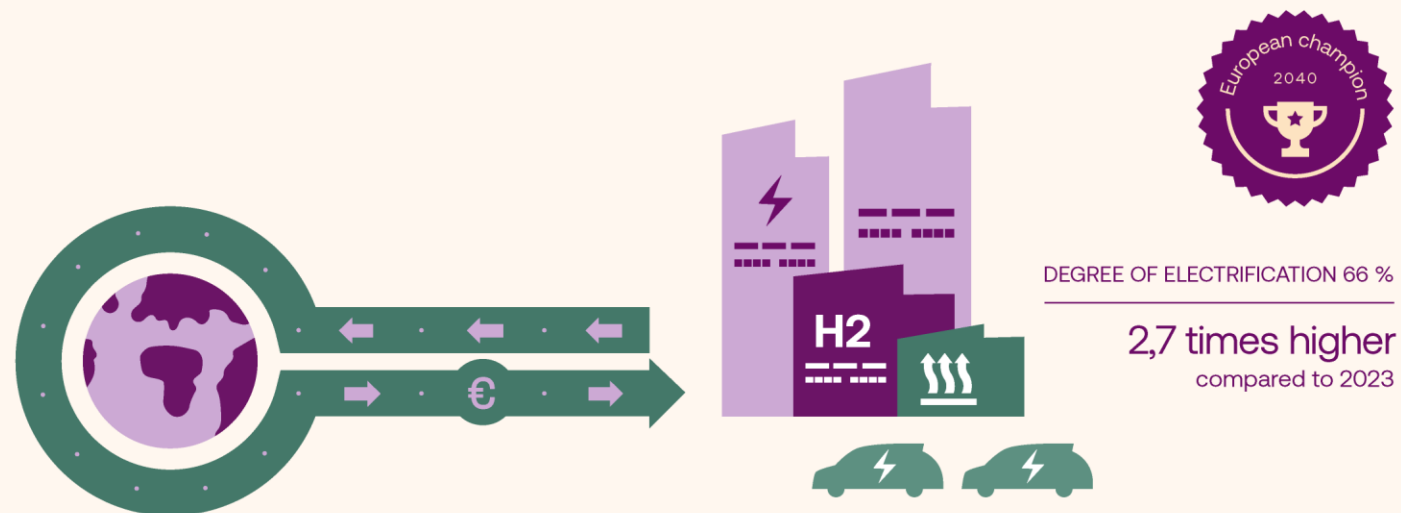
\*In this scenario, biomass is needed for combined heat and power production allowing slightly higher carbon capture in 2050.

Technical carbon sequestration  
Industrial carbon capture not taken into account

# Growing Industrial Exports

By 2040, Finland's economy will be driven by industries and services based on clean electricity, hydrogen, and captured carbon dioxide. Their development is based on reliable and competitive energy.

Hydrogen produced with clean electricity will be used to clean up industry and as a raw material for synthetic fuels. The data economy with its data centres uses a lot of clean electricity. The electrified economy will be in full swing, and the heat generated as a by-product of industry and services keeps our homes warm without emissions.





## In 2040, the European champion of the energy transition will pave the way to prosperity

Finland is the best country in Europe for energy-intensive industries and produces high-value-added products for the European and global markets.

Hydrogen produced with clean electricity is used in the export industry, which has increased in Finland. The largest use of hydrogen is as a raw material in the chemical and metal industries. Hydrogen is also used to produce clean fuels for transportation and industrial needs.

The energy sector can directly and indirectly employ 100,000 people, with the energy-utilising industries employing significantly more. The energy trade balance has turned positive.

Finland is heated using byproduct heat, heat pumps, small nuclear power, and affordable electricity. Over two million electric cars cover more than 80 percent of the driven kilometers. Household energy bills are reasonable in relation to the well-developed purchasing power.



## In 2040, the tenacious achiever has met its obligations

Finland has managed to retain part of its energy-intensive industry by electrifying its processes and improving energy efficiency. Fossil hydrogen has been replaced with hydrogen produced using clean electricity in its traditional applications, such as the production of liquid fuels and nitrogen fertilisers.

Products of the new, clean economy are imported from Sweden, Central Europe, the United States, and China. The energy sector can directly and indirectly employ 60,000 people.

Finland is heated not only with heat pumps and electricity with variable pricing but also with wood fuels. Over one million electric cars cover more than 50 percent of the driven kilometers. Some households mitigate energy costs by actively managing their energy use. Households have adapted their energy consumption to rising and fluctuating fuel prices.

40 bn €



Potential contribution of the energy economy to the national economy

10 bn €



Potential contribution of the energy economy to the national economy

# The energy future needs its makers

What makes up the European championship team of the energy transition?

At least installers, product developers, digital experts, technical salespeople, customer service representatives, nuclear physicists, and interdisciplinary specialists.

They continuously develop and implement solutions that benefit society, energy users, and the environment. Particularly valuable skills for building a bright energy future include:



Learning skills, interaction and problem solving



Cybersecurity



Project management



Science and mathematics



Customer service and sales



Environmental responsibility and sustainable development



Digitalisation and data analytics

100 000  
people



Potential employment impact  
of energy economy

60 000  
people



Potential employment impact  
of energy economy

# Hydrogen economy requires more electricity

Hydrogen is used to produce fuels for applications where switching directly to electricity is not viable. Climate-neutral fuels are obtained by combining hydrogen with captured biogenic carbon.

The flexibility of hydrogen production and storage smooths out electricity price fluctuations. Hydrogen is also used in international energy trade.

In the scenario of a persistent performer, the conditions for strong growth in the hydrogen economy have not been realised in Europe, and the majority of Europe's hydrogen needs are met through imports. Even here, hydrogen produced with clean electricity replaces some of the industry's hydrogen demand, and new production of synthetic fuels has emerged to a limited extent.



Finland's share of green hydrogen production in Europe

10%

it requires

100 TWh

of emission-free electricity



Finland's share of green hydrogen production in Europe

1%

it requires

10 TWh

of emission-free electricity

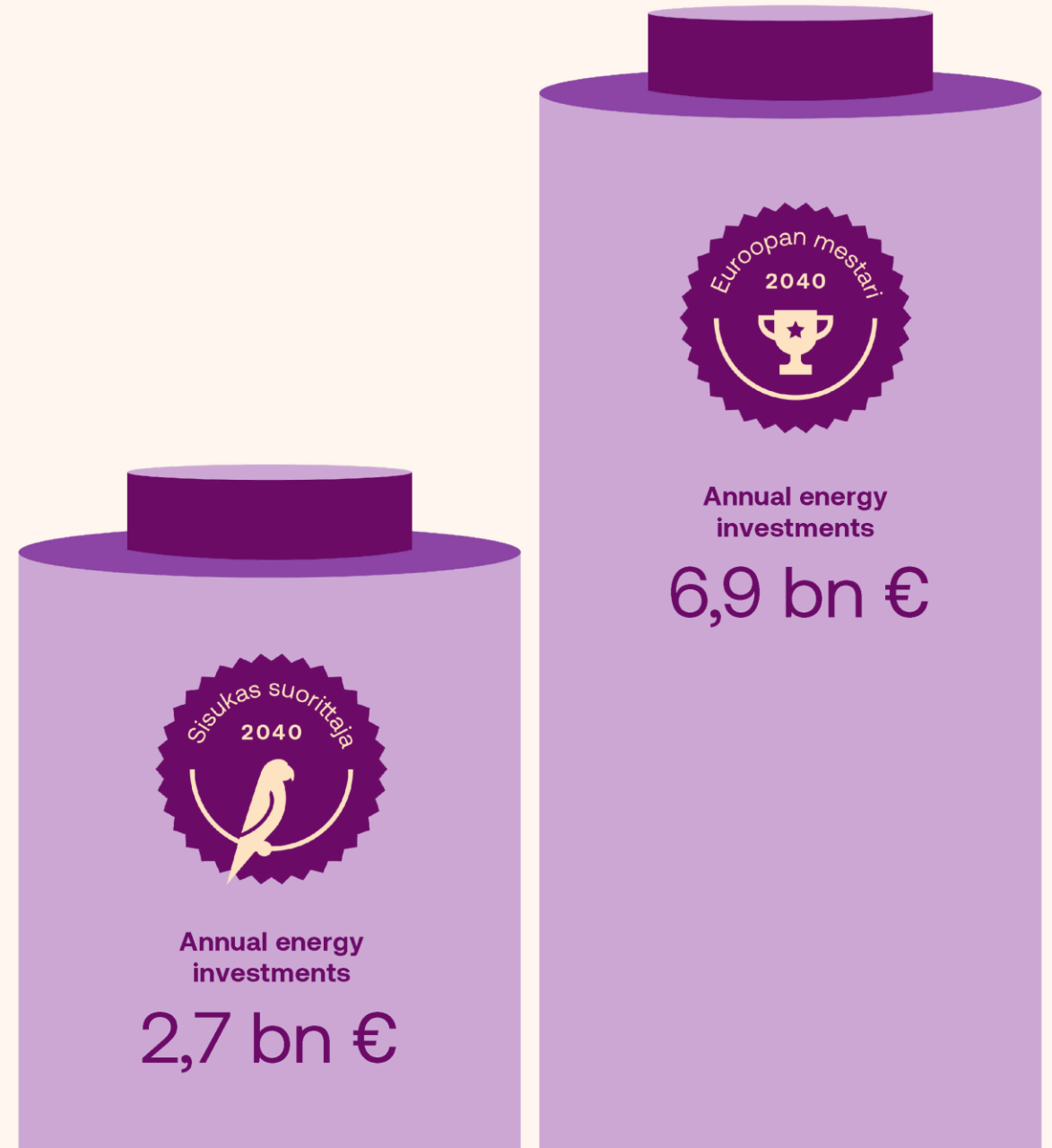
# New energy for the Finnish economy

Zero growth in the national economy and a funding crisis for the welfare state. Unfortunately, this story is familiar to everyone. The energy sector offers solutions to Finland's problems. We do this by investing in the future and inviting everyone to join in making a change.

Finnish society, energy users, and the environment will greatly benefit from being Europe's champion of the energy transition by 2040. There will be enough energy to meet the needs of an electrified society and industry while also taking care of natural capital. An advanced and clean energy system will be based on the flexible cooperation between production and consumption through strong networks.

The challenges of the 2020s have been tackled with significant investments in energy production and networks, creating favorable conditions for a new era of industry and services. A new chapter has been written in Finland's success story, securing the funding of the welfare state.

Even in a less bold vision of the future, Finland has made a demanding and tenacious performance. We have fulfilled our obligations, but we end up reading about the success stories of others.



# Five steps to European championship

Finland constantly faces challenges in its economy, security, and environment, and the world of competition isn't always fair. We need to excel in creating a favorable investment environment and leveraging our strengths. We do not succeed in a competition of state aid schemes.

We have many strengths, such as favorable wind conditions, vast land area, high expertise, reliable networks, digitalization, stable ground, and a cool climate. We cannot succeed in the energy transition alone, so we invite all parties to join forces and capitalise on our strengths.

Let's create the policy conditions for achieving excellence.





A photograph of two young women with long hair, wearing sunglasses, smiling and making peace signs. They are outdoors in a bright, sunny environment, possibly a street or a public square. The background is slightly blurred, showing buildings and a clear sky. The overall mood is positive and optimistic.

**Sustainable energy system is possible and a great opportunity**



Energiateollisuus