

Welcome to a world  
engineered by AFRY



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WELCOME TO

# AFRY Management Consulting Breakfast seminar on Energy

20 JUNE 2023



BREAKFAST SEMINAR

# Agenda

## 01

Breakfast and mingle

## 02

Welcome and introduction

Jenni Patronen, Head of AFRY Management Consulting Finland

## 03

Navigating the green economy boom in the Nordics

Oliver Pearce, Director, AFRY Management Consulting Finland

## 04

Will there be enough electricity for the Nordic energy transition?

Nikita Semkin, Principal AFRY Management Consulting Finland

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Energy crises and implications for cPPAs

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Robert Buchner, Manager AFRY Management Consulting Sweden

## 06

Coffee and mingle



AFRY AT A GLANCE

AFRY – A 125 yrs old international engineering, design, digital and advisory company supporting our clients to accelerate the transition towards a sustainable society

EMPLOYEES GLOBALLY

~ 19,000  
(2022)

NET SALES

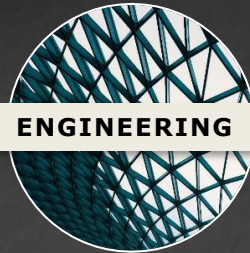
24 bn SEK  
(2022)

NUMBER OF COUNTRIES  
WITH OFFICES

> 50

NUMBER OF COUNTRIES  
WITH PROJECTS

> 100



**ENGINEERING**

- Owners/Lenders engineering
- Detail engineering
- Operational services
- Project management & execution
- Technical studies



**DESIGN**

- Architecture
- Urban planning
- Digital/UX design
- Lighting & Sound design
- Product design



**ADVISORY**

- Forward looking market analysis
- Strategic advice
- Operational excellence
- Transactions services
- Sustainability



**DIGITALISATION**

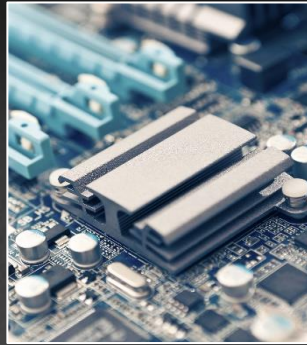
- Software engineering / development
- AI / Robotics / Drones / 5G
- System integration and management

We are organised in six different divisions covering the industry value chain in topics as infrastructure, process industry, energy and digitalisation



**INFRASTRUCTURE**

- Transportation
- Buildings
- Water
- Environment
- Architecture & Design



**INDUSTRIAL & DIGITAL SOLUTIONS**

- Advanced Automation
- Automotive R&D
- Experience Design
- Food & Pharma
- Specialised Tech Services
- Systems Management



**PROCESS INDUSTRIES**

- Pulp and Paper
- Chemicals
- Metal & Mining
- Smart Site TM & Digitalisation



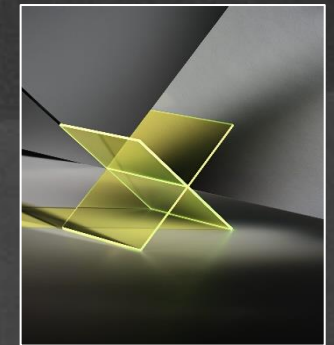
**ENERGY**

- Thermal
- Renewables
- Hydro
- T&D
- Nuclear
- Contracting



**MANAGEMENT CONSULTING**

- Energy Sector
- Bioindustry Sector
- Sustainability
- Market Analysis
- Strategic Advice
- Operational & digital transformation
- M&A and Transactions
- Capital



**AFRY X**

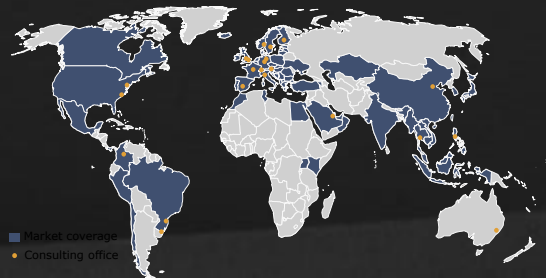
- IT and SaaS Solutions
- AI and data analytics
- Cyber security
- Digital design



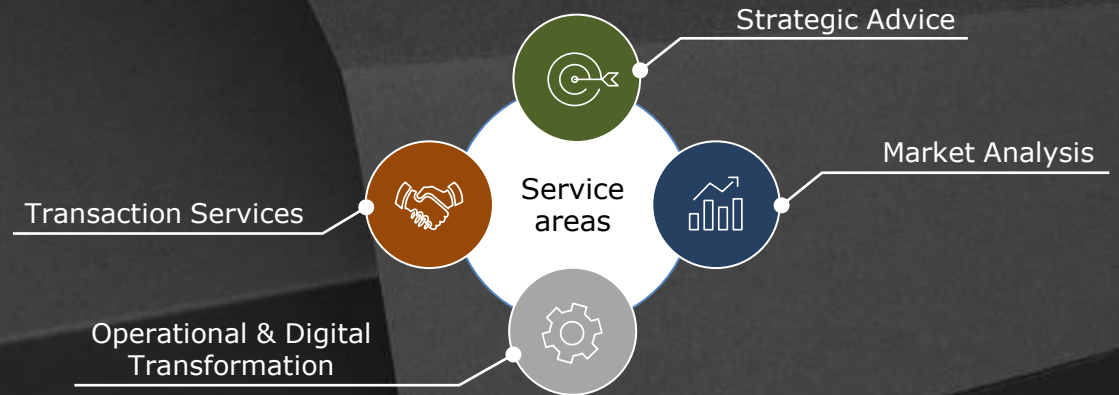
# AFRY's Management Consulting Division is a leading strategic advisor to the world's energy and bio-based industries and investment banks

## About AFRY Management Consulting

- Leading provider of strategic, market, commercial, operational, regulatory and policy advice to clients in key energy markets in Europe, the Americas, Asia and the Middle East
- Our analytical capability allows us to provide quantitative and qualitative advice with a wide range of services across the energy value chain
- We have modelled and made projections of the whole European power system for our clients over two decades, with unparalleled software development and a network of country experts
- Approx. annual revenue: >90 mnEUR
- Approx. 650 management consultants of which more than 430 are focused on the energy sector (of which 80+ work in the Nordics)
- Senior Experts with >30 yrs of work experience in the team
- Specialists located across 17 offices in 3 continents



## Service areas and industries



Energy



Bio-Industry



Capital



Sustainability



BREAKFAST SEMINAR

# Key topics for this morning

## 01

How much and how fast is electricity demand growing?

## 02

How will we meet the growing electricity demand?

## 03

What role will PPAs play in the green transition?





# New Government Programme highlights clean transition and climate handprint

“AFFORDABLE, CLEAN AND RELIABLE ELECTRICITY FOR FINNS AND THEIR WORKPLACES”

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- Finland committed to Climate Change Act – 2035 climate neutrality target
- Finland to double clean electricity production to attract clean industries. Clean economic growth at home and exporting technologies to reduce emissions globally
- Competitive advantage through smooth permitting process, RDI funding and energy transmission infrastructure
- Availability of biogenic CO2 identified as a competitive advantage, hydrogen economy development and fuel and product development based on clean hydrogen
- Demand response and smart grid solutions to decrease the electricity bills



# New Government Programme highlights clean transition and climate handprint

“EFFECTIVE AND SUSTAINABLE MEANS TO PROCEED TOWARDS CARBON NEUTRALITY”

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- Security of supply, affordable energy, climate impact and biodiversity key targets, also regionally sustainable and just development
- Supporting new investments to nuclear energy, facilitate SMR development through Nuclear Energy Act reform by 2026
- Strengthen conditions for hydro power, promoting pumped storage hydro projects
- Target to continue investments to wind power capacity, ambitious offshore wind target to be set for 2035. However additional cost burdens from capacity requirements and “fairness” requirement for wind construction projects
- Solar power as a one way to balance temporal fluctuations
- Bioenergy’s important role in phasing out fossil energy and ensuring security of supply
- Target to create cost-efficient capacity mechanism



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# Navigating the green economy boom in the Nordics

OLIVER PEARCE

# Carbon-neutrality targets and green industry in the Nordics are anticipated to lead to massive opportunities for investments in the region



## HISTORICAL CONTEXT

Relatively low and stable electricity prices

Nearly fossil free power generation

Previous investments in electrification, power production and grids basis for Nordic competitiveness



## AS IS SITUATION

Ambitious climate targets and concrete decarbonization plans

Industry taking the lead

Bottlenecks + aging grid

Lead times and conflicts of interest : current pace not sufficient

Political/regulatory uncertainties



## UPCOMING CHALLENGES

Decarbonize in time to meet climate targets

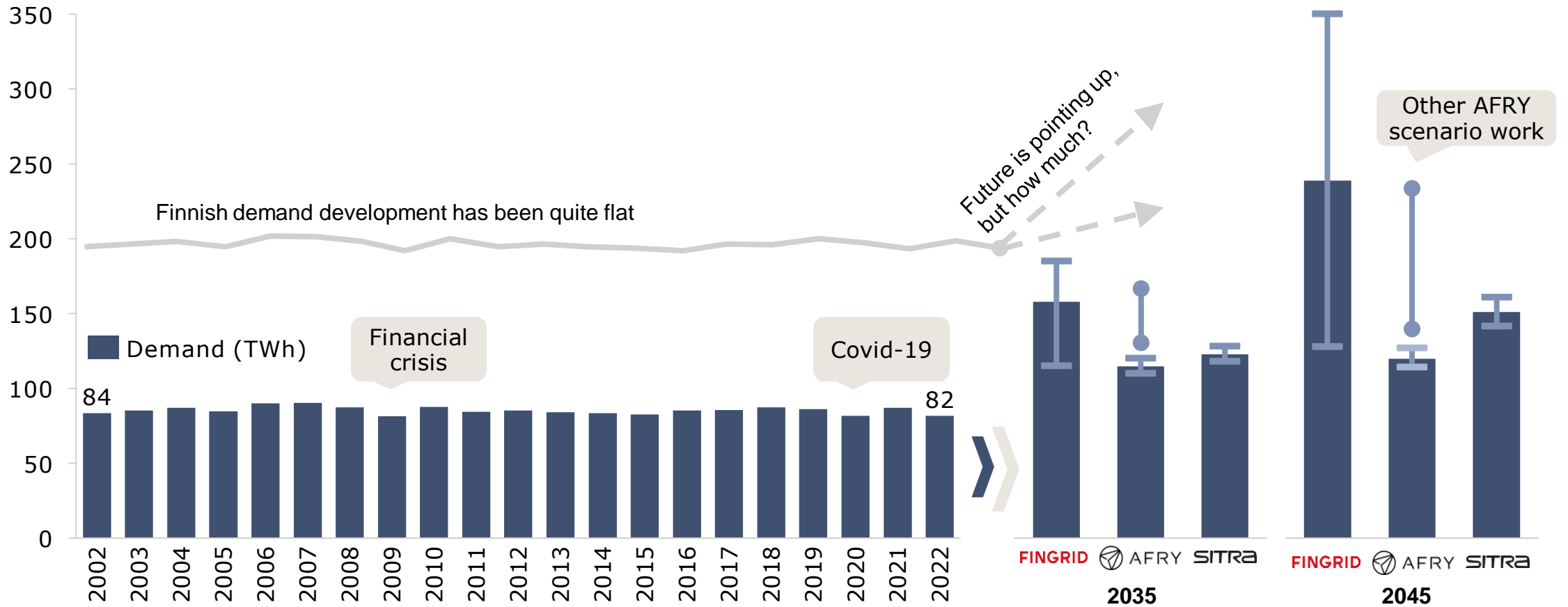
Provide access to low-cost stable renewable electricity for industry

Balance demand, production and grid while managing the interests of different stakeholders

Secure national competitiveness and economic growth



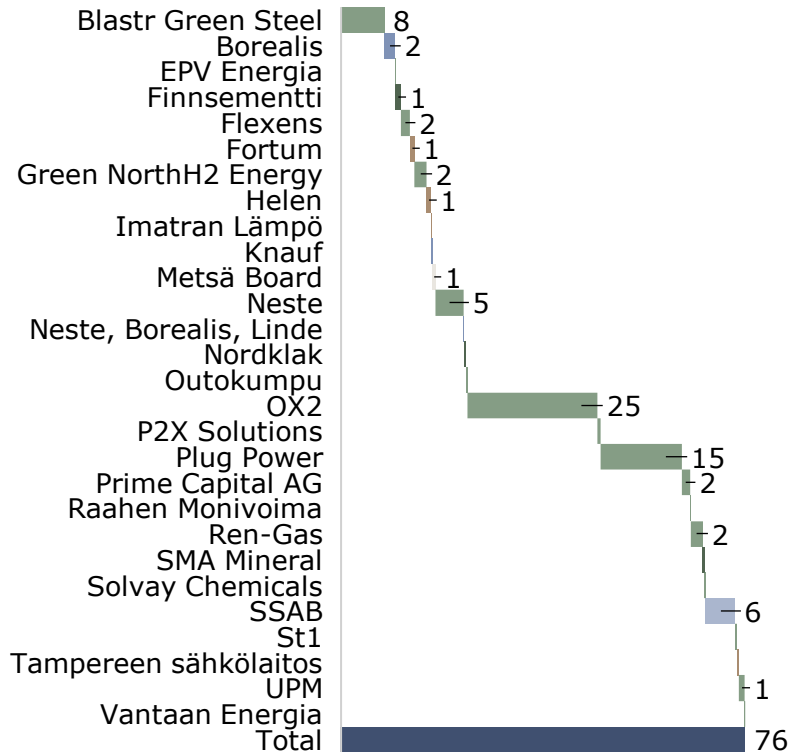
# Opportunity to electrify existing industry and attract new industry to Finland is clear - demand will grow, but by how much?



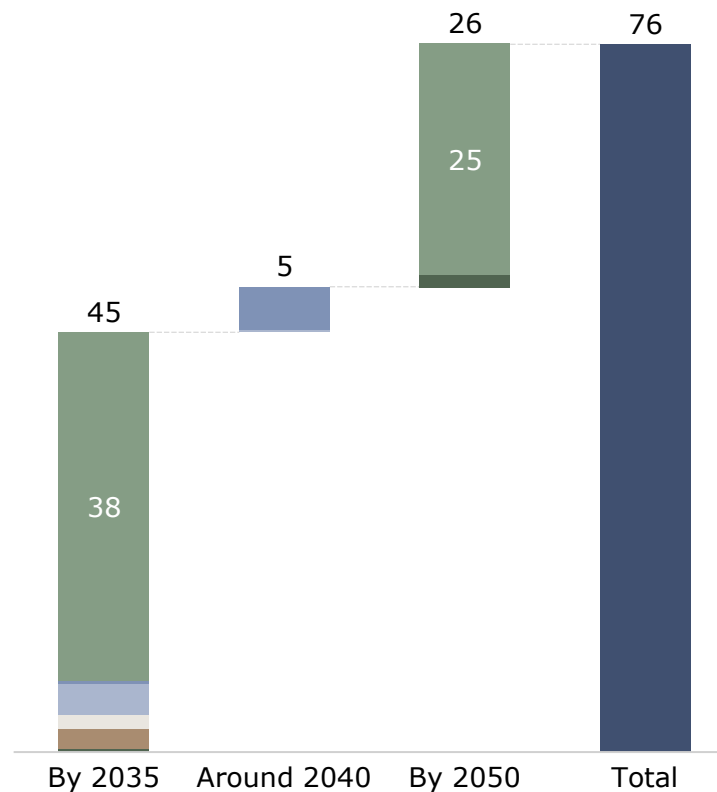
Data source: AFRY, Fingrid, Sitra

# Hydrogen, together with wider industrial electrification represents huge potential – but what will materialise?

ELECTRICITY DEMAND INCREASING PROJECTS\* (TWH)



POSSIBLE TIMELINE (TWH)



Hydrogen based | Chemical industries | Metal & mining | Pulp & paper | Heating | Other

\*High level estimates based on Confederation of Finnish Industries database  
 \*Plug Power has cumulative 3bn EUR loss since 1997

Finland has significant number of publicly announced projects

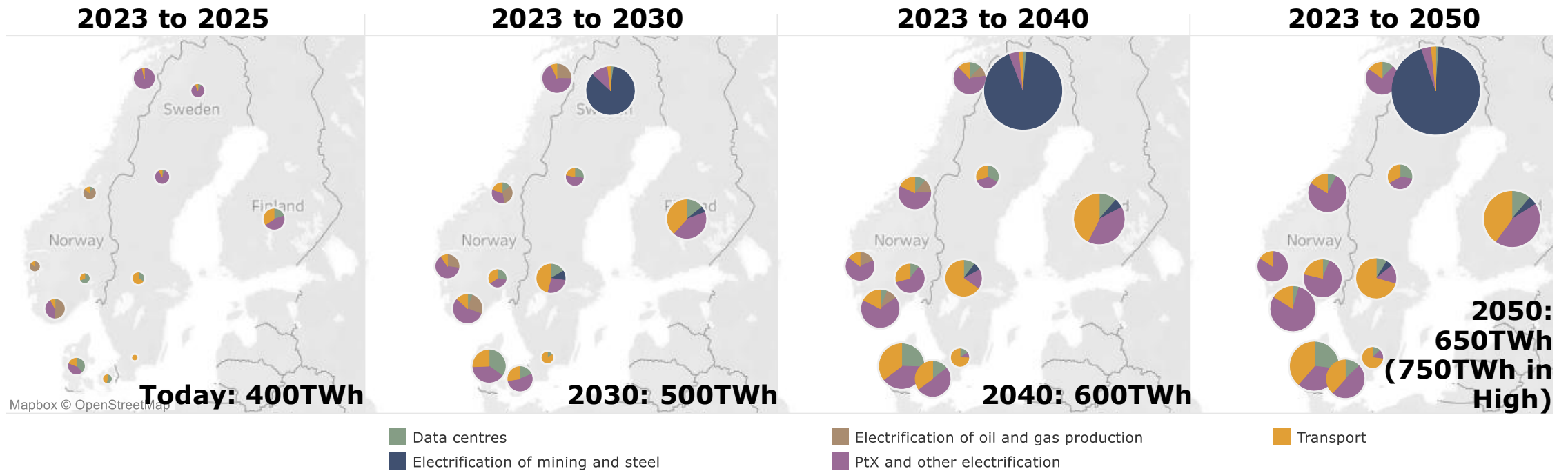
Uncertainty around how projects will materialise e.g. how to evaluate plug power?

Even with a haircut demand will increase significantly...



The same pattern across the Nordics – note that a prudent approach to demand results in significant demand growth across the region

**'NEW DEMAND' SEGMENTS, GROWTH COMPARED TO 2023, CENTRAL SCENARIO (TWH)**



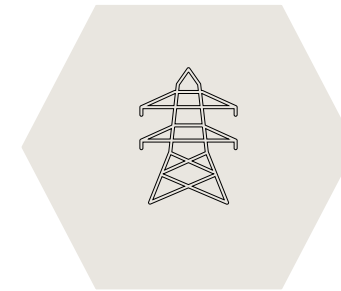
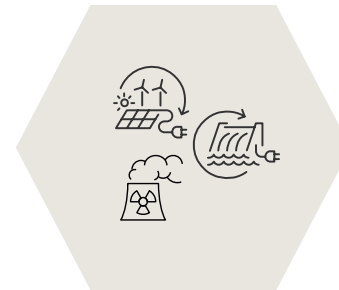
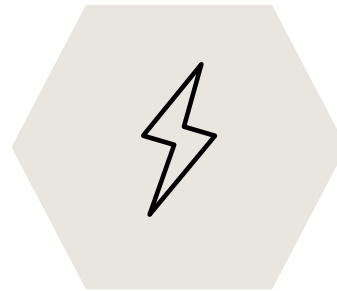
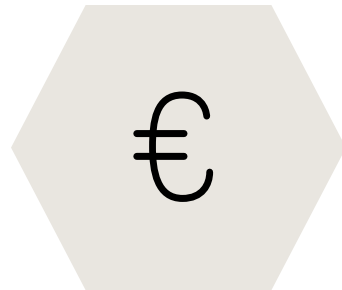
Notes: The figure only shows the Nordic demand components that are expected to see the most substantial growth in the future. 'Base' which includes residential, household, services and existing industries as well as 'heat' demand are therefore excluded from the figure. The Baltic region is omitted from this figure due to having almost of its potential within the transport sector and few demand investments planned in other 'new sectors'.

Generation mix, infrastructure development, efuel + CO2 prices are also key drivers that influence electricity and industrial competitiveness

### KEY DRIVERS IN AFRY PRICE PROJECTIONS

#### Fuel & Carbon prices

#### Generation mix



Policy & regulatory environment

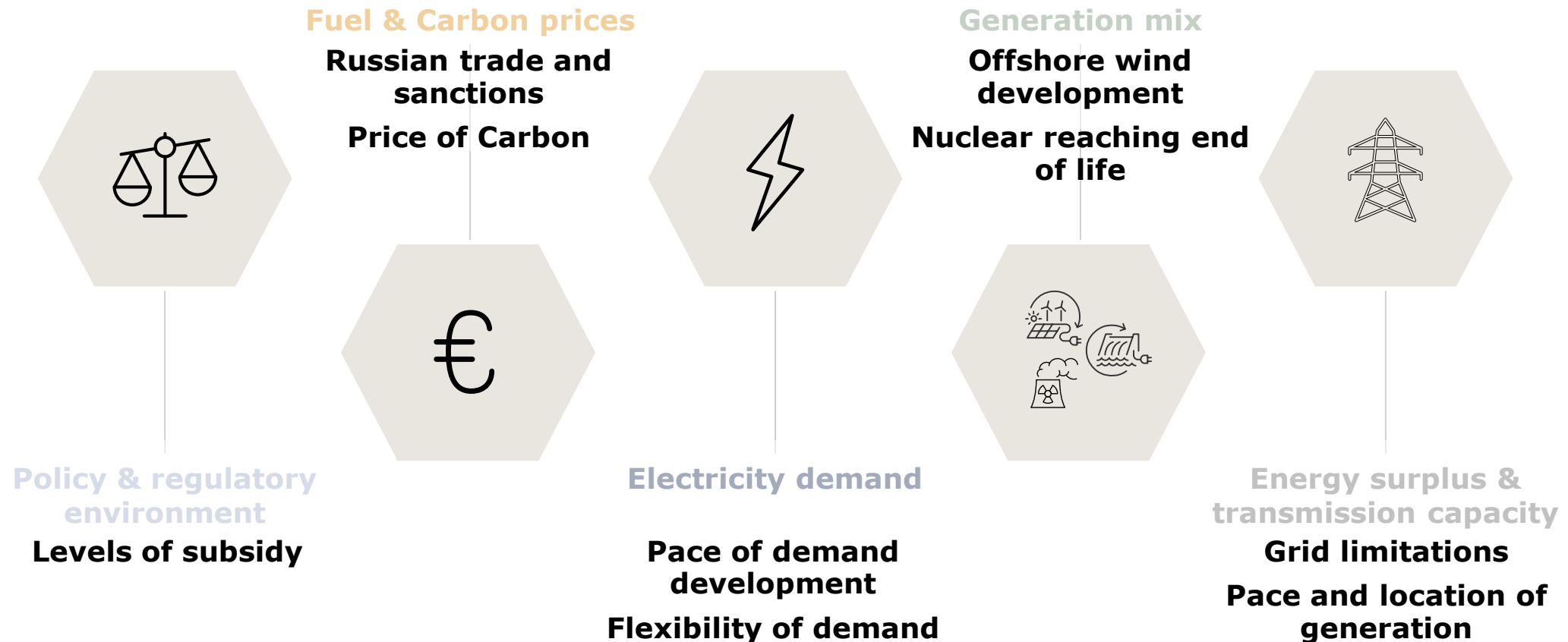
Electricity demand

Energy surplus & transmission capacity



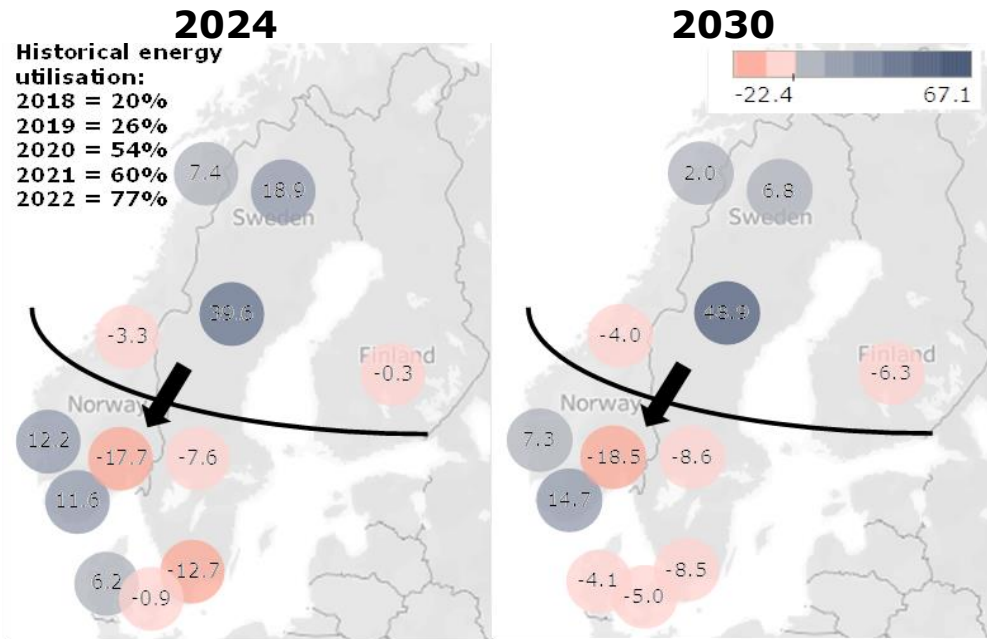
Uncertainties are present for each driver, on both the demand and generation side

### KEY UNCERTAINTIES TO DRIVERS IN AFRY PRICE PROJECTIONS



Transmission bottlenecks create a North-south split due to lead times of grid compared to wind

**ENERGY SURPLUS IN THE NORTHERN PRICE AREAS (TWH) , CENTRAL**



In a balanced long-term outlook:

- Gradual strengthening of the internal grid
- A more balanced development of new generation and demand
- Restores grid utilisation towards levels seen pre-2020
- North-South price spread closes

-> Clear need for fundamental modelling to understand area price dynamics

Sum of Northern surplus = 62 TWh  
 N-S interconnector utilisation = 85%

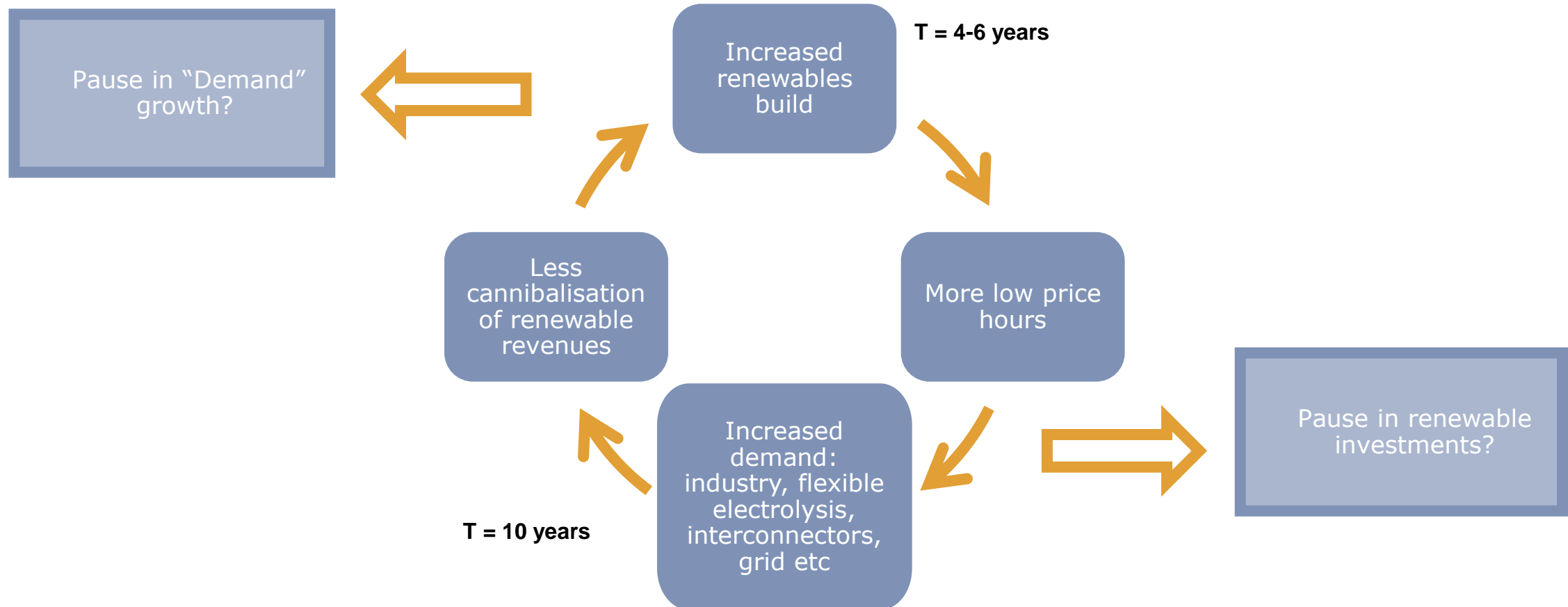
47 TWh  
 49%

Notes: The 'North-South interconnection' export capacity is defined as the sum of the interconnection capacity from NO3 to NO1, NO3 to NO5, SE2 to SE3, FIN to SE3, and FIN to EST. The utilisation rate is defined as the sum of the energy surplus (or deficit) of the northern areas (NO3-NO4-SE1-SE2-FI) divided by the potential maximum export on these connection (projected capacity presented in the exhibit and adjusted for an 80% availability). In the illustration, the Danish North Sea energy island is part of DK1 while the Bornholm energy island and Kriegers Flak is accounted for in DK2.



Growth in supply and demand forms a virtuous cycle - timing issue leads to cyclicality; providing opportunities for those that have insight/advantage

**VIRTUOUS CIRCLE OF BUILD**



# Contact details - Navigating the green economy boom in the Nordics



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+358 10 332 6078





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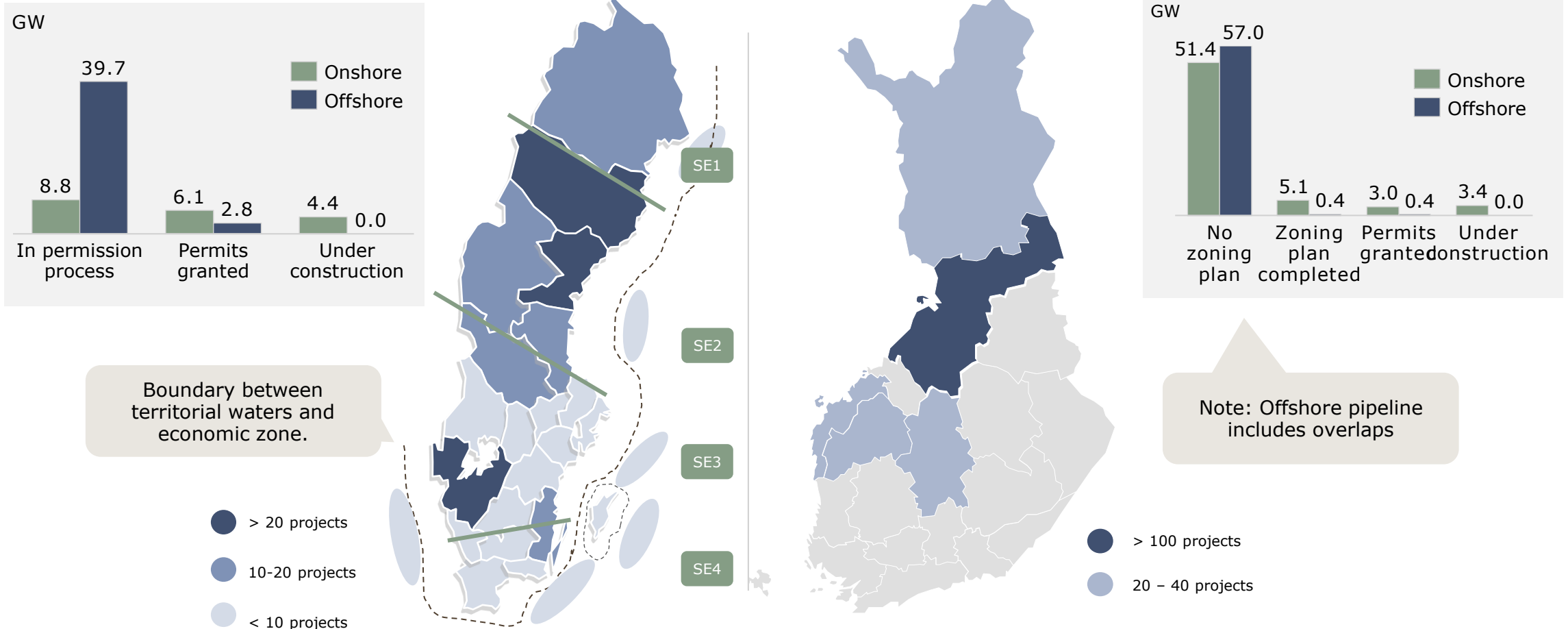


# Will there be enough electricity for the Nordic energy transition?

NIKITA SEMKIN



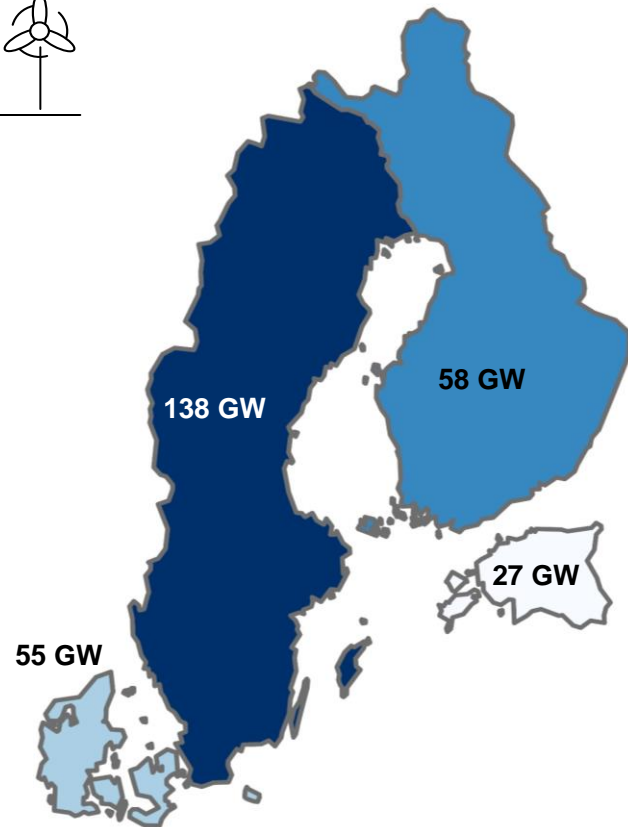
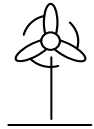
# Huge number of projects under development indicating potential and developer interest – case Sweden and Finland



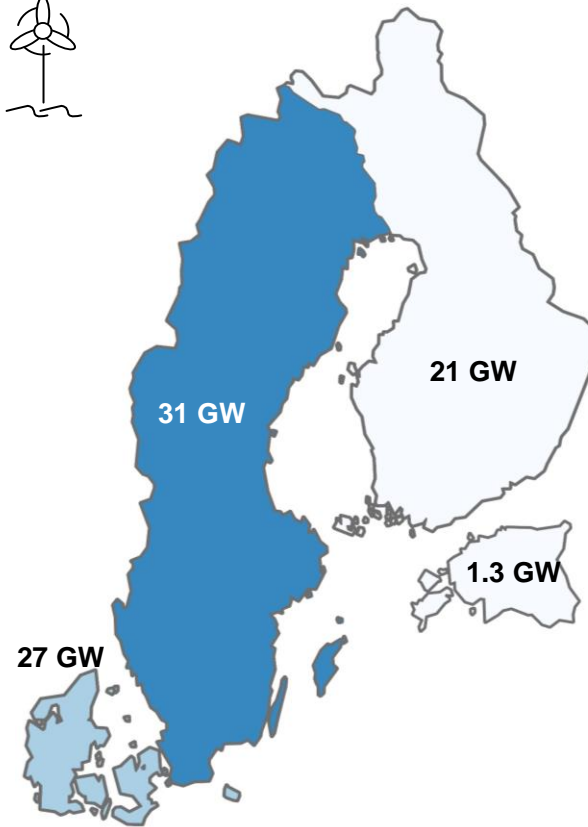
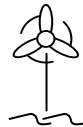
Note: Difference between Finland and Sweden caused by different statistics collection principles

# Wind deployment in the Nordics is unlikely to be constrained by techno-economical limitations

Total onshore wind potential



Total offshore wind potential



- As estimated by ENSPRESO\* (EU-28 open dataset for energy models)
- **Pipelines already higher in FI compared to "potential"**
- Real potential still higher – e.g. Fingrid (Finnish TSO) has indicated 155 GW worth of connection requests for onshore wind and another 60GW for offshore wind
- Norway has offshore target of 30 GW by 2040

\*Energy Systems Potential Renewable Energy Sources



Availability of financing also unlikely to be a constraint – Nordic wind has attracted plenty of interest from international & domestic investors

BUYERS IN RECENT NORDIC WIND PROJECT TRANSACTIONS

**ÅLANDSBANKEN**

*Luxcara*



**Allianz**



Aquila Capital

**ARDIAN**

Hana Financial Investment

exilion

octopus investments



**COMMERZ REAL**

**Lundin**   
Energy

PRIME  
CAPITAL

Renewable Power Capital



Green  
Investment  
Group

**FONTAVIS**  
clean energy infrastructure



A German  
pension fund

**Infracapital**

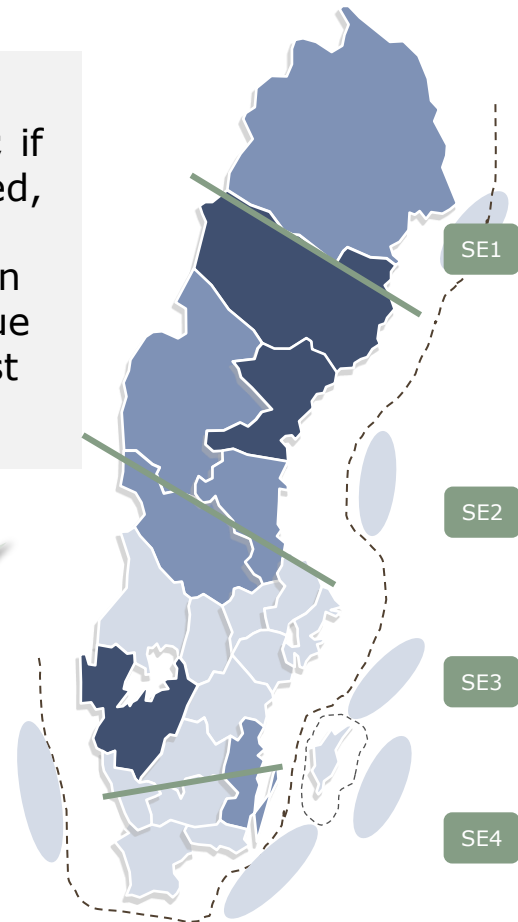
Note: List not exhaustive



# Grid congestion also becoming a significant concern for renewables development both on local and price area level

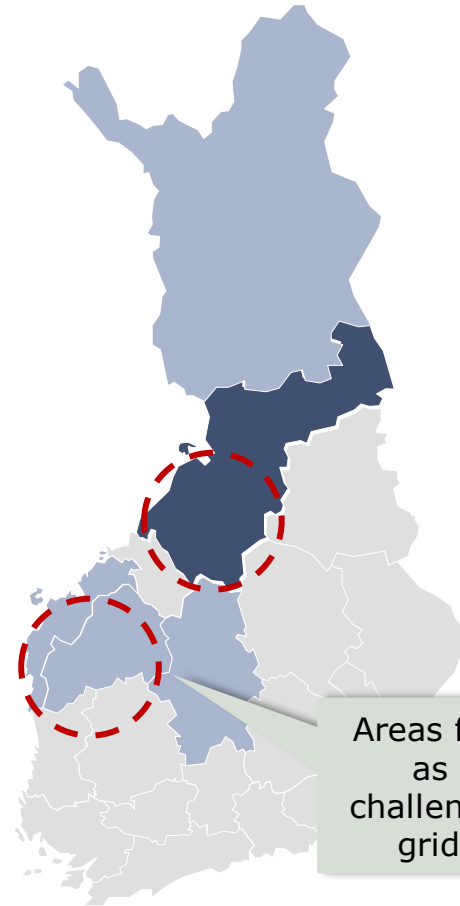
AFRY estimated impact of grid constraints in Sweden; if the situation is not improved, as much as 16 GW of new connections representing an annual socio-economic value 150 billion SEK, may be lost by 2030

Grid constraints between price zones limit full utilization of wind production potential in northern parts



10 – 20 projects in Western Finland currently being delayed because of grid constraints

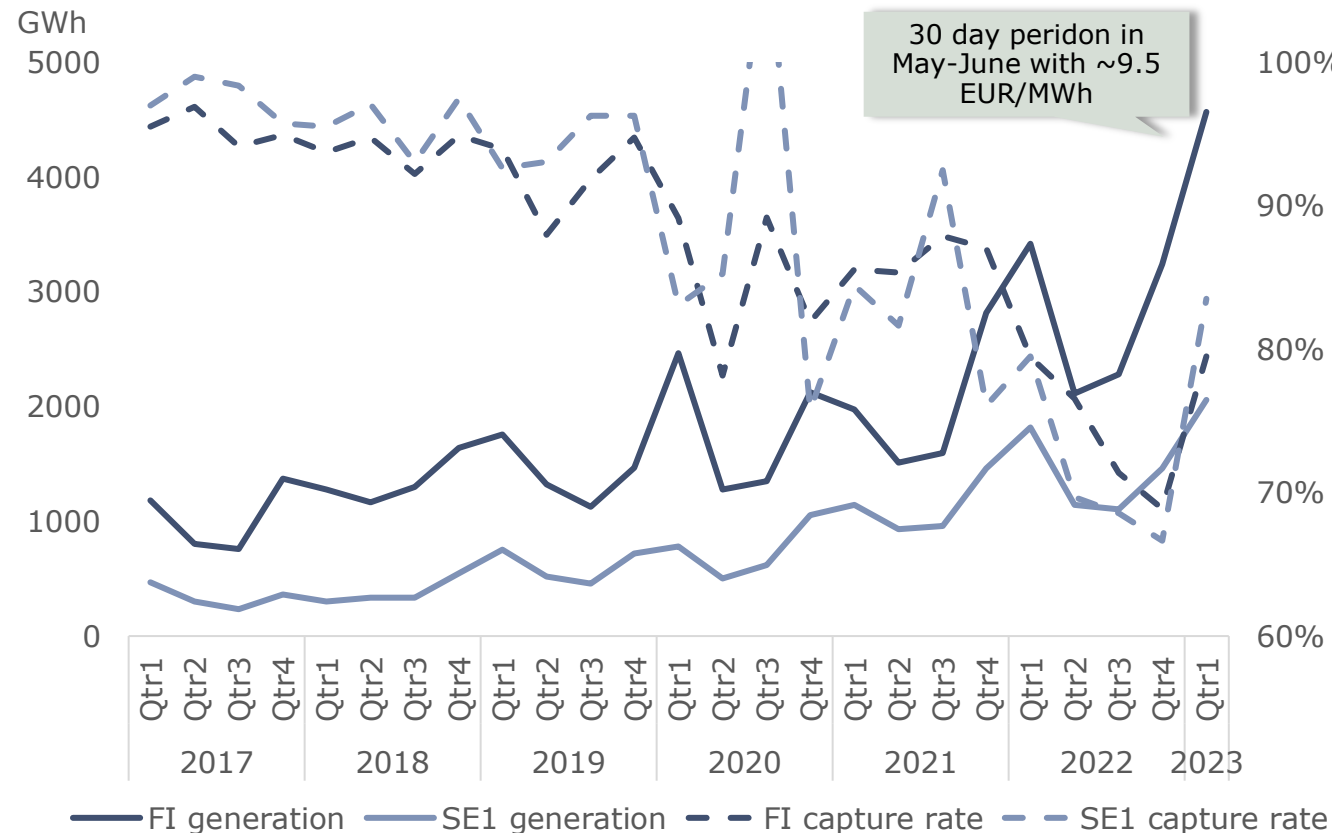
Fingrid has maintained Finland as a single price zone



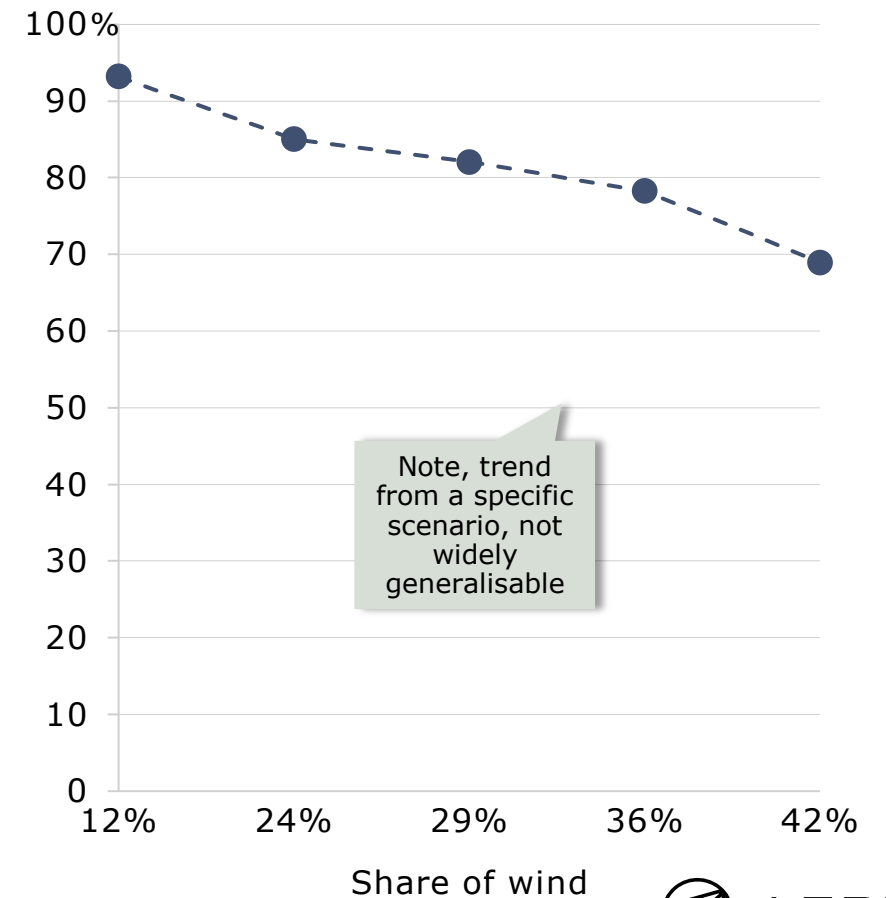
Areas flagged by TSO as particularly challenging from local grid perspective

# Wind penetration rate increase leads to its "price cannibalisation" – wind capture rate declines with increasing share of wind capacity

**WIND CAPTURE DECREASES WITH SHARE OF WIND**

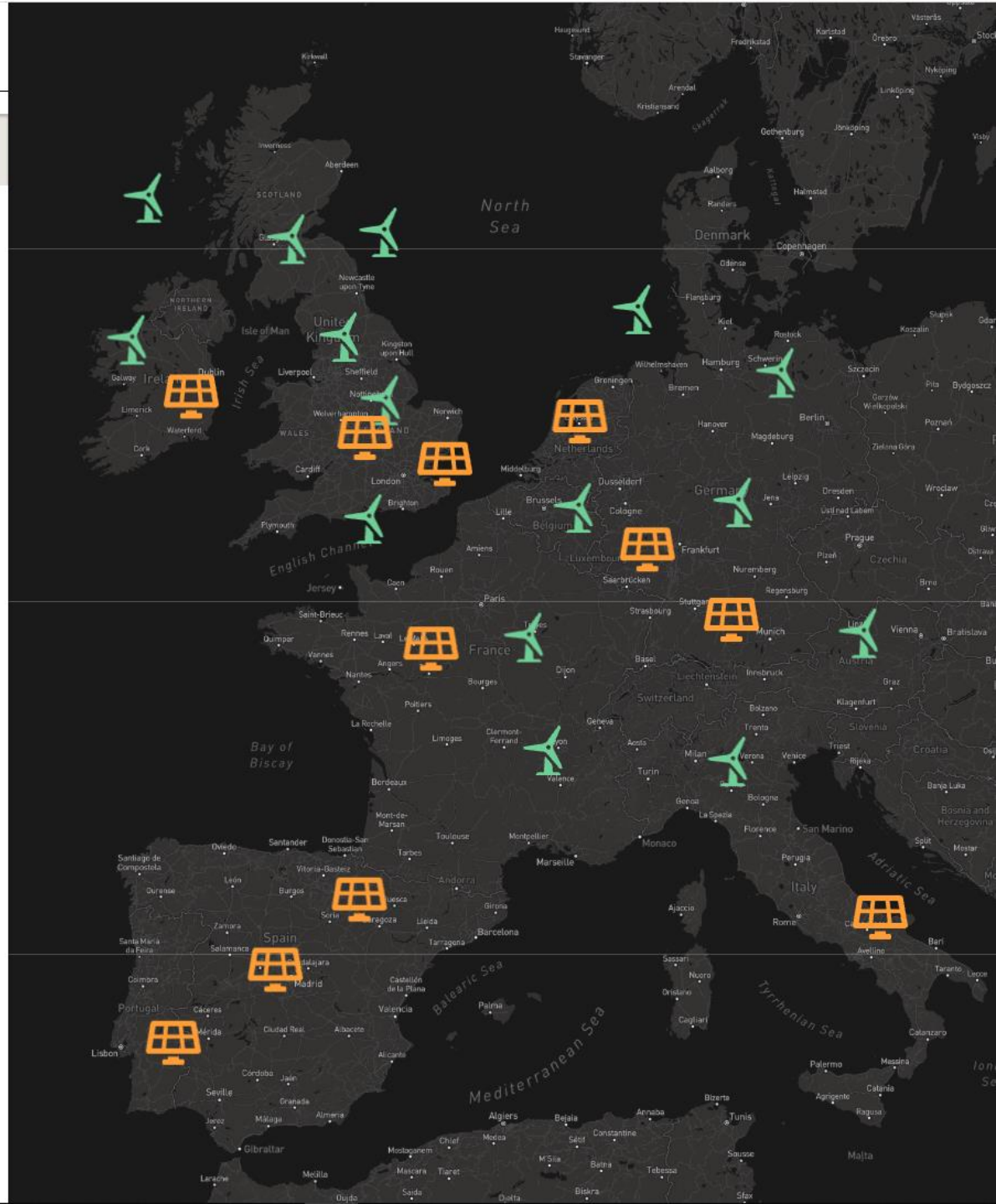


**TREND EXPECTED TO CONTINUE GOING FORWARD**



Source: AFRY, Impact of Electrification on the Finnish Power System, 2021





AFRY ANALYTICS

# AFRY Analytics *Capture* can be worth up to €10/MWh on the value of selected renewable assets

## CONTEXT

- The prices captured by single assets could largely vary from market wide projections
- These would depend on:
  - the specific locations;
  - the technical characteristics; and
  - the technical, commercial and contractual operation of such assets

## KEY QUESTIONS

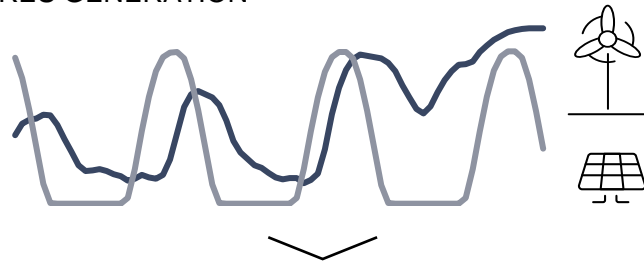
AFRY Analytics *Capture* can provide real-time answers to the following questions:

1. Which is the most profitable location for renewable assets within a market?
2. How will the different turbines and hub heights impact the wind plant revenues?
3. How a tracker solar panel perform against a fixed axis solar panel?

# Critical questions remain around integration, permitting & development timelines and social acceptance

**ABILITY TO INTEGRATE REMAINS KEY QUESTION. IN SHORT TERM TIMING BETWEEN PRODUCTION / DEMAND**

RES GENERATION



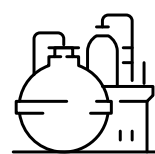
POWER SYSTEM & MARKETS



ELECTROLISYS



DEMAND



**PERMITTING AND DEVELOPMENT TIME DIFFERENCES**

**Brownfield hydrogen <5 years**

**Onshore wind 5-10 years**

**Transmission grid ~10 years**

**Offshore wind 10+ years**

**SOCIAL ACCEPTANCE IMPORTANT AS EVER**



*"Norway wind turbines should be torn down, reindeer herders say"*

Discussion related to Storheia and Roan wind projects. Norway now resuming onshore wind power licensing after 3-year break



Municipalities stopped 78% of all onshore wind project in 2021, in 2022 the figure was 73%

Proposal to adjust veto right was voted down in Riksdag



*"Municipality lives from tourism and views. General agreement has been that wind power is not wanted in Utsjoki"*

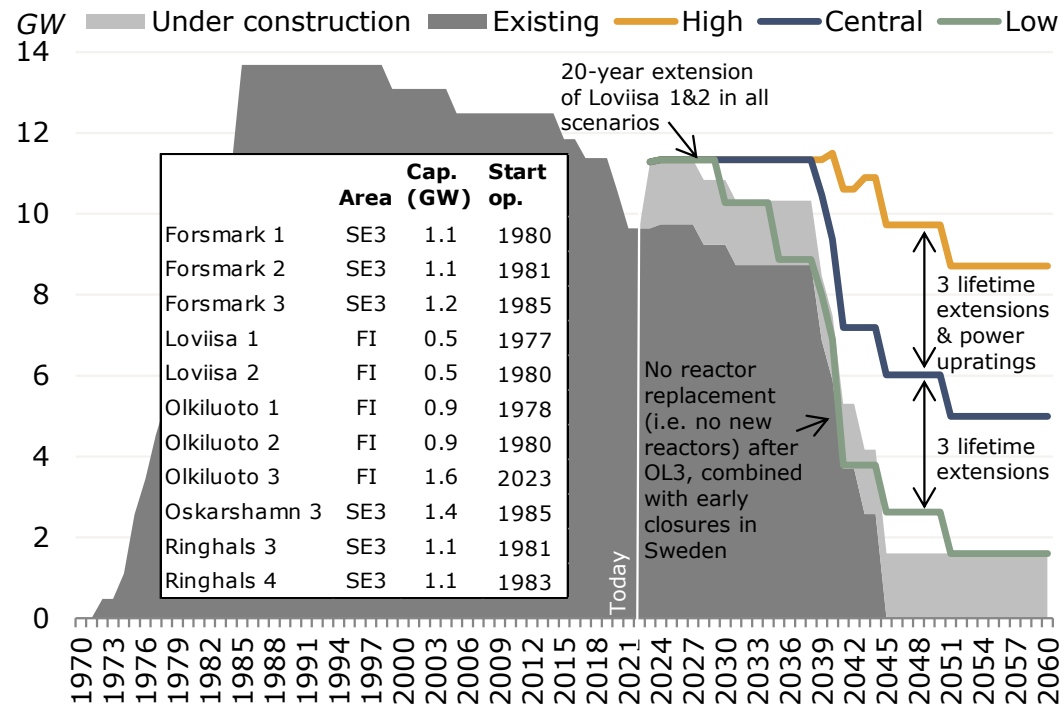
–Head of municipality, Finland



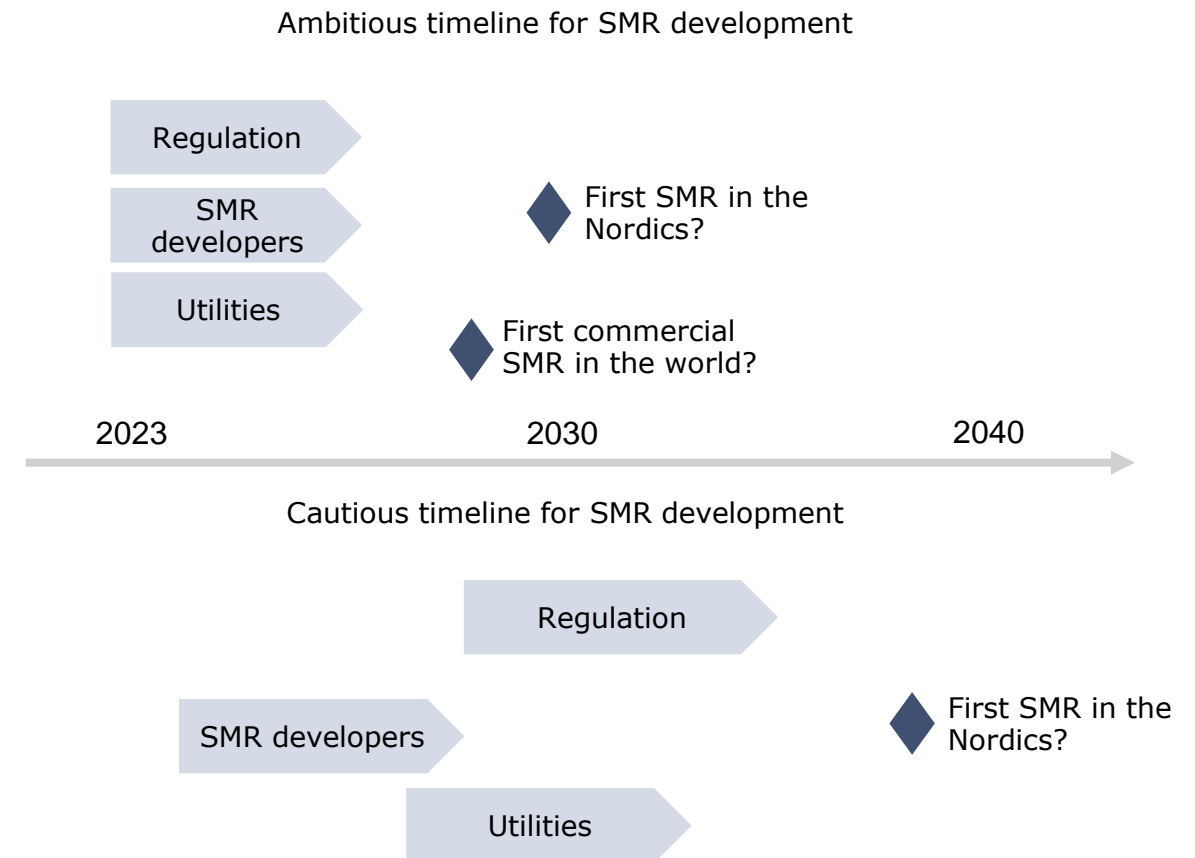


# How about nuclear capacity? Even with SMR's, new wind will be key supply source

## EXISTING NORDIC NUCLEAR CAPACITY LIKELY TO DECLINE



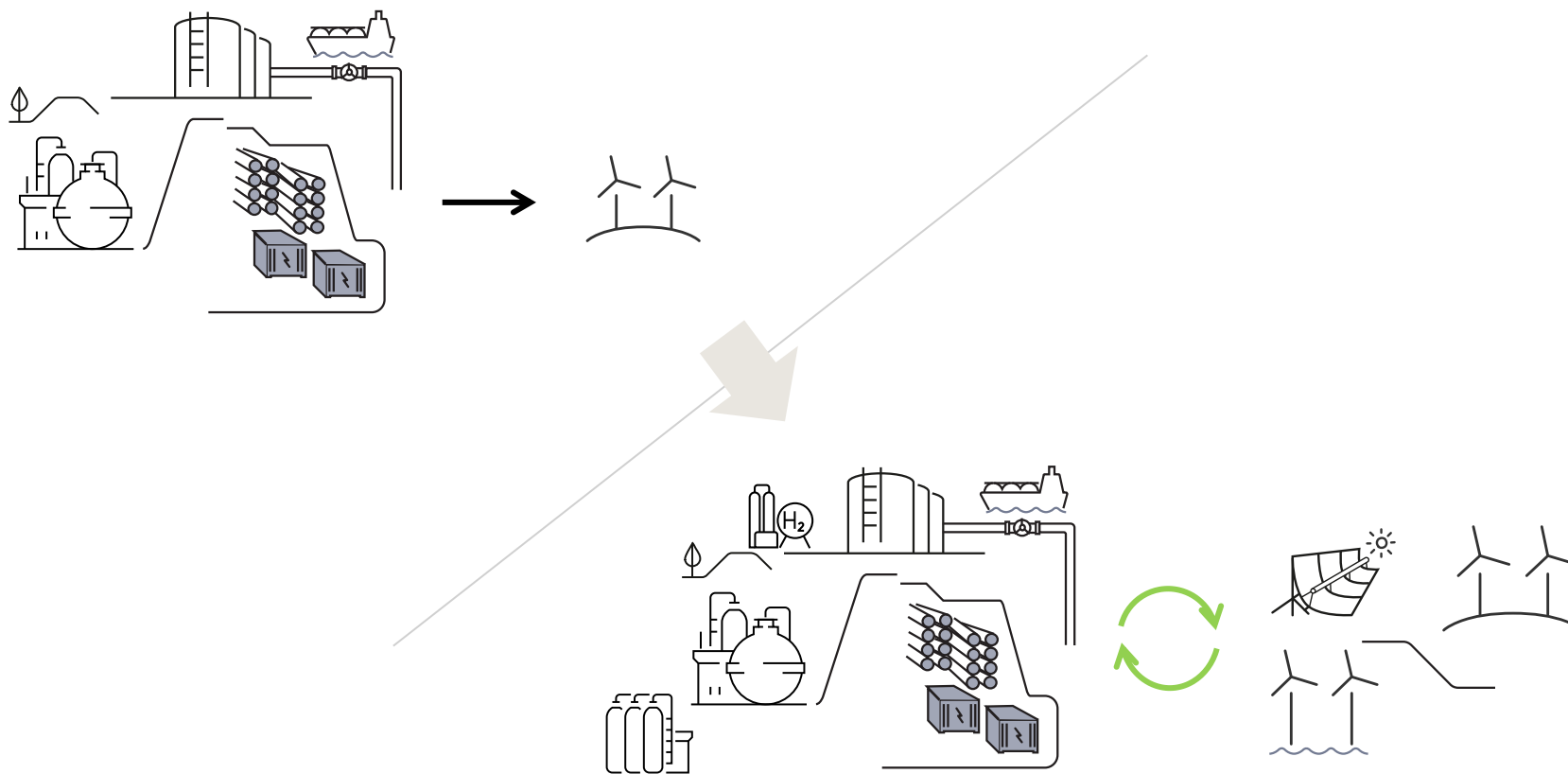
## SMR TIMELINE IS HUGELY UNCERTAIN



Source: AFRY, public information and World Nuclear Association.

Notes: Flexible demand in our modelling currently includes curtailment of industrial demand at high prices and flexible EV charging.

We will move from demand driven supply to a feedback loop



# Contact details - Will there be enough electricity for the Nordic energy transition?



**Nikita Semkin**

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# Energy crises and implications for cPPAs

Valuing increasing price volatility

KATHRINE STENE BAKKE, ROBERT BUCHNER

# PPAs are a key tool to support the build of renewables and supply green electricity to the growing green Nordic industry

## H&M signs Sweden's largest solar PPA

The agreement is for a 90MW solar park to power the retailer's operations

## Sweden's H2 Green Steel signs 14-TWh PPA to power planned electrolyzer

## How Europe's energy crisis has impacted corporate renewable PPAs

High energy prices have caused a surge in European power purchase

## Nordic wind power push faces price challenges in 'extreme' year

## Neoen signs a 10-year PPA with Coveris for a Swedish wind farm

Published by Abi Larkin, Editorial Assistant  
Energy Global, Monday, 30 January 2023 11:00

29.09.22

**Carlsberg signs significant Power Purchase Agreement with Better Energy**

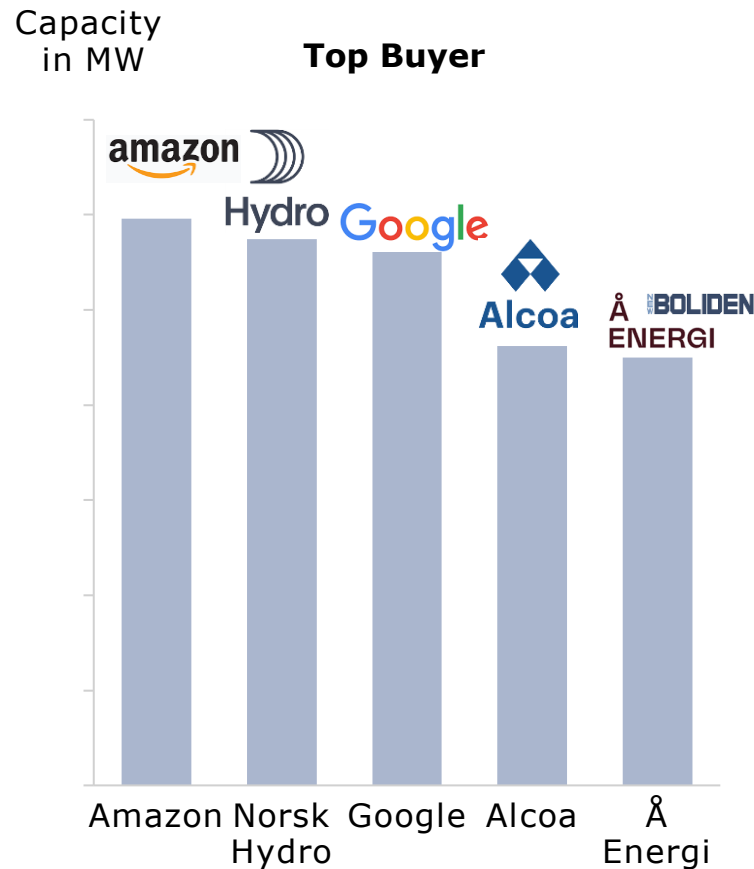
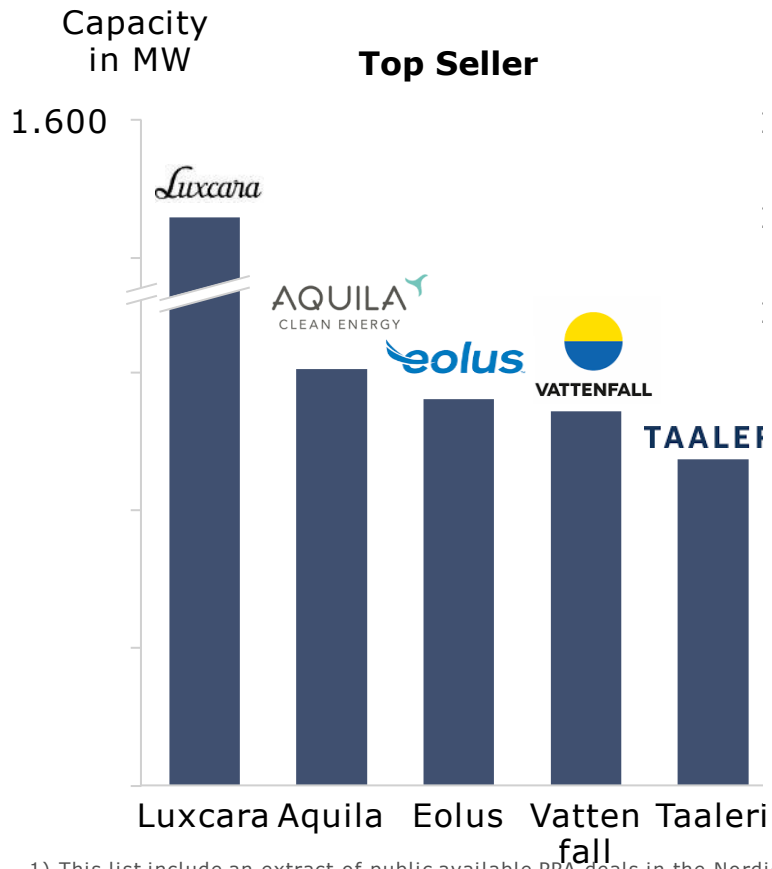
## Solar PPA prices take a dip in Europe: Is it a sunny forecast for renewables?

Solar PPA prices have dropped for the first time in two years in Europe, according to a new report, though overall wind and solar PPA prices remain 56% higher year over year

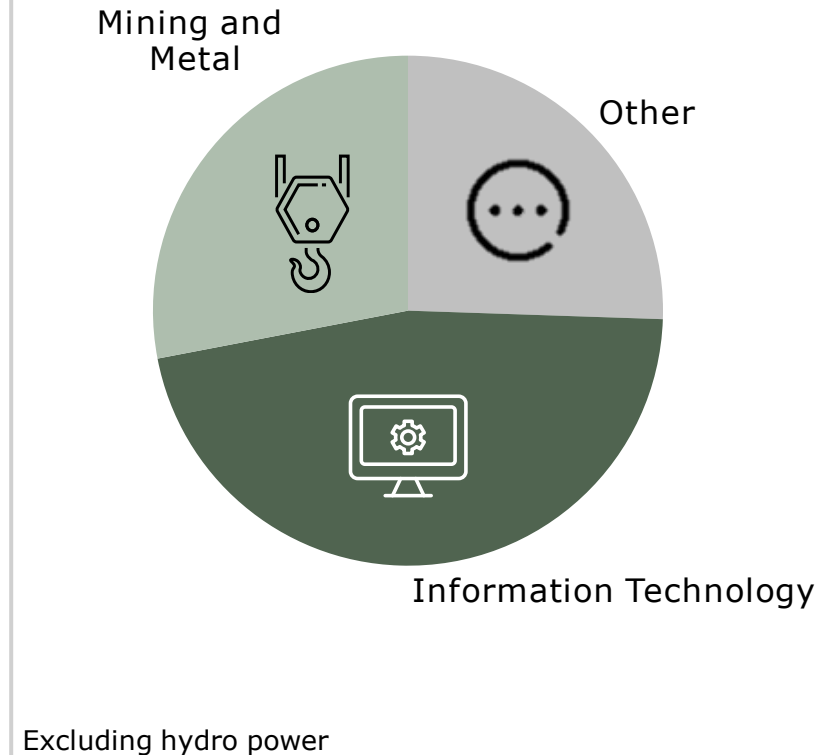


Most active in the Nordic PPA market are RES developer and investors with the IT and metal industry being the largest offtaker of electricity

**TOP WIND AND SOLAR PPA BUYERS AND SELLERS IN THE NORDICS SINCE 2018<sup>1</sup>**



**OFFTAKERS of NORDIC cPPA**

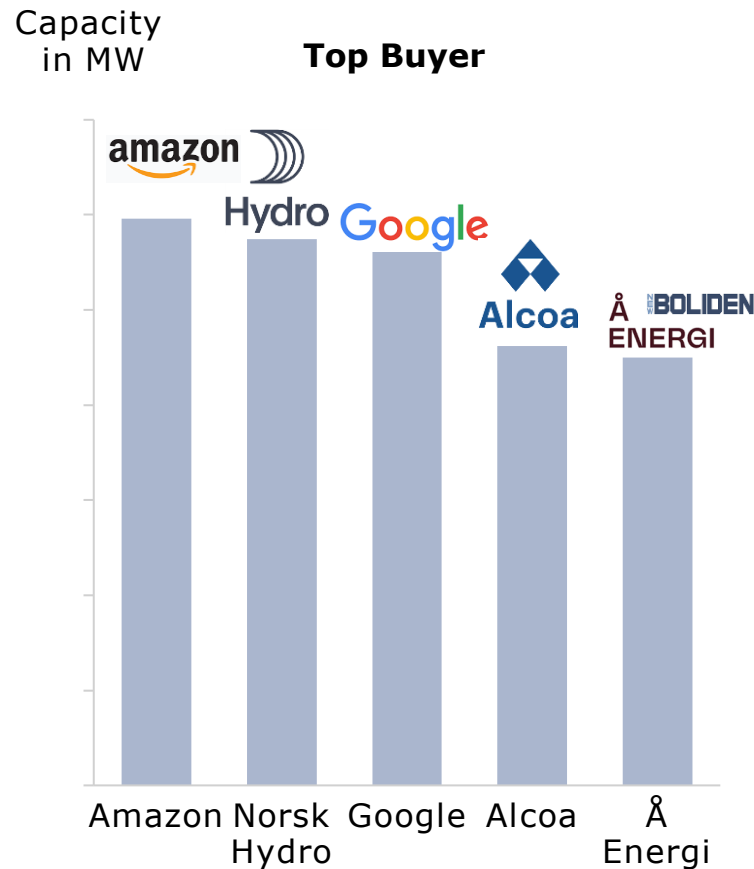
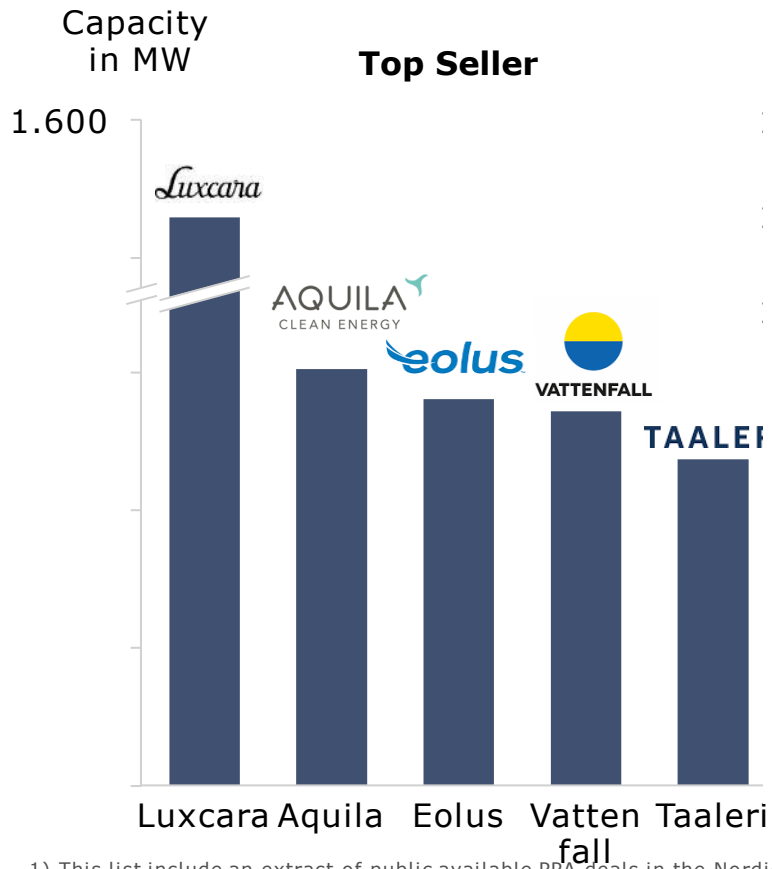


1) This list include an extract of public available PPA deals in the Nordics

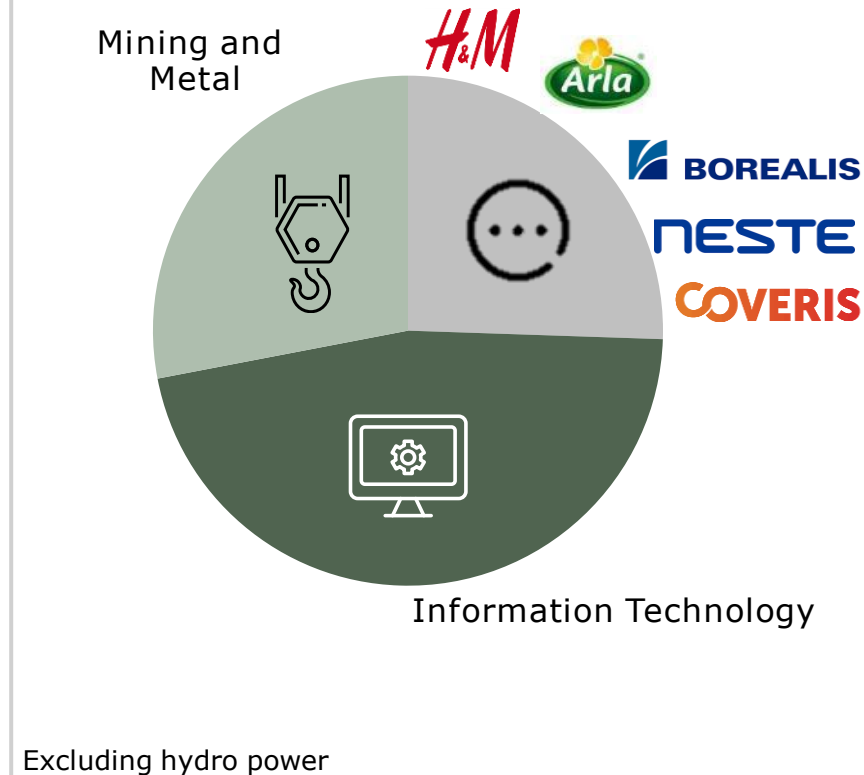
POWER PURCHASE AGREEMENTS IN THE NORDICS

Most active in the Nordic PPA market are RES developer and investors with the IT and metal industry being the largest offtaker of electricity

TOP WIND AND SOLAR PPA BUYERS AND SELLERS IN THE NORDICS SINCE 2018<sup>1</sup>



OFFTAKERS of NORDIC cPPA



1) This list include an extract of public available PPA deals in the Nordics

# PPAs provide a route to market, hedging against price volatility and access to green electricity supply



## **ROUTE TO MARKET**

Producers and consumers without inhouse power trading resources can access the market via a PPA

## **HEDGING AGAINST PRICE VOLATILITY**

PPAs may contain clauses that reduce price volatility (may be necessary e.g. to secure financing)

## **CORPORATE SOCIAL RESPONSIBILITY**

PPAs can be a key tool for companies with ambitious decarbonisation agendas

## **SECURING GREEN ELECTRICITY**

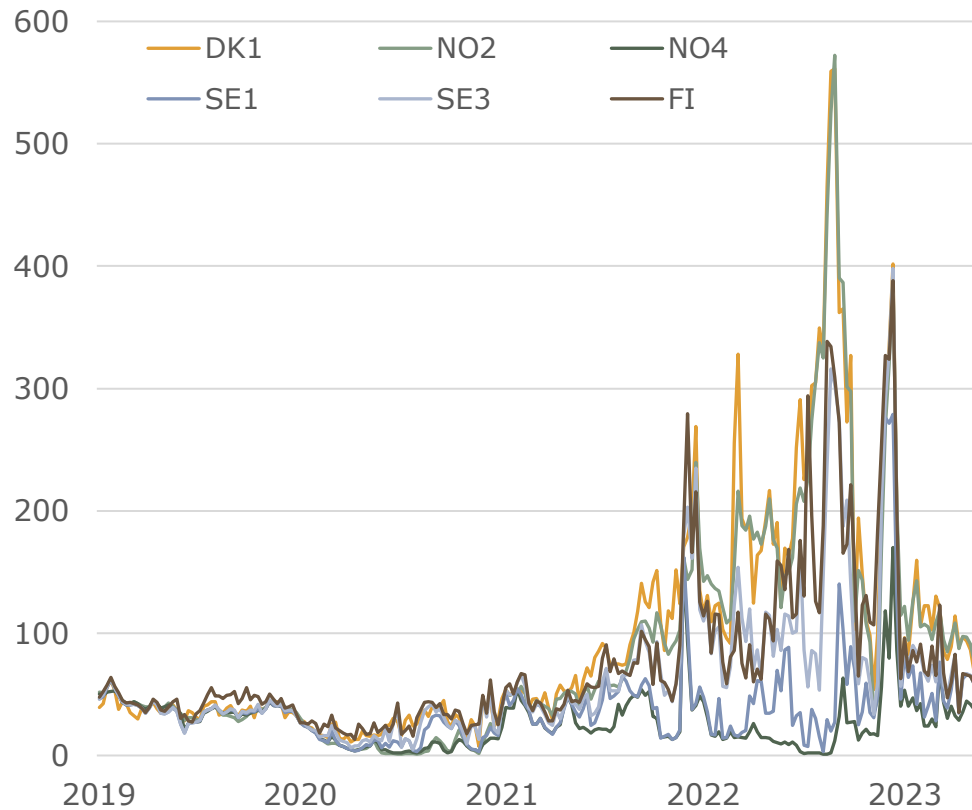
Securing sufficient volumes of electricity with the require green criteria to meet business needs (e.g. to produce green hydrogen - REDIII)





Recent market turbulence have caused a slowdown in new PPAs. We also see signs of changes to market structure and contract terms

**NORDIC SPOT ELECTRICITY PRICES (€/MWh)**



**Still demand for PPAs – uncertainty causes delays**



**New types of offtakers – smaller deal sizes**



**Deals are closed at higher prices**



**Moving towards inflation indexed prices?**

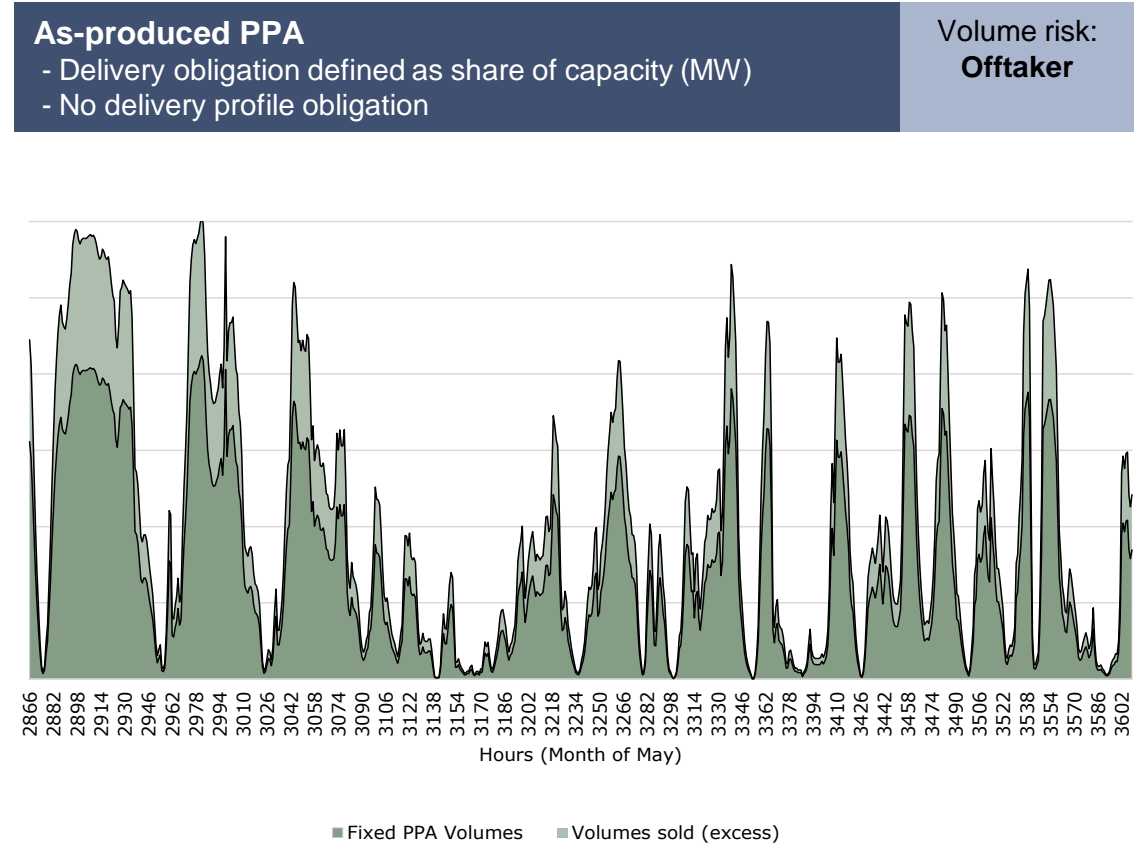
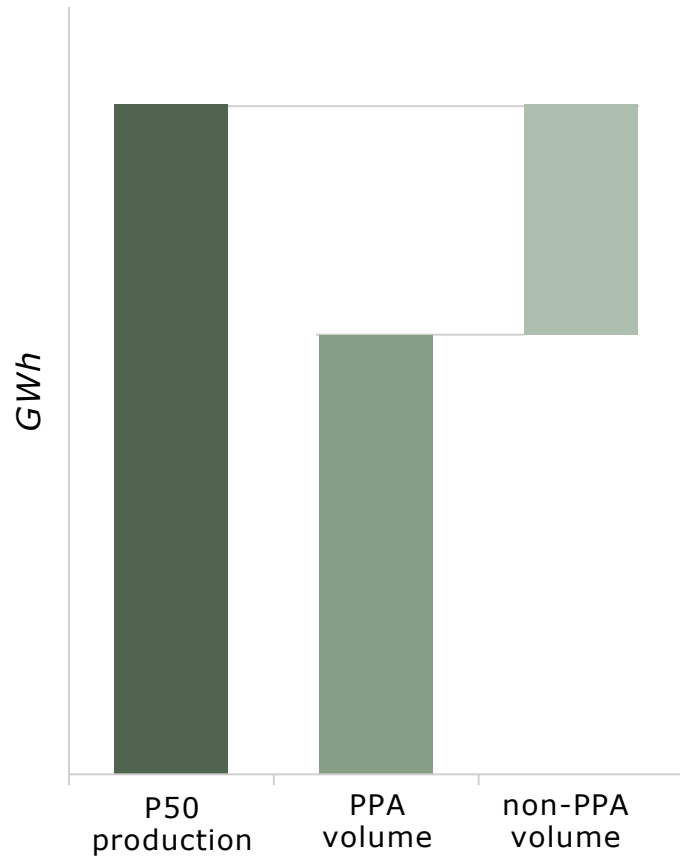


**Staggering losses on baseload PPAs  
- increased focus on shaping risk/costs**

Source of graphs: Nordpool

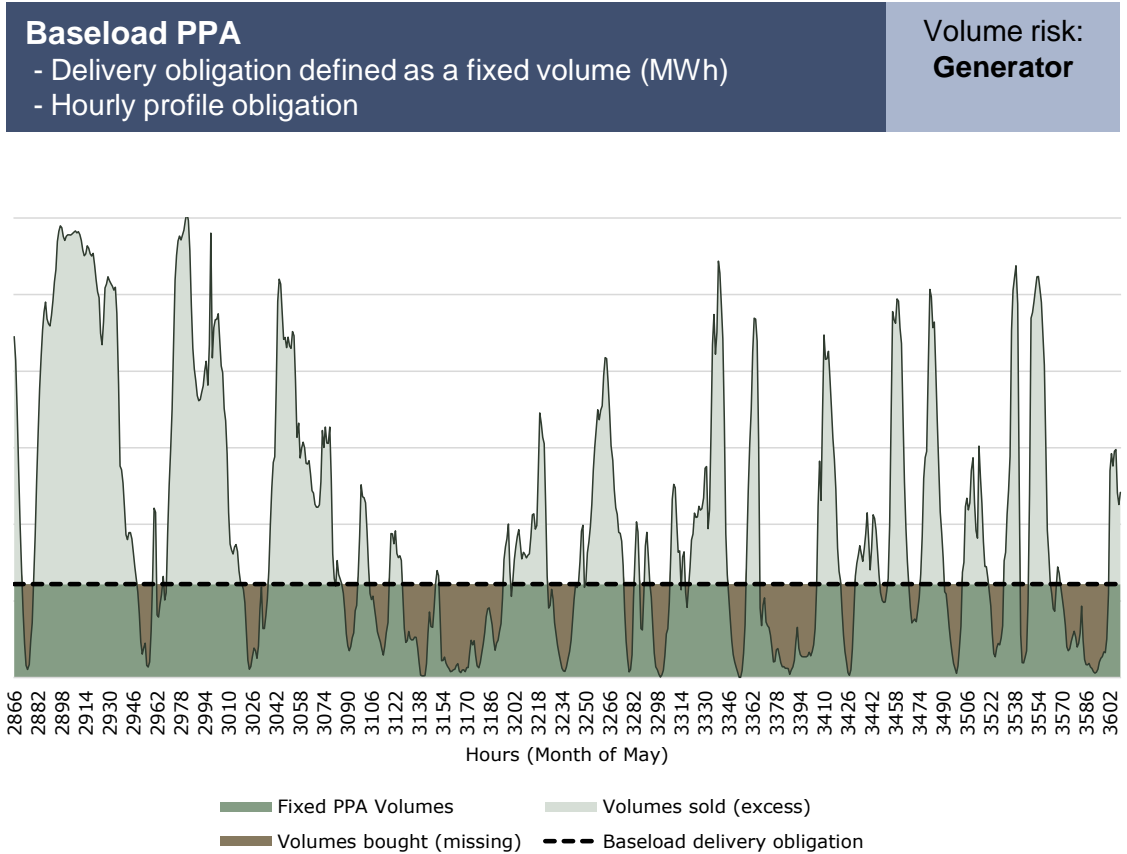
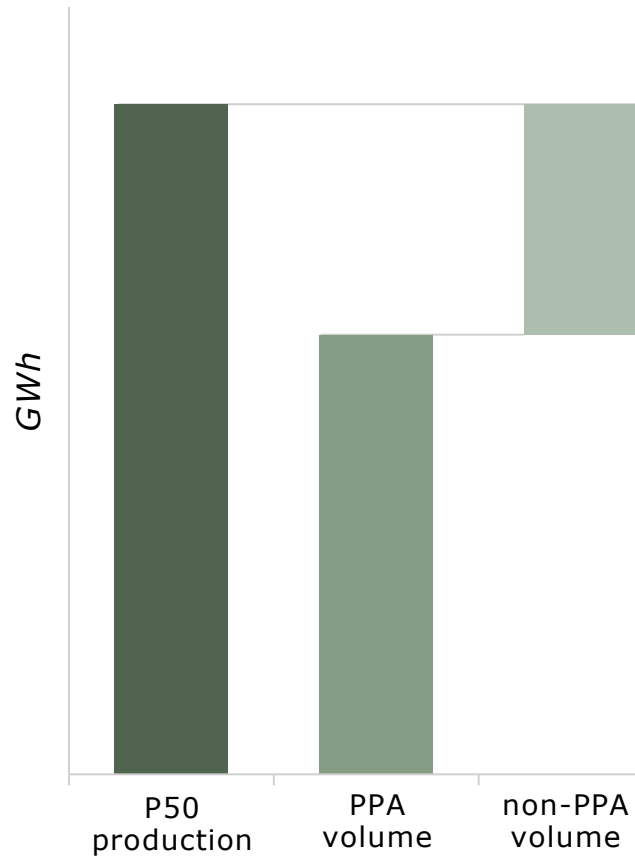
The shaping risk of a baseload PPA can be significant for a wind producer – several wind parks currently experiencing liquidity problems

**ANNUAL VOLUMES – ILLUSTRATIVE WIND FARM**



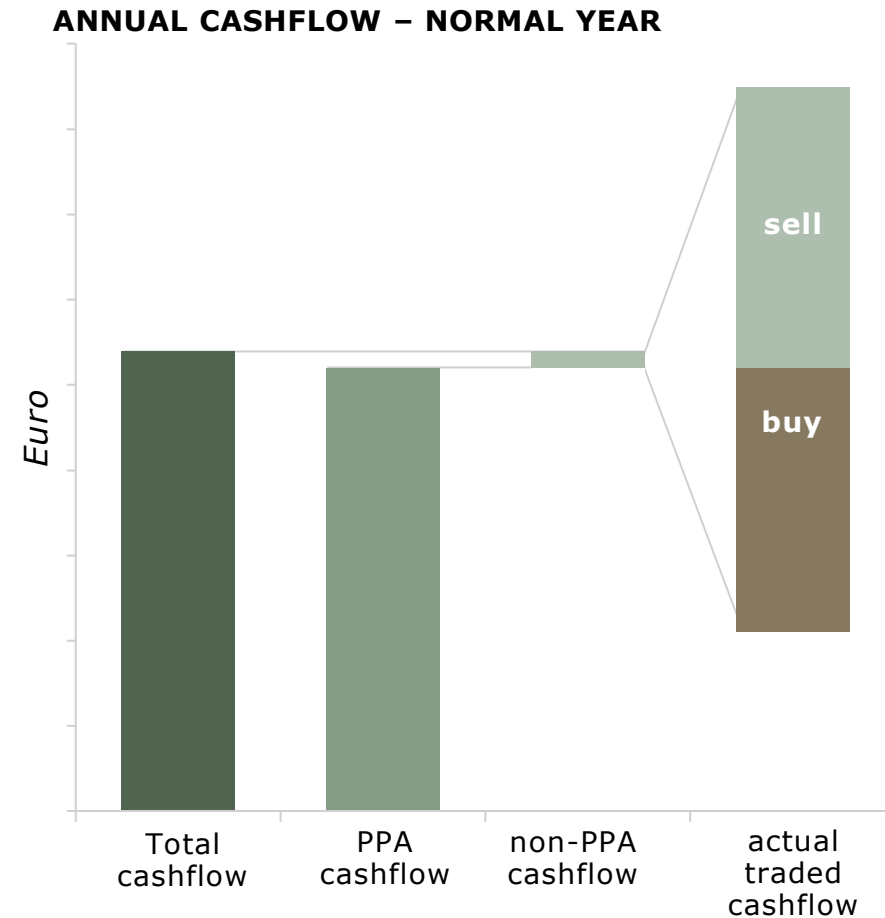
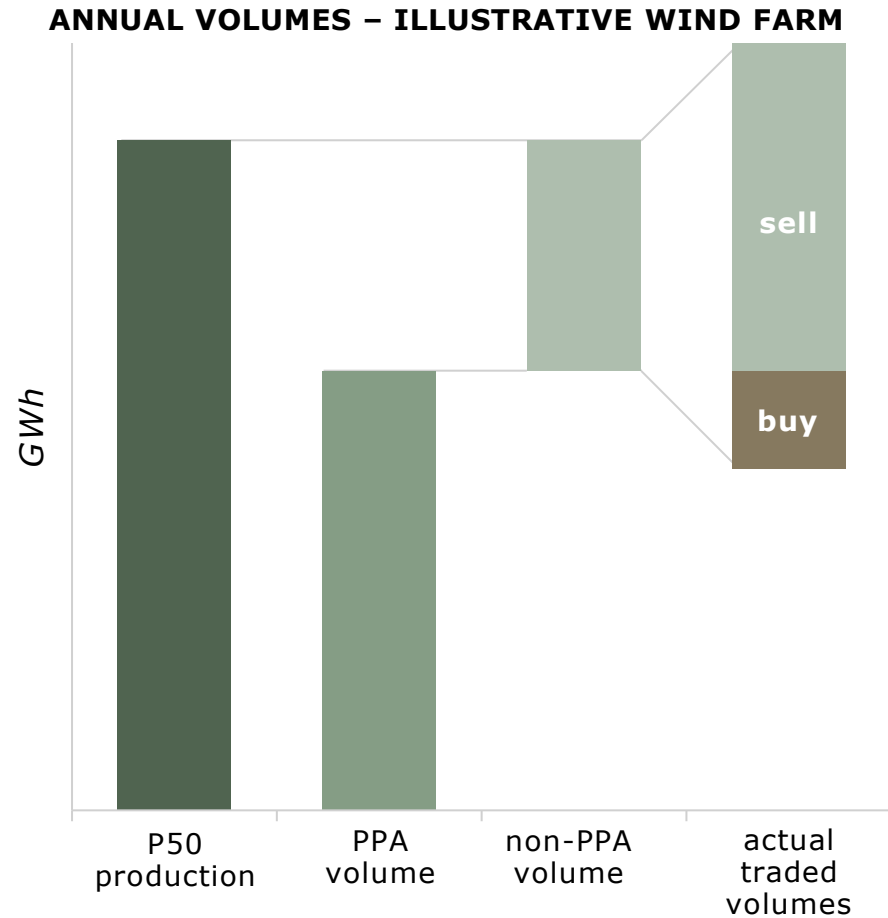
# The shaping risk of a baseload PPA can be significant for a wind producer – several wind parks currently experiencing liquidity problems

**ANNUAL VOLUMES – ILLUSTRATIVE WIND FARM**

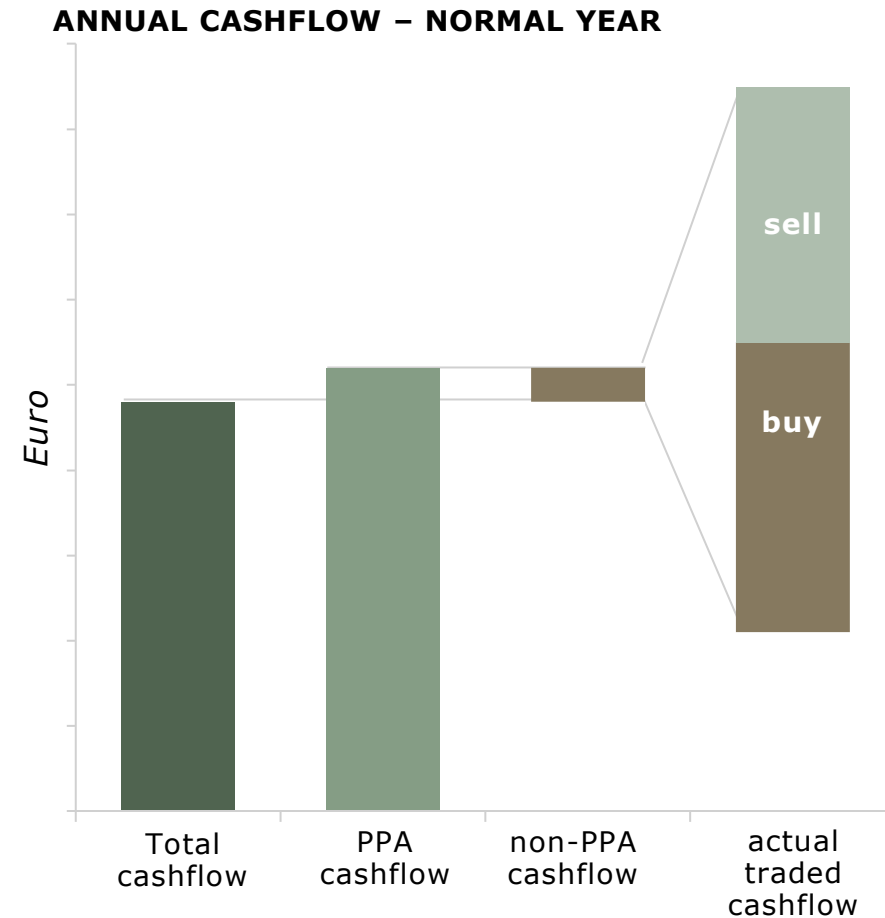
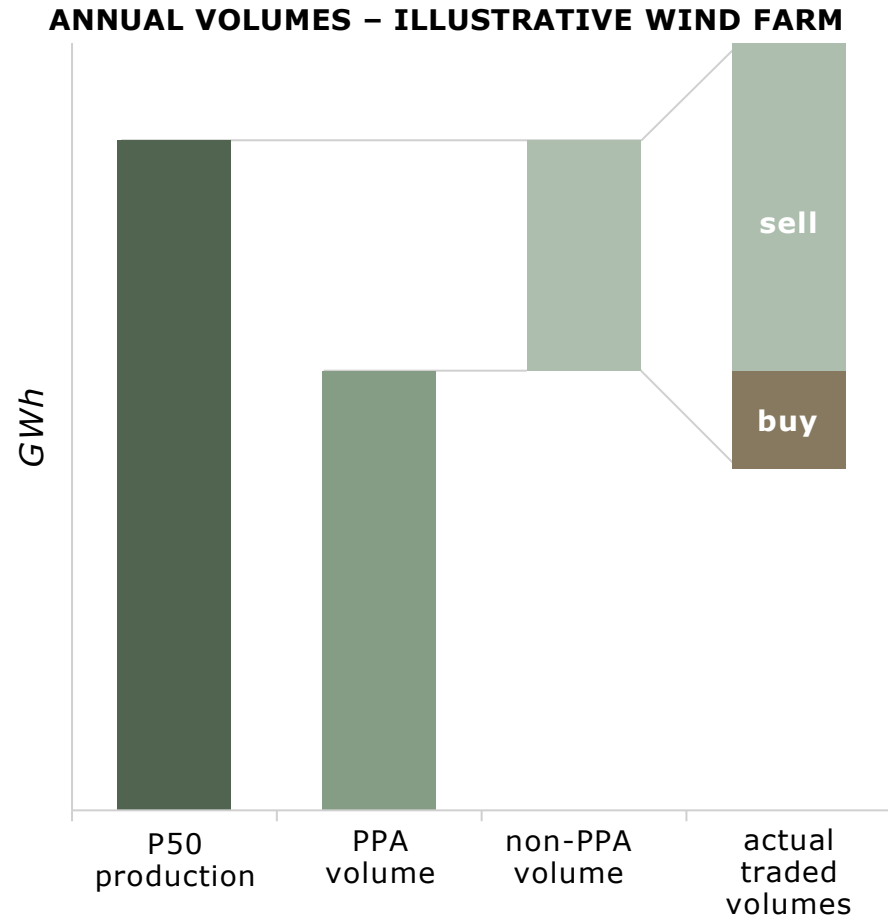




The shaping risk of a baseload PPA can be significant for a wind producer – several wind parks currently experiencing liquidity problems



The shaping risk of a baseload PPA can be significant for a wind producer – several wind parks currently experiencing liquidity problems




# 2022 was 'the perfect storm' for Nordic windfarms with baseload PPAs – and it is not over yet


## KEY CASH FLOW DRIVERS

2022


CASH FLOW EFFECT

 Wind generation vs. PPA obligation



 Cannibalisation



 Power prices



22/06/2021



Onshore wind has been one of the most exciting areas in the Nordics with lots of M&A activity. One important catalyst for the increase in RES investments is the concept of PPA – Power Purchasing Agreements.

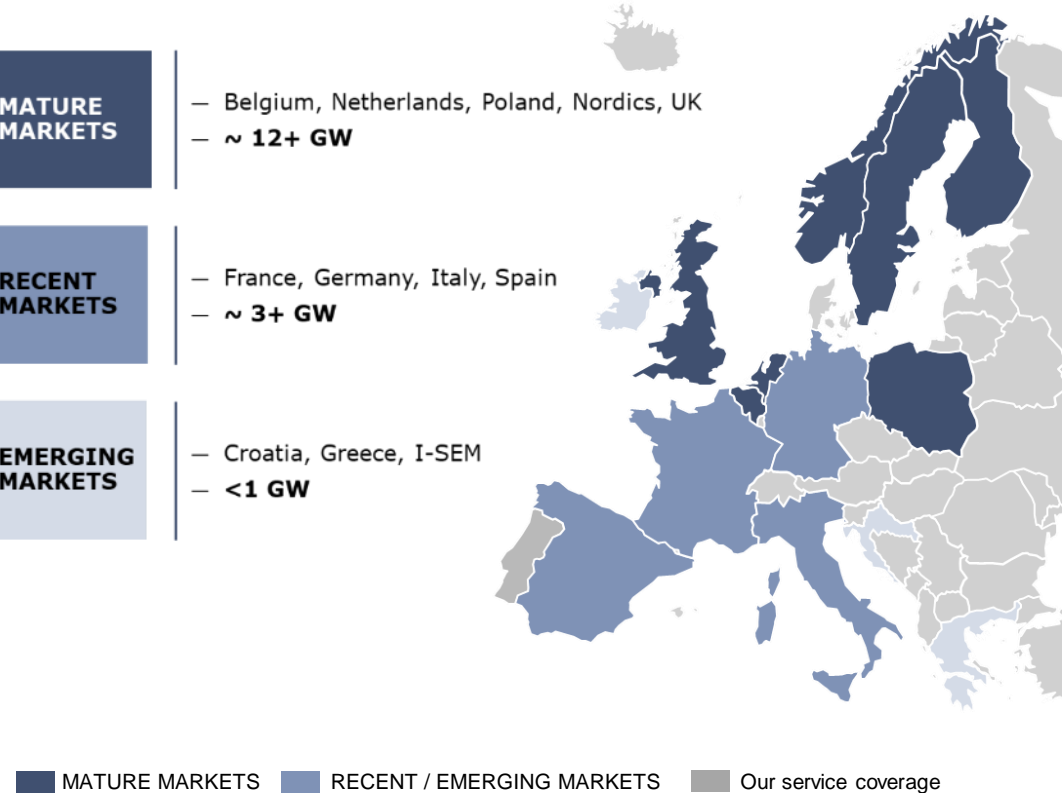
These bilateral agreements between a RES generator and an off-taker guarantee fixed revenues, thus reducing the investment risk for lenders – and the need for due diligence to correctly understand the market.

<https://afry.com/en/insight/profit-in-peril-correctly-valuing-baseload-ppas-in-nordic-market>

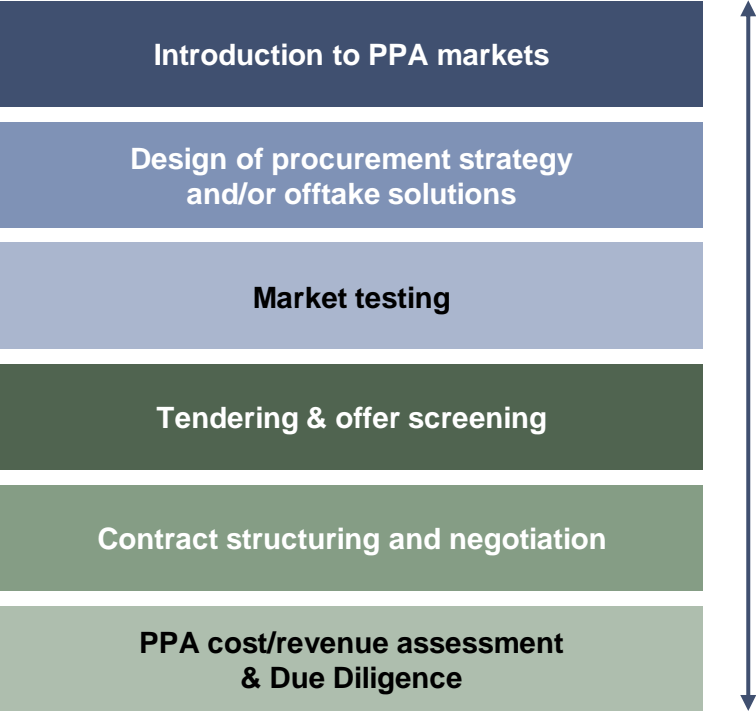


# We have GWs experience across the PPA value chain in the Nordics and European markets

## OUR PPA EXPERIENCE SPANS ACROSS MULTIPLE MARKETS



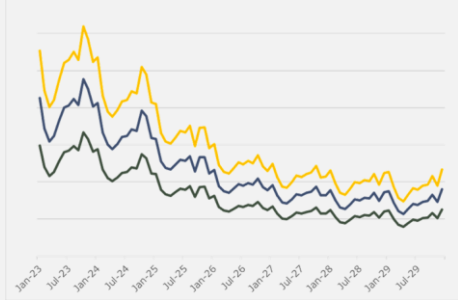
## WE ACTED IN VARIOUS CAPACITIES FOR DIFFERENT PARTIES ACROSS THE WHOLE RANGE OF ACTIVITIES



# Introducing the Daily Valuation Curve – a single go-to-point for PPA pricing

## Fundamental Methods

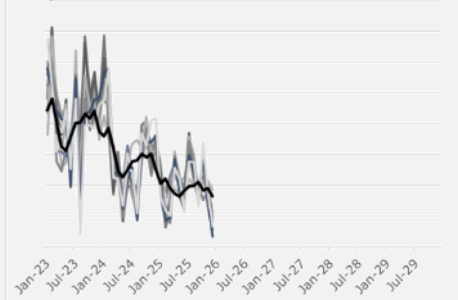
AFRY Independent Market Reports



**Scope:** Long-term scenario-based assessments  
**Foundation:** economic principles of supply & demand  
**Method:** Bottom-up analysis of interactions of all assets in system

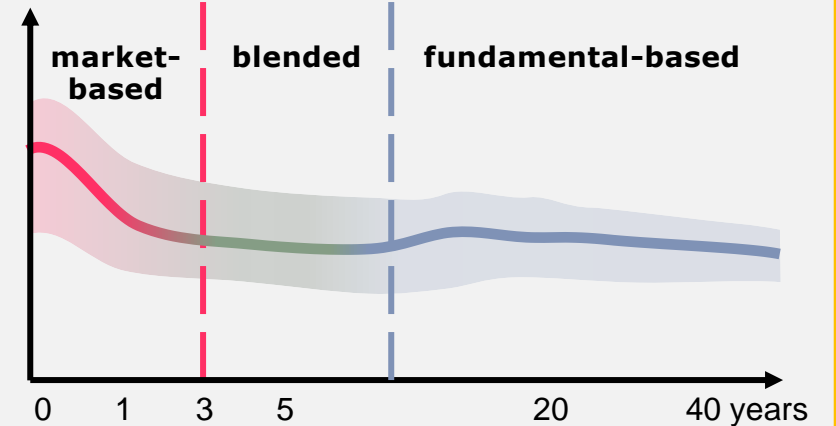
## Financial Methods

Pexapark's PexaQuote



**Scope:** Short-term probability based assessments  
**Foundation:** Historical volatility of forward contract prices only  
**Method:** Statistical analysis of historical forward curves

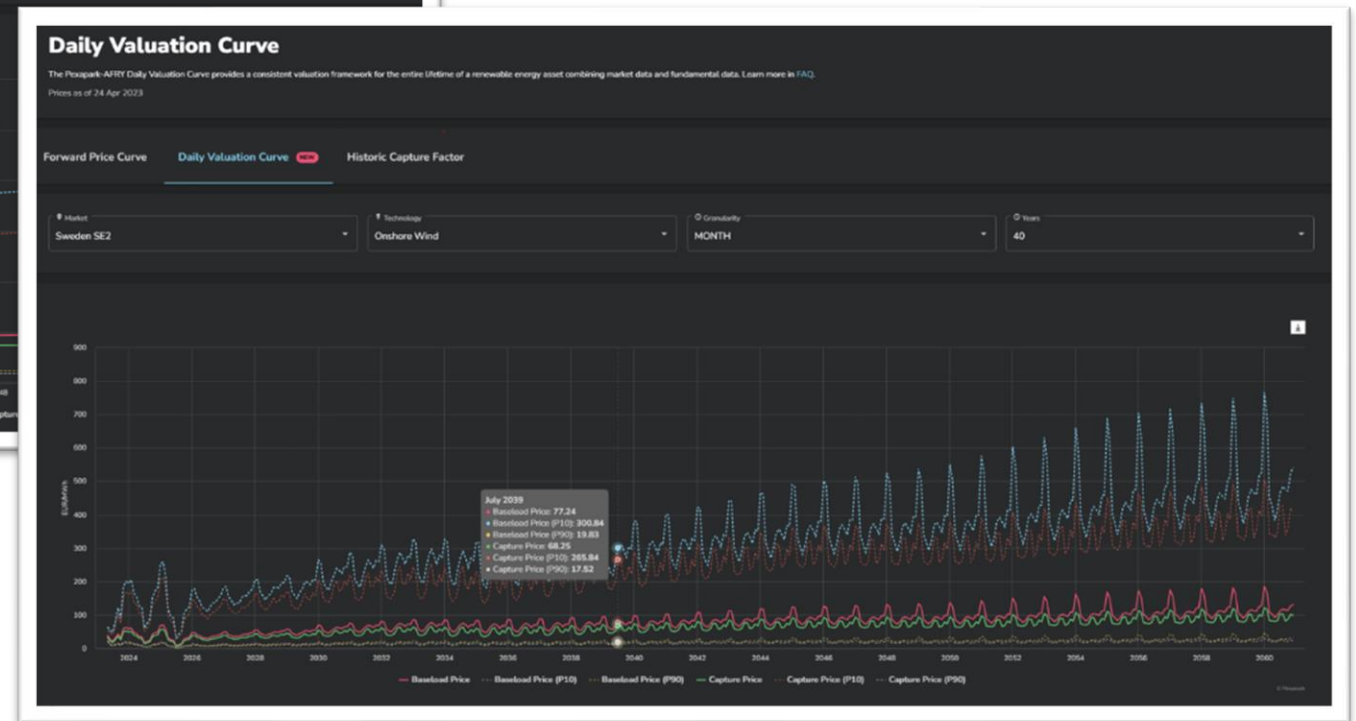
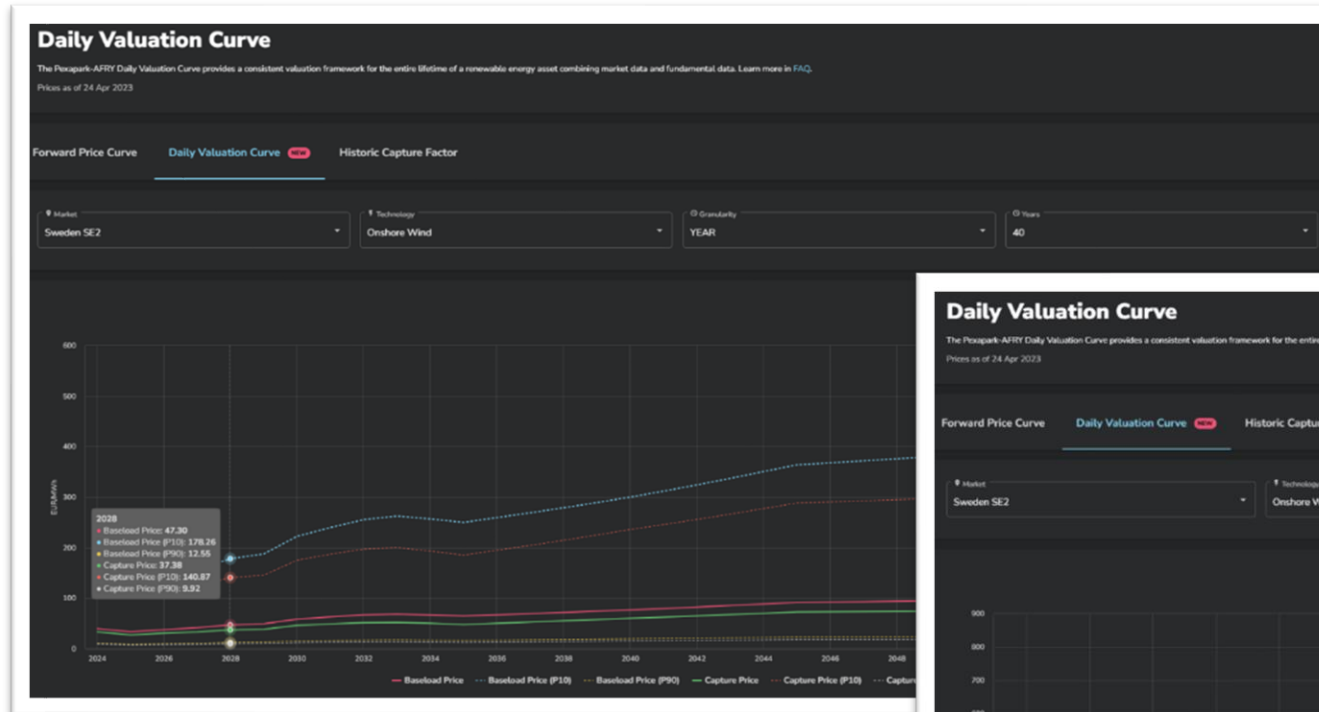
## Daily Valuation Curve



### Benefits:

1. A single standard methodology, transparently developed by the best in class providers
2. Single go-to point for consistent daily valuations from pre-deal to post-deal
3. Fully bankable approach by the two most trusted players in the market

# Introducing the Daily Valuation Curve – a single go-to-point for PPA pricing





# Contact details - Energy crises and implications for cPPAs



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BREAKFAST SEMINAR

# Key take-aways

## 01

In the shorter term, timing between generation and demand investments is key

## 02

Supply potential unlikely to constraint Nordic RES development. Obtaining social acceptance and managing grid development is critical

## 03

Understanding PPA risks and their fair value is a key enabler of successful green investments

# Contact



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A photograph of three people in conversation on a rooftop terrace. A man in a dark suit is on the left, a woman with curly hair in a black top is in the center, and a man in a blue puffer vest is on the right. They are standing on a dark wooden deck. In the background, there is a modern building with vertical slats and a landscape with trees and hills under a clear sky. In the foreground, there are out-of-focus tall grasses and purple flowers.

# Making Future