Nordic Smart Grid Alliance

27 October | Oslo

smartgrid The Norwegian Smartgrid Centre

Sveriges ambassad Oslo

BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

Agenda – Part 1

- **Setting the scene**
  - *Lene Mostue, Director, Energi 21*
- The role of energy sector towards the climate targets and alternate measures to support the grid
  - *Tone Svendsen Endal, Adviser energy systems and project manager Systemsmart energibruk, Zero*
- Flexible solutions – Example Norflex
  - *Rune Hogga, CEO of Agder Energi Fleksibilitet AS and Chairman of NODES AS and Enfo AS*
- The Norwegian Energy System and how communities can contribute to a smarter grid
  - *Karen Byskov Lindberg, Senior Advisor Distributed Energy Systems, TrønderEnergi/ANEO*

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THE SWEDISH TRADE & INVEST COUNCIL

Energi21 strategy 2022

Lene Mostue
director | Energi21|

Nordic Smart Grid Alliance – Norway: Towards the energy system of tomorrow
27th October 2022 – Embassy of Sweeden in Oslo

Oil and Energy Minister Terje Aasland
receives revised Energi21 strategy 30 June 2022.

NORWEGIAN MINISTRY OF PETROLEUM AND ENERGY ⇄ energi21

- Established by the Ministry of Petroleum and Energy in 2008. It is a permanent strategy body with its own industry-driven board appointed by the Ministry of Petroleum and Energy.
- Gives strategic advice directly to the Minister of petroleum and energy. Advice on thematic and financial commitment to research and innovation in renewable energy and climate-friendly energy technologies.
- The goal is increased value creation and efficient resource utilisation in the energy sector through investment in research and innovation.
- Prepares Norway's national strategy for research, development and commercialisation of new climate-friendly energy technology.
- Contributes to common goals and measures for increased engagement in the business sector for research and innovation.

Public R&D activity within the Ministry of Petroleum and Energy

Research and innovation within petroleum

synergies

Research and innovation within renewable energy, climate friendly energy-technologies and CCS

OG21: thematic – and financial prioritization of public research and innovation funds

- PETROMAX 2
- DEMO 2000
- 3 Research centres within Petroleum Science

Energi21: thematic – and financial prioritization of public research and innovation funds

- RESEARCH COUNCIL OF NORWAY **ENERGIX**
- **ENOVA**
- **13 research centers** for environmentally friendly energy (**FME**)
- **CLIMIT - FoU**
- **CLIMIT – Demo**

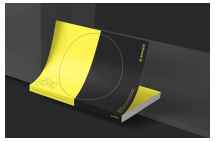
Basic research | Applied science | Piloting/ demonstration | Marketintroduction

Illustration from the Government's proposal for the state budget Prop. 1s. (2022-2023)

Energi21 strategy 2022

Energi21 strategy 2022 National strategy for research, development and commercialisation of new climate-friendly energy technology

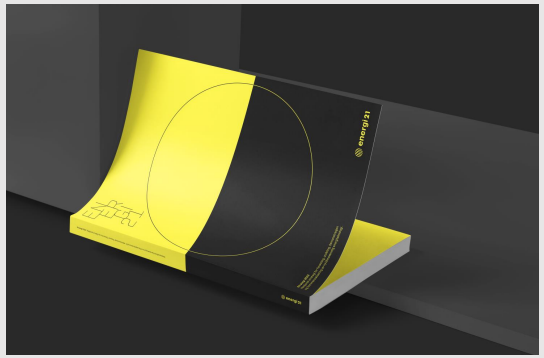
energi21



The strategy is based on an extensive body of knowledge
– great co-operation and highly valuable contribution

Body of knowledge:	Solid and comprehensive process
Engagement and contribution:	Close to 700 stakeholders from business sector, research – and innovation institutes, academia , NGOs
Workshops	Evaluation of 25+ technology and thematic areas
Cross sectoral co-operation	Analysed need of interaction and potential of knowledge transfer and synergies between sectors.
Public consultation	Overwhelming respons

The Energi21 strategy describes the necessary RD&I efforts to meet the challenges of the energy trilemma and sub-dimensons.



ENERGY SECURITY

- CAPABILITY
- RESILENCE
- DEPENDENCY

ENVIROMENTAL SUSTAINEBILITY

- DECARBONISATION
- RESOURCHE PRODUCTIVITY
- EMISSION & POLLUTION CONTROLL

ENERGY EQUITY

- AFORDABILITY
- QUALITY
- ACESSIBILITY

energi 21

Norwegian strengths within energy – competitive advantage

Renewable energy sources

Foto: Statkraft

Industrial experience

Foto: Nexans

Technology and competence platform

Foto: NTNU

Sector connection and cooperation between different industries

Energy sector is the hub of the transition to climate-neutral society

Building and construction
- Electricity
- Hydrogen
- Bioenergy

Agriculture and aquaculture
- Electricity
- Bioenergy

Transport
(maritime, aviation, landbased)

- Bioenergy
- Ammonia
- Methanol
- Hydrogen/LH2
- Electricity

- Bioenergy
- E-kerosene
- Hydrogen
- Electricity

- Electricity
- Hydrogen
- Bioenergy

Industri
- Electricity
- Hydrogen (blue and green)
- Biomass
- CCS
- Energy efficiency
- Heat pump technology

Oil and gas
- Electricity
- Hydrogen
- Energy efficiency
- CCS

Buildings
- Energy efficiency
- Heat pump
- Geothermal energy
- Bioenergy
- Electricity

Climate-friendly restructuring in all sectors will lead to increased need for electric power, climate-friendly energy technologies and increased transmission capacity.

energi 21

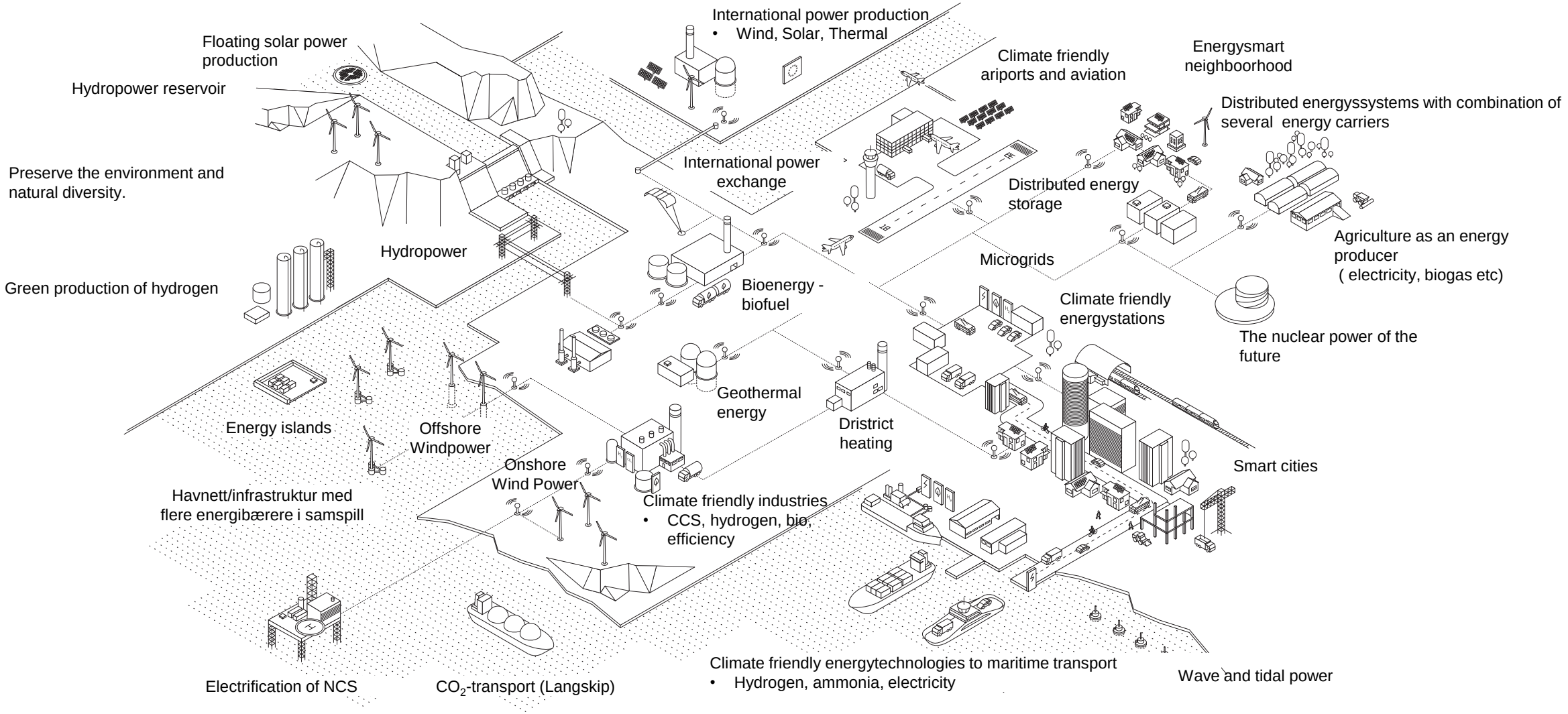
Future energy systems

Foto: Øyvind Welgaard, Statnett

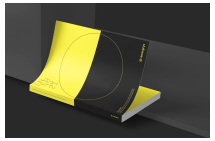
energi21

The digital, flexible and integrated energy system of the future:

high degree of complexity, consumer driven and interaction between several energy carriers



energi 21



Energi21 strategy 2022

Vision

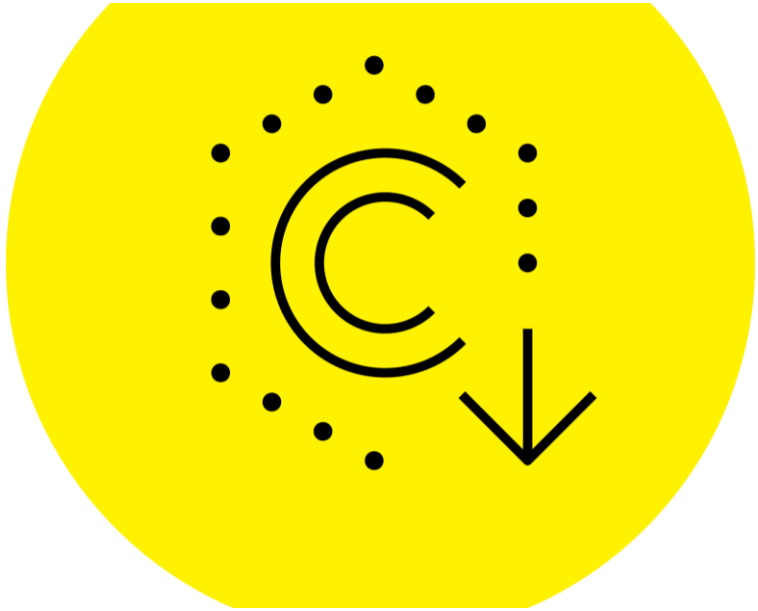
As an energy nation with national and international opportunities Energi21 has adopted the following vision:

Further develop Europe’s best energy system

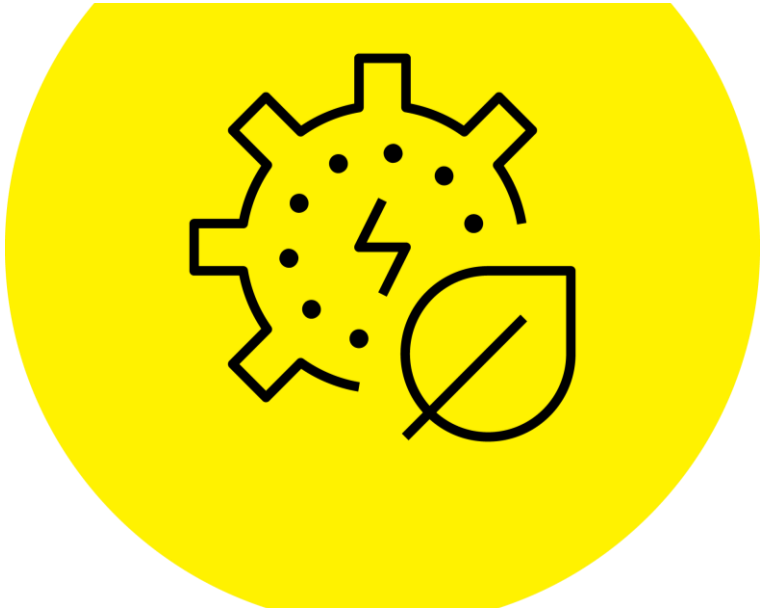
- Contributions on national – and international level:
  - renewable energy
  - industrialisation
  - business development
  - an energy system with a reliable supply and the right quality

Key challenges must be resolved in order to meet the vision and mission of the OED.

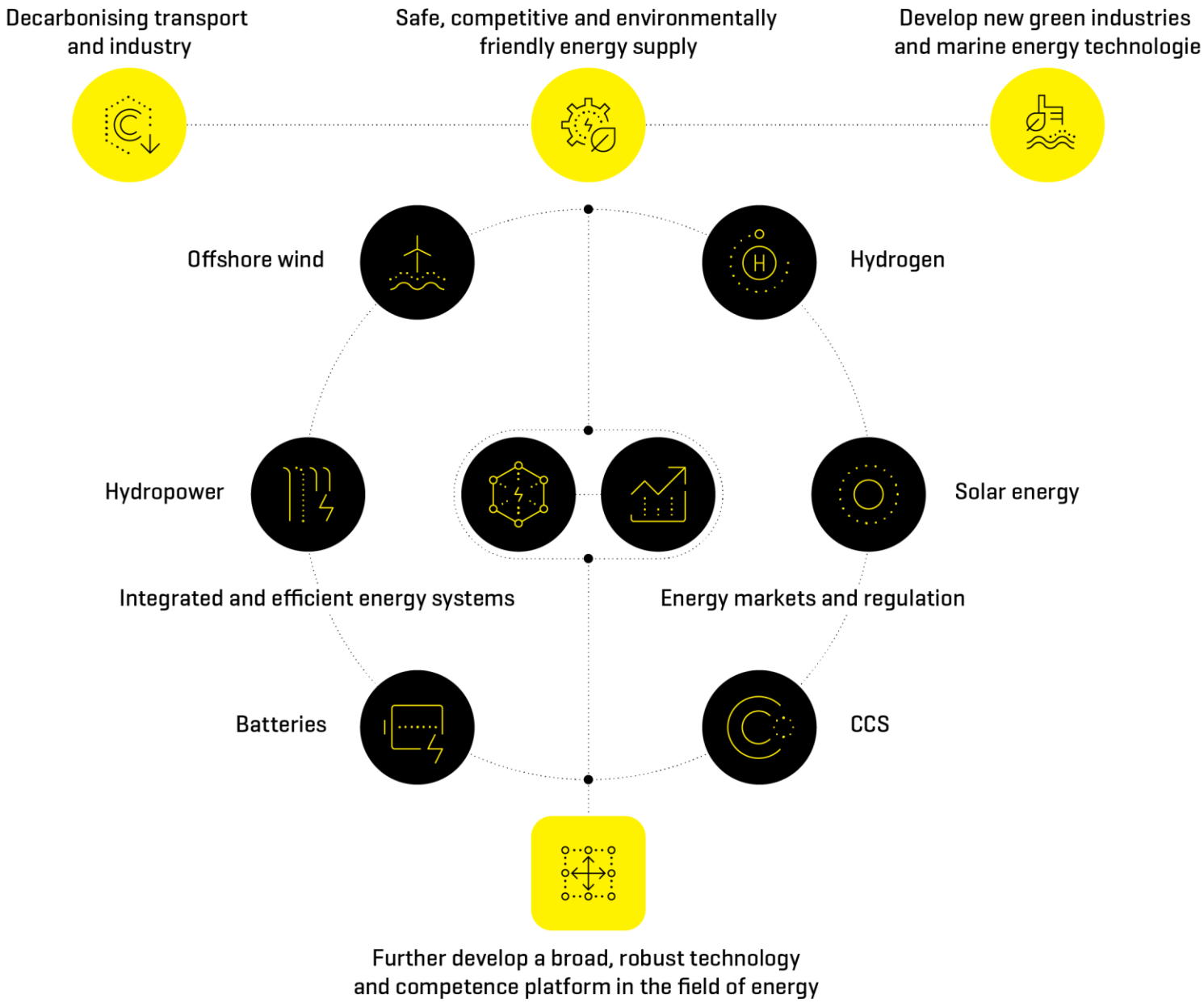
Decarbonising transport and industry



Safe,competetive and environmentally friendly energy supply



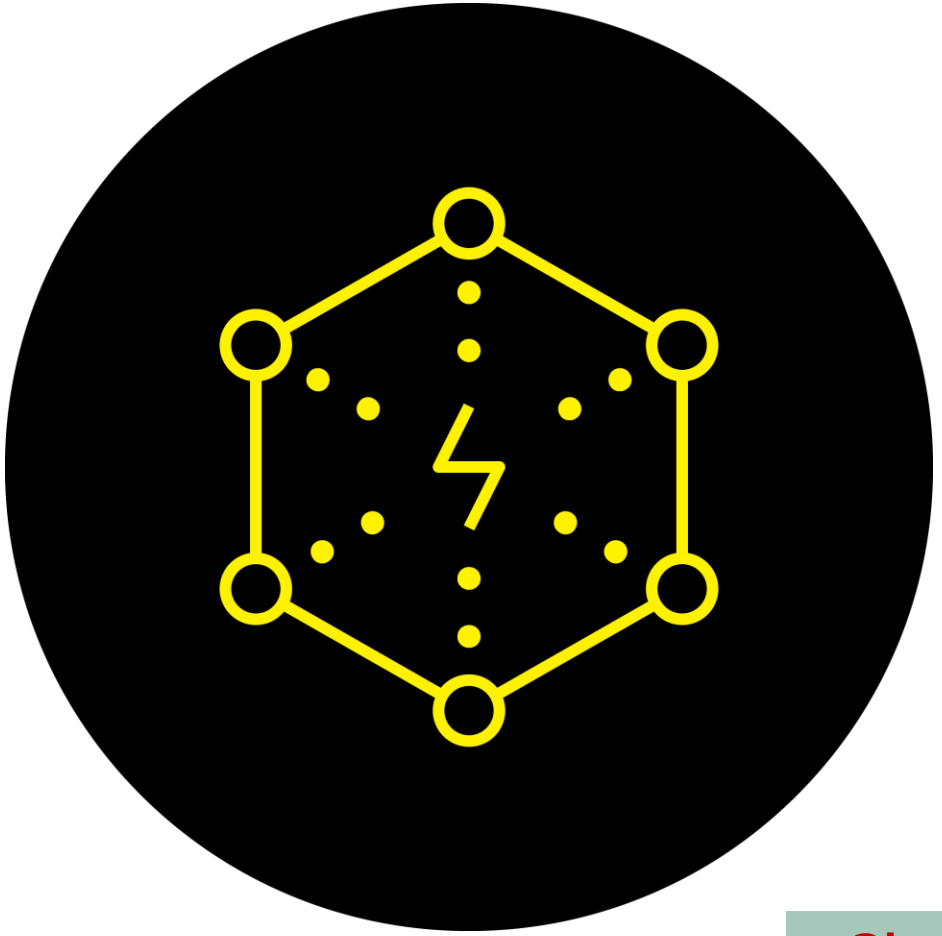
Develop new green industries and marine energy technologies


Decarbonising transport and industry
Safe, competitive and environmentally friendly energy supply
Develop new green industries and marine energy technologie
Offshore wind
Hydrogen
Hydropower
Solar energy
Integrated and efficient energy systems
Energy markets and regulation
Batteries
CCS
Further develop a broad, robust technology and competence platform in the field of energy

energi21

INTEGRATED AND EFFICIENT ENERGY SYSTEMS

Onshore – and offshore infrastructure



- Efficient and integrated energy systems are vital to achieving energy and climate goals and cut greenhouse gas emissions, boost industrialisation and achieve cost- effective utilisation of our energy sources.
- **Selected key resarch – and innovation topics:**
  - Efficient and felxible interaction between different energy infrastructures, climate friendly energy carriers and end-users
  - Next – generation components and systems
  - Multidisciplinary analysis- and simulations models
  - Digitalisation and cyber- security
  - Nature and environmental consequences

Given special attention

Næringens ambisjoner

- Forsyningssikkerhet
- Cyber- sikkert energisystem
- Digitalisering og automatisering – implementering av digitale muliggjørende teknologier (AI, sensorteknologi, stordatahåndtering, autonomi, IoT)
- Energieffektivisering bedre effekt- og kapasitetsutnyttelse
- Modernisering og effektiv utnyttelse av eksisterende infrastruktur.
- Effektiv integrasjon av fornybare energibærere, infrastrukturer og energiteknologier
- Bærekraftig bygging og drift med minst mulig tap av naturmangfold og miljøforurensinger.
- Økt innovasjon, mer næringsutvikling og industrialisering.
- Test – og demonstrasjonsprosjekter i eksisterende energisystem

Foto: Statnett

Sentrale forsknings- og innovasjonstemaer (1)

- **Effektivt og fleksibelt samspill mellom ulike infrastrukturer, energibærere og sluttbrukere.**
  - Investerings- og driftsmodellering
  - Sektor – og infrastrukturkobling
  - Fleksibilitetsløsninger
  - Effektiv utnyttelse av infrastrukturen for å elektrifisere andre sektorer
- **Neste generasjons komponenter og systemer**
  - Kabelteknologi og elektrotekniske komponenter (smarte komponenter)
  - Materialutvikling for mer effektive komponenter
  - Intelligente komponenter for konvertering mellom energibærere og energilagring.
  - Storskala energilagring og batterteknologi

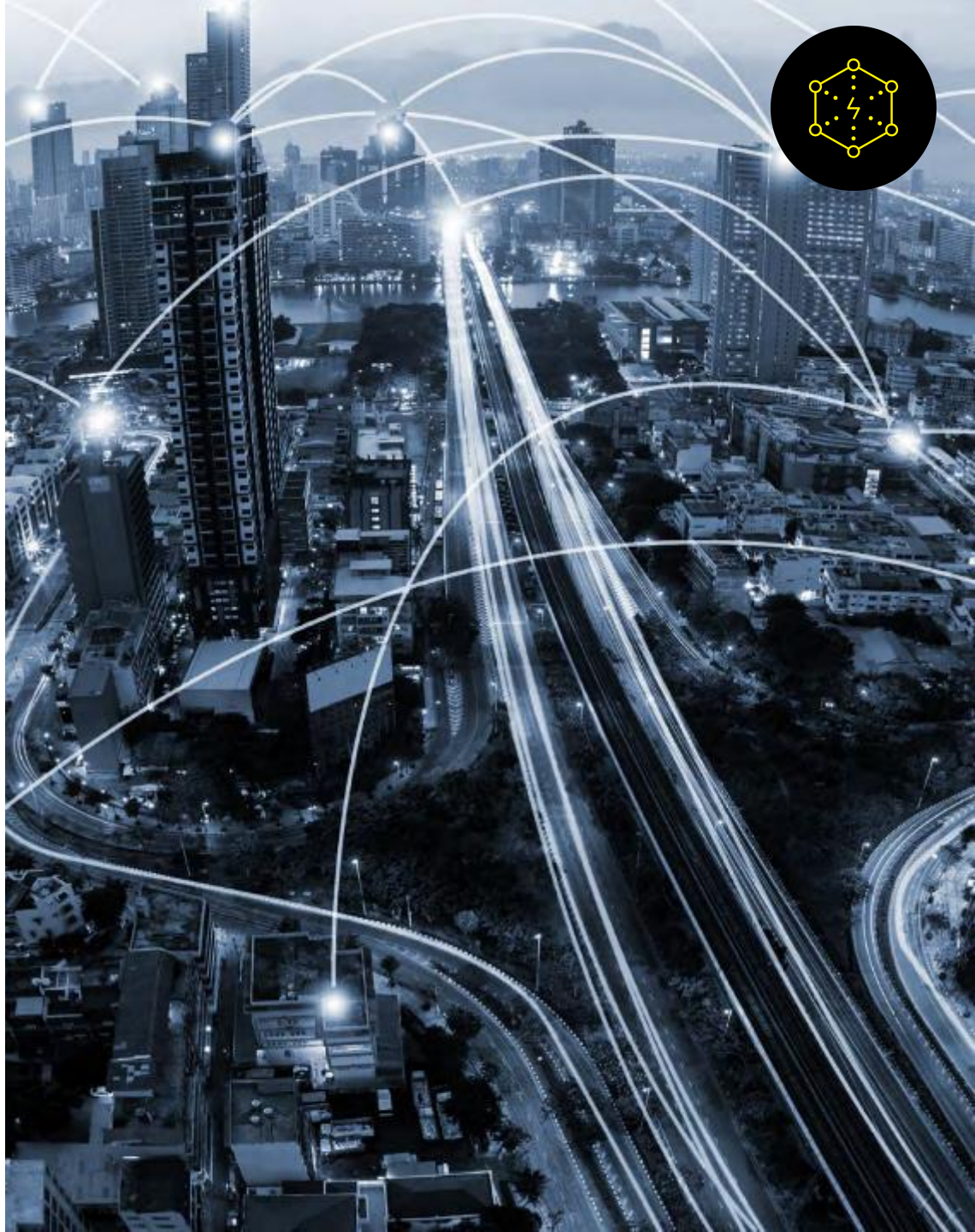


Foto.eSmart

Sentrale forsknings- og innovasjonstemaer (2)

- **Multidisiplinære analysemodeller, simuleringsverktøy og innovative styringssystemer**
  - Dynamiske og multidisiplinære analysemodeller og simuleringsverktøy.
  - Energisystemmodellering med integrasjon av det stasjonære energisystemet og transportsystemet.
  - Helhetlig modellplattform med makroøkonomiske konsekvenser av energiomstillingen.
- **Digitalisering og cybersikkerhet**
  - Bruk av AI, sensorteknologi, stordatahåndtering, autonomi og Internet of Things til effektiv planlegging, overvåking, styring og drift.
  - Cybersikkerhet og personvern
  - Systemer og metoder for bedre koordinering og kunnskapsdeling innenfor cybersikkerhet på tvers av sektorer og aktører
    Ref. egen Energi21 rapport om digitalisering av energisektoren (www.energi21.no)

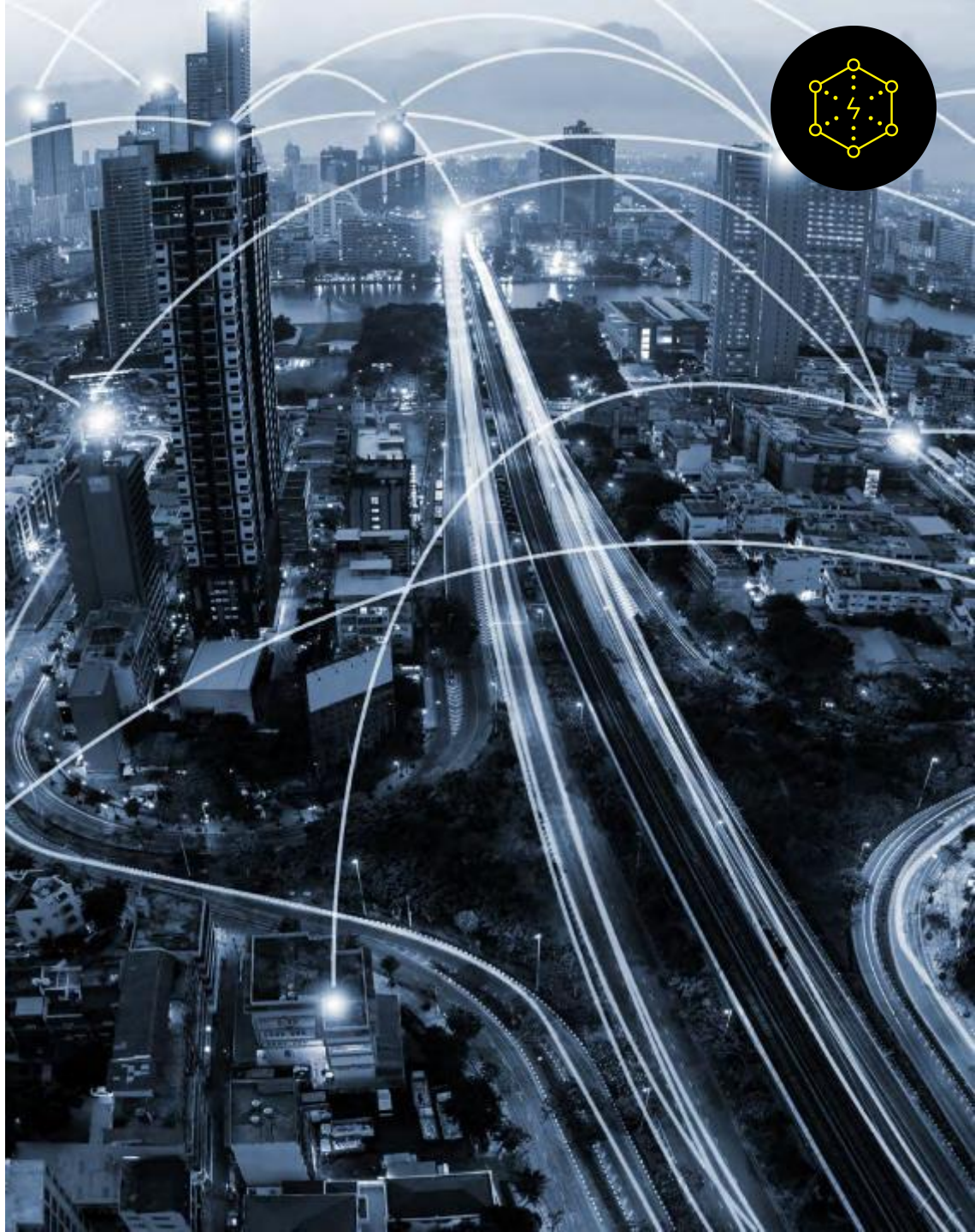


Foto.eSmart

Tiltak for iverksettelse

- Flerfaglige FoU – prosjekter
- Forsknings- og innovasjonssenter
- Storskala forskning infrastruktur med samarbeid på tvers av land og fagområder.
- Økt samarbeid mellom myndigheter, næringsliv og FoU miljøer innen miljø og bærekraft.
- Virkemidler for raskere gjennomføring av FoU-I prosjekter.
- Risikoreduserende tiltak til leverandørindustrien.
- Test- og pilotprosjekter i eksisterende infrastruktur.
- Styrke utdanningskapasiteten med fremtidsrettede fagkombinasjoner og samarbeid med aktuelle næringer.

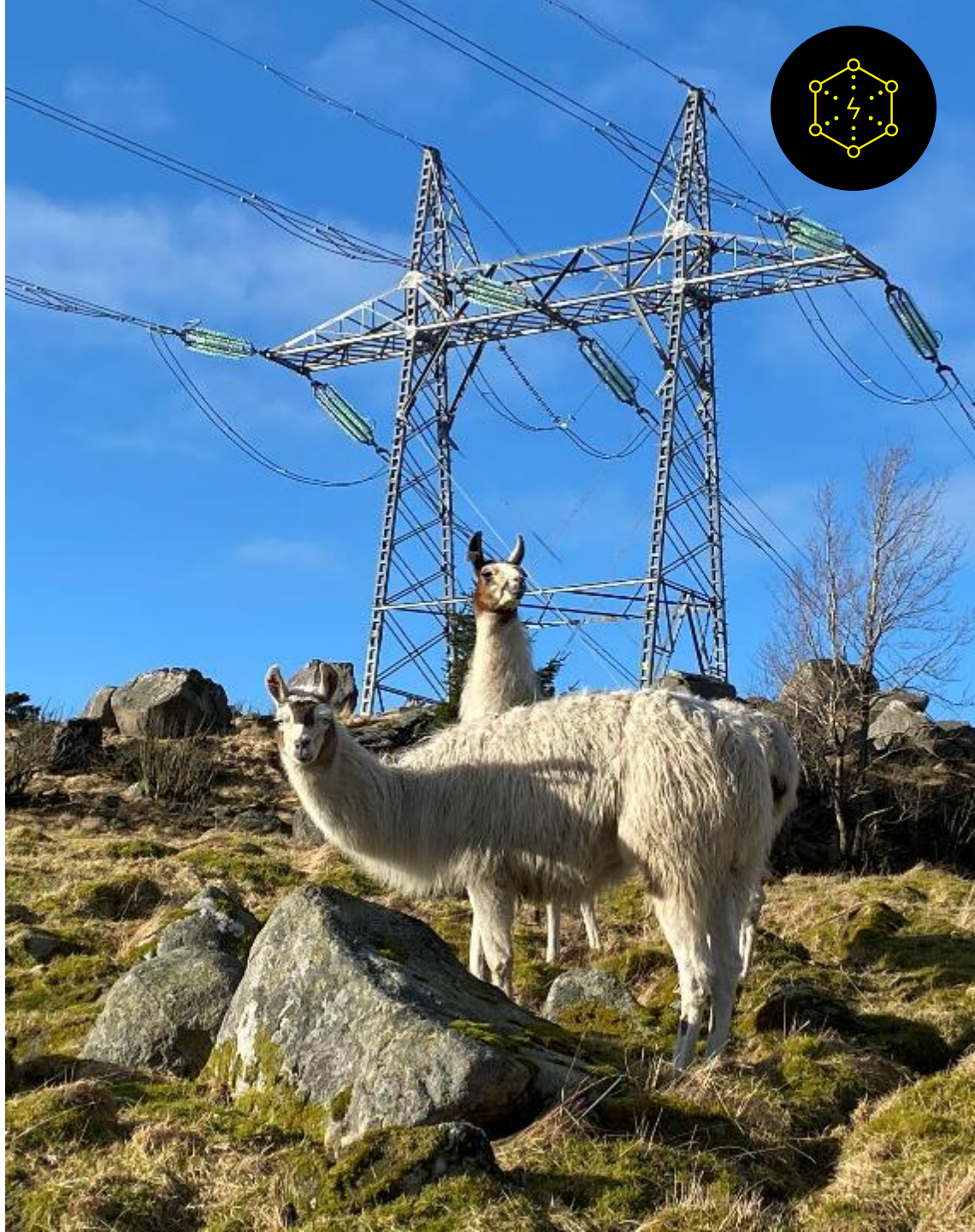


Foto: Statnett

Thank you for your attention !

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BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

The role of the energy sector towards the climate targets and alternative measures to support the grid

Tone Svendsen Endal, rådgiver energisystemer og prosjektleder for *Systemsmart energibruk*

Nordic Smart Grid Alliance 27.10.22

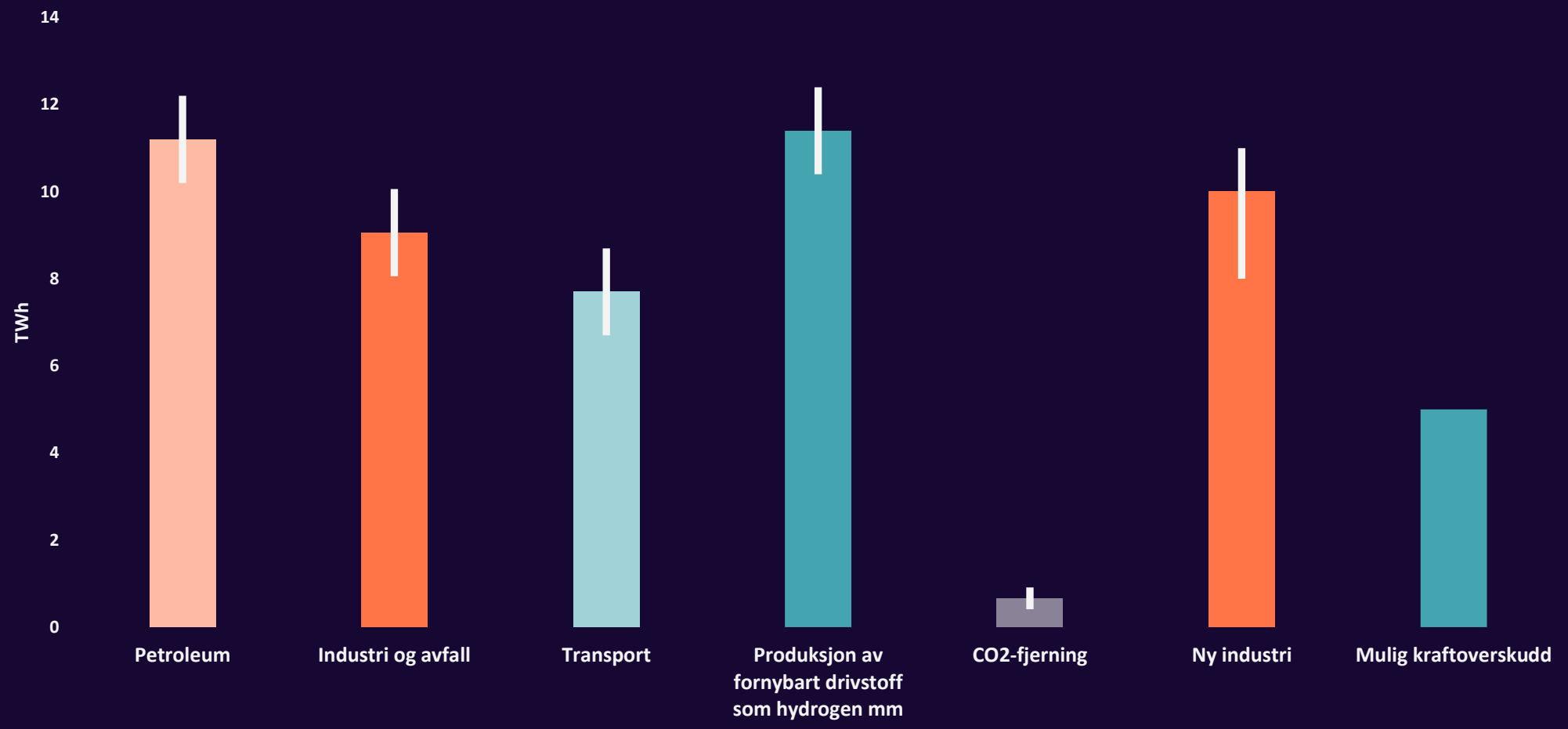
Agenda

- Klimamål som rammen
- Hva og hvor mye kreves av energibransjen for å nå klimamålene?
- Oppvarming som elefanten i rommet
- Alternative tiltak som avlaster og/eller påvirker strømnettet
- Systemintegrasjon

ZERO

ZERO
ZERO 2030:
Slik når vi klimamålene
«Innen 2030 skal 55 prosent av de norske klimagass-
utslippene kuttes, målt mot 1990. Denne forpliktelsen
gjelder hele økonomien, inklusive kvotepliktig sektor.»
Hurdalsplattformen

Nytt kraftbehov i 2030



Tiltak for å nå klimamålene innen 2030 kan bety behov for 55 TWh ny kraft

Hvor kan den kraften komme fra?

10 TWh
Vannkraft

5 TWh
Landvind

17 TWh
Havvind

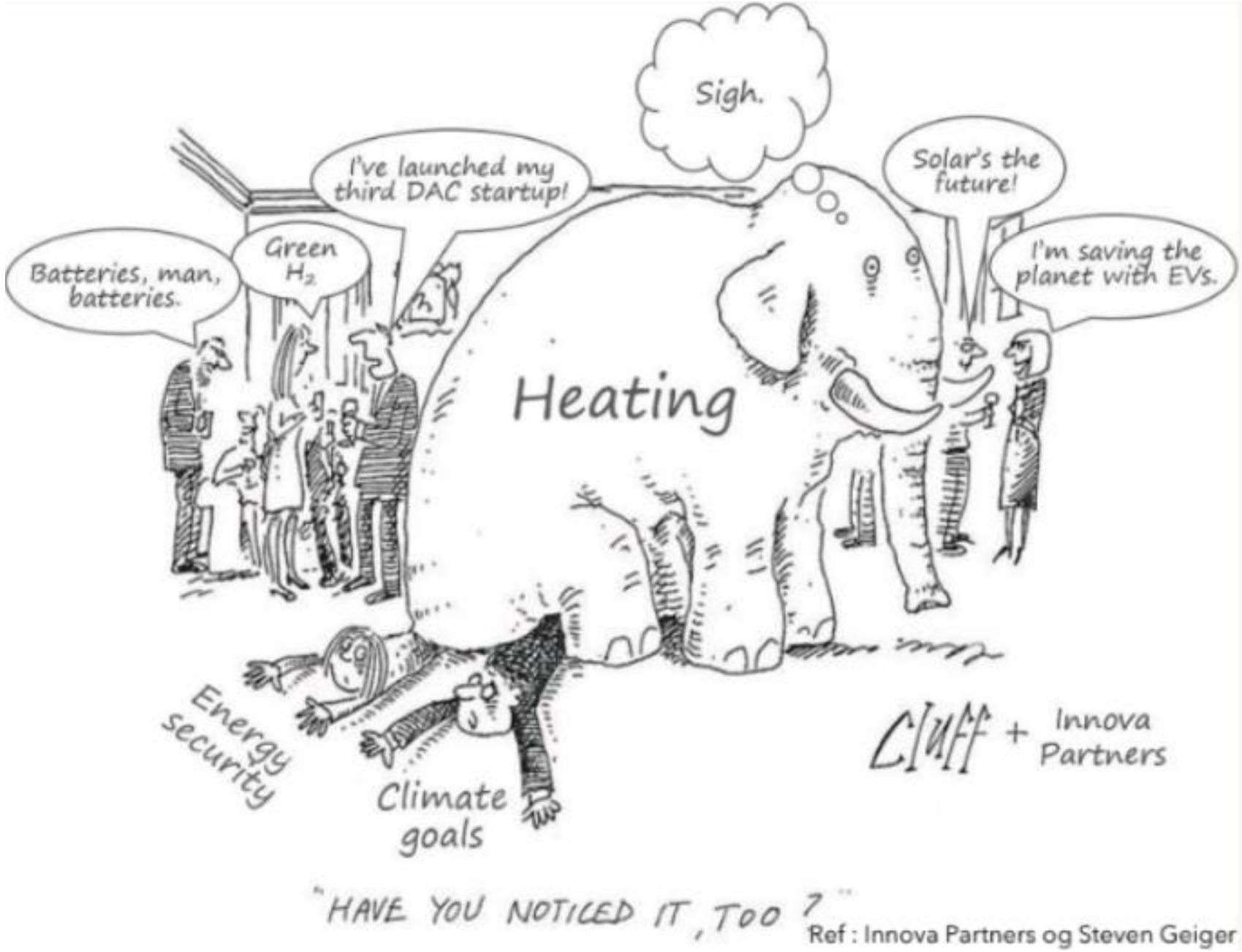
5 TWh
Bruk av varme-ressurser

8 TWh
Solenergi

10 TWh
Energieffektivisering

Dette betyr at vi må bygge mye mer nett, men også at vi må utnytte eksisterende energiressurser og -infrastruktur smartere!

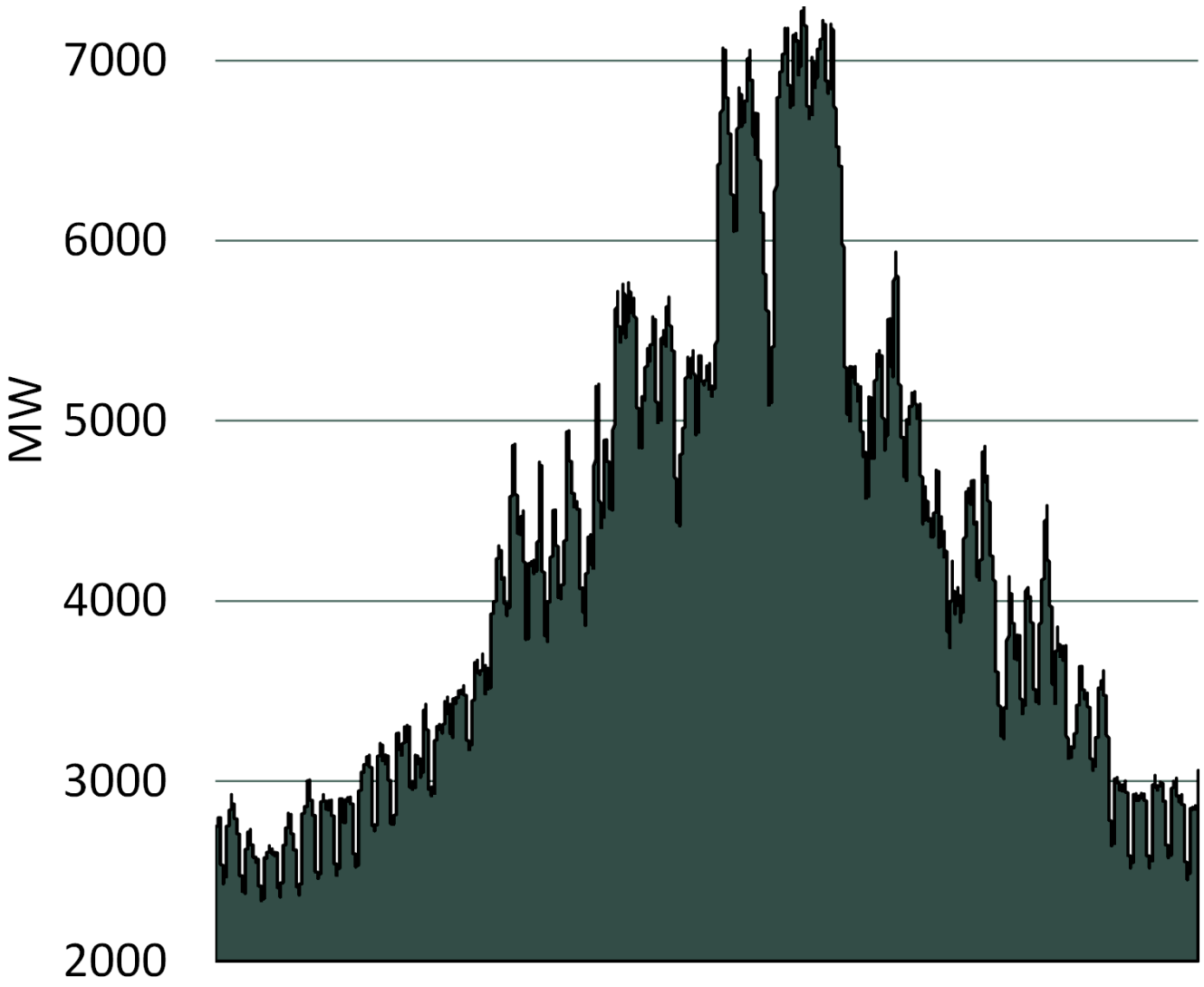
Systemsmart energibruk er en helhetlig utnyttelse av ulike energiressurser og infrastruktur som frigjør både energi og effekt til elektrifisering og grønn industri.



Ref : Innova Partners og Steven Geiger

SYSTEMSMART
ENERGIBRUK

Gjennomsnittlig forbruk per døgn på Østlandet (NO1) fra 1. juli 2020 til 30. juni 2021



Figur 2 fra Systemsmart-rapport «Fremtiden er nokså elektrisk» (lansert september 2022): Kuldeperiode gå flere uker med høyt forbruk vinteren 2021

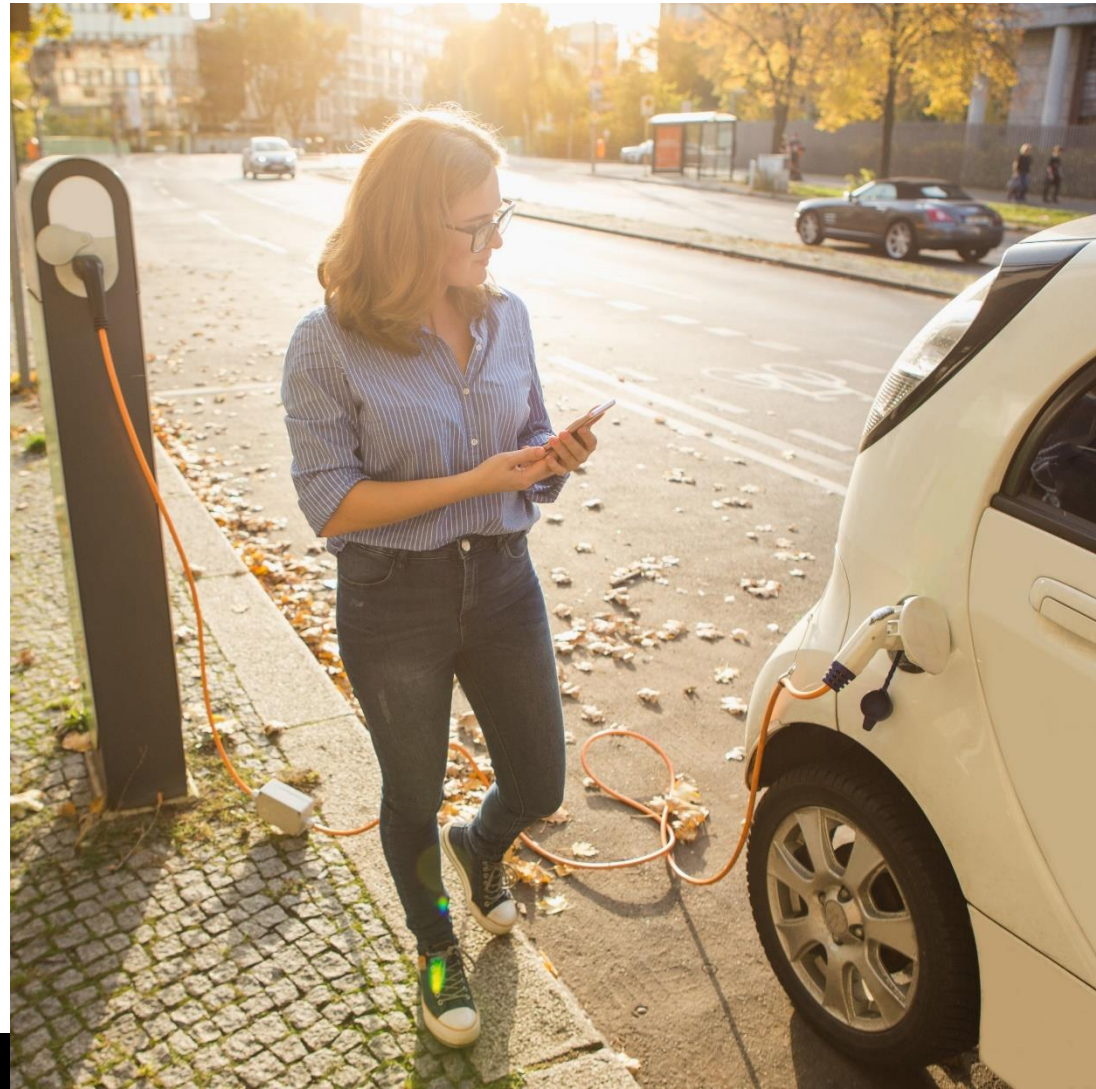
Direkte bruk av el til oppvarming i bygg driver mye av forbrukstoppene.

Og mye av forbruket er låst til bygg

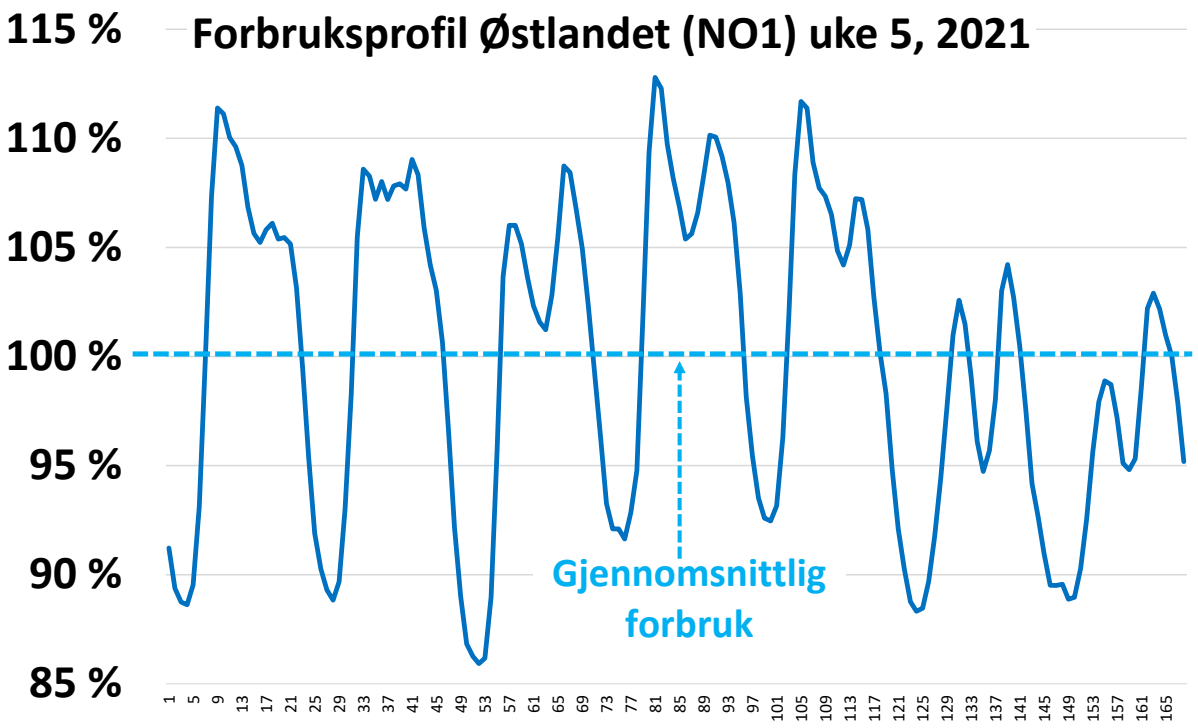
Hvilke tiltak og virkemidler kan frigjøre energi og effekt?

Fleksibilitet og flytting av forbruk

- Viktig bidrag
- Spesielt fleksibilitet som flytter forbruk ut av høylasttimer



Men flytting av elforbruk innenfor uka kan *maksimalt* senke forbrukstoppene 10-12%



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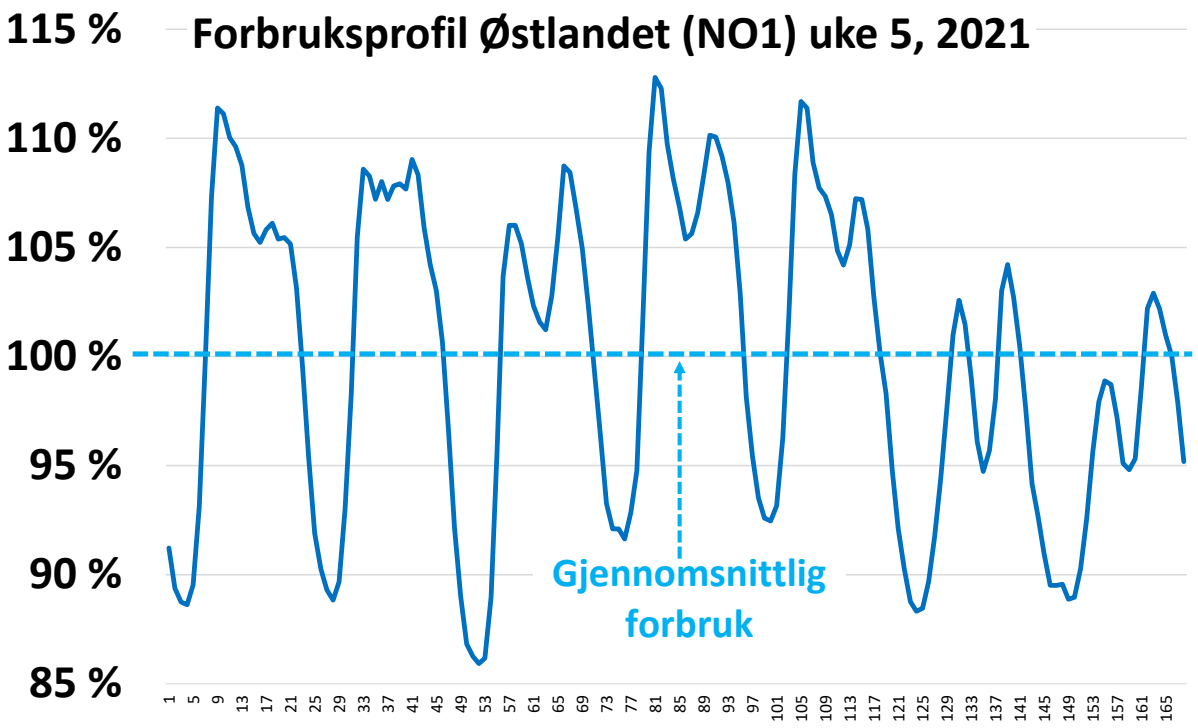
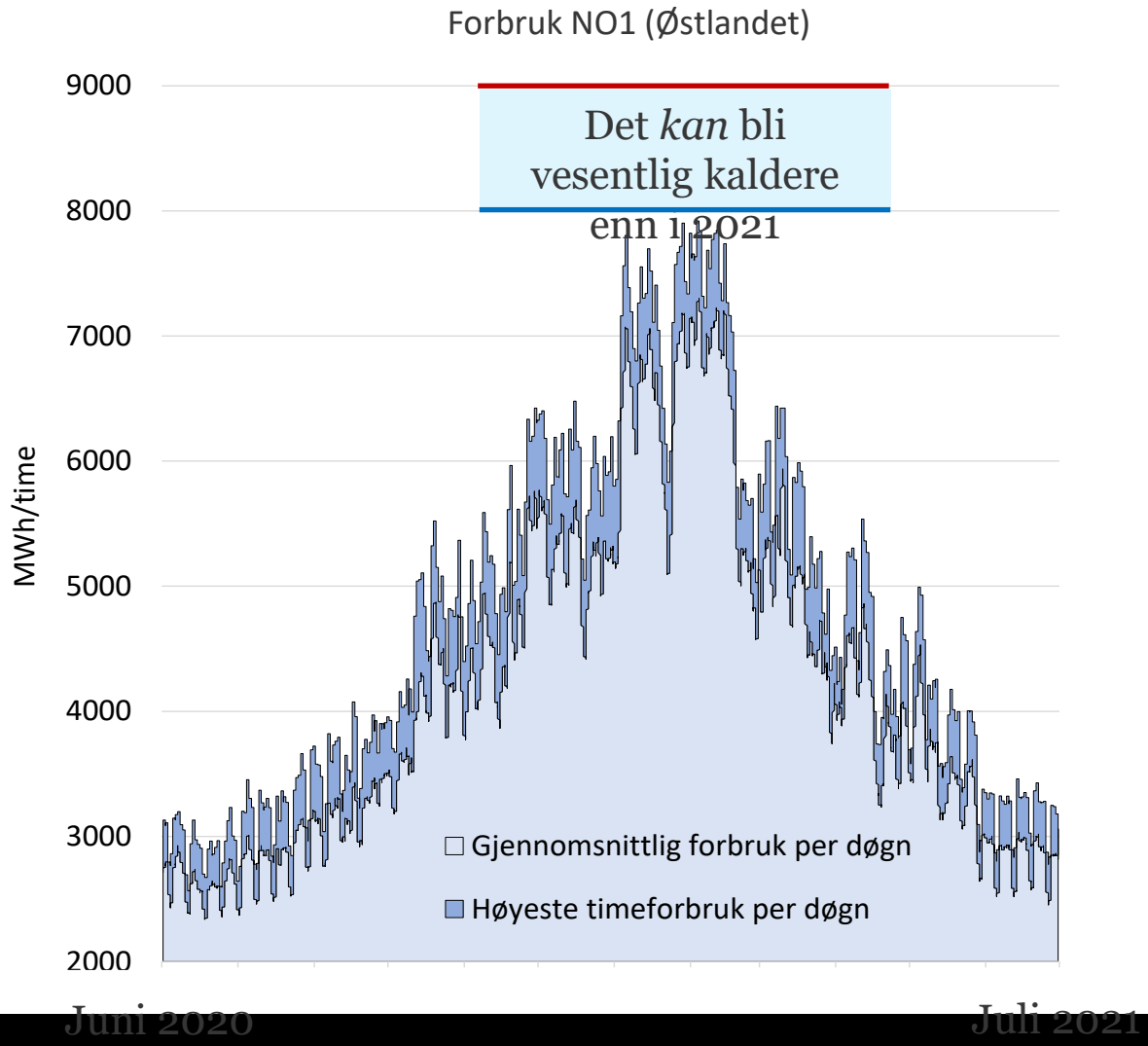


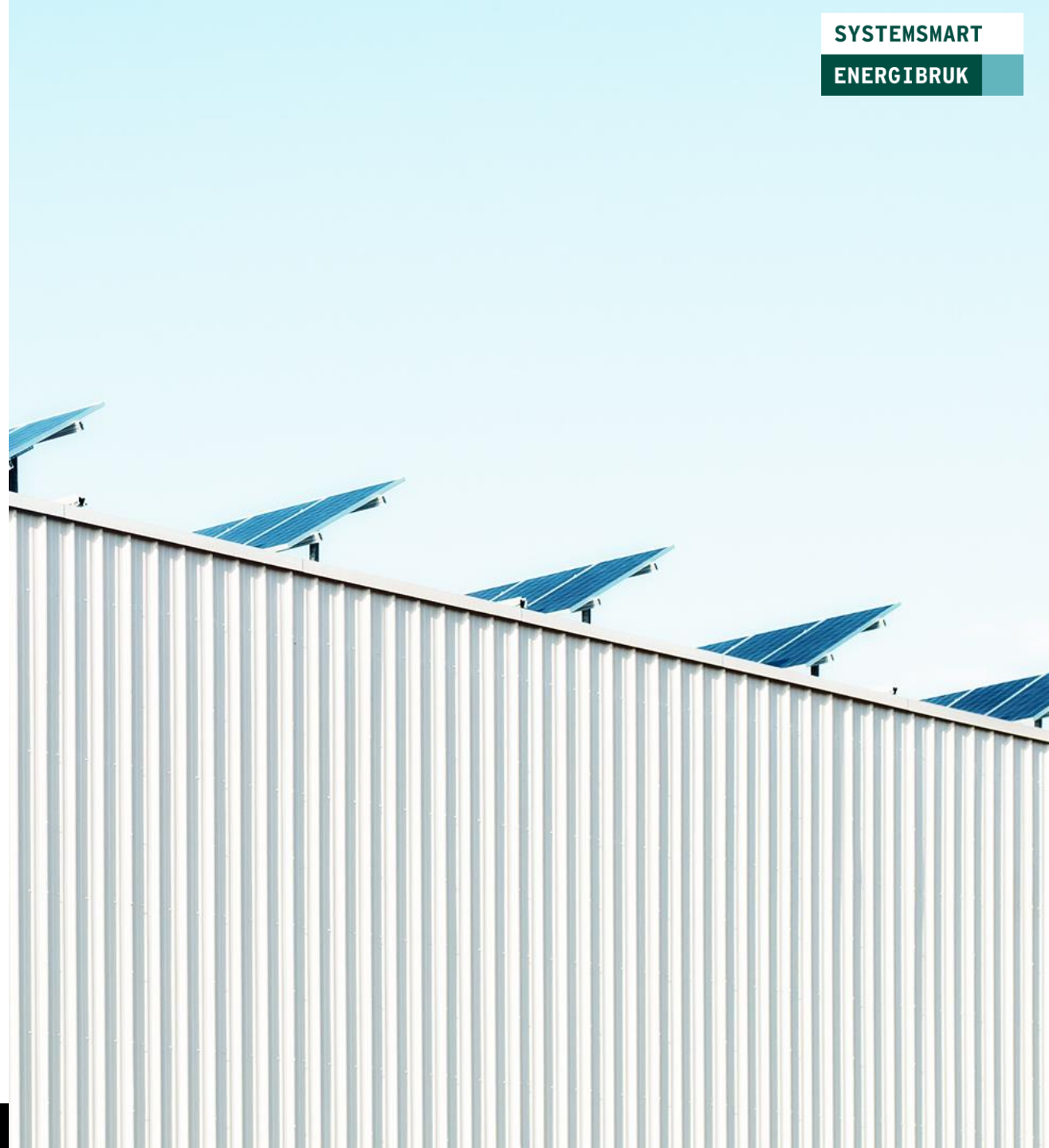


Energieffektivisering

- Siden 2016 hatt et **mål om å spare 10 TWh** i bygningsmassen.
- Skjedd lite, går mot liten reduksjon i energibruk hvis ikke virkemidler kommer på plass.
- **Eksempel på virkemidler:** Lån og støtteordninger, krav til energieffektivisering i offentlige bygg og energirevisjon i næringsbygg med høyt energiforbruk, informasjonsarbeid
- **Hvilken rolle kan nettbransjen spille?**

Lokal energiproduksjon

- Norge produserte i 2021 ~**0,15 TWh solenergi**. Multiconsult sier vi ligger 5 år bak Sverige i utbygging.
- **Høyere energipriser** gjør at flere investerer.
- Trenger fremdeles å endre regulatoriske barrierer og incentivere stor utrulling.
- **Hvordan må nettbransjen tilpasse seg dette?**



Økt bruk av termiske ressurser

- Mye varmeressurser fra industri, avfallsforbrenning og grunnvarme **går enten til spille eller blir ikke utnyttet.**
- Verdien av å **avlaste kraftnettet** synes ikke.
- **Eksempel fra Oslo**: Fjernvarmeproduksjon på 2 TWh har spart nettinvesteringer for om lag 4-7 milliarder og 10 milliarder i ny kraftproduksjon.
- **Hvordan kan kraft- og varmesystemet spille mer på lag?**

Systemintegrasjon

- EUs strategi for systemintegrasjon.
- Mangler helhetlig planlegging og sektorkobling i Norge.
- Alle dele av energisektoren må spille på lag når endringer skal skje fort.
- Det trengs tydeligere retningslinjer og rammer.

Last ned rapporten
på www.systemsmart.no

Deltakere i prosjektet

Styringsgruppe

Statnett

ENOVA

1) Norsk Fjernvarme

Elvia

Sekretariat: ZERO

Bidragsytere

NOVAP NORSK VARMEPUMPEFORENING

VIKEN FYLKESKOMMUNE

Akershus energi

STATSBYGG

GLITRE ENERGI

Borregaard

ØSTFOLD ENERGI

1) mfl: Statkraft varme, Fortum varme, Energi Norge, NoBio, Tafjord kraftvarme, Eidsiva Bioenergi, Norsk Energi, Mo Fjernvarme, Kvitebjørn Varme, Agder Energi Varme, Lyse Neo

ZERO

zero konferansen 2022

Radisson Blu Plaza Hotel
24. november

Se program og kjøp billett på

zerokonferansen.no

Takk for meg!☺

tone.svendsen.endal@zero.no
www.systemsmart.no
www.zero.no

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BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

Our renewable innovation

Nordic Smartgrid Alliance October 27 2022

Rune Hogga
CEO
Agder Energi Fleksibilitet AS

agder energi

Agder Energi

21,800 km
Power Grid lines

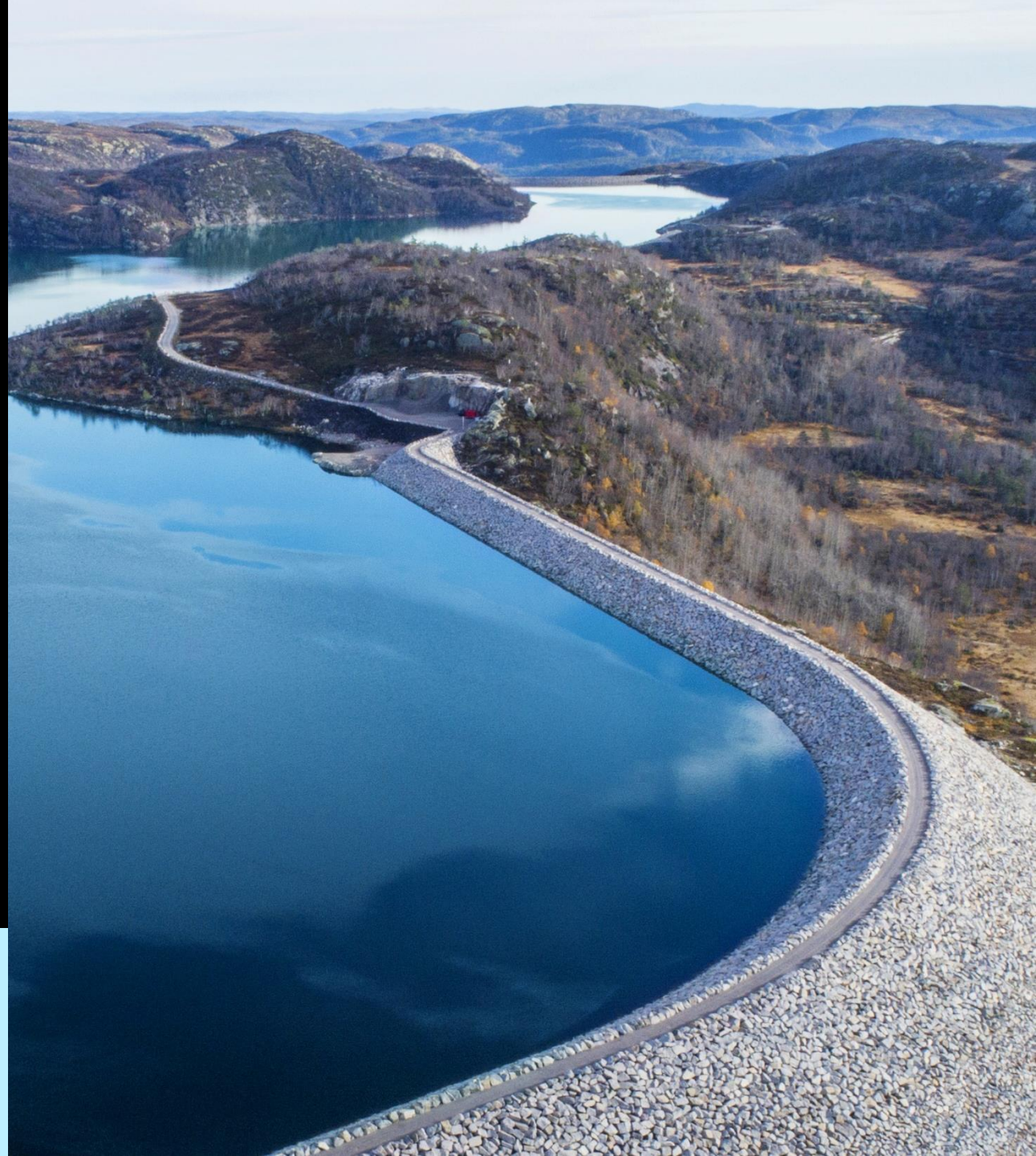
49
Power stations

<30 TWh
Renewables managed annually

8,7 TWh
Annual production

Production → Distribution → Customer

Flexible hydro power is our core business



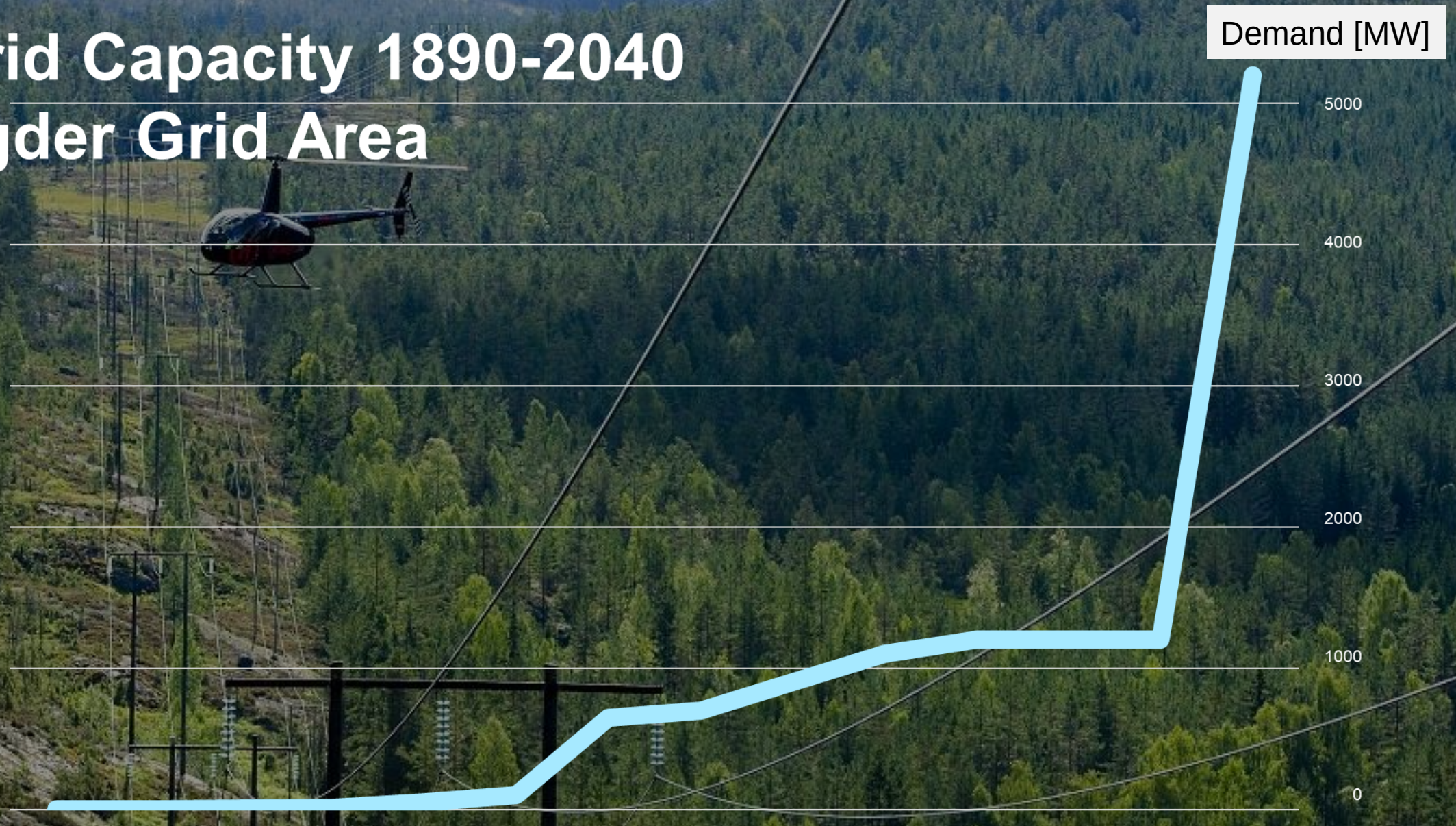
Norway has half the hydro power storage capacity in Europe

Establishing a strong offshore wind industry in Norway

Building a giga factory for battery cell production in Southern Norway

Green hydrogen production

Grid Capacity 1890-2040
Agder Grid Area



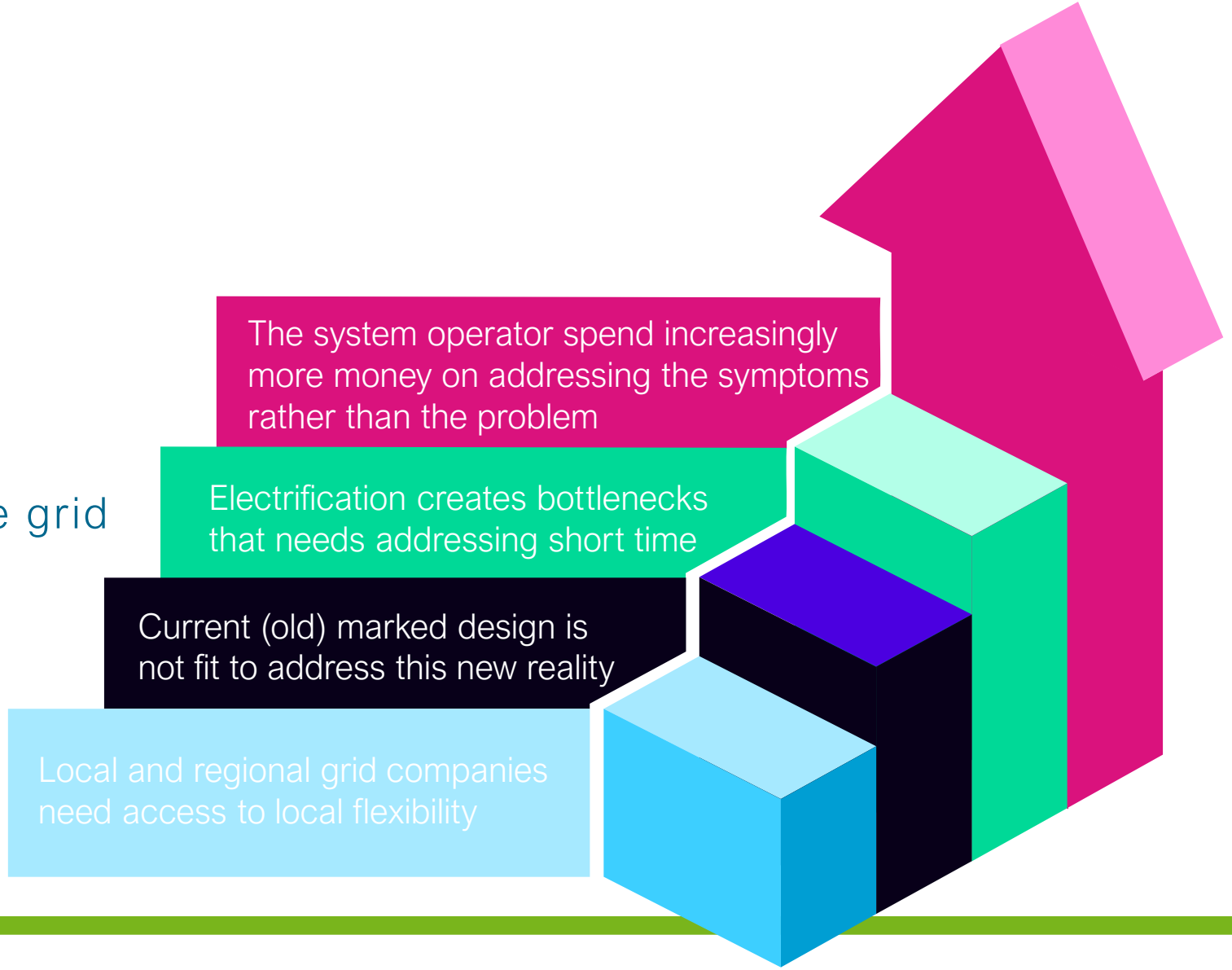
Energy transition needs more grid capacity

System costs are increasing fast

There is not enough capacity in the grid

Increased renewables creates instability and price volatility

It takes time to build grid



Smart Grid solutions

gridtools NODES EnFo

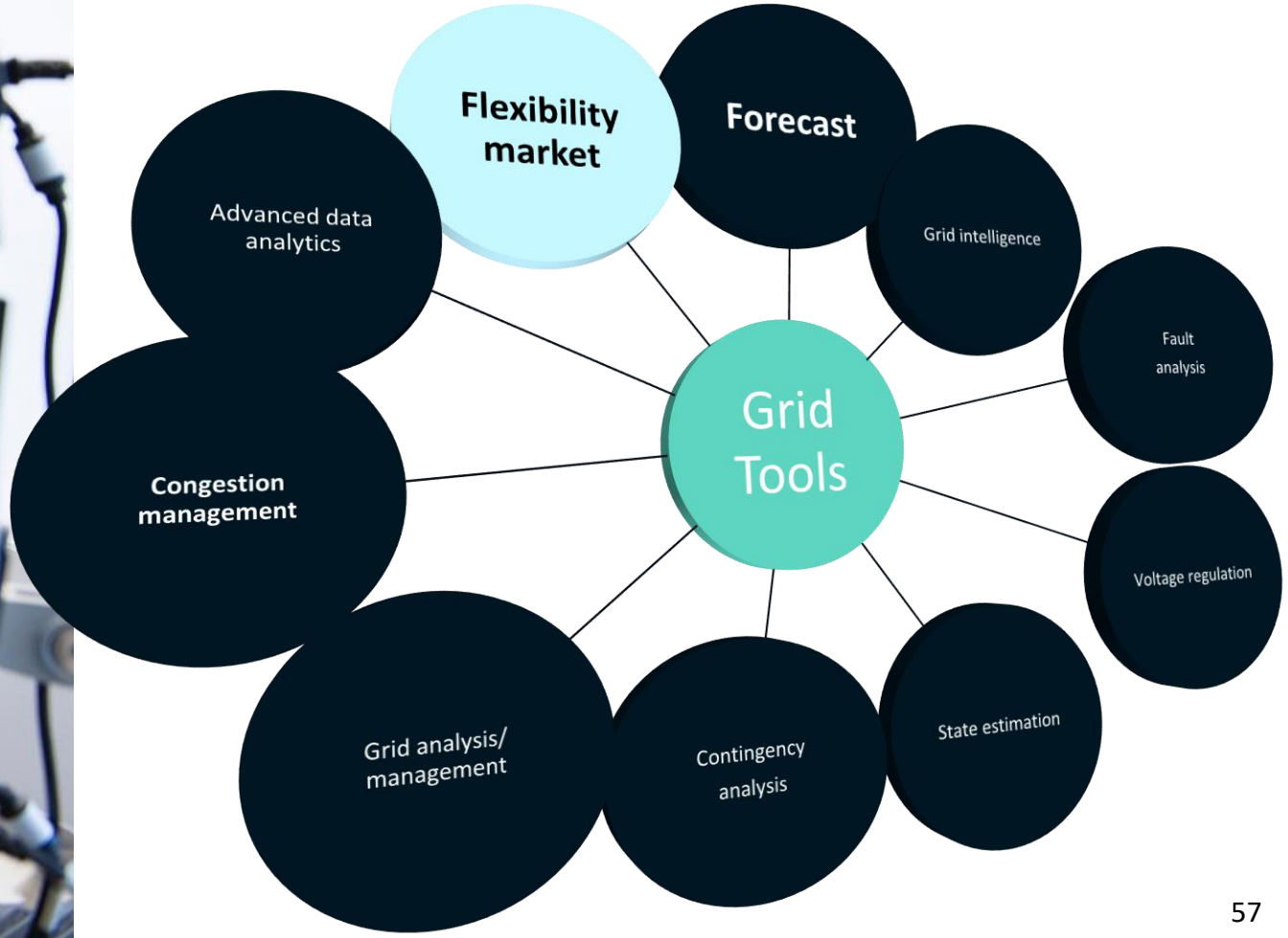
Investment deferral

Engene sub station

- Smart Grid Project with Microsoft
- Investment deferral use case
- Flexibility alternative
- Developed into large scale demonstration

DSO role

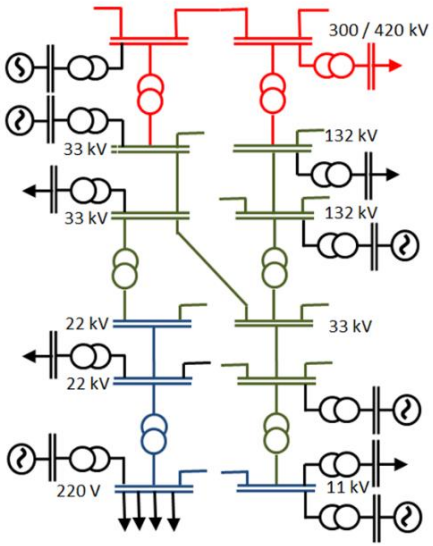
Flexibility market is one of many tools



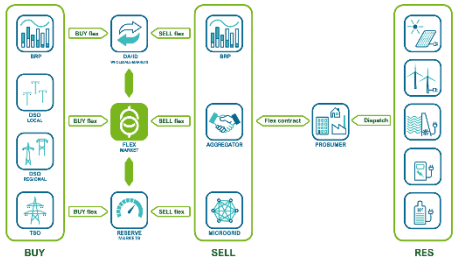
Congestion management

Alternatives

Switching

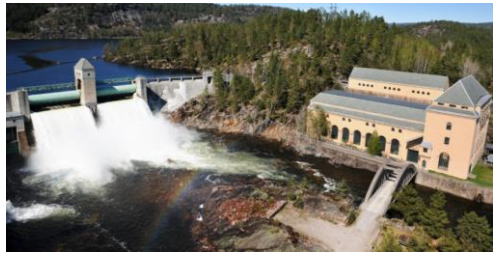


Market based flexibility



Interruptible connection agreements

Flexible production



Large scale demonstration project 2019 - 2023

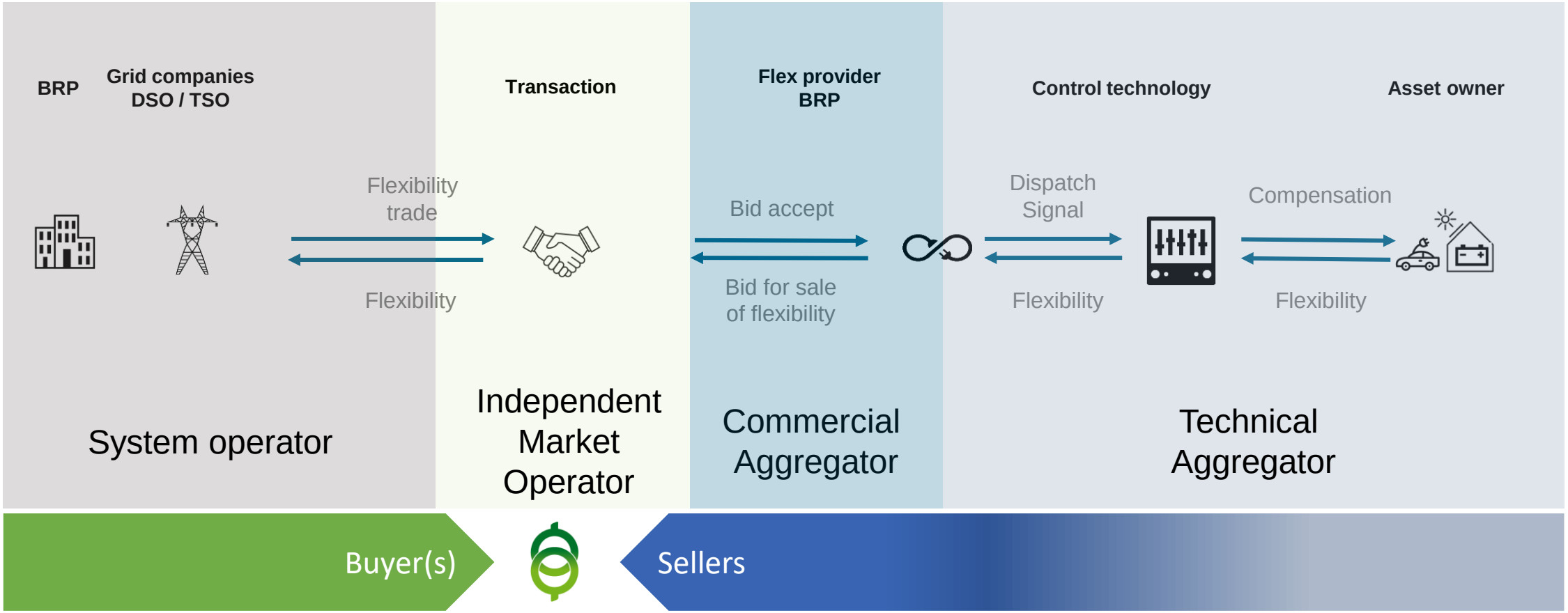
NOR FLEX

- New digital flexibility value chain
- Verification of market model
- Facilitating new business models

- Level playing field for all asset types
- Industrial, commercial and household assets
- Value stacking, aggregation DSO - TSO

agder energi GLITRE ENERGI NODES Statnett ENOVA

New digital flexibility value chain



NORFLEX

NOR FLEX

ENOVA founded

LARGE SCALE DEMONSTRATION 2019 - 2023

- Facilitating new business models
- Industrial, commercial and domestic assets
- Independent market operator
- Equal playing field for all asset types
- Value stacking, aggregation DSO - TSO

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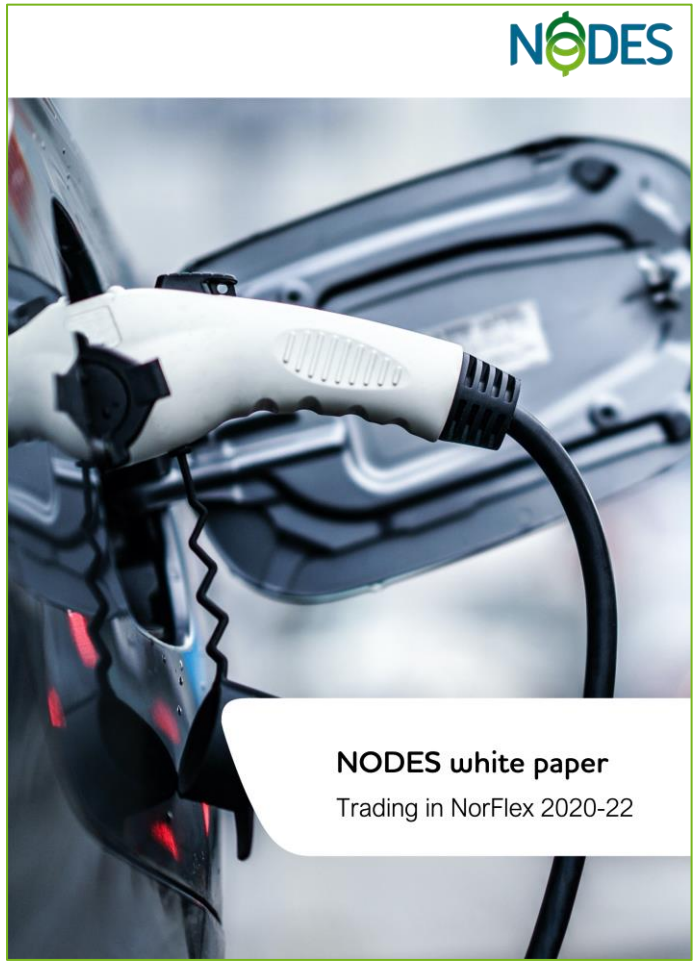
GLITRE ENERGI
Statnett

NODES

tibber
ISTADKRAFT
Ishavskraft
NOOVA
volue
GLITRE ENERGI
Entelios
A part of Agder Energi
true
a Landis+Gyr company
LOS

Grid companies DSO / TSO	Transaction	Flex Service Provider FSP/BRP	Control technology	Asset owner

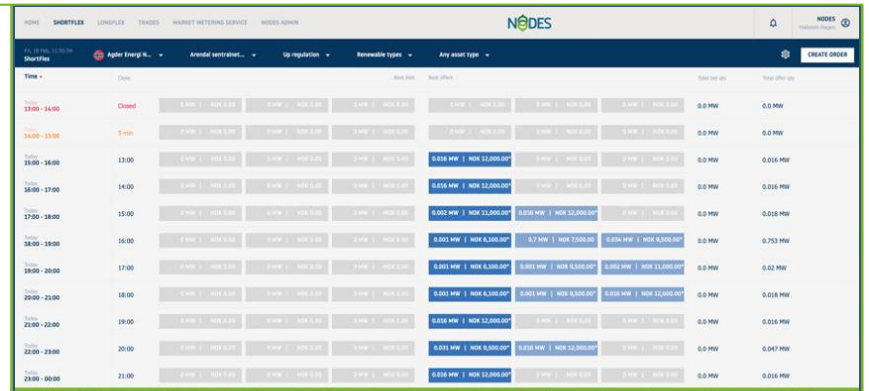
Results

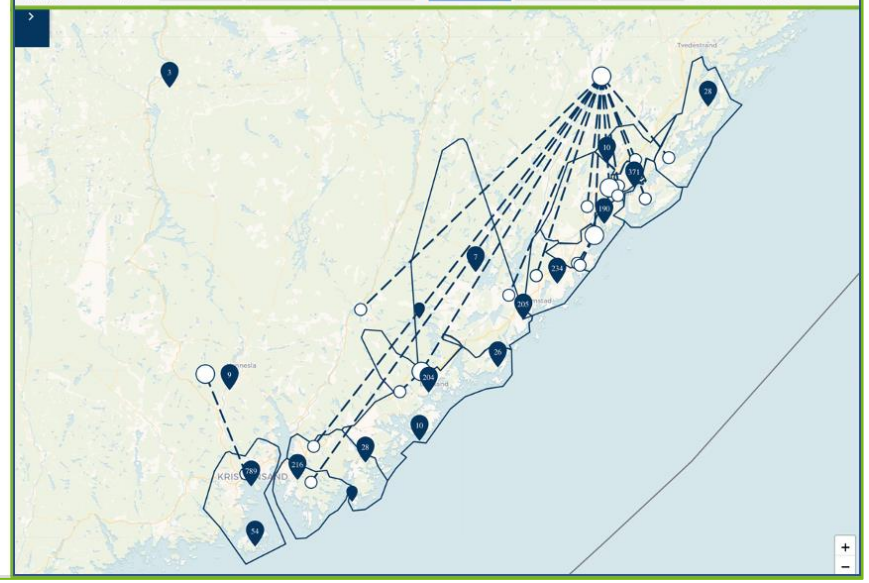


Trading statistics

Jan 2021 – Mar 2022

# aggregators	8
# assets	> 2 400
traded volume	> 600 MW*h
# trades	> 12 000
average price	850 EUR/MW*h
total contracted value	>510 000 EUR
smallest order	1 KW*h
largest order	5,4 MW*h
highest volume pr hour	7 MW





https://nodesmarket.com/publications/

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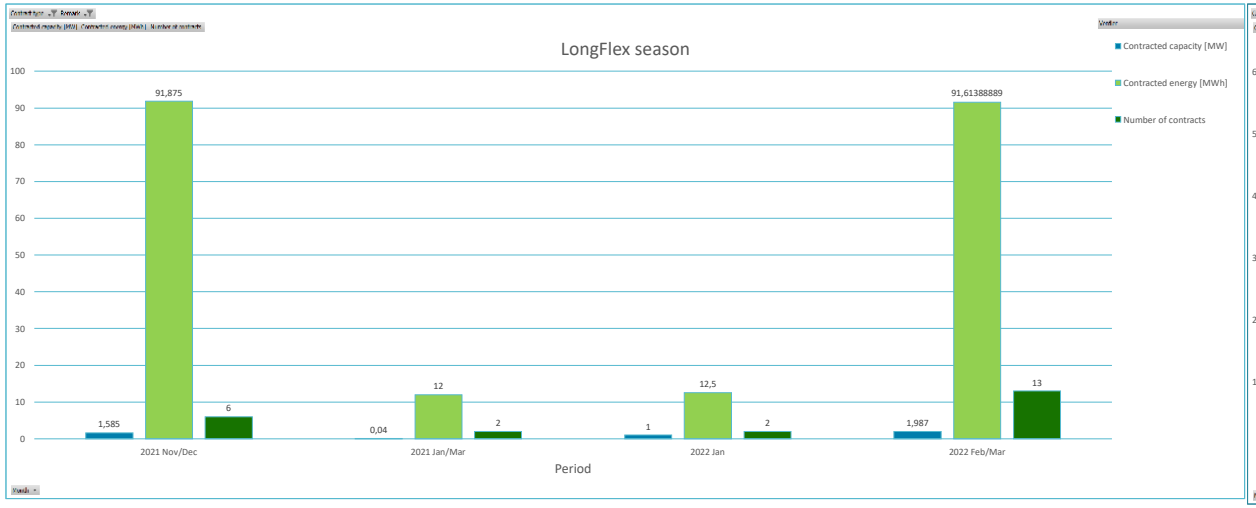
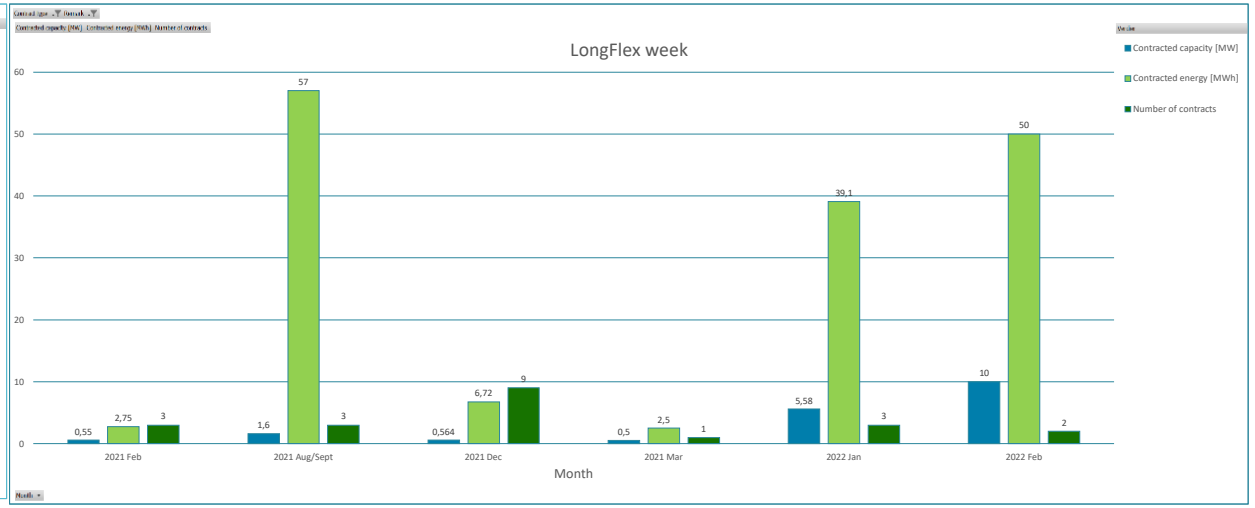
LongFlex - availability contracts



LongFlex Season

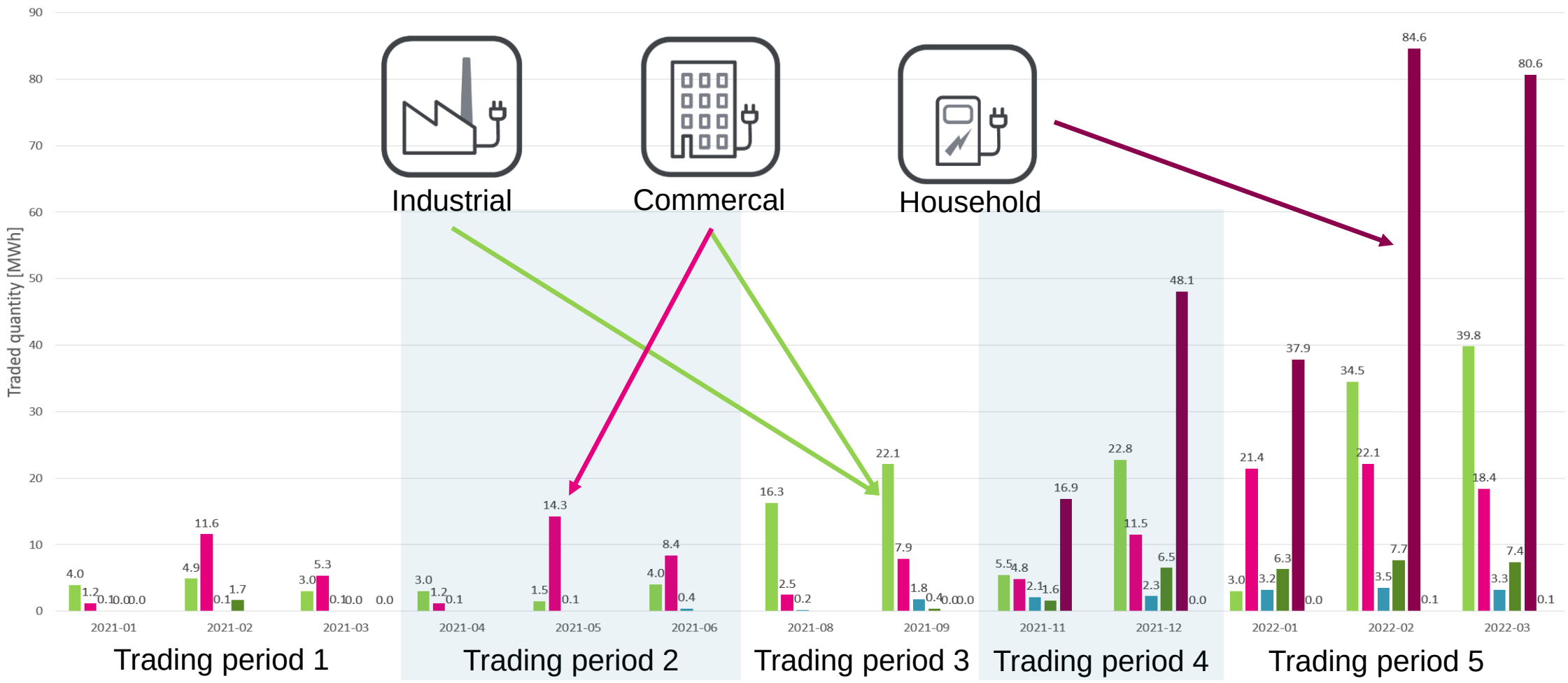


LongFlex Week

Level playing field for all asset types

NOR FLEX

ShortFlex - Activation contracts



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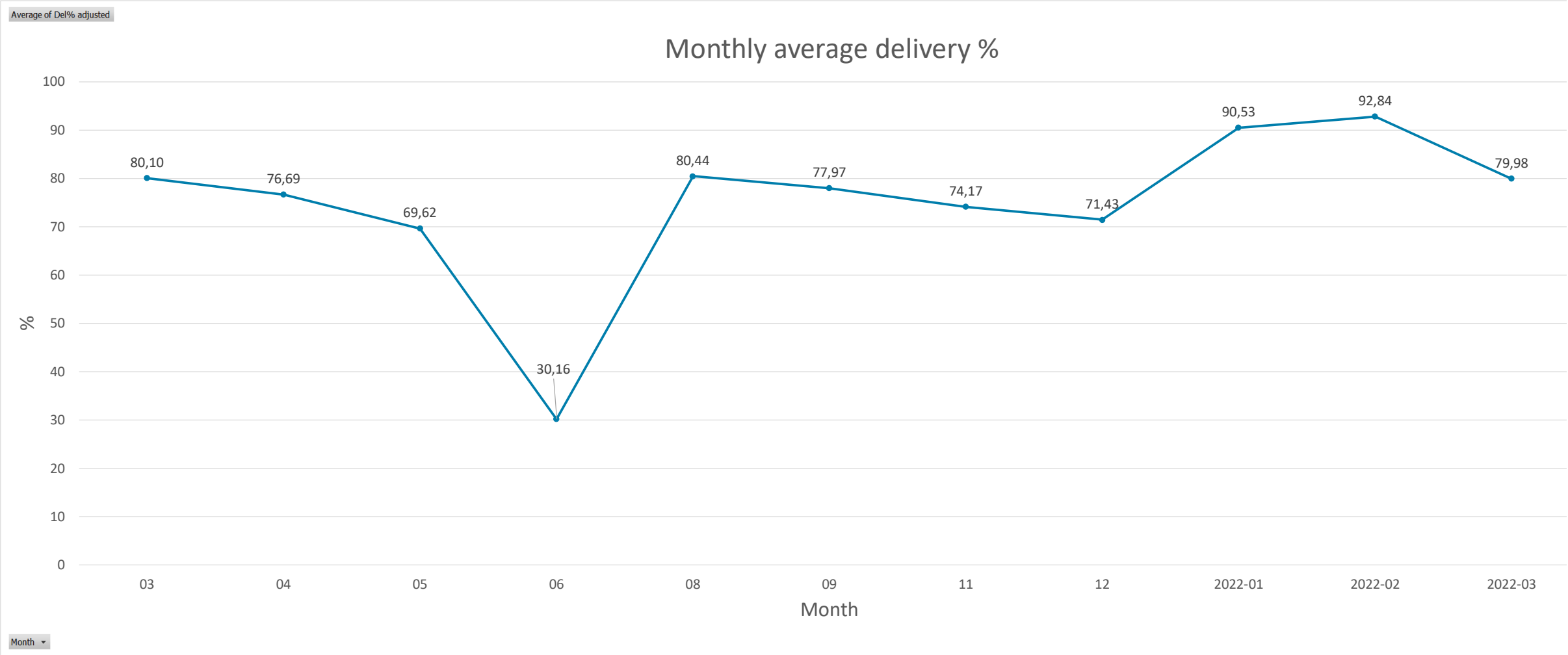
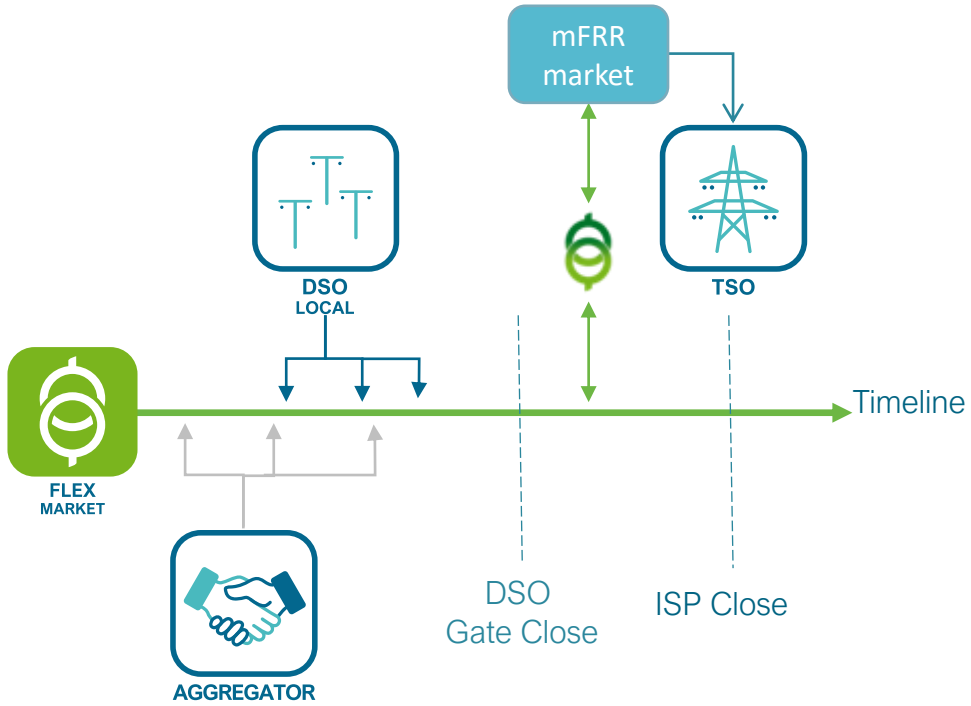
Delivery quality

Based on baselines – meter data



TSO/DSO coordination

NORFLEX – sequential access to DSR

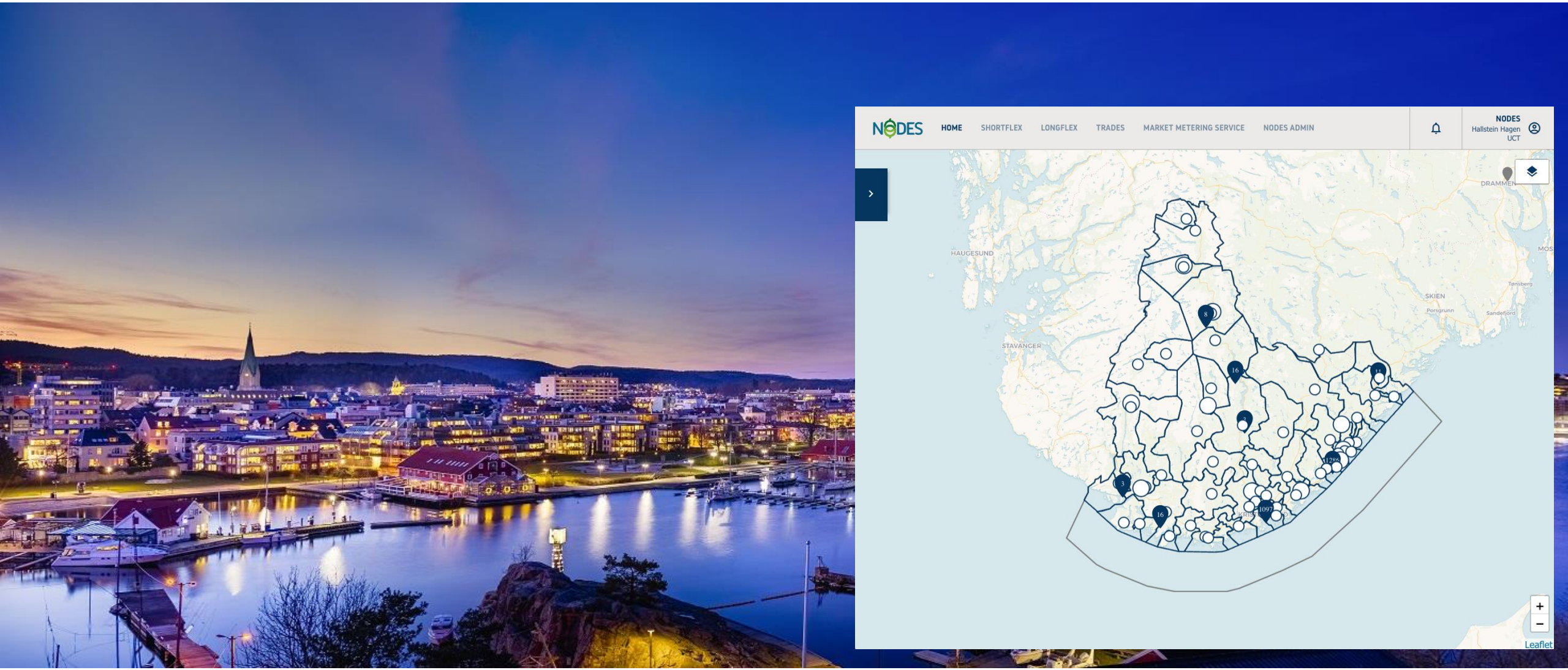


Value Stacking for flexibility providers

- NODES resolution 0,001 MW
- mFRR resolution 1,0 MW (exception from 10 MW – 5 MW rule)

….and we are continuing!

NOR FLEX



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The new company formed by the **merger** of Norwegian utilities **Agder** Energi and **Glitre** Energi will be called **Å Energi**

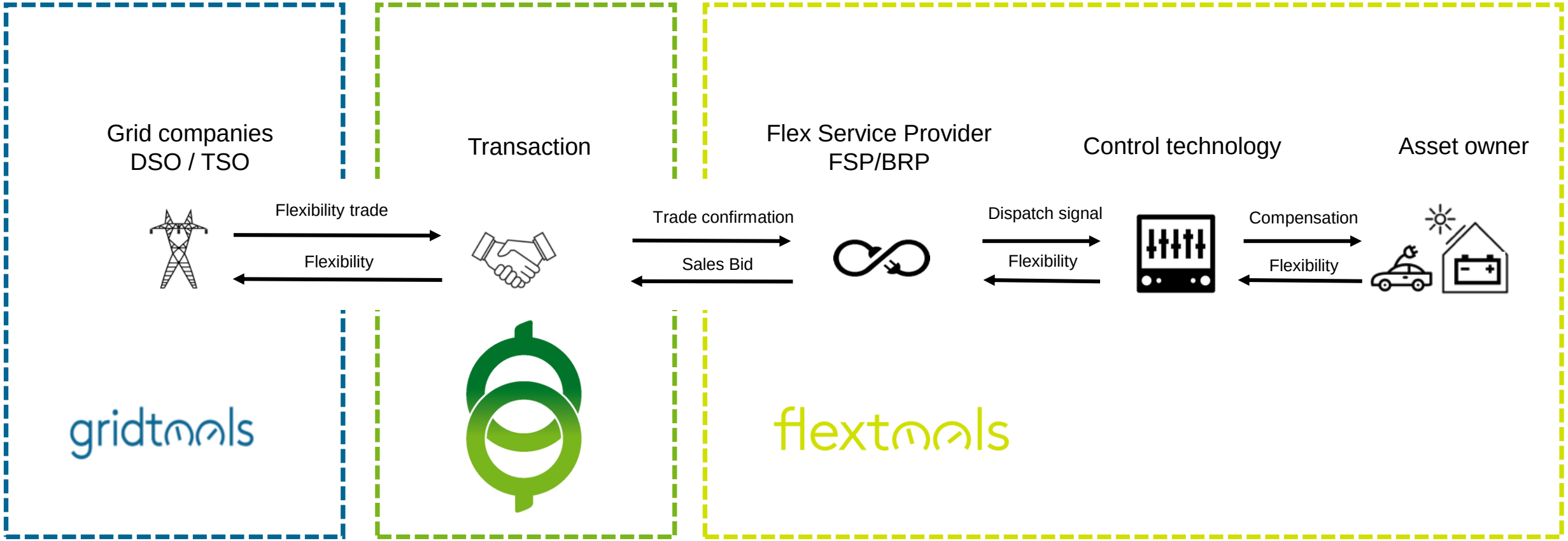
- 11,3 TWh Annual Production
- 72 Power Stations
- 30,000 km Power Grid Lines, with 310 000 end users
- >30 TWh renewables managed annualy
- Retail Private > 200 000 customers
- Retail Commercial, largest in Norway

Å
ENERGI

Å ENERGI

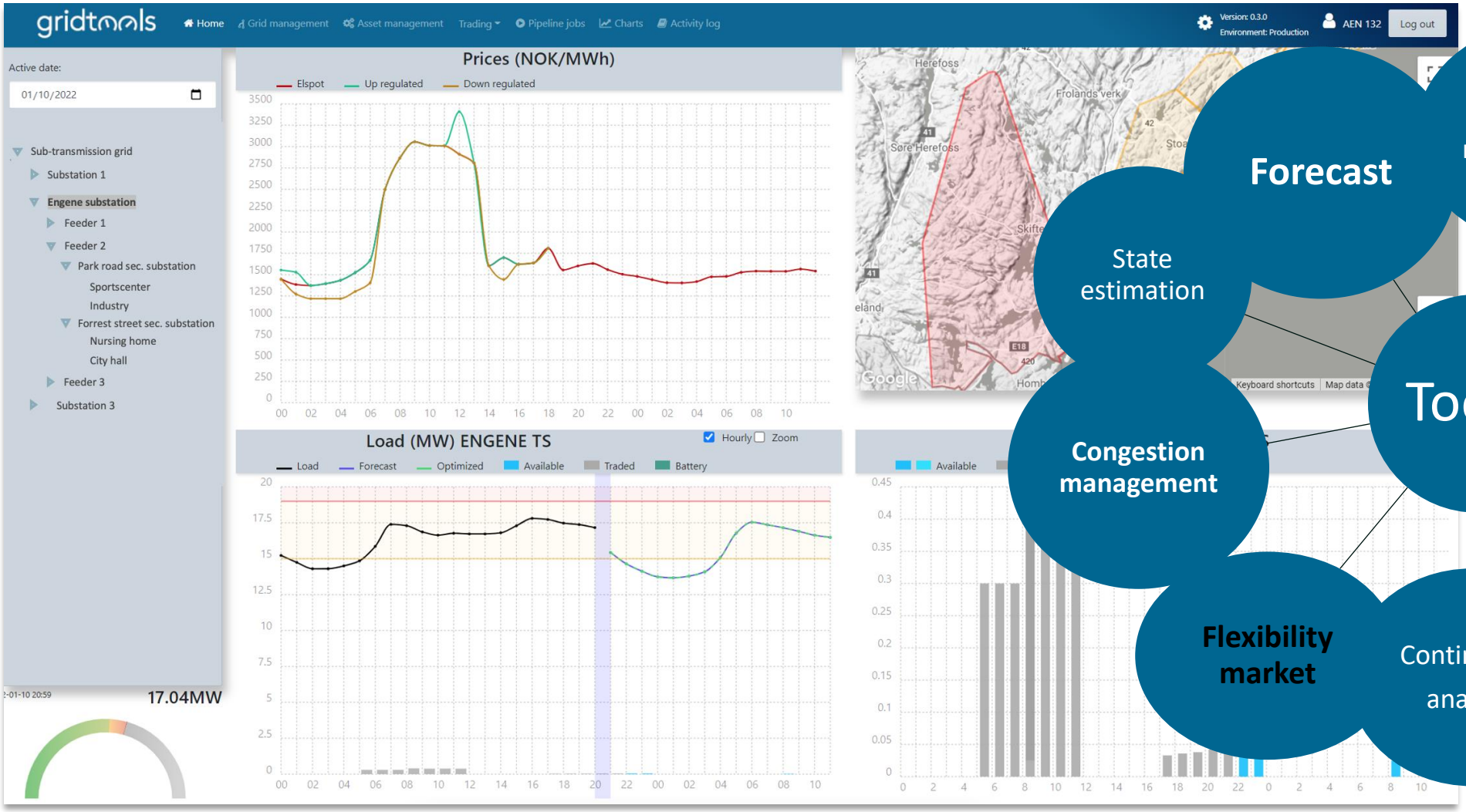
Bottom-up approach

in the new digital value chain



Grid Optimization

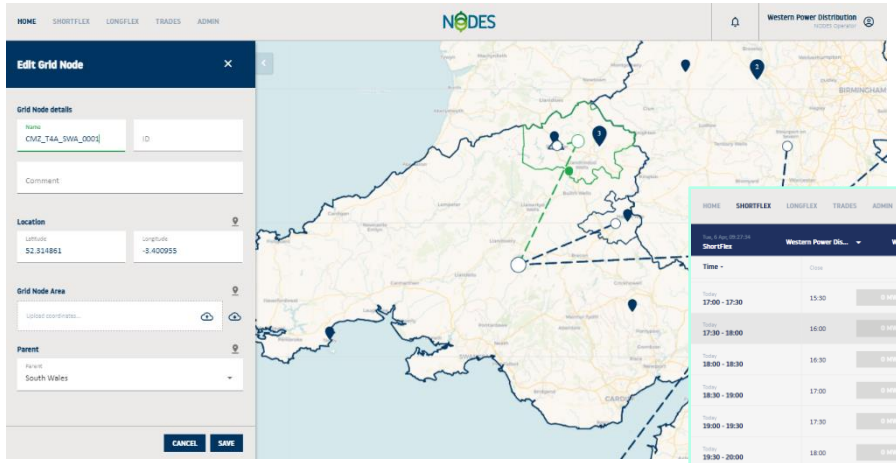
The grid operator need new tools – GridTools

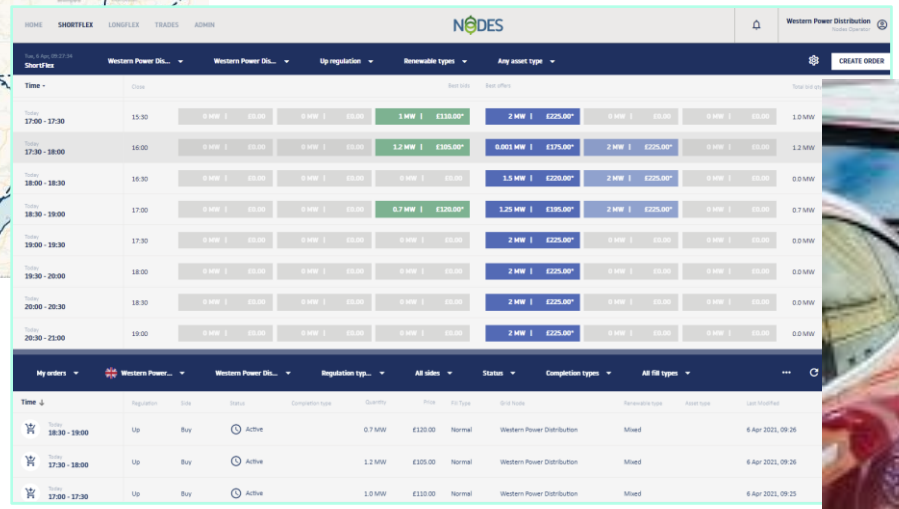


Identify
congestion areas in the grid

Trade
flexibility through a common platform

Settle
transactions between buyers and sellers





Asset Optimization

Monetize on flexible assets in the power grid

flextools

Platform connecting flexible assets to the markets

Onboarding of flexible assets through API or IoT Edge installations

200MW 15MW 190MW 5MW 50MW

Aggregation and portfolio management to meet market requirements

Trading interface for all available flexibility markets in the Nordics

Analytics and machine learning algorithms for predicting flexibility and baseline

Realize profit from your flexible assets while contributing to a more resilient and flexible grid.

Sensitivity: Internal

Thank you

Rune Hogga
CEO, Agder Energi Fleksibilitet AS
rune.hogga@ae.no

Agenda – Part 1

- Setting the scene
  - *Lene Mostue, Director, Energi 21*
- The role of energy sector towards the climate targets and alternate measures to support the grid
  - *Tone Svendsen Endal, Adviser energy systems and project manager Systemsmart energibruk, Zero*
- Flexible solutions – Example Norflex
  - Rune Hogga, CEO of Agder Energi Fleksibilitet AS and Chairman of NODES AS and Enfo AS
- **The Norwegian Energy System and how communities can contribute to a smarter grid**
  - *Karen Byskov Lindberg, Senior Advisor Distributed Energy Systems, TrønderEnergi/ANEO*

BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

The Norwegian Energy System

and how buildings and neighbourhoods can contribute to a smarter grid

Karen Byskov Lindberg, Ph.D.
Senior Advisor Distributed Energy Systems | **TrønderEnergi/ANEO**
Adj. Associate Professor | **NTNU Electric Power Engineering**

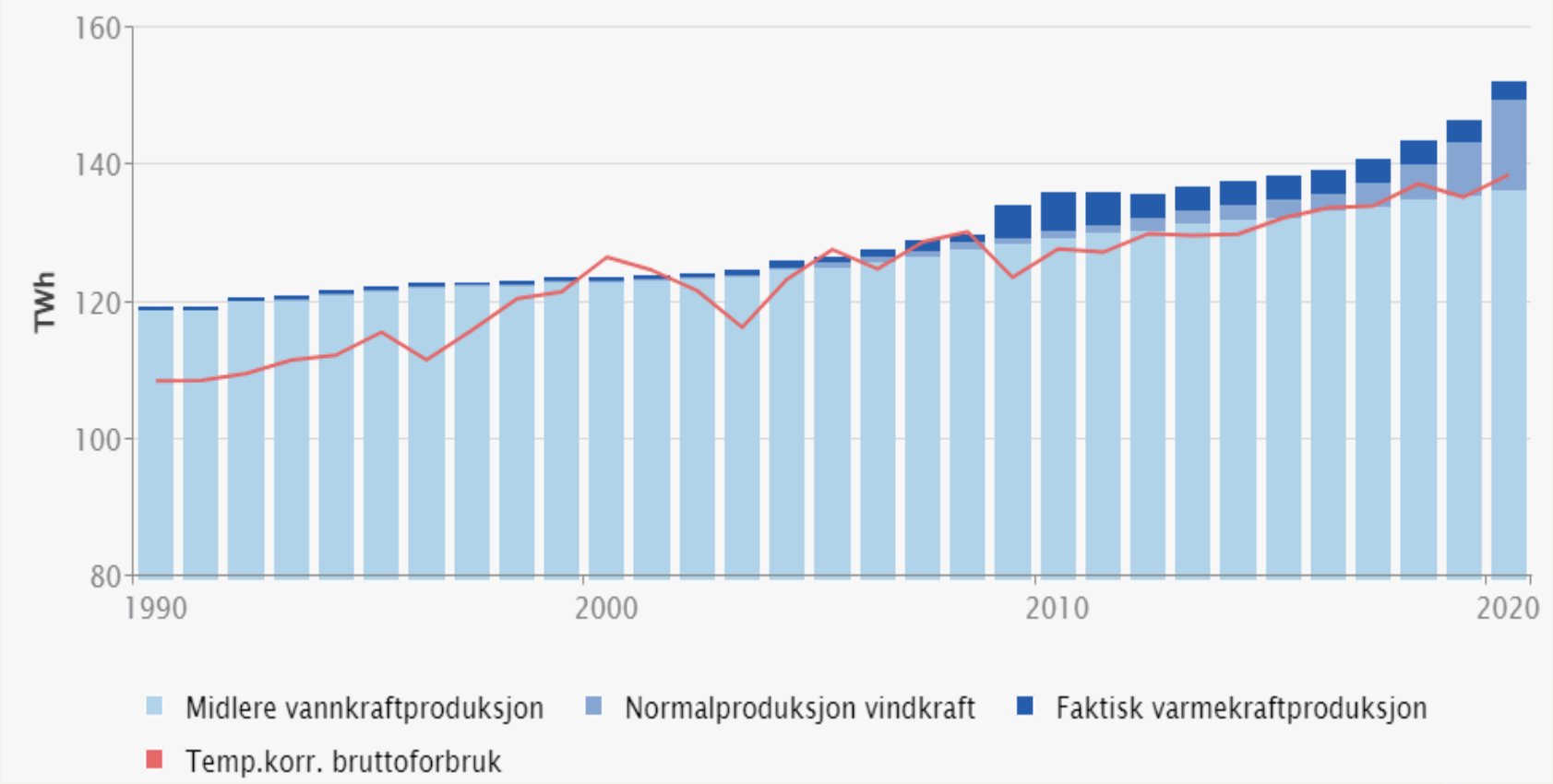
karen.byskov.lindberg@tronderenergi.no

TrønderEnergi®

Agenda

- The Norwegian Energy system
  - Power production
  - Energy use
  - Grid tariff structure
- Energy flexibility in neighbourhoods and buildings
  - Oportunities and challenges

Total electricity production in Norway



Normal year

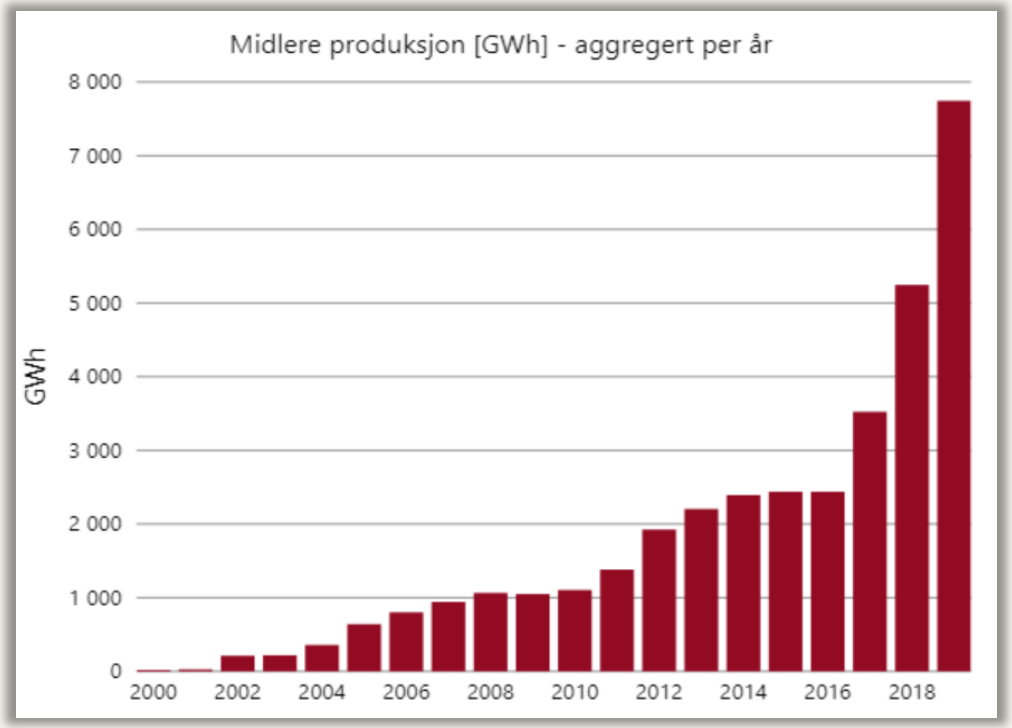
- 155 TWh produced
- 38,7 GW installed

Ref: NVE

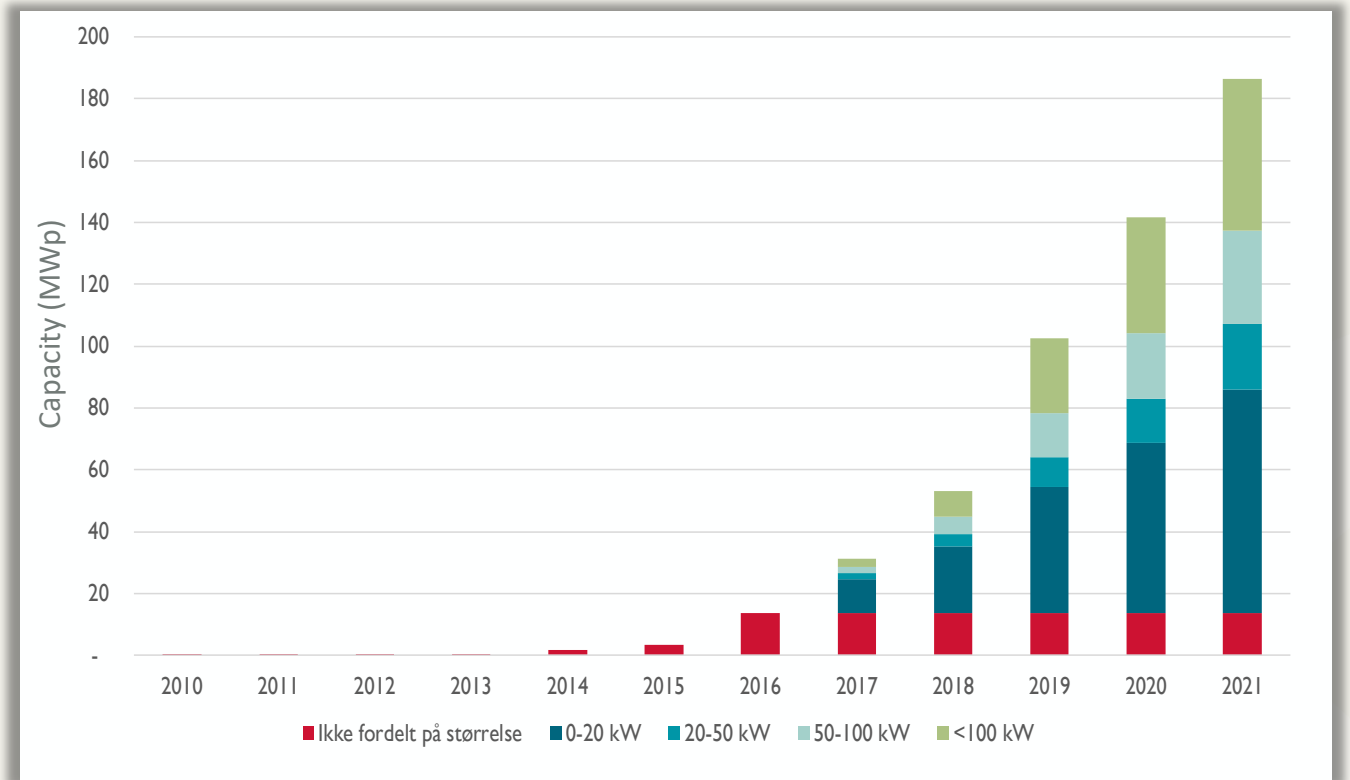
https://energifaktanorge.no/norsk-energiforsyning/kraftforsyningen/#vannkraft

Wind and Solar power production

- Wind
  - 15,4 TWh ; 4 650 MW (2021)
  - Calculated average annual production
  - (real production varies with wind conditions)

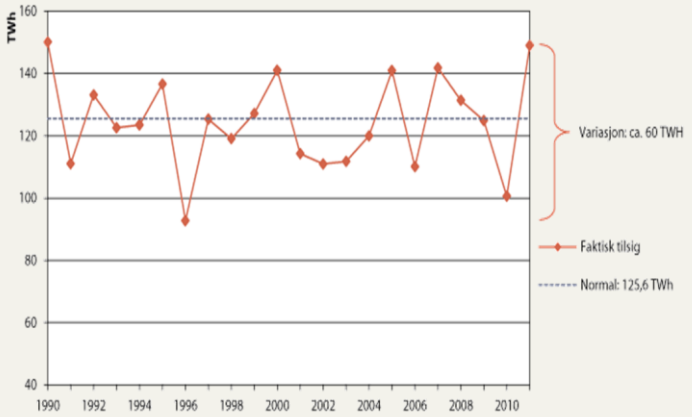


- Solar
  - 0,16 TWh ; 185 MWp (2021)
  - Accumulated installed capacity
  - Mainly building integrated

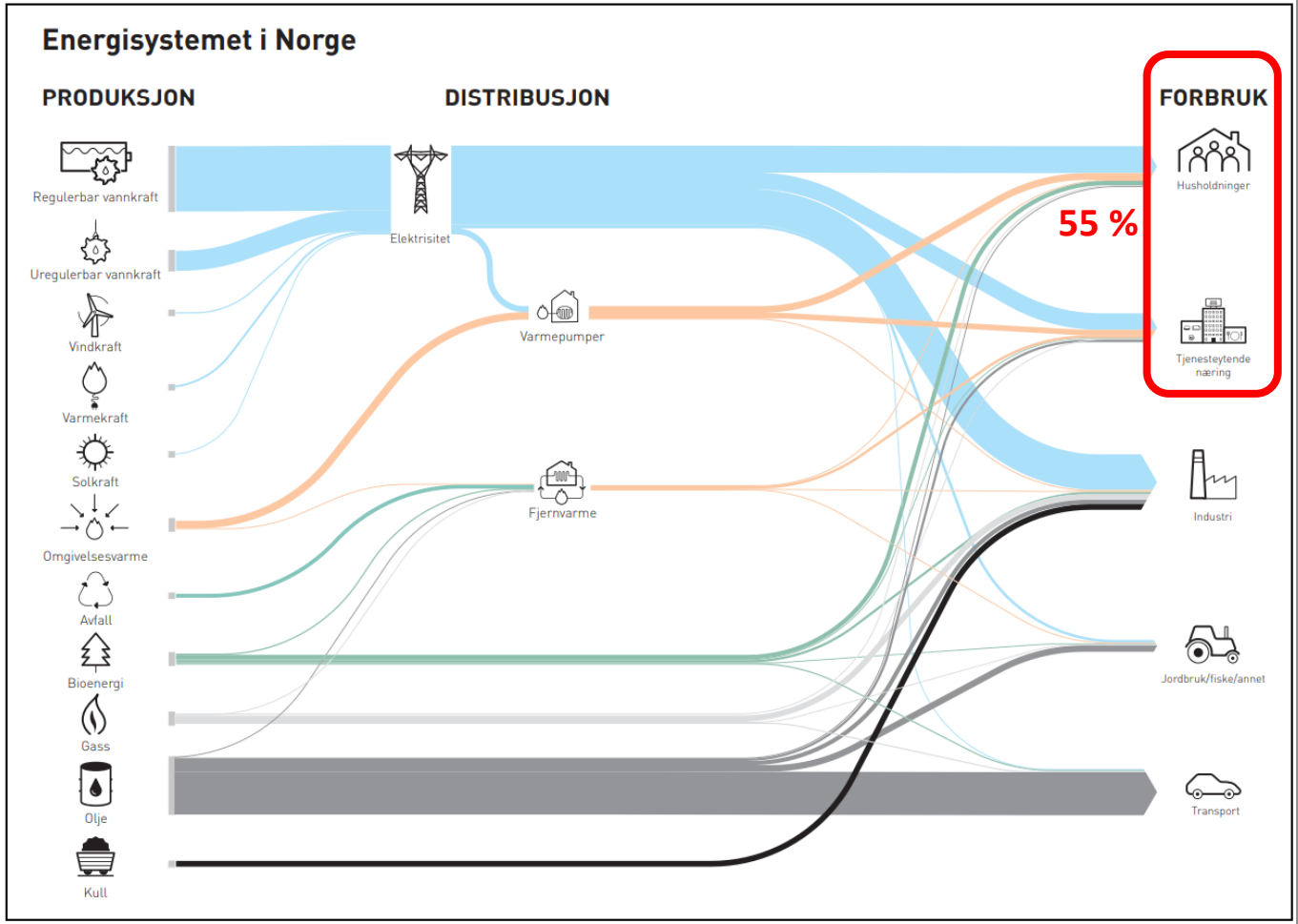


The Norwegian energy use

- Highly electrified
- Energy use in buildings (2020)
  - Electricity: 63 TWh (55 %)
  - Energy: ca 80 TWh (37 %)
- Large potential for
  - energy savings
  - On-site production (PV)



Kilde: OED/NVE



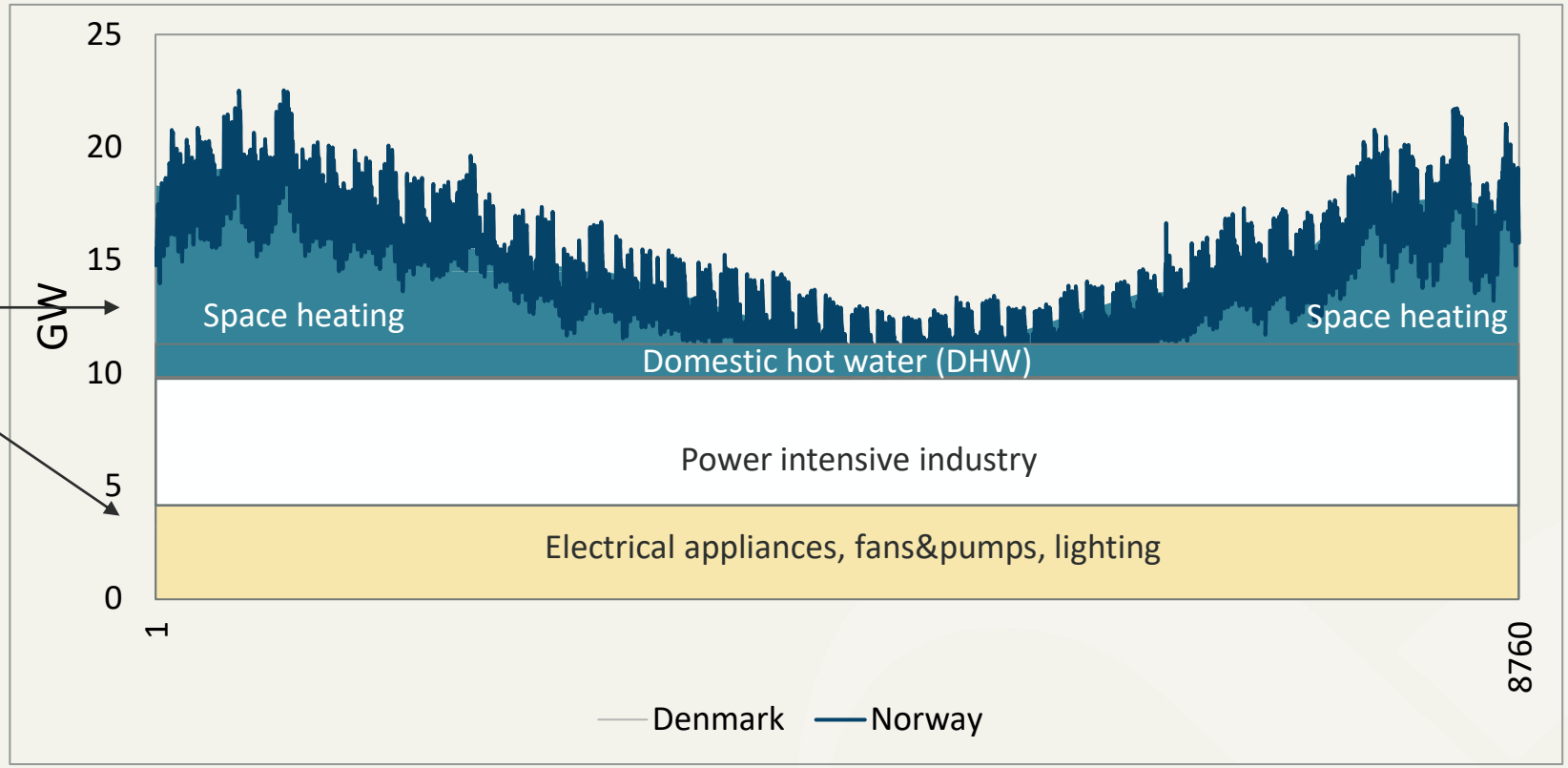
Figur 2.1 Illustrasjon av Energisystemet i Fastlands-Norge.

Tykkelsen på pilene er dimensjonert etter faktiske størrelser. For at også de tynneste pilene skal være synlige er de gjort noe større en den faktiske mengden skulle tilsi.

Kilde: SSB/NVE/OED Kilde: Stortingsmelding 25 (2015-2016). Kraft til endring – energipolitikken mot 2030.

National load profile

- Industry
- Buildings
  - Thermal electric load
  - Electric specific load
- Transport
  - EVs



Challenge

- Increased electrification
  - New industry
  - Electric mobility

- How to use the grid more efficiently?
  - Keep peak loads down
  - Utilise local energy resources

→ Buildings and neighbourhoods are part of the solution

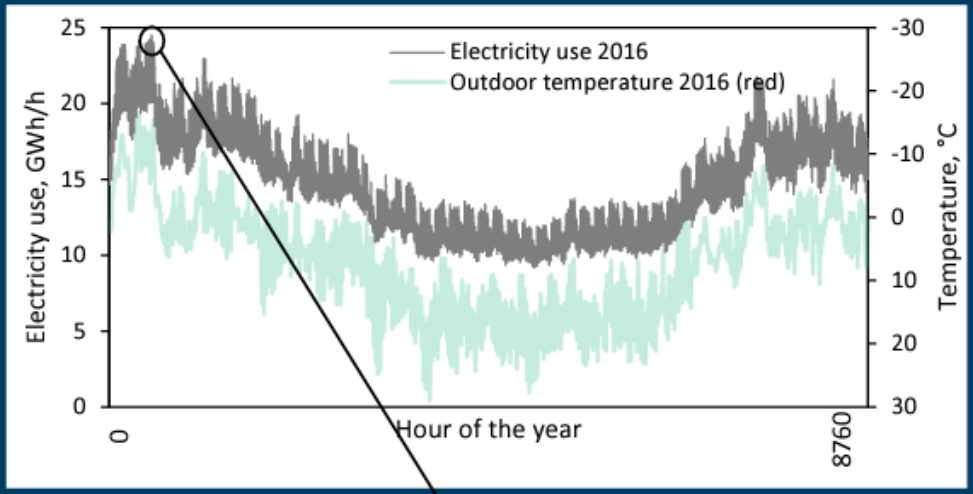
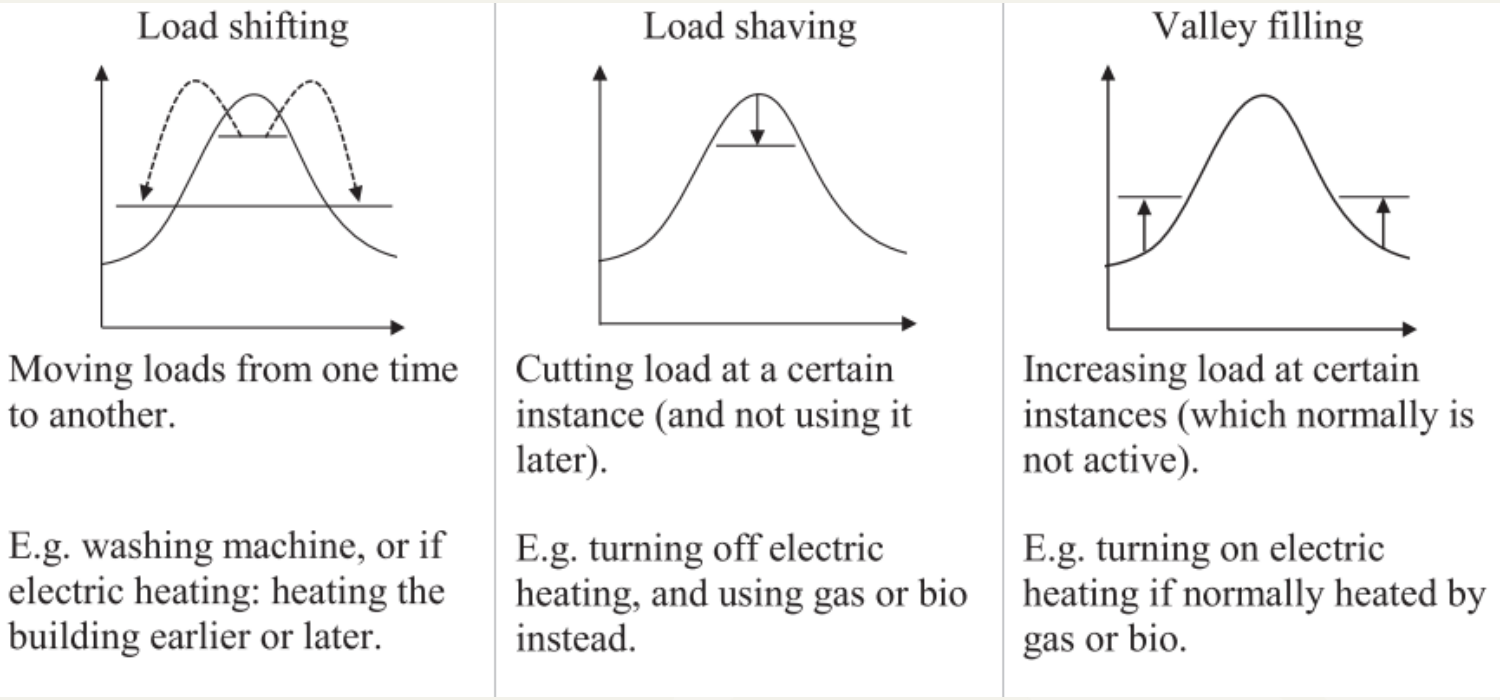


Figure 1 Hourly electricity load in Norway 2016 (NordPool)

End-user flexibility

- Change your consumption from what it *would have been*
  - FLEXIBLE DEMAND
  - DEMAND SIDE MANAGEMENT
  - DEMAND RESPONSE

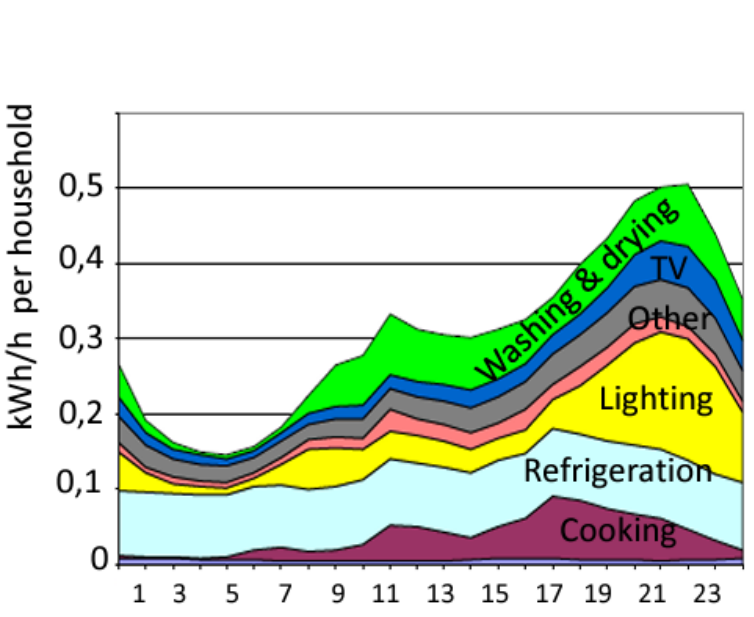
- How?
  - Moving loads in time
  - Shaving loads
  - Increasing loads



Source: Lindberg, PhD thesis NTNU 2017:35, http://hdl.handle.net/11250/2450566

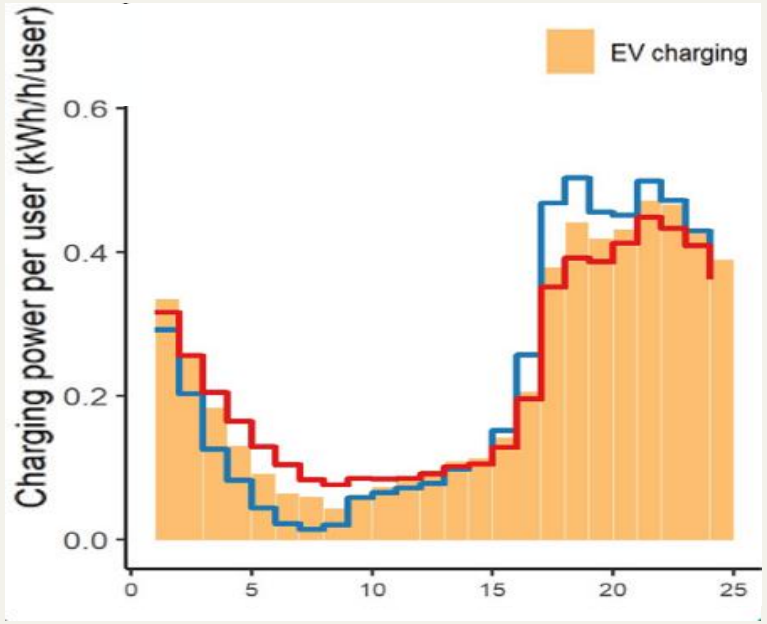
Household load profile

Household load

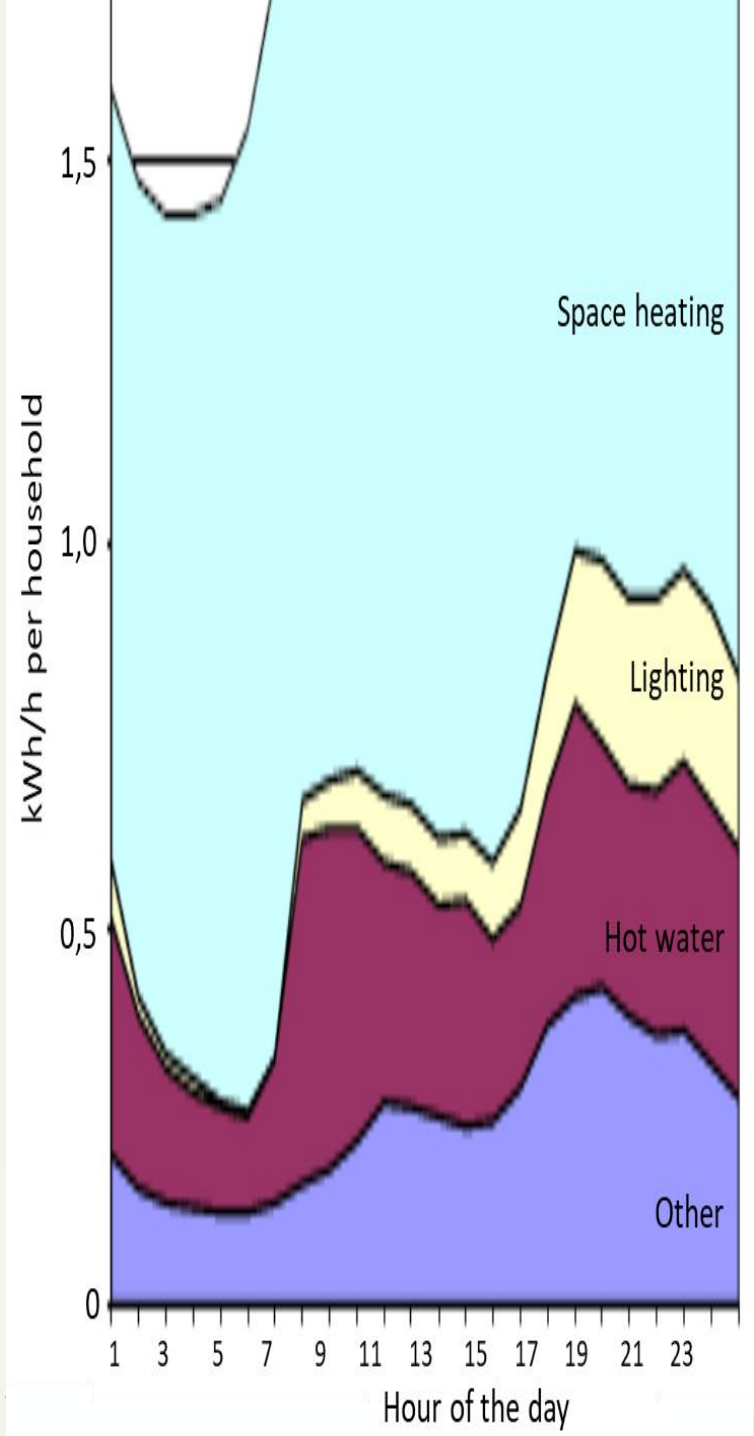


Source: SINTEF Energy

Residential EV load

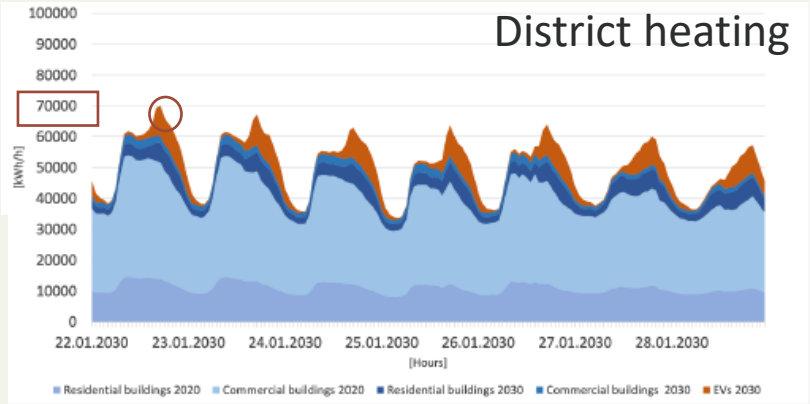


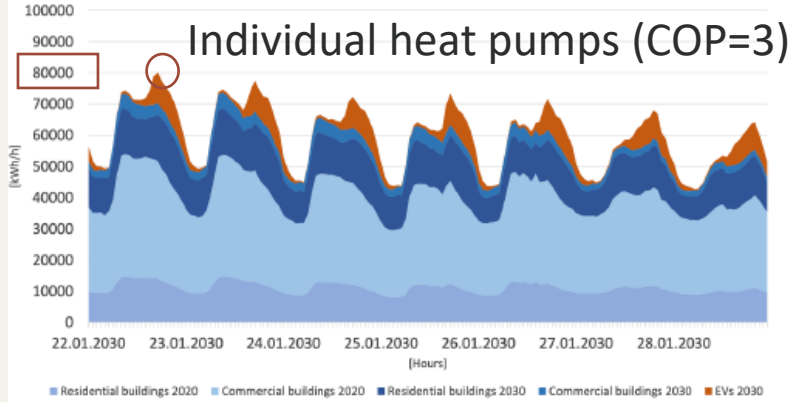
Source: Sørensen, Å. L. et al. (2021). https://doi.org/10.1016/j.enbuild.2021.110923

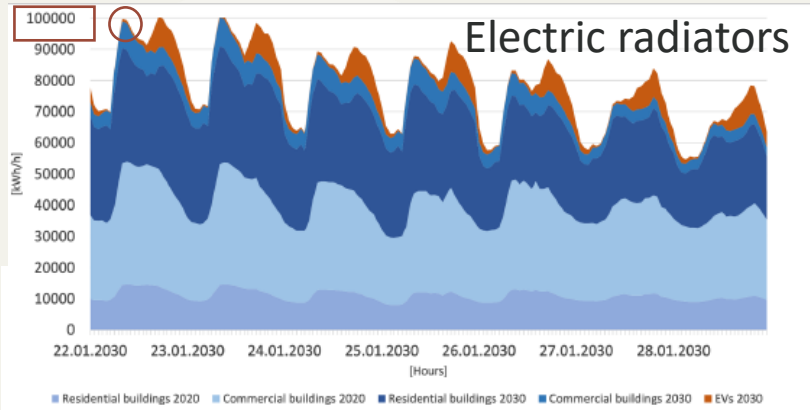


Future load profile FORNEBU

- Peak load depends on
  - Energy efficiency level
  - Heating technolgy
  - Electric vehicles
  - (New industry)
- New tools for load forecasts
  - Account for buildings energy demand and heating technology
  - PROFet



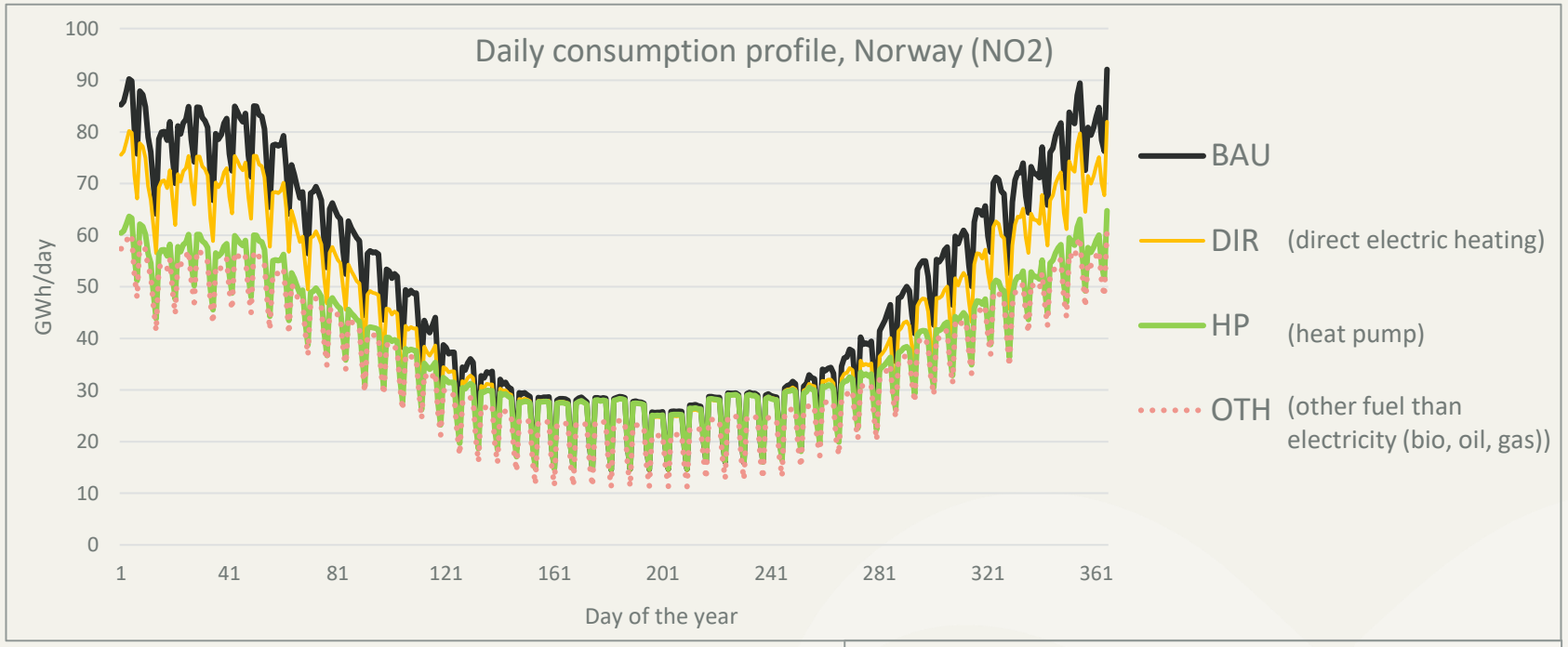




Graphs from: M.V. Kaaløy. *Fornebus Energy System towards 2030.* Project Thesis, NTNU, 2020

Energy efficiency
→Reduces both power and energy demand

- BAU: today's building stock with the size of 2030
- DIR: energy efficiency, but panel ovens
  - → 11% reduction of daily power demand
- HP: energy efficiency + heat pumps
  - → 30% reduction of daily power demand

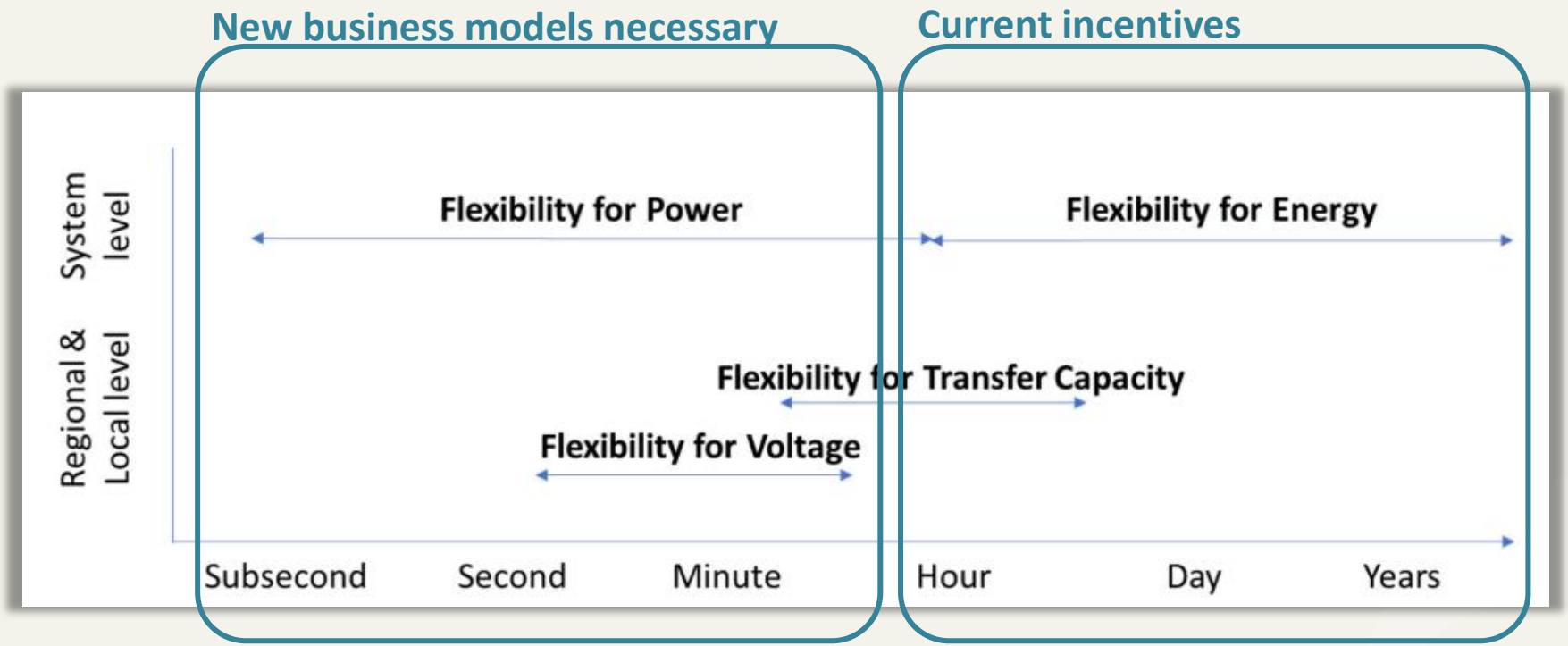


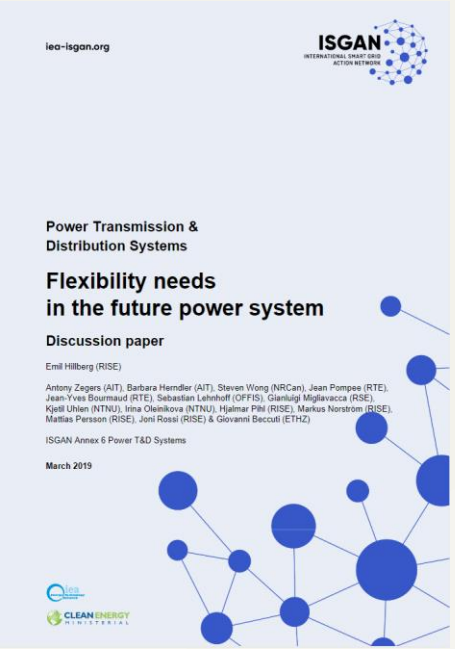
Source: Lindberg et al., 2016. *Large Introduction of Zero Energy Buildings in the Nordic Power System,* 13th International Conference on the European Energy Market (EEM), Porto, Portugal

BAU: today's building stock composition with the size of 2030
DIR, HP, OTH: 50 % energy efficient buildings

Flexibility needs in the power system

→Buildings can and must contribute





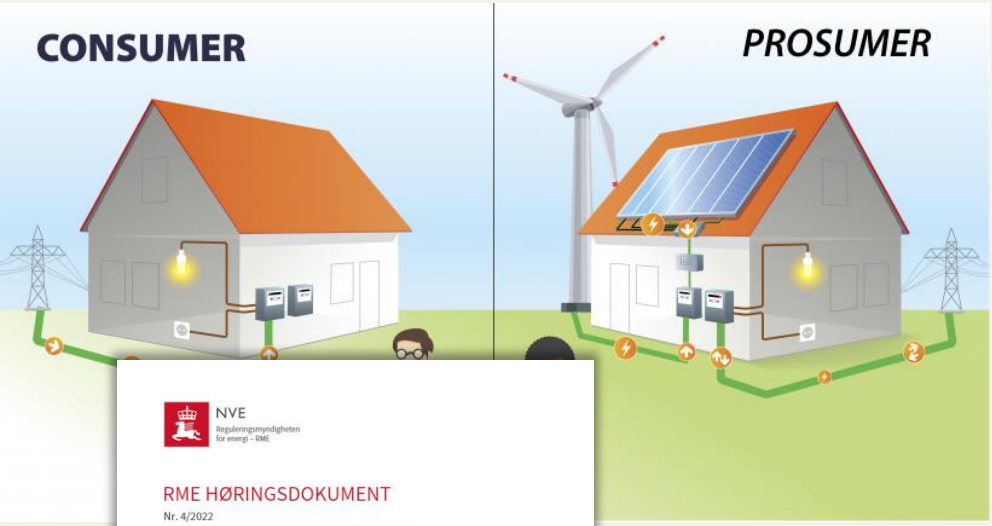
(IEA ISGAN, 2019) Flexibility needs in the future power system, http://www.iea-isgan.org/flexibility-in-future-power-systems/

Lover og regler
påvirker incentiv for lokal fleksibilitet

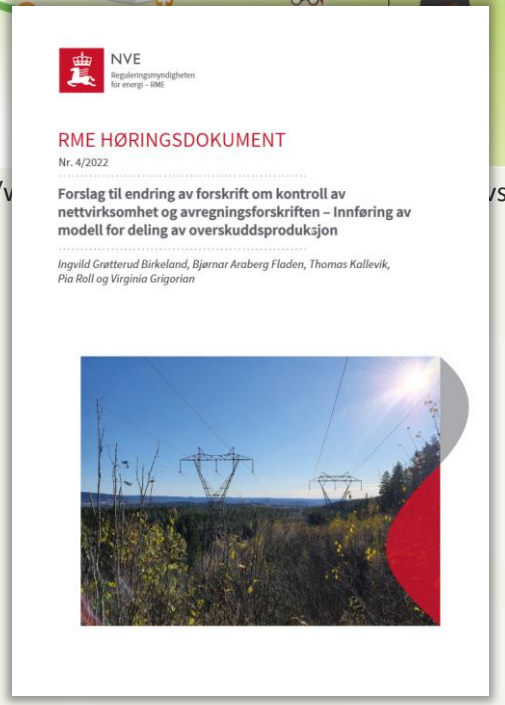
- Avregningsforskriften
  - Hver kunde skal kunne velge leverandør fritt, og hver kunde må avregnes *separat*
  - Legger *begrensninger for nabolagsløsninger* for deling av lokal solstrøm og utnyttelse av bergvarme (nærvarmenett)

- Plusskundeordningen (for prosumenter)
  - Er et *unntak* fra «Forskrift om omsetningskonsesjon» som krever at du må måle og avregne de som mottar strøm fra deg
  - Slipper innmatingstariff og slipper å ha omsetningskonsesjon
  - Ny endring foreslått 4/2022:
    - Deling av inntil 500 kW for samme *eiendom*
    - Høringsfrist var 30.sept 2022

- Elhub samler inn AMS-data
  - legger til rette for å sette opp et *virtuelt målepunkt* for flere hovedmålere under samme "kunde/selskap"
  - Men er ikke blitt gjennomført i praksis
  - Hindres av avregningsforskriften



https://v ... vs-prosumer-whats-difference


NVE
Reguleringsmyndigheten for energi – RME

RME HØRINGSDOKUMENT
Nr. 4/2022

Forslag til endring av forskrift om kontroll av nettvirksomhet og avregningsforskriften – Innføring av modell for deling av overskuddsproduksjon

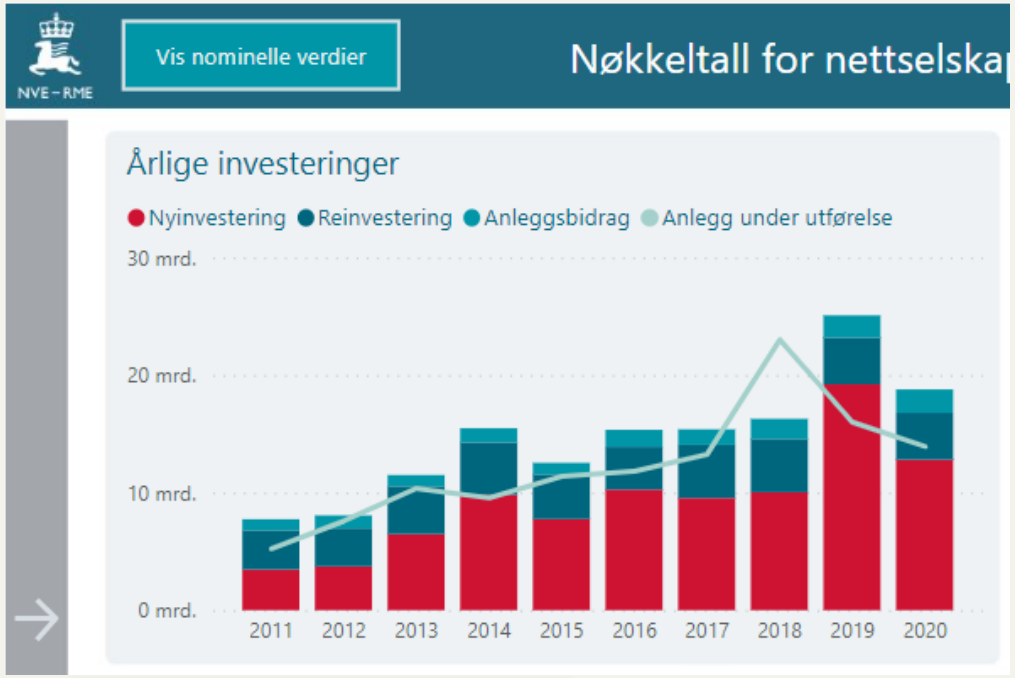
Ingvild Grøtterud Birkeland, Bjørnar Araberg Fladen, Thomas Kallevik, Pia Roll og Virginia Grigorian

Grid tariffs

- Grid tariffs will increase
  - increase by **30 %** from 2017-2025 (from 29,5 øre/kWh to 38,5 øre/kWh)
  - Income limit for DSOs increases by **50 %** from 2017-2025

- Structure of grid tariff
  - Impacts the profitability of flexible demand

- Grid tariff for Households
  - Up to now: energy only (kr/kWh)
  - From 1 July 2022: power tariff applied (kr/kW)

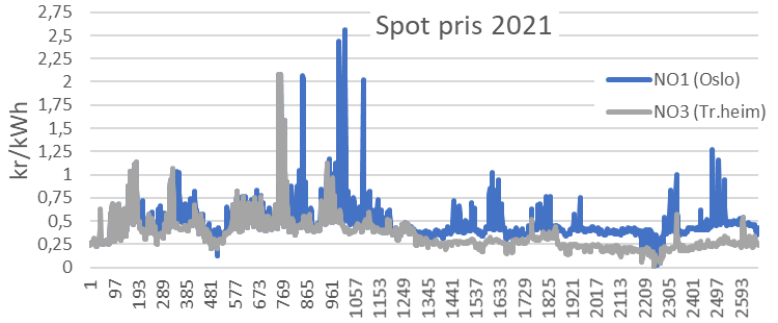


http://publikasjoner.nve.no/rapport/2018/rapport2018_55.pdf

NTNU

Incentives for households to shift

- Spot price



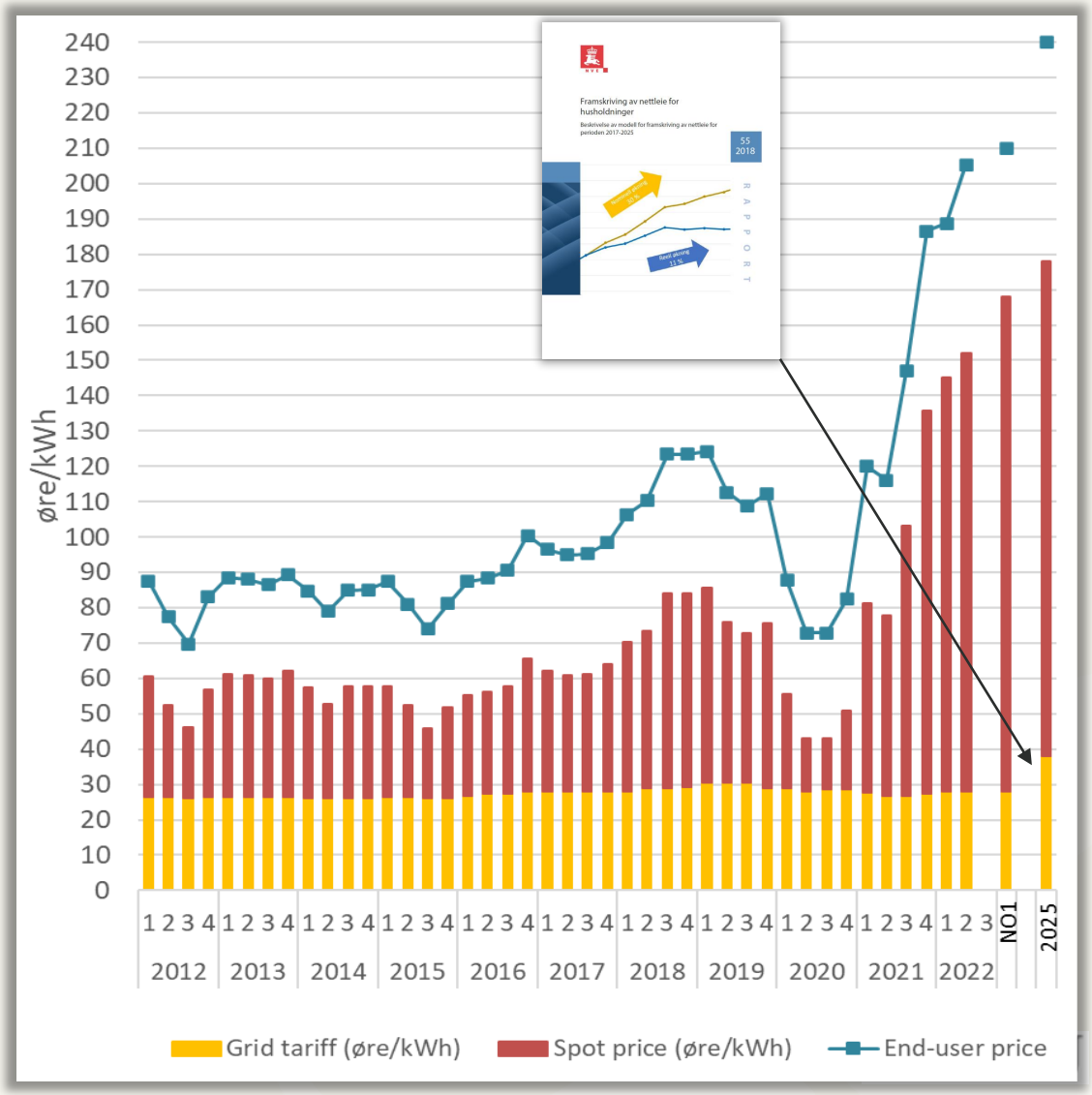
- Grid tariffs
  - Fixed (kr/mnth) + ToU Energy tariff (kr/kWh)
  - VAT (25%)

Trinn (1-10)	Kilowatt kW	Fastledd kr/mnd	kr/kW
Trinn 1	0-2 kW	**125**	125
Trinn 2	2-5 kW	**200**	57
Trinn 3	5-10 kW	**325**	43
Trinn 4	10-15 kW	**450**	36
Trinn 5	15-20 kW	**575**	33

Energiledd Dag* øre/kWh	Energiledd Natt/Helg* øre/kWh
43,10	36,85

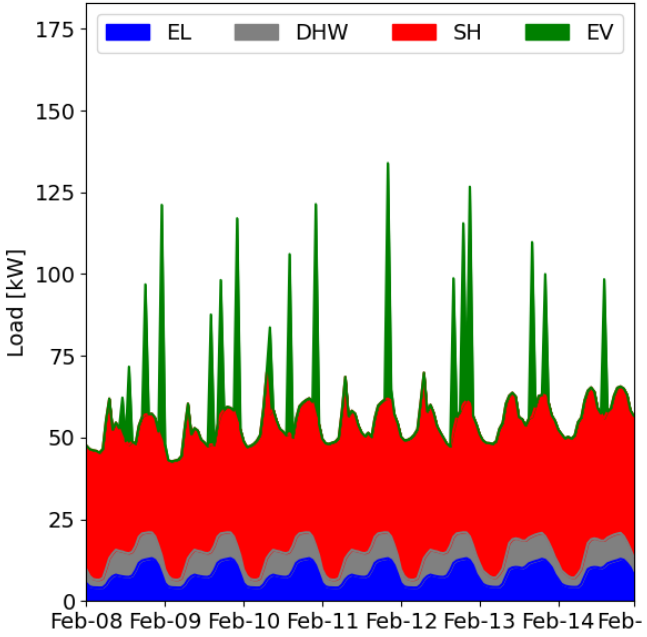
Differanse: 6,25 øre

www.elvia.no



Fleksibilitet i en boligblokk

Baseline
(uten fleksibilitet)



Kilde: SINTEFs beregninger i FlexBuild-prosjektet, https://www.sintef.no/projectweb/flexbuild/

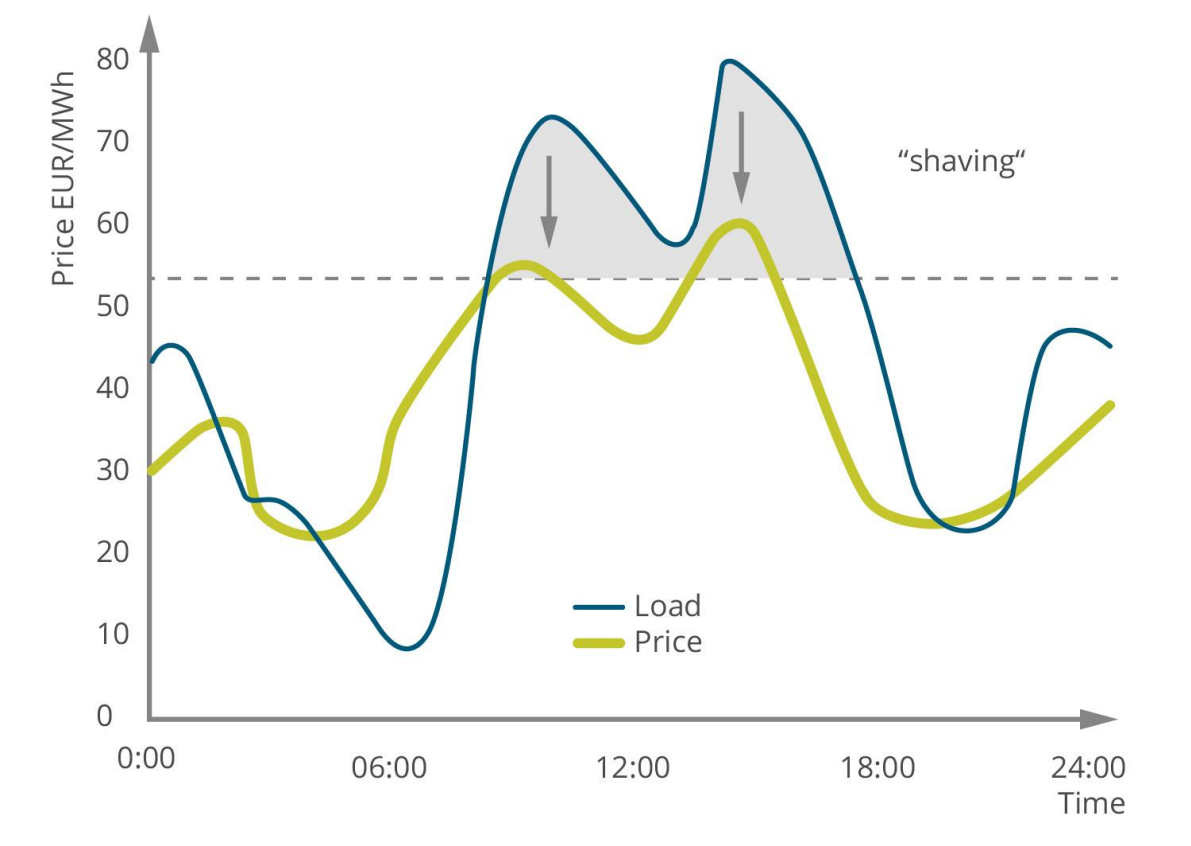
Aneo

- TrønderEnergi + HitecVision = Aneo
- Nytt fornybarkonsern
- Mål: Banebryter for det grønne skiftet med vilje og investeringskraft til å utvikle nye grønne verdikjeder.
- Satsningsområder: Fornybar energi-produksjon, elektrifisering og energieffektivisering.
- ~300 TrønderEnergi-ansatte over i Aneo
- Trønderenergi fortsetter: Forvalter vannkraft

ANEO

ANEO: Fleksibilitet som en tjeneste

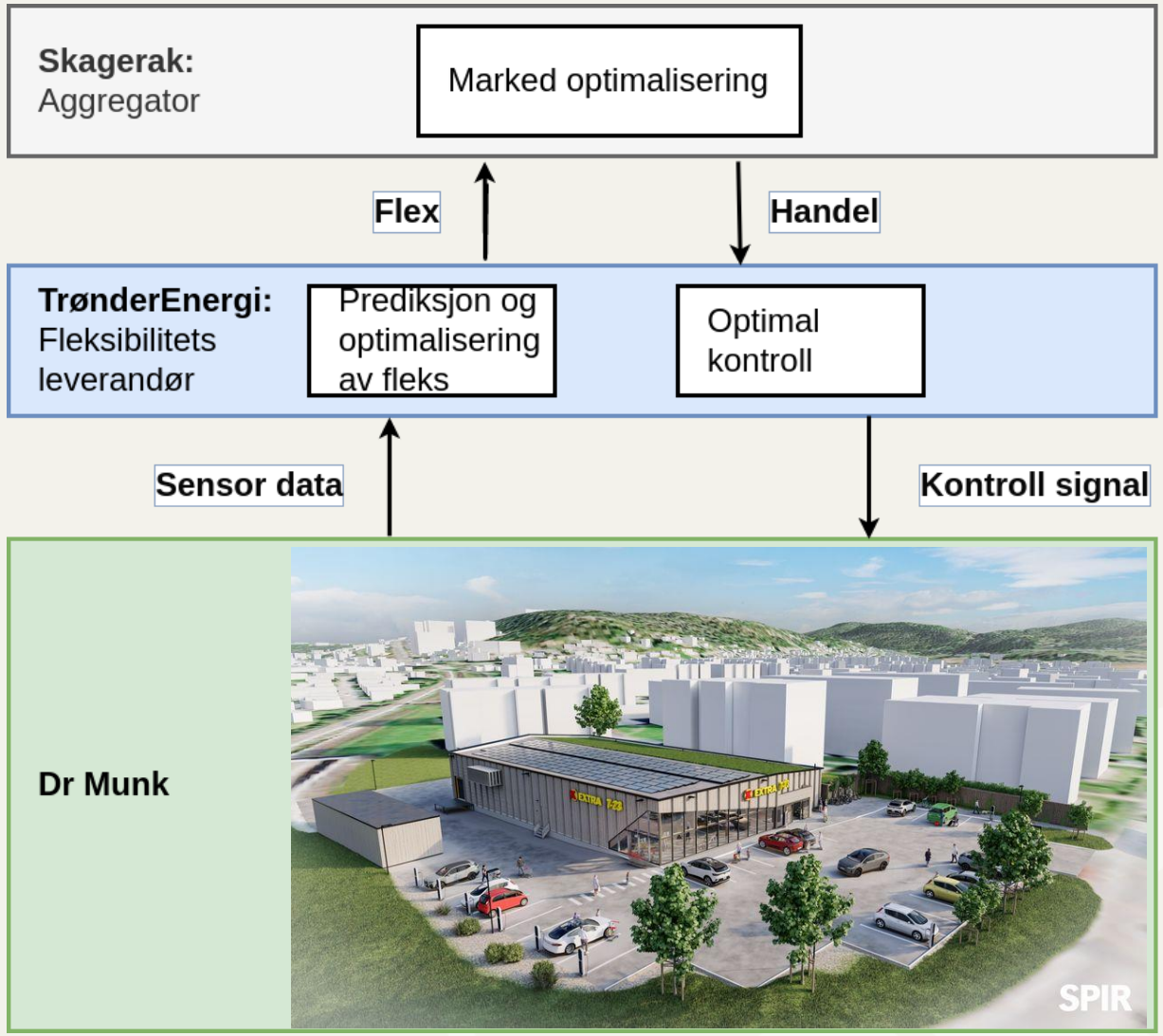
- 1) Optimalisere strømforbruk i bygg
  - ved å bruke tilgjengelig fleksibilitet
- 2) Fleksibilitet som en tjeneste
  - *Beregne* og *tilby* tilgjengelig fleksibilitet ved forespørsel fra aggregator
  - *Styre* bygg og nabolag basert på ønsket fleksibilitet



EKSEMPEL 1: COOP dagligvarebutikk

- 1) Optimalisere strømforbruk i en butikk ved å bruke tilgjengelig fleksibilitet

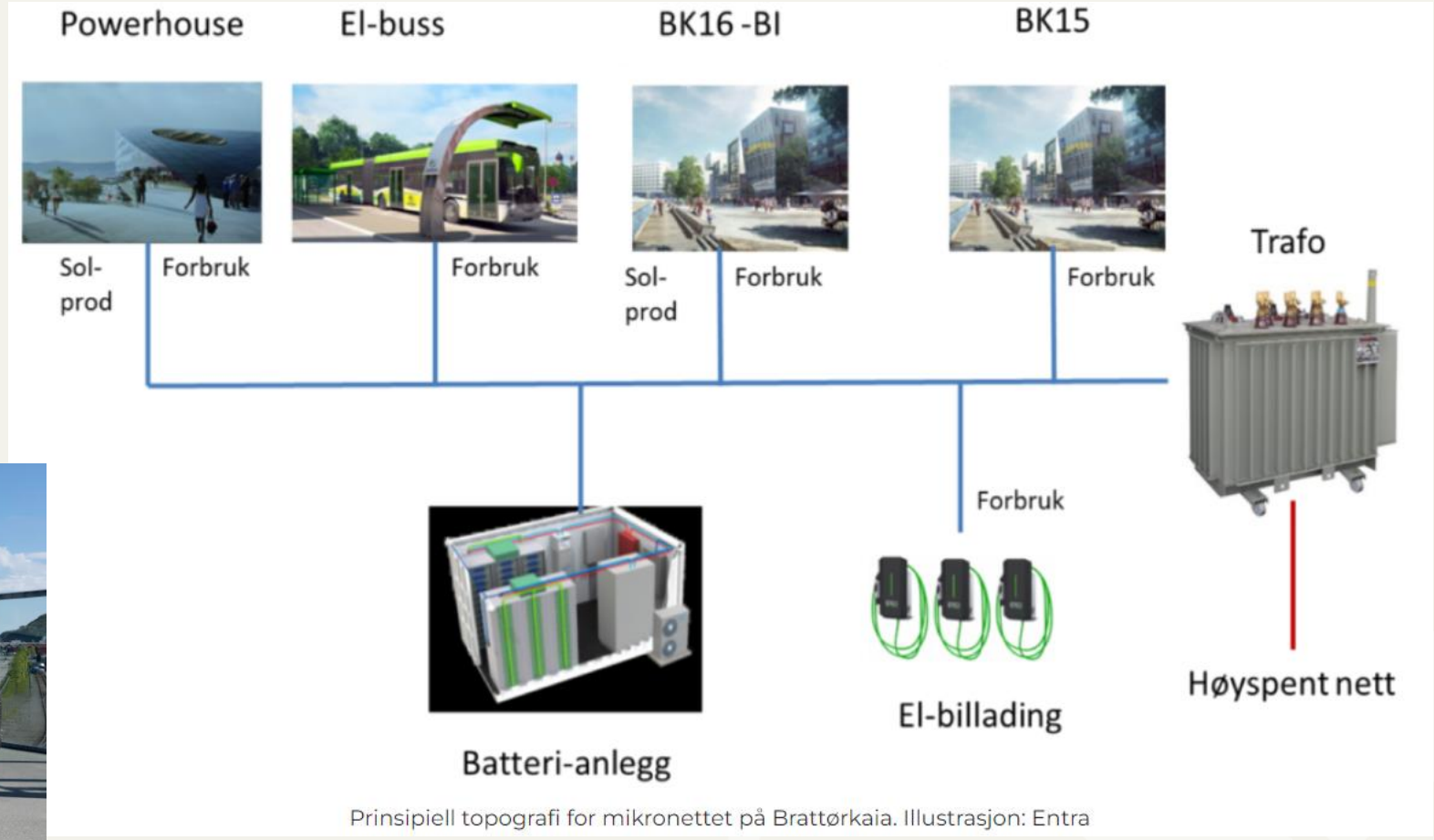
- 2) Fleksibilitet som en tjeneste
  - A) Beregne tilgjengelig fleksibilitet ved forespørsel fra Skagerak
  - B) Styre butikken basert på ønsket fleksibilitet



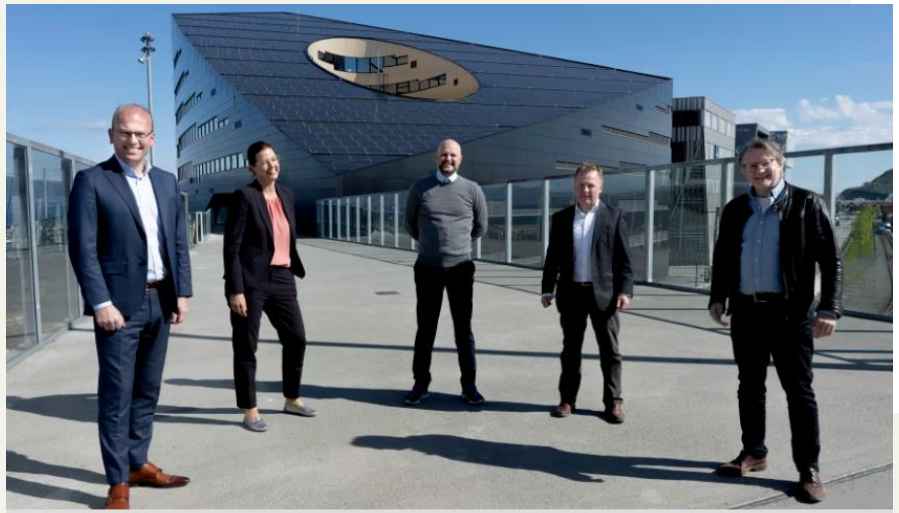
Offisiell åpning på mandag 24. okt 2022:
https://vimeo.com/763681774/d39af4b932

EKSEMPEL 2: +CityXchange EU-project

- Enabling a common energy market
- Technical innovations
  - Local trading (P2P)
  - Flexibility market
- Regulatory challenges
  - Solution: Two providers in one node
  - →Elhub reprogramming



Prinsipiell topografi for mikronettet på Brattørkaia. Illustrasjon: Entra



Samarbeidsaktørene i +CityxChange og Brattøra mikronett: Kristian Dahlberg Hauge (f.v. Trondheim kommune), Stine Hostad (Entra), Bengt Eidem (Tensio), Stig Tore Laugen (TrønderEnergi) og Bernhard Kvaal (TrønderEnergi).

CONCLUSIONS

- Norway
  - Main concern: utilisation of the grid
- Utilising local energy resouces is beneficial
  - Local renewable generation
  - Local flexibility
  - BUT; Energy efficiency first!
- Markets for flexibility
  - Still at pilot stadium (not mature)
  - R&D projects
  - Barriers: regulatory aspects

Karen Byskov Lindberg, Ph.D.

Senior Advisor Distributed Energy Systems | **TrønderEnergi/ANEO**
Adj. Associate Professor | **NTNU Electric Power Engineering**

karen.byskov.lindberg@tronderenergi.no

TrønderEnergi®

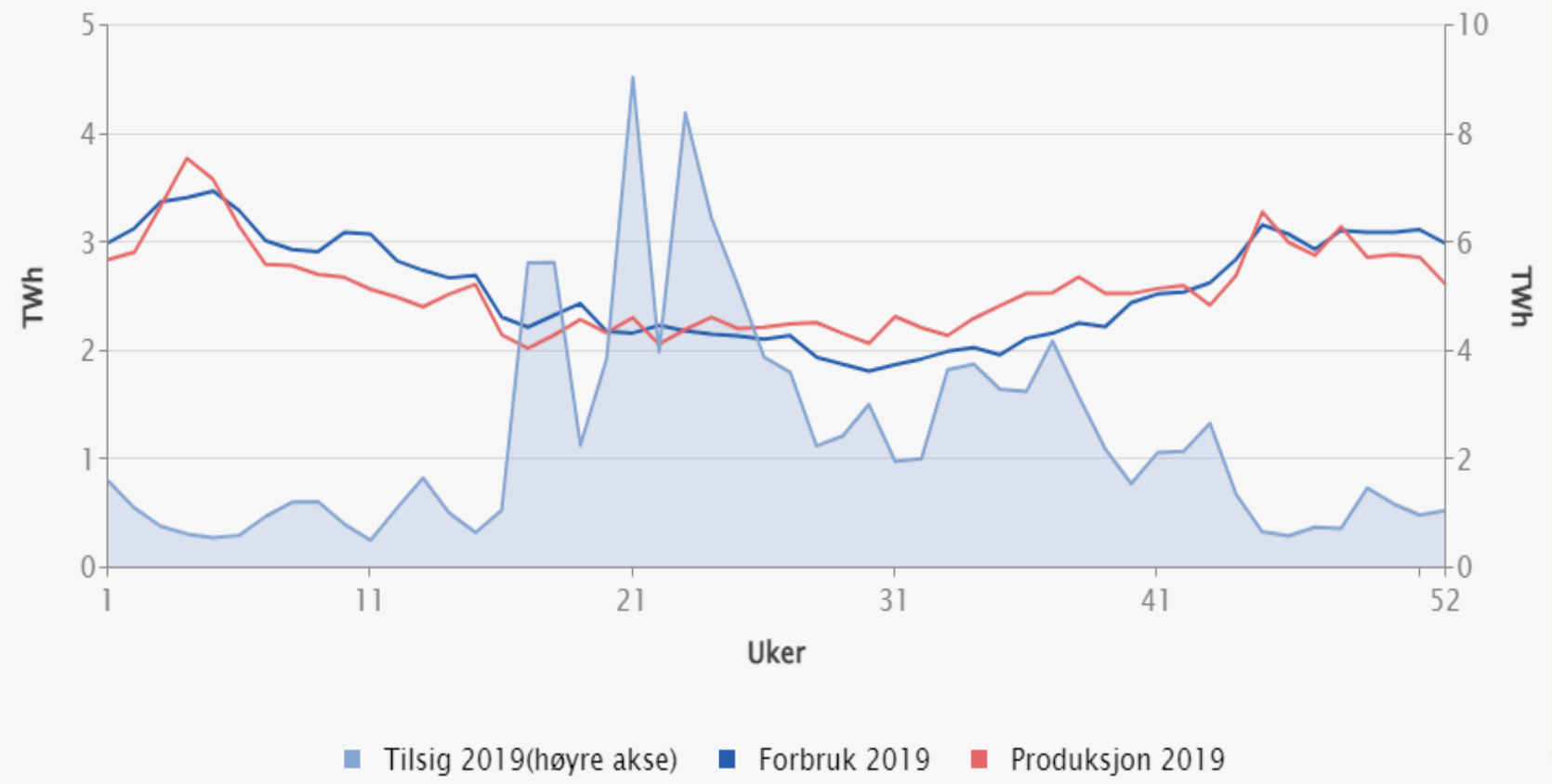
EXTRA

TrønderEnergi (Aneo from 1 Nov)

- Power producer from hydro, solar and wind
- Development of ambicious forward-looking energy related services
  - Energy as a service (EaaS)
  - Flexibility as a service (FaaS)

- Employees
  - ~300 in Trondheim, Gjøvik and Oslo
  - Strong inhouse AI competence
  - Multidiciplinary team
- Close cooperation with NTNU

Hydro power production



Normal year

- Production: 138 TWh
- Capacity: 33 400 MW

Inflow of water

- +/- 65 GWh

1000 hydro reservoirs

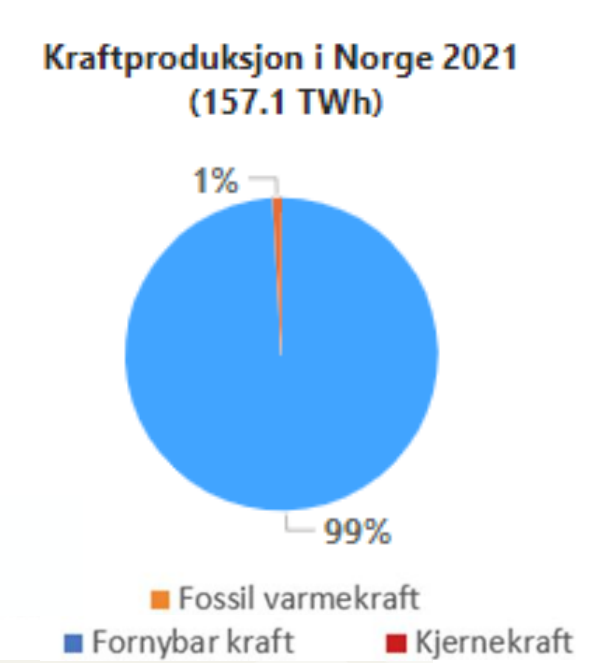
- 87 TWh capacity

Ref: NVE

https://energifaktanorge.no/norsk-energiforsyning/kraftforsyningen/#vannkraft

Hydro Power

- Characteristics
  - The hydro energy is «free» (no fuel costs)
  - Production planning
    - based on the future value of stored water (water values)
  - Large investment costs
  - Long lifetime of assets
- The Norwegian hydro power system is «energy dimensioned»
  - Security of supply is dependent on the precipitation
  - Dry years can be critical
  - Historically large capacity margin
  - Interconnection with thermal and wind/solar dominated systems is beneficial (DK, SWE and GER)



Thank you!

Part II continues at Fornebu

Agenda – Part 2

- **Company presentations**
  - **Mikael Larsson, Director Energy Markets and Financing, Mine Storage**
  - Rickard Jacobson, CEO, dLaboratory Sweden AB
  - Tommy Persson, Marketing and Sales Manager, Exeri
  - Eitan Frankental, Marketing and Sales, Griddiagnoze

BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

MINE **STORAGE**

THE ENERGY SYSTEM AND OUR MARKET

DRIVERS

DECARBONIZATION

28 % of all CO2 emissions come from fossil based power generation

ELECTRIFICATION

Electricity demand + 60% by year 2050*

NET ZERO

MORE RENEWABLES

7 x more renewables by 2040**

CONSTRAINTS

LIMITED GRID CAPACITY

ENABLER

ENERGY STORAGE

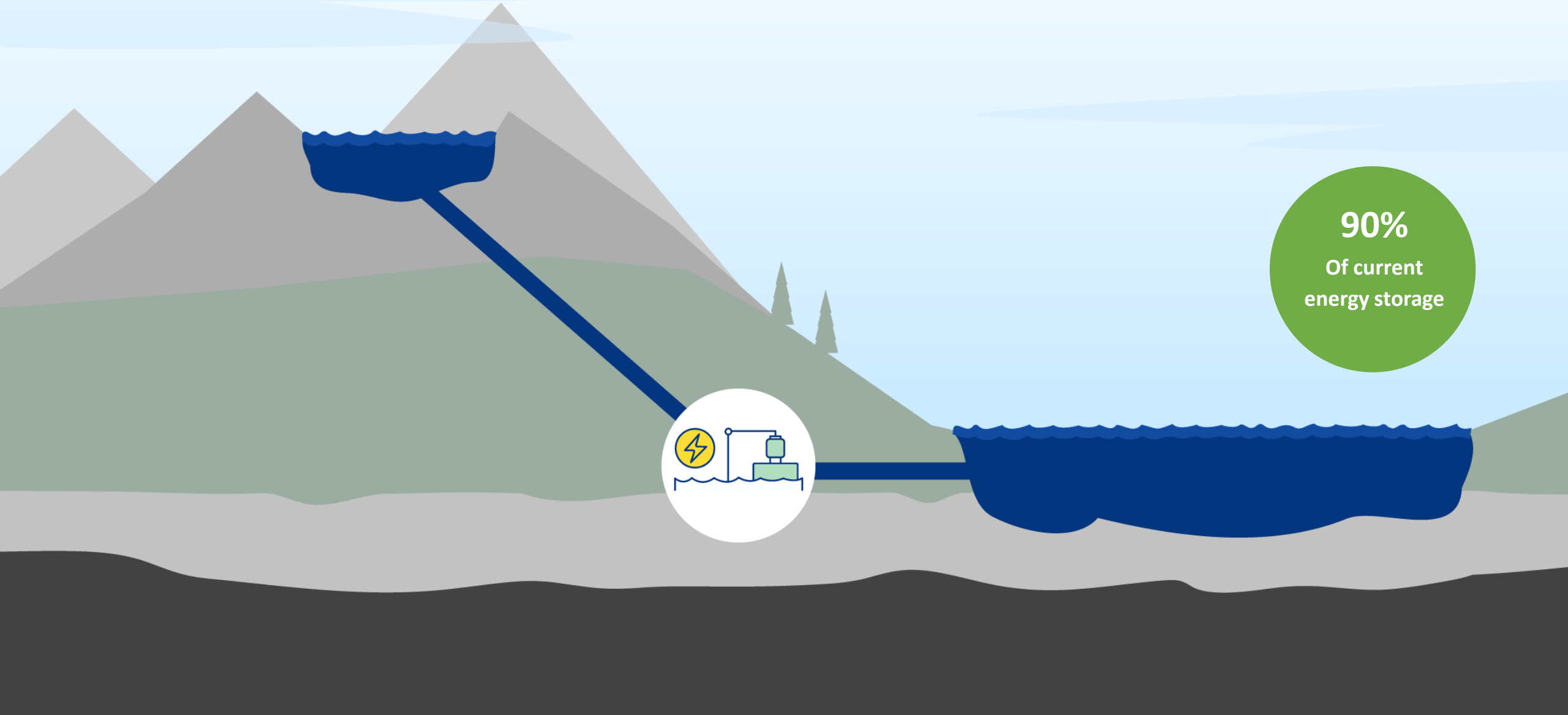
660 billion USD will be invested in energy storage by 2040***

Deployment of pumped storage will increase from 161 GW to 300 GW by 2030****

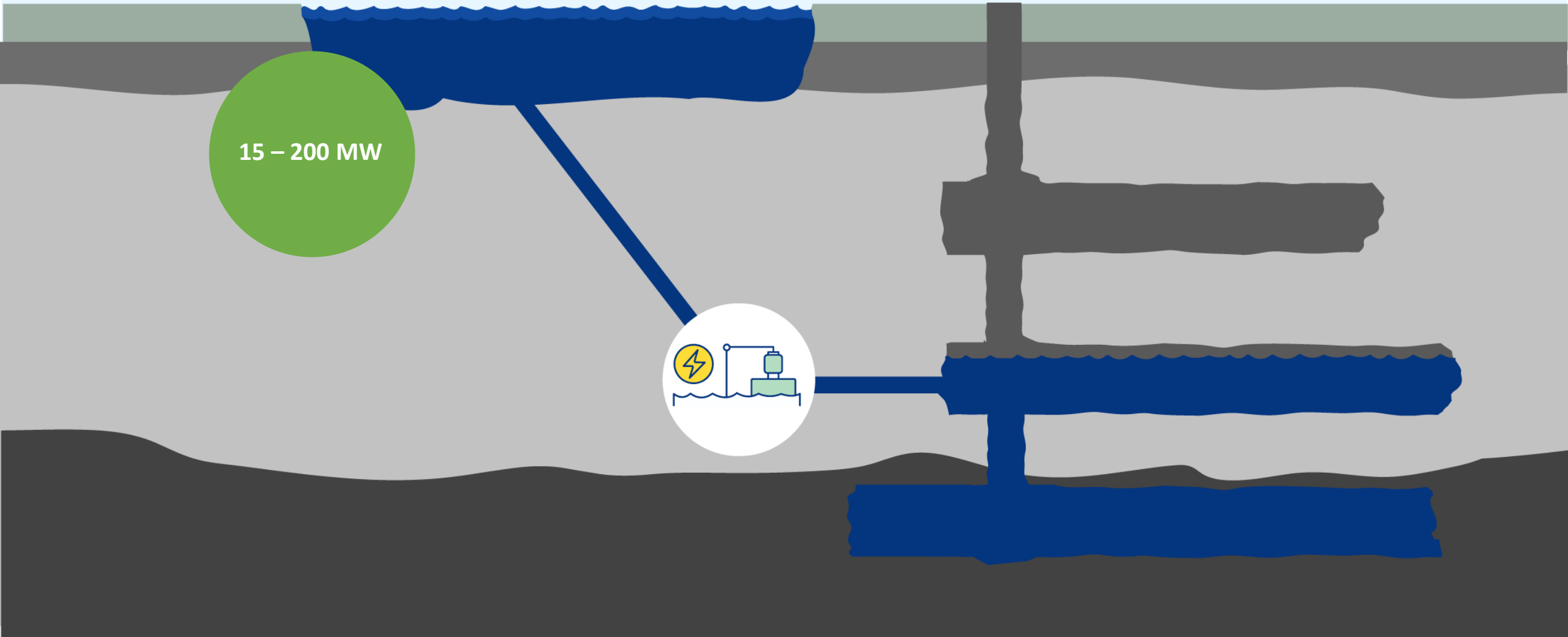
*Bloomberg, ** Rystad *** Bloomberg NEF, **** IHA/Irena

OTHER STORAGE TECHNOLOGIES

TRADITIONAL PUMPED STORAGE



MINE STORAGE CONCEPT



MORE THAN 1 MILLION MINES IN THE WORLD

* Registered closed mines, Mindat.org

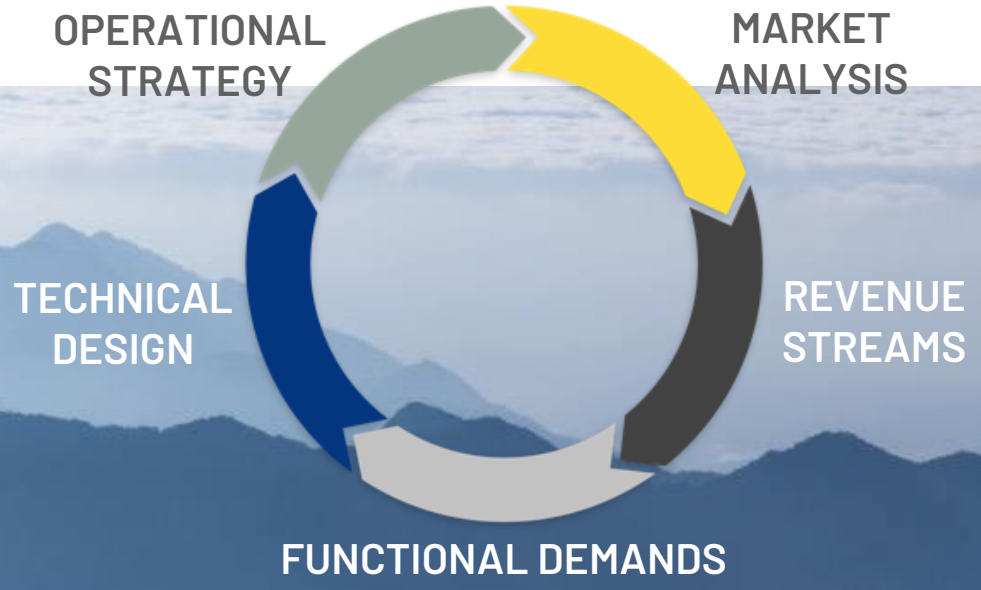
MINE STORAGE WoW™

OUR WAY OF WORKING AND INTELLECTUAL PROPERTY

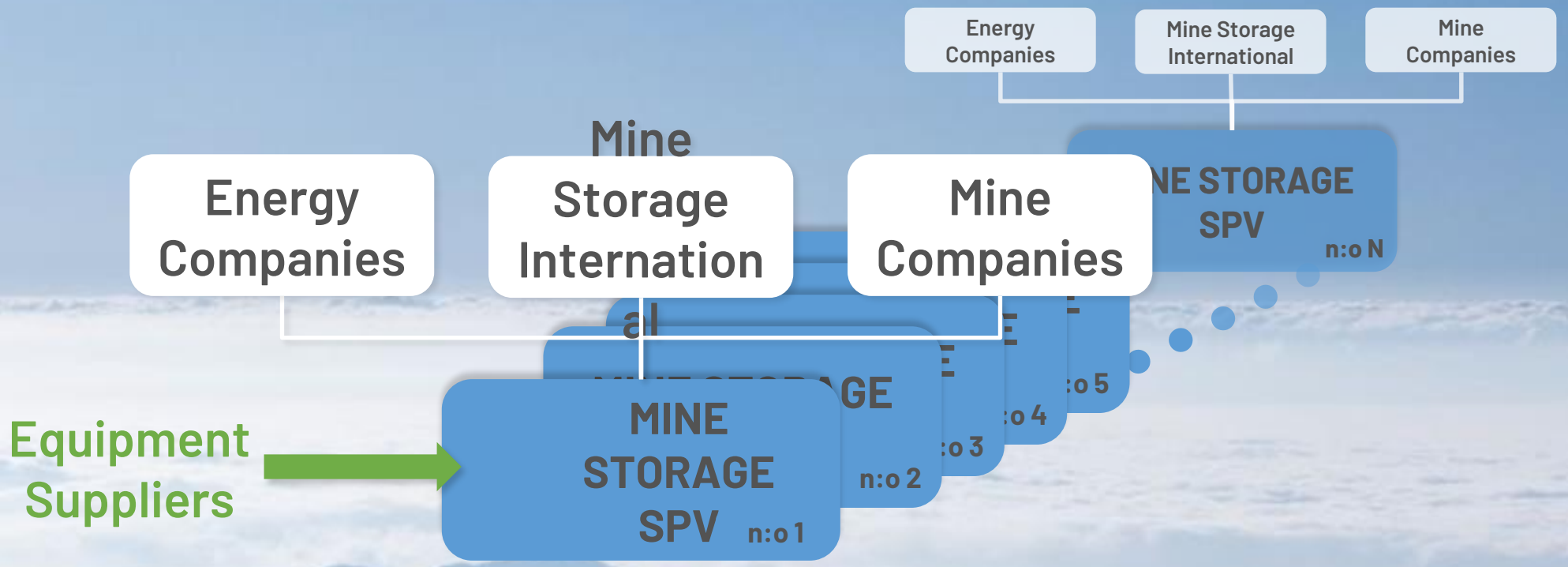
QUALIFICATION → DEVELOPMENT → CONSTRUCTION → OPERATION

- industrializes our Way of Working
- secures profitable business cases

- proprietary software
- enables faster scale-up



BUSINESS MODEL



STRATEGIC CUSTOMER COLLABORATIONS

NEW BOLIDEN

Boliden is an international mining company with operations in several countries in Northern Europe.

Initial collaboration on a closed mine in Finland to define business case and develop sustainability values.

Future collaboration and joint study to evaluate two of their mines, one in Sweden and one in Ireland.

The long term ambition is to scale-up the concept and convert several of their used mines to mine storages.

ELLEVIO

Ellevio is one of Sweden's big three regional grid operators. Ellevio is currently prohibited to connect more wind power due to constraints in overlaying grid until 2028/2031.

Collaboration and joint study to identify the critical bottlenecks in the grid, sizing and location of suitable mine storages to allow for more renewables to be connected.

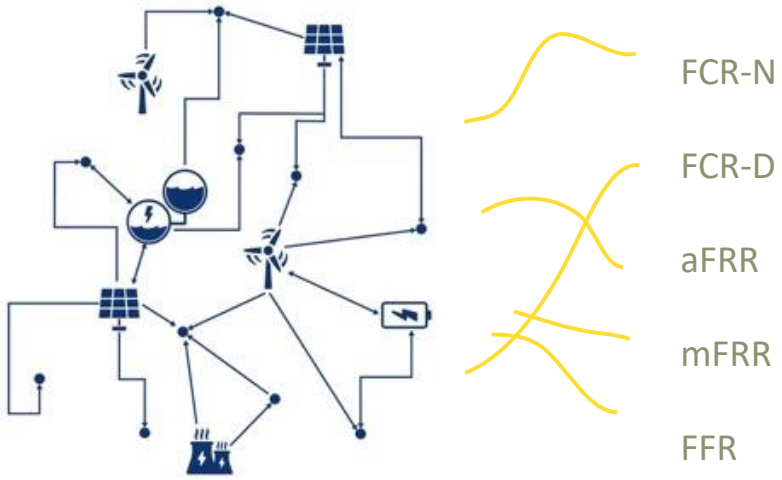
The collaboration is also aiming at developing a suitable business model for grid applications.

STRATEGIC PARTNERS

Expektra are energy market experts and an IT development company.

Together we develop the Mine Storage Operator software for bid and trading of a mine storage. A “digital twin”, which will

- initially simulate bid and trading strategies of a mine storage on historical data
- later provide operational mine storages with the bid and trading decisions



EXPEKTRA
Solutions for efficient energy systems

VOITH

Strategic partnership with **Voith Hydro**, a global player in the hydropower industry.

Their comprehensive portfolio of offerings within hydropower and long expertize in the industry makes them a very suitable partner in our first projects currently under development.

MINE STORAGE CUSTOMERS/PARTNERS

1 ENERGY COMPANIES

Energy traders and producers, such as wind- and hydropower companies need energy storage to optimise production, trade and
for grid integration.

2 GRID COMPANIES

TSO's and regional distribution system operators need storage to balance and manage grid reliability.

3 MINING COMPANIES

Mining companies need energy storage to repurpose closed mines as part of their sustainability efforts or as backup power for mines in operation.

MINE STORAGE REVENUES

ELECTRICITY TRADING

Utilizing price variations

ANCILLARY SERVICES

Frequency regulation
Network stability

GRID STABILITY

Capacity reserve &
transmission support

RENEWABLES INTEGRATION

Production optimization
of wind and solar

END USER INDUSTRIAL

Energy cost management
Power supply reliability

OPERATIONAL TEAM

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Raine Vasanoja
Founder & CCO

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Anna Engman
Founder & CMO

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Robert Magnusson
Head of Development
of Asset Management

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Mikael Larsson
Director Energy Markets
& Financing

- mikael.larsson@minestorage.com

MINE **STORAGE**

A True Enabler Of A Sustainable Energy Transition

Agenda – Part 2

- **Company presentations**
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BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

dLab

Rickard Jacobson
CEO

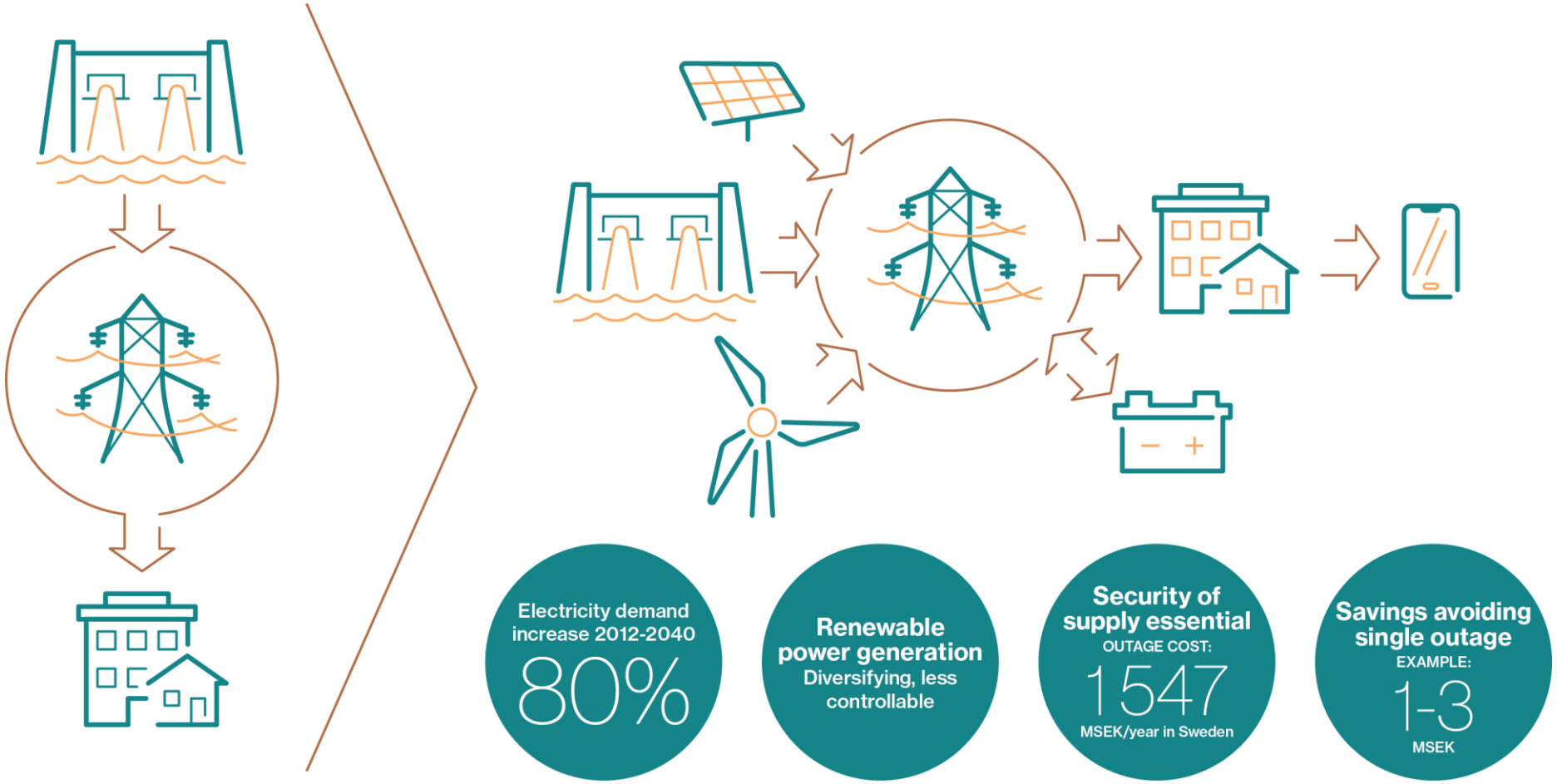
Power to Act

Vad gör dLab?

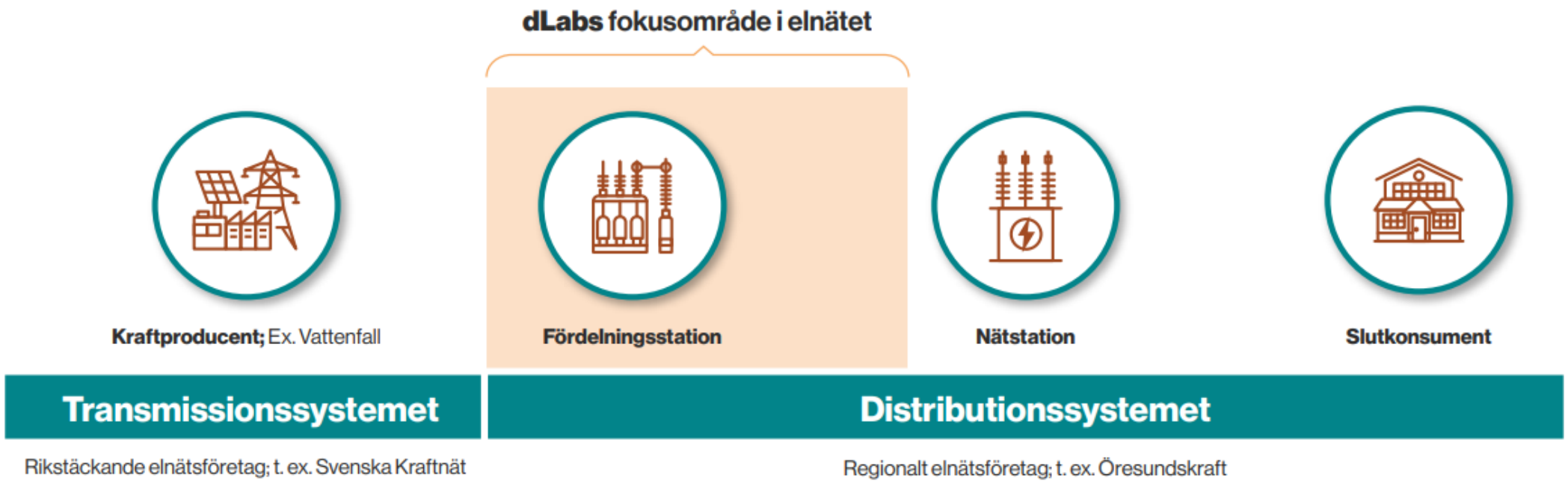
Vi hjälper elnätsbolag ta kloka beslut baserat på data!

Power Sector – Huge Transformation

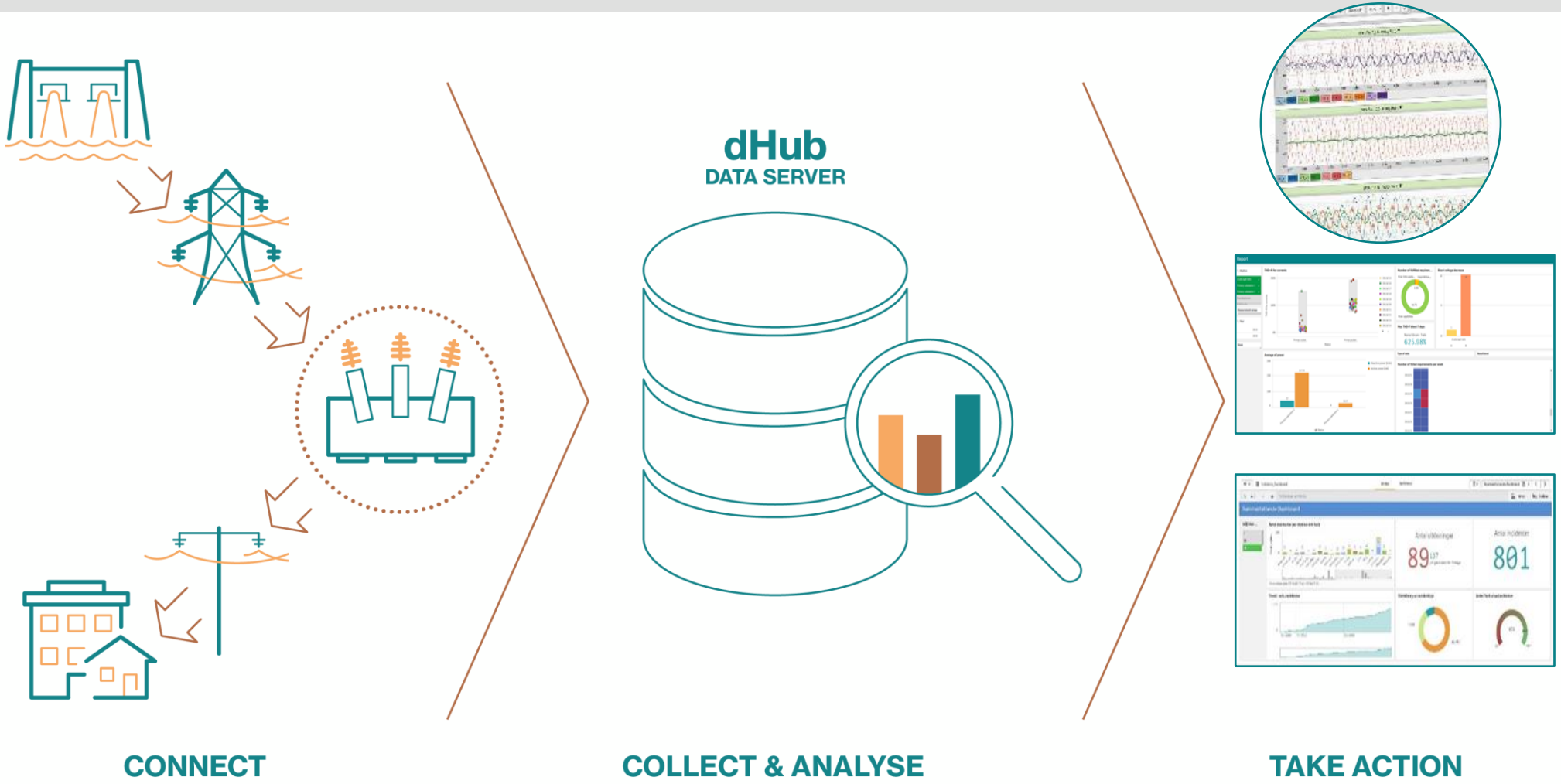
PARADIGM SHIFT



dLabs plats i elnätet



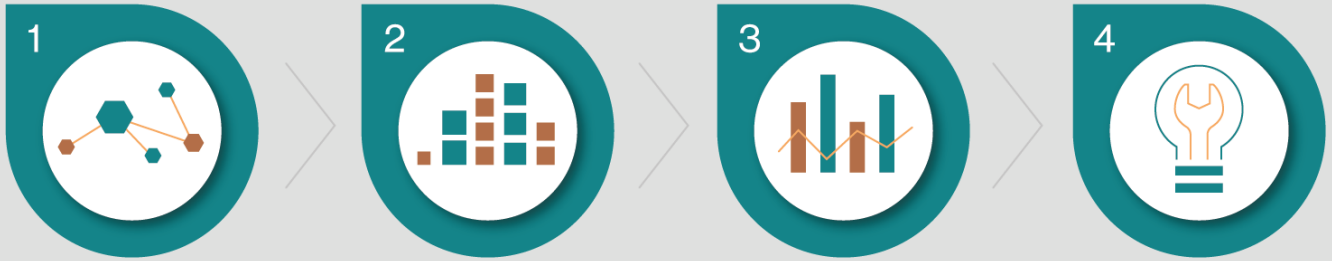
dLab’s patented solution based on world leading research



Om dLab

dLab

dInsight ANALYTICS PLATFORM



Anslut & samla in | **Analysera** | **Få insikt** | **Vidta åtgärder**

- **Digitalisering av fördelningsstationen, stöd för datadrivet beslutsfattande**
- **Många funktioner under ett paraply**
- **Oberoende av fabrikat och ålder på utrustningen i fördelningsstationen**
- **Hög IT-säkerhet – hårdvaran separerad från utrustningen i fördelningsstationen**

Varför bry sig om elnätet?

- **Ett avbrott kostar i genomsnitt 2-4 kr*/kund/min**
  - Ex fördelningsstation i Stockholm med 40 000 abonnenter med avbrott i 2h=4 800 000-9 600 000 kr!
- **Överföringskapaciteten är ett växande problem**
- **Kvaliteten på strömmen i näten går neråt**
- **Implementation av nya kraftgenererande källor (sol/vind/våg)**
- **Förbrukarmönstret ändras radikalt ifråga om var och effekt. Största bidragaren är EV-laddning**

***Kraftringen och Ellevio**

Om dLab

Grundades i Sverige 2010, kommersiellt sedan 2015

Noterades 2021 på NASDAQ First North Growth Market med 52 MSEK IPO

Framgångsrikt testat på marknaden, har skapat mervärde för 25+ kraftbolag i 90+ fördelningsstationer under de senaste 10 åren

Erfaret team, högt kvalificerade medarbetare med bakgrund ifrån kraftindustrin

Mjukvara med patenterade algoritmer för analys av fel

Databas med 300 års inspelade händelser från 90+ fördelningsstationer

I teknikens framkant med understöd av AI och ML

Förvärvade SLB 2021

dLab

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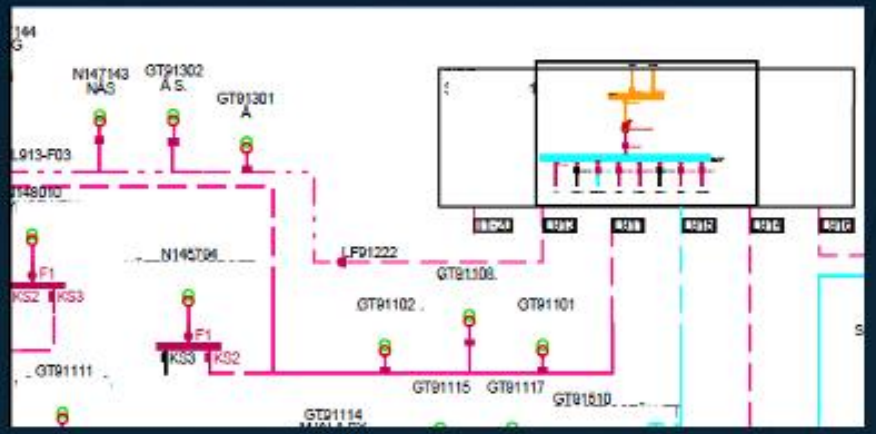
BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

Smart grid Surveillance - Know Your Grid™

Current Interface Versus Exeri Interface



*Example view – Further functionality available

Current Interface

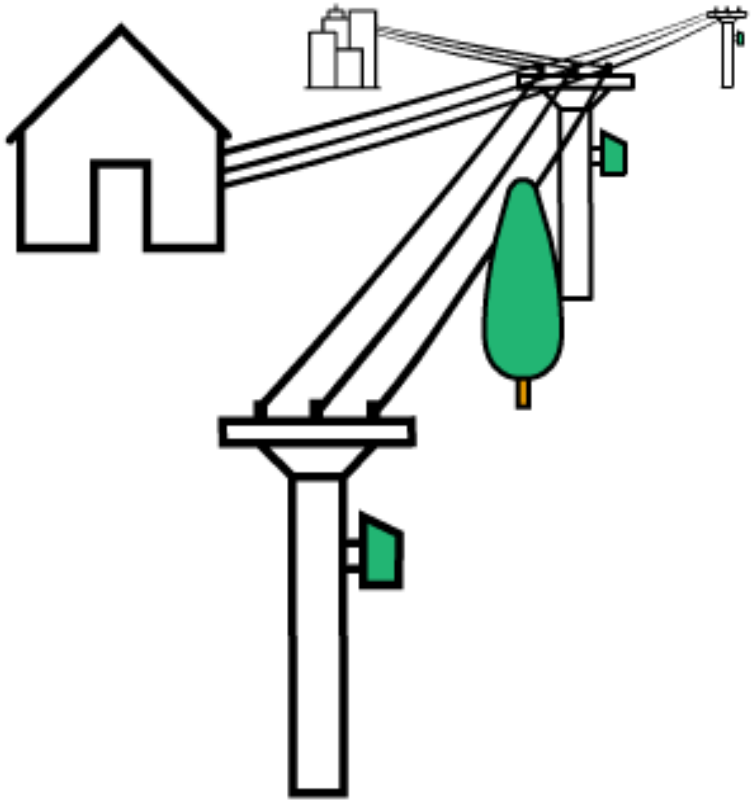
- Static display with no connection to a map of the grid
- No GPS or fault- tracking capabilities
- Outages or other faults cannot be pinpointed with greater accuracy than between substations, which may be hundreds of miles apart
- Manual inspection is required to locate and determine fault type

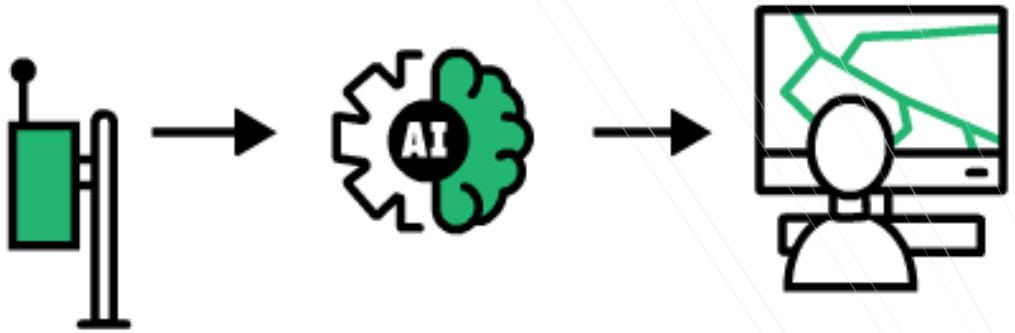
Exeri SGS Interface

- Provides grid operators with an intuitive overview of entire network and real-time decision support
- Instantaneous fault location and identification through advanced GPS and mapping technologies
- Integration with smart phones, tablets and an operator's central system
- Predictive capabilities, powered by advanced AI, enable preventative actions to be taken for future issues

EXERI
Smart Grid Surveillance

Elnätet med Smart Grid Surveillance™





EXERI
Smart Grid Surveillance

EXERI
Smart Grid Surveillance

Home | Event log | Units | Analytics | Administration | SGMS documentation | ExAcT-app download | Support

Grid alarm

# ID	AO ID	Start time	End time	Severity	Status	Probable cause	Additional information	Confirmed

To alarm list

EXERI
Smart Grid Surveillance

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Grid alarm

# ID	AO ID	Start time	End time	Severity	Status	Probable cause	Additional information	Confirmed
139	QiC-1671	2022-04-01 09:27:16	--:--:--	Critical	Active	Short Circuit	• Separate the faulty segment by opening/breaking 8790. • Cause of fault can also be present in line segment with reduced service level. • Probable phase-to-phase short-circuit.	☐
138	QiC-1521	2022-04-01 09:27:16	--:--:--	Critical	Active	No Power		☐

To alarm list

EXERI
Smart Grid Surveillance

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Grid alarm

# ID	AO ID	Start time	End time	Severity	Status	Probable cause	Additional information	Confirmed
139	QiC-1671	2022-04-01 09:27:16	--:--:--	Critical	Active	Short Circuit	• Separate the faulty segment by opening/breaking 8790. • Cause of fault can also be present in line segment with reduced service level. • Probable phase-to-phase short-circuit.	☐
138	QiC-1521	2022-04-01 09:27:16	--:--:--	Critical	Active	No Power		☐

To alarm list

EXERI
Smart Grid Surveillance

Home | Event log | Units | Analytics | Administration | SGMS documentation | ExAcT-app download | Support

Grid alarm

# ID	AO ID	Start time	End time	Severity	Status	Probable cause	Additional information	Confirmed
139	QiC-1671	2022-04-01 09:27:16	2022-04-01 09:28:40	Critical	Clear	Short Circuit	• Separate the faulty segment by opening/breaking 8790. • Cause of fault can also be present in line segment with reduced service level. • Probable phase-to-phase short-circuit.	✓
138	QiC-1521	2022-04-01 09:27:16	2022-04-01 09:28:40	Critical	Clear	No Power		✓

To alarm list

Features of Smart Grid Surveillance™

Smart Grid Surveillance Today

Fault Detection
The SGS system identifies a broad range of possible issues throughout the grid and immediately notifies the grid operator when a fault occurs.

Tilted Poles
The SGS system immediately detects tilted or broken poles, enabling operators to repair the issue before any outage or damage occurs.

Fault Location
The SGS system automatically pinpoints the exact location of a fault, substantially reducing repair times.

Decision Support
Exeri's system transforms the way grid faults are handled, providing operators with instant fault detection and categorization and real-time decision support capabilities concerning repairs.

Smart Grid Surveillance Tomorrow

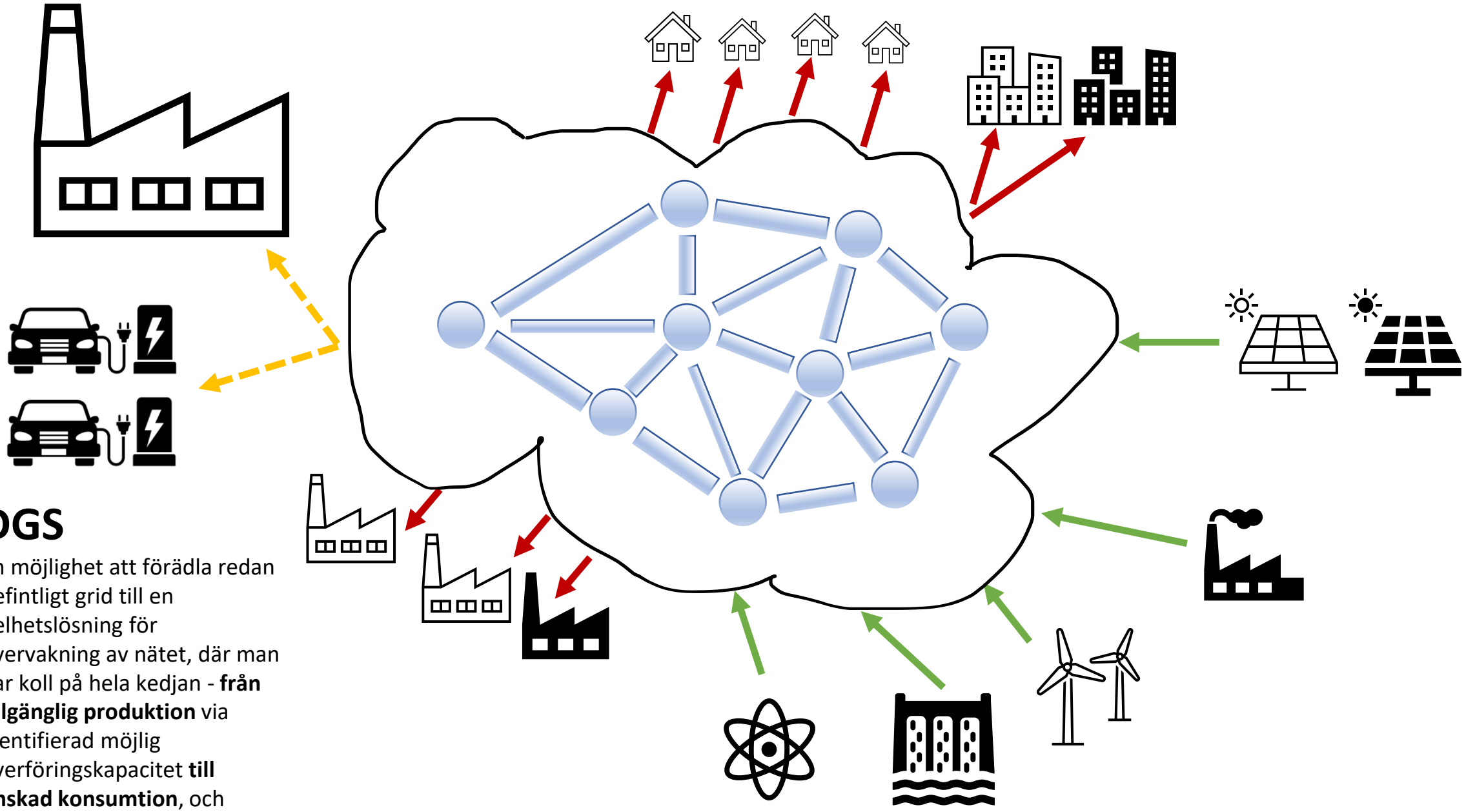
Conducting Poles
The SGS system automatically alerts operators about dangerous and hard to detect conducting poles, substantially reducing the safety hazards associated with this issue.

Fire Detection
Recognizing patterns in the data it gathers, the SGS system will identify potential problem areas on a grid and notify grid operators before a wildfire starts.

Automatic Fault Isolation
The SGS system enables operators to automatically isolate faults and re-route electricity by shutting down only the affected area – a process that currently takes hours to complete via a manual process.

Predictive Maintenance
AI algorithms will recognize patterns concerning particular faults, notifying operators concerning required maintenance before any issues or outages occur.

Powergrid



DGS

En möjlighet att förädla redan befintligt grid till en helhetslösning för övervakning av nätet, där man har koll på hela kedjan - **från tillgänglig produktion** via identifierad möjlig överföringskapacitet **till önskad konsumtion**, och därigenom kan man maximera

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  - Rickard Jacobson, CEO, dLaboratory Sweden AB
  - Tommy Persson, Marketing and Sales Manager, Exeri
  - **Eitan Frankental, Marketing and Sales, Griddiagnoze**

BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

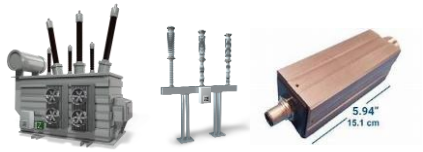
GRID DIAGNOZE

Integrated Digital Asset Management Solution

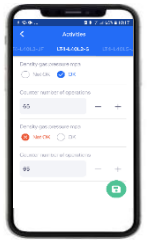
Risk Matrix for RCM

WEB

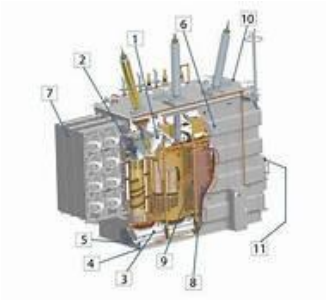
- Diagnostics



- Online monitoring

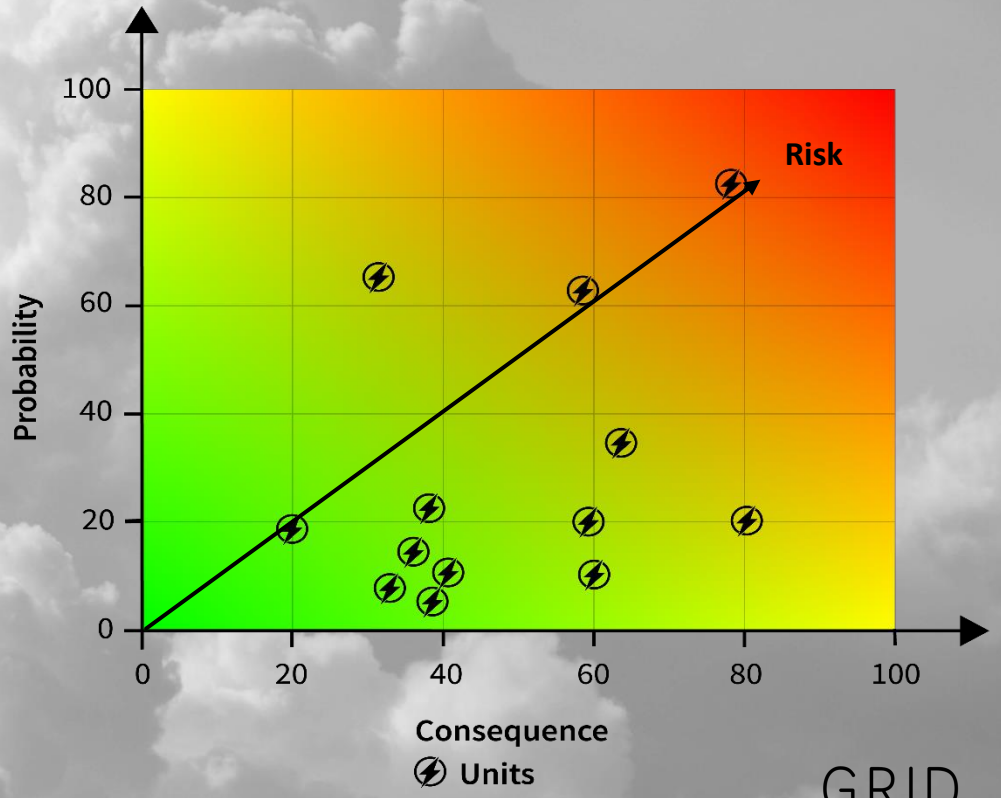


- On-site activities



- Unit data

Health Index
Analysis, interpretation, evaluation and visualization



GRID DIAGNOZE

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