Welcome to

Statnett's R&D Conference 2019

Statnett

Opening Session

Official opening of the conference	Sonja Berlijn	Statnett
The importance of R&D for TSO/DSO in Norway	Liv Lønnum	OED
Why is it important for TSOs and DSOs in Norway to perform R&D?	Ove Flataker	NVE
Why does Statnett perform R&D?	Auke Lont	Statnett
Why do we need R&D projects on different TRL levels?	Rune Volla	NFR

Norwegian Ministry
of Petroleum and Energy

The importance of R&D

Deputy Minister Liv Lønnum

Oslo 2.4. 2019

"The future is electric"

Electric airplane

Electric excavator

Future of the fjords – a full-electric passenger vessel

Electric funeral car

The future is also digital

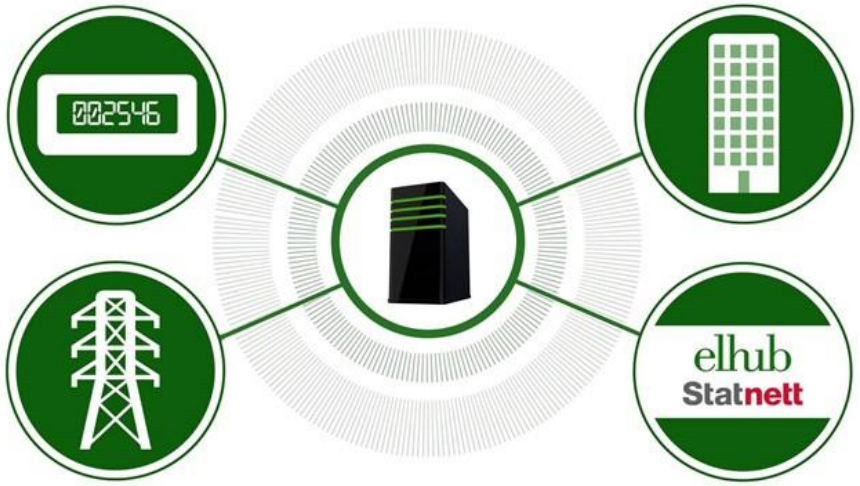


Illustration of Elhub.

Smart meters

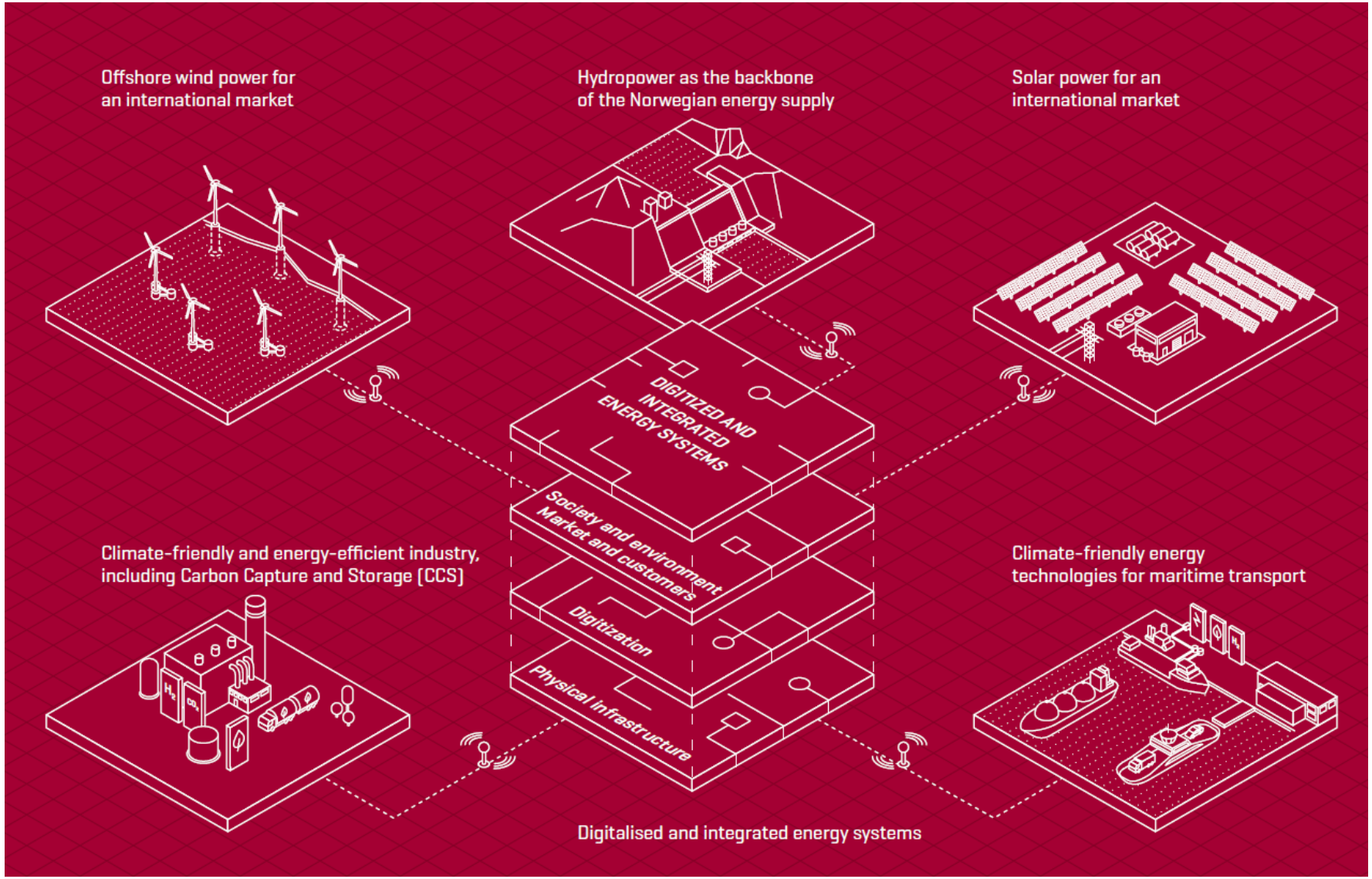
"Game of Drones": eSmart Systems is using drone-technology to inspect power lines.

The importance of R&D

CINELDI
Centre for intelligent electricity distribution
- to empower the future Smart Grid

FME CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway

FME Cineldi – research centre for intelligent electricity distribution



The revised ENERGI21-stategy and the main priorities.

Thank you for your attention!

NVE

«Why should TSOs and DSOs perform R&D»

Statnett's R&D Conference, Oslo 02.04.2019

Ove Flataker, Energy Regulatory Authority (RME)

Climate policy and technological development affect the power system and energy industry

- Cheap access to reneweable energy, mainly intermittant and desentralised
- Electrification within transportation, more capacity demanding consumption
- New technology challenges roles and business models
- Digitalisation provides new possibilities as well as vulnerabilities

- Transmission costs and distribution costs are increasing – will electricity from the grid be competetive in the future?

What does all this entail?

- Consumption must adapt to production, not only the other way round
- Consumption and production must adapt to capacity in the grid, not just the opposite

Flexibility is of the essence!

➢ Optimize the use of production resources, grid capacity and flexibility resources throughout the value chain. Key factors:

- Technology
- Competence
- Regulation

The principal aim of regulation

- Efficient markets
- Efficient operation, exploitation and development of the grid

Efficient markets

- Pan-European spot and intraday markets are in place
  - Competition between power exchanges to be introduced in 2019
- Pan-European balancing market adopted, and is currently under development
  - 15-minute time frame, lower bid size, aggregation of bids
- Independent aggregators are part of the Clean Energy Package (CEP)
  - Several balancing responsible entities at one meter point
- Grid customers own their flexibility

Efficient operation, exploitation and development of the grid

Key factors:

- The grid industry's ability and will to improve cost efficiency
  - Daily business operation, digitalisation, developing industry structure
- Grid customers' utilisation of the existing power grid and demand for a new capacity
  - Pricing of connections and use
- Regulation
  - Economic regulation vs direct regulation

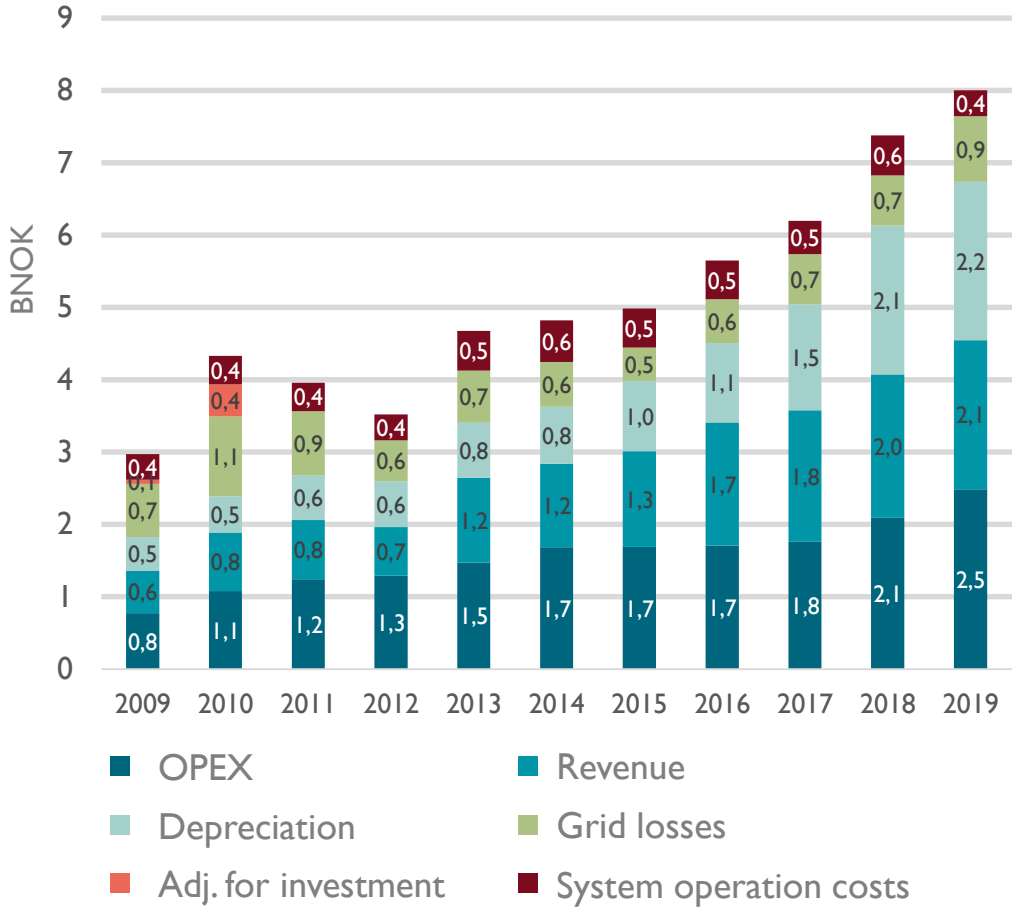
Statnett – revenue cap increased by 170 pct over 10 years

Report on cost development

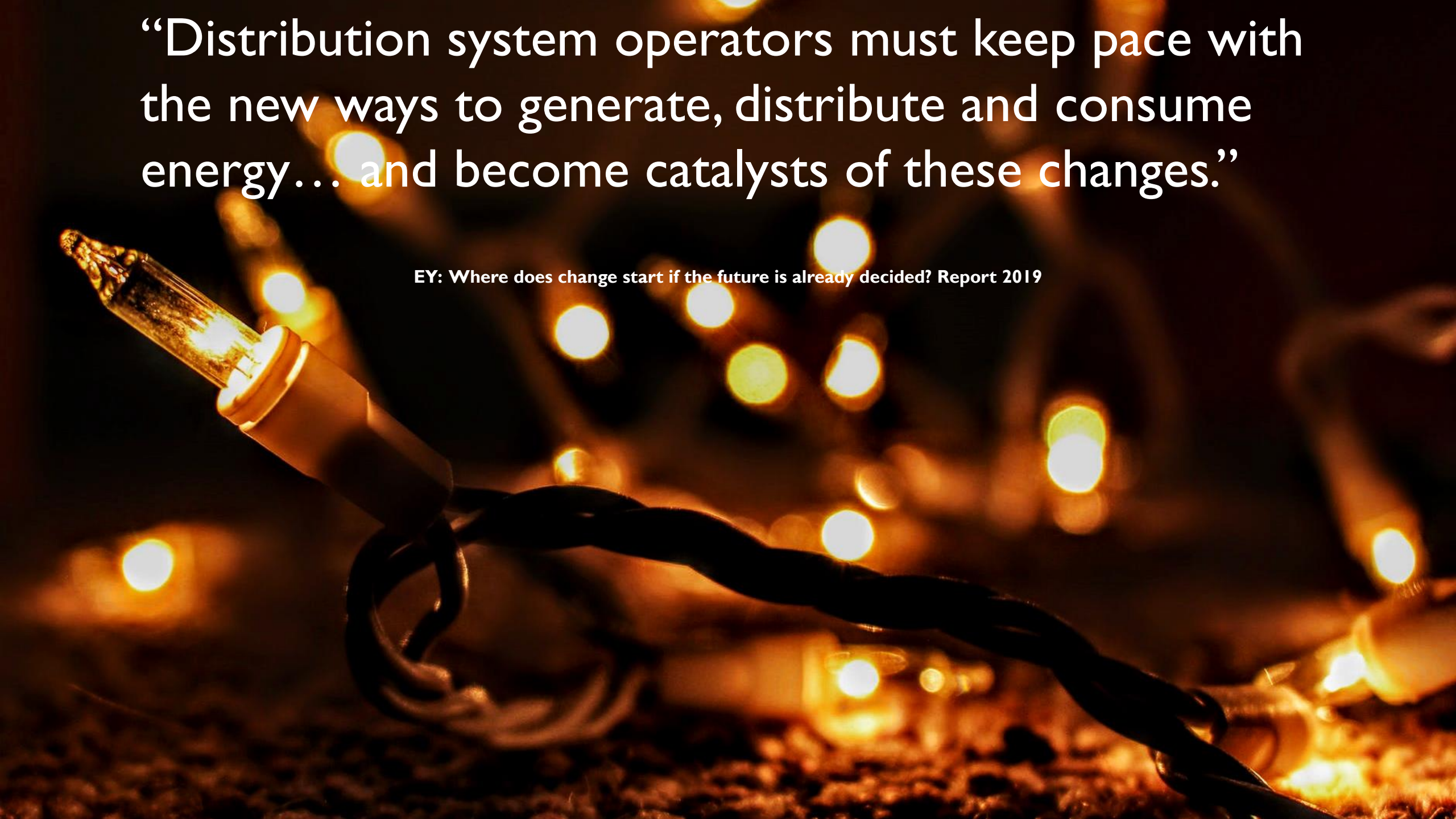
Report on large investments

Review of cost of constructing transformers and power lines

European benchmark of TSOs




NVE
DSOs will play an important role on the journey towards a low emission community – are they up to it?
25 TWh
7 GW
6 TWh
100+ GW
SHOULD NOT PAY MORE THAN NECESSARY



"Distribution system operators must keep pace with the new ways to generate, distribute and consume energy… and become catalysts of these changes."

EY: Where does change start if the future is already decided? Report 2019

AMS data

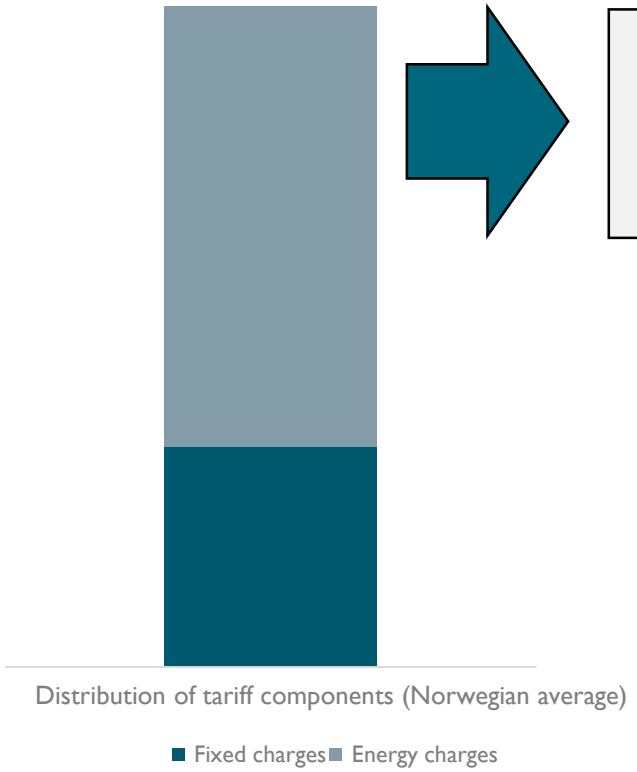
Cost reflective tariffs

Information

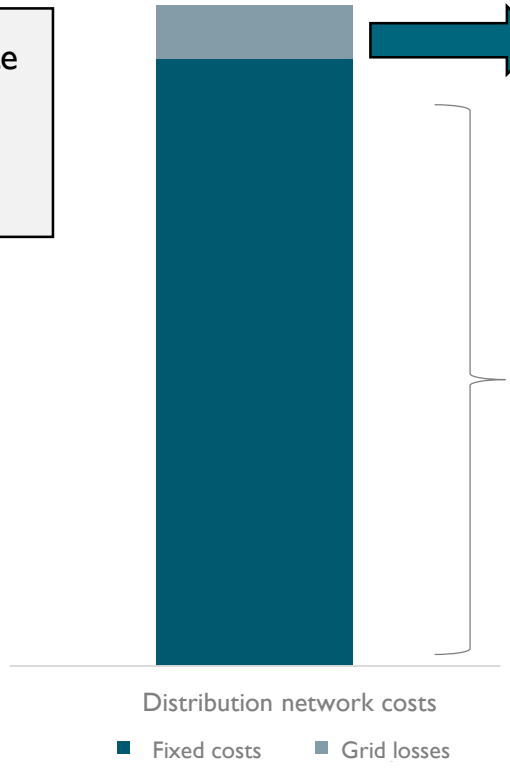
Price signal

A smarter energy system is built step by step

Today's tariffs do not reflect network costs



Energy charges constitute 2/3 of a household's electricity bill

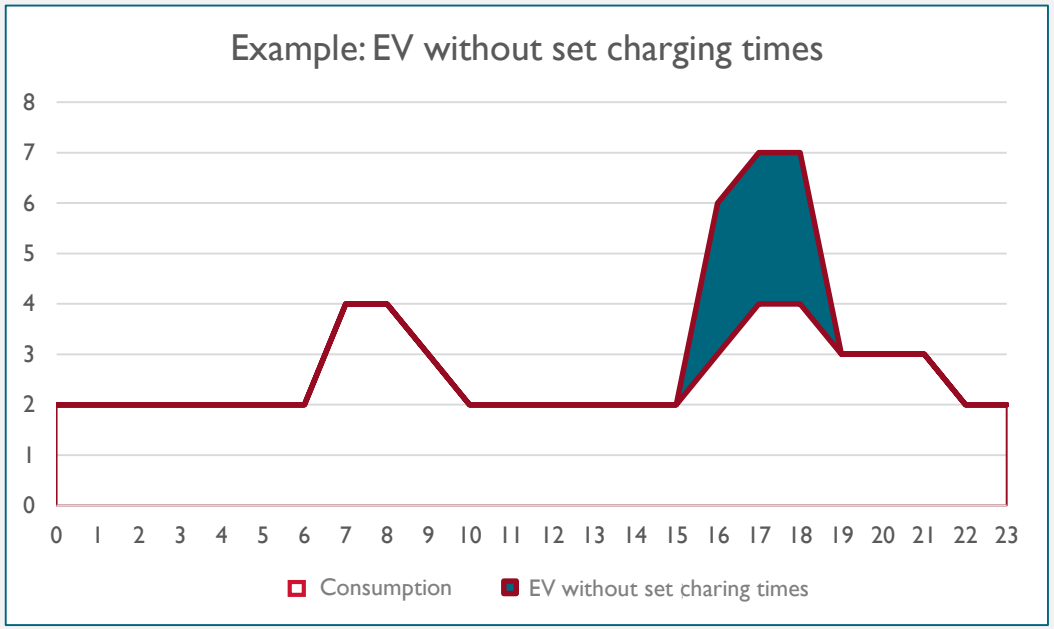


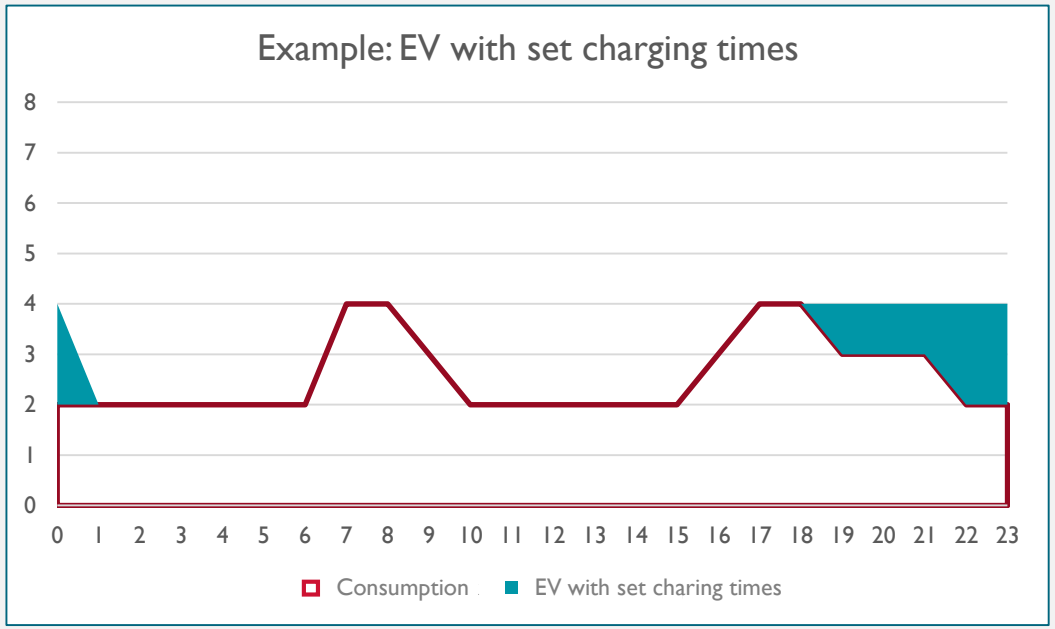
Transmission losses constitute only 8% of distribution net costs

Costs associated with availability and capacity

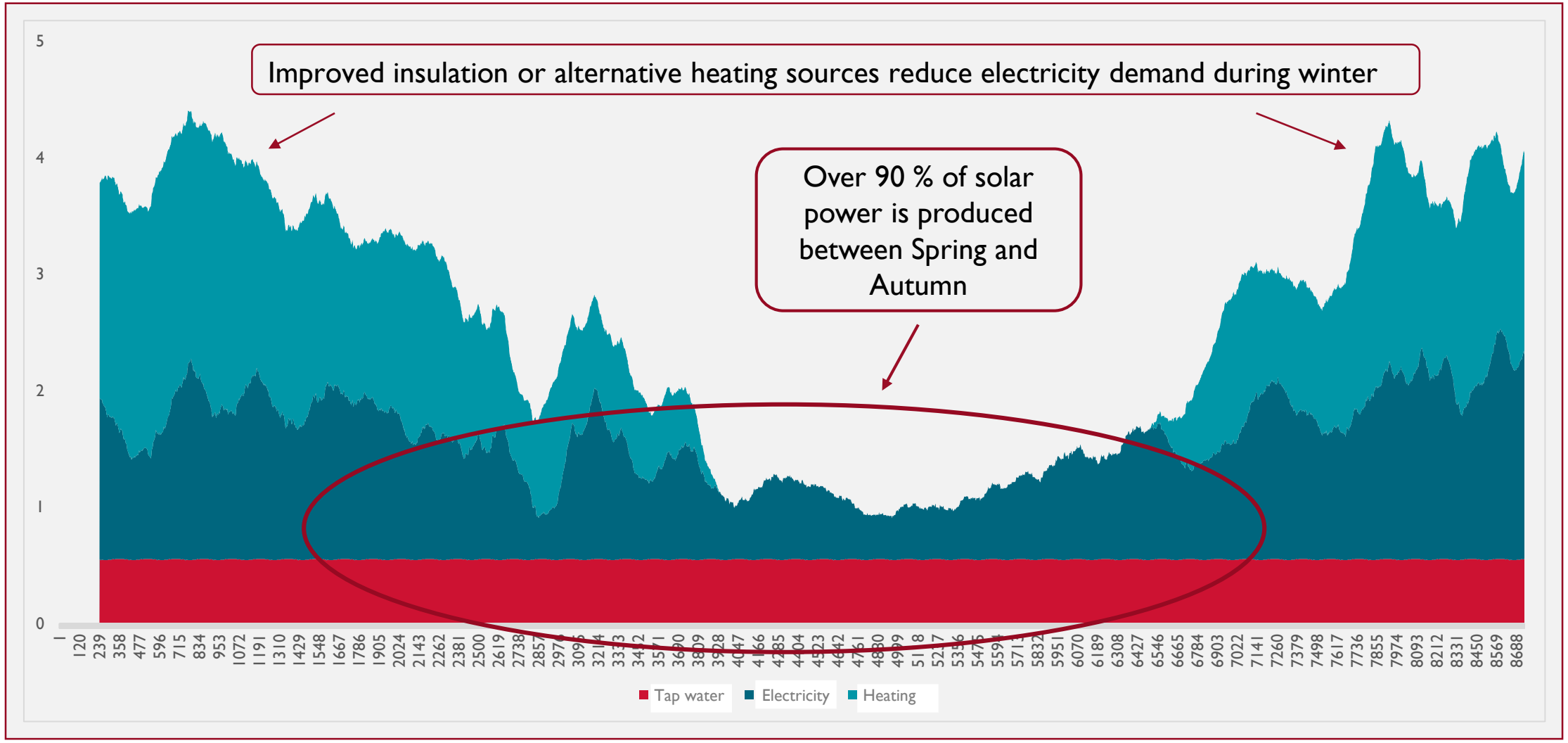
High charges for inexpensive costs and vice versa

Consumers with differing EV-charging patterns pay equivalent grid tariffs – despite a varying impact on network load



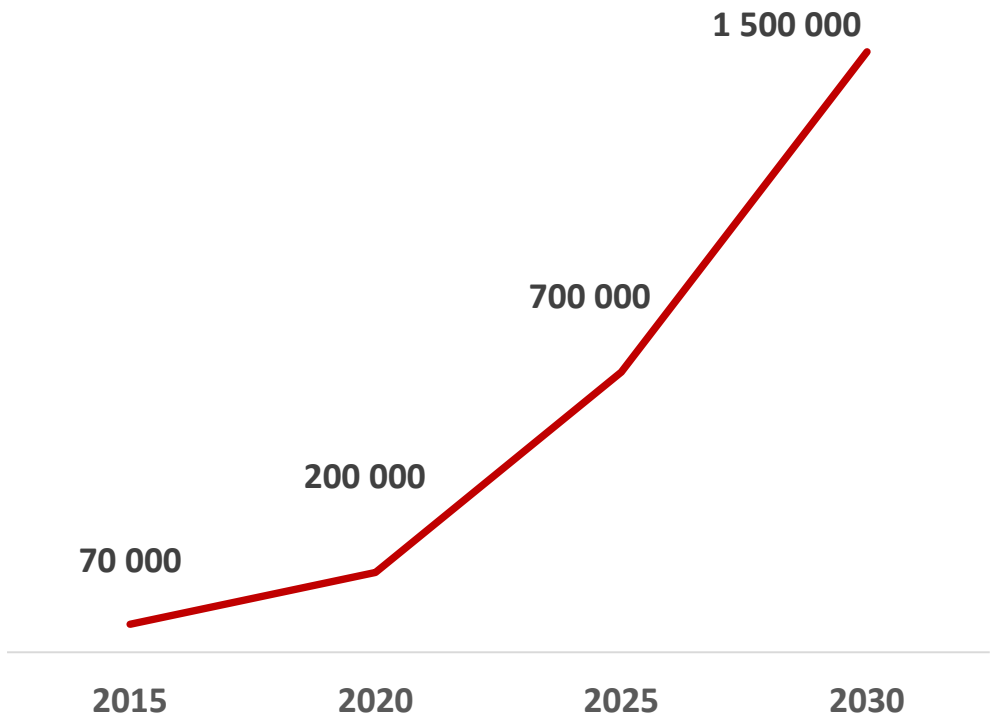


Energy initiatives get equivalent reward from grid tariffs – despite a varying impact on network load



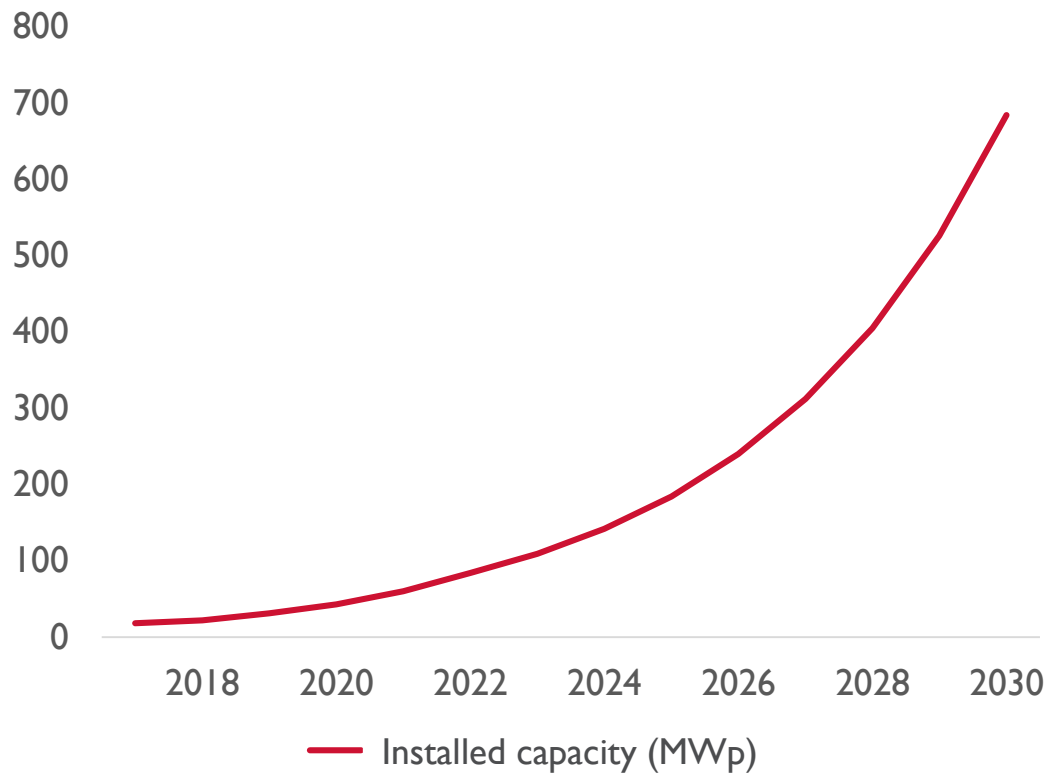
Incorrect tariff pricing will have bigger consequences in the future

EVs



Data from NVE (2016) & www.elbil.no.

Solar energy

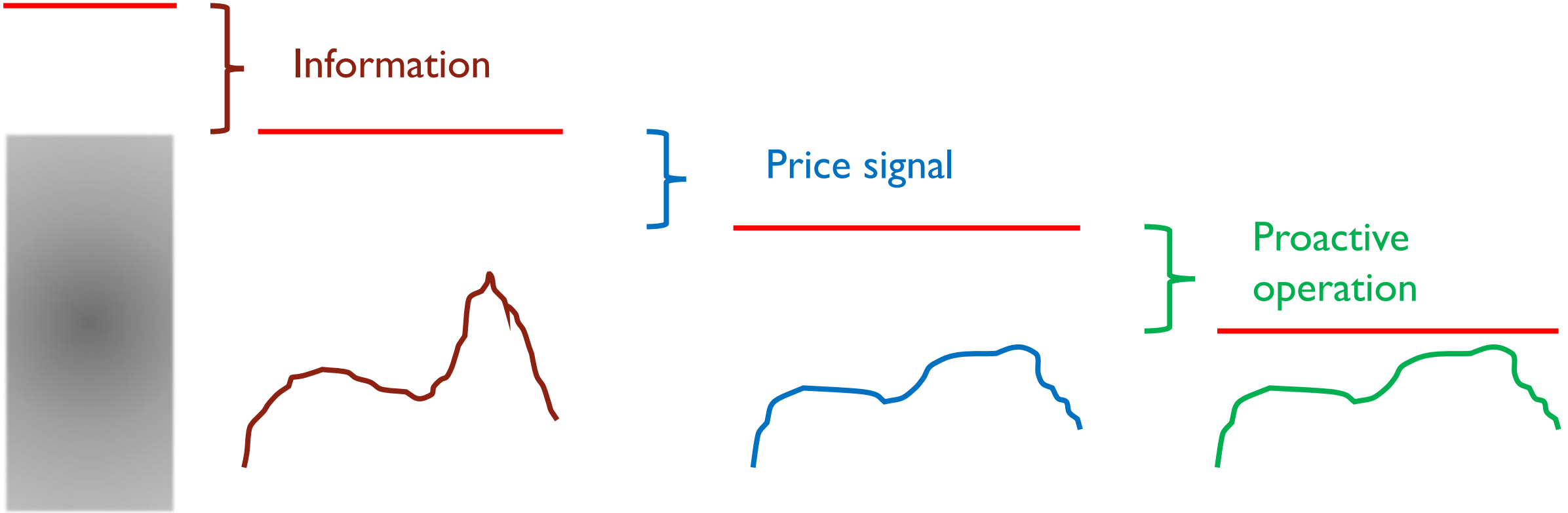


Data from "Solenergiklyngen" (a solar business cluster)

AMS data

Cost reflective tariffs

Congestion management



A smarter energy system is built step by step

From reactive to proactive operation – prerequisites

Realtime information on network conditions

- Flow, utilized capacity, voltage

Network condition forecast for relevant time horison

- Minute, hour, day

Operation systems handling large quantities of data

AMS data
DMS
Digital standard
Market info

Neutrality
Confidentiality
Cooperation TSO-DSO

Market solution for distributed flexibility

- Accentuate and prioritise available flexibility, activation, settlement

Efficient handling of small volumes with detailed geotagging

Benefits of digitalising the network

- Reliable and efficient operation
- Predictive maintenance
- Accurate revenue cap calculation
- Swifter customer service
- Efficient network planning

Industry initiative for digital «naming convention» DigIN

Delegated responsibility for system operation (Statnett pilots)

NODES initiative. Market place for distributed flexibility. Enova pilot

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Industry initiative for digital «naming convention» DigIN

Delegated responsibility for system operation (Statnett pilots)

NODES initiative. Market place for distributed flexibility. Enova pilot

Revenue cap regulation with stronger effeciency incentives soon on hearing

NVE is evaluating new regulations that will require digitalisation of network

Possible certification practices for network companies with extended tasks

Incentives towards cost efficiency for DSOs

- Total revenue depends on overall costs
- Revenue cap calculation provides competition to get the largest slice of the cake
- Each company's share is 40% own costs and 60% norm

Financing R&D

- Stimulate R&D activities that can contribute to more efficient operation, development and utilisation of the power grid
- Directed at TSO and DSOs
- An important instrument in the economic regulation model


Picture: eSmart

How it works

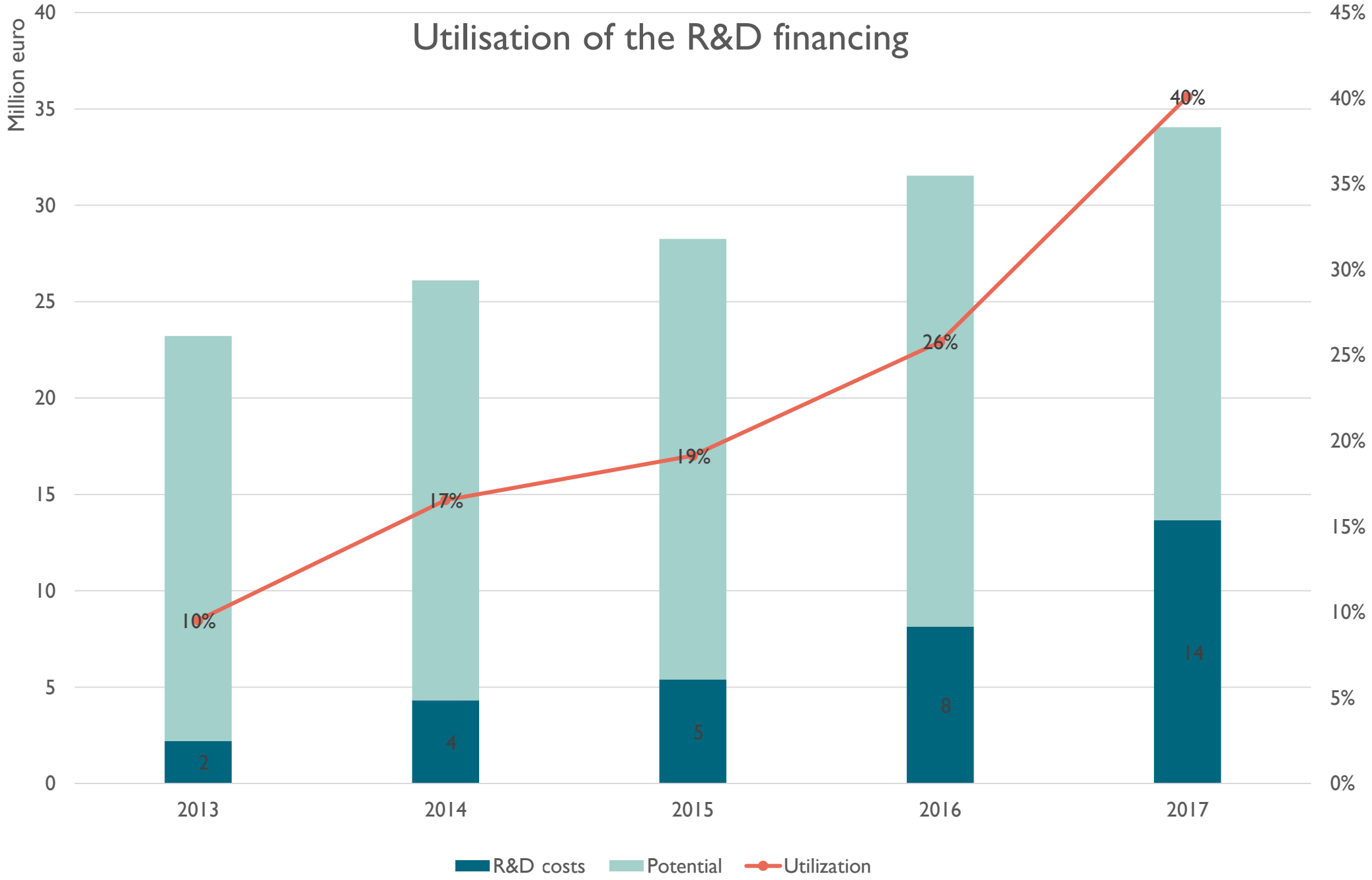
Must be relevant

Must be approved by a grant institution

Sharing of results

- The companies submit a project application to NVE
- Up to **0,3** % of the regulatory asset base (34 million Euros in 2017)
- Approved costs are added to the allowed revenue and included in the tariff basis

Bilde: NVE

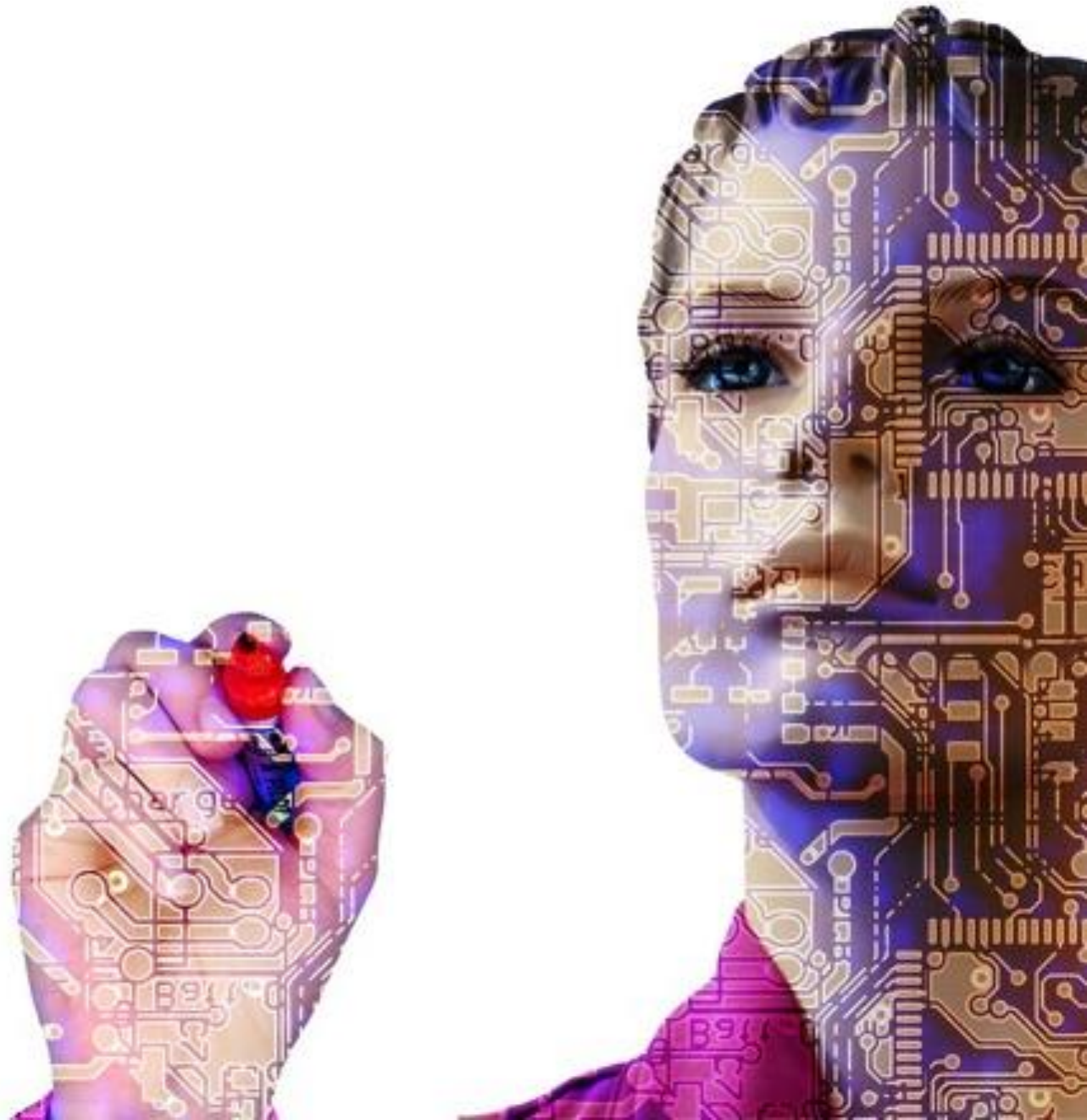


140 projects approved so far

- Cost efficiency
  - Monitoring and controlling
  - Drones
  - Lifetime analyses
- New technologies
  - Transformers, cables, sensors, protection
  - Smart grids, utilisation of flexibility
  - Energy storage, electrification, microgrids
- Digitalisation
  - Big data, machine learning
  - Cyber security

The DSOs must adapt

- Innovation
  - New technologies
  - New methods
  - New processes
- Innovative companies will in the long run get higher returns
- NVE will be an active facilitator
  - Follow developments closely
  - Regulate when needed / appropriate



A «regulatory sandbox» designed to facilitate innovative projects in a controllable environment

- **Will be launched within a few weeks**

- Elements in the framework:
  - Information
  - How to apply for exemption?
  - Criterias for exemption

- If an exemption is granted:
  - Exemption for maximum five years
  - A plan for how to exit the project
  - Results and experiences are public information
  - Report to regulatory authority

Efficient and reliable energy system is important for our future welfare and competetiveness

Flexibility is necessary to balance the system

Flexibility is a tool to reduce grid investments

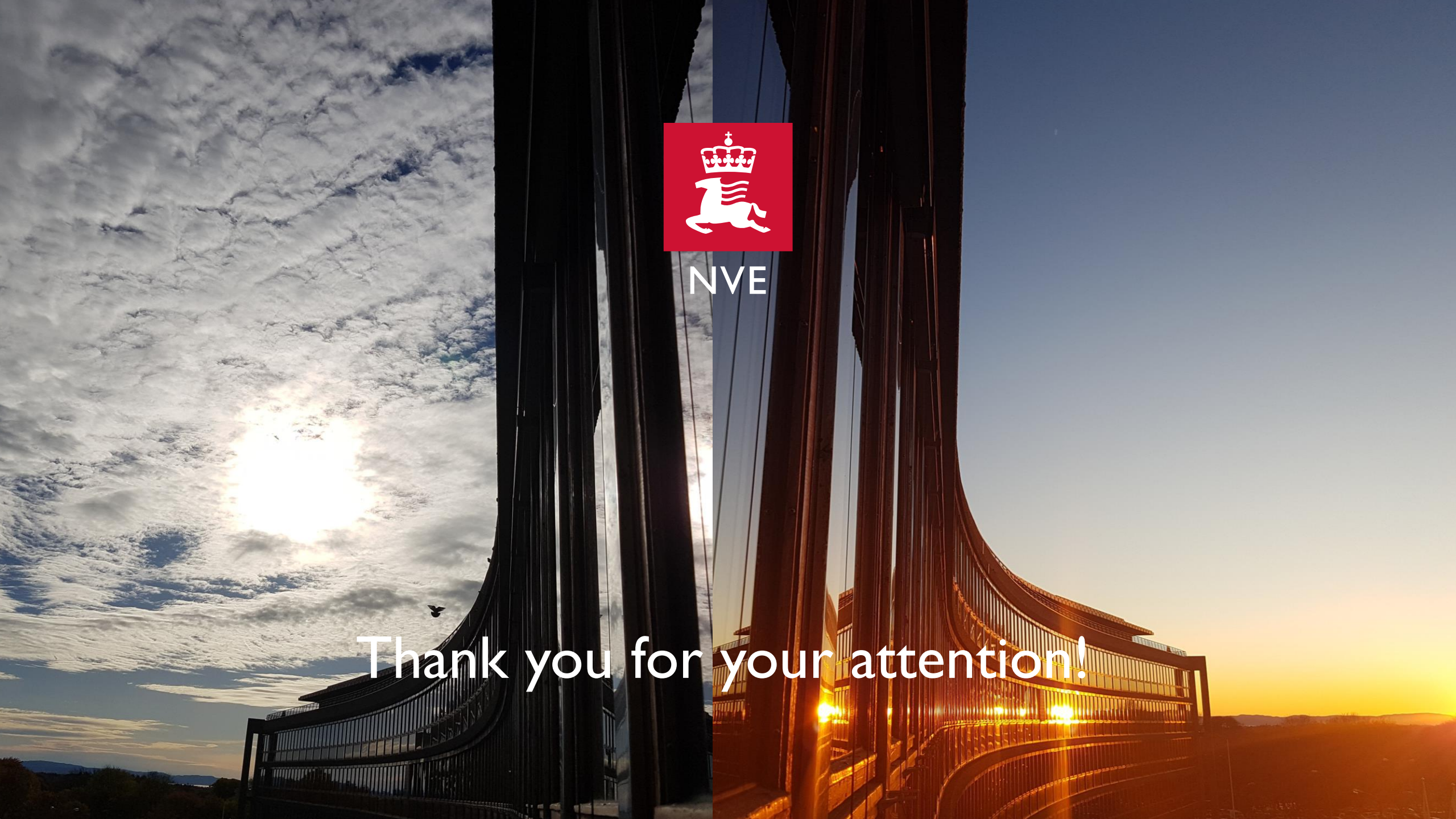
It is about:

Technology

Competence

Regulation

	Generators and consumers adapt to price signals	**Generators and consumers offer flexibility in, or close to, the operating hour**
Transmission & Wholesale level	Day-ahead market, with bidding zones Pan-European intraday market	Modernized Pan-European balancing market
Distribution & Retail level	Suppliers offer spot based contracts DSOs issue cost reflective grid tariffs	Suppliers/aggregators/ consumers offer flexibility DSOs demand flexibility through market solutions DSO/TSO interface


NVE
Thank you for your attention!

Why is R&D important for Statnett?

Auke Lont, CEO Statnett

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Statnett's R&D Conference 2019, 2nd - 3rd of April

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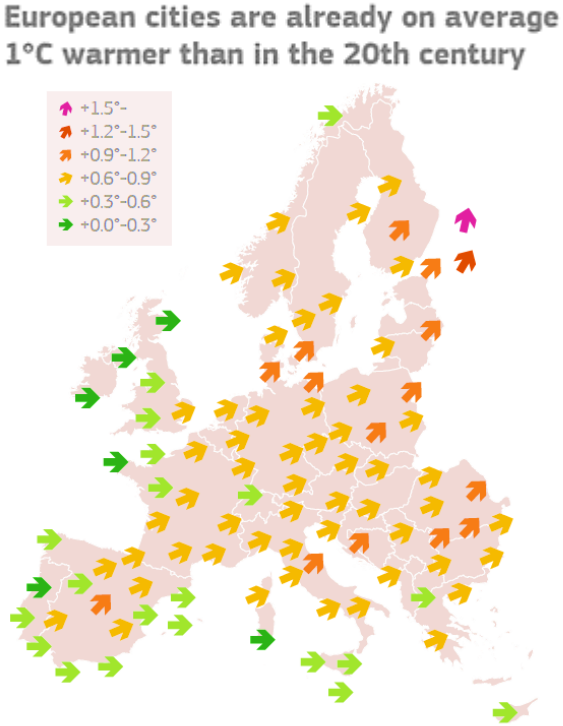
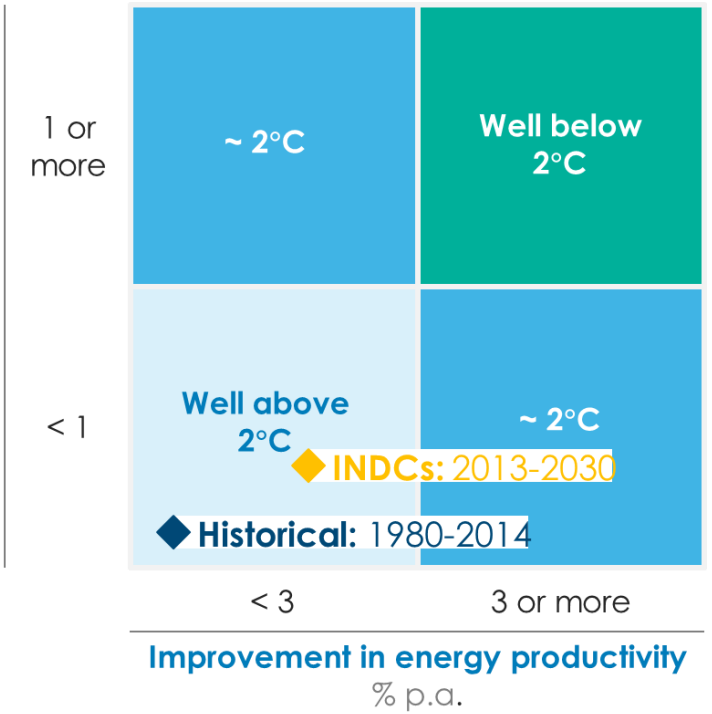
We must **accelerate**



Source: European Data Journalism Network



SOURCE: Enerdata (2015), Historic actuals

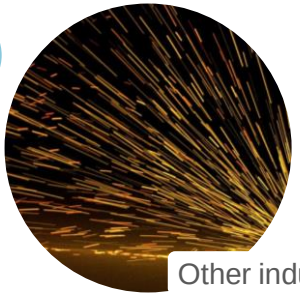
Enabling the **electric future**

Extensive electrification: 30-50 TWh

Transport

Oil & gas

Households, primary & service industry



Other industry

H_2

Hydrogen replacing fossil fuels in industry and transport

40 TWh

If production of clean electricity increase with around 30 percent, Norway's emissions can be cut in half

Aftenposten, 22.03.2019

The system is **changing fast**

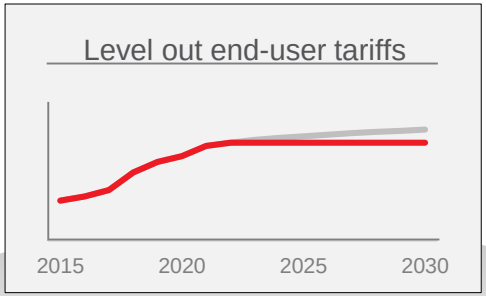
Statnett will spend

120 MNOK

a year on R&D in 2020-2023*

*0,2% of Statnett's revenue ceiling

Our **strategy**



Effective

Smart

Safe

Statnett's R&D vision 2020–2023

Stimulate and encourage innovation in the realization of **a fully electrified Norway**.

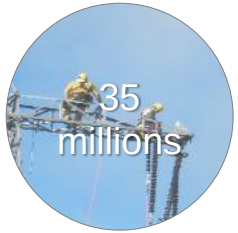
Statnett's R&D efforts will lead to increased **know-how, innovation and added value** in a safe, secure and sustainable power system.

>10,5 BN

NOK saved since 1997

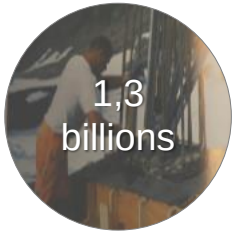
…in addition to an increased level of safety, digitalization and know-how

Voltage upgrading



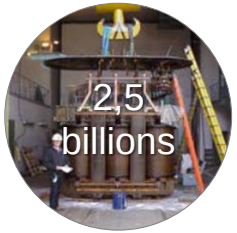
Live line work

Minimum electrical clearances



Concrete tower foundation

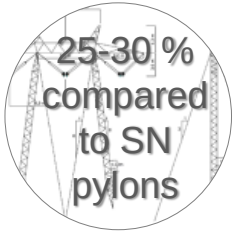
Installing aircraft warning markers using a robot



Transformers lifetime utilization

Pre-fabricated steel foundation

High temperature lines



M pylon – External guy-wires

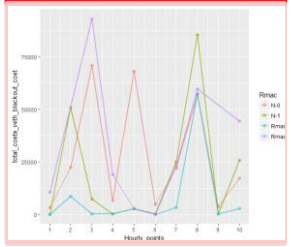
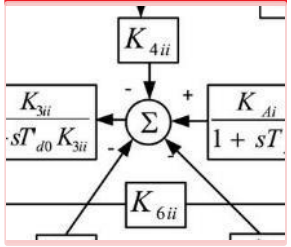
AutoDig

Digital Station

Statnett

Our areas of **digitalization**

Robots	Self-diagnosis	Digital infrastructure	Cyber physical security
			

Faster response	Prediction	Model development	User interface
			

The importance of **cooperation**

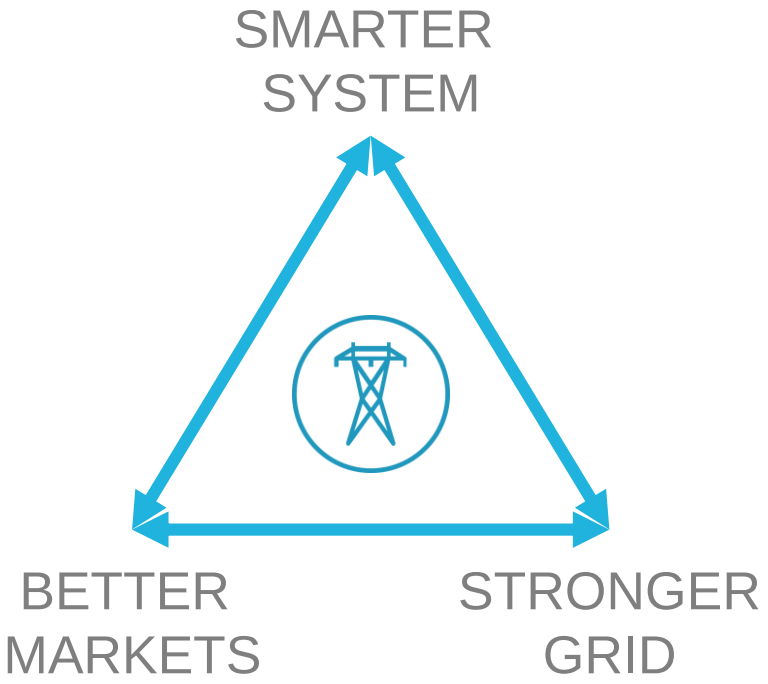
Long history of **cooperation** in research and system operation in Norway and the Nordics

But it is becoming even more important as the system is getting **more complex**

The importance of **markets**

We should use the market as a
problem solver

Innovations must play into the market and the existing system
– **smart market design is crucial!**



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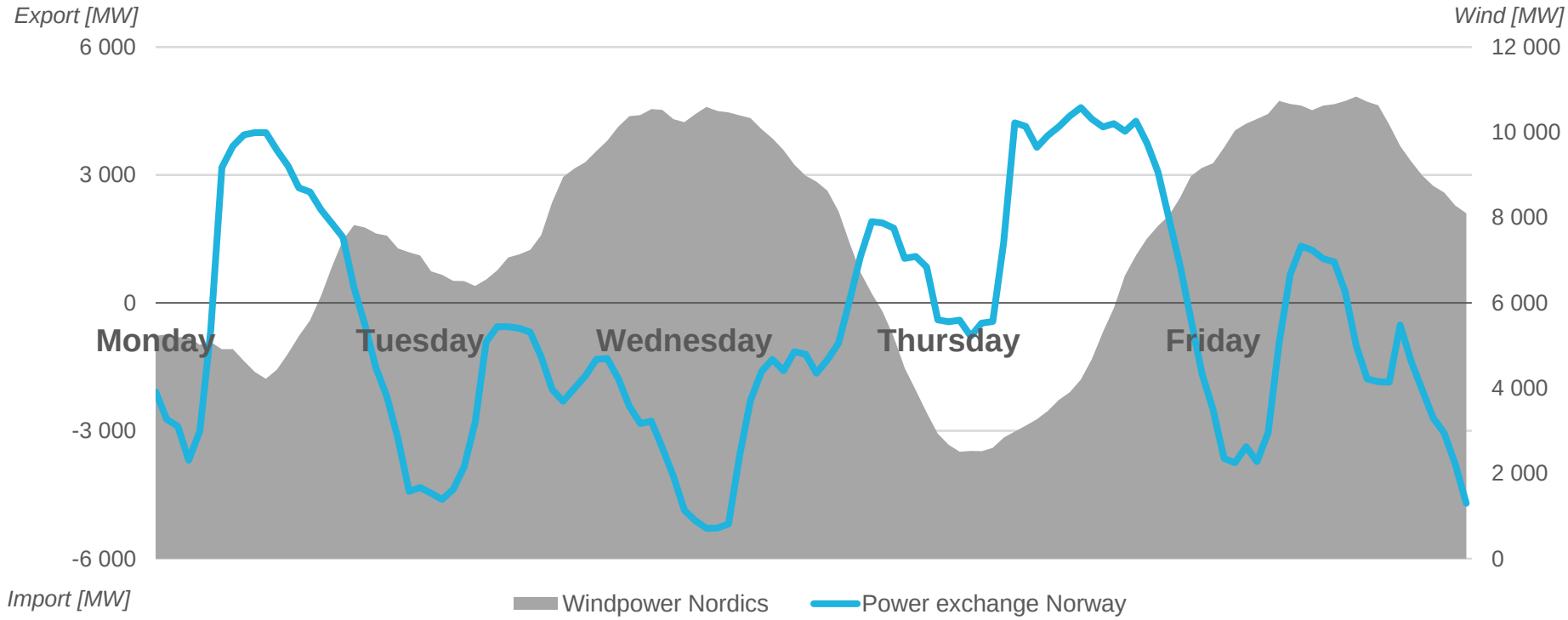
Cooperation in a **changing system**

Wind power production (Nordics) and power exchange (Norway) in week 2 2019




The future is
electric

Why do we need R&D-projects on different TRL-levels?

Rune Volla

Director, Department for Energy Research
The Research Council of Norway

09.04.2019

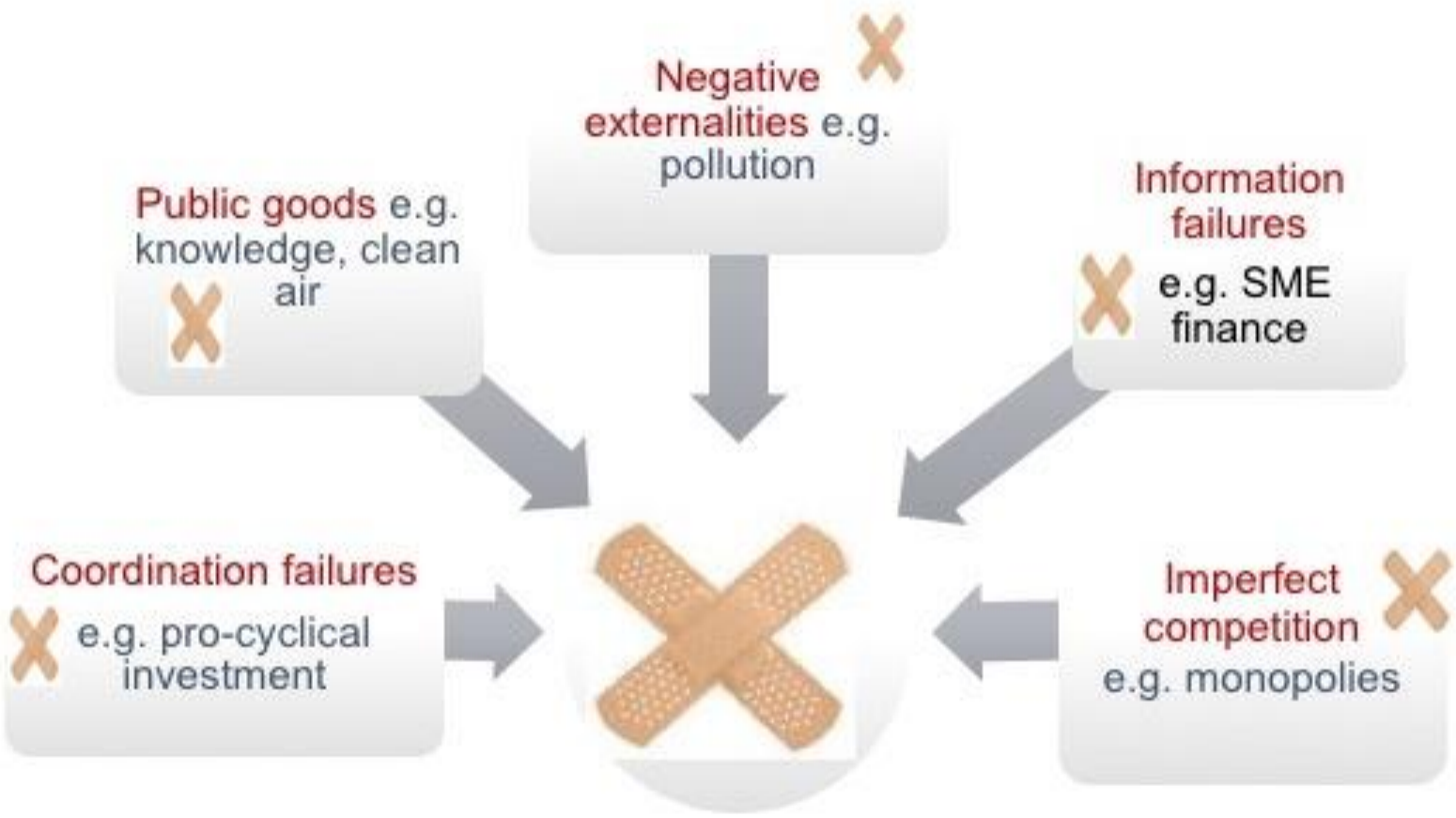
RCN's targeted instruments for energy R&D are strategic coordinated efforts (2018)

- **ENERGIX**
  NOK 417 mill.
  Renewable energy and energy efficiency

- **CLIMIT**
  NOK 92 mill.
  CO_2 Capture and Storage

- **Centres for Environmental-friendly Energy Research - FME**
  NOK 182 mill.

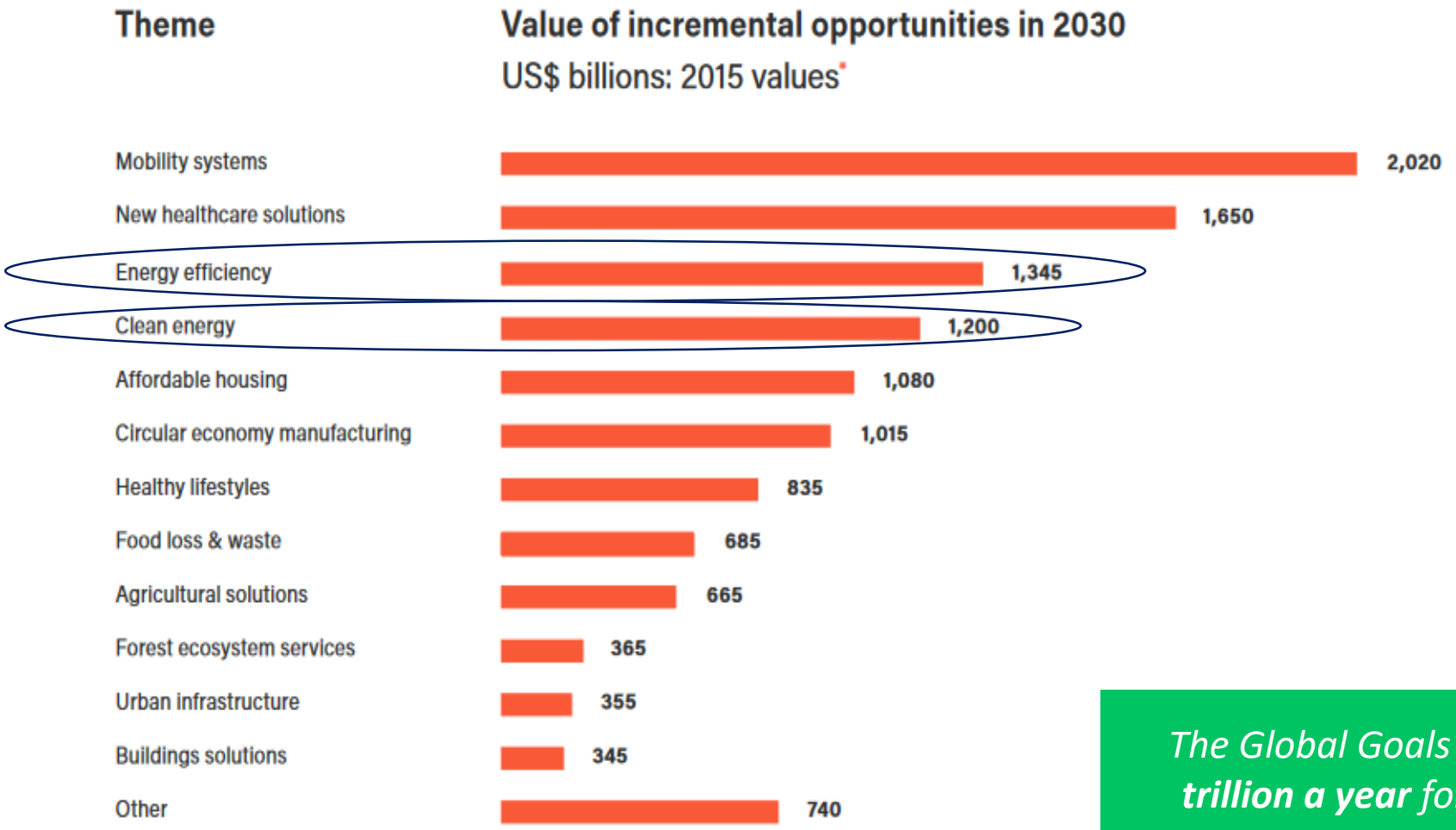
We do **not** see ourselves primarily as marked failure-fixers for private sector



Mazzucato, 2018

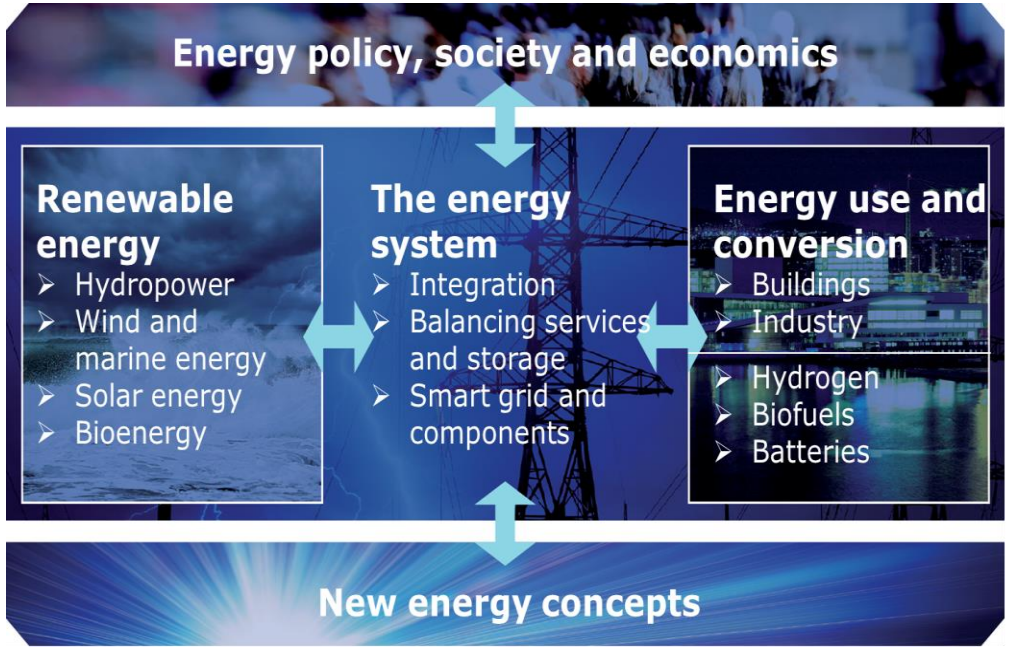
Our goals are to help solving the grand challenges..

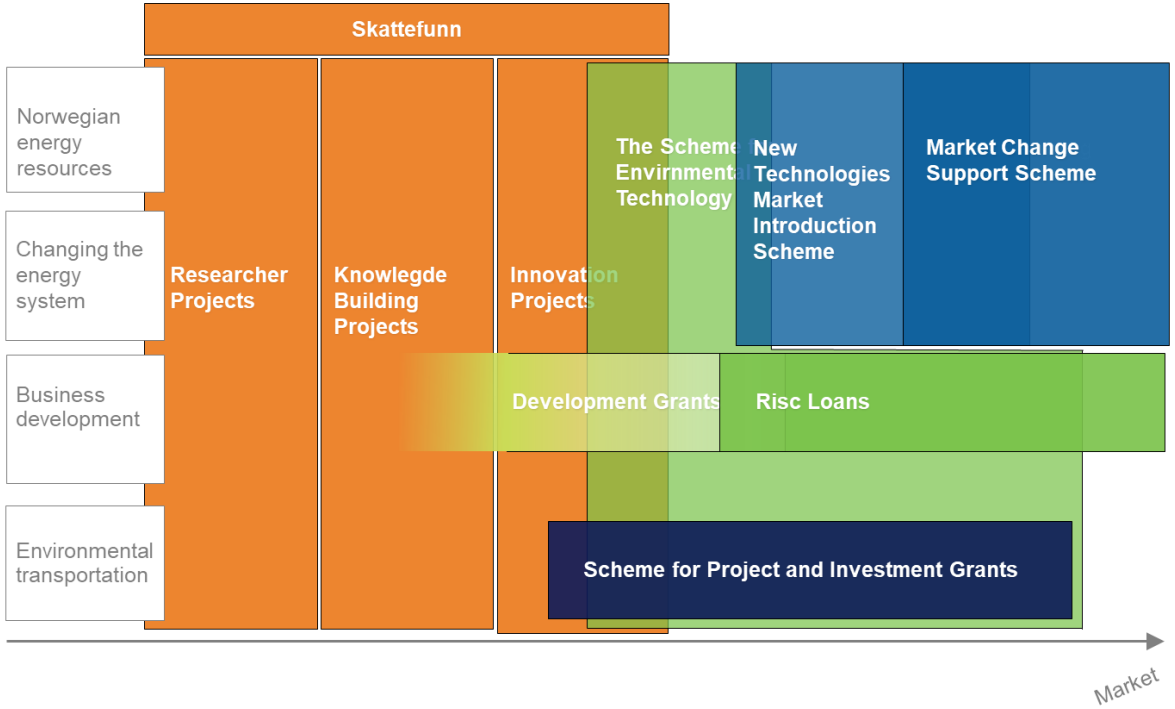
..and to create green growth in Norway



*The Global Goals could be worth up **to US$12 trillion a year** for the private sector by 2030*

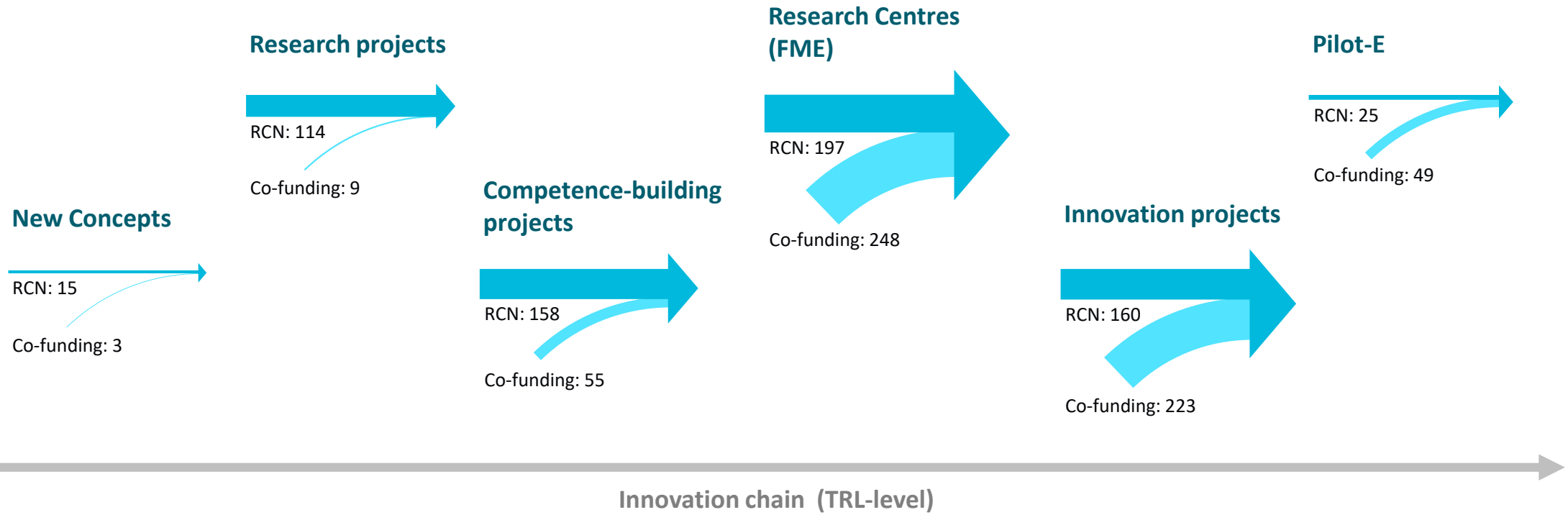
Portfolio management to ensure thematical span and TRL progress





Research Council of Norway
Innovation Norway
Enova
Transnova

2018 project funding from ENERGIX and FME programmes (in million NOK)



We need to be able to show the effects of the public R&D-effort

- A recent evaluation from Impello Management and Menon Economics concludes that R&D related to the energy sector has significant impact
- Ten years after Stortinget reached it's first climate agreement
- Case studies show:
  - Realised economic effect is **4 times** greater than the R&D investments
  - **100 bn NOK** in future economic potential

Example – projects to promote competetive industry on production, use and recycling of batteries

Advanced Materials for Magnesium-Ion Rechargeable Batteries (ADMIRE)

Background:

- Magnesium is the fifth most abundant material on earth
- Can pack more energy per unit volume than lithium
- Would be very safe during operation
- Challenges: formation of insulation layer, weight of complete cell

Primary objective:

- Develop advanced rechargeable magnesium-ion batteries with high energy density, better durability and safe operation for future stationary, transport and grid storage applications.

Project responsible: SINTEF Industri

Partners: NTNU

Type: Researcher project

Duration: 2016-2019

Financing: 9,1 mill.

Project number: 255108

Safety and modelling of aged Li-ion Batteries

Background:

The largest battery system for a ship currently built stores several MWh of electric energy. The consequences of a fire in such a system can be catastrophic. The degradation and ageing of Li-ion batteries will in many cases contribute to reduced thermal stability. This can potentially affect the safety performance of the batteries.

Objectives:

Build knowledge on safety characteristics of aged and new large commercial Li-ion cells relevant for the maritime industry, including lifetime and degradation mechanisms and thermal modelling on relevant load- and operational profiles.

Project responsible: IFE

Partners: FFI, NTNU, ZEM, Rolls-Royce Marine, RISE Fire Research, ABB, FMC Kongsberg Subsea, Beyonder, EST-Floattech, Corvus, Hydro

Type: Co

Financin

Project r

Cenate – Centrifuge Nano Technology: Nano silicon anodes for Li-ion batteries

Background:

Mixing silicon into the carbon anode is known to increase the energy density substantially. However, large volume expansions when charging a silicon-rich battery tend to reduce lifetime substantially. Cenate together with Dynatec has developed a potentially cost-efficient process for producing suitable nanoparticles.

Goal:

to increase the capacity of current lithium ion batteries with up to 40% without significant increase in the cost for battery production.

- Smaller, less heavy batteries
- Cost efficient production process

Status:

Using results from the previous DOVRE projects, Cenate is in close dialogue with a selected group of potential customers.

Project responsible: Cenate AS

Partners: IFE, SINTEF, Dynatec

Type: Innovation Project for the Industrial Sector

Duration: 2017 – 2019

Financing: Project 2018 - 14 mill.

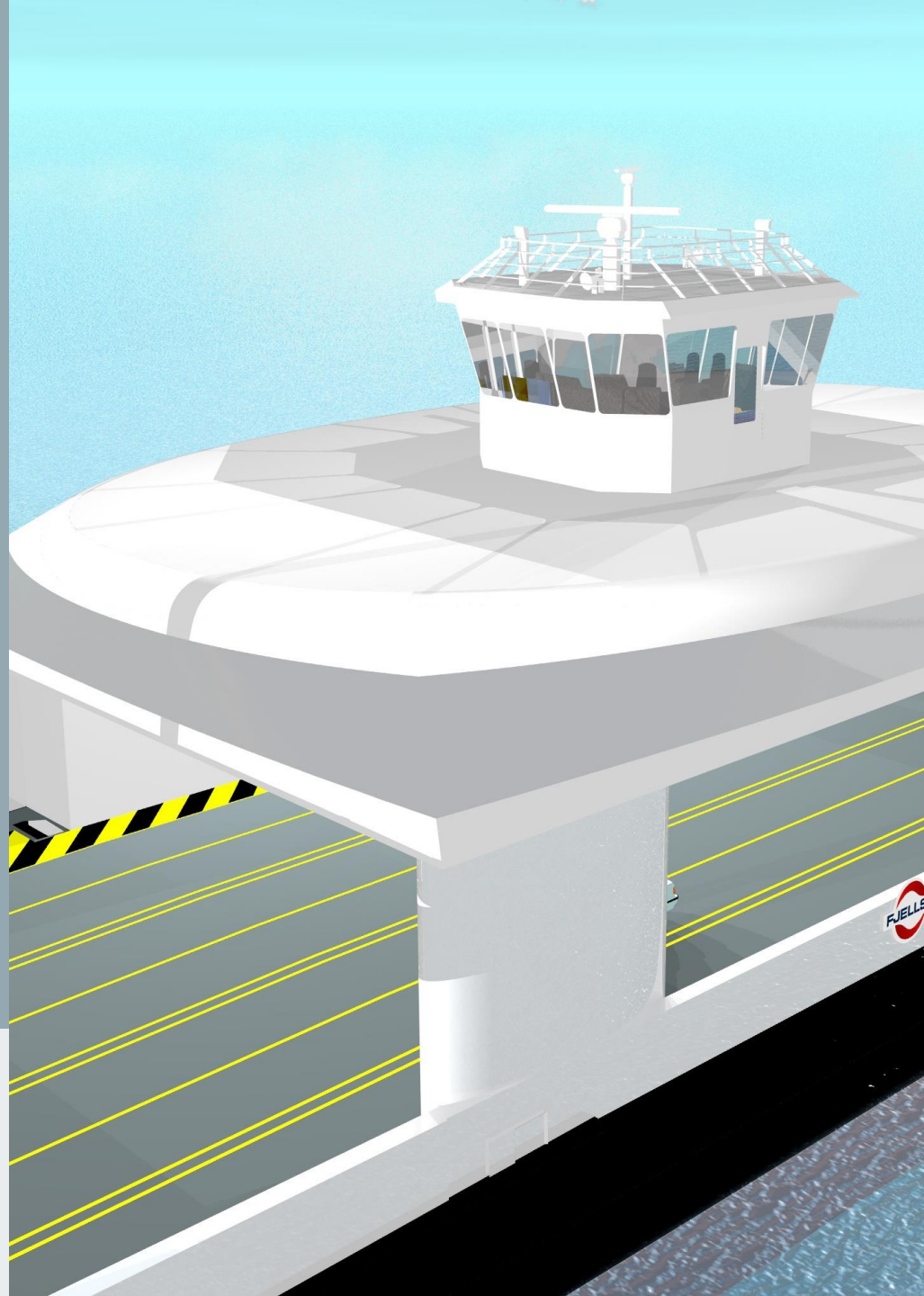
Project number: 282313

Energy-optimized concept for fully electric, emission free and autonomous ferries

Kongsberg Maritime is heading a consortium with Corvus/Grenland Energy on marine battery technology, Fjellstrand shipyard on vessel design, Grønn Kontakt on the charging of electric cars both quay-side and on board, and NTNU as a research partner within autonomy and energy management.

Goal:

To develop a state-of-the-art ferry as an integrated, zero emission aspect of a total national transportation plan.



Project responsible: Kongsberg Maritime

Partners: Corvus/Grenland Energy AS, Fjellstrand AS, Grønn Kontakt, NTNU

Type: PILOT-E (collaboration with ENOVA and Innovation Norway)

Financing: 24,5 mill. NOK from the Research Council and Innovation Norway

Project number: 269116

LIBRES - Lithium ion Battery (LIB) Recycling

Background:

- Norway has the highest EV fraction of new car sales in the world.
- The amount of used ev-batteries will increase substantially over the next 7-10 years.
- Norway has a competent metallurgical industry and an efficient battery collection scheme.

Goal:

To develop the next generation LIB recycling process. Recover valuable materials such as: lithium, cobalt, nickel, copper, aluminium, graphite and special fluoride salts.

Project responsible: Hydro Aluminium AS

Partners: NTNU, Universitetet i Agder, Batteriretur AS, Commercial partners in Norway and Germany

Type: Innovation Project for the Industrial Sector

Financing: 6,6 mill. NOK (30 pst)

Project number: 282328, duration 2018 - 2022