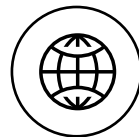




Nordlink Wilster HVDC Light station 1400 MW

Årsmöte Västerbergslagens Ingeniörsklubb (VBIK)

Dr. Magnus Callavik, Hitachi Energy
2023-Mar-20



Greater integration
of renewables



More power
Lower losses



Enhanced grid
system stability



Lower lifetime
investment

Outline

- What is happening on the Power Grid market
- Why HVDC and HVDC Light
- Recent project examples
- Future HVDC Grids
- Constraints in the supply chain and talents
- Outlook Ludvika Works
- From ABB to Hitachi
- Concluding remarks, discussion, Q&A



Kvilldal, Norway. North Sea Link



Dr. Magnus Callavik

Global Engineering Manager HVDC and HVDC Service
Deputy Global Product Group Manager HVDC and HVDC Service



Educational Background

PhD. & MSc. at KTH – Royal Institute of Technology 1994 & 1998
Research Fellow Stanford Research Institute 1994
Project Management Professional (PMP) PMI since 2008
Executive MBA at Stockholm School of Economics 2009

Journey at ABB and Hitachi Energy

Joined ABB in 1999 as PhD-trainee
Various management roles in R&D, Technology, Engineering and General Management
One year in USA in 2000 at ABB Lumms Global
Three years in China 2017-2020 as GM for ABB HVDC

My daily job at present

Manage the global engineering team with cirka 1000 engineers located in CA, CN, DE, IN, JP, SE, UK, US with around 25 megaprojects in execution world-wide and 30 active tenders

Other interesting facts

I participated in the start-up and board of EIT Innoenergy from 2009 to 2017
Board member of SEK, the Swedish IEC, 2009-2017



svt NYHETER Nyheter Lokalt Sport SVT Play Bar

7 DALARNA

Hitachi Energy

1 min

SVT

Uffe Tober, Hansson som är på besök i Ludvika och Västervik för Hitachi Energy i Sverige, om den massiva rekryteringen till företaget. Foto: Ann Leander JÄRN/SVT

Energiomställningen skapar nya möjligheter – 1 000 nya jobb till Ludvika och Västerås

UPPTÄCKAD 2 NOVEMBER 2022 PUBLICERAD 12 AUGUSTI 2022

1 000 nya jobb finns att söka på Hitachi Energy, ungefär 500 i Väst och resterande 700 tjänster i Ludvika. Anledningen är klimatomställningen som är i full gång i landet. Men det är en stor utmaning att hitta framförallt de ingenjörer som behövs.

– Vi jobbar på bred front på alla tänkbara vis för att hitta de här personerna. Bland annat tillsammans med de tekniska universiteterna säger Tobias Hansson, vd på Hitachi energy Sverige.



NyTeknik

Start | Tech | Energi | Elbilar | Hållbar industri | Fordon | Debatt | Uppgående jobb | Karriär

PREMIUM

Full fart i Ludvika-fabriken – tack vare energiomställningen

2022-05-09 06:00 Av: Linda Nohrstedt 0 kommentarer



Svensk VERKSTAD

Arbetsplats Utställning Förnyelsebar Sida

TEKNIK | HÅLLBARHET | UPPGÅENDE | UPPGÅENDE | UPPGÅENDE | UPPGÅENDE | UPPGÅENDE

Hitachi Energy bygger ny fabrik i Smedjebacken

Rekryterar mer än 500 arbetare till fabriken.



TEKNIK

ledigt jobb

ledigt jobb

Dalarnas kraftcentrum växlar upp

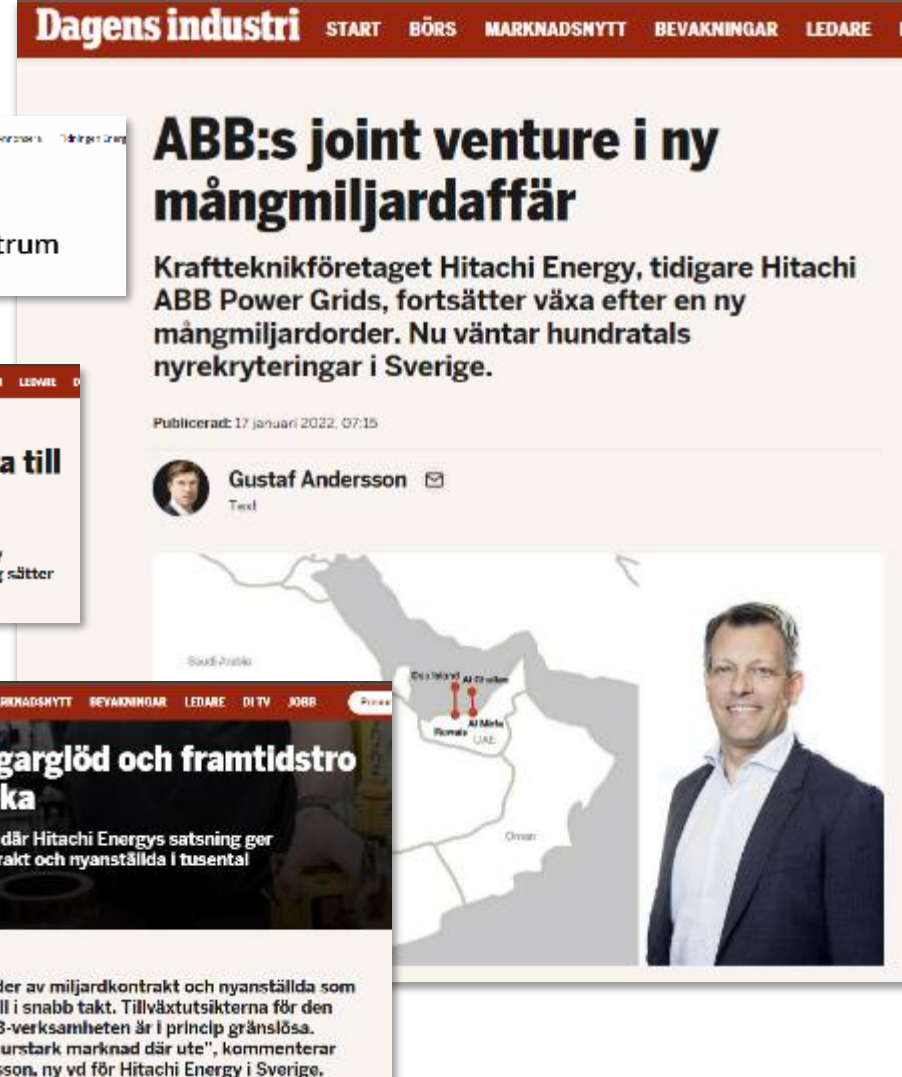


Dagens industri

START | BÖRS | MARKNADSNYTT | BEVAKNINGAR | LEDARE

Rekordtillväxten pressar kommunen – "ska leverera till hela världen"

I Ludvika har man fullt sjö med att bygga ut kommunen i den hastighet som Hitachi Energy expanderar. Bolagets snabba volymrekrytering sätter press på bostadsbyggande, skolgång och barnomsorg.



Dagens industri

START | BÖRS | MARKNADSNYTT | BEVAKNINGAR | LEDARE

ABB:s joint venture i ny mångmiljardaffär

Kraftteknikföretaget Hitachi Energy, tidigare Hitachi ABB Power Grids, fortsätter växa efter en ny mångmiljardorder. Nu väntar hundratals nyrekryteringar i Sverige.

Publicerad: 17 januari 2022, 07:15

Gustaf Andersson

Text



Nybyggarglöd och framtidstro i Ludvika

Di på besök där Hitachi Energys satsning ger miljardkontrakt och nyanställda i tusentals

Ludvika sjuder av miljardkontrakt och nyanställda som strömmar till i snabb takt. Tillväxtutsikterna för den tidigare ABB-verksamheten är i princip gränslösa. "Det är en urstark marknad där ute", kommenterar Tobias Hansson, ny vd för Hitachi Energy i Sverige.

By 2030, our energy system will need to evolve

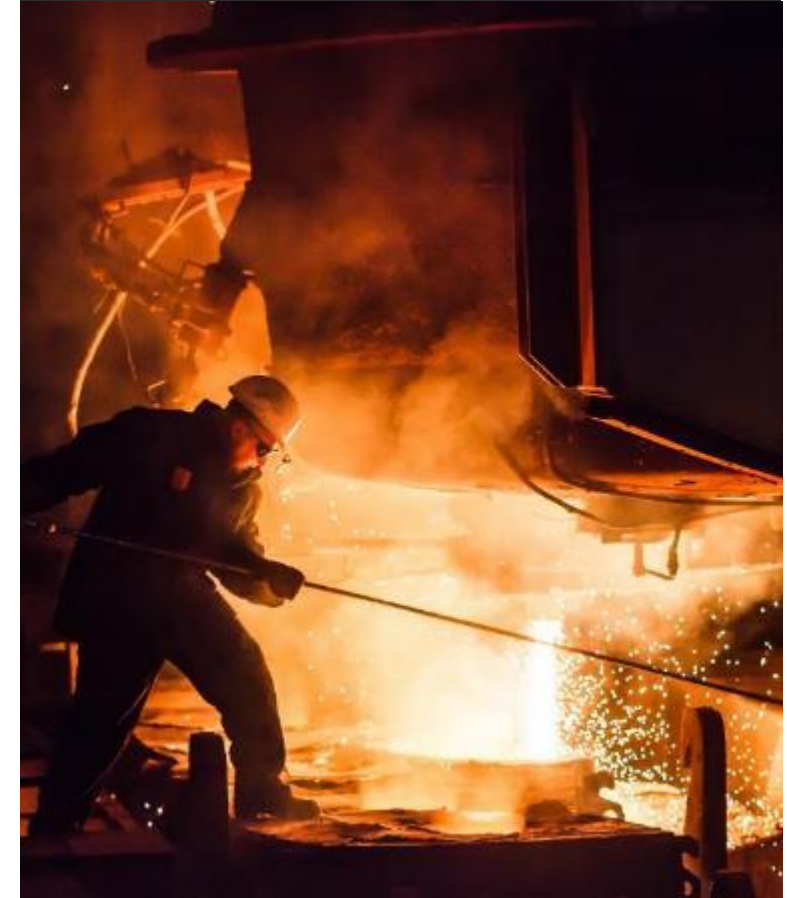
Renewable capacity must grow
4x more than it is today



Electric car sales are expected to
increase **18x the level** today

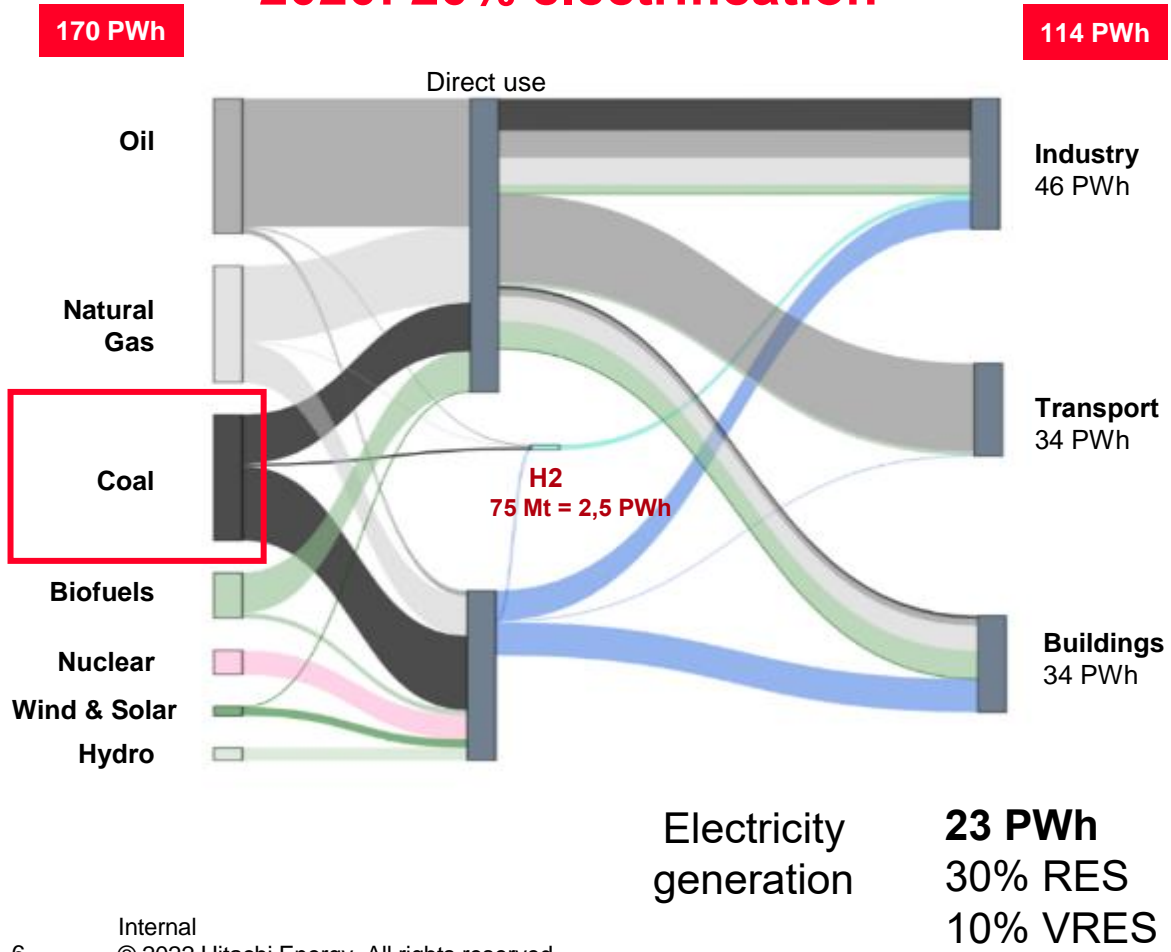


In industry, *emissions must drop
20% by 2030 and 90% by 2050



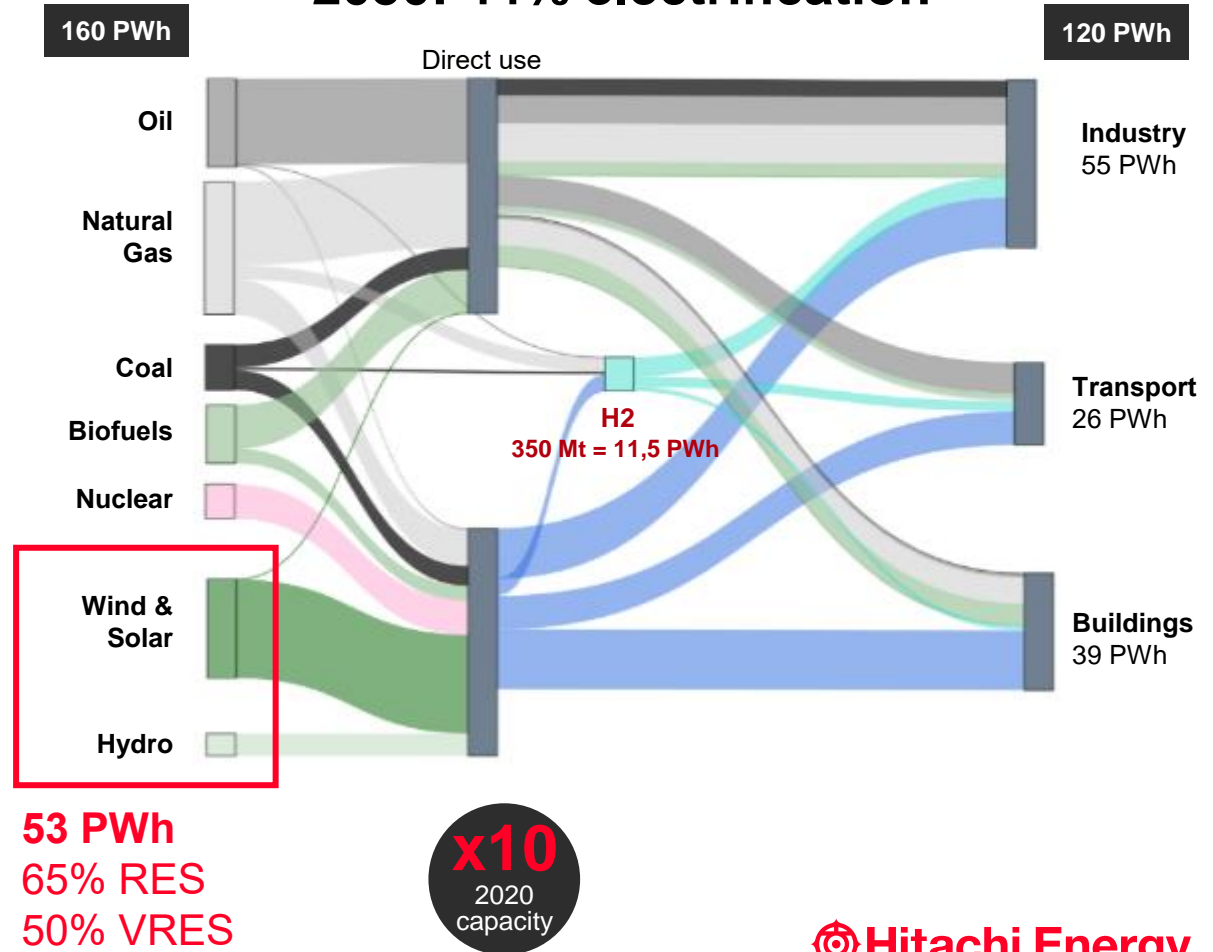
2020 dominated by conventional energy

2020: 20% electrification



2050 significant electrification of final energy use

2050: 44% electrification





“
Electricity will be the backbone of the entire energy system

01

Accelerated shift from fossil-based to renewable power generation

02

Growing electrification of Transportation, Industry and Buildings sectors

03

Sustainable energy carriers, complementary to direct electrification

Fast facts

“

Global electrification will be more than 50% of total energy demand

“

Electrification improves energy efficiency

“

All market sectors converting towards electrification

“

Energy sector-coupling beneficial

So what?

Digital and energy platforms are needed...

...to manage the enormous power system energy transition challenges:

increased complexity
additional capacity

for reduction of CO₂ emissions

Accelerating the transition to a carbon-neutral energy system requires adapting and adopting policies and regulations to enable technology and new business models to support Scalable, Flexible and Secure energy systems

“

We have placed sustainability at the heart of our Purpose - Advancing a sustainable energy future for all

Claudio Facchin
CEO, Hitachi Energy



Our Targets

Planet

Carbon-neutral in our own operations

- ↓ 50% CO₂ emissions along the value chain
- ↓ 50% waste disposed
- ↓ 25% freshwater use
- ↓ 25% hazardous substances and chemicals

People

- Zero harm
- Top quartile health absence rates
- Life-long learning culture
- Increase female diversity from 19% to 25% by 2025

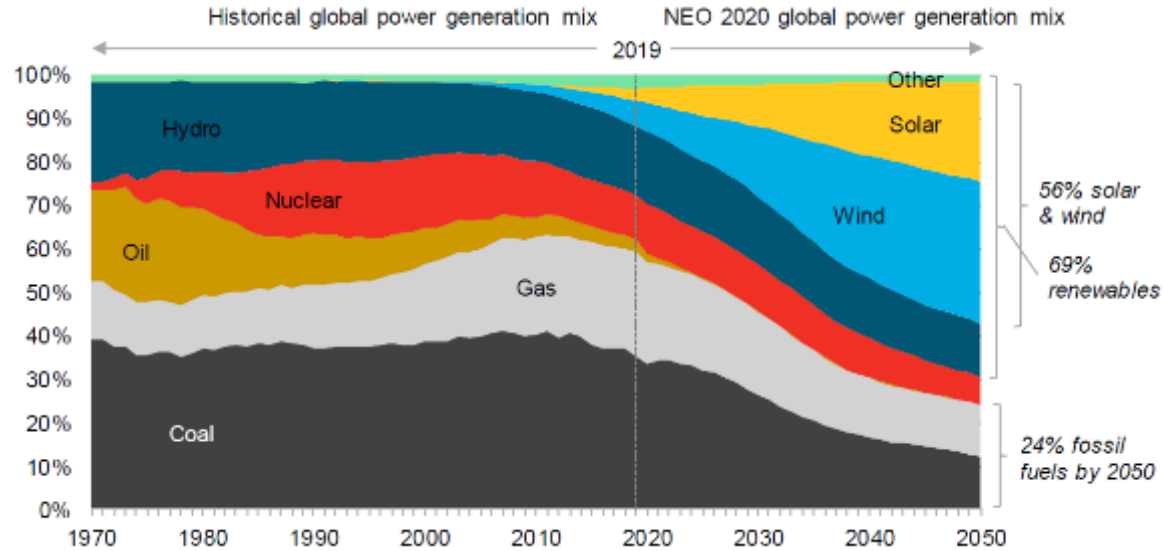
Peace

- Zero incidents of corruption and bribery

Partnerships

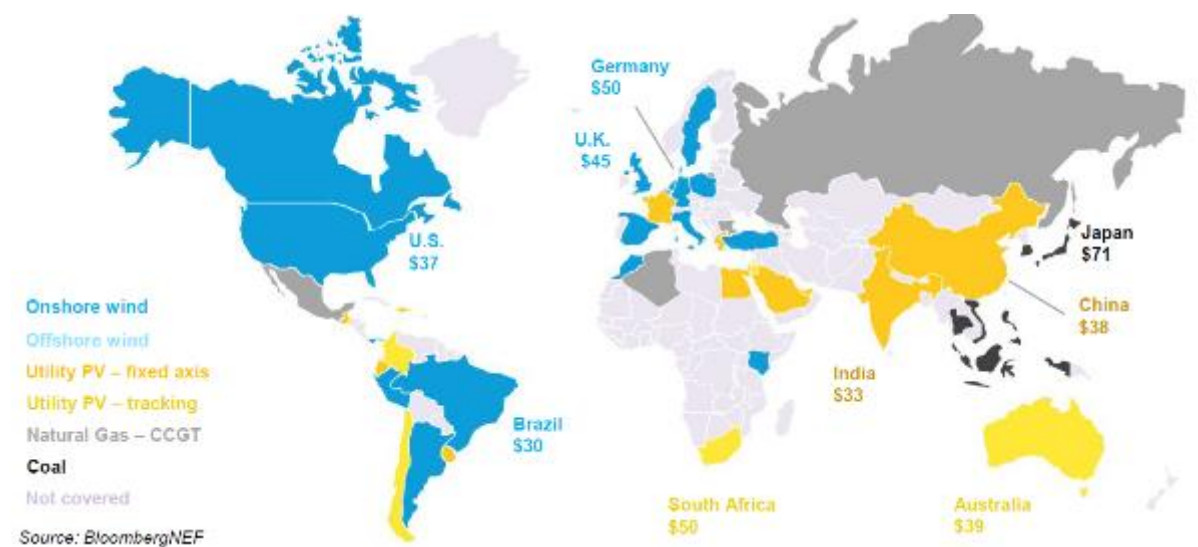
- Increase involvement in multi-stakeholder partnerships

Power generation mix



- Power capacity almost triples to 2050 with 80% new renewables and storage
- Global wind power market diagnosis favorable: outlook upgraded by 2% and solar PV beyond 2021, installations are expected to recover to prior expected levels of 130+ GW

Cost per \$/MWh

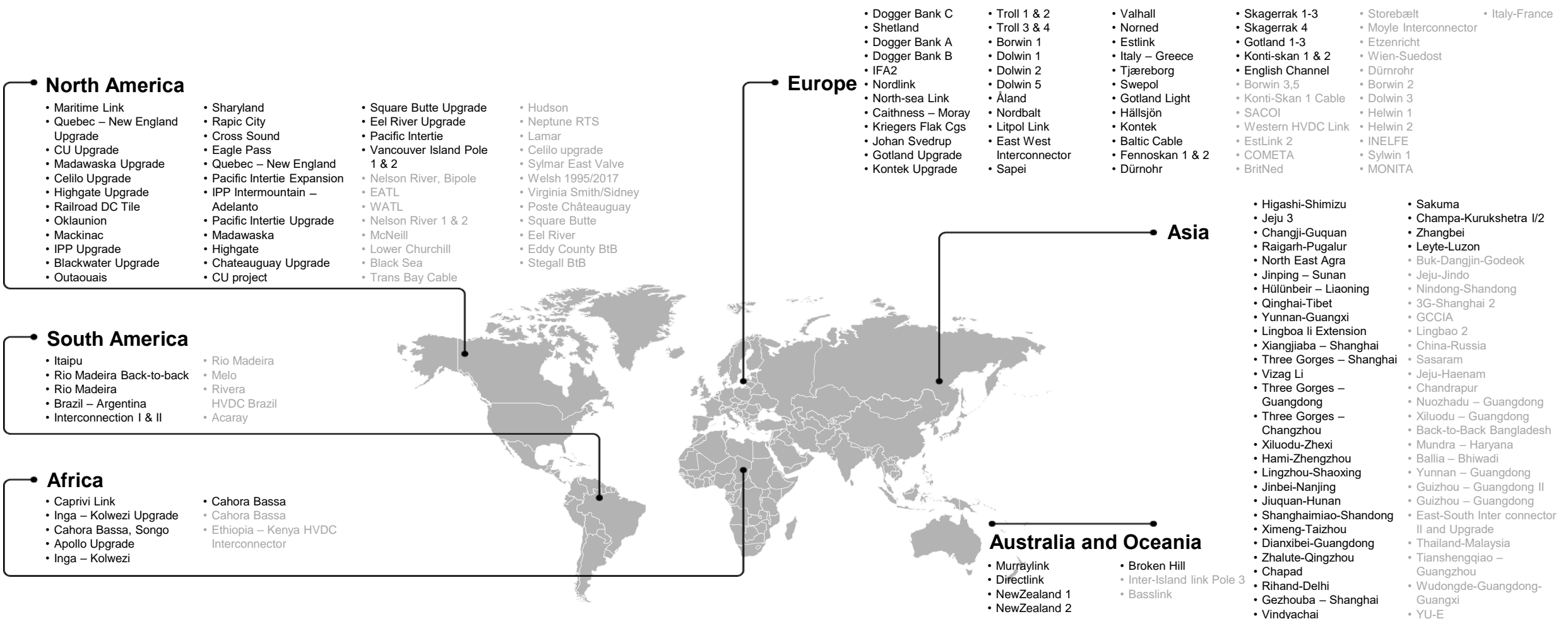


- Renewables are now the cheapest new electricity in countries making up just under 3/4 of world GDP
- Innovation and scale have driven down the costs of renewable technology

Wind and PV grow to 56% of electricity generation worldwide in 2050

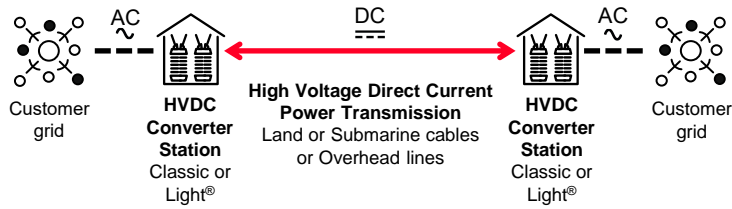
Projects delivered

Majority of projects over 60 years

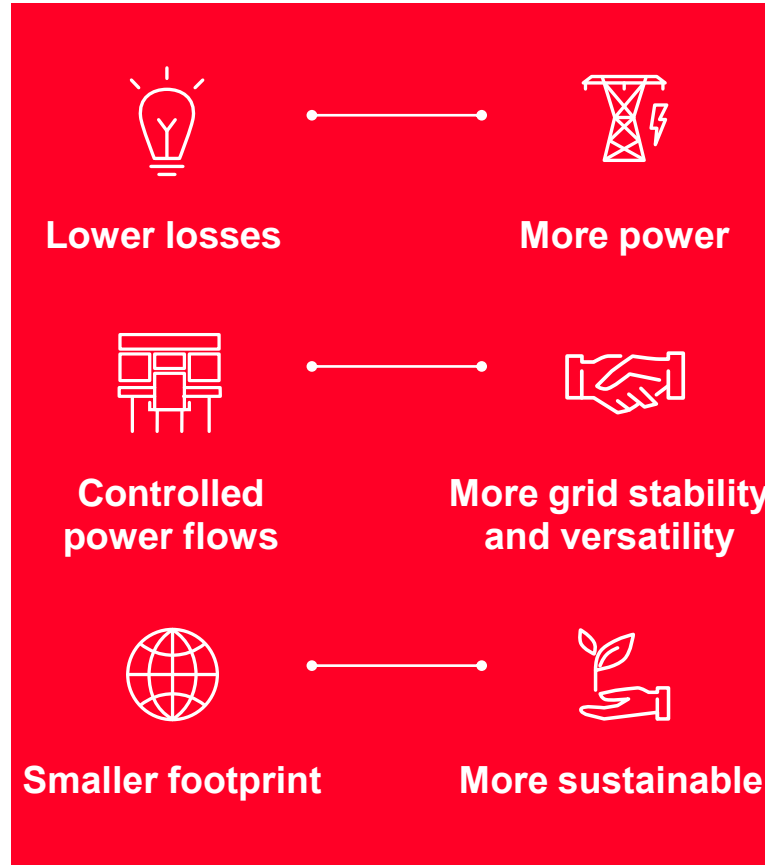


Project executed by Hitachi ABB Project delivered by ALL other suppliers

HVDC Interconnecting grids for a sustainable energy system



- Connects synchronous grids and asynchronous grids
- Technology of choice for bulk power transmission over long distances with minimum losses
- Controllable power flow enables precise energy trading
- Resolves AC bottlenecks in AC grids
- Ensure stability of the grid
- Minimal environmental impact



HVDC, the tool of choice to connect, dispatch and trade renewable power for sustainable energy systems

Record-breaking HVDC technologies





●

1st

Saudi Arabia - Egypt

First ever large-scale HVDC interconnection in the Middle East and Africa





●

720 km

North Sea Link

World's longest sub-sea electricity interconnector





●

525 kV

NordLink

One of the world's most powerful VSC interconnectors




●

3.6 GW

Dogger Bank Wind Farm

Connecting the world's largest offshore windfarm to the UK

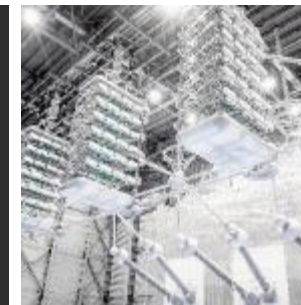




●

1,100 kV

Changji-Guquan

The world's most powerful UHVDC* converter transformer




●

800 kV

North-East Agra

The world's first multi-terminal UHVDC* transmission link

● In operations ● In final trial, commercially operational ● Recently awarded

Customer handover years:
North-East Agra 2017, Changji – Guquan 2019, NordLink 2020,
NSL 2022, Dogger Bank 2023-2025, Saudi Arabia – Egypt 2025/2026

Accelerating the energy transition in 2022 headline news



Customers:
TenneT and
TransnetBW

Supporting Germany's energy transition with an HVDC solution for **Suedlink DC4** between the north and south of the country



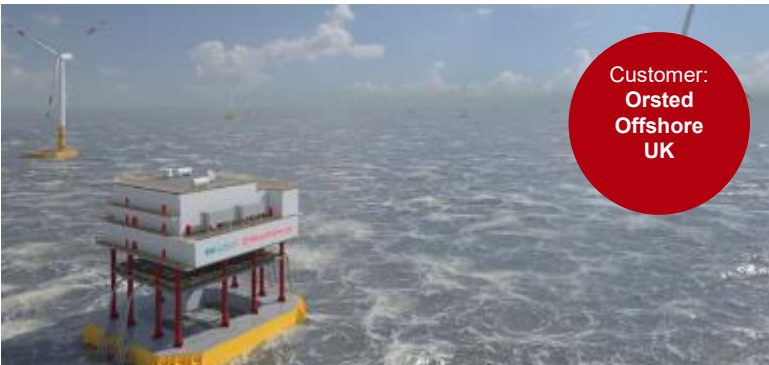
Customer:
GCCIA
UAE

Rehabilitating a complete BtB existing plant between Kuwait, Saudi, UAE



Customer:
Adani.

HVDC Light® will help transmit 1,000 MW of electricity to **Mumbai**, bringing almost 50% more power to 20 million people in India



Customer:
Orsted
Offshore
UK

Connecting one of the world's largest offshore **wind farms** to the UK power grid and providing more power to more than 3 million homes



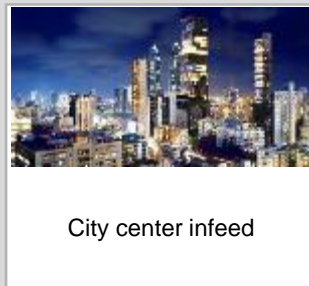
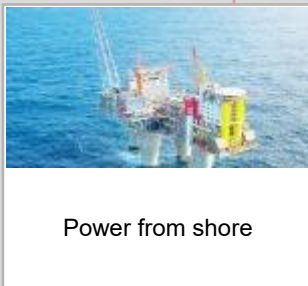
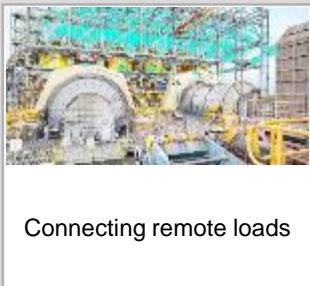
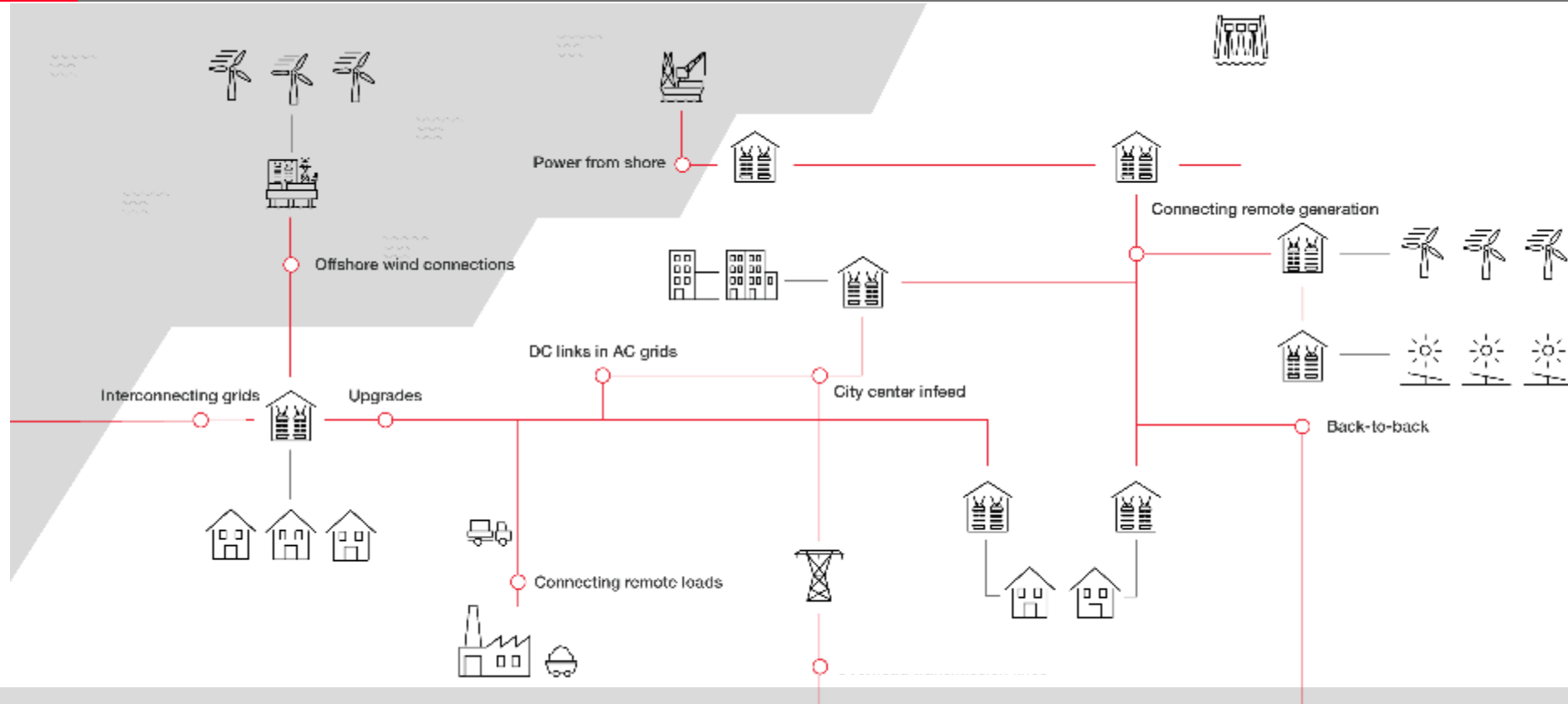
Customer:
Hydro
Quebec
Canada

New Back-to-Back VSC ChateauGuay between Canada and USA NY state











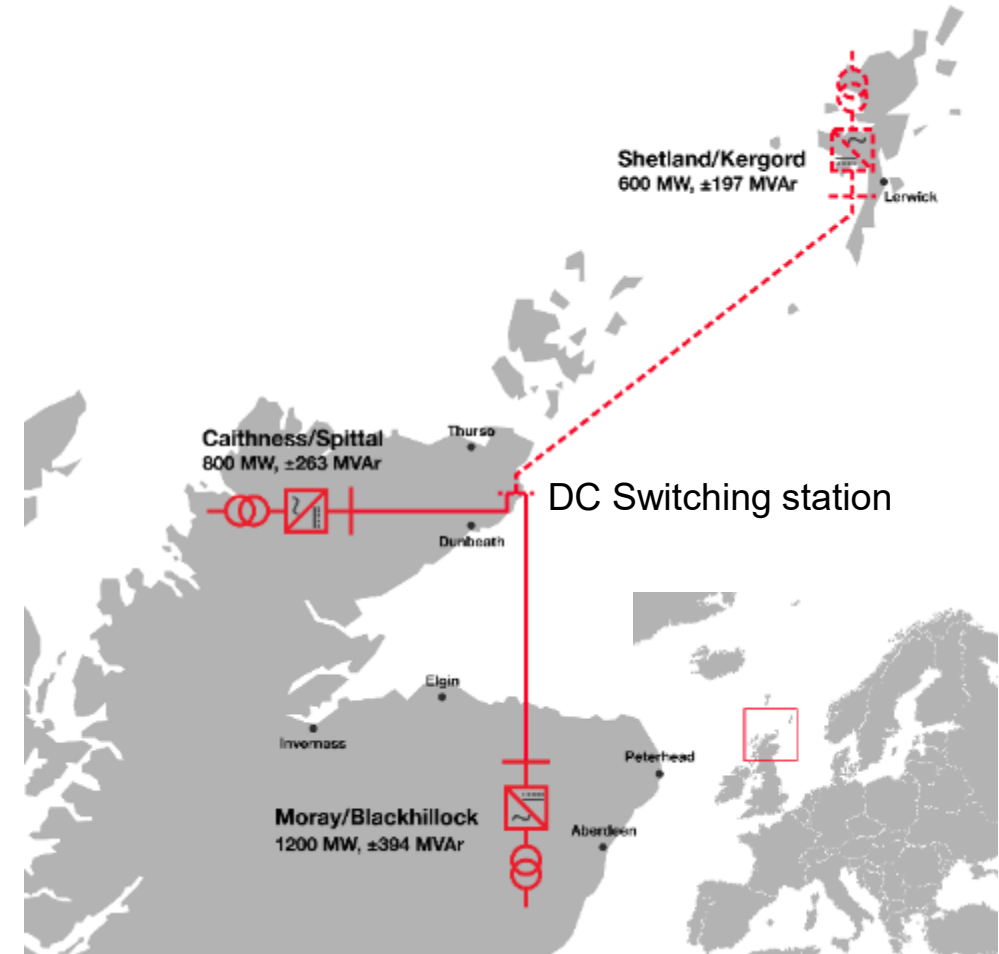
Customer:
Transmission
Developers
Inc.

Transferring renewable energy for over 1 million **New York** homes and help achieve the state's climate goals with HVDC Light



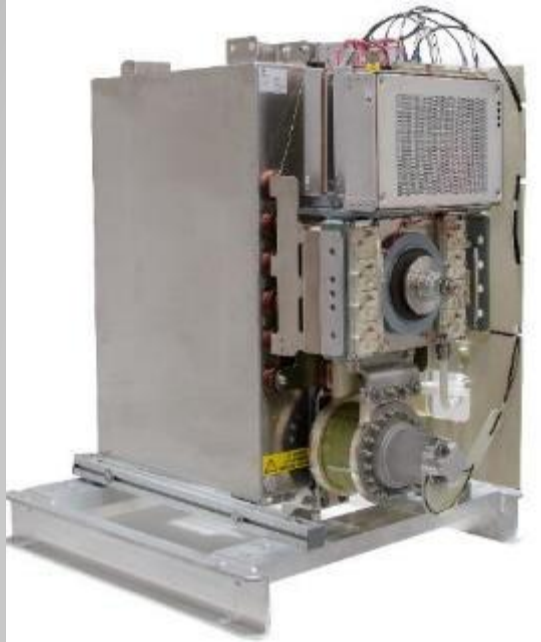
The first regional DC Grid in Europe

	Customer Scottish and Southern Electricity Networks (SSEN) Transmission
	Customer needs To link Shetland to the UK transmission system
	Our response <ul style="list-style-type: none">– First multi-terminal HVDC interconnection in Europe, with option of two more terminals– 600 MW \pm320 kV
	Customer benefits <ul style="list-style-type: none">– Multi-terminal HVDC interconnection provides flexibility to transfer power in multiple directions, based on supply and demand, with minimal power losses– Boost renewable energy and enhance security of power supply– Help to connect and transmit wind power generated on the islands to the UK– Contribute to bringing all greenhouse gas emissions to net zero by 2050
	Year 2024
	HVDC Light® converter stations
	<ul style="list-style-type: none">– Symmetric monopole \pm320 kVdc– Blackhillock: 1,200 MW– Spittal: 800 MW– Kergord: 600 MW
	DC Switching station at multi-terminal connection point

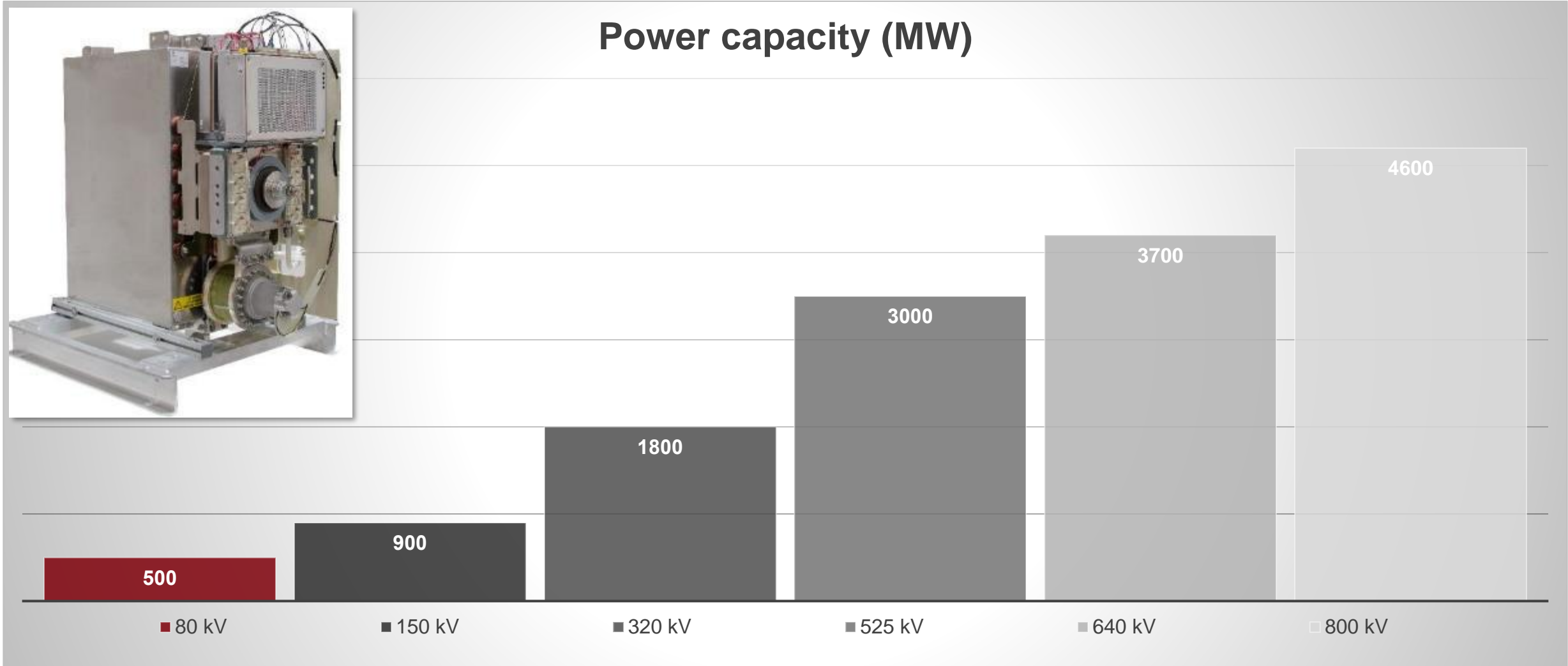


Caithness-Moray-Shetland HVDC Link - Phase 1+2

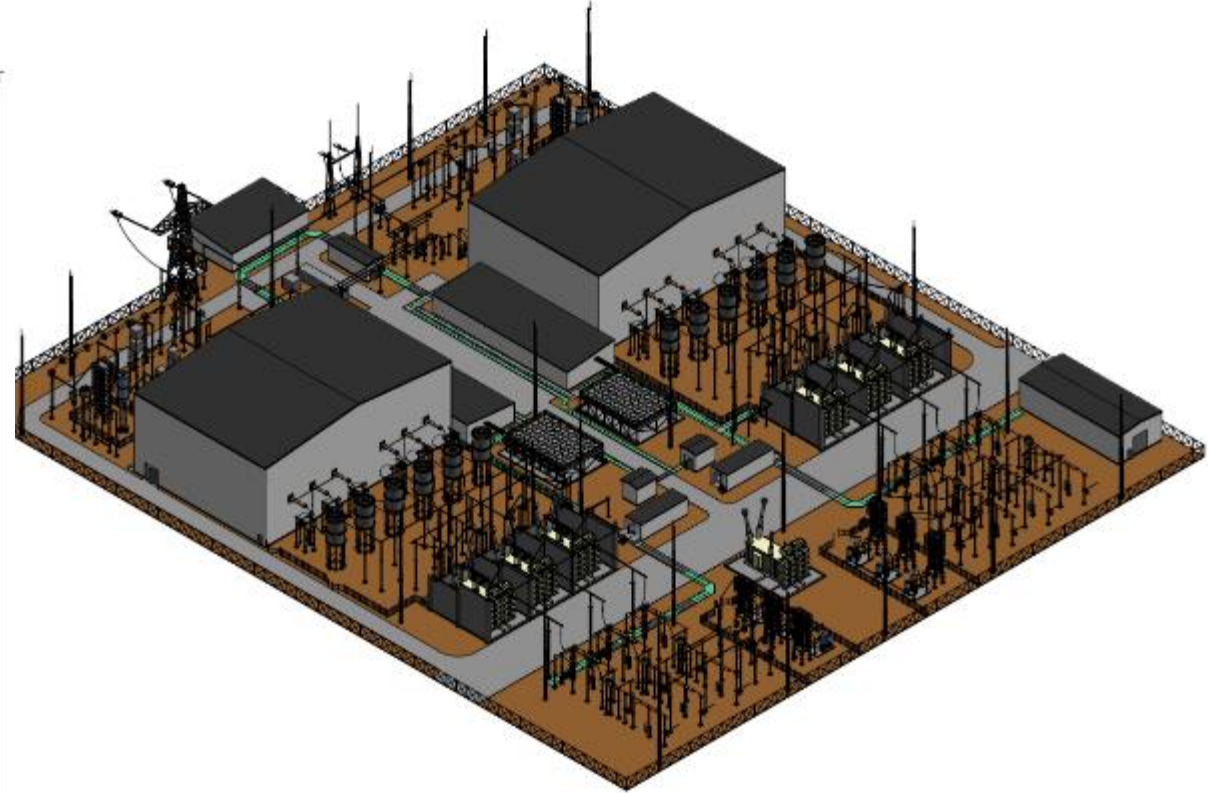
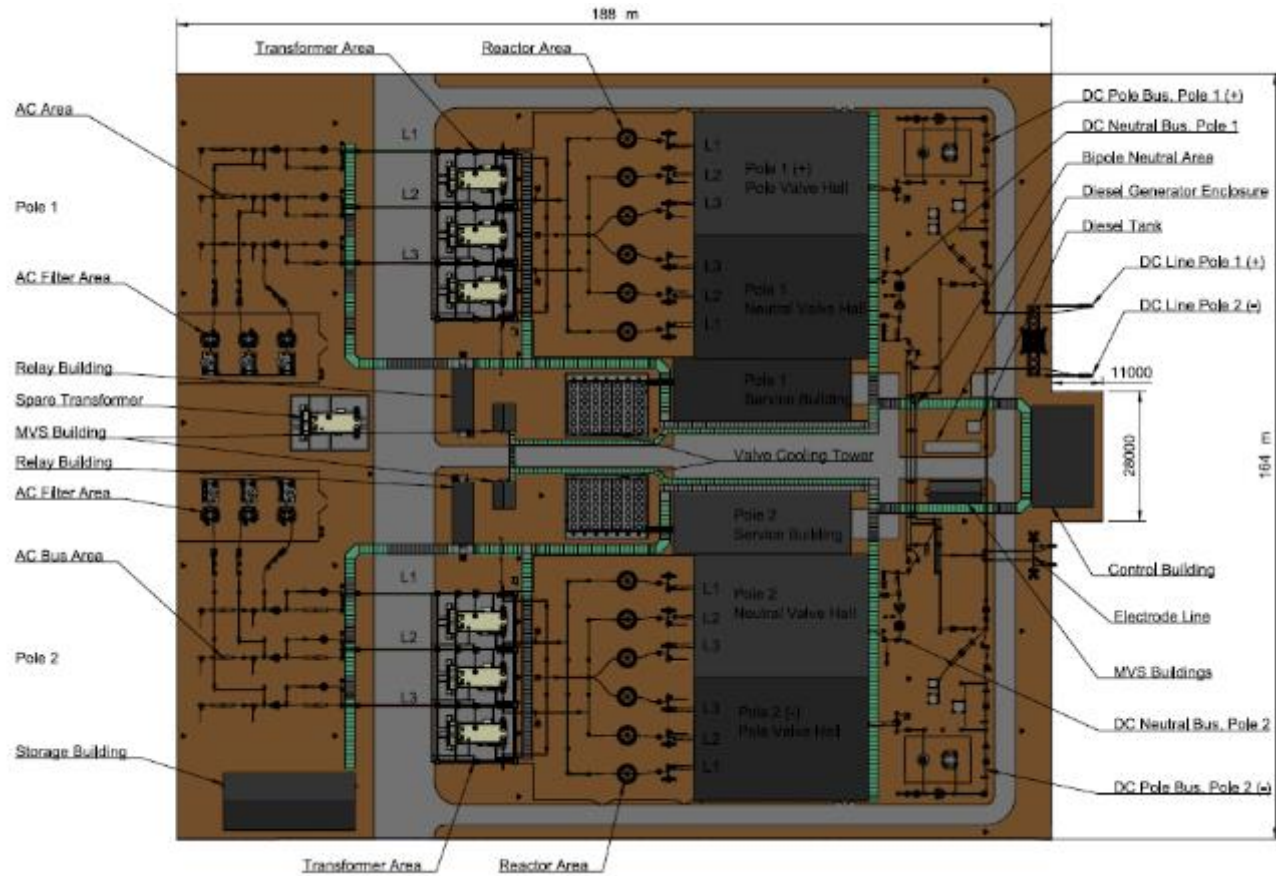
VSC Valve Cell



Power capacity (MW)



Converter Station Layout



Key points

Market drives development

Part of continuous development

Design criteria:

- Lower losses
- Optimize size
- Cost efficient
- Health and Safety
- Well defined process from paper to operation



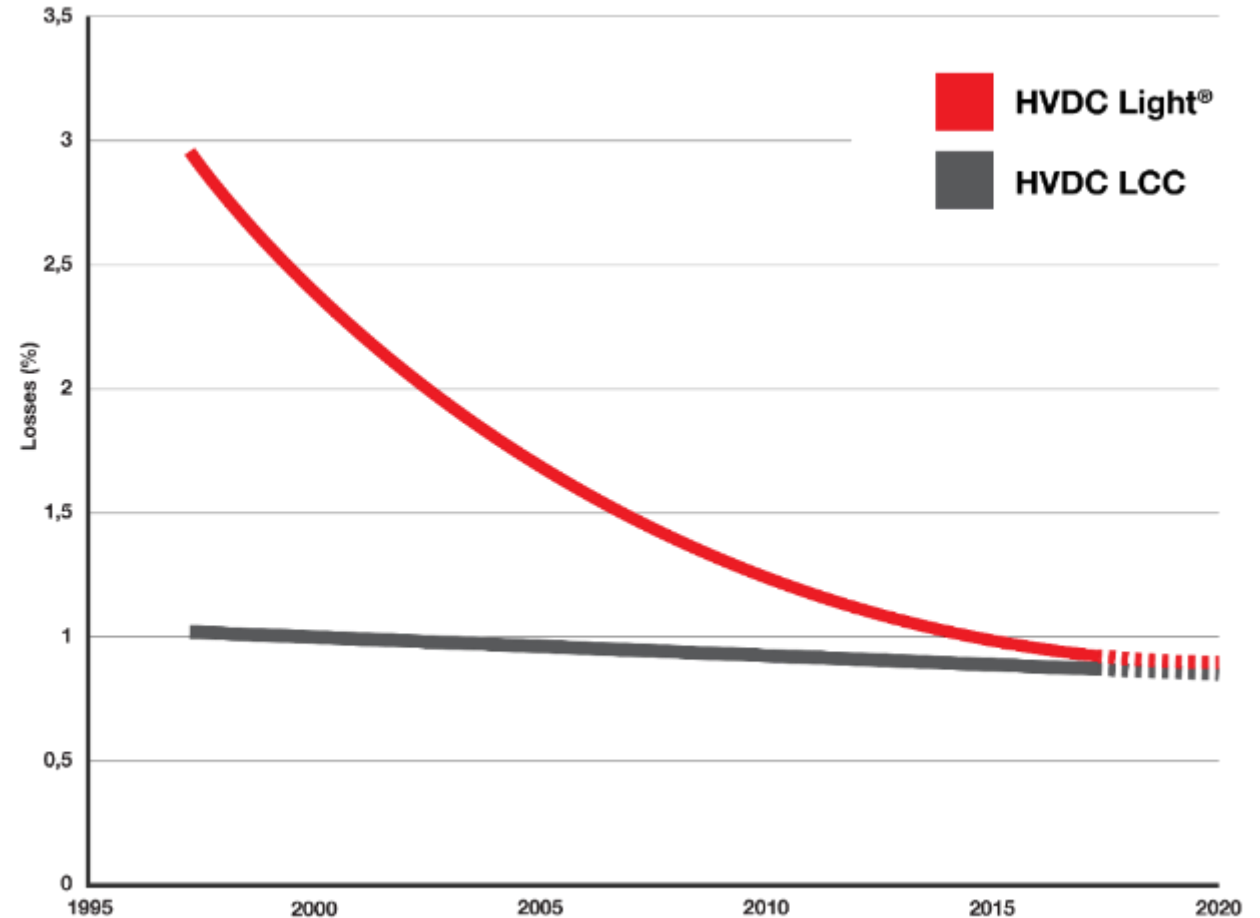
Two level



Cascaded two level



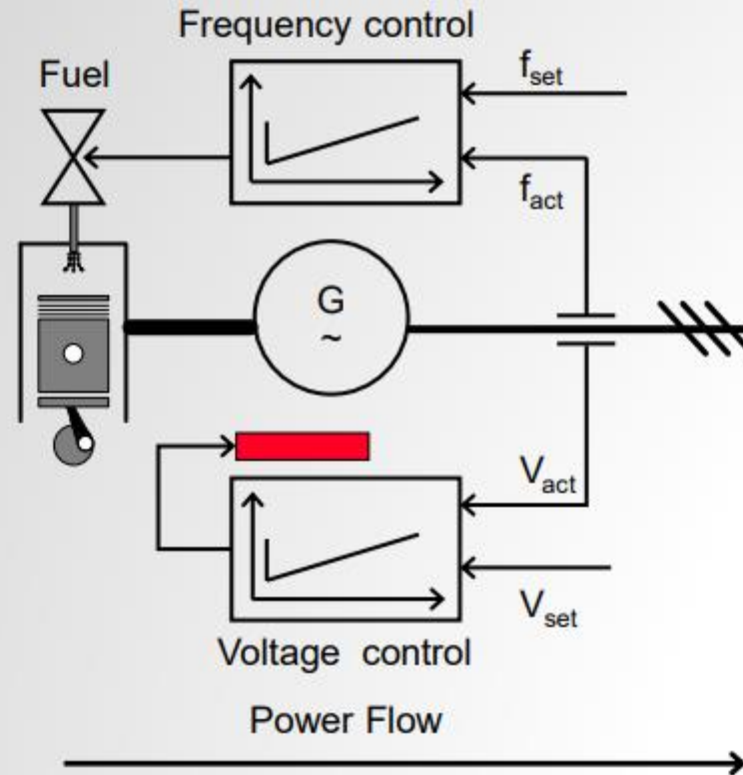
Modular multilevel



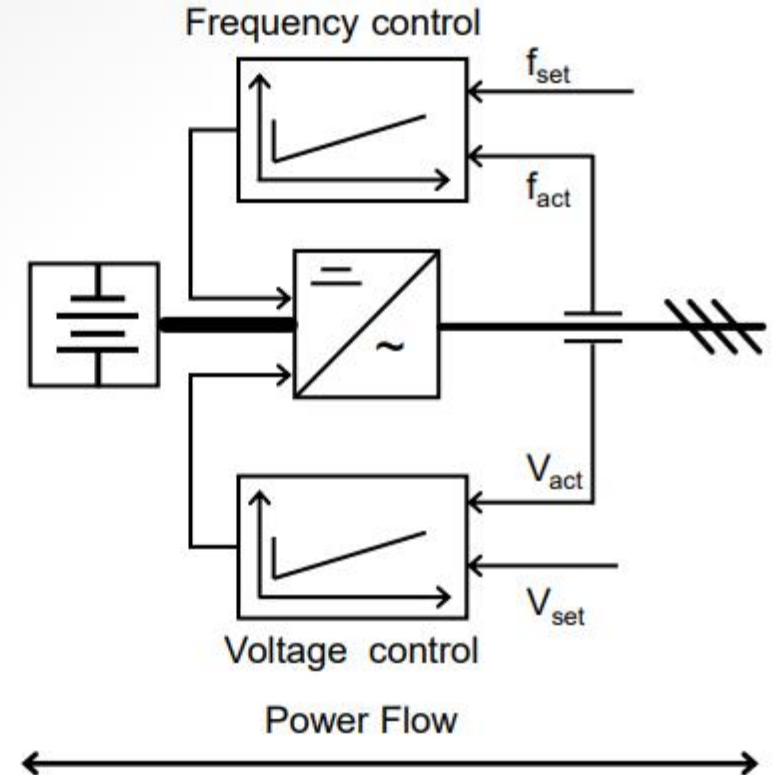
Highlights

- Emulate traditional generator behaviors & interact with the power system the same way as traditional synchronous machines.
- Creates islanded grid by controlling its own voltage and frequency
- Enables seamless transfer between grid connected & off-grid
- Overload capability ensuring availability during transient loads
- Black Start capability
- LVRT & HVRT capability

Conventional Generator

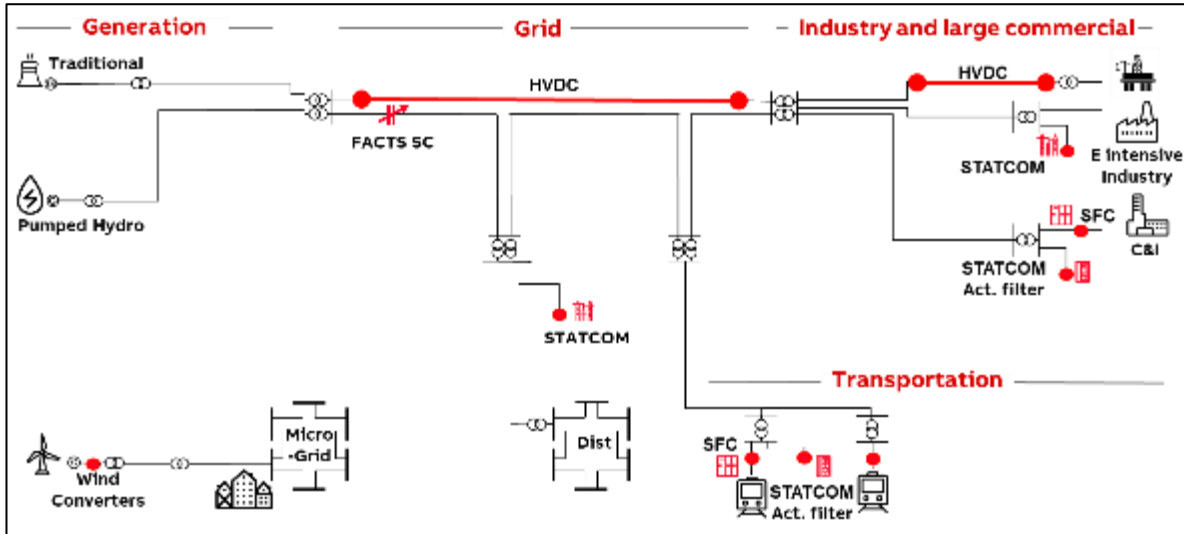


Virtual Generator



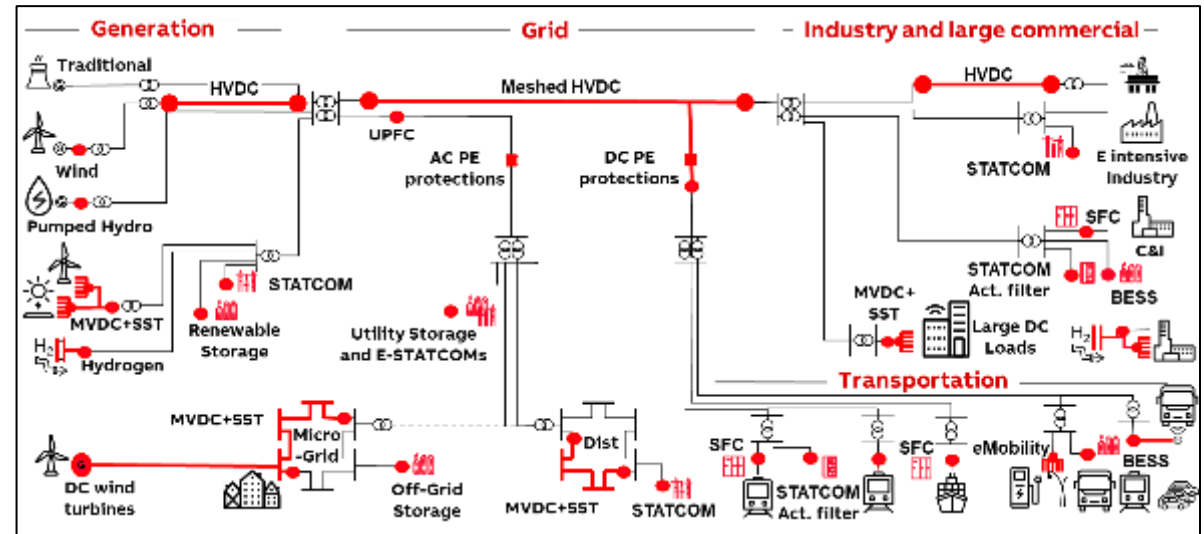
Versatile inverter platform with virtual generator functionality

Past ... The conventional utility grid



Power Electronics a niche application

Future ... The carbon-neutral future is electric



Power Electronics across the total Power Grid

Power Electronics coupled with Digital enables electricity to be the backbone of the carbon-neutral future



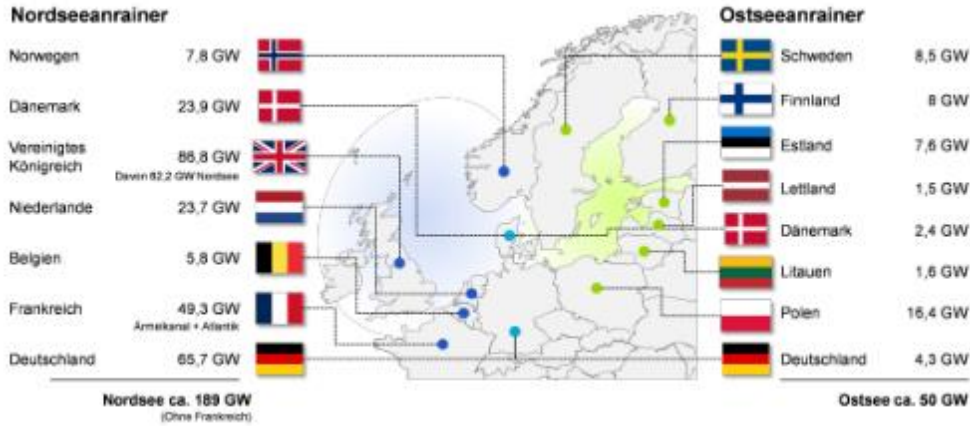
The evolution of transmission capacity

12 GW today and tomorrow



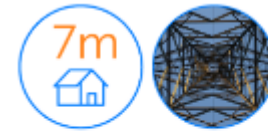
- ❑ **One new 2 GW 525 kV bipole platform design to fit Hitachi Energy, Siemens Energy and GE Vernova**
- ❑ **One cable design with bipole and metallic return to fit NKT, Prysmian and others**
- ❑ **One contract model and Framework approach**
- ❑ **Nine projects in Tennet Netherlands and six in Tennet Germany (30 GW)**

240 GW offshore wind in North and Baltic Seas



xlinks 3.6 MW wind and solar from Morocco to UK

- Agreement secured with National Grid for two 1.8GW connectors in Devon
- Powering 7 million homes before the end of the decade
- Delivering 3.6GW for an average of 20+ hours a day providing firm and flexible energy



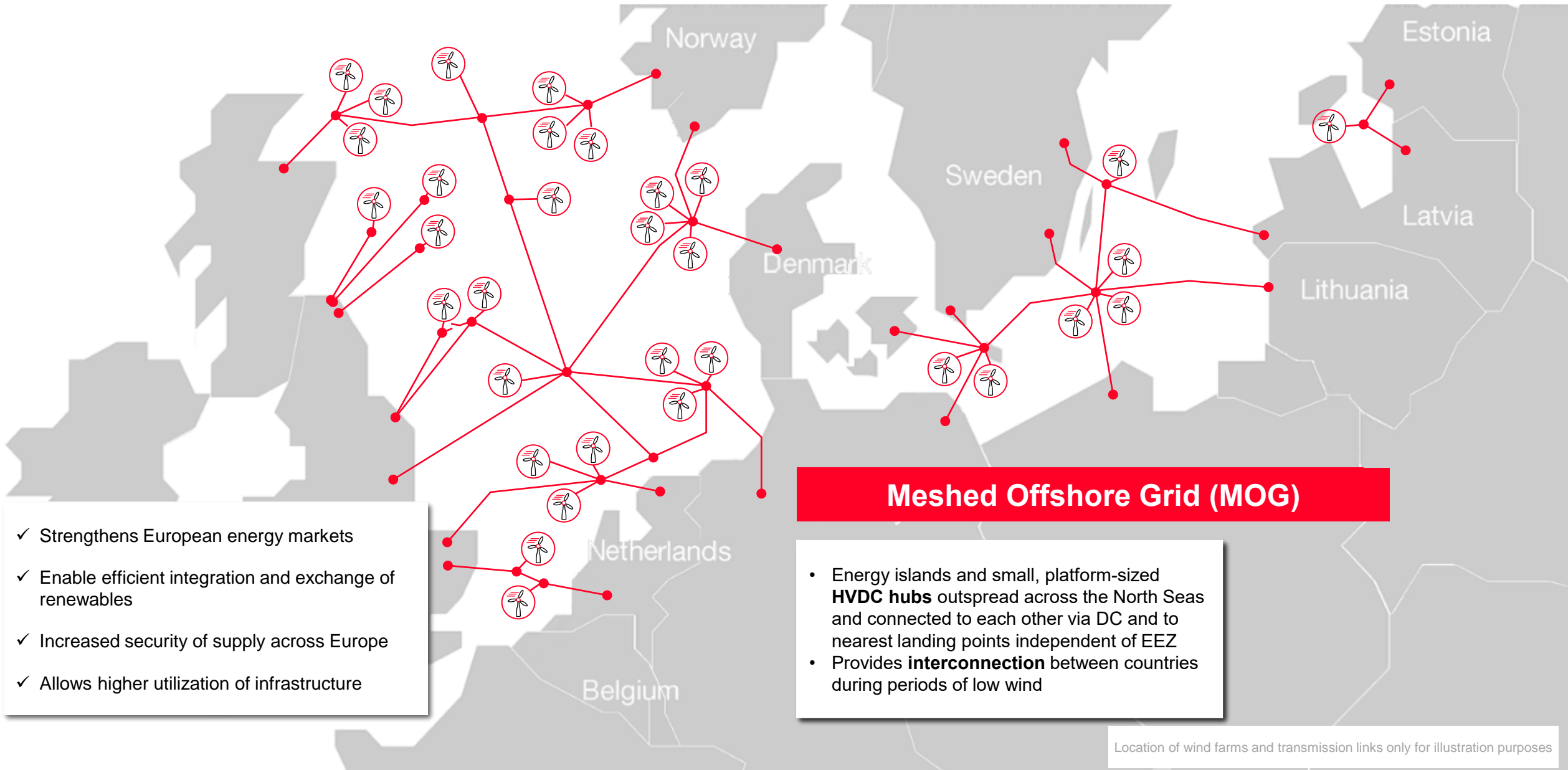
Suncable 3.2 GW HVDC link Darwin - Singapore



NEOM city KSA (170 x 0.2 x 0.5 km) for 9 M by 2045



Future scenarios - Offshore wind expansion North and Baltic Seas



- ✓ Strengthens European energy markets
- ✓ Enable efficient integration and exchange of renewables
- ✓ Increased security of supply across Europe
- ✓ Allows higher utilization of infrastructure

Meshed Offshore Grid (MOG)

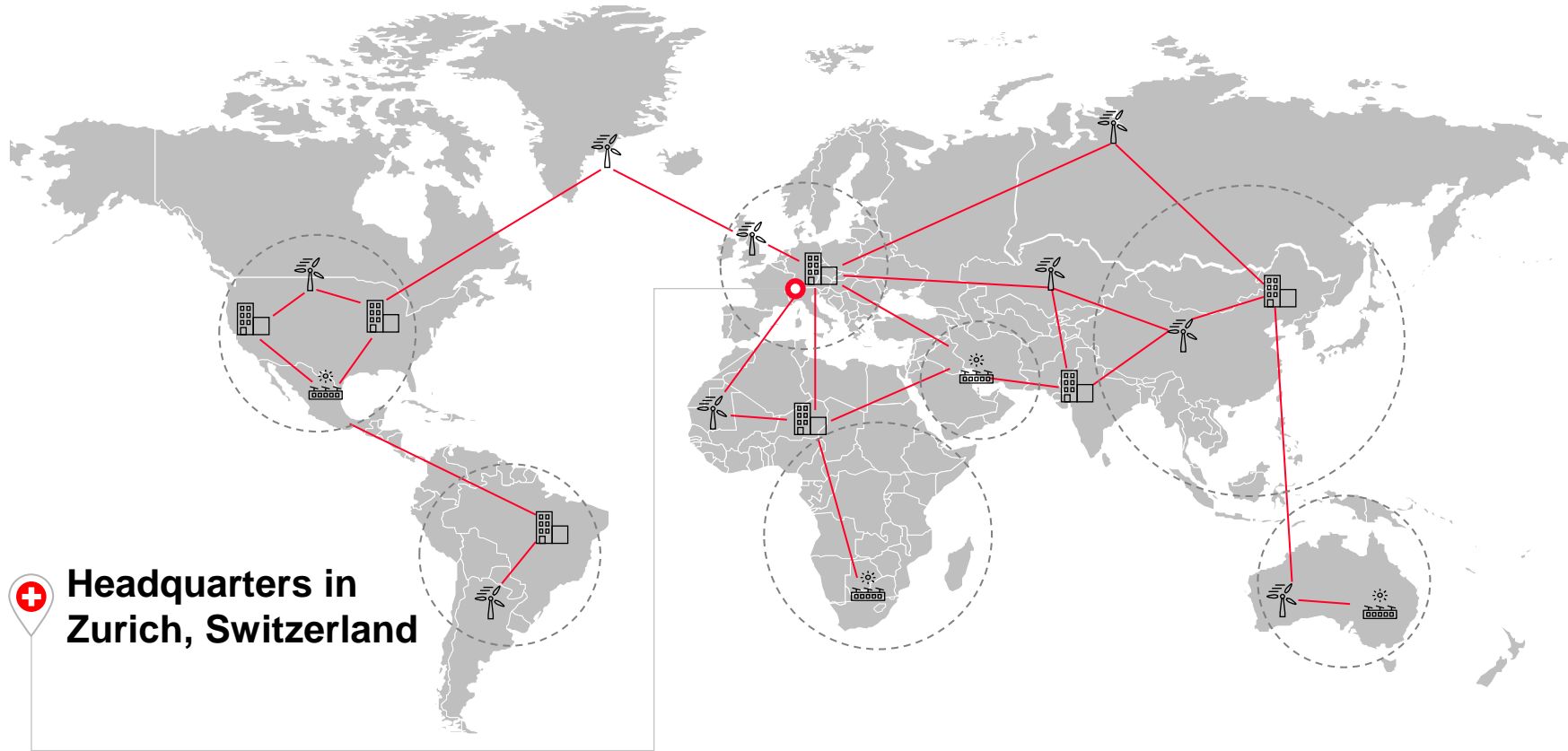
- Energy islands and small, platform-sized **HVDC hubs** outspread across the North Seas and connected to each other via DC and to nearest landing points independent of EEZ
- Provides **interconnection** between countries during periods of low wind

Location of wind farms and transmission links only for illustration purposes

Outlook from ABB to Hitachi

Hitachi Energy at a glance

Part of Hitachi with 368.000 employees and approx. 76 BUSD revenue



40,000 employees

90+
countries with
200 offices

~250
years' heritage
combined

5,500
sales employees
& field engineers

2,000
engineers &
scientists in R&D

Four Business Units

**Grid
Automation**

**High Voltage
Products**

Grid Integration

Transformers

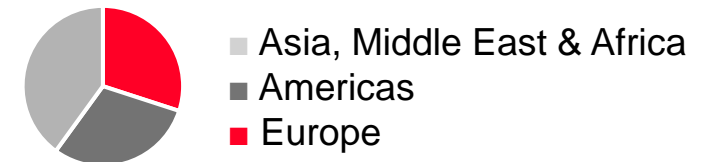
Customers



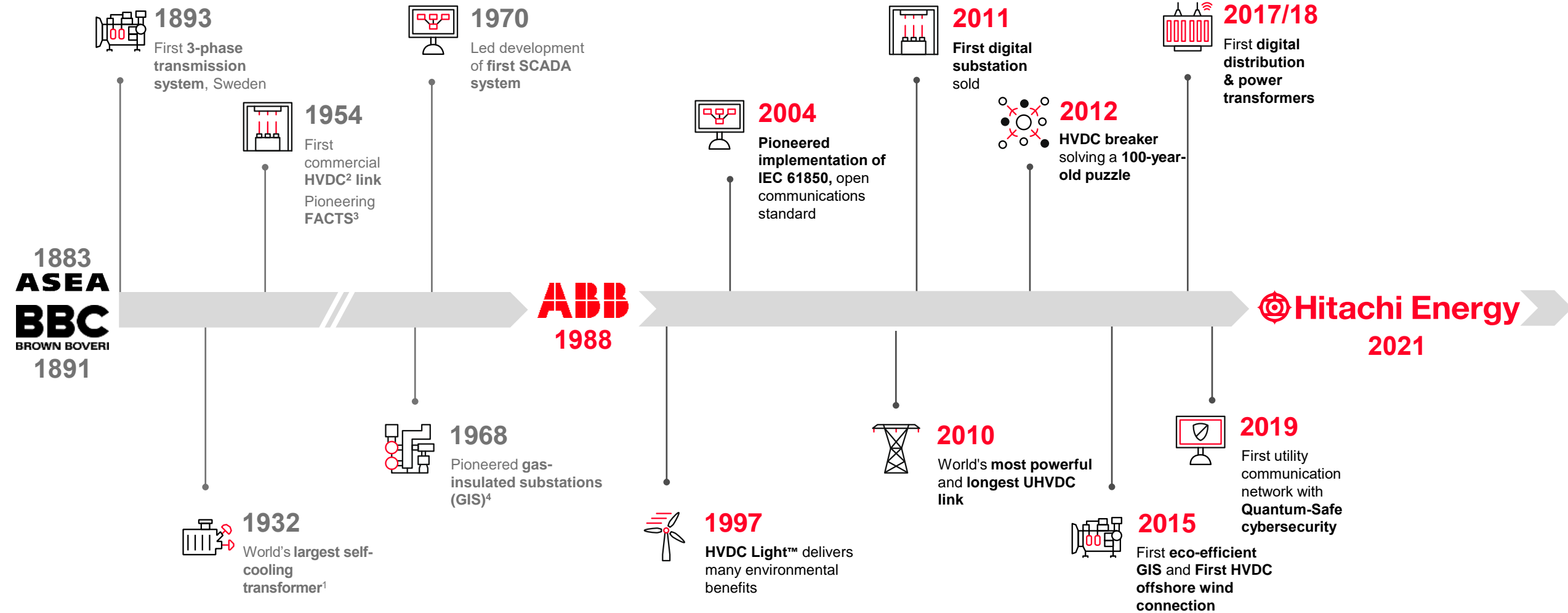
Offering



Geographies

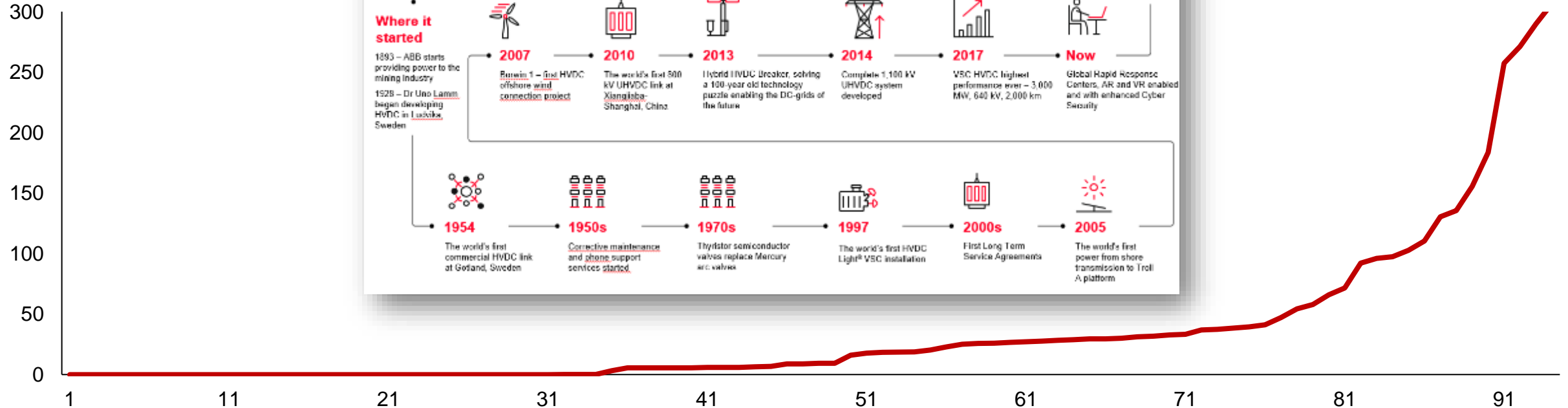


Our heritage: 13 decades of power transmission



Our technology and innovation heritage includes pioneering HVDC

Cumulated GW installed



1928

Dr Uno Lamm began developing HVDC in Ludvika, Sweden

1954

The world's first commercial HVDC link at Gotland, Sweden

1960s

Mercury arc valves replaced with thyristor semiconductor valves

1997

The world's first VSC HVDC installation

2017

VSC HVDC highest performance ever – 3,000 MW, 640 kV, 2,000 km

Exponential growth has been driven by technical developments and grid transformation needs

Ludvika - a world center of high voltage

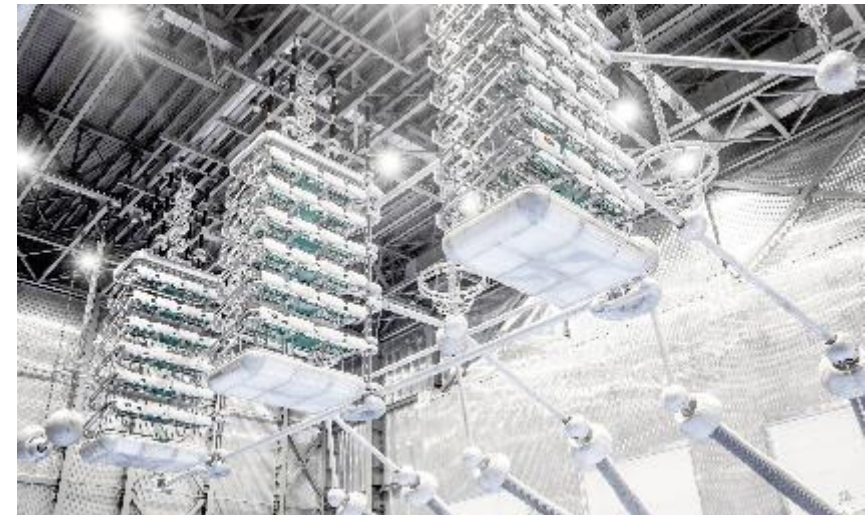
Hitachi Energy at Ludvika Works. Ca. 3500 talents in power



People – the base for innovation and growth

Diversity in thought and experience helps us create a dynamic global culture of innovation and collaboration that enables our people realize their highest potential and empowers us to deliver on our mission

Powering good for a sustainable energy future





HITACHI
Inspire the Next 