November 2021

GLOBAL TRANSMISSION SUBSTATION MARKET REPORT 2021-2030

Prepared by: **Global Transmission Research**

2.1.2 Trends in pricing and cost (3/3)

Future trends for cost of raw materials

- According to the World Bank, the aluminum price will increase to USDXXX per mt in 2021, a XX% rise from an average of USDXXXX per mt in 2020, and experience moderate growth to USDXXX per mt in 2022. By 2035, the World Bank forecasts that aluminum prices will reach USDXXX per mt.
- The predicted rise in aluminum prices could be attributed to high demand in China and its new climate policy, which focuses on greenhouse gas (GHG) emissions reduction, that could possibly limit future supply of the metal. In 2020, China accounted for XX% of all refined aluminum production.
- Similarly, the prices for copper were driven by high demand from China, which is its biggest consumer. As per the World Bank copper prices will record an average prices of USDXXXX per mt by the end of 2021. From there on, the prices are expected to decrease to USDXXXX per mt in 2022 and then increase to USDXXXX per mt by 2035.

Figure 5: Cost trends for Aluminum (USD per mt)

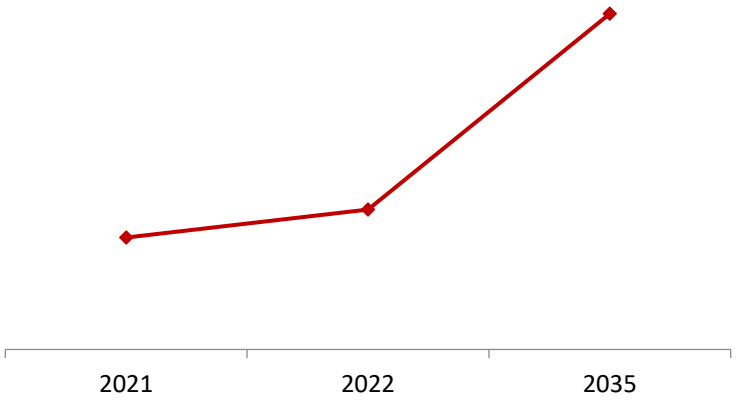
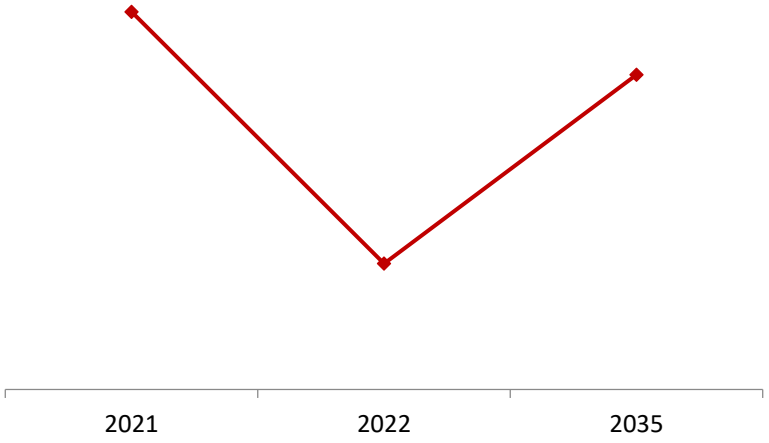


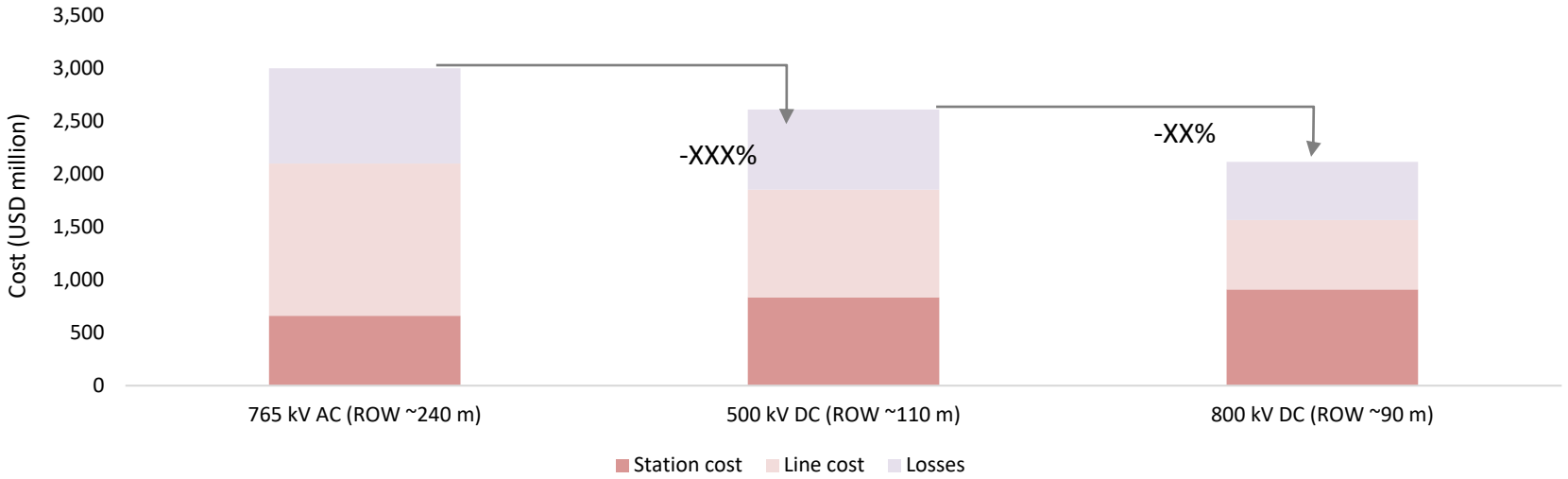
Figure 6: Cost trends for Iron-Ore (USD per dmtu)



Note: Ddmtu: Dry Metric Tonne (Ton) Unit
Source: The World Bank; Global Transmission Research

2.3.1 Analysis of project cost – HVAC vs HVDC (2/2)

Figure 2: Cost and RoW estimation for 6,000 MW transmission over 2,000 km distance



- The figure above provides an example for comparing the costs of different transmission alternatives for a 6,000 MW/2,000 km link. It takes into account, the three major factors, which form the total cost of an HVAC or HVDC system.
  - **Station costs:** HVDC transmission costs are significantly increased by high-cost rectifier and inverter stations used for AC/DC and DC/AC conversion, which are not required in HVAC transmission. The above example also show an increase in station cost of XX%- XX% with the shift of technology from AC to DC.
  - **Transmission losses and RoW:** Reduction in transmission losses is visible while moving from HVAC to HVDC system, and a better transmission efficiency at higher voltage DC transmission system. Also, we can witness a reduction in areas required for the transmission systems.
  - **Transmission line costs:** Cost of transmission line has witnessed a reduction of close to XX% while switching from HVAC to HVDC systems.

Notes: RoW- Right-of-Way
Source: Electric Power Research Institute; Global Transmission Research

2.3.2 Case study on digital substations (3/3)

Recent deployments of digital substations

Hydro-Québec at Saint-Chrysostome site, 2021

Siemens was awarded with the a turnkey contract to modernise the protection and control system at the substation on the Saint-Chrysostome site.

Key advantages:
- Decentralised systems
- Remote monitoring and management.
- Efficiency improvements
- Reduced employee health and safety risk.
- Enhanced cybersecurity and IT/OT systems.

Vietnamese Technology Resources Energy (TRE) for IaPet-Dak Doa wind farms, 2020

In 2020, Siemens was chosen to supply digital substations for wind farms, IaPet-Dak Doa 1 and IaPet-Dak Doa 2 in Vietnam.

Key advantages:
- 500/220 kV substation assets equipped with smart IOT technology.
- Sensors to measure the most important operating parameters.
- Remote monitoring provision.

Meralco's Amadeo substation, 2017

ABB[1] Power Systems delivered the first IEC 61850 Substation Automation Systems in Philippines to Meralco, for the Amadeo Substation.

Key advantages:
- Reduced operational and maintenance costs.
- Optimal life cycle management through better technology.
- Improved and smarter grid.

Powerlink's Loganlea substation project, 2017

ABB[1] Power systems made use of NCITs to replace the originally installed proprietary process bus with IEC 61850 technology and connected the primary (high-voltage) equipment to the substation protection and control devices for Powerlink.

Key advantages:
- Achieved advanced automation and the latest communications standards.
- All protection and control equipment in the system was connected to the IEC 61850-9-2 process bus.

Notes: IOT – internet of things; IT – information technology; OT –operational technology; NCIT - non-conventional instrument transformers; 1- now Hitachi Energy
Source: News reports, Global Transmission Research

2.4.2 Current state of the high voltage substation market, 2020

- As of the end of 2020, the global transmission network is estimated to comprise a transformer capacity of XXXXX GVA at 100 kV and above voltage levels. The transformer capacity has increased at a CAGR of close to XX% during the past 10 years.
- Region-wise, XX% of the total high voltage transformer capacity is located in the Asia Pacific region. This is followed by North America and Europe, which comprise XX% and XX% of the global transformer capacity respectively. AC substations accounted for a majority of the tracked substation capacity.

Table 1: Growth in transformer capacity (GVA)

Voltage	2010	2015E	2019E	2020E
100 kV–187 kV	XXXX	XXXX	XXXX	XXXX
220 kV–287 kV	XXXX	XXXX	XXXX	XXXX
300 kV–420 kV	XXXX	XXXX	XXXX	XXXX
±533 kV/500 kV	XXXX	XXXX	XXXX	XXXX
600/660 kV-800 kV DC	XXXX	XXXX	XXXX	XXXX
700 kV-765 kV	XXXX	XXXX	XXXX	XXXX
1,000/1,100/1,150 kV	XXXX	XXXX	XXXX	XXXX
Total	XXXX	XXXX	XXXX	XXXX

Figure 1: Growth in transformer capacity (GVA)

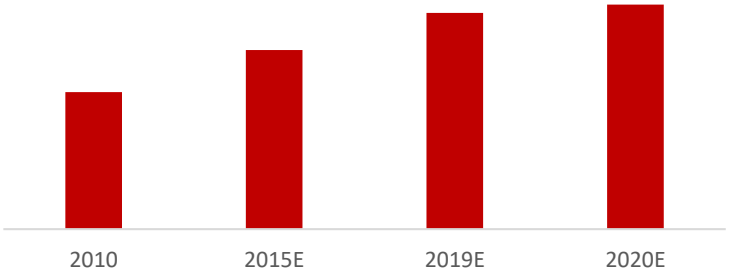


Figure 2: Share of transformer capacity by technology, 2020

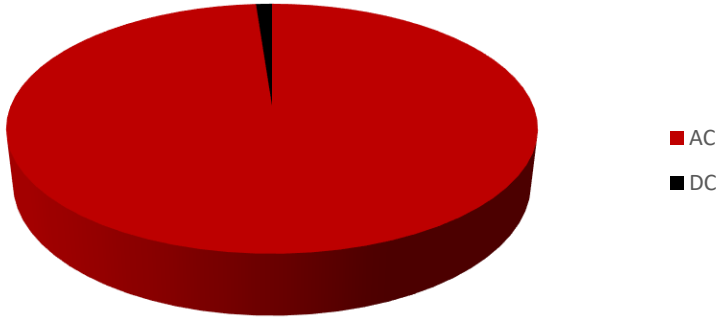
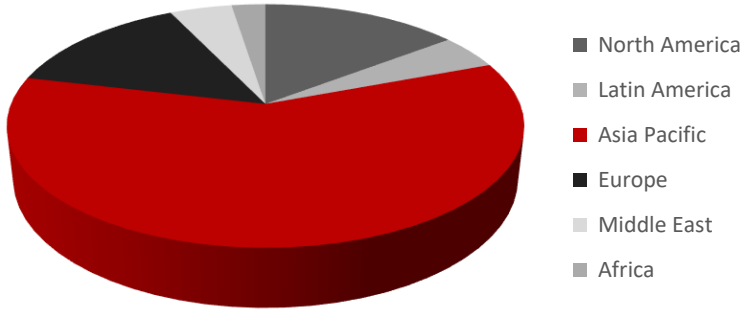


Figure 3: Share of transformer capacity by region, 2020



Notes: E-estimated. The above tables/figures do not include HVDC converter station capacity available in MW.
Source: Global Transmission Research

2.5.2 Expected growth in transformer capacity, 2021-2030

Table 2: Growth in transformer capacity (GVA)

Voltage	2021-30
100 kV–187 kV AC	XXXX
220 kV–287 kV AC	XXXX
315 kV–450 kV AC	XXXX
500 kV AC	XXXX
700 kV–765 kV AC	XXXX
800 kV DC	XXXX
1,000 kV /±1,100 kV	XXXX
Total	XXXX

- Around XXXX GVA of transformer capacity at the 100 kV and above voltage levels is estimated to be added across the globe by 2030.
- Majority of the transformer capacity (~XX%) will be at 287 kV and below voltage levels, while XXX% will be at UHV (800 kV and above) voltages.
- During 2021–30, Asia will account for close to XXXX of the total transformer capacity addition, with plans to add over XXXX GVA of transformer capacity. North America and Europe accounted for XX% and XX% respectively, followed by Latin America with a share of XX%. The Middle East and Africa regions will account for a XX% share, and XX% share respectively.

Figure 4: Share of transformer capacity, by region (%)

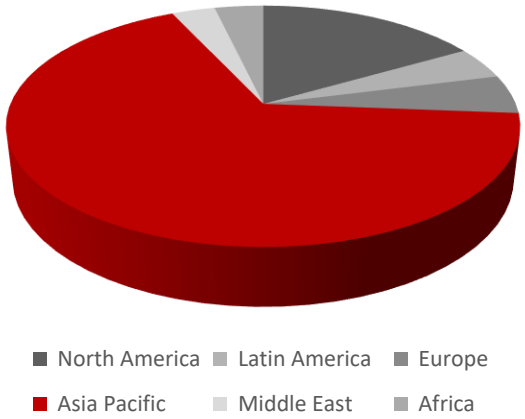


Table 3: Growth in transformer capacity by region (GVA)

Region	2021-30
North America	XXXX
Latin America	XXXX
Europe	XXXX
Asia Pacific	XXXX
Middle East	XXXX
Africa	XXXX
Total	XXXX

Notes: E-estimated. The above table does not include HVDC converter station capacity available in MW.
Source: Global Transmission Research

2.5.3 Expected demand for high voltage power transformers

Table 6: Estimated global demand for high voltage power transformers by voltage, 2021–30 (units)

Voltage	2021-30
110 kV-187 kV	XXXX
220 kV-287 kV	XXXX
300 kV-420 kV	XXXX
500 kV	XXXX
700 kV-1,000 kV	XXXX
Total	XXXX

- Globally, an estimated XXXX units of high voltage power transformers will be required between 2021 and 2030 at the 100 kV and above voltage levels.
- Over XX% of total power transformers demand will be at the 100 kV–187 kV level.
- Asia alone will account for around XX% of the total transformer demand during the ten-year period, 2021–30.

Figure 6: Share of power transformer demand, by region (%)

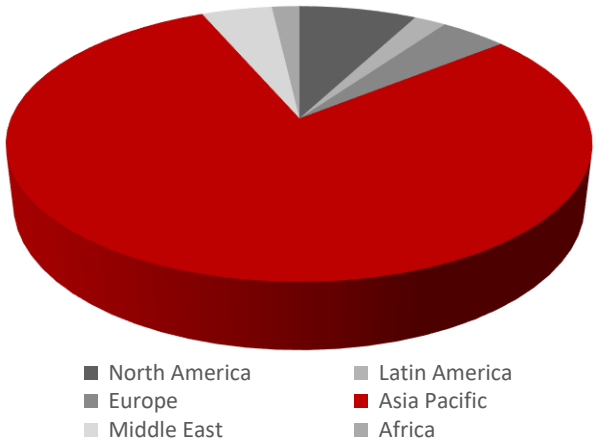


Table 7: Estimated global demand for high voltage power transformers by region, 2021–30 (units)

Region	2021-30
North America	XXXX
Latin America	XXXX
Europe	XXXX
Asia Pacific	XXXX
Middle East	XXXX
Africa	XXXX
Total	XXXX

Note: Above table/figures reflect demand for power transformers for AC substations only.
Source: Global Transmission Research

2.5.4 Forecasted market size for high voltage substations

Table 10: Estimated global market size for high voltage substations by voltage, 2021–30 (USD million)

Voltage	2021-30
110 kV-187 kV	XXXX
220 kV-287 kV	XXXX
300 kV-420 kV	XXXX
500 kV	XXXX
700 kV-1,000 kV	XXXX
HVDC[1]	XXXX
Total	XXXX

- The global market size of the high voltage substation market during 2021-30 is estimated to be USDXXX billion, of which XXX% is accounted by AC substation and the rest by HVDC converter stations.
- Globally, the high voltage AC substation market is estimated to be USDXXX billion during 2021-30 at the 100 kV and above voltage levels. Of this, AIS substation are expected to account for close to USDXXX billion (XX%) between 2021-30 and rest (XX%) will be accounted by GIS substations.
- Over XX% of AC substation market will be at the 100 kV–187 kV level.
- Asia alone will account for around XX% of the total substation market during the ten-year period, 2021–30.

Figure 8: High voltage AC substation market, by technology (%)

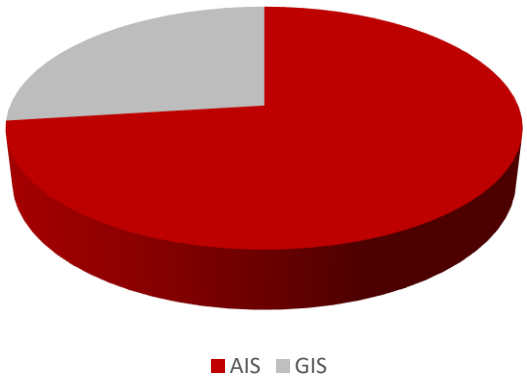


Table 11: Estimated global market size for high voltage substation by region, 2021–30 (USD million)

Region	2021-30
North America	XXXX
Latin America	XXXX
Europe	XXXX
Asia Pacific	XXXX
Middle East	XXXX
Africa	XXXX
Total	XXXX

.Note: 1- HVDC converter station; AIS – Air-insulated switchgear; GIS – Gas-insulated switchgear
Source: Global Transmission Research

Expected demand for high voltage substations

Expected demand for high voltage substations (number)

Table 3: Estimated demand for high voltage substations during 2021-30 (number)

Voltage	Number of substations		
	2021-25	2026-30	2021-30
220 kV	XXX	XXX	XXX
400 kV	XXX	XXX	XXX
Total	XXX	XXX	XXX

- It is estimated that around XX high voltage substation will be required in Poland during the ten-year period between 2021 and 2030 at 220 kV and above voltage levels.
- Of the total substation demand, XX% will be needed to set up 220 kV and remaining at 400 kV.
- About XX% of the total substation demand will be during the next five years, i.e. in 2021-25 and the remaining XX% in the latter half of the period, i.e. 2026-30.

During the next decade, XX HVDC converter station will also be set up in Poland, as part of the Harmony Link project with Lithuania.

Figure 3: Demand for substations by voltage during 2021-30 (%)

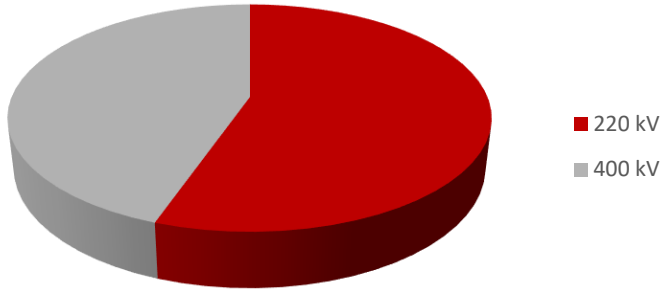
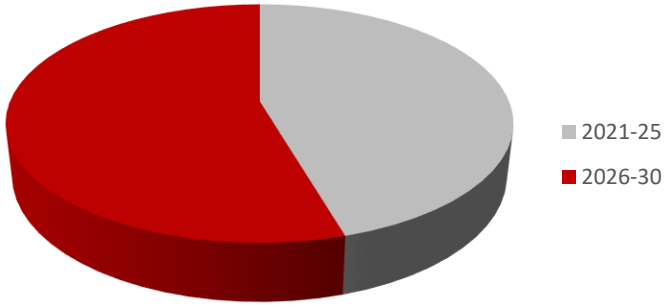


Figure 4: Demand for substations by time period during 2021-30 (%)



Note: Above table/figures reflect demand for AC substations only.
Source: Global Transmission Research

Expected market size for high voltage substations

Expected market size for high voltage substations (USD million)

Table 4: Estimated market size for high voltage substations during 2021-30 (USD million)

Voltage	High voltage substation market size		
	2021-25	2026-30	2021-30
220 kV	XXX	XXX	XXX
400 kV	XXX	XXX	XXX
Total	XXX	XXX	XXX

- An estimated market size of USDXXX million high voltage substation is expected in Poland during the ten-year period between 2021 and 2030 at 220 kV and above voltage levels.
- Of the total substation market size, over XX% will be for 400 kV substations, and remaining at other voltage levels.
- About XX% of the total substation demand will be during the next five years, i.e. in 2021-25 and the remaining XX% in the latter half of the period, i.e. 2026-30.
- The HVDC market size is estimated to be USDXXX million between 2021-30

Figure 5: High voltage substation market size by voltage during 2021-30 (%)

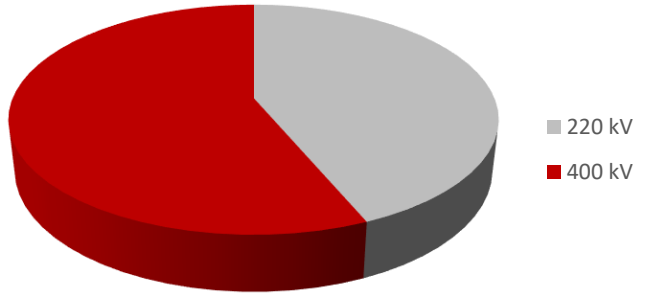
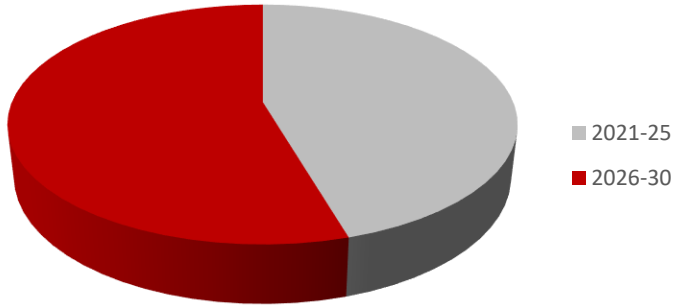


Figure 5: High voltage substation market size by time period during 2021-30 (%)



Note: Above table/figures reflect demand for AC substations only.
Source: Global Transmission Research

3.1.9 Hitachi Limited (1/2)

Company overview

Headquarters	Chiyoda City, Tokyo, Japan
Revenue (2021*)	USD21,328 million (consolidated)
Key business areas	IT, Energy, Industry, Mobility, Smart life, Automotive system, Construction machinery, Metals, etc. Energy offerings: Power grids, Power generation system, Energy & equipment management services, Power semiconductors

Key transmission product offerings

GIS; gas circuit breakers	Capacitors and filters
Turnkey substations, Substation automation and electrification	Transformers up to 1,200 kV; FACTS & HVDC systems
High power laboratory	Communication networks

Key developments

Year	Description
2020-21	Japan's New Energy and Industrial Technology Development Organization (NEDO) and its project partners Hitachi, Showa Denko Materials Co., Ltd. (Showa Denko Materials) and Sumitomo Mitsui Banking Corporation (SMBC) are undertaking a Smart Grid Demonstration Project in Poland. The project is aimed at the expansion of renewable energy with a hybrid battery energy storage system (BESS) located at the Bystra Wind Farm. In June 2020, the project reached the monitoring phase and full-scale demonstrative operation phase on September 25, 2021.
2019	In April 2021, Hitachi commenced operations of the Hida-Shinano frequency conversion facility, enabling the Shin-Shinano Substation of Japan's TEPCO Power Grid (TEPCO) to be connected to the Hida Converter Station of Chubu Electric Power Grid Company (Chubu EPCO). For this project, Hitachi delivered a line commutate converter HVDC system.

Note: *Three months ended 30 June, 2020.
Source: Hitachi Limited; Global Transmission Report

3.1.9 Hitachi Limited (2/2)

Recent collaborations

Year	Country	Company	Description
2020	Thailand	Electricity Generating Authority of Thailand (EGAT)	In May, Hitachi was selected to participate in a demand response demonstration project driven by EGAT. The project aims for system design and implementation to optimise power supply and demand balance in accordance with the comprehensive energy policy plan, Smart Grid Development Master Plan led by the Thai government.
2021	Thailand	EGAT	Hitachi and EGAT commenced the demonstration project of optimised performance enabling network for volt/var(Q) in December. The aim of the project is to reduce greenhouse gas emissions through more sophisticated and more efficient power system operations.

Source: Hitachi Limited; Global Transmission Report