Energy Transition with Cross-Border Power Transfer

Prof. Saifur Rahman
2023 IEEE President & CEO
www.srahman.org

Invited Talk
Role of Transmission in Net Zero
EEI-GCCIA COP28 Transmission Summit
Abu Dhabi, UAE, 29-30 November 2023
IEEE at Glance

- **440,000** members in more than **190** countries
- **39** technical Societies and **seven** technical Councils representing the wide range of IEEE technical interests
- **5 million+** documents in the IEEE *Xplore*® digital library, with **15 million+** downloads each month
- **1,900** active standards and **1,000+** standards under development
- Publishes **240** transactions, journals, and magazines
- Sponsors **2,000+** conferences in **106** countries annually
- Continuing Technology Education Resources
Access to ideas and innovations developed in other disciplines

Electrical and electronic engineering, computer science, IT and beyond:

- Aerospace
- Biomedical Engineering
- Broadcasting
- Circuits
- Communications
- Computing
- Control and Automation
- Electronics
- Environment
- Industrial Systems
- Information Technology
- Internet of Things
- Life Sciences
- Nanotechnology
- Optics
- Power and Energy
- Robotics and AI
- Semiconductors
- Smart Cities
- Smart Grid
- Transportation and Vehicles
- Nuclear Engineering
- And more...
No Transition without Transmission

Grid Interconnection improves Power System Flexibility
Some Case-specific Examples

Best Practices and Need-based Developments
Connecting beyond the national borders – example Europe

1. Embedded HVDC, parallel operation of AC and DC grids.
2. Off-shore HVDC grid incl. hybrid links.
3. Long-distance subsea HVDC interconnectors.
4. Connected remote islands.
5. Back-to-back connections of asynchronous areas.

Technically speaking – and looking beyond Europe – a global electricity network is also feasible.

Source: Gerhard Salge, CTO, Hitachi Energy

© 2023 Hitachi Energy. All rights reserved.
Interconnected power systems – pathways towards net zero

ENTSO-E: Ten-year network development plan

Regions are ramping up interconnection capacity to accommodate more time varying generation while maintaining high standard of reliability and resilience

© 2023 Hitachi Energy. All rights reserved. Source: ENTSO-E, https://tyndp.entsoe.eu/

ENTSO-E: European Network of Transmission System Operators for Electricity
HVDC in ENTSO-E area

Europe already has more than 30 HVDC links in operation & further 50 planned in the next 10 years

HVDC applications today and in the future
- Renewable integration
- Remote generation/load
- Interconnection
- DC links in AC grid & upgrades
- City center infeed
- Power from shore

IEA commentary on interconnection, August 2023: “In Europe, for example, cross-border trade of electricity is estimated to have delivered EUR 34 billion of welfare benefits in 2021 compared to if national markets were isolated.”
ScotWind leasing round on the 17th of January 2022: **25 GW**

Demand for Electricity in Scotland in 2030: **6 GW**
LONDON, Aug 24 (Reuters) - British authorities have given planning consent for a new 2 gigawatt (GW) subsea power link between Scotland and England.

The Eastern Green Link 2 will be developed by National Grid and Scottish and Southern Electricity Networks Transmission.
The 1400 megawatt interconnector stretches from Blyth in the UK, across the North Sea, to Kvilldal in Norway.
Gulf Coordination Council Interconnection

Major Benefit: Reduction of Reserve Requirements
Also helpful in dealing with Intermittent sources (PV)
Low-carbon, cheaper and non-intermittent electricity

Champion Hudson Power Express: 1250 MW
(Quebec to New York City)

545 km of underwater-underground transmission line
from Québec, Canada to New York City, about 500 km in NY State

Industry tends to locate in areas of low-carbon electricity to help meet their own net-zero targets for scope II and scope III emissions
# Degrees of Cross-border Power System Integration

<table>
<thead>
<tr>
<th>Integration Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral, unidirectional power trade</td>
<td>Thailand imports from Lao PDR</td>
</tr>
<tr>
<td>Bilateral, bidirectional power trade</td>
<td>Malaysia–Singapore (non-financial)</td>
</tr>
<tr>
<td>Multilateral, multidirectional trade</td>
<td>• Southern African Power Pool (SAPP)</td>
</tr>
<tr>
<td>among differentiated markets</td>
<td></td>
</tr>
<tr>
<td>Multilateral, multidirectional trade</td>
<td>• European Union Internal Energy Market</td>
</tr>
<tr>
<td>among harmonised markets</td>
<td></td>
</tr>
<tr>
<td>Unified (pooled) market structure,</td>
<td>• Nord Pool</td>
</tr>
<tr>
<td>differentiated operations</td>
<td></td>
</tr>
<tr>
<td>Unified market and operations</td>
<td>• PJM</td>
</tr>
</tbody>
</table>

Source: International Energy Agency

IEA 2019, All rights reserved.
Southern Africa Power Pool (14 countries)
Inadequate power transfer capacity
Minimum Requirements for Establishing Multilateral Power Trades

Political
- Political will
- Intergovernmental agreement(s)
- Common working language

Technical
- Harmonised technical standards (grid codes)
- Harmonised wheeling charge methodology
- Third-party access for external resources
- Data and information sharing
- Interconnector capacity calculation methodology

Institutional
- Institutional arrangements
- Settlement and payment mechanism
- Dispute resolution mechanism

Source: International Energy Agency
The NorthConnect project was meant to build a 1.4 GW undersea interconnector between Norway and Scotland. This 665-kilometer hybrid electric cable would have allowed exchanges between Scottish wind power and Norwegian hydropower.

Not approved: Uncertainty of exposure to Norway’s power grid to energy systems of other countries.
The ASEAN member states (AMS) have had a long-standing goal of integrating their power systems. ASEAN Power Grid (APG). It is composed of a series of cross-border (AC) and (DC) interconnectors. Power trade across the APG lines that currently exist is primarily bilateral.

Source: International Energy Agency
Success Stories
Laos-Thailand-Malaysia-Singapore Power Integration Project (LTMS–PIP)

The LTMS–PIP is a “pathfinder” project that is meant to demonstrate that multilateral power trading is possible in an ASEAN context. As it stands today, the LTMS–PIP involves the sale of electricity from Lao PDR to Malaysia, with Thailand acting as a transit, or wheeling, country.
Vietnam has opted to boost hydroelectricity imports from Laos. The limited electricity transmission capacity from the South to the North poses a major challenge. It is easier to import hydro electricity from Laos to shore up power supply for the North, given the shorter transmission distance.
Bangladesh-India Interconnection (HVDC link)

Bangladesh-India 400 KV Double-Circuit 1,000 MW Line

Allows Bangladesh to buy cheaper electricity and solar electricity when available
Cross-border Multi-purpose HVDC systems: Interoperability is key

**Multipurpose / Multiterminal interconnection – towards HVDC grids**

Regional HVDC grids can be further extended by connecting multiple Multiterminal interconnections, and using HVDC Breaker technology for protection.

**Interoperability is much more than technology …**

Voice of the offshore wind European Industry

- **Technologies have reached a maturity level** calling now for an industrial scale demonstration, with special attention on Grid Code Functional Specification (TSO driven) and DC Grid Control (OEM driven).

- **A system, staged and functional approach** shall be taken to implement Interoperability with all industrial stakeholders.

1. Source: EU Horizon 2020 funded project PROMOTION

© 2023 Hitachi Energy. All rights reserved.

12
Back-to-back HVDC Stations installed for stability due to Grid Code incompatibility

USD 400 Million investment could have been avoided with a compatible Grid Code

Similar Grid Code incompatibility exists between US and Mexico
Nepal, India reach ‘milestone’ deal on trade, transmission of electricity

Nepal to be permitted to participate in real-time trade in the Indian market, an upgrade from existing day-ahead energy trade.

Import of Hydropower will Reduce India’s Dependency on Coal-fired Power Stations

Source: Kathmandu Post
Nepal needs to attract investment by developing a market outside the country. Nepal needs less electricity in summer than in winter. It is opposite in India and Bangladesh due to high air conditioning load.
Hierarchy of Load Dispatch Centers

National Load Dispatch Center

Northern | North-Eastern | Western | Eastern | Southern

30+ Local Load Dispatch Centers
What Needs to Be Done?
(Issues: Politics, Technology, Institutions and Economics)

• Build platform for information exchange
• Identify benefits and risks
• Expand cross-border infrastructure
• Develop a wheeling price model
• Complement national regulation by regional coordination
• Remain cost conscious to maintain political support
No Transition without Transmission

Grid Interconnection improves Power System Flexibility
Thank you

web: www.srahman.org