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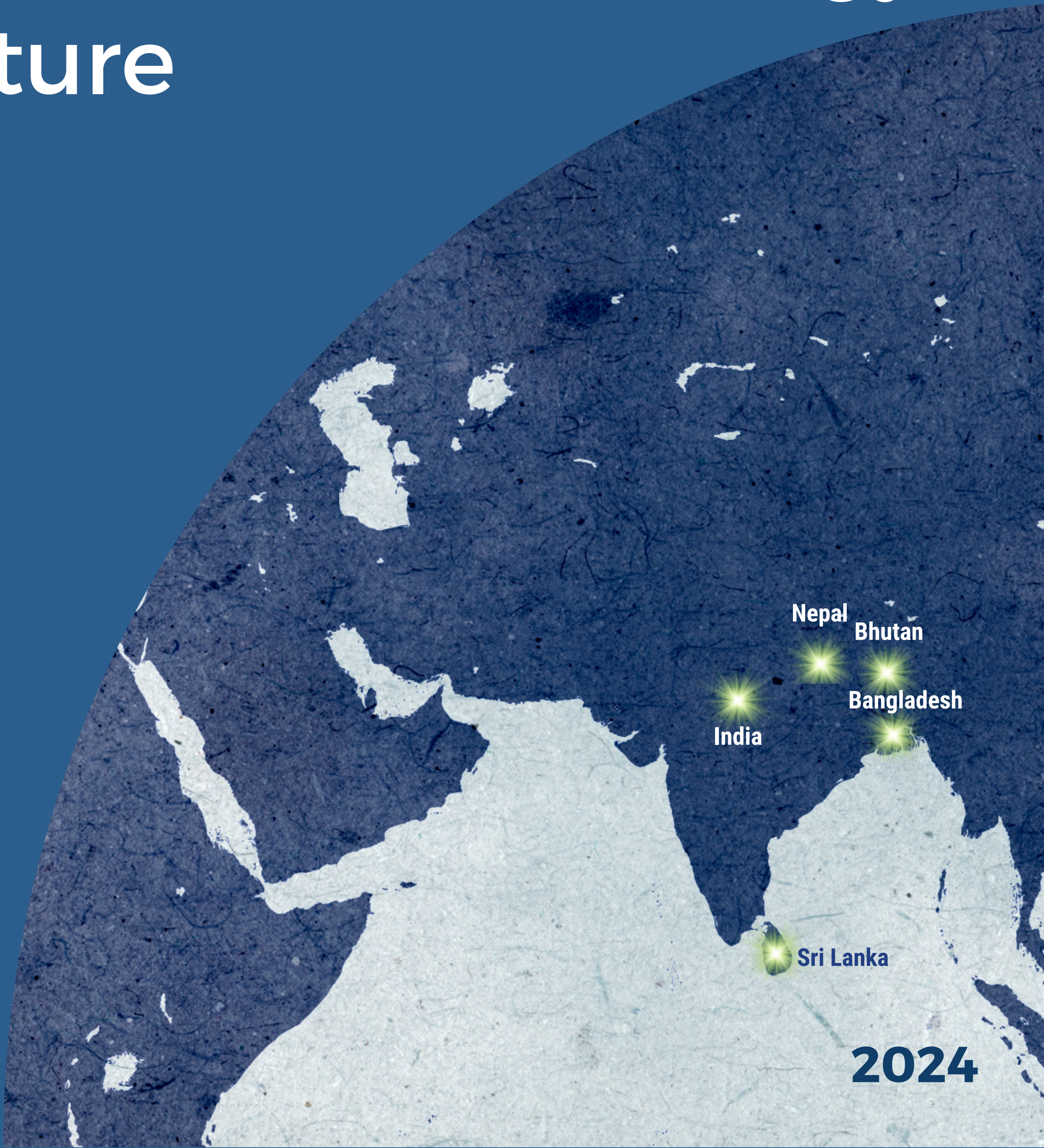
Bridging Continents: European CBET Insights for South Asia's Energy Future



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Report: Bridging Continents: European CBET Insights for South Asia's Energy Future

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Introduction

Electricity sector is undergoing a dynamic transformation as countries are in transition towards cleaner energy resources as part of their energy mix. With countries charting energy policies in alignment with the climate goals, a key topic of discussion is how to leverage resources not only from within one's borders, but also across borders. Cross-Border Electricity Trade (CBET) in this regard, also facilitates the sharing of renewable resources across regions, allowing countries to balance supply and demand more effectively. By sharing resources across borders, regions can mitigate the risks associated with supply fluctuations. This resource-sharing approach enables countries to access a diverse mix of energy sources, ensuring that when one source is underperforming—such as periods of low hydro, wind or solar generation—others can compensate as the demand fluctuates. In addition to energy security, CBET also promotes a more resilient energy infrastructure (Anbumozhi and Kumar Singh 2023). In short, CBET plays a pivotal role in achieving resource adequacy by enabling regions to pool their resources and share backup capacity.

Improved transmission capabilities are essential to maintain a reliable electricity supply that meets demand. Upgrading and expanding transmission networks allows for the efficient transfer of electricity across borders. Enhanced transmission infrastructure can alleviate congestion in local grids and reduce reliance on expensive peaking power plants. Moreover, it enables countries to tap into remote renewable energy resources that might otherwise be stranded due to inadequate infrastructure (Hurlbut and Koebrich 2019).

Cross-border trade also helps make electricity more accessible and affordable, together with better reliability and supply. By expanding the market base through interconnected systems, cross-border trade leads to lower prices for consumers as it increases competition. Studies have shown that interconnected markets can yield significant welfare benefits; for instance, Europe's cross-border electricity trade delivered estimated benefits of €34 billion in 2021 alone (Hevia-Koch et al. 2023). Other spill-over benefits of inter-connected cross-border trade include promoting cooperation between trading countries and regional economic growth through local industry and job creation (Fischhendler, Herman, and Anderman 2016).

Cross-border trade in electricity requires cooperation between various governmental and administrative bodies in a minimum of two neighbouring countries interconnected by transmission lines and cross-border interconnectors. This cooperation between neighbouring countries can be realised through intergovernmental meetings at the various ministerial, diplomatic, and official levels. Additionally, the involvement of private industrial players such as private generation companies, grid operators and distribution companies will further boost cross-border trade. Apart from the physical dimension of electricity, the electricity marketplace, such as power exchanges, also fosters cross-border trade (Puka and Szulecki 2014). Furthermore, the Global Commission on the Geopolitics (GCG) of Energy Transformation has pointed out that regional cooperation on RE and electricity will be as important as international trade in gas and oil in developing the energy system in the future.

> *The GCG has stated that "electricity trading tends to be more reciprocal"* whereas *"oil and gas flow in one direction, from an exporter to an importer"* (IRENA 2019)

The need for CBET is particularly critical in South Asia due to several interlinked factors. Firstly, South Asia is the most populous and the most densely populated geographical region in the world with an estimate of 1.94 billion people (World Bank Group 2023). South Asia is characterized by significant variations in energy demand and supply across its countries, presenting unique opportunities for optimizing resource utilization through mutual power exchanges. This diversity allows nations to balance their energy needs more effectively, especially during peak demand periods when local generation may fall short. Additionally, the region possesses vast untapped renewable energy potential—particularly in hydroelectric resources in countries like Nepal and Bhutan—which can be harnessed to meet the energy demands of neighbouring nations and vice-versa.

By facilitating CBET, countries can not only enhance energy security but also reduce reliance on imported fossil fuels—a pressing concern given rising global fuel prices exacerbated by geopolitical tensions. Moreover, CBET fosters economic cooperation and integration, enabling smaller countries to achieve economies of scale in energy production and investment, thereby driving down costs and promoting sustainable development. The environmental benefits are also notable; by tapping into renewable sources and reducing dependence on conventional fuels, CBET contributes to lower carbon emissions and improved air quality across the region. Overall, the collaborative framework of CBET not only addresses immediate energy challenges but also paves the way for long-term socio-economic growth and environmental sustainability in South Asia.

Cross Border Electricity Trade (CBET) in South Asia

Power trading in South Asia has evolved significantly, facilitated through various mechanisms such as government-to-government contracts and independent traders, covering short, medium, and long-term agreements. The cross-border electricity trade (CBET) across South Asian countries—Bangladesh, Bhutan, India, Nepal, and Sri Lanka—has increased three-fold from 2009-2010 to 2022-2023, with the potential to reach up to 43.8 GW by 2043 (Zeya Hazra 2024).

The potential for further growth in power trading across South Asia remains substantial, driven primarily by the development of transmission corridors. Robust transmission infrastructure is essential for facilitating cross-border power exchanges. For instance, Nepal's upgrade of its transmission line from 220 kV to 400 kV has significantly enhanced its power flow capacity. Initially, challenges arose regarding the responsibilities for line charges; however, solutions emerged following the establishment of this upgraded transmission line (Bhandari, Rimal, and Neupane 2020).Recent agreements between Nepal and India have solidified plans to develop two new high-capacity transmission lines by 2027-2028 and 2028-2029, further enhancing connectivity.

In Bangladesh, the Katihar-Parbatipur-Baranagar 765 kV high-voltage interconnection transmission line is a key project currently under review. Recent discussions between Bangladesh and India have focused on expediting this initiative, which aims to supply electricity from Katihar in Bihar to Baranagar in Assam through Parbatipur in Dinajpur, Bangladesh. This project is expected to enhance revenue generation and facilitate energy trade between the two nations (Chandrakar 2023).

India is actively advancing projects to enhance power supply to Bangladesh. Currently, there are two high-voltage direct current (HVDC) transmission lines at Bheramara with a capacity of 1,000 megawatts that can potentially be upgraded to around 3,000 megawatts. Additionally, a radial connection in Tripura with Bangladesh supports 800 megawatts but has the capacity for further expansion (Rehman et al. 2021).

Another significant initiative is the India-Sri Lanka Transmission Interconnection project, aimed at enhancing energy security and facilitating electricity trade between the two countries. This ambitious project involves constructing a $1.2 billion undersea transmission line that will connect Sri Lanka's power grid with India's. The interconnection will link Anuradhapura in Sri Lanka with Chennai in India and includes a 130-kilometer overland transmission line in India followed by an undersea cable that will emerge at Thiruketheeswaram in Mannar, Sri Lanka. This strategic link is expected to provide a reliable source of electricity to Sri Lanka, which has been grappling with energy shortages and aims to diversify its energy sources (Wijayatunga, Chattopadhyay, and Fernando 2015).

As of early 2024, both nations have renewed their commitment to this long-pending project that has been under discussion for nearly two decades. Sri Lanka is preparing to conduct load flow studies for its network, anticipating an initial capacity exchange of 500 megawatts from India through this new link (Samant 2023).

Challenges and Opportunities in South Asia

South Asia stands at a transformative juncture in its energy landscape, driven by ambitious targets for renewable energy adoption and net-zero emissions. This shift from fossil fuel dependency towards cleaner sources such as solar, wind, hydroelectricity, and nuclear power presents both challenges and opportunities for Cross-Border Electricity Trade (CBET). One of the primary challenges is the need for robust regulatory frameworks that balance developmental goals with climate action commitments. Countries in the region must harmonize their diverse energy security needs with climate objectives, especially as some nations contribute significantly to regional emissions while exhibiting low per capita emissions. This disparity underscores the necessity for regulators to foster regional collaboration and create harmonized frameworks that facilitate CBET (Hurlbut and Koebrich 2019).

Infrastructure development is another critical area that requires attention. The existing energy infrastructure in South Asia is often inadequate to support the ambitious renewable energy targets set by various nations. Upgrading and expanding transmission networks will be essential for efficient electricity transfer across borders, alleviating congestion in local grids, and enabling access to remote renewable resources. The potential for renewable energy generation in South Asia is immense, however, only a fraction of this potential has been developed thus far, highlighting both an opportunity and a pressing need for investment in infrastructure.

Financing poses another significant challenge. The reliance on traditional banking channels and underdeveloped bond markets limits access to capital for renewable energy projects. In many cases, countries depend heavily on developmental capital from multilateral development banks, which can lead to increased external debt. To overcome these financial hurdles, innovative funding mechanisms and public-private partnerships will be crucial. Strengthening trading networks through bilateral agreements and market-based mechanisms can help attract investment while ensuring sustainable growth (Srivastava 2024).

Capacity building is vital for regional integration and will play a key role in achieving a resilient and secure energy future for South Asia. As countries transition to cleaner energy options, there is an urgent need for knowledge sharing and technology transfer among nations. Successful examples from within the region can serve as models for others looking to enhance their renewable energy markets.

In conclusion, while the challenges facing CBET in South Asia are significant—ranging from regulatory hurdles to infrastructure deficits and financing constraints—the opportunities are equally compelling. By leveraging its abundant renewable resources and fostering regional cooperation, South Asia can not only meet its energy demands but also contribute to global climate goals. The collaborative framework of CBET will be instrumental in addressing immediate energy challenges while paving the way for long-term socio-economic growth and environmental sustainability in the region.

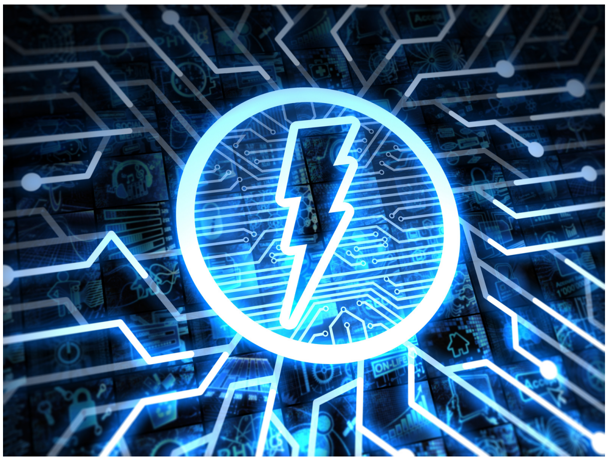
South Asia has a complex energy landscape, and dialogues on how to promote regional electricity cooperation has been under discussion for a good decade or more. Globally, there exist many models for regional electricity market development such as 1) extension of the market in one jurisdiction to encompass other jurisdictions; 2) superimposing a regional market on the trading arrangements in the different jurisdictions; and 3) establishment of a regional market, replacing existing markets, with new rules agreed by all involved jurisdictions. The appropriate model for CBET in South Asia could be one of the above models, however, there are regulatory elements within each of these models which could serve as learnings for the region.

In this report, we present the model 3, which is the case of the European Internal Electricity Market as a case example for South Asia. The European Union's (EU) experience demonstrates the effectiveness of a coordinated approach, where common policies and regulations facilitate seamless electricity trade among member states.

CBET in Europe – Case Example for South Asia

Europe has a well-integrated system that facilitates the exchange of electricity among EU member states and neighbouring countries, significantly enhancing energy security and market efficiency. Regional electricity trade is one of the critical components of the region's energy strategy, particularly in the context of the European Green Deal, Fit for 55 and the REPowerEU initiative (European Commission 2024b). The European Green Deal aims to make Europe climate-neutral by 2050, which necessitates a significant increase in renewable energy sources and enhanced interconnections between national electricity grids (European Commission 2022a). The REPowerEU plan, introduced in response to the energy crisis exacerbated by geopolitical tensions, emphasizes the need for greater energy independence and resilience, which includes accelerating investments in cross-border transmission infrastructure to enhance capacity and reliability (European Commission 2022b).

The European approach to cross border electricity trading is a combination of regulatory measures that involves rules that govern the internal electricity market, building of the necessary infrastructure for networks, the mechanisms to plan, identify and build these networks through appropriate tools and funding mechanisms, all through a coordinated approach.



EU's Electricity Market and Cross Border Electricity Trade

Cross-border electricity trade is a vital component of the European Union's (EU) internal electricity market, which has evolved significantly over the past three decades. The liberalization of the electricity sector among EU member states initiated this journey, leading to the establishment of legislative energy packages designed to create common rules for the internal market. These frameworks fostered harmonized laws and regulations, resulting in the formation of institutions that facilitate cooperation among EU countries, national regulatory agencies, transmission system operators (TSOs), and distribution system operators (DSOs) (Jevnaker 2015).

The Agency for the Cooperation of Energy Regulators (ACER) and the European Network of Transmission System Operators for Electricity (ENTSO-E) are two key entities in the EU energy landscape at the regional level. ACER, established in 2011 and based in Ljubljana, Slovenia, plays a crucial role in ensuring that the single European market for gas and electricity operates effectively. It works to integrate national energy markets, promote competition, and facilitate the transition to clean energy by coordinating regulatory actions across EU Member States and monitoring market activities to prevent manipulation and abuse (ACER 2023a).

On the other hand, ENTSO-E is responsible for the development and operation of electricity transmission networks across Europe. ENTSO-E focuses on TSO coordination and drafting essential network codes necessary for achieving the EU's energy and climate policy objectives. In addition, ENTSO-E develops the Ten-Year Network Development Plan (TYNDP), which outlines future infrastructure needs and investment strategies to support a reliable and integrated electricity grid throughout Europe, thereby facilitating the transition to a more sustainable energy system (ENTSO-E 2024a).

Electric Market Coupling

In addition to liberalisation and the establishment of new governance entities, market coupling is a key aspect of integrating the common internal electricity market. Market coupling allows electricity to be exchanged between neighbouring countries, ideally flowing from regions with lower prices to those with higher prices until price convergence is achieved (Saez et al. 2019). The EU has enhanced cross-border trade among its member states by improving market coupling procedures. Initially, cross-border trade was managed separately through explicit auctions; however, implicit auctioning has since streamlined this process by combining distinct markets into a more efficient system. This integration allows for simultaneous allocation of cross-border transmission capacity through power exchanges (Ravi Kumar, Ramesh Tunga, and Sinha 2022).

The first market coupling initiative began in 2006 with a trilateral project involving day-ahead markets from three power exchanges and three TSOs aimed at increasing market liquidity and optimizing cross-border capacities. This was followed by volume coupling in 2008 between Nord Pool and EEX, which linked quantities offered and demanded while maintaining separate price formations. The next significant step was price coupling, initiated in 2010, where prices and flows are determined simultaneously in a single transaction involving participating countries. This process involves calculating transmission capacity at the national level, determining prices based on exports and imports, and executing trades through local power exchanges (Meeus and Schittekatte 2020).

Currently, cross-border trade in the EU electricity market operates through multi-regional coupling (MRC) or 4M market coupling (4MMC), encompassing numerous bidding zone borders (ENTSO-E 2021). MRC involves 19 EU countries and accounts for approximately 85% of EU power consumption (EPEX Spot 2022). In 2015, Central Western Europe introduced flow-based market coupling (FBMC), which uses market-clearing and also allocates transmission capacities simultaneously rather than relying on pre-determined capacities. This method further refines cross-border trade by enhancing capacity allocation and integrating market activities. Additionally, cross-border intra-day trading (XBID) was launched in 2018 to allow participants from multiple EU countries to engage in a unified intra-day trade if sufficient transmission capacity is available (Meeus and Schittekatte 2020).

The Regulation on Energy Market Integrity and Transparency (REMIT)

The Regulation on Energy Market Integrity and Transparency (REMIT) is a pivotal piece of legislation enacted by the European Union to ensure the integrity and transparency of wholesale energy markets. Implemented in December 2011, REMIT was designed to address the inadequacies of existing antitrust laws in tackling complex market abuses such as insider trading and market manipulation. This regulatory framework has evolved significantly since its inception, responding to the dynamic nature of energy markets (ACER 2023b).

Key Objectives of REMIT

- Prevent Market Abuse: REMIT explicitly prohibits insider trading and market manipulation, establishing a clear legal framework to protect market integrity.
- Enhance Transparency: The regulation mandates the timely disclosure of inside information by market participants through platforms, ensuring that necessary stakeholders have access to vital market data.
- Strengthen Regulatory Oversight: REMIT empowers national regulatory authorities (NRAs) and the Agency for the Cooperation of Energy Regulators (ACER) to monitor compliance and enforce regulations effectively (Commission De Régulation De L'Énergie 2024).

Core Provisions of REMIT

- Prohibition of Insider Trading: REMIT prohibits the use of non-public information for trading purposes, ensuring that all market participants operate on a level playing field.

This includes any transactions based on confidential information that could influence energy prices.

- Prohibition of Market Manipulation: The regulation defines various forms of market manipulation and prohibits actions intended to distort market prices or influence supply and demand. This includes direct manipulation and attempted manipulation.
- Disclosure Obligations: Market participants are required to publish inside information promptly, ensuring that all relevant stakeholders can make informed decisions based on current market conditions.
- Reporting Requirements: Entities engaged in wholesale energy markets must report transaction details to ACER within specified timeframes, enhancing transparency and enabling effective monitoring.
- Registration of Market Participants: All participants must register with ACER and obtain a unique identifier through the Centralized European Registry for Energy Market Participants (CEREMP) (de Hauteclocque and de Almeida 2024).

Monitoring and Enforcement Mechanisms

REMIT establishes a dual-layer monitoring system involving both NRAs and ACER:

- Data Collection: ACER collects data on trading activities, which helps identify potential breaches of REMIT provisions.
- Investigation Powers: NRAs are empowered to investigate suspicious transactions and impose penalties for violations, enhancing regulatory oversight (de Hauteclocque and de Almeida 2024).

Recent developments in the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) highlight significant updates aimed at enhancing market integrity and transparency within the EU energy sector. In early 2024, the European Parliament approved amendments to REMIT after extensive discussions, marking the most substantial revisions to the regulation since its inception over a decade ago. These changes were officially adopted by the Council in March 2024 and the updated Regulation was published in April 2024. The amendments are part of a broader Electricity Market Design package proposed by the European Commission, which includes revisions to related directives and regulations (Micagni 2024).

One of the key changes involves the requirement for non-EU market participants to designate a representative within the EU by November 8, 2024. This representative will serve as a liaison with national regulatory agencies and ensure compliance with REMIT regulations. Additionally, the definition of market manipulation has been broadened to encompass a wider range of actions that could distort market signals or affect energy prices. The updated REMIT also introduces new reporting obligations for market players, expanding the scope to include storage contracts and coupled markets while enhancing data accuracy and transparency.

Furthermore, significant modifications have been made to the definition of wholesale energy products under REMIT. Liquefied natural gas (LNG) is now specifically included, reflecting its growing importance in energy markets. The range of derivatives covered has also been expanded to include those linked to electricity delivery through intraday and day-ahead coupling mechanisms. These developments underscore REMIT's adaptability to evolving market conditions and its commitment to maintaining robust regulatory oversight in a dynamic energy environment. Overall, these updates aim to strengthen market integrity, enhance accountability, and promote transparency across the EU's wholesale energy markets (Micagni 2024).

Key Regulations Governing CBET Infrastructure

The management of cross-border electricity trade (CBET) infrastructure in the European Union is governed by several key regulations and frameworks designed to enhance connectivity and security across member states. The Ten-Year Network Development Plan (TYNDP) outlining long-term infrastructure needs and investment priorities for the energy sector. The Trans-European Networks for Energy (TEN-E) regulation establishes a strategic framework for developing the energy infrastructure, focusing on Projects of Common Interest (PCIs) that are crucial for integrating national markets and promoting renewable energy sources. Additionally, tool such as the Cross-Border Cost Allocation (CBCA) mechanism facilitates the equitable sharing of costs associated with cross-border projects, ensuring that investments are justified and beneficial across borders. Furthermore, key infrastructure projects can also procure funding from the Connecting European Facility (CEF). These initiatives are supported by detailed network codes, which provide specific guidelines for market interactions, capacity allocation and congestion management, thereby ensuring efficient operation of the interconnected electricity grid. Together, these regulations foster a cohesive energy market that enhances the reliability and efficiency of electricity supply across Europe.

The Ten-Year Network Development Plan (TYNDP)

The Ten-Year Network Development Plan (TYNDP) is a strategic framework developed by the European Network of Transmission System Operators for Electricity (ENTSO-E) to plan and coordinate the development of electricity transmission infrastructure across Europe. A similar exercise is also undertaken for gas infrastructure by the European Network of Transmission System Operators for Gas (ENTSOG). The TYNDP aims to ensure a reliable, efficient, and sustainable energy system that aligns with the EU's climate goals and energy policies. It serves as a vital strategic planning tool, offering a long-term vision for electricity infrastructure development and ensuring that investments are directed toward areas that will yield significant benefits. By aligning with EU regulations and directives, the TYNDP guarantees that infrastructure developments comply with overarching policy goals. Furthermore, it identifies key projects that enhance interconnectivity and flexibility within the grid, contributing to a more efficient energy market capable of responding effectively to changing demands (ACER 2023e).

To achieve these objectives, the TYNDP scenarios incorporate data and assumptions about future demands for various energy carriers, such as electricity, methane, hydrogen, and liquid fuels, along with domestic resources and import capabilities. The scenario modelling also includes predictions of energy prices and the current and planned infrastructure levels for electricity and gas grids, as well as generation and storage capacities. Since 2018, initial steps toward integrated energy system planning have streamlined these scenarios and assumptions for developing electricity and gas grids. Infrastructure gaps are identified through various tools and models that simulate the energy system, primarily using market and network simulations. These simulations contribute to the cost-benefit analysis of individually planned projects, with benefit indicators established by ENTSOs based on criteria outlined in the TEN-E regulation, including sustainability, market integration, supply security and quality, as well as smart sector integration (Entsog and Entso-e 2022).

Stakeholder engagement is essential in the TYNDP process, primarily focusing on developing storylines and scenarios. ENTSOs conduct a series of webinars with interested parties, including companies with commercial interests and non-governmental organizations. This collaborative process results in multiple versions of scenario reports and guidelines, along with data spreadsheets and a visualization platform. After releasing an initial draft, stakeholders can provide written feedback, which ENTSOs consider for future revisions.

At the core of the TYNDP process are scenario development and energy system modelling. The key findings regarding infrastructure gaps, cost-benefit evaluations, and stakeholder usability depend significantly on effective modelling design. The methodology applied for the TYNDP evolves with each edition to reflect advancements in knowledge—particularly concerning the integration of gas and electricity systems—and the representation of flexible, cross-sectoral technologies. This continuous evolution ensures that the TYNDP remains relevant in addressing emerging challenges within Europe's dynamic energy landscape (ENTSO-E 2024b).

Objectives of TYNDP

The primary objectives of the TYNDP include (ACER 2023e):

- Identifying Infrastructure Needs: The TYNDP assesses the future needs of the electricity transmission system, helping to identify where investments are necessary to enhance cross-border electricity exchanges and integrate renewable energy sources.
- Facilitating Investment: By providing a clear roadmap for future infrastructure projects, the TYNDP facilitates investment from both public and private sectors, ensuring that funds are directed toward projects that will have significant benefits for the energy system.
- Supporting Policy Goals: The plan aligns with EU energy policy objectives, including the European Green Deal, which aims for climate neutrality by 2050. It supports the integration of renewable energy sources and enhances security of supply across member states.

Process of Developing TYNDP

The TYNDP process involves several key steps (ACER 2023e):

- Scenario Development: ENTSO-E develops various scenarios that reflect potential future developments in the energy landscape. These scenarios consider factors such as technological advancements, policy changes, and market dynamics.
- System Needs Assessment: This stage identifies specific needs within the electricity system based on the developed scenarios. It evaluates how different projects can address these needs while maximizing economic benefits and minimizing environmental impacts.
- Project Evaluation: Each proposed project undergoes a detailed cost-benefit analysis (CBA) to assess its viability. This analysis includes evaluating socio-economic benefits, CO_2 emissions reductions, and contributions to renewable energy integration.

- Consultation and Feedback: Stakeholders, including national regulatory authorities, industry representatives, and the public, are consulted throughout the process to gather feedback and ensure transparency.
- Publication of Results: The final TYNDP document is published biennially, detailing identified projects, their expected impacts, and recommendations for future infrastructure development.

TEN-E Regulation

The TEN-E Regulation (Trans-European Networks for Energy) is a European Union regulation that aims to facilitate the development of trans-European energy infrastructure. TEN-E aims to enhance the timely development and interoperability of energy infrastructure across Europe. This regulation is designed to accelerate the execution of infrastructure projects that align with EU energy policy objectives, including the integration of the internal energy market, ensuring supply security, promoting energy efficiency, and facilitating the incorporation of renewable energy sources (RES). It outlines various elements related to cross-border infrastructure, such as identifying and implementing Projects of Common Interest (PCIs), regulatory frameworks for these projects, and criteria for financial support under the Connecting Europe Facility for Energy (CEF-E) (Schittekatte et al. 2021).

Every two years, a list of PCIs is compiled, covering electricity, gas, oil, smart grids, and CO2 networks. These projects receive priority treatment from Member States (MS), with a stipulated 3.5-year limit on the permitting process. The regulation also introduces mechanisms like a single national authority (or "one-stop shop"), cooperation mechanisms through tools such as Cross-Border Cost Allocation (CBCA) for PCIs, and guidelines for enhancing transparency and public engagement (Couffon 2021). Furthermore, the European Commission's latest Grid Action Plan aims to address the missing links of the clean energy transition, which aims to ensure that EU grids operate more efficiently and are rolled out further and faster (European Commission 2023).

Key Objectives of the TEN-E Regulation

- Infrastructure Development: The regulation aims to accelerate the development of energy infrastructure projects that have a significant cross-border impact. This includes electricity and gas networks, smart grids, and CO2 transport networks.
- Projects of Common Interest (PCIs): The TEN-E Regulation establishes a framework for identifying and supporting Projects of Common Interest (PCIs). These are projects that are deemed essential for achieving the EU's energy policy objectives, such as

enhancing energy security, integrating renewable energy sources, and improving market integration.

- Cost-Benefit Analysis (CBA): The regulation mandates the use of Cost-Benefit Analysis methodologies to assess the economic viability and benefits of proposed projects. This ensures that projects receiving EU support are justified in terms of their costs and benefits.
- Cross-Border Cooperation: The TEN-E Regulation encourages cooperation among EU member states and between different energy sectors (electricity, gas, and renewables) to facilitate the development of integrated energy networks.
- Funding Mechanisms: The regulation provides access to funding through the Connecting Europe Facility (CEF), which supports the financing of PCIs and other energy infrastructure projects.
- Stakeholder Involvement: The regulation emphasizes the importance of stakeholder engagement in the planning and implementation of energy infrastructure projects, ensuring that the views of various stakeholders are considered (Schittekatte et al. 2021).

Cross-Border Cost Allocation (CBCA)

Cross-Border Cost Allocation (CBCA) is a procedure established under the TEN-E Regulation to determine how the costs of Projects of Common Interest (PCIs) are shared among the countries involved in a project. The CBCA process is crucial for ensuring that the financial burden of cross-border energy projects is distributed fairly among the participating member states. This mechanism not only promotes equity but also encourages investment in essential energy infrastructure, facilitating the integration of energy markets across Europe (ACER 2023c).

The need for an effective CBCA framework is underscored by the increasing complexity of energy projects that span multiple jurisdictions. As the EU aims to enhance energy security and promote sustainability, particularly considering geopolitical challenges and climate commitments, a transparent and efficient cost allocation process becomes essential (Meeus and Keyaerts 2015). Currently, the common practice is that each country bears the costs associated with assets located within its territory. However, this approach can lead to inequities, particularly when one country benefits significantly from a project while another incurs substantial costs without corresponding advantages. To address this, the TEN-E Regulation encourages innovative CBCA agreements that are informed by comprehensive Cost-Benefit Analyses (CBAs). These analyses help identify potential net losers and ensure that their losses are compensated, fostering trust and collaboration among member states (ACER 2023c).

Key Features of CBCA

- Cost Sharing: The CBCA procedure allows for the allocation of costs associated with a PCI among the countries that benefit from the project. This is particularly important for projects that span multiple jurisdictions, as it helps to avoid placing the entire financial burden on a single country.
- Transparency and Fairness: The CBCA process is designed to be transparent and fair, ensuring that all involved parties have a clear understanding of how costs are calculated and allocated. This transparency is essential for building trust among member states and stakeholders.
- Regulatory Framework: The CBCA is governed by guidelines established by the Agency for the Cooperation of Energy Regulators (ACER) and the European Commission. These guidelines outline the principles and methodologies for cost allocation, ensuring consistency across different projects.
- Stakeholder Consultation: The CBCA process includes provisions for stakeholder consultation, allowing affected parties to provide input on cost allocation decisions. This engagement helps to address concerns and improve the overall acceptance of projects.
- Incentives for Investment: By providing a clear framework for cost allocation, the CBCA encourages investment in cross-border energy infrastructure. It helps to mitigate the financial risks associated with large-scale projects, making them more attractive to investors
- Integration of Energy Markets: The CBCA procedure supports the integration of energy markets by facilitating the development of infrastructure that connects different countries and regions. This integration is essential for achieving the EU's energy policy objectives, including the transition to a low-carbon economy (ACER 2023d).

Projects of Common Interest (PCIs)

Projects of Common Interest (PCIs) are essential infrastructure initiatives that connect energy systems across EU member states, including electricity, hydrogen, and CO2 networks for an enhanced energy market integration across Europe. Established in 2013, the PCI designation is granted biannually, providing project developers with streamlined regulatory processes, expedited planning and permitting, and access to financial support through the Connecting Europe Facility (CEF). As a result, PCIs serve as a vital mechanism for advancing the EU's ambitious energy and climate objectives (ACER 2023c).

The sixth PCI project list, released on November 28, 2023, marks a significant milestone as it is the first list created under the updated Trans-European Networks for Energy (TEN-E) regulation. This new framework emphasizes the transition towards a renewable and decarbonized energy system. Notably, this is the first time projects related to hydrogen generation and infrastructure have qualified for PCI status, reflecting the EU's commitment to diversifying its energy sources (European Commission 2024a).

To compile this list, the European Commission collaborated with European Transmission System Operators (TSOs) associations ENTSO-E and ENTSOG to evaluate how well potential projects align with European energy policy goals. They focus on sustainability, flexibility, and security of supply while also assessing anticipated costs and benefits, including potential environmental advantages from reduced greenhouse gas emissions (ACER 2022). Some of the eligible project types undertaken by PCIs include:

Electricity Projects	Transmission Lines
	Smart Grids
Gas Projects	Gas Pipelines
	Liquified Natural Gas (LNG) Terminals
Hydrogen Projects	Hydrogen Transmission Networks
	Electrolysis
	Storage
CO2 Networks	Capturing and Transportation
Offshore Projects	Offshore Wind Farms
	Offshore Grids

Figure 1 Eligible Project Types under Projects of Common Interest (PCI). Source: (Červinková and Jirušek 2021)

The implementation of PCI projects is expected to yield significant economic and social benefits. These include lower energy prices, improved energy security, and increased competition within the energy market. Furthermore, PCIs contribute to achieving interconnectivity targets set by the EU that aim for a minimum level of cross-border energy capacity among member states. This interconnectedness is crucial for fostering a resilient and efficient energy system throughout Europe (Červinková and Jirušek 2021).

Projects of Mutual Interest (PMI)

The concept of Projects of Mutual Interest (PMIs) was introduced in 2022 with the revision of the Regulation on guidelines for trans-European energy infrastructure (TEN-E Regulation).

PMIs extend beyond the EU borders, involving energy infrastructure projects that connect EU countries with non-EU countries. To qualify as a PMI, a project must demonstrate a significant contribution to the overall energy and climate objectives of both the EU and the partner country. These projects are often linked with Projects of Common Interest (PCI), which are specifically identified by the European Commission as priority projects essential for achieving EU energy policy objectives. While PCIs focus on large-scale infrastructure developments that enhance interconnectivity and sustainability, PMIs complement this framework by addressing regional energy needs and fostering cooperation among neighbouring countries (European Commission 2024a).

PMIs are included in the PCI list, allowing them to benefit from streamlined permitting processes and access to EU funding, thereby facilitating their development. This relationship enhances the overall effectiveness of the PCI framework by ensuring that both large-scale and regionally significant projects receive support. As a result, PMIs play a crucial role in promoting energy security, market integration, and the transition to renewable energy sources within the EU, ultimately contributing to a more resilient and interconnected energy landscape.

Connecting Europe Facility (CEF)

The Connecting Europe Facility (CEF) is a pivotal funding mechanism established by the European Union to enhance trans-European infrastructure in the sectors of energy, transport, and digital connectivity. The CEF Energy component specifically targets the development and modernization of energy infrastructure across Europe, playing a critical role in facilitating the transition to a sustainable and integrated energy market (Strata 2023).

According to Articles 12 and 14 of the TEN-E Regulation, applications for a CEF Energy grant for projects must include a CBCA decision issued by the national regulatory authorities of the EU Member States affected by the project. However, a CBCA decision is not required for applications related to projects categorized under infrastructure categories 1c (electricity storage), 1e (smart grids), and 4 (carbon dioxide) in Annex II of the TEN-E Regulation (European Climate 2021).

Objectives of CEF for the Energy Sector

- <u>Enhancing Energy Security:</u> One of the primary goals of CEF Energy is to improve energy security across EU member states. This is achieved by investing in cross-border energy projects that enhance the resilience and reliability of energy supply systems. By connecting national grids and fostering interconnections, CEF Energy helps to mitigate the risks associated with energy shortages or disruptions, ensuring a stable supply for consumers and industries alike.

- Promoting Renewable Energy Integration: CEF Energy actively supports projects aimed at integrating renewable energy sources into the existing energy grid. This integration is essential for achieving the EU's climate objectives, particularly those outlined in the European Green Deal. By funding infrastructure that facilitates the use of renewables such as wind, solar, and hydroelectric power, CEF Energy contributes to a cleaner energy landscape and aids in reducing greenhouse gas emissions.
- Improving Interoperability: Another key objective of CEF Energy is to enhance the interoperability of energy networks across Europe. This involves ensuring that different national systems can work together efficiently, allowing for seamless electricity and gas flows across borders. Improved interoperability not only supports market integration but also enables countries to share resources during peak demand periods or emergencies (IEA 2022).

EU Network Codes

The development of network codes and guidelines is essential for facilitating Cross-Border Electricity Trade (CBET) within the European Union. These codes serve as a comprehensive framework aimed at overcoming the barriers that have historically fragmented national electricity markets. By harmonizing previously national regulations, these codes promote a cohesive approach to energy market integration (Schittekatte, Reif, and Meeus 2020).

In 2017, following a collaborative four-year process involving ENTSO-E, ACER, the European Commission, and various stakeholders, eight network codes and guidelines were finalized and implemented. This marked a significant step forward in establishing a unified energy market. The subsequent Clean Energy Package (CEP), introduced in 2016 and approved in late 2018, proposed revisions to modify the operation of existing network codes and introducing new areas for development. Among these areas are rules governing demand response, energy storage, and ancillary services, which are crucial for enhancing market flexibility (Schittekatte, Reif, and Meeus 2020).

Network codes set detailed technical standards necessary for achieving an integrated gas and electricity market in Europe. By establishing uniform rules, they eliminate barriers to cross-border trade, ensuring that energy flows smoothly across national boundaries. These codes are legally binding across the EU, meaning they do not require further national implementation.

The existing network codes encompass various aspects of the electricity market. For instance, market guidelines such as the Capacity Allocation and Congestion Management Guideline (CACM) and the Electricity Balancing Guideline (EBGL) provide regulatory frameworks for different timeframes within the wholesale market. Additionally, grid connection codes outline technical requirements for connecting demand facilities and generators while allowing some room for national adaptation. The System Operation Guideline (SOGL) and Emergency and Restoration Network Code (E&R) establish cooperation protocols among transmission and distribution system operators during normal operations or emergencies (NationalGrid 2018).

Uniformity in regulations ensures that all member states can operate seamlessly within a shared framework, enabling efficient energy exchanges and enhancing overall market stability. As countries transition towards more integrated energy systems, having standardized codes will facilitate smoother operations and foster collaboration among nations. This collective effort is vital not only for achieving immediate energy goals but also for supporting long-term sustainability objectives across Europe.

Conclusion

South Asia requires a multi-pronged approach to Cross-Border Electricity Trade (CBET) that encompasses the diverse interests and aspirations of various stakeholders. It will need to develop a model of regional electricity market that takes into account a coordinated approach on both infrastructural needs and the market design that would enhance cooperation and regional participation. As part of establishing the regional electricity model, a key component would be the improvement of transmission infrastructure within regional silos. Upgrading these capabilities at a national level will help facilitate effective CBET, thereby, enabling countries to better connect their electricity systems and optimize source allocation and utilization. Furthermore, by promoting market coupling and integration, nations can create a more cohesive energy landscape, ultimately leading to enhanced grid synchronization and price discovery. Therefore, as countries work towards establishing robust cross-border connections, the focus should be on overcoming challenges related to regulatory alignment as well as infrastructure development and operations. By addressing these critical aspects, South Asia can unlock its vast renewable energy potential, improve energy security, and foster economic growth.

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