

# Introduction

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# Introduction

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## **1. Background and Objectives**

### *Background*

Driven by economic and industrial development, population growth, and higher standards of living, electricity demand in the member states of the Association of Southeast Asian Nations (ASEAN) is projected to more than triple between 2013 and 2035 (ERIA, 2015), a growth rate higher than any other region in the world.

Plans to secure energy supplies in the region require evaluation of the geographic scope of desirable and feasible integration. For example, the ASEAN Plan of Action for Energy Cooperation 2010–2015 has a number of objectives that include the establishment of an ASEAN Power Grid (APG), increased penetration of renewable energy, and further development of an ASEAN gas network. APG, a flagship programme of 16 interconnection projects, is expected to expand from a bilateral to a subregional basis and, ultimately, achieve a totally integrated system. Smaller regional integration potential also exists between the countries of the Greater Mekong Subregion (GMS) and BIMP (Brunei, Indonesia, Malaysia, and the Philippines).

Despite the promising objectives of the ASEAN APG plan and the potential of the GMS and BIMP grids, their implementation to date has largely been problematic owing to, besides economic feasibility and political factors, market structure, harmonisation of technical standards, operational procedures, and regulatory frameworks. A coordination body called the Heads of ASEAN Power Utilities/Authorities (HAPUA) has been formed under the ASEAN mechanism. However, as with the experience of other regions, such as the Nordic and European countries, the formation of an interconnected and integrated electricity market requires further authorisation to this organisation to formulate legitimate plans, regulations, and requirements for relevant parties' actions in coordinated manner among countries in the region.

Much research has been done on the economic and technical viability of electricity integration in ASEAN (Kimura and Phoumin, 2014; Kutani and Li, 2014; Wu et al., 2012), as well as on the financial viability of power infrastructure investment (see Li and Chang, 2014). For example, Li and Chang (2014) point to three main barriers to grid interconnection in the ASEAN+2 (China and India) region:

- First, investment in transmission lines is very capital-intensive, usually costing from millions to billions of (US) dollars, and requires both public and private sector investment;

- Second, cross-border electricity trade is complicated by political, social, and environmental considerations, enough for such projects to be considered high risk; and
- Third, the profitability of each transmission line is dependent on the evolution of the pattern of cross-border electricity trade in the region, which in turn is dynamic and difficult to predict.

In many respects, the first challenge (cost) can be overcome if greater understanding and certainty is achieved in relation to the second (non-economic factors) and third (regional trade patterns) challenges. The emphasis of this project is therefore on understanding the non-economic factors and the regional trade patterns within the region.

To that end, and building on the work that has already been done in relation to integrated electricity systems in ASEAN, this project examines what the potential benefits from increased energy market integration are in the ASEAN region, why progress has been slow so far, and how the obstacles to greater regional energy and electricity integration in the Asia-Pacific can be overcome. It is, therefore, of direct and critical importance to all countries in ASEAN and East Asia.

The market design for power trading in the region should be carefully studied, following existing regional trading models such as the Nordic system, the continental regional systems in Europe, and the PJM (Pennsylvania-New Jersey-Maryland) system in the US. An appropriate market design is the key to mobilising the massive investment needed, especially from the private sector, to conduct power grid interconnection projects as well as other power infrastructure, and then profiting from their operation.

Market design is a broad concept that includes (1) allocation of costs, revenue, and rights to use cross-border transmission lines; (2) the mechanism to determine transmission (both cross-border and domestic) tariff, the resolution in case of congestion in the interconnected grid system, and the prices of grid balancing and ancillary services if market-based approaches are used for issue (1); (3) the algorithms for the prices of electricity in cross-border trade that clears the market and, correspondingly, the rules for dispatching; (4) special treatment or regulations on the electricity generated from intermittent renewable energy sources (e.g. obligations to balance the grid); (5) coordination and harmonisation among participating countries in the trading licenses, import tariff, tax structure, and system gate closure time.

The market design should be able to give correct price signals to incentivise investment in both power generation capacities and cross-border transmission infrastructure. It should also give enough incentive with clear rules to balance the interconnected grid and therefore maintain its stability and reliability. In this way, power grid interconnection in the region will not only deliver cheaper and cleaner power supply but also enhance energy security in the power sector of the region.

### *Objectives of the Research*

This ambitious, timely project has three overarching objectives:

- To assess the economic, technical, institutional, and geopolitical feasibility and desirability of electricity market integration among ASEAN countries;
- To identify existing economic, technical, institutional, and geopolitical barriers to electricity market integration;
- To identify governance and institutional arrangements that can support integrated energy and electricity markets in the Asia-Pacific that contribute to energy security, prosperity, sustainability, and stability in the region in the 21st century; and
- To present a feasible market design and business model for the pan-ASEAN electricity pool by identifying principles, frameworks, practicalities, and conditions.

These objectives feed into the key policy recommendations listed in Section 4.

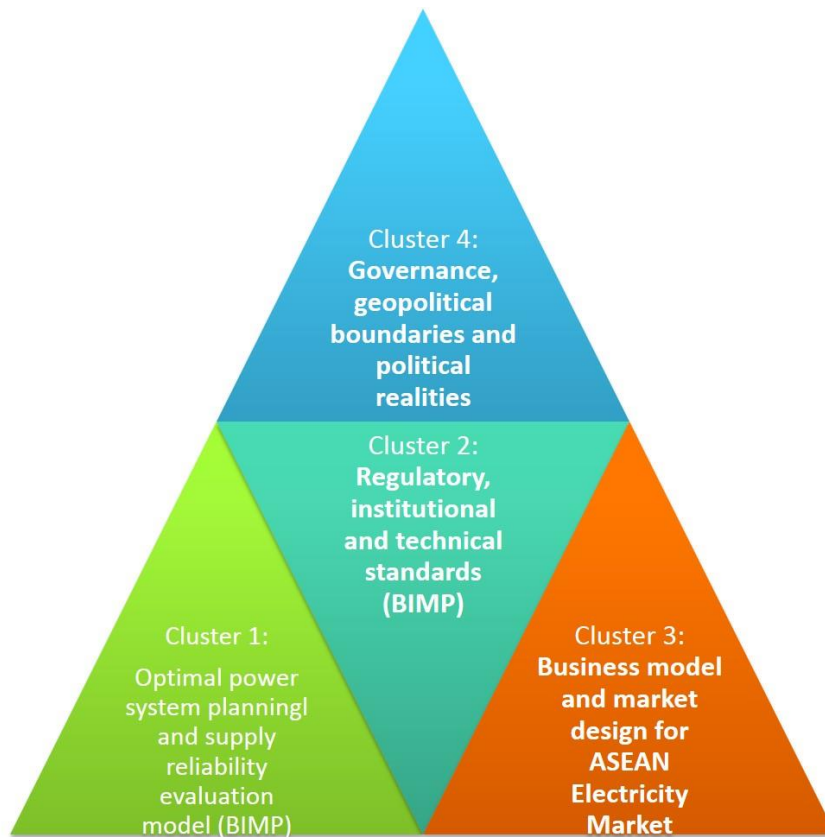
## **2. Study Method**

The research is divided into four interdependent research clusters, with each cluster conducted by one partner research institute and drawing either on quantitative or qualitative research methods. Figure 1 sets out the structure of the project as well as the topic of each research cluster.

Cluster 1 and 2 apply case studies on the BIMP countries using different methods. Cluster 1, led by the Institute of Energy Economics, Japan, conducts dynamic linear programming model to simulate the development of power infrastructure, interconnection, and exchange of power in this sub-region of ASEAN. It emphasises the economic rationale and feasibility of electricity market integration in the region. Cluster 2, led by the Brunei National Energy Research Institute, focuses on the regulatory, institutional, and technical barriers that stand in BIMP. It also develops a roadmap toward the solutions of these issues. This study thus gives some insight regarding regional specific barriers or issues for other regions based on an established understanding of the common issues in principle from previous studies.

Cluster 3 is conducted jointly by the Economic Research Institute for ASEAN and East Asia (ERIA) and the Energy Research Institute at Nanyang Technological University. The study mainly refers to the Nordic and European cases of electricity market integration and analyses both their business models and overall market design for grid interconnection and cross-border trading of electricity. In doing so, the study eventually tries to deliver implications on the possible business model and market design for ASEAN.

**Figure 1. Structure of the Research Project**



Source: ERIA Working Group.

The Cluster 4 study, carried out by one researcher from the University of Western Australia, discusses political and institutional barriers to the formation of an integrated ASEAN electricity market and derives several practical strategies in addressing such barriers as the policy implications.

### **3. Key Research Findings**

This is an ambitious project that is intentionally multidisciplinary, with researchers coming from backgrounds of economics, engineering, and political science. Each of the four clusters provides specific policy recommendations to enable and support deeper regional electricity market integration. In general, the following achievements have been made through this project:

- Identifying and articulating the benefits and limitations of integrated electricity markets in the region and thus allowing for the emergence of new technologies especially in the BIMP countries (Clusters 1 and 2).

- Quantifying the opportunities and benefits of greater penetration of renewable energy with and without grid interconnection (Clusters 1 and 2).
- Identifying an 'order of priority' for transmission line interconnections based on the economic and non-economic factors examined (Clusters 1 and 2).
- Articulating the history of electricity market integration process in other regions and drawing lessons for ASEAN countries (Clusters 3 and 4).
- Providing insights into a working business model and market design for electricity market integration, comprehensively reviewing key components such as market coupling arrangements and algorithms, congestion management and capacity auction methods, coordination mechanism and relevant network code among TSOs for grid balancing, and auxiliary services and compensation (Cluster 3).
- Recommending flexible organisational, institutional, and regulatory arrangements/road map to implement and manage the operation of interconnected grids in the region (Clusters 2 and 4).

With these findings, this project constitutes one of ERIA's efforts in its third stage of research in electricity market integration: addressing the institutional, regulatory, and technical barriers or challenges in ASEAN and proposing feasible high-level business model and market design for all stakeholders of the market integration. This stage of research remains largely uncharted waters. Thus, although these findings are unique contributions to the literature on this subject, continuous research efforts are required to achieve systematic solution to the future integration of electricity market in ASEAN.

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