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An overview of its progress and achievements**
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ASEAN power grid 20 years after: An overview of its progress and achievements

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Abstract. ASEAN Power Grid (APG) is one of the six programme areas initially identified in the first ASEAN Plan of Action for Energy Cooperation (APAEC) series, APAEC 1999-2004. It is an initiative to ensure security and sustainability of energy in the region, particularly the electricity. In each series, the APG objectives, strategies and actions are revised and updated to reflect its current state and progress. It has been twenty years since the first APAEC series and a lot of APG strategies and actions have been implemented to achieve the stated objectives. It is therefore timely to review the current state of its implementation to gain insight on its progress. In this paper, the action plans are presented and their current states of implementation are reviewed with the aim to determine their progress and achievements to date. Most of the information needed for this study was obtained from the official APAEC reports, related documents and news cuttings. To the best of our knowledge, this is the first ever work that comprehensively review the progress and achievement of the APG to date. Existing reports are usually written per timeframe rather than per programme area, making it difficult to delve deeper into a specific programme area. Among others, findings from the review show that most of the implemented actions were focusing on the physical interconnections of the power grid and a lot still need to be done with regards to the trading. However, encouraging progress with regards to trading is also seen lately. Findings from this study would provide useful insight on the current state of the APG implementation, particularly when the relevant committees are currently drafting the second phase of the APAEC 2016-2025 that will cover the period from 2021 to 2025.

1. Introduction

ASEAN stands for the Association of Southeast Asian Nations, which was established on 8 August 1967 in Bangkok, Thailand, marked by the signing of the ASEAN Declaration (Bangkok Declaration) by the founding fathers of ASEAN, namely Indonesia, Malaysia, Philippines, Singapore and Thailand. Brunei Darussalam joined ASEAN on 7 January 1984, followed by Viet Nam (28 July 1995), Lao PDR (Laos) and Myanmar (23 July 1997), and Cambodia (30 April 1999), making up the ten ASEAN member states (AMS) today. ASEAN Vision 2020 is a pledge “to chart a vision for ASEAN as a concert of Southeast Asian nations, outward looking, living in peace, stability and prosperity, bonded together in partnership in dynamic development and in a community of caring societies”. It was signed by the AMS on 15 December 1997 during the Second ASEAN Informal Summit in Kuala Lumpur, some 30 years after the establishment of ASEAN. It was partly motivated by the Asian financial crisis that hit the region in the



same year, which saw the plunge in the value of currencies, markets, assets and businesses. The crisis has strengthened the tie between the AMS, who are determined to face the challenge together with the belief that the key to economic resilience is the regional economic integration. Being a long term vision, action plans are needed to realise the ASEAN Vision 2020, resulting in the adoption of the Hanoi Plan of Action (HPA) a year later on 15 December 1998, covering the period from 1999 to 2004. The progress of its implementation would be reviewed every three years in conjunction with the ASEAN Summit Meetings. There is a total of ten sections in the HPA. Under the second (2) section on 'Enhance Greater Economic Integration', 11 areas are listed (2.1-2.11). The tenth area (2.10) on 'Develop Regional Infrastructure' includes four types of infrastructure and one of them is Energy (2.10.3). Two objectives of this energy component are listed below.

- To "ensure security and sustainability of the energy supply, efficient utilisation of natural energy resource in the region and the rational management of energy demand, with due consideration of the environment"
- To "institute the policy framework and implementation modalities by 2004 for the early realisation of the trans-ASEAN energy networks covering the ASEAN Power Grid (APG) and the Trans-ASEAN Gas Pipeline (TAGP) projects as a more focused continuation of the Medium-Term Programme of Action (1995-1999)"

This Energy component of the HPA is addressed by the action plans under the ASEAN Plan of Action for Energy Cooperation (APAEC) series that serve as the blueprint for the ASEAN cooperation in the field of energy. Each series covers a period of about six years. The first APAEC series covered the period from 1999 to 2004 (APAEC 1999-2004) [1], which was subsequently followed by the APAEC 2004-2009 [2], APAEC 2010-2015 [3] and APAEC 2016-2025 (Phase I) [4].

A total of seven programme areas are included in the APAEC namely the APG, TAGP, coal and clean coal technology, energy efficiency and conservation, renewable energy, regional energy policy and planning, and civilian nuclear energy [5]. APG is one of the areas highlighted as the top priorities for ASEAN [6]. It aims at enhancing the regional energy sustainability, security and reliability, such that a more efficient, economic and secure operation of the power system can be attained [7]. The benefits of having a regionally interconnected power systems include energy security and optimised infrastructure investment. The implementation of the APG initiative comprises two parts; the infrastructure and the trading [8]. While the infrastructure front is concerned with the physical interconnection of the grid, the trading front is looking at the means to trade the electricity that flows in the grid. The construction would begin with a regional power interconnection in the region on cross-border bilateral terms, which gradually expand to sub-regional basis towards a totally integrated Southeast Asia power grid system. After more than 20 years since the start of the APG initiative, it is timely to identify the extent to which it has progressed to date. Although news and reports are seen made on the progress, they exist piecemeal in various media. Furthermore, official reports are usually written per series timeframe rather than per programme area, making it difficult to focus on any one particular programme area. Therefore, in this paper, a chronological review of the APG progress is presented with the aim to provide a focused overview on the APG implementation progress. First, the list of action plans is presented, and then their progress is discussed. Findings show that while a number of moves is seen on the infrastructure, the trading front is lagging behind. The current trading approach is mostly through bilateral power purchase agreements between the countries involved and the ASEAN power systems remain largely unintegrated. However, more active developments are seen recently for both fronts, which give rejuvenated hope for its realisation. The rest of the paper is organised as follows. Section 2 presents about the APG background, focusing on its chronological planning. Section 3 discusses the APG progress to date and future outlook, and section 4 concludes the paper.

2. APG Action Plan

In each APAEC series, the objective of the APG programme area is revised as shown in Table 1 to reflect the current progress and determine the move forward. The progressive nature of the objectives can be seen from the use of the words, from establish to facilitate to expedite and to accelerate.

Table 1. APG strategic objective in each APAEC series to date.

APAEC series	APG objective
APAEC 1999-2004	To <i>establish</i> the policy framework and implementation modalities of the electricity networks comprising the APG
APAEC 2004-2009	To <i>facilitate</i> the implementation of the ASEAN Interconnection Master Plan and to further the establishment of policy framework of the electricity network comprising the APG
APAEC 2010-2015	To facilitate and <i>expedite</i> the implementation of the ASEAN Interconnection Master Plan and to further harmonise technical standards and operating procedures as well as regulatory and policy frameworks among the ASEAN Member States
APAEC 2016-2025 Phase I: 2016-2020	<u>Outcome-based Strategy 1:</u> To <i>accelerate</i> the development and completion of the following APG Projects identified under ASEAN Interconnection Masterplan Study II (AIMS II) by 2020. <u>Outcome-based Strategy 2:</u> To initiate multilateral electricity trading.

2.1. APAEC 1999-2004

APAEC 1999-2004 was adopted during the 17th ASEAN Ministers on Energy Meeting (AMEM) in Bangkok on 3 July 1999. It serves as the blueprint for the ASEAN cooperation in the field of energy for the period from 1999 to 2004. Three strategies for the APG programme area in this APAEC series are as below.

1. The Heads of ASEAN Power Utilities/Authorities (HAPUA) shall continue to identify, monitor and pursue bilateral and cross-border interconnections that will later develop and form part of the regional grid
2. Establish coordinated planning approach to electricity interconnections
3. Enhance interconnecting arrangements within the ASEAN sub-regional growth areas

The first strategy concerns with the development of the interconnections where 14 interconnection projects have been identified as below.

P1	Peninsular Malaysia–Singapore	P8	Sarawak–Sabah–Brunei
P2	Thailand–Peninsular Malaysia	P9	Thailand–Lao PDR
P3	Sarawak– Peninsular Malaysia	P10	Lao PDR–Viet Nam
P4	Sumatra– Peninsular Malaysia	P11	Thailand–Myanmar
P5	Batam–Bintan–Spore–Johor	P12	Viet Nam–Cambodia
P6	Sarawak–West Kalimantan	P13	Lao PDR–Cambodia
P7	Philippines–Sabah	P14	Thailand–Cambodia

Under the second strategy, the integrated policy planning approach developed for the Greater Mekong System (GMS) is expanded to include the whole ASEAN region and a comprehensive masterplan study on the APG to address the inter-related issues of interconnection including regulatory and institutional issues, financing, commercial and technical issues is conducted. For the third strategy, bilateral and multilateral electricity interconnection projects within the ASEAN sub-regional growth areas such as Singapore-Johor-Riau (SIJORI), Indonesia-Malaysia-Thailand (IMT) and East ASEAN Growth Area (EAGA) are pursued. The first APAEC series concluded on 30 June 2004.

2.2. APAEC 2004-2009

The second APAEC series (APAEC 2004-2009) was adopted by the 22nd AMEM on 9 June 2004 in Manila. The second series of APAEC covering the years from 2004 to 2009 had seen the addition of

the seventh programme area namely the civilian nuclear energy. With regard to the APG, four strategies have been defined as below.

1. Develop the APG by interconnection
2. Optimisation of the generation sector vis-à-vis indigenous resources
3. Invite private sector participation to develop the generation identified in the ASEAN Interconnection Masterplan Study (AIMS)
4. Address barriers to interconnection

With regards to the APG development by interconnection, two out of the 14 projects identified during the first APAEC series are completed, P1 and P2. For the remaining 12 projects, the expected commercial operations date (COD) would be in stages with P12 by 2005-2007, P14 by 2007, P4, P6 and P9 by 2009, and the rest to be completed beyond 2009. To address the second strategy of optimising the generation sector with respect to the natural resources, results from the AIMS conducted during the first APAEC series are leveraged. Feasibility study on the identified interconnections is also performed in an effort to involve the private sector to participate in the (power) generation development identified by the AIMS. Finally, studies on policy, regulatory, legal, financial and commercial framework are conducted to address barriers in realising the interconnections. The APAEC 2004-2009 completed on 30 June 30 2009.

2.3. APAEC 2010-2015

Moving on, the third series, APAEC 2010-2015 was adopted during the 27th AMEM on 29 July 2009 in Mandalay, Myanmar. It comprises three strategies as listed below.

1. Accelerate the development of 11 identified interconnection projects
2. Optimise the generation sector vis-à-vis the available indigenous energy resources in the region
3. Encourage and optimise the utilisation of ASEAN resources, such as, funding, expertise and products to develop the generation, transmission, and distribution sectors

The 11 projects to be accelerated are P9, P10, P13, P3, P4, P5, P6, P7, P8, P11 and P15¹, which at the moment are at various stages of development. Actions defined for the acceleration of these projects are to work on the full functioning and operationalisation of the APG Consultative Committee (APGCC) to realise the identified interconnection projects and to conduct studies to address barriers to the interconnection, cross-border trade and investment. The studies are conducted by the eight² HAPUA working groups on the following areas.

- Harmonisation of technical standard codes or guidelines for the APG in the areas of planning, design, system operation and maintenance
- Harmonisation of legal and regulatory framework for bilateral and cross border power interconnection and trade, and formulation of institutional and contractual arrangements for cross border trade to include taxation, tariff and third party access (wheeling charge)
- Identification and recommendation on the modes of financing to realise the APG

Another action to accelerate the development of the APG interconnection projects is to review and update the previous AIMS results by incorporating new elements of AMS's long-term power demand forecast, optimisation of regional long-term power development plan (with interconnection scheme), identification of feasible interconnection projects, and to implement the recommendations from the updated AIMS.

The previous strategy from the second APAEC series to optimise the generation sector vis-à-vis the available indigenous energy resources in the region is retained where two actions are defined under this strategy. The first is to conduct further optimisation studies to determine the most economic operation and possible reserve sharing scheme in the region and the second is to promote the optimal development

¹ Interconnection between East Sabah and East Kalimantan added as a result of AIMS II together with P16 (Singapore-Sumatra).

² Generation, interconnection, distribution, renewable energy, electricity supply industry, resource development, power reliability and quality, and human resources [13]

of generation resources within the ASEAN region in line with the ASEAN Fuel Policy for power generation to be formulated by the Regional Energy Policy and Planning Sub-Sector Network (REPP-SSN). Under the last strategy to encourage and optimise the utilisation of ASEAN resources, the following three actions are identified; to conduct study and identify areas where ASEAN resources can be fully utilised to benefit the ASEAN region, to implement the AIMS recommendations and pursue the appropriate options for AMS and to encourage the private sector to jointly develop power projects within the ASEAN region, notwithstanding the importance of the interconnection projects. The APAEC 2010-2015 completed on 7 October 2015.

2.4. APAEC 2016-2025

The fourth APAEC series that covers the period of ten years from 2016 to 2025 is divided into two phases of five years each. Phase I runs from 2016 to 2020 for the implementation of short to medium-term measures to enhance the energy security cooperation and to take further steps towards connectivity and integration. The strategies are as below.

1.1 APG **Priority Projects**: P13 (2017), P8 (2018) and P4 (2020)

1.2 APG On-going Projects: P2 (TBC), P9 (2019) and P10 (2016)

2.1 Laos-Thailand-Malaysia-Singapore (LTMS) power integration project (PIP)

2.2 Establish electricity trading in **at least one sub-region by 2018** namely the Northern Subsystem (Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam), Southern Sub System (Indonesia, Malaysia, and Singapore) and eastern Sub System (Brunei Darussalam, Indonesia, Malaysia and Philippines)

With regards to the first two strategies, the actions defined in the previous APAEC series such as conducting a study and identify areas where indigenous resources can be fully utilised to benefit the region and a study on the ASEAN primary energy resources for power generation are carried forward from the previous series. The same goes to the last two strategies where study to address barriers to the interconnections, cross border trade and investments is also a carried forward action, conducted by now five³ HAPUA working groups after restructuring. An issue that remains is the creation of a harmonised legal and regulatory framework for the bilateral cross border interconnection and trade, and the formulation of agreements, both institutional and contractual, for the trade that include taxation, tariff and access to the third parties. New actions in this APAEC series are the development of public private partnership including the incentive scheme, and the review on the recommendation to support the establishment of two new APG institutions by 2018; the APG Transmission System Operator (ATSO) and the APG Generation and Transmission System Planning (AGTP). Finally, inputs on the framework and schemes to facilitate multilateral electricity trade in the region will be provided during this series of APAEC, which currently is still on going.

3. Progress and Outlook

Being the first series, APAEC 1999-2004 is mainly about identification and planning. Identification of the interconnection projects to be undertaken and planning towards realising them. It is expected that at this early stage, a lot of studies such as feasibility studies need to be conducted. In 2000, the AIMS working group was created to study the viability of electricity interconnection projects, associated commercial and regulatory issues and future energy trading in the ASEAN region. Roadmaps for the concerted implementation of the APG (and TAGP) projects were approved during the 20th AMEM in Bali in 2002. The AIMS was completed in March 2003 and its final report (AIMS I) was adopted during the 19th HAPUA meeting and 21st SOME/AMEM in Langkawi, Malaysia. Amongst the achievement of the first APAEC series is the creation of the Trans-Borneo Power Grid Interconnection Coordination Committee to coordinate and oversee the implementation of the power grid interconnection study in the Borneo Island. Work on the formulation of the Memorandum of Understanding (MoU) on the APG to

³ Generation and renewable energy (HWG1), APG transmission (HWG2), distribution and power reliability and quality (HWG3), policy studies and commercial development (HWG4) and human resources (HWG5) [14]

provide a framework for a common ASEAN policy on power interconnection and trade by the HAPUA council started in 2005, during the second APAEC series. The MoU was finally signed on 23 August 2007 in Singapore. The year 2009 witnessed the establishment of the APGCC in August to oversee the overall development and implementation of the APG.

In 2010, revised and updated report of the AIMS (AIMS II) was completed, which incorporates key updates from the AMS, including the long-term power demand forecasts and the identification of feasible interconnection projects. As a result, 11 interconnection projects were deemed feasible and would be accelerated as explained earlier. More work is also seen with regards to trading. Power exchange agreement term sheet was signed in July 2011 between Sarawak Energy Berhad (SEB) and PT PLN (PLN) for SEB to sell up to 230MW of electricity to PLN using a new 275kV transmission line that will connect Mambong in Sarawak, Malaysia to Bengkayang in West Kalimantan, Indonesia by the middle of 2014 (P6). With regards to the harmonisation, HAPUA has successfully worked with the Asian Development Bank (ADB) on the “Harmonisation of Technical Codes and Guidelines in the Area Planning and Design, System Operation and Maintenance for the ASEAN Power Grid” project, which was completed in 2013. In 2014, the 32nd AMEM held on 23 September 2014 in Vientiane, Lao PDR, has endorsed the theme of the new APAEC 2016-2025, “Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All”.

In the current Phase I implementation of the fourth APAEC series, more actions on the trading front are seen materialised. In September 2016, Malaysia, Thailand and Laos have inked an MoU to facilitate the implementation of a multilateral cross-border power trade of up to 100 MW through Thailand during the 34th AMEM in Nay Pyi Taw, Myanmar. Subsequently, a tripartite Energy Purchase and Wheeling Agreement was signed between EDL (Laos), EGAT (Thailand) and TNB (Malaysia) during the 35th AMEM in Manila in 2017 to trade electricity for a two-year period beginning 1st January 2018. In a more recent development, the three countries has agreed on 4th September 2019 during the 37th AMEM in Bangkok to increase the maximum committed energy capacity trading of the Laos, Thailand and Malaysia Power Integration Project (LTM-PIP) to 300 MW. On 25 September 2019, an MoU between PLN and TNB to export 600MW of electricity from Sumatra to Malaysia (P4) was signed [9]. REPPSSN has also commenced the drafting of Phase II APAEC 2016-2025 as the continuation of Phase I. In the recent AMEM in Bangkok too, the ministers acknowledged the good progress on the development of the APAEC 2016-2025 Phase II draft and looked forward to its completion. The follow up actions on the recommendations with the proposed timelines should be reported in the next AMEM in 2020. On a related development, work on the establishment of the ATSO and AGTP is currently ongoing [10].

It has been a long journey since 1997 for the ASEAN countries to realise the APG. Although the objectives and the expected benefits of having such an integrated and interconnected power grid are very clear right from the beginning, its implementation is proven to be very challenging with a lot of hurdles that come along the way. As a result, the APG progress is lagging behind, both infrastructure-wise and the trading-wise. The target CODs of a number of the grid interconnection projects are overshoot more than once. In a number of AMEMs, the progress on the APG did not make it to the agenda. Amongst the reasons for the slow progress, compared to the progress of the regional electricity grid in other regions such as the Nordic, which started the initiative at about the same time, are the differences in terms of the economic growth of the AMS and hence the energy demand and electrification rate, and the absence of regulatory framework that binds them together legally with respect to this initiative [11]. However, low electrification rate can also be seen as an advantage, and just the reason to realise the APG. Take as an example, Laos that can export its extra capacity to Malaysia. However, in the recent years, it can be seen that the momentum towards the realisation of the APG is becoming more intense. The trading front has seen the first multilateral electricity trading agreement signed between Laos, Thailand and Malaysia. Another agreement between Malaysia and Sumatra, Indonesia was also finally signed in 2019. All of these are giving optimistic signs that ASEAN as a whole would be able to overcome the approaching challenges, come what may, and backed by the strong commitment from each ASEAN member state.

Moving ahead, the Southeast Asia region is predicted to experience the fastest growth in electricity demand. Averaging at 6% a year, it is about 12% of the projected rise in global energy use to 2040 [12]. ASEAN is well on its way to achieving universal electrification by 2030. With at least 45 million populations in the region are still deprived of electricity to date, coupled with the projected demand growth of 60% by 2040 due to the industrialisation and urbanisation, the power systems in the region are facing significant physical as well as financial strains. Rising electricity demands subsequently increases the fuel demand, in particular oil, which is currently far outpacing the regional production. In other words, the ASEAN region as a whole is now on the verge of becoming a net importer of fossil fuels. This widening gap between indigenous production and the region's projected oil and gas needs, *ceteris paribus*, will result in an enormous amount of energy trade deficit. The consequence would be the growing strains on government budgets, a situation that even an integrated and fully connected regional electricity grid *per se* might not be able to overcome. The potential solutions therefore lie in the following keywords; more renewables and improved efficiency. Renewables are currently showing a very positive development with the capacity additions of solar photovoltaic (PV) unprecedentedly exceeded the approvals of new coal-fired capacity in the first half of 2019. With indigenous energy resources production that is predicted to be below energy demand, the other means to alleviate the strains is to improve its efficiency across the value chain; the production, transmission, distribution and use by the consumers. Apart from being a pillar of sustainable energy use, the efficiency can help ease import growth, hence, the potential energy trade deficit. Therefore, agenda on increasing the share of renewables and improving the efficiency are expected to be part of the future design of the APG action plans in the subsequent APAEC series, particularly the second phase (Phase II) of APAEC 2016-2025, on top of the more concrete actions on the physical interconnections and trading.

4. Conclusion

In this paper a review on the progressive planning and implementation of the ASEAN Power Grid (APG) is presented. After more than 20 years since the initiative was first mooted, a lot of actions have taken place leading to a number of significant progress. Overall, it can be seen that interconnecting the ASEAN power grid is no easy task, taking into consideration the differences in many aspects of the AMS. With the physical interconnection projects that are mostly completed later than the target CODs, the trading initiatives are moving at an even slower pace. Nevertheless, the unrelenting commitment shown by governments of the AMS is giving the hope and optimism that APG will one day fare well with the other regional power grids such as the Nordic countries', yet moulded by its own characteristics and needs.

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