



Policy Brief

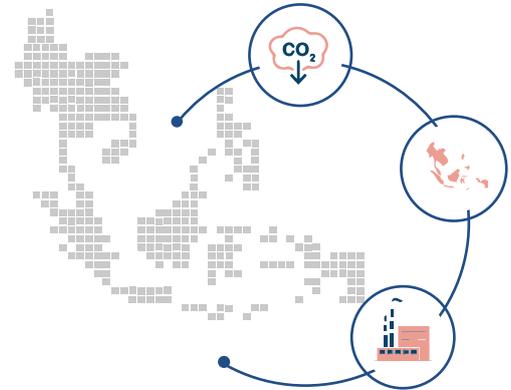
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ASEAN Centre for Energy
One Community for Sustainable Energy

Setting Emission Standards for Coal-Fired Power Plants in ASEAN

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Key messages

In the projections up to 2040, coal is projected to remain an important source of energy to power ASEAN's economic and industrial development. Improving the overall efficiency of ASEAN's coal-fired power plants by moving from sub-critical (SubC) to supercritical (SC) and ultra-supercritical (USC) technologies can contribute positively to ASEAN's decarbonisation effort.

- In the 6th ASEAN Energy Outlook (AEO6) [1], coal fired power plants (CFPPs) in the ASEAN Member States (AMS) are expected to generate 3,123 terra-watt hours of electricity contributing to 25.7% of total electricity production in the Baseline Scenario by 2040.
- In recognition of the environmental benefits, the AMS are moving towards more efficient CFPP technologies noting the access of available coal types (ranks).
- USC technology has already been adopted in several of the AMS. Selected existing USC technologies can be used to set reference standards for the emission factors of the CFPPs in ASEAN.
- Under the APAEC (ASEAN Plan of Action for Energy Cooperation) Targets Scenario (APS), APS+ and Best-Available-Technology (BAT) scenarios, with each representing a proposed emission standard for ASEAN's CFPPs, the CFPPs can contribute 1.14%, 16.56% and 31.98%, respectively, to the overall decarbonisation targets set for the AMS Targets Scenario (ATS) scenario and 0.70%, 10.15% and 19.60%, respectively, to the overall decarbonisation targets set for the APS scenario.

ASEAN's CFPPs

Fossil energy, especially coal, is the principal source of ASEAN's current and future energy supply that powers its economic development. The region's coal demand is expected to increase from 91 MTOE in 2013 to 271 MTOE by 2040, accounting for 25.5% of the total energy consumption [2]. In all the scenarios profiled in the AEO6, the CFPPs represent an important power generation option to sustain ASEAN's economic growth. While energy efficiency improvements, renewable energy penetration and other measures are seen to reduce the overall dependence on coal on a scenario-by-scenario comparison, the need for electricity from the CFPPs is found to be steadily rising in all of the scenarios. The total installed capacity of the SubC, SC and USC CFPPs is expected to increase from 258.77 GW, 206.57 GW and 120.17 GW by 2040 in the Baseline Scenario, ATS and APS,

scenario-by-scenario comparison, the need for electricity from the CFPPs is found to be steadily rising in all of the scenarios. The total installed capacity of the SubC, SC and USC CFPPs is expected to increase from 258.77 GW, 206.57 GW and 120.17 GW by 2040 in the Baseline Scenario, ATS and APS, respectively. In all of the scenarios, the total capacity of fluidised bed (FB) technology is expected to remain constant. A closer observation reveals that SubC is projected to remain the dominant CFPP technology in all of the scenarios. In the Baseline Scenario and ATS, the share of SubC technology is about the same at 72% and 73%, respectively, by 2040. In the APS, the share of SubC technology is expected to fall to about 59% while the SC and USC technologies are expected to increase to 15% and 26%, respectively, by 2040. As such, the overall emission factor of ASEAN's entire CFPP fleet is shown in Figure 1.

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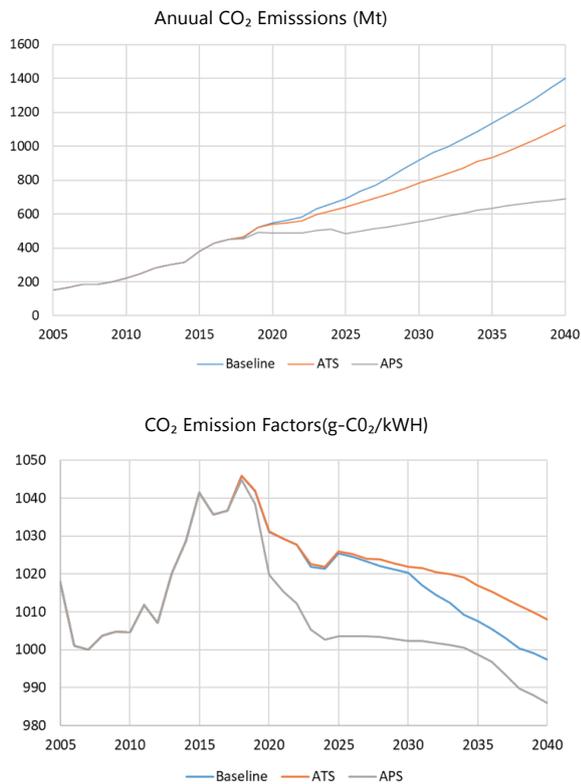


Figure 1 CFPP annual CO₂ emissions (Mt) and emission factors (g-CO₂/kWh)

While there are CO₂ emission reductions in the ATS as compared to the Baseline Scenario, these reductions are caused primarily by reduced electricity production from the CFPPs due to renewables penetration, end-use efficiency improvements and other measures. From the perspective of CFPP technologies, the overall emission factor in the ATS is worse than that in the Baseline Scenario mainly due to a higher proportion of less efficient SubC technology in the mix. The emission factor profile implies that the effective CO₂ emissions in the ATS would have been higher than in the Baseline Scenario had the total amount of electricity generated from the CFPP fleet remained the same because the emission factors in the ATS were gradually becoming higher than those in the Baseline Scenario.

The projections from the AEO6 show that ASEAN aims to move from the dominant SubC technology to the more efficient SC and USC technologies to achieve the individual AMS' national power development plans. By 2040, the total installed capacity of SC and USC CFPPs is projected to reach about 68 and 56 GW in the ATS and APS, respectively, which translates to about US\$87 and US\$72 billion investment requirements [1]. Malaysia is taking the lead in the shift towards more efficient USC technology in the outlook period from 2017 to 2040. It is also found that one of the CFPPs in Malaysia has the lowest

emission factor with USC technology fuelled by bituminous coal at 726.19 g-CO₂/kWh. In comparison, the emission factor for a CFPP can be as low as about 656 g-CO₂/kWh for a bituminous fuelled USC plant [3] and about 798 g-CO₂/kWh for an integrated gasification combined cycle (IGCC) power generation plant [4].

Proposal for reference CO₂ emission standards

During the annual meeting of the ASEAN Forum on Coal (AFOC) Council in 2019 – the specialised energy body that leads in the implementation of the Coal and Clean Coal Technology (CCT) programme under the APAEC – the AMS recognised the need to establish an emissions standard for ASEAN's CFPPs. Thus, the AFOC tasked the ASEAN Centre for Energy, through the ASEAN Climate Change and Energy Project (ACCEPT), with conducting a baseline study on regional CO₂ emissions from CFPPs. In the most ambitious scenario, the APS, fossil fuels would still make up 71% of ASEAN's total primary energy supply in 2040. About half of the coal resources in ASEAN are low-rank coal (LRC), sub-bituminous coal and lignite. Producing electricity from LCR inevitably means more CO₂ emissions per unit of electricity produced as compared to the use of higher-quality coal. While selected AMS, such as Indonesia, are working on coal upgrading demonstration projects, the AMS can work to reduce CO₂ emissions by deploying more efficient CFPP technologies.

Setting CO₂ emission standards for the CFPPs in ASEAN is arguably an effective means to benchmark the performance of the existing CFPPs and encourage efficiency improvements at both the individual plant and fleet levels. The United States stipulated an emission standard of 635 g-CO₂/kWh for newly constructed CFPPs and 816-907 g-CO₂/kWh for modified or reconstructed CFPPs [5]. Based on the currently operating CFPP technologies and reported use of coal rank in ASEAN, our analysis suggests that reference CO₂ emission standards can be drawn from a cross-comparison of the CFPP emission factors in all the AMS and the overall emission factor of all the CFPPs in the APS and ATS in 2040 at the ASEAN regional level.

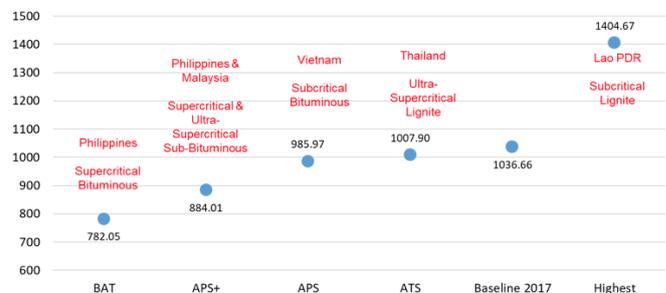


Figure 2 Reference CFPP emission factors (g-CO₂/kWh)

Decarbonisation potentials with the new emission standards

According to ACE [6], the continued deployment of CCT is expected to shape a new role for coal in facilitating in the energy transition towards low carbon energy systems in the coming years. The AFOC will promote the new role of CCT and carbon capture, utilisation and storage (CCUS) towards the energy transition and low carbon economy. The deployment of CCTs, such as SC, USC and other advanced technologies is one of the AFOC’s long-term strategies to enhance energy security, environmental sustainability and energy resilience.

In order to profile the decarbonisation potentials when the gross CO₂ emission factor of ASEAN’s entire CFPP fleet is set to reach the levels of “Best”, “Average” and “APS2040”, it is assumed that the gross CO₂ emission factor will drop linearly from the 2017 level to the 2040 targets (Figure 3). This assumption, while consistent with most of the energy systems modelling analysis studies in the literature, implies that the emission standards of the CFPPs at a fleet level will reach the SC-bituminous level in the “Best” scenario, SC/USC-sub-bituminous level in the “Average” scenario and SC-bituminous level in the “APS2040” scenario. Arguably, for individual plants, these standards are possible since they already exist in some of the AMS, such as Malaysia,

the Philippines and Vietnam. However, there would be practical challenges for all of the CFPPs in the AMS in meeting the same level of standard given the different national circumstances. Assuming that the standards are attainable somehow through regional and international partnership, ASEAN can expect significant reductions in CO₂ emissions from CFPP alone (Figure 3). When computing the effective emission reductions due to improved CFPP technologies to meet the new emission standards, the electricity generation amount is fixed at the Baseline level from 2017 to 2040. The rationale for fixing the electricity generation amount is needed to isolate the effect of technology improvement or emission standard improvements for CPFF and to eliminate the effect from renewable penetration, end-use energy efficiency improvement, and other measures that cause reduction in CFPP electricity generation.

The emission reductions are presented in two metrics, namely, accumulative emission reductions and emission reductions in 2040. The former provides a basis on the total environmental benefits attainable through moving towards more efficient CFPP technologies and higher coal-rank. The latter provides a basis for comparison with the Nationally Determined Contribution (NDC) which is usually reported against a baseline level in a specific year.

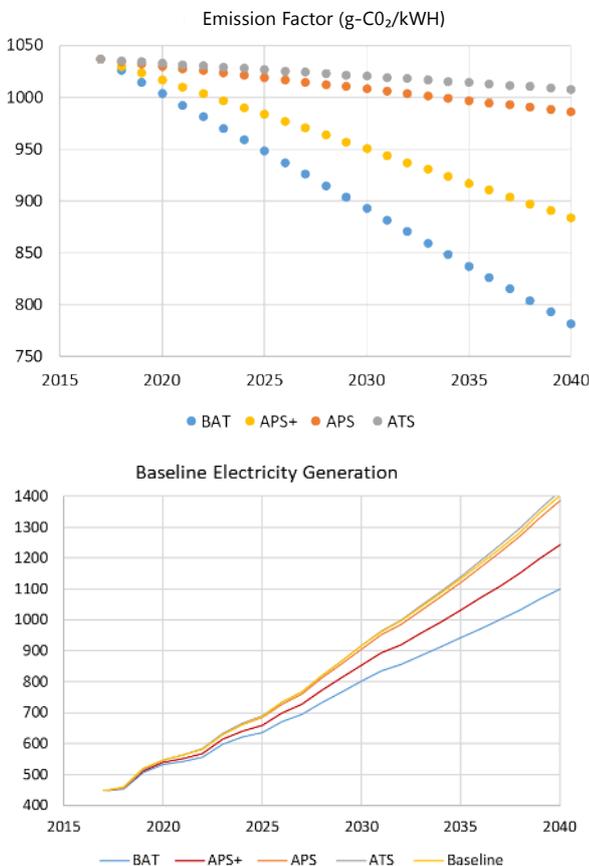


Figure 3 Emission standards and corresponding CO₂ emission trajectories

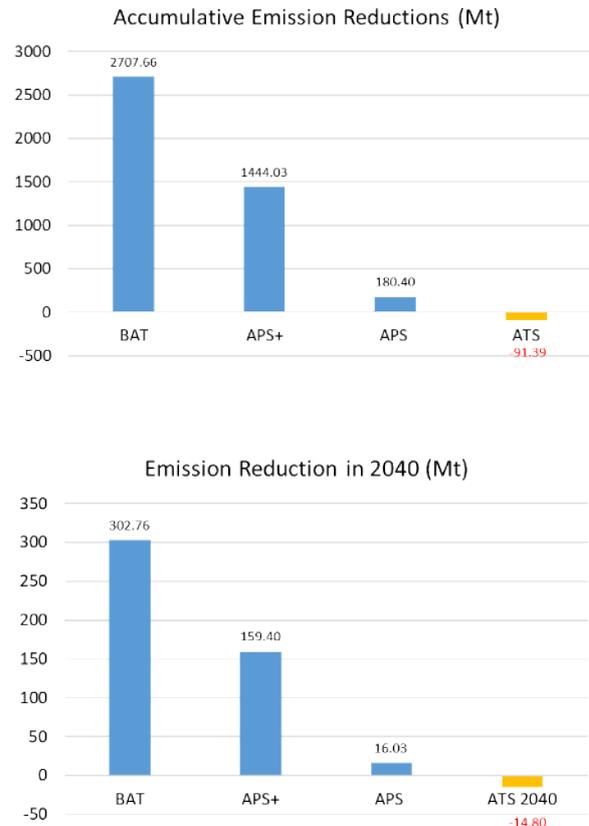


Figure 4 Decarbonisation potentials due to new CFPP emission standards

Other strategic considerations beyond decarbonisation

Improving the overall CO₂-emission factor by setting a higher emission standard for CFPPs in ASEAN would certainly contribute to the decarbonisation targets. While the environmental considerations call for rapid adoption of the best possible emission standards, the varied national circumstances means that AMS would inevitably face very different practical challenges when instituting a region-wide emission standard for CFPP. Hence based on the analysis in previous chapters, several recommendations have been built with detail as follow:

- Setting emission standards towards BAT and APS+ can make potentially significant contribution to ASEAN's decarbonization efforts and targets as identified in the AEO6.
- Proposal to consider a regional policy roadmap for harmonization of emission standard for CFPPs.
- Low carbon options such as CCUS, IGCC (acronym for integrated gasification combined cycle) and biomass co-firing could be considered to further reduce emissions from CFPPs.
- ASEAN could consider a regional carbon market to incentivize the investment in such low carbon options.

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This policy brief is developed based on "ASEAN CO₂ Emissions from Coal-Fired Power Plants: A Baseline Study" report that was endorsed at the 19th ASEAN Forum on Coal (AFOC) Council Meeting. More detail information can be found in the report, downloadable from ACE website.

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