ASEAN'S ENERGY EQUATION

THE ROLE OF LOW EMISSION COAL IN DRIVING A SUSTAINABLE ENERGY FUTURE

WORLD COAL ASSOCIATION

ASEAN CENTRE FOR ENERGY
ACE

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Contents

Note: unless otherwise indicated all data and figures are taken from analysis conducted for WCA. Unless otherwise specified, all figures are in US$.

INTRODUCTION

The delivery of affordable, reliable and sustainable electricity plays a central role in improving living standards and unlocking economic potential. Over the coming years, few places will this be more true than in the ten countries[1] that make-up the Association of Southeast Asian Nations (ASEAN).

The region has a population of more than 629 million people and continues to experience high economic growth, demographic changes and industrial development. Over the next five to ten years, greater regional integration and structural reforms realised through the establishment of the ASEAN Economic Community in 2015 will bolster growth by over 6% per annum. Indeed, at US$ 2.4trillion, the ASEAN economy in 2015 was the sixth largest in the world or the third largest in Asia[2]. By 2050, McKinsey projects the region to rank as the fourth-largest economy[3].

Over the past 25 years, according to the International Energy Agency (IEA), ASEAN energy demand has increased by over 150%[4]. As demographics continue to change and the region's economy more than triples in size, the IEA forecasts ASEAN's energy demand to increase by 80% to just over 1070 million tonnes of oil equivalent (Mtoe), comparable to three times Japan's current total energy demand. This echoed the findings from the official ASEAN publication, by the ASEAN Centre for Energy (ACE), the 4th ASEAN Energy Outlook (AEO4) which was released during the 33rd ASEAN Ministers on Energy Meeting (AMEM), October 2015 in Kuala Lumpur, Malaysia[5]. These demographic and economic trends have led the ASEAN energy sector to an inflection point. This inevitably will create dual challenges of meeting energy demand while also working to rein in greenhouse gas (GHG) emissions and other potential environmental impacts. Thus, it is critical for ASEAN to determine the most sustainable way to fuel the growth.

Voracious demand for energy presents challenges and opportunities for ASEAN as the region's governments seek to deliver an energy mix that balances social, economic and environmental imperatives.

ASEAN has proven responsive to the challenges, as recently demonstrated through the delivery of the fourth series of ASEAN energy blueprint: *ASEAN plan of Action for Energy Cooperation (APAEC) 2016-2025 Phase 1: 2016-2020*. Building on the achievements of the previous plan, the APAEC 2016-2025 is founded on the theme of 'Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All'[6]. The updated blueprint will continue to focus on seven programme areas, with 'Coal and Clean Coal Technology' (CCT) identified as one of the key strategic priorities.

The equal prominence that CCT receives alongside renewable electricity and energy efficiency is indicative of the current and forecast importance of coal for ASEAN. Over the last decade and half, coal has fuelled the region's development as reflected in its 8.4% annual average growth rate. Regional energy roadmaps indicate that coal demand will not decline in the long-term (minimum 25 years). The IEA forecasts coal to overtake gas as the primary fuel supplying electricity by 2020 and to be responsible for 50% of electricity generation by 2040 (from 32% today)[7].

There is a regional understanding that rising use of coal will necessitate a low emission technology pathway which balances the energy trilemma of security, economic development and environmental sustainability. In order to support the transition toward CCT deployment, ASEAN will require international financial, technological and other kinds of support to accelerate deployment. Such development support is fully in-line with Nationally Determined Contributions (NDCs) submitted in the lead up to the 'Paris Agreement' and the UN's Sustainable Development Goals.

ASEAN's Energy Equation – the role of low emission coal in driving a sustainable energy future provides a comprehensive analysis for the energy security and sustainable development opportunities that CCT promotes as identified in APAEC 2016-2025. The report's insights provide the framework for the 'Call to Action' as detailed in the conclusion.

[1] Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.
[2] ASEAN Secretariat. 2016. ASEAN Economic Community at a Glance.
[3] Vinayak, H.V., Tonby, O., Thompson, F. (May 2014) Understanding ASEAN: Seven things you need to know, Available at: http://www.mckinsey.com/industries/public-sector/our-insights/understanding-asean-seven-things-you-need-to-know (Accessed: 20 March 2017).
[4] International Energy Agency (2015) Southeast Asia Energy Outlook, Paris: OECD/ IEA .pg.30
[5] While the main reference for ASEAN is the 4th ASEAN Energy Outlook (AEO4), this report needs to compare with the situation in other regions. As the AEO4 only analyses the ASEAN Member States, WCA uses the data from IEA's Energy Outlook to analyse the different regions, apart from ASEAN. The 4th ASEAN Energy Outlook can be downloaded at www.aseanenergy.org/publication.
[6] ASEAN Centre for Energy (2015) ASEAN Plan of Action For Energy Cooperation (APAEC) 2016-2025, Jakarta: ASEAN Centre for Energy.
[7] International Energy Agency (2015) Southeast Energy Asia Outlook 2015: World Energy Outlook Special Report, Paris: OECD/IEA. pg.39

I: COAL WILL BE AN IMPORTANT GUARANTOR FOR SUSTAINED GROWTH IN ASEAN

The unprecedented pace and scale of economic development in ASEAN has driven a surge in demand for electricity. Between 1990 and 2014, while the region's economy grew by 5% per year on average, electricity generation grew by 7.4% reaching 843 terawatt hours (TWh) in 2014.

Natural gas has historically dominated ASEAN's electricity supply. In 2013, according to the IEA, gas was responsible for 44% of electricity generation[8], compared to 22% globally. In the recent past, coal generation has played an important, albeit supporting, role to gas – producing a third of electricity generation in 2013, compared to 41% globally.

From 2010, however, there has been an undeniable transition in regional economies toward coal-fuelled power generation. As a result, the share of gas in electricity generation declined 5% between 2010 and 2014, while the share of coal in the same period rose from 27% to 34%.

Coal's rise as the fuel of choice for ASEAN can be attributed to several factors

Diversification

ASEAN Member States (AMS) have traditionally relied on one particular fuel source for power capacity, which has often reflected the local resource endowment. In efforts to strengthen energy security many AMS are attempting to reduce their dependence on any one source of energy.

As part of these efforts, many AMS have identified an increasing role for coal as a stable, low-cost baseload power source. A recent report by the Oxford Institute for Energy Studies[9] provides compelling evidence of coal's rising prominence in ASEAN electricity generation. The study finds 25 GW of additional coal capacity was built during the period 2010 – 2015, accounting for 42% of total capacity additions over the period. With the recent addition of 7.7 GW of coal capacity entering operation, regional coal capacity was over 62 GW at the end of 2015.

ASEAN's preference for coal is forecast to continue as it remains the most economic source of long-term baseload generation. The IEA forecasts that the installed capacity of coal will increase nearly 150% from 2013 levels to 163 GW by 2035, covering over 34% of total power plant capacity in the region. Coal is expected to overtake natural gas by 2030 to become the largest source of power capacity.

In terms of generation, the IEA forecasts a three-fold increase in coal-fuelled generation from 255 TWh in 2013 to 920 TWh in 2035. As a result, the share of coal-fuelled generation in total electricity generation is expected to increase from 32% in 2013 to 48% in 2035.

Figure 1 – ASEAN: Electricity Generation Mix

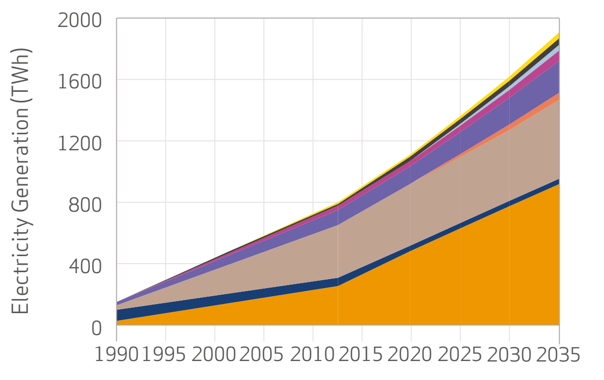
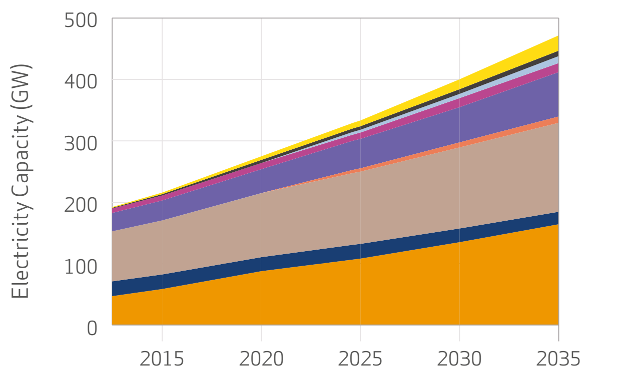


Figure 2 – ASEAN: Electricity Capacity Mix



Coal Oil Gas Nuclear Hydro Bioenergy Wind Geothermal Solar PV

Source: IEA Southeast Asia Energy Outlook 2015

[8] International Energy Agency (2016) World Energy Outlook, Paris: OECD/ IEA. pg.552
[9] Oxford Institute For Energy Studies (2016), The role of coal in Southeast Asia's power sector, Oxford

Rising demand

The link between access to affordable power, economic growth and prosperity is clear. Over the last two decades, ASEAN has experienced sustained and inclusive economic growth, lifting tens of millions from poverty and creating a 'consumer class.' Over the same period the number of people without access to electricity has declined by two-thirds[10]. It is not a coincidence that this has coincided with the rapid development of coal-fuelled electricity generation.

Demographic trends in ASEAN will have significant implications for the size and composition of the region's energy use. The regional population is forecast to rise to over three-quarters of a billion by 2040. Cities will also experience growth, with those living in urban areas projected to increase by more than 170 million. This shift will support continued growth of consumers and result in ASEAN becoming a pivotal market of the future for companies in a range of industries. Cities benefit from the critical mass and density businesses require to expand their customer, supplier and capital base. Urban areas also act as magnets for talent, particularly for workers with greater levels of skill and education. By 2040, urbanisation and its related benefits are expected to lead per capita to rise to $27,000 from $10,000 in 2013[11]. Rising incomes in the region will narrow the gap to the OECD per capita income, from one-quarter to one-half suggesting further opportunity for growth.

Like other newly industrialised economies, these factors will be an important driver in increasing energy demand. According to the IEA, per-capita energy demand will rise from 0.96 tonnes of oil equivalent (toe) to 1.4 toe in 2040. Despite growing by almost 50%, per capita demand will remain relatively low, far short of China's average and only slightly higher than India's[12]. This suggests scope for even greater levels of per-capita energy demand over the longer term.

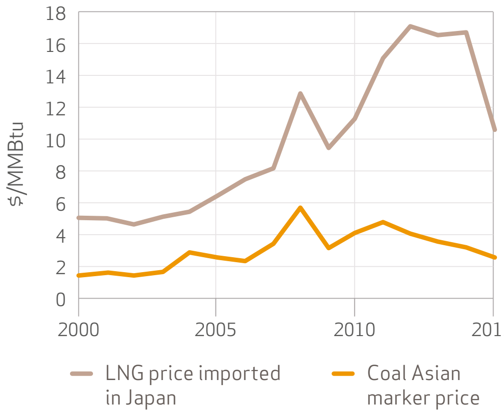
All sources of energy will be required to meet this growing demand for energy. In recent years, renewable energy has proven particularly adept at providing off-grid electricity for remote communities in the least developed economies. Urbanising and industrialising economies, however, will require the development of on-grid electricity. Coal will therefore play a major role in supporting the development of baseload electricity where it is most needed. Coal-fuelled electricity will be fed into national grids and will support social and economic development objectives across ASEAN.

The next stage of ASEAN's economic development will be dependent on the expansion of a competitive manufacturing sector. An energy sector able to meet demand will be fundamental in ASEAN efforts to market the region as a desirable place to do business. As the competitiveness of gas falls with the removal of subsidies, coal will remain central to maintaining affordable and reliable energy supply in the region.

Affordable delivery of electricity

Electricity prices are a critical driver of economic competitiveness, as well as an important factor in social objectives for residential customers. Coal-fired power plants are among the lowest sources of energy to build and operate. Natural gas was, until recently, a cost competitor to coal. However, the removal of subsidies, price volatility and international competition has led to average gas prices being twice that of coal on an energy equivalent basis.

Figure 3: Coal and Gas Prices in Asia



Source: Adapted from Oxford Institute For Energy Studies (2016), The role of coal in Southeast Asia's power sector, Oxford, p.9

The levelised cost of electricity (LCOE) provides an estimated price that generators are likely to incur producing electricity from various sources. The metric takes into account all of a system's expected lifetime costs (including construction, financing, fuel, maintenance, taxes, insurance and incentives), which are then divided by the system's lifetime expected power output (kWh). The calculation is vitally important for national power development plans to compare the costs of different technologies.

[10] *International Energy Agency (2015) Southeast Energy Asia Outlook 2015: World Energy Outlook Special Report, Paris: OECD/IEA., pg.119*
[11, 12] *Ibid pg.23*

Figure 4: ASEAN LCOE Average 2020

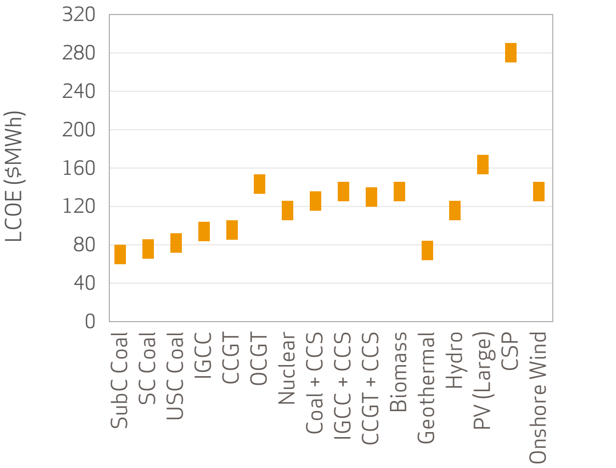
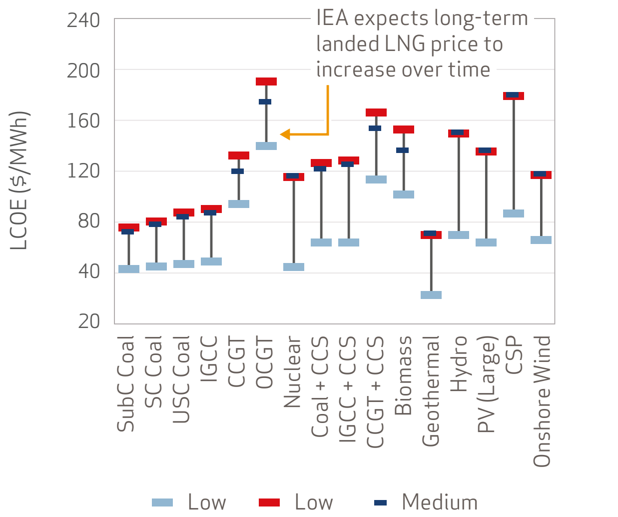


Figure 5: ASEAN LCOE Average 2035



SubC Coal: Subcritical Coal; SC Coal: Supercritical Coal, USC Coal: Ultra-supercritical coal; IGCC: Integrated Gasification Combined Cycle; CCGT: Combined Cycle Gas Turbine; OCGT: Open Cycle Gas Turbine; PV: Photovoltaic; CSP: Concentrated solar power

As demonstrated in the graph above, the various coal-fuelled power generation technologies are the lowest cost option available for mass deployment. While geothermal energy may compete with coal on a cost basis, it has limited deployment potential beyond certain jurisdictions therefore limiting its credibility as a baseload source of electricity. More advanced coal technologies have a slightly higher LCOE compared to subcritical coal, however, this is due to the initial higher capital costs. Removing this initial construction component, the operating costs are largely determined by fuel costs, so more efficient cleaner plants that burn less coal will have lower operating costs. Moreover, cleaner coal plants tend to have a lower fixed cost, due to higher levels of automation and less maintenance.

While gas-fuelled generation currently has a slightly higher LCOE than the most efficient cleaner coal technology, the IEA expects costs for gas to rise over time. As demonstrated in Figure 5, the gap between cleaner coal and gas will grow significantly through to 2035. The cost of renewables is also expected to decline over the coming decades to become more competitive with conventional power generation.[13] Low-load factors and their intermittent nature, however, will likely limit their competitiveness and they will supplement rather than power ASEAN's energy system. The LCOE of coal fitted with carbon capture and storage (CCS) technology will also rapidly decline over the coming decades as experience accumulates and knowledge is shared from existing coal + CCS facilities, such as Kemper County, Boundary Dam and Petra Nova.

> "The removal of subsidies, price volatility and international competition has led to average gas prices being twice that of coal on an energy equivalent basis."

[13] *Detail on LCOE for renewable energy in the region can be found at the ACE's publication "LCOE of Selected Renewable Technologies in the ASEAN Member States" (ASEAN-RESP, GIZ, 2016).*

II: CCT: DELIVERING CLEANER ENERGY WHILE ENSURING ECONOMIC COMPETITIVENESS

Cleaner coal technology refers to a diverse suite of technologies that can be deployed to reduce or eliminate various emissions. Broadly they fall into three categories.

1. Pollution control technology – During the burning of coal, emissions can occur that cause concerns about air quality, but technologies exist to address this challenge. These include electrostatic precipitators, fabric filters, selective catalytic reduction systems, wet and dry scrubbers, sorbents and activated carbon injection. The technology can reduce the emissions of pollutants from coal combustion by between 90% and 99.9% by stripping out the pollutants before they are emitted into the atmosphere.

2. High efficiency low emission (HELE) – HELE coal-generation utilises higher temperatures and pressures, compared to older less efficient subcritical technologies. These include supercritical (SC), ultra-supercritical (USC) and integrated gasification combined cycle (IGCC) systems. HELE units emit 25–33% less carbon than the average global existing power fleet and up to 40% less than the oldest technologies.

3. Carbon capture and storage (CCS) – The technology involves capturing the CO_2 produced by electricity generation, compressing it for transportation and then injecting it deep into a rock formation at a carefully selected and safe site, where it is permanently stored. Alternatively, the CO_2 can be used in industrial applications, such as to increase pressures in oil reservoirs in a process known as enhanced oil recovery (EOR).

With the use of coal projected to continue to grow over the coming decades, a cleaner coal technology pathway is necessary if international climate objectives are to be met.

Pollution control technology – Greater deployment required to manage rise in pollutants

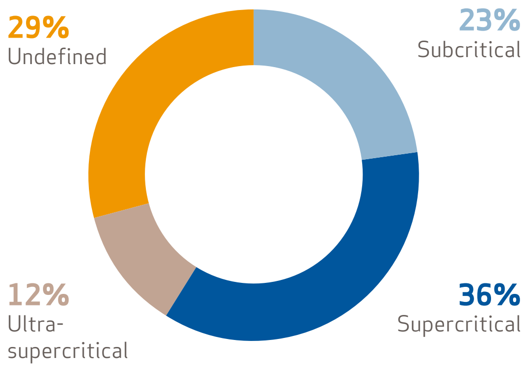
While many regional economies have taken nascent steps to address air quality, ASEAN requires more stringent health based standards and objectives for pollutants in air. According to the IEA's Energy and Air Pollution report, the current pipeline of coal construction could potentially lead to SOx, NOx and PM levels nearly doubling by 2040[14]. Beyond human health, higher soot levels could decrease regional crop yields by more than 10% each growing season, reducing the value of Asian rice production by $48.8 billion per year[15]. Given that technology exists and can be readily deployed to reduce or eliminate these pollutants it is vital that power generators are encouraged to fit such controls as standard. This could include strategies, such as regional harmonisation of pollution standards, regulation to ensure all future builds are equipped with the technology and incentives to retrofit existing facilities, such as greater support from multilateral development banks.

HELE – Improving regional coal efficiency while reducing global carbon emissions

ASEAN is making a transition away from older, less efficient subcritical stations towards HELE coal-fuelled facilities. In 2014, research indicated that subcritical technologies represented more than 90% of installed capacity and 70% of coal capacity additions for the year. Current research, however, suggests that almost half of coal stations under construction or in development are expected to make use of advanced HELE technology (see Figure 6). HELE reconciles international commitments to reduce carbon with the economic priorities of generating affordable and reliable electricity. The technology ensures that coal is part of the solution to the Paris Agreement for ASEAN.

[14] *International Energy Agency (2016) World Energy Outlook Special Report 2016: Energy and Air Pollution, Paris: OECD/IEA. pg. 209*
[15] *The Brookings Institution (2014) Retrofitting Coal-Fired Power Plants in Middle-Income Countries: What Role for the World Bank?, Washington, DC: The Brookings Institution.*

Figure 6: ASEAN Under Construction and Planned Coal-fuelled Capacity (80 GW)



Despite the clear transition, scope exists for even greater gains. While the environmental benefits from deploying HELE technologies are well understood, restrictive financing regimes may lead to developers accepting lower efficiency and poorer emission rates due to the initial higher construction and material cost differences between subcritical and HELE technologies.

Analysis indicates that 23% of coal capacity currently under construction or in development is subcritical, while a further 29% of proposed projects have not finalised the technology choice. This represents a significant opportunity to influence the type of technology that developers select.

Technology Differences – New Investments in 2016

Technology	Capital Cost (2016 $ Billion/GW)	HHV Efficiency	Emission Rate (T/MWh)
Subcritical	1.21	32%	1.04
Supercritical	1.46	37%	0.87
Ultra-supercritical	1.70	40%	0.80

Recent estimates indicate a $490 million capital cost difference between a subcritical and ultra-supercritical option for 1GW plant in ASEAN. While the ultra-supercritical option has a higher upfront expenditure, the emission rate is a quarter lower. Moreover, the increased efficiency of the plants mean fewer tonnes of coal consumption and therefore long-term lower operating costs.

Promoting HELE deployment across ASEAN would result in significant carbon reduction emissions to global benefit. Shifting the region's forecast coal capacity in 2035 from the current mix to ultra-supercritical would reduce cumulative emissions by 1.3 billion tonnes. This is an equivalent reduction of –

- The yearly emissions from China, United States and the EU (top three CO_2 contributors), or
- Three years of international shipping, or
- More than four years of international aviation [16]

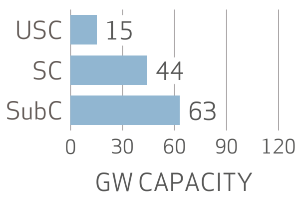
> "HELE reconciles international commitments to reduce carbon with the economic priorities of generating affordable and reliable electricity. The technology ensures that coal is part of the solution to the Paris Agreement for ASEAN."

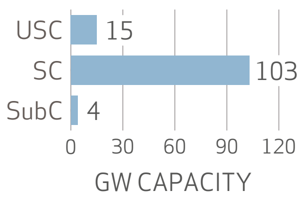
[16] *Emission Database for Global Atmospheric Research (28 November 2016) CO_2 time series 1990-2014 per region/country*

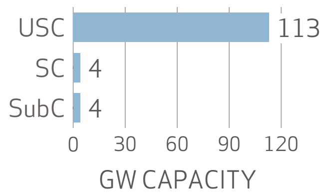
INVESTMENT IN COAL-FUELLED POWER STATIONS REQUIRED TO REDUCE EMISSIONS

	Mix per current pipeline	Shift to Supercritical	Shift to Ultra-supercritical
Scenario Description	Total installed coal capacity by 2035 based on IEA SEA-EO[1] projections with linear extrapolation between current pipeline of projects as reported by the Platts WEPD[2] (percentage of subcritical capacity through 2035 based on current pipeline)	Shift capacity from subcritical to supercritical except plant that are under construction or planned subcritical plant with capacity lower than 300 MW	Shift all capacity from supercritical in the previous scenario to ultra-supercritical

Capacity Mix[3]







	Mix per current pipeline	Shift to Supercritical	Shift to Ultra-supercritical
NPV[4] Capital Costs[5] ($ Billion) (from 2016 through 2040)	$89 Billion	$96 Billion	$108 Billion
CO_2 Emissions (tCO_2) (Cumulative from 2016 through 2040, undiscounted)	8.9 Billion	8.1 Billion	7.5 Billion

Additional $19 billion required to shift to ultra-supercritical

Additional funding can reduce carbon emissions by 1.3 billion tons

Notes:

1) International Energy Agency Southeast Asia Energy Outlook

2) Platts World Electric Power Plants Database

3) Total GW of coal capacity additions based on IEA SEA-EO projections under the New Policies Scenario to 2035

4) Net Present Value

5) Costs include only capital costs including interest during construction (IDC). Capital costs for coal plants are assumed to be flat in real terms throughout the study period.

Subcritical capacity in this analysis includes pipeline coal capacity with underfined technology plus a projected share of IEA SEA-EO total projected coal-generation capacity in proportion to the mix of subcritical, supercritical and ultra-supercritical based on coal capacity currently under construction or in development as reported by the Platts WEPD

ENVIRONMENTAL BENEFITS OF DEPLOYING CLEANER COAL TECHNOLOGY IN THE ASEAN REGION

Scenario	Capacity mix[1] (GW CAPACITY)	CO_2 emissions (tCO_2) (over 40 years)	CO_2 abated equivalent to: Subcritical plant closure[2]	Number of new wind turbines[3]	Cars removed from the road[4]
Mix per development pipeline	USC 15; SC 44; SubC 63	22.8 Billion			
Shift to Supercritical	USC 15; SC 103; SubC 4	20.8 Billion	20	15,000	96 million
Shift to Ultra-Supercritical	USC 113; SC 4; SubC 4	19.5 Billion	32	25,000	157 million

Notes:

1) Total GW of coal capacity additions based on IEA SEA-EO projections under the New Policies Scenario to 2035, assuming the mix of subcritical, supercritical and ultra-supercritical based on coal capacity currently under construction or in development as reported by the Platts WEPD

2) A subcritical plant with 500MW capacity, 75% load factor, 30 years asset life, and an emission factor of 1.04 tCO_2/MWh

3) An onshore wind turbine with 3 MW capacity, 25% load factor, asset life of 20 years

4) An average car with 12,700 annual kilometres, an emission factor of 123.4gCO_2/km and an asset life of 13.5 years

In recent years, multilateral development banks have adopted more restrictive finance policies for coal in an effort to reduce emissions. This policy has been replicated by several national development funding initiatives and private finance organisations.

While it may seem counterintuitive, limiting funding channels will likely lead to higher levels of carbon emissions. As highlighted in Part One, coal will continue to be used in ASEAN. The risk, however, is that without development bank support, cheaper, less efficient, and more polluting technologies might be used as they are all that can be afforded in the absence of concessional finance or loan guarantees. Some developers may not be able to secure this finance in private markets, which means that the role of public institutions, such as development banks, is essential.

CCS – Vital to delivering long-term regional carbon reduction

HELE technology represents significant progress on the pathway towards CCS, which has been identified as a vital technology required to meet global climate objectives. The long-term use of fossil fuels and industrial processes is dependent on the widespread deployment of the technology. Research from the Intergovernmental Panel on Climate Change (IPCC) has shown that climate action will be 140% more expensive without CCS and that meeting the 2°C target could actually be impossible without it.

While nascent the technology has been demonstrated on several coal-fuelled power plants internationally including:

- **Saskpower's Boundary Dam Project** – 115 MW station in Canada that has safely stored more than 100 000 tonnes of CO_2
- **Petra Nova** – the world's largest post-combustion carbon capture facility near Houston, Texas
- **Kemper County** – 582 MW station in Mississippi, US, that will capture two-thirds of carbon emissions.

At this stage, technology and financial barriers may restrict CCS deployment until greater experience is gained internationally; ASEAN, however, is well-placed to leverage CCS opportunities. The region benefits from an increasingly efficient coal fleet with several large potential CO_2 storage sites. Encouraging CCS deployment could also bring commercial benefits to the region through enhanced oil recovery.

In order to best leverage these opportunities, power stations should be developed with 'CCS readiness' [17]. The international community can also play an important role in the region by assisting in the development of a long-term roadmap for CCS demonstration and deployment. The Asian Development Bank's support for a China-focussed report published in 2015 could provide a potential model[18].

[17] *Coal-fired units that are technically designed to be CCS ready. A proposed model of the concept is described in International Energy Agency (2016) Reducing emissions from fossil-fired generation: Indonesia, Malaysia and Viet Nam, Paris: OECD/IEA. pg.48*

[18] *Asian Development Bank (2015) Roadmap for Carbon Capture and Storage Demonstration and Deployment in the People's Republic of China, Manila: Asian Development Bank*

III: ACTION ON CLEANER COAL IN ASIA BRINGS GLOBAL BENEFITS

Electricity markets in ASEAN undeniably face a very different set of challenges compared to more mature markets. In 2016, the World Economic Forum[19] considered potential policy approaches for fast growing economies, such as ASEAN. The report recognised the need for newly industrialising economies to balance security, affordability and sustainability. Central to this premise, WEF encouraged energy stakeholders to adopt the most efficient pathway to policy objectives.

For ASEAN the most efficient pathway undeniably includes a significant role for HELE coal generation

ASEAN requires an additional 800 terawatt hours (TWh) of annual electricity generation between 2020 and 2035. The analysis below illustrates the upfront capital investment required for different generation mix alternatives able to meet this demand growth.

The lowest cost pathway from a purely generation perspective would be achieved through deployment of subcritical coal at a cost of $180 billion. However, given the imperative to reduce emissions, this is not a practical option. Increasing investment to encourage deployment of the most efficient ultra-supercritical technology would reduce emissions by 200 million tonnes per year. To put it more simply, over the next two decades if ASEAN's HELE transition continues it could lead to a carbon reduction equivalent of India's annual emissions. It could be argued that ASEAN should invest in renewable sources of electricity, such as wind or solar. Leaving practicalities aside (intermittency,

Figure 7: Compared to renewables, HELE technologies can reduce more emissions for the same upfront investment

Investment option	Generation Mix for 800 TWh (%)		Required Capacity (GW)		Total CAPEX ($Billion)	% INCREASE in CAPEX to Baseline	Annual Emission (Bn. tCO_2)
	Coal	Renewable	Coal	Renewable			
Subcritical Coal Only	100	0	122	0	180	Baseline	0.8
Ultra-supercritical Coal Only	100	0	122	0	253	40	0.6
Subcritical Coal and Onshore Wind	83	17	101	58	253	40	0.7
Subcritical Coal and Solar PV	88	12	107	63	253	40	0.7
Onshore Wind Only	0	100	0	338	598	232	0
Solar PV Only	0	100	0	522	773	329	0

$73 Billion of additional funding required

For the same additional financing, investment in ultra-supercritical coal technology results in the least amount of emissions

Low load factor of renewable technologies means significantly higher required capacity – and therefore higher CAPEX – to generate the same TWh of electricity

Note:

1) CAPEX = Capital expenditure

[19] *World Economic Forum 2016, The Future of Electricity in Fast Growing Economies, WEF*

land access, grid suitability), analysis indicates it would cost an additional $500 billion to pursue a purely renewable investment option – close to fifty times the size of Laos's annual GDP.

Investment in HELE is a more effective carbon reduction strategy than transitioning to renewables

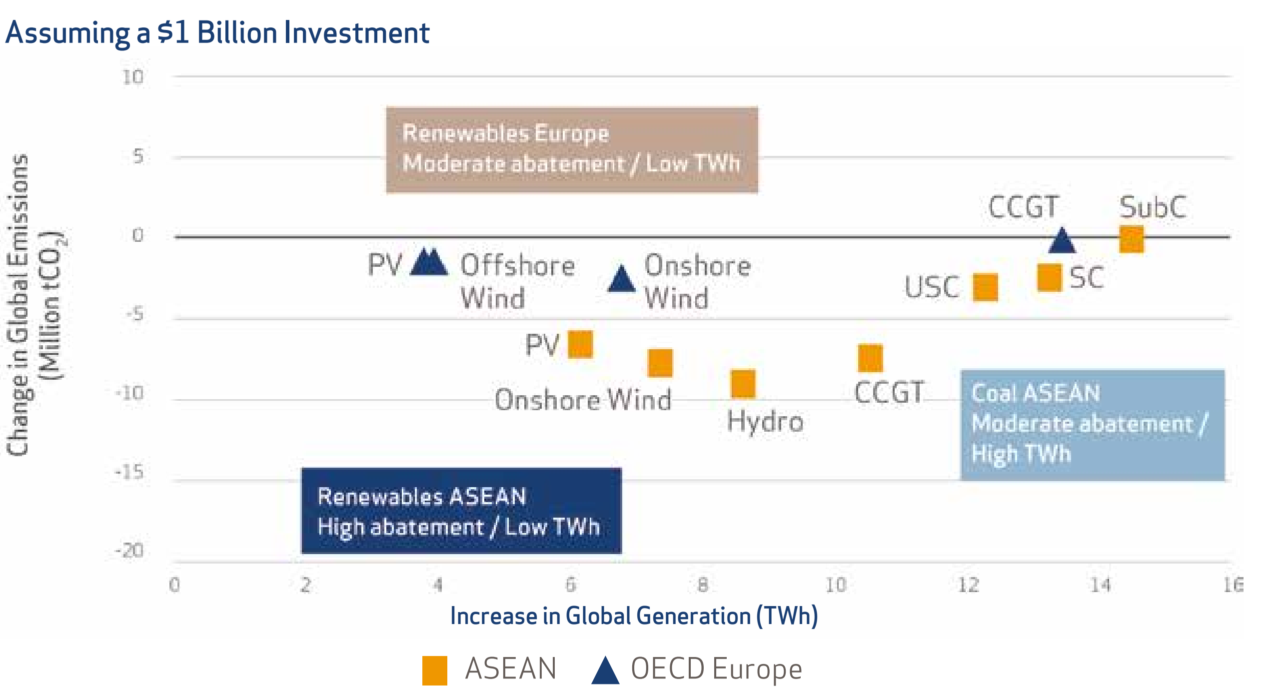
Given that energy policy and international climate action are inextricably linked, it is valuable to consider the emission reduction benefits of HELE deployment in ASEAN compared to renewable deployment in advanced markets.

Consider a hypothetical scenario in which policy makers had $1 billion to spend with the objective of producing the highest levels of electricity with the lowest emissions profile. The graph below plots several potential approaches:

- In the first scenario, the investment could be directed to continue the transition in Europe from gas (CCGT – baseline) to renewables. This would result in moderate reduction in emissions, although much lower levels of electricity generation.
- Secondly, the investment could fund a transition away from subcritical (SubC – baseline) to wind and solar deployment in ASEAN. This too is impractical given the much lower levels of electricity generated.
- In the final scenario, for the same level of expenditure, investment in HELE would achieve a similar level of CO_2 emissions reduction to the deployment of renewables in Europe, while generating up to three times more electricity.

Deployment of HELE technology in coal markets is one of the most efficient strategies to limit global emissions of CO_2. Despite this, however, HELE does not benefit from the same profile as other mitigation technologies, such as wind and solar. ASEAN countries should move to include HELE in their Nationally Determined Contributions as part of the obligations of the Paris Agreement. Formalising a role for HELE will promote opportunities for greater financial and technical support from international partners. Identifying HELE as a key technology in the low-carbon transition will also ensure a more fuel agnostic approach to climate discussions. Providing a level playing field for all mitigation technologies will ensure climate and energy debate is framed to consider the full value and costs of electricity generation.

Figure 8: The generation and emissions reduction benefit of a $1 billion HELE investment



CALL FOR ACTION

Based on the preceding analysis, ASEAN should reaffirm the regional strategies and strategic action plans for CCT.

Coal will play an increasingly prominent role in the regional energy mix over the coming decades. Increased uptake of CCT will ensure a holistic energy policy integrating social, economic and environmental imperatives. Modern HELE plants generate reliable electricity at an affordable rate with lower emissions. The technology ensures that coal can play an important role in international development and climate action initiatives. In line with these, ASEAN supports CCT utilisation to provide the affordable and sustainable electricity for the region. AMS are expected to formalise their commitment to CCT by identifying their role in key strategic documents, including the Nationally Determined Contributions submitted in-line with responsibilities of the Paris Agreement.

ASEAN should support the transition away from the least efficient technology in favour of HELE coal. With improved levels of support from partners, ASEAN should endeavour to enhance the level of action, including pledging to end the use of subcritical coal.

Recognising that barriers to the deployment of low-carbon emissions technologies in the region exist, through a Joint Ministerial Statement at the 32nd ASEAN Ministers on Energy Meeting in September 2014, the ministers voiced support for the ongoing efforts to develop HELE coal-fuelled power plants. They also agreed to generally promote the adoption of CCTs. Together with the ASEAN+3 Dialogue Partners (China, Japan, and Korea), also meeting in September 2014, ASEAN agreed to step up cooperation on financing and to develop technology cooperation programmes; promote policies on CCT, including HELE coal-fuelled power plants, the upgrading of low-rank coal, CCS, gasification, and liquefaction; and generally develop related industries in the region.

HELE facilities emit 25 – 33% less CO_2 and significantly reduce or eliminate other pollutant emissions. Adopting HELE rather than subcritical technology is one of the most efficient strategies in lowering greenhouse gas emissions. ASEAN acknowledges the need to transition away from inefficient subcritical technologies. AMS recognises that wherever economically and technically feasible HELE technology should be a conventional standard.

AMS also recognise the mitigation potential of CCS technology and support research and other related initiatives within this area. ASEAN is expecting to work to build 'CCS readiness' into the planning stages of coal-fuelled power station deployment in order to maximise CCS opportunities once technologically and economically practical.

AMS call on the international community to provide support for the deployment of CCT.

In recent years there have been significant moves at the international level to reduce the financing options available for coal-fuelled power generation projects in developing countries. Changes in policy at the various international development banks have, in some cases, trickled down into smaller banks, private financial institutions and other development agencies. This presents a significant impact to ASEAN economic and social development. These restrictive policies also ignore the technological advancement of modern CCT and their potential to meet both energy and environmental objectives.

It is important for financiers to adopt a 'fuel agnostic' approach to climate action. Climate support regimes based on fuel, rather than on a technology basis can lead to unintended consequences. As observed by the IEA's most recent World Energy Investment Outlook[20] 'countries that build new capacity will be less inclined to select the most efficient designs because they are more expensive, consequently raising CO_2 emissions and reducing the scope for the installation of CCS.'

AMS calls on the international community to provide financial, technological and policy support to accelerate the regional transition away from subcritical coal to more efficient technology. The World Coal Association's Platform to Accelerate Coal Efficiency[21] provides a potential model.

[20] International Energy Agency, World Energy Investment Outlook 2014
[21] For more information visit: www.worldcoal.org/PACE

The analysis in this report was conducted by Charles River Associates on behalf of the World Coal Association and the ASEAN Centre for Energy. Responsibility for the report lies with the World Coal Association and the ASEAN Centre for Energy. Charles River Associates is a leading global consulting firm that offers economic, financial, and strategic expertise to major law firms, corporations, accounting firms, and governments around the world.

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World Coal Association

The World Coal Association is a global industry association formed of major international coal producers and stakeholders. The WCA works to demonstrate and gain acceptance for the fundamental role coal plays in achieving a sustainable and lower carbon energy future. Membership is open to companies and not-for-profit organisations with a stake in the future of coal from anywhere in the world, with member companies represented at Chief Executive or Chairman level.

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ASEAN Centre for Energy

Established on 1 January 1999, the ASEAN Centre for Energy (ACE) is an independent intergovernmental organisation within the Association of Southeast Asian Nations' (ASEAN) structure that represents the 10 ASEAN Member States' (AMS) interests in the energy sector. The Centre accelerates the integration of energy strategies within ASEAN by providing relevant information and expertise to ensure the necessary energy policies and programmes are in harmony with the economic growth and the environmental sustainability of the region. It is guided by a Governing Council composed of Senior Officials on Energy from each AMS and a representative from the ASEAN Secretariat as an ex-officio member. Hosted by the Ministry of Energy and Mineral Resources of Indonesia, ACE's office is located in Jakarta.

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