GLOBAL CCS INSTITUTE

Brief

CCS Development in Southeast Asia

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Contents

1. Why Southeast Asia needs CCS/CCUS 2
2. Specific Drivers 3
2.1 Singapore 3
2.2 Indonesia 4
2.3 Malaysia 4
3. ESG commitments driving CCS deployment 4
4. Hub and Cluster Networks 4
5. Conclusion: The way forward 6

1. Why Southeast Asia needs CCS/CCUS

Carbon capture and storage (CCS) is vital if we are to have any chance of reducing emissions to net-zero and achieving global climate change targets. The specific contribution of CCS to emissions reduction varies across regions, depending on carbon dioxide (CO_2) emission sources and storage site availability. For the Southeast Asia region, with its power generation fuel mix and rapidly growing natural gas production, CCS has a unique and critical role to play.

In recent decades, Southeast Asia has been one of fastest growing regions of the world. Its energy demand has grown more than 80 per cent from 2000.[1] Oil, coal and gas provides more than 70 per cent of its energy (Figure 1).

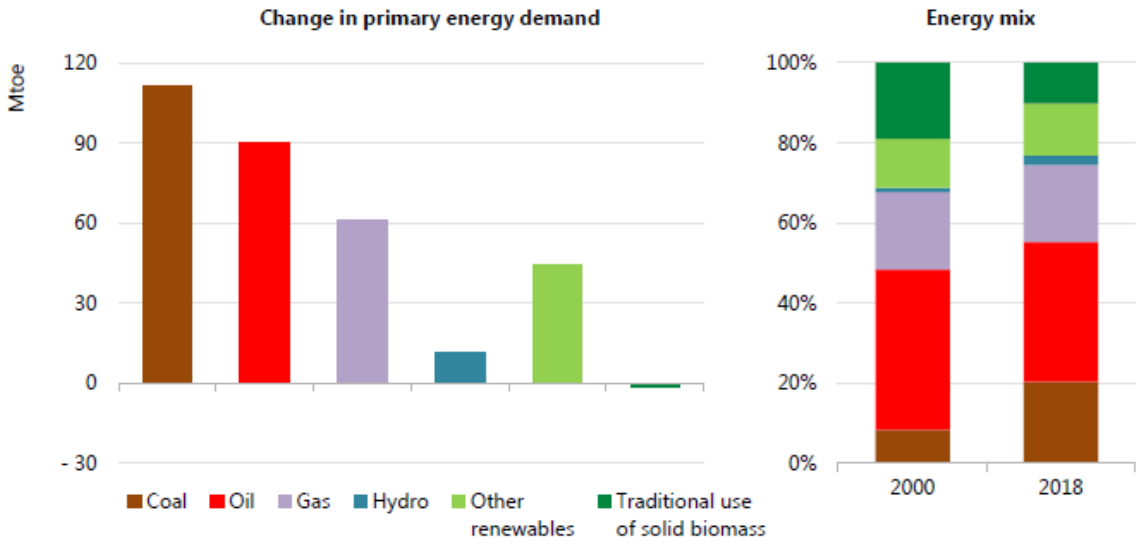

Figure 1: Southeast Asia energy demand and energy mix[2]

Under the IEA Stated Policies Scenario, fossil fuel demand across the region will be more than 800 Mtoe in 2040. Coal and gas combined provide a near equal share of the fuel used for power generation, and together make up approximately 80 per cent of the total used. A few representative countries' energy mix for power generation are listed below:

Country	Type	Gas	Coal
Malaysia[3]	Installed capacity 2017	43.0%	30.9%
Indonesia[4]	Electricity generation 2018	22.0%	58.0%
Singapore[5]	Electricity generation 2019	95.3%	
Thailand[6]	Electricity generation 2019	57.5%	16.9%
Vietnam[7]	Electricity generation 2017	17.8%	34.3%[8,9]

[1] IEA 2019, *Southeast Asia Energy Outlook 2019*.
[2] IEA 2019. *Southeast Asia Energy Outlook 2019*.
[3] Suruhanjaya Tenaga Energy Commission 2019. *Malaysia Energy Statistics Handbook 2019*.
[4] BP 2019. *BP Statistical Review-2019*.
[5] Energy Market Authority 2019. *Singapore Energy Statistics 2019*.
[6] Ministry of Energy 2019. *Energy Statistics* < http://www.eppo.go.th/index.php/en/en-energystatistics/electricity-statistic>.
[7] Vietnam Electricity 2017. *Annual Report 2017*.
[8] Asian-Power 2020. *Vietnam keeps grip on coal*. < https://asian-power.com/regulation/news/vietnam-keeps-grip-coal>.
[9] 17GW coal-fired power station under construction

Sustainable economic growth requires reliable, clean and low-carbon power. The region's fossil fuel power fleets are of relatively young age with decades of economic life[10]. The capacity of these fleets will continue to increase in the foreseeable future and, inevitably, CO_2 emissions will rise. Moreover, coal-fired power stations may have also contributed to air pollution (particulates, sulphur oxides (SOx) and nitrogen oxides (NOx)) in some ASEAN countries. When carbon capture is retrofitted to a coal-fired power station, it removes not only CO_2 but also SOx, NOx and particulates from the flue gas. Deployment of CCS or carbon capture, utilisation and storage (CCUS) in the power sector will therefore not only reduce CO_2 emissions, but also improve air quality for the region.

On the energy supply side, the region has long been a significant oil and gas producer with Malaysia being the third largest LNG exporter.[11] Several oil and gas majors have substantial assets in this region. In recent years gas production has been ramping up, due to increasing investment in exploration and development. However, it should be noted that quite a few recent natural gas projects are developing high CO_2 gas fields, both onshore and offshore. Raw natural gas streams from those fields contain 20 to 70 per cent CO_2 by volume.

The natural gas production process (LNG or pipeline natural gas) includes a CO_2 separation unit (Acid Gas Removal Unit, 'AGRU') where high concentration CO_2 (>95 per cent) is produced and vented. These high concentration CO_2 streams offer great opportunities for early mover projects as capture costs are avoided. Total cost for compression, dehydration, transport and injection may range from US$15-30/tonne CO_2 which is substantially lower than the cost for power station flue gas. This may likely increase LNG production cost marginally, depending on CO_2 concentration and other factors (for a 7 million tonnes per annum (Mtpa) LNG plant with 2 Mtpa CO_2, assuming a $25/t CCS cost and a $3/GJ LNG conventional production cost, LNG unit cost increase is $7.14/t LNG (4.37 per cent increase).

It should also be noted that geological storage resources are plentiful in the region. According to a previous study, Indonesia, Thailand, the Philippines and, Viet Nam have 54 gigatons of storage capacity[12].

2. Specific Drivers

As discussed above, there are general mandates and good opportunities for low cost CCS projects in the region. It is necessary to further examine the specific drivers for developing CCS projects.

Countries in this region are developing CCS at vastly different paces. Three representative countries' efforts in CCS are listed below:

2.1 Singapore

CCS and CCUS has gained much momentum in both public and private sectors in Singapore. Such strong interest is well justified. In 2017, Singapore's greenhouse gas emissions were 52 million tonnes CO_2e with 39 per cent primary emission from power stations (mostly gas-based) and 46 per cent from industry. For those industrial emissions, unlike electricity, it is difficult to find alternative or replacement technology to reduce emissions. Singapore recently published its Long-Term Low-Emissions Development Strategy (LEDS), stating:

> *"There are three thrusts in our strategy. First, we need to transform our industry, economy and society. Second, we will have to draw on technologies, which are not yet mature such* ***as carbon capture, utilisation and storage (CCUS), and low-carbon fuels****. Third, we will need international collaboration in areas such as well-functioning carbon markets,* ***carbon storage****, and regional electricity grids."*[13]

This document paves the way for CCUS development in Singapore and it also provides a foundation for industry to seek international collaboration on CCUS, especially storage, either in neighbouring countries or countries slightly further away, such as Australia which has abundant CO_2 storage space

[10] IEA 2019, *Southeast Asia Energy Outlook 2019*
[11] Australian Government 2018. *ASEAN Oil and Gas Market Overview.*
[12] ADB 2013. Prospects for *Carbon capture and storage in Southeast Asia*.
[13] National Climate Change Secretariat, Strategy Group, Prime Minister's Office 2020. Charting Singapore's Low Carbon and Climate Resilient Future.

and mature legal framework for CCS. For companies operating in Singapore, the Singaporean carbon tax, though at a relatively low value now, provides another driver to develop and implement a decarbonisation strategy.

2.2 Indonesia

Indonesia is home to several large gas development projects with high CO_2 concentrations. Various studies and pilot studies have been conducted with international funding support. The Indonesian oil/gas authority has been discussing CO_2-EOR/EGR[14] and its potential to increase Indonesian oil/gas production. A draft legal framework has been proposed, though further efforts are needed to codify the CCS legal framework. A Japan-Indonesia Joint Credit Mechanism (JCM) agreement may provide project developers alternative access to project finance and CCS regulation is needed in order to utilise these credits for CCS projects. Additionally, deployment of CCS in the power sector will reduce pollutants and help improve air quality for major Indonesian cities.

2.3 Malaysia

Malaysia's power and oil/gas sectors have been considering CCS for quite some time. Some of the country's gas fields have very high (more than 70 per cent) CO_2 content. Development of those high CO_2 gas fields may only be justified by combining them with CO_2 storage. One disadvantage is that most of those fields are offshore, and offshore operations (drilling, injection and monitoring) tend to have higher costs. Malaysia continues to progress towards CCS with significant activities over the past few years. These CCS activities have included, but are not limited to, capacity development, storage assessments and legal and regulatory workshops.

3. ESG commitments driving CCS deployment

In the corporate world, with ever increasing Environmental, Social and Governance (ESG) pressure on corporations, particularly in regard to climate change ambitions, more companies have established net-zero targets by 2050. Corporations operating in the Southeast Asian region are no exception, and many have taken actions to reduce their operational emissions. Corporate sustainability and climate change targets are a key driver for emissions reductions measures. From industry observations, a "*no CCS, no development*" stance appears to be becoming more common in the development of high CO_2 gas projects.

4. Hub and Cluster Networks

Due to the compact geographical area of Southeast Asia and the existence of oil/gas infrastructure close to suitable geological sites, the region is well positioned to build a CCS hub to provide CO_2 storage solutions for its countries, and nearby jurisdictions.

A CCS hub-and-cluster network delivers economies of scale and substantially reduces unit costs of CO_2 transportation and storage.[15] A network is better suited to attract investment and to reduce financial risks for individual investors. Another advantage of a network is that it would improve operational flexibility by creating multiple operators and customers, which enables storage sites switching in the event of planned or unplanned outages.[16]

This region has strong technical capabilities and it could develop a strong CCS services industry, targeting offshore operations. This region has already built up an extensive infrastructure plan for oil/gas pipelines connecting Indonesia, Singapore, Malaysia, Thailand, Vietnam, Brunei and Cambodia (Figure 2). For the development of a future CO_2 pipeline network, the *ASEAN Memorandum of Understanding (MoU) on the Trans-ASEAN Gas Pipeline (TAGP)* may provide parties valuable precedents/lessons learned in developing a multilateral agreement for transporting commercial commodity via pipeline.

[14] Enhanced Oil Recovery/Enhanced Gas Recovery
[15] Global CCS Institute 2019. *The Global Status of CCS 2019.*
[16] Global CCS Institute 2019. *Policy priorities to incentivise large scale deployment of CCS.*

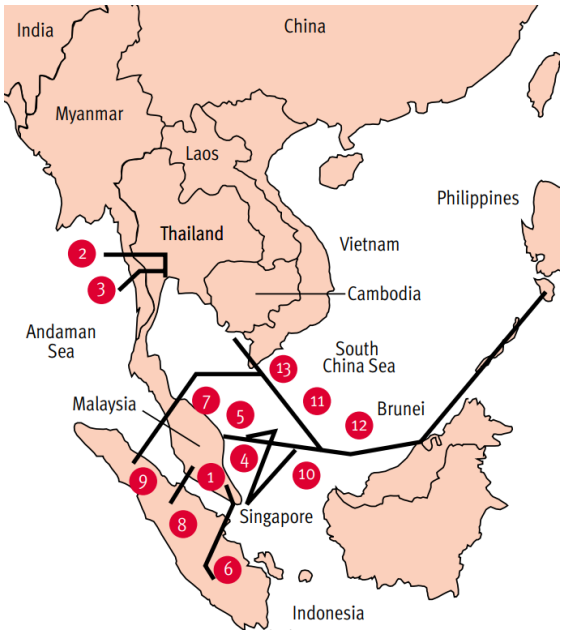

Figure 2 ASEAN gas pipelines infrastructure plan[17]

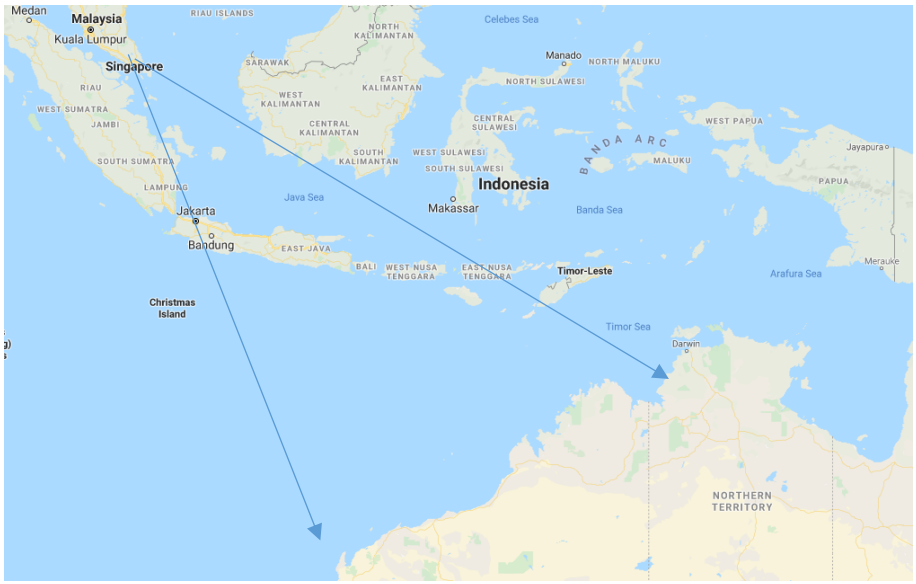

Figure 3 Potential CO_2 transport to Australia for storage

Depending on economic and other factors, such a network may well expand outside this region to include northern Australia, where offshore storage resources with great potential have been discovered and assessed (Figure 3). Existing Australian CCS regulatory frameworks provide developers with additional confidence. Carbon dioxide shipping infrastructure may also offer opportunities to be connected to a potential domestic CO_2 network in northern Australia.

It is nevertheless recognised that early mover projects tend to adopt point-to-point source-sink models due to the risks for the large infrastructure investment required to establish a hub; such as over-scaled pipeline and pumping stations. However, preliminary assessments of some early mover projects indicate that it is highly likely those projects may have very similar investment horizon for their oil/gas projects, and hence collaboration on building a network may be well timed.

[17] P Roberts et al. *Building the Trans-ASEAN gas pipeline*. Asia Pacific Review 2003.

5. Conclusion: The way forward

Deploying CCS in the Southeast Asia region will not be without significant challenges. The following key points may stimulate the thinking of public and private stakeholders when developing their CCS plan and strategy:

- Governments have a critical role to play in supporting a regional hub and cluster network. This may be in the form of direct investment, establishing a regulatory framework for CO_2 storage and other policy frameworks.
- Production Supply Contracts (PSC) are commonly employed to stimulate investment in oil/gas production and regulate profit sharing between private corporations and governments. Governments may examine the feasibility of incorporating CCS into their PSC schemes.
- Regional collaboration is vital, especially for early mover projects. Public and private stakeholders may benefit from collaborative discussions to identify areas for joint work, such as storage sites and pipeline/shipping facilities, at early stages of project development.
- As most countries in the region are developing nations, international collaboration may be particularly important. International climate finance (including climate funds, development banks) and foreign aid may provide the financial resources to support capacity development, early stage pilot and demonstration projects.
- Market mechanisms under Article 6, or other mechanisms, may be very valuable tools to incentivise CCS investment. Recently, Australia and Singapore announced their intentions to develop a memorandum of understanding (MoU) which includes CCUS.[18] This may pave the way for specific collaborations on CCUS projects and initiatives.

[18] The Prime Minister of Australia. *Media Statement*, 23 March 2020.

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