ASEANのエネルギー分野の現状・関連動向に係る調査 – 定点調査業務2023

報告書 - Singapore

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エネルギー定点調査

1. 一次エネルギー構成
- a. 国全体
- b. 今後の政策（マスタープラン（化石燃料選択、再生可能エネ導入予定等）

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- e. CCUS関連政府・民間の最新動向、主なCO2排出源、CCS貯留ポテンシャル
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- e. 権限所掌省庁と部局

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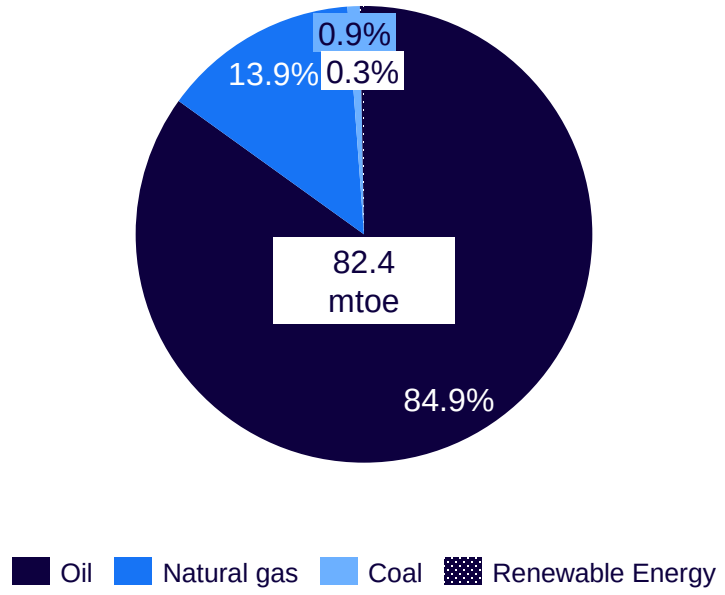
1. 一次エネルギー構成

シンガポールのエネルギー源は石油が85%程度占めている

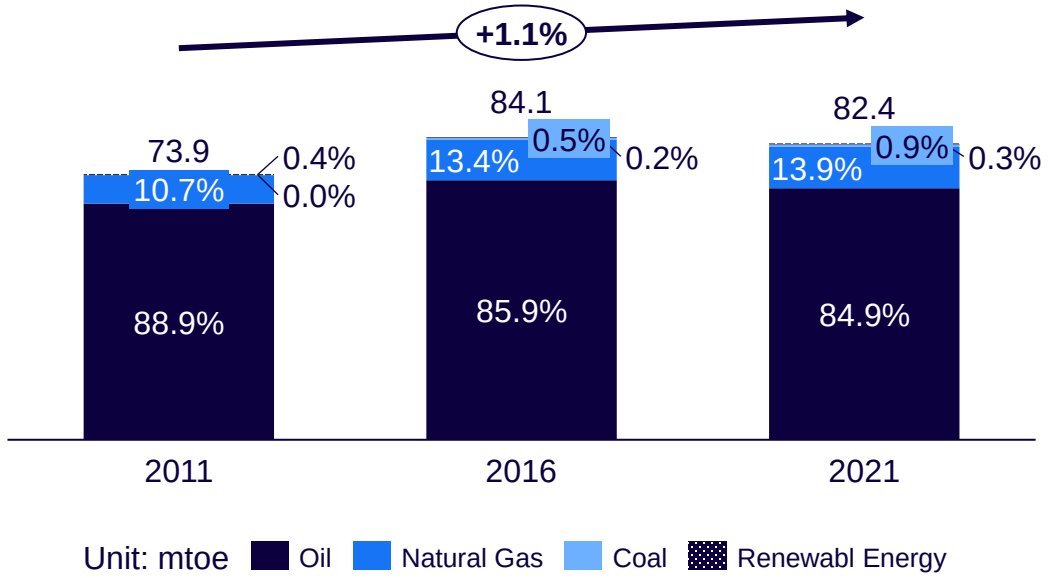
Primary Energy Consumption, by Energy Source, 2021, %

Singapore is highly dependent on oil as a fuel source, accounting for 84.9% (70 mtoe) of all energy consumed. Natural gas consumption comes in second at 13.9% (11.5 mtoe), followed by coal and renewable energy (RE) accounting for 1.2% (0.9 mtoe)



Primary Energy Consumption, by Energy Source, 2011 – 2021, %

Oil has retained dominance for 2011-2020, at around ~86.5%, with a slight YOY growth of 2.8%. With Singapore's decarbonizing plan, the switch from oil to natural gas can be observed from the growth in consumption mix of 3.8% YOY.

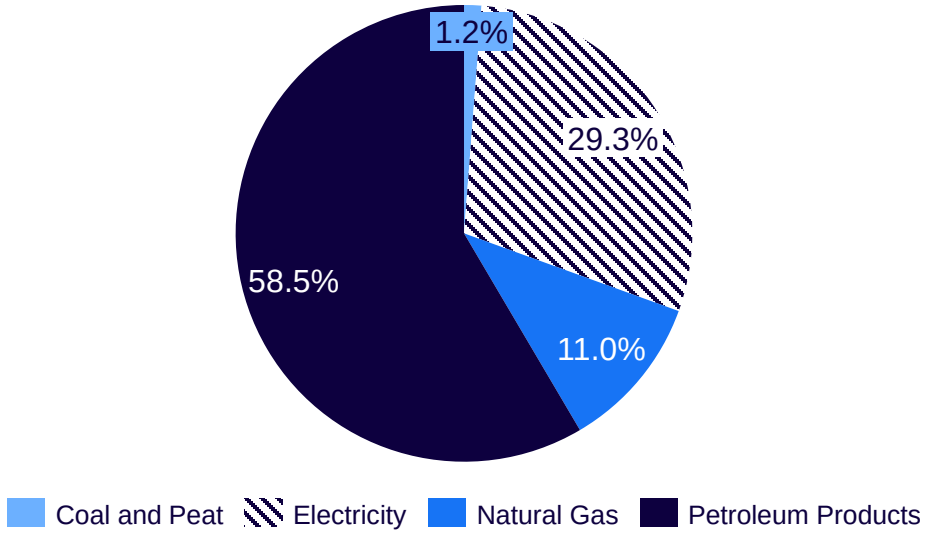


Note: mtoe= million tons of oil equivalent
Source: bp Statistical Review of World Energy 2022, Energy Market Authority 2022

最終エネルギー消費においては産業セクターが最も大きい

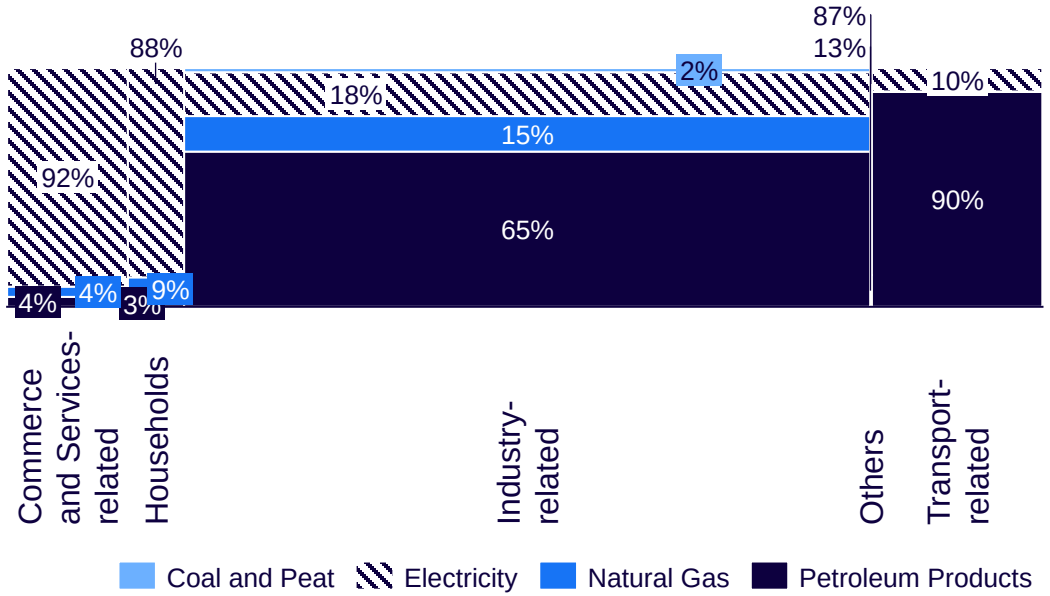
Final Energy Consumption, by Energy Source, 2020, %

Petroleum products are the leading energy product consumed at 58.5% (8.7 mtoe), largely driven by industrial demand. Natural gas comes in second at 11.0% (4.4 mtoe), primarily being used for electricity generation



Final Energy Consumption, by Sector, 2020, %

Commerce and services (1.6 mtoe) and Households (0.7 mtoe) lead in electricity in terms of % mix. However, in absolute terms, Industrials lead at 1.8 mtoe, and consume 74% of all petroleum products (6.4 mtoe) followed by transport at 26% (2.2 mtoe)



Source: Energy Market Authority 2022

シンガポールはグリーンプラン2030を発表

	Policy	Overall
2001	Energy Market Authority (EMA) Act 2001	• シンガポールのエネルギー市場を規制し、管理するために制定された法律です。この政策は、エネルギー市場庁(EMA)を設立し、シンガポールのエネルギーセクターに関する規制と政策の枠組みを提供 • EMAは、電力、ガス、液化天然ガス(LNG)などのエネルギー市場の運営と規制を担当
2007	National Energy Policy	• シンガポール政府によるエネルギーセクターの指針/方針を示した政策
2012	Energy Conservation Act	• エネルギー効率とエネルギー管理を促進するために2013年に導入された法律。この法律は、産業部門と商業部門の組織がエネルギー効率の向上に取り組むことを義務付け
2020	Long-Term Low-Emissions Development Strategy (LEDS)	• 低排出量開発戦略の略称です。LEDSは、温室効果ガス（GHG）の排出削減と持続可能な経済成長を両立させるための総合的な戦略
2021	Singapore Green Plan 2030	• シンガポール政府が2021年に発表した持続可能な包括的な戦略
2022	Enhanced 2030 Nationally Determined Contribution (NDC)	• CO2排出量のピークを2030年よりも前倒しにして、2030年のCO2排出量を約6,000万トンへと削減するという新たな目標を設定

Source: 各種2次情報よりADL作成

グリーンプランでは、“City in Nature”/”Energy Reset“/”Sustainable Living”/”Green Economy”/”Resilient Future”を5つの柱としている

Singapore Green Plan 2030

SG GREEN PLAN

Timing	2021 – 2030
Overall	The Green Plan aims to mobilize ambitious and collaborative efforts to **address climate change** and work towards **achieving the country's net-zero emissions goal**. It composes of five main pillars: City in Nature, Sustainable Living, Energy Reset, Green Economy, and Resilient Future.
Key Notes – **5 Pillars Target**	• **City in Nature:** Focusing on conserving natural capital and enhancing animal welfare standards • **Energy Reset:** Aiming to use cleaner energy sources across all sectors • **Sustainable Living:** Reducing carbon emissions and becoming a zero-waste nation • **Green Economy:** Transforming company to be energy and carbon efficiency, while seizing opportunities in the green economy. • **Resilient Future:** Aiming to bolster coastal and flood defenses, enhance food security, and mitigate urban heat increase.
Key Notes – **Initiatives and Support Measures**	• **Enterprise Sustainability Program:** Aim to help developing sustainability capabilities in enterprises, strengthening sector-specific capabilities, promoting sustainable development initiatives • **Leading Centre for Green Finance:** funding public sector green infrastructure projects targeting to become a leading center of green finance internationally • **Solar Deployment:** targeting to increase solar deployment, increase in the deployment of energy storage to address solar intermittency and enhance grid resilience.

Source: SG Green Plan

再生可能エネルギーの観点では、太陽光での発電等クリーンエネルギーの活用に力を入れることを公表

取り組むべき5課題	課題に対する目標
City in Nature (都市の自然環境)	• (～30年)年間の植樹本数を2倍とし、100万本を植樹へ
Sustainable Living (持続可能な生活の推進)	• (～30年)既存の自転車専用路/鉄道網を延長することで、移動手段に占める公共輸送の割合を75%に拡大 • (～30年)埋め立て地に送るごみを約30%削減
Energy Reset (クリーンエネルギーの活用)	• (～30年)公団住宅のエネルギー消費15%削減/建物の総床面積80%緑化 • (～30年)電気自動車の充電ポイントを倍増/(～40年)内燃機関車両の禁止 • (～50年)航空機の燃費を毎年2%減/バイオディーゼルプラントの拡張/ 水素輸入促進 • (～25年)**太陽光での発電量を約4倍へ**
Green Economy (グリーン経済の発展)	• 炭素税を企業支援プログラムへ活用/グリーンファイナンスへ注力 • 研究/イノベーションエンタープライズ2025年計画に基づきグローバルの脱炭素/水素技術への投融資を実施
Resilient Future (レジリエントな未来の構築)	• 2030年までに食料自給率をカロリーベースで30%に引き当げる

エネルギー/環境関連ジャンル

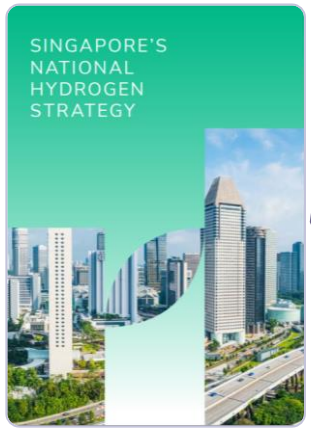
エネルギー周り注目ジャンル

- リサイクル
- 効率化・エネマネ[1)]
- 充電st/バッテリー
- 代替燃料
- 再エネ
- 代替燃料
- ゼロカーボン

出所:2021年2月発行[シンガポール・グリーンプラン2030]
1:エネマネ＝エネルギーマネジメント（HEMS＝Home Energy Management SystemやBEMS＝Building and Energy Management Systemのようなものを想定）

また、現在天然ガスに頼っている発電を水素活用に置き換える計画も打ち出し

Singapore National Hydrogen Strategy



Timing

2022 – 2050

Overall

Singapore is targeting net-zero emissions by 2050 and enhancing energy security by considering hydrogen as a critical factor. Hydrogen has the potential to **meet up to 50% of Singapore's power demands.**

Key Notes

Focus Points

In order to meet 50% national power demands in 2050, the government will focus on:

- Experimenting with the use of advanced hydrogen technologies at the cusp of commercial readiness through pathfinder projects
- Investing in research and development to unlock key technological bottlenecks
- Pursuing international collaborations to enable supply chains for low-carbon hydrogen
- Undertake long-term land and infrastructure planning
- Supporting workforce training and development of our broader hydrogen economy.

Impacts

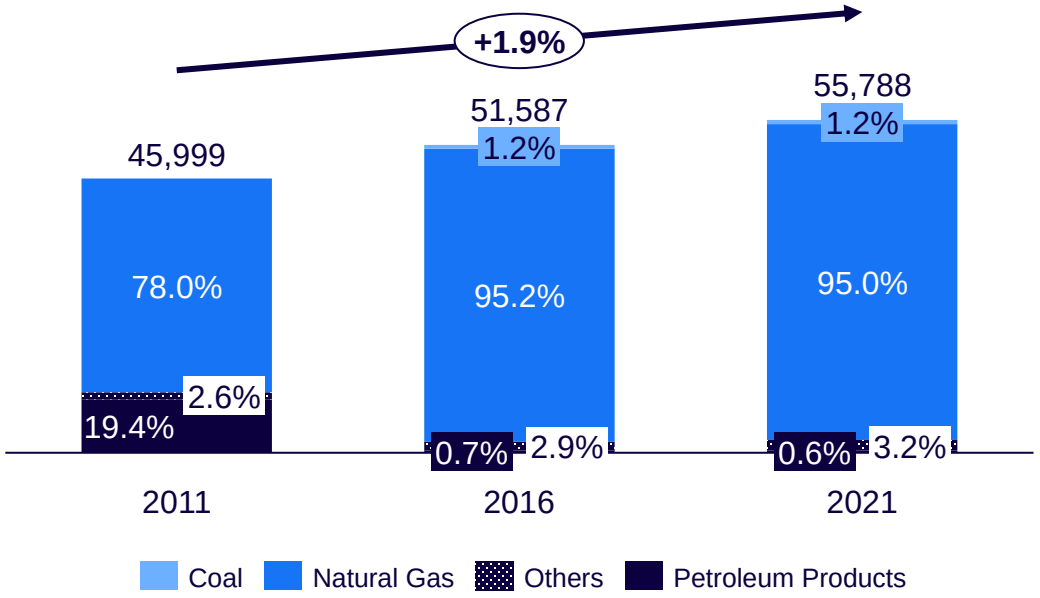
- **Domestic Impact:** Low-carbon hydrogen can complement Singapore's power mix and play a crucial role in decarbonizing industries.
- **International Impact:** Hydrogen hold promise as alternatives to fossil fuels in the maritime and aviation sectors, where Singapore's status as a prominent port and air hub positions it to drive global greener transitions.

Source: Singapore National Hydrogen Strategy

また現状の発電は天然ガスに依存しており、計画上はこの構造がしばらく続く見込み

Historical Electricity Fuel Mix
2011 – 2021, GWh

In the 2013, SG opened its first LNG terminal, leading to a sharp increase in natural gas in the electricity mix, from 78.0% (2011) to 95.2% (2016). As SG transitioned away from fuel oil, a sharp decline from 19.4% (2011) to 0.7% (2016) can be observed

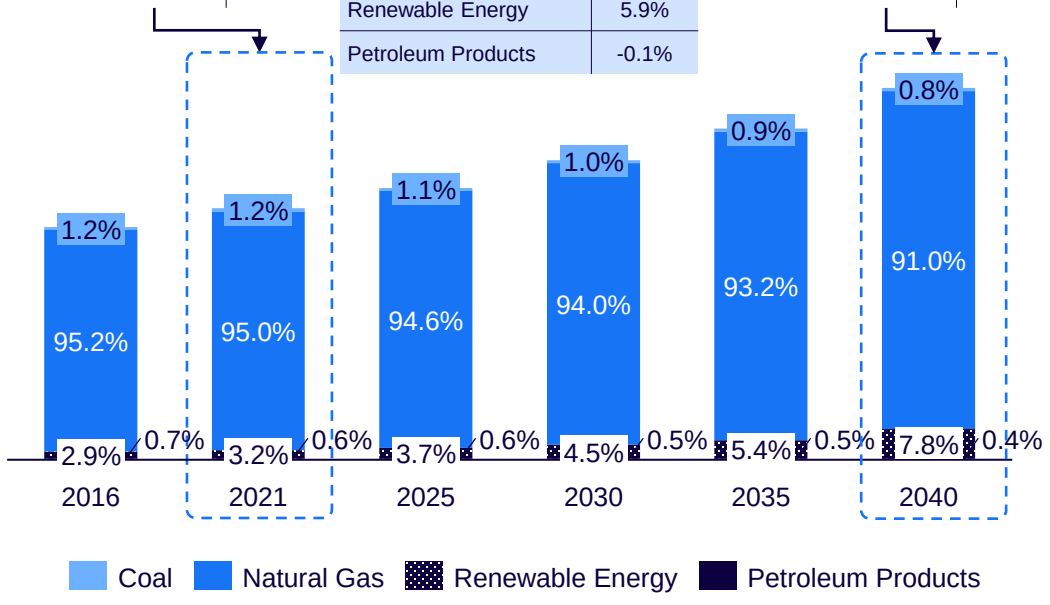


Forecast Power Generation Mix
2016 – 2040, TWh

Total	55.8
Coal	0.7
Natural Gas	53.0
Renewable Energy	1.8
Petroleum Products	0.3

Energy Type	CAGR
Total	2.1%
Coal	-0.1%
Natural Gas	1.9%
Renewable Energy	5.9%
Petroleum Products	-0.1%

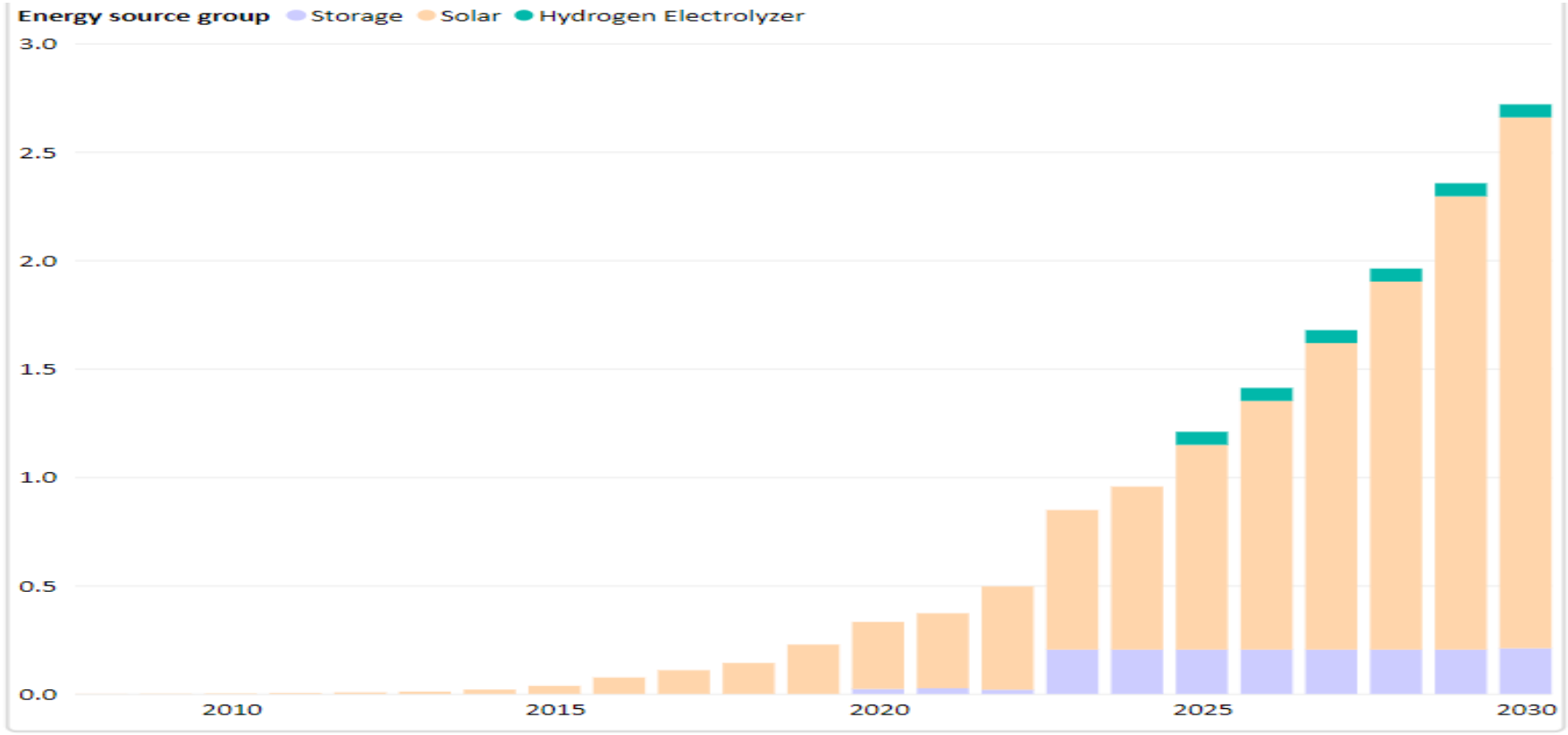
Total	82.5
Coal	0.7
Natural Gas	75.1
Renewable Energy	6.4
Petroleum Products	0.3



Note: Renewable energy incl. of Solar, Hydrogen and Biomass
Source: Energy Market Authority 2022, EMA Annual Report 2012, 2017, 2022, EMA 20th Anniversary Book

再生可能エネルギーの中では、太陽光が中心になると見込まれる

2010 – 2030, RE Energy Mix



Note: Renewable energy incl. of Solar, Hydrogen and Biomass
Source: Energy Market Authority 2022, EMA Annual Report 2012, 2017, 2022, EMA 20th Anniversary Book

List of Renewable policies in force

Policy for RE

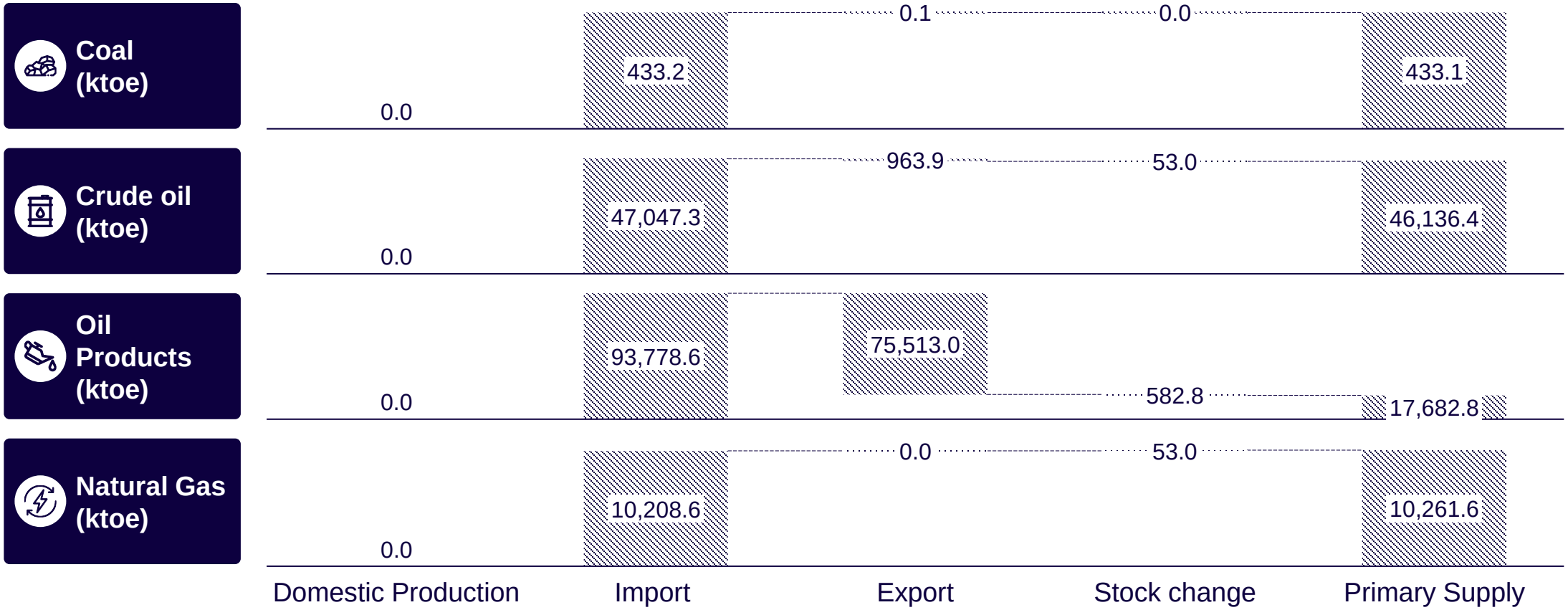
#	Title	Year	Status	Type of policy				Policy target
				Strategic Planning	Regulatory instrument	Fiscal/Finan-cial incentive	Education, R&D	
1	Energy Innovation Research Programme (EIRP)	2012	In force			X	X	Multiple RE sources
2	Experimental Power Grid Center	2011	In force				X	Multiple RE sources
3	Energy National Innovation Challenge (NIC)Singapore	2011	In force	X			X	Multiple RE sources
4	Solar Energy Research Institute of Singapore (SERIS)	2008	In force				X	Solar
5	Solar Pilot/Test-bedding Programmes	2007(April 1st)	In force	X				Solar
6	Energy Innovation programme office (EIPO) Singapore	2007	In force	X				Multiple RE sources
7	Clean Energy Research Programme (CERP)	2007	In force				X	Solar
8	Innovation for Environmental Sustainability(IES) Fund	2001	In force				X	Multiple RE sources
9	Tax Incentive for Energy- Saving Equipment	1996	In force			X		Solar
10	Joint Research with Tertiary Institutions	1991	In force				X	Multiple RE sources
11	Energy Recovery from Biomass in Municipal Waste	1979	In force		X			Bioenergy(Biomass)

Source: Organisation for Economic Co-operation and Development/International Energy Agency, IRENA

2 化石エネルギー

シンガポールは石油製品の輸出が多いことが特徴

Rate of domestic production and import/export of fossil fuel energy (2020)

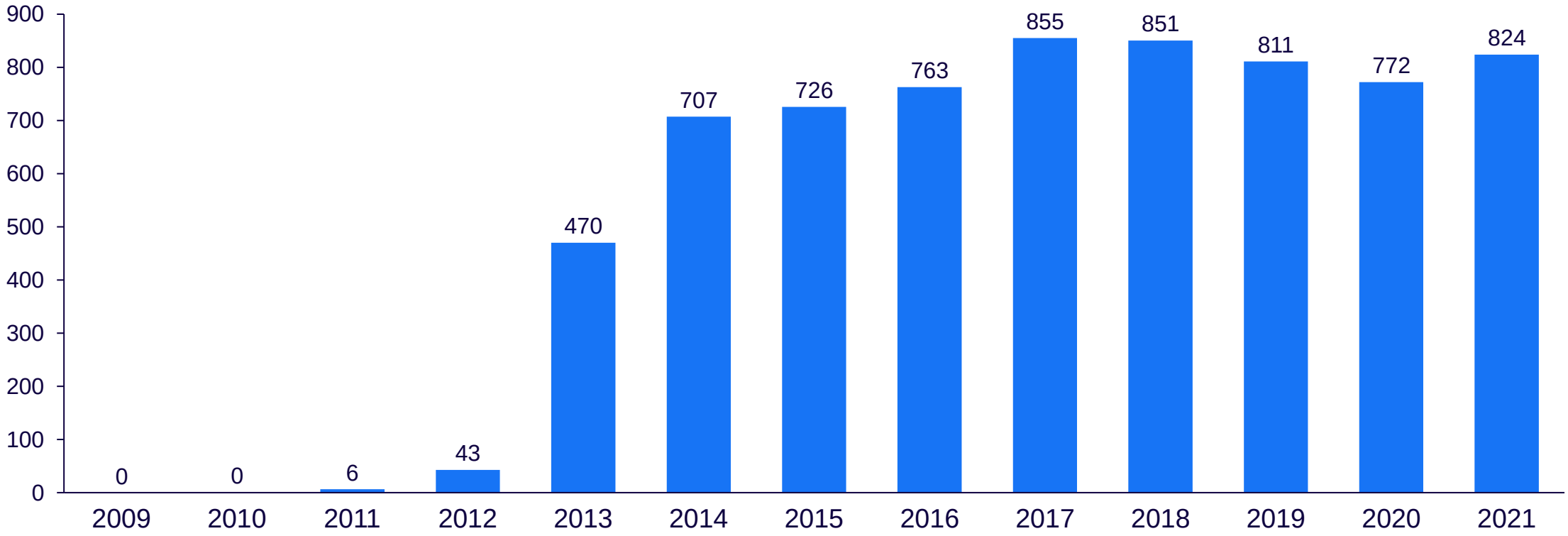


Note: Net domestic consume may not necessarily add up due to statistical adjustment and rounding
Source: Energy Market Authority 2022

石炭は輸入に頼っている

Coal Production, trade & consumption trends

2009 – 2021, Short tons

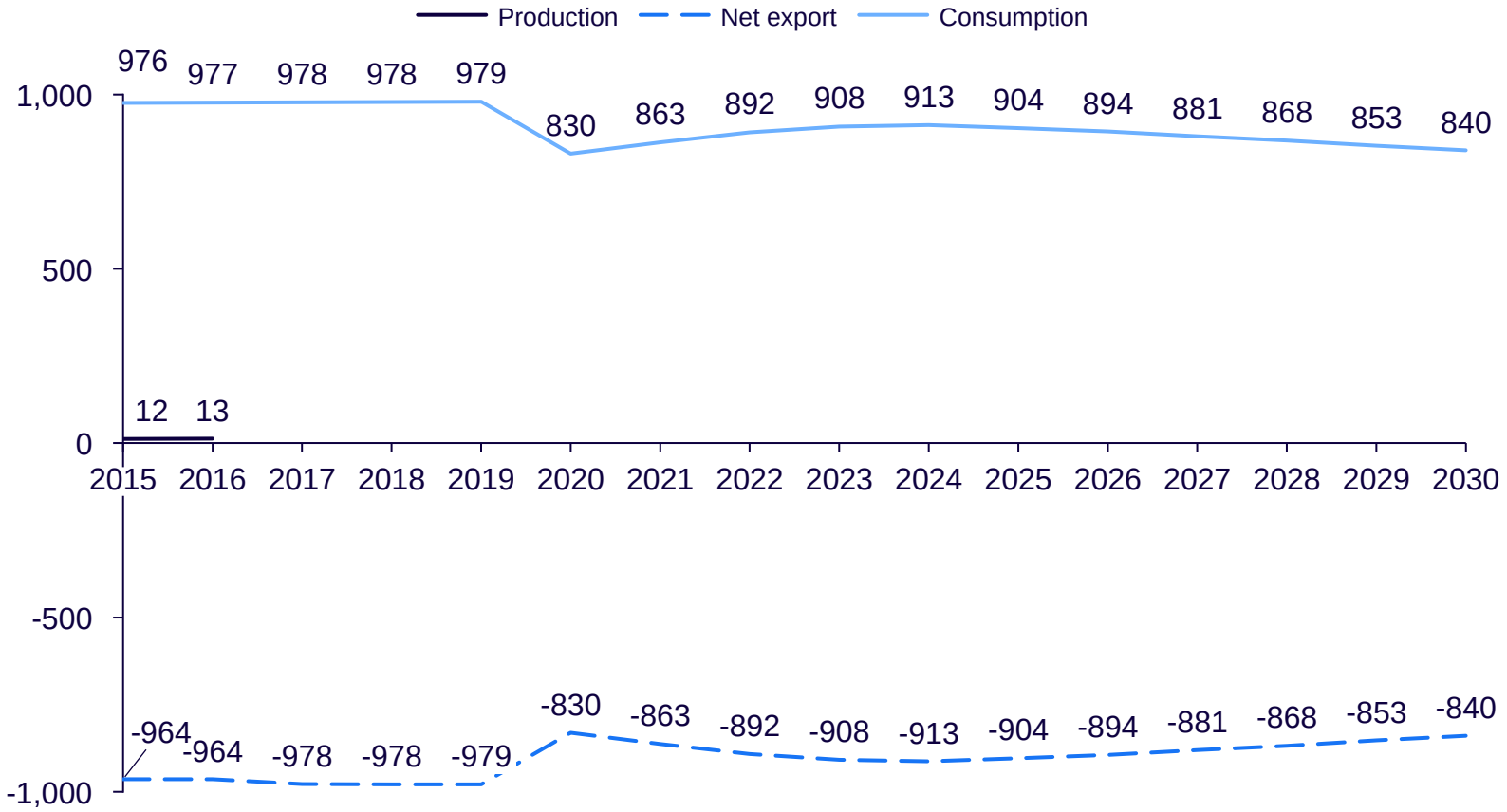


Source: Worldometer, the Global Economy

シンガポールは資源保有国ではないため、原油等の生産はできず輸入に頼っている

Crude oil & other liquids production, trade & consumption trends

2015 – 2030, 000's bpd



Comments

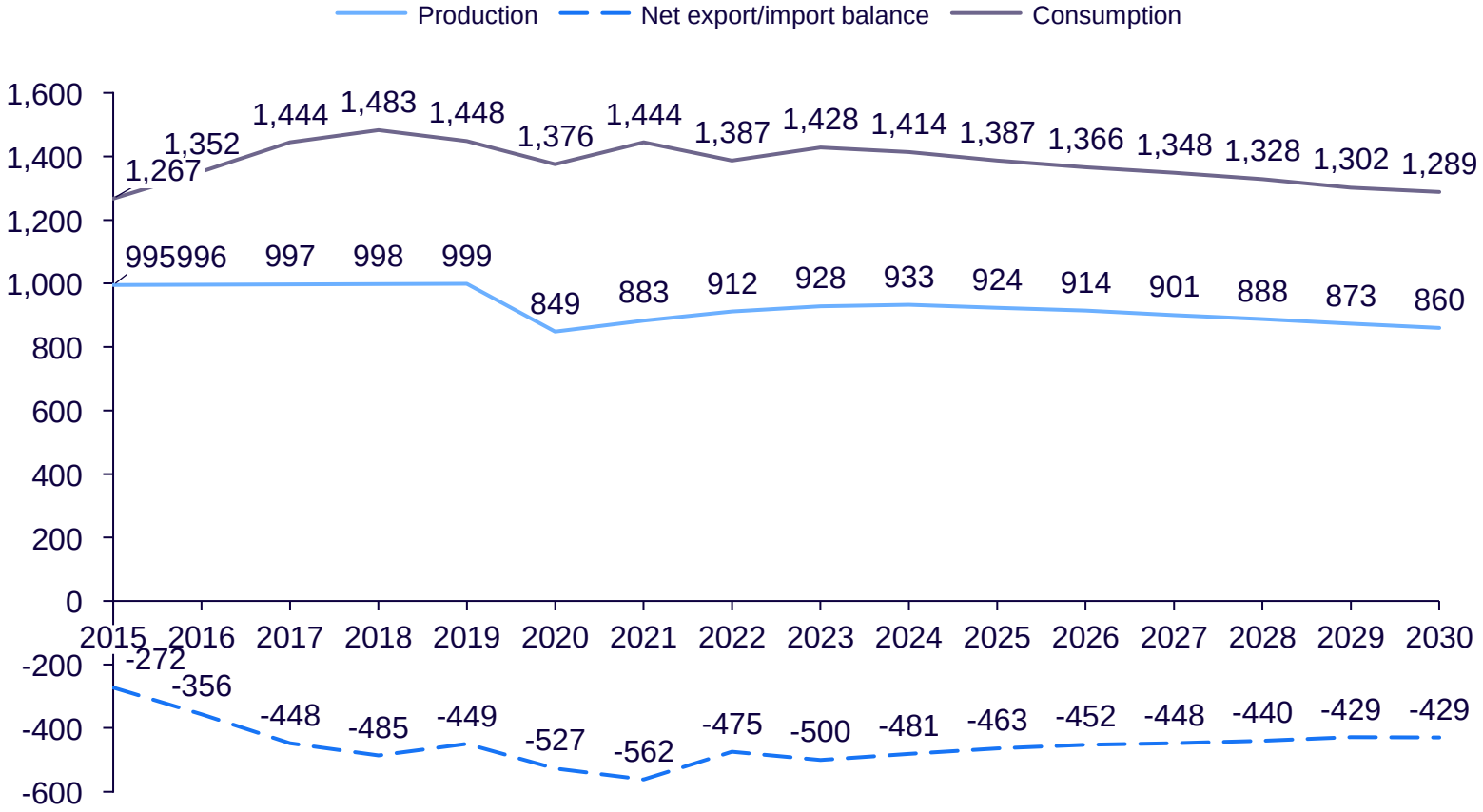
- Singapore does not produce any oil on its shores and meets domestic consumption demands through imports
- Singapore being an Oil & Gas trading hub, also engages in re-exports
- The drop of demand of 149,000 bpd for oil in the 2019-2020 period was due to COVID-19
- With efforts to cut down on oil usage, we can see that there is a slight decreasing trend of -0.30% from 2021-2030 with usage peaking in 2024 at 913,000 bpd

Note: Negative net exports means that imports are greater; 2022 – 2030 are forecasted
Source: Fitch Solutions 2022

石油精製品に関しては、主要産業でもあり製造が盛ん

Refined petroleum products production, trade & consumption trends

2015 – 2030, 000's bpd



Comments

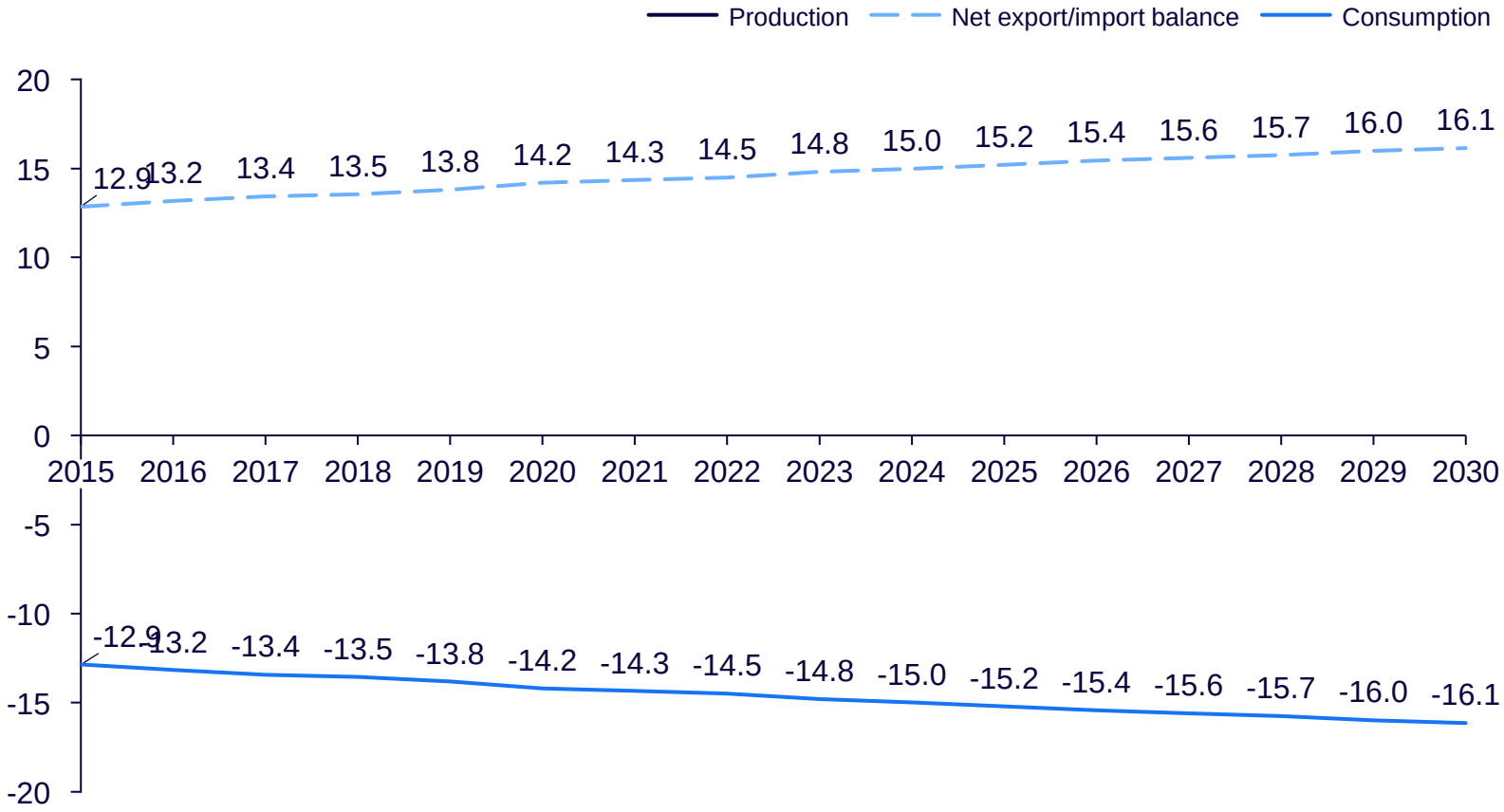
- Due to Singapore being a refinery hub in SEA, refined petroleum products production mirrors that of crude oil consumption
  - A drop of 15.1% (150 bpd) from 2019-2020 due to COVID-19
  - 2020-2024 production peaks at 933 bpd, fueled by the opening of ExxonMobil and Neste Corporations new refineries with expanded capacity
  - Consumption trends fluctuatesin the short term around ~1,400 bpd from 2020-2024 due to instability caused by Russia-Ukraine war as well as the impact of inflation
- Despite a slightly decreased growth of -0.29% from 2022 -2030, companies in SG are expanding their capacity, not hampered by the lack of land

Note: Negative net exports means that imports are greater; 2022 – 2030 are forecasted
Source: Fitch Solutions 2022, Press Release 2019, 2023

天然ガス輸入量は今後増加することが予測されている。増加する電力需要とパイプラインの減少によって、シンガポールのLNGは輸入依存度が高まる

Dry natural gas production, trade & consumption trends

2015 – 2030, bn m^3



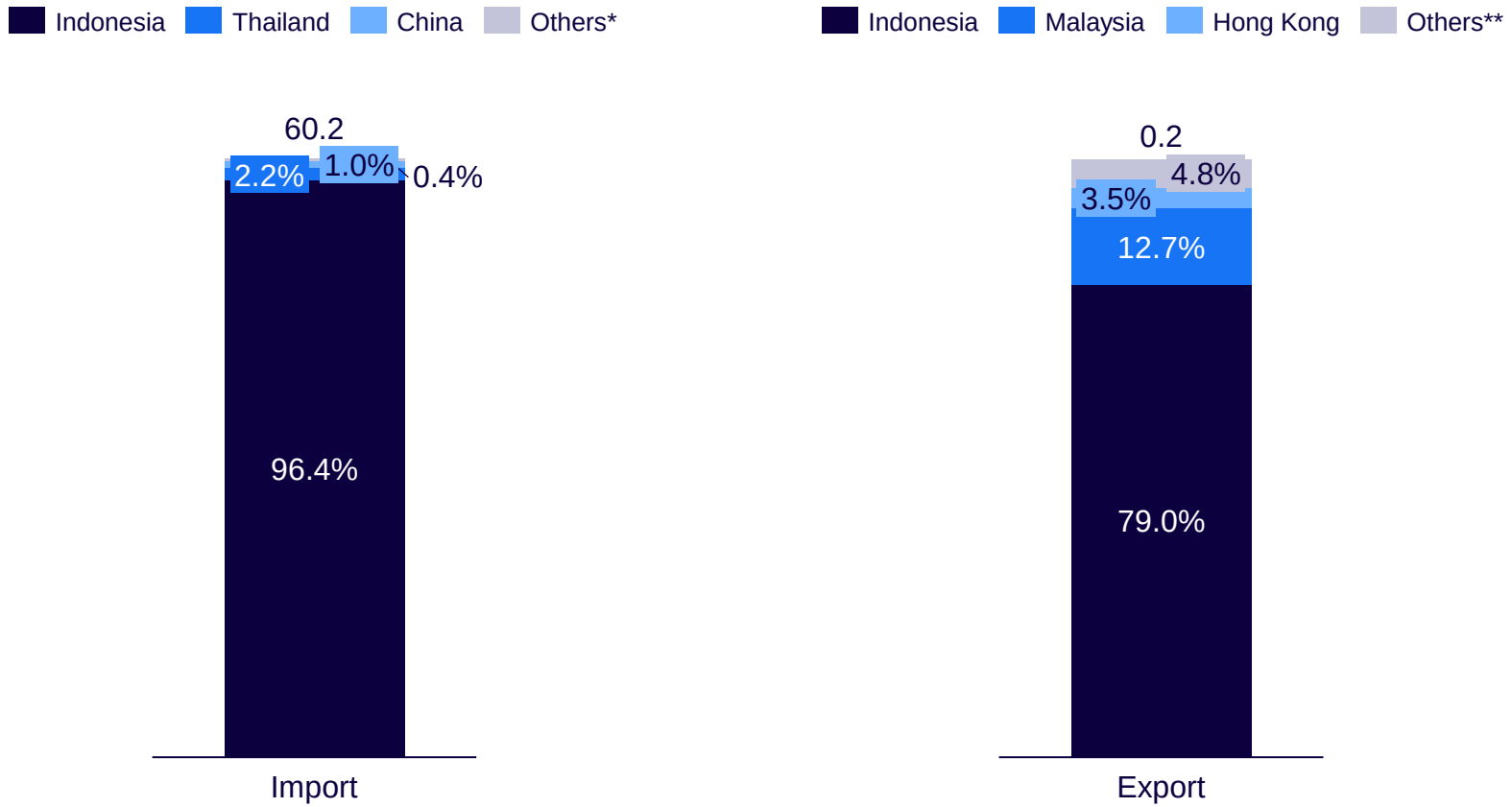
Comments

- Singapore does not produce any dry natural gas on its shores and meets domestic consumption demands through imports
- Singapore being an Oil & Gas trading hub, also engages in re-exports
- Despite COVID-19, there was not a drop in demand in the 2019 - 2021 largely due to natural gas being used as a fuel source for energy generation
- With efforts to cut down on oil usage, we can see that there is a constant increasing trend of 1.53% from 2015 -2030, for natural gas as SG transitions to becoming more dependent on natural gas for its fuel source

Note: Negative net exports means that imports are greater; 2022 – 2030 are forecasted
Source: Fitch Solutions 2022

石炭輸入はインドネシアが中心

Coal[1] trade partners
2021, USD mn



Comments

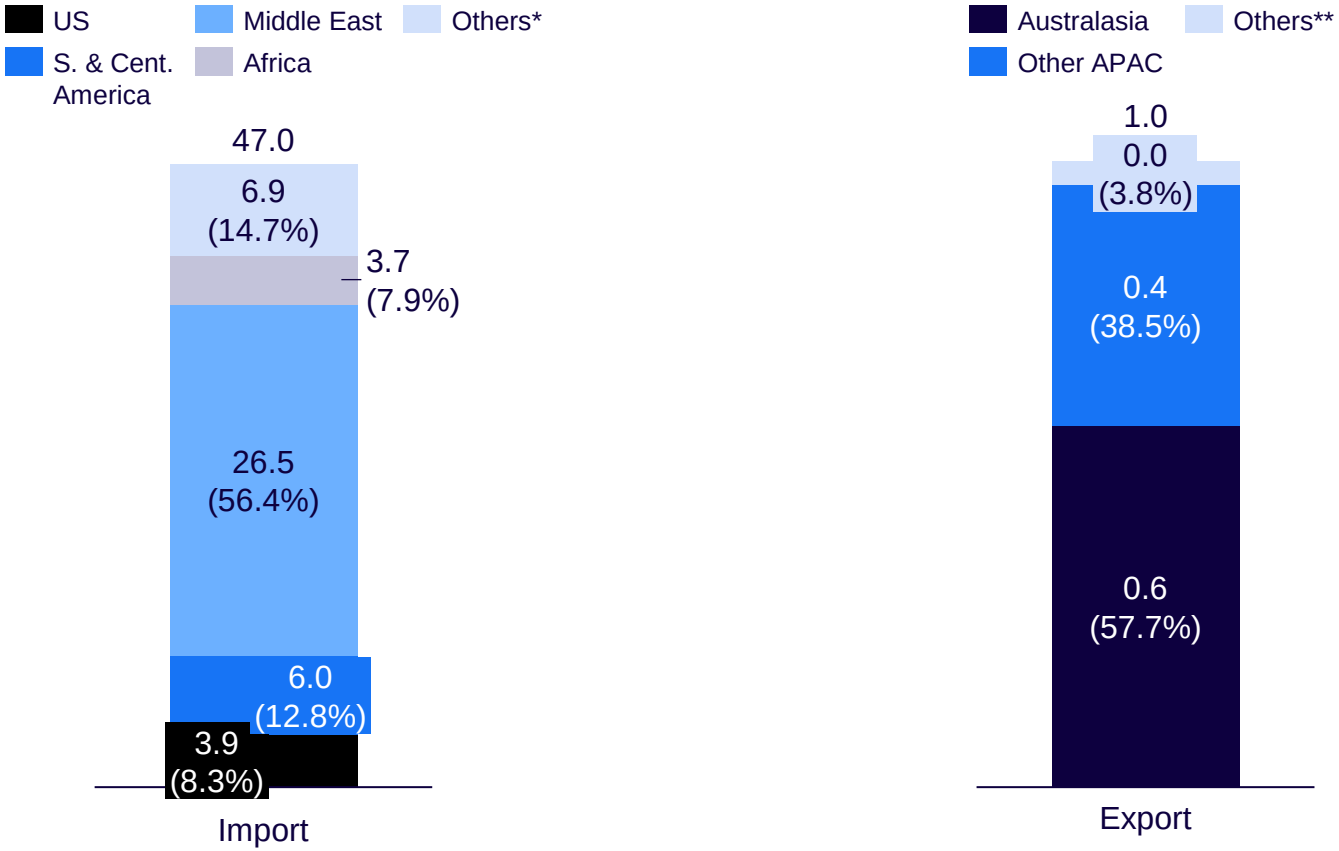
- **Coal imports from Indonesia** accounted for **USD 58 mn (96.4%)** of the total imports, followed by **Thailand** at **USD 1.3 mn** (2.2%), **China** at **USD 0.6 mn (1.0%)** and others (0.4%) consisting of Russia, Germany, France, UK, UAE, US, Australia
- Coal imports are broken down into:
  - **96.000% -** Coal other than anthracite & bituminous
  - **3.520% -** Anthracite
  - **0.034% -** Briquettes, ovoids and similar solid fuels
  - **0.046% -** Bituminous
- Coal exports are broken down into:
  - **80.3% -** Anthracite
  - **19.7% -** Coal other than anthracite & bituminous

Note: 1) Incl. Coal, griquettes, ovoids and other solid fuels manufactured from coal; * Incl. Russia, Germany, France, UK, UAE, US, Australia; **Incl. Papua New Guinea, Iraq, China, Madagascar, Maldives
Source: Trend Economy 2022

原油輸入は中東が中心

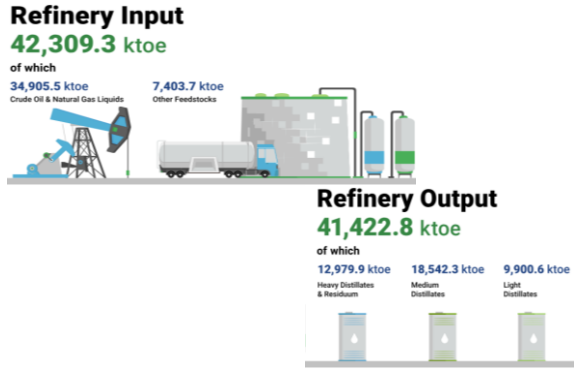
Crude Oil trade partners

2021, mtoe



Comments

- Despite economic growth in recent years, due to SG's mission to switch to natural gas, crude oil imports have taken a hit. Furthermore, with declining output, this has resulted in a reduction of crude oil exports.
- Singapore having one of the best refining capabilities in the region, separates inputs into the light (21.8%), medium (21.7%) and heavy (3.6%) for export into Australasia and countries in APAC (undefined)[1]

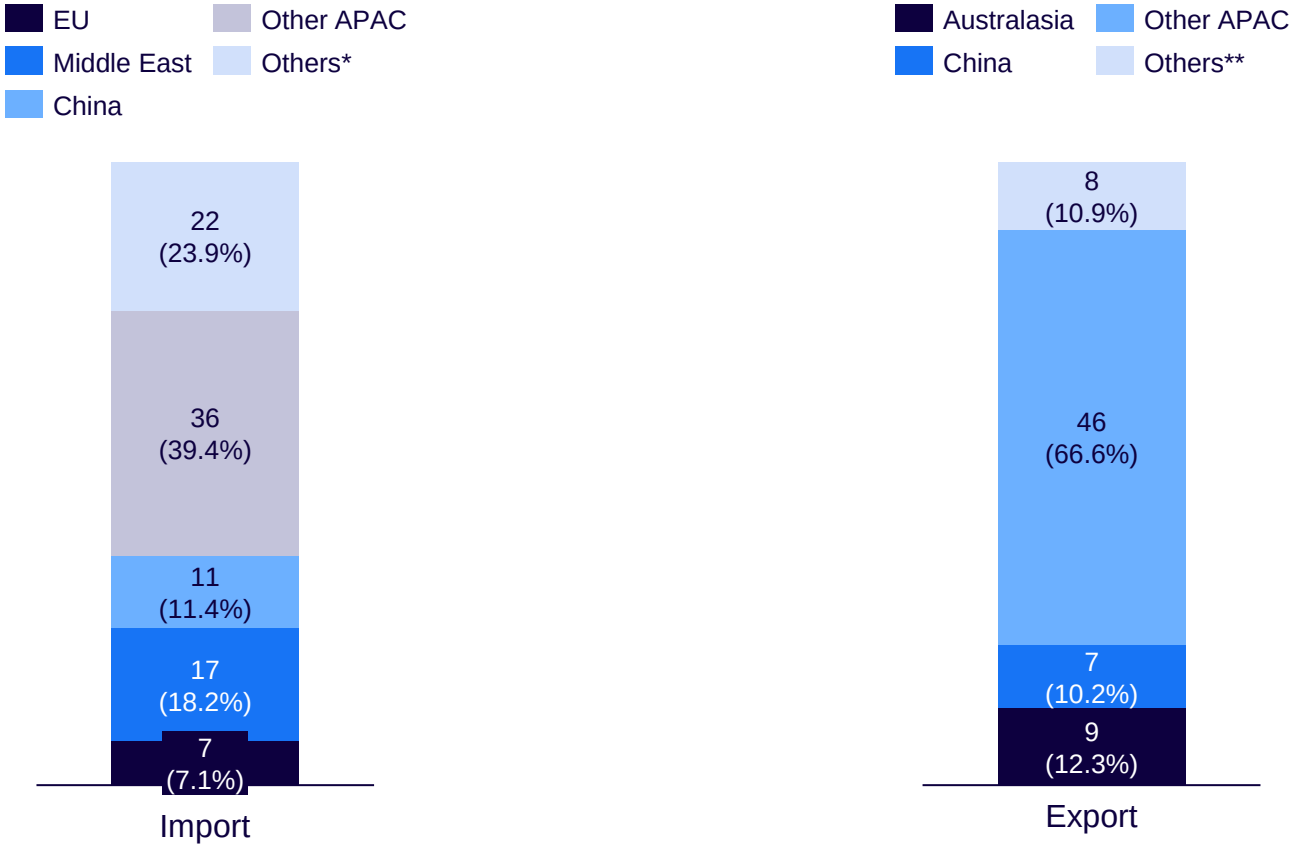


Note: Middle East consists of Iraq, Kuwait, Sauida Arabia, UAE, Other M.E. (undefined); *Others incl. of Canada, EU, Russia, Other CIS, Australasia, China, India, Other APAC; **Others incl. of S. & Cent. America, EU, M.E., Africa; 1) Figures and image are as of 2020
Source: bp Statistical Review of World Energy 2022, Energy Market Authority 2022

石油精製品は、APAC中心に輸出

Refined petroleum products trade partners

2021, mtoe



Comments

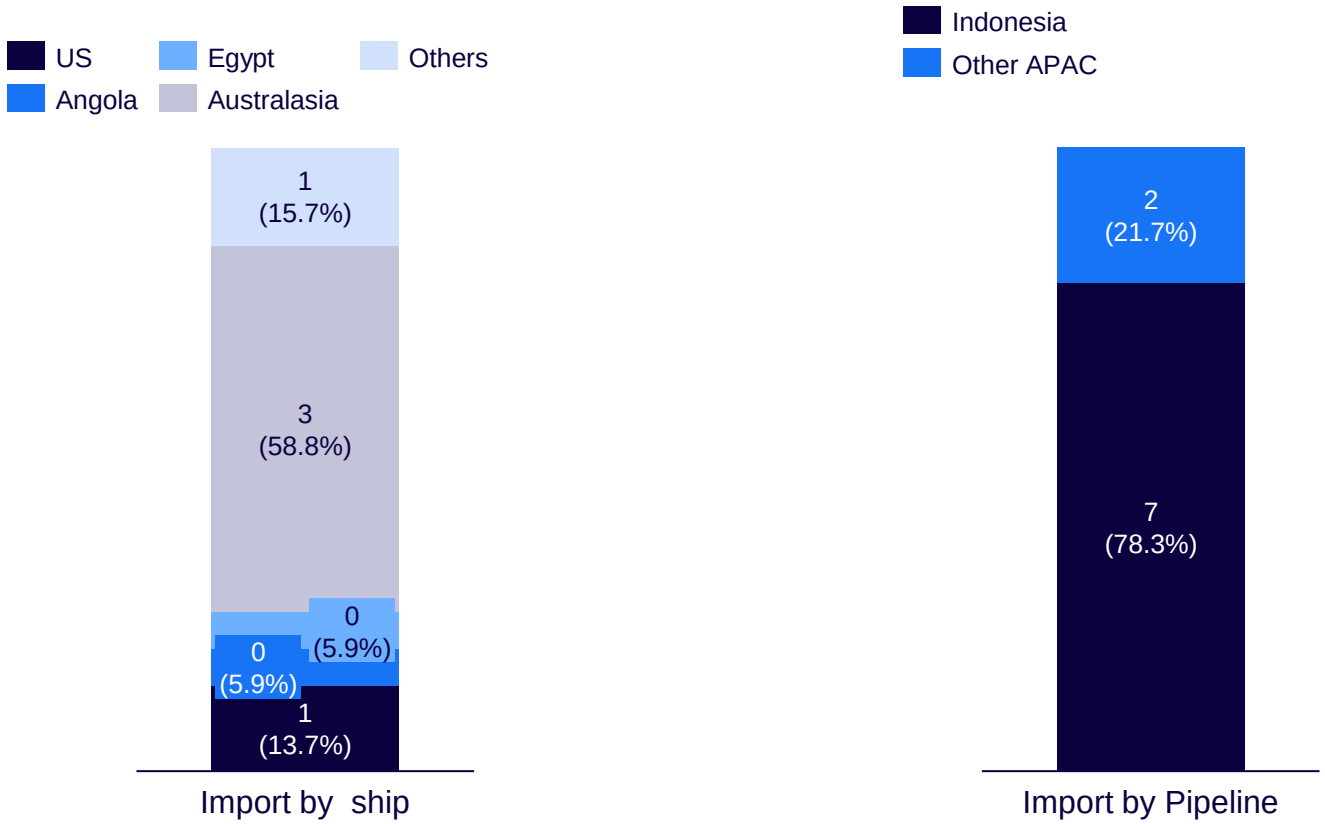
- With over 50 years of refinery experience, SG has a prominent global oil trading and refining hub, possesses advantageous attributes such as a strategic location, robust financial system, reliable infrastructure, transparent legal system, and a skilled workforce
- The country's crude oil refining capacity stands at 1.5 mn barrels per day (bpd)
- Three key refineries:
  - ExxonMobil's refinery at Pulau Ayer Chawan with a capacity of 605,000 bpd
  - Royal Dutch/Shell's refinery on Pulau Bukom with a capacity of 500,000 bpd
  - Singapore Refining Company's refinery on Pulau Merlimau with a capacity of 290,000 bpd

Note: *Others incl of Canada, Mexico, US, S. & Cent. America, Russia, Other CIS, Australasia, India, Japan; **Others incl of Canada, Mexico, US, S. & Cent. America, EU, Russia, Other CIS, M.E., Africa, India, Japan
Source: bp Statistical Review of World Energy 2022, International Trade Administration 2021

天然ガスは、海上輸送はオーストラリアが中心で、パイプラインはインドネシアが中心

Natural gas trade partners（import)

2021, bn m^3



Comments

- Imports from Australasia accounted for 3 bn m3 (58.8%) of the total imports, followed by USA at 0.7 bn m3 (2.2%) and then Angola and Egypt at 0.3 bn m3 (5.9%) each
- SG does not export any natural gas at this point

Source: bp Statistical Review of World Energy 2022

シンガポールは石炭発電所の縮小をコミットしている

Status of decreased coal usage

Singapore Asia Taxonomy

- Launched by MAS to assist Singapore in its decarbonisation efforts
- Main goal of helping financial institutions identify activies that can help them achieve net-zero goals fast
- Early retirement of coal-fired power plants
- Multiple rounds of consultation with the final version being released in Q2 2023

Powering Past Coal Alliance (PPCA)

- Singapore joined the Powering Past Coal Alliance (PPCA) at COP26, one of the first Asian countries to do so
  - Signed the Global Coal to Clean Power Transition statement
- Committed to
  - Phase out the use of unabated coal in electricity mix by 2050
  - Restrict direct government finance of unabated coal power internationally
- Coal has made up for <2% of final energy consumption YOY for the period 2005 - 2021

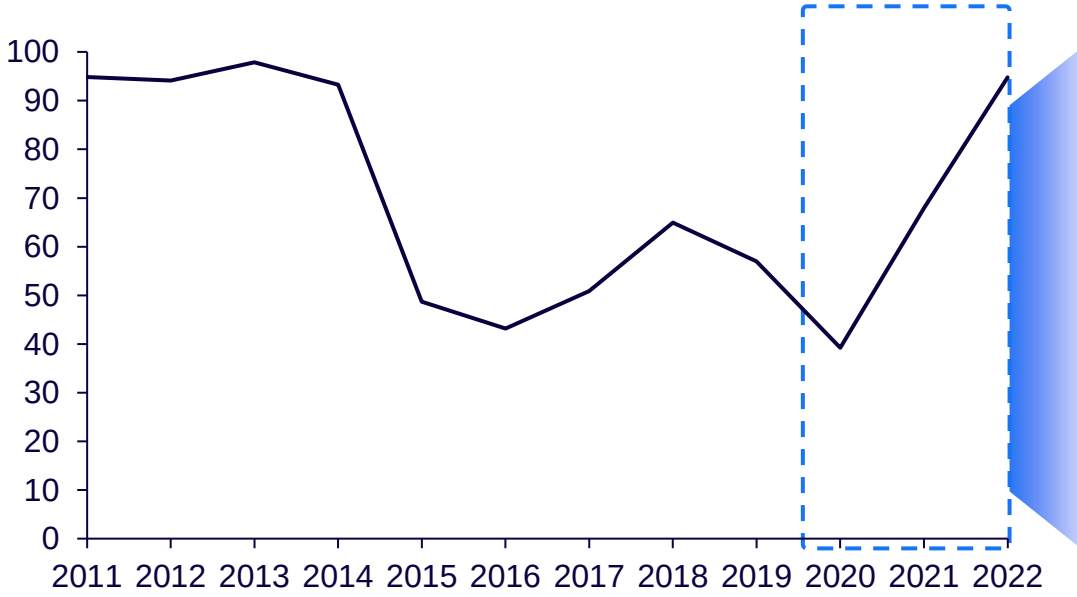
Source: The Straits Time 2023, National Climate Change Secretariat (NCCS) 2021

シンガポールにおいては近年ガソリン価格は大幅に上昇している

Global average monthly WTI spot price

2011 – 2022, USD/barrel

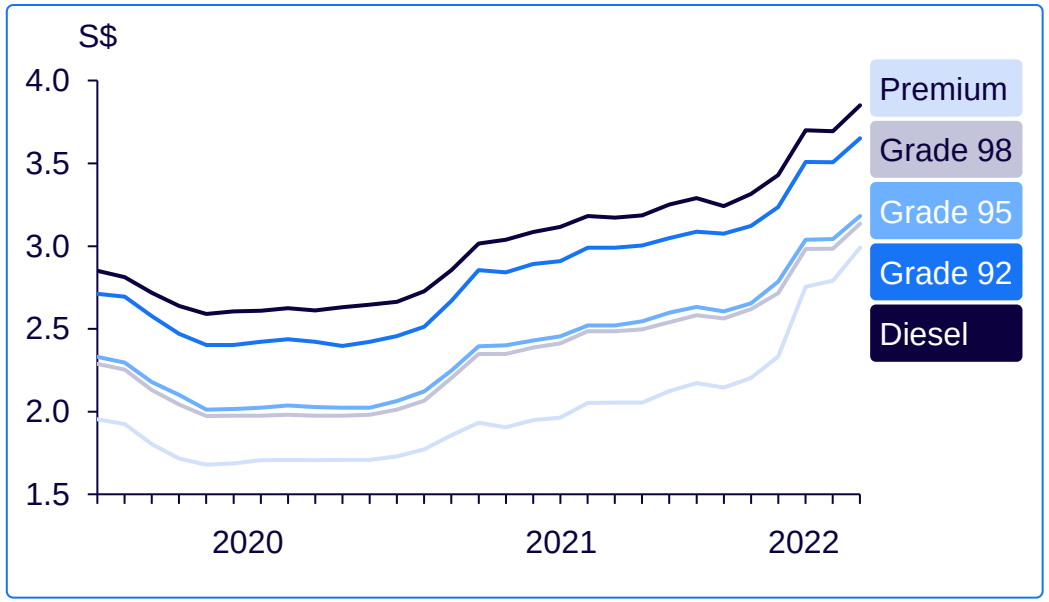
- After bottoming out in 2020, fuel prices saw a steady increase into 2021 due to opening of the economy, as well as supply constraints as refineries could not keep up
- Following the breakout of the Russia-Ukraine war, global oil prices saw a spike in demand, which spilled over to the multiple petrol grades in SG



Official selling price of Retail Petrol Prices

Jan 2020 – May 2022, SGD/litre

- The most utilized grade 95 petrol ranges between S$3.26 (Sinopec) and S$3.33 (Shell, Carltex), in Jun 2022, up from S$3.16-3.25
- The premium grade 98 moved onto break the S$4 mark hitting a peak of S$4.04 (shell), for the first time in history, however this petrol grade is only used by a minority of cars in SG

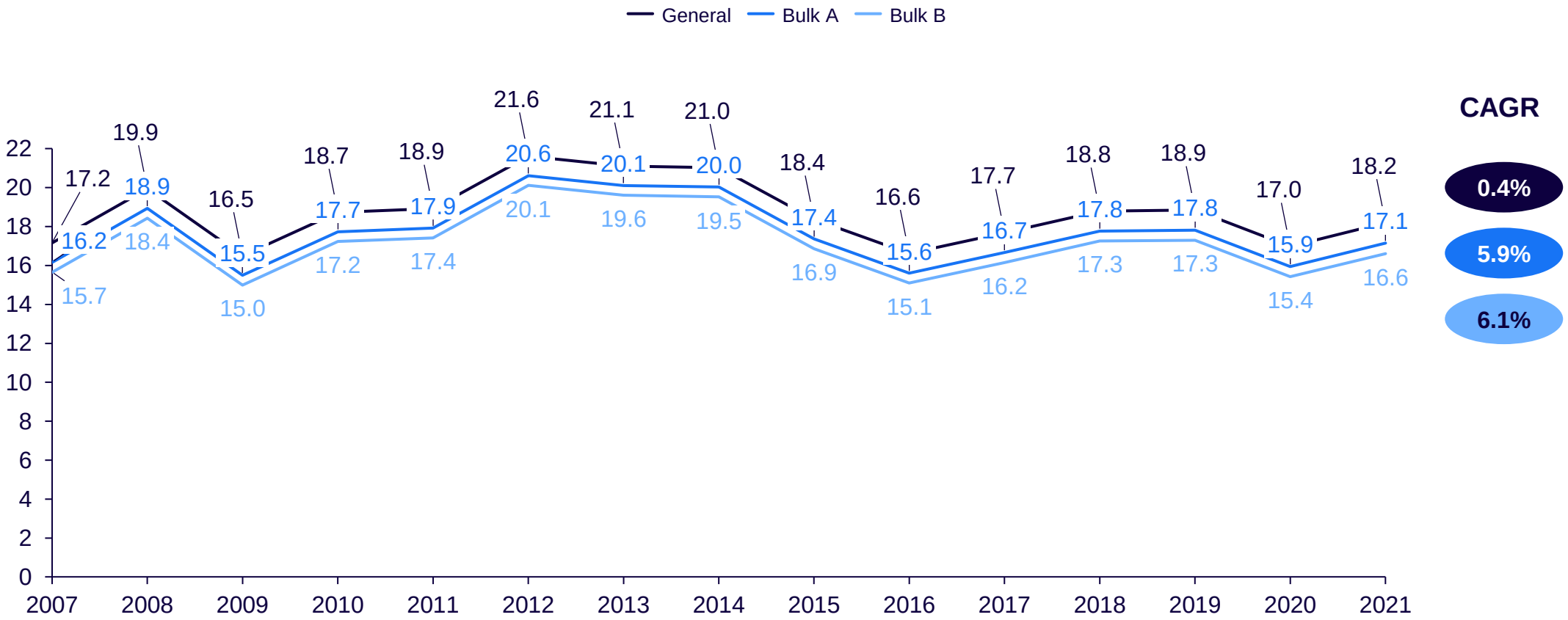


Source: The Straits Times 2022

一方で都市ガス価格は安定的に推移

Town gas tariffs

2007 – 2021, US Cents/kWh



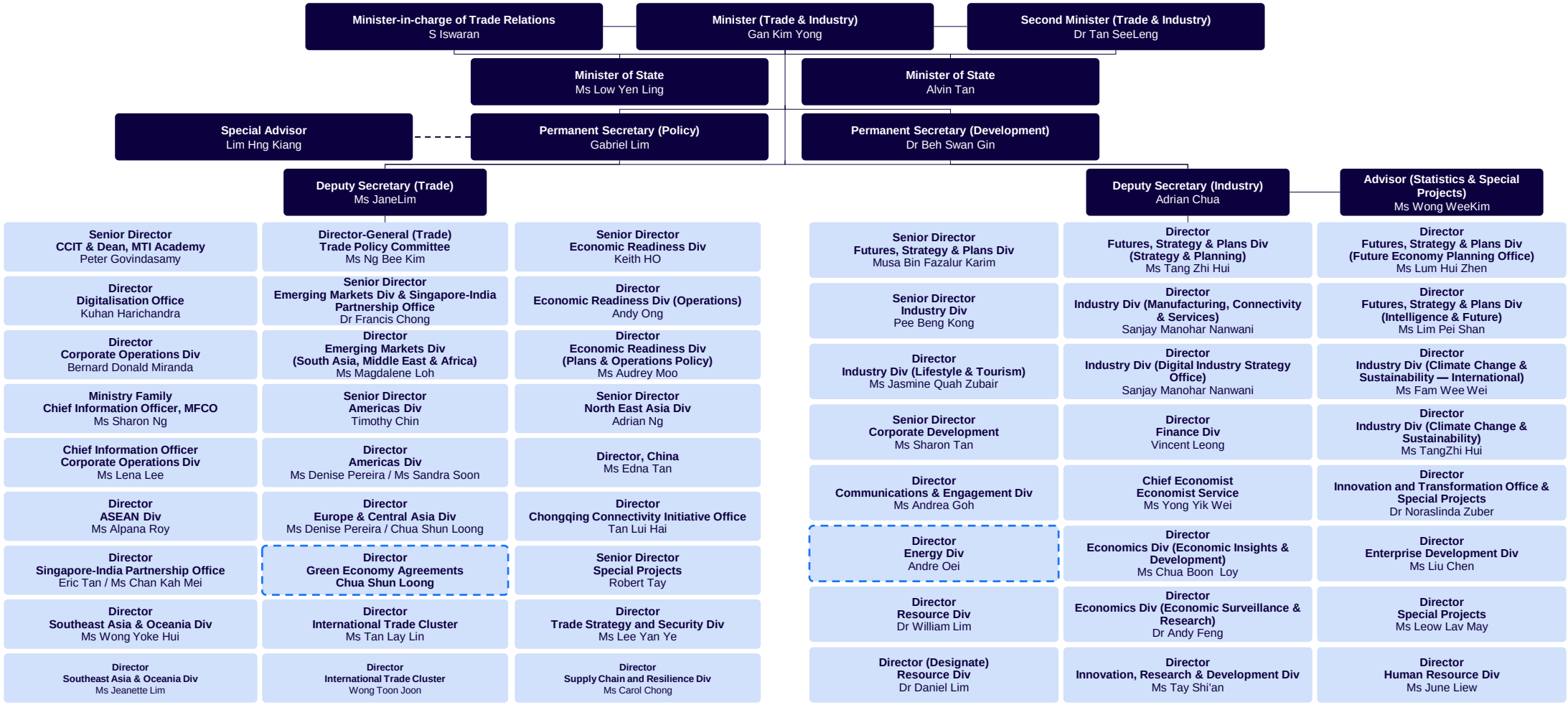
Note: General= consumption of <1 MWh/month, Bulk A= consumption of >1 MWh/month, Bulk B= consumption of >50 MWh/month
Source: Energy Market Authority 2022

エネルギーにまつわる政府機関は、EMAが中心

Ministry	Department	Role & responsibility
Ministry of Trade and Industry [MTI]	Energy Division	Develops energy policies and strategies for Singapore's sustainable energy future. They collaborate with the Energy Market Authority, government agencies, academics, and private stakeholders to foster competitive energy markets, promote renewable energy sources like solar power, and encourage international cooperation.
Energy Market Authority (Statutory board under MTI) [EMA]	Economic Regulation Division	Facilitates competition and fair market practices by regulating the electricity and gas industries
	Energy Planning and Development Division	Manages the planning and development of initiatives within the energy sector
	Industry Regulation Division	Ensures consumer safety, reliability, and security in the electricity and gas industries
	Power System Operation Division	Oversees the power system operations in Singapore, guaranteeing a consistent and dependable electricity supply to consumers
Ministry of Sustainability and the Environment [MSE]		• Enacting laws and regulations to protect the environment, • Tackle issues such as pollution control, sewerage, drainage and environmental health
National Environment Agency (statutory board under MSE) [EMA]		• Collaborates closely with partners and the community to develop and lead environmental and public health initiatives and programs • Main roles are; to improve and sustain a clean environment, foster sustainability and optimise resource utilisation, uphold stringent public health standards, deliver accurate and timely meteorological information and foster a dynamic and thriving hawker culture

Sources: MTI 2023, EMA 2023, MSE 2023, NEA 2023

Organizational Chart of Ministry of Trade and Industry



Source: MTI 2023

EMAの体制は以下

Energy Market Authority (EMA)

- The Energy Market Authority (EMA) is a statutory board under the Ministry of Trade and Industry.
- EMA's main goals are to ensure a reliable and secure energy supply, promote effective competition in the energy market and develop a dynamic energy sector in Singapore.
- EMA has three main roles: 1) Power system operator 2) Industry developer 3) Industry regulator.
- EMA is led by a CEO and has five divisions.

Corporate Service Group	Economic Regulation Division	Energy Planning and Development Division	Industry Regulation Division	Power System Operation Division
• Builds professional capabilities and capacity within EMA.	• Regulates primarily the electricity and gas industries. • Promote and safeguard competition and efficient market conduct.	• Develop long-term energy strategies and plans. • Growth of the energy industry and develop a dynamic energy landscape. • Drive relations and cooperation with key international players in energy.	• Regulates the electricity, town gas and natural gas industries to ensure adequacy and reliability of supply by setting and monitoring compliance to various regulatory requirements.	• Arranges for the secure operation of the power system in Singapore and ensures the security of supply of electricity to consumers.

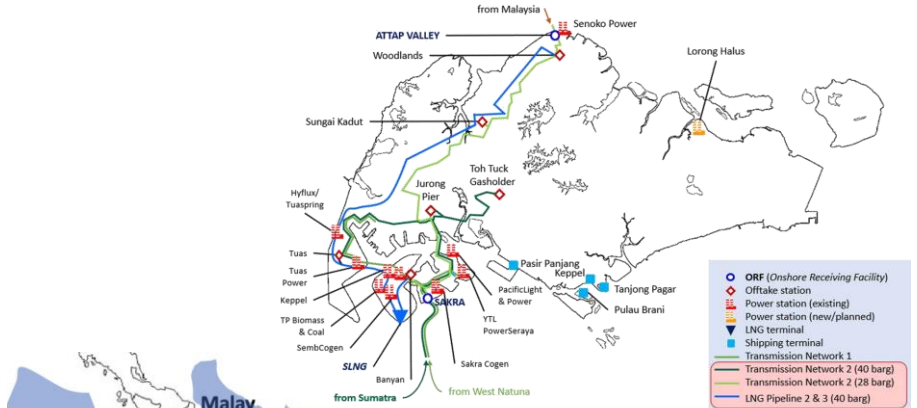
Source: EMA 2023

3 パイプライン（ガス・石油）

パイプライン天然ガスは、インドネシアのナトゥナ島およびマレーシアのスマトラ島から輸入

Gas Pipeline Network/Projects

- Singapore's piped natural gas is imported from S. Sumatra and W. Natuna in Indonesia (7.2 bn m3) and Malaysia (2.0 bn m3)
- S. Sumatra, Grissik-Batam-Singapore Pipeline
  - 468km ultra-deepwater pipeline, capacity of 650 mmscf/day
  - Owned by PT Pertamina (60%), ConocoPhillips (14%), Petroliam Nasional (14%), China National Petroleum (6%), Repsol (6%) and Others (~1%)
- W. Natuna, W. Natuna-Singapore Pipeline
  - 654km sub-sea gas pipeline, capacity of 700 mmscf/day (can be increased to 1,000 mmscf/day via mid-stream compression)
  - Owned by PT Medco Daya Abadi Lestari (75%) and Prime Natuna Energy (25%)



Source: Gas Supply 2022, EMA 2022, Offshore Technology 2021

Gas SupplyとSembcorp Gasはインドネシアから天然ガスを輸入しており、2028年まで契約が延長される見込み。Keppel Gasはマレーシアのpetronasと契約締結中

Existing imported gas contracts(Via pipelines)

- SG currently has 2 long term LNG importers (since 2016), with exclusive rights to import up to 1Mtpa of LNG each or for up to 3 years (ended Apr 2021)
  - Pavilion Energy
  - Shell
- To break up the duopoly, ExxonMobil LNG Asia Pacific and Sembcorp Fuels were appointed as additional term LNG importers
  - As of July 2022, SG made available two more import licenses and accepted bids for them
  - This comes on the onset of the piped natural gas contract from Indonesia to expire before the decade and to develop SG's position as a trading and LNG services hub

Latest Comments

- **Gas Supply** has a deal to **import around 3.6bcm of gas from Sumatra,** while **Sembcorp Gas has a contract with Indonesian state energy company Pertamina for the supply of 3.36-3.51bcm of gas** (plus a further 0.89bcm from 2010) **from West Natuna.** West Natuna has supplied gas as part of a 22-year deal since January 2001, while a pipeline from Asamera in Sumatra began supplying gas in 2006.
  - **As of Oct 2022, these agreements are set to be extended for a period of 5 years (till 2028)**
- **Keppel Gas current has 3 gas deals with Petronas,** the first a USD 3bn, 18-year contract to supply 1.2bcm annually, signed in July 2005. The gas supply pipeline will have a 3bcm pa capacity and will flow from Plentong, Malaysia to the Senoko facility in northern Singapore. The latest Heads of Agreement (HoA), signed in 2014, allows Keppel to buy 1 mtpa of LNG for 10 years till 2024.
- Pavilion Energy and Petronas signed a MOU in 2017 to explore opportunities in LNG businesses, as Senoko's contract with Petronas ended in 2018

Source: EMA 2022, The Straits Times 2022, Press releases 2014, 2015, 2017

また天然ガスの輸入を増やすべく、LNGターミナルの拡張を計画し、5億ドル以上の投資を見込む

Existing imported gas contracts(Via pipelines)

- LNG terminal: The Singapore LNG terminal is the country's first regasification terminal and came online in 2013. The terminal has four tanks, two jetties and an additional regasification facilities with throughput capacity of 11 Mtpa. It futher has the ability to accommodate 3 more storage tanks with a total capacity of 15 Mtpa

- **Oil refineries**
  - Singapore has three large refineries: ExxonMobil (605,000 bpd) at Pulau Ayer Chawan, Royal Dutch/Shell (500,000 bpd) refinery on Pulau Bukom and the Singapore Refining Company (290,000 bpd) refinery on Pulau Merlimau

Future plan

- **Oil refineries:** Exxon Mobil is expanding its capacity in its largest refinery with an investment will add 20,000 bpd of ExxonMobil Group II base stocks capacity, which includes EHC™ 50 and EHC™ 120 grades, in addition to a new high-viscosity Group II base stock. Estimated to resume operations in 2023
- Neste Corporation newly expanded refinery opened in mid-April 2023, doubleing its capacity to bring it to a total of 2.6 MT/year, of which 1 MT could be sustainable aviation fuel (SAF) which strengthens its position as the world’s leading SAF producer
- **LNG terminal:** SG is investing over US$500 million to expand its existing LNG Terminal. This expansion is part of Singapore's strategic goal to become a leading hub for natural gas trading and trans-shipment in Asia. Upon completion of all phases, the terminal will have a capacity to handle nine million metric tons per year, positioning Singapore as a potential LNG bunkering center in the future.

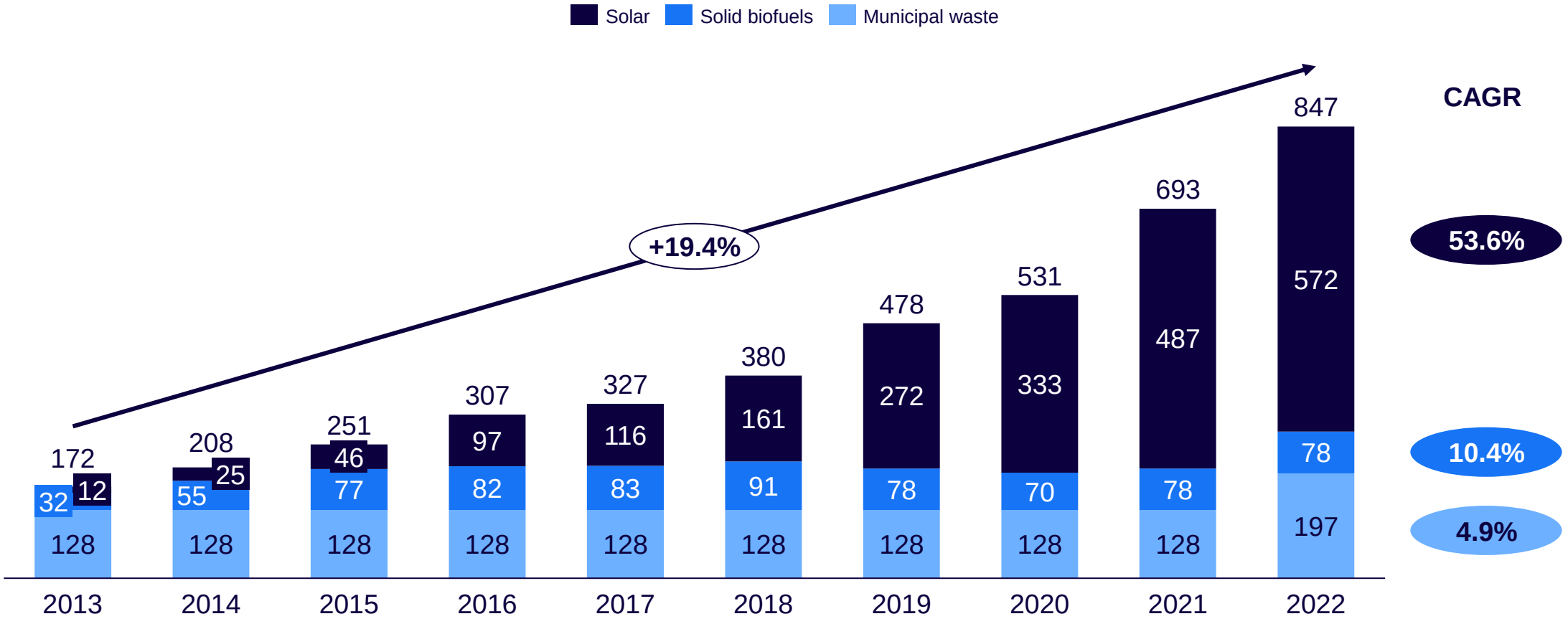
Source: ITA 2021, EMA 2022, Press Release 2019, 2023

4 次世代・再生可能エネルギー

再生可能エネルギーの中心は太陽光となっている

Cumulative RE Capacity for Singapore

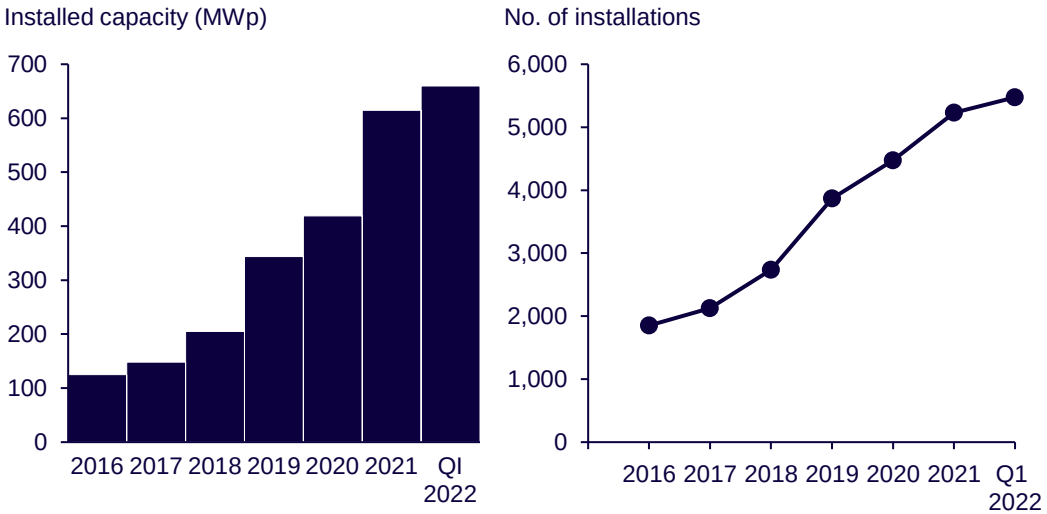
2012-2022, MW



Source: IRENA 2022

太陽光の設置状況は以下

Capacity and No. of systems as 1Q 2022



- As of the end of the first quarter of 2022, Singapore's solar PV capacity was primarily dominated by the non-residential private sector, accounting for 61.7% (413.1 MWp) of the total installed capacity. Town councils and grassroots organizations held 28.3% (189.6 MWp) of the capacity. Public service agencies and residential installations contributed 6.7% (45.2 MWp) and 3.3% (22.1 MWp) respectively.
- During the same period, Singapore had a total of 5,455 solar PV installations. Town councils and grassroots units comprised the majority with 48.9% (2,668 installations), followed by residential installations with 34.7% (1,891 installations), and the non-residential private sector with 13.0% (707 installations). Public service agencies made up the remaining 3.5% (189 installations) of the total installations.

Distribution of Solar Installation in Singapore

Total Number of Solar Photovoltaic (as at end QI 2022)
5,455 Installations

of which
3,564 Non-Residential
1,891 Residential

North N
Total 85,781.8 kWp
84,889.8 kWp Non-Residential
892.8 kWp Residential
Total 838 Installations
763 Non-Residential
75 Residential

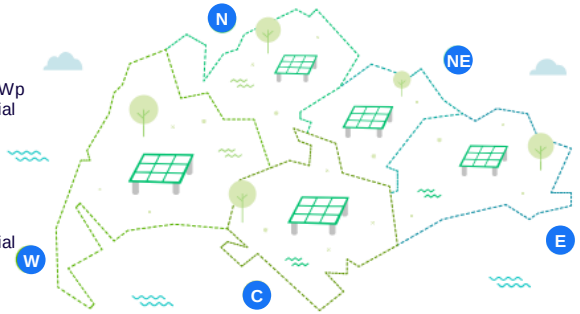
North East NE
Total 77,681.5 kWp
72,046.5 kWp Non-Residential
5,634.9 kWp Residential
Total 1,555 Installations
813 Non-Residential
742 Residential

Total Installed Capacity (as at end QI 2022)
670,093.9 kwp

of which
647,970.7 Non-Residential
22,123.3 Residential

West W
Total 319,697.9 kWp
318,402.9 kWp Non-Residential
1,295.0 kWp Residential
Total 1040 Installations
404 Non-Residential
635 Residential

Central C
Total 54,834.1 kWp
44654.4 kWp Non-Residential
10179.7 kWp Residential
Total 1,225 Installations
1,126 Non-Residential
99 Residential



East E
Total 132,098.6 kWp
127,977.8 kWp Non-Residential
4,120.8 kWp Residential
Total 798 Installations
458 Non-Residential
340 Residential

Source: EMA 2023

RE Projects in the pipeline[1]

Kranji Floating Solar	
Capacity (MW)	82
Start up date	2024
Status	Approved

Unknown Solar PV	
Capacity (MW)	14
Start up date	2024
Status	Unannounced

Unknown Solar PV	
Capacity (MW)	112
Start up date	2025
Status	Unannounced

Unknown Solar PV	
Capacity (MW)	176
Start up date	2026
Status	Unannounced

Unknown Solar PV	
Capacity (MW)	207
Start up date	2038
Status	Unannounced

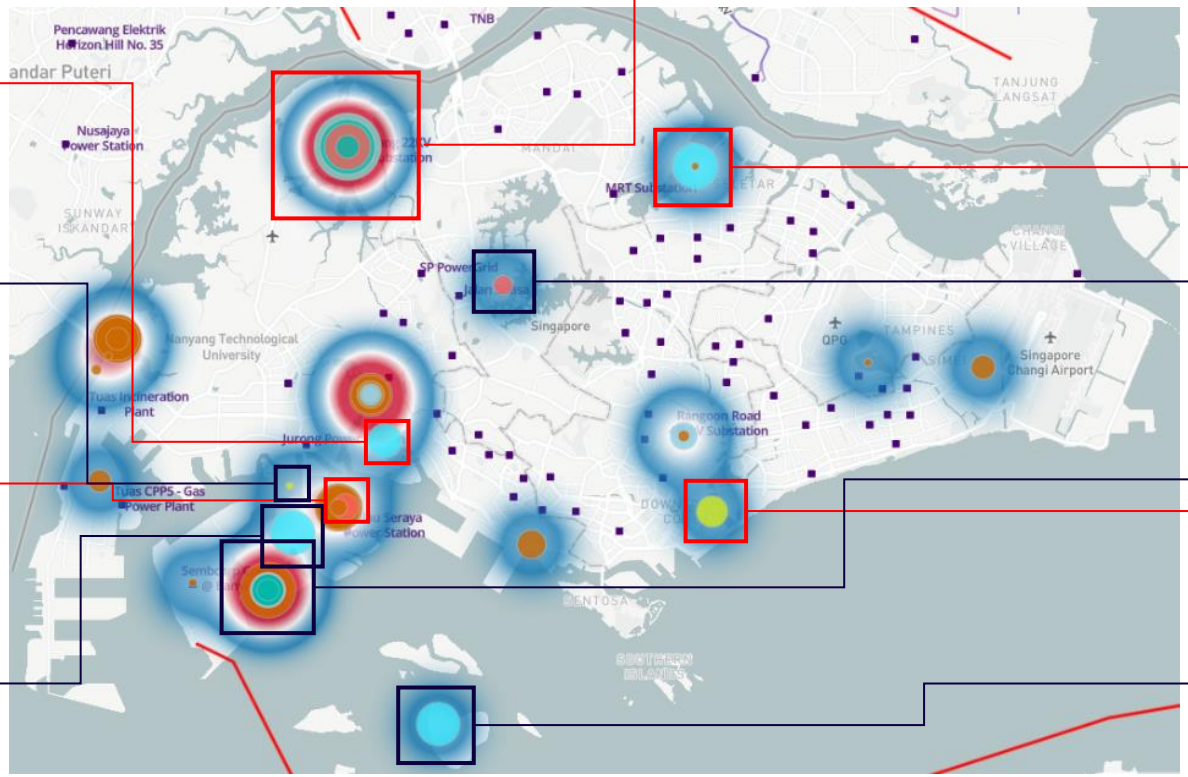
Upper Pierce Floating Solar	
Capacity (MW)	5
Start up date	2024
Status	Approved

Pandan Floating Reservoir PV	
Capacity (MW)	32
Start up date	2025
Status	Concept

Jurong Floating PV Pilot	
Capacity (MW)	1
Start up date	2023
Status	Fin. Close

SolarLand 1 Extension	
Capacity (MW)	20
Start up date	2024
Status	Approved

SolarLand 4 Tender	
Capacity (MW)	73
Start up date	2028
Status	Concept



Lower Seletar PV expansion	
Capacity (MW)	80
Start up date	2025
Status	Concept

Singapore Green Methanol	
Capacity (MW)	30
Start up date	2025
Status	Fin. close

Battery Storage unit x3	
Capacity (MW)	72
Start up date	2030-39
Status	Unannounced

Semakau Landfill Solar	
Capacity (MW)	58
Start up date	2026
Status	Concept

Note: Colours are purely for visualisation and do not hold any meaning; 1) Non-exhaustive
Source: Rystad Energy 2023

従来は、シンガポールの市場は限定的とされていたが、近年NesteやShellによりバイオ燃料や航空燃料の生産が見込まれ始めている

Development of Biomass Production

- Due to its size, and lack of agricultural land, SG has an underdeveloped biomass potential
- As quoted from Dr Thomas Reindl, Deputy Chief Executive Officer at the Solar Energy Research Institute of Singapore (SERIS) in the National University of Singapore (NUS), “In the absence of other renewable energy resources such as wind, hydropower, or biomass, harvesting the sun’s energy is the most viable form of green electricity generation in Singapore”
  - Which is consistent with the government’s plan on developing more solar installations across the island
- There has also been decreased global investment in RE R&D, leaving initial interest in bioenergy to wane
- Initial feasibility test of using biomethane in current natural gas-fired CCGT plants were a success. However, cost-reductions could not be quantified, resulting in an underdeveloped supply chain

Future Plan

- Singapore has negligible local market. The produced biodiesel will be mostly for export.
- Neste Corporation started commercial production at its 1.3 mtpa renewables fuels expansion project in Jun 2023
  - The plan will boost Neste’s sustainable aviation fuel capacity by up to 1mtpa
  - Neste is a Finnish company that produces renewable fuels largely from waste and residues from food industry like used cooking oil and animal fat
- Royal Dutch Shell is planning to build a biofuels plant in Pulau Bukom with a capacity of 550 Mtpa to help meet its emission of goal halving by 2030 (pending final investment decision)
  - The plan will produce diesel for road transport, aviation fuel or chemicals
  - At the same time, Shell cut its crude-processing capacity at Pulau Bukon

Source: EMA 20th Anniversary Book, Singapore Energy 2050 Committee report, Reuters 2023, Bloomberg 2021

シンガポール政府は、脱炭素に向けCCUSも重要なソリューションとして位置づけ

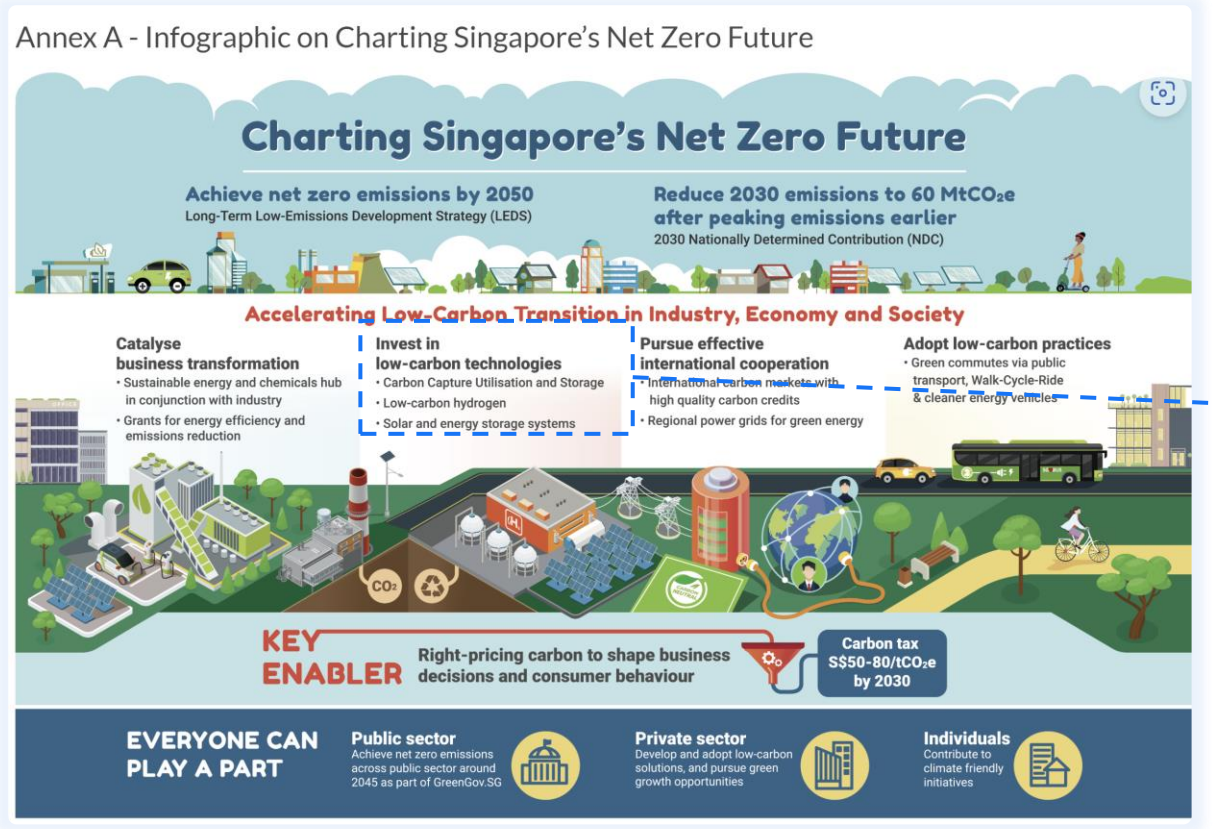
CCUSの政府動向

CCUS事業の推進に対する動向	• CCUSをLong-Term Low-Emissions Development Strategy (LEDS)における重要ソリューションと位置づけ • カーボンプライシングを採用するなど規制が生まれつつあるが、補助政策が充実しているわけではない
各種政策（産業/エネルギー/環境）	• UNFCCCに、CCUSが重要な戦略の１つであるという認識を提出１） • 国家機構変動事務局による、長期低炭素開発戦略の、１つの例として“CCUS”を取り上げている
規制	• カーボンプライシング法案が運用されている
支援策 補助金	• 低炭素エネルギーソリューションのための研究開発費用への支援 • 排出削減投資控除の優遇措置２）

Source: 各種2次情報よりADL作成
Note: 1: IEA「Carbon Capture Utilizsation and Storage; The Opportunity in Southeast Asia 2021」2) EDB 「ジュロン島を持続可能な化学・エネルギー産業拠点に」

国家気候変動事務局が発表した長期低炭素開発戦略（LEDS）ではCCUSが取り上げられている

LEDS/NDCにおけるCCUS

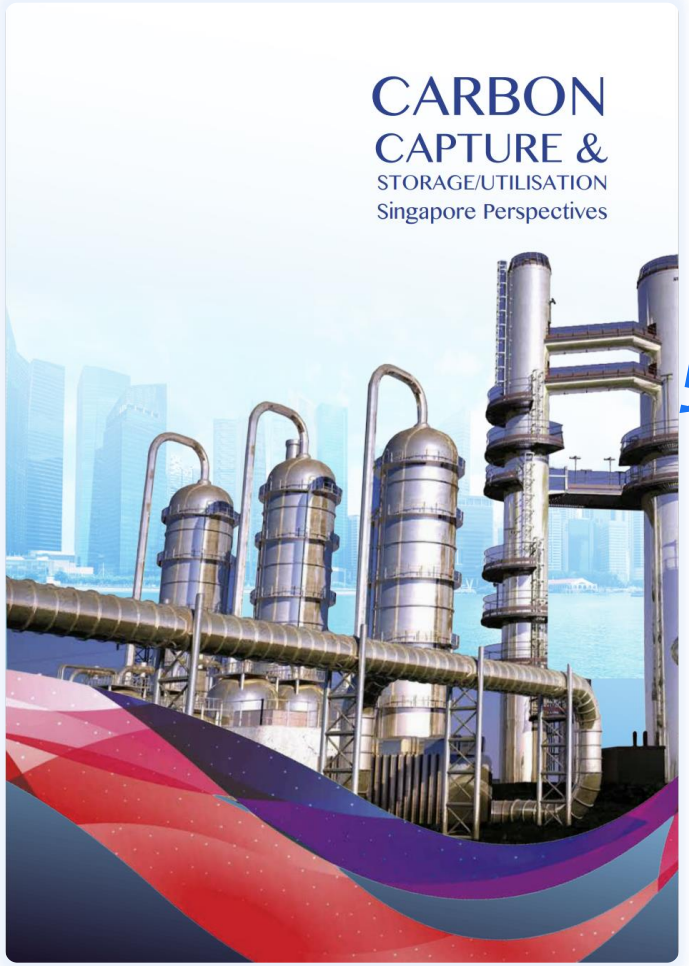


LEDS/NDCの改定版を2022年末提出
その柱として、以下4つを提案

- 産業、経済、社会の変革（再エネ比率向上、効率の向上、消費の削減）
- <u>高度な低炭素技術の採用（例えばCCUSなど）</u>
- 国際協力を促す
- 低炭素社会への移行（移動のグリーン化）

Source: Singapore Commits to Achieve Net Zero Emissions by 2050 and to a Revised 2030 Nationally Determined Contribution; Public Sector and Jurong Lake District to Lead The Way with Net Zero Targets 2022年10月

シンガポールではCCSについては、有望貯留地がなく実行するには国際輸送が必要とされており、“U”の化学製品への活用などは有望と考えられている



CC”S”について

- **The absence of suitable storage sites in Singapore means foreign sites will have to be sought.**
- International geopolitical and corporate negotiations will be necessary if Singapore decides to pursue CCS.
- Furthermore, R&D for the long-range cost-effective transport of concentrated CO2 to off-shore or regional sites will be essential.

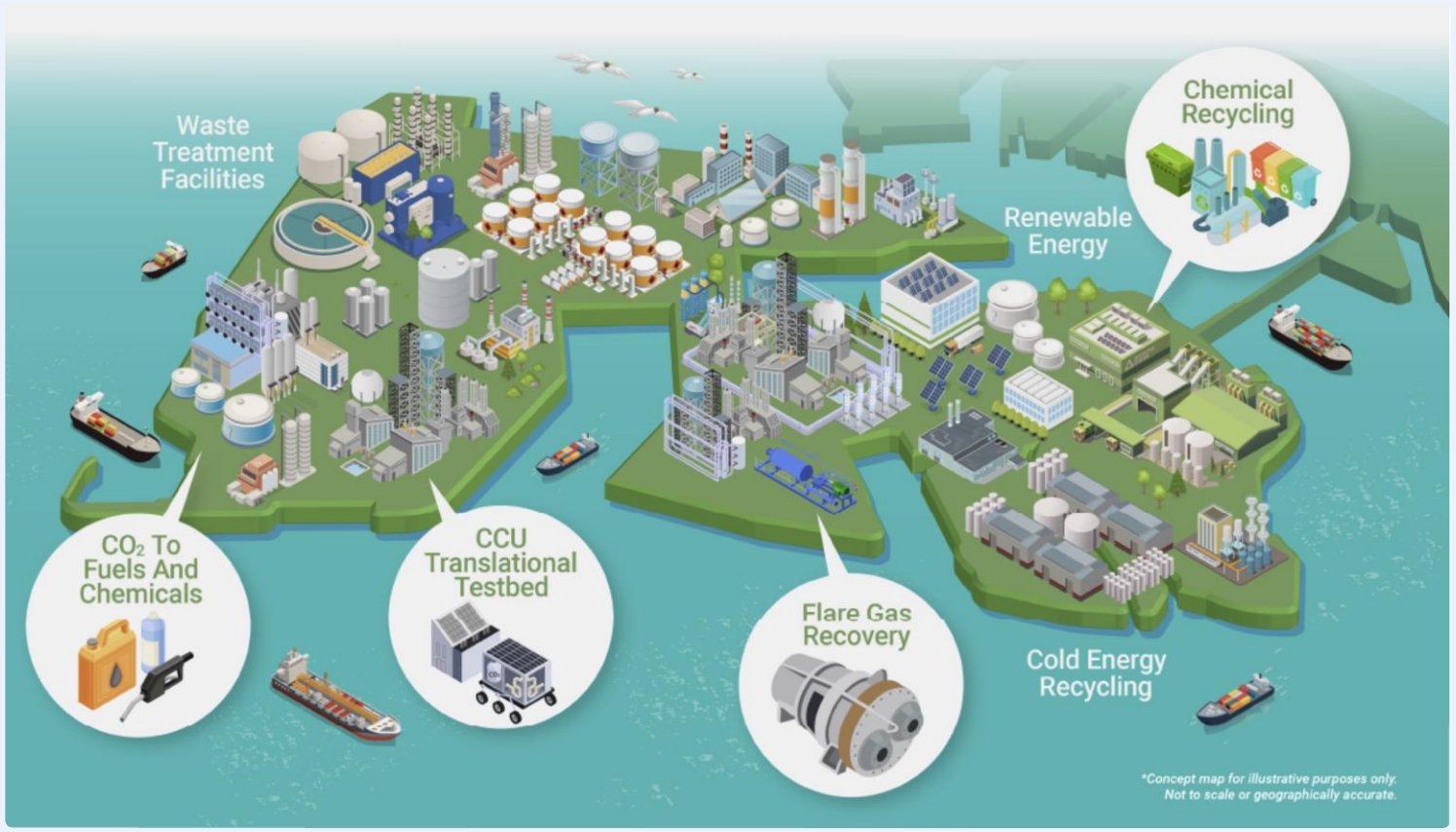
CC”U”について

- Due to Singapore’s constraints in renewable energy generation, careful assessment on the best way to utilise the renewable energy may be required.
- **For CCU to be practical, there must be a demand for the products. However, utilisation of Singapore’s CO2 alone to produce chemicals such as formic acid, acetic acid and formaldehyde would far surpass the global demand for these products. T**

Source: NCCS “CARBON CAPTURE & STORAGE/UTILISATION Singapore Perspectives

化学・エネルギー産業の集積地である、ジュロン島においてCCUの取り組みが促進されている

ジュロン島の“持続可能な化学・エネルギー産業拠点”化



- 「サステナブル・ジュロン島」を掲げ、2050年に向け
  ①持続可能な製品の生産量を2019年比で4倍に引き上げ
  ②低炭素ソリューションによる年間600万トン以上のCO_2削減を掲げる
- また2030年に向け
  ①持続可能な製品の生産量の2019年比で1.5倍
  ②シンガポールの製油所のエネルギー効率を上位1/4
  ③200万トン以上のCO_2回収
- 「CCU Translational Testbed」の設置の検討

Source: EDB「ジュロン島を持続可能な化学・エネルギー産業拠点に 2022年3月13日」

ジュロン島において、Chevron、Air Liquide、Keppel Infrastructureが等がCCUSの実装に向けて研究開発を開始、またCO₂液化海上輸送PJもスタート

ジュロン島におけるCCUSのFSを行うコンソーシアム

実施主体	• Chevron • Air liquid • Petrochina , Keppel infrastructure
検討開始年	• 2022年
目的	• シンガポールにおけるCCUSの技術的、物流的、運用的ソリューションを研究、テスト、開発
CO2排出源	• ジュロン島の工場
CO2活用法	• プラスチック、燃料などへの転換 • アジア太平洋地域の貯留層への輸送による Storage
政府による PJへの支援	• 検討段階のため未定

商船三井とシェブロンのCO₂輸送 PJ

実施主体	• Chevron • 商船三井
検討開始年	• 2022年
目的	• シンガポールで排出されるCO₂の液化海上輸送事業開発
CO2排出源	• 産業からの排出
CO2 輸送先	• オーストラリア貯留地への海上輸送
政府による PJへの支援	• 検討段階のため未定

Source: Chevron HP 2022

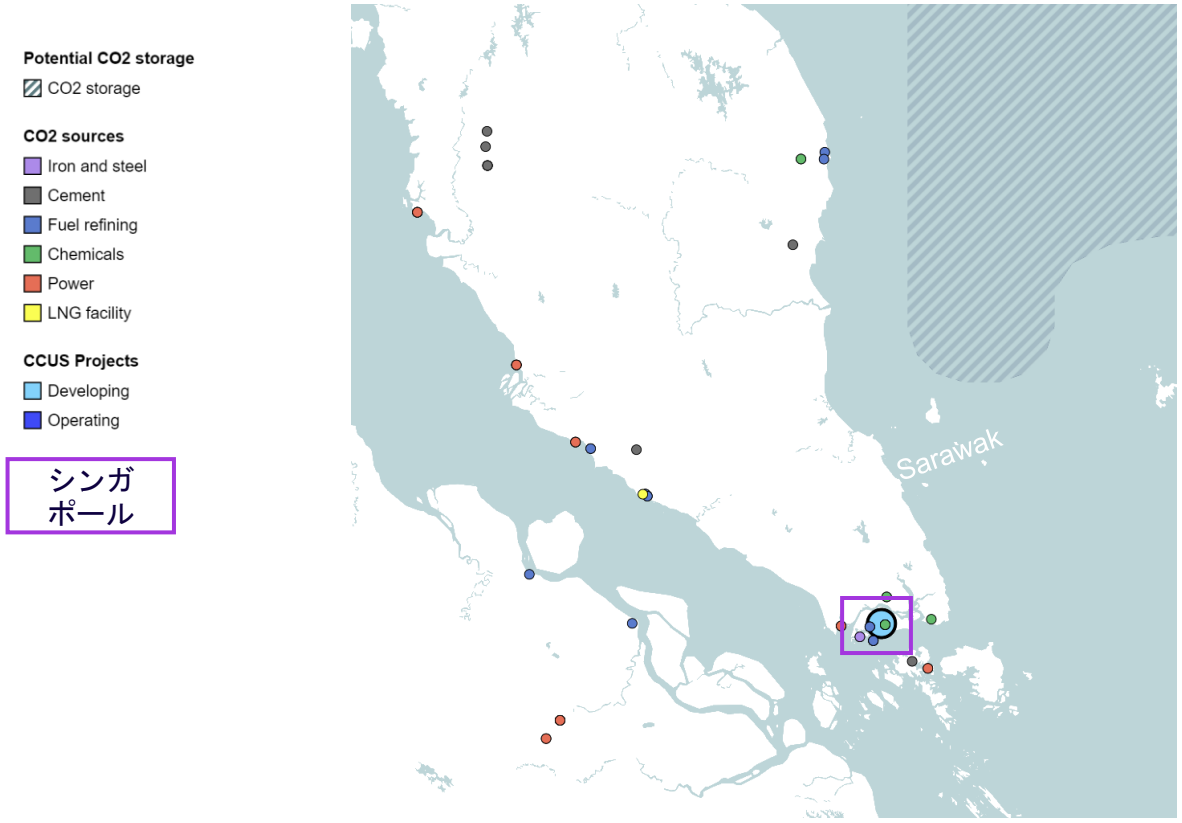
シンガポールは、産業集積地でのCO_2分離回収の可能性はあるが、東南アジアの他国と異なりStorageのポテンシャルは存在しない

	Brunei Darussala	Indonesia	Malaysia	Philippines	Singapore	Thailand	Viet Nam
Domestic CO_2 storage potential	●	●	●			●	●
Potential to use CO_2 for EOR	●	●	●			●	
Legal and regulatory frameworks for CCUS in place	○*	○	○*	○*		○*	○*
Industrial clusters with CO_2 capture prospects	●	●	●	●	●	●	●
Recognition of CCUS in long-term strategies/ goals	○	●	●		●		○
Targeted policies to support CCUS investment							
Active pilot or demonstration facilities							
Plans for commercial CCUS facilities		●	●				

Source: IEA「Carbon Capture Utilizsation and Storage: The Opportunity in Southeast Asia 2021」
Note: ● = Yes, ○ = Possibility/Partially; * = Oil and gas regulation applicable for CO2 Storage

排出源-鉄鋼業/石油精製/化学品プラント

シンガポールにおけるCO₂排出源



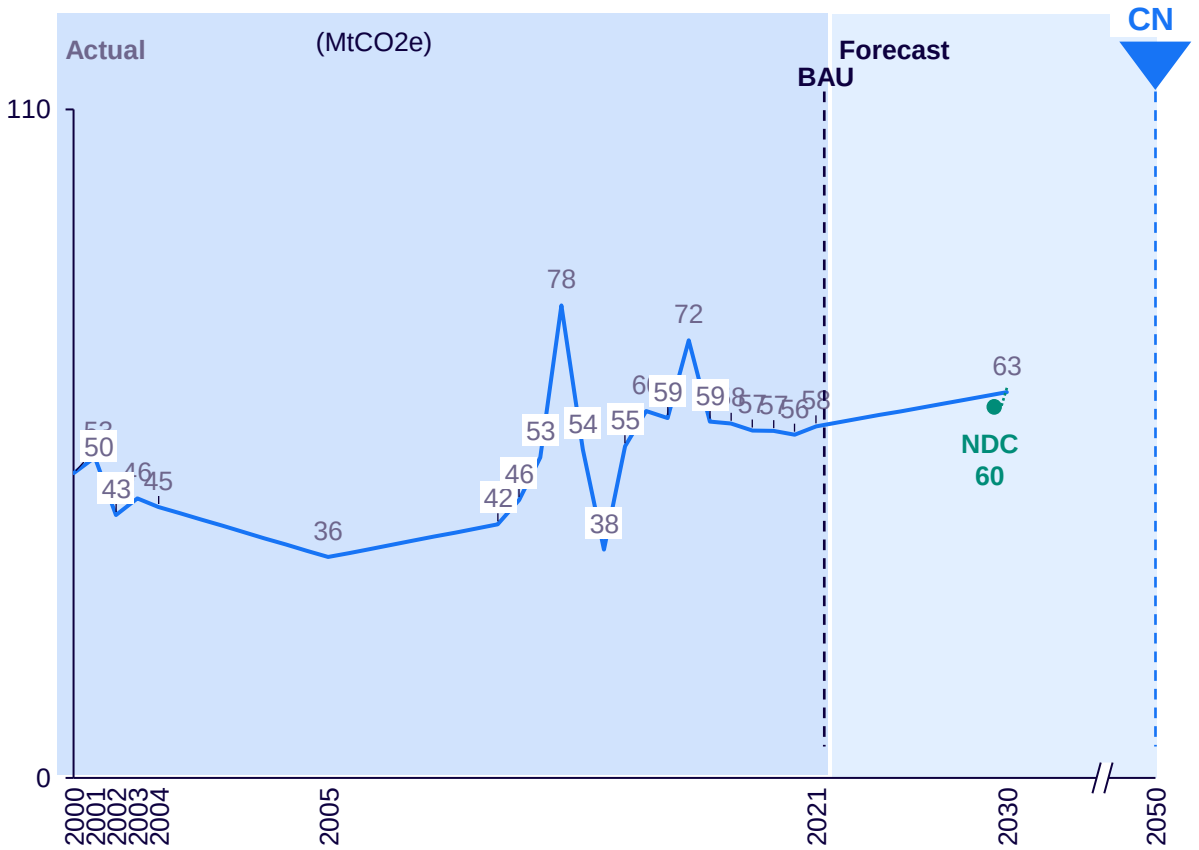
- *シンガポールでは、化学品/石油精製などが主要なCO₂排出源である*
- *その産業から排出されるCO₂回収のPJも開発中である*

Source：IEA Carbon Capture,Utilizsation and Storage「The opportunity in Southeast Asia」

シンガポールは、 2022年COP27にて、NDCを2050年にCN、また2030年に60MtCO2eへと更新

GHG Target

- **Target year** – In its 2020 Long Term Low Emissions Development Strategy (LT-LEDS), Singapore committed to achieving net zero emissions ‘as soon as viable in the second half of the century’. In November 2022, Singapore amended its LT-LEDS bringing forward its net zero target year to 2050 (National Climate Change Secretariat, 2022a).
- In November 2022, a few days prior to COP27, Singapore submitted its updated NDC, setting a new target of limiting GHG emissions in 2030 to 60 MtCO2e, down from 65 MtCO2e in the previous submission. While the target is a stronger in absolute number, it is only a marginal improvement over the last



Source: Climate Action Tracker、Singapores Second Update of its first nationally determined contribution and accompanying information

CN達成に向けて、炭素税の導入を実施、省エネ法の強化などを推進

Action for achieving GHG Target

Incentive	Subsidy	• xEV /Power charger Subsidy • Green finance • Low Carbon Energy Research Funding Initiative (LCER FI) • Productivity Improvement Grants (REG (E))
	Tax Incentives	• xEV tax incentives • Emission Reduction Investment Credits (IA (ER))
Penalty	ETS	• Carbon credit trading MOUs with many countries
	Penalty	• **A carbon tax of SDG 5/tCO_2e was applied covering LNG, power and industrial facilities which together emit more than 25 $ktCO_2e$/yr, representing approximately 43% of emissions. According to the budget of 2022 tax rate will be increased to SGD 25/tCO_2e in 2024-2025 and further SGD 45/tCO_2e by 2026-2027, with a target of reaching SGD 50-80/tCO_2e by 2030**
	Regulation	• **The Energy Conservation Act was enhance** • Green Mark Certification and Energy Labelling schemes, and home appliances Energy Performance Standards • All new developments to achieve a minimum of “Super Lower Energy Standards” • Limitation of new coal fire power plant • (for Vehicle)Emission Regulation/Vehicle emission scheme

Source: Climate Action Tracker、Singapores Second Update of its first nationally determined contribution and accompanying information ,National Climate Change Secretariat,2022b

電力セクターでは、ASEAN全体でのグリッド整備や水素発電への移行、輸送部門では2040年での内燃機関車の販売規制などでCN達成を目指す

Industry	CN target	Overall
Power Genera-tion	• **NA –**	• As cross-border clean energy trade develops, we are building a low-carbonASEAN Power Grid. This will strengthen energy resilience and decarbonisepower generation across Southeast Asia. Singapore plans to import up to 4gigawatts (GW) of low-carbon electricity by 2035, or around 30% of Singapore'selectricity supply. We will build on the Lao PDR-Thailand-Malaysia-Singapore ember 2022 7 Power Integration Project, which successfully commenced in June 2022, and use it as a pathfinder towards the broader ASEAN Power Grid vision • Singapore is targeting net-zero emissions by 2050 and enhancing energy security by considering hydrogen as a critical factor. Hydrogen has the potential to **meet up to 50% of Singapore's power demands**. • The Green Plan aims to expand solar PV installed capacity to more than 2 gigawatt-peak (GWp) by 2030. According to Trade and Industry Minister Tan II, the plan calls for the installation of energy storage systems (ESS) in response to the increase in solar power generation, with a total of 200 megawatts (MW) of ESS to be installed after 2025.
Trans-portation	• **NA –**	• (~30 years) Double the number of charging points for electric vehicles/ (~40 years) Ban internal combustion engine vehicles • Starting in January 2021, an EV early adoption incentive (expiring by the end of 2023) was introduced for EVs, refunding 45% of the additional registration fee (ARF), and the road tax was reduced.
Other	• **NA –**	• It aims to become a major Asian center for green finance, providing specialized funding for environmental projects. To this end, the government has pioneered a plan to issue green bonds (bonds) in the FY2021 government budget • Application of CCUS to petrochemical industry, etc.

Source: 各種2次情報よりADL作成

Blue CarbonやE-fuelへの取り組みが存在（ただしCOP27 前からのアップデートは限定的）

Blue Carbon

- AmazonとConservation Internationalは2022年11月15日、International Blue Carbon Instituteの設立を発表
- シンガポール経済開発庁の支援のもと、東南アジアおよびその他の地域で急務となっている、ブルーカーボンプロジェクトの開発や拡大に向けた能力、専門知識、基準、手法などを構築するための情報のハブ（拠点）

E-Fuel/E-Methanol

- TT Exploration and Production Public Company Limited (PTTEP), Air Liquide, YTL PowerSeraya Pte. Limited, Oiltanking Asia Pacific Pte. Ltd., Kenoil Marine Services Pte Ltd, and A.P. Moller - Maersk A/S have signed a Memorandum of Understanding (MoU) on a ‘Green Methanol Value Chain Collaboration’ which will explore the feasibility of establishing a green e-methanol pilot plant, with a minimum capacity of 50,000 tons per annum (TPA), and will be the first of its kind in Southeast Asia.

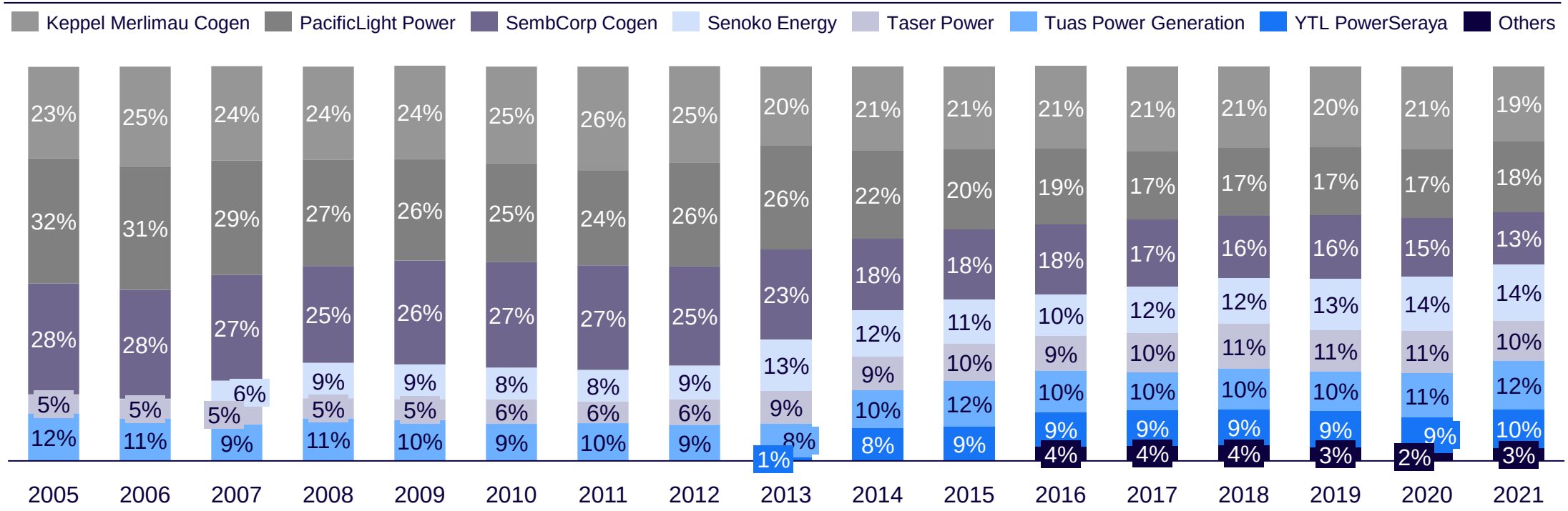
Source: Blue Carbon 2023

5 発電事業者

発電事業者はKeppelやPacificLight、SembCorp等主要7社

Market Share for Electricity Generation

2005 – 2021, %



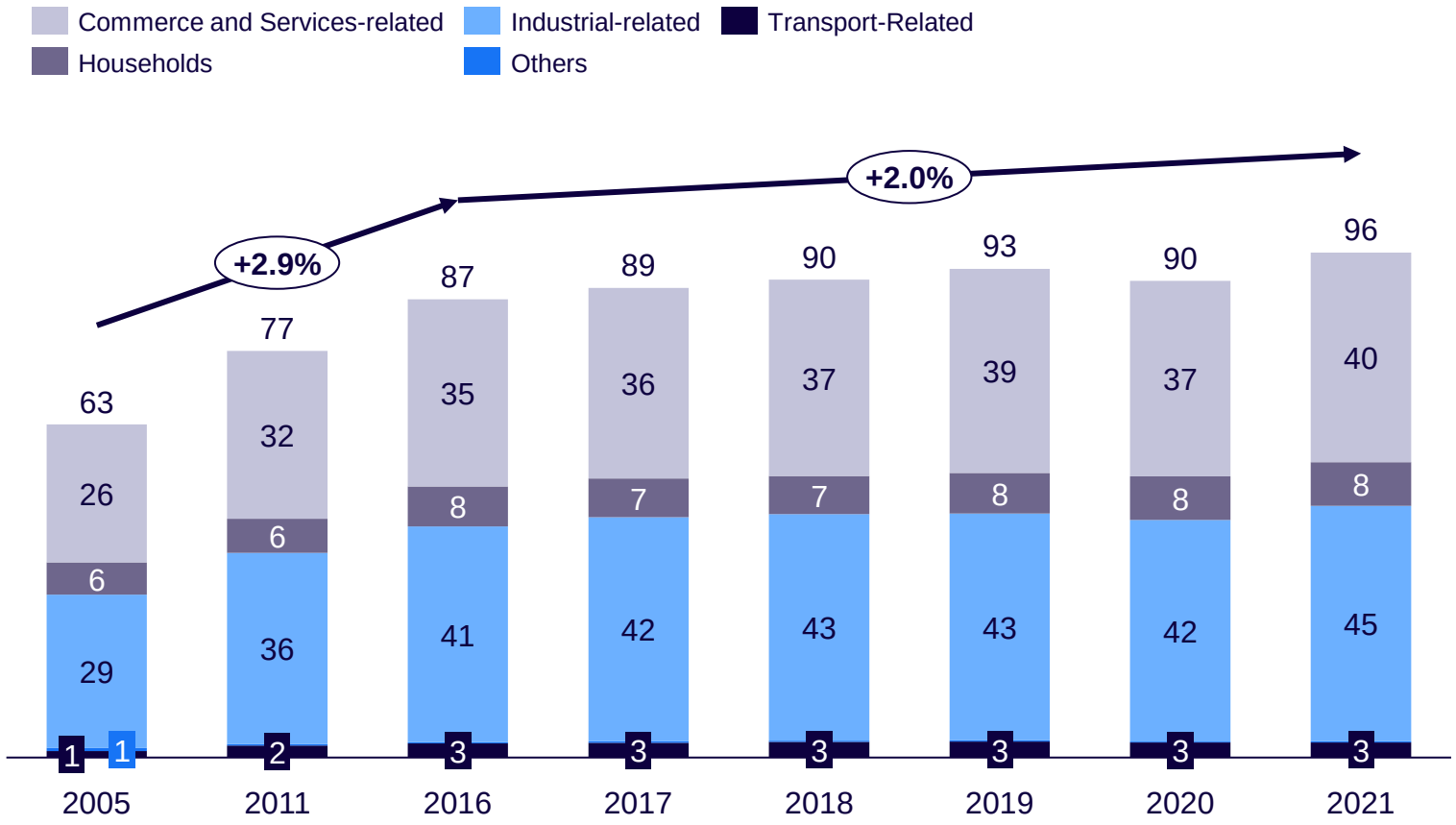
In the past 18 years, from 2005 – 2022, despite the incumbents still retaining majority of the market share, Senoko and Taser power have seen their market shares jump from 5-6% to 10-13% in 2022, whilst PacificLight and SembCorp have seen an erosion in their market share from 32% and 28% to 18% and 15% respectively.

Source: Energy Market Authority 2022

2021年の電力消費は、「商業・サービス業」と「工業」が80%以上を占める

Electricity Consumption by Sector

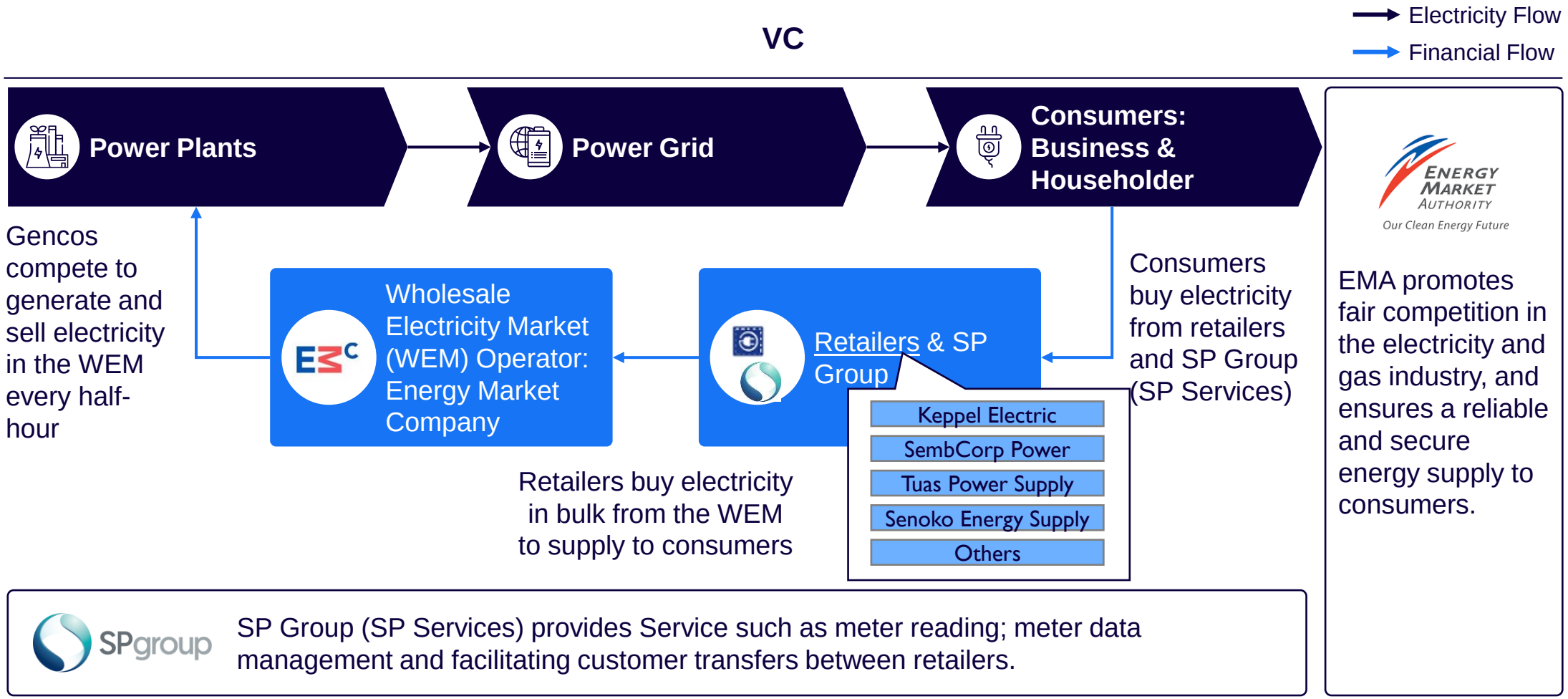
2021, TWh



In 2021, 'Commerce and Services' and 'Industrial' dominated the energy consumption**, accounting for 41.5% total with the prior consuming ~39.7 TWh and the latter ~44.6 TWh**, seeing a YOY growth of 2.6% and 2.7% respectively, which is roughly in line with the overall growth in consumption

Source: Energy Market Authority 2022

シンガポールは発電、小売り共に自由化



Source: EMA 2023
Note: 1) Non-contestable consumers are those who choose to buy electricity from SP services at regulated tariff; 2) Contestable consumers are those who choose to buy electricity from a retailer of their choice or from wholesale electricity market at the half-hourly wholesale electricity price

シンガポールはFITがない一方で、再エネの研究開発に対する支援やグリーンボンド、グリーンファイナンス等の制度は存在

Subsidy in Renewable Energy

- Singapore does not adopt Feed-in-Tariffs (FIT) system stating that FiTs would distort the energy market and increases costs for consumers. Hence, it is important to price energy correctly and send the right price signals to both consumers and investors
- Instead of subsidies, Singapore has taken proactive steps to introduce regulatory enhancements to facilitate the entry of renewable energy when such technologies become commercially viable.
- The government's support for renewables also comes in the form of funding for research and development to develop capabilities within the industry

- On the other hand, green bonds, sustainable finance, etc. are implemented

Source: CNA 2022

6 発電所

List of Power plant (1/2)

Main Power Plants

2005 – 2021, MW

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	CAGR
Keppel Merlimau Cogen	**-**	**-**	**490.0**	**490.0**	**490.0**	**490.0**	**490.0**	**896.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	**1,310.0**	
CCGT/C0-Gen/Tri-Gen	-	-	490.0	490.0	490.0	490.0	490.0	896	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	1,310.0	
National Environment Agency	**250.8**	**250.8**	**250.8**	**250.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**179.8**	**-2.1%**
Waste-T0-Energy	250.8	250.8	250.8	250.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	179.8	-2.1%
Of Which: Autoproducers	**-**	**-**	**-**	**7.2**	**23.0**	**24.4**	**95.7**	**338.7**	**335.1**	**374.1**	**463.8**	**514.3**	**684.5**	**723.0**	**824.2**	**884.6**	**1,039.1**	
CCGT/C0-Ger/Tri-Gen	-	-	-	6.9	21.5	21.5	91.1	317.0	309.3	334.8	402.6	402.6	555.3	548.4	538.5	538.5	538.5	
Solar PV	-	-	-	0.3	1.5	2.9	4.6	7.7	11.8	25.3	45.7	96.6	115.6	161.0	272.1	332.5	487.0	
Steam Turbine	-	-	-	-	-	-	-	14.0	14.0	14.0	15.5	15.1	13.6	13.6	13.6	13.6	13.6	
PacificLight Power	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	**800.0**	
CCGT/Co-Gen/Tri-Gen	-	-	-	-	-	-	-	-	800.0	800.0	800.0	800.0	800.0	800.0	800.0	800.0	800.0	
SembCorp Cogen	**785.0**	**785.0**	**785.0**	**785.0**	**785.0**	**785.0**	**785.0**	**785.0**	**785.0**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**1,188.8**	**2.6%**
CCGT/Co-Gen/Tri-Gen	785.0	785.0	785.0	785.0	785.0	785.0	785.0	785.0	785.0	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8	1,188.8	2.6%
Senoko Energy	**3,300.0**	**3,300.0**	**3,300.0**	**3,300.0**	**3,135.0**	**2,635.0**	**2,550.0**	**3,300.0**	**3,300.0**	**3,300.0**	**3,300.0**	**3,300.0**	**3,300.00**	**3,300.0**	**2807.0**	**2807.0**	**2,807.0**	**-1.0%**
CCGT/Co-Gen/Tri-Gen	1945.0	1945.0	1945.0	1945.0	1945.0	1945.0	1945.0	2807.0	2807.0	2807.0	2807.0	2807.0	2807.0	2807.0	2807.0	2807.0	2807.0	2.3%
Open Cycle Gas Turbine	105.0	105.0	105.0	105.0	190.0	190.0	105.0	-	-	-	-	-	-	-	-	-	-	-100.0%
Steam Turbine	1250.0	1250.0	1250.0	1250.0	1000.0	500.0	500.0	493.0	493.0	493.0	493.0	493.0	493.0	493.0	-	-	-	-100.0%
Senoko Waste Electricity pte Ltd	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**55.0**	**0.0%**
WTE	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	0.0%
Taser Power	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**395.7**	**395.7**	**395.7**	**395.7**	**395.7**	**395.7**	**395.7**	
CCGT/C0-Gen/Tri-Gen	-	-	-	-	-	-	-	-	-	-	395.7	3957	395.7	395.7	3957	395.7	395.7	
Tuas Dboo Trust	**-**	**-**	**-**	**-**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	**22.0**	
WTE	-	-	-	-	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	
Tuas Power Generation	**2,640.0**	**2,640.0**	**2,640.0**	**2,640.0**	**2,640.0**	**2,640.0**	**2,640.0**	**2,141.0**	**2546.9**	**2,579.4**	**2,579.4**	**2,579.4**	**2,579.4**	**2,579.4**	**2,579.4**	**1,979.4**	**1,979.4**	**-1.8%**
CCGT/Co-Gen/Tri-Gen	1440.0	1.440.0	1.440.0	1.440.0	1.440.0	1.440.0	1.440.0	1,541.0	1,946.9	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4	1,979.4	2.0%
Steam Turbine	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	1200.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	600.0	-	-	-100.0%
YTL PowerSeraya	**2736.0**	**2,519.0**	**2,544.0**	**2,576.0**	**2,700.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.0**	**3,100.00**	**2,402.0**	**2,402.0**	**2,402.0**	**-0.8%**
CCGT/Co-Gen/Tri-Gen	364.0	364.0	364.0	368.0	732.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	1472.0	9.1%
Open Cycle Gas Turbine	182.0	200.0	210.0	218	218	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	180.0	-0.1%
Steam Turbine	2190.0	1955.0	1970.0	1,990.0	1750.0	1448.0	1448.0	1448.0	1448.0	1448.0	1448.0	1448.0	1448.0	1448.0	750.0	750.0	750.0	-6.5%

Source: Energy Market Authority 2022

List of Power plant (2/2)

Natural gas power plants

Name	Operator	Output	Source
Senoko Power Station	Senoko Energy Pte Ltd	2,807 MW	Gas
Pulau Seraya Power Station	YTL PowerSeraya Pte Ltd	2,222 MW	Gas
Tuas Power Plant	Tuas Power Ltd	1,876 MW	Gas
Keppel Merlimau Cogen Power Plant	Keppel Merlimau Cogen Pte Ltd	1,310 MW	Gas
PacificLight Power Station	PacificLight Power Pte Ltd	800 MW	Gas
Sembcorp Cogen @ Sakra Power Station	SembCorp Cogen Pte Ltd	785 MW	Gas
Sembcorp Cogen @ Banyan	SembCorp Cogen Pte Ltd	404 MW	Gas
Tuaspring CCGT Power Plant	Tuaspring Pte Ltd	396 MW	Gas
ExxonMobil Power Station	Unknown	314 MW	Gas
Jurong Power Station	YTL PowerSeraya Pte Ltd	180 MW	Gas

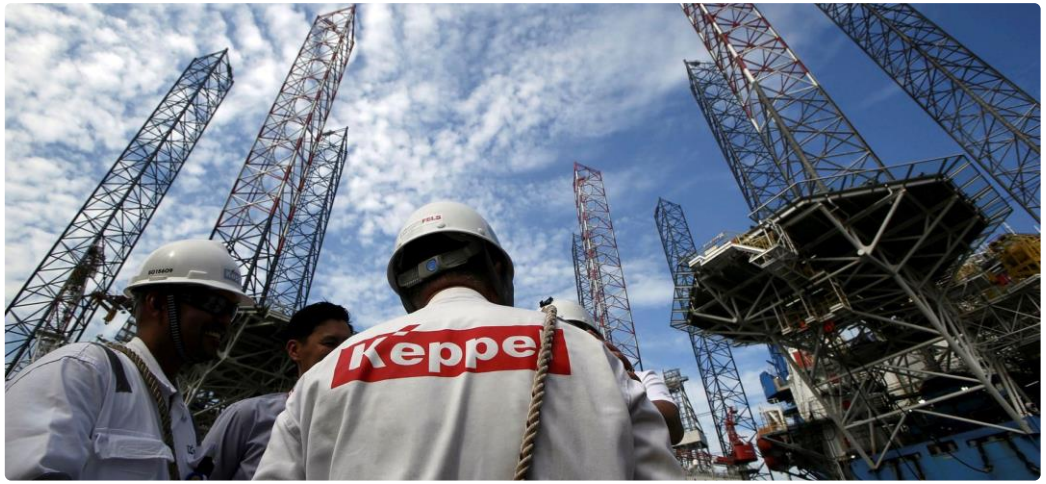
Source: OpenInfraMaps 2022

30%の水素混焼発電などの計画あり

EMA - Meranti Power Units

- Ema’s subsidiary will build, own and operated 2 open cycle gas turbine (OCGT) units, in the new power station that is going to be build in jurong island
- X2 340 MW units, replacing existing ~400 MW system which is 30 y/o
- Slated to open in 2025, can take up to 30% H2 as fuel source via enhancements to current infrastructure

Keppel Sakra CoGen Plant



- H2-ready gas PP (CoGen) built for Keppel by Mitsubishi, costing US$ 540 mn
- 600 MW capacity and slated to open in 2026, running only on natural gas, despite current turbine having 30% H2 mix ability
- Keppel and Mitsubitishi are also conducting feasibility study on using 100% ammonium PP in Singapore

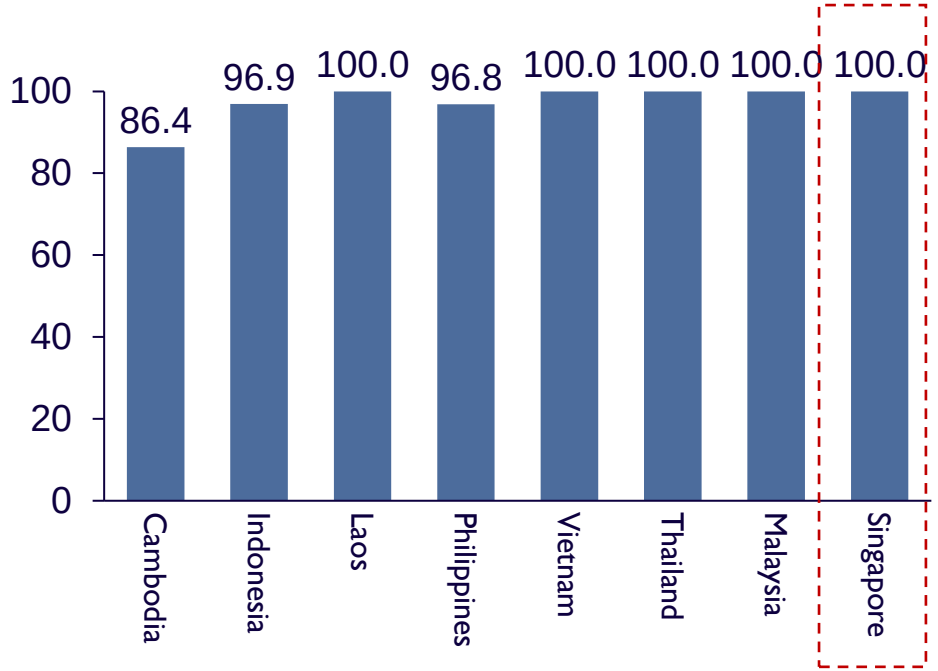
Source: CNA 2023, Recharge 2022, Mitsubishi Press Release 2022

7 電力品質

シンガポールの電力インフラの整備が進んでおり品質は比較的高い

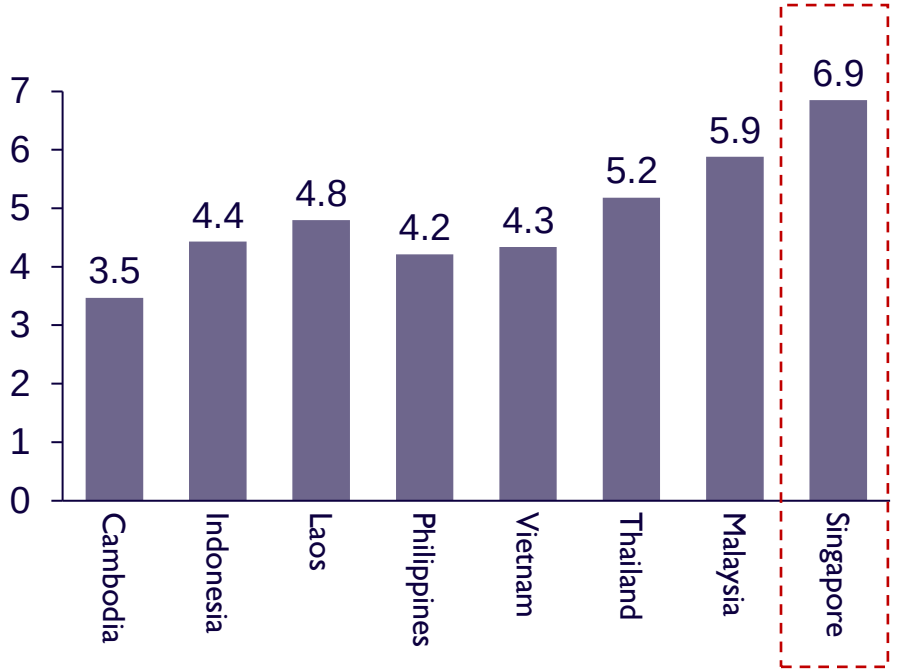
Access to Electricity

(% of population with access to electricity, 2020)



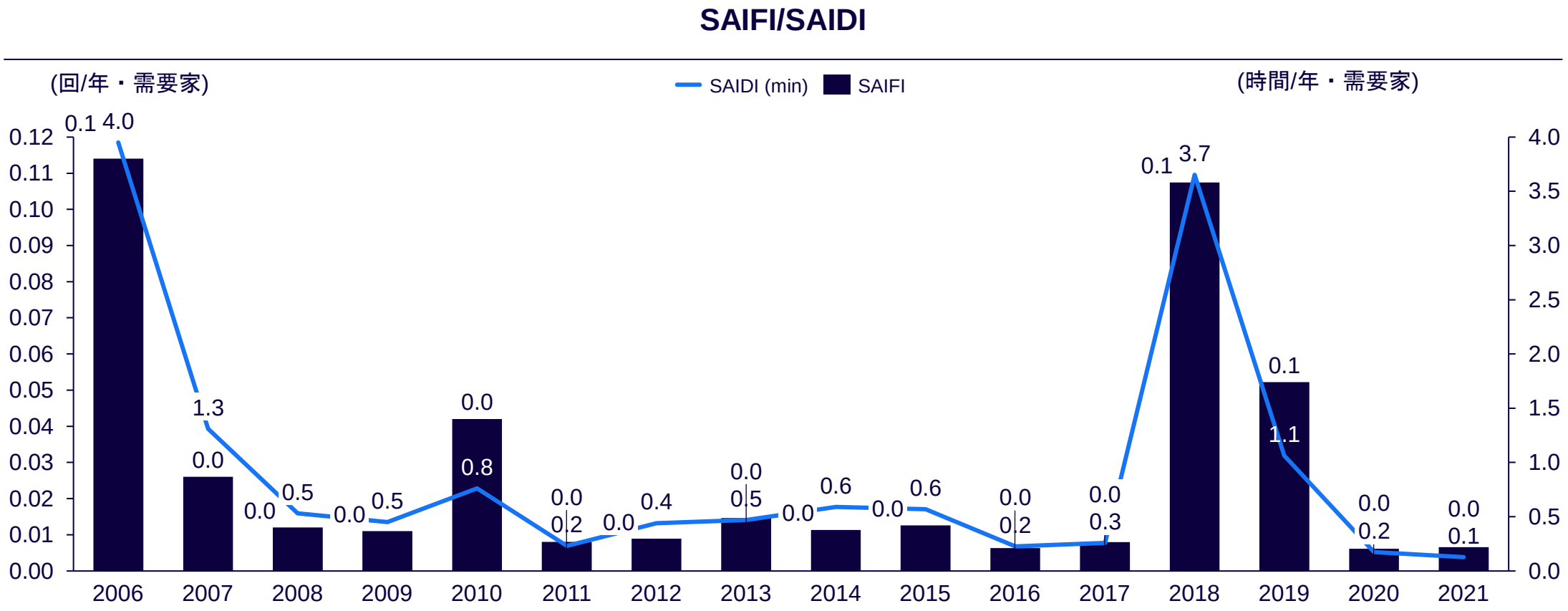
World Bank's quality of electricity supply index

(Score over 7[1], 2017)



1) The scale ranges from 1 = insufficient and suffers frequent interruptions to 7 = sufficient and reliable
Source : World Bank Global Electrification Database

シンガポールは年間平均停電時間/年間平均停電回数ともに低い値



Singapore has one of the most reliable supply of electricity. Singapore's electricity grid has an average interruption time of less than 1 minute per customer a year and is more reliable than Tokyo (4 minutes), New York (20.53 minutes), Hong Kong (23.40 minutes) and London (33.60 minutes).

Note: 1) System Interruption Duration Index (Minutes/Customer/Year) 2System Average Interruption Frequency Index (Number of Interruptions/Customer per Year)
Source: Energy Market Authority 2022

電力品質を高めるべく以下の取り組みを実施

Maintaining Electricity Quality

EMA acts to ensure that earthworks are done in a way that avoids damaging electricity cables and affecting supply to consumers.

Contractors are strongly encouraged to refer to SS576:2012 (Code of Practice for Earthworks in the Vicinity of Electricity Cables).

Starting from 1 April 2018, EMA and Singapore Power Grid (SPPG) will be implementing the Registered Earthworks Supervisor (RES) scheme to enhance the cable / gas pipeline damage prevention.

RES scheme will required earthwork supervisors to pass competency course in cable/gas pipeline damage prevention measures and are registered as a RES with SPPG before supervising worksites in the vicinity of high voltage cables and medium/high pressure gas pipelines.

Source: EMA 2023

8 送電網

シンガポールでは超々高電圧送電線（500kV以上）は使用されていない

Power Transmission Lines

Power Transmission Lines

- 送電系統は400kV、230kV、66kVで構成
- 配電系統は22kV、6.6kVで構成
- 送電線は全て地中化されており、4系統に分かれている
- 各系統の連系線は400kVでメッシュ状に連系されている

Source: Global Energy Network Institute,

2024年にシンガポール最大の変電所がLabradorに設立される

Future Plans for Transmission Network

- SP group is building SEA's first underground substation in Labrador, that will be the size of 4 football fields
  - Due for completion in 2024
  - Singapore largest substation
  - Capacity of 230kV
  - Contract was awared for Hyundai Engineering & Construction
  - Aims to serve the electricity needs of Alexandra, Clementi, Keppel, Pasir Panjang and the Science Park districts
- This fits in with Singapore 2050 plan of reliable access to energy for all

Source: SP Group Press release 2021

送電網プロジェクトと建設会社リスト

Plans for transmission line construction players

	Project Name	Companies	Timeframe Start	Timeframe End	Status
1	NS2 Interval Cable Tunnel	Temasek Holdings [Sponsor]{Singapore},SK Engineering & Construction Co. Ltd [Construction] {South Korea}		2018	Under Construction
2	NS1 Interval Cable Tunnel (Gambas - Mandai)	Samsung Construction & Trading (Samsung C&T) [Construction] {South Korea}		2018	Under Construction
3	East-West Underground Cable Tunnel, Ayer Rajah - Paya Lebar	WorleyParsons [Design/Architect] {Australia},Nishimatsu Construction Company [Construction] {Japan}, AECOM [Design/Architect] {United States}, Tritech Group Limited [Consultant/Project Management] {Singapore}, Hyundai Engineering and Construction Co Ltd. [Construction] {South Korea}, Obayshi Corporation [Construction]{Japan}, KTC Civil Engineering & Construction [Construction] {Singapore}	2012	2017	Under Construction
4	North-South Underground Cable Tunnel, Gambas - May Road	Hyundai Engineering and Construction Co Ltd. [Construction]{South Korea}, Samsung Construction & Trading (Samsung C&T) [Construction] {South Korea}, Tritech Group Limited [Construction] {Singapore},Obayashi Corporation [Construction] {Japan}, KTC Civil Engineering & Construction [Construction] {Singapore}, EirGrid [Consultant/Project Management} {Ireland}	2012	2018	Under Construction
5	NS3 Interval Cable Tunnel (Ang MO Kio - May Road)	Hyundai Engineering & Construction [Construction] {South Korea}		2018	Under Construction

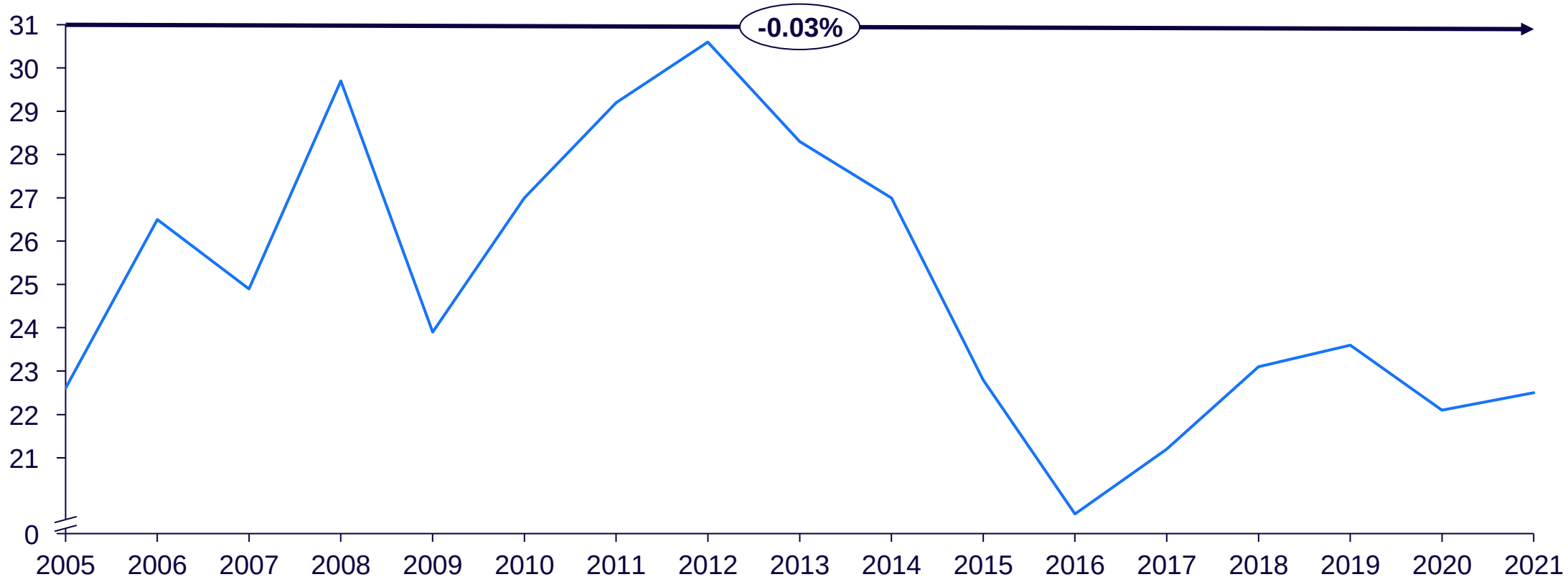
Source: BMI Key Power Projects Database (latest revision 22nd May 2023)

9 電力料金

2016年の価格から、電気料金は値上がり傾向にある

Electricity Tariff Trend[1]

2005 – 2021, cents/kWh



Note: 1) Adjusted for inflation
Source: Energy Market Authority 2022

電気料金の主な構成要素は、1）エネルギーコスト2）グリッドチャージ 3）市場支援サービス料4）市場管理および電力系統運用料の4点

Electricity Tariff Trend

- Electricity tariffs for non-contestable consumers are regulated by EMA and are updated quarterly reflecting changes in the cost of power generation.
- The four main components of electricity tariff are 1) Energy Costs (paid to the generation companies), 2) Grid Charges (paid to SP Power Assets), 3) Market Support Services Fees (paid to SP Services), and 4) Market Administration and Power System Operation Fees (paid to the Energy Market Company and the Power System Operator).
- From its low of $0.197/kWh in 2016, the inflation adjusted tariff rates have climbed steadily at a CAGR of 2.9% to reach S$0.225/kWh in 2022. on the back of increased demand as the SG government allows market forces to dictate price movements (as a total of the aforementioned price subsets)

Source: EMA 2023

電気料金の高騰を受けEMAが介入し価格安定化を図る事例もあり

Electricity Tariff Trend

- エネルギー・マーケット・カンパニー（EMC）が運営するシンガポール電力卸市場（SWEM）の卸売価格「統一シンガポール電力価格（USEP、注2）」は2021年10月以降、急騰している。高騰の背景には、世界的にガスの供給が不足する一方、需要が増加して国際ガス価格が上昇していることがある。さらに、ロシアによるウクライナ侵攻の長期化は、ガス価格がさらに上昇する要因となっている。USEPは2021年1月には1メガワット時（MWh）当たり平均77.81シンガポール・ドル（約7,556円、Sドル、1Sドル＝約97円）だったのが、2022年4月には同365.53Sドルと4倍以上に上昇した

- こうした状況を受けて、EMAは2021年10月以降、（1）電力会社が発電燃料用に天然ガスが調達できない際にLNGの供給を受けられる備蓄施設「LNG予備施設（SLF）」を設置し、（2）SWEMでエネルギー不足が予想される場合に、EMAが発電会社にSLFからLNGの調達を指示できるようにしたほか、（3）EMAが発電会社に発電に必要な燃料の確保を指示できるようにしていた

- その後も、国際電力市場の混乱が継続しているのを受けて、EMAはこのほど、2021年10月に導入した（1）～（3）とTRECSについて2023年3月末までの延長を決めた

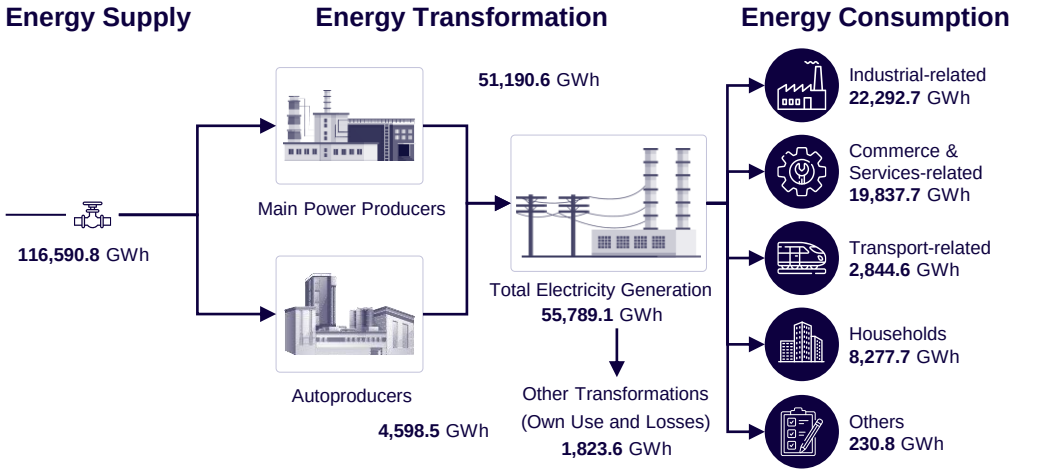
- TRECSとは、世界的なエネルギー不足により電力契約の更新や確保が困難に直面している大企業の消費者を支援するために、2021年12月に導入された。TRECSに基づき、EMAは発電会社や電力小売業者と協力して、月平均消費量が少なくとも4,000kWhの大規模消費者向けに、月々の固定料金プランまたは大幅な固定料金要素を含む料金プランを提供（２０２３年５月停止）

Source:JETRO ２０２２年６月「電力供給確保の時限装置を２０２３年３月まで延長」

10 電力需給状況

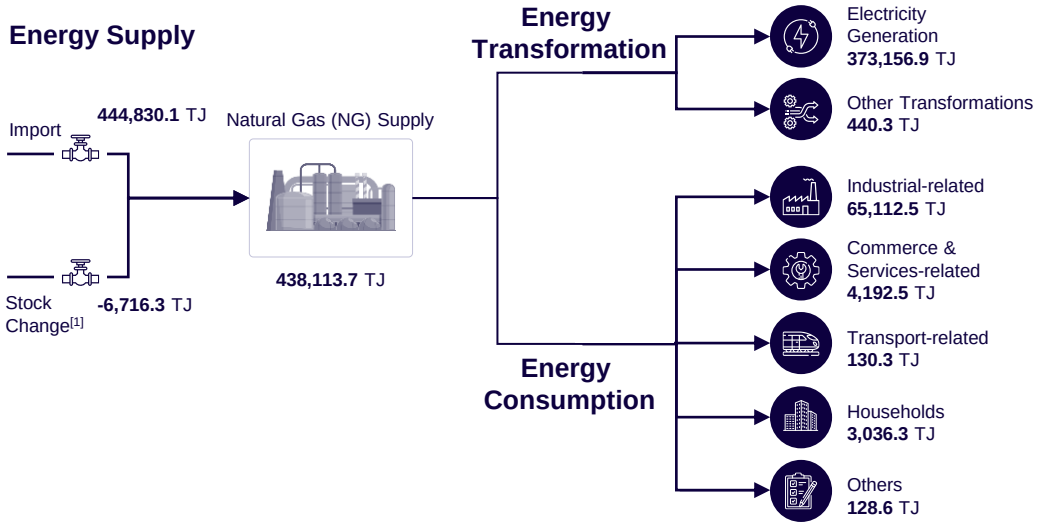
総発電量の約9割を主要発電事業者で担当。天然ガスは多くが発電事業者によって発電に使用される

Electricity Balance



- In 2021, total electricity generation reached 55.8 TWh. Main Power Producers were responsible for 91.8% of this generation, amounting to 48.4 TWh, while Autoproducers contributed the remaining 8.2%, equivalent to 4.6 TWh. The Transformation sector experienced 1.8 TWh of own-use and losses
- 'Industrials' had the largest share, at 41.7% (22.3 TWh).While 'Commerce & Services' was second with 37.1% (19.8 TWh). 'Households' contributed 15.5% (8.3 TWh), and 'Transport' had 5.3% (2.8 TWh) share of the total electricity consumption in 2021

Natural Gas Balance



- In 2021, the total supply of Natural Gas in Singapore amounted to 438,113.7 TJ (terajoules). This supply was comprised of 444,830.1 TJ of imports and an inventory stock build of 6,716.3 TJ
- The majority of Natural Gas usage, accounting for 85.3% of the total supply, was directed towards power generation, consuming 373,597.2 TJ in 2021. Additionally, 72,600.3 TJ of Natural Gas, including Town Gas, was directly consumed by end-consumers

Source: EMA 2023

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