Transport sector

Building sector

Overall industry sector

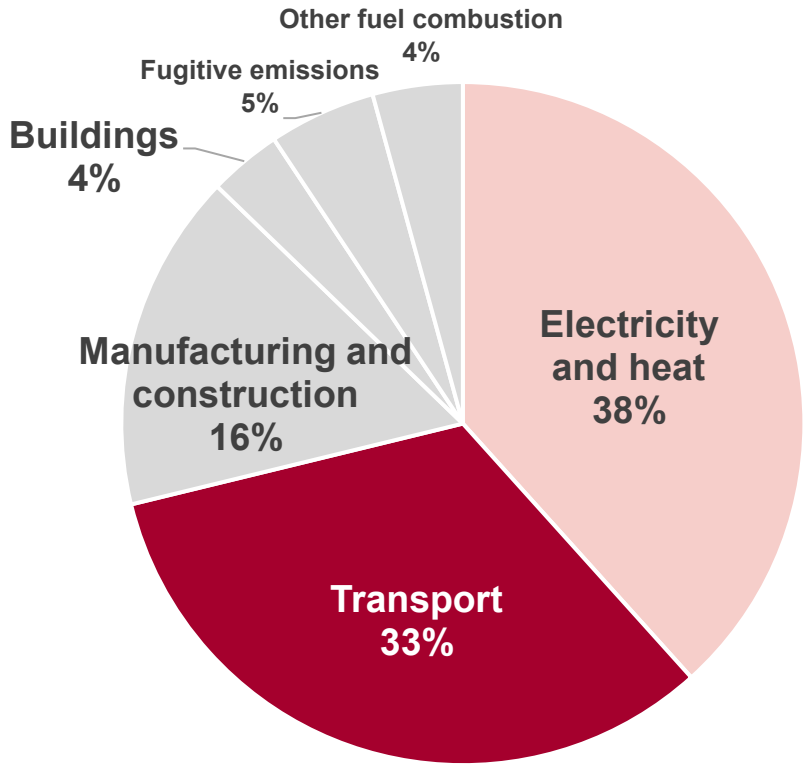
Industry – Specific sub sectors

Industry – Cross-sectors

Transport | Background information 1/3

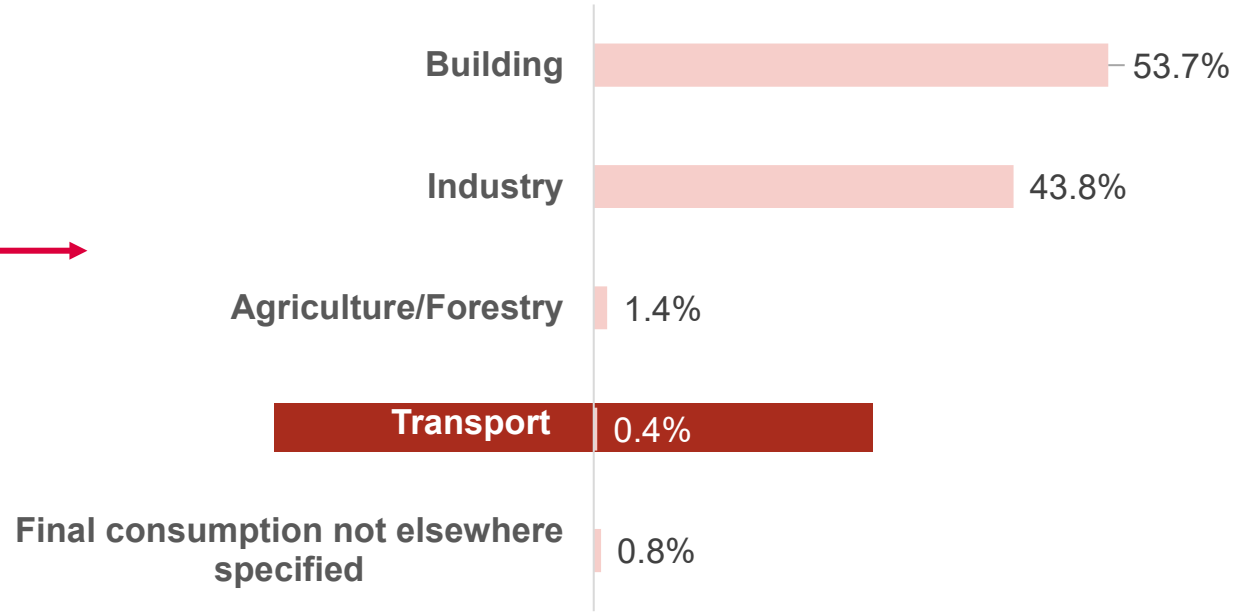
Overview

① Energy derived GHG emissions in ASEAN (2018)



Source：MRI created based on Climate Watch data (2018)

② Share of transport sector in ASEAN total electricity use

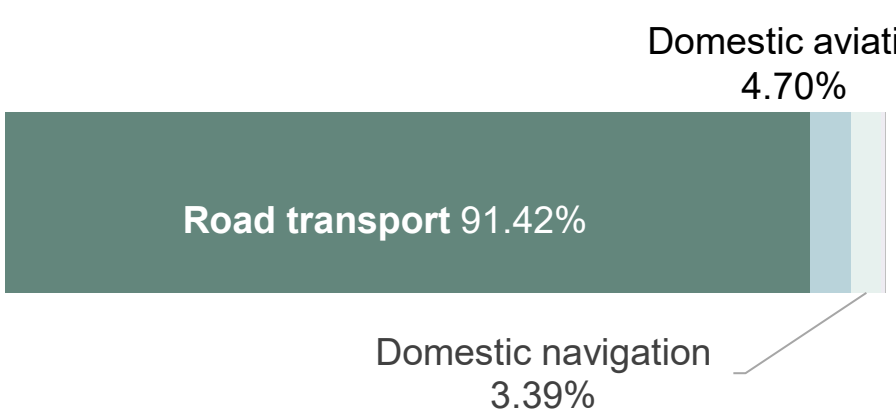


Source：MRI created based on IEA database (2021)

Transport | Background information 2/3

Emission breakdown

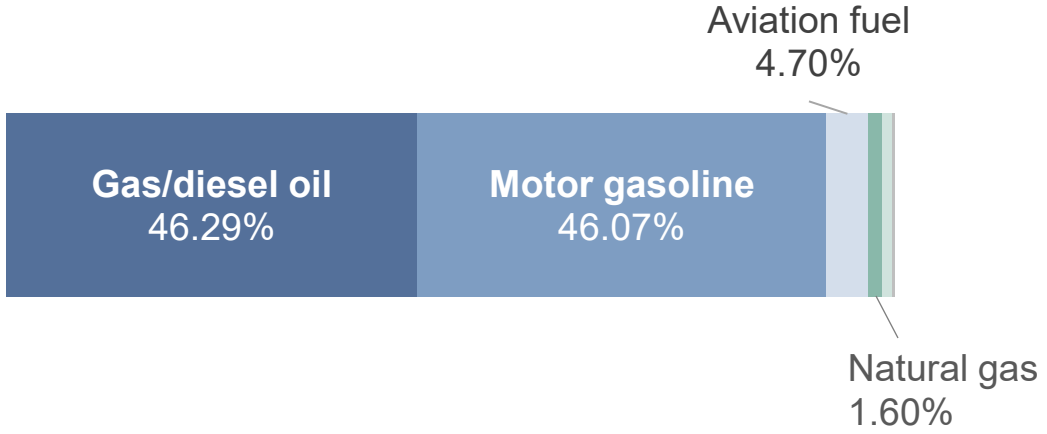
③ CO2 emissions* breakdown by mode of transport, ASEAN



Road transport	91.42%
Domestic aviation	4.70%
Domestic navigation	3.39%
Rail	0.48%
Non-specified	0.01%

(*) Emissions from direct fuel combustion only

④ CO2 emissions* breakdown by fuel type, ASEAN



Gas/diesel oil	46.29%	**Natural gas**	1.60%
Motor gasoline	46.07%	**LPG/ethane**	1.06%
Aviation fuel	4.07%	**Fuel oil**	0.28%

(*) Emissions from direct fuel combustion only

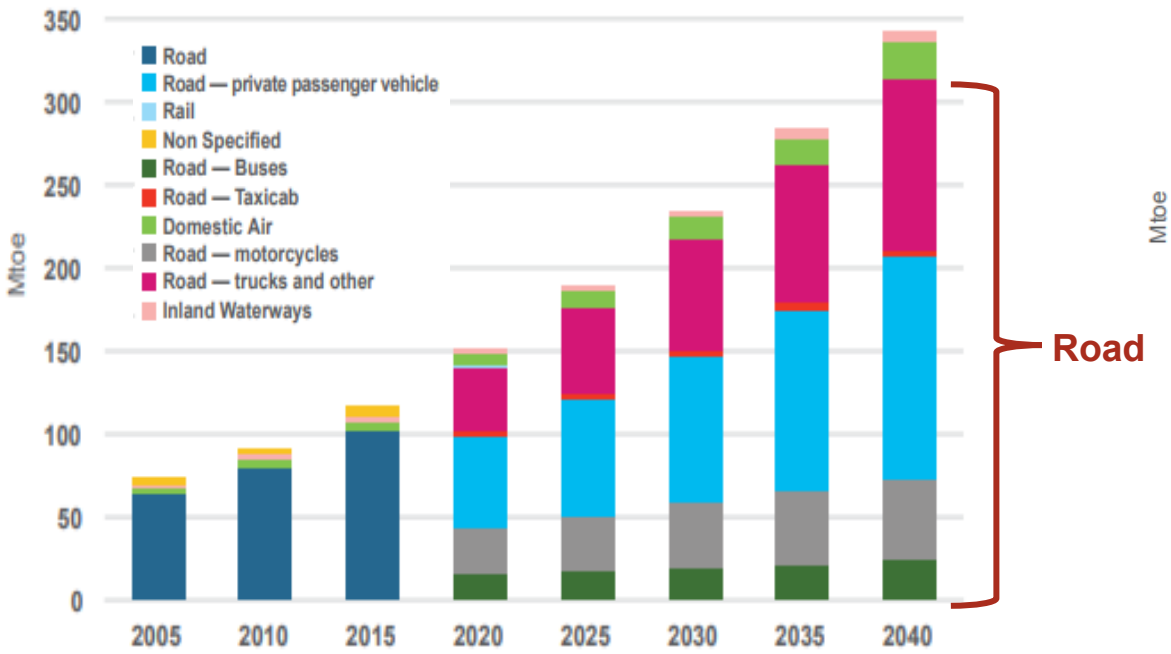
Source：MRI created based on IEA database (2021)

Transport | Background information 3/3

Energy demand forecasts

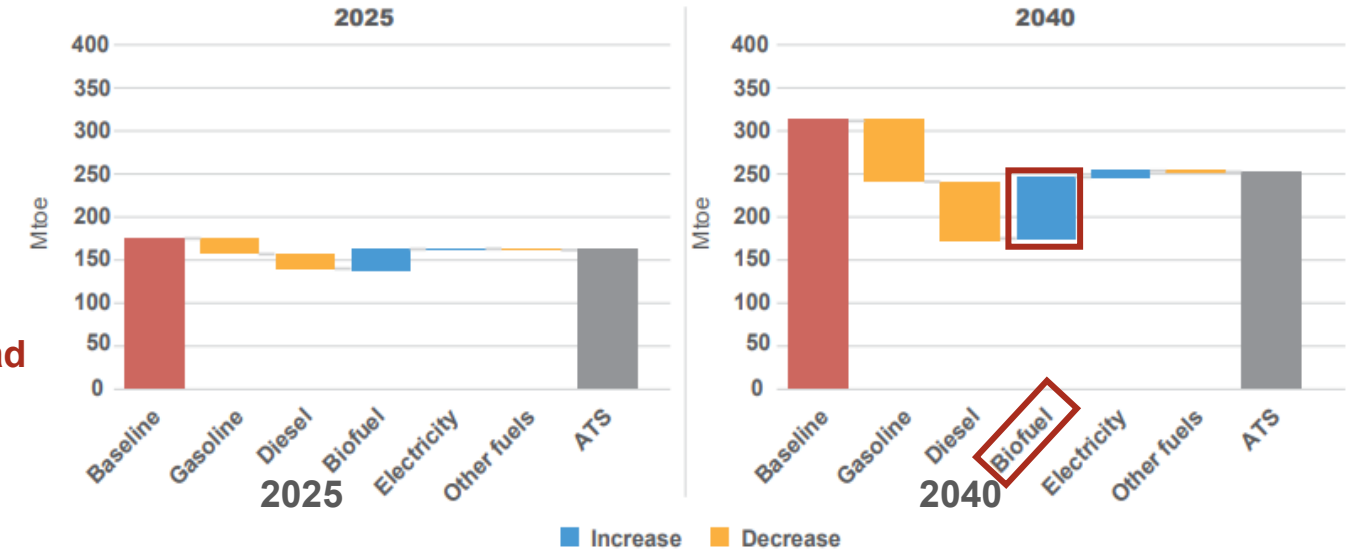
⑤ Forecasts for transport energy demand by mode of transport (baseline scenario)

- Toward 2040, energy demand for road transport is expected to outweigh other sub-sectors by far. Within road transport, private passenger vehicles take up the dominant share, followed by trucks & others, and motorcycles.



⑥ ASEAN Road Transport Energy Demand, ATS vs Baseline Scenario

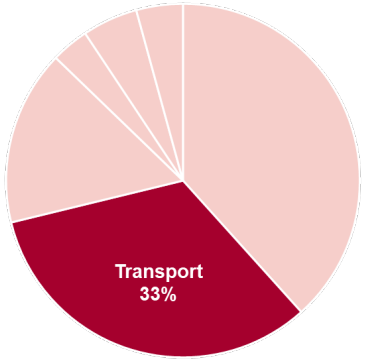
- In the ASEAN target scenario (ATS), a small part of road transport is expected to get electrified by 2040. Instead, **biofuel** will play an important role in reducing emissions from the transport sector.



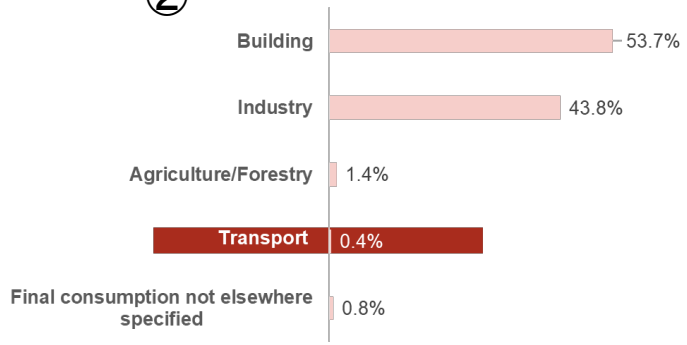
Source：ACE “The 6th ASEAN Energy Outlook 2017-2040” (2020)

Transport | Background information – Selection priorities

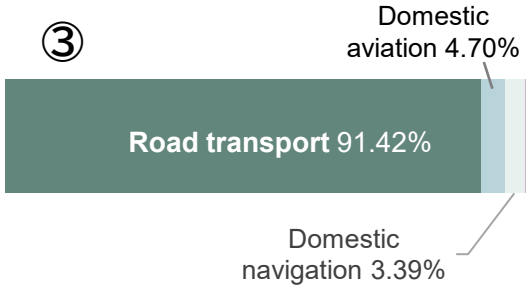
①



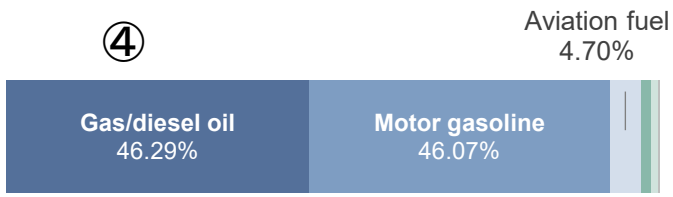
②



③



④



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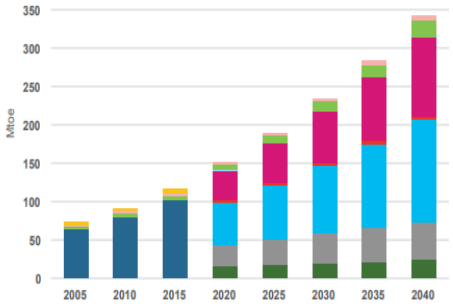

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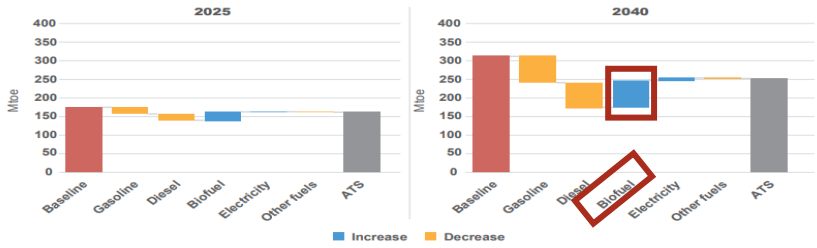


Selection priorities

- The focus of decarbonisation for the transport sector should be on the **fuel switching, including use of biofuel, and electrification of road transport,** followed by the aviation and the navigation sectors.

Transport | Technology list – 1/2 (Road transport)

Selection priorities were given to fuel switching, including use of biofuel, & electrification of the road, followed by the aviation and the navigation sectors.

Technology list in the transport sector (Road transport)

Legend: 20-tech list | Second priority list | Not selected

#	Sub-sector	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
					Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
1	**Road**	**Hydrogen fuel cell vehicles (FCEV)**	**Fuel switch**	**Electricity & hydrogen**	3	2	3	2.7	-	High priority as it is **a fuel switching** technology for the road sector utilising hydrogen. This entry consists of FCEV light-duty vehicles (passenger car, etc.) and heavy-duty vehicles (bus, truck, etc.)
2	**Road**	**Flex fuel vehicle (FFV)**	**Fuel switch**	**Biofuels**	3	3	1	2.2	Stakeholder comments suggest that biofuel is relevant in ASEAN.	High priority as it is a **fuel switching** technology for the road sector utilising biomass.
3	**Road**	**Plug-in hybrid vehicle (PHEV)**	**Electrification**	**Electricity & gasoline**	3	3	1	2.2	Stakeholders recommend including this tech.	High priority as it is an **electrification** technology for the road sector.
4	**Road**	**Hybrid electric vehicle (HEV)**	**Electrification**	**Electricity & gasoline**	3	3	1	2.2	Stakeholders recommend including this tech.	High priority as it is an **electrification** technology for the road sector.
5	**Road**	**Battery electric vehicles (BEV)**	**Electrification**	**Electricity**	3	2	2	2.3	-	Relatively high priority as it is an **electrification** technology for the road sector. This entry consists of BEV light-duty vehicles (passenger car, etc.) and heavy-duty vehicles (bus, truck, etc.)
6	Road	Hydrogen-fuelled urban transit bus & truck	Fuel switch	Hydrogen	3	1	3	2.3	-	Lower priority as there are remaining safety issues.
7	Road	Battery driven freezer/ refrigerator truck	Electrification	Electricity	3	2	2	2.3	Stakeholder comments suggest that this market has high potential in ASEAN.	Lower priority as other battery electric vehicles are represented but can be the next option.
8	Road	Electric motor bike	Electrification	Electricity	3	2	2	2.3	Stakeholders point out that motorbikes are common in ASEAN.	Lower priority as it is likely to be purchased by individuals. Can be included otherwise.
9	Road	LNG-fuelled truck	Fuel switch	Cleaner fossil fuel	3	3	1	2.2	-	Lower priority compared to other cleaner fuels (hydrogen, biomass)
10	Road	CNG bus & truck	Fuel switch	Cleaner fossil fuel	3	3	1	2.2	-	Lower priority compared to other cleaner fuels (hydrogen, biomass)
11	Road	Automated and connected vehicles	EE&C	-	3	1	1	1.6	-	Lower priority in the road transport sector.

Weighting		
	Relevance to ASEAN	30%
	Technology maturity	30%
	Contribution to energy transition	40%

Heatmaps of selected tech types (transport)

RE	EE&C	Fuel switch	Electrification	CCU	Other
	(2)	4 (6)	3 (6)		

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Transport | Technology list – 2/2 (Others)

Selection priorities were given to fuel switching & electrification of the road, followed by the aviation and the navigation sectors.

Technology list in the transport sector (Navigation, Aviation & Rail)

Legend: 20-tech list | Second priority list | Not selected

#	Sub-sector	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
					Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
12	**Navigation**	**LNG-fuelled ship**	**Fuel switch**	**Cleaner fossil fuel**	2	3	1	1.9	Stakeholders recommend including this tech.	High priority as it is a **fuel switching** technology in the navigation sector utilising cleaner fossil fuels.
13	**Navigation**	**Biofuelled ship**	**Fuel switch**	**Biofuel**	2	1	2	1.7	Stakeholder comments suggest that biofuel-related tech is relevant in ASEAN.	High priority as it is a **fuel switching** technology in the navigation sector utilising biomass. This tech consists of ships that run on biofuels such as bio-based ethanol, methanol, etc.
14	Navigation	Battery-electric ship	Electrification	Electricity	2	1	2	1.7	-	Lower priority as it has limited applicability (cannot travel long distance).
15	Navigation	Energy efficient ship engine	EE&C	-	2	1	1	1.3	-	Lower priority as the energy saving has less significant impact compared to fuel switching. Additionally, the maturity is lower.
16	Aviation	Hydrogen fuel cell electric plane	Fuel switch	Electricity & hydrogen	2	1	3	2.1	-	Lower priority as it is a less mature tech and R&D is still needed.
17	Aviation	Hybrid electric plane	Electrification	Electricity & aviation fuel	2	1	2	1.7	-	Lower priority as it is a less mature tech and R&D is still needed.
18	Rail	Hydrogen fuel cell electric train	Fuel switch	Electricity & hydrogen	1	1	3	1.8	-	Lower priority as rail transport is not a high emitter in ASEAN.
19	Rail	Magnetic levitation	Electrification	Electricity	1	2	2	1.7	-	Lower priority as rail transport is not a high emitter in ASEAN.
20	Rail	Battery electric train	Electrification	Electricity	1	1	2	1.4	-	Lower priority as rail transport is not a high emitter in ASEAN.
21	Rail	Gas hybrid train (internal combustion engine & battery)	Fuel switch	Electricity & gasoline	1	1	1	1.0	-	Lower priority as rail transport is not a high emitter in ASEAN.

Weighting		
	Relevance to ASEAN	30%
	Technology maturity	30%
	Contribution to energy transition	40%

Heatmaps of selected tech types (transport)

RE	EE&C	Fuel switch	Electrification	CCU	Other
	(2)	4 (6)	3 (6)		

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Transport sector

Building sector

Overall industry sector

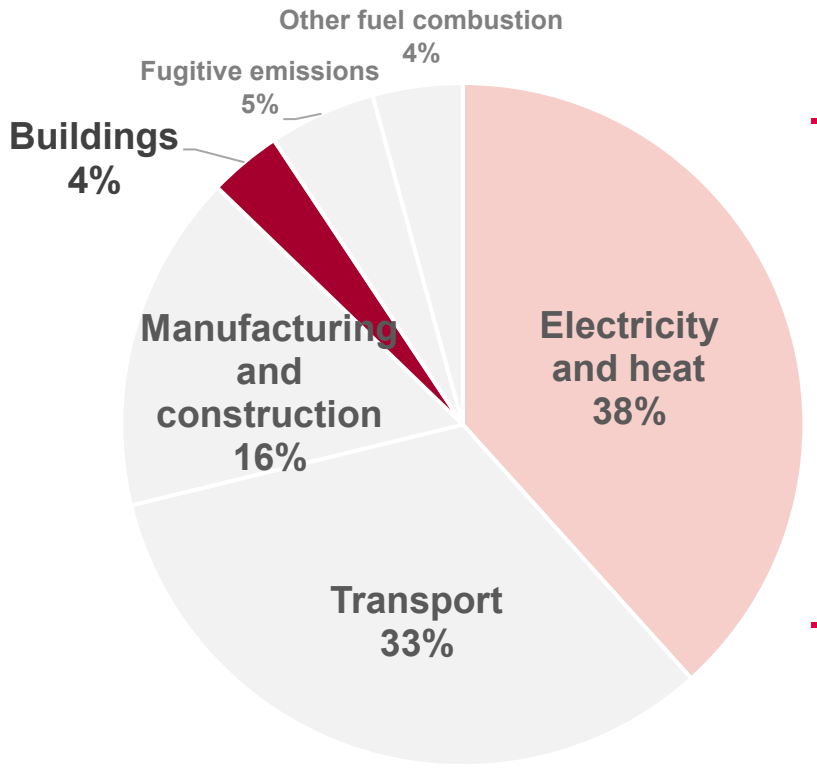
Industry – Specific sub sectors

Industry – Cross-sectors

Building | Background information 1/2

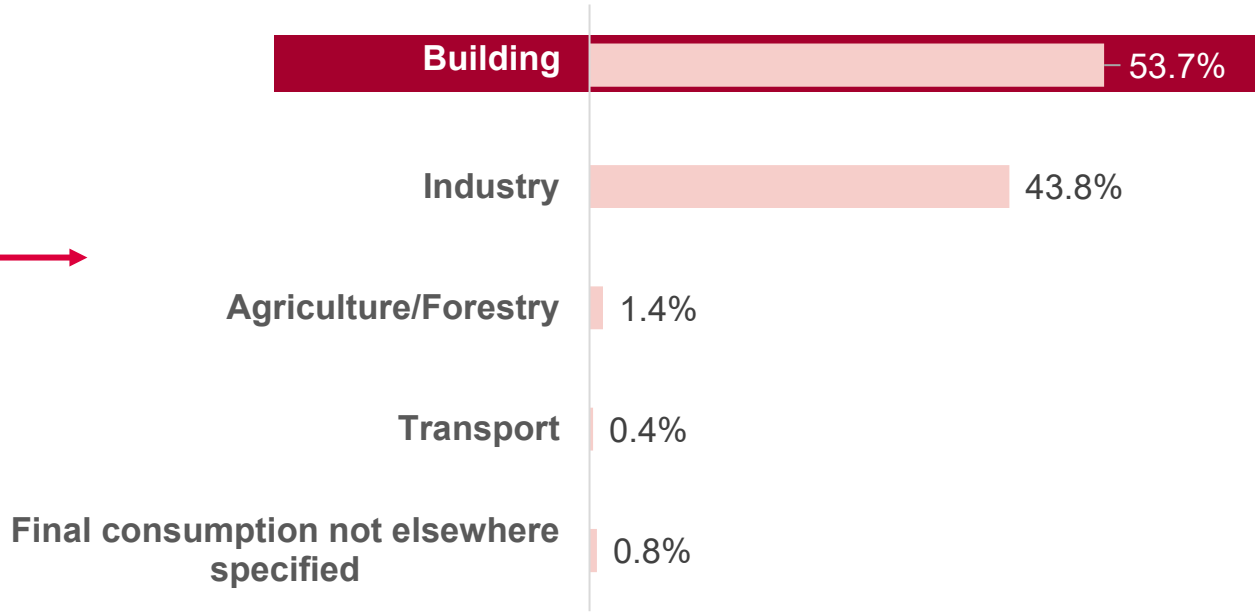
Overview

① Energy derived GHG emissions in ASEAN (2018)



Source：MRI created based on Climate Watch data (2018)

② Share of transport sector in ASEAN total electricity use

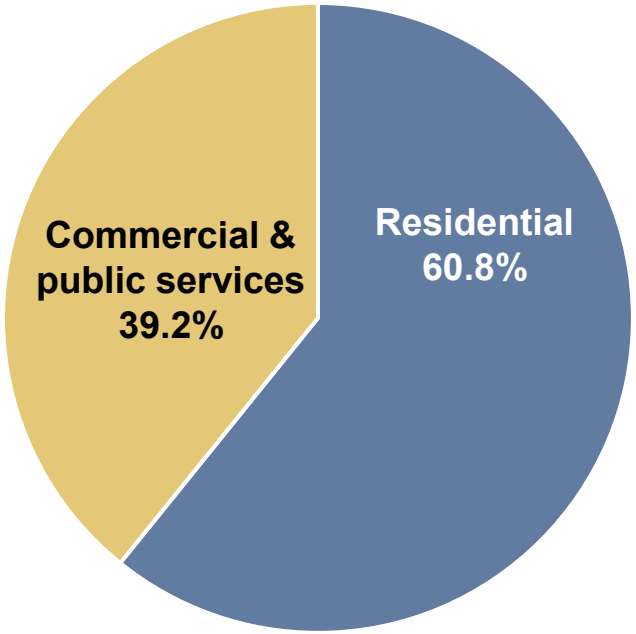


Source：MRI created based on IEA database (2021)

Building | Background information 2/2

Emission breakdown

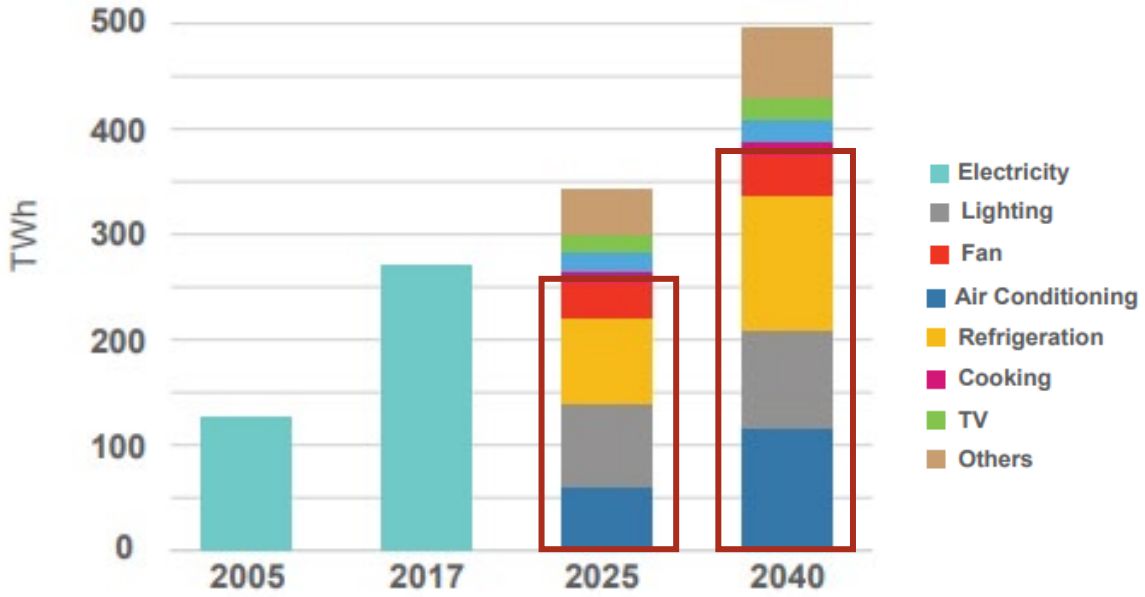
③ Electricity use breakdown by subsector, ASEAN (2021)



Source: MRI created based on IEA database (2021)

④ ASEAN Residential Electricity Demand by home appliances, Historical & Baseline Scenario

- In residential buildings, most of the electricity is used on **home appliances, space cooling** and **refrigeration**.

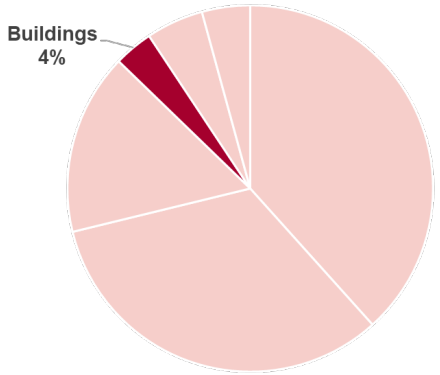


Source: ASEAN The 6th ASEAN Energy Outlook 2017-2020

Building

Background information – Selection priorities

①



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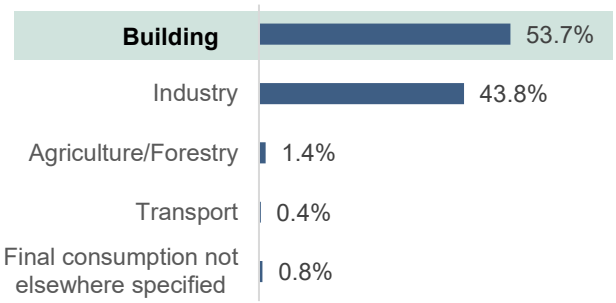

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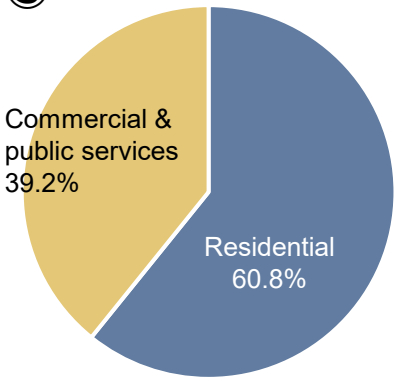

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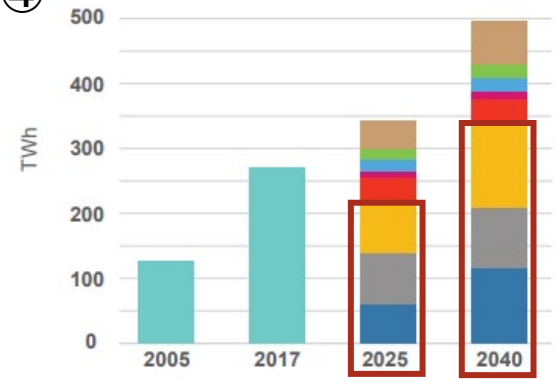


Selection priorities

- The focus should be on **energy efficiency** of the **cooling techs and home appliance** techs of the residential buildings

Building | Technology list – 1/2

Selection priorities were given to energy efficiency measures, particularly technologies that optimise electricity consumption in residential buildings.

Technology list in the building sector

Legend: 20-tech list | Second priority list | Not selected

#	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
				Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
1	**Heat pumps**	**EE&C**	**Electricity**	3	2	3	2.7	Stakeholders agree that heat pump is an important tech and should be included. In ASEAN where there is high cooling demand, air-source heat pump is especially relevant. In addition, comparison between different types of heat pumps can be useful to readers.	High priority as it is a technology for improving **energy efficiency** in the building sector, with applications in both residential and commercial buildings. This entry consists of different types of heat pumps, including air-source, water-source, ground-source, thermally-driven and solar heat pumps.
2	**Building integrated photovoltaic systems**	**RE**	**-**	3	2	3	2.7	-	High priority as it is a **renewable energy** technology that can directly reduce emissions in the building sector, with applications in both residential and commercial buildings.
3	**Fuel cell micro co-generation**	**EE&C**	**Hydrogen, natural gas or biomass**	3	2	3	2.7	-	High priority as it is a technology for improving **energy efficiency** in the building sector that also utilises cleaner fuels.
4	**Fuel combustion co-generation**	**EE&C**	**Biomass or natural gas**	3	3	2	2.6	Stakeholders suggest that biomass has high potential in ASEAN.	High priority as it is a technology for improving **energy efficiency** in the building sector. that also utilises cleaner fuels. This entry consist of cogeneration systems & micro co-generation systems using cleaner fuels such as natural gas, biomass, etc.
5	**Building energy management system (EMS)**	**EE&C**	**Electricity**	3	2	2	2.3	Stakeholders mention needs for home appliances and smart meters.	High priority as it is a technology for improving **energy efficiency** in the building sector, , with applications in both residential and commercial buildings
6	**Trigeneration systems (heating, cooling & electricity)**	**EE&C**	**Hydrogen, natural gas, biomass or solar**	3	2	2	2.3	-	Relatively high priority as it is a technology for improving **energy efficiency** in the building sector but deprioritised as it is a less mature technology compared to co-generation.
7	Biomass-fuelled heater	Fuel switch	Biomass	3	3	2	2.6	Stakeholder comments suggest that biofuel-related tech is relevant in ASEAN.	Not selected as it is similar to a fireplace, not a new technology.

Weighting

Relevance to ASEAN	30%
Technology maturity	30%
Contribution to energy transition	40%

Heatmaps of selected tech types (building)

RE	EE&C	Fuel switch	Electrification	CCU	Other
1 (1)	4 (8)	(1)			

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Building | Technology list – 2/2

Selection priorities were given to energy efficiency measures, particularly technologies that optimise electricity consumption in residential buildings.

Technology list in the building sector

Legend: 20-tech list | Second priority list | Not selected

#	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
				Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
8	Heat harvesting using building integrated materials	EE&C	-	3	1	3	2.4	Stakeholders suggested that insulation may be relevant.	Not selected as it is unlikely to be deployed standalone.
9	Energy-efficient ventilation system	EE&C	Electricity	3	3	1	2.2	-	Lower priority as it is unlikely to be deployed standalone.
10	Evaporative cooling	EE&C	Electricity	3	1	2	2	Stakeholders mention that cooling techs have high potential in ASEAN.	It works better in dry environment, thus not suitable for ASEAN humid climate.
11	Building integrated wind turbines	RE	-	3	1	2	2	-	Lower priority as challenges remain for mass deployment.
12	Reflective materials & Insulating materials for wall, façade, window, etc.	EE&C	-	3	1	2	2	Stakeholders suggested that insulation may be relevant.	Lower priority as it is unlikely to be deployed standalone.
13	Appliances using cleaner fuels	EE&C	Cleaner fossil fuel	3	2	1	1.9	-	Unlikely to be deployed standalone. Home appliacnes using electricity were prioritized and will be examined as part of a building EMS.
14	Energy-efficient household appliances (electric stove, hot and cold water tank, etc.)	EE&C	Electricity	3	2	1	1.9	-	Unlikely to be deployed standalone. To be examined as part of a building EMS.
15	Energy-efficient lighting	EE&C	Electricity	3	2	1	1.9	-	Unlikely to be deployed standalone. To be examined as part of a building EMS. This entry consists of LED lighting & smart lighting systems.

Weighting

Relevance to ASEAN	30%
Technology maturity	30%
Contribution to energy transition	40%

Heatmaps of selected tech types (building)

RE	EE&C	Fuel switch	Electrification	CCU	Other
1 (1)	4 (8)	(1)			

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Transport sector

Building sector

Overall industry sector

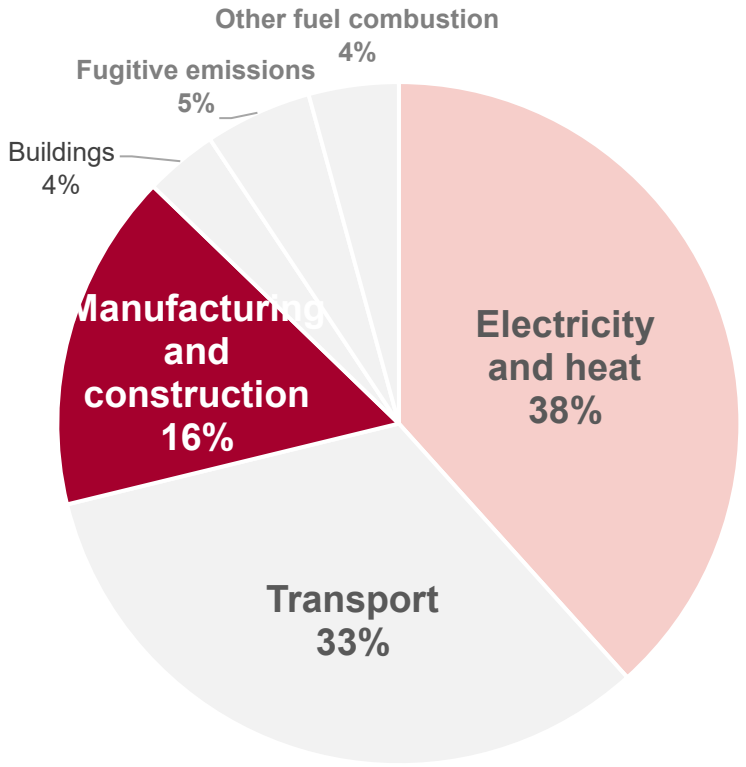
Industry – Specific sub sectors

Industry – Cross-sectors

Industry

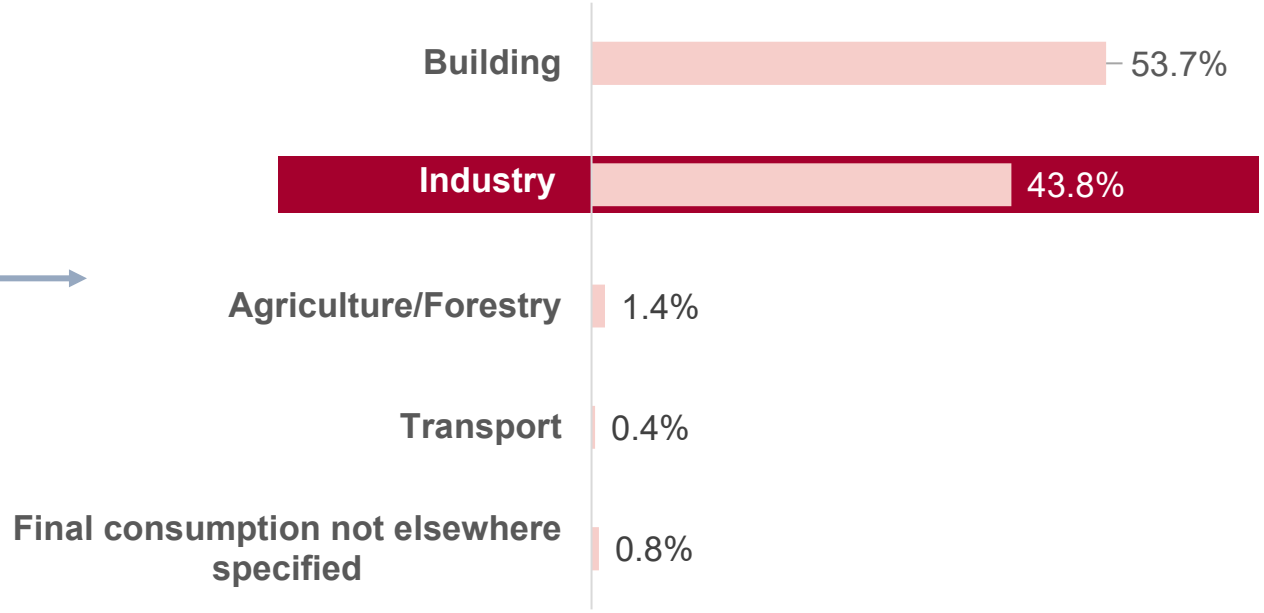
Overall background

① Energy derived GHG emissions in ASEAN (2018)



Source：MRI created based on Climate Watch data (2018)

② Share of transport sector in ASEAN total electricity use

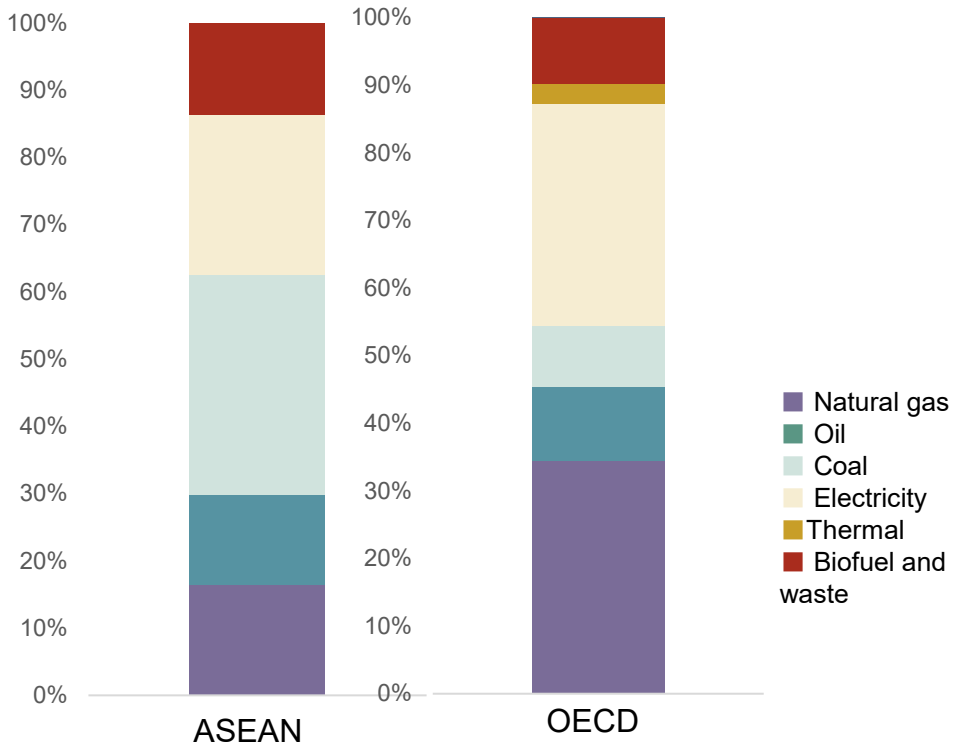


Source：MRI created based on IEA database (2021)

Industry | Energy sources

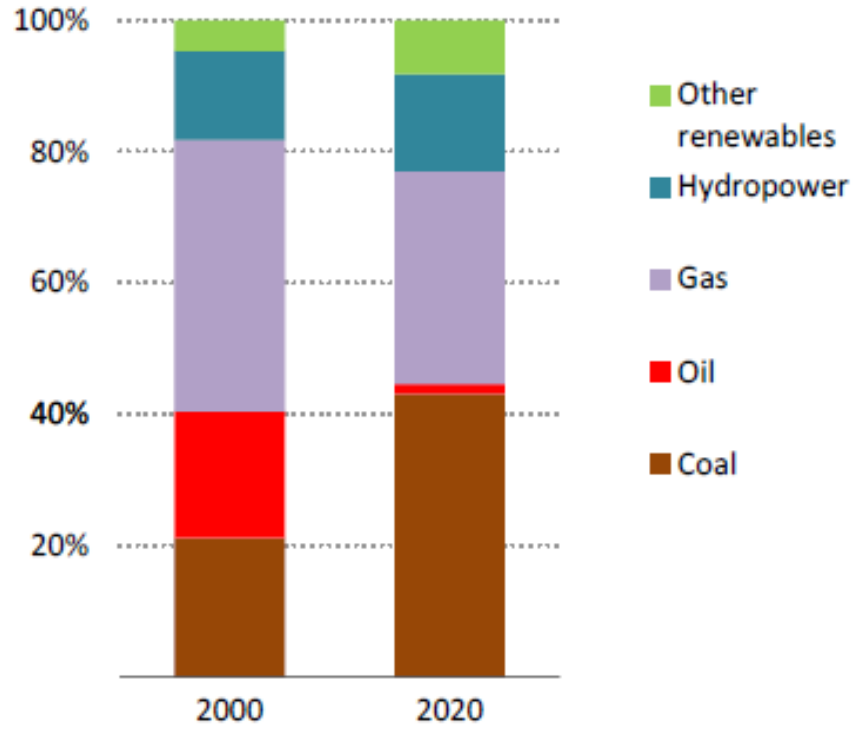
③ Industry energy consumption by source, ASEAN and OECD (2021)

>60% comes from fossil fuels. Coal is the largest source and emitter.



④ Power generation mix and share by fuels, ASEAN (2000-2020)

~20% of industry energy consumption comes from electricity, among which 80% comes from fossil fuels.



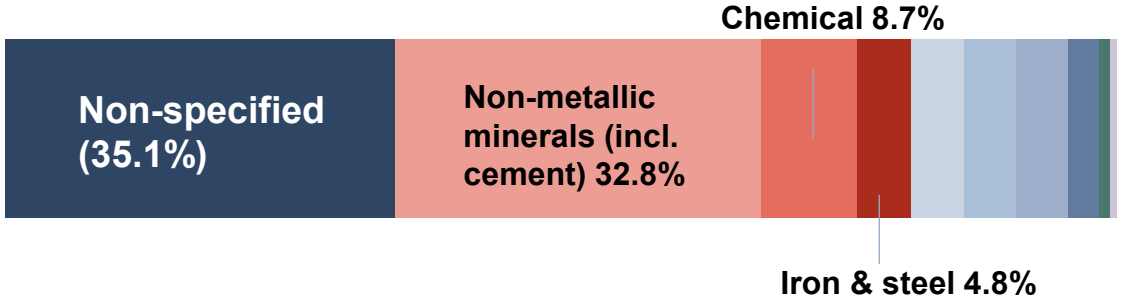
Source: IEA, Southeast Asia Energy Outlook (2022)

Industry

High-emitting sectors

④ Direct combustion emission breakdown by sub-sector, ASEAN total

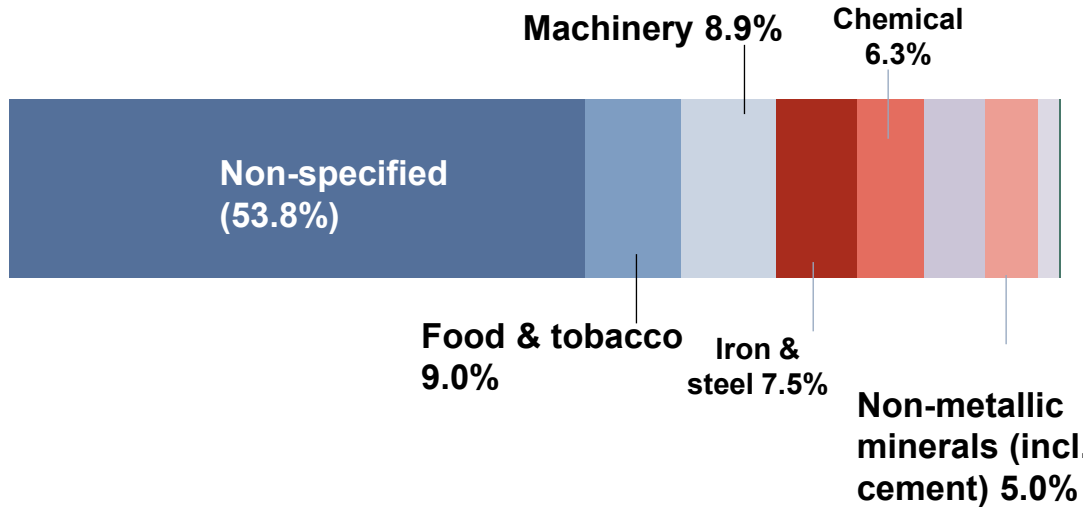
Hard-to-abate sectors **(iron & steal, cement, chemicals)** are the top emitters from direct combustion.



Non-metallic minerals (incl. cement)	32.8%	Textile & leather	4.7%
		Pulp & paper	4.7%
		Machinery	0.9%
Chemical	8.7%	Wood & wood products	0.6%
Iron & steel	4.8%	Transport equipment	0.1%
Food & tobacco	4.8%		
Industry not elsewhere specified			35.1%

⑤ Electricity use breakdown by sub-sector, ASEAN total

On top of the hard to abate sectors, **light manufacturing (esp. food & tobacco) and machinery** consumes a good portion of electricity.



Food & tobacco	9.0%	Non-metallic minerals (incl. cement)	5.0%
Machinery	8.9%		
Iron & steel	7.5%	Wood & wood products	1.9%
Chemical	6.3%	Pulp & paper	1.8%
Textile & leather	5.6%	Transport equipment	0.2%
Industry not elsewhere specified			53.8%

Source: MRI created based on IEA database (2021)

Transport sector

Building sector

Overall industry sector

Industry – Specific sub sectors

Industry – Cross-sectors

Industry Cement

Background information

Overview

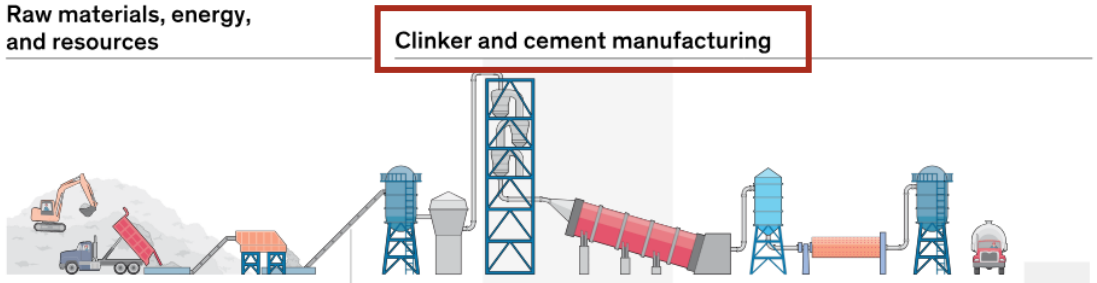
①

ASEAN country	Share of global cement export (ranking)	Export destinations with carbon tariff (share of total export)
Vietnam	10.20% (2nd)	United States (13.1%), France (1.36%)
Indonesia	2.82% (10th)	Australia (12.8%)
Thailand	2.78%(11th)	Australia (19.4%), United States (6.98%)

Source: OEC World Trade Data, Cement https://oec.world/en/profile/hs/cement

Emission breakdown

②



	Quarry	Crusher	Transport[1]	Raw mill	Kiln and preheater/ precalcinator[2]		Cooler[3]	Cement mill	Logis-tics[4]	Total
Energy, mega-joule/ton	40	5	40	100	3,150		160	285	115	3,895
CO_2, kilogram/ton	3	1	7	17	479 Calcination process	319 Fossil fuels	28	49	22	925

Source: McKinsey, Laying the foundation for zero-carbon cement, https://www.mckinsey.com/industries/chemicals/our-insights/laying-the-foundation-for-zero-carbon-cement

Industry
Iron & steel

Background information

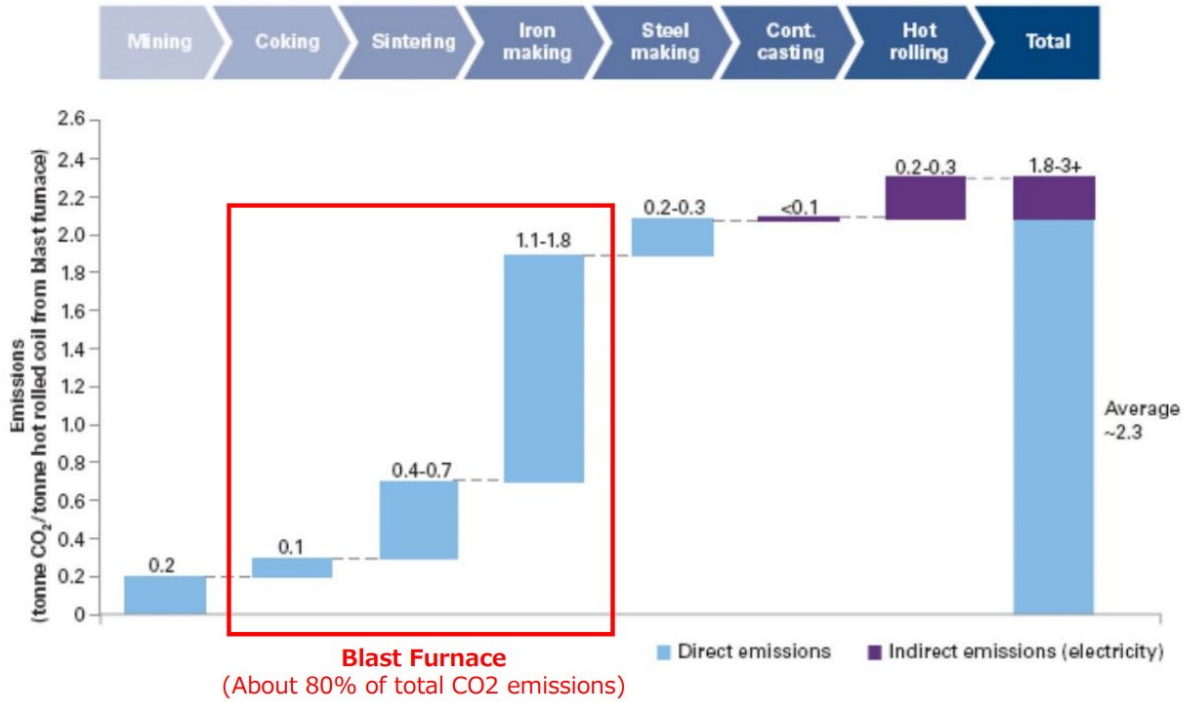
Overview

- Conventionally, iron is produced by reducing and melting iron ore and coal (coke) in a blast furnace and a basic oxygen furnace (BOF). In ASEAN, the steelmaking capacity is expected to grow 104.4 ~ 182.5 million mt by 2029-30, around **73.7 million mt of which would be from the blast furnace/BOF** route.

Source: S&P Global, Southeast Asian steel expansion unsustainable https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/051624-southeast-asian-steel-capacity-expansion-unsustainable-seaisi

Emission breakdown

③ Emission breakdown of the steelmaking process



Source: METI, Technology Road Map for Transition Finance in Iron and Steel Sector

Industry
Chemical

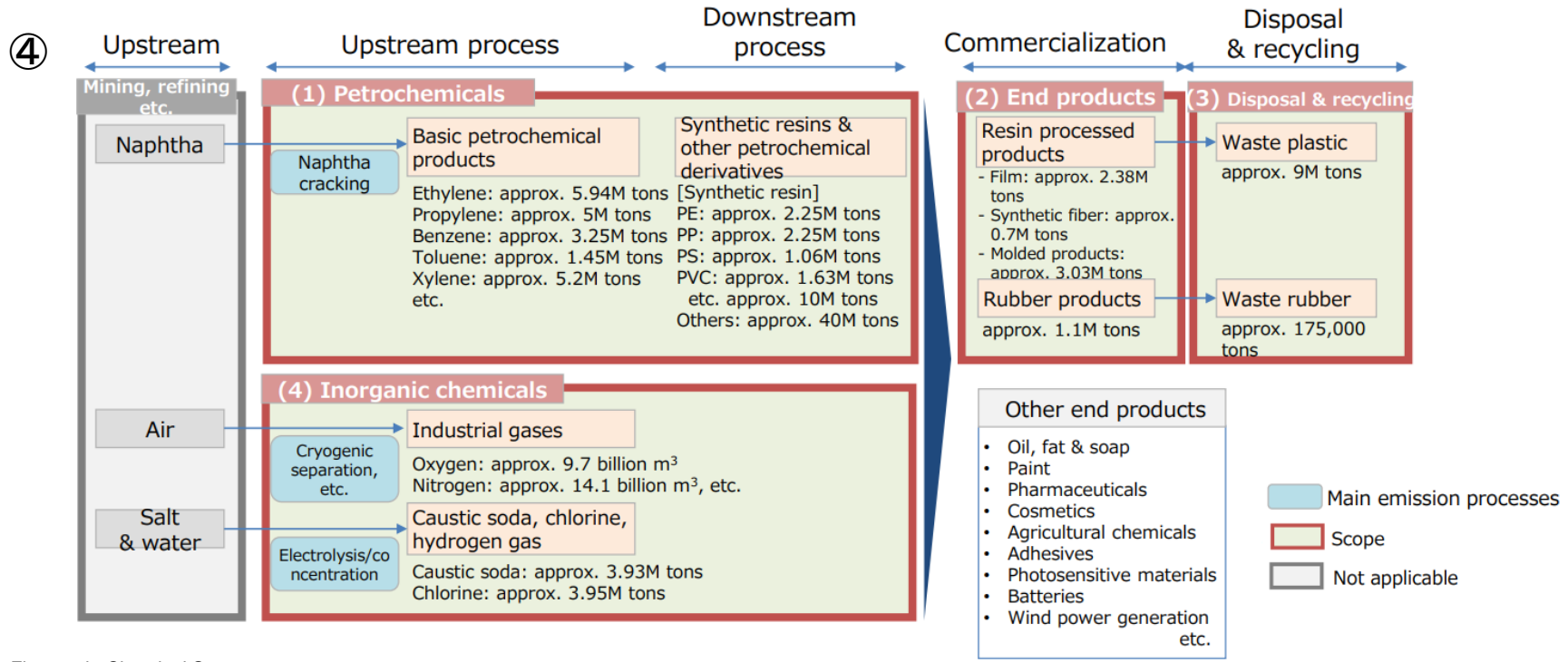
Background information

Overview

- Chemical is a small but growing industry in ASEAN. Indonesia, Vietnam and Malaysia are expanding capacity for **basic petrochemical products.**
- In the chemical industry, CO2 can be utilised in the production of various chemicals including olefins, thus there exists **potential for CCU**.

Source: KPMG Global Energy Institute, “Asia Pacific’s Petrochemical Industry: A Tale of Contrasting Regions” https://assets.kpmg.com/content/dam/kpmg/pdf/2014/11/asia-pacific-petrochemical-industry-v1.pdf

Emission breakdown



Source: METI, Technology Road Map for Transition Finance in Chemical Sector

Industry Specific

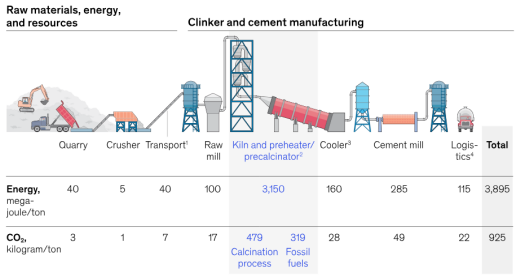
Background information – Summary and selection priorities

Cement

①

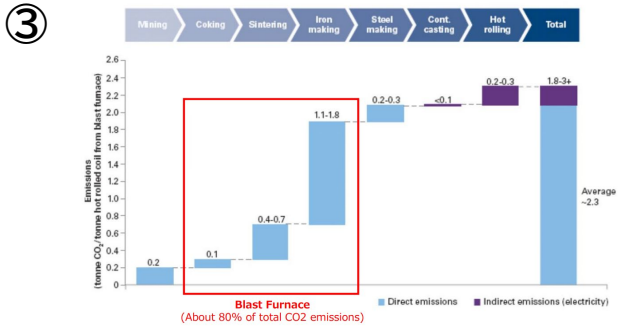
ASEAN country	Share of global cement export (ranking)	Export destinations with carbon tariff (share of total export)
Vietnam	10.20% (2nd)	United States (13.1%), France (1.36%)
Indonesia	2.82% (10th)	Australia (12.8%)
Thailand	2.78%(11th)	Australia (19.4%), United States (6.98%)

②



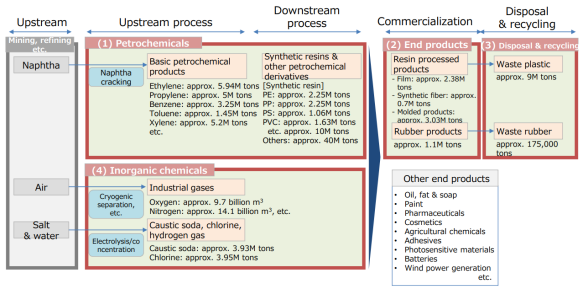
Iron & steel

③



Chemicals

④



Selection priorities

Cement

- Energy-efficient kiln
- Fuel switching/Electrification technologies
- CCU technologies to capture & utilise CO2 for cement/ concrete production

Iron & steel

- Technologies that avoid the use of BOF, including EAF & DRI
- CCU technologies to capture emissions from blast furnaces and convert it into fuels

Chemicals

- Energy and process efficient technologies
- CCU technologies, especially those that utilise CO2 in the production of for basic petrochemical production

Industry-Specific (cement) | Technology list

Industry-specific energy efficiency measures and CCU applications are prioritised, alongside alternative production pathways.

Technology list in the industry sector (cement)

Legend: 20-tech list | Second priority list | Not selected

#	Sub-sector	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
					Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
1	**Cement, concrete and glass**	**Carbon mineralisation (for concrete production)**	**CCU**	-	3	2	3	2.7	Stakeholders show strong interest in CCU.	High priority as it is a **CCU** technology specific to the cement industry.
2	**Cement, concrete and glass**	**NSP kiln**	**EE&C**	-	3	2	3	2.7		High priority as it is an **EE&C** technology specifically addressing emissions in the clinker manufacturing process.
3	**Cement, concrete and glass**	**Calcium looping**	**CCU**	-	3	1	3	2.4	Stakeholders show strong interest in CCU.	Relatively high priority as it is a CCU technology specific to the cement industry, but less mature than carbon mineralisation.
4	Cement, concrete and glass	Vertical mills	EE&C	-	3	2	2	2.3		Lower priority since it does not address the highest emitting process.
5	Cement, concrete and glass	All-electric forehearth	Electrification	Electricity	3	2	2	2.3		Lower priority since it does not address the high emitting process. This technology is for glass production.
6	Cement, concrete and glass	Reduction of clinker ratio (w/ tricalcium aluminate, blast furnace slags, etc.)	Other	-	3	2	2	2.3		Lower priority since it does not address the highest emitting process.
7	Cement, concrete and glass	Advanced grinding technologies	EE&C	-	3	1	1	1.6		Lower priority since it does not address the highest emitting process.

Weighting

Relevance to ASEAN	30%
Technology maturity	30%
Contribution to energy transition	40%

Heatmaps of selected tech types (industry specific)

RE	EE&C	Fuel switch	Electrification	CCU	Other
	1 (3)		1 (2)	2 (3)	1 (2)

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Industry-Specific (iron & steel, chemical) | Technology list

Industry-specific energy efficiency measures and CCU applications are prioritised, alongside alternative production pathways.

Technology list in the industry sector (iron & steel, chemical)

Legend: 20-tech list | Second priority list | Not selected

#	Sub-sector	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
					Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
8	**Iron and steel**	**High productivity electric arc furnace (EAF)**	**Electrification**	**Electricity**	2	2	3	2.4	-	**Alternative production pathway** that can avoid the blast furnace process.
9	**Iron and steel**	**Direct reduced iron (DRI) based on hydrogen/ natural gas blend**	**Other**	**Natural gas & hydrogen**	2	2	3	2.4	-	**Alternative production pathway** that can avoid the blast furnace process. This entry consists of DRI based on hydrogen/natural gas, and DRI based on natural gas with carbon capture.
10	**Iron and steel**	**Conversion of steel offgas to fuels/ chemicals**	**CCU**	-	2	1	3	2.1	Stakeholders show strong interest in CCU.	High priority as it is a proven **CCU** technology. This entry consists of conversion of steel offgas to fuels and conversion of steel offgas to chemicals.
11	Iron and steel	Oxygen-rich smelting reduction	CCU	-	2	1	3	2.1	-	Lower priority & can be considered as part of a CCU system.
12	Iron and steel	Plasma torch	Electrification	Electricity	2	1	2	1.7	-	Lower priority compared to DRI.
13	Iron and steel	Utilisation of plastic waste for coke production	Other	-	2	2	1	1.6	-	Lower priority due to lower emission reduction potential.
14	**Chemicals**	**Chemical production from CO2 (methanol, polycarbonate, etc.)**	**CCU**	-	2	1	3	2.1	Stakeholders show strong interest in CCU.	High priority as it is a **CCU** technology specific to the chemical industry.
15	Chemicals	Production of functional chemicals using flow method	EE&C	-	2	2	2	2		Lower priority as it is a complex technology. The production efficiency that can be achieved is different from process to process and hard to understand its contribution to energy transition.

Weighting

Relevance to ASEAN	30%
Technology maturity	30%
Contribution to energy transition	40%

Heatmaps of selected tech types (industry specific)

RE	EE&C	Fuel switch	Electrification	CCU	Other
	1 (3)		1 (2)	2 (3)	1 (2)

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation

Transport sector

Building sector

Overall industry sector

Industry – Specific sub sectors

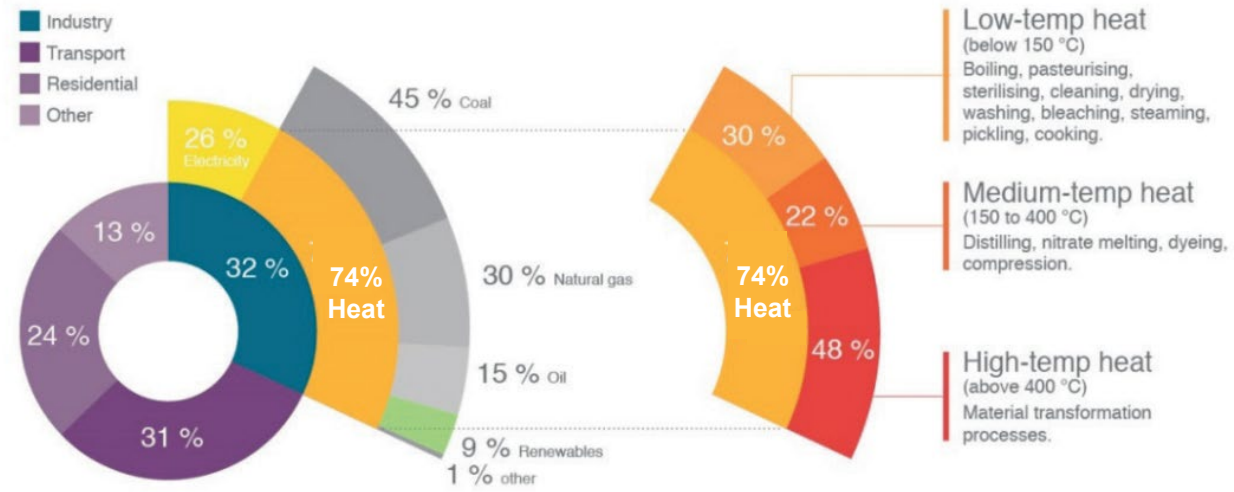
Industry – Cross-sectors

Industry Cross-cutting | Background information 1/2

Emission breakdown

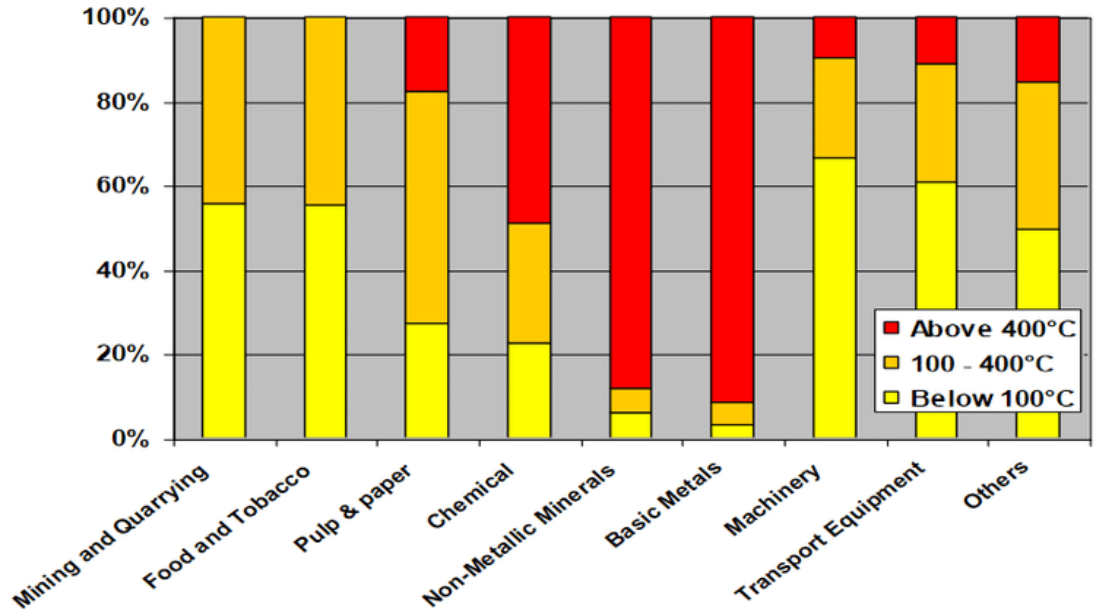
- In 2017, more than 70% of percent of **industrial energy** was used for **heating processes**, whereby 90% comes from fossil fuels.
- Light manufacturing sectors such as food and tobacco, pulp and paper, and machinery tend to use heat in the **low-to-medium temperature range (<400°C)**.

① Share and breakdown of heat demand in industry (Global, 2017)



Source: IEA, Insight Series: "Renewable Energy for Industry: From green energy to green materials and fuels"

② Temperature level of the industrial heat demand by industry sector



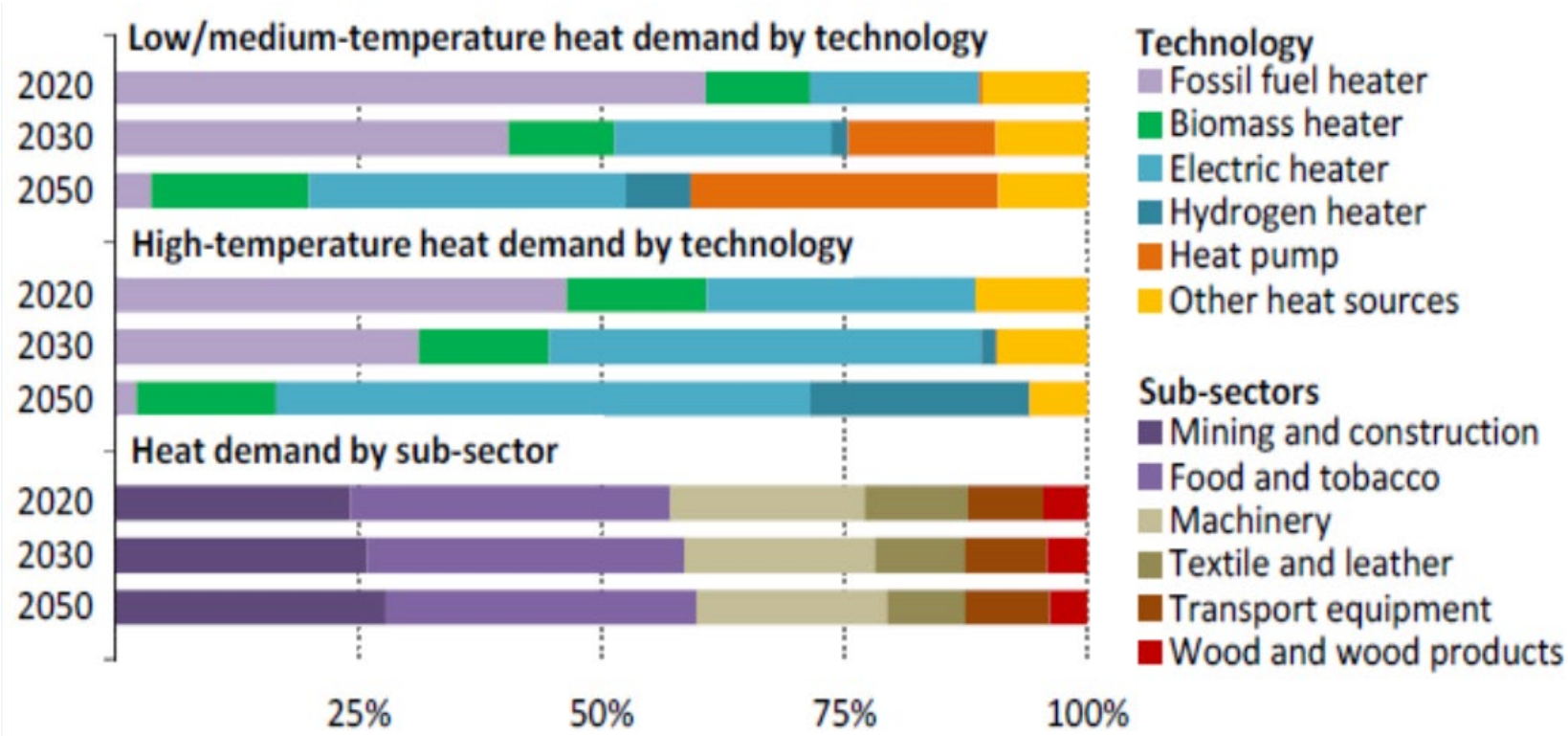
Source: Miguel Sainz Mañas, Françoise Bataille, Cyril Caliot, Alexis Vossier, Gilles Flamant. Direct absorption nano□id-based solar collectors for low and medium temperatures. A review. Energy, Elsevier

Industry Cross-cutting | Background information 2/2

Energy demand forecasts

- According to Net Zero Scenario by 2050 by IEA, the share of **electricity** in satisfying heat demand for light industries will increase rapidly toward 2050, for both low/medium temperature heating and high-temperature heating.
- Specifically, for **low-to-medium** temperature range, the use of **heat pumps** is expected to grow significantly.
- In addition, **hydrogen and biomass** are also potential transition fuels.

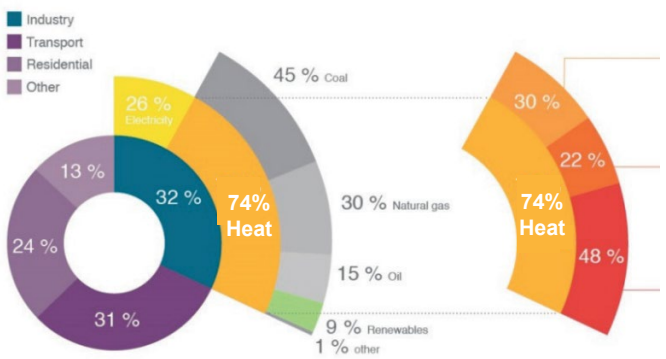
③ Share of heating technology by temperature level in light industries, NZE scenario



Source: IEA, Net Zero by 2050 A Road Map for the Global Energy Sector, Revised version, October 2021

Industry Cross-cutting | Background information – Summary and selection priorities

①



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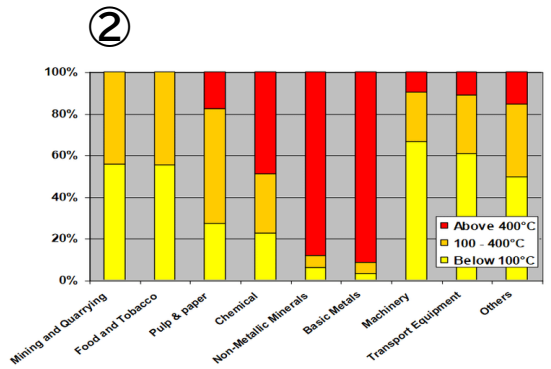

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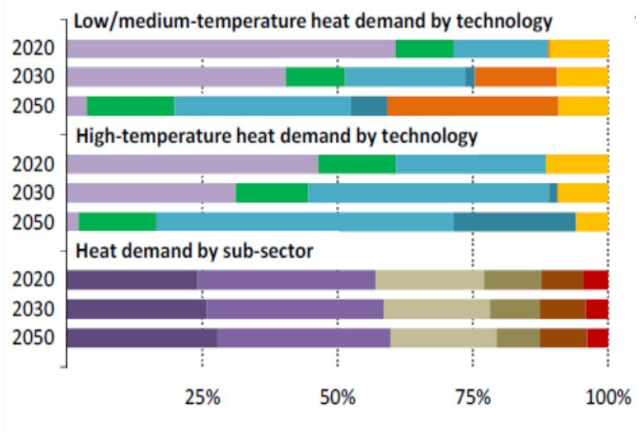

Selection priorities

- Solutions to provide less energy intense heating, primarily **fuel switching** and **electrification** are prioritised in the industry cross-cutting sector.
- At the same time, since it takes time to transition away from fossil fuels, **carbon capture** technologies can also contribute to decarbonisation.

Industry Cross-cutting | Technology list

Priorities were given to fuel switching and electrification of industrial heating processes, energy efficiency as well as carbon capture technologies.

Technology list in the industry sector (cross-cutting)

Legend: 20-tech list | Second priority list | Not selected

#	Tech name	Tech type	Fuel type	Scoring breakdown				Stakeholder comments	Reason for inclusion/exclusion
				Relevance to ASEAN	Technology maturity	Contribution to energy transition	Total		
1	**Large-scale industrial heat pump**	**Electrification**	**Electricity**	2	2	3	2.4	Stakeholders agree that heat pump is important.	High priority as it is a technology for **electrification** of industrial heating.
2	**Carbon capturing**	**CCU**	**-**	2	1	3	2.1	Stakeholders show strong interest in CCU.	High priority as these are **CCU** technologies that can be applied to a wide range of industries and can address hard-to-abate emissions. This entry consists of carbon capturing technologies such as chemical absorption, physical absorption, and physical adsorption.
3	**Hydrogen-fuelled equipment (burner, boiler, etc.)**	**Fuel switch**	**Hydrogen**	2	1	3	2.1		High priority as it is a technology for **fuel switching** of industrial heating.
4	**Waste heat recovery**	**EE&C**	**-**	2	2	2	2.0		High priority as it is an **EE&C** technology for industrial heating.
5	**Radiation heating (infrared, UV, etc.)**	**Electrification**	**Electricity**	2	2	2	2.0		High priority as it is a technology for **electrification** of industrial heating.
6	**Natural gas-fuelled equipment (burner, boiler, etc.)**	**Fuel switch**	**Natural gas**	2	2	1	1.6	Stakeholders suggest that cleaner fossil fuels are important for ASEAN.	High priority as it is a technology for **fuel switching** of industrial heating.
7	**Small-scale energy efficient heating equipment**	**EE&C**	**Hydrogen, natural gas**	2	2	1	1.4	Stakeholders suggest including this.	Important technology to reduce emissions from boilers at SMEs, but deprioritized in favour of other EE&C techs.
8	Biomass-fuelled equipment (burner, boiler, etc.)	Fuel switch	Biomass	2	3	2	2.3		Lower priority as it is not new technology.
9	Dielectric heating (microwave, radio wave, etc.)	Electrification	Electricity	2	1	2	1.7		Lower priority as it has limited applications compared to radiation heating but can be second option.
10	Use of wastes for thermal energy	EE&C	-	2	2	1	1.6		Lower priority as many challenges remain for successful deployment, such as treatment of waste before incineration, and ash treatment.
11	Introduction of advanced EMS (AI, IoT, Automated driving, etc.)	EE&C	-	2	2	1	1.6		Lower priority as it is unlikely to have a bigger impact to emission reduction compared to other EE&C techs.
12	Batteries for industrial use	EE&C	Electricity	2	2	1	1.6	Stakeholders suggest including this.	Lower priority as it can be too complex for mass deployment at present.

Weighting

Relevance to ASEAN	30%
Technology maturity	30%
Contribution to energy transition	40%

Heatmaps of selected tech types (industry cross-cutting)

RE	EE&C	Fuel switch	Electrification	CCU	Other
	1 (4)	1 (2)	1 (2)	1 (0)	

RE: Renewable energy, EE&C: energy efficiency & conservation, CCU: carbon capture & utilisation