Power Electronics Role / Application in Energy Transition

An Oil & Gas perspective

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2024 IEEE Power Electronics Society – 2024 IEEE PELS Day

20.06.2024

Content

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1. Introduction

- Background & context
- Malaysia National Energy Transition Roadmap (NETR)
- NZCE Targets
- Decarbonization Levers

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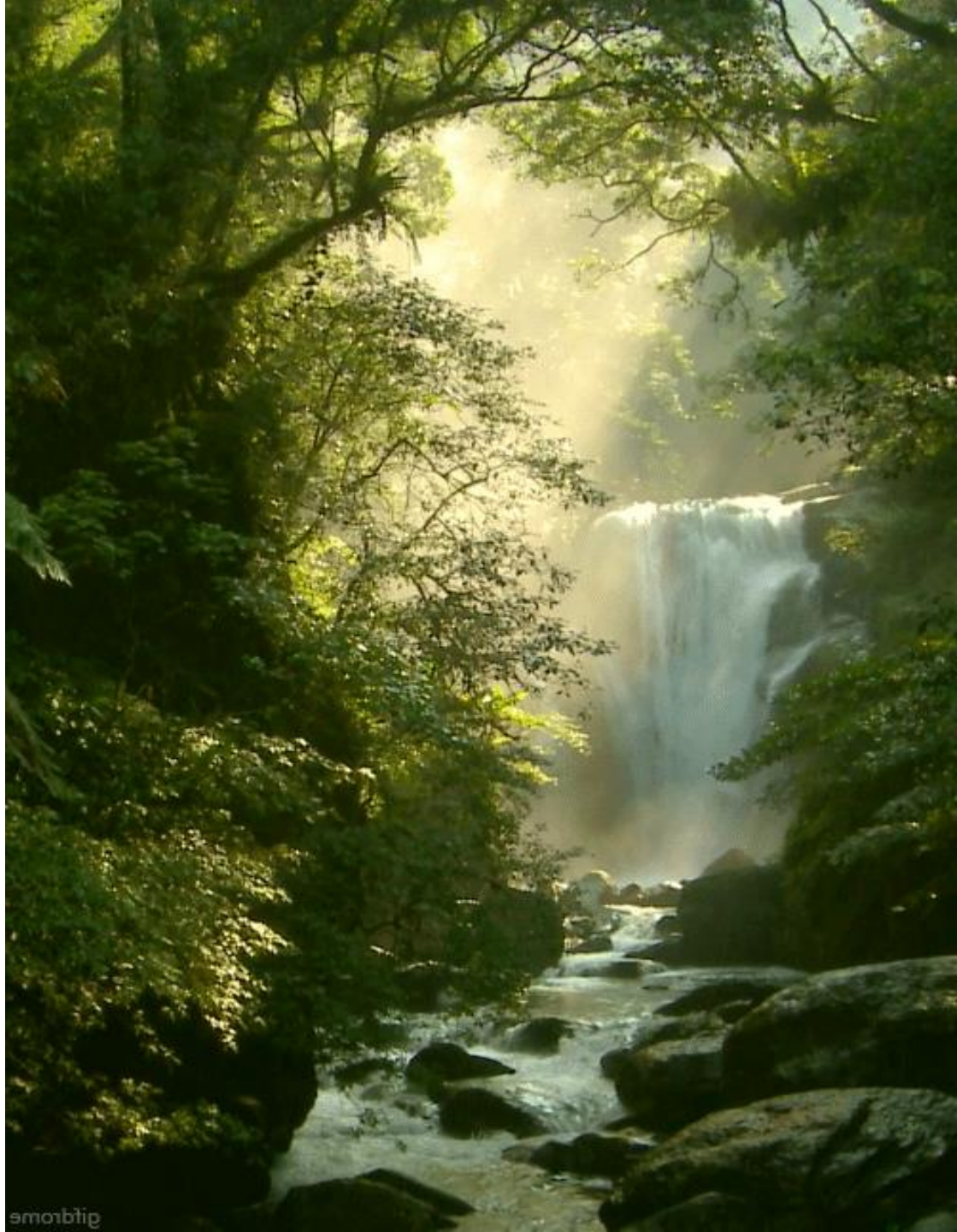
Background

Malaysia has demonstrated a strong commitment to addressing climate change by setting ambitious goals to reduce its greenhouse gas emissions.

As a signatory to the Paris Agreement, the country is pursuing impactful strategies to contribute to global efforts in mitigating the effects of climate change.



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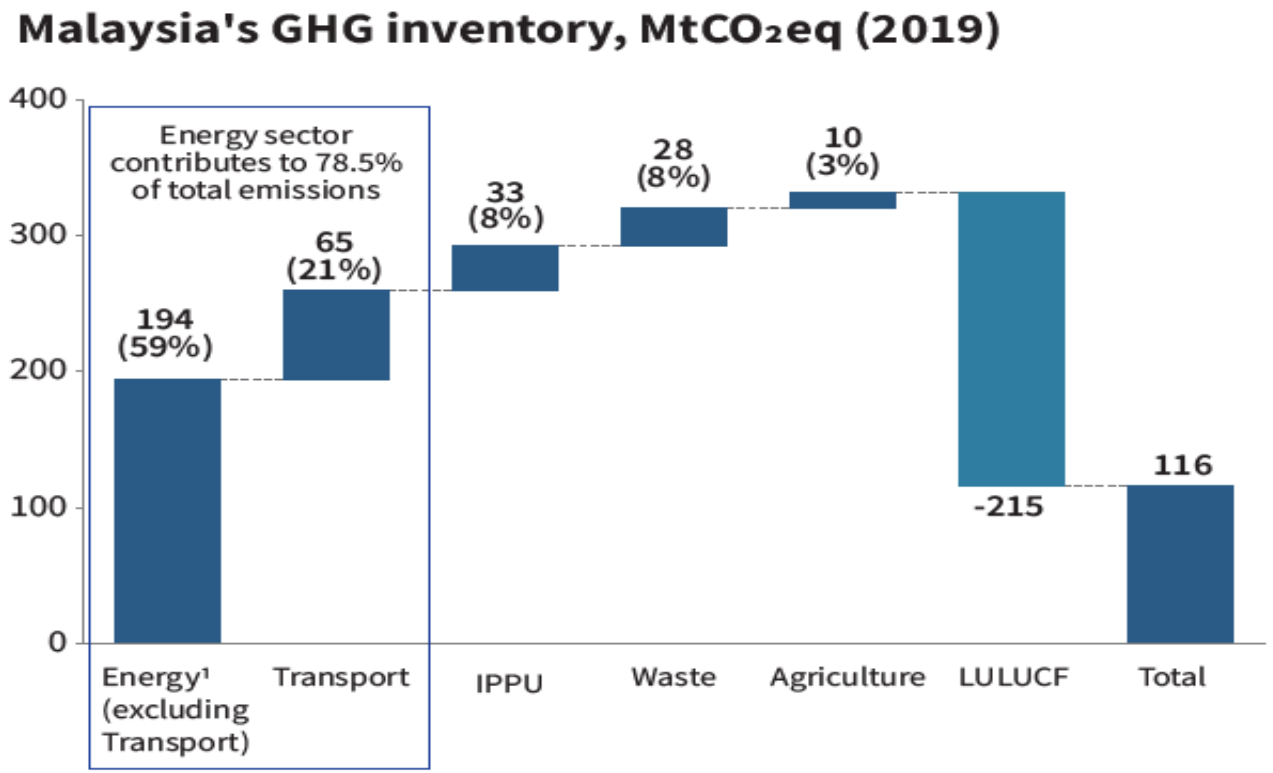
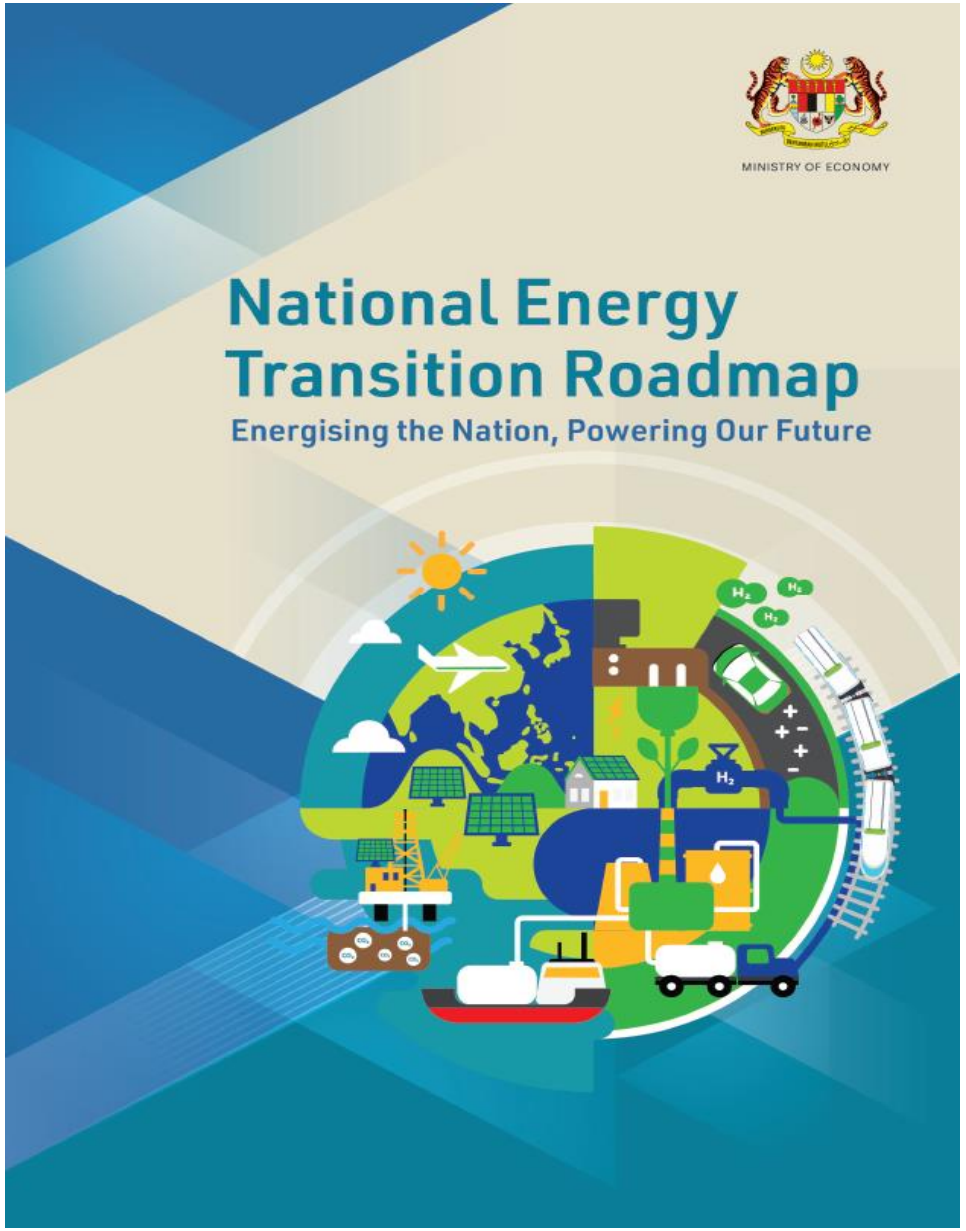
Source : National Energy Transition Roadmap

Context settings

“Malaysia urgent shift to sustainable energy is fuelled by global commitments, particularly the Paris Agreement and the need to fortify economic diversification and energy security.

Industry related to the energy transition has the potential to be a new source of growth that can benefit from the global market.”





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Source : National Energy Transition Roadmap

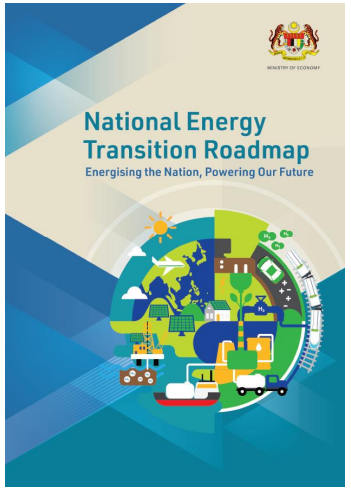
Context settings

NETR outlines:

50 initiatives under

6 energy transition levers and

5 enablers.



> "(NETR) sets the goal to accelerate energy transition and change the way energy is generated to improve climate resilience."

Key Initiatives

Energy Transition Lever: Energy Efficiency

Code	Initiatives	Champions
EE1	**Improve EE awareness** ○ Promote awareness for energy-efficient appliances and equipment through public awareness programmes ○ Redesign the 5-star labelling standards to emphasise monetary savings in addition to the technical energy savings	NRECC ST
EE2	**Improve existing Minimum Energy Performance Standards (MEPS) and 5-star rating bands** ○ Increase the number of MEPS-covered equipment ○ Establish an accelerated MEPS progression timeline for key critical appliances (e.g., with ASEAN Plan of Action for Energy Cooperation (APEC)) ○ Review the [illegible] through	ST
EE3	**Enforce mandatory [illegible] buildings** ○ Implement [illegible] energy ○ Establish [illegible]	ST
EE4	**Establish green building codes for energy-intensive residential and commercial buildings** ○ Establish a mandatory national standard that outlines EE parameters for both new residential and commercial buildings as well as retrofit for existing building to meet a minimum Building Energy Intensity (BEI) level ○ Mandate disclosure of building energy performance for commercial buildings	ST SEDA
EE5	**Establish an ESCO platform** ○ Establish a public ESCO platform to coordinate public building retrofits with private ESCOs ○ Streamline funding and create a single financial mechanism in the form of a revolving fund through ESCO platform	ST
EE6	**Launch a major EE retrofit initiative amongst government buildings** ○ Identify and prioritise [illegible] offices with BEI >200 kWh/m²/yr ○ Develop [illegible] programme	KKR JKR

Energy Transition Lever: Bioenergy

Code	Initiatives	Champions
BI-1	**Explore alternative bioenergy feedstock** ○ Explore bamboo as a feedstock ○ Support R&D of third-generation bioenergy (algae)	KPK
BI-2	**Enhance attractiveness of palm oil biomass** ○ Enhance acceptance of palm oil biomass (e.g. crude palm oil and palm oil mill effluent) to reduce indirect land use change (ILUC) charges ○ Obtain sustainable aviation fuel (SAF) certification from international bodies	KPK
BI-3	**Address challenge of supply security** ○ Facilitate biomass clustering to catalyse aggregation and reduce aggregation cost ○ Scale-up UCO collection via increasing awareness campaigns and UCO collection facilities	KPK
BI-4	**Catalyse local demand for bioenergy** ○ Establish SAF [illegible] starting with 3%	KPK SEDA
BI-5	**Improve solid waste management policies** ○ Explore [illegible] landfill tax to drive reduction in open landfills ○ Explore expansion of de-risking revenue sources and co-funding of waste-to-energy (WTE) plants to ensure financial sustainability ○ Accelerate recycling target and increase recycling infrastructure investments	KPKT

Energy Transition Lever: Green Mobility (Land Transport – Light Vehicle)

Code	Initiatives	Champions
GM-LV1	**Drive public transport modal share shift to 40% by 2040 and 60% by 2050** ○ Financially support the ongoing or future buildout of public transport infrastructure to facilitate modal share shifts ○ Facilitate electrification of public transport	MOT
GM-LV2	**Improve light vehicle fuel economy** ○ Establish robust methodology to measure fuel economy ○ Strengthen fiscal policy measures based on fuel economy ○ Determine long-term fuel standards	MOT
GM-LV3	**Accelerate electrification of light vehicles segment (E4W)** ○ Incentivise investments to build local manufacturing capacity and capability ○ Continue co-funding of public charging infrastructure ○ Implement stringent emissions standards to limit non-EEV manufacturing ○ Expand product awareness and model availabilities of EVs ○ Identify key policy challenges and opportunities that [illegible] to ramp up EV adoption including for setting up of charging infrastructure (e.g., right-to-charge regulation, approval process for charge point operator license, review of Uniform Building By-Laws)	MITI
GM-LV4	**Accelerate electrification of light vehicles segment (E2W)** ○ Incentivise E2W purchase or leasing cost to expedite total cost of ownership parity with ICE 2W, targeting B40 household ○ Foster the expansion of E2W model availability through local manufacturing or support for foreign manufacturers' setup ○ Monitor E2W charging infrastructure development and establish battery charging standards for public and home charging	MITI

Energy Transition Lever: Hydrogen

Code	Initiatives	Champions
HY-1	**Establish low-carbon hydrogen standards and regulations** ○ Adopt low-carbon hydrogen standard to ensure consistent definition of low-carbon hydrogen with global trading partners ○ Establish domestic guarantee of origin certification to meet the standards of importing countries ○ Introduce hydrogen-specific regulations relating to transportation and storage ○ Streamline permitting process for hydrogen projects for expedited [illegible]	MOSTI
HY-3	**Reduce Levelized Cost of Hydrogen (LCOH) for low-carbon hydrogen** ○ Establish hydrogen hubs to optimize economics of low-carbon hydrogen (Exhibit 5.5) ○ Establish financial incentives for large-scale manufacturing of low-carbon hydrogen and electrolyser ○ Facilitate partnerships between foreign electrolyser technology providers and local manufacturers for knowledge transfer	MOSTI MITI
HY-4	**Stimulate demand for low-carbon hydrogen** ○ [illegible]	MOSTI

Energy Transition Lever: Green Mobility (Land Transport – Heavy Vehicle)

Code	Initiatives	Champions
GM-HV1	**Enhance demand-side management with fuel economy** ○ Set common indicators and methodologies to measure fuel economy ○ Evaluate and refine selected levers to meet estimated fuel efficiency target ○ Encourage vehicle replacement through targeted incentives	MOT
GM-HV2	**Implement B30 biodiesel blending mandate** ○ Comprehensive review of biodiesel blending programme to ensure achievable blending rate ○ B30 to be mandated by 2030 when POMO spreads are projected to be economically viable	KPK
GM-HV3	**Introduce future powertrains for heavy vehicles** ○ Track advancement in technology of future fuel powertrains ○ Explore the introduction of hydrogen for long-haul trucks and battery electric vehicles (BEV) for short-to-medium-haul trucks	MOT MITI

Energy Transition Lever: Green Mobility - Aviation

Code	Initiatives	Champions
GM-AV1	**Establish overarching aviation decarbonisation roadmap** ○ Develop aviation decarbonisation roadmap collaboratively along side key stakeholders with four main elements: (i) foster industry-driven advancement through collaboration with private [illegible]	MOT
GM-AV3	**Undertake palm oil-feedstock emissions study** ○ Re-evaluate emissions related to POME and ILUC to bolster adoption of SAF derived from palm oil ○ Ensure palm oil for SAF production is sourced in a sustainable manner	KPK

Energy Transition Lever: Green Mobility -Marine

Code	Initiatives	Champions
GM-MA1	**Unlock market opportunities of biofuel in marine bunkering** ○ Research, conduct pilots, and drive technical and commercial viability of domestic biofuels usage in onboard equipment and marine bunkering fuel ○ Encourage early adoption of domestic biofuels in shipping industry to position biofuel for fuel export	KPK
GM-MA2	**Unlock market opportunities of future fuels in marine bunkering** ○ Keep track and selectively adopt pilot projects for alternative fuels and determine country strategy for these fuels as commercial viability is reached ○ Enhance competitiveness of domestic ports in future fuel marine bunkering by providing incentives, lowering costs of fuel supply and enhancing refueling efficiency ○ Develop plan for domestic coastal ships to adopt future fuels in the medium- to long-term	MOT

Energy Transition Lever: Carbon Capture, Utilisation and Storage (CCUS)

Code	Initiatives	Champions
CC1	**Develop CCUS-specific policies and regulations** ○ Develop policy and regulatory framework to facilitate the implementation of CCUS projects ○ Establish governance structure of CCUS by clearly defining roles of each ministry and agency ○ Amend existing regulations (e.g. Exclusive Economic Zone Act 1984 [Act 311] and National Land Code) to incorporate key enablers for CCUS development	Ministry of Economy
CC2	**Strengthen CCUS adoption through provision of incentives across all relevant sectors to facilitate hub development** ○ Establish carbon pricing instrument to drive the adoption of carbon capture technology for stationary emitters ○ Enhance incentives to reduce cost, enable access to funding and encourage adoption of CCUS technologies (e.g., public catalytic funds, tax credits, contracts for difference)	MOF Ministry of Economy
CC3	**CC3 - Facilitate CCUS Hub infrastructure development** ○ Explore collaboration with potential investors and financiers to fund and catalyse investments in CCUS infrastructure for hub development	Ministry of Economy
CC4	**Establish transboundary CO_2 agreement** ○ Negotiate and introduce transboundary CO_2 regulatory agreement encompassing the provisions on transboundary movement and storage of carbon, liability and cost sharing (Exhibit 5.9)	Ministry of Economy
CC5	**Promote local utilisation of CO_2 in industry** ○ Set specific mandates within in use case (e.g. cured concrete and urea)	MITI

Enabler: Financing and Investment

Code	Initiatives	Champions
EN1	**Launch a National Energy Transition Facility (NETF)** ○ Launch initial seed fund amounting to RM2 billion ○ Explore the catalytic blended finance platform, aimed at expediting the mobilisation and deployment of capital to enhance the accessibility of funds, streamline investment processes, and ensure a seamless flow of financial resources towards energy transition projects.	Ministry of Economy
EN2	**Mobilise and attract private capital for energy transition sectors** ○ Attract private capital from the green foreign direct investments (FDI), international and domestic capital markets, venture capital (VC), and private equity (PE) ○ Accelerate adoption of innovative sustainable finance instruments e.g. sustainability-linked/green/SDG financing, bonds and sukuk, blended finance structures ○ Develop capacity building programme to upskill FIs and fund managers in collaborations with Joint Committee on Climate Change (JCS) and financial industry training institutes ○ Scale-up sustainable finance literacy, awareness programmes and technical capacity building targeting SMEs by JC3 including through pilot programmes such as Greening the Value Chain ○ Expedite VC investments in high-risk, early-stage energy ventures in suitable areas	MITI BNM SC
EN3	**Roll out carbon pricing mechanism** ○ Implement a phased and meticulously calibrated carbon pricing mechanism that sends clear market signals on decarbonisation while simultaneously creating an additional capital pool for investments in energy transition ○ Roll out communication strategy to seek buy-in from the businesses and rakyat	MOF NRECC

Enabler: Human Capital and Just Transition

Code	Initiatives	Champions
EN6	**Establish green skills taxonomy and ensure strategic workforce planning** ○ Develop green skills taxonomy that defines the essential skills needed for a just transition towards a sustainable workforce ○ Facilitate a strategic alignment between workforce demand and supply based on the green skills taxonomy and competency standards of present and future industry requirements ○ Establish a task force to develop strategic plans for the future of the energy sector's workforce	Sector-specific agencies
EN7	**Develop and roll out targeted green skilling programmes** ○ Implement reskill and upskill programmes for affected workforce ○ Establish strategic partnerships with local universities and industry partners to enhance green skills ○ Enhance TVET and tertiary programmes for new green sectors	Sector-specific agencies
EN8	**Develop and implement community support programmes** ○ Develop a clear mitigation and communication plan for affected community and region ○ Implement targeted community support programmes	Sector-specific agencies
EN9	**Enhance energy literacy and energy efficiency awareness among students, SMEs and consumers** ○ Strengthen the Malaysia Energy Literacy Program (MELP) to catalyse a significant change in public perception and behaviour towards energy utilisation ○ Encourage SMEs to incorporate EE practices in their business ○ Implement energy literacy and awareness programmes at educational institutions	Sector-specific agencies TNB

Enabler: Policy and Regulation

Code	Initiatives	Champions
EN4	**Rationalise energy subsidies** ○ Develop a targeted subsidy mechanism based on needs ○ Ensure transparency and effective communication on subsidy removal ○ Leverage Pangkalan Data Utama (PADU) to facilitate targeted subsidies	MOF Ministry of Economy KPDN NRECC
EN5	**Launch the Natural Gas Roadmap (NGR)** ○ Optimise country value-add of indigenous natural gas resources ○ Enhance competitiveness of upstream oil and gas to meet domestic demand and energy transition needs (sustainability and security) ○ Plan and execute timely, and cost-effective build-out of gas infrastructure	Ministry of Economy

Enabler: Technology and Infrastructure

Code	Initiatives	Champions
EN10	**Accelerate development of domestic industries for green manufacturing and adoption of green technologies** ○ Develop programmes tailored to support SME involvement in the green value chain in the form of technical expertise and financial support	MITI
EN11	**Develop a National Energy Knowledge Hub for public access** ○ Establish a one-stop centre for energy transition data, information and programmes under the purview of MTN	Ministry of Economy

Source : National Energy Transition Roadmap

Malaysia National Energy Transition Roadmap (NETR)

Exhibit 3.3: The four guiding principles of NETR

Exhibit 2.3: The DTN Framework

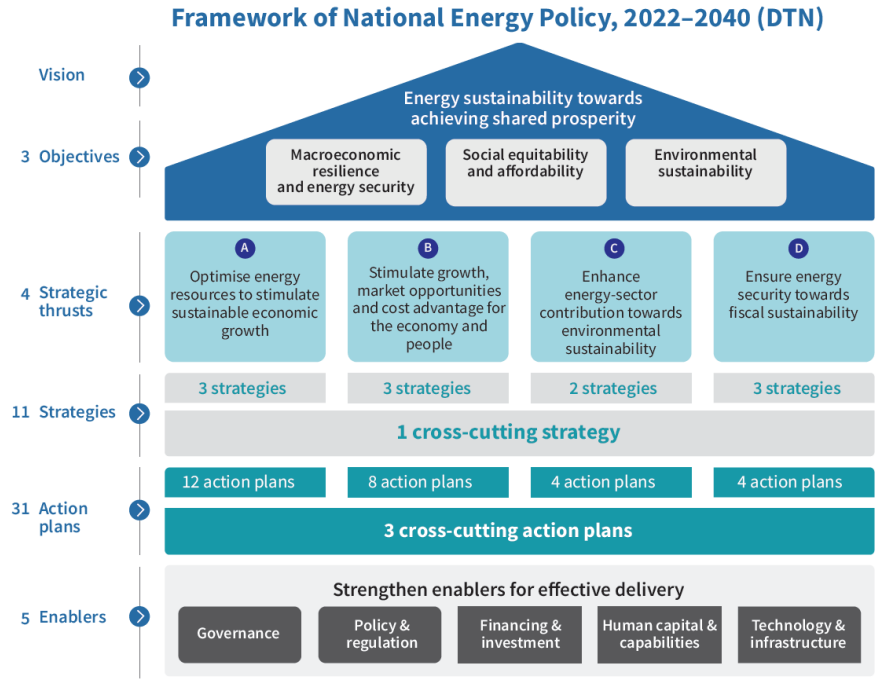
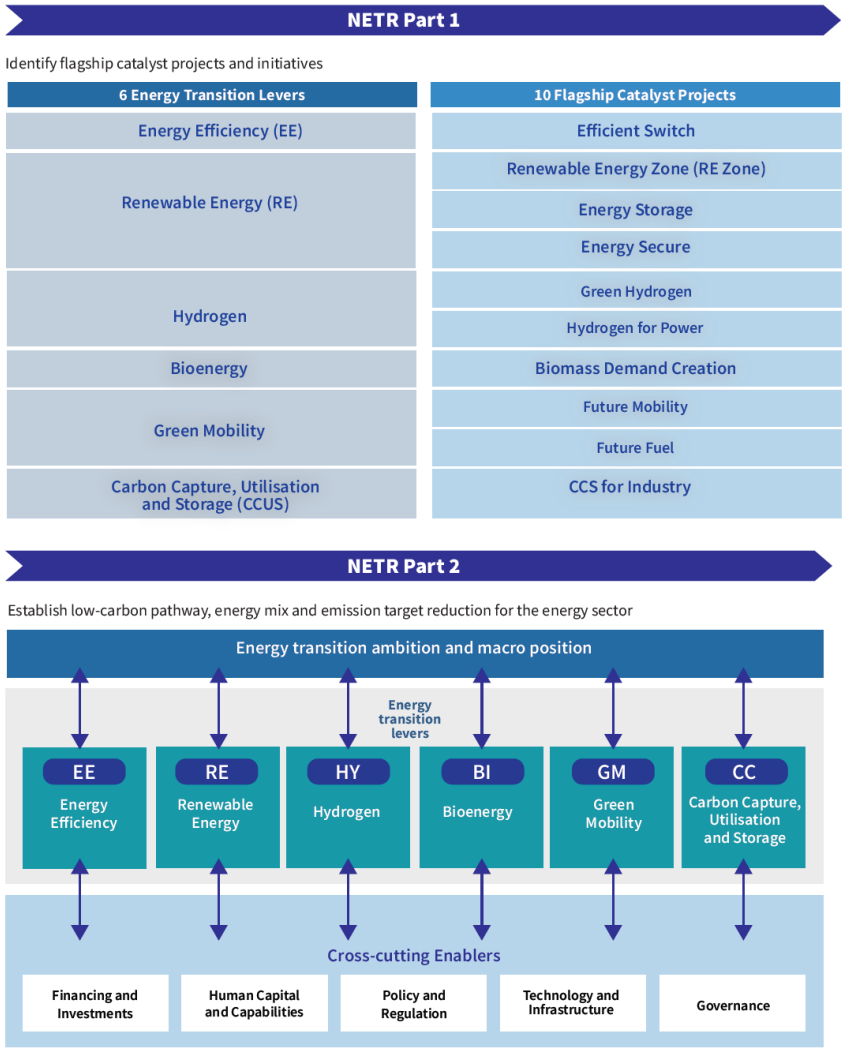


Exhibit 3.2: Parts 1 and 2 of the NETR



Sector and Key Driver		2040 DTN Low Carbon Nation Asp.	2050 NETR Responsible Transition
EE Energy Efficiency	Industry and Commercial energy efficiency savings (%)	11%	23%
	Residential energy efficiency savings (%)	10%	20%
RE Renewable energy	Coal share of installed capacity (%)	19%	0%
	RE share of installed capacity (%)	41%	70%
HY Hydrogen	Green hydrogen production (MTPA)	N/A	Up to 2.5 MTPA
	Grey hydrogen feedstock phase off (%)	N/A	100%
	Hydrogen hubs (#)	N/A	3
BI Bioenergy	Biofuel capacity (billion litres)	N/A	3.5
	Bioenergy power generation (GW)	N/A	1.4
GM Green Mobility – Land	Urban public transport modal share (%)	50%	60%
	xEV (4W) share of fleet (%)	38%	80%
	E2W share of fleet (%)	N/A	80%
	Light vehicle fuel economy	N/A	~30%
	Heavy transport fuel economy	N/A	~24%
	Biofuel blending for heavy transport (%)	B30	B30
	Hydrogen penetration for heavy transport (%)	N/A	5%
Marine	LNG penetration as alternative fuel in marine transport (%)	25%	N/A
	Green fuel penetration in marine transport (%)	N/A	40%
Av.	SAF blending mandate by 2050 (%)	N/A	47%
CC CCUS	Number of CCUS clusters (#)	N/A	3-6
	CO_2 storage capacity (Mtpa)	N/A	40-80

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A Pledge To The World
Ikrar Kepada Dunia
Ketika menjangkau pandangan hari esok

Source : PETRONAS Pathway to NZCE 2050

PETRONAS' net zero carbon emissions by 2050 pathway presents our mid- and near-term emission reduction targets and growth ambitions for new energy solutions

[Open]

Source : PETRONAS Pathway to NZCE 2050

NZCE (Net Zero Carbon Emission) Target

2024

49.5 $MtCO_2e$ cap for PETRONAS' Malaysia operations

2025

50% Methane emissions reduction for PETRONAS Groupwide natural gas value chain operations[2]

2030

25% Greenhouse gas emissions reduction for PETRONAS Groupwide

70% Methane emissions reduction for PETRONAS Groupwide natural gas value chain operations[2]

50% Methane emissions reduction for Malaysia's natural gas value chain operations[2]

2050

NET ZERO 2050

Net Zero Carbon Emissions for PETRONAS

Greenhouse gas emissions[1]

Methane emissions (included in greenhouse gas emissions target)

PETRONAS' **decarbonization** efforts will anchor on **four core strategies**:

- **Zero routine flaring and venting**
- **Electrification**
- **Energy efficiency**
- **Carbon capture and storage**

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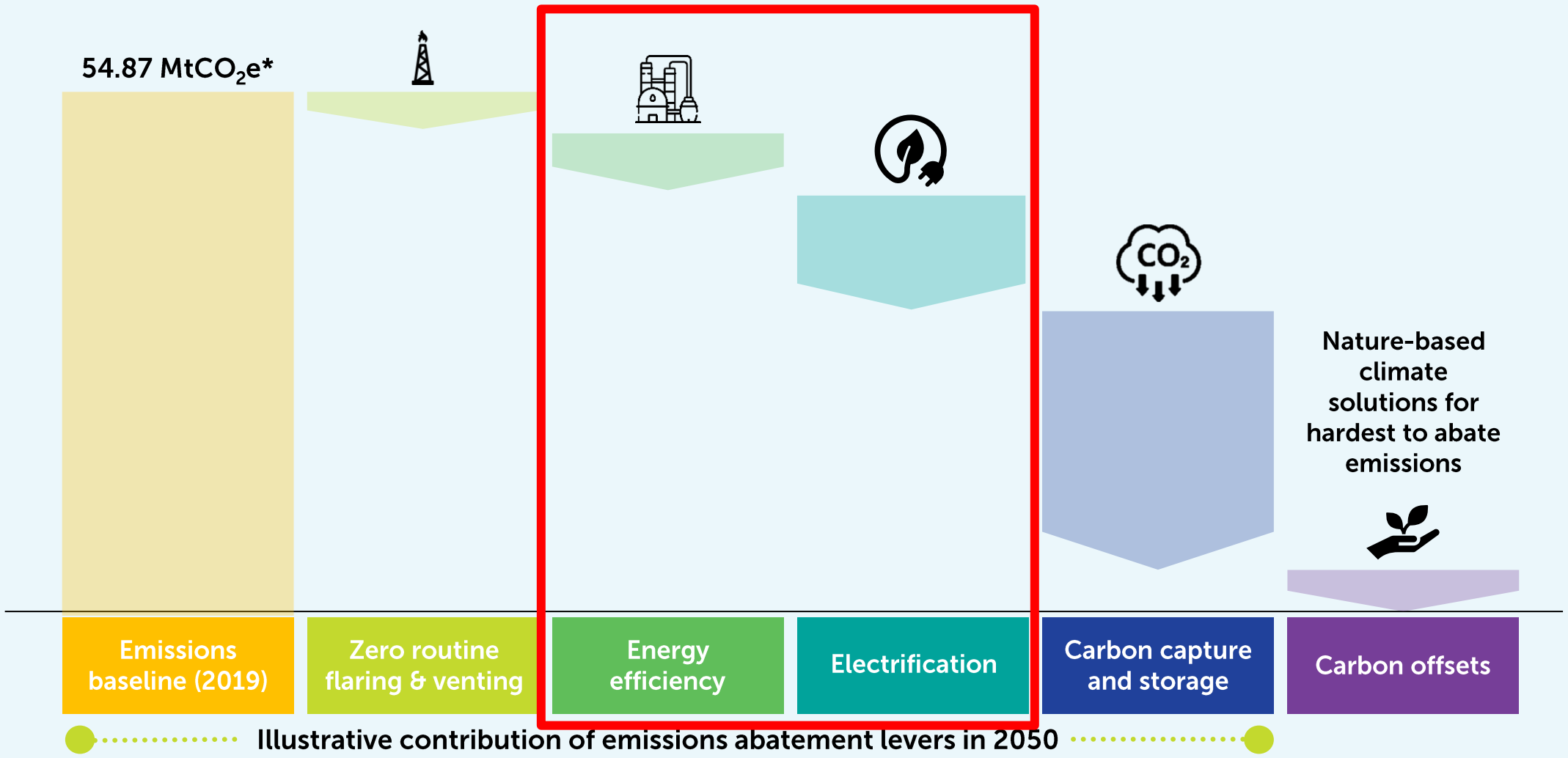
Efforts on ELECTRIFICATION and ENERGY EFFICIENCY are currently intensified to support other decarbonization levers, to meet the GHG emission reduction target by 2030.



** As a result of our enhanced emissions accounting practices, which includes a change in organisational boundary, we have adjusted our 2019 baseline reference to 54.87 Million tCO_2e (previously calculated 57.73 Million tCO_{2e}) via equity share approach : PETRONAS Integrated Report 2022*

2. Regulatory, Policy & Standards Requirement

- Malaysia status of Energy Mix
- Malaysia Energy Policy & initiatives
- IOGP standard reference
- Internal standards & initiatives

[Open]

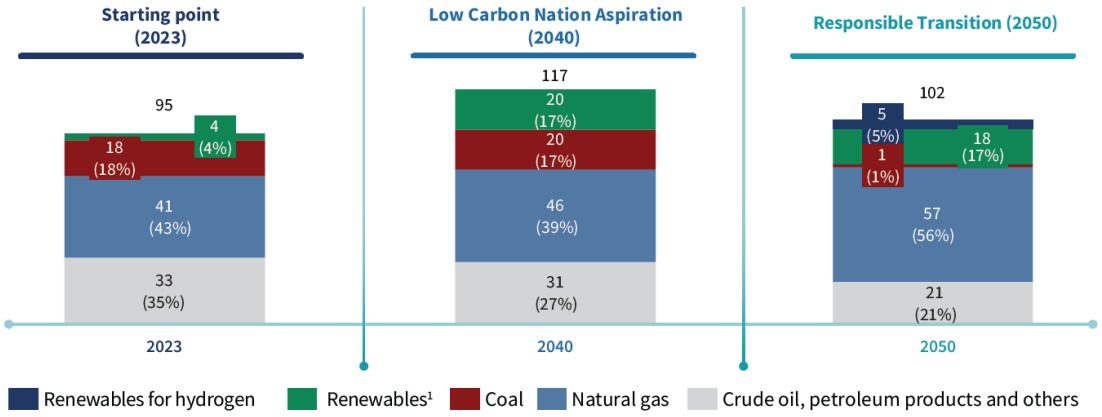
Source : National Energy Transition Roadmap

Malaysia status of Energy Mix

NETR continue to project the forecast of Malaysia Energy Mix as established in DTN.

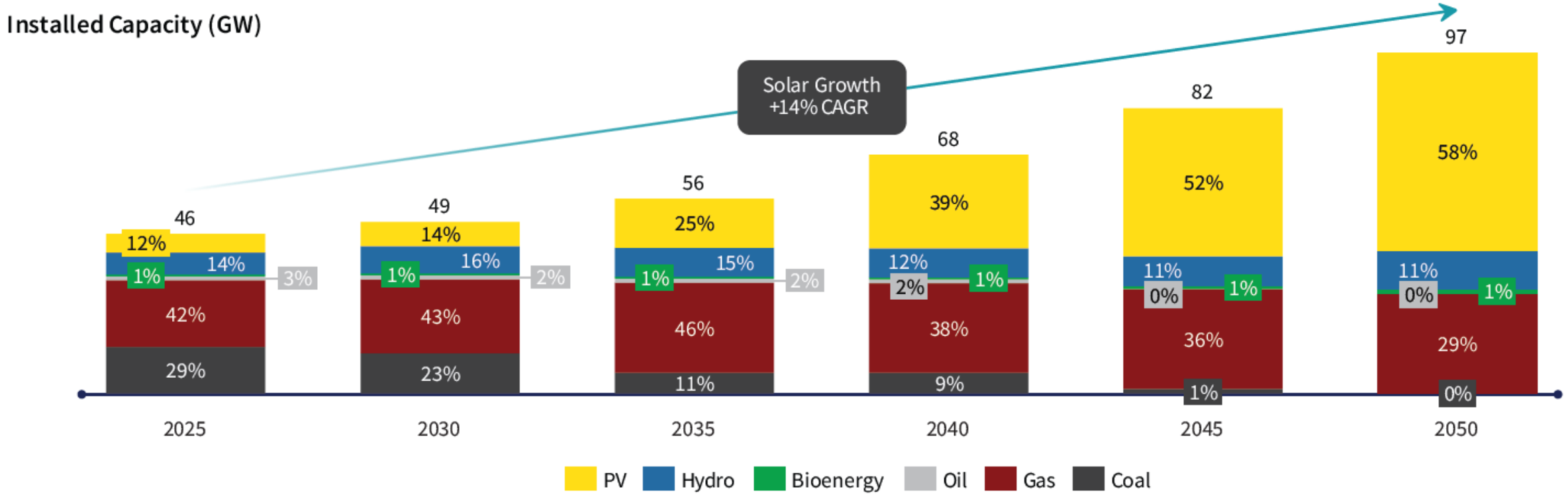
Exhibit 4.3: Malaysia's projected TPES by 2050

Total Primary Energy Supply (Mtoe), by energy source



1. Includes bioenergy, solar, hydropower and hydrogen

Exhibit 5.2: Projected power system installed capacity mix 2050



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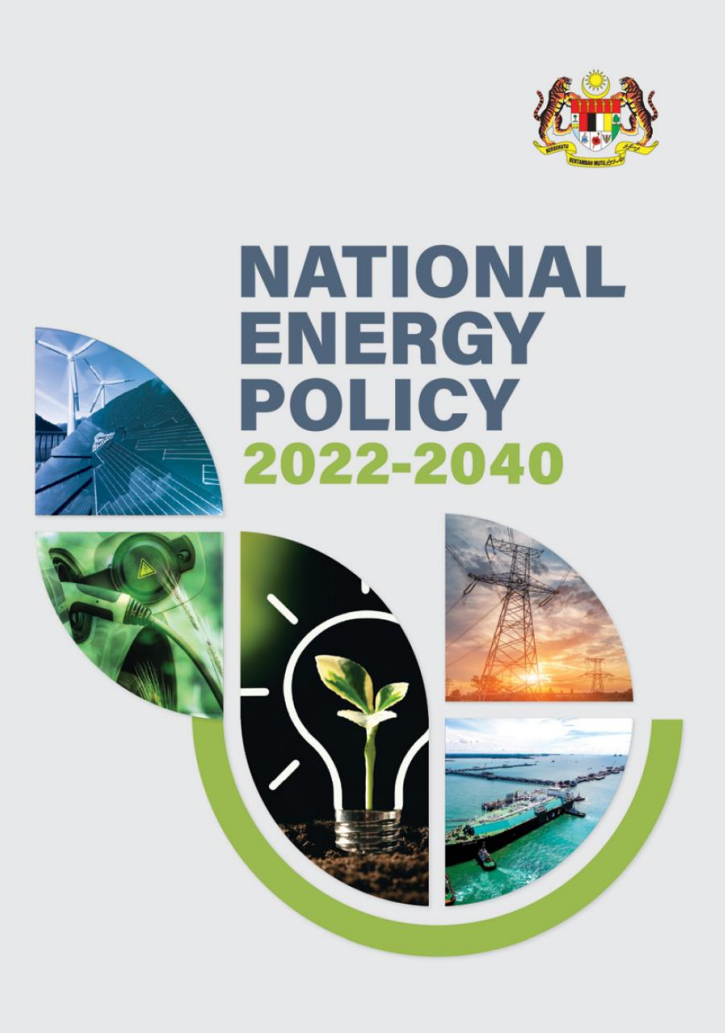
Source : National Energy Policy

Malaysia National Energy Policy (DTN)



The National Energy Policy, 2022-2040 (DTN) strategically charts the way forward and outlines key priorities for the energy sector in the coming years.

The DTN will position the energy sector as a catalyst for socioeconomic development.

The DTN's progressive Low Carbon Nation Aspiration will also ensure that the energy sector takes full advantage of opportunities arising from the energy transition, as well as ensure the sector is future-proof and strategically positioned to meet subsequent challenges.

Source : International Association of Oil & Gas Producers (IOGP

IOGP Standard Reference (1/2)

International Association of Oil & Gas Producers

The International Association of Oil & Gas Producers is the petroleum industry's global forum in which members identify and share best practices to achieve improvements in health, safety, the environment, security, social responsibility, engineering and operations.

The "Progressing a Lower Carbon Agenda" initiative was released in July 2021 with the objective to fulfil industry needs to make coordinated step change to reduce carbon and lower emissions.

The initiative identified four (4) key themes, progressed based on Opportunity Framing workshops with IOGP Engineering Leadership Council (ELC):

1) Carbon Capture and Storage,
2) Electrification,
3) Energy Efficiency,
4) Flares & Vents

[Open]

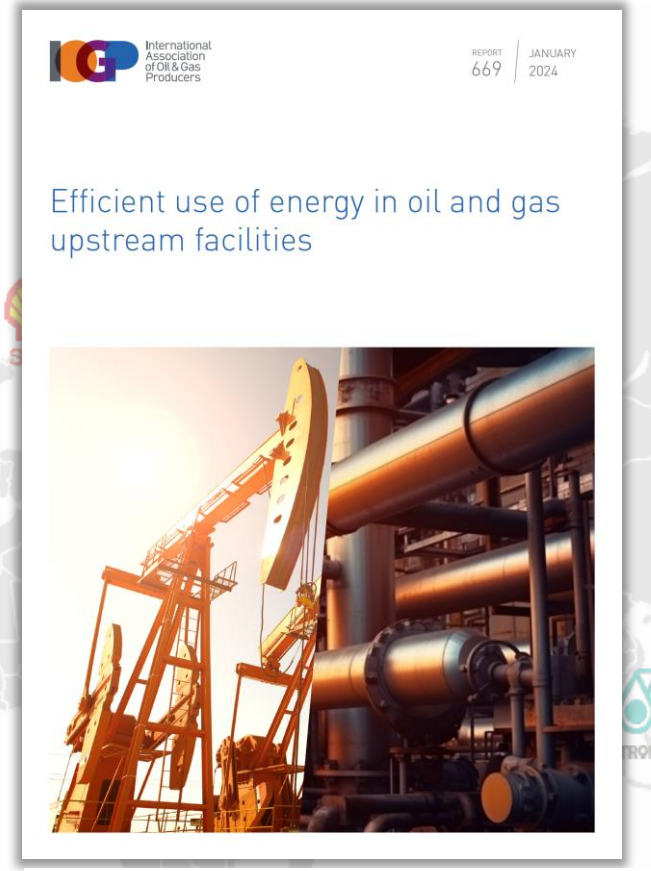
Source : International Association of Oil & Gas Producers (IOGP

IOGP Standard Reference (2/2)

International Association of Oil & Gas Producers

About

This recommended practice provides recommendations for the electrification of oil and gas (and other petrochemical processing) facilities to reduce their greenhouse gas (GHG) emissions. The use of electricity for shaft power (compression, pumping) and heat (fired heaters, boilers) allows the facility to use low/no carbon electricity to reduce GHG emissions from burning hydrocarbons.



About

This Report shares recommended practices for energy management and optimization for the design, installation, and operation of new and existing equipment and systems. This Report will enable companies to evaluate their current energy efficiency practices from an organizational, asset, system, and equipment-level perspective to identify gaps and improve energy efficiency.

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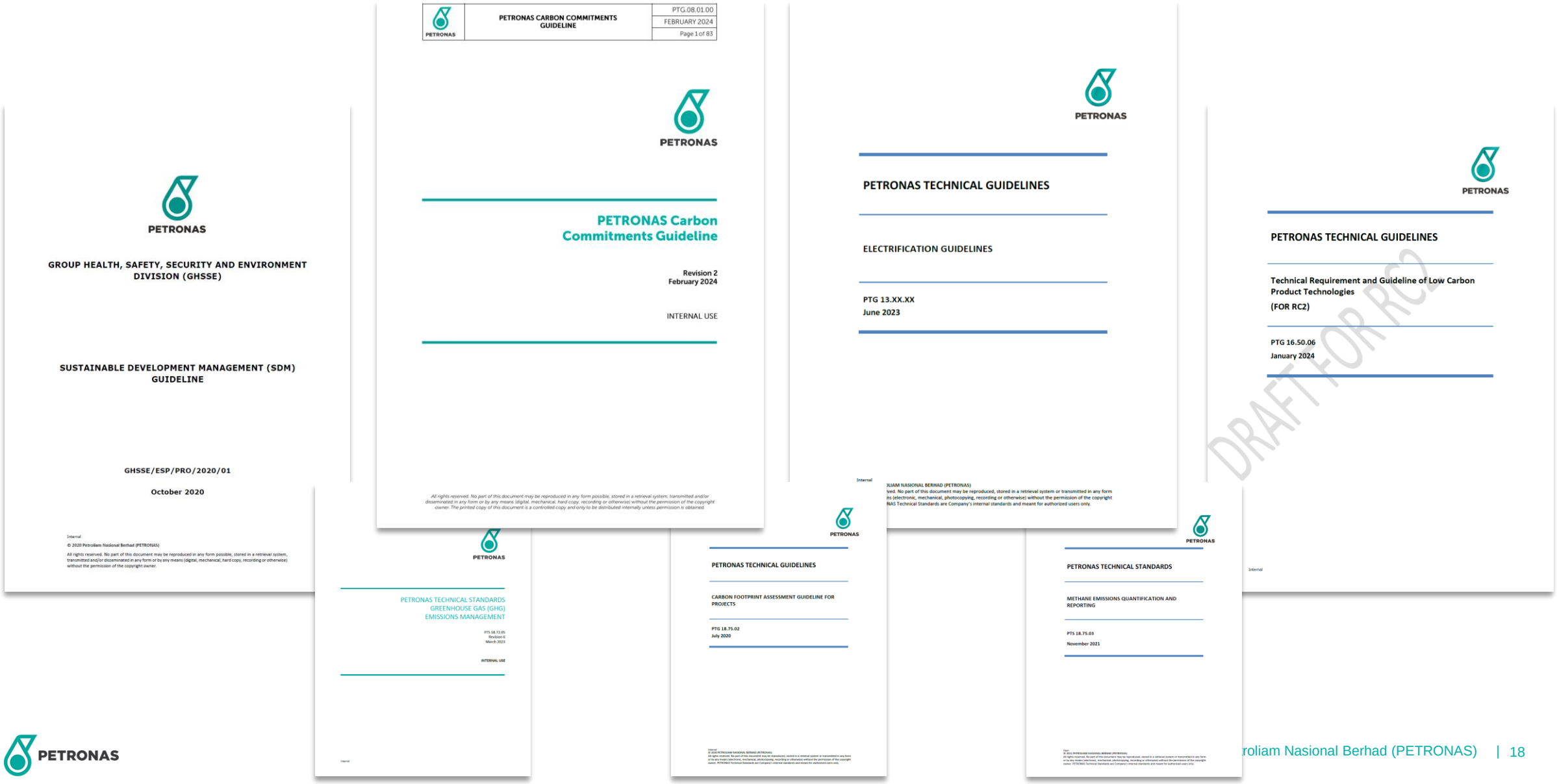
Internal Standards & Initiatives



3. Overview of Power Electronics role / application in Oil & Gas

- Overview – Typical Power Electronics applications
- Energy Transition tools for Oil & Gas Industry
- Overview of Oil & Gas business supply chain
- Role & Application of Power Electronics in Oil and Gas
- Use Case
- Challenges

[Open]

Overview

Typical Power Electronics applications

Power Electronics (PE) plays a pivotal role in the energy transition, enabling efficient and reliable conversion of electrical energy across diverse applications in the oil and gas industry.

The advanced systems are crucial for driving sustainable practices and enabling the shift towards renewable energy sources.

Power Converters

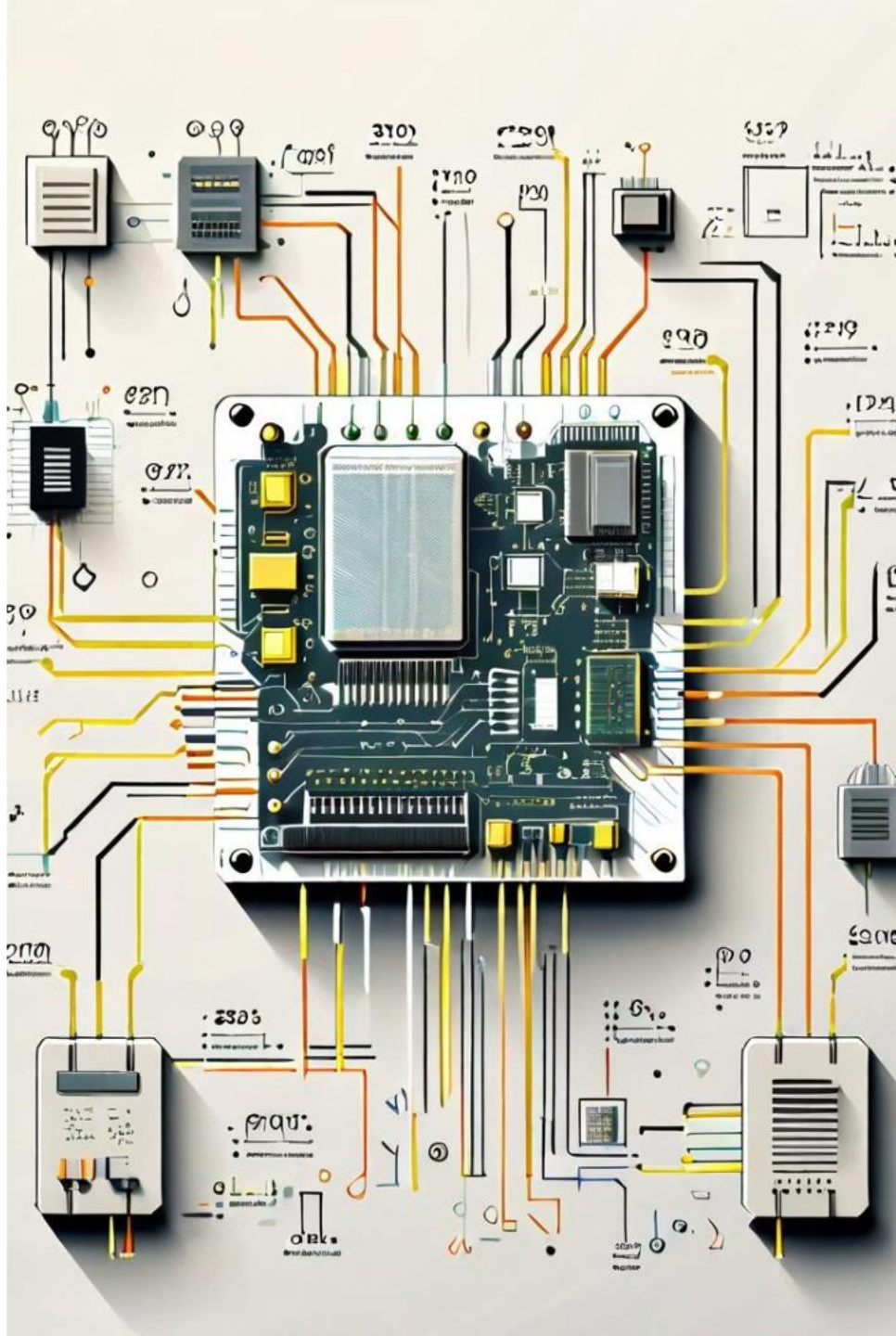
The backbone of power electronics, transforming and regulating electrical power for various applications, e.g. AC to DC or DC to AC, etc.

Semiconductors

Essential components that are used to enable precise control and efficient power conversion, e.g. transistors, diodes, advanced components such as MOSFETs and IGBTs, etc.

Control Systems

Sophisticated control algorithms and microprocessors used to manage the operation of digital / power electronics systems, to ensure reliable and optimized performance.



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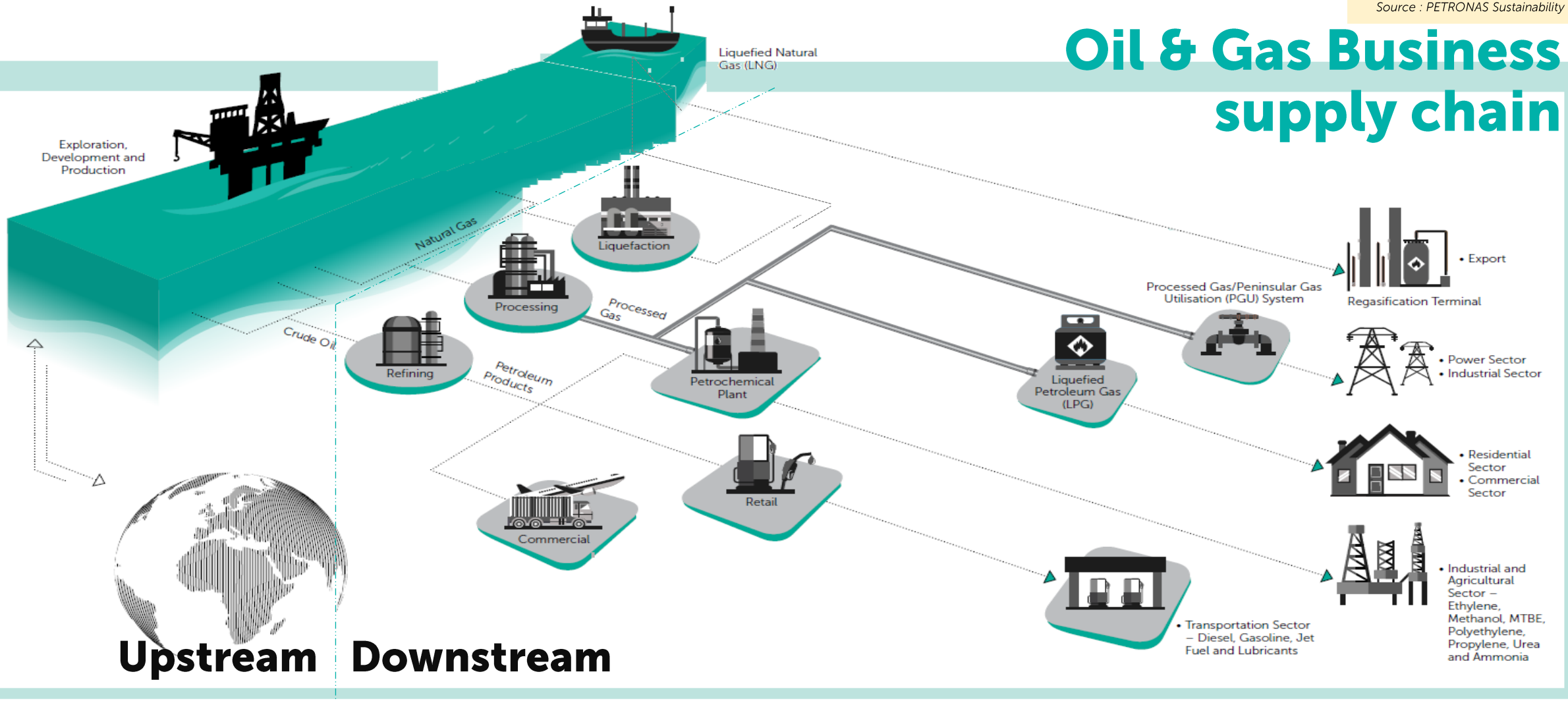
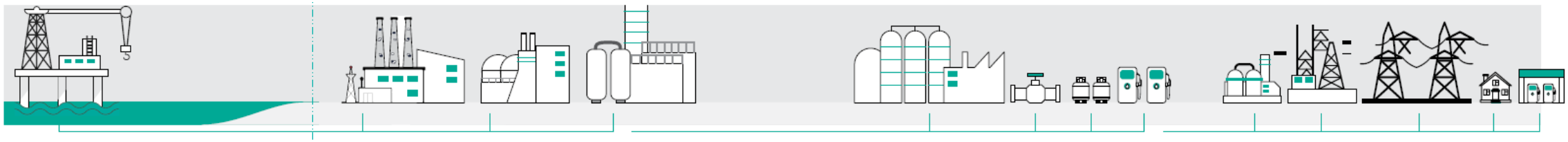
Power Electronics - Energy Transition tools for Oil & Gas Industry

Power electronics play a vital role in the oil and gas industry, enabling efficient and reliable operation of critical systems in upstream & downstream assets / facilities.

Many power electronics technologies, such as inverters, converters, and motor drives, have been used to help optimize energy consumption, reduce maintenance costs, and improve the overall performance and safety of oil & gas operations.

Oil & Gas Business supply chain





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Power Electronics in Downstream

Power electronics play a crucial role in various downstream oil and gas operations, including refining, petrochemical processing, and distribution. They enable precise control and optimization of electrical systems, driving efficiency and reliability across the downstream supply chain.

Downstream applications leverage power electronics for motor control, variable speed drives, and process automation, improving energy efficiency and reducing operational costs. They also support critical safety and monitoring systems, ensuring safe and reliable operations.

Matured

Novelty

Base Technology

[EE] UPS
[EE] AC / DC Generation – Speed/Excitation and P/Q control interfaces
[EE] Protection Device & System – Numerical electronic relay, logic control, Advance FCL
[EE] Motor & Drives – VFD and Soft Starter, Thyristor Controller, Power Electronics Heater Controller

Key

[EE] Electrical Network Automation (ENA) – SCADA, ENMCS, IMCS, CPC, Digital Twin, IT/OT architecture, Cybersecurity
[RE] Sustainable Energy Technology – Solar (PV & LSS), BESS,
[EE] Power Conditioning Device – Var Compensator, FACTS, STATCOM, integration with Harmonic filter, PF correction, etc.

Pacing

[RE] Electrification – Energy hub (E-Hub), Transmission & distribution system (HVAC / HVDC),
[EE / RE] Smart Grid – Distributed Energy Resources (DER), MicroGrid, IoE (Internet of Energy)
[RE] Energy Storage (other) – Fuel Cell, Super Capacitors, SMES (Superconducting Magnetic Energy Storage), Hydrogen

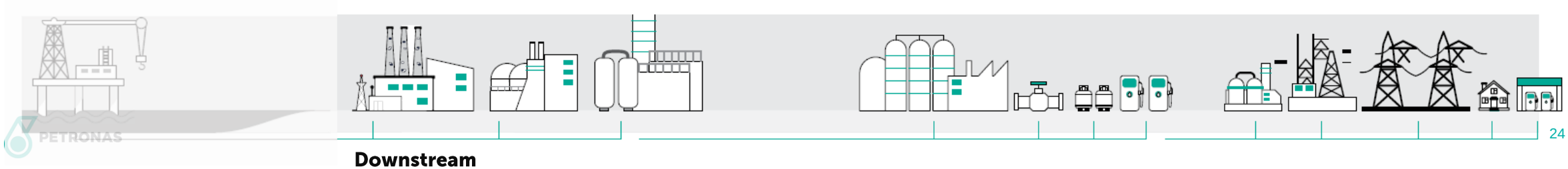
Emerging

[RE] Alternative Energy – Geothermal,

Key Initiatives

Energy Transition Lever: Energy Efficiency	
Code	**Initiatives**
EE3	Enforce mandatory audits for large commercial and industrial buildings
EE4	Establish green building codes for energy-intensive residential and commercial buildings
EE6	Launch a major EE retrofit initiative amongst government buildings

Energy Transition Lever: Renewable Energy	
Code	**Initiatives**
RE1	Establish solar parks for accelerated deployment of utility-scale solar
RE2	Promote floating solar and agrivoltaic technology
RE3	Expand virtual aggregation model for rooftop solar
RE4	Develop plan for accelerated investments of transmission and distribution
RE6	Set up RE exchange hub to enable cross-border RE trading



Downstream

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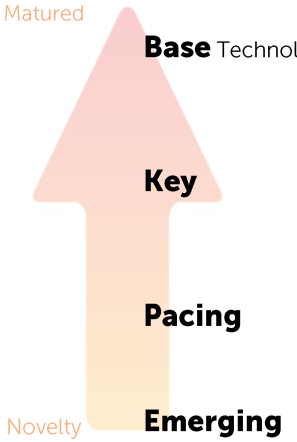
Power Electronics in Upstream

Power electronics play a vital role in the upstream oil and gas industry, enabling efficient and reliable operation of critical systems on offshore platforms and drilling rigs. These applications include variable speed drives for pumps, compressors, and other rotating equipment, as well as power conversion and control for offshore wind turbines and subsea systems.

Power electronics technologies, such as inverters, converters, and motor drives, help optimize energy consumption, reduce maintenance costs, and improve the overall performance and safety of upstream operations.



Base Technology

[EE] UPS
[EE] AC / DC Generation – Speed/Excitation and P/Q control interfaces
[EE] Protection Device & System – Numerical electronic relay, logic control, Advance FCL
[EE] Motor & Drives – VFD and Soft Starter, Thyristor Controller,

Key

[EE] Electrical Network Automation (ENA) – SCADA, ENMCS, IMCS, CPC, Digital Twin, IT/OT architecture, Cybersecurity
[RE] Sustainable Energy Technology – Solar (FPV), BESS, Wind Turbine (HSWT & LSWT).
[EE] Power Conditioning Device – Var Compensator, FACTS, STATCOM, integration with Harmonic filter, PF correction, etc.

Pacing

[RE] Electrification – Energy hub (E-Hub), Transmission & distribution system (HVAC / HVDC), Subsea Power Hub (SPH)
[EE / RE] Smart Grid – Distributed Energy Resources (DER), MicroGrid, IoE (Internet of Energy)
[RE] Energy Storage (other) – Fuel Cell,

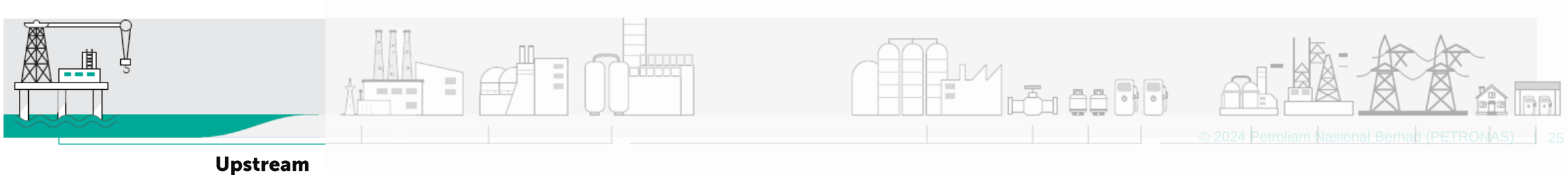
Emerging

[RE] Alternative Energy – Geothermal, Ocean Power (Wave, Tidal)

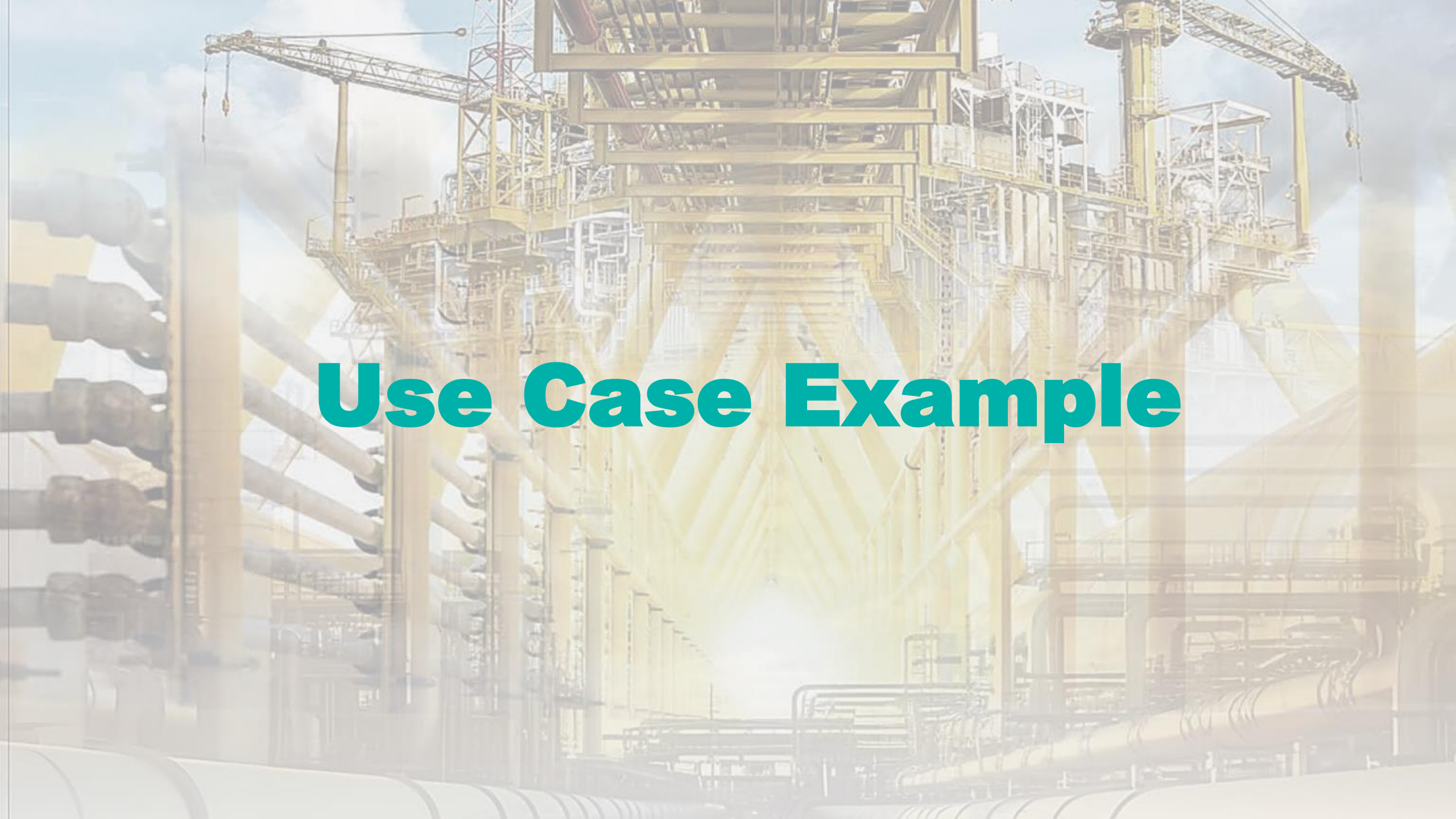
Key Initiatives

Energy Transition Lever: Energy Efficiency	
Code	**Initiatives**
EE3	Enforce mandatory audits for large commercial and industrial buildings
EE4	Establish green building codes for energy-intensive residential and commercial buildings
EE6	Launch a major EE retrofit initiative amongst government buildings

Energy Transition Lever: Renewable Energy	
Code	**Initiatives**
RE1	Establish solar parks for accelerated deployment of utility-scale solar
RE2	Promote floating solar and agrivoltaic technology
RE3	Expand virtual aggregation model for rooftop solar
RE4	Develop plan for accelerated investments of transmission and distribution
RE6	Set up RE exchange hub to enable cross-border RE trading



Upstream



Use Case Example

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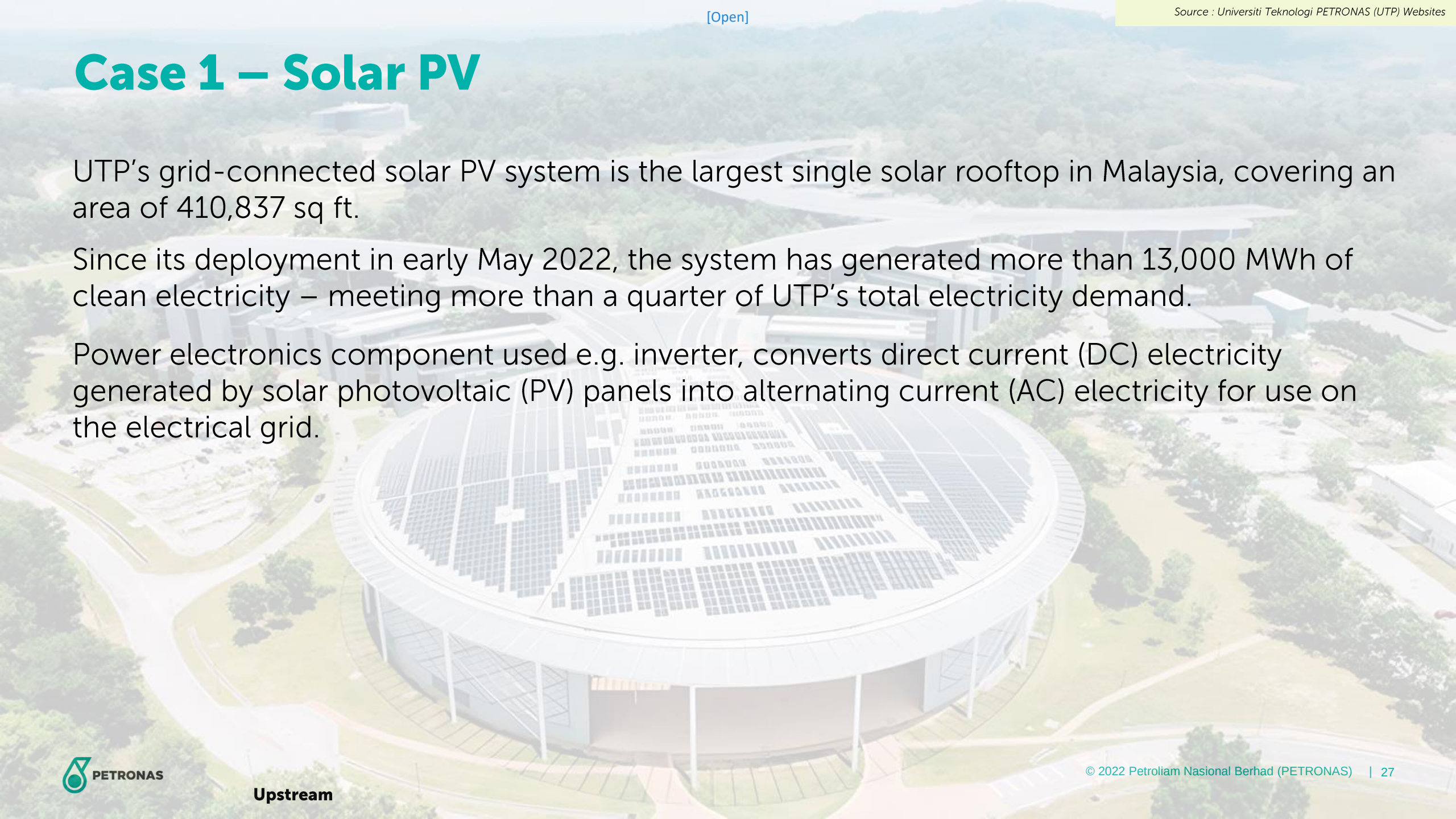
Source : Universiti Teknologi PETRONAS (UTP) Websites

Case 1 – Solar PV

UTP's grid-connected solar PV system is the largest single solar rooftop in Malaysia, covering an area of 410,837 sq ft.

Since its deployment in early May 2022, the system has generated more than 13,000 MWh of clean electricity – meeting more than a quarter of UTP's total electricity demand.

Power electronics component used e.g. inverter, converts direct current (DC) electricity generated by solar photovoltaic (PV) panels into alternating current (AC) electricity for use on the electrical grid.



Source : PETRONAS Technical Guideline (PTG)

Case 2 - Conversion of gas Turbine to Motor

Feasibility studies conducted at a gas processing plant to assess the changes and requirements for conversion of gas turbine to electric motor.

Power electronics component is used for soft starting and speed adjustment of the HV motor, leading to efficiency improvement from GT (Eff~30%) to VSD motor (Eff>90%) resulting in lower fuel gas consumption.

Case 3 – Offshore Energy Hub (E-Hub)

Installation of a new Offshore Energy Hub (EHUB) with 100-200 MW capacity that is able to receive power intake from a clean hydro power energy source of Sarawak Energy at 275 kV, complete with provision for future tie-in to the load of the existing / future offshore assets & facilities.

Transmission via HVAC will require power electronics conditioning device to compensate the Reactive Power components and prevent significant voltage drop and transmission losses.

Transmission via HVDC will require power conversion device (e.g. rectifier and inverter) for conversion from AC-DC and vice versa, over long distance

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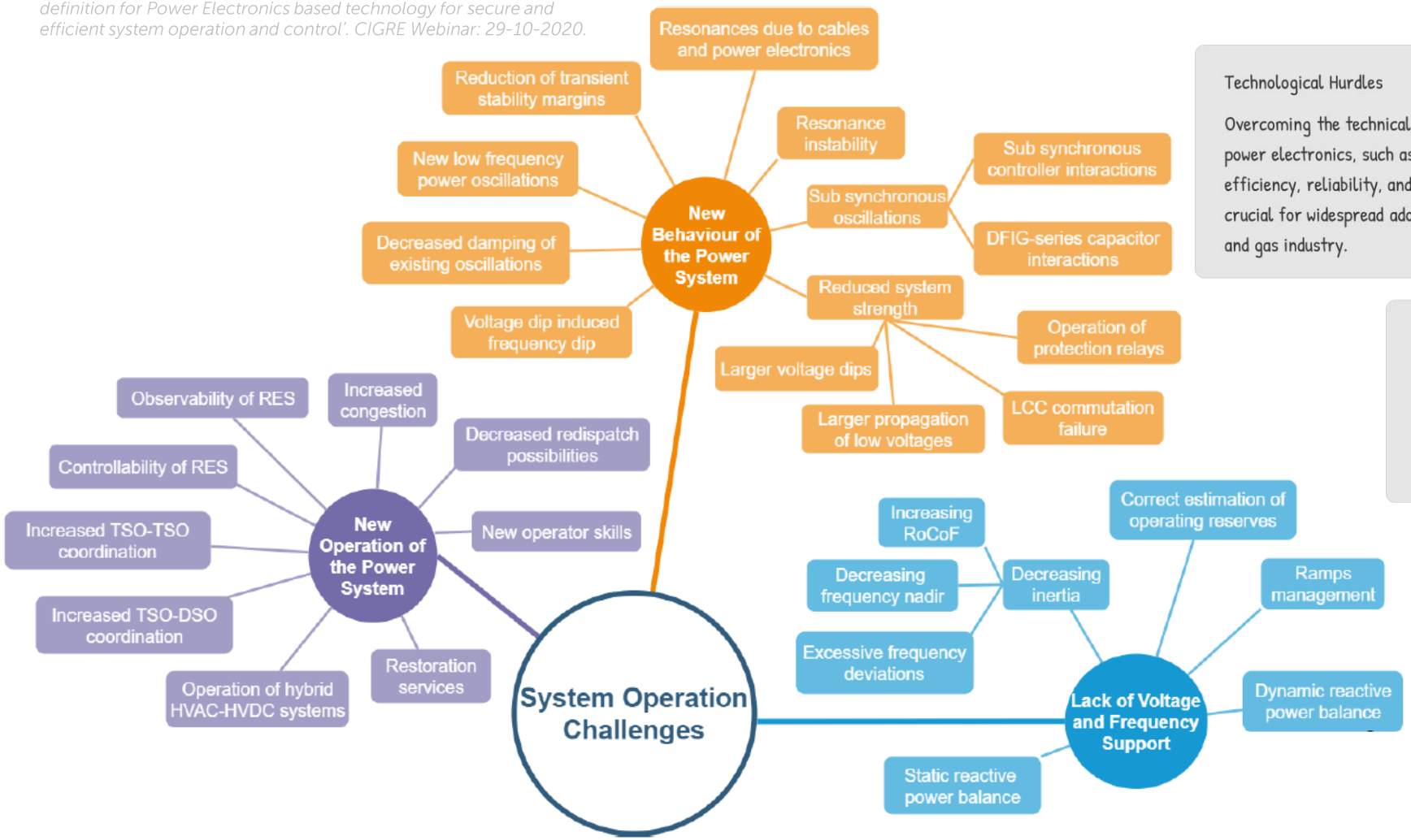
Source : CIGRE

Power Electronics Challenges in Energy Transitions

J.V. Putten, et.all (2020). 'JWG C2/B4.38 Capabilities and requirements definition for Power Electronics based technology for secure and efficient system operation and control'. CIGRE Webinar: 29-10-2020.



Technological Hurdles

Overcoming the technical complexities of power electronics, such as improving efficiency, reliability, and control, is crucial for widespread adoption in the oil and gas industry.

Cost Considerations

Reducing the initial investment and operating costs of power electronics systems is essential to making them more financially viable for oil and gas companies.

Regulatory Compliance

Navigating the evolving regulatory landscape and ensuring power electronics solutions meet safety and environmental standards is a key challenge.

Talent Acquisition

Attracting and retaining skilled professionals with expertise in power electronics is crucial for successful implementation in the oil and gas sector.

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4. Workforce Capabilities & Competencies

- Upgrade of Capabilities & Competencies
- Update of Competency Descriptor & Skill Inventory
- Continuous learning & participation in Standard development & Working Groups
- Other activities

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Source : National Energy Transition Roadmap

Capabilities and Competencies Upgrade

The growth of capacity and competencies is crucial in sustaining the support energy sector's workforce.

Exhibit 3.3: The four guiding principles of NETR

Bridging the gap between existing workforce skill sets and the emerging demand for green-skills, requires targeted training and upskilling efforts.

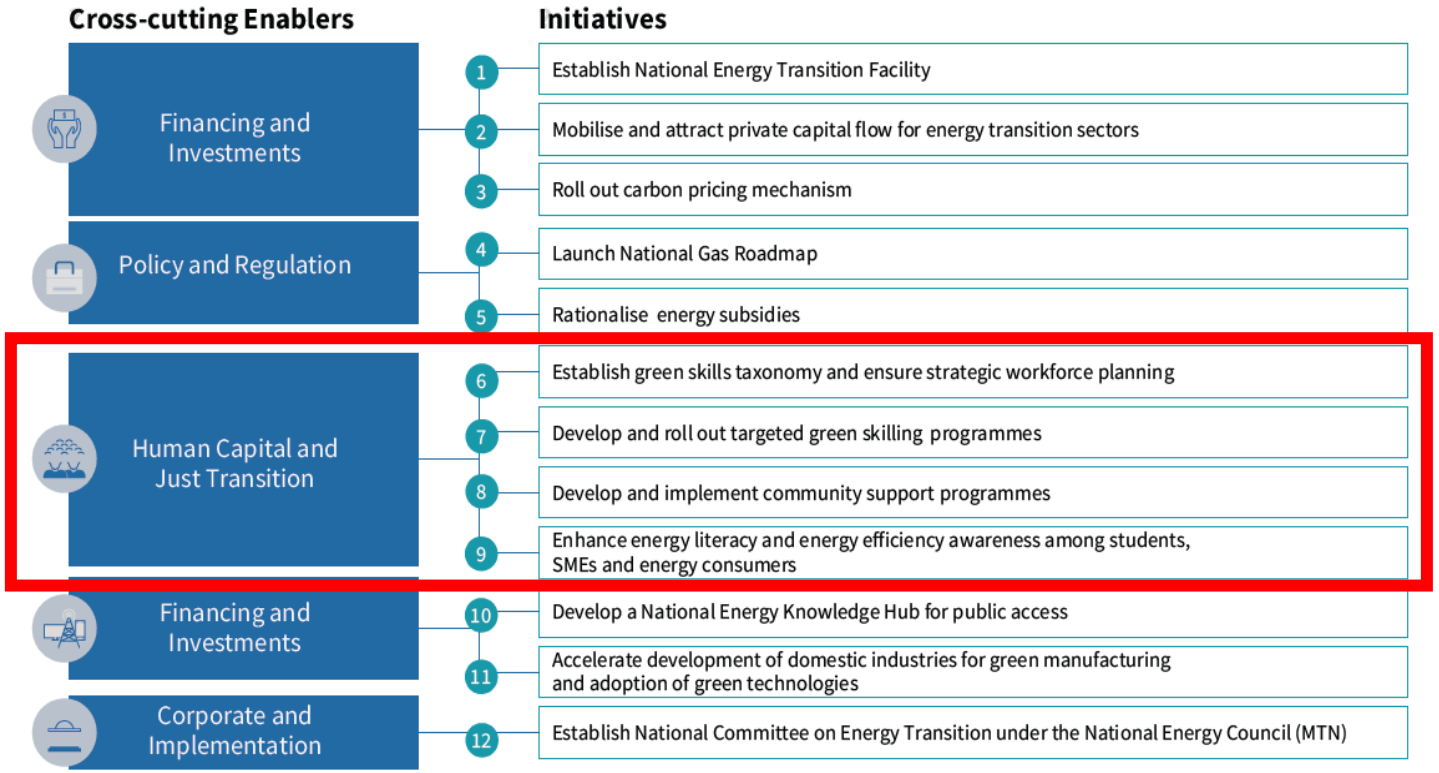
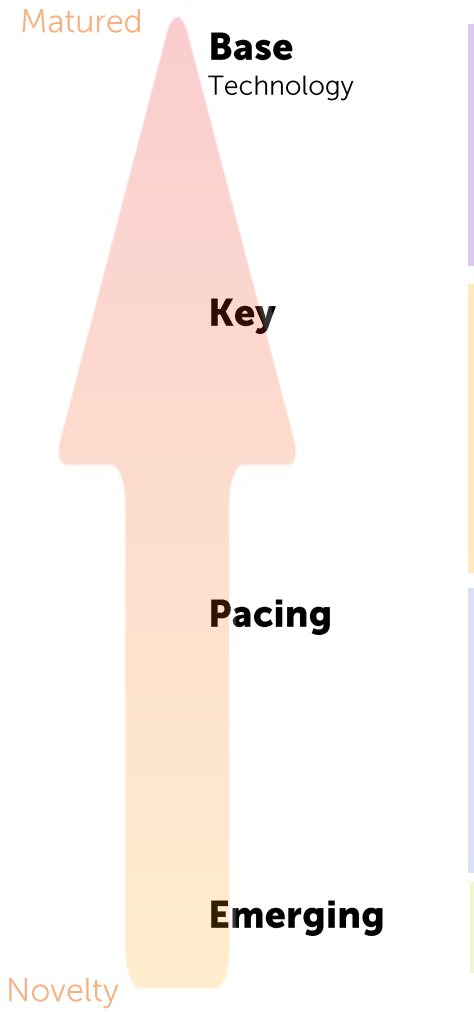


Exhibit 7.1: Cross-cutting enablers and initiatives

Key Initiatives

Enabler: Human Capital and Just Transition		
Code	**Initiatives**	**Champions**
EN6	**Establish green skills taxonomy and ensure strategic workforce planning** ○ Develop green skills taxonomy that defines the essential skills needed for a just transition towards a sustainable workforce ○ Facilitate a strategic alignment between workforce demand and supply based on the green skills taxonomy and competency standards of present and future industry requirements ○ Establish a task force to develop strategic plans for the future of the energy sector's workforce	Sector-specific agencies
EN7	**Develop and roll out targeted green skilling programmes** ○ Implement reskill and upskill programmes for affected workforce ○ Establish strategic partnerships with local universities and industry partners to enhance green skills ○ Enhance TVET and tertiary programmes for new green sectors	Sector-specific agencies
EN8	**Develop and implement community support programmes** ○ Develop a clear mitigation and communication plan for affected community and region ○ Implement targeted community support programmes	Sector-specific agencies
EN9	**Enhance energy literacy and energy efficiency awareness among students, SMEs and consumers** ○ Strengthen the Malaysia Energy Literacy Program (MELP) to catalyse a significant change in public perception and behaviour towards energy utilisation ○ Encourage SMEs to incorporate EE practices in their business ○ Implement energy literacy and awareness programmes at educational institutions	Sector-specific agencies TNB

Update of Competency Descriptor & Skill Inventory



Base Technology	[EE] UPS [EE] AC / DC Generation – Speed/Excitation and P/Q control interfaces [EE] Protection Device & System – Numerical electronic relay, logic control, Advance FCL [EE] Motor & Drives – VFD and Soft Starter, Thyristor Controller, Power Electronics Heater Controller	❑ Able to specify design and construction requirement of Power Electronics (PE) related equipment, and its features to ensure safe operation of equipment. Able to resolve problems arising in the areas of equipment design selection, operation and maintenance ❑ Able to operate PE equipment which covers, e.g. switching isolation/deisolation, access, interpret and analyze data from controller program, logic parameter settings & calibration, installation, Functional Test & commissioning, inspection, monitoring, troubleshooting, repair & part replacement, inventory & database management
Key	[EE] Electrical Network Automation (ENA) – SCADA, ENMCS, IMCS, Digital Twin, IT/OT architecture, Cybersecurity [RE] Sustainable Energy Technology – Solar (PV & LSS), Wind Turbine (HSWT & LSWT), BESS. [EE] Power Conditioning Device – Var Compensator, FACTS, STATCOM, integration with Harmonic filter, PF correction, etc.	❑ Having knowledge of basic technology, components and function in Digital Twin (DT) ecosystem. Involved in design, operation and maintenance of DT. ❑ Having knowledge and understanding of policies, theoretical and practical aspect of Solar/wind/ BESS generating system. Involved in design. Operation, maintenance and able to resolve issues related to testing, operation and maintenance of the solar/wind/BESS power generating system. ❑ Understand and able to conduct Power Quality (PQ) monitoring, analysis and survey, i.e. in relation to PQ limits & standards, voltage / frequency deviation, harmonics, transient stability, power factor, etc.
Pacing	[RE] Electrification – Energy hub (E-Hub), Transmission & distribution system (HVAC / HVDC), Subsea Power Hub (SPH) [EE / RE] Smart Grid – Distributed Energy Resources (DER), MicroGrid, IoE (Internet of Energy) [RE] Energy Storage (other) – Super Capacitors, SMES (Superconducting Magnetic Energy Storage), Fuel Cell, Hydrogen	❑ Understand basic design, theory, common equipment selection, and having some knowledge on installation, commissioning, operation maintenance on the key electrification technology. ❑ Understand basic principle, features and various technology areas to be applied in achieving smart grid objectives. Having some knowledge on advantages / benefits, issues, challenges and commercial model / analysis on smart grid technology. ❑ Understand the basic principle, type of energy storage to suit specific applications. Has some knowledge on the design selection, based on required energy storage duration and power output capability.
Emerging	[RE] Alternative Energy – Ocean Power (Wave, Tidal), Geothermal.	❑ Aware on the technical requirement of the respective technology, especially on its emission abatement, safe operation, engineering and suitability for primary generation. Aware on selection criteria and design configuration / optimization to meet operational requirement.

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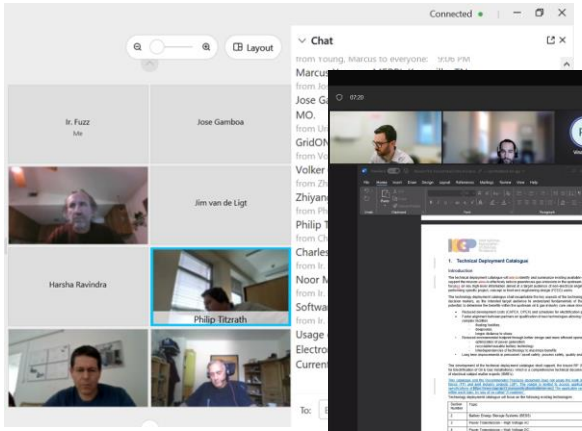
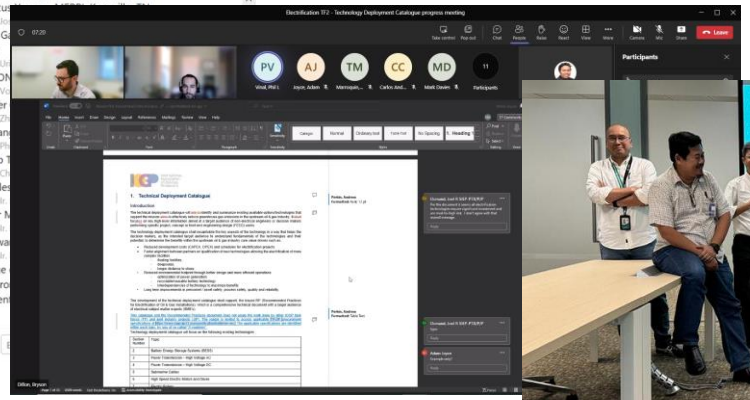
Current & Future Workforce will have to go beyond traditional skill and be equipped with future technology skills & know how.

Continuous learning /participation in Standard development Committee & Working Groups

Continuous learning and active participation in standard development committees and working groups are essential for enhancing power electronics competency and knowledge, which are crucial for supporting the energy transition.





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Other activities

Technical visits

Technical visits are vital for increasing power electronics competency and expertise, providing firsthand exposure to innovative technologies and practices that support the energy transition.

Shaping the Industry

Shaping the industry is crucial for enhancing power electronics competency and expertise, as it involves setting standards and driving innovations that are essential for supporting the energy transition.

STEM program

STEM programs are essential for increasing power electronics awareness and knowledge, as they cultivate the next generation from the grass roots who will inherit and drive the innovations towards future proofing supporting energy transition.

Collaboration with Learning institution

Collaboration with learning institutions is vital for enhancing power electronics competency and knowledge, fostering research and education that are crucial for advancing technologies to support the energy transition.

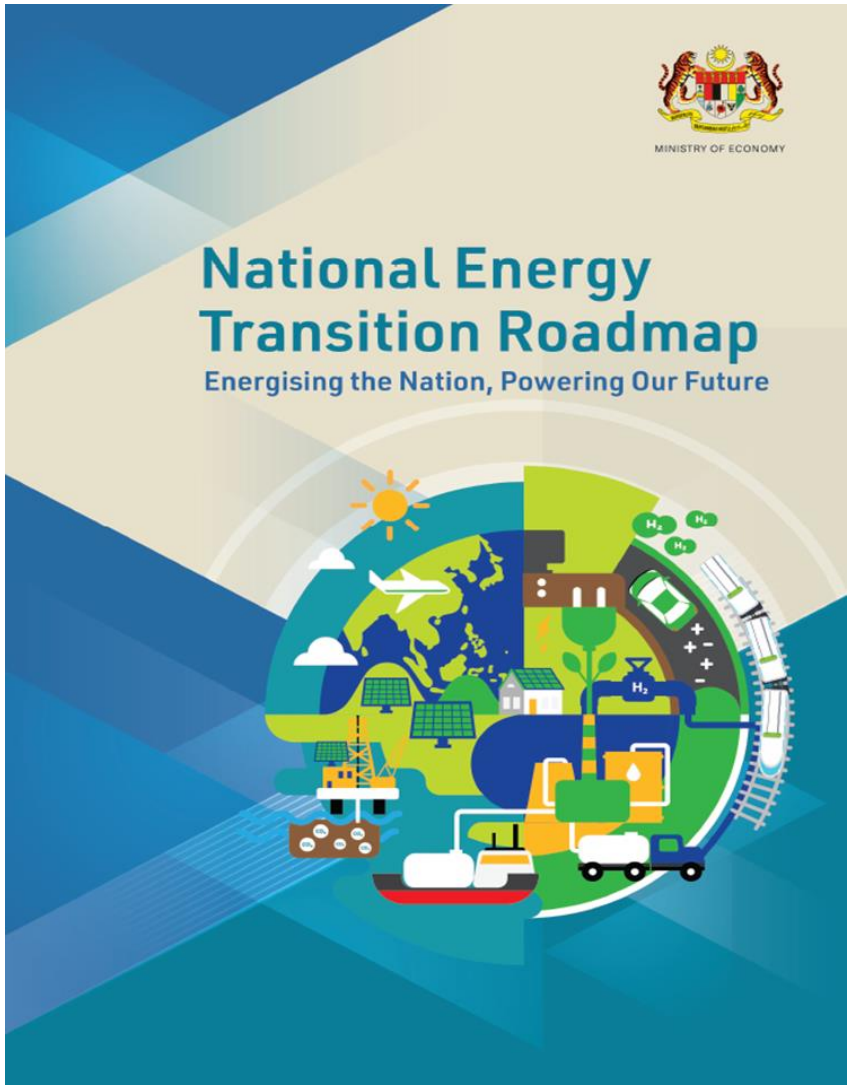
5. Conclusions

- Summary
- Power Electronics prospects
- Key Messages

[Open]

Source : National Energy Transition Roadmap

Summary



Key Initiatives

Energy Transition Lever: Energy Efficiency		
Code	**Initiatives**	**Champions**
EE3	**Enforce mandatory audits for large commercial and industrial buildings** ○ Implement mandatory investment-grade audits focusing on high-energy-consuming commercial and industrial sector ○ Establish reporting protocol as well as a strict monitoring mechanism	ST
EE4	**Establish green building codes for energy-intensive residential and commercial buildings** ○ Establish a mandatory national standard that outlines EE parameters for both new residential and commercial buildings as well as retrofit for existing building to meet a minimum Building Energy Intensity (BEI) level ○ Mandate disclosure of building energy performance for commercial buildings	ST SEDA
EE6	**Launch a major EE retrofit initiative amongst government buildings** ○ Identify energy inefficient public buildings (e.g., offices with BEI >200 = ~60-70%[a] of existing building) ○ Develop medium to long-term EE government building retrofit program and implement project via ESCO platform	KKR JKR

Energy Transition Lever: Renewable Energy		
Code	**Initiatives**	**Champions**
RE1	**Establish solar parks for accelerated deployment of utility-scale solar** ○ Identify suitable plots of land for development of solar parks through close collaboration among federal government, state governments and utility companies to enable decarbonisation of hard-to-abate industries ○ Enhance current LSS mechanism to improve financial sustainability for developers	NRECC ST MEESty ECoS SEDA
RE2	**Promote floating solar and agrivoltaic technology** ○ Remove existing regulatory barrier inhibiting floating solar and agrivoltaic (e.g. to amend existing hydropower power purchase agreements) ○ Roll out clear guidelines for floating solar and agrivoltaic ○ Adopt distinct bidding categories in future LSS auction to ensure fair competition	
RE3	**Expand virtual aggregation model for rooftop solar** ○ Expand virtual aggregation mechanism (e.g. NOVA program) to government and residential buildings for leasing and aggregation of rooftop space and sale to offtakers ○ Scale-up corporate and industrial solar rooftop programme	
RE4	**Develop plan for accelerated investments of transmission and distribution** ○ Establish amount, timing and mode of funding for grid infrastructure investment to reduce grid constraints while balancing energy trilemma (Exhibit 5.3) ○ Provide incentives for RE development and power storage facilities to improve system flexibility and address RE intermittency	NRECC, ST & TNB MEESty & SEB ECoS & SESB
RE6	**Set up RE exchange hub to enable cross-border RE trading** ○ Establish physical enabler (e.g. special purpose vehicle) to act as the market aggregator ○ Develop regulations for implementation of RE exchange hub and cross-border RE trading ○ Establish new or upgrade interconnection with neighbouring countries ○ Monetise excess power generated through bi- or multi-lateral power trading arrangements with neighbouring countries	NRECC ST

Enabler: Human Capital and Just Transition		
Code	**Initiatives**	**Champions**
EN6	**Establish green skills taxonomy and ensure strategic workforce planning** ○ Develop green skills taxonomy that defines the essential skills needed for a just transition towards a sustainable workforce ○ Facilitate a strategic alignment between workforce demand and supply based on the green skills taxonomy and competency standards of present and future industry requirements ○ Establish a task force to develop strategic plans for the future of the energy sector's workforce	Sector-specific agencies
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Power Electronics in industry is able to touch & complement if not accelerating several levers and enablers of Malaysia National Energy Transition initiatives.

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Power Electronics prospects

For oil and gas industry, as it continues to evolve, power electronics will play an increasingly crucial role in improving efficiency, reliability, and sustainability.

Innovations in semiconductor technologies, control systems, and energy storage solutions will enable even more advanced applications of power electronics in the years to come.

[Open]

Key Messages:

“Thus, it is imperative for ALL to take bold steps, to forge collaborations, and to harness our collective strength, in pursuit of a sustainable and just Energy Transition for Malaysia.”

Source : PETRONAS Integrated Report

Passionate about Progress


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50
YEARS