



EXPLORING MALAYSIA'S POTENTIAL CONTRIBUTIONS AND CAPABILITIES IN NUCLEAR POWER PLANT COGENERATION

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MALAYSIA ENERGY LANDSCAPE



TNB



POPULATION: 34.4 MILLION

Peninsular Malaysia

Regulator: Energy Commission



<https://www.st.gov.my/>



SEB

Sarawak

Regulator: Ministry of Utility and Telecommunication, Sarawak



https://mut.sarawak.gov.my/web/subpage/webpage_view/47



SESB

Sabah

Regulator: Energy Commission of Sabah (ECoS)

<https://ecos.gov.my/>



~34.8 GW
TOTAL INSTALLED CAPACITY



~26.8 GW
NATIONAL PEAK DEMAND



28% – 36%
PLANNING RESERVE BAND

Peninsular Malaysia

TNB / GSO

27,333 MW

CAPACITY

21,049 MW

PEAK LOAD

29%

RESERVE

Fuel Mix: Thermal heavy (~75% Coal & Gas). Fast demand surge driven by industrial growth & hyperscale Data Center hub in Johor/Selangor.

Sarawak Grid

SEB

5,745 MW

CAPACITY

4,575 MW

PEAK LOAD

26%

RESERVE

Fuel Mix: Clean hydro-dominated (>70%). Serves energy-intensive SCORE industries and regional cross-border ASEAN power exports.

Sabah Grid

SESB

1,751 MW

CAPACITY

1,221 MW

PEAK LOAD

27%

RESERVE

Fuel Mix: Gas & Solar focus. Restructured capacity buffer restored through fast-track solar auctions, BESS deployment, and gas turbines.

TNB NET-ZERO & COAL PHASE-OUT ROADMAP

50% Cut

COAL CAPACITY BY 2035
Halving coal generation reliance

2044 / 2045

COMPLETE COAL PHASE-OUT
Zero coal power plants operational

70% RE

INSTALLED RE SHARE BY 2050
NETR target (~170 GW total grid capacity)

Net Zero 2050

TNB CARBON NEUTRALITY
Interim -35% emissions intensity by 2035

Energy Mix Trajectory

Coal Generation 43% → 0% (2044)

Natural Gas (Transition Fuel) 36% → Baseline

Hydroelectric Power 15% Share

Solar & Emerging RE 6% → ~70% (2050)

Policy Rule: No new coal plants will be built post-2040. Gas serves as a firming transition fuel alongside major RE scaling.

Coal Plant Phase-Down Schedule

2029 – 2030 Phase: Early PPA expiration and phase-down onset for legacy units including **Kapar (KEV)**.

RETIREMENT

2035 Target: Halving overall national coal generation capacity; **Janamanjung Units 1–3** decommissioned.

50% CUT

2040 Horizon: **Janamanjung Units 4–5** & remaining legacy independent power plants reaching end of life.

2044 – 2045 Final Retirement: **Jimah East Power (JEP)** plant decommissioning marks 100% coal-free operations.

COAL FREE

Decarbonization & Tech Solutions

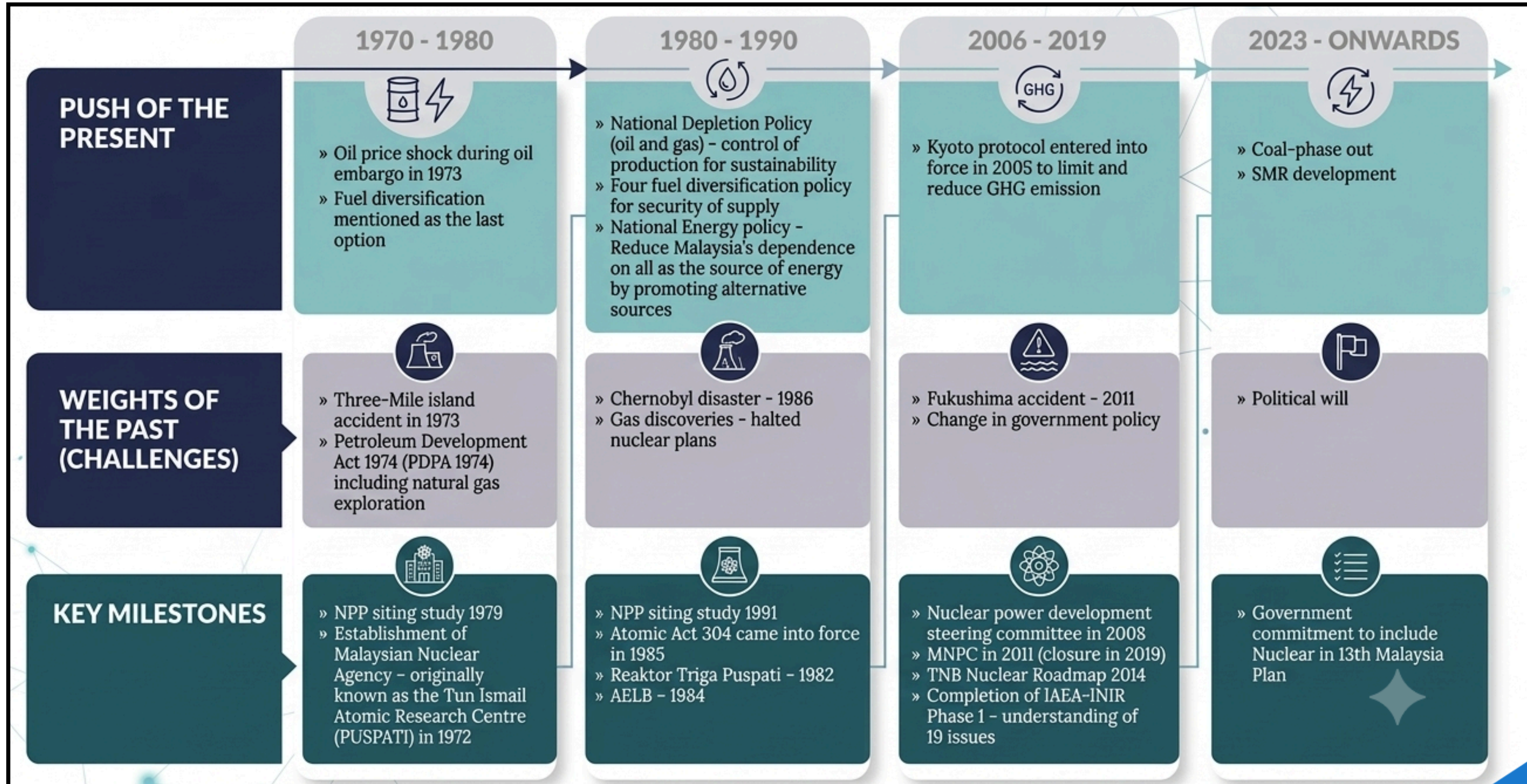


- ✓ **CCUS Pilots:** R&D carbon capture trials (Project Dragon at Jimah East & Project Chlorobloom at Janamanjung) capturing up to 90% flue gas emissions.
- ✓ **Green Hydrogen & Biomass:** Strategic co-firing trials with IHI Corp & PETRONAS to lower thermal power emissions intensity.

The 12 GW Baseload Void: Solar alone cannot replace firm coal baseload due to intermittency and low capacity factors (~18-22%).

Nuclear Role: Serves as the continuous, zero-emission thermal baseload power source to stabilize the future national grid.

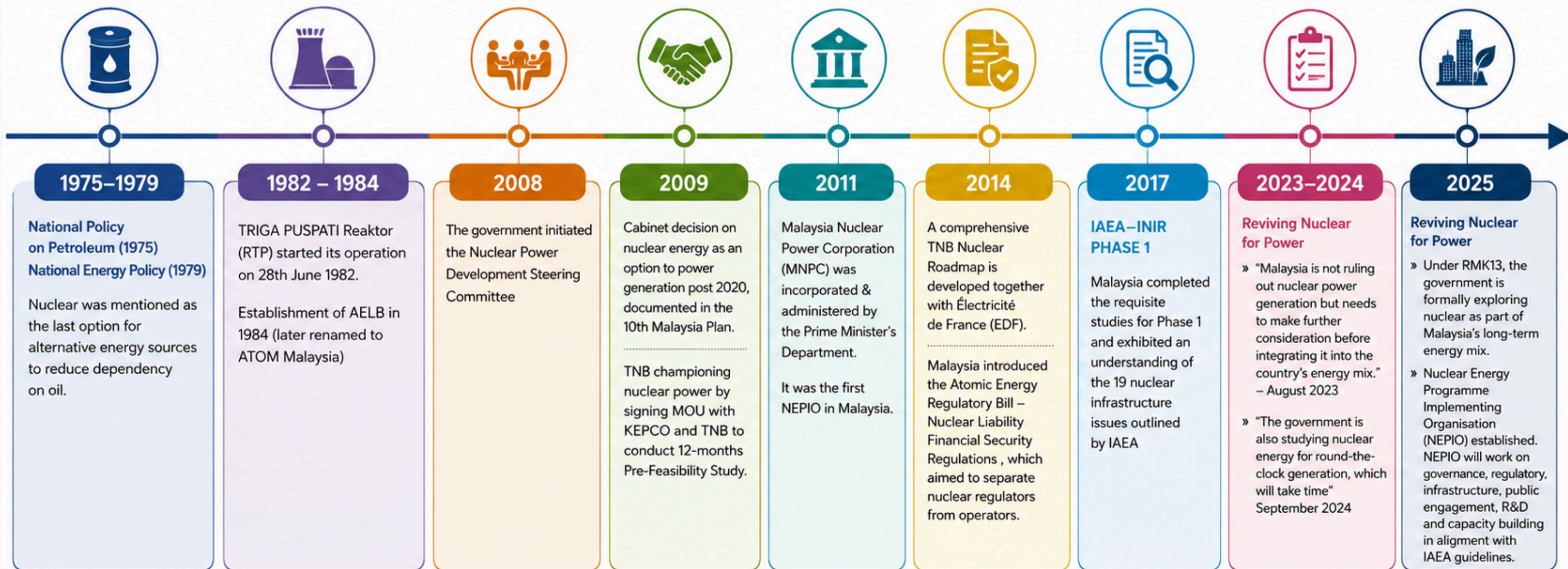
THE ATTEMPT AND THE CHALLENGES FOR NUCLEAR POWER PROGRAM



MALAYSIA NUCLEAR JOURNEY



Malaysia's step-by-step progress towards a safe, secure and sustainable nuclear future.



From early exploration to future readiness — Malaysia continues its journey towards responsible and sustainable nuclear energy for the nation.



A RENEWED NATIONAL VISION FOR ENERGY

"The government is considering nuclear energy as one of the safe, competitive and clean energy sources for the future."

- Prime Minister Anwar Ibrahim, July 2025

"Nuclear energy is actively being reassessed to complement intermittent renewables, delivering firm baseload power and industrial heat."

— Ministry of Energy Transition & Water Transformation (PETRA)



13th Malaysia Plan (2026-2030)

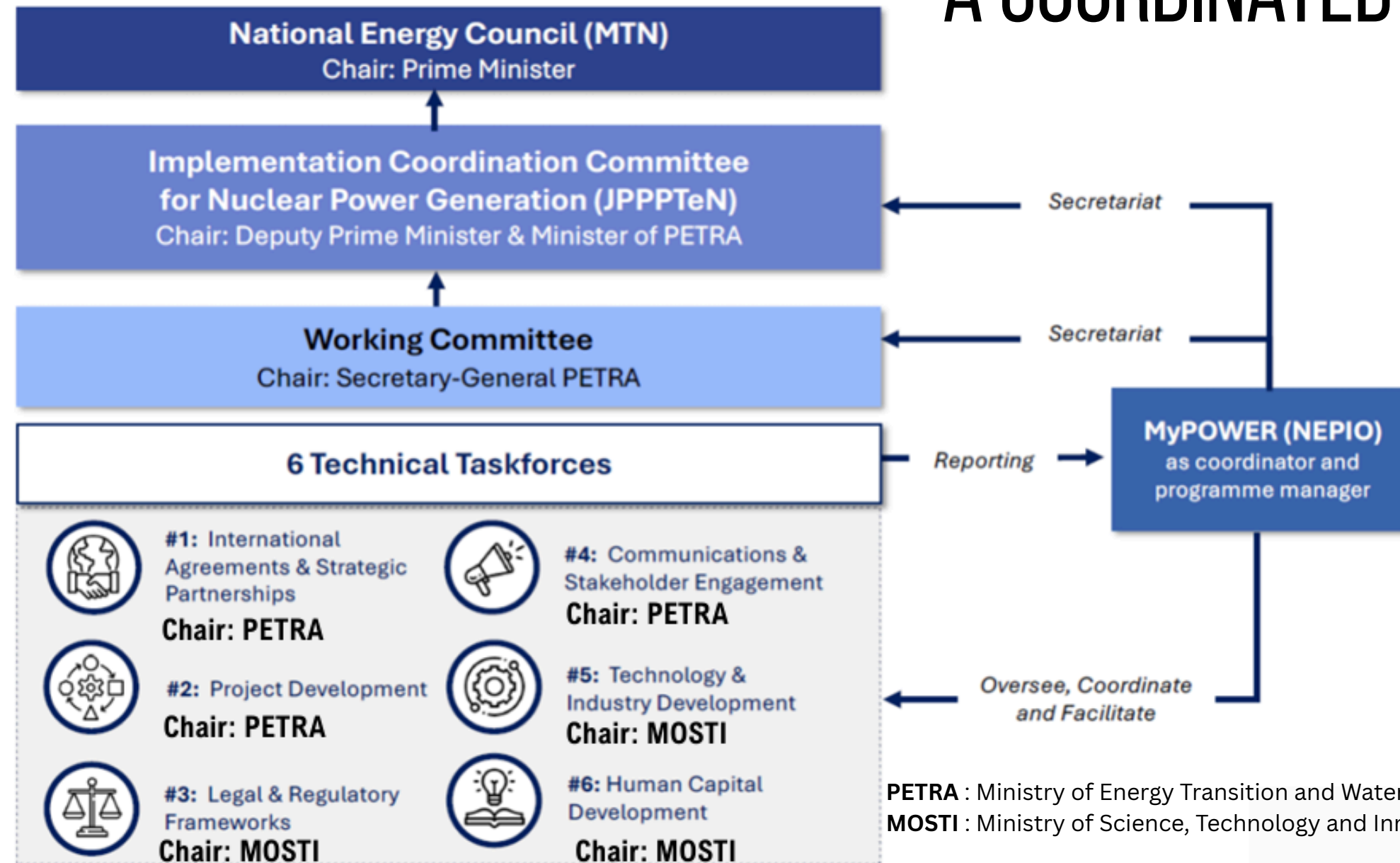
Officially **reintroduces** nuclear power as a key strategy to achieve a sustainable, low-carbon economy.

Core Objectives:

- ☑ Achieve **Net-Zero Emissions by 2050**
- ☑ Enhance long-term **energy security** and reduce reliance on volatile fossil fuel markets
- ☑ Support the growing electricity demands of a high-income nation, including data centres and high-tech industries



A COORDINATED NATIONAL EFFORT



MyPOWER NEPIO Execution Pillars

PILLAR 1

Siting & Tech

Assessing SMR siting, grid connectivity, and techno-commercial viability.

PILLAR 2

Legal & Regulatory

Modernizing regulatory frameworks under Atom Malaysia & IAEA protocols.

PILLAR 3

Human Capital

Developing national workforce, nuclear engineers, and technical capabilities.

PILLAR 4

Public Engagement

Building stakeholder trust, public awareness, and transparent communications.

PETRA : Ministry of Energy Transition and Water Transformation

MOSTI : Ministry of Science, Technology and Innovation



MyPOWER Agency & Mandate

- ✓ **Implementation Re-Tasking:** MyPOWER Corporation designated by PETRA as the lead implementation management agency for nuclear energy .
- ✓ **IAEA Phase Readiness:** Managing National Infrastructure Development (NG-G-3.1) across statutory, safety, and operational pillars.
- ✓ **Regulatory Enhancement:** Updating Atomic Energy Licensing Board (Atom Malaysia) regulations under Act 304 to cover advanced SMR standards.



POTENTIAL NUCLEAR COGENERATION IN MALAYSIA

Nuclear cogeneration using the non-electric waste thermal energy from nuclear reactors alongside electricity generation, presents major decarbonization opportunities for Malaysia.

As the country explores Small Modular Reactors (SMRs) under its energy transition roadmap and the 13th Malaysia Plan, several high-value industrial and municipal cogeneration applications stand out.



Clean Green Hydrogen

High-temperature steam extraction (500°C–750°C) enables High-Temperature Electrolysis (HTE) for low-cost hydrogen production.



Industrial Process Heat

Replaces fossil boilers in chemical refining, oleochemicals, and heavy manufacturing with zero-emission thermal steam.



Industrial Desalination

Taps secondary heat loops to supply ultra-pure water and potable water for high-volume semiconductor foundries & coastal hubs.



District Cooling for High-Density Hubs

Drives thermal absorption chillers for mega data center campuses

INDUSTRIAL PROCESS HEAT IN MALAYSIA

In Malaysia, industrial process heat is a critical foundation for both the **petrochemical and oleochemical** sectors.

Because these industries rely heavily on high-temperature reaction engineering, separation processes, and thermal purification, process heat generation accounts for a major portion of the energy consumed in major industrial hubs like **Kerteh, Gebeng, Pasir Gudang, and the Pengerang Integrated Petroleum Complex (PIPC)**.

Small Modular Reactors (SMRs) represent a potential game-changer for decarbonizing industrial process heat in Malaysia.

PARAMETER	PETROCHEMICALS (FOSSIL-BASED)	OLEOCHEMICALS (PLANT-BASED)
Temperature Range	High to Extreme Heat (300°C to >800°C)	Medium to High Heat (150°C to 300°C)
Primary Processes	Naphtha cracking → Catalytic reforming ↓ Hydroprocessing → Distillation	→ Fatty acid splitting Glycerine evaporation Fractionation → Deodorization
Heat Transfer Media	Direct-fired furnaces High-pressure superheated steam Waste boilers	Saturated steam boilers Thermal oil heaters (Therminol/Dowtherm)
Fuel Vectors	Natural gas Refinery off-gas Heavy fuel oil	Natural gas Biomass (EFB/PKS) Industrial diesel oil

CLEAN GREEN HYDROGEN IN MALAYSIA

Malaysia is positioning clean green hydrogen as a core pillar of its decarbonization strategy to achieve net-zero carbon emissions by 2050. By tapping into its abundant hydropower, solar energy, and strategic shipping locations, the country aims to become a major hub for green hydrogen production and export in Southeast Asia.

National Framework & Economic Ambitions

- Hydrogen Economy & Technology Roadmap (HETR): Launched under the National Energy Transition Roadmap (NETR), the HETR targets RM12.1 billion in hydrogen-related revenue by 2030, rising to over RM400 billion by 2050.
- Export Targets: Malaysia aims to supply major Asian markets, including Japan, South Korea, Singapore, and China.
- Emissions Reduction: Green hydrogen deployment targets a 15% reduction in overall national greenhouse gas emissions by 2050.

Potential SMR support for Green Hydrogen in Malaysia

24/7 Zero-Emission Baseload Power: Green hydrogen production via water electrolysis requires vast amounts of continuous electricity. Unlike solar, which is intermittent, SMRs provide steady, round-the-clock clean power, maximizing electrolyzer capacity factors and drastically lowering the cost per kilogram of hydrogen.

High-Temperature Thermal Electrolysis (HTSE): SMRs generate high-temperature process heat (typically 300 °C to 800 °C). Utilizing this heat directly in Solid Oxide Electrolyzer Cells (SOEC) reduces the electrical energy required to split water by up to 20–30%, making hydrogen generation far more energy-efficient.

Land-Efficient Hydrogen Hubs: SMRs have a tiny physical footprint compared to solar farms. In industrial centers with limited land availability, SMRs can be co-located with ports and heavy industrial clusters (like Kerteh, Pasir Gudang, or Bintulu) to power localized hydrogen production hubs directly.

DATA CENTER IN MALAYSIA

MALAYSIA DATA CENTER LANDSCAPE

I. OPERATIONAL CAPACITY (EST.)

150-200 MW

APPROX. 120-125 ACTIVE FACILITIES



MAJOR LOCATIONS

CYBERJAYA (KLANG VALLEY) - Enterprise Hub

JOHOR (ISKANDAR PUTERI, NUSAJAYA) - Key Cross-Border Links

II. FUTURE GROWTH & PIPELINE

4,000+ MW

PROJECTED POTENTIAL



FUTURE OUTLOOK

30-40+ NEW PROJECTS
UNDER CONSTRUCTION

EXPANDING REGIONS & HUBS

GREATER KL
(AWS, GOOGLE, MICROSOFT)

JOHOR (YTL, GDS,
BYTE DANCE CAMPUSES)

EMERGING: PENANG,
NEGERI SEMBILAN, KEDAH

DRIVERS FOR EXPANSION

OVER \$40 BILLION IN
APPROVED INVESTMENTS

HYPERSCALER DEMAND
(CLOUD & AI)

SPILOVER FROM
SINGAPORE

SOURCE: INDUSTRY ESTIMATES & REPORTS | 2024-2025

POTENTIAL NUCLEAR COGENERATION IN MALAYSIA

1 INDUSTRIAL PROCESS HEAT (Petrochemicals & Chemicals)

SPECIFIC POTENTIAL AREAS

- PENGERANG, JOHOR**
RAPID Refinery & Petrochemical Complex
- KERTEH, TERENGGANU**
PETRONAS Petrochemical Integrated Complex
- GEBENG, PAHANG**
Kuantan Industrial Park (Oleochemical & Specialty Chemicals)

APPLICATIONS

- Steam cracking
- Palm oil refining
- Oleochemical production
- Chemical manufacturing

BENEFITS

- ✓ Replace natural gas boilers
- ✓ Lower industrial CO₂ emissions
- ✓ Stable and reliable heat supply

2 CLEAN HYDROGEN PRODUCTION & CARBON UTILIZATION

SPECIFIC POTENTIAL AREAS

- BINTULU, SARAWAK**
Existing hydrogen economy, LNG export hub, Ammonia production
- SAMALAJU INDUSTRIAL PARK, SARAWAK**
Green hydrogen for heavy industries, export opportunity
- PENGERANG, JOHOR**
Refinery hydrogen demand, sustainable fuel production

APPLICATIONS

- H₂** High-temperature steam electrolysis (HTSE)
- Green ammonia
- Sustainable aviation fuel
- Hydrogen export

BENEFITS

- ✓ Clean energy export potential
- ✓ Decarbonize hard-to-abate sectors
- ✓ Strengthen Malaysia as regional hydrogen hub

3 SEAWATER DESALINATION For Water Security

SPECIFIC POTENTIAL AREAS

- LANGKAWI**
Tourism demand
- LABUAN**
Island water security
- EASTERN SABAH**
Sandakan, Lahad Datu, Tawau
- COASTAL JOHOR**
Pengerang industrial demand

APPLICATIONS

- Potable water
- Industrial water
- Emergency drought supply

BENEFITS

- ✓ Dedicated large-scale water supply
- ✓ Not drawing from public freshwater reserves
- ✓ Support industrial and community resilience

4 DISTRICT COOLING FOR HIGH-DENSITY HUBS

SPECIFIC POTENTIAL AREAS

- GREATER KUALA LUMPUR**
KLCC, TRX, Bukit Bintang
- PUTRAJAYA**
Government complexes
- CYBERJAYA**
Digital economy hub, data centres
- KULIM HI-TECH PARK**
Semiconductor industry
- JOHOR-SINGAPORE SPECIAL ECONOMIC ZONE (JS-SEZ)**
Future data centre developments

APPLICATIONS



BENEFITS

- ✓ Centralized cooling for multiple buildings
- ✓ Lower electricity peak demand
- ✓ Higher energy efficiency
- ✓ Supports data centres, commercial & industrial growth

BENEFITS FOR MALAYSIA



INDUSTRIAL DECARBONIZATION
Lower emissions, cleaner industry



ENERGY SECURITY
Reliable, stable and diversified energy



WATER SECURITY
Resilient water supply for people and industry



GREEN HYDROGEN ECONOMY
New export opportunities and green jobs



NET ZERO 2050 SUPPORT
Supports Malaysia's climate commitments



HIGH-VALUE INDUSTRIAL GROWTH
Attract investment, create high-skill jobs

EXISTING CAPABILITIES FOR FUTURE NUCLEAR COGENERATION

TECHNICAL & R&D READINESS

UNITEN INE Nuclear-Hydrogen

Institute of Nuclear Energy (INE) at UNITEN leads specialized research on Nuclear-Hydrogen Coupling, high-temp thermal modeling, and advanced reactor simulation.

ACTIVE R&D HUB (EST. 2023)

Industrial Steam Grid Expertise

Decades of operating high-pressure CHP steam distribution & boiler systems across PETRONAS refineries in PIPC Pengerang, Kertih, and Gebeng corridors.

PROVEN HEAVY CHP OPERATIONS

Hydrogen Ecosystem (HETR)

National Hydrogen Economy & Technology Roadmap framework supported by MOSTI, developing electrolysis, fuel cells, & green ammonia synthesis capabilities.

HETR TECHNOLOGY ROADMAP

INDUSTRIAL WATER INFRASTRUCTURE

Coastal Thermal Desalination

Established engineering capabilities in thermal & membrane seawater desalination supplying mega petrochemical hubs and semiconductor fab parks.

DESALINATION CAPACITY

Water Supply Grid Integration

Engineering integration expertise for linking desalination outputs with existing industrial water grids and processes.

GRID INTEGRATION CAPABILITY

Brine Management Solutions

Proven environmental management protocols for handling and processing desalination brine in compliance with regulations.

ENVIRONMENTAL COMPLIANCE

REGULATORY & INDUSTRIAL SITING PREPARATION

SMR Co-Siting Standards

Atom Malaysia & MyPOWER drafting guidelines for co-locating SMRs with industrial complexes.

REGULATORY ALIGNMENT

Thermal Hydraulic Modeling

Academic & Industry partnerships conducting safety simulations for high-temp steam loops.

SAFETY SIMULATION

Multi-Product Licensing

Establishing regulatory protocols for dual-output facilities (electricity + steam/H₂).

LICENSING PROTOCOLS

KEY CHALLENGES & IMPLEMENTATION BARRIERS

High CAPEX & Tariff Risk

High Initial capital cost for SMRs, BESS, and grid reinforcement. Compensating coal IPPs for early PPA buyouts risks upward pressure on consumer energy tariffs.

MITIGATION APPROACH:

Blended green financing, sovereign guarantees, and private co-investments.

Public Sentiment

Public anxiety regarding radiation safety, waste management, and reactor siting near Industrial complexes (NIMBYism) demands proactive social licensing.

MITIGATION APPROACH:

Transparent public engagement led by MyPOWER and IAEA educational campaigns.

Act 304 Modernization

Current Act 304 regulates research reactors but lacks explicit commercial nuclear frameworks, nuclear third-party liability laws, and spent fuel repository mandates.

MITIGATION APPROACH:

Enacting modern Omnibus Atomic Energy Legislation aligned with IAEA 3S standards.

Talent & Fuel Supply Bottleneck

Shortage of specialized nuclear safety engineers and dependency on global suppliers for High-Assay Low-Enriched Uranium (HALEU) nuclear fuel elements.

MITIGATION APPROACH:

Bilateral IAEA training programs and strategic nuclear fuel supply agreements.

CONCLUSION

Malaysia possesses strong potential to leverage nuclear cogeneration as a strategic enabler of its clean energy transition. As electricity demand continues to grow while coal-fired generation is phased out, Small Modular Reactors (SMRs) can provide reliable, low-carbon baseload electricity together with valuable process heat for industrial and non-electric applications.

Key sectors—including **industrial process heat, green hydrogen production, and data centres**—offer significant opportunities where nuclear cogeneration can enhance energy security, reduce greenhouse gas emissions, and improve industrial competitiveness. Integrating SMRs into these sectors could support Malaysia's National Energy Transition Roadmap (NETR) and long-term Net Zero ambitions.

Malaysia already has valuable foundations to support future nuclear deployment through decades of research reactor operation, technical expertise, regulatory development, and international collaboration. However, successful implementation will require continued progress in national policy, regulatory readiness, financing mechanisms, public acceptance, infrastructure development, and human capital.



THANK YOU



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