

Development of Indonesia's PeLUIt-40: Progress and Challenges



<https://id.wikipedia.org/wiki/Indonesia>

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Regional Workshop on Safety Benefits and Challenges in the Development of the
Adoption of Small Modular Reactors (EVT2404165)

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Development of Indonesia's PeLUIt-40: Progress and Challenges

Outline



01

**Indonesia's Energy
Landscape & Nuclear Vision**

02

SMR for Indonesia

03

PeLUIt-40

Concept and Design, Development, progress,
challenges and Future steps

04

Conclusion & Way Forward



01

Indonesia's Energy Landscape & Nuclear Vision

Teritorial Area : 8,300,000.00 km²

Land Area: 1,892,410.09 km²

Sea Area : Around 5.8 million km²

Population : 278,696.20 Thousand People

Provinces : 38

Indonesia

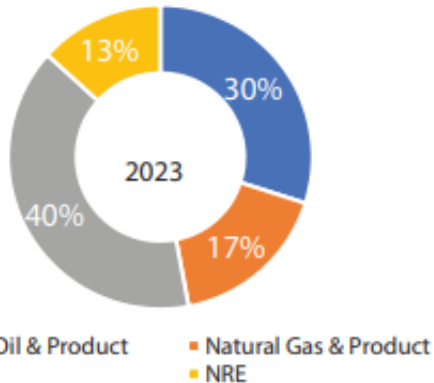
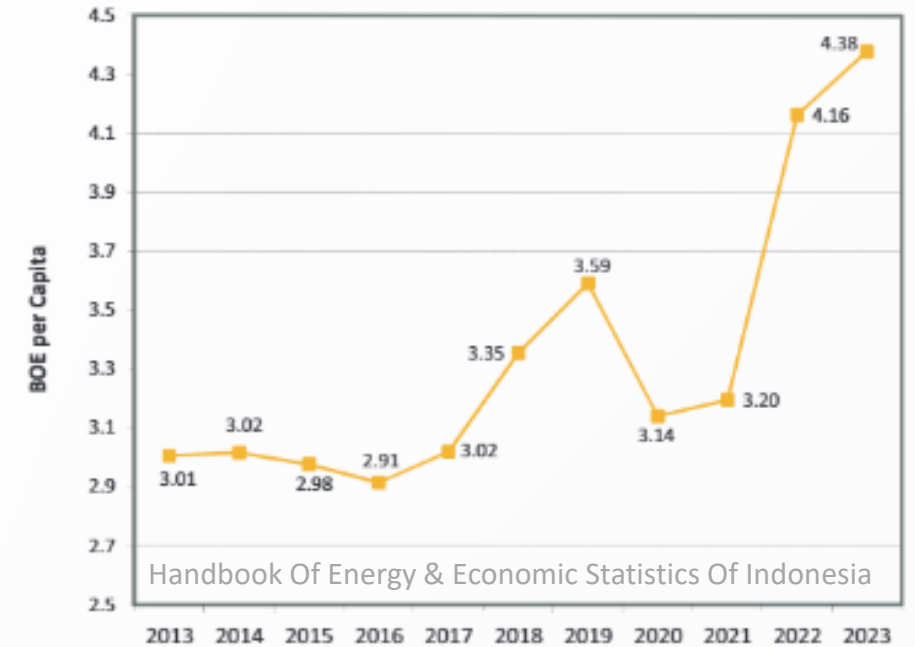
An archipelagic country with more than seventeen thousand islands



Indonesia's Energy Landscape & Nuclear Vision

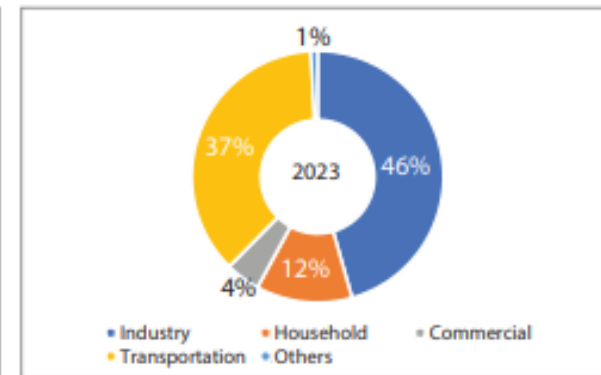
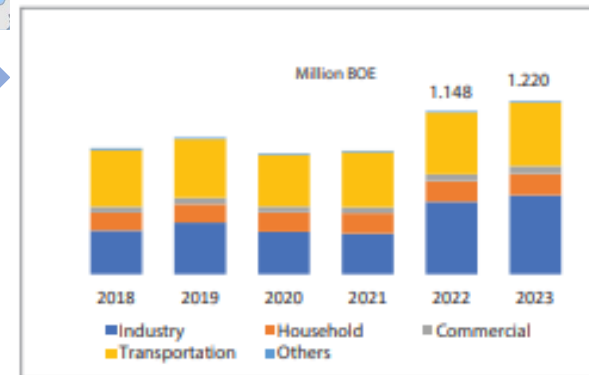


1.8. Intensity of Final Energy Consumption per Capita



✓ The primary energy mix is still *dominated by coal*.

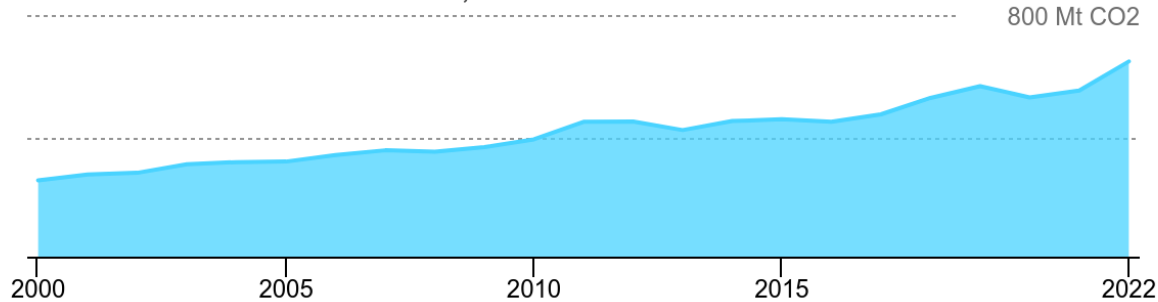
✓ The *NRE* mix is targeted to reach *23% by 2025*.



The share of coal in energy consumption in the industrial sector was the highest.

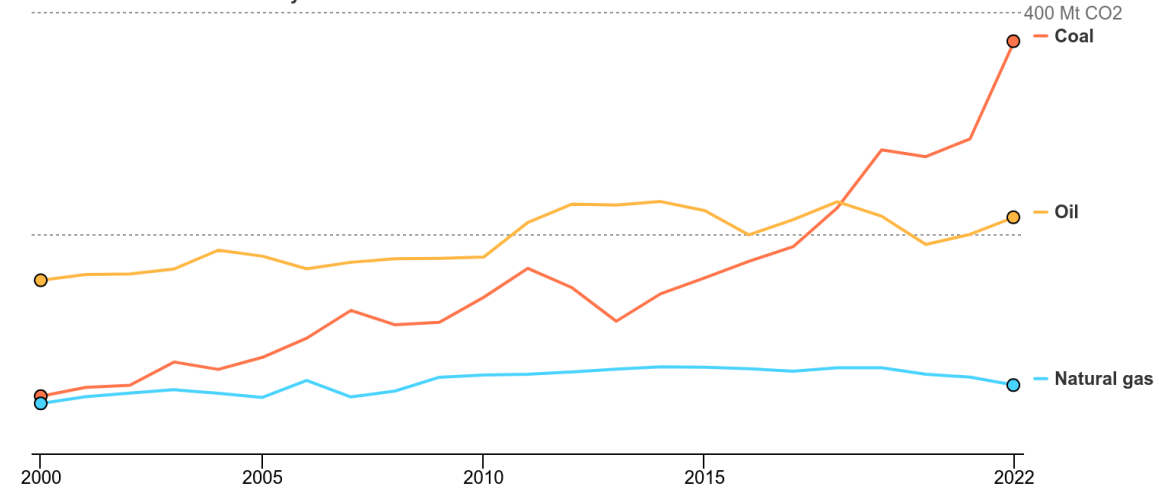
Indonesia's Energy Landscape & Nuclear Vision

CO2 emissions from fuel combustion, Indonesia



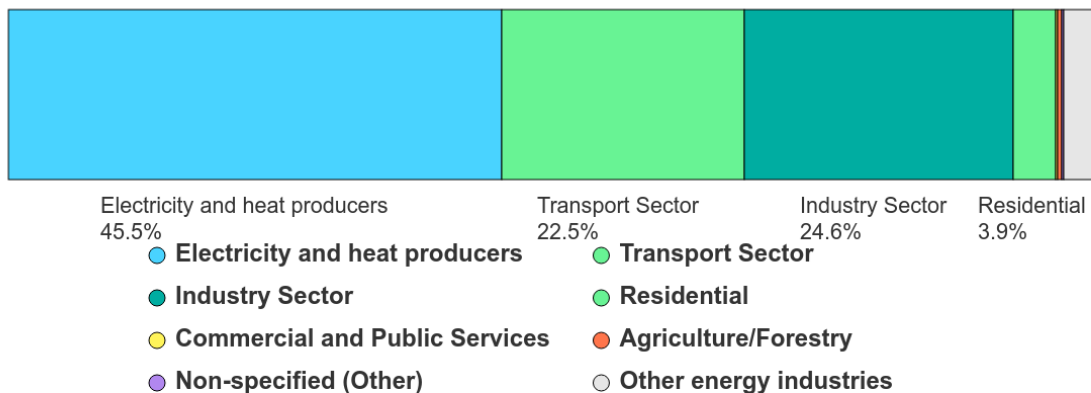
Source: International Energy Agency. Licence: CC BY 4.0

Evolution of CO2 emissions by fuel in Indonesia since 2000



Source: International Energy Agency. Licence: CC BY 4.0

CO2 emissions by sector, Indonesia, 2022



Source: International Energy Agency. Licence: CC BY 4.0

Main Sources – Fossil fuel combustion (coal, oil, gas) for power, transport, and industry.

Transport – Cars are the biggest contributors; EV adoption is growing but oil use remains dominant.

Industry – Uses fossil fuels for heat; steel and paper production are major sources.



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Indonesia Targets Achieving Net-Zero Emissions by 2060

Published on October 23, 2022

01

Indonesia's Energy Landscape & Nuclear Vision

Speaking at COP26, Energy Minister Gives Indonesia's Commitment to Net Zero Emission

Tuesday, 2 November 2021 - Dibaca 17749 kali

IDX Channel | The Government Must Reduce 9GW of Electricity from Coal-Fired Power Plants to Achieve NZE by 2060

📅 October 23, 2023 💬 No Comments

[Related Article](#)

Indonesia's Rapid Steps Towards Carbon Emission Reduction

📍 IPA News 📅 Oct 25, 2024 👤



Targeting Net Zero Emissions, Indonesia Partners Japan to Increase Human Resources Capacity and Nuclear Technology

Published on February 17, 2025

Indonesia pursues nuclear power for energy needs, not weapons

© Sabtu, 8 Februari 2025 23:28 WIB

RI sets ambitious goal for 42GW nuclear power by 2060, first operational plant in 2032

Published on 20/02/2025 GMT+7 • Reading time 2 minutes • Author: Julian Isaac • Editor: Imanuddin Razak

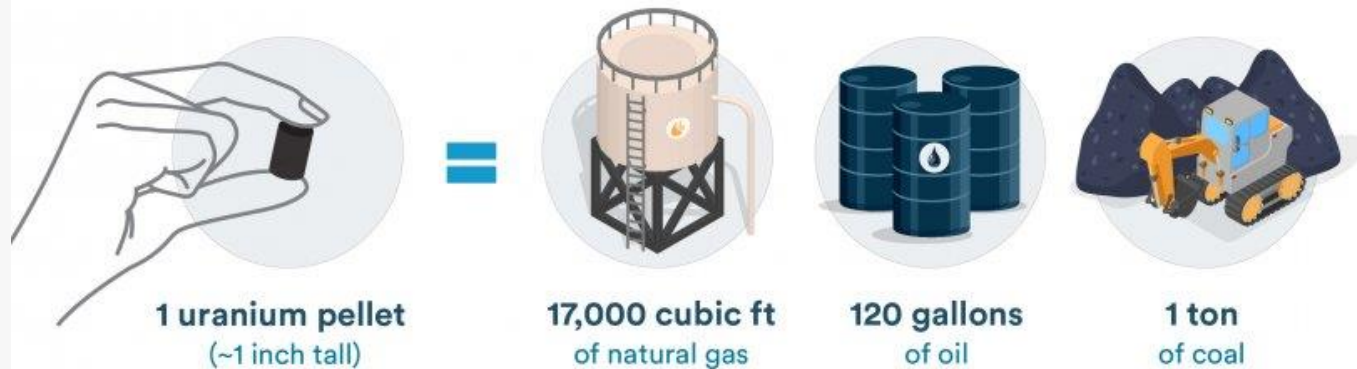


Why nuclear?



Fast Facts on NUCLEAR ENERGY

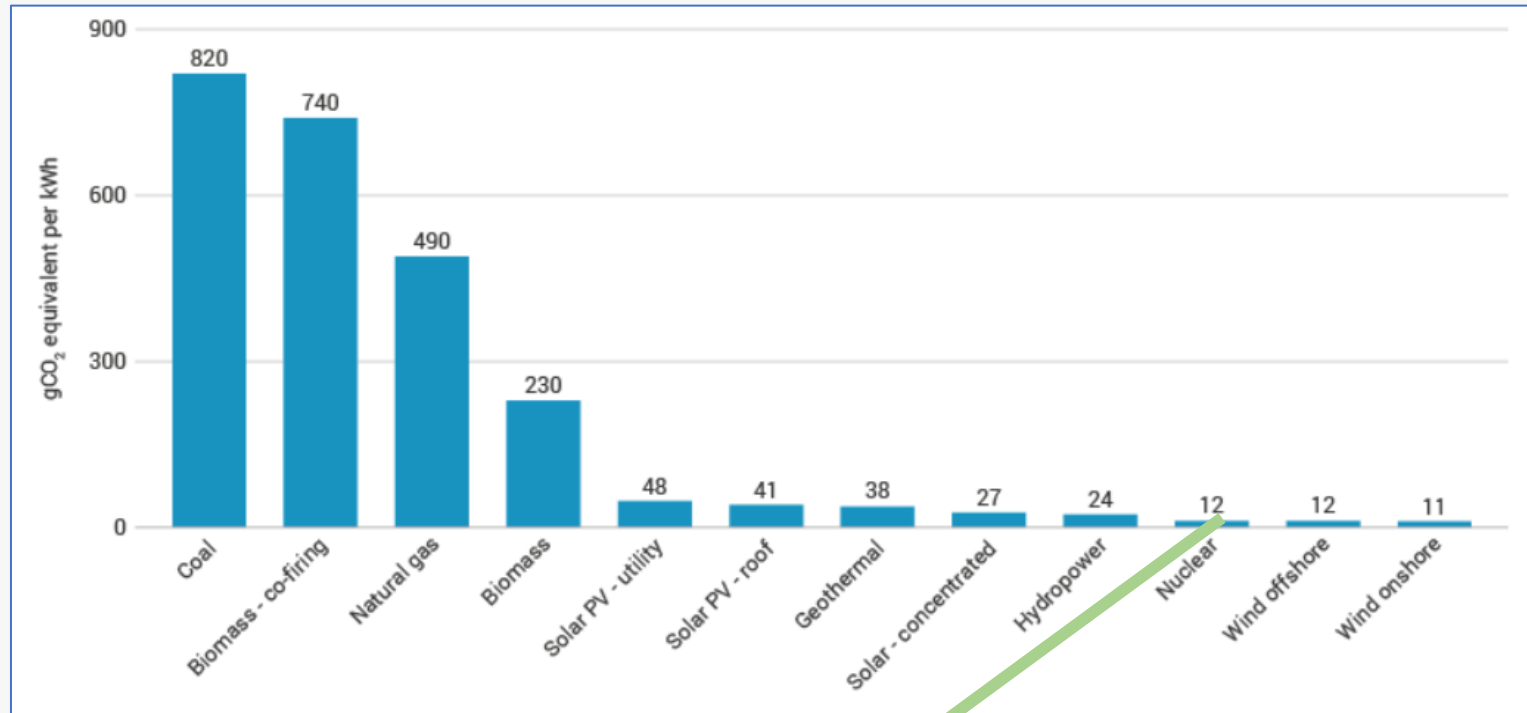
Nuclear fuel is **extremely energy dense**.



- **High Energy Density** – Nuclear fuel is about one million times more energy-dense than traditional energy sources.
- **Minimal Waste** – Despite its high energy output, the amount of used nuclear fuel generated is relatively small.
- **Recyclable Fuel** – Used nuclear fuel can be reprocessed and recycled, reducing waste and maximizing resource utilization.
- **Advanced Reactor Designs** – Some next-generation reactors are being developed to operate using recycled nuclear fuel, enhancing sustainability.



Nuclear energy is low-carbon



Indirectly

Demand for clean
energy and
Climate change

1.5°C Challenge

TODAY

70%

of electricity
comes from
burning fossil fuels



2050

≈ 80%

of electricity
will need to be
low carbon



Land Efficiency

Nuclear Power – A 1,000-megawatt nuclear facility requires just over 1 square mile of land.

Wind Power – Requires 360 times more land to produce the same amount of electricity.

Solar Power – Needs 75 times more space than nuclear energy.



Suasana PLTS Cirata 1 MW. (Dok HUMAS PEMPROV JABAR)



PLTB Tolo I berkapasitas 72 MW dibangun di Kampung Lengke-lengese, Kecamatan Binamu, Jeneponto,

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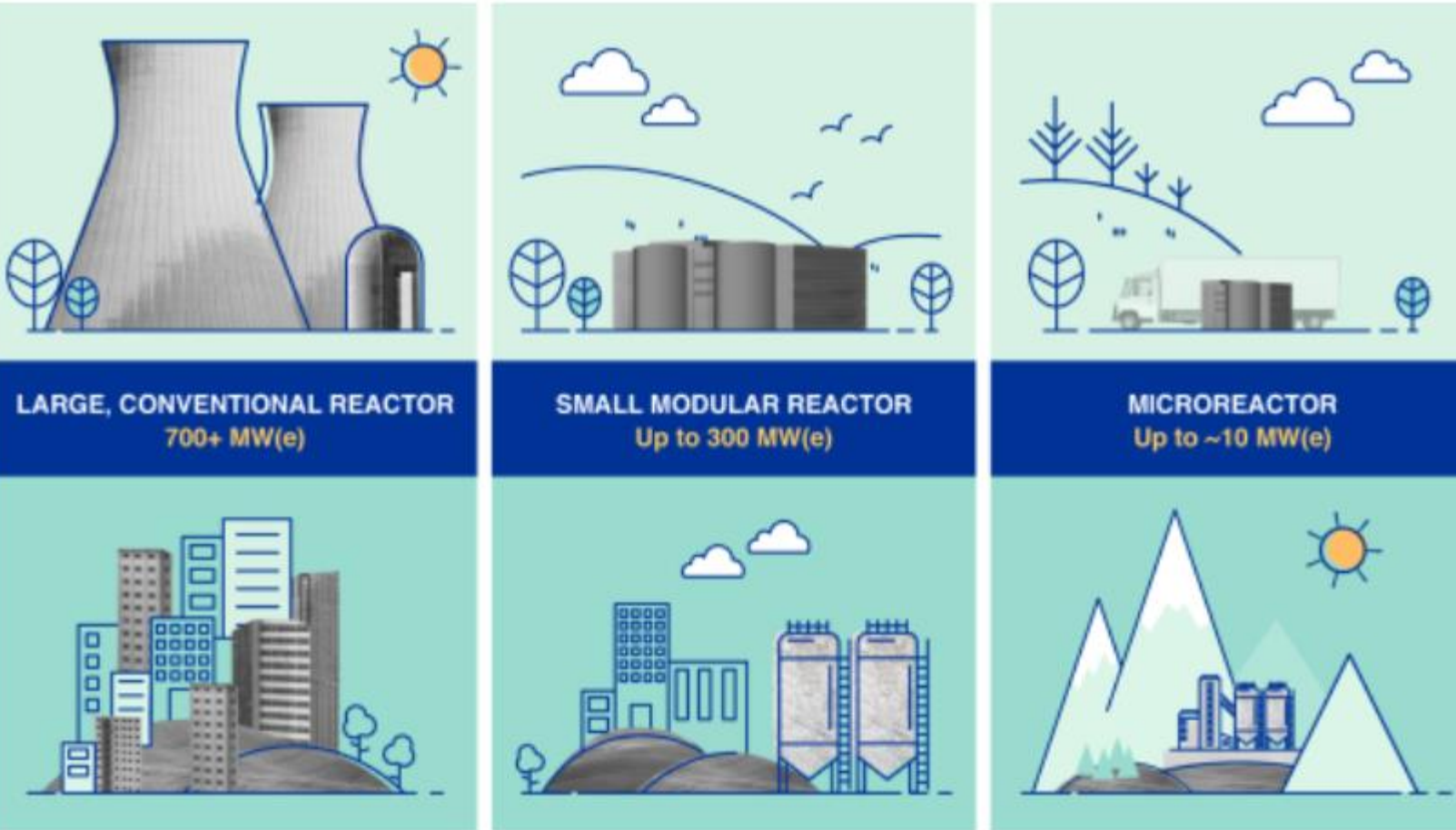


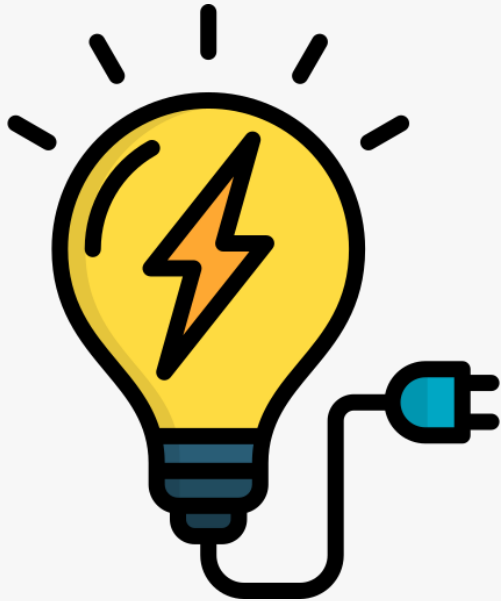
1. Flexibility and Efficiency of SMRs

- **Small & modular design:** Can be deployed in locations unsuitable for large nuclear power plants.
- **Prefabrication & fast deployment:** Manufactured in factories, transported, and assembled on-site, reducing costs and construction time.
- **Incremental scalability:** Can be added gradually to match growing energy demand.

2. Solution for Infrastructure Challenges in Indonesia

- **Ideal for remote areas & islands:** Does not require extensive grid networks.
- **Cost-effective electrification:** Can operate off-grid or integrate into existing small grids.
- **Low-carbon energy for industry & communities:** Supports decarbonization and national energy security.



**POWER**

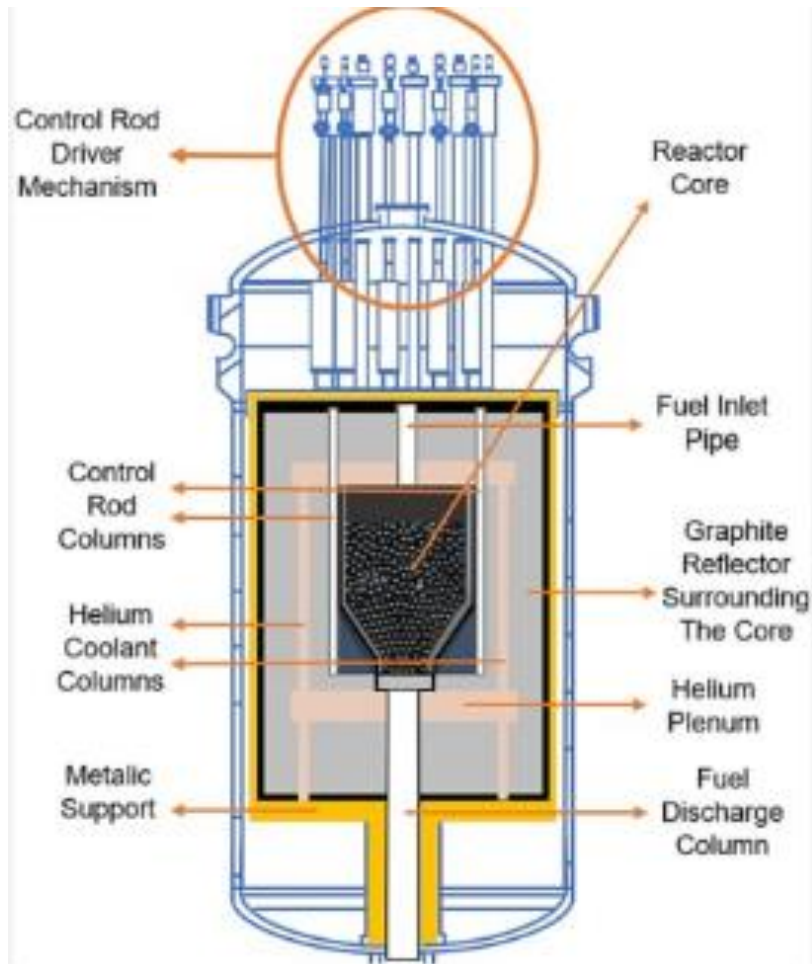
https://www.freepik.com/icon/electricity_9746847>Icon by Awicon

**HEAT**

Indonesia needs a reactor that not only generates electricity but also provides heat for industrial applications.



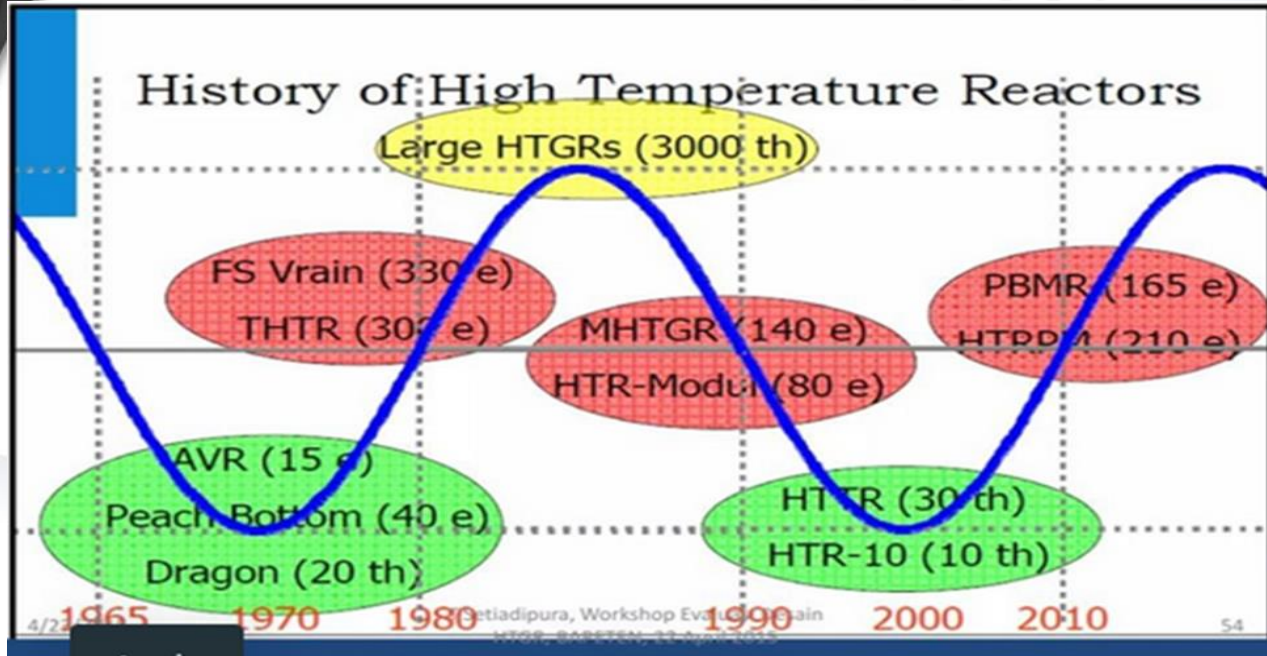
High-Temperature Gas-Cooled Reactor (HTGR)



- ✓ *High Thermal Efficiency*: Achieves 750–950°C, enabling efficient electricity generation and industrial heat use.
- ✓ *Passive Safety*: TRISO fuel retains fission products; inherent safety allows shutdown without external power.
- ✓ *Hydrogen & Process Heat*: Supports hydrogen production and provides heat for industries like petrochemicals and steel.
- ✓ *Flexible Deployment*: Suitable for small grids, ideal for remote areas and island nations like Indonesia.
- ✓ *Low Environmental Impact*: Helium coolant is inert; reduces greenhouse gas emissions.
- ✓ *Efficient Fuel Use*: Uses diverse fuels (thorium, recycled nuclear) and generates less long-lived waste.
- ✓ *Economic Viability*: Lower operational costs, modular design, and fewer regulatory challenges.

HTGR Commercialization Strategy in SMR Era

Pre-SMR Commercialization Pathway



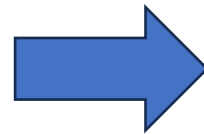
1. Small Prototype Reactor [Dragon, PeachBottom, AVR, HTR-10]
2. Medium Demo Reactor [FS Vrain, THTR, HTR-Modul, HTR-PM?]
3. Big Commercial Reactor [HTR-PM600?]

In SMR (even MicroReactor) Era?

Electricity or Energy Market for low-power grid/remote demand is huge, e.g, de-dieselization program.

In addition, co-generation potential even from small-unit, e.g. Low-Carbon H-Production, Desalination.

2-Steps Scheme using exactly same SMR:



**From Small Prototype/Demo
to
'Small but Many' Commercial Reactor.**

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History of HTGR Development

Year	Milestone
Since 90'	BATAN becoming member of IAEA Technical Working Group on Gas-cooled Reactor
2015 - 2019	BATAN plan to build a 10 MWt Pebble Bed HTGR

BATAN / BRIN and Local Partners (PLN Nusantara Power and ITB) is accumulating the knowledge of Pebble Bed HTGR.

PeLUIt Development:

2015-2016:

- **Transfer of Conceptual Design from NUKEM and OKBM-ROSATOM.**

2017:

- Got the **Site Licensing** from Regulatory Body
- **Internal Basic Design** development under IAEA Review

2018-2019:

- **Funding from KEMENRISTEK** to develop further the Basic Design. In cooperation with universities and engineering company

2021

- **PeLUIt-40 (from 10MWt → 40MWt) Initiative** started with economic feasibility based on: **de-dieselization, low-carbon H-production**, desalination.

2022 – 2024

- Cooperation with **PLN Nusantara Power** and **ITB** to further developed PeLUIt-40.

PeLUit = Pembangkit Listrik dan Uap-panas Industri (Cogeneration of Electricity & Industrial Heat).

Developed by *BRIN & ITB*.

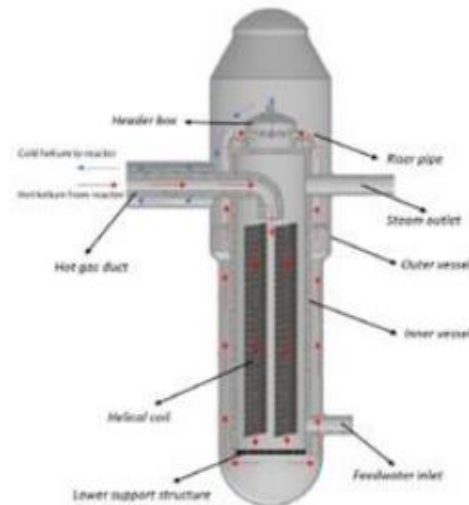
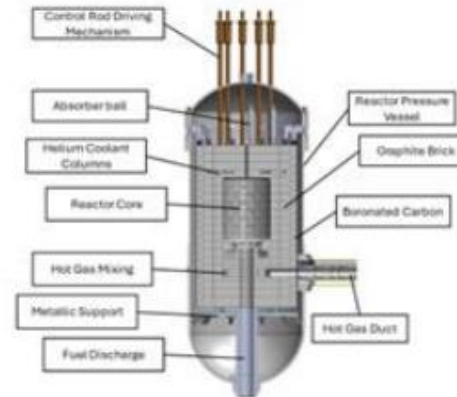
Symbolism: "*Peluit*" means "*whistle*" representing the spirit to initiate Indonesia's nuclear power era.

Apply *OTTO Refuelling scheme*



PeLUit-40 (BRIN – ITB, Indonesia)

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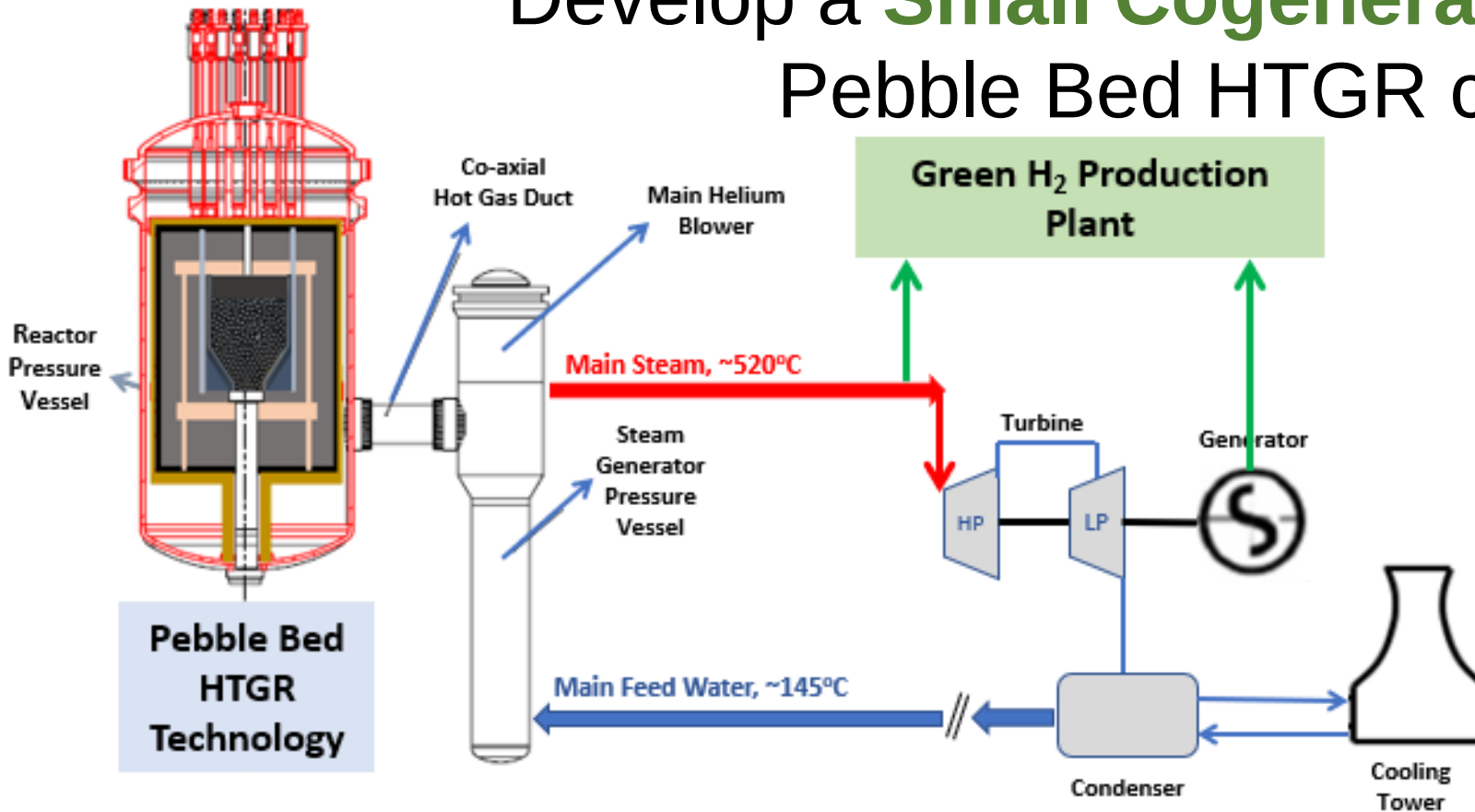


MAJOR TECHNICAL PARAMETERS	
Parameter	Value
Technology developer, country of origin	National Research and Innovation Agency (BRIN) and Bandung Institute of Technology (ITB), Indonesia
Reactor type	Pebble bed high-temperature gas-cooled reactor
Coolant/moderator	Helium/graphite
Thermal Power	30MWt / 10MWe
Primary circulation	Forced circulation
NSSS Operating Pressure (primary/secondary), MPa	3 / 6
Core Inlet/Outlet Coolant Temperature (°C)	250 / 750
Fuel type/assembly array	Spherical elements with coated particle fuel
Number of fuel assemblies in the core	27 000
Fuel enrichment (%)	17
Core Discharge Burnup Target (GWd/ton)	80
Refuelling Cycle (months)	On-line refuelling
Reactivity control mechanism	Control rod and small absorber sphere
Approach to safety systems	Combined active and passive
Design life (years)	40
Plant footprint (m ²)	~24 000
RPV height/diameter (m)	11.1 / 4.2 (inner)
RPV weight (metric ton)	180
Seismic Design (SSE)	0.26g
Fuel cycle requirements / Approach	LEU, open cycle, spent fuel intermediate storage at the plant
Distinguishing features	Inherent safety, no need for offsite emergency measures
Design status	The basic design of 30MWt/10MWe is in progress.



PeLUit-40 Proposal

Develop a **Small Cogeneration SMR** based on a Pebble Bed HTGR called **PeLUit**



Utilization and System Performance Target:

1. De-dieselization
2. H-Production of **1.3 kTonnes/year***

ZeroEmission-H₂
with a targeted cost of < **5 USD/Kg***.

***Initial Study with specific SOEC.**

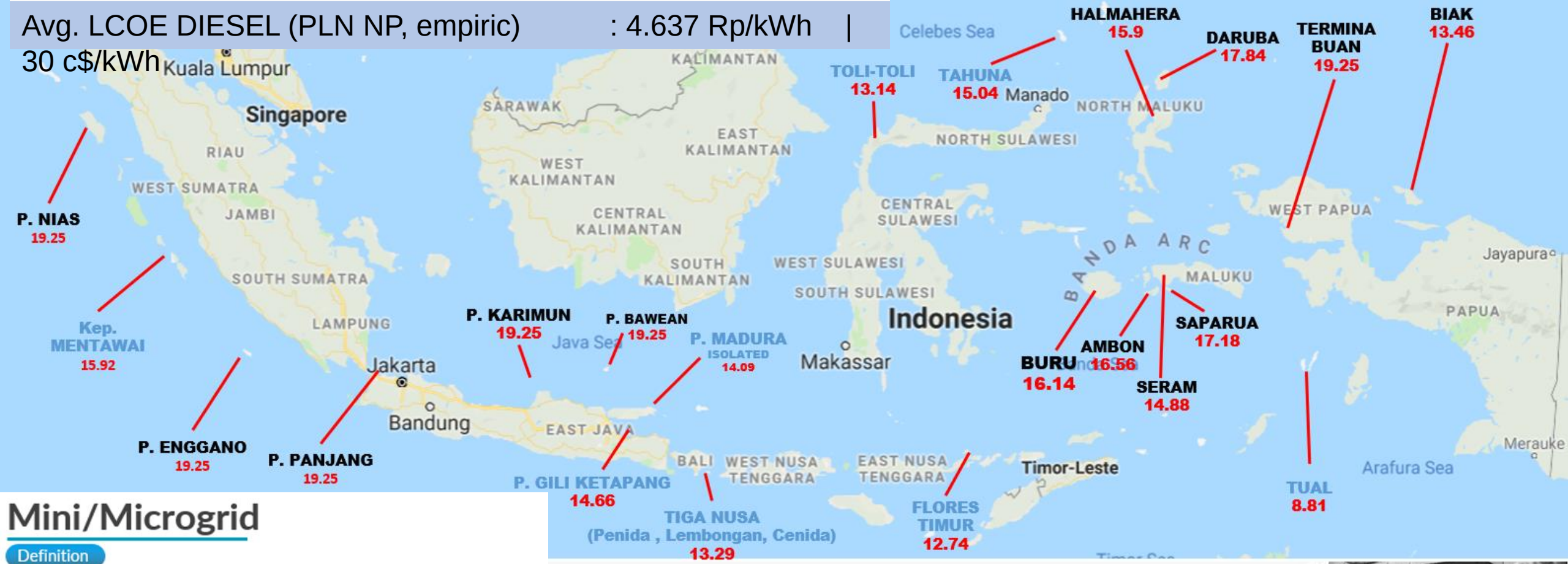
Co-development of the PeLUit with International Strategic Partners is Cordially Invited.



**5200 units diesel power plant to be replaced
In 2130 location with 2.37 GW capacity.**

Generation Cost,
MeMR(2020)

Avg. LCOE DIESEL (PLN NP, empiric) : 4.637 Rp/kWh |
30 c\$/kWh



Mini/Microgrid

Definition

A microgrid is a local electrical grid that can operate in both grid-connected and **island mode**. It is a self-contained system that can generate, distribute, and regulate electricity within a defined electrical boundary, commonly around **10KW-10MW**



Progress in Development of PeLUIt-40

Modeling and Simulation



Nuclear Engineering and Design

Volume 415, 15 December 2023, 112696

Optimum power determination and comparison of multi-pass and OTTO fuel management schemes of HTGR-based PeLUIt reactor

Nuri Trianti ^a, , Nina Widiawati, Cici Wulandari, Fitria Miftasani, Anis Rohanda, Azizul Khakim, Topan Setiadipura



Nuclear Engineering and Design

Volume 423, July 2024, 113195

Scaling law method for cost estimation of Indonesia's first HTGR (PeLUIt-40) and its implementation strategy

Rizki Firmansyah Setya Budi ^a, , Sudi Ariyanto, Djati H. Salimy, Donny Nurmayady, Elok Satiti Amitayani, Nuryanti, Kurnia Anzhar, Ewitha Nurulhuda, Nurlaila



Nuclear Engineering and Design

Volume 433, March 2025, 113873

Optimization of uranium and uranium-thorium fuel utilization in pebble bed for PeLUIt-10 reactor using PEBBED code

Cici Wulandari ^a, , Dwi Irwanto ^a, Nina Widiawati ^b, Nuri Trianti ^b, Fitria Miftasani ^b, Topan Setiadipura ^b, Zaki Su'ud ^a



Nuclear Engineering and Design

Volume 422, June 2024, 113163

Investigating geometry adjustments for enhanced performance in a PeLUIt-10 MWt pebble bed HTGR with OTTO refueling scheme

Fitria Miftasani ^a, , R Andika Putra Dwijayanto ^a, Ghulam Abrar ^b, Nina Widiawati ^a, Nuri Trianti ^a, Topan Setiadipura ^a, Dwi Irwanto ^b, Cici Wulandari ^a, Zaki Suud ^b



Nuclear Engineering and Design

Volume 432, February 2025, 113842

Analysis of TRISO failure fraction in PeLUIt reactor with increasing power

Fitria Miftasani ^a, , Steven Wijaya ^a, Nina Widiawati ^a, Anni Nuril Hidayati ^a, Dany Mulyana ^a, Hakimul Wafda ^a, Anik Purwaningsih ^a, Fajar Al Afghani ^b, Muhammad Ilham Bayquni ^b, Arya Adhyaksa Waskita ^c, Topan Setiadipura ^a



Nuclear Engineering and Design

Volume 430, 15 December 2024, 113677

Computational analysis for predicting fission product release of PeLUIt-40 under normal operating conditions

Anik Purwaningsih ^{a b}, , Dwi Irwanto ^{b d e}, Julwan H. Purba ^c



What's next?



Design approval from Indonesian
Regulatory Body (BAPETEN).



Challenges in PeLUIt-40 Development

Technology Aspects

- Challenges in fuel management (OTTO vs. Multipass)
- Testing and design validation

Regulations & Policies

- Licensing and safety standards



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04**Conclusion & Way Forward****Indonesia's Path to Its First Nuclear Power Plant**

Indonesia is eager to take the first step toward integrating nuclear power into its national energy mix as part of its energy transition strategy.

To achieve this goal:

- **International Collaboration** – Essential for the direct implementation of existing NPP/SMR technologies.
- **Strategic Co-Development** – Opportunity to build upon Indonesia's previous R&D efforts, targeting de-dieselization and low-carbon hydrogen production.
- **PeLUt-40 Proposal** – Positioned as a key candidate for co-development.

Your cooperation is warmly welcomed for co-development.





THANK YOU

Let's collaborate

Dr. Nina Widiawati

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