

Opportunity and Challenges of Nuclear Hydrogen Implementation

#26 IAEA Dialogue Forum 2026
24 - 28 August 2026, Bangkok, Thailand

Research Center for Nuclear Reactor Technology
RESEARCH ORGANIZATION FOR NUCLEAR ENERGY (BATAN)
NATIONAL RESEARCH AND INNOVATION AGENCY OF INDONESIA

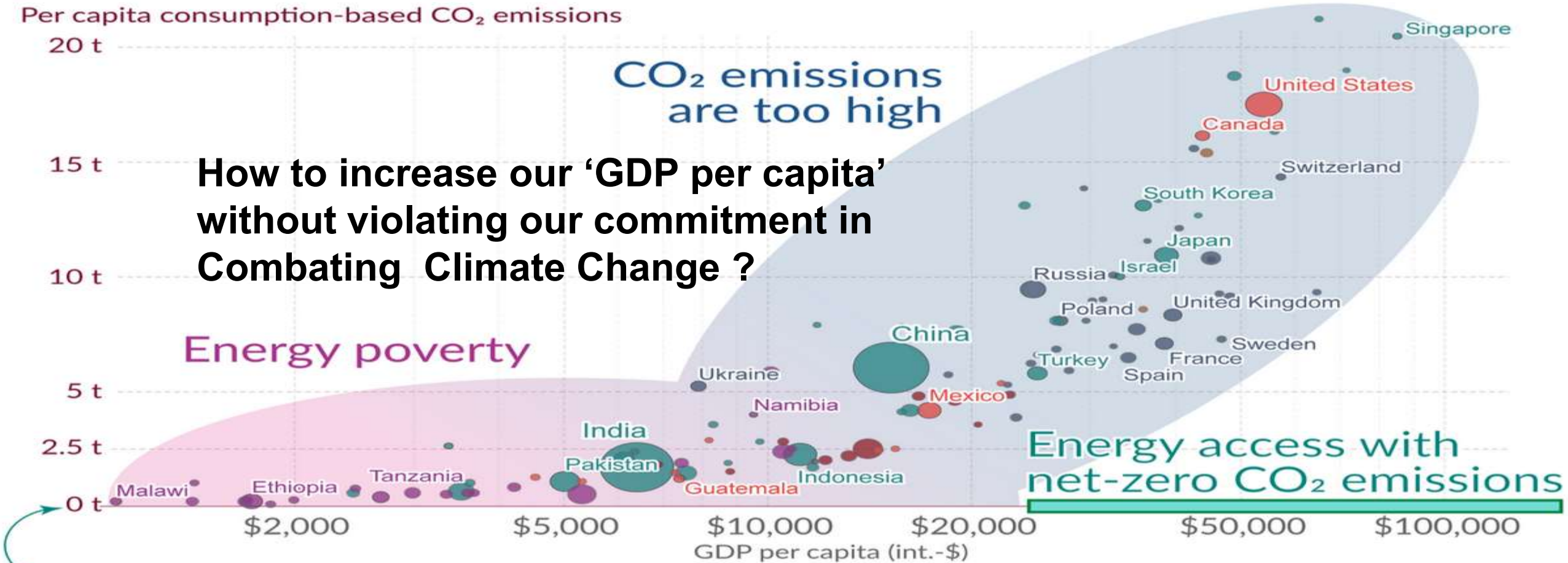
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The Challenge!!

CO₂ emissions per capita vs GDP per capita

Our World
in Data



To end climate change the long-run goal is that net-emissions decline to zero.

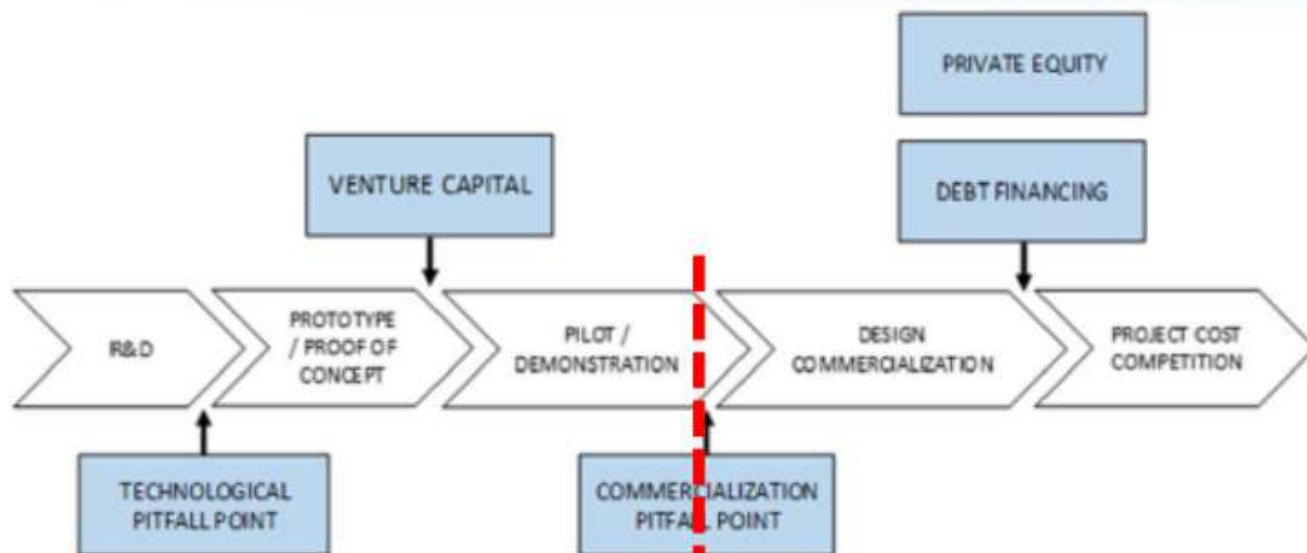
Data for 2017: Global Carbon Project, UN Population, and World Bank.

OurWorldinData.org – Research and data to make progress against the world's largest problems.

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BRIN's Role NPP Development & Implementation Strategy:

Technology Roadmaps for SMR Deployment



Strategy #2:
Joint Development
and Implementation
of NPP/SMR
Technology

Strategy #1:
Directly
Implementing Int.
NPP Technology

IAEA Nuclear Energy Series NR-T-1.18:
Technology Roadmap for SMR Deployment

BRIN's Role:
Technology Co-developer

BRIN's Role:
Technical Supporting Organization



KEMENTERIAN
ESDM

DIREKTORAT JENDERAL ENERGI BARU,
TERBARUKAN, DAN KONSERVASI ENERGI

NATIONAL GENERAL ELECTRICITY PLAN

(MINISTERIAL DECREE NO. 85.K/TL.01/MEM.L/2025)

Total **electricity demand** projected for 2060 is **1,813 TWh**, with estimated **per capita electricity consumption** of **5,038 kWh**.

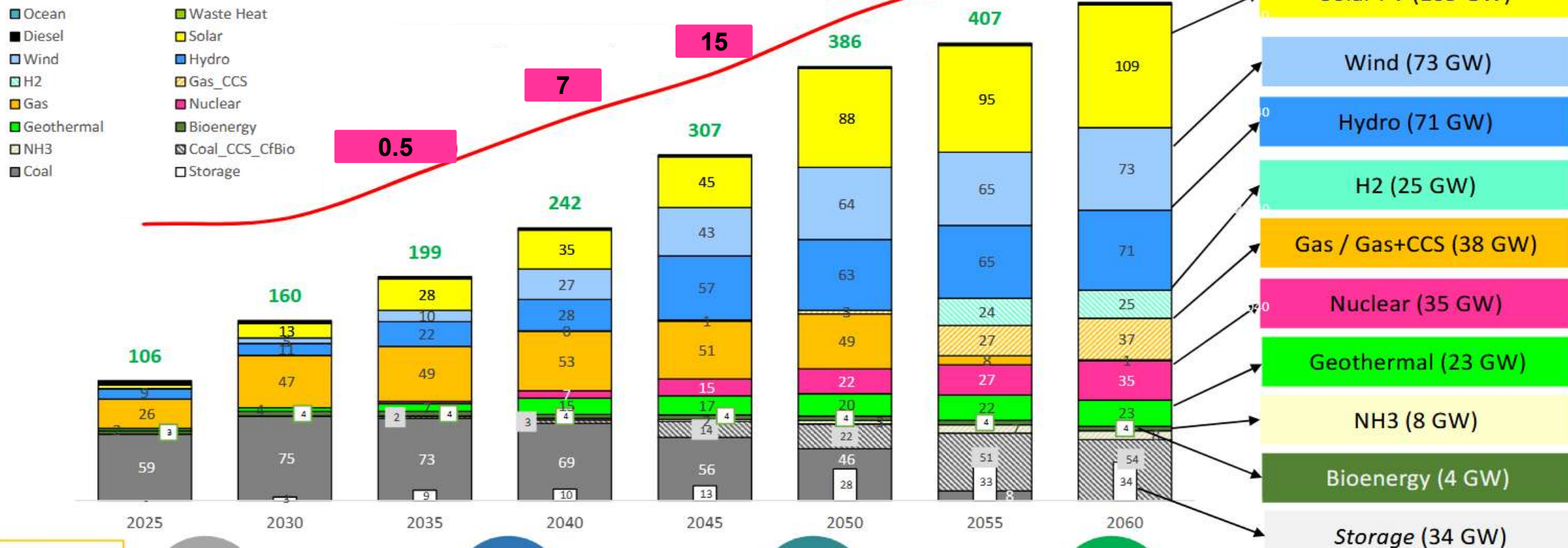
Net Capable Power (DMN) in 2060 is 443 GW consisting of:

- 42% of VRE is equipped with 34 GW of storage, and
- 58% Non VRE (dispatchable)

Supported by **SUPER GRID** to increase NRE penetration

Installed Capacity (GW)

Nuclear Energy Target [GW]



NRE Target
(Gov. Regulation
No. 40/2025)

19-23%

36-40%

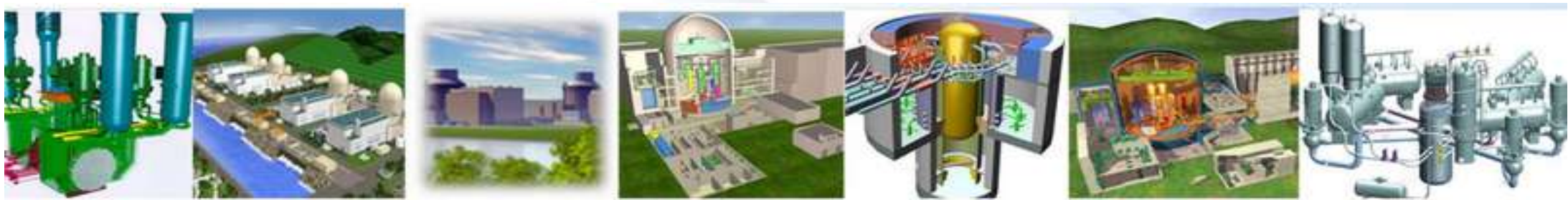
53-55%

70-72%

Nuclear Energy Options

As part of National Team, **BRIN**, will perform an
NPP Technology Study and Selection

1. Large Advance NPP [~1GWe]



NPP's Name | Power Level in MWe

China	
HPR1000	1000
CAP1400	1400

Constructed at
Pakistan,
China

France	
EPR	1600
ATMEA1	1100

Constructed at Finland, China,
UK, France

Japan	
ABWR	1350
ATMEA1	1100
APWR	1700

Constructed at Japan.

Republic of Korea	
APR1400	1400
OPR1000	1000

Constructed at
UEA, ROK

Russian Federation	
VVER-1000	1000
VVER-1200	1200
VVER-TOI	1500

Constructed at Türkiye, Belarus, Egypt,
Bangladesh, China, Russia.

United States of America	
ABWR	1350
AP1000	1100
ESBWR	1500

Constructed at China, US.

2. Small Modular Reactor [10MWe < SMR < 300MWe]



Initial Nuclear Energy Utilization Target

In particular: 500MWe in 2032

Technology Push from SMR's vendors

Power level spectrum: < 300MWe

Land or marine based

Cogeneration Potential

Indonesia Energy Demand

Economic Development and Net Zero Emission

'Huge yet distributed' demand

Dependent on diesel for many remote area

Processing abundant natural resources

Match-making



How to assess those Potential SMR for 2030 -2034 ?

10 RTA Key Elements



KE1: Site and environment

KE2: Fuel cycle

KE3: Nuclear safety

KE4: Nuclear island design and performance

KE5: Balance of plant (BOP) design and grid integration

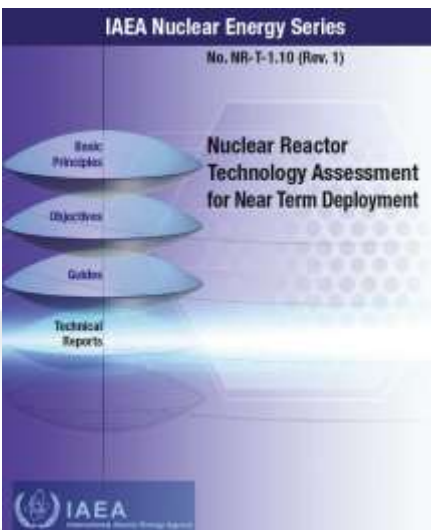
KE6: Balance of plant (BOP) design for other than electricity production

KE7: Safeguards and protection

KE8: Technology readiness

KE9: Project delivery

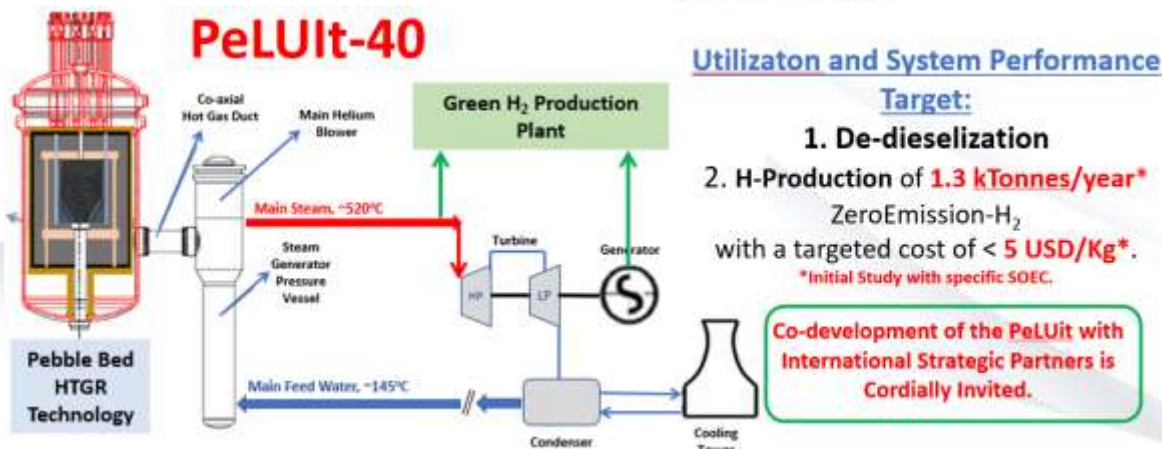
KE10: Economics and financing



3. Micro Reactor [$\leq 10\text{MWe}$]

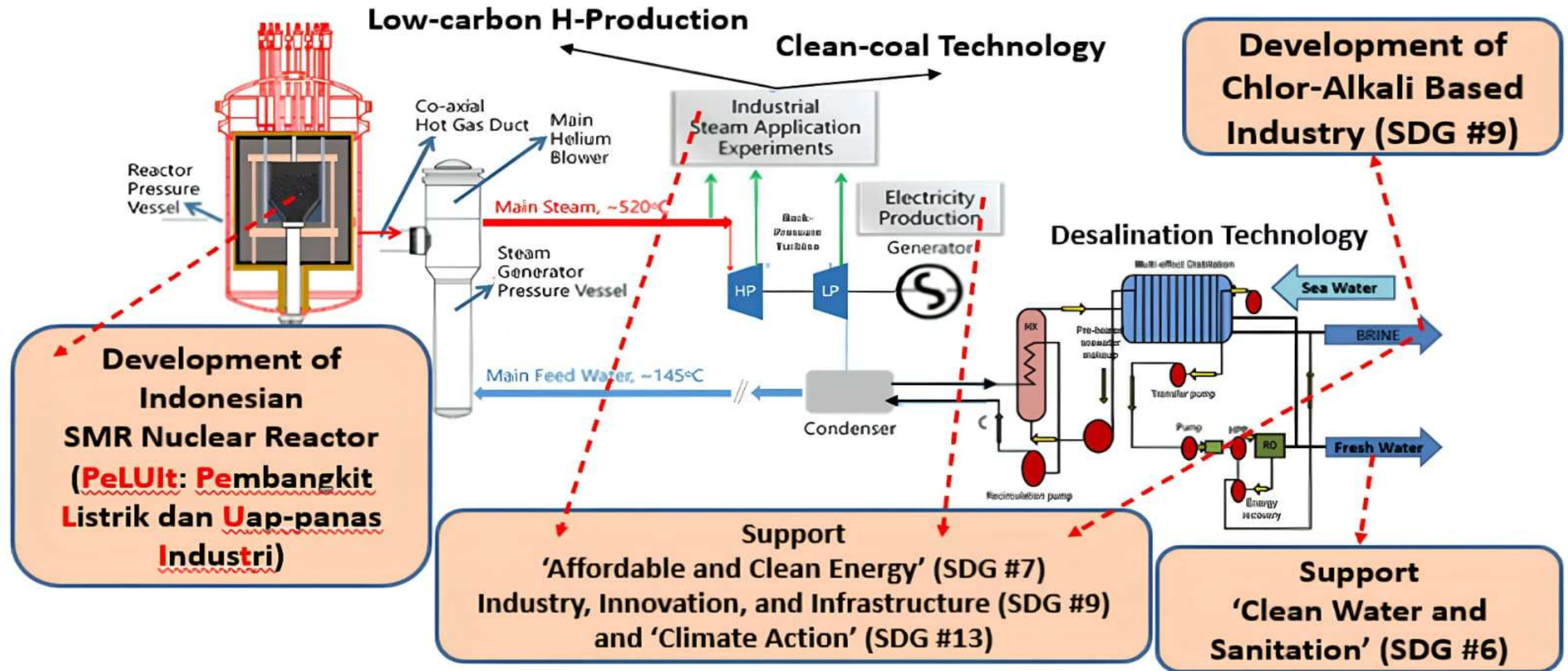


- Several countries are developing Microreactors technology for potential deployment by 2030;
- Typically to generate from 1 to 10 MWe; designed for enhanced transportability to site by modularity;
- To supply power at remote sites with mining operations, island communities, oil platforms and maritime shipping.
- Deployment opportunities in remote areas in the South-East Asian archipelagos, in North America, Middle East, and Africa.



- **Indonesian Team (BRIN, ITB, PLN-NP) currently developing a <10MWe Cogeneration Reactor based on HTGR for de-dieselization and low-carbon hydrogen production. Collaboration is cordially invited!**

PeLUit-40 and Non-Electric Utilization



RDE and PeLUit [2013 – now] He-cooled Technology based on Rankine Cycle:

Optimizing hydrogen production through SOEC-PeLUit-40 coupling: a sustainable approach to clean energy generation[☆]

Parameter	Value
Reactor core	30 MWth
Diameter of active core	180 cm
Height of active core	197 cm
Thickness of side reflector	100 cm
Thickness of top reflector	130 cm
Void thickness	40 cm
Thickness of bottom reflector	243 cm
Uranium enrichment	17%
Beginning uranium loading	5 g/pebble
Number of fuel recirculation	5 passes
Pebble balls diameter	6 cm
Diameter of fuel kernel	500 μ m
Density of fuel kernel	10.4 g/cm ³
TRISO layers	Buffer/I-PyC/SiC/O-PyC
Thickness	90/40/35/40 μ m
Density	1.05/1.9/3.18/1.9 g/cm ³
Graphite reflector density	1.75 g/cm ³

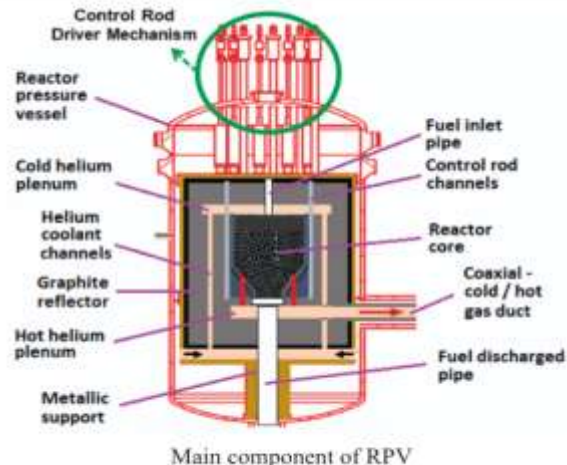


Fig. 2. The design parameters and main components of PeLUit-40 within the Reactor Pressure Vessel (RPV) (Trianti et al., 2023).

Coupling of PeLUit-40 and Commercially available SOEC Technology can provide a **204 kg/h low carbon hydrogen** and remaining **1.26 MWe** for external utilization.

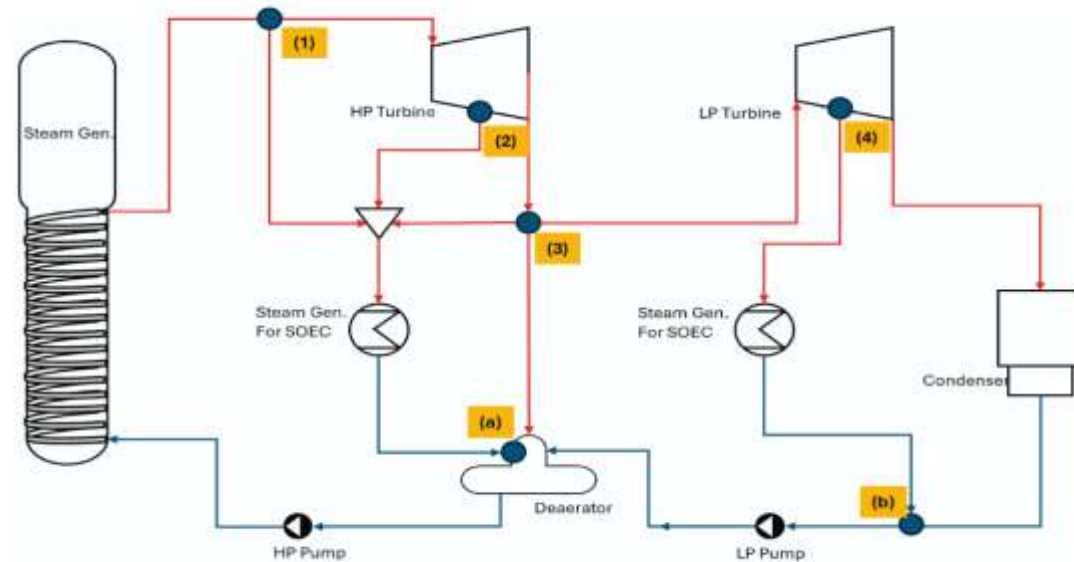


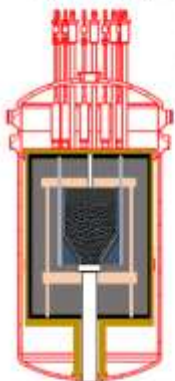
Fig. 6. Location of steam extraction and condensate return points in the PeLUit-40 scheme.

Table 4

Maximum hydrogen production from the SOEC-PeLUit-40 technology.

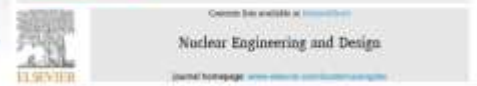
Number. of system	Feed Steam to SOEC	Hydrogen Production	Total Electric Power Req.	PeLUit-40 Net Power after steam extraction	PeLUit-40 Net Power Output after cogeneration
(a)	(kg/s)	(kg/h)	(MWe)	(MWe)	(MWe)
1	0.23	68	2.64	9.38	6.74
2	0.45	136	5.28	9.28	4.00
3	0.68	204	7.92	9.17	1.26
4	0.91	272	10.56	9.07	-1.49

Initial Plan
RDE 10MWt



PeLUit-40

- Keep the core geometry
- Optimize the power level



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

Neel Triandri¹, Nisa Wilkawan², Cici Wulandari³, Faria Miftah⁴, Aida Rahmawati⁵, Arifin Kholidi⁶, Teguh Setiadi⁷

PeLUit-10

- Keep the power level,
- optimize geometri (smaller)
- Possible use of heat-pipe as primary heat-transfer



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

Faria Miftah¹, A. Azzahra Pertiwi Dwijayanti², Gladisa Almar³, Nisa Wilkawan⁴, Neel Triandri⁵, Teguh Setiadi⁶, Irfan Irfan⁷, Cici Wulandari⁸, Zaki Saad⁹

A New Journey, potential collaboration?

A Portable **PeLUit**

- Use existing power conversion system (**Air-Brayton Cycle Gas Turbine**)
- A simple **static pebble bed core (N-cooled?)**
- Minimum operation **3years**
- Power **8MWt**

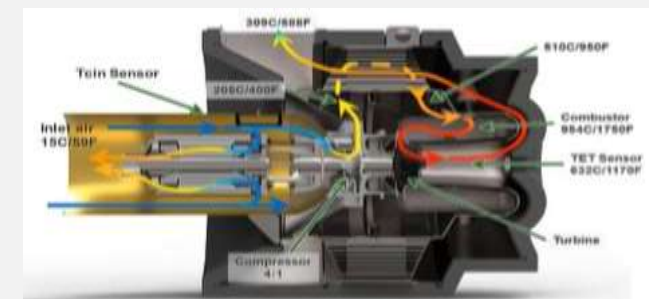
Current potential

For H-production, which electrolizer is the best to be coupled to this cogeneration portable micro-reactor ?

Static Pebble Bed Core act as Heat Provide for a Brayton Cycle in particular for the 'adiabatic heat addition phase' :



+



Commercial Existing Gas Turbine

Output:

- Electricity from Gas Turbine: **1.9MWe**
- Hot-gas: **359°C | 1 bar | 16.7 Kg/s**

Main Target:
Demo of safety features of NPP
Bases of future commercialization

Bloomenergy

SPECIFICATIONS*

Efficiency	
System	37.5 kWh/kg ¹
Warm Start-up Time	
	~10 minutes
Electrical Input	
Voltage	600VDC
Current	1500A
H₂ Input (For Start-up)	
Purity	99.9%

1.2MW BLOOM ELECTROLYZER
770kg/day



H₂ Output	
Pressure	25 mbar(g)
Temperature	100-180°C
Composition	85% H ₂ -15% H ₂ O mol
Steam Input	
Pressure	4.5-5.5 bar(g)
Temperature	150-200°C
Flow rate	10.5L of H ₂ O/kg of H ₂
Ambient Temperature	
	-20 to +45 °C

MODULAR BLOOM ELECTROLYZER KEY DATA

Power (MW)	Hydrogen Output			
	kg/hr	mt/day	mt/year	Nm ³ /hr
1.2 ¹	32	0.77	280	356
2.4	64	1.5	560	712
50	1,344	32	11,772	14,957
1000 ²	26,885	640	233,759	297,002

Resume:

- Nuclear Energy can solved the challenge of high economic development while keep the Carbon Emission Low!
- A specific target for a 500MW NPP at the latest 2032 is already declared! Let's get it ON! It is possible !
- Low carbon hydrogen from Nuclear Energy can play as an important role to add the urgency of introducing nuclear energy.
- A 30MWt PeLUt-40 design is being developed as a cogeneration nuclear reactor. It can be couple to SOEC Tech. to have 204 kg/h H production.
- A small, safe, static-pebble design with Brayton Cycle as the power conversion system is being developed to have a micro-reactor which is portable and have a cogeneration feature.

**Thank You,
Let's Collaborate,
make nuclear energy happen in
South East Asia!**



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