# Small Modular Reactor (SMR) Deployment: Challenges and Opportunities for Thailand


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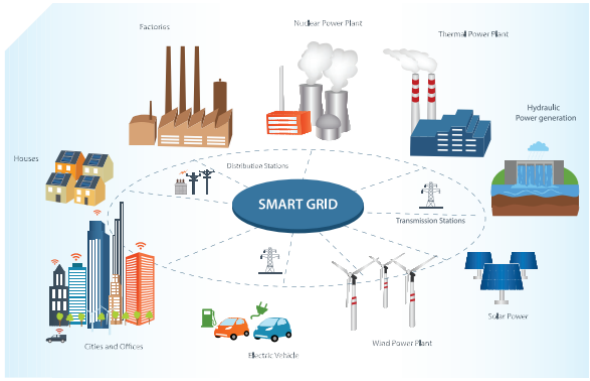


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# Thailand Power Development Plan

- Ministry of Energy (Thailand) developed 5 integration master plans as follows:
  - Thailand Power Development Plan: **PDP,**
  - Energy Efficiency Development Plan: **EEDP,**
  - Alternative Energy Development Plan: **AEDP,**
  - Natural Gas Supply Plan,
  - Petroleum Management Plan

- The new PDP called “Thailand Power Development Plan 2018-2036 (PDP2018)” focuses on
  - ***Energy Security***: increasing power demand to correspond to National Economic and Social Development Plan with fuel diversification
  - ***Economy***: maintaining an appropriate cost of power generation for long-term economic competitiveness
  - ***Ecology***: lessening carbon dioxide intensity of power generation

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# Energy Assessments

- Review of the current situation in Thailand
- Assessment of future needs for energy demand and supply
- Assessment of available energy resources
- Evaluation of technological options  use to generate electricity
- Development of alternative scenarios
- Assessment of economic, financial and environmental implementation
- Plans and strategies
- PDP 2023 will be submitted to the Minister of Energy (MOE) for consideration first, then will open for *public hearing in June 2023*

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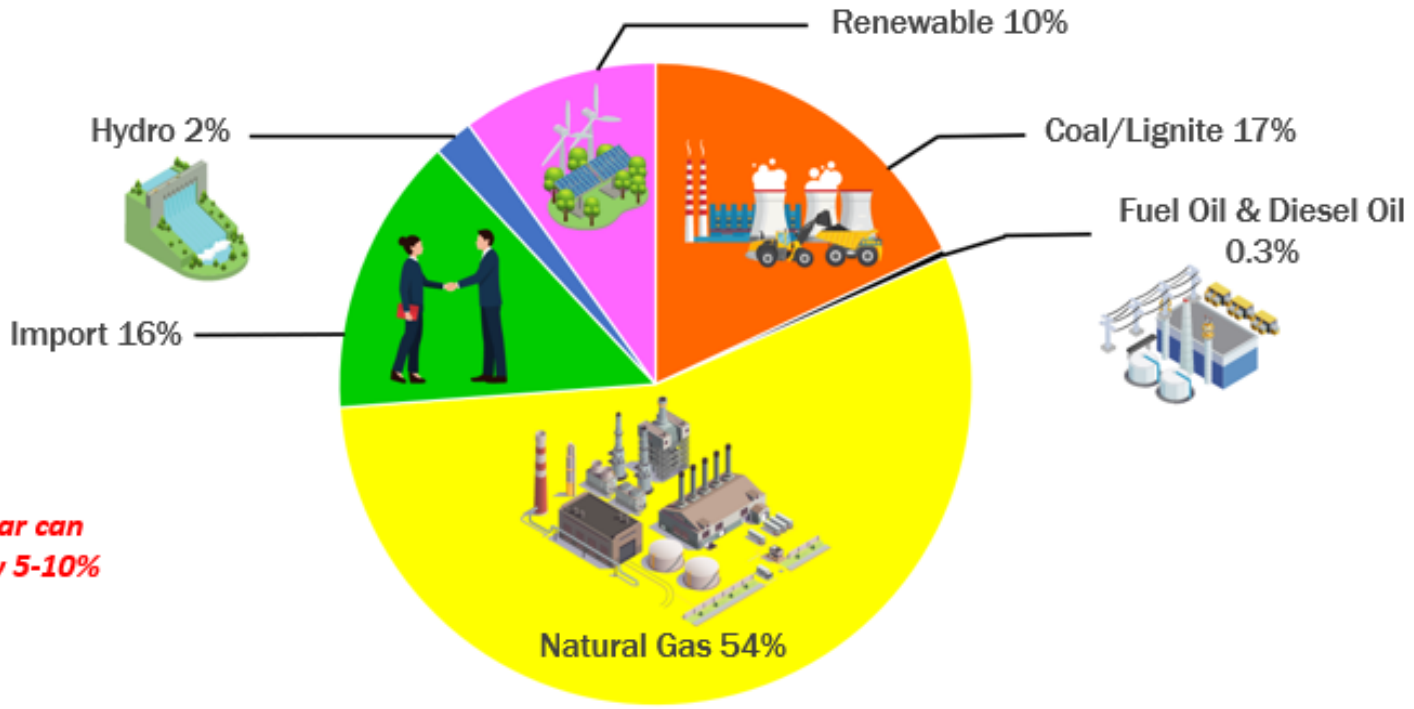
# Electricity Generating

## Electricity Generating Proportion in Thailand (2021)




***Nuclear can employ 5-10%***

Source: Energy Policy and Planning Office (Energy Statistic 2022)

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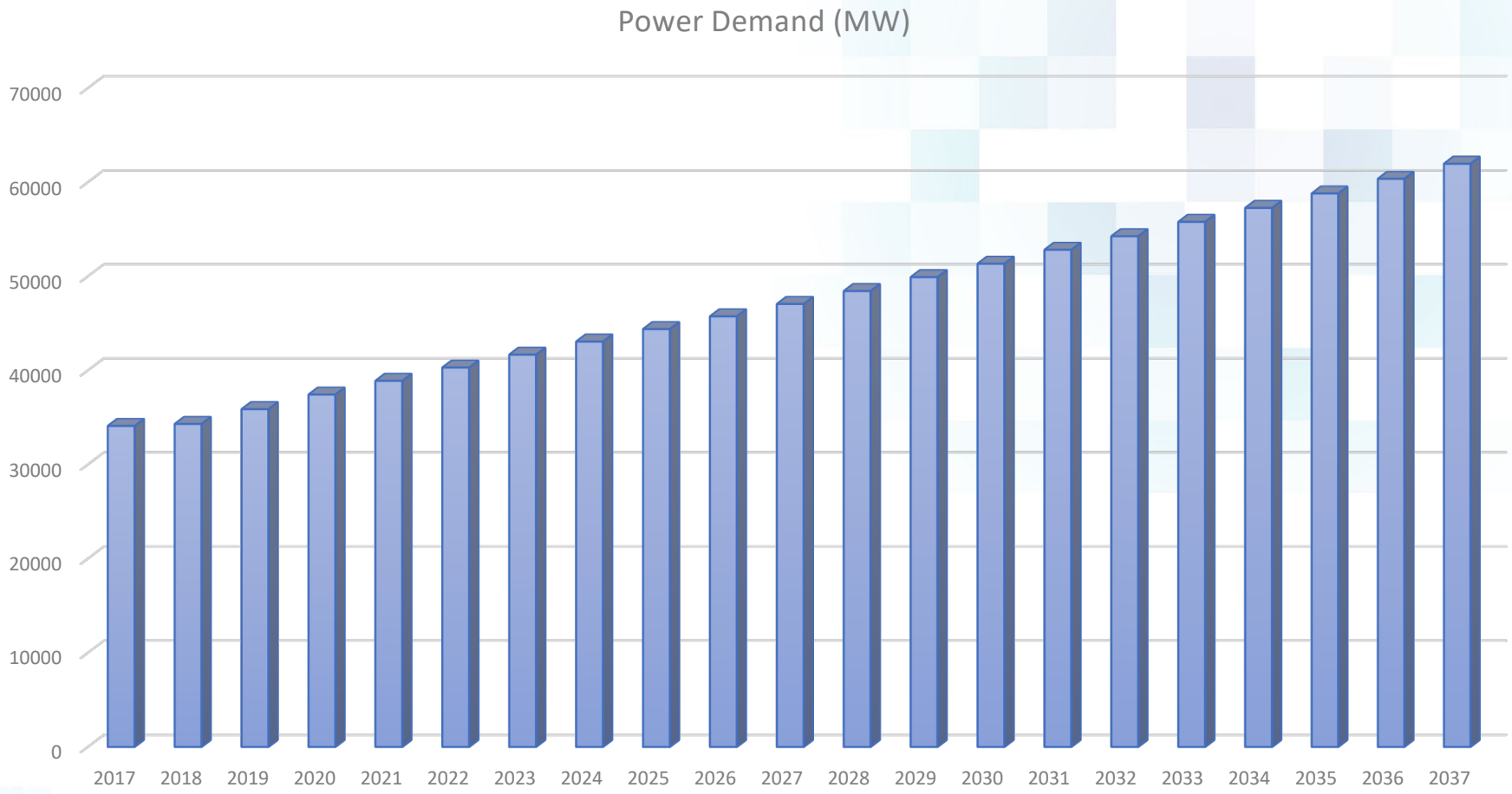
# Peak Power Demand Forecast 2017-2037




**Ref: PDP 2018 Rev03**

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# Nuclear Power Program in Thailand

| Year | # Units | Capacity (MWe) | Operation year | Note |
|---|---|---|---|---|
| **PDP 2007** | 4 | 1,000 – 1,350 | 2020, 2021 | |
| **PDP 2007 Rev. 2** | 3 | 1,000 | 2020 | |
| **PDP 2010** | 5 | 1,000 | 2010, 2012, 2024, 2025, 2028 | |
| **PDP 2010 Rev. 2** | 4 | 1,000 | 2023, 2024, 2027, 2028 | Revised after the Fukushima accident in March, 2011 |
| **PDP 2010 Rev. 3** | 2 | 1,000 | 2026, 2027 | |
| **PDP 2015** | 2 | 1,000 | 2035, 2036 | |
| **PDP 2018** | - | - | | |
| **PDP 2022 (revising)** | **➔ Ministry of Energy is considering Small Modular Reactor (SMR) to integrate into SMART grid.** | | | |

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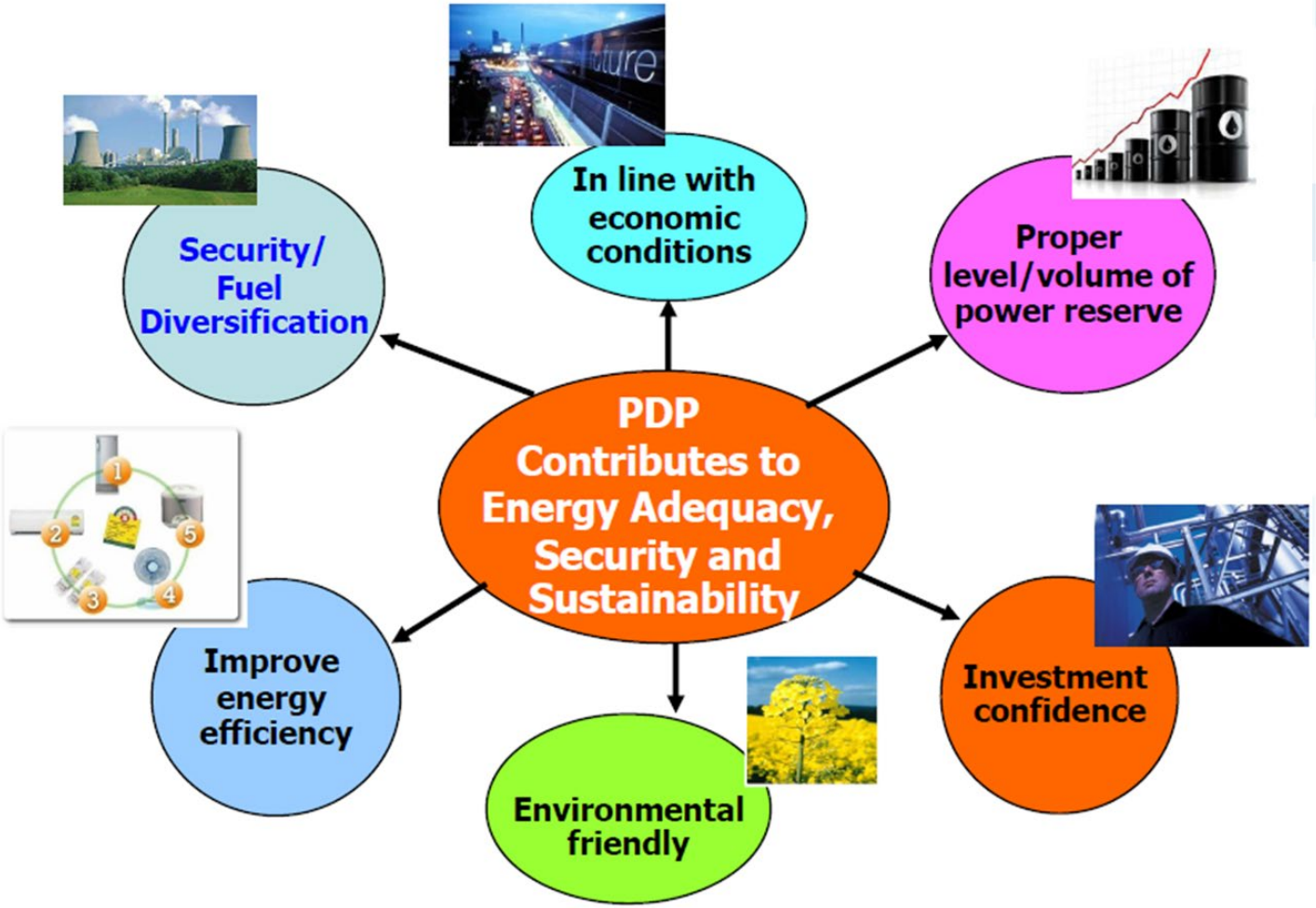
# Power Development Plan

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# Key Criteria and Requirements for SMRs in Thailand

- SMRs are varied designs address load requirements ranging from ***tens of megawatts to hundreds of mega watts***
- The ***standardized designs*** with economies scale and ***unique safety features*** required approval from regulators (Office of Atoms for Peace) for licensing
- Significant capital investment cost associated with a large nuclear power plants, therefore, Thailand interested in smaller nuclear power plants with ***lower capital investment and small grid systems***
- SMRs provides an option for ***carbon-free energy*** (smaller footprints) with ***small siting*** compared to old coal-fired power plants

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# Key Criteria and Requirements for SMRs

- ***Modularity*** factory fabrication of modules for a simple assembly on site and reactor units as modules that can be matched demand
- SMRs are ***safe, clean, affordable energy option***
- SMRs provide several benefits with ***safeguards, security, and nonproliferation*** requirements
- SMRs offer ***reducing in protection zone area*** for emergency planning requirements
- SMRs offer the challenge of building ***higher capacity grids*** in ***remote or rural areas*** which can be constructed closer to the point of electricity needed
- SMRs can be ***alternative method*** which applied to replace other carbon-emitting energy generation methods

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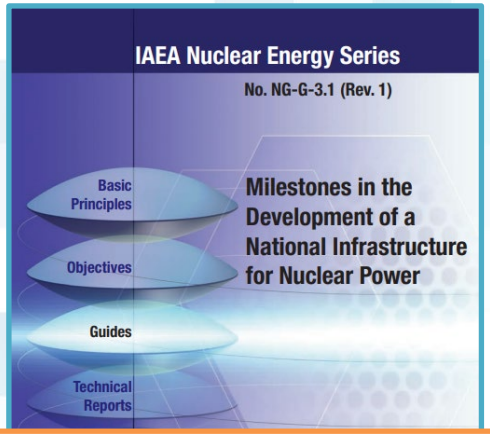
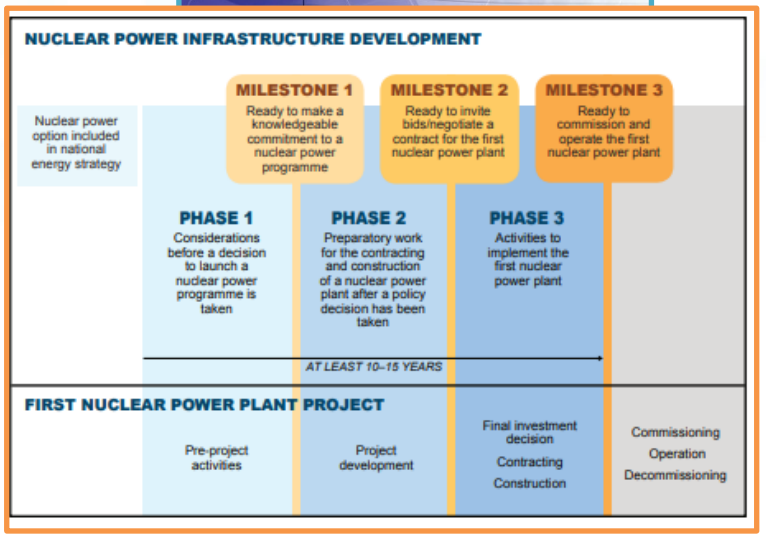
# IAEA Milestones Document

- Milestones in the Development of a National Infrastructure For Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1) 2007
- The Milestones Approach includes 19 nuclear infrastructure issues, requiring specific actions during each of the three phases that must be accomplished before embark on a nuclear power program
- The IAEA periodically reviews the status of development through INIR missions (13-18 Dec 2010)

Thailand can make a knowledgeable decision on the introduction of nuclear power




Development of the infrastructure for a national nuclear power program Ref: IAEA No. NG-G-3.1, 2007

REPORT

on

THE INTEGRATED NUCLEAR INFRASTRUCTURE REVIEW

(INIR) MISSION

to

Review the Status of the National Nuclear Infrastructure

in Thailand

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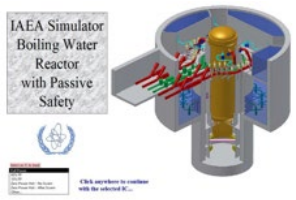
# Nuclear Workforce

- To implement a SMR program, it is important to have a ***well-prepared basic requirement with competent workforce***
- Thailand builds on a strong base of workforce development for nuclear energy
  - Thailand Research Reactor-1 (TRR-1/M1), Thailand Institute of Nuclear Technology (TINT) which operating since 1977
  - Irradiation services, isotope production, nuclear research, education and training, and public tours
  - *All vital to the evolution of nuclear technology in Thailand*
- For Thailand workforce development is often identified as the ***highest priority***
- Thailand plan to have ***national capabilities*** to supply nuclear workforce with ***international resources***

- Doctor of Philosophy (Ph.D.) in Nuclear Engineering
- Master of Engineering (M.Eng.) in Nuclear Engineering
- Master of Science (M.Sc.) in Nuclear Technology
- Bachelor of Nuclear Engineering (B. Eng.) – Start 2016





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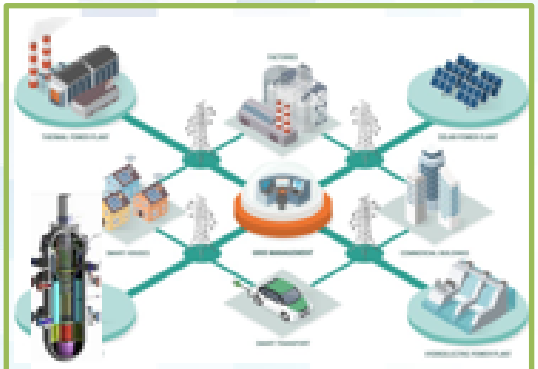
# Integration of Renewable Energy Sources with SMRs

- ***Climate change*** combined with the ***price volatility of energy*** and the intermittency of renewable resources
- ***Flexible baseload supply*** has the potential to produce positive synergism among these clean energy options
- Enhancing the ***diversity of technology and fuel sources***
- SMRs can play a stabilizing role in a grid with a large share of renewable sources and contribute to ***reducing the cost*** of a low carbon energy supply
- The synergies between SMRs and renewable energy could be a ***solution to an energy challenge***
- The ***hybrid system*** is a new approach to an energy system which could lead to better utilization of resources.

**Hybrid system**



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https://www.researchgate.net/publication/339189651

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# Criteria Before Roadmap for Operating Organization (EGAT)

| National level nuclear infrastructure has been established | Owner/operating organization (EGAT) | Selected SMRs Technology |
|---|---|---|
| 1. NEPIO and Regulatory body (OAP)<br>2. OAP need to revise the *Nuclear Energy for Peace Act and Ministerial Regulation* to have processes for reviewing and accepting SMR reactor licensing documentations | 1. Qualified technical staff (experience in planning and managing complex projects),<br>2. Reactor engineering and safety,<br>3. Power plant operations,<br>4. Health physics,<br>5. Quality assurance,<br>6. Procurement | 1. Based on proven SMR technologies,<br>2. Sufficiently component supplier base,<br>3. Prefer SMR operational data from a reference plant |

EGAT
Power for Thai Happiness

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# Criteria Before Roadmap for the Regulatory Body (OAP)

- Establish regulatory framework through Ministerial Regulations, national requirements and guidance.
- Consulting with key stakeholders.

- Regulators help an applicant (EGAT) to understand the requirements and acceptable ways to meet them.
- Provide a framework by which an applicant can conduct a safety demonstration.

Nuclear Energy Programme Implementing Organisation NEPIO

- Regulators facilitate the safe conduct of licensed activities by ensuring that the licensee (EGAT) carries out activities in compliance with the license.

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# Public Acceptance and Stakeholder Engagement

- ***Consideration of SMRs***: Licensing, siting, construction and operation
- ***Gaining public understanding and acceptance*** is challenging for considering of SMRs in Thailand
- Creating awareness of ***benefits and risks of SMRs*** to the local community and public
- ***Listening*** to stakeholders and local community to get support from them and ***building relationship***
- Start to ***engaging with stakeholders and openly discuss problems and difficulties*** encountered and the plans to successfully resolve them
- Continue to ***develop strategy and process*** through SMRs lifecycle

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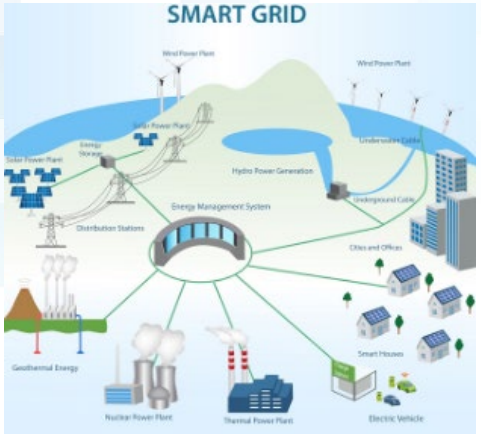
# Challenges for Considering SMRs in Thailand

- National position and national policy
  - Political instability, difficult to finance
  - Government commitment ➡ Focusing on RE + Hybrid technologies
- Public acceptance and stakeholder engagement
  - Promoting and participating of the local community
- Laws and regulation for SMRs
  - Nuclear Energy for Peace Act (updated on 2019)
  - Amendment for SMRs (licensing, security and transport)
  - Long times to license new technology
- Research on SMRs technology
  - Energy markets are rapidly change and flexible systems are attractive

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# Summary and Conclusion

- Thailand developed *infrastructure necessary* to carry out a nuclear power program including SMRs, and IAEA provided *INIR mission* to review in December 2010.
- New SMRs technology can be used to *inform policy decisions, government and industry* in terms of financial guarantees and incentives, and human resource development.
- For the SMRs project planning, *EGAT, OAP, TINT and academic institutes* were established necessary requirements and overall structures, identified by the IAEA's Milestones approach.
- Regulatory bodies (OAP), should *establish regulatory framework,* requirements and guidance that can be applied broadly, regardless of SMRs technology types being considered.
- SMRs technologies can be used for *co-generation applications* and considered as an *attractive option* to enhance energy supply security.
- *Climate change* combined with *high energy price* and the *intermittency of renewable* resources have provided an incentive to consider integrating SMRs with renewable energy sources.
- As *a hybrid with renewable energy sources*, SMRs as a flexible baseload supply which have the potential to lead positive synergism among these clean energy options.

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FIRST
FOUNDATIONAL INFRASTRUCTURE FOR RESPONSIBLE USE OF SMR TECHNOLOGY

KAERI
stands for
Korean Atomic Energy Research Institute

KONICOF

International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

JAEA


https://www.iaea.org/services/key-programmes/international-project-on-innovative-nuclear-reactors-and-fuel-cycles-inpro


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