Is Nuclear Energy Generation in Jamaica Safe?

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Director General
International Centre for Environmental and Nuclear Sciences

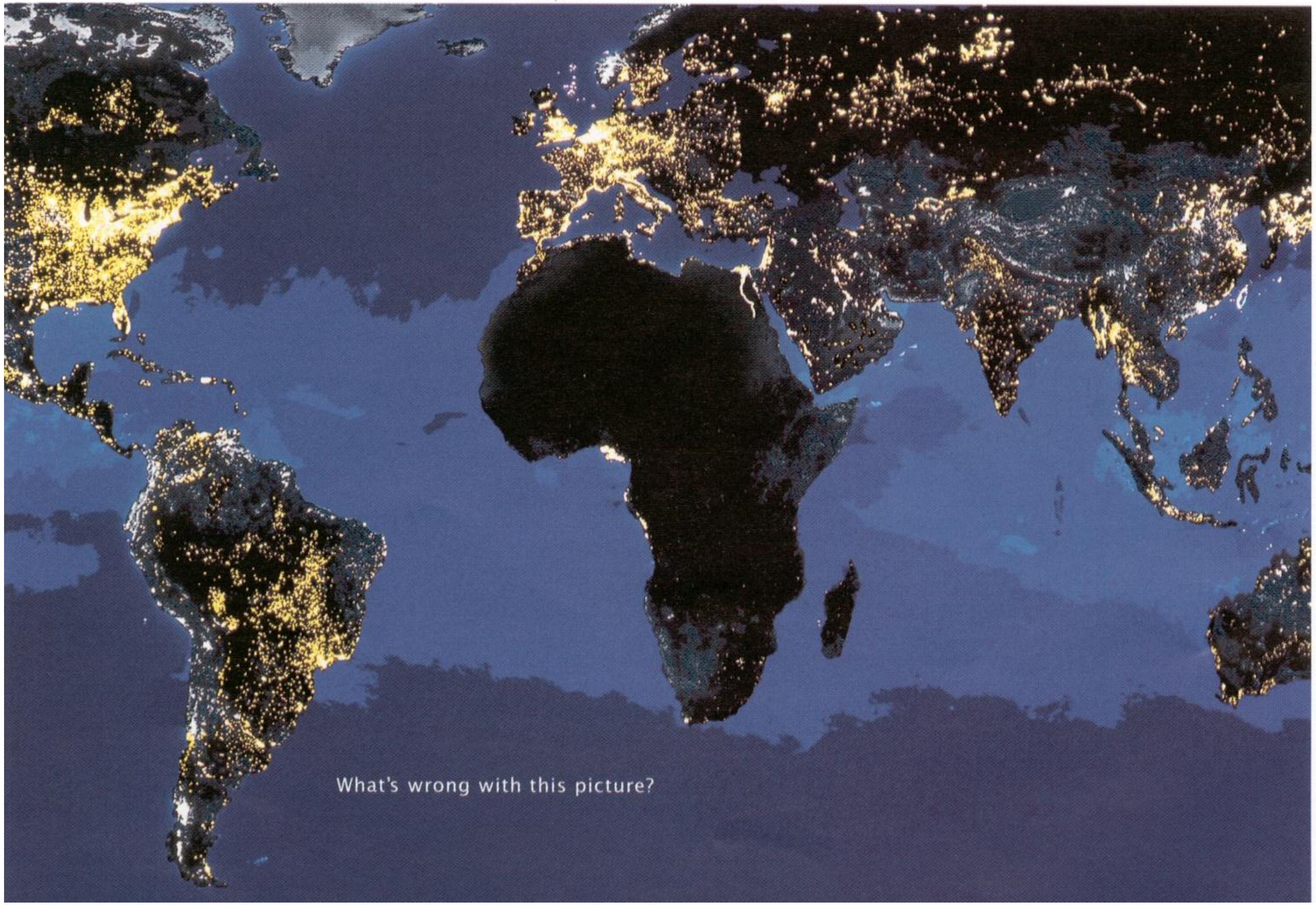
The Jamaica Institution of Engineers (JIE): "Engineering - Driver of Manufacturing, Production, Economic Growth and Health"

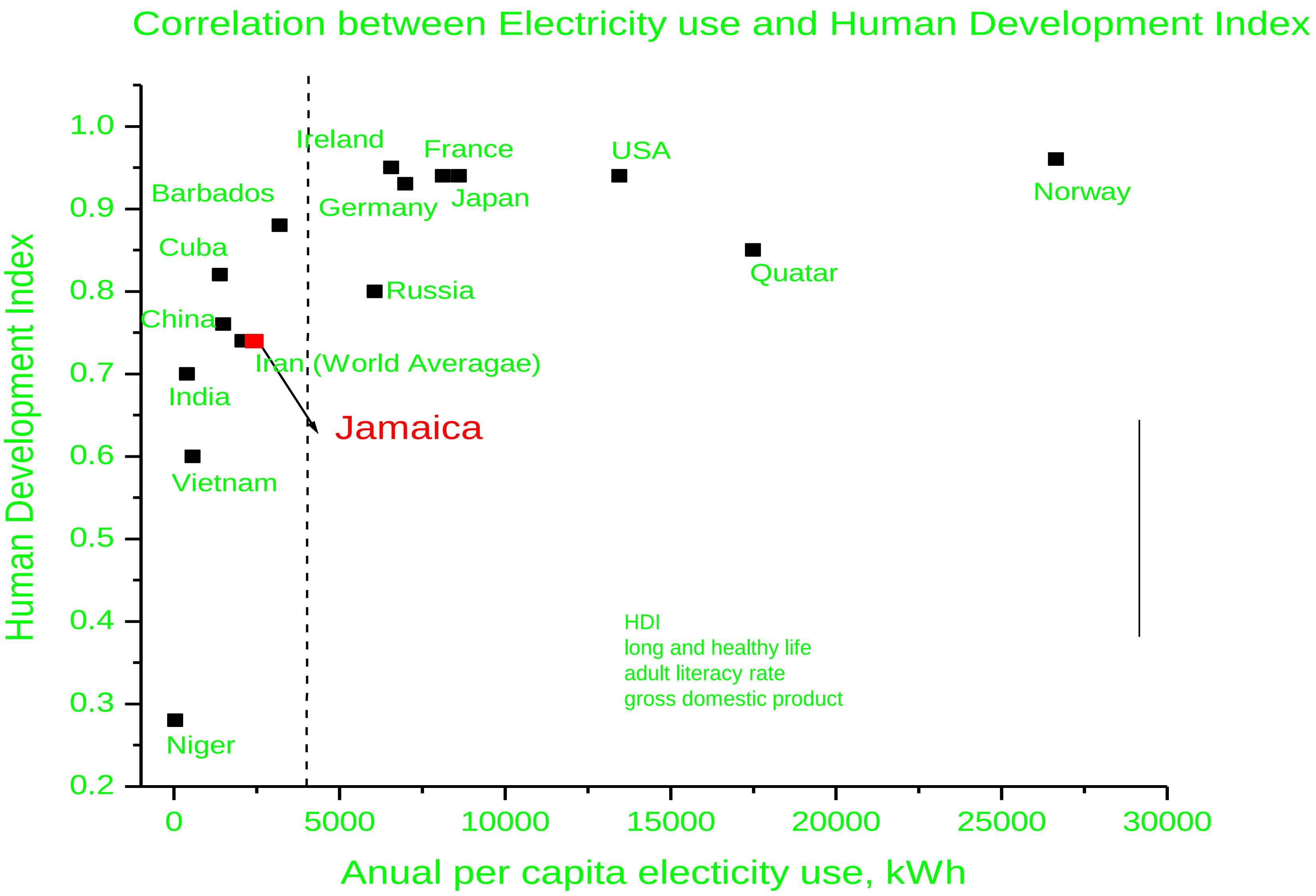
World Energy Needs

- The provision of energy has become one of the most critical:
  - Environmental
  - Political
  - Economic
  - Developmental and
  - Survival issues in the world.

- A developing country such as Jamaica is also dependent upon a future supply of secure, affordable, safe and clean energy.

Without access to Energy, the poorer nations of the world cannot develop



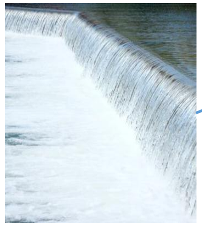

Correlation between Electricity use and Human Development Index
Human Development Index
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
5000
10000
15000
20000
25000
30000
Anual per capita electicity use, kWh
Ireland
France
USA
Norway
Barbados
Germany
Japan
Cuba
Russia
Quatar
China
Iran (World Averagae)
India
Jamaica
Vietnam
Niger
HDI
long and healthy life
adult literacy rate
gross domestic product

Situation in Jamaica today production and Consumption

40% (LNG) + 42% (Petroleum)

10%

5%



3%

Jamaica 2030 Energy production

50%

30% ?

10% ?

10% ?

Zero fossil fuels by 2050

Secure & Reliable

New source

Affordable

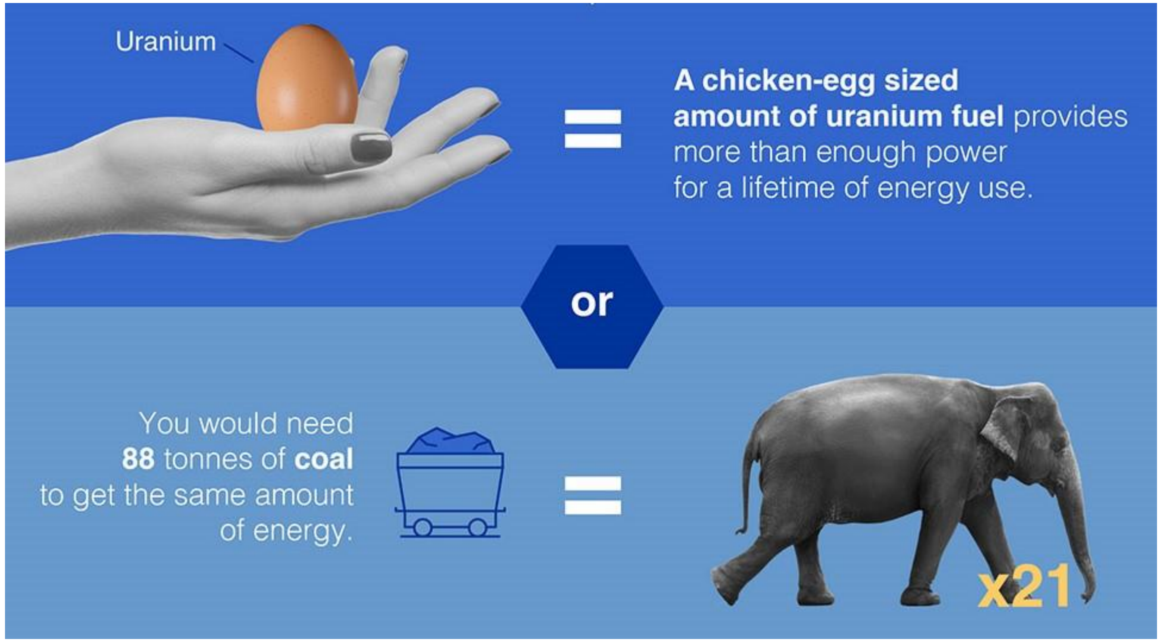
No Carbon

Secure & Reliable
Affordable
Carbon free

Established Technology

What if:

- renewable energy is not the least-cost energy source
- energy storage technologies are not sufficient to make use of variable renewable



700 MWe Coal-Fired	700 MWe Nuclear (PBMR)
Coal burned: 2 000 000 tons per year	1.5 tons uranium per year
Ash dumped: 600 000 tons per year	Spent fuel: 30 tons of pebbles per year
Air burned: 2 000 000 m^3 PER HOUR	Nil
CO_2: 6 000 000 tons per year	Nil
SO_2: 400 000 tons per year	Nil
NO_2: 100 000 tons per year	Nil
Smoke: 2 000 000 m^3 PER HOUR	Nil

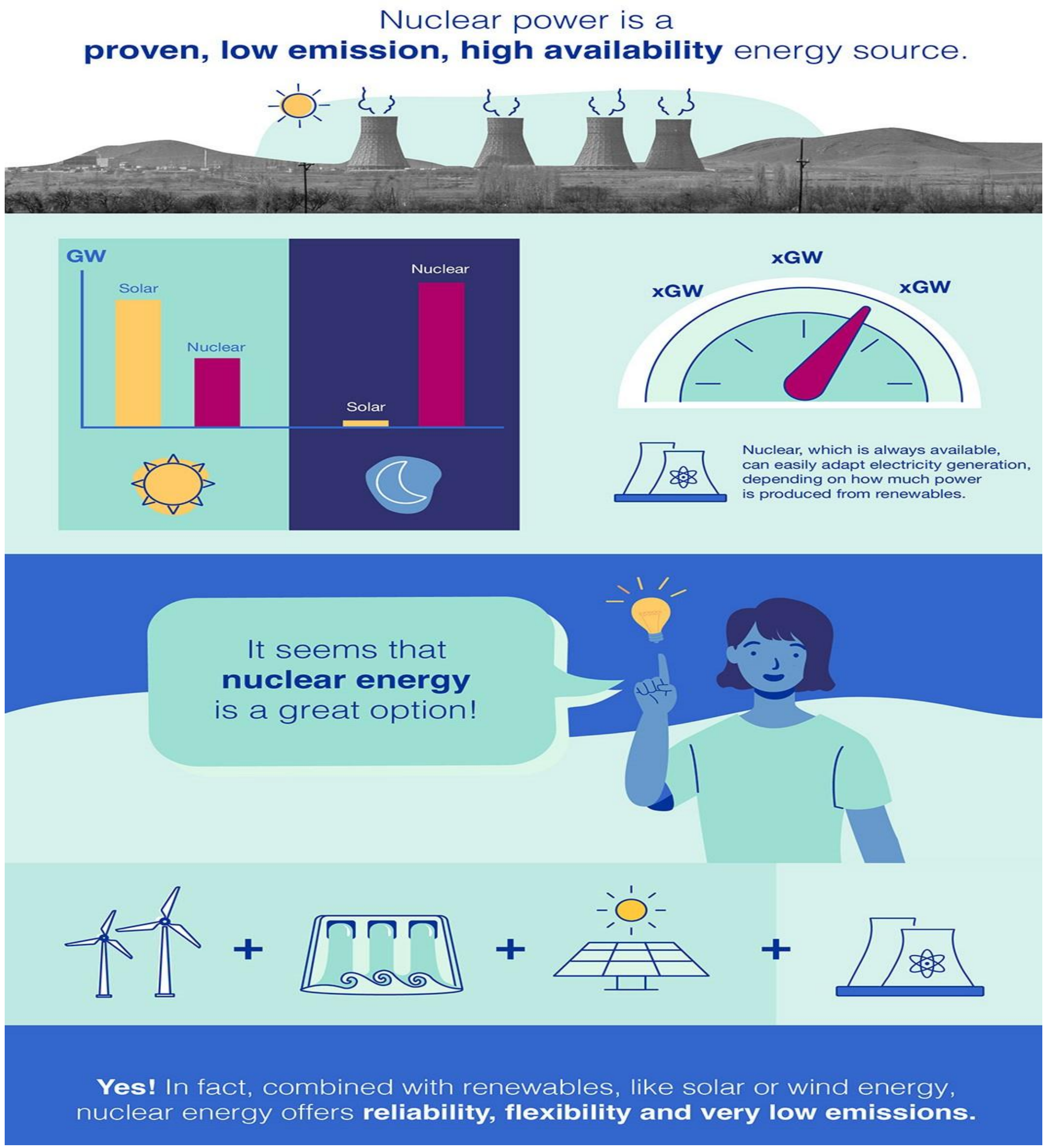
0.25 KM^2

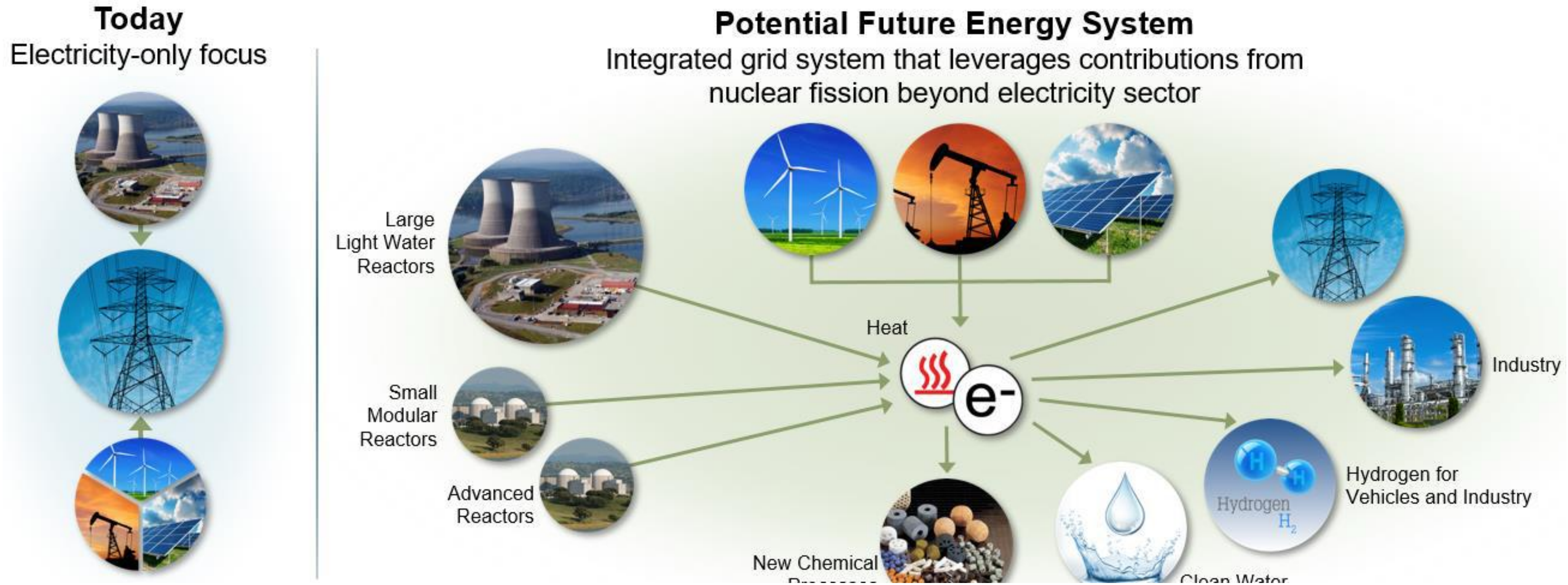
21 KM^2

40 KM^2

Hybrid Energy Systems

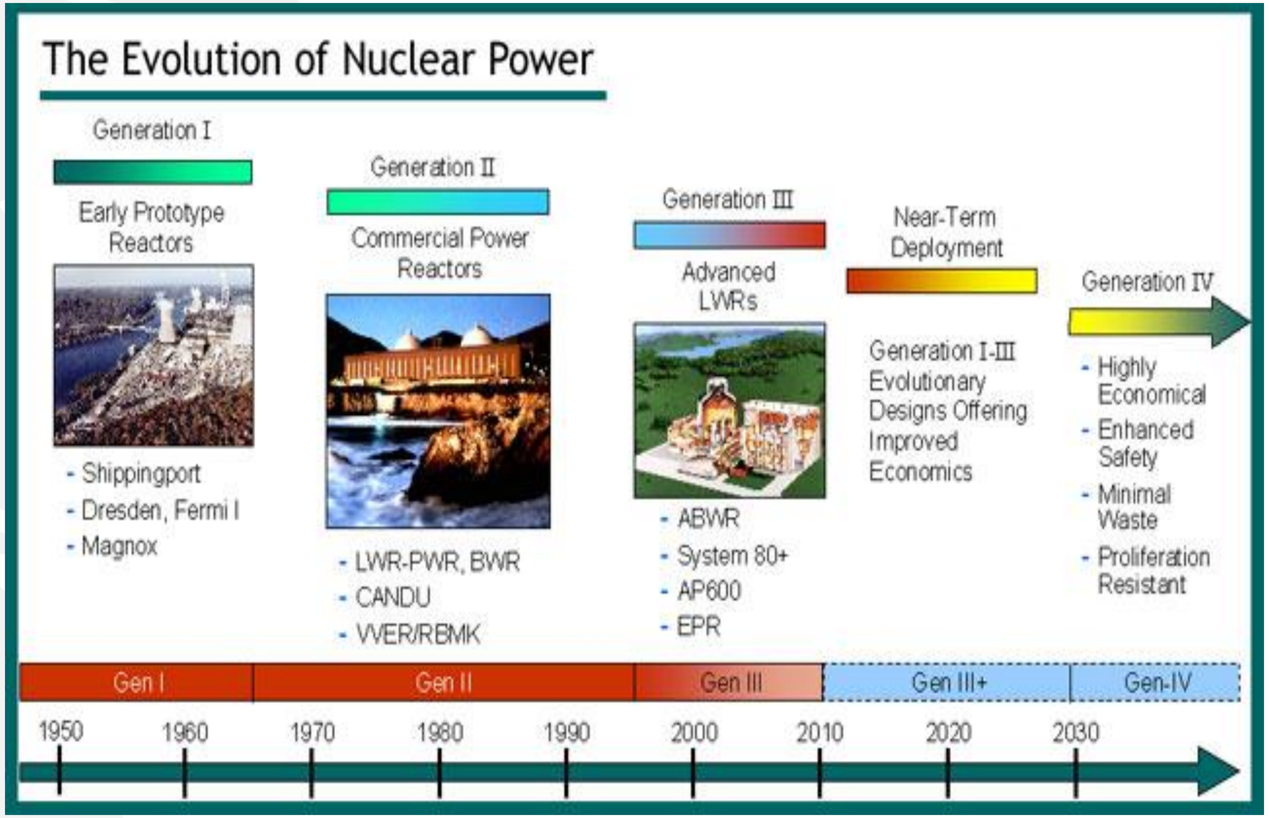
Hybrid energy systems simultaneously address the need for grid flexibility and greenhouse gas emission reduction, while optimizing financial resources. While nuclear power plants are dispatchable sources of energy – they can adjust output accordingly to electricity demand – some renewables, such as wind and solar, are variable energy sources that depend on the weather and time of day.




Today
Electricity-only focus
Potential Future Energy System
Integrated grid system that leverages contributions from nuclear fission beyond electricity sector
Large Light Water Reactors
Small Modular Reactors
Advanced Reactors
Heat
e-
Industry
Hydrogen for Vehicles and Industry
Hydrogen
New Chemical

Why Now?

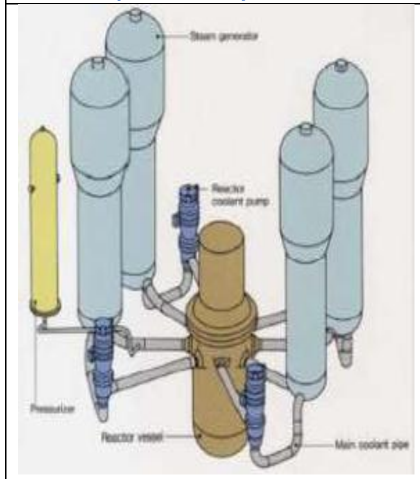
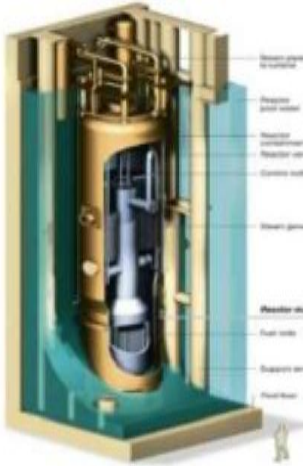
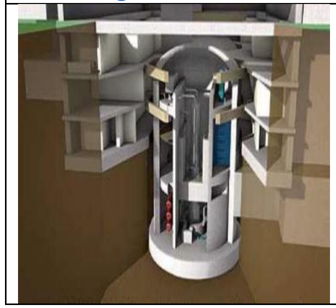
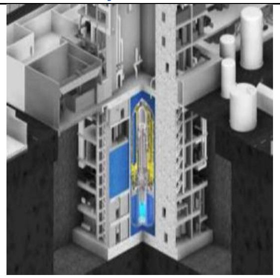
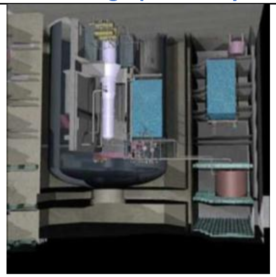
In the past the units were simply too big for our grid~ 1GWe



SMR's! Over 80 designs worldwide <300MWe

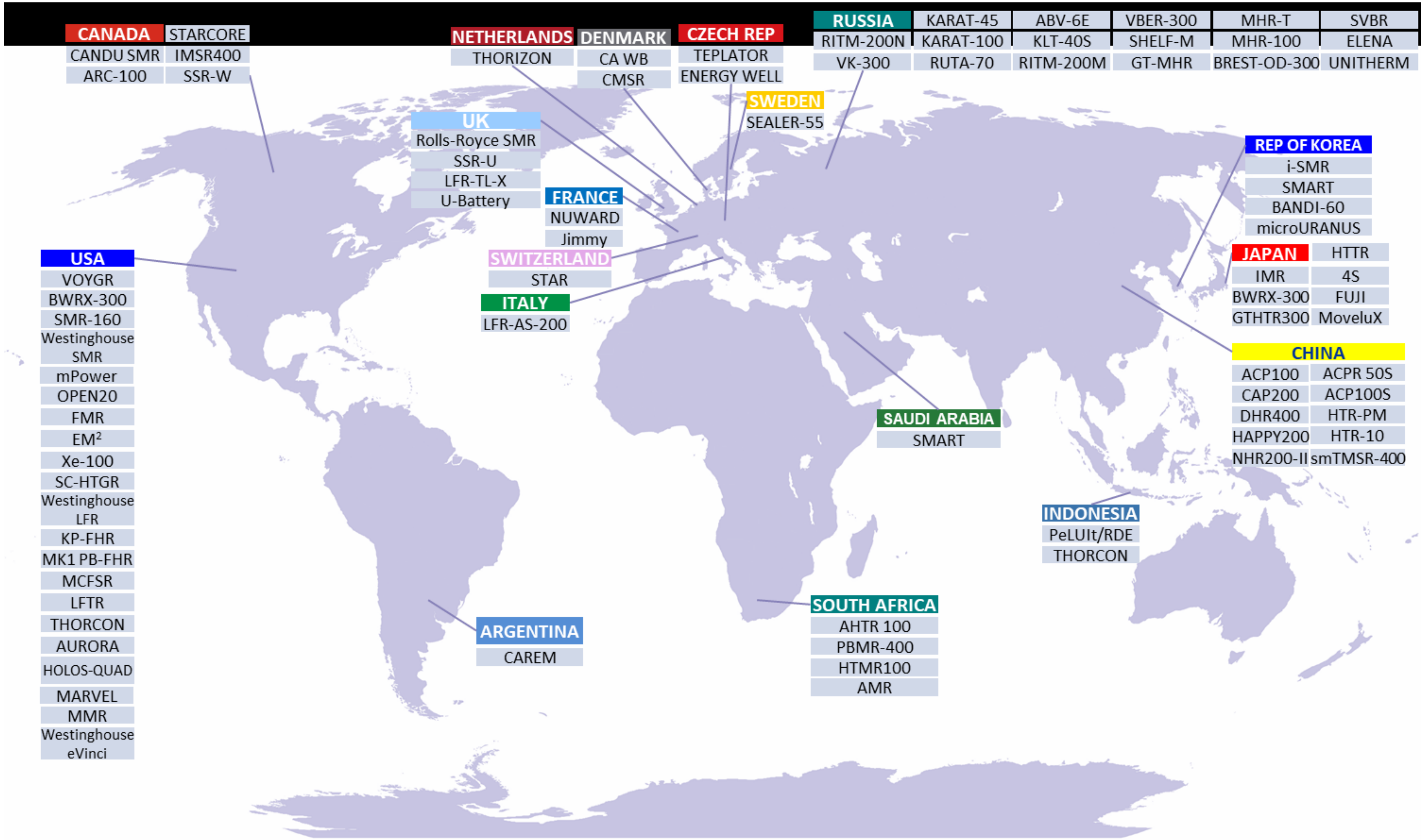
SMRs vs Conventional Nuclear Power Plants

SMRs have reduced fuel requirements. Power plants based on SMRs may require less frequent refueling, every 3 to 7 years, in comparison to between 1 and 2 years for conventional plants. Some SMRs are designed to operate for up to 30 years without refueling.

Typical SMR Design Features			
Simplification by modularization and System Integration		**Multiple-mode Plant Layout Configuration**	
			
Underground Construction for enhanced security and seismic		**Enhanced Safety Performance through passive systems**	
		• Enhanced severe accident features. • Passive containment cooling system • Pressure suppression containment.	

Reactor Designs by Country

Small Modular Reactors (SMR)

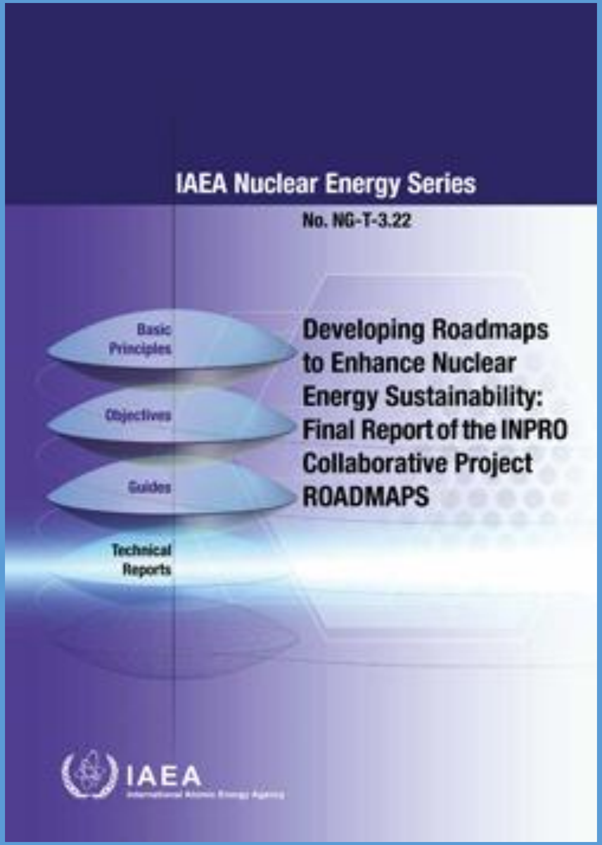


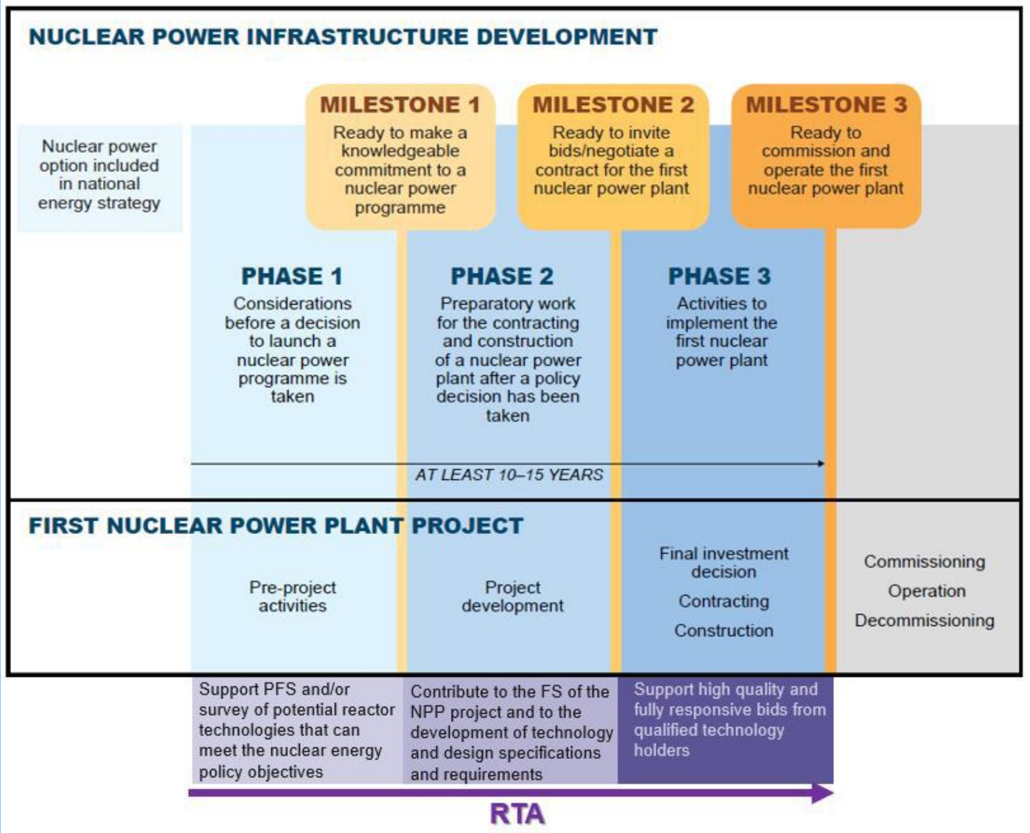
What has happened to date in Jamaica?

- Formation of the Nuclear Energy Working Committee (NEWC)-MSETT
- We have begun a public education campaign
- IAEA training: On the use of Reactor Technology Assessment tool & Education, Training Tools and Knowledge Transfer for Small Modular Reactors
- ICENS also participated in the first " Nuclear Boot Camp" this summer in collaboration with Dr. Charlyne Smith.
- Started the review of available technology

Dr. Charlyne Smith
Senior Nuclear Energy Policy Analyst
BreakThrough Institute | Build Nuclear Now

The IAEA Milestone approach to nuclear energy





Milestones approach is phased and comprehensive programme management guide creating an enabling environment for successful project

Timing is important

- Phase 1 “**Consider**”: understanding and commitment

IAEA Inter-regional project on "Supporting Member States' Capacity Building on Small Modular Reactors and Micro-reactors and their Technology and Applications as a Contribution of Nuclear Power to the Mitigation of Climate Change" INT2023

Vienna Austria

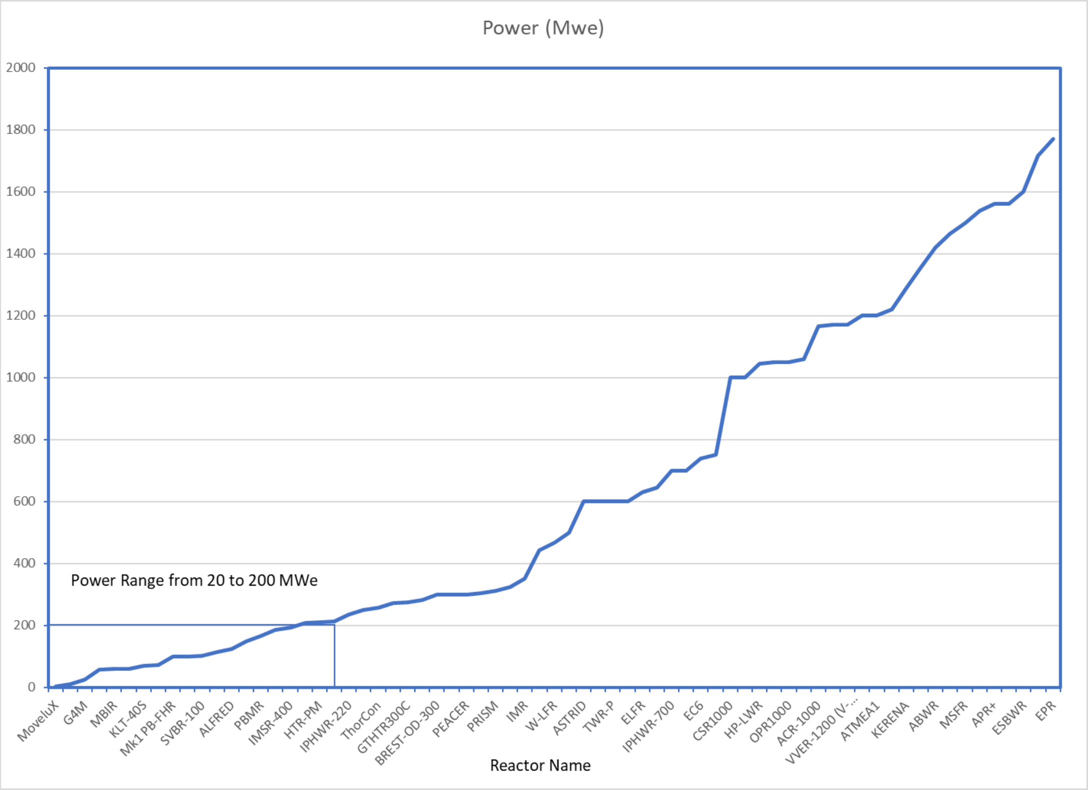
IAEA Member since 1965

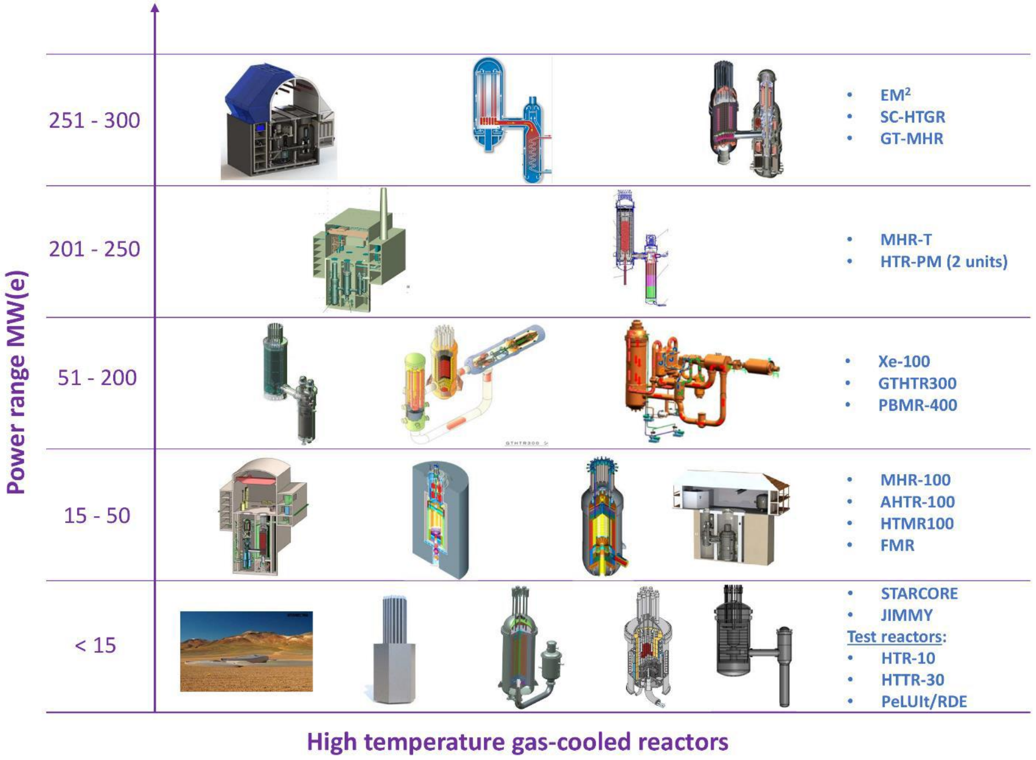
Copenhagen Denmark

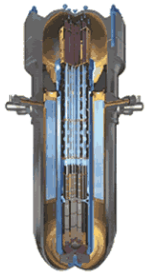
Participating Countries

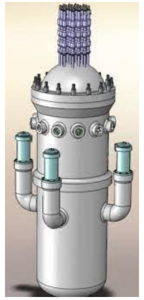
Algeria, Argentina, Australia, Austria, Belarus, Belgium, Brazil, Canada, Chile, China, Croatia, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Ghana, Hungary, India, Indonesia, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Kuwait, Kyrgyzstan, Latvia, Libya, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Philippines, Poland, Qatar, Romania, Russian Federation, Rwanda, Saudi Arabia, Singapore, Slovenia, South Africa, Sri Lanka, Sudan, Tunisia, United States of America, Zambia

Narrowing down Reactor selection by Power





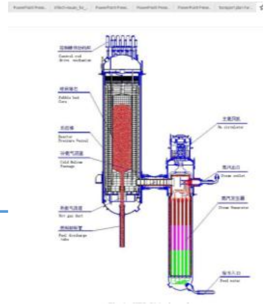




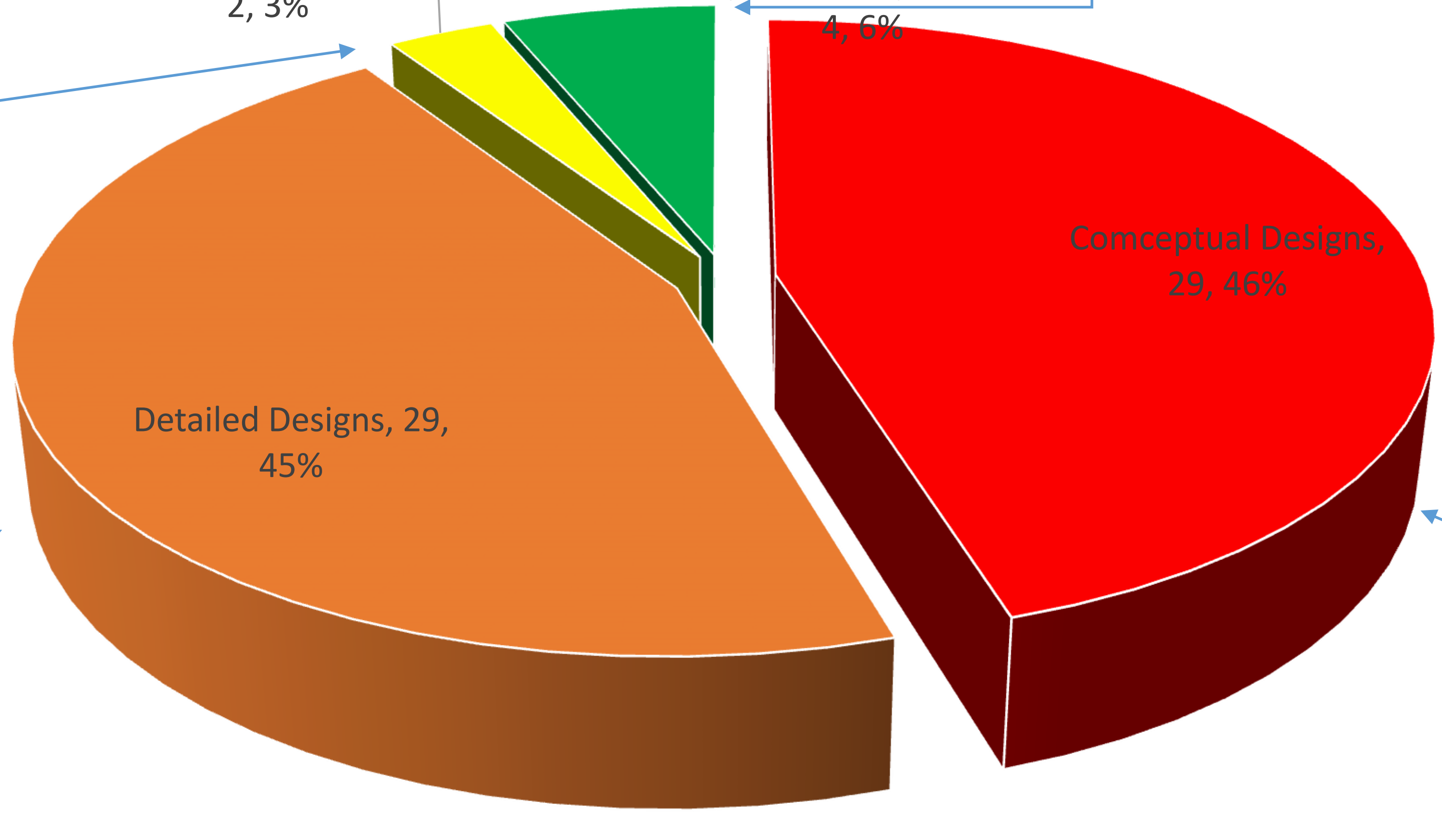
China, ACP100 (125 Mwe)
2026

Argentina, CAREM-25
(27 MWe or up to 100 Mwe)
2026

Russia, KLT40S (70 Mwe)



China, HTR-PM (211 Mwe)



2030?

2035?

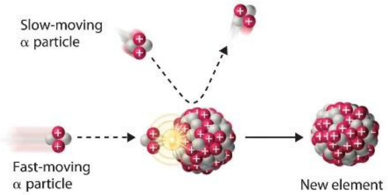
■ Comceptual Designs ■ Detailed Designs ■ Under Construction ■ In operation/Operable

Nuclear Spent Fuel Management

There are existing technical solution

- Geologic Deposits with barriers added to last thousands of years (Finland)

- Transmutation? Using fast neutrons from Generation IV fast reactors.

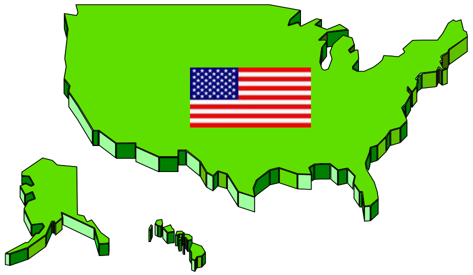


- Reprocessing spent Fuel~ 3% HLW incorporated into borosilicate glass (vitrified nuclear waste). A piece this size would contain the total high-level waste arising from nuclear electricity generation for one person throughout a normal lifetime.

URANIUM INFORMATION CENTRE Ltd. at http://www.uic.com.au/ueg.htm

ACCIDENTS

March 1979. *Three Mile Island, USA* Reactor PWR, 792 MWe



April 1986. *Chernobyl, a USSR* Reactor RBMK, 1000 Mwe (Graphite and water moderator).

March 2011. Fukushima Daiichi Nuclear Power Plant*, General Electric* Reactor BWR, (439 – 1062) MWe

Passive safety systems

- A **Passive Component** is a component which does not need any external input to operate.
- A **Passive System** is either a system which is composed entirely of passive components or a system which uses active ones in a very limited way to initiate subsequent passive operation.
- **Passive Safety Systems** are characterized by their reliance upon natural forces, such as natural circulation, gas pressure, gravity, phase change, and absence of "active" parts or processes, to accomplish their designated safety functions.

There are 4 categories of passivity " (IAEA)

CATEGORY	SYSTEMS IN THIS CATEGORY:
A	• Do not receive external signal inputs of intelligence; • Do not receive electrical power or force as external inputs; • Do not have any moving or mechanical parts; • Do not have any moving working fluid.
B	• Do not receive external signal inputs of intelligence; • Do not receive electrical power or force as external inputs; • Do not have any moving or mechanical parts; • Have a moving working fluid.
C	• Do not receive external signal inputs of intelligence; • Do not receive electrical power or force as external inputs; • Do have moving or mechanical parts; • May or may not have a moving working fluid.
D	• May receive inputs of intelligence to begin passive processes; • Energy used to initiate the passive process comes from stored • sources (i.e. batteries, elevated fluid); • May only have active components in the form of controls, • instrumentation, and valves which are used to initiate passive • processes; • May not be manually initiated.

Enabling Framework

1. Political Framework
2. Responsible Owner
3. Regulatory Framework (Nuclear Safety and Radiation Protection Act)
4. Merchant Operator
5. Fuel Supply and Waste Management
6. Finance
7. Contract Management
8. Training and Education
9. Industrial Infrastructure

Summary

- Any alternative energy sources must be price competitive.
- Stability of nuclear electricity costs is a major benefit .
- A resurgence in nuclear power generation over the course of the next half century both for environmental and economic reasons is underway.
- The relatively low initial capital cost, manageable size and modular nature of SMR's make them more suitable for small and developing countries.

Food for thought………

Admiral Rickover's 'Paper Reactor'

An academic reactor or reactor plant almost always has the following basic characteristics:

- It is simple.
- It is small.
- It is cheap.
- It is light.
- It can be built very quickly.
- It is very flexible in purpose (“omnibus reactor”)
- Very little development is required. It will use mostly “off-the-shelf” components.
- The reactor is in the study phase. It is not being built now.

On the other hand, a practical reactor plant can be distinguished by the following characteristics:

- It is being built now.
- It is behind schedule.
- It is requiring an immense amount of development on apparently trivial items.
- It is very expensive.
- It takes a long time to build because of the engineering development problems.
- It is large.
- It is heavy.
- It is complicated.

Thank you for your attention!