
NUCLEAR
POWER

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What Is Nuclear Power?

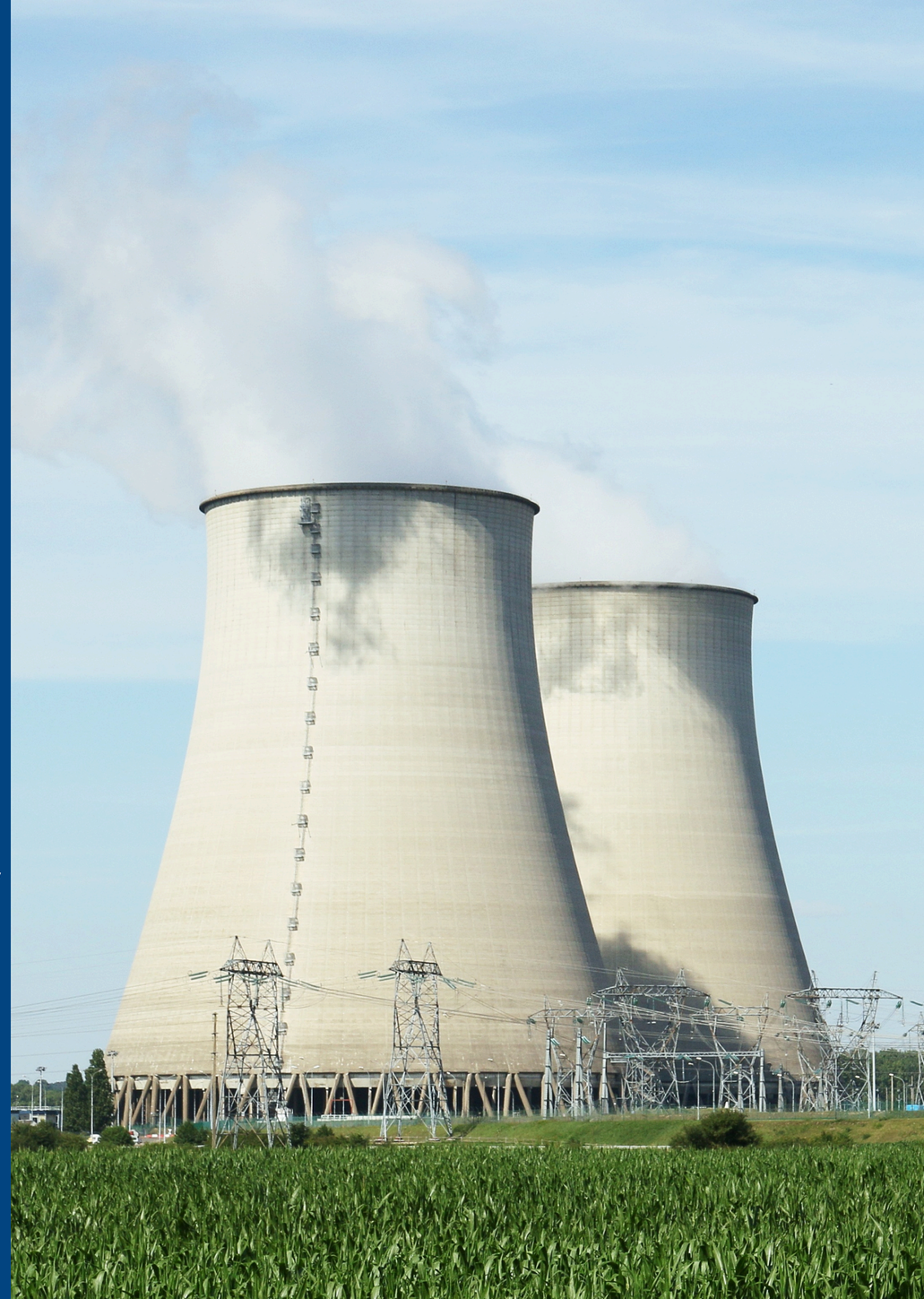
- Nuclear power is the use of nuclear reactions (mainly fission) to produce electricity.
- It is considered a low-carbon energy source, since it does not release greenhouse gases during operation

How it works?

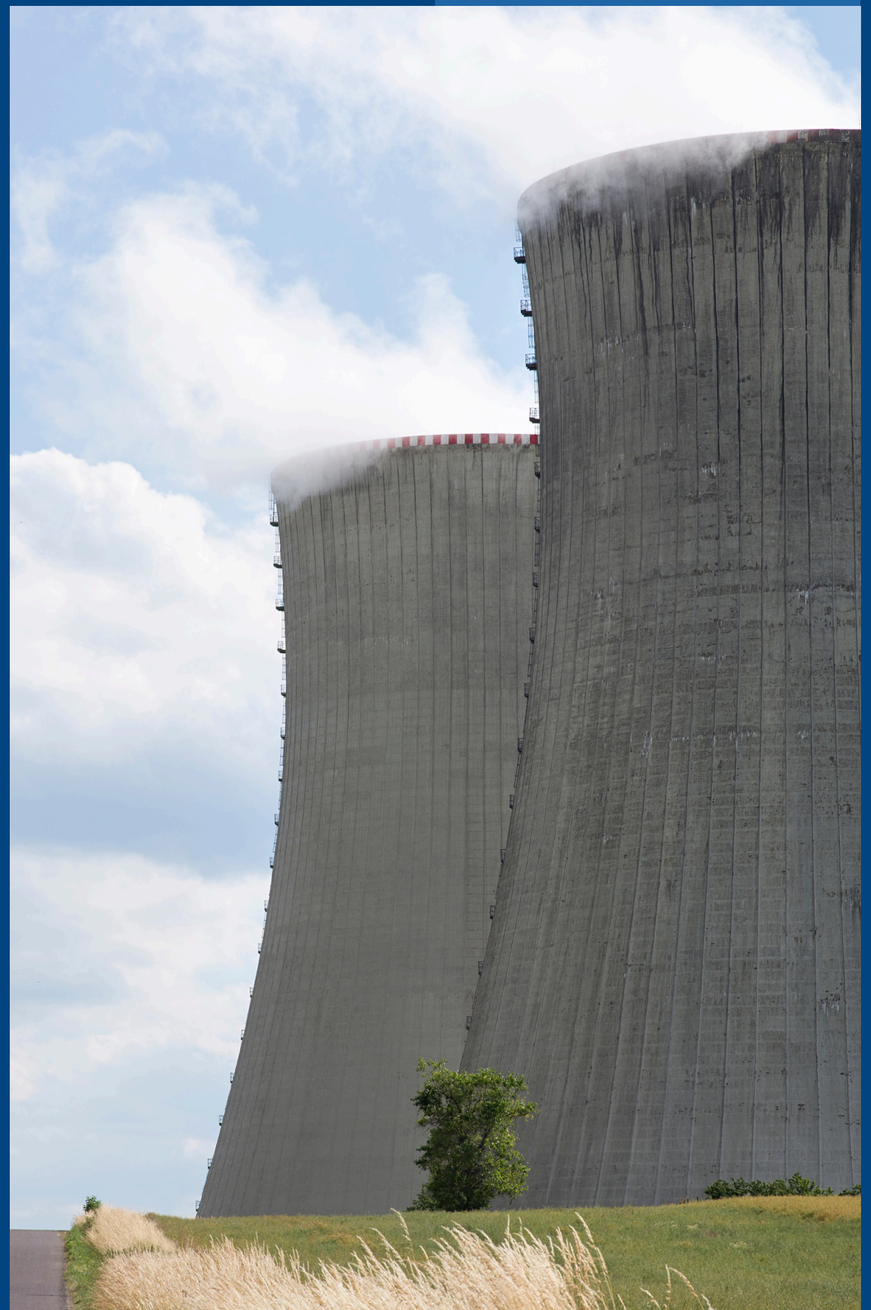
- Inside a nuclear reactor, uranium-235 (or plutonium) atoms are split during fission.
- This reaction releases a huge amount of heat energy.
- The heat is used to convert water into steam.
- The steam drives a turbine connected to a generator, producing electricity

Importance

- Provides a reliable and continuous energy supply (24/7 base load power).
- Helps in reducing dependency on fossil fuels.
- Plays a role in climate change mitigation since it is a clean energy source



Giggling Platypus Co.



Current Global Status of Nuclear Power

Number of Reactors Worldwide

- Currently, there are about 440 operational nuclear reactors across more than 30 countries.
- Additionally, around 60 reactors are under construction, showing steady growth

Share in Global Electricity

- Nuclear power contributes around 10% of the world's electricity generation.
- In some countries, it is a major source:
  France – nearly 70% of electricity from nuclear.
  USA – world's largest producer.

Current Status of Nuclear Power in India

- India has about 7.5 GW of installed nuclear capacity.This contributes only around 3% of India’s total electricity generation.
- India operates 23 nuclear reactors across 7 locations.

Major Nuclear Power Plants

- Tarapur Atomic Power Station (Maharashtra) – first nuclear power station in India.
- Kudankulam (Tamil Nadu) – largest nuclear power plant in India (with Russian collaboration).
- Kaiga (Karnataka) and Kakrapar (Gujarat) – important Pressurized Heavy Water Reactors .
- Others: Rawatbhata (Rajasthan), Kalpakkam (Tamil Nadu), Narora (U.P.)

Opportunities of Nuclear Power

Energy Demand & Climate Change

1. Rising Energy Demand

- By 2050, global electricity demand is expected to double due to population growth, urbanization, and industrialization.
- Countries like India need stable sources of energy to fuel economic growth.

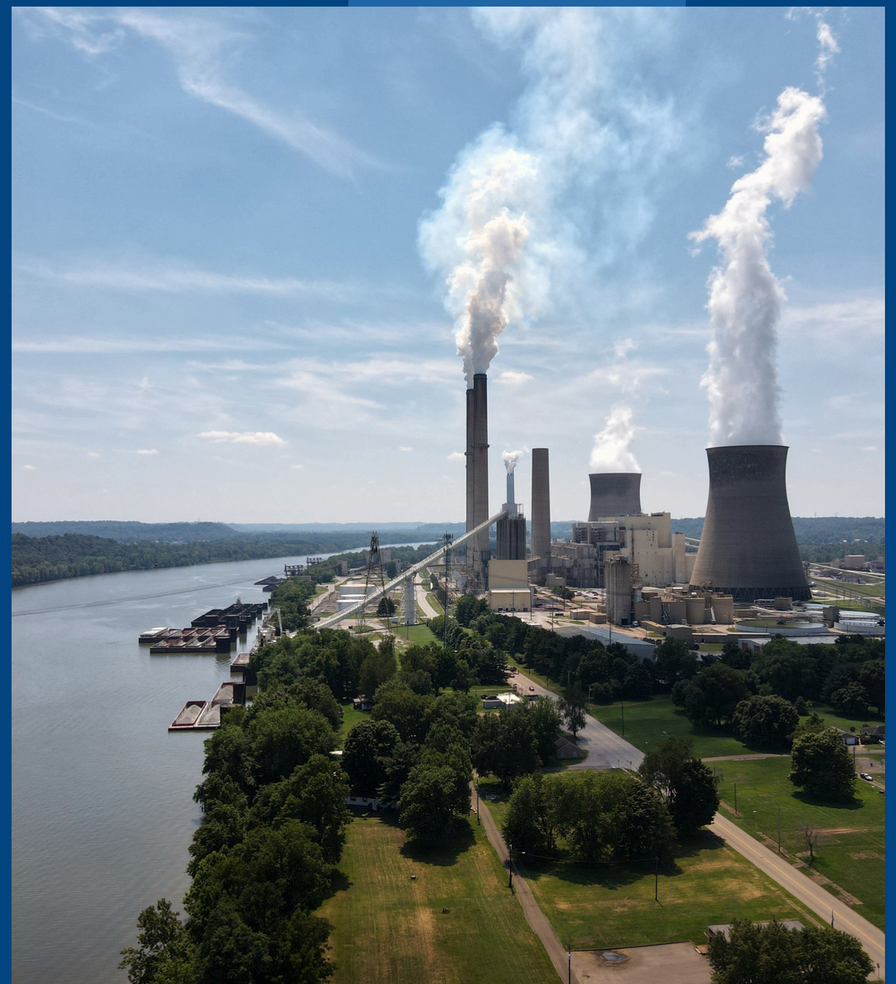
2 .Climate Change

- Fossil fuels (coal, oil, gas) are the largest contributors to carbon emissions.
- Nuclear power produces near-zero greenhouse gases during operation. Helps countries meet climate commitments

Economic & Technological Opportunities

1. Stable Electricity Supply

- Nuclear plants operate continuously for long durations (capacity factor ~90%).
- This makes them more reliable than coal, gas, or renewables.



2. Long-Term Cost Competitiveness

- Though initial investment is high, nuclear plants have a lifespan of 40–60 years.
- They provide large amounts of electricity at stable prices over time.

Challenges of Nuclear Power

1 . Accidents in History

- Chernobyl (1986, Ukraine): Worst nuclear disaster → huge radiation release, long-term health & environmental damage.
- Fukushima (2011, Japan): Earthquake + tsunami led to meltdown, displacement of thousands.

2 . Radioactive Waste Management

- Spent nuclear fuel remains dangerous for thousands of years.
- Requires safe, long-term storage in deep geological repositories.
- Still a major unsolved challenge worldwide.

Economic & Political Challenges

1 . High Costs

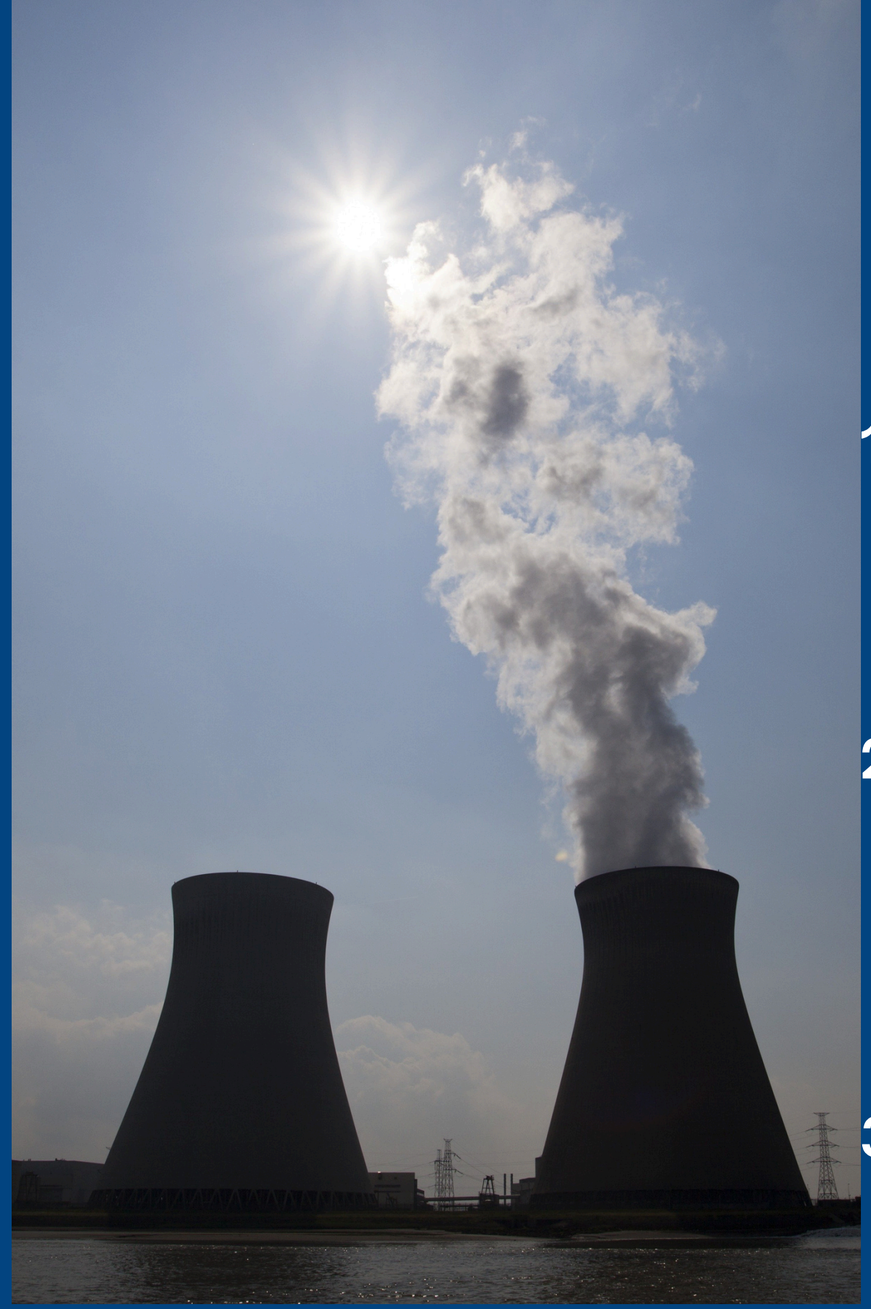
- Building nuclear plants requires billions of dollars upfront.
- Average construction time: 10–15 years, leading to delays and cost overruns.

2 . International Restrictions

- Nuclear technology is sensitive due to weaponization risks.
- Developing countries (like India earlier) faced restrictions on importing nuclear fuel/technology.

3 . Political Issues

- Public protests often delay projects (fear of radiation, displacement).
- International politics influence nuclear trade and collaboration



Future Trends in Nuclear Power

1 . Advanced Gen-IV Reactors

- Designed for higher safety, efficiency, and less waste.
- Can use fuel more effectively and even recycle spent fuel.

2 . Small Modular Reactors (SMRs)

- Compact, cheaper, and quicker to build.
- Can be deployed in remote areas or used alongside renewables.
- Safer due to passive cooling and smaller scale.

3 . Nuclear Fusion

- Fusion (joining atoms) instead of fission (splitting atoms).
- Promises limitless clean energy with no long-lived radioactive waste.

India’s Future Prospects

1 . Expansion Goals

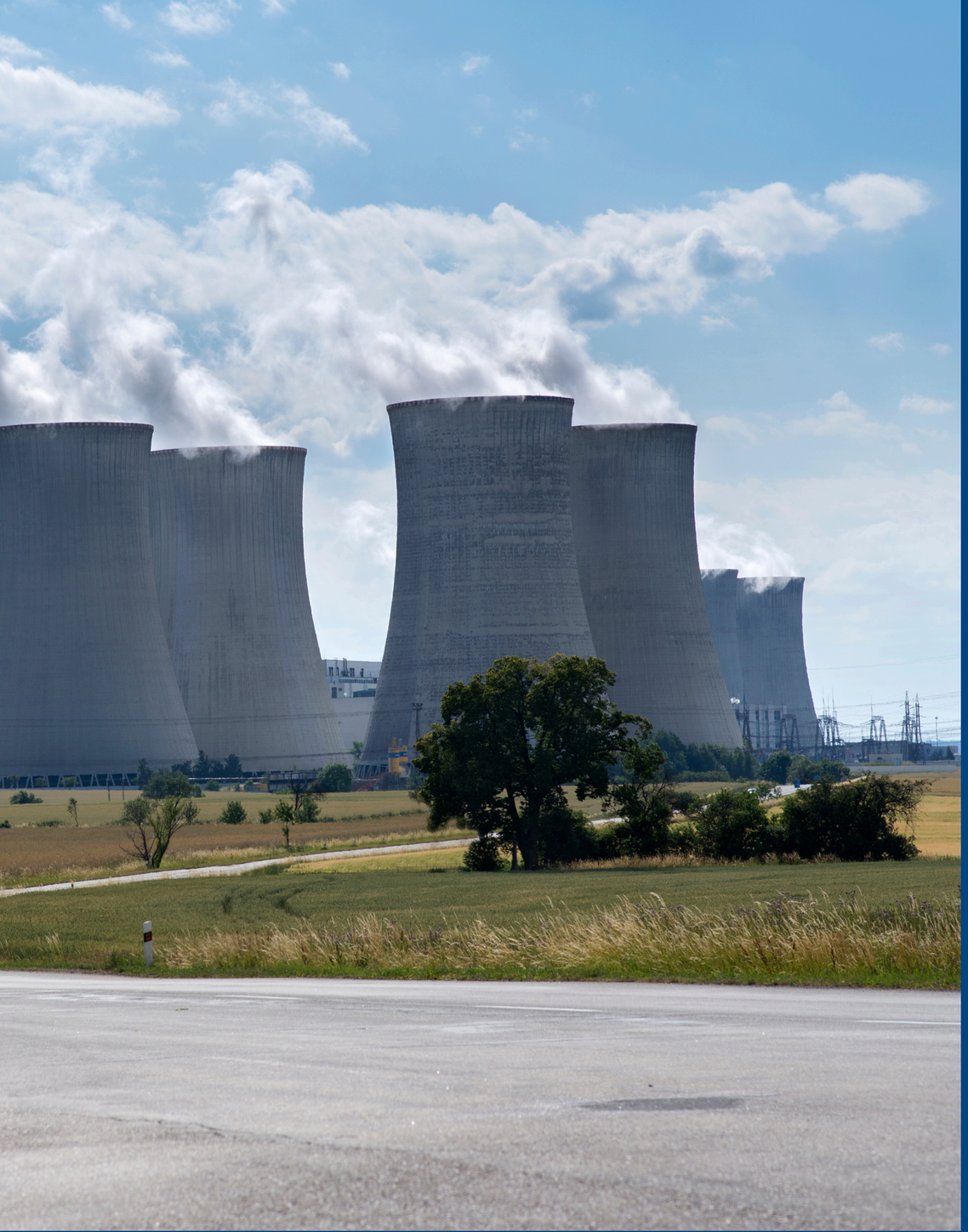
- India plans to triple its nuclear capacity to ~22.5 GW by 2031.
- Ongoing projects in Kudankulam, Kakrapar, and new reactors planned.

2 . Thorium Utilization

- India has the world’s largest thorium reserves.
- The 3-stage nuclear program aims to eventually power reactors using thorium for long-term energy independence.

3 . International Collaboration

- Cooperation with Russia (Kudankulam), France (Jaitapur project), USA, and Japan.
- Strengthens India’s energy security and global partnerships.



Conclusion

- Nuclear power offers huge opportunities in energy security and climate change mitigation. But it also comes with serious challenges like safety, waste management, and costs.
- Invest in safer technologies (SMRs, Gen-IV, fusion).
- Strengthen international cooperation for fuel, technology, and safety.
- Ensure transparent policies & public trust.

“Nuclear power is not a silver bullet, but it is a crucial piece of the puzzle in building a sustainable and secure energy future.”