# Environmental Law Institute
# Nuclear Energy in 2023: Where Are We and What's Ahead

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# Nuclear Power - Today

- Currently 420+ nuclear reactors worldwide in over 33 countries
  - 394 GWe – total net installed nuclear capacity
  - 10.5% of world's total energy/ 35% of world carbon free generation
  - 13 countries rely on nuclear power for at least ¼ of total generation
- United States is the largest operator with 93 nuclear units
  - 20% of electricity supply/45% of carbon free generation
- 53 countries operate 223 research reactors and more than 200 nuclear reactors power over 160 ships and submarines worldwide
- 54 reactors are in construction in 17 countries – China largest builder
- 30 countries are considering embarking on new nuclear programs



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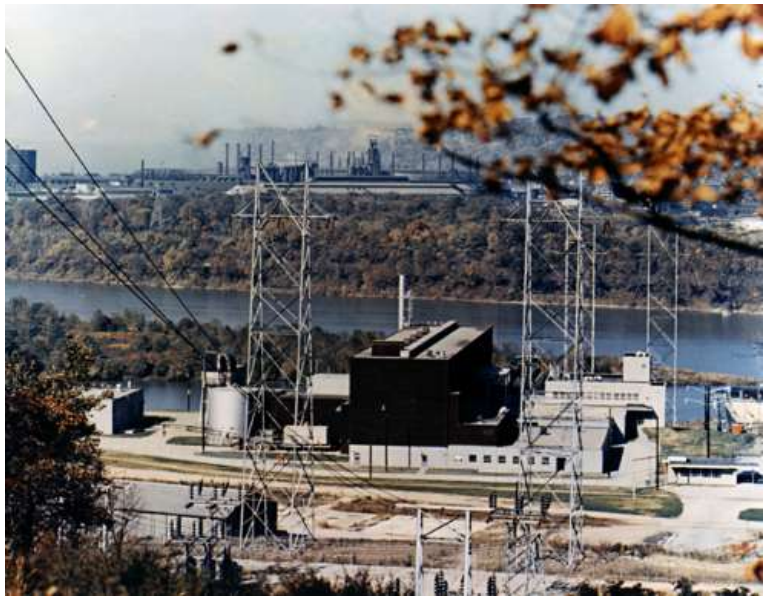
# Advanced Nuclear Reactors – Definition/Classification

- Advanced nuclear is categorized in terms of electrical generation capacity
  - Microreactors: <20 MWe
  - Small-scale reactors: 20 MWe - <300 MWe
  - Large-scale reactors: >300 MWe
- Small-scale reactors are often characterized as small modular reactors (SMRs) to reflect method of fabrication and construction
- Further classified by type of moderator transferring heat from the fission reaction to the steam plant
  - Light water (LWRs)
  - High-temperature gas (HTGRs)
  - Liquid metal-cooled
  - Molten salt

*Advanced nuclear largely represents innovative, evolutionary applications of historically proven design elements.*



Shippingport: the first U.S. commercial nuclear power plant —and an SMR!



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# Representative Technologies

| Design | Classification | Nameplate Capacity | Licensing Status |
|---|---|---|---|
| **NuScale Reactor** | Light Water | 77 MWe | NRC Certified 50 MWe design in 2022. 77 MWe currently under review. $1.4 billion DOE funding for UAMPs demonstration of 6-module reactor at Idaho National Lab. |
| **GE Hitachi BWRX-300** | Light Water | 300 MWe | Selected for deployment by Ontario Power Generation (OPG) and Tennessee Valley Authority (TVA). |
| **Westinghouse AP300** | Light Water | 300 MWe | Recently announced smaller version of AP1000. Early discussions with USNRC. |
| **Holtec SMR 160** | Light Water | 160 MWe | Ukraine intends to deploy 20 SMR-160 reactors. Potential deployment in Michigan. |
| **X-Energy XE-100** | High-Temp Gas (Pebble Bed) | 80 MWe | Selected for ARDP - deployment at Dow site in Texas. |
| **Terrestrial Energy IMSR** | Molten Salt | 195 Mwe | Selected for USNRC/CNSC pilot project. NRC pre-application discussions. |
| **TerraPower Natrium Reactor** | Sodium Fast Reactor with Molten Salt Storage System | 345 MWe<br>500 MWe (5 ½ hours) - with Molten Salt | Selected for ARDP- Partnered with PacificCorp to construct near former coal plant in Wyoming. |
| **Oklo Aurora** | Liquid Metal Cooled | 1.5 MWe/15 MWe | 1.5 MWe design under review by USNRC. 2 – 15 MWe units to be deployed in Ohio. |
| **Kairos Power** | Pebble Bed with Molten Salt Coolant | 140 MWe | Selected for $30 million risk reduction award by DOE. |




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# Increasing Interest in Advanced Reactors

States

- Increasing number of states have shown interest in deploying advanced reactors as an element of their carbon-avoidance strategies
  - National Association of Regulatory Utility Commissioners
  - Non-nuclear-states: Wyoming, Montana, West Virginia, Idaho, Colorado, North Dakota – non-nuclear states

Non-Utility Interest

- Dow
- Nucor
- Microsoft
- Google

# Federal Incentives for Advanced Reactors

## Bi-Partisan Infrastructure Bill

- Advanced Reactor Demonstration Program - $2.5 billion for X-energy and TerraPower
- Nuclear Hydrogen Hubs - $8 billion total funding

## Inflation Reduction Act

- Production Tax Credit (PTC) for operating plants - up to $15 per MWh
- Technology-Inclusive PTC for Clean Energy - $30 per MWh
- Technology-Inclusive Investment Tax Credit (ITC) for Clean Electricity – 30%
  - Additional 10% for energy communities and 10% for using U.S. components (stackable)
- Clean Hydrogen Credit - $3 per kilogram
- $700 million for high assay low enriched uranium production



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# Additional Federal Action

## Bipartisan support for advanced nuclear

- FY2023 omnibus - nuclear funding set at $1.47 billion
- FY2024 – Biden request of $1.56 billion
- H.R. 4394 provides $1.783 billion (Passed House 10/26)

## Advance Act of 2023 – Caputo/Carper Co-Sponsors

- Includes a variety of beneficial provisions –
  - Reduction in NRC licensing fees
  - Eliminates foreign ownership requirement
  - Simplified program for brownfield redevelopment
  - Creates prizes for first mover advanced nuclear companies
  - Extends Price-Anderson Insurance to 2045
- Wide variety of bills introduced in the House and Senate by advanced reactor supporters

# Commercial/Regulatory Benefits

- Scalable, 24/7 power to meet incremental electric demand growth.
- Greater flexibility means more potential applications
  - Repowering existing fossil fuel sites
  - Process heat for industrial applications and water purification/desalination and hydrogen production
- Smaller size/modularity
- Lower accident risk from improved safety features
- Reduced emergency evacuation zone
- Emissions-free generation
- Load-following capability

*Oklo's Aurora reactor: construction at INL expected to start in mid-2020s. (Oklo 2019)*



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