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Small Modular Reactor Project in the United States of America

Debate on Dispersed Nuclear Energy
An Opportunity for Poland?

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Committed to "*All of the Above*" Clean Energy Strategy

*"By 2035, 80% of America's electricity will come from clean energy sources. Some folks want wind and solar. Others want **nuclear**, clean coal and natural gas. To meet this goal we will need them all."*

~2011 State of the Union

*"Electricity generation emits more carbon dioxide in the United States than does transportation or industry, and **nuclear power** is the largest source of carbon-free electricity in the country."*

~ Secretary of Energy, Dr. Ernest Moniz

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Meeting Clean Energy Goals will Require a Shift in Electricity Production

	2010		2035	
Source	**Elect (TWhr)**	**CO_2 (Gton)**	**Elect (TWhr)**	**CO_2 (Gton)**
Natural Gas	1000	0.4	1520	0.5
Coal	1730	1.7	1800	1.8
Coal (CCS)	0	0	0	0
Nuclear (Large)	790	0	870	0
Nuclear (SMR)	0	0	0	0
Hydro	325	0	300	0
Renewable	200	0	440	0
Petroleum/Other	50	0.04	40	0.03
TOTAL	**4095**	**2.2**	**4970**	~~2.3~~ **1.0**

2010 U.S Electricity Consumption and CO_2 Emissions. ***EIA*** ***CE=42%***

EIA Reference Projections 2035
CE=43%

Source: EIA, Annual Energy Outlook 2013

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SMRs can be Game Changers

"I believe small modular reactors could represent the next generation of nuclear energy technology, providing a strong opportunity for America to lead this emerging global industry."

U.S. Senate Committee on Energy & Natural Resource Confirmation Hearing on April 9, 2013

"We are committed to fostering the safe and secure contribution of nuclear power to the global energy mix."

~ IAEA International Conference on Nuclear Security – July 1, 2013

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Light Water-Based SMR Designs

Well-understood Technology

- Uranium Oxide fuels
- Regulatory and operating experience

Commercial Interest

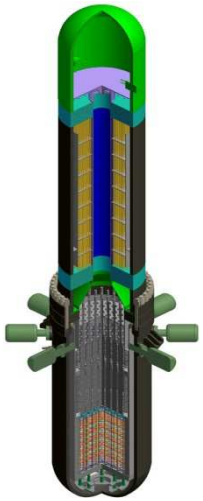
- At least 4 LWR vendors
- Vendor/Utility coalitions being established

Manufacturing industry involved

- Could revitalize U.S. nuclear infrastructure and create new industries


NuScale


Holtec


Westinghouse


MPower

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Design Features that Improve SMR Safety

- **SMR designs share a common set of design principles to enhance plant safety and robustness**
  - Incorporation of primary system components into a single vessel
    - Eliminates large pipe break accidents
  - Increased ratio of water inventory to decay heat
    - More effective decay heat removal
    - Much longer “coping time”
  - Vessel and component layouts that facilitate natural convection cooling by gravity of the core and vessel
    - Eliminates need for electrical power to drive cooling systems
  - Below-grade construction of the reactor vessel and spent fuel storage pool
    - Enhanced resistance to seismic events
    - Improved security

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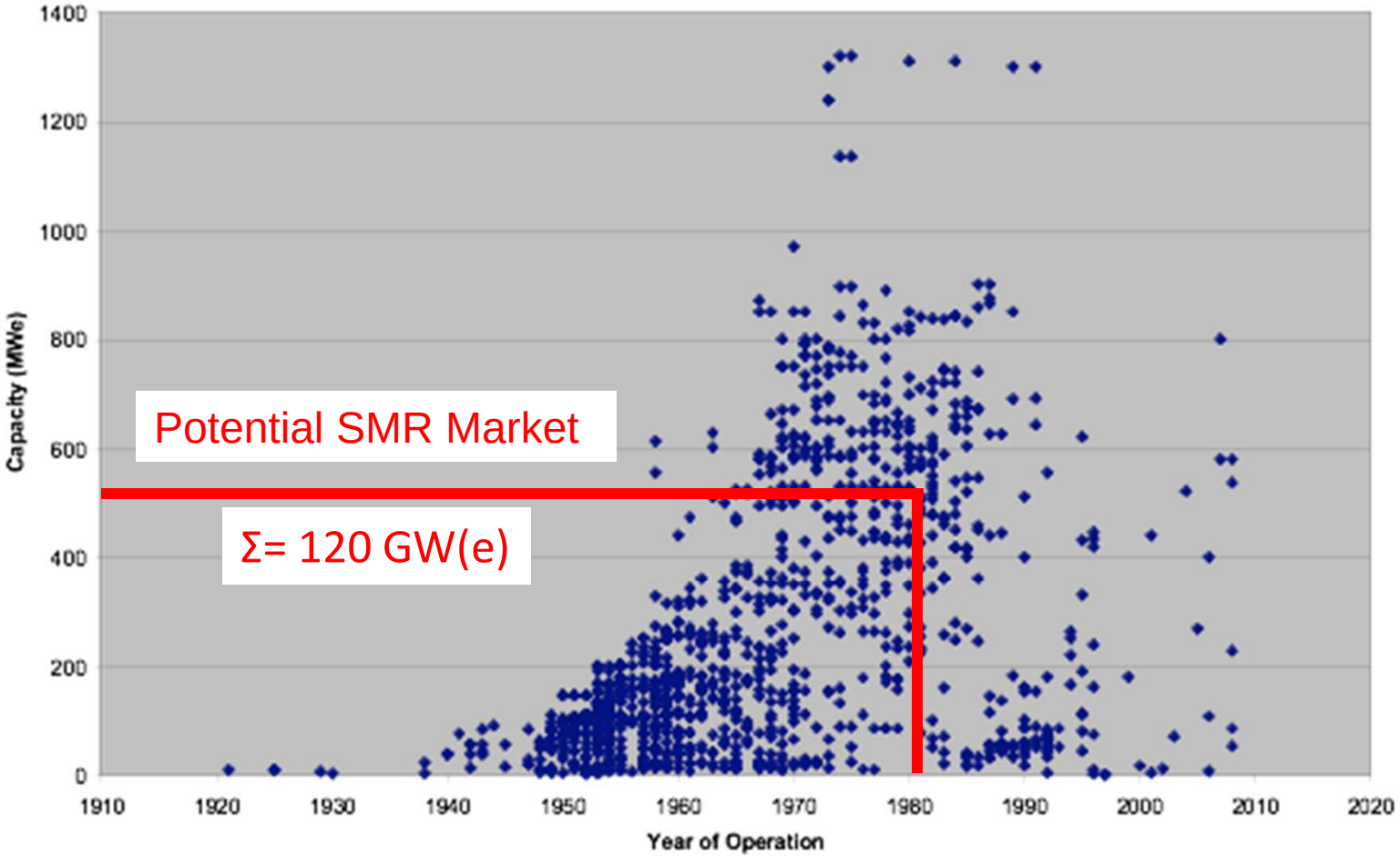
SMRs Could Potentially Replace Retiring Coal Plants



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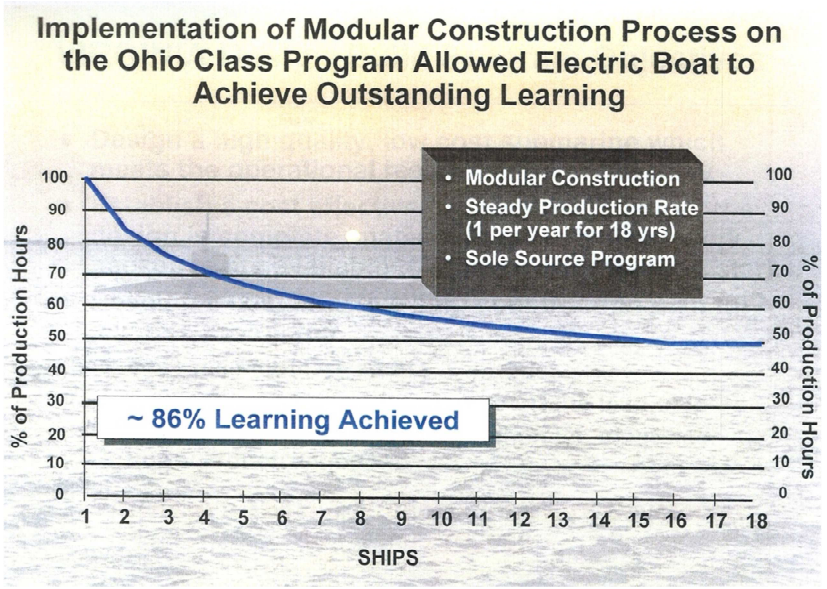
Economic Considerations

- **Capital cost comparison**
  - New AP1000 reactors in the U.S. are $5B - $7B
  - Estimate for SMRs are:
    - $4,700 - $6,000/kWe or
    - $900M - $1200M for 200 MWe plant



- **Naval reactor industrial experience shows significant learning**
  - Assembly line replication optimizes cost, schedule and quality through greater standardization of components and processes

- **Preliminary conclusion is that "economy of mass production" can be competitive with "economy of scale"**

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DOE Program to Support SMR Design Certification & Licensing

- **In 2012, DOE initiated a 6 year/$452 M program**
- **Accelerate commercial SMR development through public/private arrangements**
  - Deployment as early as 2022
- **Provide financial assistance for design engineering, testing, certification, and licensing of promising SMR technologies with high likelihood of being deployed at domestic sites**
- **Funding being provided to industry partners though cost sharing**
  - Generation mPower selected on the first funding opportunity
  - Currently reviewing applications for the second funding opportunity
- **Exploring additional mechanisms for SMR fleet deployment**

The U.S. Government wants to support the safest, most robust SMR designs that minimize the probability of any radioactivity release

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Generation mPower Progress on Certification & Licensing

- Commissioned Integrated Systems Test Facility in 2012 to analyze plant performance & response
- Established fuel fabrication & testing facility in 2013
- Conducting component prototype testing on reactor coolant pumps & control rod drive mechanisms
- Site characterization sampling at the Clinch River Site
- Significant pre-application interactions with the Nuclear Regulatory Commission
- Design Certification Application (Oct 2014) and Construction Permit Application (Jun 2015) on schedule

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Strategic Vision for SMR Deployment

- **Our long term goal is to enable deployment of a fleet of SMRs, not just 1 or 2 units**
- **Envision need for >50 GWe capacity in coming decades based on coal plant replacements alone**
- **Long term vision is that SMRs would evolve through anticipated deployment phases**
  - Regulatory *(where we are today)*
  - Early adopters *(first 20 units)*
  - Full-scale factory production *(20 – 40 units/year)*

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Summary – SMR Technologies are of Great Interest in the U.S.

- Further improve passive safety technology
- Reduce capital cost and project risk
- Regain technical leadership and advance innovative reactor technologies and concepts
- Create high-quality domestic manufacturing, construction, and engineering jobs
- Become global leader in SMR technology based on mature nuclear infrastructure and NRC certified designs

Challenge to SMR fleet deployment:
Prove economy of mass production is competitive with economy of scale