Nuclear Power in the United States: Large or Small?

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Princeton, November 12–13, 2012
Nuclear Power Reactors in the World, 2012

437 operational reactors (7 fewer than 18 months ago) in 31 countries provide about 13% of global electricity
Hitting the “Reset” Button in 2011?

New Grid Connections, Permanent Shutdowns, and New Construction Starts over the Past Decade

Nuclear Power in the United States
The Nuclear Reactor Fleet is Aging

104 operational reactors; about 40% near 40-year life, life-extensions granted
New Nuclear Power in the United States

Federal Loan Guarantees
as part of the Energy Policy Act of 2005, up to $18.5 billion
Obama Administration has sought to increase amount to $54.5 billion

Several proposed construction projects have stalled
some before and some after the Fukushima Accidents

Vogtle-3 and -4 Project (Waynesboro, GA) moving forward
2 x Westinghouse AP-1000, 2200 MWe, expected for 2016 and 2017
Combined Construction and Operating License issued in February 2012
$14 billion investment; $8.3 billion in Federal loan guarantees

“Let me state unequivocally that I’ve never met a nuclear plant I didn’t like;
Having said that, let me also state unequivocally that new ones don’t make any sense right now.”

John Rowe, Former CEO Exelon, March 29, 2012
Are New Technologies on the Horizon?

The Case of Small Modular Reactors
Could Small Nuclear Reactors Play a Role?

Several designs are based on standard light-water reactor technology

Babcock & Wilcox mPower Concept

- Light-water cooled
- 180 MWe per module, up to 10+ modules
- Underground construction
- 60-year spent fuel storage onsite
- Quasi-standard LWR fuel
- Factory-based serial production

Source: www.babcock.com/products/modular_nuclear/
Why Consider Small Modular Reactors?

- Substantially lower investment risks
  - $500 million vs $5 billion projects; combined with shorter construction times

- Better suited for electricity markets with low growth rates
  - Modules can be added to existing plants “on demand”

- Promise of enhanced safety and security
  - Almost all designs envision underground or other-nonconventional siting modes

- Potential nonproliferation benefits
  - Long-lived cores

In January 2012, DOE announced a 5-year $452 million cost sharing program to support engineering, design certification, and licensing for up to two first-of-a-kind SMR designs

www.grants.gov/search/search.do?mode=VIEW&oppId=138813
Critical Policy Issues for SMR Licensing

1. Number of Units Controlled per Control Room
   Current NRC regulations permit at most two reactors to be controlled from a single control room
   (SECY-10-0034. ML093290290)

2. Security Requirements
   “Security-informed design” versus “brute force method of securing the plant”
   Chris Mowry, Babcock & Wilcox to U.S. Nuclear Regulatory Commission, March 29, 2011

3. Insurance, Liability, Annual Fees, Decommissioning Funding
   SMR applicants argue that current regulations impact SMRs disproportionately

4. Size of Emergency Planning Zone
   SMR applicants advocate for “scalable EPZ” to take into account power level and new safety features
   Could also determine viability of some proposed deployment schemes

A. Glaser, Nuclear Power in the United States: Large or Small?, Synergize, November 2012
Could Small Modular Reactors Be Deployed at Sites That Previously Hosted Coal-fired Plants?
Coal-fired Power Plants in the United States

1370 generators at 560 sites with an installed capacity of 330 GWe*

Data on coal-fired power plants from eGRID 2012
U.S. Environmental Protection Agency
www.epa.gov/cleanenergy/energy-resources/egrid/

*includes Alaska and Hawaii
Coal-fired Power Plants in the United States

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Similar idea, first proposed by Peter Lyons, Presentation to Secretary of Energy Advisory Board (SEAB), SMR Subcommittee March 9, 2012
Coal-fired Power Plants Are Generally Closer to Urban Areas

Within 10 miles of plant:
1. 75% of U.S. nuclear power plants have population of less than 100,000
2. No U.S. nuclear power plant has population of more than 300,000
3. 60% of (considered) coal plants have population of less than 100,000; 150 sites with 70 GWe

Population data from the United States 2010 Population Census; Digital Map and Geospatial Information Center, Princeton University
Technology Choices for SMRs

Two important examples

SMRs based on established light-water reactor technology
to demonstrate commercial viability of the concept over a relatively short period of time
(often: integral pressurized-water reactors (iPWRs) using standard fuel elements)
Propose enhanced safety features resulting from reduced power level

SMRs with long-lived cores
that do not require refueling for two or three decades
Typically fast neutron spectrum (helium, sodium, or liquid-metal cooled)
(often: targeted at newcomer countries or remote locations)
Some Advanced Designs Rely on Major Departures from Established Technologies and Approaches

Mostly at conceptual stage today ... and decades away from deployment

EM²: “Nuclear Waste to Energy”
www.ga.com/energy/em2/

Traveling Wave Reactor
www.terrapower.com
Where Is Nuclear Power Heading?
Some Concluding Observations

Many countries (including the United States) remain committed to nuclear power
Internationally, deployment and role of nuclear power is likely to be more uneven

Small Modular Reactors
SMR attract significant attention; many innovative features; some prototypes will be built

Design choices will determine viability of systems for large-scale deployment
Resource utilization and proliferation risks may or may not be significantly different
(relative to gigawatt-scale reactors in use today)

Small may be beautiful ... but it is small
Even under most optimistic assumptions, little generating capacity
based on SMR technologies could be deployed by 2030