



U.S. Department of Energy Small Modular Reactor Program

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Outline

- Drivers and Benefits
- DOE SMR Program Elements and Resources
- SMR Concepts
- Government Role
- Challenges
- International Markets
- Path Forward
- Summary



Market Interest in SMRs

- Value Proposition
 - Reduced capital cost makes nuclear energy feasible for more utilities
 - Shorter construction schedules due to modular construction
 - Improved quality due to replication in factory-setting
 - Expanded siting options due to reduced water usage and reduced plant footprint
- Markets
 - Satisfy incremental growth in energy demand
 - Replacement of aging fossil plants
 - Non-electrical (process heat/desalination) customers
 - Co-location with industrial and district heating applications

Government Interest in SMRs

■ Climate Change

- Reduce U.S. greenhouse gas emissions 17% by 2020...83% by 2050
- E.O. 13514 – Reduce federal GHG emissions 28% by 2020
 - *Government missions cannot be curtailed to meet GHG target*

■ Department of Defense Mission Surety

- Studying SMR deployment at DoD facilities
- Address grid stability and fuel supply needs

■ Energy and Economic Security

- Pursue energy security through a diversified energy portfolio
- Improve the economy through innovation and technology leadership

Achieving a Clean Energy Economy

- “So tonight, I challenge you to join me in setting a new goal: By 2035, 80 percent 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 -- and I urge Democrats and Republicans to work together to make it happen.”



DOE SMR Program Mission and Objectives

- **Mission:** Improve the affordability of nuclear power by providing potential owners and investors with flexible deployment options and reduced capital costs
 - Accelerate commercialization and deployment of SMRs
 - Support continued RD&D for innovative, longer-term designs



■ Key Objectives:

- Establish cooperative agreements with industry with a goal of certifying, licensing and deploying LWR-based SMRs by FY2020
- Conduct RD&D activities that supports the development and commercialization of advanced SMR designs
- Collaborate with NRC and Standards Developing Organizations (SDO's) to address gaps in codes and standards to support SMR designs
- Conduct evaluations of advanced SMR designs for commercialization potential

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SMR Program Budget (\$ in Millions)

	FY2010	FY2011 (Request)	FY2012 (Request)
LWR SMR Licensing Technical Support	0	38.9	67.0
SMR Advanced Concepts R&D	0	Included In Above	28.7
Total	0	38.9	95.7

■ **Congressional action still pending on FY11 budget request**


- Affecting initiation of SMR activities

7

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LWR SMR Licensing Technical Support Timeline

■ **Timeline for developing competitive solicitation and issuing awards is ~6 months**



1 mo	<ul style="list-style-type: none"> • Release FOA • Prepare Merit Review Plan
2 mo	<ul style="list-style-type: none"> • Answer questions from interested parties • Letters of Intent Due
3 mo	<ul style="list-style-type: none"> • Receive Applications • Begin Review
4 mo	<ul style="list-style-type: none"> • Merit Review makes recommendations • Selection by SSO
5 mo	<ul style="list-style-type: none"> • Notify selected applicants • Collect missing documents and clarifications
6 mo	<ul style="list-style-type: none"> • Negotiations, as needed • Procurement Request/Budget Review


8

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SMR Research Focus Areas

■ **Initial planning (June 2010 workshop) has identified 5 potential technical areas:**

- **Instrumentation and Control/Human Machine Interface**
 - improved measurements, diagnostics and controls for SMR-specific environments
- **Assessment Methods**
 - Develop PRA capability and improved economic models
- **Materials, Fuels and Fabrication Technologies**
- **SMR Licensing Support**
 - Collaborate with the NRC, Nuclear Energy Institute (NEI) and American Nuclear Society (ANS) committees
- **Advanced Concept Evaluation**
 - Identify and assess the characteristics, capabilities, technologies and economic viability of advanced SMR designs



9

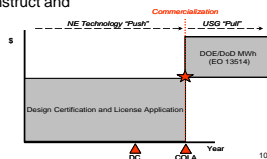
Dual Government Role for SMRs

Technology Push (DOE-NE)

- Public/private partnership to accelerate commercialization of LWR SMR designs
- Cost-share FOAK development and licensing activities
- Provide technical basis for regulatory framework

Technology Pull (DOE, DOD sites)

- Agencies enter into Power Purchase Agreements (PPA) for low-GHG electricity produced by SMRs
- PPA enables financing for a utility to construct and operate SMRs on or near federal sites



Benefits to the Nation

-- Return on Investment

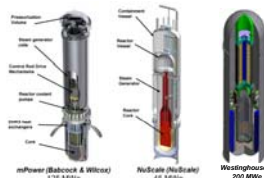
- Supports energy security, climate change mitigation and economic growth goals
- Regain technical leadership and innovation
- Improve U.S. manufacturing capability and supply chain infrastructure
- Create high-quality manufacturing, construction, and engineering jobs
- Become global leader in SMR technology based on mature nuclear infrastructure and NRC certified designs

"Most importantly, investing in nuclear energy will position America to lead in a growing industry Our choice is clear: develop these technologies today or import them tomorrow" – Secretary of Energy Steven Chu

Small Modular Reactor Concepts

Near-Term LWR Designs

- Well-understood technology
 - LWR based designs
 - Standard <5% UO₂ fuel
 - Regulatory & operating experience
 - Deployment in 10 years (2020)



Longer-Term SMRs

- Innovative technologies
 - Mostly non-LWR based designs
 - Deployment 15-20 years
- Broader applications
 - Process heat, transmutation
 - Transportable/mobile
 - Long-lived cores



Challenges

- Significant investment needed to reach commercialization
- Can the plants be built economically?
- Can the operations and maintenance costs be kept down?
- Innovative SMR concepts, systems or components will require safety, reliability and performance validation
- Some technical, policy or administrative issues will need to be addressed as part of the regulatory process for both LWR-SMRs and other advanced SMR concepts

13

Capital Cost Challenge -- Reducing financial risk

- "Typical" nuclear utility:
 - \$13 B per year revenues
 - \$13 B outstanding debt
 - \$40 B assets
 - \$17 B market capitalization
 - Would rank 173 on the Fortune 500 list
- Large nuclear power plant (~\$10 B) a difficult challenge
- Moody's 2009:
 - "We view new nuclear generation plants as a 'bet the farm' endeavor for most companies, due to the size of the investment and length of time needed to build a nuclear power facility."
 - Utilities should consider partnering with larger energy companies

14

Economies of Small and Modular

- Manufacturing Economies
 - Assembly line replication optimizes cost, schedule, and quality through greater standardization of components and processes
 - Analysis of navy shipbuilding validates "nth" of a kind optimization
- Production "Skill of the Craft" Economies
 - Economic learning through replication
 - Increased skilled workforce retention with order backlog and diverse jobs
- Modular Construction Economies
 - Prefabrication and modular construction optimizes on-site construction schedules and improves installation quality
 - Reduced schedule and cost uncertainties

15

“Complexity” Versus “Simplicity”

Onsite Construction – “Complexity”



Transport SMR to Site
“Simplicity”



16

SECY-10-0034 High Priority Items

SECY	Title	NGNP	NEI
2.1	Prototype Rx Licensing	None planned	
3.1	Defense-in-Depth	Submitted	
3.2	Use of PRA	FY-2011	
3.3	Source Terms	Submitted	FY-2011
3.4.a	Core Composition & Source Term	Submitted	
3.4.b	Accident Selection	Submitted	
3.4.c	Redundancy of Passive RHR Systems	Design needed	
3.4.d	SSC Classification	Submitted	
3.4.e	Containment Capability	Submitted	
4.1	Control Room Staffing	Design needed	FY-2011
4.3	Rx Installation During Operations	Coord. with NEI	
4.4	Co-Location at Industrial Site	FY-2011	
4.5	Security & Safeguards	Coord. With NEI	FY-2011
4.6	Aircraft Impact	Coord. With NEI	FY-2011
4.7	Emergency Planning	Submitted	FY-2011

17

International Markets

- Many countries have either indicated interest in deploying SMRs and/or indicated interest in nuclear energy as a feasible energy option
- Several nations are developing SMR concepts to satisfy a potentially lucrative international market
- International challenges to deploying U.S. SMR's designs to global markets:
 - Lack of international harmonization of nuclear industry, licensing standards and regulatory infrastructure
 - Lack of nuclear liability regime
 - Existing U.S. government policies and procedures (e.g., 123 Agreement) can be time consuming and complicated

18

Path Forward

- Establish cooperative agreements to provide cost-share assistance for first-of-a-kind engineering, licensing and design certification activities
- Support development of new/revised industry codes and standards necessary to support SMR licensing and commercialization
- Prioritize R&D needs to support SMR development
- Evaluate feasibility of advanced SMR concepts

Summary

- There is growing interest in SMRs potential to satisfy several market demands and address some key issues to new nuclear deployment
- The proposed DOE program supports near-term deployment of mature designs and development of longer-term advanced concepts
- The Federal Government can play an appropriate role in accelerating deployment
- Commercial deployment of U.S. SMR technology will help position America to lead the global clean energy economy
 - Reestablish U.S. technical leadership and innovation
 - Create high quality jobs
 - Improve U.S. global competitiveness
