Status of Light Water Reactor (LWR) Activities in the US

Presented to the
IAEA TWG-LWR

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Maximizing the Use of Existing Nuclear Plants

- **Currently, 104 operating nuclear plants provide 100 GWe of capacity which is about 20% of U.S. electric generation and over 70% of emission-free generation**
- **License Renewal – originally licensed for 40 years**
  - Nearly all existing plants expected to operate 60 years
- **Fleet maintaining greater than 90% average capacity factors**
- **Power up-rates continue**
  - 5,726 MWe added since 1977
  - 1,145 MWe currently in NRC review
  - 2,419 MWe additional up-rate capacity expected between 2010 – 2014
- **Utilities using prior nuclear investments**
  - Browns Ferry Unit 1 (Alabama) resumed operation
  - Watts Bar Unit 2 (Tennessee) restarted construction
  - Consideration being given for Bellefonte 1&2 (Alabama) construction restart

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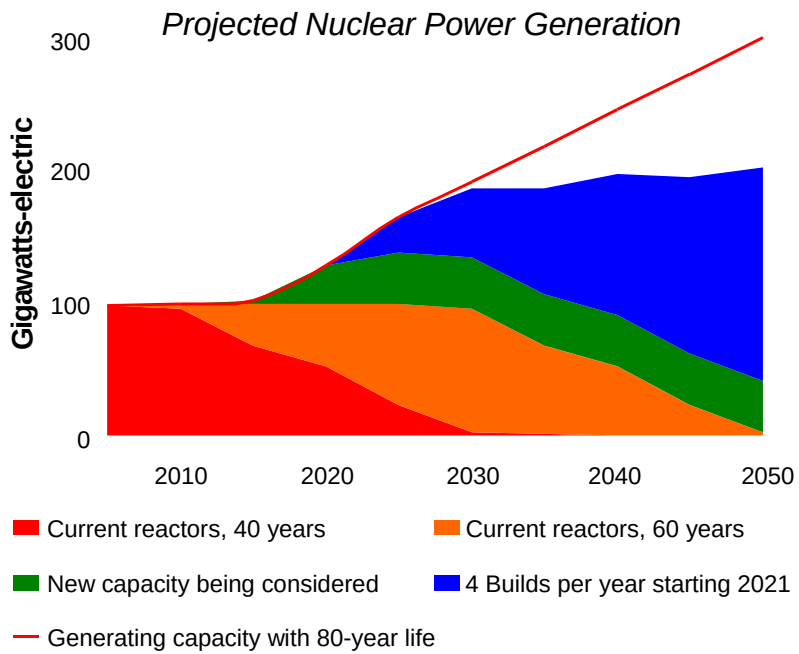
The National Interest

- **EIA AEO 2010 reference case has U.S. electricity demand expected to increase ~30% by 2035 (~1% per year)**
  - Reference case has only 6 new plants completed by 2035.
- **Nuclear generation is critical to:**
  - Reduce greenhouse gases
  - Meet electricity demand
  - Ensure energy supply security and grid reliability
  - Stabilize energy prices
- **Current nuclear plants would retire between 2029 – 2056 without second license renewal**
  - New nuclear build rate will not replace plant retirements
  - Cost to replace the current fleet exceeds $600B
  - Steep reduction in emission-free generation
- **Existing reactors reduce burden of new clean electricity that will need to come online**



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Nuclear Energy Support

"But to create more of these clean energy jobs, we need more production, more efficiency, more incentives. And that means building a new generation of safe, clean nuclear power plants in this country."

President Obama from the State of the Union,
January 27, 2010

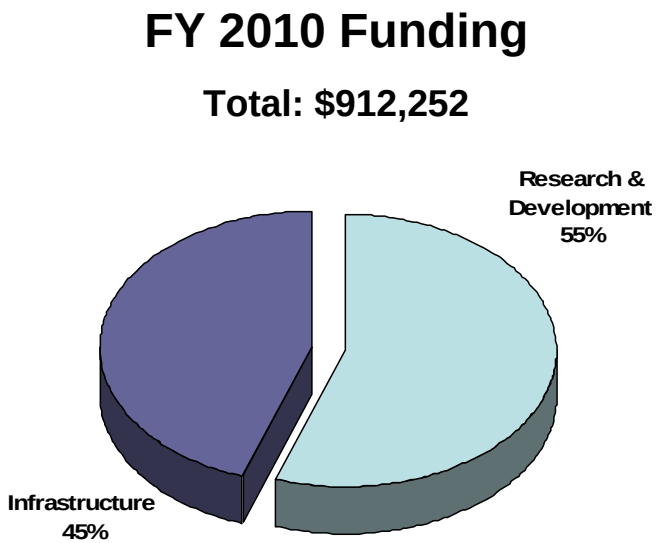
"President Obama and I are committed to restarting the nuclear industry in the United States."

Secretary Chu at the American Nuclear Society Meeting,
November 16, 2009

FY2011 Budget Request Breakdown ($k)

Program:	FY 2010 Approp	FY 2011 Request
Research & Development		
Nuclear Energy Enabling Technologies	0	99,300[a]
Integrated University Program	5,000	0
Re-Energyse	0	5,000
Reactor Concepts RD&D	0	195,000[a]
Generation IV Nuclear Energy Systems	220,137	0
Nuclear Power 2010	105,000	0
Fuel Cycle Research and Development	136,000	201,000[a]
International Nuclear Energy Cooperation	0	3,000
Infrastructure		
Radiological Facilities Management	72, 000	66,818
Idaho Facilities Management	173,000	162,482
Idaho Sitewide S&S	83,358	88,200
Program Direction	73,000	91,452
Congressionally Directed Projects	2,500	0
Total NE:	869,995	912,252

a) up to 20% of R&D funds are competitively awarded to universities



Nuclear Energy Enabling Technologies

Budget Summary
$ in thousands

Program Element	FY 2010 Approp	FY 2011 Request
Crosscutting Technology Development	0	43,332
Transformative Nuclear Concepts R&D	0	28,888
Energy Innovation Hub for Modeling & Simulation	21,384[a]	24,300
SBIR/STTR	0	2,780
Total:	**21,384**	**99,300**

a) FY2010 funding was in Generation IV Nuclear Energy Systems Program

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Reactor Concepts Research, Development, and Demonstration

Budget Summary
$ in thousands

Program Element	FY 2010 Approp	FY 2011 Request
Small Modular Reactors (SMR)	0	38,880
Next Generation Nuclear Plant (NGNP) Demonstration Project	164,268[a]	103,032
Light Water Reactor Sustainability	9,700[a]	25,758
Advanced Reactor Concepts (formerly Gen IV R&D)	18,261[a]	21,870
SBIR/STTR	6,164[a]	5,460
Total:	**198,753[a]**	**195,000**

a) FY2010 funding was in Generation IV Nuclear Energy Systems Program

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The Light Water Reactor Sustainability (LWRS) Program

Vision

- **Enable existing nuclear power plants to safely provide clean and affordable electricity beyond current license periods (beyond 60 years)**

Program Goals

- **Develop fundamental scientific basis to allow continued long-term operation of existing LWRs**
- **Develop technical and operational improvements that contribute to long-term economic viability of existing nuclear power plants**

Scope

- **Materials Aging and Degradation**
- **Risk-Informed Safety Margin Characterization**
- **Advanced Instrumentation and Controls**
- **Advanced Fuel Development**
- **Economics and Efficiency improvements**

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Current LWR Issues

- **Degradation of buried pipes**
- **Cyber Security**
- **Digital Upgrades to Instrumentation and Control**
- **Moisture Effects on Underground Cables**
- **Containment Sump Clogging**
- **Gas Voiding Issues**

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Nuclear Power 2010

- Updated status available at: http://nuclear.energy.gov/ under “Nuclear Power Deployment Scorecard”
- Early Site Permits (ESPs): 3 issued by NRC, 1 under review
- Design Certifications:
  - 4 certified (System 80+, ABWR, AP600, AP1000)
  - 4 under review (AP1000 amendment, ESBWR, US-EPR, US-APWR)
- Construction and Operating License Applications:
  - 17 submitted for 26 reactors, 13 remain under active NRC review
  - 4 Engineering, Procurement, and Construction contracts signed (Vogtle, Summer, STP, & Levy)
- Federal Financial Incentives
  - Standby Support (delay risk insurance)
  - Production Tax Credits
  - Loan Guarantees: $18.5 Billion available, conditional agreement of $8.33 billion in loan guarantees for two AP1000 reactors at Vogtle

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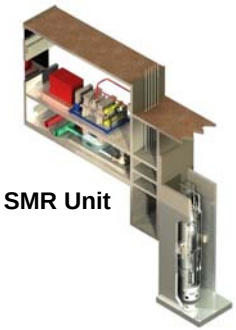
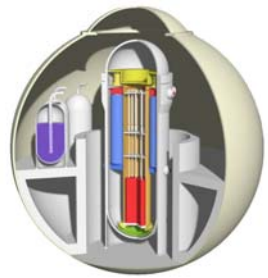
DOE is developing a small modular reactor (SMR) program that will begin in FY11

- SMRs are defined as reactor units that are 300 MWe or less and can be factory fabricated and shipped to the site by road, rail or barge
- SMR technologies and expected time to deployment
  - Light Water-cooled - 5-10 years
  - Non-LWR fast reactor designs (liquid metal or gas) - 10-15 years
  - Advanced designs (molten salt or others?) - 15 years +
- SMR operational benefits
  - Safe – employ passive safety systems, lower core damage frequency
  - Secure – below grade emplacement
  - Simple – less components and cabling, factory fabrication and reduced construction times
  - Flexible – can support remote areas of grid, provide process heat for manufacturing or industrial requirements
- SMR economic benefits
  - Expected to be competitive with large LWR costs/KWe ($4-5K/KWe)
  - Lower initial construction costs, opportunity to stagger units
  - Electrical capacity can be added in smaller increments to match demand growth



NuScale SMR Unit



Westinghouse IRIS SMR Unit

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SMRs Continued

- Industry has been actively working several designs
  - B&W – mPower (125 MW LWR)
  - Westinghouse – IRIS (~300 MW LWR)
  - NuScale – NuScale Power Unit (45 MW LWR)
  - General Electric – PRISM (~300 MW LMFR)
  - Hyperion (27 MW LMFR)
  - Toshiba – 4S (10 MW LMFR)
- Congress has introduced a number of bills supporting the development of SMRs
- The FY11 DOE SMR program intends to:
  - Support the design certification and eventual commercialization of up to 2 LWR SMR designs
  - Support industry R&D needs to enable and accelerate licensing and deployment of both near- and longer-term and SMR designs
  - Support the resolution of licensing and codes & standards issues impacting SMR deployment

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Future of LWRs

Light Water Reactors will remain the dominant power reactor technology for the foreseeable future.

<u>Near term</u>:

- **Power up-rates**
- **Digital Instrumentation and Controls replacements and backfits**
- **Plant aging issues**

<u>Longer term</u>:

- **Water use issues (cooling can consume large quantities of fresh water)**
- **Plant aging issues**
- **New fuel designs**
- **New plant designs with lower capital construction costs including small modular reactors**

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Proposed future IAEA activity

<u>Other Potential Topics</u>:

- **Power Up-rates (Issues, lessons learned)**
- **Novel LWR Fuel Designs**
- **Deployment of small-modular reactors**
- **New Construction lessons learned report**
- **Instrumentation, Control and Monitoring system upgrades lessons learned**
- **Issues with water usage**