Small Modular Reactors Maintaining Options for Missouri

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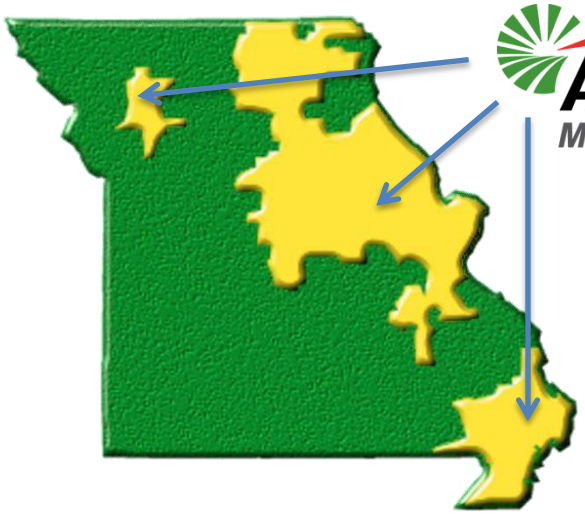
Manager, Nuclear Development

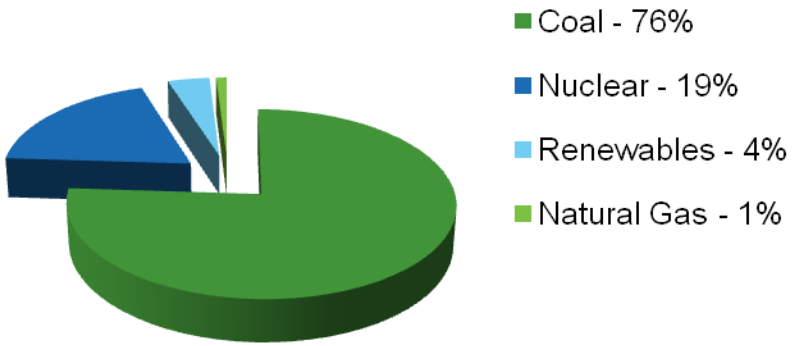
Ameren Missouri

Ameren Missouri Overview

- Regulated electric generation, transmission and distribution; gas distribution
- 1.2 million electric and 127,000 gas customers
- 24,000 square miles of service territory
  - 2,900 miles of electric transmission lines
  - 33,000 miles of electric distribution lines
- 10,400 megawatts (MW) of generation
  - Low-cost 6,600 MW baseload coal-fired and nuclear fleet
  - Coal fleet availability is consistently near or in top 25% in the US
- Reliable energy supply
- Low customer rates



2011 Fuel Mix



AMEREN MISSOURI GENERATION…over 10,000 MW

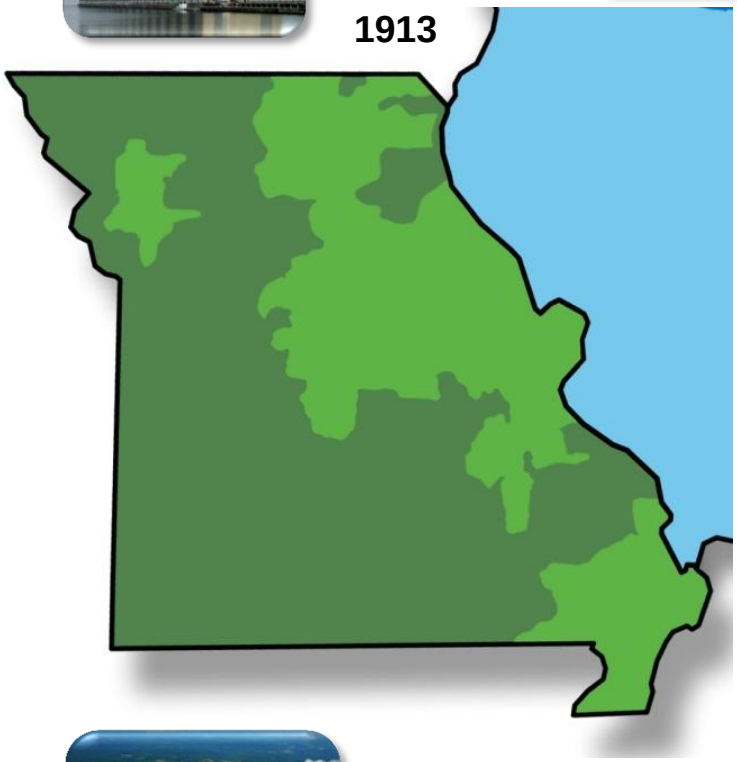
Meramec
STL Co.
839 MW
1953

Sioux
St. Charles Co.
986 MW
1967

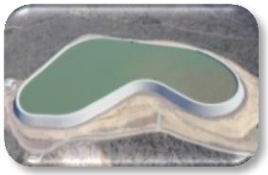
Labadie
Franklin Co.
2,407 MW
1970

Rush Island
Jefferson Co.
1,204 MW
1976

Keokuk
Iowa
137 MW
1913



CTGs
MO & IL
2,966 MW



Taum Sauk
Reynolds Co.
440 MW
1963 & 2010

Osage
Lakeside, MO
234 MW
1931

Callaway
Callaway Co.
1,200 MW
1984

galvin center for electricity innovation at ILLINOIS INSTITUTE OF TECHNOLOGY

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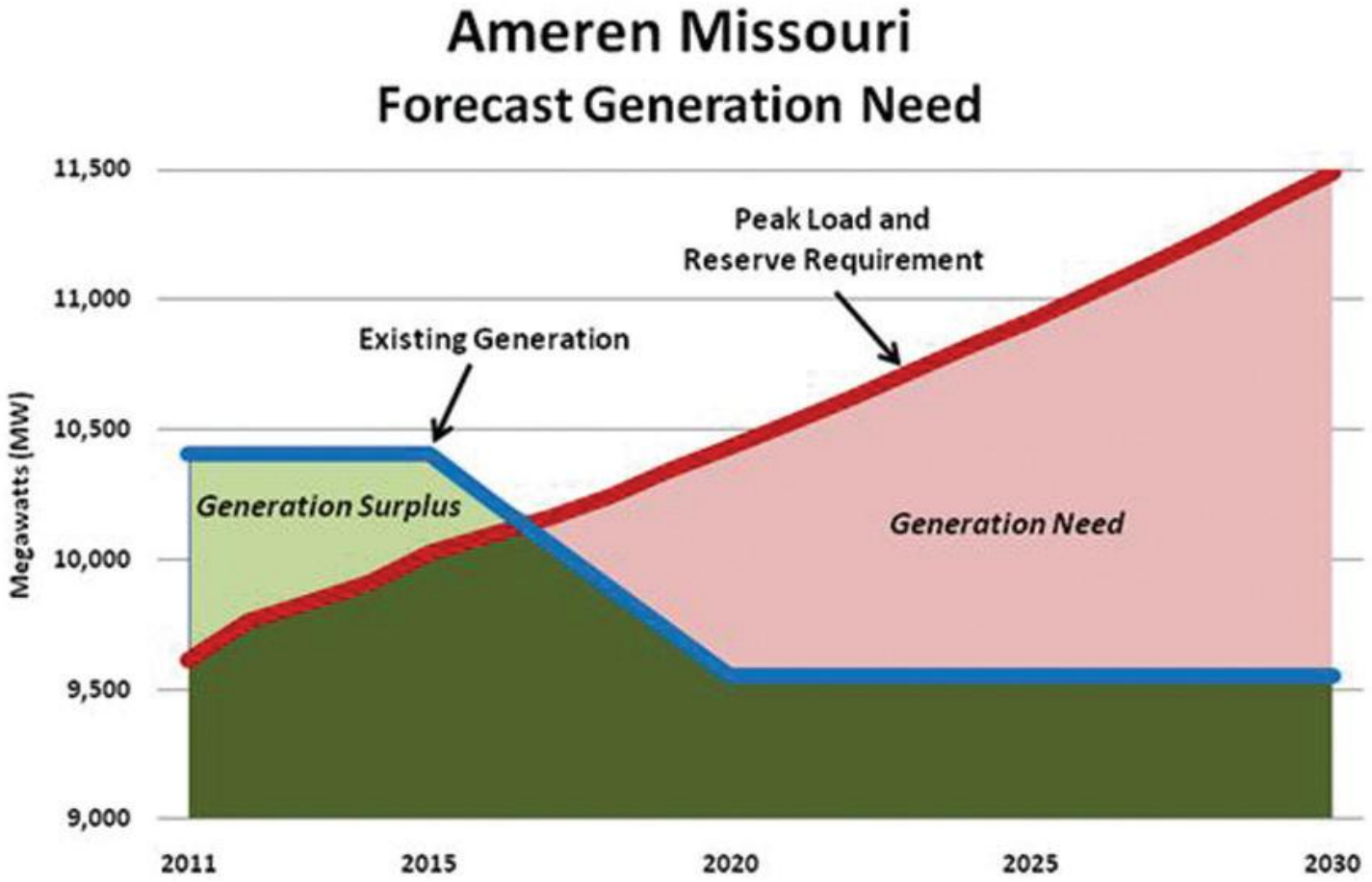
AMEREN MISSOURI – PLANNING FOR THE FUTURE



MISSOURI UTILITES FORM PARTNERSHIP FOR NUCLEAR LICENSING ACTIVITIES

- All six of Missouri's electric utility providers formed a partnership in November 2010; it is comprised of Missouri's investor-owned, rural electric cooperatives and municipal utilities. We have joined together to pursue state legislation in support of obtaining the necessary permits to build additional nuclear generation at the Callaway Plant site. Small Modular Reactors have a high level of interest among this group.

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Association of Missouri Electric Cooperatives
A Touchstone Energy® Cooperative

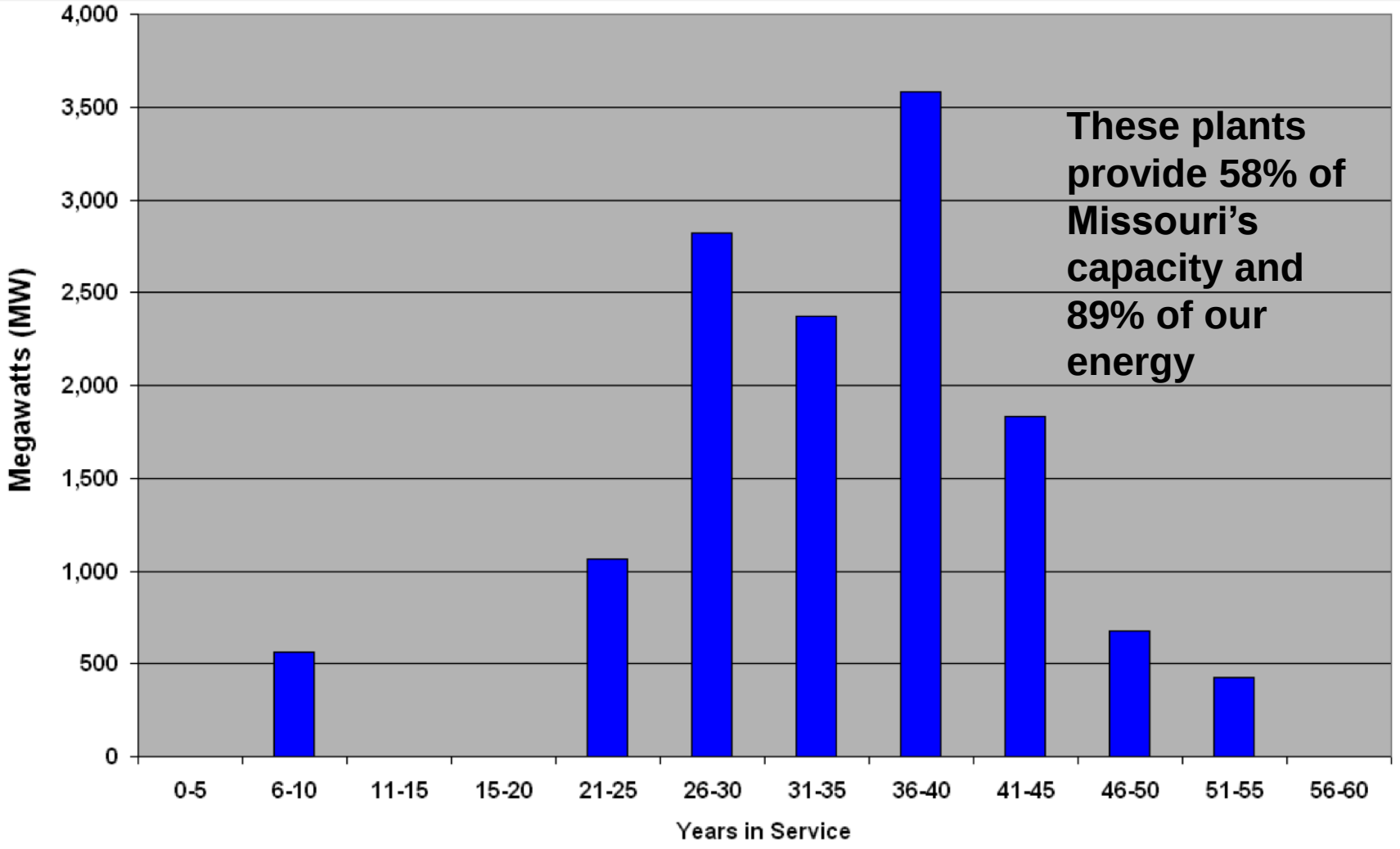
EMPIRE
SERVICES YOU COUNT ON

Ameren MISSOURI

MPUA
Missouri Public Utility Alliance

KCP&L
energizing life

MISSOURI'S AGING POWER PLANT FLEET



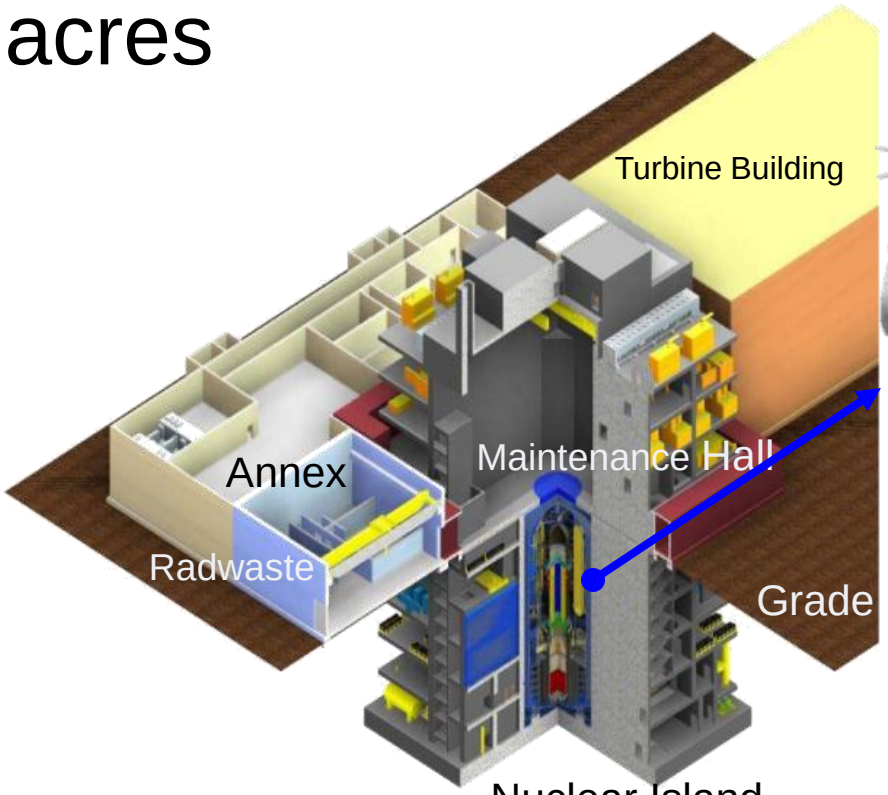
SMR PROGRAM GOALS & OBJECTIVES

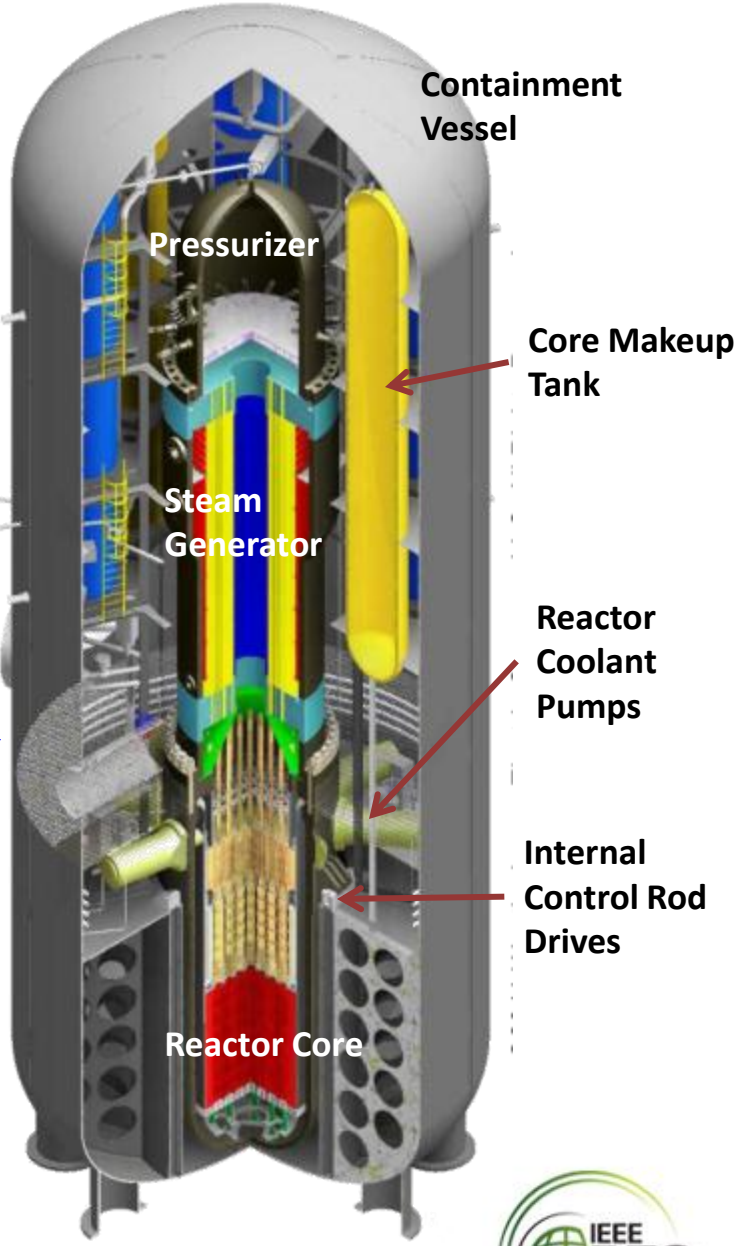
The SMR Program encourages U.S. industry to compete in the global marketplace by removing various barriers to reactor deployment and to accelerate development because DOE anticipates that NRC design certification will result in a competitive advantage over designs being developed in other countries.

U.S.NRC

SMR Plant Design

- Total land area: <15 acres

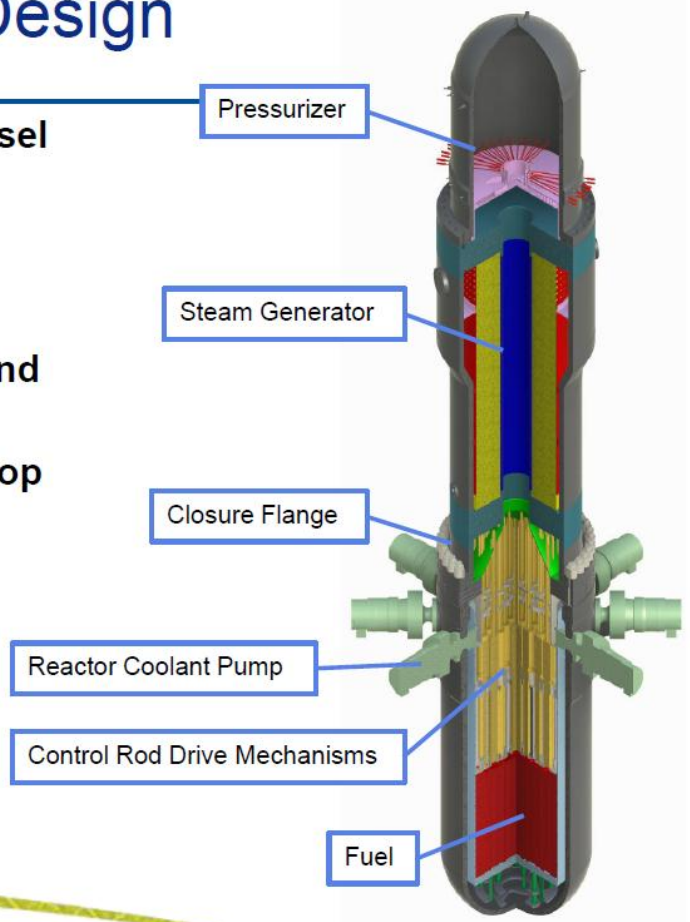




COMPACT DESIGN – MOST POWER FOR LEAST MATERIAL

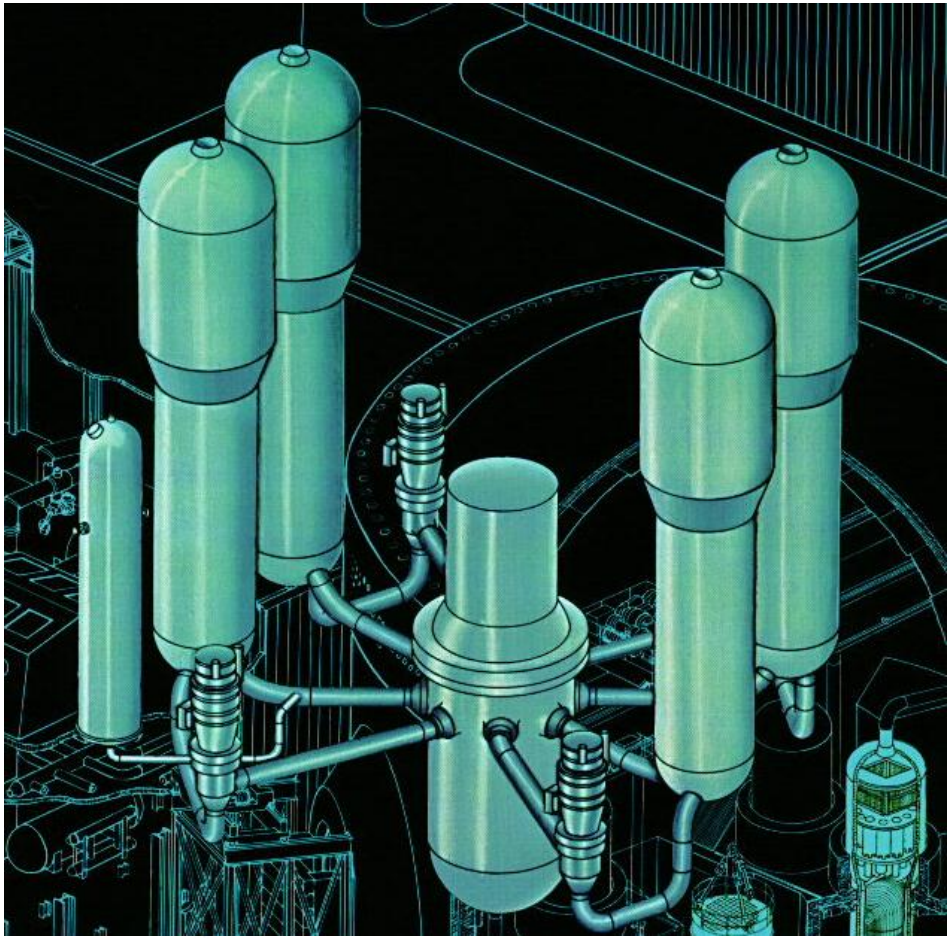
Integral PWR Reactor Design

- **ASME Section III Subsection NB Vessel**
- **Maximum flange diameter of 12 ft**
- **Reactor height ~81 ft**
- **Design flow rate of 100,000 gpm**
- **37 internal control rods (shutdown and control)**
- **Integral reactor with no large bore loop piping**
- **Straight tube steam generator with external circulation**
- **No penetrations below top of core**
  - In-vessel retention for severe accidents

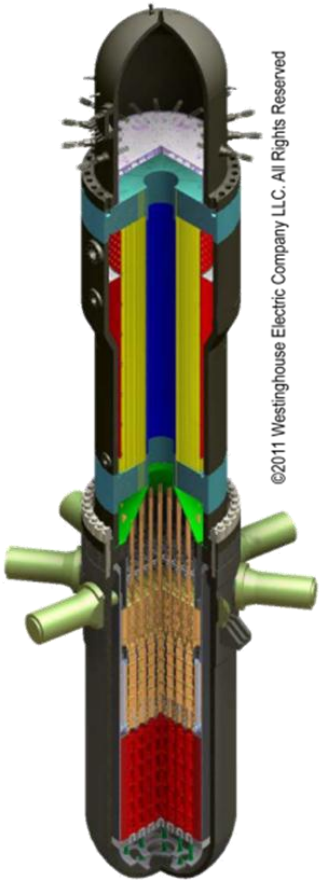


Westinghouse

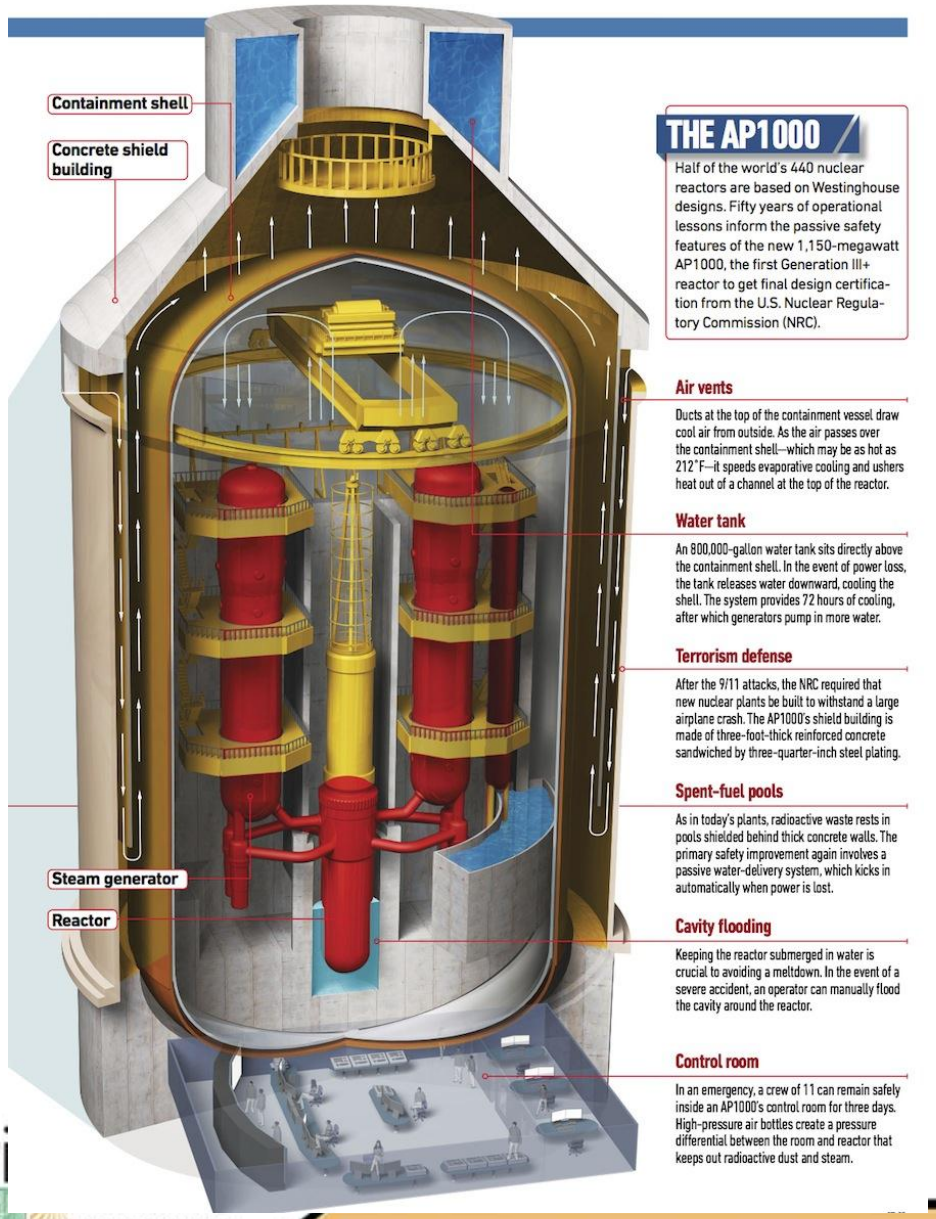
Large PWR plant design vs. Integral PWR Design



Nuclear
Power
Simplified



Compact Design – Most power for least material



THE AP1000

Half of the world's 440 nuclear reactors are based on Westinghouse designs. Fifty years of operational lessons inform the passive safety features of the new 1,150-megawatt AP1000, the first Generation III+ reactor to get final design certification from the U.S. Nuclear Regulatory Commission (NRC).

Air vents

Ducts at the top of the containment vessel draw cool air from outside. As the air passes over the containment shell—which may be as hot as 212°F—it speeds evaporative cooling and ushers heat out of a channel at the top of the reactor.

Water tank

An 800,000-gallon water tank sits directly above the containment shell. In the event of power loss, the tank releases water downward, cooling the shell. The system provides 72 hours of cooling, after which generators pump in more water.

Terrorism defense

After the 9/11 attacks, the NRC required that new nuclear plants be built to withstand a large airplane crash. The AP1000's shield building is made of three-foot-thick reinforced concrete sandwiched by three-quarter-inch steel plating.

Spent-fuel pools

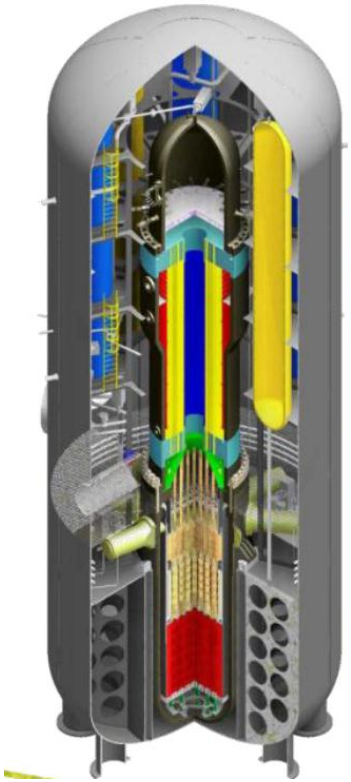
As in today's plants, radioactive waste rests in pools shielded behind thick concrete walls. The primary safety improvement again involves a passive water-delivery system, which kicks in automatically when power is lost.

Cavity flooding

Keeping the reactor submerged in water is crucial to avoiding a meltdown. In the event of a severe accident, an operator can manually flood the cavity around the reactor.

Control room

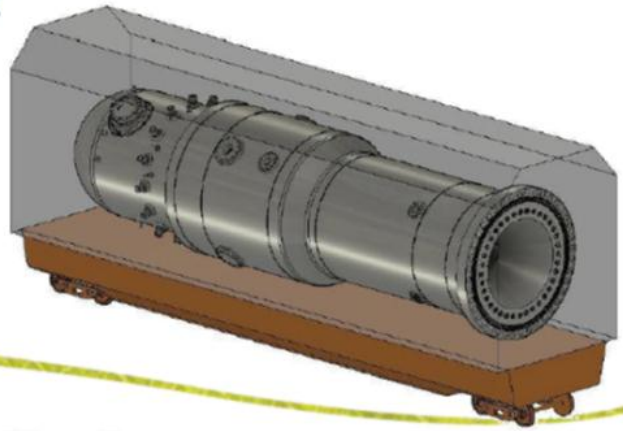
In an emergency, a crew of 11 can remain safely inside an AP1000's control room for three days. High-pressure air bottles create a pressure differential between the room and reactor that keeps out radioactive dust and steam.



Modular Construction reduces cost

Modular Construction

- **Economies of scale challenge from large reactors can be countered with modular construction**
- **SMR maximizes modular design in all aspects of plant**
- **Modular design drives work normally completed at the construction site to the factory where quality is increased and overall cost are reduced**
- **Modules are designed for road and rail transport to site and scalable to other forms of transport**



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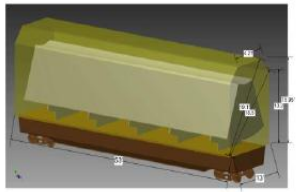
Modular Construction reduces cost

Modular Design Goal:
Increase Factory Fabrication and Reduce Schedule

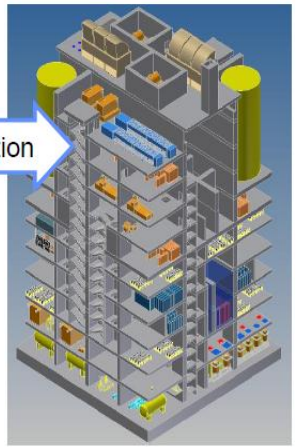
Shipping Limitations



Crane Capacity

Qualified Joints

Modules Factory Costx1 → Shipping → Staging Area Costx3 → Handling → In Situ Costx8 → Integration



Reduced Construction Schedule

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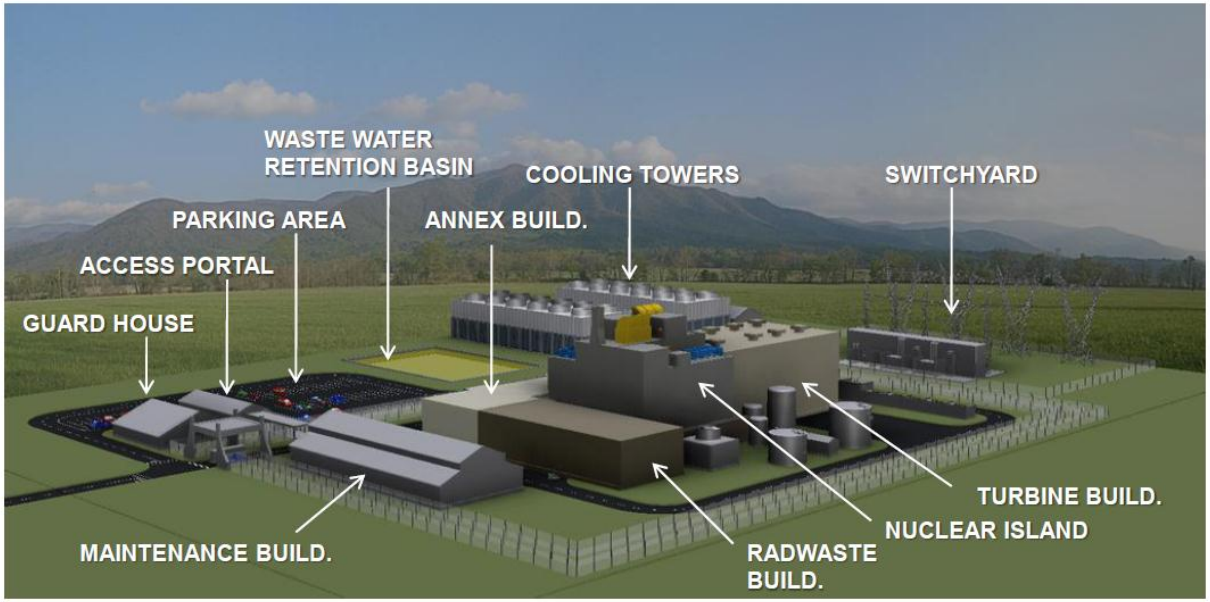
Small Foot Print – 15 acres

Site Layout – General Characteristics



ECONOMIC DEVELOPMENT OPPORTUNITIES CREATED BY DOE INVESTMENT FUNDS

- Foundation for U.S. Leadership in Next Generation Nuclear Energy Industry
  - Estimated Economic Impact of nearly $3 billion[1] in greater than 15 states
  - Stimulate greater than 9500 direct U.S. Jobs
  - Sustain greater than 9000 indirect U.S. Jobs
  - Employs 250-300 permanent jobs at the plant site

- Establish Missouri as Hub for SMR Technology
  - Supply Chain Opportunities for Missouri Manufacturers
  - Alignment with Missouri University Research and Workforce Development
  - Building the SMR Industry Cluster

[1]Based on independent economic impact analysis on U.S. economy for single SMR unit – Development Strategies, May 2012

Good Paying American Jobs!!

Westinghouse

Westinghouse Electric Company LLC at ILLINOIS INSTITUTE OF TECHNOLOGY

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The US has built small reactors before
Back when it was called “Atomic Power”

- Atomic Energy Act of 1954 promotes the use of private sector use of nuclear energy in the US

- AEC Power Reactor Demonstration Project initiated in 1955 to stimulate construction of new nuclear power plants

- This federal government program subsidized the construction of the reactor portion of the plant.

Big Rock Point – 67MWe
Online -1962
Shutdown - 1997

QUESTIONS?