

Deployment of Nuclear Energy Systems

Historical “Food for Thought”

Andrew Sowder, Ph.D., CHP
Technical Executive
Advanced Nuclear Technology

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Four Technologies Reach Global Commercial Deployment

- Commercialization resulted from close government and private sector collaboration
- Government sponsorship of basic and applied R&D
- Government involvement continued well into commercial deployment (3 of 4 designs)
- Government support also extended to A/E and design firms to accelerate test and demo units
- Governments and private interests utilized a range of collaborative and financing vehicles
- **Reactor capacity increased incrementally...and over a short timeframe**



PWRs/VVERs



BWRs

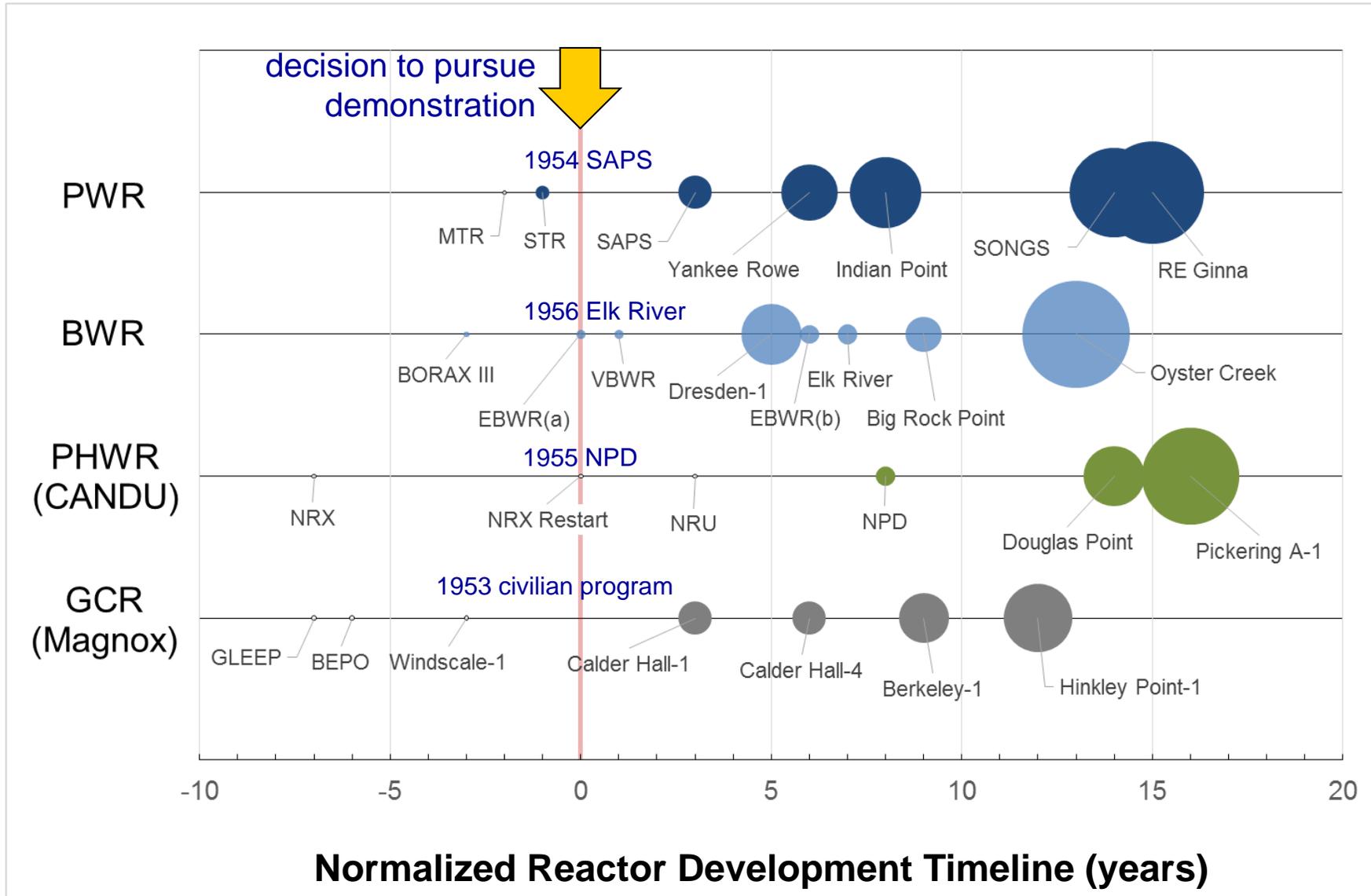


MAGNOX/AGRs

PHWRs/CANDUs



Commercialization Resulted From Progressive Scale-Up



Lead Times

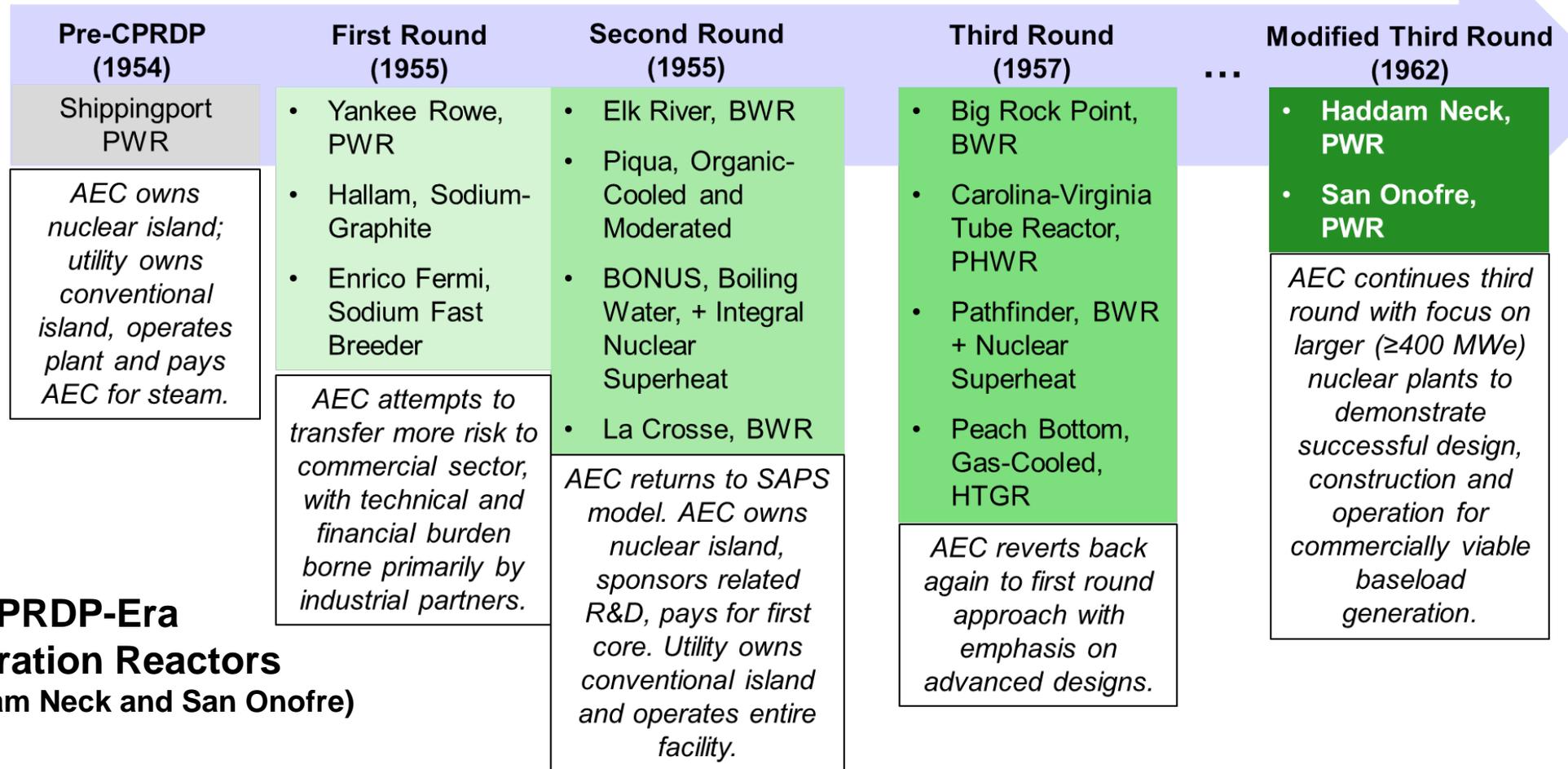
- U.S. PWR → 15 yrs
- U.S. BWR → 13 yrs
- Canada CANDU → 16 yrs
- UK GCR → 12 yrs

Government and Industry Roles in Commercialization (PWRs, BWRs, PHWRs and GCRs)

Activity	Test Reactors	Small Demonstration Reactors	Large Demonstration Reactors	First Commercial Reactors
Site Acquisition	Predominately Government	Majority Industry	Majority Industry	Predominately Industry
Nuclear Island Owner	Predominately Government	Predominately Government	Government and Industry	Predominately Industry
Conventional Island Owner	Predominately Government	Majority Industry	Majority Industry	Predominately Industry
Pre-Construction R&D	Predominately Government	Government and Industry	Government and Industry	Government and Industry
Post-Construction R&D	Predominately Government	Government and Industry	Government and Industry	Majority Industry
Nuclear Island Design	Majority Government	Government and Industry	Government and Industry	Government and Industry
Conventional Island Design	Government and Industry	Majority Industry	Majority Industry	Government and Industry
Fuel Design	Predominately Government	Government and Industry	Government and Industry	Government and Industry
Fuel Fabrication and/or Supply	Predominately Government	Predominately Government	Majority Government	Government and Industry
Nuclear Island Operator	Government and Industry	Majority Industry	Predominately Industry	Predominately Industry
Conventional Island Operator	Government and Industry	Majority Industry	Predominately Industry	Predominately Industry
Nuclear Island Constructor	Government and Industry	Government and Industry	Predominately Industry	Predominately Industry
Conventional Island Constructor	Government and Industry	Predominately Industry	Predominately Industry	Predominately Industry
Rate Assistance	Insufficient Data	Limited Data: Gov't & Industry	Limited Data: Gov't & Industry	Limited Data: Gov't & Industry

LEGEND	
	Predominately Government
	Majority Government
	Government and Industry
	Majority Industry
	Predominately Industry
	Limited Data: Gov't & Industry
	Insufficient Data

U.S. Cooperative Power Reactor Demonstration Program (CPRDP)

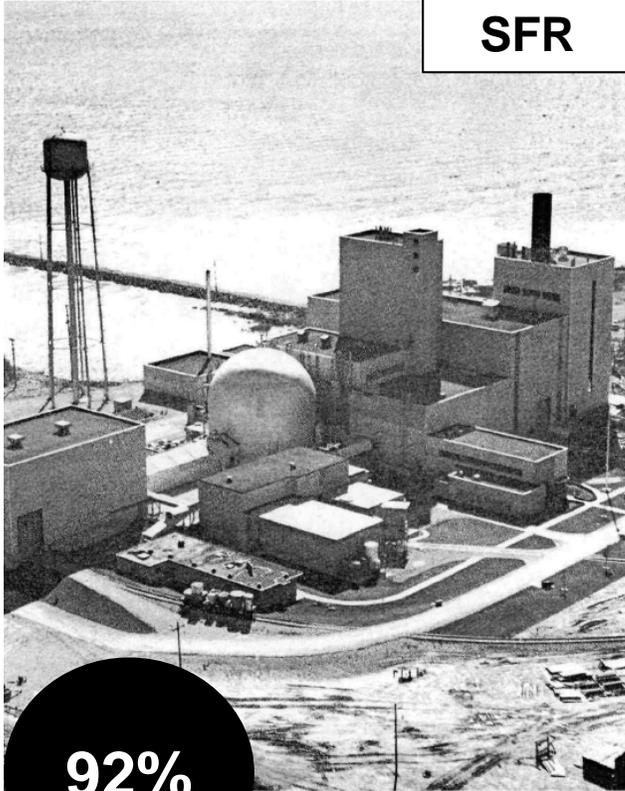


Twelve CPRDP-Era Demonstration Reactors (Plus Haddam Neck and San Onofre)

U.S. AEC and industry pursued a range of public-private partnership models.

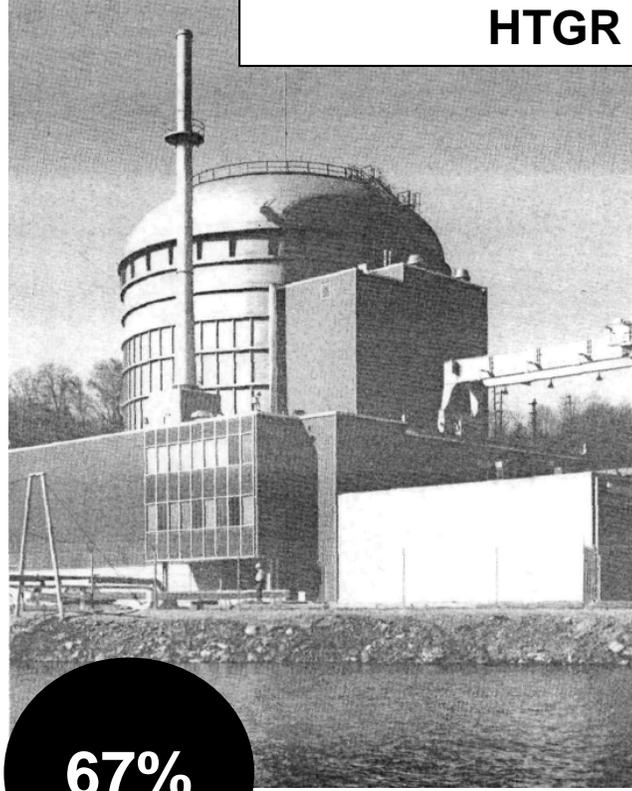
U.S. Non-LWRs Built with >50% Industry Investment

Fermi 1
SFR



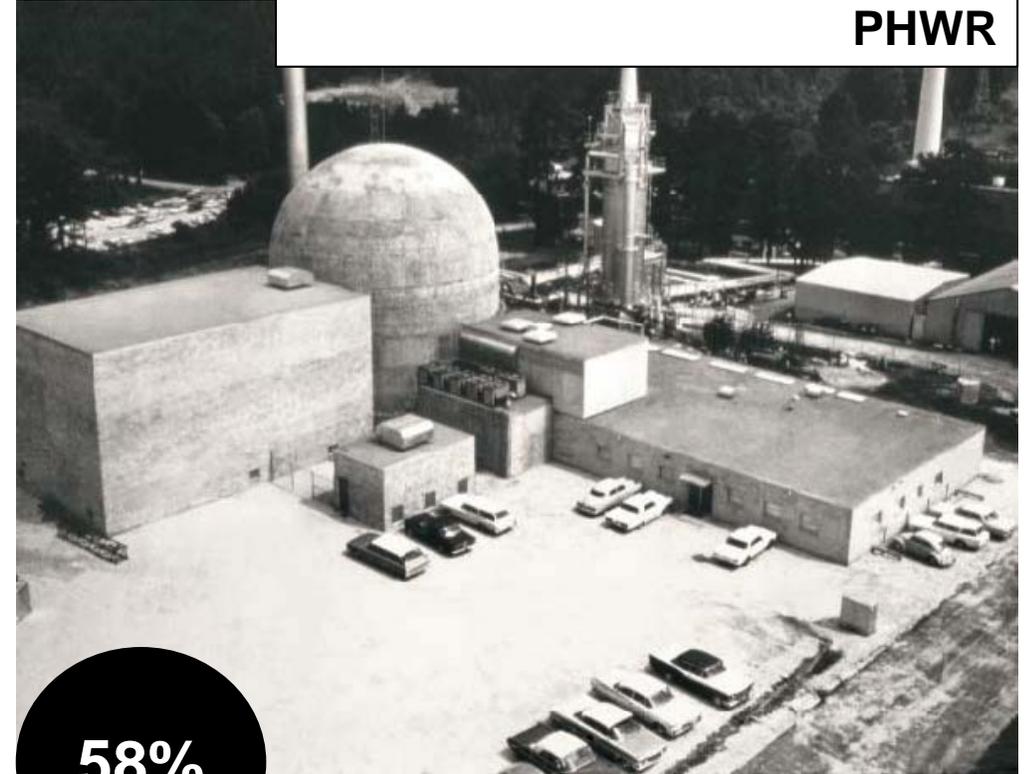
92%

Peach Bottom 1
HTGR



67%

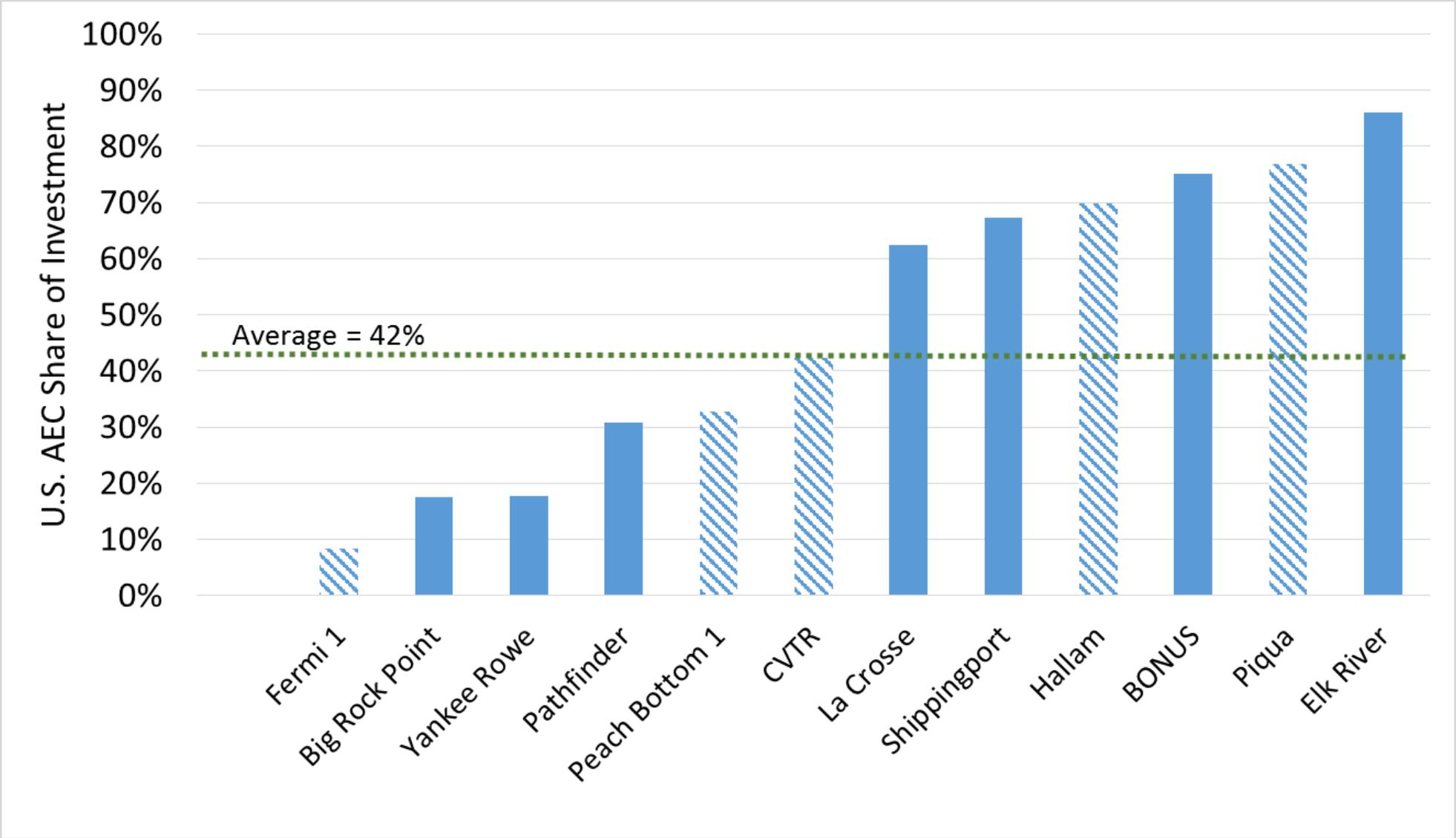
Carolina-Virginia Tube Reactor
PHWR



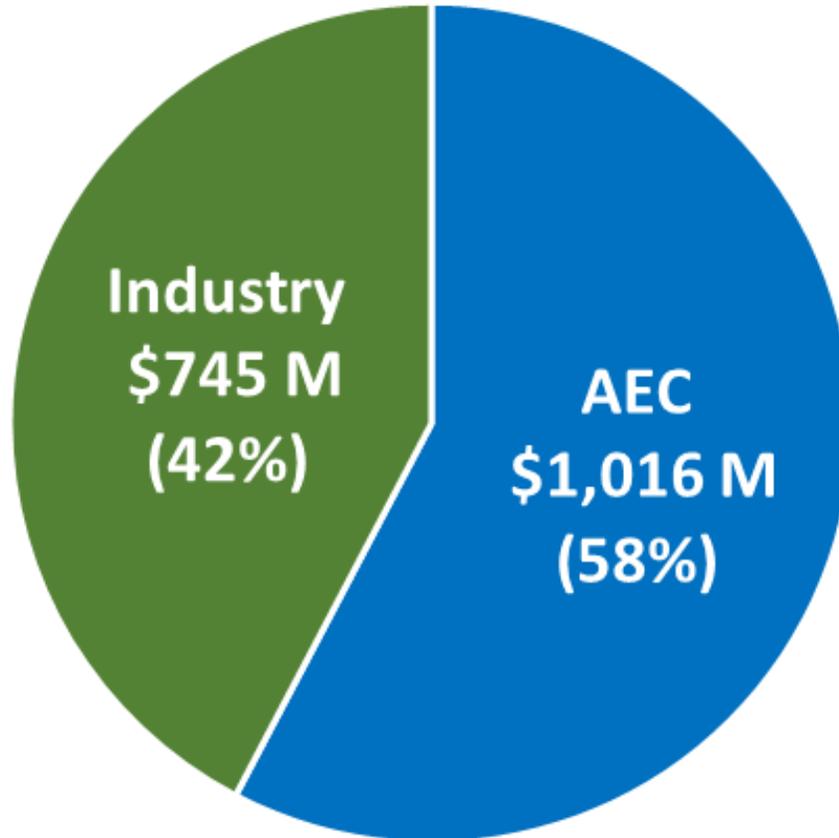
58%

Images from U.S. Atomic Energy Commission (1967)

Public and Private Investment for CPRDP-Era Reactors



Cumulative Public and Private Sector Investment in U.S. Nuclear Power Through 1962



Categories
Civilian Reactor R&D
CPRDP Demonstration Reactors (Rounds 1 -3)
Privately Financed Reactors
Commercial-scale CPRDP Reactors (Modified Round 3)
New AEC Test Reactors
Private Sector Test Reactors
Cooperatively Financed Test Reactors
Industrial Participation

Total estimated U.S. investment = \$1.76 billion (~ \$11 billion in 2017 USD)

Closing Thoughts

- Caveat: “Past performance does not guarantee future returns.”
- Public-private partnerships during original nuclear commercialization period varied (not “one-size fits all”)
 - public investment through demonstration remained substantial
 - industrial investment in demonstrations was significant, often dominant
- Successful commercialization progressed through incremental scale-up and included early industry involvement
- Investment required for demonstration of new technology measured in billions of USD

Government and Industry Roles in the Research, Development, Demonstration, and Deployment of Commercial Nuclear Reactors: Historical Review and Analysis

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