A Vital Energy Option at Risk??
The Japan and U.S. Nuclear Energy Industries

Dr. Peter B. Lyons
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Comparing Nuclear Power Programs

Risk area highlighted.

**United States**
- About 20% of U.S. electricity generation from 99 plants
- Over 60% of U.S. C-free electricity
- Capacity factors over 90%
- 87 of 99 plants have license extensions to 60 years of operation.
- But 6 U.S. nuclear plants closed.
  - more are under threat to close due to economic pressures.
- 4 modern passive AP1000 plants are under construction

**Japan**
- <2% of electricity generation
- 26 plants applied for restart
- 10 plants approved for restart
- 3 plants actually operating
  - Takahama 3 and 4 restart approved.
  - Four plants close to restart approval.
- 3 reactors approved for 60 year operation
- 3 reactors under construction in Japan.

Data as of March 28, 2017
Cost and Schedule Challenges

- "capital cost .. in the U.S. is … $5-6000/kWe, .. experience of South Korea suggests that .. $2500/kWe [is] possible."¹
  - South Korea has maintained a strong construction program!
  - Current U.S./Japan AP1000 experience shows even higher costs.

- Japan, South Korea, China, Russia – all built NPPs under 4 years.
  - But AP1000 current experience is 7-9 years for construction.

- U.S. (and maybe Japan’s?) nuclear supply chain has not been adequately exercised and maintained in recent years.

- Construction experience and active supply chain are essential!

In my view, AP1000 design is NOT the problem

Issues with U.S. Nuclear Power
Failure of “competitive” (deregulated) markets

• Deregulation has seriously complicated U.S. electricity markets
  – No future planning in fully deregulated states. Focus on lowest cost only!
  – U.S. rates in deregulated states vary widely.
  • Some deregulated states’ rates are comparable to regulated states’ rates at 9-10 cents/kWhr.
  • Some U.S. deregulated states’ rates are highest in nation.
    – Connecticut 17.7, Rhode Island 17.0, New York 15.3, California 15.4 cents/kWhr.
• In U.S., solar and wind receive significant incentives from renewable mandate programs as well as federal production tax credits.
  – “In New England, .. over 70% of revenues for ..wind and solar units in 2015-16 were federal/state programs… investment/production tax credits… renewable energy credits.”
• Six nuclear plants closed, more scheduled for closure.
• Toshiba/Westinghouse financial issues seriously cloud nuclear issues

1 America’s Hidden Energy Crisis, Copyright 2017 by Richard J. Myers
Japanese People and Economy Require Nuclear Power!!

- Japan has lost global leadership in nuclear plant construction and in climate change
  - Japanese emissions: kg-CO$_2$/kWh (from IEEJ):
    2013 - 0.57, 2014 - 0.55, 2015 - .53
- Japanese public remain unsupportive of nuclear energy and concerned with safety.
- Germany in 2016 emitted 560 g/kWh!
- Court challenges impede restarts
- Toshiba/Westinghouse financial issues seriously cloud nuclear energy future.
Both the U.S. and Japan have strong safety systems

**United States**

The Nuclear Regulatory Commission (since 1975) and the Institute for Nuclear Power Operations (industry-led since 1979) each strive for safety.

- Working cooperatively to assure safety of U.S. nuclear power operations.
- Very strong safety trends demonstrated.

**Japan**

The Nuclear Regulation Authority (NRA, since 2012) is a strong regulator. The Japan Nuclear Safety Institute (industry-led since 2012) is devoted to safety.

- The NRA has demonstrated very strong regulatory standards.
- JANSI is evolving, while mirroring the approaches of INPO.
- NRA and JANSI enable excellent safety underpinned by a strong safety culture.
- Fear of nuclear energy in Japan exists, but it is NOT logical and NOT scientific!
The Deathprint of Energy
Mortality rate in deaths/trillion kWhr over last 40 years, from J. Conca, Forbes 9/30/16

• Coal 170,000 China - 10,000 U.S.
  – Japan used ~ 1 trillion kWhr in 2014, 32% from coal
  – U.S. used about 4 trillion kWhr in 2015, 33% from coal
• Oil/Natural gas 36,000/4000
• Solar/Wind/Hydro 440/150/1400 globally - 5 U.S.
• Nuclear 90 worldwide - 0.1 U.S.

Related studies
• MIT 2013 study of U.S. air pollution-related early deaths
  – 200,000 with 54,000 from power generation (used 2005 data)
• 2016 IEA report – 6.5 million deaths worldwide from air pollution
What does a weak nuclear energy industry mean for the United States (and Japan)?

• Loss of additional fuel diversity and ultra high reliability for U.S. grid
• Large fossil imports into Japan with impact on trade balance.
• Potential loss of the largest source of clean energy in U.S.
  – Failure to meet Paris Accord Agreements for both countries??
• Loss of Japanese leadership on carbon emission reductions
• Loss of export markets for U.S. and Japan – 100s of plants will be built
• Loss of high tech jobs both in exports and operating plants
• Weakening university system for nuclear engineering

Loss of control of the global nonproliferation and safety agendas
Strong U.S. Focus on Advanced Reactors
But a Vibrant Nuclear Industry is a Prerequisite to Enable their Deployment!

- Federal investment in U.S. university nuclear engineering research approaches $0.5B since FY09
- 48 companies and research institutions are developing advanced nuclear systems (Third Way, June 2015)
  - Attributes like: passive safety, high temperature operation, meltdown proof, better economics, less waste generation, air cooling, burn waste, hybrid systems, etc.
- Gateway for Accelerated Innovation in Nuclear started at DOE.
- Light Water Small Modular Reactor application docketed at NRC. First sites for SMRs identified and in NRC review.

Does Japan have a comparable focus on advanced nuclear systems? Might stronger Japanese research and education improve public support? Support of new U.S. Administration for this is unknown at present!
Actions to Regain Global Leadership in Nuclear Power for the United States (and Japan!) - 1

Business Issues

• Government recognition of the vital attributes of Nuclear Power
  – Maintain Toshiba/Westinghouse as a strong nuclear vendor

• Government support for a strong domestic building program
  – Encourage construction of even safer plants (consider SMRs in Japan?).
  – Regain strong, experienced, domestic vendors.
  – Regain a strong domestic supply chain.
  – Treat all clean energy sources equally (PTCs, CFDs, clean energy mandates).
  – Assure functioning electricity markets that value attributes of NP.
  – May require government loans, PTCs, or PPAs initially.

• Maintenance of a strong financial institution to support exports.
  – In U.S., lack of a quorum of ExIm Bank directors limits loans to $10M.
Actions to Regain Global Leadership in Nuclear Power for the United States (and Japan!) - II

WASTE ISSUES

- United States - Implement a credible domestic waste management program with international used fuel “take back” (acceptance of used U.S.-origin fuel from foreign plants).
  - Authorize and fund both interim storage and repository programs.
    - Use a consent-based program to assure state, tribal, and local acceptability of new facilities.
    - New Administration proposing $120M in FY18 for Yucca Mountain and interim storage.
  - Russia’s BOO (Build, Own, Operate) program is highly attractive to new entrants.
    - Russia is today’s largest exporter. China is very well positioned. South Korea is doing well.
  - U.S. reactor vendors can not effectively compete without a used fuel take-back program.
- Japan - Cancellation of Monju research and its decommissioning confuse waste management intentions.
  - Government commitment to continue with the previous fuel cycle is vital.
  - Outcome of Government studies to implement a fuel cycle program without Monju will be essential.
BACKUP SLIDE
The Technical Promise of Small Modular Reactors

Safety Benefits

- Ability to operate with air cooling – away from coastline.
- Passive decay heat removal by natural circulation
- Smaller source term inventory
- Simplified design eliminates/mitigates several postulated accidents
- Below grade reactor siting assists seismic resistance and security
- Potential for reduction in Emergency Planning Zone

Economic Benefits

- Reliable and short construction times
- Reduced financial risk
- Flexibility to add units
- Improved ability to load follow
- Right size for replacement of old coal plants
- Simpler to utilize in process heat applications
- Use domestic forgings and manufacturing
- Job creation