

# **A Vital Energy Option at Risk??**

## **The Japan and U.S. Nuclear Energy Industries**

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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.

# Cost and Schedule Challenges

- “capital cost .. in the U.S. is ... \$5-6000/kWe, .. experience of South Korea suggests that .. \$2500/kWe [is] possible.”<sup>1</sup>
  - 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**

<sup>1</sup>Secretary of Energy Advisory Board, Task Force on the Future of Nuclear Power, September, 2016.

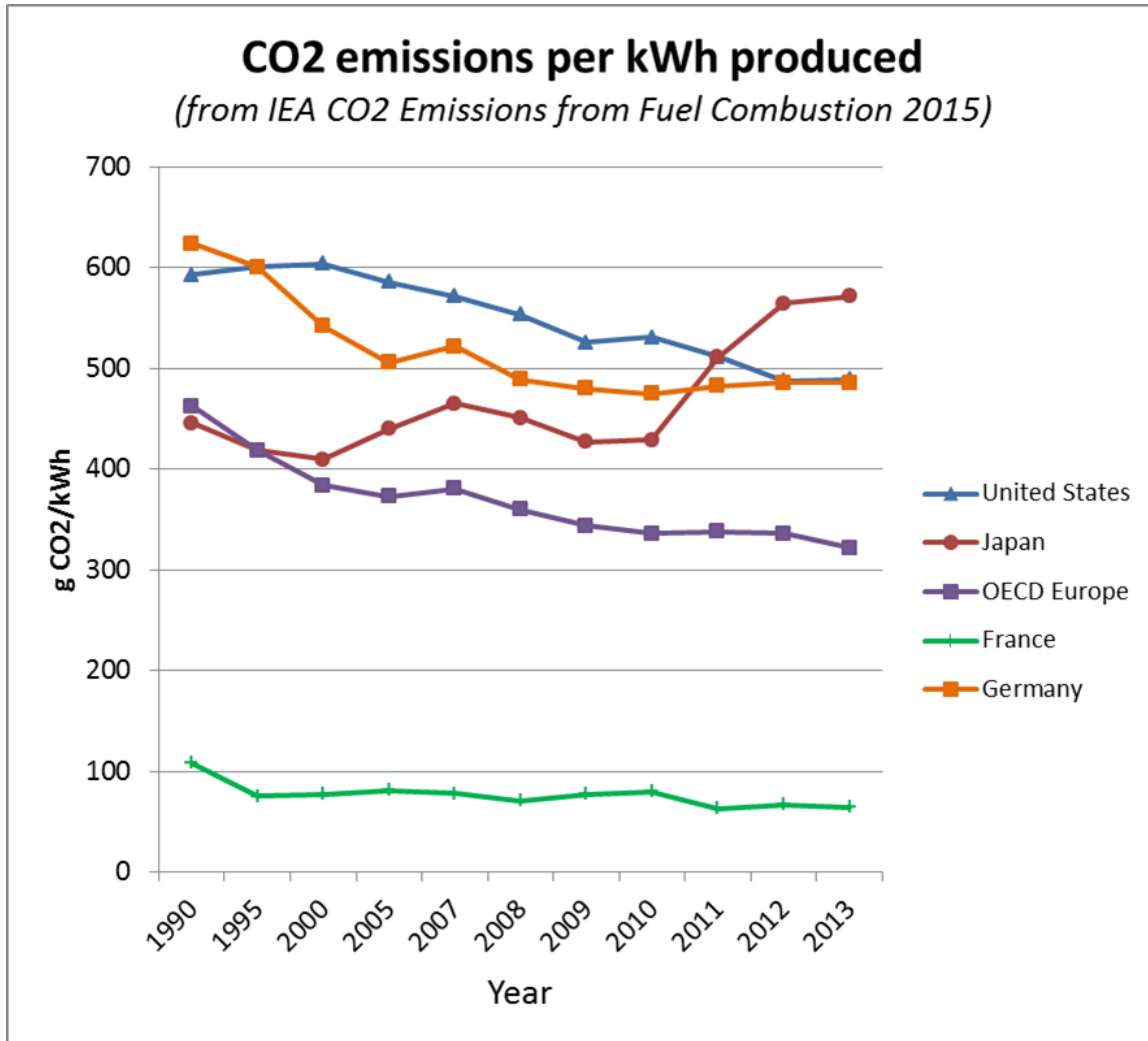
# Issues with U.S. Nuclear Power

## 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.”<sup>1</sup>
- **Six nuclear plants closed, more scheduled for closure.**
- **Toshiba/Westinghouse financial issues seriously cloud nuclear issues**

<sup>1</sup> *America’s Hidden Energy Crisis*, Copyright 2017 by Richard J. Myers

# Japanese People and Economy Require Nuclear Power!!



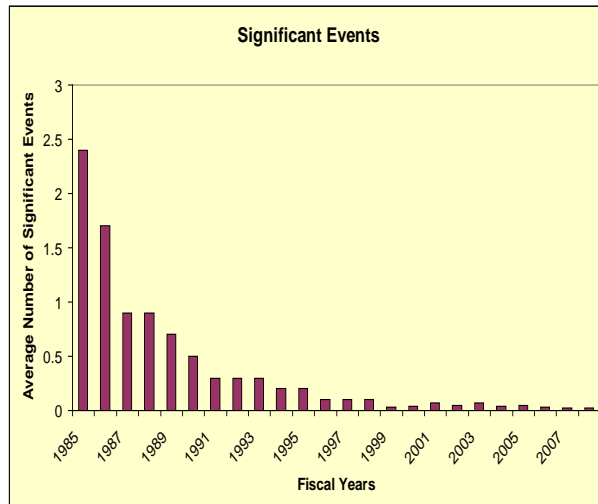
- Japan has lost global leadership in nuclear plant construction and in climate change
  - Japanese emissions: kg-CO<sub>2</sub>/kWh (from IEEJ):  
2013 - 0.57, 2014 - 0.55, 2015 - .53
- Japanese public remain unsupportive of nuclear energy and concerned with safety.
- Germany in 2016 emitted 560 g/kWh!
- 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!) - I

## **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.
  - 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.
- **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