Nuclear Power in Light of Recent Events in Japan

John Parkyn
Rural Electrification Management Association
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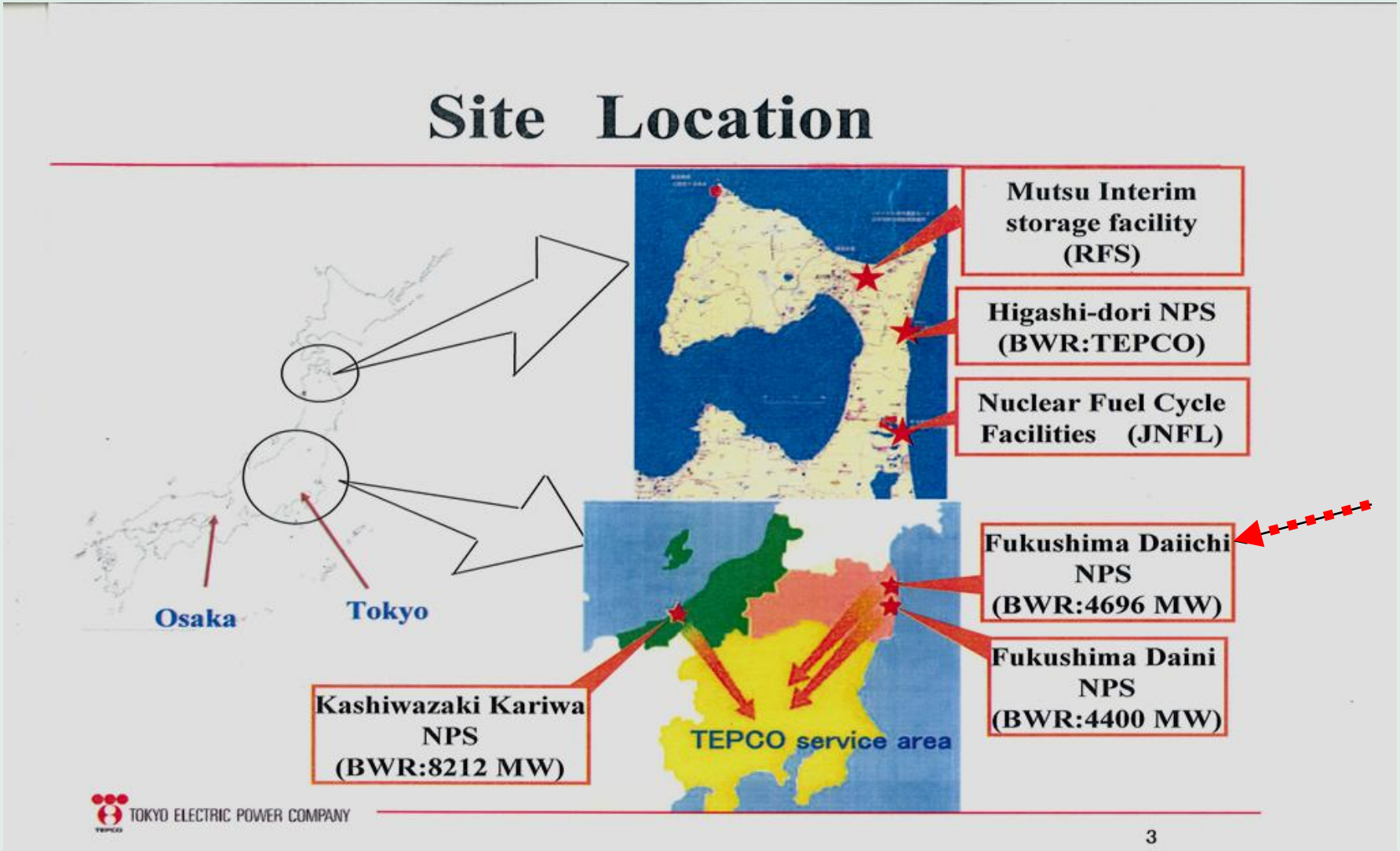
Fukushima Daiichi Nuclear Plant Prior to Earthquake and Tsunami

Fukushima Daiichi Nuclear Plant After Earthquake and Tsunami

Damage is seen at the Fukushima Daiichi nuclear plant, and white smoke rises from reactor No. 3. The nuclear plant suffered heavy damage following explosions that occurred after last week's magnitude 9.0 earthquake off the coast of Japan. (EPA / TEPCO / March 16, 2011)

Fukushima Daiichi



Fukushima I (Daiichi) Site

- Unit 1 – 460 MW (1971) shutdown scheduled 2011
- Unit 2 – 784 MW (1974)
- Unit 3 – 784 MW (1976)
- Unit 4 – 784 MW (1978)
- Unit 5 – 784 MW (1978)
- Unit 6 – 1,100 MW (1979)
- Units 7&8 – 1,380 MW cancelled April 11

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Japanese Reactor Accident Events

- Earthquake (9.0 magnitude) occurs
  - Severe damage to area around Fukushima Daiichi nuclear power plant
- Nuclear plant shutdown
- Tsunami (45-foot wall of water) caused by earthquake follows
  - Drenches on-site emergency diesel generators
- Loss of all power, drained battery banks
  - Residual heat removal flow to reactor vessels and fuel pools was terminated

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Japanese Reactor Accident Events

- Heat-up of fuel in reactors caused fuel to become exposed
  - Overheated Zircaloy cladding reacted with water to create hydrogen
- Reactor atmosphere, including hydrogen, was vented through fuel storage pool buildings to relieve containment pressure
  - Hydrogen was ignited

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Japanese Reactor Accident Events

- Hydrogen detonation caused reactors 1 & 3 to burst fuel building walls and roofs
- Failed fuel releases noble radioactive gases vented with hydrogen accounting for human exposure
- Fuel pool involvement at Unit 4 has resulted in a fire
  - Used fuel was exposed

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Japanese Reactor Accident Events

- Decay heat in reactor after shutdown is about 6% of power
  - Decreases to about 3% within five days
  - Now less than 1%
  - Units 1, 2, & 3 still not a cold shutdown
    - Need continuous cooling, not bleed and feed

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Japanese Reactor Accident Events

- Required actions
  - Restored water cover over all fuel in reactors and spent fuel pools
  - Begin capturing and filtering vapors
  - Established adequate on-site emergency power
  - Allow plants to cool to ambient temperature
  - Dismantle three damaged units and reprocess fuel
  - Once decayed sufficiently, remove spent fuel from Unit 1, 2, 3 & 4 pools and secure in dry storage or reprocess
  - Re-evaluate protection from tsunami waves for all seaside nuclear plants before returning to service

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Japanese Realities

- 2/3 of energy imported in 2010 from various countries
- Nuclear power only indigenous baseload source
- Nuclear at 35%, gas at 55%
- Nuclear being raised to at least 50%

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Current Status

- Plants still require heat removal
- Radioactive leak to ocean plugged
- Nitrogen injection started to offset hydrogen by driving out oxygen which could lead to combustion
- Covers being installed on units
- Cesium particulate scrubbing unit loaded
- Units 1-4 will be decommissioned
- Food stocks will be embargoed until within limits for contamination

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Staff Exposure

- None at lethal limits
- Health checks and screening for life
- Continuing need for workers for several months
- Long-term cleanup will not generate higher exposures

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Differences from American Plants

- LACBWR backfit to respond to seismic liquefaction with portable diesel-driven pumps delivering 900 gpm
  - 50 gpm required to avoid fuel damage
- Post Three Mile Island (TMI) backfit requires power venting of hydrogen directly out of containment
  - Not through fuel building - cannot cause building damage by starting fires

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Emergency Cooling

Lessons Learned

- Reconsider Zirc clad fuel for future use
- Consider back-fitting all plants with portable water capability independent of on-site electrical generators (i.e., diesel-driven skid pumps)
  - Access independent of debris or obstructions
- Re-evaluate risks associated with plant siting locations

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Impact on American Nuclear Power

- Slowdowns
  - Duration (approximately 1 – 3 years)
  - 26 license applications; none withdrawn
  - Years to implement or delay once issued
  - South Texas 3 & 4 put on hold

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American Licensing Problems

- Redoing each analysis for every plant regardless of pre-approved designs
- Costs of 1960s ($145 per kw) projected forward
  - With Cost of Living -- about $750 per kw
  - Current estimates with licensing and regulation -- $5,000+ per kw

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Backfits to Certified Designs

- Certified designs could be modified
- Japanese reactors endpoint unknown
- Politics not science-driven
- Yucca Mountain experience bad
- Scares off ratepayers and investors alike

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Current Flooding

- Missouri River concerns
- Pacific coast plant challenges

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Why We Need Nuclear

- Only viable clean air baseload
- Capable of being 100% U.S. produced
- Can stop energy dependence and environmental pollution by itself when coupled with other non-emitting sources such as hydro-electric, wind and solar

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My Prediction

- Forces beyond us will mandate air impact of current generation
- Our economic vulnerabilities will require an inexpensive, totally domestic solution
- U.S. will end up 50% – 60% nuclear baseload by 2040
- Our economy will need the jobs that inexpensive nuclear power will create

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Questions?

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