Security Aspects of the Growth of Nuclear Power

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Projected Growth of Nuclear Power—Optimists and Skeptics

- The IAEA projects that nuclear power generation capacity will expand by 20-100 percent by 2030.
- The World Nuclear Association, a trade group, is more optimistic—200-1000 percent growth by 2050.
- Others are skeptical of this projection, including the Center for International Governance Innovation

Expansion of Nuclear Power in Asia

- Japan—planning 13 new reactors over 10 years
- China—57 reactors planned or under construction
- South Korea—12 reactors planned or under construction
- Bangladesh, Indonesia and Vietnam plan to have reactors online by 2020.

Risks associated with growth in nuclear power

- Two processes that can support the civilian nuclear power industry can also be exploited to generate fissile material useable in nuclear weapons
  - Uranium enrichment
    - Used to low-enriched uranium (LEU) for most reactors
    - Can be used to create highly enriched uranium (HEU) for weapons
  - Spent fuel reprocessing
    - Used to extract plutonium for spent fuel
    - Plutonium can be used as fuel for reactors or weapons

Risks associated with growth in nuclear power

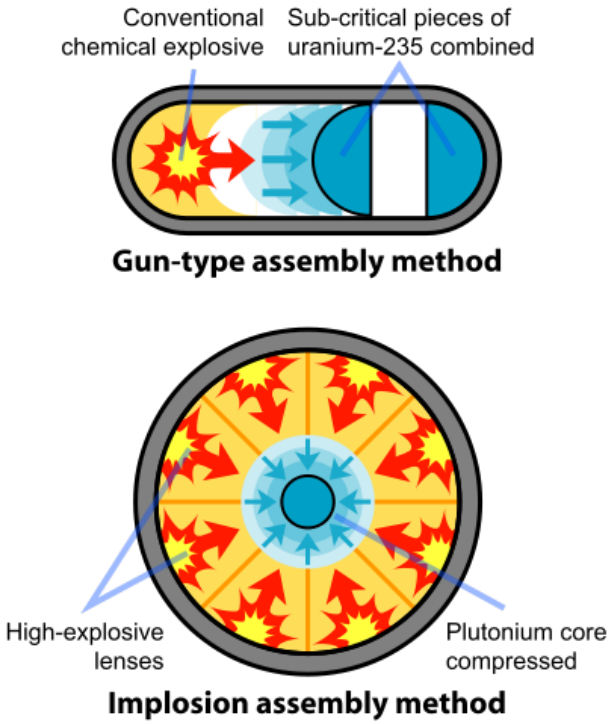
- More states will demand national enrichment and/or reprocessing facilities
- These technologies and skills are not inherently limited to peaceful use—can be used for weapons purposes once a political decision is taken
- States could
  - Divert fissile material covertly from known facilities
  - Construct covert facilities
  - Evict the IAEA and repurpose a civilian facility into a military one

Risks associated with growth in nuclear power

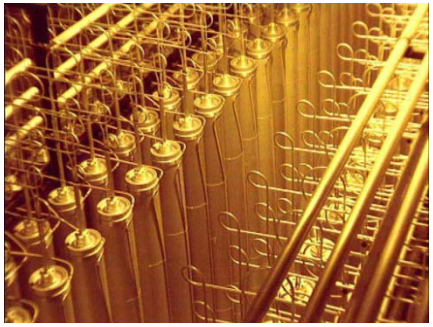
- More enrichment and reprocessing facilities and more fissile material in transit provides more targets for terrorists seeking to acquire fissile material
- More individuals with technical expertise and experience could lead to proliferation (e.g., A.Q. Khan)

Nuclear weapons

- Two basic designs
  - Gun-type: simple to construct, use HEU
  - Implosion: more challenging, use plutonium or HEU
- To build a bomb, state or group must acquire HEU or plutonium
- Enrichment and reprocessing are pathways to fissile material

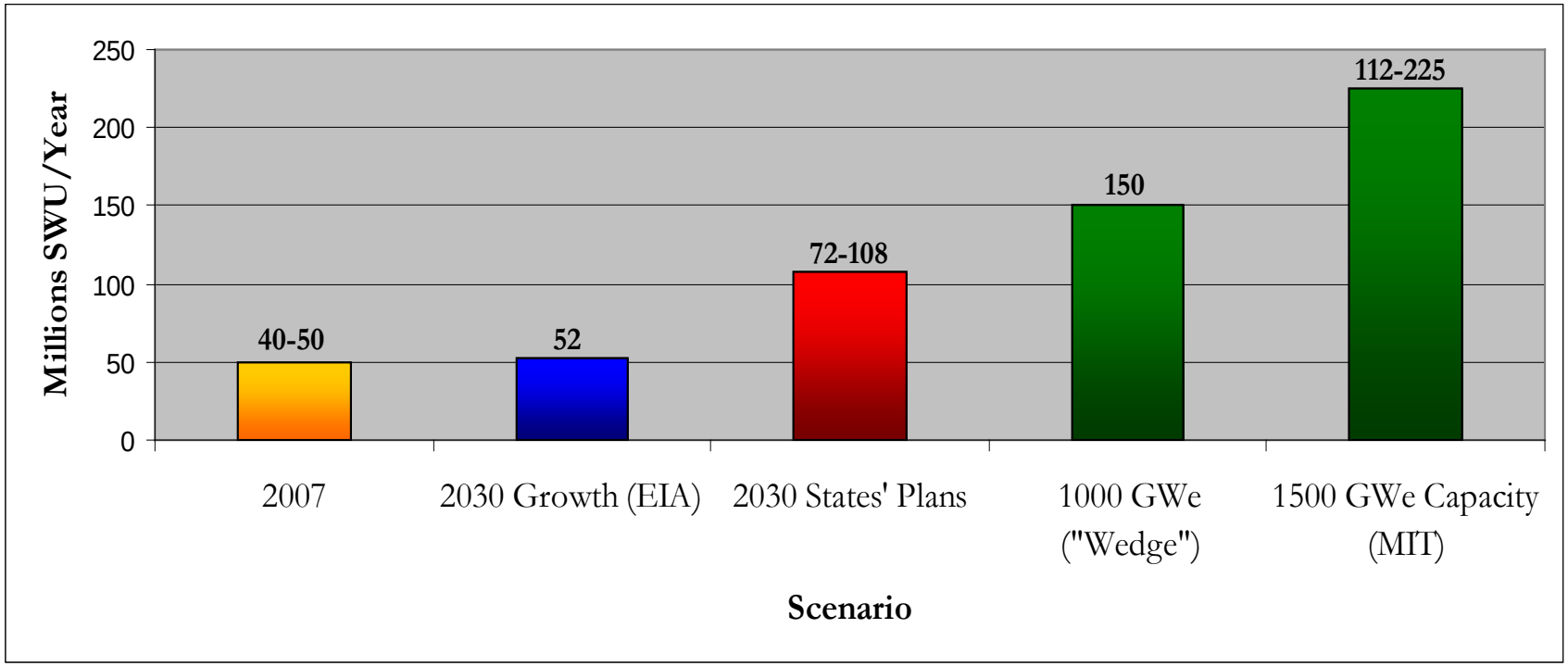


Uranium enrichment



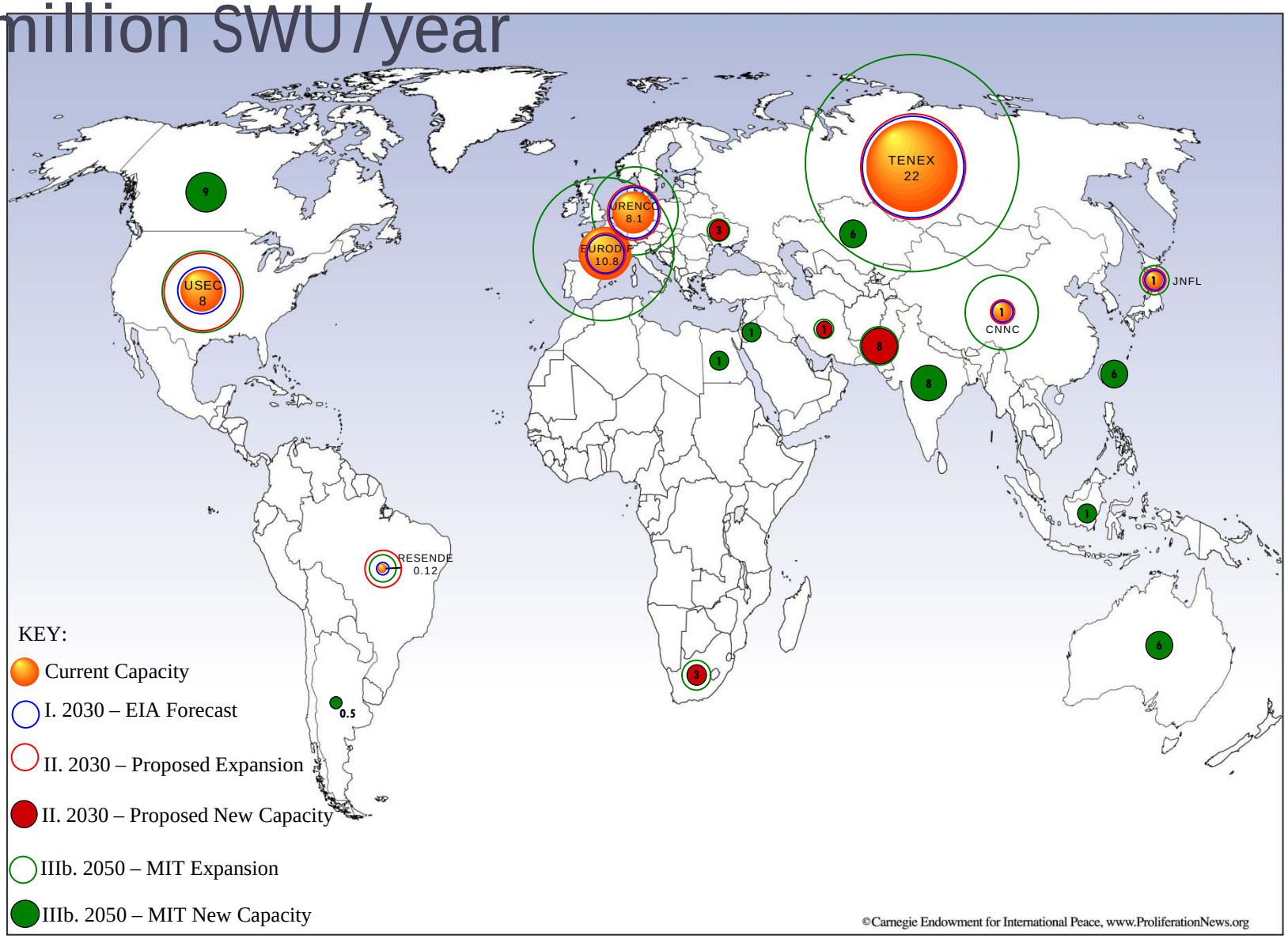
- Uranium found in nature is made up of only .7 percent fissile uranium-235. The rest is non-fissile uranium-238.
- Enrichment removes U-238 from the batch until U-235 makes up a greater proportion
- Most reactors use uranium fuel that has been enriched to 3-5 percent U-235
- Weapons typically use 80-90 percent enriched uranium

Enrichment implications of growth in nuclear power



Source: Carnegie Endowment for International Peace

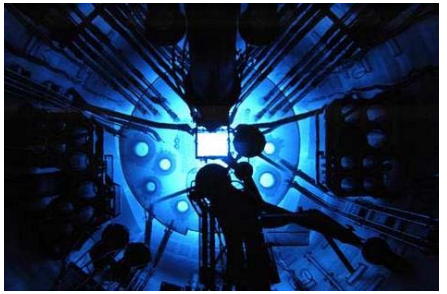
Enrichment capacities for all scenarios (million SWU/year



Risks associated with enrichment

- States with enrichment capability could operate a covert weapons program (South Africa) without testing
- States could use civilian enrichment technology and know-how to begin an overt weapons program following a decision to do so (Iran?)
- Terrorists could buy or steal HEU to build a gun-type nuclear weapon.

Civilian Uses of HEU



- HEU does have some civilian uses, which increases the risk that it might fall into terrorist hands, and provides cover for potential proliferators (e.g., Iran)
  - Research reactors
  - Medical isotopes
  - Naval reactors (military and civilian)
- Many of these tasks can be performed using LEU

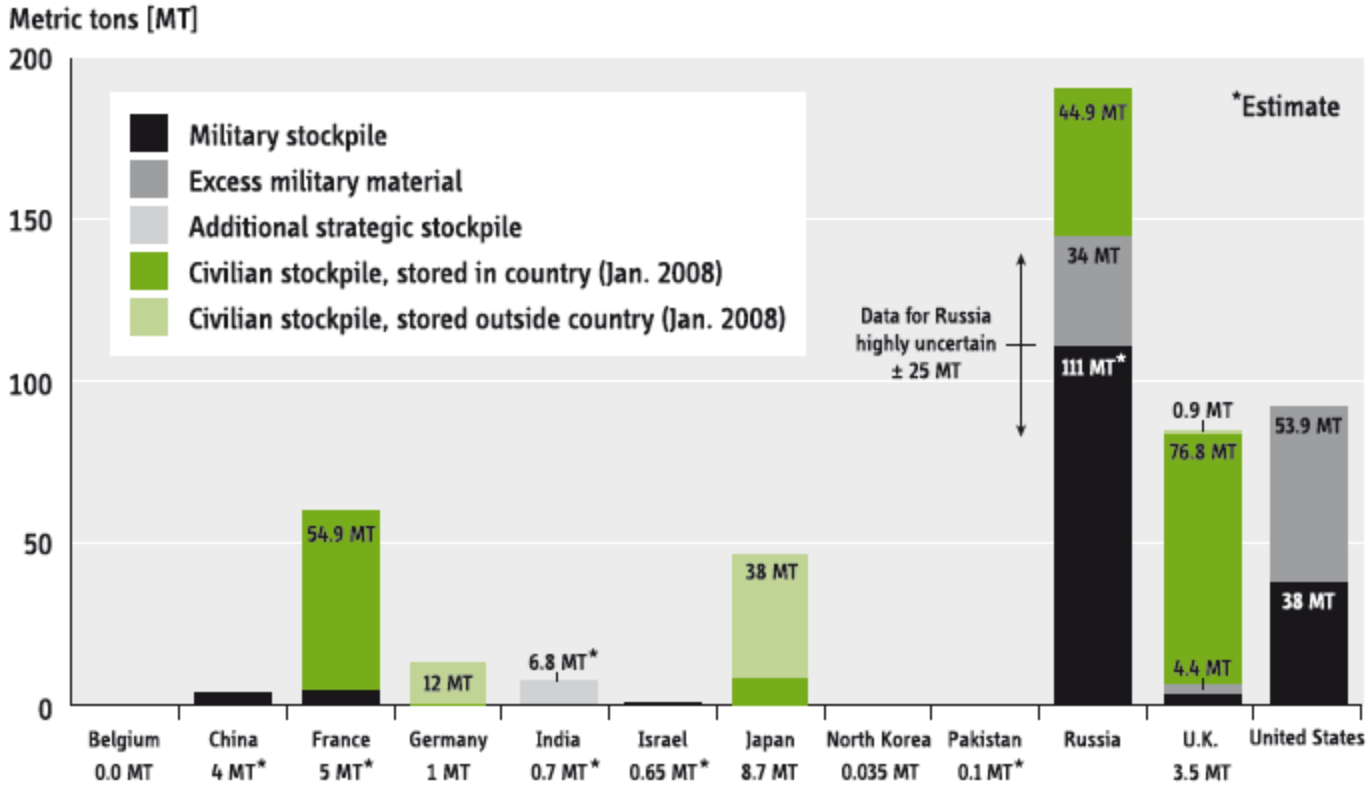
Nuclear Power Plants

- Can be source of “dirty bombs” or “dirty bombs” themselves
- In US, NRC has substantially upgraded nuclear security since 9/11
  - Since 2009, NEW plants must be able to survive crash by commercial airliner without breaching containment and keeping spent fuel cool
  - Fear terrorists could train spent fuel ponds and start fire
  - Emphasis on security culture
    - Force-on-force exercises
    - Greater personnel vetting
- Other countries?

Spent Fuel Reprocessing

- Spent fuel from a nuclear reactor contains some plutonium and uranium-235 which can be extracted and returned to a reactor or used in a nuclear weapon
- Reprocessing is a chemical process by which the plutonium and uranium are separated from the radioactive waste of the spent fuel
- Can reduce the volume of spent fuel that must be stored, and draw more energy from each batch of fuel
- The typical process, PUREX, was designed and first employed to extract plutonium for nuclear weapons

Global stocks of separated plutonium



Source: International Panel on Fissile Materials

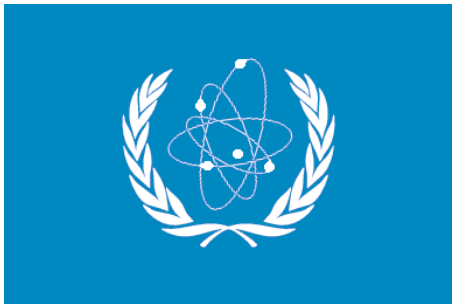
Reprocessing in Asia

- Japan—reprocessing is a national goal
  - Small pilot reprocessing facility at Tokai-mura (90 tons of spent fuel per year)
  - Commercial scale facility at Rokasho-mura, expected to be complete in October 2010 (800 tons per year, or 80% of Japan's spent fuel output)
  - Huge quantities of plutonium extracted: 5.9 metric tons stored in Japan, another 37.9 metric tons stored in Europe—enough for 1000 or more nuclear weapons.

Reprocessing in Asia

- South Korea would also like to pursue reprocessing for spent fuel storage and energy security reasons
- However, it is currently forbidden to do so by a bilateral agreement with the United States
- South Korea wants to develop 'pyroprocessing,' which does not separate pure plutonium from spent fuel
- However, pyroprocessing still poses similar proliferation risks—removes plutonium from highly radioactive spent fuel, and the plutonium could easily be separated after pyroprocessing

A straining safety net



- Increasing technological sophistication and the activities of Pakistani nuclear scientist A.Q. Khan have tested the nuclear nonproliferation architecture that was devised in the 1960s.
- The International Atomic Energy Agency failed to detect covert nuclear programs in Iraq, Iran, Libya and Syria until they were publicly exposed.
- The Nuclear Nonproliferation Treaty allows parties to withdraw without restriction or penalty, as North Korea did in 2003.

Nuclear security—a patchwork arrangement

- No overarching international agreement on nuclear security
- The Convention on Physical Protection of Nuclear Material requires states to protect fissile material in transit
- Its 2005 amendment, which requires protection at all times, has not entered into force

Nuclear security, continued

- UN Security Council resolution 1540 requires states to institute national measures for the protection of fissile material, but lacks an effective enforcement mechanism

- The IAEA provides voluntary codes of conduct and assistance programs for security

Nuclear Security Summit

- At Washington summit, states pledged to secure all vulnerable nuclear material within four years, agreed to move forward on various treaties and agreements
  - Ukraine agreed to give up HEU, and Russia announced that it no longer produces weapons-grade fissile material (last plutonium producing reactor shut down)
  - Prime Minister of Singapore attended summit
  - Malaysia passed export controls law, Philippines, Thailand and Vietnam are joining the Global Initiative to Combat Nuclear Terrorism, and Vietnam is converting a research reactor to use LEU
- South Korea to host next summit in 2012

Balancing nuclear energy growth and proliferation resistance

- Minimize and eliminate civilian use of HEU
- The IAEA Additional Protocol as a requirement for nuclear trade
- Boost the IAEA safeguards budget
- Entry into force of the Amended Convention on the Physical Protection of Nuclear Material

Balancing nuclear energy growth and proliferation resistance

- Multilateral approaches to the fuel cycle
  - The International Uranium Enrichment Center at Angarsk is a potential model
- Rely on open fuel cycle and dry cask storage (no reprocessing)
- Use international agreements to strengthen nonproliferation norms

Balancing nuclear energy growth and nuclear security

- If move ahead with nuclear energy, need to develop nuclear security infrastructure
  - New nuclear security regulators
  - Nuclear security education and training
    - Japan pledged to create new center
- Need to foster nuclear security culture
- Need to implement international agreements