Nuclear Dilemmas: Sustainable Nuclear Power after Fukushima?

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Nuclear Dilemmas: Present and Future

Ministry of Foreign Affairs of Kazakhstan and the Netherlands & T.M.C. Asser Instituut

The Hague, August 30, 2011

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Outline

- Context (I – 3 slides)
- Expansion of Nuclear Energy (II – 8 slides)
- Proliferation, Safety & Security Risks (III – 6 slides)
- How to strengthen nuclear governance? (IV – 3 slides)

I. Pillars of Sustainability

- ***The Nuclear Nonproliferation Treaty assumes that*** **is that it is possible to reap the positive, peaceful benefits of nuclear energy without further contributing to nuclear arms races.**
- **Three elements of NPT -- Disarmament, Peaceful Nuclear Cooperation & Nonproliferation – all rely on Safeguards, Safety & Security**
- **Why are nuclear safety & security now "a pillar"?**
  - April 2010 Nuclear Security Summit set in motion a process for bringing high-level attention to nuclear security.
  - March 2011 Fukushima accident highlighted nuclear safety and, as 9/11 did, lessons for nuclear security from other disasters.

I. What did Fukushima teach us?

- **Reactors AND spent fuel pools at risk**
  - Lower the risks by decreasing storage density and moving to dry storage sooner
- **Critical infrastructure is key**
  - Communications, electricity, roadways
  - Need defense in depth for all of these (e.g., backup electricity even for SNF pools)
- **Contingency planning and emergency response are key**
  - Crises may spawn ingenuity, but better approach is peer review in advance
- **In other words, strong safety-security connection**

I. Nuclear safety & security linkages

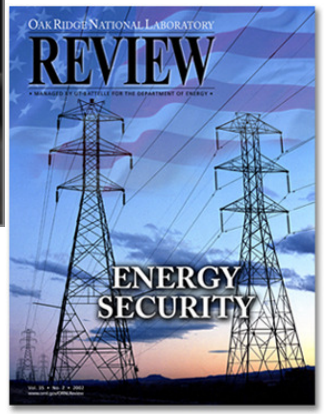
- **Single objective: to protect people, society & environment from radioactive releases**
  - If the facility is not secure, introduce potential for man-made safety problems
  - Remember that *nuclear energy cannot be sustainable without public support*
- **Borrow language from nuclear safety**
  - From "An accident anywhere is an accident everywhere" to *"An incident anywhere is an incident everywhere"* because terrorists have a learning curve too and because insider threats are unpredictable.

II. Nuclear Energy Today

- **15% global electricity generation (and declining…)**
- **30 countries (and Taiwan) operating 441 reactors** (375 GW)
  - 80% in OECD
  - 90% light water reactors
- **Construction: 61 reactors, 39 of which in Asia (not all are new)**
- **Enrichment: 9 countries hosting 56 million SWU**
- **Spent fuel separation: 6 countries**
  - UK phasing out, China phasing in
- **Waste: 0 countries with geologic repositories for commercial spent nuclear fuel (SNF)**

II. Nuclear Energy "Enthusiasm" Since 2005

- Nuclear energy rebranded as "clean, green, secure"



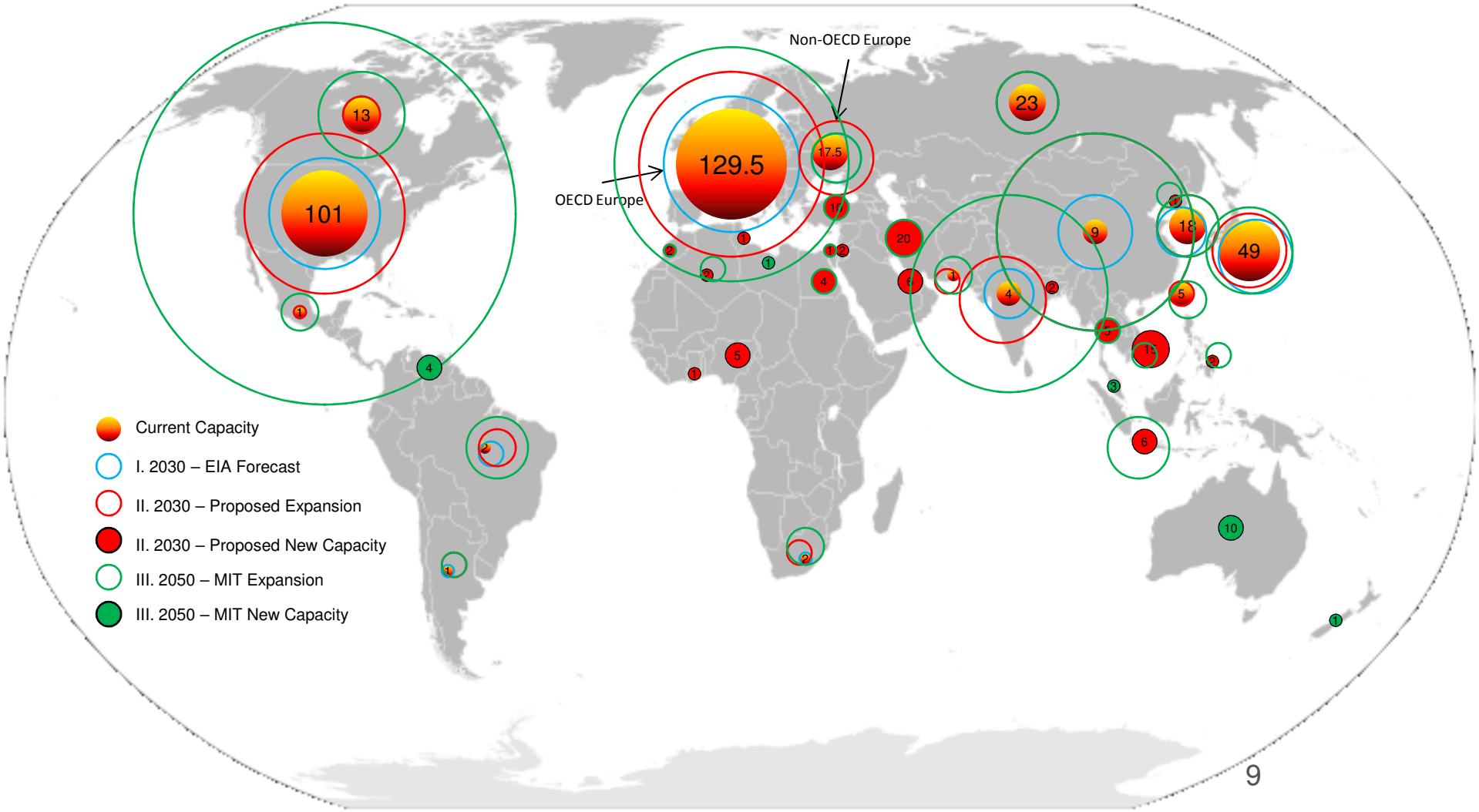
- Over 25 non-nuclear states have announced plans for nuclear power; 65 "interested"?

II. Nuclear Expansion Scenarios

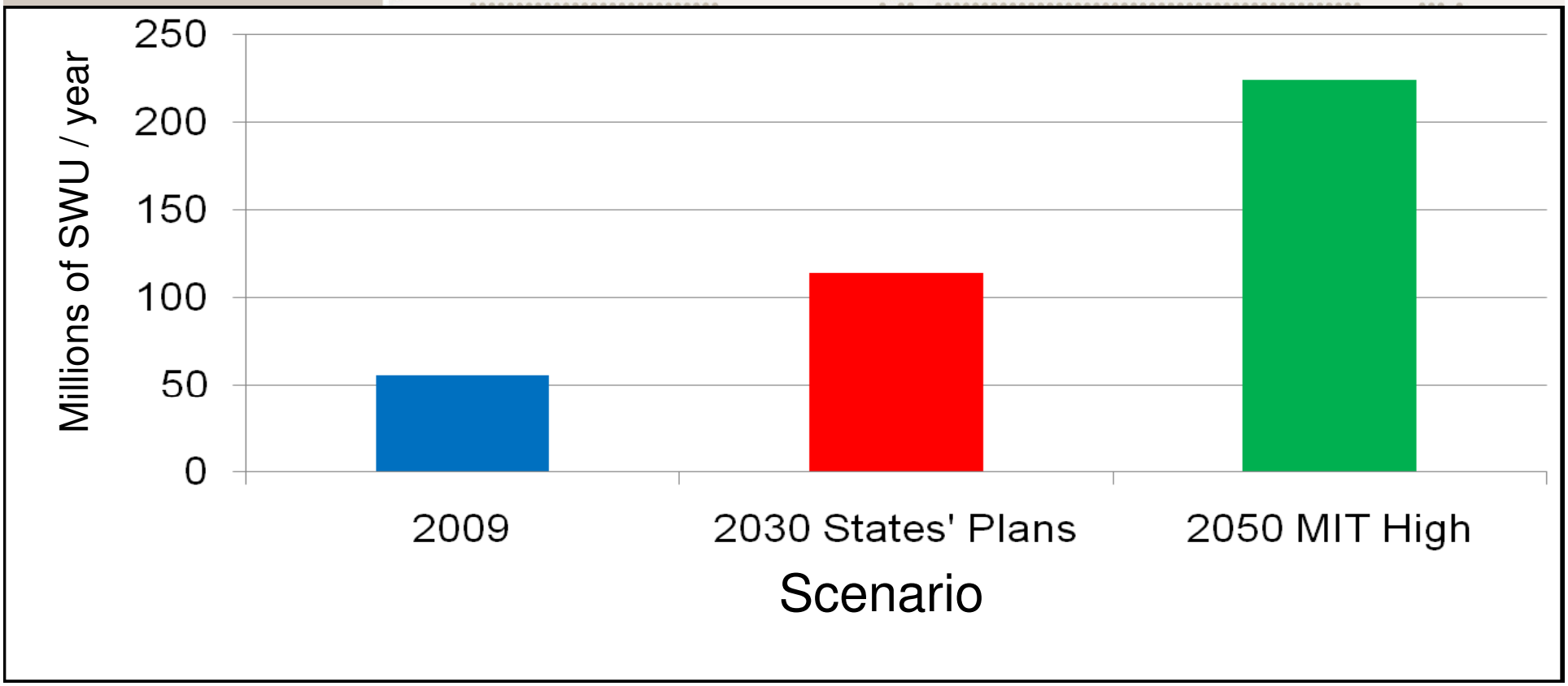
Current Capacity: 375 GWe in 30 countries + Taiwan

- **Scenario I:** Realistic growth to 2030
  +183 GW (economic model EIA)
- **Scenario II:** Wildly optimistic growth to 2030
  +573 GW (states' plans)
- **Scenario III:** Fourfold increase growth to 2050
  +1232 GW (MIT's 2050 "high" scenario)

II. Reactor Capacities for all Scenarios*

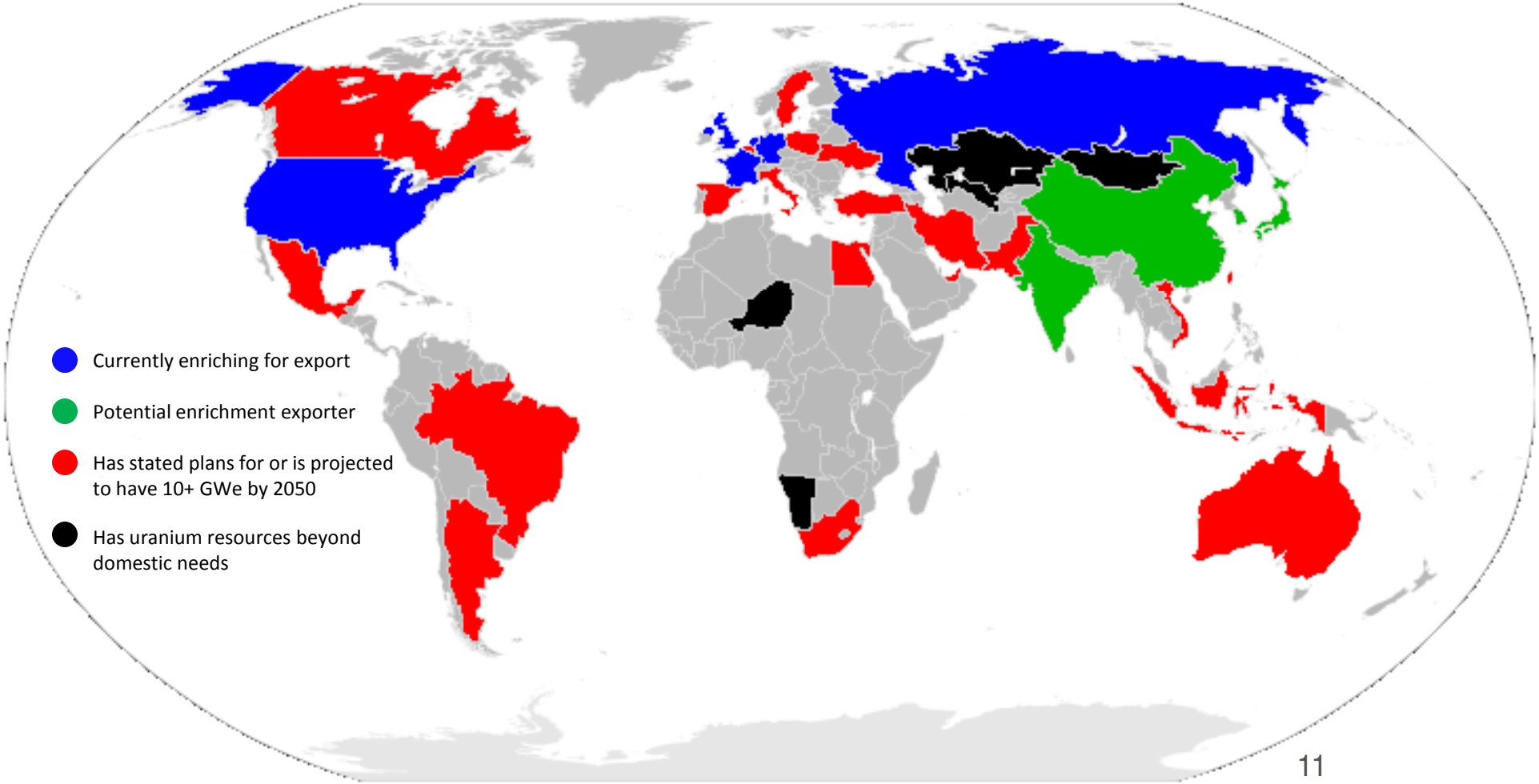


II. Enrichment Implications of Reactor Expansion



NOTE: 2030 and 2050 predict enrichment based on reactor capacity. They are based on countries' stated plans for reactor growth and the 2050 MIT "high growth" scenario, respectively. Both assume that a 1 GWe reactor requires 150,000 SWU enrichment per year.

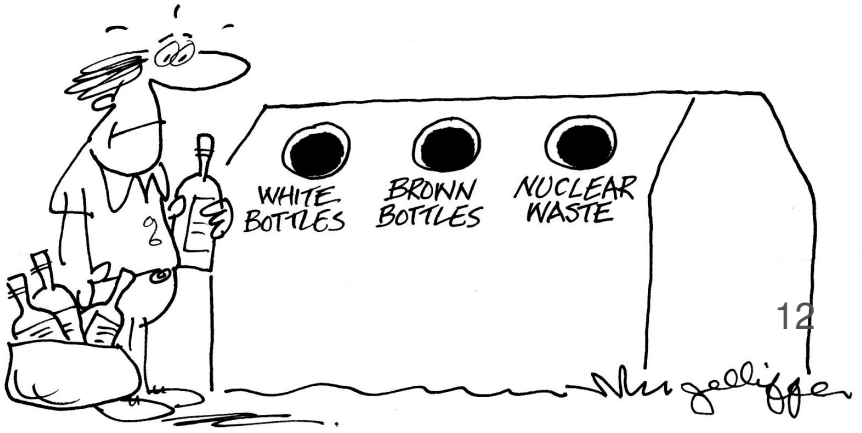
II. Current and Potential Future Enrichers of Uranium



* = Some countries fit in more than one of these categories and are listed by the first one in which they appear.

II. Spent Fuel Implications of Growth

- 1 GWe = 20 tons spent fuel/year
- "New" nuclear states will likely store SNF, or lease fuel
  - More storage requires more safety, security measures
  - Fuel leasing = more transportation, greater safety, security measures
- But, open or closed fuel cycle is still a "choice."



II. Risks of Expanding Nuclear Energy

- Potentially more reactors AND
  - New kinds of nuclear reactors
  - New suppliers
  - New locations
  - New fuel cycle capabilities – enrichment & reprocessing?

- Fukushima could put brakes on expansion but some determined to continue
  - Fuel cycle issues unlikely to go away (and become more significant if we really desire a world free of nuclear weapons)

III. Impact of Nuclear Expansion on Key Variables

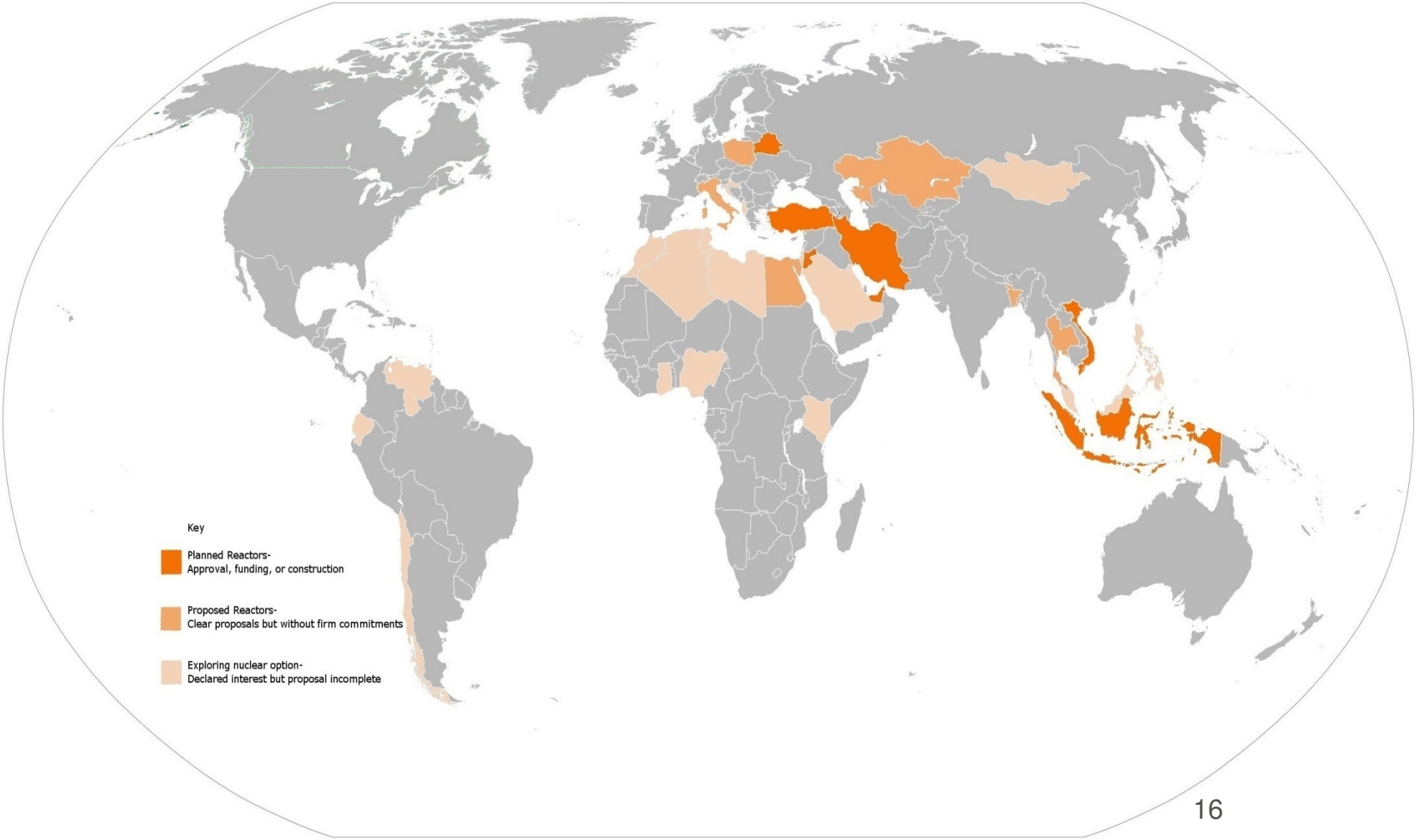
Characteristic	Safety	Security	Nonproliferation
MORE REACTORS	Risk assessment is based on reactor-years. With more reactors, individual reactor safety must improve to keep risk same	Terrorism threat (sabotage, diversion, theft)	More reactors = more expertise, materials in flow, more enrichment.
NEW KINDS	Should passive safety features have active back-up?	Some reactors more appealing targets (e.g., PHWR, anything fueled with HEU or Pu); others less (nuclear batteries?)	More heavy water reactors? More fast reactors (with recycling/reprocessing)? Floating reactors?
NEW LOCATIONS	Development of a safety culture is necessary but may take time. Implications of importing technical expertise?	It matters where plants are, how SNF pools are designed, and how tight security is.	Regional security matters; regional competitions matter.
NEW CAPABILITIES	Safety should be #1 priority for new construction. Safety issues at enrichment, reprocessing facilities	More countries with enrichment, reprocessing, potential stockpiles of separated Pu (for fast reactors) are a problem.	No legal barrier to developing entire fuel cycle, fast reactors. No progress on "Cradle-to-Grave" nuclear supply.

III. New nuclear states' capabilities affect safety, security, & proliferation risks

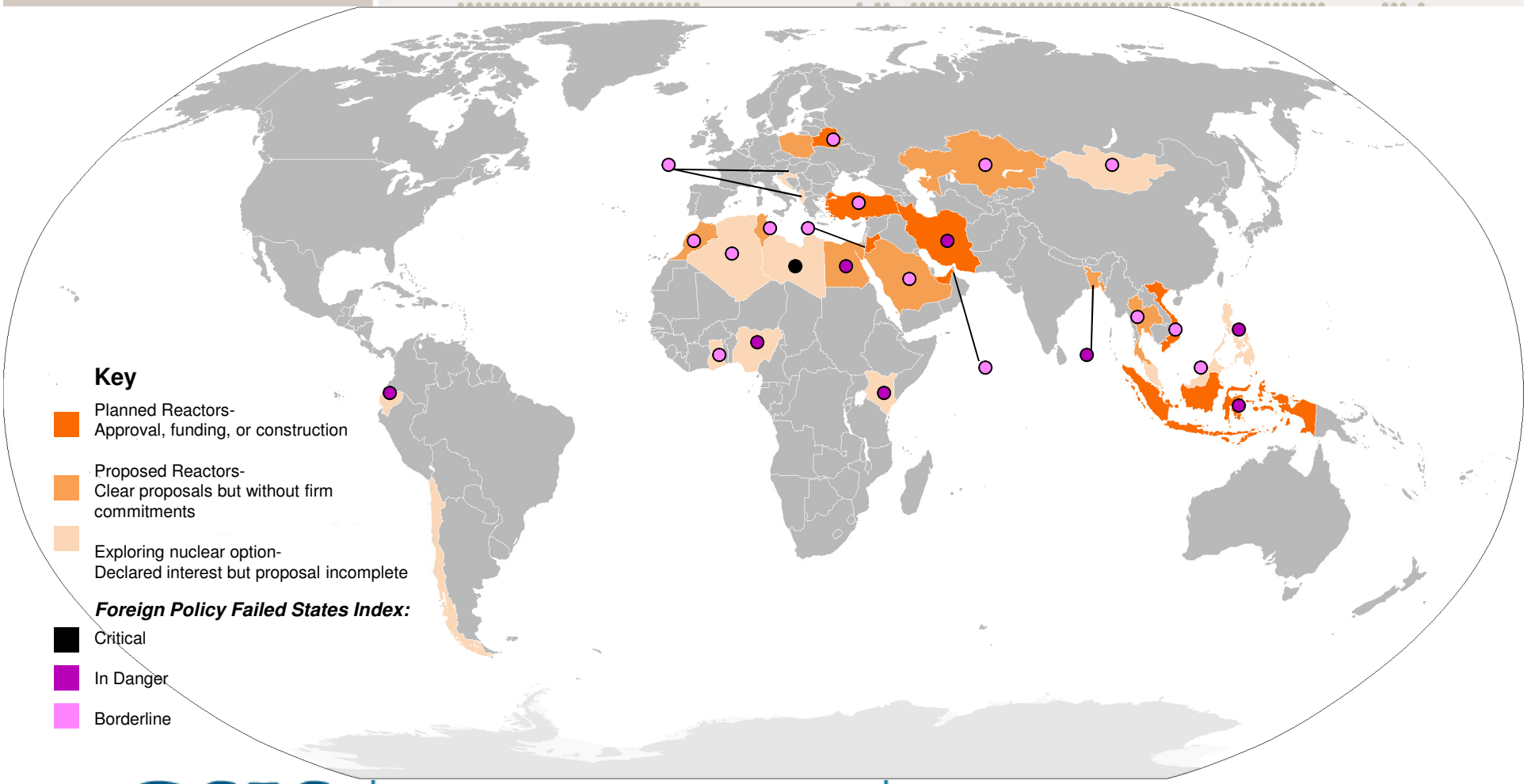
- Physical, intellectual nuclear infrastructure
  - Where are they in the IAEA process?
    - Knowledgeable commitment (Milestone 1)
    - Readiness to invite bids (Milestone 2)
    - Ready to commission and operate (Milestone 3)
- Legal, financing, regulatory frameworks
- Safety, security cultures?

III. Proposed "New" Nuclear States

Proposals as of August 2010



III. Nuclear Plans and Failed States Index 2011



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III. Impact of Nuclear Expansion on Security

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IV. Nuclear Governance Challenges

- **Common thread is reducing risks from the fuel cycle** – not just front end (enrichment, fuel) but also back end (spent fuel, waste). How?

- **Limit amount of directly weapons-usable nuclear material**
  - oDiscourage Pu, HEU use in civil cycle
  - oPromote LEU, open fuel cycle, limiting spread of sensitive fuel cycle facilities

- **Enhance focus on security**
  - oNuclear Security Summit 2012
  - oWorld Institute for Nuclear Security
  - oBetter adherence to international standards (CPPNM)

IV. Nuclear Governance: How to Lower Proliferation Risks

- Offer better alternatives
  - Promote *all energy options* (especially efficiency) and *all approaches*, including regional facilities, cross-border electricity transmission, regional fuel cycle centers
  - Fund regional storage repositories
- Adopt Additional Protocol as condition of supply
  - Bilaterally (Japan, US)
  - NSG
- Greater transparency and harmonization needed by national governments on the terms of their nuclear cooperation agreements

IV. Nuclear Governance: How to Lower Proliferation Risks

- Promote multinational voluntary approaches
  - Enrichment providers should open up to investment, including new U.S. plants.
  - Reinvigorate global campaign for international repository
- Reshape FMCT negotiations for legally binding e/r restrictions
  - **FMCT stuck in Geneva on stocks vs. new production debate.**
  - **Shift the debate. If not making fissile material for weapons, do we need national facilities?**
  - **Require multinationalization of all sensitive fuel cycle facilities which would:**
    - **level playing field;**
    - **give FMCT a real disarmament job;**
    - **divert the "rights" argument away from the NPT.**

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