



Small Modular Reactor: Security & Proliferation Considerations

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Nuclear Enthusiasm

- 61 countries (according to IAEA) are now interested in nuclear power that do not now have power reactors
- Many of these have limited transmission and distribution grids
- Many would be well-served by smaller reactors
- Choices?
 - Traditional LWRs from China (300MWe range) and South Korea (100MWe SMART)
 - PHWRs from India (220, 540 MWe)
 - Floating reactors from Russia (35, 65 MWe, HEU-fuelled)
 - Other small modular reactors

Proliferation and Reactors

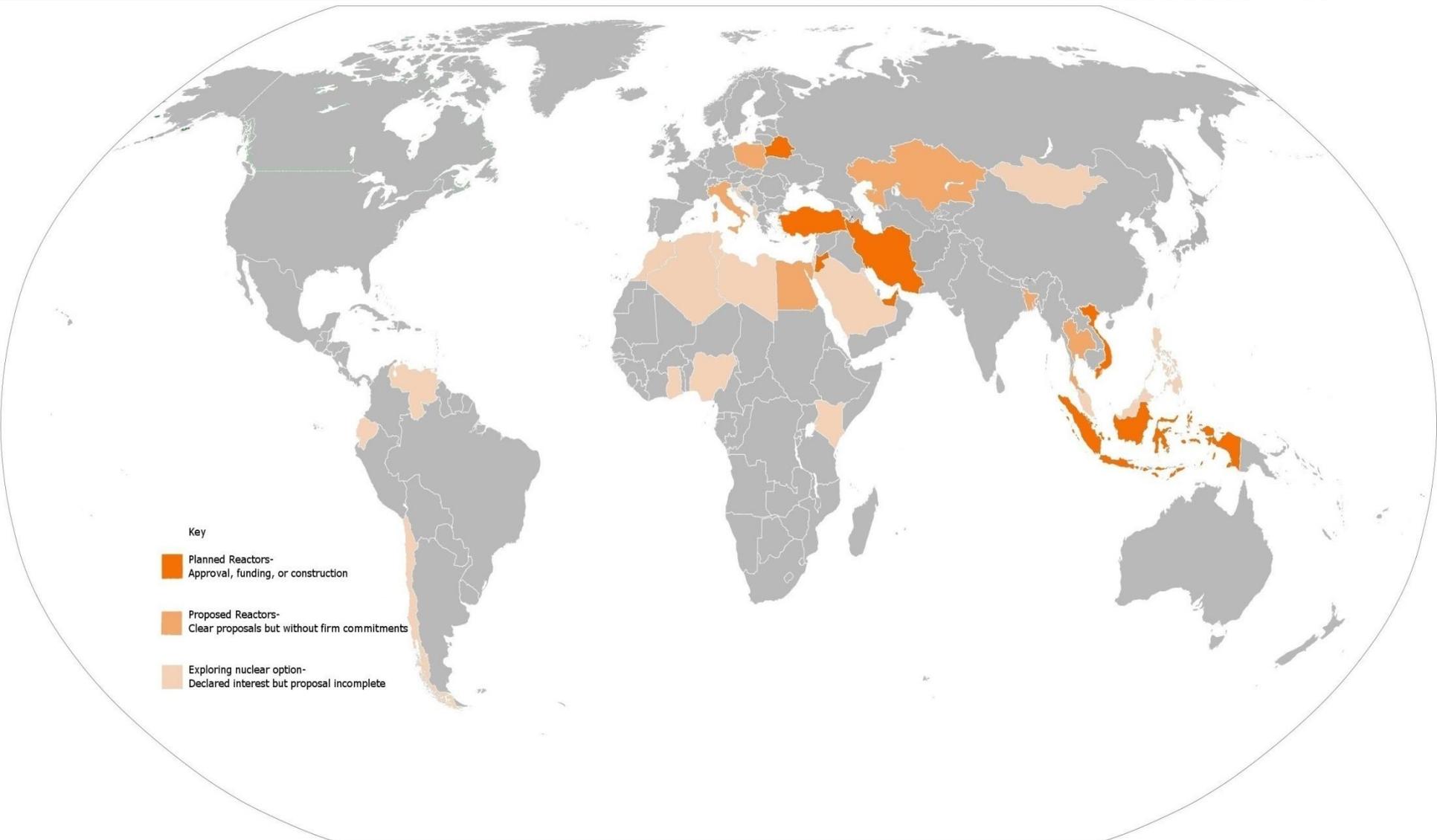
- Generally, the proliferation risks from expanded distribution of reactors considered small, compared to expansion of uranium enrichment and spent fuel reprocessing capabilities
- Nonetheless, not all reactors are equal
 - Some present monitoring challenges (e.g., on-line refuelling)
 - Some present security challenges (e.g., floating reactors)
 - Some have lower burn-up (e.g., PHWRs) and thus the resultant plutonium could be more appealing to divert
 - Some require HEU or PU for initial fuel

General Concerns

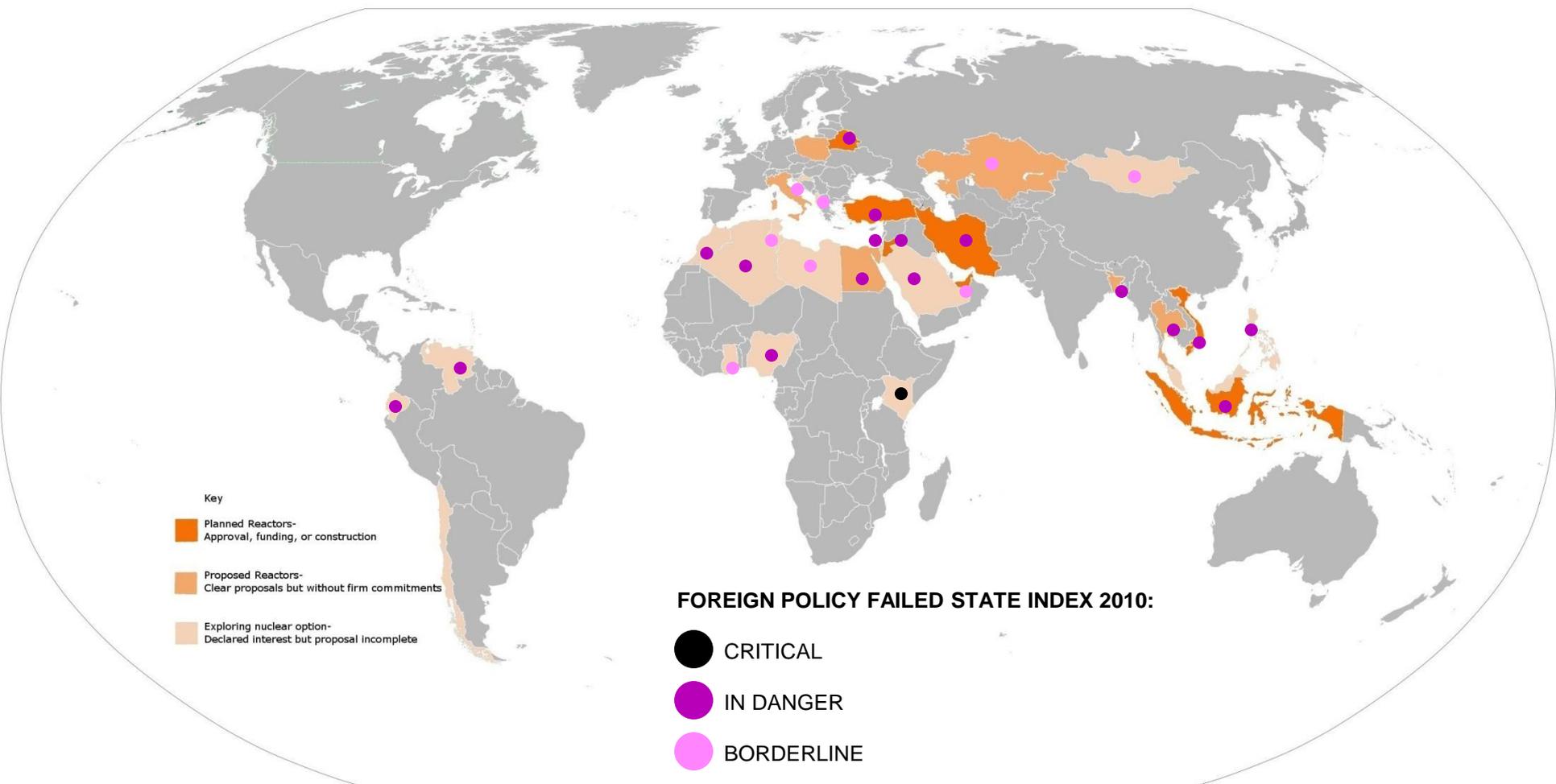
- Many more reactors, more widely dispersed
 - 439 npps now in 30 countries + Taiwan
 - IAEA: high range ~ 100 SMRs by 2030; 500-1000 SMRs by 2040?
- Remote locations
 - Proliferation-resistance and physical protection challenges
- Management/operational concerns
 - Who operates? Who regulates?
 - Nuclear liability (300 MWe is liability classification; what happens when they are linked together?)
 - Safeguards issues
- Nuclear waste

Proposed “New” Nuclear States

Proposals as of August 2010



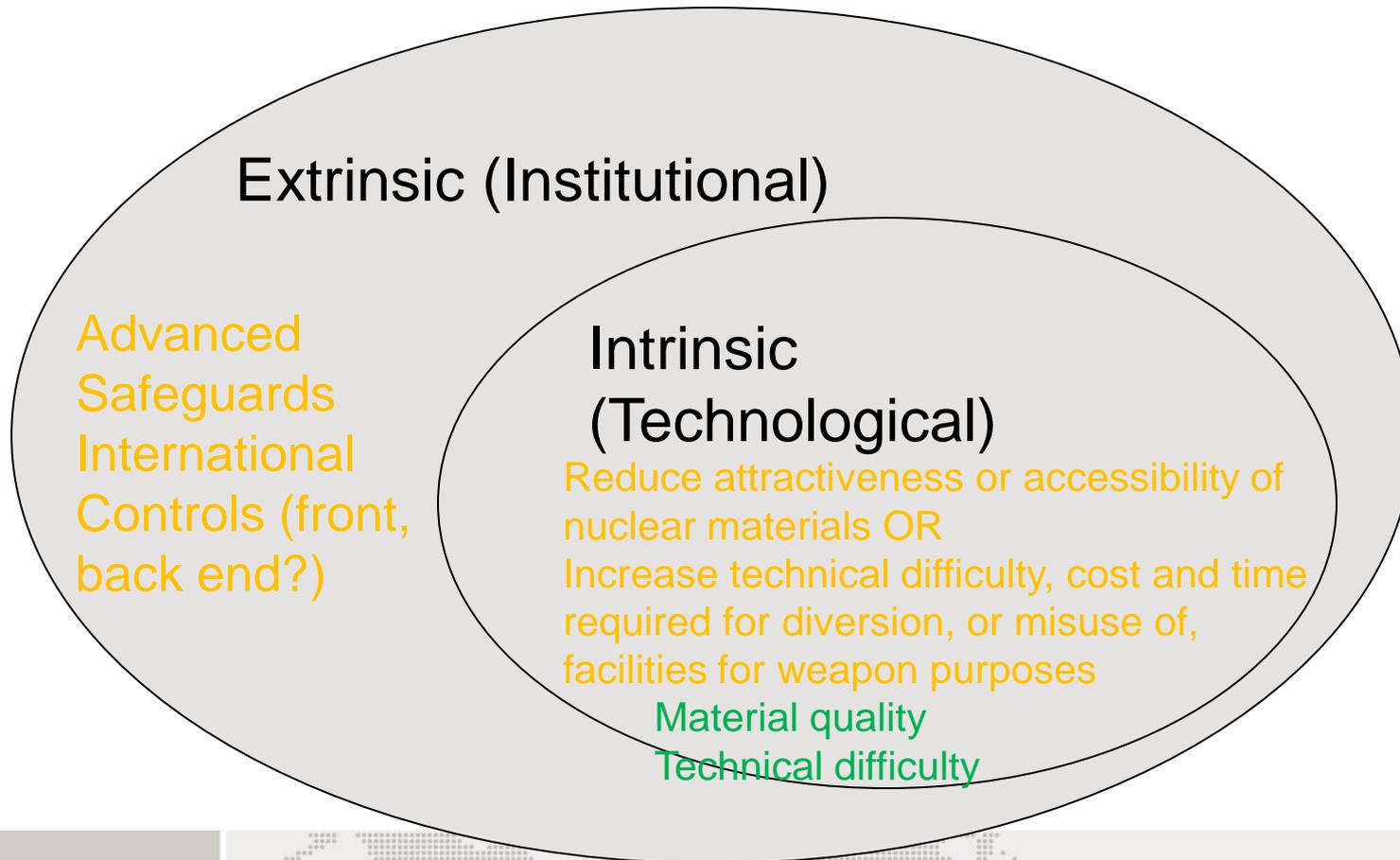
Nuclear Plans and Failed State Index 2010



Proliferation-Resistance

- IAEA: characteristic of the nuclear energy system that **impedes the diversion or undeclared production of nuclear materials, or misuse of technology**, by the host state in order to acquire nuclear weapons or other nuclear explosive devices.
- **Extrinsic proliferation resistance** features are those that result from the **decisions and undertakings of states** related to nuclear energy system
- **Intrinsic proliferation resistance** features are those that result from the **technical design of nuclear energy systems**, including those that facilitate the implementation of the extrinsic measures

Proliferation-Resistance



Potential to Improve Proliferation-Resistance

- Small reactors with long-lived cores to allow expanding nuclear power to the developing world without increased proliferation risks
 - But lifetime cores require higher enriched uranium for LWRs or fast reactors (commercialization not yet successful).
- Underground placement to improve security from terrorists, proliferation threats
- Off-site refueling and off-site SNF storage

To optimize proliferation-resistance

- Need to consider reactors within context of fuel cycle, proliferation and waste management
- Need to be incorporated into institutional arrangements for fuel assurances (cradle-to-grave?) and waste disposal that do not promote reprocessing