Nuclear Power and Nuclear Proliferation:

Policy Priorities for the Next Decade

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Environmental and Energy Study Institute Briefing
Russell Senate Office Building, Washington, DC, May 20, 2010

Revision 5

America's Energy Future: Technology and Transformation
National Academy of Sciences; National Academy of Engineering; National Research Council
Washington, DC, July 2009
www.nap.edu/catalog.php?record_id=12091

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Nuclear Energy

Utilities in the United States ha
in adding new nuclear powe
tion sources. As of July 200
(USNRC) had received 17 applicati
licenses[1] for 26 units, and it expec
units by the end of 2010.[2] The 1
constructed in the 1970s and 19
supply: nuclear power provides
70 percent of electricity produ
tions. These plants provide ele
with capacity factors greater
remain, and no new nuclear
than 30 years.

This chapter discusse
the United States, includi

[1]Previously, the licensin
required a different licens
part of the USNRC's new
[2]The USNRC's lists
reactors/new-reactors/c
expected-new-rx-appli
[3]The net capacity

Domestic Debates of Proliferation Risks

need to take into account the global challenges of nuclear power
more so than they usually do today

"The risk of proliferation is a controversial subject, and there are differing points of view about how it should affect technology trajectories within the United States."

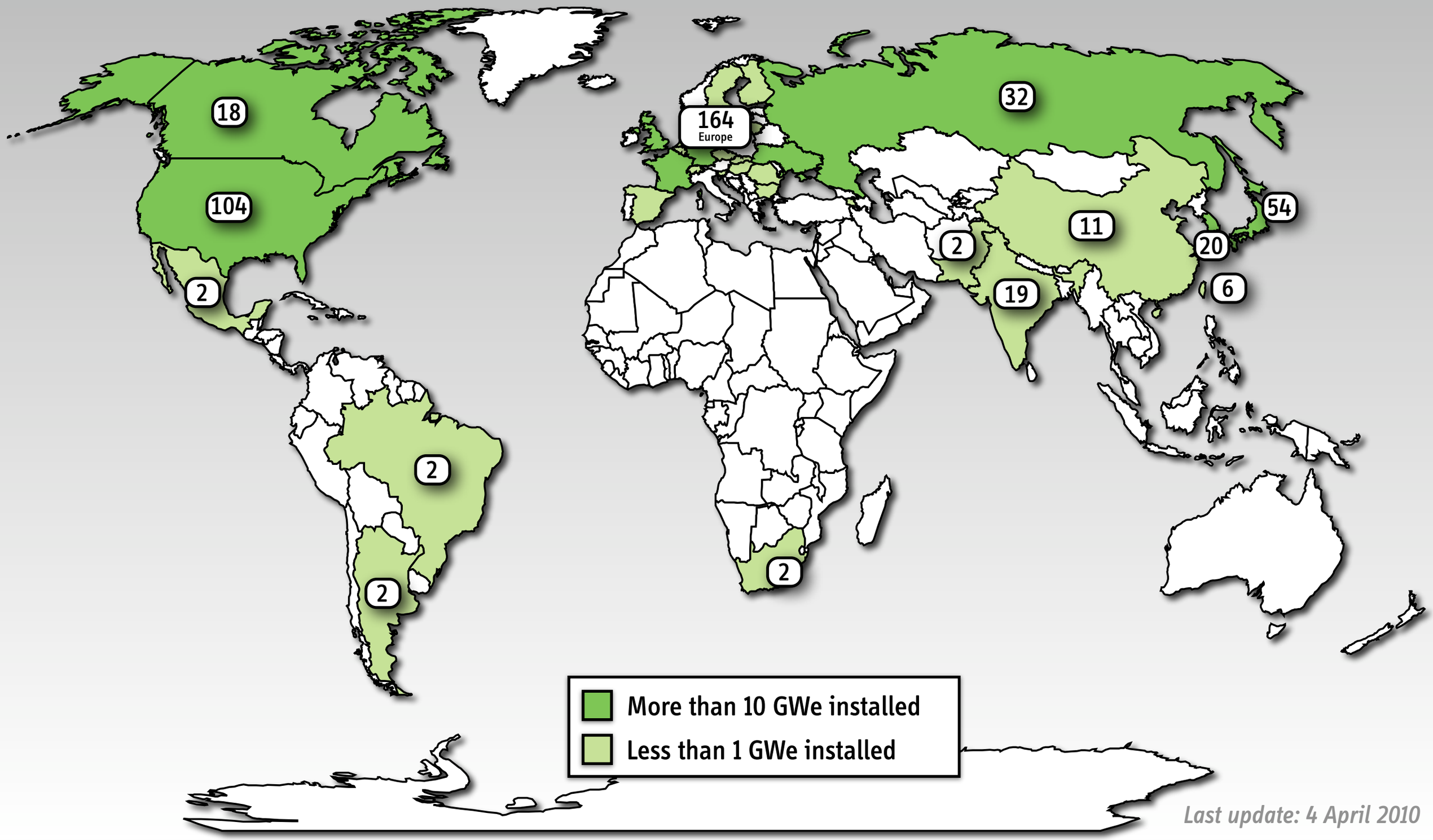
(AEF, Chapter 3, p. 111, Footnote 16)

"An expansion of nuclear power and associated fuel cycle technologies in this country does not directly affect the proliferation of nuclear weapons technology."

(AEF, Chapter 8, Nuclear Energy, p. 491)

Nuclear Power Reactors in the World, 2010

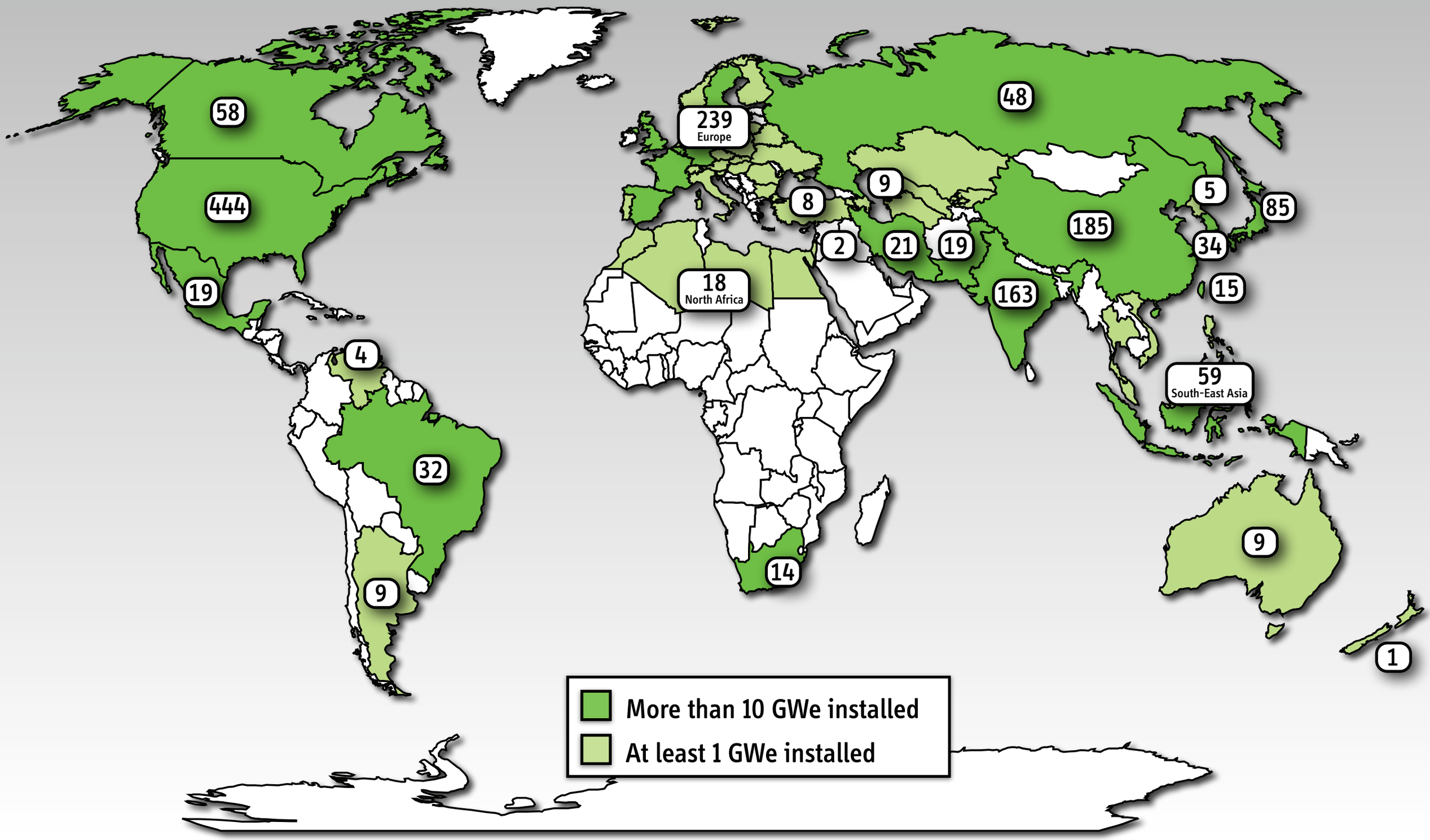
(438 reactors in 30 countries)



Last update: 4 April 2010

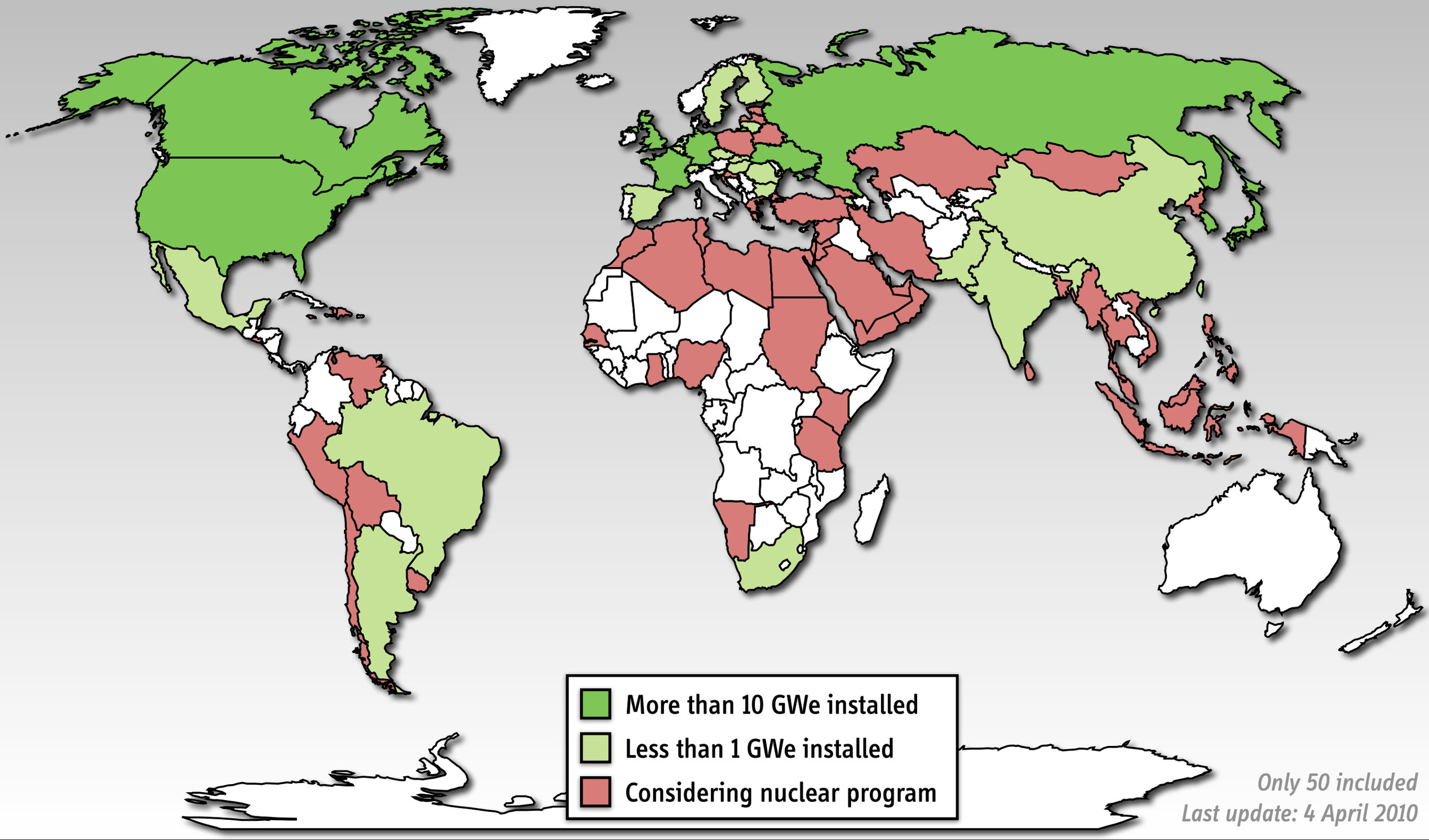
Global Nuclear Expansion Scenario

(1500 GWe in 58 countries, based on 2003 MIT study)



Nuclear “Newcomer” Countries

According to the IAEA, 60+ countries are currently considering nuclear programs



Only 50 included
Last update: 4 April 2010

The Decade Ahead

Little new capacity will be added in the United States
and (even less so) in Western Europe

Little (if any) capacity will come online in "newcomer" countries

By the end of the decade, we will understand better the
economics and some other constraints for both nuclear and its competitors

We may take options off the table at that point

In particular, nuclear power may have to be taken off the table
if "global deployment scenario" remains unacceptable

What Should Be Done In the Meantime?

Refrain From Reprocessing

Pros and Cons of Reprocessing

Theoretically, large reduction in uranium demand when combined with deployment of fast breeder reactors

Access to directly weapon-usable material

Reprocessing facilities are difficult and expensive to safeguard

Environmental concerns (liquid and gaseous emissions)

Reprocessing is expensive

Reprocessing is Expensive

and will remain so for the next decades

La Hague Reprocessing Plant, July 2005
Source: Wikipedia

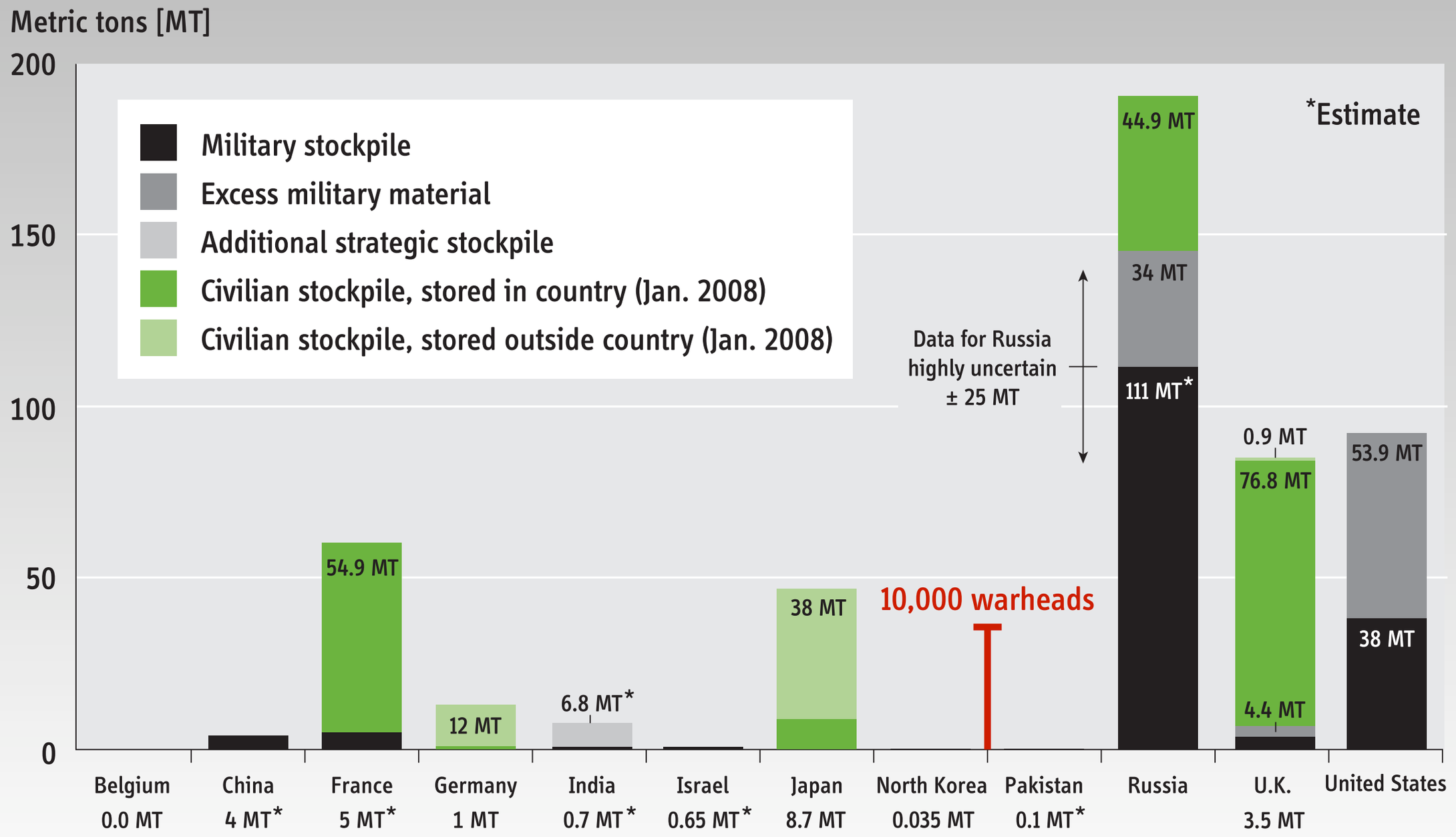
Plutonium fuel is about 3x more expensive than standard uranium fuel today

(more than $10,000/kg of MOX fuel compared to about $3,500/kg of low-enriched uranium fuel)

Uranium price would have to increase 4-5 fold to make reprocessing and plutonium-use competitive

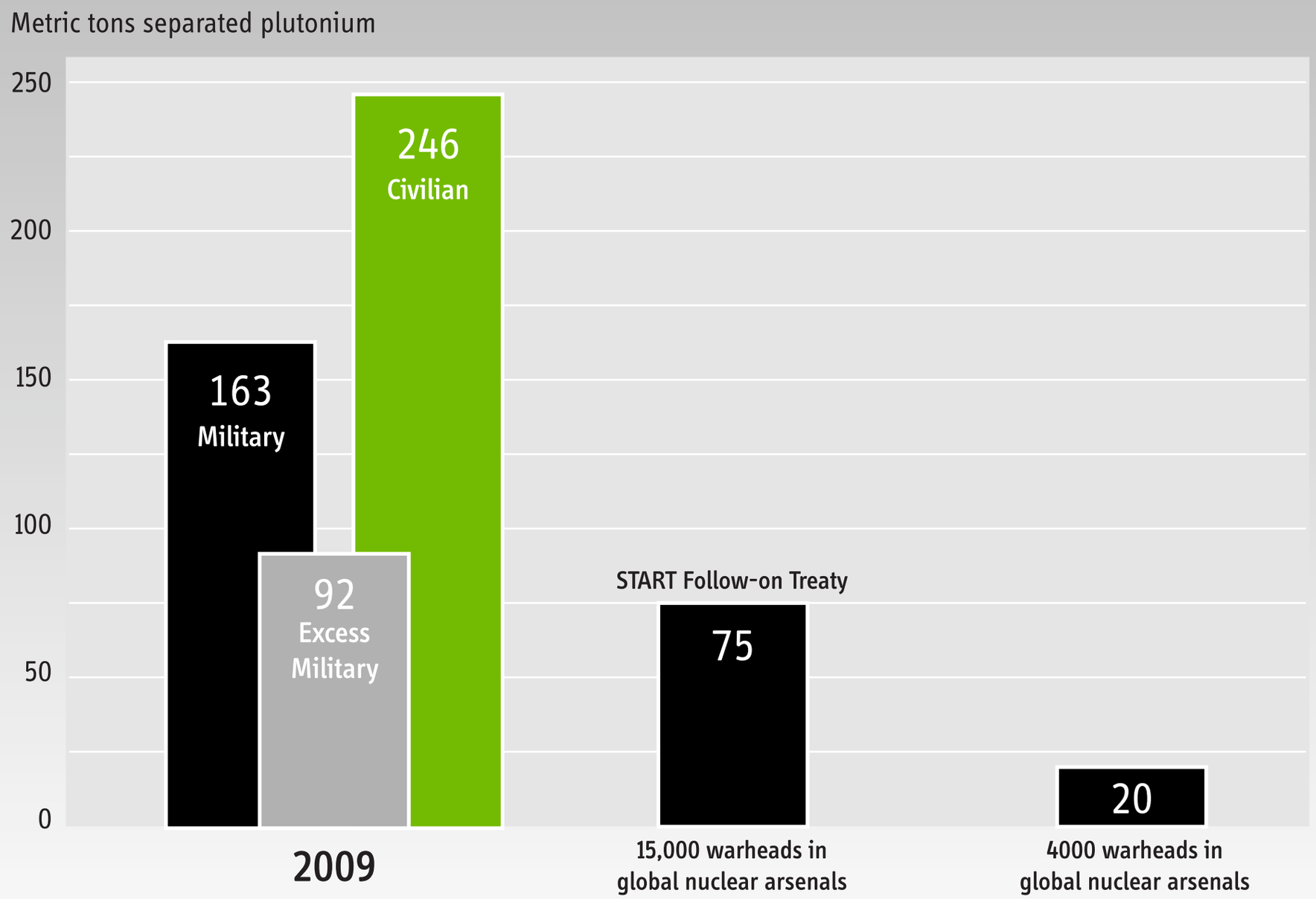
Stockpiles of Separated Plutonium, 2009

Global stockpile is 500 tons, half is civilian and this stock is growing



Global Fissile Material Report 2009, International Panel on Fissile Materials, Princeton, NJ, 2009, www.ipfmlibrary.org/gfmr09.pdf

Civilian Separated Plutonium in a Disarming World



R. Socolow and A. Glaser, "Balancing Risks: Nuclear Energy and Climate Change," *Daedalus*, 2009

Dry Cask Storage of Spent Fuel

is a simple and proven strategy for the next decades

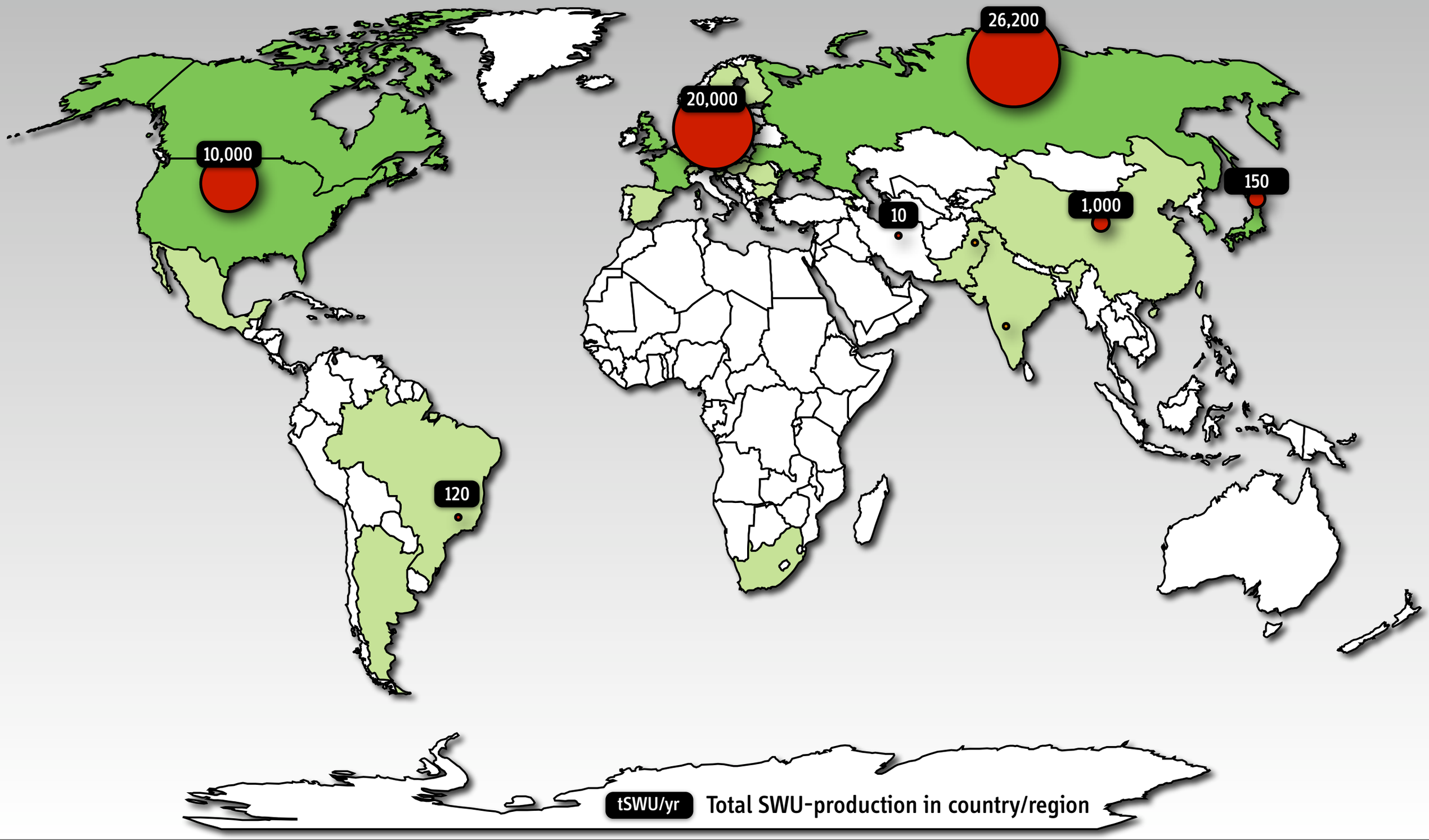
Source: Department of Energy

See for example: www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage.pdf

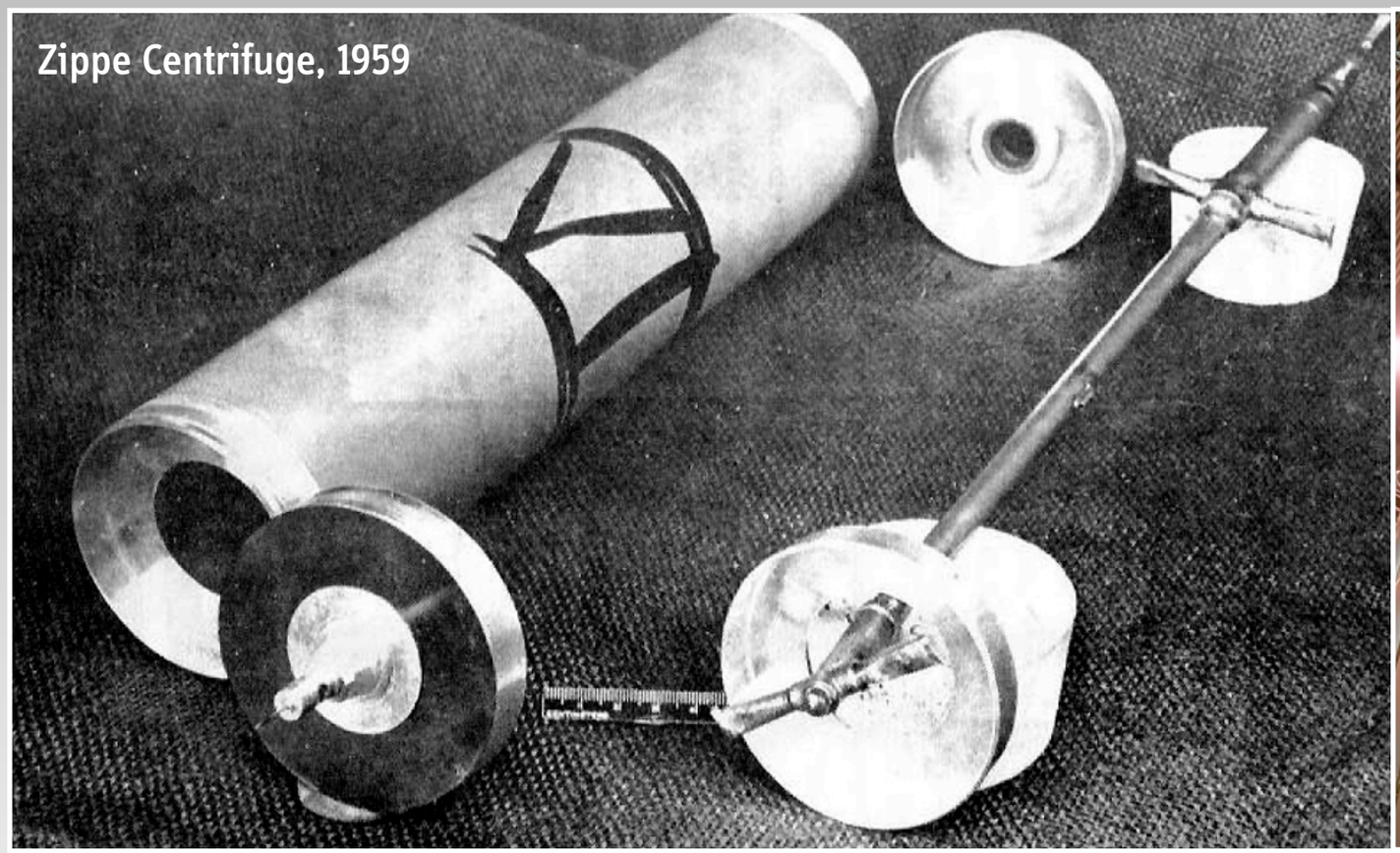
Build a New Framework for the Nuclear Fuel Cycle

Global Enrichment Capacities, 2010

(14 operational plants in 10 countries, not including two military plants)



Why Centrifuges Are Different



Characteristics of centrifuge technology relevant to nuclear proliferation

Rapid Breakout and Clandestine Option

Iran's Second Enrichment Site, near Qom

(Fordow Plant, revealed in September 2009 at 34.885 N, 50.996 E)

Global Enrichment Capacities, 2010

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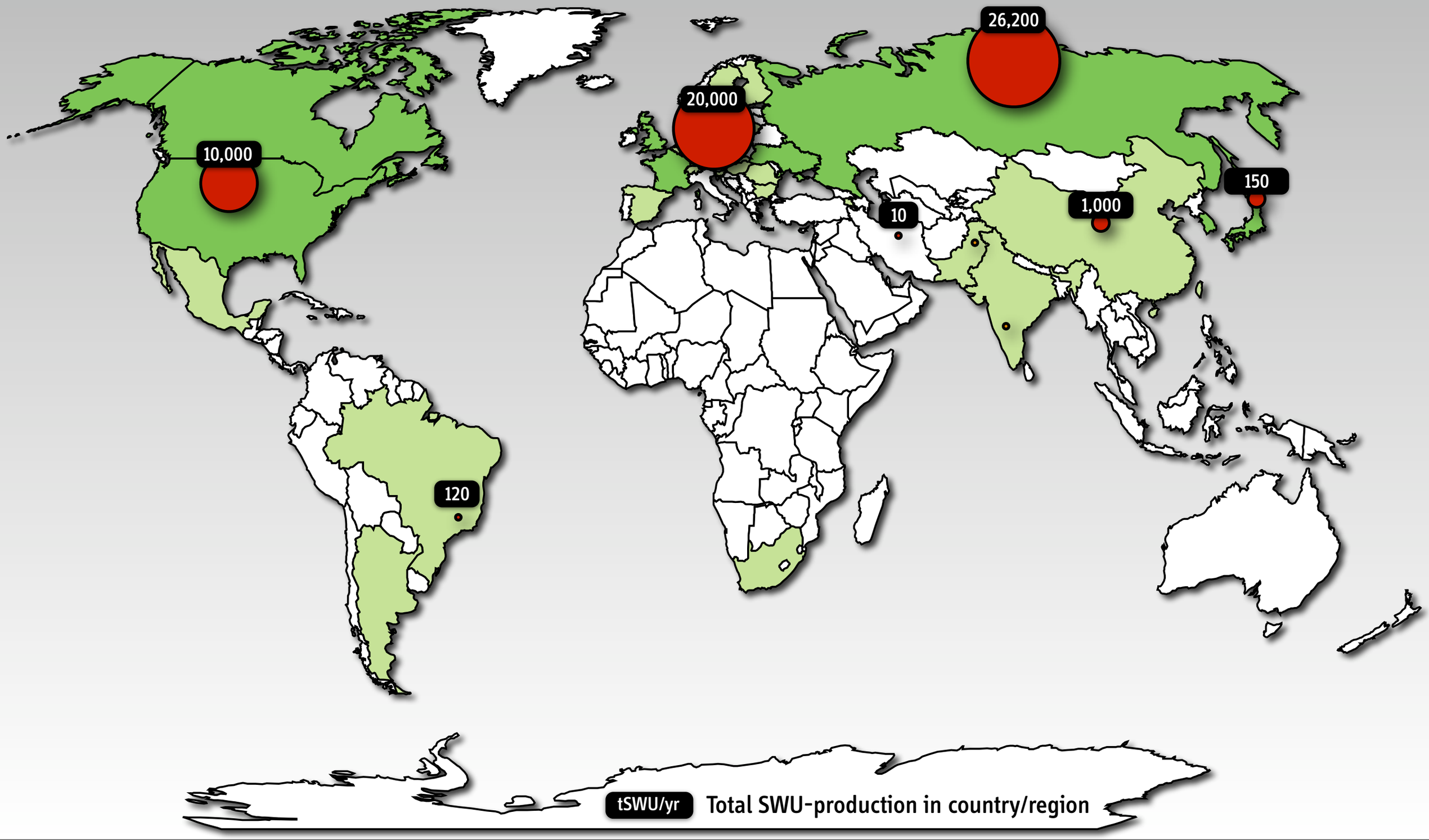
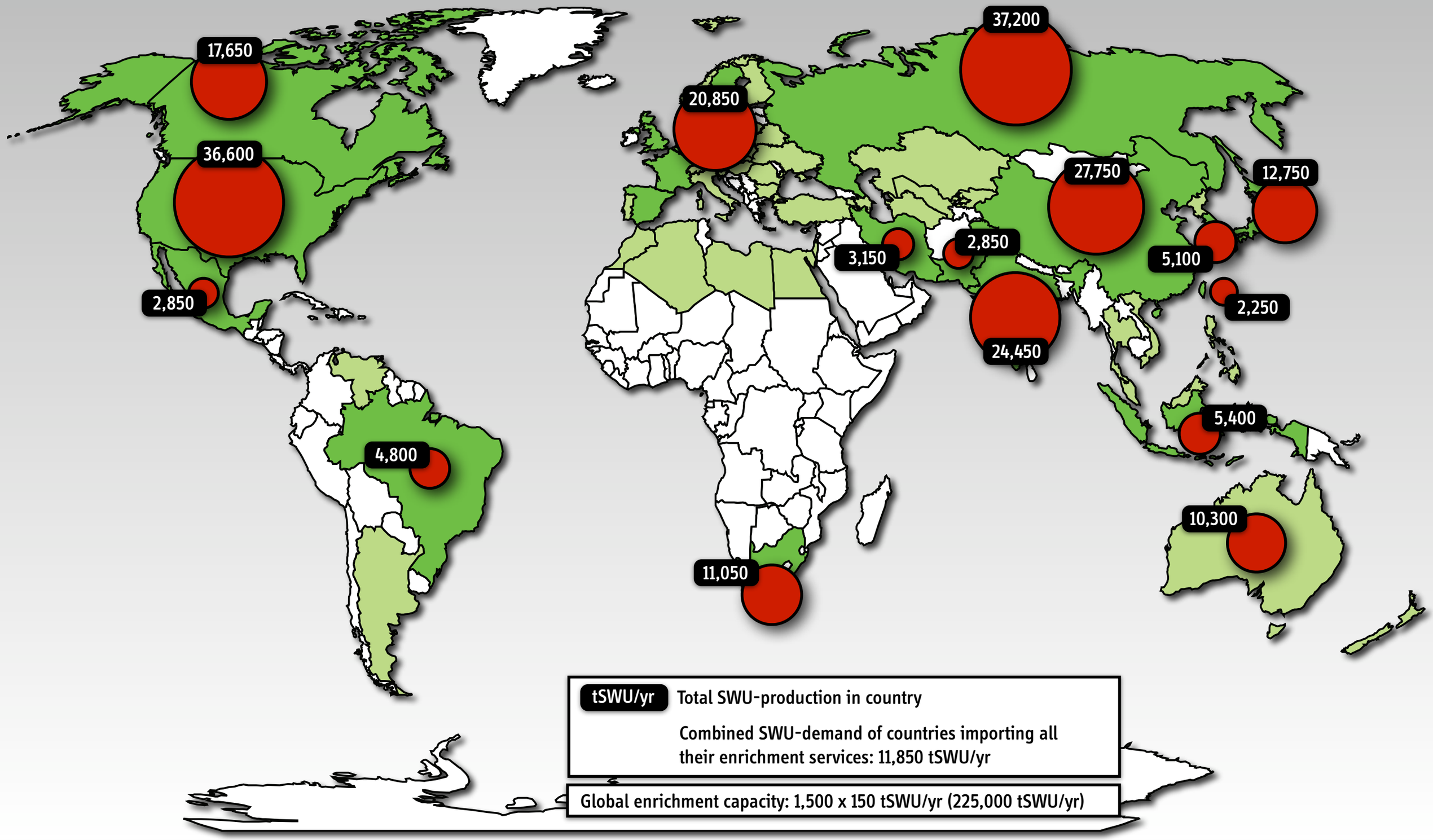


Enrichment Demand and Distribution

(for 1500 GWe Global Nuclear Expansion Scenario based on light-water reactors)



Remarks of U.S. President Obama

Hradcany Square, Prague, Czech Republic, April 5, 2009

"We should build a new framework for civil nuclear cooperation, including an international fuel bank, so that countries can access peaceful power without increasing the risks of proliferation. That must be the right of every nation that renounces nuclear weapons, especially developing countries embarking on peaceful programs. No approach will succeed if it is based on the denial of rights to nations that play by the rules."

Multilateral Approaches to the Nuclear Fuel Cycle

involving Joint Ownership of Enrichment Plants

Nonproliferation Objectives

Prevent the further spread of sensitive nuclear technologies
Assure the peaceful use where they remain

Multinational Plants Can Help Achieve These Objectives

Regional plants as a confidence-building measure

Reduce the number of plants worldwide

Implementation of modern and effective international safeguards

Over time, ease concerns about clandestine enrichment programs

once a strong norm against national research and development of sensitive nuclear technologies emerges

Areva Eagle Rock
3,000 tSWU/YR

Paducah
11,300 tSWU/YR

Urenco Eunice
3,000 tSWU/YR

USEC Piketon
3,500 tSWU/YR

Portsmouth
7,400 tSWU/YR

GLE Wilmington
3,500-6,000 tSWU/YR

The United States ought to:

- seriously explore the possibility of multilateral approaches for its own (new) enrichment plants; and
- facilitate IAEA safeguards in these plants, also to help establish state-of-the-art safeguards approaches

Concluding Remarks

Nuclear power could make a significant contribution to climate-change mitigation

but the world is not now safe for a rapid and global expansion of nuclear power

The next decade will be critical

Not much new nuclear capacity will be added in the United States and Europe

Time to establish economics, adequate technologies, and new norms of governance

U.S. leadership would make a decisive difference

The once-through fuel cycle must become the norm again

To move forward, multilateral approaches need support of major nuclear suppliers