

Falling Behind: International Scrutiny of the Peaceful Atom

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Current Safeguards Wisdom: We Can Cope

- States have an “inalienable right” to any nuclear activity or material so long as it has some conceivable civilian application and is inspected by the IAEA
- Luckily, the line between what is dangerous – covert nuclear fuel making -- and all other “safe” nuclear pursuits including operating “proliferation resistant” light water reactors, is sufficiently bright and clear.
- Whatever the IAEA can inspect, it can adequately safeguard against military diversions
- Reactors and nuclear fuel making can be made much more proliferation resistant. Until then nuclear fuel assurances will tide us over

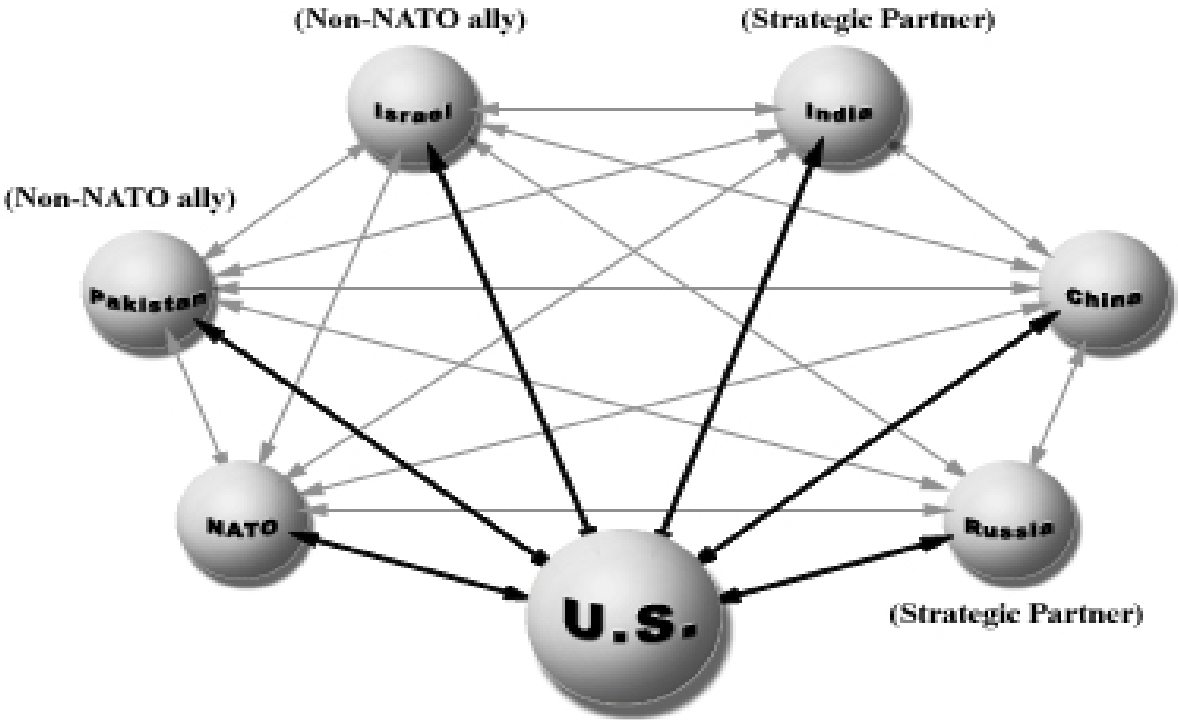
A More Complete View: We're Overplaying Our Hand

- The NPT doesn't ban any specific nuclear materials or technology nor does it recognize any *per se* right to any either
- Operating large reactors now can bring nations quite a ways towards acquiring bombs
- The IAEA can't reliably find covert nuclear fuel making plants, account for many bombs worth of weapons usable material produced at declared fuel making plants, or detect diversions from them in a timely manner. The agency even has difficulty maintaining adequate inspections continuity over fresh and spent fuel rods
- Suggested technical fixes (e.g. GNEP) are not likely or timely; institutional fixes (e.g., assure fuel at "reasonable" prices) could make matters worse.

Current Proliferation Seems Manageable

(With DPRK Disarming and Iran Nonnuclear)

Post-911
Today



21 Possible Strategic Relationships
(6 of the most important with the US)

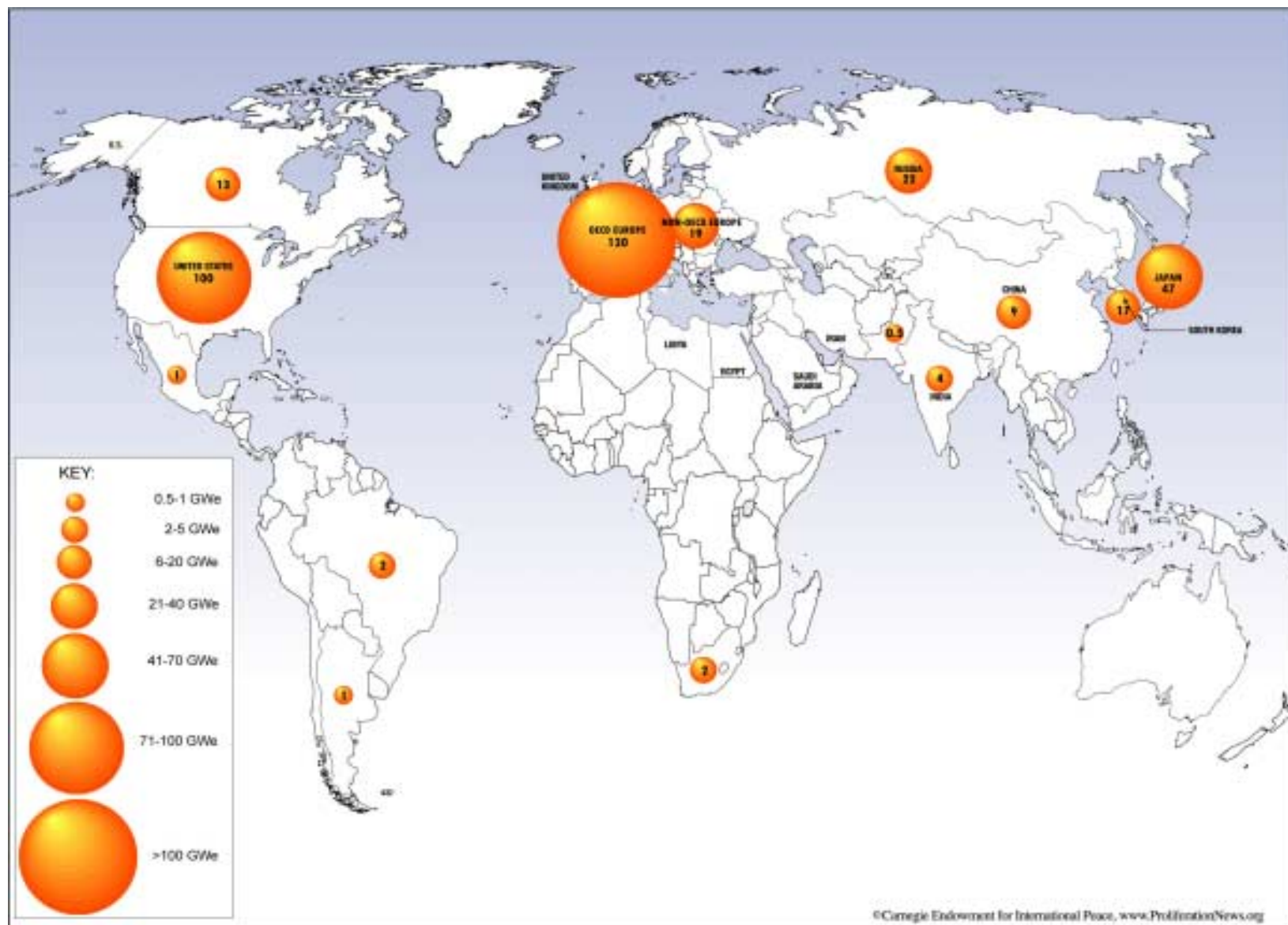
But Civilian Nuclear Programs Could Become Pacing Events

See: Victor Gilinsky, Harmon Hubbard, Marvin Miller, ***A Fresh Examination of the Proliferation Dangers of Light Water Reactors***, October 22, 2004

Available at <http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20041022-GilinskyEtAl-LWR&PDFFolder=Essays>

Civilian Nuclear Power Currently Is Limited

(Gigawatts electric, GWe)



But at Least 18 States Since 2006 Have Announced Plans to Build Large, “Peaceful” Nuclear Reactors by 2020#

- Turkey (US, France) +
- Egypt (US, Fr. China) +
- S. Arabia, (Fr., US, Rus.)*
- UAE (France)
- Yemen
- Morocco (France)
- Jordan (US, Fr).
- Libya (US, France)
- Algeria (Rus., Fr. US) +
- Qatar (Fr.)
- Tunisia
- Syria (DPRK?)
- Indonesia (RoK)
- Bangladesh (Rus.)
- Nigeria
- Vietnam (Rus.)
- Australia
- Israel

• Applauded by Israeli officials as an “announcement directed against Iran”

+ Possibly interested in developing a nuclear weapons option

() Countries that have initiated or are discussing nuclear cooperation to build power reactors

31 states currently operate power reactors

Back to the Future? Countries With Declared Civilian Programs That Have Toyed with Weapons Programs

Reactors Only

- Taiwan
- South Korea
- Algeria
- Iraq
- Egypt
- Israel
- Sweden

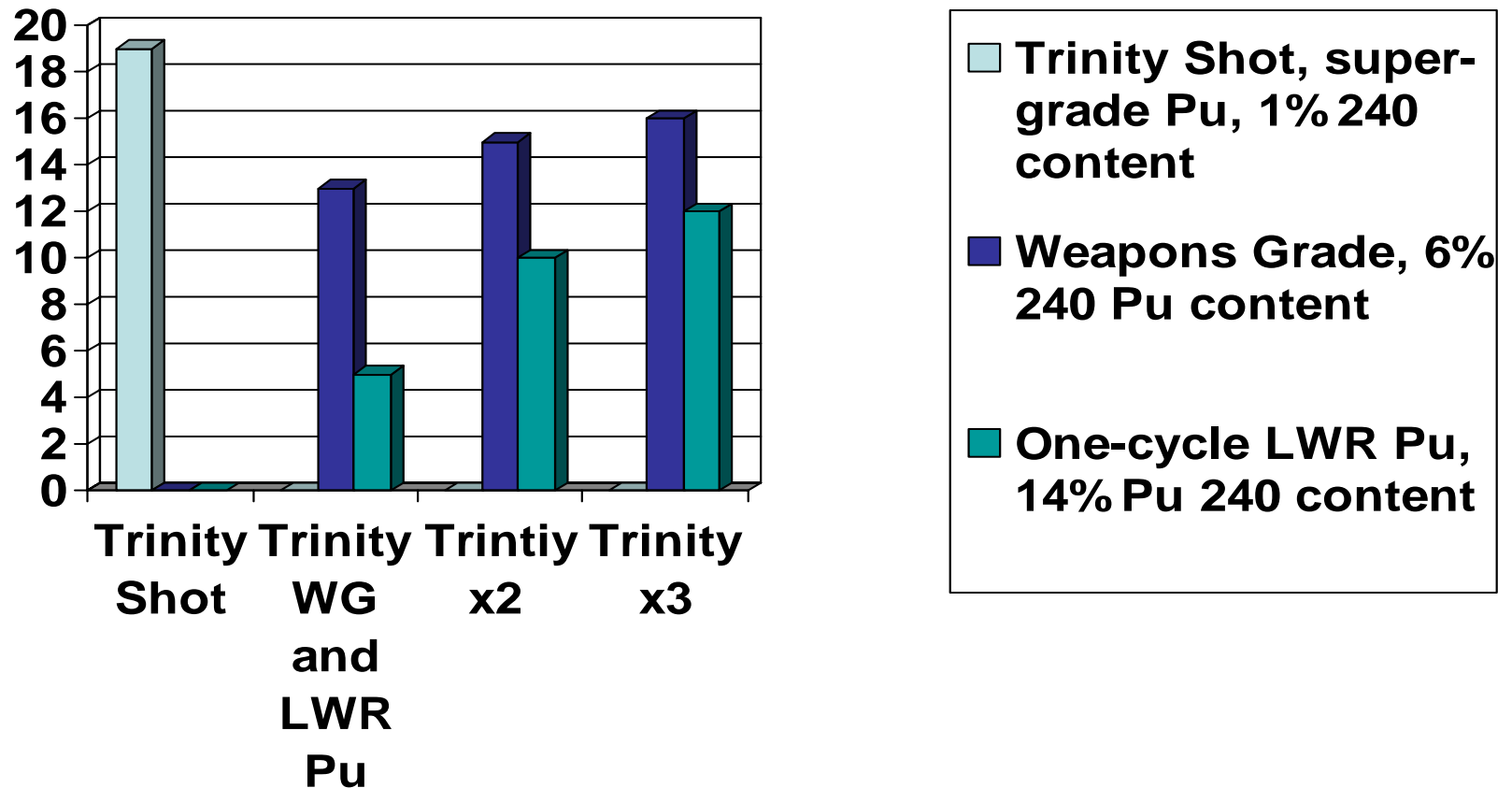
Reactors and Fuel Making

- o South Africa
- o Brazil
- o Argentina
- o India
- o France
- o Iran

In its 1st Year, A Large LWR Makes 50 or More Crude Bombs' Worth of Near Weapons-Grade Plutonium

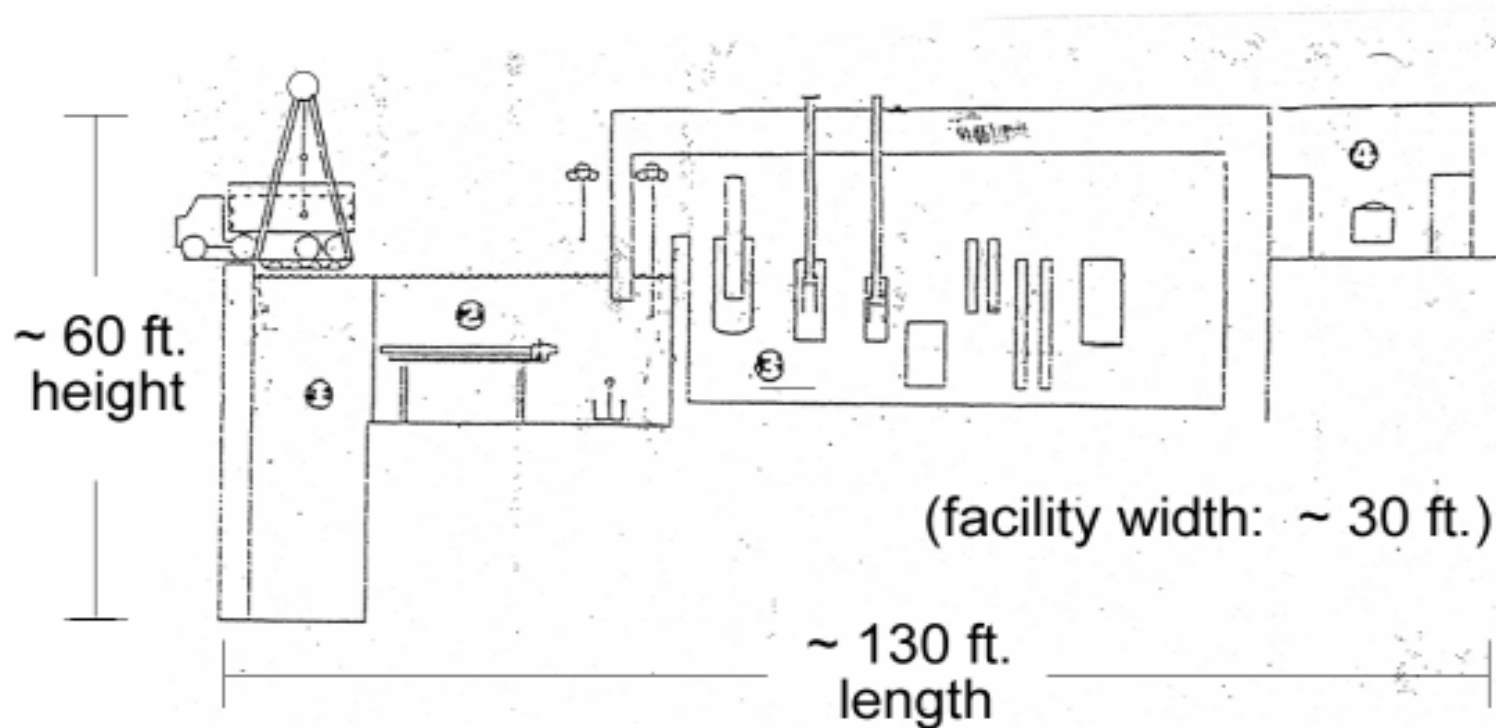


Estimated Yields for Different Bomb Technologies Using One-cycle LWR Pu (Hubbard 2003)



Problem: Simple, Small Reprocessing Plant Can Make As Many as 20 Bombs a Month (e.g., Ferguson-Culler)

10-day startup, 1 bomb's-worth-a-day production rate



Sources: Adapted from D.E. Ferguson, "Simple, Quick (Re)Processing Plant," Memorandum to F.L. Culler, Oak Ridge National Laboratory, August 30, 1977; and J.A. Hassberger, "Light-Water Reactor Fueling Handling and Spent Fuel Characteristics," Fission Energy and Systems Safety Program, Lawrence Livermore National Laboratory, circa February 26, 1999.

Fresh Fuel's A Worry Too

- 4,000 swus required to convert natural uranium into one bomb's worth (20 kgs) of HEU
- 700 swus – 1/5th the effort or time – is required to convert 3.5% fresh fuel to one bomb's worth (with 3,000 P-1 centrifuges, and LEU feed, ***Iran could have its first bombs worth in less than 8 weeks versus nearly a year.***)
- Fresh fuel must be delivered every 12-18 months to LWR reactors like Bushehr
- Crush and fluorinate the ceramic fresh fuel pellets is all that needed to get LE UF₆

**But Wouldn't IAEA Safeguards Check
Such Threats?**



Not Unless They Are Upgraded (Slide 1)

- Of IAEA's ~1,200 remote nuclear inspection cameras, nearly 800 have no near-real-time feedback. Virtually all of the countries of concern have no near-real-time feedback
- IAEA internal review of May 2005 found in that "Over the past 6 years, there have been 12 occasions when facility lights were turned off for a period greater than 30 hours" See <http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20070731-NPEC-ReportOnIaeaSafeguardsSystem&PDFFolder=Reports>
- Of those 400 IAEA cameras that have near-time feedback, many depend on internet connections that can be interrupted

Not Unless They Are Upgraded (Slide 2)

- Under Additional Protocol's "Integrated Safeguards", IAEA remote monitoring will occur in some case only once every *12 months – i.e., in far more time than it might take to make a bomb.*
- US State Dept. officials requested NPEC self-censor 2 scenarios for spent fuel rod diversions that could evade IAEA detection entirely. Similar scenarios, it turns out, were described elsewhere on the web by IAEA's own Safeguards advisory group chairman. See <http://www.npec-web.org/Frameset.asp?PageType=Single&PDFFile=20041022-GilinskyEtAl-LWR&PDFFolder=Essays>

And Supplemented (slide 1)

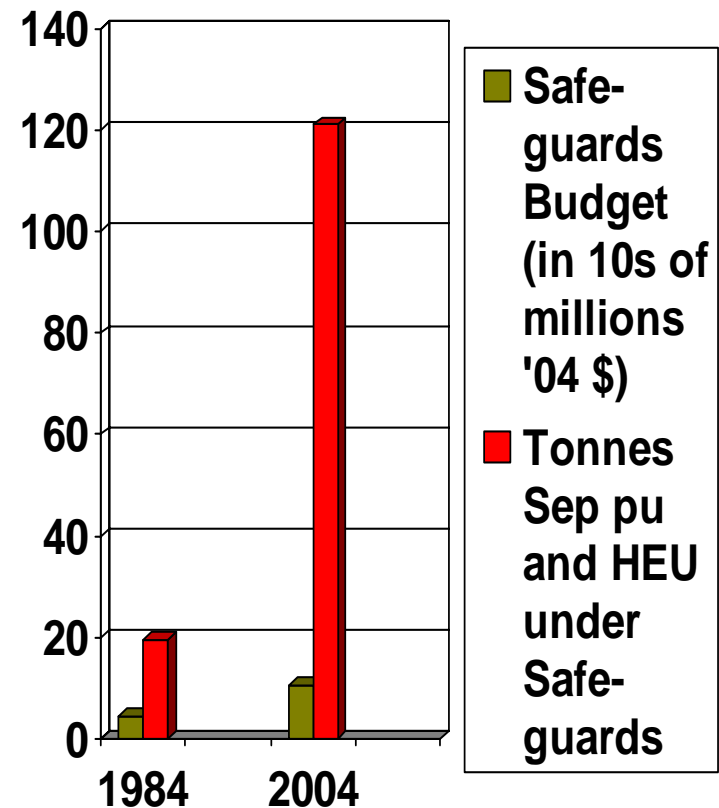
- **No Wide Area Surveillance unit or technical capability funded to seek out covert nuclear activities; *former alone might cost 20-40 million dollars a year for Iran or North Korea***
- **Fuel making, on-line fueled reactors (e.g., heavy water reactors) cost much more to monitor than other facilities**
- **Analysis of samples and images and surveys for implementing integrated safeguards will require much more and more qualified staff**

Not Unless They Are Upgraded (Slide 2)

- **R and D for safeguards technologies needs to be driven by IAEA as much as by what is volunteered by donors**
- **Increased amounts and production of direct use materials – MoX and Pu– will present special monitoring headaches**
- **All of this will require much more funding for safeguards – one to two orders of magnitude more than current budget**

IAEA Safeguards Spending vs. Mounting Weapons Usable Material Stockpiles

- o From 1984 to 2004, the IAEA's safeguards budget roughly doubled to \$105 m in constant '04 dollars
- o During the same period, the amount of separated plutonium and HEU under IAEA inspections increased 6-fold (i.e., enough for 12,000-21,000 bombs)



Too High: IAEA's Significant Quantity Estimates -- 8kgs (pu) and 25 kgs (HEU)

Figure II(a)

NRDC Estimate of the Approximate Fissile Material Requirements for Pure Fission Nuclear Weapons

	WEAPON-GRADE PLUTONIUM (kg)			HIGHLY-ENRICHED URANIUM (kg)		
Yield (kt)	Technical Capability			Technical Capability		
	Low	Medium	High	Low	Medium	High
1	3	1.5	1	8	4	2.5
5	4	2.5	1.5	11	6	3.5
10	5	3	2	13	7	4
20	6	3.5	3	16	9	5

Values rounded to the nearest 0.5 kilogram.

False Confidence: IAEA Conversion Times and Timeliness Detection Goals

MATERIAL	IAEA Conversion Time	NPEC Commissioned Estimate	Official IAEA Timeliness Detection Goal	Recommended Timeliness Detection Goals
Pu, HEU, U233 in metal form	Order of days (7-10)	Order of days (7-10)	One month	Timely detection is not possible
In fresh MOX	Order of weeks (1-3)	Order of days (7-10)	One month	Timely detection is not possible
In irradiated spent fuel	Order of months (1-3)	Order of months (1-3), if reprocessing - enrichment plant on tap (7-10 days)	Three months	For countries with covert or declared nuclear fuel making plants, timely detection is not possible
Low enriched uranium	Order of months (3-12)	Order of weeks to months	One year	For countries with covert or declared enrichment plants, timely detection is not possible

Too Hard: Declared Nuclear Fuel Making

- **Sellafield** (Euratom safeguards meeting IAEA criteria)
 - 29.6 kgs pu MUF (Feb. 2005)
 - 190 kgs pu in “leak” undetected for 8 months
- **Tokia Mura**
 - MoX, 69 kgs pu MUF (1994)
 - scrap 100-150 kgs pu MUF (1996)
 - Pilot reprocessing 206kgs – 59 kgs pu MUF (2003)
 - Commercial reprocessing 246 kgs/yr pu MUF (2008?)
- **Cogema-Cadarache** reprocessing plant
 - Euratom report 2002, “unacceptable amount of MUF”, 2 yrs to resolve
- **Similar MUF challenges at centrifuge enrichment plants**
see http://www.asno.dfat.gov.au/publications/addressing_proliferation_challenges_from_spread_enrichment_capability.pdf
- **No Country-specific listing of MAF**

El Baradei 2004 Statement to the IAEA Board of Governors

“ . . . if they have the required fissile material — HEU or plutonium — **we are relying primarily on the continued good intentions of these countries,** intentions which are in turn based on their sense of security or insecurity, and could therefore be subject to rapid change. **Clearly, the margin of security this affords is thin, and worrisome.**”

Yet the IAEA continues to speak as though it can meet its safeguarding criteria with regard to nuclear fuel making.

States' Rights to Atomic Energy: U.S. Views NPT As Iran and DPRK Do

- “One of the things that Iran has illustrated to us is that there is a major **loophole** in the [nuclear Nonproliferation Treaty] NPT. The **loophole** is one whereby countries, under the guise of a civil program, can develop the wherewithal for nuclear weapons.” US Ambassador to IAEA, June 7, 2006
- Allowing enrichment and reprocessing is “widely recognized as the most significant **loophole** in the NPT” – Under Secretary of State for AC and IS, 9/08/05
- “Iran, while retaining **its right to enrichment and reprocessing**, would, nonetheless, find it in its interest to give up that right in terms of its own territory” – President’s National Security Advisor 11/18/05

A *Per se* Right to the Entire Fuel Cycle?

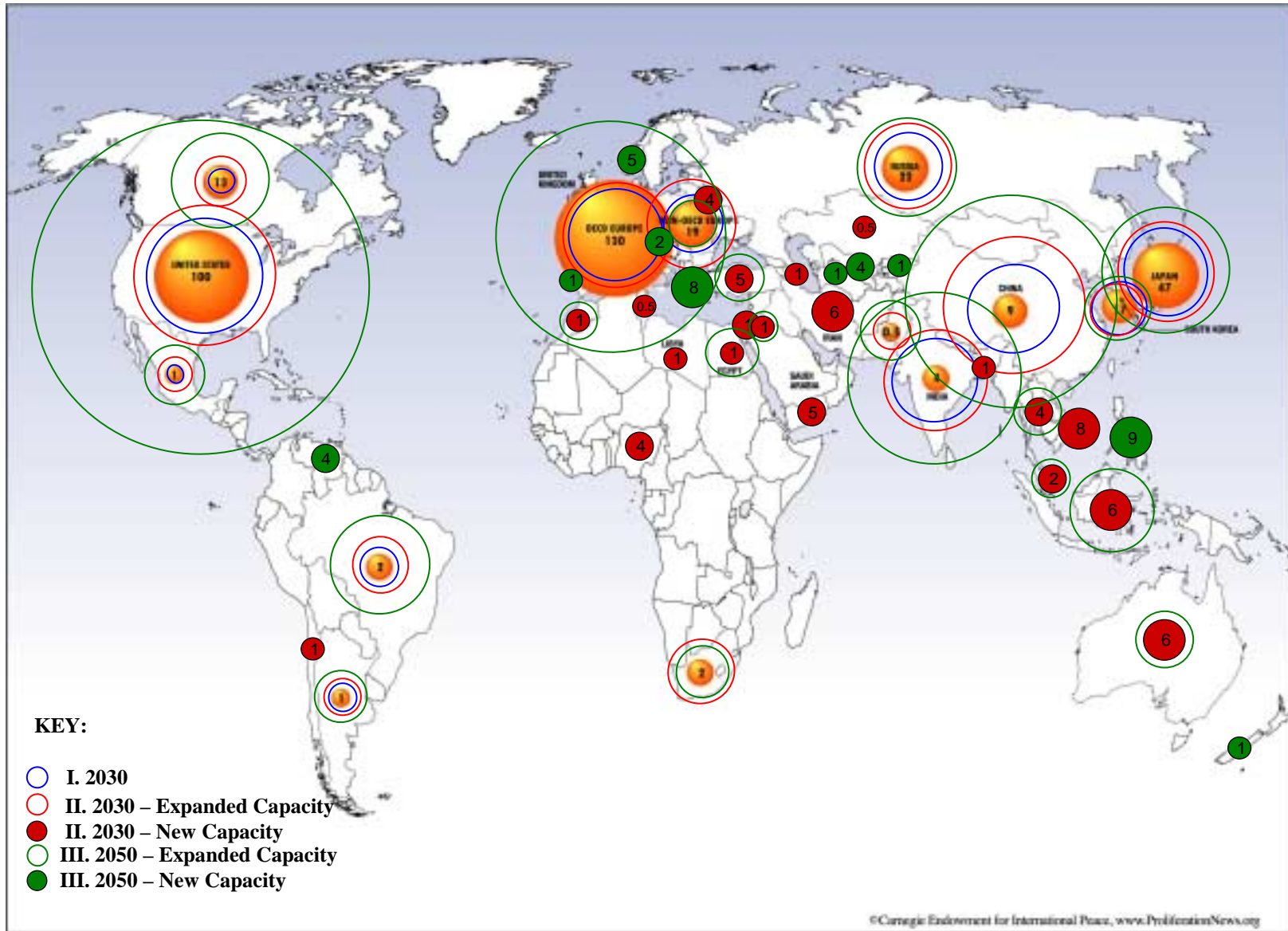
- **NPT aim as stated in a 1965 General Assembly resolution GA Res. 2028 (XX) Nov. 19, 1965) was to write a treaty “void of loop-holes”**
- **Enrichment and reprocessing not mentioned in the NPT text**
- **Spanish, Brazilian, Romanian, Mexican NPT proposals to make sharing “the entire technology of reactors and fuels” a “duty” explicitly rejected in 1967.**
- **Swedish, English and Burmese NPT negotiators’ expressed interest in setting forth criteria against nuclear fuel making**
- **All “peaceful” activities must be capable of being “safeguarded” to “prevent diversion”**
- **Article V, preamble urge sharing the “benefits” of peaceful nuclear energy and PNE’s, not of sharing money-losing technology that brings states to brink of having bombs.**
- **Standard legal practice favors tight construction that does not defeat purpose of the contract**

Where Are We Headed Assuming the Rules Are Read This Way?

“The regime will not be sustainable if scores more States Develop the most sensitive phases of the fuel cycle and are equipped with the technology to produce nuclear weapons on short notice – and, of course, each individual State which does this only will leave others to feel that they must do the same. This would increase all of the risks – of nuclear accident, of trafficking, of terrorist use, and of use by states themselves.” – *The Secretary – General of the United Nations, NPT Review Conference, May 2, 2005*

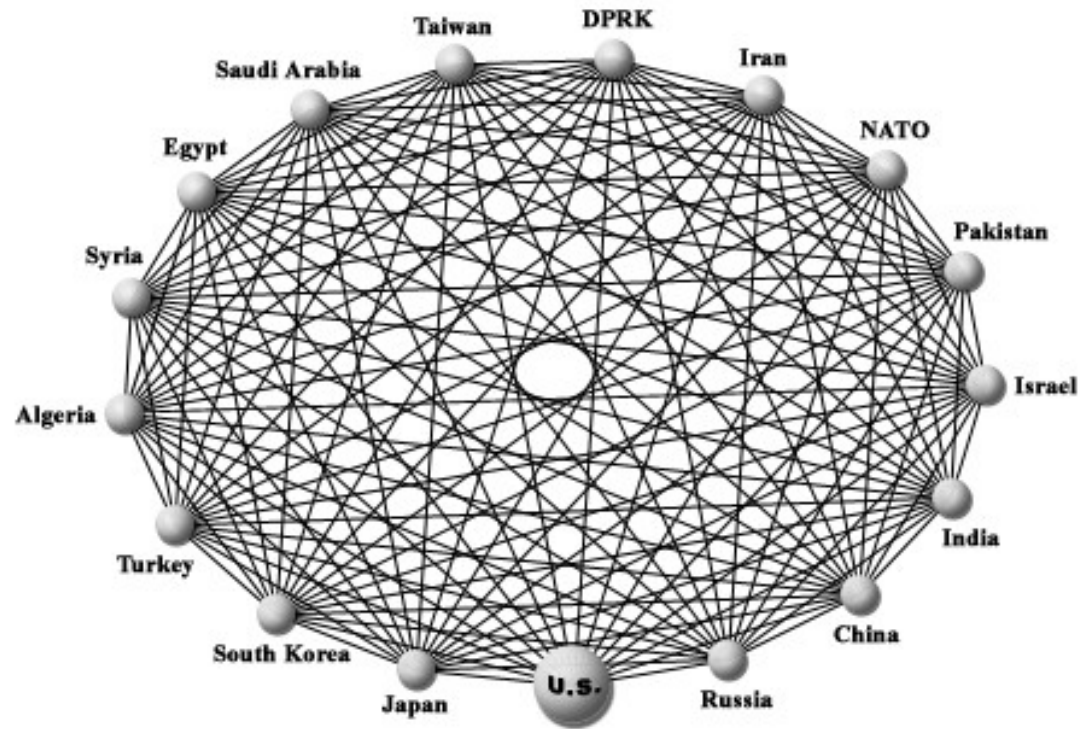
2050 Reactor Capacities for all Scenarios

(Gigawatts electric, GWe)



With More Nuclear-Ready States: Ramp Up to a Nuclear 1914?

Possible Proliferated Future



(136 chances for strategic miscalculation)

Today, plus

Iran DPRK Taiwan Saudi Arabia Egypt
Syria Algeria Turkey South Korea Japan

What Does Economics Suggest?

Cap Cost	Keystone	Moody's	S&P	Historical
Nuclear	\$3600-4000	\$5000-6000	\$4000	\$2000-2500
Coal	NA	\$2500-2900	\$2500	\$1500
IGCC	NA	\$3300-3700	\$2800	NA
Gas CC	NA	\$700-900	\$700	\$500-750

Key Safeguard Recommendations

Slide 1

- *What is “peaceful” and protected under the NPT should be reconsidered as a part of 2010 NPT Review Conference*
- *IAEA estimates of significant quantities, conversion times, and timeliness detection goals need to be updated.*
- *IAEA should distinguish between what it can safeguard from what it can monitor jettisoning ambitions to verify FMCT and “safeguarding” fuel making plants for more honest goals*

Key Safeguard Recommendations

Slide 2

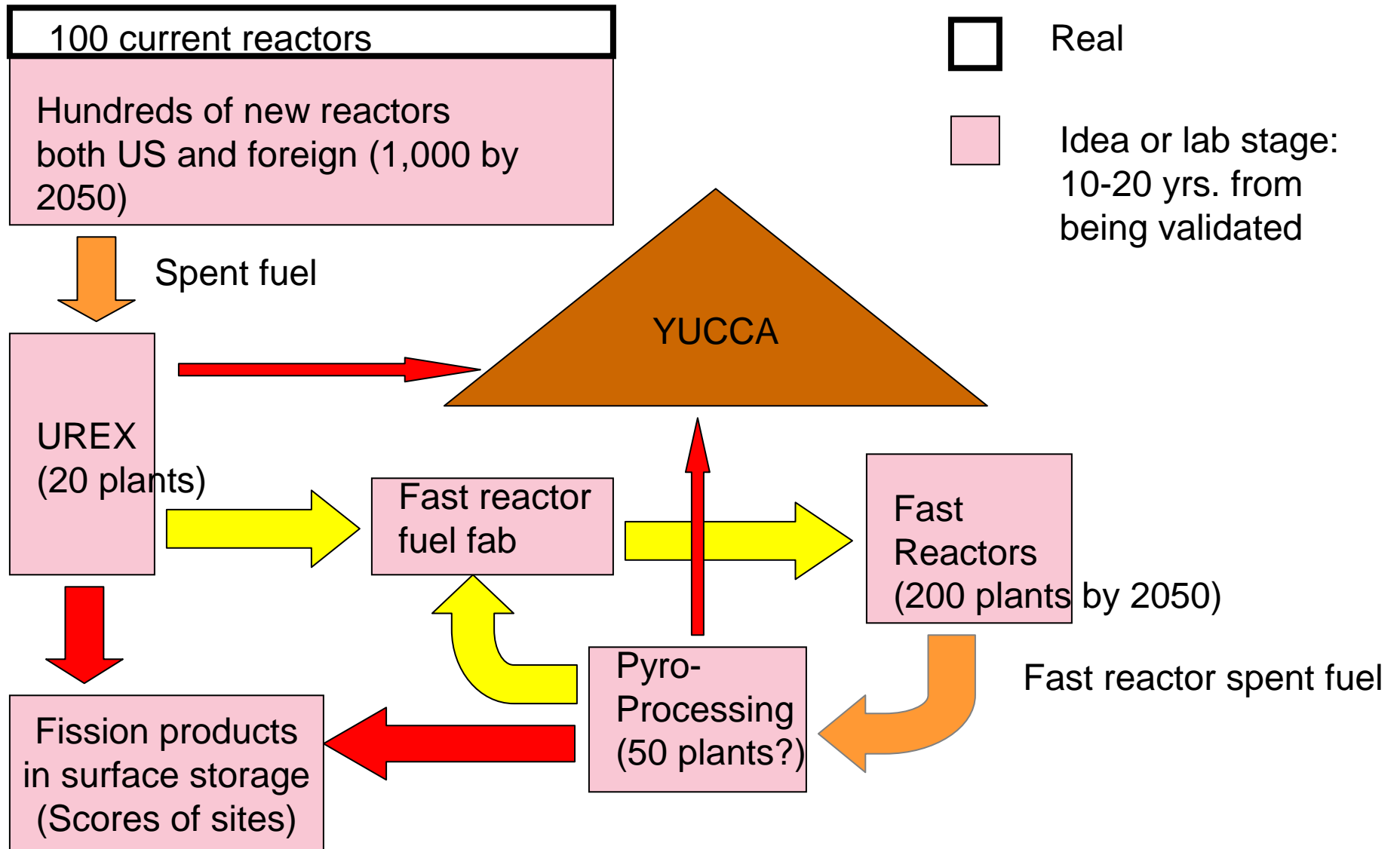
- ***IAEA safeguards material accountancy capabilities (especially the tracking of fuel rods, wide area surveillance) need much more funding*** through user-fees
- ***IAEA and UNSC enforcement actions should place burden of proof on suspect party*** and be made country-neutral and much more automatic
- ***Additional Suggestion:*** Should identify the full external and internal costs of nuclear power, compete energy projects in open international bidding on the basis of these costs (and The Energy Charter Treaty and the Global Energy Treaty for Sustainable Growth). Only projects that can compete economically against non-nuclear alternatives should be encouraged by any Kyoto follow one and be viewed as being protected under the NPT.

Back Up Slides

Bandwidth Requirements for Satellite Based Near-real-time Conductivity

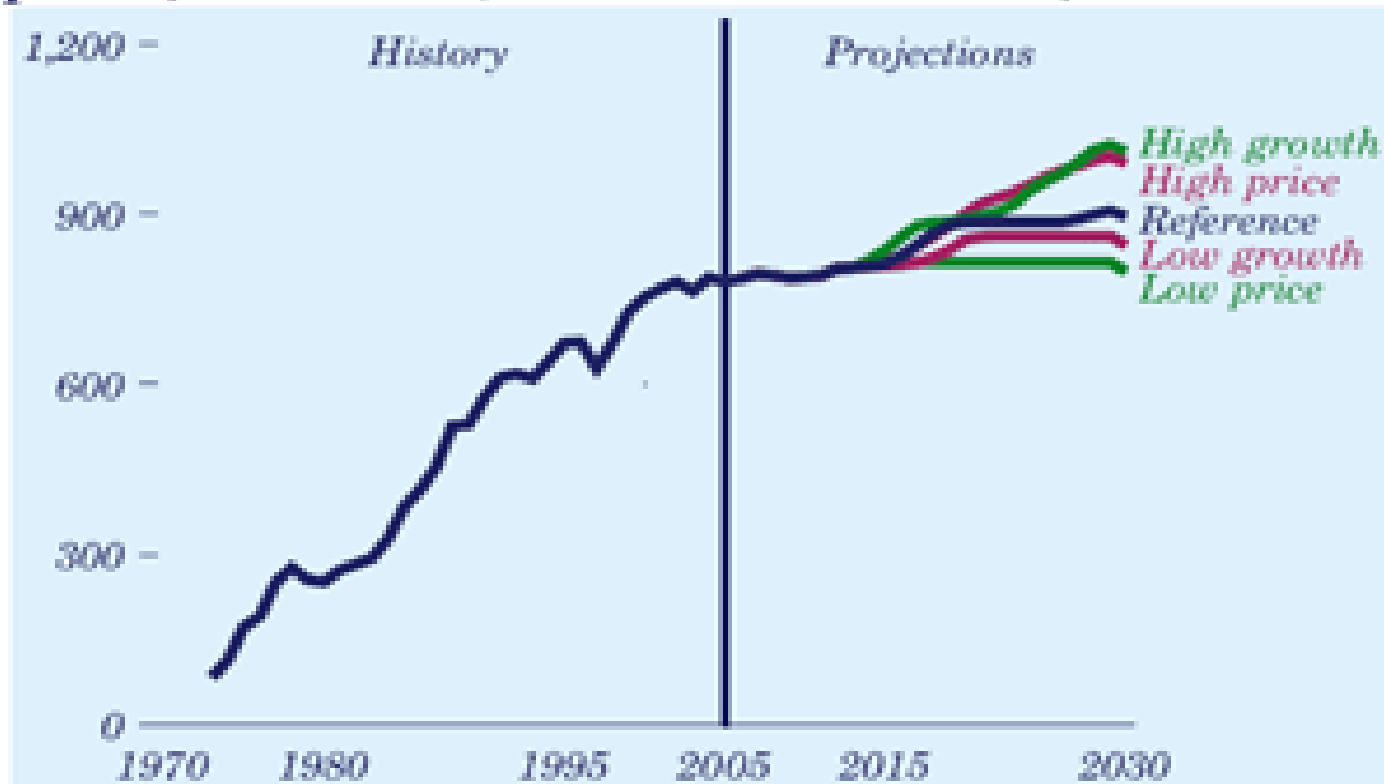
- **A relatively simple nuclear site may produce as little as 1 Mbyte/day (e.g. seals and state of health –SoH - data only)**
- **A typical light water reactor site may produce around 10 Mbytes/day (e.g. 2 surveillance cameras, seals and SoH)**
- **A large facility with multi-camera surveillance may produce up to 200 Mbytes/day**
- **A large and complex facility with multi-camera surveillance, radiation monitoring and process monitoring systems may produce data at many Gbytes/day**

GNEP – US Proposed Technical Fix: Questionable and Well Over the Horizon

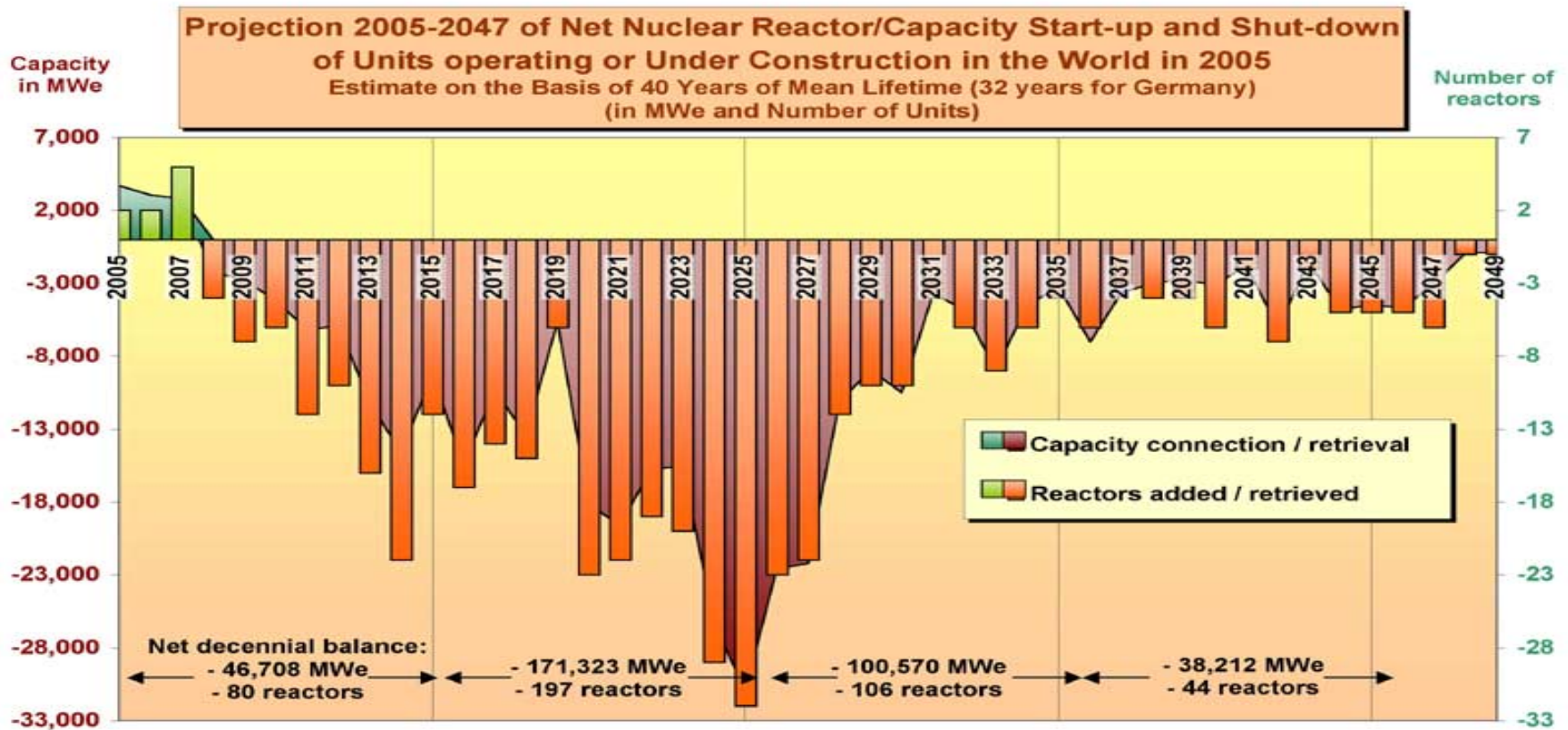


US DOE EIA Projects As Much as a 38% increase in Nuclear Power by 2030

Figure 58. Electricity generation from nuclear power, 1973-2030 (billion kilowatthours)



Even With Major, New Builds – i.e., Nearly 400 More Reactors – Nuclear Power May Only Stay Roughly Even Through 2035



Source: IAEA PRIS