# Expanding Nuclear Energy, Preventing Nuclear Terrorism

Matthew Bunn

Energy & Security Search Seminar

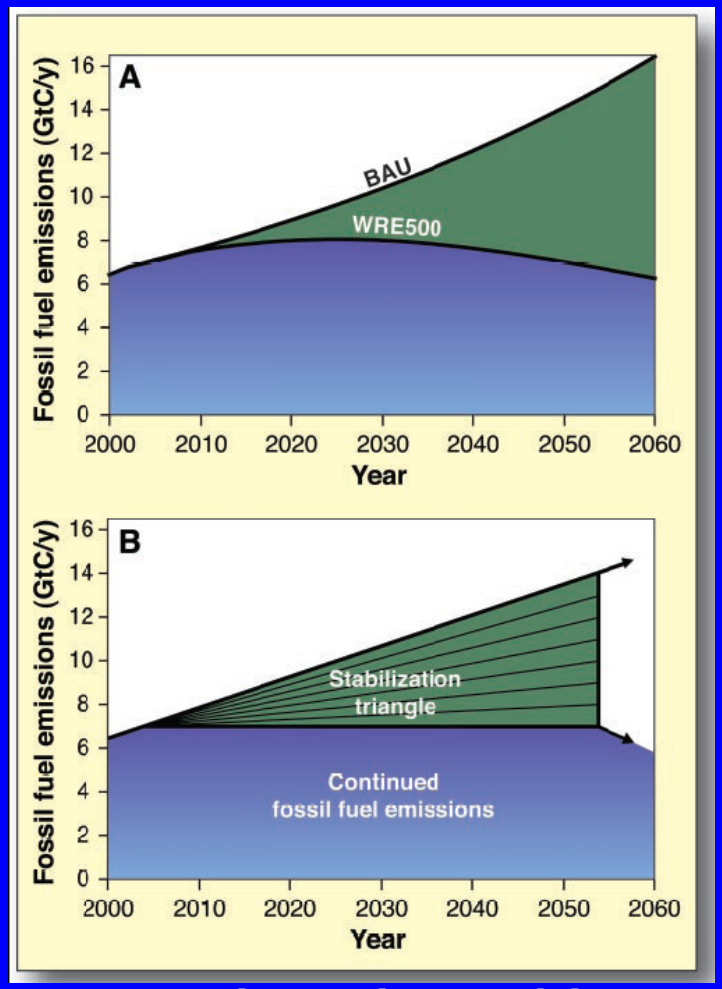
Harvard Kennedy School

March 13, 2008

http://www.managingtheatom.org

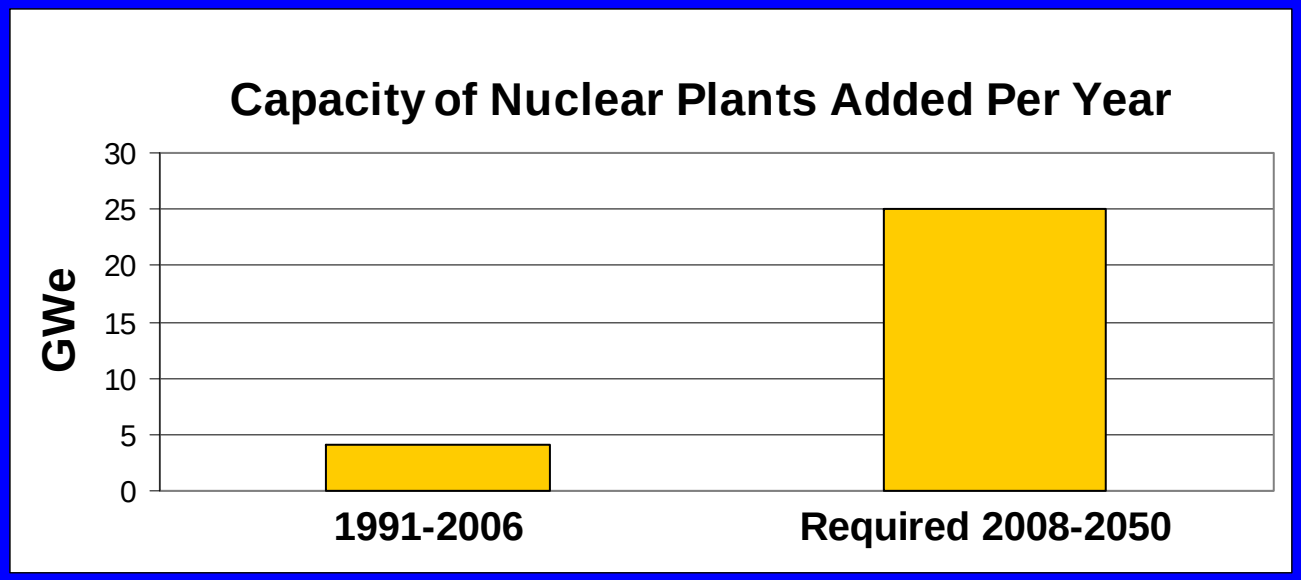
# The energy-climate context

- *Dramatic* nuclear growth required for climate contribution large enough to be significant
- To provide *one* of seven "wedges" needed to stabilize CO2 at 500 ppm, nuclear would have to add 700 GWe of capacity by 2050 – in addition to replacing existing 369 GWe of capacity
- 2 wedges – as in Stern report – may be unobtainable



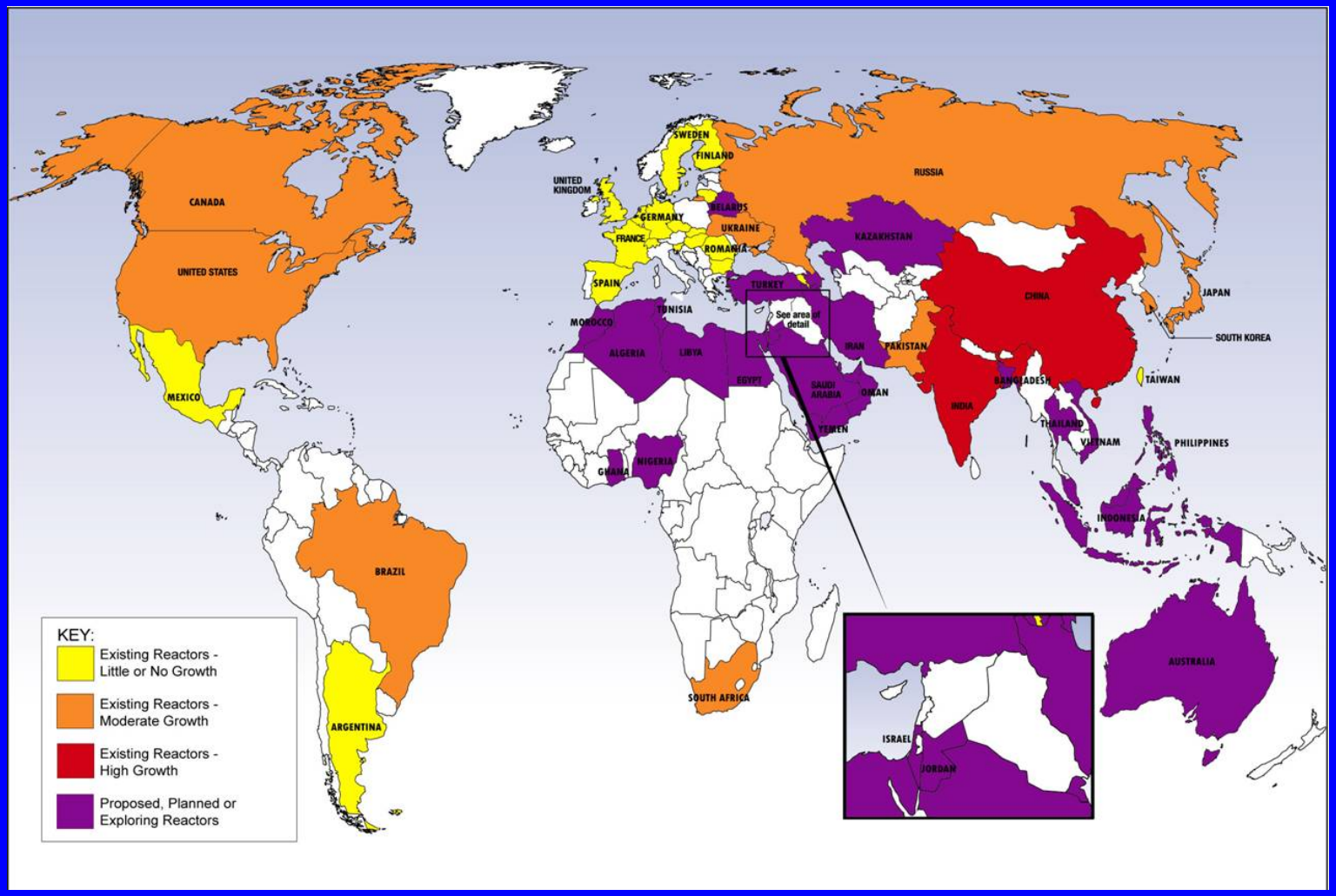

*Source:* Pacala+Socolow, "Stabilization Wedges," *Science* **305** 968-972 (2004)

# For nuclear stabilization wedge, huge increase in construction needed




- Need to shift from 4 to 25 GWe/yr
- Nuclear must become dramatically more attractive to governments and utilities than it has been
- Any major disaster, from accident or terrorism, would doom any realistic prospect for major nuclear contribution to the climate problem

# Large-scale nuclear growth implies nuclear spread – the picture so far




*Source:* Sharon Squassoni, Carnegie Endowment for International Peace

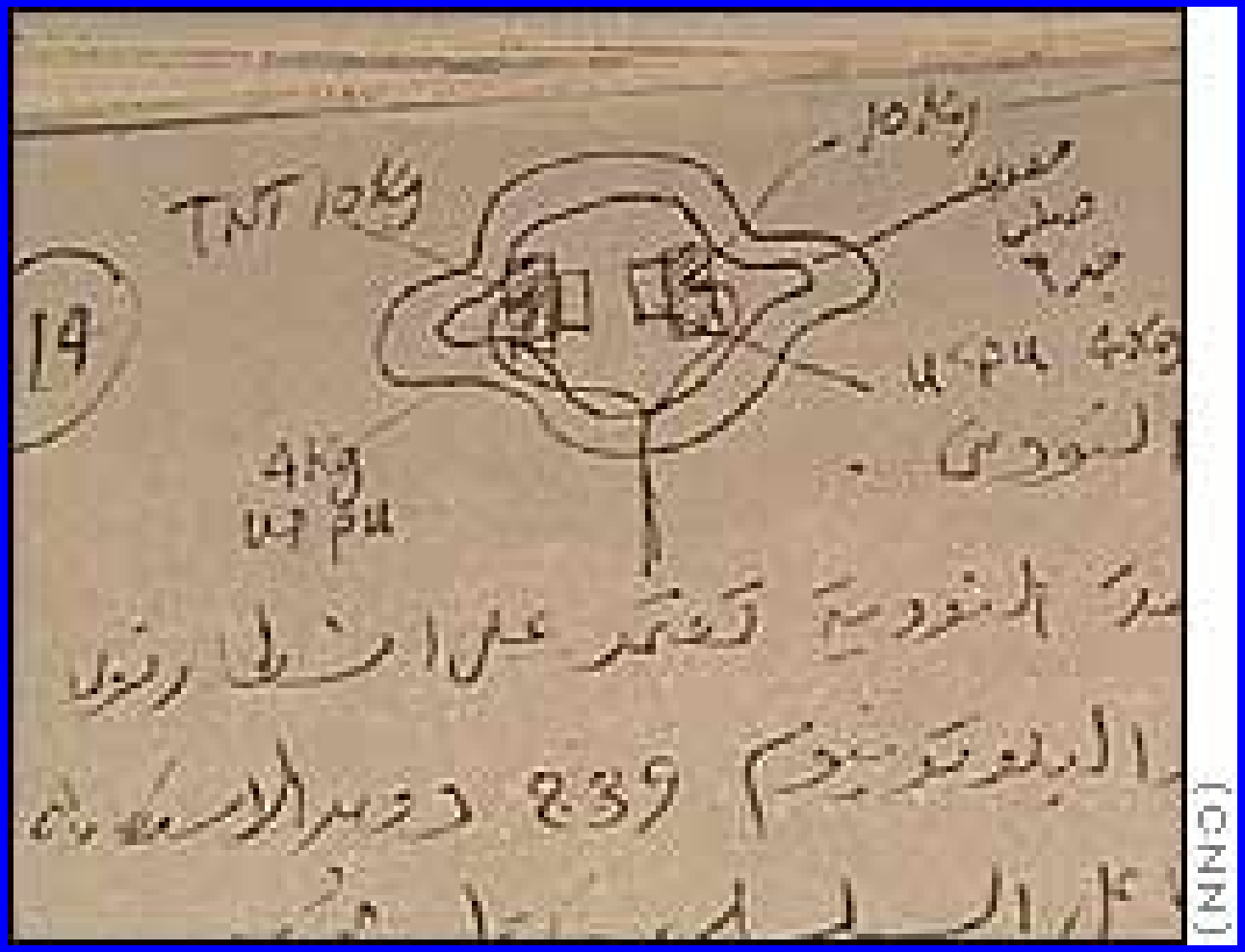
# Issues that have to be addressed to enable substantial nuclear growth

- Factors affecting whether governments and utilities *want* to build nuclear power plants:
  - Economics
  - Safety
  - Security & terrorism
  - Proliferation
  - Waste
  - Assurance of supply
  - National pride & prestige
  - Weapons options, regional balancing
  - Public perceptions of above
- Also constraints on whether governments and utilities *can* build nuclear power plants at desired pace:
  - Production capacity (e.g., steel containment vessels), personnel, infrastructure (e.g., regulations, grids), capital availability…

# Issues that have to be addressed to enable substantial nuclear growth

- Factors affecting whether governments and utilities *want* to build nuclear power plants:
  - Economics
  - Safety
  - Security & terrorism
  - Proliferation
  - Waste
  - Assurance of supply
  - National pride & prestige
  - Weapons options, regional balancing
  - Public perceptions of above
- Also constraints on whether governments and utilities *can* build nuclear power plants at desired pace:
  - Production capacity (e.g., steel containment vessels), personnel, infrastructure (e.g., regulations, grids), capital availability…

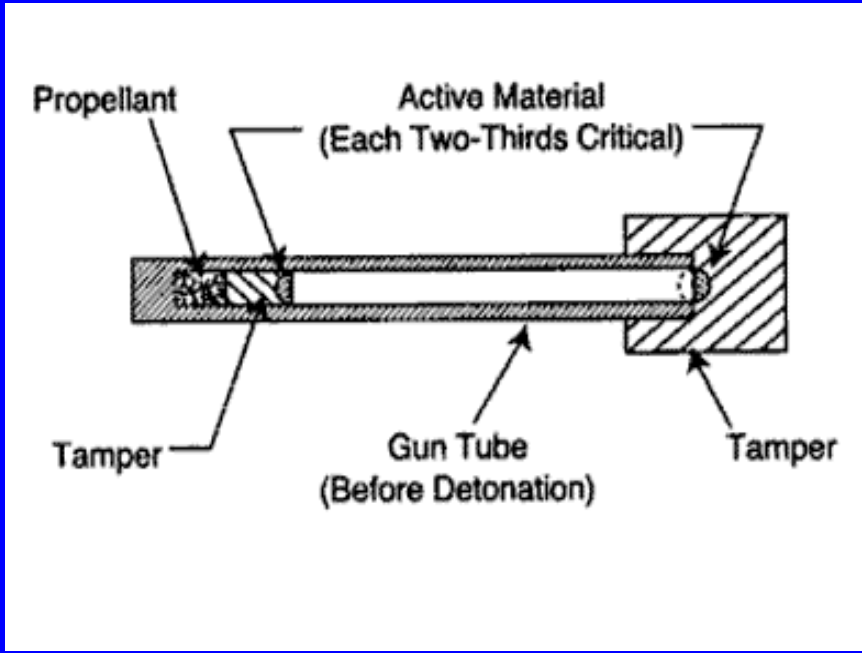
# Terrorists are seeking nuclear weapons




*Source:* CNN

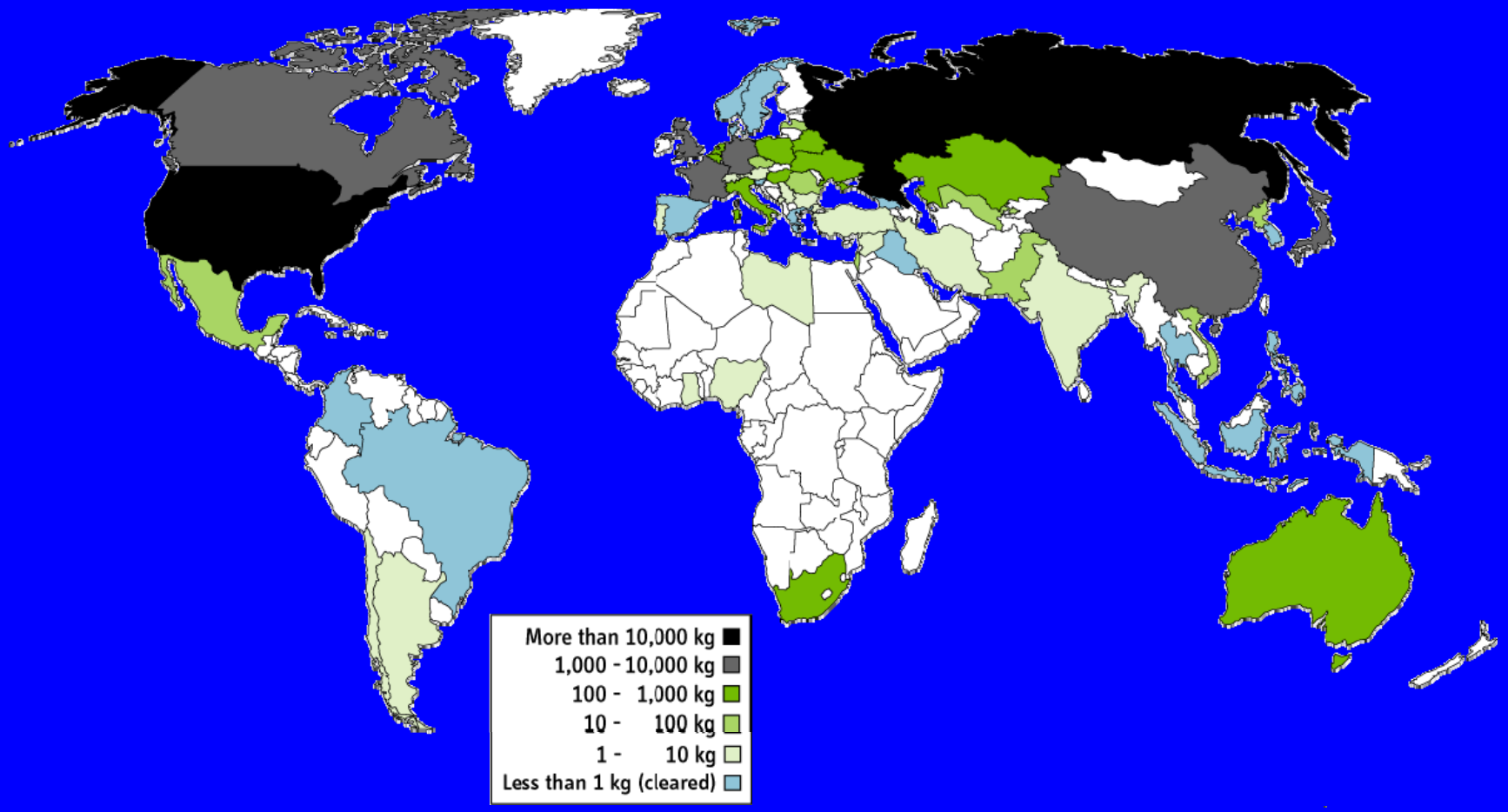
# With nuclear material, terrorists may be able to make crude nuclear bombs

- With HEU, gun-type bomb – as obliterated Hiroshima – very plausibly within capabilities of sophisticated terrorist group
- Implosion bomb (required for Pu) more difficult, still conceivable (especially if they got help)




*Source:* NATO

# Large and widespread stocks of highly enriched uranium




*Source:* International Panel on Fissile Material, *Global Fissile Materials Report 2007*.

# Widely varying nuclear security: Moscow HEU building, 1994

*Source:* DOE

# Securing nuclear stockpiles -- a global problem

- Thousands of tons of weapons-usable nuclear material exist in hundreds of buildings in more than 40 countries worldwide
- Security ranges from excellent to appalling -- no binding global standards in place
- ~130 operational research reactors fueled with HEU in dozens of countries – most with modest security
- Pakistan: small nuclear stockpile, heavily guarded – but huge threats, outsider and insider
- Russia has world's largest stocks, largest number of buildings and bunkers, substantially improved security (but still significant weaknesses) – but large outsider and insider threats

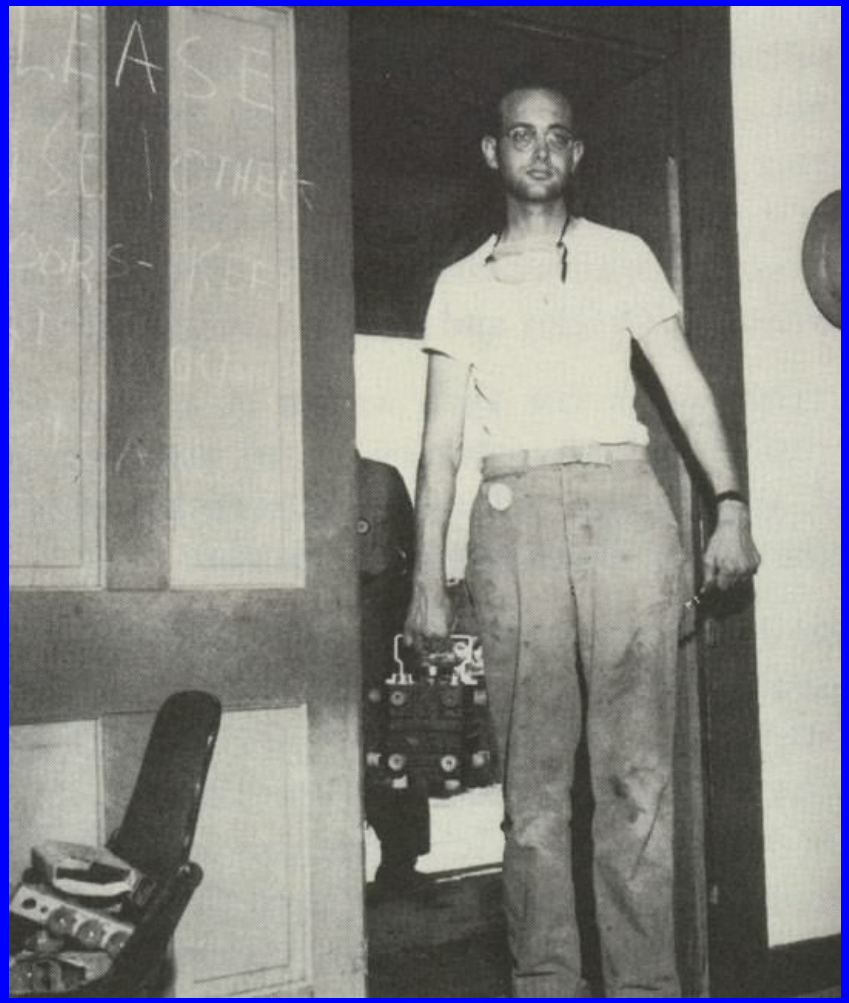
# The Pelindaba incident: a case study

- Major intrusion at facility with 100s of kilograms of weapon-grade HEU, November 2007 – virtually unreported outside S. Africa
- Coordinated attack by 2 teams of armed gunmen
- 1 team of 4 people:
  - Defeated the perimeter security system, entered without detection
  - Spent 45 minutes on-site without being engaged by site security forces
  - Went to the emergency control room, shot an officer there, who raised an alarm
  - Exited by the same route
  - 3 people later arrested, released without charges – little public information
  - Motive unclear, links to known groups unclear

# The Pelindaba incident (II)

- Before this occurred, did U.S. intelligence know:
  - That security at this site was so poor that a team of 4 could penetrate undetected, spend 45 minutes on-site, and never be engaged?
  - That there had been a previous penetration by one person two years earlier?
  - That a senior facility official had been assassinated in June?
  - That there were groups in South Africa with the capability to mount a coordinated attack by 2 teams of well-trained gunmen, possibly with insider help?
  - That the process of requiring the site to be able to defend against a specified design basis threat (DBT) had been stalled for years?
  - Anything about the factors that might convince South African officials to cooperate in beefing up security, removing the HEU at this site (both of which U.S. officials had unsuccessfully proposed)?

# Nuclear smuggling is hard to stop – plutonium box for first-ever bomb



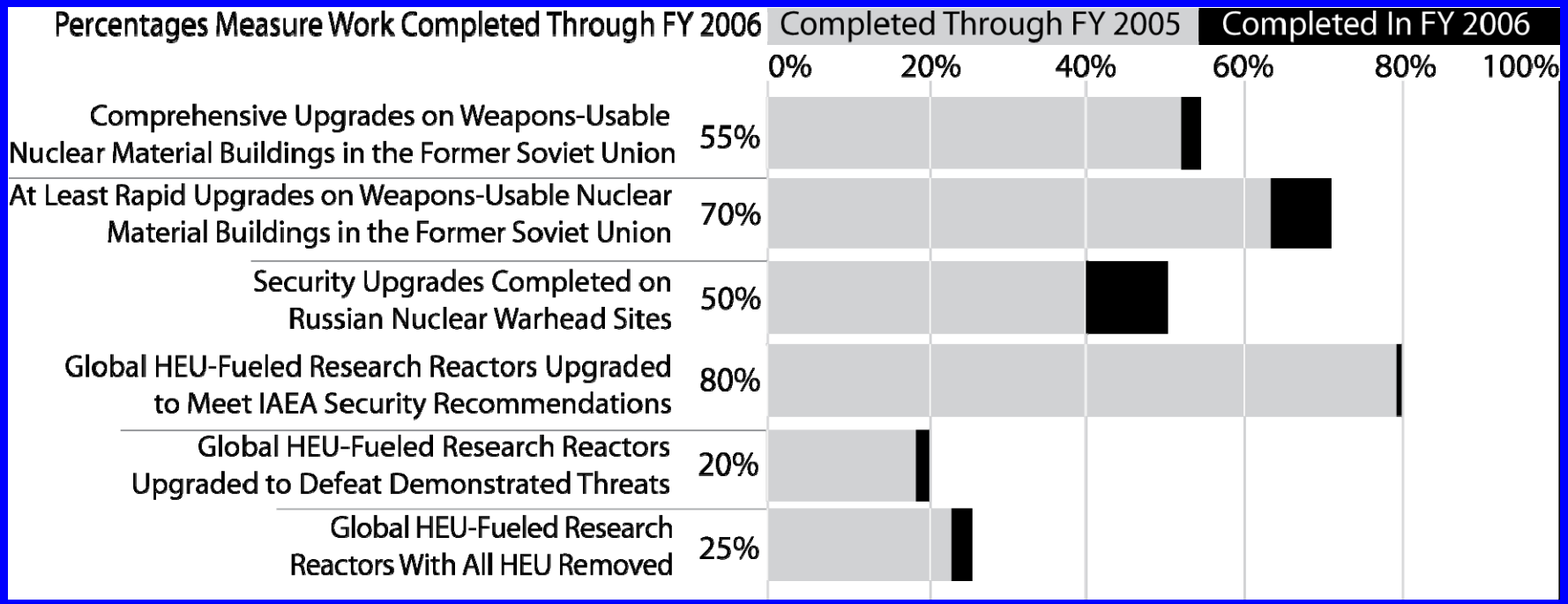
*Source:* Los Alamos

# Nuclear terrorism risks: the good news

- No convincing evidence that a nuclear weapon or the materials to make one have yet fallen into the hands of a terrorist group or hostile state
- No convincing evidence any terrorist group has yet put together the expertise to make a bomb if it got the material
  - Some evidence of confusion, lack of nuclear knowledge by some in al Qaeda
- Failed Aum Shinrikyo and al Qaeda efforts suggest that even sophisticated, well-financed terrorist groups have difficulty pursuing the nuclear path
- Post-9/11 disruption of centrally controlled al Qaeda has probably reduced their nuclear potential (though recovering)
- *But what may be happening that we don't know about?*

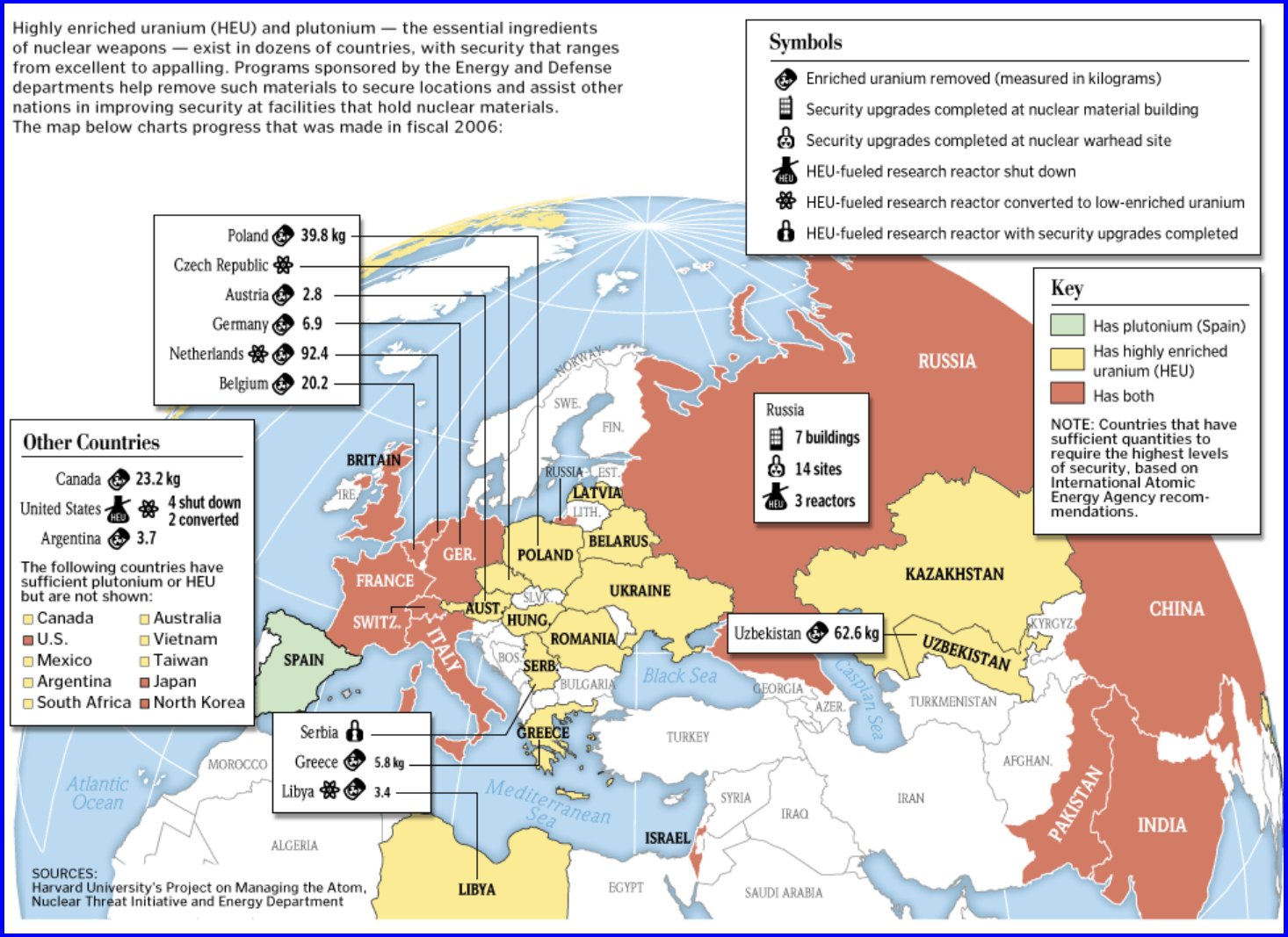
# More good news: Real progress in programs to reduce the risk…

**Progress of U.S.-Funded Programs to Secure Nuclear Stockpiles**




*Source: Author's estimates, described in* Securing the Bomb 2007

# Progress in programs to reduce the risk: one year's work

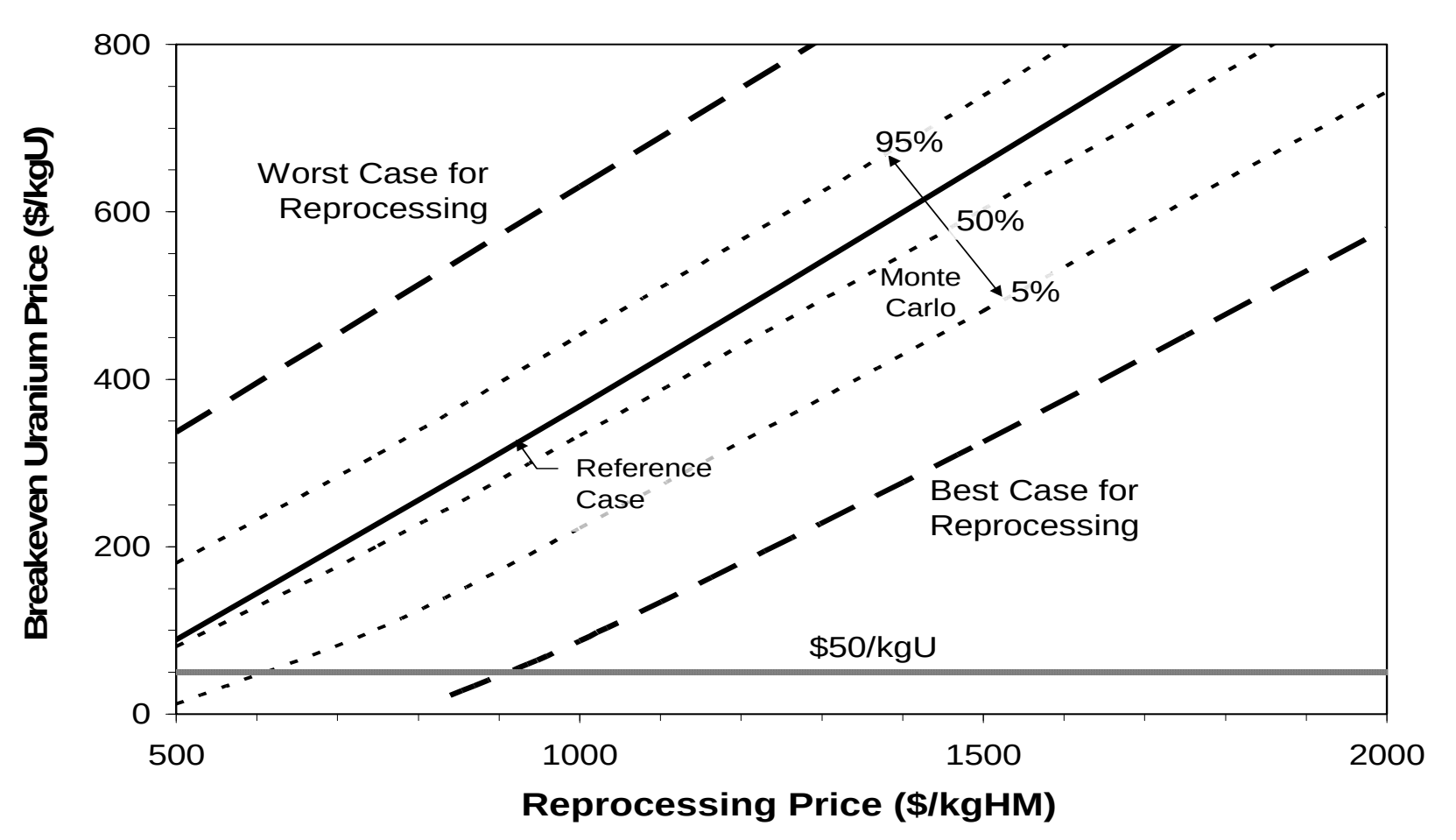



*Source:* Washington Post

# And: expanding nuclear energy <u>need not</u> increase nuclear terrorism risks

- Could have global nuclear energy growth with no use of directly weapons-usable nuclear material in the fuel cycle
  - Low-enriched uranium (LEU) fresh fuel can't be made into a bomb without technologically demanding enrichment
  - Plutonium in massive, intensely radioactive spent fuel beyond plausible terrorist capacity to steal and process
- By contrast, risk of nuclear <u>sabotage</u> or nuclear <u>accident</u> would tend to increase with more reactors in more countries – requires new policy steps to keep risks acceptably low
- If plutonium from spent fuel is reprocessed and recycled, nuclear energy contribution to nuclear terrorist risks would increase
  - Reprocessing converts plutonium into portable, not very radioactive, readily weapons-usable forms

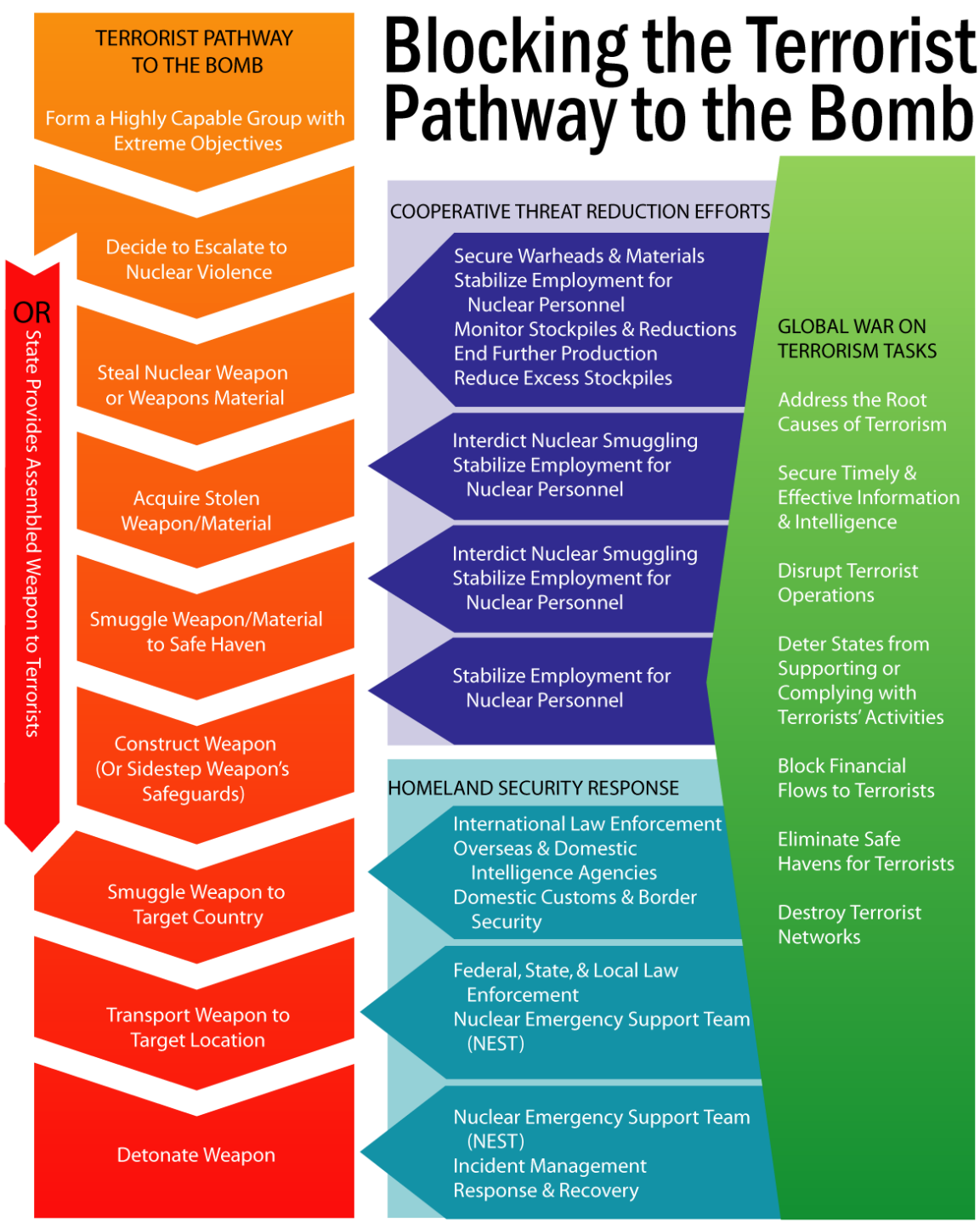
# Fortunately, plutonium reprocessing doesn't pay…




Source: Bunn, Fetter, Holdren, van der Zwaan, *The Economics of Reprocessing vs. Direct Disposal of Spent Nuclear Fuel* (2003)

# Blocking the terrorist pathway to the bomb

*Source:* Bunn, Wier, Holdren, *Controlling Nuclear Warheads & Materials*, 2003



# Policy recommendations: Global nuclear security standards

- Best pursued initially through political-level commitments
  - Broad enough to allow each country to follow own approach
  - Specific enough to be effective
  - Possibility: common minimum design basis threat (DBT): all nuclear weapons and weapons-usable materials should at least be protected against…
- Make use of UN Security Council Resolution 1540
  - Requires all states to provide "appropriate effective" security and accounting for nuclear stocks
  - Should work out common understanding with key states that to be "effective" security systems must be capable of defeating demonstrated terrorist and criminal threats – and other essential elements of effective systems
  - Should then work to help (and pressure) all states to put these essential elements in place

# Policy recommendations: Nuclear material removals

- Global Threat Reduction Initiative (GTRI) has accelerated removals, but more needs to be done:
  - Expand to cover materials and facilities not yet covered (e.g., 2/3 of U.S. HEU abroad not covered by U.S. take-back offer)
  - Focus not only on conversion of HEU-fueled reactors, but on shut-down of unneeded reactors also – faster and cheaper in some cases
  - Provide targeted incentives to convince states, facilities, to close or convert reactors, give up HEU
  - Seek strengthened national security rules – needed in themselves, and the costs of meeting them give facilities an incentive to give up their weapons-usable nuclear material
  - Seek to minimize locations with, transports of, separated plutonium as well, and seek high security standards for those that remain
  - Drastic further consolidation for nuclear warheads as well
  - To lead, United States has to get its own house in order – convert, secure HEU-fueled reactors, strengthen nuclear security rules

# Policy recommendations: Strengthening the sense of urgency

- Essential to convince national leaders, nuclear managers, that nuclear terrorism poses a real threat to *their* interests:
  - Joint threat briefings
  - Fast-paced nuclear vulnerability surveys
  - Realistic security performance tests
  - Nuclear terrorism war games
  - Shared threat incident databases
  - Threat-focused training
- If such measures work, the probability of effective action to reduce nuclear terrorism risks will be high; if they do not work, the probability of success will be low