PERSPECTIVES ON U.S. NONPROLIFERATION POLICY

THE CASE OF SPENT FUEL REPROCESSING

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Tokyo, 14 September 2016

Revision 2x

OUTLINE / OVERVIEW

- Origins of U.S. Policy on Plutonium
- Weapon-usability of Plutonium
- Spent Fuel Reprocessing Today
- The Global Fissile Material Stockpile
- U.S. Plutonium Policy: Today and Tomorrow
- The Way Forward

U.S. NONPROLIFERATION POLICY

(ORIGINS OF U.S. POLICY ON PLUTONIUM)

HOW PLUTONIUM SEPARATION FOR CIVILIAN APPLICATIONS BEGAN

SEABORG ERA (1945–1970)

Expecting the inevitable and rapid growth of nuclear power while facing limited uranium resources, many countries (including the United States and Japan) launched fast-neutron ("breeder") reactor programs

FORD/CARTER ERA (1970s)

President Ford in 1976 issued a presidential directive deferring commercial reprocessing and recycling of plutonium in the United States; President Carter extended this deferral indefinitely

Sources: Science Photo Library (top) and Jimmy Carter Library (bottom)

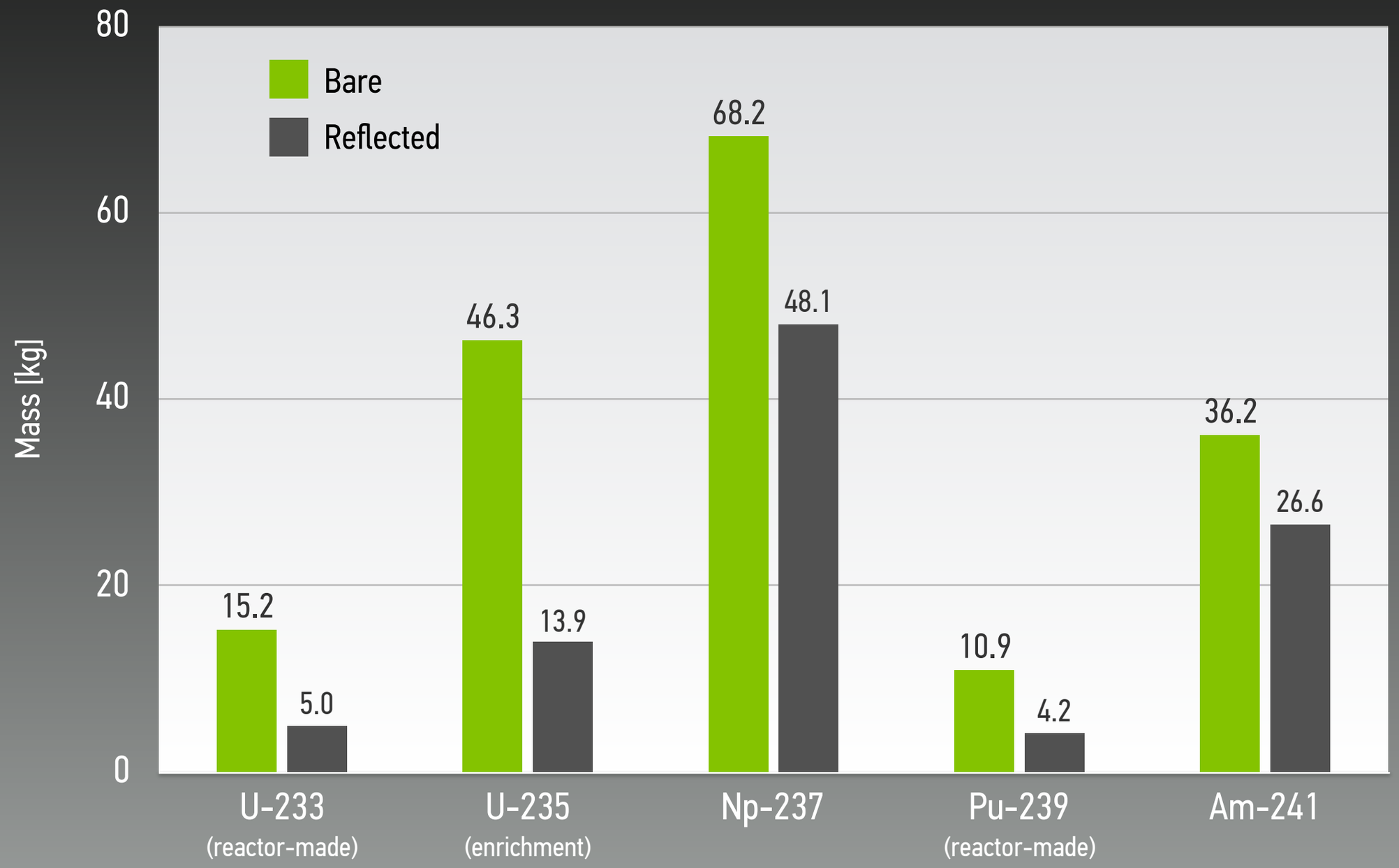
WHO CAN MAKE FISSILE MATERIAL TODAY

ENRICHMENT AND REPROCESSING FACILITIES WORLDWIDE

WEAPON-USABILITY OF PLUTONIUM

(THE ORIGINAL ARGUMENT AGAINST REPROCESSING)

PLUTONIUM HAS THE SMALLEST CRITICAL MASS OF ALL FISSILE MATERIALS



H. A. Feiveson, A. Glaser, Z. Mian, and F. von Hippel, *Unmaking the Bomb,* MIT Press, Cambridge, MA, 2014

VERY SMALL AMOUNTS OF PLUTONIUM ARE SUFFICIENT TO MAKE A NUCLEAR WEAPON

6 KILOGRAMS

In his diary, President Truman mentioned that the Trinity device [and the Nagasaki bomb] contained 6 kilograms of plutonium; formally declassified only in 2000

4 KILOGRAMS

The United States has declassified the fact that “a mass of 4 kilograms of plutonium or uranium-233 is sufficient for one nuclear explosive device” (1994)

2 KILOGRAMS

Recently published Soviet documents show that some low-yield tests in 1953 used only 2.0 kg and 0.8 kg of weapon-grade plutonium

ESSENTIALLY ALL PLUTONIUM MIXTURES ARE NUCLEAR WEAPON-USABLE

" At the lowest level of sophistication, a potential proliferating state or sub-national group using designs and technologies no more sophisticated than those used in first-generation nuclear weapons could build a nuclear weapon from reactor grade plutonium that would have an assured, reliable yield of one or a few kilotons (and a probable yield significantly higher than that).

At the other end of the spectrum, advanced nuclear weapon states such as the United States and Russia, using modern designs, could produce weapons from reactor grade plutonium having reliable explosive yields, weight, and other characteristics generally comparable to those of weapons made from weapons-grade plutonium."

Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives
U.S. Department of Energy, DOE/NN-0007, Washington, DC, January 1997, pp. 37–39, www.ccnr.org/plute.html

SPENT FUEL REPROCESSING TODAY

(THE NUCLEAR ENERGY CONTEXT)

FUTURE OF NUCLEAR POWER

(POST FUKUSHIMA)

GLOBAL IMPACT OF FUKUSHIMA

Several countries (including France, Germany, and Japan) have reevaluated their energy strategies; lower growth rates for nuclear power and more diversity in energy portfolios

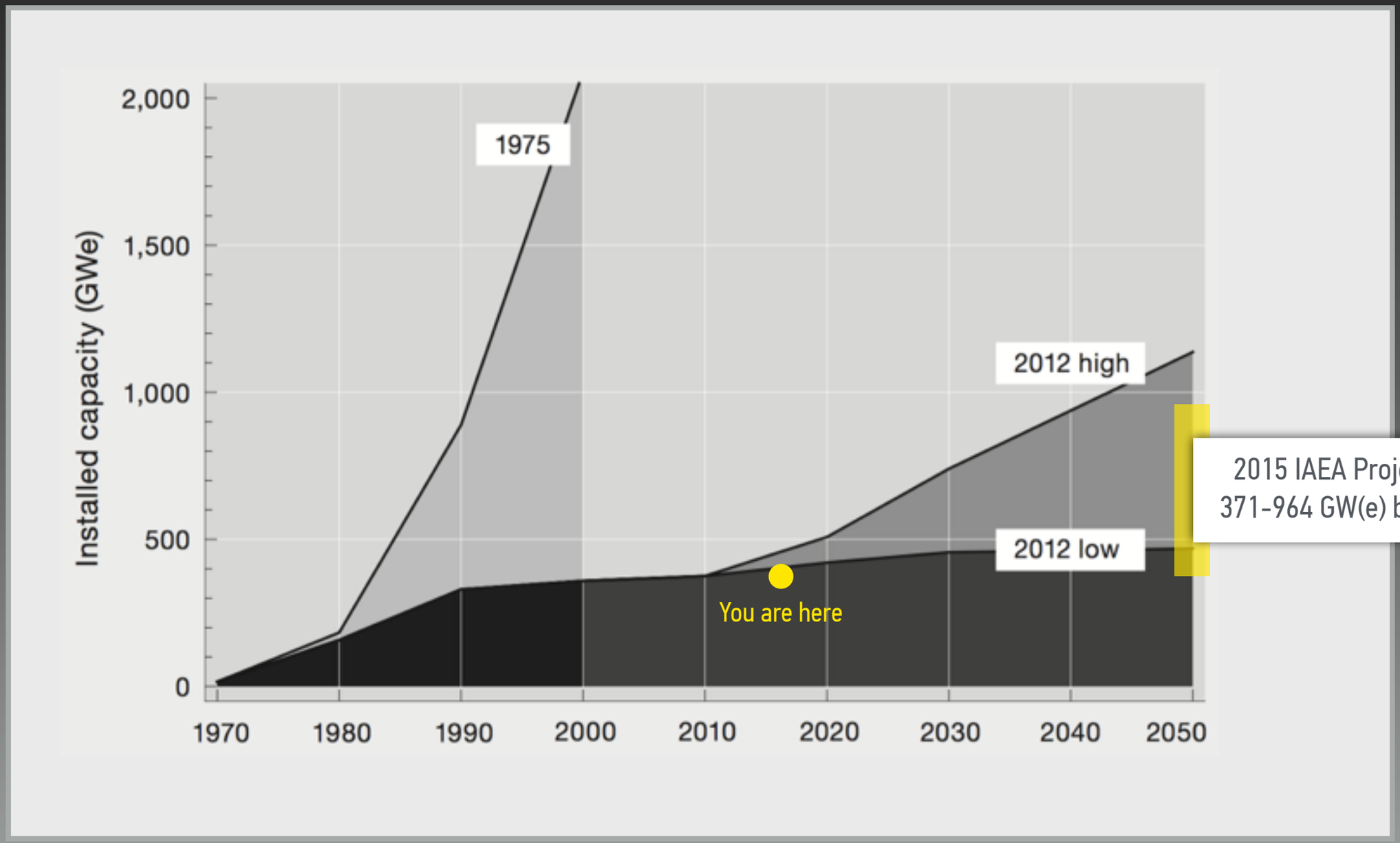
GLOBAL PROJECTIONS FOR NUCLEAR POWER HAVE DROPPED

Much lower than a decade ago despite more ambitious climate-mitigation targets; market share of nuclear power expected to decrease in many scenarios

Sources: DigitalGlobe (top) and mining.com (bottom)

NUCLEAR POWER FORECASTS

HAVE DROPPED SIGNIFICANTLY OVER TIME



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THE CASE OF REPROCESSING IS WEAK TODAY

(AND WILL REMAIN SO IN THE FORESEEABLE FUTURE)

URANIUM WILL REMAIN ABUNDANT THROUGHOUT THIS CENTURY

Significant additional resources have been discovered in many regions worldwide; uranium price has been stable (when corrected for inflation);

Japan is a pioneer in research on uranium extraction from seawater

FAST-NEUTRON REACTORS REMAIN A TECHNOLOGY NIGHTMARE

"Expensive to build, complex to operate, susceptible to prolonged shutdown as a result of even minor malfunctions, and difficult and time-consuming to repair." (Admiral Hyman Rickover, 1956)

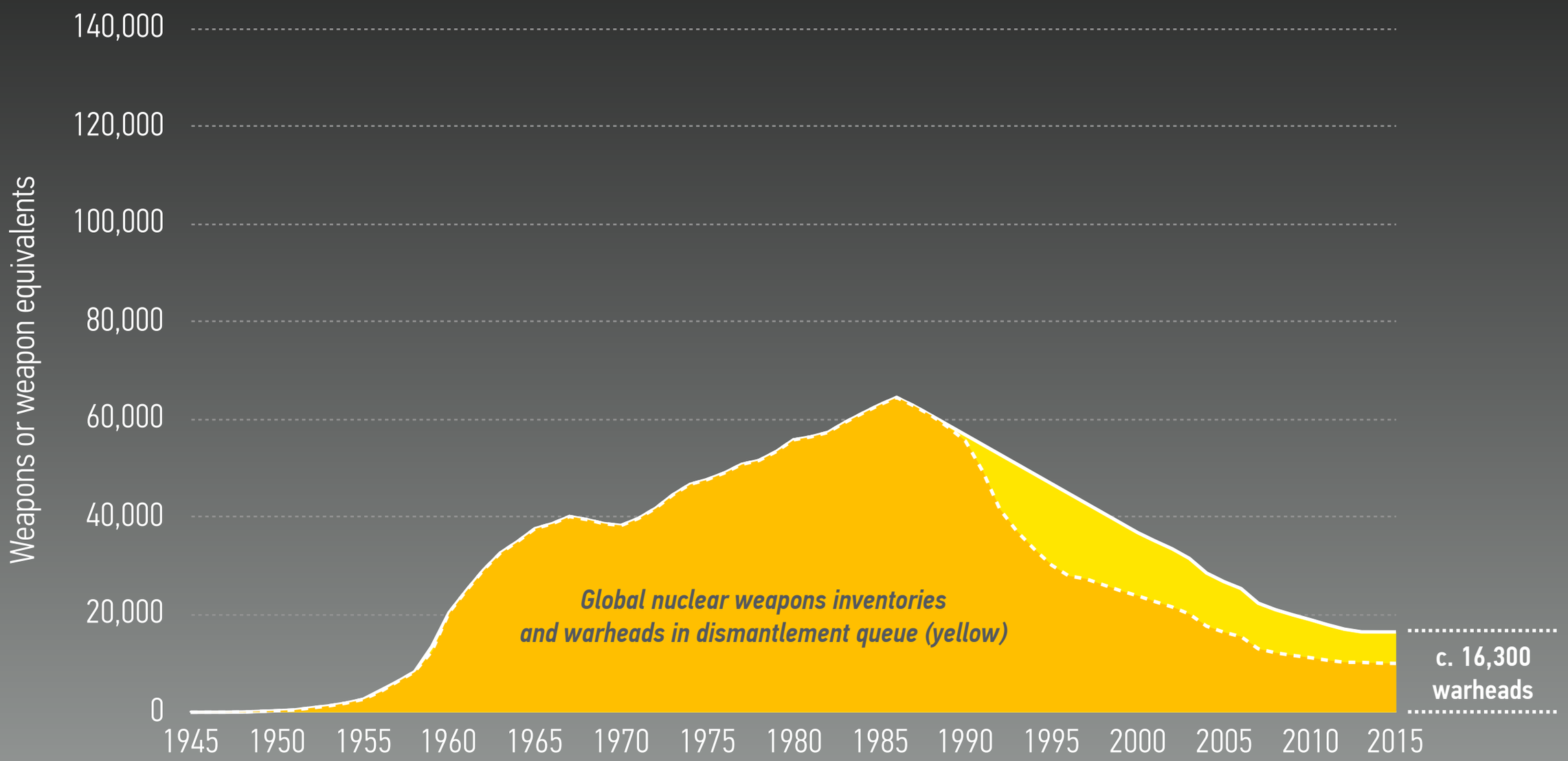
Sources: wikipedia.org/Ikiwaner (top), JapanTimes/Kyodo (bottom)

THE GLOBAL FISSILE MATERIAL STOCKPILE

THE CASE OF PLUTONIUM

NUCLEAR WEAPONS AND FISSILE MATERIALS

GLOBAL INVENTORIES, 1945–2015

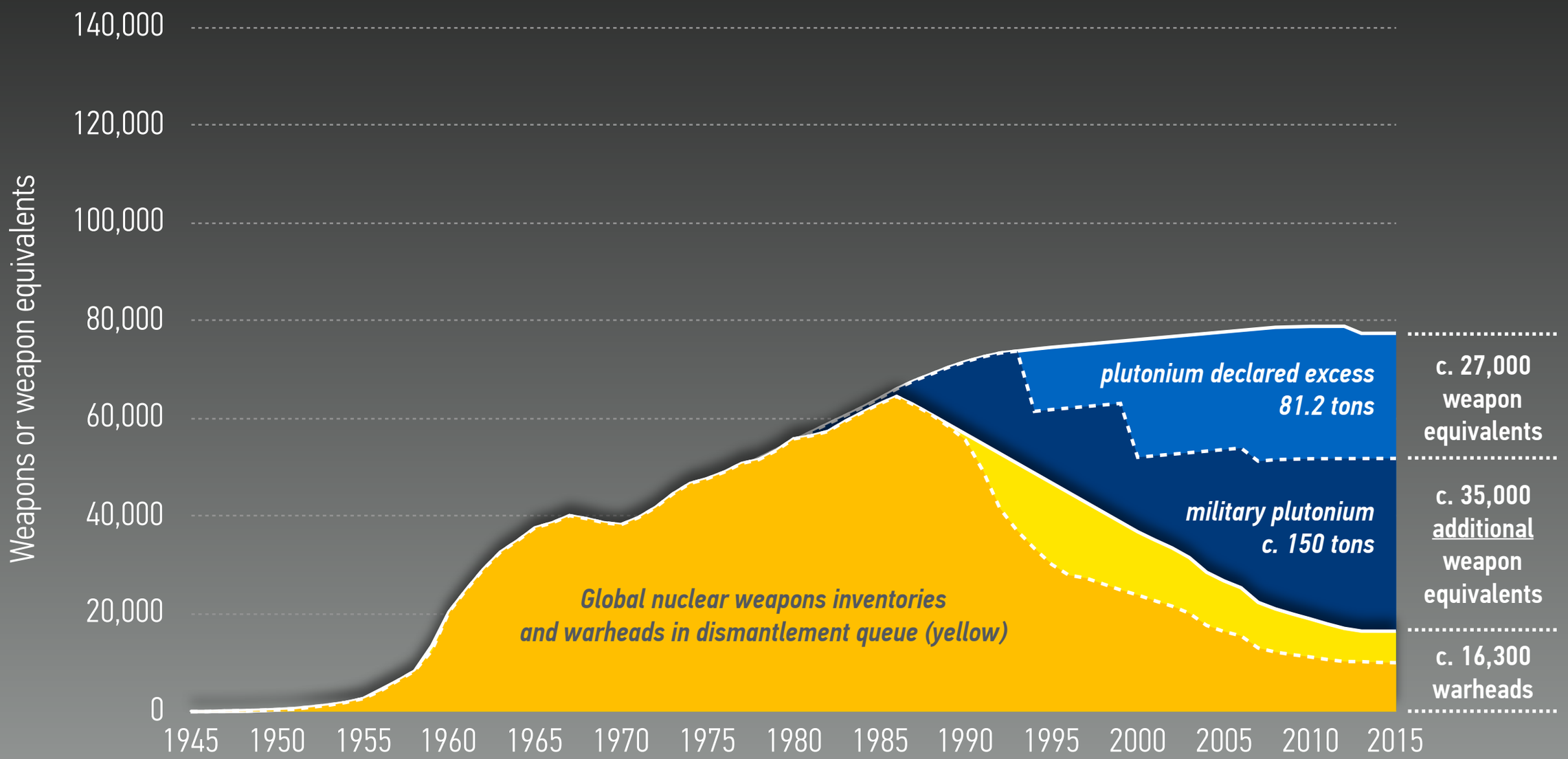


Hans M. Kristensen and Robert S. Norris, "Global Nuclear Weapons Inventories, 1945–2013," *Bulletin of the Atomic Scientists,* 69 (5), 2013, 75–81

NUCLEAR WEAPONS AND FISSILE MATERIALS

GLOBAL INVENTORIES, 1945–2015

THE CASE OF SEPARATED PLUTONIUM



Hans M. Kristensen and Robert S. Norris, "Global Nuclear Weapons Inventories, 1945–2013," *Bulletin of the Atomic Scientists,* 69 (5), 2013, 75–81
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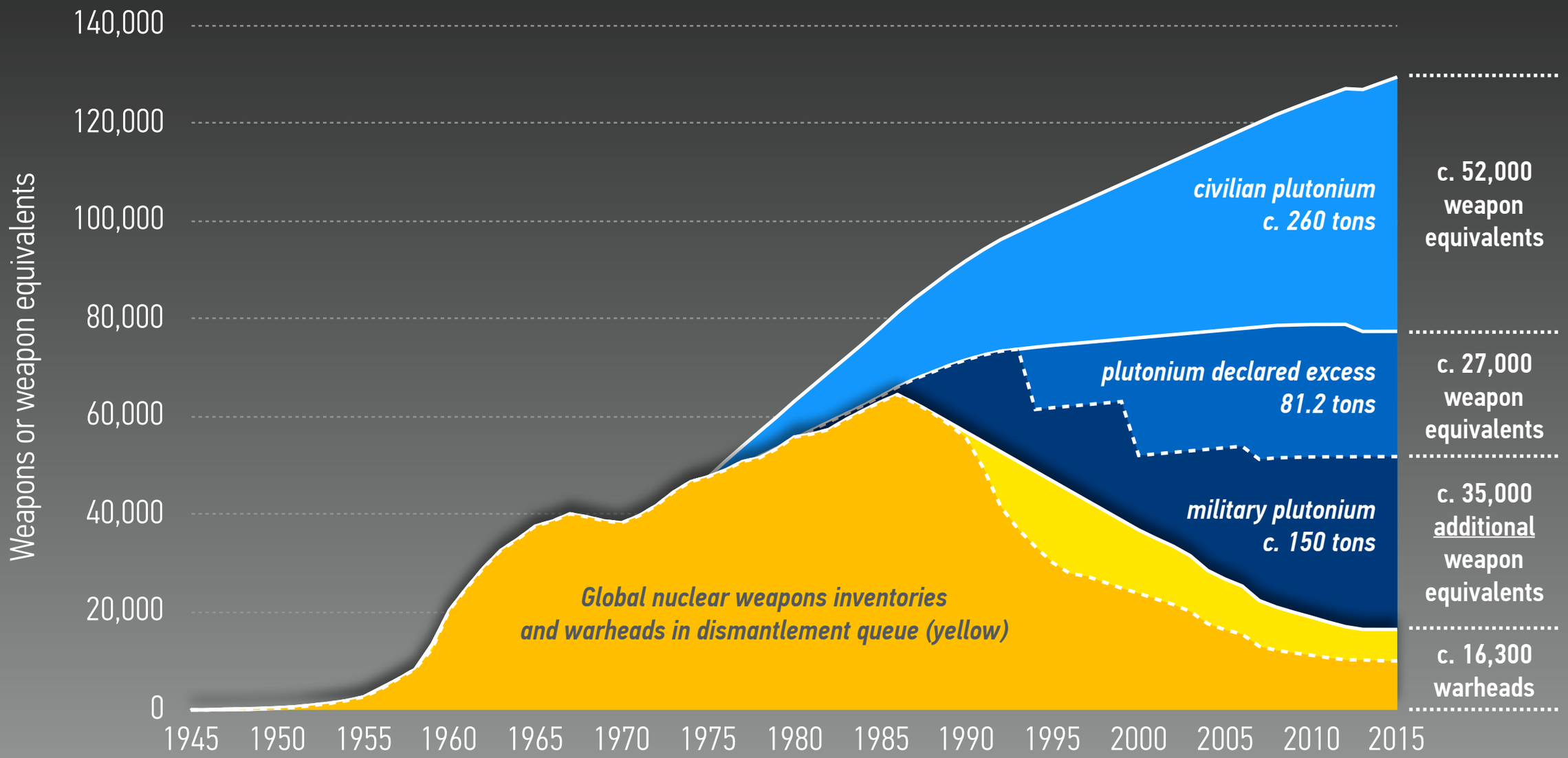
NUCLEAR WEAPONS AND FISSILE MATERIALS

GLOBAL INVENTORIES, 1945–2015

THE CASE OF SEPARATED PLUTONIUM



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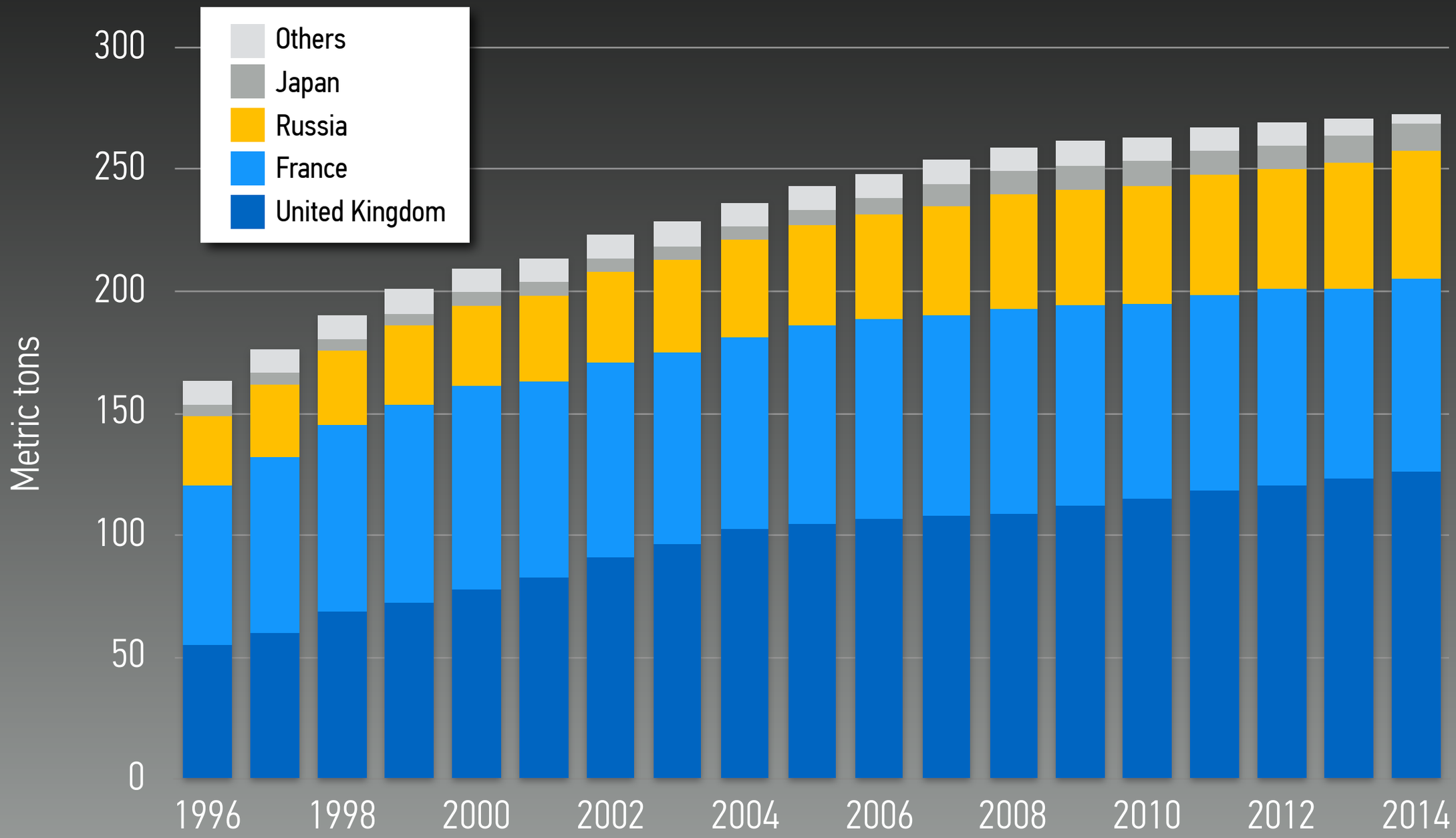
CIVILIAN PLUTONIUM, 1996–2014

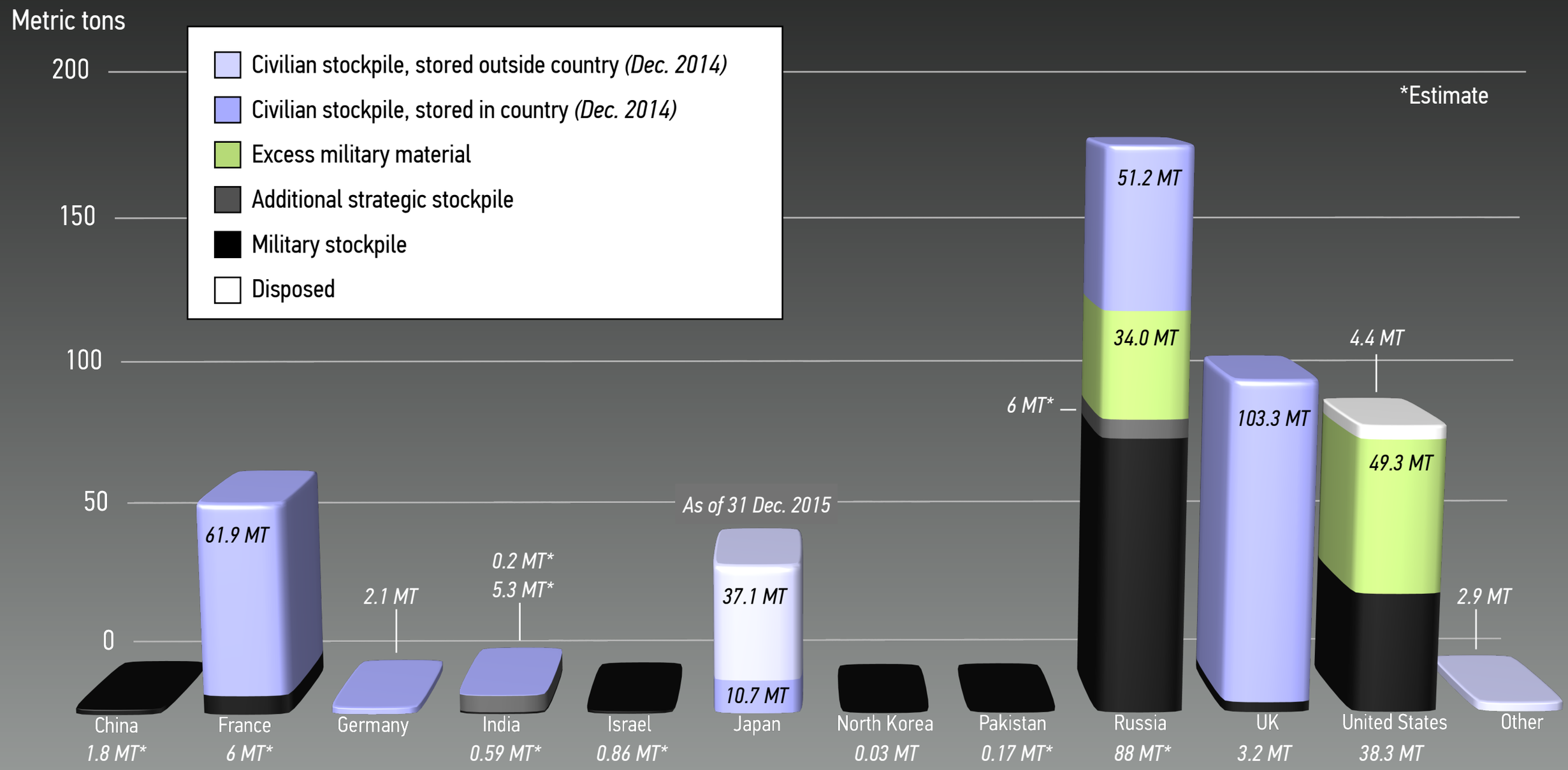
EVOLUTION OF DECLARED STOCKPILE (BY LOCATION)



Numbers are based on the annual INFCIRC/549 declarations and are for the end of the reported year

SEPARATED PLUTONIUM, 2015

GLOBAL STOCKPILE IS ABOUT 503 TONS, MORE THAN HALF IS CIVILIAN AND THIS STOCK IS GROWING



Global Fissile Material Report 2015, International Panel of Fissile Materials, Princeton, December 2015, www.ipfmlibrary.org/gfmr15.pdf

U.S. NONPROLIFERATION POLICY

TODAY AND TOMORROW

"AMERICA'S NUCLEAR FUTURE"

BLUE RIBBON COMMISSION, 2010–2012

"No currently available or reasonably foreseeable reactor and fuel cycle technology developments—including advances in reprocessing and recycling technologies—have the potential to fundamentally alter the waste management challenge this nation confronts over at least the next several decades, if not longer.

Put another way, we do not believe that today's recycle technologies or new technology developments in the next three to four decades will change the underlying need for an integrated strategy that combines safe storage of SNF with expeditious progress toward siting and licensing a disposal facility or facilities."

“AMERICA’S NUCLEAR FUTURE”

SELECTED NEAR-TERM ACTION ITEMS

CONSOLIDATED INTERIM STORAGE

One or more consolidated dry-cask storage facilities should be established, independent of the schedule for opening a repository;

Proven safe, secure, and cost-effective elsewhere

INTERNATIONAL ENGAGEMENT

Launch a major international effort to enable the safe management of nuclear wastes in all countries with nuclear power programs;

Support multilateral approaches to the nuclear fuel cycle

Sources: gns.de (top) and iaea.org (bottom)

IRAN NUCLEAR DEAL

COVERS BOTH URANIUM (ENRICHMENT) AND PLUTONIUM

NO SIGNIFICANT PLUTONIUM PRODUCTION

As part of the deal, Iran agreed to redesign its (40 MW) Arak reactor; power will be reduced to 20 MW and reactor will use low-enriched fuel; plutonium production drops from 7–8 kg to less than 1 kg per year

NO REPROCESSING

"For 15 years Iran will not, and does not intend to thereafter, engage in any spent fuel reprocessing or construction of a facility capable of spent fuel reprocessing."

Sources: Wikipedia/Nanking2012 (top)

NUCLEAR SECURITY SUMMIT PROCESS

2010–2016

BACKGROUND

Initiative that grew out of the 2009 Obama Prague speech;

initially, focus on (civilian) highly enriched uranium, but agenda gradually expanded to also include separated plutonium

2016 JOINT STATEMENT ON NUCLEAR SECURITY COOPERATION

Highlighted the "mutual goal of minimizing stocks of HEU and separated plutonium worldwide;" Japan contributed with the shipment (return) of 330 kg of plutonium to the United States

Sources: nss2016.org (top) and Thomson Reuters (bottom)

THE WAY FORWARD

ITEMS ON THE U.S. NONPROLIFERATION AGENDA

NUCLEAR (POWER) PROGRAMS IN NORTHEAST ASIA

United States and South Korea signed a new 123 Agreement in 2015; it does not currently provide “advance consent” for enrichment and reprocessing; joint study on pyro-reprocessing to be completed by 2021

FUTURE OF THE 123 AGREEMENT WITH JAPAN

Japan is the only country in the region with “advance consent” for spent fuel reprocessing; duration of current agreement is 30 years (1988–2018), but it will remain in force unless it is terminated by one of the parties

Sources: U.S. Department of Energy (top) and Reuters/Kyoto (bottom)

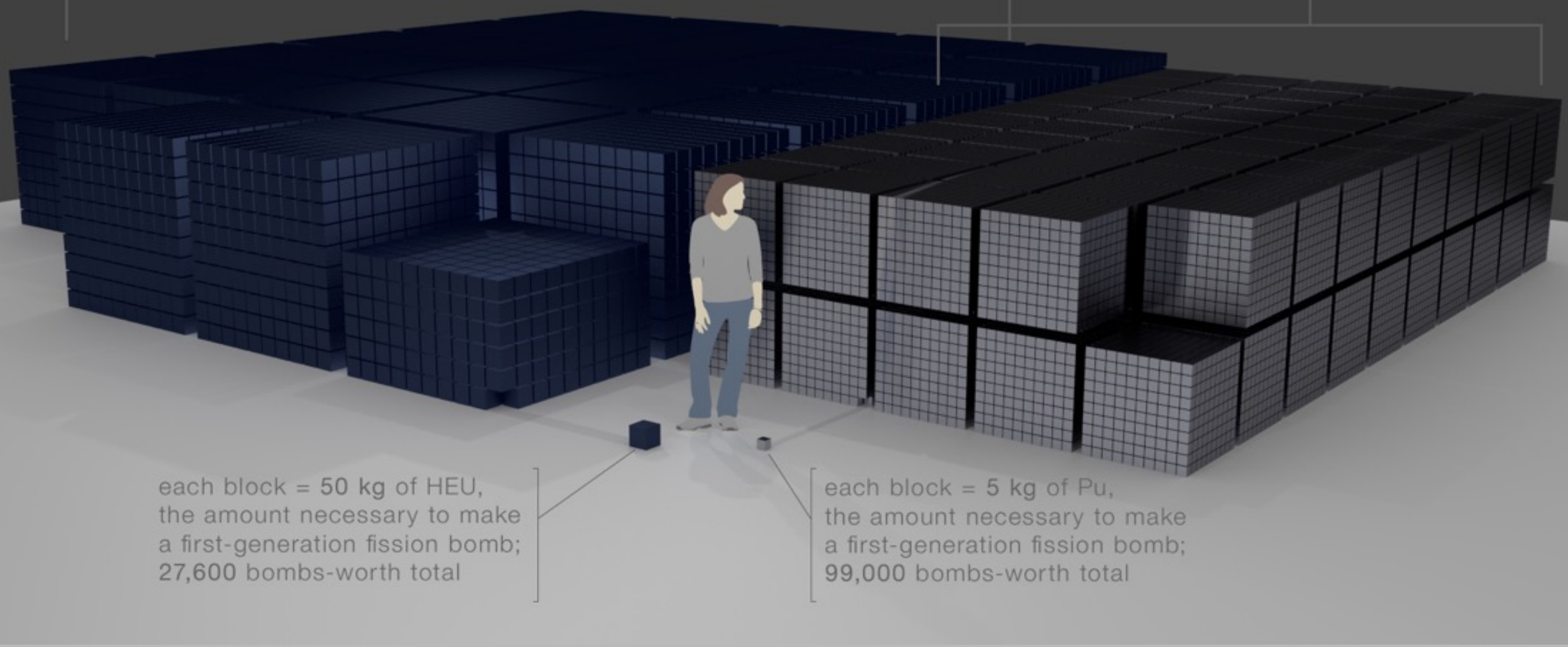
World Stockpiles of Fissile Materials

1345

1380 tons of highly-enriched uranium

503

495 tons of separated plutonium



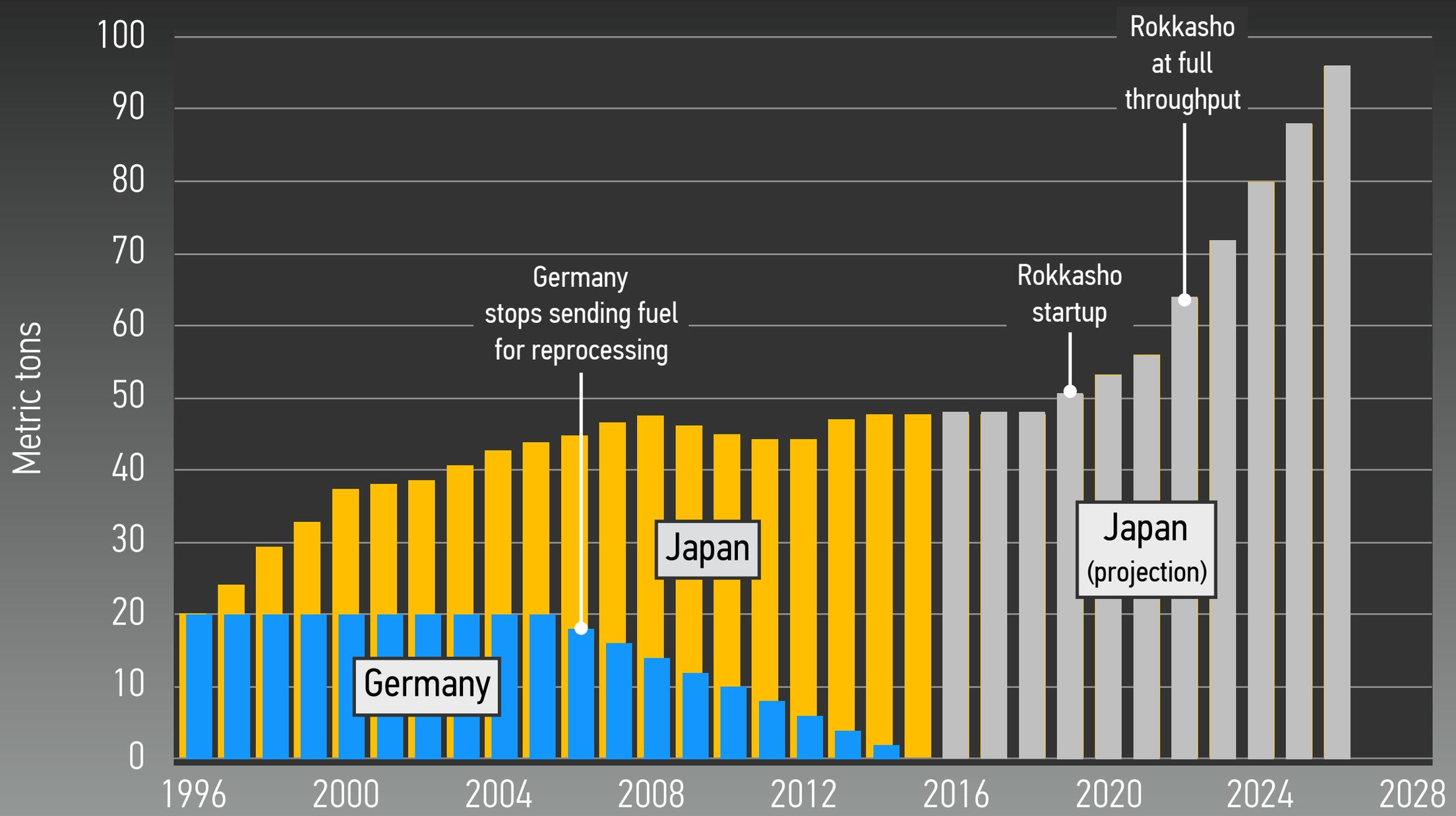
each block = **50 kg** of HEU,
the amount necessary to make
a first-generation fission bomb;
27,600 bombs-worth total

each block = **5 kg** of Pu,
the amount necessary to make
a first-generation fission bomb;
99,000 bombs-worth total

Graphic by Alex Wellerstein, nuclearsecrecy.com

PLUTONIUM TRENDS

IMPLICATIONS OF TWO DIFFERENT BACK-END POLICIES



Numbers for Japan are based on the annual INFCIRC/549 declarations and are for the end of the reported year

CONCLUDING THOUGHTS

DEALING WITH GLOBAL STOCKPILE OF SEPARATED PLUTONIUM

OPPORTUNITIES FOR REGIONAL/INTERNATIONAL COLLABORATION

Joint development of plutonium disposition alternatives with countries facing similar challenges (France, United Kingdom, United States);

Deep-borehole disposal of plutonium is one such promising alternative

IAEA CUSTODY OF EXCESS PLUTONIUM AS AN INTERIM MEASURE?

Envisioned in the IAEA Statute; such a measure could help address concerns with large (and growing) stockpiles of separated plutonium

First proposed by Fred McGoldrick, Arms Control Today, September 2014

Sources: panoramio.com/loisiko (top) and IAEA ImageBank (bottom)

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