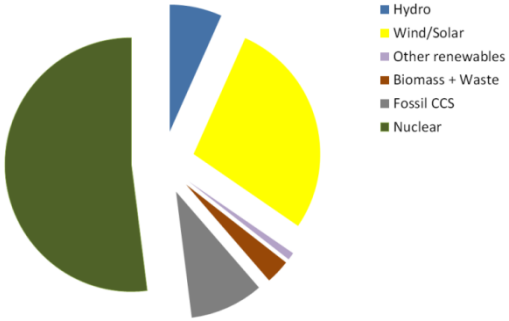

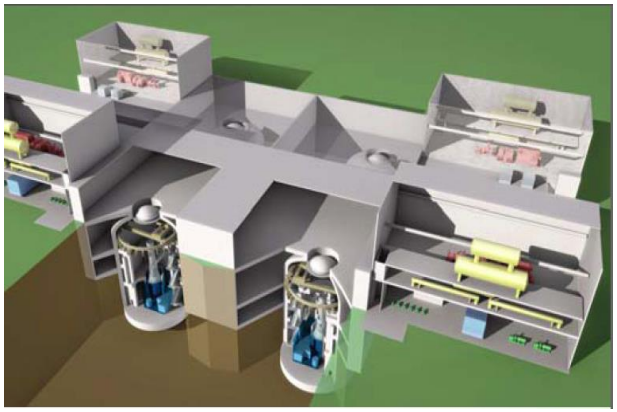

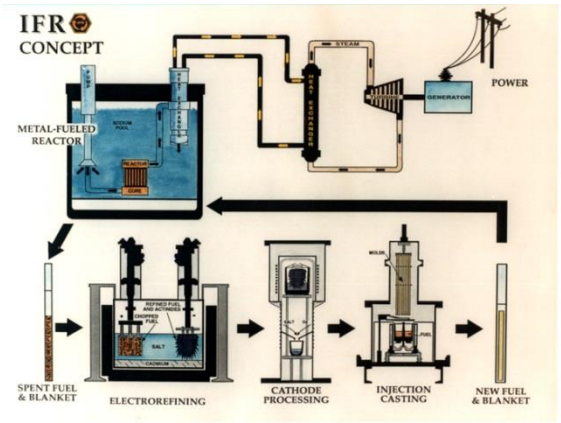

Paydirt 2013 Uranium Conference, 29 April 2013

What is Plan B for nuclear waste?

Prof. Barry W. Brook

Sir Hubert Wilkins Chair of Climate Change

barry.brook@adelaide.edu.au

http://bravenewclimate.com

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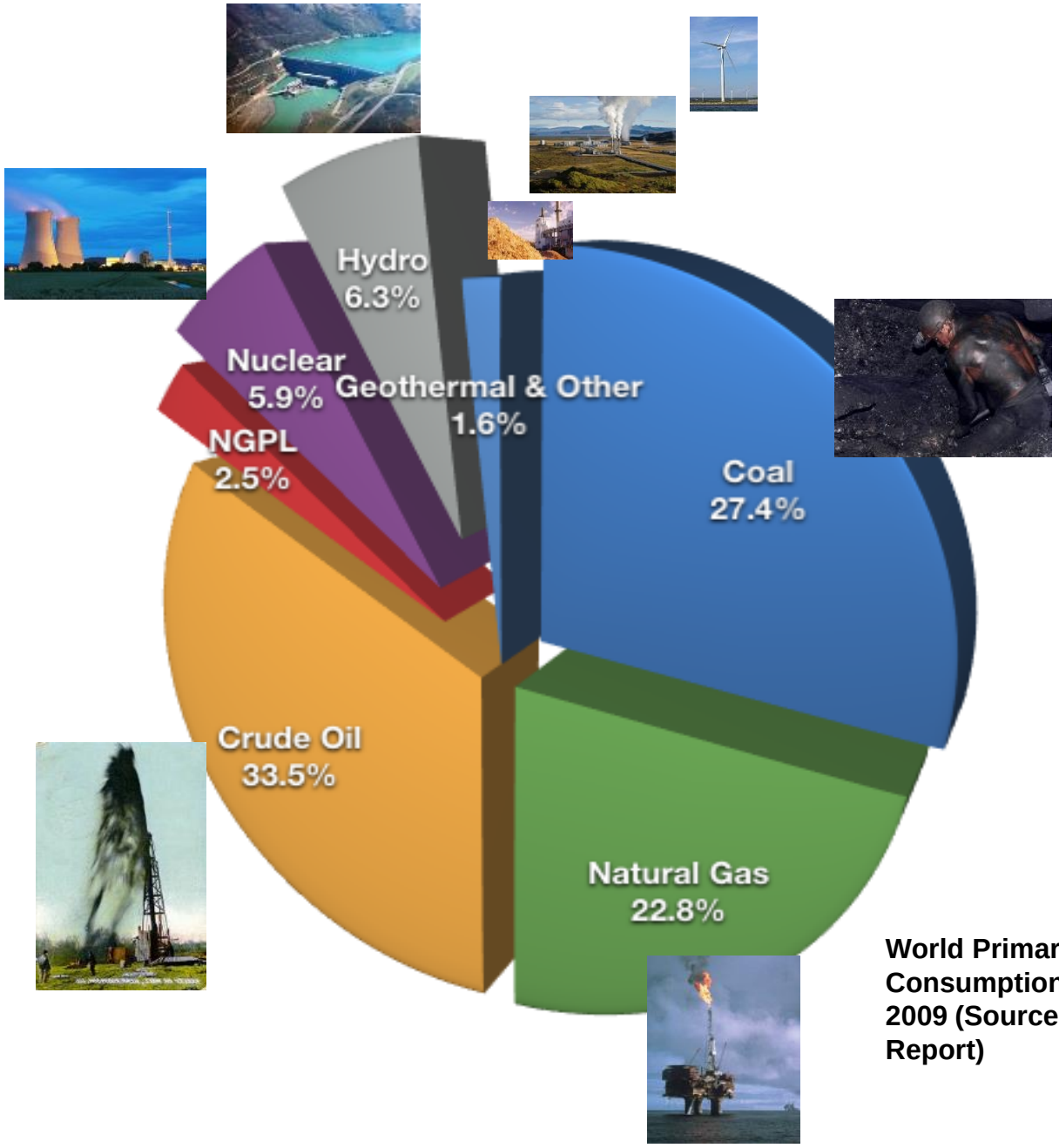
Environment Institute

Where ideas grow



World Primary Energy Consumption by source 2009 (Source: IEA 2009 Report)

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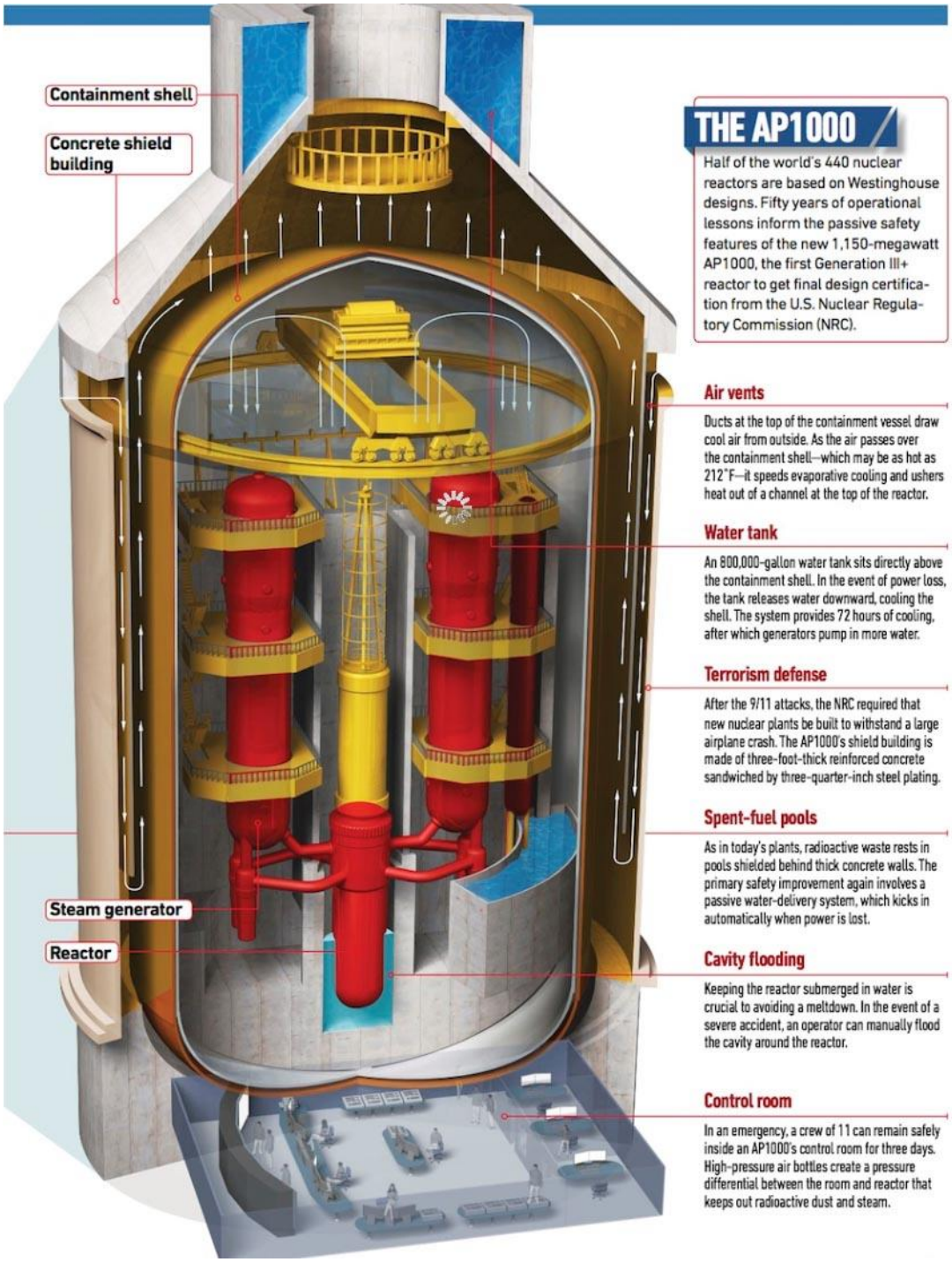

THE AP1000

Half of the world's 440 nuclear reactors are based on Westinghouse designs. Fifty years of operational lessons inform the passive safety features of the new 1,150-megawatt AP1000, the first Generation III+ reactor to get final design certification from the U.S. Nuclear Regulatory Commission (NRC).

Air vents

Ducts at the top of the containment vessel draw cool air from outside. As the air passes over the containment shell—which may be as hot as 212°F—it speeds evaporative cooling and ushers heat out of a channel at the top of the reactor.

Water tank

An 800,000-gallon water tank sits directly above the containment shell. In the event of power loss, the tank releases water downward, cooling the shell. The system provides 72 hours of cooling, after which generators pump in more water.

Terrorism defense

After the 9/11 attacks, the NRC required that new nuclear plants be built to withstand a large airplane crash. The AP1000's shield building is made of three-foot-thick reinforced concrete sandwiched by three-quarter-inch steel plating.

Spent-fuel pools

As in today's plants, radioactive waste rests in pools shielded behind thick concrete walls. The primary safety improvement again involves a passive water-delivery system, which kicks in automatically when power is lost.

Cavity flooding

Keeping the reactor submerged in water is crucial to avoiding a meltdown. In the event of a severe accident, an operator can manually flood the cavity around the reactor.

Control room

In an emergency, a crew of 11 can remain safely inside an AP1000's control room for three days. High-pressure air bottles create a pressure differential between the room and reactor that keeps out radioactive dust and steam.

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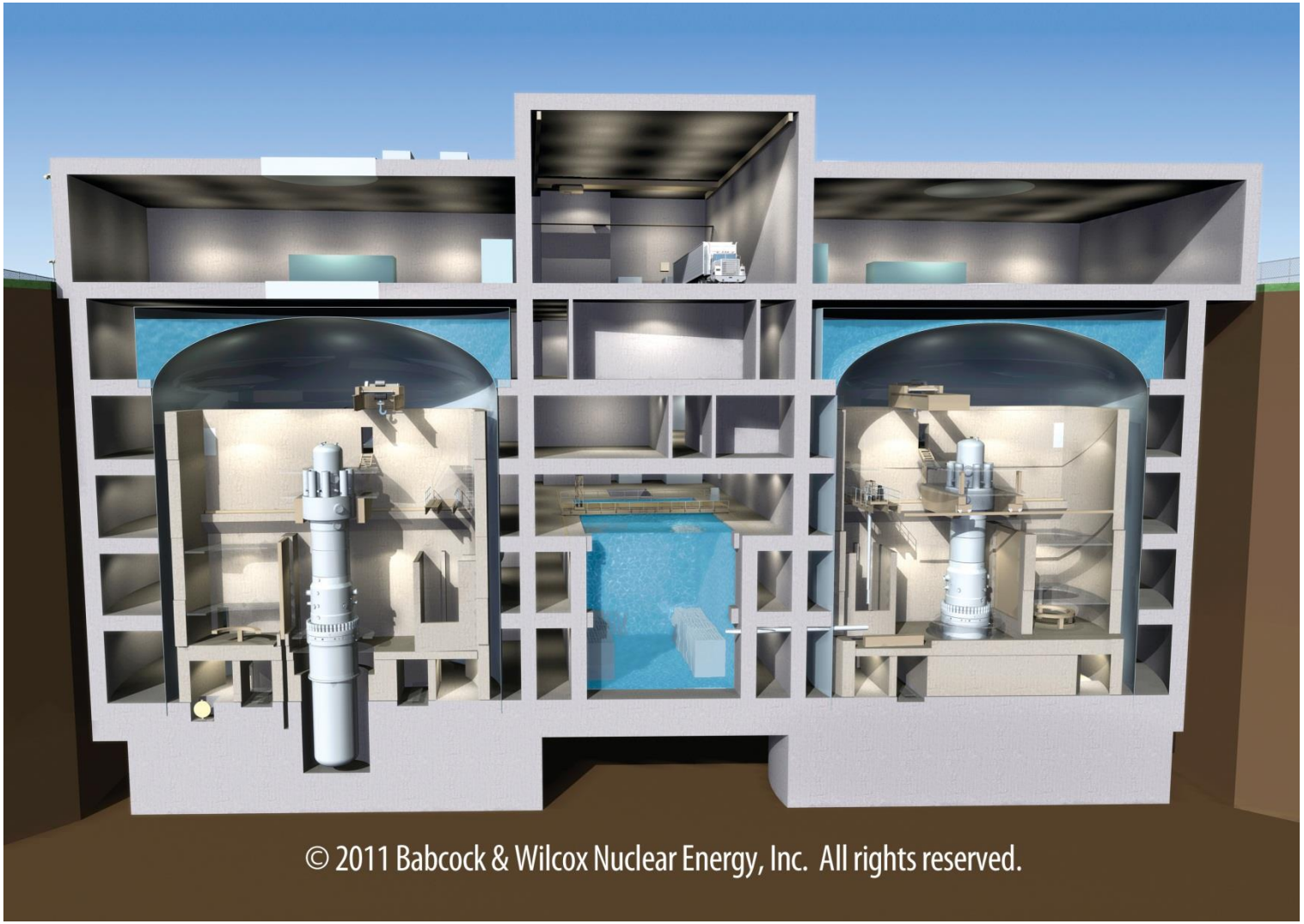
Two B&W *mPower* reactor modules generating 360 MWe



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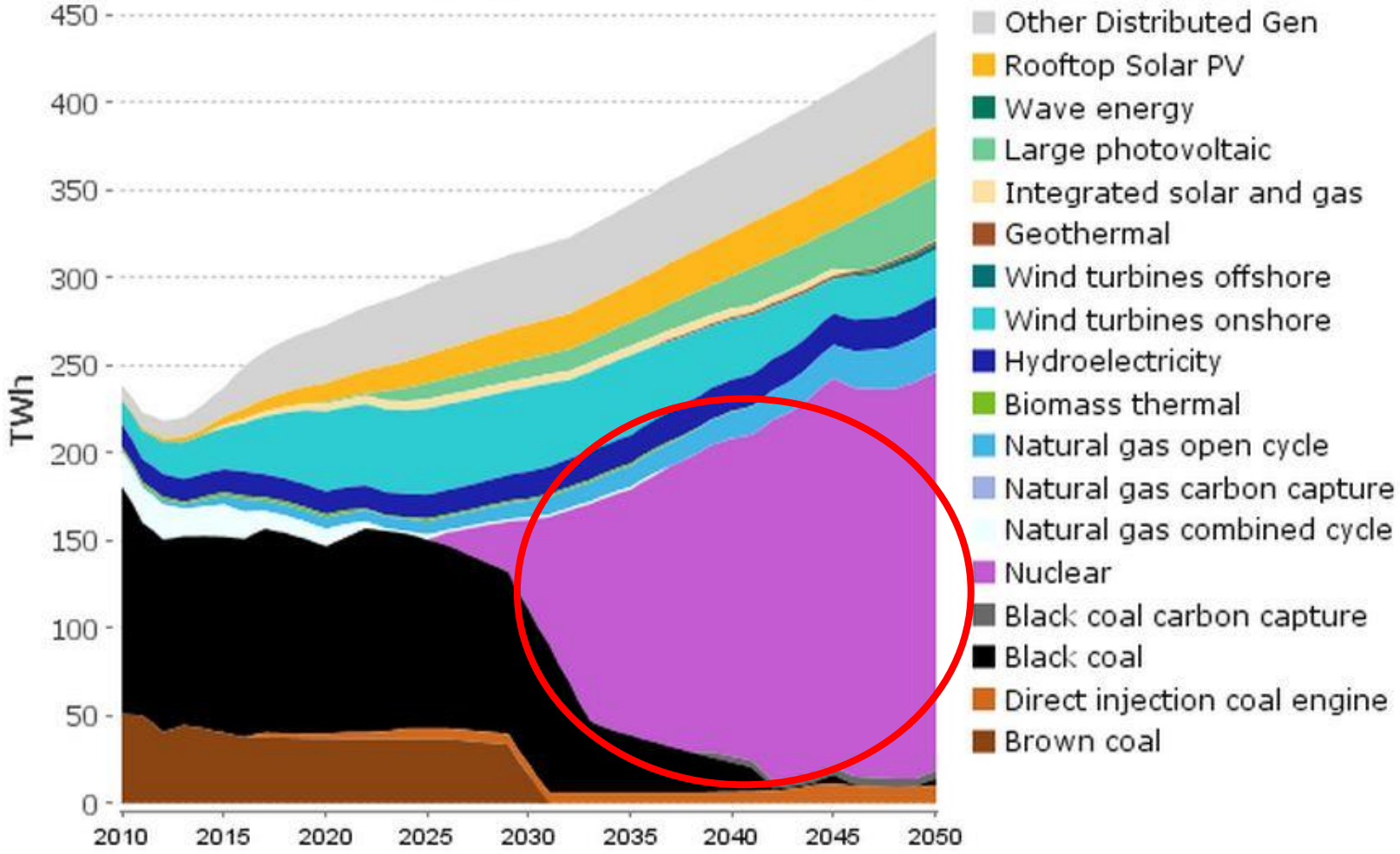
Electricity generation by technology



Source: Copyright Commonwealth Scientific and Industrial Research Organisation 2012-.
Chart based on user selected assumptions and generated by CSIROs eFuture tool,
Electricity Simulation Model #1953. Conditions of use, see www.efuture.csiro.au (Background).

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Four key (perceived) barriers to large-scale nuclear

- Economics
- Civic safety
- Proliferation
- **Waste disposal**

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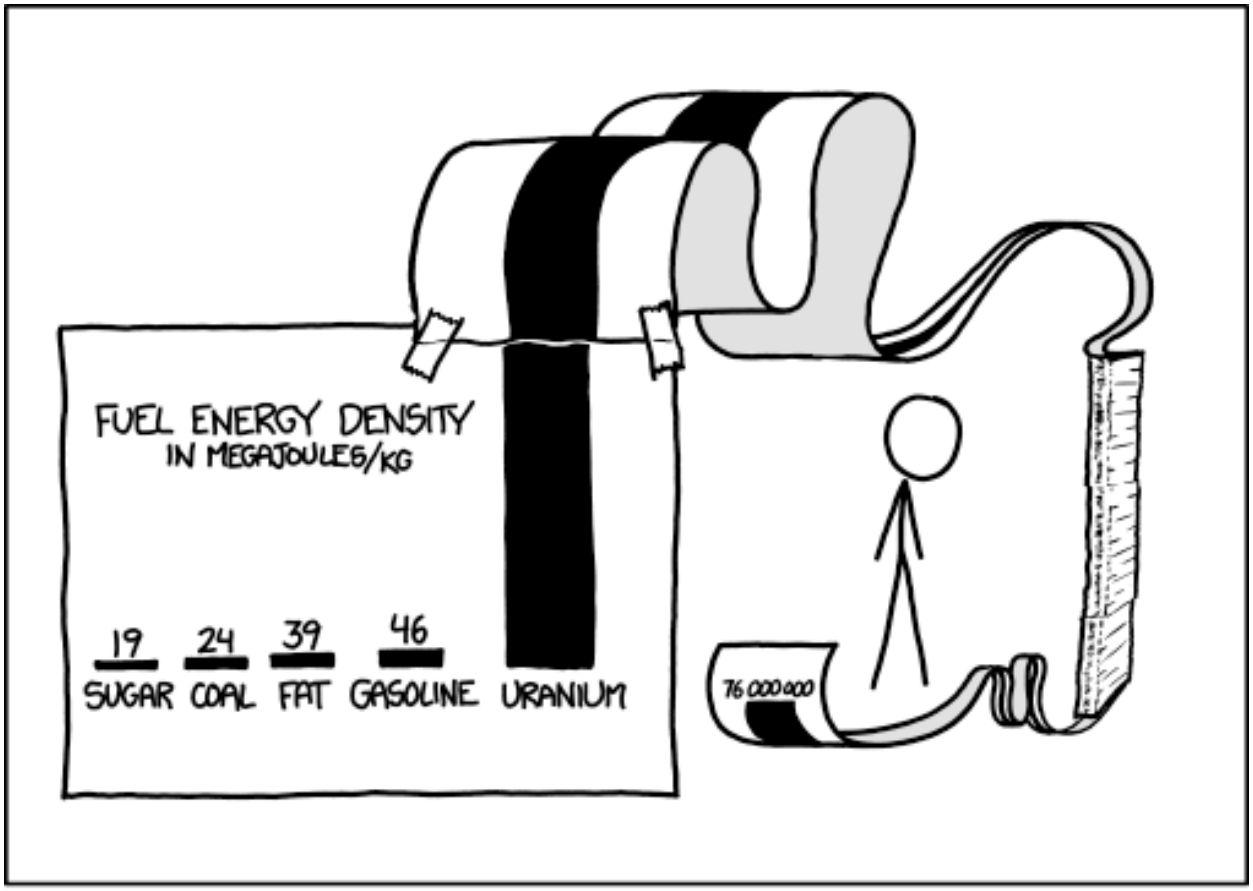
High energy density = little waste



SCIENCE TIP: LOG SCALES ARE FOR QUITTERS WHO CAN'T FIND ENOUGH PAPER TO MAKE THEIR POINT *PROPERLY.*

Annual Mass Flow for LWR

Uranium Ore

100 tons

Enrichment

85 tons

Depleted Uranium

15 tons

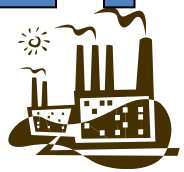
1000 MWe LWR

13.85 tons U

0.13 tons Pu

Used Uranium Reserve

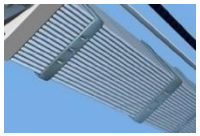
1.00 tons F.P.
0.02 tons M.A.



Reprocessing

13.85 tons Uranium
1.00 tons Fission Products
0.13 tons Plutonium
0.02 tons Minor Actinides

Disposal
(100,000 years)



Spent Fuel

Disposal
(100,000 years)

European recycle
- Saves 15% uranium
- But no reduction in waste life

Direct disposal is the current U.S. policy

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Environment › Nuclear waste

Cumbria rejects underground nuclear storage dump

The only local authorities in the UK still involved in feasibility studies have voted against the disposal facility

Martin Wainwright
guardian.co.uk, Wednesday 30 January 2013 16.09 GMT

TECH | 1/17/2013 @ 1:00PM | 4,740 views

U.S. Launches 35-Year Quest For A New Yucca Mountain

6 comments, 5 called-out + Comment Now + Follow Comments

In what critics are calling a stall tactic, the U.S. Department of Energy revealed late last week it will search for a new permanent depository for the country's growing stockpile of spent nuclear fuel, with a target opening date of 2048.

(Image credit: Getty Images via @daylife)

In the meantime, most fuel will likely remain dispersed at reactor sites throughout the country. DOE

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Slow progress towards US use of MOX

21 February 2011

While construction continues on a mixed oxide nuclear fuel plant at Savannah River, negotiations on where the fuel will be used remain in the early stages.

The $4.8 billion Savannah River MOX Plant is being built by Shaw Areva MOX Services to combine 34 tonnes of 'surplus' plutonium oxide with uranium oxide to create fuel for conventional power reactors. Russia is disposing of an identical amount of plutonium through a bilateral arms reduction deal that eliminates explosive fuel from some 17,000 unwanted nuclear weapons.

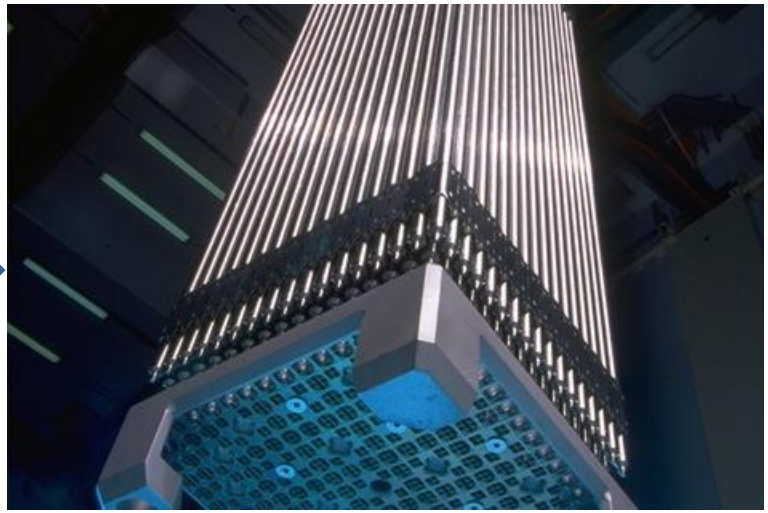
Construction work at Savannah River

Rethink slows MOX construction

18 April 2013

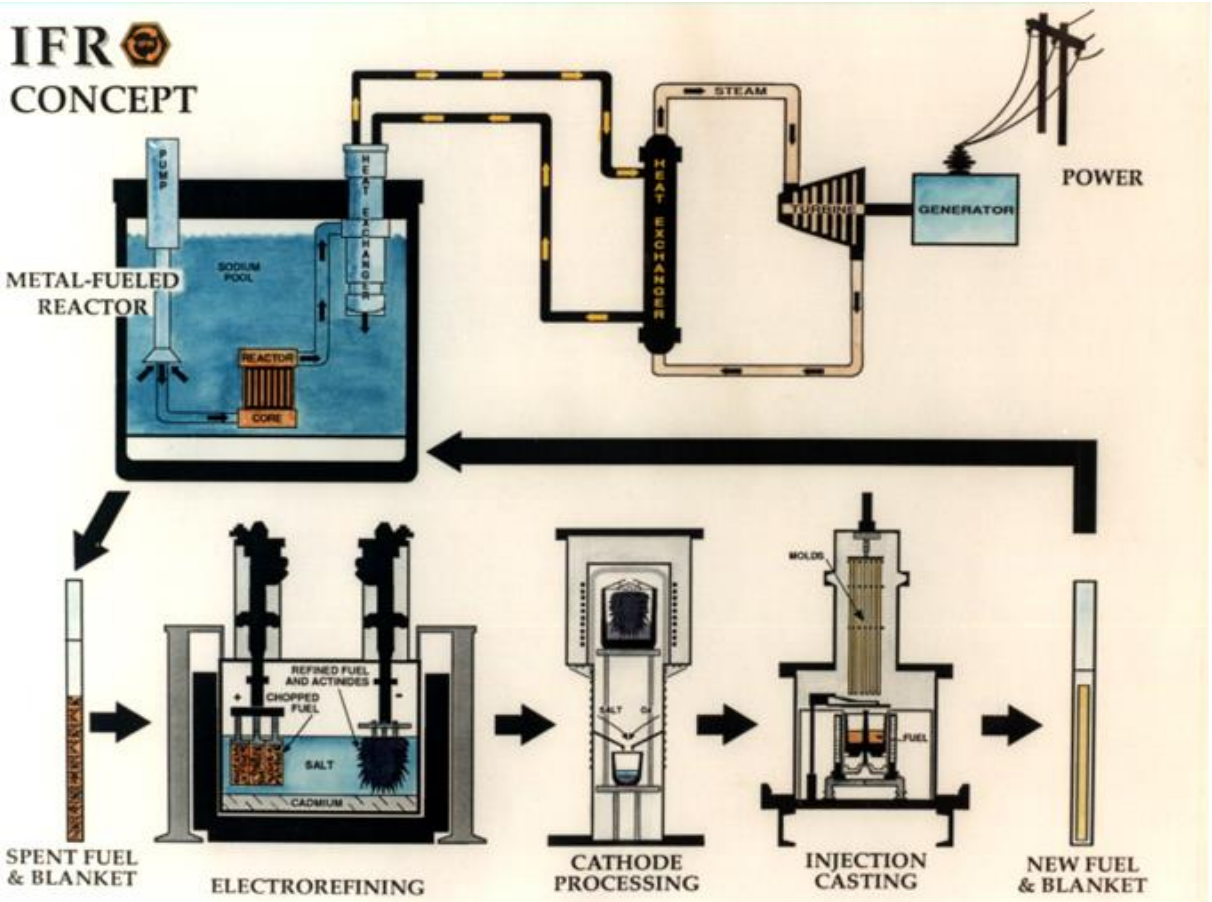
Work on a facility to convert weapons plutonium into reactor fuel is to be slowed down as the US National Nuclear Security Administration (NNSA) reconsiders its plutonium disposition strategy.

Nuclear ‘waste’ is nuclear fuel!



e.g. UK legacy plutonium stockpile: 100 tonnes

= 1 million gigawatt hours of energy


IFR
CONCEPT
STEAM
HEAT EXCHANGER
TURBINE
GENERATOR
POWER
METAL-FUELED
REACTOR
PUMP
SODIUM
POOL
HEAT EXCHANGER
REACTOR
CORE
REFINED FUEL
AND ACTINIDES
CHOPPED
FUEL
SALT
CADMIUM
MOLDS
SALT
Cd
FUEL
SPENT FUEL
& BLANKET
ELECTROREFINING
CATHODE
PROCESSING
INJECTION
CASTING
NEW FUEL
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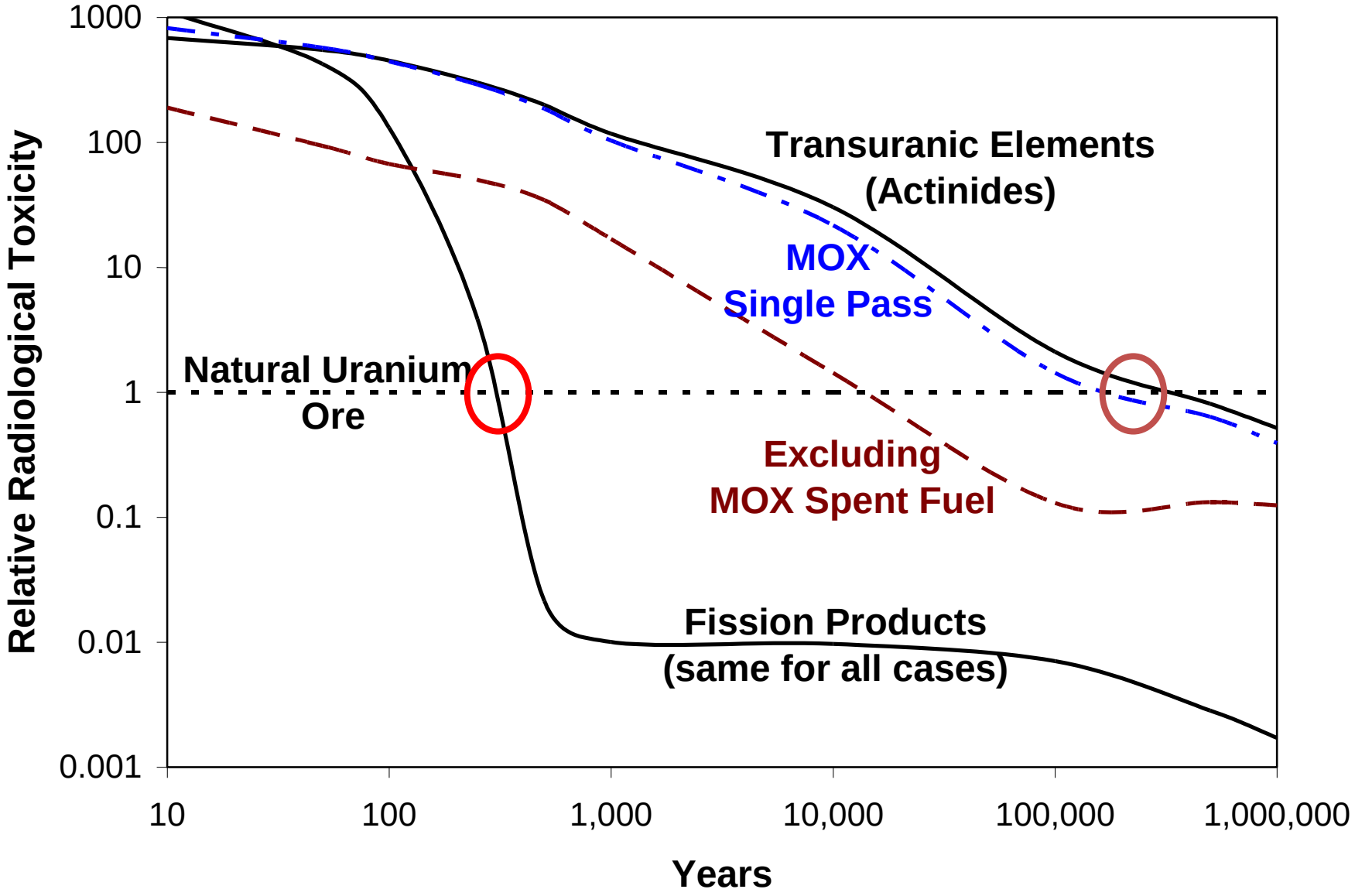
EBR-II
REACTOR PLANT 767


FUEL CONDITIONING FACILI



Relative radiological toxicity of spent fuel constituents

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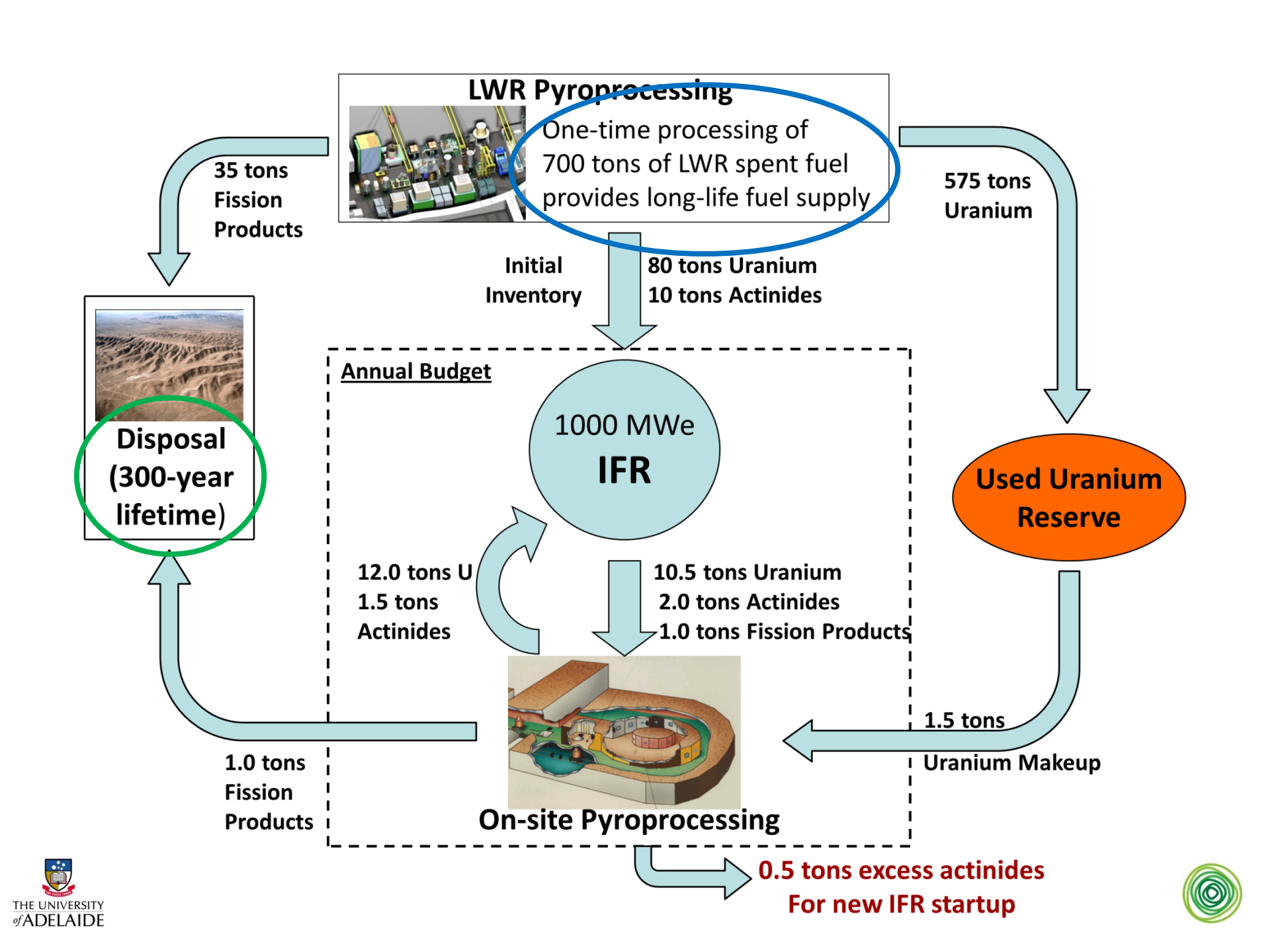


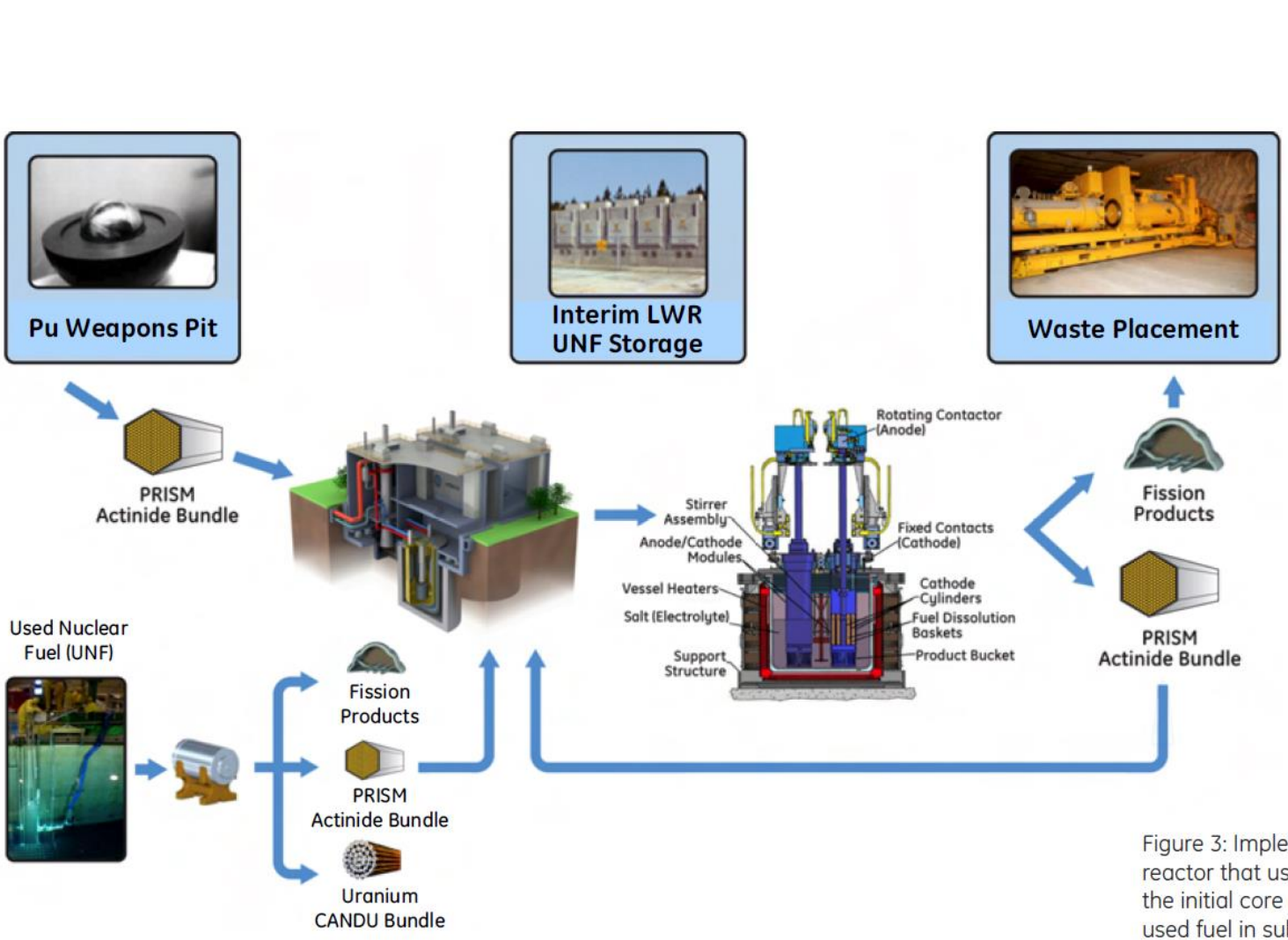
UK government could waste £billions via MOX to keep AREVA happy!

UK government proposes using MOX – producing most expensive fuel for the most expensive reactors (EPRs) and still being left with more waste and plutonium.

AREVA submission to consultation: "Gen IV reactors will be available on industrial scale only after 2040… this timescale is not compatible with the urgency…

GE Hitachi submission: we "respectfully disagree" – plutonium is an economical fuel for a sodium-cooled fast reactor. PRISM construction schedule: <u>36 months</u>

GEH proposal: *waste to energy*



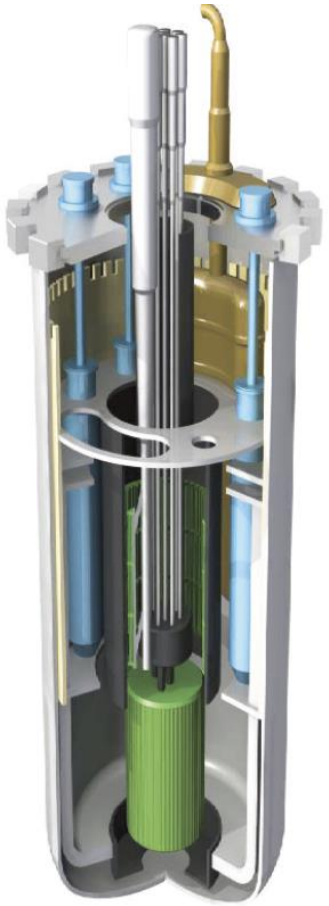


Figure 3: Implementation of a fuel qualification reactor that uses excess weapons material as the initial core and recycled light water reactor used fuel in subsequent operations

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ALL THE SPENT FUEL IN THE WORLD CAN BE RECYCLED INTO IFR FUEL