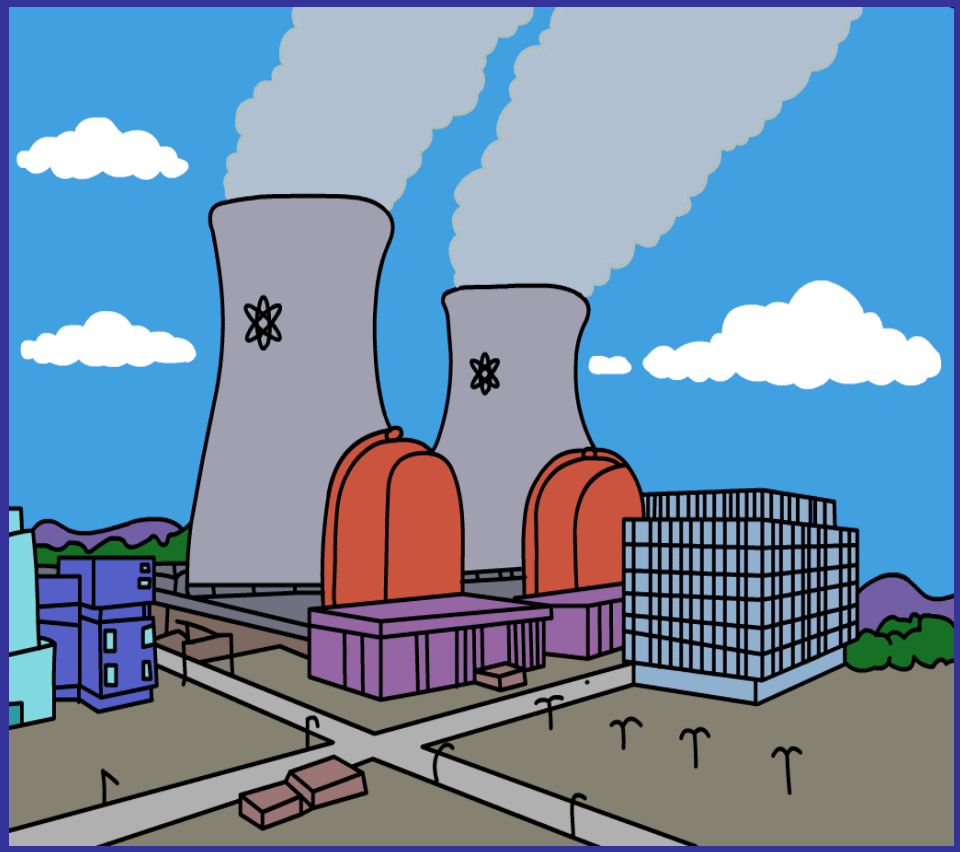
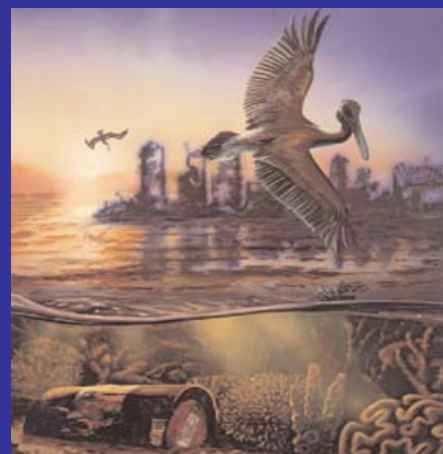


Nuclear power for a greenhouse planet: What the US & world can learn from DeGaul's vision of energy-independent France realized

Observations on nuclear electric power policy & experience presented at the American Enterprise Institute, Washington, DC, Feb. 20, 2008, by Marty Hoffert, prof. emeritus of physics, New York University; email: marty.hoffert@nyu.edu



Climatic implications for energy tech

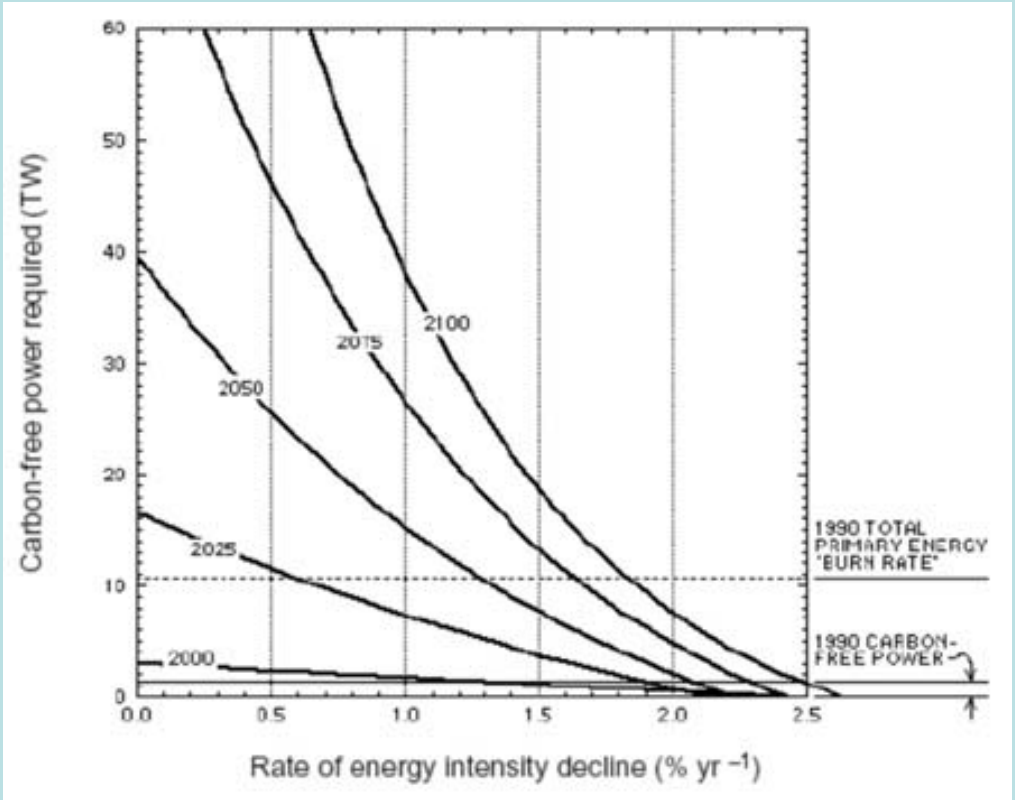
- Preventing two degree Celsius warming (above which icecap melting may become irreversible) implies 100-300% of primary power consumed today must come from some combination of non-CO2 emitting energy sources and "negawatts" of demand reduction by midcentury. No technologically ready cost-effective solution “on the shelf” today can do this.

- Still, near-term, plugin hybrids with carbon-neutral electrcial recharge, green buildings and halting the massive buildup of conventional coal plants in China, India and the US are critical.

- In parallel, we need targeted research, development, demonstration & deployment of three classes of carbon-neutral primary power: (1) coal gasification combined cycle power plants producing electricity and hydrogen with CO2 stored underground; (2) new generations of operationally safe, proliferation-resistant and waste-managed nuclear reactors burning fuel bred from U-238 and thorium, and eventually fusion; and (3) renewable energy, primarily solar and wind, with appropriate transmission and storage tech deployed at the global scale, including space-based solar. Major hurdles must be overcome in ALL of these compared to conventional coal as a primary power source.

-- Marty Hoffert (2008)

Slowing global warming with growing global GDP requires massive carbon-neutral power AND massive efficiency gains



❖Twenty-first century tradeoff between emission-free carbon-free primary power supply and energy intensity decline rate to stabilize atmospheric carbon dioxide at 550 ppm [from Hoffert et al., *Nature* 395, 881-884 (1998)]. Energy intensity is the ratio of primary energy consumption to gross domestic product, (E/GDP).

❖Tens of terawatts from supply & tens of "nega-terawatts" from demand reduction *both* needed by 2050 to stabilize climate with continued GDP growth; much more needed by 2100.

❖MIH arguing that alt. energy supply vs. demand reduction is a "false dichotomy" with Amory Lovins (with pocketed banana) at *Technosphere Conf.*, Synergia Ranch, New Mexico, Oct. 2005.

MIH Dec. 2005

Breeding nuclear fuel is essential for SUSTAINABLE nuclear power at the ten terawatt level and beyond

That U-235 contains less energy in identified resouces than natural gas means that making plutonioum from U-238 [99% of U] or U-233 from thorium is essential for fission to become a sustainable primary power source:

"Breeders are particularly important because they have an extremely high efficiency rate of use of uranium and thorium, while with the use of burner reactors only, the resources of high grade uranium would be used up rapidly. One would then be forced to mining rock containing small amounts of uranium – a scheme we refer to as mining "yellow coal." But by the use of of breeders, the "good" uranium would last a very long time. . . one must find a schedule of reactor construction that . . . must not use more natural uranium than the resource base provides, and at a definite time – for our study, the year 2030 – it must be capable of operating virtually independently at the power level achieved at that time, without requiring still more natural uranium."

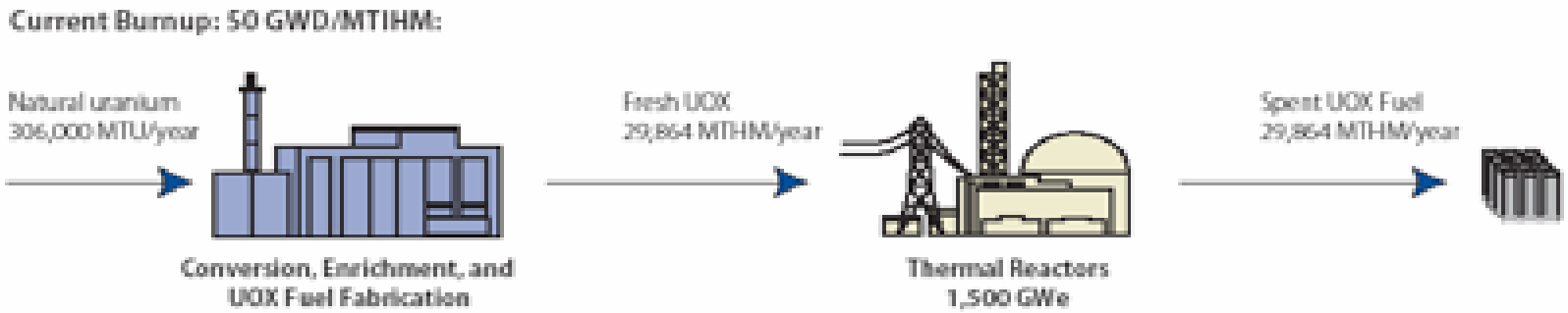
--- W. Häfele (1981) *Energy in a Finite World* (IIASA Energy Systems Program, Laxenburg, Austria, Vol. 2, p. 20).

That was then (before TMI & Chernobyl); This is now . . .

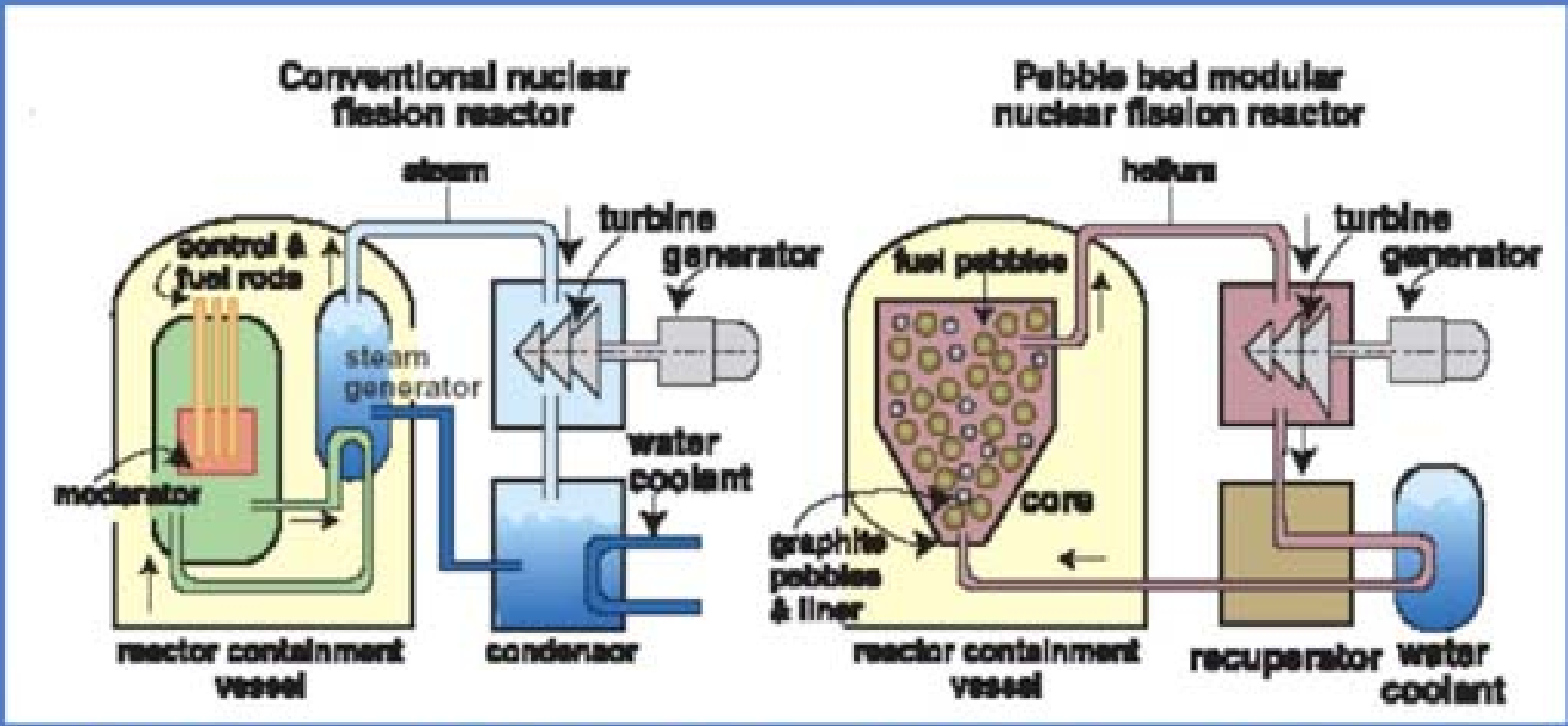
The most authoritative recent study on re-starting nuclear in the US & world is J. Duetch & E. Moniz, Eds. (2003), *MIT Study on The Future of Nuclear Power* (Cambridge, MA). They stay as far as possible from breeders:

"We conclude that, over at least the next 50 years, the best choice to meet [Cost, operational safety, waste disposal & weapons proliferation] challenges is the open, once-through fuel cycle." (At most, with one "mixed oxide" recycle of "waste" plutonium, as in France's plans. For various reasons, France discontinued their full-fledged phenix and superphenix plutonium breeder reactors.)

Figure 4.1 Open Fuel Cycle: Once-Through Fuel — Projected to 2050



CAN "GREEN" NUKES SAVE THE DAY?



Light water reactors (LEFT) have had operational safety, cost, waste disposal & proliferation problems. New helium-cooled pebble bed reactors (RIGHT) are theoretically immune to coolant loss (TMI) and criticality (Chernobyl) accidents. Other problems may be technically soluble also.

BUT: U-235 resources burned at 10 TW with "once-through" reactors will only last 6-30 years: WE'D NEED TO START BUILDING BREEDERS NOW!