Power Shift? Atomic Energy and the Environment following the Japanese Earthquake Crises

Noel Maurer

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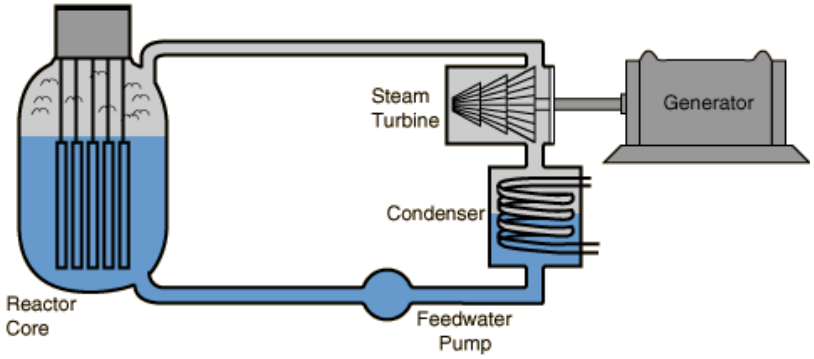
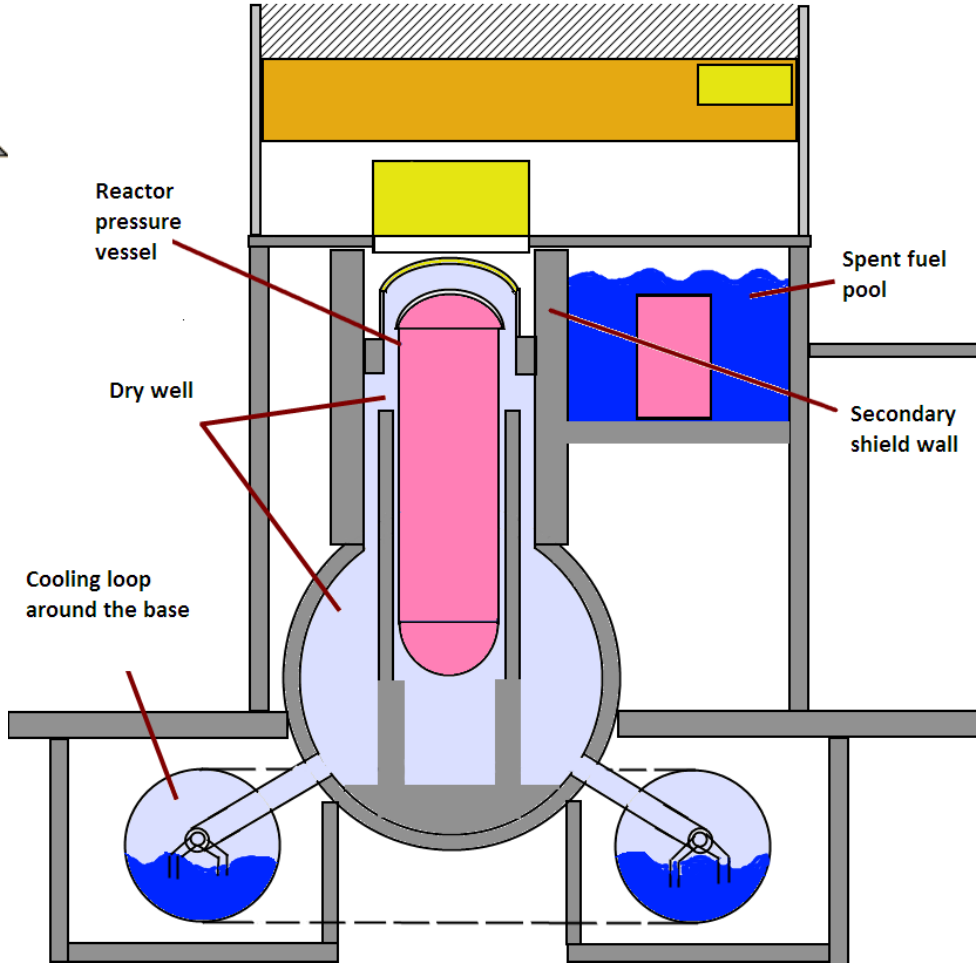
Boiling water reactors 101





The disaster

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***The quake*:**

- 9.0 Richter scale earthquake strikes at 2:46 local time on March 11, 2011;
- Units 1, 2, and 3 go into automatic shut down: this trips the cooling systems to backup power (e.g., the grid or emergency generators);
- At 3:06pm, a 49-foot tidal wave strikes the plant and knocks out the diesel generators and the remaining grid connection.

***The immediate consequences*:**

- Explosion in unit 1 on March 12, at 3:36pm local time;
- Explosion in unit 3 on March 14, at 11:15am local time (six deaths);
- Explosion in unit 2 on March 15, at 6:14am local time.
- Unit 3 is where there were worries about a containment breach. There were also worries that the water in the spent fuel pool had boiled dry.

***The response*:**

- Evacuations began on March 12; by March 15 the zone was 12 miles around the plant;
- Self-Defense Force helicopters begin dropping water on fuel pools on March 17—firefighters arrive the next day;
- Freshwater replaces seawater on March 26;
- Contamination into ocean noted on April 2

Radiation dosages

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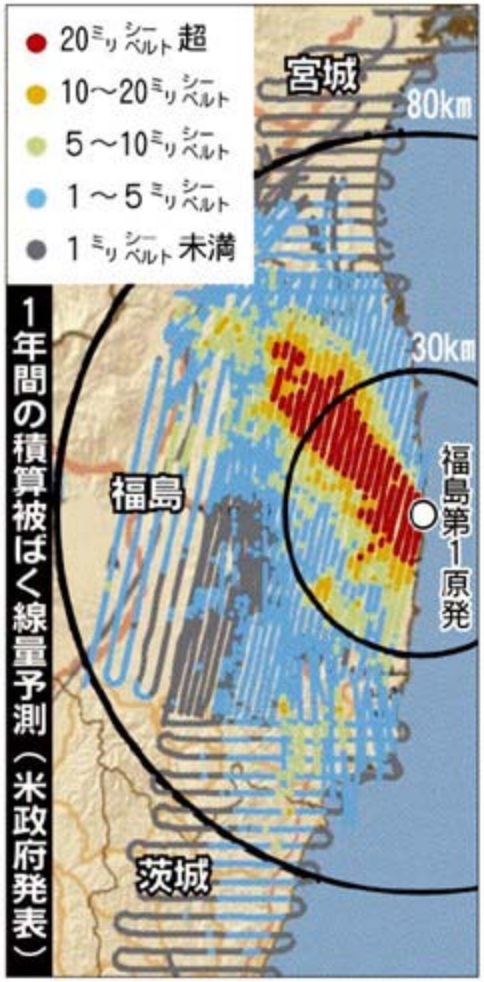

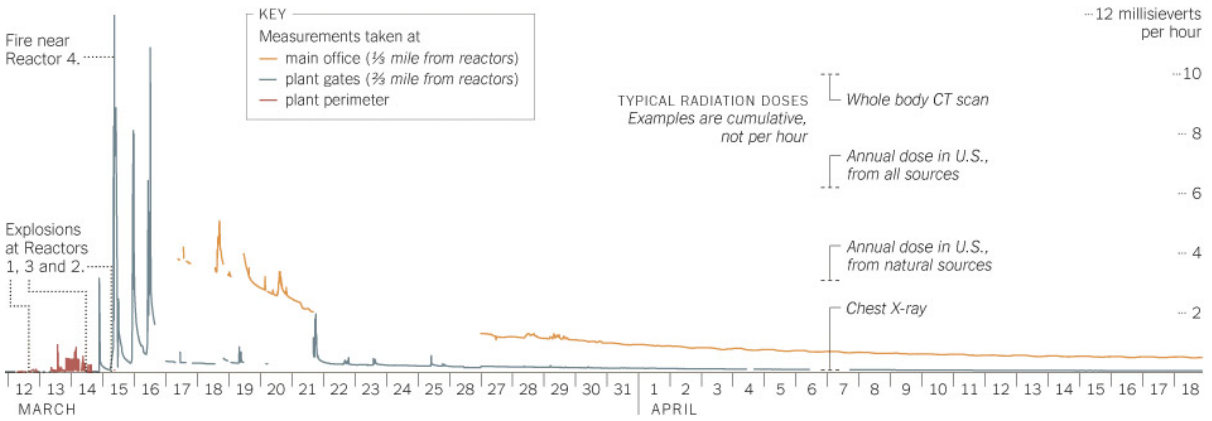

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Current status

Unit	1	2	3
Power (MWe /MWth)	460/1380	784/2381	784/2381
Type of Reactor	BWR-3	BWR-4	BWR-4
Status at time of EQ	In service – auto shutdown	In service – auto shutdown	In service – auto shutdown
Core and fuel integrity	Damaged	Severe damage	Damaged
RPV & RCS integrity	RPV temperature decreasing	RPV temperature stable	RPV temperature stable
Containment integrity	No information	Damage suspected	Damage suspected
AC Power	AC power available - power to instrumentation – Lighting to Central Control Room	AC power available – power to instrumentation – Lighting to Central Control Room	AC power available – power to instrumentation – Lighting to Central Control Room
Building	Severe damage	Slight damage	Severe damage
Water level of RPV	Around half of Fuel is uncovered	Around half of Fuel is uncovered	Around half of Fuel is uncovered
Pressure of RPV	Slowly increasing	Stable	Stable
CV Pressure Drywell	Stable	Stable	Stable
Water injection to RPV	Injection of freshwater – via mobile electric pump with off-site power	Injection of freshwater – via mobile electric pump with off-site power	Injection of freshwater – via mobile electric pump with off-site power
Water injection to CV	No information	No information	No information
Spent Fuel Pool Status 04/20/2011 07:00 UTC	Fresh water injection by concrete pump truck	Freshwater injection to the Fuel Pool Cooling Line	Freshwater injection via Fuel Pool Cooling Line and Periodic spraying

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Fukushima's effect

What should happen;

What will happen;

Why it matters—but not the way one might think.

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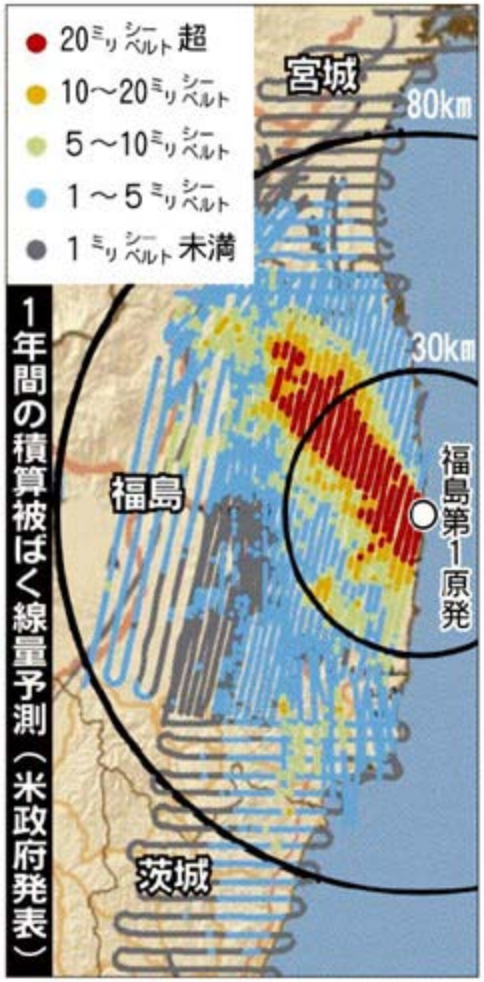

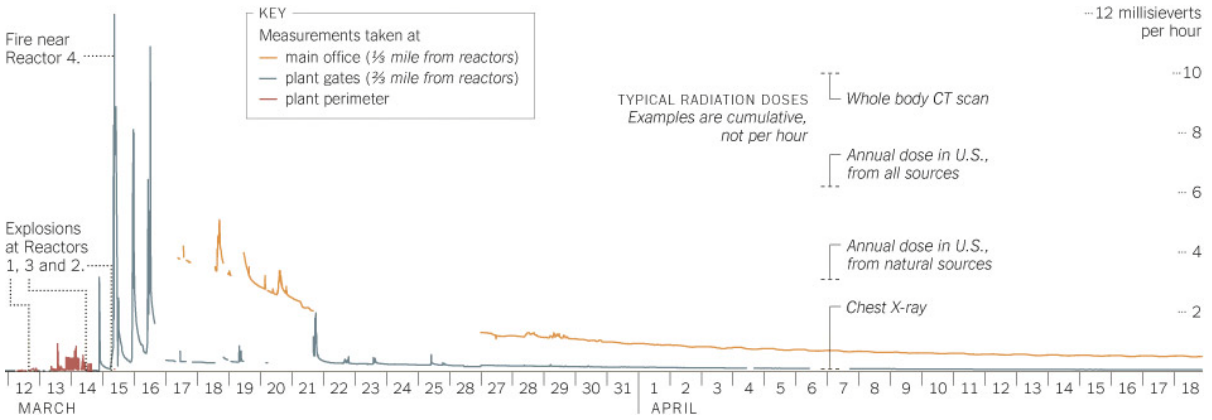

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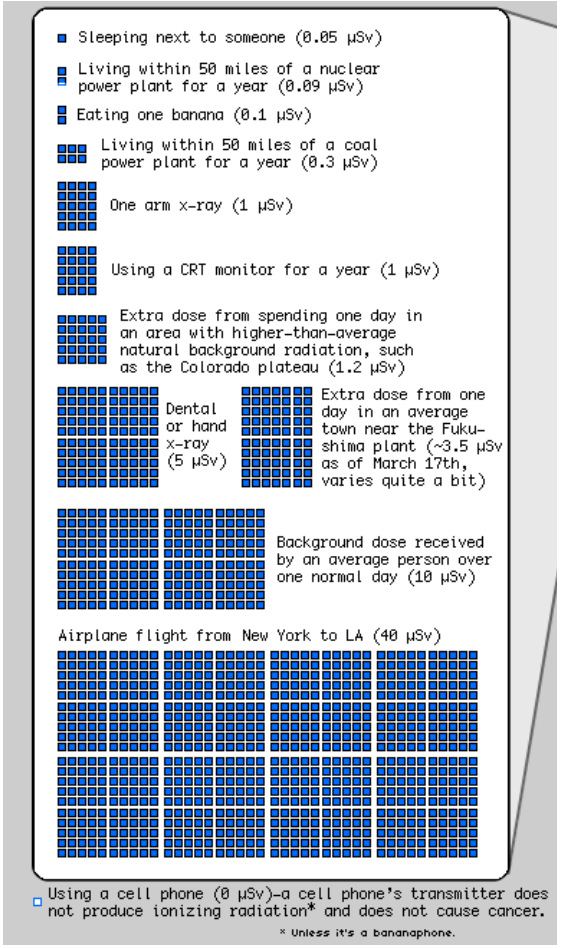

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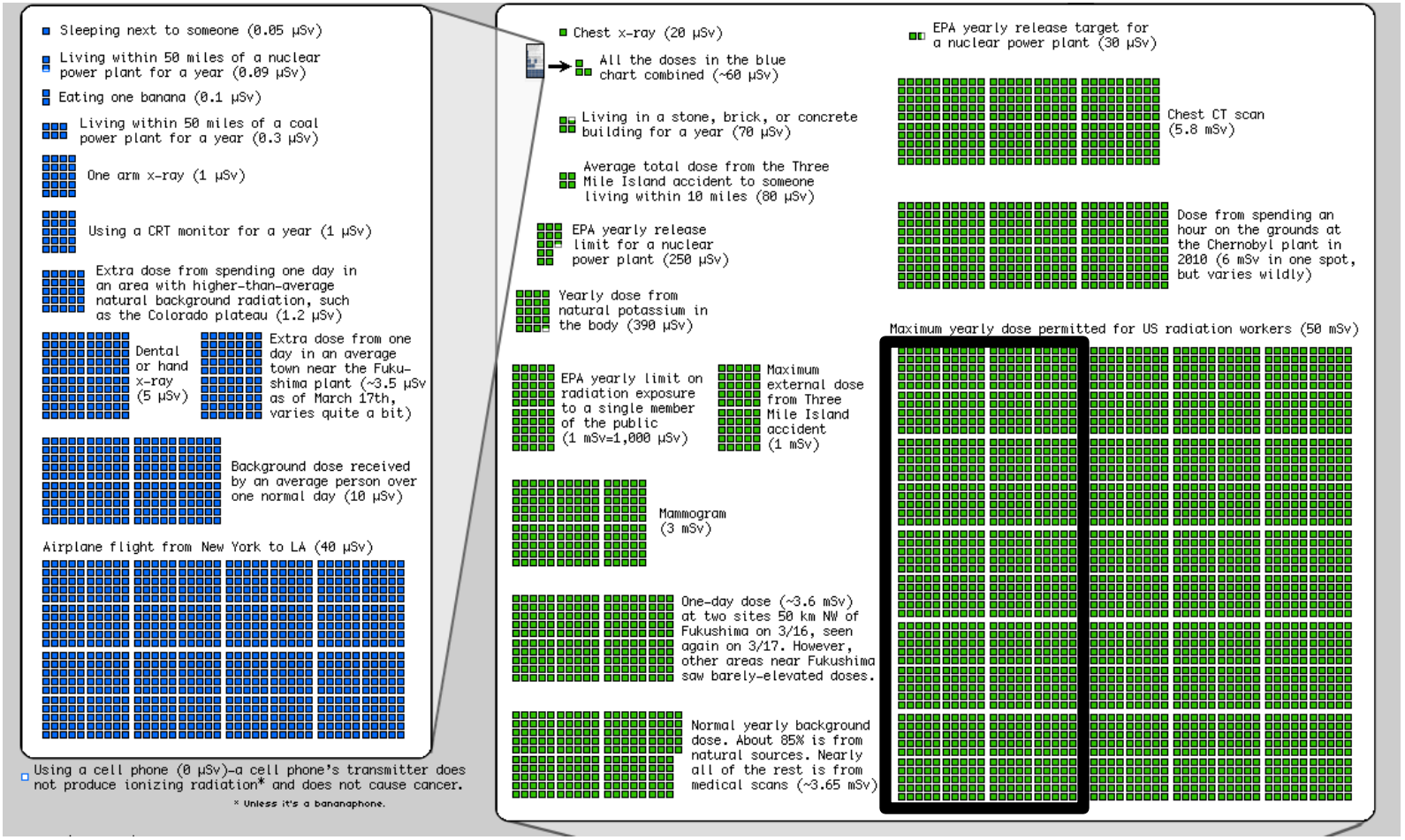

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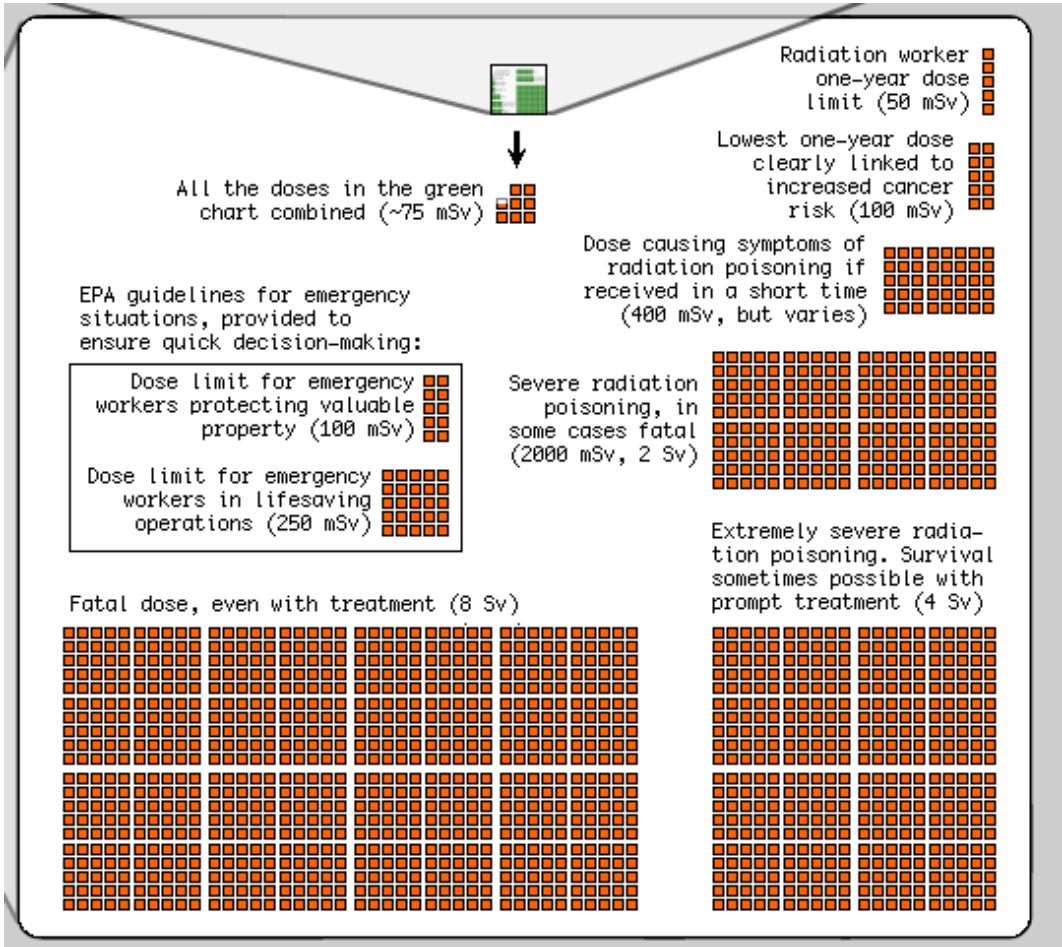

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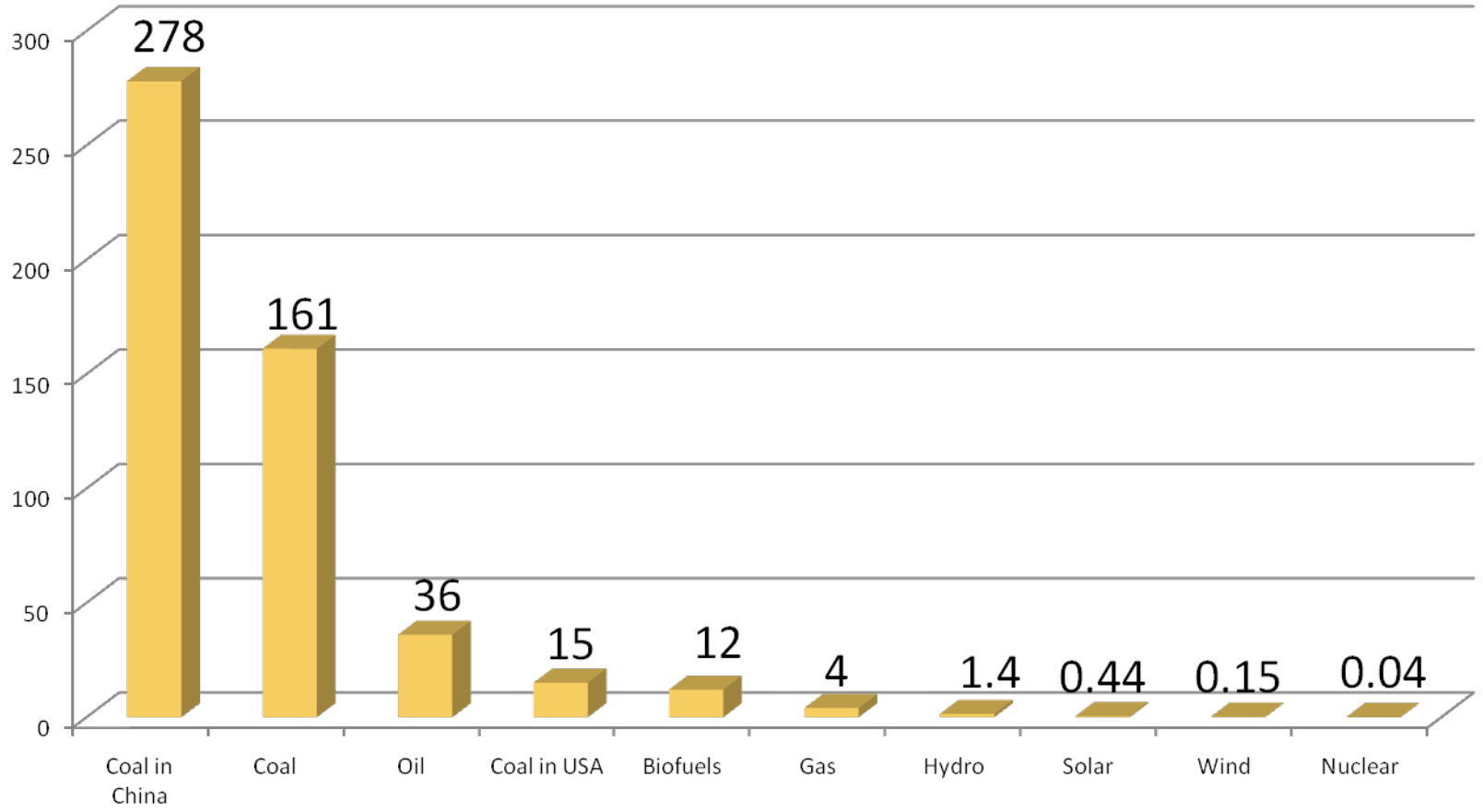
Danger, Will Robinson?



What will happen

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***Cancellations and suspensions*:**

Italy has suspended all nuclear regulations, effectively stopping plans for four reactors;
Germany is in the middle of a large anti-nuclear backlash;
China suspended work on 28 units under construction;
India reviewing plans for a 9.9.-GW nuclear island in Jaitapur, Maharashtra;
U.S. worried about San Onofre and Diablo Canyon on the California coast;
Court challenges in Britain over eight planned reactors.

***Likely slowdowns in construction plans*:**

The Chinese government, in particular, seems to be very seriously reviewing its plans to expand nuclear power;
It seems unlikely that India's plans will escape the backlash;
Germany is highly unlikely to replace its existing plant as it becomes obsolete, which otherwise had looked likely;
Consider the rapidity with which deepwater drilling restarted in the U.S. after Macondo — are there parallels?

***Innovative technologies in jeopardy* :**

"Nuclear batteries" and small offshore plants;
It seems unlikely that India's plans will escape the backlash;
Germany is highly unlikely to replace its existing plant as it becomes obsolete, which otherwise had looked likely;
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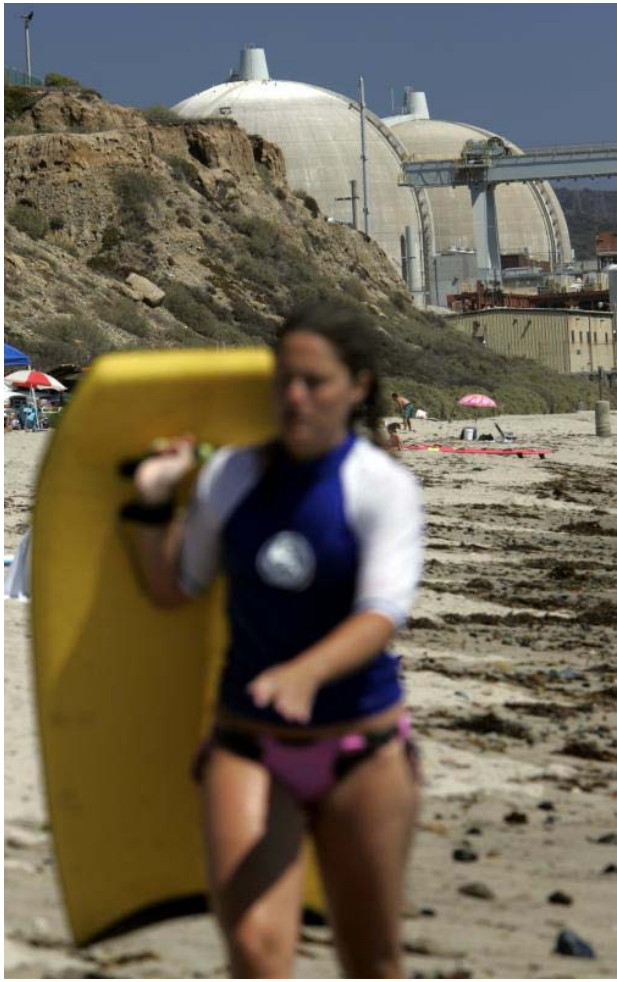

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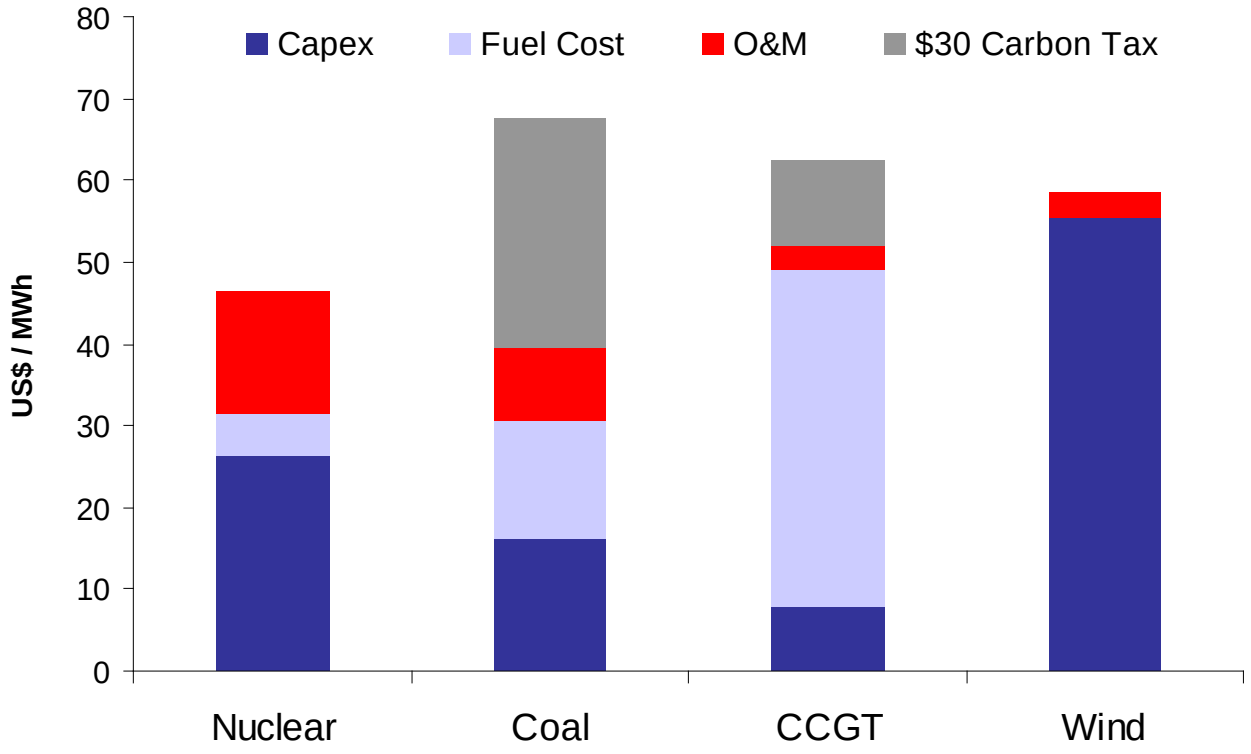
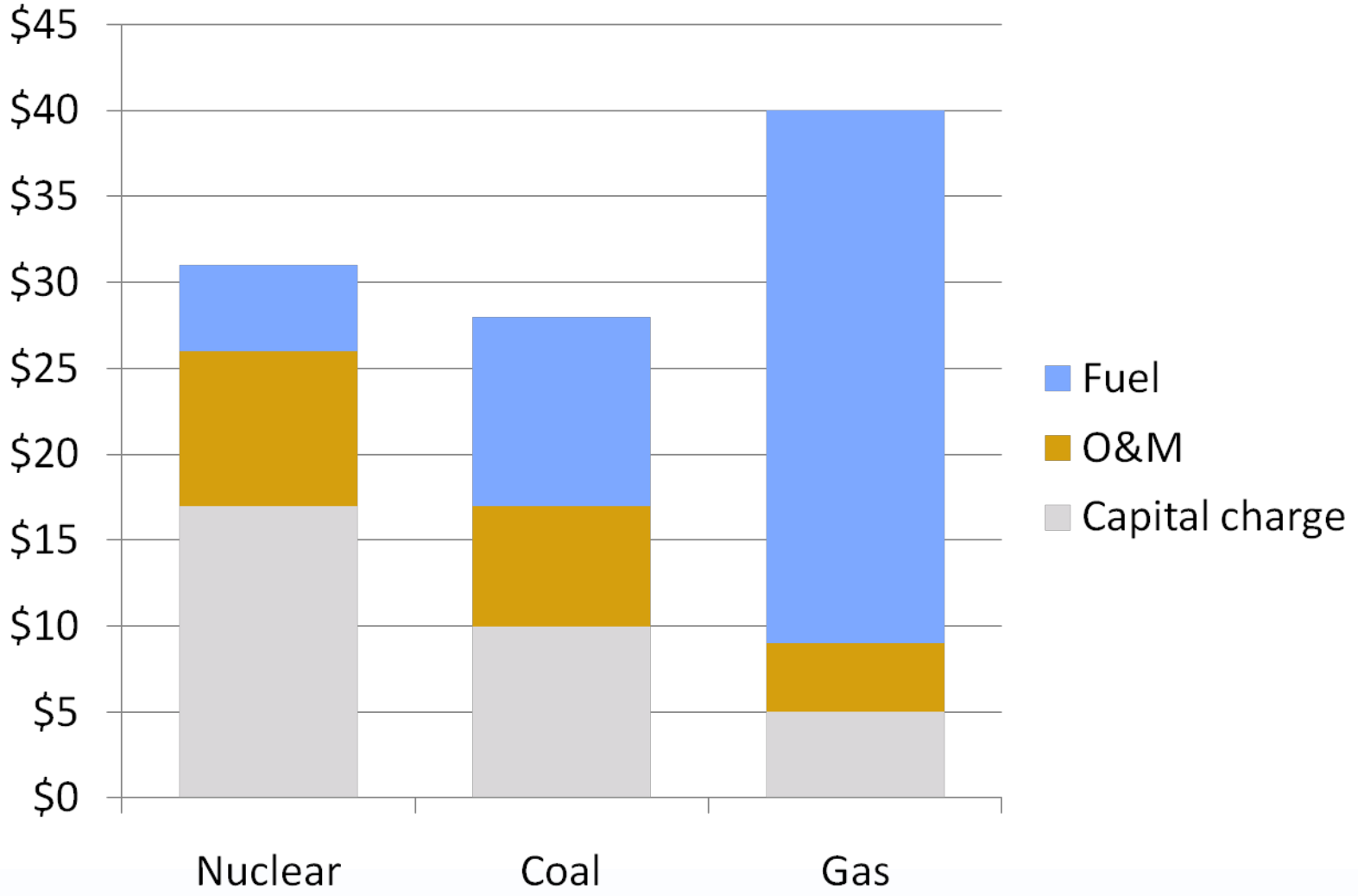
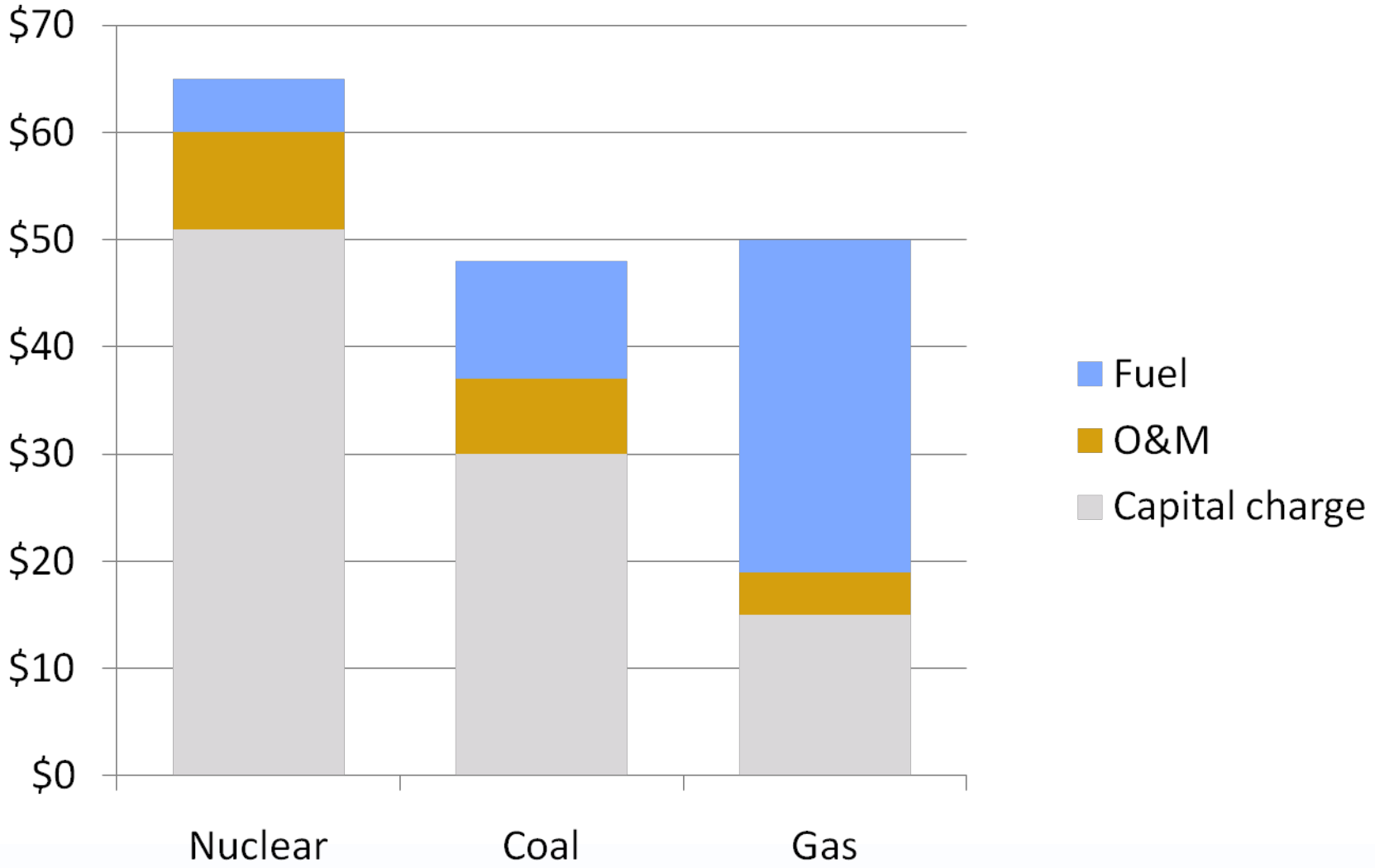
The real barrier: Economics



The cost of nuclear (1)



The cost of nuclear (2)



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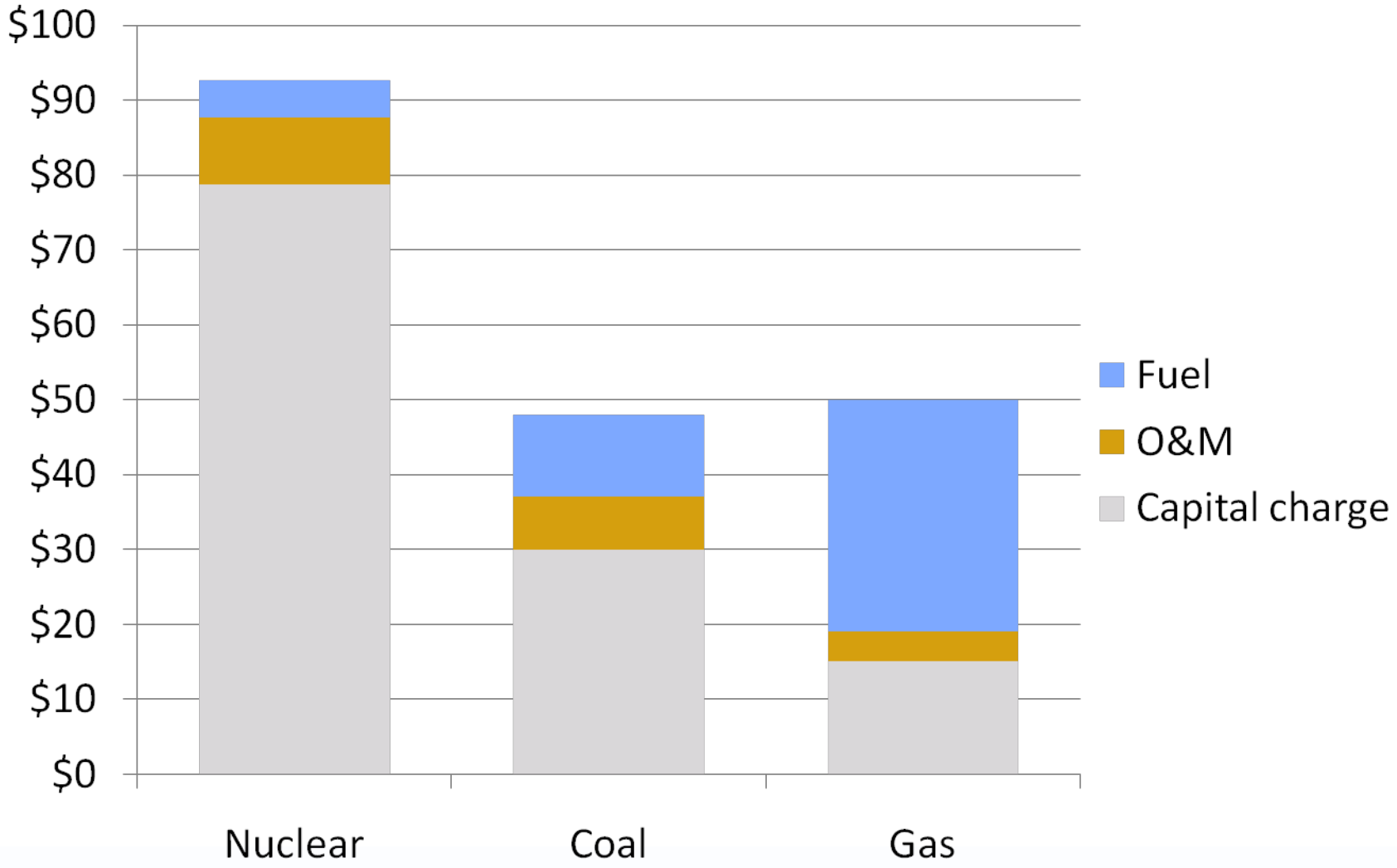
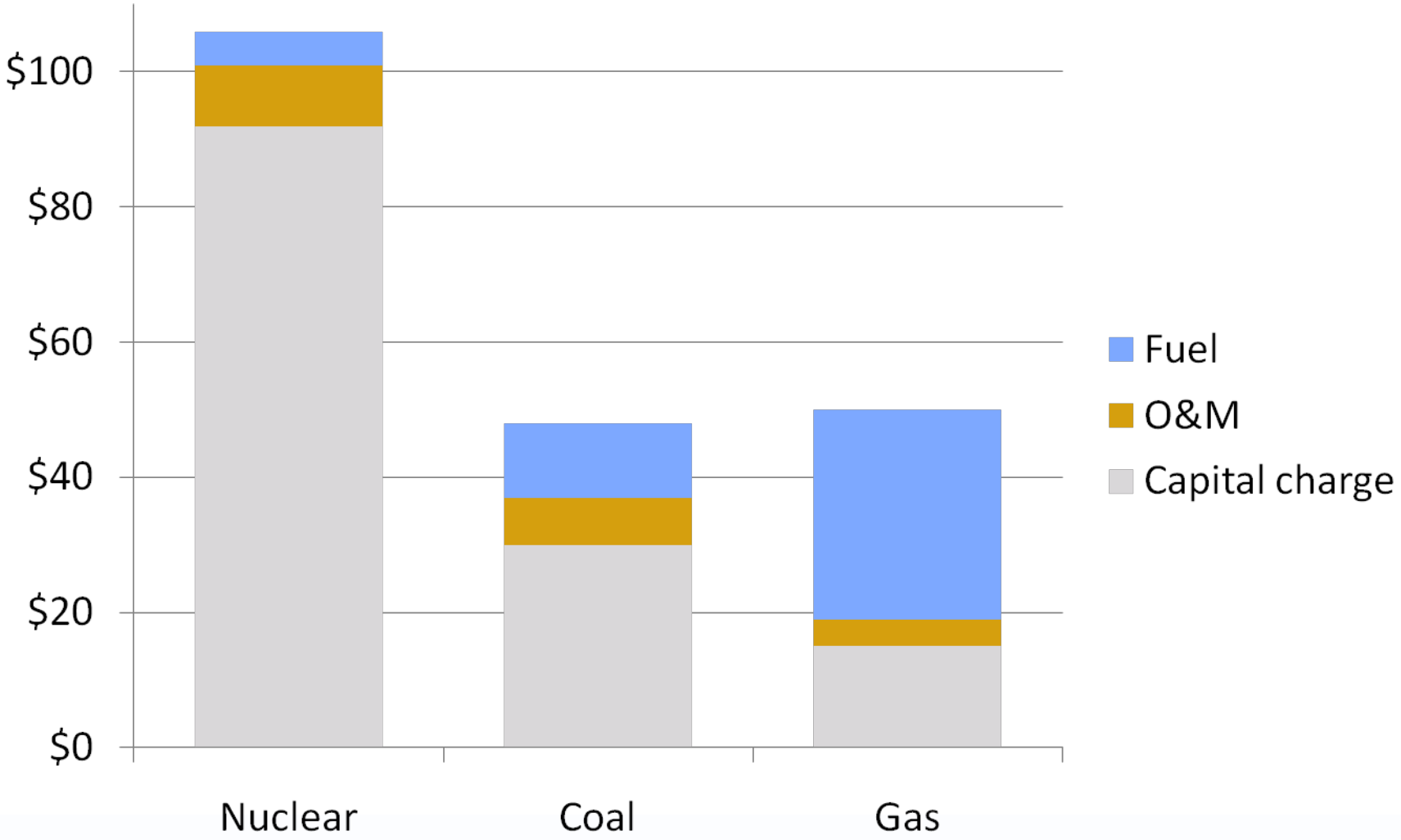
The cost of nuclear (3)



The cost of nuclear (4)



Cost escalation

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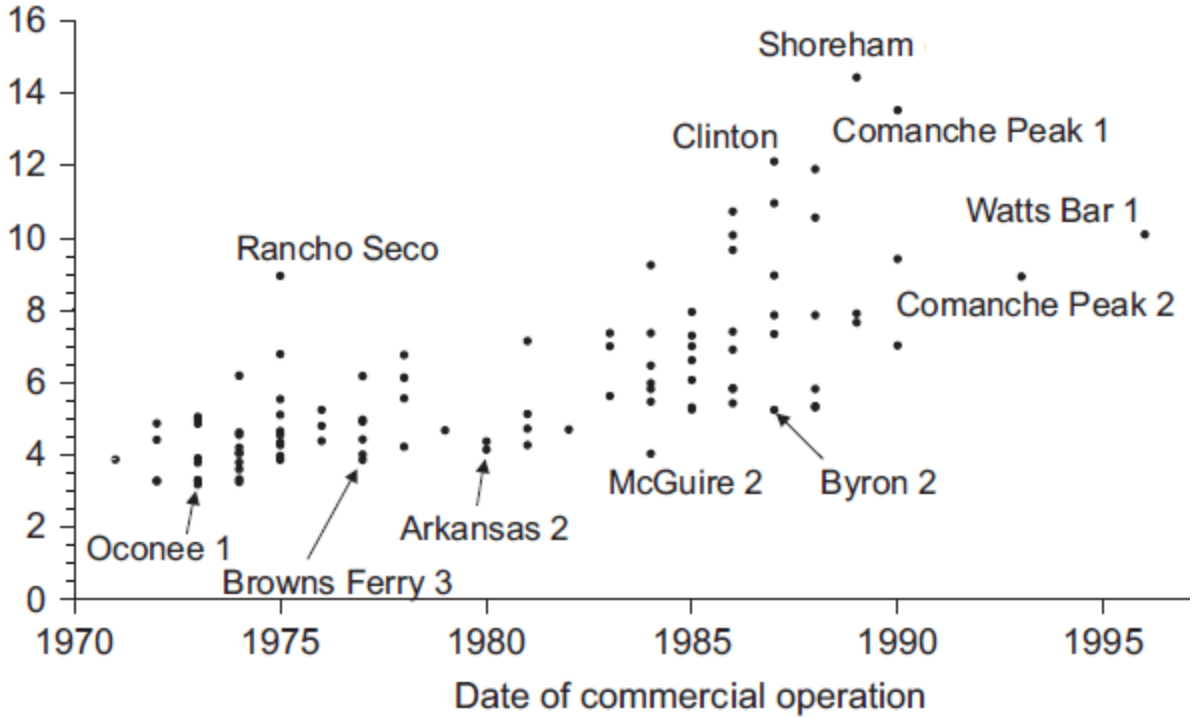

Cost escalation

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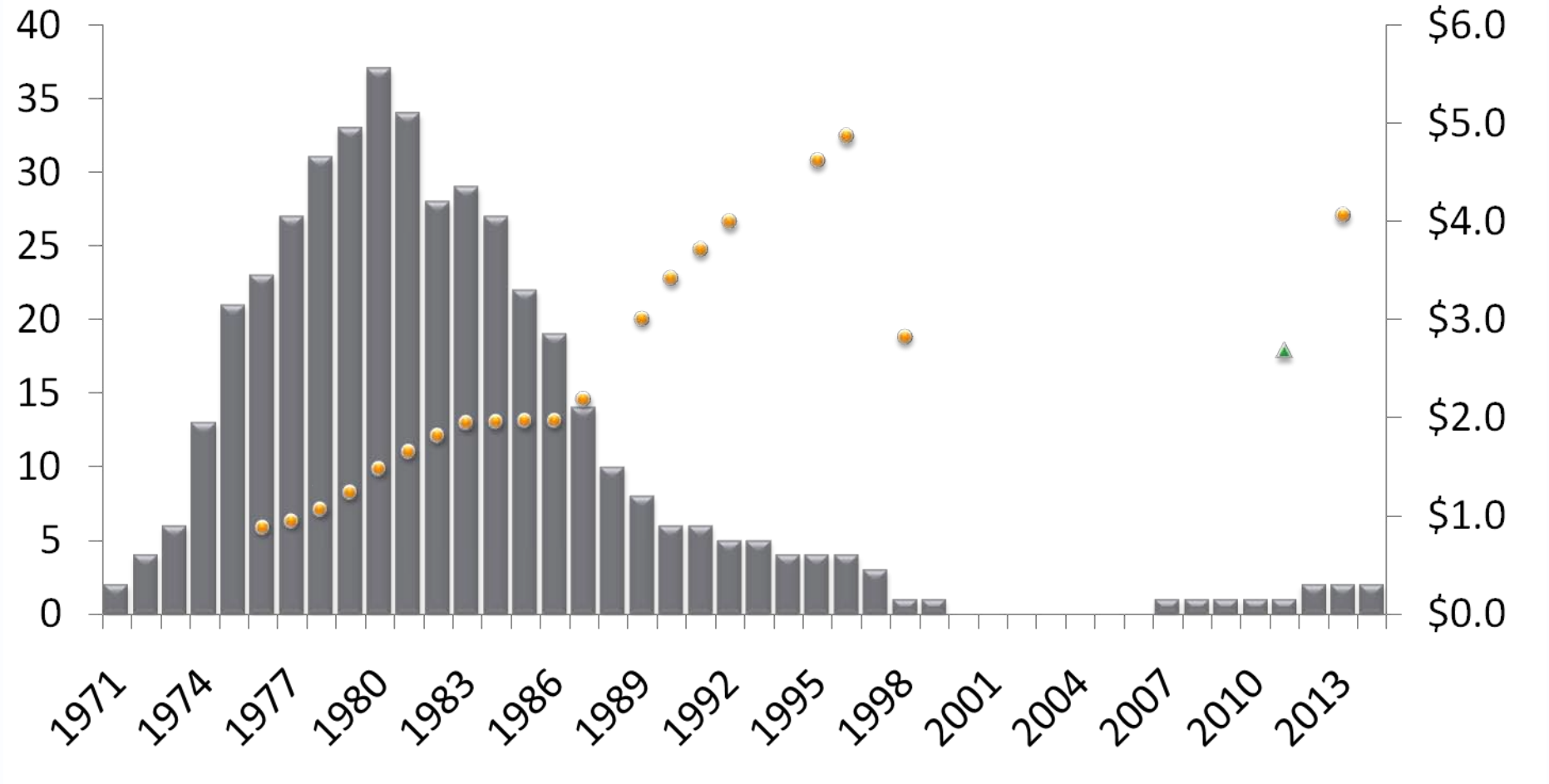

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Where France “temporarily” stores nuclear waste

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Fighter jets overhead

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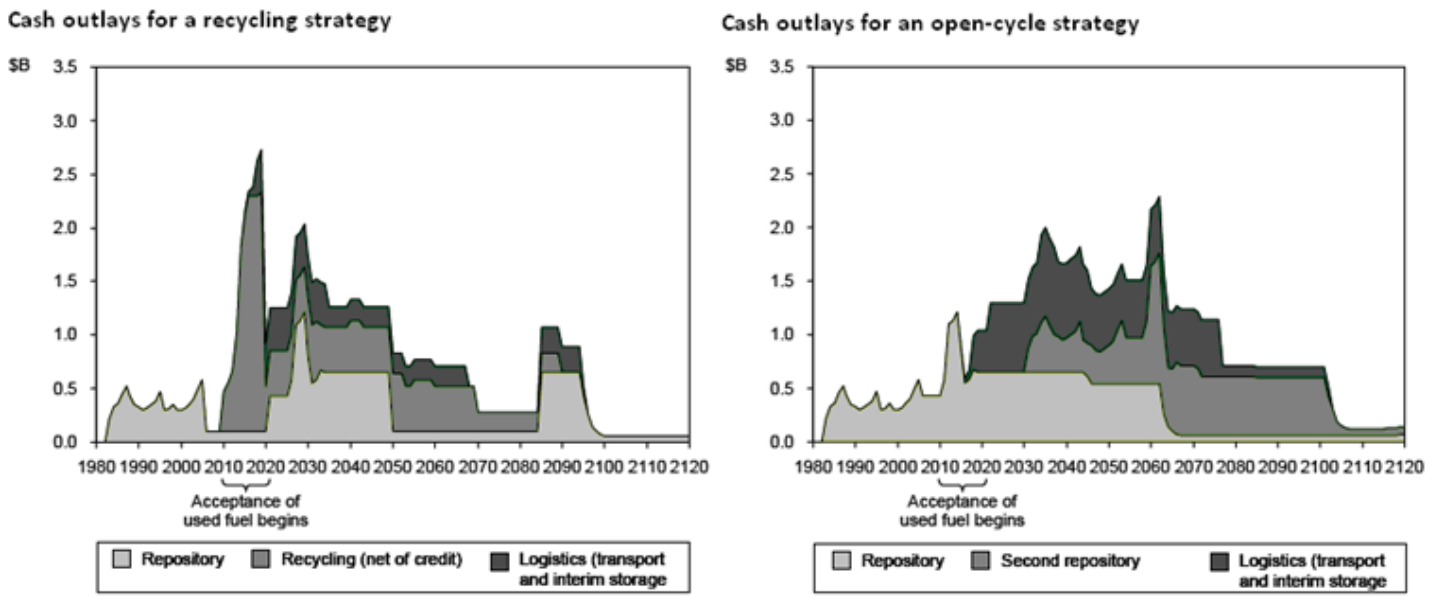
You can almost see England

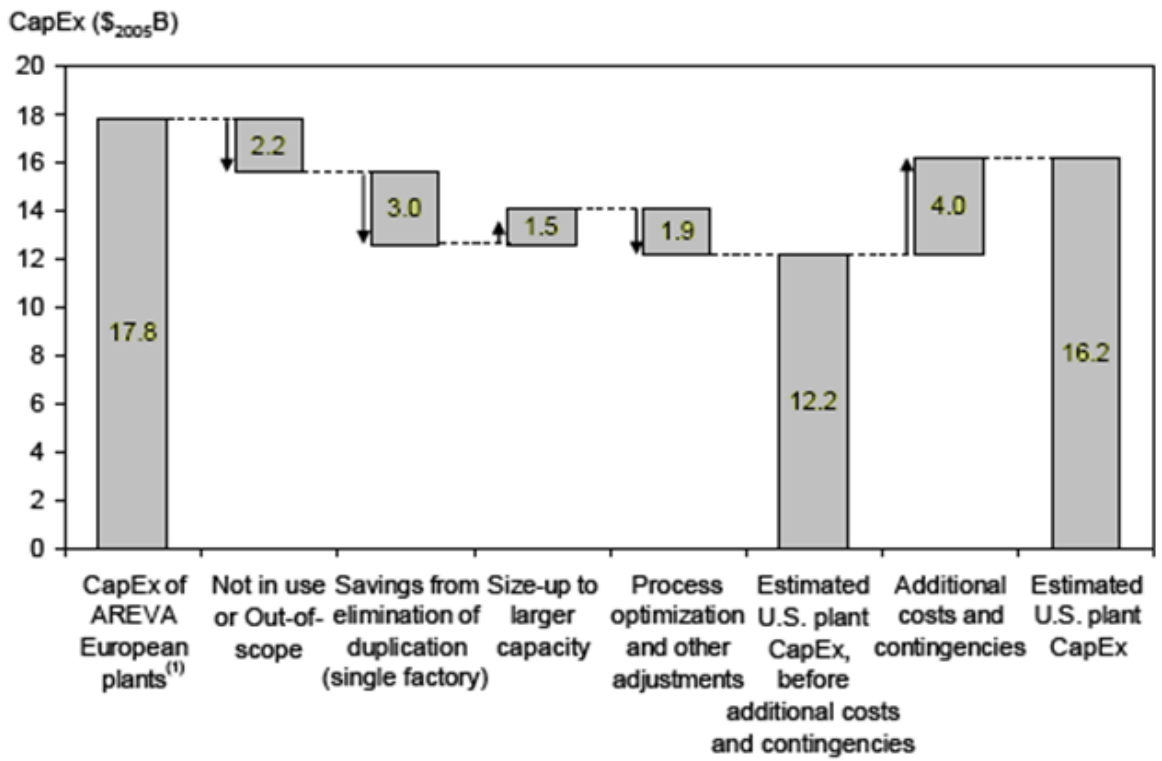
Back end costs



Source: BCG (2006) Economic Assessment of Used Nuclear Fuel Management in the United States, pp. 79-81.
Note: "Credit" refers to the value of MOX fuel.

Reprocessing plant expenditures

Capital investments at La Hague / Melox vs. U.S. plant



(1) La Hague and Melox. Refers to real actualized costs, including standard contingencies, and assumes 1€ = $1.15 (purchasing power parity).

Conclusions

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George Monbiot:

> "A crappy old plant with inadequate safety features was hit by a monster earthquake and a vast tsunami. The electricity supply failed, knocking out the cooling system. The reactors began to explode and melt down. The disaster exposed a familiar legacy of poor design and corner-cutting. Yet, as far as we know, no one has yet received a lethal dose of radiation.
>
> "The energy source to which most economies will revert if they shut down their nuclear plants is not wood, water, wind or sun, but fossil fuel. On every measure (climate change, mining impact, local pollution, industrial injury and death, even radioactive discharges) coal is 100 times worse than nuclear power."

Fukushima has produced a political reaction. In some cases — Britain, China, the U.S. — it is a reasonable one. In others — Germany, Italy — it seems rather less so. ("Curious," said the Dutch energy minister of German plans.)

The reaction will raise the costs of future plants. But they were already expensive without subsidies!

Translation: inasmuch as Fukushima has reduced the political will to provide those subsidies, then it has greatly damaged the future of nuclear power. Without nuclear, it is unclear how carbon-free baseload power can be generated.

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Questions?