EEPS 517
Energy Crises

(and the World of Energy)

Lecture 7 – Chernobyl to Fukushima
(Nuclear accidents and their aftermath)

Barış Sanlı
Bilkent University – EEPS Program

Aim

- Nuclear rise and fall affected coal, nat gas & ren
- Nuclear accidents left long lasting impacts
- Crises & renewables

Reading List

- Confronting Nuclear Risks: Counter-Expertise as Politics within the French Nuclear Energy Debate, Nature and Culture, September 2008, Sezin Topçu, DOI: 10.3167/nc.2008.030205
- Producing Power: The Pre-Chernobyl History of the Soviet Nuclear Industry, Sonja D. Schmid, 2015, Chapter 5. Chernobyl: From Accident to Sarcophagus
- Myths and representations in French nuclear history:The impact on decommissioning safety, Christophe Martin, Aurélien Portelli, Franck Guarnieri, https://hal-mines-paristech.archives-ouvertes.fr/hal-00868830
- The politics of Nuclear Energy in Western Europe, Edited by Wolfgang C.Müller, Paul W. Thurner, Chapter 6. Nuclear Politics in France: High Profile Policy and Low-Salience Politics by Sylvain Brouard and Isabelle Guinaudeau
- The paralysis in Energy Decision Making: European Energy Policy in Crisis, Malcolm Grimston, 2016, Chapter 3.9. The Accidents – Chernobyl, Fukushima and Three Mile Island

Today

Iran oil: US to end sanctions exemptions for major importers

22 April 2019

Share

Iran nuclear deal

Iran insisted the sanctions were illegal and that it had attached "no value or credibility" to the waivers.

Mr Trump reinstated the sanctions last year after abandoning a landmark 2015 nuclear deal between Iran and six world powers.

Under the accord, Iran agreed to limit its sensitive nuclear activities and allow in international inspectors in return for sanctions relief.

Donald J. Trump
@realDonaldTrump

Saudi Arabia and others in OPEC will more than make up the Oil Flow difference in our now Full Sanctions on Iranian Oil. Iran is being given VERY BAD advice by @JohnKerry and people who helped him lead the U.S. into the very bad Iran Nuclear Deal. Big violation of Logan Act?

4:37 PM · Apr 22, 2019 · Twitter for iPhone

https://www.bbc.com/news/world-middle-east-48011496

Iran timeline

- 8 Dec 1953 – Eisenhower "Atoms for Peace"
- 1957 Iran nuclear program started
- 1967 US supplied Iran 5 MW nuclear research reactor
- 1975 Atomic Energy Organization of Iran concluded an agreement with MIT to provide specialized training
- 1976 Shah increased budget from $31m to $1B

https://www.brookings.edu/blog/up-front/2013/12/18/sixty-years-of-atoms-for-peace-and-irans-nuclear-program/

What is EPR?

https://www.epri.com/#/pages/product/3002014979/?lang=en-US

North Korea

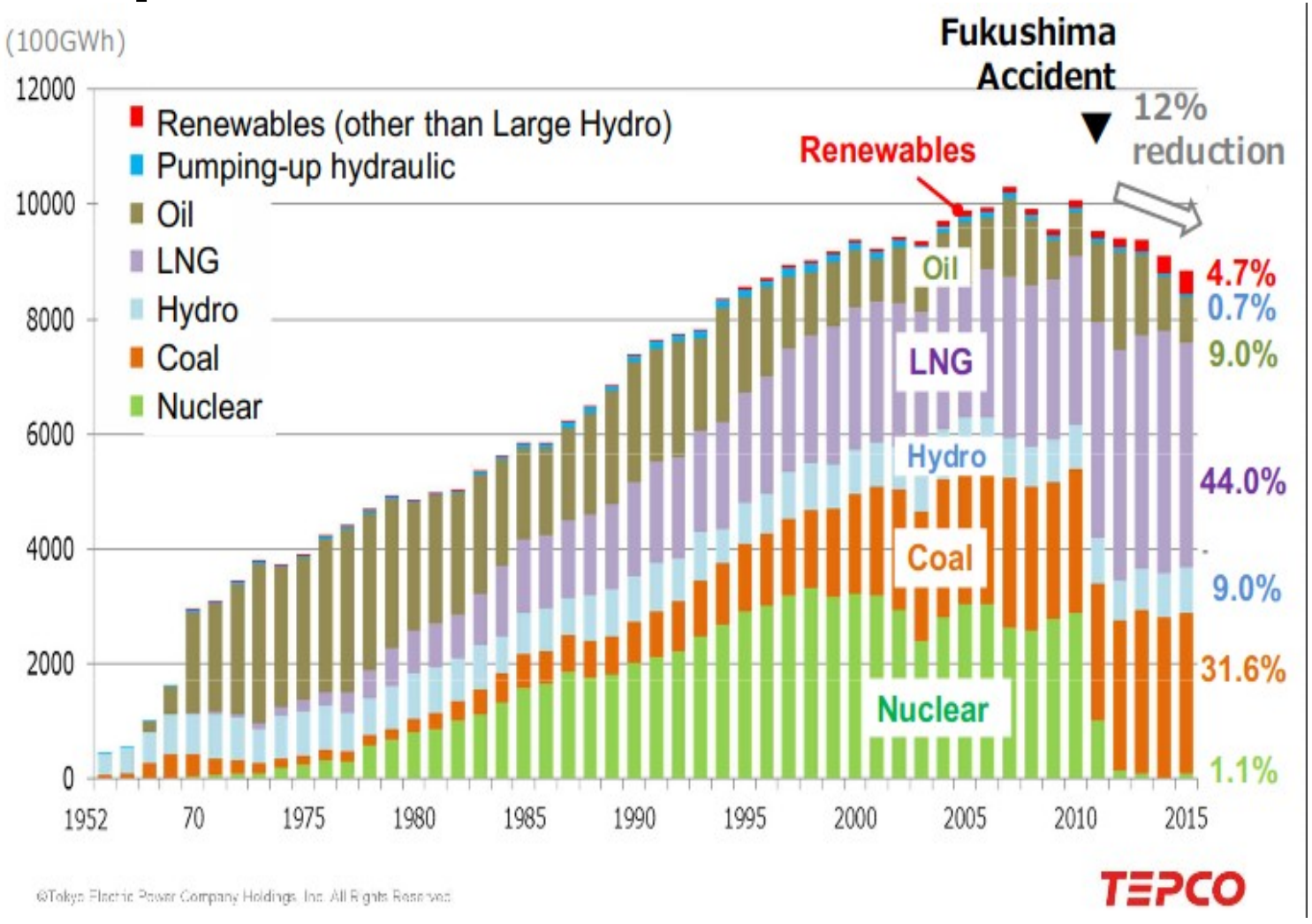
Background

The detonation of a nuclear weapon at high altitude or in space (~30 km or more above the earth's surface) can generate an intense electromagnetic pulse (EMP) referred to as a high-altitude EMP or HEMP. HEMP can propagate to the earth and impact various ground-based technological systems such as the electric power grid. Depending on the height of the explosion above the earth's surface and the yield of the weapon, the resulting HEMP can be characterized by three hazard fields, denoted as E1 EMP, E2 EMP, and E3 EMP.

https://www.epri.com/#/pages/summary/000000003002014979/?lang=en-US

https://www.independent.co.uk/news/world/asia/north-korea-emp-strike-us-claim-kim-jong-un-attack-west-trump-a7725121.html

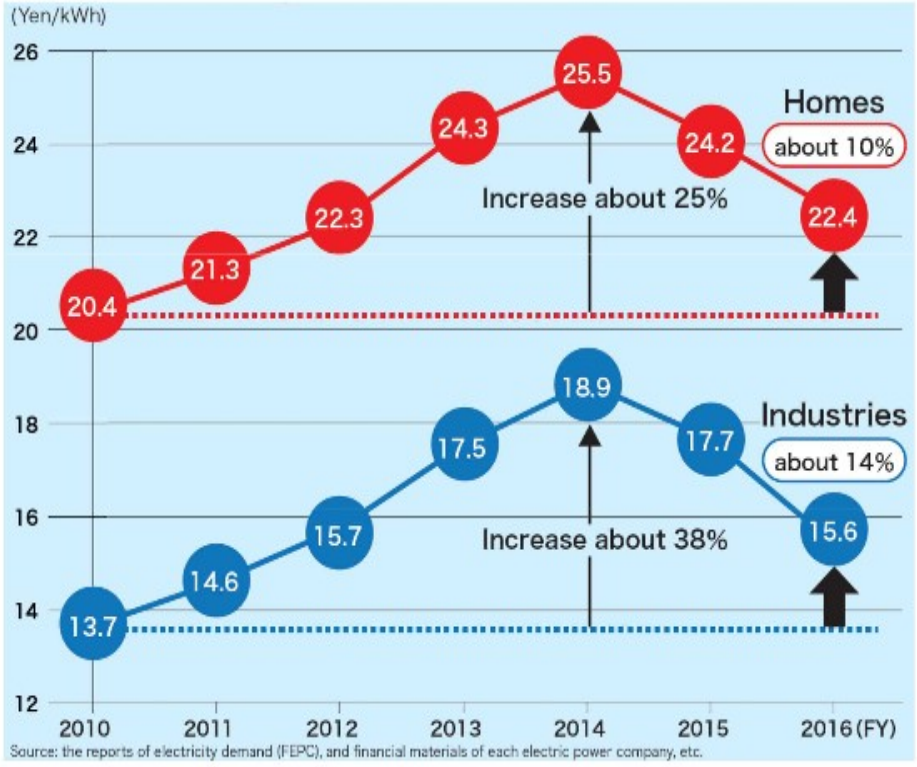
Japan – Post Fukushima (I)



https://www.iea.org/media/workshops/2019/nuclear/Session2.2_Hideki_Masui.pdf

Japan – Post Fukushima (II)

- In spite of the market deregulation, electricity rate have increased as a result of purchasing more fossil fuels due to prolonged nuclear shutdown



http://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2017.pdf

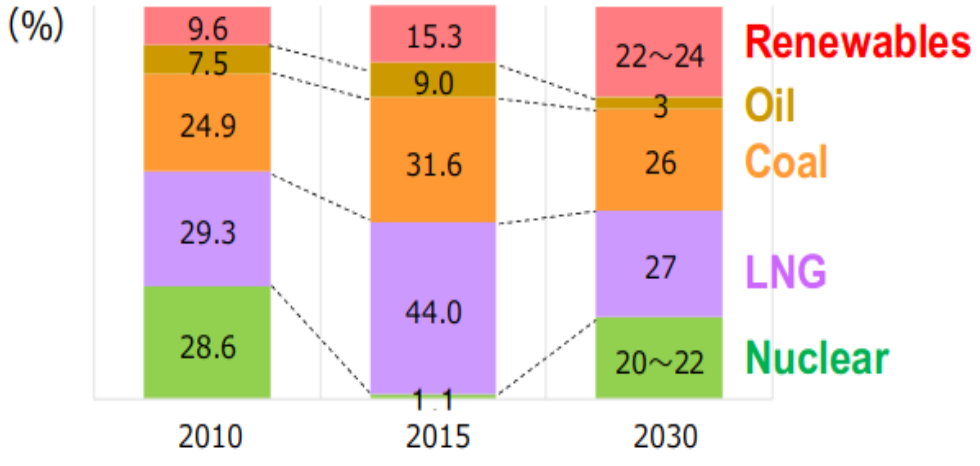
https://www.iea.org/media/workshops/2019/nuclear/Session2.2_Hideki_Masui.pdf

Japan – Post Fukushima (III)

Basic Policy

- Reduce nuclear power dependence, while utilizing NPPs
- Adopt renewable energy as much as possible
- Improve the efficiency of thermal power plants
- Promote energy-saving (electricity-saving)

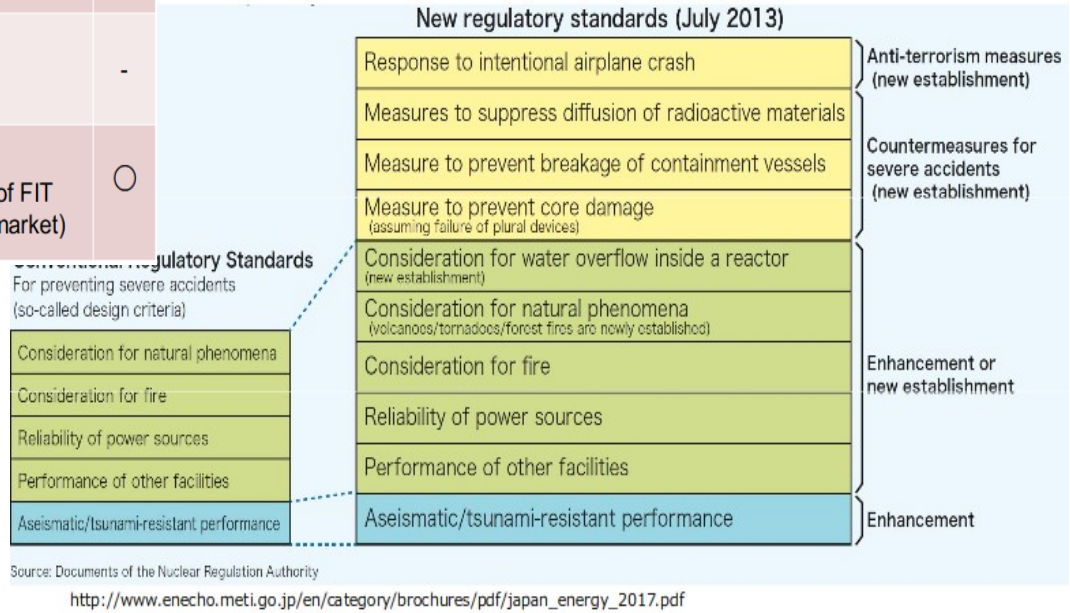
Generation portfolio



https://www.iea.org/media/workshops/2019/nuclear/Session2.2_Hideki_Masui.pdf

Japan – Electricity Market Reform

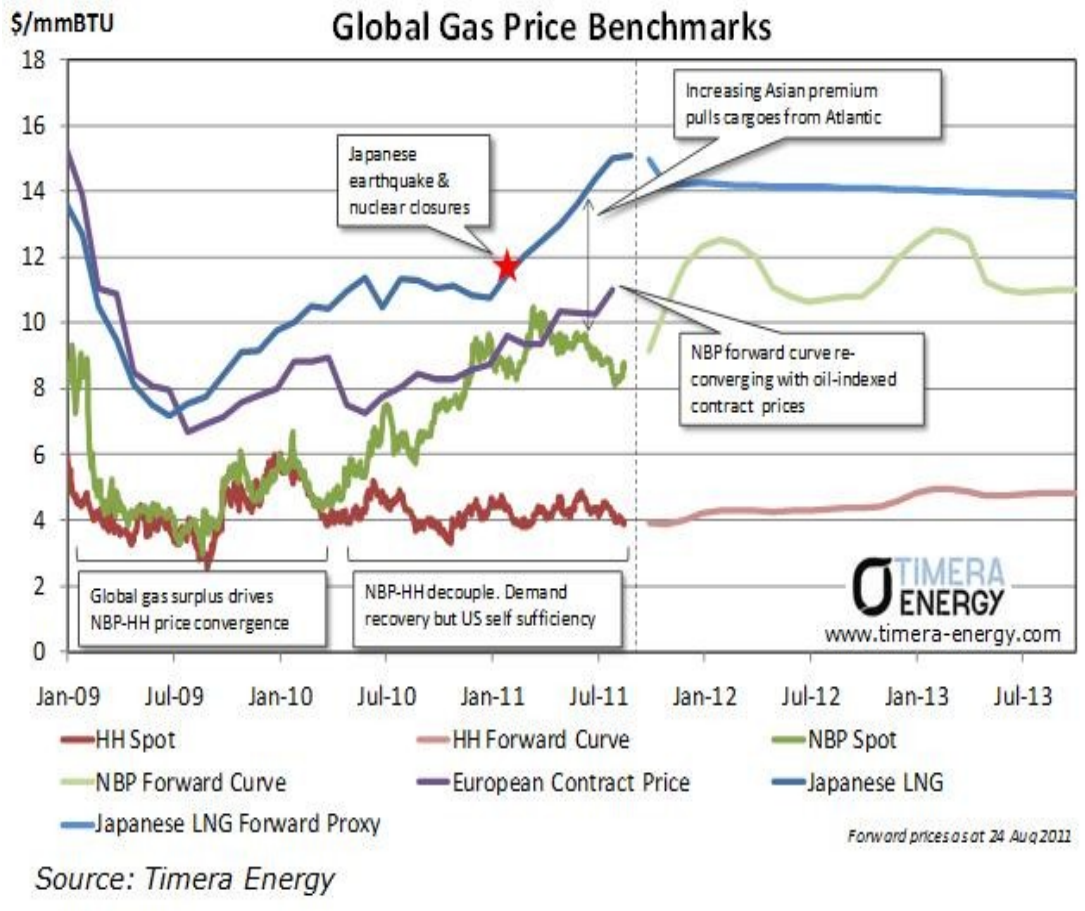
	Purpose of the market	Transaction	Delivery	Nuc
Wholesale energy market (kWh)	Meet energy demand	already under operation		-
Base load market (kWh)	Provide an easy access for new player to the base load generation	2019	2020	○
Capacity market (kW)	Ensure long-term grid	2020	2024	○
Imbalance & Ancillary service market (ΔkW)	Help balance the transmission system	2021		-
Zero emission certificate market (CO2)	Provide incentives for generators to maintain and develop zero emission sources	2019 (2018 start of FIT renewables market)		○



http://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2017.pdf

https://www.iea.org/media/workshops/2019/nuclear/Session2.2_Hideki_Masui.pdf

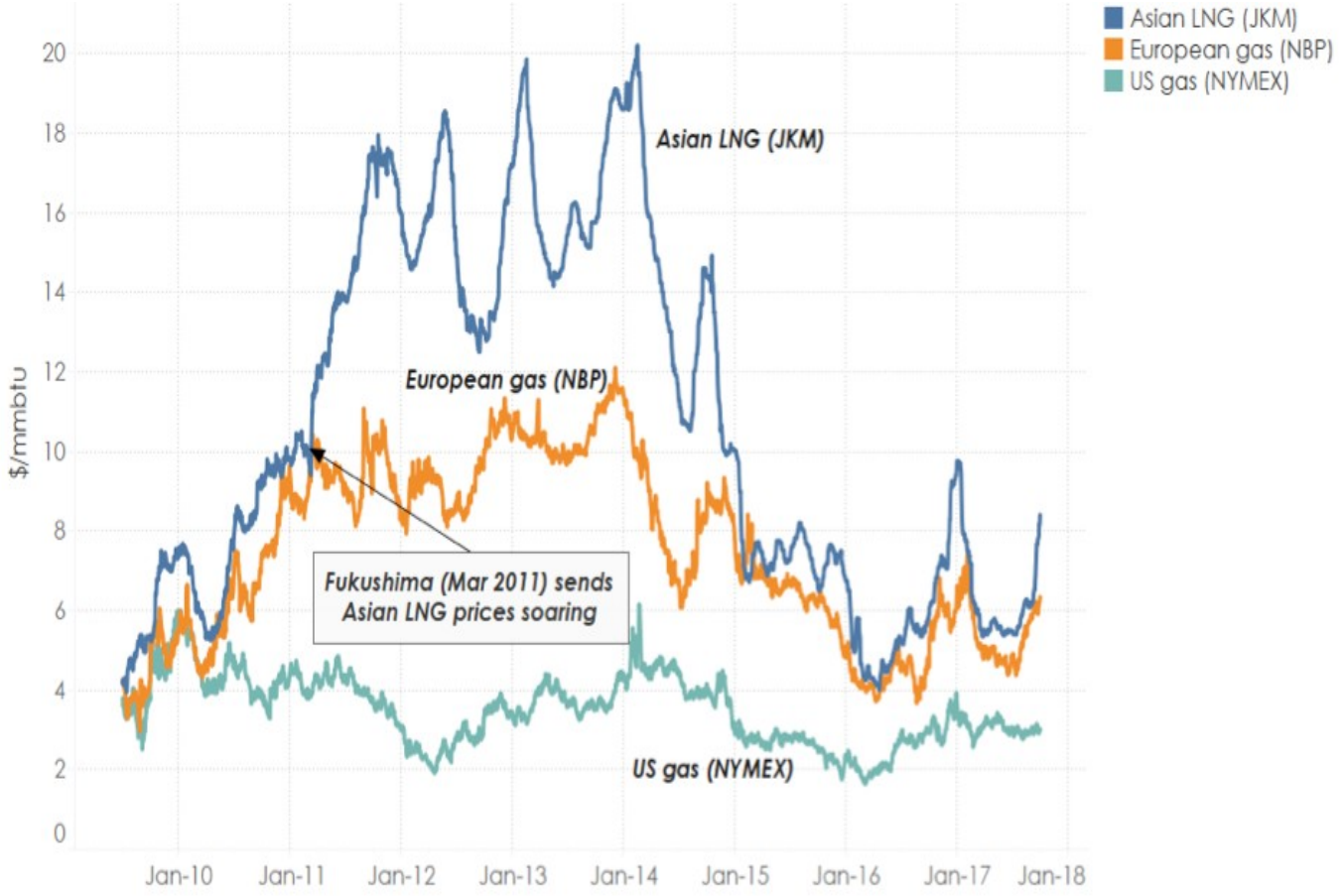
2011 price forecasts



Source: Timera Energy

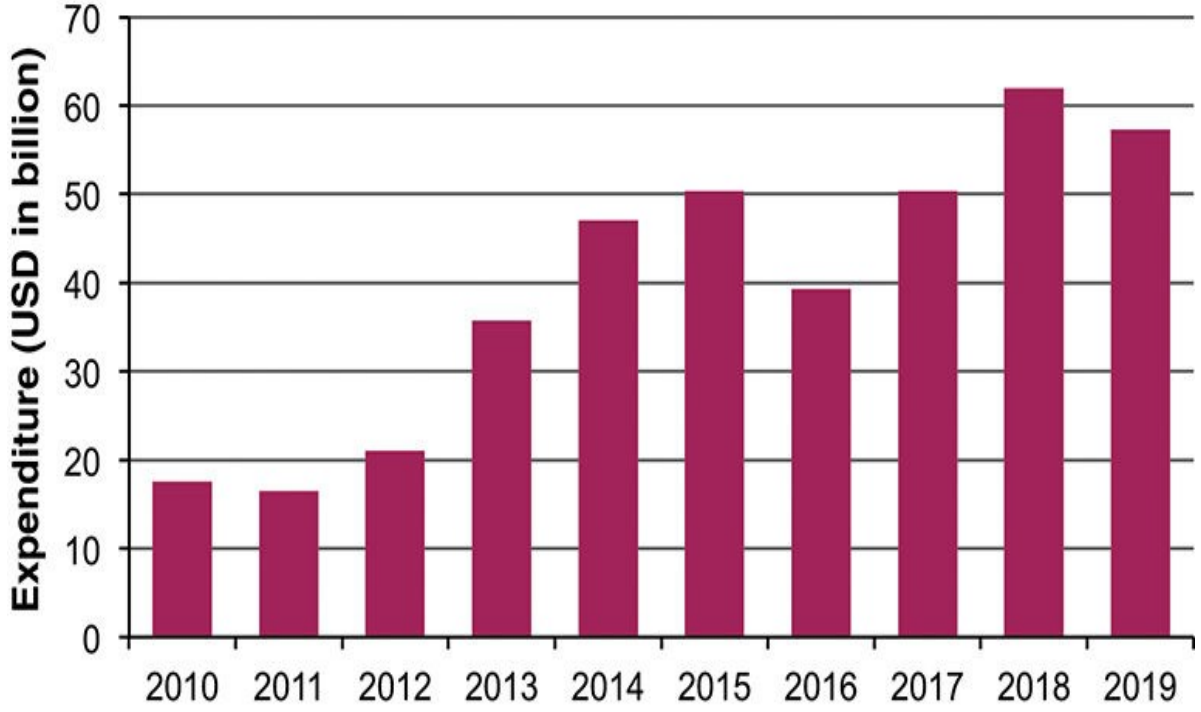
https://timera-energy.com/european-gas-pricing-dynamics/

Daily spot gas prices



https://energypolicy.columbia.edu/research/report/they-might-be-giants-emerging-lng-importers-are-reshaping-waterborne-gas-market

Historical and forecast global capital expenditure in LNG facilities, 2010–2019



https://www.spe.org/en/print-article/?art=53

Crude demand

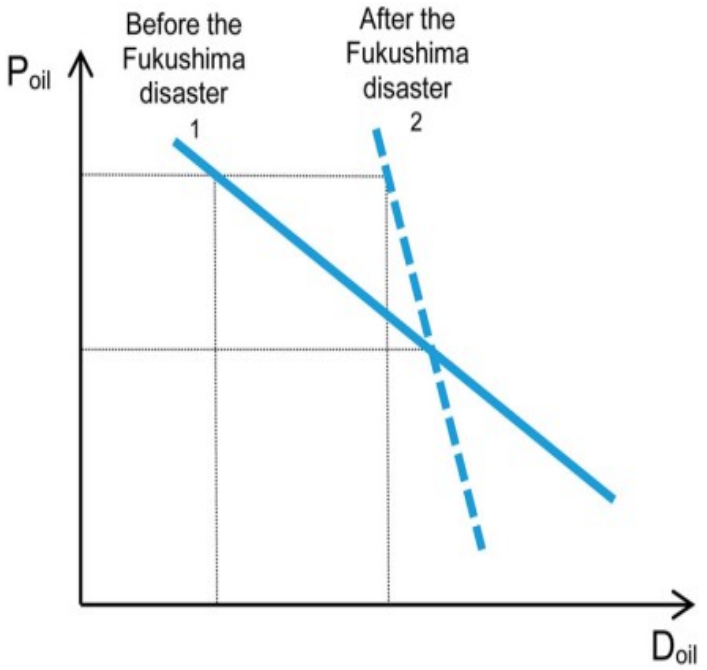
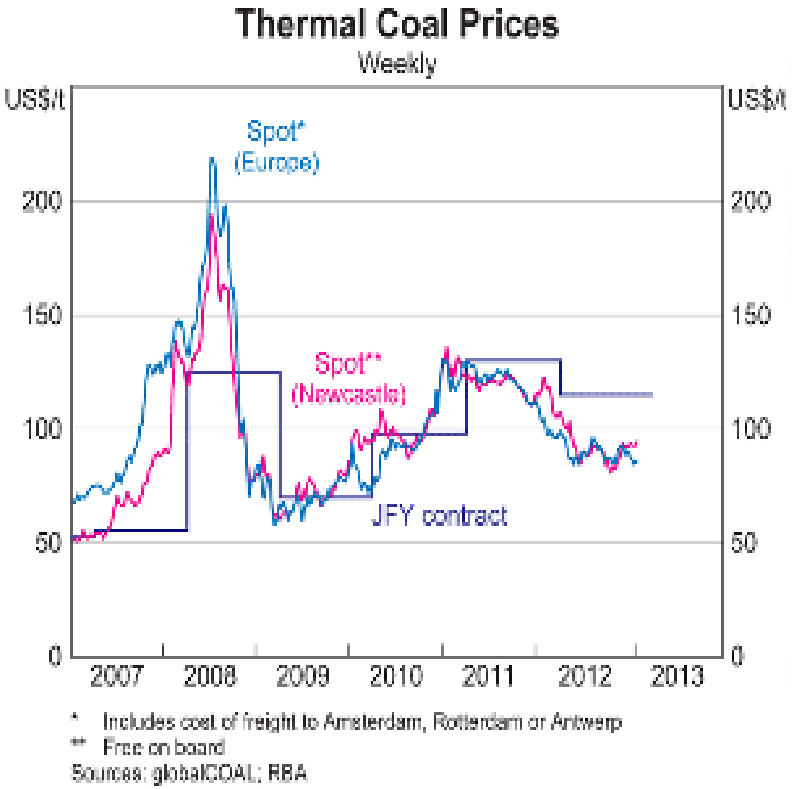
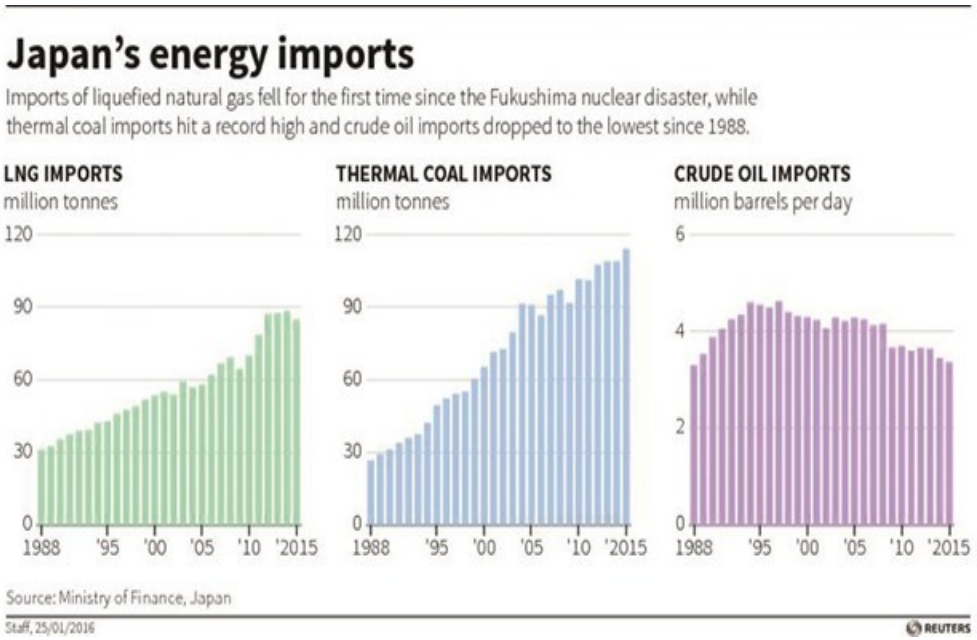


Figure 4. Crude Oil Demand Curve Before and After Fukushima Source: Authors' compilation.

https://www.researchgate.net/publication/315702017_Impact_of_the_Fukushima_Nuclear_Disaster_on_the_Oil-Consuming_Sectors_of_Japan

Coal price





https://www.sourcewatch.org/index.php/Annual_Japan_-_Australia_thermal_coal_negotiations

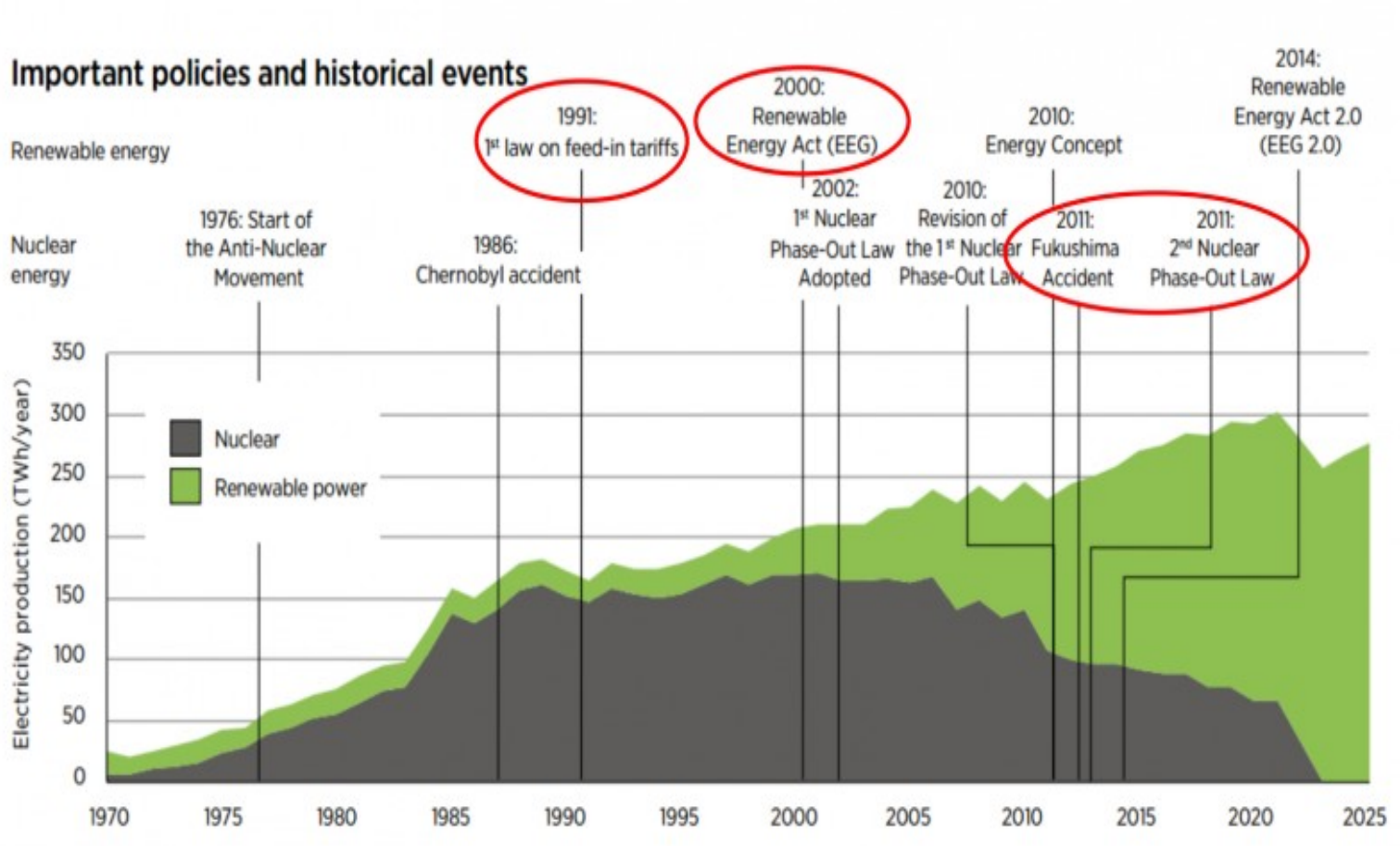
https://www.gulf-times.com/story/477374/As-Japan-s-oil-gas-power-use-stalls-coal-imports-h

Fukushima catalyzed Energiewende

- 2000 : SDP & Greens abandon nuclear
- 2010 : Merkel decided to roll back
- After Fukushima
  - Phase out as of 2022

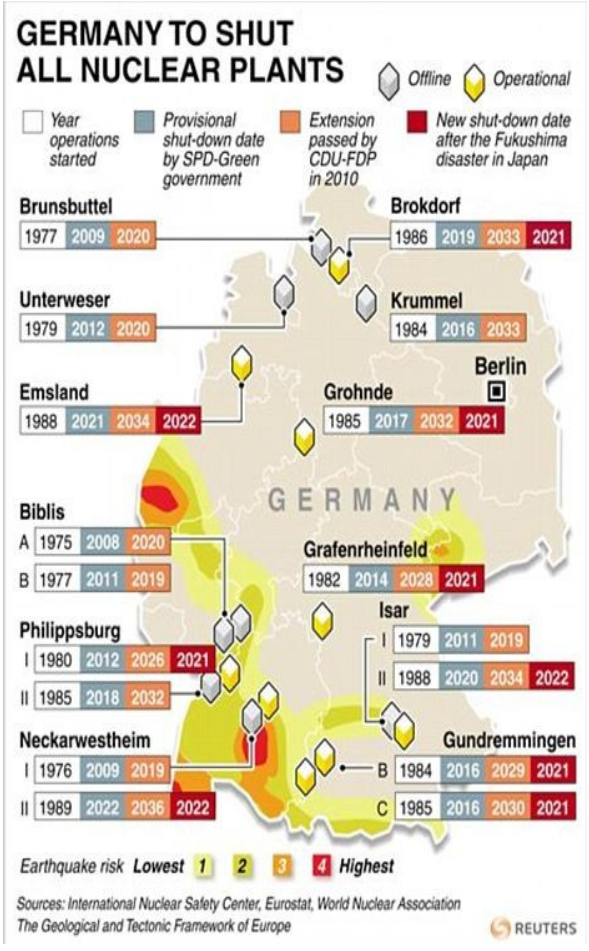
https://www.thelocal.de/20160311/five-years-after-fukushima-germanys-energy-transition-still-faces-challenges

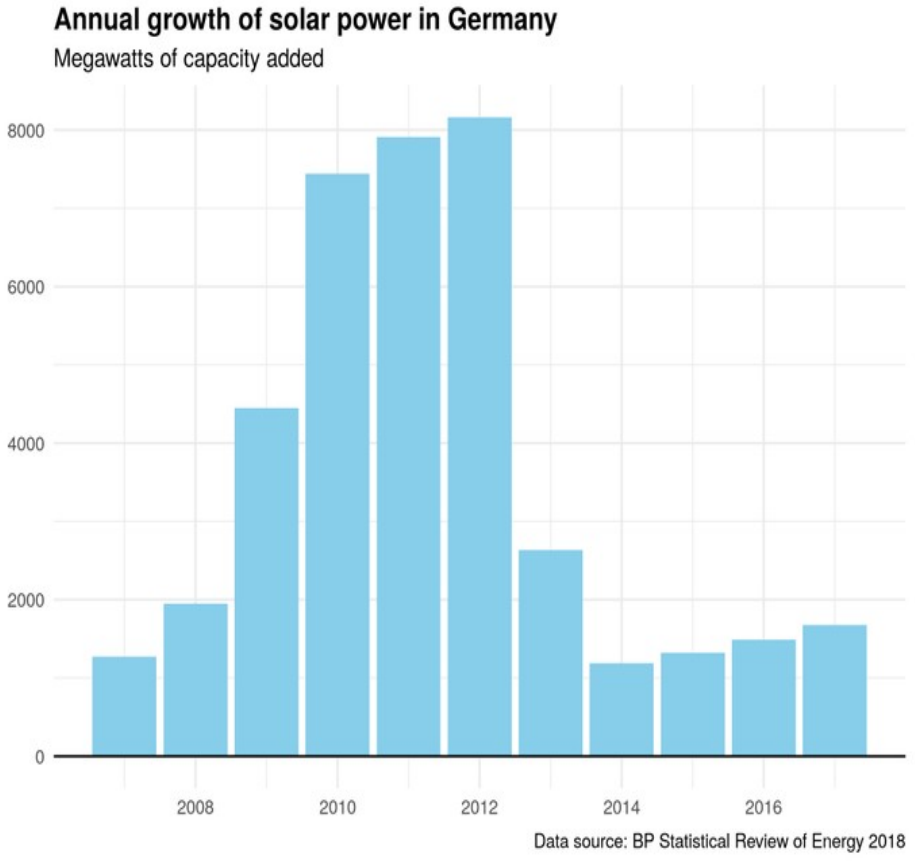
Nuclear and Germany



https://www.resilience.org/stories/2017-06-22/germany-shows-its-worth-fighting-for-energy-democracy/

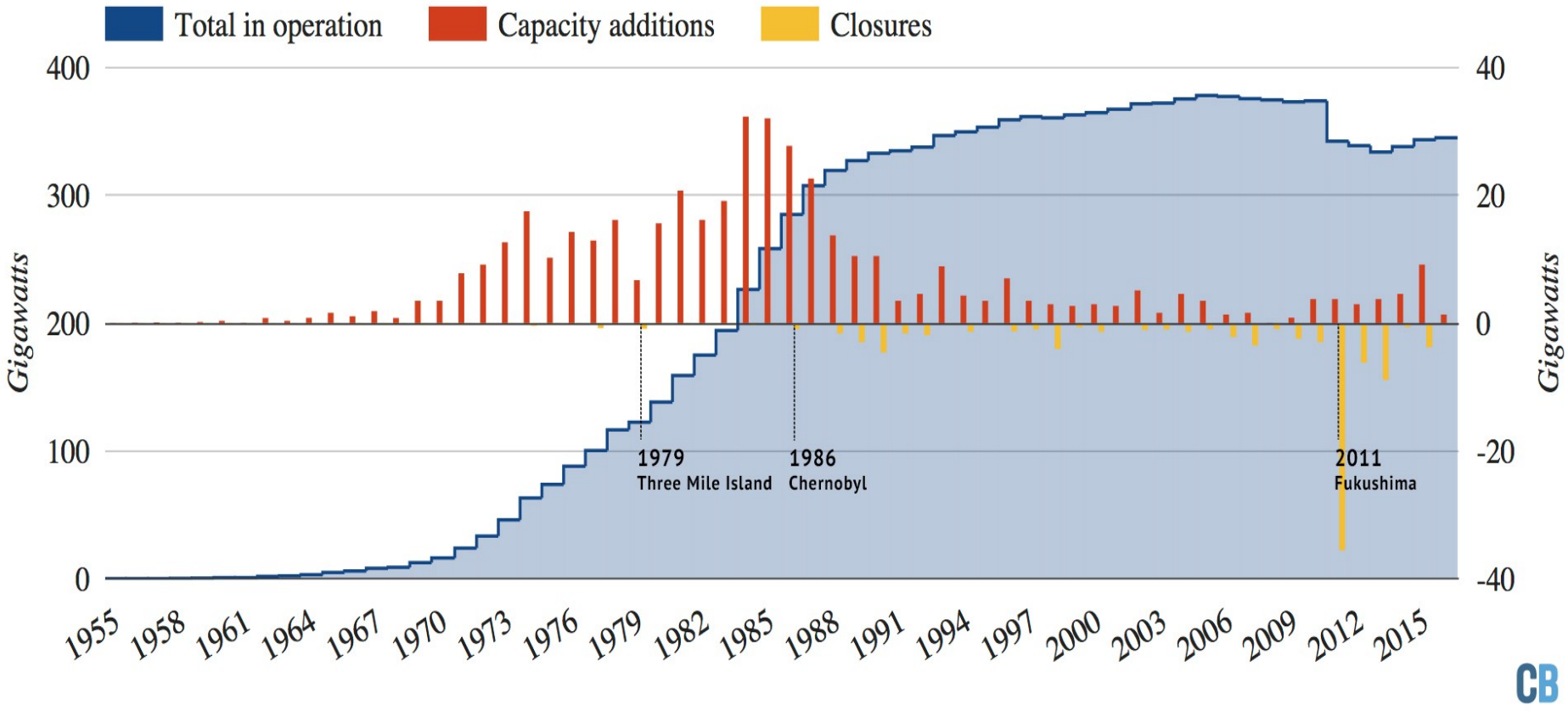
Nuclear shutdown





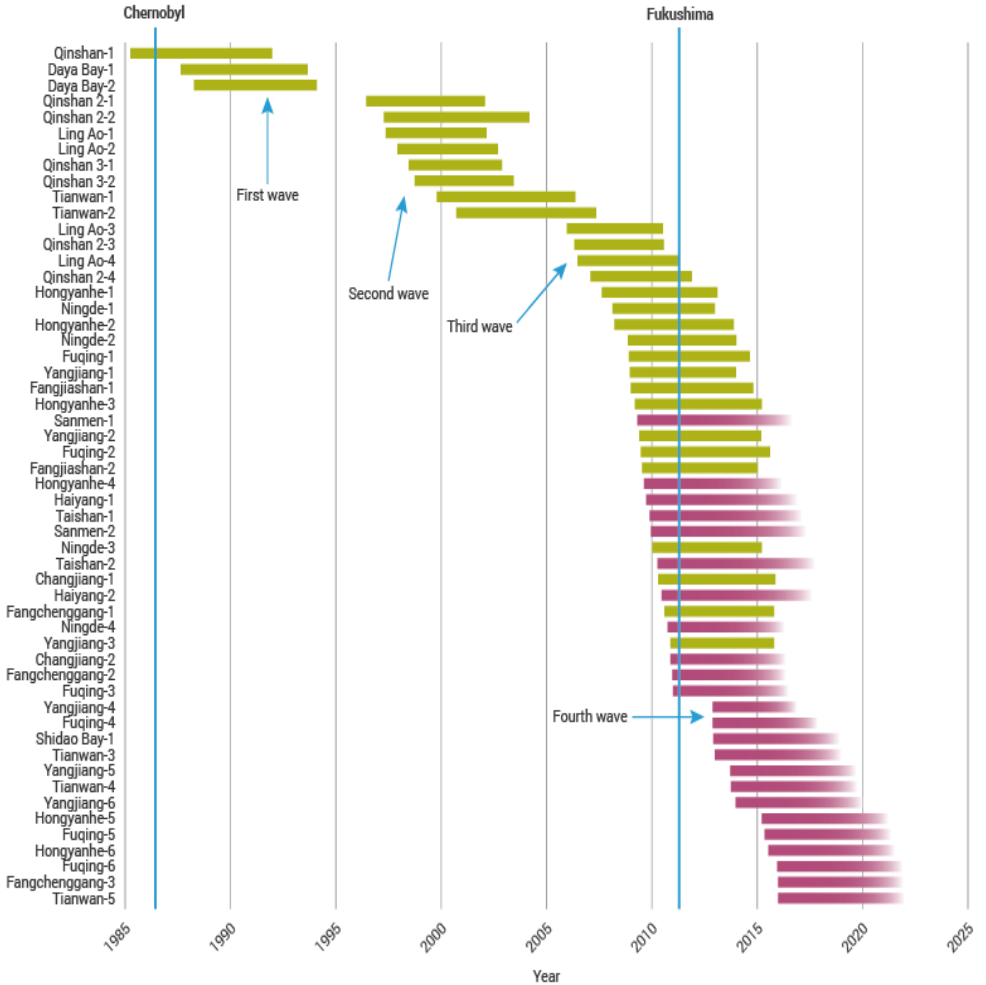
https://www.dailymail.co.uk/sciencetech/article-1392359/Germany-pledges-nuclear-shutdown-2022-following-Fukushima-disaster.html

Global Nuclear Generation Capacity



https://www.carbonbrief.org/analysis-the-legacy-of-the-fukushima-nuclear-disaster

China nuclear power plant



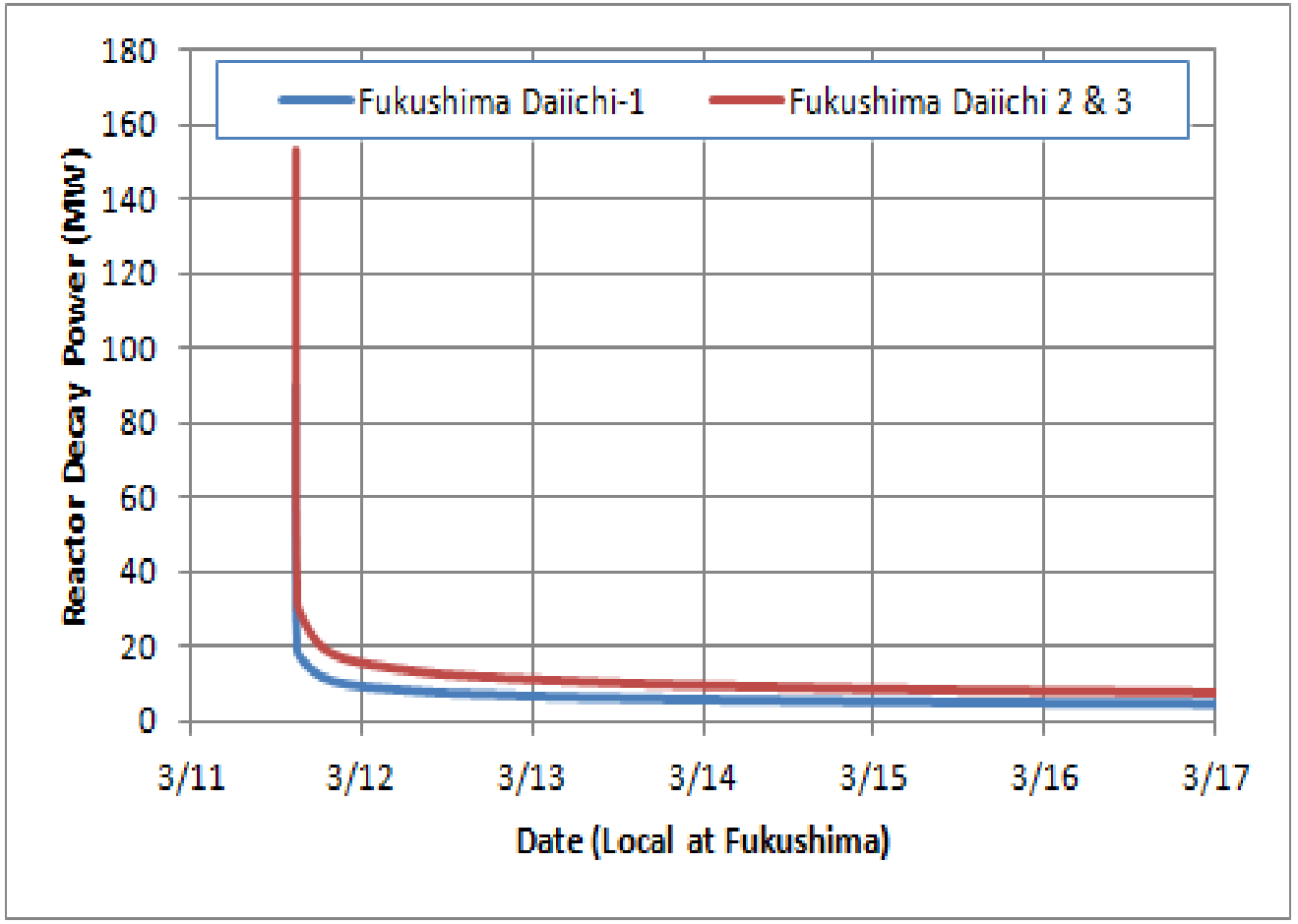
http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx

What is decay heat?

- When all control rods are inserted, reactor is shutdown, power drops to 7% in 1 second
- " The power does not drop to zero because of the radioactive isotopes that remain from the prior fissioning of the fuel. These radioactive isotopes, also called fission products, continue to produce various types of radiation as they decay, such as gamma rays, beta particles, and alpha particles. The decay radiation then deposits most of its energy in the fuel, and this is what is referred to as decay heat. "

https://mitnse.com/2011/03/16/what-is-decay-heat/

Decay Heat



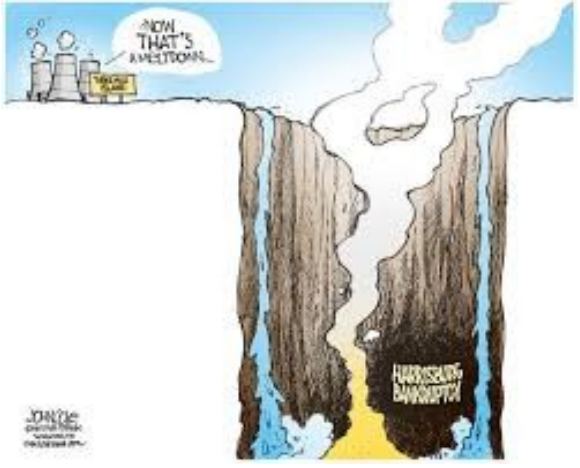
The decay heat drops off very slowly after about 1 day where the decay power is already below 1% of the operating power of the reactor. After a year the decay power is about 0.06% of the operating power of the reactor.

If the decay heat is not removed then the reactor fuel begins to heat up and undesirable consequences begin as the temperature rises such as rapid oxidation of the zircaloy cladding (~1200C), melting of the cladding (~1850C), and then the fuel (~2400-2860C).

https://mitnse.com/2011/03/16/what-is-decay-heat/

Three Mile Island

- Movie "The China Syndrome"
  - 16 March 1979 : "a nuclear meltdown scenario"
- 28 March 1979 : Three Mile Island



TMI

The accident stopped the U.S. nuclear power industry in its tracks.

No more nuclear plants were ordered in the United States following the accident and none started after 1974 were completed, former nuclear regulator Peter Bradford notes.

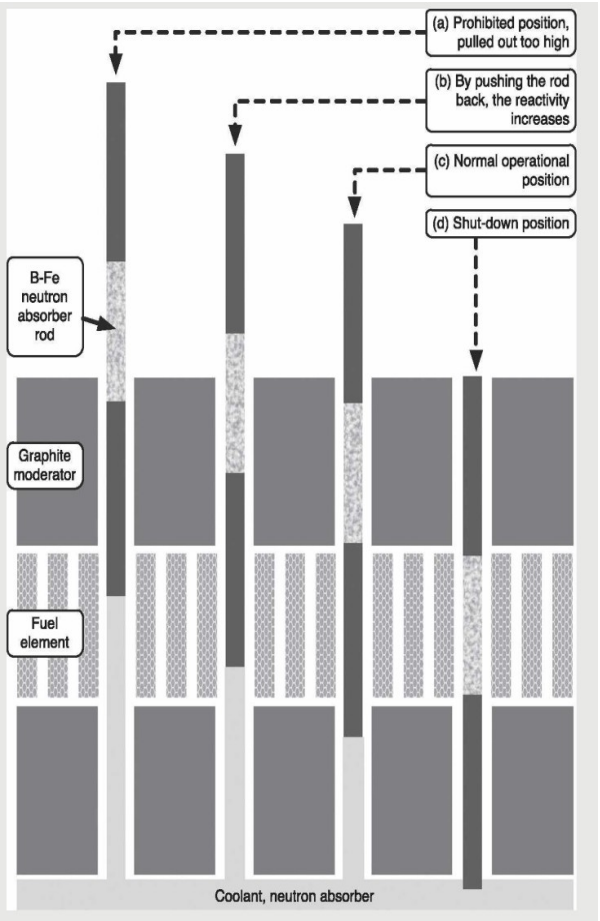
"The credibility of an industry was lost," Bruce Williams, a vice president of Exelon Nuclear, which now owns the Three Mile Island station, told a Pennsylvania newspaper in 2004.

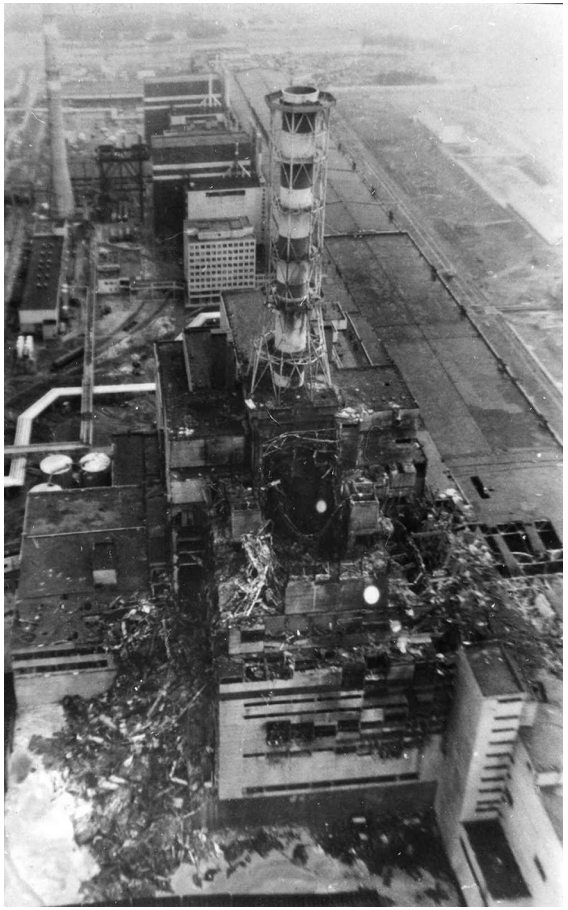
Thirty years later, the U.S. nuclear power industry is attempting a revival, citing reactors' ability to generate electricity without the climate-threatening carbon emissions that spew from coal-fired generators.

https://www.philly.com/business/what-happened-to-three-mile-island-nuclear-waste-after-the-accident-20190414.html

https://archive.nytimes.com/www.nytimes.com/gwire/2009/03/27/27greenwire-three-mile-island-still-haunts-us-reactor-indu-10327.html

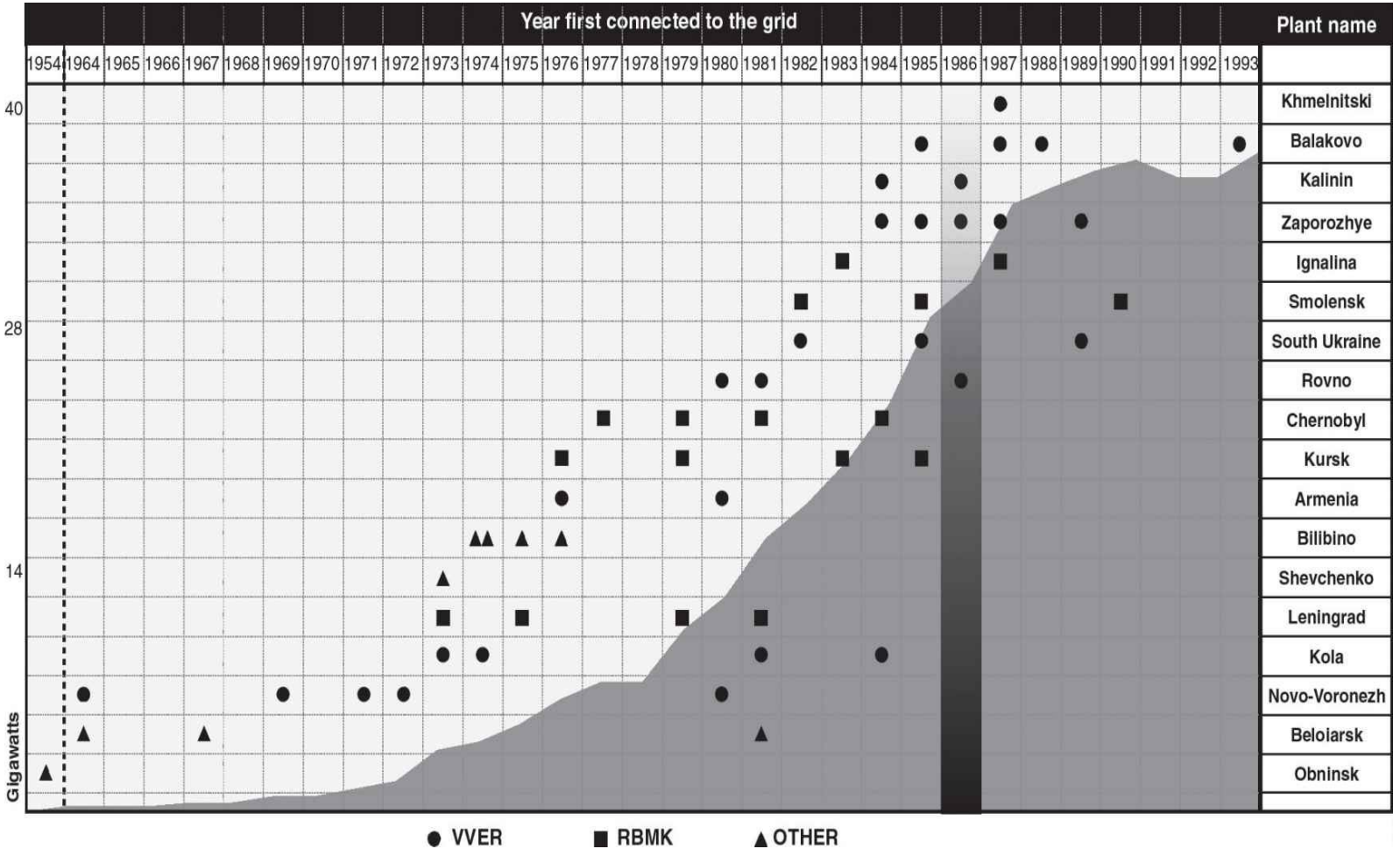
Chernobyl - Rods





Producing Power: The Pre-Chernobyl History of the Soviet Nuclear Industry, Sonja D. Schmid, 2015

VVER - RBMK



Producing Power: The Pre-Chernobyl History of the Soviet Nuclear Industry, Sonja D. Schmid, 2015

Radiance of France

- De Gaulle believed in a strong state,national planning, and large-scale technological projects.
- "Gaulle returned to power: "We are in the epoch of technology," declared the general on one occasion. "A State does not count if it does not bring something to the world that contributes to the technological progress of the world."

The radiance of France, Gabrielle Hecht, 1998

A Technological nation

- Nuclear Cathedrals
- Nuclear Castles

Imagining a Technological Nation

Clearly, however, the nuclear program was a site for articulating and negotiating the meaning of a technological France. The image of a radiant and glorious France appeared repeatedly in the discourse of engineers, administrators, labor militants, journalists, and local elected officials. These men actively cultivated the notion that national radiance would emanate from technological prowess.

France had lost nearly a million and a half people in the war. The industrial infrastructure was in shambles. Food was scarce and expensive. France had lost its self-respect. It had also lost its standing among world leaders—a loss made glaringly obvious by de Gaulle's absence at Potsdam and Yalta. The bombing of Hiroshima and Nagasaki highlighted the enormous technological gulf between France and the United States. The consequences of the war for the French empire remained unclear, but prospects already looked grim in Indochina. The embarrassed, destitute nation resigned itself to accepting American economic aid in the slow and painful task of reconstruction. To use Robert Frank's phrase, France entered the second half of the twentieth century "haunted by its decline."[3]

No wonder, then, that the nation expressed such enthusiasm when Zoé, its first experimental nuclear reactor, underwent a chain reaction in December 1948, only four years after the Liberation. This success, proclaimed one newspaper, was "a great achievement, French and peaceful, which strengthens our role in the defense of civilization."[4] The following year, scientists isolated France's first milligram of plutonium. President Vincent Auriol paid Zoé a visit and solemnly declared: "This achievement will add to the radiance of France."[5]

"The radiance of France"—a phrase usually interchangeable with "the grandeur of France"—appeared regularly in many realms of postwar discourse. These two notions referred back to France's glorious past, from the golden reign of Louis XIV to the "civilizing mission" of the empire.[6] France's radiance had taken a severe beating during the war, and decolonization threatened to hasten the decline.[7] How could the nation regain its former glory? What would radiance or grandeur mean in the radically reconfigured geopolitics of the postwar world?

The radiance of France, Gabrielle Hecht, 1998

Chronology

Table 6.A1. Main Events of the Nuclear French Policy

Year	Policy decision
1945	Nuclear research: Creation of the Commissariat à l'Energie Atomique (CEA)
1951	Proposal of a nuclear energy programme
1952	Decision to go nuclear approved by the Parliament
1958	Criticality date of the first commercial nuclear plant Marcoule G2
1959	Grid date of Marcoule G2 nuclear plant
1970	The 6th plan (1971–5) decided the building of 8000 MW of nuclear power
1974	Messmer plan: 13 new nuclear plants (13 Mwe) every two years
1981	Moratorium & cancelation of the Plogoff nuclear plant
1982	Re-starting of the building of nuclear plants
1991	Closure of the nuclear programme launched in 1974 with the order of a last reactor (Civaux)
1998	Dismantling of fast-breeder experimental nuclear plant Superphénix
2005	Decision to build a new EPR nuclear plant (Flamanville 3—start in 2012)
2009	Decision to build a new EPR nuclear plant (Penly—start in 2017) & increase of the life time of the existing nuclear plant to 40 years (+10 years)
2012	Cancelation of the Penly plant and announcement of the closing of Fessenheim before 2017
2015	Adoption of a law that caps nuclear power

The politics of Nuclear Energy in Western Europe, Edited by Wolfgang C.Müller, Paul W. Thurner

France ?

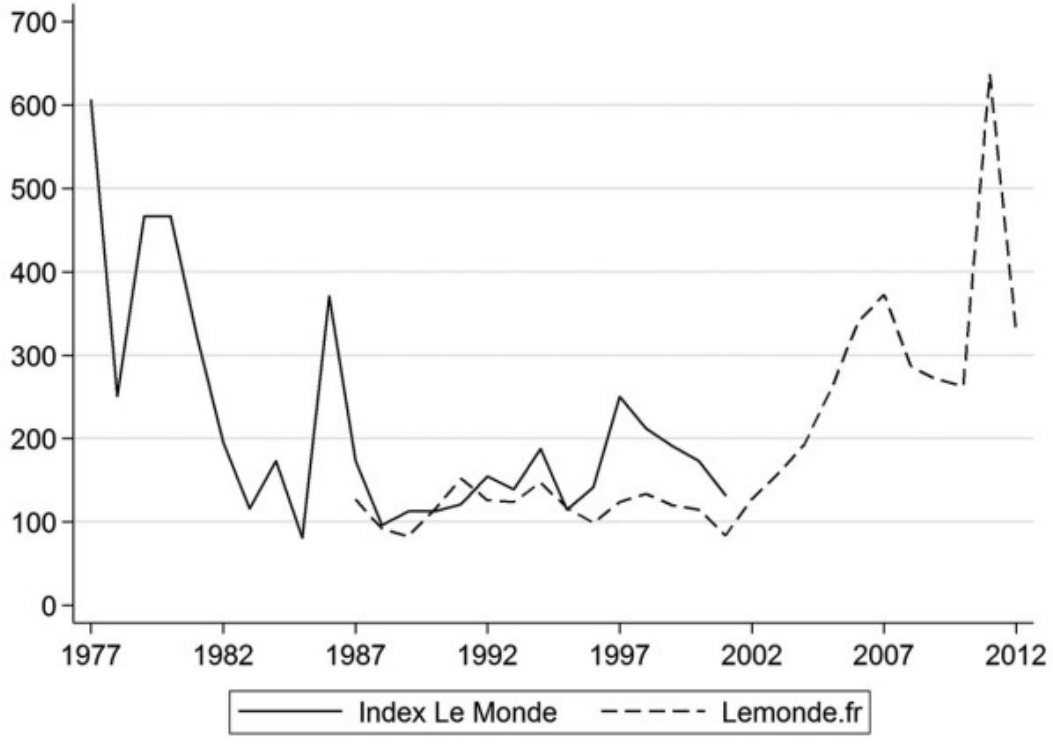


Figure 6.6. Media Attention to Nuclear Energy in France 1977–2012

The politics of Nuclear Energy in Western Europe, Edited by Wolfgang C.Müller, Paul W. Thurner

Nuclear Energy Policy

APPENDIX 1: POLICY DEVELOPMENT GRAPH

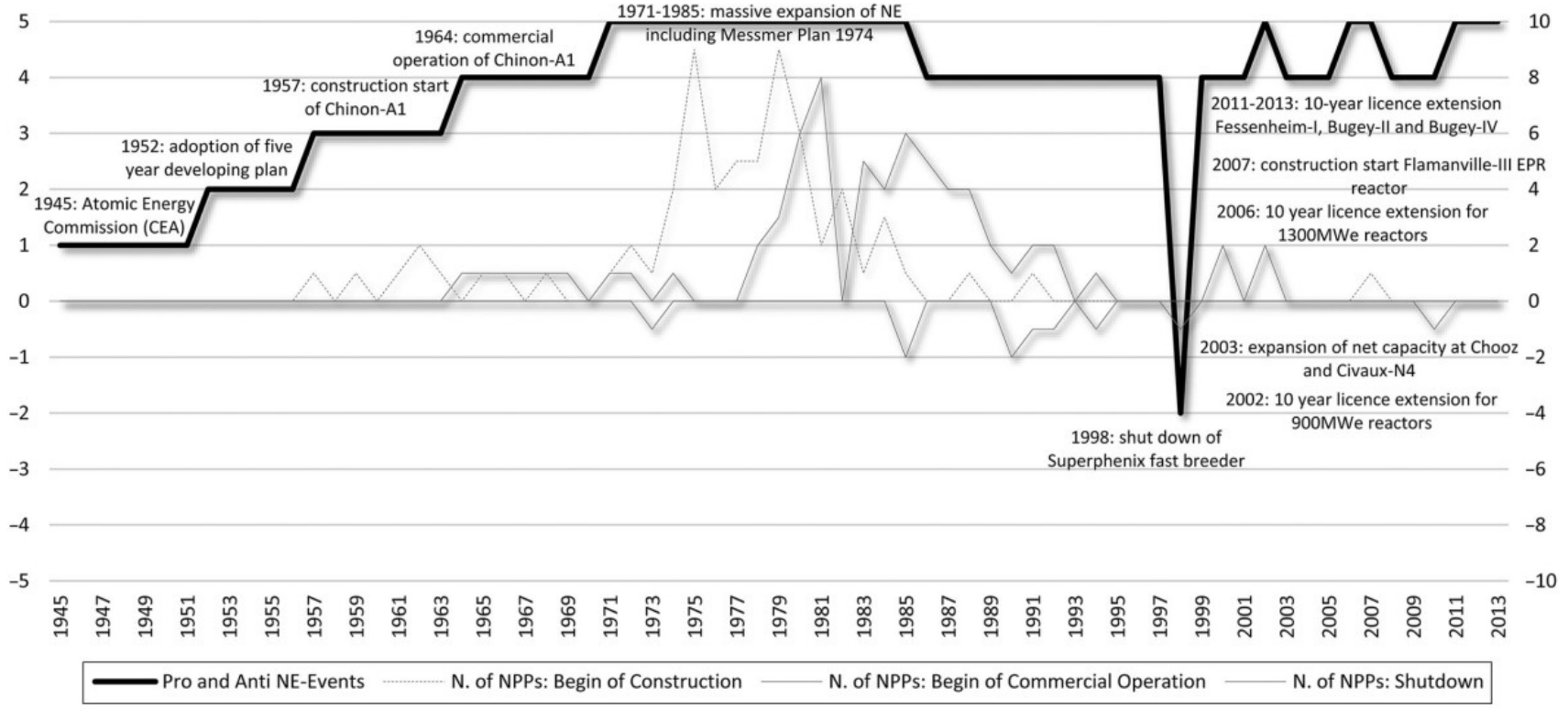


Figure 6.A1. Nuclear Energy Policy Development in France, 1945–2013

The politics of Nuclear Energy in Western Europe, Edited by Wolfgang C.Müller, Paul W. Thurner

France 2018

The minister, Nicolas Hulot, an environmental activist and former television star who regularly ranked as one of Mr. Macron's most popular ministers, made the surprise announcement during a live interview on France Inter radio in which he said he no longer wanted to "lie to myself."

"I don't want to create the illusion that my presence in the government means that we are up to the task on these issues, and so I have decided to leave the government today," Mr. Hulot told the stunned radio hosts, one of whom asked him whether he was being serious.

Mr. Macron has championed the fight against climate change on the international stage, vowing to #MakeThePlanetGreatAgain after President Trump pulled the United States out of the 2015 Paris climate deal.

But the French leader has been criticized domestically by environmental groups and activists for postponing a campaign promise to cut nuclear energy's share of electricity production in France to 50 percent, down from 75 percent, and for not aggressively tackling issues like the use of pesticides in agriculture.

The New York Times

France's Environment Minister Resigns Live on Radio, a Blow to Macron

https://www.nytimes.com/2018/08/28/world/europe/france-environment-minister-nicolas-hulot.html

France 2019

New French energy law puts off difficult climate decisions

Geert De Clercq 4 MIN READ

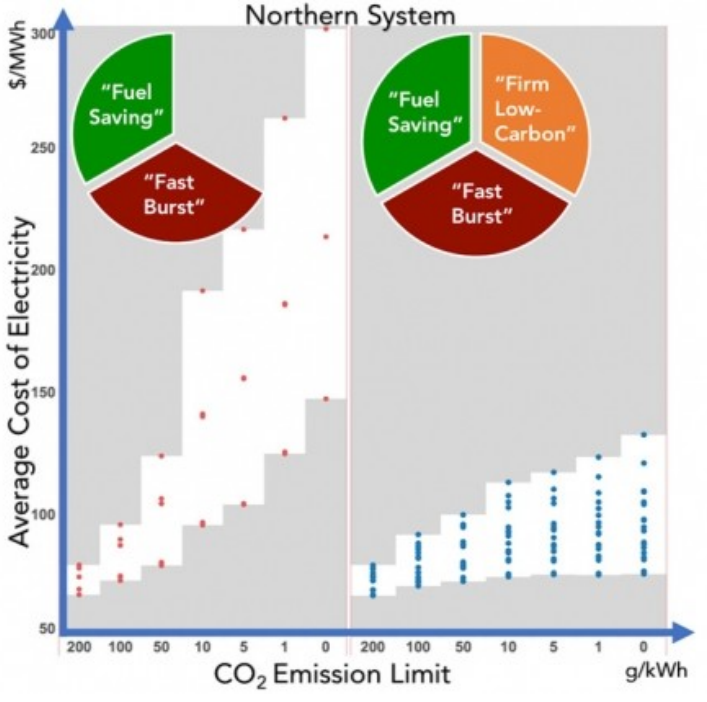
PARIS (Reuters) - France has set more ambitious targets to cut carbon emissions by 2050 but few measures will take effect on President Emmanuel Macron's watch as the "yellow vest" protest movement limits his scope for environmental protection.

Months after coming to power in 2017, Macron dropped that law's key provision - despite a pledge to respect it - to reduce nuclear energy's share in French electricity production to 50 percent by 2025, from 75 percent currently.

The new law will delay the 50 percent nuclear target to 2035, transfer the European Union's 2018 "Winter Package" energy targets into French law and will also form the framework for a detailed "PPE" 2019-2028 energy strategy.

https://www.reuters.com/article/us-france-energy/new-french-energy-law-puts-off-difficult-climate-decisions-idUSKCN1S61X1

Study: Adding power choices reduces cost and risk of carbon-free electricity



http://news.mit.edu/2018/adding-power-choices-reduces-cost-risk-carbon-free-electricity-0906

Videos

Three Mile Island, Nuclear Power Plant Accident: March 28, 1979

https://www.youtube.com/watch?v=eGI7VymjSho

Three Mile Island Documentary: Nuclear Power's Promise and Peril | Retro Report | The New York Times

https://www.youtube.com/watch?v=_0P9S4F4KpQ

What Caused the Catastrophic Nuclear Accident in Chernobyl?

https://youtu.be/tFo_0eEt1IY?t=217

Zero Hour: Disaster at Chernobyl Discovery Channel (2004)

https://youtu.be/ITEXGdht3y8?t=1140

Questions

- barissanli.com
- @barissanli