GET1024 / GEC1036 Lecture 20

Public Perception on Radiation I

Definition of terms

Historical account on attitude

- Before WWII: Intrigued
- WWII to 1970: Promise of cheap electricity
- 1970 – 2000: Growth in NPPs, but more protests
- 2000 – 2011: Nuclear Renaissance?
- 2011 onwards: Shift to Asia

Surveys

“Meaning” of “Public”

- From dictionary (e.g., https://en.oxforddictionaries.com/definition/public)
  - “Of or concerning the people as a whole” (e.g., public view)
  - “Of or involved in the affairs of the community, especially in government or entertainment” (e.g., public spending)
  - “A section of the community having a particular interest or connection.” (e.g., the reading public)

Gabriel Almond's Three Classes of "Publics"

- US political scientist Gabriel Almond defined three classes of "public":
- General public
  - Majority of the population
  - May have little or no interest in the specifics of an issue or policy matter, or in politics in general.
  - *Latent attitudes* and opinions maybe activated by events
- Attentive public
  - Typically, a minority of the population
  - More interested in politics [Certain issues may be more salient to them – "issue publics"]
  - Pay more attention to political news and information
  - Mobilized by elites in political appeals
- Policy and opinion elite
  - Public officials, journalists and other influential people *including academics, economists, think tanks, etc.*
  - Influence public opinion by articulating policies to attentive and general publics

http://desart.us/courses/1010/publics.html

Meaning of “Perception”

- From dictionary (e.g., https://en.oxforddictionaries.com/definition/perception)
  - “Awareness of something through the senses” (e.g., perception of pain)
  - “The neurophysiological processes, including memory, by which an organism becomes aware of and interprets external stimuli” (definition in Psychology Zoology)
  - “Intuitive understanding and insight” (e.g., ‘‘He wouldn't have accepted,” said my mother with unusual perception)
- Related to “perceive”
- Two other common terms used are “attitudes” and “opinions”
- There are some differences between “perception” which often means what we interprets a certain situation or object to be while “attitude” includes our evaluation of it (favorably or unfavorably). Attitude = Perception + Evaluation
- Also, a slight difference between attitude and opinion (in social science): An attitude is a durable orientation toward some object, while an opinion is more of a visible expression of an attitude – like answering a survey question.

Radiation, Radioactive, Nuclear & Atomic

- From scientific viewpoint, these are very specific terms and connote certain processes:
  - Radiation – transfer of energy through waves or particles through space – could be ionizing or non-ionizing
  - Radioactive – concern with decay of the nucleus – mainly α, β and γ radiation
  - Nuclear – pertaining to the nucleus of the atom, as in nuclear energy (due to changes nucleus), nuclear force, nuclear power plant, nuclear bomb.
  - Atomic – pertaining to the whole atom – in physics does not include nuclear reaction. Generally, only deal with the electronic transitions (configuration of electron arrangements)

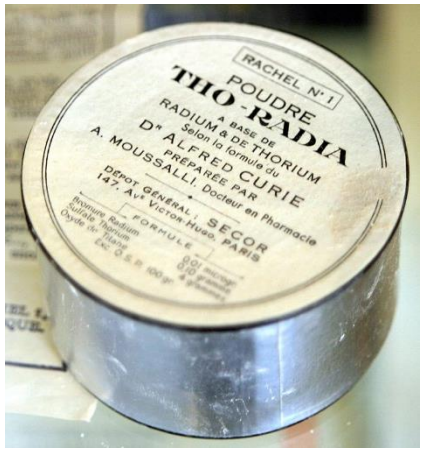
Radiation, Radioactive, Nuclear & Atomic

- In common usage, many differences are blurred.
  - Atomic = Nuclear as in Atomic Bomb, Atomic Energy, IAEA, etc. Use of terms “atomic bombs” by H.G. Well in novel *The World Set Free* in 1914 before the concept of nucleus was well established. Szilard (who discovered chain reaction) also used this term and it gained popular use after WWII. (Generally accepted as ok – just nomenclature.)
  - Radioactivity and radiation. Some may confuse radiation with radioactivity. Often does not differentiate between different types of radiation. May give the impression that any form of radiation (including radio wave, infrared radiation) is dangerous.
  - Strong association between nuclear with radiation.
    - Perception that anything pertaining to nuclear has radiation.
    - When authors discuss the dangers of radiation, some refer only to ionizing radiation but often without stating so.
    - Nuclear magnetic resonance (NMR) technique was re-named as magnetic resonance imaging (MRI) for greater public acceptance.

Public Perception before World War II

- Discoveries in x-ray, radioactivity towards end of 19th century. Beneficial use in medical field, e.g., use of x-ray by Marie Curie in WWI to image broken bones and locate bullet in injured soldiers.
- Public generally **positive** and **intrigued** towards these new discoveries.
- Many other devices / products proclaiming health benefits, e.g., radioactive water, face powder, toothpaste, etc. Even invented machine to x-ray the feet when fitting shoes.
- Radioactive materials used in consumer products e.g., as in uranium in Fiesta dinnerware.
- No regulating bodies to limit the level of exposure from these radiation as the dangers was not well understood or studied.

One of Curie's mobile x-ray units used by the French in WWI. (Image from http://theconversation.com/marie-curie-and-her-x-ray-vehicles-contribution-to-world-war-i-battlefield-medicine-83941)



Public Perception (WWII to ~1970)

- Use of atomic bombs in ending the WWII generally had a positive effect on the public of the world (besides Japan) though some scientists including those working in Manhattan Project were concerned over the destructive power of atomic bombs, especially later with the stockpile of nuclear warheads.
- Efforts to limit more countries entering the “nuclear club” – in exchange for peaceful use of nuclear power in their countries.
- Promise of a very cheap source of electrical power:

  Lewis Strauss, then chairman of the United States Atomic Energy Commission, said in 1954: "Our children will enjoy in their homes electrical energy **too cheap to meter**...”
- Different designs of reactors tested in the 1950s – 60s. Light water reactors (PWRs & BWRs) became the main designs to be used commercially.
- Start a massive programme of building of many large commercial nuclear power plant in US towards the end of 1960s.

Public Perception (WWII to ~1970)

- During the 1950s, when nuclear power was still in the early states of development, pollsters did not even bother to survey the public on the issue.[1]
- In the early 1960's, a few scattered protests against local plants gained national attention, but opinion polls indicated that less than a quarter of the public opposed nuclear power.
- On the other hand, the public became concerned about nuclear weapons testing from around 1954, following extensive nuclear testing in the Pacific. In 1963, many countries ratified the Partial Test Ban Treaty which prohibited atmospheric nuclear testing.[2]
- Towards the end of 1960s, the anti-nuclear movement which initially were against nuclear weapons also started to target nuclear power.

[1] From article http://www.princeton.edu/~ota/disk3/1984/8421/842111.PDF
2 From https://en.wikipedia.org/wiki/Anti-nuclear_movement

Public Perception (1970s – 1990s)

- In the early 1970s, there were large protests about a proposed nuclear power plant in Wyhl, West Germany. The project was cancelled in 1975 and anti-nuclear success at Wyhl inspired opposition to nuclear power in other parts of Europe and North America.[1]

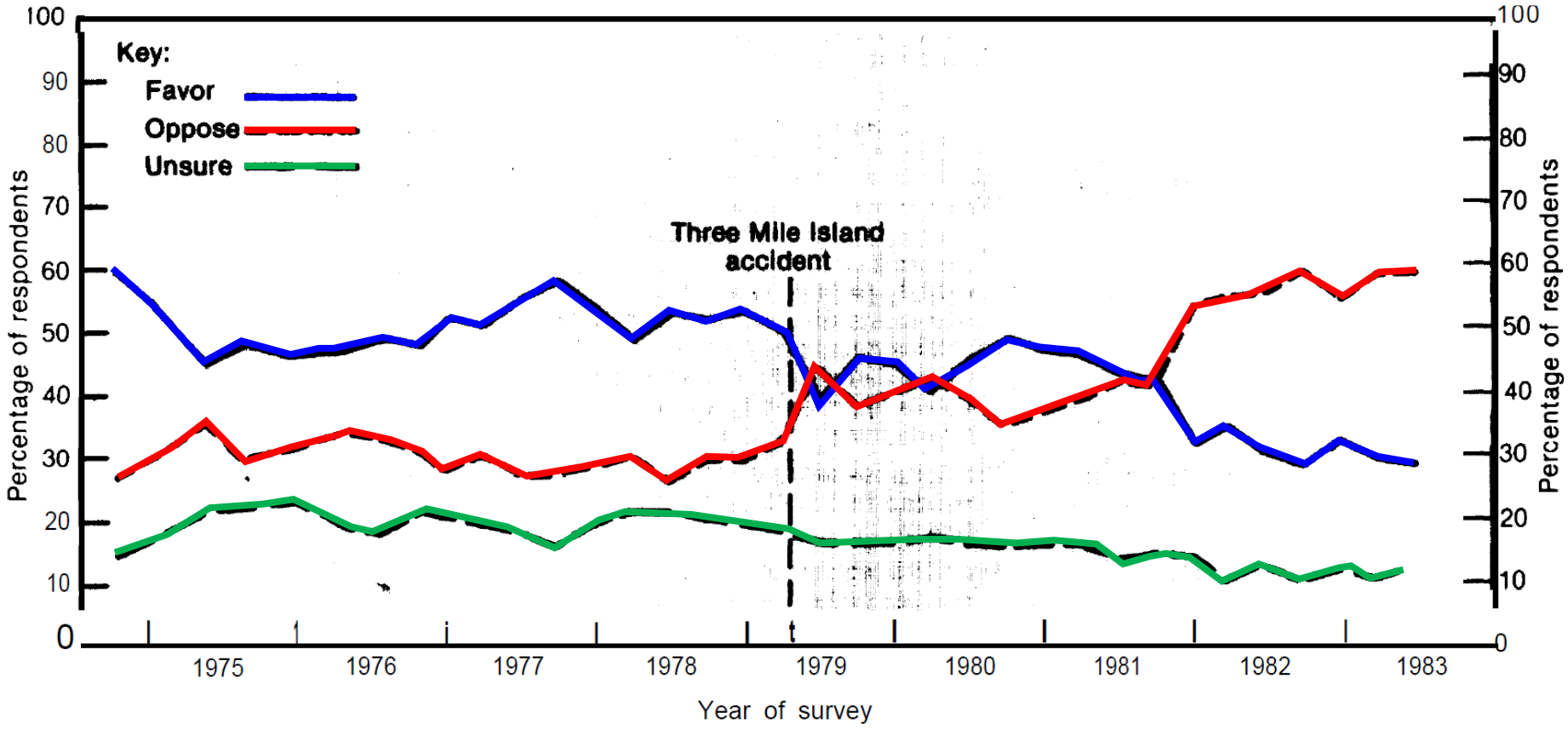
The reasons behind the protests at Wyhl are mainly economic and ecological.[2] It turns out the nuclear power turned out to be a lot more expansive than promised. Local farmers, wine makers, fishermen and tour agencies fear that the NPP would affect their livelihood through contamination of land and rise in temperature of water in the lake used for cooling. This rise in temperature will also affect the ecology of the region.

Picture from http://www.dianuke.org/pictures-40-years-german-anti-nuclear-movement/

1 From https://en.wikipedia.org/wiki/Anti-nuclear_movement
2 From article http://www.esiweb.org/pdf/esi_turkey_tpq_vol9_no2_tina-flegel.pdf

Public Perception (1970s – 1980s)

- In US, the support for construction of nuclear power plants dropped drastically from 60% to 30% in the one decade from 1974 to 1983 as shown in the graphs below.



Graph showing the response to the question: "**Do you favor or oppose the construction of nuclear powerplants?**" from US respondents during the years of survey from 1974 – 1983.

Notice the sharp drop in 1979 during the Three-Mile Island Accident and screening of movie "China Syndrome"[2] which lead to more respondents opposing than favoring.

[1] From article http://www.princeton.edu/~ota/disk3/1984/8421/842111.PDF
May view at https://www.youtube.com/watch?v=oVOB5R6Amzo

Reasons Behind Protests Against Nuclear Power

Anti-nuclear critics see nuclear power as a dangerous, expensive way to generate electricity. Opponents of nuclear power have raised a number of related concerns[1]:

- **Nuclear accidents**: a concern that the core of a nuclear power plant could overheat and melt down, releasing radioactivity.
- **Radioactive waste disposal**: a concern that nuclear power results in large amounts of radioactive waste, some of which remains dangerous for very long periods.
- **Nuclear proliferation**: a concern that some types of nuclear reactor designs use and/or produce fissile material which could be used in nuclear weapons.
- **High cost**: a concern that nuclear power plants are very expensive.
- **Attacks on nuclear plants**: a concern that nuclear facilities could be targeted by terrorists or criminals.
- **Curtailed civil liberties**: a concern that the risk of nuclear accidents, proliferation and terrorism may be used to justify restraints on citizen rights.

[1] From https://en.wikipedia.org/wiki/Anti-nuclear_movement

NPP Prospects in US till 2000

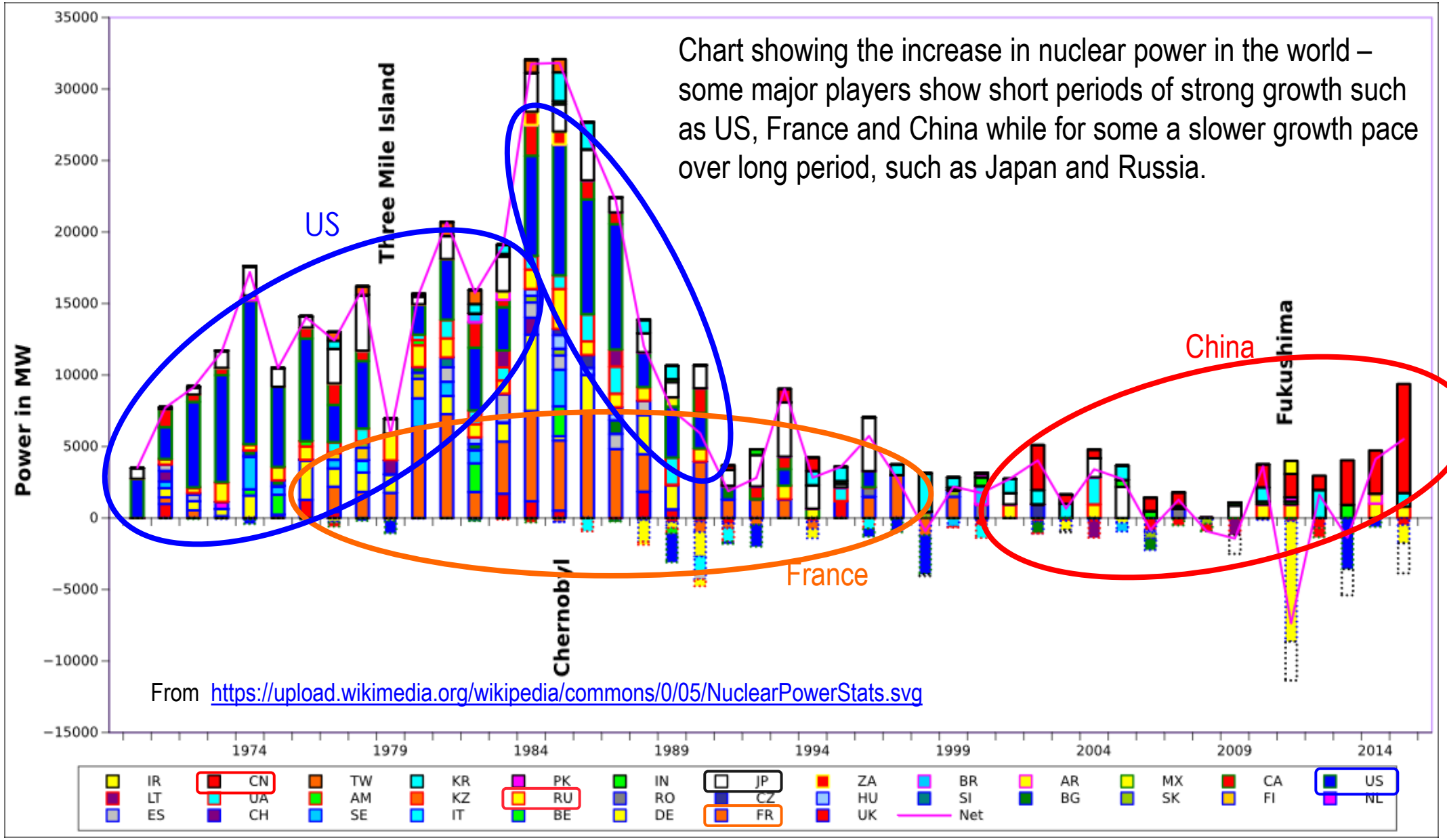
- By 1976, many nuclear plant proposals were no longer viable due to a slower rate of growth in electricity demand, significant cost and time overruns, and more complex regulatory requirements.
- Also, there was considerable public opposition to nuclear power in the USA by this time, which contributed to delays in licensing planned nuclear power stations, and further increased costs.
- This was particularly galvanized by the Three Mile Island accident in 1979. Eventually, more than 120 reactor orders were ultimately cancelled and the construction of new reactors ground to a halt.
- Huge financial losses for the nuclear industry – unwillingness to enter this field again.
- Of the 253 nuclear power reactors originally ordered in the United States from 1953 to 2008,
  - 48% were cancelled,
  - 11% were prematurely shut down,
  - 14% percent experienced at least a one-year-or-more outage
- Thus, only about one fourth (27%) of those ordered, or about half of those completed, are still operating and have proved relatively reliable.

From https://en.wikipedia.org/wiki/Anti-nuclear_movement_in_the_United_States. See this website also for the list of organizations and individuals in US who are openly anti-nuclear.

Nuclear Renaissance?

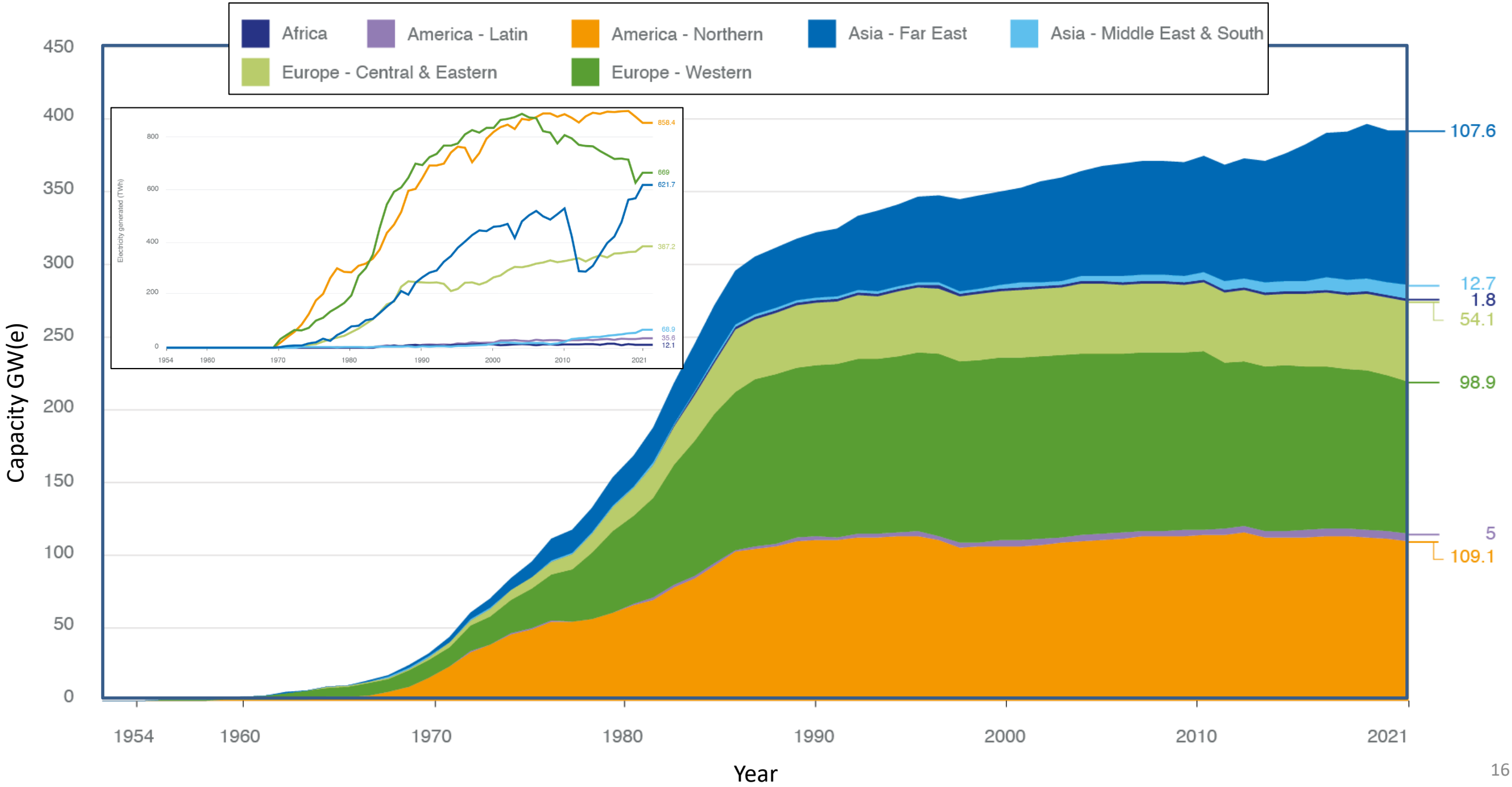
- The turn of the millennia marks some optimism for the nuclear industries – often mentioned as the Nuclear Renaissance.
- Acknowledging nuclear power as possibly the most effective means to combat the production of CO_2 and thus climate change, the attitudes towards nuclear power has improved in many countries resulting in some countries considering starting new nuclear power programmes or building new nuclear power plants to replace the aging ones or to add to the current fleet.
- There had not been a major nuclear accident since Chernobyl in 1986 and thus both the industries and some sectors of the public were getting confident (and perhaps also a little complacent) about the safety of NPPs.
- Rapid economic growth in East Asia, particularly China, has also resulted in many new NPPs being built there.
- However, looking at the actual new nuclear power plants added to the grid since 2000 given on the next slide, the idea of Nuclear Renaissance seems a little too optimistic.

Nuclear Renaissance?



From https://upload.wikimedia.org/wikipedia/commons/0/05/NuclearPowerStats.svg

Regional Nuclear Power Capacity Over Time



Environmentalists vs Nuclear Power?

- Environmentalists have traditionally opposed to nuclear power and have been one of the strongest voices of the anti-nuclear camp. (Again, started initially against testing of nuclear bomb.)
- Environmentalists also fight against climate change – against the use of fossil fuels for power production which increases greenhouse gases to the atmosphere.
- Nuclear power is non-intermittent, produces very little CO_2 for the whole production cycle and is a mature technology.
- Environmentalists were forced to look critically at the risks of nuclear power vs continuing to use fossil fuels. Of course there are other choices such as solar, wind, hydroelectric, waves, geothermal but none is able to scale up fast enough. Renewables such as solar and wind has the property of being intermittent and requires either batteries or another backup source.

Technology	g CO_2/kWh$_e$
Coal	1001
Natural gas	469
Solar PV	46
Geothermal	45
Solar thermal	22
Biomass	18
Nuclear	16
Wind	12
Hydroelectric	4

Data from https://en.wikipedia.org/wiki/Electricity_generation

Environmentalists and Nuclear

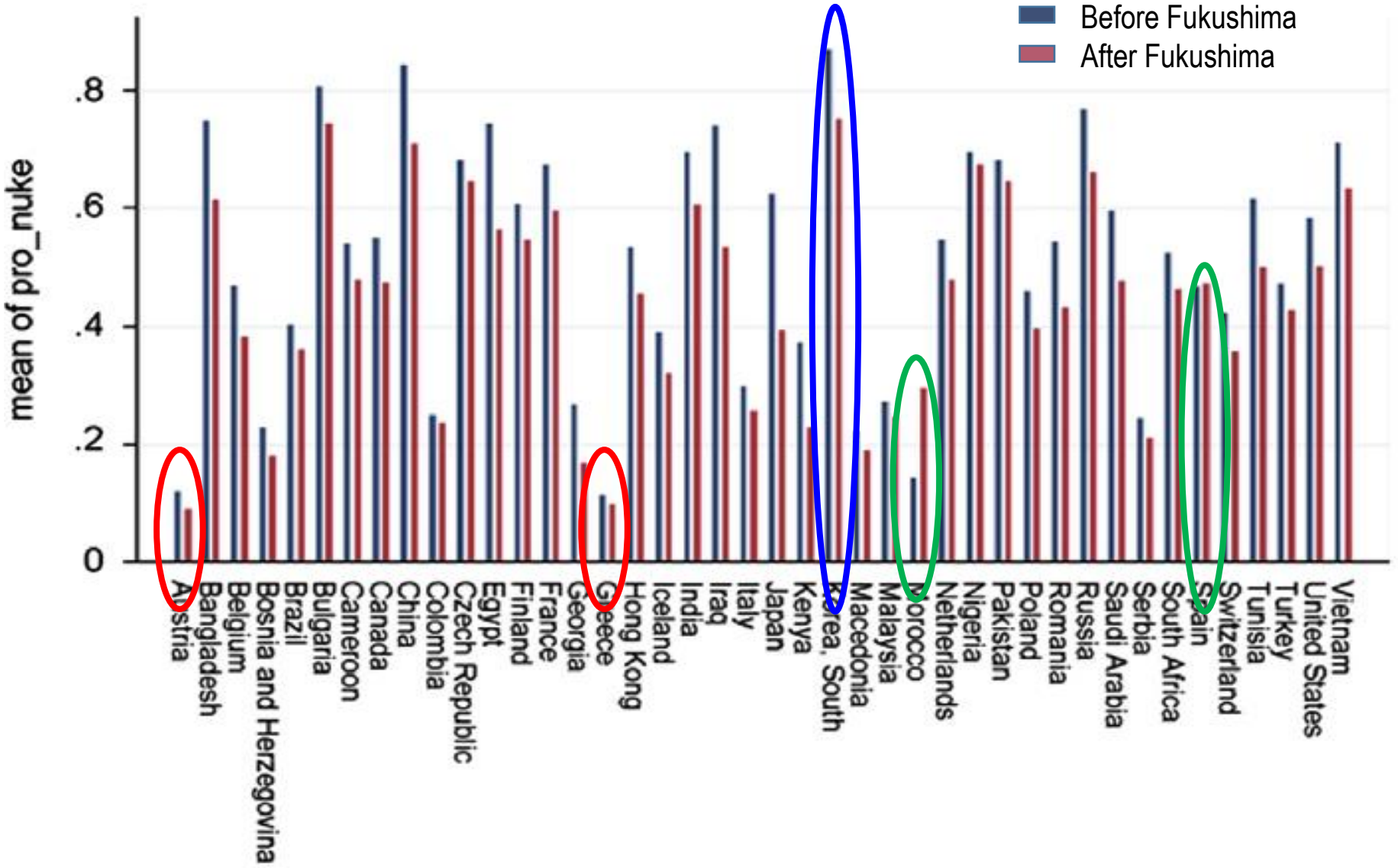
- Thus, in the use of nuclear power, there is a split of views from the environmentalists.
- Some very prominent environmentalists are pro-nuclear (power only) including Patrick Moore (one of the earliest members of Greenpeace), James Hansen (climate change activist), James Lovelock, Mark Lynas, Carol Browner, etc. For a more complete list of pro-nuclear groups and individuals, see https://en.wikipedia.org/wiki/Pro-nuclear_movement.
- A move *The Pandora's Promise* – see https://www.youtube.com/watch?v=RJ1cEUieWm0 produced in 2013 featured quite a number of environmentalists who have become pro-nuclear.
- Open letter by James Hansen and 3 other environmental scientists to other environmentalists in 2013. (See https://edition.cnn.com/2013/11/03/world/nuclear-energy-climate-change-scientists-letter/index.html)

Effects of Fukushima-Daiichi Accident

- The anticipated Nuclear Renaissance was also dented by the Fukushima-Daiichi accident in 2011.
- Decision to hasten the shutdown of nuclear power plants were made by Germany, Italy voted not to restart nuclear programme, Switzerland not to replace existing NPPs, etc.
- Stress tests on existing plants were conducted in many countries, added more requirements to both existing plants as well as those being built (increasing time and cost)
- Some countries delayed plans for further explanation or to start nuclear programme. For example in China, delay the decision to start building inland nuclear plant.
- Public confidence was also dented and support for new builds in most countries fell appreciably,
- Even enrolment into nuclear programmes in universities suffered.

http://www.klimaretter.info/protest/hintergrund/8705-die-groessten-anti-atom-demos-aller-zeiten

Effects of Fukushima-Daiichi Accident



Graph from paper by Kim *et al* "Effect of the Fukushima nuclear disaster on global public acceptance of nuclear energy", Energy Policy **61** (2013) 822-828

Only two countries (Spain and Morocco) out of 42 showed increase in those supporting nuclear power.

Also showed the huge difference in support e.g., in South Korea vs Greece or Austria.

Announcements

- **NUS Wellbeing Day on 6 April (Thursday)**
  - The two tutorial classes on this day will be postponed to the following Thursday, 13 April.
- **Term Test 2**
  - Date: **14 April 2023** (Friday of Week 13)
  - Time: **12:05 – 1:05 pm** (Usual Lecture Hour)
  - Venue: **LT20** (Usual Lecture Venue)
  - Coverage – Lectures from Future Nuclear Power Plants onwards (i.e., Lectures 12 – 21)
  - Basic knowledge of earlier lectures is still needed as part of application but will not tested explicitly.
  - Similar format as Term Test 1: **25 MCQs**
- **Video for Project**
  - Due on **16 April 2023 (Sunday)**. Upload to Canvas Assignment "Group Project Video"
- **Written Report**
  - Due on **16 April 2023 (Sunday)**. Upload to Canvas Assignment "Group Project Report"