

1) Fukushima at 10: What Happened
and the Real Lessons for Energy Policy

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2) Before the Disaster

The US persuaded Japan to install over 50 npps despite frequent earthquakes and tsunamis (Despite the many deaths and injuries from the atomic bombs dropped on Hiroshima and Nagasaki, and the country experiencing frequent earthquakes, Japan was persuaded by the USA to install over 50 nuclear power plants, starting in 1966.

Nuclear power in Japan, https://en.wikipedia.org/wiki/Nuclear_power_in_Japan)

TEPCO retained the standard GE designs with standby diesel generators located low down

TEPCO ignored 2000 and 2008 studies warning of tsunamis that could flood the plant.

Yet the regulator NISA took no action (Nuclear power in Japan, https://en.wikipedia.org/wiki/Nuclear_power_in_Japan)

TEPCO was found guilty in 2002 of falsifying inspection reports

(2011-03-31 Japan's Nuclear Crisis Takes Its Toll On Utility, <https://text.npr.org/135002320>)

3) [Nuclear power plants in Japan] nucleartourist.com

4) [reactor]

5) Decay Heat after Shut-down

Always occurs with all nuclear power plants.

In the event of a Station Black-Out (SBO), can give rise to a Loss of Cooling Accident (LOCA) and within hours, Meltdown of nuclear fuel rods, and the production of Hydrogen, which can explode, breaching the final containment and, releasing Radioactive Fission Products and Fallout

6) Decay Heat Curves – Fukushima

(2011-05-26 Decay Heat of Fuel in Reactor...,

https://www.tepco.co.jp/en/nu/fukushima-np/images/handouts_110526_01-e.pdf)

7) Loss of Cooling – Reactor 1

Emergency Cooling by Isolation Condenser (IC) which has water for 8 hours

Needs no power, but off when batteries ended

Could not determine status via instruments

Steam from the ‘pig’s nose’ was misinterpreted as indicating that IC was working.

This was never tested in 40 years

Hence Core Meltdown, Hydrogen Explosion and Radioactive Release

8) Loss of Cooling – Reactor 3

Emergency Cooling by Reactor Core Isolation Cooling

(RCIC), which needs a pumped water supply

Safety Relief (SR) valve needed 120 vdc, so when the backup batteries ended, it could not be opened.

They then tried using batteries from worker’s cars

But none of 8 would open when the vessel pressure was high – 600 kPa - a fundamental design flaw

They tried substitute water injection from fire engines.

But leakage was 55% - another major design flaw.

This was never tested in 40 years (also for R1 & R2)

Hence Core Meltdown, Hydrogen Explosion and Radioactive Release

9) Loss of Cooling – Reactor 2

Emergency Cooling by Reactor Core Isolation Cooling (RCIC), which needs a pumped water supply
Safety Relief (SR) valve needed 120 vdc, so when the backup batteries ended, it could not be opened.
They then tried using batteries from worker's cars
But none of 8 would open when the vessel pressure was high – 600 kPa - a fundamental design flaw
Attempted 'vent' to lower pressure. Valve needed compressed air, but 70 m pipe was only seismic class C and failed - another major design flaw.
Hence Core Meltdown and Radioactive Release
(2014-01-16 NHK Fukushima 'Meltdown' Documentaries, <http://cms.energypolicy.co.uk/nuclear/278>)

10) Fukushima Daiichi – Dose Rates v Time

11) Fission Products (examples)

12) Fukushima Daiichi – Fallout - 1

13) Fukushima Daiichi – Fallout - 2

14) Radioactive Water – 1

(2020-02-10 The Outline of the Subcommittee on Handling of the ALPS Treated Water Report, Slide 1, <https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/sumALPS202002.pdf>)

15) Radioactive Water - 2

10 years after the disaster, water is still being pumped in to cool Reactors 1-3 and the melted down 'corium' beneath them
Also groundwater runs downhill, past the 'corium'. Both pick up radioactive materials. Total waterflow was ~ 490 t/day
Later some groundwater was diverted by a land side 'ice wall',
costing the public \$ 320 million and consuming 44 million kWh/y (5 MW continuously)
(2018-03-08 Tepco's 'ice wall' fails to freeze Fukushima's toxic water buildup, <https://www.reuters.com/article/us-japan-disaster-nuclear-icewall/tepcos-ice-wall-fails-to-freeze-fukushimas-toxic-water-buildup-idUSKCN1GK0SY>)
The reduced waterflow of ~ 110 t/day is processed by the ALPS cleanup plant.
The water still contains Tritium, an isotope of Hydrogen that it cannot remove. The half-life is 12.3 years
So the water has to be stored in steel tanks.

16) Radioactive Water - 3

10 years after the disaster, with around 1000 water tanks filled, containing about 1 million tonnes, space will run out by 2022.
A panel has proposed releasing the tritiated water into the sea
(2020-02-01 Fukushima radioactive water should be released into ocean, say Japan experts, <https://www.theguardian.com/world/2020/feb/01/fukushima-radioactive-water-should-be-released-into-ocean-say-japan-experts>)
But this is resisted by fisherfolk, whose livelihood was destroyed by the original disaster, and has only slowly recovered
(2019-07-16 Fukushima fishermen concerned for future over release of radioactive water, <https://www.theguardian.com/environment/2019/sep/16/fukushima-fisherman-fear-for-future-over-release-of-radioactive-water>)
Also the tritiated water would enter the food chain - seaweed, fish and shellfish - increasing the radioactivity. (Japan limit 100 Bq/kg)
(2018-06-05 PART 1: Radioactive water at Fukushima Daiichi: What should be done?, <https://safecast.org/2018/06/part-1-radioactive-water-at-fukushima-daiichi-what-should-be-done/>)
The health effects of eating such seafoods is disputed.
But the European Committee on Radiation Risk (ECRR) says that there is no safe limit and the internal health effects - cancers, deaths and genetic - are ~ 1000 x those for external exposures
(2010 2010 Recommendations of the European Committee on Radiation Risk, pages 4, 12, 108, 136, 140, <http://euradcom.eu/wp-content/uploads/2016/04/ecrr2010.pdf>)

17) Decommissioning - 1

(2019-12 Revision of "the Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station", Slide 1, https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20191227_1.pdf)

18) Decommissioning - 2

Used fuel in reactors or pools pose high risks as loss of cooling could cause overheating and huge radioactive releases
TEPCO has emptied the pool of R4, which was offline, no fuel
Emptying of R3 pool with 566 fuel rods is due to end in 03/2021
Removal from R2 pool with 615 is due to start in 2024-2026

Removal from R1 pool with 312 is due to start in 2027-2028

All pools are due to be emptied by 2031, with fuel transferred to dry casks for safer storage

Of the three meltdowns, R2 may be of 237 t and R1 + R3, 880 t

But such debris has never been removed before

(2019-12-31 Fukushima decommissioning plans revised,

<https://www.neimagazine.com/news/newsfukushima-decommissioning-plans-revised-7581105>)

(2020-03-13 Japan's 3/11 Recovery Stalled by Fukushima Decommissioning Delays,

<https://thediplomat.com/2020/03/japans-3-11-recovery-stalled-by-fukushima-decommissioning-delays/>)

19) Health Effects - Institutions

The International Atomic Energy Authority (IAEA) promotes nuclear power

The World Health Organization (WHO) has deferred to the IAEA

(2009-05-28 Toxic link: the WHO and the IAEA,

<https://www.theguardian.com/commentisfree/2009/may/28/who-nuclear-power-chernobyl>)

The US Nuclear Regulatory Commission (NRC) and the UK Office for Nuclear Regulation (ONR) are too close to the nuclear industry

The Biological Effects of Ionizing Radiation (BEIR) was set up by the US National Academy of Sciences

The International Committee on Radiation Protection (ICRP) evolved from the US Committee on Radiation Protection

Only the European Committee on Radiation Risk (ECRR) is independent of nuclear interests

20) Health Effects of Releases

Magnitudes of Prompt and Latent Cancers and Deaths

Evidence from Atom Bombs, Testing and Chernobyl

Effects of this last were minimised by IAEA-WHO

Yet evidence from Chernobyl is in over 30,000 reports

Best summary in English is Yablokov et al, 2009

Latent Deaths 1986 to 2004 is put at 985,000

Radiation also damages DNA, leading to still-births and genetic deformities, including in all future generations

(2007 Chernobyl: Consequences of the Catastrophe for People and the Environment, Yablokov et al,

http://www.strahlentelex.de/Yablokov_Chernobyl_book.pdf)

(2010 2010 Recommendations of the European Committee on Radiation Risk, Search on 'DNA',

<http://euradcom.eu/wp-content/uploads/2016/04/ecrr2010.pdf>)

(2011-09-05 Estimate of Consequences from the Fukushima Disaster, Vitazkova, J. & Cazzoli, E. P 38

<http://www.npsag.org/upload/userfiles/file/CastleMeeting2011/Papers/09%20-%20Paper.pdf>)

21) Health Effects - Evidence

Interpretation of the evidence on health effects of ionizing (nuclear) radiation after Chernobyl, 1986, differs markedly

(2010 2010 Recommendations of the European Committee on Radiation Risk, pp 4, 5, 44,

<http://euradcom.eu/wp-content/uploads/2016/04/ecrr2010.pdf>)

22) Fukushima Latent Health Effect Estimates

23) Readiness for Nuclear Disasters

Off-Site Centre some distance away, with air filtration

Thermal Model to predict progression of LOCA

Requires monitoring of Temperatures & Radioactivity on & near site

Plume Model to estimate path of Radioactive Release

Requires Real-Time Weather Data – wind speed, direction & rain

Communicate the Plume Model Output to Local Authorities

To inform the Populace about Evacuation Areas and Routes

24) Fukushima Daiichi – Evacuation Areas

(See legends on images)

25) Worst Cases and Probabilities

Nuclear Releases to date are far short of worst case

Effect of larger Reactors

Effect of Multiple Reactors

Effect of Spent Fuel Pools

Effect of larger Release Fractions

Effect of release passing over larger populations

Fallout depends on wind speed, direction and rainfall

26) The Kondo Report - 1

Following the explosions and radioactive releases at Fukushima on and after 2011-03-12, the then Prime Minister of Japan, Naoto Kan, required Shunsuke Kondo, Chairman of the Japan Atomic Energy Commission, to report on the 'worst case' scenario.

This was delivered in late March 2011. It was not made public, but was reported in the Asahi Shimbun on 2012-01-07. The whole text was included in the 2012-02-28 report of the private panel on the Fukushima disaster chaired by Koichi Kitazawa.

27) The Kondo Report - 2

28) The Kondo Report - 3

29) The Kondo Report - 4

The 'worst case' scenario would require:

- Mandatory evacuation of all within 170 km

- 'Voluntary' evacuation of all within 250 km

These include Fukushima City, with 290,000,

Sendai, with 1 million

and Tokyo, with 35 million

(2011-03-25 Rough Description of Scenario(s) for Unexpected Situation(s) Occurring at the Fukushima Daiichi Nuclear Power Plant, <http://kakujooho.net/npp/KondoMemoE.pdf>)

(2012-02-07 Fukushima in Review: A Complex Disaster, A Disastrous Response, Yoichi Funabashi and Kay Kitazawa, <https://journals.sagepub.com/doi/pdf/10.1177/0096340212440359>)

30) The Momal Report (from IRSN of France)

(2017-06-19 "Le scénario noir du nucléaire" <https://www.lejdd.fr/Economie/Exclusif-JDD-le-scenario-noir-du-nucleaire-595593-3136544>)

31) Nuclear Releases – Actual and Worst Cases

32) Probabilities

Originally Risk was taken as Consequence

Later Risk was taken as Consequence x Probability

But Probabilistic Safety Analysis requires:

- Identification of accident sequences (billions)

- Probabilities for each unit in sequence (most are unknown)

In practice, far fewer sequences are considered

So the overall Probability must be an under-estimate

And is not just unknown, but unknowable

Hence Probability must be taken as 1 – i.e. inevitable

And Risk must be taken as Consequence

(2011-06-08 The Case Against Nuclear Power, Section 2, <http://cms.energypolicy.co.uk/nuclear/243>)

33) Insurance and Ethics

From the beginning of civil nuclear power in 1954, the worldwide insurance industry refused to provide complete cover

The operators' interests were secured by limiting their liability with the Paris Convention of 1960 and the Vienna Convention of 1963

(2003-11 Swiss Re. 'Nuclear Risks in Property Insurance and Limitations of Insurability'. P 2.

http://media.swissre.com/documents/pub_nuclear_risks_in_property_insurance_en.pdf)

These were prompted by US Price-Anderson Act of 1957 and followed by the UK Nuclear Installations Act of 1965 whereby, apart from a nominal amount, the risk is carried by the State

Such 'Statutory Indemnities' are 'unquantifiable' – i.e. infinite

(2009-10 'Department for Business, Innovation and Skills resource accounts 2009-10: including the consolidated resource accounts for the year ended 31 March 2010' (HC 211, Session 2010-11).

<http://www.bis.gov.uk/assets/biscore/corporate/docs/b/10-p102-bis-resource-accounts-2009-10.pdf>)

The Versicherungsforen Leipzig found in 2011 that the mean sum payable for a nuclear disaster could be € 6090 billion

(2011-04-01 Versicherungsforen Leipzig. 'Studie: Berechnung einer risikoadäquaten Versicherungsprämie...'.
http://www.bee-ev.de/downloads/publikationen/studien/2011/110511_BEE-Studie_Versicherungsforen_KKW.pdf ??)

The German Ethics Commission found in 2011 that withdrawal from nuclear energy is necessary, recommended and possible because there are less risky alternatives

(2011-05-30 Ethics Commission for a Safe Energy Supply. 'Germany's energy transition – A collective project for the future'.
P 4. <https://archiv.bundesregierung.de/resource/blob/656922/457334/784356871e5375b8bd74ba2a0bde22bf/2011-05-30-abschlussbericht-ethikkommission-en-data.pdf>)

34) Human Factors - 1

1] There has been gross negligence for over 50 years (when Fukushima Daiichi was built), not just in TEPCO and the other operators, but also in NISA and the other agencies supposedly responsible for nuclear safety.

a) Despite the many deaths and injuries from the atomic bombs dropped on Hiroshima and Nagasaki, and the country experiencing frequent earthquakes, Japan was persuaded by the USA to install over 50 nuclear power plants, starting in 1966. (Nuclear power in Japan, https://en.wikipedia.org/wiki/Nuclear_power_in_Japan)

b) Moreover, when siting the nuclear power plants, they ignored the stones that mark the height reached by tsunamis over many centuries.

(2011-04-20 Earthquake and Tsunami in Japan on March 11, 2011, Slide 23, https://www.vgb.org/vgbmultimedia/Fukushima_VGB_rev16-p-4465.pdf)

c) Japan was almost entirely unprepared for a nuclear disaster, despite the numerous Reactor Safety Studies that had been published elsewhere from 1957 (WASH-740) and the several prior disasters - Windscale 1957, TMI 1979 and Chernobyl 1986. (2011-05-26. 'Official Transcript of Proceedings. Advisory Committee on Reactor Safeguards. Subcommittee on Fukushima'. NRC. Pp 92-96. <http://pbadupws.nrc.gov/docs/ML1114/ML11147A075.pdf>)

f) Japan had no standards for the radioactivity of food and water until after Fukushima. They rapidly adopted those of the EU. (Martin J. Frid. 'Food Safety: Addressing Radiation in Japan's Northeast after 3.11', The Asia-Pacific Journal Vol 9, Issue 31 No 3, August 1, 2011. http://japanfocus.org/-Martin_J_-Frid/3580)

2] The Fukushima disaster was aggravated by the personnel being responsible for multiple reactors. One control room was shared between Reactors 1 and 2, a second between Reactors 3 and 4, a third between Reactors 5 and 6, and – after the earthquake - some were in a separate 'Quake-Proof' building. Reactors 4, 5 and 6 were shut down. However – especially after the tsunami – their attention was divided, making the management of each operating reactor more difficult.

(2012-04-11 THE REAL LESSONS OF FUKUSHIMA, Gordon Taylor, Page 19, <http://cms.energypolicy.co.uk/nuclear/244>)

3] There had been no testing or drills of Station Blackouts (SBOs) or Loss of Cooling Accidents (LOCAs).

(2012-04-11 THE REAL LESSONS OF FUKUSHIMA, Gordon Taylor, Page 19, <http://cms.energypolicy.co.uk/nuclear/244>)

4] a) The SPEEDI programme for predicting the path of the radioactive plume - and so guide evacuation - was still not operational. Lacking this, some evacuees were guided into the path of the fallout.

(2011-12-27. 'Without SPEEDI, residents fled in direction of radiation'. Asahi Shimbun.

<http://ajw.asahi.com/article/0311disaster/fukushima/AJ201112270061> ?)

b) Japan lacked any means of mapping the nuclear fallout from the air, and had to rely on the US military based in Japan.

(2011-05-26. 'Official Transcript of Proceedings. Advisory Committee on Reactor Safeguards. Subcommittee on Fukushima'. NRC. Pp 92-96. <http://pbadupws.nrc.gov/docs/ML1114/ML11147A075.pdf>)

5] With the future of Japan at stake, the possibility of withdrawal of the 250 workers from Fukushima Daiichi led to Prime Minister Naoto Kan (of the Democratic Party of Japan) going to TEPCO HQ to forbid it. The 'Fukushima 50' stayed in the control rooms.

(2012-02-07 Fukushima in Review: A Complex Disaster, A Disastrous Response, Yoichi Funabashi and Kay Kitazawa, <https://journals.sagepub.com/doi/pdf/10.1177/0096340212440359>)

(2012-04-11 THE REAL LESSONS OF FUKUSHIMA, Gordon Taylor, Page 19, <http://cms.energypolicy.co.uk/nuclear/244>)

6] To provide emergency cooling for the reactors, firefighters were summoned (from Tokyo), but – in view of the dangers - were limited to those over 40.

(2012-04-11 THE REAL LESSONS OF FUKUSHIMA, Gordon Taylor, Page 19, <http://cms.energypolicy.co.uk/nuclear/244>)

35) Human Factors - 2

7] The Japanese government and nuclear industry comprises the 'Nuclear Village'. This pursues a pro-nuclear energy policy and divides up the spoils between the politicians, nuclear plant suppliers and nuclear plant operators. Even so, before Fukushima, it produced only one third of Japan's electricity.

(2012-09-09 Japan's Nuclear Village, <https://apjff.org/-Jeff-Kingston/3822/article.pdf>)

8] The later government of Shinzo Abe (of the Liberal Democratic Party) passed a state secrecy law that could jail whistleblowers for 10 years. This could be applied to any government corruption and incompetence – such as prevails in the nuclear industry (see above).

(2014-12-10 Abe defends Japan's secrets law that could jail whistleblowers for 10 years,

<https://www.theguardian.com/world/2014/dec/10/japan-state-secrets-law-security-dissent>)

9] The Abe government has coerced 'voluntary' evacuees to return by cutting off housing subsidies after only six years. This is still strongly resisted by the evacuees despite the hardships.

(2017-03-10 Fukushima evacuees face 'forced' return as subsidies withdrawn,

<https://www.theguardian.com/world/2017/mar/10/japan-fukushima-nuclear-disaster-evacuees-forced-return-home-radiation>)

10] The Abe government has encouraged the restart of the 39 remaining operable nuclear power plants after stress testing that was much criticised. However, this is a prefectural (provincial government) decision, and only a few have been persuaded, mostly on economic grounds. Nuclear power is still strongly resisted by most of the Japanese people.
(2020-10-20 Tenth reactor to restart in Japan following Fukushima disaster shutdown, <https://bellona.org/news/nuclear-issues/2020-10-tenth-reactor-to-restart-in-japan-following-fukushima-disaster-shutdown>)
(2021-01-19 Funding law for areas home to nuclear plants eyed for renewal, <http://www.asahi.com/ajw/articles/14119178>)

11] There have been no successful prosecutions of those responsible for the disaster and the lack of preparedness. Only one case has been brought privately, but it failed.
(2019-09-19 Fukushima disaster: Nuclear executives found not guilty, <https://www.bbc.co.uk/news/world-asia-49750180>)

12] The Abe government has changed the decommissioning timetable five times, putting back the date for clearing the nuclear fuel that still requires continuous cooling. Meanwhile any loss of cooling risks another disastrous radioactive release.
(2019-12-27 Outline of the 5th Revision: “the Mid-and-Long term Roadmap”, Slide 2, https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20191227_1.pdf)

13] There is a shortage of workers to do the cleanup. This is not done by TEPCO employees but is subcontracted to companies hiring vulnerable people – unemployed and socially isolated – without any clarity about who is responsible for their wellbeing.
(2011-04-29 'Dying for TEPCO? Fukushima's Nuclear Contract Workers'. Paul Jobin. The Asia-Pacific Journal Vol 9, Issue 18 No 3. <http://www.japanfocus.org/-Paul-Jobin/3523>)
This will continue for another 30 years at least. The Abe government has eased the immigration laws in order to bring in workers who are evidently seen as expendable. The Russians call such people ‘human robots’.
(2019-05-23 Japanese firms resist hiring foreign workers under new immigration law – poll, <https://www.reuters.com/article/uk-japan-companies-foreignworkers/japanese-firms-resist-hiring-foreign-workers-under-new-immigration-law-poll-idUKKCN1SS310>)

14] The Abe government is deliberately misleading the world about the status of the Fukushima disaster with the Olympics, by locating some events in Fukushima prefecture.
(2020-02-05 Fukushima and the 2020 Olympics, <https://www.greenpeace.org/international/story/28509/fukushima-and-the-2020-olympics/>)

36) The Real Lessons - Summary
The IAEA and ONR reports lack detail and data
Deaths may be 350-3000 or 10,000 - 200,000
Contaminated land may be 13,000 - 30,000 km²
The plume passed over Tokyo, but it did not rain
UK siting criterion is 30 km, but Kondo is 250 km

37) The Real Lessons of Fukushima - 1
Many quantitative studies have been found, but no proper studies from the IAEA or the UK ONR.

Plume models of radioactive releases are essential to inform evacuations. The Japanese have such a plume model (SPEEDI), but it was ignored until later.
Also they had no instrument for airborne radioactivity measurements and had to rely initially on aerial surveys carried out by the US military.
(2011-05-26 NRC. 'Official Transcript of Proceedings. Advisory Committee on Reactor Safeguards. Subcommittee on Fukushima'. Pp 92-96. <http://pbadupws.nrc.gov/docs/ML1114/ML11147A075.pdf>)

Yet these deficiencies were omitted or downplayed in the reports of the IAEA Fact Finding Mission.
(2011-06-16 IAEA INTERNATIONAL FACT FINDING EXPERT MISSION OF THE FUKUSHIMA DAI-ICHI NPP ACCIDENT..., https://www-pub.iaea.org/mtcd/meetings/pdfplus/2011/cn200/documentation/cn200_final-fukushima-mission_report.pdf)

38) The Real Lessons of Fukushima - 2
Nearly 15,000 workers have received doses of up to 250 mSv.
About 85,000 were forced to evacuate, and 70,000 chose to. Yet the cost of housing the latter is being withdrawn.

Excess cancers and resulting deaths may take up to 50 years to appear. Depending on the dose-effect model assumed, these may be 350 to 3000 or 10,000 to 200,000.

Radioactivity above Japanese government limits has been found in many foods. This has destroyed the businesses of farmers and fisherfolk over wide areas.

The compensation for persons and businesses has been estimated at 3.6 trillion yen (\$ 47 billion).

39) The Real Lessons of Fukushima - 3

The area of land contaminated with radioactive cesium to more than 10,000 Bq/m² is about 30,000 km², some 8% of the land area of Japan. Part of this will be uninhabitable for 10 to 20 years or more.

According to the decontamination plan, the land area for which the dose to humans would be over 1 mSv/y is about 13,000 km².

The cost of the decontamination measures have been estimated at from 1.2 to more than 10 trillion yen (\$130 billion).

Yet the insurance fund available is only about 120 billion yen (\$ 1.6 billion) per nuclear plant. Since TEPCO is virtually bankrupt, almost all the cost must be met by the taxpayers.

Such costs for actual and worst cases are extortionate and mean that nuclear power can never be competitive.

40) The Real Lessons of Fukushima - 4

Of the radioactive fallout from Fukushima, only 19% fell on Japan, 2% on other land, and 79% on the sea. So the fallout over land could have been higher by up to 5 times.

The radioactive plume passed over Tokyo, but it was not raining.

If it had been, the human health and other consequences would have been hugely higher.

Scenarios with larger releases, all over land and over crowded cities, as in the Kondo Report, have consequences that are even more horrific.

Japan shut down all the nuclear power plants. Later the government forced the restart of a few, against citizen opposition.

Germany, Switzerland and Italy have decided to join most other countries and phase out nuclear power.

41) The Real Lessons of Fukushima - 5

The UK criteria for siting nuclear power plants consider only a small radioactive release and fallout reaching 30 km.

Yet the Fukushima release was about 4000 times as much and the Nuclear Installations Inspectorate Fukushima 'reasonable worst-case scenario' release is about 270,000 times as much.

According to the Kondo Report, the worst case release would require evacuation for 170 or 250 km or more - e.g. from Hinkley Point to Birmingham or London.

Also the compensation for the land and property losses and the decontamination costs would be far larger than for Fukushima, at roughly £ 1 trillion.

So almost all the citizens of Britain are threatened by the existing and proposed nuclear power plants. In the words of Dr John Gofman, this is 'licensing random premeditated murder'.

(2012-04-11 THE REAL LESSONS OF FUKUSHIMA, Section 13, <http://cms.energypolicy.co.uk/nuclear/244>)

(1982 'Nuclear Witnesses, Insiders Speak Out'. Freeman, L. <http://www.ratical.org/radiation/inetSeries/nwJWG.html>)

42) [front cover]

43) Rational Energy Policy - Questions

Oil is used for transport, gas and coal for heat and power, but what is electricity used for ?

How much less energy could be used for all these services ?

In the UK, electricity is 20% of energy and nuclear is 20% of electricity = 4% of energy, so what will replace the (depletable) uranium ?

What will replace the 96% that is oil, gas & coal ?

44) Rational Energy Policy - Answers

After a major nuclear release, all nuclear plants may be shut down – as happened after Fukushima

As the consequences are completely unacceptable, all nuclear power plants should be phased out

Others are moving to supplying all energy services with increased energy efficiency and renewables

These are safe, robust (not subject to disastrous events with huge consequences) and sustainable

Japan generates 23% from renewables – 3 x from npps

In 2019, hydro 8%, other renewables 15%, nuclear 7%. Hence renewables are over 3 times nuclear.

Japan Overview, <https://www.eia.gov/international/analysis/country/JPN>

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Reports with References are at:

www.energypolicy.co.uk/TheCaseAgainstNuclearPower.pdf

and

www.energypolicy.co.uk/FukushimaRealLessons.pdf

More presentations and papers on energy are at: www.energypolicy.co.uk