**Germany’s elephant in the room.**

* **Co2 in Germany since nuclear switched off**
* **CO2 per kWh of different energy sources**
* **UK biggest absolute reduction in Co2** <http://www.world-nuclear-news.org/EE-Anti-nuclear-Germany-is-Europes-biggest-GHG-emitter-13111701.html>
* **ElectricityMap.org**
* **Grid watch (UK and France)**

Beware the headlines. That’s nothing new, of course. You may have heard that Germany is in the midst of a great *Energiewende*, or energy transition. The highly-publicised plan would have Germany reduce greenhouse gas emissions by 80-95% of 1990 levels and produce 60% of its electricity from renewable energy sources by the year 2050 [1]. An honourable ambition! I hear you cry. Honourable indeed, but behind the glossy PR there lurks a dirty secret.

*[Disclaimer: I work in the nuclear industry! But fear not, in this article I am going to do something incredible: try to rely on data rather than my opinions.]*

Let your mind slip back to 2011. There was this *huge* earthquake off the coast of Japan [2]. Like, really huge. Likely, you’ll remember it as being the “Fukushima” earthquake, because of the damage to the Fukushima Daiichi Nuclear Power Plant (<https://en.wikipedia.org/wiki/Fukushima_Daiichi_nuclear_disaster>), and the media-coverage frenzy that followed. In Japan, the event is known as the 2011 Tōhoku (TOH-ho-ku) earthquake. It was the most powerful ever recorded in Japan, and the fourth most powerful earthquake in the world since modern record-keeping began in 1900 [3]. Sounds strong but, if you’re like me, you’ll prefer an absolute over a relative number. I recommend reading the first few sections of the Wikipedia entry (https://en.wikipedia.org/wiki/2011\_T%C5%8Dhoku\_earthquake\_and\_tsunami) yourself (yeah, I use Wikipedia, and so should you – more on that in a future blog post!), but here I have reproduced some of the most interesting figures, with the caveat that many of them are from “media” sources, rather than scientific journals or official government statistics:

The force of the earthquake *moved* Honshu, the main island of Japan, 2.4m to the east [4]. The tsunami waves were 40.5m high [5], that’s the same as a thirteen story building. In places the waves travelled 10km inland, or the distance from Canary Wharf to Hyde Park in London [6]. Not impressed? Well, the effects of the earthquake were not limited to Japan. It is estimated that the earthquake *shifted the Earth on its axis by 10 to 25cm* [7]. Yep, you read that right. And if the Tōhoku earthquake seems to you like it happened only yesterday, maybe that’s because the quake might have *increased the Earth’s rotational speed by 1.8µs per day* [8]!

Whilst I cannot vouch for the accuracy of the above numbers, sadly we do know that the tremors and ensuing tsunami killed at least 15,984 [9] people, with many more missing, presumed dead. Over a *million* buildings were damaged or destroyed [10]. The World Bank estimated the cost of recovery and reconstruction to be US$235 billion, making it the *costliest natural disaster in history* [11][12].

I’m sorry if it feels like I’m labouring the point – and there is one coming, I promise – but it’s important to remember just how powerful the 2011 Tōhoku earthquake was before we get to what happened at the Fukushima Daiichi plant, and what happened halfway around the world in Germany in that months that followed.

I’m not going to give the blow-by-blow Fukushima story – you can read the Diet (parliament) of Japan’s produced an official report here (<http://large.stanford.edu/courses/2013/ph241/mori1/docs/NAIIC_report_hi_res10.pdf>). The International Atomic Energy Agency (IAEA) report is probably the most authoritative and informative, and anything I discuss below related to the accident is taken from their work. If you don’t have hours to burn, the Encyclopaedia Britannica (yes, they do still exist) summarised the incident succinctly here (<https://www.britannica.com/event/Fukushima-accident>).

Contrary to what you may assume, there is no evidence of damage to the main safety systems of the Fukushima Daiichi plants (there were three reactors involved) from the earthquake itself (i.e. from ground vibrations). The problem lay in the plant operators’ underestimation of the likelihood of large tsunamis and the damage they might cause. Tsunami flooding caused the Fukushima plants to lose electricity supply to vital systems required to cool nuclear fuel that remains hot (due to radioactive decay products https://en.wikipedia.org/wiki/Decay\_heat) even after the reactor has been shut down.

TEPCO, the operator of the plants, made valiant efforts to cool the reactor cores as well as what are known as the Spent Fuel Pools (a kind of big swimming pool where old fuel is stored until it’s cooled down). They also made a series of well-documented mistakes, exacerbated by indecision and unclear division of responsibility between it, the nuclear regulator and the government. The result was a nuclear operator’s worst possible day at the office: some of the nuclear fuel got so hot it melted through its protective containment. You’ve probably heard of this event before, if only in Hollywood sci-fi: a core meltdown. Eventually, some fraction of this leaked fuel made it into the air and sea. Bad news.

We all “know” we should fear radiation. We shouldn’t

This was one hell of a bad day at the office.

, and tsunami damaged We all know that stuff went wrong, and radioactive material was released to the environment

Websites such as fukuleaks (<http://www.fukuleaks.org/web/?p=13038>) have sprung up that are part pressure group, part conspiracy wackos. I’m all for holding governments and business to account, but why not do that by providing google-able information about the radiation dose to humans from the Fukushima accident, instead of wilfully omitting it (<http://www.fukuleaks.org/web/?page_id=13790>).

(PAHs) are known to be carcinogenic and toxic [13]

How many died from imposing the exclusion zone over those that would have died from cancer.

but there is an elephant in the room, and the elephant happens to spew out *massive* quantities of sooty, sulphurous, carcinogenic pollution.

[1] [*The Energy of the Future: Fourth "Energy Transition" Monitoring Report — Summary*](https://www.bmwi.de/Redaktion/EN/Publikationen/vierter-monitoring-bericht-energie-der-zukunft-kurzfassung.pdf) (PDF). Berlin, Germany: Federal Ministry for Economic Affairs and Energy (BMWi). November 2015. Retrieved 2017-11-18.

[2] <https://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami>

[3]

1. [*"New USGS number puts Japan quake at 4th largest"*](http://www.cbsnews.com/stories/2011/03/14/501364/main20043126.shtml). [*CBS News*](https://en.wikipedia.org/wiki/CBS_News). Associated Press. 14 March 2011. [*Archived*](https://www.webcitation.org/5xgjFTgf4?url=http://www.cbsnews.com/stories/2011/03/14/501364/main20043126.shtml) from the original on 4 April 2011*. Retrieved 15 March 2011*.
2. Branigan, Tania (13 March 2011). [*"Tsunami, earthquake, nuclear crisis – now Japan faces power cuts"*](https://www.theguardian.com/world/2011/mar/13/japan-tsunami-earthquake-power-cuts). The Guardian. London. [*Archived*](https://www.webcitation.org/5xDAT05x0?url=http://www.guardian.co.uk/world/2011/mar/13/japan-tsunami-earthquake-power-cuts/print) from the original on 15 March 2011*. Retrieved 15 March 2011*.
3. [**Jump up^**](https://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami#cite_ref-3news_31-0) [*"Japan quake – 7th largest in recorded history"*](http://www.3news.co.nz/Japan-quake---7th-largest-in-recorded-history/tabid/417/articleID/201998/Default.aspx). 11 March 2011. [*Archived*](https://www.webcitation.org/5xtOn8fYs?url=http://www.3news.co.nz/Japan-quake---7th-largest-in-recorded-history/tabid/417/articleID/201998/Default.aspx) from the original on 12 April 2011*. Retrieved 11 March 2011*.

[4] ["Quake shifted Japan by over two metres"](http://www.dw-world.de/dw/article/0,,14909967,00.html). [*Deutsche Welle*](https://en.wikipedia.org/wiki/Deutsche_Welle). 14 March 2011. [Archived](https://www.webcitation.org/5xBeYFfOD?url=http://www.dw-world.de/dw/article/0%2C%2C14909967%2C00.html) from the original on 14 March 2011. Retrieved 14 March 2011

[5]  [*"March 11th tsunami a record 40.5 metres high NHK"*](http://www3.nhk.or.jp/daily/english/13_04.html). .nhk.or.jp. 13 August 2011. [*Archived*](https://web.archive.org/web/20110728013451/http:/www3.nhk.or.jp/daily/english/13_04.html) from the original on 28 July 2011*. Retrieved 7 September 2011*.

[6] Roland Buerk (11 March 2011). ["Japan earthquake: Tsunami hits north-east"](http://www.bbc.co.uk/news/world-asia-pacific-12709598). BBC. [Archived](https://www.webcitation.org/5x7SSocBe?url=http://www.bbc.co.uk/news/world-asia-pacific-12709598) from the original on 12 March 2011. Retrieved 12 March 2011.

[7] Chang, Kenneth (13 March 2011). [*"Quake Moves Japan Closer to U.S. and Alters Earth's Spin"*](https://www.nytimes.com/2011/03/14/world/asia/14seismic.html). The New York Times. [*Archived*](https://web.archive.org/web/20110316002603/http:/www.nytimes.com/2011/03/14/world/asia/14seismic.html) from the original on 16 March 2011*. Retrieved 14 March 2011*.

[8] [*"大地震で一日が短縮、軸の振動も変化"*](http://www.nationalgeographic.co.jp/news/news_article.php?file_id=20110317002&expand&source=gnews) (in Japanese). [*National Geogrphic*](https://en.wikipedia.org/w/index.php?title=National_Geogrphic&action=edit&redlink=1). 2011-03-17*. Retrieved 2011-03-19*.

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