Everything I believed about nuclear waste was wrong

I've feared it. I've protested it. Now I'm hugging it

ZION LIGHTS

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Visiting dry storage casks at Sizewell B in Suffolk, UK

For most of my life, I have been terrified of nuclear waste. I believed it was a green, gloopy, corrosive liquid as depicted in *The Simpsons*. I thought it was dumped in riv contaminated the environment with radiation and gave people cancer. I feared wast as if it *was* cancer.

I was 18 years old and I believed that nuclear energy was dangerous, the nuclear industry was evil, and renewables were the only way to save humankind.

I changed my mind about nuclear energy when I learned that it is essential for decarbonisation, that nuclear power stations have the smallest land footprint of all energy sources per unit of electricity they produce, and that the energy they produc clean and reliable. However, one thing continued to concern me: nuclear waste.

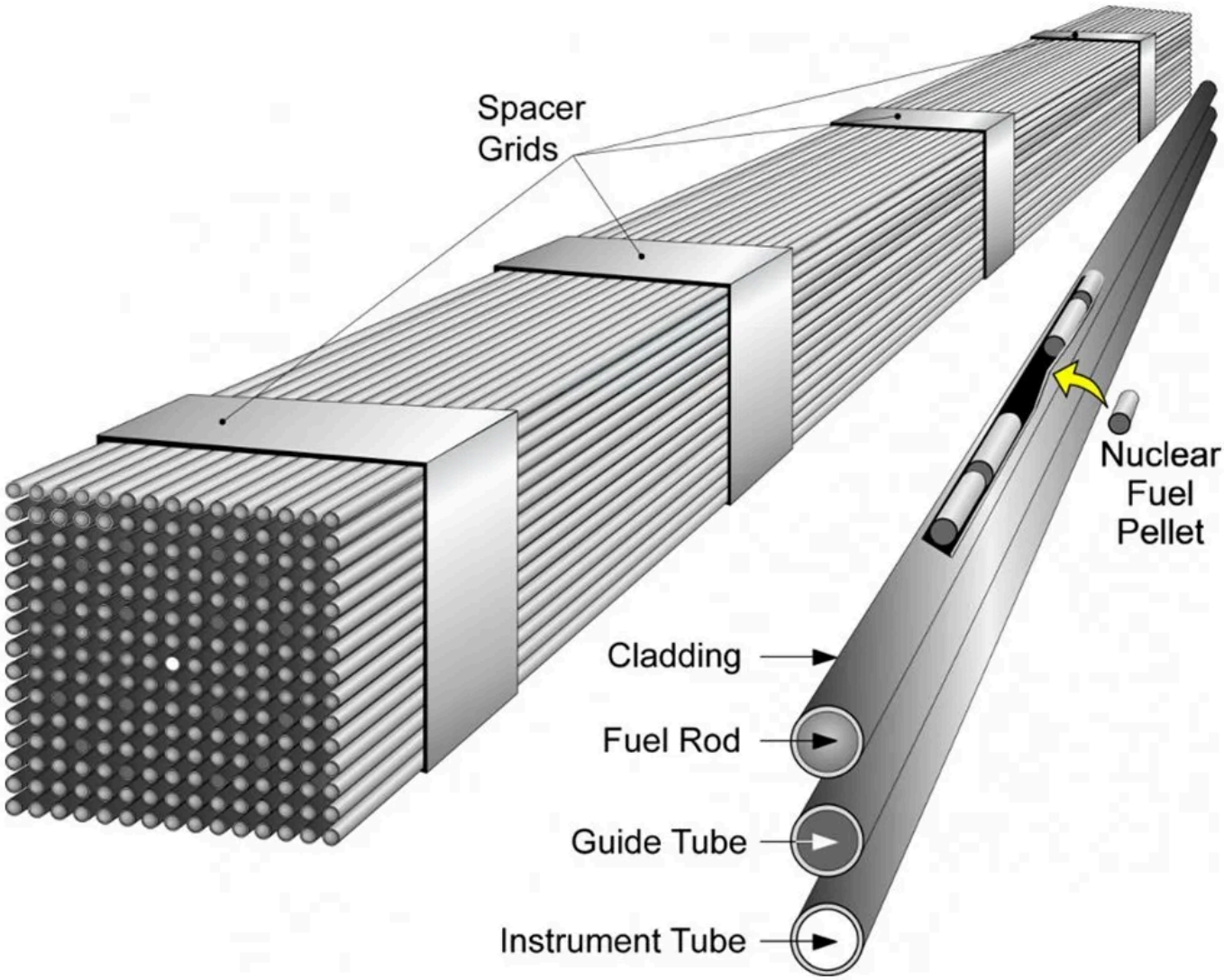
I had been told by countless friends and green organisations, of which I was an acti member, that there were huge amounts of nuclear waste in the world, that it could n be disposed of safely, and that it was leaking into our precious environment. It was years before I realised that I had been misinformed, by people who were themselve misinformed.

What is nuclear waste?

Nuclear wastes are classified according to how radioactive they are. Low- and medium- level wastes include things like used protective clothing, tools, wiping clo and other disposable items that have been used on site. These are not particularly hazardous, but because of the nuclear industry's high safety standards they are trea with rigorous caution - so much so that steel and concrete from nuclear plants can

only be recycled as scrap if their radiation levels are a thousand times lower than th same materials from the oil and gas industry.

High-level radioactive waste consists of *irradiated*, or *spent*, nuclear reactor fuel. Th fuel is in a solid form, consisting of small fuel pellets in long metal tubes called rod structured group of fuel rods is called a fuel assembly. Again, I was wrong: there is scary green liquid. The waste is not even *liquid*.



Nuclear fuel schematic (Image: U.S. Department of Energy)

What I'd been told about leaking waste was not to do with nuclear energy. The leak vats I was afraid of were from weapons-related reactors, such as the Hanford Nucle

Site in Washington State, where the U.S. Department of Defense and the Departme of Energy produced plutonium for use in the atomic weapon program. Some of thes contaminants leaked into the land and water, including into the Columbia River.

I learned that I had been confusing waste from nuclear energy with waste from nuc weapons.

How much waste is there?

I was also confused about how much nuclear waste there is in the world. It turns ou that there isn't very much of it. All the high-level nuclear waste produced in the wo would fit in a single football field to a height of approximately ten yards.

The amount of high-level waste produced during nuclear energy production is also small: a typical large reactor produces about 25-30 tonnes of used fuel per year. Worldwide, 97% of the waste produced by the nuclear power industry is classified a low- or medium-level waste. In France, where fuel is reprocessed, just 0.2% of all radioactive waste by volume is classified as high-level waste.

Cooling pools

When a fuel assembly is removed from a reactor because it can no longer provide useful power it is extremely hot, both thermally and radioactively. It is immediately transferred to a cooling pool where it is stored alongside other used fuel for two to years as it cools down and becomes less radioactive. After this, it can be moved to a dry storage cask.

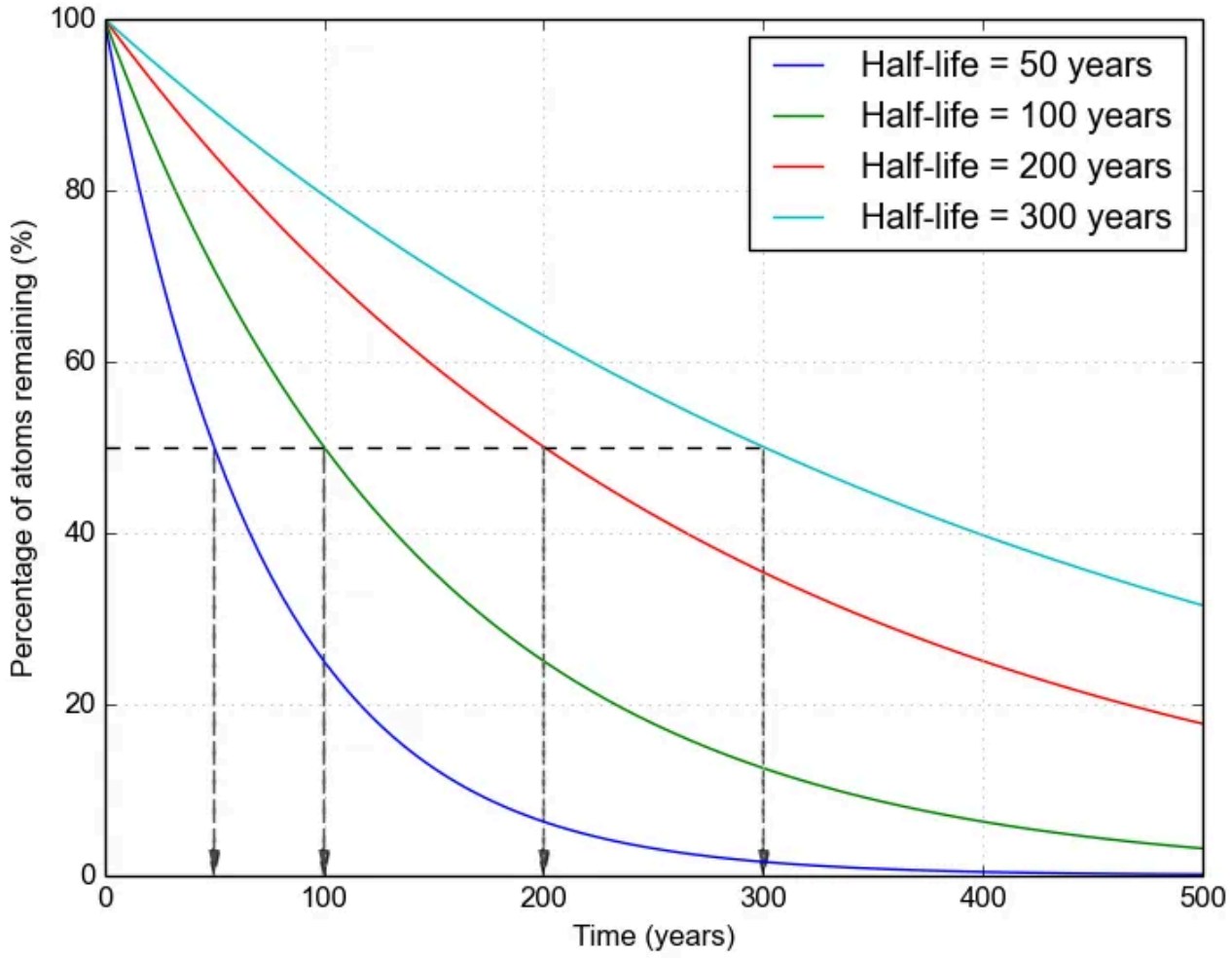
What about the radiation?

After I realised how wrong I'd been about what nuclear waste is, I was determined t learn how it is managed. This required a lot more work as I had to understand how waste is managed by other industries and also from fossil fuels and renewable production, to give a fair comparison.

We live in an industrialised civilisation where waste is a by-product of our everyday lifestyles. Many of these wastes are hazardous, including lead, mercury, arsenic, cadmium, chromium, chlorine, hydrofluoric acid, cyanide, asbestos, dioxins, many other carcinogens, clinical wastes and various pathogens. They are, for the most pa managed carefully. But arguably, of all of them, nuclear waste is managed the most carefully.

I had this misconception about nuclear waste and radioactivity, where I believed th it would stay highly radioactive for many hundreds of thousands of years. I learned that unlike other industrial toxic wastes, the principal hazard associated with high-level waste - radioactivity - diminishes significantly with time. This is known as *radioactive decay*. The amount of time it takes for the radioactivity of radioactive material to decrease to half its original level is called the *radioactive half-life*.

The decay of heat and radioactivity over time means that after only forty years, the radioactivity of used fuel has decreased to about one-thousandth of the level at the point when it was unloaded. Less than 1% is radioactive for 10,000 years. This porti can be easily isolated and shielded to protect humans and wildlife.



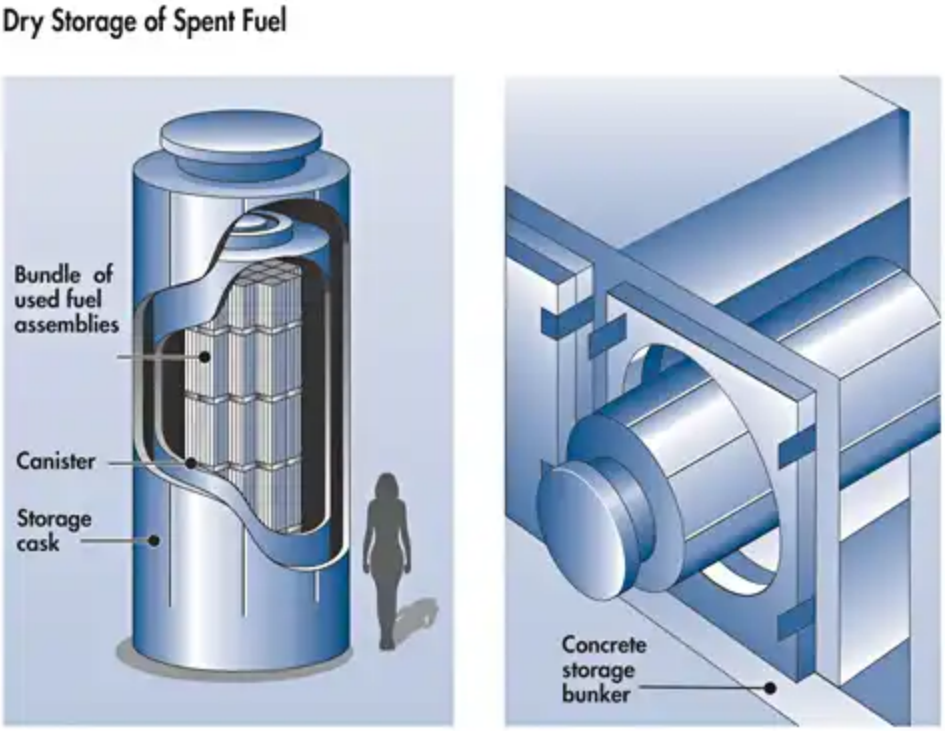
How is nuclear waste transported?

When spent fuel has to be transported, e.g. to reprocessing plants, it is carried in dr storage casks. These containers are extremely strong and have been rigorously teste by being dropped from heights, having railway locomotives crash into them, and planes flown into them, as demonstrated by this cask test from 1978.

What is dry storage?

When the fuel assembly has cooled down, it is transferred to a stainless-steel and concrete dry storage cask. These are designed to contain fuel assemblies for around century. The casks shield radiation, which means you can stand next to one and not

exposed to radiation from the waste inside. The casks are usually stored at the powe station. I'm standing among dry storage casks in the photo at the top of this article.



Reduce, reuse, reprocess

Fuel rods contain 90% of the potential energy from the uranium in them. In some countries, such as France, Japan, and Russia, used fuel is reprocessed to extract usa fuel to make new fuel assemblies. Through this method of recycling, up to 96% of th reusable material in spent fuel can be recovered.

France's national policy of recycling spent fuel has meant that it needs 17% less nat uranium to operate its plants than it would without recycling. There is currently enough energy in the nuclear waste in the United States to power the entire countr for 100 years with clean energy.

It's a no-brainer to me, now, to say that we should go green and recycle our nuclear waste. Ultimately, it's only waste if you waste it.

Deep geological repositories

The international scientific consensus is that deep geological repositories are the m effective approach to permanently dispose of high-level radioactive waste. Deep geological repositories are already an accepted method of long-term disposal of wa containing arsenic, cyanide, mercury, and other toxic chemicals.

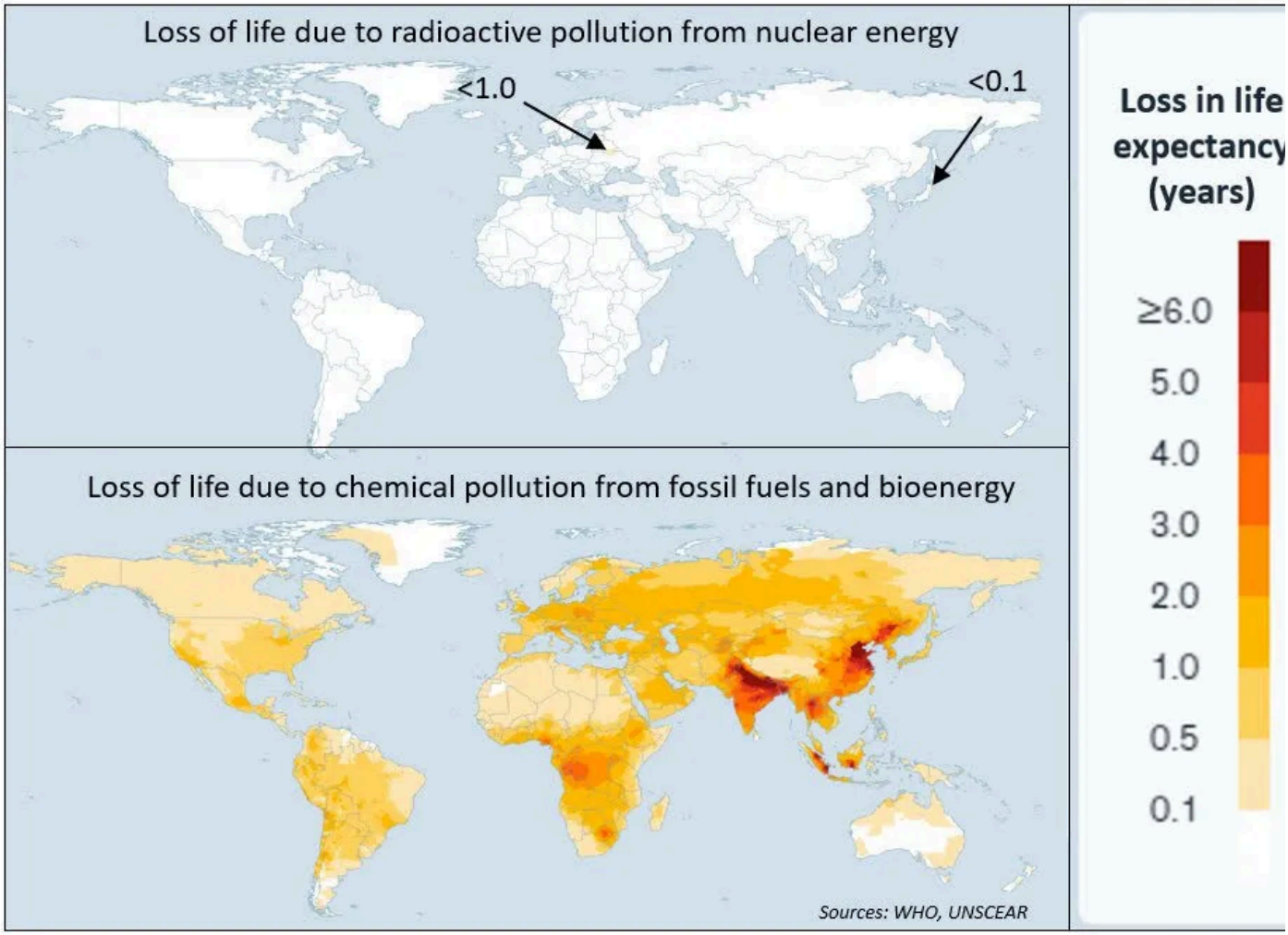
Finland has created the world's first deep geological repository 450 metres below ground level to bury high-level nuclear waste, and Sweden has just approved plans f their first underground repository.

How does other waste compare?

If we want to compare like for like, we have to think about nuclear waste versus wa from other energy production industries.

As you read this, waste from fossil fuels is being stored in the Earth's atmosphere, a we breathe it in every day. Air pollution from fossil fuels causes millions of deaths a year.

When I was 24 I attended an anti-nuclear protest because of what we environmentalists believed was a silent killer: radiation. But radiation hasn't harme anywhere near as many people as fossil fuels. I now realise that we live with real sil killers every day: air pollution from burning fossil fuels and the slow march of clima change.



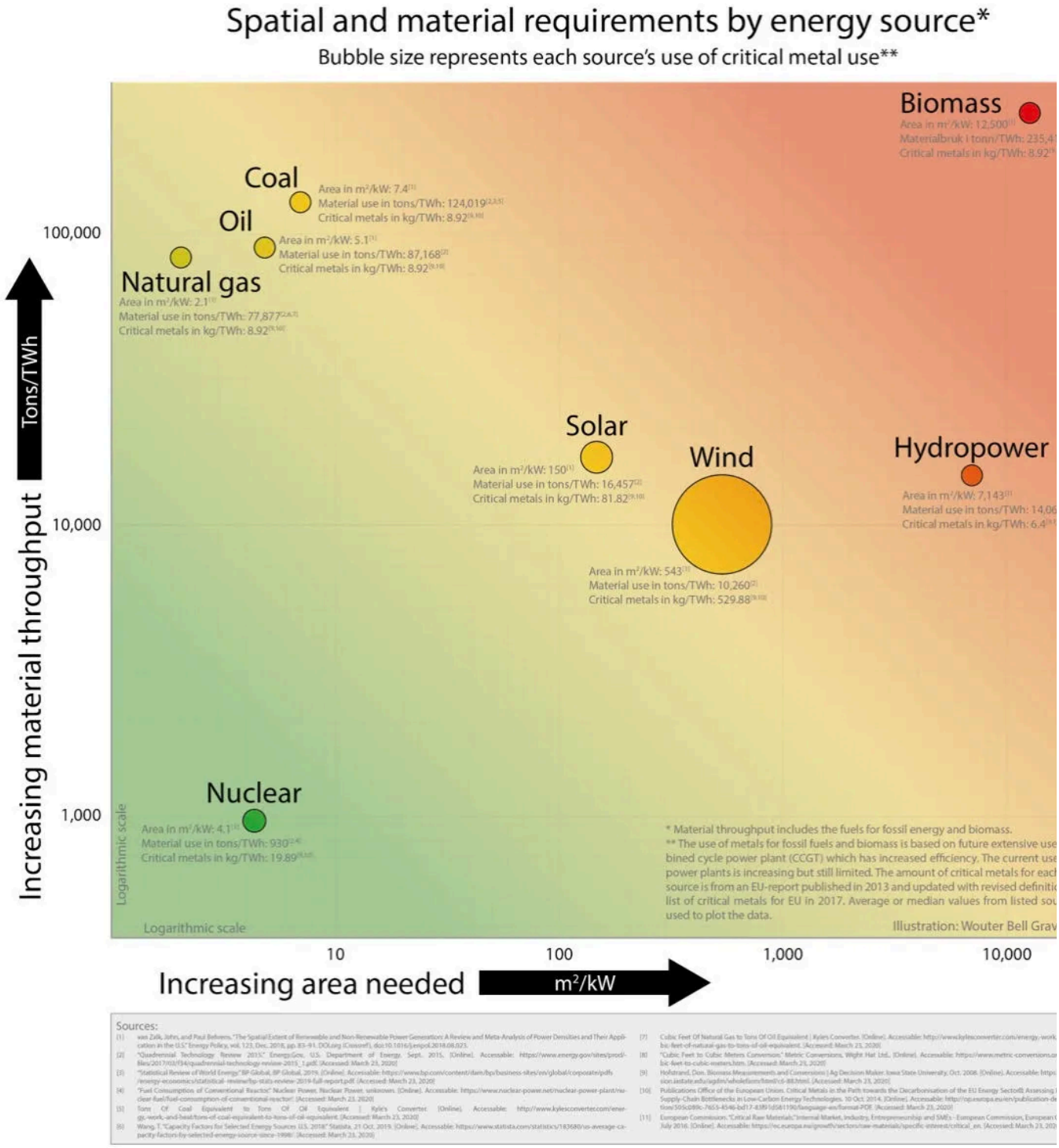
Waste from renewables is seldom recycled because it is difficult to do. I champione renewable technologies for years, so it came as a shock to me to learn that the solar panels I had been promoting as an environmental solution are rarely recycled. The toxic waste they leave behind usually ends up in landfill sites where it leaches dangerous chemicals into the ground, often in developing countries where it is dumped. I also learned that batteries cannot be recycled. And that wind turbine bla have similar issues. This isn't to say that we should abandon renewables altogether, but to illustrate that all energy generation carries an environmental cost, and no solution is perfect.

I was 29 and I was heartbroken. With the scaling of renewables, how were we going wean off of fossil fuels and still meet our energy needs? It was time for me to rethin nuclear energy.

What about waste from mining?

All sources of energy and virtually everything that supports your daily life - your phone, the chair you're sitting on, the packaging your food arrived in, the table you it at - requires a degree of mining. The impressive thing about nuclear energy is tha is powered by uranium, which is an incredibly dense energy source, which means tl we need very little uranium to create a lot of power, which is a good thing if, like m you care about efficiency, recycling, and doing as little harm to the environment as possible.

Of all the energy sources, nuclear uses the least amount of materials.



Rethink waste

Many of the misconceptions about nuclear waste have been spread by activists who genuinely fear waste as much as they fear cancer. Meanwhile the most reliable

alternative to nuclear energy - coal - actually *is* causing cancer, respiratory issues, a other serious health problems.

Fear campaigns have led to tight regulation of nuclear power plants and nuclear wa which means that to see dry fuel casks you have to jump through hoops with securi clearance, over-the-top security checks, supervised visits and so on.

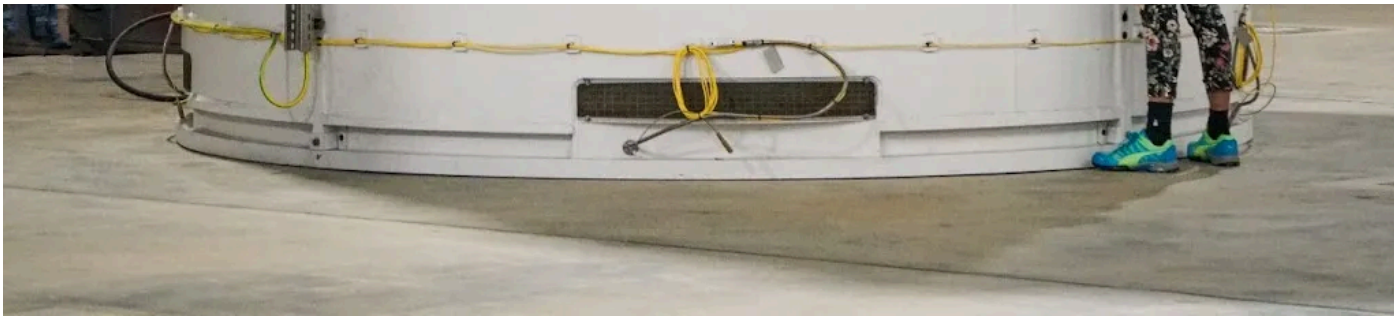
I think we should normalise nuclear waste by putting it in public places that allow people to see it. In the Netherlands, COVRA (The Central Organisation For Radioactive Waste) stores all of the country's high-level waste and is also a public museum and art gallery that hosts many exhibitions.

Inside COVRA: the art of preservation

On a panel in Paris last year, I called nuclear power plants national monuments, an believe that they are, because they represent clean air, good jobs, and high-quality lifestyles. I think we should decorate nuclear power stations like the mural on the Cruas-Meysse cooling tower in France. We should celebrate what humankind can

achieve with clean energy: a high quality of life for everybody, without the negative impacts of burning fossil fuels.

Now I am in my 30s and I have two children. I have hugged dry fuel casks. I understand that each cask represents 4 billion kilowatt-hours of zero-carbon electricity. That's enough to run nearly 1.3 million homes for a year. I tell this to my children. Every day when I wake up, I am grateful to be able to provide my family w a warm, safe home, as I know that billions of people around the world do not yet sh this privilege.



Tree hugging looks different today

I believe in an energy-abundant future, one informed by science over the fear of thi that we don't understand. After a decade of being afraid, I now understand that nuclear energy is essential for the future and that nuclear waste is a positive part of that future.

Realising all of this about waste and then seeing how it is managed and stored mark a turning point for me from being someone who protested nuclear energy to someo who now champions it globally. Knowledge is power, and no longer fearing someth I didn't understand has been liberating. I hope it will be for you too. Because the tru waste is the amount of time we spend worrying about spent fuel instead of celebrat what this clean, reliable source of energy gives us.

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