Einstein's Greatest Legacy

In a famous 1905 paper, Albert Einstein gave the scientific basis whereby sunlight could be converted into electricity. This was the same year he published his even more famous Theory of Relativity, an idea that is universally acclaimed today. But his paper on the Photoelectric Effect has far greater significance for the everyday world we actually live in, because his insight has lead directly to the development of solar panels, which convert sunlight into electricity. Although few foresaw it in 1905,
he opened the door to the almost limitless possibilities of harnessing solar energy.

Einstein's paper on photoelectricity described what happens when visible light is absorbed by an opaque material. He proposed light to be made up of distinct packets of energy called photons. When a photon is absorbed, it does so by transferring its energy to an atom, which then releases an electron. If the absorbing material conducts electricity, the electron is rapidly recombined with a neighbouring atom, speeding up its thermal motion, which we measure as ambient temperature. Heat from sunlight is an ordinary experience, but the heat produced is usually quickly lost to the immediate surroundings, making direct solar heating hard to apply for many purposes. But in some materials, the free electrons can accumulate to produce a measurable current. That is the photoelectric effect.

It took us about a century of development to understand the nature of semiconductors, and how to purify and structure them into useful collectors of photoelectrons, to provide a cheap source of electricity. The result is the modern solar panel, which captures those released electrons, “rounds them up”, and herds them into useful quantities of electrical power, through the magic of physics. And the beauty of this is that electrical energy is transferrable, and can be directed almost anywhere (via conducting wires), for almost any purpose.

Solar photovoltaic panels have been mass-produced since about the year 2000, and their cost per watt of capacity has tumbled to few percent of what they they were back then. They are made from silicon, the second most abundant element in the Earth's crust. They work even (better) at very low temperatures, and last for a long, long time as they have no moving parts.

Solar photovoltaic electricity is without a doubt the future of energy. It can provide all the energy we could ever need in the future, so long as the sun is shining above the horizon. Solar panels even produce electricity (though not as much) in cloudy daylight (whereas thermal solar panels are basically useless when the day is cloudy).

Solar photovoltaic is now the cheapest form of new energy, costing 3 cents a kilowatt-hour or less in projects now underway in the sunniest regions of the planet. At higher latitudes, where sunlight is more spread out, and more attenuated by its passage through Earth's atmosphere, it's not quite that cheap, but still a bargain. It competes well with the time-averaged utility rates of 10 to 20 cents per kilowatt hour that prevail in North America. Almost everywhere on Earth, solar photovoltaic can outcompete fossil fuels on basic energy cost.

But Einstein didn’t tell us what to do when the sun goes down. For that we need to have stored power to provide electricity on demand. That's where hydroelectricity becomes really, really important.
Water stored at elevation is the only efficient way to store energy on a massive scale - other than as hydrocarbon fuel. Batteries have a role in energy storage (especially where portability is needed),
but will never be able to store such massive amounts of electrical energy as hydro can. It defies the basics of chemistry to think they ever could. The only efficient way to store energy chemically is within hydrocarbon bonds. That's why our human bodies store energy as fats (and carbohydrates in general), remember? And also why 93% of the mass of our human body is made from those three elements oxygen, carbon, hydrogen.

But actually, we’re trying to get the planetary energy diet off hydrocarbons, and for a very simple reason. When combusted, hydrocarbons produce carbon dioxide. Too much of that in our atmosphere, and our planet is cooked. Just ask Venus if you don't believe me. Our present release of CO_2 emissions is nudging planet Earth to a warmer climate than human beings have never lived with. It is true that for most of Earth's history, our planet has been warmer than it is at present. But we have no reason to believe a return to that warmer condition will sustain the survival of the eight billion humans who inhabit this planet.... not to mention all the other life forms that walk, crawl, fly and swim on Earth.

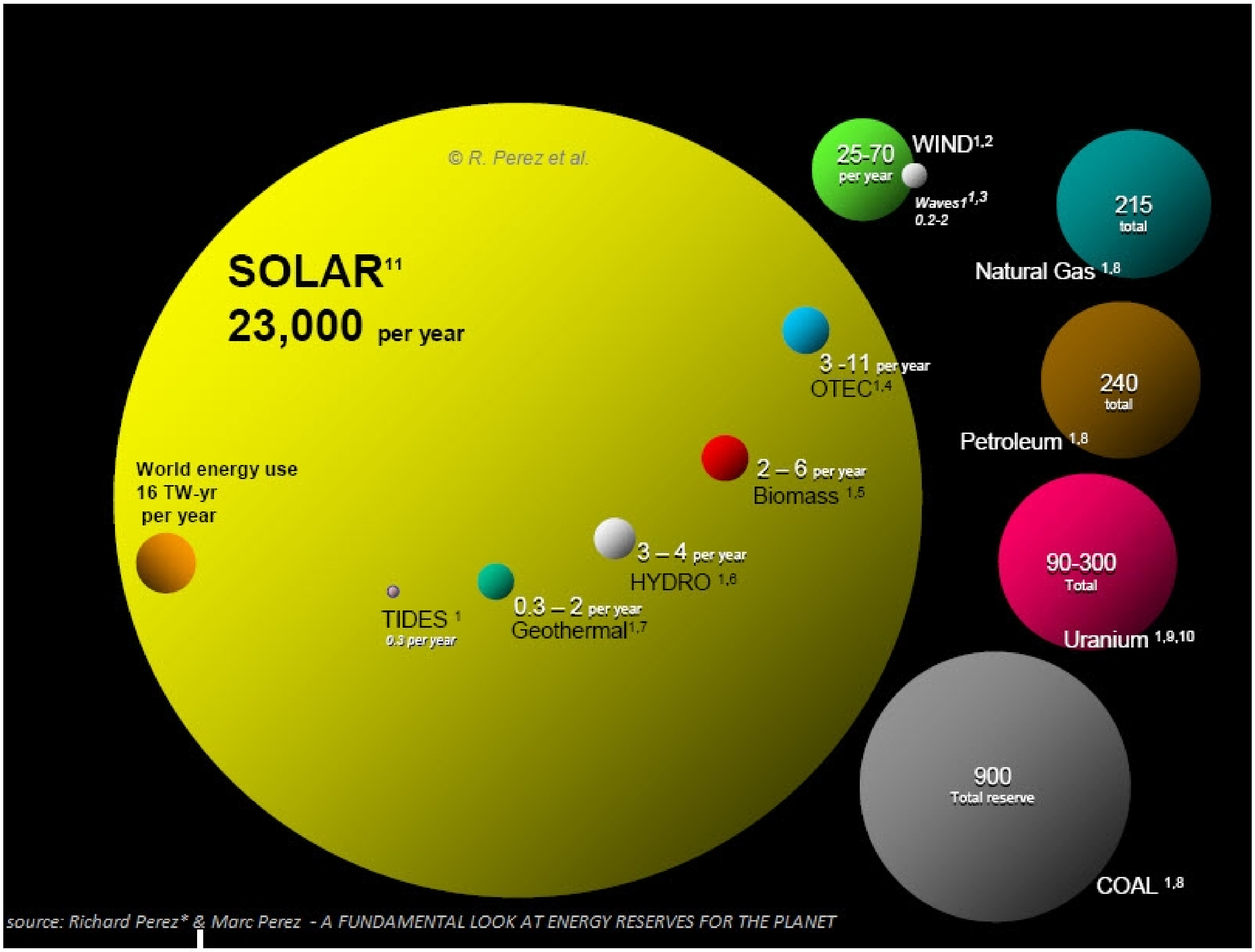
Intelligent species don't kill themselves by their energy use.

Let's remember what made fossil fuels so wonderful in the first place: they are there when you need them. Multi-reservoir hydroelectric systems like the Great Lakes, and the hydro-developed Peace and Columbia Rivers overwhelmingly offer our best opportunity to have hydrocarbon-free power whenever and wherever needed (with some exceptions, as for aviation). Let's not blow this opportunity to save the planet from being cooked by carbon dioxide overload on Earth's atmosphere!

It's really very simple.

- Solar photovoltaic energy can power the world by daylight.
- Wind can give us electricity whenever it is blowing, day and night.
- In the intervening times, we will require the massive energy storage offered by reservoir-to-reservoir or reservoir-to-sea level hydroelectric production.
- A balance of wind, solar, hydro is required to keep Canada (and the world) energized at all times.

If we want a planet with abundant energy so as to offer a high standard of living, one that doesn't lead to catastrophic changes of temperature, rainfall and sea level, achieving this balance is essential.



Comparing finite and renewale planetary energy reserves)Terawatt-years).
Total recoverable reserves are shown for the finate resources.

Not every place on Earth can easily balance supply and demand from these three forms of gifted solar energy. Some are too dry or too flat for massive hydro storage.

But with British Columbia's (and Canada’s) very special combination of topography and rainfall, we have the best sites in North America and the world for storing hydroelectric power. Anyone who tells you that we shouldn’t optimize this gift of energy has probably been consciously or subconsciously brainwashed by the fossil fuel lobby. Also, he/she probably doesn't expect to be around when things get really heated up.

For all generations to follow us, let’s get building now.

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