Energy Choices

As we all learned in school, and inherently know, energy exists in many forms - motion, heat, light, electricity, bioenergy, and gravity, to name but a few. It is transformed between these forms, and is never destroyed, but often becomes unavailable to us.

Practically speaking, energy becomes available to us from three kinds of processes: chemical, nuclear, and gravitational (representing the four basic forces of nature: electromagnetism, the weak and strong nuclear interactions, and gravity).

1. Chemical energy is the energy of life forms, and fossil life forms. Overwhelmingly, these chemical sources of energy favour or involve carbon, the most versatile and strongest bonding element because of its unique electronic shell structure. Nothing compares with hydrocarbons in terms of specific energy density. That's why the human body (and typically, all animals) is 93% composed of only three elements: oxygen, hydrogen and carbon. If you want energy in convenient, dispatchable amounts, chemical energy is what's needed. It gets us out of bed in the morning.

2. Nuclear energy powers the interior heating of the Earth through element fission, and powers the Sun by nuclear fusion of hydrogen to helium. The Earth's interior heat is plentiful but challenging to access. In some locations (such as Iceland), geothermal energy is accessible, but for most of the planet the development costs for geothermal energy will remain a serious barrier.

   The Sun's radiated energy, the gift of solar nuclear fusion, is universally available all over the planet. Sunlight constantly floods one side of Earth ~10,000 faster than all human activity could consume it, bringing us heat and light. We now have the technology (thanks to Einstein) to convert that light directly into electricity, which can power almost any tethered application (that is to say, not airplanes) we can think of.

   Over any ten day interval, sunlight gives the Earth more energy than is contained in all the fossil energy reserves known to exist on the planet. Where does all that solar energy go? A great deal of it goes into moving things around on our planet's surface, that is to say wind, ocean currents, and water driven by the hydrologic cycle.

   In other words, we have more solar energy than we could ever use, but the trick is to store it for use during nighttime.

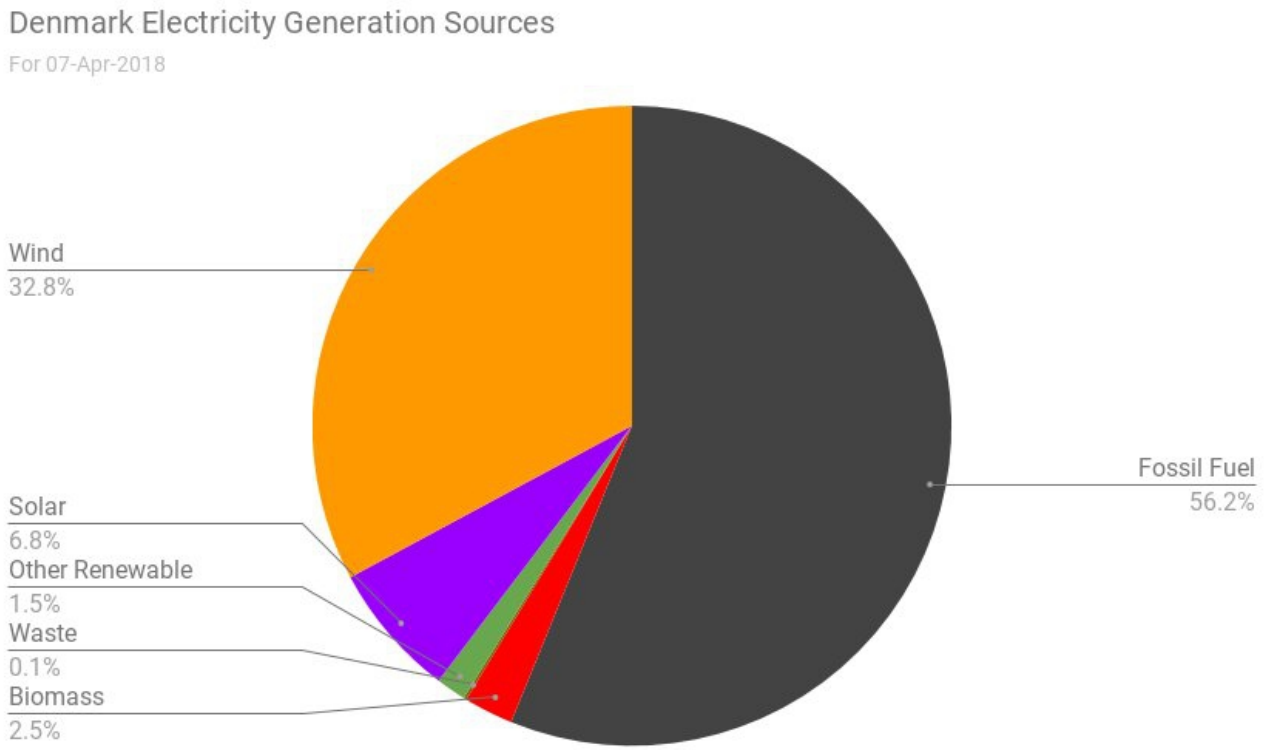
3. Gravity is the largest reserve of energy in the universe, forming stars and galaxies. At the end of a massive star's life, it releases more energy undergoing gravitational collapse than it produced over its millions or billions of years of nuclear fusion. On Earth, gravitational energy is more modestly accessible, because we inhabit the surface of a planet, and can only move so far above or below that gravitational equipotential surface. Water stored at elevation is the perfect form of gravitational energy for use when solar energy is not available (nighttime), harvested as hydro. If the water flows reservoir-to-reservoir, or reservoir to sea level, downstream flooding isn't a problem.

At this point in our technological development, we can see as a forever solution that solar energy can satisfy the majority of all our industrial & domestic needs, inexhaustibly. The only challenge rests in our ability to store it for times when the sun is not shining on us.

We need to clarify a misunderstood point: many people expect that by storing the sun's energy in batteries we will be able to power our cities through the times of dark and calm, but that's not economically feasible. Consider this: it takes 50 to 100 kg of lithium batteries to contain the same chemical energy as 1 kg of gasoline. And there's not that much lithium on the planet: lithium was created in the Big Bang, but mostly destroyed at stellar temperatures. There's probably enough recoverable lithium on Earth to power a billion electric vehicles. There's not enough to power all the cities of the world through darkness.

So the reality is this: to be powered dominantly by the sun and wind, we will absolutely need stored hydro to buffer their intermittency of supply. Other non-carbon sources of energy (such as tides, waves, geothermal) will be consigned to playing minor roles in our energy budgets, for a host of practical reasons.

A number of European countries, particularly Denmark & Germany, have led the world for decades in the development of wind and solar energy. On good days, they can power their electrical grid entirely from these two sources of electricity. But overall, it's not that simple to balance supply with demand every second (or millisecond) of every day:



Wind is wonderful, solar shines, but without the ability to draw on hydroelectric power as needed, many regions will be stuck with a heavy dependence on fossil (or nuclear) energy in order to balance their grid.

It doesn't have to be that way. Canada is most favoured among all regions of the Earth in its ability to produce electricity whenever we need it. God didn't cover 9% of the surface of this country with water for no reason.

Conclusion

In the face of all the current controversy over where to source our energy, perhaps we should reflect on famous '*serenity prayer'.* It is also known as the 'alcoholic's prayer', which is fitting because we are addicted to fossil fuels, even though we know they are hurting us and everything we love on this planet.

> *"G*rant me the **serenity** to accept the things I cannot change;
>
> courage to change the things I can;
>
> and wisdom to know the difference.*"*

We cannot change the laws of physics and chemistry, but we can change how we apply them to supply energy. The wise choice is to select what we know works. Solar energy works, and we have the ability to store it.