A FUNDAMENTAL LOOK AT ENERGY RESERVES FOR THE PLANET

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Global warming, fossil fuel depletion, the growth of large new economies, and the latent risks of terrorism and international conflict are weaving an uncomfortable stranglehold on the world's energy outlook. This is reflected by an extreme volatility in energy commodity prices and associated economic disruptions, superimposed over long-term environmental worries.

The International Energy Agency, through its programs such as Solar Heating and Cooling*, is actively working to advance the new energy technologies and strategies needed to meet future demand while reducing dependence on the liquid fossil fuels that currently drive the planet's economies.

Often cited alternatives include clean coal, nuclear, and an array of renewable options: hydropower, biomass/biofuels, geothermal, ocean thermal energy conversion, waves, tides, wind, solar, etc. In the eyes of leaders and decision makers, developing such a mix of alternatives is a reasonable approach to bring about the desired stable energy future -- akin to putting future energy eggs in different baskets. However this view presupposes that all alternatives have a comparable capability. Hence the purpose of this brief note: to step back and take a fundamental look at their respective potential.

The three-dimensional rendering in Figure 1 compares the current annual energy consumption of the world to (1) the known reserves of the finite fossil and nuclear resources and (2) to the yearly potential of the renewable alternatives. The volume of each sphere represents the total amount of energy recoverable from the finite reserves and the energy recoverable per year from renewable sources.

This direct side-by-side view shows that:

- The renewable sources are not all equivalent by far. The solar resource is orders of magnitude larger than all the others combined. Wind energy could probably supply all of the planet's energy requirements if pushed to a considerable portion of its exploitable potential. However, none of the others – most of which are first and second order byproducts of the solar resource -- could, alone, meet the demand. Biomass in particular could not replace the current fossil base – the rise in food cost paralleling the recent rise in oil prices and the resulting increase in the demand for biofuels is symptomatic of this underlying reality. On the other hand, exploiting only a very small fraction of the earth's solar potential could meet the demand with considerable room for growth.

- While coal reserves are vast, they are not infinite and would last at most a few generations if this became the predominant fuel, notwithstanding the environmental impact that would result from such exploitation if now elusive clean coal technologies do not fully materialize.

- Nuclear energy is not the global warming silver bullet. Reserves of uranium are large, but they are far from limitless. Putting aside the environmental and proliferation unknowns associated with this resource, there would simply not be enough nuclear fuel to take over the role of fossil fuels -- the rise in the cost of uranium that paralleled and even exceeded that of oil from 1997 to 2007 is symptomatic of this reality. Of course this statement would have to be revisited if an acceptable breeder technology or nuclear fusion became deployable. Nevertheless, short of fusion itself, even with the most speculative uranium reserves scenario and assuming deployment of advanced fast reactors and fuel recycling[10], the total finite nuclear potential would remain well below the one-year solar energy potential.

In conclusion logic alone would indicate that the planetary energy future will be solar-based. There will of course be challenges, managing this locally variable -- but globally stable and predictable -- resource, in particular developing the necessary storage technologies and infrastructures. However, solar energy – as embodied by dispersed PV and CSP -- is the only quasi-ready-to-deploy resource that is both large enough and acceptable enough to carry the planet for the long haul.

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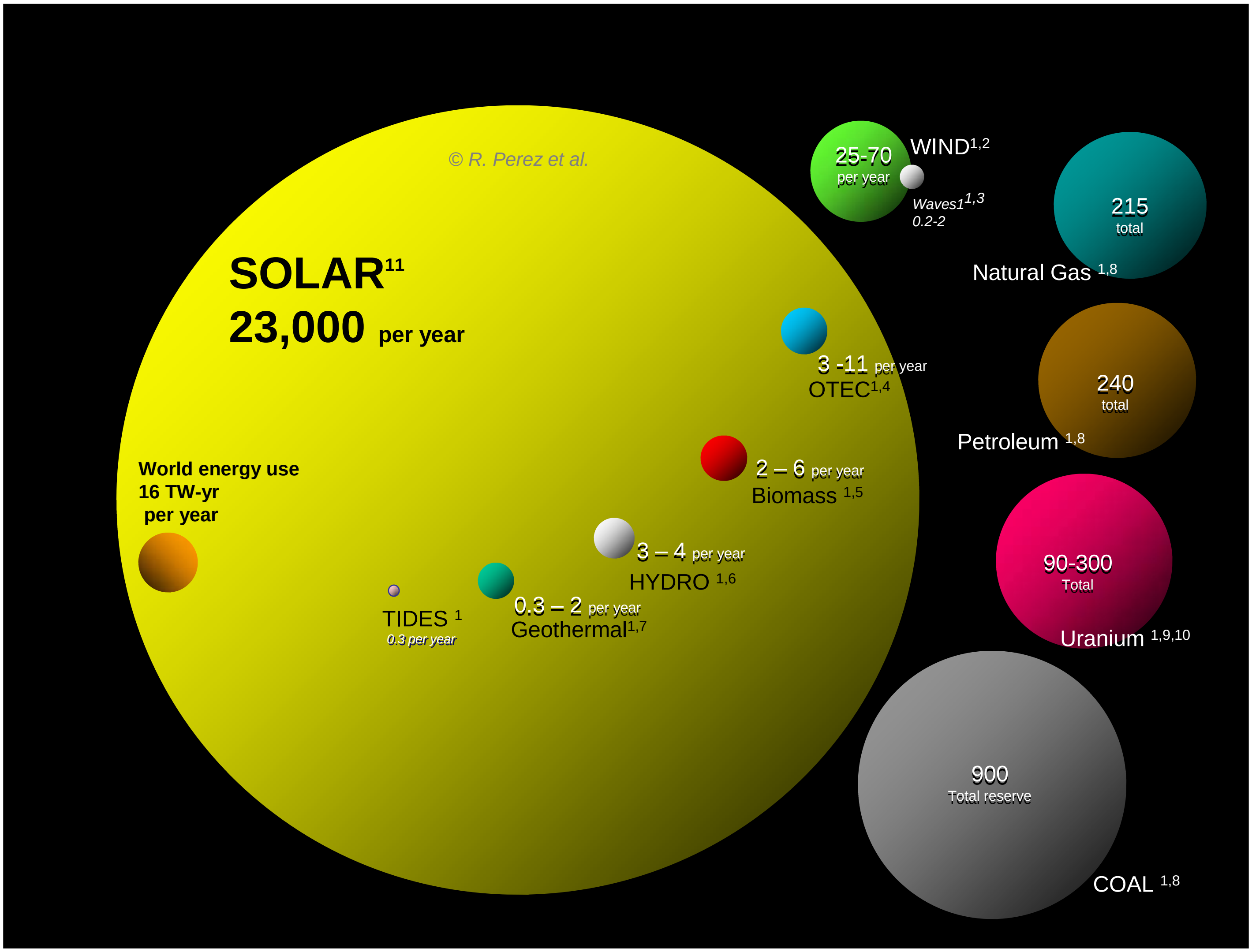

Figure 1: Comparing finite and renewable planetary energy reserves (Terawatt-years). Total recoverable reserves are shown for the finite resources. Yearly potential is shown for the renewables.

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