New Options for Electricity without Fossil Fuels

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With a new political environment in Trenton, we can look forward to the possibility of significantly improving the supply and storage of electrical power in New Jersey. Here are some directions for this:

1. Start-up of community solar projects. This allows for significantly lower cost of energy due to the economy of scale in comparison to rooftop solar (as much as a factor of 2.8). Here is a reference for this:

https://www.nrel.gov/news/press/2017/nrel-report-utility-scale-solar-pv-system-cost-fell-last-year.html

Community solar could allow for full participation of anyone and everyone in the state. Keep your house and your rooftop shaded by trees and thereby get lower air conditioning bills. Also, homes and buildings surrounded by large trees have significantly higher resale value than those without.

2. Bring in solar power from bodies of water. In other countries there is expanding use of what is known as “floating solar”. An up-to date description of this is here:

https://en.wikipedia.org/wiki/Floating_solar

and here:

http://www.powermag.com/floating-solar-panel-industry-makes-a-splash/

China and India seem to be leading in this type of development. Systems are being built with power levels as high as 150 megawatts. There is a very rapid, near exponential growth rate in this form of generation.

3. Expand offshore wind farms. As of 2018, nearly all of the largest offshore wind farms are at just two locations: Germany and the United Kingdom. A list of these is here:

https://en.wikipedia.org/wiki/Offshore_wind_power

If it works there it can also work all along the Atlantic coast. We need to give maximum support to this type of clean power.

4. Plan for new forms of large scale energy storage. With a large expansion of solar and wind power, both of which are intermittent, there is a need for either fossil fuel as back-

up power or larger and more cost-effective energy storage. The phrase energy storage today is usually thought to be from batteries. Yes, for cars, cell phones, and flashlights, batteries are the best choice. On the other hand, for large scale storage within the electricity power grid, there is only one practical cost-effective choice today, and that is pumped storage hydroelectricity or pumped hydro for short:

https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity

Worldwide today, pumped hydro represents over 95 percent of grid storage capacity. Most pumped hydro systems use a low elevation reservoir perhaps from a dam on a river to supply the water for pumped hydro. There is also usually an artificial (man-made) reservoir at the top of a nearby hill to store the potential energy. A pump-turbine assembly is used at the lowest part of the system to pump water up for storage, and to generate power with a turbine-generator when power for the grid is needed. Many people assume that all possible locations across the world for pumped hydro have already been evaluated, so we are near the limit of what we can do in this regard. This may not be correct. The assumption of a need for a reservoir of water at the lowest part of the system is a mistake. A reservoir of water at the low side is not necessary. All that is needed there is a supply of water, perhaps not from a reservoir. What this means is that the low supply of water can be from a naturally flowing river without a dam. The cost of building a dam and the environmental disturbance it creates can be completely avoided. Lest anyone think that this is a brand new idea, it is not. There are at least three examples of this in operation today, all of them in Germany, two being along the Rhine river and one along the Elbe river:

Säckingen (Owner is Schluchseewerk AG in the Black Forest, Baden-Württemberg) with 360 MW in turbine mode and 300 MW in pump mode utilizes the river Rhine. Operation started in 1967.

Waldshut (Owner is Schluchseewerk AG in the Black Forest, Baden-Württemberg) with 150 MW turbine mode and 80 MW in pump mode utilizes the river Rhine. Operation started in 1951.

Geesthacht in the North of Germany (low head application; medium head: 83m) has 120 MW in turbine mode and 96 MW in pump mode and utilizes the river Elbe. Operation started in 1958.

I wonder how many grid scale battery systems placed into use today will still be operating 60 years from now. A good guess might be zero.

Anyone who has hiked along the Appalachian trail past Sunfish pond in New Jersey and looked down at the nearby Delaware river can see that the idea described above can be replicated here just as well as in Germany.  The same could be said for many locations along the Hudson river.  Perhaps the first step to explore this idea further is to find the very best locations in North America where a river has very high nearby hills and also a sufficient volume of flow so that the flow generated by the pumped storage system is a small fraction of the flow in the river.  There is already a pumped hydro system in New Jersey just east of Sunfish pond, but it uses a dam to form its low reservoir:

https://en.wikipedia.org/wiki/Yards_Creek_Generating_Station

The upper reservoir at Yards creek is in the same part of Worthington State Forest as is Sunfish pond.

Also, there is now a plan to use Lake Mead and the Colorado River below the dam for pumped storage:

www.nytimes.com/interactive/2018/07/24/business/energy-environment/hoover-dam-renewable-energy.html

Perhaps a large portion of Lake Mead could also be used for floating solar electricity generation.  Evaporation loss of water would thereby be reduced.

Another variation on the theme of pumped storage is **off river or closed loop pumped hydro. In this case all that is needed is a high hill next to a low valley (no river).  Two separate artificial reservoirs would be built, (although a natural lake could also be used at either location).**  There is a very active study of closed loop pumped hydro by groups in Australia, and some also in the United States.

In all forms of pumped hydro, there will be at least one large body of water that could be suitable for floating solar electricity generation.  Combining these different ideas could offer a more cost effective way to expand both generation and storage to the point that we could very realistically use nothing but solar, wind, and hydroelectricity for all future grid electrical power.