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# Some Remarks on Energy Storage and Energetic Complementarity

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## Abstract

This letter to the editor presents some notes related to the technological and economic limitations of the means actually available for energy storage and highlights the role that can be played by the notion of energetic complementarity in order to make feasible alternatives for a better use of the energy resources at our disposal. The notion of complementarity may represent a major advance in the design of energy generation projects, but its application depends on a broader conception of the projects and the contexts in which they are included.

## Keywords

Energy Storage, Energetic Complementarity, Energetic Complementarity in Time, Energetic Complementarity in Space

Dear Editor,

During the last centuries, there is a big question to be answered by humans: what is the best way to store energy? There have been other questions over time that may have been more important than this in their respective historical moments, but this is one of those questions that remains for the longest time without adequate economic and technological responses. That question is a permanent challenge and each day we try to build a convincing and adequate answer.

We currently have few methods for energy storage, and we have very few means that can be efficiently used for energy storage. Many advances were done on traditional batteries, flywheels, supercapacitors, hydrogen cells, thermal fluids and so on, but all of them have restrictions for some reasons. Small energy densities, large structures required, explosion hazards or other practical limitations that, together with the environmental impacts of manufacture and use, may

constitute barriers that are difficult to transpose.

The demand for energy grows daily both with the increase of the population and with the growth of the expectation by quality of the available energy. Nowadays, we continue (in large scale, in many countries) using fossil fuels to obtain energy supplies, but all people know that we need another way to do that. In addition to environmental issues, fuel consumption is associated with centuries-old geopolitical relations that may be weakened by the advance of local use of renewable resources.

In some countries, where hydropower resources are available, this is usually done in association with large reservoirs and interconnected electrical power systems. If we remember the new solar and wind generators, working together on grid systems, we know that these contributions are limited by the availability and the characteristic intermittency of natural energy resources. And hydro can "integrate" these effects.

Why we don't use renewable resources generating energy to be stored in water reservoirs located along the space between the hills and mountains? Can we model these solutions to prove its reliability? I think so! Even in countries with low hydroelectric (and even other renewables) capability. There are modern methods and new methods coming up permanently to solve these issues and show us the best solutions.

We need to establish the location of suitable sites for use as high reservoirs in reversible hydroelectric generation schemes. So we can use the energy of the sun and the wind to pump water into these reservoirs. We already know how to competently design hybrid systems of this type, regardless of their size or scale! These water reservoirs would work obviously like large capacitors storing energy for future uses.

I agree that these studies have been carried out for several decades. But usually the projects for power generation are designed with the focus on their own generation capacity. The operation project of these plants can be conceived taking into account the interaction of these enterprises with the energy system in which they will be inserted. We must devise power systems and their storage capacity in a broader and more complete way.

One of the keys to achieving a paradigm shift in the design of energy generation systems is the insertion of the concept of complementarity in the design of solutions for obtaining energy supplies. Complementarity is a concept that must be considered by managers and decision makers to design generation systems and storage systems together, crossing borders and overcoming old business and institutional links.

The study of energetic complementarity [1] [2] and the concepts [3] [4] [5] necessary for its better understanding have been advancing in the last years and have been attracting the attention of groups of researchers around the world. The complementarity inserted in the design of the projects will allow a better use of available renewable resources and a better design of devices for energy conversion.

Obviously, the project design process must take into account a huge number of factors, including legitimate environmental concerns and also the possible multiple uses of water and other renewable resources. On the other hand, a broader conception of projects should possibly provide new design parameters for so many factors.

The application of the concept of energetic complementarity in project design, extending the connection of projects beyond political or economic boundaries, will allow a long-term planning for obtaining energy supplies, overcoming even regional difficulties imposed by climatic factors.

An effort of this extension will require joint work of engineers, geologists, climatologists, environmental experts, and other specialists, improving our ability to analyze both in continental scenarios and in local scenarios. Can we do this before the time is over?

## References

[1] Beluco, A., Souza, P.K. and Krenzinger, A. (2008) A Dimensionless Index Evaluating the Time Complementarity between Solar and Hydraulic Energies. *Renewable Energy*, **33**, 2157-2165. https://doi.org/10.1016/j.renene.2008.01.019

[2] Hoicka, C.E. and Rowlands, I.H. (2011) Solar and Wind Resource Complementarity: Advancing Options for Renewable Electricity Integration in Ontario, Canada. *Renewable Energy*, **36**, 97-107. https://doi.org/10.1016/j.renene.2010.06.004

[3] Beluco, A., Souza, P.K., Livi, F.P. and Caux, J. (2015) Energetic Complementarity with Hydropower and the Possibility of Storage in Batteries and Water Reservoirs. In: Sørensen, B., Ed., *Solar Energy Storage*, Academic Press, London, 155-158. https://doi.org/10.1016/B978-0-12-409540-3.00007-4

[4] Denault, M., Dupuis, D. and Couture-Cardinal, S. (2009) Complementarity of Wind and Hydro Power: Improving the Risk Profile of Energy Inflows. *Energy Policy*, **37**, 5376-5384. https://doi.org/10.1016/j.enpol.2009.07.064

[5] Kougias, I., Szabó, S., Monforti-Ferrario, F., Huld, T. and Bódis, K. (2016) A Methodology for Optimization of the Complementarity between Small Hydropower Plants and Solar PV Systems. *Renewable Energy*, **87**, 1023-1030. https://doi.org/10.1016/j.renene.2015.09.073