June 2023 | Hugo Björling, Nora Jaredson Lilja | Lund University

Hybrid^2

Leveraging Hydrogen and Batteries for Flexible and Profitable Renewable Energy Production

Unlocking the full potential of renewable energy, this study unveils an operational strategy leveraging hybrid energy storage systems to maximise profit by choosing between hydrogen production, electricity storage, and grid delivery based on market prices.

Have you wondered how the green transition should be accelerated, especially seeing the problems we have with intermittence of renewable energy sources (RES)? Well, one solution for this is the increased development of hybrid energy storage systems (HESS), using both hydrogen and batteries. The research provided in our masters thesis demonstrates that HESSs provide a means to make wind and solar production plannable within the hour and highlights the potential for hydrogen market development. By leveraging price variations, HESS can generate revenue and enhance the plannability of variable RES.

The research is relevant due to the pressing need for climate action, the need for plannable energy production, the challenges posed by high electricity prices, and the growing demand for hydrogen gas. By making renewable energy production plannable, grid stability can improve while investments become more profitable, ultimately impacting your electricity security and wallet. Also, making HESS as profitable as possible contributes to the increased development of the hydrogen market, which can be a good solution to decarbonising hard-to-reach sectors such as transportation and industry. Alas, the solution addresses critical needs in the energy transition.

The findings of the thesis have practical implications and point to potential future applications. One integral part of the study was to find sound dimensions for components in a HESS to enable technical functionality and economic viability. The optimised HESS configuration provides a blueprint for future investments in renewable energy systems. The system comprised of the appropriately set dimensions demonstrated a very high profitability, which highlights the economic benefits of exploring investments in HESS.

One intriguing aspect is that the study found that hydrogen gas sales are a major driver of profit. This finding indicates the potential for the hydrogen market to grow and contribute to sustainable energy solutions beyond electricity generation. Another interesting find was that hydrogen may be better suited as an energy storage medium as opposed to direct electricity storage, because of the poor profitability of fuel cells in this application. This highlights that fuel cells may be more appropriate for other applications (e.g. transport), or with other economical circumstances where controllability is highly valued, or after increased advancements in the technology.

The research method involved the construction of a model in the OpenModelica software that simulates a system with wind and solar power as well as a HESS. The developed strategy comprises two parts: an economic component that plans based on current market conditions and future production forecasts, and a technical component that ensures continuous electricity supply and component protection. The method also consists of a literature review and techno-economic dimensioning of components utilising and investment appraisal of the system.

In conclusion, this study showcases the potential of HESS in making RES plannable and driving the growth of the hydrogen market. HESS offers practical solutions to issues regarding intermittent RES and sustainability in both transportation and industry. The research can serve as an indicator of how to make these investments profitable and underscores the importance of acting to leverage the future opportunities in renewable energy and hydrogen markets.

This popular scientific article is based on the master thesis: *Harnessing Hydrogen and Batteries: Hybrid Energy Storage System for Versatile and Profitable Renewable Power Production* written by Hugo Björling and Nora Jaredson Lilja (2023).