

SAARC Webinar

on



“Pumped Storage Hydropower: Opportunities and Challenges in SAARC Region”

Market Mechanisms and Investment Risk for PSH Projects

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Pricing Mechanisms for PSP - Long-Term Power Purchase Agreement (PPA)

- Calculate levelized cost of storage
- Provision for pumping energy (captive solar or DISCOM provides it)
- Long-term agreement - revenue certainty for developer; assured capacity for DISCOM
- Is it the best deal for both parties?
- Project delays may increase tariffs (e.g., Tehri PSP in India)

Wholesale Energy Markets - Energy Arbitrage

- Let demand-supply balance decide the cost of wholesale electricity
- Many countries (including India) have adopted wholesale electricity markets starting from the 1990s.
- Market competition is expected to reduce cost of electricity...no clear evidence yet
- **Energy arbitrage opportunity** - PSP earns revenue from peak and off-peak price differential
 - ✓ Price cap is key (India - Rs. 10/unit vs. average of Rs. 5.51/unit; PJM, USA - \$3.75/unit in PJM vs \$0.08/unit¹)
 - ✓ Can we guarantee sufficient price differential for long term?

¹: <https://www.thehindubusinessline.com/markets/india-only-market-with-no-substantial-decline-in-electricity-prices-in-2023/article67813002.ece>;
https://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2022/2022-som-pjm-press-briefing.pdf; <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/electric-power/021622-pjm-to-propose-updated-maximum-energy-reserve-product-price-caps-to-ferc>

Capacity Markets

- Alternative to long-term PPA
- Capacity requirements for short, mid and long terms are identified and market players compete to meet the requirements
 - ✓ e.g., PJM uses auction approach in its capacity market¹
- Provides more certainty for PSP developer than just energy markets
- More capacity than required may be procured
 - ✓ Procured too much fossil-fuel based capacity...over 26 GW now considered unreliable increasing cost of new capacity²

¹<https://www.enelx.com/n-a/en/stories/your-definitive-guide-pjm-capacity-auctions>

²<https://www.nrdc.org/bio/claire-lang-ree/pjms-capacity-auction-real-story>

Government Support

- Tax breaks and subsidies
- Facilitation of land acquisition
- Streamlined siting and permitting process
- Government pays for some costs
- Special auctions to only procure energy storage, including PSP
- R&D support

China

▪ Two-Part Tariff

- It comprises of fixed, annual capacity-based payment and generation-based tariff
- The capacity payment will recover most of the fixed costs and related taxes and provides remuneration for ancillary services
- The generation tariff is designed to make up for the variable costs in operation such as pumping and generation losses

▪ Capacity-based Lease Arrangements

- An annual payment for the project owners is set to rent the facility to the grid company.
- The payment will cover the total costs of the project (excluding the cost of electricity in pumping operation) and taxes, and generate approximately 5% rate of return.
- The amount of payment is irrespective of the amount of electricity generated and the fluctuation of electricity price, hence allowing the grid operator to dispatch the pumped storage station in the manner that provides most benefit to the system (Kumar et al., 2023).

Japan

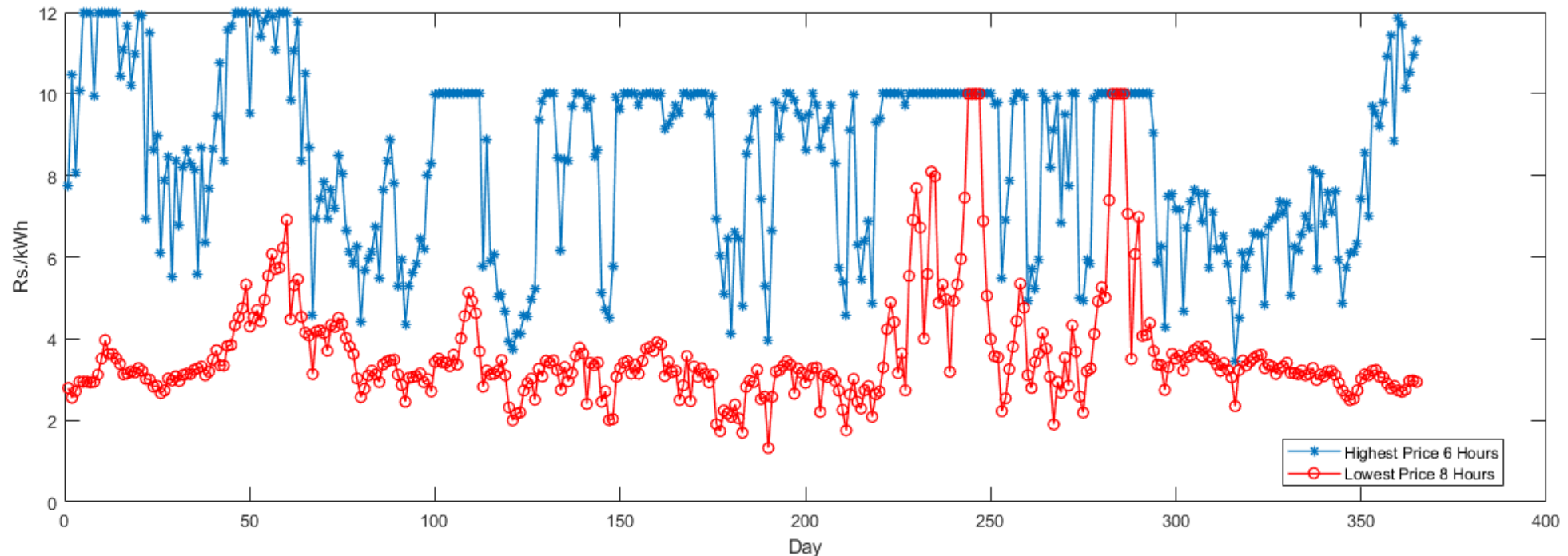
- Energy arbitrage opportunities via spot market
- Price certainty through capacity market
- Government support for PSP through R&D (e.g., sea water-based PSP) and taxes and subsidies (exact levels unknown)
- The Organization for Cross-regional Coordination of Transmission Operators (OCCTO) in Japan conducted Long-term Decarbonisation Power Source Auction in January 2024
 - ✓ A total 1.67GW of projects won contracts, including 32 battery energy storage system (BESS) totaling 1.1GW and three pumped hydro energy storage (PHES) projects totaling 577MW

USA

- Several tax credits available to renewable energy resources including hydropower
 - ✓ E.g., Production tax credit provides \$5.50/megawatt-hour + additional credit of \$22.00/megawatt-hour if labor standards are met
 - ✓ PTC is available for projects beginning construction before 2025
- 40% of electricity under vertically integrated utilities; 60% under wholesale markets
- Business models available - Long-term PPAs, energy arbitrage, capacity markets
- 25-year PPA signed by LADWP, California for 400 MW of solar and 800 MWh of energy storage in California's Central Valley
 - ✓ Capacity market mechanism in CAISO - around \$7.7/kW-month paid for capacity contracts...energy storage assets must be able to deliver rated power for four hours to participate
 - ✓ Capacity market mechanism in PJM - capacity payment is only made for the power level that can be sustained for at least 10 hours (advantage PSP!)

Business Models of PSP in India

- Long term PPA
- Round the clock power (PSP + solar/wind hybrid)
- Energy arbitrage exists but unlikely to be profitable on its own
- Currently working to develop business models for PSP in India...results by middle of next year



Developing Business Models

- Qualitative analysis or modelling
- Modelling is better...provides data to back logic
- We are using optimization approaches for developing business models for India

Given:

- ✓ Spot price curves
- ✓ Ancillary services price
- ✓ Storage volume under contract
- ✓ PPA tariff in Rs./MWh

Find:

- ✓ What fraction of 1 MW should be sold in spot market, ancillary services market, and under contract to maximize profit
- Own tools can be developed or commercial/open source production cost simulation software can also be used

Key Takeaways

- PSP is required for ensuring reliable power supply under high RE levels
- PSP business models in India and South Asia is challenging because market is very sensitive to price increases
- Business models are unique to each country...even developed countries providing government support
- Modelling in optimization software provides a good way for developing customized business models



Thank You

