

## European Solar Energy Storage

# Pumped hydro energy storage costs



## Overview

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Does pumped storage hydropower use financial assumptions?

Pumped storage hydropower does not calculate levelized cost of energy (LCOE) or levelized cost of storage (LCOS) and so does not use financial assumptions. Therefore, all parameters are the same for the research and development (R&D) and Markets & Policies Financials cases. 2024 ATB data for pumped storage hydropower (PSH) are shown above.

How much does pumped hydro cost?

To read more about pumped hydro costs and economics, please see our article [here](#). This data-file is included as part of TSE's Full Subscription. Pumped hydro costs run at \$2,250/kW for a 0.5GW x 12-hour storage facility. We model a 25c/kWh storage spread to generate a 10% IRR.

What is a pumped storage hydropower plant?

Pumped storage hydropower (PSH) plants are a sizable part of the energy mix in the U.S., with 40 PSH plants in operation in 2015, totaling about 22 GW in installed capacity (DOE 2016) and an estimated 553 GWh of energy storage (Uria-Martinez et al. 2021).

What is NREL's cost model for pumped storage hydropower technologies?

With NREL's cost model for pumped storage hydropower technologies, researchers and developers can calculate cost and performance for specific development sites. Photo by Consumers Energy. Pumped storage hydropower (PSH) plants can store large quantities of energy equivalent to 8 or more hours of power production.

How much storage does a pumped hydro project need?

In a best case scenario, it may be possible to reduce total storage spread to around 10c/kWh; while more marginal projects will require above 50c/kWh. To read more about pumped hydro costs and economics, please see our article

here. This data-file is included as part of TSE's Full Subscription.

Is Pumped Storage Hydropower (PSH) energy limited?

Like every other energy storage technology, PSH is energy limited and cannot meet the requirements of every service simultaneously. There is competition for the energy in the PSH unit, with intertemporal competition being a key factor.

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### Pumped Storage Hydropower Capabilities and Costs

The paper provides more information and recommendations on the financial side of Pumped Storage Hydropower and its capabilities, to ensure it can play its necessary role in the clean energy transition.

### The Cost of Pumped Hydroelectric Storage

Here we will take a closer look at the cost of pumped water storage vis-à-vis batteries and conventional methods in order to understand the best options available.



### How do the operational costs of pumped hydro storage compare ...

Operating costs are relatively low, typically a fraction of a cent per kWh. Efficiency: Modern PHS facilities achieve an efficiency rate of about 85%, meaning they lose about 15% of the energy stored during the cycle.

### How do the costs of pumped hydro storage compare ...

Comparing the costs of pumped hydro storage

(PHS) to other energy storage solutions involves examining both capital costs and operating characteristics. Here's a breakdown of how PHS compares:



## Pumped Storage Hydropower , Electricity , 2024 , ATB , NREL

Operation and maintenance (O& M) costs and round-trip efficiency are based on estimates for a 1,000-megawatt (MW) system reported in the 2020 DOE Grid Energy Storage Technology Cost and Performance Assessment (Mongird et al., 2020).



## Pumped Storage Hydropower Capabilities and Costs

Capital expenditure (CAPEX) represents the upfront investment costs to develop a storage facility; often quoted as cost per unit of power capacity (kW) installed (typically for rapid response systems), or cost per unit of energy storage (kWh) installed (for diurnal / bulk scale systems).



## Pumped Storage Hydropower Valuation Guidebook

As an energy storage technology, pumped storage hydropower (PSH) supports various aspects of power system operations. However, determining the value of PSH plants and their many services and contributions to the system has been a challenge.



## Pumped Storage Costs

The short run marginal cost of producing energy using a pumped storage hydroelectric turbine is the cost of pumping water to the reservoir divided by the pumping efficiency of the unit.



## **Pumped Storage Hydropower Cost Model , Water Research , NREL**

With NREL's cost model for pumped storage hydropower technologies, researchers and developers can calculate cost and performance for specific development sites.

## **How do the costs of pumped hydro storage compare to other energy**

Comparing the costs of pumped hydro storage (PHS) to other energy storage solutions involves examining both capital costs and operating characteristics. Here's a breakdown of how PHS compares:

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