EGU General Assembly 2021

# Revisiting the storage-reliability-yield concept in hydroelectricity (EGU21-10528)

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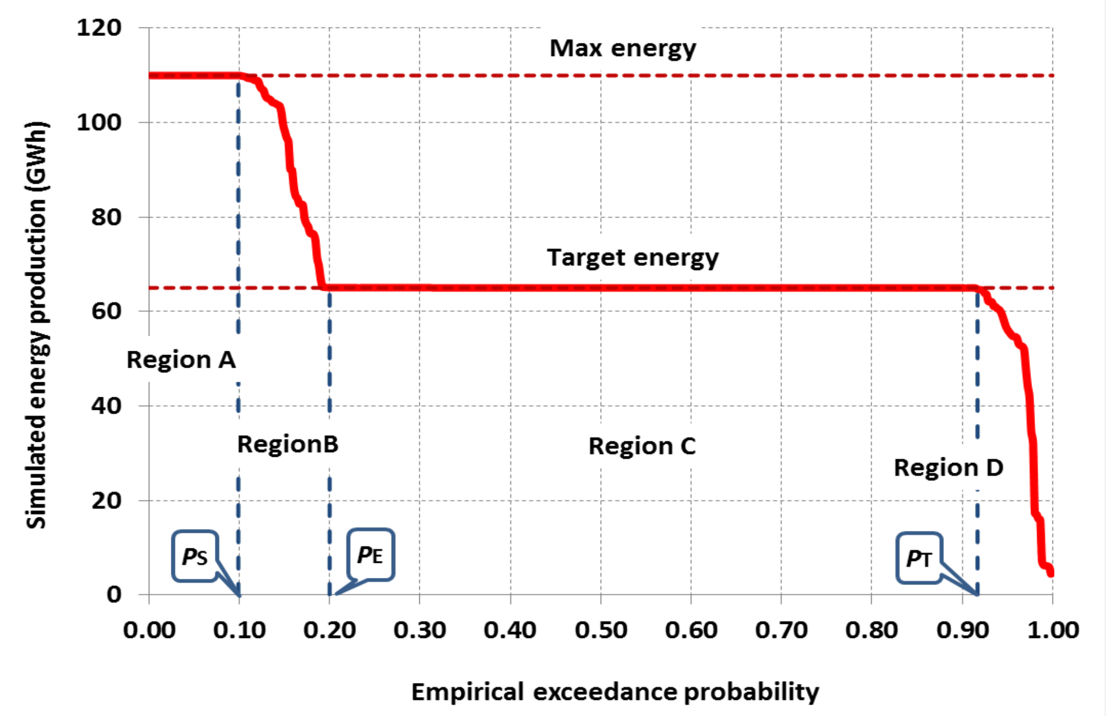
## 1. Water supply vs. hydroelectric reservoirs

- Water supply delivered locally vs. hydropower delivered to **large-scale interconnected grids**.
- Outflows driven by the water demand vs. releases dictated by a **target energy** and the **head**.
- Hydroelectric systems allow for employing **surplus releases to avoid spill losses**, by taking advantage of the excess capacity of turbines.
- Simple water balance calculations vs. complexities induced by **non-linearities across storage-head-energy conversions**.

Common framework for representing the storage-reliability-yield trade-offs: **stochastic simulation**

## 2. Overview of reservoir operation via the simulated energy-probability curve

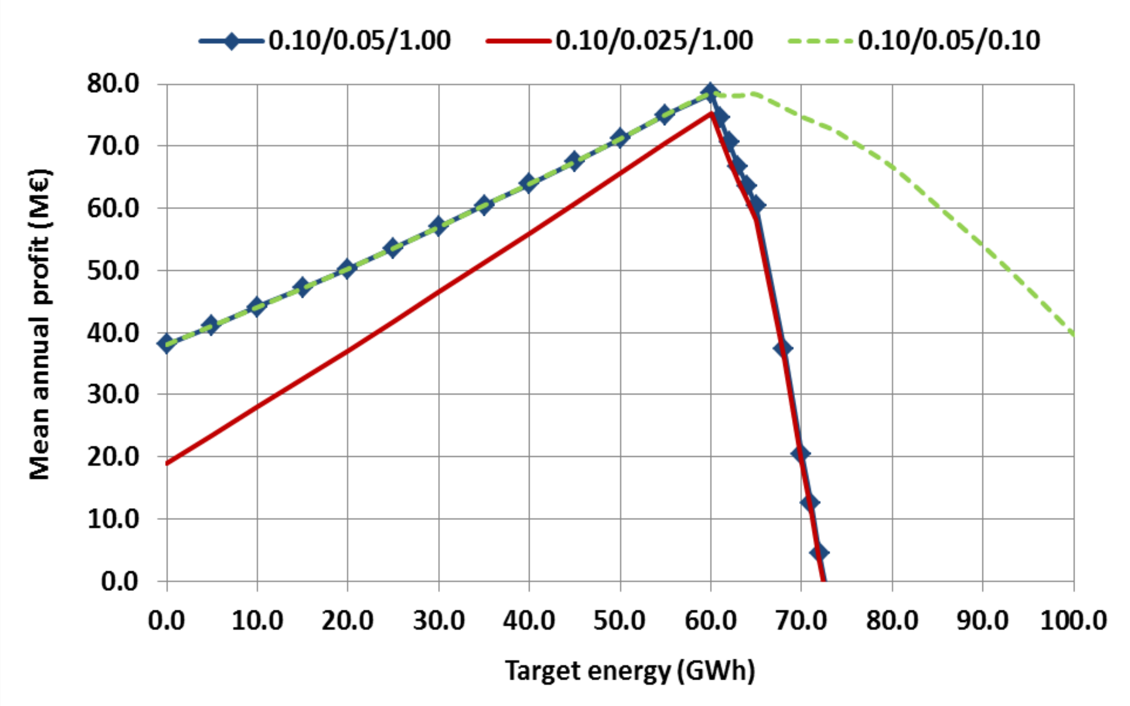



## 3. SRY concepts adapted to hydroelectricity

- **Reliable (firm) energy**: steady-state target energy production, fulfilled with a given reliability
- **Reliability**: probabilistic quantity, estimated empirically, by encountering for energy deficits over a simulation period (in the context of hydropower, this should be very high, e.g. 99% on monthly basis)
- **Secondary energy**: excess (up to the target) energy produced by surplus releases through the turbines

## 4. Insights into the optimization problem

- **Control variable** = target energy production
- Pseudo-economic **objective function** (mean annual profit) reflecting the different **market prices** of reliable vs. secondary energy and energy deficits
- Ensures maximization of reliable energy

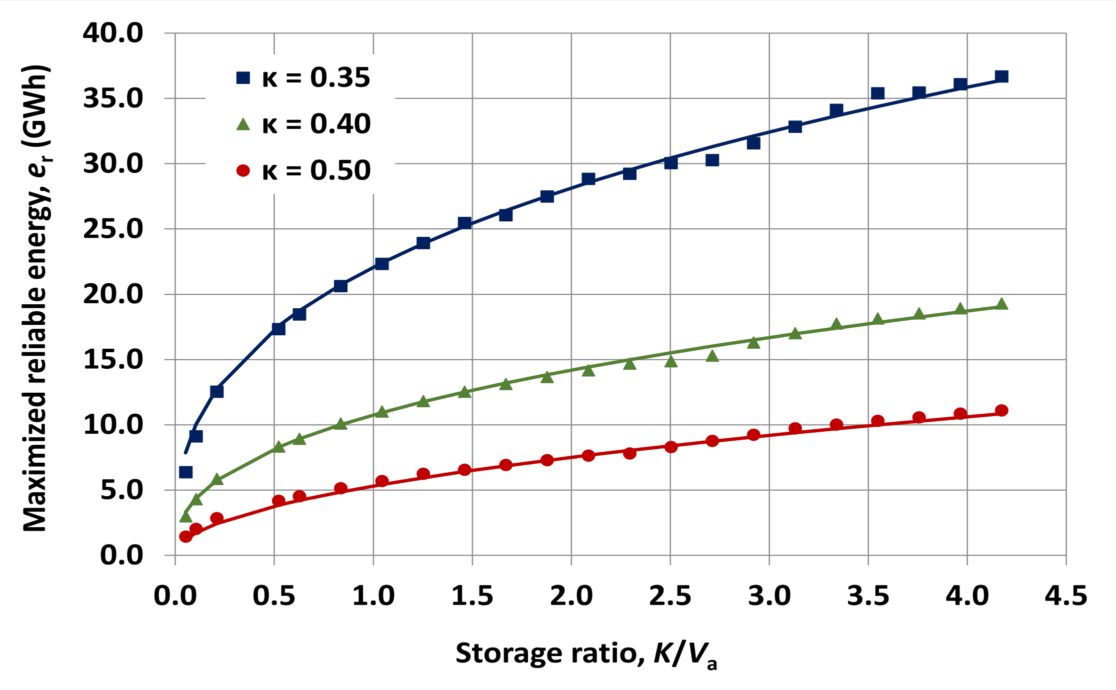



## 5. Simulation experiments

- Synthetic inflow data (5000 years) reproducing the hydrological regime of three rivers in Greece
- Two operational modes (base and peak energy)
- 7 reservoir geometry patterns, in terms of shape parameter, $\kappa$, of a generic storage-elevation function
- Simplified assumptions in layout and conversions
- Empirical formula for 99% reliable energy, $e_\alpha$, as function of the **storage ratio** and **shape parameter**

$$e_\alpha = \frac{1}{\beta\kappa - \delta}\left(\frac{K}{V_\text{a}}\right)^\kappa$$

$K$: reservoir capacity; $V_\text{a}$ : mean annual inflow; $\beta, \delta$: hydroclimatic parameters




**Info:** Efstratiadis, A., I. Tsoukalas, & D. Koutsoyiannis, Generalized storage-reliability-yield framework for hydroelectric reservoirs, *Hydrol. Sci. J.*, 66(4), 580–599, doi:10.1080/02626667.2021.1886299, 2021.