Hydro + Storage

Flexibility to enhance services and enable new capabilities

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Idaho National Laboratory

Argonne NATIONAL LABORATORY

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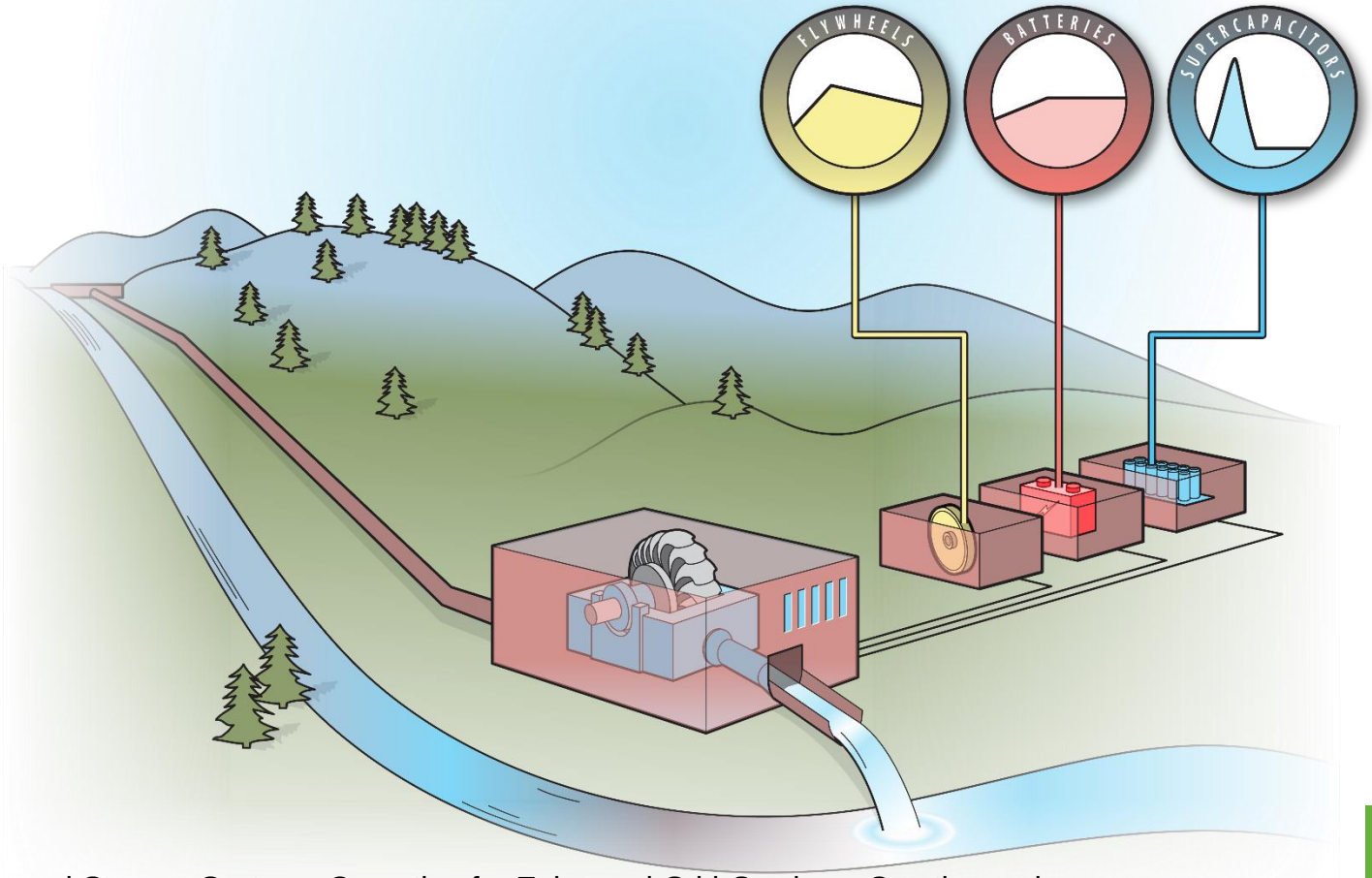
Integrated hydropower and energy storage[1]

Increasing flexibility through "virtual reservoirs"

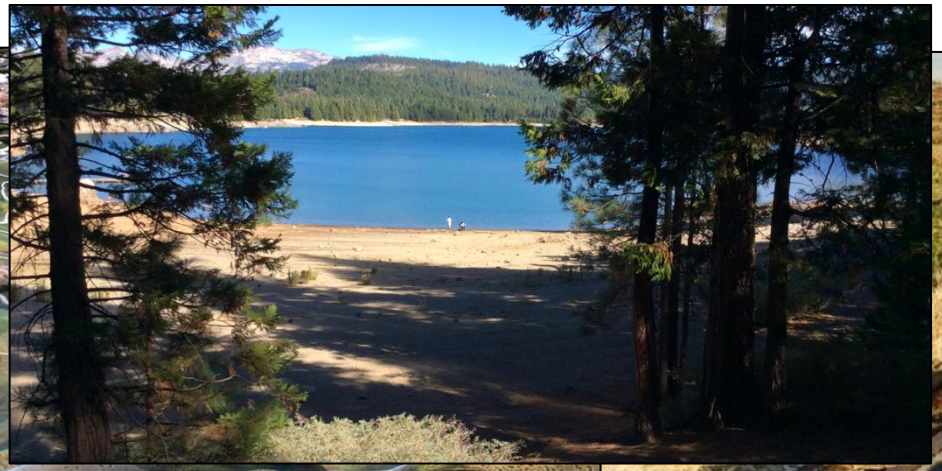


[1] Integrated Hydropower and Storage Systems Operation for Enhanced Grid Services: Creating and Demonstrating "Virtual Reservoirs" (Forthcoming).

Even dispatchable hydropower plants have limits to their flexibility

- Ice House Dam flow requirements in FERC license:
  - Minimum monthly flows (fishing and habitat)
  - Minimum daily flows (recreation/boating)
  - Maximum ramp rate (safety and habitat)
  - Maximum discharge capacity (safety)
  - Pulse requirements (mimic natural variability)

Sources: KOIN, Idaho News, American Water College, Phys.org, and Portland Monthly

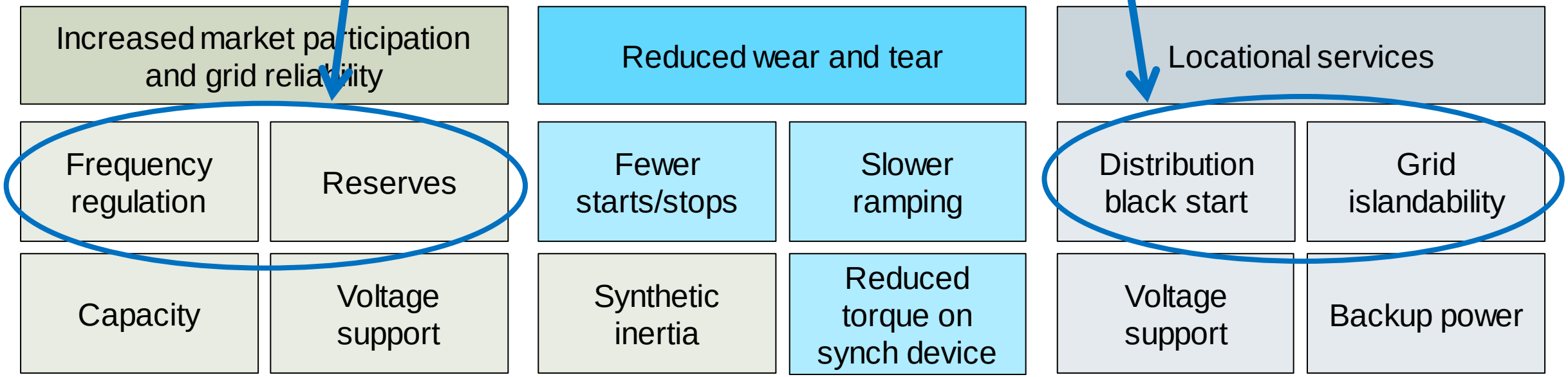


Increased flexibility from integrated storage enables diverse benefits

Examples with Idaho Falls Power highlight two markedly different use cases

Case study on enhanced market revenue

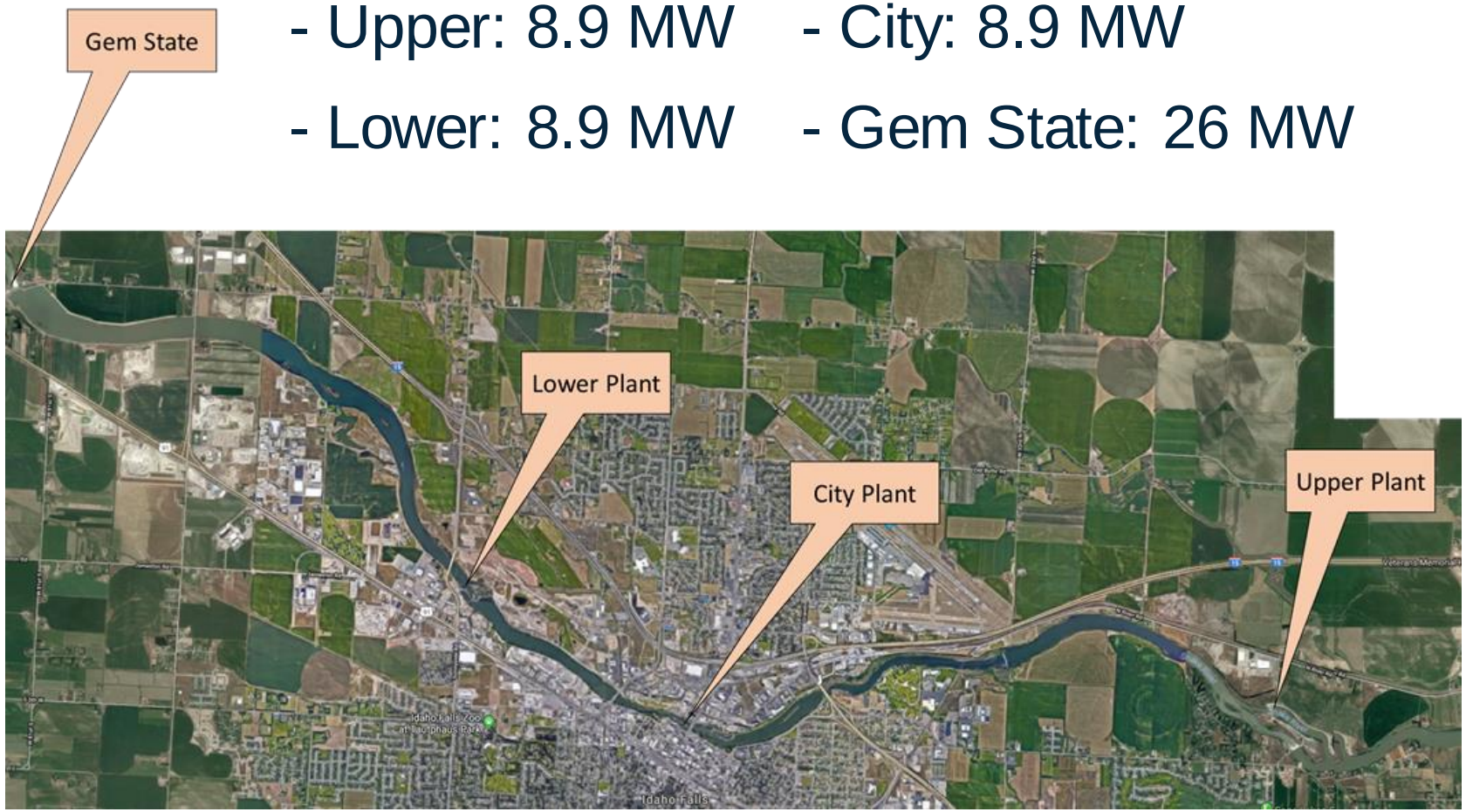
Field demonstration on local resilience capabilities (now postponed)



Idaho Falls Power: municipal hydropower utility on the Snake River

Four run of river hydropower plants:

- Upper: 8.9 MW
- City: 8.9 MW
- Lower: 8.9 MW
- Gem State: 26 MW

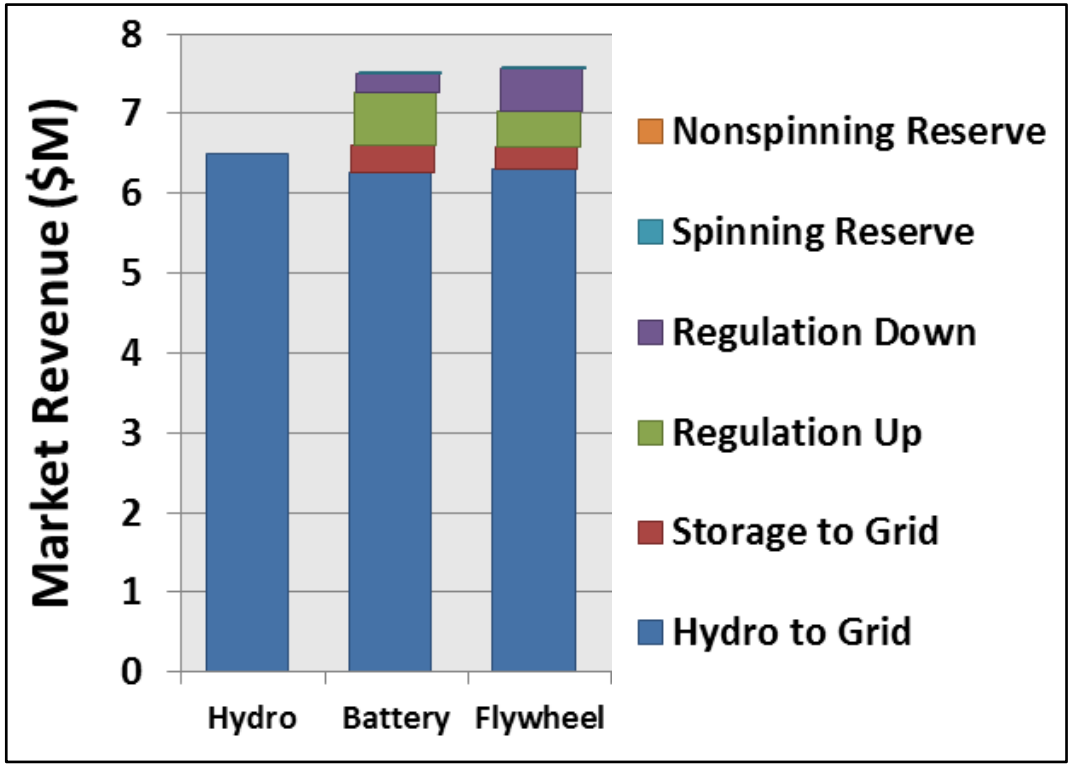


- These plants connected to the distribution and sub-transmission systems.
- Under normal conditions, balancing is performed by Rocky Mountain Power.

Integrated Storage can boost ancillary service market participation:
Case study based on four run of river hydropower plants

Revenue increases due to integrated energy storage:

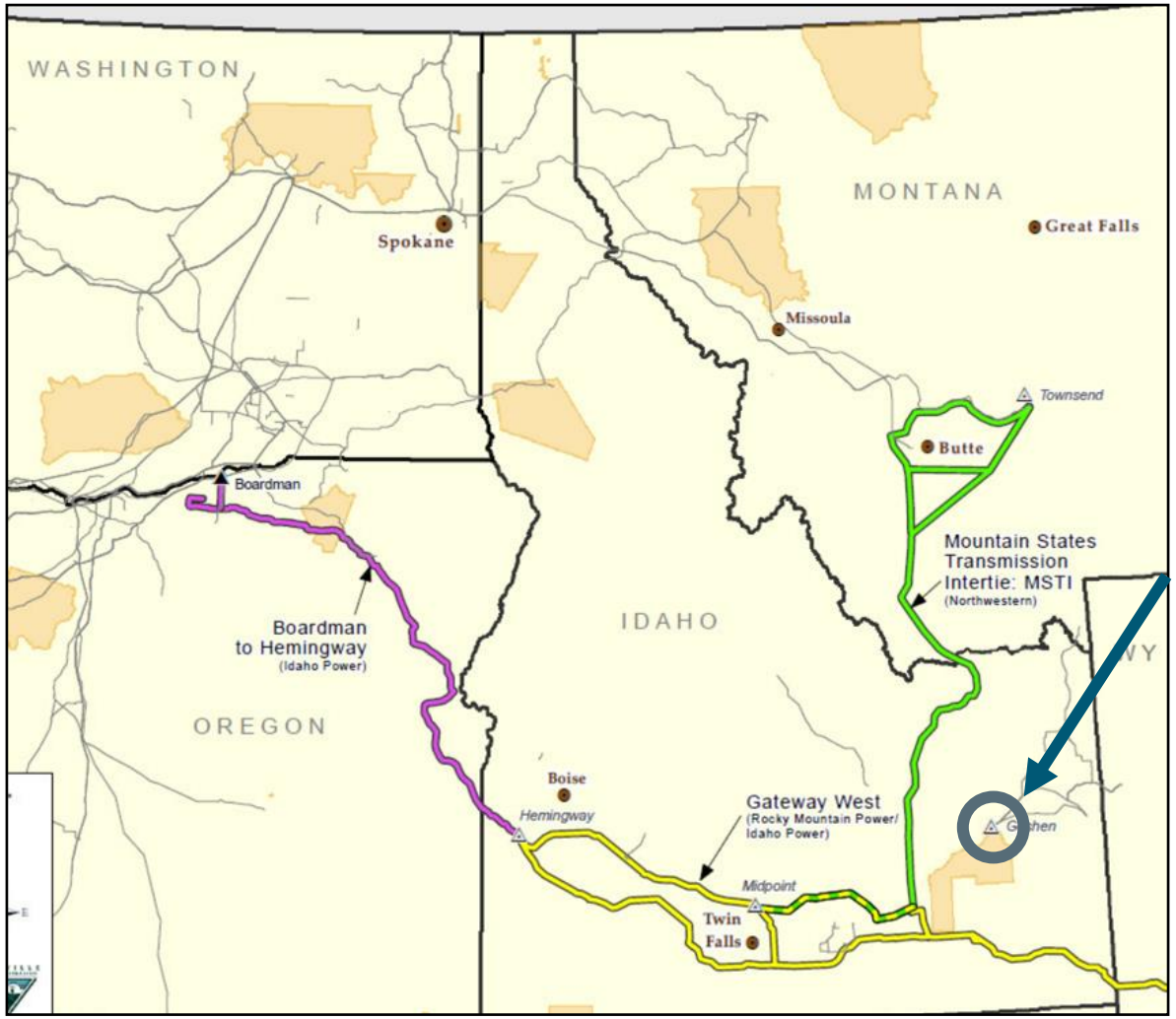
- Battery: +12.2% to +15.8%
- Flywheel: +12.0% to +16.3%
- Range is based on market assumptions



CHEERS model by Argonne optimizes market participation

- Uses range of CAISO market conditions
- Maximizes revenue over each 24-hour period
- Energy storage likely oversized and not optimized to maximize financial performance

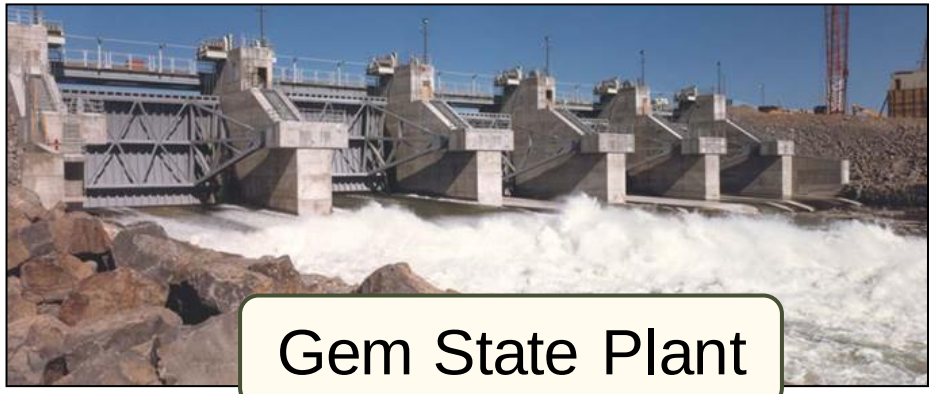
Idaho Falls Power provides critical services for Eastern Idaho and would like to enhance resilience of electric supply



Idaho Falls connection to transmission system

Goshen Wind Project

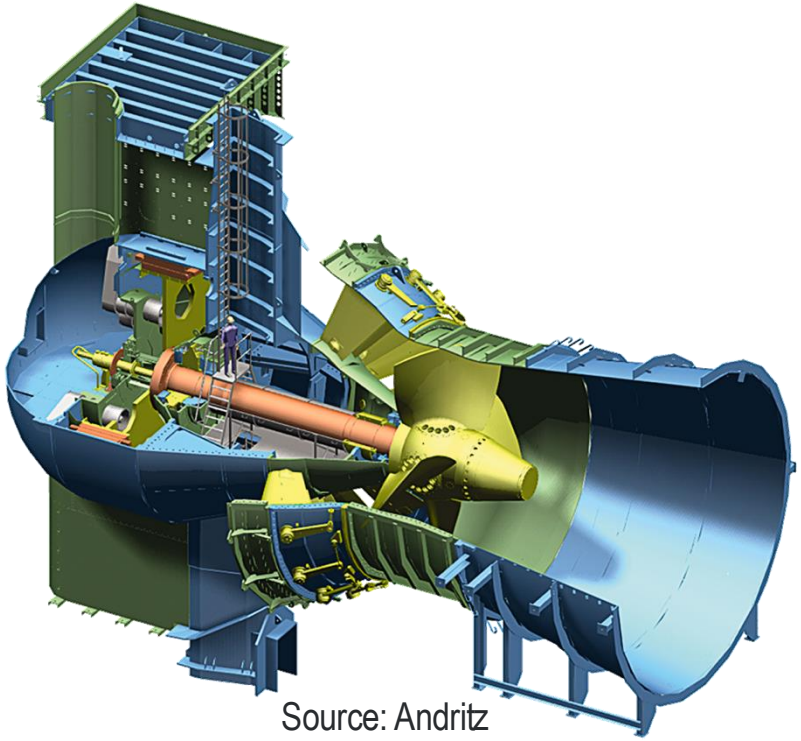
Credits: BP Energy and IFP



Gem State Plant

Integrated storage can enable new capabilities:
Islanding and black start using small, low-head hydropower

- IFP's ROR hydropower plants are tied to distribution but unable to use them for black start or islanded operation because they cannot ride through step changes.
- Integrated storage can sufficiently enhance stability properties to enable these uses.



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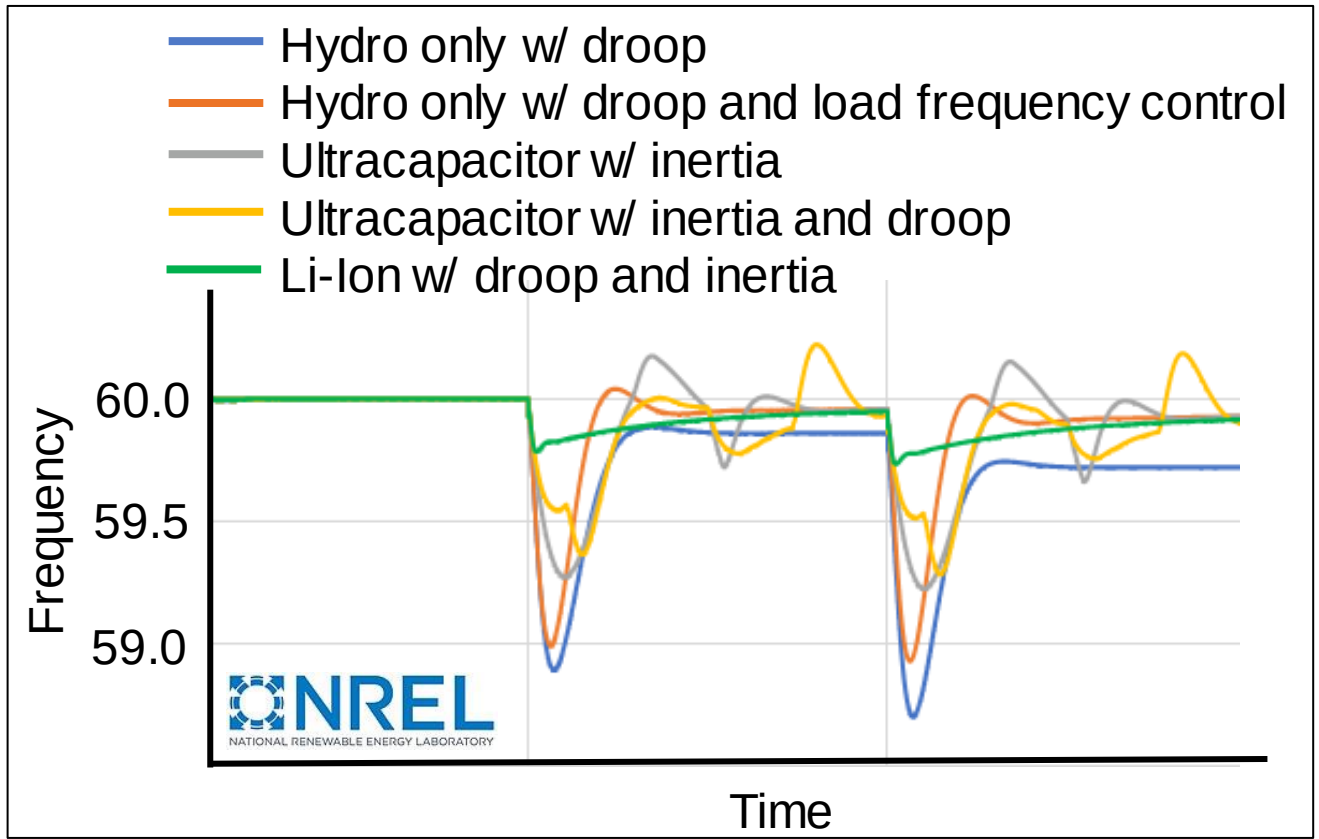

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What would you do with the extra flexibility?

Frequency regulation	Slower ramping
Distribution black start	Capacity
Fewer starts/stops	Grid islandability

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