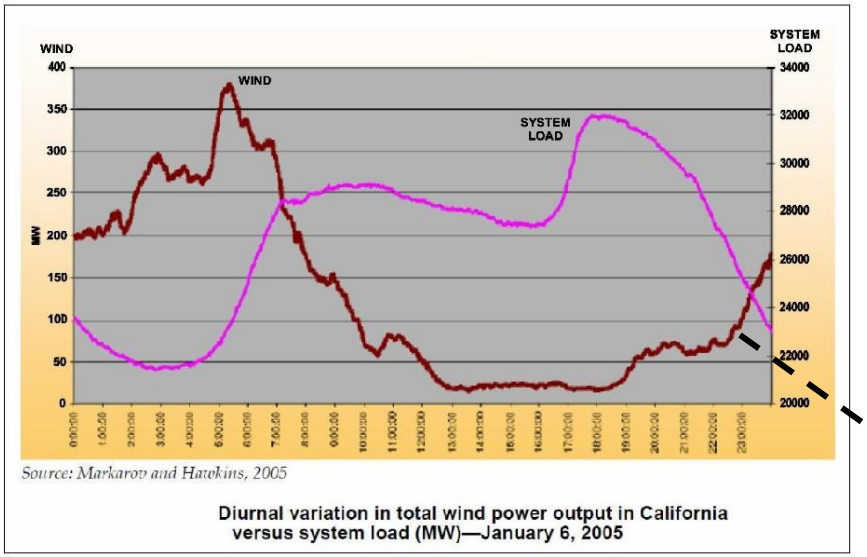
Grid-Scale Electricity Storage Overview

October 2010

Business Plan

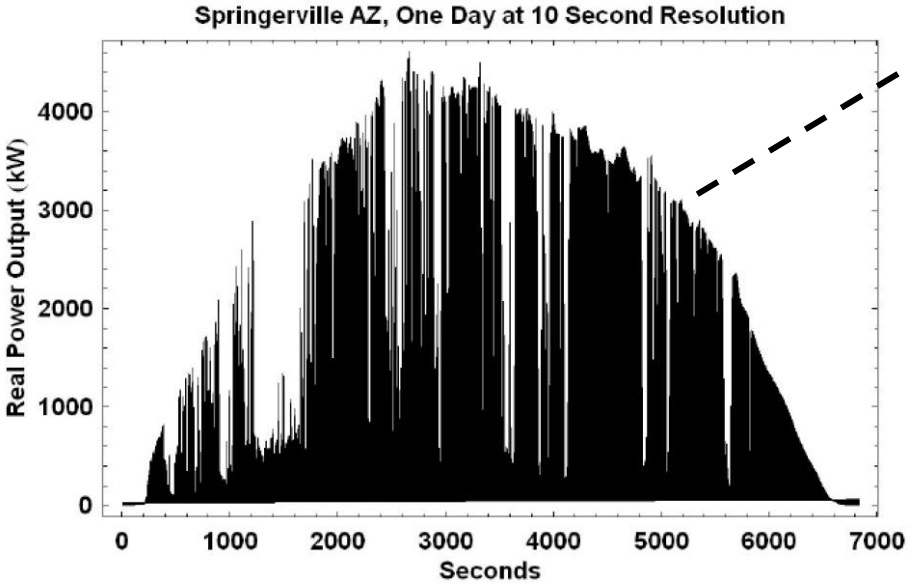
- **Company Goals:**
  - **Build large scale electricity storage systems superior to power plants and current energy storage technologies**
  - **Sell systems and/or energy services under contract to utilities**
  - **License technology in strategically selected markets**
- **Development Sequence:**
  - **Phase 1: Prototype Development & Test (2010-2011)**
  - **Phase 2: Ancillary Service Plant Commercialization (2011+)**
  - **Phase 3: Peaking Plant Commercialization (2013+)**

The Grid: Huge Supply Chain with No Warehouse



Source: Markarov and Hawkins, 2005

Diurnal variation in total wind power output in California versus system load (MW)—January 6, 2005



- **US generation capacity: 1088 GW**
- **US storage capacity: 22 GW**
- **Fast growing renewable energy is causing severe problems:**

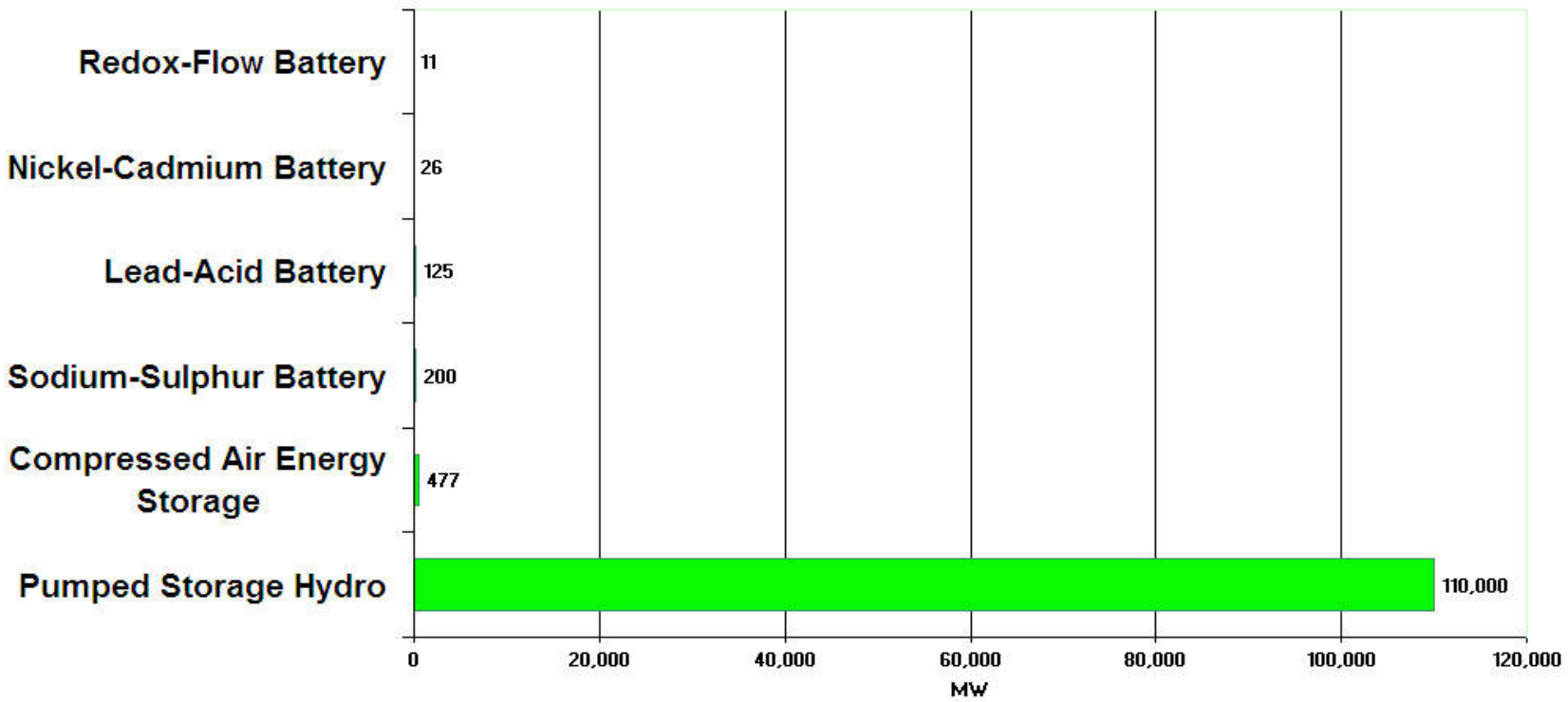
Wind is variable….

Solar is worse….

…but the grid can't compensate – it requires dispatchable energy.

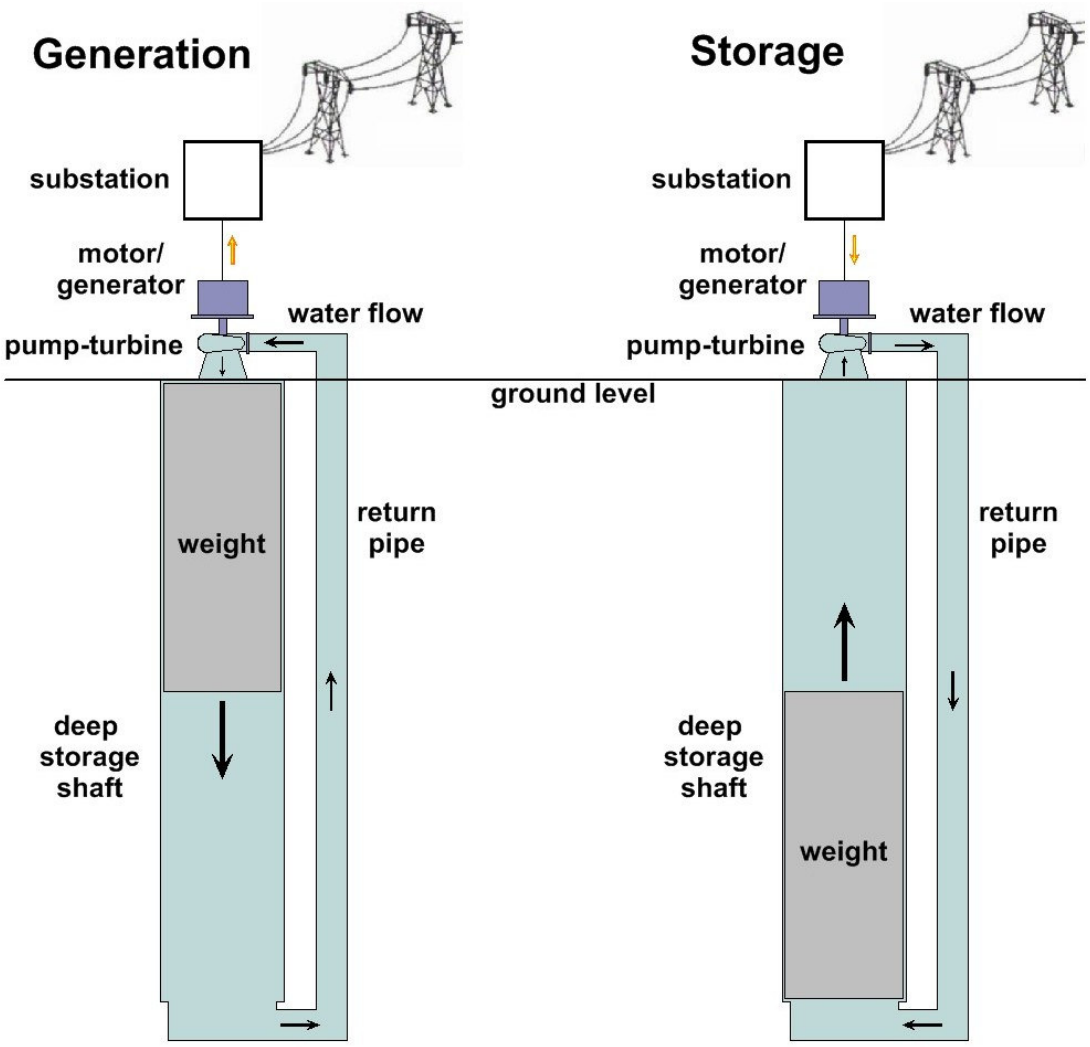
Energy storage is the only viable solution

Worldwide Energy Storage Capacity



- **Pumped Storage Hydro (PSH) is the only commercially successful bulk storage technology.**
- **Many more PSH installations would exist if not for all its problems.**
- **Gravity Power can solve those problems.**

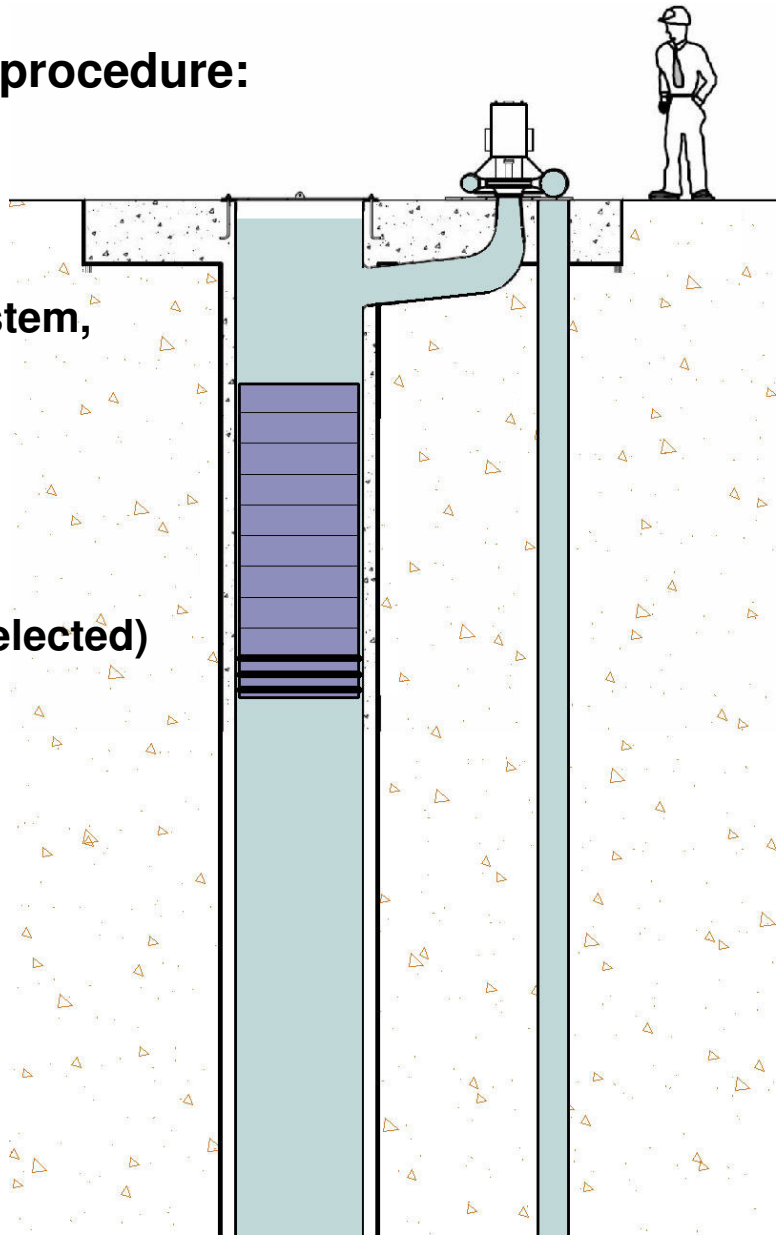
The Gravity Power Module (GPM)



- Modular, underground pumped storage
- High efficiency (75-80%)
- Ramps far faster than gas turbines (peaking plants)
- Low cost materials (cement, iron ore, steel)
- Environmentally benign
- Flexible siting
- Fast permitting
- Rapid construction
- Expandable
- Short time to revenue
- Patents Pending

Prototype Development

- **Follows standard hydropower industry procedure:**
  - **Design→simulation →tests at sub-scale**
- **Design & simulate:**
  - **Pump-turbine, weights, seals, power system, controls, system dynamics**
- **Fabricate at sub-scale:**
  - **Pump-turbine**
  - **Complete GPM (1.5m x 60m shaft, site selected)**
- **Test and validate**
  - **Component capabilities**
  - **System operation & dynamics**
- **Design advanced shaft-boring machine**



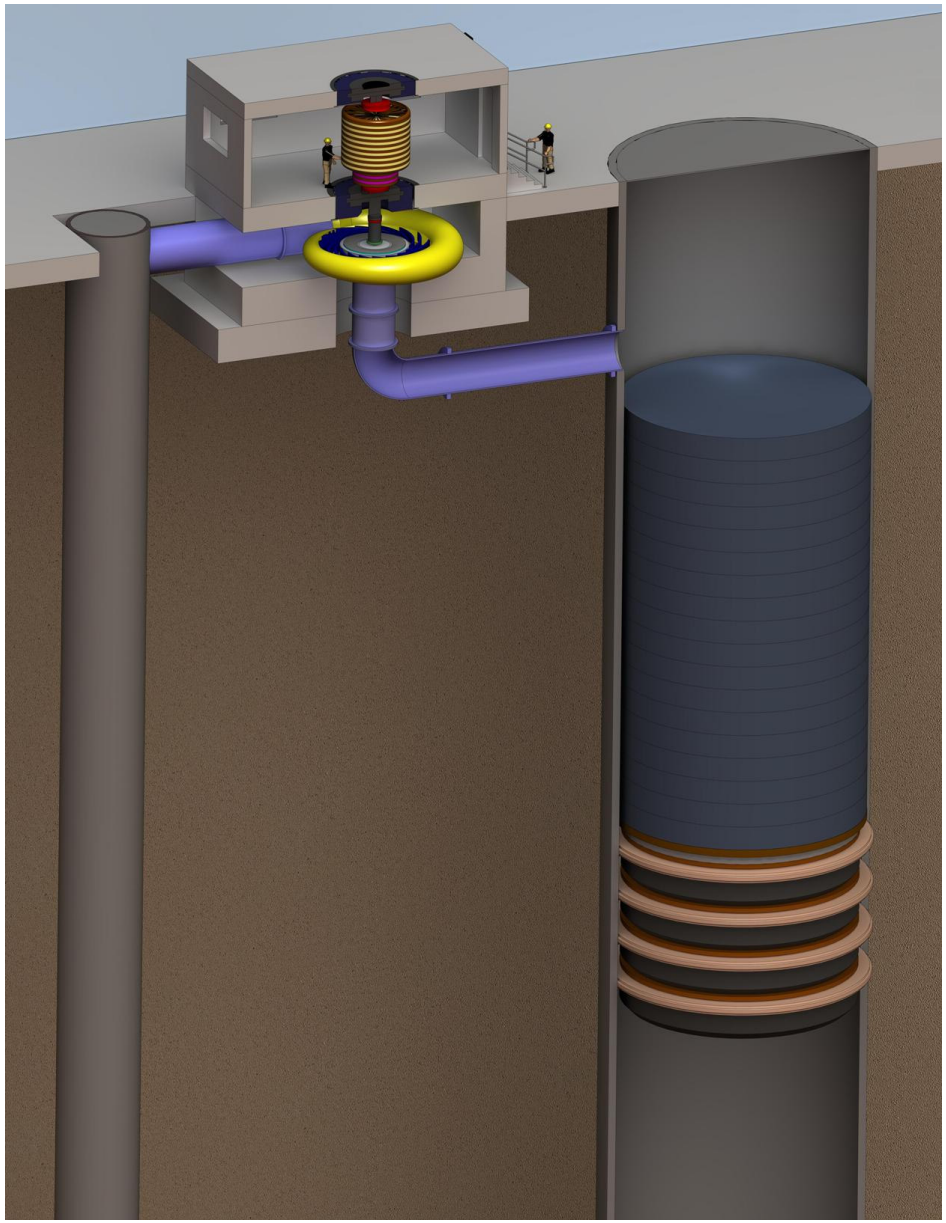
Initial Product: Ancillary Service Plants

A-GPM Parameters

- 6m storage shaft, 2m return pipe
- 500m deep
- 8000-tonne storage mass
- ~25 MW with 8.5 MWh per module initially, more energy later

Market

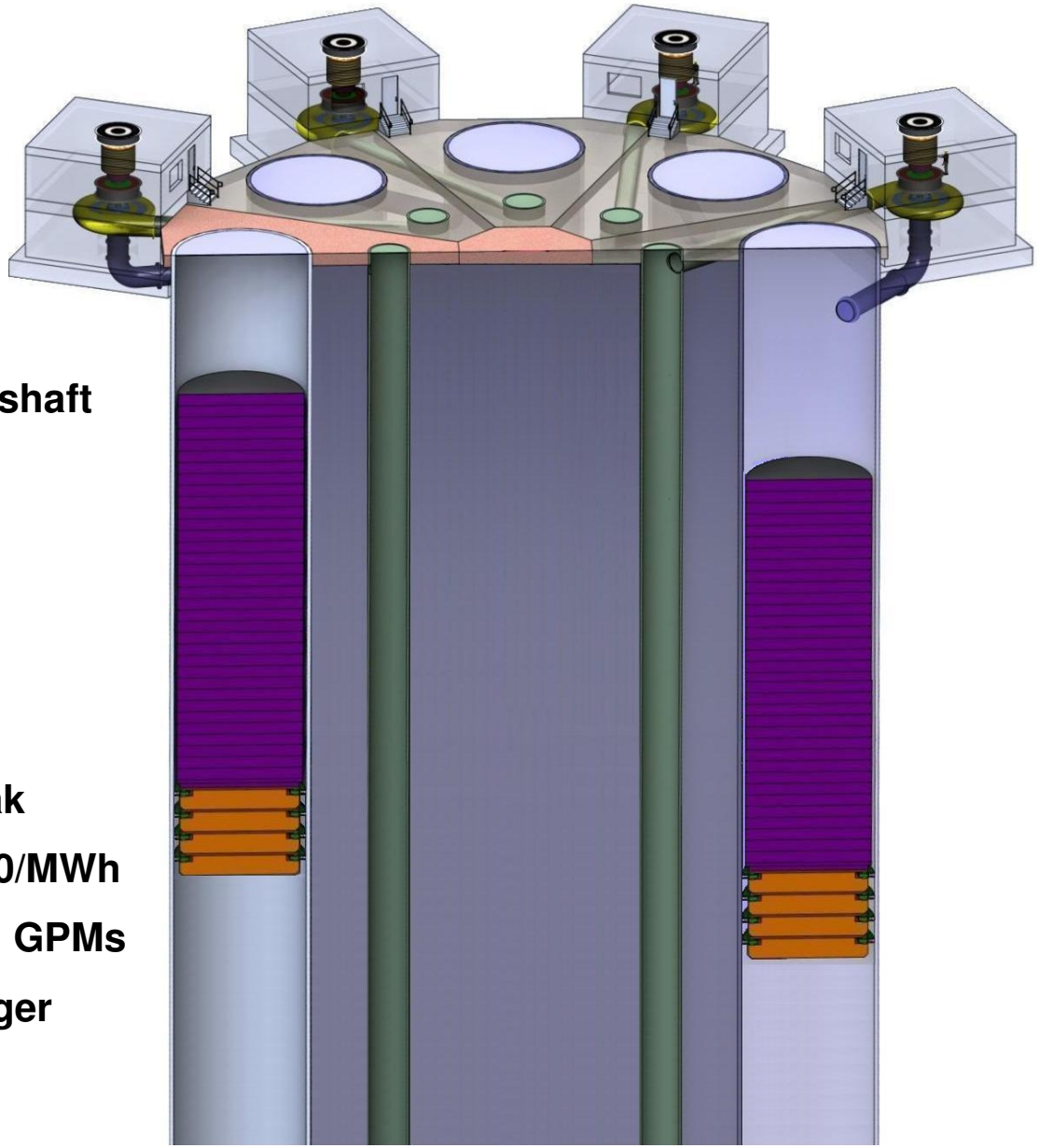
- ~50 GW in U.S.
- ~2000 GPMs @ ~$25M each
- Performs better than thermal plants
- System payback time: ~5-10 years
- System lifetime: 30+ years



Second Product: Peaking Plants

B-GPM Parameters

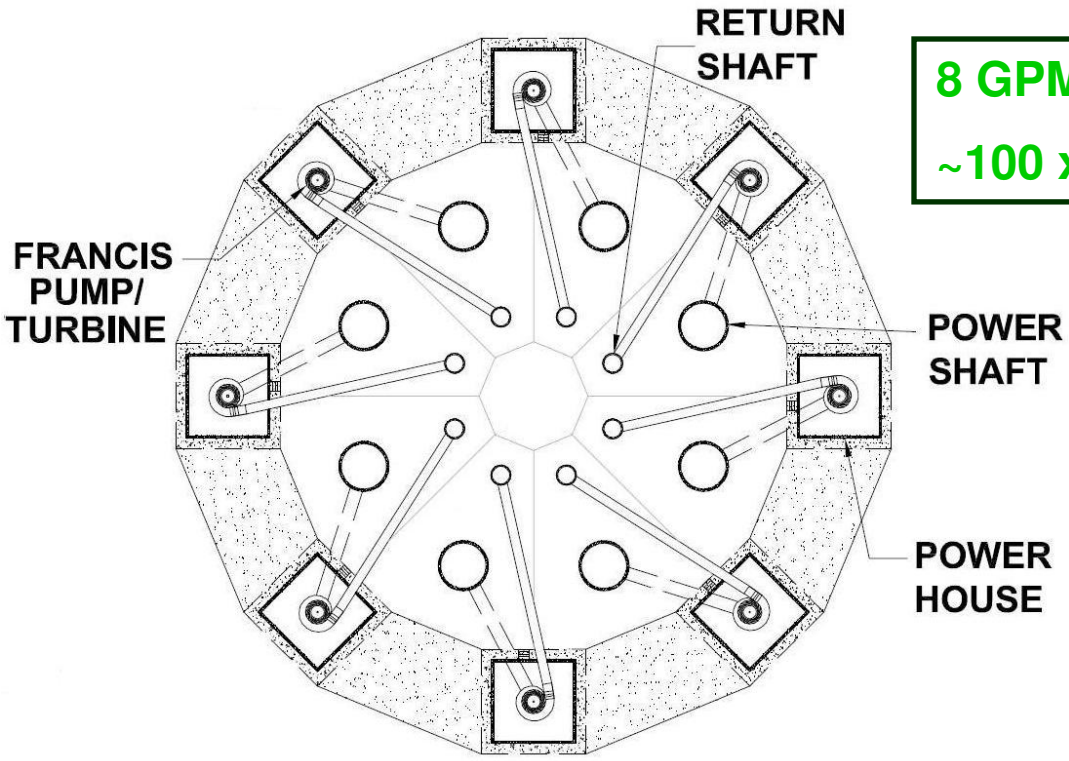
- Bulk energy storage
- 10m storage shaft
- 3m return pipe
- 1000-2000m deep
- Up to 150 MW for 4 hrs per shaft
- Up to 210,000 tonnes/shaft
- Up to 2400 MW in 2.5 acres



Market

- Buy cheap energy off peak
- Sell valuable energy on peak
- Differential can exceed $100/MWh
- ~200 GW in U.S. = 4000 big GPMs
- Foreign market is much larger

Example Installation Layouts

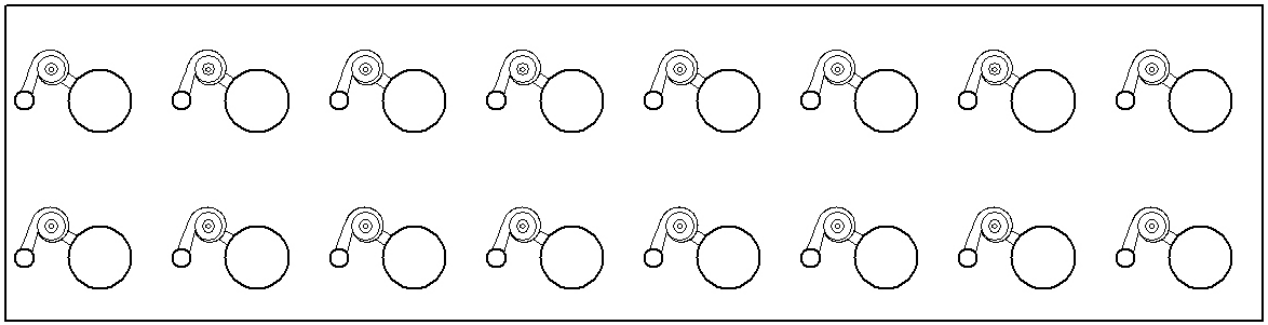


8 GPMs = Up to 1,200 MW

~100 x 100 meters (2.5 acres)

16 GPMs = Up to 2,400 MW

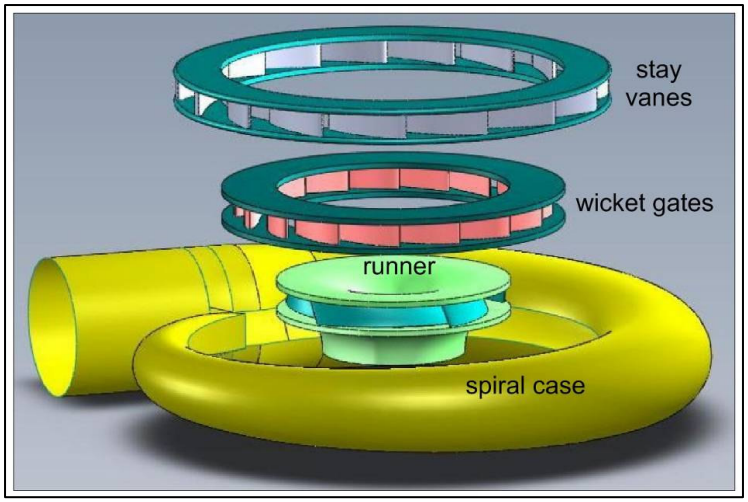
~50 x 200 meters (2.5 acres)



Key Enablers

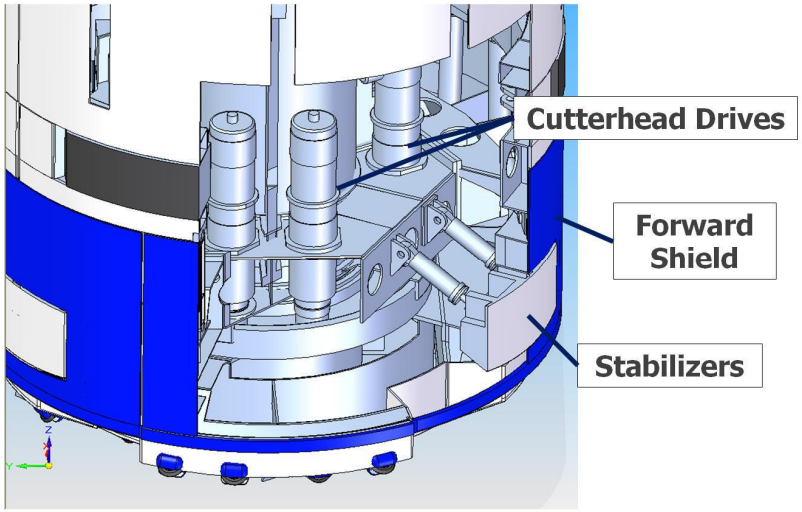
Francis pump/turbine

- High efficiency
- Not yet mass-produced anywhere
- Custom design in development at GP
- Mass production will slash costs



Advanced Shaft Boring Machine

- Radically reduces shaft construction cost
- Strategic collaborator on board



Local Content

- GPM cost is mostly determined by labor and material costs <u>at the construction site</u>
- ➔ Lower cost in developing countries

Pumped Storage Hydro is the only successful large-scale electricity storage technology

Gravity Power makes it feasible everywhere

Contact us to find out more

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