

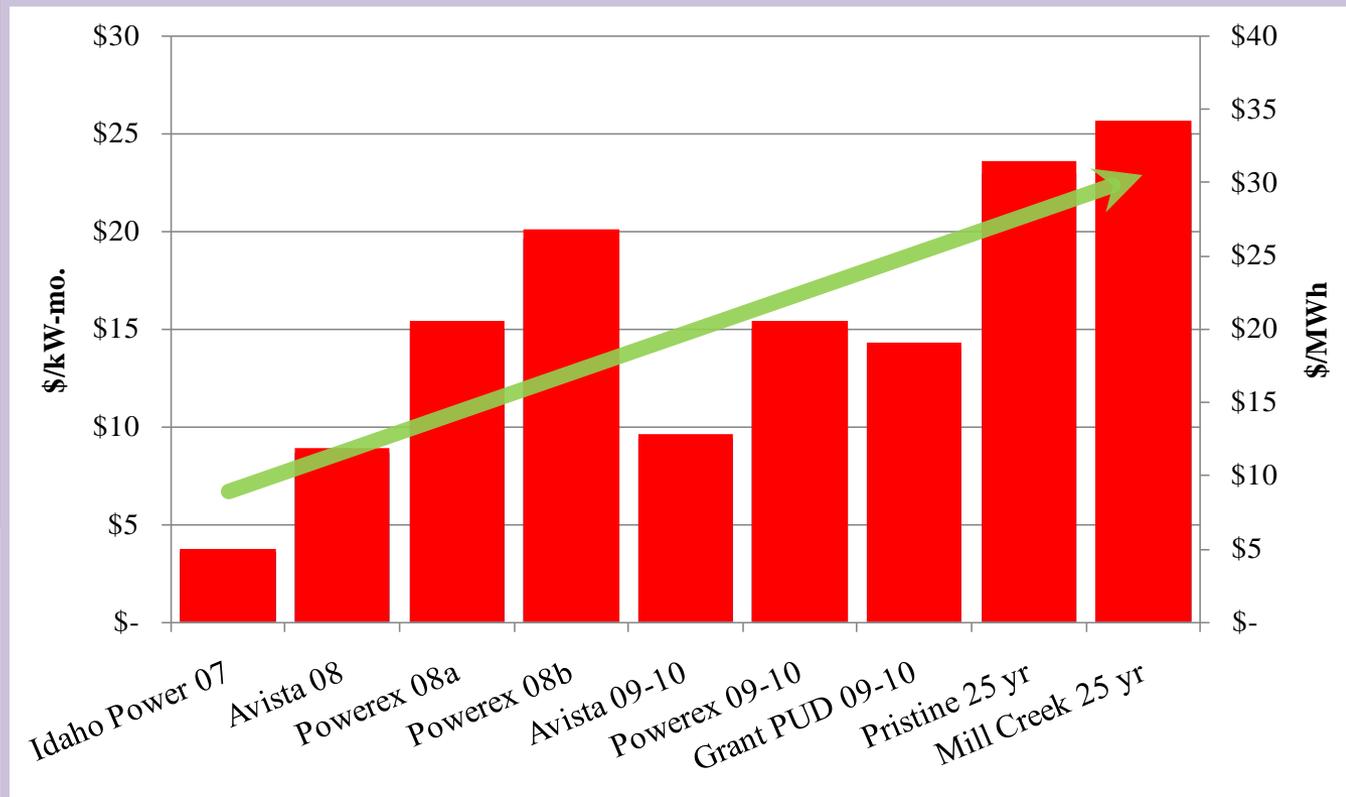
# Presentation Agenda – Part 2

- Project Value Streams
- Key Pumped Storage Development Issues – it has value but will it be valued?
- Recommendations to create a different outcome



# Energy Storage Economics

**Regulation  
Product -  
Scarce  
Commodity**



Trend is up as regulation becomes a scarce commodity

# Pumped Storage Economics

## Benefits

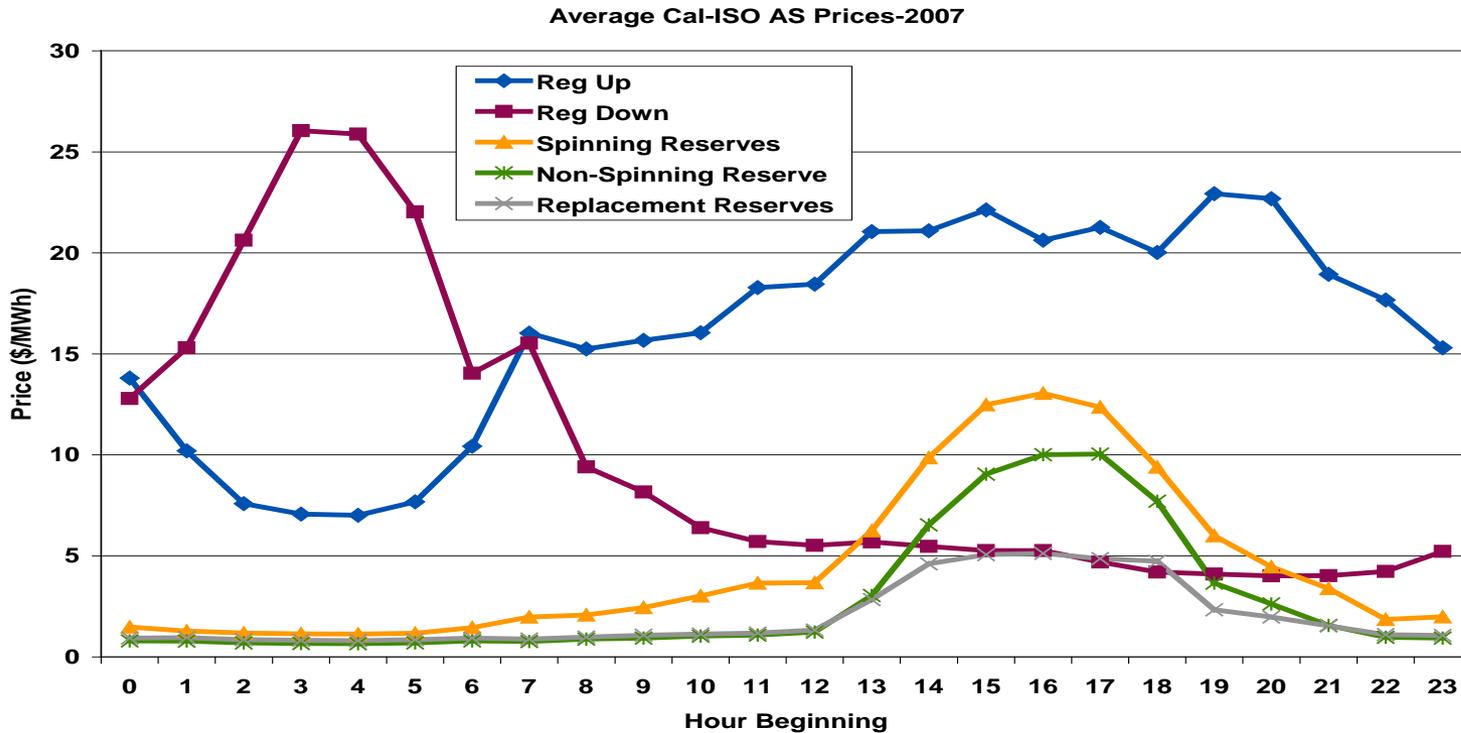
- Energy Arbitrage – buy low, sell high
- Capacity (reliability) value
- Ancillary services value (ability to move output or demand)
  - Load following/ rapid ramping / inc and dec reserves
  - Frequency regulation
  - Bulk power shifting
- Avoided carbon costs

# Overview of Markets

## Market Challenges/Barriers

- Deregulation – lost our “long-term system planning”
- No long-term markets (spot/day-ahead only)
  - No project financing without long-term contracts
  - Some important benefits aren't recognized
    - PS & Large Hydro stabilize energy prices
    - Grid Security/Reliability
    - Portfolio Optimization – other products are more efficient
    - Transmission Line Deferral (new or upgrades)
    - RE Energy “Recycling” (optimize use of wind & solar)
- Regulated Transmission vs Competitive Generation
- Natural Gas – adequate infrastructure?

# Ancillary Services Price Relationships



**Ancillary Services (AS) are needed to provide the short term balancing between load and generation**

# Development Challenges for Pumped Storage

## Projects are Capital Intense

- Licensing (\$millions) → Construction/Operation (\$billions)

## Regulatory/Licensing:

- Long lead time for permitting and licensing
- Regulated Transmission vs Competitive Generation

## Market Limitations:

- Existing revenue opportunities are not sufficient for new projects
- Missing long-term contracts valuing energy storage services
  - Including pumped storage and conventional hydropower
- Regional differences in generation and energy storage needs
- Pumped Storage's role in energy security for domestic electric grid

# Challenges to Develop Pumped Storage and Working with FERC and ISOs/PUCs

## Market Needs:

- Valuing services energy storage provides (missing revenue streams)
- Level playing field for all energy storage technologies
- Regional differences in generation and energy storage needs
- Bulk energy storage's role in energy security for domestic electric grid
- Embedded environmental cost of “carbon-based competition”

## Regulatory Needs:

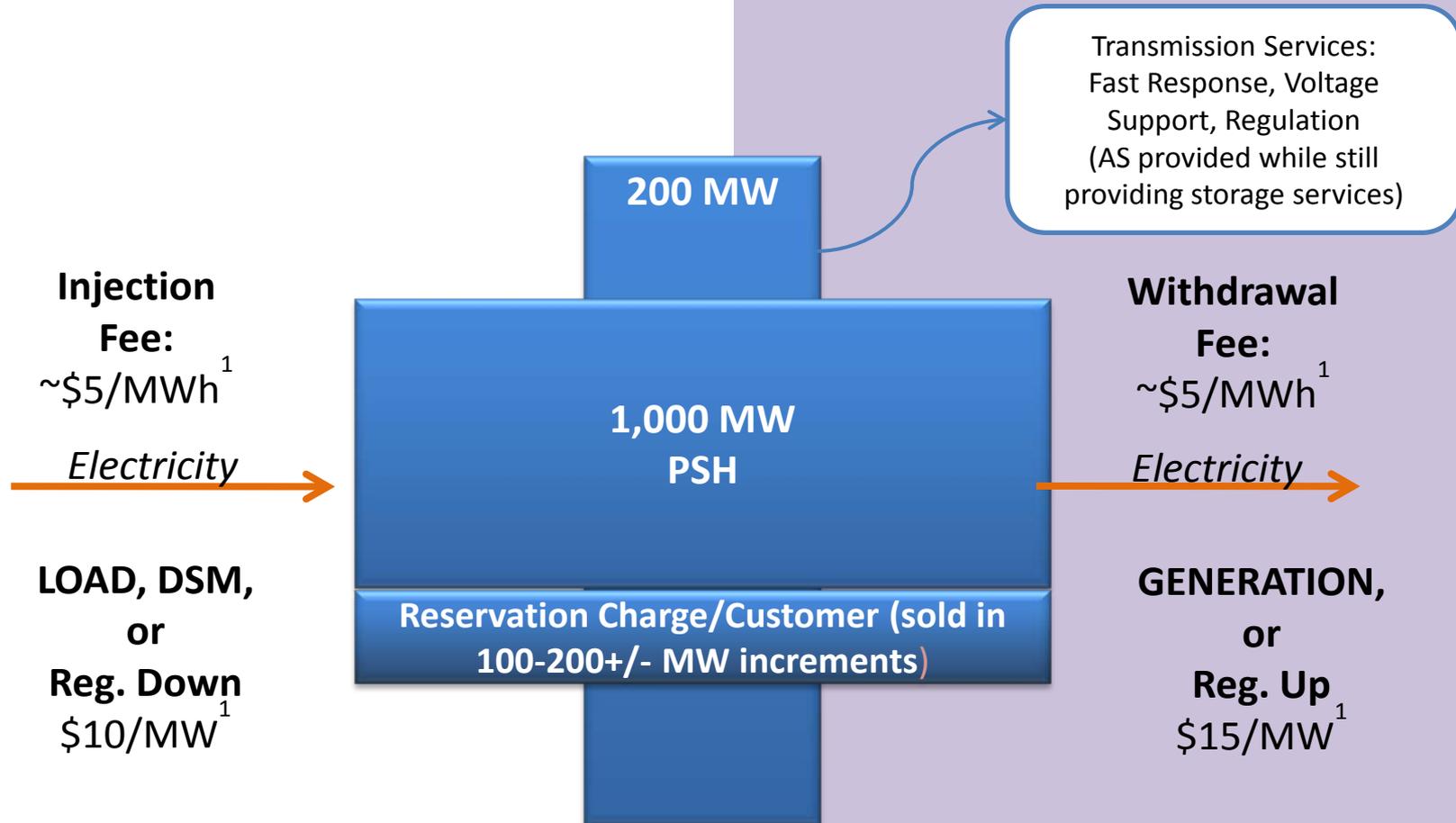
- Streamlined licensing for low-impact pumped storage projects
- Reconcile Regulated transmission & Competitive generation

**Markets: “We need it but cannot help pay for it”**

# What Can Be Done to Address Challenges?

Markets: Energy Storage Model –

Similar to Gas Storage



# Recommendations to Overcome Challenges

- Conduct a comprehensive, granular study to analyze and model the sub-hourly energy grid services and value of pumped storage in the Pacific Northwest grid given its potential role of enabling and integrating large blocks of renewable energy region and mitigating oversupply

# Contact Info

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