Energy Storage Market Trends and Business Models

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The plan

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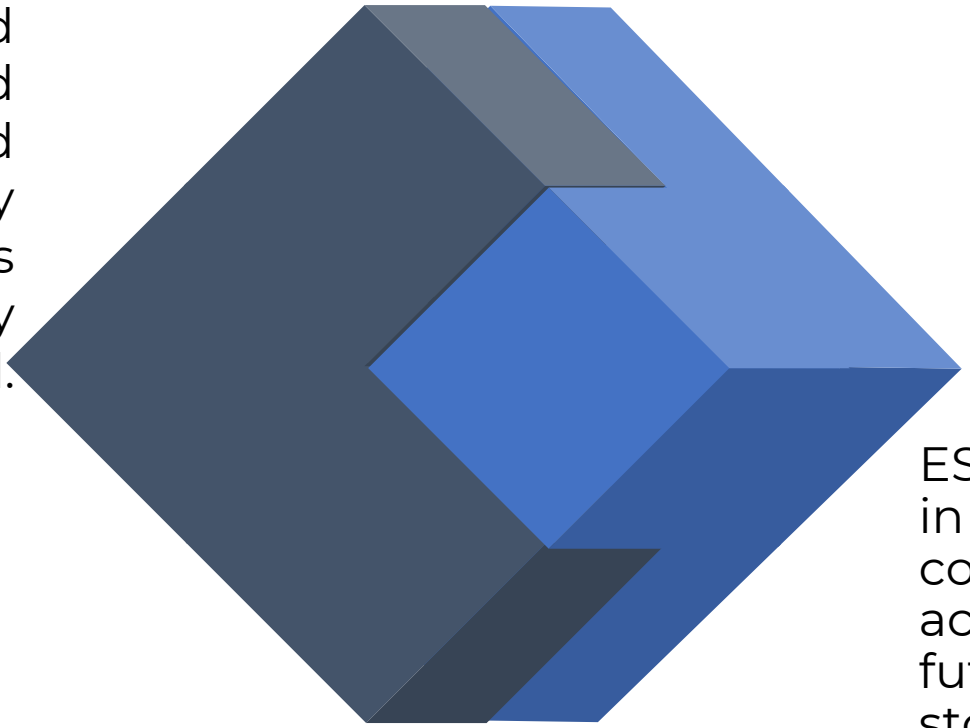
What is energy storage?

An energy storage system (ESS) is a device that stores electricity when the demand is low and provides stored electricity when the demand is high. This improves energy efficiency and stabilizes operations of the electricity grid.

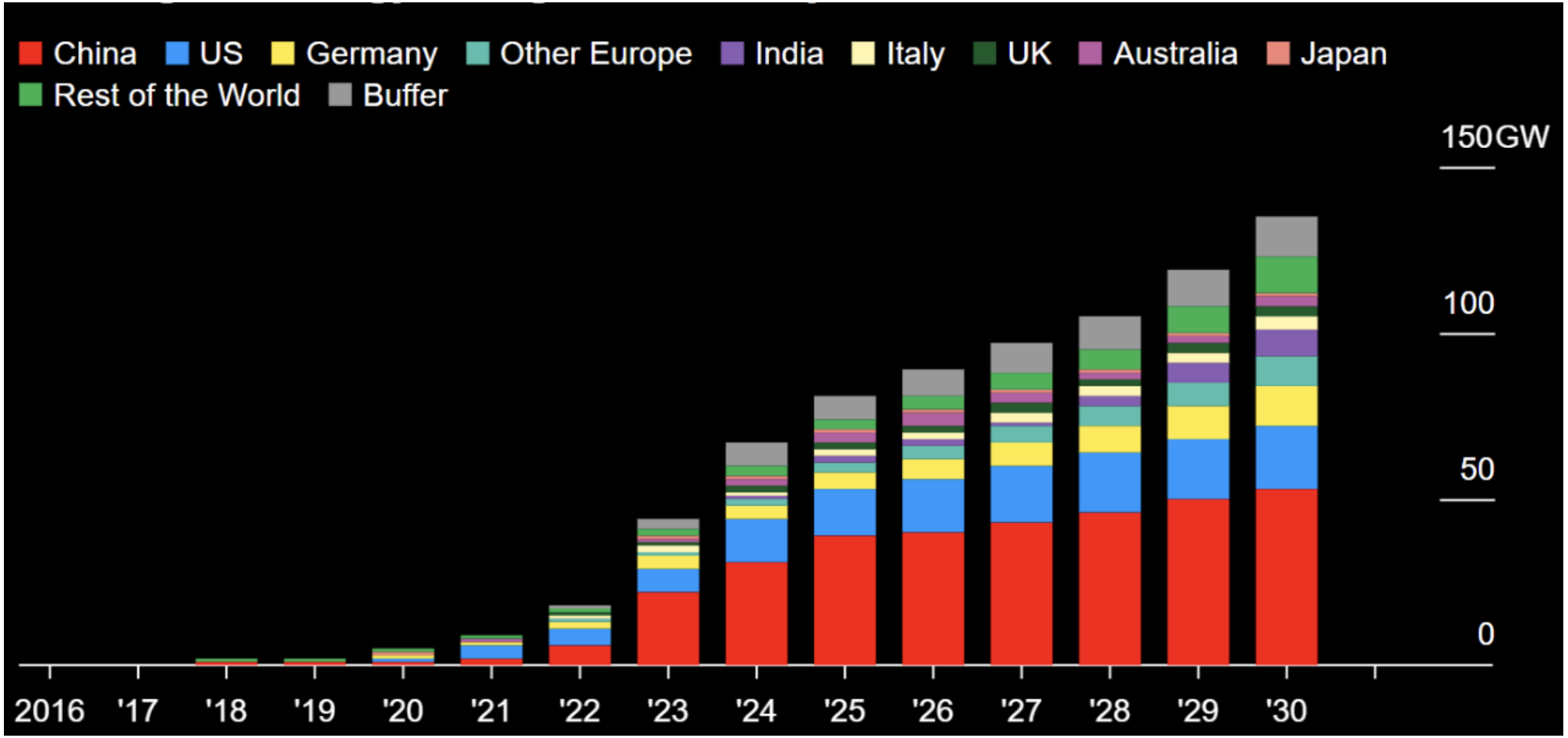


ESS are valuable components in most energy systems and could be an important tool in achieving a low-carbon future. In addition energy storage deployment is competitive or near competitive in today's energy system.

Use cases

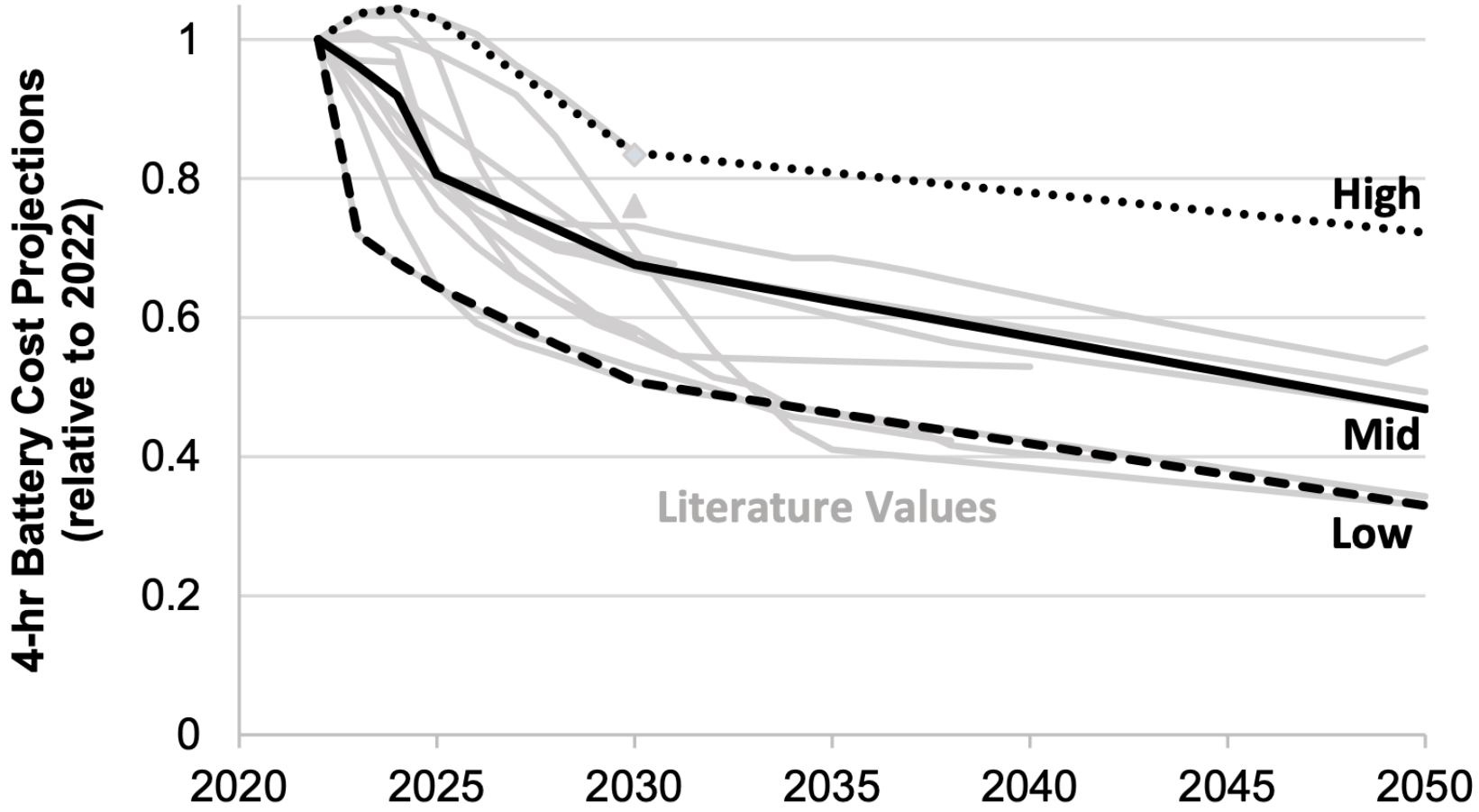
Service	Wholesale	Transmission and Distribution	Utility Scale Ren. + Storage	Commercial and Industrial	Commercial and Industrial Ren. + Storage	Residential Ren. + Storage
Economic Energy Arbitrage	X	X	X			
Supply Capacity	X	X	X	X	X	
Load Following		X	X	X	X	X
Transmission Congestion Relief		X	X	X	X	X
Distribution Deferral		X				
Transmission Deferral		X				
Demand Charge Management				X	X	X
Economic Renewables Shifting (Wind)	X	X	X		X	X
Economic Renewables Shifting (PV)	X	X	X		X	X
Baseload Generation Time Shift	X	X	X			
Frequency Regulation	X	X	X	X	X	
Black Start		X				
Spinning Reserve	X	X	X	X	X	
Non-Spinning Reserve	X	X	X	X	X	
Volt-VAR Support	X	X	X	X	X	X
Volt-WATT Support	X	X	X	X	X	X
Frequency-WATT Support	X	X	X	X	X	X
PV Smoothing		X	X		X	X
Renewables Firming		X	X		X	X
Renewables Curtailment		X	X		X	X
Islanded Microgrid				X	X	X
Backup Power				X	X	X
Scheduled Energy Arbitrage	X	X	X			

Global Situation(battery focused-without PHS)



*Bloomberg NEF

Pricing: The downwards trend



*NREL US

%30 avg. cost reduction expected relative to 2022

Cost Trends: Declining battery prices and impact on adoption

1. Plummeting Battery Prices

- 89% decline (2010–2023): From 1,200/kWhto** 1,200/kWh to** 140/kWh** (BloombergNEF).
- 2030 Projection: <$80/kWh (CATL, Tesla Gigafactories).

2. Key Cost Drivers

- Scale: Gigafactories (Tesla, CATL, BYD) driving economies of scale.
- Tech Innovations: LFP batteries (cobalt-free), dry electrode manufacturing.
- Supply Chain: Cheaper lithium, recycling (Redwood Materials, Li-Cycle).
- Policy: U.S. IRA tax credits, EU Battery Alliance subsidies.

3. Impact on Energy Storage Adoption

- EVs: Affordable EVs (e.g., BYD Seagull at $10k, Tesla Model 3).
- Grid Storage:
  - 4h lithium-ion storage now cheaper than gas peakers (Lazard LCOE).
  - Utility-scale projects (e.g., Tesla Megapack, Vistra Moss Landing).
- Residential ESS: 50% price drop (2016–2023) for systems like Powerwall.
- Emerging Markets: Solar+storage microgrids (India, Africa).

4. Future Challenges

- Raw Materials: Price volatility (lithium, nickel).
- Supply Chain Risks: Geopolitical tensions (China dominance).

5. Outlook

- Solid-state/sodium-ion: Further cost cuts ($50/kWh by 2030).
- Second-life batteries: Repurposed EV packs slashing storage costs.

Regional Trends: Storage growth in key markets

United States

- **Policy Driver**: Inflation Reduction Act ($369B for clean energy).
- **Key Growth**:
  - *Grid-scale*: Texas (ERCOT), California (SGIP).
  - *Residential*: Tesla Powerwall, Sunrun solar+storage.

China

- **Dominant Player**: 70% global battery production (CATL, BYD).
- **Growth Areas**:
  - Renewables integration (Gobi Desert mega-projects).
  - EV-backed V2G (vehicle-to-grid) pilots.

Europe

- **Policy Push**: REPowerEU, €210B energy independence plan.
- **Hotspots**:
  - Germany: Residential ESS (Sonnen, E3/DC).
  - UK: Offshore wind + storage (Dogger Bank).

Australia

- **Leadership**: World's largest battery (Hornsdale, Victoria Big Battery).
- **Driver**: 82% rooftop solar adoption + grid modernization.

India

- **Ambition**: 500 GW renewables by 2030 + 4,000 MWh storage tenders.
- **Projects**: Solar Energy Corp. (SECI) hybrid auctions.

Emerging Markets

- **Africa**: Solar+storage microgrids (Kenya, Nigeria).
- **Latin America**: Chile's Atacama Desert solar-storage hubs.

Business Models for Energy Storage:Utility owned

Grid Asset Ownership

- Purpose: Direct control over storage for grid stability and peak demand management.
- Examples:Peaker Replacement: Vistra's Moss Landing (CA) replaces gas plants .Frequency Regulation: AES's Alamitos BESS (CA) balances renewables.
- Benefit: Rate-base recovery (approved by regulators) ensures ROI.

Renewable Integration

- Hybrid Projects: Co-locate storage with solar/wind to reduce curtailment.
- NextEra: 700 MW solar + 250 MW storage in Florida. Benefit: Maximizes renewable utilization, meets state mandates.

Capacity & Resource Adequacy

- Strategy: Bid storage into capacity markets (e.g., ERCOT, PJM).
- NV Energy: 1.2 GW solar + 590 MW storage to meet Nevada's 50% renewable target. Benefit: Avoids penalties for under-delivery during peak demand.

Virtual Power Plants (VPPs)

- Model: Aggregate distributed storage (residential/commercial) into grid assets.
- Green Mountain Power (VT): Tesla Powerwall fleets reduce peak load. Benefit: Lowers infrastructure costs, engages customers.

Transmission & Distribution (T&D) Deferral

- Use Case: Delay costly grid upgrades by deploying storage at congestion points.
- Ex:Hawaiian Electric: Storage on Oahu defers $1B in transmission upgrades.
- Benefit: Capital cost savings, faster deployment.

Why Utilities Own Storage?

- Regulatory Compliance: Meet state storage mandates (e.g., CA, NY).
- Revenue Control: Capture value from grid services vs. third parties.
- Long-Term Planning: Align storage with grid modernization goals.
- Challenges: High capex, regulatory approval delays, evolving market rules.

Business Models for Energy Storage:Utility owned

Core Focus:

- Grid reliability, compliance, and long-term planning.

Key Strategies:

- Replace Fossil Peakers: Install large-scale batteries to retire gas plants (e.g., Vistra's 1.6 GWh Moss Landing, CA).
- Hybrid Projects: Pair storage with renewables to meet mandates (e.g., NV Energy's solar+storage in Nevada).
- Defer Grid Upgrades: Use storage to delay costly transmission lines (e.g., Hawaiian Electric on Oahu).

Revenue Model:

- Ratepayer-funded investments (approved by regulators).
- Sell capacity/services to wholesale markets.

Unique Challenges:

- Slow regulatory approval processes.
- Risk of stranded assets if tech outpaces planning

Business Models for Energy Storage: independent power producers

Core Focus:

Market agility, innovation, and diversified revenue.

Key Strategies:

- **Merchant Storage**: Profit from energy arbitrage (buy low, sell high) in deregulated markets like ERCOT (e.g., Broad Reach Power).
- **Storage-as-a-Service**: Lease storage to businesses (e.g., Stem's Athena platform for Walmart).
- **Ancillary Services**: Sell fast-response grid services (e.g., Fluence in CAISO markets).

Revenue Model:

- Wholesale market profits, long-term PPAs, SaaS subscriptions.

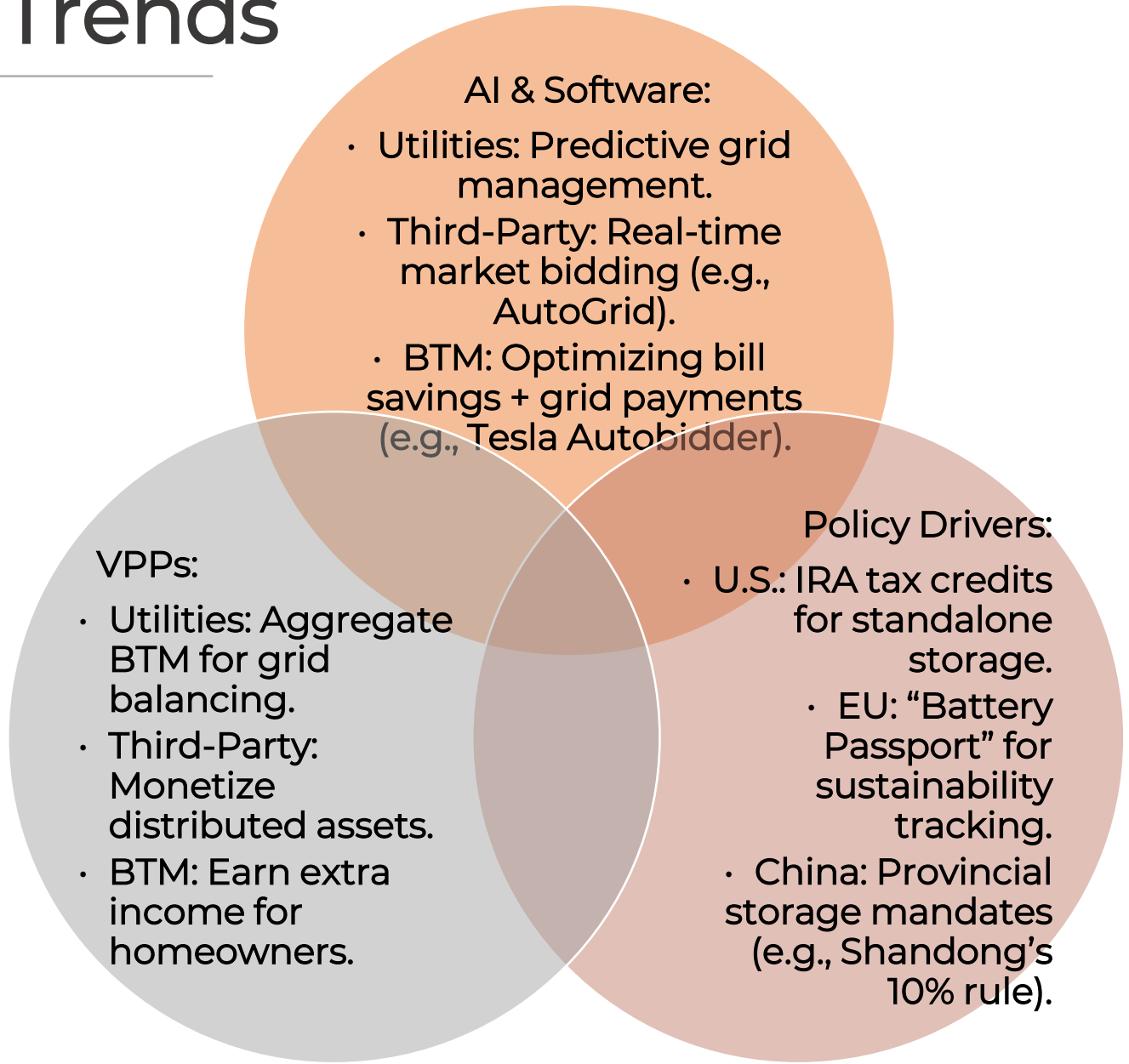
Unique Challenges:

- Exposure to volatile energy prices.
- Competing with subsidized utility projects.

Business Models for Energy Storage:behind the meter

- Core Focus: *Customer savings, resilience, and distributed energy.*
- Key Strategies:
  - **Residential VPPs**: Pool home batteries to support the grid (e.g., Tesla + PG&E's 16,000 Powerwall network).
  - **C&I Demand Shaving**: Cut peak demand charges for factories (e.g., Enel X at Coca-Cola plants).
  - **Community Microgrids**: Share storage across neighborhoods (e.g., Brooklyn Microgrid).
- Revenue Model:
  - Customer energy bill savings + grid service payments.
- Unique Challenges:
  - Navigating complex interconnection rules.
  - Educating customers on ROI.

Business Models for Energy Storage:Cross-Cutting Trends

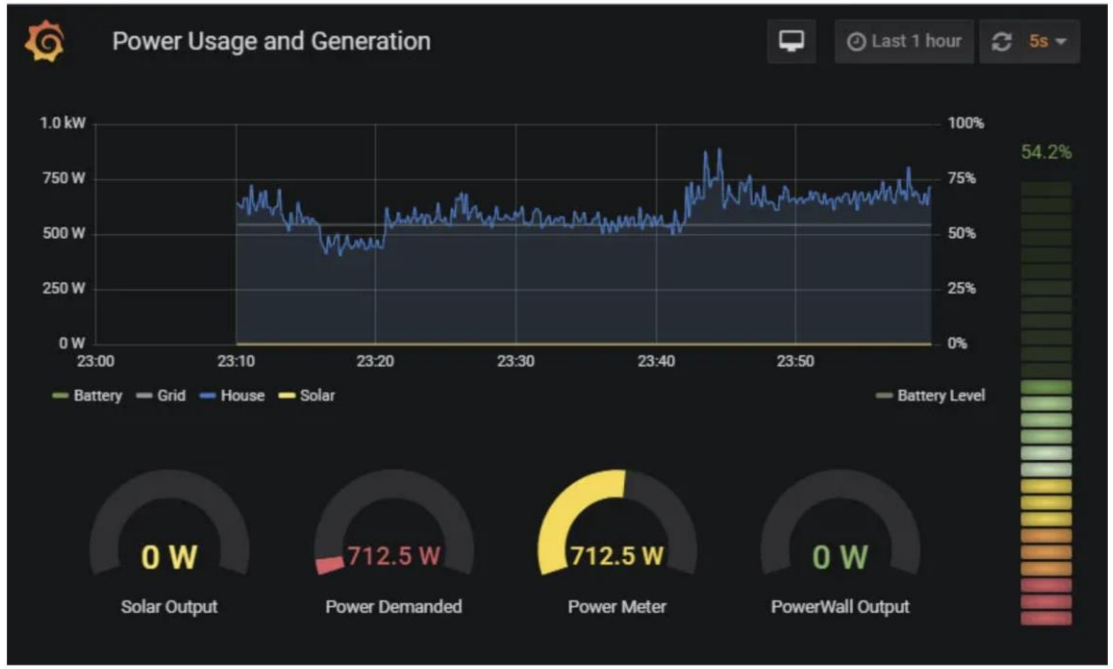


Monetization strategies: Wholesale

- Strategies:
  - **Energy Arbitrage**: Buy low during off-peak (e.g., midday solar surplus), sell high during peaks (e.g., 6–9 PM).
  - **Capacity Payments**: Earn fixed fees for guaranteeing availability (e.g., NYISO's Installed Capacity market).
- Examples:
  - ERCOT (Texas): Storage earns $50–200/MWh during summer peaks.
  - CAISO: Tesla's 182.5 MW Moss Landing project trades daily spreads.
- **Tools**: AI-driven platforms (e.g., **Tesla Autobidder**) optimize bids in real-time.
- **Challenges**: Declining midday prices due to solar oversupply.
- **Future**: Hybrid "renewable + storage" PPAs (e.g., NextEra's 700 MW solar + 250 MW storage).

Tesla's Autobidder Software Surpasses $330 Million in Profits for Energy Investors

by SAMUEL BRYANT



*driveteslacanada.ca

Monetization stategies: ancillary services

- Strategies:
  - **Frequency Regulation**: Respond in <1 second to grid fluctuations (e.g., PJM's Reg D market).
  - **Black Start**: Help restart grids post-blackout (e.g., UK's 2023 National Grid tender).
- Examples:
  - Fluence's 100 MW project in CAISO earns $1.5M/month from regulation.
  - Australia's FCAS market: Storage earns $80–150/MW-day.
- **Tools**: Service-stacking software (e.g., **Fluence Mosaic**) to prioritize high-value services.
- **Challenges**: Strict performance penalties for slow response.
- **Future**: Fast Frequency Response (FFR) markets in Europe.

Monetization stategies: demand charge management peak shaving

Strategies

- Peak Shaving: Use storage to cap grid draw during demand spikes (e.g., factories, data centers).
- TOU Arbitrage: Shift energy use to off-peak periods (e.g., EV charging depots).

Examples

- Walmart: 40% demand charge reduction using Stem's storage.
- Kauai Island Utility: 15% cost cut with Tesla Powerpacks.

Tools

- Load forecasting AI (e.g., Stem Athena) to predict demand spikes.

Challenges

- ROI requires high demand charges (>$15/kW).

Future

- "Solar + storage + fuel cells" for 24/7 load shifting.

Monetization stategies: Virtual Power Plants

1. Key VPP Revenue Streams

- Grid Services:
- Frequency regulation, capacity payments (e.g., Tesla + PG&E in California).
- Peak shaving for utilities (e.g., Sunrun's 8,000-home VPP in New England).
- Energy Arbitrage: Buy low (off-peak), sell high (peak) using aggregated storage.
- Demand Response: Reduce commercial/industrial demand charges (e.g., Stem's C&I VPPs).

2. Business Models

- Utility Partnerships:
- Tesla + PG&E: 16,000+ Powerwalls provide 32 MW grid capacity.
- Sonnen (Germany): 60,000+ home batteries balance grid demand.
- Third-Party Aggregators:
- Swell Energy: Pays homeowners to pool storage into VPPs.
- AutoGrid: AI-driven optimization for C&I fleets.

3. Benefits

- For Customers: Bill savings, resilience, and lease payments (e.g., $50–200/year per household).
- For Utilities: Avoid $1M+/MW in peaker plant investments.
- For Aggregators: Scalable revenue from software + service fees.

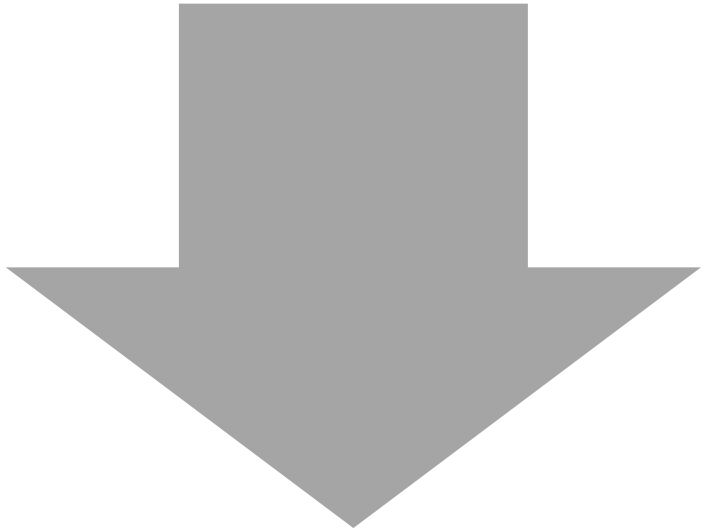
4. Challenges

- Regulatory Hurdles: Market access in non-deregulated regions (e.g., Southeast U.S.).
- Tech Complexity: Interoperability of diverse storage systems.
- Consumer Trust: Data privacy concerns.

Financing models:Capital-intensive vs. service-based models

1. Capital-Intensive Models

- **High Upfront Costs**: Owned assets (e.g., utility/grid-scale storage).
- **Funding Sources**: Equity, green bonds, project finance loans.
- **Examples**:
  - *Tesla Megapack*: Utility-owned projects (e.g., Moss Landing).
  - *AES Fluence*: Grid-scale storage financed via corporate balance sheets.
    Pros: Full revenue control, long-term ROI.
    Cons: High risk (price volatility, tech obsolescence).

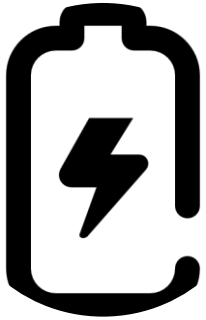


2. Service-Based Models

- **Low/No Upfront Costs**: Third-party ownership, pay-as-you-go.
- **Funding Sources**: Leasing, PPAs, SaaS subscriptions.
- **Examples**:
  - *Stem's Storage-as-a-Service (SaaS)*: C&I clients pay monthly fees.
  - *Sunrun Solar + Storage Leasing*: Homeowners lease systems.
    Pros: Lower barriers to entry, risk transferred to operator.
    Cons: Limited revenue upside, dependency on operator performance.

Regulatory and policy considerations: promoting energy storage

1. Key Incentives
   - Grants & Subsidies:
     - U.S. IRA: 30% Investment Tax Credit (ITC) for standalone storage.
     - EU Innovation Fund: €40B for grid-scale storage R&D.
     - India's PLI Scheme: $2.5B for domestic battery manufacturing.
   - Rebates:
     - California's SGIP: 0.50–0.50–1.00/Wh for residential storage.



2. Storage Mandates
   - U.S. State Targets:
     - California: 11.5 GW by 2030.
     - New York: 6 GW by 2035.
   - EU Renewable Energy Directive: Requires member states to integrate storage into energy plans.
   - China: Provincial mandates (e.g., Shandong: 10% storage for new renewables).

3. Tax Credits & Exemptions
   - U.S. IRA Bonus Credits: +10% for domestic content, +20% for low-income projects.
   - UK Super-Deduction: 130% tax relief for storage investments.
   - India: 5% GST rate for batteries (vs. 18% for other electronics).

Case Studies and Best Practices: Utility-Scale Innovations

1.Tesla + PG&E (California)

- Virtual Power Plant (VPP): 16,000+ Powerwalls aggregated to provide 32 MW grid capacity.
- Impact: Avoided $1.2B in gas peaker investments.
- Takeaway: Scalable residential storage can replace fossil infrastructure.

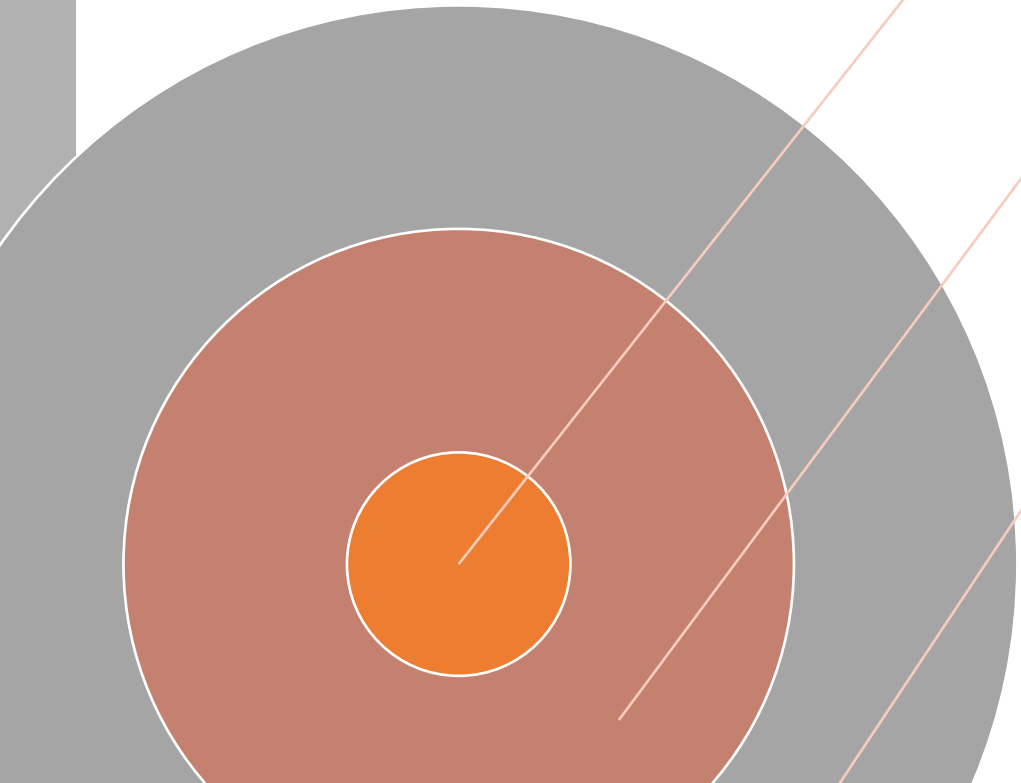
2.Fluence + AES (Long Beach, CA)

- Storage-as-a-Service: 100 MW/400 MWh system leased to utilities for peak shaving.
- Impact: $2M/month revenue from energy arbitrage + ancillary services.
- Takeaway: Third-party ownership lowers utility CAPEX.

3.NextEra Energy (Florida)

- Solar + Storage PPA: 700 MW solar + 250 MW storage at $30/MWh.
- Impact: Cheaper than gas, 24/7 renewable power.
- Takeaway: Hybrid projects de-risk renewables.

Case Studies and Best Practices: Commercial & Emerging Models



1.BYD’s Blade Battery (China)

- Innovation: LFP batteries for buses, $100/kWh cost.
- Impact: 50% market share in global electric buses.
- Takeaway: Vertical integration cuts costs.

2. Sonnen (Germany)

- Community Storage: 60,000+ home batteries in VPPs for grid balancing.
- Impact: 200+ GWh traded annually.
- Takeaway: Decentralized models empower prosumers.

3.Form Energy (US)

- Iron-Air Batteries: 100-hour storage at $20/kWh.
- Impact: Pilot projects replacing coal plants in Minnesota.
- Takeaway: Chemistry innovation enables long-duration storage.

Case Studies and Best Practices: Sustainability & Circular Economy

1.Redwood Materials (Nevada)

- Recycling: 95% Li/Co recovery from EV batteries.
- Impact: Supplies 30% of CATL's raw materials.
- Takeaway: Closed-loop systems cut mining dependency.

2.ACES Delta (Utah)

- Hydrogen + Storage: 220 MW hydrogen storage for 300 GWh seasonal energy.
- Impact: Powers 150,000 homes for 100+ hours.
- Takeaway: Hydrogen complements batteries for seasonal needs.

3.Stem (California)

- AI-Driven Storage: Athena software optimizes 1.3+ GW of C&I storage.
- Impact: 20–40% demand charge savings for clients.
- Takeaway: Software unlocks hidden value.

Discussion and questions