Putting Fuel Cells to Work for Energy Storage
About Ballard

- **Leader in hydrogen fuel cells**
  - **Portfolio of proven commercial solutions**
    - Fuel cell stacks, power modules and systems to meet requirements of a wide range of applications
  - **Strong delivery capabilities**
    - Access to ~2,000 patents and licenses
    - High volume manufacturing facility
    - Effective SI/OEM & channel partnerships
    - 100MW+ of fuel cell products shipped

- **Putting fuel cells to work**
  - **Meeting demand for clean, reliable energy**
    - Backup and supplemental power for telecom networks
    - Distributed power for renewable energy generation
    - Full forklift fleet conversions at US distribution centers
    - World’s largest fuel cell bus fleet

Commercial Customers Include:

- Daimler
- BC Transit
- Motorola
- FirstEnergy
- ACME
- China Mobile Limited
- Plug Power
- Walmart
Distributed Generation: Market Segmentation

- Base Load Generation (by-product hydrogen)
- Utility Peak Load Generation
- Energy Storage (independent power producers)

Chemical producers
Utilities
Solar
Wind
Integrated Fuel Cell Solution for Energy Storage

Renewable Energy

solar → hydro → wind → electricity

electrolyser → hydrogen storage → MW DG solution

H₂ → merchant H₂ → clean energy → utility

clean energy
Advantages of PEM fuel cells for energy storage

- Fast start-up for excellent load-following capability
- Highly scalable and configurable, with superior energy density
- Minimizes wasted electricity via curtailment by storing the energy as hydrogen
Longer duration run times will favour fuel cell due to cost of storage expansion versus battery addition.
# Case Study: Wind Farm Energy Shifting with Fuel Cells

## Wind Farm: 100MW

- PPA peak rate: $60/MWh, 8hrs
- PPA off-peak rate: $25/MWh, 16hrs
- CAPEX: $200 million
- ANNUAL REVENUE: $9.6 million

## With Fuel Cell Solution:

- 25MW fuel cell (4hr operation guarantee)
- 460kg/hr electrolyser and H2 storage
- PPA peak rate: $125/MWh, 8hrs
- PPA off-peak rate: $25/MWh, 16hrs
- CAPEX: $267 million
- Annual revenue: $17 million

## RESULTS:

- 75% increase in revenue, mitigates revenue risk associated with curtailment of off peak wind production

*No merchant hydrogen production assumed
PPA: power purchase agreement*