Energy Storage and Future Roles for the Prosumer and the Retailer

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Changing the Dynamics

www.insightoptom.com.au

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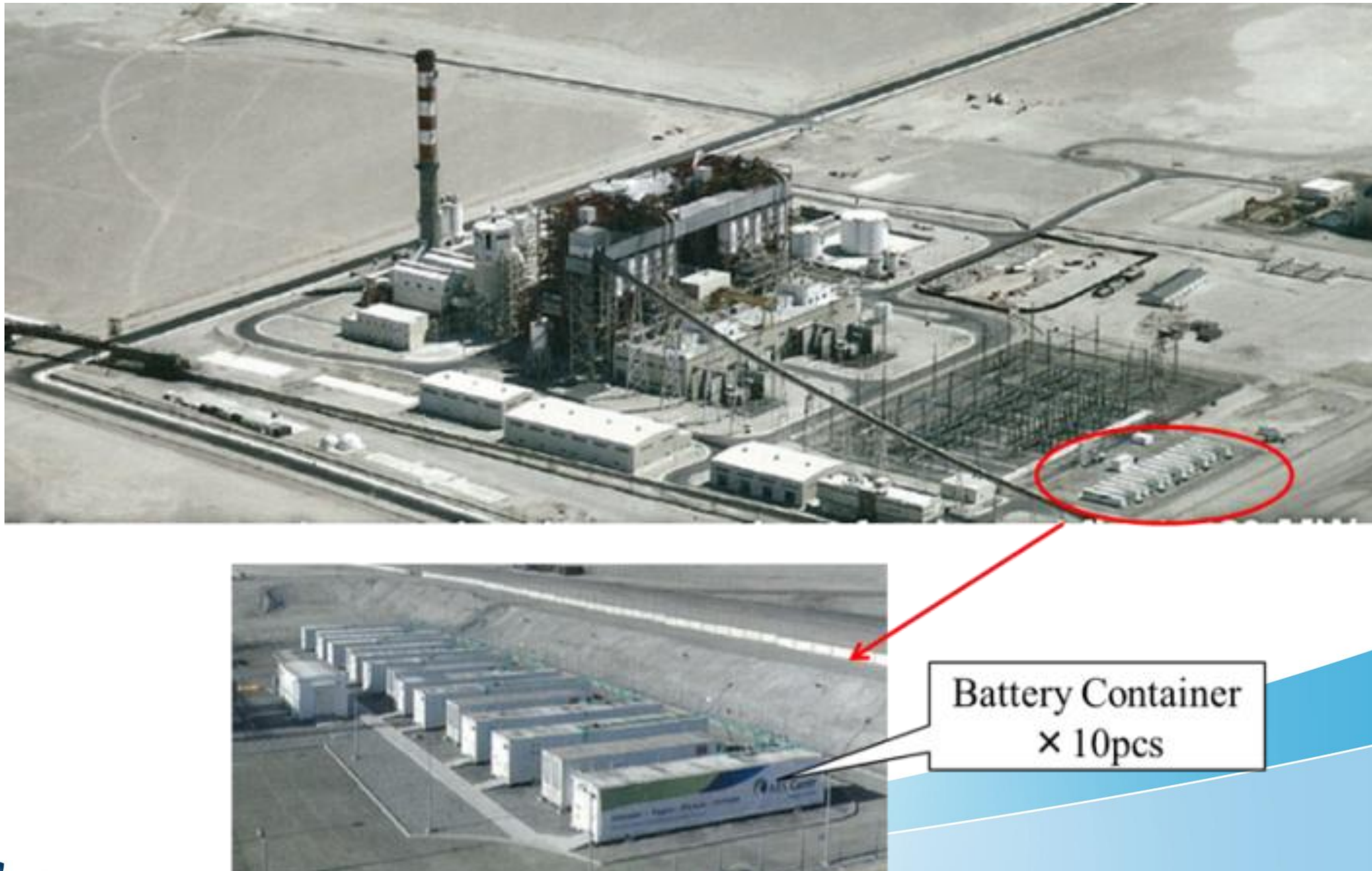
Bulk Energy Storage Technologies

- Pumped Hydro power system
- Large scale Hydrogen Generation and Storage combined with Fuel Cell recovery
- Compressed Air Energy Storage
- Flywheels
- Solar Thermal Generation and Storage
- Lithium Ion Batteries

Bulk Energy Storage Applications

- High <u>Power</u> BESS
  - Spinning Reserve
  - Voltage Control
  - Frequency Stability/Correction
  - VAR Compensation
  - Power Smoothing
  - Power Factor Correction
  - Primarily short term operations, demanding high power outputs for short periods, and fast recovery, meaning high power inputs in short periods for fast recharge.

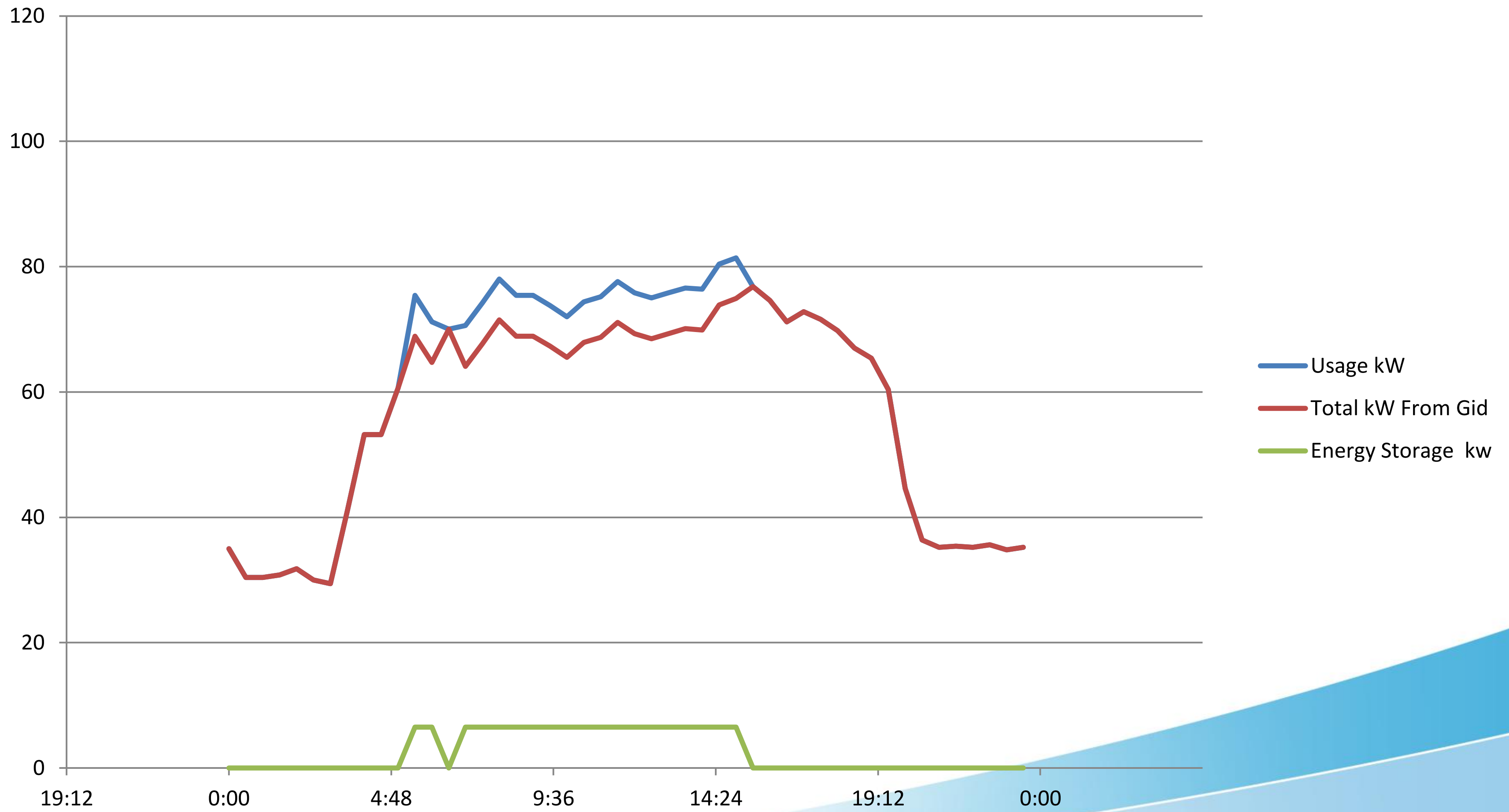
High Power BESS



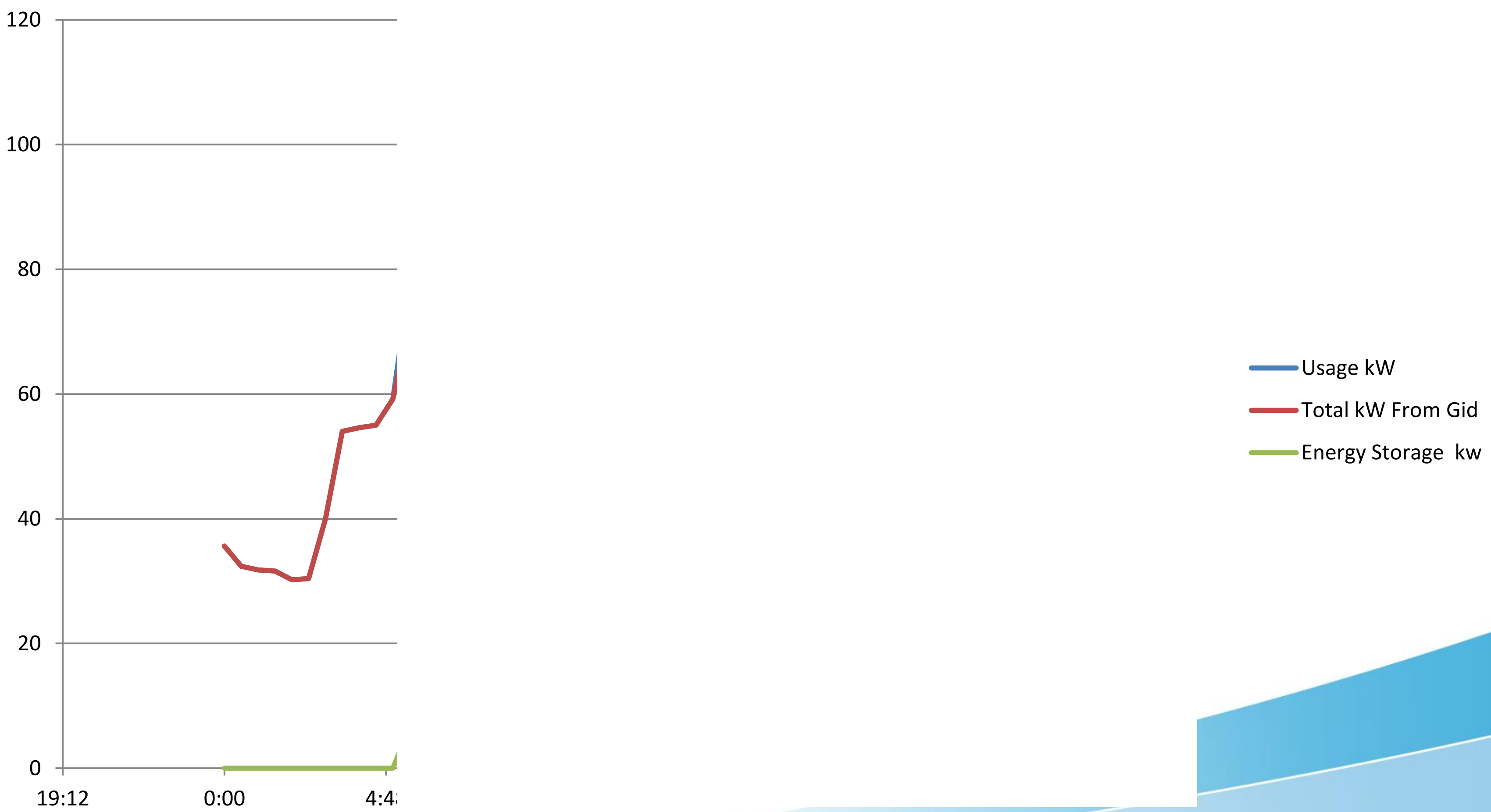
Bulk Energy Storage Applications

- High Energy BESS
  - Peak Lopping/Limiting
  - Energy Shifting/Arbitrage
  - Islanding (another term for Self Sufficiency)
  - Longer term Power Smoothing and Power Factor Correction.
  - Primarily long term (>1hr) operations, demanding an energy storage medium able to deliver very large amounts of energy (eg batteries with high AHr capacities) for long periods.

Daily Energy Consumption



Daily Energy Consumption



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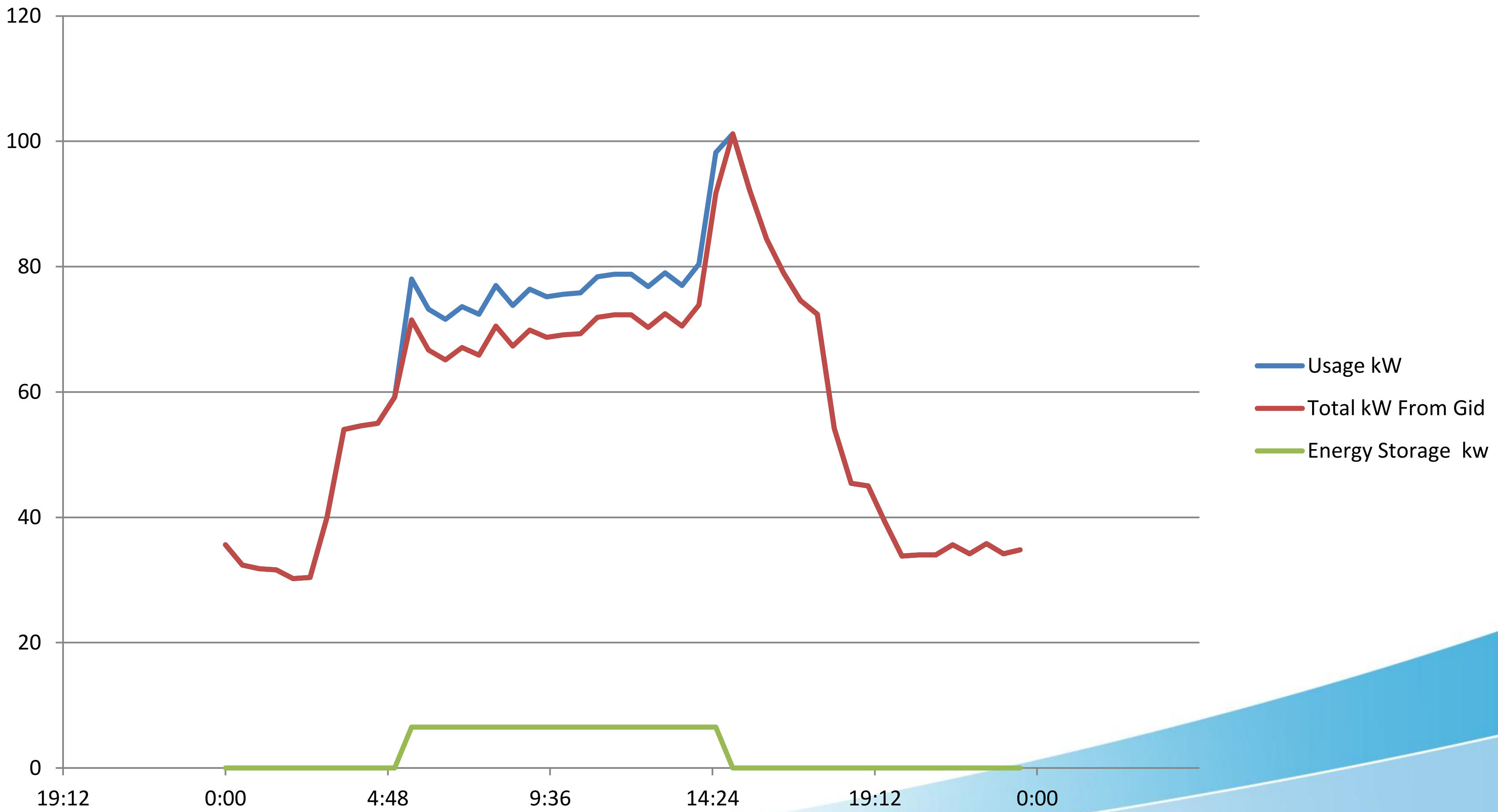

Safety

- Lead Acid Batteries
  - Standards for safe installation well defined
  - 6% overvoltage -> H_2 Evolution
- Li-Ion Batteries
  - No gasses when controlled properly
  - No standards mandated
  - 0.5% overvoltage ->carbon monoxide, volatile hydrocarbons and substantial quantities of H_2

Ventilation and Safety

- All lead acid batteries can vent H_2, but sealed cells usually only vent any qty if overcharged. But adequate ventilation always mandatory.
- For VRLA batteries, AS2676 and AS3011
- Goal is to ensure H_2 concentration less than 2% by volume in the enclosure or room
- Ventilation rate qv = 0.006nI litres/second
  - n is no. of cells, I is charge rate in A/Ahr and depends on whether charger has overvoltage cutoff
- Passive ventilation A = 100qv cm^2
- Active ventilation requires air flow sensors

System Design and Layout for Safety

- Major design consideration is heat dissipation and thermal management
- Bulk Energy Storage Systems can require large current flows
- Conductor temperature rise will be conducted to battery plates via terminals

System Design and Layout for Safety

- Consider access for cell replacement
  - 900mm clear space in front of any battery rack is mandatory (AS3011)
  - OH&S restricts lifting heavy objects above shoulder height – use mechanical lifters
- Consider access for maintenance
  - Space and height must be provided to allow torqueing battery terminals
  - Space and height must be provided to allow measuring cell voltages
  - Terminals must be touch protected, particularly as most BESS systems operate well above ELV

System Design and Layout for Safety

- Multiple parallel strings of high capacity batteries means very high short circuit currents at high DC voltages
- Appropriately rated bi-directional switchgear is mandatory
- Arc-flash protection must be considered
- Consider how one faulty cell or string is to be replaced

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System Design and Layout for Safety

- Battery string layout critical in multiple parallel string systems
  - Uneven string cable lengths leads to uneven charging/discharging (=uneven SOC) which directly affects life and capacity
  - Risk of under or overvoltage on a string
  - Overcharge of one string can trip protective device, which can cascade
  - This effect in VRLA batteries can be reduced by periodic equalisation charge, and use BMS
  - Active Battery Management System can also help, particularly for Li-Ion batteries, but should monitor every cell.

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Operating Environment

- Battery performance over operating temperature range affects cost of temperature control system and reliability if it fails
- Every 10^{o}C rise in average VRLA battery internal temperature halves battery life
- High Power flows in the batteries themselves create internal heating which must be dissipated.
- BCA requires 120/120/120 fire rated enclosures (class 2-9)
- Fire protection systems must be compatible with chemical composition of battery

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The Retailer

- Who controls the Prosumer's asset?
- Reduction in Network peak demand may yield additional returns
- Retailers ideally positioned to achieve this
- Where is the return for the Prosumer?

Thankyou