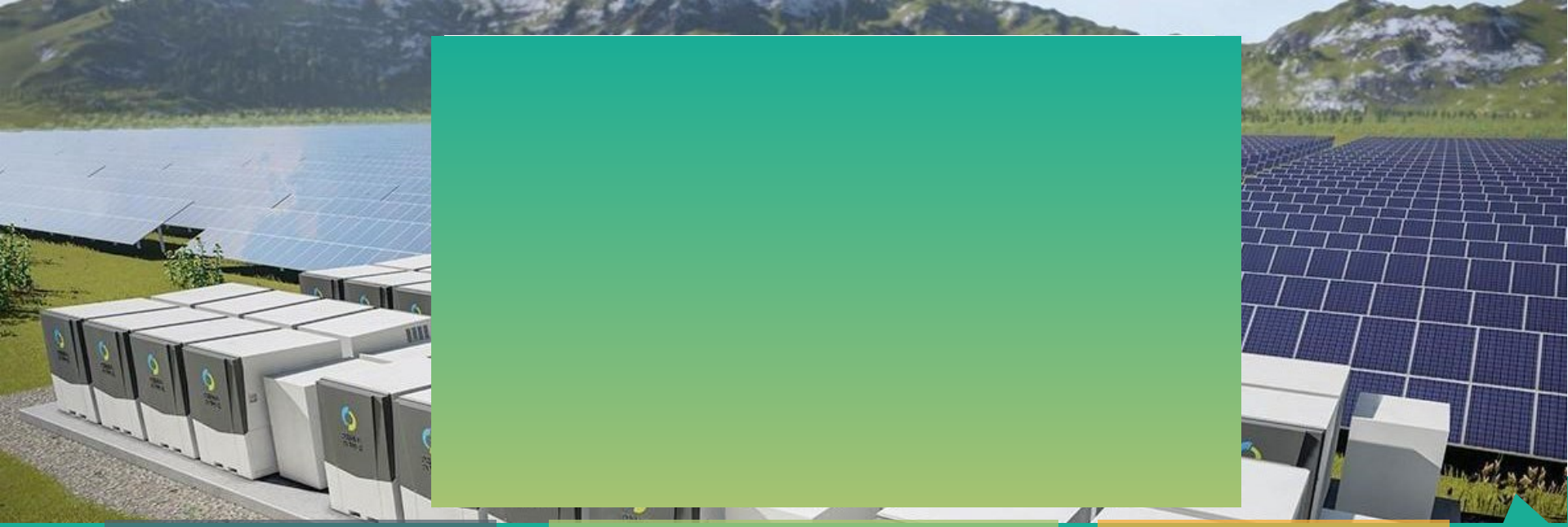
Urban Microgrids Battery and Energy Storage Solution

- My name is Peter Ng.
- >30 years in power engineering industry
- 2006~2017 : Managing Director and board member of Narada Asia Pacific Pte. Ltd. Business in battery storage solution with distribution network in Singapore and Asia Pacific countries
- 2018~ Business advisor, consultant in energy storage solution integration for micro-grid distributed energy storage solution (DESS)
- 2022~ volunteers @ sustainable energy association of Singapore (SEAS) energy storage system working group.
- Having obtained the ACLP (advanced certificate in learning performance), continues the journey as a skill future industry trainer to impart knowledge and learning experiences.

✧ **Continue to up-skill and grow with industry partners and communities.**
✧ **Be empowered with lifelong learning opportunities, skills and knowledge sharing.**



History Energy Storage Solution Application

AWARENESS

Technology and components to form an Energy Storage System

APPRECIATE

Application and Safety.

APPLY

Awareness – Application and Benefits of Energy Storage System

1

Solve renewable energy challenges – solar energy intermittency and manage storage of excess energy.

2

Frequency regulation - stability of power quality . Quick response to maintain system frequency range

3

Primary Contingency Reserve – fast acting generation capacity that can be activated quickly to compensate sudden shortfall of electricity supply.

4

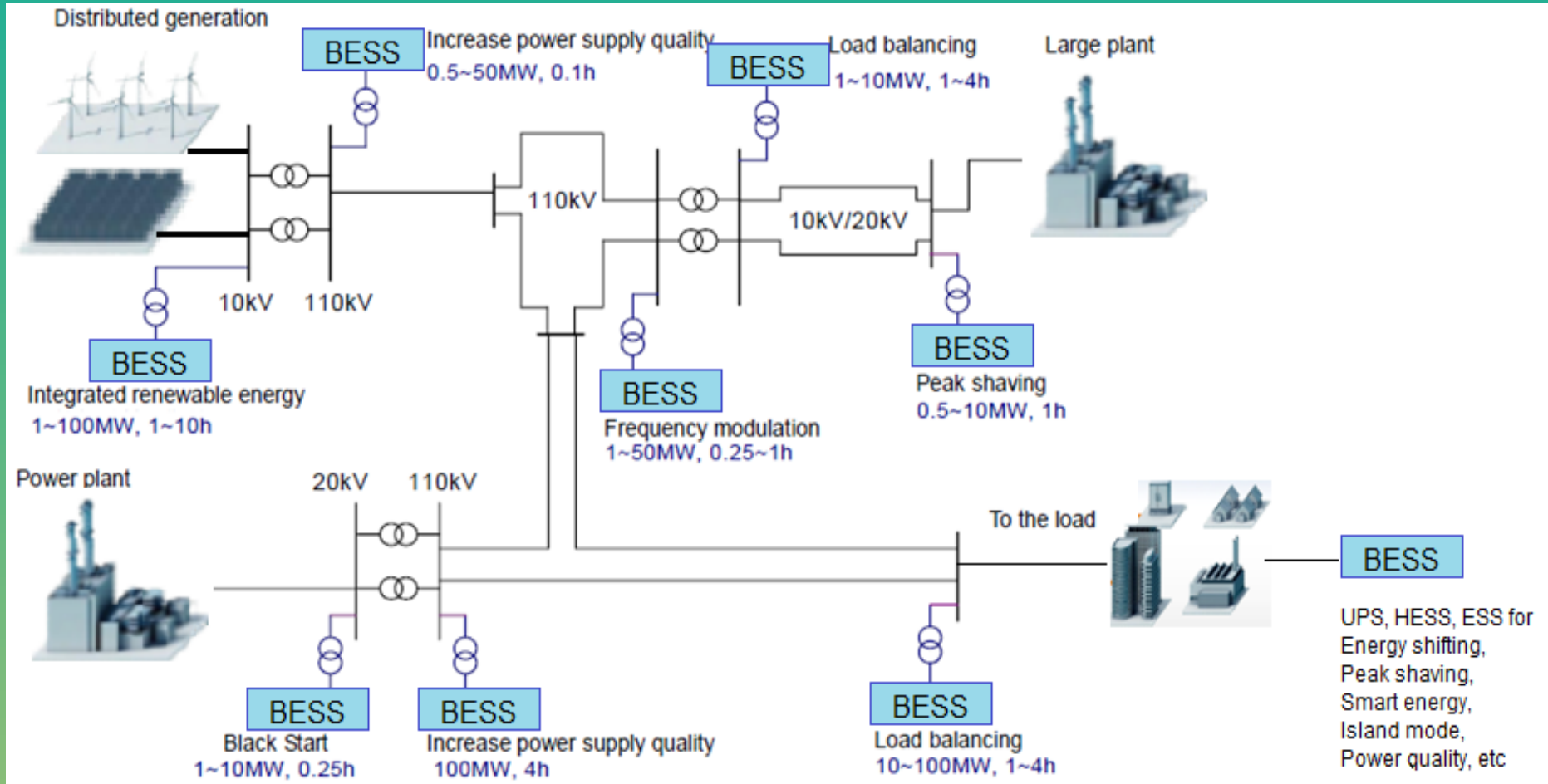
Peak shaving - use battery to manage energy consumption from peak to non peak.

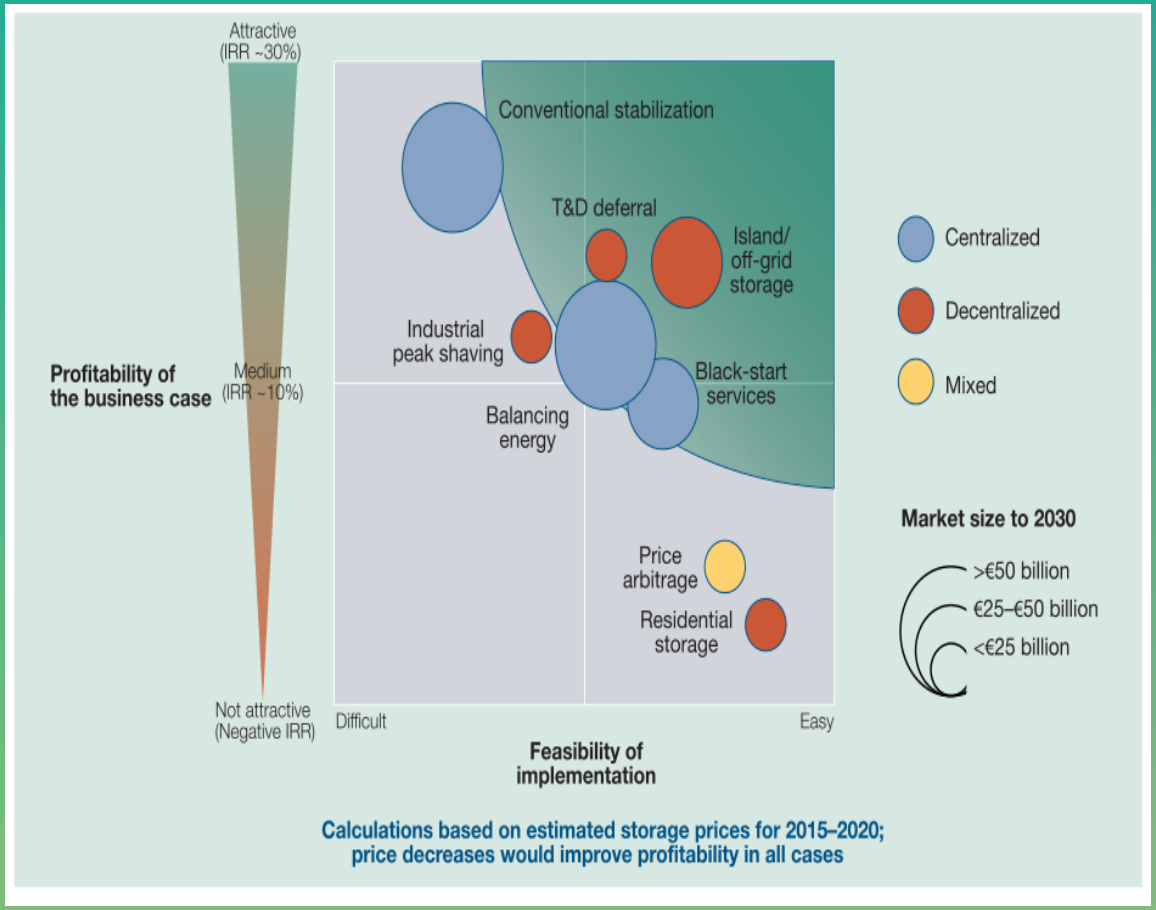
5

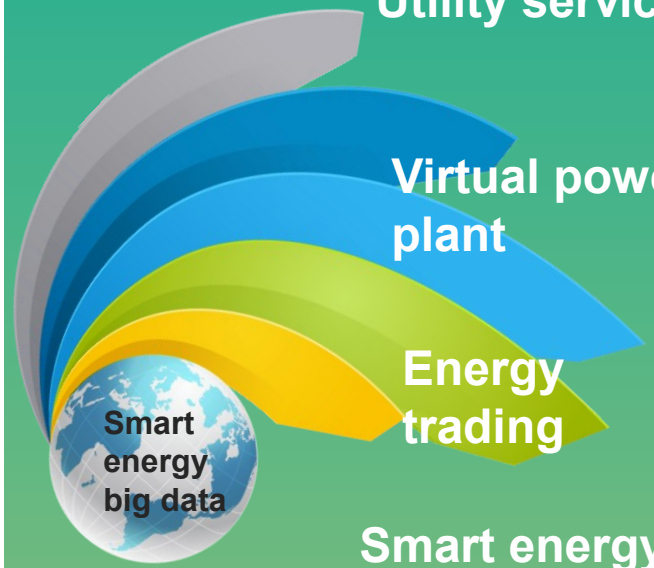
Grid deferral - ESS help defer the cost of building new transformers and substations by meeting short term peak load demand

Application	Value
Energy arbitrage	Provide flexibility between supply and demand
Ramp-rate control / firming of renewables	Reduce the strain on the balancing and reserve capacity of the power system by reducing the intermittency of renewables
Reduction of curtailment losses	Avoid revenue loss by storing energy during periods of curtailment, or avoid curtailment altogether
Frequency control	Provide additional frequency response reserve to the power system, allowing more non-synchronous
Voltage control	Provide voltage support to the grid, increasing its transmission/distribution capacity
Stacked applications	A combination of the above!

Feasibility of ESS implementation

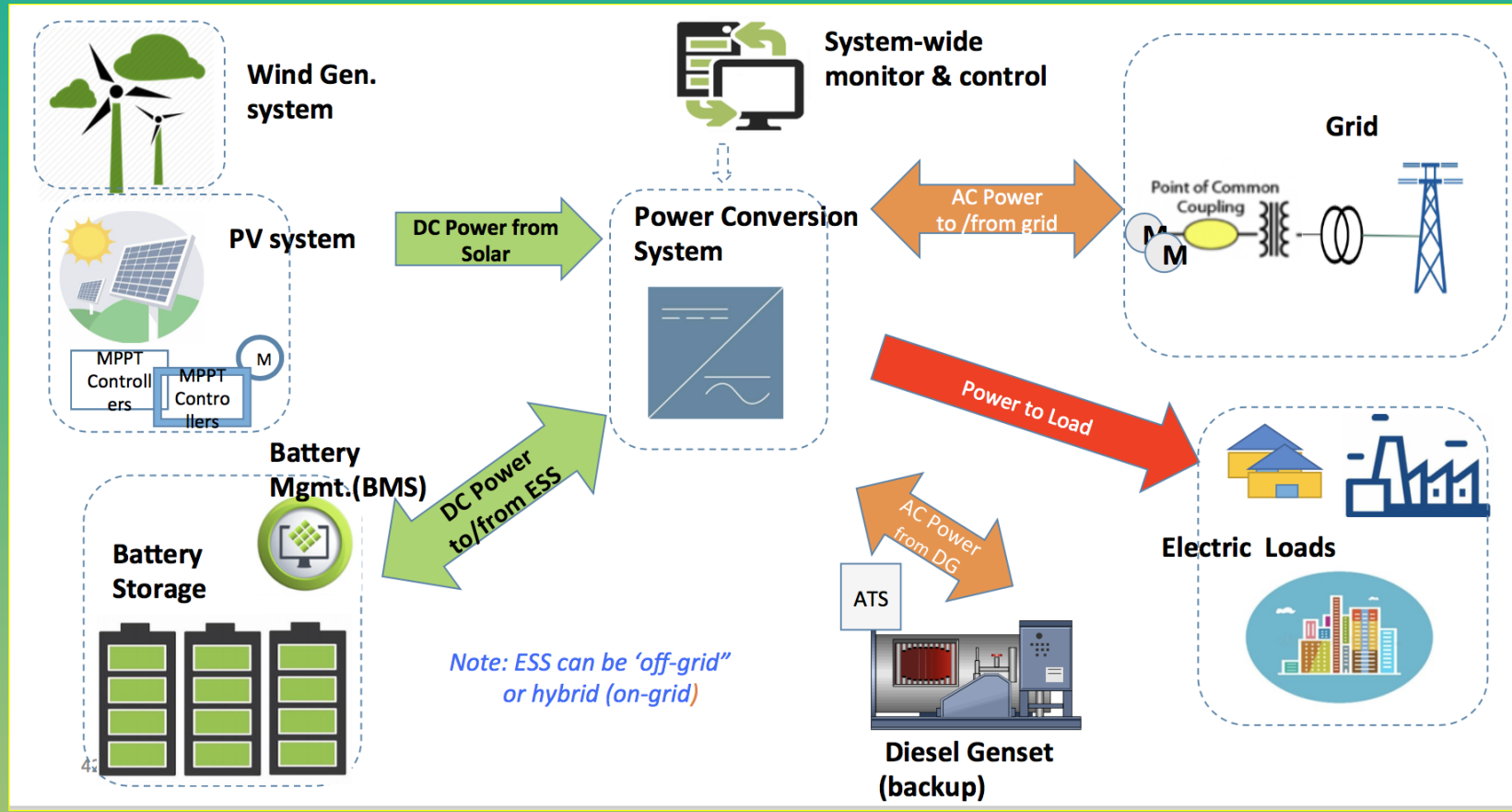






Smart energy multiple application

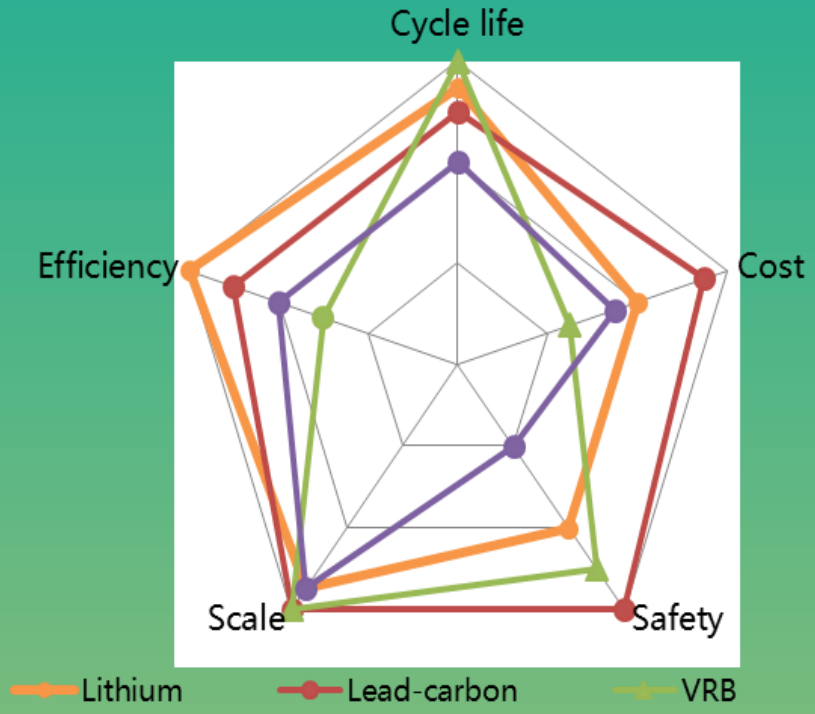
Appreciate - Different technologies application in Energy Storage System



Battery Chemistry (Common trend)

Parameter	Lead Carbon Battery	Li-ion Battery	Vanadium Redox Flow Battery (VRB)	Sodium-ion Battery
Efficiency (DC+AC)	65-80%	85-90%	70-80 %	80-90%
Available C-Rates	C/10 – 0.5C	C/4 – 4C	C/10 – 0.2C	Fast charge to 80% in 15mins (close to 4C)
Depth of Discharge (DOD)	50%	80%	100%	90-100%
Energy Density (Wh/kg)	40 - 60	LFP: ~180Wh/kg NMC: ~300Wh/kg	8 -14	~160Wh/kg
Energy Density (Wh/L)	50-100	200-800	20-70	A bit lower than LFP
Cycle cycle	800 – 2000	2000 – 4000	≥10000	3000-5000
Cycle time (years)	3-5	8-10	15-25	10-15
Fire Safety	High	Medium	High	High
CAPEX ($/kWh)	350 – 630	390-580	600 – 1000	Chasing after Lithium-ion
Chemicals Toxicity / Environmental impact	High	High	Medium	Low

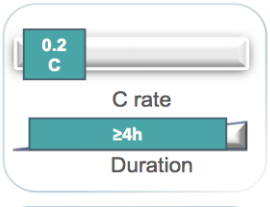
Comprehensive comparison of different battery technology (general)



- ✓ **Specific energy**
- ✓ **Power density**
- ✓ **Response time**
- ✓ **Storage efficiency**
- ✓ **Lifetime**
- ✓ **Environment & Safety**

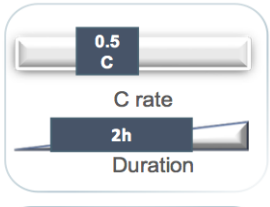
BESS Technology application (typical)

High Energy



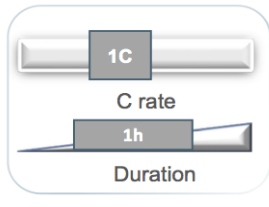
- **Chemistry**
  Lead carbon
- **Application**
  peak shaving, demand response
- **Specification**
  REXC 2V1000AH
  5000 cycles@60%DOD
  10 year design life
- **Salability**
  Yes, Battery cluster 672V/672kWh；Battery system 1.3MWh

Energy



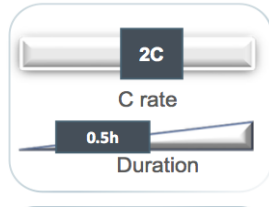
- **Chemistry**
  LFP
- **Application**
  peak shaving, time shifting
- **Specification**
  FE 3.2V125Ah
  6000 cycles @80%DOD
  15 year design life
- **Salability**
  Yes, Battery Rack 768V/192kWh；Battery System 3MWh

Medium



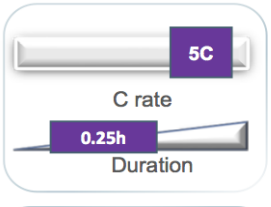
- **Chemistry**
  LFP
- **Application**
  Power smoothing, ramp rate control
- **Specification**
  FE 2V105Ah
  5000 cycles@80%DOD
  15 year design life
- **Salability**
  Yes, Battery Rack 768V/150kWh；Battery System 2.4MWh

Power



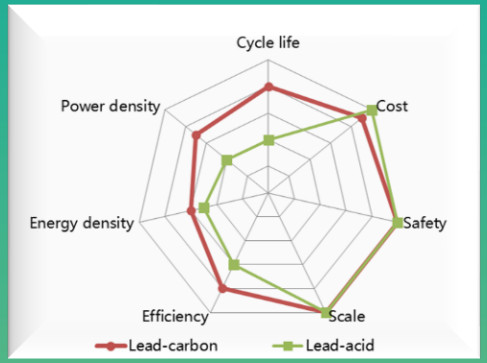
- **Chemistry**
  LFP
- **Application**
  Frequency/Voltage regulation, load following
- **Specification**
  FE 3.2V80Ah
  5000 cycles@80%DOD
  15 year design life
- **Salability**
  Yes, Battery Rack 768V/120kWh；
  Battery System 2.0MWh

High Power



- **Chemistry**
  LFP
- **Application**
  Frequency regulation, Voltage regulation, IDC
- **Specification**
  FE 3.2V50Ah
  5000 cycles@80%DOD
  15 year design life
- **Salability**
  Yes, Battery Rack 512V/88kWh； Battery System 1.3MWh

Apply - Different type technologies : VRLA-Lead Acid Battery ESS



- Lead carbon technology combines the feature of super capacitor and lead acid battery
- Active carbon into negative active material
- Long life @ PSOC performance
- Good cycle life
- Fast Recharge
- Feasible manufacture technology
- Low cost - Recyclable
- Rank high in safety .
- Disadvantage : Low specific energy

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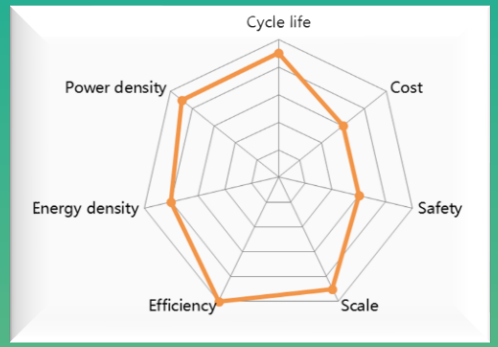
Apply - Different type technologies : Lithium Ion Battery Energy Storage System



Advantages

- High specific power & energy
- High efficiency
- Long cycle life

Disadvantages

- Difficult to manage cell grouping
- High overall cost
- Safety concerns

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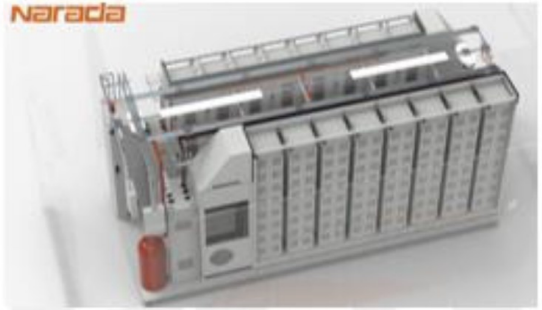
Apply – Typical Container Battery Energy Storage System

Lead Carbon Containerized Solution

None-Walk-In Lithium Containerized Solution

Walk-In Lithium Containerized Solution



Full Populated 20’ Lithium Containerized Solution

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Apply – Plant Energy Management System

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