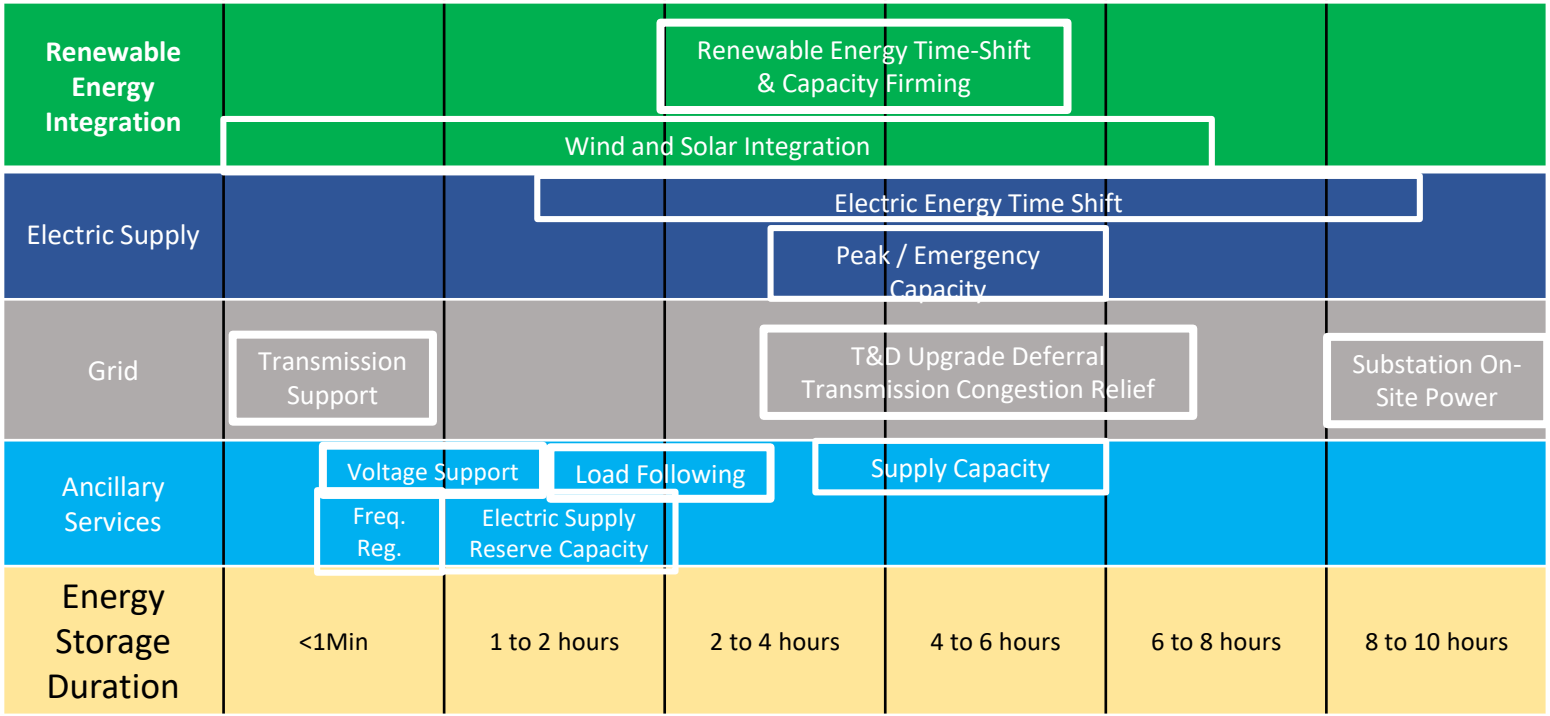

ESS INC
THE CASE FOR FLEXIBLE ENERGY STORAGE
March 19 2018
2017
Global Cleantech
100
TOP 100 COMPANY
Cleantech Group

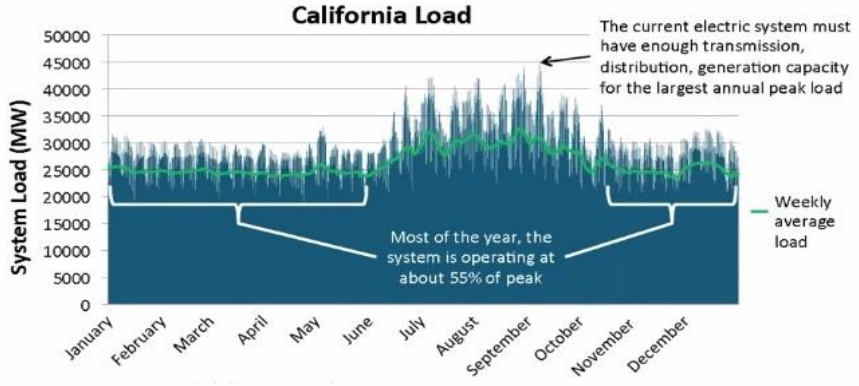
The Case For Flexible Energy Storage

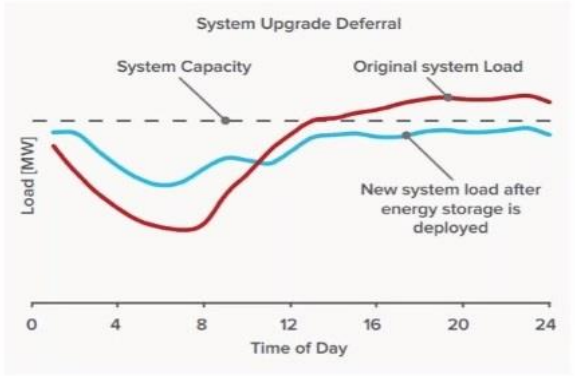


Flexible Energy Storage for 20 years maximizes the return on investment

Applications

T&D DEFERRAL APPLICATIONS





Multiple Stacked Use Cases

- T&D Upgrade Deferral
- Renewable Energy Time Shifting
- Peak Demand Capacity
- Ancillary Services

Requirements:
> 4 hours duration, daily cycles, 20+ year life
Flexible to handle ancillary services

RENEWABLE TIME SHIFTING APPLICATIONS

December hourly production at 1.35 overbuild with no battery vs. 1.6 overbuild with battery and overnight charging

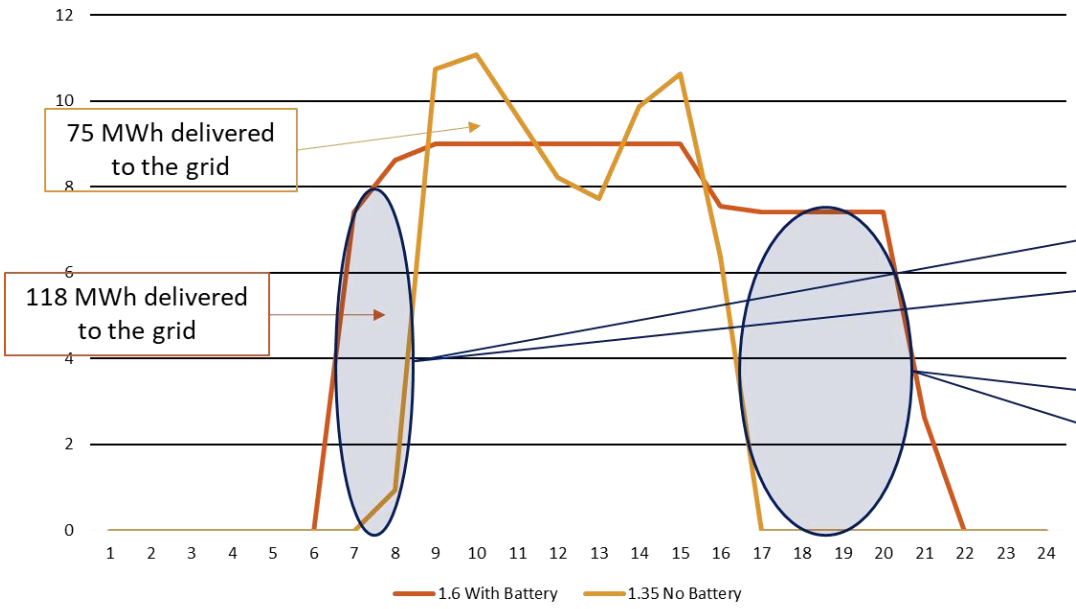
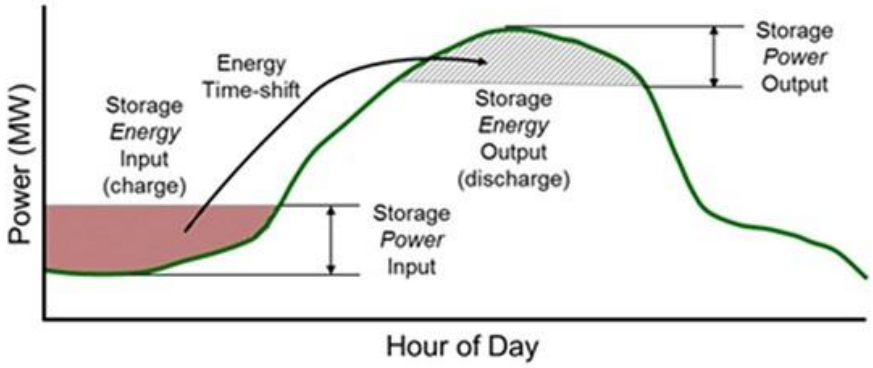


FIGURE 5-3: PGE's LOLE (hours per year) in 2021 before capacity actions

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
6	0.13	0.11	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.28
7	0.47	0.37	0.32	0.04	0.00	0.00	0.01	0.02	0.03	0.09	0.84	1.13
8	1.88	1.01	0.68	0.09	0.00	0.00	0.03	0.10	0.10	0.16	1.17	2.48
9	3.20	1.73	0.77	0.05	0.01	0.01	0.13	0.39	0.12	0.13	2.12	3.97
10	2.55	1.16	0.53	0.04	0.01	0.04	0.38	0.83	0.17	0.07	1.72	3.60
11	1.88	0.80	0.34	0.02	0.02	0.09	0.81	1.52	0.23	0.05	1.27	2.89
12	1.58	0.51	0.17	0.01	0.03	0.18	1.35	2.33	0.36	0.04	0.99	2.41
13	1.46	0.31	0.09	0.01	0.06	0.33	2.10	3.36	0.53	0.03	0.86	1.79
14	1.19	0.16	0.05	0.00	0.08	0.50	3.08	4.57	0.82	0.02	0.72	1.34
15	0.91	0.13	0.04	0.00	0.11	0.66	3.91	5.57	1.22	0.03	0.62	1.05
16	0.79	0.14	0.03	0.00	0.12	0.86	4.59	6.36	1.65	0.04	0.76	1.40
17	1.27	0.25	0.06	0.00	0.16	1.00	4.78	6.69	1.99	0.09	1.32	3.22
18	3.14	0.66	0.15	0.01	0.16	0.84	4.51	6.71	2.11	0.26	3.01	5.66
19	5.04	1.47	0.40	0.01	0.15	0.58	3.72	6.26	1.96	0.41	4.62	7.40
20	4.86	1.74	0.58	0.02	0.12	0.36	2.84	5.09	1.75	0.34	4.22	6.62
21	3.55	1.23	0.40	0.02	0.06	0.19	1.75	3.75	1.42	0.14	3.01	4.63
22	2.01	0.65	0.12	0.01	0.02	0.07	0.72	2.01	0.38	0.02	1.62	2.60
23	1.08	0.33	0.02	0.00	0.00	0.01	0.03	0.22	0.01	0.00	0.54	1.27
24	0.16	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.22

57% more power delivered to the grid. All of it in the hours the utility needs it the most.

PEAK DEMAND CAPACITY APPLICATIONS



Source: E&I Consulting

Figure 1. Electric Energy Time-shift.

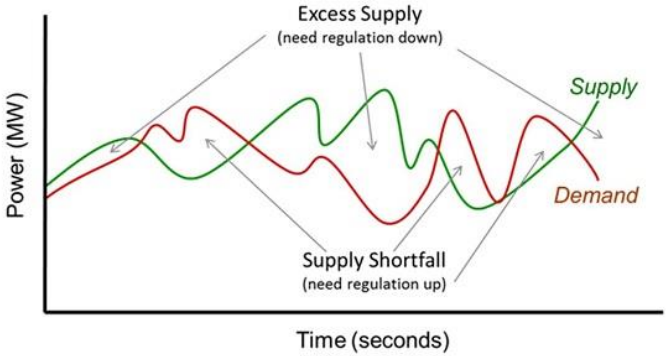
Multiple Stacked Use Cases

- T&D Upgrade Deferral
- Renewable Energy Time Shifting
- Peak Demand Capacity
- Ancillary Services

→

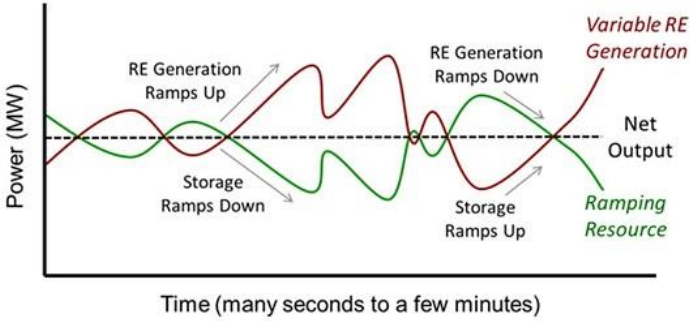
Requirements:
> 4 hours duration, daily cycles, 20+ year life
Flexible to handle ancillary services

ANCILLARY SERVICES APPLICATIONS



Source: E&I Consulting

Figure 5. Frequency regulation needs due to momentary differences between demand and a variable supply.



Source: E&I Consulting

Figure 8. Variable renewable generation and storage ramping.

Multiple Stacked Use Cases

- T&D Upgrade Deferral
- Renewable Energy Time Shifting
- Peak Demand Capacity
- Ancillary Services

→

Requirements:
> 4 hours duration, daily cycles, 20+ year life
Flexible to handle ancillary services

Leading The Long Duration Charge

Company

- Founded in 2011
- HQ in Wilsonville, OR
- Investors Include BASF, Presidio Partners, Pangaea, Cycle Capital, IPM
- World Wide Sales

Technology

- Iron Flow Battery
- Lowest cost battery
- No capacity fade
- Safest battery technology on the market
- ESS proprietary and IP protected technology

Manufacturing

- 100,000 ft^2 facility in Wilsonville, OR
- Scaling to 1 GWh/year
- Efficient & Scalable manufacturing
- Distributed manufacturing model

Applications

- Long duration technology
- Isolated-grid & Micro-grids
- Renewable integration
- Fast response for Ancillary Services

World Class Team

Intellectual Property

+ 5 Patents Granted
+ 19 Patents Pending

Craig Evans – Founder & CEO

+ ClearEdge Power: Director of Design & Product Development
+ United Technologies: Advanced Manufacturing, Meade Award

Dr. Julia Song – Founder & CTO

+ ClearEdge Power: VP R&D
+ Milliken & Company

Jay Corn– Chief Financial Officer

+ Sundrop Fuels: Chief Financial Officer
+ New Jersey Resources: VP Finance/Corporate Development

Hugh McDermott– SVP Business Development

+ BetterPlace: VP Global Business Development
+ Silver Springs Network: VP Sales

Shelley Peng – VP Marketing

+ Nike, Inc.: Global Director of Communications
+ Deloitte & Touche: Director

Mark Hagedorn – Director of Operations

+ FEI Company: Operations/Value Engineering
+ Detroit Diesel: Product Validation Manager

Board Of Directors

Dave Lazovsky - Chairman

+ Intermolecular: Founder, former President & CEO
+ Applied Materials

Craig Evans

+ ESS, Inc.: CEO

Andrew Haughian

+ Pangaea Ventures: Partner

Shirley Speakman

+ Cycle Capital

Pulakesh Mukherjee

+ BASF Ventures

Mike Niggli

+ SDG&E: Former President & COO
+ Nevada Power Company: Chairman & CEO

Nevin Caldwell

+ Duracell: SVP Mfg & Technical Operations
+ Private Equity - COO

Investors

PANGAEA VENTURES LTD.

BASF We create chemistry

CYCLE CAPITAL MANAGEMENT

PRESIDIO PARTNERS

IPM

arpa·e

TRULY CLEAN LONG-DURATION ENERGY STORAGE HAS ARRIVED.

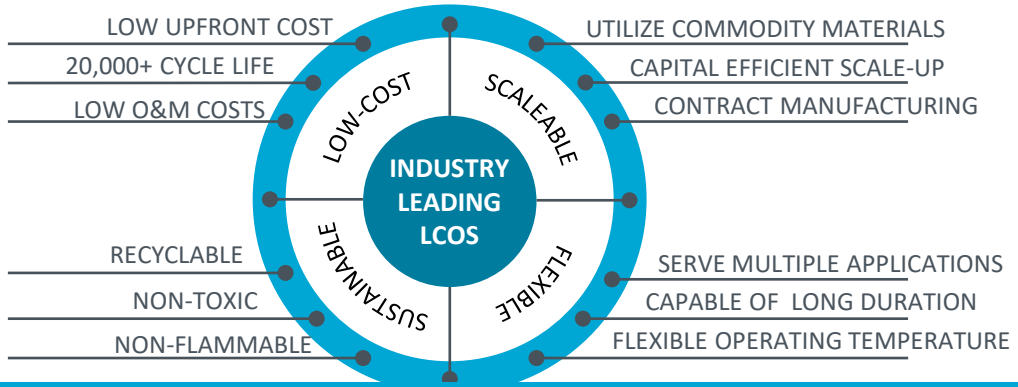
Using food-grade and earth-abundant elements like iron, salt and water, our innovative All-Iron Flow Battery is changing the face of energy storage. With lower costs, longer durations and no noxious fumes, no one has to choose between their bottom line and a sustainable future.

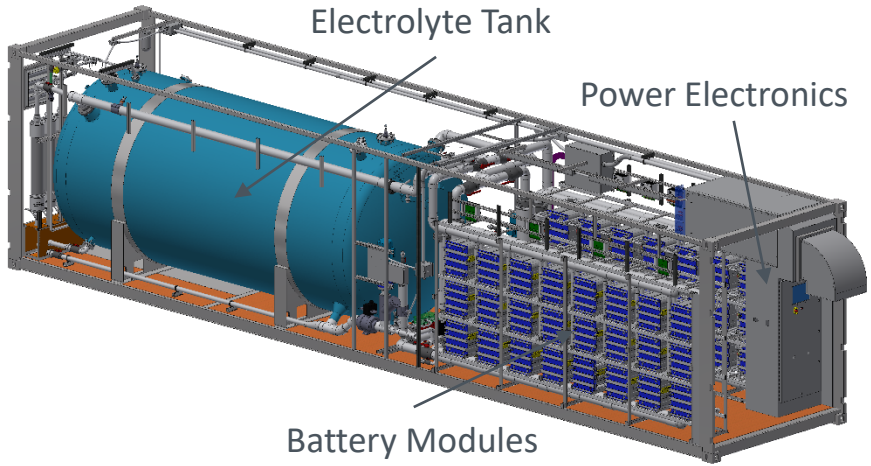
OVER 20,000 CYCLES

4+ HOURS OF LONG DURATION STORAGE

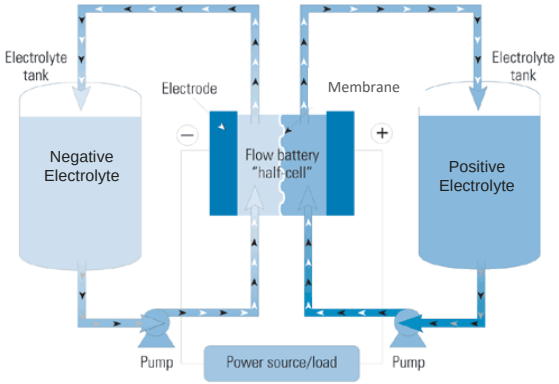
ECO-FRIENDLY NON-TOXIC • NON-FLAMMABLE NO CORROSIVE ACIDS

20+ YEARS OF NO DEGRADATION

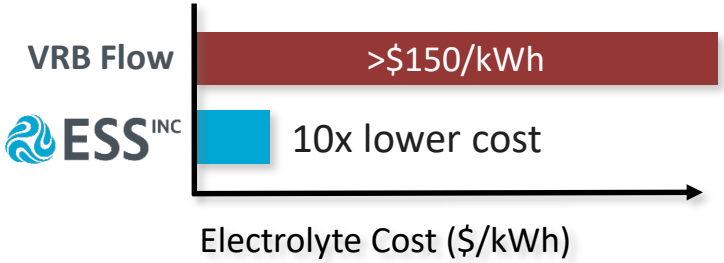




AVOIDING HISTORICAL FLOW BATTERY PITFALLS



Low cost abundant electrolyte materials



Iron + Salt + Water

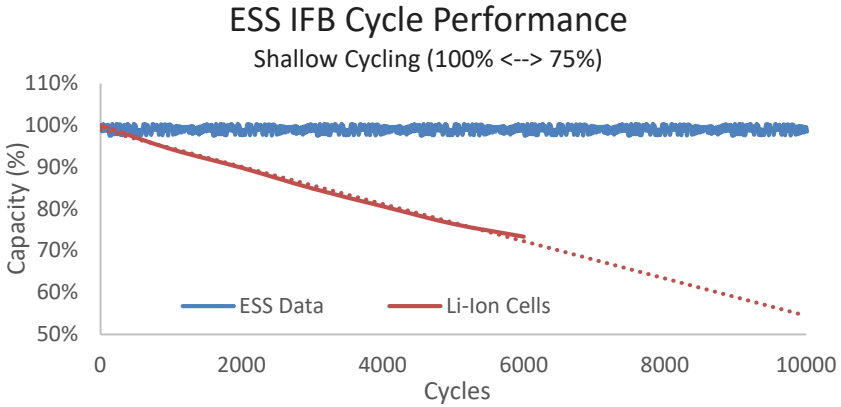
No Degradation Battery Chemistry

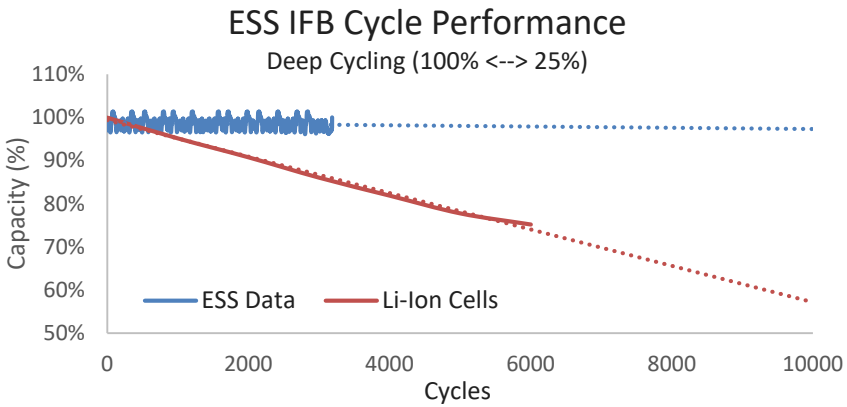
+ Voltage range eliminates carbon electrode corrosion -
+ Benign chemistry easy on construction materials

Best Battery Safety & Toxicity Profile

+ pH similar to soda and wine, no toxic materials
+ Inherently safe, no fire risk
+ Environmentally friendly
+ 100% recyclable

SUPERIOR PERFORMANCE DRIVING LOWEST LEVELIZED COST OF STORAGE (LCOS)





Operating Conditions	ESS IFB	Li-Ion (NMC)
Temperature	0-60°C	25-30°C

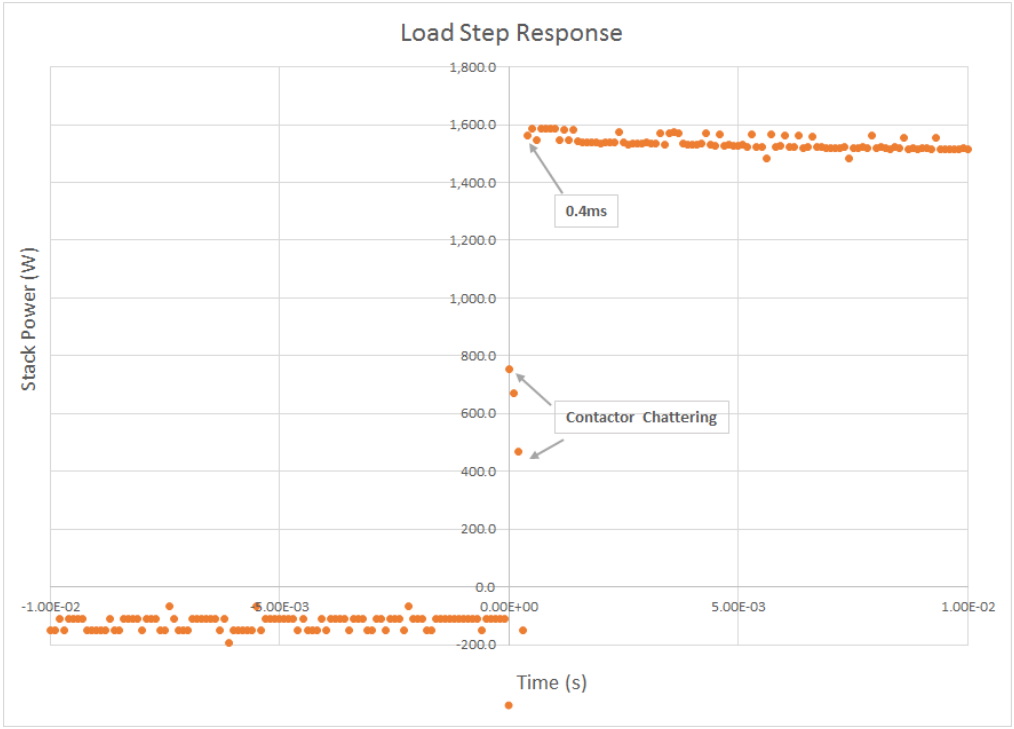
+ No capacity fade over lifetime
+ No HVAC or fire suppression requirements
+ No need to oversize or augment system
+ Never replace batteries

FAST RESPONSE CAPABILITY

- Flexible for Ancillary Services and responding to transient loads

DC Response of IFB Battery

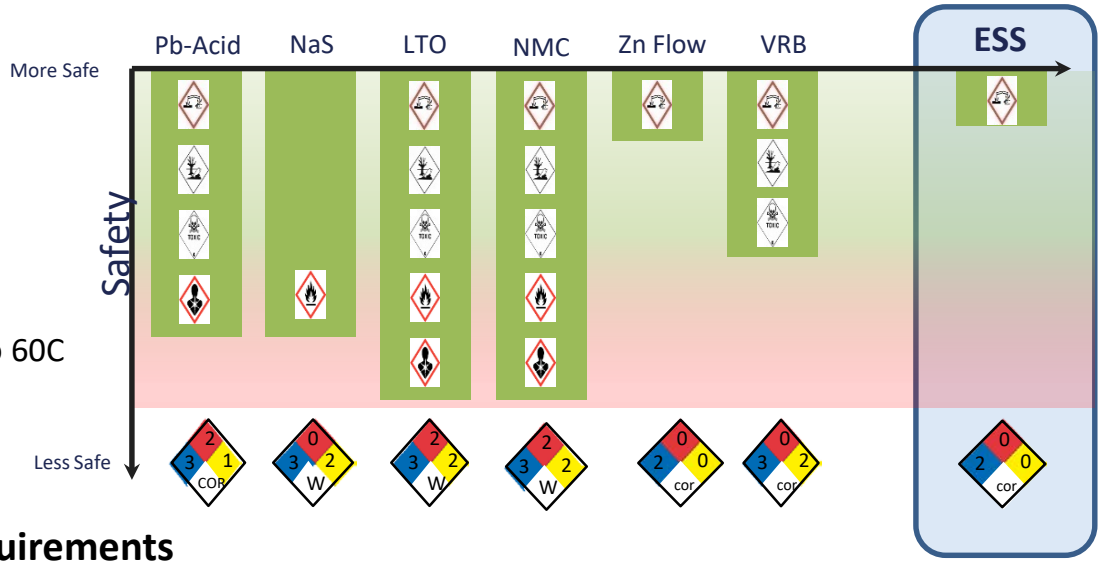
+ Zero-to-Full Rated Power in .4 ms



LOWEST SOFT COSTS – FASTEST TO DEPLOY

- **Minimal permitting requirements**
  - No fire risk
  - No hazmat risk
  - No explosion risk
- **Fast to deploy and commission**
  - No special siting requirements
  - No HVAC requirements – operates up to 60C
  - No fire suppression requirements
  - Engineered for seismic zones
- **Minimal on-going compliance requirements**
  - No specialized training or licensing for operation
  - No specialized incident response requirements

Best Battery Safety & Toxicity Profile



FLEXIBLE ENERGY STORAGE

Energy Warehouse™

+ Flexible building block
+ Instantaneous response
+ Turnkey design for fast installation
+ Inverter and Power electronics included
+ Nominal Power: 50kW
+ Capacity at nominal power: 8 hours

Flexible Power and Energy

+ Scalable to MW and MWh Utility Scale
+ Smooth the renewables or bulk shift the energy
+ Reduce demand charges
+ Support utility application
+ Or…. do all of the above

ESS SPOTLIGHT INSTALLATIONS

UCSD Microgrid
400kWh
Microgrid

Operational Q2 2017

US Army Corps
225kWh
Off-grid/Renewables

Operational Q2 2016

DNV-GL
400kWh
Renewable Integration

Operational Q2 2017

Stone Edge Farms
60 kWh
Microgrid/Renewables

Operational Q1 2015

Additional 2.4MWh currently under production for delivery in North America, Latin America and Western Europe

FLEXIBLE ENERGY STORAGE

2015 | 2016 | 2017 | 2018 | 2019

10kW/60kWh

Military

60kW/225kWh

Commercial

50kW/400kWh

100kW/400kWh

75kW/600kWh

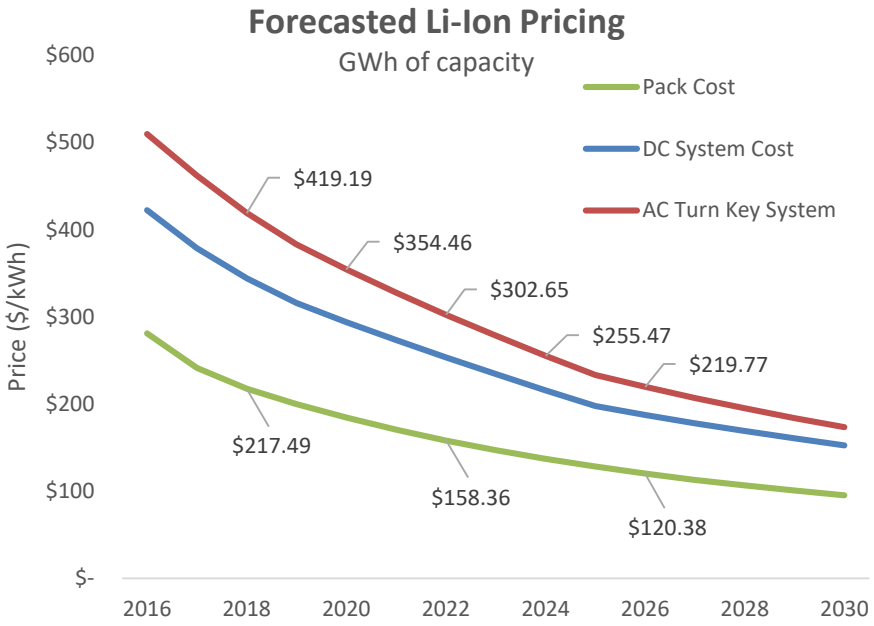
Utility

ESS Energy Centers

30MW/120MWh

PRODUCT ROADMAP - INCREASING ENERGY DENSITY

ESS BATTERY PRICING ADVANTAGE



Li-Ion vs. ESS Pricing ($/kWh)

Year	Li-Ion AC Price	ESS AC Price*
2018	419.19	$306.65
2019	$383.20	$289.00
2020	$354.46	$258.82
2021	$327.87	$241.39
2022	$302.65	$236.62

Li-Ion LCOS > $0.15/kWh

ESS LCOS* = $0.06/kWh

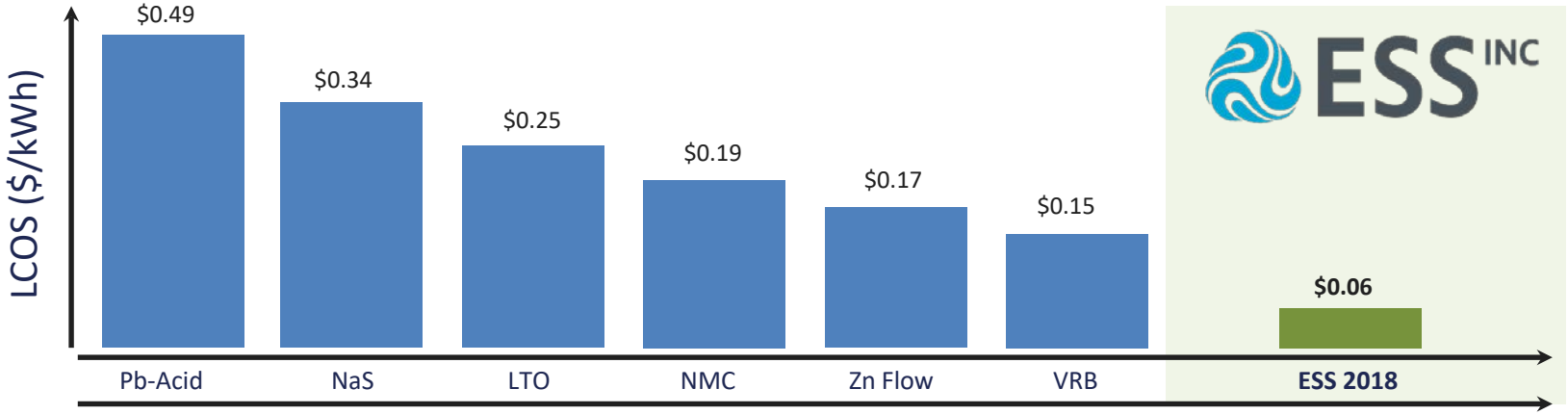
*As quoted, based on 250MWh volume, 2019 shipments of containerized 3.2 hour usable systems. Projected pricing beyond 2019.

- ESS AC system all-in cost << best-in-class Li-Ion high-volume cost (e.g. BYD)
- Enables upfront pricing (customer CapEx investment) significantly below Li Ion
- ESS LCOS < 50% of Li-Ion → ***Worlds lowest cost energy storage solution***

Industry Leading Storage Cost
Lowest Cost Long Duration Storage

LCOS calculated for peak shaving or renewable integration

+ 6 hours usable of storage, 1 cycles per day
+ 25 years of operation
+ Equipment technology margins included



ESS Energy Centers
Current Strategic Partnership Program

Data Centers

- Safe, reliable data storage
- Flexible data storage capacity
- Commercial & Industrial locations
- ISO class 8 or class 9 environment
- Standard for data communications

ESS Energy Centers

- Safe, reliable energy storage
- Flexible energy storage capacity
- Commercial & Industrial locations
- Conventional warehouse environment

50MWh Energy Storage Center example:

- Price*: <$275/kWh; LCOS: <$0.05/kWh
- Footprint: <1 acre

*Based on 2018 orders, 2019 deployment

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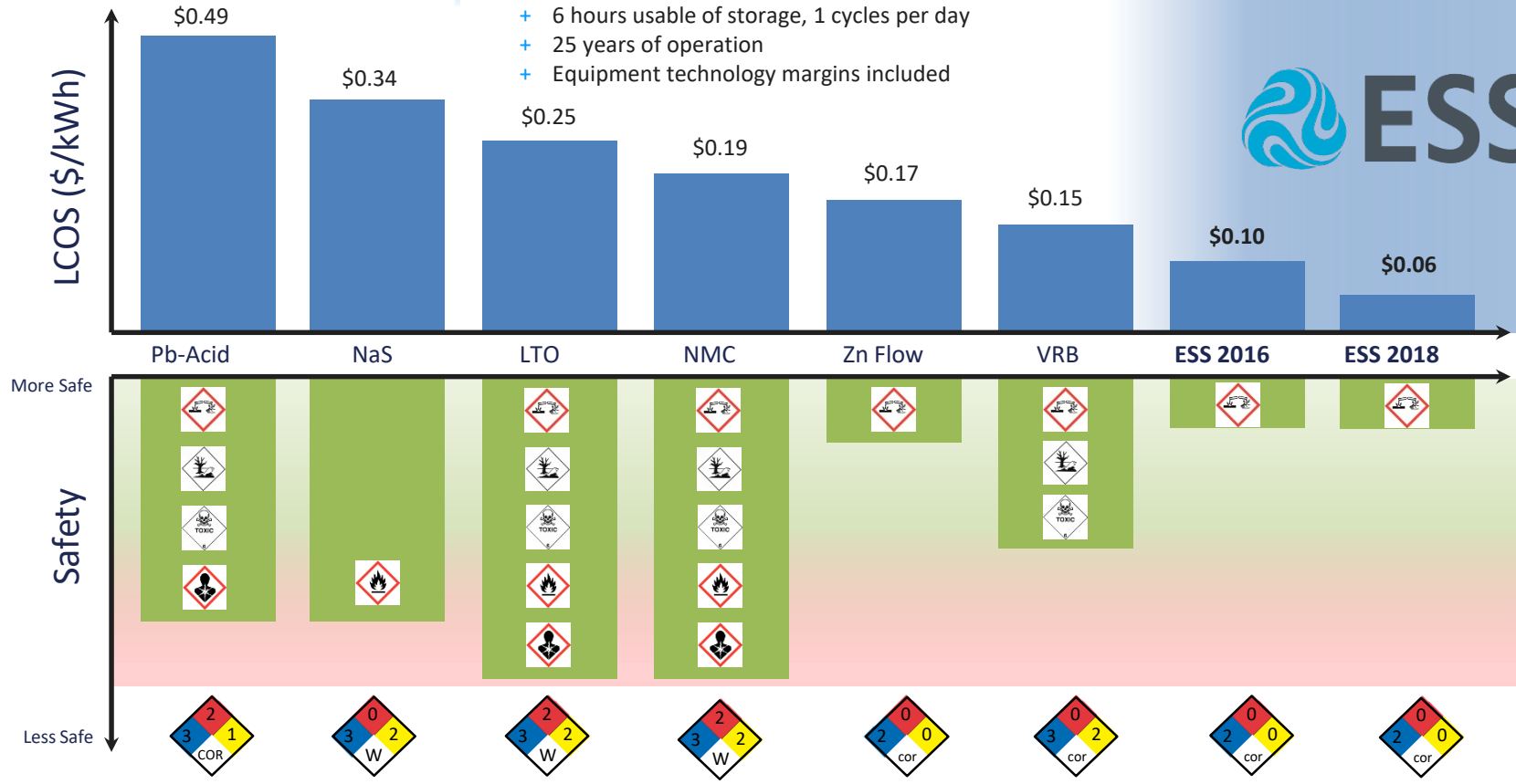
LCOS Calculated for RE Integration

Assumptions

- 6 hours usable of storage, 1 cycles per day
- 25 years of operation
- Equipment technology margins included



LCOS Calculation

Purchases for the System
- Equipment (i.e. batteries)
- Site preparation (foundation)
- Transportation (new material and old material)
- Disposal

Operation & Maintenance
- Labor to service system
- Services used (i.e. Internet)
- Materials used

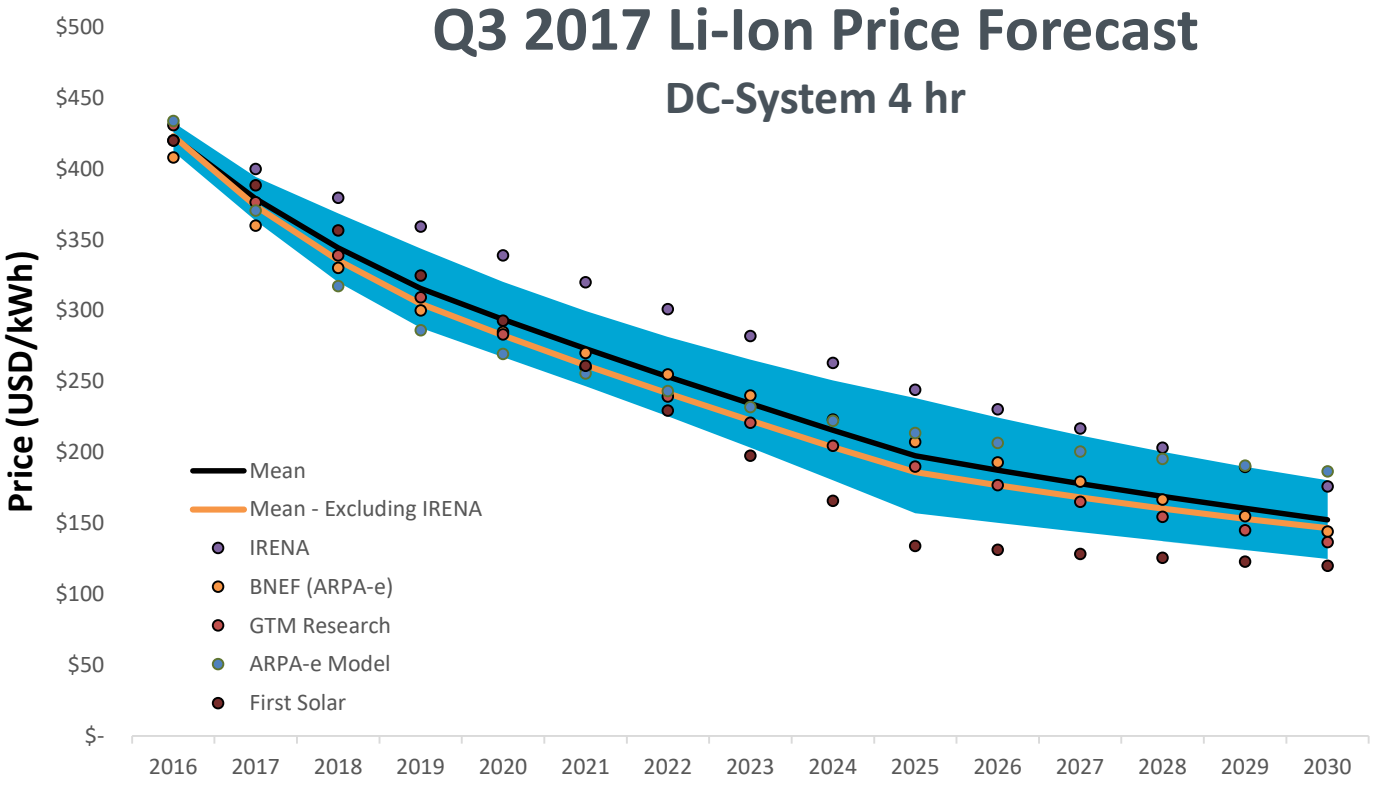
Reliability
- May or may not be included in O&M
- Typically hold a warranty provision in COGS
- ESS typically holds a 3-5% warranty provision

$$LCOS = \frac{\sum CapEx + \sum O\&M}{\sum kWh}$$

Useable energy
- Accounts for capacity fade
- Usable State of Charge
- Round trip efficiency

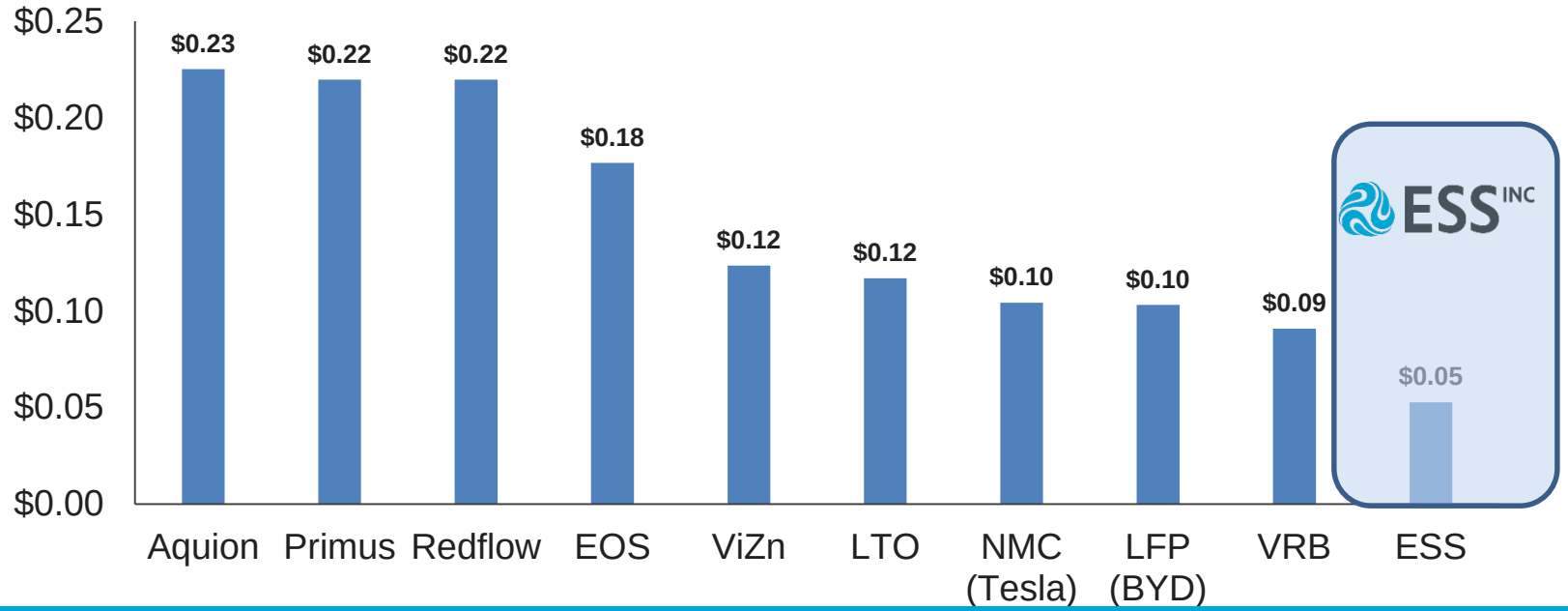
Li-Ion Pricing

Price Forecasts (4 hr DC System)

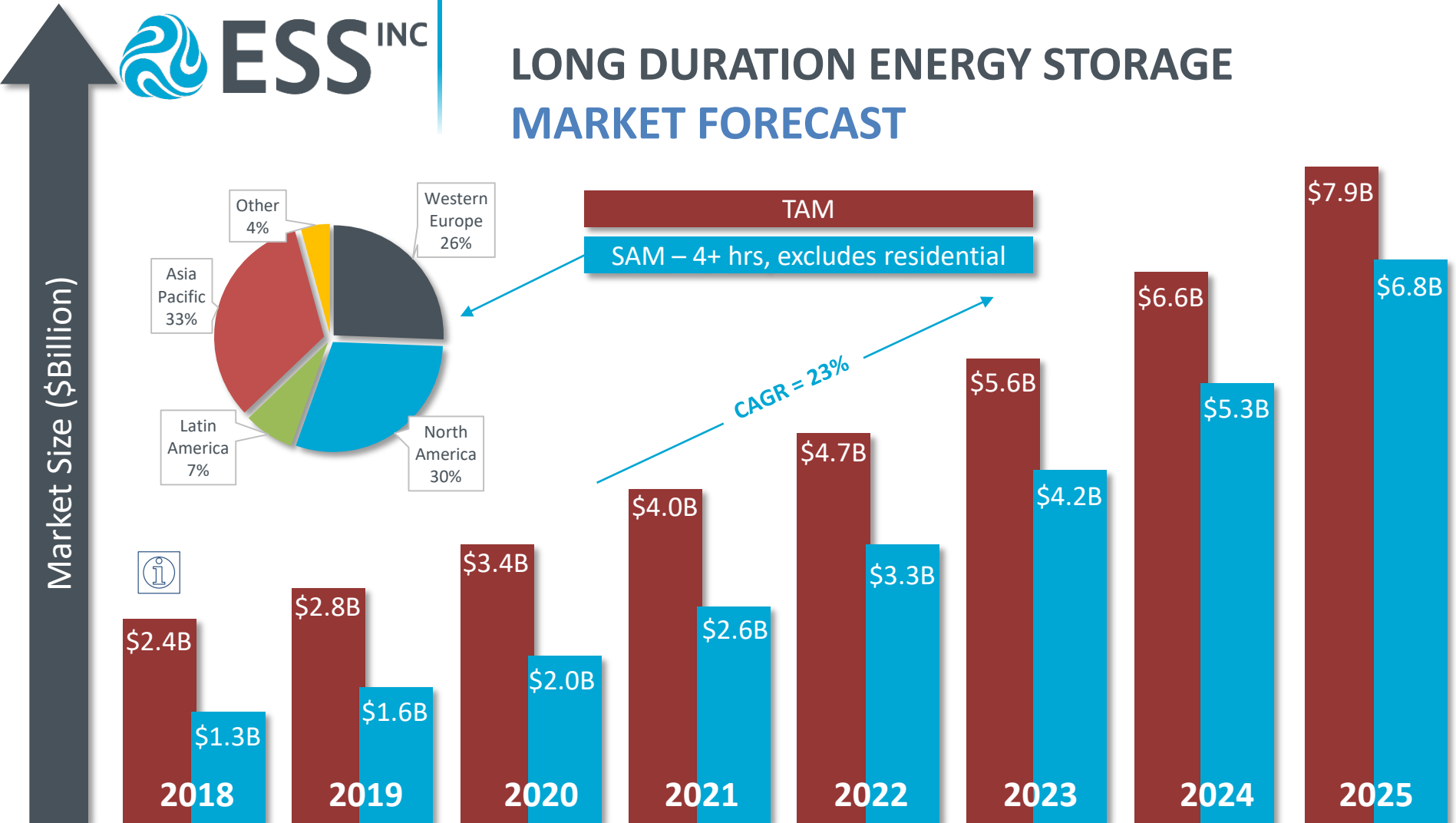


LCOS COMPARISON - 2020

Levelized Cost Analysis - 2020
CapEx Cost Analysis

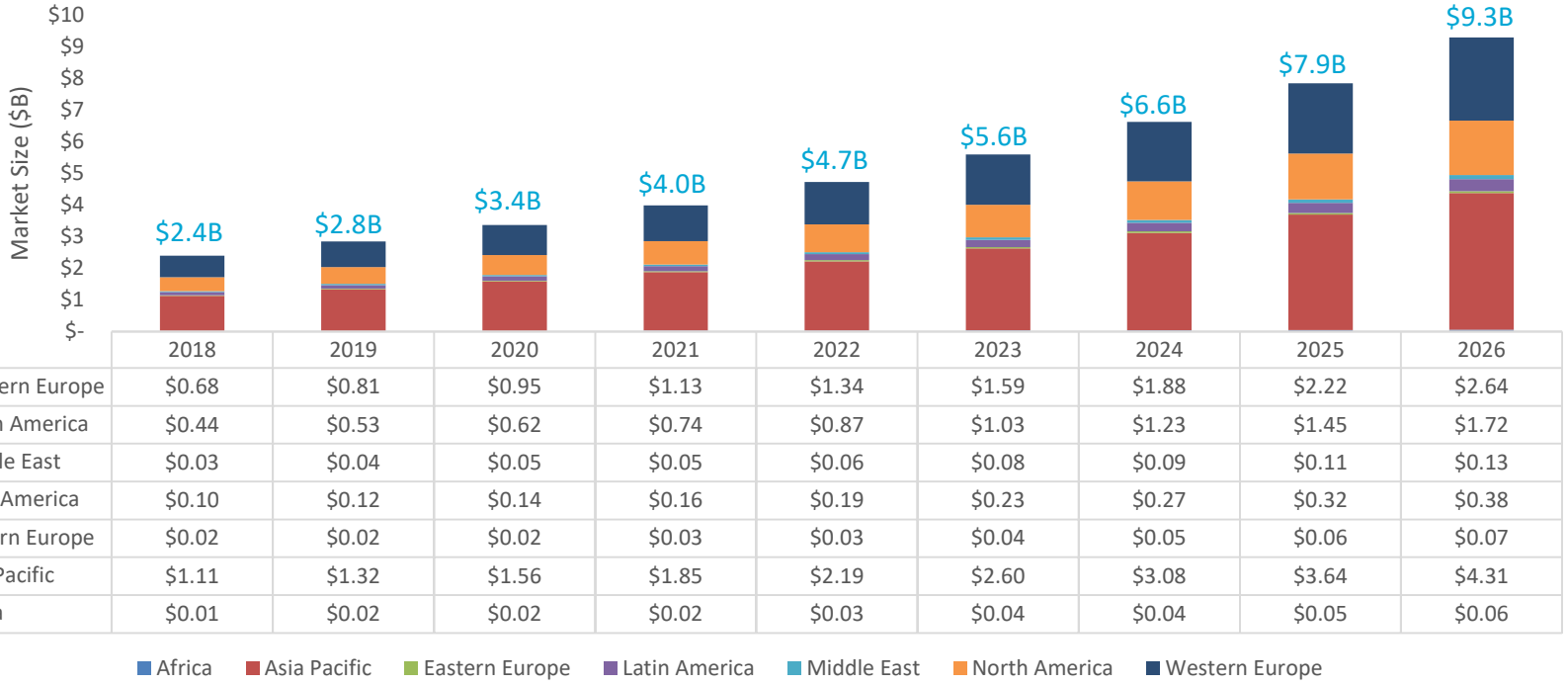


LONG DURATION ENERGY STORAGE
MARKET FORECAST



Market Analysis -
10 Year Total Available Market Projection

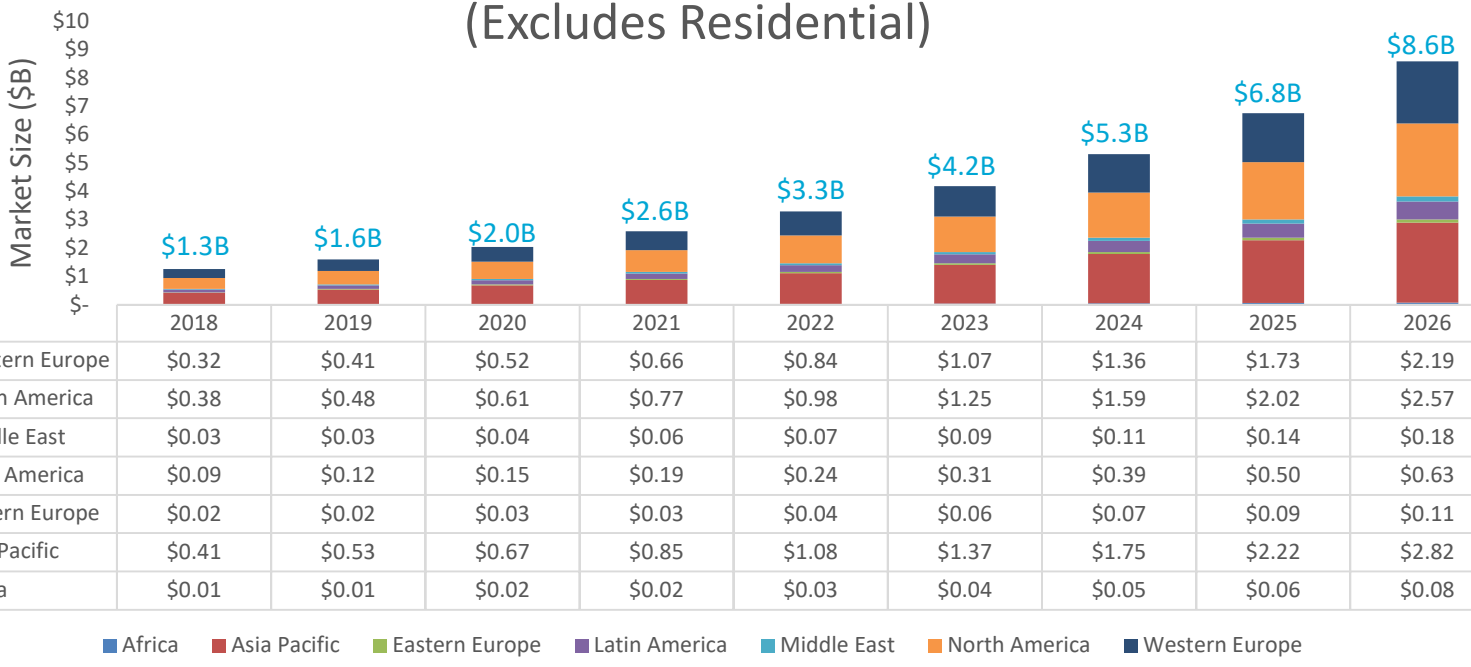
Energy Storage Total Available Market - Annual



	2018	2019	2020	2021	2022	2023	2024	2025	2026
Western Europe	$0.68	$0.81	$0.95	$1.13	$1.34	$1.59	$1.88	$2.22	$2.64
North America	$0.44	$0.53	$0.62	$0.74	$0.87	$1.03	$1.23	$1.45	$1.72
Middle East	$0.03	$0.04	$0.05	$0.05	$0.06	$0.08	$0.09	$0.11	$0.13
Latin America	$0.10	$0.12	$0.14	$0.16	$0.19	$0.23	$0.27	$0.32	$0.38
Eastern Europe	$0.02	$0.02	$0.02	$0.03	$0.03	$0.04	$0.05	$0.06	$0.07
Asia Pacific	$1.11	$1.32	$1.56	$1.85	$2.19	$2.60	$3.08	$3.64	$4.31
Africa	$0.01	$0.02	$0.02	$0.02	$0.03	$0.04	$0.04	$0.05	$0.06

Market Analysis -
10 Year Served Addressable Market

Energy Storage Long Duration Market
Annual SAM
(Excludes Residential)



	2018	2019	2020	2021	2022	2023	2024	2025	2026
Western Europe	$0.32	$0.41	$0.52	$0.66	$0.84	$1.07	$1.36	$1.73	$2.19
North America	$0.38	$0.48	$0.61	$0.77	$0.98	$1.25	$1.59	$2.02	$2.57
Middle East	$0.03	$0.03	$0.04	$0.06	$0.07	$0.09	$0.11	$0.14	$0.18
Latin America	$0.09	$0.12	$0.15	$0.19	$0.24	$0.31	$0.39	$0.50	$0.63
Eastern Europe	$0.02	$0.02	$0.03	$0.03	$0.04	$0.06	$0.07	$0.09	$0.11
Asia Pacific	$0.41	$0.53	$0.67	$0.85	$1.08	$1.37	$1.75	$2.22	$2.82
Africa	$0.01	$0.01	$0.02	$0.02	$0.03	$0.04	$0.05	$0.06	$0.08