ADB

ASIA CLEAN ENERGY FORUM 2023

Navigating toward
a Carbon-Neutral Future
through Clean Energy Solutions

13–16 JUNE 2023

21st century storage technology.

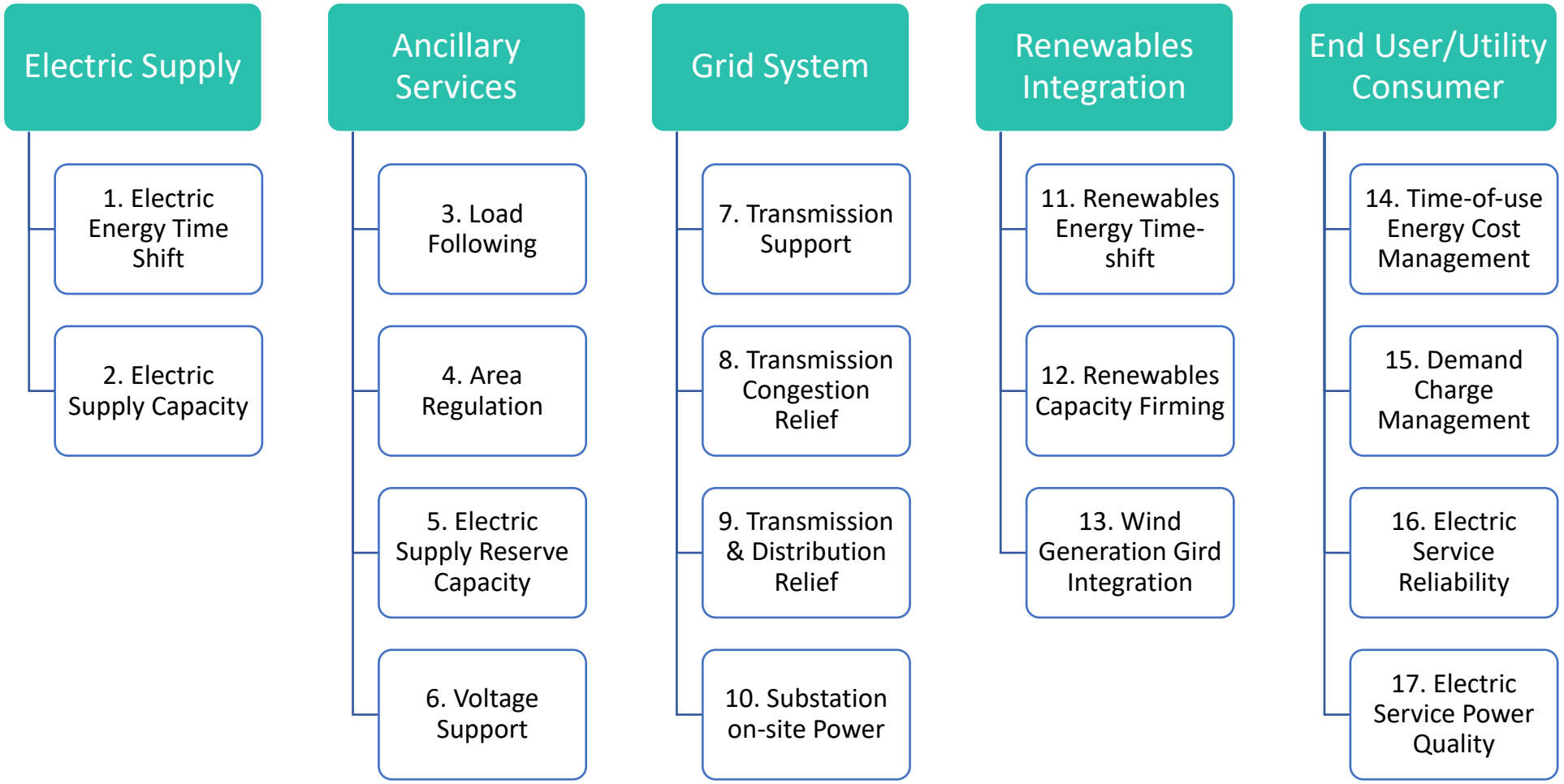
Colin Steley
stratcon.ph

No Transmission – No Transition!

21st Century T&D Systems for Net Zero

17 Services that ESS can provide

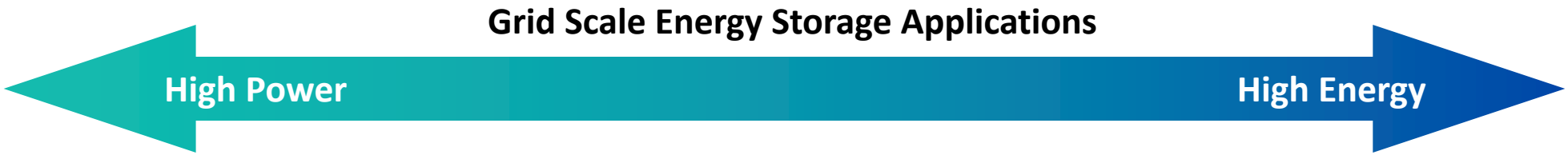
Across Transmission, Distribution, Generation and Behind the meter applications, ESS needs to “stack” services.



MRS, 2022, Othman, Hisham. Energy Storage Applications in Transmission and Distribution grids

Grid Scale Energy Storage Requirements

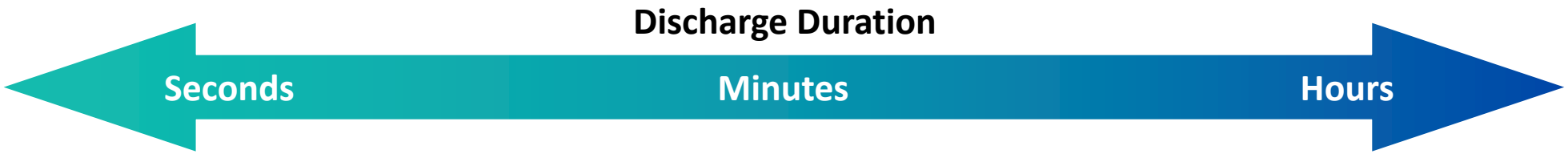
High power and/or high energy requirements are needed for grid scale storage applications



- Power Quality
- Improved Grid Resilience

MW/MWh

- Energy Management
- Decouple Generation From Demand



- Voltage & Frequency Regulation
- Transient Smoothing
- Reactive Power Control

- Synchronous Reserve
- Uninterrupted Power Supply
- Black Start

- Load Levelling
- Peak Shaving
- Energy Trading
- Island Operation
- RE Integration

Pumped Storage is not new & growing

Pumped storage can meet both power and energy requirements, but are location specific

- Of the 80 pumped storage projects under construct above 1,000MW, 73 of them are in China.

https://en.wikipedia.org/wiki/List_of_pumped-storage_hydroelectric_power_stations

Are Li-ion BESS the solution?

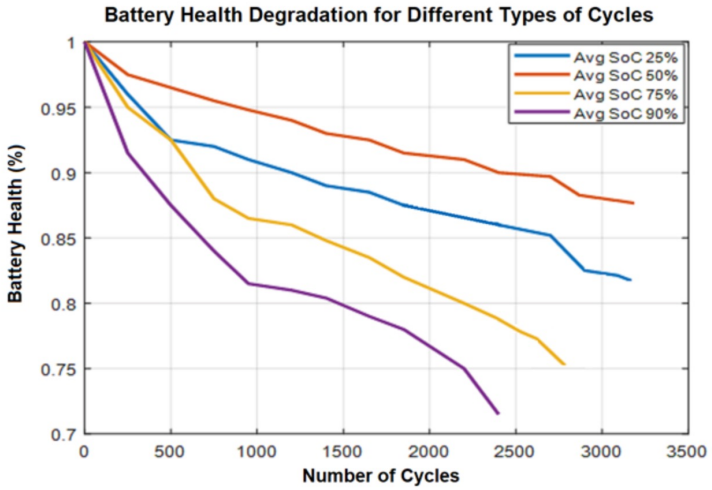
Li-ion ESS are modular making them easy to scale to specific application however each have limitation

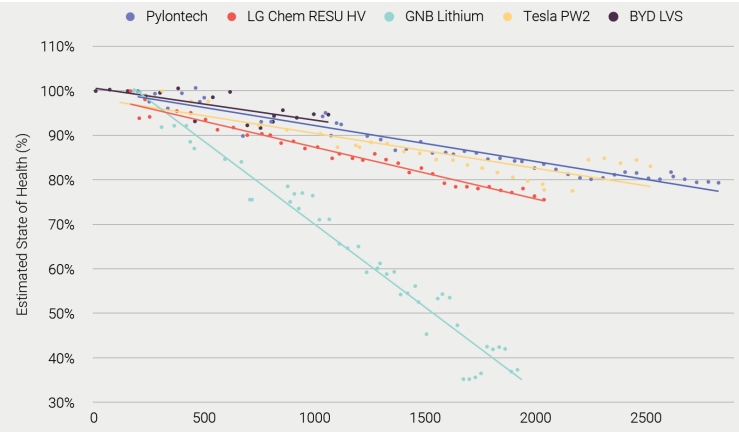
LI-ION BATTERY CHEMISTRY	NOMINAL VOLTAGE (V)	CYCLE (LIFE)	CHARGE CURRENT RATE (C)	DISCHARGE CURRENT RATE (C)	THERMAL RUNAWAY (°C)	PACKAGING (TYPICAL)	SPECIFIC ENERGY (Wh/Kg)	APPLICATIONS	REMARKS
Nickel Manganese Cobalt Oxide (NMC)	3.6 (3.0-4.2) range	1000+	0.7-1C	1-2C	210°C (410°F)	18650, 21700	150-220	E-Bikes, Medical Devices, EVs, Industrial	High-specific energy, Low self-heating rate
Lithium Iron Phosphate (LFP)	3.2 (2.5-3.65) range	2000+	1C	1C	270 °C (518°F)	18650, 32650, prismatic	90-120	Stationary Applications with high capacity, EV	Flat discharge voltage, high power, low capacity, safe
Lithium Nickel Cobalt Aluminium Oxide (NCA)	3.6 (3.0-4.2) range	500-1000	0.7C	1C	150 °C (302°F)	18650	200-260	Medical, Industrial, Electric Powertrain	Long life, fast charge, wide temperature range, safe & expensive
Lithium Titanate Oxide (LTO)	2.4 (1.8-2.85) range	35000	10C	10C	No thermal runaway	Prismatic	50-80	Electric Vehicle and Energy Storage Systems	Highest capacity with moderate power
Lithium Cobalt Oxide (LCO)	3.6 (3.0-4.2) range	500-1000	0.7- 1C	1C	150 °C (302°F)	18650 Prismatic & pouch cell	150-200	Laptops, Mobile Phones, Tablets, Cameras	High energy, limited power
Lithium Manganese Oxide (LMO)	3.7 (3.0-4.2) range	300-700	0.7-1C	1C	250 °C (482 °F)	Prismatic	100-150	Medical Devices, Electric Powertrains, Power Tools	High power, less capacity; safer than LCO

https://www.ionenergy.co/resources/blogs/lithium-ion-battery-types/
modified

How are (certain) Li-ion ESS the solution?

Real world Li-ion applications are showing much shorter life expectancies than specs and significant fire risk





Variable	Value
DoD	75-90%
SoC	50-80%
RTE	70-85%
Cycles	5-7000?
SoH @ Xyrs	????

BREAKING: MASSIVE explosion at lithium batteries facility in Grand-Couronne, France

By **Chris King** 16 January 2023 · 21:26

Australia Tesla Megapack 450 MW Energy Storage Facility Fire – Sep 8, 2021
One of the newest and largest Battery Energy Storage Systems ignited just three days after being commissioned. "It took 150 firefighters and 30 trucks four days to extinguish this fire."

Article: Fire at 450MWh Tesla Battery Site in Australia Raises Lithium Concern
Article: Tesla Megapack Batter Burned for Days in Grid Storage Fire

Smoked! California Battery Storage System Overheats Again - Feb 15 2022
Vistra Corp. was once again forced to shut down part of California's biggest battery storage system after some components malfunctioned.
The company took offline its 100-megawatt Moss Landing battery facility after a safety system activated late on Sunday, according to a statement. It's the second incident at the plant in less than six months.

Article: California's Largest Battery Storage Shut Down by Smoke, Again

Tesla Terror: Lithium Battery 'Bombs' Exploding in Toxic Fireballs - Sept 17 2021
Giant batteries are said to be the Planet's saviour, but be sure you're well clear when they explode into toxic fireballs that firefighters can't extinguish.

Article: Tesla Terror Report

Why Do Lithium Batteries Burn? - July 2021
n April 2021, three pallets of lithium-ion powered mobile phones caught fire at Hong Kong International Airport (HKIA). Responders spent 40 minutes extinguishing the fire.

Article: What Makes Lithium Batteries a Fire Hazard?
Video: Hong KongAircraft Lithium Fire

https://www.storlytics.net

https://batterytestcentre.com.au/wp-content/uploads/2022/06/Battlab-Report-12-Final.pdf

Where are LTO ESS developments?

The application of LTO technology is developing providing exceptional infrastructure value.

Imagine a BESS that can:

Guarantee 35,000 cycles over a 30-year warranty

USD $0.04 to $0.05/kWh LCOS / LCOE

100% DoD | 100% SoC | 98.5%TRE

Provide 10C charge /discharge rate

Zero thermal runaway risk / wide operating temperature

Minimal degradation over time / stable & reliable

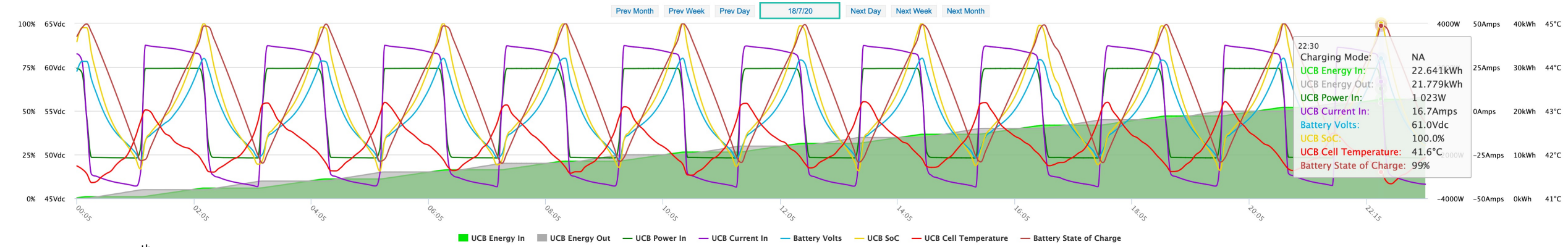
Can integrate both supply side management and DSM

Real-time, real-world testing

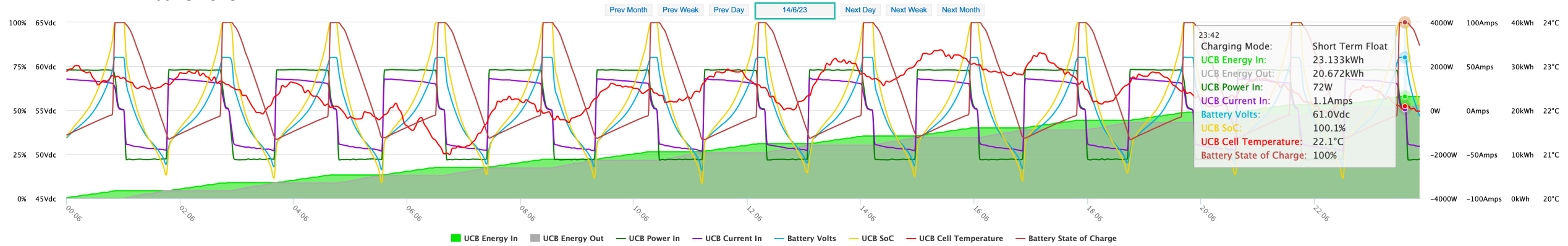
Arvio have an ultracapacitor LTO ESS working to around 14,000 cycles with close to zero degradation

- Around 14,000 cycles at 1C (charged/discharged over 1 hour), 100% SoC, cycled once daily under standard operating conditions provides a life span of **over 37 years**.

18th July 2020



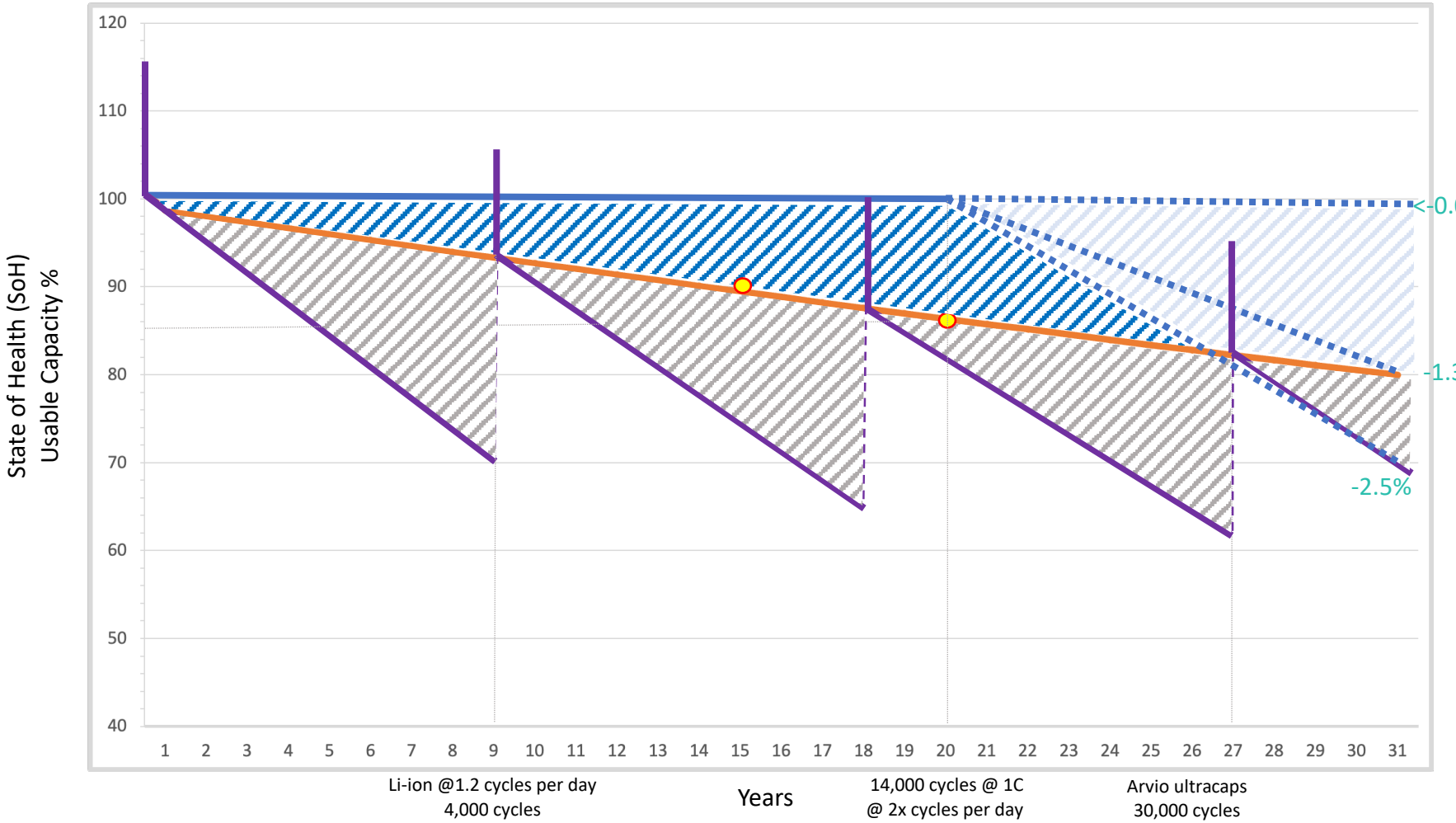
14th June 2023



The image above shows one of the first days cycling the ESS 13 times on the 18th July 2020 until 14th June 2023.

Utility Scale Solar + BESS

The only ESS solution to match a solar PPA and still have significant State of Health / capacity there after, guaranteed.



- There will be considerably less curtailment losses using LTO
- Much better system stability, resilience and flexibility with LTO
- Significant less thermal runaway risk with LTOs

PV Degradation rate

Li-ion Degradation rate

Actual Arvio Titan Degradation rate

Potential Arvio Degradation rate

Arvio Performance Guarantee

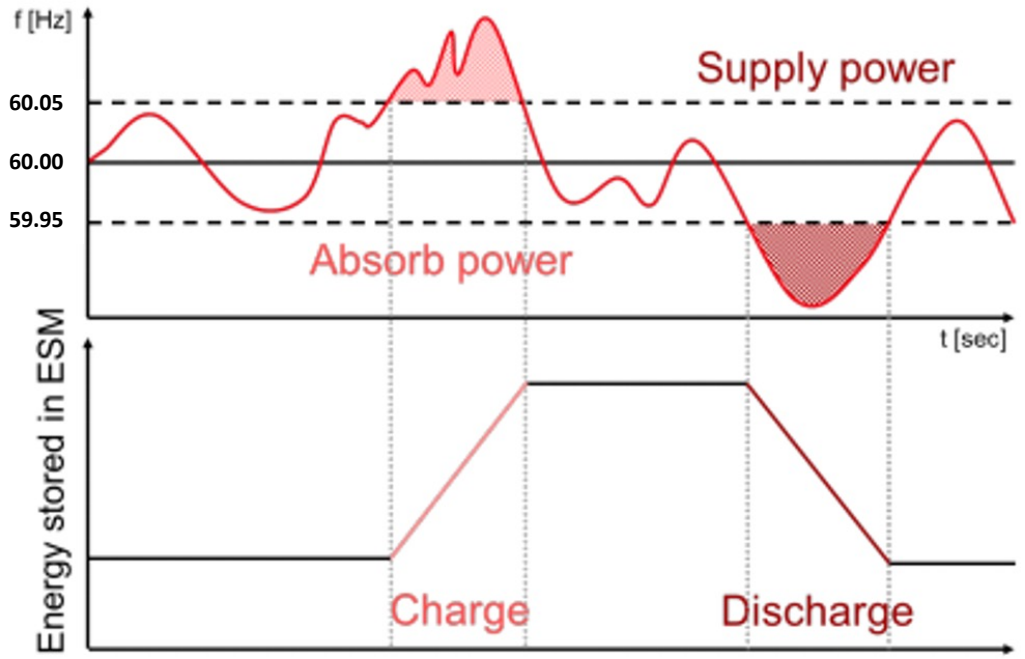
Lost kWh to Li-ion Degradation

Potential kWh gain from Arvio ultracapacitor batteries

Frequency Regulation

Grid Ancillary Services

The energy storage is charged / discharged in response to an increase or decrease, respectfully of grid frequency. Given the requirement for extremely fast delivery of MW power requirements for milliseconds to multiple minute requirements, this is a particular attractive option due to its rapid response time and emission-free operation.



Service

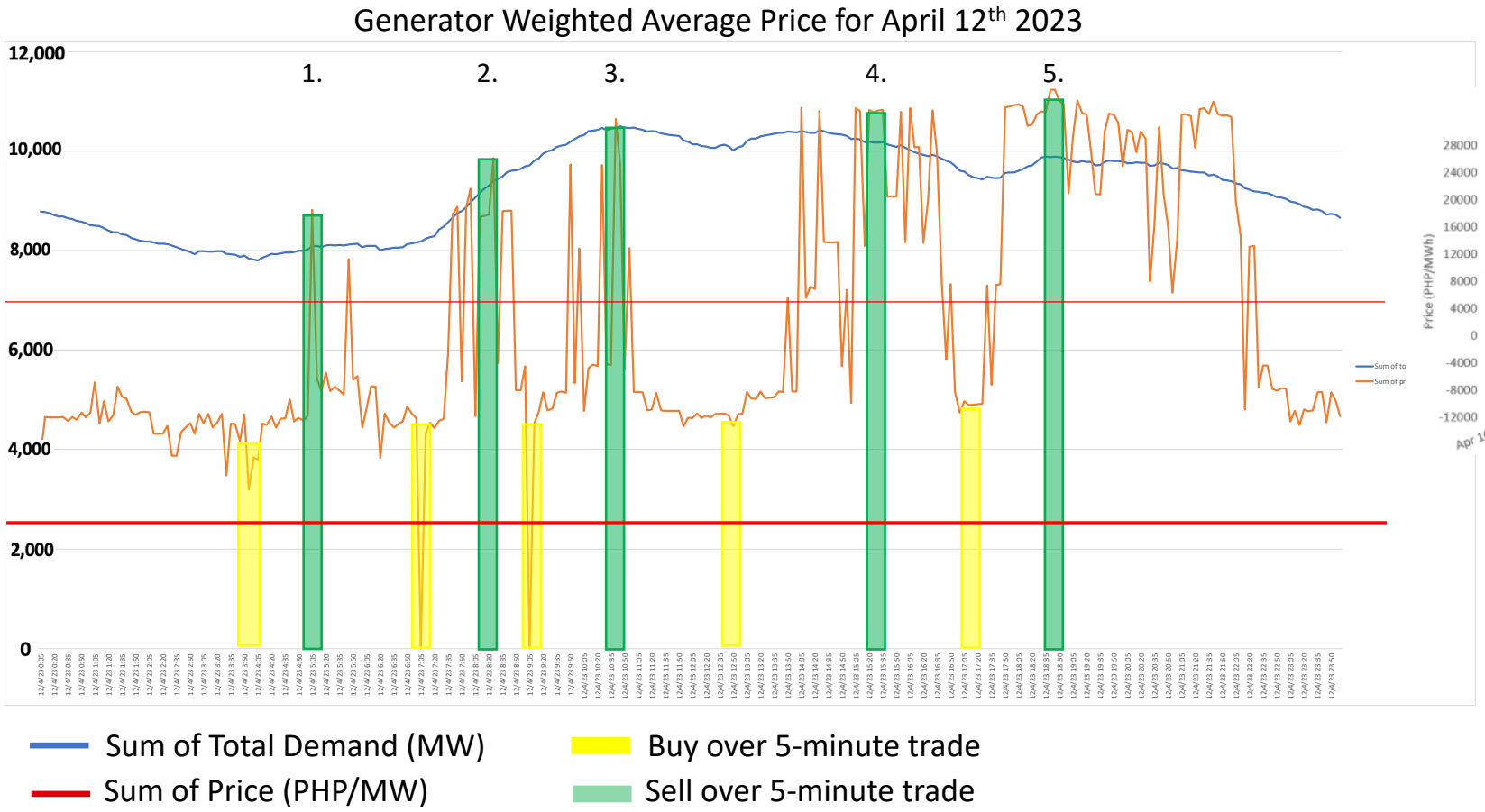
- ✓ Increase reliable operation of the grid
- ✓ Improve flexibility of the grid
- ✓ Reduces the need for additional generation facilities which are expensive to operate and maintain

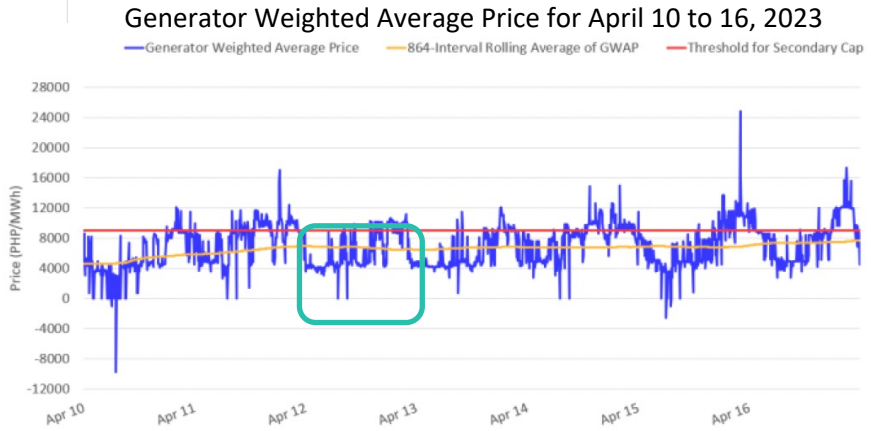
Arvio Benefits

- ✓ Up to 10C charge/discharge rate allows for a smaller ESS
- ✓ Multiple cycles per day allow for constant charge/discharge
- ✓ Minimal performance degradation over the warranty period means the State of Health and thus performance will remain constant

Spot Market Arbitrage

With 35,000 cycles and a 10C rate, new LTO ESS can work within a 5-minute trading interval

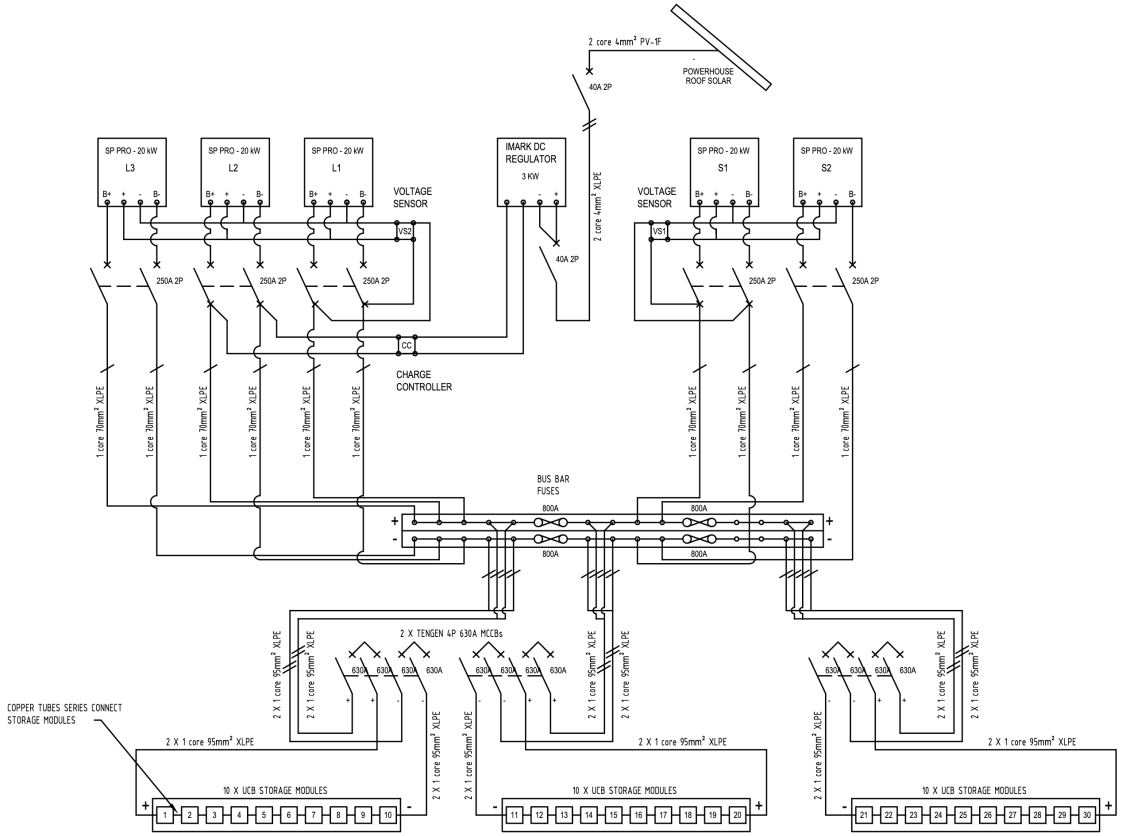




- 35,000 cycles over 20 years is 4.79 cycles per day
- A 10C ESS can charge and discharge in 6 minutes.

Conversion of 2Ø to 3Ø operation

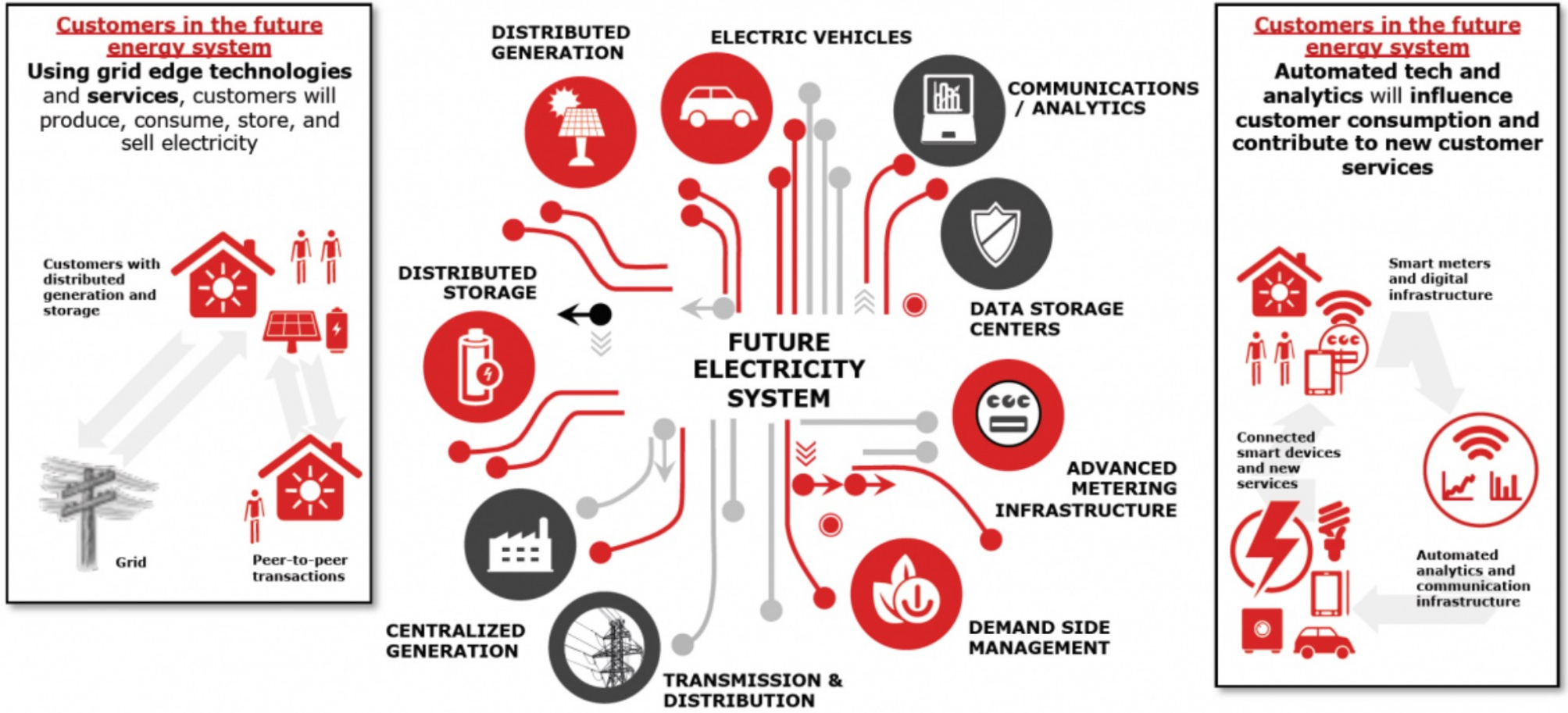
Turn 2Ø phase, poor power quality, edge of grid power supply to stable and reliable 3Ø supply



The cost to extend an existing 3Ø to an area will be a multiple compared this solution.

Flexibility & Resilience-as-a-Service

An electrical power system ready for the Energy Transition needs to allow for flexibility & provide resilience



The future energy system will require stacked services from BESS solutions.

https://www.energynetworks.com.au/news/energy-insider/controlled-chaos-why-the-grid-of-the-future-will-need-new-standards/