

A Perspective on ESS Opportunities in the Global Energy Transition

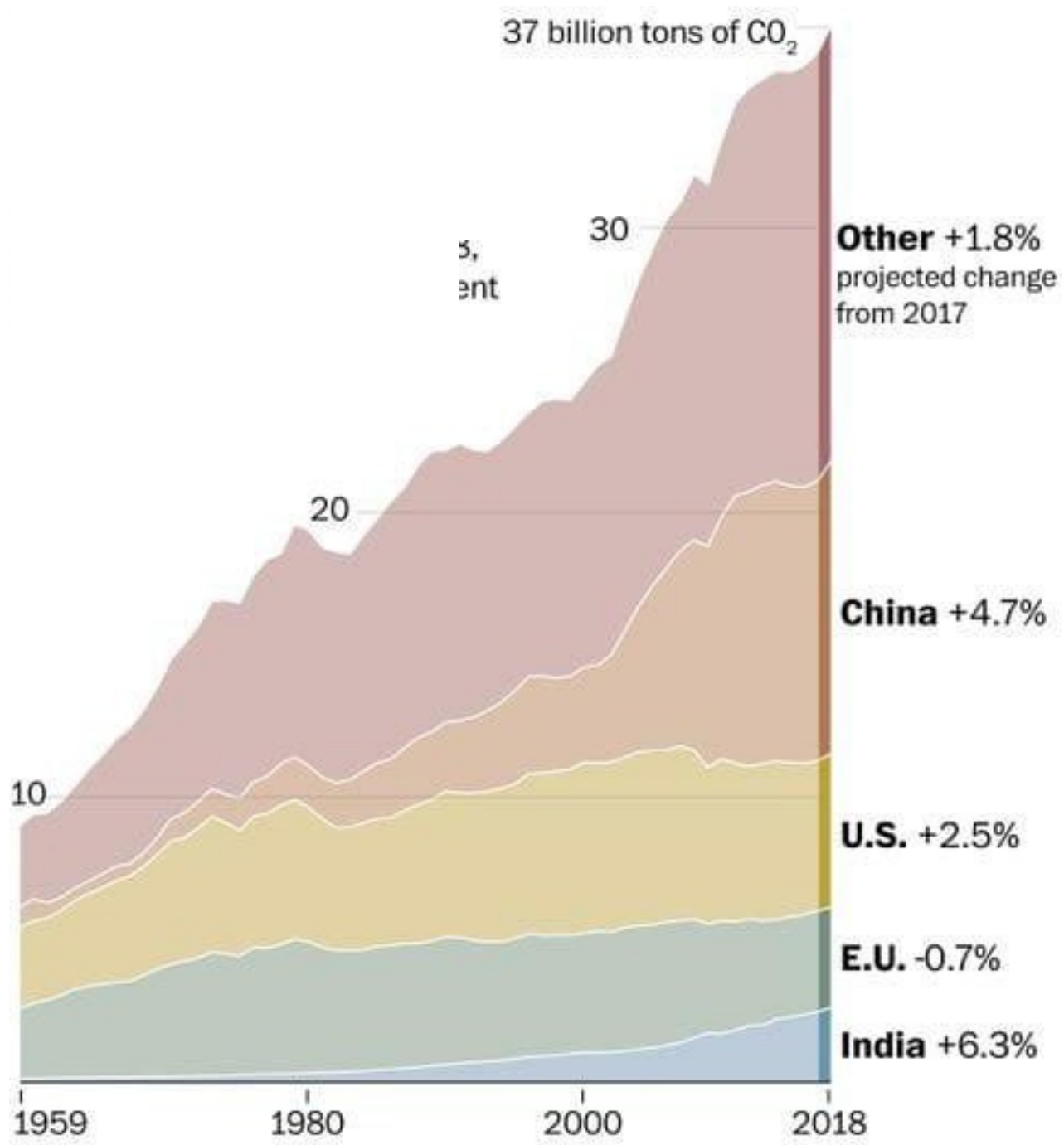


Doing Good and Doing Well: ESS in The Future of Energy

Global Energy Storage Program Event
05/13/2021

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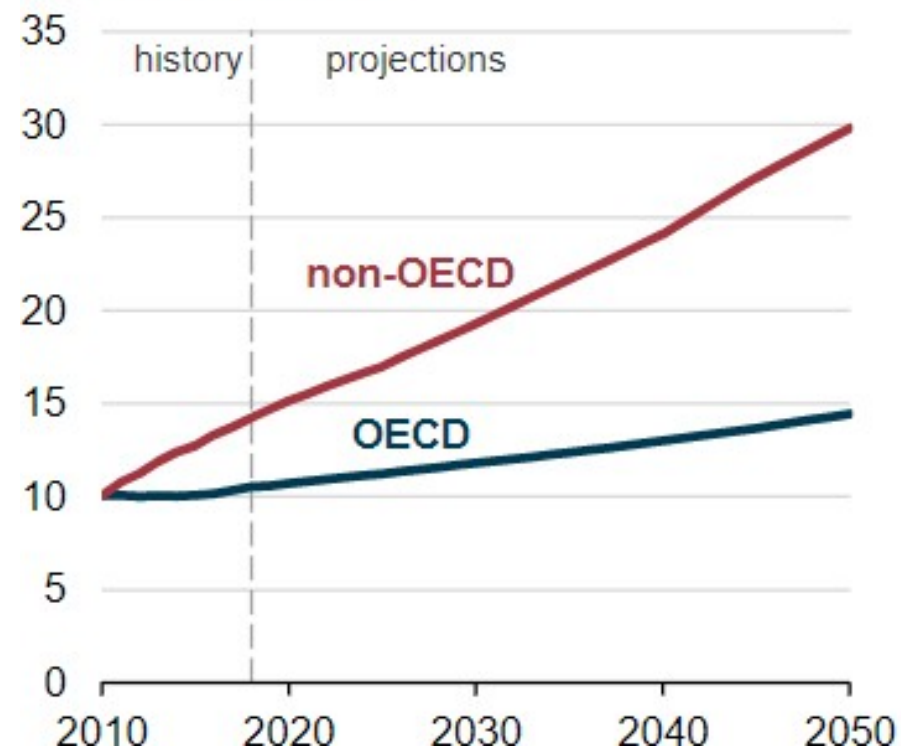




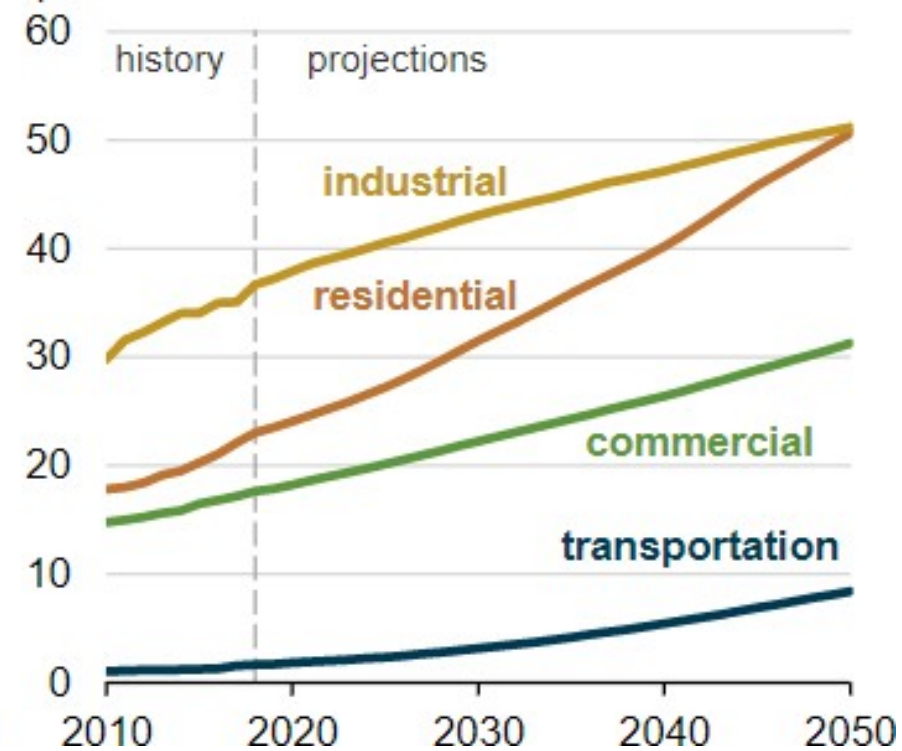
Source: Global Carbon Project / The Washington Post 2018
Figure show emission from fossil fuels and industry, which includes cement, manufacturing, but not deforestation
2021-05-13 Global Energy Storage Program Event Key Note

Higher electricity demand in developing economies

Global net electricity generation
trillion kilowatthours

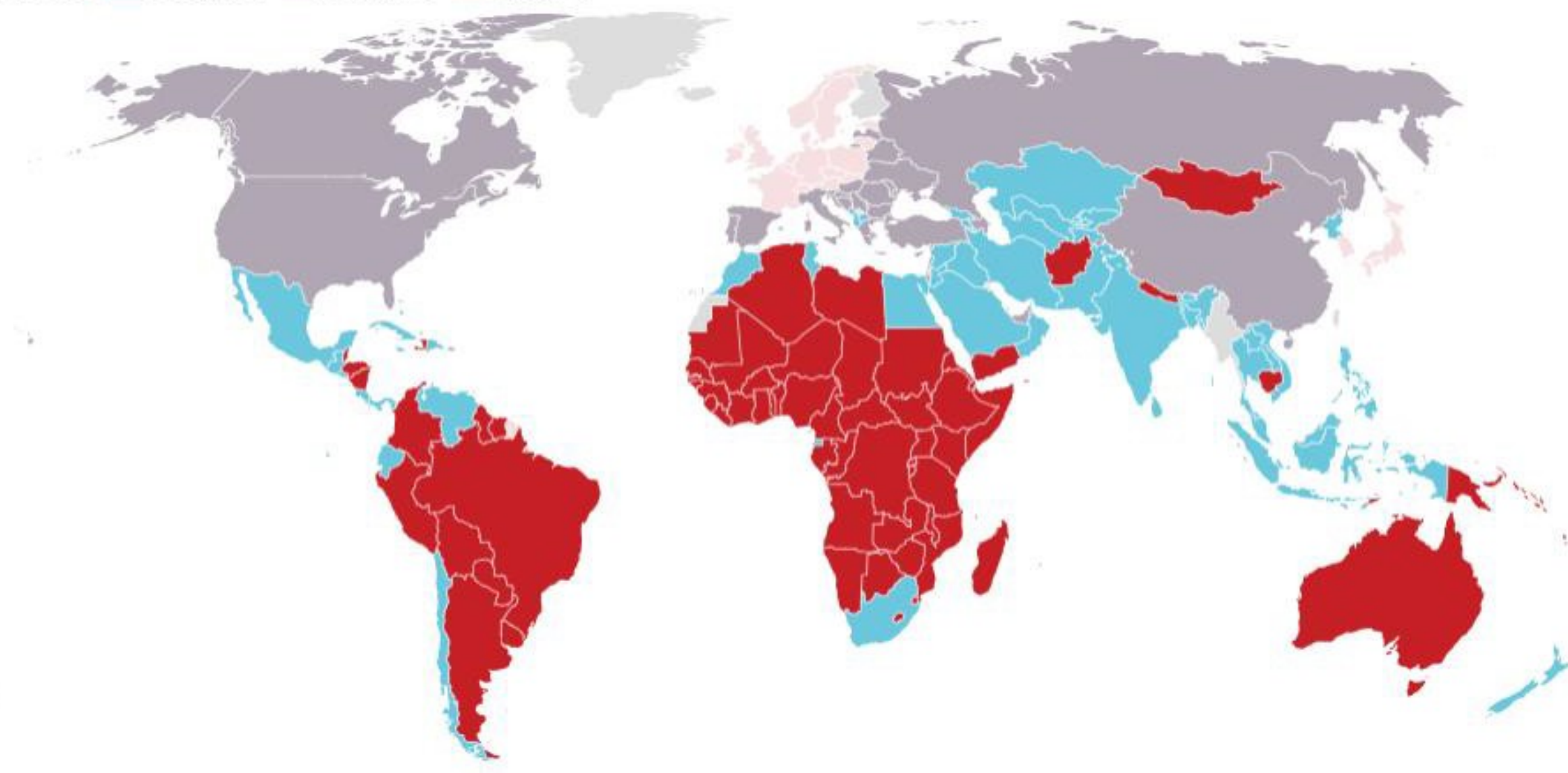


Global electricity use by sector
quadrillion British thermal units



Share of land required to generate all energy from solar

0.1% or less Below 1% Below 5% Over 5%

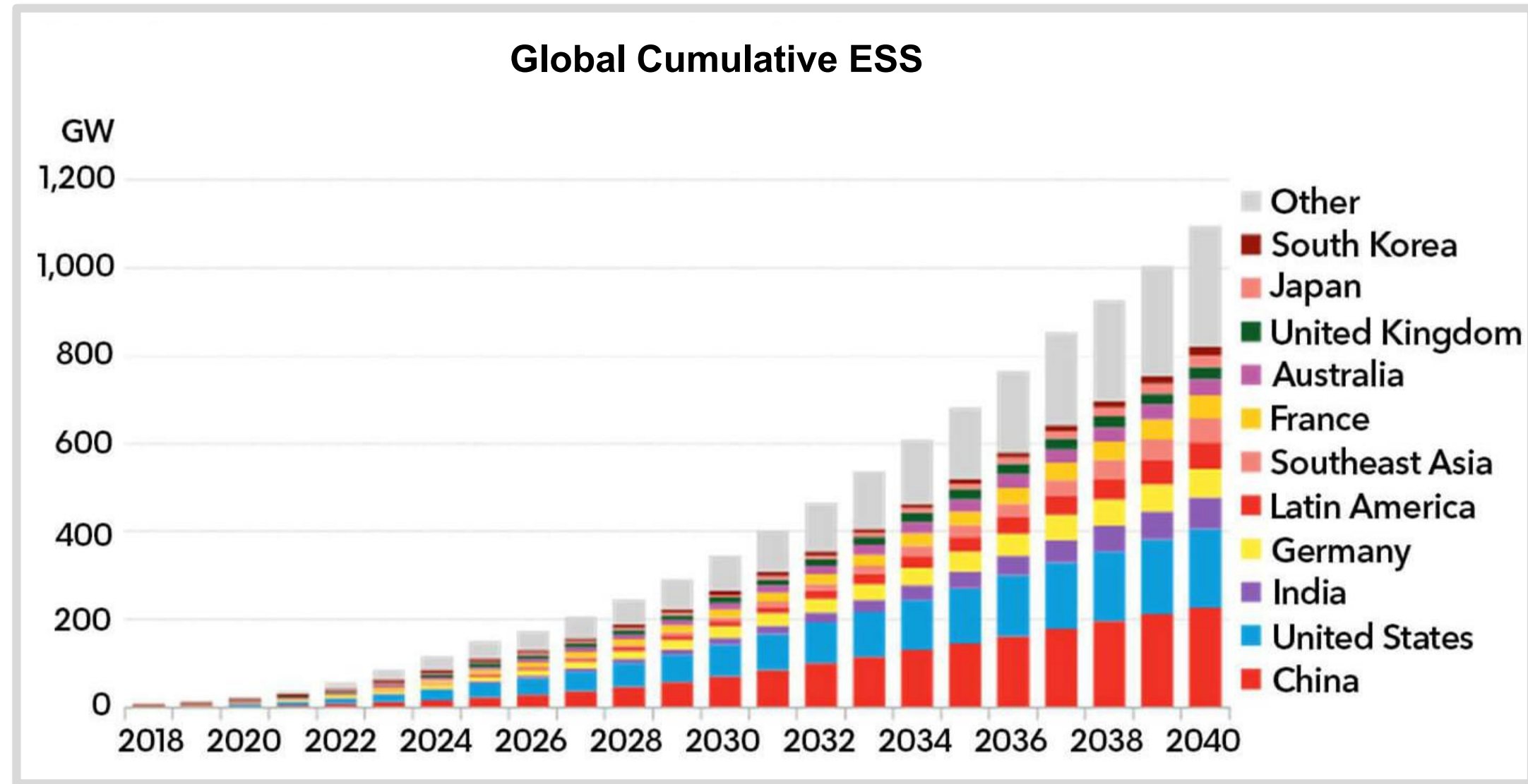


Renewables need Energy Storage Systems

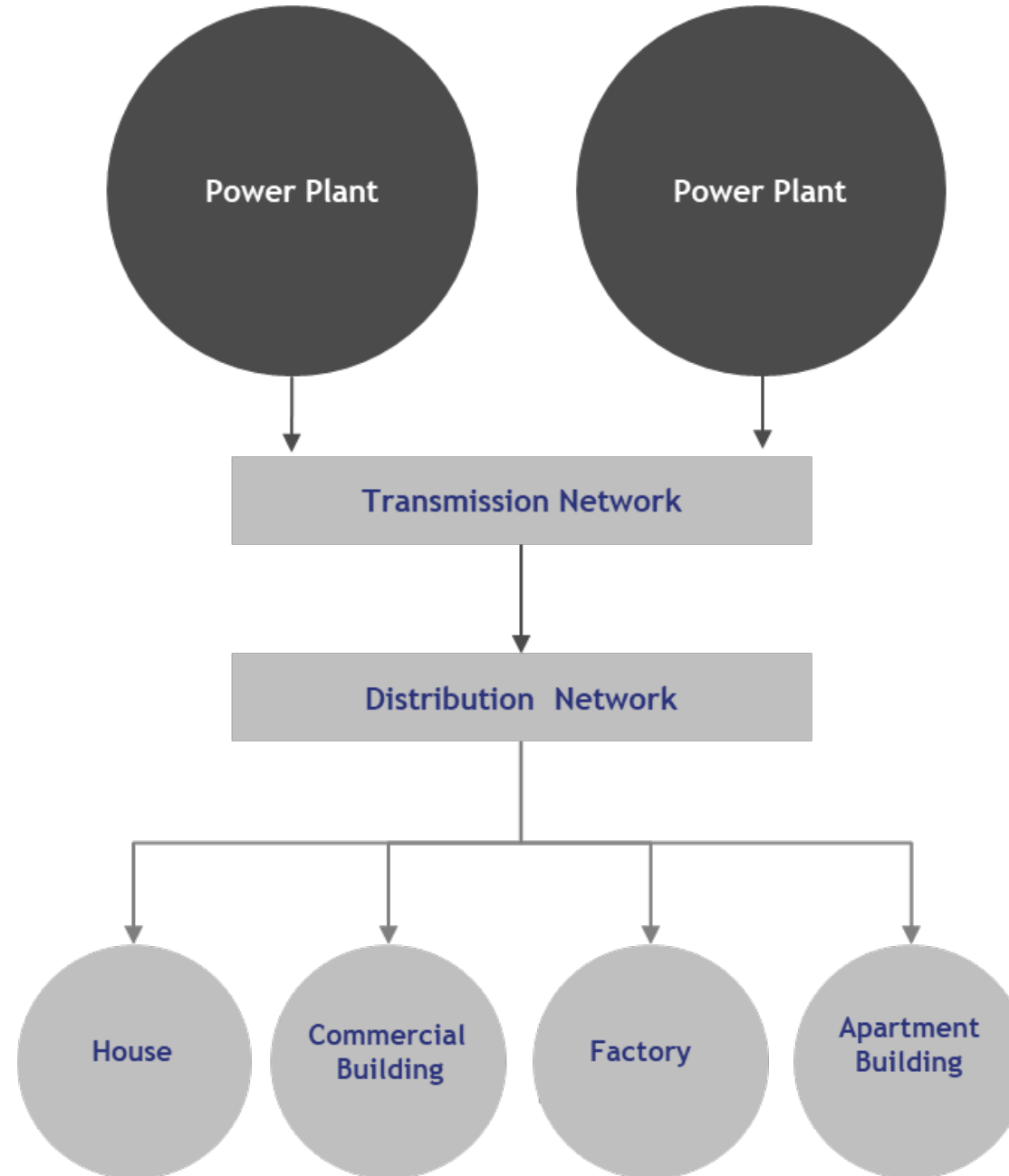


Source: Beacon battery energy storage system and Solar Plant, located in the Mojave Desert in California. <https://www.powermag.com/designing-for-extremes-battery-storage-in-the-mojave-desert/>
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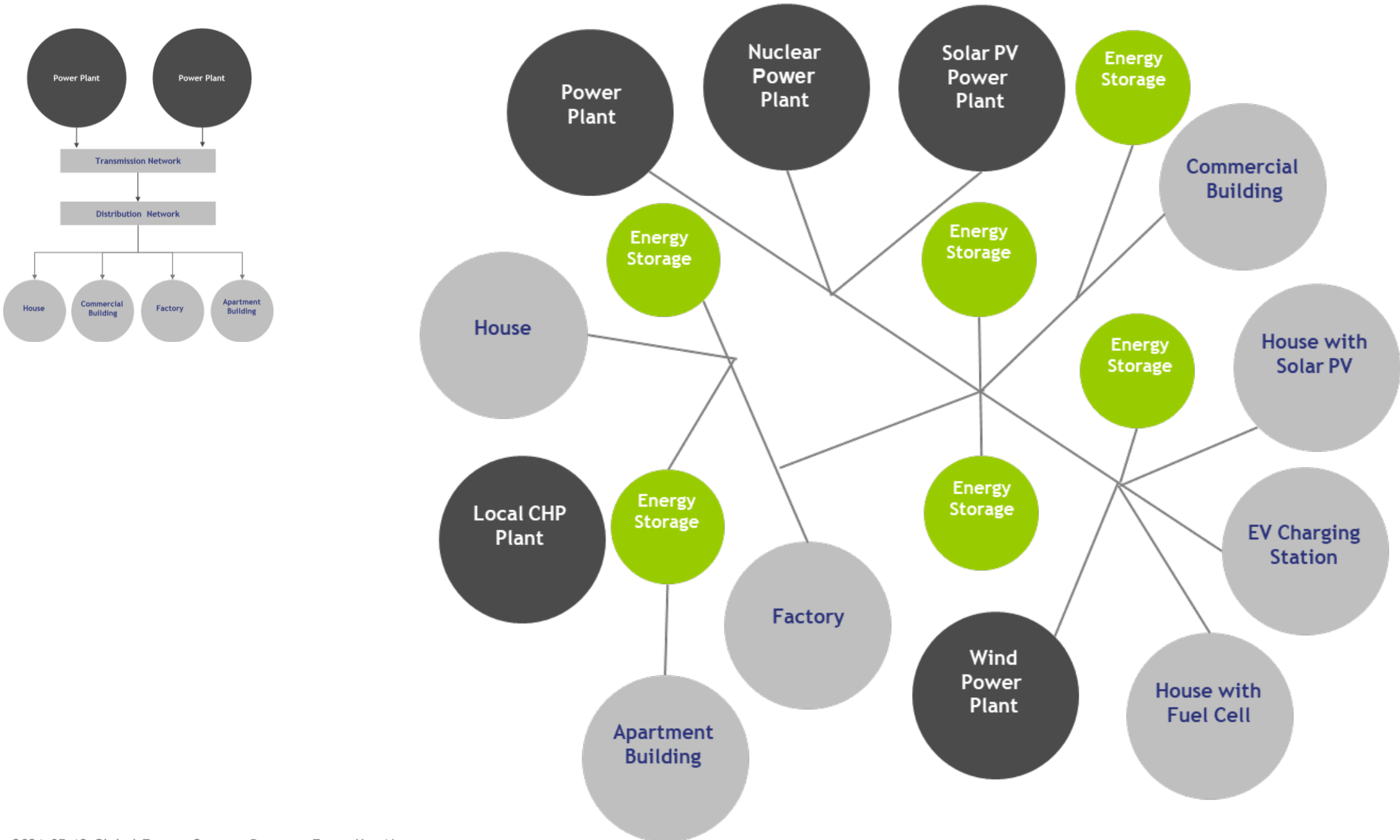
Growth through a Global Energy Transition



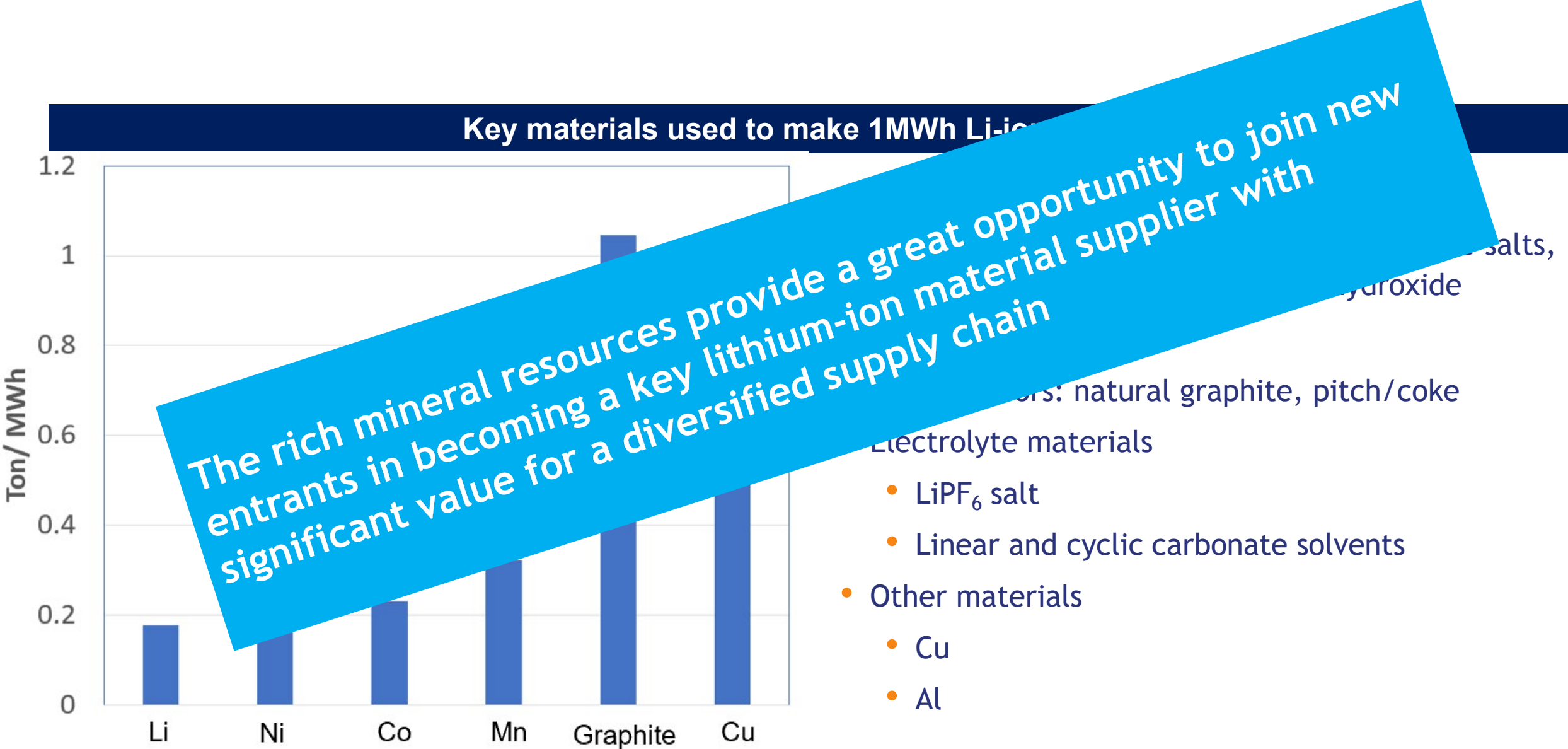
Aging electricity infrastructure



Growth through a Global Energy Transition



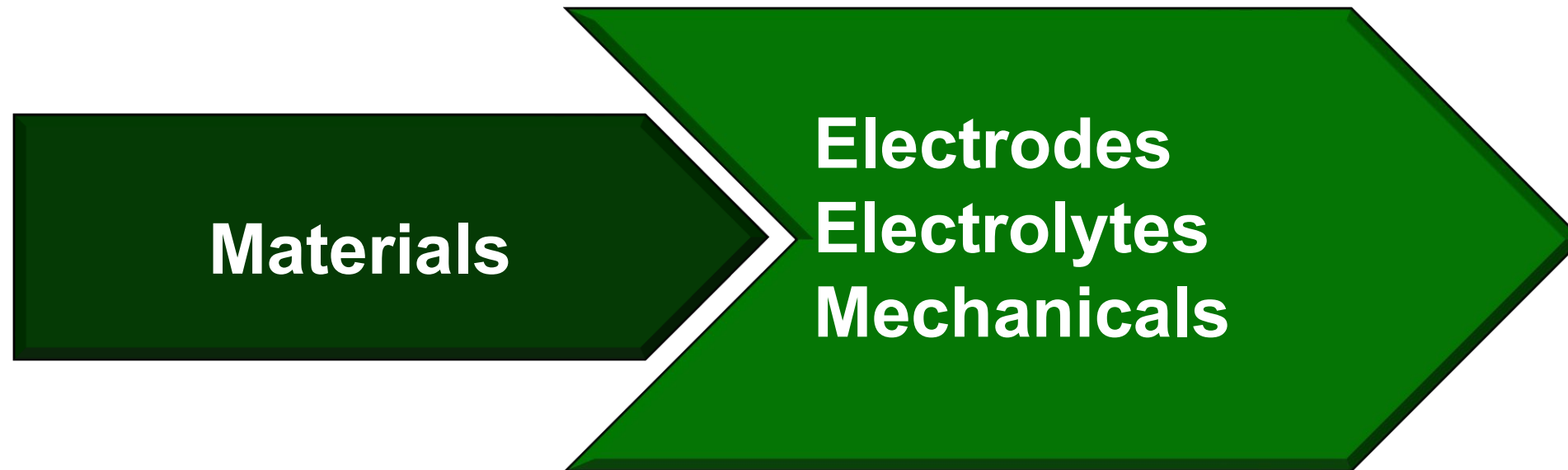
Lithium-ion battery growth drives high demand for key materials

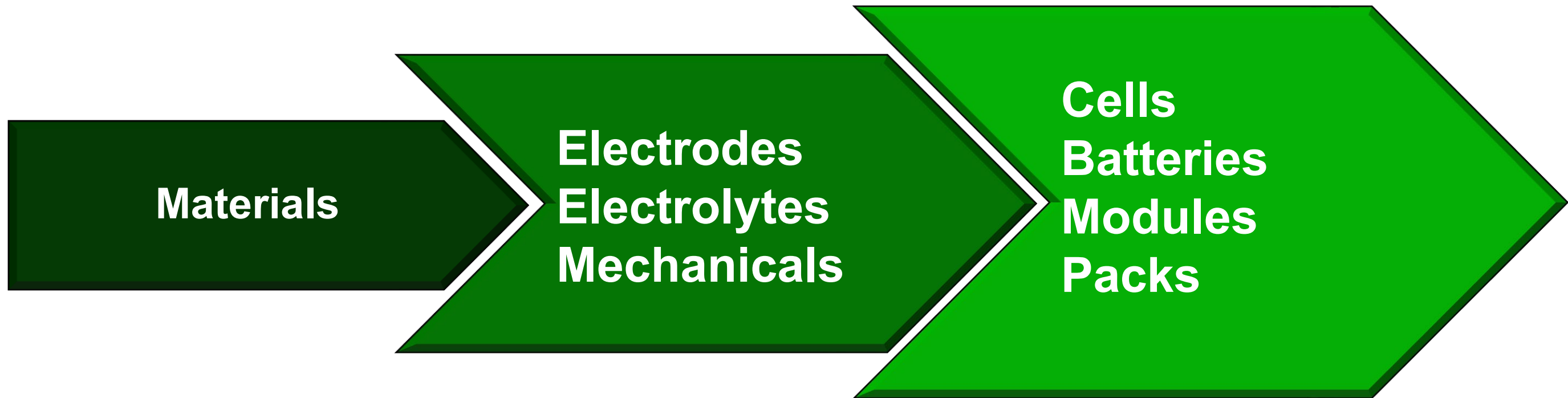


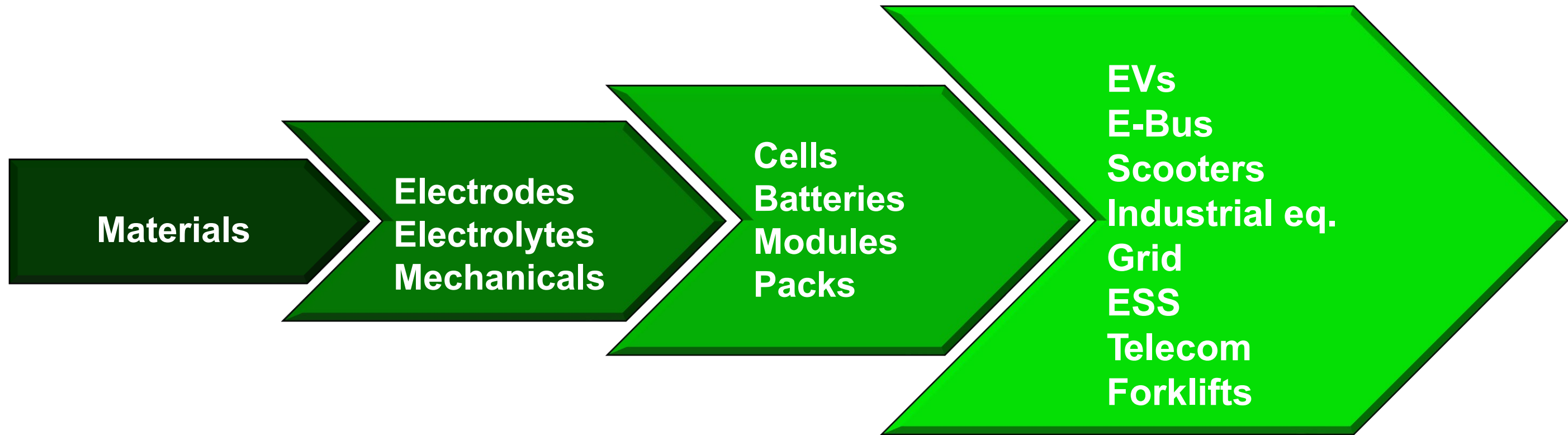
Sustainability and Economic Opportunity



Materials







The Ecosystem for Sales

from a battery manufacturers perspective

Battery Manufacturer

- Cells
- Modules
- Racks
- Electronics

BATTERY MANUFACTURER'S
TARGET CUSTOMERS

Helping to Create Pull for System Integrators

SYSTEM
INTEGRATORS

DEVELOPERS

END
CUSTOMERS



Unmet Needs
=
Opportunity

Today's Global Electric Vehicle Market: 1-in-2,000 Chance of Fire

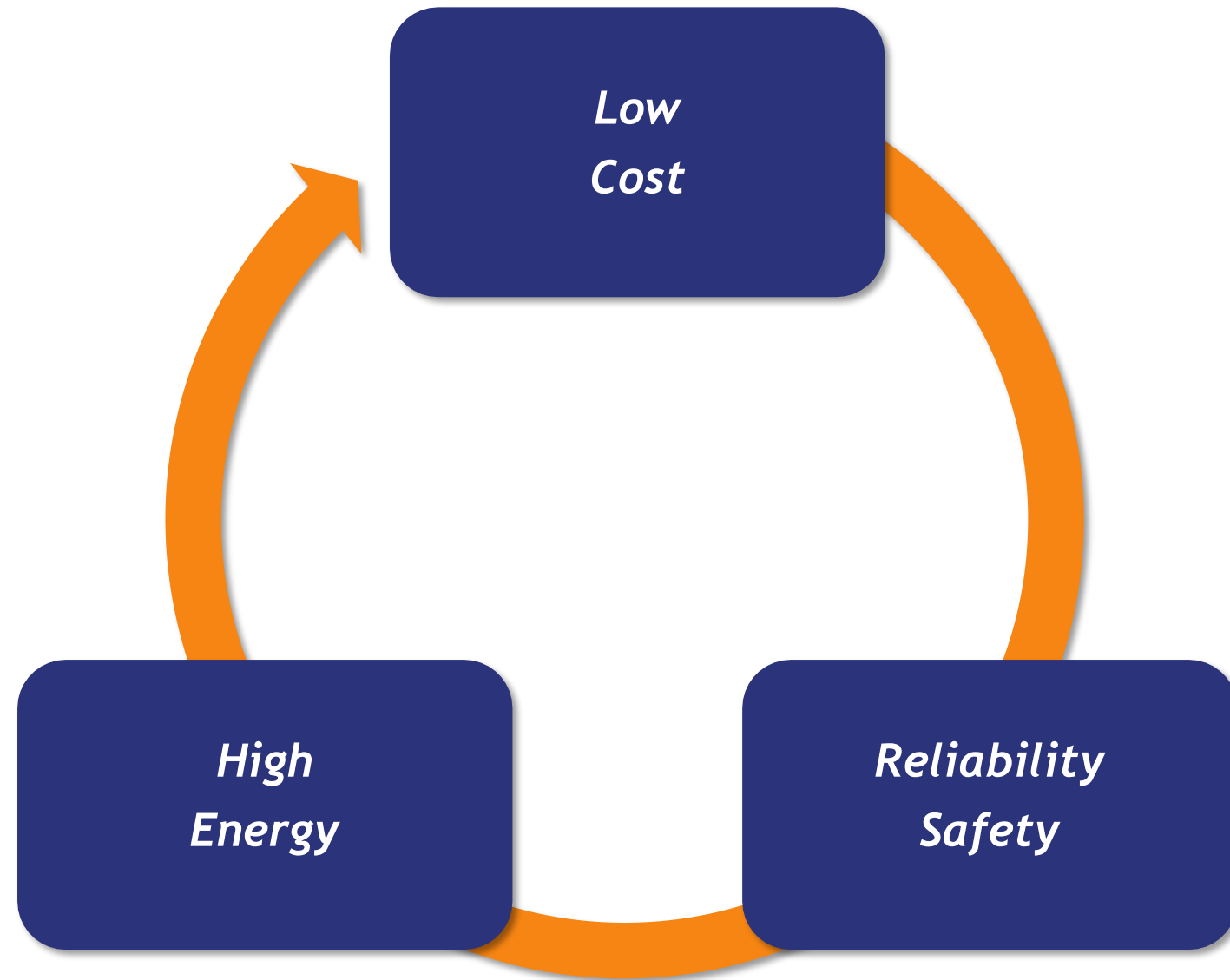


Today's Global ESS Market: 1-in-10 Chance of Fire



Low Statistical Field Failures Matter at High Volumes

Application	Size	# Cells in market			Projected# field failures
		Prismatic (90Wh)	Polymer (60Wh)	Cylindrical (10Wh)	
Cellphone	10Wh			1	1 in 10M
Laptop	100Wh			10	1 in 1M
EV	50KWh	556	833	5,000	1 in 2,000
BTM C&I ESS	250KWh	2,778	4,167	25,000	1 in 400
Utility Scale ESS	10MWh	111,111	166,667	1M	1 in 10



Utility and Large C&I Energy Storage Systems



Enterprise 66 kWh
18 Modules



Mid-Size 52 kWh
14 Modules



Compact 20 kWh
6 Modules



48V Residential and Small C&I Energy Storage Systems









48V 300Ah Lithium-ion battery rack



48V 50Ah Lithium-ion battery module



Market Leader Decision (March'21): VW is moving 80% to a prismatic battery cell platform

Cylindrical cell (18650, 21700)	Prismatic cell (VDA Standards)	Polymer cell (Pouch Cell)
 Panasonic TESLA	 SAMSUNG SDI CATL 	  

Extensive testing to standards improves designed safety, but only one test today captures how well a system fails (UL 9540a)



- **UL 1642 - Standard for Safety for Lithium Batteries**
 - Covers primary and secondary lithium batteries for use as power sources in products

- **UL 9540 - Standard for Safety for Energy Storage Systems and Equipment**

- Requirements cover energy storage systems that receive electric energy, store the energy and delivers electrical energy for loads or local power systems



- **UL 1741 - Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources**
 - Covers inverters, converters, charge controllers and interconnection equipment for use in stand-alone (not grid-connected) or utility-interactive (grid-connected) power systems

- **UL 9540A - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems**

- Evaluates the fire characteristics of a BESS that undergoes thermal runaway for cells, battery modules, battery racks and BESS systems



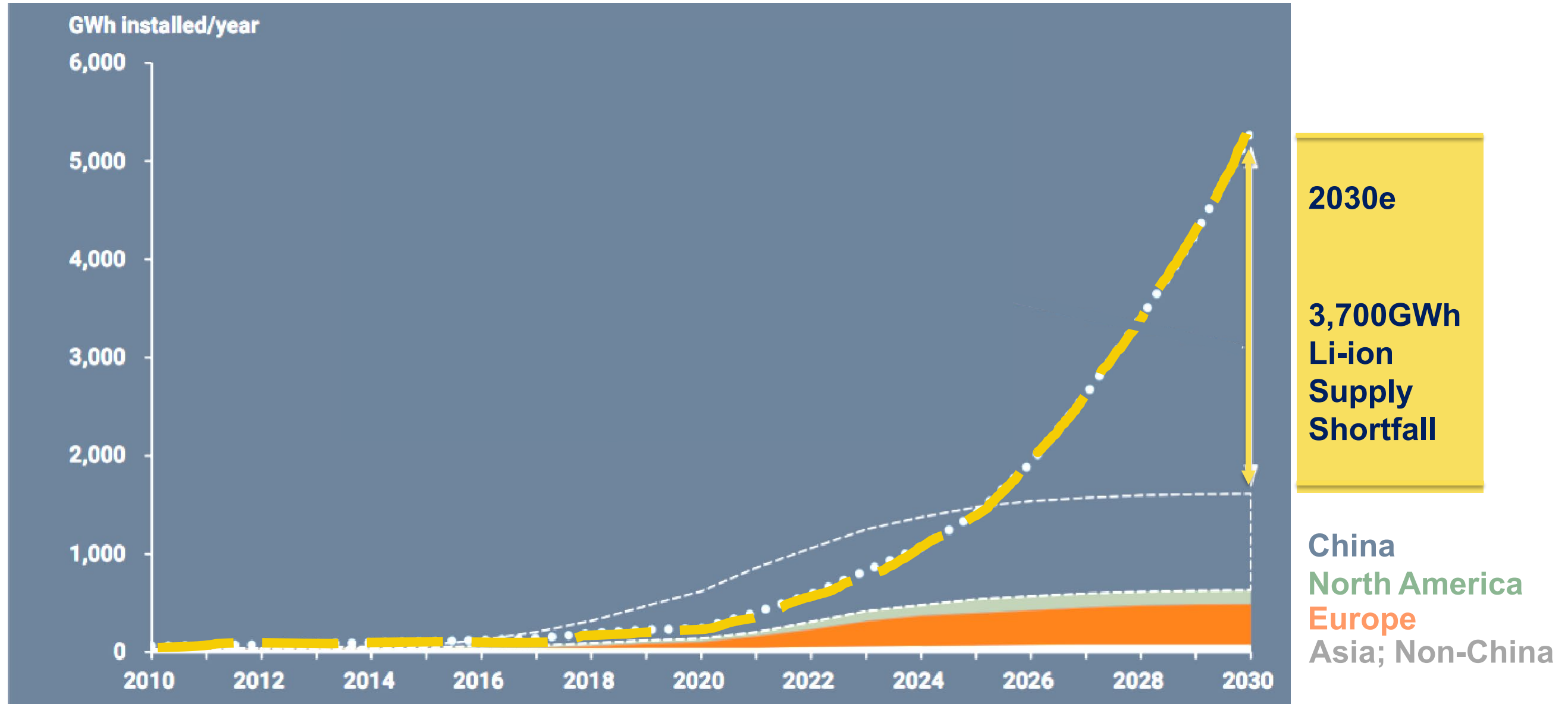
- **UL 1973 - Standard for Safety for Batteries for Use in Light electric Rail Applications and Stationary Applications**
 - Covers electric energy storage systems for use as energy storage for stationary applications such as for PV, wind turbine storage etc.

- **IEEE 693 2018 - Recommended Practice for Seismic Design of Substation**

- Design recommendation and qualification of power substation equipment including stationary batteries for seismic events.



Li-ion Battery Supply / Global Demand 2010 - 2030



A silhouette of a person in mid-air, jumping over a gap between two dark, jagged rock formations. The person's arms are outstretched upwards, and their legs are in a jumping position. The background is a bright blue sky with scattered white clouds. A large, bright sun is positioned to the right of the person, creating a strong lens flare effect that radiates across the sky. The overall mood is one of triumph and achievement.

Doing Good
and
Doing Well

Massive ESS Opportunities in the Global Energy Transition

- how will we
shape it together?



Doing Good and Doing Well: ESS in The Future of Energy

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