

Safety is essential for ES Facilities!

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First Wind,
30-MW Kahuku Wind, Oahu

15 MW Pb/Acid based
Xtreme Power Battery

Destroyed by third Fire
2012, \$30M Damage



Actions Towards Energy Storage Safety

Safety is an overarching concern that needs to involve diverse partners.

- **DOE Office of Electricity Safety Meeting, Feb. 2014**
 - **Representatives from:**
 - National Laboratories: Sandia, PNNL
 - Utility Organizations: EPRI, NRECA
 - Fire Departments, Fire Fighters
 - Building Commissions
 - Insurance Industry
 - Testing Laboratories
- **Energy Storage Safety Strategic Plan**
 - **Science-based Safety Validation Techniques**
 - **Incident Preparedness**
 - **Safety Documentation**

Grid Energy Storage Safety Initiative

Strategic Energy Storage Safety Plan – Dec. 2014

DOE has identified *Validated Safety* as a critical need for the success of grid energy storage. This will:

- Decrease human and financial risk
- Minimize installation cost
- Accelerate acceptance of new technologies
- Increase bankability



2019 – Fires at 23 locations in Korea



20MW, Liverpool, Sep. 2020



2MW, McMicken, AZ, April 2019



300 MW, Moorabool, Australia, July 2021

Battery Safety is essential!

Energy Storage has become a Resounding Success!

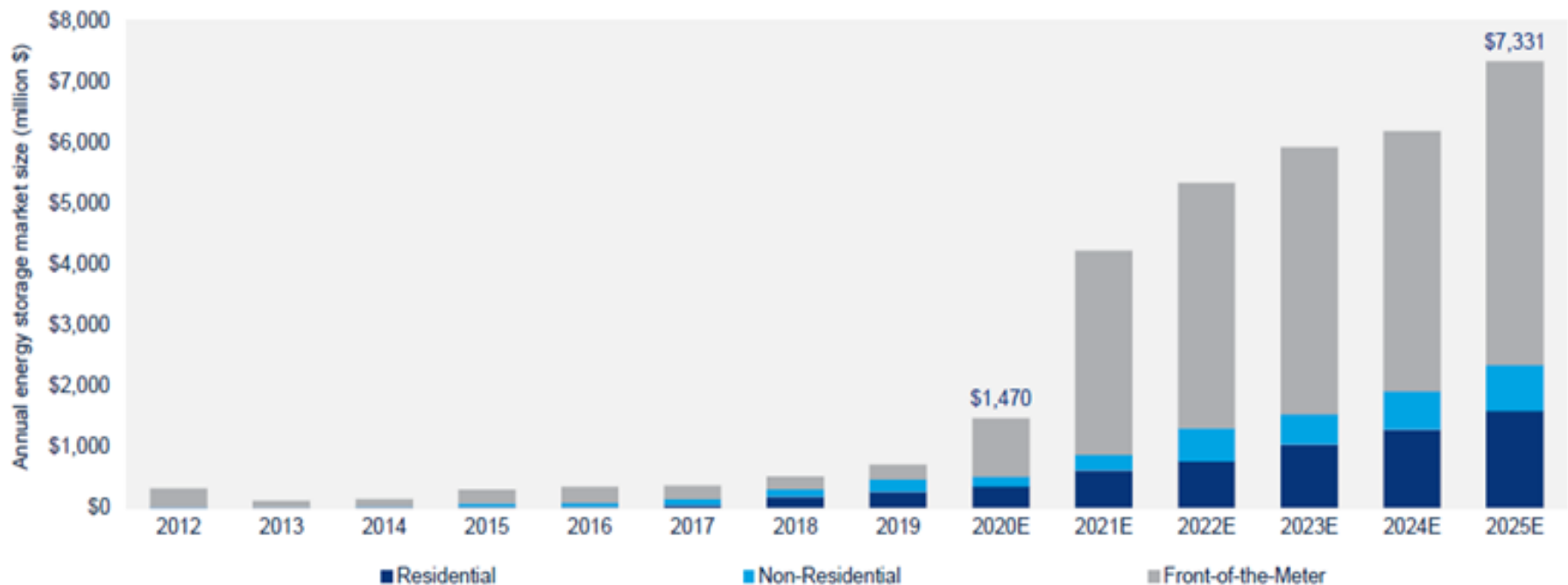
Wood Mackenzie P&R/ESA | U.S. energy storage monitor Q4 2020

woodmac.com

U.S. energy storage will be a \$7.3 billion annual market in 2025

Market crosses \$1 billion annual threshold in 2020, despite COVID-19 impacts

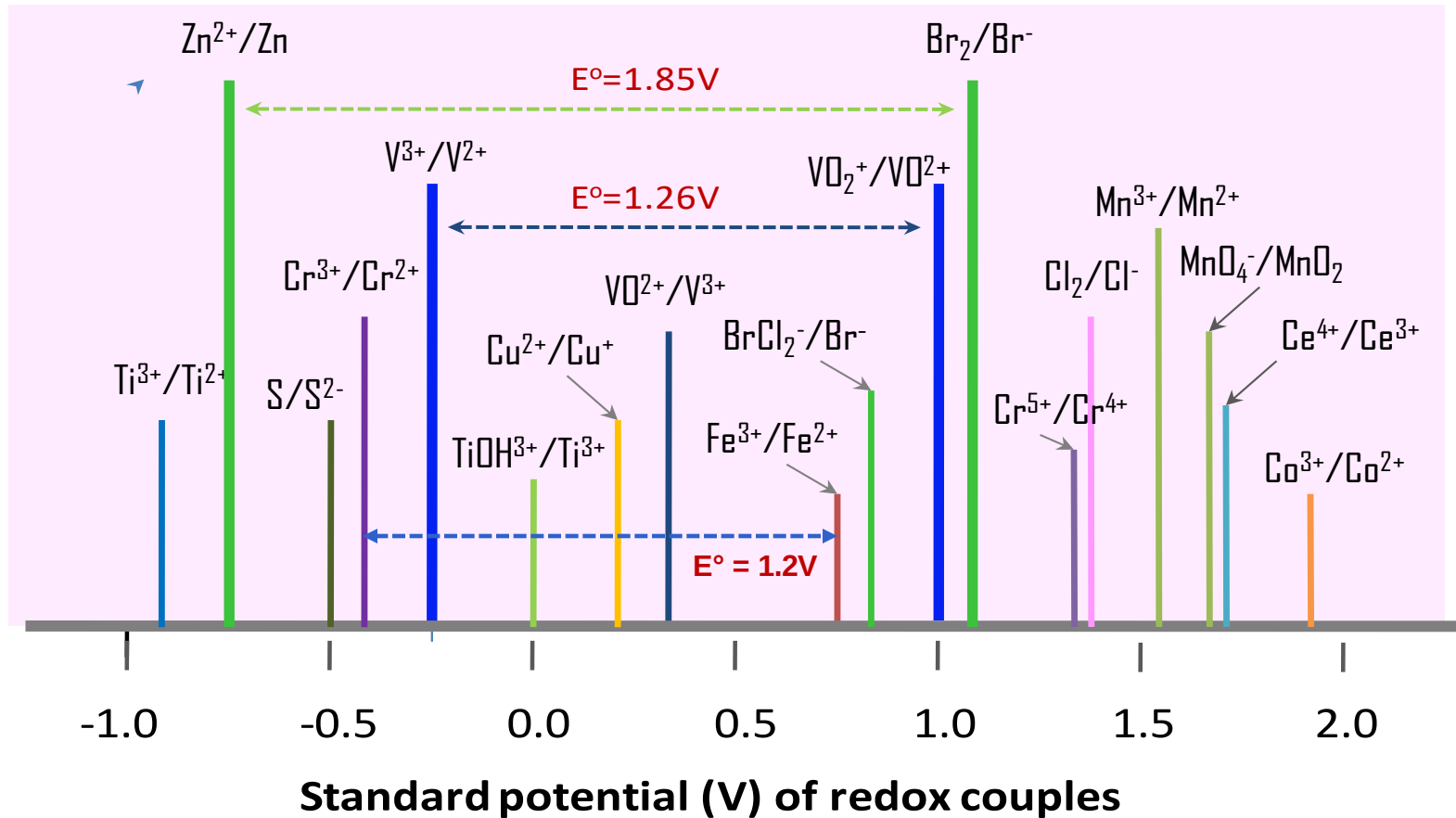
U.S. annual energy storage market size, 2012-2025E (million \$)



Despite Covid 2020, has seen extraordinary growth of ES

The DOE-OE ES Program
Works on Safety and Reliability
and on
Developing New Storage Technologies
that are Safer, more Cost-effective
and Environmentally Acceptable

Redox Couples for Flow Batteries



We want high Potential !

Hydrogen Evolution may occur
in Aqueous Systems
Potentially leading to Explosions!

In case of a Breach,
Electrolyte may get into
Surface and Ground Water!

Largo, Primus, Quino, Otoro,
Lockheed Martin,
ESS, Form, CMblu, Invinity,
Honeywell, Redflow,

Vanadium, Zinc-Bromine. Iron,
Aqueous Organics:
Prussian Blue, Quinones

Storage of Various Durations will be Needed: Short, Medium, and Long

15 min – 4 hrs: smoothing renewables. Li-ion

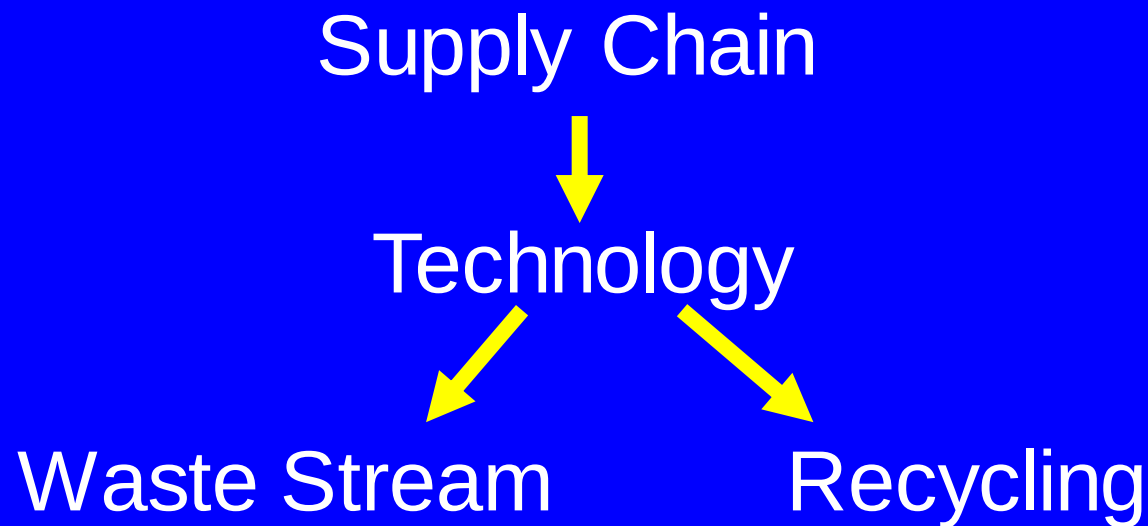
4 – 12 hrs: day/night PV storage. Flow Batteries

12h – 3 days: bad weather backup. Thermal/Gravity

We will need some 1200-2300 GWh of Energy Storage!

Security, Safety, and Reliability
must be Part of the Design
of the Energy Storage System.
This includes
Transportation, Commissioning,
Sensing, Monitoring,
Maintenance,
Provisions for Accidents,
and Decommissioning.

Ultimately the Issue is much Bigger!
We need not only Safety and Reliability,
but also Sustainability!



To achieve real Sustainability
we would Ultimately like
to have a Circular Technology
Based on
Earth Abundant and Inexpensive
Materials!

Supply Chain and Waste Stream
must be Designed into the System!

There will be a huge amount
of Storage on the Future Grid.
It must be Safe, and Inexpensive.
It must also be Sustainable
and Earth friendly!