

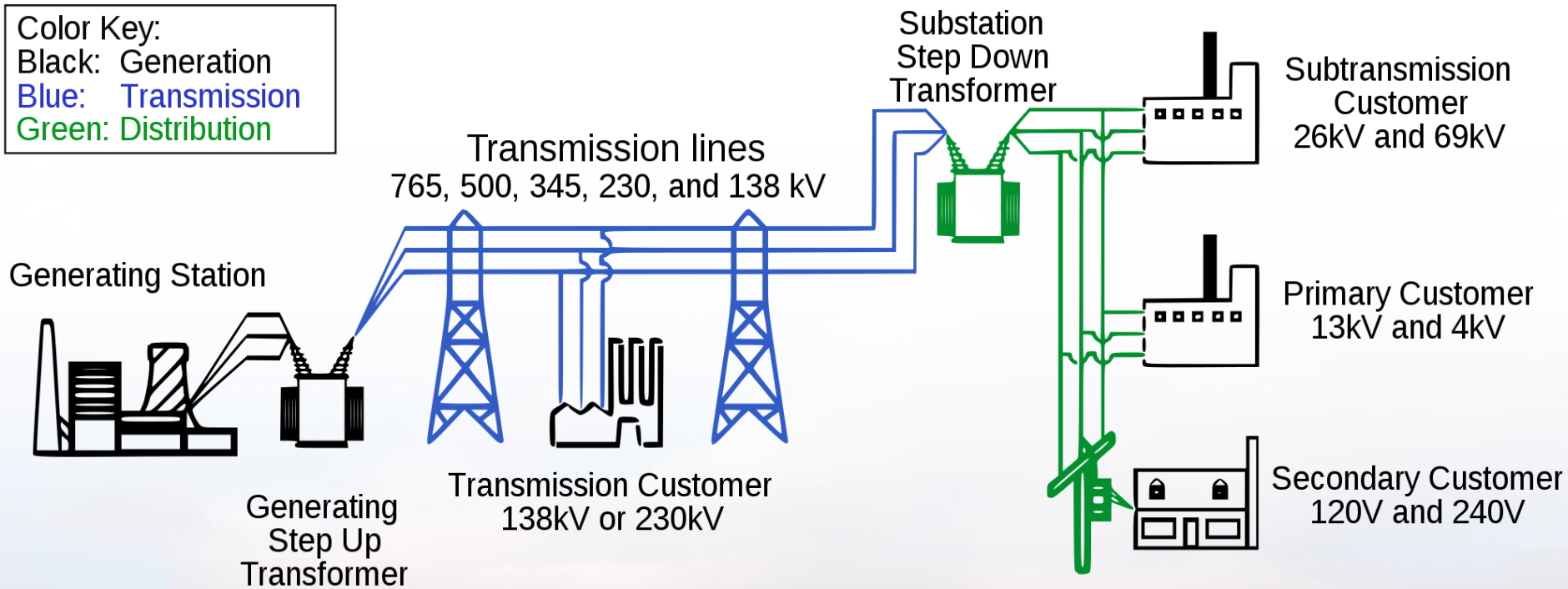


Energy Storage on the Grid Edge

**Energy Storage Workshop for
Southwest Utility Regulators
Sandia National Laboratories, Albuquerque, NM**

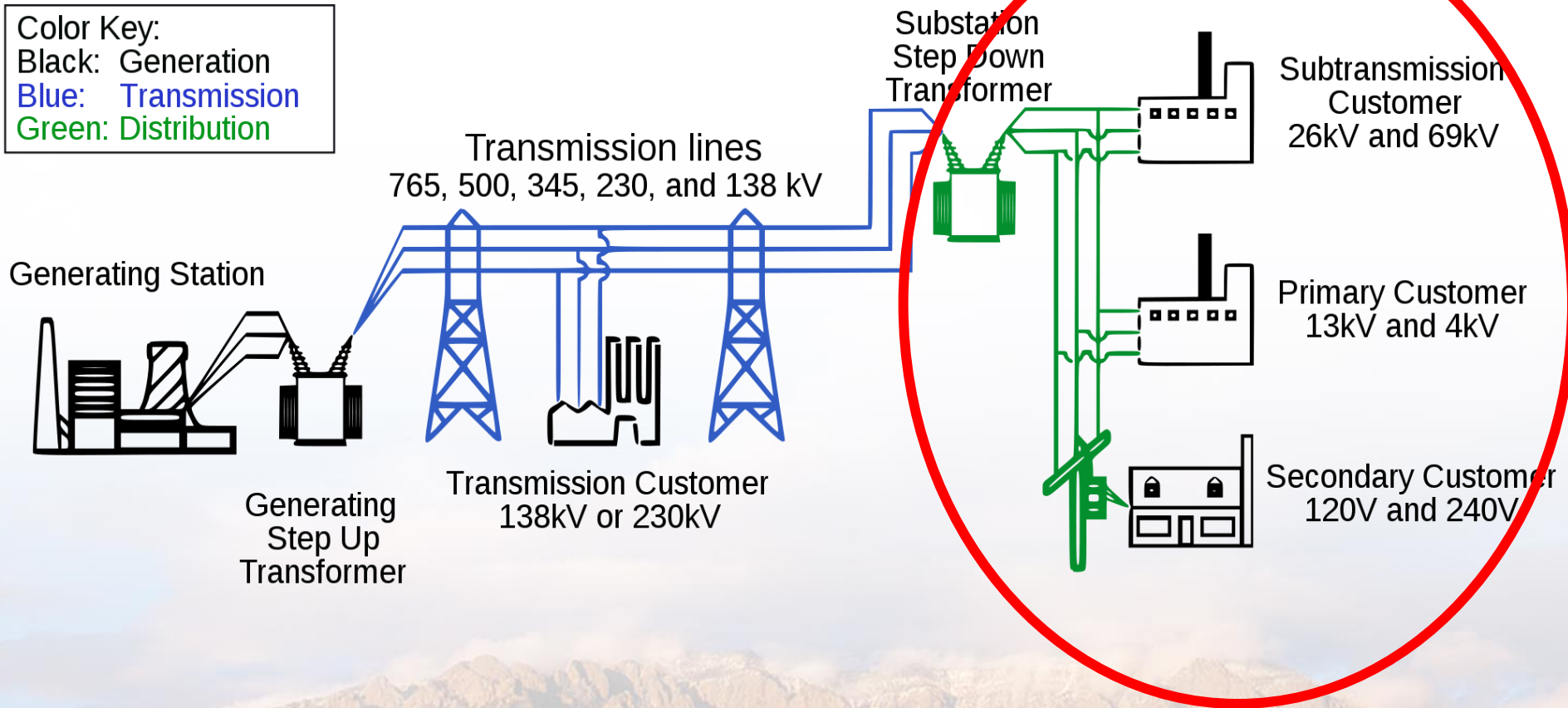
Abbas Akhil
Renewable Energy Ventures, LLC
abbas@revtx.com
(505) 280-0997

The Electric Grid

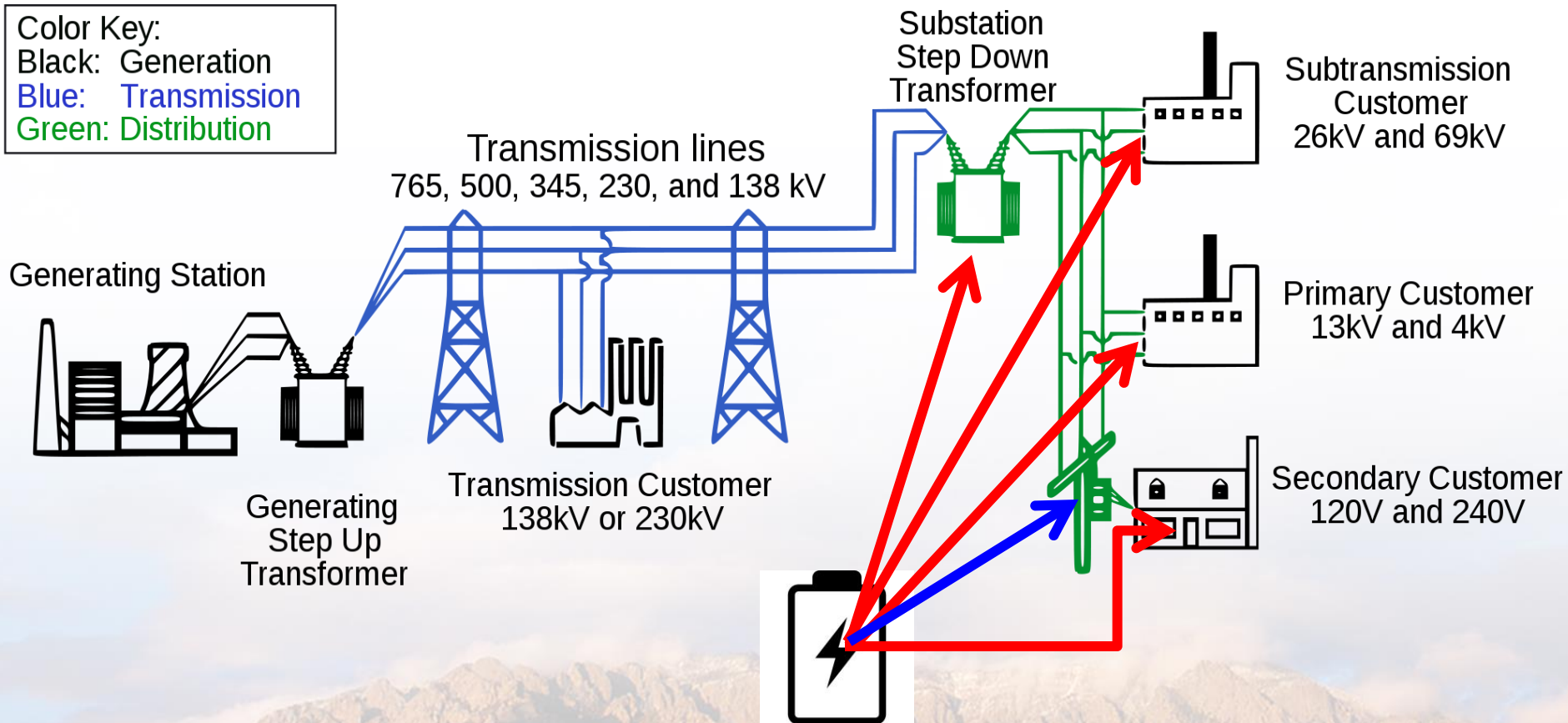


The Grid Edge

Color Key:
Black: Generation
Blue: Transmission
Green: Distribution



Energy Storage at The Edge





What Does Storage Do at the Grid Edge?

STORAGE APPLICATION	TRANSMISSION	DISTRIBUTION	CUSTOMER SITED
T&D Deferral	YES	YES	X
Ancillary Services	YES	YES	YES
Load Leveling	YES	X	X
Demand Response	X	X	YES
Peak Shaving	X	X	YES
Distr. Ren. Integration	X	X	YES

Regulatory Framework to Monetize Value

STORAGE APPLICATION	TRANSMISSION	DISTRIBUTION	CUSTOMER SITED
T&D Deferral	Exists	Partial	Needed (P)
Ancillary Services	Exists	Exists	Needed
Load Leveling	Exists	-	-
Demand Response	-	-	Needed
Peak Shaving	-	-	Needed
Distr. Ren. Integration	-	-	Needed
STORAGE APPLICATION	TRANSMISSION	DISTRIBUTION	CUSTOMER SITED
T&D Deferral - Movable	Needed	Needed	Needed
Ancillary Services***	??	-	Needed
Demand Response***	-	-	Needed
Peak Shaving***	-	-	Needed
Distr. Ren. Integration***	-	-	Needed

*** SHARED OWNERSHIP of the storage system

Renewable Energy ventures, LLC



What is needed?

- Regulatory framework that allows monetization of distributed storage in the distribution system, with option for “shared” ownership
- An “Aggregator”: Combine the outputs of “clustered” distributed storage systems into a “single” source
- Responds to “grid” needs at a *significant* scale
- Control hardware/software that allows the coordinated management of “clustered” storage systems



Technology Match for Grid Edge Applications

APPLICATION	TRANSMISSION	DISTRIBUTION	CUSTOMER SITED
T&D Deferral	Flow/CAES	Flow/Li	Li
Ancillary Services	Flow/Li/Fly	Flow/Li/Fly	Li/Fly
Load Leveling	Flow/CAES	-	-
Demand Response	-	-	Li
Peak Shaving	-	-	Li
Distr. Ren. Integration	-	-	Li

STORAGE APPLICATION	TRANSMISSION	DISTRIBUTION	CUSTOMER SITED
T&D Deferral - Movable	-	Li/Flow	Li

*** SHARED OWNERSHIP of the storage system



Industry Stakeholders and Drivers

Tesla home energy storage

- ◆ Most visible presence, collaboration with Solar City
- ◆ “....will sell 116 MWh of storage systems to SolarCity in 2016.”
- ◆ Powerwall: 6.4 kWh,

S&C Electric – Off-the-shelf PureWave Community Energy Storage system: 25 kW/25 – 50 kWh

Swell Energy partnership with Verengo Solar for residential storage

One Japanese auto manufacturer developing residential storage system



Industry Drivers

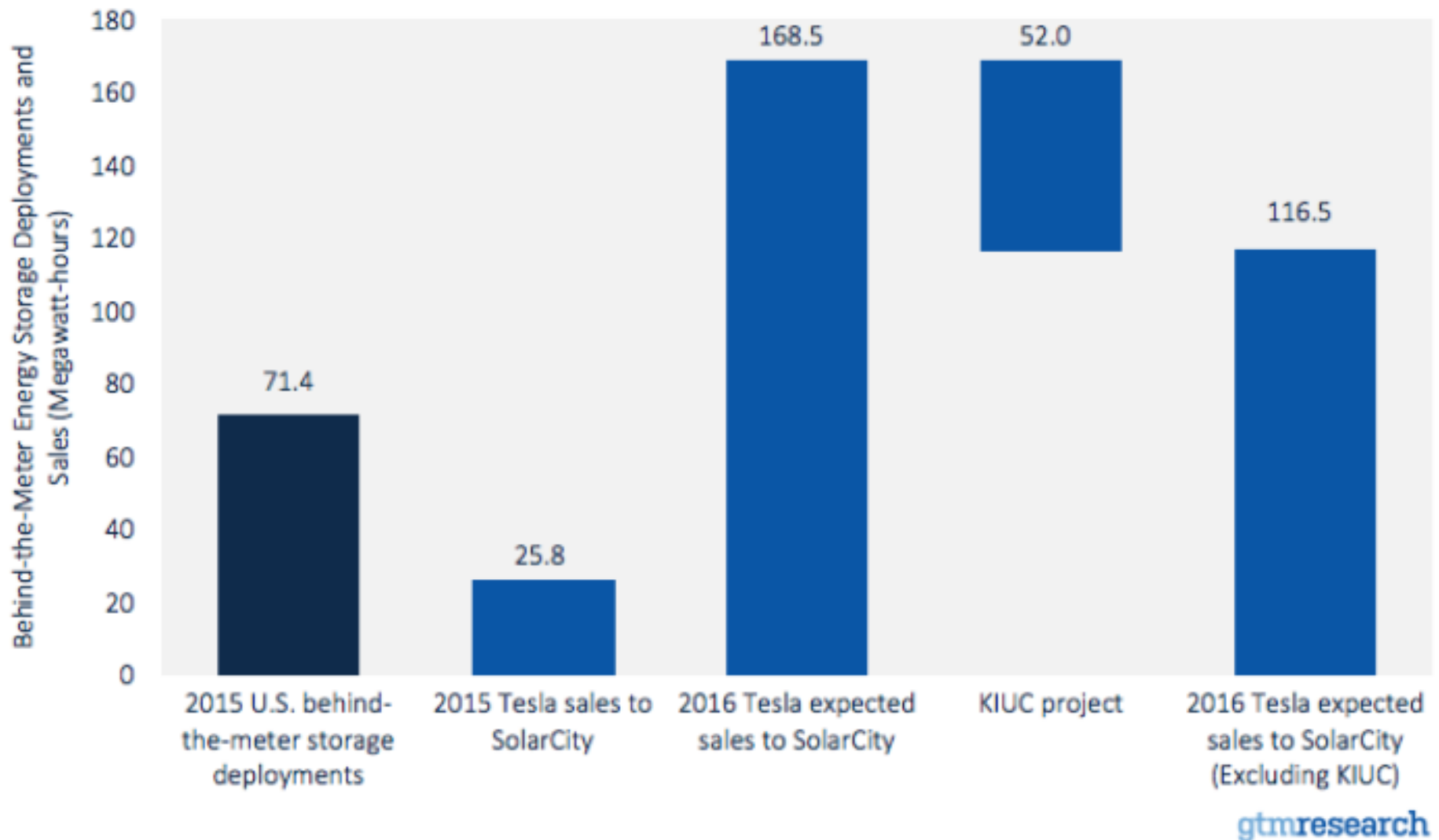
Residential photovoltaic energy storage

Microgrid component of energy storage: projected growth in microgrid installed capacity

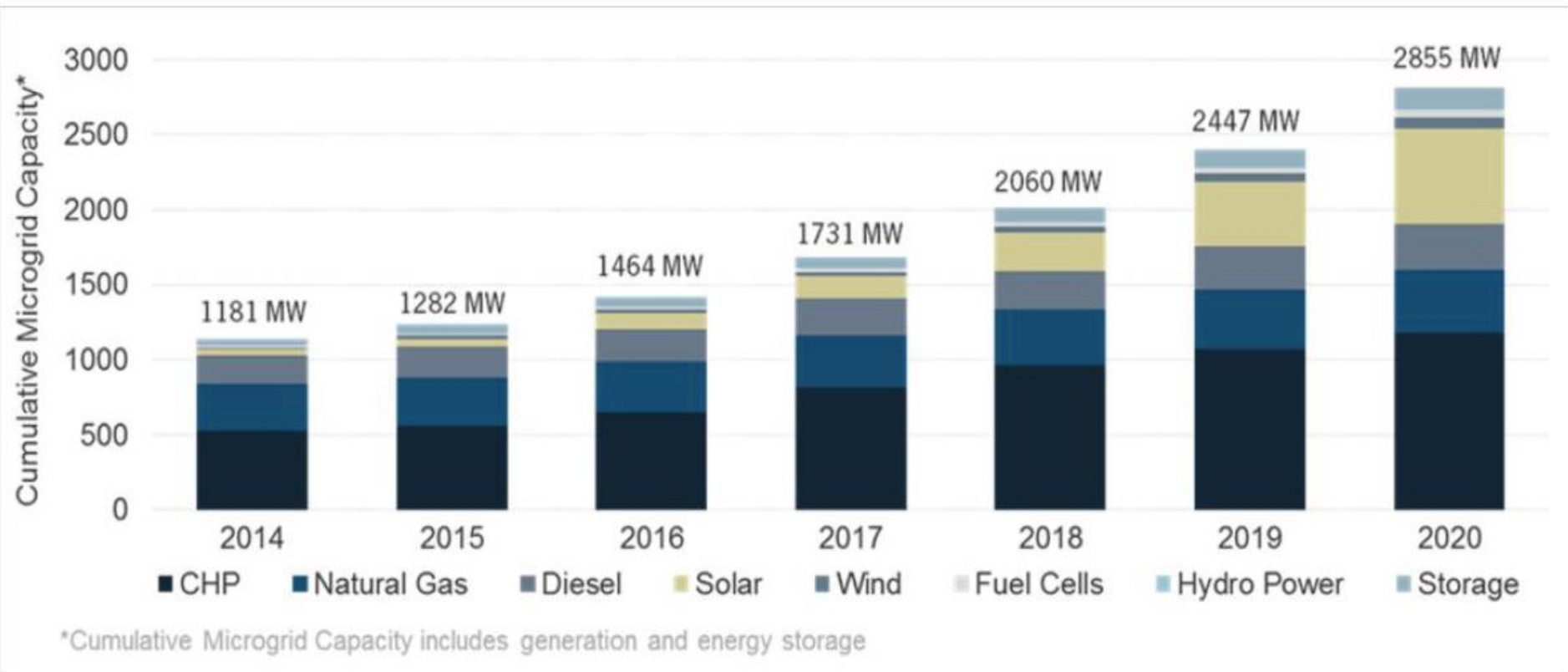
Second-use of EV batteries

Change in electric utility T&D practice

Customer-side Storage Deployment - 2015



U.S. Microgrid Capacity Forecast To 2020



Source: GTM Research/ABB

Tesla Storage Products - Powerwall

Technology

Wall mounted, rechargeable lithium ion battery with liquid thermal control.

Model

6.4 kWh

For daily cycle applications

Warranty

Ten years

Efficiency

92.5% round-trip DC efficiency

Power

3.3 kW

Depth of Discharge

100%

Voltage

350 – 450 volts

Current

9.5 amperes



Tesla Storage Products - Powerpack



Peak Power

50 kW

Energy Capacity

95 kWh (AC)
100 kWh (DC)

Weight

1,720 kg (3,800 lbs)

Dimensions

L x W x H: 1,321 mm (52") x 966 mm (38")
x 2,185 mm (86")

Renewable Energy Ventures, LLC

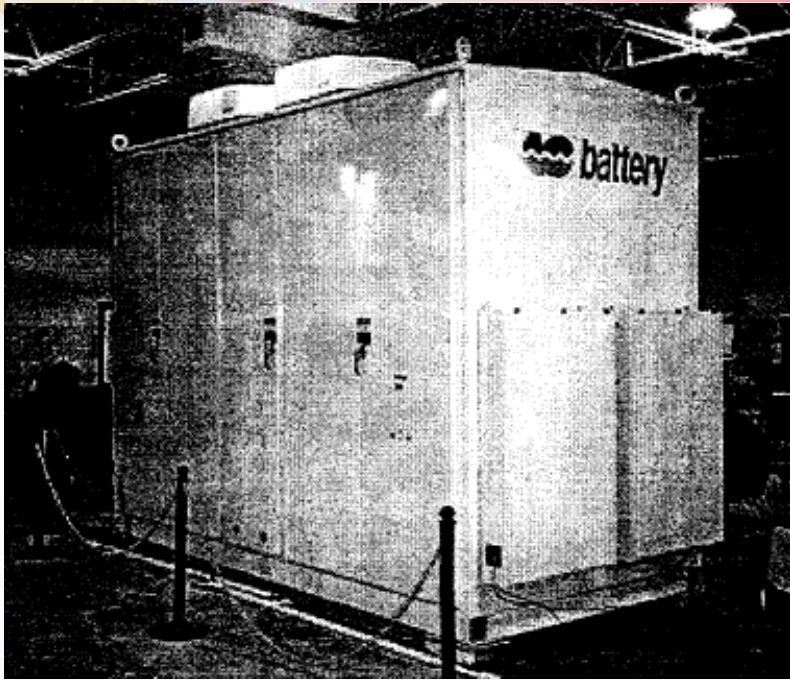
S&C Community Energy Storage - PureWave



Ratings, Dimensions, and Weight

Active and Reactive Power	25 kVA
Energy	25 - 75 kWh
Secondary Voltage	240 / 120V
Battery	Li-Ion
Round-Trip AC Energy Efficiency	> 85%
Dimensions (CES only)	50 inches L x 34 inches W x 31 inches H
Weight (CES only)	Approx. 750 lbs.

What Started it All



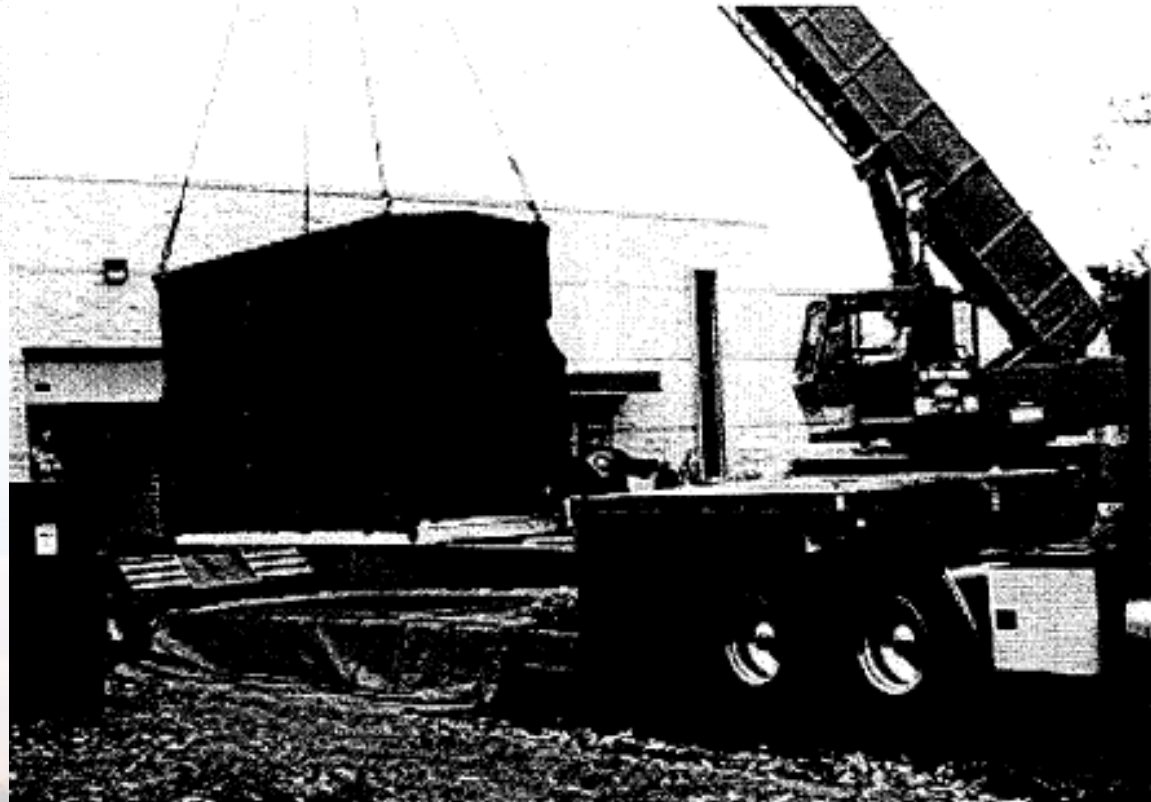
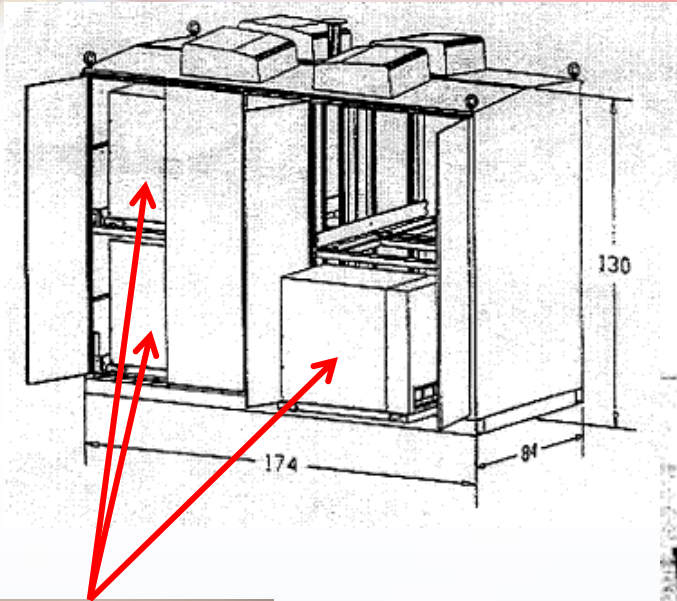
Power: 200 kW
Energy: 167 kWh

First-ever:

- Containerized battery storage for utility applications
- Factory-assembled, ac-ac aggregation of modules
- Transportable



What Started it All



**8 modules: includes batteries and power conversion electronics
25 kW; 20 kWh**

What Started it All



Questions?