One Size Does Not Fit All:

Complexities, Use Cases, & Trends in Energy Storage

Presented By:

NEXTracker
A Flex Company

2/6/2018

Speakers:

Bryan Urban, Executive Vice President, *Leclanché North America*

Joshua Weiner, Storage Integration Director, *NEXTracker*

Janice Lin, California Energy Storage Alliance (CESA) Founder and CEO, *Strategen*

Moderator:

Daniel Finn-Foley, Senior Analyst, Energy Storage, *GTM Research*

gtm: WEBINAR

Audience Console

Today's Speakers

Bryan Urban
Executive Vice President,
Leclanché North America

Joshua Weiner
Storage Integration Director,
NEXTracker

Janice Lin
California Energy Storage Alliance (CESA)
Founder and CEO, *Strategen*

Daniel Finn-Foley
Senior Analyst, Energy Storage
GTM Research

Upcoming GTM Events: 15% off with code WEBINAR

blockchain in energy forum 2018

New York, NY
March 8

s3 solar software summit 2018

San Diego, CA
April 30

solar summit 2018

San Diego, CA
May 1 - 2

grid edge innovation summit 2018

San Francisco, CA
June 20 - 21

u.s. power & renewables summit 2018

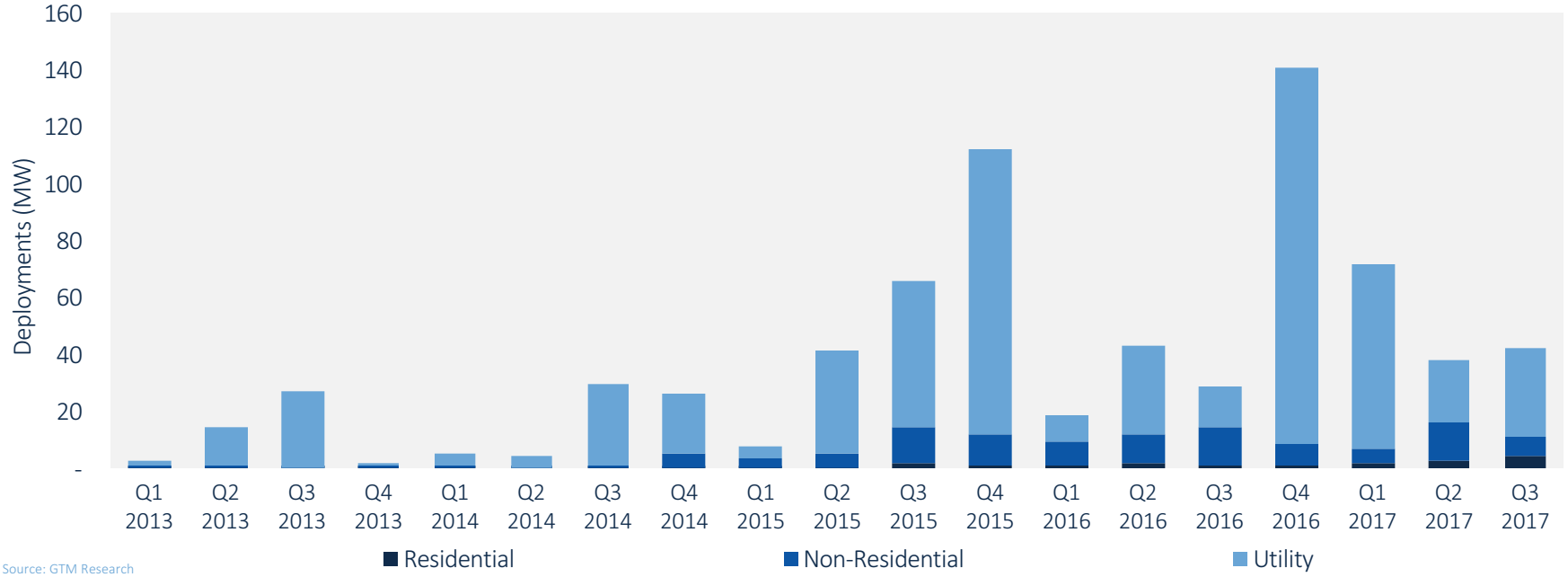
Austin, Texas
November 13 - 14

u.s. energy storage summit 2018

San Francisco, CA
December 11 - 12

U.S. Q3 2017 Deployments in Megawatts Up 46% Over Previous Year

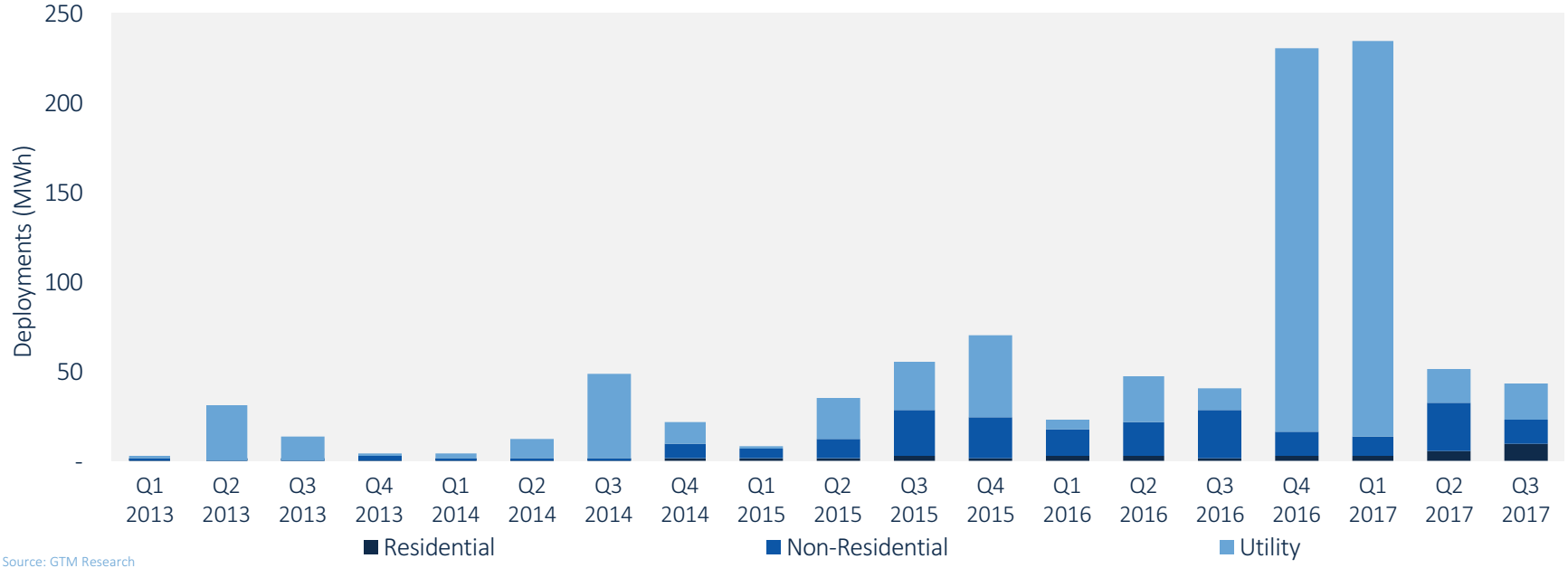
U.S. Quarterly Energy Storage Deployments by Segment (MW)



Source: GTM Research

U.S. Q3 2017 Deployments in Megawatt-Hours Up 5% Over Previous Year

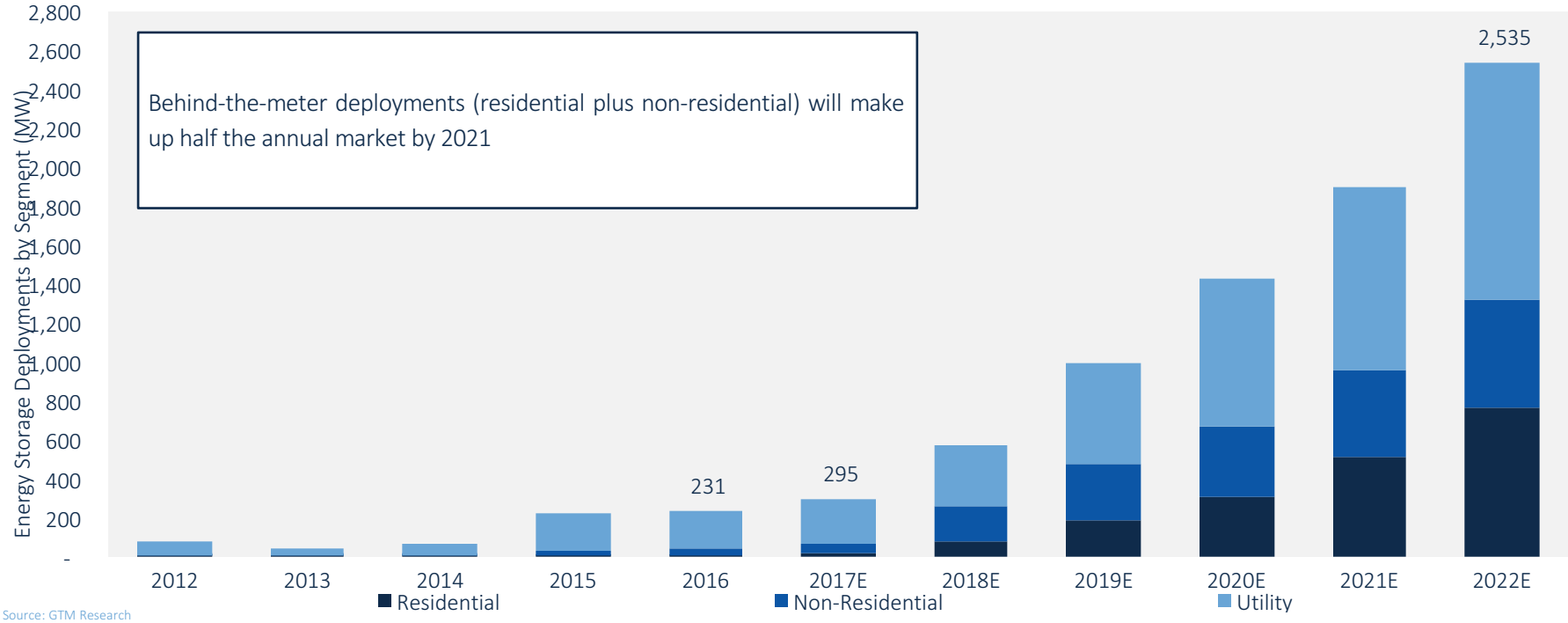
U.S. Quarterly Energy Storage Deployments by Segment (MWh)



Source: GTM Research

U.S. Energy Storage Annual Deployments Will Reach 2.5 GW by 2022

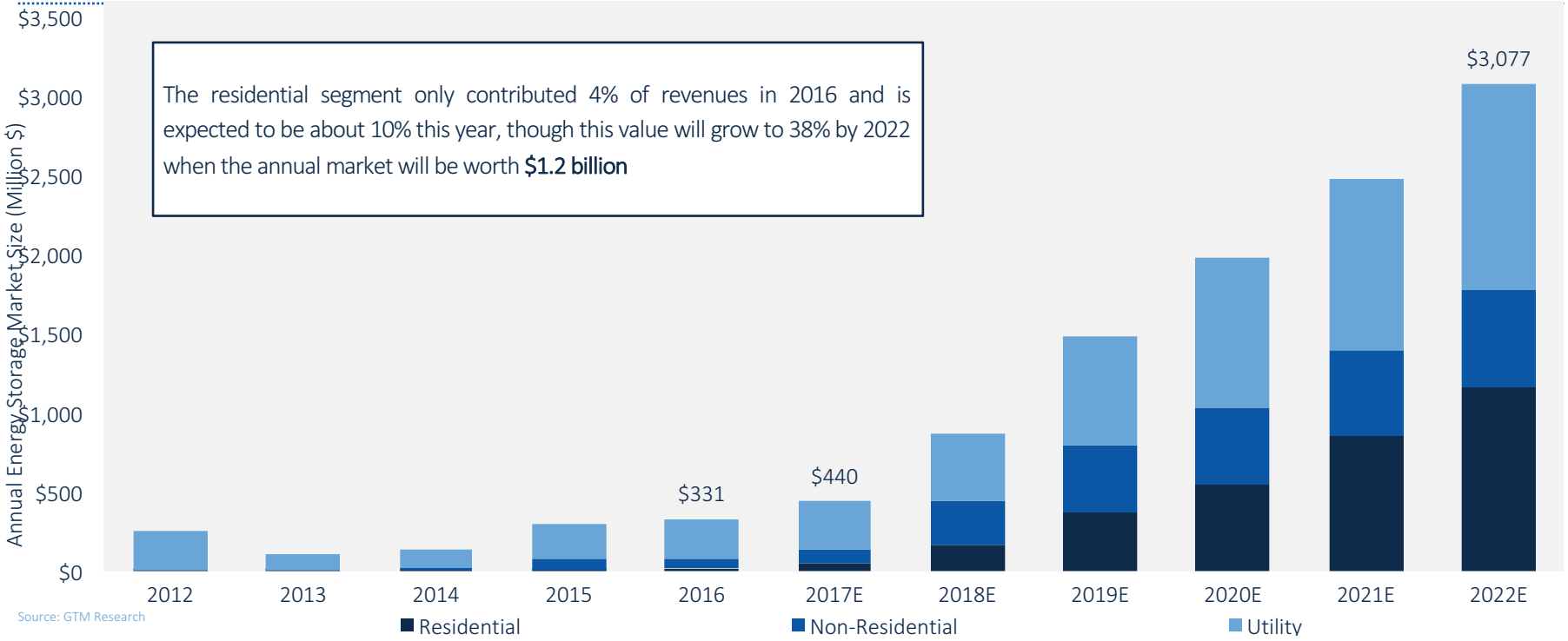
U.S. Annual Energy Storage Deployment Forecast, 2012-2022E (MW)



Source: GTM Research

Energy Storage Will Be a $3.1 Billion Market by 2022

U.S. Annual Energy Storage Market Size, 2012-2022E (Million $)



Source: GTM Research

One Size Does Not Fit All: Complexities, Use Cases, & Trends in Energy Storage

FEBRUARY 6, 2018

AGENDA

- Greentech Media – Daniel Finn- Foley
- California Energy Storage Alliance (CESA)- Janice Lin, Founder and CEO
- Leclanche- Bryan Urban, VP North America Sales
- NEXTracker- Josh Weiner, Director of Energy Storage Integration
- Q&A

CESA
CALIFORNIA ENERGY STORAGE ALLIANCE

California Energy Storage Alliance

The **California Energy Storage Alliance (CESA)** is a mission-driven nonprofit industry advocacy group committed to advancing the role of energy storage in the electric power sector through policy, education and outreach.

Board Members

8minutenergy RENEWABLES
Advanced Microgrid Solutions
FLUENCE A Siemens and AES Company
AltaGas
enel
ENGIE by people for people
EASTPENN
ecoult energy storage solutions
LG Chem
LOCKHEED MARTIN
LS Power
MAGNUM
NEXTera ENERGY RESOURCES
NEXTracker A Flex Company
SNC·LAVALIN
SolarCity
SOUTHWEST GENERATION
WELLHEAD

Future of California's Energy Grid: Highly Renewable, Highly Flexible

IRP: More Renewables are Needed to Meet 42MMT 2030 GHG Goal

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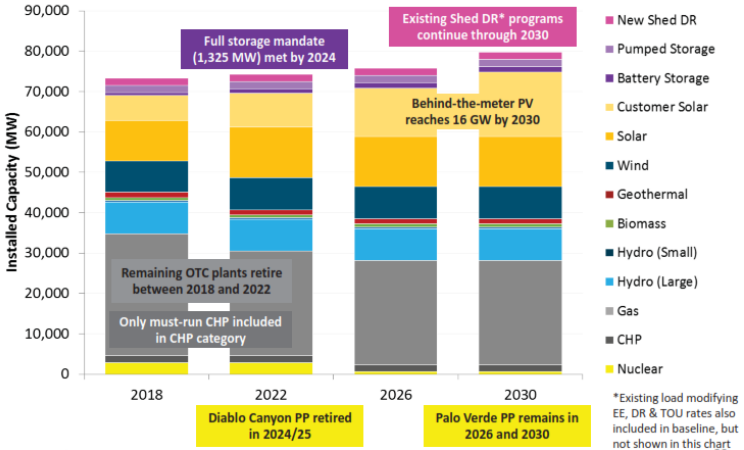
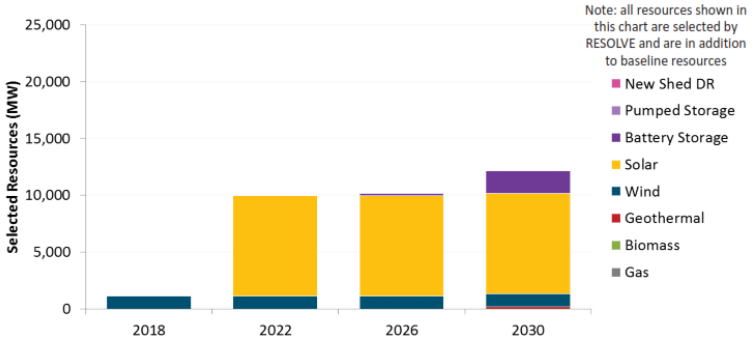
The CPUC's Reference System Plan recommends + 9,000 MW of utility-scale solar PV and + 1,100 MW of wind in California (on top of assumed +16,000 MW of additional rooftop PV)

CPUC Proposed Baseline Resources 2018-2030



Source: E3 RESOLVE Model & CPUC IRP Workshop (2017)

CPUC Proposed 42 MMT Reference System Plan 2018-2030



Source: E3 RESOLVE Model & CPUC IRP Workshop (2017)

Current Real-Time Operational Difficulties

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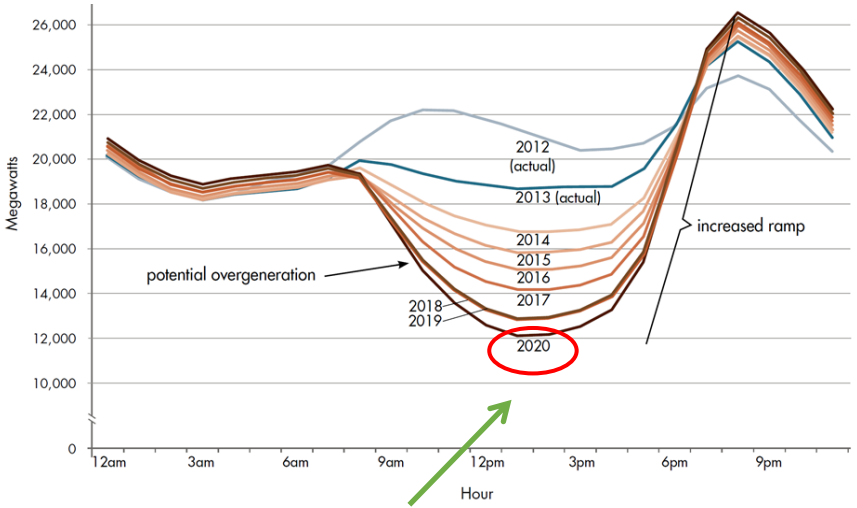
Planning models often focus on three-hour ‘solutions’, which can blur actual hourly and intra-hour ramps, outages, and other factors that make the real-time operation of the grid a growing challenge

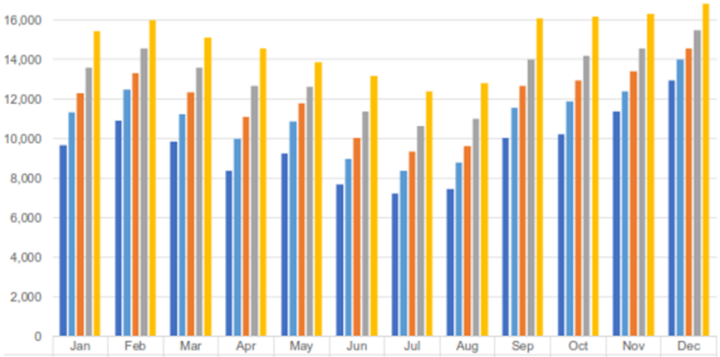
CAISO Net Load



Source: CAISO (2013)

California’s **2017 ‘duck curve’** is ahead of schedule and frequently reached below estimated 2020 levels during YTD 2017
(Lowest net load so far: 8,453 MW)

CAISO Monthly 3-Hour Upward Ramps 2016-2020



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(Actual)	9,687	10,891	9,828	8,397	9,263	7,669	7,214	7,463	10,030	10,228	11,375	12,960
	11,342	12,465	11,253	9,973	10,878	8,996	8,379	8,768	11,575	11,900	12,391	14,004
	12,282	13,313	12,352	11,111	11,803	10,039	9,326	9,617	12,660	12,954	13,376	14,567
	13,595	14,543	13,574	12,672	12,631	11,350	10,616	10,982	13,981	14,199	14,553	15,495
	15,439	15,984	15,089	14,572	13,859	13,181	12,391	12,821	16,061	16,169	16,293	16,817

Source: CAISO (2017)

2030 Grid Operations with Renewables: Spring

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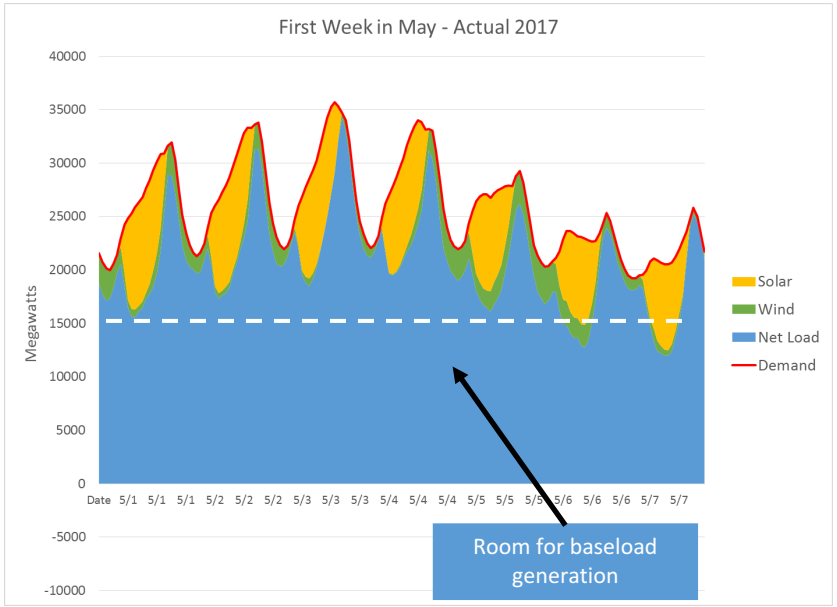
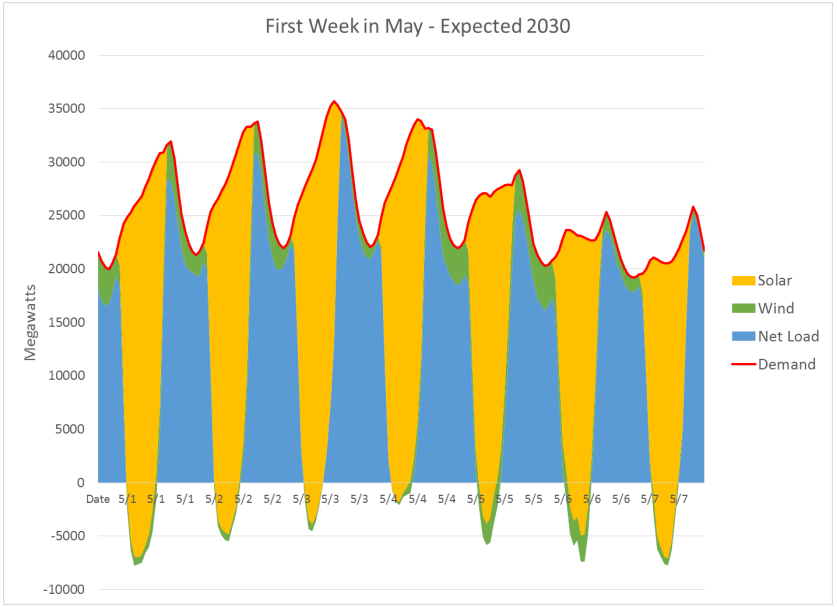
Today: Net load is met by Flexible Gas, Baseload Gas, Nuclear, Geothermal, Imports/Exports, and Curtailments



Source: CAISO OASIS data (2016)

2030: Net load will need to be met by a combination of Flexible Resources, Imports/Exports, and Curtailment



Source: CAISO OASIS data (2016), 2030 IRP Proposed Reference System Plan Scenario

2030 Grid Operations with Renewables: Summer Icicles of Opportunity!

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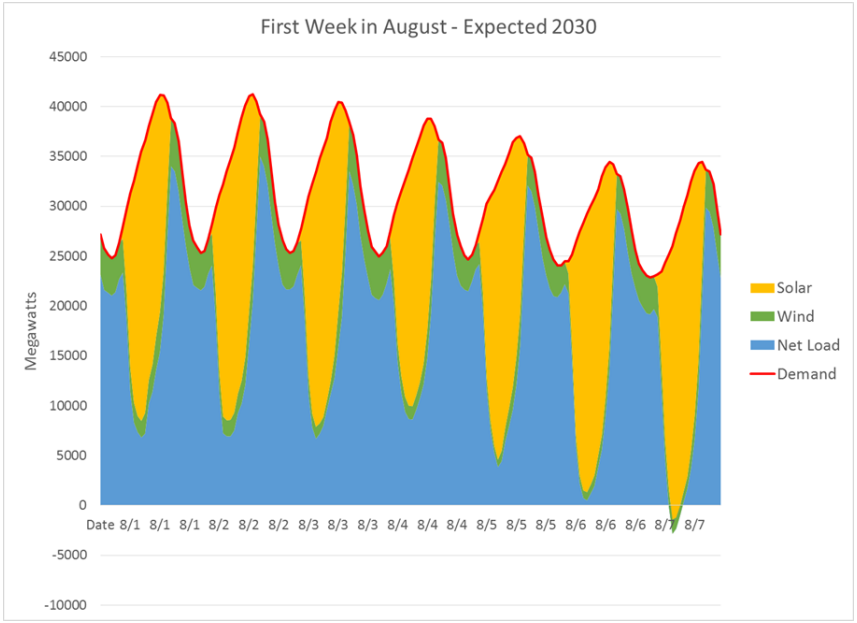
These steep ramps and overgeneration risks are not just a spring-time problem-

They are a year-round opportunity!



Source: CAISO OASIS data (2016), 2030 IRP Proposed Reference System Plan Scenario

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Top Energy Storage Trends & Drivers

Underlying Global Drivers	Cost competitive renewables Rapidly declining cost of energy storage Resource diversification for reliability and resiliency Increasing need for grid flexibility Global awareness and interest in energy storage
Technology & Application Innovation	Innovative new long duration solutions Hybridization – optimization of existing assets Aggregation
Planning & Procurement Innovation	Multi use value stacking Proactive consideration as alternative to status quo solutions (non wires alternative, local capacity, reliability)

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Upcoming 2018 Events

CESA Market Development Forum (MDF): February 28, Berkeley, CA

CESA's annual invite-only event open to CESA members and key stakeholders. Join CESA!

(www.storagealliance.org/MDF2018)

ESNA Solar+Storage Summit, powered by Strategen + ESI

ESNA @Solar Power International's California Solar Expo: March 27, San Diego, CA

(www.esnaexpo.com/regional)

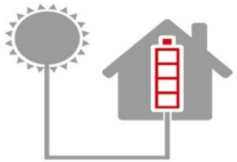
6th Energy Storage North America (ESNA) Conference + Expo: November 6-8, Pasadena, CA

Largest grid-connected energy storage conference in North America, covering all applications including EV charging

(www.esnaexpo.com)

Leclanché

Energy Storage Solutions



Who we are

Leclanché at-a-glance

We are experts in energy storage, with a focus on strategic growth markets		• Headquartered in Switzerland / Americas head office in Dallas, Texas • Over 100 years of energy storage expertise – Since 1909
We have capabilities to deliver complete customer solutions		• Reference projects in multiple market segments ranging from utility-scale power generation/microgrids to mass eTransport • 100 MWh in operations in 2018
We can integrate any battery chemistry with our software and systems		• Deliver fully-integrated, turn-key solutions in Stationary and e-Transport markets utilizing multiple battery technologies • Advanced battery management system and cloud-based asset management software
We have proprietary, market-leading cell technology		• Proprietary technology with market-leading charging speed, cycle life and thermal stability for world class performance – over 100 patents
We bring quality European engineering to global markets		• Rich heritage of high quality design engineering and European precision – 50 engineers, with 20 in software development
We power clean, intelligent energy for the future		• Intelligent software, systems integration and power controls to deliver best-in-class storage solutions for advanced applications

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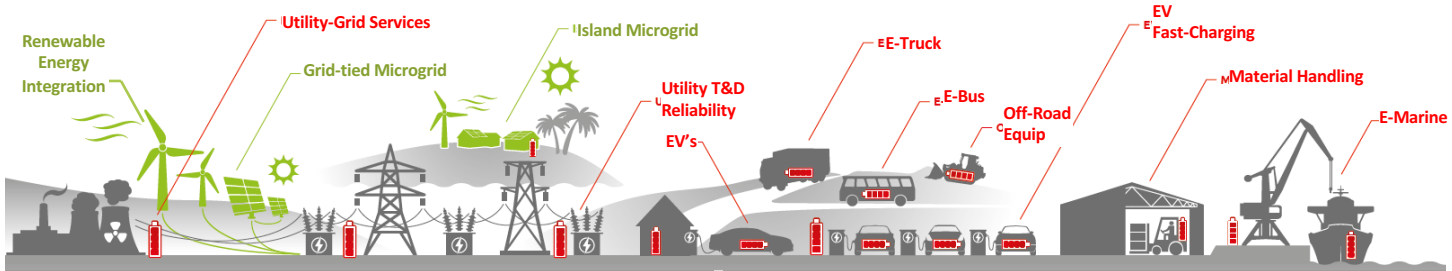
Stationary

eTransport

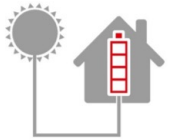


Grid Ancillary Services
C&I Storage Solutions
Micro-grid Systems
PV Solar + Storage
Community Storage
EV Charging Stations

Electric Buses
Electric Ferries
Warehouse Equipment
Industrial Marine
Fleet Trucks
Light Vehicles

Leclanché
Energy Storage Solutions

CASE STUDY: Commercial & Industrial Customer Behind-the-Meter Battery Storage



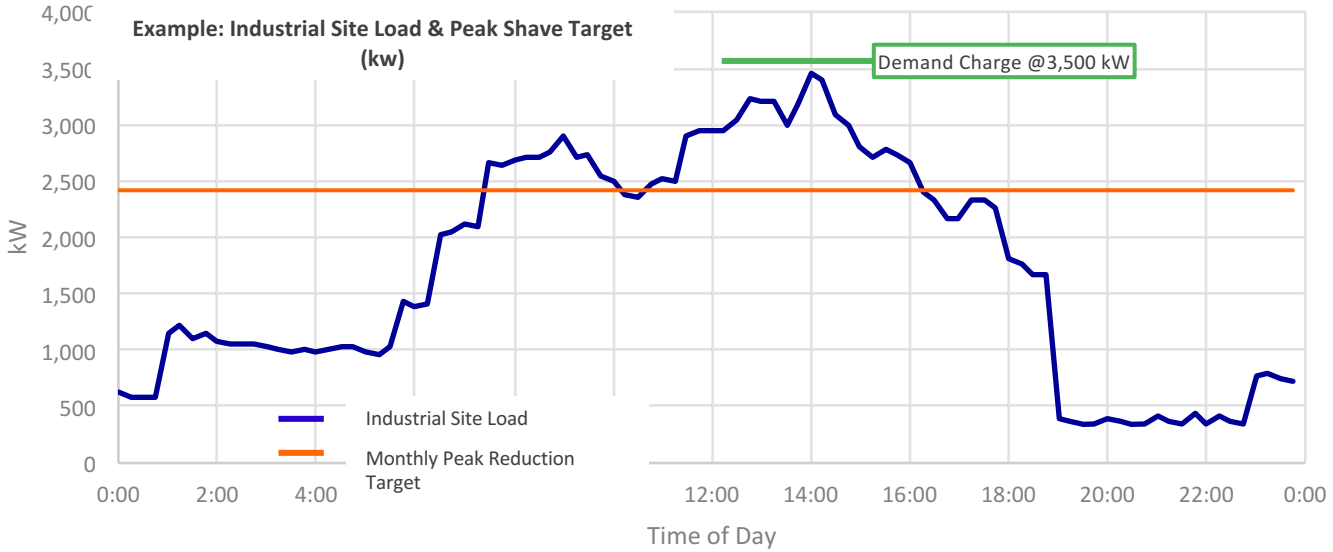
Peak Shaving / Demand Charge Reduction

Canadian Global Adjustment Charge

C&I Application: Peak-Shaving and Demand Charge Reduction

Demand Charge Reduction Example: Hit The Target

- Below is an example of an industrial site with a sporadic load curve (purple) and a peak of 3.5 MW.
- The orange line indicates the sites Reduction Target of 2.4 MW for the month.
- To achieve the full Reduction Target, the battery must have enough power to offset the peak load above the target peak line (1.1 MW in this case) and energy capacity to provide power for the full site load in excess of the target peak.
- The battery begins recharging at 16:00 when the site load drops below the target peak.

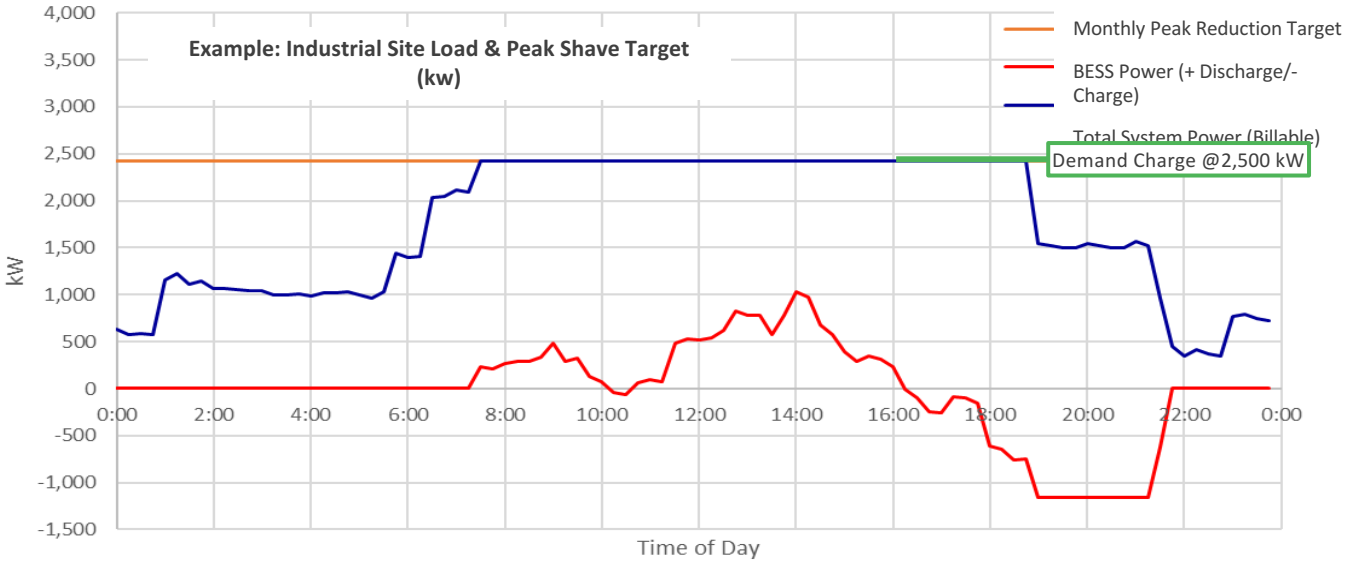


C&I Application: Peak-Shaving and Demand Charge Reduction

Leclanché Energy Storage Solutions

Battery System Reduces Site Power to the Target

- Below is the effect of adding the BESS for the same period as the previous slide. Site load has been reduced by the BESS power ("Total System Power").
- The orange line indicates the same 2,400 kW Reduction Target from the previous slide.
- The battery (red line) provides the power and energy to offset all the area above the target peak.
- At 16:00, the battery recharges when the site load drops below the target peak until fully charged.

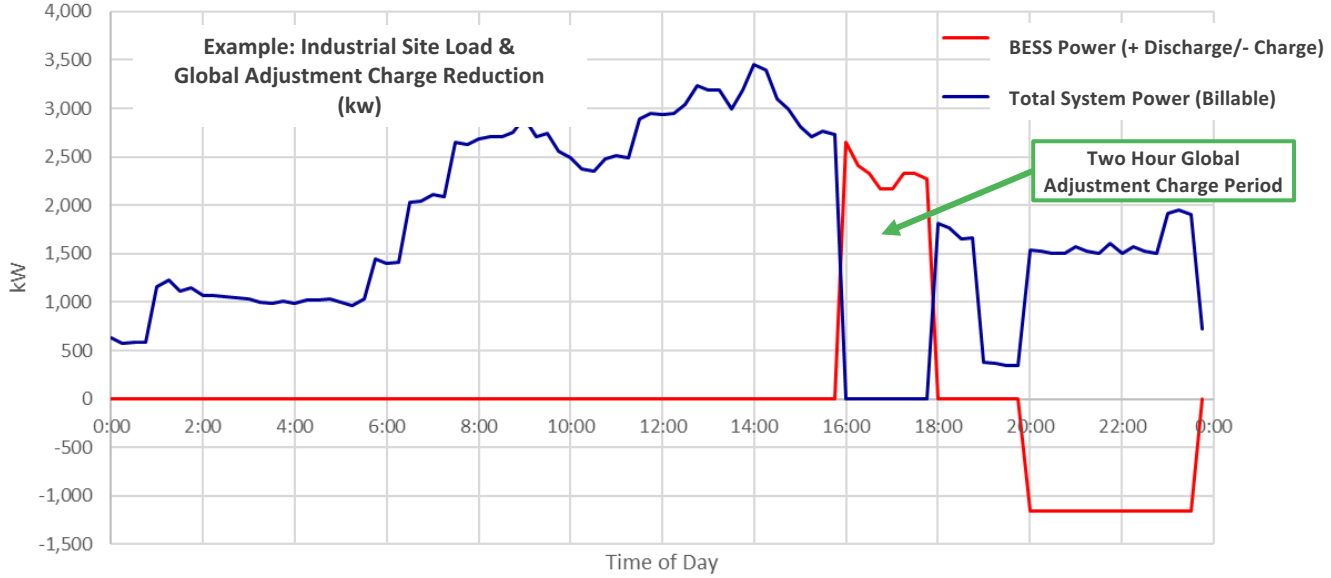


C&I Application: Global Adjustment Charge Reduction (Ontario)

Leclanché
Energy Storage Solutions

Battery System Reduces Site Power During the Key Period

- Below is the effect of adding the BESS for the same period as the previous slide. Site load is reduced by the BESS power for 2 hours. ("Total System Power")
- The projected Global Adjustment Charge period is from 16:00 to 18:00.
- The battery (red line) provides the power and energy to offset all onsite load for the two hour period. **(0 kW net billable load)**
- At 20:00, with system operations past any possible Global Adjustment Charges, the battery recharges for approx. 4 hours until fully charged.



C&I Reference Project: Canadian Global Adjustment Charge

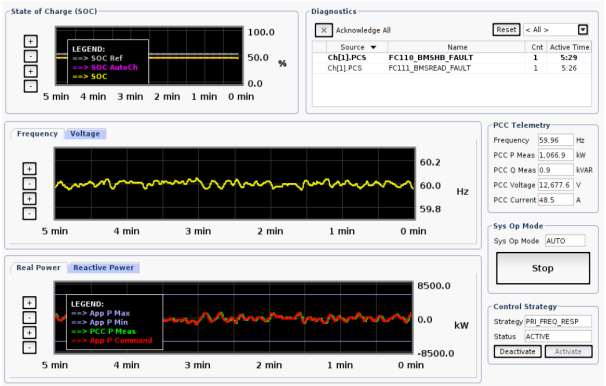
Leclanché
Energy Storage Solutions

Project:	**Manufacturing Facility (Confidential)**
Location:	**Toronto, Canada**
Size:	**2.0 MW / 4.9 MWh**
Application:	**Peak Charge (Global Adj) Reduction**
Status:	**Under Construction**
COD:	**Q2/2018**
Scope:	**Turn-key EPC Contract**
Controls:	**Leclanche EMS / Leclanche UFMS**

ieso
Connecting Today.
Powering Tomorrow.

NEXTracker

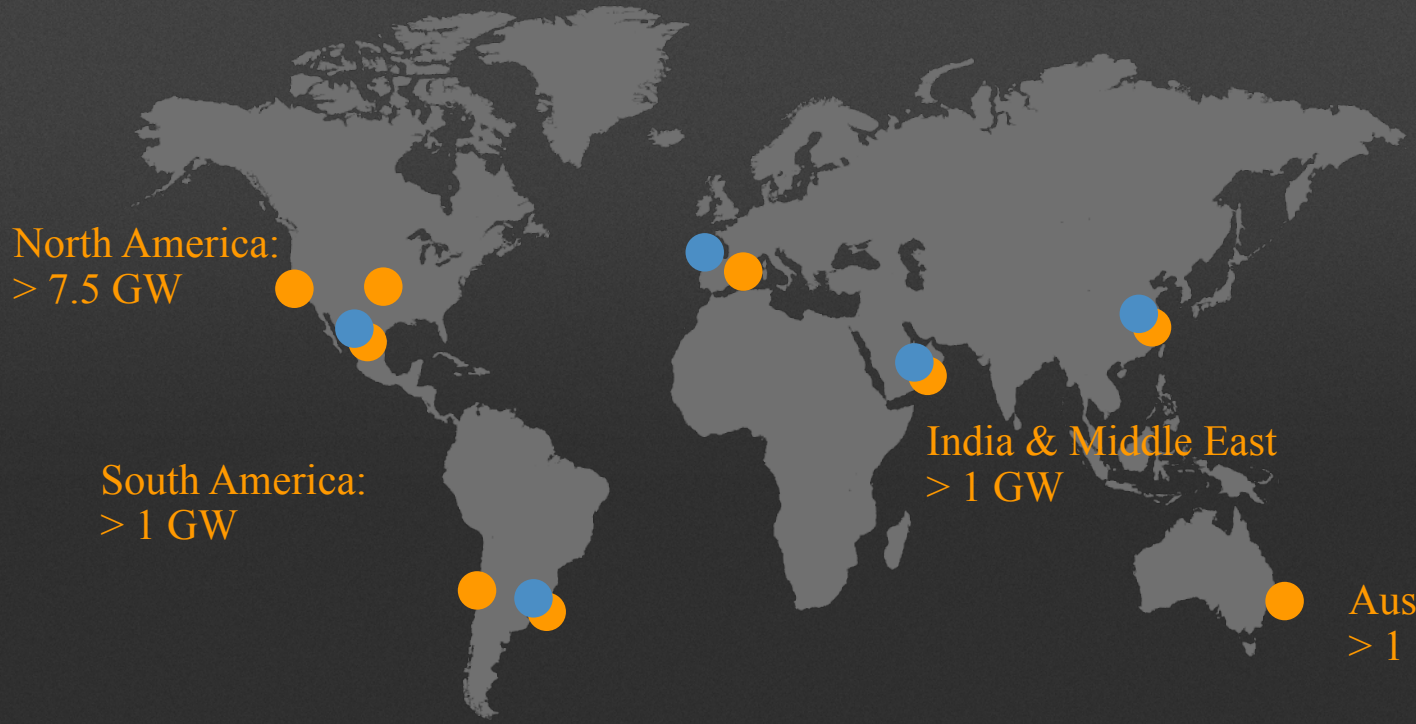
Leclanche will utilize a standardized 1.0 MW / 2.5 MWh 40' ISO Container for C&I Applications as the building block



EMS Controls Screen

EXAMPLE ECONOMICS ON GLOBAL ADJUSTMENT CHARGE	
Total IESO System Load (MW)	23,000 MW
Customer Load (MW)	2.0 MW
Average % of Total Load	0.00870%
Total IESO Global Adjustment ($ millions)	$12,000 CAD
Global Adjustment Charge (Annual $)	**$1,043,500** CAD

GLOBAL PRESENCE



Global offices (9)
Manufacturing centers (5)

KEY METRICS

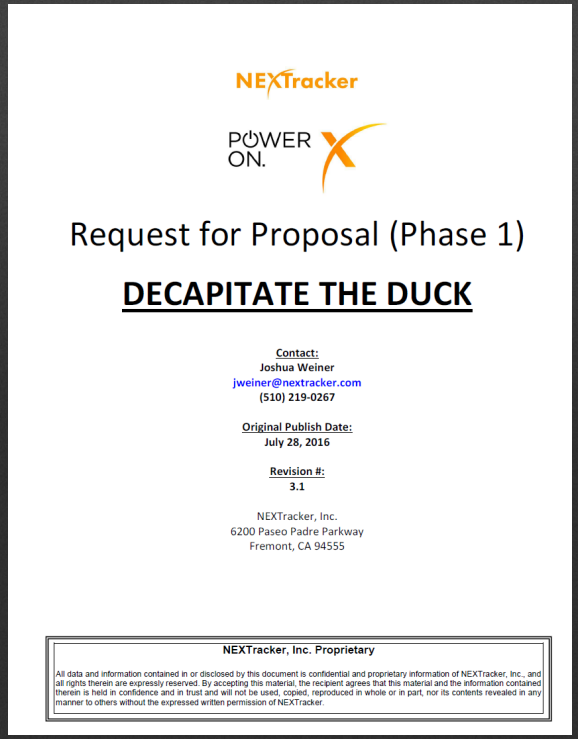
- 11 GW trackers sold worldwide
- 175 MW weekly manufacturing capacity
- #1 market share position globally for two consecutive years

DECAPITATE THE DUCK RFP

1) Only two requirements:
   a) lowest TCO system
   b) standardized demand profile

2) Technology neutral
   a) Lithium (5 types)
   b) Flow (6 types)
   c) Flywheel (2 types)
   d) Ultracapacitors (1 type)
   e) Advanced Lead-Acid (1 type)
   f) Copper-Zinc (1 type)
   g) Nickel-Iron (1 type)

3) No deadline – all are welcome, anytime



NEXTracker

POWER ON.

Request for Proposal (Phase 1)

DECAPITATE THE DUCK

Contact:
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(510) 219-0267

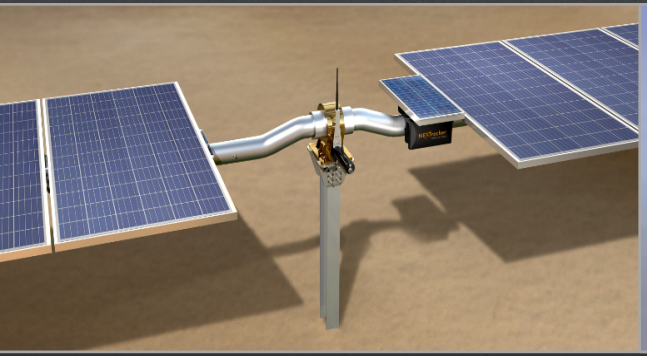
Original Publish Date:
July 28, 2016

Revision #:
3.1

NEXTracker, Inc.
6200 Paseo Padre Parkway
Fremont, CA 94555

NEXTRACKER PRODUCT PORTFOLIO

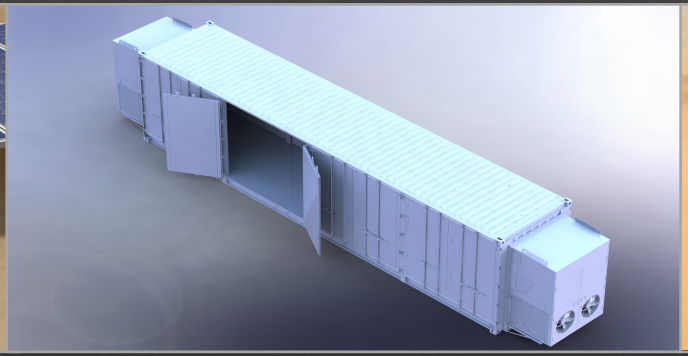
Products designed to maximize long-term value and offer the lowest LCOE & LCOS



NX Horizon™
Self-Powered Tracker

Designed for utility-scale and distributed generation systems

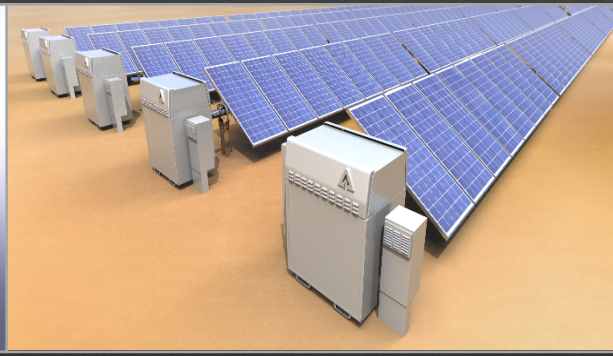
Advanced self-powered independent row design with best-in-class energy yield



NX DRIVE™
Energy Storage System

Standardized balance-of-plant solution for generation-plus-storage or standalone storage applications

Pre-engineered for a range of Lithium-Ion Batteries



NX FLOW™
Integrated Solar + Storage System

Fully integrated modular solution designed for solar-plus-storage applications

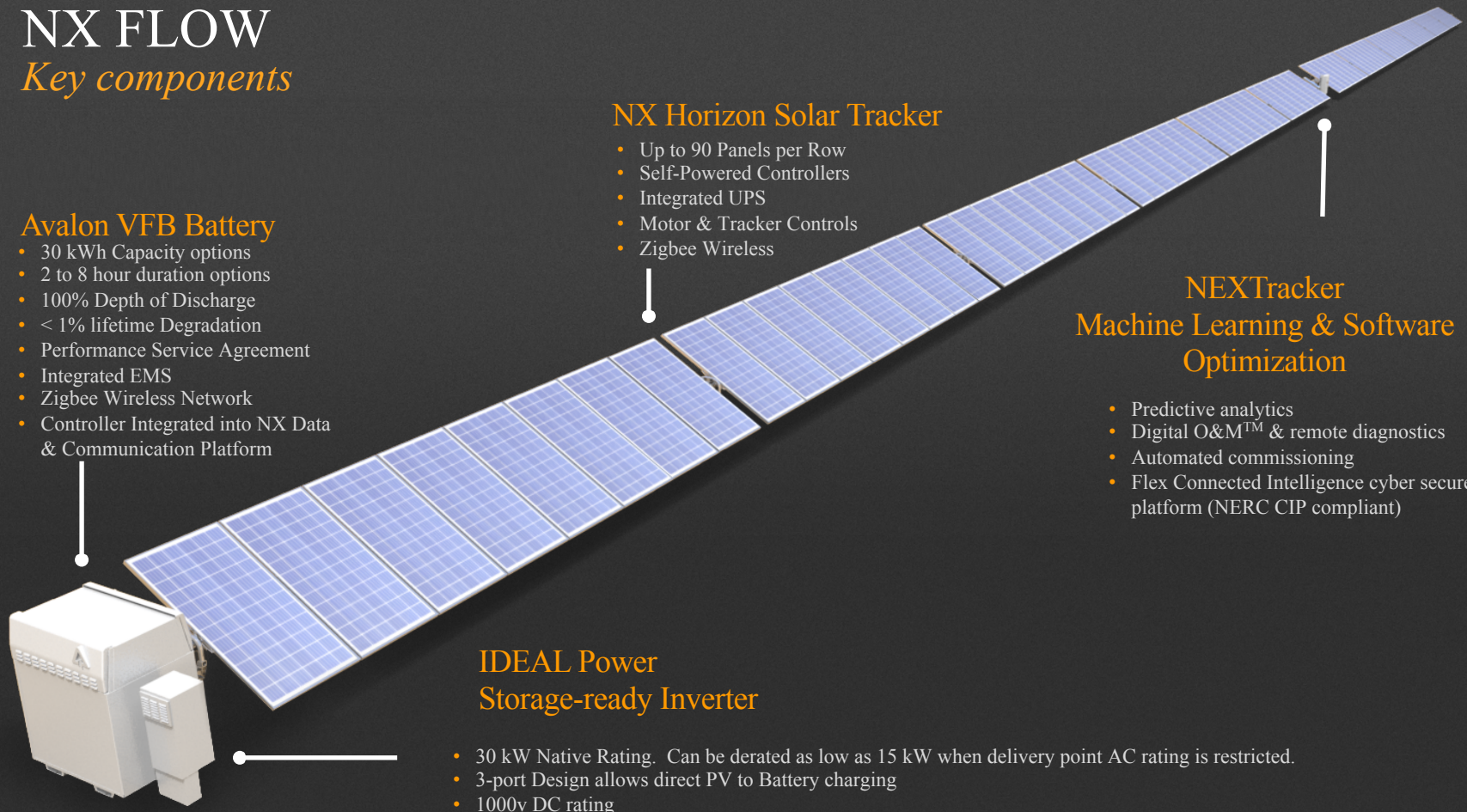
Combines advanced vanadium flow battery with inverter and NX Horizon tracker

NX FLOW
Key components

NX Horizon Solar Tracker
- Up to 90 Panels per Row
- Self-Powered Controllers
- Integrated UPS
- Motor & Tracker Controls
- Zigbee Wireless

Avalon VFB Battery
- 30 kWh Capacity options
- 2 to 8 hour duration options
- 100% Depth of Discharge
- < 1% lifetime Degradation
- Performance Service Agreement
- Integrated EMS
- Zigbee Wireless Network
- Controller Integrated into NX Data & Communication Platform

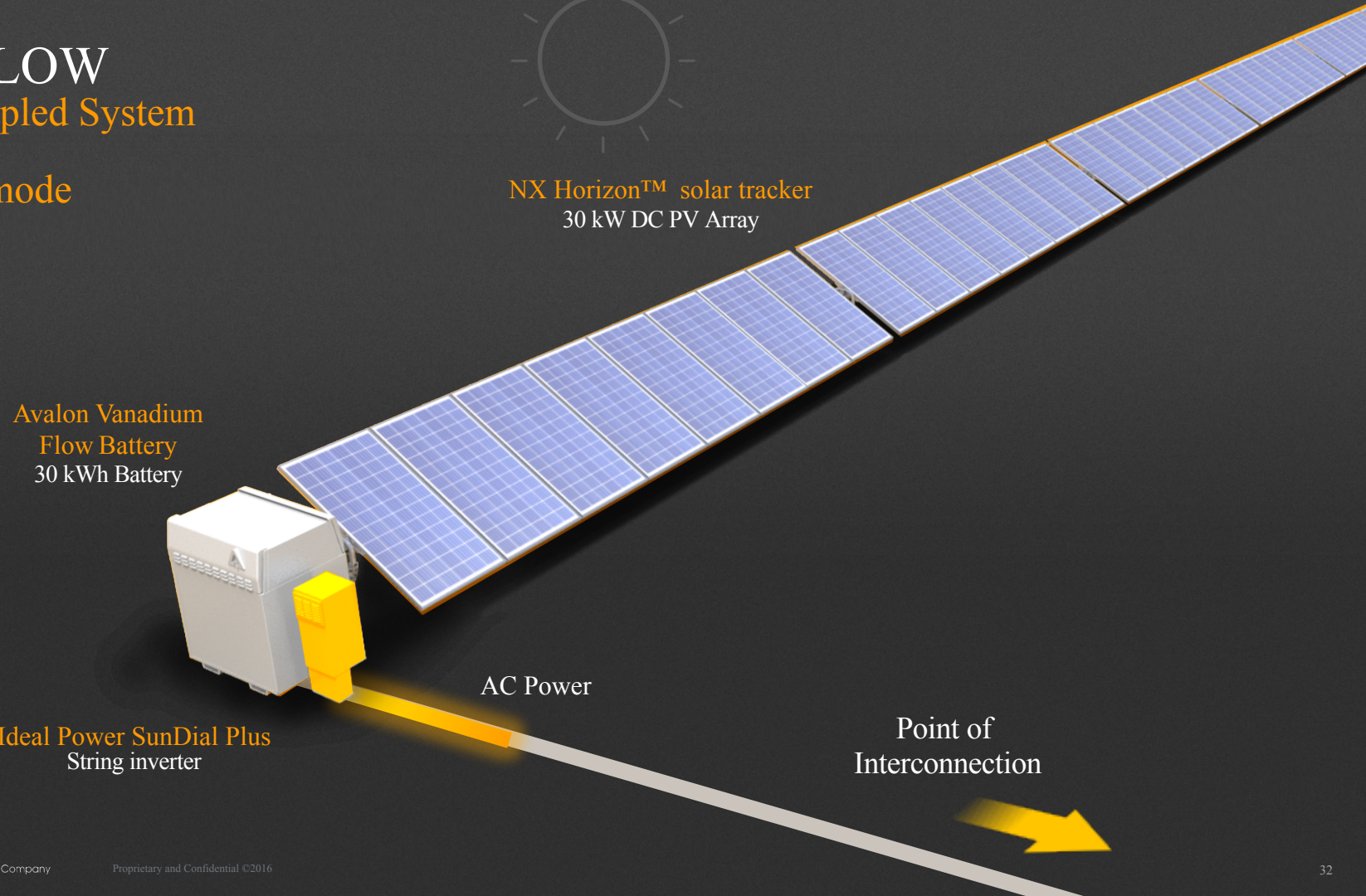
NEXTracker Machine Learning & Software Optimization
- Predictive analytics
- Digital O&M™ & remote diagnostics
- Automated commissioning
- Flex Connected Intelligence cyber secure platform (NERC CIP compliant)



IDEAL Power Storage-ready Inverter
- 30 kW Native Rating. Can be derated as low as 15 kW when delivery point AC rating is restricted.
- 3-port Design allows direct PV to Battery charging
- 1000v DC rating

NX FLOW
DC Coupled System

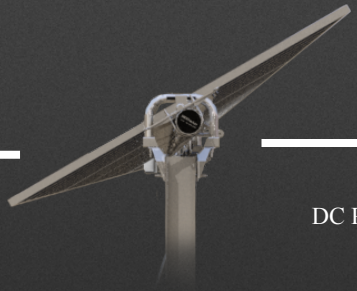
charge mode



NX FLOW PLUS - DC COUPLED SYSTEM

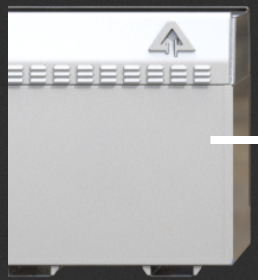
Only One Inverter Pass = Lower Inverter Loss

NX Horizon™ Solar Tracker
30 kW DC PV Array



DC Power

Avalon Vanadium Flow Battery
30 kWh Battery



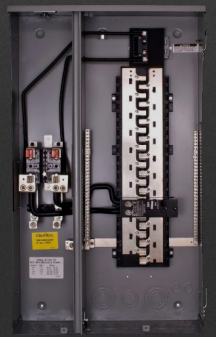
DC Power

Ideal Power SunDial Plus
String Inverter

Inverter Loss

AC Power

Point of Interconnection



NX FLOW USE CASE: PV + STORAGE LOAD SHIFTING

Increased PV Self-Consumption & Peak Demand Mgmt.

Project location: Bakersfield, CA

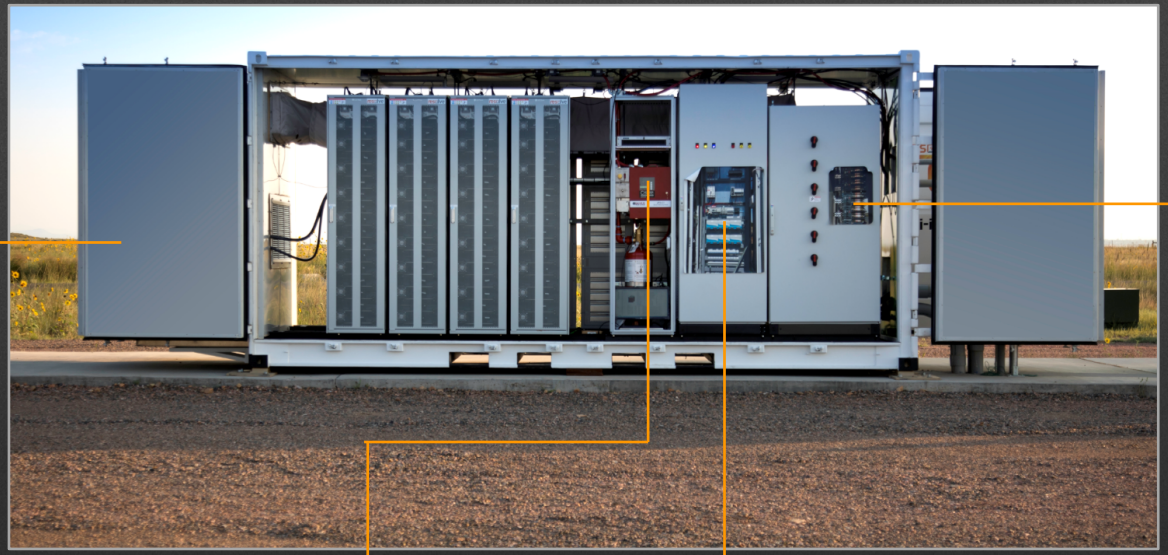
ESS capacity: 960kW/2.88MWh

NX Flow specs: (96) NX Flow 30kWh/10kW batteries.
(96) 30kW PV + ESS 3-pole Inverters

Application: DC Coupled- NX Flow charges from PV plant during off peak hours, and offsets customer's peak demand by up to 960 kW.

Benefit: System owner was able to shorten their payback from 6.2 years to 3.7 years by adding NX Flow system to a 4.5 MW NEXTracker PV array

NX DRIVE
Key components



Enclosure:
- Insulated
- Checker plate interior and floor
- Side bi-fold doors
- Purpose built with ISO HQ dimensions

Fire Detection and Suppression:
- Control panel
- Sensors
- Battery backup
- Horn
- Strobe
- Agent + storage container (NOVEC 1230)
- Discharge nozzles and piping
- NFPA 855 compliant

AC Panel:
- Aux transformer
- Aux load power distribution
- PLC/RTU
- Battery string CBs
- 3kVA UPS
- Power supply for DC aux loads

DC Panel:
- Fuses
- Disconnect
- Metering
- GFD
- Surge protection

NX DRIVE USE CASE: PV + STORAGE LOAD SHIFTING

Increased PV Self-Consumption & TOU Bill Mgmt.

Project location: Fresno, CA

Site capacity: 2MW/8MWh (C-rate: C/4)

NX Drive specs:

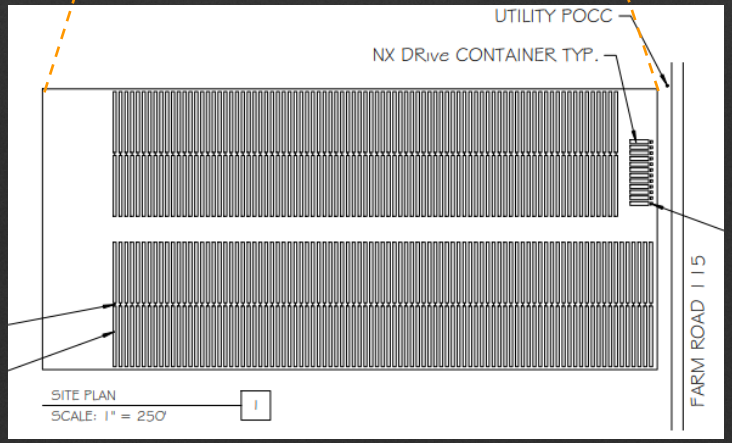
(2) NX Drive containers, 40’ long.
(60) LG battery racks
(2) 1MW AC Inverters
(2) 1000 kVA transformer

Application:

AC Coupled- NX Drive absorbs energy from PV plant during sun light hours, and offset customer's demand by up to 2 MW during peak demand periods.

Benefit:

System owner was able to shorten their payback from 6 years to 3.5 years by adding NX Drive system to an existing 5 MW NEXTracker PV array



NX DRIVE USE CASE: NREL 1 YEAR RUNNING

Project location: Boulder, Colorado- National Wind Technology Center @ NREL

Site capacity: 1MW/1MWh (1 C-rate)

NX Drive specs: (1) NX Drive enclosure, 20’ enclosure
(12) LG battery racks

Application: DC Coupled- NX Drive stores energy from wind turbines up to 1 MW. NREL is testing peak demand, and other test cases such as ESS for islanded and remote systems

Benefit: 3rd party reliability and bankability.

NEXTracker A Flex Company

NX DRIVE

Optimized Footprint

40’ Solution

20’ Solution

Q & A

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THANK YOU