

DOCKETED	
Docket Number:	18-IEPR-06
Project Title:	Integrating Renewable Energy
TN #:	223872
Document Title:	Flexible, Renewable, Curtailment-Proof Baseload
Description:	Presentation by Alex Au at the June 20, 2018 IEPR Workshop on Renewable Integration and Electric System Flexibility
Filer:	Stephanie Bailey
Organization:	NEXTracker and SepiSolar
Submitter Role:	Public
Submission Date:	6/19/2018 3:35:44 PM
Docketed Date:	6/19/2018

Flexible, Renewable, Curtailment-Proof Baseload

Presented by: Alex Au (CTO, NEXTracker)
Josh Weiner (CEO, SepiSolar)

June 20th, 2018

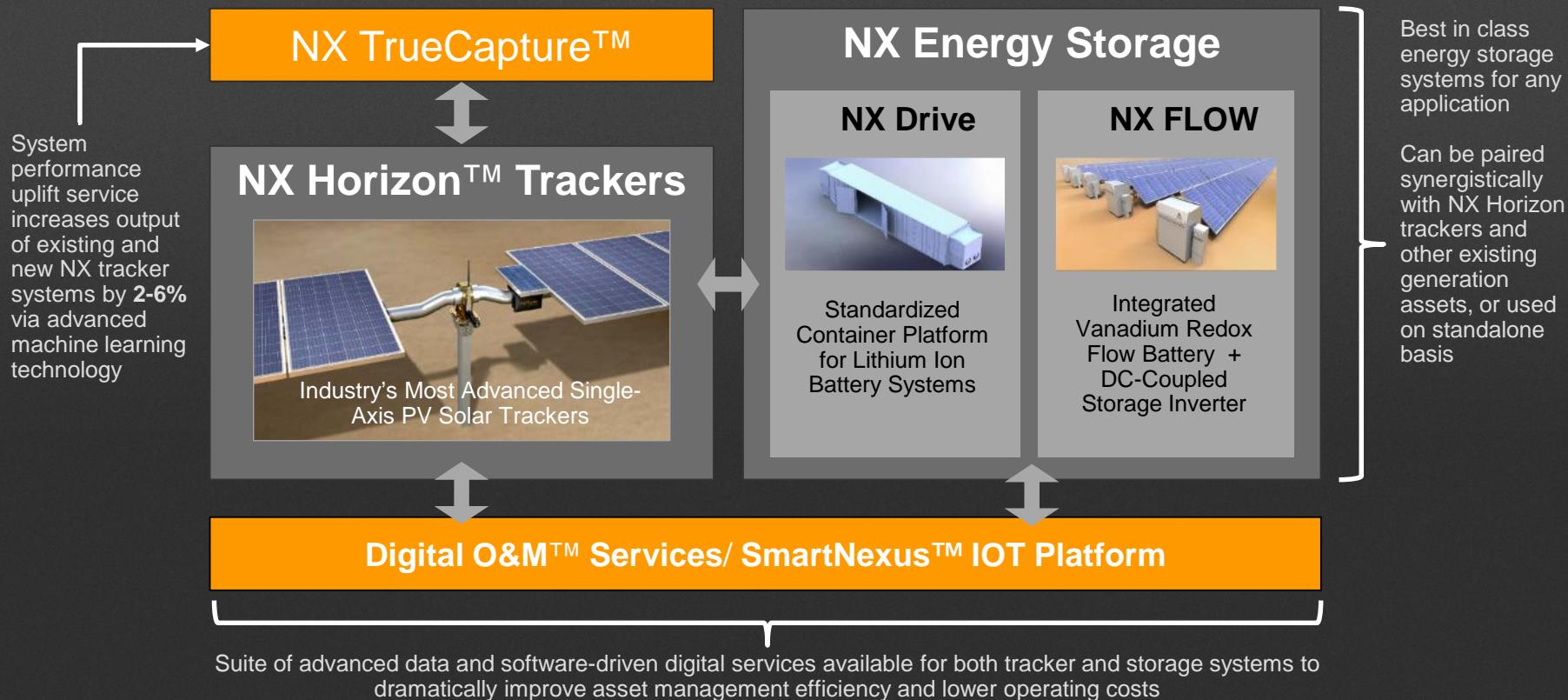
Curtailment Is A Problem That Has Already Been Solved

- Hawaii 100% renewables by 2045
 - April 2017: Curtailment levels on Oahu could conceivably reach 10%, while estimates for curtailment on Maui and Hawaii Island range from 20% to 50%. Energy storage is now a requirement.
- California
 - March 2017: the ISO observed solar curtailment exceeding 30 percent of the solar production for an hour.
- China
 - November 2017: Jilin, Heilongjiang and Inner Mongolia, all on China's northern border, also had double-digit abandonment rates, [NEA figures show](#). Nationwide, the average rate of curtailment was 12.2 percent in the last quarter, compared to 13.6 percent in the first half of the year.

NEXTracker Has Productized A Solution

- Renewable assets must be designed as a “Base Load” from the very beginning
 - Include 4 to 8 hour storage
 - DC-coupled with high DC-to-AC ratio using de-rated inverters
 - Software controls to integrate PV + Storage hardware to provide predictable power output regardless of seasonality and weather
- “It’s an interesting growing pain of our increasingly green grid,” said Shannon Eddy of the Large-Scale Solar Association. “We’re curtailing the cleanest and newest resource on the grid, and leaving alone the 2,000+ megawatts of mostly fossil imports and in-state gas.”

NEXTracker PRODUCT & SERVICE ECOSYSTEM



NX PV + STORAGE KEY USE CASES

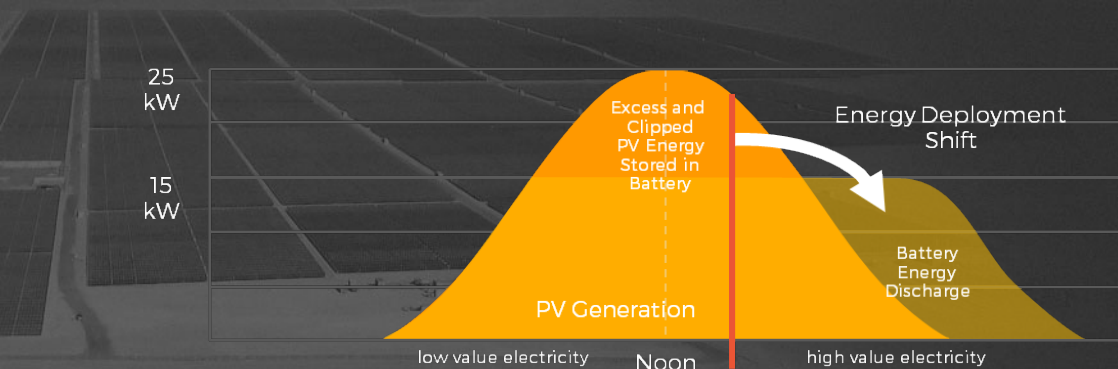
Peak demand
shaving

Electricity rate
arbitrage

Ancillary
services

Load shifting

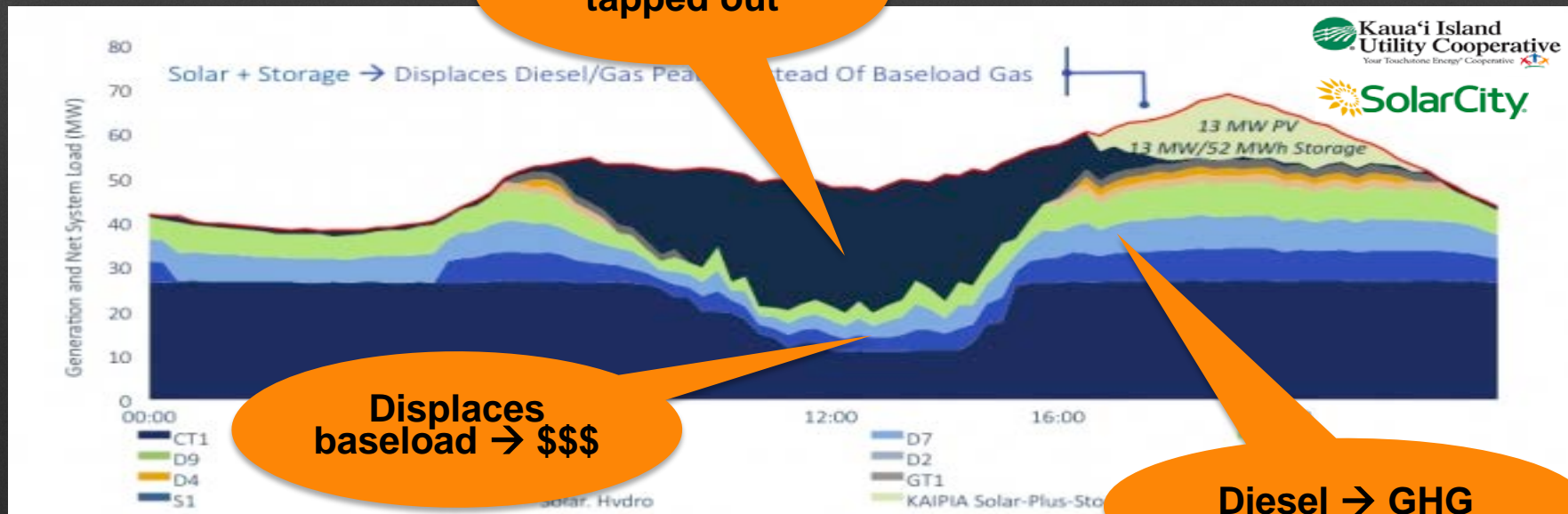
Demand
response services



Wins for everyone

- NEXTracker provides flexible, curtailment-proof solutions to get more solar/wind to the customer, less power impact to the grid, and NERC-CIP compliant, cyber-secure technology to the entire ecosystem.
- Win for customers
- Win for utilities
- Win for products and services industries

PV+storage as a System



Source: KIUC, GTM Research, NREL SAM, CT = Combustion Turbine, D=Diesel, GT = Gas Turbine, S=Solar

Both Lithium and Vanadium Solutions Leverage the same System Data Backbone

BrightBox knowledge, systems and tools support and enhance NEXTracker and Flex opportunities in energy and other industrial applications

Physical/Embedded Systems:

- Hardware
- Electronics
- Firmware

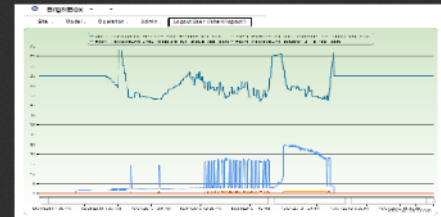


Data Science-Driven Software Applications:

- Adaptive Control
- Simulation
- Performance Optimization
- Intelligent Services

IoT Platform:

- Connectivity
- Data
- Security



Appendix

Curtailment

- Jilin, Heilongjiang and Inner Mongolia, all on China's northern border, also had double-digit abandonment rates, [NEA figures show](#).

Nationwide, the average rate of curtailment was 12.2 percent in the last quarter, compared to 13.6 percent in the first half of the year.

- On June 8, 2015, Hawaii became the first state in the nation to commit to converting its electric power supply to 100% renewable energy, with a deadline set for 2045. This goal challenges the state to tap its plentiful, natural, clean sources of power, while its utilities must build grids, interconnection infrastructure, and business models that will make these power sources accessible and affordable.
- It is expected that midday distributed solar generation in Hawaii will continue to increase, which may mean that a greater percentage of new grid-scale projects (including potential community solar projects) may likely face curtailment. Without some form of mitigation, we believe that curtailment levels on Oahu could conceivably reach 10%, while estimates for curtailment on Maui and Hawaii Island range from 20% to 50%.

Solution to Curtailment

- Curtailment is already happening.
 - Hawaii curtailment levels on Oahu could conceivably reach 10%, while estimates for curtailment on Maui and Hawaii Island range from 20% to 50%.
- These examples validate a need to have PV + Storage

Curtailment website

- Solar Industry April 2017
 - <https://issues.solarindustrymag.com/article/new-ppa-model-help-hawaii-address-solar-curtailment>
- GTM November 17, 2017
 - <https://www.greentechmedia.com/articles/read/china-faces-uphill-renewable-energy-curtailment-challenge#gs.tm8MWjg>

Curtailment (% of Total PV Power)

40%

Battery Round-Trip Efficiency

75%

Total PV Power 1000 kW

Curtailed PV Power 400 kW

Uncurtailed PV Power 600 kW

Energy Delivered (without battery) 6612 kWh

Energy Delivered (with battery) 8664 kWh

Increase in delivered energy 31%

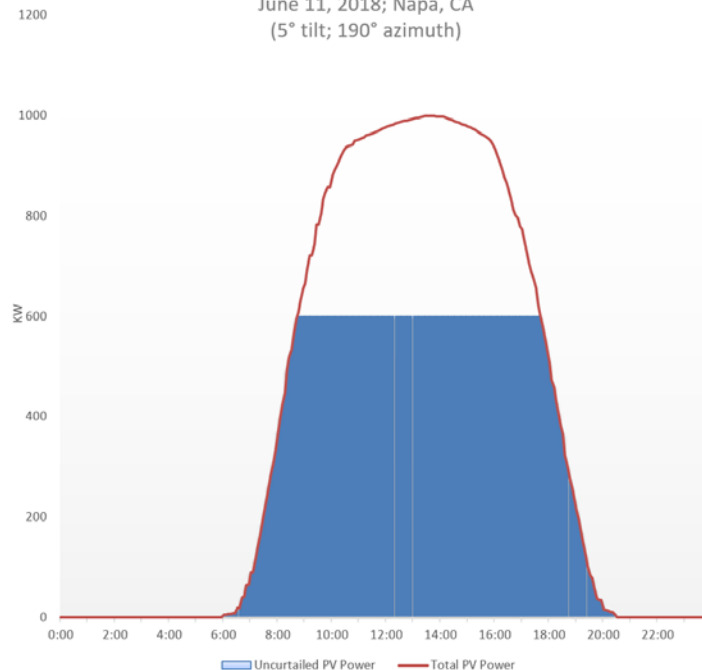
Battery Power 400 kW

Battery Energy 2,370 kWh

Battery Hour Rating 5.9 Hours

Actual PV Generation Profile

June 11, 2018; Napa, CA
(5° tilt; 190° azimuth)



% Curtailment	PV Size	Battery kW	Battery kWh	Battery Hour Rating
0	1000	0	0	0.0
10	1000	100	377	3.8
20	1000	200	956	4.8
30	1000	300	1626	5.4
40	1000	400	2370	5.9
50	1000	500	3178	6.4
60	1000	600	4039	6.7
70	1000	700	4955	7.1
80	1000	800	5929	7.4
90	1000	900	6964	7.7

ITC/NEM compliant DC coupled solution

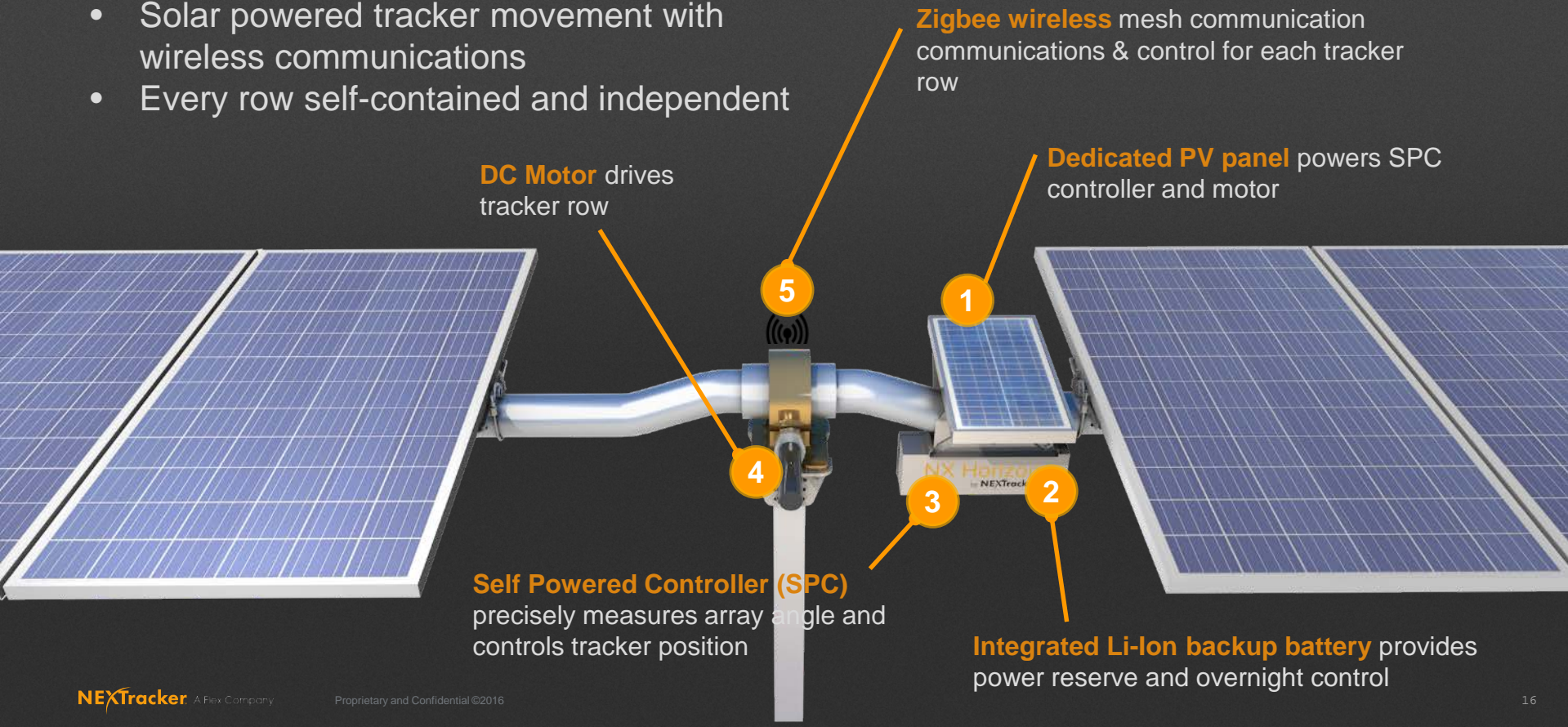
- Does not charge storage using grid electrons
- Test run by UL
 - Developed an approved

Derated inverter

- Smart inverter is another way of saying curtailment

NX HORIZON SELF POWERED TRACKER (SPT)

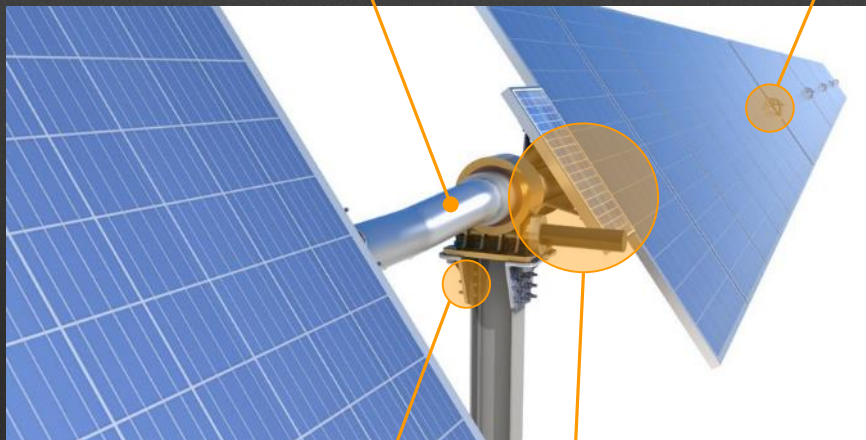
- Solar powered tracker movement with wireless communications
- Every row self-contained and independent



NX Horizon Highlights

2.5mm tubes for
interior rows

Improved BHA
attachment saddle



Update pier hole
pattern

2nd generation
controller & motor



Updated wind
stowing logic



Enhanced NCU
capability & security
(Apollo program)

INDUSTRY'S MOST ADVANCED WIND SHIELD

INTELLIGENT, REAL-TIME WIND DEFENSE STOWING

- Fast acting wind stow logic responds to on-site measured wind speeds
- Developed through extensive wind tunnel studies & testing with industry's leading wind researchers CPP

1. Perimeter weather stations measure real-time wind speed & direction



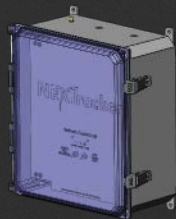
2. NCU onboard logic triggers stow command



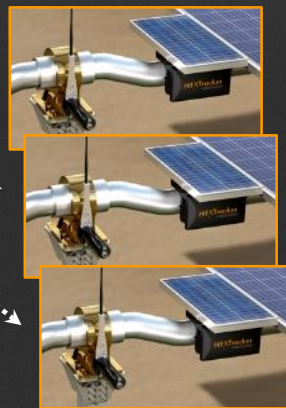
3. Command propagated to up to 100 trackers



4. Arrays move to Safety Stow Position



Zigbee wireless mesh communications

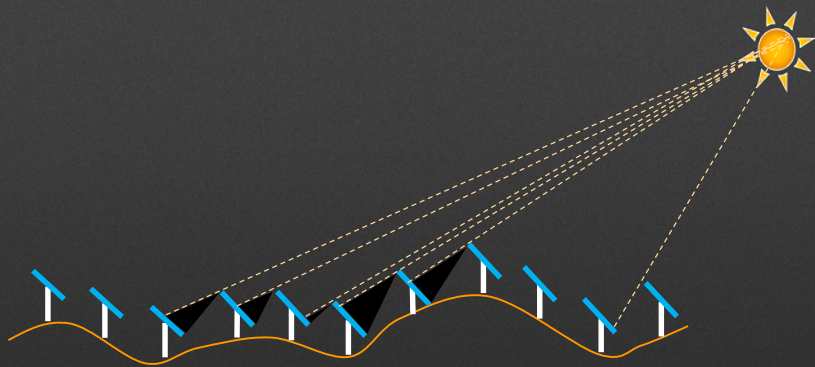


Onboard backup battery on each row ensures reliable stowing

- Always stows into the wind
- 30° stow angle for maximum row stability
- Stow time approx. 90 seconds

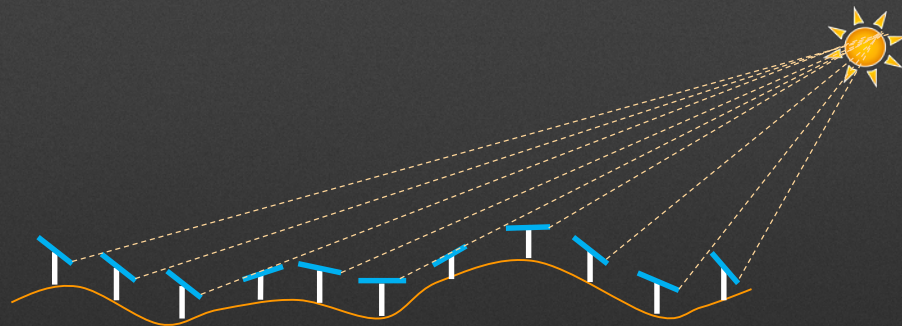


CAPTURE UP TO 6% MORE ENERGY



CHALLENGE:

The reality with most sites demonstrates that PV panels are shaded with industry standard “Backtracking” methodology



NX SOLUTION:

With NXYE, we minimize these energy losses and add value by optimizing performance up to 6% more across most site conditions

E ↔ W

TrueCapture Shade Avoidance Mode

Before: Standard tracking/ Backtracking

- Standard backtracking – each row follows same backtracking algorithm
- Assumes all rows are same height so does not fully correct for shading
- Entire array must be 'detuned' to a lower GCR to completely eliminate shading



After: TrueCapture Shade Avoidance Mode

- System self-learns row height differences using smart panel technology, then uses that data to adjust tracking of each individual row to eliminate shading
- System will re-learn periodically to continue enhancing performance



TrueCapture System Architecture

Cloud-Based Data Services

Weather Forecasts

Satellite-based weather data service with global coverage

Forecast accuracy continuously improved based on input from on-site weather station

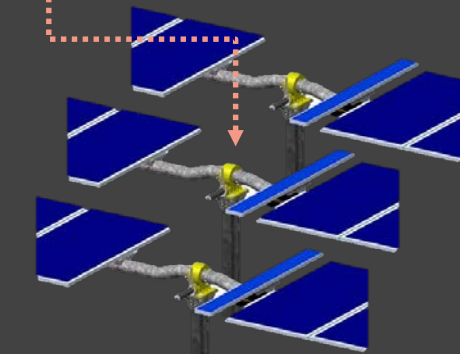
Customer Site

On-site computer used to aggregate data; communicates with trackers via NCU network

TrueCapture Control Module (Software)

Software 'brain' of TrueCapture control system, runs on NX SCADA device

NX SCADA



NX Independent Tracker Rows with SPCs & SMART PV PANELS

Measures diffuse light and sends data to weather service via NX SCADA

Local Weather Station(s)

Secure (NERC-CIP compliant) data pipeline using Flex Connect



NX/ Flex Data Center

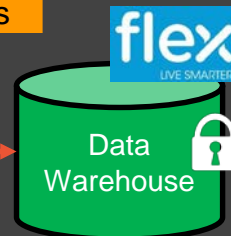
Machine-learning software; calculates optimal tracking algorithms

TrueCapture Engine

NX TrackerOps

Tracker monitoring software

Ensures TrueCapture results match expectations



Secure tracker data repository

INTRODUCING DIGITAL O&M™

Real-time and historical data analysis of key tracker features:

- Tracker angle
- Controller health and battery performance
- Motor performance
- Slew gear performance

Higher plant availability

Reduced truck rolls



Data Science Team (Cross Functional)

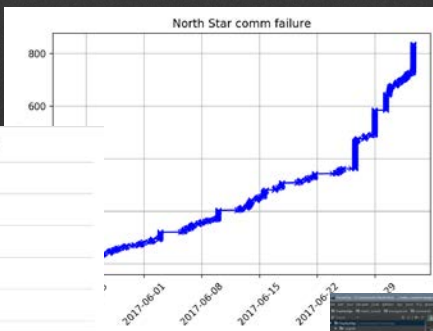
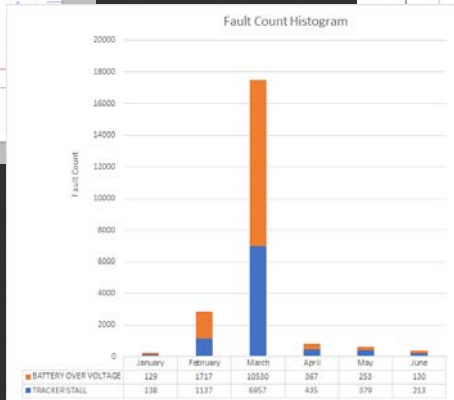
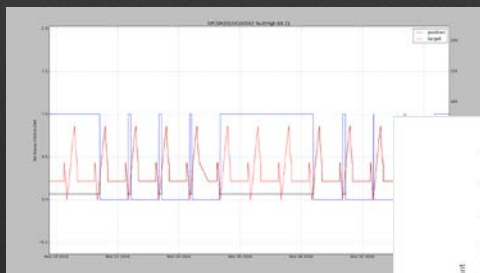
Analyze
available
Data

Determine
trends

Create a
signature

Algorithm to
search fleet

Create a
Work
Order

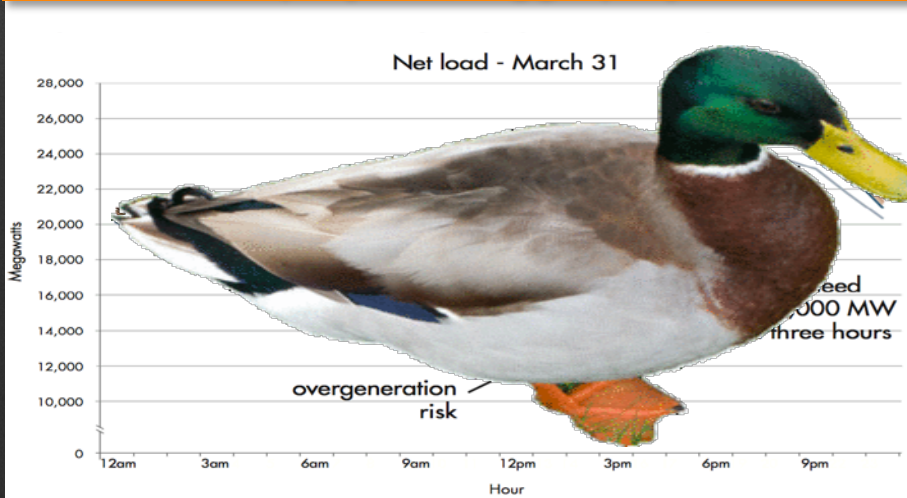


A screenshot of the NEXTracker Internal Portal. The page shows a 'Submit a ticket' form with fields for Priority, Requester, Location, Category, Subject, and Description. A note at the top states: 'Note: For all Business Systems inquiries and request including NetSuite, Salesforce, etc. and for requesting service, software, hardware, etc. please use the service catalog instead.' The form is currently empty.

Decapitate the Duck

We can take control of the dialogue

**Peak shave, load shift, asset deferral =
more projects, bigger projects**



- Words used to hurt the PV industry
- Duck Curve
- Baseload

NX FUSION PLUS

What is it?

Avalon VFB Battery

- 25 kWh Capacity
- 10 kW Peak Power
- Integrated BMS
- Zigbee Wireless Network
- Controller Integrated into NX Data & Communication Platform

Flex PV Modules (or other by request)

- 300 – 350 Mono
- NX Optimized Mounting Rails

NEXTracker Horizon

- 80 Panel Row
- Self-Powered Controllers
- Integrated UPS
- Motor & Tracker Controls
- Zigbee Wireless

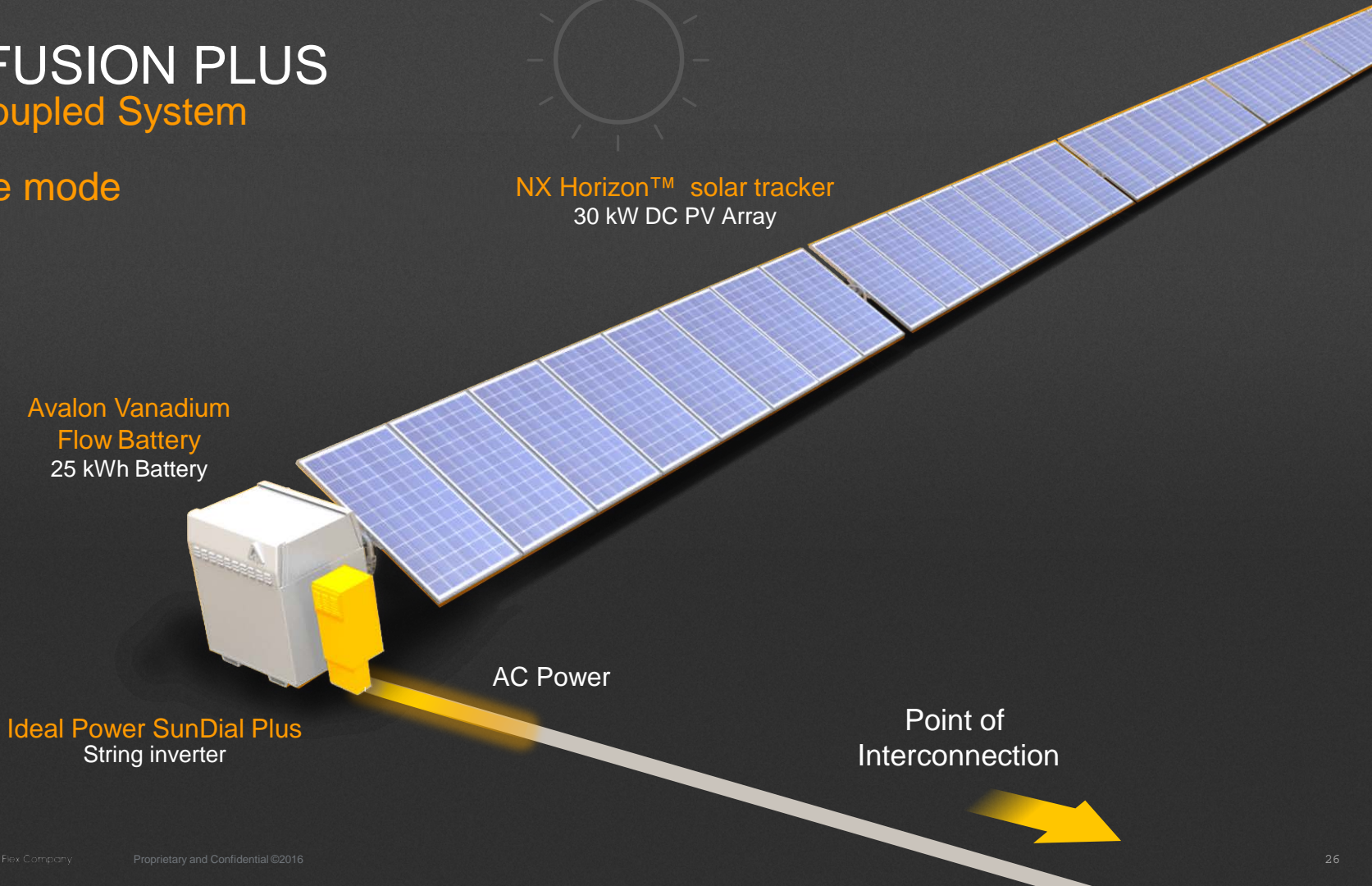
IDEAL Power Storage-Enabled Inverter

- 30 kW Rating
- 97.5% Peak Efficiency
- 3-port Design Including DC Battery Charge / Discharge
- Integrated EMS

NX FUSION PLUS

DC Coupled System

charge mode

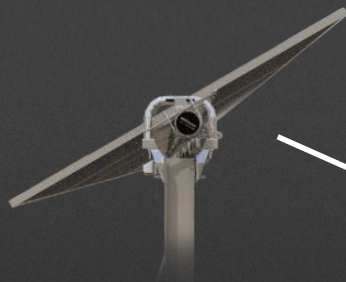


NX FUSION PLUS

“DC Coupled” Storage

NX Horizon
solar tracker

25 kW
DC
PV Array



Avalon VFB

25 kWh Battery



Bi-Directional

10 kW DC Max
Charge / Discharge
Capacity

- ITC based on renewable charging
 - 100% = 100% ITC
 - 75% = 0% ITC
- Higher IRR then just Storage alone



Ideal Power
SunDial Plus

3-Port Storage
Enabled String
Inverter

Uni-Directional
AC Power

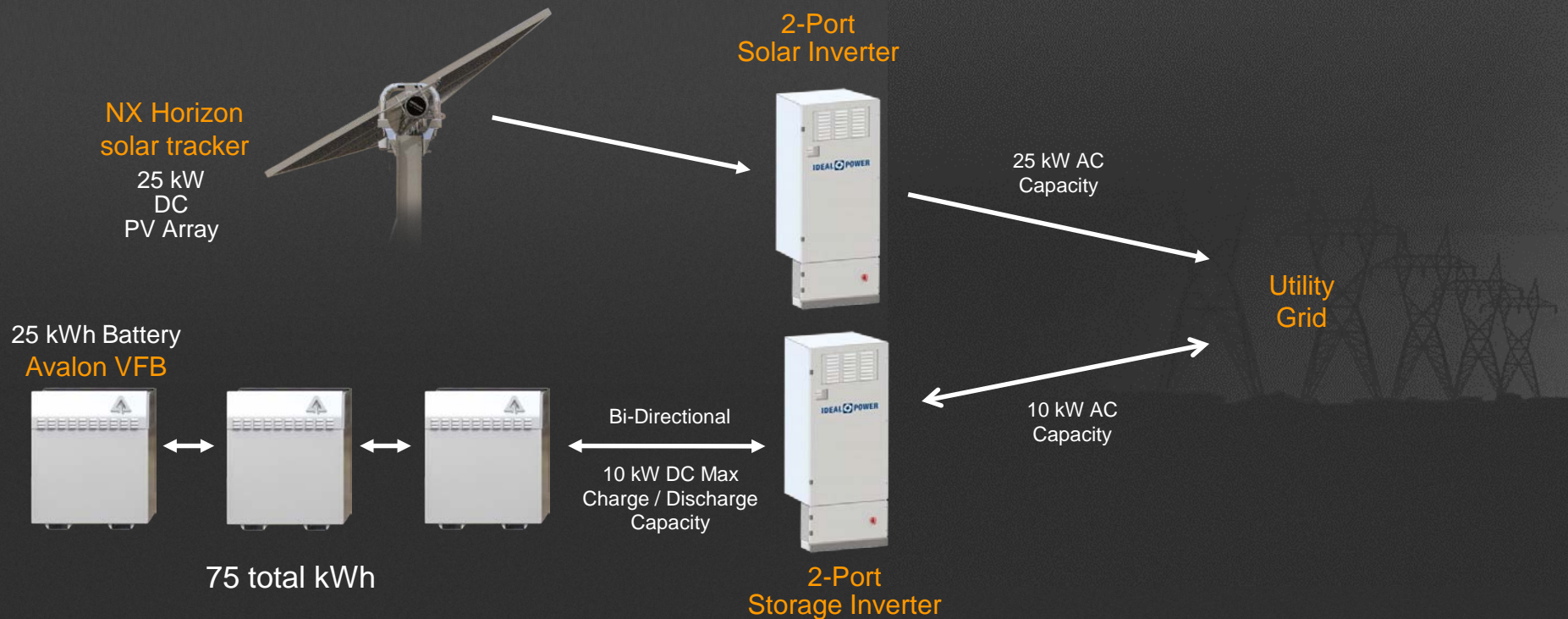
15 to 18 kW
AC Rated Capacity

Utility
Grid

NX FUSION PLUS

“AC Coupled” Storage

- Double the inverters
- Storage charged from grid cannot get ITC



Avalon Vanadium Flow Wins

- Avalon officially received CA Manufacturer status by SGIP, which gives +20% bonus rebate in CA
- Avalon V1 “test-to-failure” unit has 6-1/2 years of run-time with 0.1% per year measured degradation, confirmed by DNV GL

