Innovative Non-Invasive Load Control

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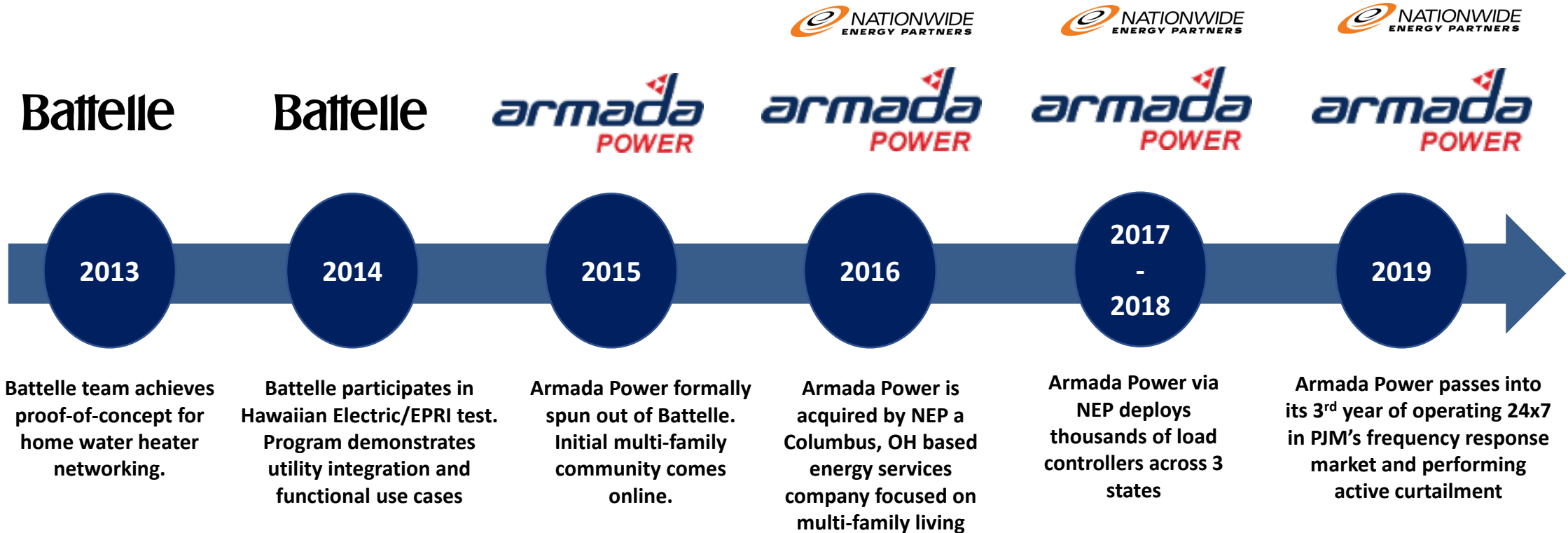**Presented at the 2019 ACEEE Hot Water Forum**

INTRODUCTION

Armada Power is a patented behind the meter solution that turns an electric water heater into an energy storage and grid balancing asset. Armada's unique technology intelligently aggregates micro loads to create a scalable, non-wires alternative enabling non-invasive demand response, frequency management, voltage control and circuit relief solutions.

We turn an electric water heater into a low cost storage device with no impact on comfort

EVOLUTION OF ARMADA POWER

2013	2014	2015	2016	2017 - 2018	2019
Battelle team achieves proof-of-concept for home water heater networking.	Battelle participates in Hawaiian Electric/EPRI test. Program demonstrates utility integration and functional use cases	Armada Power formally spun out of Battelle. Initial multi-family community comes online.	Armada Power is acquired by NEP a Columbus, OH based energy services company focused on multi-family living	Armada Power via NEP deploys thousands of load controllers across 3 states	Armada Power passes into its 3rd year of operating 24x7 in PJM's frequency response market and performing active curtailment

# ARMADA SOLUTION STACK

Hardware

LCS 2100 load controller

Two-way, real-time communications & control device

Available in wifi mesh or cellular communications configurations

UL certified, 20 year tested life

Monitoring temperatures, state of charge, tank status, LCS status, etc.

Onboard metering & computing chipset allows remote updating & hands-off operations

Can be installed as a retro fit to existing water heater or fully integrated into new water heater

Tank is not pierced or disrupted. Tank UL certification remains intact. Installation routes power supply through LCS & takes about 30 mins
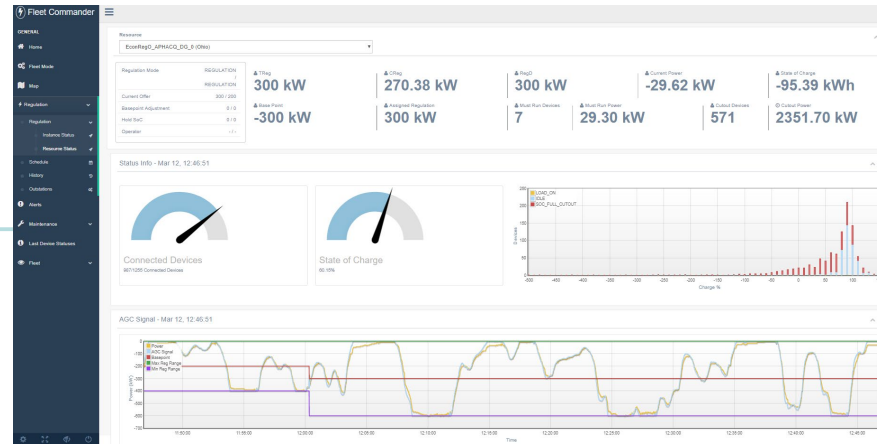
Software

Patented AI based fleet control, decisioning & alerting

Cloud-based (AWS) software

Monitoring temperatures, state of charge, tank status, LCS status, etc.

Supports multiple hierarchies: fleet level, across zones, down to individual units

Web portal control & dashboard interface

Managing real-time, two-way communications with LCS devices

Scalable to millions of LCS devices

SCADA Integration

SCADA system agnostic

Full integration with PJM real-time market SCADA system

Requires 30ms response times

Two-way delivery of data (market signals down, meter data up)

Currently supporting 150 different signaling & control scenarios

4

ARMADA APPLICATIONS

	Multi-Family (MDU)	Utility (IOU, Co-op)	Commercial & Industrial
Solutions	Electric water heater fleet management • Intelligent load control via hardware/software mix • Non-invasive resident experience • Generates net income and operational efficiencies Smart Apartment Solution • Fleet control and monetization of IoT devices • Data and telemetry for operations and maintenance actions	Advanced demand response (Non-invasive) T&D system enhancer • Local feeder congestion relief • Real time load analysis for circuit reconfig • Automated voltage deviation response • End of line voltage measurement • Restoration load prioritization • Primary frequency balancing • Renewables firming • Microgrid load control and stability support	VFD management and monetization • End use case requires the load to be interruptible VFD Failure detection • Identification of power fluctuations indicating degradation of VFD Non-VFD processes • possibility of providing capital for VFD via ABB partnership
Target/GTM	Target: Property owners and managers GTM: Armada sells direct	Target: IOUs/Co-ops GTM: Armada sells via channel partners	Target: Applications with stored energy such as water treatment, waster water facilities, variety of industrial pumps, refrigeration compressors GTM: Armada sells via channel partners
Monetization	1. Energy market participation 2. Demand cost reduction 3. Operational cost reduction 4. Predictive maintenance 5. Carbon benefits	1. Regulatory programs (EE, DR, Grid mod) 2. Cost reduction (deferred circuit upgrades) 3. System efficiency gains 4. Carbon benefits 5. MDU acquisition programs	1. Energy market participation 2. Demand cost reduction 3. Predictive maintenance 4. Carbon benefits

ARMADA RESULTS TO DATE

- ✓ 5,256,000 MwH of frequency regulation provided in market

- ✓ 96% Reg D performance score believed to be the highest in PJM

- ✓ 10 Mw of local curtailment performed

- ✓ 8 outage restoration assistance events

- ✓ 750m water heater data points collected

- ✓ 150+ maintenance issues identified and solved

- ✓ 11 patents granted, 3 pending

- ✓ 4,000 tons of carbon offset

- ✓ 0 cold shower complaints in 2 years of operation

15 min interval meter reads from an Armada community during CLP event

Time	Actual Demand	Armada Shave	Possible Demand
13:45	0	0	0
14:00	0	0	0
14:15	0	0	0
14:30	1310	675	1985
14:45	1540	675	2215
15:00	1744	675	2419
15:15	1937	675	2612
15:30	2191	675	2866
15:45	2527	675	3202
16:00	2483	675	3158
16:15	2410	675	3085
16:30	2151	675	2826
16:45	1996	475	2471
17:00	2060	175	2235
17:15	1803	0	1803
17:30	1619	0	1619
17:45	1531	0	1531

- Armada sees restoration, reduces load immediately
- Community Ramping
- Community sets Peak
- Armada can see Peak
- Armada waits to get under Peak
- Armada puts water heaters back in

ARMADA LESSONS

1. Monetizing loads is difficult. Solutions have to be inexpensive, accurate, and flexible.

2. You can run residential curtailment events that don't impact comfort and you can drive program subscription levels by doing so.

3. The splint incentive can be solved, multi-family residents can be brought into the energy solution fold.

4. Markets can be difficult to work with, let someone with experience help.

5. Make installation super easy. Don't pierce the tank.

6. Be accurate. Constantly measure, don't guess.

7. Think broadly about the next generation of load control.

Armada Resident App
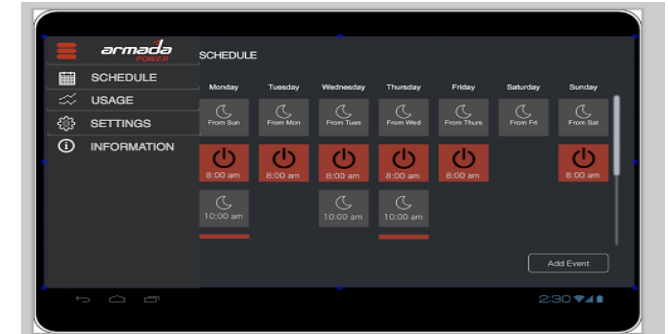
Armada Commercial Portal

Thank You

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PRESIDENT

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