Vehicle-Grid Integration with PI System Infrastructure

Presented by Val Miftakhov

eMotorWerks
SMART [GRID] EV CHARGING

VS.

10M EVs in the US by 2025

=

Up to 100 GW additional demand

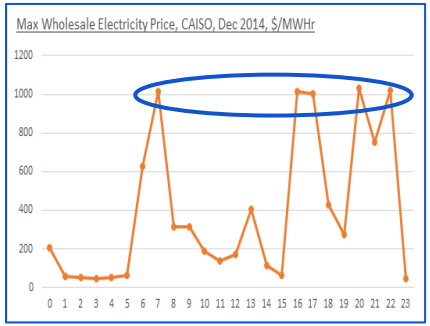
15%+ of the total US load!

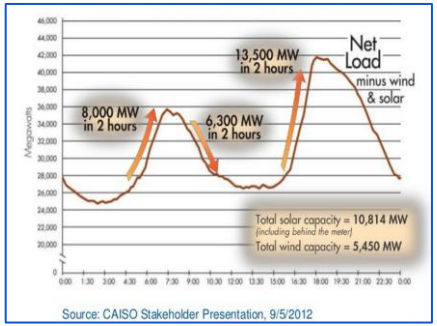
JuiceBox: Smart[Grid] EV Charging Platform

Today's Challenges

ISOs & Utilities

- High peak energy costs
- Costly capacity upgrades
- Volatility of renewables, DG & EVs





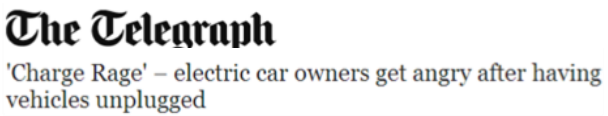
EV Owners

- High hardware cost
- "Dumb" boxes
- Insufficient coverage

$899
HCS-60, 48 amp


THE AUSTRALIAN DIGITAL SUBSCRIPTION $1 for the first 28 days* LEARN MORE

Electric cars spark 'charge rage' as Silicon Valley workers go flat


The Telegraph

'Charge Rage' – electric car owners get angry after having vehicles unplugged

Radically New Model

PDR

A/S

DR

$

$

$

JuiceBox: No Cost to End User,
Supported by Grid Services

JuiceBox Advantage

Unique Grid Value

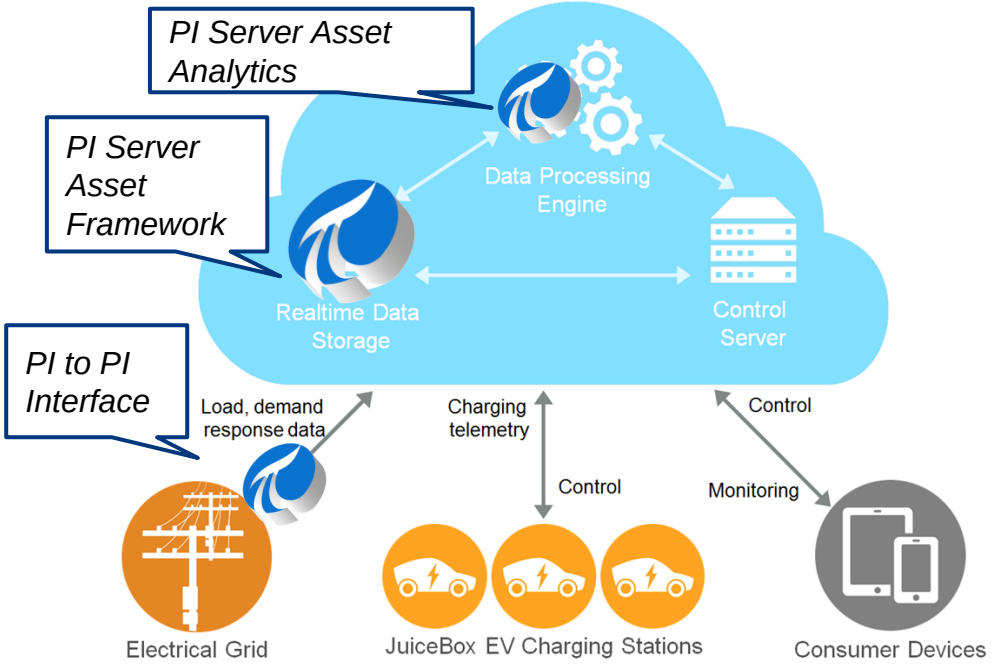
- Reduce energy costs
- Defer costly upgrades
- Balance supply & demand

Outstanding User Value

- Near-free hardware
- Higher performance
- Best features

Value of Grid Services = 10x the Cost

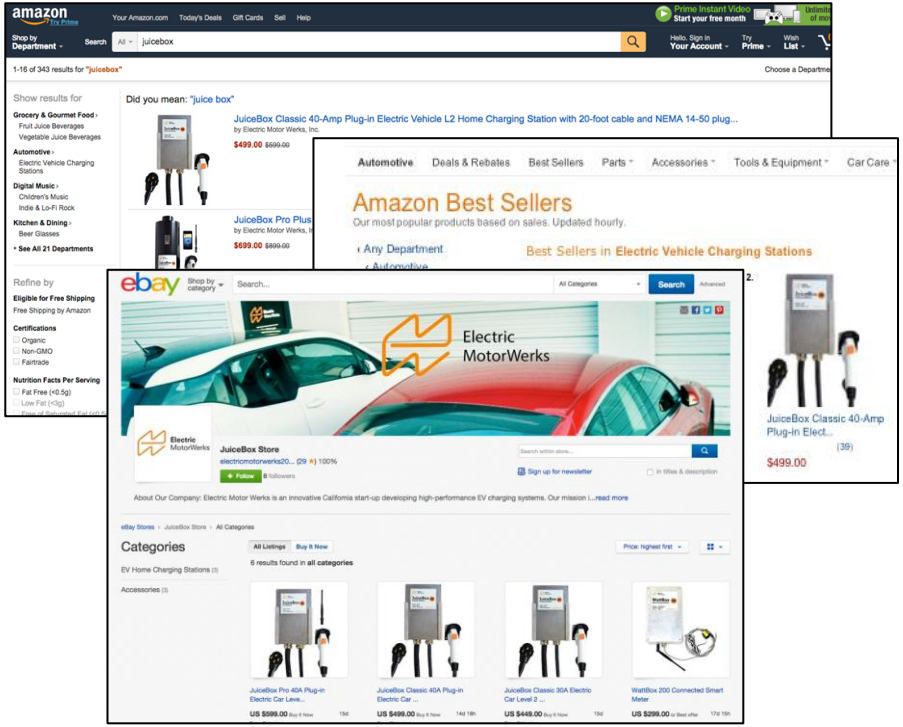
JuiceBox PI-Enabled Platform



- Best-in-class Smart[Grid] EV hardware
- Best-in-class UX & design
- Cloud-based load management
- Cloud-based energy market engine

Real Product, Grid-ready Now

- **Over 3,000 units deployed**
- Smart[Grid] **ready**
  - Precise charge rate control
  - 3-second control latency
  - Instant local grid response
  - High-speed data collection
  - Nest-like control API



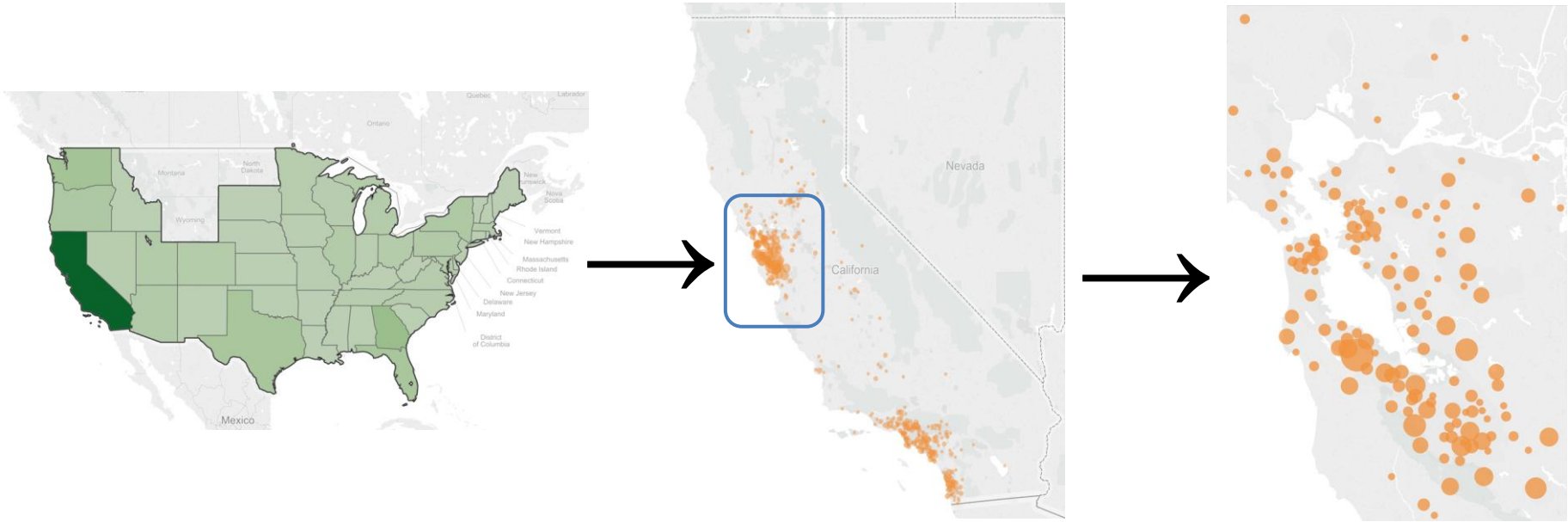
JuiceBox: Data Acquisition Engine

Every JuiceBox is a high-speed, grid-connected data acquisition device. Distributed, precise, and exposed to the outdoor environment.

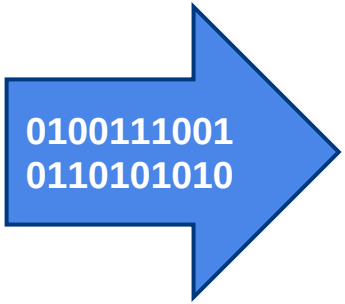
	Description	Potential uses
Environmental Data	Temperature, baro-pressure, altitude (via GPS), precise lon/lat (via GPS), light intensity	• Home weather station (display via SmartPhone) • 100-foot data grid for weather modeling • Second-by-second solar generation prediction • Fire detection
Grid Data	Voltage, Frequency, Voltage phase offsets across distribution grid	• Instant detection of local over-generation / overload • Submetering loads • Health monitoring for distribution grid
EV data	EV make & model, Plugged state, instantaneous active / reactive power, Energy Consumption, SoC / Miles Driven, EV charger power quality	• Home occupancy detection • Local grid capacity planning • Health monitoring for EV subsystems (charger, battery)

First traction: 1,000+ unit submetering deal with 3 utilities in California

JuiceBox: National Coverage



JuiceBox Tags and AF Elements Tree

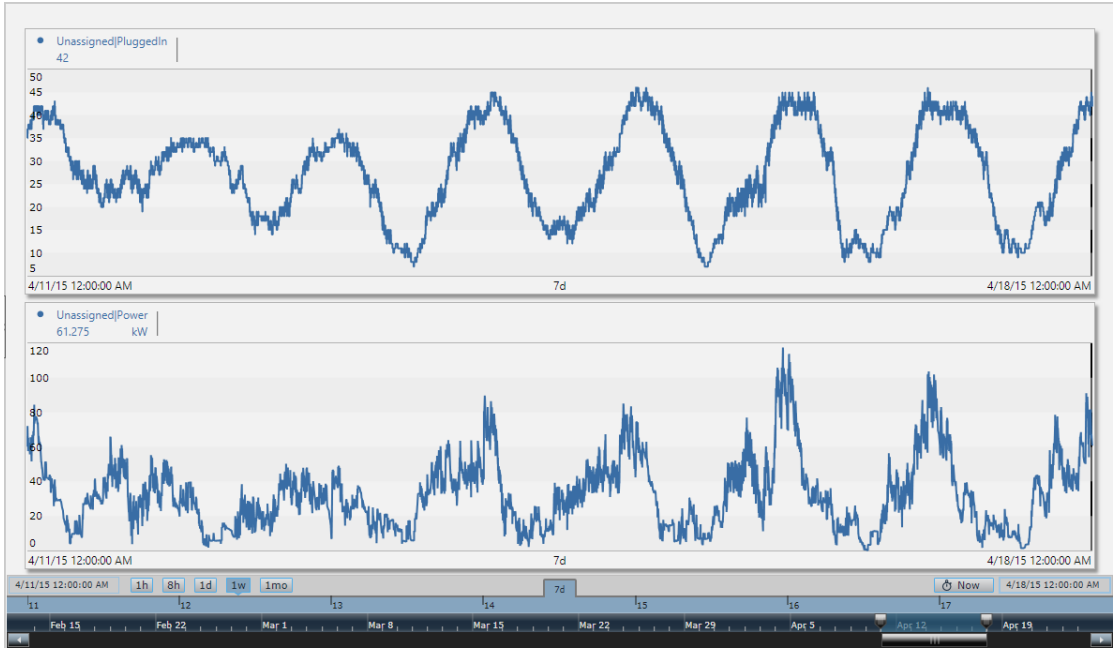


Initially, 8 data tags per JuiceBox, loaded using PI Web API, called from the UDP JuiceBox Listener:

- Charging State
- Amperage
- Voltage
- Power
- Power Factor
- Frequency
- Temperature
- Charging session energy

In PI Server AF elements tree, elements are organized per SLAP where they belong. JuiceBox element path template: **\\server\database\utility\slap\unitid**

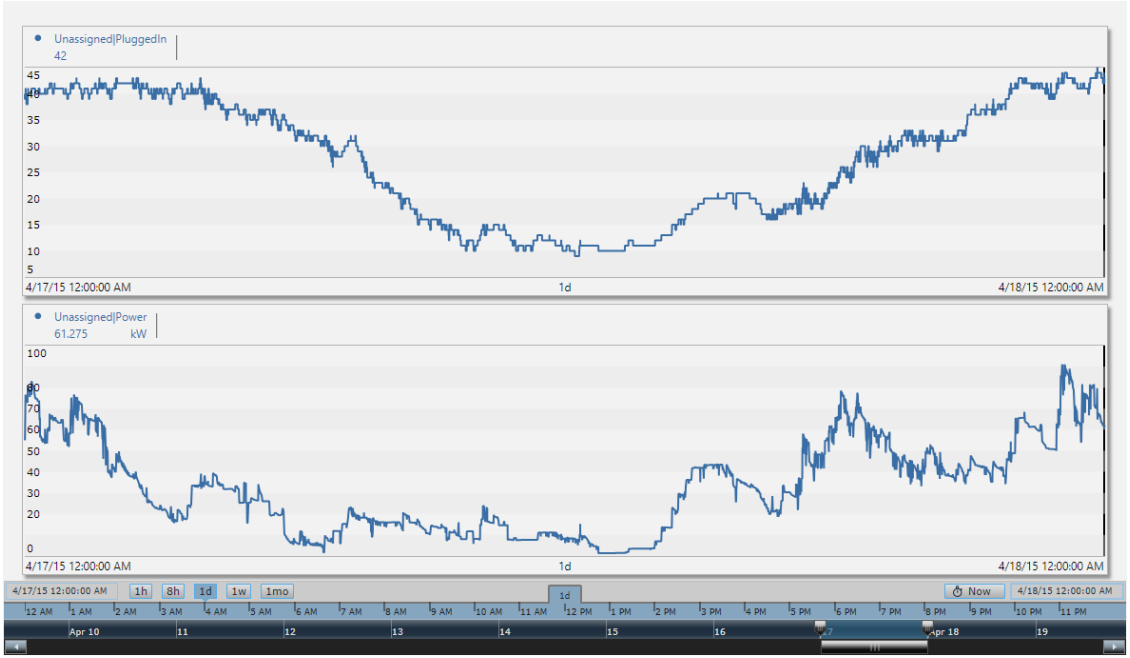
JuiceBox Aggregation, 7-Day View



Sat Apr 11 – Sat Apr 18, 2015

- Top chart: plug-in status
  - Of ~80 total units, highest # of plugged-in units is 50, lowest – 5
  - Flatter during weekends
- Double-peak pattern during weeknights – when people come home and then after midnight

JuiceBox Aggregation, 1-Day View

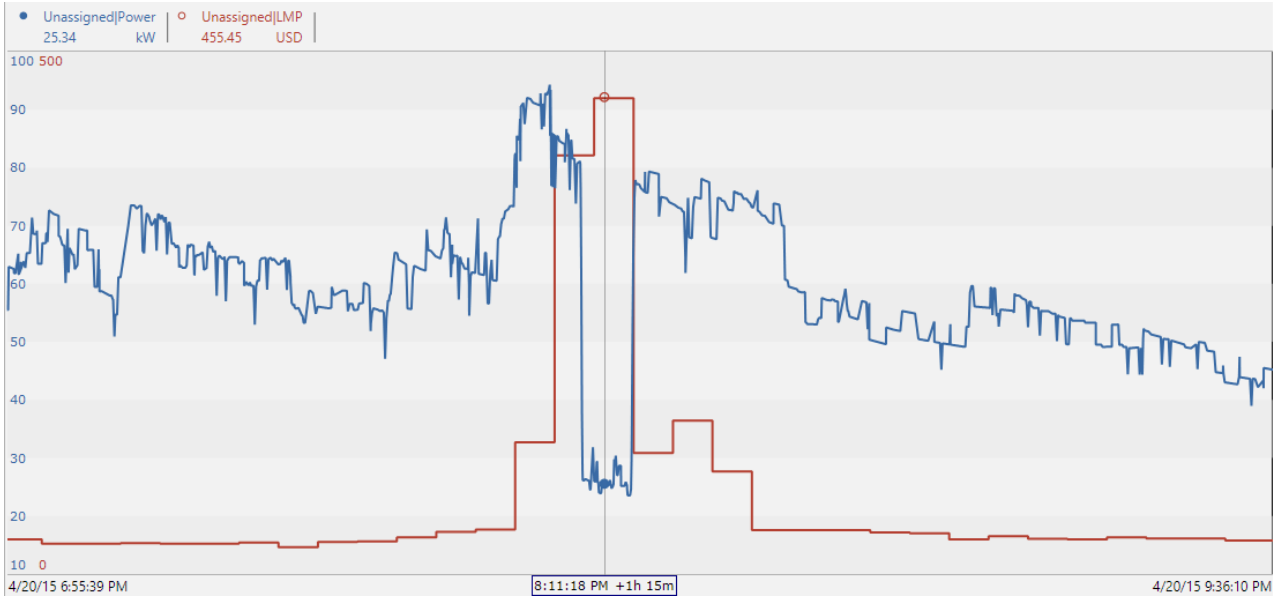


Sunday April 19, 2015

- Top chart: plug-in status
  - Of ~80 total units, highest # of plugged-in units is 50, lowest – 15
  - Strong ramp around 8pm
- Peak power ~100kW, right after 11pm start of off-peak time, with secondary peak when people come home
- By 2am, most cars are charged

JuiceBox Grid Control Example

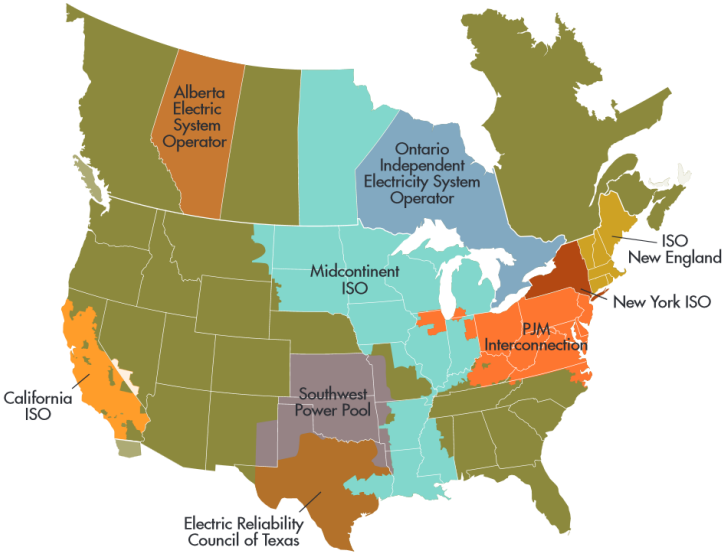
JuiceBox power consumption and locational marginal pricing at SLAP_PGP2



PDR load reduction event

- A 10-minute event @8:10 pm April 20, 2015 when LMP was ~$460 / MWH
- 70 kW reduction from 80 units (21 charging at the time)
- Consistent with $100-$150 / unit / year revenue expectation from PDR alone

PDR Alone = $5B Market Today



Total costs of energy = **$87B**

Costs attributable to price spikes = **$5B**

Multiple Grid Services

	Market mechanism	How we extract value	2020 Market Size
 ISOs	Proxy Demand Response	Reduce charging load when prices peak	$5-7B
	Ancillary Services	Rapidly match power supply & demand	$2-3B
 Utilities	Demand Response	Reduce load per signals from utilities	$3B
	Local Load Balancing	Manage load profile in local distribution	
 End customers	Demand Charges	Reduce building's peak power charges	$10B+
	Upfront Hardware Cost	EV charging equipment acquisition	$2B

Ready To Scale with the PI System

- **3,000+ JuiceBox in use, stable platform** (V12)
- **Great grid model unit economics** → Charging infrastructure with a solid ROI
- **High-profile deployments** with key energy players

Call to Action

1. **How can your Utility, ISO, or RTO turn EVs from Challenge into Opportunity?**

2. **How can your Electric Vehicle OEM provide reduce the costs of charging equipment & infrastructure for its drivers?**

3. **How can we help you make this happen [with the PI System]?**

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Questions

Please wait for the microphone before asking your questions

State your
name & company

THANK YOU