

**DRIVING THE FUTURE OF SUSTAINABLE
MOBILITY.**



BMW GROUP IN THE U.S.

ECONOMIC IMPACT.

- The **annual economic impact** of the BMW Group in the U.S. totals approximately \$43.3 billion.
- 70% of the vehicles produced in the U.S. are **exported to 140 countries worldwide**. This makes BMW Manufacturing Co. the **largest vehicle exporter in America by value**.

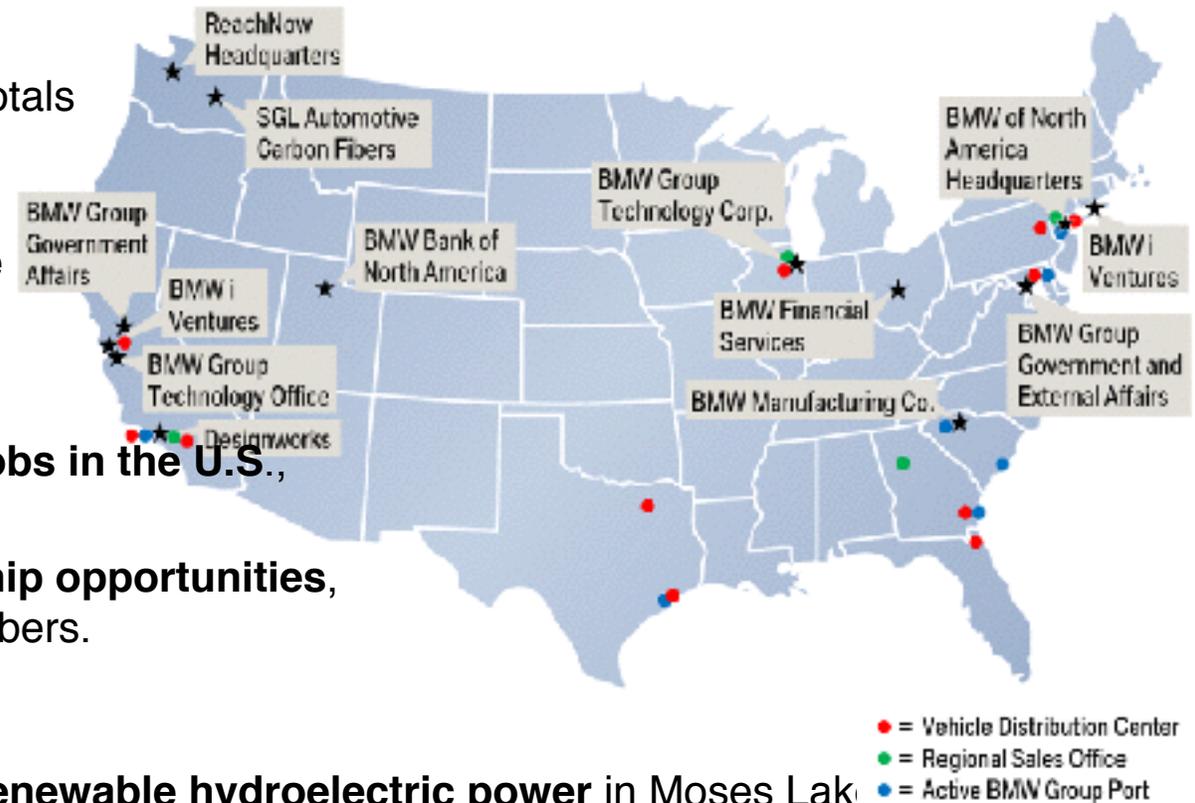
COMMUNITY INVESTMENT.

- The BMW Group provides and **supports more than 120,000 jobs in the U.S.**, including manufacturing, dealer network, and suppliers.
- We have a long tradition of creating **training and apprenticeship opportunities**, including programs geared towards returning U.S. service members.

SUSTAINABLE GROWTH.

- Carbon fiber used by the BMW Group is produced with **100% renewable hydroelectric power** in Moses Lake.
- The four major buildings that comprise our headquarters in Woodcliff Lake, New Jersey are powered by up to **30% renewable solar panel energy**.

Sources: U.S. Department of Commerce; University of South Carolina Moore School of Business Study, June 2017



BMW GROUP TECHNOLOGY OFFICE USA. FOCUS AREAS.

SUSTAINABILITY

FUTURE MOBILITY CONCEPTS	BATTERY TECHNOLOGY
POWERTRAIN	SMART HOME
SMART GRID	RENEWABLE ENERGY
BATTERY 2ND LIFE	SMART CHARGING



DIGITALIZATION

CONNECTED CAR	APP CENTER
SENSORS	ADVANCED DRIVER ASSISTANCE SYSTEMS
BIG DATA AND MACHINE LEARNING	HIGHLY AUTOMATED DRIVING
USER EXPERIENCE	INTERNET OF THINGS



THE NEXT 100 YEARS

BMW
GROUP



THE BMW GROUP: FROM TRADITIONAL CAR PRODUCER TO FUTURE MOBILITY PROVIDER.

Premium car producer.

Providing solutions for mobility.

Develop, produce, and sell automobiles.

Develop and distribute mobility services.



Rolls-Royce
Motor Cars Limited

BMW Motorrad

ChargeNow

DriveNow

ParkNow

ReachNow

CONVERGENCE OF MULTIPLE TRENDS IN THE AUTOMOTIVE INDUSTRY THAT HAVE THE POTENTIAL TO DRAMATICALLY CHANGE MOBILITY.

Automated



- Smooth traffic flow
- Reduce accidents
- Increase safety
- Increase productivity

Connected



- Optimize eco-routing
- Encourage multimodality
- Early warning
- Improved safety features

Electrified



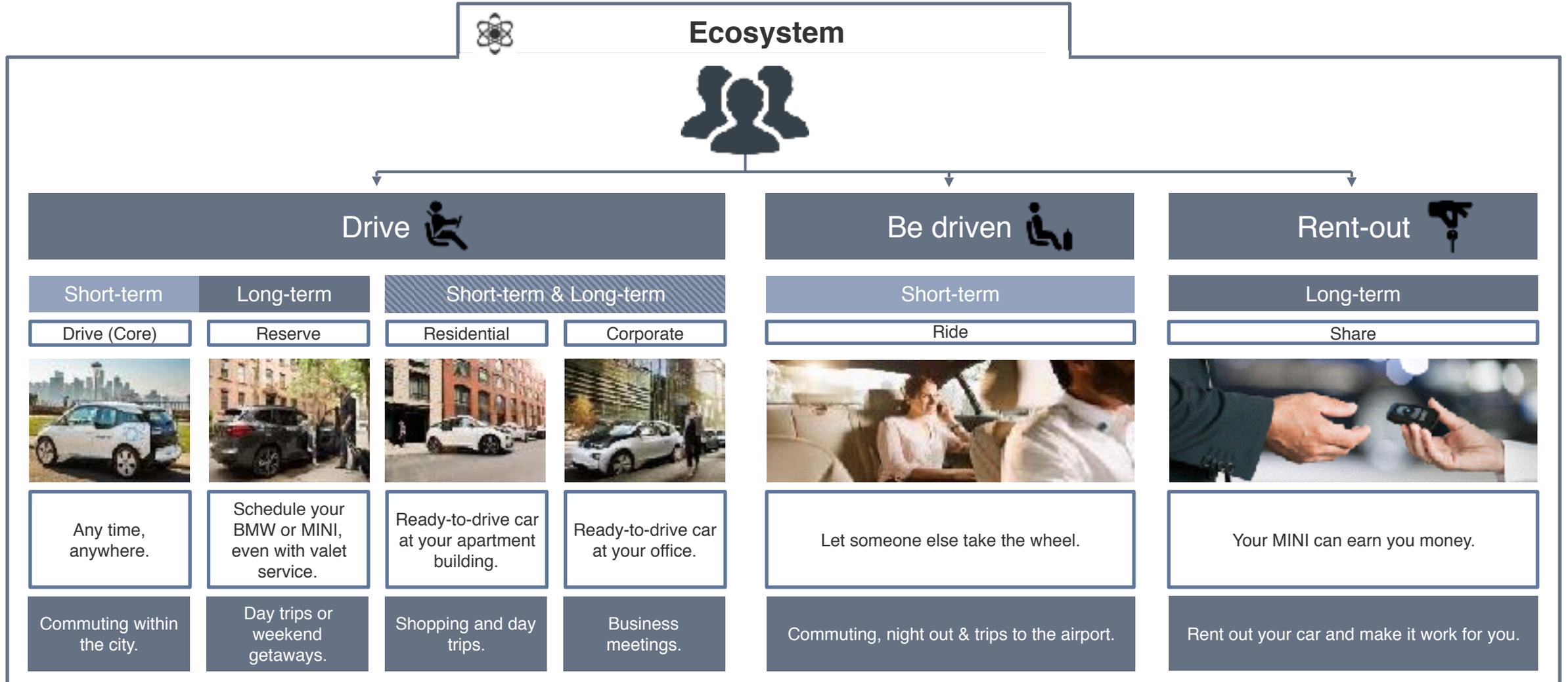
- Zero tailpipe emissions
- Increase energy efficiency
- Reduce sound
- Leverage renewable energy

Shared

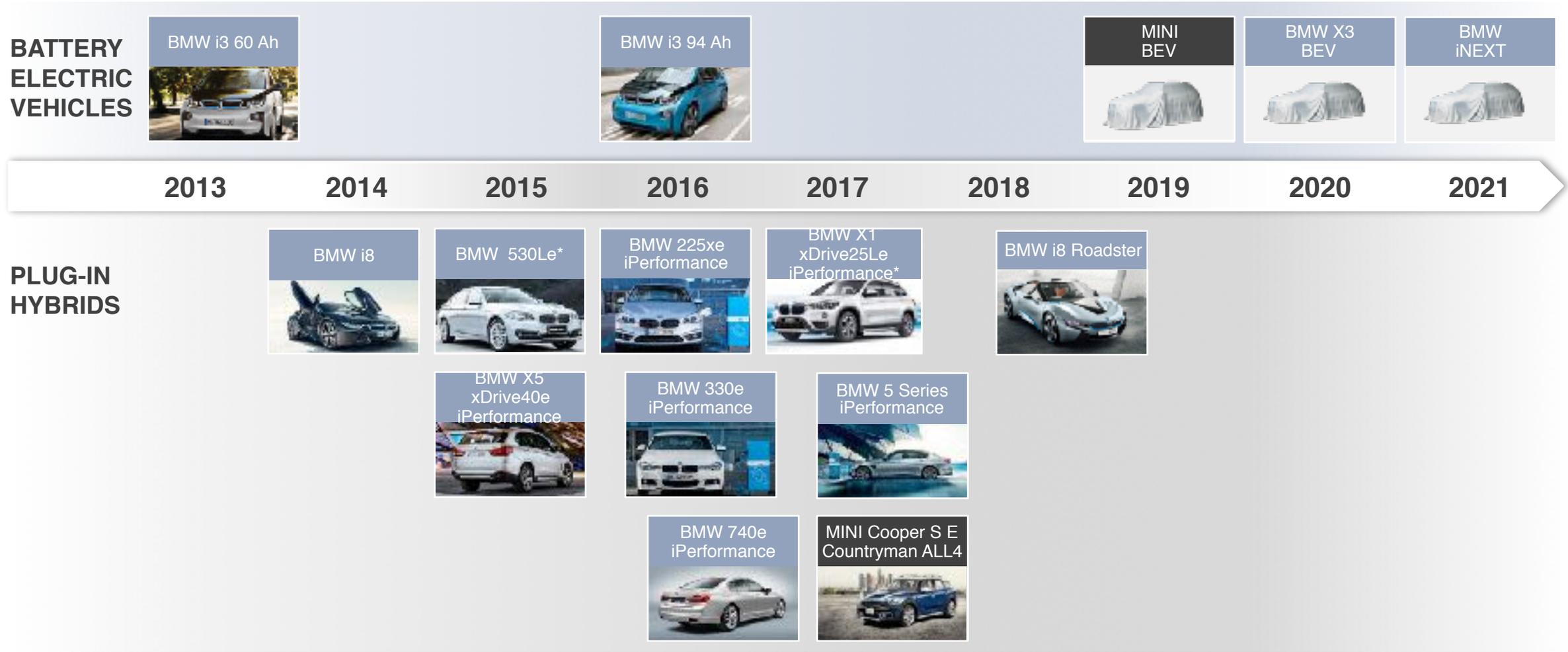


- Reduce congestion
- Remove vehicles
- Replace old inefficient cars
- Reduce VMT

REACH NOW.



SIGNIFICANT NUMBER OF ELECTRIFIED MODELS ARE ALREADY ON THE STREET.





Michelle Bogen | BMW of North America, LLC | November 2017

BMW VEHICLE-GRID INTEGRATION RESEARCH.

SMART CHARGING AND THE SUSTAINABILITY VISION.

DIGITAL CHARGING SERVICES. HOLISTIC APPROACH.



MY HOME ENERGY CENTER

Energy management devices in cooperation with external partners



WALLBOX PRO

Intelligent charging interface and connection of vehicle to home charging services



GREEN ENERGY

High-quality green electricity offers with partners



INSTALLATION-SERVICE

Installation check and Wallbox installation from one provider



ENERGY STORAGE CONCEPT

Maximization of energy usage from renewable self-generation

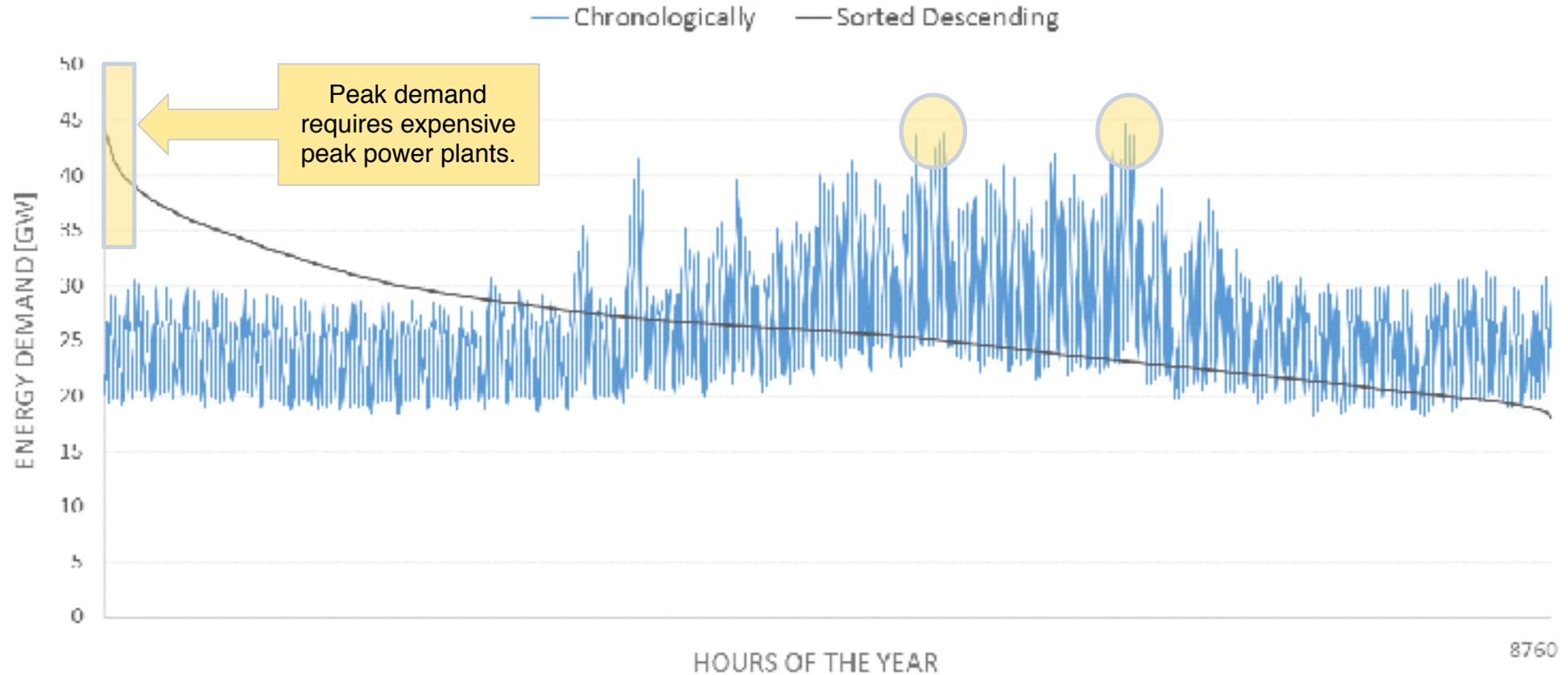


MY GREEN ENERGY

Solar systems and carports in cooperation with external partners

WHAT IS DEMAND RESPONSE? ELECTRIC VEHICLES AS AN ASSET TO THE ELECTRICITY GRID.

CALIFORNIA'S HOURLY ENERGY DEMAND 2014



BMW SMART CHARGING VISION.

BMW envisions a future where electric vehicles help the grid reach new levels of sustainability.



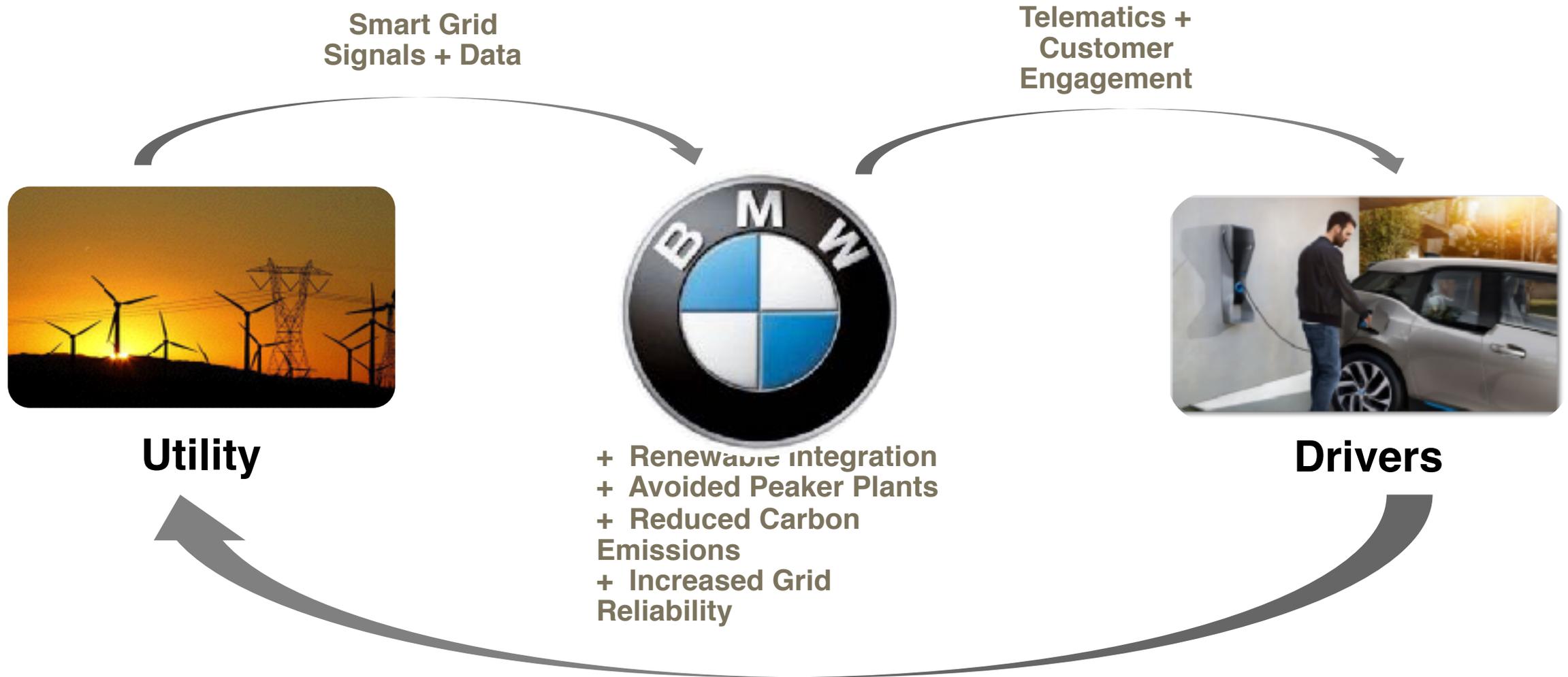
Utility



Drivers

BMW SMART CHARGING VISION.

BMW envisions a future where electric vehicles help the grid reach new levels of sustainability.



BMW I CHARGEFORWARD. PROGRAM DETAILS.

- Approx. 100 BMW i3 customers around the Bay Area
- Every event required 100-kW load drop
- Two types of events: Day Ahead (24 hr response) and Real Time (4 min response)
- PG&E called over 200 events during 18-month pilot (July '15 – Dec. '16)
- 100 kW / 240 kWh second-life battery contributed remaining load drop by discharging to the grid
- BMW customers received upfront incentive and daily incentive for ongoing participation
- Custom smartphone app to inform BMW of charging needs



TECHNICAL SOLUTION: VEHICLE TELEMATICS.

The BMW software backend communicates with each participating vehicle using the on-vehicle telematics system...



Grid Signal



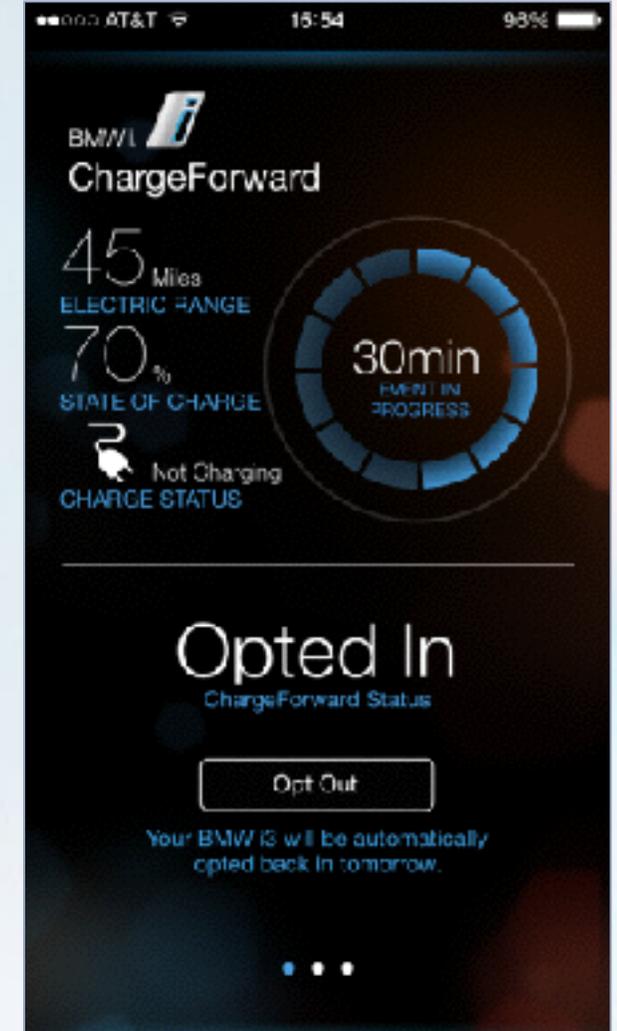
...BMW only selects vehicles for participate if they meet a minimum state of charge and the driver is willing to participate...

...BMW uses the storage system to supplement the vehicle pool.

BMW I CHARGEFORWARD. THE CUSTOMER ALWAYS HAS THE RIGHT OF WAY.

BMW won't constrain drivers' mobility needs:

- Automatic enrollment in Demand Response events, rather than opting-in.
- If the customer sets a departure time, it will always be obeyed.
- Pro-active opt-out: *'Today I don't want to participate'*.
- Re-active opt-out: Push notification to inform customers if vehicle is paused from charging + option to react.



BMW I CHARGEFORWARD. SECOND-LIFE STATIONARY BATTERY ENERGY STORAGE.



EVGRD

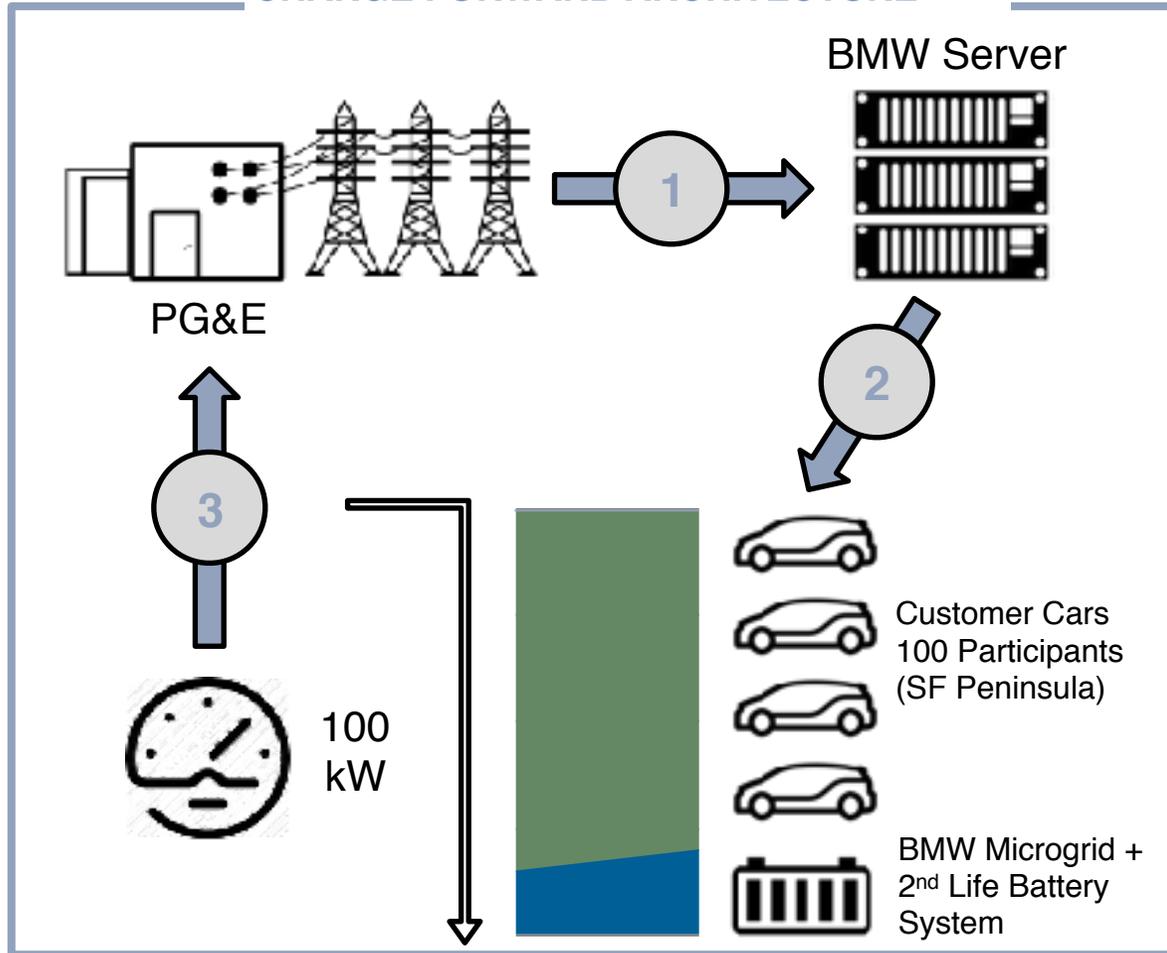
BMW B2L
EES
System



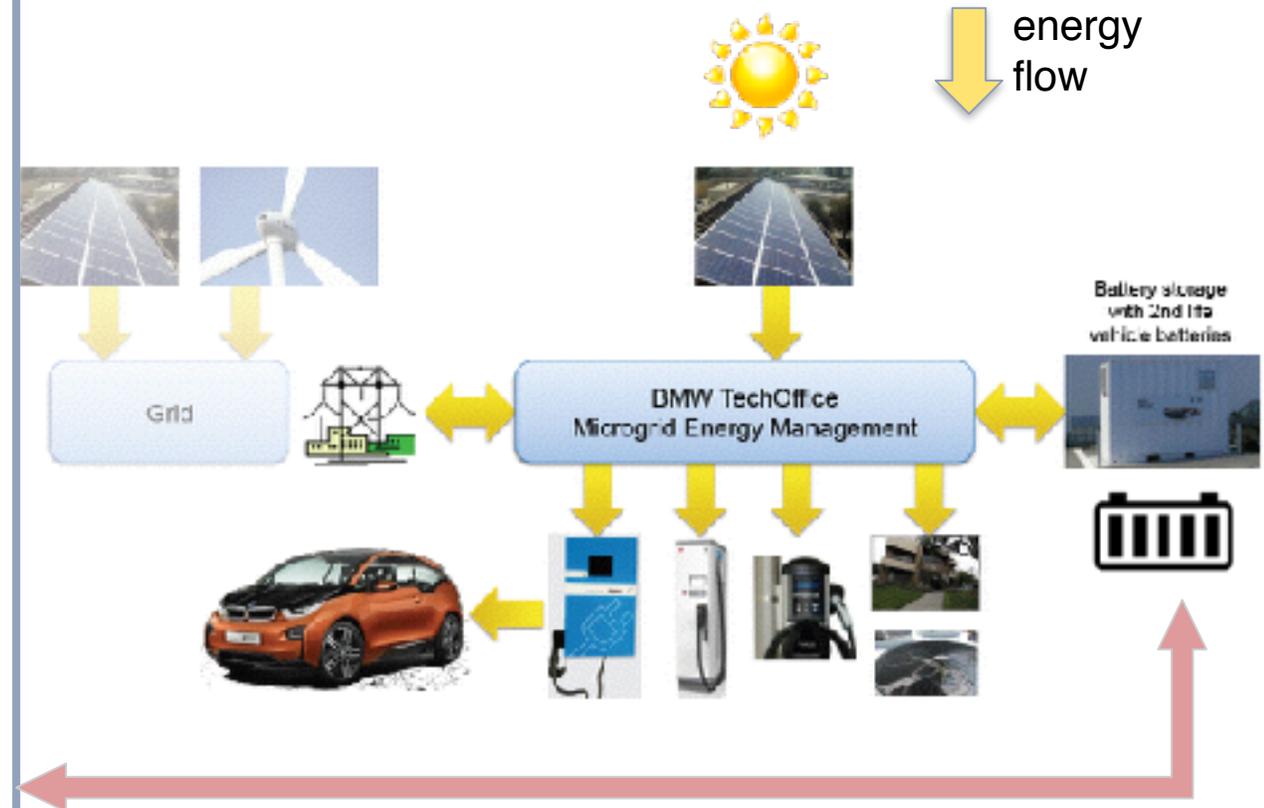
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BMW | CHARGE FORWARD. SYSTEM ARCHITECTURE.

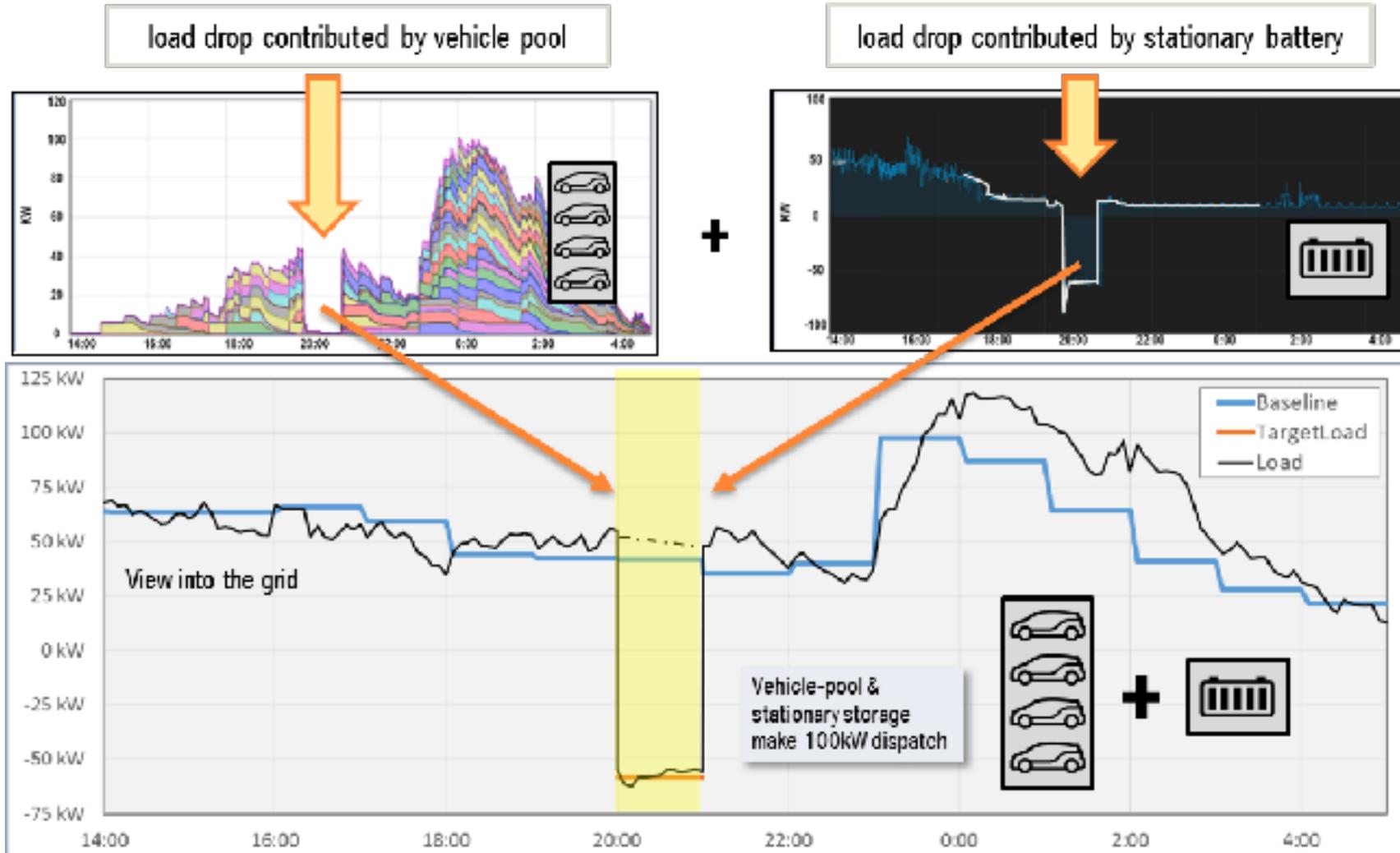
CHARGE FORWARD ARCHITECTURE



BMW TECH-OFFICE SMART MICRO-GRID



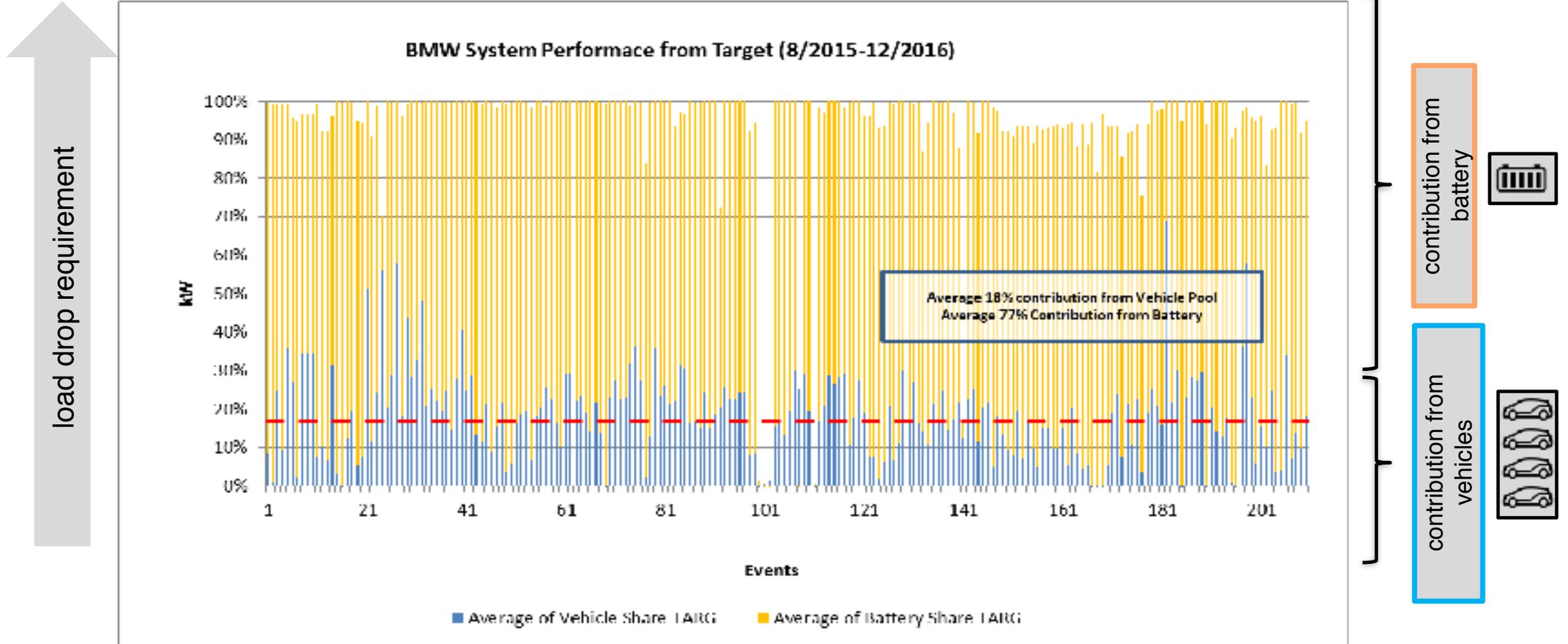
BMW I CHARGEFORWARD. SYSTEM FEEDBACK DURING DEMAND RESPONSE.



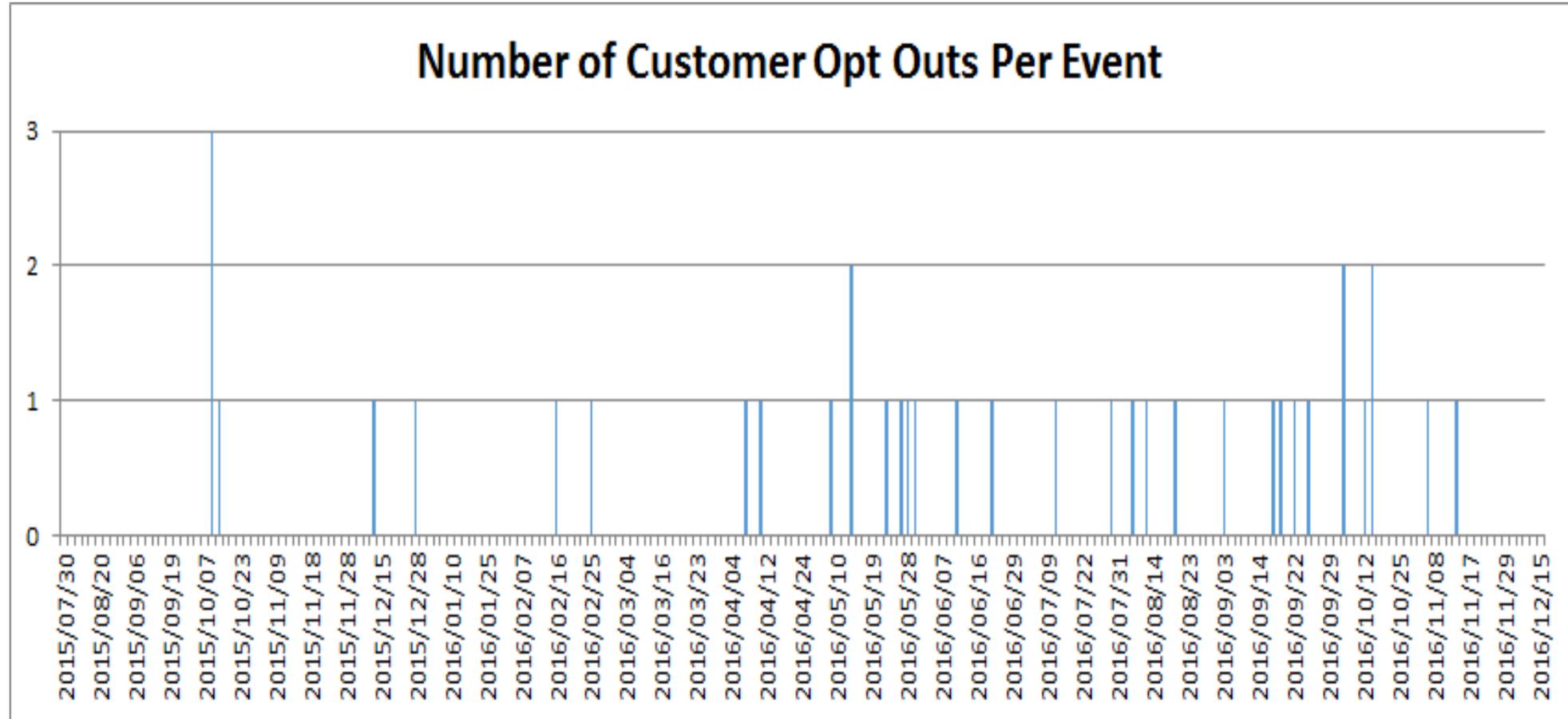
BMW I CHARGEFORWARD. RESULTS.

- 200+ Demand Response Events over 18 months
- 19,500 kWh in load reductions
- Low Customer Opt-Out Rate
- Battery Makes Majority of Load Reduction
- Final Report released June 2017 (posted on PG&E's 'Currents' website)

BMW I CHARGEFORWARD. RESULTS.



BMW | CHARGEFORWARD. CUSTOMER PARTICIPATION.



Customer opt-out rates were very low with most events having no opt-outs.

BMW | CHARGEFORWARD. HIGH CUSTOMER SATISFACTION.

93%

Were interested in participating in similar program in the future.

Participants wanted more communication from BMW and PG&E regarding the objectives of the program and if they were helping the success of the program.

98%

Were satisfied with the program compared to 92% surveyed at earlier phase.

98%

Would recommend the program to family and friends compared to 86% surveyed at earlier phase.

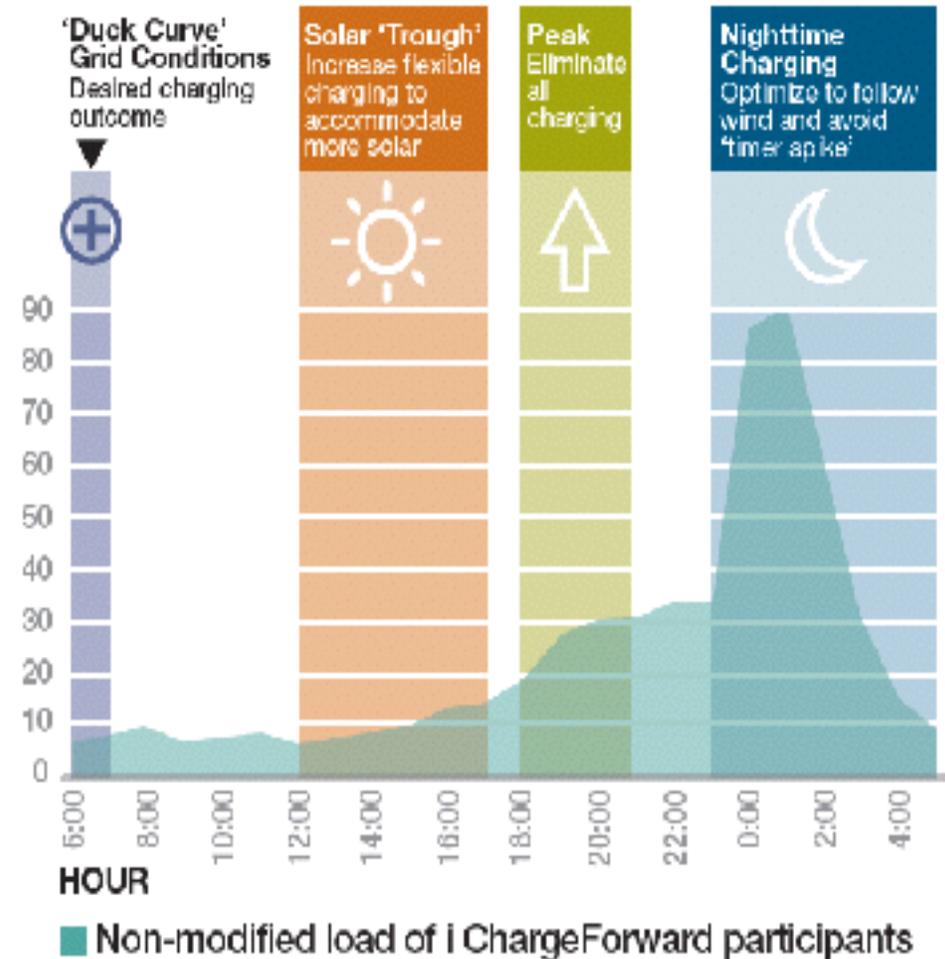
NEXT STEPS. BMW I CHARGEFORWARD PHASE 2.

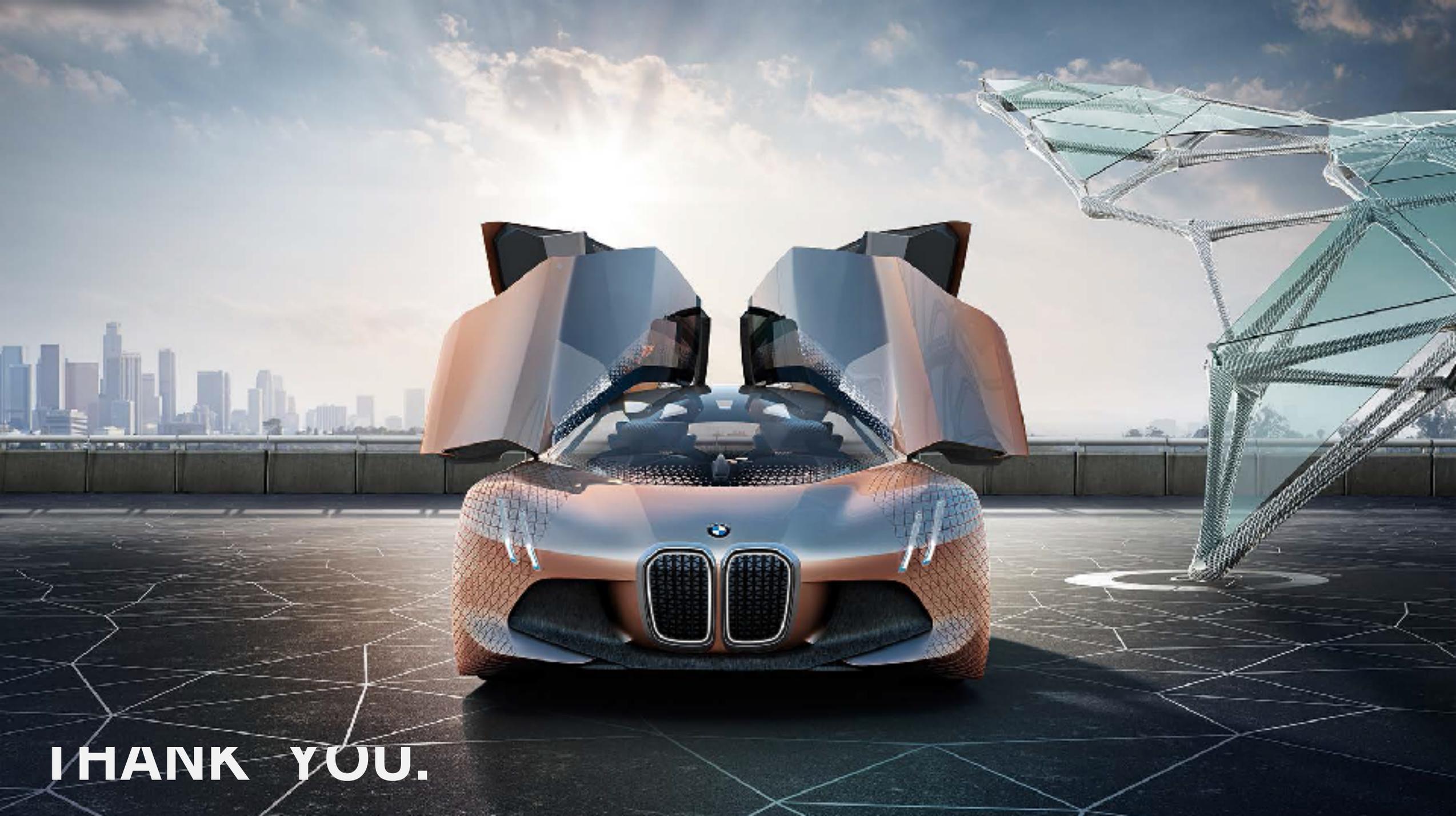
Overview

- 300-400 participants throughout the Bay Area
- Over 50 events since April 2017

New Features

- Longer curtailment events
- Optimizing nighttime charging
- Increasing charging in response to local/system excess solar on the grid
- Shifting charging across grid locations (home and away-from-home)
- Messaging to engage customers





I HANK YOU.