U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Advanced Grid Research
OFFICE OF ELECTRICITY
US DEPARTMENT OF ENERGY

An EV Future:

Navigating the Transition

A Voices of Experience Initiative

Merrill Smith & Chris Irwin, Advanced Grid Research & Development Division

Lee Slezak, Vehicle Technologies Office

An EV Future: Navigating the Transition

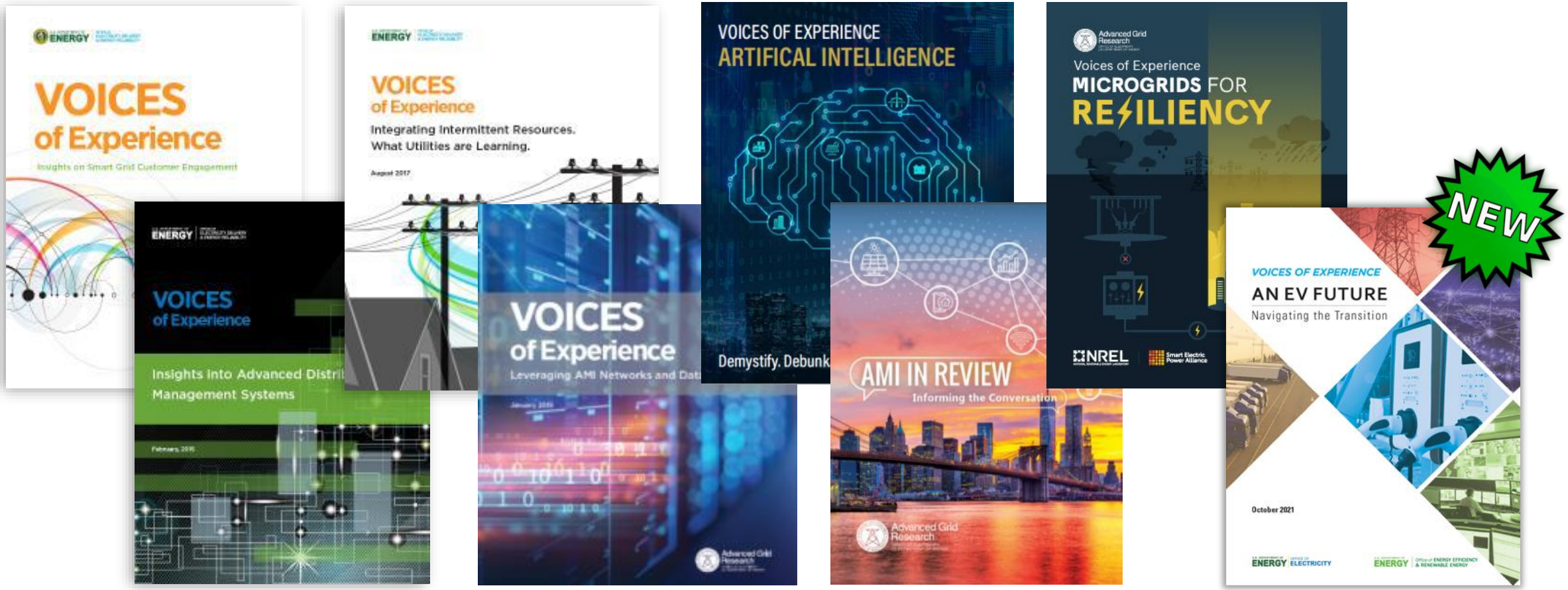
Providing clarity on infrastructure requirements and policy needs to prepare for growing EV adoptions

- Partnership between **AGR&D and VTO**
- **Facilitated forward-looking discussions** with stakeholders across the TE ecosystem
- Focused on **the build-out of the EV charging infrastructure and its integration with the electric grid**
- **Utilized AGR&D's Voices of Experience Approach**
- **Initiative website:** www.EVplusGridWorkshop.com

Underlying Goals

- Provide a forum to exchange ideas and share experience
- Bridge perspectives
- Facilitate connections
- Identify new pathways or uncover potential obstacles
- Provide high-level insights, considerations, and references

Voices of Experience Series



Download the reports at https://www.smartgrid.gov/voices_of_experience.html

Initiative Objectives

1. Explore what the transition to EVs will mean from different stakeholder perspectives
2. Understanding views on opportunities, potential pitfalls, and considerations for building the necessary electricity and charging infrastructure
3. Provide a consolidated overview of ongoing activities
4. Identify pre-competitive research needs or areas where the federal government's expertise, resources, or convening power could assist efforts

Stakeholders

- Utilities (investor-owned, municipal, & coops)
- Charging network providers
- OEMs
- Research/Academia
- Retailers/Fleets
- Advocates/Industry associations
- Vendors
- Government/policy

Steering Committee Members

- Phil Jones, **Alliance for Transportation Electrification**
- Patricia Taylor, **APPA**
- Michael Rowand, **Duke Energy**
- Jeffrey Lehman, **EV Chargeworks (originally with AEP)**
- Matt Nelson, **Electrify America**
- Dorothy Kellogg, **NRECA**
- Rustam Kocher, **Portland General Electric and Char.IN (originally with Daimler Trucks North America)**
- Garrett Fitzgerald, **SEPA**
- Bill Boyce, **SMUD**
- Jordan Smith, **Southern California Edison**
- Lincoln Wood, **Southern Company**
- Scott Phillippi, **UPS**
- Steve Zimmer, **USDRIVE**
- Erika Myers, **World Resources Institute (originally with SEPA)**

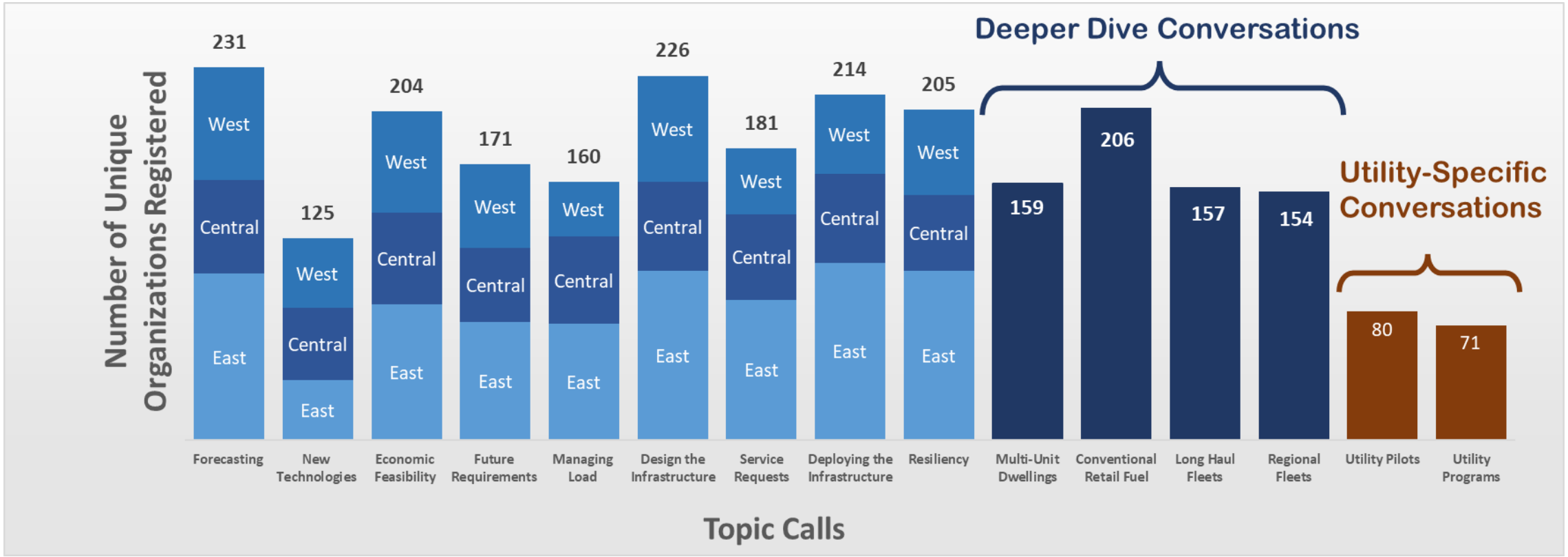
Selected to represent the ecosystem of transportation electrification stakeholders

Initiative Scope and Call Topics

Initial Scope and Topics		
Planning Conversation	**Operations Conversation**	**Business Conversation**
Forecasting	Managing Load	Designing the Infrastructure
Service Requests	New Technology Implications	Deploying the Infrastructure
Understanding Future Requirements	Resilience & Reliability	Economic Feasibility

Additional Call Topics		
Case Study Webinars (Deeper dive on recurring themes)		**Utility-Specific Calls** (Focused discussions on internal operations)
Multi-family and Underserved Communities	Long Haul Fleets and Travel Center Plazas	Lessons Learned from Pilots
Regional and Local Fleets	Conventional Retail Fueling	Programs and Processes

Call Registrations

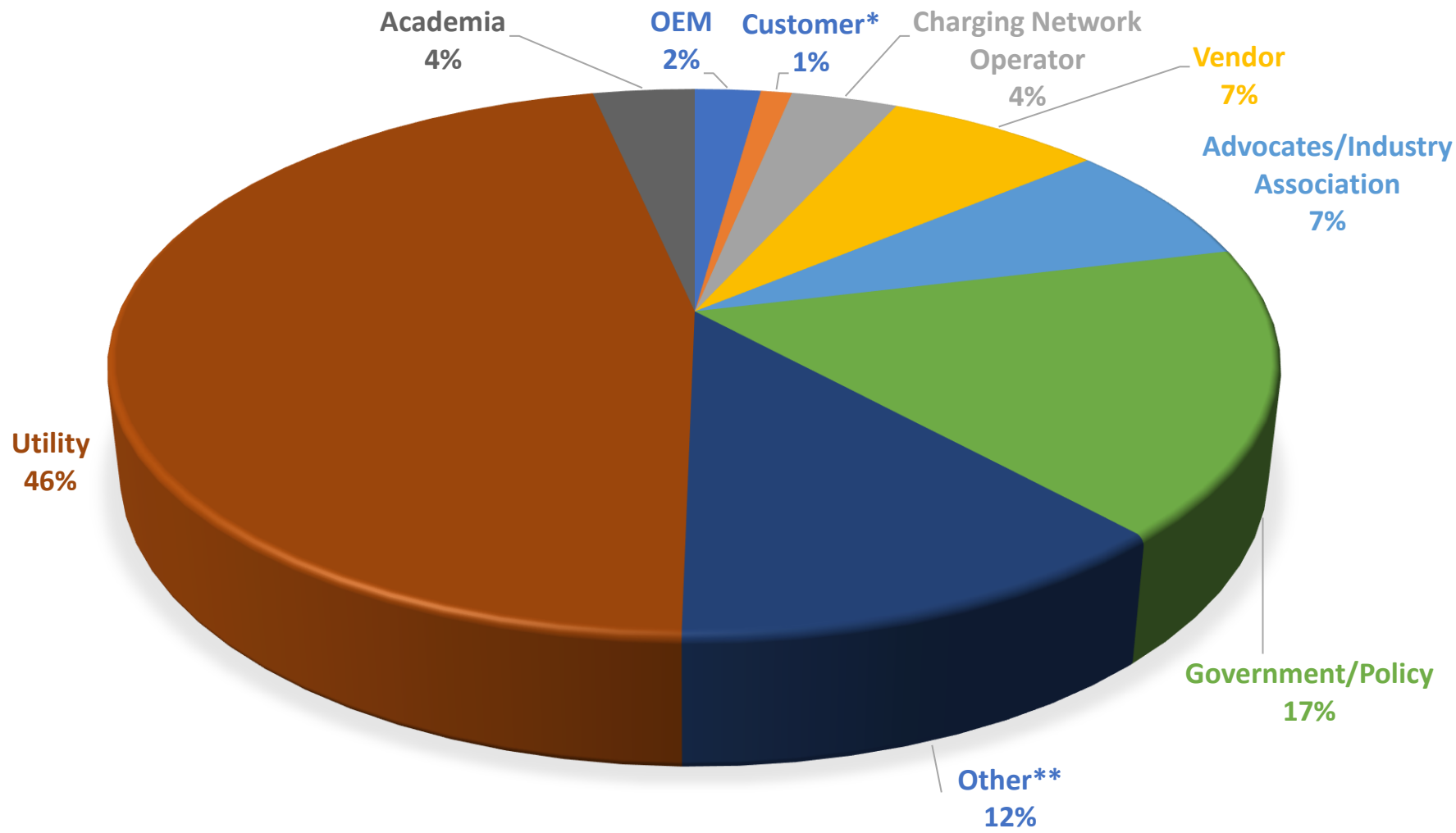


Statistics

- 33 total calls: First 9 topics covered in 27 calls – 3 calls/topic
- 700 distinct organizations with 3500 total unique registrants
- 27 Organizations from 18 other countries

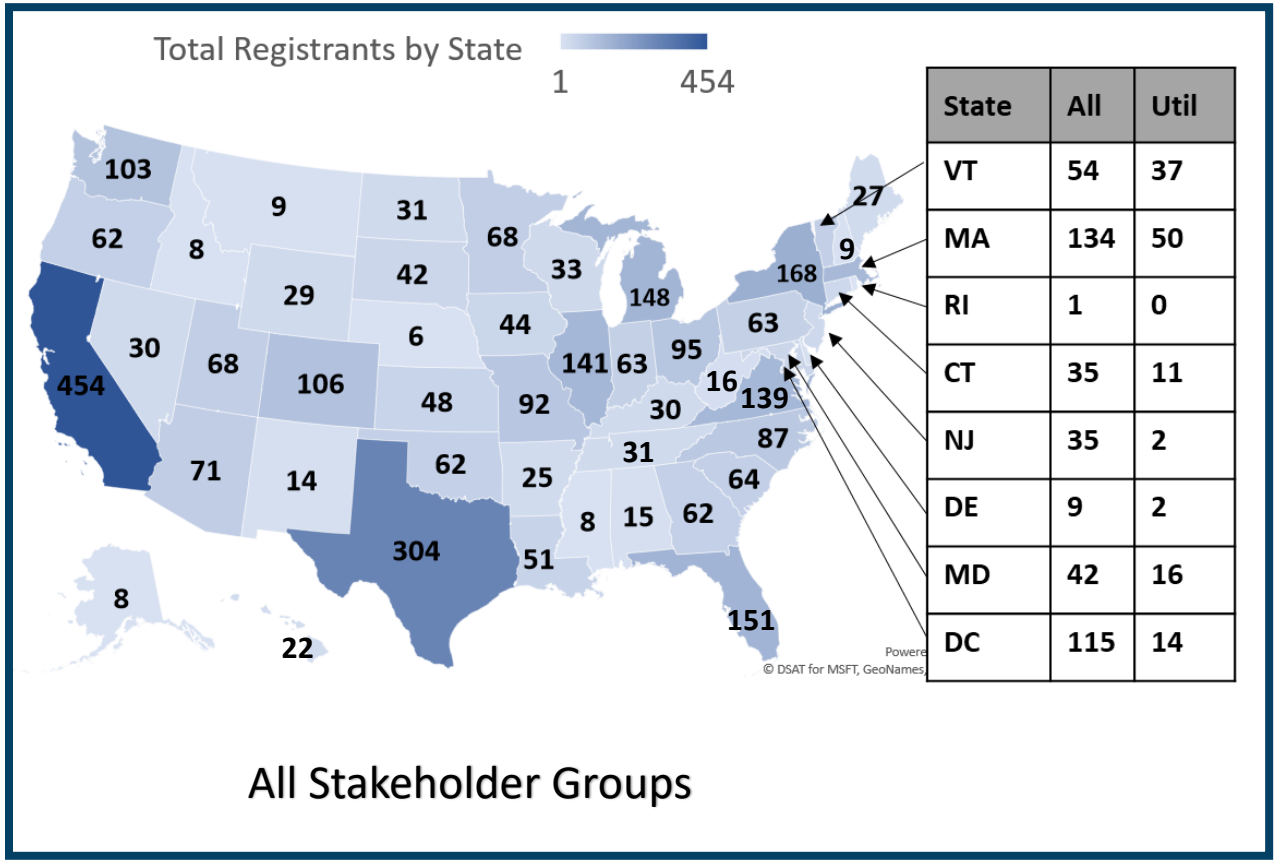
Note: Excludes national laboratories and support contractors; Based on registrations not attendees

Registrations by Stakeholder Category



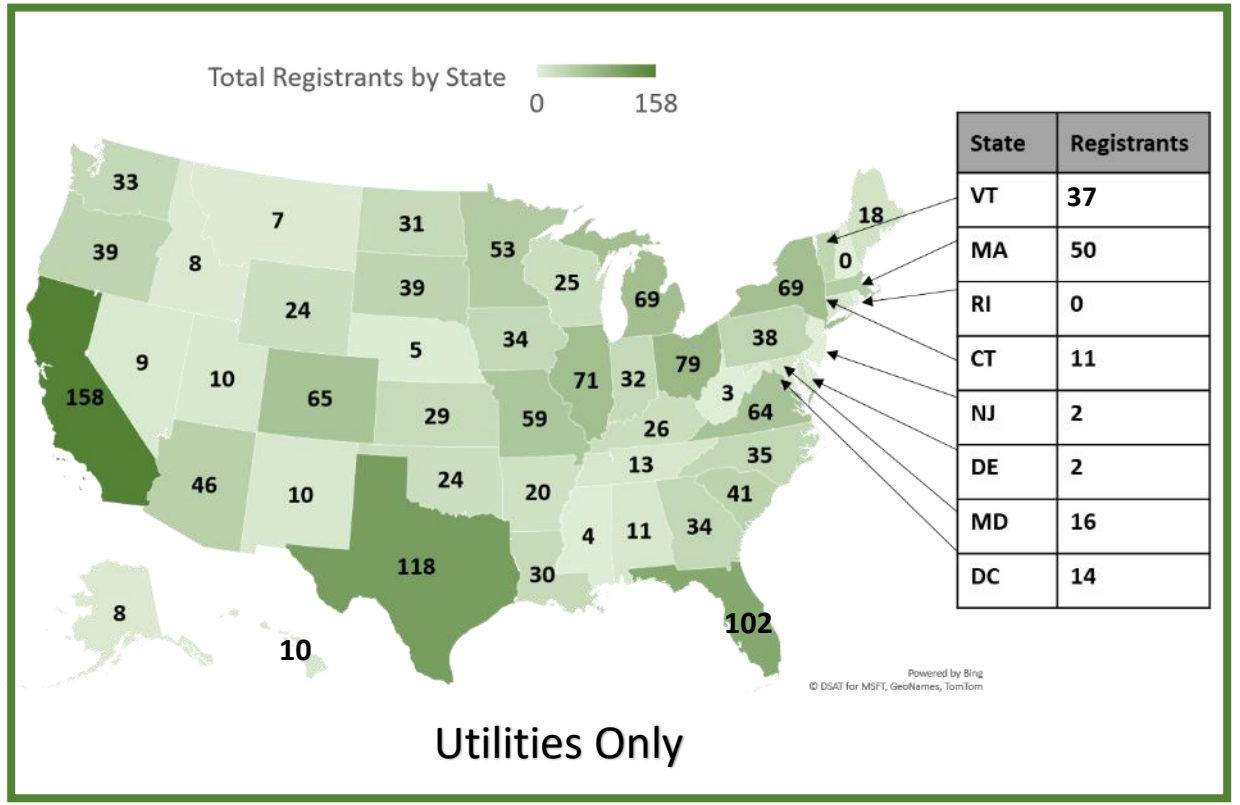
*Customer includes organizations that will use the charging or install it for their own use, such as fleet owners or retailers.
**Other includes fuel retailers, consultants, and representatives from other industries like solar.

Geographic Representation of Registrations



State	All	Util
VT	54	37
MA	134	50
RI	1	0
CT	35	11
NJ	35	2
DE	9	2
MD	42	16
DC	115	14

All Stakeholder Groups



State	Registrants
VT	37
MA	50
RI	0
CT	11
NJ	2
DE	2
MD	16
DC	14

Utilities Only

Notes: Excludes national laboratories and support contractors. Uses registration data.

International Registrations

Africa
- PortHarcourt Electricity Distribution Company (phEd)
- T Kau Solar Solutions
- Electricity Company of Ghana

Arabian Peninsula
- DNV GL
- Clean Energy Business Council
- Dhofar Power Company

Australia
- Tritium
- Smart Grid Solutions

Brazil
- CPFL Energia

Canada
- Dunsky Energy Consulting
- Nova Scotia Power
- Shell

27 Organizations registered across 18 Countries

East Asia
- State Grid Corporation China
- Smart Taipei City Office
- Shell

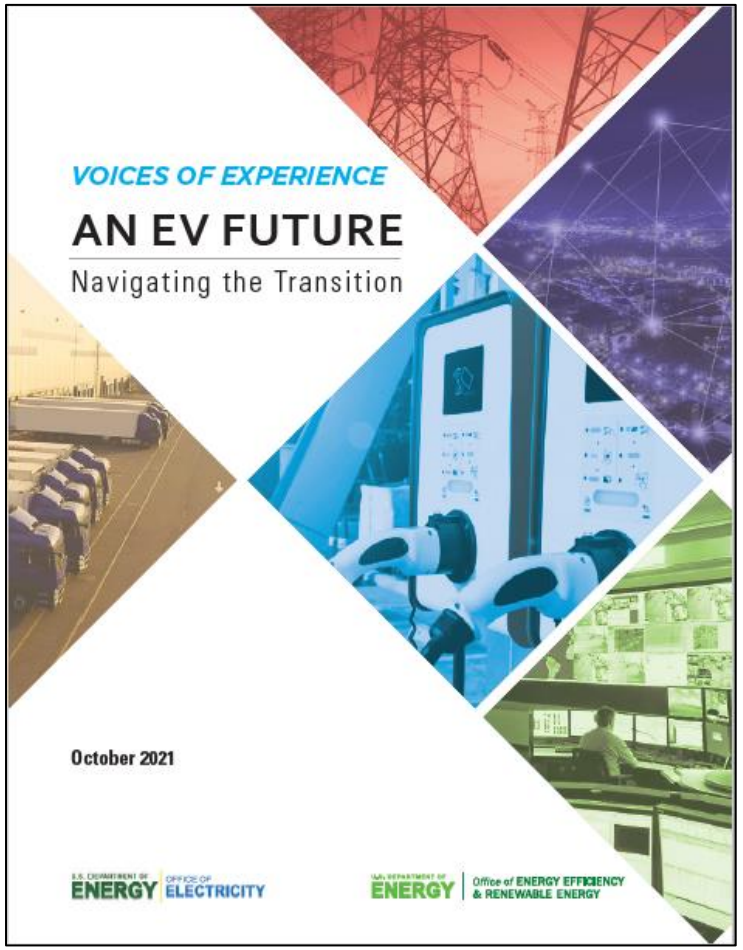
Europe
- Reinhausen Group
- FCG Germany GmbH
- Webasto
- VINCI Energies
- PANDO Group
- AICO EDV-Beratung GmbH
- NXP Semiconductors N.V.
- Shell

India
- NewMo
- (SDAU) Sardarkrushinagar Dantiwada Agricultural University
- L'Energy Mobility
- Kongu Engineering College
- BFPL

Mexico
- CENACE
- Shell

About the Document

- Not a DOE roadmap nor a technical report
- Represents the combined voice of participants
- Maintains the conversational tone of discussions
- Designed to be skimmable with stand-alone chapters
- Obtained approval for all examples and quotes attributed to a specific company or individual
- Reviewed by industry steering committee
- Posted on
  1. Smartgrid.gov Voices of Experience webpage: https://www.smartgrid.gov/voices_of_experience.html
  2. Initiative website: www.EVplusGridWorkshop.com



Overview of Content

Contents at a Glance

CHAPTER SECTIONS

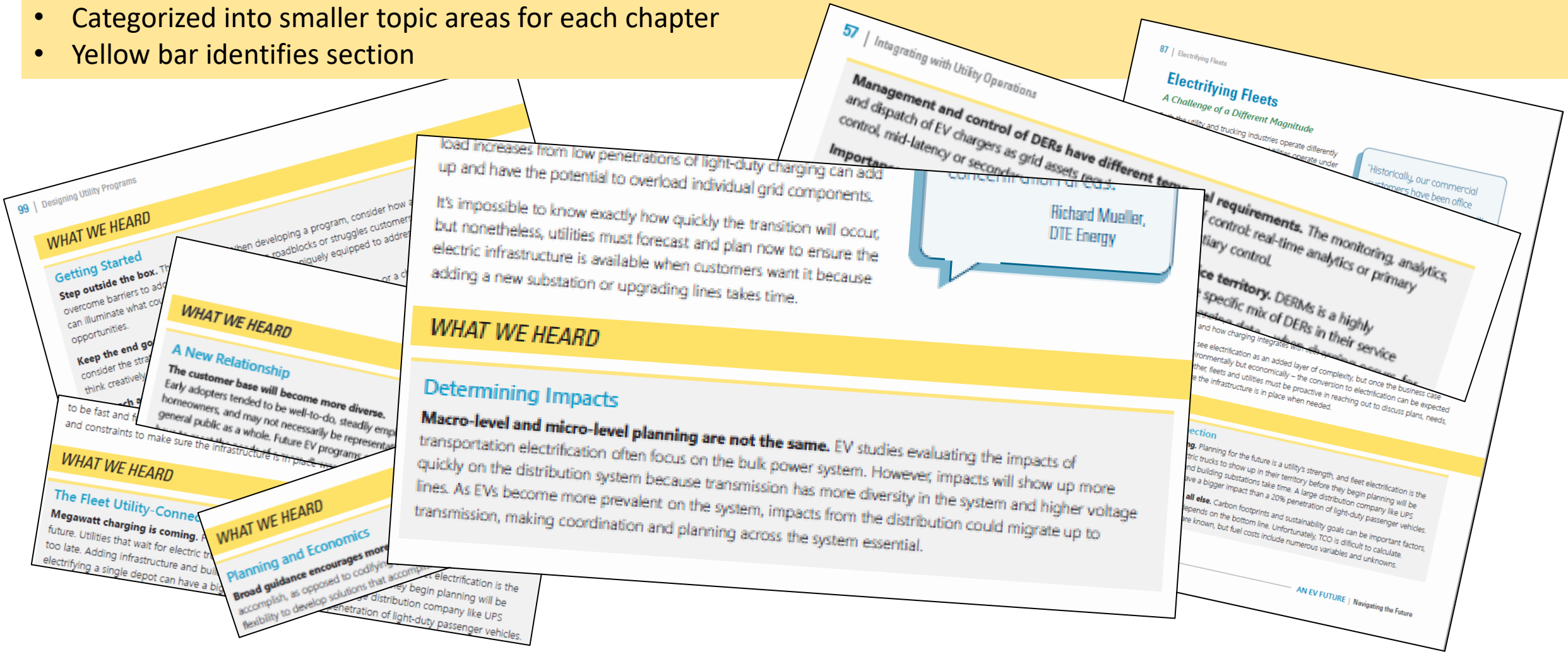
- What we Heard
  - Insights from participations
- Questions to Consider
  - Questions raised by participants or unanswered questions
- Experiences from the Field
  - Participant examples
- Resources
  - Links to helpful information or references

ALSO INCLUDED:

- Quotes
- Call out Boxes
- Fun Facts
- Small examples to support insights
- Definitions
- Word on the Street

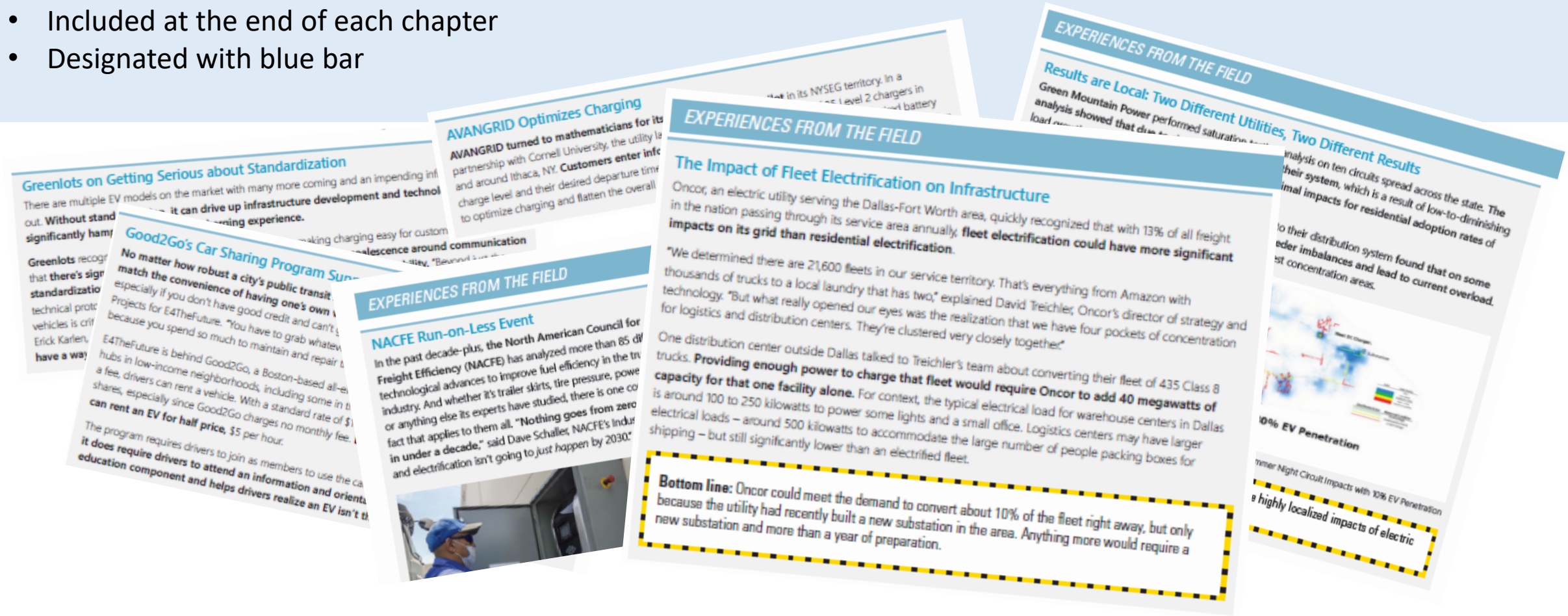
What We Heard Sections

- Insights edited and compiled to represent the combined voice of participants
- Categorized into smaller topic areas for each chapter
- Yellow bar identifies section



Experiences from the Field Sections

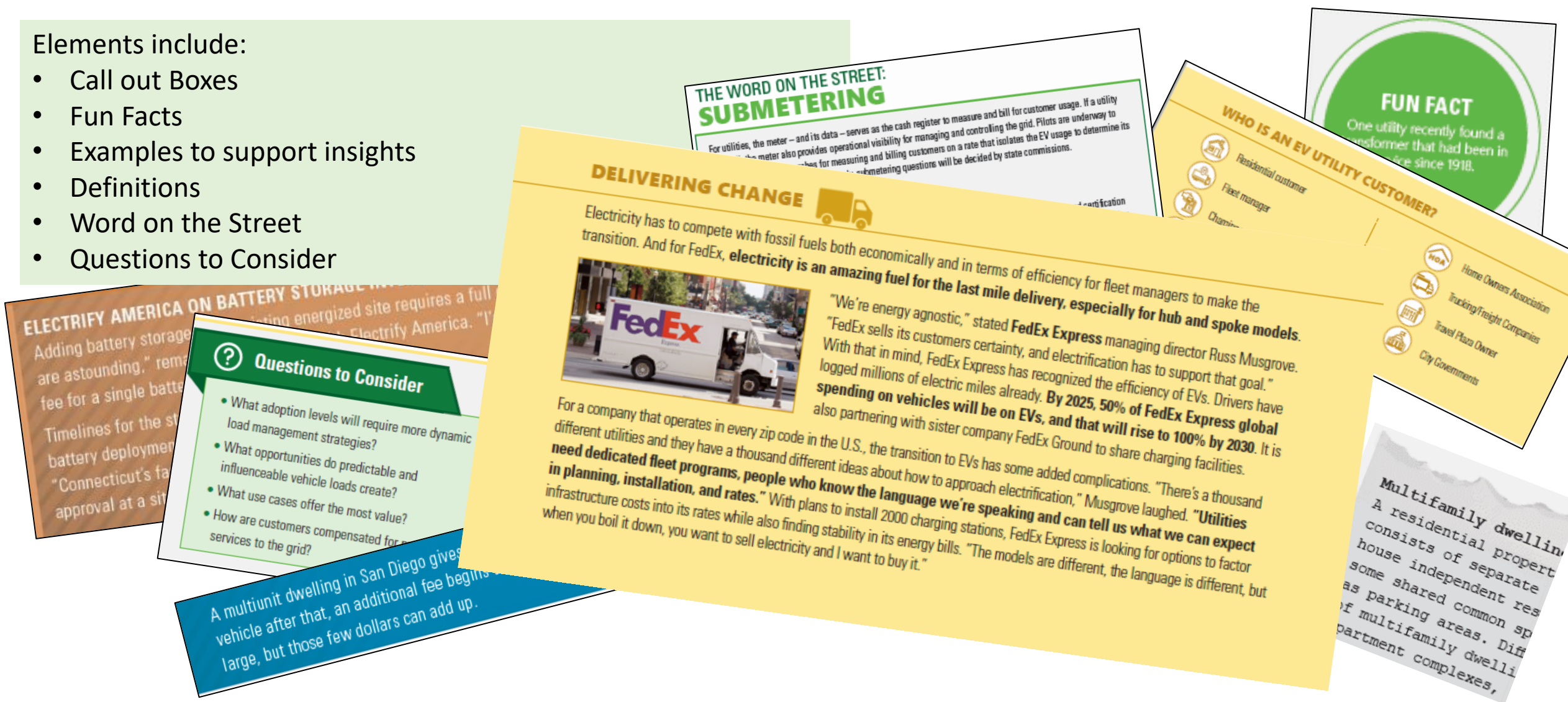
- Highlights different approaches and provides specific examples of what industry is doing (sometimes in response to a specific issue)
- Included at the end of each chapter
- Designated with blue bar



Interesting Elements

Elements include:

- Call out Boxes
- Fun Facts
- Examples to support insights
- Definitions
- Word on the Street
- Questions to Consider



Participant Quotes

- The Voice of Participants
- Represents stakeholders categories that participated

Regulators

"Balancing creativity and reasonable constraints can promote social values and further development and innovation in electrification. This is the balanced sweet spot for a measured approach to growth and success."

Commissioner Maria S. Bocanegra, Illinois Commerce Commission

Vendors

"People think of it like plugging your phone into the wall, but you have an entire ecosystem that has to be factored into the implementation."

Chris King, Siemens

Charging Network Providers

"It's important to align the interests of the grid and the interest of the electric vehicle driving public."

Matt Nelson, Electrify America

Utilities

"In distribution, everything is local. Due to equipment vintage and configuration, impacts may not be limited to the highest concentration areas."

Richard Mueller, DTE Energy

Retailers

"Stay positive. Think of what's possible instead of the knee jerk reaction of 'no, that's not going to work here.' We need to hit the reset button and overcome legacy friction to move forward."

John Thomas, TA Petro

Advocates

"Equity has to be baked in from the beginning of a project."

Terry Travis, EVNoire

Trucking

"It's really going to take a village. To figure all this out, it's imperative we all work together."

Bill Combs, Penske Transportation Solutions

Fleets

"Zero emissions will be here from coast to coast."

Russ Musgrove, FedEx Express

Transforming Industries

What the Transition to Electrification will Mean

- **The pace of change is unparalleled.**
  Changes are not only related to electric vehicles but also to the transmission, generation, and distribution of electricity.

- **Utility size and governing structure could drive different solutions.**
  Challenges, solutions, and motivations will vary depending on the utility's size, regulatory environment, and operating structure.

- **The transition is about more than sustainability and a low carbon future.**
  Sustainability may be a component, but it must make economic sense for businesses and consumers will have a range of reasons for going electric.

- **Business will rely on utilities in new ways.**
  Interaction with the utility will change as companies become reliant on electricity for more aspects of their business. This can mean multiple new partners.

- **New market dynamics can create tensions.**
  Reimagining business models and developing mutually beneficial solutions can put tension to constructive use.

- **Uncertainty can hamper deployments.**
  Companies need assurances that the infrastructure will be in place and that costs will be stable.

- **Industry announcements are signaling a commitment to transportation electrification.**
  New announcements are being made but optimism is balanced with measured hesitancy.

- **Change is inevitable but not always easy.**
  Recognize there will be hiccups along the way. Be mindful of impacts to customers, employees, and the organization at large.

> "During the nascent phase, there will be hybrid or parallel market development that will converge as the new industry emerges."
>
> Phil Jones, Alliance for Transportation Electrification

Key Takeaways

Emerging Themes from Participant Conversations

- **EVs loads are mobile and unpredictable.**
  They aren't the same as traditional building loads.
- **Unanswered questions remain.**
  Stakeholders are looking for more information.
- **Collaboration is paramount.**
  Segments of the economy that might have previously been siloed will become partners.
- **Social justice requires special attention.**
  Equity and inclusion move to the forefront as the nation moves from the early adopter phase.
- **Creative thinking needs to be balanced with reasonable constraints.**
  New approaches must be balanced by cost and science-based considerations.
- **A robust, visible charging network is critical.**
  Reducing range anxiety requires more than bigger batteries with longer range.
- **Solutions will evolve over time.**
  Don't narrow in on a solution too quickly.
- **Utilities are the nexus.**
  The transition to electric vehicles cannot happen without them.
- **The utility-customer relationship is changing.**
  EVs require more touchpoints and more interaction with the electric utility that may require process, policy or regulatory changes.
- **Fleets are a much greater challenge.**
  Power requirements for fleets will not be inconsequential. It could require new substations or new transmission lines.
- **There is a shortage of skilled workers.**
  Utilities and businesses face workforce shortages as they work to keep pace with fast-growing demand.

Rustam Kocher

Rustam Kocher is the Transportation Electrification (TE) team manager at Portland General Electric (PGE), Oregon's largest electric company. He and his team are responsible for operationalizing and scaling PGE's electric transportation product portfolio.

Prior to joining PGE, Rustam was a founding member of the E-Mobility Group at Daimler Trucks North America, building DTNA's electric truck and charging offerings from the idea stage to reality.

Rustam also leads the global Megawatt Charging System task force at CharIN, where over 120 companies, government labs, and agencies are working together to standardize the MCS charging connecter that will enable long distance truck and bus travel.

A self-described "EVangelist," Rustam "drives on sunshine" by using the solar panels on his home to charge his two electric vehicles. He proudly hasn't purchased gasoline in over 10 years and enjoys long road trips with his wife in Jasper, their red Model Y. Back in 2012, he predicted that 50% of new car sales would be electrified by 2022 and is working hard to make that a reality.

Rustam is proud to work at an organization that supports the transition of the transportation sector from carbon-intensive fossil fuels to a clean energy system and that is working to decarbonize their own electricity supply.

EV Future – Stakeholder Insight Highlights

1) Infrastructure upgrades and investment

- Needed regardless of whether they're used right now.
- Meeting timelines for government mandates, industry demand, and the emerging EV market, might require utilities to replace aging, but still operational infrastructure, upgrade conductors or transformers, or make additional investments that traditional load growth can't justify.
- Effective mechanisms have emerged for utilities to invest in backbone infrastructure.
- If electrified transportation is seen as necessary for supporting societal benefits and customer preferences, discussions about how infrastructure is funded are essential.
- Several approaches have emerged, such as line extension and contributions in aid of construction (CIAC) allowances.

**Regulating the Pace of Change chapter*

EV Future – Stakeholder Insight Highlights

2) Megawatt charging is coming

- Planning for the future is a utility's strength, and fleet electrification is the future.
- Utilities that wait for electric trucks to show up in their territory before they begin planning will be too late.

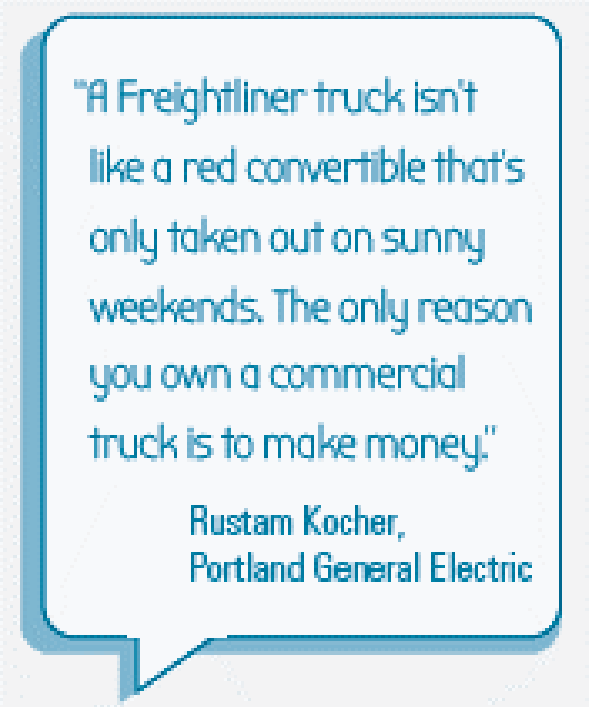
**Electrifying Fleets Chapter*

EV Future – Stakeholder Insight Highlights

3) Trucks are tools

- Owners don't want them idle
- Commercial vehicles aim for the highest utilization rates possible.
- While truck batteries may be able to provide grid services, utilities shouldn't bank on it.

**Integrating with Utility Operations*



EV Future – Stakeholder Insight Highlights

4) Public-private partnerships

- Can help offset enormous investments
- No entity, public or private, can finance the macro shift to electrification alone.
- The current nationwide petroleum infrastructure to supply and distribute fuel was built using investments from the past 100 years.
- Electrifying transportation in a matter of decades will demand similarly significant financing.

**Powering the Future chapter*

Electric Island

EV charging impacts on Distribution System at scale through propensity analysis

Richard Mueller

Engineering Manager: Interconnections, New Technology and Standards

Nov 4th, 2020 Updated Nov 15th 2021

Stakeholder Insight Highlights from Report

- **Macro-level and micro-level planning are not the same.** EV studies evaluating the impacts of transportation electrification often focus on the bulk power system. However, impacts will show up more quickly on the distribution system because transmission has more diversity in the system and higher voltage lines. (Anticipating the Future Chapter)
- **No single penetration level will cause impacts.** Even at low penetrations, there is the potential for overloading of individual grid components. The threshold for what will cause issues varies by circuit, feeder, and location. (Anticipating the Future chapter)
- **Last mile distribution impacts are easy to underestimate.** Vehicle charging, especially residential charging, might not seem significant, but aging infrastructure can be a limiting factor. Lower voltage conductors or older transformers that are still functional might not be able to accommodate additional load. (Anticipating the Future chapter)
- **Impacts don't necessarily show up on the highest concentration feeders.** Distribution planners must consider how charging may affect voltage parameters, protection schemes, transformer sizing, and other design constraints. In some instances, even a low number of EVs connected to the system can introduce feeder imbalances and lead to current overload. (Anticipating the Future chapter)
- **What is proposed in theory may not be as simple in practice.** There are many compounding variables that make the reality of optimized or managed approaches much different from the possibilities and ideas put forth by its advocates. (Integrating with Utility Operations Chapter)

> "In distribution, everything is local. Due to equipment vintage and configuration, impacts may not be limited to the highest concentration areas."
>
> Richard Mueller, DTE Energy

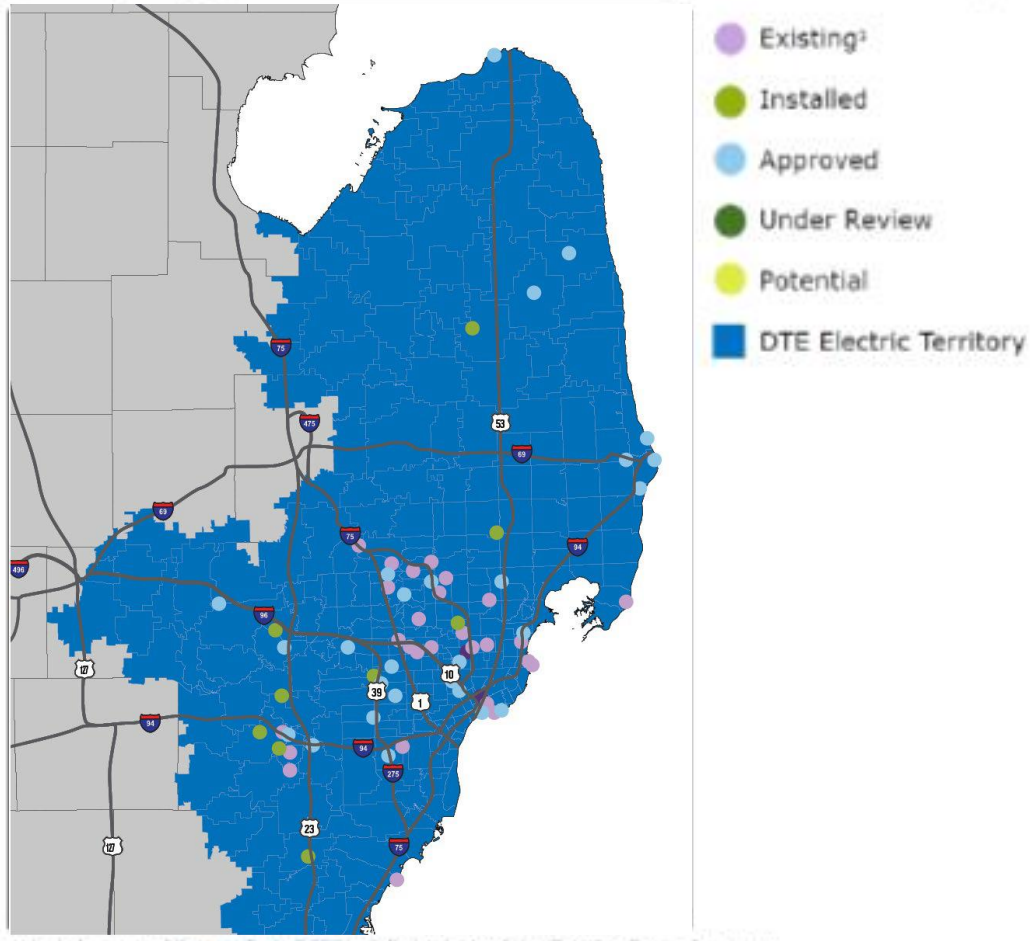
DTE at a glance

- Southeast Michigan and Detroit Area
- 2.1 million electric customers
- 5M+ registered vehicles
- 11 GW peak load: heavy industry, Advanced manufacturing and logistics
- Service territory ranges from very urban to very rural
- Substantial Vehicle OEM, supplier EV technology, batteries and autonomous vehicle R&D
- DTE Charging Forward program (rebates and make ready)

DTE

Commercial Level 2 and existing Fast Charger Program fully subscribed with many installed or under construction

Fast Charging (DCFC) Applications and Existing Infrastructure



1. Existing infrastructure includes any public, non-Tesla DCFC installed outside of the Charging Forward program
Source: Alternative Fuels Data Center

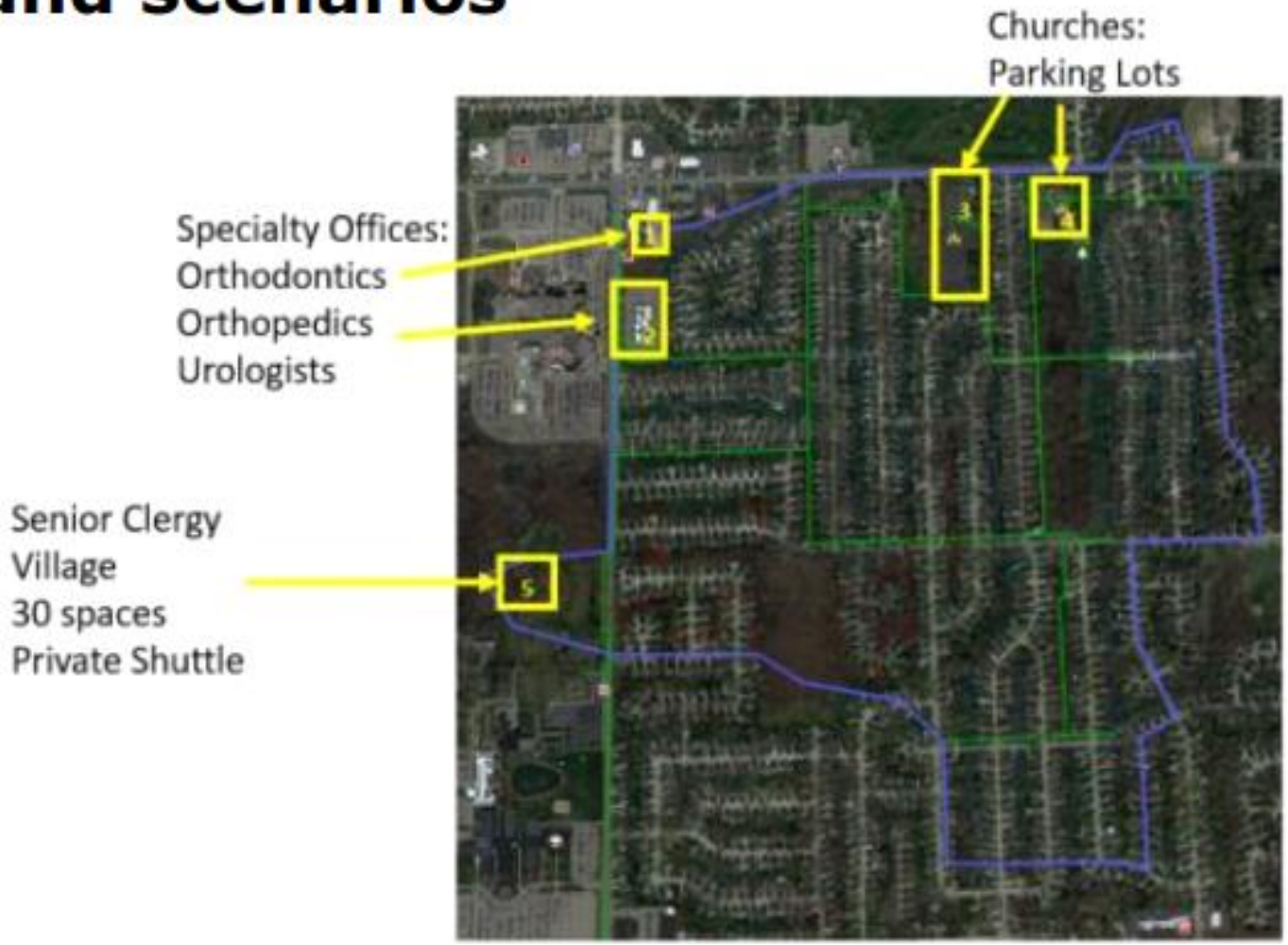
Residential program applications doubled from last year. More State and Federal programs incoming.

Demand holidays help adoption, but ultimately will normalize out either through higher upfront costs or revised tariffs

DTE

Propensity analysis allowed for a deep dive of potential EV use cases and scenarios

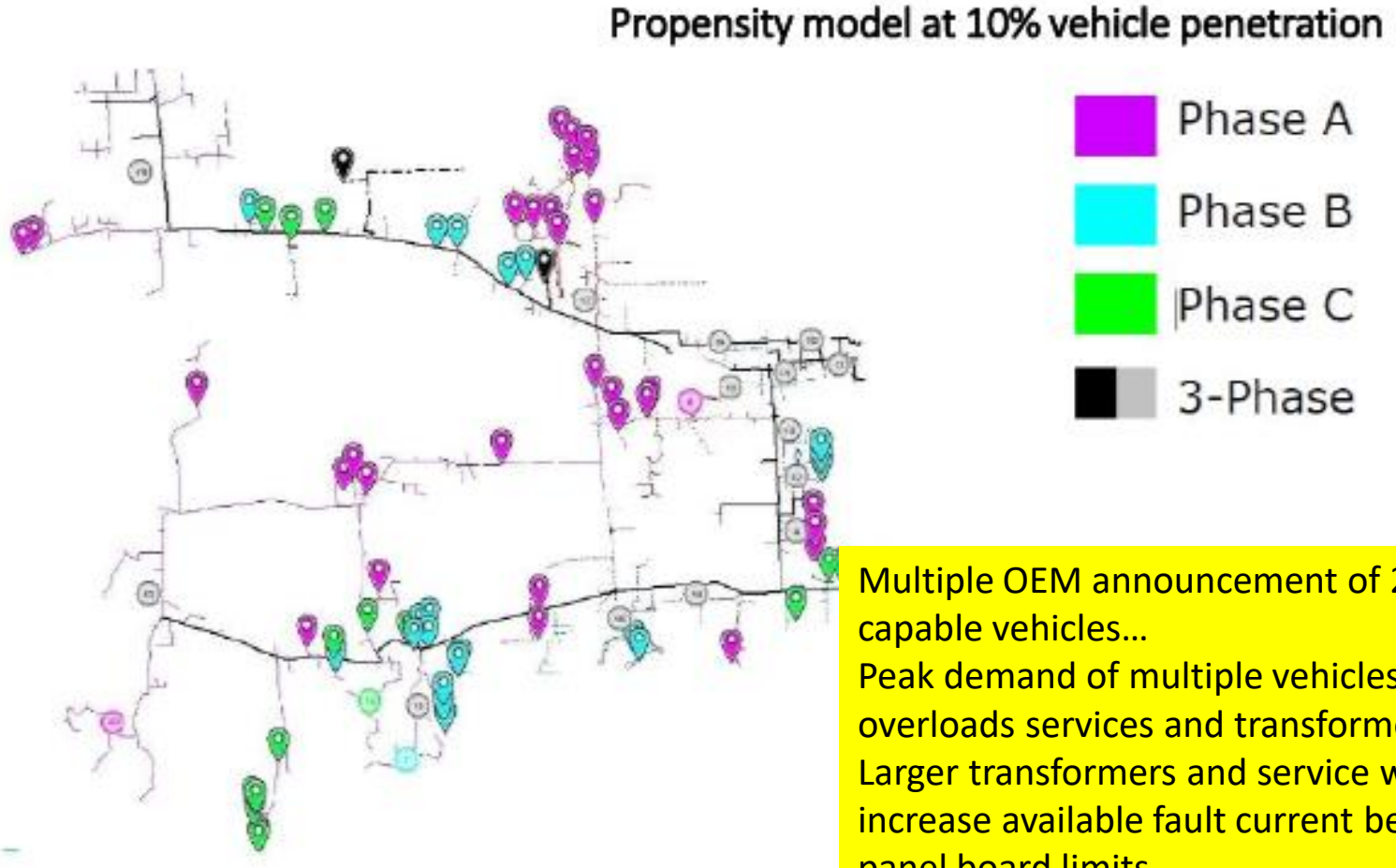
- Look at adoption impacts to distribution system decoupled from EV sales projections
- How many vehicles do business have (This wasn't a electric utility problem before, where do we get the data?)
- Investigate when vehicles were at various locations and how they were used.



In Distribution, everything is local due to equipment vintage and configuration. Impacts may not be seen in the highest concentration areas

Common issues at low penetrations:

- Clustering can quickly overload poletop and padmount transformers, Secondaries, service,
- Feeder imbalance can multiply the localized effects.

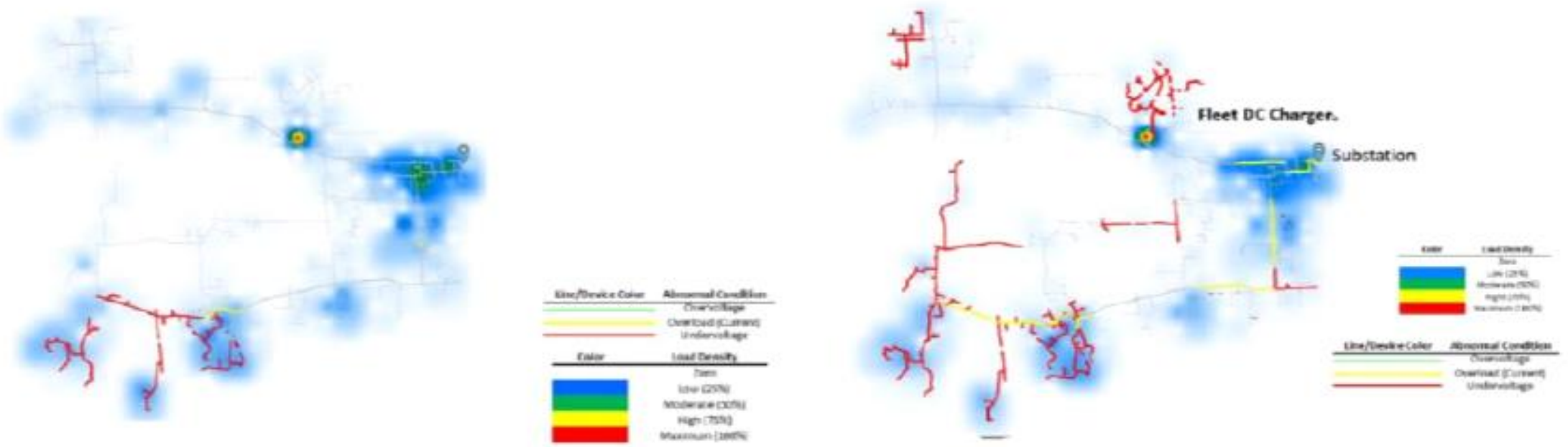


Multiple OEM announcement of 20KW capable vehicles…
Peak demand of multiple vehicles overloads services and transformers.
Larger transformers and service wire increase available fault current beyond panel board limits.
Do we need multiple services to a home? Do we need to look at 3 phase services for more locations?

DTE

In Distribution, everything is local due to equipment vintage and configuration. Impacts may not be seen in the highest concentration areas

Figure 4: Summer Night Circuit Impacts from Increased EV Penetration[4]



10% EV Penetration

30% EV Penetration

Multiple OEM announcement of 20KW capable vehicles…
Should single phase areas be upgraded to three phase? How to plan primary underground in new subdivisions?

A number of utilization scenarios came from the propensity analysis that present interesting challenges for load managing EVs at scale.

Lawn Service + Snowplowing

- May have minimal to no load at an existing gravel lot or pullout yard
- Heavy duty Pickups towing trailers with equipment every day (100% charge need each night?)
- Additional Electric lawn equipment

Multiple OEM announcement of 20KW capable vehicles…

- Plowing snow in the winter (high torque needed, cold weather impact on batteries, could be all hours until snow is cleared)

School, Church or youth activity buses

- Most of these locations have nearly no electrical load today
- Some non-municipal locations had multiple medium sized buses that served the community in multiple ways at unpredictable times (deliveries, tours, shuttles)
- Big Opportunity for V2G

V2G technology is here, even though it will take some time to stabilize

A number of utilization scenarios came from the propensity analysis that present interesting challenges for load managing EVs at scale.

Rural Agricultural Electrification

- Multiple small and large tractors likely all DC 50-150KW under daily use
- Multiple heavy duty pickup trucks (minimum 20KW level II AC)
- Heavy duty tractors, Harvester Combines with long duration use (DC 150KW – 1MW)
  - Some Farms had on 5-10 self propelled diesel units @ 400 HP likely these will need to be Xtreme fast charging as well
- Loads already very seasonal to meet harvest, Pumping in Spring, processing, grain drying in Fall
- *Time critical* planting, harvest and Hauling of fertilizers, agricultural products with heavily loaded Class 9 vehicles.

Opportunities for local charging pools?

Multiple OEM announcement of 20KW capable vehicles… demonstrations of BEV farm equipment

Mixed Use and Mid-rise charging present specific challenges for service planning and determining the proper sizing for the demand

- Ordinances and incentives are driving installation or pre-installation for large banks of EV charging in multi-level buildings
- Traditional service sizing uses demand diversity factors well established based on decades of usage patterns and known building loads such as HVAC, pumps and elevators.
- Garages have typically been low utilization lighting, fans and elevators/lifts. EVs increase demand by at least an order of magnitude. What is the right diversity factor for EVs and what factors modify this?
- If EVs are on shared service, overloads will impact residents. Should the garage be a separate service? Separate transformers? This all costs more and takes additional space and is very difficult to change once built, but developers may be unwilling to pay for additional utility infrastructure up front.
- Charge management systems are typically proprietary and likely don’t have interoperable utility interfaces to deal with local constraints. With V2G on the doorstep how does this all play out with interconnections?

Conclusions and Questions that came up from the analysis

- At high penetrations Hot summer nights and Cold winter nights become the most interesting cases to study
  - Time shifting is a great tool to move the load off of peak, but what happens at high penetration when EVs are causing the peak?

Multiple OEM announcement of 20KW capable vehicles, higher peak demand

- What are the long term impacts of Covid?

Chip shortage impacting vehicle sales, used EVs are very popular

  - Charging intensity?

Less vehicle miles for many due to work from home, much heavier usage for some for delivery

  - Charging location?

Big impact from work from home on Residential electric usage

  - Free up more opportunities for vehicle utilization?

Residential Customers more concerned than ever about resiliency of home electricity

- What role does autonomy and changing ownership models bring?

Still Need to understand ride sharing, autonomy still in adolescent stage

- ***Managed charging needs to be a lot more dynamic and much more local and customer need focused***

Locally Resilient and Interoperable too!

DTE

EV Future Final Webinar
November 16, 2021
Transportation Electrification and Equity: Income-tiered Equitable Carsharing

Susan Buchan
Director of Energy Projects
E4TheFuture
www.e4thefuture.org

EQUITY

Critical Points from the Report:

- **Low-income customers care about the environment and are often keenly ware of environmental impacts that disproportionately affect their neighborhoods.**
- **Air Quality is a major benefit. Many low-income neighborhoods are near industrial areas, airports, brownfields, trucking depots, ports and manufacturing facilities that negatively impact air quality and increase airborne particulate matter. Childhood asthma rates are typically highest in environmental justice areas and bringing transportation electrification to these residents may be welcomed by the local community.**
- **Utilities already play a major role and responsibility in providing accessibility and social equity. Utilities already implement energy efficiency programs geared to disadvantaged community members, and they have a responsibility to serve all customers equitably.**
- **In the EV transition this means providing charging infrastructure, lower cost options to personal EV ownership. Currently those with access to financial capital are able to benefit from EV adoption at multiple levels.**
- **We cannot meet our climate goals without engaging all segments of society.**

GOOD2GO

A Model for Equitable Access to Electric Vehicle Technology

Affordable Housing Hosted EV Carsharing

E4 THE FUTURE

TheGOOD2GO EV

Carsharing Model

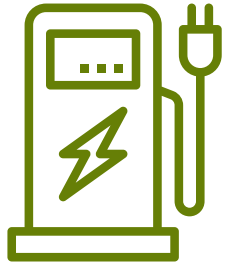
Community-based Membership

Open to customers of all income levels -with reduced rates for low income. No fee to join.

Resident Focused Host Sites

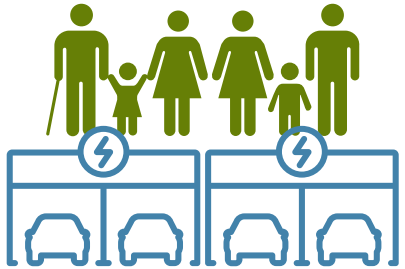
Convenient member access at multi-unit affordable housing dwellings and city municipal lots=enhanced member buy-in and oversight

Environmental Justice Community Infrastructure



Introduces electric vehicle technology to EJ communities and increases charging infrastructure in underserved areas

Replicable and Scalable Program Elements



Economies of scale provide expansion opportunities. Highly replicable due to common site characteristics.

THE INEVITABLE (POSITIVE) CONSEQUENCES OF AN EV CARSHARING PROGRAM

Reduced Traffic Congestion & Parking Needs	One carsharing vehicle removes 6-11 vehicles from the road* and frees up property used for parking
Reduced Household GHG Emissions	4 -18% emission reduction overall by carsharing households*
Introduces EV Technology To EJ Communities	High income buyers account for a disproportionately high fraction of electric vehicle purchases. Black and Latino buyers make up only 12% of EV purchases**
Economic Development	Low-income households and households of color spend a greater proportion of their income on transportation - 30% on average. The volatile cost of gasoline, location of available affordable housing and access to public transit is beyond household control

*Sheehan and Martin, 2017
**Muehlegger & Rapson, 2019

The GOOD2GO Model

WHY CDC/HOUSING AUTHORITY DEVELOPMENTS MAKE SENSE AS HOST SITES

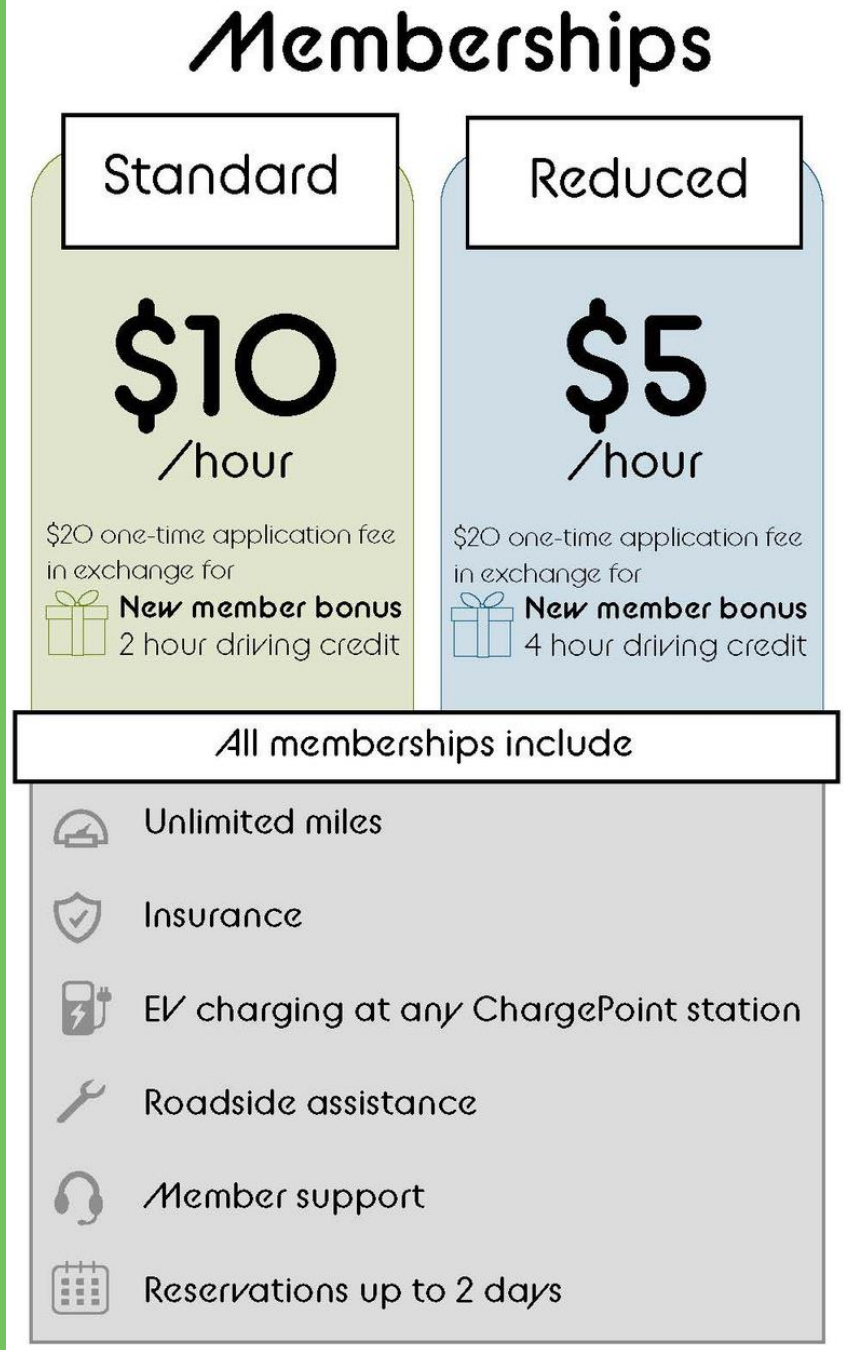
- Cars available at member residences
  - Research shows members seek a 1/4 mile or less walk to cars
- A complement, not competitor, to public transit
  - When public transit doesn't reach a destination or requires multiple stops/changes
  - Doctor's visits, Vet visits, job interviews, trips with small children/the elderly, alternative to a vehicle for families that use mostly public transit
- Shopping for healthy foods, bulk/large items
  - Alleviate "food desert" effects
  - Savings from larger quantities/comparison shopping
- Reduced parking needs provide additional space for affordable housing units
- Community buy in &oversight of vehicles = less vandalism/theft
- Familiarizes EV technology to all residents of service territory

Memberships

Good2Go offers two income tiers, Standard and Reduced. To qualify for the reduced rate, members send Good2Go proof of participation in an economic assistance program (e.g., Mass Health, R2 rates, LIHEAP, SSI/SSP, Section 8, WIC, SNAP, TAFDC, and more).

Good2Go offers hands-on support for its members. Members are introduced to EVs through individualized orientations prior to making their first reservation. Local staff and bilingual phone support are always available should a member have a question.

This approach results in confident, safe EV drivers.



The HURDLES

Insurance	Insurance for carsharing is not a well-defined product. One quote in MA was $25k/car/year! As carsharing program accident histories become available, this could change. Adding carsharing vehicles to existing fleet insurance is not often an option.
EVSE & Tax rebates alone don't get the poor into EVs	EVSE in low-income neighborhoods is often underutilized due to the low number of residents that can afford an EV (many can't afford a reliable ICE vehicle, and many can not finance a car due to credit score issues
Sharing Economy Adoption and Responsibility	A shared vehicle brings new responsibilities: making reservations, returning the car clean, not running out of charge while traveling. Community education is extremely important.
Community Engagement	Good community partners will be key to outreach. Resident champions from inside the community build trust . Building the confidence of members that they can and should drive an EV must be overcome by initial onboarding and education and continuing touchpoints with programs.

QUESTIONS?

www.evgood2go.org

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Thank you!

Download the report at

- www.EVPlusGridWorkshop.com/final-report