SBD

June 2023 3000d-23

EVS36

Industry Conference & Exhibition

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Management & technology consultants to the automotive industry for over 20 years

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- Shared Mobility
- EV
- Cybersecurity
- Anti-theft

Our role:

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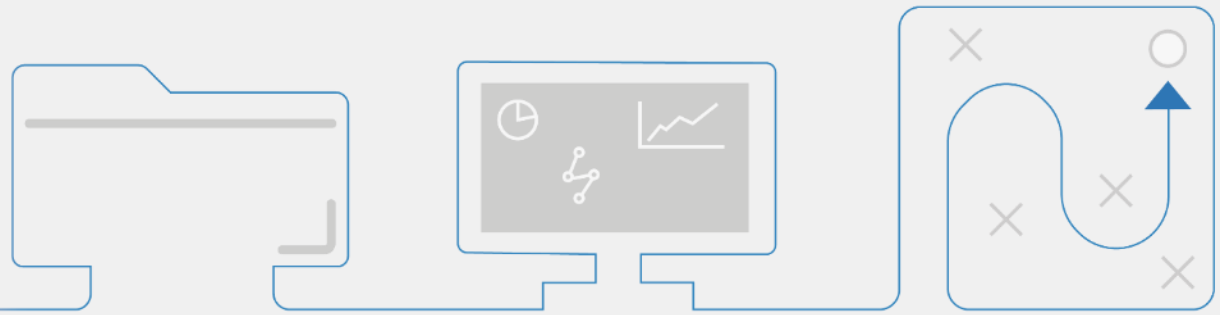

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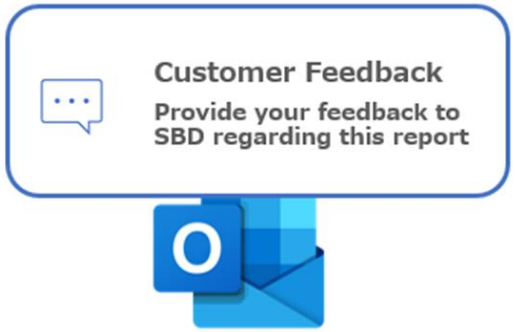
3000d - EVS36 Event Report



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Introduction

A brief introduction to the EVS36 event and the report

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What is EVS36?

The EVS event series commenced in 1969 as a distinguished global academic forum and has since established itself as the foremost and most extensive gathering in the global electric transportation industry. The 36th Electric Vehicle Symposium and Exposition (EVS36) was orchestrated and hosted by EDTA in Sacramento, California. It serves as a platform to exhibit pioneering advancements within the industry and stands as the longest-standing international conference dedicated to electric transportation and related technologies.

Encompassing captivating presentations delivered by industry experts and thought leaders, an exposition featuring exhibitors from across the globe, and various networking events, EVS36 presents diverse opportunities to demonstrate leadership, gain insights from professionals, and enlighten the public and media about electric transportation technologies.

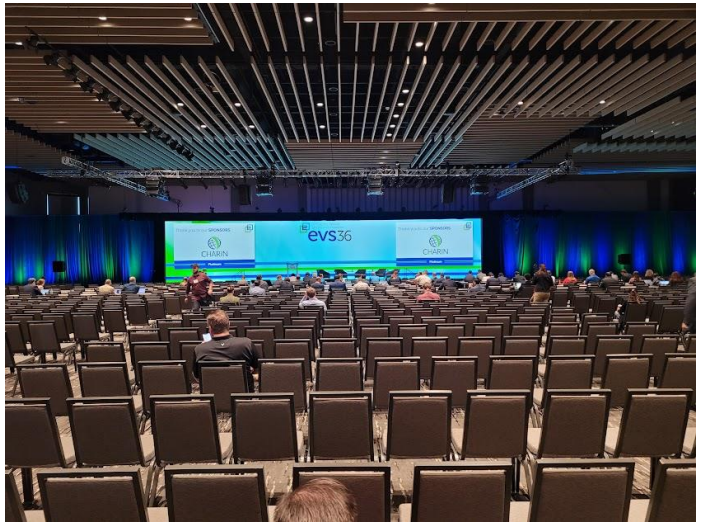
Report Focus

SBD's EVS36 event covers a wide range of topics, providing key information and insights related to the electric vehicle industry. Throughout the event, notable highlights are discussed, shedding light on the latest developments, advancements, and trends within the field.

Sessions
67

Stakeholders
2,200

Exhibitors
184



Source: EVS36

Conferences & Sessions

Summary of presentations and panels during the show with insights into trends discussed

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Plenary Session: Driving the Transition to E-Mobility

Interesting statements during the plenary session:

Fiona Ma:

- Arnold Schwarzenegger was instrumental in progressing California's climate initiative. He famously switched from supporting large Hummers to efficient EVs. Governor Newsome has pledged to maintain the climate initiatives despite budget deficits.
- California beat their 1.5M ZERV target by 2 years. $10B of State funding has been earmarked to reach the next goal of 100% ZEV sales by 2035. Currently, 21% of all vehicles on the road in California are zero emission, compared to 4% in the USA.

Christopher Coes:

- $7.5B in funding is being provided over the next 5 years to establish a world class charging network, ensuring sufficient coverage for all drivers.
- Community chargers will be the lynchpin of a sustainable charging network.

Paul Lau:

- SMUD is committed to eliminating all carbon emissions from our energy supply by 2030. We are running a managed charging pilot program with Ford, BMW, and GM.

Patty Monahan:

- GM was one of the first automakers to agree with Governor Newsome's commitment to decarbonizing transport in the state.
- Charger reliability is currently a major challenge. Tesla learned how to solve this early on. Other automakers and CPOs are starting to understand this as well.

Key Takeaway

EVS is a unique event in that it moves to a new location around the world each year. This provides the host city, state, and country with an opportunity to highlight their efforts to decarbonize transportation in the region. This opening plenary was a great example of this, with representatives of the US government, the State of California, and the local Sacramento utility providing insights into the electric vehicle market and industry. With California being the most progressive state (in decarbonization) in the US and the still fresh US IIJA and IRA acts, there was plenty to highlight!

Presenters:

- Fiona Ma – USA, State Treasurer
- Christopher Coes - Assistant Secretary for Transportation Policy, USA
- Paul Lau – SMUD, CEO & General Manager
- Patty Monahan - California Energy Commission, Commissioner

Session List

SMUD Sacramento Municipal Utility District




Session 1E: Supporting EV adoption through EV hotspots analysis

- We needed to model the uptake of EVs to ensure that the grid can support future adoption.
- We decided to model the city of Ottawa as a first test.
- Our census data showed a strong correlation between household income and EV ownership. Correlation (R) values have ranged from .40 up to 0.53 from 2017 to 2020.
- We modelled EV uptake based on income groups, with high income groups increasing much faster than lower income. By modelling this on a street-by-street basis, we can begin to understand the potential EV uptake rates and therefore the need for charging.
- This methodology can be used by utilities to estimate where power must be built out as EV sales increase.
- Going forward, we need to consider the potential impact of used EVs on the uptake, since these will be more affordable and may allow lower income families to electrify at a faster rate than we currently see.

Presenter:

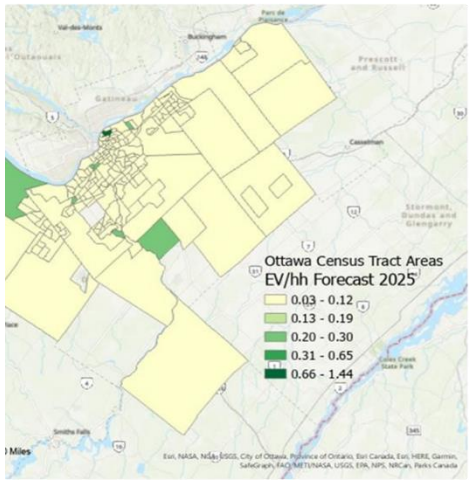
Session List

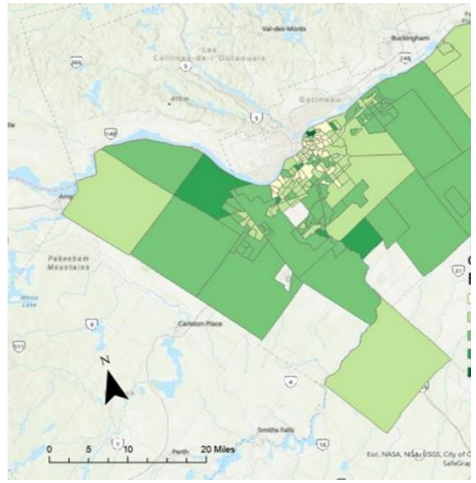
- Hajo Ribberink - Natural Resources Canada

Natural Resources Canada | Ressources naturelles Canada

Canada

EV Hotspots in Ottawa in 2025 and 2030





Source: Natural Resources Canada

Key Takeaway

One of the major concerns about the electric revolution is that electric grids (both regional and local) will not be able to cope with the increased demand for electricity. Many electric utilities and government groups have forecasted the future demand various methods. Here, Natural Resources Canada presents a new approach to forecasting the power demands by modelling the uptake of EVs based on the income level of residence on each street in Ottawa. Assumptions were made around the likelihood of purchasing a new EV versus due to income levels, but they have not yet figured the purchase of used EVs into the model.

Session 1E: Coming of age

Understanding electric vehicle (EV) use over time via used vehicle market data

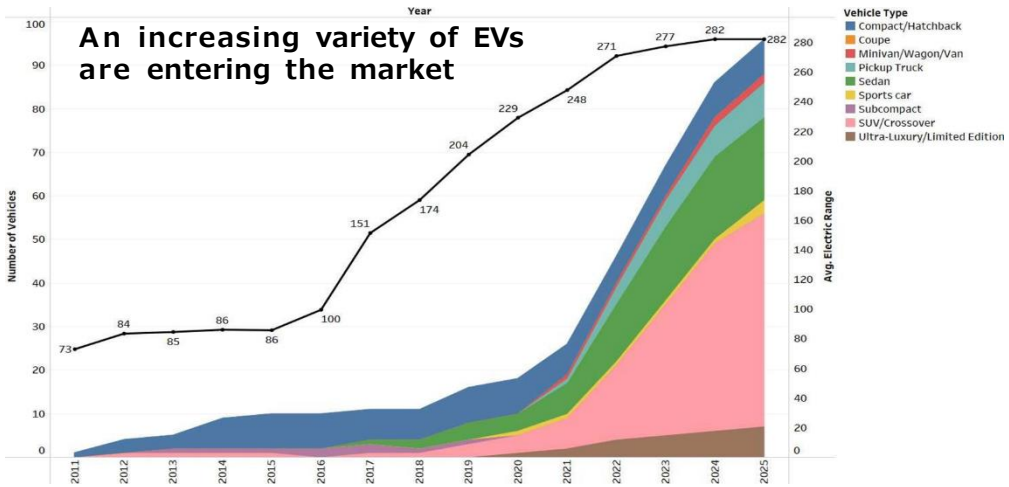
- Estimates of EV use vary widely from 5,300 miles per year to 12,500.
- EPRI's study includes 174,000 vehicles, which is a much larger sample size than from other studies.
- PHEVs are used slightly less than hybrids and BEVs are used significantly less than hybrids.
- An additional 100 miles of range is associated with 1,000 additional miles of annual usage.
- Teslas are used more than non-Teslas, regardless of range.

Presenter:

Session List

- Allan Zhao - Electric Power Research Institute (EPRI)

EPRI ELECTRIC POWER RESEARCH INSTITUT



Source: EPRI

Key Takeaway

- The study highlights the average use of EVs compared with hybrids and PHEVs and finds that the average yearly use of BEVs is lower than the other two.
- Yearly EV use varies between 5,300 and 12,500 miles a year and Teslas (which are much more in number) are used more on average.

Session 1E: Plug-in hybrid adopters and BEVs

Do plug-in hybrid adopters switch to battery electric vehicles (and vice versa)?

- One third of EV sales in California last year were repeat EV buyers.
- PHEVs were initially considered to be a 'transitional' technology.
- We conducted a survey of 4,167 consumers to understand their vehicle replacement patterns.
- One third of PHEV owners switched to a conventional vehicle, another third switched to BEV, and the remaining third stayed with PHEV.
- The majority of BEV owners stay with BEV, yet some go to conventional or PHEV.
- Regarding the reasons to switch from BEVs to PHEVs, many said it was because their vehicle's range was too short (especially if they adopted a short-range BEV), another major reason was wanting to spend more time outdoors where chargers are more difficult to find.
- Reasons to switch from PHEV to BEV are dominated by wanting to reduce operating expenses and wanting to reduce their vehicle emissions.
- Those that switched from BEV to ICE found that charging was inconvenient, and they did not have level 2 charging access at home. BEVs with a short range did not have a significant effect on pushing people toward ICE.
- A reduction in the number of vehicles in the household leads to a shift away from electrification.
- We recommend that BEVs and PHEVs are incentivized to have longer ranges, and ensure access to charging at home

Key Takeaway

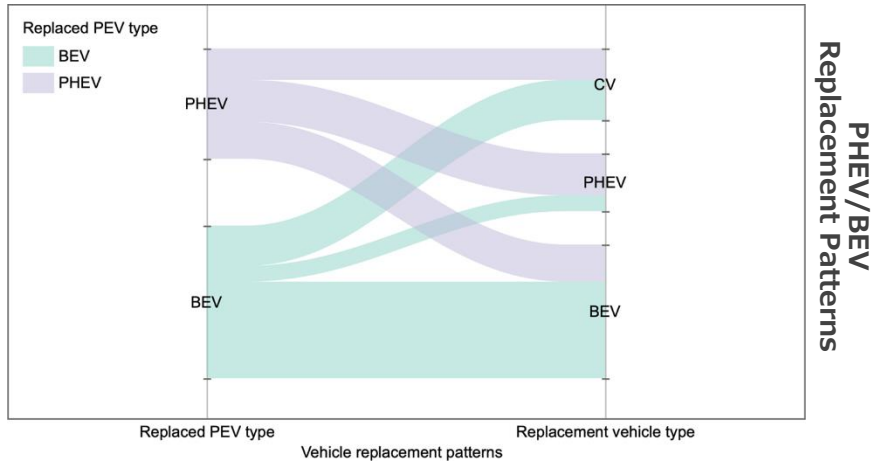
- While the majority of BEV owners are likely to stick to their choice, lacking charging infrastructure both public in remote areas and private at home is causing some to shift to PHEVs or ICEs.
- Short range also plays a role in owners moving away from BEV albeit not a major one.
- The main driver for BEV adoption is the lower operating expense and reduced emissions.

Presenter:

Session List

- Scott Hardman – Researcher, University of California Davis (ITS-Davis)

UC DAVIS
UNIVERSITY OF CALIFORNIA



Source: University of California Davis

Session 1E: Building on what is already working

Describing a more nuanced understanding of rebated EV consumer groups

- We surveyed people who qualified for California's Clean Vehicle Rebate to understand their drivers and barriers to buying an EV.
- "The highest-value information channels are experience-based and peer-centric, though some groups prioritize expert opinions.
- "Messaging emphasizing practical benefits, such as cost savings, charging convenience, and HEV/Carpool benefits may be particularly useful for more racially and ethnically diverse consumer groups."
- "Finding info about electricity rates and metering options is difficult across the board, especially for younger buyers"
- About 72% of applicants are male with 83% having at least a bachelor's degree in the household. 77% of applicants own a detached house.
- The most influential information sources are: Other PEV drivers, vehicle test drives, and third-party car-buying websites.

Presenter:

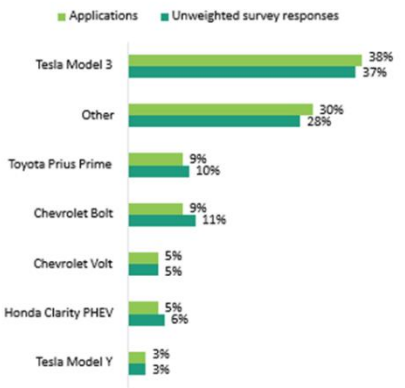
Session List

- John Anderson - Center for Sustainable Energy

Center for Sustainable Energy®

Application and Survey Data

Purchase/Lease Dates	1 June 2017 – 30 November 2020
Program Participants (Applications)	N = 198,922 PHEV: 57,162 (29%) BEV: 136,005 (68%) – Tesla: 92,142 (46%) – Non–Tesla BEV: 43,863 (22%) FCEV: 5,755 (3%)
Survey Response Dates	1 August 2017 – 24 March 2021
Survey Respondents (unweighted)	n = 33,524 PHEV: 9,599 (29%) BEV: 22,925 (68%) – Tesla: 14,597 (44%) – Non–Tesla BEV: 8,328 (25%) FCEV: 1,000 (3%)
Weighting Method	Iterative Proportional Fitting (aka raking)
Representative Dimensions	Vehicle technology type (PHEV vs. BEV), model, purchase vs. lease, residence county
Program as % of EV Market	43% (with FCEV, 42% without FCEV)



Source: Center for Sustainable Energy

Key Takeaway

- On behalf of the California Air Resource Board (CARB) the Center for Sustainable Energy's Clean Vehicle Rebate project (CVRP) promotes EV adoption with rebates between $1,000 and $7,500.
- Among the drivers and barriers to the EV purchase for subjects eligible for the CVRP, there is the importance of information channels such as car-buying 3rd party websites, vehicles test drives, and clearer information about electricity rates, and practical benefits.

Session 2A: Charging Infrastructures for Mobility Electrification

Sizing of charging infrastructures for mobility electrification under smart charging conditions

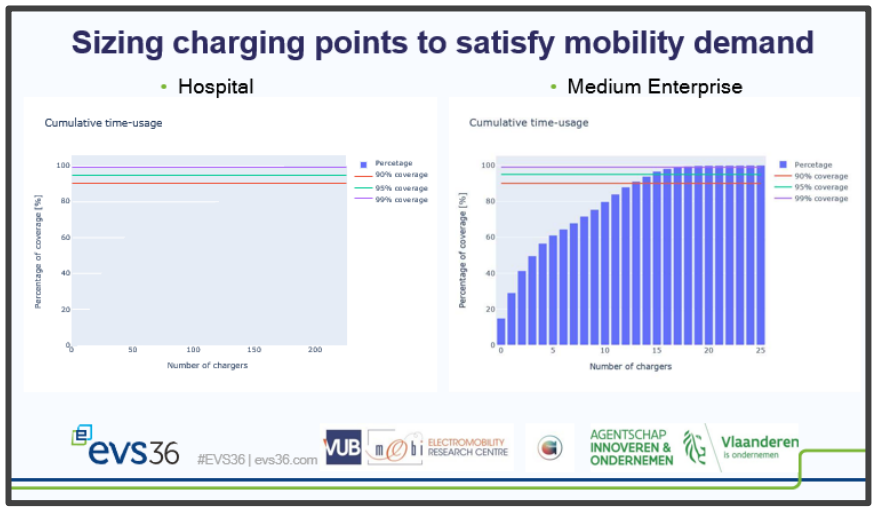
- As businesses begin to electrify their parking lots for employee and visitor usage, they need to decide what power level to offer to optimize smart charging.
- We developed a model for a medium enterprise company and for a hospital to determine what size chargers should be installed.
- The team used actual charging data form the hospital to understand the average usage.
- Smart charging enables maximization of self-consumption (meaning no need to sell power back to the grid) which is the best solution.
- The cost of owning a photo-voltaic system can be reduced significantly if smart charging is used
- The number of simultaneous charging sessions can be just a fraction of the total number of vehicles in the fleet.

Presenter:

Session List

- Cedric De Cauwer - Vrije Universiteit Brussel

VRIJE UNIVERSITEIT BRUSSEL



Source: Vrije Universiteit Brussel

Key Takeaway

- For the proper development of a charging infrastructure which is key to the wider adoption of EVs it is necessary to gain an understanding of the size and level of power offered by smart chargers.
- Smart charging can impact positively the infrastructure by enabling the maximization of self-consumption and reducing the financial impact of photo-voltaic systems.

Session 3D: Accelerating the transition

How the UK and Canada are delivering the demand, supply and infrastructure for electric vehicles

- Both the UK and Canada are working to rapidly transition transportation to electricity
- The UK's zero emission mandate was developed based on some of California's zero emission policies. The initial requirements go into effect in 2024, with an increase to 100% PHEV or BEV by 2030.
- Canada is working on similar legislation that is expected to be rolled out later this year.
- The UK offers plug-in vehicle grants for motorcycles, taxis, vans, and large trucks. The general plug-in grant has ended since the larger-volume passenger vehicle market appears to be stabilizing naturally.
- Canada provides an incentive for all road vehicles, including tax incentives. This can be as much as $200,000 CAD for heavy trucks.
- Canada's Green Freight program helps companies reduce their fuel consumption.
- The UK is aiming to increase their 42,259 public chargers to 300,000 by 2030. Canada is aiming to increase theirs from 21,000 to 85,000 by 2027.
- Canada and the US just announced the Canada-US Alternative Fuel Corridor to allow transit from Kalamazoo, Michigan to Quebec City, Canada.

Key Takeaway

- With different stages of development both Canada and the UK are continuously developing their own regulations for EVs and charging infrastructure growth.
- The UK has already stopped the subsidies for passenger vehicles as the market starts to develop organically, but maintains those for motorcycles, taxis, vans and trucks.
- Canada still maintains tax incentives for all road vehicles.

Presenters:

- Nick Shaw - UK Office For Zero Emission Vehicles
- Zoiey Cobb - Transport Canada

Office for Zero Emission Vehicles

Transport Canada Canada

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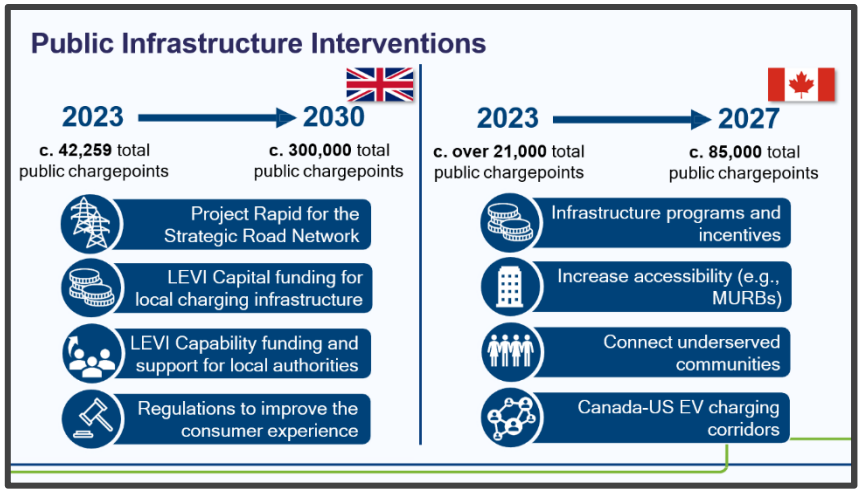

Source: UK Office For Zero Emission Vehicles and Transport Canada

Session 3D: UK ZEV mandate

A world-leading regulatory framework to drive supply and consumer confidence

- The UK has legislated to be a net zero economy by 2050. The 2030 ZEV mandate is a step toward that goal.
- The UK is creating a tradeable CO2 credit to help automakers achieve these goals. This will be separate between cars and vans, but the two metrics will affect each other.
- The tradeable credits will be given to automakers for the non-ZEVs that they don't make. These can then be traded on the open market.
- These credits will mandate a 120-mile range and an 8-year / 80,000-mile warranty including the battery (70% State of Health), motors, and fuel cells.
- There are flexibilities that allow automakers to borrow credits from the government in the 2024-2026 period, but they must be paid back. A compounding interest rate of 3.5% is applied to any credits borrowed.
- Through 2029, requirements can be waived if a manufacturer builds less than 2,500 vehicles, yet they are allowed to bank credits for any ZEVs that they do build.
- If an automaker cannot meet their targets, they must pay £15,000 per car and £18,000 per van. This is similar in magnitude to penalties applied in California and Canada.
- This legislation is still being finalized, expecting to be published this Summer, to go into effect Jan 1, 2024.

Key Takeaway

- The UK is finalizing a new set of regulations featuring tradeable CO2 credits that should help it achieve the net-zero target by 2050.
- The credits will be granted to OEMs producing zero-emission vehicles with requirements of at least 120-mile range, and 8-year/80,000-mile range.
- Credits can be traded and borrowed, but fines are applied for OEMs missing the targets.

Presenter:

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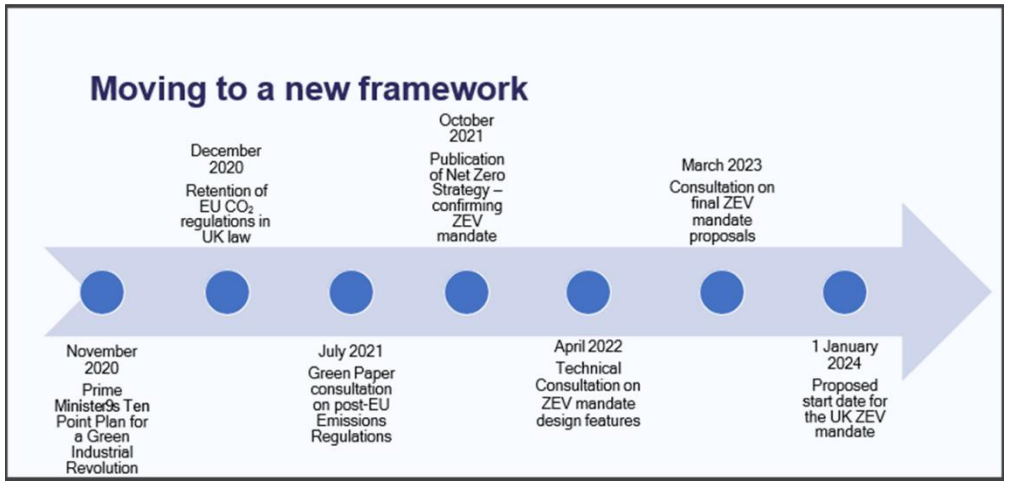
- James Vickery - Department For Transport, UK

Department for Transport



Source: Department For Transport, UK

Session 4B: Exploring Workplace/public charging

Exploring workplace or public charging demand for electric vehicles (EVs) in California

- In California, 35.6% of PEV drivers had to rely on public charging or work charging because they had no access to charging at home.
- We've been able to show that when free charging is offered at workplaces, charging demand shifts from home to work linearly. So if workplaces begin to offer free charging, we will expect a shift in power demand from suburban/rural areas to urban areas.

Presenter:

Session List

- Kihyun Kwon - Institute Of Transportation Studies, UC DAVIS, United States

ITS UCDAVIS INSTITUTE OF TRANSPORTATION STUDIES

MODEL RESULTS (Charging Demand)

- eVMT
  - The daily statewide average eVMT is 307.3 (miles)
  - If workplace charging is free, the charging demand will increase by 43%
  - If home charge accessibility decreases from 90% to 64%, the charging demand will increase by 3£%
  - If the portion of long-range EVs increases from 85% to 95%, the charging demand will increase by 0.13%

Table 4. eVMT at work destinations for commute trips

Scenarios	Assumptions of charging characteristics			Charging Demand Model (eVMT)			
	Long range fraction	Access to charging at home	Workplace charge free	Mean	Std Dev	Min.	Max.
Base	85%	90%	Paid	307.3	1692.1	0	88170.5
Free work charge	85%	90%	Free	440.5	2425.5	0	126292.1
Low home charge	85%	64%	Paid	406.5	2238.1	0	116582.9
High long range	95%	90%	Paid	307.7	1694.4	0	88295.6

Source: UC DAVIS

Key Takeaway

- Charging infrastructure development remains a key point to EV adoption and users' habits.
- The research observed how since the majority of EV users do not have access to private charging, free charging offered sometimes in workplaces has the potential to shift significantly the power demand from rural areas to urban ones.

Session 4B: Effect of temperature on EV range

How temperature affects electric vehicle range: On-road testing results with four BEVs?

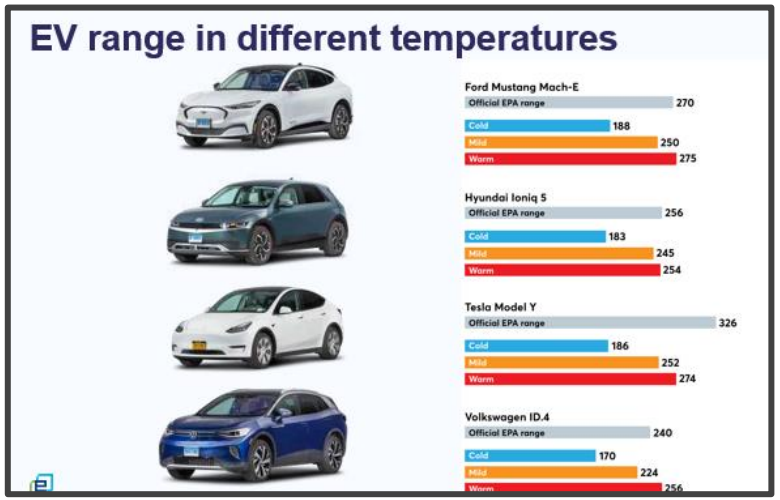
- Consumer Reports tested 4 vehicles to understand how range was affected in differing weather conditions. They tested the Ford Mustang Mach-e, Hyundai Ioniq 5, Tesla Model Y, and VW ID.4 on the same section of highway, at the same speed, same climate control settings, and with the same drivers. This covered very cold, warm, and moderate temperatures.
- We found that the range was the longest during warm humid summer days, which was a bit surprising.
- The Mach-e stood out as having the most accurate range prediction.
- We expected the cars to underperform their EPA range due to the EPA tests occurring at lower speeds versus our highway testing.
- The vehicles on average lost 25% of their range due to cold weather (versus moderate) and closer to 35% versus warm weather.
- The Tesla Model Y greatly underperformed its EPA rating.

Presenter:

Session List

- Gabriel Shenhar - Consumer Reports

Consumer Reports



Source: Consumer Reports

Key Takeaway

- The research observes the significant differences in EV battery performance on highways based on 3 different weather conditions: warm, moderate, and cold.
- The best performance is obtained in warm humid weather. The worst result is obtained in cold weather where the range loss was 25% higher than in moderate weather and 35% higher than in worm one.

Session 4B: How EV drivers navigate vehicle charging

How do electric vehicle drivers navigate the real and virtual worlds of vehicle charging?

- UC Davis interviewed 18 EV drivers to understand their charging behavior.
- We found a clear divide between Tesla charging experiences and everyone else.
- Typically, EV owners use the OEM's mobile app to set their maximum SOC and the charging start times (specifically because of time-of-use rates in California). The maximum SOC is usually set to the OEM's recommended maximum. They may override if they know they have a long trip the next day.
- If they do no have home charging, they do not use the OEM's app and instead use a public eMSP's app to find a public charging location and plan their route.
- For non-Tesla drivers, the drivers may use multiple networks and the selection is driven by what incentives are offered by the OEM, such as e-tron drivers selecting Electrify America since VW provides a free charging allowance there.
- Non-Tesla drivers rarely use the OEM's app if they rely on public charging. They also often don't use the built-in navigation system's route planning and instead rely on 3rd party apps like ABRP or Plugshare.
- All drivers typically use an app to check their charging options prior to making a long trip, but they will actively manage the route, selecting the chargers that look best to them.
- For routine long trips, drivers will learn which chargers they like to use the most and ignore routing guidance.
- 17 of the 18 drivers interviewed had stories of unreliable charging.
- They also asked for better design of the parking spots and layout.

Key Takeaway

- A series of interviews to EV owners revealed how Tesla still leads the EV charging experience thanks to its vertical integration.
- Non-Tesla owners are less likely to use OEMs proprietary apps and will instead rely on 3rd party ones for finding the chargers, and even for navigation and route-setting.
- Almost all the interviewed drivers had issues with unreliable chargers.

Presenter:

Session List

- Kenneth Kurani - Electric Vehicle Research Center, University Of California, Davis

UCDAVIS
Electric Vehicle Research Center
Institute of Transportation Studies

Asked to talk about charging information, EV Drivers say they want better information

- **Better Information about Charging**
  - Detailed information about amenities near to/at chargers
    - Presently, information provided by in-vehicle navigation, EVSE network providers, and third-parties is often vague and generic
      - Link information to user reviews, e.g., Yelp?
  - Information about the charging location itself may be incomplete
    - Where charging is located within a larger facility such as a regional mall or multi-level parking structure
  - Driver-supplied information
    - Capability for EV drivers to provide updates gives PlugShare the appearance of being the most accurate, up-to-date, and useful
    - For those EV drivers for whom <participating in the community= is important, this feature is one way they do so

Source: University Of California, Davis

Session 4B: Charging management strategies

Charging management strategies: Techniques to increase charger utilization and reduce congestion

- Charging at work motivates people to buy EVs, but crowded or congested charging at work demotivates them.
- In this study, we are trying to improve utilization of workplace charging infrastructure by reducing stagnation (station blocked after charging is complete) and congestion (more EVs than chargers).
- We completed 40 semi-structured interviews with drivers.
- The majority of drivers interviewed typically charged at home while only a few charged primarily in public.
- Many of the workplaces required some form of eMSP membership such as ChargePoint
- In some cases, workplaces impose certain rules around charging, such as limiting to a certain number of hours or requiring that you move your car during lunchtime.
- Valet charging is a premium option where workplaces employ someone to move the vehicles around to ensure that they are all charged throughout the day.
- "Digital Queueing" is where people can wait for a charger by selecting an in-use charger in an app (such as ChargePoint), and the app will tell them when the current vehicle has been filled or disconnected.
- Collective management strategies such as using joint spreadsheets, email groups, and group chats, can be useful for small groups.
- Valet charging is certainly the most effective, but also the most expensive option.
- We recommend clear rules around charging and enforcement. There should also be more parking spots than EVSEs so that a single vehicle doesn't block the EVSE.

Key Takeaway

- Interviews with EV owners find that the majority rely on home charging.
- For the ones relying on public charging, workplaces become the main resource and usually require a membership.
- Charging spot management via alerts, valet charging, limited charging hours, or other systems is key to avoiding a few drivers occupying chargers for a whole day.

Presenter:

Session List

- Katrina Sutton – Calstart, United States

Background: Where do people charge?

- Primarily Home (50–80%) –charging when you are at home
- Work (15–20%) –where people park when they are at work
  - Charging at work motivates adoption of PEV
  - Congested workplace charging deceases PEV adoption
- Public (5%) –charging that is neither at work or home

Source: Calstart

Session 5A: GridShield

Mitigating unforeseen local power peaks on the grid caused by EVs

- In the near future, smart charging will be mandatory to prevent brown outs due to the growth of EVs, especially in the Netherlands.
- Smart charging will solve the majority of the excess demand situations, however additional safeguards are needed to prevent unpredictable situations.
- GridShield is a proof-of-concept project run by ElaadNL to improve grid resiliency by delaying or shutting down charging when grid capacity is strained. This is particularly important for renewable energy generation where solar and wind energy can fluctuate unpredictably.
- The GridShield system was paired with ElaadNL's Smart EMS system which has a user interface that allows the driver to select how much charge they need and by when. The price adjusts dynamically based on the expected grid impact and time-of-use fees.
- The physical components of the GridShield system consists of an RF transmitter attached to the transformer which measures the energy being used, and a receiver in the individual chargers. When necessary, a signal is transmitted to the chargers to tell them to reduce power consumption. As additional capacity becomes available, the system can tell the chargers that they can increase power delivery.

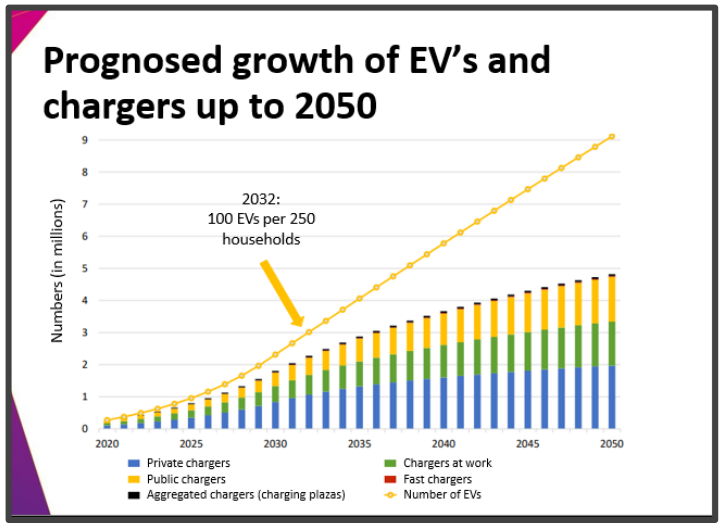
Key Takeaway

- The GridShield project is based on smart charging to improve grid resilience as the number of EVs on the market increases and smart charging eventually becomes mandatory.
- The project by ElaadNL uses a smart EMS system for EV owners to select the amount of charge needed at a specific time and delivers it by adjusting price depending on the time and impact of charge on the grid.

Presenter:

- Frank Geerts - ELAADNL

Session List



Source: ELAADNL

Session 5A: Charging Failures

The prevalence of charging failures during DC fast charger uptime

- The US NEVI Formula Program requires an annual uptime of at least 97%. $7.5B of funding support those chargers that can meet this requirement.
- Currently reliability is generally lower that this level, so as an industry we need to understand the reasons for low reliability and resolve it.
- Few studies employ actual data related to reliability and “uptime” has various definitions.
- Many remote uptime studies ignore interoperability issues that could be difficult to find in the data sets.
- We collected data from 54 rest areas, covering thousands of sessions from 2019 through 2022.
- Two brands of EVSE were studied. Successful events were measured at 54% for Brand A versus 71% for Brand B. This was based on simply confirming that the session dispensed at least 1kW.
- However, we discovered that unsuccessful events were over-represented because a user would retry multiple times which would be recorded as multiple failed charging events.
- To fix this, we grouped the failed events for the same user ID. This was only possible with Brand B as Brand A didn’t have a user ID, but we were able to filter out failed events for Brand A that occurred within 5 minutes of each other.
- Using this analysis method, we discovered that 17% of events failed to start. 3% of sessions that started, failed to complete.
- Brand A’s failure rates were still much higher than Brand B, so we looked at what the causes were.
- The majority of failures were labelled as communication errors, but some sessions failed without any error listed.
- To improve reliability, we recommend that error codes are standardized, uptime is precisely defined, and interoperability testing is completed.

Key Takeaway

- The analysis looked at two brands of EV chargers and quantified their failure rate, considering the US NEVI formula program that provides up to $7.5 bn funding for chargers with uptime of at least 97%.
- Uptime was 83% overall, with the majority of errors labelled as communication.
- Error code standardization and uptime definition are required to improve reliability.

Presenter:

Session List

- Tisura Gamage - University Of California, Davis, Electric Vehicle Research Center

UCDAVIS
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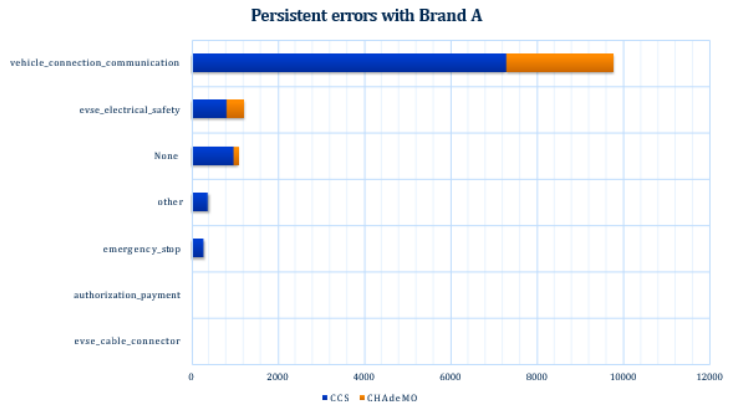
Institute of Transportation Studies

Causes of Charging Failures



Source: University Of California, DAVIS

Session 5A: Deep Learning Tool

Developing a deep learning tool to detect electric vehicle supply equipment failures

- UC Berkeley recently conducted a survey of 181 open DCFC stations and found that 25% of chargers had reliability issues. However, a survey of CPOs claimed that 95-98% of chargers were operational.
- Mechanical, electrical, communication, membership issues are the various categories of common failures.
- CPO's typically perceive a much higher uptime because they cannot see all failure types. For instance a mechanical or communication failure cannot be reported to the CPO.
- This study's purpose is to help CPOs understand when a failure is occurring even if it isn't reported by the EVSE.
- The study used data from 80,000 sessions in an hourly time series. A naïve probabilistic approach was used with LSTM-AD to create a machine learning algorithm. Anomalies were classified by the type of error reported.
- As an example, we can estimate the probability of charging within each hour. The probability of not charging in a particular hour can be quite high (70+%), but the probability of no use for several consecutive hours is very low. By monitoring the usage patterns, we can detect when a charger is likely blocked or otherwise disabled despite no error being reported.
- CPOs can use this tool to set up alerts when an anomaly is detected. Each anomaly will have a specific probability related to it and that will change over time, allowing the CPO to decide at what point action should be taken versus waiting for high probability to be confirmed.
- We recommend that CPOs eliminate RFID and app requirements and for EVSEs to employ roaming SIMs so that a single mobile network failure doesn't lead to session failures.

Key Takeaway

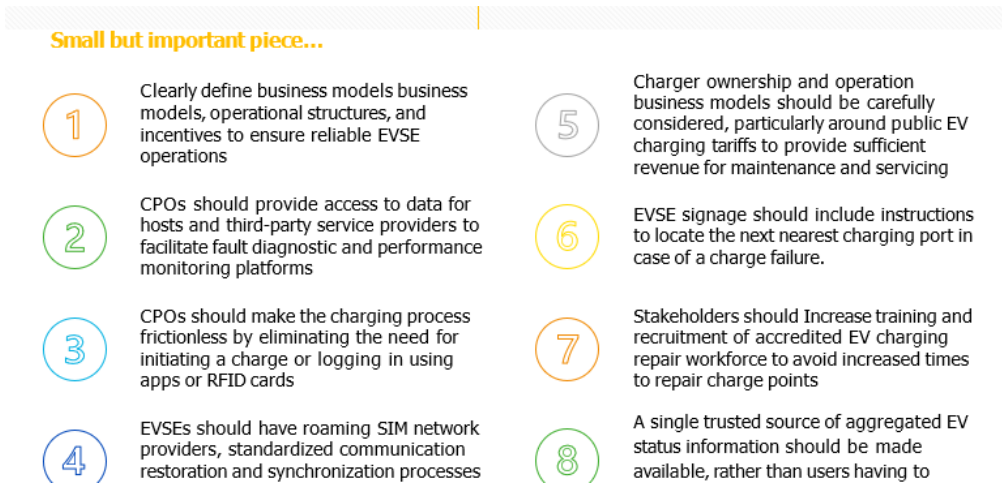
- In this study, UC Berkeley found that 25% of chargers have reliability issues, but only a small percentage is identified by CPOs resulting in unreliable uptime reports.
- Via a machine learning algorithm anomalies are classified and reported. The tool developed is able then to calculate a probability of the time, duration, and likelihood of malfunctioning events, which can be adopted by CPOs to improve the service and autonomously decide when to take action.

Presenter:

Session List

- Vaishnavi Karanam - Institute Of Transportation Studies, UC DAVIS

ITS UCDAVIS INSTITUTE OF TRANSPORTATION STUDIES



Source: University Of California, DAVIS

Session 6E: Battery Research and Innovation

Battery research and innovation – a study of patents and papers

- This project sought to understand which countries had been developing the greatest number of patents and scientific papers.
- The volume of patents and papers are the same, where X patents in a country would be roughly X papers in that same country.
- China produced more patents and papers than any other country by a wide margin. More than half of all papers and patents related to batteries now belong to China.
- Few of the Chinese papers included cooperation between universities and corporations at only 2%. At the other end of the scale, Germany and Japan had around 11% with corporate and academic cooperation.
- We also studied how frequently the papers were cited in other papers. United States and Canada were cited approximately three times more than the average. China was also cited more than average. German patents were seldom cited.
- More patent applications are being issued in China versus papers in recent years, which suggests that practical application of their research is leading to production.

Presenter:

Session List

- Hans Pohl - Lindholmen Science Park, Sweden

Lindholmen Science Park

Trends and ratios papers and patents

	2002 - 2007			2008 - 2013			2014 - 2019		
	Paper	Patent	Paper/ patent	Paper	Patent	Paper/ patent	Paper	Patent	Paper/ patent
Canada	389	194	2.01	849	240	3.54	2,619	390	6.72
China	2,717	479	5.67	10,937	3,772	2.90	48,138	54,485	0.88
France	778	274	2.84	1,452	845	1.72	2,572	1,188	2.16
Germany	499	915	0.55	1,582	4,391	0.36	5,604	6,608	0.85
Japan	1,862	4,349	0.43	2,621	11,117	0.24	4,643	14,300	0.32
South Korea	1,076	4,267	0.25	2,813	9,590	0.29	7,788	17,026	0.46
Sweden	159	43	3.70	284	97	2.93	988	149	6.63
United States	2,984	2,818	1.06	7,182	5,489	1.31	17,216	9,796	1.76
World	13,775	14,939	0.92	33,831	38,541	0.88	102,132	111,518	0.92

Source: Lindholmen Science Park, Sweden

Key Takeaway

- The research into battery technology papers and patents released observes how China is significantly ahead of any other country (with over 50% of the total) on this.
- Papers and patents in the same country usually match in number.
- Japan and Germany lead in terms for cooperation between private and universities with around 11%, while US and Canada ones are cited 3 times more than the average.

Session 6E: Battery chemistry choices by OEMs

Battery chemistry choices by OEMs: Implications for future EV transitions

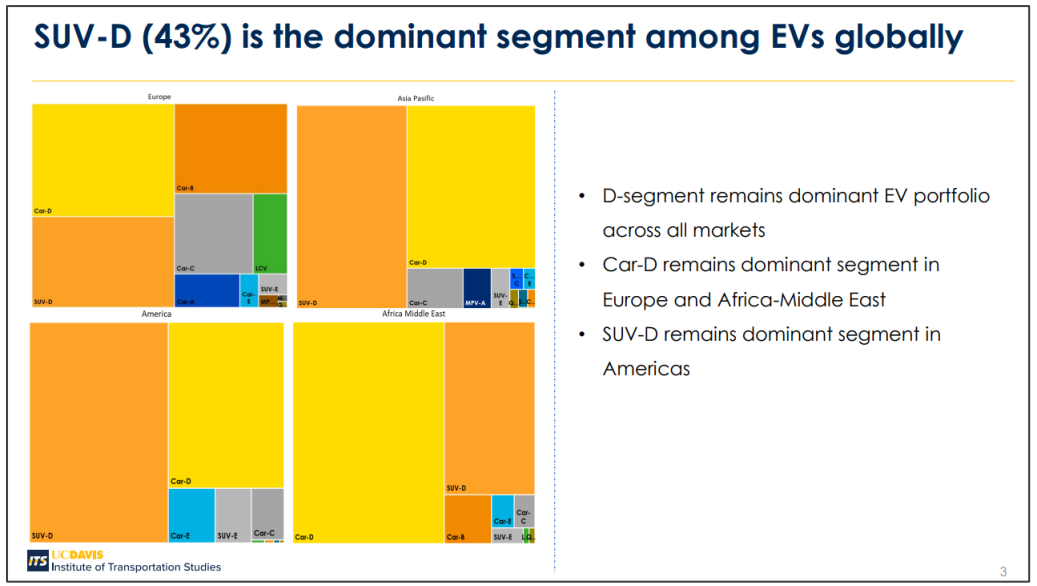
- Affordability is the key factor that drives OEMs' selection of battery chemistry. In Asia, there's a nearly even split between LFP and NMC. Whereas in the Americas, the split is between NCA and NMC, and in Europe it is almost all NMC. Because Asia (particularly China) has a very mature market, lower cost vehicles must be made available to continue to drive volumes to lower-wealth individuals. More nascent markets like Europe and the Americas, are targeting wealthier consumers as the first wave of adopters.
- SUV-D and CAR-D segments are dominant in the EV portfolio.
- China produces 80% of all batteries around the world, with 50% of those being NMC 523/622.
- In North America, NCA is dominant because of Tesla's preference for the technology. This is not seen in other regions.
- BEV SUV-D segment sales increased fivefold between 2021 to 2022.
- PHEV trends are shifting from SUV-D to SUV-C segment.
- Supply chain risk is also another reason to choose one chemistry over another.
- The various on-shoring regulations like the IRA (US), PIL (India), and EU Batt will limit OEMs' chemistry choices.

Presenter:

Session List

- Hanif Tayarani - University Of California, Davis, United States

UC DAVIS
UNIVERSITY OF CALIFORNIA



Source: University Of California, Davis

Key Takeaway

- Battery chemistry diffusion is highly diversified based on regional differences with LFP leading in Asia and especially China, NMC dominating in Europe, and NCA in the US.
- China is moving to offer low-cost EVs to significantly increase the volumes, while in both Europe and US the target market for EVs is still the wealthy.
- Affordability remains a key factor for EV battery chemistry adoption and diffusion.

Session 7E: Heterogeneity of electric vehicle features

Heterogeneity of electric vehicle ownership across rural California

- We evaluated the impact of various features on the environment and cost of operation.
- The features evaluated were:
  - Eco-Driving
  - Eco-Charging
  - Smart-Fast Charging
  - Smart Thermal Management (Battery and Cabin Preconditioning)
  - Heat pump product changes
- The analysis looked at 3 vehicles: An LCV, a small BEV, and a large PHEV
- We evaluated 3 different driving scenarios across the three vehicles.
- Belgium was used as a normalized baseline because of the milder climate.
- The features reduced cost between 4 and 11%. Urban trips are expected to provide additional advantages, but this was not studied here.
- The main advantage to these features is the ability to reduce battery size.

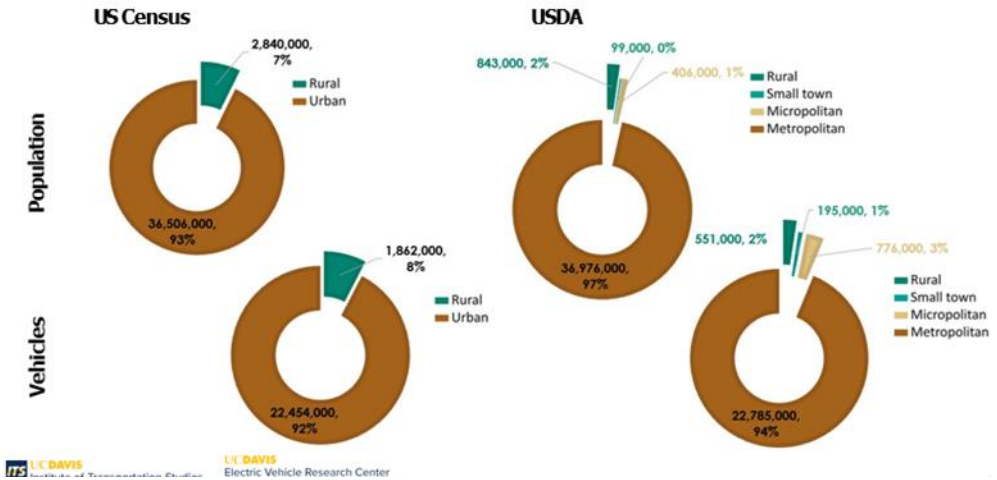
Presenter:

Session List

- Anya Robinson - University Of California, DAVIS United States

UC DAVIS UNIVERSITY OF CALIFORNIA

Different definitions tell different stories



Source: University Of California, DAVIS

Key Takeaway

- The research highlights the advantages of adopting features such as eco-driving, eco-charging, smart-fast charging, smart thermal management, and heat pump products, with the main one being the ability to reduce battery size.
- By taking 3 different kinds of vehicles as samples, the study finds that the use of these features reduced costs by 4 to 11%.

Session 7E: Economic and environmental assessment

Economic and environmental assessment of technologies optimizing the execution of long trips for electric vehicle

- Rural areas lag urban areas in EV adoption. Since California aims to be carbon-neutral by 2045, it's critical that all populations are understood to ensure electrification meets the state's goals.
- There are 66 million rural residents in the US, which is 20% of the population, but are spread over 97% of the land mass. California's rural residents account for 7% of the state's population.
- The Section 177 states that follow California's CARB regulations account for 25% of the US's rural population.
- This study aims to understand the differences between rural and urban EV drivers.
- Our study shows that urban areas are more likely to have older vehicles. This means that rural areas will have a larger impact per vehicle on the environment for the same vehicle type.
- Our study also shows that EVs are located mostly along the California coast while pick-up trucks are located mostly inland. The two categories are nearly mutually exclusive.
- We determined that we cannot make a one-size-fits-all recommendation to solve the rural heterogeneity issues. However, we also need to consider:
- There is a greater opportunity for at-home charging due to the higher proportion of detached homes.
- Cohort clusters may help to inform the relevant incentive types for rural areas.
- Rural areas are likely to be more difficult to electrify for several reasons, one of those being a higher proportion of lower-income families.

Key Takeaway

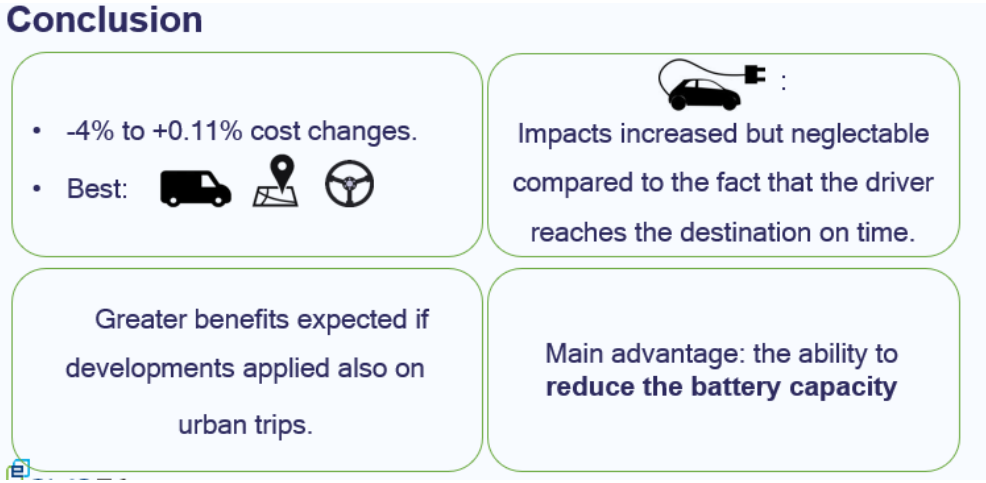
- The study highlights the differences between rural and urban areas and the subsequent differences in EV adoption in California.
- The differences go down to vehicle types with pickup trucks located inland while EVs are mostly on the coast. But rural areas tend to have newer vehicles and thus a larger impact per vehicle on the environment. While heterogeneous and with a higher % of low-income families, rural areas also present opportunities like more convenient home charging.

Presenter:

Session List

- Léa D'Amore - Vrije Universiteit Brussel – MOBI

VRIJE UNIVERSITEIT BRUSSEL



Source: Vrije Universiteit Brussel – MOBI

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Expert Insight

Industry focus has shifted to charging

While automakers are still heavily focused on improving vehicle capability and quality, the broader EV industry focus has firmly shifted to charging infrastructure, as clearly underscored by an audience poll conducted at EVS36. Charging infrastructure involves dozens of industry sectors and business models as well as thousands of individual companies, making collaboration and coordination absolutely critical to the successful deployment of convenient and reliable charging systems.

Robert Fisher, Domain Principal - Electrification, SBD Automotive

A global EVS, not quite an American show

EVS36 Sacramento, USA seemed scaled down vs. prior EVS35 Oslo, Norway in terms of overall automotive industry presence, breadth of expo, and visitor attendance. It was unexpected to observe a quite limited proportion of US-based providers and US-based professionals, given the location. The elephant in the hall was Tesla NACS charging connector and its ambitions of becoming a standard in the US, given the show happened only days after the related announcements by Ford and GM to adopt it.

Alessio Ballatore, Business Development Director, SBD Automotive

Enabling more BEV miles is still the goal

In order to drive more BEV miles, owners must be provided with the necessary charging facilities. Vehicle manufacturers, charging providers and Government must pay careful attention to the accessibility of chargers and how they can increase the number of BEV miles travelled. Organisations that can optimise the placement and capacity of public charging facilities, based on real-world data, have the greatest potential to achieve this goal.

Mike Levet, Senior Analytical Reports Specialist, SBD Automotive

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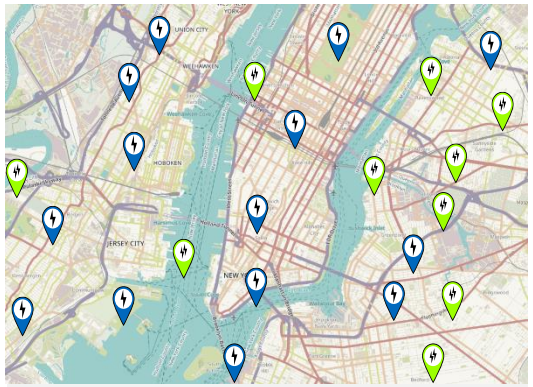
EV Guide

SBD's EV Guide provides insight into the current situation for mass-produced passenger and light commercial EVs, their features.

Learn more



EV Charging & Infrastructure Guide

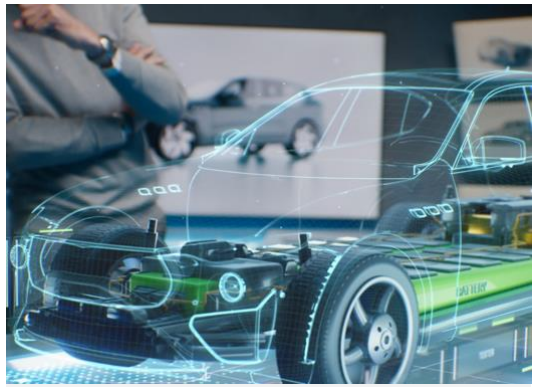
This guide maps out the current landscape of EV charging and tracks its developments.

Learn more

EV Legislation & Incentives Guide

The guide provides in-depth analysis of how and where legislation is impacting electrification in the automotive industry.

Learn more



EV Battery Technologies & Ecosystem

SBD's new battery report dives deep into the technologies, chemistries, and players in the battery industry.

Learn more

Contact SBD Automotive

Do you have any questions?

If you have any questions or feedback about this research report or SBD Automotive's consulting services, you can email us at info@sbdautomotive.com or discuss with your local account manager below.

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