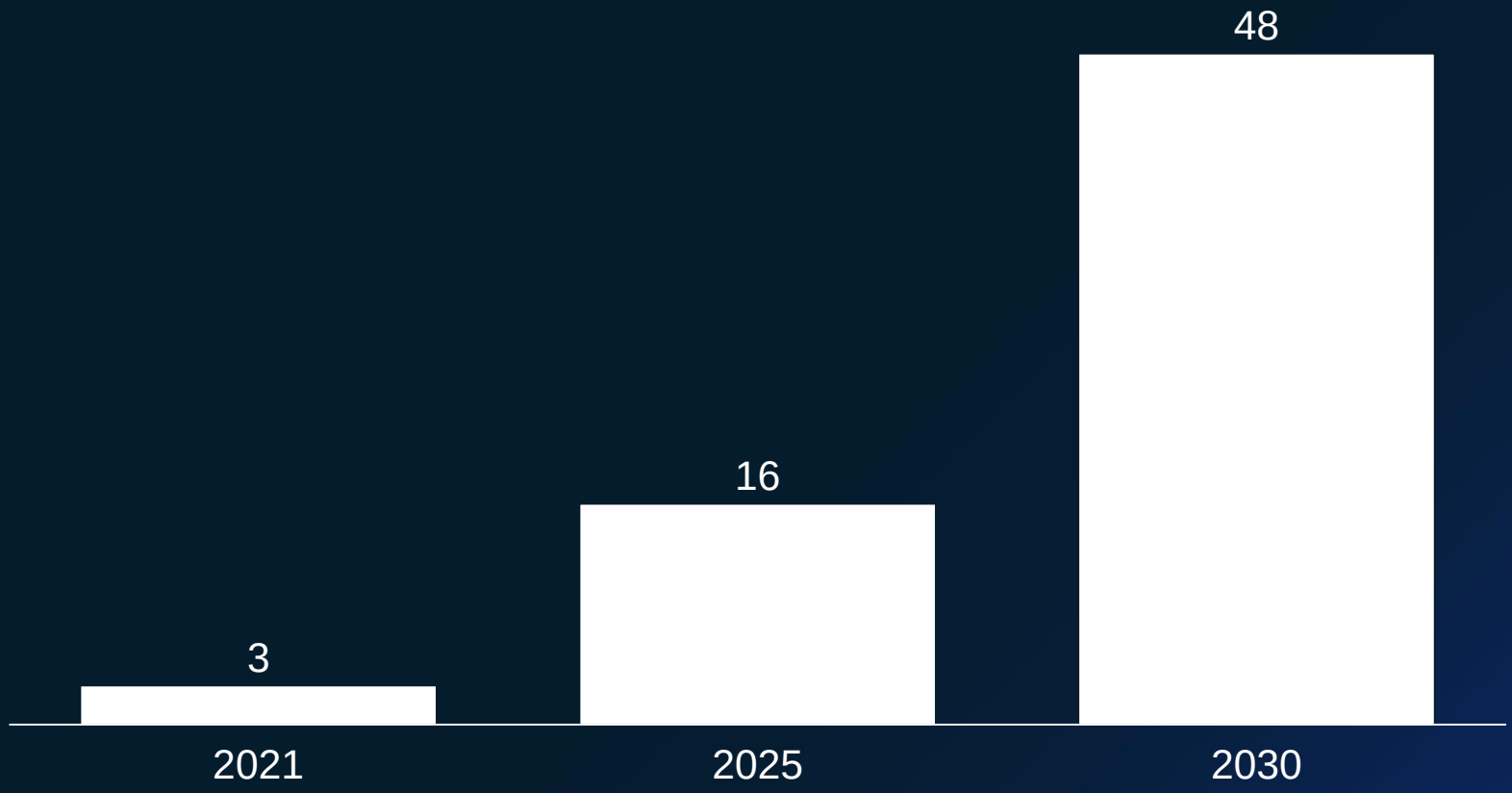
Key EV/EVCI questions facing states

1. **What will demand be for EVs and thus, EV chargers?**
2. Where should chargers be located?
3. How can the EV/EVCI investment be funded or financed?
4. How can states support this transition?

48M electric vehicles could be on the road in less than 8 years

EV parc (total number of vehicles)[1], Millions of BEVs and PHEVs



1. Based on a scenario where zero emissions vehicles (battery electric vehicles, plug in hybrid electric vehicles, fuel cell electric vehicles) account for half the vehicles sold in the United States in 2030, in line with a federal target that half of new passenger cars and light trucks sold in 2030 are zero emissions vehicles

Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

Automakers and battery manufacturers have announced new US manufacturing plans

Recent announcements for EV production and supply chain investments

Not comprehensive

Automotive OEMs

"**GM plans $4 billion** to convert the Orion, Mich. Assembly plant to produce **electric versions of the Chevrolet Silverado and GMC Sierra** pickup trucks. Production of the **Bolt EV and Bolt EUV** will continue during the conversion." ***(Forbes,1/25/22)***

"…**Ford to bring electric zero-emission vehicles at scale** to American customers… Called BlueOval City, the complex will be constructed on a nearly **6-square-mile site in west Tennessee** and build next-generation electric F-Series pickups…" ***(Ford, 7/21/21)***

"The local (Georgia) economic development agency…approved its portions of the deal (for) **Hyundai Motor Group to build a $5.5 billion electric car plant** near Savannah… Hyundai plans to build **the company's first U.S. plant dedicated to electric vehicles**… to start construction next year and begin producing up to 300,000 vehicles per year in 2025" ***(AP, 7/19/22)***

"**Rivian to site second manufacturing plant in Georgia**… in Morgan and Walton Counties. The project represents a $5-billion site development and manufacturing investment. Once ramped, the Georgia facility will be capable of **producing up to 400,000 vehicles per year**." ***(Rivian, 12/16/21)***

Battery Manufacturers

"**Panasonic, Tesla's main battery manufacturer** and a key investor in the company's earliest days, says it intends to build a **massive $4 billion battery plant in Kansas** to supply packs for the auto industry's fast-moving shift to electric cars and trucks…The project will be **one of the largest battery plants in the U.S.**" ***(Forbes, 7/14/22)***

"The **U.S. Energy Department** on Monday announced it intends to **loan a joint venture of General Motors Co (GM.N) and LG Energy Solution (373220.KS) $2.5 billion to help finance construction of new lithium-ion battery cell manufacturing facilities.**" ***(Reuters, 7/25/22)***

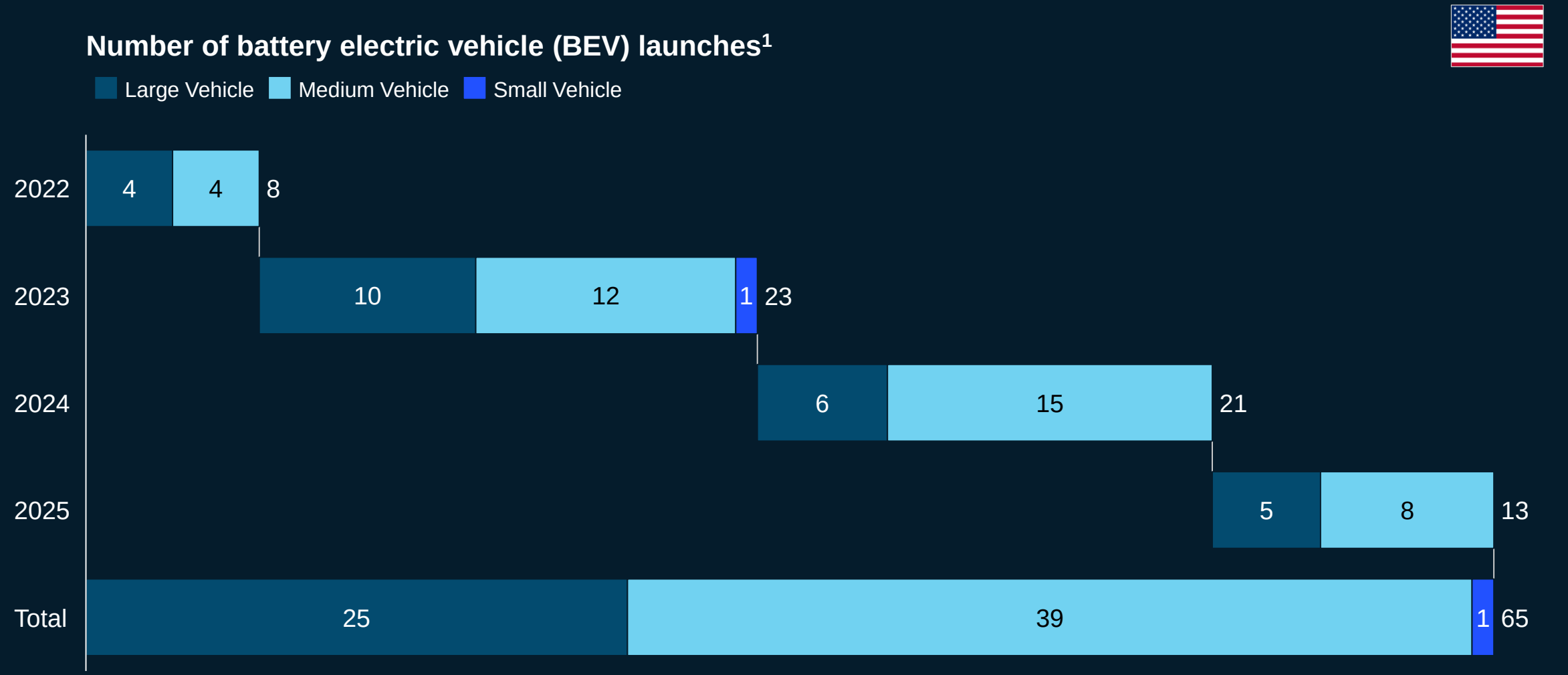
Materials Production and Mining

"**Albemarle** Corp (ALB.N) plans to build a lithium processing plant in the United States that **would produce as much of the electric vehicle battery metal as the entire company produces today**, a bullish bet on America's all-electric…" ***(Reuters, 6/27/22)***

Talon's acquisition of the Michigan Nickel Properties is **directly responsive to Senator Manchin and other national leaders on both sides of the aisle to take urgent action to establish a battery mineral supply chain from mine to battery within the United States**" ***(Talon, 8/10/22)***

Source: Press Search (August 12)

Electric-vehicle production is expected to increase by 2025

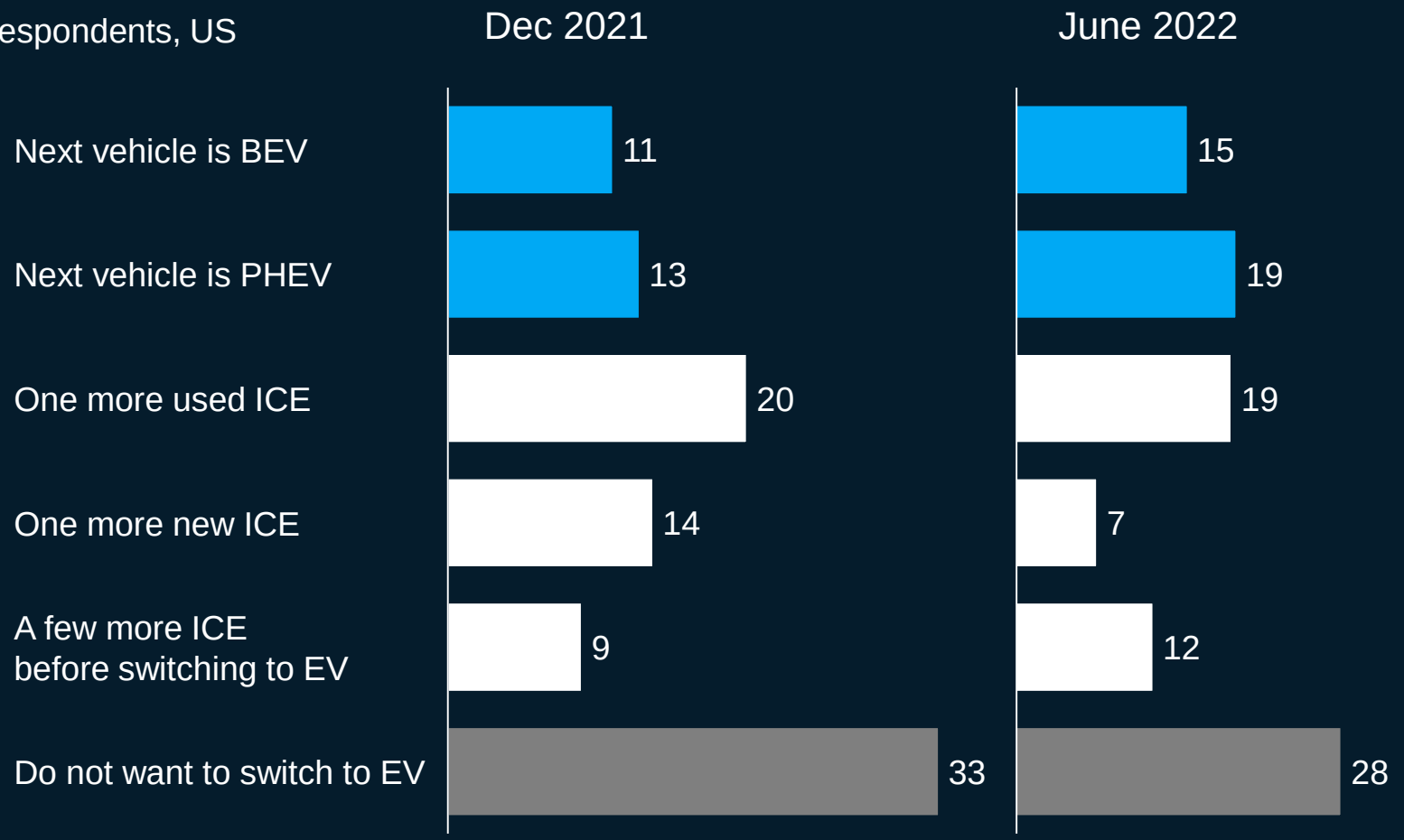


1 Vehicle size classification based on automotive industry class segmentation: small =A/B segment, medium = C/D segment, large = E/F/HVAN segment.
Source: IHS Automotive, "Net-zero emissions in US government fleets" (April 2022)

Next vehicle is electric for 34% of American consumers – significant acceleration of electrification intent in 6 months

Buying waves EV vs. ICE

Share of respondents, US



+10% pts

increase in consumer EV openness since December 2021

Source: MCFM Mobility Consumer insights, Ukraine Crisis Impact consumer survey, dated August 2022, global n = 4,096 US n = 507

What will EV charging demand be by corridor?

4 parc scenarios

30-year time horizon

20+ vehicle and user segments

50 states

8 Use cases


Single-family home


Multi-family home


Work


Destination


Fleet hub


Public overnight


Public fast off-highways


Public fast on-highways

9 charger technologies


AC Slow L1 (<4kw)


AC Slow L2 (4 – 15 kw)


AC Fast L2 (15 – 22 kw)


DC 25 kw


DC 50 kw


DC 120 kw


DC 150 kw


DC 350 kw


DC 500+ kw

Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

Key questions facing DOTs

1 What will demand be for EVs and thus, EV chargers?

2 **Where should chargers be located?**

3 the EV/EVCI investment be funded or financed??

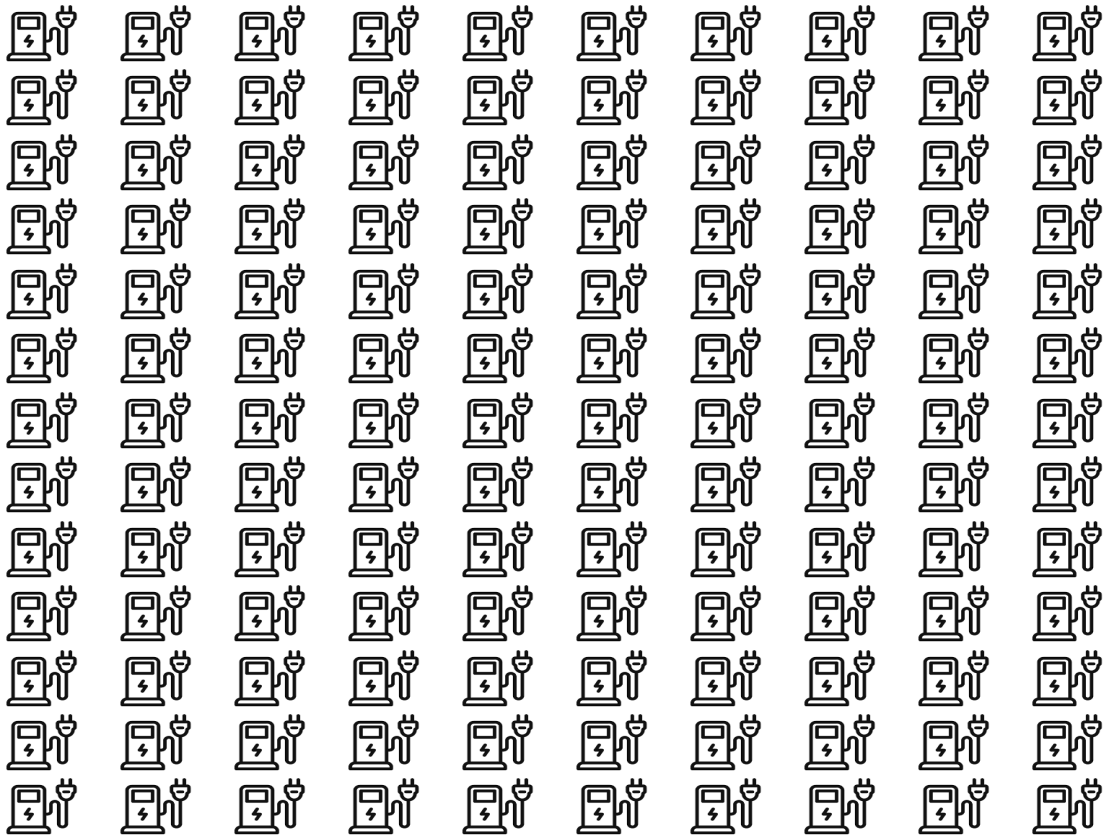
4 How can states support this transition?

1M+ public chargers required by 2030 to meet demand

10,000 chargers

2021 EV Public Chargers

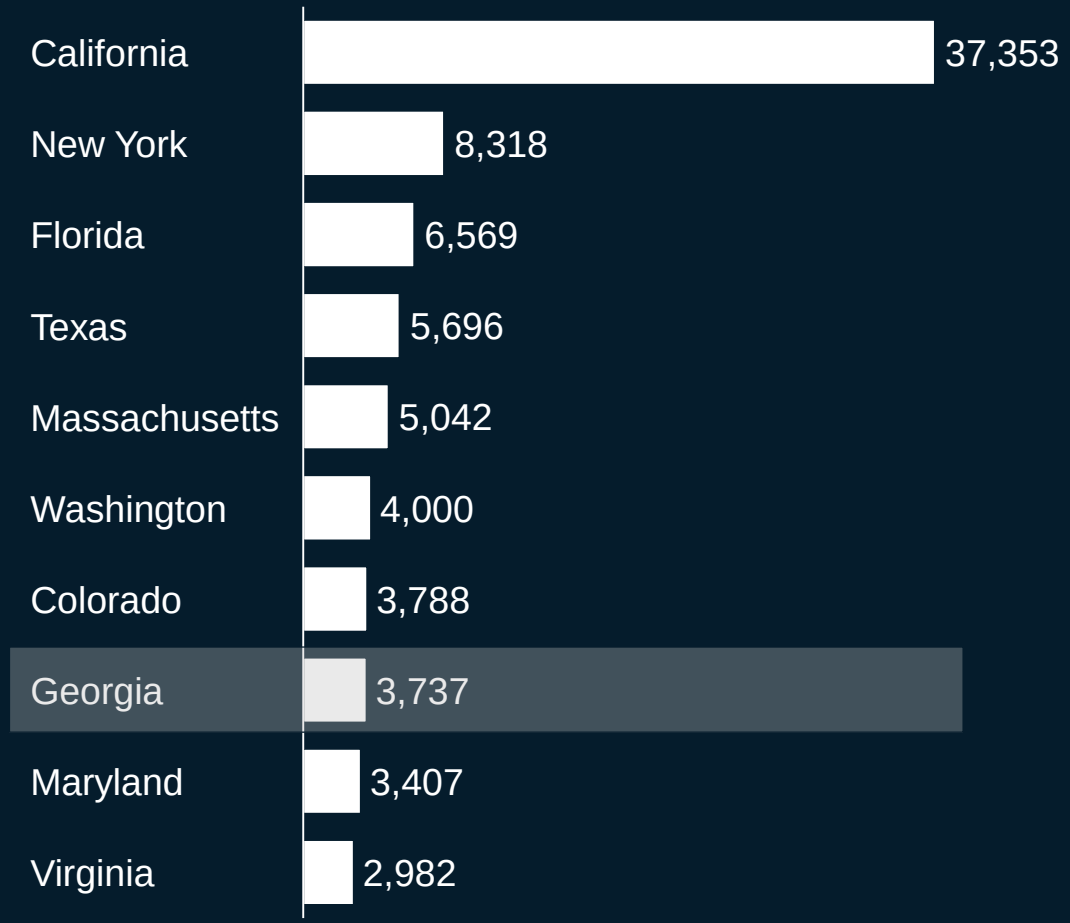
2030 EV Public Chargers



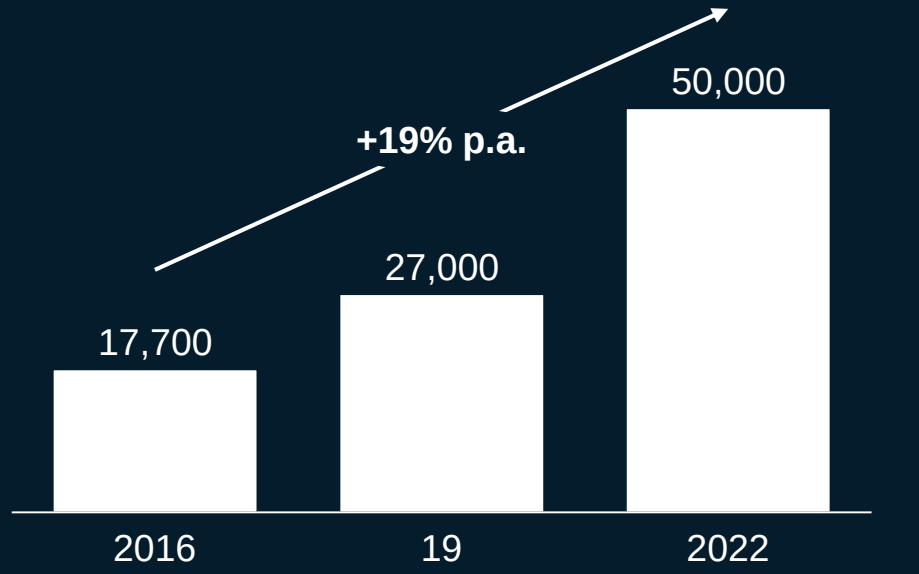
Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

The US electric-vehicle charging-infrastructure network has expanded significantly in recent years

Publicly accessible charging outlets in the US,
Number of outlets*



Publicly accessible charging stations in the US,
Number of stations*



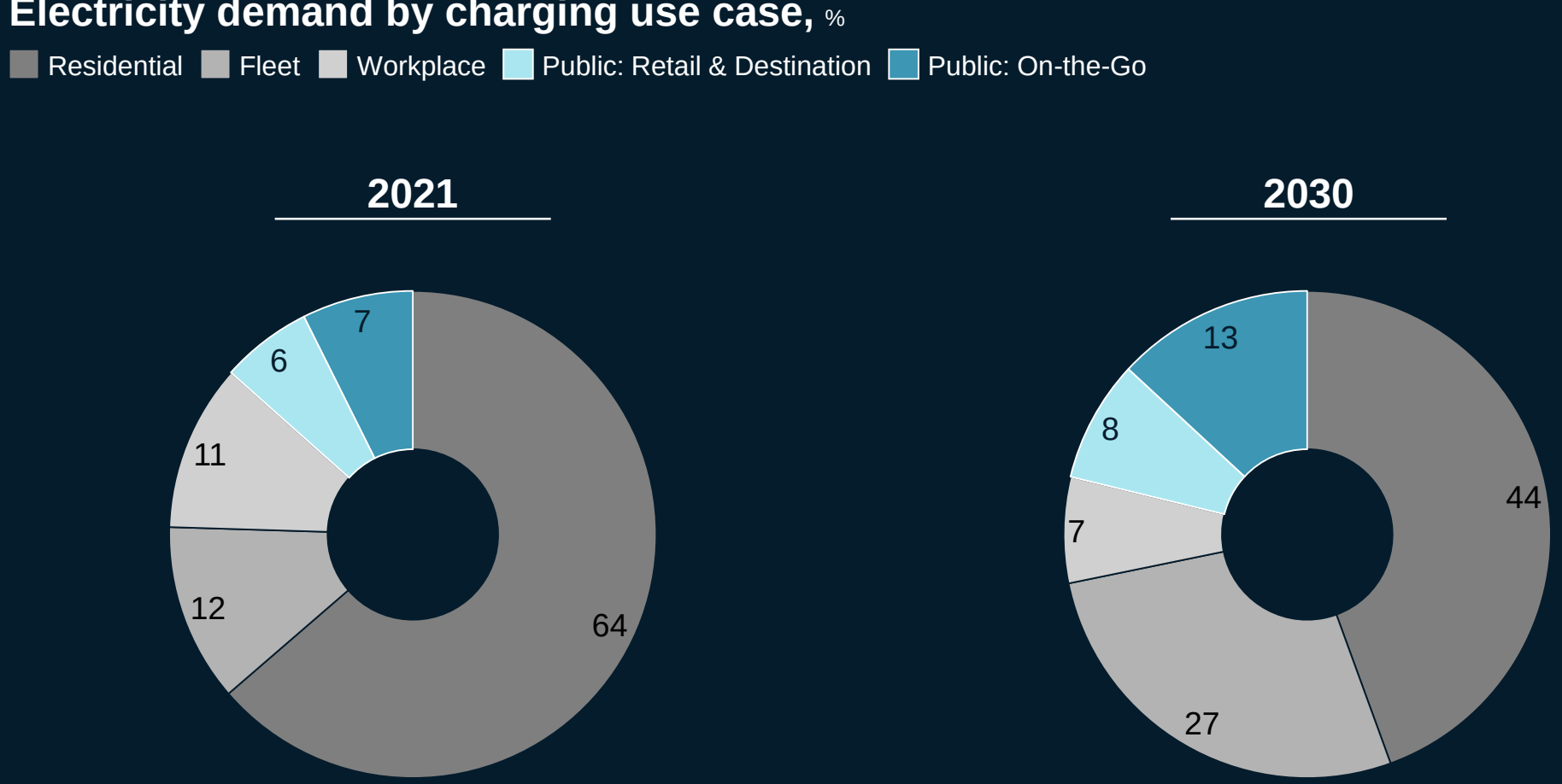
Total public stations in 2022*,
~50,000

Total public charging outlets in 2022*,
~128,000

* As of August 2022
Source: US Department of Energy, Alternative Fuels Data Center, "Net-zero emissions in US government fleets" (April 2022)

Public chargers would need to deliver more than 20% of the electricity consumed by EVs in 2030

Electricity demand by charging use case, %



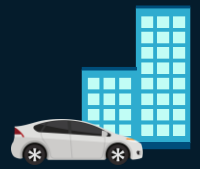
* Based on a scenario where electric vehicles account for half the vehicles sold in the United States in 2030, in line with a federal target.
Source: McKinsey Center for Future Mobility, Building the electric-vehicle charging infrastructure America needs (April 2022)

EVs have multiple options to “refuel” – out-of-home use cases with strongest growth until 2030

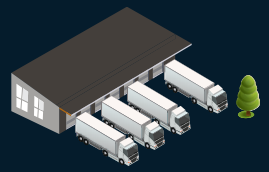
United States View | Base case | Apr 2022 | All vehicle types

Charging use case

Residential
(single & multi family)
- Private and/or shared parking
- Multiple hours/day



Work
(e.g. office, govt property)
- Shared parking
- Few hours during work (2-10 hours)



Fleet depot
(e.g. vocational, courier)
- Private parking
- Charging need dependent on fleet management

Public overnight
(e.g. on street / curb-side)
- Public parking
- Multiple hours overnight (>8hrs)

Destination
(e.g. mall, car park)
- Public parking
- Few hours during visit (<4 hours)

On-the-go
(e.g. retail EV charging stations)
- Public parking
- Quick necessary on-the go (<1 h)

% of energy charged

Today

~60% | ~10% | <5% | <1% | ~10% | ~15%

~70% across home and work

Commercial vehicles drive ~5-10x passenger vehicles miles with lower efficiency

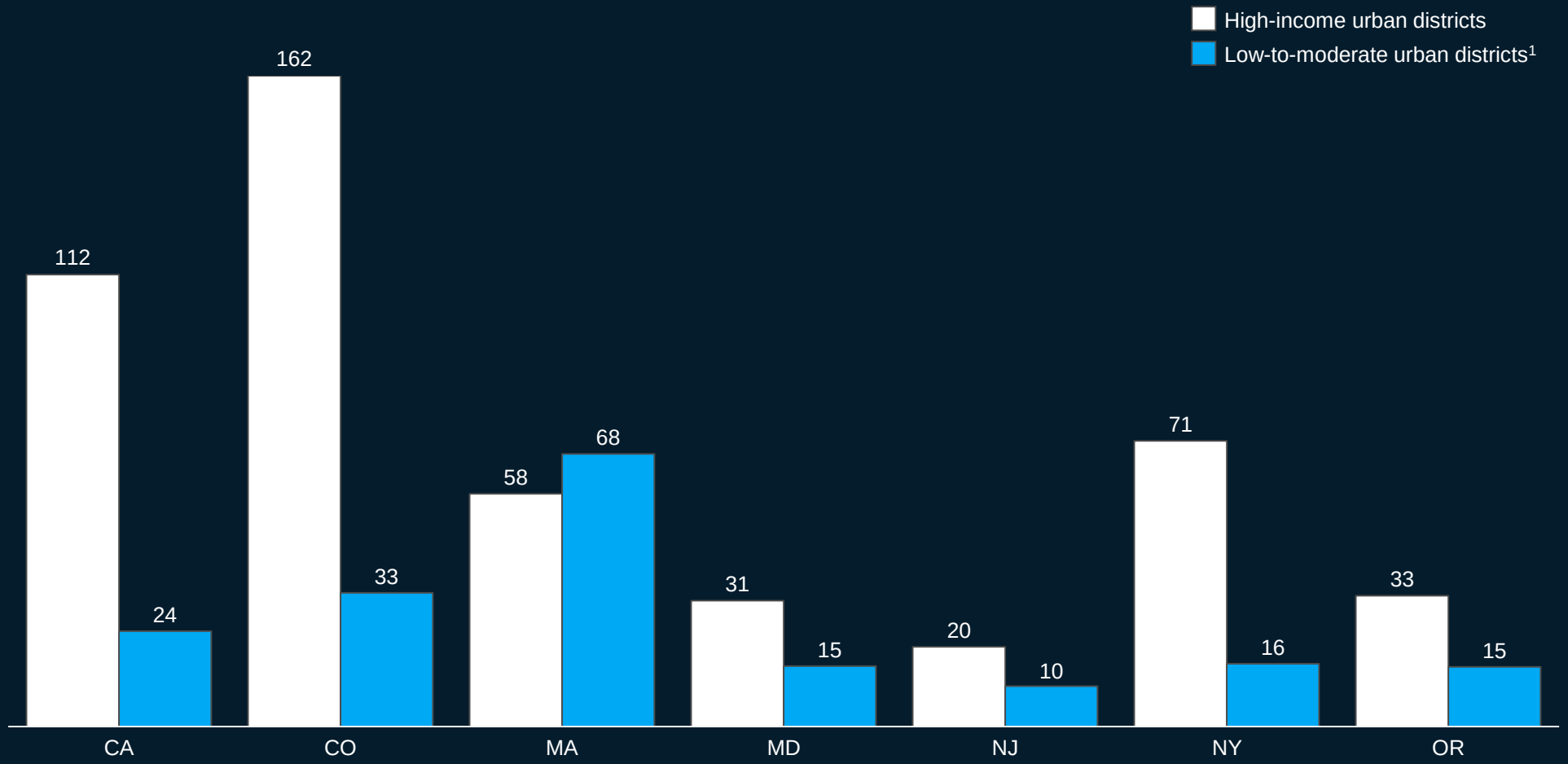
2030

On-the-go use cases

Source: McKinsey Center for Future Mobility (Apr 2022)

Public EV chargers are currently concentrated in high-income urban areas

Chargers per 100,000 households, by income level



1) Defined as having income levels lower than 80% of the area median income (AMI)

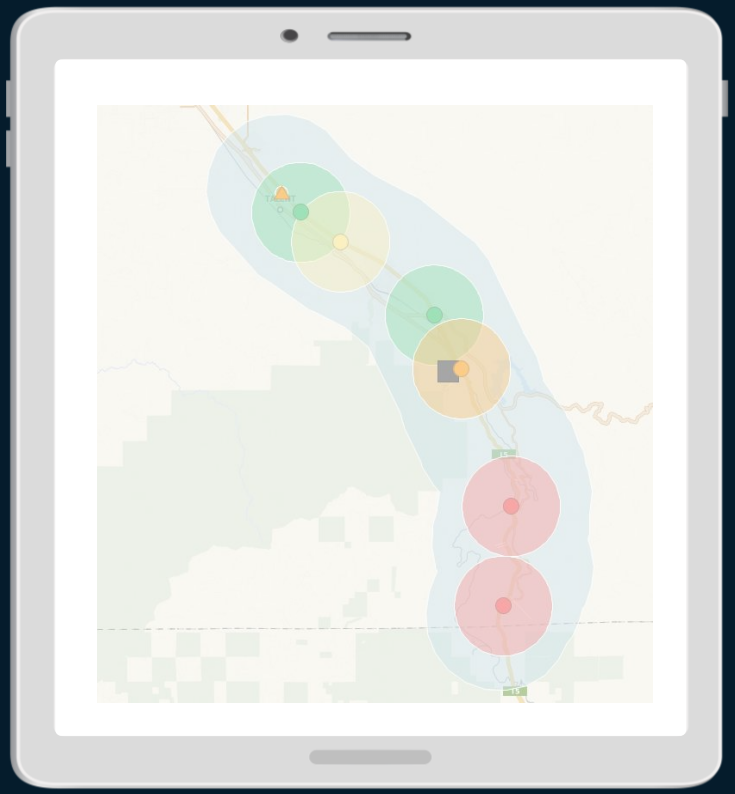
Source: Alternative Fuels Data Center, US Census, US Department of Housing and Urban Development, Building the electric-vehicle charging infrastructure America needs (April 2022)

At the micro-site level, where should chargers be placed?

A scoring rubric can be applied to each highway exit or rest area

Criteria	Average annual daily traffic		# of quick service restaurants		# of retail locations		# of gas stations		
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Other index
Strong	> 100k	> 40k	> 15	> 6	> 50	> 10	> 4	> 4	< 100
Middle	60k-100k	20k-40k	10-14	3-5	35-49	5-9	3	3	100-200
Weaker	< 50k	< 15k	< 5	0	< 25	< 2	0	0	> 300

Each highway exit and rest stop gets a rating



Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

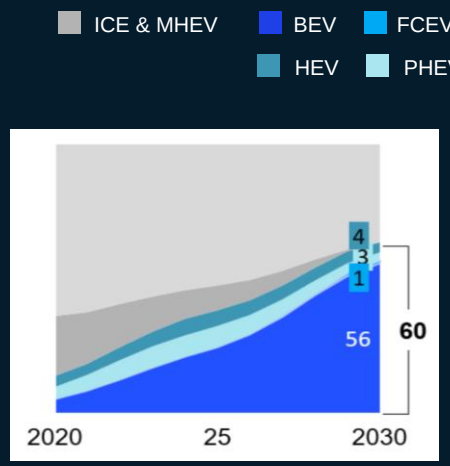
What infrastructure requirements at each site?

Not exhaustive Exemplary

1 EV parc

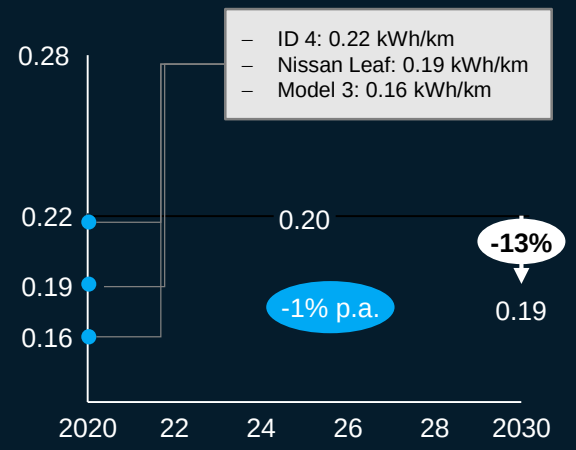
EV uptake, # of vehicles

Example



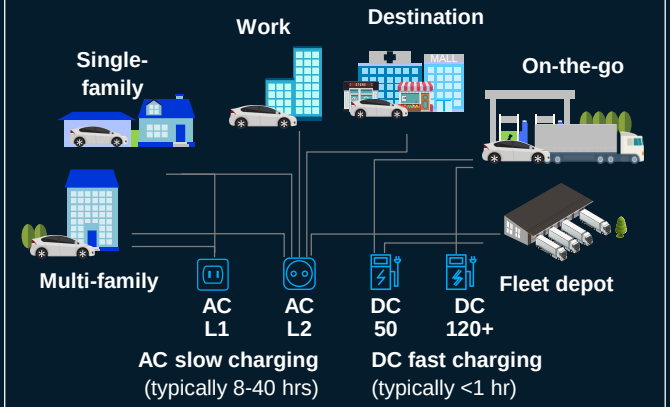
2 Energy demand

Vehicle efficiency, kWh/km



3 Charging behavior

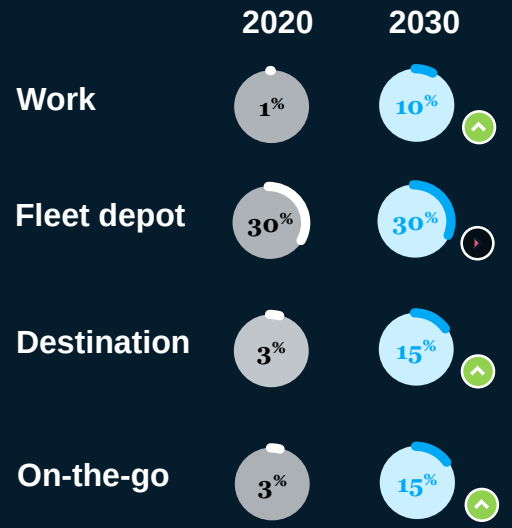
Use cases & technologies



4 Infrastructure need

Charger utilization, in %

Example DC 150 kw charger



Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

Key questions facing DOTs

1 What will demand be for EVs and thus, EV chargers?

2 Where should chargers be located?

3 How can the EV/EVCI investment be funded or financed?

4 How can states support this transition?

>$30B still to be accounted for installing public chargers

Additional Funding

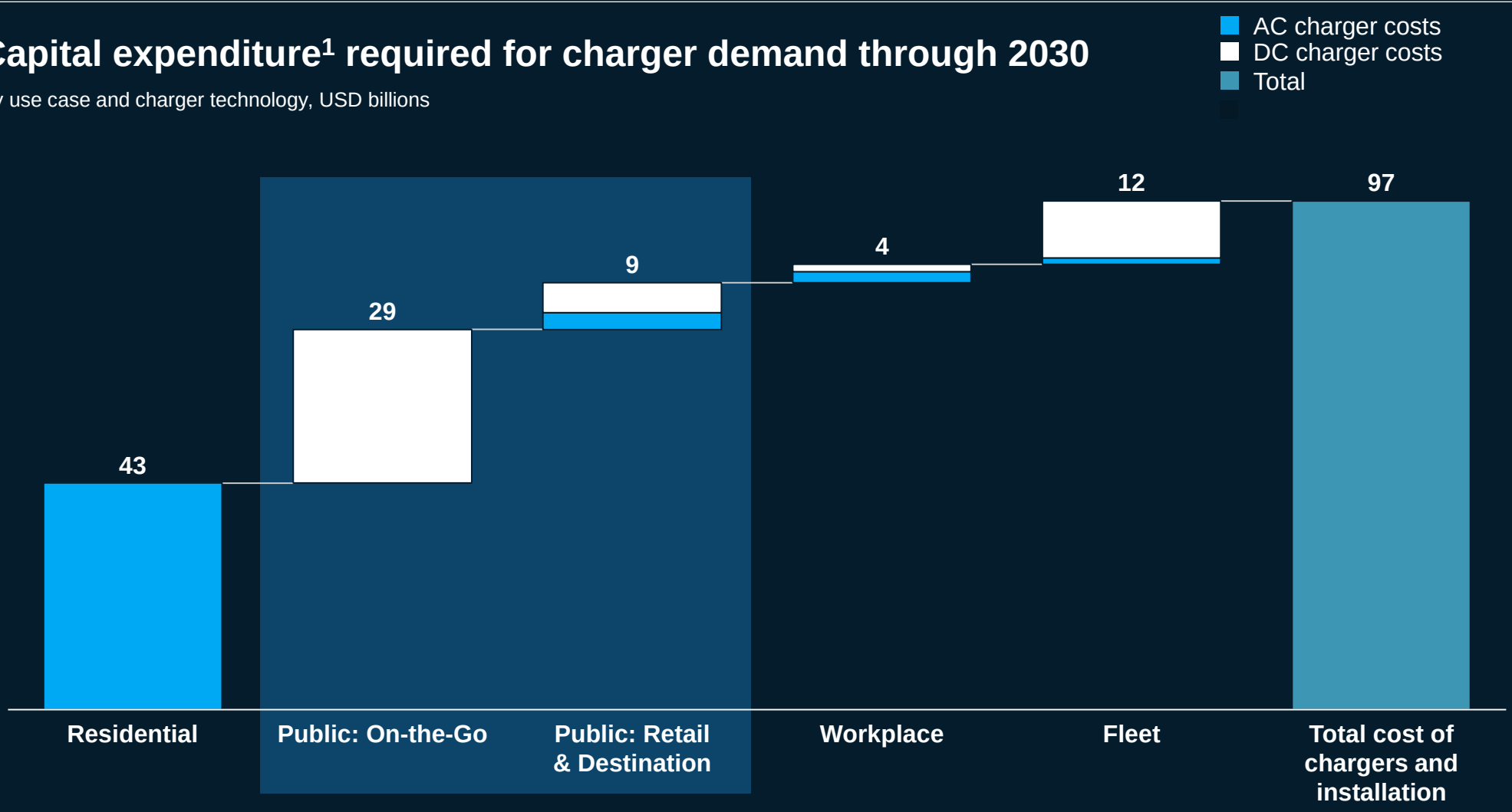
BIL Funds for installation of public EV chargers

Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

Hardware, planning, and installation for public charging could cost more than $35 billion through 2030

Capital expenditure[1] required for charger demand through 2030

By use case and charger technology, USD billions



1) Includes the cost of charger hardware, planning and engineering, and charger installation; does not include costs for grid and site electrical upgrades

* Based on a scenario where electric vehicles account for half the vehicles sold in the United States in 2030, in line with a federal target.
Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

IRA reforms energy tax incentives through a mix of extensions, modifications, and new programs over the next 10-years

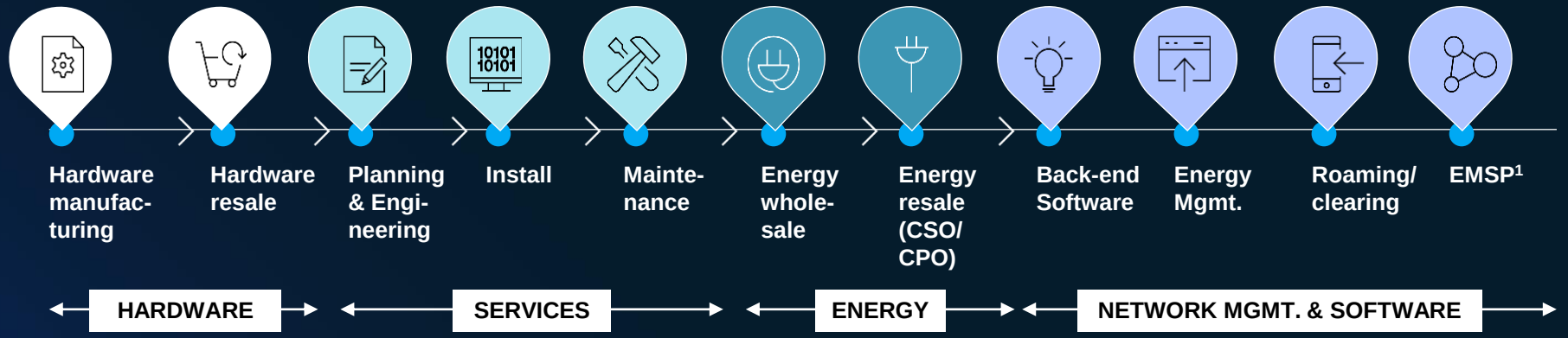
Not comprehensive

Selected tax credit modifications in draft IRA legislation

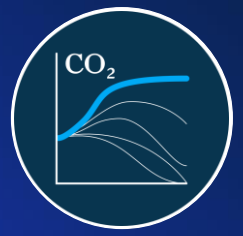
Rates shown reflect maximum credit values, including all adders (e.g. bonuses for paying prevailing wages and locating in energy communities). Dollar values reflect 2021 values and do not include proposed future year inflation adjustments. Not all tax credit modifications proposed in the IRA are shown below.

Source: Press Releases, Senate

11 value chain steps



7 dimensions (not exhaustive)



4 **EV Penetration** scenarios

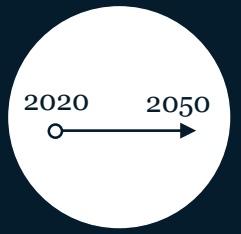
50 **States**

10+ **Vehicle Segments**

8 **Use Cases**

9 **Charging tech-nologies**

5 **Regional Arche-types**[1]



30 **years**

1. Only for Passenger Cars

Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

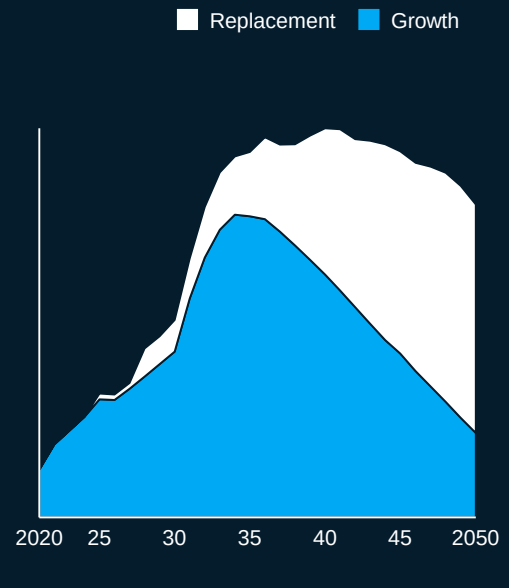
Where can private investment be leveraged?

Not exhaustive

1 Charging infrastructure

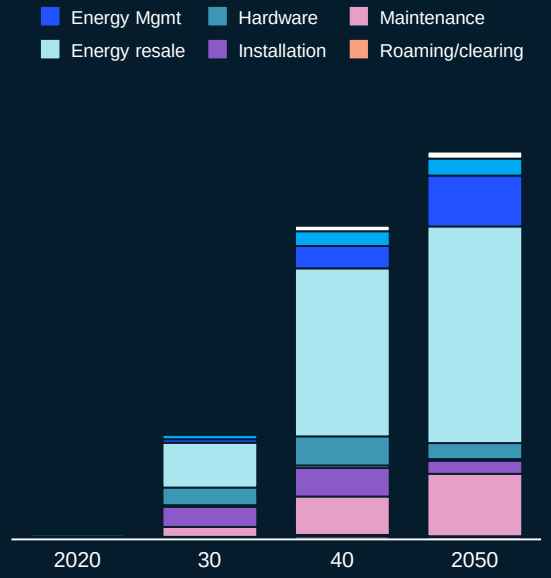
Total charger sales

Example



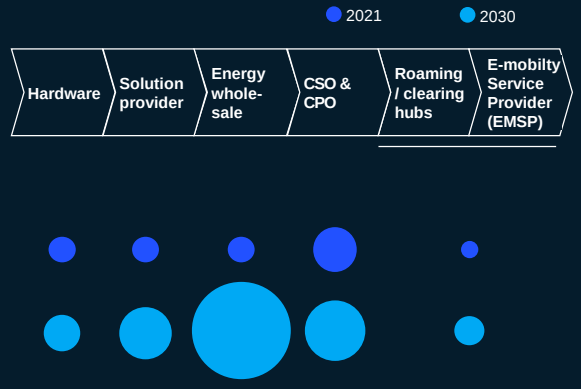
2 Revenues & investments

Revenues by value chain step



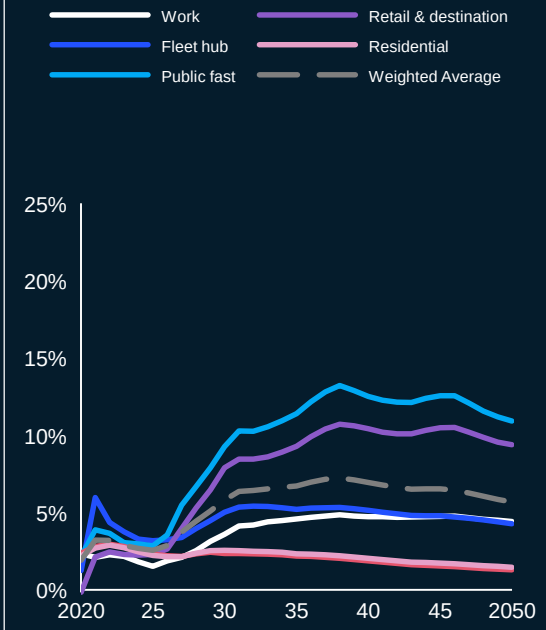
3 EBITDA/ EBIT

EBITDA by value chain step



4 Return on invested capital (ROIC)

By use case in percent



Source: McKinsey Center for Future Mobility (April 2022), AASHTO GIS Conference (April 2022)

Key questions facing DOTs

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2 Where should chargers be located?

3 How can the EV/EVCI investment be funded or financed?

4 **How can states support this transition?**

Considerations for states regarding EV adoption and EVCI buildout

Use data-driven baseline and decision-making for site and partner selection

Ensure holistic long-term vision and iterative planning for additional chargers and facilities needed

Take a lifecycle budgeting approach and seek private sector engagement

Be intentional around diverse stakeholder engagement, preparing for barriers and adapting to them

Promote continuous program improvement opportunities

Consider equity as a priority across location selection and workforce development goals

Source: Expert interviews