ENEVATE®

Solving Difficult Problems Together to Help Mitigate Climate Change

Technical developments, Grid and enablement of high penetration of electric vehicles

Benjamin Park, PhD | Founder & CTO

Enevate is a battery technology company supplying breakthrough technologies to the battery industry. Its pure silicon-dominant Li-ion cells designed with its own electrolyte and cell designs allow for unique properties including extreme fast charge while increasing high energy density, wide temperature operation, safety, and potential for reduced cost.

Enevate Fast Facts

Mission: Develop innovative battery technologies to accelerate adoption of electrified mobility

Pioneers Founded 2005 in Southern California, USA – UC Irvine Anteater founders

- Projected to be one of **first companies achieving next-gen silicon Li-ion commercialization** going to production in 2022

Vision A cleaner and sustainable environment through a variety of battery powered applications and products that are accessible and affordable to everyone

Business Model Battery technology licensing & transfer

- Non-capital intensive, leverages experienced high volume & quality battery makers to supply the EV industry

Technology Developed over 15+ years with ~500 patents issued and in-process

- Tested by 20+ battery and automotive manufacturers in Asia, US, and Europe
- Licensing new 4th Generation XFC-Energy® technology with eXtreme Fast Charge for high volume commercialization

Leading industry investors, partners, and customers

RENAULT NISSAN MITSUBISHI LG Chem Fidelity INVESTMENTS SAMSUNG ENERTECH

Advantages of Enevate's patented XFC-Energy® technology for high volume commercialization

- **10X faster charging, 5-minute extreme fast charge** with:
  - **30% longer range** with energy densities of 800-1000 Wh/L
  - **100% better low-temperature performance**
  - **Safer battery** with no lithium plating
  - **Higher efficiencies** in regenerative braking & charger utilization
- **Lower cost** than today's conventional graphite Li-ion battery technology
- **Designed for existing battery manufacturing equipment and processes**
- **Delivers up to a 26% CO_2 greenhouse gas reduction** during manufacturing compared to conventional li-ion batteries

Addressing Consumer & Key Industry Pain Points

Pain Points for EV Adoption	Enevate Delivers
Carbon Footprint	Up to 26% smaller carbon footprint
Long Inconvenient Charging Time	Up to 10x Faster 5-minute Extreme Fast Charge
Price Premium over ICE	20% lower cost anode affordable EVs
Driving Distance	30% more EV range higher energy density
Low-temp performance	>100% better low temperature performance
Safety	Safer Battery, no lithium plating
Efficiency	Higher efficiencies in regenerative braking and charger utilization

Competitive advantage for EVs when they can charge as fast as refueling a gas vehicle

Li-ion Cell Technology Development Experience

ENEVATE

HIGHLY EXPERIENCED IN LI-ION TECNOLOGY DEVELOPMENT

15+ years

Li-ion Cell Development

4 generations

Silicon-dominant Li-ion Cell Technology

1 million meters

Electrodes Produced

150k Li-ion cells

Assembled and Finished

190k electrical tests

Performed

3,000 channels

Available for Battery Tests

136 million hrs, **15,000** yrs

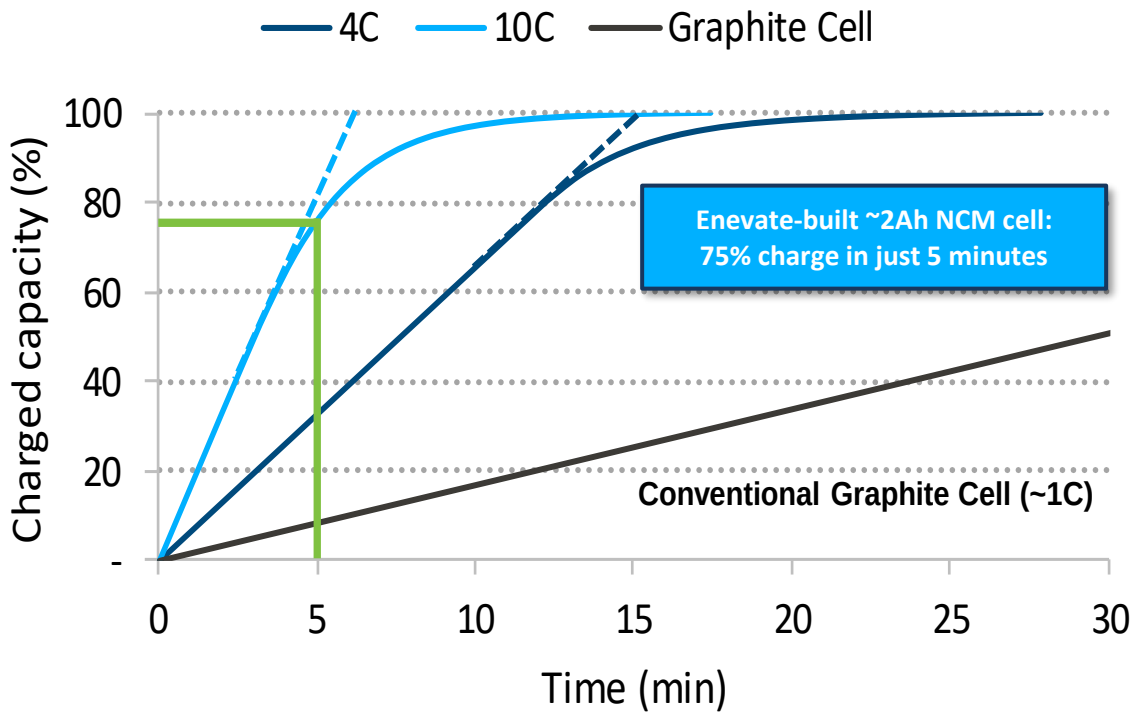
Cumulative Cell Testing

4 billion datapoints, **890 GB** data

Collected & Analyzed

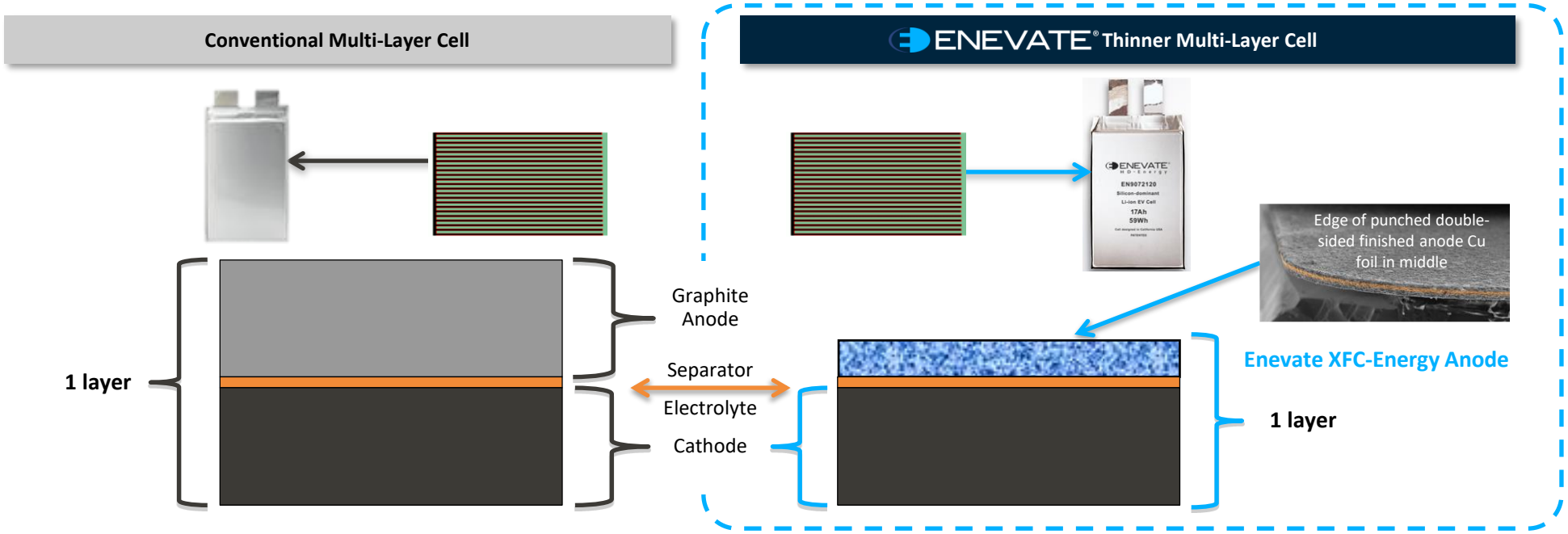
How does Enevate Achieve… Extreme Fast Charge + High Energy Density?

1. **Si-dominant Anode** to meet market demand & next-gen specifications
2. **Electrolyte & Additives** prevent side reactions & growth on Si surface
3. **Cell Design & Cell Formation** to optimize performance



Silicon Dominant vs Graphite Dominant Performance

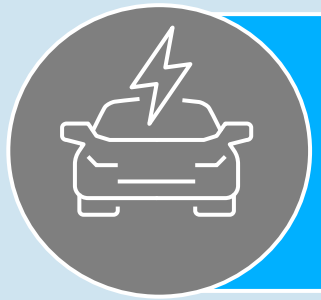
ENEVATE VS CONVENTIONAL LI-ION CELLS



Enevate is able to deliver more energy in a smaller cell through our innovative XFC-Energy technology, employing a silicon dominant micro-matrix

Why Ultra Fast Charge?

WHY BOTHER WITH FAST CHARGE?



Only about 1 of 5 cars have access to overnight charging [1, 2, 3, 4, 5]

- Approximately 25% of car owners don't park in their garage
- More homes have cars vs a garage and most of those who have garages have multiple cars
- The percent of vehicles with access to charging lies between 8% and 30% with the base case being 22% due to households having multiple vehicles, others having no access to a garage or the ability to install an electrical port

Improve existing infrastructure utilization - even without ultra-fast chargers [6, 7]

- Today's vehicles taper charge relatively quickly & many cars are charging at only 60% of the max rate starting at just 35% SOC
- Fast-charge capable cars would be able to charge at the max rate enabling faster charging even at today's existing chargers
- With an estimated $50B to build out the US's charging network, both efficient use of new AND existing infrastructure is required

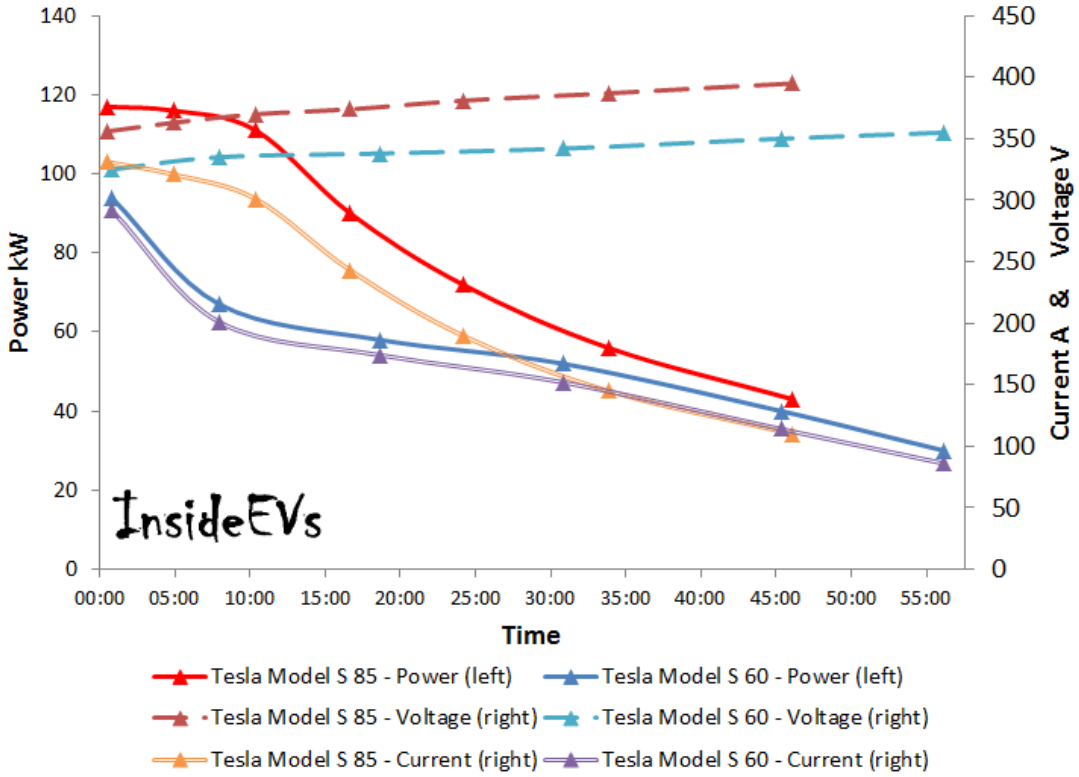
Support drivers becoming more comfortable with less expensive vehicles with shorter range lowering the price for those vehicles

- Fast charging makes electric vehicles even more convenient
- You can charge in drive through charging stations like a gas vehicle AND charge at home or the workplace
- You can better capture the energy from regenerative braking and make the car even more efficient

Enevate's next generation technology can significantly reduce required infrastructure spend by revolutionizing how EV batteries charge.

1. Enabling Fast Charging: A Technology Gap Assessment 2. EV Market Projections 3. Home Garage 4. DOE Study 5. Carnegie Mellon 6. Charging Taper 7. Infrastructure Estimates

Example 40-200 kW charger profile



- **The current for charging starts dropping quickly**
- **Enevate's battery could charge at full rate for almost the entire time lessening charge time even for chargers in the 40-200 kW range where the cell is charged up to roughly twice as fast**
- **For 300+kW chargers, the efficiency could be improved by 3X (1.5C vs 4.5C as an assumption)**

Cost of charging equipment and infrastructure

EVSE Unit Costs

EVSE Type (single port)	EVSE Unit Cost Range
Level 1	$300-$1,500
Level 2	$400-$6,500
DCFC	$10,000-$40,000

Assume $25,000 for DCFC**

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

EV Everywhere U.S. DEPARTMENT OF ENERGY

Clean Cities U. S. Department of Energy

Cost of infrastructure (McKinsey & Co)

- $50B to ensure public charging station access similar to gas stations in US, Europe, and China combined.
- $11B only for the US

**Costs Associated With Non-Residential Electric Vehicle Supply Equipment Factors to consider in the implementation of electric vehicle charging stations, November 2015, U.S. Department of Energy Vehicle Technologies Office

Can the grid handle EVs or fast charging?

- Grid is going through the “largest transformation in its history”
- Coal and nuclear -> natural gas, wind, solar
- Extreme weather puts stress on grid and drought reduced hydroelectric output
- Grid operators are looking for energy storage
- (Hopefully) Short-term issue that technology can solve

Photo: Daniel Acker/Bloomberg News

- West Risks Blackouts as Drought Reduces Hydroelectric Power
- https://www.wsj.com/articles/west-risks-blackouts-as-hydroelectric-power-dries-up-11624008601?mod=article_inline
- America’s Power Grid Is Increasingly Unreliable
- https://www.wsj.com/articles/americas-power-grid-is-increasingly-unreliable-11645196772?mod=article_inline
- Electricity Shortage Warnings Grow Across U.S.
- https://www.wsj.com/articles/electricity-shortage-warnings-grow-across-u-s-11652002380?mod=hp_lead_pos4

Can the grid handle EVs or fast charging?

- If every American switched to an EV, analysts estimate using up to 25% more electricity than today.
  - May require new generation and transmission networks
- Most optimistic targets for EV adoption are around 50% by 2030.
- Local generation will handle some of the burden via solar and charge at home.

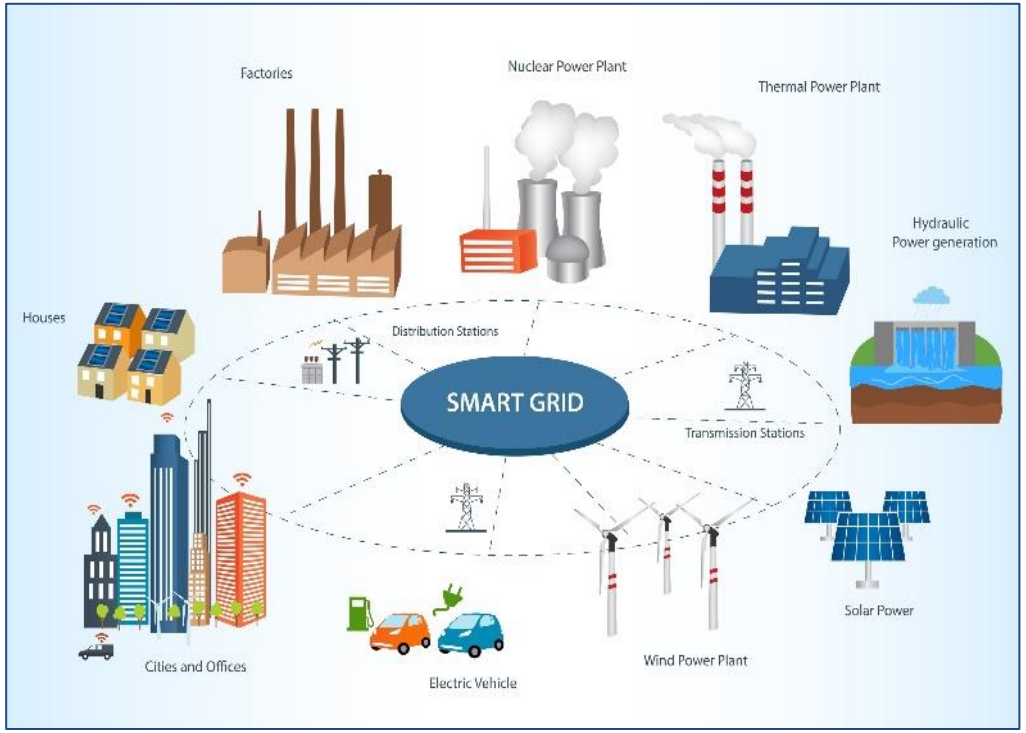
- Electric Cars Are Coming, and Fast. Is the Nation's Grid Up to It?
- https://www.nytimes.com/2021/01/29/climate/gm-electric-cars-power-grid.html

Can the grid handle EVs or fast charging?

- As long as all cars are <u>not</u> charging at once, “the grids in most developed nations will be just fine”

- **UK,** for example, the total energy required for all EVs if the total fleet was electrified is 69.1TWh and the grid produced 323TWh in 2019 (which matches the approx. 20% number given in the previous slide).
  - The grid produced 402TWh in 2005, so the capacity is there.

- **US**, it’s 1106.6TWh needed which is 27.6% of the total US grid capability
  - Several utilities companies are confident that they can handle the load.



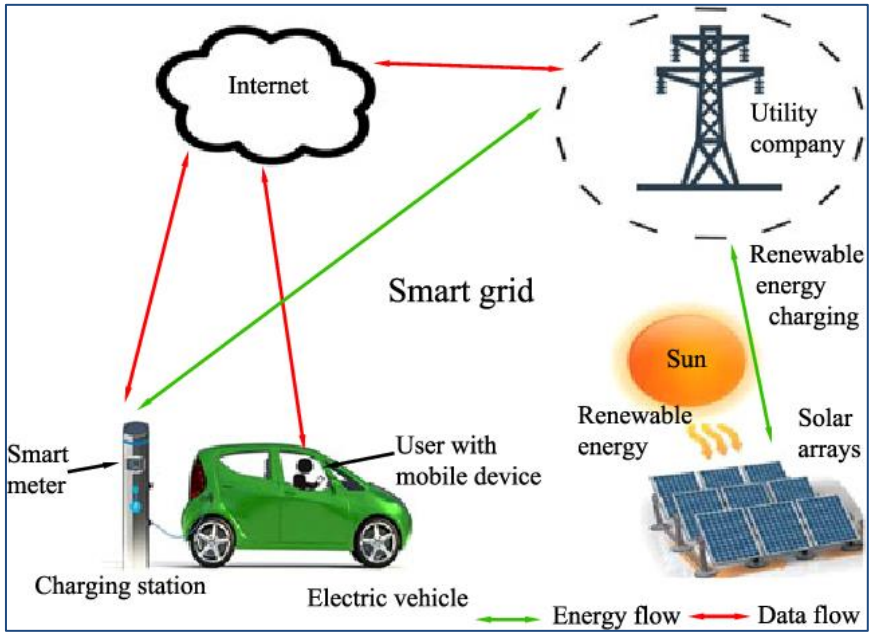
- Electricity Grids Can Handle Electric Vehicles Easily – They Just Need Proper Management
- https://www.forbes.com/sites/jamesmorris/2021/11/13/electricity-grids-can-handle-electric-vehicles-easily--they-just-need-proper-management/?sh=420890ed7862

Can the grid handle EVs or fast charging?

- So far, we established that the grid could handle EVs, the question now is whether the grid can handle fast charge?

- Mitigating effects of EV charging stations on the grid are needed.
  - Planning EV charging stations with storage (similar to current storage tanks for gas stations)
  - Pricing incentives to adjust EV charging demand during excess generation times.

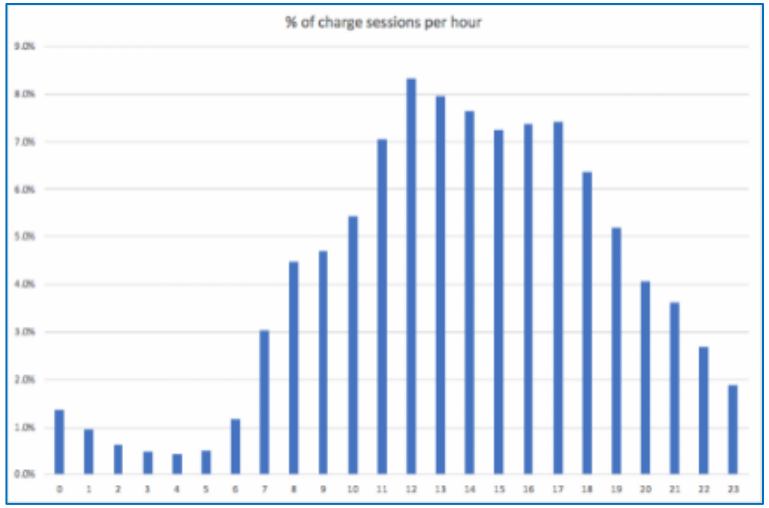
- **Conclusion:** Today's chargers could handle fast charge with better planning and mitigating actions.



- EVs are on a roll. How will US power grids manage rising demand for charging?
- https://www.spglobal.com/commodity-insights/en/market-insights/blogs/electric-power/042420-evs-are-on-a-roll-how-will-us-power-grids-manage-rising-demand-for-charging

Can the grid handle EVs or fast charging?

- With charging stations that have battery storage, it would be beneficial to the grid – especially with smart fast charge stations and V2G solutions
- Grid operators and also charging station operators can get increased revenue
- Fast charging happens mainly during the day when more renewable energy is produced (solar) and can compliment slow charging (night-time)
- Faster charging stations than what exists today will be connected to either the medium voltage or high voltage grid – this reduces the permits required and can address more cars – it's more efficient and profitable for operators
- Looking at a 1 MW grid connection (requires just one permit) can handle a large number of cars (especially with battery storage)



- Why fast charging stations are good for the grid
- https://fastnedcharging.com/hq/why-fast-charging-stations-are-good-for-the-grid/

Today’s chargers can already fast charge

It all depends on the car

- Automakers believe customers are more willing to accept a lower range car with smaller battery if they can charge the car in a very short amount of time.

- Today, 350-400 kW chargers already exist.
- What vehicle can charge in ~5 mins:
  - Up to 35-40 kWh packs – small urban mobility vehicles
  - 2 wheelers
- What vehicle can charge in ~15mins:
  - Up to 85-100 kWh packs – covers most every vehicle

- Higher rate chargers are possible, but they will likely be built with battery storage on site and more advanced cooling for the connection or require a larger connection














Communication and collaboration is key to make this happen

- **Technology developers: startups, academia, research labs**
  - Develop technologies that will accelerate the shift to cleaner technologies
  - Innovative companies like Enevate, world-class universities like UCI, National labs
- **Industry heavy-weights**
  - Adopt technologies and ensure timing of solutions works out
  - Auto companies, aerospace companies, energy storage companies
- **Infrastructure/regulatory bodies, Organizations/centers for collaboration**
  - Ensure that energy can be delivered and load can be handled and to ensure smooth communication and speed up implementation
  - Grid/energy companies, airports, local and federal government, California Energy Commission, CalPlug

Thank you!

www.enevate.com