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## Ample Inc Comments on Fiscal Year 2021â€“2022 Light-Duty EV Infrastructure Funding

AMPLE, Inc. appreciates the opportunity to provide comments to the California Energy Commission (CEC) regarding the stateâ€™s Fiscal Year 2021 â€“2022 Light-Duty EV Infrastructure Funding. Ample, Inc. is a San Francisco-based company that operates a battery swap-based electric vehicle (EV) repowering service. This response is intended to highlight specific areas in which CECâ€™s plans, as conveyed during the Light Duty Electric Vehicle Infrastructure Allocation Workshop on December 2, 2021, could be modified to better serve the needs of Californians.

*Additional submitted attachment is included below.*

Levi Tillemann
Vice President, Policy and International Outreach
AMPLE, Inc. 100 Hooper St.
Suite 25
San Francisco, CA 94107
ltillemann@ample.com

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## *Ample Inc Comments on Fiscal Year 2021–2022 Light-Duty EV Infrastructure Funding*

AMPLE, Inc. appreciates the opportunity to provide comments to the California Energy Commission (CEC) regarding the state’s Fiscal Year 2021 –2022 Light-Duty EV Infrastructure Funding. Ample, Inc. is a San Francisco-based company that operates a battery swap-based electric vehicle (EV) repowering service. It is Ample’s intention to install and maintain a significant network of battery swap stations within the State of California, throughout the United States and internationally. Ample’s modular battery swapping is a cost-effective means of transitioning drivers without access to overnight EV charging to electric vehicles. The CEC has requested feedback on its 2021-2022 Clean Vehicle Investment Plan. This response is intended to highlight specific areas in which CEC’s plans, as conveyed during the Light Duty Electric Vehicle Infrastructure Allocation Workshop on December 2, 2021, could be modified to better serve the needs of Californians.

The CEC is engaged in a broad sweep of initiatives aimed at decarbonizing California’s mobility system. Many of these activities center around the electrification of automobility. However, time and again two key variables that will ultimately determine whether electric vehicles are in fact able to serve the needs of a vast majority of Californians are largely omitted from the Commission’s analysis of programs and policies: time and cost premiums associated with public charging as compared to gasoline.

Much of the relevant data on these variables is closely held by EV charging companies, and remains opaque to consumers, policymakers and researchers. But we know that public charging is significantly more expensive than gasoline and that the time required for public charging is prohibitive for many use cases. This is especially true for low-income and working Californians. So while the policy community’s intense focus on delivering environmental justice is laudable, asking low-income residents to rely on charging networks that are both slow and expensive is not a solution. Promoting “environmental justice” cannot be synonymous with telling low-income residents, those who live in multi-unit dwellings (MUD) , street parkers and TNC drivers that they must rely on slow, expensive public charging rather than fast and comparatively cheap gasoline.

Doing so is like telling a citizenry starved for bread that they should instead eat cake: it is likely to provoke an intensely negative backlash.

CEC's hesitancy to confront the twin challenges of public EV charging (time and cost) has resulted in plans that underestimate the infrastructure challenges of electrifying the state's automobility system. At the same time, CEC's planning does not encourage or fully account for important and powerful technological solutions to the aforementioned challenges that are today being deployed globally. For instance, battery swapping is playing an increasingly important role repowering electric vehicles both China and Europe. Despite this, in many ways, swapping is explicitly or implicitly omitted from CEC's Fiscal Year 2021 –2022 Light-Duty EV Infrastructure Funding.

## Modular battery swap as a solution to California's infrastructure challenges

Embracing technology-neutral approaches to EV infrastructure would allow for transformative technologies like Ample's modular battery swapping to fill significant gaps in CEC's Clean Transportation Program Investment Plan going forward. This includes but is not limited to provision of V2X energy services, repowering solutions for high-utilization vehicles, and electrification options for disadvantaged communities. Allowing batteries to charge external to the vehicle results in cascading benefits from a number of different perspectives, including: user/driver, grid, EVSE operator, environmental, infrastructure buildout and resource-use.

*Driver perspective*
From a driver perspective, modular battery swap allows refueling in a fraction of the time fast charging requires. Modular battery swap allows people who street park, park in urban garages, travel long distances, or can't afford installation of expensive charging infrastructure (at home or in fleet applications) to own and operate EVs. Because modular battery swap systems trickle charge batteries they also significantly extend the life of EV batteries.

*The grid*
Modular battery swap strengthens the grid by evening out demand and providing flexible energy storage for renewables – a result of the ancillary battery banks that are core components of the system. By absorbing renewable energy when it is plentiful and dispensing it quickly via swap when and where it is needed, modular battery swap fills a critical gap in our energy infrastructure. Swap systems can also curtail energy consumption when desirable or feed energy back into the grid when demand peaks.

*EVSE operator*
Modular battery swap is profitable. Because modular swap stations allow for high capacity factors, they can service roughly 10X as many vehicles as an equivalently powered fast charger. This means swap stations can absorb demand charges and profitably repower electric cars.

*Environmental*
Modular battery swap allows EV batteries to fill up with zero carbon energy when renewable energy is plentiful and dispense that energy quickly when it is needed. Counterintuitively, a modular battery swap system utilizes fewer batteries in aggregate (this is not true for standard battery swap). This is because a modular battery swap system can dynamically adjust the amount of battery storage dispensed to a vehicle depending on the driver's needs. For example, a fleet vehicle may only require 30 miles of range most days, while occasionally traveling much farther. A modular battery swap system can meet that daily demand with a smaller battery pack (by utilizing fewer battery modules) then add additional battery modules for longer trips on demand.

*Infrastructure deployment*
Modular battery swap allows for rapid, economical deployment of charging infrastructure. This is because modular battery swap stations do not require construction. They can be assembled onsite in a matter of days

because they are largely prefabricated. Infrastructure sufficient to cover a medium-sized city can be deployed within the space of weeks and easily scaled thereafter.

*Resource efficiency*
Modular battery swap stations allow for extremely high throughput (similar to a gasoline station) for a much smaller geographic footprint and lower system cost than chargers. Each station uses the equivalent space of only two parking spots. Because modular battery swap has the capacity to charge continuously, a less powerful grid connection can charge more batteries (ergo vehicles). Modular battery swap also allows for variable battery pack capacity and more intensive duty cycles for electric vehicles (because of faster repowering). These last two characteristics improve the economics of electrifying fleets and, even more importantly, reduce an EV's embedded GHG emissions and resource consumption.

## Response to questions from CEC's Fiscal Year 2021 –2022 Light-Duty EV Infrastructure Funding Workshop

The aforesaid is meant to provide context for Ample's responses to CEC's questions from the Fiscal Year 2021 –2022 Light-Duty EV Infrastructure Funding workshop.

**Questions from CEC on Microgrids, Resiliency, and Charging; MIDAS/ELRP Integrated Charging**

- Should this program only be open to existing CEC funded microgrid projects to help them expand their EV charging capabilities?
- What should be the relative focus on V1G vs V2G technologies?
- What key questions need to be answered to help microgrid integrated charging scale up?
- Should funding for the whole microgrid or just charging aspects be available through this program?
- How could the VGI user experience be improved through this solicitation?
- What type of enabling technologies are needed to help EVSEs take advantage of MIDAS and ELRP? Some examples: Software development, customer understanding, transceiver innovation, etc.
- What are the best charging installation types/locations for this program? Should eligibility be statewide?
- What other VGI technologies do MIDAS and ELRP complement or duplicate?

Battery swapping is a cost-effective means of building out the storage capacity required to decarbonize the grid. Conversely, the costs of integrating electric vehicle charging systems into the U.S. grid without battery swapping are astonishing. The Boston Consulting Group (BCG) pegs the cost of upgrading the grid for electric vehicles through 2030 at between $1,700-$5,800 per car.[1] Assuming annual auto sales of 1.7 million units in California, a 100% EV sales scenario would correspond to between $2.9 billion to almost $10 billion in grid system upgrades annually. Further, BCG's analysis shows that higher numbers of EV sales will result in higher (not lower) per vehicle grid integration costs.

[1] Sahoo, Anshuman, et al. "The Costs of Revving Up the Grid for Electric Vehicles." United States - EN, United States - EN, 8 Jan. 2021, www.bcg.com/en-us/publications/2019/costs-revving-up-the-grid-for-electric-vehicles.

A significant portion of this cost can be offset by grid storage assets in the form of battery swap stations. By separating the process of charging from the action of transferring energy into an electric vehicle, battery swap stations allow for better managed, more constant and more efficient utilization of existing grid assets as compared to charging. The potential for improving the integration of renewable energy is particularly important. Significant static storage capacity combined with battery swapping allows the electrical system to capture the energy from intermittent low carbon energy sources (e.g. wind and solar) when available and to dispense that energy quickly when it is needed.

Again, modular battery swap strengthens the grid by evening out demand and providing flexible energy storage for renewables as a result of the ancillary battery banks that are core components of the system – absorbing renewables when they are plentiful and dispensing them quickly via swap when and where they are needed.

**Questions from CEC on Local Government Fleet Charging**

- Restricted fleet charging or include public charging?
- First-come, first-served? Or competitive solicitation?
- Equity by air district? By region? By size?
- Reward implemented streamlined permits for chargers?
- Should fund the whole electric supply or just the vehicle charging?

Given the huge challenges of fleet electrification, Ample urges the CEC to adopt a stance of technology neutrality in its efforts to fund fleet electrification infrastructure. It is also important to remember that fleets that utilize zero emissions electric vehicles are investing private funds into capital that will provide two important public goods: clean air and reduced GHG emissions. From that perspective, the CEC should not only seek to encourage fleet electrification, but *to prioritize high-intensity utilization of electric vehicles by fleets*. Allowing public access to fleet repowering infrastructure may actually undermine these goals. The benefits of high-intensity fleet electrification extend beyond the immediate community. Indeed, establishing sustainable business models for fleet electrification will have cascading national and international impact.

Currently, both the logistics and economics of EV charging are extremely challenging within a fleet context. In the case of a Level 2 (L2) system, the mere act of charging renders the entire fleet unusable for a large portion of the vehicles' potential duty cycle (as they need to be stationary and plugged in). Further, commercial-grade L2 chargers cost many thousands of dollars to install and the simultaneous draw from many L2 chargers generally requires costly upgrades to a facility's electrical system and lead to significant demand charges associated with higher sustained electrical demand. In the case of high-power charging (DCFC), the high cost of infrastructure and associated demand charges pose similar or greater hurdles. But there are other cost and logistical obstacles as well. In order to charge in under an hour, an EV cannot be charged to full capacity (i.e. it can only be charged to ~80%). This results in excess deployment of costly and resource-intensive batteries on a systemic basis. Even charging a vehicle up to 80% requires fleet operators to engage in an expensive game of musical chairs, reshuffling vehicles every 30-60 minutes. This is not only labor-intensive (thus costly); it is extremely impractical. Such an operational structure further disadvantages EVs from a cost and utility standpoint.

There are a number of fleet focused sectors in which these problems are likely to be more pronounced. One is ride share – which is challenging from the standpoint of electrification but also presents one of the biggest opportunities for emissions reduction on a per vehicle basis. TNC drivers would benefit disproportionately from the deployment of battery swapping infrastructure. Until recently, Ample was the only company renting EVs to TNC drivers in the Bay Area. As of Summer 2021, Sally also rents EVs to Uber drivers using Ample's modular battery swapping system to repower their vehicles. And while recently non-battery swap-based entrants have also attempted to enter the San Francisco market, generally speaking, the high cost and lengthy charge times associated with electric vehicles mean that neither drivers nor fleet companies can afford to use EVs in high-intensity applications like ride share unless those vehicles are battery swap enabled. (Demand from the taxi/ride share sector was one of the forces that led to the rise of battery swapping in China.) Assuming one hour a day of EV charging (which is, in fact, a very generous assumption) a rideshare driver would sacrifice roughly $5000 of income annually simply due to charging time. With per mile equivalent costs between $4.60 to almost $10/gal – or roughly twice the retail price of gasoline in California – most fast chargers are not only slow, but expensive. Conservatively estimated, the time plus energy cost penalty for drivers who transition from gasoline to public charging infrastructure would be around $9,000 annually. For vehicles which are charged at a fleet depot, all the aforementioned challenges are simply transferred to the fleet operator.

Battery swapping solves many of the logistical, cost and energy challenges associated with fleet charging. We ask the CEC to thoughtfully consider how to craft policy that does not inadvertently exclude battery swapping going forward as most of its solicitations have in the past.

**Questions from CEC on DC Fast Charger Corridors**

- From the presented four possible concepts, how would you order them for level of importance?
- Which corridors with little or no DC fast charging currently available would you prioritize and why?
- What should be the minimum power level for DC fast chargers on corridors?
- Are there other DC fast charger corridor concepts we should consider?

In the short term, DC fast charging corridors will be an important enabler for long-distant EV travel. In the longer-term CEC should consider what role battery swapping might play in providing a more seamless transition for drivers from gasoline to electric in long haul applications. Unlike fast charging, battery swapping can fully replenish a battery in minutes and without the added environmental cost of degrading an electric vehicle's battery. The experience of China (which currently hosts over 80% of world EV charging infrastructure) and the country's decision to aggressively incentivize battery swapping should be thoroughly studied by California. Given the advanced stage of Chinese charging infrastructure, Chinese policymakers have a higher fidelity view of the systemic opportunities and challenges associated with fast chargers and battery swapping and have opted to aggressively promote the latter.

**Questions from CEC on Block Grants for Light Duty EV Charging Infrastructure; BESTFIT 2**

- Should any changes or improvements be made to the design of the BESTFIT solicitation?
- Should the 3 Areas of Focus remain the same, or are there other challenges we should consider addressing?
- Is a maximum award of $1M the right amount?
- Should we have a 2 phase application process (initial 5 page abstract, followed by a full application if the abstract passes)?
- Are there other ways to differentiate the two future Block Grants?
- Should projects be regionally targeted, statewide, or offer both?
- What other project concepts should be considered for light duty EV charging infrastructure incentive projects?

In practice, the CEC has created a two-tier system for dispensing EV incentives. This system awards generous subsidies to one set of technologies based on specific DC fast charging standards, while disadvantaging competing technologies. Given the low number of miles electrified in the State of California and nationally, and the importance of creating new opportunities for California residents without access to overnight charging to adopt EVs, we strongly urge the CEC to increase the size of the BESTFIT and significantly rework its block grants programs so as not to exclude or disadvantage competing repowering technologies, such as battery swapping.

The CEC has correctly identified the importance of providing more charging options for multi-unit dwelling residents, street parkers, low-income residents and others who are not well served by today's EV charging system. However, CEC should also realize that providing access to high-cost charging that is many orders of magnitude slower than comparable gasoline or diesel refueling options is not an attractive solution to those populations. Technologies like battery swap provide an experience that is, from the standpoint of convenience and time, identical to that of refueling with gasoline. Rather than seeking to develop and incentivize energy solutions that will resolve the issues faced by these communities, CEC is (perhaps inadvertently) reifying the existing system and the benefits it confers upon incumbent industry and affluent suburban EV owners.

**Question from CEC on High Density Level 2 Charging/Low Income Residential Charging**

- Which project type is most visible to drivers?

- Which project gives drivers the most charging confidence?

- What are the characteristics of the charging environment needed to shift a driver's attitude from uncertain about charging availability to confident about charging options?

- Are there other project types we should be considering?

- Are there target applicants besides the electric vehicle service providers (EVSPs) or residents that we should be considering?

- How can we provide EVSE options to garage-less or driveway-less residents?

- What are the best approaches to low-income verification?

- When focusing on low-income communities, how can we avoid green gentrification?

More than half of American vehicles lack access to an overnight charging point and CEC significantly overestimates the ability of DC fast charging and public L2 charging to support drivers without access to home charging. The inadequacy of public charging as a solution is demonstrated vividly by the experience of China – the world's largest EV market. Today, China accounts for over 80% of DC fast charging stations installed globally. Yet despite this robust charging network, over the last two years China has undergone a major policy shift to prioritize the deployment of battery swap-enabled electric vehicles and battery swap stations. Publicly announced additions for battery swapping facilities in China will be capable of repowering over 80 million vehicles a week by the year 2025.

Yet CEC has largely disregarded battery swapping. Battery swapping is a particularly powerful solution to provide repowering services to vehicles of multi-unit dwellings (MUDs) residents, rural communities and street parkers. For these constituencies battery swapping allows for many of the same operational benefits as gasoline or hydrogen but at a lower cost of infrastructure and with better interoperability with traditional EV charging systems.

At 59 cents a kilowatt hour (a standard price for public EV charging in California) the cost of refueling a Nissan Leaf is equivalent to a Prius driver paying about $8.40 a gallon. In some cases, EVSE pricing is also done on an hourly basis. However, the costs are generally roughly equivalent. These exorbitant costs and charge times are not sustainable or equitable for Californians that lack access to at-home charging.

## Conclusion

California has been a world leader in EV policy. However, California's policy is no longer setting the pace for innovation in the global EV market, and state regulations, programs and policies are even failing to keep pace with deployed technologies. More worrisome, many of California's current and planned policies are disconnected from the scale of the electrification challenge ahead and overlook inability of the existing EV system to fulfill the needs of future EV drivers.

Today, a tiny percentage of California's vehicle miles traveled (VMT) are electric. And it is unwise to assume that the business models and technologies that got us to ~2% electric VMT (probably about where California is today) will be the same business models and technologies that enable the state to achieve 10%, 40% or 95% electric VMT.

In light of this, Ample strongly urges CEC to pursue technology neutral, performance-based programs that are open to innovation. Technology neutrality will be a critical variable deciding whether California successfully achieves its electrification and decarbonization goals. No government agency and no single corporation, NGO or individual possesses the capacity to foresee the exact convergence of ideas and technologies that must emerge in order to address the climate crisis. Accordingly, well-designed CEC policies will avoid command and control-style technology requirements in favor of performance-based requirements with technology-neutral criteria. Efforts to promote particular technology standards or approaches are unlikely to solve the climate crisis or to age gracefully.

On the other hand, aggressive policy that incentivizes performance and penalizes environmental externalities has the very real prospect of dramatically accelerating the critical transition to a zero-carbon clean energy economy.