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Hands-Free-Charging of EVs

Additional submitted attachment is included below.

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The Energy Commission is currently soliciting ideas and stakeholder input for the 2018 – 2020 EPIC Triennial Investment Plan. For those that would like to submit an idea for consideration in the 2018-2020 EPIC Triennial Plan, we ask that you complete the form below. Submittals are due by **5:00 p.m. on February 10, 2017.**

Part 1. Initiative Description and Purpose:

1. Please provide a brief description of the proposed initiative:

This initiative is proposing to develop world's first conductive hands-free charger for Electric vehicles. The goal of this initiative is to make EVs easy and convenient to own for everyone, including Americans with disabilities, residents of high density low income residential units. In doing so, make EVs appeal to a broader audience, promote their deeper deployment as DER and in turn help more renewable energy to be brought on-line.

Going forward, in the EV market there several key changes on the horizon: (i) EV market is on the cusp of early adopters and incentivized buyers to a more mass market. Furthermore, these markets should also include high density low income residential units. Such mass market inherently demands all possible conveniences to sustain, (ii) EV market is also transitioning from a norm of 100mi/charge to 200mi/charge cars. This in turn demands high power chargers to charge these EVs in reasonable time, (iii) self driving cars or self driving electric cars are on the horizon. Such cars- whether your own or Ubers' will drop you off at your door and proceed to your garage or to Ubers' charging farm. You are not going to run behind – just to plug it in (iv) due to its daily plugging in and out requirement, Americans with disabilities are generally staying away from EVs.

All of these changes clearly demand a Hands-free-High-Power (conductive) charging system for electric vehicles. This is exactly what this initiative aims to address.

2. What technical and/or market barriers would the proposed initiative help overcome? For scientific analysis and tools, what knowledge gaps would the proposed initiative help fill?

The need for a hands-free-charger is clear. However an appropriate solution does not exist in the market, primarily because the industry's early attempts to solve this problem using wireless power transfer have yielded low efficiency systems with significant radiation hazard. Although such technology is inappropriate for EVs, it has been funded from an unrelated but very lucrative market of inductive power transfer to medical implants. What is needed is a charging solution optimized for the power levels and geometries of EVs. Industry – or to be precise, new developmental capital has been reluctant to rethink a proper hands-free solution (such as the one proposed in this project), for EVs because of (i) EVs are still gaining momentum and their charger then becomes a dependent market, adding to the uncertainty, (ii) due to its long development cycle and relatively low returns, any vehicle hardware solutions are not the most favored by the ROI yardsticks.

Part 2. Benefits and Impacts

3. If this initiative is successful, either fully or partially, what would be the expected impact? Who are the primary users and/or beneficiaries?

Beneficiaries of this initiative:
1. Every EV owner benefits from the charging convenience. This will save 2.4MT CO2/charger/year by eliminating missed charge cycles.
2. Americans with Disabilities benefit since this technology will make EVs easy to own.
3. High density low income residential units: The hands free charging technology – when combined with self-parking cars can enable MDU residents to charge EVs at nearby shared charging facilities, thus improving EV ownership in underprivileged low income neighborhood. By enabling charging farms, the cost of charging infrastructure can be shared over larger communities, making them cheaper. Being conductive, the charger can modulate the charging rate to make most of future real-time prices and thus reduce the cost of charging for underprivileged community EV owners.
4. Once fully realized, this technology will create screwdriver-ready projects for charger installation EV retrofit that will provide boost to labor market.
5. California Ratepayers: By promoting EV ownership, California grid will see a larger pool of EVs as DERs. With that, California grid can integrate more renewables into grid.
6. California Ratepayers: In case of emergencies such as earthquakes, a bi-directional charger such as proposed in this project will be able power up user's home using power from EV batteries.
A mechanized hands-free conductive charger is one of the critical pieces in promoting EV ownership in underprivileged communities. Such communities frequently have high density residential units as well as in many cases older electrical infrastructure. A mechanized charger – together with self-parking EV, can consolidate EV charging needs of large communities into charging farms, thus giving the underprivileged communities a way to access EV, cheaper transportation costs, reducing charging infrastructure costs by spreading them over a larger community and in the process create shovel-ready infrastructure jobs.

The technology proposed in in this initiative will create screwdriver-ready installation and retrofit jobs that a technician of basic training can undertake. It will also create shovel-ready charging infrastructure jobs right in the underprivileged communities. To be specific, Green Dot's hands free charger can be an add-on after-market accessory as well as an advanced option at the time of an EV purchase. This directly means that (i) a mechanic will be employed to undertake the aftermarket retrofit work, which is estimated to be 45min for a skilled mechanic and 1h30m for an unskilled mechanic per aftermarket EV. Additionally the ground side installation to be done in user's garage or in a charging farm will employ an electrician with estimated 45min work per charger. Both of these jobs, are new creations of this proposed project.

4. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed initiative:

Although it will take a while to measure, one direct performance matrix is to measure the change in EV ownership in overall population, Americans with disabilities and disadvantaged communities.
However a quicker way to measure is to record the customer satisfaction of the EV owners with hands free charger, record their statistics for how much % of time the EV remains connected to the grid and compare it with those without hands-free charger.

5. Please provide a list of peer-reviewed references that support the responses for questions 3 and 4. Proposed initiatives that include peer-reviewed references will be given stronger consideration.

Proposed technology's impact have not been realized yet, because it has not been deployed yet.
Consequently there is no peer-reviewed data documenting these benefits.

6. (For technologies only) What competitive advantages does the proposed technology solution have over current benchmark technologies? If the technology is beyond the prototype stage, what strategies do you suggest to bring to scale?

A competing technology is wireless or magnetic-induction charging. This technology works well for low power charging of toothbrush because the necessary power and consequently the magnetic fields are quite small for such applications. However scaling of the same principle to power levels required for EVs creates prohibitive efficiency and safety implications. E.g., a charging system from “PluglessPower” (www.pluglesspower.com) tested by Idaho National Laboratory reveals that the charger radiation exceeds the safety limits for pacemaker safety (10V/m limit, 83V/m actual), can waste up to 1.7MWh/ch/yr (1.6 Ton of CO_2/yr).
Another competitive technology is manual charger described in SAE-J-1772 standard (http://standards.sae.org/wip/j1772/). Being manual, it cannot offer convenience for Americans with disabilities, or protections against missed charge cycles, or enable charging farms for high density low income residential units, or unplug self-moving cars that have finished charging.

Part 3. Connection to Energy Commission's EPIC Framework

Energy Commission staff have developed a draft strategic framework to guide the CEC's planning and implementation of EPIC across triennial investment cycles. One of the objectives of the draft strategic framework is to communicate a consistent set of priorities for organizing current and future EPIC investments.

7. Please indicate which of the following strategic framework themes you feel the proposed initiative best fits within:
    - Advance Technology Solutions for Deep Energy Savings in Building and Facilities
    - Accelerate Widespread Customer Adoption of Distributed Energy Resources
    - Increase System Flexibility from Low-Carbon Resources
    - Increase the Cost-Competiveness of Renewable Generation
    - Create a Statewide Ecosystem for Incubating New Energy Innovations
    - Maximize Synergies in the Water-Energy-Food Nexus
    - Develop Tools and Analysis to Inform Energy Policy and Planning Decisions
    - Catalyze Clean Energy Investments in California's Underrepresented and Disadvantaged Communities