STATE OF CALIFORNIA Edmund G. Brown Jr., Governor

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

October 6, 2015

Terry O'Day
11390 West Olympic Boulevard, Suite 250
Los Angeles, CA 90064

RE: High Power Open Access Charger Proposal

Dear Mr. O'Day:

I have received NRG's request to approve the use of $2.2 million in CPUC-NRG Settlement funding for the attached "Standards Development and Demonstration for Open-Platform, Very High Speed Electric Vehicle Charging" project (High Powered Charger Project, or Project). NRG submitted this proposal on March 20, 2015, and amended it in response to CPUC staff feedback on September 16, 2015. In response to further CPUC staff feedback and requests, NRG submitted a final amended proposal on October 5, 2015. This letter approves the use of $2.2 million from the CPUC-NRG Settlement's Technology Demonstration Program for this Project, as submitted to the CPUC on October 5, 2015.

In 2012, the Federal Energy Regulatory Commission (FERC) approved the CPUC-NRG Settlement (FERC Docket EL02-60). The settlement includes, among other provisions, that NRG spend $5 million as part of the Technology Demonstration program. This program funds projects related to the "deployment, demonstration, and testing of electric vehicle charging technology." (Section (4)(d)(i) of the settlement). The settlement requires that NRG and CPUC agree on any projects that are funded as part of the Technology Demonstration program.

As part of the proposal NRG commits to providing the CPUC with quarterly reports on its progress, drafted in partnership with UC Davis researchers. We look forward to the first progress report on the High Powered Charger Project in 2016.

Sincerely,

Timothy J. Sullivan
Executive Director

Cc: Arocles Aguilar, General Counsel, CPUC
Marcelo Poirier, Attorney, CPUC
Brian Turner, Deputy Executive Director, CPUC
Edward Randolph, Director, Energy Division, CPUC
Judith Ikle, Program Manager, Energy Division, CPUC
Melicia Charles, Supervisor, Energy Division, CPUC
Jason Houck, Analyst, Energy Division, CPUC

NRG ENERGY

Standards Development and Demonstration For Open-Platform, Very High Speed Electric Vehicle Charging

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An NRG proposal for the Technology Demonstration Program

NRG eVgo

3/20/2015

Amended September 16, 2015

Project Background

Auto manufacturers have announced the next generation of Electric Vehicles (EVs) that will greatly expand their capability in terms of range. Many of these vehicles are moving towards 200-250 miles of range (60kwh or greater of battery capacity) on a single charge, affordable to average consumers ($20,000-$30,000). The announcements anticipate the vehicles entering the market in 2016-2017.

The entry of these new vehicles makes it possible to reach a new generation of consumers, who are single-car households – younger, less affluent, and more likely to rent versus own their home compared to the current generation of drivers. The ability to carry greater batteries with greater energy density and thus more total electricity onboard also enhances the need for very high power chargers (100kW and greater) to repower the vehicles in a reasonably brief amount of time. 100kW and greater chargers will enable drivers to refill the larger capacity batteries with the same amount of time spent recharging as current EV drivers. Combining convenience with increased range may for the first time allow drivers with limited access to reliable home or workplace charging to own an EV.

Today, only Tesla has charging stations offering greater than 50kW charging rate and the company's stations are only available to Tesla drivers. Both the Chademo and SAE Combo standard have set power level limits at 50kw, which matches the capability of today's vehicle battery capacity and charge acceptance capability. Multiple other automakers have expressed interest in developing charging stations greater than 100kW, but the cost and risk of developing and deploying a cross-automaker charging technology is daunting.

Objective

The proposed project will build an open standard, open service model with 100kW or greater charging equipment, and deploy it in a demonstration to gain real-world results. The objective is to create a prototype super-high power charger with both ChaDeMo (if feasible) and SAE Combo connectors (in order to serve all automakers), completed by end of 2016 – in time for deployment with the new vehicles scheduled to enter the market. The learnings from this project will then be applied to a potentially larger rollout of stations across California and eventually the country.

Objectives:

1. Develop specifications for charging system
2. Develop high power charging system
3. Establish best practices for site development
4. Test and validate capability with different auto OEM's
5. Validate station economics at a public charging location
6. Report progress, findings, and develop new research on the value of high-speed charging for drivers and state policy objectives
7. Evaluate consumer usage behaviors

Uniqueness

Today's deployment of publically available fast chargers has been limited to 50kW. While this charging level is satisfactory for today's vehicles with less than 30 kWh battery packs it is woefully under rated for coming vehicles with 60 kWh or greater packs. The next generation of vehicles will require higher power to allow consumers to recharge in a reasonable about of time (less than 30 minutes). Secondly today's infrastructure all too often is built with only 1 or 2 chargers at each location. Many times this is a point of frustration for drivers who arrive at the charging station only to find they are third or fourth in line to charge. With each charge taking up to 30 minutes this can end up being a very long wait. This project will work to resolve both issues. First we will work with the established industry partners to produce an open non-proprietary standard charger with a power level of up to 150kW (100kW may be the maximum achievable for CHAdeMO)[1], which will be the highest charging standard for passenger vehicles available. This project will also find the best methods to increase the number of charge stations available while minimizing the potential impact to the grid. Different strategies will be employed such as on-site generation, energy storage and power sharing[2]. Each strategy will be tested to mitigate adverse utility grid impacts while still providing the customer with the expected level of service.

Use Cases

- Travel between cities and major destinations
  With the advent of long range BEV's coming to market intercity travel becomes feasible. This is only possible with strategically placed stations along major routes to enable such travel.

- "Garage-less" residents recharging in their home city.
  Developing high-speed charging may be more convenient for drivers and less expensive for the industry than bringing dedicated charging to renters who do not have a reliable place to park. Consider below for illustration:

    - If an array for these would-be drivers were to cost 2 to 3 times the average cost for a multifamily property ($5,000 per driver), then roughly $10,000 to $15,000 would be required per driver.
    - The projected cost of a 100kW+ charger with two charging standards is $60,000, with installation cost of $60,000. It should be able to comfortably serve up to 30 drivers per day, who charge twice per week, which is roughly 100 drivers of capacity. This makes the required capital investment per driver roughly $1,200.

  Although this analysis does not factor operating costs, which are significantly greater for fast chargers due to demand charges and maintenance, the order-of-magnitude difference in capital costs suggest this may be the technology pathway to reaching this important market demographic.

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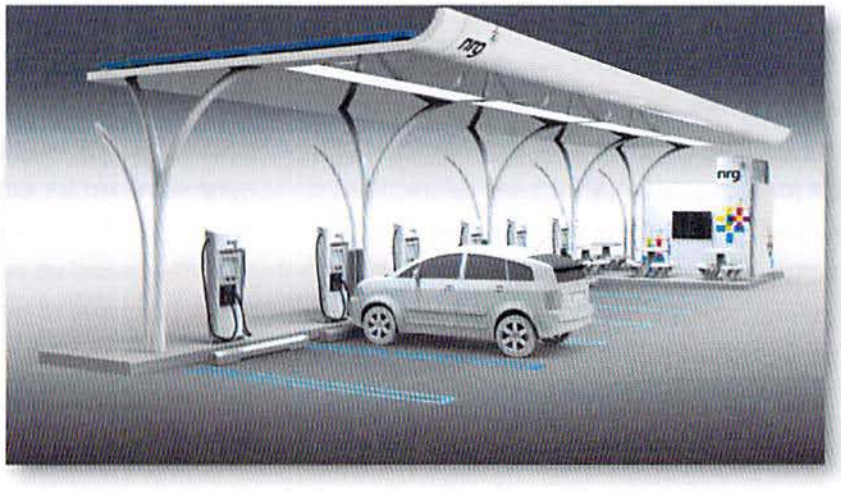
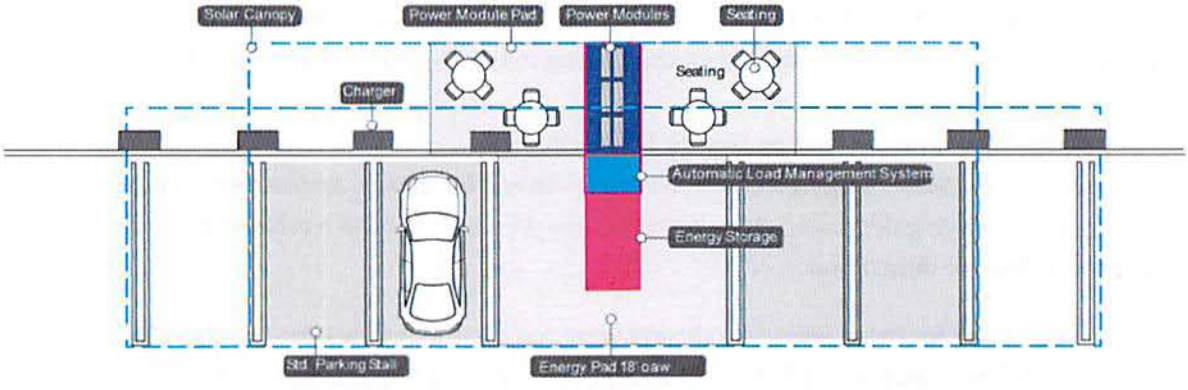
[1] The Chademo standard currently limits the current output to 50kw. Demonstration of 100kw was completed by Kia in Korea using this standard.

[2] Power sharing – The ability for 2 or more chargers to limit the simultaneous output.

Demonstration and Project Approach

NRG plans on demonstrating all aspects of this project in a demonstration site located in a public charging site at Lucky's Supermarket at 5000 Mowry Blvd., Fremont, California. This will include: high power DC chargers, 6-10 charging stalls all capable of outputting maximum power, on-site generation (solar and other), automatic load management system and on-site energy storage.





PARKING LOT AISLE

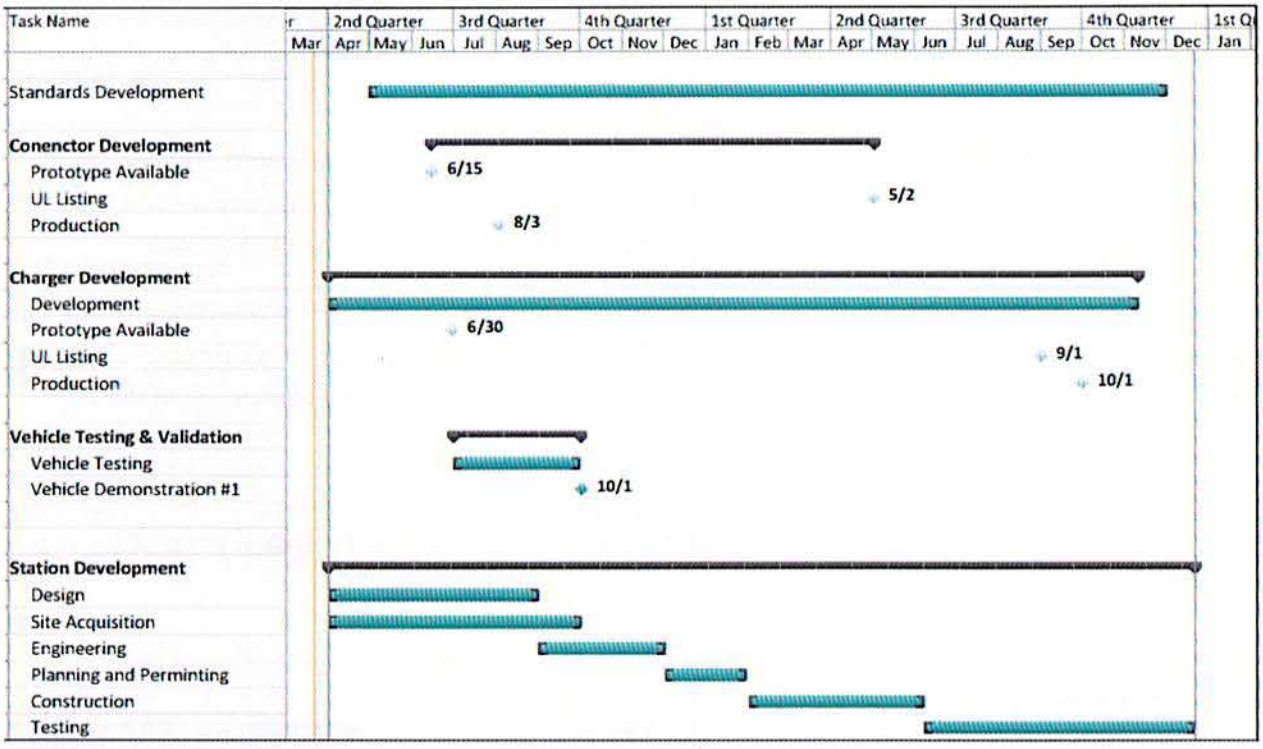
NRG will partner with major automakers (including: Audi, GM, Ford, BMW, Kia, Nissan) and with industry partners such as BTC, ABB, Rema, Society of Automotive Engineers, and Underwriters' Laboratories to implement the project. Support letters from these automakers has been provided along with this proposal. The total cost is anticipated to be $2,100,000. NRG and the project partners will complete several technical and business-related tasks listed below.

1. Update Chademo and SAE Standards to reflect higher power charging
2. Develop specifications for charging system
3. Develop charging system
4. Develop high power connector for both Chademo and SAE Combo
5. Refine the user experience

6. Optimal Cord length, ergonomics and optimal charging port location
7. Establish best practices for site development
8. Test and validate capability with different auto OEM's
9. Validate station economics

Project Timing

The project will start on October 15, 2015 and continue through the end of 2016. Below is a timeline of the major project events.



Results Analysis

NRG will utilize internal technical resources as well as resource from the project partners to review different aspects of the development. These results and lessons learned will be incorporated into the charger development, deployment site and/or the final project findings.

Additionally, Michael Nicholas, Postdoctoral Research at UC Davis will conduct a study to characterize the ongoing value and potential of extreme high power charging for EVs.

There are at least three to be studied by Nicholas regarding charging one's vehicle either at home or in public: Convenience, economy, and need. All three relate to faster charging..

Convenience: In the context of 100kW+ charging, the main difference from standard fast charging is speed. More speed means more convenience. How might this affect demand for charging? What is the

threshold for waiting time per charging event? How does this interact with range generated per charge? How many more events are generated based on convenience versus a regular 50kW fast charger? If small battery BEVs could use faster charging, how might this affect usage? How many times are people willing to stop in long distance BEVs?

Economy: How does usage vary with the price of charging for 100kW+ charging? How much are people willing to pay for speed? Given a choice between a 100kW charge and a 50kW fast charge, how much more are people willing to pay? Will they pay more than the price of gasoline?

Need: How many people may want to use 100kW+ charging on long trips versus short trips? How many long trips do people take, and where are the long distance corridors? Do 200 mile BEVs open up the demand for "garageless" BEVs? How often would people need to charge near home on a fast charger versus a L2 charger?

Interviews with OEMs: Interviewing OEMs in advance of the hardware rollout and after will give valuable information on how OEMs conceive of fast charging and how it will be implemented on their vehicles. This will add realism to the analysis and may present facts that will change the results.

We'll use a mix of past surveys and modeling to get results. One possibility is to ask questions on our currently running surveys of Tesla owners and owners of other BEVs and PHEVs. Another possibility is to use the fast charger intercept survey (the one above) to both ask questions and recruit respondents for future surveys that are more targeted.

This work will build upon UC Davis' existing fast charging research program, including its current survey, found here http://evsurvey.its.ucdavis.edu/fast/1002. Together, this body of research will provide California and the EV industry with a robust assessment of this technology.

Key Partners

Partner	Role
Ford, Audi, BMW, VW, GM, Nissan and Kia	Provide vehicles for integration, testing and demonstration
BTC, Signet, ABB and others	Develop 150kw charger
Rema	Develop 150 kW CCS connector/cable
Underwriters' Laboratories	Safety Evaluation
Society of Automotive Engineers	Review and Update of J1772 standard
IEC	Review and Update of relevant standards
Chademo & JIS	Review and update of Japanese standard
University of Davis, Michael Nicholas	University research and reporting partner
Pacific Gas and Electric	Utility partner

Budget

	Man Hours or Quantity	Hourly Rate or Unit Cost	Total
Charger Development			
Supplier #1 for Combo	1	$ 250,000	$ 250,000
Supplier #2 for ChaDeMo	1	$ 250,000	$ 250,000
J1772 Connector Development	1	$ 75,000	$ 75,000
Automotive Standards Up date	560	$ 125	$ 70,000
Program Management & System Engineering	2880	$ 125	$ 360,000
Charger Testing and Integration	160	$ 125	$ 20,000
Power Center Development and construction	1	$ 735,000	$ 735,000
Energy Storage Integration (100kwh/50kw)	3	$ 100,000	$ 300,000
Power Center Safety, testing and analysis	320	$ 125	$ 40,000
Research and Reporting Partner (UC Davis)			$ 100,000
		Total	$ 2,200,000

Reporting

NRG will provide quarterly reports to the CPUC during the course of the Project on the same reporting schedule as the existing settlement agreement. UC Davis will partner to produce the reports, which will evaluate progress toward the key milestones, partnerships, and ongoing relevance of the work for industry. Having UC Davis as an independent reporting partner will provide the external assessment required to guarantee that state ratepayers get the full value of the program benefit.

Key milestones in the program are identified in the Program timing chart above, and success will be determined largely on conclusion of the charger integration with Auto OEMs and completion of the testing and deployment site in Fremont. Additionally, progress in the technology standard setting organizations and the reporting processes are public and will be independently verified. To determine ongoing relevance, Michael Nicholas will review grant-making and policy-setting by state agencies

combined with automaker interviews to determine if the Project is moving forward the objective to match the needs of the industry and consumers.

NRG shall submit a report, with confidential and redacted versions, to the Commission prepared by the lead individual representing the Research Partners (Mike Nicholas) summarizing the results analysis, provided, however, that information deemed confidential under the NRG/CPUC Agreement need not be disclosed.

Without waiving the confidentiality protections afforded under the NRG/CPUC Agreement, the report shall include the following information:

1) Collecting quantitative demonstration activity data from site:
    a) EV charge events, battery charge events, battery discharge events;
    b) average system demand, peak period of charge events;
    c) battery capacity at beginning, capacity at end; and
    d) maintenance and repair events summary.
2) Collecting demonstration financial data:
    a) utility cost, service and support cost;
    b) development, equipment, installation costs.
3) Charging Equipment
    a) Specifications
    b) Equipment cost
4) Qualitative evaluations:
    a) Key implementation process assessment:
        i. Include timeline of major events related to: base infrastructure design and permitting; interconnection studies; equipment testing; execution of agreements.
    b) Lessons learned: Including technical, business operations, legal, and regulatory issues and policy implications; customer experience and satisfaction.

Approval Request

We ask that the CPUC grant approval for this project before October 1 in order to be effective in the technology standard setting process required for technology adoption..