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May 18, 2023
In reply, refer to:
CRC Project No. SM-CR-9

Dear Prospective Bidder:

The Coordinating Research Council (CRC) invites you to submit a written proposal to provide services for "Assess the Battery-Recharging and Hydrogen-Refueling Infrastructure Needs, Costs and Timelines Required to Support Regulatory Requirements for Light-, Medium-, and Heavy-Duty Zero-Emission Vehicles" (CRC Project No. SM-CR-9). A description of the project is presented in Exhibit A, "Statement of Work."

Please indicate by email **as soon as possible** if you or your organization intends to submit a written proposal for this research program. CRC will answer technical questions regarding the Request for Proposal if they are submitted in writing. CRC will then return written answers to all of the bidders, along with a copy of the original questions.

A CRC technical group composed of industry representatives will evaluate your proposal. CRC reserves the right to accept or reject any or all proposals. Key contract language examples are presented in Exhibits B, C, D, and E. CRC must adhere to standard contract language with minor adjustments only in extraordinary circumstances. **Failure to agree to these contract clauses as written may result in the project being awarded to another contractor.**

Important selection factors are listed in Exhibit F. CRC evaluation procedures require the technical group to complete a thorough technical evaluation before considering costs. After developing a recommendation based on technical considerations, the costs are revealed and the recommendation is modified as needed.

The proposal must be submitted as two separate documents. The technical approach to the problem will be described in part one, and a cost breakdown that is priced by task will be described in part two. The cost proposal document should include all costs associated with conducting the proposed program. The technical proposal should not be longer than 10 pages in length (not including resumes). **The schedule / timeline information must be included in the technical proposal; failure to do so may result in your proposal being set aside as non-responsive.**

CRC expects to negotiate a cost-plus fixed fee or cost reimbursement contract for the research program.

The technical and cost proposals should be submitted to:
Christopher J. Tennant Email: **ctennant@crcao.org**

The deadline for receipt of your proposal is **AS SOON AS POSSIBLE**

EXHIBIT A

Statement of Work

Assess the Battery-Recharging and Hydrogen-Refueling Infrastructure Needs, Costs and Timelines Required to Support Regulatory Requirements for Light-, Medium-, and Heavy-Duty Zero-Emission Vehicles

Motivation

The U.S. EPA has issued Notices of Proposed Rulemaking for light-duty, medium-duty, and heavy-duty on-highway vehicles and engines for model years 2027 to 2032, including a requirement for decreasing greenhouse gas (GHG) fleet average emissions. EPA has published a projected penetration rate of new zero-emission vehicles (ZEVs) sales as an example compliance path (Table 1). ZEVs include battery-electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) and, under some interpretations, plug-in hybrid electric vehicles (PHEVs). Internal combustion engines that consume hydrogen produce no tailpipe GHGs, SOx, or particulates, but do produce NOx. However, they are capable of operating on fuel with far lower purity than that required for FCEVs.

In addition, the California Air Resources Board (CARB) has adopted several rules setting ZEV sales requirements for both light- and medium/heavy-duty vehicles through 2035. The Advanced Clean Cars II (ACCII) rule sets increasing sales requirements for light-duty ZEVs beginning in 2026MY and ending with 100% new car sales-2035MY.It is an extension of the current Advanced Clean Cars (ACC) regulation for 2018-2025MY. Sixteen states have opted in to the ACC regulations[1]. Five have also adopted the new ACCII regulations as well, with more expected to follow.

For medium- and heavy-duty trucks, California adopted the Advanced Clean Trucks (ACT) regulation rule, which sets increasing ZEV sales requirements from 2024 to 2035 (Table 2). Eight other states have adopted the Advanced Clean Trucks regulation with rulemaking underway in several more.[2]

For plug-in electric vehicles, several classes of chargers are available that support different charging needs. These include Level 2 and Direct Current Fast-Charging (DCFC) for light-duty and heavy-duty vehicles. Both have impacts on the electrical grid to varying degrees depending on type and size. For hydrogen, light-duty and heavy-duty

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[1] Colorado (from 2023MY), Connecticut, Delaware (from 2027MY), Maine, Maryland, Massachusetts, Minnesota (from 2025MY), New Jersey, New York, Nevada (from 2025MY), New Mexico (from 2026MY), Oregon, Rhode Island, Vermont, Washington (from 2025MY), and Virginia (from 2025MY) have adopted Advanced Clean Cars I regulations. *https://tinyurl.com/4k7whbsu*
Alternative URL: https://ww2.arb.ca.gov/sites/default/files/2022-05/%C2%A7177_states_05132022_NADA_sales_r2_ac.pdf
To date, Massachusetts, New York, Oregon, Vermont, and Washington have adopted Advanced Clean Cars II.

[2] Colorado, Massachusetts, Maryland, New Jersey, New York, Oregon, Vermont, and Washington have adopted ACT. Connecticut, Maine, and North Carolina are in the process of adopting it. Find most up-to-date information here: *https://www.electrictrucksnow.com/states*

vehicles are served by different classes of stations – the fuel source, quality, and delivery method depend on the type and size. The carbon intensity of electricity is controlled by separate policies and goals in each state. For hydrogen for transportation in California (the current main market), the minimum proportion of renewable H_2 is set by law and reducing the carbon intensity is incentivized by the Low Carbon Fuel Standard.

Goal

In order to support the growing ZEV fleet that is expected as a result of these rules, electric recharging and hydrogen refueling infrastructure expansion will be necessary. While this infrastructure is not required by regulation, several incentives exist to encourage it, such as National Electric Vehicle Infrastructure (NEVI) grants for plug-in vehicle charging, and Charging and Fueling Infrastructure (CFI) grants for electric, natural gas, propane, and hydrogen. Both are funded by the 2021 Infrastructure Investment and Jobs Act (IIJA).

Understanding the scope, cost, and timelines for developing this ZEV infrastructure will assist planning and inform policy development.

All stakeholders desire to achieve accelerated deployments of ZEVs through the optimized allocation of available federal funding. In that regard, and for the first time, there are multiple clean powertrain options providing various impacts to the customer and the supporting infrastructure. The effect of powertrain electrification on the electrical grid and potential hydrogen production/distribution, combined with a progressing portfolio of diverse energy sources, is extremely complex and may present challenges or opportunities that were unexpected. Understanding the comprehensive implications of electric charging and hydrogen expansion will help guide decision-making. Toward that end, an assessment should be completed as soon as possible of the scope of the ZEV infrastructure that will be needed to support the envisioned transition to light-duty, medium-duty, and heavy-duty ZEVs.

Description

Data bases (such as PlugShare and other data sets developed by DOE, EPRI and CEC, etc.) could be used to track where and to what extent cars and trucks are operated throughout the country.

Those utilization trends, perhaps depicted through heat-maps and initially expressed in terms of the aggregate VMT and energy needs, by vehicle weight class and type, could be converted into electric-power equivalents, which could yield a calculation of how much battery power would be required to support various percentage rates of new BEV cars and trucks coming into the nationwide fleet, and what impact that would have on the capacity and readiness of the electrical grid.

That battery-power calculation could then be used to calculate the number and location of private and public BEV-truck recharging stations that would be necessary to deliver the aggregate calculated need for BEV-car and BEV-truck battery power.

Using those data, a detailed matrix could be developed, showing on a year-over-year basis, the number and general location of BEV recharging stations that would need to be installed and operational between 2027 and 2032 to support a reasonable implementation of the proposed GHG standards. A similar assessment would need to be developed for the hydrogen-refueling infrastructure that will be needed to support the development and operation of FCEVs and hydrogen internal combustion vehicles. An example is shown in Table 3.

Potential tools for this analysis include ADOPT, TEMPO, and EVI-X, all from NREL. It may also be appropriate to consider other private contractors who might be able to give a less detailed answer in a shorter time frame.

The specific topics and questions that the requested infrastructure needs assessment should address are as follows:

1. What level of ZEVs can the current infrastructure in the U.S. support – and, with current utility company forecasts?
2. What are the aggregate energy requirements needed to support the predicted ZEV penetration rates required to fulfill current and proposed vehicle regulations?
3. What impacts will those aggregate energy requirements have on the electrical grid and hydrogen-refueling pathways, including production capacity, transmission/distribution capacity, necessary transmission and distribution upgrades, and availability of sufficient charging/refueling outlets? Consider current trajectory of infrastructure deployment given current policies such as West Coast Electric Highway, Electrify America, etc.
4. Determine the number, location, size (in kW), costs and timelines for the BEV-recharging and H_2-refueling stations needed to support the envisioned deployment of ZEVs and assess the necessary upgrades to the electrical grid, as well as those associated costs and timelines.
5. How would alterations to the fleet mix of BEVs, FCEVs, and PHEVs affect the infrastructure challenges, opportunities, and costs?
6. As a related assessment, build off historical data to develop or adopt a sales model for LD, MD, HD ZEVs through 2035 that complies with existing and expected rulemakings from CARB and EPA. Based on those models, calculate the implied energy demand and evaluate the resulting impact on energy supply infrastructure at both the local and regional level. Assess the likely timeline and cost to meet this supply. Apply sensitivity analyses to results.
7. Determine the contributions of vehicle-to-grid BEVs and H_2 production/storage to overall grid requirements as the proportion of renewable energy production increases under current trajectories and state policy.
8. As hydrogen demand rises, hydrogen supply will make a transition from relatively small and local boutique supply arrangements to larger scale interstate distribution and delivery, likely through pipelines. Those pipelines can be either dedicated hydrogen lines or compressed natural gas lines adapted for dual use. The delivery method for hydrogen will define quality and purity levels at the destination and this, in turn, may impact the economics and use cases of the resulting retail hydrogen

and the powertrain type in a heavy truck application (ICE or FCEV). The specific research task on this point is to determine how different delivery methods may affect the quality or purity of hydrogen and its cost to an end user as the infrastructure to deliver hydrogen develops. Identify the impact on total cost of ownership for an end-user operating fuel cell electric vehicles versus internal combustion engine vehicles fueled with hydrogen.

9. Examine existing and potential government regulatory and financial incentives, especially for:
    a. DCFC equipment along rural and inter-city corridors
    b. Cross-country network of heavy-duty electric charging stations
    c. Cross-country network of heavy-duty hydrogen refueling stations (for various storage: 35MPa, 70MPa, and cryo-compressed)

Potential Expansion Topics

10. Examine the regulatory landscape for utility companies to invest in infrastructure. Consider if any regulatory changes could ease development.
11. Examine potential impact on jobs and wages at automakers (manufacturing, service/repair) and other stakeholders.

Deliverables

Quick (target June 30)

1. Nationwide assessment of:
    a) number of ZEVs that can be supported by current infrastructure
    b) projected electricity/hydrogen demand
    c) expected electricity/hydrogen supply – include proportion that is low-carbon
    d) gap
    - Use assumed fleet mix from [Department of Energy/VISION]

2. Nationwide projection of:
    a) number/size of charging/refueling stations required to be installed
    b) approximate cost
    c) approximate time to build out

3. Nationwide projection of:
    a) generation/production and distribution infrastructure upgrades that would be required to fulfill the projected demand
    b) proportion of generation increase that is expected to be low-carbon

Extended

4. Localized heat maps for item 1
5. Localized projections for item 2
6. Regional projections for item 3
7. Sensitivity analysis to
    a) Adoption of VGI for BEV/EVSEs and H2 production for storage
    b) Shift in fleet mixes around BEV, FCEV, and PHEV

8. Assets to address the remaining questions in the Description.

Tables

Table 1: EPA's Potential Estimated Targeted ZEV Penetration Rates (in red)

Model Year	Vocational Trucks	Short-Haul Tractors	Long-Haul Tractors	Light-Duty Vehicles
	EPA Target	EPA Target	EPA Target	EPA Target
2027	20%	10%	0%	36%
2028	25%	12%	0%	45%
2029	30%	15%	0%	55%
2030	35%	20%	10%	60%
2031	40%	30%	15%	63%
2032	50%	35%	20%	67%

Table 2: CARB's Required ZEV Proportion of New Vehicle Sales (in red)

Model Year	Light-Duty Vehicles	Class 2b-3 Trucks	Class 4-8 Trucks	Class 7-8 Tractors
	ACCII	ACT	ACT	ACT
2024	*	5%	9%	5%
2025	*	7%	11%	7%
2026	35%	10%	13%	10%
2027	43%	15%	20%	15%
2028	51%	20%	30%	20%
2029	59%	25%	40%	25%
2030	68%	30%	50%	30%
2031	76%	35%	55%	35%
2032	82%	40%	60%	40%
2033	88%	45%	65%	40%
2034	94%	50%	70%	40%
2035	100%	55%	75%	40%

* Set by Advanced Clean Cars I

Table 3: Example Truck Fleet Daily Energy Demands

The nationwide truck fleet could be broken down into separate ZEV categories, differentiating each truck's daily energy demands, and the power and locations of the charging stations needed to power them. Using a heat-map of current truck utilization trends and the targeted ZEV penetration rates in the GHG Phase 3 rule, the table could be used to identify the ZEV energy and charger needs for ZEV trucks.

Medium- and Heavy-Duty Zero-Emission Vehicles					
Vehicle Weight Class, Type, and Typical Operation	**Typical Energy Needs (kWh/day)**	**Minimum Charger Power (kW)**		**Chargers Needed per Vehicle**	
		At Depot	**En Route**	**At Depot**	**En Route**
Class 4-5 trucks - local	130	50	0	0.5	0
Class 6-7 trucks - local	130	50	0	0.5	0
Class 6-7 trucks - regional	195	50	50	0.5	0.1
Class 8 trucks - regional	270	50	150	1	0.1
Class 8 trucks - long haul	450	100	250	1	0.2
Class 8 tractors - regional	315	50	150	1	0.2
Class 8 tractors - long haul	525	150	350	1	0.2
Class 8 tractors - cross country	1,050	0	1,000	0	0.2

EXHIBIT B

REPORTS

A. CONTRACTOR shall submit a technical progress report covering work accomplished during each month of the contract performance. The report shall contain a description of overall progress, plus a separate description for each task or other logical segment of work on which effort was expended during the reporting period. Periodic conference calls may also be requested by CRC to update the technical committee overseeing the project.

B. CONTRACTOR shall submit to CRC a draft final report on or before DRAFT FINAL REPORT DUE DATE. The *Draft Final Report* shall be reviewed and returned to CONTRACTOR with comments no later than forty-five (45) days thereafter. The report shall document, in detail, all of the work performed under the contract including data, analyses, and interpretations, as well as recommendations and conclusions based upon results obtained. The report shall include tables, graphs, diagrams, curves, sketches, photographs, and drawings in sufficient detail to comprehensively explain the results achieved under the contract. The report shall be complete in itself and contain no reference, directly or indirectly, to the monthly progress reports and should be suitable for publication in the peer-review literature. Additional rounds of review may be required prior to acceptance of the Final Report. If applicable, data from the research shall be provided in a format suitable for releasing to the public along with the final report.

The draft report must have appropriate editorial review corrections made by the contractor prior to submission to CRC to avoid obvious formatting, grammar, and spelling errors. The report should be written in a formal technical style employing a format that best communicates the work conducted, results observed, and conclusions derived. Standard practice typically calls for a report structure that includes:

- CRC Title Page and Disclaimer Statement (both provided by CRC)
- Table of Contents
- List of Figures
- List of Tables
- List of Acronyms and Abbreviations
- Executive Summary
- Background
- Approach (including a full description of all experimental materials and methods)
- Results
- Conclusions (may also include Recommendations if CRC requests them)
- List of References
- Appendices as appropriate for the scope of the study.

Incomplete draft reports or reports of poor quality requiring additional outside editorial review may have outside editorial services charged back to the project budget.

EXHIBIT C

INTELLECTUAL PROPERTY RIGHTS

Title to all inventions, improvements, and data, hereinafter, collectively referred to as ("Inventions"), whether or not patentable, resulting from the performance of work under this Agreement shall be assigned to CRC. CONTRACTOR shall promptly disclose to CRC any Invention which is made or conceived by CONTRACTOR, its employees, agents, or representatives, either alone or jointly with others, during the term of this agreement, which result from the performance of work under this agreement, or are a result of confidential information provided to CONTRACTOR by CRC or its Participants. CONTRACTOR agrees to assign to CRC the entire right, title, and interest in and to any and all such Inventions, and to execute and cause its employees or representatives to execute such documents as may be required to file applications and to obtain patents covering such Inventions in CRC's name or in the name of CRC's Participants or nominees. At CRC's expense, CONTRACTOR shall provide reasonable assistance to CRC or its designee in obtaining patents on such Inventions.

To the extent that a CRC member makes available any of its intellectual property (including but not limited to patents, patent applications, copyrighted material, trade secrets, or trademarks) to CONTRACTOR, CONTRACTOR shall have only a limited license to such intellectual property for the sole purpose of performing work pursuant to this Agreement and shall have no other right or license, express or implied, or by estoppel. To the extent a CRC member contributes materials, tangible items, or information for use in the project, CONTRACTOR acknowledges that it obtains only the right to use the materials, items, or information supplied for the purposes of performing the work provided for in this Agreement, and obtains no rights to copy, distribute, disclose, make, use, sell or offer to sell such materials or items outside of the performance of this Agreement.

EXHIBIT D

RELATIONSHIP OF PARTIES

It is agreed and understood that CONTRACTOR is acting as an independent contractor in the performance of any and all work hereunder, and to the extent caused by CONTRACTOR, CONTRACTOR shall be solely liable and responsible for the payment of all legal claims for damages made by its employees or agents, or by another person or persons, on account of any property damage or on account of personal injury sustained or suffered by, or on account of the death, of any person or persons, or on account of any other legal claims arising or growing out of CONTRACTOR's negligence in the performance of the agreement; and CONTRACTOR undertakes to indemnify CRC against any such liability.

EXHIBIT E

KEY PERSONNEL REQUIREMENTS

Certain skilled experienced professional and/or technical personnel are essential for successful performance by CONTRACTOR of its obligations and work under this Agreement. These personnel are persons whose resumes were submitted for evaluation of the Proposal and are identified by CRC as "Key Personnel". CRC awards contracts based on several requirements and the reputation and experience of Key Personnel are a significant requirement. CONTRACTOR agrees that CONTRACTOR will not remove or replace any Key Personnel from the contract work without compliance with paragraphs (a) and (b) hereof.

(a) If any Key Personnel for whatever reason becomes, or is expected to become, unavailable for work under this Agreement (or any specific Project) for a continuous period exceeding thirty (30) work days, or is not expected to perform the work hours and volume of work indicated in the proposal or initially anticipated, the CONTRACTOR shall immediately notify CRC and shall, subject to the concurrence of CRC, promptly replace such Key Personnel with personnel of at least substantially equal ability and qualifications acceptable to CRC.

(b) All requests for approval of substitutions of Key Personnel hereunder must be in writing to CRC and provide a detailed explanation of the circumstances necessitating the proposed substitutions. Requests for substitution must contain a complete resume for the proposed substitute Key Personnel, and any other information requested by CRC needed to approve or disapprove the proposed substitution. CRC will evaluate such requests and notify CONTRACTOR of approval or disapproval thereof in writing. CRC is not responsible for, and shall not be charged, any fees or other costs related to such replacement Key Personnel's performance of the services until the replacement Key Consultant has obtained the same proficiency and knowledge regarding the services as the former Key Personnel.

(c) If CRC determines that suitable and timely replacement of Key Personnel who have been reassigned, terminated or have otherwise become unavailable for the contract work is not reasonably forthcoming or that the proposed replacement Key Personnel would impair the successful completion of the contract or the services ordered, at the option of CRC, (i) the Agreement (in whole or in part related to the applicable contract work) may be terminated by CRC or (ii) the contract price or fixed fee may be equitably adjusted downward to compensate CRC for any resultant delay, loss, or damage, in an amount acceptable to CRC

EXHIBIT F

PROPOSAL EVALUATION CRITERIA

1) Merits of proposed technical approach.
2) Previous performance on related research studies.
3) Personnel available for proposed study – related experience.
4) Timeliness of study completion.
5) Cost.