EXHIBIT E

CORNELL UNIVERSITY

The College of
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To the Audi CO2 Cy Pres Settlement Fund:

With the attached proposals, we respectfully request support from the Audi CO2 Cy Pres Settlement Fund to enable faculty within the College of Arts & Sciences at Cornell to pursue research and development related to the mitigation of climate-change impacts through two five-year projects led by Professor Héctor D. Abruña in Cornell University's Department of Chemistry and Chemical Biology. The budgets of of the two projects total $8.3 million:

- **Fuel Cell Development:** Fuel cells represent one of today's most promising and efficient energy conversion technologies. Devices that make possible the integration of renewable energy sources, fuel cells have the potential to dramatically alter the energy landscape, which could lower and eventually eliminate the use of fossil fuels and thus mitigate the environmental and climatic effects of their continued use. Through the proposed project, we seek to develop a long-term solution to the global climate challenge by harnessing a unique array of Cornell collaborators who will expand experimental facilities where the synthesis of fuel cell materials could be scaled up - and tested at scale and in devices that would be commercially relevant.

- **Advanced Battery Technology:** Energy storage technologies are essential to the effort to eliminate the use of fossil fuels in a number of areas, including transportation and electrical power generation. In the case of batteries, especially for automotive applications, the main challenges include enhancing energy and power density, shortening charging times, and extending durability while minimizing cost and maximizing safety. Over the past few decades, science and industry have made strides in these areas. Advancing recent findings to address the remaining challenges lies at the heart of our proposed research. Through this project, Cornell will establish experimental facilities where the synthesis of materials for batteries could be further developed and commercialized.

Thank you again for this opportunity. Michelle Houle Hitz, Director of Development, is available to answer any specific questions. She can be reached at mmh11@cornell.edu or (607) 254-6139.

Sincerely,

Ray Jayawardhana

Ray Jayawardhana
Harold Tanner Dean of Arts and Sciences

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Proposals to the Audi CO2 Cy Pres Settlement Fund
Executive Summary

The College of Arts & Sciences at Cornell University occupies the nexus of discovery and impact. Our researchers collaborate across disciplines and colleges, partnering with applied scientists, engineers and other practitioners within and beyond the university to tackle the greatest challenges of our time. Given the depth and breadth of Cornell's research excellence – and our deep commitment to addressing climate change, which is a university-wide priority – we are uniquely positioned to enable groundbreaking new technologies while transforming research successes into real-world applications with lasting impact.

The two projects outlined below have a total budget of $8.3 million and a five-year duration:

Fuel Cell Development: Through a project led by Professor Héctor D. Abruña in Cornell University's Department of Chemistry and Chemical Biology, we seek to develop a long-term solution to the global climate challenge by harnessing a unique array of Cornell collaborators working together on fuel cell technologies. The proposed project has a duration of five years and a budget of $5.3 million.

Advanced Battery Technology: Through a project led by Professor Héctor D. Abruña in Cornell University's Department of Chemistry and Chemical Biology, Cornell will establish experimental facilities where the synthesis of materials for batteries could be expanded and tested at scale and in devices that would be commercially relevant. The proposed project has a duration of five years and a budget of $3 million.

Fuel Cell Development at Cornell University
The Abruña Group

Fuel cells represent one of the most promising and efficient energy conversion technologies, especially for decentralized electricity and long-distance and heavy-duty transportation/electric vehicles (EVs) applications. They have the potential to dramatically alter the energy landscape by enabling the integration of renewable energy sources, which in turn would make it possible to eliminate fossil fuels and mitigate the environmental and climatic effects brought about by their continued use.

> **Through a project led by Professor Héctor D. Abruña in Cornell University's Department of Chemistry and Chemical Biology, we seek to develop long-term solutions to the global challenge of climate change by harnessing a unique array of university collaborators. To this end, the College of Arts & Sciences asks you to consider a gift of approximately $5.3M over five years to undertake this project.**

The Challenge

Efficient energy conversion technologies represent an essential element in the effort to lower and eventually eliminate the use of fossil fuels in the generation of electricity and in transportation. While technologies have improved dramatically in recent decades, additional research and development and demonstration are needed to address remaining challenges and accelerate adoption.

Fuel cells represent one of the most attractive technologies for the generation of electricity from chemical fuels. Hydrogen (H_2) fuel cells can transform the chemical energy in hydrogen (and other fuels) directly into electricity with an energy efficiency two to three times higher than that of internal combustion engines. Considering the high energy density (34 kWh/kg) and fast refill times (≤5 min) of H_2 gas, hydrogen fuel cells have emerged as critical energy technologies for decentralized electrical energy storage and powering long-distance electric vehicles. While most of the advances in fuel cells have been in those operating at low pH (acid), the recent development of alkaline fuel cells (those that operate at high pH) is especially promising as they enable the use of non-precious metals to replace Pt, the most expensive component of current fuel cell technologies. In recent work, we have developed Mn-Co "spinel" electrocatalysts that, in alkaline media, rival and even surpass the performance of Pt-based systems (at a fraction of the cost) in realistic membrane electrode assembly (MEA) devices. However, they exhibit limited durability (20% decay in performance after 100 hours of operation), especially under high power operation. Advancing these findings lies at the heart of the proposed research. Equally important is our effort to inform the public about the potential benefits of fuel cell technologies and empower them to engage in energy systems reform and transformation.

Proposed Solution

At Cornell, we have tremendous expertise in the synthesis and characterization of novel materials for energy applications (energy materials). Cornell's world-class facilities in X-ray science (CHESS), electron microscopy, and other fields, and its research centers, such as CABES (Center for Alkaline-based Energy Solutions), EMC^2 (Energy Materials Center at Cornell), CCMR (Cornell Center for Materials Research), and CESI (Cornell Energy Systems Institute), have enabled great progress in fuel cell and other energy related technologies. Breaking through to real-world impact, however, will require **putting in place (A) an applied-research infrastructure that is typically not found at universities and (B) "living laboratory" demonstrations that highlight for the public at large the application and integration of these technologies, as well as the innovations at Cornell that make such advances possible.**

A. Enhanced Infrastructure

The proposed project would require establishing experimental facilities where the synthesis of fuel cell materials could be scaled up and tested at scale and in devices that would be commercially relevant. For fuel cells, this effort would require facilities for the fabrication and characterization of MEAs (membrane electrode assemblies, the "heart" of fuel cells). Integration of these facilities with Cornell scientists researching energy materials would enable an accelerated and smooth transition from the bench to commercial prototypes.

We would also require expanded MEA fabrication and testing facilities. Currently, our facility has two fuel cell test stations; expanding to four would dramatically enhance our ability to test the materials that we have developed in real, integrated devices. In order to make the most efficient use of these testing facilities, we would need to scale up our ability to make electrocatalysts, catalyst supports, membranes, and ionomers (the components of MEAs). This would require the purchase of high temperature furnaces, autoclaves, filtration equipment, and rotary evaporators. To make the best use of the above-mentioned facilities, we would need four additional personnel to work on synthesis of electrocatalysts (2) and synthesis of membranes and ionomers (1) and to carry out fuel cell testing (1).

B. "Living Laboratory" Demonstration Project

In an effort to demonstrate the value of the above-described activities to the general public, Cornell would establish a small fleet of fuel cell powered cars along with a renewable ("green") hydrogen fueling station. (As a point of reference, a 1MW hydrogen refueling station can obviate/eliminate 6,400 metric tonnes of CO_2 per year, which is equivalent to, during each month of operation, eliminating as much pollution as an average U.S. driver generates in 100 years!) We would engage companies such as GM, Toyota, and Mercedes-Benz (many of which already have existing collaborations with Cornell) to provide fuel cell powered vehicles as part of the demonstration project. In addition, we would modify the fuel cell stack in one vehicle to include Cornell's fuel cell technologies, making it possible to study the technologies in real-world conditions. The latter effort would seek to illustrate to the general population how fundamental research is translated into real-world application. While fuel cell technologies hold tremendous promise, the general population is not generally aware of their potentially transformative effects on the energy landscape. This demonstration project would serve as a showcase to inform and educate the population at large and, again, to empower individuals to consider the possibilities of energy systems reform and transformation.

Impact

Cornell is poised to take its fuel cell research from bench to industry. Diminishing the cost and enhancing the durability of fuel cells are key to making their broad deployment possible. Improved MEA testing capabilities would enable us to test a variety of Cornell-developed materials (catalysts, supports, and membranes) and technologies that we feel confident will enhance durability of materials for low-cost alkaline fuel cells toward the 1,000-hour operation benchmark for practical applications in fuel cell devices.

A tremendously ambitious initiative, this project would place Cornell firmly at the forefront of energy research and development. The applied research facilities proposed here would make it possible for Cornell to continue to build its emerging ecosystem for generating, attracting, and retaining start-up companies through the expanding network of Entrepreneurship at Cornell, which seeks to make Cornell and Ithaca a hub for commercialization. In addition, several energy stakeholders, including NYSERDA, ESD/NYSTAR, and the U.S. Department of Energy, are exploring large-scale funding of centers and demonstration facilities, such as the one we've described, offering the possibility of future collaboration and investment. Supporting start-ups and established companies alike, our "living laboratory" has the potential to bring high paying jobs and provide economic development to the Upstate New York.

Timeline

We expect the project would take five years to complete, with Year 1 beginning in academic year 2021-2022. Graduate students and post-doctoral fellows would be involved throughout the entire project, including summers, and undergraduate students would be involved during the academic year. The Enhanced Infrastructure phase would begin in Years 1 and 2, with the "Living Laboratory" Demonstration phase beginning in Year 3.

Funding Needs

Cornell seeks funding of approximately $5.3M over the course of five years to cover project expenses, including salary costs associated with hiring graduate students, post-doctoral fellows, and summer research support for Professor Héctor Abruña, the lead faculty member. Primary equipment needed in the Enhanced Infrastructure phase include the fuel cell fabrication and test station, as well as a catalyst ink sprayer system and hydrogen and carbon monoxide sensors ($75,000 each for a total of $150,000); high-temperature furnaces, autoclaves, filtration equipment, and rotary evaporators ($300,000). The primary equipment costs in the Demonstration phase include those associated with a renewable hydrogen fueling station ($2.5M).

About Héctor D. Abruña and the Abruña Group

Professor Abruña, the Émile M. Chamot Professor of Chemistry, completed his graduate studies with Royce W. Murray and Thomas J. Meyer at the University of North Carolina at Chapel Hill and was a postdoctoral research associate with Allen J. Bard at the University of Texas at Austin. After a brief stay at the University of Puerto Rico, he joined Cornell in 1983 and was Chair of the Department from 2004 to 2008. Professor Abruña is the director of CABES (Center for Alkaline-based Energy Solutions), a U.S. Department of Energy funded Energy Frontier Research Center. His research group focuses on the study of electrochemical phenomena of new materials, using a wide variety of techniques, with emphasis on applications such as fuel cells and batteries. He was elected to the National Academy of Sciences in 2018 and the American Academy of Arts and Sciences in 2007. He is the recipient of numerous awards, including an Alfred P. Sloan Foundation Research Fellowship, a John S. Guggenheim Fellowship, a J. W. Fulbright Senior Research Fellowship, the Faraday Medal of the Royal Society, and the Conway Prize. He was awarded the Allen J. Bard Medal for 2019, one of the highest honors of the Electrochemical Society. In 2021, he was honored by the American Chemical Society (ACS) with the ACS National Award in Analytical Chemistry for his pioneering work in electrochemistry, including the development of fuel cell and battery materials.

The Abruña Group performs cutting-edge, interdisciplinary research to address problems of electrochemical interest, from fundamental studies of battery and fuel cell systems to molecular electronics. The team employs standard electrochemical techniques in addition to X-ray methods, scanned probe microscopies (SECM), nanoscale fabrication, electron microscopy (SEM, TEM), DEMS, and a variety of spectroscopic techniques (UV-vis, IR, Raman). The group also synthesizes novel, tailored inorganic complexes, and organic battery materials to drive discovery of new chemical and electrochemical properties.

Fuel Cell Development at Cornell University's Abruna Group							
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Total**
Personnel							
	Abruna, H.D. *(summer salary)*	31,738	32,690	33,671	34,681	35,721	**168,501**
	Postdoctoral Associates *(two)*	107,520	110,746	114,068	117,490	121,015	**570,839**
	Graduate Students *(two)*	76,699	79,000	81,380	83,810	86,320	**407,209**
	Fringe Benefits (rate set by university)	51,525	53,071	54,663	56,303	57,992	**273,554**
	Total Salaries and F/B	**267,482**	**275,507**	**283,782**	**292,284**	**301,048**	**1,420,103**
Capital Equipment		300,000	150,000	2,500,000			**2,950,000**
See "Funding Needs" section for detail							
Travel		4,000	4,120	4,244	4,371	4,502	**21,237**
Other Direct Costs							
	Materials and Supplies	40,000	41,200	42,436	43,709	45,020	**212,365**
	Other *(Lab-related fees)*	15,000	15,450	15,914	16,391	16,883	**79,638**
	Graduate Student Tuition/Health	18,440	37,480	38,120	38,800	39,540	**172,380**
	Total Other Direct Costs	73,440	94,130	96,470	98,900	101,443	**464,383**
Total Direct Costs		**644,922**	**523,757**	**2,884,496**	**395,555**	**406,993**	**4,855,723**
Total Indirect costs		**64,492**	**52,376**	**288,450**	**39,556**	**40,699**	**485,573**
10% for Administrative costs							
Total Budget		**709,414**	**576,133**	**3,172,946**	**435,111**	**447,692**	**5,341,296**
Total Requested							**5,341,296**

The College of
Arts&Sciences

Advanced Battery Technology at Cornell University

The Abruña Group

Rechargeable batteries represent one of the most promising energy storage technologies. They have the potential to dramatically alter the energy landscape by enabling the integration of renewable energy sources, which in turn would make it possible to eliminate fossil fuels and mitigate the environmental and climatic effects brought about by their continued use.

> **Through an initiative led by Professor Héctor D. Abruña in Cornell University's Department of Chemistry and Chemical Biology, we seek to develop long-term solutions to the global challenge of climate change by harnessing a unique array of university collaborators. To this end, the College of Arts & Sciences asks you to consider making a commitment of $3M over five years to undertake the proposed project.**

The Challenge

Energy storage technologies are essential to the effort to eliminate the use of fossil fuels in numerous areas, especially in terms of transportation and electrical power generation. While science and industry have made great strides in this area over the past few decades, additional research and development is needed to address remaining challenges.

In the case of batteries, especially for automotive applications, the main challenges include enhancing energy and power density, shortening charging times, and extending durability while minimizing cost and maximizing safety. Lithium sulfur (Li/S) batteries represent one of the most promising technologies today because of their very high energy density (>2600 Wh/kg) when compared to more traditional lithium ion battery (150-250 Wh/kg) technologies. In addition, the cost of sulfur (~$40/ton) is dramatically lower than that of Co, Mn, and Ni (i.e., Co: $28,000-52,000/ton), typical elements employed in conventional transition metal oxide cathodes. We have made significant advances in the performance of S-based cathodes and developed electrolyte systems that enable cycling of metallic Li anodes for over 500 cycles with minimal degradation. (Li metal anodes are needed to take full advantage of the high capacity of sulfur.) One of the remaining challenges is to combine these two advances into a full battery system. This will require additional novel materials and battery cell architectures as well as extensive testing in both "coin cells" and pouch cells. Advancing these findings lies at the heart of the proposed research. Equally important is to educate and inform the public about the need for, and promise of, these important technologies so as to empower individuals and communities to be engaged in energy systems reform and transformation.

Proposed Solution

At Cornell, we have tremendous expertise in the synthesis and characterization of novel materials for energy applications (energy materials). Cornell's world-class facilities in X-ray science (CHESS), electron microscopy, and other fields, and its research centers, such as CABES (Center for Alkaline-based Energy Solutions), EMC^2 (Energy Materials Center at Cornell), CCMR (Cornell Center for Materials Research), and CESI (Cornell Energy Systems Institute), have enabled great progress in energy related fields and technologies such as fuel cells and batteries. Moving those advances forward to enable real-world impact will require **putting in place (A) an applied-research infrastructure that is typically not found at universities and (B) "living laboratory" demonstration projects that highlight for larger audiences the application and integration of these technologies, as well as the innovations at Cornell that make such advances possible.**

A. Enhanced Infrastructure

The proposed project would require establishing experimental facilities where the synthesis of materials for batteries could be expanded and tested at scale and in devices that would be commercially relevant. For batteries, having access to a "pouch cell" assembly facility would be key. Integration of these facilities with Cornell scientists researching energy materials would enable a smooth transition from bench to commercial prototypes.

For the enhanced experimental facilities for batteries, we would need to establish a pouch cell assembly and testing facility. This effort would require the integration of numerous components, including calendaring equipment, vacuum sealer, cell sealer, ultrasonic welder for tabs, hydraulic press for punching electrodes, dies, pouch fixtures, and consumables. These components would be, in turn, assembled inside a "double glove box." To make the best use of these facilities, we would need four additional personnel to work on the synthesis and characterization of battery materials (2), electrochemical testing (1), and the assembly and use of a pouch cell facility (1).

B. Demonstration Project

In an effort to demonstrate the value of the above-described activities to the general public, Cornell would establish a small fleet of battery powered cars along with fast battery chargers. We would engage companies like Tesla, Nissan, BMW, Ford, and GM (many of which already have existing collaborations with Cornell) to provide battery powered vehicles that would be part of the test fleet. We would also modify one of those vehicles to integrate Cornell battery technologies.

Impact

The proposed project would help Cornell take its research from bench to industry. The enhanced infrastructure, particularly adding pouch cell testing capabilities to our existing coin cell testing capabilities (>100 channels), would allow us to accelerate such testing and lead to fully integrated, Cornell-based Li/S battery technologies that are low cost and safe with high energy and power density and long-term durability. The integration of a sulfur cathode with a metallic lithium anode would dramatically transform the electrical energy storage landscape.

The research facilities proposed here would make it possible for Cornell to continue to build its emerging ecosystem for generating, attracting, and retaining start-up companies through the expanding network of Entrepreneurship at Cornell, which seeks to make Cornell and Ithaca a hub for commercialization. In addition, several energy stakeholders, including NYSERDA, ESD/NYSTAR, and the U.S. Department of Energy, are exploring large-scale funding of centers and demonstration facilities, such as the one we've described, potentially offering future opportunities for collaboration and investment. Supporting start-ups and established companies alike, our "living laboratory" has the potential to bring high paying jobs and encourage economic development in upstate New York.

In addition, the proposed demonstration project would generate valuable information with respect to performance metrics under real-life use conditions. Our goal would be to illustrate to the public how research universities move advances to real-world environments. While the population is broadly familiar with the use of batteries, it is not generally aware of their potentially transformative effects on the energy landscape. This demonstration project would serve as a showcase to inform and educate the public and in so doing, empower individuals to engage in energy systems reform and transformation.

Timeline

We expect the project would take five years to complete, with Year 1 beginning in academic year 2021-2022. Graduate students and post-doctoral fellows would be involved throughout the entire project, including summers, and undergraduate students would be involved during the academic year. The Enhanced Infrastructure phase would begin in Years 1 and 2, with the Demonstration phase beginning in Year 3.

Funding Needs

Cornell seeks funding of approximately $3M over the course of five years to cover salary costs associated with hiring graduate students, post-doctoral fellows, and summer research support for Professor Héctor Abruña, the lead faculty member. The primary equipment costs in the Enhanced Infrastructure phase include those associated with pouch cell assembly and testing facility components ($550,000). The primary equipment costs in the Demonstration phase include those associated with fast battery EV chargers ($250,000).

About Héctor D. Abruña and the Abruña Group

Professor Abruña, the Émile M. Chamot Professor of Chemistry, completed his graduate studies with Royce W. Murray and Thomas J. Meyer at the University of North Carolina at Chapel Hill and was a postdoctoral research associate with Allen J. Bard at the University of Texas at Austin. After a brief stay at the University of Puerto Rico, he joined Cornell in 1983 and was Chair of the Department from 2004 to 2008. Professor Abruña is the director of CABES (Center for Alkaline-based Energy Solutions), a U.S. Department of Energy funded Energy Frontier Research Center. His research group focuses on the study of electrochemical phenomena of new materials, using a wide variety of techniques, with emphasis on applications such as fuel cells and batteries. He was elected to the National Academy of Sciences in 2018 and the American Academy of Arts and Sciences in 2007. He is the recipient of numerous awards, including an Alfred P. Sloan Foundation Research Fellowship, a John S. Guggenheim Fellowship, a J. W. Fulbright Senior Research Fellowship, the Faraday Medal of the Royal Society, and the Conway Prize. He was awarded the Allen J. Bard Medal for 2019, one of the highest honors of the Electrochemical Society. In 2021, he was honored by the American Chemical Society (ACS) with the ACS National Award in Analytical Chemistry for his pioneering work in electrochemistry, including the development of fuel cell and battery materials.

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Total Requested							**2,976,296**