BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Application of Southern California Edison Company (U 338-E) for Approval of the Results of Its 2013 Local Capacity Requirements Request for Offers for the Moorpark Sub-Area.	Application 14-11-016 (Filed November 26, 2014)

TESTIMONY OF RINALDO S. BRUTOCO

PRESIDENT OF THE WORLD BUSINESS ACADEMY

Laurence G. Chaset
KEYES, FOX & WIEDMAN LLP
436 14th Street, Suite 1305
Oakland, CA 94612
E-mail: lchaset@keyesandfox.com
Phone: (510) 314-8385
Attorney for World Business Academy

Date: April 8, 2015

TABLE OF CONTENTS

TESTIMONY OF RINALDO S. BRUTOCO

PRESIDENT OF THE WORLD BUSINESS ACADEMY

I. INTRODUCTION

Q: Please state your name and business address for the record.

A: Rinaldo Brutoco. 2020 Alameda Padre Serra, Suite 135, Santa Barbara, CA 93103.

Q: What is your academic background and professional qualifications?

A: Attachment A to this testimony contains my Curriculum Vitae which describes my academic background and professional qualifications.

Q: What is the purpose of your testimony?

A: To examine issues relating to the questions raised by SCE's Application, specifically, to explain why the World Business Academy (the "Academy") protests the proposed LCR procurements as currently configured for this area.

II. THE BASIS AND JUSTIFICATION FOR THE ACADEMY'S PROTEST

Q: What is the Academy's main reason for protesting the proposed PPA with this specific project in its currently configured form?

A: Simply put, the two gas-fired projects that SCE proposes to procure -- specifically the 262 MW single-cycle combustion turbine sponsored by NRG Energy Center Oxnard LLC ("Oxnard") as well as the proposed 54 MW refurbishment of the existing Ellwood peaker plant by NRG California South LP (intended to address reliability concerns in the Goleta area) -- are the least

effective choices to meet the identified Local Capacity Requirements ("LCR") and related reliability needs while also pursuing California's aggressive GHG reduction goals. Given California's policy to achieve dramatic reductions in GHG emissions over the next 35 years, it would be irresponsible, imprudent, and unwise, as well as directly contrary to State policy, for this Commission to approve yet more conventional gas-fired generation facilities to meet system reliability needs when numerous developed technologies enabling the capture, storage, and strategic generation of renewable energy are readily available on the market.

Q: Is there a better alternative to meet the identified LCR than the gas-fired projects proposed by SCE?

A: Yes. Rather than relying exclusively on inefficient traditional gas-fired peaker plants, SCE should research and make a serious, credible effort to enter into contracts for the distributed installation of hybrid storage and power generation plants utilizing photovoltaics (PV) and advanced fuel cells, the latter of which can initially be operated using renewable or conventional natural gas and then easily converted to use renewable-based hydrogen as a feedstock, once sufficient infrastructure to manufacture hydrogen from surplus generated renewable energy is developed. Such baseload plants, when combined with proven lithium-ion and/or flow battery technologies capable of instantly providing dispatchable power, will provide the nucleus and foundation towards the development of a community microgrid system that is 100% reliable and immune to the inherent vulnerabilities and limitations of the particular local transmission system connected to the area and California's current antiquated system of centralized energy generation and transmission in general.

In this context, it should be noted that the National Fuel Cell Research Center ("NFCRC") located on the campus of University of California, Irvine, has

advocated for the distributed application of fuel cell technology in the development of TIGER ("Transmission Integrated Grid Energy Resource") stations as a viable alternative to gas-fired peaker plants capable of providing local grid support at key points in the distribution system.[1]

Q: Are there good examples of already existing fuel-cell installations that could serve as a model for what is needed in the Moorpark sub-area?

A. Yes. Utility-scale fuel cell installations are already operating successfully. For example, in South Korea, "The Gyeonggi Green Energy fuel cell park, located in Hwasung City is fully operational. The largest fuel cell park in the world, this facility consists of 21 Fuel Cell Energy DFC3000® power plants, rated at 2.8 megawatts each, requiring only about 5.1 acres of land for 59 megawatts of new and renewable power. The fuel cell park provides continuous baseload electricity to the South Korean electric grid and usable high quality heat for a district heating system. POSCO Energy commenced construction on this project in November 2012 and finished construction in only 13 months, illustrating the ability to rapidly construct multi-megawatt fuel cell installations that enhance grid resiliency."[2]

In addition, Delmarva Power is deploying 30 MW of Bloom Energy Fuel Cells – enough to power about 22,000 homes – that will produce clean, reliable power for its Delaware customers. Delmarva Power plans to deploy the Bloom Energy Servers at Delmarva Power substations. These systems are scalable, modular,

---

[1] See Samuelsen, Scott, "What Fuel Cells Bring to the Power Equation," Intelligent Utility (June 12, 2014), Para. 7 (http://www.intelligentutility.com/article/14/06/what-fuel-cells-bring-power-equation). The TIGER Station concerns the deployment of stationary power at a distribution substation of an electric utility. The Academy has concluded, based on its own independent research into the work of Dr. Samuelsen and others, that a fuel cell-based TIGER Station is now commercially viable.

[2] See more at: http://globenewswire.com/news-release/2014/02/19/611481/10068981/en/World-s-Largest-Fuel-Cell-Park-Completed-in-South-Korea.html - sthash.ZiAsxxwj.dpuf

clean, and quiet, so they can be clustered and located virtually anywhere there is natural gas service and an electric load to serve. The utility's Bloom Energy Servers will decrease carbon dioxide emissions by approximately 50% compared to the average emissions from Delaware's electric grid, will nearly eliminate smog-forming NOx as well as particulate and SOx emissions, and will use less than 0.002% of the water required by conventional electricity generation.[3]

Q: In what ways would the use of fuel cells be preferable to relying on traditional gas peakers?

A: The proactive use of fuel cells for grid reliability stands in stark contrast to the reflexive measures presently proposed by utilities, in which single-cycle natural gas peaker plants (basically jet engines strapped to concrete pads) are offered as the only viable solution for countering the intermittency and/or diurnal fluctuations of some forms of renewable energy. Complex problems such as these are rarely solved by overly simplistic solutions, and the "simple" solution presently offered by utilities of installing massive gas-powered peaker plants to support an obsolete, centralized grid energy system leaves too many unsolved variables that will haunt the Commission (and by extension the citizens of California) for decades to come. It will also result in massive amounts of equipment being purchased that, in time, will be "stranded" thereby dramatically increasing the ultimate cost to society to provide power, which could have been obtained, instead, using preferred resources and preferred technologies.

It is worth noting that, as *TIME* magazine reported in its March 9, 2015 issue, the opening of California's new Desert Sunlight Solar Farm, which now supplies 550MW of electricity was inconceivable as being economic just a few years ago. The *TIME* article goes on to observe that a new 750MW plant is being built in Riverside, CA, but this may in fact be the last mega-sized photovoltaic ("PV")

[3] See more at: http://www.bloomenergy.com/customer-fuel-cell/delmarva-power-clean-energy/

facility, because PV is getting so inexpensive to put on individual residential and commercial buildings. Thus, it is likely that Desert Sunlight may well be the last glittering "behemoth" of its kind as California moves more aggressively into rooftop solar as a primary source of energy produced locally. It is precisely because PV is so inexpensive that we can now envision it as the primary source of preferred or renewable energy required for a microgrid located in a given geographical region, when that microgrid also has a way to economically store excess daylight production either in a battery storage facility for nighttime discharge or as hydrogen for later use in a companion fuel cell.

Developing an energy procurement strategy that seeks opportunities to transform our current energy infrastructure would be infinitely more far-sighted and in line with California's long-term sustainable energy vision than the obsolete, inefficient and dirty gas-fired resources that SCE is proposing to contract for in this Application. Such an opportunity currently exists within the Moorpark Sub-Area and the Commission should follow the precedent set by ALJ Yacknin in her proposed decision in the Commission's Carlsbad proceeding[4] requiring San Diego Gas & Electric to conduct an RFO solicitation in order to strictly adhere to State policy and priorities regarding the Loading Order as expressed in the Commission's Track 4 decision.[5]

Strict adherence to the Loading Order is an explicit requirement that State policy has imposed on the IOUs regulated by this Commission, and aggressive ongoing efforts to procure the preferred resources needed to achieve the State's ambitious GHG reduction targets must be the lodestar that guides all utility procurement

[4] A.14-07-009, Decision Denying Without Prejudice San Diego Gas & Electric Company's Application For Authority To Enter Into Purchase Power Tolling Agreement With Carlsbad Energy Center, LLC, issued March 6, 2015 (the "Carlsbad PD").

[5] D.12-03-014, Decision Authorizing Long-Term Procurements for Local Capacity Requirements Due To Permanent Retirement of The San Onofre Nuclear Generating Stations, pp. 14-16.

activities going forward. Although SCE has gone through the motions of conducting an RFO solicitation, the resulting procurement proposal consisting of over 96% of gas-fired generation stands in stark contrast to the Loading Order hierarchy to "procure renewable generation to the fullest extent possible."[6]

The Academy believes that the only method of providing guaranteed reliability to all ratepayers, without the inequitable exposure to power plant emissions on the part of less influential (*i.e.,* less politically powerful) communities, is to develop a plan whereby smaller, cleaner hybrid generation and storage facilities are located adjacent to utility substations and receive increasingly higher percentages of power from preferred resources like solar PV. Such facilities can provide both baseload and flexible power in a microgrid system comprised of businesses and residences located within an appropriate radius of a given substation. By developing a network of relatively autonomous microgrids, each community within the Moorpark Sub-Area will no longer be held hostage to the inevitable collapse and/or abandonment of our current 19th-century technology, which relies almost entirely upon a *seriously compromised* high-power, long-distance transmission infrastructure.

III. THE RESULTS OF SCE'S 2013 LCR RFO ARE FUNDAMENTALLY FLAWED

Q: Do the results of SCE's 2013 LCR RFO for the Moorpark sub-area enhance the safe and reliable operation of SCE's electrical service in that sub-area?

A: In a word, **NO**. With regard to the Santa Barbara Energy Needs Area ("Santa Barbara ENA") of the Moorpark Sub-Area (including, but not limited to, the communities of Carpinteria, Summerland, Montecito, Santa Barbara, and

[6] D.12-03-014, p. 14

Goleta), the reliability enhancements from the proposed refurbishment of the Ellwood facility are illusory, and will fail to provide ratepayers with sufficient energy for near 100% reliability when combined with net available capacity from sub-transmission lines under development as a backstop to the compromised high-voltage transmission lines currently providing power to the region.[7]

According to the California Energy Commission's Power Plant Database,[8] Santa Barbara County currently hosts a mere 145.11 MW of generating power, 11 MW of which lies outside SCE's service area and 56.7 MW of which resides at the Ellwood Generating Station, a facility SCE describes in its testimony as "a peaker facility that has historically been unreliable."[9] The next largest plant, at 49.8 MW, is owned and operated by Exxon and is likely unavailable to the public except in an emergency. Excluding the unreliable Ellwood Generating Station effectively results in a net generating capacity of only 77.41 MW for the entire County, while excluding both the Ellwood and Exxon facilities leaves a net generation capacity of only 27.61 MW!

The remaining power needed to service the affected area is imported into the region at the Goleta Substation via compromised high-voltage transmission lines, as disclosed by SCE in 2012 to the Commission in a separate proceeding entitled the "Santa Barbara County Reliability Project" (the "SBCRP Application").[10] In

---

7 SCE Testimony, Section III, "Basis for Establishing LCR Procurement Need," pp. 5-7.

8 California Energy Commission, Energy Almanac, California Power Plant Database (Excel File), (the "CEC Power Plant Database"). See http://energyalmanac.ca.gov/powerplants/Power_Plants.xlsx.

9 SCE Testimony, p. 46.

10 A.12-10-018, Application of Southern California Edison Company (U338E) for a Permit to Construct Electrical Facilities with Voltages between 50 kV and 200 kV: Santa Barbara County Reliability Project, pp. 2-7. (http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M031/K723/31723142.PDF). See Also, SCE Testimony, pp. 5-7.

the SBCRP Application, SCE attested to the "unique geographical limitations" of the area that limited high-voltage transmission to a single ROW from the Santa Clara Substation in Ventura County to the Goleta Substation located at the northern end of the Santa Barbara ENA. SCE further described certain "climatic events" "which weakened soils and destabilized several 220 kV tower footings," effectively rendering the ENA susceptible to a "simultaneous outage" of both 220 kV transmission lines.

SCE went on to give a remarkably blunt assessment of the potential consequences of an outage created by one or more of the compromised towers coming down:

> "In particular, the loss of a single 220 kV tower could potentially result in prolonged outages to the ENA as repair crews would have to wait until the terrain was stabilized to repair or replace the tower, reconnect any interrupted lines and re-energize the system. SCE estimated that it could take several weeks until terrain was deemed dry and stable enough to support the heavy equipment associated with tower repair or replacement activities. In addition, even after terrain was deemed stable enough to support reconstruction and/or replacement activities, more time would be required to complete the actual replacement or reconstruction, potentially prolonging the timeframe that customers within the ENA may be subjected to rotating outages."[11]

The above statement contradicts SCE's 2014 Testimony in this proceeding that "[w]ithout an answer to local reliability needs in the Goleta service area, long

[11] SBCRP Application, p. 5

term outages of the remaining load could occur for several weeks."[12] It would appear that SCE is ***correctly*** saying it would take many weeks, at least, to get the proper equipment in place if rain created further erosion that would compromise a tower, and that the repairs themselves would take many more weeks after that.

It is hard to overstate the dire consequences to the Santa Barbara ENA from a worst-case scenario where one or more transmission towers fail during an extreme *El Nino* rainy season. In such a probable and entirely foreseeable scenario, many months could pass while a chain of storms pounds the Santa Barbara coastline, after which one to two months of dry weather would be needed before repair crews could even begin repairs. Adding to this strong probability that the most compromised towers would be located in extremely difficult terrain requiring access and provisioning through costly air support, it is entirely possible that a prolonged period of rotating outages, which SCE has foreseen since 1998 -- and the Commission has been aware of since at least 2012 -- could persist for the better part of a year or even longer.

As noted above, many of the 220 kV transmission towers are located in remote areas with steep terrain and limited-to-zero accessibility by road, thereby rendering the cost of fixing one or more downed towers prohibitive. Therefore, instead of proposing to reinforce and buttress the compromised towers, SCE itself proposed to upgrade two back-up 66 kV sub-transmission lines from the Santa Clara Substation to the Carpinteria Substation located at the extreme southern end of the Santa Barbara ENA. In its SBCRP Application, SCE estimated the cost of the proposed upgrades to be "approximately $51.2 million

[12] SCE Testimony, Section III, "Basis for Establishing LCR Procurement Need," p. 7.

in 2012 constant dollars,"[13] so one can imagine the amount that would be needed to proactively repair or upgrade the 220 kV towers. SCE then noted that as currently configured, these back-up lines are woefully inadequate for serving the energy needs of the Santa Barbara ENA:

> "[T]he 2012 projected peak demand for the ENA served by Goleta Substation is 265 MVA, and the existing back-up 66 kV facilities would not have adequate capacity to serve the entire load if needed during emergency conditions. The three existing back-up 66 kV subtransmission tie lines collectively have a maximum operating limit of 124 MVA under normal operating conditions, but two of these 66 kV subtransmission lines also serve load in the Santa Clara System, which reduces their capacity to serve the ENA if needed. As a result, for prolonged outages, only 100 MVA of load in the ENA can be supported from these 66 kV lines in an emergency situation. Accordingly, SCE projects that 165 MVA of peak load would be dropped and rotating outages would occur in the ENA."[14]

SCE then admitted that even if completed, the proposed "upgrades" to the sub-transmission lines would be insufficient to effectively serve the Santa Barbara ENA during an outage from a failure of one or more of the 220 kV transmission towers:

> "In order to minimize the potential for prolonged customer outages, SCE determined in 1998 that reconductoring to increase the capacity

---

13 In a footnote, SCE provides this caveat: "This is a conceptual estimate, prepared in advance of final engineering and prior to CPUC approval. Pension and benefits, administrative and general expenses, and allowance for funds used during construction are not included in this estimate."

14 SBCRP Application, p. 4.

of two of the three existing 66 kV subtransmission tie lines that connect the Santa Clara 66 kV Subtransmission System and Goleta 66 kV Subtransmission System would address the existing limitation in redundant service for the ENA. Based on the forecasted 2012 peak load and considering existing operating procedures, this reconductoring and capacity increase of the 66 kV subtransmission lines would increase the electrical power delivered to the ENA by 80 MVA (from 100 MVA to 180 MVA) during a prolonged outage of both 220 kV transmission lines. This system work would enable SCE to serve a majority of the load in the ENA and decrease the amount of load that otherwise would be dropped."[15]

Thus, Using SCE's 2012 projections, even after successfully completing the proposed "upgrades" to the back-up sub-transmission lines (which probably wouldn't happen for a number of years as the SBCRP proceeding is still in the EIR review stages), the Santa Barbara ENA would be left short by 85 MVA following a failure of one or more 220 kV transmission towers. Alternatively, the CAISO 2014-2015 ISO Transmission Plan dated March 15, 2015 forecasts the 2016 summer peak load for the Goleta Substation at 321 MW, increasing the net shortfall from 85 MW to 141 MW.[16]

Conversely, in its 2014 Testimony in the current proceeding, SCE states that "[w]ith the loss of both Goleta-Santa Clara 230 kV transmission lines, 59% of the Goleta load can be supported by the backup system." Applying that metric to the 2016 load forecast of 321 MW yields a shortfall of 131.69 MW. Under either

[15] SBCRP Application, pp. 5-6.

[16] In a footnote on Page 4, SCE states that "During a CAISO declared emergency, a third-party owned gas-fired generator could be dispatched by the CAISO to serve additional load in the ENA." Should this reference be directed to the 49.8 MW Exxon facility, then the net shortfall would be reduced to 91.2 MW.

scenario, SCE's proposed "refurbishment" of the 54 MW Ellwood facility, plus the addition of a meager 0.5 MW of storage, will be grossly inadequate to ensure reliable delivery of power to the Santa Barbara ENA, which will continue to suffer through an extended period of "rotating outages" while repairs, if any, are made to the fallen 220 kV transmission towers and wires.

Q: Are the results of SCE's 2013 LCR RFO for the Moorpark sub-area a reasonable means to meet the 215-to-290 MW of identified LCR need determined by D.13-02-015?

A: In a word, **NO**. While going through the motions of procuring Preferred Resources in its RFO, SCE did not exhaustively research potential applications of all available Preferred Resources to fill the identified reliability needs of the area. Instead, SCE placed the burden on manufacturers and suppliers of Preferred Resources to submit bids competitive with traditional gas-fired resources, such as single-cycle turbine plants, *which will almost certainly be allowed to operate outside their permitted emissions requirements for extended periods of time* under entirely foreseeable circumstances involving the failure of compromised or threatened transmission lines described above. In addition, because SCE ignores the overwhelming possibility that gas peaker plants will become "stranded" assets long before they are amortized, the projected "apples to apples" cost of PV, fuel cells and battery storage will prove to be *less expensive* than the proposed gas-fired peakers, because these Preferred Resources will function for their full respective amortization cycles.

As a result of SCE's *de minimis* efforts to include renewable resources in its planning, over 96% of the energy contracts comprising SCE's requested procurement involve the construction of gas-fired generation, which does little to advance California towards its GHG reduction goals, and which will with near certainty continue to have substantial adverse impacts on public health due to

their emissions of criteria air pollutants in amounts far greater than SCE represents will occur.

Whereas SCE has already completed the RFO process with respect to the Moorpark Sub-Area, the process for its Renewable Distributed Generation Preferred Resources Pilot RFO in Orange County just commenced on November 20, 2014. SCE's seriousness in expediting the Orange County pilot project process is evidenced by the accelerated timetable for that project, with all offers to be submitted by June 22, 2015 and all PPAs signed by August 26, 2015.[17] If SCE can expedite its process for Orange County, the Academy believes it can and should take similar expedited action in order to provide comparable benefits for its ratepayers in Ventura and Santa Barbara Counties, preferably on a concurrent schedule and timeline.

Q: Is there significant political opposition to SCE's proposed gas-fired plants for the Moorpark sub-area?

A: There most certainly is. Concurrent with its participation in this proceeding, the Academy has begun briefing national, state and local elected officials regarding the nature of the energy reliability issues facing the Moorpark Sub-Area and SCE's proposed procurement of additional power, mostly in the form of gas-fired peaker plants, to meet long-term LCR as well as to solve related reliability issues by 2021. After being briefed, all such officials have expressed numerous concerns relating to the severe consequences to be visited upon their constituents should the severely compromised transmission lines fail. These officials have also stated their opposition to the incomplete and environmentally retrograde

[17] SCE PRP RFO Website, RFO Schedule, https://sceprprfo.accionpower.com/_scedgpr_1401/calendar.asp.

nature of SCE's proposed power procurement as a solution to these issues, and have expressed their support for the Academy's distributed microgrid solution utilizing renewable energy, fuel cell and battery technologies.

Specifically, the Academy has received letters from U.S. Congresswomen Julia Brownley and Lois Capps, copies of which are attached hereto and incorporated herein as Attachment B. The Academy also anticipates receiving additional letters of support from other public officials who represent ratepayers in the Moorpark Sub-Area that will endorse the Academy's positions in this proceeding, and the Academy hereby reserves the right to supplement this filing when it receives these additional endorsements of its position in this proceeding from other elected public officials representing ratepayers in Santa Barbara and Ventura Counties.

Q: Are the LCR RFO contracts consistent with the Commission's Emissions Performance Standards ("EPS")?

A: While the gas-fired facilities proposed by SCE currently comply with EPS standards as peaker plants, it is likely that these plants will operate much longer than anticipated due to the transmission issues described above and from significant increases in cumulative grid demand from accelerated purchases of electric vehicles and the overall electrification of California's transportation sector. That is to say that, although they are described as "peak-load-providing" plants, it is very likely that in the future, these plants will have to perform much more like baseload power plants than peaking plants. In such a case, these plants will be held to a higher standard of emissions control, which will add dramatically to their cost.

There is also a strong likelihood that the current EPS exemptions presently enjoyed by peaker facilities will be rescinded, such that the facilities proposed by

SCE will no longer be compliant with EPS requirements. Under these circumstances, the proposed facilities would either need to add carbon capture equipment at great expense, or will have to prematurely retire as a stranded asset (also at great expense).

Q: Should the Commission approve these contracts prior to a final decision by the California Energy Commission (CEC) of the California Environmental Quality Act (CEQA) review?

A: Given the likelihood that both proposed peaker plants will operate much more frequently and longer than anticipated, with attendant carbon and fine particulate emissions, the Academy believes that should the Commission actually wish to approve SCE's Application covering these two plants, it should, in any event, delay approval of the contracts pending CEC CEQA approval. Moreover, during that intervening period, the Commission should use the time to explore a more distributed and environmentally friendly solution along the lines that the Academy proposes in Section IV (below) of this Testimony.

Q: Is the 54 MW Ellwood Refurbishment project appropriate for the Commission to consider in this proceeding and, if so, is the contract reasonable?

A: The Ellwood Refurbishment project is not appropriate for consideration in this proceeding as it does not meaningfully address the structural LCR needs of the area. Moreover, the refurbishment and long-term operation of this plant would pose a health hazard to the surrounding community in the event of a transmission line failure. Adopted as part of SCE's procurement "path of least resistance," the Ellwood peaker plant provides a modicum of reliability should there be insufficient grid resources, but exists primarily as a partial back-stop against the inevitable failure of one or more high-voltage transmission towers. During that time, the refurbished "peaker plant" at Ellwood will be required to operate

continuously, providing only a portion of the total energy needed to service the area and exposing ratepayers living within close proximity[18] to plant emissions of hazardous fine particulates for an indeterminate period of time until the transmission towers are repaired or local resources are developed that obviate the need for the transmission lines. For all these reasons, the Academy concludes that the proposed contract for this project is not reasonable and should not be approved by the Commission.

Q: Is the contract with NRG California South LP, for a 0.5 MW storage project, reasonable?

A: The storage project is reasonable in the short term, as there currently is very little local distributed generation from intermittent renewable resources. However, storage capacity will need to quickly expand should such resources rapidly increase within the next few years as is currently anticipated.

IV. A BETTER SOLUTION EXISTS TO MEET MOORPARK SUB-AREA LCR NEEDS THAN WHAT SCE HAS PROPOSED

Q: Is there a better LCR solution for the Santa Barbara ENA than what SCE has proposed in its Application in this proceeding?

A: There most certainly is a better solution. The discussion above demonstrates that the Santa Barbara ENA faces unique challenges requiring a distributed solution outside of the traditional transmission grid planning paradigm. Functionally, the Santa Barbara ENA exists in a virtual peninsula, with one tenuous connection to the high-voltage regional grid, and with an inadequate alternative source when that tenuous connection is eventually severed.

[18] It should be noted that Ellwood Elementary School is situated less than 1,000 feet from the peaker plant facility.

Given the extreme and exigent circumstances described above, the only true solution for providing the Santa Barbara ENA with reliable power is to develop local distributed power generation and storage facilities utilizing fuel cell and battery technologies in tandem with large-scale development of renewable resources (*i.e.,* the massive deployment of PV as quickly as possible as a primary energy source with a parallel development of fuel cells and storage to reliably and effectively integrate that solar energy into the grid in an environmentally superior manner). In the Comments that were filed late last year in the Commission's distributed resource planning docket,[19] many participants stated the need for a test case in which the viability of a community-based distributed energy system, or community microgrid should be developed. The Santa Barbara ENA offers the State of California a unique opportunity to conduct such a needed test case.

As part of its ongoing activities, the Academy has performed substantive research into the design and technologies underlying the development of a community microgrid[20] and is currently developing a microgrid solution for the Santa Barbara ENA that will ultimately operate completely carbon-free using (i) fuel cell plants located adjacent to wastewater and landfill facilities to provide base load energy using renewable biogas and/or hydrogen feedstocks (such fuel cell plants could also be sited at a water-desalination plant, where they would operate essentially around the clock providing power to supply needed drinking water for the citizens of Santa Barbara County, with generated power diverted as needed to address electric load during periods of peak demand); (ii) lithium-ion and/or flow battery storage plants, located adjacent to each substation within the

[19] *See,* Docket R.14-08-013.

[20] In particular, the Academy has studied and will likely endorse and adopt many of the methodologies developed by the Clean Coalition (http://www.clean-coalition.org/our-work/community-microgrids/) in connection with various microgrid demonstration projects, including their collaboration with PG&E in the Hunter's Point Community Microgrid Project.

distribution network, to store surplus renewable energy and provide dispatchable and frequency and voltage response services; and (iii) solar PV and storage systems, installed throughout the Santa Barbara ENA on commercial and residential rooftops and at designated south-facing hillsides located near the substations and battery storage facilities.[21] These generation and storage facilities would of course be complemented by robust energy efficiency and demand response programs to help reduce peak and overall system loads.

Instead of reflexively installing a gas turbine peaker plant as a band-aid for a much deeper and systemic problem, SCE would serve the Moorpark sub-Area far more intelligently and in an environmentally superior manner with a proposal to develop facilities from the list set forth above in an amount sufficient to cover any shortages resulting from the inevitable transmission failure. Moreover, by relocating energy generation and storage closer to ratepayers (*i.e.,* moving 150 MW of the proposed energy requirement addressed in the SCE Application in this proceeding north to the Santa Barbara ENA), the latent transmission issues faced by the Santa Barbara ENA can be *permanently circumvented and rendered moot for the foreseeable future*.

Q: How should the Commission address the Academy's proposal?

A: While the Academy clearly understands that all the elements of such a system cannot be implemented in the context of the current proceeding, it urges the Commission to take prompt, decisive and affirmative steps in the direction that the Academy is pointing: *i.e.,* towards the establishment of an advanced, distributed, environmentally superior, community-based power system for the Santa Barbara ENA.

[21] As the entire Santa Barbara ENA faces southward, abundant opportunities exist to place large solar PV installations at locations receiving optimal periods of direct sunlight (8-9 a.m. to 5-6 p.m. generally).

Thus, the Commission should reject the proposed gas-fired peaker plants that SCE has proposed for approval in this Application, and direct SCE to: (i) immediately begin the process of developing and/or procuring fuel cell and battery-based plants to be located at local wastewater and landfill facilities in the Santa Barbara area; (ii) seek formal Commission approval to incentivize the widespread installation of solar PV arrays on large commercial rooftops and all available residences in the Santa Barbara area; and (iii) begin a serious exploration, in concert with the water agencies in the Santa Barbara area, regarding the development of water-desalination plants operated using fuel cells fed by either renewable biogas or hydrogen electrolyzed from surplus renewable generation, could effectively address the needs in the Santa Barbara ENA for both reliable water service and reliable electric power during periods of peak demand once PV has been much more broadly deployed. A more detailed description of the implementation of this proposed microgrid system will be detailed in the Academy's separate testimony of Robert Perry.

It should be also noted that the solution the Academy offers herein is not limited to the Santa Barbara ENA portion of the Moorpark Sub-Area. For over 50 years, the citizens of Oxnard and Camarillo have been forced to live under the shadow of two massive power plants located on their shores. While most of the power generated by these plants is transmitted to other cities, including Santa Barbara, the community living alongside these plants must breathe the emissions spewed by, and swim in waters receiving the discharges from, these antiquated plants. The time for these communities to reclaim their coastline is long overdue and, while the Academy has not yet had an opportunity to evaluate the Ventura ENA, we are confident that a similar microgrid solution allowing for a cleaner, more distributed energy system to directly serve that community can be fashioned, as well.

V. THE VIRTUE OF THE HYDROGEN FUEL CYCLE

Q: What is the basis for the Academy's advocacy of hydrogen as an alternative to fossil fuels as a primary feedstock fuel for reliability projects that will facilitate the increasing reliance of renewable energy resources to meet California's energy needs?

A: Hydrogen is the ultimate fuel for transportation, residential and commercial electricity needs. Moreover, unlike fossil fuels, the amount of available hydrogen is virtually limitless, as it comprises approximately 75% of all atoms in the Universe. The technology to make hydrogen by the electrolysis of water has been well established for over 100 years, and with sufficient economies of scale, a hydrogen-based energy economy will be less expensive, more reliable and much cleaner than continued reliance on fossil-fuel-based technologies. Most importantly, the electricity needed to electrolyze hydrogen from water can be generated from surplus wind, solar, Ocean Thermal Energy Conversion ("OTEC") and geothermal sources.

Furthermore, it should be noted that at least one fuel cell manufacturer, Fuel Cell Energy, is developing a high-temperature fuel cell that can co-produce both electricity and hydrogen, and states that this concept has the potential to meet the Department of Energy hydrogen cost targets, while producing power for less than $0.10/kWh.[22]

Q: What are the primary reasons why this Commission should prefer hydrogen generated from renewable sources, rather than natural gas, as the primary fuel for meeting grid reliability needs going forward?

A: Business and policymakers around the globe are waking up to the scope of the

[22] See, http://www.fuelcellenergy.com/assets/Hydrogen-Co-production-1.pdf

climate crisis. Global warming has become an undeniable force: unprecedented storms, droughts, floods, fires, desertification, social disruption, ocean acidification, and ecological destruction threaten the life-support systems of the planet as tens of millions of "Environmental Refugees" will need to flee their traditional homelands for "higher ground."

The scope and magnitude of this challenge cannot be overstated as climate-disruptive events are currently wreaking havoc globally. We are literally dealing with forces that could, within just a matter of decades, cause massive disruptions, which will require vast emergency responses by political bodies at every level, as has been well detailed in the article "*The Coming 'Instant Planetary Emergency'* by the highly respected reporter Dahr Jamail in 2013.[23] Indeed, Mr. Jamail's latest articles on this same subject paint an even more grim picture, which continues to sketch environmental collapse as it is occurring. The substance of this article is of such critical importance to the issues that the Commission is addressing in this proceeding that the entire article is appended to this Testimony as Attachment C.

Science tells us that what we are experiencing now is the beginning of an unprecedented catastrophe for human civilization. Without swift action, our continued pollution of the atmosphere with greenhouse gases expelled from the extraction and burning of fossil fuels, will trigger irreversible environmental feedback loops (*e.g.*, more CO_2, more methane releases and less polar and glacial ice), which will exponentially accelerate the heating of our planet. This scenario is unacceptable for business and for society as a whole; global warming is a mortal threat to the continued existence of human civilization as we know it. It is also a crisis that threatens many animal and marine species with extinction.

[23] http://www.thenation.com/printmail/article/177614/coming-instant-planetary-emergency

However, we have the technology and the capital to quickly transition to the next energy paradigm: a system for powering our lives that does not add greenhouse gas to the atmosphere. The plummeting cost for this technology will drive down the cost of energy for all human needs, including water desalinization, as more machines are mass produced to collect 100% renewable energy, electrolyze it at increasingly lower prices (*e.g.*, in the last 15 years, the cost for a kilowatt of solar energy has dropped by 90% and 75% for wind due to mass production of solar cells and windmills), then use that "green hydrogen" to power our increasingly demanding requirements for electricity.

A system now exists that can harness the almost limitless energy provided by the sun and the earth and in doing so, to provide abundant energy for the effort to re-stabilize our planet. One-hundred-percent carbon-free, nuclear-free energy is not only possible; it is vital to the future of our civilization. And, this energy will be created locally in the years ahead from renewable resources where the excess generating capacity during peak performance hours is electrolyzed into hydrogen to address diurnal fluctuations and supply base power on demand. As a result, long-distance transmission lines, invented in the 19th century, will become an artifact of the past. We must move as quickly as possible to this new energy paradigm.

VI. THE ACADEMY'S MOONSHOT PROJECT: A VISION FOR A SUSTAINABLE ENERGY FUTURE

Q: What is the Academy's proposed approach to move in this new direction?

A. The Academy is actively promoting an initiative that we call the Clean Energy "Moonshot," a systemic solution to address many of the challenges of transitioning from fossil fuels to 100% renewable energy. This plan demonstrates a pathway for the implementation of renewable energy in a manner

that is economically beneficial to local and global economies.

The Clean Energy "Moonshot" is the result of decades of research by the Academy into alternative energy, micro- and macro-economics, finance, politics, and whole-systems design. Our passionate and inspired team is driven by the vision of this new world and the benefits to all that will result.

The implications of this paradigm shift for business are many, including massive new growth opportunities for entire economic sectors; a renewed focus on high-tech industrial products that can be developed, manufactured, installed, and maintained in California and throughout the United States; and an opportunity for businesses to lead in the effort to halt global warming.

Q: What is the goal of the Clean Energy "Moonshot"?

A: The Clean Energy "Moonshot" proposes a challenge along the lines of President John F. Kennedy's 1961 "moonshot" challenge to land a man on the moon and return him safely by the end of the decade. Its goal is 100% carbon-free, nuclear-free energy for California within 10 years at no additional cost to ratepayers.

Q: Is such a goal practically achievable?

A: Yes. We know for a fact that *it is currently possible* to create a 100% carbon-free, nuclear-free reliable and resilient and scalable microgrid energy system, which does not rely upon any long-distance transmission lines. According to a 2012 study by University of Delaware researchers Willett Kempton and Cory Budischak,[24] renewable energy production and energy storage using hydrogen

[24] "Cost-minimized combinations of wind power, solar power and electrochemical storage, powering the grid up to 99.9% of the time." See, http://www.ceoe.udel.edu/windpower/resources/BudischakEtAl-2013-CostMinimizedWindSolarPJM.pdf.

gas could fully power any size electricity grid by 2030 at costs comparable to the nonrenewable systems in use today.

Utilizing a computer model for wind, solar and storage calculated to meet demand for one-tenth of the U.S. grid, their results debunk "the conventional wisdom that renewable energy is too unreliable and expensive." "For example," adds Budischak, "using hydrogen for storage, we can run an electric system that today would meet a need of 72 gigawatts, 99.9% of the time, using solar, offshore wind, and inland wind." The Kempton-Budischak study does not factor in the positive effects of adding significant geothermal and OTEC resources to the energy production mix, which could accelerate the study's timeline.

Also supporting this vision is the 2014 study from Stanford University Professor Mark Z. Jacobson,[25] which proposes that all-purpose California end-use power demand, including energy for ground transportation, will be met with 25% onshore wind (24,700 5-MW turbines beyond existing wind), 10% offshore wind (7,800 5-MW turbines), 15% concentrated solar power (1,230 100-MW plants), 15% solar PV power plants (2,140 new 50-MW plants), 10% residential rooftop PV (19.1 million new 5-kW systems), 15% commercial/government rooftop PV (1.29 million new 100-kW systems), 5% geothermal (72 100-MW new plants), 0.5% wave (4,960 0.75-MW devices), 0.5% tidal (3,370 1-MW turbines), and 4% hydro (but no new hydroelectric power plants). Again, the addition of OTEC to this energy mix would accelerate the timetable *and* provide millions of gallons of pure drinking water to California on a regular basis.

When compared with current goals and benchmarks, 100% renewable electricity for the entire State of California is an ambitious goal. Some might even call it

[25] "A roadmap for repowering California for all purposes with wind, water, and sunlight." See, http://web.stanford.edu/group/efmh/jacobson/Articles/I/CaliforniaWWS.pdf.

unrealistic. However, we now know that is not true, and many in the scientific community are becoming similarly convinced. Former Vice President Al Gore, in his most recent book *The Future: Six Drivers of Global Change*, reminds us that reality has far outstripped initial projections when it comes to the degree and scope of developing renewable infrastructure:

> "On a global basis, the combination of government subsidies for the speedier development of renewal energy technologies and the requirements that some utilities use them to produce a higher percentage of the electricity they generate has contributed to dramatic advances far beyond what most predicted. In 2002, a leading energy consulting firm projected that one gigawatt of solar electricity would be produced worldwide by 2010; that goal has been exceeded by seventeen times. The World Bank projected in 1996 that China would install 500 megawatts of solar energy by 2020. China installed double that amount in 2010 alone.
>
> "The past projections of increased wind energy have also turned out to be overly pessimistic. The U.S. Department of Energy projected in 1999 that the U.S. wind capacity would reach ten gigawatts by 2010. Instead, that goal was met in 2006 and has now been exceeded four times over. In 2000, the U.S. Energy Information Agency projected that worldwide wind capacity would reach thirty gigawatts by 2010. Instead, that goal was exceeded by a factor of seven. The same agency projected that China would install two gigawatts of wind by 2010; that goal was exceeded by 22-fold and is expected to be exceeded 75-fold by 2020.
>
> "[…] Industry and investor predications at the beginning of the

> mobile telephone revolution, for example, wildly underestimated how quickly that new technology would spread. After the Arab-OPEC embargos in the 1970s, projections for the adoption of energy efficiency measures were also way off. What both of these prior examples have in common with renewable energy technologies is that all three are "widely dispersed" technologies that experienced unpredicted exponential growth because of the virtuous cycle, within which the increasing scale of production drove sharply lower costs– which in turn drove even faster growth."[26]

It is critical to note that this "virtuous cycle" occurs precisely because renewable energy from solar, wind, and other technologies is so abundant that the cost to capture, store, and deliver that energy is plummeting faster than can be imagined. This is what we refer to as an energy economy based on "abundance" — *i.e.*, the more renewable energy you use, the more equipment like solar cells, electrolyzers and fuel cells get built, and the cheaper that abundant energy becomes relative to everything else. *The precise opposite is true of an economy based on fossil fuels, which are inherently scarce and which will always rise in price the more society uses them.*

This fundamental difference between an energy system based on scarcity (fossil fuels) and one based upon abundance (renewables) means that the sooner society switches to renewable hydrogen, the faster we will drive down energy costs as a percentage of Gross Domestic Product and thereby increase gross domestic economic activity. Let's never forget that every star -- *every one of the billions of stars* -- in the heavens is a giant hydrogen fusion reactor. Tapping into renewable hydrogen is literally tapping into the fuel source of the Universe. It doesn't get

[26] *The Future: Six Drivers of Global Change*. See, http://www.algore.com.

any more abundant than that.

Q: Are there other recent technological breakthroughs that would realistically support the vision that you espouse?

A: Yes. There is a reason that almost everyone in the developing world now has access to international communications: wireless technology. As Gore points out, if companies had relied on building (and maintaining) telephone wires across the continent, the communications revolution would never have taken place. When the world relied on a centralized copper-wire system to enable a phone call to occur, globally only 23% of households had phones. Since the decentralized wireless cell phone revolution, approximately 86% of households now have access to a phone[27] and the number continues to rise.

It is interesting to note that the system of centralized copper wires to deliver telephone messages is a 19th Century technology that first appeared in the 1860's in New York. By coincidence, the use of long-distance transmission of electricity began in the same decade in the same city. It is time to move to the 21st Century with our energy-distribution methodologies as we have already done with our telecommunications technologies.

Q: What's the lesson that this telecommunications revolution should teach us with regard to the prospects for a clean energy future?

A: Our current centralized energy system is restraining our efforts to achieve 100% clean energy. Currently, we rely on high-voltage transmission lines crisscrossing the state. These lines transport electrons from giant "base power" plants to consumers. This system is inefficient, with up to 15% of the generated energy being lost as "line loss" along the path to the consumers! Transmission lines are

[27] UN Report on Telecommunication Access. See, http://goo.gl/UQ4FMp.

also extremely fragile, are in need of constant repair and replacement, and are highly vulnerable to terrorism. Many national and international security experts now believe that America's electricity grid is *the most vulnerable* single terrorist target facing us. Equally important, this highly vulnerable system is inflexible and is not scalable. Moreover, it is extremely difficult (perhaps impossible) to build a significant number of new power lines in a state like California, the state that invented "not in my backyard."

Most plans to bring renewable energy online rely on massive new installations of transmission lines, which is a political non-starter. Rather, to enable the full replacement of fossil fuels, just like cell phones replacing landlines, we need a decentralized option. Combining leading research from academics and economists with real-world experience from business leaders, regulators, and scientists, the Academy proposes an economically and politically viable pathway for implementing 100% renewable energy in a modular and scalable manner as a honeycombed network of microgrids throughout the State of California.

Q: What is this economically and politically viable pathway?

A: California needs to focus its efforts on building community microgrids. Currently California relies on a massive and delicate electricity grid -- an expansive network of aluminum alloy wires, copper wires, transformers, power plants, substations, relays, sensors, towers, and other infrastructure. Experts "wheel" or transfer power up and down the length of this very long state to maintain adequate service and to literally keep the lights on in businesses and homes all across California. This system relies on centralized power production and long-distance transmission of electricity, a model that started in the 19th century and worked for much of the 20th century, but is now -- like telephone infrastructure before it -- in dire need of modernization. In order to ensure reliability, the system greatly overproduces power and pushes it back and forth

across the State losing electrons with every mile.

An alternative system using local power production and distribution in a collection of microgrids, would strengthen, supplement and gradually replace the existing statewide grid wherever microgrids were operating. Microgrids currently exist all over the world, ranging from simple systems using small generators to provide electricity to a handful of connected homes, to more robust systems which power entire communities in Germany, university campuses like UCSD, or military bases. The beauty of a microgrid is its simplicity: produce and manage power locally, where it is used, from renewable resources.

Q: What, specifically, are the benefits of microgrids over the current system?

A: A defining characteristic of a microgrid is that it has the capability to provide power to its users without connection to the statewide grid – a feature known as "islanding." This degree of autonomy makes these systems robust during storms or disasters when large swaths of the statewide grid fail. This independence also opens up other unique possibilities.

For example, in a microgrid, energy is managed locally, within the microgrid service area. Local energy management gives microgrids one critical advantage that is essential to the transition to a decarbonized energy system: ***microgrids can integrate an unlimited amount of renewable energy***. The statewide grid, which relies on centralized power generation, is limited in its capacity to integrate distributed energy resources (like solar panels and wind turbines). Because of the smaller scale and local expertise, microgrids can be built to manage intermittent renewable energy supply and energy storage without needing additional fossil fuel-based power to "balance the grid."

Q: What role can microgrids play in moving California quickly towards a clean

energy future?

A: A wide implementation of microgrids is the most logical and direct path to the zero-carbon energy future. The Clean Energy "Moonshot" calls for a shift away from the massive, centralized statewide gird to neighborhood-scale local microgrids -- or what we call Community Microgrids.

The statewide grid currently includes roughly 3,000-plus substations, which act as the connection point for large geographic areas. The substation is where the large transmission wires from the grid connect with the smaller local distribution wires that feed power to homes and businesses. We envision a future where each of these ~3,000 substations become independent but interconnected microgrids, providing reliable service, local management, and even local-energy markets to incentivize businesses and homeowners to produce as much renewable energy as possible within a given community.

Microgrid installations of a similar scale are already proving to be hugely successful. The microgrid power generating assets at the University of California, San Diego ("UCSD") campus provides 35.1 MW of power, which equates to about 75% of the campus peak power demand. The UCSD grid provides reliability for the sensitive laboratory equipment, avoiding power interruptions that could disrupt research.[28] This installation saves the 1,200-acre campus approximately $800,000 per month, meaning the energy savings alone repays the $8 million cost of installation every ten months, according to reporting by EnergyBiz.[29]

---

[28] UCSD Microgrid "Keeping the Lights On." (*Triton*, UCSD Alumni publication, 2012). See, http://goo.gl/j6ygO3.

[29] "MicroGrids Would Enhance Smart Grids." (*EnergyBiz*, Sep. 19, 2013). See, http://goo.gl/LGKhU3.

Following this example, California can be the proving ground for the wide deployment of microgrids. As first movers, the companies and investors involved in making these changes happen will have the opportunity to lead the global deployment of this methodology and be the source of California's next "economic miracle," which is capable of replicating the benefits of Silicon Valley's technology revolution.

Q: Is there any reason NOT to believe that microgrids are the best future for California's electricity system?

A: No. Experts writing about the grid of the future share the view that interconnected microgrids are a deployable technology with great potential to both support and eventually replace the old system. "Microgrids: A Regulatory Perspective," is a detailed exploration of the advantages of microgrids, written by staff at the California Public Utilities Commission.[30] Energy economist, Dr. Lorenzo Kristov, Principal for Markets and Infrastructure Policy at the California Independent Systems Operator, and California Institute of Technology Scholar, Dr. Paul De Martini, coauthored a visionary paper titled "21st Century Electric Distribution System Operations," outlining a future energy system based on the distributed microgrid concept.[31] The Academy has complemented this article with one I published several months ago, which dovetails the use of fuel cells into the Kristov/DeMartini formulation to provide a complete theoretical basis for the microgrids being proposed in this testimony. A copy of my article is appended to this testimony as Attachment D.

---

30 "Microgrids: A Regulatory Perspective." California Public Utilities Commission (April, 2014). See, http://www.cpuc.ca.gov/NR/rdonlyres/01ECA296-5E7F-4C23-8570-1EFF2DC0F278/0/PPDMicrogridPaper414.pdf.

31 "21st Century Electric Distribution System Operations." See, http://resnick.caltech.edu/docs/21st.pdf.

Taken together, the body of academic work supporting microgrids is a clear signal to regulators, business, and California residents that local, decentralized power is the future we must embrace.

Q: How would this microgrid-based system function?

A: With the systemic shift away from centralized power production and towards Community Microgrids, distributed energy production can flourish. The Clean Energy "Moonshot" calls for the widest deployment possible within a Community Microgrid service area of proven technologies for energy efficiency, passive energy collection, and local energy production such as solar PV and small wind turbines, as well as geothermal and OTEC resources where available. The goal of this deployment would be to create as much power as possible from rooftops and small installations across a Community Microgrid.

Depending on local energy resources, a varying percentage of the microgrid's energy will come from a steady source. The Clean Energy "Moonshot" calls for the deployment of fuel cell power plants to buffer the renewable energy system by creating electricity from stored gas reserves. Fuel cell power plants, initially powered by methane gas, can easily be transitioned to renewable hydrogen gas with minor alterations, permitting a smooth shift from the current energy paradigm to the next energy paradigm.

Q: What are the overall advantages of fuel cells over traditional resources like gas turbines?

A: Fuel cell plants operate at approximately the same efficiency as a natural gas turbine "peaker" plants. Instead of building new natural gas turbines (which would commit California to at least 25 years of carbon-based power generation, or to the premature abandonment of such facilities as "stranded assets" at great expense to California ratepayers), we should instead build fuel cell facilities,

which would initially be fueled by natural gas, but which can inexpensively be transitioned to use 100% hydrogen at that point in the near future when the state's hydrogen delivery infrastructure has been built out, which is now rapidly occurring due to the Governor's hydrogen fueling stations initiative, the so-called "hydrogen highway." Using fuel cells as the immediate solution provides the time necessary to fully deploy all of the PV that a Community Microgrid for the Santa Barbara ENA would ultimately rely on and support.

Unlike gas-fired turbines, fuel cell plants can be sited in any residential or commercial area, are acoustically benign and do not release criteria pollutants that have negative health effects on local populations. These advantages make permitting and siting fuel cells (as smaller, non-emitting individual power generators widely spread throughout the Community Microgrid) much easier than siting large gas turbines in one specific area and then pumping that energy throughout the service territory. It will therefore be much easier to integrate fuel cells in populated areas than is the case for gas turbines.

Q: If California were to quickly transition to this better future that you envision, how would the state deal with the potential problem of surplus renewable generation?

A: Any excess renewable energy created within the Community Microgrid can be stored for later use. By powering an electrolyzer with excess renewable energy, wastewater -- *which is now being dumped into the sea by tens of millions of gallons a day* -- can be split into hydrogen and oxygen, at a conversion factor of approximately 2-3 gallons of wastewater per 1 kg of hydrogen. The hydrogen gas can be stored in carbon-fiber tanks, then used later in a fuel cell to power fuel cells used in hydrogen-powered electric vehicles or to create electricity at utility-scale fuel cell power plants, where the only by-product would be clean, drinkable water.

In this regard, it is important to point out that hydrogen infrastructure is already being deployed for California's transportation sector, with the first zero-emission hydrogen-powered Fuel Cell Electric Vehicles ("FCEVs") manufactured by Hyundai[32] already on sale in California, with more makes and models due later in 2015. Moreover, Toyota, having walked away from an existing deal for battery cars with Tesla, is now focusing on bringing their FCEVs to market in 2015.[33] The State has allocated $200 million over ten years to subsidize the creation of the initial refueling infrastructure needed to support these vehicles, including six stations that will provide 100% renewable hydrogen to customers.[34] Like the battery-based electric vehicles currently available, FCEVs have no emissions other than pure water, and unlike EVs, FCEVs can refuel in mere minutes and already have a range approaching 300 miles.

Q: Why is hydrogen the optimal fuel to move our society away from reliance on fossil fuels with minimum disruption?

A: Hydrogen from renewable energy is the perfect carbon-free substitute for oil that will allow our society to move away from fossil fuels with minimal disruption. Like oil, hydrogen can be used for a wide variety of energy uses and can be proactively stored as a strategic reserve to prevent extended and unforeseen shortages resulting from severe weather events. Using current technology, hydrogen gas stored at 10,000 psi can be economically transported from the place it was created (assuming a 200-mile radius) and still be profitable at the equivalent cost of $3.75 per gallon of gasoline or less.

---

32 2015 Hyundai Tucson Fuel Cell Test Drive (*AutoMedia.com*, June 25, 2014). See, http://goo.gl/PVF0wK.

33 "Toyota Phasing Out Battery Deal with Tesla in Its Long Running Beef with Batteries," (*Forbes*, May 2014). See, http://goo.gl/s3ujBV.

34 See, http://www.energy.ca.gov/releases/2014_releases/2014-05-01_hydrogen_refueling_stations_funding_awards_nr.html.

A "red herring" is often raised, suggesting that it would require far too much energy to store hydrogen in *liquid form* to make it practical. This canard is false, as everyone who recites it knows, because there is never a reason to compress hydrogen to more than 10,000 psi, which takes an extremely small amount of energy. Now that we know the standard for automobile and truck usage is 10,000 psi, there should be no logical reason to even consider compressing hydrogen beyond that point, as it makes no economic sense to do so. Moreover, transportation of hydrogen at that compression level is presently as economical as is the transportation of liquid fossil fuels today.

This $3.75 equivalent price point is approximately equal to the current cost of gasoline in California. However, the cost to store, transport and use hydrogen will decrease over time as we expand the energy infrastructure and develop more efficient technology just as the cost to capture and use wind and solar has fallen dramatically with increased use. As we've seen with past renewable energy developments, this fact is key: **the more we use it, the cheaper it becomes**.

Even better, the more machines we make to capture, store, transport and utilize hydrogen, the cheaper those machines become and the more manufacturing opportunities will be available for "first mover" economies like California. The economic size of the opportunity of moving first into the hydrogen economy is as great or greater than the original opportunity that powered Silicon Valley. It is worth noting that the Apollo program is widely credited for launching two technologies: 1) the demand for silicon chips, and 2) the use of hydrogen fuel cells as the Apollo Command Module's primary source of electric power and drinking water.

Q: What are the long-term benefits to California of moving aggressively in this

direction that you advocate?

A: If California moves forward seriously to implement the Clean Energy "Moonshot" initiative, California will become the global leader in advanced energy “sunrise” industries: hydrogen electrolysis, fuel cell manufacturing, hydrogen storage, hydrogen gas for transportation, microgrids, associated information technology and control systems.

Moreover, the clean energy solution offered by this "Moonshot" will be applicable in every community in the world. The Community Microgrid with Fuel Cell Buffer solution can integrate with existing energy systems, gradually replacing aging grids. Or, this solution can be built from the ground up in developing communities that currently do not have electricity infrastructure (for example, using locally specific renewable energy sources like river turbines, a concept that the Academy is currently exploring with the Indian government).

This solution, coupled with pioneering leadership and investment here in California, can catalyze unimaginable growth in the advanced energy industry. As with microprocessor technology and biotechnology, there is no upper limit to the expansion of the Community Microgrid with Fuel Cell Buffer solution.

Q: Does this conclude your prepared testimony?

A: Yes, it does.

ATTACHMENT A

CURRICULUM VITAE OF RINALDO S. BRUTOCO
PRESIDENT OF THE WORLD BUSINESS ACADEMY

Rinaldo S. Brutoco

Professional Expertise:

Mr. Brutoco is an economics and business consultant specializing in energy policy, renewable energy, finance, innovation, and adaptation strategies for climate change. For almost thirty years he has been an international leader in advancing the nature of good corporate governance, corporate accountability, business transparency, and ways that corporations can fulfill their social compact by providing goods and services that the public needs and wants in appropriate, and financially prudent ways. He received a Congressional Commendation to this effect in October, 2010 for his outstanding contributions to the field of corporate responsibility.

Mr. Brutoco was 25 years old, when, in 1972, he became the youngest attorney at that time to argue before the California Supreme Court in the case of *California Public Interest Law Center v. Public Utilities Commission*. Brutoco, Founder and Principal of the California Public Interest Law Center, won what was at the time the largest class action lawsuit in the history of the United States.

Since 1992, Mr. Brutoco has served on the board of the $2.5 billion market-capitalization men's clothing company, Men's Wearhouse.

Mr. Brutoco ran a start-up and turnaround practice for many years, in which he regularly dealt with forensic accounting (this work included a number of matters where financial issues were misrepresented). In this work, he was required to serve as an acting CEO, Board Member, Chairman of the Board, or in some other senior management function in order to turn his clients' companies around or to guide them successfully past the start-up phase.

In this capacity, Mr. Brutoco was appointed by the Federal District Court in Washington, D.C., as one of three directors in charge of United Press International ("UPI") the first time it went into bankruptcy, with the specific task of taking over, running, turning around, and selling all of the company's television (in major markets like Chicago) and radio (over 240 stations) assets that were held in a UPI subsidiary, and returning the proceeds of those sales to the parent on whose board he sat. Mr. Brutoco successfully kept every one of these stations out of bankruptcy, turned them around, and sold them all within 18 months.

In the 1980's, Mr. Brutoco conducted complicated analyses of tax shelters. This work was reviewed by the United States Tax Court, and Mr. Brutoco was approved as a tax expert for all purposes without restriction in connection with his provision of testimony in complex cases before the tax court on behalf of individual plaintiffs.

Mr. Brutoco is currently designated as a financial expert for purposes of reporting to the U.S. Securities and Exchange Commission.

As an entrepreneur, Mr. Brutoco has spearheaded several businesses. He is: Principal and Chief Executive Operator of the ShangriLa Consulting Group, Inc.; Founder, Executive Chief, and CEO of Seven Oaks Ranch, an organic food and cosmetic manufacturer and distributor of several propriety brands with distribution in over 3,500 outlets in the United States, which is growing at highly compounded annual rates; and Founder and Chairman of H2 Clipper, which has developed a revolutionary, highly patented hydrogen-powered dirigible.

Co-Founding Channel 100, Mr. Brutoco was the CEO of the first company in the world to offer pay-cable television services. Additionally, he was the Founder and CEO of Universal Subscription Television, one of the first companies to offer over-the-air television transmissions of major motion pictures. Also, he was the Chairman of the Board for the two start-up years of an organic beverage company, KeVita, which, as one of the fastest growing companies of its kind in the history of the country, currently has sales in excess of $25 million per year after less than three years of being actively in the marketplace.

Mr. Brutoco also served as the CEO and Chairman of the Red Rose Collection, the sole distributor for 12 years of Mother Teresa's personally endorsed biographical motion pictures, *Mother Teresa* (1986) and *Mother Teresa: The Legacy* (2004).

Mr. Brutoco is a regular guest lecturer at the Stanford Business School, the Columbia Graduate School of Business, the Kellogg Graduate Business School at Northwestern University, and the Keenan-Flagler Graduate School of Business at North Carolina University.

Current Positions:

- President, World Business Academy
- President, The Chopra Foundation
- Principal and CEO, The ShangriLa Group
- Board Member, The Men's Wearhouse, Audit and Governance Committees

Articles (Selected):

- "The Market is Lying: Why We Must Tax Carbon, Not Subsidize It," *Truthout* (July, 2011)
- "The Upcoming Nuclear Peril: Worse than the BP Oil Disaster," *Truthout* (July, 2010)
- "Pellet Power: Coal Power Substitute," *Common Cents* (August, 2009)
- "An Economic Solution Through Service, Not Greed," *Huffington Post* (October, 2008)
- "The Nuclear Nemesis," *Trends* (American Bar Association), Vol. 39, No. 5 (June, 2008)
- "The New Paradigm of Governance: Guidelines for CEO Succession," *Perspectives*, Vol. 19, No. 2 (January 2005)
- "The New Paradigm of Governance: The Demise of the Imperial CEO," *Perspectives*, Vol. 19, No. 1 (January 2005)
- "The New Paradigm of Corporate Governance: The Buck Stops Here," *Perspectives*, Vol. 19, No. 5 (September 2005)

Books:

- Co-Author, *Freedom from Mid-East Oil* – a comprehensive treatment of the world's energy challenges, climate change and solutions for the future of energy. Focused on nuclear power, oil, wind energy and hydrogen (World Business Academy, 2007). ISBN 978-0-9794052-2-8

- Co-Author, *Profiles in Power: The Anti-Nuclear Movement and the Dawn of the Solar Age* – a college textbook on nuclear energy. (Twayne/Simon & Schuster, 1997) ISBN 0-8057-3879-7
- Principal resource to the authors: *Winning the Innovation Game* by Denis Waitley and Robert Tucker (Fleming H. Revell Company, 1986) ISBN 0425115313
- Contributing Author, *New Paradigms in Business*. (G. P. Putnam's Sons, 1993) ISBN 0-87477-726-7
- Contributing Author, *Birth 2012 and Beyond.* (Shift Books, 2012) ISBN 0-9848407-0-0

Keynote / Expert Speaker (Selected):

- Massachusetts Institute of Technology Forum of the Central Coast (Feb., 2013)
  The Hydrogen Future: Transitioning Away from Dirty Power
  Audio Link
- Sustainable, Responsible Investing Conference (October, 2012)
  In conversation with Mindy Lubber, President of Ceres
  The Practice and Politics of Aligning Business Interests With Human Interests
  Video Link
- Sages and Scientists Symposium (March, 2012)
  Eight Basic Human Rights, Climate Change and The Global Marshall Plan
  Video Link
- Cortona International Transdisciplinary Conference (September, 2010)
  The Role of Business at a Time of Conscious Evolution
  Video Link
- Kenan-Flagler Business School, University of North Carolina – Chapel Hill
  Center for Sustainable Enterprise, Distinguished Speaker Series (March, 2008)
  Lemons to Lemonade: Environmental, Social and Economic Sustainability as a Sustainable Business Advantage
  Video Link

Past Service (Selected):

- Board Member, The Gorbachev Foundation
- Co-Founder and Board Member, State of the World Forum
- Board Member, Center for Earth Concerns
- Founder, California Public Interest Law Center

Recognition (Selected):

- Congressional Commendation recognizing Mr. Brutoco for his leadership in business (November, 2010)
  Link to Congressional Record

- Effie Award for Advertising Effectiveness
  The American Marketing Association (1981)

Education:

- Bachelor of Arts, Santa Clara University, 1968, graduated with honors, earning a degree in Economics and Philosophy
- Juris Doctor, University of California Los Angeles School of Law, 1971, Order of the Coif

ATTACHMENT B

LETTERS FROM CONGRESSWOMEN BROWNLEY AND CAPPS

JULIA BROWNLEY
26TH DISTRICT, CALIFORNIA
MEMBER OF CONGRESS
http://juliabrownley.house.gov

Congress of the United States
House of Representatives
Washington, DC 20515–0526

COMMITTEE ON VETERANS' AFFAIRS
RANKING MEMBER, SUBCOMMITTEE ON HEALTH
SUBCOMMITTEE ON ECONOMIC OPPORTUNITY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENVIRONMENT
SUBCOMMITTEE ON SPACE

December 22, 2014

Rinaldo Brutoco
World Business Academy
2020 Alameda Padre Serra
Suite 135
Santa Barbara, CA 93103-1757

Dear Mr. Brutoco :

Thank you for taking the time to update me on your ongoing work related to clean, renewable energy and microgrids. It was a pleasure to speak with you again.

As we discussed, I share your interest in the development of clean, renewable, reliable energy in Southern California. As a member of the Science, Space, and Technology Committee's Environment Subcommittee, I have been working in Congress to protect and preserve our environment and natural resources for future generations. Investments in clean, renewable, and sustainable energy will not only reduce our dependence on fossil fuels, but it will also counterbalance the effects of climate change on our economy and in our communities.

Like you, I also agree that maintaining an adequate, reliable supply of electricity in Ventura County is of paramount importance. However, I have serious concerns about proposals to build new power plants along the California coast, particularly in Oxnard. Not only am I skeptical about the need for this new generating capacity, but I also believe that we should be looking at clean, renewable energy sources, like solar and wind, before considering new fossil fuel powered facilities.

Furthermore, I strongly believe that the California Public Utilities Commission (CPUC) should take into account the views of local communities when siting new facilities. The environmental justice impacts of a new power plant in Oxnard cannot be overstated. Roughly 85 percent of the residents of Oxnard are people of color with 17 percent of the community earning below the federal poverty level. Oxnard is a community that is enriched by a diverse population of hard-working people who are looking for a good life for their families. That is why it is concerning to me that this community is being considered once again for another power plant. Oxnard residents are entitled to clean water, clean air, clean and accessible beaches, and a healthy environment. Yet, Oxnard's beautiful coast has been a target over the decades for dirty industrial uses, including two existing power plants and the Halaco superfund site, which not only blight views, but endanger the public health of the community. Restoration of the Oxnard coastline would be an economic boon to the entire region, bringing new jobs and opportunities to the area, and improving the public health of the adjacent communities.

WASHINGTON, DC OFFICE
1019 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
PHONE: 202-225-5811
FAX: 202-225-1100

OXNARD, CA OFFICE:
300 EAST ESPLANADE DRIVE, SUITE 470
OXNARD, CA 93036
PHONE: 805-379-1779
FAX: 805-379-1799

THOUSAND OAKS, CA OFFICE
223 EAST THOUSAND OAKS BOULEVARD, SUITE 411
THOUSAND OAKS, CA 91360
PHONE: 805-379-1779
FAX: 805-379-1799

LOIS CAPPS
24TH DISTRICT, CALIFORNIA

2231 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-0524
(202) 225-3601
www.capps.house.gov

COMMITTEE ON
ENERGY AND COMMERCE

Congress of the United States
House of Representatives

DISTRICT OFFICES:

☐ 1411 MARSH STREET, SUITE 205
SAN LUIS OBISPO, CA 93401
(805) 546-8348

☐ 301 EAST CARRILLO STREET, SUITE A
SANTA BARBARA, CA 93101
(805) 730-1710

☐ 1101 SOUTH BROADWAY, SUITE A
SANTA MARIA, CA 93454
(805) 349-3832

March 30, 2015

Mr. Rinaldo Brutoco
World Business Academy
2020 Alameda Padre Serra, Suite 135
Santa Barbara, CA 93103

Dear Mr. Brutoco,

Thank you for your work to reduce our dependence on fossil fuels and to increase the use of clean, renewable energy technologies. Like you, I firmly believe that climate change is one of the most serious threats we face. To address this problem we must both reduce the greenhouse gas emissions driving climate change and increase the use of clean, renewable sources of energy.

While transitioning away from fossil fuels to cleaner, more sustainable sources of energy will not be easy, it is absolutely necessary. Our continued dependence on fossil fuels is unsustainable for both our environment and economy, and we owe it to future generations to begin working toward this transition now rather than waiting until it is too late.

This will require a comprehensive approach that includes everything from building more renewable energy generation projects, to increasing energy efficiency, to modernizing our electric grids to accommodate the evolving challenges and demands. I strongly support these efforts because they will not only help mitigate the impacts of climate change but will also drive economic growth. Construction of solar and wind projects will create jobs, commercialization of new technologies will lead to new businesses, and increased energy efficiency will lower energy costs for businesses and consumers.

Addressing climate change is one of the defining challenges of our time, and there is much work to be done. Again, thank you for your efforts to pursue a clean energy future, and please keep me informed as you continue this important work.

Sincerely,

Lois Capps

LOIS CAPPS
Member of Congress

ATTACHMENT C

"THE COMING 'INSTANT PLANETARY EMERGENCY'"
BY DAHR JAMAIL
THE NATION
DECEMBER 17, 2013

The Coming ‘Instant Planetary Emergency’

How will climate change affect the future of the planet? Scientists predict it will be nothing short of a nightmare.

Dahr Jamail

December 17, 2013

Waves wash over a roller coaster from a Seaside Heights, New Jersey, amusement park that fell in the Atlantic Ocean during Superstorm Sandy. (AP Photo)

I grew up planning for my future, wondering which college I would attend, what to study, and later on, where to work, which articles to write, what my next book might be, how to pay a mortgage, and which mountaineering trip I might like to take next.

Now, I wonder about the future of our planet. During a recent visit with my eight-year-old niece and 10- and 12-year-old nephews, I stopped myself from asking them what they wanted to do when they grew up, or any of the future-oriented questions I used to ask myself. I did so because the reality of their generation may be that questions like where they will work could be replaced by: Where will they

get their fresh water? What food will be available? And what parts of their country and the rest of the world will still be habitable?

The reason, of course, is climate change—and just how bad it might be came home to me in the summer of 2010. I was climbing Mount Rainier in Washington State, taking the same route I had used in a 1994 ascent. Instead of experiencing the metal tips of the crampons attached to my boots crunching into the ice of a glacier, I was aware that, at high altitudes, they were still scraping against exposed volcanic rock. In the pre-dawn night, sparks shot from my steps.

The route had changed dramatically enough to stun me. I paused at one point to glance down the steep cliffs at a glacier bathed in soft moonlight 100 meters below. It took my breath away when I realized that I was looking at what was left of the enormous glacier I'd climbed in 1994, the one that—right at this spot—had left those crampons crunching on ice. I stopped in my tracks, breathing the rarefied air of such altitudes, my mind working hard to grasp the climate-change-induced drama that had unfolded since I was last at that spot.

I haven't returned to Mount Rainier to see just how much further that glacier has receded in the last few years, but recently I went on a search to find out just how bad it might turn out to be. I discovered a set of perfectly serious scientists—not the majority of all climate scientists by any means, but thoughtful outliers—who suggest that it isn't just really, really bad; it's catastrophic. Some of them even think that, if the record ongoing releases of carbon dioxide into the atmosphere, thanks to the burning of fossil fuels, are aided and abetted by massive releases of methane, an even more powerful greenhouse gas, life as we humans have known it might be at an end on this planet. They fear that we may be at—and over—a climate change precipice hair-raisingly quickly.

Mind you, the more conservative climate science types, represented by the prestigious Intergovernmental Panel on Climate Change (IPCC), paint scenarios that are only modestly less hair-raising, but let's spend a little time, as I've done, with what might be called scientists at the edge and hear just what they have to say.

"We've Never Been Here as a Species"

“We as a species have never experienced 400 parts per million of carbon dioxide in the atmosphere,” Guy McPherson, professor emeritus of evolutionary biology, natural resources, and ecology at the University of Arizona and a climate change expert of twenty-five years, told me. “We’ve never been on a planet with no Arctic ice, and we will hit the average of 400 ppm…within the next couple of years. At that time, we’ll also see the loss of Arctic ice in the summers.… This planet has not experienced an ice-free Arctic for at least the last three million years.”

For the uninitiated, in the simplest terms, here’s what an ice-free Arctic would mean when it comes to heating the planet: minus the reflective ice cover on Arctic waters, solar radiation would be absorbed, not reflected, by the Arctic Ocean. That would heat those waters, and hence the planet, further. This effect has the potential to change global weather patterns, vary the flow of winds, and even someday possibly alter the position of the jet stream. Polar jet streams are fast flowing rivers of wind positioned high in the earth’s atmosphere that push cold and warm air masses around, playing a critical role in determining the weather of our planet.

McPherson, who maintains the blog Nature Bats Last, added, “We’ve never been here as a species and the implications are truly dire and profound for our species and the rest of the living planet.”

While his perspective is more extreme than that of the mainstream scientific community, which sees true disaster many decades into our future, he’s far from the only scientist expressing such concerns. Professor Peter Wadhams, a leading Arctic expert at Cambridge University, has been measuring Arctic ice for forty years, and his findings underscore McPherson’s fears. “The fall-off in ice volume is so fast it is going to bring us to zero very quickly,” Wadhams told a reporter. According to current data, he estimates “with 95% confidence” that the Arctic will have completely ice-free summers by 2018. (US Navy researchers have predicted an ice-free Arctic even earlier—by 2016.)

British scientist John Nissen, chairman of the Arctic Methane Emergency Group (of which Wadhams is a member), suggests that if the summer sea ice loss passes “the point of no return,” and “catastrophic Arctic methane feedbacks” kick in, we’ll be in an “instant planetary emergency.”

McPherson, Wadham and Nissen represent just the tip of a melting iceberg of scientists who are now warning us about looming disaster, especially involving Arctic methane releases. In the atmosphere, methane is a greenhouse gas that, on a relatively short-term time scale, is far more destructive than carbon dioxide (CO). It is twenty-three times as powerful as CO per molecule on a 100-year timescale, 105 times more potent when it comes to heating the planet on a twenty-year timescale—and the Arctic permafrost, onshore and off, is packed with the stuff. "The seabed," says Wadham, "is offshore permafrost, but is now warming and melting. We are now seeing great plumes of methane bubbling up in the Siberian Sea…millions of square miles where methane cover is being released."

According to a study just published in *Nature Geoscience,* twice as much methane as previously thought is being released from the East Siberian Arctic Shelf, a two million square kilometer area off the coast of Northern Siberia. Its researchers found that at least 17 teragrams (one million tons) of methane are being released into the atmosphere each year, whereas a 2010 study had found only seven teragrams heading into the atmosphere.

The day after *Nature Geoscience* released its study, a group of scientists from Harvard and other leading academic institutions published a report in the *Proceedings of the National Academy of Sciences* showing that the amount of methane being emitted in the United States both from oil and agricultural operations could be 50 percent greater than previous estimates and 1.5 times higher than estimates of the Environmental Protection Agency.

How serious is the potential global methane build-up? Not all scientists think it's an immediate threat or even the major threat we face, but Ira Leifer, an atmospheric and marine scientist at the University of California, Santa Barbara, and one of the authors of the recent Arctic Methane study, pointed out to me that "the Permian mass extinction that occurred 250 million years ago is related to methane and thought to be the key to what caused the extinction of most species on the planet." In that extinction episode, it is estimated that 95 percent of all species were wiped out.

Also known as "the Great Dying," it was triggered by a massive lava flow in an area of Siberia that led to an increase in global temperatures of six degrees Celsius. That, in turn, caused the melting of frozen methane deposits under the seas.

Released into the atmosphere, it caused temperatures to skyrocket further. All of this occurred over a period of approximately 80,000 years.

We are currently in the midst of what scientists consider the sixth mass extinction in planetary history, with between 150 and 200 species going extinct daily, a pace 1,000 times greater than the "natural" or "background" extinction rate. This event may already be comparable to, or even exceed, both the speed and intensity of the Permian mass extinction. The difference being that ours is human-caused, isn't going to take 80,000 years, has so far lasted just a few centuries and is now gaining speed in a non-linear fashion.

It is possible that, on top of the vast quantities of carbon dioxide from fossil fuels that continue to enter the atmosphere in record amounts yearly, an increased release of methane could signal the beginning of the sort of process that led to the Great Dying. Some scientists fear that the situation is already so serious and so many self-reinforcing feedback loops are already in play that we are in the process of causing our own extinction. Worse yet, some are convinced that it could happen far more quickly than generally believed possible—even in the course of just the next few decades.

The Sleeping Giant Stirs

According to a NASA research report, "Is a Sleeping Climate Giant Stirring in the Arctic?": "Over hundreds of millennia, Arctic permafrost soils have accumulated vast stores of organic carbon—an estimated 1,400 to 1,850 petagrams of it (a petagram is 2.2 trillion pounds, or 1 billion metric tons). That's about half of all the estimated organic carbon stored in Earth's soils. In comparison, about 350 petagrams of carbon have been emitted from all fossil-fuel combustion and human activities since 1850. Most of this carbon is located in thaw-vulnerable top soils within 10 feet (3 meters) of the surface."

NASA scientists, along with others, are learning that the Arctic permafrost—and its stored carbon—may not be as permanently frosted as its name implies. Research scientist Charles Miller of NASA's Jet Propulsion Laboratory is the principal investigator of the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE), a five-year NASA-led field campaign to study how climate change is affecting the Arctic's carbon cycle. He told NASA, "Permafrost soils are warming even faster

than Arctic air temperatures—as much as 2.7 to 4.5 degrees Fahrenheit (1.5 to 2.5 degrees Celsius) in just the past 30 years. As heat from Earth's surface penetrates into permafrost, it threatens to mobilize these organic carbon reservoirs and release them into the atmosphere as carbon dioxide and methane, upsetting the Arctic's carbon balance and greatly exacerbating global warming."

He fears the potential results should a full-scale permafrost melt take place. As he points out, "Changes in climate may trigger transformations that are simply not reversible within our lifetimes, potentially causing rapid changes in the Earth system that will require adaptations by people and ecosystems."

The recent NASA study highlights the discovery of active and growing methane vents up to 150 kilometers across. A scientist on a research ship in the area described this as a bubbling as far as the eye can see in which the seawater looks like a vast pool of seltzer. Between the summers of 2010 and 2011, in fact, scientists found that in the course of a year methane vents only thirty centimeters across had grown a kilometer wide, a 3,333 percent increase and an example of the non-linear rapidity with which parts of the planet are responding to climate disruption.

Miller revealed another alarming finding: "Some of the methane and carbon dioxide concentrations we've measured have been large, and we're seeing very different patterns from what models suggest," he said of some of CARVE's earlier findings. "We saw large, regional-scale episodic bursts of higher than normal carbon dioxide and methane in interior Alaska and across the North Slope during the spring thaw, and they lasted until after the fall refreeze. To cite another example, in July 2012 we saw methane levels over swamps in the Innoko Wilderness that were 650 parts per billion higher than normal background levels. That's similar to what you might find in a large city."

Moving beneath the Arctic Ocean where methane hydrates—often described as methane gas surrounded by ice—exist, a March 2010 report in *Science* indicated that these cumulatively contain the equivalent of 1,000–10,000 gigatons of carbon. Compare this total to the 240 gigatons of carbon humanity has emitted into the atmosphere since the industrial revolution began.

A study published in the prestigious journal *Nature* this July suggested that a fifty-gigaton "burp" of methane from thawing Arctic permafrost beneath the East Siberian sea is "highly possible at anytime." That would be the equivalent of at least 1,000 gigatons of carbon dioxide.

Even the relatively staid IPCC has warned of such a scenario: "The possibility of abrupt climate change and/or abrupt changes in the earth system triggered by climate change, with potentially catastrophic consequences, cannot be ruled out. Positive feedback from warming may cause the release of carbon or methane from the terrestrial biosphere and oceans."

In the last two centuries, the amount of methane in the atmosphere has increased from 0.7 parts per million to 1.7 parts per million. The introduction of methane in such quantities into the atmosphere may, some climate scientists fear, make increases in the global temperature of four to six degrees Celsius inevitable.

The ability of the human psyche to take in and grasp such information is being tested. And while that is happening, yet more data continues to pour in—and the news is not good.

Out of the Frying Pan, Into the Fire

Consider this timeline:

*** Late 2007:** *The Intergovernmental Panel on Climate Change (IPCC)announces that the planet will see a one degree Celsius temperature increase due to climate change by 2100.*

*** Late 2008:** *The Hadley Centre for Meteorological Research predicts a 2C increase by 2100.*

*** Mid-2009:** *The UN Environment Programme predicts a 3.5C increase by 2100. Such an increase would remove habitat for human beings on this planet, as nearly all the plankton in the oceans would be destroyed, and associated temperature*

swings would kill off many land plants. Humans have never lived on a planet at 3.5C above baseline.

*** October 2009:** *The Hadley Centre for Meteorological Research releases an updated prediction, suggesting a 4C temperature increase by 2060.*

*** November 2009:** *The Global Carbon Project, which monitors the global carbon cycle, and the Copenhagen Diagnosis, a climate science report, predict 6C and 7C temperature increases, respectively, by 2100.*

*** December 2010:** *The UN Environment Programme predicts up to a 5C increase by 2050.*

*** 2012:** *The conservative International Energy Agency's World Energy Outlook report for that year states that we are on track to reach a 2C increase by 2017.*

*** November 2013:** *The International Energy Agency predicts a 3.5C increase by 2035.*

A briefing provided to the failed UN Conference of the Parties in Copenhagen in 2009 provided this summary: "The long-term sea level that corresponds to current CO_2 concentration is about 23 meters above today's levels, and the temperatures will be 6 degrees C or more higher. These estimates are based on real long-term climate records, not on models."

On December 3, a study by eighteen eminent scientists, including the former head of NASA's Goddard Institute for Space Studies, James Hansen, showed that the long-held, internationally agreed-upon target to limit rises in global average temperatures to two degrees Celsius was in error and far above the 1C threshold that would need to be maintained in order to avoid the effects of catastrophic climate change.

And keep in mind that the various major assessments of future global temperatures seldom assume the worst about possible self-reinforcing climate feedback loops like the methane one.

“Things Are Looking Really Dire”

Climate-change-related deaths are already estimated at 5 million annually, and the process seems to be accelerating more rapidly than most climate models have suggested. Even without taking into account the release of frozen methane in the Arctic, some scientists are already painting a truly bleak picture of the human future. Take Canadian Wildlife Service biologist Neil Dawe, who in August told a reporter that he wouldn’t be surprised if the generation after him witnessed the extinction of humanity. All around the estuary near his office on Vancouver Island, he has been witnessing the unraveling of “the web of life,” and “it’s happening very quickly.”

“Economic growth is the biggest destroyer of the ecology,” Dawe says. “Those people who think you can have a growing economy and a healthy environment are wrong. If we don’t reduce our numbers, nature will do it for us.” And he isn’t hopeful humans will be able to save themselves. “Everything is worse and we’re still doing the same things. Because ecosystems are so resilient, they don’t exact immediate punishment on the stupid.”

The University of Arizona’s Guy McPherson has similar fears. “We will have very few humans on the planet because of lack of habitat,” he says. Of recent studies showing the toll temperature increases will take on that habitat, he adds, “They are only looking at CO_2 in the atmosphere.”

Here’s the question: Could some version of extinction or near-extinction overcome humanity, thanks to climate change—and possibly incredibly fast? Similar things have happened in the past. Fifty-five million years ago, a five-degree Celsius rise in average global temperatures seems to have occurred in just thirteen years, according to a study published in the October 2013 issue of the *Proceedings of the National Academy of Sciences*. A report in the August 2013 issue of *Science* revealed that in the near-term Earth’s climate will change ten times faster than at any other moment in the last 65 million years.

“The Arctic is warming faster than anywhere else on the planet,” climate scientist James Hansen has said. “There are potential irreversible effects of melting the Arctic sea ice. If it begins to allow the Arctic Ocean to warm up, and warm the ocean floor, then we’ll begin to release methane hydrates. And if we let that happen,

that is a potential tipping point that we don't want to happen. If we burn all the fossil fuels then we certainly will cause the methane hydrates, eventually, to come out and cause several degrees more warming, and it's not clear that civilization could survive that extreme climate change."

Yet, long before humanity has burned all fossil fuel reserves on the planet, massive amounts of methane will be released. While the human body is potentially capable of handling a six-to-nine-degree Celsius rise in the planetary temperature, the crops and habitat we use for food production are not. As McPherson put it, "If we see a 3.5 to 4C baseline increase, I see no way to have habitat. We are at .85C above baseline and we've already triggered all these self-reinforcing feedback loops."

He adds: "All the evidence points to a locked-in 3.5 to 5 degree C global temperature rise above the 1850 'norm' by mid-century, possibly much sooner. This guarantees a positive feedback, already underway, leading to 4.5 to 6 or more degrees above 'norm' and that is a level lethal to life. This is partly due to the fact that humans have to eat and plants can't adapt fast enough to make that possible for the 7-to-9 billion of us—so we'll die."

If you think McPherson's comment about lack of adaptability goes over the edge, consider that the rate of evolution trails the rate of climate change by a factor of 10,000, according to a paper in the August 2013 issue of *Ecology Letters*. Furthermore, David Wasdel, director of the Apollo-Gaia Project and an expert on multiple feedback dynamics, says, "We are experiencing change 200 to 300 times faster than any of the previous major extinction events."

Wasdel cites with particular alarm scientific reports showing that the oceans have already lost 40 percent of their phytoplankton, the base of the global oceanic food chain, because of climate-change-induced acidification and atmospheric temperature variations. (According to the Center for Ocean Solutions: "The oceans have absorbed almost one-half of human-released CO_2 emissions since the Industrial Revolution. Although this has moderated the effect of greenhouse gas emissions, it is chemically altering marine ecosystems 100 times more rapidly than it has changed in at least the last 650,000 years.")

"This is already a mass extinction event," Wasdel adds. "The question is, how far is it going to go? How serious does it become? If we are not able to stop the rate of

increase of temperature itself, and get that back under control, then a high temperature event, perhaps another five to six degrees [C], would obliterate at least 60 percent to 80 percent of the populations and species of life on Earth."

What Comes Next?

In November 2012, even Jim Yong Kim, president of the World Bank Group (an international financial institution that provides loans to developing countries), warned that "a 4C warmer world can, and must be, avoided. Lack of action on climate change threatens to make the world our children inherit a completely different world than we are living in today."

A World Bank–commissioned report warned that we are indeed on track to a "4C world" marked by extreme heat waves and life-threatening sea-level rise.

The three living diplomats who have led UN climate change talks claim there is little chance the next climate treaty, if it is ever approved, will prevent the world from overheating. "There is nothing that can be agreed in 2015 that would be consistent with the two degrees," says Yvo de Boer, who was executive secretary of the United Nations Framework Convention on Climate Change in 2009, when attempts to reach a deal at a summit in Copenhagen crumbled. "The only way that a 2015 agreement can achieve a two-degree goal is to shut down the whole global economy."

Atmospheric and marine scientist Ira Leifer is particularly concerned about the changing rainfall patterns a recently leaked IPCC draft report suggested for our future: "When I look at what the models predicted for a 4C world, I see very little rain over vast swaths of populations. If Spain becomes like Algeria, where do all the Spaniards get the water to survive? We have parts of the world which have high populations which have high rainfall and crops that exist there, and when that rainfall and those crops go away and the country starts looking more like some of North Africa, what keeps the people alive?"

The IPCC report suggests that we can expect a generalized shifting of global rain patterns further north, robbing areas that now get plentiful rain of future water supplies. History shows us that when food supplies collapse, wars begin, while famine and disease spread. All of these things, scientists now fear, could happen on

an unprecedented scale, especially given the interconnected nature of the global economy.

“Some scientists are indicating we should make plans to adapt to a 4C world,” Leifer comments. “While prudent, one wonders what portion of the living population now could adapt to such a world, and my view is that it’s just a few thousand people [seeking refuge] in the Arctic or Antarctica.”

Not surprisingly, scientists with such views are often not the most popular guys in the global room. McPherson, for instance, has often been labeled “Guy McStinction”—to which he responds, “I’m just reporting the results from other scientists. Nearly all of these results are published in established, esteemed literature. I don’t think anybody is taking issue with NASA, or *Nature*, or *Science*, or the *Proceedings of the National Academy of Sciences*. [Those] and the others I report are reasonably well known and come from legitimate sources, like NOAA [the National Oceanic and Atmospheric Administration], for example. I’m not making this information up, I’m just connecting a couple of dots, and it’s something many people have difficulty with.”

McPherson does not hold out much hope for the future, nor for a governmental willingness to make anything close to the radical changes that would be necessary to quickly ease the flow of greenhouse gases into the atmosphere; nor does he expect the mainstream media to put much effort into reporting on all of this because, as he says, “There’s not much money in the end of civilization, and even less to be made in human extinction.” The destruction of the planet, on the other hand, is a good bet, he believes, “because there is money in this, and as long as that’s the case, it is going to continue.”

Leifer, however, is convinced that there is a moral obligation never to give up and that the path to global destruction could be altered. “In the short term, if you can make it in the economic interests of people to do the right thing, it’ll happen very fast.” He offers an analogy when it comes to whether humanity will be willing to act to mitigate the effects of climate change: “People do all sorts of things to lower their risk of cancer, not because you are guaranteed not to get it, but because you do what you can and take out the health protections and insurance you need in order to try to lower your risk of getting it.”

The signs of a worsening climate crisis are all around us, whether we allow ourselves to see them or not. Certainly, the scientific community gets it. As do countless communities across the globe where the effects of climate change are already being experienced in striking ways and local preparations for climatic disasters, including increasingly powerful floods, droughts, wildfires, heat waves and storms are underway. Evacuations from low-lying South Pacific islands have already begun. People in such areas, out of necessity, are starting to try to teach their children how to adapt to, and live in, what we are causing our world to become.

My niece and nephews are doing something similar. They are growing vegetables in a backyard garden and their eight chickens provide more than enough eggs for the family. Their parents are intent on teaching them how to be ever more self-sustaining. But none of these heartfelt actions can mitigate what is already underway when it comes to the global climate.

I am 45 years old, and I often wonder how my generation will survive the impending climate crisis. What will happen to our world if the summer Arctic waters are indeed ice-free only a few years from now? What will my life look like if I live to experience a 3.5 Celsius global temperature increase?

Above all, I wonder how coming generations will survive.

ATTACHMENT D

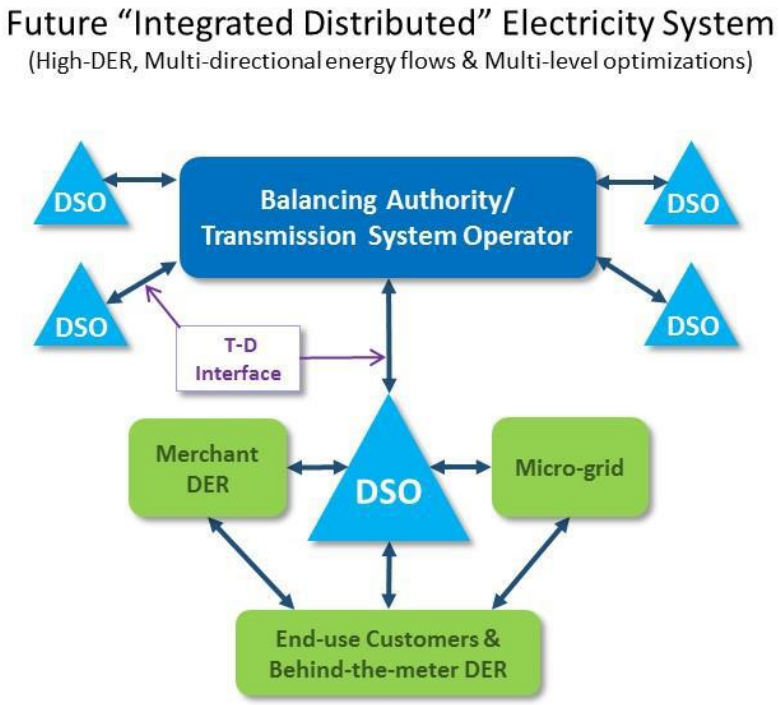
R.S. BRUTOCO ARTICLE ON
THE ROLE OF FUEL CELLS IN MICRO-GRIDS

The Role of Fuel Cells within a Microgrid System

Rinaldo S. Brutoco

November 25, 2014

California is positioned to transition from the current inefficient, centralized transmission infrastructure to a 21st-century honeycomb of microgrids, each of which is connected to the transmission grid (i.e., a "macrogrid") via a buffered gateway utilizing fuel cell technology located at the substation nexus between the distribution and transmission grids.[1] In Figure 1 below[2], this gateway (represented by the two-way arrow labeled "T-D Interface") is managed and operated by a Distributed System Operator ("DSO") responsible for the microgrid's underlying local distribution area (items shown in green).



[1] See DeMartini, Paul and Kristov, Lorenzo, "21st Century Electric Distribution System Operations," May 2014. In their paper, authors Kristov and De Martini identify this gateway nexus as "the basic building block of the new power system, namely, the set of distribution facilities that radiate from each transmission-distribution interface point, plus the DER and customers connected to those facilities." In a related footnote, the authors note that "[t]ypically this interface point is a substation linking a set of radial distribution circuits to the high-voltage transmission network."

[2] See De Martini and Kristov, infra, at p. 2. It should also be noted that the "Micro-grid" in Figure 1 refers to the traditional application of microgrid systems to mission-critical facilities such as hospitals, data centers and commercial complexes. In our larger model, these systems are a subset and component of the microgrid local distribution area.

Within a microgrid, fuel cell assets provide a continuous energy "buffer" or management capability to cover shortages resulting from the inherent diurnal variations of renewable energy resources (i.e. photovoltaic).

Capable of using natural gas, renewable biogas and hydrogen feed stocks, a fuel cell plant located at the substation gateway is superior to conventional gas turbine facilities in that a 50MW capability for example, could be created by "daisy chaining" a series of ten 5MW fuel cell modules. In our example, only one of these fuel cell modules might be required during normal daylight operations, with each additional module being brought on line as the Direct Renewable Resource produces less energy. (In our example, the Direct Renewable Resource could be a photovoltaic array that captures solar energy, which would drop in late afternoon to zero at night). On the transmission side of the gateway, a fuel cell plant could provide (i) back-up power to the transmission grid in a steady and reliable manner for other microgrids located within the state "macrogrid," (ii) excess power for sale to other states via regional transmission lines, or (iii) emergency power in the event of grid failure (for example, when the San Diego grid was "tapped" by the failure of a high-voltage transmission tower located outside the San Diego area).

Operated in tandem with electrolysis equipment utilizing gray water from local water treatment facilities, a fuel cell plant will be able to solve the "duck curve" dilemma[3] by being programmed to sequentially bring fuel cell modules online as Direct Renewable Energy sources decline in output, thereby meeting rising demand in the late afternoon hours and providing off-peak power using hydrogen previously electrolyzed from excess Direct Renewable Energy generated during previous peak periods. Under this system, grid instability from over-generation would no longer be a concern, curtailment measures would never be needed again and there would be no need to limit development of renewable resources as all excess Direct Renewable Energy would either be sold through the "macrogrid" or diverted to produce hydrogen through electrolysis.

In short, substituting fuel cells for conventional methane turbines ultimately creates a distinct pathway for the development of a renewable hydrogen economy, and creates additional demand for "green" hydrogen in a secondary market for fuel cell electric cars (FCEVs). As part of its long-term strategy, a DSO managing a microgrid could elect to store renewable hydrogen as an energy reserve to maximize resiliency and/or sell excess reserves to local refueling stations currently under development in the state of California. As the secondary FCEV market develops in California, the sale of renewable hydrogen to refueling stations (mandated by SB 1505 to equal one-third of all hydrogen produced for that purpose[4]) will become a secondary revenue stream for DSOs operating microgrids and their ratepayers who feed renewable energy back into the microgrid.

---

[3] California Independent System Operation (CAISO), "What the duck curve tells us about managing a green grid," (2013).

[4] California Environmental Protection Agency | Air Resources Board, "Facts About Environmental and Energy Standards for Hydrogen Production (SB 1505)," April 27, 2010.

While the modularity, quiet operation and small footprint of fuel cell technology allows for strategic deployment of fuel cell power plants in densely populated areas within the local distribution area, we see other "competing" technologies as complementary to developing an optimized microgrid system. For example, in our 50MW model, it may be prudent to plan for the installation of a small battery component to provide frequency and or phase regulation services and on-demand power while fuel cell modules are sequentially coming online. By integrating both technologies, frequency response time can be maximized while also maintaining a much smaller footprint than could otherwise be achieved by building an entire facility using battery technology. Supercapacitors may also provide a useful role in leveling extremely short load modulations. The ultimate goal is to bring the strengths of all renewable technologies to bear on developing the best microgrid possible.