**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 ROBERT PERRY

DIRECTOR OF ENERGY RESEARCH OF THE

WORLD BUSINESS ACADEMY

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I. INTRODUCTION

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

A: Robert Perry. 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: The World Business Academy ("Academy") has proposed, as a superior alternative to the project that the Southern California Edison Company ("SCE") has submitted for Commission approval in this proceeding: a hybrid power generation and storage system relying on new, local solar PV generation along with fuel cell and battery technologies. This hybrid system would be the first stage in developing a community-wide energy “cloud” of networked microgrids developed at the substation level.

The purpose of my testimony is to compare and contrast (i) the environmental, operational and economic costs and benefits of installing the Academy's proposed hybrid system against (ii) SCE’s proposed project within the context of the inevitable failure of the solitary high-voltage transmission line that provides most, if not all, power for the Santa Barbara Energy Needs Area (“ENA”), which includes but is not limited to the cities of Santa Barbara, Goleta, Montecito, Summerland and Carpinteria.[1] Based on this analysis, my testimony will demonstrate that by taking certain environmental, operational and economic externalities into account, the overall **costs** of developing such distributed generation and storage facilities will be **lower** than the actual costs of SCE's proposed project and that the overall **benefits** of the Academy's proposed alternative will be **greater** than the benefits from SCE's proposed project.

II. SCE'S PROPOSED REFURBISHMENT OF THE ELLWOOD PLANT DOES NOT MEET THE IDENTIFIED LCR NEED

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

A: In a word, NO. I agree with the Testimony of Rinaldo S. Brutoco, the Academy's President, which is being submitted simultaneously with my Testimony, that the reliability enhancements from the proposed refurbishment of the Ellwood facility are illusory, and will fail to provide ratepayers with sufficient energy to achieve near 100% operational reliability, even when combined with net available capacity from sub-transmission lines under development as a backstop against the failure of the compromised high-voltage transmission lines currently providing power to the region.[2]

In its Response filed under in proceeding, SCE states that the Ellwood Refurbishment Project is not part of the LCR procurement (*italics* added):

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[1] As disclosed by SCE in 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. *See also*, Testimony of Rinaldo S. Brutoco, President of the World Business Academy, pp. 4-9, filed concurrently herewith.

[2] A.12-10-018, at pp. 4-5.

> "SCE is not proposing to count the 54 MW Ellwood Refurbishment project toward its LCR procurement authorization for the Moorpark sub-area. This unit was assumed to be online in CAISO's LCR need assessment. However, in the absence of a long-term PPA, *the likelihood of a permanent retirement of this resource, which plays an important role for system reliability, would significantly increase, which in turn would result in additional and higher LCR need in the Moorpark sub-area. The proposed Ellwood Refurbishment PPA avoids the need for SCE to develop additional new resources in excess of SCE's current LCR procurement authorization for the Moorpark sub-area.*
>
> "Refurbishment of the Ellwood facility is necessary to enhance certain operational characteristics of the unit to maintain system reliability in the Goleta portion of the Moorpark sub-area. As indicated in SCE's LCR Procurement Plan, approved by the Energy Division on September 4, 2013, *reliable resources in the Goleta area are needed to maintain system reliability for local communities in the area*."[3]

A footnote in the above excerpt references SCE's Track 1 Procurement Plan, where the gravity of the impact from the loss of the high-voltage transmission lines is fully explained:

> "As can be seen from Figure II-3, the Goleta substation area is served radially from Santa Clara substation by two 230 kV lines,

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[3] *See*, Southern California Edison Company's (U 338-E) Response to Protests to Its Application for Approval of the Results of Its 2013 Local Capacity Requirements Request for Offers for the Moorpark Sub-Area, p. 7.

Santa Clara-Goleta No. 1 and No.2. *The two Santa Clara-Goleta 230 kV lines are co-located on a single tower corridor through rugged mountainous terrain in a wooded area that is subject to natural hazards including soil erosion and wildfires.* If an outage occurred on the two Santa Clara-Goleta 230 kV lines, SCE can serve approximately two-thirds of the peak loads served by Goleta substation by being transferred to an adjacent 66 kV system once a proposed upgrade to that system that presently awaiting CPUC approval is completed. [A footnote appended to this sentence reads as follows: *Before completion of the upgrade to the 66 kV system currently awaiting CPUC approval, SCE can only serve one-third of peak load by transferred the load to an adjacent 66 kV system*, if an outage occurred on the two Santa Clara-Goleta 230 kV lines.] However, *the time period to restore full service to load served by Goleta substation could be significant.* Due to the rugged terrain, loss of the Santa Clara-Goleta lines due to environmental hazards could result in *rolling blackouts in this area for an extended period. There is significant value to the local communities in seeking generation sited in this area*."[4]

It appears from SCE's foregoing statements that the true purpose for "refurbishing" this aging turbine plant is not to provide peaking services to the Moorpark Sub-Area (which services would seem to be rarely needed, given the extremely limited output of the Ellwood plant in recent years), but rather to act as a "fail-safe" against the impending failure of the current compromised high-voltage transmission line. Furthermore, should the proposed 54 MW peaker plant in the Ellwood neighborhood be completed, its capacity would not fully

[4] *See,* Track 1 Procurement Plan of Southern California Edison Company Submitted Pursuant to Energy Division Pursuant to D.13-02-015, p. 16.

cover the energy shortage resulting from the failure of the existing transmission line, when power is rerouted through the sub-transmission lines connecting the Moorpark Sub-Area grid to the opposite southern end of the Santa Barbara ENA at the Carpinteria Substation.

The CAISO's 2014-2015 ISO Transmission Plan, dated March 27, 2015, forecasts the 2016 summer peak load for the Goleta Substation at 321 MW.[5] However, prior to completion of the currently proposed sub-transmission upgrade, the Santa Barbara ENA faces a shortage of 66% of its peak load, or 214 MW, in the event of a transmission failure. Even if the proposed upgrade is completed, the ENA is still short 33% of peak load, or 107 MW. Therefore, under the most optimal scenario described above, the proposed peaker plant would only partially mitigate a foreseeable catastrophe, and even with the proposed refurbishment of the Ellwood plant and completion of the proposed sub-transmission line upgrade, energy delivery services by SCE to the Santa Barbara ENA in the event of a primary transmission line failure could in no manner be described as “reliable.”

With regard to safety, the circumstances described in the previous paragraphs would also require changing the function of the “peaker” plant, required to operate only a few hours each day, to more of a baseload role, such that the Ellwood plant would be required to be constantly operating to cover a portion of the 33-66% power shortage for most of the day and well into the night. Under this scenario, the emissions of carbon and hazardous fine particulates from the refurbished Ellwood plant would likely triple or quadruple, and that plant would likely be operating during school hours at Ellwood Elementary, which is situated less than 1,000 feet from the plant site.

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[5] *See,* CAISO 2014-1015 ISO Transmission Plan, p. 122.

As for sound pollution, the Academy has yet not found relevant data concerning the noise emissions from this plant, but it is a well-established fact that even when enclosed, such jet engine turbine plants have a loud acoustic signature.

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: The procurement proposed in this proceeding is not reasonable in that (i) under the best circumstances, the proposed peaker plant only serves the energy needs of the larger Moorpark Sub-Area at the expense of adjacent Ellwood residents; (ii) in the event of a transmission failure, the plant's 54 MW capacity will be insufficient to cover the shortage resulting from rerouting power to the 66 kV sub-transmission lines; and (iii) in the event of a transmission failure, the plant will operate far outside its intended parameters, subjecting the primarily residential area, and particularly the school children attending the adjacent elementary school located less than 1,000 feet from the facility site, to vastly higher emissions of hazardous particulates which have been known to cause major adverse medical conditions, including cancer.

Although the Commission's Track 1 Decision in D.13-02-015 does not mandate the procurement of any particular type of resource for the Moorpark Sub-Area, there are numerous references in that Decision to the preference for preferred resources as specified in the Loading Order (italics added):

> "SCE is also authorized to procure between 215 and 290 MW of the Moorpark sub-area of the Big Creek/Ventura local reliability area. *The LCRs require resources be located in a specific transmission-constrained area in order to ensure adequate available electrical*

capacity to meet peak demand, and ensure the safety and reliability of the local electrical grid.

. . .

"The long-term LCRs are expected to result from the retirement of thousands of MW from current once-through cooling generators due to compliance with State Water Quality Control Board regulations. *We anticipate that much of the additional LCR need currently forecast by the California Independent System Operator can be filled by preferred resources, either through procurement of capacity or reduction in demand.* Preferred resources include energy efficiency, demand response, and distributed generation including combined heat and power. Energy storage resources may also be available.

"In the next long-term procurement proceeding, expected to commence in 2014, we will evaluate whether there are additional LCR needs for local reliability areas in California."

. . .

"SCE is directed to begin a solicitation process to procure authorized LCR resources. The first step is a plan to issue one or more Request for Offers and/or to enter into cost-of-service contracts per Assembly Bill 1576 (Stats 2005, ch. 374). *SCE should also actively pursue locally-targeted and cost-effective preferred resources. SCE's procurement plan shall be consistent to the extent possible with the multi-agency Energy Action Plan, which places cost-effective energy efficiency and demand response resources first in the Loading Order, followed by renewable resources and then fossil-fuel* *resources. Energy storage resources should be considered along with preferred resources.*[6]

. . .

"As part of our review of SCE's procurement plan, and when considering SCE's procurement application, *we will require SCE to show that it has done everything it could to obtain cost-effective demand-side resources which can reduce the LCR need, and cost-effective preferred resources and energy storage resources to meet LCR needs.* This task includes efforts already underway and approved in other Commission proceedings, with *an eye to focusing such efforts in the specific local geographic areas where LCR needs exist*."[7]

The Commission even takes notice of SCE's acknowledgement that new technologies embodied in preferred resources can better serve the Moorpark Sub-Area (footnotes omitted, *italics* added):

"SCE recommends deferring authorization for procuring additional local capacity in the Big Creek/Ventura local area until the next LTPP cycle (expected to commence in 2014). SCE contends that barriers to construction of new LCR generation is not as difficult in the Big Creek/Ventura local area as in the LA basin local area, because "this area does not have as many, or as stringent, siting restrictions as the LA basin." *SCE further argues that newer technology of various sizes is more likely to be the replacement*

[6] D.13-02-015, Decision Authorizing Long-Term Procurement for Local Capacity Requirements, Summary, pp. 2-3.

[7] D.13-02-015, p. 78.

generation in the Moorpark sub-area, which may be able to be built in 5 to 7 years."[8]

The requirement to locate resources "in a specific transmission-constrained area in order to ensure adequate available electrical capacity to meet peak demand, and ensure the safety and reliability of the local electrical grid" seems to prioritize the needs of the residents within the "transmission-constrained area" over the broader requirements of the Moorpark Sub-Area. The focus on procuring demand-side resources, preferred resources and energy storage also places a burden on SCE to look for a "better fit" for the Santa Barbara ENA. Even SCE acknowledges these circumstances, arguing that "newer technology of various sizes is more likely to be the replacement generation in the Moorpark sub-area."[9] In this light, installing a 54 MW peaker plant that is likely to exceed its operating parameters for an extended period of time during a foreseeable emergency clearly does not qualify as a "best fit" solution for the Santa Barbara ENA.

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 54 MW Ellwood Refurbishment project is neither an appropriate nor a reasonable project for the Commission to approve, as this proposed facility is not the "best fit" for the densely populated and extremely transmission-constrained Santa Barbara ENA, which is already subject to a potentially catastrophic failure of its high-voltage transmission system. Moreover, this proposed project is located in the rapidly developing Ellwood residential area of Goleta, less than 1,000 feet away from the local elementary school. There are also large

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[8] D.13-02-015, pp. 68-69.

[9] *Id.*

residential tracts located on both sides of the plant site that would be adversely impacted should the plant need to operate longer hours than originally intended due to the transmission line failure.

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

A: For the near term, the small capacity of the proposed storage project is reasonable in that there has not been much penetration to date by intermittent renewable resources in the Santa Barbara ENA. However, the scale of penetration by renewable resources in the Santa Barbara ENA is expected to ramp up dramatically as area communities become aware of the fragile state of the local transmission and distribution grid. Electricity customers in this area will therefore soon be demanding a more reliable and resilient distributed solution. This significant increase in demand for renewable generation will, in turn, require much larger procurements of storage and distributed generation for the Santa Barbara ENA in subsequent LCR proceedings.

III. SCE'S PROPOSED REFURBISHMENT OF THE ELLWOOD PLANT WILL POSE SERIOUS ADVERSE ENVIRONMENTAL HAZARDS

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

A: No. In the event of a transmission failure as described above, the plant’s proposed operation as a peaker facility, scheduled to run only a few hours a day to supply extra energy during peak load periods, would be completely undermined, as continuous operation during the foreseeable transmission failure would inevitably be required to make up for a portion of the shortfall.

Peaker plants are designed to quickly deliver power for short periods and their high emissions profile requires them to operate only a few hours a day in order to remain within EPS requirements. As the impending transmission failure would be deemed an “emergency,” SCE would certainly apply for an exemption from EPS requirements until either the high-voltage transmission lines are repaired (at an extremely high cost), or local generation and storage facilities are developed. Ironically, it is just those types of facilities that the Academy is currently proposing to implement on a proactive basis in lieu of the proposed peaker plant.

The fuel cell and battery technologies that would comprise these facilities are wholly compliant with all EPS standards, as they have an extremely low emissions footprint and are capable of operating free of all carbon and fine particulate emissions.

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

A: Given the likelihood that both of the peaker plants proposed for approval in this Application will operate much longer than anticipated, with attendant carbon and fine particulate emissions, the Academy urges the Commission to delay approval of the contracts pending CEC CEQA approval and to use the interim period to pursue a more distributed and resilient solution. Moreover, the CEQA review of the proposed 54 MW Ellwood peaker plant should unquestionably include a careful consideration of likelihood that there will be serious issues with the primary transmission lines, which will require much longer, if not continuous, operation of the plant during any interim period during which those lines are being repaired.

IV. THE DISTRIBUTED ALTERNATIVE PROJECT THAT THE COMMISSION SHOULD DIRECT SCE TO PROCURE

Q: What would be a more appropriate and reasonable procurement for the Commission to consider in this proceeding?

A: A significantly more reasonable and appropriate procurement solution would be to reallocate a substantial portion of the total 316 MW of capacity authorized pursuant to the Commission's Track 1 Decision for development within the Santa Barbara ENA to make up for the imminent energy shortage inherent in SCE’s current proposal. All such reallocated resources can and should be Preferred Resources. A mix of clean, distributed resources would be far superior to replacing an old gas turbine plant with a “new” turbine combustion facility for the next 25-30 years. (Indeed, there is a high likelihood that increasingly stringent emission standards will render such a "new" turbine combustion facility a “stranded asset” long before the end of its useful life.)

The Academy's proposed Distributed Alternative Project that the Commission should direct SCE to procure instead of the two peaker plants proposed in the Application under review would include:

<u>Solar PV (Distributed Generation)</u>. The foundation for any distributed energy system is locally sited generation. It is essential that the latent energy capacity of solar PV within the Santa Barbara ENA be developed to the fullest extent possible, with a concurrent development of storage capacity based on projected solar PV penetration. As a result of its unique geography, the entire Santa Barbara ENA is south-facing, providing ample opportunities to install solar PV in areas exposed to direct sunlight for extended periods each day.

To date, the Santa Barbara ENA has a very little installed solar PV systems, and there is plentiful commercial/industrial roof space on which to mount large PV systems for an aggregate multi-megawatt capacity. Attached as Exhibit C to this Testimony are aerial digital photographs[10] of prime rooftop locations within the Santa Barbara ENA that are within close proximity to substations. As is evident from the attached aerials, the conversion of this fallow roof and parking lot space is capable of generating between 50-100 MW of daily capacity for direct use during the daytime or for storage for later use off-peak.

Additionally, undeveloped fields on south-facing hillsides adjacent to substations can be developed as community solar projects, where investors and local citizens can own equity shares of dedicated solar PV generation without having to personally own PV systems, and receive dividends on their equity through a credit reduction on their utility bill. There are south-facing hillsides, located within proximity to substations, from the San Marcos Pass to Goleta and as far north as Gaviota, to add at least another 50-100 MW of capacity, if needed.

Strategic development of existing rooftops, public and private parking areas and south-facing hillsides will create enough renewable energy generation within the Santa Barbara ENA to continuously power a properly managed microgrid distribution system. With properly distributed and located generation, storage and electrolysis facilities, there should be no concerns regarding grid instability from over-generation, as the microgrid system will incorporate an established hierarchy for the application of any surplus energy: first to serve microgrid load and maximize local storage capacity; second, for transmission to the outer Moorpark Sub-Area if needed; and finally, for the electrolysis of water into hydrogen either for long-term storage or for sale to hydrogen fuel cell ("HFC")

[10] These digital aerials were created using Google Earth software.

vehicle refueling stations as a secondary revenue source. With properly allocated resources, there should be no scenario where surplus renewable energy would have to be wasted through needless curtailment measures.

Hybrid Fuel Cell-Battery Plants Strategically Located at Wastewater, Landfill and Desalination Sites. To the extent possible, these plants would utilize fuel cell technology to provide essentially baseload, carbon-neutral power using available biogas feedstock from anaerobic digesters at municipal wastewater and landfill sites, while an appropriately sized battery component would provide ramping, peak shaving and ancillary services to the adjacent area. The hybrid plant servicing the city's soon-to-be-activated desalination plant would play a particularly unique role within the Santa Barbara ENA: connected to both the plant and the distribution grid, this facility would be available on a continuous standby basis to provide emergency grid support services by instantly diverting all or a portion of its capacity from its baseload function serving the desalination plant to other areas in order to meet peak load needs at either the distribution or transmission grid levels when the primary solar PV generation is not available, or in case of a transmission line failure, as described above.

Such a strategic position within the microgrid will effectively enable a baseload energy source also to offer dispatchable energy via switchable grid service functions. Furthermore, because fuel cells are modular, switching capabilities would be assigned on a per unit basis, allowing for immediate or gradual ramping during the early morning and late afternoon/early evening hours as shown in the by now well-known "duck curve" graph.[11]

[11] California ISO, "Fast Facts: What the Duck Curve Tells Us about Managing a Green Grid," 2013.

Flow Batteries (Utility-Scale Energy Storage) at Substation Locations. These utility-scale installations would be located adjacent to substations and calibrated to store enough excess solar energy generated during peak periods for transitional ramping needs, off-peak generation at night and for ancillary services such as phase and voltage regulation to enhance grid reliability.[12] The unique characteristic of flow batteries is the capacity to hold large volumes of charged, non-toxic[13] electrolyte in underground tanks as stored energy, and then to discharge that energy over many hours, with the only limiting factor being the size of the tanks storing the electrolyte in either a charged or discharged state.

For example, a flow battery facility with a 5 MW capacity connected to underground tanks holding 50 MW of charged electrolyte could provide energy at full capacity for 10 hours, effectively bridging the nighttime portion of the 24-hour diurnal cycle until sunrise, when solar PV resources would again start delivering power to the grid and recharging the discharged electrolyte. During the day, the flow battery's virtually instantaneous response capabilities allow for load leveling of daily power fluctuations, providing a constant and even source of energy to the surrounding area. As dusk approaches and renewable generation begins to fade, flow batteries quickly pick up the slack, discharging stored energy to meet demand.

Lithium-Ion Batteries (Distributed Energy Storage) in High Density Areas. Solar PV systems at commercial-industrial sites and designated city blocks would be supplemented by battery storage systems designed to provide 2-4 hours of power

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[12] Hardin, Mark and Brown, Amanda, "CPUC Energy Storage Use Case Analysis - Distribution Energy Storage: Distributed Storage Peaker," California Public Utilities Commission -- Energy Storage Proceeding, R.10-12-007.

[13] Prior flow battery prototypes using toxic electrolyte materials initially made the technology environmentally untenable for consideration by the Academy. However, new methods incorporating zinc redox technology have alleviated those concerns.

(appropriately scaled to meet load requirements) in the event of an outage or to support other areas in the distribution grid. Using advanced grid management software, such "nanogrids" within the Santa Barbara ENA will also be able to combine their aggregate storage to collectively act as a "virtual peaker" plant to supplement utility-scale storage during high load periods, for daily ramping requirements or to provide extended grid support to other affected areas during outages.[14]

Demand Response/Energy Efficiency Programs (Peak and System Load Mitigation). Every credible energy system must develop efficiency and demand response programs, which serve to reduce overall and peak system loads. SCE should be required to procure a diverse program set of Demand Response and Energy Efficiency resources to help close any gap between projected peak loads and the emerging distributed energy system.

Q: How would you implement this proposed distributed resource plan within the scope of this proceeding?

A: First and foremost, local capacity must be developed in an amount that exceeds whatever shortage would be created from a failure of the primary transmission line. As the IOU responsible for the Moorpark Sub-Area, SCE should be required to reconcile existing and anticipated capacity (both before and following completion of the sub-transmission line upgrade) with the CAISO's 2016 projected peak load of 321 MW for the Goleta substation that currently serves as the transmission-distribution nexus point for the Santa Barbara ENA.

Once SCE has conducted a transparent analysis that accurately quantifies the shortage resulting from a transmission failure, the Commission should authorize

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[14] Hardin and Brown, "CPUC Energy Storage Use Case Analysis - Distribution Energy Storage: Distributed Storage Peaker," *supra*.

an comprehensive feasibility study that would include a requirement for SCE to develop a detailed recommendation regarding the optimal set of Preferred Resources (distributed generation, storage, and/or load reduction through demand response and energy efficiency measures) to address the shortfall.

Following completion of the foregoing feasibility study, an accelerated RFO process, similar in nature to SCE's Preferred Resources Pilot Project recently initiated for Orange County, would be completed on an expedited basis and contracts negotiated and approved on a schedule similar to the Orange County PRP. [15]

Subject to completion of the foregoing measures, the Academy believes that initial procurements should involve the development of utility-scale fuel cell and/or battery plants at various substation locations. Appropriately sized fuel cell plants would be installed at substations located near natural gas and biogas sources such as wastewater treatment facilities and landfills. Within the Santa Barbara ENA, these locations include the following facilities:

Tajiguas Landfill. The landfill facility currently processes enough biogas from landfill emissions to generate approximately three megawatts (3 MW) of power using an obsolete diesel reciprocal engine. Santa Barbara County is also developing a Resource Recovery Project at the landfill to add an additional amount of biogas to generate 1+ megawatt of power (as currently delivered by the diesel engine), for an increase in volume of approximately 33% over current levels. The Academy believes that this biogas resource would be better utilized in a fuel cell system, which would not only generate electricity at an efficiency rate of ~47% (increased to ~80% through CHP conversion), but would also produce a syngas that can be

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[15] SCE, "Preferred Resources Pilot," June 2014. *See also,* "SCE's Preferred Resources Pilot ("PRP")," November 6, 2013 and "SCE PRP RFO Schedule."

filtered into a pure hydrogen byproduct, to be used either by the fuel cells to generate additional carbon-free electricity, or stored and sold as a secondary revenue source to local refueling stations for advanced clean fuel vehicles that are scheduled to come on-line by the end of 2015.

Depending on the relative efficiency rate of the engine currently operating at the landfill, the Academy believes that this new facility at the landfill site can increase energy production by at least 25%. It should also be noted that there are many south-facing hillsides located adjacent to the landfill site that could serve as utility-scale community solar projects to generate additional renewable energy to the Santa Barbara ENA.

Goleta Wastewater Treatment Plant ("WWTP"). Subject to the volume of biogas produced at the plant, a 1.4 or 2.8 MW fuel cell plant could be installed, with the heat discharge from the fuel cells used to heat the digester units at the wastewater treatment plant. In addition to carbon-neutral energy, which could be delivered to the University of California, Santa Barbara campus in furtherance of their 2025 mandate, hydrogen by-product would also be produced and either sold to refueling stations for secondary revenue or used by the fuel cells to produce more clean energy. To the extent there is insufficient biogas, the fuel cells could also use conventional natural gas to deliver power to the area until such time as a more robust hydrogen delivery infrastructure is developed in California.

El Estero WWTP / Charles Meyer Desalination Plant. An appropriately scaled fuel cell plant would be located at the wastewater treatment plant in the same manner as at the Goleta WWTP. As discussed above, energy from the fuel cell plant would be primarily used to power the desalination plant, but would be also available on a standby basis for dispatch to the distribution and/or transmission grid when needed. Because power would always be needed to operate the desalination plant, deliverability of this energy would only be limited by the ability to quickly switch the power output of the fuel cells from the plant to the grid and back again. In this unique arrangement, baseload generation by fuel cells can be used in a flexible, dispatchable manner.

Other Substations. Depending on certain criteria, either fuel cells or flow batteries would be located at all substation sites. For substations with access to natural gas and biogas, fuel cells offer a clean, quiet source of energy, while also providing heat and hydrogen byproducts for direct use or for conversion into surplus energy for storage and/or sale to refueling stations for hydrogen-powered vehicles.

One substation with locational features meriting the application of both technologies is located in downtown Santa Barbara. This substation could potentially access vast amounts of solar energy from solar PV on commercial, industrial and retail rooftops and parking lots located within the 800-acre area comprised of downtown Santa Barbara and adjacent areas zoned for commercial, industrial and retail ("CIR") use (collectively, the "SBCIR").

Applying a conservative metric of 100,000 square feet (100K SF) for every megawatt (MW) of electricity using solar panels[16] with a 12% efficiency

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[16] The standard solar panel on the market today is sized at 3 feet by 5 feet, or 15 sq. ft., and produces about 260 watts. Thus, 100,000 sq. ft. could theoretically accommodate 1,733 kW of solar panels. Discounting that amount of generation by the standard factor of 15% to account for the conversation of DC solar generation into AC power for use on the grid, that leaves as much as 1,473 kW of AC power that could be generated in an area of 100,000 sq. ft. Thus, the 1 MW per 100,000 sq. ft. number being used in my subsequent calculations significantly understates the amount of electricity that could be generated by solar PV panels covering that amount of space.

rating[17], and assuming 50% of the SBCIR contains rooftop, parking and others surface areas capable of solar PV development, the energy capacity of the SBCIR can be roughly estimated at varying penetrations of 25% (43.67 MW), 35% (61.14 MW), 50% (87.35 MW) and 65% (113.55 MW). Attached as Exhibit C are digital photos of the SBCIR and selected test sites, along with calculations used to estimate available solar capacity.

Given the population density and diverse energy usage in the SBCIR, it would be advisable to deploy fuel cell, flow battery and electrolysis capacity and features to manage the large volumes of energy generated once solar PV development in the SBCIR reaches a saturation point. Although these modular technologies will not require immediate installation of the entire projected capacity, space should be allocated so that additional units can be added as solar PV capacity reaches targeted milestones. Initially, while solar PV development is still low, an emphasis on developing flow battery capacity will allow the SBCIR to store whatever surplus renewable is generated for use at night. Once surplus energy exceeds maximum flow battery capacity based on forecast nightly load requirements, then such energy can be diverted to other areas within and outside the Santa Barbara ENA or used for electrolysis of wastewater into hydrogen as a long-term storage reserve or for sale to local HFC vehicle refueling stations.

For substations located adjacent to south-facing hillsides, a flow battery would be best for short-term storage and use within the 24-hour diurnal cycle. Such substations located near potential renewable energy resources include the, Goleta and San Marcos substations, which are located adjacent

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[17] *See,* Energy.gov, "Installing and Maintaining a Home Solar Electric System," July 2, 2012.

to south-facing hillsides that could be developed as Solar Community Projects for the generation of utility-scale energy. Attached as Exhibit D are digital images of the area surrounding these substations, with areas of potential solar development and possible flow battery installation sites indicated thereon.

In summary, the Academy proposes that for this proceeding, the Commission should direct SCE to initiate an RFO to procure the following energy projects in lieu of SCE's proposed refurbishment of the 54 MW Ellwood peaker plant:

Preferred Resource Type	**Site Location**	**MW**
PV with Battery Storage	Large CIR Rooftops/Parking Areas	75.0
Fuel Cell Plants	Ellwood/Landfill/WWTP/Desal Sites	42.0
1.8/3.6/7.2 MW Flow Battery Plants	Substation Locations	18.0
Energy Efficiency / Demand Response	Throughout SB ENA	15.0
	Total Procurement	**150.0**

V. THE ACADEMY'S BETTER ALTERNATIVE PROJECT IS MORE COST EFFECTIVE THAN SCE'S PROPOSED GAS TURBINES

Q: Can these Preferred Resources be procured on a cost-effective basis?

A: Yes. The cost of installing Solar PV panels on commercial and industrial sites has plummeted in recent years and now has achieved parity with gas-fired peaker plants on a levelized cost of energy ("LCOE") basis.[18] Likewise, energy efficiency and demand response programs have been proven effective in

[18] *See,* Lazard Ltd., Lazard's Levelized Cost of Energy Analysis — Version 8.0, Sept. 2014, pp. 2-4.

reducing peak and overall loads on a per-dollar basis. Fuel cell and flow battery technologies, however, are just beginning to offer their products to the energy marketplace and have not yet achieved economies of scale that will lower production costs such that they can directly compete with established GFG suppliers on a strictly economic, cost per kilowatt-hour, basis.

This does not mean, however, that procuring these advanced energy products as part of a distributed resources plan to construct a community-wide microgrid is not a cost effective endeavor, when incorporating various unaccounted-for externalities, including but not limited to (i) the health benefits from avoided fine particulate emissions from the Ellwood Peaker Plant, (ii) the avoided costs of fully upgrading the high-voltage transmission lines to reliably bring enough power to the Santa Barbara ENA, and last but not least, (iii) the extremely high value to the State of California of successfully developing and operating a community microgrid project in an extremely transmission-constrained area. Numerous participants in many hearings before the Commission have called for such a demonstration project in order to begin the transition towards a more reliable and resilient distributed energy system.[19]

Furthermore, as shown below, the LCOE of fuel cells and flow batteries are very competitive with peaker plants whose operation is limited to a few hours each day. Combined together, both technologies offer a feature set that is modular, scalable and more importantly, capable of operating completely carbon-free from renewable sources.

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[19] Picker, Michael, "Guidance for Section 769 – Distribution Resource Planning," as attached to the Assigned Commissioner's Ruling in CPUC Proceeding R.14-08-013, pp. 5-7. *See also,* "CA CEC PON-14-301: Demonstrating Secure, Reliable Microgrids and Grid-Linked Electric Vehicles to Build Resilient, Low-Carbon Facilities and Communities," EnergyStorage.org.

Q: What are the primary sources of your analysis regarding the comparable LCOE of fuel cells, flow batteries and gas turbine peaker plants?

A: The major reference relied on in developing this analysis is the most recent report prepared by Lazard, a highly respected financial advisory and asset management firm with offices all over the world ("Lazard Report"), regarding its LCOE analysis of conventional and renewable technologies.[20] Over the years, the Lazard Report has become a standard reference point within the energy industry and has received extensive and favorable press coverage.[21] Also incorporated into my analysis is a 2011 study on the added value of fuel cells prepared by the National Fuel Cell Research Center at the University of California, Irvine (the "NFCRC Report").[22] The NFCRC Report evaluates fuel cells from a wide range of data, including the additional value from avoided health costs and emissions that were excluded in the Lazard Report. Regarding efficacy of flow batteries, I am relying on a 2014 study comparing the capabilities of flow battery energy storage against gas turbine peaker plants.[23]

Q: What is the conclusion of the Lazard Report with respect to the relative cost advantages of fuel cells versus traditional gas peakers?

A: The Lazard Report confirms that in the range of LCOE values provided to various technologies, the highest unsubsidized LCOE value assigned to fuel cells

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[20] See, Lazard Ltd., Lazard's Levelized Cost Of Energy Analysis — Version 8.0, Sept. 2014. Lazard has been publishing versions of this study since 2008 through its Global Power, Energy & Infrastructure Group. This group is active in all areas of the traditional and alternative energy industries, including regulated utilities, independent power producers, advanced transportation technologies, renewable energy technologies, meters, smart grid and energy efficiency technologies, and infrastructure.

[21] See, *e.g.*, "Lazard Releases New Levelized Cost of Energy Analysis," Business Wire, September 18, 2014. See also, coverage of and references to the Lazard Report in *The Financial Times*, the Institute of Electrical and Electronics Engineers website, and *Energy Industry Today*.

[22] National Fuel Cell Research Center, "Build-Up of Distributed Fuel Cell Value in California: 2011 Update / Background and Methodology," University of California, Irvine, July 24, 2011.

[23] Lyons, Chet, "Guide To Procurement of Flexible Peaking Capacity: Energy Storage or Combustion Turbines?," Energy Strategies Group, October 7, 2014, p. 14.

($176) is less than the lowest such value assigned to gas peaker plants ($179).[24] Also, when calculating the average unsubsidized LCOE of these technologies based on the ranges provided in the Lazard Report, the average unsubsidized LCOE of fuel cells ($145.50 = the average of $115 and $176) is $59 lower (28.85%) than the unsubsidized LCOE to build a natural gas peaker plant ($204.50 = the average of $179 and $230) as proposed by SCE in this Application.

Furthermore, after incorporating the benefit calculations of avoided health costs and emissions provided in the NFCRC Report, the savings for adopting fuel cell technology over a gas peaking plant increases to 55.89%, for a net LCOE of $90.20/MWh.[25]

Q: Would you please describe some of the key assumptions underlying, and the data supporting, this conclusion of the Lazard Report?

A: To quote from the Lazard Report itself, "[I]nputs were developed with a leading consulting and engineering firm to the Power & Energy Industry, augmented with Lazard's commercial knowledge where relevant. This study (as well as previous versions) has benefitted from additional input from a wide variety of industry participants."[26]

It is important to note that the Lazard Report excludes a number of other important factors that would have produced an even more lopsided LCOE cost advantage for fuel cells over gas turbines. Again, to quote from the report itself:

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24 Lazard Report, Unsubsidized Levelized Cost of Energy Comparison, at p. 2.

25 See Table A in Attachment B, attached hereto.

26 Lazard Report, Summary Considerations, at p. 19.

"Other factors would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this current analysis. These additional factors, among others, could include: capacity value vs. energy value; *stranded costs related to distributed generation* or otherwise; network upgrade, transmission or congestion costs; integration costs; and costs of complying with various environmental regulations (e.g., carbon emissions offsets, emissions control systems). *The analysis also does not address potential social and environmental externalities*, including, for example, the social costs and rate consequences for those who cannot afford distribution generation solutions, *as well as the long-term residual and societal consequences of various conventional generation technologies that are difficult to measure* (e.g., nuclear waste disposal, environmental impacts, etc.)"[27] [Emphasis added.]

Q: What are some of the other key assumptions used in the Lazard Report that yield cost advantages for fuel cells over traditional gas turbines?

A: Lazard's assumptions include the following:

1. Net Facility Output. Lazard's assumption for the output of fuel cell plants is based on a small facility of 2.4MW (with an assumed average capital cost of $5,650/KW), whereas the assumed size of gas peaking plants are in a range from 103MW to 216MW (with an assumed average capital cost of $900/KW). However, applying routine economies of scale that have been achieved whenever "beta" technologies have become mass produced, it can reasonably be assumed that the cost/KW of constructing a fuel cell plant of a size similar to the assumed peaker plant (103-216MW) would drastically

[27] *See*, Lazard Report, Introduction, at p. 1.

reduce fuel cell capital costs to a range that is more in line with the capital costs associated with constructing a peaker plant.

2. CO2 Emissions. Both fuel cell and peaker plants are assumed to run on natural gas. While peaker plants are assigned a fixed value of 117 lb/MMBtu, Lazard assigns fuel cells a range of 0 to 117 lb/MMBtu, acknowledging that CO2 emissions from a fuel cell facility will ultimately lie somewhere between the two extremes.

3. Construction Time (Months). Lazard assumes a 3-month construction period for a 2.4MW fuel cell plant and a 35-month construction period for a peaker plant. Confirming this timeline is Fuel Cell Energy's 15MW plant in Bridgeport, CT, which was designed and built within one year.[28] While constructing a fuel cell plant equivalent in size to a 103-216MW peaker plant would undoubtedly take longer, most if not all of the additional build-out associated with construction of a larger plant could occur simultaneously, keeping project completion well below the 35-month time period ascribed by Lazard for peaker plants. Thus, there is a significant public benefit in relying on fuel cells and flow batteries, each of which can be constructed on a modular basis, rather than on large gas turbines, because given the local capacity requirements created by the shutdown of the San Onofre Nuclear Power Plant ("SONGS") and numerous "once through cooling" ("OTC") facilities located throughout California, the installation of modular fuel cells and flow batteries will be able to meet that need much more quickly than gas turbines.

4. Heat Rate (Btu/KWh). Peaker plants are assigned a range of 9,000 to 10,300 Btu/KWh, while fuel cell plants operate at a much lower range of 6,600 to 7,260 Btu/KWh. Standard designs for stationary fuel cell facilities incorporate combined cooling and/or heating and power ("CCHP") features

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[28] "Fuel Cell Park Makes Polluted Plot into Clean Energy Exemplar," Hartford Courant, January 2, 2014.

that increase overall efficiency by using the heat created during the catalytic process that takes place within the fuel cell to cogenerate direct heating, cooling (through the use of absorption chillers) and/or electricity.

Q: **Could the fuel cells analyzed in the Lazard Report run on renewable hydrogen rather than on natural gas?**

A: Yes.

Q: **How would that work?**

A: Solar and other forms of renewable energy can be used to electrolyze water (including gray water byproduct from waste treatment facilities) into hydrogen as a feedstock for fuel cell plants. A hybrid power plant utilizing the combination of fuel cells properly modified to run on hydrogen, and a flow battery component able to store surplus renewable energy for dispatchability and phase and voltage regulation services, would be able to provide both baseload and peaking functions to address grid load fluctuations relying entirely on electrons generated from renewable resources. This flexible ability to transition to hydrogen is unique to fuel cell technology and is lost if conventional gas-fired technology is chosen to address grid fluctuations.

Q: **You stated that the Lazard Report excluded from its analysis a consideration of various societal benefits, which would tilt their analysis even further in favor of fuel cells over conventional gas turbines. Is there a way to take such other factors into account?**

A: Yes.

Q: **How would that be done?**

A: As noted above, the analysis in the Lazard Report does not address "long-term residual and societal consequences of various conventional generation technologies that are difficult to measure." However, the NFCRC Report aggregated the various benefits associated with fuel cell technology to calculate the additional value that can be realized by ratepayers by using fuel cells as opposed to conventional gas-fired facilities. Averaging the range of values from health benefits and avoided emissions (CO2, NOX, SOX, VOC, PM10 and PM2.5) associated with the use of fuel cells that is provided in the NFCRC Report,[29] I calculated the additional fuel cell value from these benefits and found that in a scenario with a fuel cell plant operating on natural gas and using CCHP efficiency measures during 75% of its operations, the average estimated benefit (or cost reduction) from avoided health costs and emission was $55.30/MWh. Subtracting this estimated benefit from Lazard's average LCOE of $145.50, the net cost of using fuel cells was $90.20/MWh, which is over 126% less than the $204.50/MWh average LCOE assigned to gas peaker plants in the Lazard Report.[30]

VI. OTHER ENVIRONMENTAL BENEFITS OF THE ACADEMY'S DISTRIBUTED ALTERNATIVE PROJECT

Q: Are there other economic and environmental benefits of using fuel cells and batteries as opposed to conventional gas-fired turbines?

A: There certainly are. Such benefits include the following:

a. <u>Flexibility to Further Reduce GHG Emissions Using Renewable Feedstocks (Hydrogen and Biofuels)</u>. Over its 25- to 30-year lifespan, a natural gas peaking plant will operate primarily on one type of fuel: natural gas extracted using fracking operations that emit methane (a greenhouse gas many multiples of times more potent than CO2 on initial release), consume precious water supplies and rely on a mixture of chemicals that invariably enters our

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29 NFCRC Report, at p. 4.

30 See Table B in Attachment B, attached hereto.

groundwater reserves. By contrast, developing fuel cell facilities in order to meet the needs that traditional gas turbines can provide, leaves the door open for a transition to 100% renewable fuel in the form of hydrogen produced from renewable sources and gray water or biogas generated from waste treatment facilities. Combined with CCHP co-generation from generated heat, fuel cell plants offer the highest electrical efficiency of any comparable system, resulting in more efficient fuel use and reduced carbon signature with the lowest environmental impact of any power generation system using similar fuels.

b. Modularity Creates Ability to Provide Both Baseload and Peaking Services. Capable of using natural gas, renewable biogas and (when properly modified) hydrogen feedstocks, a fuel cell plant is superior to conventional gas peaking facilities in that a fuel cell plant can be operated as a source of baseload power, or in tandem with battery facilities that can serve as phase/voltage regulators to level energy fluctuations and address peaking concerns during the late afternoon/early evening hours. Such a potent combination dramatically enhances the ability of distributed generation and storage to balance renewable generation within microgrid systems in a manner far superior to large, noisy gas turbine peaker plants that emit hazardous particulates to the surrounding community.

c. Greater Reliability and Lower Maintenance Costs. Due to the electrochemical nature of both the fuel cell and flow battery power generating process which involves fewer moving parts, a hybrid fuel cell/flow battery facility is more durable, reliable and can be maintained and operated with less oversight than traditional gas-fired facilities.

d. Modularity, Small Footprint and Quiet Acoustics of Fuel Cell and Battery Plants Allow for Both Centralized and Distributed Deployment. Unlike gas-fired facilities, whose loud acoustic signature requires either development in sparsely populated areas or limited operating hours, the compact design and extremely quiet acoustics of fuel cell and battery plants allows for siting at or near the point of use in densely populated areas. These non-intrusive characteristics allow fuel cell and battery systems to be sited and installed in a relatively short period of time, and the costs associated with long lead times for siting, permitting and construction are largely avoided. Low emissions and quiet operation also mean that fuel cell and flow battery systems can be rapidly deployed with little to no "NIMBY" opposition from the local community.

e. Co-Production of Hydrogen. Fuel Cell Plants using biogas or natural gas feedstocks emit a syngas effluent containing a hydrogen component that can be extracted and stored for re-use during off-peak generation periods (thereby further increasing fuel cell efficiencies) or sold to refueling stations as a secondary revenue stream.

Q: Coming back to the subject of carbon, are there social costs that have traditionally not been valued but that should be imputed to facilities like gas-fired peakers?

A: Yes. The Fact Sheet issued by the U.S. Environmental Protection Agency ("EPA") on the Social Cost of Carbon ("SCC") acknowledges that "[t]he SCC is meant to be a comprehensive estimate of climate change damages and includes, among other things, changes in net agricultural productivity, human health, and property damages from increased flood risk. However, it does not currently include all important damages. As noted by the IPCC Fourth Assessment Report, *it is 'very likely that [the SCC] underestimates' the damages* [emphasis added]. The models used to develop SCC estimates do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research. Nonetheless, the SCC is a useful measure to assess the benefits of CO2 reductions."[31]

Q: Given the "lack of precise information on the nature of damages," is it still possible to attempt to quantify the benefits of CO2 reduction?

A: Yes. EPA's SCC Fact Sheet does include four SCC estimates for use in regulatory analyses. Each of these estimates relies on a different set of assumptions and results in projected SCC emissions on a 5-year basis for 35 years starting in 2015 and ending in 2050. Ranging from most conservative to aggressive, these estimates are: (1) 5% Discount Rate Assumed - $12/ton for 2015, rising to $28/ton in 2050; (2) 3% Discount Rate Assumed - $39/ton for 2015[32] , rising to $79/ton in 2050; (3) 2.5% Discount Rate Assumed - $58/ton in 2015, rising to $104/ton in 2050; and (4) 95th Percentile with a 3% Discount Rate - $109/ton in 2015, rising to $235/ton in 2050.

Q: Can you explain why the carbon prices seen to date in California have been hovering at the very bottom of this range?

A: Yes. The EPA's SCC Workshops in 2011 and 2012 established this range of mostly conservative, industry-based metrics and, as indicated in carbon price data provided by the California Carbon Dashboard,[33] the "market" soon adopted the cheapest valuation offered by the EPA following their publication as indicated by the following price points for California Carbon Allowance Futures: High Price - $23.75 at 9/7/2011; End of 2011/2012/2013 - $15.50/$14.75/$12.05; and 2014 – Price ranges from $11.66 to $12.55; Current (4/6/15) - $12.63.

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31 US EPA, Fact Sheet: Social Cost of Carbon, November, 2013, at p. 1.

32 It is worth noting that the U.S. Office of Management and Budget has issued guidance recommending a CO2 price of $37/ton.

33 Climate Policy Initiative, California Carbon Dashboard.

Q: In comparing the costs of gas turbines burning natural gas, in competition with flow batteries that can store large quantities of surplus renewable energy during peak periods, and fuel cells that can accommodate hydrogen generated from renewable resources as a feedstock, what price should this Commission adopt in this proceeding to reflect the social cost of carbon?

A: When EPA established the initial metrics for SCC in 2011, the perceived pace of climate change was much more moderate, allowing for adoption of very conservative projections regarding the increase in carbon emissions. However, in the intervening years, estimates on the rate of climate change have increased drastically, and the time window for mitigation/remediation has decreased proportionately. This scientific evolution, that has consistently confirmed accelerating rates of climate change, therefore necessitates the adoption of a "worst case" pricing scenario such as the EPA's "95th Percentile" model.[34]

Employing this model, which is eminently reasonable in light of our growing realization concerning the true cost associated with climate change, it is inconceivable that the gas turbines proposed in this Application would compare favorably to fuel cells when all costs are taken into account. This result is further validated when adding the ability of fuel cells to transition to carbon-free feedstocks such as hydrogen, electrolyzed from renewable resources as California's hydrogen infrastructure is developed, as mandated under SB 1505.[35] Under these circumstances, and taking into account the inherent price volatility of a finite resource such as natural gas, it is reasonable to foresee that the cost per MWh of power generated by the proposed gas turbines could eventually be two or even three times as expensive as power generated by fuel cells using hydrogen

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34 Shindell, Drew, J., Climatic Change, "The Social Cost of Atmospheric Release," Springer Netherlands, February, 2015.

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

made from renewable resources. In a study just released this March, the Union of Concerned Scientists confirmed the existence of such a dynamic:

> "Many experts believe that low natural gas prices are not sustainable over the long term. For example, the U.S. Energy Information Administration's (EIA) Annual Energy Outlook projects that spot prices will significantly increase from the recent low point of $2.75 per MMBtu in 2012 to $6.03 per MMBtu in 2030 and $7.65 per MMBtu in 2040 (EIA 2014c). Factors that contribute to upward pressure on prices and the risk of price volatility include uncertain available supply and potentially increasing demand for natural gas from electric utilities, other competing domestic users, and exporters."[36]

It cannot be overstated that the cost of natural gas is highly volatile. In addition to the factors listed above, today's "low" gas prices are, in large measure, the direct result of the dramatic increase in domestic natural gas supplies attributable to the broad deployment of hydraulic fracturing ("fracking") processes. However, "fracking" has come under close scrutiny due to its serious potential adverse environmental impacts and, as a result, has become subjected to strenuous political opposition in many jurisdictions. New York State has already imposed serious restrictions on "fracking," and local restrictions on "fracking" have been passed in 26 states.[37] To the extent that natural gas production is negatively impacted as a result of this broad-based popular movement, natural gas prices WILL go up.

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36 Union of Concerned Scientists, "The Natural Gas Gamble: A Risky Bet on America's Clean Energy Future," March 2015, "Price Volatility," pp. 12-14, Excerpt: p. 14.

37 "Local Actions Against Fracking – Passed Measures," Food and Water Watch, 2015.

Q: How does the issue of risk play into how the Commission should consider the social cost of carbon in this case?

A: This question has been addressed by a number of eminent scholars. The most enlightening discussion of the relationship of risk to the SCC is by Dr. Mark Trexler, a well-known expert on climate change mitigation who currently "specializes in corporate perceptions of climate change risk and how they respond to the uncertainties surrounding climate change and climate policy."[38] Dr. Trexler opined as follows:

> "The topic of risk is critical, and this is where inconsistencies in how we think about SCC risk and other risks become most obvious. Offshore oil platforms in the North Atlantic are NOT designed to have a 50% chance of withstanding ocean conditions for the next 100 years; instead, they are designed to withstand one-in-10,000 year events. At a more personal level, virtually all of us buy fire insurance for our homes. On average, however, very few of our houses will burn down (the probability is so low as to be roundable to zero). So when we think about risk we're not thinking about 'averages.' When the OMB uses an "average" SCC value of $35/ton, it's being risk-neutral, not risk-averse. If we want to address climate change, wouldn't we want to implement an SCC value that would have more than a 50% chance of getting it right? Based on the OMB's own updated SCC estimates, selecting an SCC with a 95% chance of getting it right would mean a $90 SCC today, growing to more than $200 in 2050. That's a game changer by

[38] Climatographer's Blog, About Mark C. Trexler.

anyone's measure, and many observers would argue even that figure is too low due to inadequately quantified climate risks."[39]

Q: Based on the foregoing analysis, what conclusions should the Commission draw?

A: The Lazard Report confirms that the average LCOE from a fuel cell plant on an unsubsidized basis is $145.50, or 28.85% less than the average LCOE of $204.50 to build a natural gas peaking plant. When average benefits of avoided health costs and emissions are included, the savings for adopting fuel cell technology over a gas peaking plant increases to 55.89%, for a net LCOE of $90.20/MWh.

On a megawatt-hour basis, the calculated average CO2 emissions in the NFCRC Report equals $12.95, a figure slightly above the most conservative SCC model offered by the EPA using a risk-neutral cost-benefit analysis. However, the EPA has admitted in its own Fact Sheet that the current cost-benefit model for calculating SCC underestimates the true costs of CO2. Thus, a model needs to be adopted that incorporates society's aversion to the risks posed by climate change and its willingness to accept higher CO2 costs to produce a certainty of significant GHG reductions.

Currently, the "95th Percentile" model incorporating a 3% discount rate mostly closely matches that need. This model places a much higher value on avoided CO2 emissions than previously used, and will inevitably drive the comparative net LCOE for fuel cells and flow batteries, on an MWh basis, to a point that is dramatically lower than the anticipated cost per MWh from the gas turbines proposed in this Application.

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[39] Trexler, Mark, "What's Missing From the OMB's New Social Cost of Carbon? Risk Aversion," Climatographers, June 20, 2013. See also, Kaufman, Noah, "Why is Risk Aversion Unaccounted for in Environmental Policy Evaluations?," NERA Economic Consulting, July 9, 2014.

Q: Are there additional steps that the Commission should take to explore the viability of promising clean energy technologies such as fuel cells?

A: Yes. I believe that there is ample time available for the Commission to conduct an comprehensive comparative study of fuel cells and flow batteries as flexible, adaptable technologies that can operate at a level of performance equivalent or superior to natural gas peaker plants, while also retaining the ability to fully integrate with a new, distributed carbon-free energy system based primarily on renewable energy.

Although the World Business Academy does not expect the Commission to conduct a holistic study of the relative "big picture" economics of fuel cells and batteries versus traditional gas-fired resources in the context of this proceeding, the Academy does urge the Commission to conduct or commission such a study in the near future, either as part of the Commission's Long-Term Procurement Planning process or as part of a larger inter-agency effort to address California's clean energy goals. With such a study in hand, the Commission will be in a much stronger position to direct its jurisdictional utilities to put an end to the ongoing, environmentally harmful practice of proposing the construction of new fossil-fired plants to meet system needs for local capacity and instead look for combinations of preferred resources to facilitate the integration of ever-increasing amounts of variable renewable generation.

Furthermore, substituting fuel cells and batteries for conventional gas turbines will ultimately create a distinct pathway for the development of a renewable hydrogen economy, and creates additional demand for “green” hydrogen in tandem with the emerging market for fuel cell electric cars ("FCEVs") currently under development in California. As a secondary FCEV market develops in California, the sale of renewable hydrogen to refueling stations (as mandated by

SB 1505 to equal one-third of all hydrogen produced for that purpose[40]) will increase demand and build economies of scale that will lower the cost of hydrogen. As the price of hydrogen becomes more affordable, fuel cell plants can incrementally transition to 100% carbon-free operation.

If the Commission allows the proposed peaker facilities to move forward without serious consideration of alternative technologies that are environmentally superior in all respects and that will ultimately be a better deal for ratepayers, it will have sentenced Ellwood and Oxnard citizens to at least 20 years of living next to large, noisy, highly visible centralized plants that have no prospects for significantly reducing carbon and particulate emissions during its useful lifespan.

The Commission therefore needs to recognize that by choosing fuel cell technology and various Preferred Resources to meet the identified LCR need, it will dramatically enhance the ability of the citizens living within the Moorpark Sub-Area to locate distributed power generated by quiet fuel cell and battery plants, housed in unobtrusive structures arranged in a wide variety of configurations that maximize energy reliability and resilience while also yielding these facilities virtually invisible to the surrounding community.

Moreover, such a choice will significantly expand the flexibility of SCE to meet its local reliability needs in a much more flexible manner than would be the case if it is forced to rely for 20+ years of traditional gas peakers. Rather, by strategically distributing some or all of the power infrastructure, which a switch to fuel cells and batteries to meet the identified LCR need will facilitate, SCE and its PPTA partner will greatly enhance the resilience and reliability of the

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

local power grid while taking up the historic mantle of leading the state to the renewable energy economy of the future.

Q: Does this conclude your prepared testimony?

A: Yes, it does.

ATTACHMENT A

CURRICULUM VITAE OF ROBERT PERRY DIRECTOR OF ENERGY RESEARCH OF THE WORLD BUSINESS ACADEMY

Robert Perry

Professional Expertise:

Mr. Perry currently serves as the Director of Energy Research for the World Business Academy, a non-profit business think tank, action incubator and network of business and thought leaders, whose mission is to inspire business to assume responsibility for the whole of society and assist those in business who share our values.

As Director of Energy Research, Mr. Perry is the primary source for research and analytical support services in connection with the Academy's Safe Energy Project, whose objectives are to (1) rid the state of California of nuclear power plants, (2) stand up for ratepayers' interests in proceedings before the California Public Utilities Commission and (3) to introduce and champion a plan for the conversion to 100% renewable energy in California called The Clean Energy "Moonshot" Project, to create a replicable renewable energy model for the world.

In his capacity as Director of Energy Research, Mr. Perry performs a wide range of general, technical and financial research and analysis concerning issues underlying all aspects of the Safe Energy Project, including but not limited to current and emerging energy generation, transmission and distribution, microgrid, and storage systems as they relate to the development of an integrated system of distributed energy capable of operating entirely on renewable energy, either directly or indirectly through a storage medium such as hydrogen.

Prior to his tenure at the World Business Academy, Mr. Perry served as the Executive Assistant to the CEO of Ameristar Casinos, a publicly-held company operating a chain of regional casinos. As Executive Assistant, Mr. Perry performed a wide range of analytical functions, including but not limited to preparation of annual regulatory filings with state gaming authorities, distribution of a daily report summarizing industry media and financial analysis, review and analysis of internal financial reports and periodic securities filings, and weekly audit control analysis reports.

Prior to serving at Ameristar, Mr. Perry worked for 20 years with a variety of law firms as a corporate, securities and real estate legal assistant. During that time, Mr. Perry performed due diligence research and drafted primary and ancillary documents relating to wide range of business transactions (mergers and acquisitions, real estate portfolio development and management, venture capital financings and initial/secondary private and public offerings). A subset of these skills also included the preparation and review of budgetary reports, projections, market analyses and investment materials, including all relevant compliance documentation required on state and federal levels.

Education:

Paralegal Certification in Corporate, Securities and Real Estate Specialties, University of San Diego, 1983

Bachelor of Arts Degree in Liberal Studies, with emphases in History, Music and Political Science, University of California, Santa Barbara, 1983

ATTACHMENT B

TABLES

TABLE A

LCOE COST VARIANCES USING LAZARD / NFCRC DATA

	Unsubsidized LCOE			% Variance (Cost Reduction v. Add'l Cost)		
	Low	High	Ave.	Fuel Cell	Adj. Fuel Cell	Gas Peaking
Fuel Cell	115.00	176.00	145.50	0.00%	-61.31%	**28.85%**
Fuel Cell (Adjusted)*	89.30	91.10	90.20	38.01%	0.00%	**55.89%**
Gas Peaking	179.00	230.00	204.50	-40.55%	**-126.72%**	0.00%

* Avoided Health Cost / Emissions from 100% NG / 75% CCHP Operations per NFCRC Report

TABLE B

COST REDUCTIONS FOR HEALTH BENEFITS AND AVOIDED EMISSIONS

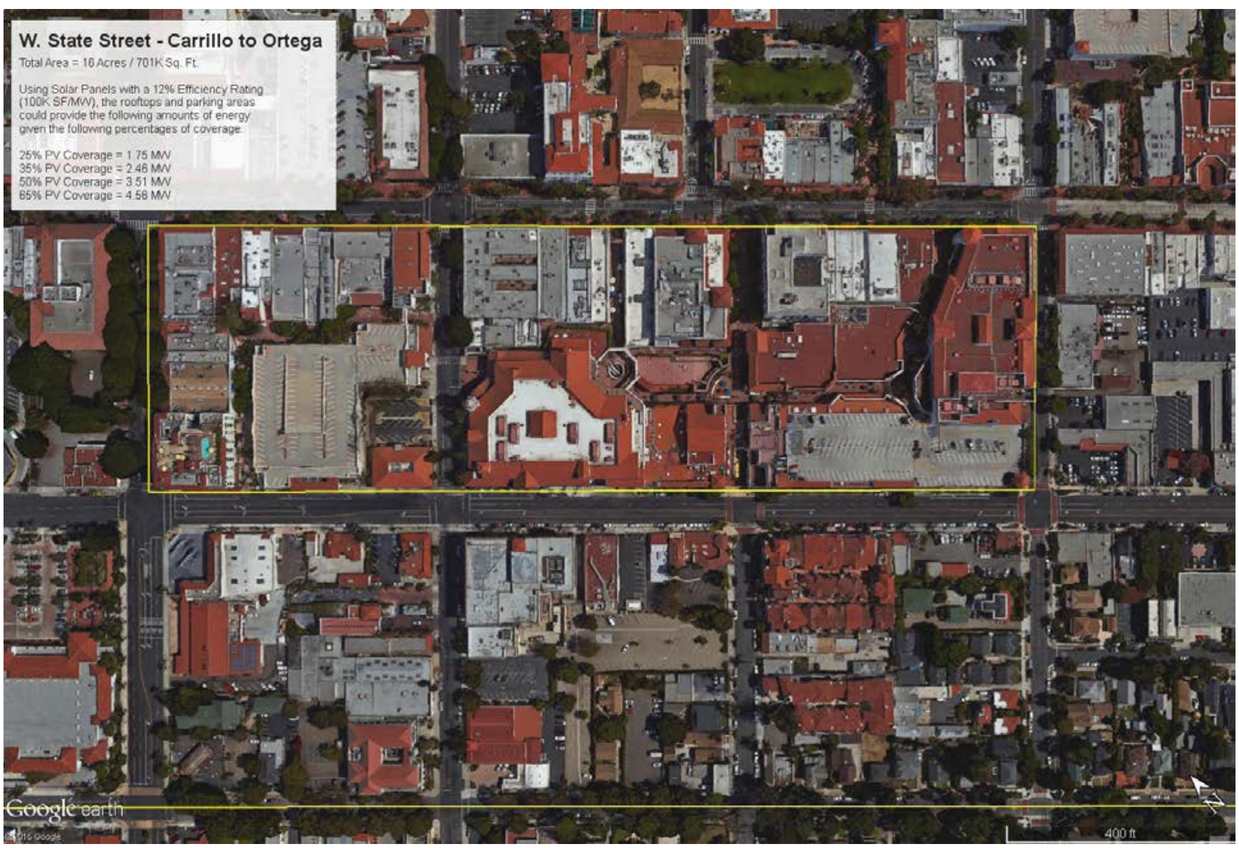
	Low	High	Ave.
Fuel Cell Unsubsidized LCOE ($/MWh)	**$115.00**	**$176.00**	**$145.50**
(Per Lazard Report)			
	Operational Assumptions:		
NFCRC Benefit Calculations	**100% NG / 75% CCHP**		
Health Benefits	2.14	2.18	2.16
Avoided CO2 Emissions	0.16	2.43	1.30
Avoided Other Emissions	0.27	3.88	2.08
Total (₵/KWh)	2.57	8.49	5.53
Converted to:			
Total ($/MWh*)	**$25.70**	**$84.90**	**$55.30**
Adjusted Unsubsidized LCOE ($/MWh)	**$89.30**	**$91.10**	**$90.20**

* = (₵/KWh x 1000 KWh/MWh) ÷ 100 ₵/$

ATTACHMENT C

AERIAL PHOTOS AND ESTIMATES REGARDING SOLAR PV CAPACITY


SB CIR (Comm./Ind./Retail) Area
Total Area = 800+ Acres / ~35M Sq. Ft.
Assuming 50% of TA (Rooftops and Parking Lots)
is Available for PV Installations of Solar Panels
(12% Efficiency Rating - 100K SF/MW), the SBCIR
area indicated could provide the following amounts
of energy given the following percentages of coverage:
25% PV Coverage = 43.67 MW
35% PV Coverage = 61.14 MW
50% PV Coverage = 87.35 MW
65% PV Coverage = 113.55 MW
SB Substation
Santa Barbara
SB Desal Plant
Google earth
N
2000 ft


W. State Street - Carrillo to Ortega
Total Area = 16 Acres / 701K Sq. Ft.
Using Solar Panels with a 12% Efficiency Rating
(100K SF/MW), the rooftops and parking areas
could provide the following amounts of energy
given the following percentages of coverage:
25% PV Coverage = 1.75 MW
35% PV Coverage = 2.46 MW
50% PV Coverage = 3.51 MW
65% PV Coverage = 4.56 MW
Google earth
400 ft

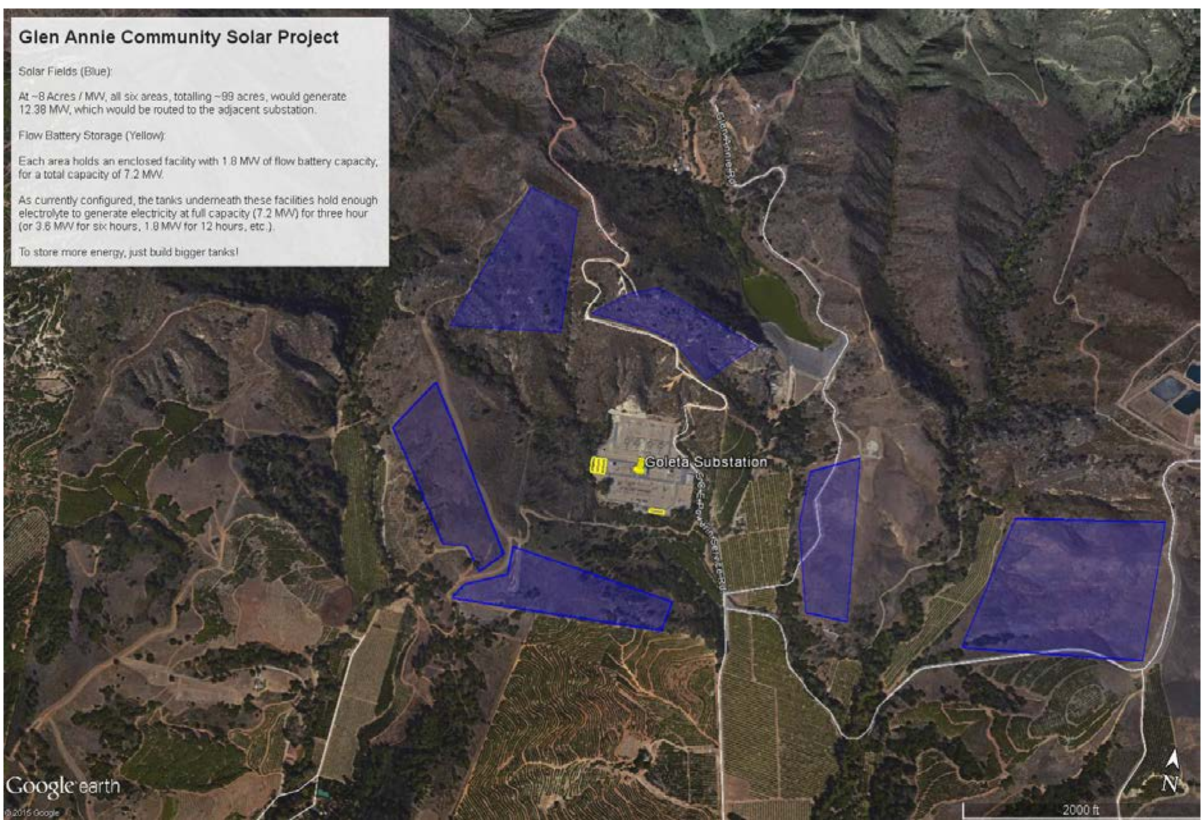

Camino Real Marketplace
Total Area = 41 Acres / 1.791M Sq. Ft.
Total Rooftop Area = 486,531 Sq. Ft.
Using Solar Panels with a 12% Efficiency Rating (100K SF/MW), the rooftop could provide the following amounts of energy given the following percentages of coverage:
25% PV Coverage = 1.22 MW
35% PV Coverage = 1.70 MW
50% PV Coverage = 2.43 MW
65% PV Coverage = 3.16 MW
Solar PV on Costco Building (lower left) is rated at 554 KW.
If 50% of the entire area (rooftops and parking areas) were covered with solar panels, the complex could generate 8.95 MW!
Legend
Camino Real Marketplace
Feature 1
Hollister Ave
Cross Town Route
Santa Felicia Dr
Los Ninos
Davenport Rd
Georgetown Rd
Phelps Rd
Google earth
N
800 ft


USPS Distribution Center
Total Site Area = 14.5 Acres / 629,738 Sq. Ft.
Total Rooftop Area = 233,856 Sq. Ft.
Using Solar Panels with a 12% Efficiency Rating (100K SF/MW), the rooftop could provide the following amounts of energy given the following percentages of coverage:
25% PV Coverage = 0.58 MW / 580 KW
35% PV Coverage = 0.82 MW / 820 KW
50% PV Coverage = 1.17 MW
65% PV Coverage = 1.52 MW
If 50% of the entire area (rooftops and parking areas) were covered with solar panels, the complex could generate 3.15 MW!
Google earth
N
400 ft

ATTACHMENT D

AERIAL PHOTOS AND ESTIMATES REGARDING POTENTIAL COMMUNITY SOLAR PROJECTS


San Marcos Community Solar Project
Solar Fields (Red):
At ~8 Acres / MW, the largest area (top) is 65 Acres, or 8.13 MW. If all five areas were developed, they would generate 12.7 MW, which would be routed to the adjacent substation (lower right).
Flow Battery Storage (Yellow):
Each area holds an enclosed facility with 1.8 MW of flow battery capacity.
As currently configured, the tanks underneath these facilities hold enough electrolyte to generate electricity at full capacity (1.8 MW) for three hour (or .9 MW for six hours, etc.).
To store more energy, just build bigger tanks!
San Marcos Substatio
Google earth
1000 ft
N


Glen Annie Community Solar Project
Solar Fields (Blue):
At ~8 Acres / MW, all six areas, totalling ~99 acres, would generate 12.38 MW, which would be routed to the adjacent substation.
Flow Battery Storage (Yellow):
Each area holds an enclosed facility with 1.8 MW of flow battery capacity, for a total capacity of 7.2 MW.
As currently configured, the tanks underneath these facilities hold enough electrolyte to generate electricity at full capacity (7.2 MW) for three hour (or 3.6 MW for six hours, 1.8 MW for 12 hours, etc.).
To store more energy, just build bigger tanks!
Goleta Substation
Google earth
2000 ft
N