Rulemaking No.: 20-11-003

Exhibit No.: CEERT-01

Witness: James H. Caldwell, Jr.

Commissioner Marybel Batjer

ALJ Brian Stevens

OPENING PREPARED TESTIMONY OF THE CENTER FOR ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGIES

Rulemaking 20-11-003
2021 Extreme Weather Event Reliable Electric Service

January 11, 2021

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OPENING PREPARED TESTIMONY OF
CENTER FOR ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGIES

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I.
EXECUTIVE SUMMARY

The Center for Energy Efficiency and Renewable Technologies (CEERT) is a nonprofit public-benefit organization founded in 1990 and based in Sacramento, California. CEERT is a partnership of major private-sector clean energy companies, environmental organizations, public health groups and environmental justice organizations. CEERT designs and fights for policies that promote global warming solutions and increased reliance on clean, renewable energy sources for California and the West. CEERT is working toward building a new energy economy, including cutting contributions to global warming and reducing dependence on fossil fuels. CEERT has long advocated before the Commission for increased use of preferred resources and for California to move towards a clean energy future.

Rulemaking (R.) 20-11-003 is the Order Instituting Rulemaking (OIR) to Establish Policies, Processes, and Rules to Ensure Reliable Electric Service in California in the Event of an Extreme Weather Event in 2021. On December 18, 2020, Administrative Law Judge (ALJ) Stevens issued a Ruling Introducing a Staff Report and Questions to the Record and Seeking Responses from Parties in Opening and Reply Testimonies (December 18 ALJ Ruling). On December 21, 2020, Assigned Commissioner Batjer issued an Assigned Commissioner's Scoping Memo and Ruling (Scoping Memo). On December 28, 2020, President Batjer released a Ruling Directing the State's Three Large Electric Investor-Owned Utilities to Seek Contracts for Additional Power Capacity to be Available by the Summer of 2021 or 2022 (December 28 Ruling). On January 8, 2021, a Proposed Decision was issued that mirrors the directives in that December 28 Ruling.

By this Testimony, Exhibit (Ex.) CEERT-01, CEERT provides its response to the December 18 ALJ Ruling and issues identified in the Scoping Memo. Specifically, CEERT opposes any new investment in the gas fleet, including any "expansion of gas-

fired generation assets."[1] Clean resources, such as solar + storage hybrids, demand response (DR), and behind-the-meter (BTM) distributed energy resources (DERs) must be considered and procured in this proceeding. These resources are essential to ensuring reliability for Summer 2021, as has already been confirmed by the Preliminary Root Cause Analysis related to the power outages caused by the August 2020 heat storm, while maintaining the State's commitment and goals set for the transition to carbon-free energy resources.

As such, CEERT recommends the following:

1. The Commission should focus on least-regrets solutions to maintain reliability in Summer 2021, including procurement of available clean energy resources and demand-side solutions. Any last resort incremental investment in gas must be restricted to short-term contract only.

2. The Commission should ensure the mitigation measures taken to increase reliability in Summer of 2021 are equivalent solutions to the causes of the August 2020 outages, as outlined in the Preliminary Root Cause Analysis.

3. While the focus is clearly on resources that can be on-line by early Summer 2021, the Commission should recognize that there is equal or greater urgency to procure clean resources that can be on line for the Fall of 2021 and Summer 2022.[2]

II.
CEERT RESPONSE TO SCOPING MEMO ISSUES

Issue 1(a) in the Scoping Memo addresses "[e]xpedited procurement that could be online by summer 2021 and 2022, including the expansion of gas-fired generation

[1] Scoping Memo, at p. 2.

[2] While it is common to point out that net peak load is moving to later in the day, it is less common to note that is also movint to later in the year. Thus, October heat storms coinciding with reduced seasonal solar output represent a growing stress period that is not recognized in current monthly RA showing requirement.

assets."[3] The December 28 Ruling sets this initiative in motion. Furthermore, President Batjer designated the December 28 Ruling as "essentially an extension of…D.19-11-016….[in which] the Commission directed [LSEs] to procure 3,300 megawatts of incremental capacity at a minimum as a 'least regrets' strategy."[4] This directive has now been embedded in a Proposed Decision issued in this proceeding on January 8, 2021, and scheduled for a vote by the Commission as soon as February 11, 2021.[5]

CEERT agrees that there is a need for additional capacity. This fact is supported by the emergency procurement order for 3,300 megawatts (MW) of incremental resources *at minimum* in D.19-11-016.[6] However, the Commission must ensure that resulting procurement is in the best interest of the people of California and the environment. This is particularly important where D.19-11-016 did not model the extreme weather event of August 2020 or for any forecasted period after that.

Nevertheless, D.19-11-016 frames the emergency procurement order with the following sentiment:

> "The Commission's concern is to ensure safe and reliable electric service, in a manner that keeps the electricity sector on a path to the 2030 greenhouse gas (GHG) emissions goals articulated in Senate Bill (SB) 350 (DeLeón, 2015), SB 100 (DeLeón, 2018), and Commission Decision (D.) 18-02-018. The electricity resources required in this decision are necessary to continue to integrate the growing amount of renewable energy delivering to the electric grid."[7]

Furthermore, D.19-11-016 takes a technology-neutral approach to resource procurement type.[8] While it includes retrofitted existing natural gas as an eligible resource type, the decision also states that the Commission "[anticipates] <u>that hybrid generation and storage projects</u> will fare well in competitive solicitations for system reliability resources and should be strongly considered (emphasis added)".[9]

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[3] Scoping Memo, at p. 2.
[4] December 28 Ruling, at p. 3. D.19-11-016 is the Decision Requiring Electric System Reliability Procurement for 2021-2023 issued in R.16-02-007 (Integrated Resource Planning (IRP)) on November 7, 2019.
[5] Proposed Decision, at pp. 10, 14.
[6] D.19-11-016, at p. 3.
[7] *Id.*, at p. 2.
[8] *Id.*, at p. 44.
[9] *Id.*; emphasis added.

In this regard, December 28 Ruling and now the Proposed Decision rely on D.19-11-016 as authority for ordering IOUs to procure gas-fired generation. And, while both directives call for incremental energy storage capacity and upgrades to natural gas plants, both, in conflict with D.19-11-016, completely exclude hybrid resources, other distributed energy resources (DERs), and demand response (DR) eligible under D.19-11-016 from procurement consideration.[10]

The reasoning behind this rigid resource type selectivity adopted in the December 28 Ruling and Proposed Decision remains profoundly unclear. Almost 3 GW of active hybrid or co-located solar + storage project interconnection requests with online dates in 2021 sit in the CAISO interconnection queue.[11] Furthermore, an additional 7 GW of hybrid or co-located solar + storage projects with online dates in 2022 also sit in the CAISO interconnection queue.[12] These resources, appropriately configured, are dispatchable at full capacity through net peak hours after sunset in the summer.[13] In addition, they optimize scarce transmission capacity for full deliverability and do not contribute to extreme ramping conditions in lower demand hours.[14] In addition to other clean non-fossil DERs and DR, they are more than capable of providing necessary near term incremental capacity. Thus, it is prudent that the Commission lift the procurement restrictions to allow for the competitive solicitation of all resources that have the potential to meet reliability needs in Summer of 2021 and beyond and immediately alter the December 28 Ruling and Proposed Decision to do so.

Put simply, the extension of gas-fired generation, especially pursuant to long-term contracts, is *not* an appropriate solution to the issues outlined in the Preliminary Root Cause Analysis of the Mid-August 2020 Heat Storms, and nothing in D.19-11-016 authorizes procurement by IOUs restricted to gas-fired generation to meet an event it never considered nor was it part of the modeling record on which that decision relied. The facts and responses before the Commission today to support any procurement in

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[10] December 18 Ruling, at p. 4.
[11] California ISO Controlled Grid Generation Queue for All: Active which can be found at https://rimspub.caiso.com/rims5/logon.do# and http://www.caiso.com/PublishedDocuments/PublicQueueReport.pdf as of January 11, 2021. (This document is updated daily).
[12] *Id.*
[13] *See*, R.19-11-009 (RA) CEERT Revised Track 3B.2 Proposal (December 18, 2020).
[14] *Id.*

response to a potential extreme weather event in 2021 can only be based on the Preliminary Root Cause Analysis undertaken in response to the August 2020 extreme weather events. In that regard, the Preliminary Root Cause Analysis outlines three factors that contributed to rotating outages on August 14 and 15, 2020: demand exceeding the existing resource planning targets, lack of sufficient resources to meet net peak demand, and some practices in the day-ahead energy market that exacerbated the supply challenges.[15]

While these interwoven factors contributed to the reliability challenges last August, the Preliminary Root Cause Analysis does *not* identify extended natural gas generation as a near-term solution. In fact, in its near-term recommendations to bring additional resources online, the Preliminary Root Cause Analysis only identifies a single specific resource category:

> "[additional resource development]…will <u>most likely focus on 'demand side' resources such as demand response</u> and, as possible, the acceleration of online dates of resources under development but not scheduled to be online by summer 2021. This can complement the resources that are already under construction (emphasis added)."[16]

Furthermore, the natural gas fleet's performance during the heat storm in isolation does not warrant such exclusive focus on additional procurement from these resources apart from other viable resource options. In fact, on August 14th the natural gas fleet

> "…collectively experienced 1,400 MW to 2,000 MW of forced outages (i.e., derating or lowering the resource's available capacity) largely attributed to the extreme heat, and day-of outages. Additionally, almost 400 MW of planned outages had not been substituted."[17]

The August 2020 west wide heat storm was an extreme weather event that no single resource type could have prevented. Rather, California's resource mix at the time as a whole, factoring in exports and decreased accessibility to imports, fell short of filling unexpected generation gaps caused by the extreme heat. Thus, the solution of retrofitting gas plants does not directly address the underlying problem presented in the Preliminary Root Cause Analysis: inadequate planning targets and processes. With

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[15] Preliminary Root Cause Analysis of the Mid-August 2020 Heat Storms, October 6, 2020, at pp. 3-4.
[16] *Id*., at p. 65.
[17] *Id*., at p. 8.

climate change making extreme weather events all the more frequent, CEERT urges the Commission to take a step back and determine the true "least regrets" strategy to increase reliability in Summer 2021.[18]

Investment in the gas fleet is not only not supported by either D.19-11-016 or the Preliminary Root Cause Analysis, but it also directly conflicts with a "least regrets" strategy, as increased dependence the gas fleet will likely exacerbate reliability issues while locking California into fossil fuel generation for the foreseeable future. CAISO's analysis in its Resource Adequacy (RA) Enhancements Initiative Draft Final Proposal and Sixth Revised Straw Proposal demonstrates that accounting for forced outages in the net qualifying capacity (NQC) of the natural gas fleet results in a 12.5% average reduction in NQC.[19] Many high load hours over the last three years have seen gas forced outage rates over 20%[20] This data reveals the discrepancy between theoretical reliability and actual reliability of the natural gas fleet. Mitigating this lack of performance will consume the bulk of the 3,300 MW of procurement authorized by D.19-11-016. Thus, increased gas procurement is not the best "least regrets" solution and will likely magnify California's reliability issues.

In addition, increased reliance on the aging gas system is ultimately antagonistic to the best interests of California ratepayers in both cost and public health. As California continues along its clean energy transition, develops a more diverse resource portfolio, and prices for renewable energy continue to fall, the need for natural gas resources will continue to decrease over time. Seeing as incremental natural gas generation must be a long-term investment to be even remotely cost-effective,[21] the burden of the cost from these stranded investments will ultimately fall on ratepayer's shoulders.

[18] December 28 Ruling, at p. 3.
[19] Day 1 Presentation: RA Enhancements Draft Final Proposal and Sixth Revised Straw Proposal. CAISO January 5, 2021
[20] *Id.*
[21] *See, e.g.,* Southern California Edison Market Announcement for Bilateral Contracting for Summer 2021 0r 2022 Capacity, December 30, 2020. The attached term sheet contemplates contract terms of 10, 15 or 20 yrs.

III.
CEERT RESPONSES TO THE DECEMBER 18 ALJ'S RULING

Attachment 1 to the December 18 ALJ Ruling divides the Guidance to Parties for their January 2021 Proposals into five topic areas: Critical Peak Pricing (CPP) design, marketing, and expansion to non-investor-owned utility (IOU) load serving entities (LSEs); New Emergency Load Reduction Program (ELRP); Changes to existing IOU demand response (DR) programs; Expedited Integrated Resources Plans (IRP) procurement; and Expanding electric vehicle (EV) participation in DR programs.[22] CEERT has focused on issues related to Expedited IRP Procurement in this Testimony.

CEERT supports expediting IRP procurement of clean resources for Summer 2021 and fully supports timely procurement of clean resources for Summers 2022 and 2023. However, CEERT seeks clarification in how this procurement initiative will interface with the ongoing IRP process, including D.19-11-016 and the LSEs' IRP filings from September 2020. Specifically, CEERT seeks clarification as to whether this procurement initiative is complementary to or a replacement of the upcoming Procurement Track in the Spring 2021 IRP process. In either case, CEERT maintains that, as proposed extensions of D.19-11-016, any expedited procurement initiatives in this proceeding must fully align with the provisions of that decision rather than carving out natural gas procurement as the preferred solution without reason. As stated in Section II, D.19-11-016 does not serve as support for the Commission in this proceeding to selectively consider and prioritize IOU procurement of gas-fired generation as a response to the potential of another extreme weather event in Summer 2021 or Summers 2022 or 2023.

IV.
CONCLUSION

CEERT urges the Commission to re-evaluate and align proposed reliability solutions to the causes of California's rolling blackouts in August 2020. Long-term gas contracts are not a "least regrets" solution, are not required or supported by D.19-11-061, and are not aligned with the issues and possible solutions outlined in the Preliminary Root Cause Analysis. Furthermore, increased dependence on natural gas

[22] December 18 ALJ Ruling, Attachment 1, at p. 1.

will only increase air quality issues and increase ratepayer costs without successfully resolving reliability issues. CEERT recognizes that overarching changes to planning processes and metrics will not materialize before Summer 2021. However, CEERT urges the Commission to reassess true least regrets strategies and take necessary interim approaches to facilitate the procurement of clean demand-side resources, as called for in the Preliminary Root Cause Analysis, to the greatest extent before committing California to additional fossil fuel generation for the next decade.

APPENDIX A

STATEMENT OF QUALIFICATIONS

James H. Caldwell, Jr.

STATEMENT OF QUALIFICATIONS OF JAMES H. CALDWELL, JR.

Q1 *Please state your name and business address.*

A1 My name is James H. Caldwell, Jr., and my business address is 1650 E. Napa Street, Sonoma, CA 95476. The offices of the Center for Energy Efficiency and Renewable Technologies (CEERT) are located at 1100 11th Street, Suite 311, Sacramento, CA 95814.

Q2 *Briefly describe your present employment.*

A2 I am an independent consultant who specializes in renewable resources and transmission policy. My current clients include CEERT and several renewable developers interested in the California. My detailed resume is attached.

Q3 *Please summarize your professional and educational background.*

A3 My academic and professional background includes over fifty years of experience in the energy industry. For the past thirty years, I have specialized in renewable technology and project development including photovoltaic solar, concentrating solar thermal power, wind, biomass, and geothermal. I have been employed in technical and executive positions in the oil industry (Atlantic Richfield), the California utility industry (Los Angeles Department of Water and Power), the US Department of Energy, renewable trade associations, and several large and small renewable resource developers. I have a BS degree in Chemical Engineering from Stanford University and an MBA from California State University at Long Beach. My detailed resume is attached.

Q4 *Have you previously testified on behalf of CEERT, before the California Public Utilities Commission?*

A4 Yes. I have testified multiple times before the Commission over the last 25 years on topics ranging from energy resource planning and policy to procurement. Most recently, I testified on behalf of CEERT in A.20-04-013 (Pacific Gas and Electric Company Application for Approval of the Oakland Clean Energy Initiative (OCEI); A.19-04-016 (Southern California Edison Company (SCE Application for

Approval of the Results of its 2018 Local Capacity Requirements Request for Proposal); A.16-08-006 (PG&E Diablo Canyon); Tracks 1 (Local Reliability) and 4 (San Onofre Nuclear Generating Station (SONGS) of the Commission's Long-Term Procurement Plan (LTPP) Rulemaking (R.12-03-014); and Track 2 of the Resource Adequacy (RA) Rulemaking (R.17-09-020).

Q5 *What is the purpose of your testimony?*

A5 The purpose of my testimony is to sponsor Exhibit CEERT-01, the Opening Prepared Testimony of the Center for Energy Efficiency and Renewable Technologies (CEERT) in R.20-11-003 (Extreme Weather).

Q6 *Was Exhibit CEERT-01 prepared by you or under your supervision?*

A6 Yes.

Q7 *Are the statements made in your testimony true and correct to the best of your knowledge and belief?*

A7 Yes.

Q8 *To the extent that Exhibit CEERT-01 contains expressions of opinion, do they represent your best professional judgment?*

A8 Yes.

Q9 *Do you adopt Exhibit CEERT-1 as your sworn testimony in R.20-11-003 (Extreme Weather)?*

A9 Yes.

Q8 *Does this conclude your statement of qualifications?*

A8 Yes, it does.

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James Caldwell is a renowned energy professional with fifty years of experience in virtually all phases of energy production and public policy. He has Chemical Engineering and MBA degrees with an extensive plant operations and construction management background, as well as hands on corporate planning and finance experience. He has managed large organizations, been an officer of a Fortune 100 company, and started his own business. Relevant experience is as follows:

PRIVATE CONSULTING (October 2010 to Present)
For the past six years, Mr. Caldwell has used his expertise to leverage the achievement of California's goal for producing a large majority of its electricity from renewable resources with an interim goal of 33% of electric demand by 2020 while maximizing development of in-state renewable resources, managing customer bills through cost control of renewable development and grid integration, improving energy efficiency, and actively involving consumers through what is known as Demand Response. He serves as Senior Advisor for the Center for Energy Efficiency and Renewable Technologies (CEERT) in advocating this long term policy and near-term actions to achieve defined milestones before the California Public Utilities Commission, the California Energy Commission, the California Independent System Operator, the Legislature, Governor's Office, and other state and local government agencies. He also advises a number of renewable development companies on specific project matters typically involving grid interconnection, transmission and wholesale market issues.

SOLAR MILLENNIUM, LLC (February 2010 to October 2010)
Mr. Caldwell was an executive consultant to Solar Trust of America, a German owned manufacturer/developer of solar thermal technology, assisting them in permitting and interconnecting 2250 MW of solar projects in California and Nevada. He devised a transmission strategy to interconnect 1500 MW of these projects to the CAISO grid with over 90% of the required transmission upgrades funded by the interconnecting utility rather than the project developer. This strategy required two policy changes by the CAISO and favorable FERC and CPUC rulings.

He also functioned as President of Solar Millennium, LLC (the development arm of Solar Trust of America) in charge of permitting before the California Energy Commission and the Bureau of Land Management. This strategy resulted in receiving both State and Federal authorization to commence construction on 1500 MW of new solar thermal facilities covering more than 11,000 acres in the Eastern Mojave Desert. Formal agreements to support the projects were reached not only with State and Federal regulatory agencies, but also with Riverside County, Native American Tribes, labor unions, and five national and regional environmental groups.

LOS ANGELES DEPARTMENT OF WATER AND POWER (December 2006 to October 2009)
Mr. Caldwell joined the Los Angeles Department of Water and Power as a full time executive consultant reporting to the General Manager and the Board of Water and Power Commissioners. In March 2008, he was appointed Assistant General Manager of LADWP for Environmental Affairs. He resigned from that position in October 2009. He managed corporate environmental affairs and advised the Department on its Power Integrated Resource Plan to dramatically increase the use of renewable energy, eliminate reliance on coal, engage the customer base in energy efficiency and clean distributed generation, and improve the efficiency and flexibility of the Department's natural gas generation. He also advised the Department on

its Water Integrated Resource Plan to generate all new water resources for the City of Los Angeles from recycling and storm water capture while significantly reducing per capita water consumption. In addition to the Corporate Planning role for both the Water and the Power System Integrated Resource Plans, Mr. Caldwell had line responsibility for siting, permitting and obtaining California Environmental Quality Act approvals for the projects that made up the Department's Integrated Resource Plans. He also designed and implemented new City Planning ordinances for water conservation, customer based renewable energy development (called a "Feed In Tariff"), and low impact development.

PPM ENERGY (June 2004 to December 2006)
Mr. Caldwell joined PPM Energy (now Iberdrola Renewable Energy) as Director of Renewable Policy. At PPM, he was responsible for regulatory affairs, transmission policy, and wholesale market structure issues nationwide, and legislative affairs in California. PPM Energy has a wind project development pipeline of over 10,000 MW spread throughout the country. Mr. Caldwell was responsible for ensuring that state legislation, transmission tariffs, market rules, and transmission expansion projects are in place to facilitate the build-out of that pipeline. Much of this effort focused on implementation of ambitious Renewable Portfolio Standard programs in California, Colorado, Minnesota, New York, Iowa, and Texas.

AMERICAN WIND ENERGY ASSOCIATION (May 2001 to May 2004)
As Policy Director, Mr. Caldwell was responsible for AWEA's Transmission Initiative to integrate wind into the nation's wholesale electricity market structure and create regional grids capable of moving significant amounts of wind energy from resource rich areas to load centers. He led the wind industry effort at the Federal Energy Regulatory Commission to adopt balanced national market rules to facilitate entry of this unique technology into wholesale electricity markets while ensuring grid reliability and avoiding subsidies to wind and/or cost shifting onto other technologies and market participants. This effort led to a series of FERC Orders and adoption of innovative market rules at, for example, the Bonneville Power Administration, the California Independent System Operator, the Midwest Independent System Operator, the PJM Independent System Operator, ERCOT (Texas), the New York Independent System Operator, and the Western Area Power Administration. He advised AWEA's Legislative and Communications staff on all technical matters and served as liaison to regionally based environmental/energy company organizations (including CEERT in California) pursuing renewable energy development.

RENEWABLE RESOURCES (October 1980 to April 2001)
Mr. Caldwell is the former President of ARCO Solar Inc., the photovoltaic subsidiary of Atlantic Richfield Company. In that position, he was also a Vice President of Atlantic Richfield Company. As President of ARCO Solar, Mr. Caldwell took that company from a research organization with less than $3 million in revenue to an integrated worldwide manufacturing and marketing operation with over $30 million in sales. He created joint ventures in Japan and Germany, and partnered with ninety-six exclusive distributors selling ACRO Solar products in 126 countries. Prior to becoming President, Mr. Caldwell was the Senior Vice President for Manufacturing, Research, and Engineering where he constructed what, at the time, was the world's largest photovoltaic central station power plant, the 6.5 MW Carisso Plains project in Central California, as well as every large grid connected photovoltaic project constructed anywhere in the world prior to 1990. When Atlantic Richfield decided to sell ARCO Solar, Mr. Caldwell left ARCO and attempted to purchase the company. He raised over $50 million in equity to purchase and fund the company's business plan, but was outbid by Siemens AG in July of 1989.

After leaving ARCO, Mr. Caldwell started his own consulting/project development business. He developed numerous power plant projects around the globe in partnership with Bechtel Enterprises and several European organizations. Projects included a 300 MW combined cycle gas fired power plant in Thailand, a 30MW gas turbine/water desalination cogeneration facility in an oil refinery on the island of

Cyprus, a 10 MW waste wood fired power plant in northern California, and a 5 MW diesel generator/water desalination cogeneration facility in the Cape Verde Islands.

Mr. Caldwell's consulting clients included most of the national environmental organizations with a direct interest in energy policy including the National Resources Defense Council, the Sierra Club, Union of Concerned Scientists, and Environmental Defense. He also consulted for several independent power producers including Enron and PG&E's National Energy Group, and regional transmission organizations such as the California Independent System Operator.

ATLANTIC RICHFIELD COMPANY (August 1965 to September 1980)
Prior to his assignment with ARCO Solar, Mr. Caldwell held a variety of positions over a twenty-four year career with Atlantic Richfield. After graduating from college, he began employment with ARCO's predecessor, Richfield Oil Corporation, as a Refinery Process Engineer. A fourteen-year stint in refinery operations culminated in the position of Refinery Operations Manager at ARCO's Los Angeles refinery.

Mr. Caldwell was then assigned as Manager of Downstream Planning in ARCO's Corporate Planning Department. He oversaw ARCO's capital budget and worldwide strategic business plan for refining and marketing; petrochemicals; transportation including oil and gas pipelines and marine shipping; and ARCO's non-energy related diversification program. He led a corporate team that developed company investment and research policy for all synthetic fuels including coal gasification, coal liquefaction, biomass to energy, and concentrating solar power.

After leaving Corporate Planning and before assignment to ARCO Solar, he was the Project Manager and Owner's Representative for the Colony Oil Shale Development Company in Denver CO -- ARCO's primary venture into synthetic fuels. In addition, he managed ARCO's non-energy diversification effort into agricultural genetic engineering and vegetable seed production.

AFFILIATIONS
Mr. Caldwell is a former member of the Clean Air Act Advisory Committee for the Environmental Protection Agency, the Energy Modeling Committee of the Energy Engineering Board of the National Academy of Sciences, the Advisory Committee on Energy Policy for the Office of Technology Assessment, and the Advisory Board for the USAID Energy Training Program. He is a life member of the IEEE and the AIChE. Along with his wife, Jan McFarland and V. John White, in 1990 he helped found the Center for Energy Efficiency and Renewable Technologies in Sacramento, CA, and currently serves as Senior Advisor and At Large Member of the Board of Directors.

EDUCATION
Mr. Caldwell received a B.S. Degree in Chemical Engineering from Stanford University (1965) and an MBA from California State University at Long Beach (1978). He is married with three children and three grandchildren.

References on request.