Audacious Ambitions – Part 1, California

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1. Introduction

It must seem to people outside of California that we are crazy. After all, we push ahead to a sustainable future in spite of many obstacles, and have doing this for many decades. Yep, must be crazy.

But I saw the future shortly after the year 2000, and I didn't even know it. Then I started working with California Energy Commission (CEC) in the AMI-part of my career. After a while, I noted that there were few engineers employed by this organization, but many economists. After a few more years I understood:

- Get the economics right and everything else will fall into place, and
- Given enough cubic dollars, anything is possible

Considering that California passed the UK last spring to become the fifth largest economy in the world (gross domestic product surpassing $2.7 trillion),[1] California has lots of cubic dollars. Add in a progressive government (and voters) to which sustainability is one of their core values, and it is inevitable that a large part of our resources will be spent pushing ahead on this front.

The good news for Californians (and others) is that we have now turned loose the same forces that fueled our economic strength on technologies related to clean energy, and that is what this paper is about.

This paper explores contributions that the California Government makes in funding clean energy startups, and also the roles of clean energy funds in California. The second paper in this series extends this to the world's clean energy startups, and how they are supported by two California organizations.

2. Government Grants and Loans

I started my search back at the CEC, since they frequently fund clean energy projects. The place to look how this happens is in news releases. The first release I read led me to a major green power fund, which quickly led me to many others.

The following excerpt is from the referenced CEC "About…" document.[2]

The California Energy Commission is the state's primary energy policy and planning agency… The Energy Commission is committed to reducing energy costs and environmental impacts of energy use − such as greenhouse gas emissions − while ensuring a safe, resilient, and reliable supply of energy.

[1] Jonathan J. Cooper, NBC News Bay Area, "California Is Now World's 5th Largest Economy, Surpasses UK", May 4, 2018, https://www.nbcbayarea.com/news/california/California-Is-Now-Worlds-5th-Largest-Economy-Surpasses-UK-481770711.html

[2] The California Energy Commission Core Responsibilities, https://www.energy.ca.gov/commission/fact_sheets/core/CEC-CoreResponsibilities.pdf

Seven core responsibilities guide the Energy Commission…

- *Advancing State Energy Policy*
- *Achieving Energy Efficiency*
- *Certifying Thermal Power Plants*
- *Investing in Energy Innovation*
- *Transforming Transportation*
- *Developing Renewable Energy*
- *Preparing for Energy Emergencies*

2.1. Recent CEC Grant and Loan Activity

The following is a summary of CEC grant and loan activity in 2018. More specifics as well as activity in earlier years can be found through the link at the end of this subsection. Typical grants/loans are in the low $Million range. The following are types of recipients and projects.

- California Test Bed Initiative, will provide participating energy entrepreneurs with testing and certification services needed to refine their prototypes, as well as verification that new technologies meet customer performance and safety specifications before field trials.[3]
- Local governments' and government agencies' efforts to enhance building efficiency, improve renewable mobility infrastructure, develop renewable energy sources, and develop renewable and/or resilient energy infrastructure (microgrids or similar projects).
- State colleges' and universities' projects to develop renewable and/or resilient energy infrastructure (microgrids or similar projects). Note that these projects are not necessarily at the colleges/universities, but may be at other public facilities.
- Improve energy efficiency in, and add self-generation for low-income multifamily dwellings
- Support for entrepreneurs working on early-stage clean energy concepts (CalSEED) and support of later-stage projects
- Institutes related to the energy infrastructure (like the Electric Power Research Institute) to demonstrate clean and resilient energy concepts (from the Electric Program Investment Charge)
- Grants to key industries in California to improve energy efficiency (like food processors)
- Support for zero- or lower-carbon mobility

[3] Energy Commission Approves Efficiency Standards: Will Save Consumers Millions of Dollars, Reduce Pollution, https://www.energy.ca.gov/releases/2018_releases/2018-12-10_business_meeting_press_release_nr.html

https://www.energy.ca.gov/releases/index.php?getyear=2018

3. Green Energy Funds

Some of the wealthiest firms and individuals in the U.S. have created venture funds to boost technologies that will sustainably produce energy and/or benefit the environment. For each of these funds, I will list their self-stated purpose / goal, main website link, and a few startups they are funding in California.

I believe the first firm below is the largest, or at least the most influential. It was started by Mr. Gates, and its board members also include Mr. Benioff (Salesforce.com), Mr. Bezos (Amazon), Mr. Bloomberg, Mr. Branson (Virgin), Mr. Ma (Alibaba), Ms. Whitman (Hewlett Packard), Mr. Zuckerberg (Facebook) and Ms. Chan (Mr. Z's significant other). Link below is to the full board.

http://www.b-t.energy/coalition/who-we-are/

3.1. Breakthrough Energy

By the middle of the century, the world will use twice as much energy as we do today, much of it in places that have never had access to power before. And that's a great thing: the more access to energy people have, the larger our economies grow and the better our lives become.

But to get there, we need different tools than the ones that have served us in the past. Breakthrough Energy is committed to investing in new technologies to find better, more efficient and cheaper energy sources. The global energy market is massive, and finding a way to open it up is an investment opportunity worth getting right.

http://www.b-t.energy/

Fervo Energy is developing technology for power generation from enhanced geothermal systems that can deliver electricity at a cost of 5 to 7 cents per kilowatt hour. Fervo's design incorporates proven, cost-effective current technologies from other fields like petroleum drilling. Electricity from geothermal reservoirs have the potential to produce over 100 gigawatts (GW) of electricity in the United States. Previous developments of enhanced geothermal systems have primarily relied on simple designs that have produced lower flowrates than required for commercial viability. Fervo Energy's approach can overcome these technical challenges and unlock the full potential of geothermal energy. https://www.fervoenergy.com/

Pivot Bio is developing nitrogen fixation in cereal crops. Half of our world's food supply is dependent on synthetic nitrogen fertilizer, yet it has serious environmental impacts. Fertilizer contributes to about 500 ocean dead zones around the globe; decomposes into nitrous oxide which is responsible for about 5 percent of global warming; and prevents the natural ability of soil microbes to produce nitrogen that nourish food crops. Farmers are looking for new tools today that can help them reliably feed their nitrogen-hungry crops in a more environmentally sustainable way. Through the power of biology, machine learning and computational modeling, Pivot Bio reawakens microbes' natural ability to convert nitrogen from the air to meet crops' daily nitrogen-needs.

August, 2018, Bloomberg: Pivot Bio and farmers in the company's Intent to Pivot program are beta testing the first sustainable source of nitrogen for corn. These plants receive nitrogen on-demand each day from Pivot Bio's proprietary and field-tested

microbes. This beta program is the final step before the product is commercially available for use with corn for 2019 planting. https://www.pivotbio.com/

QuantumScape is developing a solid state lithium battery (Lithium metal anode). There is very little information on their website (listed below), but the media has done a reasonable job of covering them. The reason for this secretiveness is that several other groups (worldwide) are working on this technology. However QuantumScape has two things that these others do not. (1) They have attracted major investments from several firms, and are considered to be a unicorn[4] (over $1 Billion valuation), and (2) the Volkswagen Group, who just invested $100 Million in QuantumScape, has claimed to have tested sample battery cells that perform at "automotive rates of power."

Authors comment: I just noted QuantumScape's address in San Jose, California. This is the same facility that I worked at for what is now the Siemens PowerTG Group for over 17 years (then Landis & Gyr, TELEGYR when I left). I moved over to Siemens during their acquisition of Landis & Gyr, and TELEGYR moved out of that facility and across the street a few years after that. http://www.quantumscape.com/

3.2. California Clean Energy Fund

The California Clean Energy Fund (hereafter CalCEF) manages a number of other programs that are covered below. We will start out with their self-described mission.

We have an audacious plan for rapid clean energy adoption and for building equity into the energy economy in California, the United States and around the world.

Bloomberg description: "California Clean Energy Fund is a private equity and venture capital firm specializing in direct and fund of fund investments. The firm invests in early stage and seed/startup companies. It seeks to invest in private clean energy and transformational clean technology companies focused on low carbon transportation, green building, cleaner fossil fuel, solar, energy efficiency, lighting sector, energy storage, products and services including software, renewable generation, power and communication transmission lines, electric power distribution, demand-side management, and all forms of power including demand and supply side stationary."

3.2.1. CalSEED

The California Sustainable Energy Entrepreneur Development Initiative (CalSEED) is a funding and professional development program for innovators and entrepreneurs working to bring early-stage clean energy concepts to market. Powered by the California Clean Energy Fund's mission to create a clean energy economy for everyone, CalSEED supports diverse entrepreneurs who deliver equitable outcomes from their clean tech innovations.

CalSEED is a funding initiative of the California Energy Commission.

http://calseed.fund/

The following is a sample of funded start-ups.

[4] Eric Wesoff, Greentech Media (GTM), " VW Invests $100M in QuantumScape, a Battery-Building Unicorn", June 28, 2018, https://www.greentechmedia.com/articles/read/wv-quantumscape-investment#gs.43oh1hJm

Lilac Solutions: Most of the world's lithium reserves are found in salt brines, with current production concentrated in South America. The conventional process for extracting lithium from brines requires large evaporation ponds that are vulnerable to weather, large quantities of chemical inputs, and long periods of time for construction and processing. This conventional process also suffers from low lithium recovery and cannot access new lithium resources in the US and around the world. Lithium producers are seeking new extraction methods.

Lilac Solutions has developed a new ion exchange technology to address the challenges face by lithium producers. Lilac's technology streamlines operations, boosts lithium recovery, and expands production into new resources. Their process is modular and can be ramped in time with the market. http://www.lilacsolutions.com/

Saratoga Energy Research Partners, LLC is developing an inexpensive production process to synthesize graphite from CO_2. Saratoga's technology electrochemically separates CO_2 into oxygen and graphitic carbon, an essential material in lithium-ion batteries. Graphite produced by the Saratoga process is well suited for … electric vehicles, grid storage, and a broad spectrum of other energy and industrial applications.

In addition to offering sustainable sourcing and cost benefits, Saratoga Energy's graphite also has performance advantages. Graphite made with its patented process can charge and discharge more quickly, making it ideal for electric vehicle customers. http://www.saratoga-energy.com/

DTE Materials manufactures batt insulation derived from natural fibers. A patent-pending process utilizes the latest in materials science to provide high performance insulation without sacrificing the bottom line. This process not only improves the thermal insulation (R-value) properties of all plant based materials, but allows the extraction of valuable byproducts - minimizing excess waste. Their insulation has superior performance and is truly sustainable as their source plants create up to 410% more cellulose per acre relative to trees. https://www.dtematerials.com/

Ocean Motion Technologies is developing a modular mechanical buoy system that can harness oceanic wave energy and store it in compressed air or utilize it for electricity production through a turbine generator. This is an extensible technology that works at all levels of generation and storage -- from scientific instruments to grid-scale applications. https://www.oceanmotion.tech/

3.2.2. CalCharge

CalCharge is a groundbreaking public-private partnership working to accelerate the development, commercialization, and adoption of new energy storage technologies for the consumer, transportation, and grid markets. CalCharge brings together emerging and established companies, academic and research institutions, government agencies, and other key stakeholders to spur advanced manufacturing and increase the growth of the energy storage sector.

Through its programs, CalCharge creates a "center of gravity" for the California energy storage cluster that enables these diverse stakeholders to collaborate, identify barriers to emerging technology success, develop solutions, and help provide access to resources that clear the path to commercialization. The goal – a thriving California energy storage cluster that is a key driver of industry and market growth globally.

Member private firms include utilities, universities, automotive firms, national laboratories, unions, electric equipment firms, and battery development startups.

http://calcharge.org/

The following is a sample of the start-ups.

Enovix is developing a next-generation lithium-ion battery with our patented 3D cell architecture and high-capacity silicon anode to increase energy density and improve safety. https://enovix.com/

Blue Current is an energy storage startup company developing a new generation of safer and higher energy batteries based on our novel solid-state electrolyte technology. http://www.bluecurrent.com/index.html

EnZinc has developed a new zinc anode, using technology, developed by the US Naval Research Laboratory, which can be used in a family of batteries. The batteries will have equivalent or better performance than Li-ion but at a lower cost. Other solutions using zinc have sought additives or mechanical systems to extend the cycle life. EnZinc will offer the world's first structural zinc electrode solution in the form of a zinc metal micro-sponge. Perfect for both mobile and stationary applications. http://enzinc.com/index.html