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In the Matter of: REVISED APPLICATION FOR CERTIFICATION FOR THE HYDROGEN ENERGY CALIFORNIA PROJECT	Docket No. 08-AFC-08A DECLARATION OF JIM CROYLE PROVIDING SUPPLEMENTAL INFORMATION PURSUANT TO THE COMMITTEE ORDER DENYING MOTION TO TERMINATE APPLICATION FOR CERTIFICATION AND GRANTING REQUEST FOR SUSPENSION

Attached is the Declaration by Jim Croyle, Chief Executive Officer of SCS Energy California, the parent company of Hydrogen Energy of California, providing supplemental information pursuant to the Committee Order Denying Motion to Terminate Application for Certification and Granting Request for Suspension (Docket No. 205238-1).

Dated: January 6, 2016

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/s/ Michael Carroll

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In the Matter of: REVISED APPLICATION FOR CERTIFICATION FOR THE HYDROGEN ENERGY CALIFORNIA PROJECT	Docket No. 08-AFC-08A DECLARATION OF JIM CROYLE PROVIDING SUPPLEMENTAL INFORMATION PURSUANT TO THE COMMITTEE ORDER DENYING MOTION TO TERMINATE APPLICATION FOR CERTIFICATION AND GRANTING REQUEST FOR SUSPENSION

I, Jim Croyle, declare as follows:

I am the Chief Executive Officer of SCS Energy California, the parent company of Hydrogen Energy of California (HECA or the Applicant) for the above-described integrated gasification combined-cycle power generating facility with carbon capture and sequestration in Kern County, California (the Project). I am duly authorized to make this Declaration. Except where stated on information and belief, the facts set forth herein are true of my own personal knowledge and the opinions set forth herein are true and correct articulations of my opinions regarding the Project.

I have worked in the energy field for a number of years on a wide variety of energy projects. If called as a witness, I could and would testify competently to the opinions set forth herein.

On May 5, 2015, HECA filed a Request for Suspension of the Application for Certification ("AFC") proceeding for the Project. On July 3, 2015, the Committee issued an Order denying a Motion to Terminate the Project and granted the Applicant's Request for Suspension for a six-month period ending on January 6, 2016. On November 30, 2015, Applicant filed a "Report To Committee And Request To Reinitiate AFC Proceedings" (the information contained therein is incorporated by reference into this Declaration). On December 1, 2015, a memo from the Hearing Officer was issued that gave the parties until December 15, 2015 to submit comments on the request to reinitiate the AFC proceeding, as well as notice that the Committee will hold a public hearing.

This Declaration has been prepared to provide supplemental information pursuant to the Committee's Order granting the suspension request.

I. Proposed Consulting Agreement With University of California (Lawrence Berkeley National Laboratory and Lawrence Livermore National Laboratory)

The Suspension Order called for HECA to provide "Documentation of an executed CO2 off-take and carbon sequestration agreement, for a site that is both feasible and available for such use." (Suspension Order, p. 3.) For reasons previously stated in our filing dated November 30, 2015 (Docket No. 206794), which I incorporate by reference, it is no longer feasible for HECA to pursue an offtake agreement with Occidental Petroleum. However, HECA has not abandoned pursuit of a permanent sequestration solution consistent with the overall objective of applying carbon, capture and sequestration (CCS) to the project's CO2 emissions.

In lieu of an offtake agreement with Occidental Petroleum, HECA has pursued a partnership with the University of California (LBNL and LLNL) to facilitate the permanent sequestration of CO2 beneath the Project site utilizing Class VI wells permitted by the U.S. Environmental Protection Agency (EPA). This approach eliminates the need to contract with a CO2 off-taker, as well as the need to permit facilities and analyze associated environmental impacts at a site other than the Project site, all of which greatly simplify the environmental review and permitting of the Project.

Specifically, HECA and University of California (LBNL and LLNL) have been in active communication and engaged in ongoing negotiations for a formal contractual relationship to cover the remainder of the permitting period to satisfy permitting requirements and develop the HECA plant site for saline storage. Dr. Elizabeth Burton, WESTCARB Technical Director, has been the lead contact person for the University of California (LBNL and LLNL). As shown in the attached draft term sheet, the general focus of the proposed work by LBNL is: (1) meeting the EPA UIC Class VI requirements, (2) planning injection and storage operations, and (3) meeting all related CEC requirements. HECA has generally agreed to the terms of the draft term sheet and I anticipate that a formal agreement can be reached in due course. It is the intention of HECA to finalize and extend this relationship throughout the life of the project, including construction and operations, but the specific tasks and costs cannot be determined until permits are issued with accompanying conditions and requirements.

II. Technical Memorandum From Lawrence Berkeley National Laboratory

Please find attached the technical memorandum from Dr. Burton providing an initial assessment of the saline geologic storage potential for CCS at the HECA site.

III. HECA's Persistent and Sustained Efforts To Pursue AFC

Please see my declaration in Support of Applicant's Response to the Motion to Terminate, dated May 26, 2015 (Docket No. 204739) for a timeline of activities HECA has completed in pursuit of the AFC leading up to the Suspension Order. As stated in my earlier Declaration, I continue to believe that "HECA has engaged in frequent and sustained actions intended to produce a CO2 off-take agreement and advance review of the AFC." A summary of continuing activities since the Suspension Order is provided next.

July 2015

HECA evaluated and finalized its decision to explore saline aquifer sequestration for CO2 in lieu of sequestration via EOR. HECA's decision was based on: (1) EPA certification of Class 6 wells for Future Gen in Illinois making saline aquifer CO2 storage feasible, for the first time, for projects like HECA, (2) the information from the LBNL when asked what existing WESTCARB studies tell us about the potential to store the CO2 in formations within a 30km radius of the site and, and (3) the high probability of having the injection wells on the HECA site itself. LBNL provided a preliminary assessment of the geologic storage potential at the HECA site concluding that shifting to a saline formation injection on-site as an alternate has a high potential for success.

On July 27, 2015, HECA had a conference call with Mr. David Mohler, the newly-appointed Deputy Assistant Secretary, Office of Clean Coal and Carbon Management, to provide a brief project update including work related to pursuing Class VI well permits for permanent capture and sequestration of the Project's CO2. A follow-up meeting was scheduled for September 22, 2015 at the DOE's Washington D.C. headquarters to discuss the updated project in more depth.

September 2015

On Friday, September, 11, 2015 HECA and LBNL participated in a conference call with the Environmental Protection Agency, Region 9 which is responsible for issuing Class VI well permits. EPA Region 9 has pre-emptive jurisdiction regarding Class VI wells. EPA headquarters will work closely with Region 9 leveraging the previous work done by the Agency in issuing Class VI well permits for the two sequestration projects in Illinois. The initial discussions with EPA focused mostly on the application, the guidance documents created to assist in the application and the permitting process in very general terms. The EPA is prepared to begin discussions with the team (EPA HQ and Region 9 EPA, HECA, the National Labs) and in coordination with the CEC, upon our formal notice to begin the Class VI well permitting process, which we will do immediately upon resumption of the AFC process.

On September 22, 2015, HECA met with DOE headquarters and provided Mr. Mohler and his team with a formal project synopsis, a detailed proposal for finalizing the development phase of the Project, the LBNL proposal for site characterization and support for Class VI well permit applications, and a revised monthly budget for completing development which includes permitting (at the local, state and federal level), engineering adjustments, commercial agreements finalization, and financing work with HECA's bankers.

As part of the package HECA prepared for DOE, LBNL provided a proposal for fully modeling and characterizing the proposed sequestration site and working with HECA in the Class 6 well certification process. The existing geomodel created by the National Labs, using existing data and information specific to the HECA site and surrounding areas, is a key component in HECA's selection of specific target injection.

The meeting concluded with DOE asking HECA to provide additional information regarding the economic underpinnings of the project and a segmented budget to include proposed milestones for ongoing monitoring of project progress.

October 2015

Per DOE's request, HECA provided DOE with the following information:

- The monthly budget for the remaining development period.
- An early budget with suggested milestones for monitoring progress over the three to six months following reinstatement of the AFC proceedings and approval of the revised development budget.

During the month of October, 2015, HECA continued its interaction with the new clean coal program management staff at DOE discussing the optimal path forward for the project. HECA provided a number of documents requested by DOE to assist in the budget and planning processes. Prior to the September 22, 2015 meeting with the new management at DOE headquarters, HECA submitted a budget estimate and project synopsis to accommodate a non-EOR CCS approach. Subsequent to that meeting and at DOE's request HECA provided the following:

- Monthly budget estimate.
- Milestones and related budget to achieve said milestones.
- The September update to the CEC from HECA detailed the specific set of milestones proposed by HECA to DOE. HECA calculated a milestone budget for DOE that essentially broke down the budget in terms of milestone period. We provided DOE the estimated project cost for milestone 1 (months 1-3) and Milestone 2 (months 4-6).
- Interactive financial model and talking points including sensitivity analyses to commodity pricing, power pricing and interest rate volatility.
- Discussion on HECA's investment team and project team needed to implement the new CO2 program.

HECA communicated to DOE that a project timeline, DOE resumption of funding or a timeline for the resumption of funding is needed immediately to maintain consultant, vendor, political and regulator support of the project. We emphasized the importance of the schedule as it relates to both the CEC's schedule and to meet the terms of the funding program.

November 2015

DOE officials in the Office of Fossil Energy have received HECA's plan for sequestering the captured CO2 from the project on-site and said that after legal research, the DOE has concluded that the AFC certification process must be reinstated in order for DOE to reinstate funding and set revised milestones.

IV. CCS and Climate Policy

The Energy Commission must not lose sight of the larger climate policy issues at stake when considering whether to reinstate the HECA licensing case. For the world to have any chance of keeping global climate change to below 2°C rise compared to pre-industrial levels at least cost, all available low-carbon technology options, including Carbon Capture and Sequestration (CCS), must be pursued. As stated by Maria van der Hoeven (Former Executive Director, International Energy Agency), "With coal and other fossil fuels remaining dominant in the fuel mix, there is no climate friendly scenario in the long run without CCS." International Energy Agency, Foreword to the Technology Roadmap: Carbon Capture and Storage (2013).

Modelling from the International Energy Agency (IEA) has long shown that CCS has an important role to play under a 2°C scenario. For example, its 2015 World Energy Outlook notes that, globally, three-quarters of coal-fired power generation would come from CCS-equipped plants, and in industrial processes, 10% of the cumulative CO_2 emissions over the period to 2040 would be captured and stored under its 450 parts per million (ppm) CO_2-equivalent scenario. *See* https://hub.globalccsinstitute.com/insights/roadmap-scenario-modelling-confirms-important-role-ccs (containing links to the aforementioned papers).

Key findings from the Global CCS Institute's *Global Status Of CCS 2015, Summary Report* include the following:

- To limit global temperature increases to no more than 2°C, climate models suggest a 40% to 70% global reduction in emissions by 2050 compared to 2010 is necessary, with emission levels near zero or below in 2100.

- CCS has a key role to play in curbing CO_2 emissions from fossil fuel-based power generation and is the only option available to significantly reduce direct emissions from many industrial processes.
- Modelling by the IEA shows that CCS provides around 13% of the required cumulative emissions reductions through 2050 in a 2°C world compared to 'business as usual.'
- The Intergovernmental Panel on Climate Change (IPCC), in its November 2014 Fifth Assessment Summary for Policymakers report, highlighted the following points in the event CCS is not available or its implementation is delayed:
  - Without CCS, the cost of achieving 450 ppm CO_2-equivalent concentrations by 2100 could be 138% more costly (compared to scenarios that include CCS).
  - Only a minority of climate models could successfully produce a 450 ppm scenario in the absence of CCS.

Many climate models indicate a temporary 'overshoot' of atmospheric concentrations, which requires the world needing to achieve 'net negative emissions' to meet climate goals. The availability and widespread deployment of bioenergy with CCS is important in a world where 'net negative emissions' are required. *See* http://status.globalccsinstitute.com/#key-findings.

Both the US Environmental Protection Agency (EPA) and the California Air Resources Board (ARB) recognize the key role CCS must play in climate policy:

- In August 2015, EPA finalized CO_2 new source performance standards (NSPS) for new, modified and reconstructed fossil fuel-fired electric generating units under Clean Air Act section 111(b). U.S. Environmental Protection Agency, "Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units" (Aug. 3, 2015) (pre-publication version)

[Docket ID No. EPA-HQ-OAR-2013-0495] available at http://www.epa.gov/airquality/cpp/cps-final-rule.pdf (hereinafter Final NSPS). Partial CCS (20%) is the "best system of emission reduction" (BSER) for Newly Constructed Fossil Fuel-Fired Steam Generating Units (utility boilers and integrated gasification combined cycle units).

- ARB states that CCS "is an important strategy to reduce greenhouse gas (GHG) emissions and mitigate climate change" and "is currently developing a quantification methodology to be utilized when determining carbon emission reductions from CCS for both the Cap and Trade and Low Carbon Fuel Standard programs." *See* http://www.arb.ca.gov/cc/ccs/ccs.htm. ARB further notes: "Studies by the Intergovernmental Panel on Climate Change (IPCC) and the California Council on Science and Technology (CCST), have shown that CCS has the potential to reduce carbon emissions by millions of metric tons, and may be an integral part of meeting California's long term climate goals." *Id.* (internal citations omitted).

V. Underground Injection Control (UIC) Class VI

On December 10, 2010, EPA issued a rule that established a new well class, Class VI, for the Underground Injection Control (UIC) Program. 75 Fed. Reg. 77243 (December 10, 2010). The Class VI rule established minimum technical criteria to protect underground source of drinking water from the long-term subsurface storage of CO_2. The rule became effective on September 7, 2011 after a 270-day period during which states could apply for and receive primary enforcement responsibility (primacy). To date, EPA directly implements the Class VI Program nationally as no states have yet received primacy. 76 Fed. Reg. 56982 (September 15, 2011). All permit applications for Geologic Sequestration (GS) projects must be directed to the appropriate EPA Region (here, EPA Region 9) in order for a Class VI permit to be issued. *See* 75 Fed. Reg. 77243 (December 10, 2010).

- While the elements of the Class VI final rule are based on the existing regulatory framework of EPA's UIC Program, the requirements are tailored to address the unique nature of CO_2 injection for GS. As such, the Class VI final rule requires, among other things:
  - Geologic site characterization (which includes (1) the location of known/suspected faults that may transect the confining zone and whether they would interfere with containment and (2) the seismic history and whether seismicity might interfere with containment) to ensure that GS wells are appropriately sited;
  - Requirements for the construction and operation of the wells that include construction with injectate-compatible materials and automatic shutoff systems to prevent fluid movement into unintended zones;
  - Requirements for the development, implementation, and periodic update of a series of project-specific plans to guide the management of GS projects;
  - Periodic re-evaluation of the area of review around the injection well to incorporate monitoring and operational data and verify that the CO_2 is moving as predicted within the subsurface;
  - Rigorous testing and monitoring of each GS project that includes testing of the mechanical integrity of the injection well, ground water monitoring, and tracking of the location of the injected CO_2 using direct and indirect methods;
  - Extended post-injection monitoring and site care to track the location of the injected CO_2 and monitor subsurface pressures until it can be demonstrated that underground sources of drinking water (USDWs) are no longer endangered;

- Clarified and expanded financial responsibility requirements to ensure that funds will be available for corrective action, well plugging, post-injection site care, closure, and emergency and remedial response; and
- A process to address injection depth on a site-specific basis and accommodate injection into various formation types while ensuring that USDWs at all depths are protected.

Accordingly, HECA's compliance with EPA's UIC Class VI permitting program will provide assurance that concerns about the sequestered CO_2's impact on USDWs and/or its neighbors are fully addressed. For additional information on EPA's UIC Class VI permitting program, including Fact Sheets, please see http://www.epa.gov/uic/supporting-documents-final-rule-uic-class-vi-wells.

VI. Economic Viability Of Sequestration Strategy

Please find attached report on the economic viability of the Project using CCS without an offtake agreement. As noted in the attached, the economic viability of the Project has not been dependent on the forecasted EOR revenue from the anticipated offtake agreement with Occidental.

VII. Addressing Outstanding Data Requests

As stated in our filing dated November 30, 2015 (Docket No. 206794), the majority of outstanding data requests relate primarily to facilities and activities that were to occur on and in the Elk Hills Oil Field for enhanced oil recovery (EOR) and CO2 sequestration. These data requests pertained to both surface impacts (e.g., biological and cultural resource impacts) and the details of the proposed EOR and sequestration. Given that both the proposed location and nature of the sequestration have changed, the outstanding data requests are no longer relevant.

Given the significant change in project design to eliminate the Elk Hills component, it is not feasible for HECA to "modify the inapplicable data requests so that they apply to the changes in the project and respond to those modified data requests" as required by the suspension order. Due to the elimination of the EOR component of the project, the large majority of outstanding data requests are now no longer directly applicable. Furthermore, for data requests not affected by the recent project changes, HECA has been hesitant about engaging CEC staff, the public and other agencies until the new project design is established. We recognize that CEC staff, other agencies and members of the public have expended significant time and effort reviewing information about the project, and we do not want to request additional effort until we are sure about the new project design. As discussed above, I believe the new proposed consulting agreement with LBNL, once finalized, will provide adequate assurance to allow HECA to meaningfully re-engage interested parties if the CEC restarts the AFC proceedings.

Instead of attempting to resolve outstanding data requests that may be moot or outdated, HECA has developed new mitigation measures to offset impacts that may remain even with the elimination of EOR. As such, HECA proposes three new mitigation strategies:

- **Water Resources –** HECA commits to developing a water mitigation program to offset the project's average operational use of groundwater above the historical baseline for the site.
- **Air Quality –** HECA commits to providing funding for the installation and operation of an air quality monitor following the construction of the project, by which we attempt to address multiple requests from members of the public.
- **Prime Farmland –** HECA commits to offset direct project impacts to Prime Farmland at a 2:1 ratio via the establishments of a conservation easement or fee payment, by which we attempt to address community concerns about farmland impacts.

Executed on January 6, 2016, at the location of Concord, Mass.

I declare under penalty of perjury of the laws of the State of California that the foregoing is true and correct to the best of my knowledge.

JAMES L. CROYLE

ATTACHMENT

Draft – Proposed Term Sheet: LBNL Support for the HECA Project

Point-of-contact: Elizabeth Burton, eburton@lbl.gov, (925)899-6397
Period of performance: January 2016-October 2016
Estimated Budget: $850,000

Over the next 6-9 months, LBNL proposes to provide support to the HECA project in the initial activities necessary to support saline formation storage via injection at the HECA site. HECA will need to prepare injection well and other permits and perform site planning related to injection well placement, design, and operations, including monitoring, measurement, reporting and verification (MMRV) planning and collection of basic and baseline on-site data. LBNL's work will be divided into two main areas, one focused on assisting HECA in meeting EPA UIC Class VI requirements and the other on supporting planning of injection and storage operations. Work in these two areas is divided into three main tasks, which will proceed concurrently or sequentially as appropriate to meet the overall objectives of meeting permitting requirements and planning development of the HECA plant site for saline storage.

Task 1: Preliminary Site Characterization

1) To guide permitting and planning activities, LBNL will develop a preliminary site characterization and assessment of the HECA plant site's suitability and potential capacity for safe storage of the volumes of CO_2 to be generated by the plant at full operation (est. 3 million tonnes/year for 30 years). Specifically, LBNL will integrate any significant existing HECA site data into the existing Kimberlina geomodel and perform computational simulations using the modified model. The current Kimberlina geomodel is centered at a location approximately 30 km to the east-northeast of the HECA site. That model was built using data from over 200 wells within 50 km of the site; thus, the geomodel encompasses the HECA site. LBL will adapt this model to be centered at the HECA plant site, extending 50 km from that point, and incorporating data from any additional wells to the west and south, which were outside the boundaries of the original Kimberlina model and that might provide additional well control for key target formations. At this preliminary stage, only publicly available data will be incorporated, for example, well files at CalDOGGR, remote sensing datasets, such as gravity and magnetics, legacy seismic, and published scientific reports or papers.

Deliverable: HECA site geomodel

Task 2: Support for EPA UIC Class VI requirements

LBNL will perform activities that support the delineation and periodic re-evaluation of the Area of Review and preparation of a Corrective Action Plan:

- Coordinate with HECA, EPA and state permitting staff as needed to align work planning with permit data requirements

- Provide technical expertise at HECA's request at public hearings and other meetings that occur as part of the permitting process
- Perform site characterization and rock and fluid parameter estimations to support computational modeling of CO2 injection over the life of the project (see Task 1 above);
- Perform computational modeling to assist HECA and EPA in delineating the Area of Review (AoR), in determining any wells to be included in the Corrective Action Plan, and the Remedial Response Plan
- Perform model parameter sensitivity analyses, including analyses to inform the optimum time interval for re-evaluation of the AoR and to determine what operational data is important to re-evaluation of the AoR
- Prepare an archive of modeling inputs and data to support subsequent AoR re-evaluations.

2) The Class VI Rule requires that "the AoR is delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream and is based on available site characterization, monitoring, and operational data" [40 CFR 146.84(a)]. Although no actual operational data are available at the HECA site, the geo-model of the subsurface at the site, developed in Task 1 above, will be used to create a computational model. In this task, the geomodel and computational model will be improved iteratively, using results of sensitivity analyses to determine which if any commercial seismic data ('spec' data), well log or core data should be obtained to improve the accuracy of the geo-model and the physical-chemical properties model, and, thus, the computational predictions. LBNL's geo-model of the HECA site will be used to perform simulations of annual and cumulative injections expected during the lifetime of plant operation.

Also, LBNL will support HECA through assisting with the following required information for a Class VI permit:

1. The method for delineating the AoR, including the model to be used, assumptions that will be made, and the site characterization data on which the model will be based;
2. The indications from the model of the minimum fixed frequency, at least once every five (5) years, that the owner or operator should propose to reevaluate the AoR;
3. The site- and project-specific monitoring and operational conditions that would warrant a reevaluation of the AoR prior to the next routinely scheduled reevaluation;
4. How specific monitoring and operational data (e.g., injection rate and pressure) will be used to inform an AoR reevaluation;
5. The locations and timing at which old known wells within the AoR may be potentially impacted by injection and which wells should be included within a phased or unphased Corrective Action Plan.

Deliverables: Attendance and presentations at hearings and meetings
Report of results of computational models and archive of inputs and data
Report of methodology
Report describing LBNL's findings on #1-5 above.

Task 3: Permitting Site Design and Injection Planning

Based on the geologic and injection modeling results and guidance from permitting agencies, LBNL will use its expertise to assist HECA with technical planning related to injection and storage design, including detailed site characterization, injection operations planning, and MMRV, including developing:

3) Plans for initial on-site subsurface data acquisition, including location(s) for seismic surveys, a site characterization and/or pilot, small-scale injection well and well test plans to improve model certainty and reduce subsurface risk elements of commercial-scale injection
4) Baseline monitoring plans to establish background data on key issues such as local groundwater quality, atmospheric and soil CO2 levels, and micro-seismic activity
5) Injection design and operations plans including the number and locations of injection wells and the target formations and depth intervals for storage
6) Well completion designs, including downhole instrumentation for monitoring and verification
7) Draft MMRV plan, including number and locations of monitoring wells, measurement methods, and frequency of measurements

Deliverable: Report describing proposed plans for various well locations, instrumentation, baseline monitoring, and MMV

ATTACHMENT

January 5, 2016

Technical Memo: Assessment of Saline Geologic Storage at the HECA Site

For: Jim Croyle, Hydrogen Energy California Project
By: Dr. Elizabeth Burton
WESTCARB Technical Director
Lawrence Berkeley National Laboratory
RE: Assessment of Saline Geologic Storage at the HECA Site

The HECA site near the communities of Tupman and Buttonwillow lies within the geologic basin known as the Southern San Joaquin Valley. The West Coast Regional Carbon Sequestration Partnership (WESTCARB), among others, has studied the geology of the rock formations in the Southern San Joaquin Basin at various levels of detail. These findings are based on over 1500 wells drilled primarily for the purpose of oil exploration in the region, including the area surrounding the HECA site. These results indicate that at the HECA site thick sandstones to provide CO2 storage and thick overlying shales to provide seals against leakage are present.

Process of Storage Site Assessment and Permitting

An area being considered for geologic storage of CO2 is first assessed by use of existing well data from the area. These well data show the types of rocks and fluids that are present in the subsurface, typically by interpreting a set of geophysical well logs and sometimes by acquiring actual rock samples by coring. For storage in an active or depleted oil or gas field, there will be wells placed exactly in the proposed storage location; however, for geologic storage in saline formations where no hydrocarbons are present, it is unlikely that any wells have previously been drilled at the exact location. However, because the sandstone and shale rock formations that are suitable for storage are formed in laterally continuous layers, geologists can make correlations confidently across undrilled areas by using surrounding well data.

This process has been used for saline storage site permitting in several cases. One example is the Decatur project in Illinois. Another is the Montezuma Hills project in Solano County. A third is the Kimberlina site near Bakersfield. In all of these cases, data from pre-existing wells located outside of the proposed storage area were used to construct a geologic model of the storage site. These models formed the basis for the applications these projects made for EPA UIC well permits to drill characterization and/or pilot injection wells at the storage location.

Previous Studies Relevant to HECA

Several reports on the geology of the area inclusive of the HECA site were published by the California Energy Commission. These reports demonstrate that the formations of the Southern San Joaquin Basin are a very large potential storage resource based upon criteria developed by NETL and applied to California by the California Geological Survey. These criteria include that: the depth to target storage reservoirs exceeds 800 meters; target formations have suitable thickness and permeability to provide storage; and there is suitable thickness of overlying shales or other impermeable cap rock formations to prevent upward migration of stored CO2 over time.

The San Joaquin Basin extends about 350 km (220 mi.) from the Stockton Arch to its southern terminus at the northern Transverse Ranges, and averages 80–110 km (50–70 mi.) wide. It is bounded on the east by the Sierra Nevada and on the west by the Central Coast Ranges and the San Andreas Fault. The basin is filled with predominantly marine sedimentary rocks that attain an aggregate thickness of over 9,150 m (30,000 feet). These rocks are interbedded sequences of sands and shales that make ideal CO2 storage sites. The California Geological Survey notes that the San Joaquin Basin contains many more rock sequences with geologic carbon sequestration potential than any other California basin (Figure 1). The great thickness of these rock sequences means that there are potentially several stacked target sand formations that may be usable for storage at the HECA site.

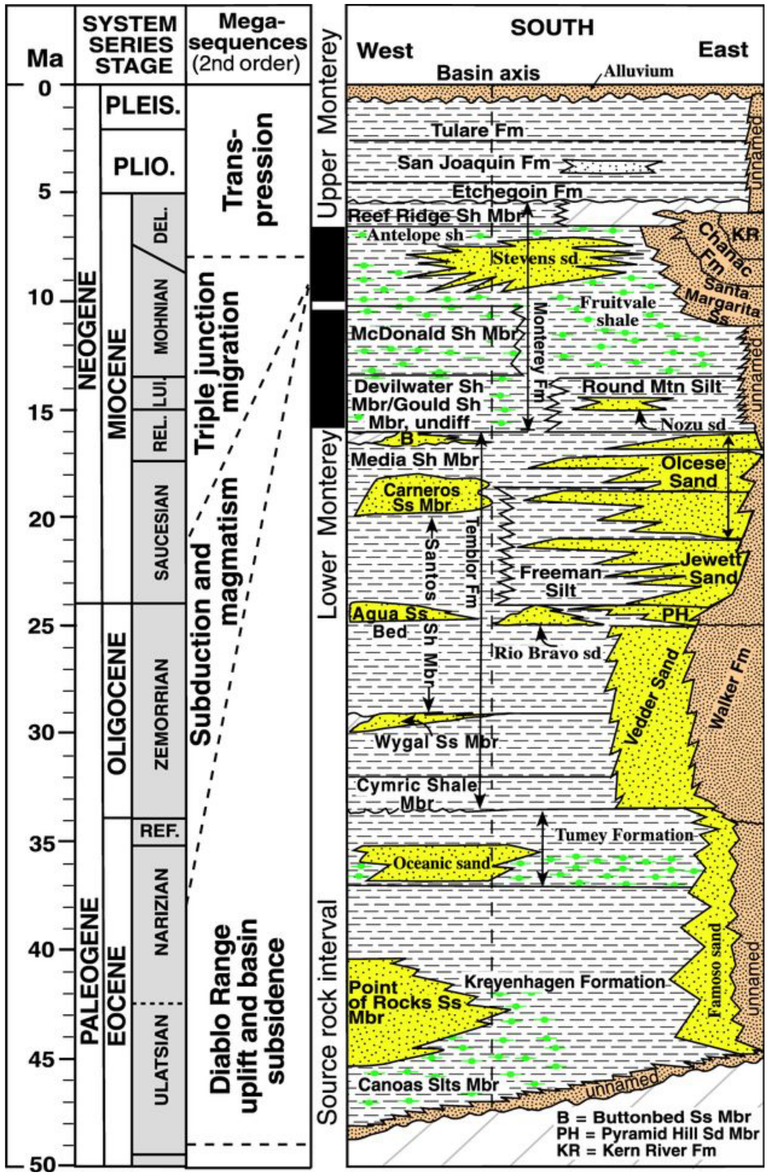

Figure 1: Stratigraphy of the Southern San Joaquin Valley (From USGS publication: Hosford Scheirer, A. and L.B. Magoon, 2008, Age, Distribution, and Stratigraphic Relationship of Rock Units in the San Joaquin Basin Province, California). Sandstones (storage formations) are shown in yellow. Shales (sealing units) are shown in dashed gray.

In addition to these basin-scale studies, WESTCARB also undertook more detailed studies of the storage potential of the rock formations in the Southern San Joaquin Valley around a specific site, the Kimberlina power plant, which is located at the intersection of Highway 99 and Kimberlina Road, north of Bakersfield. A three-dimensional geologic model with a 50 km radius was developed, centered on the Kimberlina site. The Kimberlina site model was developed for saline storage within rock formations that were delineated in 3 dimensions and assigned porosity and permeability characteristics by using well data from DOGGR for exploration and production wells located in oilfields and wildcat wells within the 50 km radius of the model. Over 1500 well datasets were used (Figure 2).

Given that the radial distance from the Kimberlina site to the HECA power plant site is approximately 30 km, the Kimberlina model encompasses the HECA site. The WESTCARB geomodel for Kimberlina can be used to provide greater detail on the storage potential of the four formations at the HECA site which lies within its boundaries.

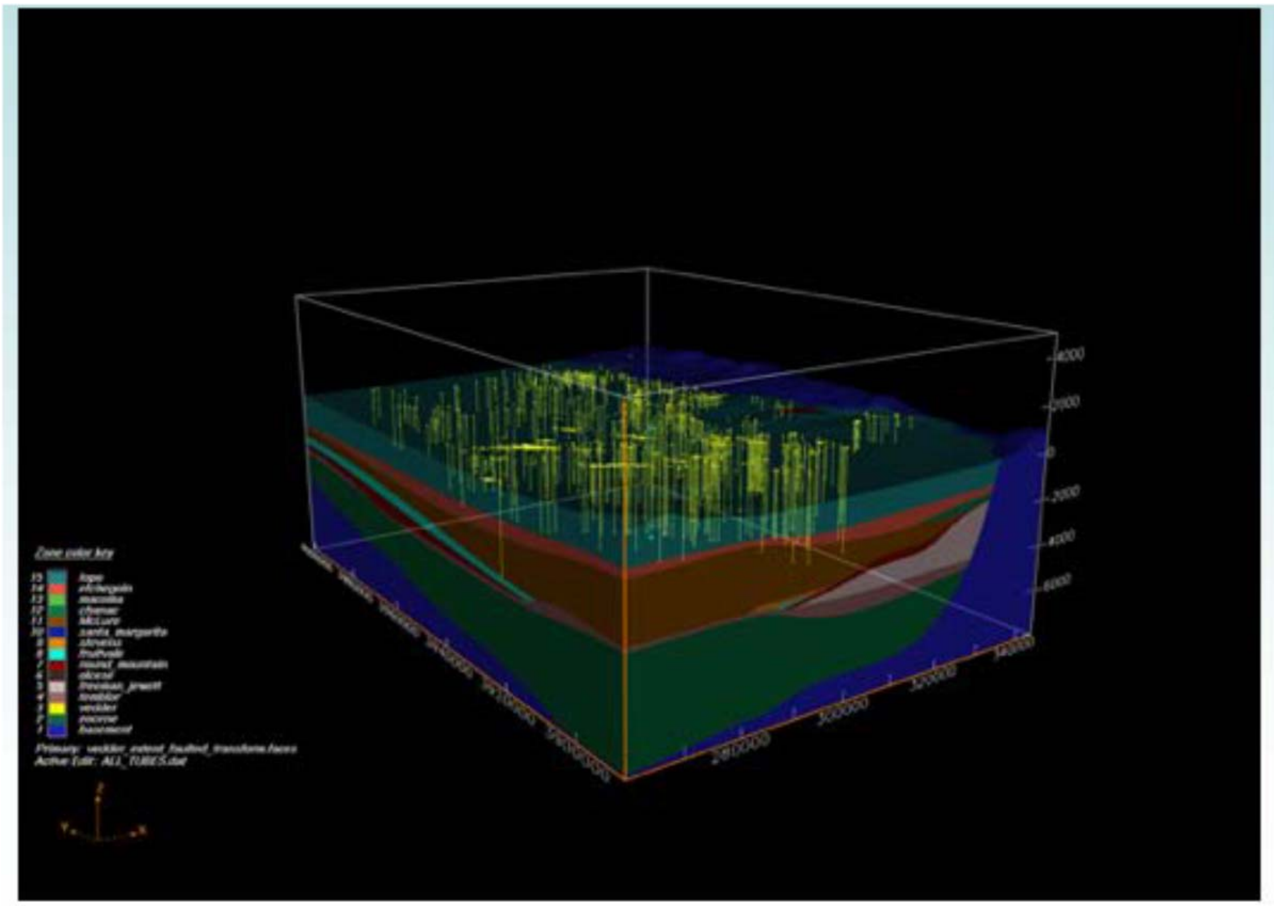

Figure 2: View of the 3-dimensional Kimberlina geomodel showing the locations of the 1500 well sites used to develop the volumes of the sandstone and shale formations.

Geologic Formations at the HECA Site

Based on the Kimberlina geomodel and other studies, the rock formations which are potentially good targets for CO_2 storage in the southern San Joaquin at HECA include the Vedder, Olcese, Stevens (Monterey and Fruitvale), and Etchegoin (or their equivalents, noting that formation names may change from E-W across the valley) (See Figure 1).

The Vedder is Oligocene–lower Miocene in age and was deposited predominantly in a marine shelf environment as sea level was rising. At moderate depths of 1,525– 2,745 m (5,000–9,000 feet), porosities range from 20–40 percent and permeabilities from 31–2,400 md. Vedder sandstones are overlain by the lower Miocene Jewett and Pyramid Hills sandstones and the Freeman silt. The Freeman silt gradationally overlies and intertongues with the Jewett sandstone and the overlying lower Miocene Olcese Sandstone. Porosities between 15–22 percent are typical in sandstones below 3,050 m (10,000 feet), while higher porosities of up to 38 percent occur in shallow sands. Permeabilities range from 6–5,000 md (DOGGR, 1998). Olcese sands range in depth from 700 m (2,300 feet) in the Ant Hill Field to 2,715 m (8,900 feet) in the Mountain View Field. Porosities range from 20–34 percent and permeabilities from 150–2,000 md (DOGGR, 1998).

During the Late Miocene, the southern San Joaquin Basin underwent rapid tectonic changes. Localized uplifts shed sands into a deep water basin so that the Stevens sandstones also include the interbedded shales of the Monterey Formation and laterally equivalent Fruitvale Formation on the east side of the basin. Stevens sandstones are generally medium–fine grained sands between 2–76 m (5–250 feet) thick. However, thick sections of interbedded sandstone and shale can exceed 1,525 m (5,000 feet) in aggregate thickness. Depths range from less than 60 m (200 feet) on the west side of the basin to over 4,270 m (14,000 feet) in the south central basin. Porosities in sandstones shallower than 3,050 m (10,000 feet) range from 20–35 percent with permeabilities of up to 6,500 md in the shallowest sandstones. Below 3,050 m (10,000 feet), porosity and permeability decline to 10–20 percent and 0.2 to 1,000 md, respectively (DOGGR, 1998). The Stevens sandstones provide significant oil production in the area and were the main formations targeted for CO2-EOR operations at Elk Hills using HECA's CO2.

The Etchegoin Formation consists largely of sands and mudstones deposited in transitional marine to coastal bay and riverine environments throughout much of the west and central basin where it reaches a thickness of about 1,680 m (5,500 feet). Individual sandstone units are generally thin, ranging from 2 to over 60 m (5 to over 100 feet) but total sandstone thickness is considerably more. Sandstones are enclosed in or overlain by Etchegoin shales ranging from >1 m (a few feet) to over 300 m (1,000 feet) thick. Porosities range from 12–40 percent and permeabilities from 1 to 22,320 md in sandstones up to 2,290 m (7,500 feet) deep, and decline to 17 percent and 200 md, respectively, at 3,170 m (10,400 feet) in the Yowlumne Field (DOGGR, 1998).

The primary target formation for storage chosen at Kimberlina was the Vedder Formation. The Kimberlina geomodel was used to develop a simulation of a large-scale CO2 injection of approximately 1 million tonnes over four years into the Vedder. The simulation indicated that this volume could be successfully injected into the Vedder, provided information for leakage risk assessment over the predicted interval for migration of the CO2 and stabilization after twenty years, and provided a basis for planning injection and monitoring well placement and operations.

It is clear from the above data that at least four sandstone formations underlying the HECA site meet the criteria for high storage potential. As noted above, however, the porosity, permeability and thicknesses of these units vary significantly across the southern San Joaquin Basin, but overall, the ranges for these values indicate that the HECA site has suitable formations for storage.

While this report could provide many static images of cutaways of the geomodel, such as in Figure 2 above, a better review for CEC staff of what is known about the HECA site geology may be made through a live demonstration and display of the computer graphics, manipulated to show the relevant views or cross-sections.

January 5, 2016

Importance and Advantages of the Saline Storage Option

Saline vs. EOR as a Storage Option

From the standpoint of monitoring, reporting and verification (MRV) in the context of greenhouse gas emissions reductions, saline storage has several advantages over storage combined with EOR operations. These include:

1) The absence of a large number of wells penetrating the storage formation. CO2 leakage risk studies identify pre-existing wells as the greatest risks. Oil or gas fields have significantly higher risk than saline storage locations in this regard. These wells may include unrecorded improperly plugged or abandoned wells, or poorly completed operating wells
2) All CO2 injected is intended to remain permanently in the subsurface in saline storage operations. In EOR operations, CO2 is recycled multiple times through a closed system which includes the subsurface formation, produced fluids, and surface pipelines and tanks. This complexity makes it difficult to decide when a volume of CO2 qualifies as permanently sequestered in the subsurface.
3) Single ownership of CO2 from “cradle to grave”, that is, from plant production to permanent storage, simplifies legal questions of custody and long term stewardship.

Consistency with Climate Change Goals

The HECA project provides the only opportunity currently for California to include CCS technology in its portfolio of GHG emissions reduction options. The Air Resources Board’s Climate Change Scoping Plan 2008 and 2013 Update recognize that CCS must play a role in reducing industrial and electricity sector emissions in order for the state to meet its 2030 and 2050 goals as set by Governors’ Executive Orders. In that context, ARB is currently working on drafting of the quantification methodologies for geologic CCS projects to be included as a compliance option under cap-and-trade.

ATTACHMENT

Hydrogen Energy California Project

Economic Summary related to On-Site Saline Aquifer Sequestration

Revenues

At least since SCS Energy acquired HECA, the economic viability of the project has never been dependent on the forecasted EOR revenue from the anticipated Oxy agreement. In a project of this capital magnitude (over $4 billion), a revenue stream of less than $50 million per year does not move the needle much in a return analysis or debt service coverage analysis. HECA's anticipated revenue pursuant to the OXY/HECA Term Sheet would have been $24mm to $47mm per year depending on the price of oil. The capital markets would assume the lower number in its investment decision making the EOR revenue relevance to economic viability even less. At the present price of oil the revenue would in fact be $24mm.

The economics of EOR were significant for Oxy because of the tertiary recover possibilities in the Elk Hills and the price of oil at the time BP and Oxy negotiated the terms of a contract to be entered into by the parties. The value of the deal to HECA was not the revenue but simply that HECA cannot operate unless it sequesters a high percentage of its CO2; and EOR is an accepted method of sequestering CO2.

Capital

Similar to the revenue side, in the context of this $4 billion plus project, the capital required for saline aquifer sequestration with injection wells located on our own land, is trivia. This is true as well for the additional Operations and Maintenance costs associated with saline aquifer sequestration.

Before moving the project from New Jersey to California in September of 2011 at the encouragement of NETL, and amending the HECA AFC application to reflect the "polygen" configuration SCS Energy brought from New Jersey to solve the high cost of BP's power only CCS deal, there was no EOR and the CO2 was to be sequestered under the sea bed 70 miles off the New Jersey coast. SCS Energy and Schlumberger Carbon Services did significant work on project feasibility at the New Jersey location. Based on the knowledge gained from the SCS/Schlumberger feasibility study and cost estimates, HECA can conservatively estimate the all-in capital costs for saline aquifer sequestration to be in the range of $73-$95 mm. While we anticipate these cost estimates will actually decrease when we work on the detail with the National Labs going forward, we are utilizing the high range value to assess project viability under what we consider to be worst case.

Operating and Maintenance Expense

Again based on the Schlumberger work, HECA conservatively estimates the annual operating expenses for sequestration at our present site to be in the range of $10-$14mm (excluding actual CO_2 capture and compression costs, which is already included in HECA plant operations expenses).

In all, the switch to saline aquifer sequestration could alter the bottom line by a negative $45mm to $68mm ($24mm to $47mm of lost revenue plus $21mm (operating expense plus debt service due to additional capital recovery). In terms of Return on Investment, this represents a reduction of 150 to 200 basis points. These are not impacts that affect project viability. Furthermore, keeping control and ownership of the CO2 and its sequestration process eliminates significant risk from the investor and banker perspective. We have not tried to monetize the value of that risk reduction (for example the cost of shutdowns resulting from glitches in the EOR process), but I believe the project comes out ahead financially and probably significantly.

General

Since September 2011, HECA's economics have been its strength because (1) the Project is located in a state that values low carbon footprint products, (2) HECA's location is at the end of the pipeline for California's vast fertilizer demands, thus giving HECA a significant transportation cost advantage, and (3) HECA's "polygen" structure builds operation flexibility and thus an efficient use of capital.

HECA is perfectly positioned to support California's CCS policy. Its "polygen" structure combines low carbon footprint power and low carbon footprint agricultural product operations in the same project. It follows and implements work done on CO2 storage feasibility by state and federal agencies. It can now take advantage of saline aquifer sequestration due to EPA Class VI well certifications for Future Gen and ADM in the Midwest.

The bulk of the remaining AFC work was related to Oxy and its potential EOR operations. That has been simplified and the injection wells will be on the HECA site where biological and historical work has already been done.

It is note worthy that the MRV plan associated with the on going demonstration of sequestration in the Elk Hills was not finalized and approved. One huge benefit to saline aquifer sequestration, which HECA is now doing, is that the MRV and knowing precisely where the plume is over time will be a significantly less complex effort and more useful to California's documented understanding of the long term usefulness of CCS.