REPORT ON ADVISORY COUNCIL ACTIVITIES IN FEBRUARY-APRIL 2014: THE PATH FORWARD FOR THE ENERGY SECTOR TOWARD CALIFORNIA'S 2050 GREENHOUSE GAS (GHG) GOAL

EXECUTIVE SUMMARY

This report summarizes ongoing activities of the Advisory Council during February-April 2014, consolidating presentations received, and subsequent discussion and consideration by Council members during this period. It is the intent of the Council to continue study of this topic throughout 2014. As more information is received and evaluated by the Council, conclusions and recommendations are expected to evolve, and will be documented in future reports.

The following presentations were made at the February 13, 2014 Advisory Council meeting:

1. *Roadmaps for Transitioning California and the Other 49 States to Wind, Water and Solar Power for All Purposes* by Dr. Mark Jacobson, Professor of Civil and Environmental Engineering and Director of the Atmosphere/Energy Program at Stanford University.
2. *California's Transition to a Low Carbon Economy: Infrastructure, Regulation, and Local Action* by Dr. Jim Williams, Chief Scientist at Energy + Environmental Economics, and until recently, an associate professor of international environmental policy at the Monterey Institute of International Studies.

A video recording of these presentations and the Council's discussion can be reviewed at *baaqmd.granicus.com/MediaPlayer.php?publish_id=081f9418-e64b-1031-927d-78be5054b89b*

Based on these presentations, the Council has identified several key emerging issues. Primary among these is the need for further investigation and definition of the most appropriate role for the District, both in its own activities and working in collaboration with other agencies also involved in the future of energy use and production in the Bay Area.

From its activities in February-April 2014, the Advisory Council has developed the following preliminary draft recommendations for further consideration during the year:

1. Planning: The District should join together with other state, regional, and local agencies in a collaborative regional effort to plan for, facilitate, and coordinate energy-related response actions to assist in achieving the Bay Area's share of California's target of 80 percent reductions in GHG emissions by 2050.
2. Coordination: The District should encourage and support legislative and other efforts if needed to provide responsible planning agencies, including the District, with additional statutory and regulatory authorities and resources to coordinate and implement Bay Area energy-related response actions.
3. Grants: The District should further incorporate into its grant programs, as appropriate within its mission and statutory authorities, criteria that further incentivize electrification, clean energy and energy efficiency.
4. Education: The District should adopt an aggressive public education campaign that stresses the economic, health, and resiliency co-benefits of a shift to a low-carbon economy.

BACKGROUND

Professor Mark Jacobson

1. Jacobson has developed a 50-state roadmap for transforming the U.S. from dependence on fossil fuels to 100% renewable energy by 2050. Each state has the opportunity to transition to renewable wind, water, and solar (WWS) power for all purposes.[1]
2. A comprehensive approach to future energy sector planning would consider more than carbon reduction. A 100% WWS strategy would consider all aspects of climate change and also minimize negative externalities associated with air pollution, public health impacts, and resource availability. According to Jacobson, the benefits of such a transition in California would be thousands fewer air pollution deaths per year, tens of billions of dollars in reduced global climate costs, tens of thousands of new jobs, and reduced future energy costs.
3. Given the scale and complexity of this transformation, action needs to begin. Reasons for needing this transition include the impacts of climate change, the health effects of air pollution (which Jacobson stated kills 2.5 to 4 million people worldwide each year based on estimates of the World Health Organization), and the risk that rising fossil fuel prices lead to economic, social, and political instability.
4. While often considered to be cleaner than current fossil fuel energy technologies, some non-WWS energy technologies may themselves present significant adverse climate, environmental, and/or health effects, as compared to WWS sources. According to Jacobson, these "not recommended" fuel sources include natural gas, "clean coal" with carbon capture, nuclear, soy/algae biodiesel, and ethanol (corn, cellulosic, sugarcane).
5. Jacobson illustrated the land use impacts of a 100% WWS scenario for California. In this example scenario, existing WWS sources would be retained, with improved efficiency. New WWS sources to replace existing non-WWS sources would be a mix of 35% from wind, 55% from solar, and 10% from other sources (geothermal, hydro,[2] tidal, wave). The footprint of the total energy supply portfolio in this scenario would be less than 1% of the state's land area (or ~2.7% including the open space between wind turbines). This scenario would require tens of thousands of new on- and offshore wind turbines, millions of residential roof photovoltaic (PV) systems, several thousand large-scale solar plants, and a number of geothermal, hydro, tidal, and wave plants and devices.
6. While the intermittent nature of renewables is sometimes cited as a barrier to high levels of renewable electricity integration, Jacobson stated that over 99.8% of California's energy needs can be supplied from WWS (without over-sizing) using real-time demand-response or energy storage to match power generation to daily and time-of-day demand.

[1] "All purposes" as used here refers to electricity, transportation, building heating and cooling, and industry. For more details and the illustrative plans developed by Professor Jacobson and his collaborators for California and other states, see www.thesolutionsproject.org.

[2] The scenarios assume that existing large hydro supplies would remain in place.

7. According to Jacobson, WWS energy technologies are in many cases cost-competitive with conventional sources today when life-cycle costs are considered. Including a conservative estimate of fossil fuels' negative externalities would make WWS sources even more cost effective. By 2020-2030, WWS sources will be less expensive than conventional supplies, even without accounting for externalities.
8. Jacobson also spoke about using excess electricity to generate hydrogen as an energy storage mechanism. Energy storage is a key element in the use of renewable power.

Dr. Jim Williams

1. California's climate goals include the AB 32 requirement to reduce statewide GHGs to 1990 levels by 2020, along with the goal of reducing GHGs to 80% below 1990 levels by 2050 (Executive Order S-3-05).
2. Beyond 2020, Williams believes the California policy approach is likely to follow a similar framework to AB 32, but a transformation of the energy system is required to meet the 2050 goal. Williams identified three primary strategies related to energy:
    a. Reduce energy use through efficiency (in buildings and vehicles) and smart growth. Examples include the retrofit of the majority of existing homes over the next 20 years and achieving "zero net energy" in all new homes beginning in 2020.
    b. Decarbonize both electricity and transportation fuels. The state's loading order[3] may need to be modified to integrate greater concentrations of renewables. However, Williams stated that some low carbon electricity resources will still be needed to maintain grid reliability.
    c. Electrification of transportation, building heating/cooling and industrial processes. Over the next 20 years, examples include the replacement of 70% of gasoline and diesel light-duty vehicles with EVs or PHEVs, as well as the replacement of 75% of existing gas water heaters with electric heat pump water heaters.
3. The scale of up-front investment needed statewide by 2050 is quite large,[4] but variability in fossil fuel costs also presents a cost risk for inaction. Decarbonization and electrification will shift the energy economy to be dominated by fixed (capital) costs rather than variable (fuel) costs. In addition, there will be co-benefits (climate, health, etc.) that come with this shift.
4. The extent of the transformation requires solutions to a variety of technical and planning challenges. In addition, achieving these goals will require better coordination across state and regional agencies and sectors that have typically operated in silos, as well as the establishment of clear GHG mandates to guide the actions of each agency.

[3] The loading order defines the priority that utilities must assign to different types of electric supply, with efficiency and demand response coming first, followed by renewables and then other supplies.
[4] There is a large uncertainty in both technology costs and fuel costs, but the net cost increase could be on the order of ~$500 billion by 2050. The cost estimates presented did not provide a value for the co-benefits (reduced externalities) of shifting away from polluting fuels.

5. Of particular note for the District, as transportation is electrified, emissions from the transportation sector (regulated by the State) will shift more and more toward stationary sources (regulated by the District).
6. Williams argued that public support and politics are bigger obstacles than technical abilities in reducing our GHG emissions for the future.

KEY EMERGING ISSUES

1. Further definition of the Bay Area's role. Further investigation is needed to identify, evaluate, and prioritize policies and measures that the District and other regional agencies can implement to support and advance attainment of the District's 2050 GHG reduction goals. Policies and measures need to be developed that are effective, efficient, and feasible, and they need to be coordinated across agencies, accounting for each agency's mission and authorities.
2. Further evaluation of the District's role. To achieve 2050 GHG reduction goals, a fundamental transition in energy sources and usage will need to be made across California and thus the Bay Area. This transition affects a number of areas that are within the District's ability to regulate, as well as other areas that are outside the District's current authority. Further evaluation of the District's evolving role is needed, including its authority and capacity to regulate and/or permit stationary sources that emit GHGs (with a long-range goal of reducing use of carbon fuels and their impacts on climate, air quality, and public health), influence indirect GHG emissions associated with energy consumed within the District, continue to educate the public, and coordinate with other agencies or expand its role in areas that the District has not traditionally pursued, including:
    a. Energy efficiency (e.g., codes, financing, retrofits)
    b. Energy use (e.g., choice of supply, rates, reliability)
    c. Energy generation (e.g., distributed energy, on-site renewable, CCS)
    d. Sources of energy use and emissions in buildings (e.g., water heaters, furnaces)
    e. Planning (e.g., zoning, density, infill)
    f. Transit (e.g., mode shifting, biking, walkable cities)
    g. Vehicles and goods movement (e.g., infrastructure, consumer choices, technology development)
    h. Non-energy/non-CO_2 GHGs (e.g., methane, HFCs, SF6)
    i. Waste (e.g., waste management, landfill gases)
    j. Agriculture (e.g., animal feedlots, agricultural tillage, forestry)
    k. Tailpipe emissions from vehicles
    l. Upstream/life-cycle impacts (e.g., emissions over life cycle, not just in the District)
    m. Water (e.g., use, pumping, efficiency)
    n. Climate change adaptation
    o. Carbon sequestration
    p. Parks and public lands
3. Decarbonization of energy used in the District. For the Bay Area to achieve long-term climate goals in the energy sector, a fundamental transition must be made to lower per capita GHG

emissions. Although it will require cooperation and coordination with the California Public Utilities Commission (CPUC) and California Energy Commission (CEC), further investigation is needed in the District to develop and deploy major improvements in energy efficiency in all sectors, including transportation. Attainment of the District's 2050 GHG reduction goals will require more than just energy efficiency. Energy supply will need to be decarbonized, and energy demand will need to be supplied through low and no-carbon resources. How this will be done -- what policy choices, regulatory approaches, technology developments, and implementation measures will be needed – is a major and critically important emerging issue. Further investigation is needed to identify, develop, and deploy measures to reduce the carbon intensity of energy (imported and produced within the Bay Area) used in residential, commercial, and industrial applications, as well as in the transportation sector.

4. Resiliency. Further investigation is needed to better understand how the shift to low-carbon energy supply and demand might help insulate California from the worst impacts of climate change, including drought, reduced snow pack, sea level rise, heat waves, and energy price volatility.
5. Grid reliability. Further investigation is needed to identify means by which grid reliability and back-up power generation can be ensured while also transitioning from fossil fuels to low carbon energy sources. Zero (or minimum) emission energy source dispatching strategies and tools for implementing those strategies need to be developed, demonstrated, and deployed.
6. Financing availability. Further investigation is needed to identify, evaluate, and demonstrate the availability and feasibility of mechanisms necessary to finance the measures required to achieve the District's 2050 GHG reduction goals, including additional innovative financing measures that provide benefits for all interested stakeholders.

RECOMMENDATIONS

Based on information presented at the February 13, 2014 meeting of the Advisory Council, as well as member input, the Advisory Council offers the following preliminary draft recommendations for further discussion and consideration throughout 2014. It is the intent of the Council to revisit these recommendations throughout the year, modifying them if appropriate as additional information and input is received.

1. Planning. We recommend that the District join together with other state, regional, and local agencies in a collaborative regional effort to plan for, facilitate, and coordinate energy-related response actions to assist in achieving the Bay Area's share of California's target of 80 percent reductions in GHG emissions by 2050.
    a. Coordinated multi-agency planning will assist in further defining agency roles and authorities, helping to identify and prioritize cross- and intragency energy supply response options, based on a combination of climate, air quality, public health, water, economic, and other factors.
    b. Planning should consider the following core principles:

i. Greater electrification of energy use across all sectors, including transportation, will be necessary.
ii. Lower-carbon energy sources should be further encouraged where electrification is not feasible.
iii. Greater decarbonization of electricity supply will need to occur, resulting in an increasing shift from reliance on fossil fuels to renewable sources.
iv. Diversification of energy sources, biological resources, and economic investments is expected to be necessary and lead to strength, sustainability, and stability in each area.
v. All key externalities (e.g., climate, air quality, health, water) should be considered, not just dollar cost.

c. The District should further integrate its share of high-priority energy supply response actions into:
   i. District air quality and climate planning efforts, including the District's multi-pollutant planning approach.
   ii. The District's regulatory, permitting, and other programs.
   iii. The District's CEQA guidelines.

2. Coordination. We recommend that the District encourage and support legislative and other efforts if needed to provide responsible planning agencies, including the District, with additional statutory and regulatory authorities and resources to coordinate and implement Bay Area energy-related response actions.

3. Grants. We recommend that the District, as appropriate within its mission and statutory authorities, consider incorporation into its grant programs criteria, and if necessary seek authority and funding, to further incentivize:

   a. Development of infrastructure to support electrification (e.g., EV charging stations, solar PV, electrical heating and cooling), including enhancement of incentives for residents and building owners.
   b. Clean-energy backup emergency power systems, rather than diesel/gasoline generators, at both individual building and community levels.
   c. Promotion of energy efficiency measures in buildings, appliances, and processes, considering building performance, potential unintended adverse health consequences, and measures to minimize such consequences.

4. Education. We recommend that the District consider:

   a. Integration into its public education programs further recognition of energy choices and their public health, air quality, and climate benefits.
   b. Development of outreach strategies that further stress economic, health, and resiliency co-benefits of a shift to a low-carbon economy, and that use bottom-line metrics that best appeal to issues about which people care most (e.g., personal and family health and cost).

5. Operations. We recommend that the District consider as appropriate further steps to reduce the carbon footprint of its operations and facilities.

GLOSSARY

Carbon intensity – The average emission rate of grams of carbon dioxide released per unit of energy produced.

CCS (Carbon Capture and Sequestration) – The process of trapping carbon dioxide at its emission source, transporting it to a usually underground storage location, and isolating it there.

Cellulosic ethanol – Ethanol produced from biomass of various kinds, including waste from urban, agricultural, and forestry sources.

Clean coal with carbon capture – see CCS, above.

Decarbonization – The declining average fossil carbon footprint of primary energy over time.

Electrification – To supply (a region, community, building, etc.) with electric power.

Energy source dispatching strategies – Strategies for controlling energy flows to "the grid" from numerous energy sources (such as a combination of wind, water and solar) to balance the temporally-variable availability of each source with the total overall energy demand.

EV – Electric Vehicle

Externalities – External effects, often unforeseen or unintended, accompanying a process or activity.

GHG (Greenhouse Gases) – A gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Other greenhouse gases include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

HFC (Hydrofluorocarbon) – A suggested replacement for the chlorofluorocarbon (CFC) coolant gas used in chillers and air conditioners.

Low-carbon – Minimal output of greenhouse gas (GHG) emissions.

PHEV (Plug-in Hybrid Electric Vehicle) – A hybrid vehicle which utilizes rechargeable batteries, or another energy storage device, that can be restored to full charge by connecting a plug to an external electric power source (usually a normal electric wall socket).

PV (Photovoltaic) – Producing electric current or voltage caused by electromagnetic radiation, especially visible light from the sun.

SF_6 (Sulfur hexafluoride) – An inorganic, colorless, odorless, non-flammable, extremely potent greenhouse gas which is an excellent electrical insulator.

Soy/algae biodiesel – Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat) with an alcohol producing fatty acid esters. Biodiesel is meant to be used in standard diesel engines and is thus distinct from the vegetable and waste oils used to fuel converted diesel engines. Biodiesel can be used alone, or blended with petrodiesel in any proportions. Biodiesel can also be used as a low carbon alternative to heating oil. A variety of oils can be used to produce biodiesel. These include algae, which can be grown using waste materials such as sewage and without displacing land currently used for food production.

Zero-carbon – Zero output of greenhouse gas (GHG) emissions.