BAY AREA
AIR QUALITY
MANAGEMENT
DISTRICT

ADVISORY COUNCIL MEETING

WEDNESDAY
NOVEMBER 12, 2014
9:00 A.M.

7TH FLOOR BOARD ROOM
939 ELLIS STREET
SAN FRANCISCO, CA 94109

AGENDA

CALL TO ORDER

1. **Opening Comments** — **Sam Altshuler, Chairperson**
   Roll Call — **Clerk**

   The Chairperson shall call the meeting to order and make opening comments. The Clerk of the Boards shall take roll of the Advisory Council members.

2. **PUBLIC COMMENT ON NON-AGENDA MATTERS**

   Pursuant to Government Code Section 54954.3, the public has the opportunity to speak on any agenda item. All agendas for Advisory Council meetings are posted at the District, 939 Ellis Street, San Francisco, California 94109 at least 72 hours before a meeting. At the beginning of the meeting, an opportunity is also provided for the public to speak on any subject within the Advisory Council's purview. Speakers are limited to three minutes each.

3. **APPROVAL OF THE MINUTES OF THE ADVISORY COUNCIL MEETING ON OCTOBER 8, 2014**

   The Advisory Council will consider approving the draft minutes of the Advisory Council meeting of October 8, 2014.

DISCUSSION

4. **Discussion of Draft Report on the Advisory Council's Meeting on September 10, 2014**

   The Advisory Council will discuss, finalize and consider approval of the draft report on the September 10th meeting on "California's Energy Future and the Move Towards the 2050 Green House Gas Goals."

5. **Discussion of Draft Report on the Advisory Council's Meeting on October 8, 2014**

The Advisory Council will discuss and potentially finalize and consider approval of the draft report on the October 8th meeting on "Energy Storage and Smart Grid Technologies and Their Relationship to the 2050 Greenhouse Gas Goals."

6. **Discussion of Advisory Council Presentation to the Board of Directors**

The Advisory Council will discuss presenting a summary of the Advisory Council's 2014 activities to the Board of Directors.

7. **Discussion of Senate Bill 1415**

The Executive Officer/Air Pollution Control Officer (APCO) will provide the Advisory Council an update on Senate Bill 1415.

OTHER BUSINESS

8. **Report of the Executive Officer/APCO**

The Executive Officer/APCO will provide the Advisory Council a report of recent and upcoming activities.

9. **Selection of Slate of Officers for 2015**

The Advisory Council will select a slate of officers for 2015.

10. **Future Topics for the Current Advisory Council**

Council members and staff will discuss future topics to be covered by the current Advisory Council.

11. **Chairperson's Report**

The Chairperson will provide the Advisory Council a report of recent and upcoming activities.

12. **Advisory Council Member Comments/Other Business**

Advisory Council members may make a brief announcement, provide a reference to staff about factual information or ask questions about subsequent meetings.

13. **Time and Place of Next Meeting**

January 14, 2015 at 9:00 a.m. at 939 Ellis Street, San Francisco, California 94109.

14. **Adjournment**

The Advisory Council meeting shall be adjourned by the Chairperson.

CLERK OF THE BOARDS **(415) 749-5073**
939 ELLIS STREET, SAN FRANCISCO, CA 94109 **FAX: (415) 928-8560**
sgallagher@baaqmd.gov **BAAQMD homepage:**
www.baaqmd.gov

Contact:

- To submit written comments on an agenda item in advance of the meeting. Please note that all correspondence must be addressed to the "Members of the Advisory Council" and received at least 24 hours prior, excluding weekends and holidays, in order to be presented at that Council meeting. Any correspondence received after that time will be presented to the Council at the following meeting.

- To request, in advance of the meeting, to be placed on the list to testify on an agenda item.

- To request special accommodations for those persons with disabilities notification to the Clerk's Office should be given in a timely manner, so that arrangements can be made accordingly.

Any writing relating to an open session item on this Agenda that is distributed to all, or a majority of all, members of the body to which this Agenda relates shall be made available at the District's offices at 939 Ellis Street, San Francisco, CA 94109, at the time such writing is made available to all, or a majority of all, members of that body.

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
939 ELLIS STREET, SAN FRANCISCO, CALIFORNIA 94109
FOR QUESTIONS PLEASE CALL (415) 749-5016 or (415) 749-4941

EXECUTIVE OFFICE:
MONTHLY CALENDAR OF AIR DISTRICT MEETINGS

NOVEMBER 2014

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Advisory Council Regular Meeting *(Meets on the 2nd Wednesday of each Month)*	**Wednesday**	**12**	**9:00 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	**Thursday**	**13**	**9:30 a.m.**	**Board Room**
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)* **- CANCELLED**	**Monday**	**17**	**9:30 a.m.**	**4th Floor Conf. Room**
Board of Directors Climate Protection Committee – *(Meets 3rd Thursday every other Month)* - **CANCELLED AND RESCHEDULED TO MONDAY, DECEMBER 1, 2014**	**Monday**	**17**	**9:30 a.m.**	**Board Room**
Board of Directors Nominating Committee *(At the Call of the Chair)*	**Monday**	**17**	**9:30 a.m.**	**Room 716**
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Monday**	**17**	**9:45 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)* - **CANCELLED**	**Monday**	**24**	**9:30 a.m.**	**Board Room**
Board of Directors Stationary Source Committee *(Meets Quarterly at the call of the Chair)*	**Monday**	**24**	**9:30 a.m.**	**Board Room**
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)*	**Wednesday**	**26**	**9:30 a.m.**	**4th Floor Conf. Room**

DECEMBER 2014

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Climate Protection Committee – *(Meets 3rd Thursday every other Month)*	**Monday**	**1**	**9:30 a.m.**	**Board Room**
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**3**	**9:45 a.m.**	**Board Room**
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)*	**Monday**	**15**	**9:30 a.m.**	**4th Floor Conf. Room**

DECEMBER 2014

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**17**	**9:45 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	**Thursday**	**18**	**9:30 a.m.**	**Board Room**
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)*	**Wednesday**	**24**	**9:30 a.m.**	**4th Floor Conf. Room**

JANUARY 2015

TYPE OF MEETING	DAY	DATE	TIME	ROOM
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**7**	**9:45 a.m.**	**Board Room**
Advisory Council Regular Meeting *(Meets on the 2nd Wednesday of each Month)*	**Wednesday**	**14**	**9:00 a.m.**	**Board Room**
Board of Directors Climate Protection Committee – *(Meets 3rd Thursday every other Month)*	**Thursday**	**15**	**9:30 a.m.**	**Board Room**
Board of Directors Executive Committee *(Meets on the 3rd Monday of each Month)*	**Monday**	**19**	**9:30 a.m.**	**4th Floor Conf. Room**
Board of Directors Regular Meeting *(Meets on the 1st & 3rd Wednesday of each Month)*	**Wednesday**	**21**	**9:45 a.m.**	**Board Room**
Board of Directors Mobile Source Committee *(Meets on the 4th Thursday of each Month)*	**Thursday**	**22**	**9:30 a.m.**	**Board Room**
Board of Directors Budget & Finance Committee *(Meets on the 4th Wednesday of each Month)*	**Wednesday**	**28**	**9:30 a.m.**	**4th Floor Conf. Room**

AGENDA: 3

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Sam Altshuler and Members of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: October 29, 2014

Re: Approval of the Minutes of the Advisory Council Meeting on October 8, 2014

RECOMMENDED ACTION

Approve the attached draft minutes of the regular meeting of the Advisory Council on October 8, 2014.

DISCUSSION

Attached for your review and approval are the draft minutes of Advisory Council meeting on October 8, 2014.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Sean Gallagher
Reviewed by: Maricela Martinez

Attachment: Draft Minutes of the Advisory Council Meeting of October 8, 2014

Draft Minutes – Advisory Council Regular Meeting of October 8, 2014

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109
(415) 749-5073

DRAFT MINUTES

Advisory Council Regular Meeting
Wednesday, October 8, 2014

Note: Audio and video recordings of the meeting are available on the website of the Bay Area Air Quality Management District at http://www.baaqmd.gov/The-Air-District/Board-of-Directors/Advisory-Council/Agendas-and-Minutes.aspx.

1. CALL TO ORDER:

Chairperson Sam Altshuler called the meeting to order at 9:05 a.m.

Roll Call:

Present: Chairperson Sam Altshuler, P.E.; Vice-Chairperson Liza Lutzker, M.P.H.; and Members Robert Bornstein, Ph.D., Harold Brazil, Jonathan Cherry, A.I.A., Heather Forshey, Stan Hayes, John Holtzclaw, Ph.D., Rick Marshall, P.E., P.L.S., Bruce Mast and SaraT L. Mayer, M.P.P.

Absent: Secretary Jessica Range, LEED A.P.; and Members Ana M. Alvarez, D.P.P.D., Benjamin Bolles, Jeffrey Bramlett, M.S., C.S.P., Frank Imhof, Kraig Kurucz, Timothy O'Connor, Esq., Estes Al Phillips (resigned) and Laura E. Tam.

Also Present: None.

Opening Comments:

Chairperson Altshuler provided an update on Senate Bill 1415 and made brief statements regarding today's agenda.

2. PUBLIC COMMENT ON NON-AGENDA ITEMS: No requests received.

3. APPROVAL OF THE MINUTES OF THE ADVISORY COUNCIL (COUNCIL) MEETING ON SEPTEMBER 10, 2014

Council Comments: None.

Public Comments: No requests received.

Council Action:

Member Holtzclaw made a motion, seconded by Member Mast, to approve the minutes of the Council meeting on September 10, 2014; and the motion carried by the following vote of the Council:

AYES: Altshuler, Bornstein, Brazil, Cherry, Hayes, Holtzclaw, Lutzker, Marshall and Mast.

NOES: None.

ABSTAIN: Forshey and Mayer.

ABSENT: Alvarez, Bolles, Bramlett, Imhof, Kurucz, O'Connor, Phillips, Range and Tam.

Opening Comments (Continued):

The Council discussed the composition of the work group that will prepare the draft Council report on the upcoming presentation.

DISCUSSION

4. Discussion of Draft Report on the Council's Meeting on September 10, 2014

Council Comments:

The Council deliberated upon proposed revisions to the draft report on the Council meeting on September 10, 2014.

PRESENTATION

5. Energy Storage and Smart Grid Technologies and Their Relationship to the 2050 Greenhouse Gas (GHG) Goals

Chairperson Altshuler introduced Haresh Kamath and provided a brief description of his background and that of the Electric Power Research Institute (EPRI).

Energy Storage and Smart Grid Technologies and Their Relationship to 2050 GHG Goals
Haresh Kamath
Program Manager, Energy Storage
EPRI

Mr. Kamath gave a presentation entitled *The Integrated Grid: Energy Storage and Smart Grid Technologies and their Relationship to 2050 GHG Goals* (a copy of which is available on the website of the Bay Area Air Quality Management District at http://www.baaqmd.gov/The-Air-District/Board-of-Directors/Advisory-Council/Agendas-and-Minutes.aspx).

Council Comments:

The Council and Mr. Kamath discussed the funding sources for EPRI; the psychology of the increase in photovoltaic installations; the role of state and federal regulations in spurring industry deployment of sustainable technology; the adequacy of the current deployed grid storage worldwide and need for solutions to uneven demand and production including, but not limited to, storage; who pays for installations of the various devices and systems being discussed; the viability of the California goal to have an additional 2% storage capacity by 2020; primary challenges to integrated grid approach; possible solutions to issues of limited lifecycle and waste generation relative to battery storage; recommendations Mr. Kamath would make to the Board of Directors if given the opportunity; why phone batteries were alluded to in the presentation as a resource instead of a demand; reconciliation of seemingly competing claims about the energy demand of consumer electronics as a percentage of total energy demand; the complexity of the interplay between meteorological conditions and energy demand; the source of seemingly unattainable estimates of necessary storage capacity and possible solutions; the need for research on the differences in the reliability of sustainable energy sources in Germany and California; the role of demand response in examining and achieving storage capacity needs; whether there is a significant role to be played by a regional agency, such as the Air District, in the current phase of the larger dialogue at the state and federal levels; and whether the Council should invite Amory Lovins to present on the subject of negawatts.

Public Comments:

Mark Roest, SeaWave Battery, Inc., addressed the Council regarding estimated megawatt storage capacity needs; projections about renewable energy becoming less expensive than fossil fuel-generated energy; expected battery capacity from emerging technologies utilizing materials of decreased toxicity; and the inconsistency of the wind patterns at the Suisun and Tehachapi wind farms compared to prevailing generalizations about wind power generation.

Council Action: None; receive and file.

DISCUSSION (CONTINUED)

6. Discussion of Draft Report on the Council's Meeting on September 10, 2014 (Continued)

Council Comments:

The Council continued to deliberate upon proposed revisions to the draft report on the Council meeting on September 10, 2014.

Public Comments: No requests received.

Council Action: None; receive and file.

OTHER BUSINESS

7. Future Topics for the Current Council

The Council and staff discussed potential directions the Council may go with future topics and invited the submission of suggestions for further discussion at the next Council meeting.

8. Chairperson's Report

Chairperson Altshuler called for nominations for the slate of officers for 2015; nominated Member Cherry for Secretary; and asked whether the Council would consider extending the term of the slate of officers for 2014 through the first half of 2015.

The Council discussed extending the term of the slate of officers for 2014 through the first half of 2015; the appointment or reappointment of members whose terms are expiring at the end of 2014; and concerns regarding the Council's ability to achieve a quorum in 2015.

9. Council Member Comments/Other Business

Member Hayes commended Air District staff on their appearance at a recent, local Air & Waste Management Conference and for the ultrafine particulate matter presentation on display in the Air District's seventh floor lobby.

10. Time and Place of Next Meeting:

Wednesday, November 12, 2014, Bay Area Air Quality Management District Headquarters, 939 Ellis Street, San Francisco, CA 94109 at 9:00 a.m.

11. Adjournment: The meeting adjourned at 12:24 p.m.

Sean Gallagher
Clerk of the Boards

AGENDA: 4

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Sam Altshuler and Members of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: October 29, 2014

Re: Discussion of Draft Report on the Advisory Council's Meeting on September 10, 2014

The draft report of the September 10, 2014, Advisory Council Meeting on *The Path Forward for the Energy Sector to Move Towards the 2050 Greenhouse Gas Goals* will be discussed, finalized and considered for approval.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Sean Gallagher
Reviewed by: Maricela Martinez

Attachment: Draft Report of the Advisory Council's Meeting on September 10, 2014

EXECUTIVE SUMMARY

This report summarizes ongoing activities of the Advisory Council during September-November 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 during the early portion of 2015. 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 presentation was made at the September 10, 2014 Advisory Council meeting:

> *Energy and Climate Opportunities for the Bay Area* by Daniel M. Kammen, Ph.D., Class of 1935 Distinguished Professor of Energy, Energy and Resources Group and Goldman School of Public Policy, Founding Director of the Renewable and Appropriate Energy Laboratory, University of California, Berkeley

A video recording of these presentations and the Council's discussion can be reviewed at http://baaqmd.granicus.com/MediaPlayer.php?publish_id=2b960489-3929-11e4-bf9a-00219b9a9d7d

Building on the foundation of AB 32 and the numerous policies implemented in California to meet the climate and clean energy goals, Dr. Kammen presented his "SWITCH" model, which analyzes the adequacy of energy generation, transmission, and storage systems to satisfy load by allowing for the possibility of a variety of energy sources (including solar, wind, water, nuclear, geothermal, and fossil), as well as energy conservation.

The model suggests that there are multiple pathways to achieve greenhouse gas (GHG) emissions reduction goals while simultaneously ensuring grid reliability, so long as carbon pricing is integrated into the decision-making process. Each of these pathways is projected to be economically comparable to, or cheaper than, the business as usual strategy.

Some of the recommendations contained in this report are for the Air District to: (1) consider carbon analysis and accounting during decision making for major projects submitted as part of the permitting process; (2) provide education about the cost-effectiveness of shifting to a low-carbon energy future; (3) conduct future energy and climate change work in a manner that is consistent with principles of promoting equity and advancing environmental and economic opportunities in disadvantaged communities, and (4) promote user-friendly tools to assist individuals, business and local governments to reduce their carbon footprint.

BACKGROUND

Energy policy in CA

1. CA remains in a leadership position on climate change mitigation and clean energy development. Not only did the state adopt AB 32 in 2006, a bill that sets an aggregate climate pollution target for the year 2020, it has also adopted a series of integrated and complementary policies to address climate change and promote clean energy development across the economy. This "interlocking set of policies" guarantees that, even if one program fails, the others can remain intact and aim toward the same ambitious performance target.

2. While California's climate program sets ambitious targets, California represents only 2% of worldwide greenhouse gas (GHG) emissions. For maximum effectiveness in the effort to limit climate change, statewide efforts must work within and promote international actions to combat climate change. Moving forward, California's global leadership position on climate change policy will be as important, if not more, than its effectiveness at reducing in-state emissions.

Dr. Kammen's SWITCH Model

3. The SWITCH model, developed by Dr. Kammen and collaborators, is a high-resolution energy-capacity-planning model based on a representation of electric grid within the Western Electricity Coordinating Council (WECC) region. (Other regions in the world have also been modeled using SWITCH, yielding nearly identical results.) As described by Dr. Kammen, SWITCH explicitly models energy sources, sinks, storage and transmission within the WECC. Further, it accounts for changes within the WECC that are the result of policies that impact carbon prices and renewable portfolio standards. Other policies may also have impacts that are not accounted for in the model, and the model does not take into account health costs, non-carbon environmental benefits, or other externalities, nor does it model electric-pricing demand response (since data in this area are sparse). Minimizing system costs to deliver power on an hourly basis and maintaining capacity reserve margins are explicit model constraints, and the model is run across a wide variety of seasons and times of day.

Model results and conclusions

4. Using SWITCH, Dr. Kammen asserts that there are many pathways to achieve the AB 32 GHG reduction goals while also ensuring reliability of the electric grid. However, Dr. Kammen and SWITCH find that embedding a carbon price into relevant decision-making processes must also be achieved for this result to be reached.

5. Each of the pathways for AB 32 compliance is projected to be lower cost than the business as usual (BAU) strategy. These findings are projected to hold even when SWITCH is run on a wide variety of days, including the least windy, hottest days in summer time.

6. According to Dr. Kammen and the SWITCH model, constraints on technology are not projected to be a limiting factor in meeting the goals embedded within AB 32 and other clean energy policies. Instead, policy and market forces will likely prevail, enabling investments in technological improvements that will cut emissions and deliver clean energy solutions.

   For example, large-scale renewables have historically proven difficult to bring on-line without substantial new transmission capacity and sufficient backup power, while new transmission lines and large-scale energy generation facilities have proven challenging to site. Recent policy developments that enhance the permitting process for siting renewable energy sources and transmission capacity have been promising, but further long-term policy support will still be needed "to ensure coordinated investment in research and development and infrastructure, and efficient deployment of enabling technologies such as storage, demand response, flexible transmission, and active controls."[1]

   Furthermore, according to SWITCH and Dr. Kammen, a carbon price point of approximately $40 per ton is forecast for 2030 to create an economic incentive to decarbonize economies across the planet. At present, the California carbon price is about $12/ton, and it is $20/ton in China.

7. In all iterations of SWITCH, the "duck curve" problem, which utility companies use to illustrate concerns about mismatched renewable generation and demand (i.e., time-of-day availability of solar energy), is not projected to be problematic. Other energy sources in the near term, and a better distribution of energy assets (including improved energy storage) in the long term provide solutions to this so-called problem.

Climate change mitigation and social equity

8. According to Dr. Kammen, if climate change efforts proceed without regard to equity, issues of environmental and social injustice will remain, and are likely to be exacerbated. For example, without a focus on equity, energy efficiency programs may leave homeowners who cannot afford efficiency upgrades with higher energy bills as compared to homeowners who can afford the upgrades. Similarly, low-income renters may become priced out of

[1] Mileva A, JH Nelson, J Johnston, and DM Kammen. "SunShot Solar Power Reduces Costs and Uncertainty in Future Low-Carbon Electricity Systems." *Environ Sci Technol* **2013,** 47, 9053-9060.

upgraded, energy efficient housing in transit-rich, mixed use, low-carbon intensive urban cores and into higher-carbon intensive and transit-deficient suburbs. Instead, when working on climate issues, it is crucial that consideration of environmental and social justice be at the forefront.

Reconciling with other speakers

9. Four previous speakers have presented to the Advisory Council in 2014 on the topic of the Bay Area's Energy Future (Dr. Mark Jacobson of Stanford University, Dr. Jim Williams of Energy + Environmental Economics, Dr. Jane Long of Lawrence Livermore National Lab, and Emilio Camacho, Esq., Advisor to California Energy Commissioner Hochschild). While each speaker presented a somewhat different approach to achieving AB 32's 2050 GHG reduction goal, all four concurred that there are three essential areas for action: 1) continued focus on energy efficiency, 2) the electrification of end-uses, and 3) the decarbonization of the energy supply.

10. Drs. Long and Jacobson parted ways on their assessment of the feasibility of relying solely on wind, hydropower, and solar (WWS) to meet California's energy future needs. Dr. Jacobson argued that virtually 100% of energy needs could met through WWS without over-sizing the capacity of the generation system while Dr. Long argued that the low load factors for wind and solar (30-40%) present tremendous load balancing challenges that cannot be met with a WWS-only strategy. Instead, according to Dr. Long, California will need to rely on an "all of the above" approach.

11. According to Dr. Kammen, an approach somewhere between Drs. Long and Jacobson is needed, though his view of long-term (i.e., 2050) climate goals aligns more closely with Dr. Jacobson.
    a. Dr. Kammen expressed that, while Dr. Long's vision seems to be that the future will largely resemble the present, he is much more optimistic that the future of storage technologies and other technological innovations will radically transform energy possibilities.
    b. At the same time, Dr. Kammen noted issues with Dr. Jacobson's approach of re-starting our entire energy system from scratch, and that significant expansion of existing energy infrastructure is needed for the energy future.
    c. The models employed by Drs. Jacobson and Kammen also differed, with the former matching supply with demand and the latter adding an economic component that accounts for costs of necessary developments in infrastructure.

12. Dr. Williams stressed the importance of the electrification of all end-uses. Dr. Kammen agreed that electrification is extremely important, but he went on further to identify the use of lifecycle analysis of carbon intensity as the key

methodology to guide our decisions about whether and when to electrify any given end use.

KEY EMERGING ISSUES RELEVANT TO THE BAY AREA

The key emerging issues identified below represent a synthesis of the information contained in the presentations given to the Advisory Council in the 2014 by speakers as well as analysis of these presentations by the Advisory Council.

1. Business objectives that meet and even go beyond the AB 32 goal can be cost-effective, i.e., they can make or save money for utilities and many other types of businesses. Storage, grid infrastructure, and developing renewable energy sources all represent opportunities for the utility companies to generate revenue. Further, investment in fossil fuels will, in the long-term, be a poor economic choice given increasing carbon prices, and divesting companies' investments and retirement accounts from fossil fuels represents a financially prudent decision.

2. Equity and environmental justice are important considerations associated with climate change mitigation because the adverse effects of climate change will disproportionately affect disadvantaged communities. Policies put into place to mitigate climate change must not exacerbate existing equity issues. Strong public policy will need to be put into place to balance the need for considerations of equity in all projects with the simultaneous requirement that all projects be pro-business.

3. There is an urgent need to improve upon and develop technologies for storing cleanly-produced energy. Through laws such as AB 2514, the California Public Utilities Commission (CPUC) has endorsed a target of having at least an additional 2% of California's 2020 energy mix provided by storage during peak demand times and when renewable sources like WWS are low.
    a. Several energy storage technologies and designs currently exist, including compressed air, batteries, hydrogen, and pumped hydroelectric.
    b. Energy storage elements are optimal when co-located with renewable energy generation elements, especially in those areas most in need of storage support. A so-called "locational feed-in tariff" would create a price signal from utilities to incentive the placement of renewable generation and storage in locations most in need of energy.

4. When observed on a carbon intensity basis, metropolitan cities exhibit a carbon emissions doughnut pattern, with lower-emission urban cores and higher emission suburbs. Some of this is due to commute patterns, but it is also due to larger homes and greater reliance on vehicles to procure goods and services (versus in dense, "complete" neighborhoods that are mixed-use, walkable, bikable, and transit-rich). Taking this pattern into account in environmental permitting and investments in suburban areas can alleviate some of these concerns, as can improvements in walking and cycling infrastructure and innovations on the mass transit of both people and goods. Further, the large square footage of homes and open land in

suburban areas provides important opportunities for energy generation, such as in the installation of solar panels.

5. Individuals and local jurisdictions (urban and suburban) can be empowered to make the best choices that benefit the environment and save money through user-friendly tools like CoolCalifornia.org, which was developed to assess, and provide tips on how to reduce, the carbon footprint of individuals, business, and jurisdictions.

6. There is a need to better understand demand response among Bay Area residents. The CPUC defines demand response as "end-use electric customers reducing their electricity usage in a given time period, or shifting that usage to another time period, in response to a price signal, a financial incentive, an environmental condition or a reliability signal."

RECOMMENDATIONS

1. The Air District should make carbon analysis and accounting a business requirement for all institutions and activities above a certain threshold (to be defined) as part of the initial permitting and renewal processes.
    a. Don't charge businesses for their carbon emissions (yet), but require this accounting for all permits issued.
    b. The analysis should take into account lifecycle emissions and address the full carbon exposure from direct and indirect business activities.
    c. Pay particular attention to the permitting of back-up diesel engines and generators, including requiring analyses of both the proposed and alternative fuels and systems.

2. The Air District should work with utilities to ensure a mutual exchange to understand future energy strategies and their respective costs and benefits. The District should also work with utilities to promote public outreach and understanding. In particular, emphasize the message that "green" energy strategies are actually cost-effective and can save utilities and consumers money.

3. The Air District should examine its own internal investments, including holdings in employee retirement accounts, and consider fully divesting from fossil-fuel holdings. Externally, the Air District should educate businesses in the region about fossil-fuel divestment and potential long-term cost-savings.

4. The Air District should develop mechanisms, both internally and externally, to incentivize projects that promote environmental, public health, and economic advancement, especially in areas most heavily burdened by air pollution or areas projected to be most affected by the adverse effects of climate change. Examples that might meet these three criteria and could be further investigated by Air District staff are to:

a. Provide permitting incentives for projects that can demonstrate positive results in a lifecycle carbon analysis, especially if they also serve disadvantaged communities (e.g., such projects go to front of the line for review).
b. Expedite the permitting of clean energy projects in the Bay Area for those projects demonstrating that issues of equity have been considered in siting decisions.
c. Encourage local governments to facilitate use of creative and collaborative partnerships with business towards sustainable goals and shared resources. For example, encourage local governments to facilitate arrangements in which excess heat produced by one site, such a fuel cell combined heat and power installation, is used for heating needs by a second, geographically close site, such as a dry cleaning facility.
d. Promote the advancement of innovative technologies and business models to reduce GHG pollution while improving citizen mobility. For example, working with car-sharing companies to develop sliding scale rates for electric vehicle (EV) car-share rental, or working with public and/or private entities to develop fuel-cell public transportation projects (buses or ferries) that reduce vehicle miles travelled (VMT) and employ mass transit in disadvantaged communities using low-carbon, clean energy.
e. Working with commercial lending and advocacy organizations to improve the purchase of electric vehicles through traditional home mortgage tools.

5. The Air District should promote the use of CoolCalifornia.org for individual, business, and local government use.
    a. This tool could be provided as a mechanism for projects and their alternatives to be assessed.
    b. Work with Association of Bay Area Governments (ABAG) to use this tool for assessing alternative for Sustainable Communities Strategies in future planning iterations.

6. There remains disagreement among experts about several issues relating to full reliance on renewable energy sources. In order to better understand the Bay Area's energy future, we recommend that the Air District staff and Advisory Council gain a better understanding of the air quality and climate change mitigation issues related to energy storage potential, grid infrastructure, and the so-called "duck curve" problem.

7. Support CPUC work on the following:
    a. Developing incentives to subsidize programs that finance the deployment of electricity storage systems
    b. Providing incentives for utility companies to identify locations where the grid system is currently (and is projected to be) in the most need of

support and energy storage and then co-locate renewable energy generation facilities in those locations.

c. Mandating that utilities establish net metering at all residences and businesses (i.e., every electricity meter should function in a two-way communication pathway between consumers and utilities).

GLOSSARY

BAU – Business as usual

Carbon pricing – A method of reducing GHG emissions by charging those who emit carbon dioxide (CO2) for their emissions. That charge, called a carbon price, is the amount that must be paid for the right to emit one ton of CO2 into the atmosphere. Carbon pricing usually takes the form of a carbon tax or a requirement to purchase permits to emit (also called "allowances"). Because such permits are privately tradable and emissions are limited to the total number of available permits (the cap), this system is known as cap-and-trade.

Combined heat and power – The use of a single fuel source to simultaneously generate electricity and useful heat. This is also known as “cogeneration.”

CPUC – California Public Utilities Commission

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

Demand response – End-use electric customers reducing their electricity usage in a given time period, or shifting that usage to another time period, in response to a price signal, a financial incentive, an environmental condition or a reliability signal

District – Bay Area Air Quality Management District

Divestment – The reduction of some kind of asset by an individual or business for financial, ethical, or political objectives.

Duck curve – A graphic that utility companies use to illustrate concerns about mismatched renewable generation and demand (i.e., lack of availability of solar energy during high use early evening hours).

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

Environmental justice – The idea that all people, regardless of their race, color, nation or origin or income, are able to enjoy equally high levels of environmental protection. Environmental justice communities are commonly identified as those where residents are predominantly minorities or low-income; where residents have been excluded from the environmental policy setting or decision-making process;

where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices and activities in their communities. Environmental justice efforts attempt to address the inequities of environmental protection in these communities.

EV – Electric Vehicle

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

Flexible transmission – A system composed of static equipment used for the transmission of electrical energy. Flexible transmission is meant to increase the reliability of energy grids and reduce power delivery costs. These systems improve transmission quality and efficiency of power transmission by supplying reactive power to the grid.

GHG – (Greenhouse Gases) – A gas in the 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 (SF6). Black carbon, or soot, is not an actual greenhouse gas, as it is a solid, and warms the atmosphere differently to a gas. However, it may be responsible for as much as 25 percent of observed global warming.[2]

Lifecycle analysis - A technique to assess environmental impacts associated with all the stages of a product's life from-cradle-to-grave (i.e., from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

Load - The amount of electric power delivered or required over a given period at a constant rate.

Load balancing – Load balancing refers to the use of various techniques by electrical power stations to store excess electrical power during low demand periods for release as demand rises.

Locational feed-in tariff – A policy mechanism designed to accelerate investment in location-specific energy storage projects and distributed energy resource projects that feed energy into the grid. Prices offered by utilities for these resources would differ by location in order to maximize benefit to the grid, by placing such resources at energy bottlenecks and sensitive areas.

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[2] See http://oceana.org/en/our-work/climate-energy/climate-change/learn-act/greenhouse-gases

Net metering – A service to an electric consumer under which electric energy generated by that electric consumer from an eligible on-site generating facility and delivered to the local distribution facilities may be used to offset electric energy provided by the electric utility to the electric consumer during the applicable billing period.

VMT – Vehicle miles travelled

WECC – Western Electricity Coordinating Council. The WECC region encompasses the states of Washington, Oregon, California, Idaho, Nevada, Utah, Arizona, Colorado, Wyoming, portions of Montana, South Dakota, New Mexico and Texas in the United States, the Provinces of British Columbia and Alberta in Canada, and a portion of CFE's system in Baja California in Mexico.

WWS – Wind, water, solar

AGENDA: 5

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Memorandum

To: Chairperson Sam Altshuler and Members of the Advisory Council

From: Jack P. Broadbent
Executive Officer/Air Pollution Control Officer

Date: October 29, 2014

Re: Discussion of Draft Report on the Advisory Council's Meeting on October 8, 2014

The draft report of the October 8, 2014, Advisory Council Meeting on *Energy Storage and Smart Grid Technologies and Their Relationship to the 2050 Greenhouse Gas Goals* will be discussed and potentially finalized and considered for approval.

Respectfully submitted,

Jack P. Broadbent
Executive Officer/APCO

Prepared by: Sean Gallagher
Reviewed by: Maricela Martinez

Attachment: Draft Report of the Advisory Council's Meeting on October 8, 2014

EXECUTIVE SUMMARY

This report summarizes activities of the Advisory Council during October 2014, consolidating a presentation received, and subsequent discussion and consideration by Council members. It is the intent of the Council to continue study of this topic during the early portion of 2015. 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 presentation was made at the October 8, 2014 Advisory Council meeting:

The Integrated Grid: Energy Storage and Smart Grid Technologies and their Relationship to 2050 GHG Goals

Haresh Kamath
Program Manager
EPRI, Electric Power Research Institute, Palo Alto, CA

A video recording of this presentation and the Council's discussion is available at: http://baaqmd.granicus.com/MediaPlayer.php?publish_id=ee8a8cdd-4f30-11e4-bf9a-00219b9a9d7d

EPRI states that its mission is to conduct research, development, and demonstration on key issues facing the electricity sector on behalf of their funding members, energy stakeholders , and society. EPRI does not advocate any particular position, but provides information about the effects of policy decision systems as it relates to the electric utility industry. EPRI receives funding from electric utilities as well as other sources.
Building on other presentations to the Council in 2014 focusing on energy conservation and renewable sources of energy, the October meeting focused on energy storage and integrated electric transmission systems, aka smart electric grids.

In this report, the Council recommends that the Air District:

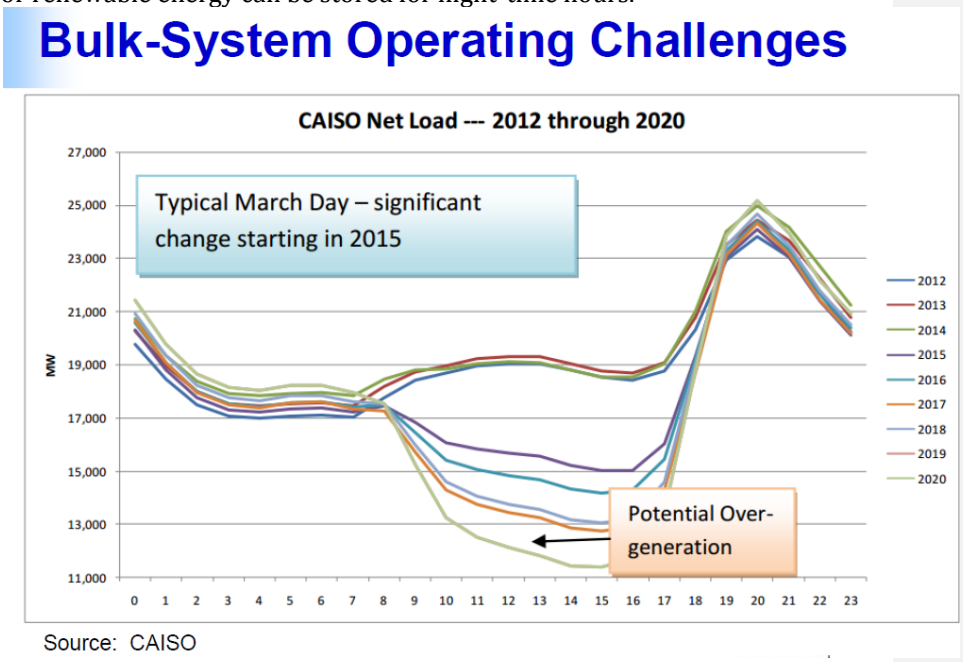
1. conduct a careful holistic evaluation of all benefits and costs associated with energy generation, distribution, transmission and use while considering air quality and climate change benefits.
2. consult and coordinate with relevant agencies and other stakeholders involved in energy-related planning (distributed generation and back-up generators) to ensure that the utilities and CPUC include these new electric resources in their planning process, e.g.,
   Public agencies (e.g., CPUC, DOE, ARB, EPA)
   Private sector (e.g., PG&E, refineries, other)
3. track the European experience with Feed-in Tariffs and their renewable power grids.

4. further evaluate carbon sequestration for power plants including power plants burning renewable fuels (waste, and biomass).
5. promote energy efficiency measures as a resource for the grid.
6. support research to increase flexibility in storage technology, demand response, and the integrated electric grid.
7. promote distributed generation power plants in combination with waste heat capture and use (i.e., Combined Heat and Power).

BACKGROUND

Managing the Electric Energy Flow in CA

1. Energy storage (primarily electricity in concept) is key as we head towards an electric system that is increasingly powered by renewable sources of electricity. Solar and wind power are notable in their inability to provide power 24/7 due to their inherent nature of dependence on variable sun and wind patterns from one hour to the next as well as day or month. Hydro power is variable depending on the season and previous winter's precipitation.
2. The duck curve, a graph of net electric load (the load after variable renewable generation is accounted for), graphically shows the potential problem of misaligned renewable energy supply and peak energy demand. Peak generation occurs mid-afternoon but peak demand occurs at the end of each day, 1800-2300 hours, after the sun goes down and the wind speeds decrease. Evening and night loads are served primarily by fossil fueled generators. After a certain point, adding more renewables to the generation mix no longer reduces GHGs unless demand can be shifted to daylight hours or renewable energy can be stored for night-time hours.



Source: CAISO

3. Energy storage using advancements in lithium ion batteries technology is being applied to the grid, but it is early in its development. Batteries, however, are likely to continue to be expensive, inefficient, and relatively short-lived.

4. Within the last 4 years, new EVs have been added to the US fleet representing 5 GWh of storage capacity. It is unknown what kind of system storage benefit these batteries could offer if they were properly networked together. Such an approach is theoretically possible but would face significant technical, economic and regulatory hurdles.
5. California has set a policy goal of adding storage capacity equivalent to 2% of grid capacity by 2020; California already has 1.5% storage; Europe already has 5% and Japan has 10-15%.
6. Pumped storage is relatively efficient, is large, but has environmental issues. New opportunities are also limited: "All the good locations have been taken." However, as the value of storage increases, developers may consider new sites that were previously considered uneconomic. PG&E has a large pumped storage power plant (Helms Power Plant) east of Fresno. Pumped storage is the single largest storage technology currently in use by a wide margin.
7. Compressed air has been explored as an energy storage mechanism but has not been fully developed. Underground caverns in California from depleted natural gas fields are being considered. Germany and Alabama have 400 MW demonstrated energy storage using compressed air.
8. Energy can be stored by making hydrogen from excess renewable electricity, however significant challenges exist (low conversion efficiency, 25%). Hydrogen is a huge opportunity for use as storage, but is not ready now.
9. Thermal storage combined with concentrated solar thermal generation is another concept.
10. Flywheels are another energy storage mechanism.
11. More advanced solutions to bulk energy storage are projected to be two decades away. While research into advanced storage continues, storage implementation is likely to be dominated by present-day technologies at least for the next ten years, and are likely to be most effective at smaller scales.
12. Demand response management and energy conservation may offset some storage capacity needs.

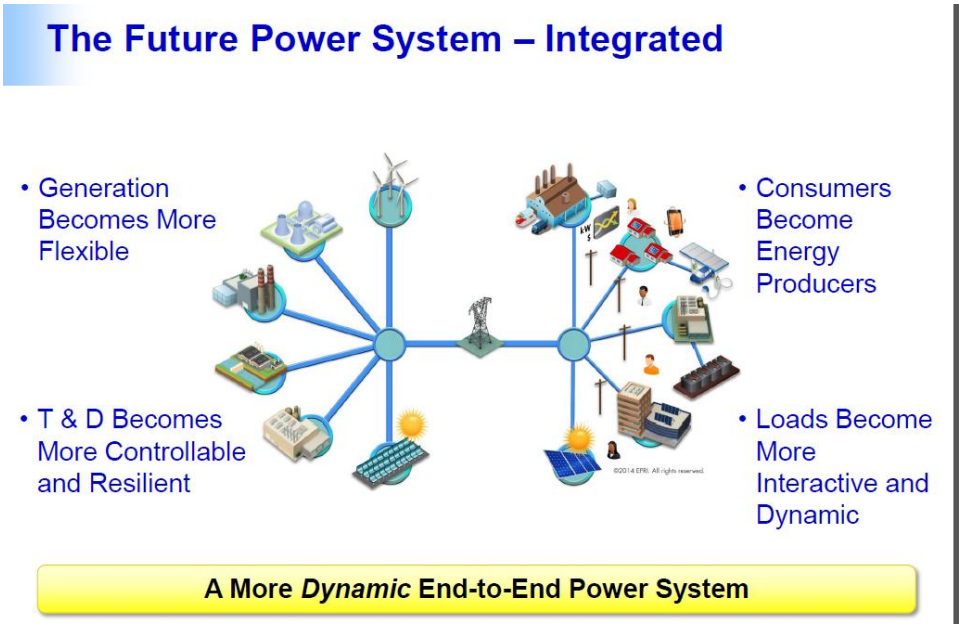
Comment [HK1]: AB2514 ultimately did not make a recommendation of exactly how much storage would be added to the grid. The pursuant CPUC proceeding set a procurement target of 1325 MW, which is about 2% of the California grid capacity.

Integrated Transmission Systems/Smart Grids

1. Highly reliable, stable voltage, stable frequency (60 cycles), affordable, and safe access of the public electricity is critical today in our ever increasing digital world. An electric transmission and distribution system plays a critical role in managing these attributes and is essential in connecting sources of electricity to the end users. Historically, a small number of large remote power plants provided electricity to users throughout the state. With the production of electricity at many small sources (distributed generation), often operating intermittently when the sun shines or the wind blows, new challenges emerge that change how the grid operates. Think of the grid as "just in time delivery of electricity" and the unique challenges that it creates

for power production and transmission. Grids are not currently designed to have electricity flow "backwards" as it will exist with renewable sources of electricity in the future (e.g, homeowner roof top PV arrays feeding power into the grid during the day while drawing power from the grid in the evenings). The grid will have to be modified to operate in the future as an increasing number of sources go on line.

2. The current interconnected grid provides a number of essential services even to consumers with distributed generation sources, including power reliability, start up power, energy efficiency, voltage quality, and energy transactions. We need to move to an integrated grid that allows distributed generation to enhance grid operation for everyone, by providing the additional services of resiliency, voltage support, emissions reductions, loss reduction, demand response, and distribution optimization.
3. Demand response allows utilities to meet peak electrical demand by influencing or managing the demand of electricity by customers. For example, some customers willingly curtail electric usage (e.g., cut off air conditioners) during times of high electric demand. Perhaps future charging of electrical vehicles will be controlled to occur after evening peak loads or during the day through workplace charging, if solar power is abundant enough to allow low-cost charging approaches.
4. Zero energy homes, while not consuming more energy than they produce on an annual basis, must still be connected to the grid in order to receive electricity when electric demand exceeds the home's ability to provide power (the sun isn't shining). The grid must be designed to still handle peak power demands though less and less electricity comes from central generation on an annual basis as more zero energy homes are built.
5. The single biggest challenge to integrated grid? Changing the industry mind set of utility executives and regulators. Other industries have undergone similar cultural shifts; for example, the break-up of the AT&T monopoly in 1982 led to a telecom industry transform that has introduced radical and unforeseen changes to business models, particularly in the last 5-10 years..



Renewable Power and Distributed Power

1. Distributed generation refers to generation of electricity at localized sites. Distributed Energy Resources (DER) includes such things as home and business owned solar panels, fuel cells, back-up generators, storage facilities, etc. Fuel cells at customer locations are 50% efficient, but they are expensive. Combined heat and power allocates waste heat from distributed generation plants to space heating, water heating, and industrial processes requiring heat, thereby improving overall energy efficiency to 80-90%.
2. Solar PV costs have dropped dramatically to the point that they are cheaper than installation of conventional large fossil fueled power plants when normalized on a $/kW of unit production capacity. This metric is a little deceptive in that a fossil power plant can produce power 8760 hours each year while solar and wind have more limited hours of operation. However, the energy for solar and wind power plants is free while the energy for fossil fuel is costly and escalating with inflation.
3. Utility scale solar power plants produce more power than the aggregate sum of all domestic solar panels.
4. A renaissance of natural gas usage with its low cost is occurring with its abundance of supply. Combined cycle power plants are 50+% efficient, less transmission line loss.
5. For now, natural gas is the fuel of choice for power plants in the US, filling the void when renewable power is not available.

Reconciling with other speakers

Comment [HK2]: Depending on the location, solar may be cheaper even on a $/kWh basis for energy (that is, it has achieved "grid parity") but this is assuming that the rest of the grid is present to provide reliability, peak power, etc.

Comment [HK3]: Note that there are operations and maintenance costs associated with solar and wind, though there are no fuel costs.

1. The key take away from Haresh Kamath is that significant storage capacity is needed to support an electric grid powered entirely by renewable power (WWS). Other speakers earlier in 2014 did not address this. Currently, we have only 1.5% storage capacity with another 2% mandated by 2020 in California.
2. The concept of doing all that is possible to meet the 2050 goals, as discussed by Jim Williams and Jane Long, is consistent with the presentation by Haresh Kamath.

Comment [HK4]: The point was made earlier, but unless load is constrained to meet availability of energy, a grid powered entirely by renewables must have some kind of reserve generation. In many places around the world with high penetrations of renewables, this reserve generation is fossil, nuclear, or hydro generation – but then the grid is not 100% renewable. In addition, such places make extensive use of curtailment when there is *overgeneration* of renewable energy. Both problems are addressed by storage.

KEY EMERGING ISSUES RELEVANT TO THE BAY AREA

1. Managing the load and making it match the renewable resource is critical to maintain electric grid reliability. Even with a home solar system, there is a need to be connected to the grid for reasons of electric reliability and stability, as well as to provide "start-up power" for such things as large appliances.
2. Embedded in the customer charges for electricity are the cost of the energy to produce the electricity, the cost of the power plants and its maintenance, and the cost of the transmission and distribution system. The latter two costs are fixed costs that are spread among all customers. As the usage of utility-generated electricity drops with the introduction of renewable power, the utility will need to recover its fixed costs through adjustment in electric rates. In other words, the utility's capacity to meet peak demand must still be large, even though it will be operated at a lower capacity during most hours. The more that energy generation is distributed to the edges of the grid (such as with home solar), the less energy is being transmitted by the grid. This means a smaller and smaller base over which to spread the costs associated with operating and maintaining the grid itself. Kamath referred to this concept as "stranded assets", a common term in the utility industry. Thus, economic and equity challenges exist in the transition to a renewable grid.
3. Integrated grids will experience seminal changes ahead within the next 10 years. Lots of change has already occurred over the last 5 years.
4. Voltage variation (e.g., due to passing clouds) is an issue with solar power; it is currently happening in grids supported by solar plants.
5. Germany has a "feed in tariff" where providers of renewable power are paid for new electric capacity added to the grid. The large number of solar arrays has resulted in voltage swings on the grid as solar energy is affected by passing clouds. To avoid such swings, a more flexible grid will be needed.
6. 0-36 GW of electric capacity variation occurs in Germany's renewable energy sources (primarily solar and wind). They run coal plants to fill voids, which has resulted in greater CO2 emissions. It is presently unknown how variable California's renewable energy portfolio is. Natural gas use in power plants is the default scenario followed by energy storage is the backup mechanism projected for California.
7. Energy storage and demand response work together.

8. All grid services need to be valued in the rate making process, including power quality, reliability, capacity, etc.
9. Costs must be equitably allocated as the grid transforms.
10. Efficiency measures should be considered a resource.
11. There is a tradeoff between reliability and cost of electricity.
12. Carbon capture and storage needs to be considered for use in gas power plants providing back-up power to fill voids.
13. Having diverse sources of electricity is desirable. However we need more options than WWS unless large-scale storage and demand response options are available. Renewable power needs a complementary energy source that is low carbon. Coal and gas currently fill that void in different grids, but they are high carbon unless equipped with carbon sequestration.
14. All eyes are on California on how we address storage and use of renewables.

RECOMMENDATIONS

In this report, the Council recommends that the Air District:

1. conduct a careful holistic evaluation of all benefits and costs associated with energy generation, distribution, transmission and use while considering air quality and climate change benefits.
2. consult and coordinate with relevant agencies and other stakeholders involved in energy-related planning (distributed generation and back-up generators) to ensure that the utilities and CPUC include these new electric resources in their planning process, e.g.,
   Public agencies (e.g., CPUC, DOE, ARB, EPA)
   Private sector (e.g., PG&E, refineries, other)
3. track the European experience with Feed-in Tariffs and their renewable power grids.
4. further evaluate carbon sequestration for power plants including power plants burning renewable fuels (waste, and biomass).
5. promote energy efficiency measures as a resource for the grid.
6. support research to increase flexibility in storage technology, demand response, and the integrated electric grid.
7. promote distributed generation power plants in combination with waste heat capture and use (i.e., Combined Heat and Power).

Acronyms:

Compressed air Energy Storage (CAES) : Excess power from renewable electricity is used to compress air which is stored in underground reservoir (depleted gas field or natural caverns). The compressed air is then withdrawn and used to drive power plant turbines when electricity is in demand.

Demand Response: Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.[1]
Duck curve: A graphic that utility companies use to illustrate concerns about mismatched renewable generation and demand (i.e., lack of availability of solar energy during high use early evening hours).

Feed in Tariff: A feed-in tariff drives renewable energy market growth by providing developers long-term purchase agreements for the sale of electricity generated from renewable energy sources.[2] These purchase agreements typically offer a specified price for every kilowatt-hour (kWh) of electricity produced and are structured with contracts ranging from 10 -25 years.[3]

Integrated grid and smart grid: an electric grid that collates many diverse and perhaps small sources of electricity into a functional grid capable of providing reliable, stable, cost effective, and safe electricity.

Load: The amount of electric power delivered or required over a given period at a constant rate.

Stranded assets: a concept relating to being able to capture the cost, through rate making, of power plants and transmission lines when distributed generation and energy conservation reduce the sale of electricity produced by the utility. The current configuration of the electric utility is designed to provide power 24/7, 365 days a year. This allows fixed costs of assets to be spread out over the year. With

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[1] Federal Energy Regulatory Commission, http://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp, accessed Oct. 24, 2014

[2] Menanteau, P.; Finon, D.; Lamy, M. (2003). "Prices versus quantities: choosing policies for promoting the development of renewable energy." *Energy Policy*, (31, 8); pp. 799–812. As cited in *A Policy-maker's Guide to Feed-in Tariff Policy Design (NREL),* http://www.nrel.gov/docs/fy10osti/44849.pdf, accessed Oct. 24, 2014

[3] Klein, A. (2008). *Feed-in Tariff Designs: Options to Support Electricity Generation from Renewable Energy Sources*. Saarbrucken, Germany: VDM Verlage De. Muller Aktiengesellschaft & Co. KG. As cited in *A Policy-maker's Guide to Feed-in Tariff Policy Design (NREL),* http://www.nrel.gov/docs/fy10osti/44849.pdf, accessed Oct. 24, 2014

energy conservation and distributed generation, there is less opportunity for the utility to recover its cost of generation and transmission assets.

Stranded assets: those investments which have already been made but which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return, as a result of changes in the market and regulatory environment.[4] For example, investments in Liquid Natural Gas (LNG) import terminals become stranded assets in the wake of the shale gas boom.

WWS: Wind, water, solar

Zero energy homes: homes designed to produce enough electricity to meet their annual needs though the homes still need to be connected to the grid to ensure that electricity is available 24/7. Key is the concept that the solar panels of these homes provide extra electricity to the grid and that the homes are built to use energy efficiently

[4] International Energy Agency (2013), Redrawing the Energy-Climate Map: World Energy Outlook Special Report, p. 98, http://www.iea.org/publications/freepublications/publication/WEO_Special_Report_2013_Redrawing_the_Energy_Climate_Map.pdf, accessed Oct. 24, 2014