Carneros Innovation Dialogue:

A strategic dialogue on innovative approaches to spur investment in clean technologies

Report prepared by:
Irving Mintzer
J. Amber Leonard

Graphic Recording by Emily Shepard

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FOREWORD

California has pioneered environmental policy since the 1970s and has served as a national model by boldly setting standards, designing incentives, enforcing disincentives and readjusting major drivers of market dynamics that helped to ignite and drive a first wave of "green" innovation, green in that the innovation helped achieve a vibrant economy while reducing greenhouse gas emissions. As a result, California has become a world leader in greenhouse gas emissions reductions at the same time our state economy has grown to one of the largest in the world.

But while California has made enormous progress, the state's rate of population growth and impacts on fuel and electricity consumption and GHG emissions requires that our next wave of innovation be larger, faster and more powerful than the last to meet the mandate of the landmark California Global Warming Solutions Act of 2006 (AB 32).

Next 10 convened the "Carneros Innovation Dialogue" in October 2007 to help further this next wave of green innovation. The Dialogue brought together senior state policymakers, business leaders, academics, and representatives of non-governmental organizations to explore the most effective policies to spur the development of clean technologies at the speed and size necessary to successfully implement AB 32 and grow the economy.

This report provides a detailed discussion of that Dialogue, and includes a series of innovative policy ideas for consideration by the California Air Resources Board and its Economic and Technology Advancement Advisory Committee. To meet the mandate of AB 32 and go beyond those targets to meet the GHG reduction goals of the Governor's executive order for 2050, both existing strategies and new breakthroughs will be needed.

We want to thank Jason Mark and the Energy Foundation for helping to develop the Carneros Innovation Dialogue and for connecting us with Irving Mintzer and Amber Leonard who so ably conceptualized and organized the meeting. Leading this effort for Next 10, Irving and Amber worked tirelessly to bring everyone together, develop the agenda, work with the presenters, facilitate the meeting, and prepare this report -- and we are sincerely grateful for all their efforts and look forward to working with them in the years to come.

Special thanks to everyone who attended the Dialogue for their insights and ideas, especially those who worked with Next 10 and MEG before, during, and after the Dialogue to make the meeting a success.

Sincerely,

F. Noel Perry
Founder, Next 10

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Executive Summary

In an era of growing population and an expanding economy, the emissions reduction targets of the California Global Warming Solutions Act of 2006 (AB 32, Pavley-Núñez) and of Governor Schwarzenegger's Executive Order (S-3-05) on a 2050 strategy for greenhouse gas emissions reductions create historic challenges and opportunities for California. To meet these challenges, the state must rapidly scale up deployment of clean technologies.

On October 17-18, 2007, Next 10 convened a strategic dialogue in Carneros, CA. The primary purpose of this dialogue was to explore the most effective path for advancing the development of clean technologies in support of the economic and environmental goals outlined in AB 32.

The Carneros Dialogue brought together a wide range of stakeholders from the public and private sectors, including State government officials; representatives of the California legislature; strategic thinkers in the finance and investment sectors; senior executives from major industrial and manufacturing companies; along with leading academics and representatives of influential non-governmental organizations. The Carneros Dialogue represents an important step in framing a shared vision of the challenges raised by AB 32 and developing a common language across sectors for addressing those challenges.

The participants in the Carneros Dialogue recognized that the scale of the challenges raised by AB 32 and the Governor's Executive Order on Greenhouse Gas Emissions was of sufficient magnitude that the State would need to develop a portfolio of policies and measures to meet these challenges. There was broad agreement that it is no longer realistic to discuss whether the State should respond using traditional command-and-control regulations, or a market-based cap-and-trade program, or through a series of targeted incentives to spur investment in clean technologies. All of these approaches (and more) will be needed to meet the challenges of human-induced climate change in California.

Building on the recommendations of CalEPA's Market Advisory Committee concerning the design of the proposed California cap-and-trade program for GHGs and the ARB's recently enacted list of Early Actions, the participants in the Carneros Dialogue identified a range of ideas concerning targeted policies to accelerate commercialization of existing clean technologies, sustain technology innovation and R&D activities focused on the next generation of such technologies, and encourage investment in the manufacturing infrastructure needed to produce these technologies within the state. The suite of recommendations developed in the course of the Carneros Dialogue is presented later in the full report.

In screening the opportunities identified during the Dialogue, the participants discussed a range of screening criteria or key characteristics that could be important in setting priorities for policy development and program implementation. Among the criteria discussed were:

- The importance of promoting those activities that could **leverage additional resources** beyond those available to state government and enable the development of other complementary technologies or activities;
- The importance of considering the **scalability** of each technology or program, i.e., the ability of a given approach to significantly reduce greenhouse gas emissions across California, and the opportunity to extend the use of each technology or program both to other regions of the United States and to other countries (especially to rapidly industrializing countries like China, India, Brazil, and Mexico);
- The impacts of each technology or strategy on low-income communities and the implications of each application for considerations of **environmental justice**;
- The **cost-effectiveness** of each proposed policy, program, or strategy in contributing to the reduction of statewide GHG emissions; and
- The ability of various strategies to work together in a complementary manner, to **generate synergies** in a consistent fashion, and to reinforce efforts underway in other states or under consideration at the federal level.

The participants recognized that the Carneros Dialogue did not allow sufficient time for a complete and comprehensive assessment of each proposed program, strategy, or approach. The term "recommendations" in the following section should not be understood to imply that a formal consensus was reached on each point. It is used here to report out interesting and challenging concepts worthy of further exploration by ETAAC and the ARB staff. In sum, the participants in the Carneros Dialogue urge that the ideas and concepts discussed during the Carneros Dialogue be considered by ETAAC and the ARB, but subjected to further analysis and vetting along the important dimensions identified above.

The set of policies, programs, and measures developed by the participants in the Carneros Dialogue are organized into the following categories of actions:

- Information programs, public outreach campaigns, and education strategies;
- Strategies to promote research, development, and demonstration of clean technologies;
- Policies and programs to increase market demand for clean technologies;
- Programs to facilitate financing of investments in clean technologies by end-users (both consumers and firms);
- Policies, strategies, and approaches to improve institutional coordination and streamline regulatory processes; and
- Programs, campaigns, and strategies to encourage firms to locate clean tech manufacturing and production facilities in California.

The following are among the key ideas in each category (some concepts recommended for consideration below appear in more than one category of actions). The listing of specific recommendations does not imply the endorsement of each proposal by all

Dialogue participants. For an expanded discussion of these approaches, as well as additional recommendations, please see the section on Key Strategies.

- **Information programs, public outreach campaigns, and education strategies**
  - *Develop "Green Labels" for consumer products and all products or assets procured by the state;*
  - *Support the establishment of a California institute for climate solutions as a joint undertaking of the State's higher education institutions and the CPUC; and*
  - *Create a "Green Cities" program to recognize California cities and towns that make public commitments to specified levels of emissions reductions or to the use of specific levels of renewable energy for municipal purposes.*

- **Strategies to promote research, development, and demonstration (R, D, &D) on new and emerging clean technologies**
  - *Support the establishment of a California institute for climate solutions as a joint undertaking of the State's higher education institutions and the CPUC;*
  - *Develop programs to underwrite cost-shared research on long-term high risk technology development projects through public-private partnerships involving small businesses located in California;*
  - *Develop a California Carbon Bank and Trust to fund research, development and demonstration projects in clean technologies by small businesses; and*
  - *Sponsor high-profile competitions to stimulate innovative examples of clean technologies.*

- **Policies, programs, and strategies to increase market demand for clean technologies**
  - *Implement enhanced and expanded performance standards for vehicles and fuels; roads and pavements; residential, commercial, and institutional buildings; as well as for systems of water use and transport;*
  - *Implement "Green Procurement" standards for State agencies that would apply to the acquisition of all products and assets not designated for use in public emergencies or by emergency service personnel;*
  - *Encourage local municipalities and regional governments to implement "Smart Growth" policies that promote urban in-fill, lower the average level of vehicle miles traveled (VMT), reduce congestion and limit suburban sprawl; and*
  - *Require mandatory retrofit of energy efficiency measures at the point of transfer or sale for all commercial and residential buildings. Each building would need to be brought up to the level of current building performance standards (e.g., Title 24 for energy use) before the transfer of title could be completed.*
  - *Introduce a revenue-neutral "fee-bate" program for vehicle manufacturers that is calibrated to the expected lifetime emissions of light-*

duty vehicles delivered for sale in California (for example, as proposed under AB 493).

- **Programs to facilitate financing of investments in clean technologies by end-users (both consumers and firms)**
  - *Develop a California Carbon Bank and Trust to finance early stage investments in clean technologies by small businesses;*
  - *Encourage public/private partnerships to "green" state buildings through the sale to private concerns of State-owned real estate assets and their subsequent lease-back by State agencies;*
  - *Provide low-interest financing for residential and commercial investment in energy efficiency measures, water use efficiency measures, or renewable energy technologies using funds derived from tax-exempt bonds sold through Municipal Assessment Districts (as is now being initiated in Berkeley);*
  - *Require mandatory retrofit of energy efficiency measures at the point of transfer or sale for all commercial and residential buildings. Each building would need to be brought up to the level of current building performance standards (e.g., Title 24 for energy use) before the transfer of title could be completed (see also Recommendations on Increasing Market Demand above); and*
  - *Encourage the use of Clean Renewable Energy Bonds (CREBs) under the U.S. Energy Policy Act of 2005 (EPACT) to facilitate third-party financing of investment in energy efficiency measures and renewable energy technologies.*

- **Policies, strategies, and approaches to improve institutional coordination and streamline regulatory processes**
  - *Designate a "Wizard of Woo," a master marketer and facilitator, whose office would have a mandate to attract clean technology investments to California. This office would act as the primary focal point for information on available clean technologies and on the permitting requirements for new or expanded clean technology facilities. It would also act as the point of coordination for statewide efforts to encourage clean tech companies to locate new or expanded manufacturing facilities within the state; and*
  - *Appoint a "Clean Tech Czar" in the Governor's Office who would receive quarterly reports from all state agency heads summarizing the impact of their agency's programs on statewide GHG emissions during the previous quarter.*

- **Programs, campaigns, and strategies to encourage firms to locate clean tech manufacturing and production facilities in California**
  - *Create "Green Enterprise Zones" that incorporate single permits for the establishment of clean tech manufacturing businesses (1) meeting pre-set performance standards for emissions and waste; and (2) producing energy efficiency systems, water use efficiency systems, renewable energy technologies or advanced vehicles;*
  - *Modify the California Alternative Energy and Advanced Technology Financing Authority (CAEFTA) to allow financing of alternative energy manufacturing facilities; and*
  - *Designate a "Wizard of Woo," a master marketer and facilitator, whose office would have a mandate to attract clean technology investments to California. This office would act as the primary focal point for information on available clean technologies and on the permitting requirements for new or expanded clean technology facilities. It would also act as the point of coordination for statewide efforts to encourage clean tech companies to locate new or expanded manufacturing facilities within the state. (Note: Also assigned to Recommendations on Regulatory Streamlining above).*

These recommendations reflect the understanding of the participants in the Carneros Dialogue that, if California's population continues to increase and the State's economy continues to expand, reaching the AB 32 targets for 2020 will require reducing the average rate of GHG emissions per dollar of GSP in the near- to mid-term. This is likely to necessitate significant changes in consumer behavior as well as massive deployment of currently commercial clean technologies. The participants recognized that a wide range of technological and policy innovations will be required to achieve these goals. The necessary innovations will range from advances in the engineering design of clean technologies to the development of innovative business models, new institutional arrangements, and creative financing approaches.

For the longer term, in order to reach the 2050 goals of the Governor's Executive Order, California must at minimum sustain and, in fact, accelerate the current pace of technology innovation. Participants felt that California will need to focus on developing the next generation of clean technologies so that these technologies will be commercially available soon after 2020. The State's efforts in this regard would be reinforced by encouraging new public-private partnerships that can stimulate commercial deployment of existing technologies while promoting longer-term, high-risk research on future generations of clean energy technologies.

It is important to note a general consensus among the participants of the Carneros Dialogue on one key issue. All the participants agreed that continued development of clean technologies is critical to a healthy economy in the post-AB 32 world. The participants also concluded that the State has an important role to play in establishing a stable policy environment and creating the conditions in which innovative entrepreneurial activity can flourish in this sector.

Furthermore, many participants thought that, in order to capture the full economic and political benefits (including job creation) of investments in clean energy technologies by public agencies, private firms, and individual consumers in California, the State should encourage investment in the manufacturing infrastructure needed to produce these technologies within the State.

Many participants believed, however, that the clean technology sector of the California economy will be stronger and more successful if it can develop around a set of business models that are based on self-sustaining commercial market development and that can help shift consumer spending to available, and cost-effective, low-carbon alternatives. If clean technologies instead follow a trajectory that relies on generous continuing subsidies from government -- as did commercial nuclear power in the 1960s -- the associated businesses may experience a measure of fragility, and could be easily undermined by changes in the political winds or by perturbations in government budget cycles. By following a self-sustaining trajectory that is more like that of hand calculators, cellular phones, and laptop computers (i.e., profiting from initial government support for critical, high-risk R&D but aggressively pursuing a transition to self-sustaining business models), the clean tech sector can form a robust pillar of communal strength in the next stage of California's economic and environmental development.

The challenges ahead can only be met successfully with a portfolio of strategies in which both regulation and market measures are applied in an integrated fashion. An emissions cap-and-trade program, carefully designed regulations, market-oriented policies, inventive forms of R&D support, innovative public-private partnerships, and wide-ranging educational campaigns can spur investment in clean energy technologies and reduce future greenhouse gas emissions. All of these approaches and more will be needed to achieve the State's policy goals.

The scale of the challenge facing California is unprecedented and transformational. The appropriate response will need to be both sure-footed and bold. The Carneros Dialogue has demonstrated that one important step on this path involves bringing together an unusually diverse set of key stakeholder communities in a process of frank conversation. In Carneros, they found a safe haven for exploring shared objectives and discovering common ground. Many participants in the Carneros Dialogue have indicated that useful next steps might include careful assessment of the range of opportunities identified in this strategic conversation as well as carefully structured and well-prepared opportunities for further dialogue in the future.

Introduction

In an era of growing population and an expanding economy, the emissions reduction targets of the California Global Warming Solutions Act of 2006 (AB 32, Pavley-Núñez) and of Governor Schwarzenegger's Executive Order on Greenhouse Gas Emissions create historic challenges for California. To meet these challenges, the state must quickly scale up deployment of clean technologies, including renewable energy technologies, energy efficiency systems, advanced vehicles and alternative fuels, low-emissions industrial technologies, and improvements in the efficiency of water use and transport. Achieving this level of deployment will require that California employ a broad portfolio of policy strategies that include carefully designed regulations, market-oriented policies such as an emissions cap-and-trade program, inventive forms of R&D support, innovative public-private partnerships, and wide-ranging educational campaigns, along with new financing mechanisms. If the State is successful in these efforts, clean technologies could become a critical component in the development of a sustainable state economy.

On October 17-18, 2007, Next 10 convened a strategic dialogue in Carneros, CA. The primary purpose of this dialogue was to explore the most effective path for advancing the development of clean technologies in support of the economic and environmental goals outlined in AB 32. (The agenda for the Carneros Dialogue is attached as Appendix A of this report.) The Dialogue brought together a broadly gauged group of senior state officials, leaders of the legislature, thought leaders in the finance and investment sector, seasoned executives from California's industrial and manufacturing sectors, along with academic experts and other key stakeholders. This gave participants a chance to share views and perspectives informally on these important issues with individuals from outside their own communities.

To ensure a free and frank discussion, the meeting operated under "Chatham House Rules." Remarks made by participants (other than facilitators and presenters) were considered to be "not for attribution." The meeting in Carneros created a 'safe harbor' for the participants and provided an opportunity for frank and informal exchanges outside the spotlight of formal regulatory processes or legislative hearings. It allowed the participants to step beyond the short-term commercial and political agendas of their 'home institutions' and to brainstorm together about the strategic challenges facing California.

The meeting began on October 17 with an informal dinner at a local winery and a presentation by Kevin Kennedy on the scale of the challenge presented by AB 32. A morning panel of presentations on October 18 set the stage for discussions during the Carneros Dialogue. Dan Kammen, Irving Mintzer, and Margaret Taylor explored historical and current experiences with efforts to reduce greenhouse gas emissions and spur innovation in jurisdictions beyond California. (A summary of the presentations is attached as Appendix C of this report.) Following these presentations, Alan Lloyd and Ed Pike offered the group an informal summary of the current work and future plans of the Air Resources Board's Economic and Technology Advancement Advisory Committee (ETAAC). Peter Schwartz then led an intense and broad-ranging conversation with the

participants that explored the principal driving forces and key uncertainties in the world outside California that will affect the context in which any California-specific strategies to reduce emissions and spur innovation may unfold.

These conversations led to "brain-storming" discussions whose objective was to identify (a) innovative approaches to accelerating the commercialization of existing clean technologies, (b) measures to sustain or increase the pace of technology innovation, (c) approaches that can encourage consumers and firms to adapt their behavior in ways that meet their economic aspirations with lower levels of emissions; and (d) strategies to attract investment in the manufacturing infrastructure needed to produce these technologies within the state.

The following summary report of the Carneros Dialogue will be forwarded to the Economics and Technology Advancement Assessment Committee of the California Air Resources Board. In addition, the participants hoped that the Carneros Dialogue will provide a basis for on-going conversations between state officials, leaders of the business community, and others concerned with meeting the challenges raised by AB 32.

*** * ***

Developing a Shared Vision of the Future and Some Common Language for Dialogue

The Carneros Dialogue commenced with a stage-setting discussion that highlighted the scale of the challenges presented by AB 32, which requires the state to reduce economy-wide emissions of greenhouse gases to the 1990 level by 2020. Analysis presented by the Air Resources Board recognized that California's population is forecast to increase by nearly 25% from the 1990 level and that the State's economy is expected to expand at nearly the same rate during this period. Many of the fastest growing communities in the state are projected to be in the inland and Central Valley regions. If current trends continue, the new households that will result from this in-migration into California are likely to face conditions that encourage increased use of air conditioning (compared to the today's average home in the state) and to longer average commuting distances as new homes are built farther out into peri-urban and rural areas. The Air Resources Board projects that, if these current trends continue unabated, California's emissions of greenhouse gases (GHGs) are likely to be about 174 million metric tons of carbon equivalent higher in 2020 than they were in 1990.

By definition, the aggregate level of economy-wide GHG emissions in any given year is the product of the population multiplied by the level of Gross State Product (GSP) per capita multiplied by the level of GHG emissions per dollar of GSP. If we accept the assumptions of the State Department of Finance that the population of California will grow by almost 50 percent from 2000 to 2020, and that the level of Gross State Product per capita will increase significantly during the same period, then it will only be possible to achieve the economy-wide emissions reduction targets of AB 32 if the State can

significantly reduce the level of emissions per dollar of GSP. Consequently, the workshop participants focused their attention on the following needs:

(1) to accelerate the commercialization and deployment of existing clean technologies;
(2) to sustain or even increase the pace of technological innovation and invention in ways that can lead to reduced greenhouse gas emissions per dollar of GSP;
(3) to encourage consumers and firms to adapt their behavior in ways that meet their economic aspirations with lower levels of emissions; and
(4) to identify strategies capable of attracting investment in the manufacturing infrastructure needed to produce these technologies within the state.

Increasing their sense of urgency about addressing these issues, the participants in the Carneros Dialogue received notification during the meeting that the Intergovernmental Panel on Climate Change had reported that the direct warming effect of the continuing atmospheric buildup of the six Kyoto greenhouse gases (GHGs) has already reached a level equivalent to 455 ppmv of carbon dioxide (CO_2).[1] A general consensus emerged within the group that the window of opportunity for managing the risks of human-induced climate change will not remain open for long. Many of the participants expressed concerns that public and media attention could not be sustained indefinitely and that the opportunity for introducing significant policy measures (particularly those that require strong public support) may be fleeting.

As a shared vision of the challenge ahead emerged within the group, the focus of attention shifted to the question of how best to promote the necessary changes while maintaining the State's prospects for economic development and environmental justice. All of the participants in the Carneros Dialogue recognized and appreciated the importance of the new regulations already outlined by the Air Resources Board in its list of discrete Early Actions and the parallel efforts of the ARB to consider implementation of an economy-wide GHG cap-and-trade program, as recommended by the Market Advisory Committee of CalEPA. Nonetheless, the participants pointed out that, to achieve the goals of AB 32, the proposed cap-and-trade program must be complemented by a portfolio of carefully targeted incentives and other market-oriented measures that can spur investment in clean technologies, can encourage changes in consumer behavior, and can promote technology innovation over the coming decades. It is, in short, not a question of whether to choose between traditional regulatory approaches or market-oriented measures but rather a case in which both regulation and market measures must be applied together in order to synchronize the efforts of individual consumers, private firms, and state institutions in the common effort to achieve the State's environmental and economic goals simultaneously.

[1] However, taking into account the off-setting (i.e., cooling) effects of aerosols and other pollutants, the net warming effect of all human emissions is equivalent today to a concentration of approximately 375 ppmv of CO_2, leaving a relatively small window of opportunity for policies and measures to slow the advance toward the dangerous threshold of a warming equivalent to 455 ppmv of CO_2 for all GHGs plus other radiatively active trace substances (e.g., aerosols, black carbon, etc.).

As can be expected when a diverse group of people meet together, individuals around the room came to the conversation with very different understandings of some key terms used throughout the Dialogue. The following were some of the terms for which participants began the Dialogue with quite different definitions:

- *Technology*
- *Clean Technologies*
- *Invention*
- *Innovation*
- *Adoption*
- *Diffusion*
- *Learning by doing*
- *Incentives*
- *Demand*

As some of the participants had hoped, the following distinctions and clarifications of these terms emerged and were further refined in the process of writing and reviewing this report.

Technology: A combination of hardware, software, and social organization needed to produce, distribute, maintain, and use a set of end-use devices or to provide an on-going service as well as to safely dispose of any associated residuals.

Clean Technologies: A class of technologies that includes: systems to improve the efficiency of energy use or energy supply; systems to improve the efficiency of water use or water supply; systems to harvest useful energy from renewable energy sources; systems to provide alternative vehicle fuels and advanced, low-emissions vehicles; as well as low-emissions systems for industrial production and manufacturing.

Innovation: A change in the engineering design, commercial application, organizational structure, institutional arrangement, or policy associated with the delivery of a product or service that may be associated with the commercialization of an existing technology.

Invention: An idea, sketch, or model for a new device, process, or system.[2]

Adoption: is the first commercial implementation of a new invention.

Diffusion: Refers to the widespread use of a commercial innovation, and is often studied as a communication process between current and potential users of a technology.[3]

[2] Clarke, N., and M. Riba (1998). *Patent Information for Technology Foresight.* Vienna, Austria: European Patent Office.

[3] Rogers, E.M. (1995). Diffusion of Innovations. 4th ed. New York: Free Press.

Learning by doing: refers to the post-adoption innovative activity that results from knowledge gained from difficulties or opportunities exposed through operating experience.[4]

Incentive: A financial payment or other inducement that changes the relative prices or the perceived benefits resulting from the acquisition or use of a selected good or service.

Demand: The level or quantity of a good or service that is requested, desired, or purchased by end-users.

It is important to acknowledge that, whereas in academic and economic debates the distinctions between "innovation" and "invention" are finely drawn, in common parlance the term "innovation" is frequently used to cover both sets of meanings.

Framework for Considering Alternative Policies and Strategies

The participants in the Carneros Dialogue recognized that there was a broad range of possible policies and strategies that could be employed in California to spur investment in clean technologies and to sustain the current pace of technological innovation. In the course of the Dialogue, the following categories of policies, strategies, and measures emerged:

A. **Information** programs**, public outreach** campaigns**, and education** strategies;
B. Strategies to promote **research, development, and demonstration** of new and emerging clean technologies in the state.
C. Policies, programs, and strategies **to increase market demand** for clean technologies;
D. Programs to facilitate **financing of investments in clean technologies by end-users** (both consumers and firms);
E. Policies, strategies, and approaches to **improve institutional coordination and streamline** regulatory processes; and
F. Programs, campaigns, strategies to **encourage firms to locate** clean tech manufacturing and production facilities in California.

The next section will use these categories to differentiate the opportunities identified during the Dialogue for spurring investment, sustaining innovation, and reducing future emissions. (Some concepts recommended for consideration below appear in more than one category of actions.)

In screening these opportunities identified during the Dialogue, the participants discussed a range of screening criteria or key characteristics that could be important in setting priorities for policy development and program implementation. These included:

[4] Cohen, W., and R. Levin (1989) "Empirical Studies of Innovation and Market Structure." In *Handbook of Industrial Organization, Vol 2*, edited by R. Schmalensee and R.D. Willig. Amsterdam: Elsevier.

- The importance of promoting those activities that could **leverage additional resources** beyond those available to state government and enable the development of other complementary technologies or activities;
- The importance of considering the **scalability** of each technology or program, i.e., the ability of a given approach to significantly reduce greenhouse gas emissions across California, and the opportunity to extend the use of each technology or program both to other regions of the United States and to other countries (especially to rapidly industrializing countries like China, India, Brazil, and Mexico);
- The impacts of each technology or strategy on low-income communities and the implications of each application for considerations of **environmental justice**;
- The **cost-effectiveness** of each proposed policy, program, or strategy in contributing to the reduction of statewide GHG emissions; and
- The ability of various strategies to work together in a complementary manner, to **generate synergies** in a consistent fashion, and to reinforce efforts underway in other states or under consideration at the federal level.

In considering these screening criteria, the participants recognized that the Carneros Dialogue did not allow sufficient time for a complete and comprehensive assessment of each proposed program, strategy, or approach. The term "recommendations" in the following section should not be understood to imply that a formal consensus was reached on each point. It is used here to report out interesting and challenging concepts worthy of further exploration by ETAAC and the ARB staff. In sum, the participants in the Carneros Dialogue urge that the ideas and concepts illustrated below be considered by ETAAC and the ARB, but subject to further analysis and vetting along the important dimensions identified above.

Key Strategies Meriting Further Consideration by ETAAC and ARB

The participants in the Carneros Dialogue identified a large number of approaches by which California could spur investment, sustain innovation, and reduce future emissions of greenhouse gases. For the purposes of this report, we present a representative sampling of those ideas below, grouped into the categories identified above and organized into two types of recommendations: (1) key recommendations and (2) other useful recommendations.

Key recommendations include policies, programs, or strategies suggested by several of the working groups during the Dialogue or amplified by the discussions in plenary. Other recommendations mainly include measures suggested by more than one working group but not explored extensively. The listing of specific recommendations here does not imply the endorsement of each proposal by all Dialogue participants. Future Dialogue sessions will be used to further assess and prioritize the full range of suggestions that arose during the Carneros Innovation Dialogue.

A. Information Programs, Public Outreach Campaigns, and Education Strategies

Key recommendations:

(1) **Develop "Green Labels" for consumer products and all products or assets procured by the state**. The Green Label, capturing both carbon and energy information, would identify the energy consumption and the quantity of greenhouse gas emissions resulting from the manufacture and use of the product or service. The label would include the rate of energy consumption by the device under typical operating conditions as well as the level of energy consumption when the device is "asleep" (i.e., operating in a reduced power or standby mode). The information provided by such a label would inform decision-making by end-users (i.e., individual consumers, firms, institutions, and agencies), highlighting the GHG implications of choosing one product or service over another.

(2) **Support the establishment of a California institute for climate solutions as a joint undertaking of the State's higher education institutions and the CPUC.** This California institute for climate solutions would be charged with training technology developers, financing and conducting high-risk R&D on the next generation of clean technologies, and evaluating alternative policy strategies to reduce emissions through accelerated commercialization of existing clean technologies. The California institute for climate solutions would undertake both basic scientific research and applied engineering research on emerging clean technologies. It would also finance social science research on policy effectiveness and market commercialization of existing technologies to promote innovation in business models and institutional adaptation to changing market conditions. The proposed Institute would also develop a program of systematic statewide public outreach to promote technology transfer and the widespread deployment of clean technologies within California.

(3) **Create a "Green Cities" program to recognize California cities and towns that make public commitments to specified levels of emissions reductions or to the use of specific levels of renewable energy for municipal purposes.** This program could be based on a model similar to the Connecticut Clean Energy Communities Program, which rewards cities certified to the alliance with a state-funded investment in a designated renewable energy supply system. The program could also include a variety of forms of contests and prizes for cities and towns that are successful in efforts to lower their energy use below a specified level or to develop innovative programs that create new examples of "best practices," or accelerate the commercialization of new technologies that significantly reduce GHG emissions.

Other Recommendations Meriting Further Analysis and Research:

(a) Expand workforce training programs through the California community college, state university, and UC systems to prepare students for jobs in the clean tech sector. Programs supported by this approach should include both vocational and professional training. Programs may include a return to the co-op education model where students work part of the year "in the field" with existing firms and for the remainder of the year pursue their studies in a classroom setting.

(b) **Develop a public awareness and outreach campaign to demonstrate that improving energy efficiency or using renewable energy is both "cool" and "sexy."** A modern public relations campaign at the scale and quality used for drug abuse and AIDS education (or similar to the marketing campaign for new consumer products) could have important benefits in reinforcing traditional California values toward stewardship of the environment that have long been held by voters and consumers. The campaign would appeal to Californians, showing that the purchase or use of certain consumer goods or technologies is desirable and in their self-interest.

(c) **Develop a public information and awareness campaign, similar to the Japanese "Top Runner" program, which would provide ratings of the best performing vehicles, appliances, and other energy or water end-use devices. The ratings would be updated annually.** Such a program could provide consumers with the means to make more informed comparisons among alternative products or services and would provide firms with an annual incentive to improve product performance while lowering product-related GHG emissions.

B. Strategies to Promote Research, Development, and Demonstration (R, D, &D) on New and Emerging Clean Technologies

Key recommendations:

(1) **Support the establishment of a California institute for climate solutions as a joint undertaking of the State's higher education institutions and the CPUC.** This California institute for climate solutions would be charged with training technology developers, financing and conducting high-risk R&D on the next generation of clean technologies, and evaluating alternative policy strategies to reduce emissions through accelerated commercialization of existing clean technologies. The California Climate Solutions Institute would undertake both basic scientific research and applied engineering research on emerging clean technologies. Patents emerging from such research would be owned 50% by the State of California. The California institute for climate solutions would also finance social science research on policy effectiveness and market commercialization of existing technologies to promote innovation in business models and institutional adaptation to changing market conditions. The proposed Institute would also develop a program of systematic statewide public outreach to

promote technology transfer and the widespread deployment of clean technologies within California.

(2) **Develop program to underwrite cost-shared research on long-term high risk technology development projects through public-private partnerships involving small businesses located in California.** Financing for these new partnerships would be derived from State sales of tax-exempt bonds. Patents emerging from such research would be owned 50% by the State of California.

(3) **Develop a California Carbon Trust to fund research, development and demonstration projects in clean technologies by small businesses.** The Carbon Trust could act like a venture capital fund to finance critical R, D, & D to promote invention of next-generation technologies. The funds for the proposed Carbon Trust could be derived from the proceeds of auctions for emissions allowances under the proposed California emissions cap-and-trade program. (See related discussion of a California Carbon Bank under section D on programs to facilitate financing end-user uptake of clean technologies.)

(4) **Sponsor high-profile competitions to stimulate innovative examples of clean technologies.** Competitions with significant prizes can be used to stimulate creativity and entrepreneurship, as well as galvanizing public support for the introduction and deployment of the best new technologies.

Other Recommendations Meriting Further Analysis and Research:

(a) **Link a new LED lighting design competition to development of new lamps and the establishment of new performance standards for lighting design in commercial buildings.**

(b) **Increase the level of grant-funded research supporting small businesses in research on emerging renewable energy technologies, energy efficiency systems, water conservation measures, advanced vehicles, and alternative fuels.** The additional funding for such research would be derived from small increases in the public goods charges included in electricity, water, and natural gas bills by distribution companies.

C. Policies, Programs, and Measures Designed to Increase Demand for Clean Technologies

Key recommendations:

(1) Implement enhanced and expanded performance standards for vehicles and fuels; roads and pavements; residential, commercial, and institutional buildings; as well as for systems of water use and transport. Such measures could include standards for higher levels of tire inflation as well as for mandatory

use of "cool paints" in light-duty vehicles sold in California. Such standards would reduce fuel use by lowering rolling resistance and lowering the cooling load to be met by on-board air conditioning systems. Similarly, the State could require the use of "cool pavements" on all roads or parking structures that receive financial support or tax benefits from State funds. In the buildings sector, the State could require the use of "cool roofs" to lower cooling demand in residential and commercial structures, as well as in all new office or warehouse space procured for State government purposes. In the water sector, the State could require specific measures and standards to promote cost-effective water conservation in the transport, storage, and use of potable water and could require water distribution companies to develop a "preferred loading order" that would encourage investments in water efficiency before making investments in new water supply. (This concept is similar to the process that the CPUC requires of electricity load-serving entities.)

(2) Implement "Green Procurement" standards for State agencies that would apply to the acquisition of all products and assets not designated for use in public emergencies or by emergency service personnel. Such measures could apply to all durable and consumable products used by state agencies as well as to all real estate-related assets. Similar standards could be imposed on contractors working on state-funded jobs. In the vehicle sector, such standards could require, for example, that a minimal fraction of all non-emergency light-duty vehicles purchased for use by State employees meet or exceed the Pavley standard on GHG emissions. As an example of such a program, the State could use its procurement power to purchase a significant number of plug-in hybrid electric vehicles (PHEV) in order to support the early development of a PHEV market. In the electricity sector, such measures could include imposing a Renewable Energy Portfolio Standard on electricity purchased to meet the operational requirements of each State agency.

(3) Encourage local municipalities and regional governments to implement "Smart Growth" policies that promote urban in-fill, lower the average level of vehicle miles traveled (VMT), reduce congestion and limit suburban sprawl. Such measures could include congestion charges for vehicles entering central city areas, increased parking fees in downtown commercial districts, and zoning requirements that encourage multi-family dwelling units at the expense of new single-family homes. In addition, such measures could include additional land conservation requirements that limit conversion of farmlands, wetlands, and forested areas to residential development. This program might also include revenue transfer measures that increase subsidies for public transit (or even pay transit riders to use the service), with revenues funded by a combination of congestion charges, increased parking fees, and higher bridge tolls.

(4) Require mandatory retrofit of energy efficiency measures at the point of transfer or sale for all commercial and residential buildings. Each building

would need to be brought up to the level of current building performance standards (e.g., Title 24 for energy use) before the transfer of title could be completed. This measure would increase the rate at which the performance of the building stock improves, as it requires system upgrades to occur with each change of ownership (i.e, approximately every 7-10 years) rather than at the point of building replacement (typically after 50 years or more). Implementation of these standards could be tied to low-interest financing measures discussed later in this report.

(5) Introduce a revenue-neutral "fee-bate" program for vehicle manufacturers that is calibrated to the expected lifetime emissions of light-duty vehicles delivered for sale in California. This program, similar in principle to the Clean Car Discount bill (AB 493) that was recently considered by the State legislature, would offer payments to manufacturers for delivery of high-efficiency light-duty vehicles for sale in the State (i.e., high-efficiency vehicles could be defined as those whose emissions are forecast to be significantly lower than the Pavley requirements). The revenue for these payments could be derived from fees charged to manufacturers for light-duty vehicles that have projected emissions exceeding the Pavley standard and are delivered for sale in the state.

Other Recommendations Meriting Further Analysis and Research:

(a) Expand the current RPS standard for utilities to require 33% of electricity to be derived from renewable energy sources by 2020. This program would be linked to a flexible compliance mechanism that allowed load-serving entities to comply with the requirement through the purchase of tradable Renewable Energy Certificates (sometimes called "Green Certificates" or "Green Tags") that are derived from renewable electricity supply projects located in California.

(b) Create a California market for tradable "White Certificates." This program would tie the existing CPUC regulations requiring utilities to give preference to investments in energy efficiency to a flexible compliance mechanism that allowed load-serving entities to meet a portion of their compliance requirements through the purchase of White Certificates. Such certificates represent the certified emissions reductions that are the result of in-state investments in energy efficiency measures. To address considerations of environmental justice, a minimal fraction of the White Certificates submitted for compliance purposes must represent investments in energy efficiency made in low-income or historically-disadvantaged communities in California. As an extension of this program, California could allow the sale of state income tax credits earned through investment in energy efficiency by firms, agencies, tribes, or households. (This program could be similar in design to the Business Energy Tax Credit program recently adopted in Oregon).

(c) Require load-serving entities to allow sales of on-site power into the electricity grid in excess of the demand for electricity used at that site. Currently, California's net metering rules allow on-site distributed generation

systems to sell electricity back into the grid, but only up to an amount equal to the energy purchased from the grid. This program would allow individual households or commercial enterprises to act as net energy suppliers to the grid. A related element of this program would encourage the load-serving entity to purchase the electricity generated on-site at the then-current time-of-use price level.

(d) Develop enhanced building energy performance standards for solar-ready and plug-in hybrid compatible houses and commercial buildings. This program would require the incorporation of design elements to facilitate the installation of solar-electric systems and include the control system elements that would facilitate the integration of such systems with plug-in hybrid electric vehicles. This measure would ensure that the introduction of plug-in hybrid vehicles occurs in a way that increases the reliability and stability of the local electricity distribution grid, rather than making the local grid more vulnerable to voltage excursions and unplanned outages. Such standards would increase the likelihood that the electricity driving a PHEV comes from a renewable energy source.

(e) Expand the concept of Hybrid/High-Occupancy Vehicle lanes on California freeways to restrict the use of car pool lanes to vehicles whose expected GHG emissions are at least 30% below the Pavley level or by vehicles whose emissions per passenger mile reach equivalent levels. Under this program, a compact car significantly exceeding the SULEV standard (whether hybrid or not) might be allowed to use the HOV lane with only the driver aboard. A mid-size car might require at least two passengers. A full-size SUV might require a minimum of 5 passengers plus the driver to use the same HOV lane. To increase the incentive value of this program in driving demand for high-mileage vehicles, the program might designate the two inside (left-most) lanes of all California freeways as HOV lanes limited to vehicles with low-emissions per passenger-mile.

(f) Introduce a feed-in tariff rule (that might be similar to the old Standard Offer Number 4 under PURPA) for sales of electricity from renewable energy technologies into the local electricity distribution grid. Alternatively, this program could offer a supplemental payment by the state to qualifying, utility-scale (i.e., > 1 MWe) renewable electricity projects (similar to the Connecticut Project 100 program).

(g) Require occupancy sensors in all hotels, motels, and public agency buildings in order to extinguish lights, heaters, and air conditioning units when the rooms are unoccupied. This measure would reduce energy consumption that occurs inadvertently but does not provide an economically valued energy service.

(h) Encourage collection of forest residues and trimming of understory material in fire-prone areas. Collected residue would be used as biomass-derived fuel or feedstock for chemical syntheses. This measure could, if carefully

implemented, help to reduce fire dangers as well as GHG emissions from forest fires, in addition to providing an economically valuable resource for fuel and feedstock.

(i) Develop pilot program for utility ownership of batteries for plug-in hybrid electric vehicles (PHEV). Having the utility own and lease-back the hybrid vehicle battery could eliminate the primary cost uncertainty in ownership of a hybrid vehicle. By tieing this ownership to a commitment by the vehicle owner to make the vehicle's electricity storage system available to the utility in the event of an unplanned local outage event, the PHEV could contribute to stability and reliability in the operation of the grid.

(j) Develop collaborative R&D programs with the EU and Japan to promote innovation in the design of new clean technologies and to promote commercial deployment of existing clean technologies through the development of common standards.

(k) Install speed governors that limit the use of all state-owned, non-emergency, light-duty vehicles to speeds below 65 mph for vehicles whose expected GHG emissions exceed the Pavley standard. This program would encourage state agencies and their employees to buy and drive high efficiency vehicles.

D. Programs to Facilitate Financing of Investments in Clean Technologies by End-users (both consumers and firms)

Key recommendations:

(1) Develop a California Carbon Bank to finance investments in clean technologies by small businesses. The Carbon Bank would provide below-market financing for commercial consumers to upgrade their businesses through investment in energy efficiency, renewable energy, and other productivity-enhancing clean technologies. The funds for the Carbon Bank would be derived from the sale of tax-exempt state bonds and from the forward sale of carbon credits accruing from the investments made in participating businesses. In exchange for low- or zero-interest financing, the State would acquire ownership of the carbon credits generated by development projects financed through the California Carbon Bank. (See further the discussion of a Carbon Trust in Section B above on promotion of R, D, & D.)

(2) **Encourage public/private partnerships through the sale to private concerns of State-owned real estate assets and their subsequent lease-back by State agencies.** Prior to lease-back, the private party purchasing the asset would have to upgrade the facility to exceed by a specified amount the then-current building energy-performance, water use, and waste-minimization standards. Such transactions could be designed to have a clear tax benefit for the private firm and provide a pulse of money to the State treasury in the short term.

(3) **Provide low-interest financing for residential and commercial investment in energy efficiency measures, water use efficiency measures, or renewable energy technologies using funds derived from tax-exempt bonds sold through Municipal Assessment Districts.** This program, similar to the program already initiated in Berkeley, would allow citizens in cooperating jurisdictions to participate in voluntary associations in order to acquire financing at below market rates for investments in energy efficiency, improvements, water use efficiency improvements, or renewable energy technologies. The below-market financing is based on the bond rating of the participating municipality.

(4) **Encourage the use of Clean Renewable Energy Bonds (CREBs) under the U.S. Energy Policy Act of 2005 (EPACT) to facilitate third-party financing of investment in energy efficiency measures and renewable energy technologies.** Arrangements of this type, such as the recent three-party project in which Bank of America financed the installation of 5 MWe of solar photovoltaic power systems on school buildings and facilities operated by the San Jose Unified School District, provide significant operating savings for the host institution or agency and important tax benefits for the investor/owner of the renewable energy equipment.

(5) Modify the California Alternative Energy and Advanced Technology Financing Authority (CAEFTA) to allow financing of alternative energy manufacturing facilities. Currently, this special bonding authority allows the State to underwrite investments in advanced vehicle manufacturing and alternative fuel production facilities as well as the production of energy from renewable energy technologies. The proposed modifications would expand the available authority, allowing the State to provide low cost financing for manufacturing facilities that produce renewable energy technologies (e.g., solar cell or wind turbine production facilities).

Other Recommendations Meriting Further Analysis and Research:

(a) Encourage municipalities to expand support for car-sharing and ride-pooling arrangements and to provide free bicycles for use in central city areas. Existing programs offer to connect passengers departing from the same neighborhoods and travelling to the closely located destinations. Expanded programs could allow car-pool users to enjoy free or subsidized parking in downtown locations. In addition, California cities and towns could develop programs modeled on the Paris Bicycle Pilot Program, which will soon offer citizens the free use of up to 20,000 bicycles (activated by swiping a credit card) and associated with secure parking facilities as well as protected bicycle traffic lanes in the most densely travelled areas of the City of Light.

(b) Employ State bond financing mechanisms to provide below-market financing for public-private partnerships to undertake high-risk, long-term research necessary for the development of the next generation of clean technologies. Under this program, the State agency funding the research would acquire a share in ownership of the carbon credits resulting from deployment of the technologies developed through these partnerships.

(c) Provide revenue-neutral fee-bates for real estate developers who coordinate new residential development with the planning of "sustainable communities." Models for such communities include provision for clean tech industry, high-density housing, and public transit as components of "Smart Growth" policies. Revenues to offset the rebates given to "sustainable communities" would be collected from land-use assessments applied to strictly residential or recreational developments that encourage increased commuting, higher levels of road congestion, and increased air pollution.

(d) Require all load-serving entities, gas distribution, and water distribution companies to offer "on-bill financing" for consumer investments in energy efficiency-improving or water-saving technologies, or for installation of on-site renewable energy technologies. On-bill financing allows consumers to amortize the high up-front cost usually associated with investments in efficiency measures or renewable energy technologies through the monthly payment of their utility bills, often at rates that are below the typical consumer's cost of funds. One model of such a program would encourage load-serving entities and gas-distribution companies to re-introduce the zero-interest loan programs that they offered to California consumers in the 1970s and 1980s to finance energy efficiency and renewable energy investments.

(e) Encourage California pension funds to offer third-party financing of clean technology investments at large commercial facilities or local government agencies.

(f) Use State bond financing for adding biofuel pumps at existing gasoline and diesel fueling stations. The resulting expansion in availability of such pumps would allow the existing fleet of flex-fuel vehicles to travel around the state with increased reliance on emissions-reducing biomass-derived fuels. It would also encourage increased market penetration of flex-fuel vehicles (and non-petroleum fuels) in California's light-duty vehicle fleet.

E. Regulatory Streamlining and Institutional Coordination

Key recommendations:

(1) **Designate a "Wizard of Woo," a master marketer and facilitator, whose office would have a mandate to attract clean technology investments to California. This office would act as the primary focal point for information on available clean technologies and on the permitting requirements for new or expanded clean technology facilities. It would also act as the point of coordination for statewide efforts to encourage clean tech companies to locate new or expanded manufacturing facilities within the state.** In addition to information about permitting requirements, the Wizard of Woo would provide firms with specific referrals to the individual in each agency who is responsible for evaluating permit applications and proposals for new facilities. The Wizard would also coordinate efforts to have senior State officials (including the Governor) meet with senior executives of select companies that are considering large-scale investments in new or expanded facilities in California. Additionally, the Wizard would act as the State's principal agent promoting exports of clean technologies from California to other regions and countries.

(2) **Appoint a "Clean Tech Czar" in the Governor's Office who would receive quarterly reports from all state agency heads summarizing the impact of their agency's programs on statewide GHG emissions during the previous quarter.** This new position would raise the profile of emissions reductions and heighten the focus of each agency on its ability to encourage the deployment of clean technologies by both the public and private sectors.

Other Recommendations Meriting Further Analysis and Research:

(a) **The Climate Action Team should help agencies become more transparent by reporting publicly the GHG emissions impacts of each agency's annual budget requests and to compare this estimate to the previous year's performance by each agency.** By highlighting the impacts of each year's budget request, the Climate Action Team could help agency heads to focus the attention of agency staff on the need to continuously reduce GHG emissions through the policies and operations of State agencies. These Climate Action Team reports should include the GHG emissions implications of land-use policies promulgated by State water, agriculture, and forest management agencies.

F. Incentives for Manufacturers to Locate in California

Key recommendations:

(1) **Create "Green Enterprise Zones" that incorporate single permits for the establishment of clean tech manufacturing businesses (1) meeting pre-set performance standards for emissions and waste; and (2) producing energy efficiency systems, water use efficiency systems, renewable energy**

technologies or advanced vehicles. For the purposes of this program, advanced vehicles could be defined as any light-duty vehicle who's expected GHG emissions are at least 30% below the Pavley standard, when operated in California with commercially available fuels or electricity.

(2) **Designate a "Wizard of Woo," a master marketer and facilitator, whose office would have a mandate to attract clean technology investments to California. This office would act as the primary focal point for information on available clean technologies and on the permitting requirements for new or expanded clean technology facilities. It would also act as the point of coordination for statewide efforts to encourage clean tech companies to locate new or expanded manufacturing facilities within the state.** (Note: See Regulatory Streamlining discussion above.)

(3) **Modify the California Alternative Energy and Advanced Technology Financing Authority (CAEFTA) to allow financing of alternative energy manufacturing facilities.** Currently, this special bonding authority allows the State to underwrite investments in advanced vehicle manufacturing and alternative fuel production facilities as well as the production of energy from renewable energy technologies. The proposed modifications would expand the available authority, allowing the State to provide low cost financing for manufacturing facilities that produce renewable energy technologies (e.g., solar cell or wind turbine production facilities).

Other Recommendations Meriting Further Analysis and Research:

(a) **Develop a "Made in the Golden State" trademark to identify consumer goods and other products manufactured in California.** Such a program would reinforce growing consumer preference toward purchase of locally grown or locally manufactured goods.

(b) **Create "Green Energy Parks" for manufacturing enterprises in which all energy used for plant operations is derived from renewable energy sources and in which cross-fertilization among enterprises could lead to the development of new "innovation clusters."**

(c) **Develop "business incubators" for clean technology manufacturing facilities.**

(d) **Encourage clean tech companies to locate in "sustainable communities" by providing enhanced access to communications and transportation infrastructure in these communities.**

Conclusions and Next Steps

Absent new policies and programs, California's emissions of greenhouse gases will grow significantly by 2020, due to the combined effects of a rising population and an expanding economy. To achieve the emissions reduction goals of AB 32, California must deflect the trajectory of future emissions growth by decreasing the average rate of GHG emissions per dollar of Gross State Product (GSP).

If California's population continues to increase and the State's economy continues to expand, reducing the average rate of GHG emissions per dollar of GSP in the near- to mid-term is likely to require significant changes in consumer behavior as well as massive deployment of currently commercial clean technologies and the development of additional clean technologies that are nearing commercial readiness today.

A wide range of innovations will be required to achieve the 2020 economic and environmental goals of AB 32. These include advances in the engineering design of clean technologies along with the development of innovative business models, new institutional arrangements, and creative financing approaches.

For the longer term, in order to reach the 2050 goals of the Governor's Executive Order, California must sustain or even accelerate the current pace of technology innovation and invention in order to develop the next generation of clean technologies and to bring them to commercial success prior to 2050. The State's efforts in this regard would be reinforced by encouraging new public-private partnerships that could stimulate commercial deployment of existing technologies and promote longer-term, high-risk research on future generations of clean energy technologies.

In order to capture the full economic and political benefits (including job creation) resulting from investments in clean energy technologies by public agencies, private firms, and individual consumers in California, the State should encourage investment in the manufacturing infrastructure needed to produce these technologies within the State.

Carefully designed regulations, market-oriented policies, inventive forms of R&D support, innovative public-private partnerships, and wide-ranging educational campaigns, as well as new financing mechanisms will be necessary to achieve the AB 32 targets, and California's still more ambitious emissions reduction goals for 2050. These programs, policies, and strategies can spur investment in clean energy technologies and reduce future greenhouse gas emissions. The issue is no longer whether to rely solely on conventional technology-oriented regulations, or economy-wide cap-and-trade programs, or targeted incentives. All of these approaches and more will be needed to achieve the State's policy goals. The further challenge is to design an integrated portfolio of programs that synchronizes the efforts of individual consumers, private firms, and state institutions in the common effort to achieve the state's environmental and economic goals.

It is important to note a general consensus among the participants of the Carneros Dialogue on one key issue. All the participants agreed that continued development of the clean tech sector is critical to a healthy economy in the post-AB 32 world. The participants also concluded that the State has an important role to play in establishing a stable policy environment and creating the conditions in which innovative entrepreneurial activity can flourish in this sector.

Many participants believe, however, that the clean technology sector of the California economy will be stronger and more successful if it can develop around a set of business models that are based on self-sustaining commercial market development for these technologies. If clean technologies instead follow a trajectory that, like commercial nuclear power in the 1960s, relies on generous continuing subsidies from the (State or federal) government, the associated businesses may experience a measure of fragility, and could be easily undermined by changes in the political winds or by perturbations in government budget cycles. By contrast, if these technologies develop along a trajectory that is more like that of hand calculators, cellular phones, and laptop computers (i.e., profiting from initial government support for critical, high-risk R&D but aggressively pursuing a transition to self-sustaining business models), the resulting enterprises can form a robust pillar of communal strength in the next stage of California's economic and environmental development.

The scale of the challenge facing California is unprecedented and transformational. The appropriate response will need to be both sure-footed and bold. The Carneros Dialogue has demonstrated that one important step on this path involves bringing together an unusually diverse set of key stakeholder communities in a process of frank conversation. In Carneros, they found a safe haven for exploring shared objectives and discovering common ground. Many participants in the Carneros Dialogue have indicated that useful next steps might include careful assessment of the range of opportunities identified in this strategic conversation as well as carefully structured and well-prepared opportunities for further dialogue in the future.

Acknowledgements

The authors are grateful to a number of people for their contributions to the Carneros Innovation Dialogue and to our thinking about innovative policies to sustain investment in clean technologies. First and foremost, we want to thank Noel Perry, Marcia Perry, Sarah Henry and Rishell Jordan of NEXT 10, who have given so generously of their time and resources.

We would also like to thank the participants in the Carneros Dialogue who engaged in an intensive and high-spirited conversation, sharing freely of their experiences, their insights, and their good ideas. In particular, we would like to thank those participants who participated in extensive pre- and post-meeting interviews, helping us to design the meeting and to better understand the nuances of the conversation at Carneros.

We want to offer a special note of thanks to Jason Mark, Winston Hickox, Mary Nichols, Eileen Wenger Tutt, Alan Lloyd, Wally Maguire, John Wilson, Morrow Cater, Peter Schwartz, and Ed Pike, whose ideas guided our planning and enriched our preparations for the Carneros Innovation Dialogue. We are especially grateful to Wally Maguire, who facilitated one of the small working groups convened during the meeting; to Peter Schwartz, who facilitated the plenary discussion of critical uncertainties facing California, as well as one of the small working groups; and to Kevin Kennedy, whose presentation highlighted the scale and complexity of the AB 32 challenge. We would like to thank Dan Kammen and Margaret Taylor for the excellent presentations of their commissioned research, which set the context for the day's discussions. Finally, we want to thank Emily Shepard, our graphic recorder, whose artful representations of the discussion made complicated concepts much clearer to all those who participated in the Carneros Innovation Dialogue.

We are also very appreciative of the excellent comments we received from those who reviewed early drafts of our report.

This report reflects our understanding of the strategic conversations that unfolded during the Dialogue. Any errors of fact or interpretation are solely the responsibility of the authors.

I.M.
J.A.L.
November 2007

Appendix A

Carneros Innovation Dialogue:

A strategic dialogue on innovative approaches to spur investment in clean technologies

Wednesday, October 17, 2007

7:00 - 9:30 **Reception and dinner** at Grgich Winery for those arriving Wednesday afternoon
Intro of Next 10 and this meeting

- Introduction to Next 10, Next 10's reasons for convening this meeting , overview and potential usefulness of Green Innovation Index
- Context and goals of this Innovation Dialogue
- Introduction of participants present at the dinner (Name, affiliation, primary reason for participating in this dialogue, expectations)

Self-intros by participants

"**Where will current trends lead?**" Kevin Kennedy, ARB
Discussion

Thursday, October 18, 2007

9:00 - 9:15 **Welcome and overview of the meeting:**

Objectives:

1. To begin a strategic conversation that will identify innovative, cost-effective approaches to achieving the goals of AB 32, that will sustain innovation, and make clean technologies a pillar of the state's economic development strategy;
2. To identify for consideration by ETAAC a set of specific recommendations of innovative financial and non-financial measures to sustain technology innovation, spur investment in clean technologies, and reduce CA's emissions per dollar of GSP

Key Questions:

1. What more can CA reasonably do to stimulate a more rapid market transformation to an efficient economy?
2. How can CA further accelerate commercialization of existing and new renewable energy technologies, and energy efficiency systems, as well as emissions-reducing technologies outside the energy sector?
3. How can CA create an attractive climate for investment in the manufacturing infrastructure needed to produce these technologies within the state?
4. What do we need to understand about California's business climate and what can be done to improve that climate in order to achieve the goals of AB 32?

9:15 - 9:45 **Self-introductions of Participants**

9:45 – 10:00 **Expected Outcomes**:

1. Workshop results and a set of commissioned papers will serve as inputs to the ETAAC;
2. Workshop will provide the basis for on-going dialogue between state officials and leaders of the business community.

Ground rules for the meeting

10:00 - 11:30 Panel: **Recent experience with initiatives to spur investment and innovation**

- Public outreach and education
- Public and regulatory policies
- Regulatory streamlining
- Facilitating financing
- Location incentives for manufacturers

Presentation**: What can CA learn from innovative approaches implemented in other states to spur investment in clean technologies, to sustain innovation, and to reduce the emissions intensity in the near- to mid-term?** Irving Mintzer

Presentation: **What innovative approaches are other countries using to spur investment in clean technologies, to sustain innovation, and to reduce the emissions intensity of their economies?** Dan Kammen

Presentation: **What policy strategies have proved effective in the past for inducing innovation and reducing emissions?** Margaret Taylor

Discussion, reactions, and ideas

11:30 – 11:45 Break

11:45 - 12:30 Lunch

12:30 – 1:30 **What outside forces might change the context in which CA's AB 32 implementation plans unfold?** Peter Schwartz
Guided exposition of participants' views of the critical uncertainties, major driving forces, or potentially disruptive events that could affect CA's ability to implement public policies or investment strategies designed to accelerate commercialization of clean techs and reduce emissions by 2020

1:30 - 3:00 Facilitated group work: **What makes sense in the current CA context?**
Intro (10 min), Small group work (40 min), Report back to large group (40 min)
Group to identify specific innovative strategies that can accelerate market penetration of clean technologies in CA and advance the goals of AB 32 in ways that complement other CA policy priorities

3: 00 - 3:30 Break

3:30 - 5:00 Facilitated group work: **How can CA strengthen the attractiveness of the State's business climate and reinforce its ability to attract new investment in the manufacturing infrastructure needed to produce clean technologies and "green collar jobs" within the state -- without beggaring the tax base?**
Intro (10 min), Small group work (40 min), Report back to large group (40 min)

5:00 - 5:30 **Wrap-up and Next Steps**

Appendix B
Carneros Innovation Dialogue:
A strategic dialogue on innovative approaches to spur investment in clean technologies

Participants in the Carneros Dialogue

Dialogue Participants

Adams, Tom (Chairman, CLCV)
Adler, Dan (Vice President, CalCEF)
Bohn, John (Commissioner, CPUC)
Brown, Edward G. (CA Attorney-General)
Brown, Robert (Director, Environmental and Vehicle Engineering, Ford Motor Co.)
Brunello, Tony (Deputy Secretary, Resources Agency)
Byron, Jeff (Commissioner, CEC)
Cater, Morry (Cater Communications)
Coony, Steve (CA Chief Deputy Treasurer)
Corey, Richard (Asst Chief, Research Division, ARB)
Crane, David (Governor's Advisor on Jobs and Economic Development)
Doucette, Diane (Director, Climate Campaign, E2)
Feierstein, Mitch (Cheyne Capital)
Geesman, John (Commissioner, CEC)
Goulder, Larry (Professor of Economics, Stanford and Vice Chair, MAC)
Henry, Sarah (Next Ten)
Henton, Doug (Collaborative Economics)
Hernandez, Randal (Vice President, Bank of America)
Hickox, Winston (Partner, California Strategies and Chair, MAC)
Huhman, Steve (Vice President, Morgan Stanley)
Jordan, Rishell (Next Ten)
Kammen, Dan (Professor, Energy and Resources, UCB)
Kennedy, Kevin (Office of Climate Change, ARB)
Knight, Ben (Vice President, Automotive Engineering, Honda North America)
Leonard, Amber (MEG)
Lipper, Kip (Consultant to Senate President Pro Tem Perata)
Lloyd, Alan (President, ICCT and Chairman, ETAAC)
Lockyer, Bill (CA Treasurer)
Love, Mike (National Regulatory Affairs Manager, Toyota Motors NA)
Mark, Jason (Program Director, Energy Foundation and member ETAAC)
Martin, Tom (PCG Group)
McCoy, Catherine (Stark Capital)
McGuire, Wally (President, FlexYourPower)
Mintzer, Irving (MEG)

Nichols, Mary (Chair, CARB)
Perry, Marcia (Next Ten)
Perry, Noel (Next Ten)
Pike, Ed (Staff Scientist, ICCT)
Pollak, Harrison (CA Deputy Attorney-General)
Pulling, Wendy (Vice President, Environmental Policy, PG&E)
Redway, Bettina (CA Deputy Treasurer)
Regis, Steve (Vice President, Cal Portland Cement and Member of the Board, CMTA)
Ruskin, Ira (Member CA State Assembly)
Ryan, Nancy (Advisor to President Peevey, CPUC)
St Marie, Stephen (Advisor to Commissioner Bohn, CPUC)
Schuparra, Kurt (Associate, California Strategies)
Schwartz, Peter (Chairman, GBN and Alta Partners)
Shahinian, Leon (Senior Portfolio Manager, CalPERS)
Shepard, Emily (Graphic Recorder)
Shugar, Dan (President, Powerlight/SunPower)
Sowell, Arnie (Policy Director, Office of Assembly Speaker Nunez)
Sweeney, Jim (Professor of Economics, Stanford and Director, Precourt Institute)
Taylor, Margaret (Professor of Public Policy, Goldman School, UCB)
Tutt, Eileen (Deputy Secretary, External Affairs, CalEPA)
Wang, Devra (Senior Attorney, NRDC)
Wilson, John (Advisor to CEC Commissioner Rosenfeld)
Woodward, Tim (Partner, Nth Power)

Appendix C
Carneros Innovation Dialogue:
A strategic dialogue on innovative approaches to spur investment in clean technologies

Experiences in Other Jurisdictions & Impacts of Cap-and-Trade Regimes on Innovation

California is not the only jurisdiction that is addressing the challenges of climate change and attempting to exploit the opportunities offered by clean technology. A number of other states and some countries are pursuing similar objectives. The section below summarizes several papers and presentations by participants in the Carneros Dialogue which highlight some of these efforts and the lessons learned from historical experience with market-based measures designed to limit or reduce emissions of atmospheric pollutants.

Approaches of Other Countries to Limiting Greenhouse Gas Emissions and Promoting Clean Technologies

Dan Kammen and others in the University of California's Energy and Resources Group have surveyed the efforts of other countries to reduce GHG emissions and to promote clean technologies. They have identified several examples of innovative policies that may provide useful information to California as it develops the scoping plan for AB 32.

- *Germany: Feed-in Tariffs to Promote Investment in Solar Electric Systems*

Kammen (2007) describes the **German feed-in tariff law** as a renewable energy policy designed to reinforce the financial security of investments in renewable energy technologies and thus to stimulate investments in these technologies.[5] The German feed-in tariff law obliges electricity distribution companies and load-serving entities to buy electricity output from distributed renewable energy sources at a fixed price over a fixed time period. By setting the level of the feed-in tariff to exceed the typical cost of electricity production from a renewable energy technology, the policy ensures that the investor will receive a reasonable rate of return.

Kammen notes that under current (i.e., late 2007) California market conditions, the average cost of generating electricity from solar photovoltaic power systems is approximately $0.25 per kWh.[6] In these circumstances, Kammen argues, an initial feed-

[5] Kammen, Daniel M., 2007. "Developing a Framework and Exemplary Projects to Meet California's Climate Protection Goals and Economic Growth." Energy and Resources Group, University of Califonia, Berkeley. Mimeo.

[6] This estimate assumes a solar cell price of $2.50-3.00 per Watt(p), an installed module cost of $5.00 – 6.00 per Watt(p), and an average output of 2,000 – 2,5000 Watt-hours per Watt(p) of installed capacity.

in tariff set below the current PG&E peak price charged to time-of-use (TOU) customers (i.e., $0.32/kWh) could complement the current Renewable Portfolio Standard and encourage additional investment in this clean technology.

Largely as a consequence of the feed-in tariff, more than 1 GW(p) of solar electric capacity was installed in Germany in 2006. This compares to 170 MW(p) installed in the US during the same period. The German program steps down the size of the subsidy by 5% per year for each year of the program's operation, eventually phasing out the subsidy entirely.

Kammen points out that feed-in tariffs of this type can be used to engage new, often smaller classes of providers (e.g., households or commercial facilities) to invest in solar electric systems. By setting the initial feed-in tariff at an attractive level but reducing the promised payments for new systems by a fixed amount in each future year, the system can be designed to encourage early action and stimulate rapid deployment. The underlying assumption is that such early investments will accelerate the achievement of economies-of-scale in manufacturing and thus reduce the expected future costs of these technologies.

- *Japan: New Sunshine Program*

Kammen and Peterman (2007) evaluated **Japan's New Sunshine Program**, which was first established in the wake of the 1970s oil shocks, then updated in the 1990s.[7] In its current incarnation, the program promotes research, demonstration, and installation of renewable energy technologies, especially photovoltaic (PV) power systems. Working through the Ministry of Economy, Trade, and Industry (METI), the program underwrites the costs of R&D, field tests, and demonstration projects. The New Sunshine Program promotes public-private partnerships through an "informal collaborative network throughout government and industry." This collaboration proved critical to the program's success, dovetailing efforts to expand demand for PV systems, increase production volumes, lower solar cell production costs, and stimulate installation of PV systems by end-users.

The New Sunshine Program provides cash rebates for purchases by households and has implemented policies on net-metering. Rebates for end-user purchases were originally set at 50% of system cost in 1994, declined to 10% of such costs in 2003, and were phased out entirely in 2005. The Japanese policies on net metering require local electric utilities to buy back surplus power produced on-site by households and commercial installations at prices equivalent to the then-current charge paid by these customers for power drawn down from the grid.

[7] Kammen, Daniel M. and C. Peterman, 2007. "Appendices: DRAFT International Programs of Conceptual Interest." Energy and Resources Group, University of California, Berkeley. (Mimeo).

The New Sunshine Program has achieved considerable success in "jump-starting" the PV industry in Japan. In 1995, Japan produced approximately 18 MW(p) of PV systems and had an installed capacity of 43 MW(p). During the 2003 fiscal year, Japanese utilities bought back approximately 180 MWh of electricity produced by distributed PV systems. By 2004, Japan was the world's leading manufacturer of these systems, producing over 500 MW(p), a production volume equivalent to more than 25% of global output. In 2005, Japan's installed capacity exceeded 1400 MW(p).

The New Sunshine Program was extremely successful in stimulating the expansion of the solar photovoltaic power sector in Japan and resulted in the generation of large quantities of solar electricity. The electricity output of Japan's photovoltaic installations allowed the country to slow the growth of fossil fuel imports and to avoid significant emissions from fossil fuel power plants between 1994 and 2005.

However, Kammen and Peterman point out that the cost of the avoided emissions was rather high. They calculate that a 10-year investment equivalent to US$ 4.5 billion resulted in over 1100 MW(p) of installed capacity that today generates in excess of 1.7 billion kWh per year. If this much electricity had been generated with a mix of sources similar to that found in California in 2002, Kammen and Peterman estimate that the output would have been equivalent to emissions of 270,000 tons of CO_2. This would represent an average cost of avoided emissions equivalent to about US$ 17,000 per ton of CO_{2e}. Taking account of the continuing annual output of the PV systems after the 'sunset' of the New Sunshine subsidies, Kammen and Peterman observe that the estimated cost of emissions avoided by this program still remain in excess of $550 per ton of CO_{2e}.

Innovative Approaches Used by Other States to Limit GHG Emissions and Promote Clean Technologies

Irving Mintzer and Amber Leonard have recently identified and reviewed innovative programs being implemented by other states to spur investment in clean technologies and to reduce emissions.[8] The primary mechanisms used by these programs involve approaches other than direct financial payments to end-users. These kinds of programs can be grouped into the following categories:

1. Public outreach and education programs;
2. Measures improving institutional coordination and streamlining regulatory processes;
3. Strategies to increase demand for clean technologies;
4. Measures to facilitate financing of clean technologies and lower market barriers associated with high initial cost of these technologies; and

[8] Mintzer, Irving and J. Amber Leonard (2007). "Innovative Approaches to Spur Investment in Clean Technologies Implemented in Other States." MEG, LLC. (Mimeo)

5. Financial and non-financial incentives to locate manufacturing infrastructure for clean technologies within the state.

Using these categories, the following section describes some of the innovative approaches being used by other states that might provide useful models for California.

- *Public Outreach and Education Programs*

The **Connecticut Clean Energy Communities Program** is a public outreach and education program begun in 2004 and managed by the Connecticut Clean Energy Fund (CCEF). It operates as a public-private partnership involving two NGOs (Community Energy and Sterling Planet) along with the CT Department of Public Utility Control, and the CT Office of Consumer Counsel.

Cities and towns are eligible for designation as a **CT Clean Energy Community** if they commit, by 2010, to purchase the equivalent of 20% of the power that will be consumed by municipal buildings and community services in the form of electricity derived from renewable energy technologies. The municipal government must sign-up, in addition, one of the following groups of stakeholders from their community who will commit to buy Renewable Energy Certificates equivalent to 20% of their own electricity consumption by 2010:

- A group of 100 residential customers of the local electric utility; or
- A group of 100 electricity customers in a regional school district; or
- A group of residential customers equivalent to 10% of the households in the municipal jurisdiction; or
- A commercial or industrial customer with annual electric energy demand equivalent to 1 GWh of clean energy.

For signing up each qualifying group of stakeholders, the CCEF provides the community with a solar PV power system that has a rated capacity of 1 kW(p). The PV system must be used to supply electricity to a public building or to a community service. Finally, the community must commit to use 100% of the municipal cost savings that result from the output of the State-funded PV systems to purchase additional clean, renewable electricity.

In 2006, the program accounted for a supply of 19,125 MWh, and avoided the release of 8,313 tons of CO_2 (approximately 2,060 MT of carbon). About 11,000 households had signed up to purchase renewable electricity by the end of 2006 (compared to the program target of 20,000 households). The price premium paid by each participating household for "green" electricity is estimated to be $7-10 per month. By the end of 2006, the program reached sufficient customers to offset approximately 0.055 percent of the State's electricity demand, progressing toward the 2010 program goal of 0.3 percent of the State's electricity demand.

The CT Clean Energy Fund hopes the program will ultimately lead to the installation of PV power systems capable of supplying 1 percent of the State's residential customers and will supply 0.3 percent of the state's annual electricity demand. More significantly, the CCEF hopes that this program will raise awareness of clean energy technologies and demonstrate the opportunities they present for protecting the environment at a reasonable cost while meeting the energy needs of Connecticut's citizens.

- *Improving Institutional Coordination and Streamlining Regulatory Processes*

The **Colorado Climate Change Coordinator** represents a new position established in the Colorado Governor's Office in April 2007. The role of this position is to improve inter-agency coordination and streamline regulatory action on issues related to climate change. The **Office of the Climate Change Coordinator** is currently limited to the Coordinator and a few support staff. It is expected to grow in both size and influence over the coming year.

The Climate Change Coordinator serves as the Governor's representative in all major policy discussions on issues related to climate change. She works with senior officials in all State agencies that have mandates affecting the State's future greenhouse gas (GHG) emissions, ensuring the coordination of policies and programs implemented by State agencies, including those that affect Colorado's ability to respond to the impacts of climate change. She coordinates state programs with the policies and programs implemented by Colorado municipalities and will develop a program of systematic outreach to the business community across the State.

This position is expected to raise the profile of climate change among state policymakers and officials. It will increase coordination among the agencies and expand communication with the private sector. In the future, the Coordinator may work with agency leaders to simplify and streamline the regulatory requirements for bringing clean technologies into Colorado.

- *Strategies to increase demand for clean technologies*

Connecticut's Project 100 is a legislatively-mandated program established in 2005 and designed to increase the demand for renewable electricity technologies in Connecticut. **Project 100** promotes the development of large renewable energy projects to meet the state's electricity needs by requiring the State's electricity distribution companies to sign long-term power purchase agreements (PPAs) for 100 MWe of renewable energy capacity. This electricity must be produced from utility-scale (> 1 MWp) renewable electricity generating plants. These PPAs are required to remain in effect for at least ten years in order to ensure the project developers of a stable, long-term market for the output from these new renewable energy projects.

The CCEF analyzes and evaluates project proposals submitted to the program and makes recommendations to the State's electricity distribution companies. Projects that meet program standards for technical feasibility, cost-effectiveness, and quality of management are identified by CCEF staff. In some cases, the CCEF may choose to participate in funding some portion of a certified project's capital costs.

Under this program, the State pays the participating distribution companies a price premium of $0.055 per kWh for each kWh derived from qualifying in-state renewable energy projects that are certified by the Connecticut Clean Energy Fund (CCEF).

When fully operational, the projects selected for participation in Project 100 are expected to generate more than 250,000 MWh of renewable electricity annually, with an annual cost of approximately $13 million for support payments to distribution companies. Projects selected from the Round I solicitation are currently in development. Approximately 15 MWe of new projects have negotiated long-term PPAs with CT electric distribution companies and are being implemented today. Eleven additional projects representing an additional 70 MWe of new renewable capacity were recommended as a result of the Round II solicitation (concluded in March 2007).

- *Measures to facilitate financing of clean technologies and lower market barriers associated with their high initial cost*

The **Oregon Business Energy Tax Credit** is a mechanism to facilitate financing of new investments in energy efficiency or renewable energy technologies, including both on-site installations by end-users and investments in manufacturing infrastructure. This program was introduced in 2005 and expanded in 2007. The program allows Oregon firms, institutions, municipalities, Native American communities, farms, and non-governmental organizations to earn a tradable tax credit by investing in on-site renewable energy systems or energy efficiency measures.

If the **Business Energy Tax Credit** is used directly by the developer or investing entity, the value of the tax credit is equivalent to 50 percent of the capital cost for the renewable energy system or energy efficiency measure. Alternatively, if the project developer wishes to sell or trade the tax credit to an entity that has an existing Oregon income tax liability, the state sets the value of the credit at 35 percent of the capital cost of the energy efficiency investment. In 2007, the State raised the value of the tradable credit for investments in renewable energy systems to 50% of the total capital cost of the system and expanded the program's eligibility to include investments in renewable energy manufacturing facilities. (With this expansion of the program, the Oregon Business Energy Tax Credit also acts as an incentive for locating new manufacturing infrastructure in the state.)

This tradable tax credit may be earned on projects with capital costs of up to $20 million. When purchased by an entity with an Oregon income tax liability, the value of the credit is usually spread over five years. For example, in the case of a project claiming a 35% credit, 15% of the project capital cost can be applied in the first tax year, and 5% of the capital cost remains applicable as a credit in each of the next four successive tax years. For projects with total capital cost of $20,000 or less, the full value of the purchased credit may be applied in a single tax year.

Additionally, business owners who purchase **pre-certified, high-efficiency, hybrid vehicles** can also earn a Business Energy Tax Credit. The amount of the vehicle cost which is eligible for the hybrid vehicle tax credit is equal to the incremental cost of the hybrid vehicle, determined by comparison to the cost of a conventional vehicle of equivalent size, capacity, and functionality.

To facilitate operations of the Business Energy Tax Credit Program and to ensure economic efficiency in this emergent market, the Oregon Department of Energy provides a free service to Oregon entities wishing to participate in the program. Acting as a broker or a "market-maker," the Department assists project developers or investing entities by matching up a purchasing entity (called a "pass-through partner,") with investors and project developers wishing to sell renewable energy or energy efficiency tax credits.

The program has enjoyed considerable success and continues to grow. In 2006, over 10,000 business energy tax credits were sold or traded in Oregon. The size of each credit reflects the capital cost of its associated project, with the value set by the state as a fixed percentage of the capital cost.

- *Incentives to locate manufacturing infrastructure in-state*

The **New Jersey Renewable Energy Business Venture Assistance Program** (NJBVAP) is an innovative financing mechanism designed to provide incentives for in-state development of small businesses working in the state's renewable energy sector. The NJBVAP operates as a partnership between the New Jersey Board of Public Utilities and the NJ Economic Development Authority. Implemented through New Jersey's Clean Energy Program, the NJBVAP provides below-market financing for businesses with less than 500 employees, providing seed funding and commercialization assistance to encourage clean technology development and the construction of manufacturing infrastructure in NJ.

Technology investments eligible to receive this assistance include solar power systems, wind power systems, fuel cells using renewable fuels, wave energy systems, tidal energy installations, sustainably harvested biomass projects, and hydrogen production systems powered by renewable energy technologies. In addition to these renewable energy supply technologies, the program also finances the development of "balance of systems" components that are needed to ensure successful commercialization of renewable energy supply technologies.

Up to $500,000 per project is available to firms in the form of a recoverable grant whose repayment is contingent upon the future success of the business. Participating firms must provide a cost-sharing investment equivalent to 25 percent of the value of grants received from this program. In the event that the firm is successful in generating future revenues, the grant converts to an interest-free loan, with the firm repaying the principal amount of the grant.

The program has approximately $5 million per year available to fund development, deployment, and commercialization activities. This amount is expected to fund a minimum of ten projects per year.

Lessons from Past Experience with Emissions Control Regimes

Margaret Taylor (2007) of UC Berkeley's Goldman School of Public Policy has explored historical experience with cap-and-trade programs (CTPs) and their influence on technological innovation.[9] Her paper helps to fill an identified weakness in the literature by providing empirical evidence regarding the effects of the main existing CTPs on innovative activity, as defined to include both technology adoption and invention.[10,11] The main finding of the paper is that the low allowance prices that characterize the history of CTPs to date, whether considered "over-allocated" or "successful," are accompanied by a steep decline in inventive activity across a broad set of relevant

[9] Taylor, Margaret, 2007. "The Dynamics of Innovation and Cap and Trade Programs." Goldman School of Public Policy, University of California, Berkeley. (Forthcoming).

[10] A.B. Jaffe, R.G. Newell, and R.N. Stavins, (2002). Environmental policy and technological change. Environmental & Resource Economics, vol 22 pp. 41-69.

[11] T.H. Tietenberg, (2006). Emissions Trading: Principles and Practice, Resources for the Future, Washington D.C.

environmental technologies, in contrast to levels achieved during traditional environmental regulation.[12]

The paper also shows that technology supplier firms, not the emissions sources likely to be regulated under a CTP in California, dominate inventive activity in many climate-relevant technologies, including carbon capture and sequestration, photovoltaic cells, wind power, solar thermal electric power, and solar water heating. This is important because these supplier firms are unlikely to capture the main benefit of CTPs, which is to provide emissions sources with the flexibility to pursue a range of options – including technology purchases – to achieve targeted emissions levels at low cost. Indeed, technology suppliers have faced a peculiar dilemma under past CTPs for sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the U.S. Early sales by suppliers of highly effective emissions-reducing technologies to emissions sources have helped to lower allowance prices, thereby reducing the demand for later technology purchases by other customers (even to the point of significant cancellations of existing technology orders). Confronting decreased future market expectations, supplier firms have had less reason to invest in costly and uncertain R&D efforts to improve their technologies over time.

Although sufficient time has not elapsed since the advent of the European Union Emissions Trading Scheme (EU-ETS) to do a similar study on an operational, climate-specific CTP, other researchers have pointed out that low-carbon investment decisions under the EU-ETS are being delayed by the risk of low future carbon dioxide (CO_2) prices.[13] This may be early evidence that a similar invention dynamic is at play under the EU-ETS as was true under the SO_2 and NO_x CTPs that Taylor investigated.

If low allowance prices and the resulting effects on inventive activity actually reflect proper balancing of social benefits and costs, why then worry about any disincentive a CTP for climate policy might provide to the long-term R&D efforts of technology suppliers? After all, Taylor's review of adoption behavior under CTPs shows that emissions sources – often significant contributors to gross domestic product – have employed surprisingly low-cost methods of attaining emissions targets in response to the two more successful CTPs in the U.S. As a society, this means that one of the cost savings associated with CTPs is economizing on inventive efforts focused on unnecessary, higher-cost solutions to environmental problems.

[12] This decline is measured in patents, which are the most widely used metric of inventive output in the literature. Patents are required by law to publicly reveal the details of a completed invention that meets thresholds of novelty, usefulness, and non-obviousness. Studies have shown that patenting activity parallels research and development (R&D) expenditures, which are often difficult to find at a disaggregated enough level for research purposes, and can also be linked to events that occur outside the firm. Surveys (Napolitano and Sirilli, 1990; Scherer et al., 1959; and Sirilli, 1987) demonstrate that 40–60% of the innovations detailed in patent applications are eventually used by firms. Patents are probably best thought of as a well-accepted intermediary outcome of inventive activity that is tied both to the input of R&D expenditures and to ultimate hopes of commercialization. See (Z. Griliches, 1990) for a review of the use of patent statistics as economic indicators, including some of their strengths and weaknesses.

[13] M. Grubb, and K. Neuhoff, (2006). Allocation and competitiveness in the EU emissions trading scheme: policy overview. Climate Policy, vol 6, pp. 7-30.

The chief reason for concern is that inventive activity is an important hedge against future uncertainties in the science of what is considered a "safe" GHG concentration. Recent findings regarding an accelerating growth[14] in the concentration of atmospheric CO_2 and faster-than-predicted ice melts[15] provide cautionary examples of why society may well need to exceed policy targets set in earlier periods of scientific understanding. In this context, society may need to be able to draw on the results of persistent inventive efforts by technology suppliers developing currently expensive technologies with high GHG mitigation potential in order to attain revised emissions goals even before the more dramatic emissions reductions of 80% below 1990 levels, enshrined in the 2005 Executive Order, come into play.

Sustained public and private sector R&D in pursuit of climate-relevant technology innovation will be important, as the likelihood of finding innovative success (first through invention and then commercial adoption) is highest with the broadest set of searchers and the broadest field of search. The private sector is particularly important: of all the U.S. R&D expenditures tabulated by the National Science Foundation between 1953 and 2004, 57% was by industry without federal support. Although theoretically, public R&D funding could make up for any disincentives to long-term R&D that might accompany a climate CTP, it is risky to count on sustaining high levels of public R&D funding over time because of budget exigencies. Public subsidy programs, including tax credits, are similarly risky. In contrast, policy instruments such as performance-based standards, renewable portfolio standards, and energy efficiency standards, which indirectly support environmental technology development by creating opportunities for these technologies to enter the marketplace and then potentially improve through economies of scale and learning effects, are much less likely to lapse because of fiscal constraints.

In addition to potentially supplementing a climate CTP with such invention-focused "insurance" policies, refinements in CTP design could potentially help to resolve any CTP under-invention problems. For example, creating a formal institution and mechanism within a CTP for modifying the cap at regular intervals – perhaps every five years, as determined in advance – based on the state of the science and the development of new technologies, would preserve the advantages of a CTP with regard to aggregate low cost emissions reductions while sustaining the market expectations of technology suppliers. This would, in turn, provide these firms with an incentive to maintain significant R&D efforts, which may provide the best chance of meeting long-term climate goals.

Discussions during the Carneros Dialogue strongly reinforced Taylor's conclusion that a cap-and-trade program *by itself* is not enough to achieve the goals of AB 32, but must be combined with other carefully targeted measures and strategies.

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[14] C.L.Q. Josep, G. Canadella, Michael R. Raupacha, et al., (2007). Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. Proceedings of the National Academy of Sciences.

[15] J. Hansen, M. Sato, P. Kharecha et. al. (2007) Climate change and trace gases. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, vol. 365 pp.1925-1954.