JCCTRP Policy Brief 2019-1

Exploring Climate and Transport Policy Linkages between California, Quebec, Ontario as well as Northeastern and Mid-Atlantic States

Summary of the Joint Workshop of the Joint Clean Climate Transport Research Partnership (JCCTRP) & California Climate Policy Modeling Forum (CCPM)

FEBRUARY 27-28, 2019

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About the JCCTRP

The Joint Clean Climate Transport Research Partnership (JCCTRP) is a new interdisciplinary and transdisciplinary research partnership focusing on issues related to transport and climate policy in Quebec, California, Ontario and Vermont. The ultimate goal of the JCCTRP is to identify technical, economic and political factors shaping the potential for environmentally effective, economically efficient, and politically viable low-carbon transport and climate mitigation policy, and understand their implications for emissions trading. The JCCTRP Secretariat is located at the École des sciences de la gestion at the Université du Québec à Montréal (ESG-UQÀM).

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About the CCPM

The California Climate Policy Modeling Forum (CCPM) is a joint project of the UC Davis Policy Institute for Energy, Environment and the Economy and the Sustainable Transportation Energy Pathways program of the Institute of Transportation Studies. It is an ongoing project to bring together policy makers, modeling groups, and key stakeholders in California to: (i) improve the state of knowledge of plausible pathways/scenarios for future technology adoption, energy use, air quality, and GHG emissions, (ii) identify plausible mid-point goals and/or targets for GHG emissions between 2020 and 2050, (iii), discuss policy options needed for meeting the state's climate and air quality goals, identify policy gaps, and improve existing policies, and (iv) improve the state of modeling, including identifying ways to make the models and model findings more useful and accessible to policy-makers and other stakeholders.

WWW.POLICYINSTITUTE.UCDAVIS.EDU/FOCUS-AREAS/CLIMATE-NEUTRALITY/CALIFORNIA-CLIMATE-POLICY-MODELING-DIALOGUE

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Social Sciences and Humanities Research Council of Canada

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Canada

National Center for Sustainable Transportation

CONTENTS

EXECUTIVE SUMMARY

The two-day JCCTRP-CCPM workshop held at UC Davis, February 27-28, brought together participants from California, Quebec, Ontario and Vermont, among others, to consider interjurisdictional policy-making related to transportation and climate issues. This document is a brief summary of workshop deliberations and insights gained at the first day of the JCCTRP-CCPM workshop. The group covered a range of technical issues related to modeling transport systems as well as complex policy instruments such as cap-and-trade and the low-carbon fuel standard (LCFS). By organizing the workshop to move from the bottom-up, starting with urban/regional models, jurisdictional transport and energy system models and culminating with policy tools with important interjurisdictional components, we sought to break silos between various modeling teams, stakeholders and policy makers.

Some specific findings included:

- *California climate and transport policy (such as cap-and-trade and LCFS) is complex and requires large teams to implement, manage and administer. There are concerns that this can create challenges for other jurisdictions interested in adopting similar policies, but without the policy infrastructure that California has established.*
- *Despite the complexity of California's climate and transport policy, considerably greater modeling capacity has been developed in other jurisdictions than is commonly recognized. Indeed, much modeling capacity appears to have been added recently as researchers and policy-makers grapple with the climate challenge. Quebec and other jurisdictions appear to be closing the modeling capacity gap with California, with Canadian provinces potentially possessing greater capacity with urban transport models integrating a land-use component.*
- *What currently distinguishes California transport and climate policy is how modeling is incorporated into the policy process, particularly legal requirements that models be used in certain transport and climate policy decisions. This does not appear to have an equivalent in Quebec or other Canadian provinces, nor in municipal nor provincial government relations with the Canadian federal government.*
- *While recognizing the need for policy experimentation, a need for consistent policy across jurisdictions is clear: sending similar signals to consumers, fuel producers, and others across jurisdictions sends much clearer and stronger signals than would a range of different, uncoordinated programs.*
- *Still, each jurisdiction has its own circumstances and policy priorities and processes, and it will be difficult to have identical policies across them. But this should not prevent researchers and practitioners from identifying and seizing opportunities to increase consistency, linkages and learning across jurisdictions where possible.*
- *Also important was the notion that more modeling does not necessarily always and unambiguously improve public policy. If not properly calibrated or at a sensible resolution to the question at hand, the model can confound or mislead the policy process. Matching modeling to policy appropriately is a nuanced but important point that came up several times during the day.*
- *Much more work is required to understand the kinds of policy linkages and harmonization needed, their technical and political feasibility, and the impact they will have. Models that include multi-jurisdictional aspects are in a nascent phase, and group efforts created at this workshop should be continued and developed into deeper efforts to assess and guide multi-jurisdictional policy making efforts.*
- *Over next phase of the JCCTRP, from 2019 through early 2020, the partnership shall building on insights gained at the California workshop by leveraging existing partner modeling capabilities across jurisdictions in order to explore the technical and political feasibility of carefully selected scenarios for reducing greenhouse gas emissions in the transport sector.*

INTRODUCTION: AN OPPORTUNITY TO INTEGRATE THE TRANSPORT SECTOR MORE FULLY INTO CLIMATE ACTION

There is an opportunity to more fully integrate the transport sector into concerted climate action in North America. California and Quebec have played a leadership role in climate policy through the establishment of an emissions trading system operating under the aegis of the Western Climate Initiative (WCI). At the same time, the Canadian federal government has made carbon pricing a cornerstone of its climate action plan. Similarly, states in the northeastern United States, including Vermont, have established the Regional Greenhouse Gas Initiative (RGGI). Recently, in late 2018, almost all RGGI states have announced the development of a framework "for a regional program to address greenhouse gas emissions in the transportation sector" under the auspices of the Transportation and Climate Initiative (TCI).[1] Yet despite the importance of carbon pricing as a policy instrument for combating emissions, it is not the only instrument for reducing emissions. Other important policy instruments include low-carbon fuel standards (which employ a price on carbon associated with emissions per unit of fuel energy), zero emission vehicle mandates as well as public transportation and urban planning efforts. Interdisciplinary and transdisciplinary research collaborations across jurisdictions involved in carbon pricing—particularly those linked by emissions trading systems—promise to shed light on many questions facing governments, business and other policy actors in the jurisdictions involved.

In order to seize this opportunity, experts from California, Quebec, Northeastern States and beyond working in the area of climate change and transport policy came together for an exciting learning workshop at UC Davis on February 27-28. The first day was organized as a joint workshop of the Joint Clean Climate Transport Research Partnership (JCCTRP) and California Climate Policy Modeling Forum (CCPM). Participants explored climate and transport policy issues from the perspective of both technical-economic modeling and public policy, with the workshop seeking to cultivate linkages between the two. Altogether, nearly 40 people participated in the first day of the workshop (Figure 1, Annex 1 & 2). The second day was a research workshop of the JCCTRP, where research findings on transport and modeling capabilities amongst partners were discussed and partners adopted a plan for undertaking a preliminary analysis of various low-carbon transport and climate change mitigation policy modeling scenarios across jurisdictions. The event was hosted by the Institute of Transportation Studies at UC Davis and co-organized with *École des sciences de la gestion* at the *Université du Québec à Montréal* (ESG-UQAM) with support provided, in part, by the Social Sciences and Humanities Research Council of Canada as well as the National Center for Sustainable Transportation, a University Transportation Centers (UTC) program of the US Department of Transportation.

This document is a brief summary of the insights discussed at the first day of the JCCTRP-CCPM workshop. Experts from across jurisdictions presented different modeling efforts underway at various scales (urban, regional, jurisdictional and interjurisdictional) as well as the role of modeling in the policy process. Sessions were generally paired, with a first session discussing

[1] https://www.mass.gov/news/commonwealth-joins-regional-states-to-reduce-transportation-emissions (published December 18, 2018)

different modeling tools from a more technical point of view with a second session focusing more on policy issues.

***FIGURE 1*. PHOTOGRAPH OF PARTICIPANTS TO THE JCCTRP-CCPM WORKSHOP OUTISDE THE PUTAH CREAK LODGE AT UC DAVIS, FEBRUARY 27, 2019**

OPENING REMARKS AND KEYNOTE PRESENTATION

The day began with a welcome from Lew Fulton, Director, of Sustainable Transportation Energy Pathways at ITS-UC Davis. He highlighted the wonderful venue for the workshop—the Putah Creek Lodge at UC Davis—and also gave some background on the CCPM. This was followed by a brief presentation by Mark Purdon, Assistant Professor at ESG-UQAM and also Executive Director of the *Institut québécois du carbone* (IQCarbone). His presentation sought to provide context on the JCCTRP, especially the opportunity to cultivate policy learning across partners jurisdictions. It is widely recognized that California is a world leader in climate and transport policy, but there are concerns that what appears to be working in California is not readily transferable to other jurisdictions.[2] He also stressed the need to consider the political saliency of climate and transport policy, as evidenced by the "gilet jaune" movement that erupted in France in fall 2018.[3]

[2] Bang G, Victor DG and Andresen S (2017) California's Cap-and-Trade System: Diffusion and Lessons. *Global Environmental Politics* **17**:12-30.
[3] https://www.theguardian.com/world/2018/dec/05/france-wealth-tax-changes-gilets-jaunes-protests-president-macron (published December 5, 2018)

These introductory remarks were followed by a presentation on the TCI by Drew Veysey from the Georgetown Climate Center, part of Georgetown Law in Washington, DC. He summarized the TCI's work since its establishment in 2010, which culminated in an announcement in December 2018 that Northeastern and Mid-Atlantic States plus Washington DC would "design a regional low-carbon transportation policy proposal that would cap and reduce carbon emissions from the combustion of transportation fuels… and allow each TCI jurisdiction to invest proceeds from the program, into low-carbon and more resilient transportation infrastructure".[4] Over the course of 2019, the TCI will work to design the policy, including determining the level of cap and identifying shared priorities for investment of proceeds, as well as consult with other experts, conduct further stakeholder engagement, undertake technical and economic analysis and examine macroeconomic effects and complementary policies.

This was followed by a keynote presentation entitled *Regional planning and climate change mitigation in California* by Genevieve Giuliano, Professor at the University of Southern California where she is Margaret and John Ferraro Chair in Effective Local Government and Director of METRANS Transportation Center. She provided background on California's unique history of environmental regulation as well as regional transportation policy. In terms of environmental regulation, Professor Giuliano explained how California's initial leadership in air quality regulation has evolved into that for greenhouse gas (GHG) regulation. In particular, she stressed how California has pioneered technology-forcing regulations, such as low emissions vehicle mandate, as well as institutions such as the California Air Resources Board (CARB) for governing this emerging sector. In terms of planning, Professor Giuliano highlighted the establishment of Metropolitan Planning Organizations (MPOs) under the 1962 Federal Aid Highway Act as well as their subsequent modification through the 1991 Intermodal Surface Transportation Efficiency Act. Identifying an important link with modeling, all MPOs must produce a Long Range Regional Transportation Plan (RTP) whose approval is linked to federal transport funding. Similarly, California adopted the Sustainable Communities and Climate Protection Act (SB 375) in 2008, which established California regional emissions reductions targets and also required MPOs for each region to develop a Sustainable Communities Strategy (SCS) that integrates transportation, land-use and housing policies to plan for achievement of the emissions target for their region, with CARB determining compliance. Experience to date has demonstrated that it is difficult for California's regions to attain these regional emission reduction targets, however.

PANEL 1: URBAN/REGIONAL-SCALE MODELING TOOLS

The first panel featured experts on urban/regional-scale modeling tools. It began with a presentation by Caroline Rodier, Associate Director of the Urban Land Use and Transportation Center of ITS-UC Davis, providing a brief history of travel models from a policy perspective. She explained how transportation planning first developed around the 4-Step Travel Demand Model

[4] https://www.transportationandclimate.org/nine-states-and-dc-design-regional-approach-cap-greenhouse-gas-pollution-transportation (accessed March 20, 2019)

in the 1960s-70s, though an improved version would become the standard for the 1990 Clean Air Act Amendments. Currently, activity-based travel demand models are used for federal transit funding and California climate policy. However, there are still some limitations, such as an inability to simulate shared mobility and automated vehicles as well as issues of model granularity, that then constrain the model from responding to policy questions.[5]

This was followed by a presentation by Jason Hawkins, a PhD student at the Faculty of Applied Science and Engineering at the University of Toronto, entitled *Regional Demand Modelling and Carbon Pricing*. He discussed an activity-based transportation model being developed for the Toronto region known as CUSTOM (Comprehensive Utility-maximizing System of Travel Options Modelling) as well as the development of an integrated land-use and transportation model based on a series of environmentally extended social accounting matrices (SAMs) for the Canadian province of Alberta. Linking land-use and transportation modeling promises to significantly improve the identification of emission reduction opportunities through urban planning.

The third presentation in this session was by Marc-André Tessier of the Ministère des Transports du Québec (MTQ), who discussed urban transport models currently used by the Quebec government in numerous regions and their link to climate policy. The MTQ has developed a regional traffic simulation model using the EMME software package as well as a road emissions evaluation model using the MOVES model developed by the EPA. They can be used to estimate GHG emissions under various climate policy scenarios.

The last presentation on Panel 1 was by Professor Lisa Aultman-Hall of the University of Vermont Transportation Research Center. She highlighted the importance of long-distance intercity travel for GHG emissions, especially given increasing rates of air travel, which are not yet well integrated into most transport models, which have urban/regional foci. This is an important gap in understanding the implications of transport policy for climate change mitigation. For example, in 2016, transportation accounted for 28% of GHG emissions in the US, of which 9% were from aircraft.[6]

PANEL 2: URBAN/REGIONAL TRANSPORT AND CLIMATE POLICY EXPERIENCE

The second panel of Day 1 of the JCCTR-CCPM was intended to shine light on how transport policies discussed above were actually being used in the decision-making processes of cities and consumers.

We were fortunate to have a presentation by Dr. Alberto Ayala, Executive Director of the Sacramento Metropolitan Air Quality Management District (Sac Metro AQMD). Similar to the

[5] Rodier CJ, Pourrahmani E, Jaller M and Freedman J (2019) Automated Scenarios: Simulation of System-Level Travel Effects in the San Francisco Bay Area.
[6] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

keynote presentation, his presentation highlighted how transportation and air quality planning at the municipal level in California are inter-related and subject to a number of conditions in order to receive federal transportation funding. It was also noted that a variety of local policy drivers exist, ranging from attainment of US National Ambient Air Quality Standards as well as the Sac Metro AQMD future mobility and zero emission goals, the local electric utility's (SMUD) 2040 carbon neutrality commitment, the regional transit agency's (SacRT) transition towards excellence in service and environmental stewardship, the local transportation planning agency (SACOG) drive towards prosperity and smart growth as well as the local transportation authority (STA) push for transformative improvements. The presentation closed with an emphasis on the need for proper alignment between state and local commitments for maximum impact. The second presentation of this panel was by Cara Clairman, founder and CEO of Plug'n Drive, an Ontario NGO working with government and industry to increase electric vehicle sales in Canada to 5% of new passenger car sales by 2020 (which currently amount to less than 1%). Some of the challenges that consumers face is a lack of awareness of incentives and information on total cost of electric vehicle ownership—perhaps an opportunity for modeling?

PANEL 3: STATE/PROVINCIAL-SCALE MODELING TOOLS

With the third panel, we began the transition from the urban/regional level to jurisdictional level, though reverting here to a focus more of the technical aspects of models operating at the state/provincial scale. The session was moderated by Dr. Marshal Miller, Senior Development Engineer at ITS-UC Davis.

The first speaker on Panel 3 was Amber Mahone, of the California consulting firm Energy and Environmental Economics (E3). She discussed the E3 PATHWAYS model, which has been used in California and other states to evaluate long-term, economy-wide energy scenarios, with a focus on implications in the electricity and natural gas sectors. The utility of this model lies in its ability to translate policies or GHG emission goals into effects on fuels, vehicles, end-uses, consumption, etc. The models allows decision-makers to get answers to questions like: *How does the transportation sector fit within economy-wide goals? What share of new vehicle sales must be ZEVs reached and by when in order to meet a specific climate policy goal? What is the relative cost in dollars per tonne of carbon abatement of measures across the economy?*

This was followed by a presentation of by Dr. Kathleen Vaillancourt of Energy Super Modelers and International Analysts (ESMIA), a consultancy firm based in Montreal. She discussed the North American TIMES Energy Model (NATEM), which has been used to model different technological requirements for various climate policy scenarios in Canada, including at the federal and provincial levels. Modeling was found to have considerable import for public policy, particularly in communicating the magnitude of the challenges, identifying opportunities for emission reductions, and pointing out areas requiring greater research. But challenges abound, none the least being the complexity of the many models which detracts from their accessibility and transparency, data limitations as well as some inherent limitations of the TIMES family of optimization models (which do not measure impacts on GDP or employment). Developing a

modeling culture and consolidating linkages at the policy-science interface, one of the ambitions of the JCCTRP, should continue to be explored.

The third speaker of this panel was Jonathan Dowds, research analyst at the University of Vermont's Transportation Research Center. He gave a presentation entitled *Modeling Electric Vehicle Energy Demand and Regional Dispatch with Cap-and-Trade Programs* which summarized research that was unique in linking trip tour-based travel behavior data with time-resolved electricity demand and regional dispatch capacity and, by implication, GHG emissions.[7] This allows policy-makers, for example, to understand the need for pricing and other policies to design desirable electric vehicle charging time and locations for optimal operation of the grid.

A final presentation by Dr. Marshal Miller focused on existing transport models and scenarios used for investigating the climate policy implications of California's trucking sector. Transport models included truck choice models (TCMs) and transport transition models (TTMs), while modeling scenarios included business-as-usual (BAU), high penetration of zero emission vehicles (High ZEV), Low ZEV and ZEV + Biofuel scenarios. This provides answers about the rate of fleet stock turnover, GHG emissions, as well as vehicle and fuel costs.

PANEL 4: STATE/PROVINCIAL TRANSPORT AND CLIMATE POLICY EXPERIENCE

Sessions in the afternoon continued with a panel whose aim was to explore how the jurisdictional models above might be being used in the transport and climate policy process.

A first presentation was given by Dr Austin Brown, Executive Director of the UC Davis Policy Institute for Energy, the Environment, and the Economy. He spoke of the use of modeling in the policy process and raised key strategic questions about the virtues and vices of different modeling approaches, particularly the prospect of building a comprehensive model for climate-transport policy systems.

The second presentation was by Annalisa Schilla, responsible for Climate Action and Research Planning Section at the California Air Resources Board who spoke about California's transportation policy goals. Transportation currently accounts for 39% of California's GHG emissions and, to meet California's 2030 emission reduction targets, it will be necessary to develop new fuel options while achieving significant reductions in vehicle miles traveled (VMT)[8] as well as promote sustainable development and land-use, such as building more affordable housing. This is a particular challenge since VMT has been increasing since about 2012 after an considerable

[7] Dowds, J., P. D. Hines, and S. Blumsack. Estimating the Impact of Fuel-Switching between Liquid Fuels and Electricity under Electricity-Sector Carbon-Pricing Schemes. *Socio-Economic Planning Sciences*, Vol. 47, No. 2, 2013, pp. 76–88.

[8] For example, VMT expressed as a percentage of 2005 VMT in California stands at 13% today and will need to fall to 8% by 2030 for passenger vehicles and 16% to 7% by 2030 for trucking.

reduction from 2005. At the same time, particular attention needs to be given to environmental justice issues, for example, ensuring that all communities see improvements in local air quality.

A final presentation for this panel was given by Jennifer Wallace-Brodeur of the Vermont Energy Investment Corporation (VEIC) who spoke about the role of modeling in transportation, climate and energy policy in Vermont. She drew attention to key policy documents including the Vermont Comprehensive Energy Plan (CEP) as well as other regional and municipal energy plans. The CEP is particularly important in that it defines sector energy goals, renewable energy goals, and GHG reductions targets for the state. She also discussed various policy advocacy initiatives to monitor progress on Vermont's transport, energy and climate goals, including their use of models. Most recently, the Vermont government presented results of the *2018 Decarbonization Study*, undertaken by Resources for the Future. Results indicated, amongst other things, that (i) carbon pricing alone (at levels modeled between $19 - $77 per tCO2e in 2025) was unlikely to be sufficient to meet Vermont's GHG reduction targets, (ii) carbon pricing might generate $75-$434M in annual revenue and (iii) impacts on GDP, employments levels and overall economic welfare are small.

PANEL 5: INTERJURISDICTIONAL EMISSION TRADING

The fifth panel of the workshop opened up discussion about interjurisdictional emissions trading, which is particularly important in the context of California and Quebec's efforts to reduce GHG emissions. Since 2014, the two jurisdictions have linked there emissions trading systems, with the Canadian province of Ontario also participating during the first half of 2018 before elections there.[9] Experience with emissions trading is also relevant as discussion in Northeastern States are considering a framework "for a regional program to address greenhouse gas emissions in the transportation sector" which may or may not resemble such a system. Given that transportation is the largest source of emissions in most Canadian and US jurisdictions, one jurisdiction's efforts to reduce emissions in the transport sector will have implications for others with whom it may be linked. For example, existing economic models suggest that it is less expensive for Quebec firms to purchase emission allowances from their California counterparts where it is cheaper to reduce emissions in comparison to Quebec which has some of the largest clean, hydroelectric resources in North America.[10]

The first presentation was made by Professor James Bushnell of the UC Davis Department of Economics who summarized some of his recent work.[11] A leading expert on California's cap-and-

[9] Cloarec B and Purdon M (2018) Evolution of the Joint Carbon Market: Impact of the Entry and Potential Exit of Ontario, Institut québécois du carbone, Montréal; Houle D, Lachapelle E and Purdon M (2015) The Comparative Politics of Sub-Federal Cap-and-trade: Implementing the Western Climate Initiative. *Global Environmental Politics* **15**:49-73.
[10] Purdon M and Sinclair-Desgagné N (2015) Les retombées économiques prévues du marché du carbone conjoint de Californie et du Québec. *Notes & Analyses sur les États-Unis/on the USA* 29: 1-18.
[11] Borenstein S, Bushnell J, Wolak FA and Zaragoza-Watkins M (2018) Expecting the unexpected: emissions uncertainty and environmental market design (WP 274R), Energy Institute at Haas, Berkeley; Borenstein S, Bushnell J and Wolak FA (2017) California's Cap-and-Trade Market Through 2030: A Preliminary Supply/Demand Analysis (WP 281), Energy Institute at Haas, Berkeley.

trade system, in his presentation he sought to explain observed price trends on the carbon market which, during the first five years of the program, have been very close to the administrative price floor. In the absence of such a price floor, extremely low or high prices would be the most likely outcomes for two reasons. First, there is significant uncertainty surrounding forecasts of future "business as usual" (BAU) emissions, which are used to design cap-and-trade systems. Actual BAU emissions in California have been below model forecasts, despite faster than expected economic growth. This is because BAU emissions are tied to economic activity and weather conditions that are inherently difficult to model but also, importantly, because they are subject to the uncertain effects of (non-market) complementary policies. Second, at politically feasible carbon prices, the price responsiveness of emissions abatement is small compared to uncertainty in emissions levels. Under such conditions, complementary policies act to steepen the abatement supply curve by mandating mitigation that would otherwise have occurred in response to a rising carbon prices, but which might not be politically attainable. The combination of uncertainty over BAU emissions and the relatively modest price-responsiveness of emissions results in outcomes skewed towards either very high or very low prices—providing justification for both a price floor and ceiling. While very high or low prices are not an economic impediment to the operation of cap-and-trade markets, they may be a political impediment, as they are likely to trigger administrative interventions.

Professor Charles Séguin at ESG-UQAM presented preliminary findings from the application of an economic model developed by UK researchers to assess the economic advantages of linking carbon markets between jurisdictions.[12] This model is innovative in being able to decompose the joint benefits of linking into a (i) pair size effect, (ii) volatility effect, (iii) and dependency effect. In an innovative twist, the model was applied to gauge the economic advantages of certain US states and Canadian provinces the emissions trading system established between California and Quebec. Preliminary results modeling these three combined effects highlight that linking benefits partners by reducing aggregate permit price volatility. Additional (yet unmodeled) benefits of linking include reduced leakage and improved competition fairness and cheaper emission reductions through trade in permits. However, linking emissions trade systems might also involve certain costs such as (i) administrative costs of harmonizing systems, (ii) increased exposure to permit over allocation, (iii) and increased exposure to political uncertainty. Preliminary results suggest that all jurisdictions gain from linking but, in terms of the distribution of benefits, smaller jurisdictions benefit more.

The final presentation of this panel was given by Professor Normand Mousseau, currently academic director of the Institut de l'Énergie Trottier at the École Polytechnique in Montréal. He reviewed experiences with carbon markets in various parts of the world and provided a history of the California-Quebec carbon market and an update recent market prices. He also drew attention

[12] Doda B and Taschini L (2017) Carbon dating: When is it beneficial to link ETSs? Journal of the Association of Environmental and Resource Economists 4:701-730.

to the important role of complementary policies. His presentation concluded with a number of questions for further reflection including whether the market can be a genuine motor for energy transitions given its proclivity to target the least-cost emission reductions (low-hanging fruit) and, if so, how can carbon markets be improved.

PANEL 6: LOW-CARBON FUEL STANDARD

The discussion on emissions trading systems and carbon prices above set the stage for our final panel of the day which focused on the low-carbon fuel standard (LCFS), one of the more important complementary policies in California.

A first presentation was provided by Jim Duffy of the California Air Resources Board (CARB), who gave background and an update on the instrument, which saw important amendments added in 2018. Essentially, the goal of the LCFS is to reduce the carbon intensity of transportation fuels. It does so by mandating transport fuel providers to achieve, for the average of fuels sold, a carbon intensity standard, which is gradually reduced, for light-duty vehicles, to -20% relative to traditional fuels by 2030. The carbon intensity of various alternative fuels is gauged through life-cycle analysis (LCA) relative to traditional gasoline. For example, biodiesel is associated with a -66% reduction in carbon intensity and electricity with a -72% reduction. Significantly, fuel providers can gain credit for reducing their carbon intensity below the standard and sell this to other fuel providers who have not been able to do so. Prices associated with these credits were above $100 UDS over the course of 2018. Significantly, California's LCFS does appear to be producing results, displacing nearly 2 billion gallons (7.6 billion liters) of gasoline in 2017. Important to the integrity of the LCFS is the LCA associated with each alternative fuel, including indirect land-use change, as well as efforts to gauge their supply, many of which might originate out of state. These supply issues are being addressed through a Biofuel Supply Module (BFSM), which has recently been developed by CARB. Essentially, the model converts feedstock to fuel, applies a variety of cost parameters, and then assesses whether or not the fuel out-competes other fuel supply that would otherwise enter the California market. Of course, uncertainties in forecasting biofuel supply and use also present themselves, which CARB is now grappling with. These include anticipating (i) demand reduction for fuel used by light-duty vehicles, (ii) rate of ZEV adoption, (iii) development of dairy digester gas for transportation use, (iv) availability of and competition for waste feedstocks and (v) development of advanced cellulosic technologies.

The second presentation was provided by Julie Witcover, Assistant Project Scientist at the UC Davis Policy Institute for Energy, Environment, and the Economy. Her presentation addressed LCFS programs being undertaken outside of California, including the Pacific Coast Collaborative (that includes California, Oregon, Washington and the Canadian province of British Columbia), RenovaBio in Brazil (slated to start in 2020), and Canada's federal Clean Fuel Standard (to start in 2022). Importantly, all these LCFSs are supported by various models such as GREET, GTAP-AEZ, CCLUB, GHGenius and RenovaCalc. Those in California, Oregon and Washington also seek to model indirect land-use change. Her presentation also stressed the similarities and differences between LCFS and cap-and-trade. While similar in certain ways, the LCFS only

addresses the transport sector, generates no revenue for the state, promotes financial transfers from high-carbon to low-carbon fuel providers, and incentivizes technological change in the fuel sector (rather than targeting the lowest cost abatement opportunities in the economy). The relationship between LCFS and broader economy-wide efforts to reign in emissions such as cap-and-trade systems and carbon taxes would benefit from closer investigation.

The last presentation of the day was given by Dr. Colin Murphy, Deputy Director of the UC Davis Policy Institute for Energy, Environment, and the Economy, who distilled some important lessons learned from California's experience with the LCFS. First, it is important to understand that transitions of the kind required in the transport sector will take time. Ideal solutions, like high zero emission vehicle (ZEV) penetration and high-use public transport systems, may not be technically or politically feasible in the near term. The LCFS addresses this reality by requiring greater use of available alternative, low-carbon fuels and incentivizing the production of more advanced fuels in the future. He also stressed the importance of life-cycle analysis (LCA) in evaluating alternative fuels, especially their indirect effects. One of the concerns with large-scale use of biofuels is that it might prompt unsustainable land-use change in parts of the world where biofuels might thrive but which currently harbor carbon sequestering forests or are used for agriculture.[13] Experience to date indicates that the LCFS in California has incited a number of energy transitions including over 2,000 electric vehicle charging stations, 500 compressed natural gas stations and a blossoming biofuel industry in-state. Importantly, an LCFS can complement carbon pricing by reducing compliance costs, which has political and economic benefits. Steady progress appears to be being made as the LCFS is ramped up to California's 2030 target of a 20% reduction of transport fuel carbon intensity.

PUBLIC SEMINAR

It has been customary for the JCCTRP to include a public seminar to allow members of the public the opportunity to dialogue with experts. The public seminar of the California workshop involved remarks by a representative of the Quebec government office in Los Angeles, Ms Élizabeth Mackay, allowing participants in California to better understand the position of the Quebec government on climate and transport.[14] Ms Mackay spoke energetically about the common interest Quebec and California have in confronting climate change and various opportunities this represents for both jurisdictions. For example, she called attention to a Quebec electric vehicle firm, Lion Electric Co., which recently opened an office in California.[15] The JCCTRP was also singled out as an important opportunity to share knowledge and

[13] Searchinger T, Heimlich R, Houghton RA, Dong F, Elobeid A, Fabiosa J, Tokgoz S, Hayes D and Yu T-H (2008) Use of US croplands for biofuels increases greenhouse gases through emissions from land us change. *Science* **319**:1238-1240; Fargione J, Hill J, Tilman D, Polasky S and Hawthorne P (2008) Land clearing and the biofuel carbon debt. Science 319:1235-1238.
[14] The Québec Government Office in Los Angeles, inaugurated in 1970, promotes the interests of Québec in the Western US. The Québec Trade Office in Silicon Valley was opened to provide support to small and medium-sized Québec companies, notably technology companies, wishing to expand their business in the Silicon Valley region and Northern California.
[15] https://thelionelectric.com/en

cultivate technical and policy insights. A short video of the public seminar and commentary by various participants will shortly be made available on the JCCTRP website.

CONCLUSION

The first day of the JCCTRP-CCPM workshop was intended as a learning workshop to bring participants from various backgrounds and from both inside and outside academia together to explore complex issues related to climate and transport policy. By addressing technical issues related to modeling transport systems as well as complex policy instruments such as cap-and-trade and the low-carbon fuel standard (LCFS), we sought to shed light on these important tools which are too often left black-boxed. By organizing the workshop to move from the bottom-up, starting with urban/regional models, jurisdictional transport and energy system models and culminating with policy tools with important interjurisdictional components, we sought to break silos between various modeling teams as well as experts in public policy. Just as important was building understanding and relationships amongst researchers and practitioners across the various jurisdictions involved. There was certainly a feeling that this first day of the JCCTRP-CCPM workshop at UC Davis was another step towards seizing the opportunity to more fully integrate the transport sector into concerted action in North America.

ANNEX 1: DAY 1 WORKSHOP PROGRAM

8:00 – 8:30 am	Light breakfast
8:30 – 9:00 am	Introductory Remarks **Welcome* - Lew Fulton (UC Davis) **Why the JCCTRP?* - Mark Purdon (ESG-UQAM) **Update on transport and climate policy in Northeastern States* - Drew Veysey (Georgetown Climate Center, Washington)
9:00 – 9:30 am	Keynote Address *Evolution of regional planning in California and links to climate change mitigation* - Genevieve Giuliano (University of Southern California)
9:30 – 10:30 am	Panel 1: Policy Modeling Forum: Urban/Regional-Scale Modeling Tools *Transport models used and their links to climate mitigation* - Caroline Rodier (UC Davis, California) - moderator - Jason Hawkins (University of Toronto, Ontario) - Marc-André Tessier (Ministère des Transports, Québec) - Lisa Aultman-Hall (University of Vermont)
10:30 – 10:45 am	Coffee Break
10:45 – 11:45 am	Panel 2: Urban/Regional Transport and Climate Policy Experience *How are transport models being used and their links to climate change mitigation* - Genevieve Giuliano (University of Southern California) - moderator - Alberto Ayala (Sacramento Metropolitan Air Quality Management District) - Cara Clairman (PlugNDrive, Ontario)
11:45 – 12:45 am	Panel 3: Policy Modeling Forum: State/Provincial-Scale Modeling Tools *Transport and energy systems models and their links to climate mitigation* - Marshal Miller (UC Davis) – moderator - Kathleen Vaillancourt (Energy Super Modelers and International Analysts, Quebec) - Amber Mahone (E3, California) - Jonathan Dowds (UVermont)

12:45 – 1:30 pm	Lunch Break
1:30 – 2:30 pm	<u>Panel 4: State/Provincial Transport and Climate Policy Experience</u> *How are transport and energy system models being used and their links to climate change mitigation* - Lew Fulton (UC Davis) – moderator - Austin Brown (UC Davis) - Annalisa Schilla (California Air Resources Board) - Jennifer Wallace-Brodeur (Vermont Energy Investment Corporation)
2:30 – 3:30 pm	<u>Panel 5: Policy Modeling Forum: Interjurisdictional Emission Trading</u> *Emissions trading models of jurisdictions involved in JCCTRP, including WCI & RGGI* - Mark Purdon (ESG-UQAM) – moderator - Normand Mousseau (Institut de l'énergie Trottier, Québec) - Charles Séguin (ESG-UQAM) - James Bushnell (UC Davis)
3:30 – 3:45 pm	Coffee Break
3:45 – 4:45 pm	<u>Panel 6: Policy Modeling Forum: Low Carbon Fuel Standard</u> *Transportation and energy systems models and their links to climate change mitigation* - Austin Brown (UC Davis) – moderator - Jim Duffy (California Air Resources Board) - Colin Murphy (UC Davis) - Julie Witcover (UC Davis)
4:45 – 5:00 pm	<u>Round Table Discussion</u> - Austin Brown (UC Davis) – moderator
5:00 – 6:00 pm	Open Reception (Putah Creek Lodge, UC Davis)
6:00 – 7:00 pm	<u>Public Seminar (Putah Creek Lodge, UC Davis)</u> **Keynote Remarks* - Élizabeth Mackay (Quebec Government Office in Los Angeles) – keynote remarks **Panelists* - Lew Fulton (UC Davis) – moderator - Genevieve Giuliano (University of Southern California) - Normand Mousseau (Institut de l'énergie Trottier, Québec) - Drew Veysey (Georgetown Climate Centre, Washington DC) - Mark Purdon (ESG-UQAM)

ANNEX 2: WORKSHOP PARTICIPANTS

Quebec	Ontario	California	Northeastern States
1) Mark Purdon, École des sciences de la gestion, UQÀM & Institut québécois du carbone (IQCarbone) **2) Myriam Goulet, JCCTRP Coordinator**, École des sciences de la gestion, UQÀM (MSc candidate) **3) Kathleen Vaillancourt**, Energy Super Modelers and International Analysts (ESMIA) **4) Normand Mousseau**, Institut de l'énergie Trottier **5) Charles Séguin,** École des sciences de la gestion, UQAM **6) Jacques Papy,** Département des sciences juridiques, UQAM **7) Louis-Charles Coderre**, Université de Montréal (MSc candidate) **8) Mme Élizabeth Mackay,** Québec Government Office in Los Angeles **9) Marc-André Tessier**, Ministère des Transports du Québec	**1) Cara Clairman**, Plug N'Drive **2) Colleen Kaiser**, Faculty of Environmental Studies, York University (PhD candidate) **3) Jason Hawkins**, UToronto Department of Civil Engineering (PhD candidate) **4) Dianne Zimmerman**, Partners in Project Green Program	**1) Lew Fulton**, UC Davis **2) Austin Brown**, UC Davis **3) Julie Witcover**, UC Davis **4) Genevieve Giuliano**, USC **5) Mark Northcross**, NHA Advisors **6) Sonya Ziaja**, California Public Utilities Commission **7) Caroline Rodier,** UC Davis **8) James Bushnell,** UC Davis **9) Colin Murphy,** UC Davis **10 Amber Mahone**, E3 **11) Annalisa Schilla**, CARB **12) Jim Duffy,** CARB **13) Alberto Ayala,** Sacramento Air Quality Management District **14) Guihua, Wang,** CARB **15) Behdad, Kiani,** UC Davis **16) Karen Block,** UC Davis **17) Marshall Miller,** UC Davis **18) Beth Bourne,** UC Davis **19) Rosa Dominguez-Faus,** UC Davis **20) Yunshi Wang**, UC Davis **21) Francois Castonguay,** UC Davis (PhD Candidate)	**1) Jennifer Wallace-Brodeur**, Vermont Energy Investment Corporation **2) Jonathan Dowds,** University of Vermont, Transportation Research Center **3) Lisa Aultman-Hall,** University of Vermont, Transportation Research Center **4) Drew Veysey**, Georgetown Climate Centre