IN THE HIGH COURT OF NEW ZEALAND
WELLINGTON REGISTRY

I TE KŌTI MATUA O AOTEAROA
TE WHANGANUI-Ā-TARA

CIV-2021-485-000341

UNDER	Judicial Review Procedure Act 2016 and part 30 of the High Court Rules 2016
IN THE MATTER OF	an application for judicial review
BETWEEN	**LAWYERS FOR CLIMATE ACTION NZ INCORPORATED** Applicant
AND	**THE CLIMATE CHANGE COMMISSION** First Respondent
AND	**MINISTER FOR CLIMATE CHANGE** Second Respondent

AFFIDAVIT OF DR MICHAEL ALLEN TOMAN

(Independent expert witness for the Climate Change Commission: cost benefit analysis and multi criteria analysis)

Affirmed: 9 December 2021

Counsel acting: Victoria Casey QC
Clifton Chambers

Luke Cunningham Clere
Barristers & Solicitors
PO Box 10-357
WELLINGTON

I, Michael Allen Toman, of Washington DC, affirm–

INTRODUCTION

1. My full name is Michael Allen Toman. I am a Senior Fellow at Resources for the Future, an independent, nonprofit research institution in Washington, DC, United States. However, in preparing this affidavit, I am acting entirely in an independent capacity.

2. I have been asked by the Climate Change Commission to provide expert evidence in response to aspects of the claim brought by LCANZ (Lawyers for Climate Action New Zealand Incorporated) against the Commission's advice to the Minister for Climate Change in *Ināia tonu nei: a low emissions future for Aotearoa*, released on 21 June 2021.

3. I have been provided with a copy of the High Court Code of Conduct for Expert Witnesses. I have read the Code of Conduct and agree to comply with it.

4. In this affidavit I refer to the Climate Change Commission's Advice. I understand that the Commission's Advice and Supplementary Volumes have already been compiled into a paginated bundle. References in this affidavit will accordingly be to the Commission's Advice and Supporting Volumes, which have been combined together as a single paginated "Advice Bundle". The page references I will give will be to the page number at the top of each page (not the original page numbers, as these were not continuous in the original volumes).

QUALIFICATIONS AND EXPERIENCE

5. A copy of my curriculum vitae is attached to this affidavit and marked "**MT-1**".

6. As indicated in my curriculum vitae, since receiving my PhD in economics in 1983, I have held several positions in independent, nonprofit research institutions and international organizations. During that time I have researched and provided policy advice on a number of climate change and related issues involving comparing benefits and costs of policies.

7. My current research interests include climate change adaptation, international climate policy, energy and economic growth, and sustainable development.

8. From September 1994 to February 1996, I was a Senior Staff Economist on the staff of US President Bill Clinton's Council of Economic Advisers, in which role I led an inter-agency technical working group responsible for devising guidance for implementing a new Executive Order on economic analysis of proposed regulations (EO 12866)..

9. I have been an adjunct lecturer at the Nitze School of Advanced International Studies, Johns Hopkins University, and the School of the Environment, University of California at Santa Barbara.

10. I have a Bachelor of Arts from Indiana University, a Masters of Science in applied mathematics from Brown University, and Master of Arts and PhD degrees in economics from the University of Rochester.

11. My professional publications on the topic of benefit-cost analysis and multi-criteria analysis include:

    11.1 "Economics and 'Sustainability': Balancing Tradeoffs and Imperatives," *Land Economics*, November 1994.

    11.2 "Cost-Benefit Analysis and Regulatory Reform" (Alan Krupnick and Ray Kopp, co-authors), *Human and Ecological Risk Assessment*, November 1997.

    11.3 "Using Cost-Benefit Analysis to Improve Environmental Regulations" (Scott Farrow, co-author), *Environment* magazine, March 1999.

    11.4 "Assessing Sustainability: Some Conceptual and Empirical Challenges" (Ronald Lile and Dennis King, co-authors), *International Journal of Environment and Pollution*, November 1999.

    11.5 "The Need for Multiple Types of Information to Inform Climate Change Assessment," *Journal of Benefit Cost Analysis,* March 2015.

    11.6 "Implementing Precaution in Benefit-Cost Analysis: The Case of Deep Seabed Mining" (Kerry Krutilla, David H. Good, Tijen Arin, co-authors), *Journal of Benefit-Cost Analysis*, February 2021.

SCOPE OF MY EVIDENCE

12. I have been provided with the Commission's advice and the affidavit of Dr William Taylor. I have also been provided with a link to the Climate Change Response Act 2002, and directed in particular to sections 5M and 5ZC.

13. I have been asked to provide my expert opinion on Dr Taylor's criticism of Commission's Advice, on the basis that the Commission did not undertake a cost benefit analysis (CBA) or a multi criteria analysis (MCA).

14. I confirm that the answer to this question is a matter within the scope of my expertise.

APPROPRIATENESS OF COST BENEFIT ANALYSIS AND MULTI CRITERIA ANALYSIS

15. The comments in this affidavit focus on paragraphs 129 – 137 of Dr Taylor's report, which appear under section heading 5, "Question 3: Has the CCC assessed the costs and benefits of setting more ambitious budget levels?".

16. However, the context for these comments is provided by Dr Taylor's statements in paragraph 136 and 137:

> 136. In my view, the appropriate way to balance the economic objectives in the Act with the noneconomic objectives in the Act (i.e., taking a wider view that looks at the opportunities, benefits, costs, and risks to society) would be to conduct both a CBA [cost-benefit analysis] and an MCA [multi-criteria analysis] ... they are complements, not substitutes.
>
> 137. However, comparing multiple policy options is crucial to this. In other words, assessing the impact of a single option will tell you whether that option provides net benefits, but it will not tell whether the best option has been adopted (however "best" is defined in the specific context) ...

17. Further setting the stage are Dr Taylor's observations in Paragraphs 131 and 132:

> 131. Good policy development should compare multiple policy options against the counterfactual....
>
> 132. Doing so ensures that the policy which is chosen maximizes the net benefits from taking action. When I refer to "maximising net benefits" I mean "maximising the objective function" of the policy maker, whatever that objective function may be. Note that "net benefits" can therefore include both economic (i.e., efficiency benefits) and non-economic considerations. In the current context, there are a number of objectives in the Act that are not purely economic but which should guide the CCC's assessment of the different options. The existence of other objectives is why Treasury

recommends Multi-Criteria Analysis (MCA) as a complement to formal cost benefit analysis (CBA)....[1]

18. The Guidance from New Zealand Treasury summarises the use of CBA and MCA for analysing the behavioral, economic, and social consequences of specific policy measures that constrain the choices of actors covered by regulation or otherwise induce changes in those choices (i.e., "sticks" and "carrots"). CBA and MCA can be very useful tools for such purposes, though there are practical limits on what they can accomplish. On the other hand, the Commission is not charged with prescribing regulatory, fiscal, or other methods for changing individual actors' emission-producing choices. The Commission's remit entails is to provide advice on the amounts of emissions in the budget periods, the appropriate limit on off-shore mitigation, and the means for assessing progress. Inferences from application of CBA or MCA to the Commission's recommendations, without specifying the types of policies that could be used to meet the emission budgets, would be speculative.

19. There are other practical difficulties with Dr. Taylor's argument on application of CBA and MCA to the Commission's advice to the Minister for Climate Change, consistent with the Commission's responsibilities under sections 5ZA and 5ZC of the Climate Change Response Act 2002. The Commission's advice is informed by considerable analysis of the costs that could result from policies to reduce emissions, and the impacts of those costs on different parts of New Zealand society. Nevertheless, the breadth of factors the Commission is charged to consider limits what can be learned from applying CBA in carrying out its work.

20. Section 4.3.2 of the Commission report describes a modelling framework used by the Commission in formulating its advice.[2] It includes a technology-rich model (ENZ)[3] to

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1 The Treasury, *Cost Benefit and Multi-Criteria Analysis*, available at https://www.treasury.govt.nz/information-and-services/regulation/information-releases/regulatory-review-programme/cost-benefit#:~:text=Cost%20Benefit%20Analysis%20(CBA)%20and,in%20conjunction%20with%20each%20other>.

2 Climate Change Commission *Ināia tonu nei: a low emissions future for Aotearoa* (June 2021), Advice Bundle at 72 – 73.

3 "ENZ" refers to the Energy and Emissions New Zealand model. ENZ is an economy-wide model that covers all the main emitting sectors in New Zealand – energy, industry, transport, agriculture, forestry and waste. The Commission used this model to understand the scale of the emissions reductions that are achievable in each sector over time: Advice Bundle at 73 and Climate Change Commission "Modelling and data", available at <https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/modelling/>.

gauge the achievability of emissions reductions in different sectors, and the costs of different technology mixes; an economy-wide model (C-PLAN)[4] to gauge the overall impact of emissions budgets; and a microsimulation model (DIM-E)[5] to look more deeply into employment impacts.

21. This multi-model approach represents an advanced state of the art in policy analysis. It allows the Commission to address the economic elements identified in Sections 5M and 5ZC of the Act – subject to constraints on the quantity and quality of data available for setting up the models.[6] However, the breadth of the Commission's remit is a major challenge that limits what can be done using CBA in the way Dr Taylor represents.

22. As noted in Section 5.1 of the Commission's report, the Commission has grouped the numerous economic and non-economic factors it must consider under the Act into three groupings.[7] Emission budgets must be determined in ways and have effects that are just, inclusive, and equitable. Budgets must be ambitious in moving New Zealand toward a decarbonized future. They must also be technically achievable and economically affordable (not necessarily cheap, but economically manageable), accounting for inherent uncertainties in both dimensions.

23. To use CBA in the way Dr Taylor represents for defining and evaluating an emissions budget, the policies to be used for achieving the budgets have to be prescribed so that behavioural changes resulting from different reductions in emissions also can be inferred. The Commission would need to validate that the options in question are

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4 "C-PLAN" refers to the Climate Policy Analysis economic model. C-PLAN is a computable general equilibrium (CGE) model that takes data on the interactions between economic actors to understand how the structure of the economy could be affected by policy. It was used to understand the overall impact of the recommended emissions budgets on GDP and the economy: Advice Bundle at 73 and Climate Change Commission "Modelling and data", available at <https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/modelling/>.

5 "DIM-E" refers to the Distributional Impacts Microsimulation for Employment. DIM-E is a microsimulation model that takes the economy-wide outputs of C-PLAN and combines them with more granular data from Stats New Zealand. The Commission used the DIM-E model to understand effects on employment across different sectors, regions, demographic groups and socioeconomic groups: Advice Bundle at 73 and Climate Change Commission "Modelling and data", available at <https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/modelling/>.

6 The task of economically evaluating alternative targets and paths for emission reductions is inherently complex, given the number of channels through which emissions reductions can have economic impacts and the uncertainty surrounding many of them. For example, most general-equilibrium models are not set up to address internal migration of people or firms, or the impacts of contractual structures and regulation in the power sector.

7 Advice Bundle at 78 – 87.

technically feasible and do not result in unacceptable non-economic impacts. This level of analysis is beyond the scope of what can be accomplished with BCA.[8]

24. In principle, MCA could be used to try to accomplish this. However, both measurement challenges and absence of unambiguously defined weights on different criteria limit what MCA could do. The factors the Commission is charged to address include many that are not only difficult if not impossible to express in terms of economic comparisons, but also hard to quantify using non-economic metrics. This applies especially to consideration of social and cultural characteristics; the intergenerational distributional of costs, benefits, and risks; factors affecting the Crown-Māori relationship; and impacts on all aspects of the Māori world (te ao Māori).

25. This is a huge practical challenge because, as noted in the New Zealand Treasury guidance cited previously, MCA basically operates by looking at how observed or projected values of different criteria compare to benchmark values for the criteria. Thus, in a MCA in which one criterion was net economic impacts, one could in principle examine how different options for emission budgets compare to a normalized benchmark value of zero for the current status quo. Another criterion might be long-term emissions of greenhouse gases, and one could compare estimated emissions with different policies to an estimate under continued business as usual. This sort of cardinal measurement cannot be extended to the other sorts of criteria mentioned above, however.

26. Even if criteria all were measurable, the other key issue with MCA is the essential arbitrariness of the weights applied to different criteria measures to obtain a single numerical "score." The New Zealand Treasury guidance states that "The criteria can be ranked (or weighted) in terms of their [relative] importance – or left to decision makers to determine what they think the ranking should be." The first alternative unduly privileges the value judgments of the MCA analyst. The latter alternative is more reasonable, but it also implies that carrying out its own MCA is inherently outside the remit of the Commission. The Commission's function is only to advise.

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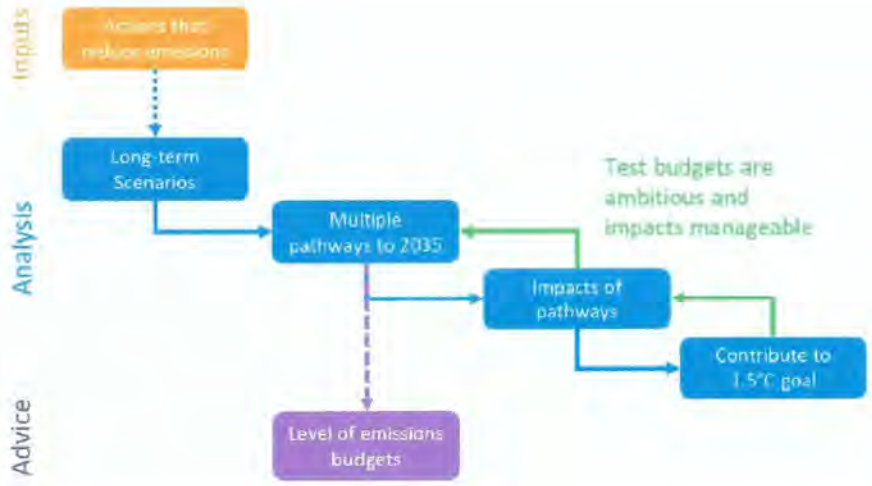
[8] Even in more circumscribed regulatory assessments, it is recognized that more than quantified net economic benefits must be considered and that other effects should be considered in a transparent way. The US Executive Order 12866 stipulates in Section 1(b)(6) that regulatory benefits should justify costs, not necessarily just exceed them in a purely cardinal comparison; and that the factors other than net economic benefits that are represented as justifying the regulation need to be clearly documented and explained (see https://www.archives.gov/files/federal-register/executive-orders/pdf/12866.pdf.

27. Finally, even if the Commission were to be provided with weights for the different criteria (which it is not, under the Act), and the problems of quantification somehow were not present, all the interdependencies among factors that affect the extent to which a particular set of emissions budgets are just, inclusive, and equitable; ambitious; and technically achievable and economically affordable would impose overwhelming practical challenges in trying to carry out a MCA.

28. In light of that, I believe that the process used by the Commission to recommend emission budgets, as illustrated in the two figures below,[9] is a reasonable and defensible approach for providing advice to the Minister under the Act. The process combines assumptions, analysis, and judgments to facilitate consideration of ambition of budgets and manageability of impacts, including the distribution of impacts across different groups. It allows judgments to be made about uncertain and especially non-quantifiable impacts – judgments that draw upon consultations with stakeholders and the public, as well as the opinions of Commission members themselves.

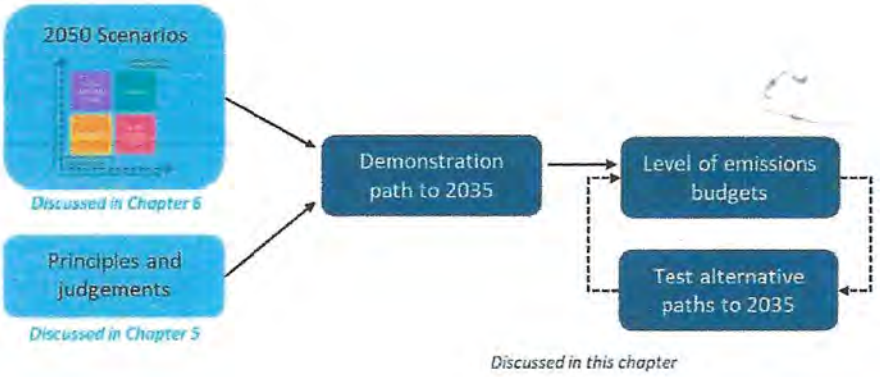
Stages of analysis for developing the CCC's advice (CCC Final Advice Figure 4.2)[10]



9 These figures also appear in Dr Taylor's Report as Figures 5.2 and 5.3, at pages 32 and 33.

10 Advice Bundle at 67.

CCC's process to determine the levels at which to set the first three emissions budgets (CCC Final Advice Figure 7.1)[11]



Affirmed by Michael Allen Toman

12/9/21

Michael Allen Toman

District of Columbia

The foregoing instrument was acknowledged before me

This 9 day of Dec, 2021

by Tajaye Williams

Notary Public[12]

My commission Expires May 31, 2026

TAJAYE LAMARON WILLIAMS NOTARY PUBLIC DISTRICT OF COLUMBIA EXP. - 05/31/2026

11 Advice Bundle at 115.

12 A person duly authorised to administer oaths in the District of Columbia

MICHAEL A. TOMAN

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https://scholar.google.com/citations?user=yGHcsBkAAAAJ&hl=en

December 2021

Principal Positions:

December 2020 – present

Resources for the Future (RFF): Senior Fellow and Research Staff Director

RFF is an independent, nonprofit, and rigorously nonpartisan research institution in Washington DC founded in 1952. Its mission is to carry out academic-grade research (mainly in economics) on numerous environmental and natural resource problems; publish research findings in peer-reviewed journals; and share research findings with policy makers and other stakeholders.

As a Research Staff Director, I oversee and support the professional development and performance of ~ 6 other full-time researchers, as well as co-leading RFF's recruiting for other research staff and participating with senior management in setting institutional policies for research and policy engagement. My own research and policy engagement include international and domestic climate change policy. I also have taken responsibility for building out a data-oriented RFF initiative on earth observation for policy.

April 2009 – November 2020

Manager, World Bank Development Research Group (DECRG), Sustainability and Infrastructure Team

The World Bank's Research Department includes 60+ PhD-level researchers all focused on economic development issues. Their work is judged on the basis of contribution to knowledge, as indicated by quantity and quality of peer-reviewed journal article publications; and relevance to solving key current and looming challenges to poverty reduction and sustainable development, as indicated by the ability of staff to contribute to the Bank's operational activities. All researchers in DECRG actively collaborate with scholars outside the Bank as well as with colleagues in the organization.

I managed a team of ~12 full-time PhD-level researchers whose work covers a variety of topics involving sustainability and infrastructure issues including climate change mitigation and impacts/adaptation, energy and economic development, environmental protection, agriculture, water, transport, urbanization and regional development. I was responsible for advising team members on research program development and implementation; providing quality assurance and other feedback on research

products; mentoring team members in initial years of career development; and helping to frame collaboration with the Bank's operational activities, as well as outreach to external partners/stakeholders/donors.

September 2008 – November 2020

Lead Economist, World Bank Development Research Group
My own World Bank research projects addressed several energy, environment, and climate-change issues including potential relevance of "carbon pricing" in Ethiopia and South Africa; economic benefits and GHG reductions from regional power sector integration in South Asia; community forest management and carbon sequestration in Nepal; motivations for and benefits from adoption of "clean cooking" in rural Ethiopian households; the impacts of energy sector development on poverty alleviation; and operationalization of macro-scale "green growth" policies for economic development. I also provided six or more weeks of hands-on support each year on a range of topics to operational units in the Bank.

April 2006 – September 2008

Senior Economist and Director, Environment, Energy and Economic Development Program, RAND Corporation
I oversaw and participated in the development and delivery of a portfolio of interdisciplinary projects worth over $1 million, conducted for various public and private sector clients including the US Departments of Energy and Defense, Hewlett Foundation, and Bipartisan Policy Center. My duties as Program Director included (co-)development of project ideas, and marketing to prospective clients; quality assurance; staff evaluations and recruitment; and interacting with various RAND advisory boards. My research topics included factors renewable energy potential in the US; economic and environmental impacts of new investment in synthetic fuels; energy security; and criteria for evaluating GHG mitigation policy options.

January 2003 – April 2006

Senior Economist, Environment Division, Sustainable Development Department, Inter-American Development Bank
I provided knowledge leadership for IDB operational staff on utilization of international "carbon finance" to support projects in IDB client countries that would limit greenhouse gas emissions while also improving economic returns. My activities included general education on carbon finance for IDB sector experts, and analysis of possibilities for using carbon finance in projects for energy efficiency, renewable energy, mass transit upgrading, and landfill management. I also established agreements between IDB and the World Bank and UN agencies for the IDB to have "direct access" to project co-financing from the Global Environment Facility.

September 1981 – January 2003

Resources for the Future (RFF): Fellow and Senior Fellow (1981-2003), and Research Division Director (1997-2002)
As a Research Division Director, I oversaw and participated in the development and delivery of a portfolio of research projects worth ~ $US 1 million on average, using funding from government agencies, private foundations, and unrestricted private sector contributions. I managed a team of ~7 full-time researchers, with responsibilities including program concept development; workshops and other interactions with stakeholders; and quality assurance and staff evaluation. I also participated actively in information-sharing meetings with potential donors as part of institutional fund raising; and I spearheaded efforts to improve outreach to broader audiences, notably a series of "Issue Briefs" on climate change issues. As a junior and then senior researcher, I developed proposals to fund research projects and publish research findings on numerous topics, including climate change, environmental policy in Eastern Europe, public utility policy, the application of cost-benefit analysis for policy evaluation, and operationalization of sustainable development principles in concert with cost-benefit analysis.

September 1994 – February 1996

Senior Economist, White House Council of Economic Advisers
As a senior staff member for the three Senate-confirmed CEA members, I had day-to-day responsibility for addressing all issues pertaining to natural resources, the environment, and climate change that came to CEA from other parts of the Executive Office of the President, or from executive branch agencies.

I co-chaired (with OMB) an inter-agency task force charged with updating the agency guidance for economic analysis of proposed Federal regulations under Executive Order 12866, particularly the guidance for environment and health regulations. Revision was needed so that the guidance reflected changes relative to the predecessor executive order, 12291. The new guidance maintained the central focus on benefit-cost analysis, and it incorporated key updates in methodology for discounting, valuing risk, and measuring externalities. However, it also addressed the importance of benefits and costs that are difficult to measure but still important to include in analysis of new rules (as reflected in the modified decision criterion in 12866 that benefits should *justify* the costs of a new regulation). I also participated in other inter-agency task forces addressing options for reducing greenhouse gas emissions, and hazardous waste prevention and cleanup (including Federal as well as private-sector sites).

Teaching and Other Related Experience

Fall semesters, 1984 –2012	**Adjunct faculty member, Nitze School of Advanced International Studies, Johns Hopkins University (1984-2012)** I taught a traditional semester-long course on fundamentals of natural resource and environmental economics that was required for terminal master's degrees in international economics and international relations.
Spring quarter, 2000-2010 (6 occasions)	**Adjunct faculty member, Bren School of the Environment, University of California, Santa Barbara** I was invited by the Dean of the Bren School to teach elective one-week intensive courses on either energy economics and policy, or climate change economics and policy, for students pursuing terminal master's degrees in this highly interdisciplinary program.
Episodically, 1986-present	**Guest lecturer, international professional learning programs (World Bank Institute, Foreign Service Institute, USAID)** Over the years I have been invited numerous times to offer 2-3-hour presentations on basic economic concepts and their practical applications to energy, environment, and climate change issues to professional audiences at the World Bank and the State Department's Foreign Service Institute. I also was invited on three USAID-funded education tours to make presentations to government, business, and civil society representatives on environmental policy and sustainable development – two in India and one in Russia.

Education:

PhD	Economics, University of Rochester, 1983
MA	Economics, University of Rochester, 1981
MSc	Applied Mathematics, Brown University, 1977
BA	Economics and Mathematics, Indiana University, 1976 (summa cum laude, Phi Beta Kappa, National Merit Scholar)

Publications

Climate Change

Refereed Articles, Chapters, Books

"Prospects for a Global Greenhouse Gas Accord: Lessons from Other Agreements" (Peter Morrisette, Joel Darmstadter, and Andrew Plantinga, co-authors), *Global Environmental Change*, June 1991.

"Equity and International Agreements for CO_2 Containment" (Dallas Burtraw, co-author), *Journal of Energy Engineering*, August 1992.

Assessing Surprises and Nonlinearities in Greenhouse Warming (Joel Darmstadter, volume co-editor), Resources for the Future, 1993.

"An Overview of Adaptation to Climate Change" (Rosina Bierbaum, co-author), in Joel Smith et al, eds., *Adapting to Climate Change: An International Perspective*, Springer-Verlag, 1996.

"Research Frontiers in the Economics of Climate Change," *Environmental and Resource Economics*, April/June 1998.

"Using Emissions Trading to Regulate US Greenhouse Gas Emissions: An Overview of Policy Design and Implementation Issues" (Carolyn Fischer and Suzi Kerr, co-authors), *National Tax Journal*, September 1998.

"The Economics of 'When' Flexibility in the Design of Greenhouse Gas Abatement Policies" (Richard Morgenstern and John Anderson, co-authors), *Annual Review of Energy and Environment*, 1999.

"Climate Change Policy" (Jason Shogren, co-author), in *Public Policies for Environmental Protection*, 2nd ed. (Paul Portney and Robert Stavins, eds.), 2000.

"Early Emission Reduction Programs: An Application to CO_2 Policy" (Ian Parry, co-author), *Energy Journal*, 2002.

"Ancillary Benefits of Reduced Air Pollution in the U.S. from Moderate Greenhouse Gas Mitigation Policies in the Electricity Sector (Dallas Burtraw, Alan Krupnick, Karen Palmer, Anthony Paul, and Cary Bloyd, co-authors), *Journal of Environmental Economics and Management*, June 2003.

India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country (volume editor), RFF Press, 2004.

"Economic Analysis and the Formulation of U.S. Climate Policy," in *Painting the White House Green* (Randall Lutter and Jason Shogren, co-eds.), RFF Press, 2004.

Impacts on U.S. Energy Expenditures and Greenhouse-Gas Emissions of Increasing Renewable-Energy Use (James Griffin and Robert Lempert, co-authors), Technical Report TR-384-1-EFC, RAND, 2008.

Unconventional Fossil-Based Fuels: Economic and Environmental Tradeoffs (Aimee Curtright, David Ortiz, Joel Darmstadter, Brian Shannon, co-authors), Technical Report TR-580-NCEP, RAND, 2008.

Strengthening U.S. International Energy Assistance to Reduce Greenhouse Gas Emissions and Improve Energy Security (Scott Hassell co-author), Occasional Paper OP-251-RC, RAND, 2009.

"In Search of Effective and Viable Policies to Reduce Greenhouse Gases" (Nicholas Burger, Liisa Ecola, and Thomas Light, co-authors), *Environment*, May-June 2009. (Also Occasional Paper OP-252-RC, RAND, 2009.)

"Contrasting Future Paths for an Evolving Global Climate Regime" (Scott Barrett, co-author), *Global Policy* 1(1), January 2010.

China's Technological Catch-Up Strategy for Industrial Development: Impact on Energy Efficiency and CO_2 Emissions (Michael T. Rock, co-author), Oxford University Press, 2015.

"International Cooperation in Advancing Energy Technologies for Deep Decarbonisation," in Scott Barrett, Carlo Carraro and Jaime de Melo (eds.), *Towards a Workable and Effective Climate Regime*, FERDI, November 2015.

"Climate Change, Industrial Transformation, and 'Development Traps'" (Alexander Golub, co-author), *Environment and Resource Economics*, February 2016.

"Collective Action and Carbon Sequestration in Nepal" (Randall Bluffstone, Eswaran Somanathan, P Jha, Hari Luintel R. Bista, Naya Paudel, Bhim Adhikari, co-authors), *Journal of Forest and Livelihood*, 2016.

"Does Collective Action Sequester Carbon? Evidence from the Nepal Community Forestry Program" (Randall Bluffstone, Eswaran Somanathan, Prakash Jha, Harishara Luintel, Rajesh Bista, Naya Paudel, co-authors), *World Development*, January 2018.

"Fuel savings, cooking time and user satisfaction with improved biomass cookstoves: Evidence from controlled cooking tests in Ethiopia" (Zenebe Gebreegziabher, Abebe D Beyene, Randall Bluffstone, Peter Martinsson, Alemu Mekonnen, co-authors), *Resource and Energy Economics*, May 2018.

"Carbon Pricing and Cross-Border Electricity Trading for Climate Change Mitigation in South Asia" (Govinda Timilsina, co-author), *Economics of Energy and Environmental Policy*, 2018.

"Exploring Carbon Pricing in Developing Countries: A Macroeconomic Analysis in Ethiopia" (Andualem Telaye Mengistu, Pablo Benitez, Seneshaw Tamru, and Haileselassie Medhin, co-authors), *Sustainability*, August 2019.

"Funding Inclusive Green Transition through Greenhouse Gas Pricing" (Thomas Sterner, Richard T. Carson, Marc Hafstead, Peter Howard, Sverker Carlsson Jagers, Gunnar Köhlin, Ian Parry, Ryan Rafaty, E. Somanatan, Jan Christoph Steckel, Dale Whittington, Francisco Alpizar, Stefan Ambec, Claudia Aravena, Jorge Bonilla, Reza Che Daniels, Jorge Garcia, Niklas Harring, Kanishka Kacker, Suzi Kerr, Haileselassie Medhin, Pham Khanh Nam, German Romero, Olof Johansson-Stenman, Jintao Xu, Min Wang, co-authors), *IFO DICE Report* 18(1): 3-8 (Spring 2020).

"Climate Adaptation Finance in World Bank Economic Development Programs: The Challenges of Systemic Transformation via 'Scaling Up'" (Todd A. Eisenstadt and Ifeoluwa Olawole, co-authors), *Sustainability*, September 2021.

Working Papers

"Responding to Threats of Climate Change Mega-Catastrophes" (Carolyn Kousky, Olga Rostapshova, Richard Zeckhauser, co-authors), World Bank Policy Research Working Paper 5127, November 2009.

"Technological Learning, Energy Efficiency, and CO2 Emissions in China's Energy Intensive Industries" (Michael T. Rock, Yuanshang Cui, Kejun Jiang, Yun Song, and Yanjia Wang, co-authors), World Bank Policy Research Working Paper 6492, June 2013.

"Community Managed Forest Groups and Preferences for REDD+ Contract Attributes: A Choice Experiment Survey of Communities in Nepal" (Sahan T. M. Dissanayake, Prakash Jha, Bhim Adhikari,

Rajesh Bista, Randall Bluffstone, Harisharan Luintel, Peter Martinsson, Naya Sharma Paudel, E. Somanathan, co-authors), World Bank Policy Research Working Paper 7326, June 2015.

"Do Improved Biomass Cookstoves Reduce Fuelwood Consumption and Carbon Emissions? Evidence from Rural Ethiopia Using a Field Experiment with Electronic Monitoring" (Alemu Mekonnen, Abebe Beyene, Randy Bluffstone, Zenebe Gebreegziabher, Peter Martinsson, Ferdinand Vieider, co-authors), World Bank Policy Research Working Paper 7324, June 2015.

"Preferences for REDD+ Contract Attributes in Low-Income Countries: A Choice Experiment in Ethiopia" (Sahan T. M. Dissanayake, Abebe Damte Beyene, Randall Bluffstone, Zenebe Gebreegziabher, Peter Martinsson, Alemu Mekonnen, Ferdinand M. Vieider, co-authors), World Bank Policy Research Working Paper 7296, June 2015.

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Affirmed

Michael Allen Toman }

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District of Columbia

The foregoing instrument was acknowledged before me this 9 day of December, 2021

by Tajaye Williams

Notary Public

My Commission Expires May 31, 2026