

CHRIS CALWELL

PRINCIPAL, ECOS RESEARCH

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Chris Calwell is an internationally recognized expert operating at the intersection of the technologies and policies needed to address climate change. Chris digests and synthesizes deeply technical information, extracts the meaning for a broader audience, incorporates the relevant market context, and then conveys a highly visual narrative in a manner that is understandable and actionable by business leaders, policymakers and individual consumers.

His areas of technical expertise and experience include:

- energy efficient consumer electronics, appliances, lighting, and power conversion devices
- innovative approaches to utility energy efficiency policy and program design
- zero net energy homes, electric vehicles, and renewable energy sources
- biochar
- climate-related clean technology investing

After serving seven years in the Natural Resources Defense Council's (NRDC) Energy Program, Chris co-founded Ecos Consulting in 1997. Advantage IQ purchased the firm in 2009, combining it with other acquisitions and existing businesses to create Ecova, where Chris continued to work until shortly after the firm was purchased by GDF Suez in mid-2014. He recently co-founded Ecos Research, where he focuses on climate-stabilizing technologies and policy tools.

While at Ecova, Chris led efforts into new energy efficiency and environmental initiatives on behalf of numerous clients, including the U.S. EPA ENERGY STAR® program, the California Energy Commission, PG&E, NRDC, NYSERDA and Natural Resources Canada. This work included the development of entirely new energy efficiency approaches in the field, including:

- component-based energy savings targets for complex products
- active mode efficiency consideration for consumer electronics
- climate-driven policies for consumer products, such as progressive efficiency and sufficiency specifications (see <http://ecee.org/policy-areas/sufficiency> for other specific examples)
- new approaches to product efficiency and performance testing that more closely mirror actual product usage patterns.

Chris helped to incubate and launch TopTen USA, a non-profit organization dedicated to helping consumers find and purchase the most energy efficient products. He has been honored by ACEEE as a Champion of Energy Efficiency for his pioneering research and policy efforts in external power supply efficiency. He is a founding member of the Southwest Colorado Renewable Energy Society (now the Sustainability Alliance of Southwest Colorado).

EDUCATION AND CERTIFICATIONS

- M.A., Energy & Resource Group, University of California at Berkeley, CA; 1989
- B.A., Environmental Studies, Trinity University; San Antonio, TX; 1987
- Energy & Environmental Policy Program, University of Oslo, Norway; 1985

EXPERIENCE

Principal, Ecos Research, Durango, CO, March 2015-present

Chris conducts research to assess and improve the energy efficiency and performance of a variety of consumer products and building types on behalf of utilities, government agencies, non-profit organizations, and investment firms.

Guest Lecturer, Semester at Sea, Portugal and Spain, June 2014

Chris assisted Professor Michael Maniates in lectures and field trips for his undergraduate energy course, and also developed a stand-alone lecture on zero net energy homes and electric vehicles that he presented to a cross section of students, faculty and administrative staff of Semester at Sea.

Senior Research Fellow and Founder, Research & Policy, Ecova, Durango, CO, 1997–2014

- Led investigations into future opportunities for energy efficiency specifications, labeling programs and market transformation incentive programs; responsible for developing project strategy and leading development of mandatory efficiency standards and voluntary market transformation program recommendations.
- Led research, writing and presentations associated with linking future energy efficiency strategies to climate constraints.
- Clients included the U.S. Department of Energy, the EPA ENERGY STAR® program, the California Energy Commission, PG&E Codes and Standards Enhancement Initiative (CASE), Natural Resources Defense Council (NRDC), NYSERDA, TopTen USA, eceee and Natural Resources Canada.
- Oversaw development of standardized energy efficiency test procedures for new consumer product categories, as well as analysis of the resulting data sets.
- Pioneered active mode efficiency metrics and voluntary and mandatory specifications for electronic products such as external power supplies, battery chargers, televisions, computers, monitors, audio equipment, and imaging equipment.
- Served as Principal Investigator for Ecova's work to more fully understand the technical opportunities for energy savings in clothes dryers and the changes needed to efficiency test procedures for them.

Accomplishments – Zero Net Energy (ZNE) Homes

- Oversaw the design and construction of a ZNE home in Durango, Colorado that incorporates state of the art building shell, HVAC, lighting, appliance, window, energy monitoring, EV charging, and PV technologies, and that will serve as a living laboratory for assessing the effectiveness of future technology developments
- Developed ZNE curriculum regarding plug loads, appliances, lighting and energy monitoring and control systems and team-taught courses on those topics for Pacific Gas & Electric and Southern California Edison

Accomplishments – Internal and External AC-DC Power Supplies

- Developed globally accepted standardized test procedures for external and internal power supplies (with EPRI).

- Helped to secure adoption of an ENERGY STAR specification and mandatory efficiency standards for external power supplies in California (identical standards were adopted in six other U.S. states and are now the basis of a DOE rule-making under federal standards); currently supporting development of a Tier II ENERGY STAR specification.
- Conducted an international design competition for efficient power supplies with support from the Power Sources Manufacturers Association.
- Honored as a Champion of Energy Efficiency at the ACEEE 2006 Summer Study; award shared with Noah Horowitz, NRDC; Andrew Fanara, ENERGY STAR; and John Wilson, California Energy Commission.

Accomplishments – Lighting

- Served as lead author and presenter for general service lighting standards efforts on behalf of clients in California, U.S. federal legislation, Canada and the EU.
- Identified the sizeable energy efficiency opportunity for incandescent lamps under PG&E CASE project; currently providing analysis of various incandescent lamp phase-out proposals (state, national and international).
- Provided technical and policy expertise to NRDC and U.S. EPA in the development of new ENERGY STAR labeling programs for light fixtures, CFLs and ceiling fans.
- Worked with NRDC to identify the technical requirements and market mechanisms needed to transform the market to more efficient lighting.
- Conducted the company's pioneering research into the energy and safety problems with halogen torchieres, representing clients in media events designed to encourage torchiere replacement.

Course Instructor, Automobiles and the Environment, Colorado College, Colorado Springs, CO March 1998

- Designed and taught a three-credit-hour course on the environmental, social, historical, cultural and geographical implications of the automobile in America.

Course Co-Instructor, Energy for Planet Earth, Colby College, Waterville, ME January 1997

- Taught an intensive three-credit-hour energy course for 14 undergraduates through the physics department; covered basic physical principles of energy, quantitative methods, estimation skills and environmental and policy considerations.

Energy and Environmental Researcher/Writer 1995–1997

- Conducted a variety of energy efficiency research and writing projects for NRDC, E Source and Green Seal.
- Managed assessment of residential light fixture market, specification development and report recommending that the EPA establish an ENERGY STAR program for that market.

Energy and Transportation Scientist, NRDC, San Francisco, CA 1988–1995

- Assisted in the launch of an incentive-based California regulatory system for utility investments in energy efficiency.

- Collaborated with utilities in the development of residential DSM programs.
- Developed a series of consumer guides on energy efficiency and other environmental topics.
- Created and chaired the California Compact and piloted its residential lighting program concept through national implementation at the Consortium for Energy Efficiency.
- Conducted a key portion of NRDC's early research into transportation and utility-based mitigation strategies for global warming; activities included primary research on the financial workings of the automobile industry and designed a series of new state and national-based incentive strategies for improving fuel efficiency.
- Teamed with Bank of America and Pacific Gas & Electric to launch and expand the national Recycled Paper Coalition.

Photographer and Writer, Home Energy, Berkeley, CA 1988–1991

- Provided a series of cover photographs and short articles on energy efficiency subjects.

Robotics and Computing Educator, Champlain College Computer and Science Space Camp, Burlington, VT 1987

- Taught children ages seven to 17 a variety of science related topics, including programming, robot design and operation, solar cooker design and reentry vehicle model building.

Environmental Technician, Kansas Department of Health & Environment, Topeka, KS 1986

- Created a computer database to automate the tracking of permits for the commercial use of radioactive sources around the state.

EDUCATION AND CERTIFICATIONS

- M.A., Energy & Resource Group, University of California at Berkeley, CA; 1989
- B.A., Environmental Studies, Trinity University; San Antonio, TX; 1987
- Energy & Environmental Policy Program, University of Oslo, Norway; 1985

RELEVANT PRESENTATIONS AND PUBLICATIONS

Big Changes Afoot: What Will the Utility Business Look Like in 20 Years?, Green Business Roundtable presentation, Durango, CO, December 10, 2014.

New Approaches to Energy Efficiency: Our Best Hope for Stabilizing the Climate and Improving Competitiveness, keynote presentation at Portuguese Council for an Energy Efficient Economy (PCEEE) conference, Lisbon, Portugal, June 20, 2014.

Zero Net Energy Homes – Occupant Factors: Lighting, Appliance and Plug Load Topics and Energy Monitoring and Home Automation, full-day ZNE training sessions taught on behalf of PG&E, SCE, and SMUD, 2011-2014.

LEDs: Ready for Liftoff?, AESP webinar, March 2014.

Emerging Technology Dryer Testing, Prepared for the Northwest Energy Efficiency Alliance, with Dave Denkenberger, Brian Spak and Apurva Pawashe, November 2013.

Are Test Procedures Passing the Test? Ensuring That Measured Results Are Representative of Energy Use in the Field, Energy Efficient Domestic Appliances and Lighting (EEDAL) Conference, Coimbra, Portugal, September 2013.

Analysis of Potential Energy Savings from Heat Pump Clothes Dryers in North America, CLASP report prepared for the Super Efficient Dryer Initiative, with Dave Denkenberger, Nathan Beck, Brandan Trimboli and Debbie Driscoll, March 2013.

Results from CLASP-Funded Energy Efficiency Testing of European Heat Pump and US Conventional Clothes Dryers, May 31, 2012.

Residential Clothes Dryers: A Closer Look at Energy Efficiency Test Procedures and Savings Opportunities, prepared for the Natural Resources Defense Council, with Dave Denkenberger, Serena Mau and Eric Wanless, November 2011.

Next Generation Lighting Programs: Opportunities to Advance Efficient Lighting for a Cleaner Environment, US Environmental Protection Agency report commissioned by ENERGY STAR, with Luke Mason, Laura Moorefield, and Kevin Simonson, November 2011.

Evaluating the Potential of Halogen Technologies: European EcoDesign and Labelling Requirements for Directional Lamps, prepared for eceee, with Luke Mason and Laura Moorefield, March 7, 2011.

Residential Clothes Dryers: An Investigation of Energy Efficiency Test Procedures and Savings Opportunities, with Paul Bendt and Craig Billingsley, prepared for NRDC, November 6, 2009.

"Radical Redesign Nears for Battery Chargers," *Power Electronics Technology*, April 2007, pp. 20 – 25 (with Suzanne Foster Porter).

Building a Better Bulb: Technologies, Policies, and Programs Behind the Battle to Increase the Efficiency of General Service Incandescent Light Bulbs, in the proceedings of the ACEEE 2006 Summer Study on Energy Efficiency in Buildings, Asilomar, CA (with Peter May-Ostendorp and Gary Fernstrom).

Battery Charger and Internal Power Supplies Standards Recommendations, for the California Energy Commission Public Interest Energy Research Program, July 2006 (with Suzanne Foster Porter).

OTHER PRESENTATIONS

New Directions for Energy Policy in a Climate-Constrained Era, presentation to ACEEE, October 2010.

Scaling Power Use to Functionality: Design Strategies and Opportunities for Energy Savings, APEC Standby Conference, Tokyo, October 19, 2010.

Lighting Portfolio Planning for Efficiency Programs: Advanced Session, ENERGY STAR partner meeting, Denver, October 4-5, 2010.

Bending the Curve Downward: What Will It Take to Sharply Reduce Residential Greenhouse Gas Emissions?, CCSE Clean Energy Conference, San Diego, September 16, 2010.

Assessment of Options for Improving Energy Efficiency Test Procedures for Displays, research funded by US EPA ENERGY STAR, NRCAN and NYSERDA, August 11, 2010.

Is Efficient Sufficient? (no) The Case for Shifting Our Emphasis in Energy Specifications to Progressive Efficiency and Sufficiency, eceee workshop, Brussels, May 18, 2010.

Appliances for Presidents: Brief Thoughts on Appliance Energy Use and Policy Opportunities to Reduce It, presentation at UC Davis Rosenfeld Symposium, March 9, 2010.

Portfolio Review Project, Presentation to Oncor, with Lois Gordon, January 13, 2010.

Prospects for Residential Lighting Programs in Light of Federal Lamp Standards, presentation to annual SWEEP conference, November 10, 2009.

The Nuts and Bolts of Reducing Residential Energy Consumption, Yale University lecture, October 5, 2009.

Reexamining the Role of CFLs in Meeting Savings Targets, presentation at ACEEE Energy Efficiency as a Resource conference, September 29, 2009.

Replacement Technologies for GLS: What Can We Expect from Future Incandescents, CFLs and LEDs?, A Beacon to the Future: India's Path Toward Low Carbon Lighting, Delhi, India, April 1, 2009.

New Approaches to Reducing Absolute Energy Consumption: Sufficiency, Progressive Efficiency and TopTen, ACEEE Market Transformation Symposium, Washington DC, March 30, 2009 and eceee Summer Study, Nice, France, June 4, 2009.

Understanding Plug Loads and the Opportunity for Energy Savings, National Rural Electric Cooperative Association annual meeting, New Orleans, February 12, 2009.

After 28 Years of Warming Up, Are You Ready for the New Efficiency Race Ahead?, Northwest Energy Coalition annual meeting, Portland, OR, December 5, 2008.

Consumer Electronics: Global Harmonization Opportunities for Energy Savings, Global Product Efficiency 2008, Brussels, Belgium, October 31, 2008.

Plugging the Savings Gap: How Efficient Plug Loads Can Contribute to Your Program Portfolio, ESOURCE Forum, Denver, CO, September 24, 2008.

Climate Changes Everything: New Approaches to Efficiency in the Northwest. Presented to the Northwest Energy Efficiency Task Force, Portland, OR, August 1, 2008.

Thinking Strategically About Residential Plug Loads: New Approaches to Maximizing Energy Savings. Presented to the stakeholders developing the residential section of the California Long-term Energy Efficiency Strategic Plan. Sacramento, CA, December 11, 2007. (Special note: the strategy presented was adopted; see Section 2, page 9: http://www.californiaenergyefficiency.com/docs/CA_longterm_EE_Strategic%20Plan.pdf.)

OTHER PUBLICATIONS

Evaluation of Best-in-Class LED Reflector Lamps, IEE White Paper prepared for the Edison Foundation, with Kevin Simonson, Luke Mason, Laura Moorefield and Erica Lighthiser, January 2013.

An Energy Efficiency Philosophy for Electronic Products, July 5, 2012.

Northeast Regional Residential Lighting Strategy, commissioned by NEEP, with Energy Futures Group, D&R International, and Optimal Energy, November 2011.

Power Scaling in Proportion to Data Processing. Prepared by Ecos for the Australian Department of Climate Change and Energy Efficiency, as part of the Asia-Pacific Partnership on Clean Development and Climate. June 2011.

Cutting Edge Feasibility. Prepared by Ecos for the Australian Department of Climate Change and Energy Efficiency, as part of the Asia-Pacific Partnership on Clean Development and Climate. June 2011.

Implementing Progressive Efficiency Specifications: Considerations for ENERGY STAR, with Alyssa Go, October 31, 2010.

Is Efficient Sufficient? The Case for Shifting Our Emphasis in Energy Specifications to Progressive Efficiency and Sufficiency, prepared for eceee and US EPA ENERGY STAR, March 22, 2010.

Assessment of Options for Improving Energy Efficiency Test Procedures for Displays, prepared for ENERGY STAR, Natural Resources Canada and NYSERDA, March 17, 2010.

"Defining a Standard Metric for Electricity Savings," *Environmental Research Letters,* with Jonathan Koomey and numerous co-authors. March 9, 2010.

NRDC Comments to the FTC on Lamp Labeling Study, with Noah Horowitz and Laura Moorefield, March 23, 2009.

B-class Halogens and Beyond: Design Approaches to Complying with the Proposed EU Eco-Design Domestic Lighting Requirements, a technical and economic analysis of the draft Eco-design requirements proposed for general service lighting, prepared for the European Council for an Energy Efficient Economy (eceee) with financial support from the European Climate Foundation and Defra's Market Transformation Programme (UK), December 11, 2008, with Laura Moorefield and Craig Billingsley.

Efficiency in a Climate-Constrained World: Are we Aiming High Enough? In the proceedings of the 2008 ACEEE Summer Study. Asilomar, CA. August 20, 2008.

Energy and Economic Alternatives to the Desert Rock Energy Project: Comments on the Draft Environmental Impact Statement, prepared for Diné CARE, January 2008 (with Paul Sheldon and Riley Neugebauer).

Editorial: "Arthurian Legend Meets Climate Constraints," *Home Energy,* July/August 2006.

Lean, Green and Solid State: Measuring and Enhancing Computer Efficiency, in the proceedings of the ACEEE 2006 Summer Study Conference on Energy Efficiency in Buildings, Asilomar, CA (with Kim Herb and Peter May-Ostendorp, *Ecos Consulting;* and Rebecca Duff, *ICF Consulting*).

In Search of Synergy: The role of benchmarking in measuring and enhancing computer efficiency, proceedings of the 2006 IEEE International Symposium on Electronics and the Environment, San Francisco, CA, May 2006 (with Peter May-Ostendorp, Kim Herb, and Arthur Howard).

Synergies in Swimming Pool Efficiency: How Much Can Be Saved? Draft submitted to the Natural Resources Defense Council, February 13, 2006 (with Jeremy Rivera and Laura Moorefield).

Summary Report on Power Supply Efficiency Dependence on Voltage and Power Output, for the California Energy Commission Public Interest Energy Research Program, January 2006 (with Peter May-Ostendorp).

Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market, PNNL-15730 report prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830, Pacific Northwest National Laboratory, Richland, WA, 2006 (with L.J. Sandahl, T.L. Gilbride, M.R. Ledbetter, and H.E. Stewart).

Residential Heat Pump Water Heaters: Energy Efficiency Potential and Industry Status, prepared for the Natural Resources Defense Council, November 2005 (with Jan Harris and Chris Neme).

Proposed Energy Efficiency Specifications for General Service Incandescent Lamps. CASE Report for PG&E's PY2005: Title 20 Standards Development. July 13, 2005.

Recommendations for Tier I ENERGY STAR Computer Specification, presentation for the ENERGY STAR® Stakeholders Meeting hosted by Dell Computers, Austin, Texas, June 21, 2005 (with Noah Horowitz, NRDC; Peter Ostendorp and Kim Herb, Ecos Consulting).

80 PLUS: A Strategy for Reducing the Inherent Environmental Impacts of Computers, for 2005 IEEE International Symposium on Electronics and the Environment, May 2005 (with Peter Ostendorp).

Televisions: Active Mode Energy Use, New Horizons for Energy Efficiency, report prepared for the Natural Resources Defense Council, March 2005 (with Suzanne Foster and Peter Ostendorp).

Power Supply Census, for the California Energy Commission PIER program, March 2005 (with Suzanne Foster, Travis Reeder and Catherine Hardy).

Ac-Dc Server Power Supplies: Making the Leap to Higher Efficiency. Applied Power Electronics Conference 2005 (with Arshad Mansoor, EPRI Solutions).

Designing Ac-Dc Power Supplies for Improved Energy Efficiency: A Technical Primer, prepared for the California Energy Commission with Public Interest Energy Research Funds. December 2004 (with Suzanne Foster; Arshad Mansoor, EPRI Solutions and Tom Geist, EPRI Solutions).

Policy Recommendations for Improving Energy-Efficiency Labeling in the United States, report prepared for the National Commission on Energy Policy, October 22, 2004 (with Catherine Hardy and My Ton).

Forging Ahead with Desktop PC Power Supply Efficiency Improvements, presentation at the Intel Technology Symposium, September 8, 2004 (with Suzanne Foster, Ecos Consulting; David Hiller, Lilly Huang and David Perchlik, Intel Corporation; and Craig Hershberg, U.S. EPA).

If We're Only Snoozing, We're Losing: Opportunities to Save Energy by Improving the Active Mode Efficiency of Consumer Electronics. ACEEE 2004 Summer Study Conference Proceedings on Energy Efficiency in Buildings. (with Suzanne Foster and Noah Horowitz).

Analysis of Standards Options For Single-Voltage External Ac to Dc Power Supplies. CASE Report for PY2004: Title 20 Standards Development, May 3, 2004.

"Charge! A New Battle Cry for Energy Efficiency," *Home Energy*, vol. 21, no. 2, March/April 2004, pp. 18-22 (with Suzanne Foster).

Dealer Incentives for Fuel Efficiency: Are They a Cost Effective Way to Save Gasoline? for the National Commission on Energy Policy, March 4, 2004 (with Catherine Hardy, Debbie Gordon and My Ton).

Power Supply Efficiency: What Have We Learned? for the California Energy Commission's Public Interest Research Group (PIER) program, February 2004, (with Suzanne Foster, Vicki Fulbright and Wendy Ghiasinejad).

Test Protocol for Measuring the Energy Efficiency of Battery Charging Appliances, prepared with Public Interest Energy Research and Title 20 funds from the state of California, and available at <http://www.efficientpowersupplies.org/methods.asp>, October 2003, (with Suzanne Foster, Andrew McAllister, and Arshad Mansoor).

Laptops: How Much Do They Use and How Much Can We Save? prepared for the Natural Resources Defense Council, September, 2003, (with Suzanne Foster).

Battery Chargers and Energy Efficiency, Summary of Findings and Recommendations, prepared for the Natural Resources Defense Council, October, 2003 (with Suzanne Foster, Travis Reeder, and Riley Neugebauer).

LED Lighting Technologies and Potential for Near-Term Applications, prepared for the Northwest Energy Efficiency Alliance, June 2003 (with My Ton, Kate Conway, and Suzanne Foster).

Mercury in Fluorescent Lamps: Environmental Consequences and Policy Implications for NRDC, final report submitted to Natural Resources Defense Council, May 31, 2003, (with Carolyn Dunmire, Andria Jacob, My Ton, Travis Reeder, and Vicki Fulbright).

Low Rolling Resistance Tires, for Green Seal's *Choose Green Report*, March 2003, (with My Ton and Travis Reeder).

"Save \$100 Just by Changing Light Bulbs," *Bottom Line Personal*, vol. 24, no. 4, February 15, 2003, p. 6.

California State Fuel-Efficient Tire Report: Volume II, for the California Energy Commission, January 2003, (My Ton, Deborah Gordon, Marissa Olson, Travis Reeder, and Suzanne Foster).

Sorry, Wrong Number: The Use and Misuse of Numerical Facts in Analysis and Media Reporting of Energy Issues, *Annual Review of Energy & the Environment*, 27:119 – 158, 2002, (with Jonathan Koomey, Skip Laitner, Jane Thornton, Richard E. Brown, Joseph H. Eto, Carrie Webber, and Cathy Cullicott).

Analysis of Standards Options for Low-Voltage Wall Transformers, prepared for Pacific Gas & Electric, August 2002 (with Travis Reeder).

2001: A CFL Odyssey. What Went Right? Paper presented at the 2002 ACEEE Summer Study, Asilomar, CA, (with John Zugel, Ecos Consulting, Peter Banwell and Wendy Reed, U.S. Environmental Protection Agency).

Power Supplies: A Hidden Opportunity for Energy Savings, for the Natural Resources Defense Council, May 2002, (with Travis Reeder).

Out with the Old, In with the New: Why Refrigerator and Room Air Conditioner Programs Should Target Replacement to Maximize Energy Savings, for the Natural Resources Defense Council, November 2001, (with Travis Reeder).

Could Universal Ballasts Increase Consumer Acceptance of Compact Fluorescent Light Fixtures? Focus Group Findings and Research Opportunities, for the Natural Resources Defense Council, October 2001, (with My Ton, Pamela Freedman, and John Zigel).

Oil from the Arctic National Wildlife Refuge: Too Little, Too Late, for the Natural Resources Defense Council, February 2001, (with Cathy Cullicott).

"Ceiling Fans: Fulfilling the Energy Efficiency Promise," *Home Energy*, January/February 2001, (with Noah Horowitz).

Compact Fluorescent Torchieres: A Case Study in Market Transformation, for the 2nd International Conference on Energy Efficiency in Household Appliances and Lighting, September 2000.

Residential Ceiling Fans: A Look at Their Energy Use and Opportunities for Energy Savings, for the Natural Resources Defense Council, August 8, 2000, (with Noah Horowitz).

Lighting the Way to Energy Savings: How Can We Transform Residential Lighting Markets? for the Natural Resources Defense Council, December 7, 1999, (with Chris Granda, Lois Gordon and My Ton).

Halogen Torchiere Market Transformation: A Look at Progress to Date and Future Strategies, for the Natural Resources Defense Council, September 10, 1999, (with Chris Granda).

Regional Efficiency Opportunities in the Midwest, Southwest and Southeast: The Key to National Market Transformation, Ecos Consulting Inc, December 7, 1998, (with My Ton).

How Far Have We Come? Remaining Opportunities for Upgrading Fluorescent Ballasts and Lamps, Strategic Memo SM-98-4, E Source, May 1998, (with Danielle Dowers and Doug Johnson).

Halogen Torchieres and University Residence Halls: National Survey Results, Ecos Consulting Inc., November 5, 1998, (with Penny Cody and Susan Oster).

Halogen Torchieres: A Look at Market Transformation in Progress, paper presented at Right Light IV, Copenhagen, Denmark, November 1997, (with Evan Mills, Lawrence Berkeley National Laboratory).

Cool It! Eight Great Ways to Stop Global Warming, membership brochure prepared for the Natural Resources Defense Council, October 1997.

The Campus Lighting Efficiency Project: The Halogen Torchiere Opportunity, Ecos Consulting Inc., paper presented at The Greening of the Campus II Conference, Ball State University, Muncie, Indiana, September 1997, (with Kurt Teichert, Brown University).

Energy-Saving Torchieres: Coming to a Store Near You, Tech Update TU-97-8, E Source, July 1997.

Campus Lighting Efficiency Project: Replacing Halogen Torchieres on Campus with Safer, More Efficient Lamps, Ecos Consulting Inc. memorandum, June 16, 1997 (with Ian Todreas).

Big Lamp on Campus: An Energy and Environmental Curriculum Module for Colleges Concerned about Halogen Lamp Use, Ecos Consulting Inc., submitted to the U.S. Environmental Protection Agency, Office of Air and Radiation, ENERGY STAR Programs under Grant # CX820578-01-0 to the Natural Resources Defense Council, April 15, 1997.

Diminishing Returns: Oil Projections Meet Economic Realities in the Arctic National Wildlife Refuge, for Natural Resources Defense Council, February 1997.

"Bright Prospects for CFL Torchieres," *Home Energy*, vol. 14, no. 1, January/February, 1997, p. 13.

"Zap Energy Waste and Save Dollars in your Home," *Green Guide #34*, Mothers and Others for a Livable Planet, January 14, 1997.

"Halogen Uplights and Hot Ceilings." *International Association for Energy-Efficient Lighting Newsletter*, vol. 5, no. 16, 4/96, December, 1996, pp. 1, 3, 10-11, (with Evan Mills, Lawrence Berkeley National Laboratory).

"Wallboard, Fiberboard and Flooring," *Choose Green Report*, Green Seal, December 1996, (with Lynn Simon).

Halogen Torchieres: Cold Facts and Hot Ceilings, Tech Update TU-96-10, E Source, September 1996.

Energy-Efficient Residential Luminaries: Technologies and Strategies for Market Transformation, submitted to the U.S. Environmental Protection Agency under Grant # CX824685 to the Natural Resources Defense Council, May 13, 1996, (with Chris Granda, Charlie Stephens and My Ton).

LED Traffic Lights: Test Results Give Green Light for Additional Installations, Tech Update, E Source, November 1995.

"The Halogen Torchiere: Starting Over with America's Most Popular Light Fixture," Natural Resources Defense Council internal memorandum, January 30, 1995.

Beyond Gridlock: Linking Automakers' Profits to Energy Efficiency, NRDC book manuscript, unpublished, 1994.

What's the Charge? Estimating the Emissions Benefits of Electric Vehicles in Southern California, NRDC/EDF joint report, 1994, (with Francis Chapman and Diane Fisher).

No More Tailpipes: The Role of Electric Vehicles in Clearing California's Air, NRDC policy analysis synthesized from "What's the Charge?" 1994.

California Energy and Global Warming in *California's Threatened Environment*, Planning and Conservation League Foundation, 1993, Island Press (edited by Tim Palmer).

Introduction, *The Next Step: 50 More Things You Can Do to Save the Earth*, 1991, Earthworks Press.

Clearing the Air: The Dollars and Sense of Proposition 128's Atmospheric Protection Provisions, NRDC Special Report, September, 1990, (with Allen Edwards, Cliff Gladstein, and Lily Lee).

30 Simple Energy Things You Can Do to Save the Earth, 1990, Earthworks Press (with John Javna and Seth Zuckerman).

"Link Between Emissions, Fuel Economy," *Forum for Applied Research and Public Policy*, spring 1990, pp. 13-18.

Introduction, *50 Simple Things You Can Do to Save the Earth*, 1989, Earthworks Press.

The Decline of Conservation at California Utilities: Causes, Costs, and Remedies, July 1989, NRDC Special Report, (with Ralph Cavanagh).

"Toward a National Energy Policy," *World Policy Journal*, spring 1989, pp. 239-264, (with Ralph Cavanagh, David Goldstein, and Robert Watson).

The Near-Term Potential for Simultaneous Improvements in the Fuel Efficiency and Emissions of U.S. Automobiles. Master's Thesis. Energy & Resources Group: University of California, Berkeley, May 18, 1989.