Summary of Benefits Analyses and Findings in 22 Clean Energy Studies

Study Information			Key Benefit Findings		
Title	**Study Link**	**Summary of Analysis and Methods**	**Energy**	**Emissions, Air Quality, and Health**	**Economic**
The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest	SWEEP (2002)	**Analysis.** Analyzes benefits from $9B invested in EE in homes and businesses in the Southwest from 2003-2020 by comparing a BAU scenario to a "High Efficiency" scenario. "High efficiency" assumes widespread adoption of cost-effective, commercially available EE measures that would reduce electricity consumption by 18% by 2010 and 33% by 2020. **Methods.** Residential and commercial cost-effective energy savings modeled with DOE-2.2. Industrial cost-effective energy savings potential modeled with LIEF. Energy cost savings and avoided emissions modeled with NEMS. Macroeconomic effects modeled with IMPLAN.	➢ Avoid $10.6B capacity investment (thirty-five 500 MW plants) ➢ Avoid $25B electricity supply costs per year by 2020 ➢ Avoid $2.4B end-use natural gas cost per year by 2020	➢ Reduce CO_2 emissions by 26% ➢ Reduce SO_2 emissions by 4% ➢ Reduce NO_X emissions by 5% per year All percent change estimates are relative to 2020 baseline emissions	➢ Increase regional employment by 0.45% (58,400) FTE jobs per year versus 2020 baseline ➢ Increase salary income by $1.34B per year versus 2020 baseline
The Economics of Solar Power for California	Cinnamon et al. (2005)	**Analysis.** Analyzes benefits of the *Million Solar Roofs* initiative from 2007 - 2016, which seeks to install 3000 MW of solar on CA roofs by the end of 2016 - currently there are about 84.3 MW installed. Analysis covers retrofit and new construction applications. **Methods.** Infrastructure and emission savings based on E3 Avoided Cost model. Primary analysis performed with Million Solar Systems Model, based on solar market data from CEC and CPUC.	➢ Avoid $7.1M capacity infrastructure costs (3,000 MW of peak capacity)	➢ Avoid $5,526M in emission costs, including NO_X and CO_2	➢ Additional $0.50 economic activity in CA per $1 invested; 40 FTE jobs in CA per MW
Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California	Stoddard et al. (2006)	**Analysis.** Analyzes benefits of concentrating solar power (CSP) for CA for two deployment scenarios: $7B and $13B invested (2100 MW and 4,000 MW) from 2008-2020. Emphasized in-state impact of employment created from manufacture, installation, and operation of CSP plants. **Methods.** CSP performance and cost analyzed with Excelergy. Displaced emissions estimated with emission factors from California Air Resources Board. Macroeconomic effects modeled with RIMS II.	➢ CSP scenarios avoid between 8%-18% of peak electricity demand growth by 2020 ➢ 4000 MW of CSP avoid $60M per year of natural gas costs in CA	Each 100 MW of CSP avoids (per year): ➢ 7.4 tons of NO_X emissions ➢ 2.6 tons of VOCs ➢ 191,000 tons of CO_2	➢ Each dollar spent on CSP yields direct and indirect impact of $1.40 to GSP ➢ Each 100 MW of CSP yields 94 permanent jobs

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Economic Impact of Oil and Natural Gas Conservation Policies	REMI (2004)	**Analysis.** Analyzes benefits of oil and natural gas conservation programs in CT that encourage installation of EE equipment. Three scenarios analyzed from 2005-2020: oil program, gas program, combined programs. Oil and gas programs expected to avoid 1.89 and 2.07 $MMTCO_2e$ by 2020, respectively. Program funded by a 3% natural gas and oil-use surcharge. **Methods.** Macroeconomic effects modeled with REMI. Public health effects from avoided emissions estimated with EPA's COBRA model.			Net benefits from 2005-2020 include ($1996): ➢ 2,092 average annual jobs ➢ $3.1M output ➢ $2.03M GSP; ➢ $1.8M real disposable income
Assessment of Energy Efficiency Potential in Georgia: Final Report	Jensen and Lounsbury (2005)	**Analysis.** Analyzes benefits of EE in GA from 2005-2015 for three investment scenarios: minimally, moderately, and very aggressive. Analysis included four main parts: collect GA energy profile data; estimate EE potential; estimate benefits; review policy options to achieve EE potential. **Methods.** EE potential modeled with ICF's EEPM. Direct energy cost savings modeled with ICF's IPM. Macroeconomic effects modeled with Georgia Economic Modeling System (GEMS). Public health effects estimated with EPA's COBRA model.	➢ Avoided generation in 2010 ranges from 1,207-4,749 GWh; ➢ Regional wholesale electricity costs reduced by 0.5% - 3.9% by 2015 ➢ Reduce peak demand 1.7% - 6.1% by 2015	➢ CO_2 emission reduced 0.6% - 2.4% ➢ SO_2 emissions reduced 0.2% - 1.3% ➢ NO_X emissions reduced 0.3% - 1.9% All estimates versus 2010 baseline.	➢ 1.6 - 2.8 job impact per $1M net benefit ➢ Generate 1500 – 4200 net jobs by 2015 ➢ Increase personal income $48 - $157M by 2015
The Economic and Environmental Impacts of Clean Energy Development in Illinois	Bournakis et al. (2005)	**Analysis.** Analyzes benefits of IL *Sustainable Energy Plan*: RE supplying 8% of generation by 2012, 16% by 2020; Reduce load 16% by 2020 with EE; 1570 MW of CHP by 2020; 2000 MW of IGCC by 2020. Measures analyzed separately and collectively. **Methods.** Emission savings assume displacement coal-fired electricity, and estimated with emission factors and other EIA, EPA, DOE, and EPRI data. Macroeconomic effects modeled with ILREIM.		By 2020, avoid: ➢ 0.4 million tons per year (mtpy) of SO_x ➢ 0.2 mtpy of NO_X ➢ 90.1 mtpy of CO_2	By 2020, increase: ➢ output 2.12%, ➢ income 1.83% ➢ employment 1.85% (191,000 net new jobs)

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Job Jolt: The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland	Hewings and Yanai (2002)	**Analysis.** Analyzes benefits of implementing the *Repowering the Midwest Clean Energy Development Plan* for a 10-state region in the Midwest that includes reducing electricity demand by 28% by 2020 with EE, and diversifying towards RE and CHP generation over a 20-year period. **Methods.** Analysis performed with Census and other data, and econometric I-O models developed by REAL at the University of Illinois.			By 2020: ➢ Over 200,000 net new jobs ➢ $19.4B increase in regional economic output
2002 Energy Efficiency Activities: A Report by the Division of Energy Resources	DOER (2004)	**Analysis.** Analyzes benefits of $138 million of ratepayer-based EE investments during 2002 and cumulative EE investments from 1998-2002. Analyzes annual and lifetime benefits to participants and all consumers. **Methods.** Energy cost savings, energy system benefits, emission savings estimated with actual program data, ISO-NE data, other data, DOE's Energy 2020, and a bid-stack model. Macroeconomic effects modeled with REMI.	➢ $19.4M savings from 1998-2002 ($5.9M for 2002 only) due to lower wholesale electricity prices ➢ 0.5% (48 MW) peak demand reduction in 2002.	2002 emission reductions: ➢ 394 tons SO_2 ➢ 135 tons NO_X ➢ 161,205 tons CO_2; Lifetime effect of 2002 actions: ➢ 5,516 tons SO_2 ➢ 1,890 tons NO_X ➢ 2,256,870 tons CO_2	In 2002: ➢ 1,778 new jobs ➢ $139M in GSP ➢ $79M disposable income Lifetime effect of 2002 actions ➢ 315 permanent jobs, ➢ $22M GSP ➢ $15M in income
The Public Benefit of Energy Efficiency to the State of Massachusetts	Bernstein et al. (2002)	**Analysis.** Analyzes retrospectively the benefits of EE in MA from 1977-1997 and projects future benefits through 2015. Study does not establish a link between actual government EE programs and changes in EE. **Methods.** Uses an econometric model. Changes in energy intensity used to approximate efficiency changes by controlling for sector composition, energy prices, new capital, and climate.		In 1997, past EE avoided: ➢ 2.0M tons of CO2 ➢ 11,000 tons of SO_2 ➢ 4,000 tons of NO_X Versus 1997 baseline	➢ From 1977-1997 EE produced $1,644 - $2,562 in per capita GSP ➢ $323 - $2,322 additional per capita gains by 2015.

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The Work that Goes Into Renewable Energy	Singh and Fehrs (2001)	**Analysis.** Analyzes labor requirements for renewable energy deployment in the U.S. Labor estimates from construction, installation, and O&M only account for direct effects – indirect multiplier effects no examined. Study not specific to any particular state. **Methods.** Used survey information, not based on a model. Authors collected primary employment data from companies in the RE and coal sectors. Accounts for jobs in manufacturing, transport, delivery, construction, installation, and O&M. Includes a comparison with coal power.			Job effects: ➢ 35.5 person-years per MW of solar ➢ 4.8 person-years per MW of wind ➢ 3.8-21.8 person-years per MW of biomass co-firing ➢ 5.7 person-years per $1M solar or wind cost over 10 years
Electric Energy Efficiency and Renewable Energy in New England: An Assessment of Existing Policies and Prospects for the Future	Sedano et al. (2005)	**Analysis.** Analyzes benefits of EE and RE in New England from Public Benefits Funds and RPS programs. Study assumes current policies change only as planned, through 2010 – does not cover unplanned scenarios. **Methods.** Used actual and estimated data on program expenditures and savings. Air quality, emission benefits estimated with OTC's Emission Reduction Workbook. Macroeconomic effects modeling with IMPLAN.	➢ In 2004, EE reduced peak demand by 1,421 MW	From 2000 – 2010, avoid: ➢ 31.7M tons (6%) of CO_2 ➢ 34,200 tons of SO_2 ➢ 22,039 tons of NO_X	From 2000 – 2010, net increase of: ➢ $6.1B economic output ➢ $1.04M wage income ➢ 28,190 job years
New Jersey's Clean Energy Program: 2005 Annual Report	N.J. BPU (2006)	**Analysis.** Analyzes benefits of New Jersey's *Clean Energy Program*, which includes strategies to increase EE and RE. Analyzes annual and lifetime impact of measures installed in 2005. By 2008, program seeks to have 6.5% of NJ electricity provided by RE. By 2012, program seeks to have 785,000 MWh and 0.6 mcf of natural gas saved per year from EE. **Methods.** Not detailed in report.		Avoided emissions from 2005 activities, for 2005-2020: ➢ 13.2M tons of CO_2 ➢ 46,317 tons of SO_2 ➢ 21,813 tons of NO_X	
New York Energy $mart[sm] Program Annual Report for 2005 - Program Evaluation and Status Report	NYSERDA (2006)	**Analysis.** Analyzes annual and lifetime benefits of the New York *Energy $mart Program* for activities completed through 2005 – total investment of $1.2 billion, and 1,950 GWh annual electricity savings. Program consists of EE, RE, load management, and R&D initiatives. **Methods.** Outlay and energy savings estimated primarily using actual program data. Macroeconomic effects modeled with IMPLAN.	➢ From 1999 – 2005, 1,040 MW reduction in peak demand	Actions to date avoid (per year): ➢ 1.4 million tons of CO_2 ➢ 3,170 tons of SO_2 ➢ 1,750 tons of NO_X	From 2008-2017, actions to date yield (per year): ➢ Average of 4,100 jobs ➢ $182M labor income ➢ $244M output

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Economic Impacts of Oregon Energy Tax Credit Progams: BETC/RETC	Grover (2005)	**Analysis.** Analyzes annual and lifetime benefits of Oregon's business energy tax credit (BETC) and residential energy tax credit (RETC) program activities in 2003 ($30.9 million invested, $27.9 million energy cost savings in 2003). RETC/BETC provides tax credits for EE purchases, RE installation, hybrid vehicles, or other energy projects. **Methods.** Macroeconomic effects modeled with IMPLAN.			For every $1M in energy savings, programs generate *annually*: ➢ $1.1-$1.5M increase in output ➢ 11-13 jobs ➢ $352-$433k increase in wages
Economic Impact of Renewable Energy In Pennsylvania	Pletka (2004)	**Analysis.** Analyzes benefits of implementing a 10% RPS in PA over the period 2006-2025, which would require $4.68 billion direct investment. A statewide renewable energy supply curve was created to determine the least-cost portfolio. **Methods.** Study used a simple linear model with publicly available data, and BEA's RIMS II model to estimate macroeconomic effects.			Over 2006-2015 period: ➢ Increase output $10.1B ➢ Increase earnings $2.8B ➢ Create 85,000 jobs
Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP): September 2003 - August 2004	Haberl et al. (2004)	**Analysis.** Analyzes benefits of the *Texas Emissions Reduction Plan* (TERP), which promotes EE and RE measures to meet Federal ambient air quality standards. The Texas Commission on Environmental Quality implements the program. **Methods.** Analysis performed with data from the TCEQ and EPA, including eGRID, to estimate the energy savings and NO_X reductions from energy code compliance in new residential construction.		NO_X emissions reduced by: ➢ 346 tons per year in 2004 ➢ 824 tons per year in 2007 ➢ 1,416 tons per year in 2012	
Ancillary Benefits of Reduced Air Pollution in the United States from Moderate Greenhouse Gas Mitigation Policies in the Electric Sector	Burtraw et al. (2001)	**Analysis.** Analyzes benefits of GHG and criteria pollutant mitigation, including the value of health impacts from air quality changes. Analyzes various carbon-tax scenarios from 2000-2010. **Methods.** Used Haiku electricity model to simulate effects on retirement and system dispatch. Emission changes translated into health effects with damage functions and TAF atmospheric transport model. Concentration-Response functions used to estimate health endpoints.		➢ NO_X related health benefits in 2010 range from $315 - $408M ➢ NO_X related health benefits *per ton* of carbon emissions reduced, range from $7.5 - $13.2 dollars	

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Redirecting America's Energy: The Economic and Consumer Benefits of Clean Energy Policies	Nayak (2005)	**Analysis.** Analyzes benefits of two potential policies: national 20% RPS by 2020, and 20% RPS with reallocation of $35 billion of fossil fuel and nuclear subsidies to EE and RE. **Methods.** Analysis used regional forecast data from EIA and other sources, along with IMPLAN to estimate macroeconomic effects.		20% RPS with reallocation avoids: ➢ 634M tons of CO_2 ➢ 1.9M tons of SO_2 ➢ 0.8M tons of NO_X By 2020 versus baseline.	20% RPS with reallocation achieves, by 2020: ➢ 154,589 net annual new jobs ➢ $6.8B net increase in wages ➢ $5.9B average annual net increase in GDP
An Approach to Quantifying Economic and Environmental Benefits for Wisconsin's Focus on Energy	Sumi et al. (2003)	**Analysis.** Analyzes benefits of Wisconsin's *Focus on Energy* program, which encourages EE investment and fosters EE and RE markets. Analyzes benefits of the program's first year and forecasts next 10 years. **Methods.** Macroeconomic effects modeled with REMI. Emission savings estimated using emission factors from plant-specific emissions and operations-related hourly data, which are applied to the program's energy savings.		Reduce emissions by: ➢ 110,045 tons per year of CO_2 ➢ 445 tons per year of SO_2 ➢ 264 tons per year of NO_X	Cumulatively over 2001-2010: ➢ Increase business sales $1.5B ➢ Increase GSP $0.9B ➢ Increase disposable income $0.8B ➢ Generate 18,956 job-years

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The Economic Impact of Energy Efficiency Programs and Renewable Power for Iowa	Weisbrod et al. (1995)	**Analysis.** Analyzes benefits of Iowa EE programs and RE power facilities from 1995-2015. Analysis included EE and RE scenarios: EE assumed programs continue or are phased out; RE assumes large-scale wind under alternative assumptions about adoption and cost. **Methods.** Program cost and savings, including RE cost and productivity, estimated using program survey data. Macroeconomic effects modeled with REMI.			EE achieves: ➢ 25 job-years for every $1M invested ➢ $1.50 of disposable income for every $1 invested Biomass achieves: ➢ 84 job-years per $1M invested ➢ $1.45 disposable income per dollar invested Wind achieves 2.5 job-years per $1M invested.
Increasing the Texas Renewable Energy Standard: Economic and Employment Benefits	Deyette and Clemmer (2005)	**Analysis.** Analyzes benefits of increasing Texas' current RPS (requiring 2.7% of sales from new renewable energy by 2009) to a requirement of 20% renewable energy by 2020. The study also analyzes a more modest increase to about 8% renewable energy by 2025. **Methods.** Impacts on electricity and natural gas prices and consumer energy bills were examined using the Department of Energy's National Energy Modeling System (NEMS) model. Macroeconomic impacts were quantified using IMPLAN. Expenditure breakdown and local share data for wind projects were based on NREL's Jobs and Economic Development Impacts (JEDI) model.	By 2025, the 20% RPS achieves: ➢ 9% reduction in average electricity prices ➢ 3% reduction in natural gas prices ➢ Residential solar heating systems that offset 390 MW of peak capacity	By 2025, the 20% RPS avoids: • 20 million metric tons of CO_2 emissions	By 2020, the 20% RPS achieves: • $950M additional income • $440M increase in GSP • 24,650 net new jobs (2.8 times more jobs than with fossil fuels)

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The Washington Clean Energy Initiative: Effects of I-937 on Consumers, Jobs and the Economy	Deyette and Clemmer (2006)	**Analysis.** Analyzes benefits of an RPS that would support 1,300 average megawatts (avgMW) of renewable sources by 2025, along with 1,000 avgMW of cost-effective energy efficiency from 2010 – 2025. The analysis compares the clean energy initiative with a reference case in which no further energy efficiency and renewable energy investments are made after 2009. **Methods.** Effects on electricity rates, total resource costs, and consumer electricity bills were examined using a spreadsheet model. Macroeconomic impacts were analyzed using IMPLAN. Expenditure breakdown data for construction, O&M of renewable plants was based on a variety of sources, including state and federal agencies, renewable developers, utilities, and NREL's Jobs and Economic Development Impacts (JEDI) model.	The set of efficiency measures developed under the initiative achieve: ➢ An average savings of $0.54 cents/kWh due to avoided T&D ➢ Avoided construction of six natural gas power plants, operating at an average capacity of 165 MW each.	By 2025, the initiative avoids: ➢ 4.6 million metric tons of CO_2 emissions	By 2025, the initiative achieves: ➢ $138M additional income ➢ $148M increase in GSP ➢ $30M in income to rural landowners ➢ 1,230 net new jobs in the year 2025 (2.6 times more jobs than would be created using fossil fuels)