Table 1. Measuring Energy-Based Job Creation

Assessment Category	Reference	Economic Impact Results	Energy Technology Evaluated	Pre/Post	Region Examined
Jobs per energy output	Sastresa (2009) [36]	Jobs per megawatt: 0.86 wind 43 solar thermal 38 photovoltaic 1.38 total weighted average	Wind & solar (thermal/photovoltaic)	Post	Aragon, Spain
	Moreno & Lopez (2008) [40]	Wind (13.2 jobs/MW) Solar-thermal (7.5 jobs/1000m2) Solar-photovoltaic (37.3 jobs/MW peak) Biofuels (6.5 jobs/1000 tons/year) Hydroelectric (20 jobs/MW) Biomass-thermal (0.121 jobs/tep) Biomass-electric (4.14 jobs/MW) Biogas (31 jobs/MW)	Wind, solar thermal & photovoltaic, biofuels, Hydroelectric, biomass thermal & electric, biogas	Pre	Asturias, Spain
	Simons & Peterson for the Electric Power Research Institute and California Energy Commission (2001) [41]	Jobs per megawatt: Wind (2.57 constr., 0.29 O&M) Geothermal (4.00 constr., 1.67 O&M) Biomass (4.29 constr.,1.53 O&M) LFG/Biogas (3.71 constr., 2.28 O&M) Solar thermal (5.71 constr., 0.22 O&M) Solar photovoltaic (7.14 constr., 0.12 O&M) Small hydroelectric (5.71 constr., 1.14 O&M)	Wind, geothermal, LFG-biogas, biomass, solar thermal, solar photovoltaic, small hydroelectric	N/A	California
	Pedden for the National Renewable Energy Laboratory (2006) [42]	Meta-analysis of 13 existing studies found that jobs-per-megawatt ratio of wind in rural communities is highly variable, ranging from 0.36 to 21.37. Ratio appears highly dependent on existing skills in the community.	Wind	N/A	United States
	Kammen, Kapadia, & Fripp (2006) [43]	Total average employment for energy technology (both manufacturing and installation and ongoing O&M): Photovoltaic, 7.41–10.56 jobs per MWa Wind, 0.71–2.79 jobs per MWa Biomass, 0.78–2.84 jobs per MWa (MWa refers to average installed megawatts derated by specified capacity factor of the technology.)	Photovoltaic, wind, biomass	N/A	United States

Assessment Category	Reference	Economic Impact Results	Energy Technology Evaluated	Pre/Post	Region Examined
Jobs per energy output + other factors	Blanco & Kjaer (2009) [44]	Data from 2007: 15.1 jobs created per megawatt of installed capacity Additional 0.4 jobs per megawatt of cumulative capacity in O&M and other activities Modeling efforts predicted wind capacity to grow from 55 GW in 2007 to 300 GW in 2030, with a resultant doubling effect of direct wind energy employment (from 154,000 to 377,000 employees)	Wind	N/A	European Union
	Calzada Álvarez (2009) [37]	Each "green" megawatt installed destroys 5.28 jobs, on average, elsewhere in the economy: 8.99 by photovoltaics 4.27 by wind energy 5.05 by mini-hydroelectric Since 2000, Spain has spent €571,138 to create each "green job," including subsidies of more than €1 million per wind industry job. Associated programs resulted in the destruction of nearly 110,500 jobs elsewhere in the economy, or 2.2 jobs destroyed for every "green job" created.	Photovoltaic, wind, small hydroelectric	Post	Spain
	Singh & Fehrs (2001) [45]	Solar (2-kw plant) = 35.5 person years per megawatt Wind (37.5-MW plant) = 4.8 person years per megawatt Biomass co-firing (100–750 MW)= 3.8–21.8 person years per megawatt If impact is calculated per monetary unit invested, the effect of renewable energy sources on the creation of employment is around 1.4 times greater per $1 million invested than in a coal-fired thermal power station over the same period of time.	Wind, solar photovoltaic (small scale), biomass co-firing	Pre	United States
Total Jobs	Bezdek for the American Solar Energy Society. (2007) [46]	Base case scenario: RE jobs increase 190% from 2006 levels, from 446,000 to 1.3 million; EE jobs increase 85%, from 8 million to 15 million Moderate case scenario: RE jobs increase 600%, to 3.1 million; EE jobs increase 122%, to 17.8 million Advanced scenario: RE jobs increase 1,700%, to 7.9 million; EE jobs increase 300%, to 32 million	Wind, solar, hydroelectric, biomass, geothermal, biofuels, energy efficiency	Pre	United States

Assessment Category	Reference	Economic Impact Results	Energy Technology Evaluated	Pre/Post	Region Examined
	Prepared for Gridwise Alliance by KEMA, Inc (2009) [47]	Potential disbursement of $16 billion in smart grid incentives projected to catalyze smart grid projects worth a total of $64 billion. Projects would lead to 280,000 jobs in the deployment stage, with 140,000 new direct jobs becoming permanent, ongoing positions.	Smart grid technologies	Pre	United States
	Lehr, Nitsch, Kratzat, Lutz, & Edler (2008) [48]	Model predicts overall employment impact to be positive, with a projection of 400,000 employees in the renewable energy industry in Germany in 2030.	The whole industry of technologies for the use of renewable energy, including heat systems and biofuels	Pre	Germany
	Wei, Patadia, & Kammen (2010) [35]	Many scenarios are discussed and conclusions drawn in the modeling efforts, highlighted most notably by the following: A national Renewable Portfolio Standard of 30% by 2030, coupled with a "moderate EE scenario" (0.37% reduction in annual energy consumption), can create over 4 million job-years beyond business as usual Increasing nuclear generation to 25% and CCS to 10% of total generation can generate an additional 500,000 job-years	Renewable energy, energy efficiency, CCS, nuclear power	Pre	United States
	Algoso & Rusch for the NJPIRG Law and Policy Center, 2004 [49]	Installed capacity of 10,200 MW of wind energy projected to create equivalent of 11,100 year-long jobs in manufacturing and installation, 740 permanent O&M jobs, and 12,700 indirect jobs. Jobs/MW ratio: 2.48.	Wind	Pre	Maryland, Delaware, New Jersey, Pennsylvania
Total Jobs + other factors	Hillebrand, Buttermann, Behringer, & Bleuel. (2006) [50]	Expansive effect found from increases in renewable energy installation and contractive effect resulting from an increase in production cost of power. An estimated increase of 33,000 new jobs is expected in 2004; however, the contractive effect offsets these gains, and ultimately the net job balance in 2010 will be slightly negative (−6,000 jobs).	Renewable energy technologies eligible for German Feed-in Tariff, 2004–2010	Pre	Germany
	Laitner & McKinney (2008) [34]	The studies reviewed show an average 23% efficiency gain with a nearly 2-to-1 benefit–cost ratio. This set of studies suggests that a 20–30% gain in energy efficiency estimated within the U.S. economy might lead to a net gain of 500,000–1,500,000 jobs by 2030.	--	Pre	United States

Assessment Category	Reference	Economic Impact Results	Energy Technology Evaluated	Pre/Post	Region Examined
	Roland-Holst (2008) [32]	From 1972 through 2006, California energy efficiency measures have allowed state residents to redirect their spending to other goods and services in the economy, creating the equivalent of approximately 1.5 million full-time jobs (total payroll $45 billion) and household energy savings of $56 billion. For every 1 job lost in the energy supply chain, more than 50 have been created economy-wide. Looking forward, 100% compliance with Assembly Bill 32 greenhouse gas emissions regulations is projected to increase gross state product by $76 billion and create more than 400,000 new efficiency and climate action–driven jobs. The first 1.4% of annual efficiency gains estimates the creation of 181,000 additional jobs, with an additional 1% yielding 222,000 more.	Economy-wide analysis, not limited to specific set of technologies	Pre and Post	California
	Williams, Acker, Goldberg, & Grevel (2008) [51]	For a 60-MW wind project in Coconino County, the estimated range of construction jobs (90% likelihood) was found to be 59–149. Ongoing O&M jobs were projected at 26–42. During the construction phase, estimated local economic activity generated by the wind project was found to be $4.3–11.2 million annually; during O&M this activity was projected at $0.78–1.32 million. Differences in local economies between Coconino and Navajo counties led to slight to moderate variances in results for Navajo County.	Wind	Pre	Navajo and Coconino counties, Arizona
Gross Domestic Product	Ragwitz, Schade, Breitschopf, et. al. (2009) [52]	Current European Union RE policies could result in an increase of gross domestic product (GDP) of 0.11–0.14% by 2020, and 0.15–0.30% by 2030. More aggressive policy assumptions could increase GDP by 0.23–0.25% by 2020 and 0.36–0.40% by 2030 (including moderate exports of RE technologies). As far as employment, jobs would be stimulated by Renewable Energy Standard policies, but the results should be expected to be more moderate than the GDP effects.	All renewable energy technologies with European applications (or European manufacturing potential)	Pre	European Union

Assessment Category	Reference	Economic Impact Results	Energy Technology Evaluated	Pre/Post	Region Examined
Multipliers	MacGregor & Oppenheim (2008) [33]	Investing in low-income energy efficiency was calculated to have an average local economic multiplier of 23 in the states evaluated, an estimated 2.7 times greater than the multiplier of an equal investment in the local manufacturing sector.	Energy efficiency	Pre	Arkansas, Louisiana, Texas, Mississippi,

CCS, carbon dioxide emissions capture and sequestration; constr., construction; EE, energy efficiency; GW, gigawatt; LFG, landfill-derived gas; MW, megawatt; N/A, not applicable; O&M, operations and maintenance; RE, renewable energy; RES, renewable energy standard.