Reinventing Fire Jobs Model Methodology

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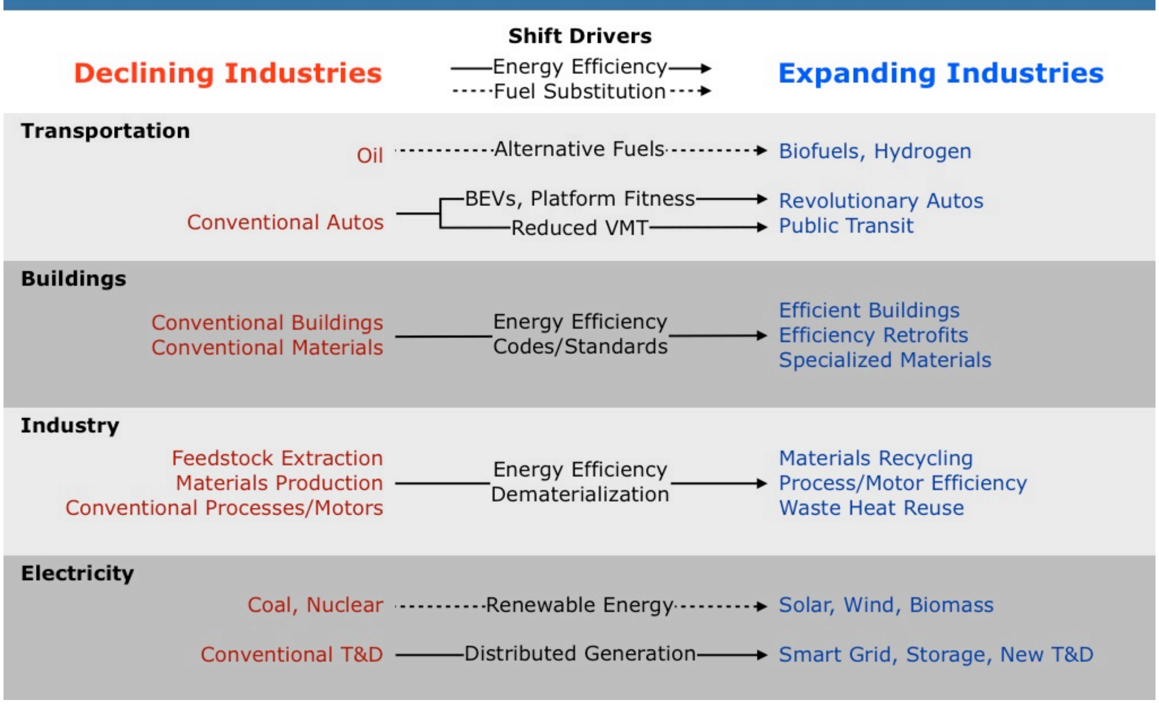
The Reinventing Fire (RF) jobs analysis examines how the RF vision affects job **quantity** and **quality** across sectors.

Identifying Declining and Expanding Industries

Examining the strategies laid out in RF, the outcomes and industries shown in figure 1 were identified as having a potentially large jobs impact and are the focus of the RF jobs analysis. Industries shown in figure 1 are organized by sector and separated into those thought to be declining or those likely to expand with RF outcomes. Drivers for the shift from declining to expanding industries are also shown and fit into two categories: 1. Improved efficiency and 2. Fuel substitution by renewables.

Major RF job impacts and their drivers were identified



Types of RF Job Creation

Both of the drivers noted in the previous section—efficiency and fuel substitution—can create jobs; they can also lead to job loss in other industries.

Job creation or loss can be considered on three levels: direct (onsite), indirect (suppliers), and induced (respending).

Energy efficiency creates jobs on all three levels. The initial investment in efficiency creates jobs for the providers of that efficiency on the direct and indirect level. At the third level, avoided energy expenditures yield extra disposable income. As these savings are respent, they create additional (induced) jobs across the economy.

In our analysis, fuel substitution's job creation is examined primarily on the first two levels, but the third level also requires consideration. Jobs are created for manufacture, operations, and maintenance of renewable energy production facilities. For the net jobs impact, avoided jobs for conventional, non-renewable energy are accounted for too. Fuel substitution induced jobs include losses resulting from increased electricity prices and gains due to decreased mobility expenditure (see transportation and electricity sector-specific methodology below for more details).

Quantitative Methodology for Estimating Net Job Creation

To estimate the net quantitative effect on U.S. jobs of the strategies employed in RF, we primarily use a jobs multiplier approach. Jobs multipliers measure the amount of jobs created for a given increment of investment, revenue or industry output—for example jobs created per million dollars of investment, or jobs created per megawatt-hour of power generation. Multiplier values vary depending on the industry, the output, and how the output is produced (e.g., renewable vs. fossil-fueled or nuclear generation).

Multipliers give job creation numbers, but generally do not give the *net* jobs impact that accounts for any job loss that may be created by an investment. For example, investing in biofuel production displaces oil production and the jobs it creates. To account for these job losses, the avoided output or investment in a given industry is used to estimate job loss; subtracting this value from job creation gives us the net jobs impact.

Using this method, jobs are measured in job-years, defined as full-time employment for one person for one year. Job-years are then averaged over the 40-year RF implementation period, from 2010 to 2050 (although many investments made 2050 would continue to provide further employment after 2050, so not counting them understates total job-years created). For example, an investment in building efficiency creating 5,200,000 job-years equates to 130,000 new jobs for the 40 years.

Multipliers values were taken from a variety of literature sources. We used the different multiplier assumptions to estimate a range of jobs estimates. Sources were based on both bottom-up and input/output analyses. For consistent comparison between sources, it is important to note which job impact levels—direct, indirect, and induced—are included and excluded from each source. Where multipliers were used from more than one literature source, the calculated numbers of jobs were averaged across sources.

Quantitative methodology notes and sources for each sector are given in table 1 below.

Transportation Sector
Quantitative Notes and Sources

	Notes	Sources
Baseline	Calculated by summing direct employment data in transportation-related industries affected by RF.	[1],[2], RMI Analysis
Oil Industry	Current refining and distribution jobs[2] are eliminated by 2050; however, some some may be retained to make feedstocks and lubricants not counted in RF.	[2]
VMT Reduction	RMI estimated auto-industry employment reductions due to RF VMT reductions to be as follows: –25% manufacturing, 0% retail, –50% parts, –50% repair. Error bars for each occupation type were assumed to be ±25% applied to each individual occupation type. RMI found no relevant and reliable jobs multipliers in the literature.	RMI Analysis
Efficient Autos	Calculated using jobs multipliers[4] and auto industry revenue increase taken from RMI transportation sector consumer adoption model. An ORNL study[3] also predicts a revenue increase.	[3],[4]
Biofuels	Calculated using hydrogen[5] and second-generation biofuels[6,7] jobs multipliers and respective RF production volumes.	[5],[6],[7]
Induced	Calculated using jobs multipliers for transportation-sector energy and avoided expenditures taken from RMI transportation-sector consumer adoption model.	[8].[9].[10]

Buildings Sector
Quantitative Notes and Sources

	Notes	Sources
Baseline	The building construction industry employs over 4 million workers, 2% of whom are estimated to be focused on building efficiency.	[8]
Building efficiency industry growth	Calculated using jobs multipliers and the RF buildings efficiency investment made beyond business-as-usual levels.	[8],[9],[11]
Induced	Calculated using jobs multipliers for building sector energy and expenditure savings.	[10],[12],[13]

Industry Sector
Quantitative Notes and Sources

	Notes	Sources
Baseline	~32 million of the total 150 million U.S. workforce is employed in industry—a much broader category than the other sectors.	[12]
Industrial efficiency industry job growth	Calculated using jobs multipliers for the RF industrial efficiency investment to be made beyond business-as-usual levels.	[8],[9]
Induced	Calculated using jobs multipliers for industry-sector energy and expenditure savings. The literature doesn't focus much on industrial efficiency-induced jobs, so we believe the uncertainty may be understated here.	[8],[9],[11]

Electricity Sector
Quantitative Notes and Sources

	Notes	Sources
Baseline	Calculated using electricity production and electricity sector multipliers[11] and verified using data from the Bureau of Labor Statistics.[2]	[11]
Reduced demand	Calculated using jobs multipliers[11] for the *Transform* scenario. In *Transform*, demand is reduced by ~28%, even after including new demand from electric vehicles.	[11]
Coal and nuclear	RF *Transform* scenario will eliminate the remaining (after 28% demand reduction) coal and nuclear generation by 2050. (Coal and nuclear jobs are still shown in the RF portfolio column due to 2010–2050 job-year averaging.)	[11]

Replace w/ RF portfolio	Calculated using jobs multipliers[11] and the *Transform* generation portfolio. The result is especially sensitive to the solar jobs multiplier, and it is noteworthy that the averaged result shown is in agreement with a National Renewable Energy Laboratory study suggesting a 50% job intensity reduction by 2025[14].	[11],[14]
Induced	Conservatively using engineering economics rather than financial economics that properly account for relative risk,*Transform* is expected to increase electricity prices somewhat, though they would also become far more stable. Externalities aside, consumers have less disposable income than had they invested in efficiency only without adopting the *Transform* portfolio. This results in reduced spending throughout the rest of the [more job-intensive] economy, thus reducing employment.[15] This reduction is calculated using jobs multipliers[10,11] and the system cost increase modeled in the National Renewable Energy Laboratory's ReEDS model.	[10],[11],[15]

QUALITATIVE METHODOLOGY—ASSESSING OPPORTUNITY DISTRIBUTION AND STABILITY

The quality of these jobs is also important. Job quality can be defined in many ways; based primarily on the job quality discussion we found in the literature, the RF analysis utilized the following criteria to assess job quality impacts for each of the industries and drivers noted in fig 1.

We examined the distribution of opportunity among job types, including the spread of occupations, skills, and salaries that characterize an industry's workforce. For example, 97% of U.S. jobs created since 1990 have been in non-manufacturing industries—a trend that has resulted in fewer exported goods and greater polarization of wages. Better-distributed job growth—by category, occupation, training level, and location—could counteract this trend.

We examined the distribution of opportunity amongst communities, regions, and businesses, since some outcomes favor urban or rural communities or certain geographical regions. Relatively new business opportunities in efficiency and renewables can support and require entrepreneurism, and often favor small-business development that is the main engine of U.S. job creation and of much socioeconomic advancement.

We examined the stability of these opportunities, including resistance to offshoring and the expected duration of employment. Manufacturing jobs have historically faced offshoring and labor intensities reductions by technological innovation and increased productivity. Such onsite jobs as construction, installation, and operations and maintenance are either inherently stable or not easily outsourced. However some of these are contracted, providing only temporary or short-term employment.

We also examined the likely training needs and the feasibility of the necessary investments in skills/education required to meet job demand in an industry. Varying retraining efforts are required to sustain job shifts between industries. If training is inadequate, a shortage of qualified labor can prevent growth in an industry.

The sources we found most useful for each RF sector are shown in table 2.

Qualitative Sources	
Transportation	[4],[7],[16],[17]
Buildings	[11],[17],[18]
Industry	None
Electricity	[17],[19],[20],[21],

[1]Bureau of Labor Statics. 2010a. *Automotive Industry: Employment, Earnings, and Hours*. U.S. Department of Labor. http://www.bls.gov/iag/tgs/iagauto.htm.

[2]———. 2010b. U.S. Department of Labor. http://www.bls.gov/.

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[4]Baum, A., and D. Luria. 2010. *Driving Growth: How Clean Cars and Climate Policy Can Create Jobs*. Natural Resources Defense Council.

[5]DOE. 2008. *Effects of a Transition to a Hydrogen Economy on Employment in the United States*. Report to Congress. U.S. Department of Energy, July. www.hydrogen.energy.gov/pdfs/epact1820_employment_study.pdf.

[6]APEC. 2010b. *A Study of Employment Opportunities from Biofuel Production in APEC Economies*. Asia-Pacific Economic Cooperation, February. www.biofuels.apec.org/pdfs/ewg_2010_biofuels_employment.pdf.

[7]BERA. 2009. *U.S. Economic Impact of Advanced Biofuels Production: Perspectives to 2030*. Bio Economic Research Association.

[8]Ehrhardt-Martinez, K., and S Laitner. 2008. The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture.

[9]Bezdek, R. H. 2007. *Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century*. American Solar Energy Society. http://www.greenforall.org/resources/renewable-energy-and-energy-efficiency-economic.

[10]Executive Office of the President Council of Economic Advisers. 2009. *Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009*. May. http://www.whitehouse.gov/assets/documents/Job-Years_Revised5-8.pdf.

[11]Goldman, C. 2010. Energy Efficiency Services Sector: Workforce Size and Expectations for Growth.

[12]Laitner, J, and V. McKinney. 2008. *Positive Returns: State Energy Efficiency Analyses Can Inform US Energy Policy Assessments*.

[13]Wei, Max, Shana Patadia, and Daniel M. Kammen. 2010. Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the U.S.? *Energy Policy* 38, no. 2 (February): 919-931. doi:10.1016/j.enpol.2009.10.044.

[14]Friedman, B. 2009. *NREL PV Jobs/Labor Intensity Project*. NREL, November 19. http://irecusa.org/wp-content/uploads/2009/11/Friedman.pdf.

[15]Calzada, G., R. J Merino, J. R J Rallo, and J. I B Garcia. 2009. Study of the Effects on Employment of Public Aid to Renewable Energy Sources. *Universidad Rey Juan Carlos, http://www. juandemariana. org/pdf/090327-employment-public-aid-renewable. pdf*. http://www.juandemariana.org/pdf/090327-employment-public-aid-renewable.pdf.

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[17]White, S., and J. Walsh. Greener Pathways: Jobs and Workforce Development in the Clean Energy Economy. *Center on Wisconsin Strategy*.

[18]Pollin, R., and J. Wicks-Lim. 2008. Job Opportunities for the Green Economy. *PERI*.

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[20]Sterzinger, George, and Matt Svrcek. 2004. *Wind Turbine Development: Location of Manufacturing Activity*. Renewable Energy Policy Project, September.

[21]PEW. 2010a. *Who's Winning the Clean Energy Race?* http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/G-20Report-LOWRes-FINAL.pdf.