

MEASURING THE GREEN ECONOMY

APPENDIX 2

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Economics and Statistics Administration

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Methodology for Estimating Shipments/Receipts and Employment for Green Products and Services

Section A

Estimating Shipments/Receipts and Employment for Green Products and Services Using Economic Census Data

The main data source for this report is the Census Bureau’s Economic Census. The Economic Census measures business activity every five years. Businesses receive a form if they have at least one paid employee and have significant production within their industry area. The Census covers most sectors of the economy. A few sectors, including agriculture, rail transportation, private education, and public administration are not covered. In addition, government-owned establishments are not covered. The most recent Economic Census was taken in 2007, and is the basis for this report. ESA analysts also used results from the previous (2002) Economic Census to measure changes over time in manufacturing.

Data from the Economic Census are classified by industry using the North American Industry Classification (NAICS) system. NAICS codes are the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. economy.

The NAICS industries are further disaggregated into individual, multi-digit product/service codes. ESA analysts selected green product lines by examining these product/service codes.¹ For example, the six-digit NAICS code 333414 — heating equipment (except warm air furnaces) manufacturing — includes 21 product lines. One of the product lines is “solar energy collectors” (product code 333414A136), which ESA analysts determined fit the definition of a green product.

¹ For the purposes of this project, we defined green products or services as those with a predominant function of conserving energy and other natural resources, or reducing pollution. The green product/service definitions and a list of green products and services that were included in the analysis are in the main report. (Available online at <http://www.esa.doc.gov/GreenEconomyReport/>.)

The Economic Census collects direct measures of the dollar value of shipments for manufacturing and sales/receipts for non-manufacturing at the individual products/services level. However, employment is only available at the six-digit NAICS industry level. ESA determined employment by assuming that the share of employment at the six-digit NAICS level accounted for by green products was the same as the share of shipments for that industry accounted for by green products.

However, the sum of the product code shipments in an industry does not exactly equal the level of shipments at the six-digit industry level. This occurs for two reasons. First, the Census Bureau does not report on individual products where there are disclosure concerns. If only a small number of firms in an industry produce a specific product, Census will not disclose shipments of that product in order to maintain the confidentiality of the data source. Second, Census is not able to categorize all shipments for a six-digit industry into the specific product lines of that industry.

ESA analysts computed the share of green shipments by using the sum of the total reported product line shipments in a six-digit industry, rather than the reported total industry shipments. The sum of the green product code shipments as a share of the sum of total product code shipments in an industry then represents the “green share” of that industry. These percentages were then applied to measures of employment at the six-digit NAICS industry level to obtain measures of the employment related to green products/services within each industry.

For example, in NAICS code 333414, the only green product line was the one for solar energy collectors. The sum of all the product code shipments in that industry totaled \$3.5 billion, while solar energy collector shipments were valued at \$36.1 million. The green share of the industry was then about one percent (\$36.1 million divided by \$3.5 billion). ESA analysts assumed that the employment share would be the same, so this one percent was applied to NAICS 333414 employment of 19,247. As a result, ESA analysts calculated that there were 196 green jobs in the industry.

Total green manufacturing shipments are equal to the sum of the value of green product shipments across NAICS industries. Total green employment is equal to the sum of the estimated green employment across NAICS industries.

While ESA analysts were able to follow this method directly for manufacturing, non-manufacturing industries required some additional steps. Non-manufacturing (services) industries available in the Economic Census included utilities; wholesale trade; retail trade; transportation and warehousing; information, finance and insurance; real estate, rental and leasing; professional, scientific, and technical services; management of companies and enterprises; administrative and support; waste management and remediation services; educational services; health care and social assistances; arts, entertainment, and recreation; accommodation and food services; and other services (except public administration).

ESA analysts used the following conventions when analyzing the non-manufacturing (services) sector data. First, for the small group of NAICS codes for which the 4- and 5-digit NAICS codes were equivalent to the 6-digit level, we used the 4- or 5-digit codes. Also, where product codes existed across several industries, we determined whether the product was green by examining

both the product and industry. For example, the product code 30960 (admissions to cultural institutions) is associated with several NAICS industry sectors, such as nature parks and other similar institutions that would be considered green services and historical sites that would not be considered green services.

The results of these calculations using Economic Census data (without the supplemental estimates to be described subsequently) are presented in Table 2A.

Table 2A
Measures of Green Manufacturing and Non Manufacturing
2007 Economic Census Data

	Level		Percent of Total	
	<i>Narrow</i>	<i>Broad</i>	<i>Narrow</i>	<i>Broad</i>
<i>Manufacturing</i>				
Product Shipments (U.S. \$ billions)	40	62	0.9	1.4
Employment (thousands)	123	167	0.9	1.3
<i>Services</i>				
Product Receipts (U.S. \$ billions)	231	326	1.1	1.5
Employment (thousands)	1190	1587	1.3	1.7

Section B

Estimating Supplemental Green Product and Service Shipments/Receipts and Employment

Data available from the Economic Census have limitations for assessing green products and services. First, product codes were not designed to identify the environmental impact of products or services. Second, only products and services that have their own product code can be separately assessed. As a result, there are some products and services that may be generally recognized as green that could not be separately assessed within the current 2007 Economic Census coding framework. This includes products such as alternative fuel vehicles and energy efficient appliances. We attempted to account for certain green products and services not covered in the Economic Census by using other data sources to estimate the sales and employment associated with these products.

ESA analysts relied on data from a number of public and private sources, and gathering and comparing information from such disparate sources was challenging as each green product or service had unique data constraints. These other sources of information often were market share estimates for each of these green products and services. This market share was then applied to the broader NAICS industry or product codes to estimate the value of shipments for these green products and services. Appendix Table 2B contains a range of rough estimates of the receipts and employment supported by these missing green products and services. The methodology and data sources for each green product or service included in Appendix Table 2B are discussed below.

All of the products and services in the supplemental estimates were considered unambiguously green, so these estimates were added to both the narrow and broad category results from the 2007 Economic Census analysis.² The low and high supplemental estimates shown in Table 2B were applied to the narrow and broad categories accordingly. Where we did not have a range of estimates, the same estimate was applied to both the narrow and broad categories of green.

Table 2B
Supplemental Estimates of Green Industries and/or Products, 2007

	Green Share of Total Market (estimated range)		Sales/revenues/ shipments (U.S. \$ millions) (estimated range)		Employment (estimated range)	
	Low	High	Low	High	Low	High
Alternative Fuel Vehicles and Hybrids	6.7%	10.2%	\$29,200	\$44,400	76,400	116,200
Hybrids only	1.8%	2.7%	\$7,600	\$11,600	20,000	30,500
Green Building/Construction Services	3.5%	4.8%	\$36,000	\$49,000	223,600	304,300
Energy Efficient Appliances ¹			\$12,800	\$12,800	96,400	96,400
Manufacturers	40%	40%	\$5,800	\$5,800	68,200	68,200
Appliance Stores	40%	40%	\$7,000	\$7,000	28,200	28,200
Solar Photovoltaics	n.a.	n.a.	\$1,716	\$1,716	6,170	6,170
Organic Agriculture			\$20,600	\$20,600	105,490	105,490
Organic Agricultural Production	0.6%	0.6%	\$1,700	\$1,700	4,258	4,258
Organic Food Retail	3.8%	3.8%	\$18,900	\$18,900	101,232	101,232
Total Supplemental Green Industries and/or Products			\$100,316	\$128,516	508,060	628,560

n.a.- not available

¹ The green share of the total market was computed as a weighted average of five energy efficient appliances (hot water heaters, refrigerators, clothes washers, room air conditioners and dishwashers). The individual market shares for these products ranged from 6% to 77%.

Source: Various government and private data sources as explained in Appendix 2.

Several major green products or services are not included in this analysis because data constraints or measurement issues precluded the estimation of the green market share. A list of

² For the 2007 Economic Census data analysis, we categorized products and services using both a narrow definition and a broad definition of green. The narrow definition includes only those products and services for which ESA analysts assumed there was wide agreement regarding their classification as green. The broad measure includes products and services whose green status may be more open to debate.

these green products and services — e.g., green personal care and beauty products, green IT (energy efficient computers and recycling of equipment), small wind turbines, etc., — is provided at the end of this section.

Alternative Fuel Vehicles and Hybrids³

The demand for alternative fuel vehicles (AFVs) and gas-electric hybrids has expanded as interest in reducing emissions has grown and gasoline prices have risen. AFVs are powered by a variety of sources of energy including hydrogen, ethanol, natural gas and electricity. Hybrids have also grown in popularity because of the energy efficiency they provide while still using conventional gasoline. Foreign automakers continue to dominate the market — specifically Toyota, which produces roughly 75% of total hybrid vehicles.⁴ However, in recent years, domestic auto producers have entered the market, producing hybrid light duty vehicles as well as heavier vehicles, such as sport utility vehicles.

We assume that few U.S. workers were involved in the manufacturing of AFVs and hybrids in 2007. Almost all hybrid vehicles were manufactured outside of the U.S. in 2007. Although there is significant U.S. production of flex-fuel vehicles, very few owners of these use alternative fuels, thus ESA elected to exclude these vehicles from our analysis. ESA estimates, therefore, relate to the retail sales and distribution of AFVs and hybrids.

The size of the AFV market remains small relative to the overall market for light duty vehicles. According to the Department of Energy, 1.3 million AFVs and hybrids were sold in 2007, of which, roughly one-fourth were hybrids.⁵ There are no publicly available data on the dollar value of sales of AFVs and hybrids, therefore, the value of sales were estimated based on a published range of the average cost of hybrids, which was \$23,000 to \$35,000.⁶ In 2007, ESA analysts estimated annual sales of AFVs to be between \$29.2 and \$44.4 billion and sales of hybrids only to be between \$7.6 and \$11.6 billion. Thus, AFVs and hybrids constituted a 6.7% to 10.2% share of U.S. light duty vehicle sales and hybrids alone accounted for 1.8% to 2.7% of the market.⁷

Employment related to the AFV market is difficult to estimate. While more than one million workers were employed in the sale of new vehicles at auto dealerships in 2007 (NAICS 44111), those same workers also sold vehicles that were not AFVs or hybrids. Also, new auto dealerships sell more than just automobiles. Therefore, in order to estimate an upper bound on the number of jobs associated with the AFVs and hybrids market, we loosely estimated that the proportion of the workforce employed in sales and distribution of AFVs and hybrids were roughly proportional to the share of these vehicles in the market. This approximation resulted in

³ Hybrids are not considered AFVs since they use gasoline, which is not an alternative fuel.

⁴ U.S. Department of Energy, Alternative Fuels and Advanced Fuels Data Center, Table “HEV Sales by Model, Trend of sales by HEV models from 1999-2009.” http://www.afdc.energy.gov/afdc/data/docs/hev_sales.xls

⁵ U.S. Department of Energy, Energy Information Administration. *Annual Survey of Alternative Fueled Vehicles*, Table S1. “Summary of Onroad Alternative Fuel and Hybrid Vehicles Made Available by Weight Class, Fuel Type and Configuration, 2007.” http://www.eia.doe.gov/cneaf/alternate/page/atftables/atft_s1.xls

⁶ This price range was published by Carsdirect.com, which noted that some larger hybrid vehicles have prices above this range. <http://www.carsdirect.com/car-pricing/whats-the-average-cost-of-a-new-hybrid-car>

⁷ Total retail sales of U.S. vehicles were obtained from the *Statistical Abstract of the U.S.*: “Table 1024. Retail Sales and Leases of New and Used Vehicles.” <http://www.census.gov/compendia/statab/2010/tables/10s1024.xls>

a range of employment of 76,400 to 116,200 for AFVs and hybrids and 20,000 to 30,500 for hybrids alone.

Green Building Construction

Green building construction is often a focus of discussions about green jobs and green business. The Environmental Protection Agency (EPA) defines “green building” as the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation and deconstruction.⁸ A number of green building standards have evolved over the past two decades and are now the standards by which green buildings are measured. These include the Leadership in Energy and Environmental Design (LEED), Energy Star, and the National Green Building program.

The 2007 Economic Census data and product codes do not allow for the estimation of the green portion of the construction industry. Therefore, in this analysis, ESA analysts used green building estimates from McGraw Hill Construction (MHC), which monitors construction activity through a broad network of construction databases and market intelligence. MHC defines a green building as one that is built to LEED standards or some equivalent green building program or one that incorporates a number green building elements across five categories — energy efficiency, resource conservation, responsible site management/construction and improved industry air quality.⁹ MHC counts the entire value of the construction project when started and excludes buildings with a few basic green features.¹⁰ MHC estimates green construction spending to have ranged from \$36 to \$49 billion (\$24 to \$29 billion for non-residential building and \$12 to \$20 billion for residential buildings) for 2008. This range represents a small portion of the overall construction industry, in the range of 3.5% to 4.8% of total construction industry value of construction in place (VIP) as measured by the Census Bureau. The VIP total construction estimate used here was adjusted and excluded infrastructure-related construction, such as highways, sewers, water, and water conservation because the MHC estimates do not include non-building infrastructure construction. The low and high green building shares of total construction estimates were applied to total construction industry employment (NAICS 23) from the 2007 Economic Census (excluding NAICS 236 which includes infrastructure-related construction) to obtain an estimate of green building employment in the range of 223,600 to 304,300.¹¹

Energy Efficient Appliances

Energy efficient appliances help reduce electricity usage and conserve water. ESA used the EPA's ENERGY STAR product specifications to determine the share of home appliances

⁸ Environmental Protection Agency, Green Building Basics. (<http://www.epa.gov/greenbuilding/pubs/about.htm>).

⁹ McGraw Hill Construction, *2009 Green Construction Outlook: Drivers and Trends*, November 2008.

¹⁰ Since the MHC green construction estimates contain the entire value of the construction project, there is likely double counting of some of the energy efficient appliances and green building materials counted elsewhere in this analysis.

¹¹ Estimates of the size of the green building market and the impact of spending on green building vary based on the definitions used. For example, a U.S. Green Building Council study estimates that green construction spending supported more than 2 million jobs over the 2000-2008 period (directly and indirectly). See USGBC, *Green Collar Jobs*, November 2009. (<http://www.usgbc.org/ShowFile.aspx?DocumentID=6435>)

produced which were “green.” Specifications for earning the ENERGY STAR are available for more than 60 product categories, including several major household appliances such as refrigerators, dishwashers, clothes washers and room air conditioning units. The EPA recently developed ratings for water heaters. However, there are no ratings for gas or electric ranges.¹²

The EPA estimates Energy Star market share data for four major household appliance categories (refrigerators, dishwashers, clothes washers and room air conditioners) among other product categories.¹³ This analysis only covers those four major categories, which represent a small segment of the home appliance market and only partially cover all available Energy Star qualified products.¹⁴ In 2007, an estimated 30% of refrigerators sold at the retail level were Energy Star qualified. According to the 2007 Economic Census, shipments of household refrigerators (product code 3352221100) totaled \$4.8 billion. Thus the estimated value of Energy Star qualified refrigerators shipped in 2007 was almost \$1.5 billion (0.30 x \$4.8 billion). ESA analysts performed similar calculations to compute the value of shipments for all four types of appliances using the Energy Star estimated market shares of 41% for clothes washers, 50% for room air conditioners and 77% for dishwashers.

A challenge arises when estimating the value of shipments for room air conditioners and dishwashers in the Economic Census because there are no single product codes for each of these appliances. The product code for room air conditioners (3334156100) also includes dehumidifiers, which slightly overstates the size of the market. Dishwashers are included in a miscellaneous appliance manufacturing category that also includes hot water heaters (3352285100). Thus, hot water heaters, with an estimated green market share of 6%, are included as an energy efficient appliance, so there are five items included in the energy efficient appliance line in Appendix Table 2B. The market share estimates were applied to total manufacturing employment in each appliance category to arrive at an estimate of jobs associated with the manufacturing of energy efficient appliances — about 68,200.

ESA analysts used the same Energy Star market share data to compute retail sales of Energy Star qualified products. ESA analysts applied the average market share of shipments for the group of appliances listed above (40%) to the total appliance store sales revenues (\$17.4 billion) to estimate a value of \$7 billion. We do not know the extent to which other stores sell household appliances or household appliance stores sell other types of appliances. For example, some department and home improvement stores are major sellers of appliances and are not captured using this method. Roughly 70,000 workers were employed by household appliance stores according to 2007 Economic Census data, so we estimated that 40% or 28,200 workers were associated with the sale of energy efficient appliances. The combined manufacturing shipments

¹² A list of Energy Star appliances can be found on the EPA/DOE Energy Star website. (http://www.energystar.gov/index.cfm?c=manuf_res_pt_appliances)

¹³ U.S. Department of Energy, Energy Star Program, “2007 ENERGY STAR Qualified Appliance Retail Sales Data – National.” http://www.energystar.gov/ia/partners/manuf_res/2007FinalSalesData.xls

¹⁴ The American Council for an Energy Efficient Economy (ACEEE) attempted to estimate aggregate energy efficiency for the entire group of Energy Star products. They used shipments data on number of Energy Star items sold and estimated an average price of each product after which they arrived at an aggregate sales estimate. They estimated the total investment in Energy Star products (residential and commercial) at \$88 billion in 2004. See: Karen Ehrhardt-Martinez and John A. “Skip” Laitner, “The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture,” May 2008. (<http://aceee.org/pubs/e083.pdf?CFID=1664432&CFTOKEN=20896320>)

of energy efficient appliances and appliance store retail sales of energy efficient appliances were estimated at \$12.8 billion. Combined employment was estimated at 96,400 employees.

Photovoltaics

Photovoltaic (PV) cells are semi-conductor devices that generate electricity when exposed to the sun. Manufacturers assemble the cells into modules, which can be installed on buildings, parking structures or in ground-mounted arrays. Electricity generation is the predominant end use for PV cells and modules.

The Energy Information Administration (EIA) estimated the total revenue of PV cell and module shipments in 2007 to be \$1.72 billion, based on the Annual Photovoltaic Module/Cell Manufacturers Survey.¹⁵ EIA estimated that 6,170 workers were employed in the photovoltaic manufacturing industry in 2007.¹⁶ The figures are included in Appendix Table 2B as both the low and high measures for both revenue and employment of the photovoltaic industry.

Organic Agriculture

The Economic Census excludes agriculture. However, ESA analysts elected to include organic food production in its measure of green business. Organic food production meets ESA's definition because it preserves the soil and ecosystem through the use of natural fertilizer and pest management methods. The market for organic products remains small relative to overall agricultural output. According to the 2007 Census of Agriculture, the value of organically produced commodities was \$1.7 billion compared to a total market value of agricultural products sold in the United States of \$297.2 billion in 2007.¹⁷ About 0.57% of crop production by value was therefore organic production (that is, \$1.7/\$297.2 billion). Applying this percentage to the 747,000 workers in the farming sector, organic food production employed 4,258 people.¹⁸

ESA also included retail sales of organic food. According to the Nutrition Business Journal, organic food retail sales were \$18.9 billion in 2007. Total food and beverage store sales (not including beer, wine and liquor) were \$503.4 billion in 2007. Therefore, organic food retail sales accounted for about 3.8% of retail sales for food and beverage stores. In 2007, the number of employees in the food and beverage retail industry was 2,696,309. The total number of employees associated with organic retail food sales is, by this method, 101,232.

The measures for organics noted above are only for crop production and retail sales. Because of data constraints, ESA could not determine a method of accounting for sales of organic foods in the food processing, wholesale trade or food services (e.g., restaurants) industry sectors.

¹⁵ Energy Information Administration, "Solar Photovoltaic Cell/Module Manufacturing Activities 2008." (<http://www.eia.doe.gov/cneaf/solar.renewables/page/solarreport/solarpv.html>)

¹⁶ Ibid.

¹⁷ U.S. Department of Agriculture, *2007 Census of Agriculture*, Volume 1, Table 2. Market Value of Agricultural Products Sold Including Landlord's Share and Direct Sales: 2007 and 2002, p.9. (http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf); (http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_1_US/st99_1_002_002.pdf).

¹⁸ Bureau of Economic Analysis, Industry Economic Accounts, GDP by Industry, Full and Part-time Employment, 1998-2008. (http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1998-2008.xls).

Supplemental Green Products and Services Not Included

Several major green products or services are not included in this analysis because of data or resource constraints and measurement issues. Since many green products and services are relatively new in their development, few data exist, especially for the benchmark year — 2007. Additionally, ESA wanted this report and the estimation process to be both transparent and replicable. This limited data availability. The following products and services are not included due to data/resource constraints:

- Hydro turbine manufacturing
- Green IT processes and equipment
- Green or organic personal care items and beauty products
- Architectural, landscaping and urban planning
- Green chemicals and cleaners

Another reason some products or services were not included in this analysis was because of measurement issues, i.e., the inability to link the data to a corresponding NAICS or product codes. While data were available for the following products, such measurement issues precluded the estimation of the market share:

- Compact fluorescent lighting (CFLs)
- Small wind turbine manufacturing
- Utility scale wind turbine manufacturing

Additionally, a number of green products and services constituted only a very small percentage of their respective markets. The following were not included because they would have an insignificant effect on the results:

- LED lighting
- Biodegradable plastics and bioplastics
- Fuel cell and hybrid batteries

Finally, several products and services were outside the scope of industries included in the Economic Census, particularly the public sector, so services such as public mass transit were not included in our analysis.

Although not directly accounted for in Appendix Table 2B, a few of these products and services may be included in other product categories that ESA defined as green. For example, some green architectural, landscaping and urban planning would be part of green building construction.

Section C

Review and Comparison of Environmental Industry and Product Definitions and Lists

The green product and services definition and selection criteria for this study drew from a number of efforts to define environmental industries, technologies, and products and services. Although the exact definition of green varies across studies, many of the studies define green in similar ways. Most studies utilize the concepts of energy efficiency, renewable or clean energy sources, and protection of the environment as guiding principles for defining the green economy. Table 2C summarizes the definitions that a number of these efforts adopted.

The definition in this report was influenced by the environmental product and service definitions used in a Bureau of the Census Survey of Environmental Products and Services (SEPS) sponsored by the Environmental Protection Agency (EPA) and the International Trade Administration (ITA) of the U.S. Department of Commerce (EPA and DOC, 1998; and Becker and Shadbegian, 2009). The SEPS survey was a one-time survey conducted in 1995 and included only businesses that produced environmental products or services. The products and services covered in the survey included air, water, wastewater and solid waste treatment and management; energy conservation; noise pollution control; and environmental monitoring, assessment, analysis, administration, management, and engineering activities. Because our current study was not based on a dedicated survey of businesses producing environmental products and services, but rather drew from Economic Census data, we needed to identify environmental products and services using the existing industry and product coding framework. Even though environmental/green products and services do not necessarily conform to the traditional industry and product classification system, such as the NAICS and their corresponding product codes, using the above definition identified many of the same green products and services that were measured in the SEPS study.

The survey method also allowed SEPS to distinguish products and services by whether they were used “for environmental purposes” or “not for environmental purposes” within an industry. This was not possible in our analysis. Because products and services could be both green and non-green, we often had to make decisions about whether a majority of the selected product or service was green, and only included those industry and product categories that could be considered mostly, or entirely, green. The SEPS effort, like this one, could not account for the environmental effects associated with the product life cycle, that is, from production to disposal.

The basic SEPS environmental goods and services definitions and survey framework stemmed from international work in the early 1990s on environmental industries led by the Organization for Economic Cooperation and Development (OECD) and Eurostat. After attempts to describe the environmental industry in the 1990s, there was recognition that data and analysis on environmental business activities were lacking or needed improvement to assess better the status and potential of environmental industries, including industry growth and employment, new markets and technology, trade patterns, and policy implications. This launched several country efforts to define and collect data on the environmental goods and services sector, including the SEPS work in the U.S. This collective work culminated in an OECD and Eurostat manual on data collection and analysis of environmental goods and services industries.

Eurostat published an update to this manual in 2009 to offer guidance to countries on how best to compile, analyze and interpret data on the environmental goods and services sector. The goal of the manual was to promote comparable metrics across their member countries. Eurostat identifies and classifies environmental goods and services, as well as reviews several country and international lists of environmental goods and services. Their definitions and lists compare closely to the one used in our study, as they both reflect the ultimate goal of identifying products and services based on their environmental protection, energy conservation or natural resource management capabilities. One of the major product and service categories where our study diverges from the Eurostat environmental product and service list is mass transportation. Our study included private mass transit services because they address energy conservation goals by providing an alternative to single automobile ridership.

The definitions and lists summarized were designed to further our understanding of the economic and policy implications of environmental business activities. There have also been some efforts to identify environmental goods and services for tracking international trade, identifying emerging international markets and setting trade tariffs. These lists have also been used in trade negotiations.

The Asian-Pacific Economic Cooperation (APEC), the World Trade Organization (WTO) and the International Trade Administration (ITA) of the U.S. Department of Commerce have developed trade-oriented environmental product lists. A number of the products or technologies on these lists are not exclusively used for environmental protection or natural resource management, and in many cases, it is unknown what share of trade volume or sales of these goods are devoted to environmental uses. An example of these products is monitoring and analysis equipment, which includes medical equipment and instruments. While these products may have some environmental or resource-conserving purposes, they often have a wide variety of uses. There are other potential environmental products that are excluded from these lists, particularly chemicals, because they are covered under other international trade lists.

An OECD (2005) report compares the OECD list described earlier and the APEC list that was compiled in the late 1990s. Both lists have been used to frame the WTO list established to assist in trade negotiations targeting environmental goods and services. The environmental technology products classification was meant, therefore, to promote favorable tariff treatment and to be easily identifiable by customs agents. In contrast, the OECD and Eurostat lists of environmental goods and services accounted more for the lifecycle of products, and more generally, were based, on best methods for data collection and analysis to track the importance of environmental and conservation activities on businesses and the economy.

The ITA environmental technologies list drew from the APEC list and discussions with other U.S. agencies and businesses. The list and the trade statistics based on it can be accessed online on ITA's environmental industries website at:

<http://web.ita.doc.gov/ete/eteinfo.nsf/f8251ed83d3dc9ca85256ada00734a48/12a863cd896bd62985256ada00725f06?OpenDocument>

Comparison with National Studies and State-Level Surveys

Several studies have estimated the contribution of green businesses and jobs to the U.S. economy. While the definitions and scope of coverage vary somewhat, most studies use concepts similar to those in this report as guiding principles to identify green businesses, products, and services, namely energy efficiency, renewable or clean energy sources, natural resource conservation and protection of the environment. There are also some methodological and regional differences between the studies. Summaries of the definitions used, scope of coverage, and results of these studies are in Table 2C. The following discusses these studies and compares our study to these.

The Pew Charitable Trusts (2009) took an approach similar to our study and obtained comparable results. In place of the Economic Census, Pew used a proprietary business database. They identified businesses as green if they produced products or services that met their definition of a clean energy economy (see Table 2C). Similar to our study, Pew did not include business employment as green if it was associated with achieving more environmentally-friendly business operations, such as achieving more energy efficient production or instituting a recycling program. The unit of analysis was the business firm and the products or services the firm provided. The Pew study listed Standard Industrial Classification (SIC) codes identified as being part of the clean energy economy, whereas we used the NAICS and product coding framework of the Economic Census to classify environmental products and services. The U.S. Census Bureau provided a concordance between the 8-digit SIC codes that Pew defined as having clean energy activities to corresponding NAICS codes. A review of this concordance showed that the industry coverage in our study corresponded with Pew's SIC list. Pew estimates that about 0.5% of national employment in 2007 was in green jobs.

Pew's national results were nearly identical to a study by Global Insight (2008), which used the same employment-by-business database and applied a similar methodology to that of Pew. A differentiating factor of the Global Insight study was its focus on the green economy in metropolitan areas, whereas the Pew study included a state-level analysis. The Global Insight study included environmental jobs in government administration. Our study and the Pew study estimated green jobs only in the private business sector.

Pew and Global Insight both used a proprietary database that covers most of the private sector economy, which limits the ability of others to replicate their results because the underlying data are not readily available. In contrast, our report examines individual products and services using Census data, freely available to all analysts. The methodology used in our report allows others to create their own definition of green products and replicate this study.

The two studies that differed most from our study were the American Solar Energy Society (ASES, 2009) and the Political Economy Research Institute (PERI, 2008). These two studies had the highest estimates of green jobs, from 9 to 14 million jobs. This is four to six times greater than our study estimates using the broad definition of green. These studies largely based their count of green jobs on an analysis of occupations, rather than estimating jobs associated with green businesses as the other studies had done. One problem with counts involving occupations is an occupation can often include both green and non-green work. Many of those employed in occupations that PERI lists, such as heating/air conditioning installers, civil

engineers, welders, and others, would not be entirely devoted to green work. Furthermore, jobs in green occupations may not be exclusive — an accountant may work at a wind mill manufacturing facility or a wind technician may work for a petroleum company.

While the aforementioned studies provide information about the entire U.S. economy, many studies were based on state-level surveys. The results of these studies range from green jobs accounting for 1.6% of employment in Washington State (Washington State Employment Security Department, 2008) to 4.8% in Missouri (Missouri Economic Research & Information Center, 2009). Survey results from Michigan (Michigan Department of Energy, 2009) and Oregon (WorkSource Oregon Employment Department, 2009) indicate green employment levels in the middle of this range, at about 3% of total employment in those states. Many of these studies, because they are dedicated environmental surveys, offer a more direct method for measuring the green economy. They used very similar definitions as our study, and had similar results (see Table 2C). One major difference relative to our study is that many of these state-level study estimates included green jobs at state and local governments.

Overall, our study is more in line with the national studies and state-level surveys that used businesses as the unit of analysis and identified green jobs based on employment in these businesses. The exclusion of green jobs in the government sector is one area where our study diverged from many other studies. The strength of our study, however, is that we used Economic Census data which is a freely available, comprehensive source of business information, allowing others to replicate this study based on their own definitions of green products and services.

Table 2C
Comparison of National and Regional Studies that
Estimate the Size of the Green Economy

Study	Green Definition and Scope of Coverage	Findings
<p>Environmental Product and Service Lists</p> <p><i>Eurostat (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study defined environmental goods and services as consisting of a heterogeneous set of producers of technologies, goods and services that: 1) Measure, control, restore, prevent, treat, minimize, research and sensitize environmental damages to air, water and soil as well as problems related to waste, noise, biodiversity and landscapes. This includes ‘cleaner’ technologies, goods and services that prevent or minimize pollution; and 2) Measure, control, restore, prevent, minimize, research and sensitize resource depletion. This results mainly in resource-efficient technologies, goods and services that minimize the use of natural resources. ▪ This study also described environmental products and services as being either a "connected" or "adapted" good or service. The sole purpose of a connected good or service is environmental protection or resource management. An adapted good is one that is less polluting or more resource efficient than the equivalent normal goods which furnish a similar utility. 	<p>Not Applicable</p>
<p><i>International Trade Administration (2010)</i></p>	<ul style="list-style-type: none"> ▪ This trade list is based on harmonized tariff schedule (HTS or HS) categories considered "environmental technologies" by the U.S. Department of Commerce and is believed to capture the most complete portion of environmental trade activity possible. The product codes overlap with a number of industry sectors. ▪ Environmental technology product classifications are mostly meant to promote favorable tariff treatment and be easily identifiable by customs agents. The ITA environmental technologies list drew from other international and U.S. efforts to identify environmental products. 	<p>Not Applicable</p>

Study	Green Definition and Scope of Coverage	Findings
<p>National-Level Studies</p> <p><i>American Solar Energy Society (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study encompassed jobs in all aspects of renewable energy and energy efficiency: 1) renewable energy including wind, photovoltaic, solar thermal, hydroelectric power, geothermal, biomass, fuel cell and hydrogen technologies; and 2) energy efficiency including recycling, remanufacturing, or energy efficient production; e.g., construction, manufacturing, autos, appliances, etc. ▪ - This study covered these activities in businesses, government, universities, non-profit, foundations and related agencies. 	<ul style="list-style-type: none"> ▪ 9.1 million jobs associated with energy efficiency and renewable energy occupations in 2007
<p><i>PERI (2008)</i></p>	<ul style="list-style-type: none"> ▪ - The study identified six strategies for diminishing global warming: 1) building retrofitting; 2) mass transit; 3) energy efficient automobiles; 4) cellulosic biomass fuels; 5) wind power; and 6) solar power. ▪ - They selected industries and occupations associated with each strategy for 12 states. ▪ - The analysis was based on an input-output model. 	<ul style="list-style-type: none"> ▪ 14.3 million jobs in 45 green occupations, representing 9% of the national workforce in 2007 ▪ The estimate would be larger if service and support occupations were included.
<p><i>Pew Charitable Trusts (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study defined a clean energy economy as one that generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources. The clean energy economy cuts across five categories: 1) clean energy; 2) energy efficiency; 3) environmentally friendly production; 4) conservation and pollution mitigation; and 5) training and support. ▪ This was a national and state-level analysis that counted businesses and jobs associated with companies supplying products and services generated by the clean energy economy, not the companies that used these products and services. 	<ul style="list-style-type: none"> ▪ 770,385 clean jobs nationally, or 0.5% of total national employment in 2007 ▪ The share of clean jobs by state ranged from 0.3% to 1.0% of total employment in each state.
<p><i>Global Insight (2008)</i></p>	<ul style="list-style-type: none"> ▪ This study defined green jobs as any activity that: 1) generates electricity using renewable or nuclear fuels; 2) agriculture jobs supplying corn or soy for transportation fuel; 3) manufacturing jobs producing goods used in renewable power generation; 4) equipment dealers and wholesalers specializing in renewable or energy-efficient products, 5) construction and installation of energy and pollution management systems; 6) government administration of environmental programs; and 7) supporting jobs in the engineering, legal, research and consulting fields. ▪ This study focused on the national economy and on metropolitan areas. ▪ This study used business data from a private source. 	<ul style="list-style-type: none"> ▪ 751,051 jobs in 2006 associated with green sectors of the economy ▪ 0.5% of national employment

Study	Green Definition and Scope of Coverage	Findings
<p>Study National-Level Studies (cont'd)</p> <p><i>U.S. Environmental Protection Agency and the U.S. Department of Commerce, Survey of Environmental Products and Services (1998)</i></p>	<ul style="list-style-type: none"> ▪ This study defined the environmental industry as the manufacture of products, performance of services and construction of projects used, or that potentially could be used, for measuring, preventing, limiting or correcting environmental damage to air, water, and soil. The industry also includes services related to the removal, transportation, storage, or abatement of waste, noise, and other contaminants. ▪ This was a national survey of businesses producing green products and services. 	<ul style="list-style-type: none"> ▪ 774,000 green employees in 1995 ▪ 0.4% of manufacturing shipments in 1995
<p>State-Level Surveys</p> <p><i>Michigan Department of Energy (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study measured jobs directly involved in generating or supporting a firm's green-related products or services. ▪ The green economy is defined as being comprised of industries that provide products or services in five areas: 1) agriculture and natural resource conservation; 2) clean transportation and fuels; 3) increased energy efficiency; 4) renewable energy production; and 5) pollution prevention or environmental cleanup. 	<ul style="list-style-type: none"> ▪ 96,767 direct green jobs and 12,300 support green jobs in 2008 ▪ 3.4% of Michigan private employment
<p><i>Missouri Economic Research and Information Center (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study defined green jobs as those directly involved in a firm's green-related products or services. ▪ Those surveyed were from the energy, manufacturing, building, farming, salvage/remediation, and government sectors. 	<ul style="list-style-type: none"> ▪ 131,103 direct and support jobs in 2008 ▪ 4.8% of Missouri jobs
<p><i>Washington State Employment Security Department (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study identified green jobs in four areas: 1) energy efficiency; 2) preventing and reducing pollution; 3) renewable energy; and 4) mitigating or cleaning up pollution. 	<ul style="list-style-type: none"> ▪ 47,194 direct green jobs in 2008 ▪ 1.6% of total private state employment
<p><i>WorkSource Oregon Employment Department (2009)</i></p>	<ul style="list-style-type: none"> ▪ This study defined green jobs as those that provide a service or produces a product that: 1) increases energy efficiency; 2) produces renewable energy; 3) prevents, reduces, or mitigates environmental degradation; 4) cleans up and restores the natural environment; and 5) provides education, consulting, policy promotion, accreditation, trading and offsets, or similar services supporting the previous categories. 	<ul style="list-style-type: none"> ▪ 51,402 green jobs in 2008 ▪ 3% of Oregon's private, state government and local government employment

REFERENCES

- American Solar Energy Society (ASES). *Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century*. by Roger Bezdek. January 2009.
- Becker, Randy A. and Ronald J. Shadbegian. “Environmental Products Manufacturing: A Look Inside the Green Industry.” *The B.E. Journal of Economic Analysis & Policy*. Volume 9: Issue 1. 2009.
- Bureau of Economic Analysis. Industry Economic Accounts. “GDP by Industry-Full and Part-time Employees 1998-2008.” (http://www.bea.gov/industry/xls/GDPbyInd_VA_NAICS_1998-2008.xls)
- Campbell, Richard J. and Linda Levin. “Renewable Energy — A Pathway to Green Jobs?” *Congressional Research Service*. September 24, 2009.
- Dimitri, Carolyn and Lydia Oberholtzer. *Marketing U.S. Organic Foods: Recent Trends from Farms to Consumers*. USDA, Economic Research Service. Economic Information Bulletin No. (EIB-58) September 2009. 33pp. (http://www.ers.usda.gov/Publications/EIB58/EIB58_ReportSummary.html)
- Ehrhardt-Martinez, Karen and John A. “Skip” Laitner. “The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture.” Report Number E083. Washington, DC: American Council for an Energy-Efficient Economy. May 2008. (<http://aceee.org/pubs/e083.pdf?CFID=1664432&CFTOKEN=20896320>)
- Eurostat. “The Environmental Goods and Services Sector: A Data Collection Handbook.” *Eurostat Methodologies and Working Papers*. 2009.
- Florida Agency for Workforce Innovation. Labor Market Statistics Center. *Selected Green Jobs Surveys Conducted by State Workforce Agencies in Washington, Michigan, Oregon, Minnesota, and California*. May 2009.
- Global Insight. *U.S. Metro Economics — Current and Potential Green Jobs in the U.S. Economy*. Prepared for the U.S. Conference of Mayors and Mayors Climate Protection Center. October 2008.
- International Trade Administration. U.S. Department of Commerce. “Trade Statistics for Environmental Products.” (<http://web.ita.doc.gov/ete/eteinfo.nsf/f8251ed83d3dc9ca85256ada00734a48/12a863cd896bd62985256ada00725f06?OpenDocument#Top%2020%20Environmental%20Export%20Produ>). Accessed in January 2009.
- McGraw Hill Construction. *2009 Green Construction Outlook: Drivers and Trends*. May 2009.
- Michigan Department of Energy, Labor & Economic Growth. Bureau of Labor Market Information & Strategic Initiatives. *Michigan Green Jobs Report 2009, Occupations & Employment in the New Green Economy*. May 2009.
- Missouri Economic Research & Information Center. Department of Economic Development. *The Missouri Green Jobs Report*. 2009.
- OECD and Eurostat. *The Environmental Goods & Services Industry: Manual for Data Collection and Analysis*. 1999.

- Pew Charitable Trusts. *The Clean Energy Economy — Repowering Jobs, Businesses & Investments Across America*. June 2009.
- Political Economy Research Institute (PERI). *Job Opportunities for the Green Economy: A State-by-State Picture of Occupations that Gain from Green Investment*. by Robert Polin and Jeannette Wicks-Lim. June 2008.
- Steenblik, Ronald. “Environmental Goods: A Comparison of the APEC and OECD Lists.” *OECD Trade and Environment Working Paper No. 2005-04*. Joint Working Party on Trade and Environment. 2005.
- U.S. Bureau of the Census. *Statistical Abstract of the United States*. 2009. (<http://www.census.gov/compendia/statab/>)
- U. S. Department of Agriculture. Economic Research Service. Economic Briefing Room. “Sales of Organic Food by Category, 2000-2010.” (<http://www.ers.usda.gov/Briefing/Organic/Gallery/OrganicSales.htm>)
- _____. National Agricultural Statistics Service. *2007 Census of Agriculture*. AC-07-A-51. December 2009. (http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf)
- U.S. Department of Energy. Energy Information Administration. “Annual Photovoltaic Module/Cell Manufacturers Survey.” Form EIA-63B. Table 3.2: Annual Photovoltaic Domestic Shipments. Table 3.6: Photovoltaic Cell and Module Shipment Revenue by Type, 2006 and 2007. Table 3.16: Employment in the Photovoltaic Manufacturing Industry, 1998-2007. (<http://www.eia.doe.gov/cneaf/solar.renewables/page/solarreport/solarpv.html>)
- U.S. Environmental Protection Agency and the U.S. Department of Commerce. “Survey of Environmental Products and Services.” Prepared for the EPA and ITA by the Bureau of the Census. February 1998.
- U.S. Green Building Council. *Green Collar Jobs*. prepared by Booz Allen Hamilton. November 2009. (<http://www.usgbc.org/ShowFile.aspx?DocumentID=6435>)
- Washington State Employment Security Department. *2008 Green Economy Jobs in Washington State*. by Alan Hardcastle. Washington State University Extension Energy Program. January 2009.
- WorkSource Oregon Employment Department. *The Greening of Oregon’s Workforce: Jobs, Wages and Training*. June 2009.