SIZING UP OUR REGION'S GREEN ECONOMY

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CHICAGO REGION CLEAN ECONOMY HIGHLIGHTS

- There were **92,567 clean jobs** in the Chicago Region economy in 2015, accounting for approximately 2% of total jobs. A similar proportion of jobs in the U.S. economy is clean.[1] Although very small portion of the regional economy, clean jobs are likely to be a sizeable portion of the broader economy in the near future. 25,585 clean jobs added to the regional economy during the period of 2005-2015 accounts for more than 21% all new jobs created in the Chicago Region economy.

- The regional clean economy grew faster than the regional economy as a whole between 2005 and 2015. While **clean economy jobs increased by 38%**, total regional jobs increased by only 2.8%. The region's clean economy outperformed the national clean economy (clean jobs in the U.S. grew by 27% during the same period). Also, it is notable that during the same period, the regional economy as a whole lagged the national growth rate.

- The **Chicago Region's clean economy is performing better than the national clean economy**. The region gained 25,585 clean jobs from 2005 to 2015. However, 5,112 jobs in the region are attributable to its relative competitive position in the clean economy. That is, a gain of more than five thousand clean jobs is attributable to characteristics specific to the local economy.[2]

- At the regional level, **most of the clean jobs are concentrated in industries that focus on energy efficiency and greenhouse gas reduction**. Among clean economy categories, establishments classified in **Energy and Resource Efficient added the most jobs** while those establishments classified in Renewable Energy had the largest employment rate increase (60%).

- Overall, **clean economy jobs pay higher wages** than other jobs. In 2015, the average wage for a clean economy job was $ 63,769 while it was $ 58,887 for all jobs in the region. A comparable difference is observed for clean jobs in the U.S.

- Although a small proportion of total regional jobs, **clean economy jobs are likely to contribute to higher quality of life**. Average wages in 24 clean economy segments (out of 39) are higher than average regional wages in 2015. Professional energy services, HVAC and building control systems, green architecture and construction services are the largest clean economy segments with considerably higher wages.

- The Chicago Region is **specialized in at least ten clean economy segments**. Employment concentration in professional energy services, lighting, air and water purification technologies is at least twice as high as the national average.[3] This suggests that regional firms in these segments are specialized in the production and delivery of certain goods and services that are likely sold outside the region.

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[1] The Chicago Region refers to the 14-county Chicago-Naperville-Elgin Metropolitan Statistical Area (MSA), which consists of the following counties: Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, Will, Kenosha (WI), Jasper (IN), Lake (IN), Newton (IN), and Porter (IN).

[2] Based on shift-share analysis, if the region's clean economy growth rate were identical to that of the national economy, then the number of jobs in the region should have grown by only 18,340 between 2005 and 2015 instead of 23,452.

[3] The concentration is determined by the Location Quotient (LQ), which compares local employment levels to national levels. A LQ greater than 1 indicates concentration and the higher the number, the greater the concentration. Professional energy services LQ is 3.25 (3.25 times that of the national employment level); Lighting LQ is 2.51; and Water purification LQ is 2.44.

COOK COUNTY CLEAN ECONOMY HIGHLIGHTS

- There were **55,800 clean jobs in the Cook County economy in 2015** (60% of the regional total), accounting for approximately 2.2% of total jobs. A slightly larger proportion of jobs in Cook County is clean compared to the nation. In 2015, 2.07% of all jobs were classified as clean in the U.S. Although very small portion of the regional economy, clean jobs are likely to be a sizeable portion of the broader economy in the near future. 12,788 clean jobs added to the local economy during the period of 2005-2015 accounts for more than half of all new jobs created in the county economy.

- The **local clean economy grew faster than the local economy as a whole between 2005 and 2015**. While clean economy jobs increased by 29%, total local jobs increased by only 1.0%. The county's clean economy grew at almost the same rate as the national clean economy. Clean jobs in the nation grew by 27.4%. It is worth noting that during the same period, the local economy as a whole lagged the national growth rate by a wide margin (1% vs. 6%).

- From **2005 to 2015, clean jobs in the county increased by 12,787, to 55,800**. Among clean economy categories, Greenhouse Gas Reduction, Environmental Management and Recycling added the largest number of jobs and had the largest employment rate increase (41.7%).

- At the local level, **most of the clean jobs are concentrated in industries that focus on energy efficiency and greenhouse gas reduction categories**. A similar pattern is observed at the national level although to a lesser level. A similar concentration is observed at the clean economy segment level. Three top clean economy segments (Public mass transit; Waste management and treatment; and Recycling and reuse) constitute nearly 60% of total clean jobs in Cook County. The same three segments account for only one third of all clean jobs in the U.S.

- Overall, **clean economy jobs pay higher wages** than other jobs. In 2015, the average wage for clean economy job was $ 64,517 while it was $ 61,915 for all jobs in the county. A comparable difference is also observed for clean jobs in the U.S. It is notable, however, that the difference between the average wage for clean economy jobs and average wages for all jobs in the nation is more significant ($ 62,089 and $52,942).

- **Cook County specializes in at least nine clean economy segments**. Employment concentration in pollution reduction, professional energy services, lighting, public mass transit, and green architecture and construction services is at least twice as high as the national average.[4] This suggests that local firms in these segments are specialized in the production and delivery of certain goods and services that are likely sold outside the county.

[4] The concentration is determined by the Location Quotient (LQ), which compares local employment levels to national levels. A LQ greater than 1 indicates concentration and the higher the number, the greater the concentration. Pollution reduction LQ is 3.30 ((3.30 times that of the national employment level); Professional energy services LQ is 3.10; Public mass transit LQ is 2.47; Lighting LQ is 2.62; and green architecture and construction services LQ is 2.43.

1. INTRODUCTION

This report provides data on the size and growth rate of the green/clean economy for Cook County, the Chicago Region, and the U.S. as a whole from 2005 to 2015.[1] In addition to tracking employment and establishment figures for different geographies in different segments of the clean economy, the report also focuses on measures of regional specialization and growth performance. Regional specialization measure identifies clean economy segments in which the regional or the county clean economy is specialized relative to the national economy. For this purpose, we calculate employment-based location quotients (LQs). Additionally, a shift-share (SS) analysis is conducted to better understand how the local and regional clean economies are changing, and in which segments they are most competitive (relative to the nation). By disaggregating the portions of change that result from local factors versus broader changes in the national economy or in the particular clean economy segment, the shift-share analysis sheds light on the sources of growth and decline in the local/regional clean economy.

The report is organized as follows. Section Two defines the clean economy and briefly examines different approaches to measuring the size of the clean economy. Key findings from previous studies as well as methodological limitations associated with these approaches are discussed in this section. Section Two concludes by introducing a framework to quantify green jobs by utilizing publicly available industry employment statistics. Section Three analyzes employment trends in clean economy categories and segments at the national, regional, and local levels based on a classification system developed by the U.S. Bureau of Labor Statistics and the Brookings Institution. The performance of these segments (roughly equivalent to relatively well-known traditional industry clusters) are evaluated by examining changes in employment levels and establishment counts over a period of 10 years—long enough to reveal important dynamics, but short enough to focus on the kinds of local changes that may be malleable through local/regional planning activity.

[1] The Chicago Region refers to the 14-county Chicago-Naperville-Elgin Metropolitan Statistical Area (MSA), which consists of the following counties: Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, Will, Kenosha (WI), Jasper (IN), Lake (IN), Newton (IN), and Porter (IN).

2. THE CLEAN ECONOMY AND ITS MEASUREMENT

2.1. Definition

Defining the clean economy is the first step in any attempt to assess its size. The clean economy in this study is defined as "economic activity that produces goods and services with an environmental benefit or adds value to such products using skills or technologies that are uniquely applied to those products".[2] This is a relatively narrow definition compared to public usage of the term green economy which refers to general reorganization of industries and organizations to achieve environmental sustainability.[3] As discussed below, there are practical and policy reasons for delimiting the scope of clean economic activities.

This is a product-based definition, meaning that the job estimation method based on this definition separates out the production-oriented portion of the clean economy from the broader deployment of environmental and energy efficiency processes. Thus, clean process jobs that are associated with energy-saving practices of private organizations or households are excluded from the measurement. Other excluded jobs include those related to environmental advocacy (e.g. Greenpeace), general education (e.g. Environmental Science professors) unrelated to specific job training, and scientific research not associated with clean product development.[4]

In the above definition, an environmental benefit means that the clean technology, good or service has at least one of the following uses:[5]

- Preventing or minimizing pollution, degradation or natural resources depletion.
- Managing natural resources, including energy, air, and water, for greater efficiency, conservation, or protection.
- Carrying out other activities such as measurement and monitoring, control, research and development, education, and training related to environmental protection and/or resource management.

[2] "Sizing the Clean Economy: A National and Regional Green Jobs Assessment". The Brookings Institution, 2011. Available at: https://www.usda.gov/oce/reports/energy/ExplorationGreenJobPolicies-October%202011.pdf

[3] "An Exploration of Green Job Policies, Theoretical Underpinnings, Measurement Approaches, and Job Growth Expectations. The U.S. Department of Agriculture, 2011. Available at: https://www.usda.gov/oce/reports/energy/ExplorationGreenJobPolicies-October%202011.pdf and "Green Jobs Metrics: A Guide to Efforts to Quantify the Green Economy". Headwater Economics, 2012. Available at: https://headwaterseconomics.org/wp-content/uploads/Green_Jobs_Metrics.pdf.

[4] Alternative definitions are provided by the U.S. Department of Commerce and the U.S. Department of Labor Bureau of Labor Statistics (BLS). These definitions and the details of measurement methods associated with these definitions are discussed in the Appendix.

[5] This section in large part draws from the Brookings report.

"Add value" means the definition also includes economic activities that add value as part of the clean economy supply chain. However, only those suppliers that make products or provide services that are used exclusively in the clean technologies are included in the measurement (e.g. blades, frames, environmental engineering). For example, home weatherization, energy retrofitting, and solar panel installation require skills that distinguish those services from traditional maintenance work or roofing. Such distinction is necessary because there are suppliers that provide products that are used across industries and purposes (e.g. screws, computer equipment, and accounting service). Including all suppliers would have led to an overestimation of clean jobs and establishments.

According to this product-based definition, the green outputs are sold to intermediary users for further processing or final users (i.e., consumers) and might include research and development, installation, and maintenance services. Green goods and services fall into one of the following five groups: (1) *Agricultural and Natural Resources Conservation, (2) Education and Compliance, (3) Energy and Resource Efficiency, (4) Greenhouse Gas Reduction, Environmental Management, and Recycling, (5) Renewable Energy.*

The strength of this approach is that it offers a clear, concrete description of products and activities that are commonly considered as green by many federal agencies and industry associations.[6] This conceptual clarity contributes to better understanding and communication of analyses and policies across researchers, organizations, and local and state governments. Moreover, it allows for annually available industrial employment and establishment data to be used as proxy measure for green jobs and businesses (i.e., BLS's Quarterly Census of Employment and Wages (QCEW) and Census County Business Patterns). This availability makes the long-term industrial trend analysis and short-term, data-driven planning adjustments possible. Given the levels of detail provided in these data sets, there are multiple dimensions for assessing the range of environmentally desirable products or services as well as the jobs required to produce them.

The fundamental weakness of the product-based definition is that it might under-estimate the number of clean jobs in the economy by failing to capture green activities that are not directly associated with the production of end products and services such as energy conservation in a firm. Similarly, jobs associated with the environmentally friendly processes and practices such as generating solar power for use within a retail establishment, using high MPG (Miles per Gallon) vehicles to transport employees, redesigning product packaging to reduce the use of plastics, and collecting and recycling waste created during a manufacturing process will not be counted as clean.

[6] Energy Star products; Federal Energy Management Program (FEMP) products (U.S. Department of Energy); Environmentally Preferable products (EPA); OEPNU Bio-based products (U.S. Department of Agriculture); Energy Star qualified homes; Leadership in Energy and Environmental Design (LEED) certification.

There are two primary reasons for excluding process-oriented jobs and focusing on clean production jobs: (a) measurement difficulties associated with the former and (b) clean production jobs provides more useful information for economic development.

2.2. *Previous Studies*

It is a very challenging task to count the exact number of jobs in the clean economy because the clean economy pervades many traditional industry classifications and many industry codes in the North American Industry Classification System (NAICS) contain establishments that fall both inside and outside the clean economy categories. None of the existing industrial statistical databases maintained by the U.S. Bureau of Labor Statistics (BLS) or the U.S. Census Bureau identifies clean jobs or establishments. To the best of our knowledge, there are only two comprehensive, nation-wide surveys that attempted to measure the clean economy with reference to existing industry classes: a Brookings study conducted in 2010 (Clean Economy Database, results published in 2011) and a BLS survey (Green Goods and Services (GSS)) conducted in 2010 and 2011 (results published in 2013).[7] The former is the only study that measured clean jobs at the metropolitan regional scale (BLS's survey is limited to the national and state levels). The only comprehensive study that examined the size of clean economy at the regional scale is prepared by RW Ventures and INC (Innovation Network for Communities) which utilized the clean economy database developed by the Brookings Institution.[8] Following are the key findings from these studies for the U.S. and the Chicago Region.

- There were 2,675,545 clean economy jobs in the U.S. in 2010 (Brookings Institution). According to the BLS survey, there were 3,243,533 clean economy jobs in 2010 and 3,401,279 in 2011 (corresponding to approximately 2% of total employment).

- The clean economy was manufacturing intensive at the national level. According to Brookings study, nearly 26 percent of all clean economy jobs are in manufacturing establishments. BLS reports a smaller share (15%) for the manufacturing sector, but it still accounts for the largest share of all sectors.

- After manufacturing, construction and professional/technical services accounts for the largest shares of clean economy jobs.

- The clean economy offered more opportunities and better pay for low- and middle-skilled workers than the national economy as a whole. Median wages in the clean

[7] Available at https://www.bls.gov/ggs/home.htm.

[8] "Sizing the Clean Economy: A National and Regional Green Jobs Assessment". The Brookings Institution, 2011. Available at: https://www.usda.gov/oce/reports/energy/ExplorationGreenJobPolicies-October%202011.pdf

economy—meaning those in the middle of the distribution—are 13 percent higher than median U.S.

- With 79,388 clean economy jobs, the Chicago Region ranked number three (3) among the 100 largest metro areas in the U.S. in 2010 (approximately 1.8% total employment).

- Chicago was the nation's largest metropolitan exporter of clean technologies, goods, and services. A total of estimated $2 billion worth of clean economy exports was recorded for the region in 2010. The Chicago Region had seven clean economy segments that exported over an estimated $100 million per year, the largest of which is professional energy services.

- Twelve (12) clean economy segments have significant growth potential in the Chicago Region: Biofuels/Biomass; Green Chemicals; Organic Farms & Food Production; Recycled Content Products; Smart Grid; Solar Thermal Energy; Vehicle Electrification; Water Purification and Treatment; Wind Energy; Green Building; Building Energy Management; and Energy Efficient Lighting (RW Ventures).

The methodology section that follows describes the main data sources used and the estimation procedure developed in this study.

2.3. Methodology

The "Clean Economy Database" (2011) developed by the Brookings Institution's Metropolitan Policy Program and "Green Goods and Services (GSS)" survey (2013) conducted by the U.S. Bureau of Labor Statistics provides the basis for estimation procedure developed in this report. We adopted the same production-oriented, establishment-based clean economy definition used in these past studies. Similarly, the same clean economy categories and segments are used for comparability reasons.

The Clean Economy Database contains information on employment and establishment counts for the U.S. as a whole, the fifty states, and for the hundred largest metro regions in the country. This information is available for two time points (2003 and 2010) and provided by five (5) broad clean economy categories and thirty-nine (39) detailed clean economy segments (Table 1).[9] The database also has information on 6-digit NAICS industries that correspond to clean economy segments. Although this gives the reader a good sense of how the clean economy segments correspond to the traditional economy industries, it is limited for analysis purposes as there is no

[9] The report and the supplementary documents available at https://www.brookings.edu/research/sizing-the-clean-economy-a-national-and-regional-green-jobs-assessment/ provides category and segment-level data for the national level only. For the states and regions, only aggregate employment and establishment numbers are reported.

complete information as to what proportion of jobs in traditional industries account for clean jobs in corresponding clean economy segments. In other words, not a single traditional industry receives the "green" label; rather, "green jobs" are estimated to exist in different proportions in different sectors (ranging from 0.01% to 100%). The database lists employment and establishment counts for only those industries that are fully part of the clean economy (i.e., 100% correspondence between a traditional industry and clean economy segment. For example "solar heaters and collectors" corresponds to the solar thermal segment and renewable energy category). These fully corresponding industries account for approximately 49% of all clean jobs in the U.S. in 2010. We supplemented this information with BLS's GSS data that has nearly complete information on traditional industry-level clean job counts. Merging these two databases provided us with a solid basis for making estimation decisions for future years with reasonably high-level of confidence.

Table 1: The Clean Economy Categories and Segments

Category	Segment
Agricultural and Natural Resources Conservation	Conservation
	Organic Food and Farming
	Sustainable Forestry Products
Education and Compliance	Regulation and Compliance
	Training
Energy and Resource Efficiency	Appliances
	Battery Technologies
	Electric Vehicle Technologies
	Energy-saving Building Materials
	Energy-saving Consumer Products
	Fuel Cells
	Green Architecture and Construction Services
	HVAC and Building Control Systems
	Lighting
	Professional Energy Services
	Public Mass Transit
	Smart Grid
	Water Efficient Products
Greenhouse Gas Reduction, Environmental Management, and Recycling	Air and Water Purification Technologies
	Carbon Storage and Management
	Green Building Materials
	Green Chemical Products
	Green Consumer Products
	Nuclear Energy
	Pollution Reduction
	Professional Environmental Services
	Recycled-Content Products Recycling and Reuse
	Recycling and Reuse
	Remediation
	Waste Management and Treatment
Renewable Energy	Biofuels/Biomass
	Geothermal
	Hydropower
	Renewable Energy Services
	Solar Photovoltaic
	Solar Thermal
	Waste-to-Energy
	Wave/Ocean Power
	Wind

1. ***Renewable energy.*** Electricity, heat, or fuel generated from renewable sources. These energy sources include wind, biomass, geothermal, solar, ocean, hydropower, and landfill gas and municipal solid waste.

2. ***Energy and resource efficiency.*** Products and services that improve energy efficiency. Included in this group are energy-efficient equipment, appliances, buildings, and vehicles, as well as products and services that improve the energy efficiency of buildings and the efficiency of energy storage and distribution, such as Smart Grid technologies.

3. ***Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse*.** These are products and services that:
   - Reduce or eliminate the creation or release of pollutants or toxic compounds, or remove pollutants or hazardous waste from the environment.
   - Reduce greenhouse gas emissions through methods other than renewable energy generation and energy efficiency, such as electricity generated from nuclear sources.
   - Reduce or eliminate the creation of waste materials; collect, reuse, remanufacture, recycle, or compost waste materials or wastewater.

4. ***Natural resources conservation.*** Products and services that conserve natural resources. Included in this group are products and services related to organic agriculture and sustainable forestry; land management; soil, water, or wildlife conservation; and storm-water management.

5. ***Environmental compliance, education and training, and public awareness.*** These are products and services that:
   - Enforce environmental regulations.
   - Provide education and training related to green technologies and practices.
   - Increase public awareness of environmental issues.

As a first step in the development of our estimation procedure, we converted 8-digit SIC codes to 6-digit NAICS codes using the cross-walk table developed and provided by Don Walls (developer of NETS - National Establishment Time-Series). And then, we found each set of NAICS industries corresponding to each of the 39 clean economy segments. That gave us the number of clean jobs and establishments in each segment that are accounted for by different NAICS industries. As a second step, we computed the proportion of NAICS industry jobs and establishments in each segment using the numbers from Step 1 and 2010 employment data from BLS (Quarterly Census of Employment and Wages, QCEW). In most cases, clean jobs and establishments constitute only a small percentage of total industry employment. In order to find clean jobs and establishments for more current years, as a last step, we applied the proportions obtained in Step 2 to current industry data (QCEW in 2011, 2012, 2013, 2014, and 2015). The clean economy jobs for the years 2005 through 2009 are estimated using the technique called linear interpolation. Because we know the 2003 and 2010 clean jobs figures (through Clean Economy Database), we assumed that employment grew linearly from 2003 to 2010.

The same method is applied to regional and county-level industry data to estimate clean jobs. For the 14-county Chicago Region, we obtained the segment-level employment data from RW Ventures for the years 2003, 2007, 2008, 2009, and 2010 (RW Ventures' data was drawn from the Brookings database). Using the 2010 clean jobs information and QCEW data for the same year, we adjusted the industry level proportions (developed above in Step 2) for the region. This adjustment corrects for the fact that the relative size of clean economy segments are different at the national and regional scales. To find clean jobs and establishments for more current years, we applied the regionally adjusted proportions to current regional industry data (QCEW in 2011, 2012, 2013, 2014, and 2015).

For Cook County, we did not have any information on the number of total clean jobs or the size of different clean economy segments discussed above for the U.S. and the Chicago Region. In the absence of local level data regarding clean jobs, we used regional proportions to estimate jobs in Cook County. This method assumes that equivalent shares of jobs and establishments in local industries are clean in Cook County as in the Chicago Region. The figure obtained by this method is considered to be a reasonable approximation to reality because more than half of the regional jobs (58%) are located in Cook County in any of the last five years.

Like any estimation procedure in economic analysis, this method has certain shortcomings that the reader needs to be aware of when interpreting the findings. The first and the main limitation of this approach is that the proportion of establishments and jobs that are green within an industry is assumed to be constant over time (This applies to only those industries in which only a certain proportion of jobs are classified as clean in 2010). The second limitation is that no new industry is becoming green. This is obviously a weak assumption given the overall positive trend in the clean economy in the last decade. The Brookings methodology has a fixed set of industries (both for 2003 and 2010) that are classified as fully or partially clean. It is probable that some establishments in certain industries not previously classified as part of the clean economy became green and started producing clean products or providing clean technology services. Because it is not feasible to reproduce the Brookings study, we have to rely on this assumption.

Finally, to the extent that clean establishments have different employment trends from non-clean establishments, some employment figures would be underestimated. This is so because the procedure applies industry-wide employment trends to clean establishments within the industry to estimate clean jobs in that industry. We believe that this limitation is particularly applicable to the manufacturing sector in which most establishments experience decline in employment (owing to increases in technological innovations and outsourcing). For example, employment in the national household refrigerator and home freezer manufacturing sector (NAICS 335222) was 21,339 in 2005 while it was 14,460 in 2015 (a decline of 31.5%). This decline will influence the growth rate of the clean economy segment called "Appliances" negatively although it might be the case that unlike the industry-wide trend, clean establishments in this

particular manufacturing sector gained employment or did not experience the decline as drastically as non-clean establishments. Given these limitations, the clean jobs reported in this study could be considered conservative estimates.

3. FINDINGS

3.1. The Clean Economy in the United States

There were 2,893,743 clean jobs in the U.S. economy in 2015, accounting for approximately 2.1 percent of total jobs. From 2005 to 2015, the percentage of total employment associated with the production of green goods and services increased by less than one percent (0.35%). Still, the 622,010 clean jobs added to the national economy during the period of 2005-2015 accounts for 7.9 percent all new jobs created in the U.S. economy, suggesting that clean jobs are likely to be a sizeable portion of the broader economy in the near future.

The national clean economy grew faster than the U.S. economy as a whole between 2005 and 2015, increasing by 27 percent compared to 6 percent growth for total national jobs (Table 2 and Figure 1). Differences in employment growth can also be seen in Figure 2 where employment levels for the national clean economy and the U.S. economy as a whole are shown as shares of 2005 employment.

Among the clean economy categories, Greenhouse Gas Reduction, Environmental Management, and Recycling had the most jobs (1,173,245) while Agricultural and Natural Resources Conservation had the largest employment rate increase (from 18.1% to 18.3%; Table 2 and Figure 3). Not reported here directly, most clean jobs are concentrated in these traditional industry sectors: Manufacturing, Construction, Professional & Technical Services, Administrative & Waste Services, and Transportation.

Table 2: Jobs by Clean Economy Categories, U.S., 2005 - 2015

Clean Economy Categories	**Employment, 2005**		**Employment, 2015**		**Change (%) 2005-2015**
	Jobs	**Share (%)**	**Jobs**	**Share (%)**	
Agricultural and Natural Resources Conservation	411,798	18.1	530,205	18.3	28.8
Education and Compliance	108,519	4.8	136,793	4.7	26.1
Energy and Resource Efficiency	719,607	31.7	918,431	31.7	27.6
Greenhouse Gas Reduction, Environmental Mgmt., and Recycling	912,715	40.2	1,173,245	40.5	28.5
Renewable Energy	119,094	5.2	135,068	4.7	13.4
Clean Economy Total	**2,271,733**	**100.0**	**2,893,743**	**100.0**	**27.4**
Total Economy	***131,571,623***	***NA***	***139,491,699***	***NA***	***6.0***

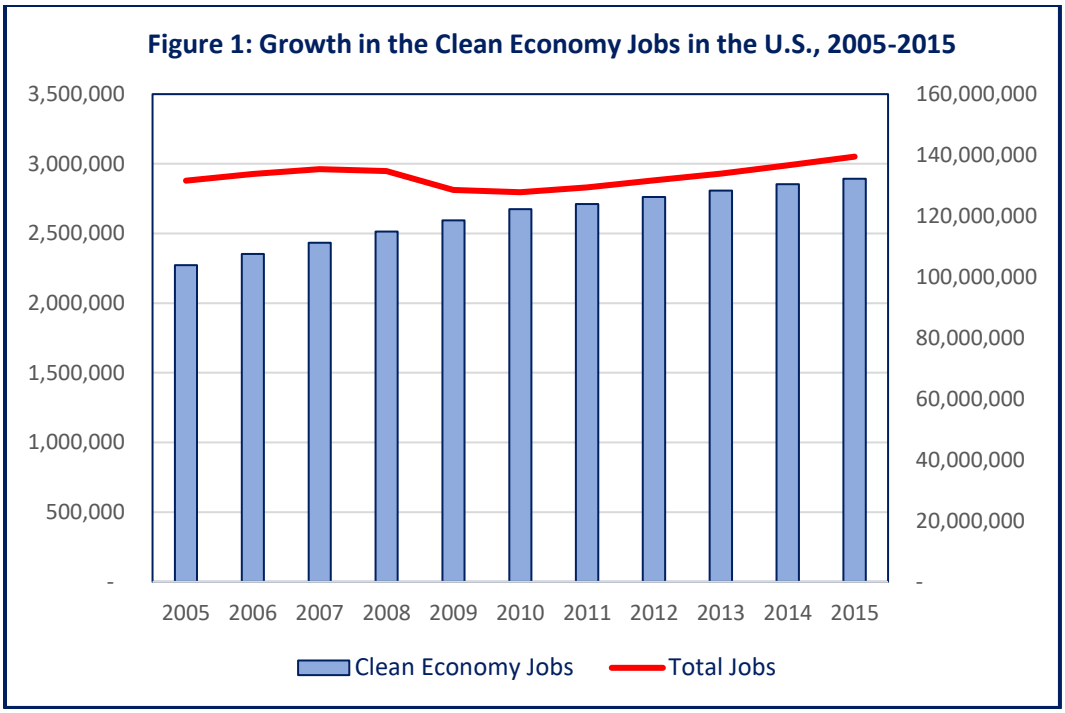


Figure 1: Growth in the Clean Economy Jobs in the U.S., 2005-2015
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
-
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
-
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Clean Economy Jobs
Total Jobs

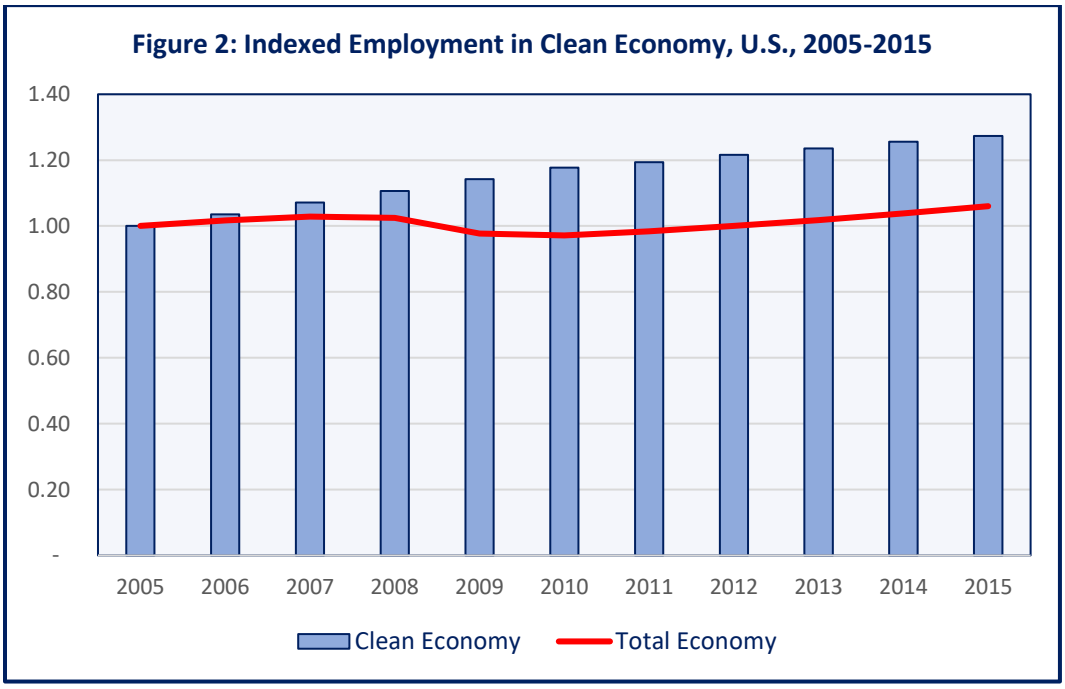
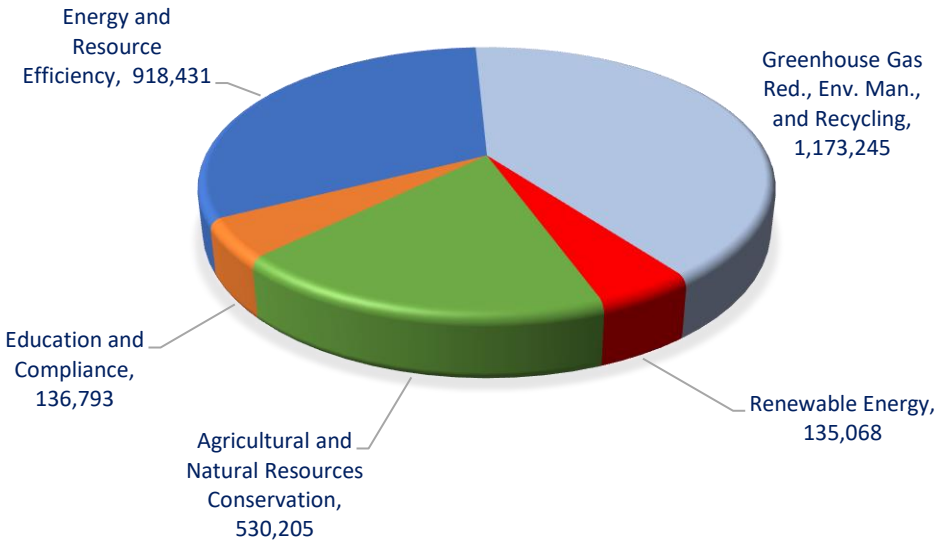


Figure 2: Indexed Employment in Clean Economy, U.S., 2005-2015
1.40
1.20
1.00
0.80
0.60
0.40
0.20
-
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Clean Economy
Total Economy

Figure 3: Jobs by Clean Economy Categories, U.S., 2015



At the detailed clean economy segment level, Waste Management and Treatment, and Public Mass Transit had the most jobs (425,595 and 396,903, respectively) while Training and Solar Thermal had the largest employment rate increase, 265% and 155%, respectively (Table 3 and Table 4). Segments with a small number of establishments and employment might indicate that the firms in these segments are relatively new and likely to be engaged in production activities that are technologically very different from those firms in relatively more mature segments. Carbon Storage and Management, Wave/Ocean Power are two examples of these nascent segments.

In terms of new jobs created in clean economy segments, establishments classified in Public Mass Transit, Conservation, and Professional Environmental Services added the most jobs (Table 4). Six segments lost jobs since 2005 (Table 4). Decline in Sustainable Forestry Products is probably a reflection of the increased productivity in the agriculture sector over time (higher capital/technology to labor ratio). Employment decline in Hydropower is likely due to a decreasing share of Hydropower in power generation and also productivity gains. Job loss in primarily manufacturing oriented clean economy segments (Energy-saving Consumer Products; Appliances; Green Chemical Products; Water Efficient Products) is more complicated to explain. This could be either due to increases in productivity or just a by-product of the estimation procedure employed in this study (because employment in most manufacturing industries are declining, the method automatically produces negative growth rates for segments which mostly consists of manufacturing industries). It is possible that clean establishments which are classified in the same 6-digit NAICS code with traditional establishments might be experiencing different growth rates (publicly available data sources do not allow us to make such distinction). To the

extent that the latter explanation is true, the number of clean jobs are underestimated for these segments.

Table 3: Clean Jobs and Establishments by Clean Economy Segments in the U.S., 2015

Clean Economy Segment	Rank	Jobs, 2015	Share (%)	Est., 2015	Share (%)
Waste Management and Treatment	1	425,595	14.7	16,333	15.4
Public Mass Transit	2	396,903	13.7	6,948	6.6
Conservation	3	322,599	11.2	11,386	10.8
Energy-saving Building Materials	4	180,291	6.2	5,532	5.2
Professional Environmental Services	5	167,694	5.8	6,848	6.5
Recycling and Reuse	6	152,340	5.3	9,228	8.7
Organic Food and Farming	7	145,324	5.0	10,638	10.1
Regulation and Compliance	8	136,516	4.7	2,307	2.2
Green Building Materials	9	81,659	2.8	3,547	3.4
Green Consumer Products	10	81,610	2.8	3,462	3.3
HVAC and Building Control Systems	11	74,513	2.6	1,279	1.2
Nuclear Energy	12	72,094	2.5	760	0.7
Recycled-Content Products Recycling and Reuse	13	67,970	2.4	2,205	2.1
Green Architecture and Construction Services	14	63,308	2.2	6,331	6.0
Sustainable Forestry Products	15	62,283	2.2	1,287	1.2
Remediation	16	58,943	2.0	2,885	2.7
Professional Energy Services	17	52,145	1.8	2,405	2.3
Hydropower	18	44,293	1.5	1,988	1.9
Appliances	19	36,810	1.3	1,110	1.1
Air and Water Purification Technologies	20	28,525	1.0	894	0.9
Wind	21	28,183	1.0	1,573	1.5
Solar Photovoltaic	22	27,312	0.9	525	0.5
Green Chemical Products	23	23,046	0.8	715	0.7
Energy-saving Consumer Products	24	20,712	0.7	1,231	1.2
Biofuels/Biomass	25	20,151	0.7	591	0.6
Carbon Storage and Management	26	19,845	0.7	10	0.1
Battery Technologies	27	18,203	0.6	606	0.6
Smart Grid	28	16,886	0.6	513	0.5
Lighting	29	15,726	0.5	520	0.5
Water Efficient Products	30	15,369	0.5	415	0.4
Pollution Reduction	31	13,343	0.5	241	0.2
Fuel Cells	32	7,720	0.3	128	0.1
Solar Thermal	33	6,915	0.2	327	0.3
Waste-to-Energy	34	3,030	0.1	306	0.3
Geothermal	35	2,523	0.1	103	0.1
Renewable Energy Services	36	2,239	0.1	106	0.1
Electric Vehicle Technologies	37	425	0.1	427	0.4
Wave/Ocean Power	38	423	0.1	14	0.1
Training	39	278	0.1	27	0.1
Total		**2,893,743**	**100.00**	**105,754**	**100.00**

Table 4: Employment Growth in Clean Economy Segments in the U.S., 2005-2015

Clean Economy Segment	Rank	Jobs, 2005	Jobs, 2015	Change (#)	Change (%)
Training	1	76	278	202	265.2
Solar Thermal	2	2,713	6,915	4,202	154.9
Wave/Ocean Power	3	176	423	247	140.2
Wind	4	13,501	28,183	14,681	108.7
Carbon Storage and Management	5	228	425	197	86.3
Solar Photovoltaic	6	15,376	27,312	11,936	77.6
Fuel Cells	7	4,542	7,720	3,179	70.0
Electric Vehicle Technologies	8	11,820	19,845	8,025	67.9
Professional Environmental Services	9	104,051	167,694	63,643	61.2
Smart Grid	10	10,986	16,886	5,899	53.7
Recycling and Reuse	11	100,918	152,340	51,423	51.0
Green Architecture and Construction Services	12	42,134	63,308	21,174	50.3
Renewable Energy Services	13	1,490	2,239	749	50.2
Biofuels/Biomass	14	14,040	20,151	6,111	43.5
Professional Energy Services	15	36,504	52,145	15,640	42.8
Air and Water Purification Technologies	16	20,031	28,525	8,494	42.4
Conservation	17	228,449	322,599	94,150	41.2
Public Mass Transit	18	291,546	396,903	105,357	36.1
Remediation	19	45,142	58,943	13,802	30.6
Waste Management and Treatment	20	329,401	425,595	96,194	29.2
Regulation and Compliance	21	108,443	136,516	28,073	25.9
Energy-saving Building Materials	22	143,335	180,291	36,955	25.8
Geothermal	23	2,007	2,523	515	25.7
Pollution Reduction	24	10,727	13,343	2,615	24.4
Organic Food and Farming	25	119,224	145,324	26,100	21.9
Battery Technologies	26	15,040	18,203	3,163	21.0
HVAC and Building Control Systems	27	62,924	74,513	11,589	18.4
Recycled-Content Products Recycling and Reuse	28	57,400	67,970	10,570	18.4
Green Building Materials	29	71,519	81,659	10,140	14.2
Waste-to-Energy	30	2,781	3,030	249	9.0
Green Consumer Products	31	77,098	81,610	4,511	5.9
Nuclear Energy	32	69,168	72,094	2,926	4.2
Lighting	33	15,706	15,726	20	0.1
Sustainable Forestry Products	34	64,125	62,283	(1,842)	-2.9
Energy-saving Consumer Products	35	22,356	20,712	(1,644)	-7.4
Appliances	36	43,082	36,810	(6,272)	-14.6
Green Chemical Products	37	27,031	23,046	(3,985)	-14.7
Water Efficient Products	38	19,630	15,369	(4,261)	-21.7
Hydropower	39	67,008	44,293	(22,716)	-33.9
Total		**2,271,733**	**2,893,743**	**622,010**	**27.4**

3.1.1 Clean Manufacturing

The clean economy is manufacturing-intensive, with 23 percent of all clean jobs involved in manufacturing, versus nine percent of the broader economy (Table 5). Given that the clean jobs in the manufacturing sector account for the largest share of any sector in the total clean economy, it is important to look at what portion of manufacturing is clean. According to figures in Table 5, 5% of manufacturing jobs are clean while 4% of manufacturing establishments are clean (more than twice the share of clean jobs in the broader national economy). The smaller establishment share for clean manufacturing indicates that clean manufacturing establishments have more employees than non-manufacturing establishments in the clean economy.

Table 5: The Share of Clean Jobs in the Manufacturing Sector, U.S., 2015

	Jobs		Establishments	
	#	Share	#	Share
Clean Manufacturing Jobs	623,452	23%	14,737	15%
Total Clean Jobs	2,675,547	100%	96,501	100%
All Manufacturing Jobs	12,339,633	9%	340,722	4%
Total Economy Jobs	139,491,699	100%	9,522,775	100%
Clean Manufacturing / All Manufacturing	N.A.	5%	N.A.	4%

3.1.2 Wages in the Clean Economy

Overall, clean economy jobs pay higher wages than other jobs. In 2015, the average wage for a clean economy job was $ 62,089 while it was $ 52,942 for all jobs in the U.S. economy (Figure 4 and Table 6). However, wage levels vary widely given the substantial amount of variation among clean economy segments. The highest paying jobs at the national level are in Solar Photovoltaic, Nuclear Energy, and Fuel Cells segments. Professional Environmental Services is the largest clean economy segment with considerably higher wages than the national average wage for all jobs. Although a small proportion of total national jobs, clean economy jobs are likely to contribute to higher quality of life. Average wages in 28 clean economy segments (out of 39) are higher than average national wages in 2015.

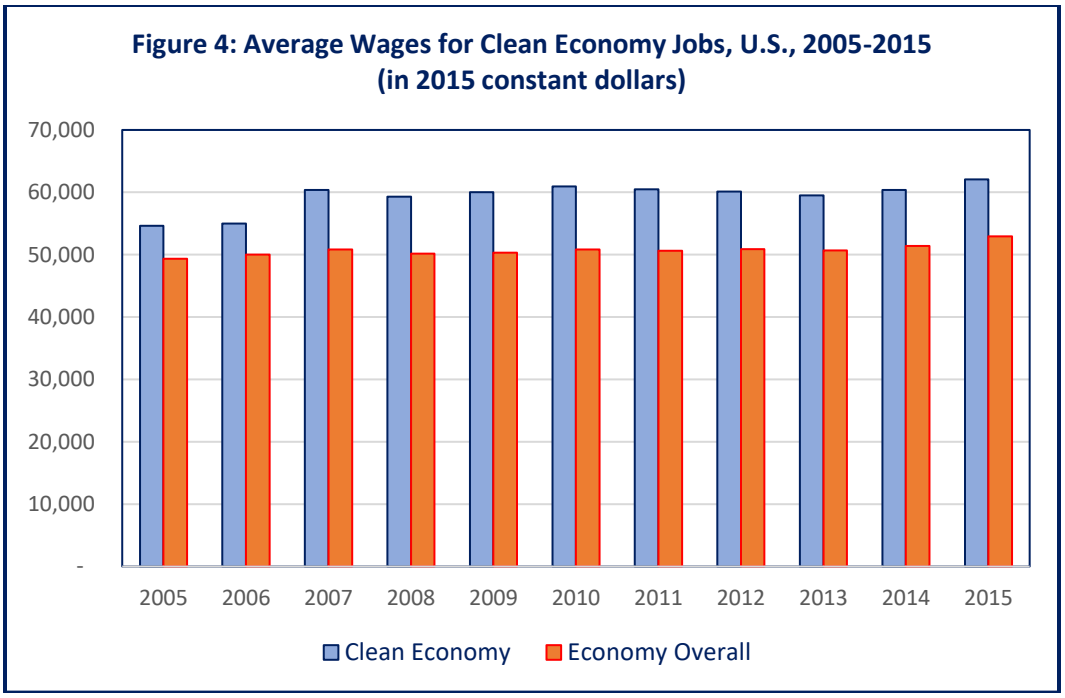


Figure 4: Average Wages for Clean Economy Jobs, U.S., 2005-2015
(in 2015 constant dollars)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Clean Economy
Economy Overall

Table 6: Clean Economy Segments with Highest Average Wages, U.S., 2015

Clean Economy Segment	Jobs, 2015	Wages, 2015
Solar Photovoltaic	27,312	$135,719
Nuclear Energy	72,094	$126,299
Fuel Cells	7,720	$125,332
Professional Energy Services	52,145	$116,329
Hydropower	44,293	$104,928
Waste-to-Energy	3,030	$96,500
Professional Environmental Services	167,694	$96,092
Wind	28,183	$92,592
Lighting	15,726	$87,231
Biofuels/Biomass	20,151	$82,096
Green Architecture and Construction Services	63,308	$76,595
Energy-saving Consumer Products	20,712	$74,074
Geothermal	2,523	$73,172
Smart Grid	16,886	$72,613
Green Chemical Products	23,046	$70,858
Air and Water Purification Technologies	28,525	$70,421
Solar Thermal	6,915	$70,114
Battery Technologies	18,203	$69,431
Renewable Energy Services	2,239	$67,216
Regulation and Compliance	136,516	$64,893
Sustainable Forestry Products	62,283	$63,263
Conservation	322,599	$61,490
Appliances	36,810	$60,847
Recycled-Content Products Recycling and Reuse	67,970	$60,341
HVAC and Building Control Systems	74,513	$59,367
Remediation	58,943	$59,319
Waste Management and Treatment	425,595	$56,709
Energy-saving Building Materials	180,291	$54,771
Clean Economy	***2,893,743***	***$62,089***
Total Economy	***139,491,699***	***$52,942***

3.2. *The Clean Economy in the Chicago Region*

There were 92,567 clean jobs in the Chicago Region economy in 2015 (an increase of 25,585 jobs from 2005), accounting for approximately 2% of total jobs (Table 7 and Figure 5). [10] As discussed in the previous section a similar proportion of jobs in the U.S. economy is clean. Still, 25,585 clean jobs were added to the regional economy during the period of 2005-2015, accounting for more than 21 percent of all new jobs created in the Chicago Region.

Although a very small portion of the regional economy, clean jobs are likely to be a sizeable portion of the broader economy in the near future. The regional clean economy grew faster than the regional economy as a whole between 2005 and 2015. Clean economy jobs increased by 38% while total regional jobs increased by only 2.8% (Table 7 and Figure 6). Differences in employment growth can also be seen in Figure 7. Furthermore, the region's clean economy outperformed the national clean economy (clean jobs in the U.S. grew by 27% during the same period) even though the regional economy as a whole lagged the national growth rate (2.8% vs. 6.0%) (Table 7 and Table 8).

Among clean economy categories, establishments classified in Energy and Resource Efficiency added the most jobs (13,161) while those establishments classified in Renewable Energy had the largest employment rate increase (60%) (Table 7 and Figure 8). Employment decline in Education and Compliance could be due to job losses in the public sector associated with environmental regulation. Compared to the composition of the national clean economy, clean jobs in the region are more concentrated in Energy and Resource Efficiency segment and less concentrated in Agricultural and Natural Resources Conservation segment (Figure 8), which would be expected since the Chicago region is more urbanized than the U.S. as a whole. Higher concentration of clean jobs in the Energy and Resource Efficiency segment are explained by the region's strong specialization in key professional and technical services, manufacturing industries, and the presence of a large public transit network.

[10] The Chicago Region refers to the 14-county Chicago-Naperville-Elgin Metropolitan Statistical Area (MSA), which consists of the following counties: Cook, DeKalb, DuPage, Grundy, Kane, Kendall, Lake, McHenry, Will, Kenosha (WI), Jasper (IN), Lake (IN), Newton (IN), and Porter (IN).

Table 7: Jobs by Clean Economy Categories, the Chicago Region, 2005 - 2015

Clean Economy Categories	Employment, 2005		Employment, 2015		Change (%) 2005-2015
	Jobs	Share (%)	Jobs	Share (%)	
Agricultural and Natural Resources Conservation	4,833	7.2	7,335	7.9	51.8
Education and Compliance	639	1.0	589	0.6	(7.8)
Energy and Resource Efficiency	30,381	45.4	43,542	47.0	43.3
Greenhouse Gas Red., Env. Man., and Recycling	30,121	45.0	39,486	42.7	31.1
Renewable Energy	1,009	1.5	1,616	1.7	60.1
Clean Economy Total	***66,982***	***100.0***	***92,567***	***100.0***	***38.2***
Total Economy	***4,271,038***	***NA***	***4,391,992***	***NA***	***2.8***

Table 8: Changes in Clean Jobs in the Chicago Region and U.S., 2005 - 2015

	2005	2010	2015	*Change, 2005-2015*	*Annual Average Change in Jobs*
Chicago Region	66,982	79,388	92,567	***38.2%***	***3.8%***
United States	2,271,733	2,675,544	2,893,743	***27.4%***	***2.7%***

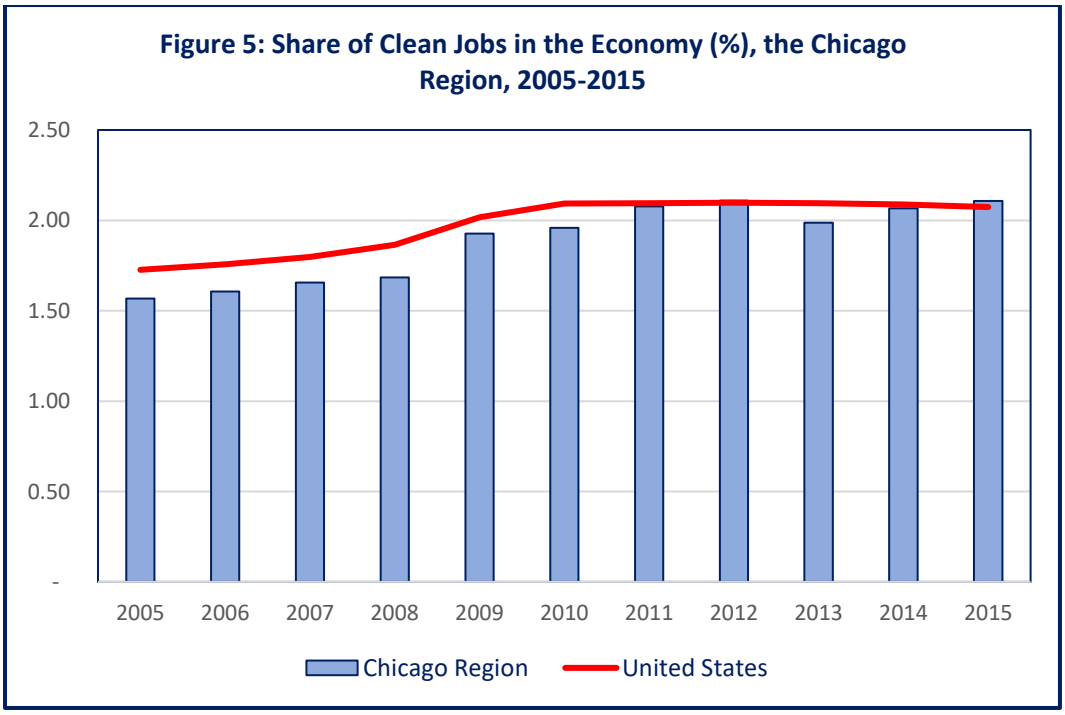


Figure 6: Growth in the Clean Economy Jobs in the Chicago Region, 2005-2015

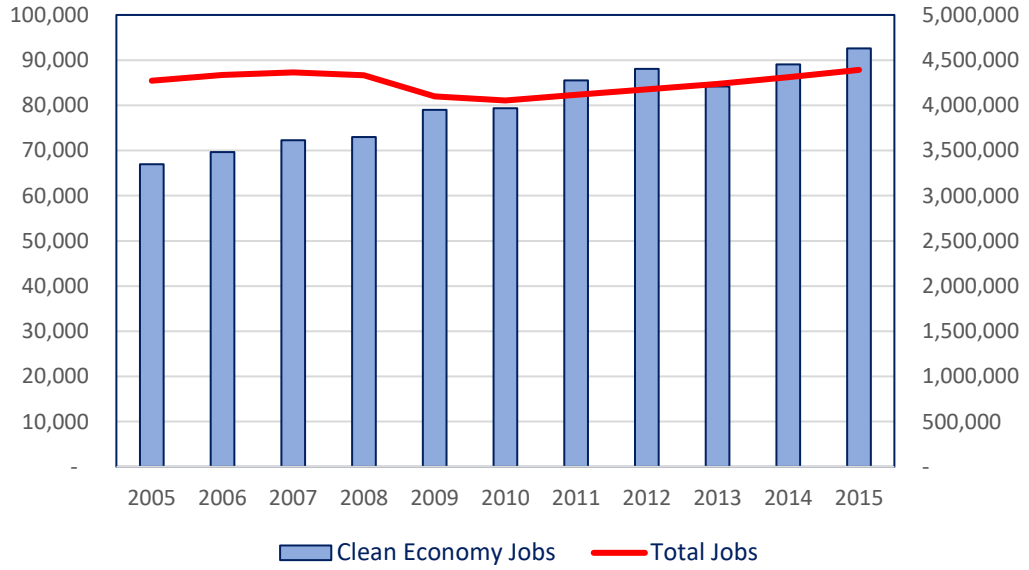


Figure 7: Indexed Employment in Clean Economy, the Chicago Region, 2005-2015

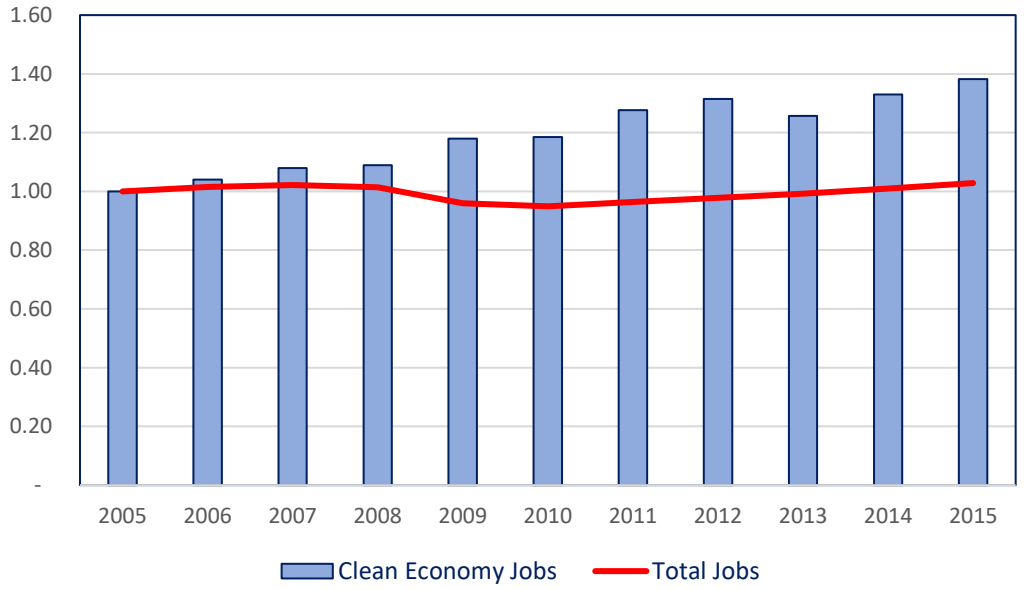


Figure 8: Jobs by Clean Economy Categories, the Chicago Region, 2015

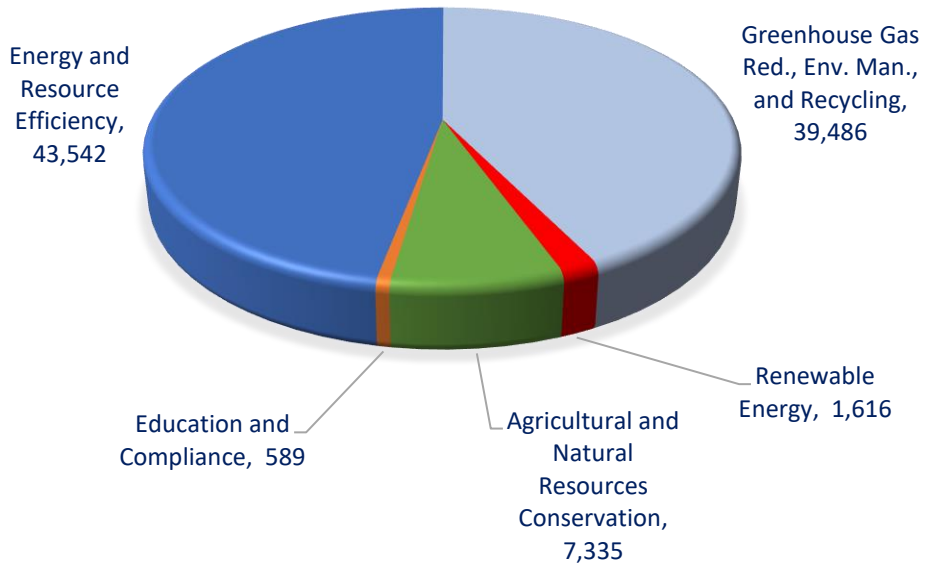


Table 9 examines the distribution of clean jobs in the region at a finer-grained level and compares it by segment to the distribution of clean jobs at the national level. At the regional level, most of the clean jobs are concentrated in industries that focus on energy efficiency and greenhouse gas reduction. Public Mass Transit, Waste Management and Treatment, Recycling and Reuse, and Professional Energy Services had the most jobs respectively in the region (5,000 jobs or more) and are concentrated disproportionally relative to the nation. For example, Public Mass Transit segment accounts for 27.5 percent of the clean jobs in the region while it only accounts for 13.7 percent of the clean jobs in the U.S. Although this finding is indicative of more efficient energy usage in passenger transportation at the local level, it is less interesting for economic development because public transit is a population serving or non-basic sector of the economy. An important finding here for economic development is the higher concentration of clean jobs (compared to the national level) in export oriented or basic sectors such as Professional Energy Services. Employment in this segment is concentrated three times more at the regional level than at the national level. In addition, it ranks 4th by employment in the region while ranking 17th at the national level (Systematic analysis of regional specialization is done through Location Quotients in the following pages).

Similar to observation for the national clean economy, segments with a small number of establishments and employment figures might indicate that firms in these segments are relatively new and probably engaged in production activities that are technologically very different from those firms in more mature segments. Solar Thermal, Smart Grid, Water Efficient Products, and Renewable Energy Services are few examples of these nascent segments.

In terms of new jobs created, Public Mass Transit, Waste Management and Treatment, and Recycling and Reuse added the most jobs (Table 10). The fastest growing segments by employment are Solar Photovoltaic, Appliances, Pollution Reduction, and Solar Thermal (employment doubled in all of these segments). Since employment levels in these segments were very low in 2005, it is important to examine changes in jobs in segments with relatively high level of employment. Two large segments with a substantial increase in employment are Recycling and Reuse and Organic Food and Farming. The large number of jobs created is likely to due to favorable regional conditions for companies in these segments (i.e., increased demand), which might help continue this positive trend in the future.

Unlike the overall positive trend in the regional clean economy, ten segments experienced decline from 2005 to 2015. The reasons discussed above for national trends are likely applicable to the shrinking regional clean economy segments as well. However, there may be specific factors in the region responsible for these downward trends (this is beyond the scope of current study, but will be subject to future investigation).

Table 9: Clean Jobs and Establishments by Clean Economy Segments in the Chicago Region and U.S., 2015

	Chicago Region					United States				
Clean Economy Segment	**Rank**	**Jobs, 2015**	**Share (%)**	**Est., 2015**	**Share (%)**	**Rank**	**Jobs, 2015**	**Share (%)**	**Est., 2015**	**Share (%)**
Public Mass Transit	1	25,446	27.5	531	11.3	2	396,903	13.7	6,948	6.6
Waste Management and Treatment	2	16,535	17.9	1,072	22.8	1	425,595	14.7	16,333	15.4
Recycling and Reuse	3	6,477	7.0	336	7.1	6	152,340	5.3	9,228	8.7
Professional Energy Services	4	5,335	5.8	279	5.9	17	52,145	1.8	2,405	2.3
HVAC and Building Control Systems	5	4,084	4.4	131	2.8	11	74,513	2.6	1,279	1.2
Organic Food and Farming	6	3,861	4.2	182	3.9	7	145,324	5.0	10,638	10.1
Green Architecture and Const. Services	7	3,779	4.1	473	10.0	14	63,308	2.2	6,331	6.0
Green Consumer Products	8	3,159	3.4	113	2.4	10	81,610	2.8	3,462	3.3
Professional Environmental Services	9	2,961	3.2	470	10.0	5	167,694	5.8	6,848	6.5
Conservation	10	2,413	2.6	192	4.1	3	322,599	11.2	11,386	10.8
Energy-saving Building Materials	11	2,276	2.5	93	2.0	4	180,291	6.2	5,532	5.2
Nuclear Energy	12	2,229	2.4	17	0.4	12	72,094	2.5	760	0.7
Air and Water Purification Technologies	13	2,190	2.4	67	1.4	20	28,525	1.0	894	0.9
Green Building Materials	14	1,683	1.8	108	2.3	9	81,659	2.8	3,547	3.4
Remediation	15	1,398	1.5	140	3.0	16	58,943	2.0	2,885	2.7
Recycled-Con. Prods. Recycling & Reuse	16	1,366	1.5	41	0.9	13	67,970	2.4	2,205	2.1
Lighting	17	1,241	1.3	49	1.0	29	15,726	0.5	520	0.5
Sustainable Forestry Products	18	1,061	1.1	13	0.3	15	62,283	2.2	1,287	1.2
Biofuels/Biomass	19	1,051	1.1	26	0.5	25	20,151	0.7	591	0.6
Green Chemical Products	20	935	1.0	31	0.7	23	23,046	0.8	715	0.7
Regulation and Compliance	21	585	0.6	92	2.0	8	136,516	4.7	2,307	2.2
Battery Technologies	22	563	0.6	23	0.5	27	18,203	0.6	606	0.6
Pollution Reduction	23	553	0.6	140	3.0	31	13,343	0.5	241	0.2
Appliances	24	286	0.3	12	0.3	19	36,810	1.3	1,110	1.1
Wind	25	284	0.3	19	0.4	21	28,183	1.0	1,573	1.5
Water Efficient Products	26	254	0.3	6	0.1	30	15,369	0.5	415	0.4
Solar Photovoltaic	27	169	0.2	25	0.5	22	27,312	0.9	525	0.5
Energy-saving Consumer Products	28	150	0.2	12	0.2	24	20,712	0.7	1,231	1.2
Smart Grid	29	111	0.1	6	0.1	28	16,886	0.6	513	0.5
Renewable Energy Services	30	66	0.1	10	0.2	36	2,239	1.0	106	0.1
Solar Thermal	31	28	0.0	2	0.0	33	6,915	0.2	327	0.3
Fuel Cells	32	17	0.0	0	0.0	32	7,720	0.3	128	0.1
Geothermal	33	14	0.0	1	0.0	35	2,523	0.1	103	0.1
Training	34	4	0.0	0	0.0	39	278	0.1	27	0.1
Waste-to-Energy	35	2	0.0	0	0.0	34	3,030	0.1	306	0.3
Hydropower	36	1	0.0	0	0.0	18	44,293	1.5	1,988	1.9
Carbon Storage and Management	37	-	0.0	-	0.0	26	19,845	0.7	10	0.1
Electric Vehicle Technologies	38	-	0.0	-	0.0	37	425	0.1	427	0.4
Wave/Ocean Power	39	-	0.0	-	0.0	38	423	0.1	14	0.1
Total		***92,567***	***100.0***	***4,712***	***100.0***		***2,893,743***	***100.00***	***105,754***	***100.00***

Table 10: Employment Growth in Clean Economy Segments in the Chicago Region, 2005-2015

Clean Economy Segment	Rank	Jobs, 2005	Jobs, 2015	Change (#)	Change (%)
Solar Photovoltaic	1	12	169	157	1,310.0
Appliances	2	82	286	204	248.2
Pollution Reduction	3	216	553	337	156.1
Solar Thermal	4	13	28	15	115.1
Recycling and Reuse	5	3,345	6,477	3,132	93.6
Organic Food and Farming	6	2,235	3,861	1,626	72.8
Public Mass Transit	7	14,908	25,446	10,538	70.7
Wind	8	169	284	115	67.8
Conservation	9	1,491	2,413	922	61.9
Biofuels/Biomass	10	716	1,051	336	46.9
HVAC and Building Control Systems	11	2,858	4,084	1,226	42.9
Air and Water Purification Technologies	12	1,584	2,190	606	38.2
Waste Management and Treatment	13	12,068	16,535	4,467	37.0
Green Building Materials	14	1,265	1,683	418	33.0
Energy-saving Building Materials	15	1,771	2,276	505	28.5
Remediation	16	1,099	1,398	299	27.2
Lighting	17	1,030	1,241	211	20.5
Green Architecture and Construction Services	18	3,223	3,779	556	17.3
Professional Environmental Services	19	2,549	2,961	412	16.2
Battery Technologies	20	494	563	69	13.9
Green Chemical Products	21	842	935	93	11.1
Recycled-Content Products Recycling and Reuse	22	1,243	1,366	123	9.9
Renewable Energy Services	23	63	66	3	4.9
Professional Energy Services	24	5,180	5,335	155	3.0
Carbon Storage and Management	25	-	-	-	NA
Electric Vehicle Technologies	26	-	-	-	NA
Fuel Cells	27	-	17	17	NA
Training	28	-	4	4	NA
Wave/Ocean Power	29	-	-	-	NA
Sustainable Forestry Products	30	1,107	1,061	(46)	(4.2)
Smart Grid	31	119	111	(8)	(6.3)
Green Consumer Products	32	3,405	3,159	(246)	(7.2)
Regulation and Compliance	33	639	585	(54)	(8.4)
Nuclear Energy	34	2,505	2,229	(276)	(11.0)
Waste-to-Energy	35	2	2	(0)	(13.4)
Energy-saving Consumer Products	36	179	150	(30)	(16.6)
Geothermal	37	26	14	(12)	(46.8)
Water Efficient Products	38	535	254	(281)	(52.6)
Hydropower	39	8	1	(7)	(84.8)
Total	***40***	***66,982***	***92,567***	***25,585***	***38.2***

3.2.1. *Clean Manufacturing*

Regarding the share of clean jobs in the manufacturing sector, equivalent percentages are observed for the region as the nation. In the Chicago Region, 5 percent of manufacturing jobs and 4 percent of manufacturing establishments are clean (Table 11). However, the share of the manufacturing sector in the regional clean economy is slightly smaller than the national level (20% at the regional level vs. 23% at the national level). The manufacturing sector accounts for a relatively smaller share of clean jobs in the region due to the dominance of service industries (public transit, energy services etc.). This suggests that some regional non-manufacturing sectors that are part of the clean economy are likely to be cleaner than the regional manufacturing sector (measured as the proportion of clean jobs within the sector). Still, the manufacturing sector is cleaner than the regional economy as a whole (5% of regional manufacturing jobs are clean while only 2.1% of all regional jobs are clean).

Table 11: The Share of Clean Jobs in the Manufacturing Sector, the Chicago Region, 2015

	Jobs		Establishments	
	#	Share	#	Share
Clean Manufacturing Jobs	18,463	20%	446	9%
Total Clean Jobs	92,567	100%	4,712	100%
All Manufacturing Jobs	362,194	9%	11,951	5%
Total Economy Jobs	4,016,846	100%	253,650	100%
Clean Manufacturing / All Manufacturing	N.A.	5%	N.A.	4%

3.2.2. *Wages in the Clean Economy*

Overall, clean economy jobs pay higher wages than other jobs. In 2015, the average wage for a clean economy job was $63,769 while it was $58,887 for all jobs in the region (Figure 9). As discussed in the previous section, a comparable difference is observed for clean jobs in the U.S., however, it is more significant ($62,089 v. $52,942) (Figure 10). While these figures suggest clean economy jobs in the region may not offer as competitive wages as the regional jobs in general, this is an average figure and it is lowered substantially by the relatively large number of low-paying jobs in the Public Mass Transit segment ($35,000). A comparison of wages for regional clean jobs with national equivalents that excludes public transit jobs shows regional clean jobs do pay competitively higher wages (Figure 11).

Although a small proportion of total regional jobs, clean economy jobs are likely to contribute to a higher quality of life. Average wages in 30 clean economy segments (out of 39) are higher than the average regional wages for all jobs in 2015 (Table 12). Nuclear Energy, Professional Energy Services, Professional Environmental Services, HVAC and Building Control Systems, Green

Architecture and Construction Services are the largest clean economy segments with considerably higher wages.

Figure 9: Average Wages for Clean Economy Jobs, the Chicago Region, 2005-2015 (in 2015 constant dollars)

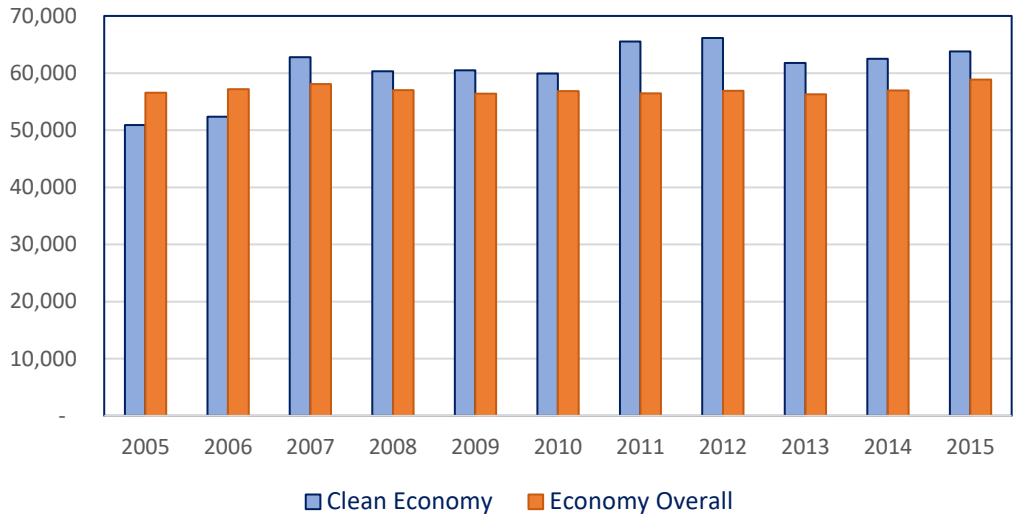
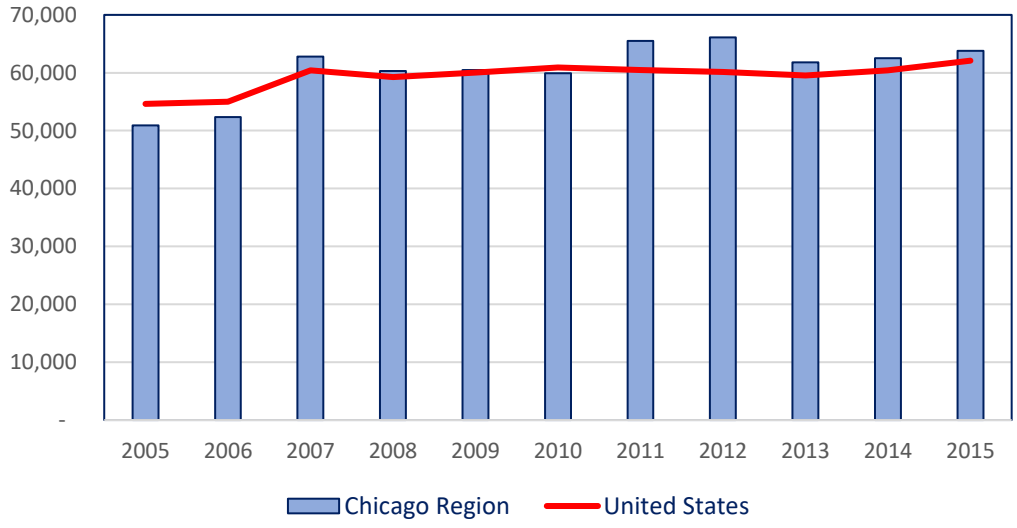


Figure 10: Average Wages for Clean Economy Jobs (with Public Mass Transit Jobs), the Chicago Region, 2005-2015, (in 2015 constant dollars)



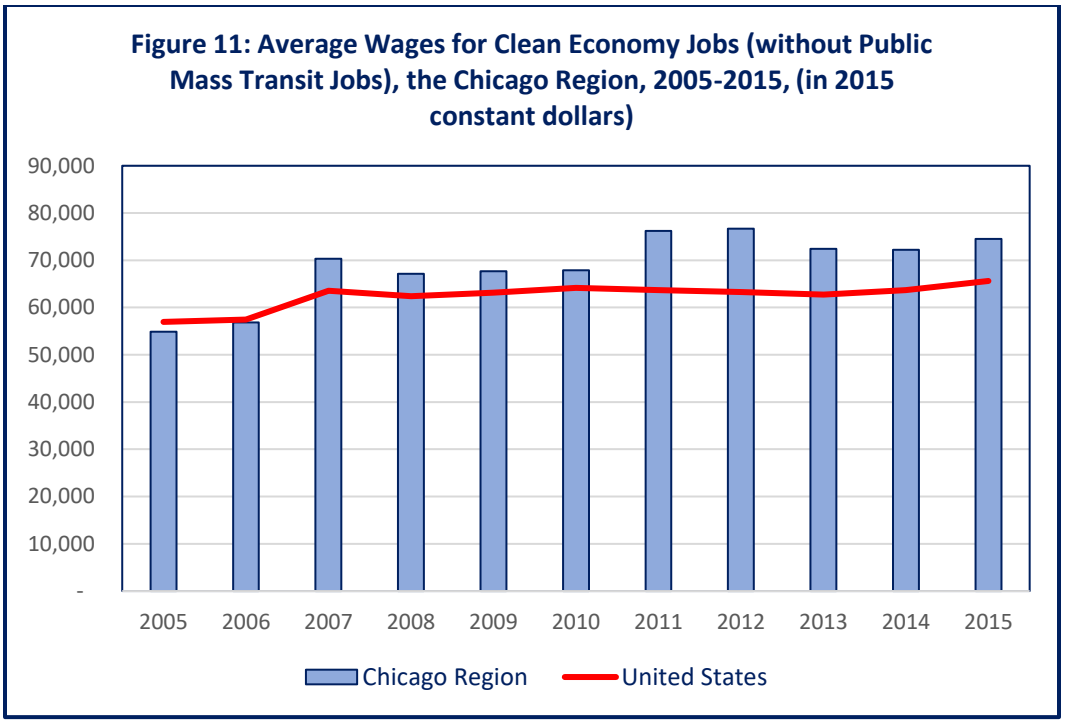


Figure 11: Average Wages for Clean Economy Jobs (without Public Mass Transit Jobs), the Chicago Region, 2005-2015, (in 2015 constant dollars)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Chicago Region
United States

Table 12: Clean Economy Segments with Highest Average Wages, the Chicago Region, 2015

Clean Economy Segment	Jobs, 2015	Wages, 2015
Hydropower	1	$ 151,811
Nuclear Energy	2,229	$ 123,983
Fuel Cells	17	$ 114,159
Regulation and Compliance	585	$ 113,381
Professional Energy Services	5,335	$ 111,432
Waste-to-Energy	2	$ 106,430
Professional Environmental Services	2,961	$ 103,501
Wind	284	$ 93,054
HVAC and Building Control Systems	4,084	$ 87,781
Solar Thermal	28	$ 87,676
Green Architecture and Construction Services	3,779	$ 85,422
Biofuels/Biomass	1,051	$ 85,392
Geothermal	14	$ 81,816
Sustainable Forestry Products	1,061	$ 79,119
Renewable Energy Services	66	$ 77,595
Appliances	286	$ 73,032
Smart Grid	111	$ 72,815
Battery Technologies	563	$ 70,895
Green Chemical Products	935	$ 70,595
Waste Management and Treatment	16,535	$ 67,898
Water Efficient Products	254	$ 67,515
Recycled-Content Products Recycling and Reuse	1,366	$ 65,137
Pollution Reduction	553	$ 65,123
Air and Water Purification Technologies	2,190	$ 64,815
Remediation	1,398	$ 61,270
Green Building Materials	1,683	$ 60,915
Lighting	1,241	$ 60,713
Green Consumer Products	3,159	$ 59,441
Organic Food and Farming	3,861	$ 59,166
Energy-saving Building Materials	2,276	$ 59,116
Clean Economy	***92,567***	***$ 63,769***
Total Economy	***4,391,992***	***$ 58,887***

3.2.3. Regional Specialization in Clean Economy Segments

The Chicago Region is specialized in at least ten clean economy segments based on 2015 Location Quotients (LQs), an economic analysis technique used to identify the concentration of an industry sector in a region compared to the nation (see Regional Economic Measure in the Appendix). Employment concentration in Professional Energy Services, Lighting, and Air - Water Purification

Technologies is at least twice as high as the national average. This suggests that regional firms in these segments are specialized in the production and delivery of certain goods and services that are likely sold outside the region.

Table 13: Regional Specialization in Clean Economy Segments, the Chicago Region, 2015

Clean Economy Segment	Regional Employment, 2015	Establishments, 2015	LQ, 2015
Professional Energy Services	5,335	279	3.25
Lighting	1,241	49	2.51
Air and Water Purification Technologies	2,190	67	2.44
Public Mass Transit	25,446	531	2.04
Green Architecture and Construction Services	3,779	473	1.90
HVAC and Building Control Systems	4,084	131	1.74
Biofuels/Biomass	1,051	26	1.66
Recycling and Reuse	6,477	336	1.35
Pollution Reduction	553	140	1.32
Green Chemical Products	935	31	1.29
Waste Management and Treatment	16,535	1,072	1.23
Green Consumer Products	3,159	113	1.23

3.2.4. Components of Employment Growth in Clean Economy Segments

As noted, the regional clean economy is performing better than the national clean economy. Using Shift-Share analysis, a technique to analyze change over time in the local economy compared to the national economy, suggests that the region has some competitive advantage (see Regional Economic Measure in the Appendix).

The national growth component (see below) shows that, if the region's clean economy growth rate were identical to that of the national economy, then the number of clean jobs in the region should have grown by 18,340 between 2005 and 2015. However, the region gained 25,585 clean jobs from 2005 to 2015. Of the difference (7,245 jobs), the industry mix component indicates that the region has 2,133 more jobs than it would have if its structure were identical to the nation, which means the local clean industrial mix has some industries that are growing faster than the national average. The local share component indicates that 5,112 jobs in the region are attributable to its relative competitive position and characteristics specific to the local economy.

Regional Shift = 25,585 jobs
National Shift = 18,340 jobs
Industry Mix = 2,133 jobs
Local Competitive Shift = 5,112 jobs

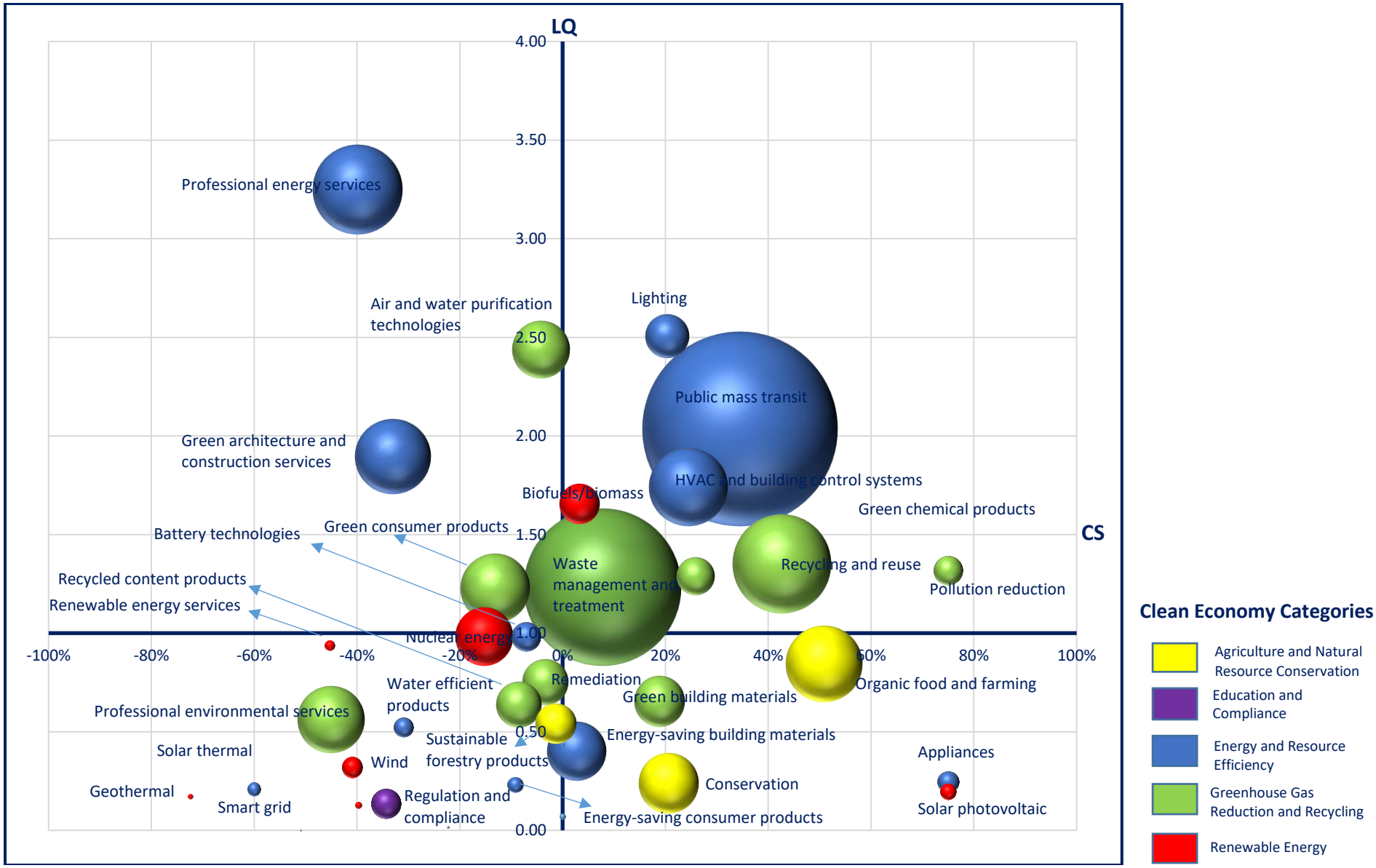
Figure 12 graphically summarizes the employment size, and the concentration and growth performance results for individual clean economy segments. The employment concentration relative to the nation (LQ) appears on the vertical axis and the local component of the change in employment from 2005 to 2015 appears on the horizontal axis. The size of the circles represents current employment levels while the different colors correspond to five clean economy categories. Segments that appear in the upper right quadrant (high LQ-high competitive shift) represent solid strengths in the regional economy. For example, Lighting, HVAC and Building Control Systems, Recycling and Reuse are both locally concentrated and growing locally faster than the national industrial average. Positive competitive shifts suggest that local factors, specific to the Chicago Region, contributed to the growth of these segments.

Industries that appear in the upper left quadrant (high LQ-low competitive shift) represent current industrial strengths that are maturing or struggling. Two major service-oriented clean economy segments (Professional Energy Services, and Green Architecture and Construction Services) and two major manufacturing-oriented segments (Air and Water Purification Technologies, and Green Consumer Products) are located in this quadrant. Negative competitive shifts mean that these segments are not growing at the same rate as the national industrial average. Among those four industries, only Green Consumer Products segment has negative growth rate from 2005 to 2015.

Industries that appear in the lower right quadrant (low LQ-high competitive shift) represent potential emerging local industrial strengths. Two manufacturing-related clean economy segments (Energy Saving Building Materials and Green Building Materials) appear in this quadrant. Conservation and Organic food and farming segments are also located in this quadrant. Because they are growing faster than national industry trends suggest, these industries might expand and become regionally concentrated in the future.

The lower left quadrant (low LQ-low competitive shift) contains segments that are not locally concentrated, suggesting the regional economy does not currently exhibit a competitive advantage to support employment growth in these segments.

Figure 12: Regional Concentration and Regional Effects, the Chicago Region



3.3. *The Clean Economy in Cook County*

Sixty percent of the region's clean jobs are in Cook County (55,800 jobs), accounting for approximately 2.2% of total local jobs (Table 14 and Figure 13). A slightly larger proportion of jobs in Cook County is clean compared to the entire Chicago Region (2.1%) and the nation (2.1%).[11]

The 12,787 clean jobs added to Cook County during the period of 2005-2015 accounts for more than half of all new jobs created. And as with the region, Cook County's clean economy grew faster than the local economy as a whole between 2005 and 2015. Clean economy jobs increased by 29.7 percent while total local jobs increased by only 1.0 percent (Table 14). Differences in employment growth can also be seen in Figure 15 where employment levels for the local clean economy and the local economy as a whole are shown as shares of 2005 employment. The county's clean economy grew at almost the same rate as the national clean economy. However, it is important to note that during the same period, Cook County's economy as a whole lagged behind national growth by a wide margin (1% vs. 6%) (Table 14 and Table 15).

Among the clean economy categories, Greenhouse Gas Reduction, Environmental Management and Recycling added the largest number of jobs and had the largest employment rate increase (41.7%) (Table 14). At the local level, most of the clean jobs are concentrated in two clean economy categories: Energy and Resource Efficiency and Greenhouse Gas Reduction. A similar pattern is observed at the national level although to a lesser degree (Energy and Resource Efficiency is the largest segment in Cook County, but second largest in the U.S.) (Figure 16).

Table 14: Jobs by Clean Economy Categories, Cook County, 2005 - 2015

Clean Economy Categories	**Employment, 2005**		**Employment, 2015**		**Change (%) 2005-2015**
	Jobs	**Share (%)**	**Jobs**	**Share (%)**	
Agricultural and Natural Resources Conservation	4,060	9.4	4,030	7.2	(0.7)
Education and Compliance	625	1.5	574	1.0	(8.2)
Energy and Resource Efficiency	20,814	48.4	26,880	48.2	29.1
Greenhouse Gas Reduction, Environmental Mgmt., and Recycling	16,671	38.8	23,619	42.3	41.7
Renewable Energy	842	2.0	697	1.2	(17.2)
Clean Economy Total	**43,013**	**100.0**	**55,800**	**100.0**	**29.7**
Total Economy	**2,507,049**	**N.A.**	**2,531,066**	**N.A.**	**1.0**

[11] This is in large part due to public transit jobs at the Chicago Transit Authority (CTA), located in the City of Chicago (Cook County).

Table 15: Changes in Clean Jobs in Cook County, the Chicago Region, and the U.S., 2005 - 2015

	2005	2010	2015	*Change, 2005-2015*	*Annual Average Change in Jobs*
Cook County	43,013	51,422	55,800	***29.7%***	***3.0%***
Chicago Region	66,982	79,388	92,567	***38.2%***	***3.8%***
United States	2,271,733	2,675,544	2,893,743	***27.4%***	***2.7%***

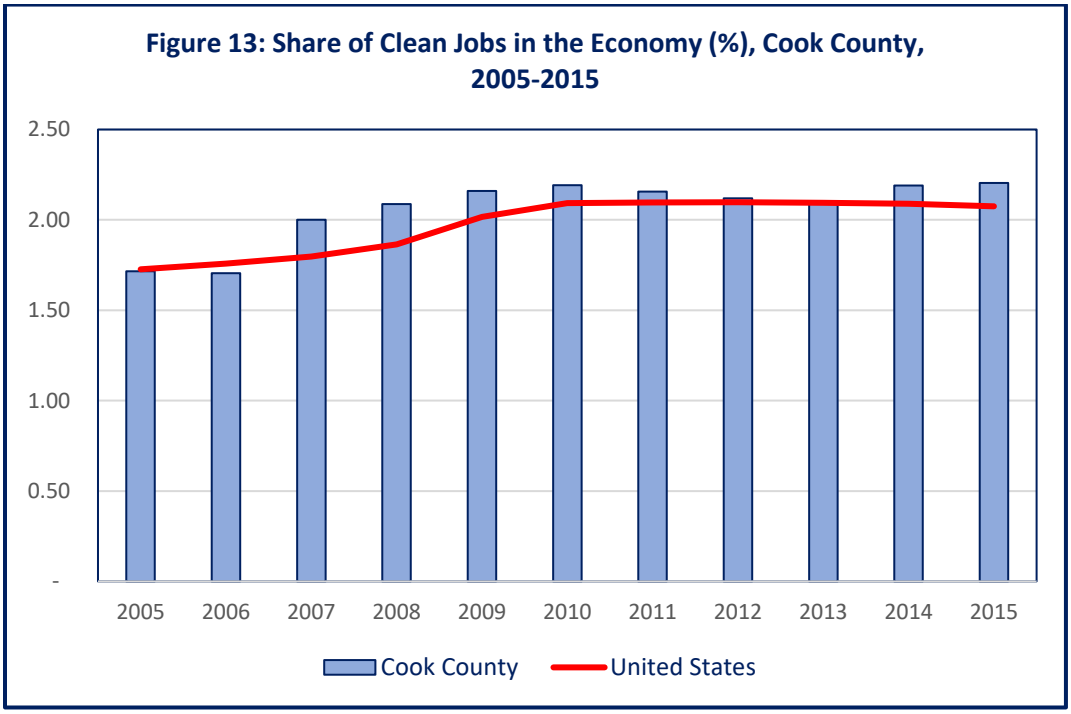


Figure 14: Growth in the Clean Economy Jobs in Cook County, 2005-2015

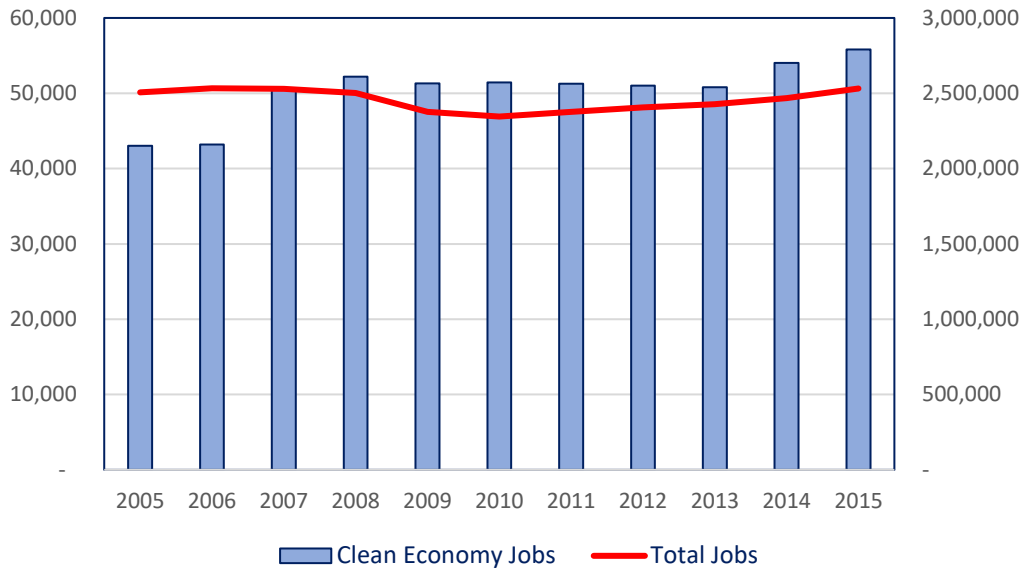


Figure 15: Indexed Employment in Clean Economy, Cook County, 2005-2015

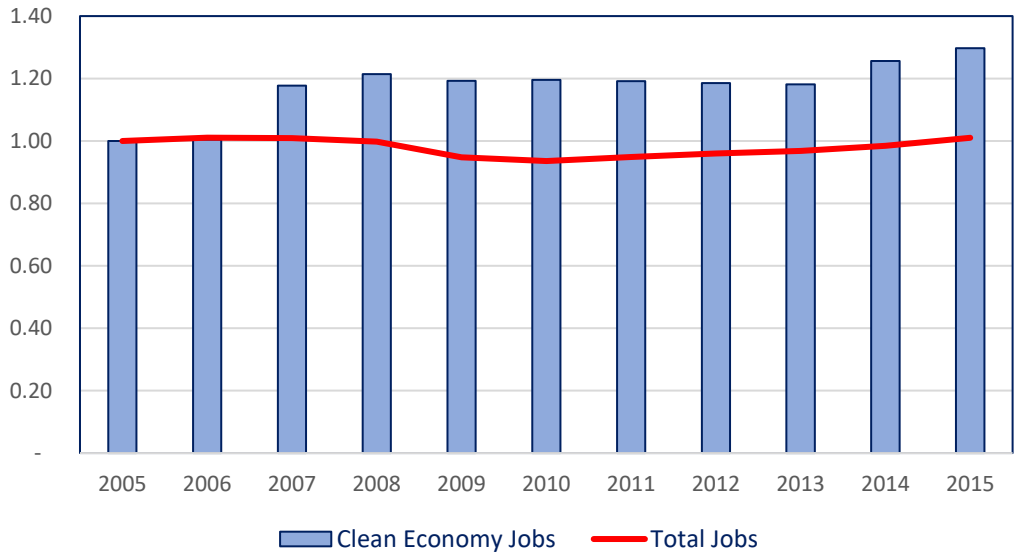


Figure 16: Jobs by Clean Economy Categories, Cook County, 2015

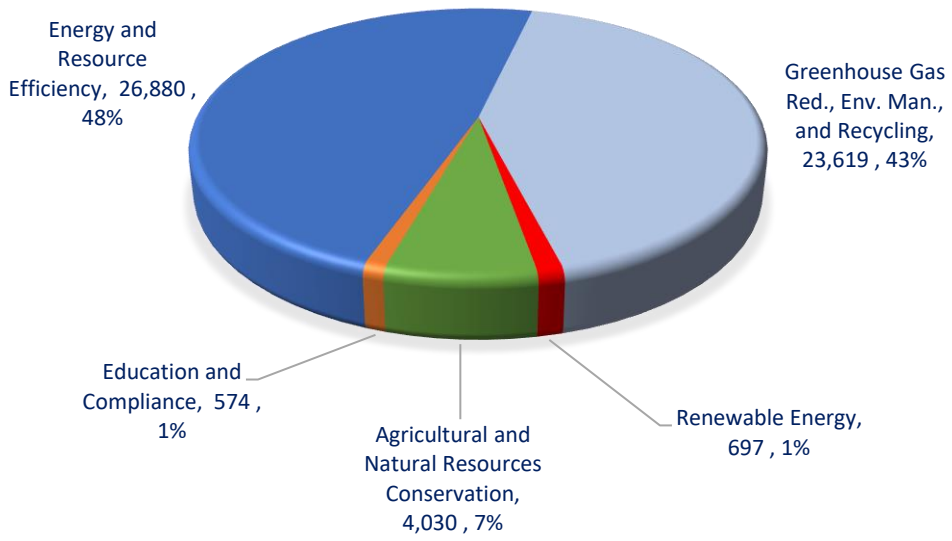


Table 16 examines the distribution of clean jobs in the county at finer-grained level and compares the distribution of clean jobs by segment to the national level. At the local level, most of the clean jobs are concentrated in establishments that focus on energy efficiency and greenhouse gas reduction. A similar concentration is observed at the clean economy segment level. Three top clean economy segments (Public Mass Transit; Waste Management and Treatment; and Recycling and Reuse) constitute nearly 60 percent of total clean jobs in Cook County. The same three segments account for only one third of all clean jobs in the U.S. Public Mass Transit, Waste Management and Treatment, Recycling and Reuse, Professional Energy Services, Green Architecture and Construction Services had the most jobs respectively in the county (2,000 jobs or more).

Similar to observations about the national and regional clean economies, a segment with a small number of establishments and employment figures might indicate that firms in these segments are relatively new and likely to be engaged in production activities that are technologically very different from those firms in mature segments. Solar Thermal, Smart Grid, Water Efficient Products, and Renewable Energy Services are few examples of these nascent segments.

In terms of new clean jobs created, Public Mass Transit, Waste Management and Treatment, and Professional Energy Services added the most jobs (Table 17). The fastest growing segments by employment are Waste-to-Energy, Wind, Professional Energy Services, and Solar Photovoltaic, Pollution Reduction, and Professional Environmental Services (employment doubled in all these segments). Since employment in some of these segments was relatively low in 2005, it is

important to examine changes in jobs in segments with relatively high level of employment. Two large segments with a substantial increase in employment are Professional Energy Services and Professional Environmental Services. Significant job creation in these segments is likely due to favorable local conditions for companies in these segments (i.e., increased demand), which may continue in the future.

Unlike the overall positive trend in the local clean economy, ten segments declined since 2005. The reasons discussed above for the declining national clean economy segments are likely applicable to shrinking local clean economy segments as well. However, there might be locally-specific factors responsible for these downward trends (this is beyond the scope of current study, but will be subject to future investigation).

Table 16: Clean Jobs and Establishments by Clean Economy Segments in Cook County and U.S., 2015

	Cook County					United States				
Clean Economy Segment	Rank	Jobs, 2015	Share (%)	Est., 2015	Share (%)	Rank	Jobs, 2015	Share (%)	Est., 2015	Share (%)
Public Mass Transit	1	17,804	31.9	374	15.1	2	396,903	13.7	6,948	6.6
Waste Management and Treatment	2	10,738	19.2	538	21.8	1	425,595	14.7	16,333	15.4
Recycling and Reuse	3	4,919	8.8	199	8.0	6	152,340	5.3	9,228	8.7
Professional Energy Services	4	2,934	5.3	157	6.3	17	52,145	1.8	2,405	2.3
Green Architecture and Construction Services	5	2,788	5.0	304	12.3	14	63,308	2.2	6,331	6.0
Organic Food and Farming	6	1,868	3.3	53	2.1	7	145,324	5.0	10,638	10.1
Professional Environmental Services	7	1,613	2.9	229	9.3	5	167,694	5.8	6,848	6.5
Conservation	8	1,516	2.7	63	2.5	3	322,599	11.1	11,386	10.8
Green Consumer Products	9	1,411	2.5	55	2.2	10	81,610	2.8	3,462	3.3
HVAC and Building Control Systems	10	1,249	2.2	74	3.0	11	74,513	2.6	1,279	1.2
Green Building Materials	11	998	1.8	54	2.2	9	81,659	2.8	3,547	3.4
Recycled-Con. Prods. Recycling & Reuse	12	981	1.8	25	1.0	13	67,970	2.3	2,205	2.1
Pollution Reduction	13	799	1.4	100	4.1	31	13,343	0.5	241	0.2
Lighting	14	749	1.3	26	1.0	29	15,726	0.5	520	0.5
Sustainable Forestry Products	15	647	1.2	7	0.3	15	62,283	2.2	1,287	1.2
Remediation	16	633	1.1	61	2.5	16	58,943	2.0	2,885	2.7
Nuclear Energy	17	628	1.1	8	0.3	12	72,094	2.5	760	0.7
Energy-saving Building Materials	18	613	1.1	37	1.5	4	180,291	6.2	5,532	5.2
Regulation and Compliance	19	572	1.0	3	0.1	8	136,516	4.7	2,307	2.2
Green Chemical Products	20	502	0.9	18	0.7	23	23,046	0.8	715	0.7
Air and Water Purification Technologies	21	396	0.7	22	0.9	20	28,525	1.0	894	0.8
Biofuels/Biomass	22	291	0.5	4	0.2	25	20,151	0.7	591	0.6
Wind	23	284	0.5	14	0.6	21	28,183	1.0	1,573	1.5
Battery Technologies	24	284	0.5	10	0.4	27	18,203	0.6	606	0.6
Water Efficient Products	25	169	0.3	3	0.1	30	15,369	0.5	415	0.4
Appliances	26	135	0.2	6	0.2	19	36,810	1.3	1,110	1.0
Energy-saving Consumer Products	27	95	0.2	7	0.3	24	20,712	0.7	1,231	1.2
Solar Photovoltaic	28	56	0.1	11	0.4	22	27,312	0.9	525	0.5
Smart Grid	29	56	0.1	3	0.1	28	16,886	0.6	513	0.5
Renewable Energy Services	30	34	0.1	5	0.2	36	2,239	0.1	106	0.1
Solar Thermal	31	16	0.0	1	0.0	33	6,915	0.2	327	0.3
Geothermal	32	14	0.0	1	0.0	35	2,523	0.1	103	0.1
Fuel Cells	33	4	0.0	0	0.0	32	7,720	0.3	128	0.1
Training	34	2	0.0	0	0.0	39	278	0.0	27	0.0
Waste-to-Energy	35	2	0.0	0	0.0	34	3,030	0.1	306	0.3
Hydropower	36	1	0.0	0	0.0	18	44,293	1.5	1,988	1.9
Carbon Storage and Management	37	-	0.0	-	0.0	26	19,845	0.7	10	0.0
Electric Vehicle Technologies	38	-	0.0	-	0.0	37	425	0.0	427	0.4
Wave/Ocean Power	39	-	0.0	-	0.0	38	423	0.0	14	0.0
Total		**55,800**	**100.0**	**2,472**	**100.0**	**40**	**2,893,743**	**100.0**	**105,754**	**100.0**

Table 17: Employment Growth in Clean Economy Segments in Cook County, 2005-2015

Clean Economy Segment	Rank	Jobs, 2005	Jobs, 2015	Change (#)	Change (%)
Waste-to-Energy	1	0	2	2	947.7
Wind	2	47	284	238	508.4
Professional Energy Services	3	628	2,934	2,306	367.0
Solar Photovoltaic	4	12	56	44	365.3
Pollution Reduction	5	216	799	583	270.0
Professional Environmental Services	6	544	1,613	1,069	196.4
Appliances	7	82	135	53	64.6
Recycling and Reuse	8	3,055	4,919	1,865	61.0
Waste Management and Treatment	9	6,901	10,738	3,837	55.6
Remediation	10	417	633	216	51.9
Recycled-Content Products Recycling and Reuse	11	708	981	272	38.4
Public Mass Transit	12	13,232	17,804	4,573	34.6
Conservation	13	1,199	1,516	316	26.4
Solar Thermal	14	13	16	3	21.9
Geothermal	15	11	14	2	17.5
Battery Technologies	16	264	284	19	7.4
Sustainable Forestry Products	17	625	647	21	3.4
Carbon Storage and Management	18	-	-	-	NA
Electric Vehicle Technologies	19	-	-	-	NA
Fuel Cells	20	-	4	4	NA
Training	21	-	2	2	NA
Wave/Ocean Power	22	-	-	-	NA
Nuclear Energy	23	635	628	(8)	(1.2)
Green Architecture and Construction Services	24	2,824	2,788	(35)	(1.2)
Renewable Energy Services	25	35	34	(1)	(2.5)
Green Building Materials	26	1,046	998	(49)	(4.6)
Regulation and Compliance	27	625	572	(53)	(8.5)
HVAC and Building Control Systems	28	1,398	1,249	(149)	(10.7)
Lighting	29	868	749	(119)	13.7)
Energy-saving Consumer Products	30	113	95	(17)	(15.4)
Smart Grid	31	66	56	(11)	(16.0)
Organic Food and Farming	32	2,235	1,868	(367)	(16.4)
Green Consumer Products	33	1,746	1,411	(335)	(19.2)
Green Chemical Products	34	661	502	(159)	(24.0)
Water Efficient Products	35	235	169	(67)	(28.3)
Energy-saving Building Materials	36	1,105	613	(492)	(44.5)
Air and Water Purification Technologies	37	741	396	(345)	(46.6)
Biofuels/Biomass	38	716	291	(424)	(59.3)
Hydropower	39	8	1	(7)	(92.0)
Total		43,013	55,800	12,788	29.7

3.3.1 Clean Manufacturing

Regarding the share of clean jobs in the manufacturing sector, the percentage of clean manufacturing jobs at the county level is smaller compared to the regional and national levels. In Cook County, 4 percent of manufacturing jobs and 3 percent of manufacturing establishments are clean (Table 18). Reflecting the pattern at the regional level, the share of manufacturing sector in the local clean economy is much smaller compared to the national level (13% at the local level vs. 23% at the national level). There are a few possible reasons for this pattern. First, the local clean economy is dominated by service industries (public transit, energy services etc.) that reduce the share of clean manufacturing jobs in the local clean economy. Second, manufacturing jobs in the county may be concentrated in sub-sectors that are less amenable to transitioning to the clean economy. Third, there may be locally specific factors that prevent some manufacturing establishments from producing green products and/or clean technologies. Still, the local manufacturing sector is cleaner than the local economy as a whole (4% of local manufacturing jobs are clean while only 2.2% of all local jobs are clean).

Table 18: The Share of Clean Jobs in the Manufacturing Sector, Cook County, 2015

	Jobs		Establishments	
	#	Share	#	Share
Clean Manufacturing Jobs	7,605	14%	224	9%
Total Clean Jobs	55,800	100%	2,472	100%
All Manufacturing Jobs	186,967	7%	6,426	4%
Total Economy Jobs	2,531,066	100%	152,794	100%
Clean Manufacturing / All Manufacturing	N.A.	4%	N.A.	3%

3.3.2 Wages in the Clean Economy

Overall, clean economy jobs pay higher wages than other jobs. In 2015, the average wage for clean economy jobs was $64,517 while it was $61,915 for all jobs in the county (Figure 17). As discussed above, there is a comparable difference for clean jobs in the region and in the U.S. Also, as noted earlier, the average pay for clean jobs is lowered substantially by the relatively low-paying jobs in the Public Mass Transit segment (average of $35,000). The comparison of wages for regional clean jobs with their national equivalents (without public transit jobs) show that regional clean jobs do pay competitively higher wages (Figure 18 and Figure 19).

Average wages in 24 clean economy segments (out of 39) are higher than average regional wages in 2015 (Table 19). It is important to note that at the regional level 30 of 39 clean economy segments have higher than average wages in 2015. In Cook County, Professional Energy Services, Professional Environmental Services, HVAC and Building Control Systems, Green Architecture and Construction Services are the largest clean economy segments with considerably higher wages.

Figure 17: Average Wages for Clean Economy Jobs, Cook County, 2005-2015 (in 2015 constant dollars)

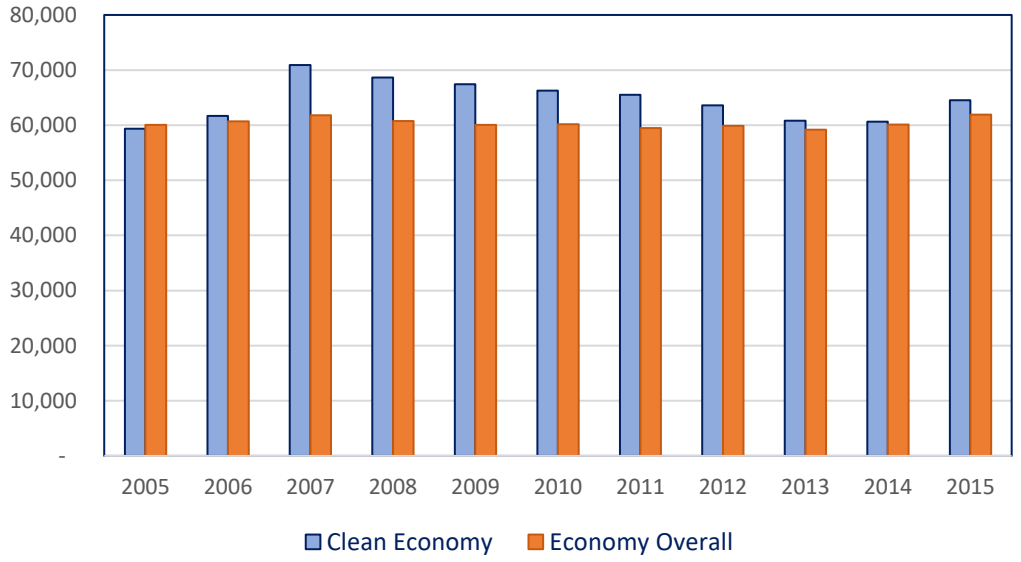


Figure 18: Average Wages for Clean Economy Jobs (with Public Transit Jobs), Cook County, 2005-2015, (in 2015 constant dollars),

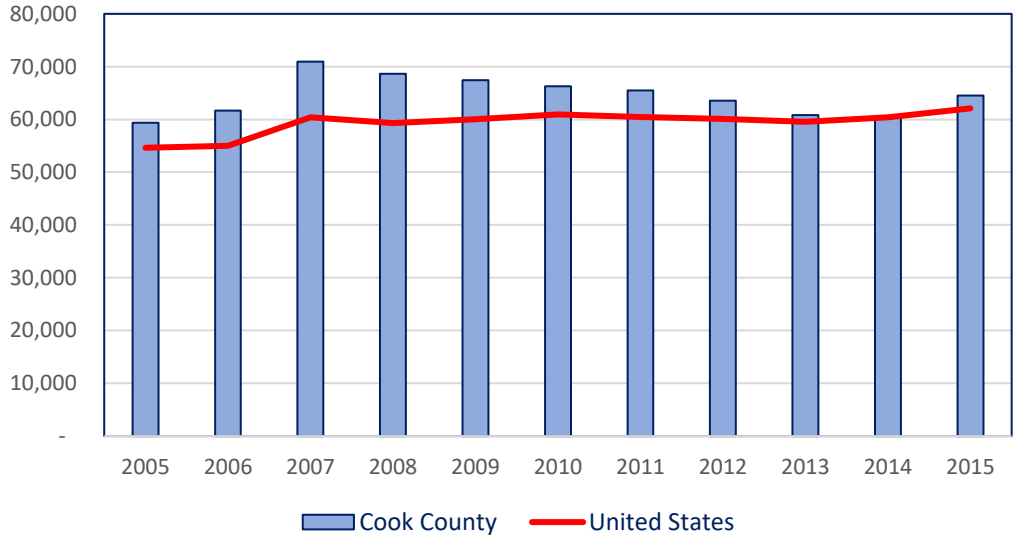


Figure 19: Average Wages for Clean Economy Jobs (without Public Transit Jobs), Cook County, 2005-2015, (in 2015 constant dollars)

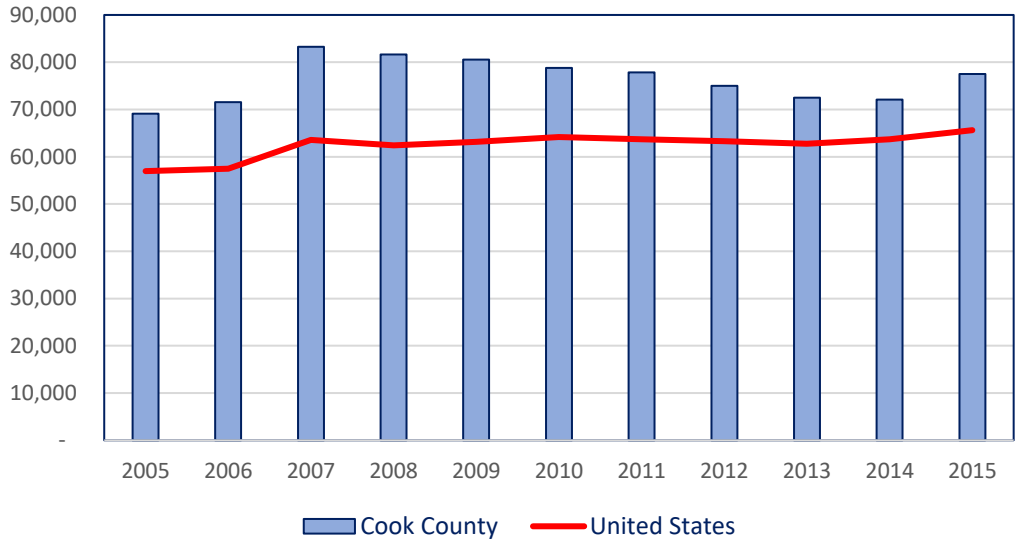


Table 19: Clean Economy Segments with Highest Average Wages, Cook County, 2015 (2015 dollars)

Clean Economy Segment	Jobs, 2015	Wages, 2015
Wind	284	$137,756
Nuclear Energy	628	$133,058
Professional Energy Services	2,934	$123,054
Professional Environmental Services	1,613	$115,349
Fuel Cells	4	$114,405
Solar Thermal	16	$103,860
Waste-to-Energy	2	$103,430
Hydropower	1	$101,747
HVAC and Building Control Systems	1,249	$95,751
Biofuels/Biomass	291	$92,375
Green Architecture and Construction Services	2,788	$87,555
Renewable Energy Services	34	$85,701
Geothermal	14	$84,696
Sustainable Forestry Products	647	$81,996
Appliances	135	$81,542
Smart Grid	56	$78,336
Battery Technologies	284	$76,383
Regulation and Compliance	572	$74,474
Waste Management and Treatment	10,738	$73,824
Green Chemical Products	502	$72,395
Conservation	1,516	$70,817
Water Efficient Products	169	$68,614
Air and Water Purification Technologies	396	$68,076
Recycled-Content Products Recycling and Reuse	981	$65,691
Clean Economy	***55,800***	***$64,517***
Total Economy	***2,531,066***	***$61,915***

3.3.3 Regional Specialization in Clean Economy Segments

Cook County specializes in at least eight clean economy segments. Employment concentration in Pollution Reduction, Professional Energy Services, Lighting, Public Mass Transit, and Green Architecture and Construction Services is at least twice as high as the national average based on LQ scores in 2015 (Table 20). This suggests that local firms in these segments are specialized in the production and delivery of certain goods and services that are likely sold outside the county.

Table 20: Local Specialization in Clean Economy Segments, Cook County, 2015

Clean Economy Segment	Local Employment, 2015	Establishments, 2015	LQ, 2015
Pollution Reduction	799	100	3.30
Professional Energy Services	2,934	157	3.10
Lighting	749	26	2.62
Public Mass Transit	17,804	374	2.47
Green Architecture and Construction Services	2,788	304	2.43
Recycling and Reuse	4,919	199	1.78
Waste Management and Treatment	10,738	538	1.39
Green Chemical Products	502	18	1.20

3.3.4 Components of Employment Growth in Clean Economy Segments

The Cook County clean economy is performing slightly better than the national clean economy based on the Shift-Share analysis completed. The national growth component (see below) shows that, if the county's clean economy growth rate were identical to that of the national economy, then the number of clean jobs in the county should have grown by 11,777 between 2005 and 2015. However, the region gained 12,787 clean jobs from 2005 to 2015. Of the difference (1,010 jobs), the industry mix component indicates that the county has 1,502 more jobs than it would have if its structure were identical to the nation, which means the county industrial mix has some industries that are growing faster than the national average. However, the local share component indicates that 492 jobs fewer jobs in the county are attributable to its relative competitive position and characteristics specific to the local economy.

Cook County shift = 12,787 jobs
National Shift = 11,777 jobs
Industry Mix = 1,502 jobs
Local Competitive Shift = - 492 jobs

Figure 20 below graphically summarizes the employment concentration and growth performance results for individual clean economy segments. In this graph the LQ (the employment concentration relative to the nation) appears on the vertical axis and the local component of the change in employment from 2005 to 2015 appears on the horizontal axis. The size of the circle represents current employment levels while the different colors correspond to five clean economy categories.

Segments that appear in the upper right quadrant (high LQ-high competitive shift) represent solid strengths in Cook County. For example, Pollution Reduction, Professional Energy Services, and Recycling and Reuse are both locally concentrated and growing locally faster than the national

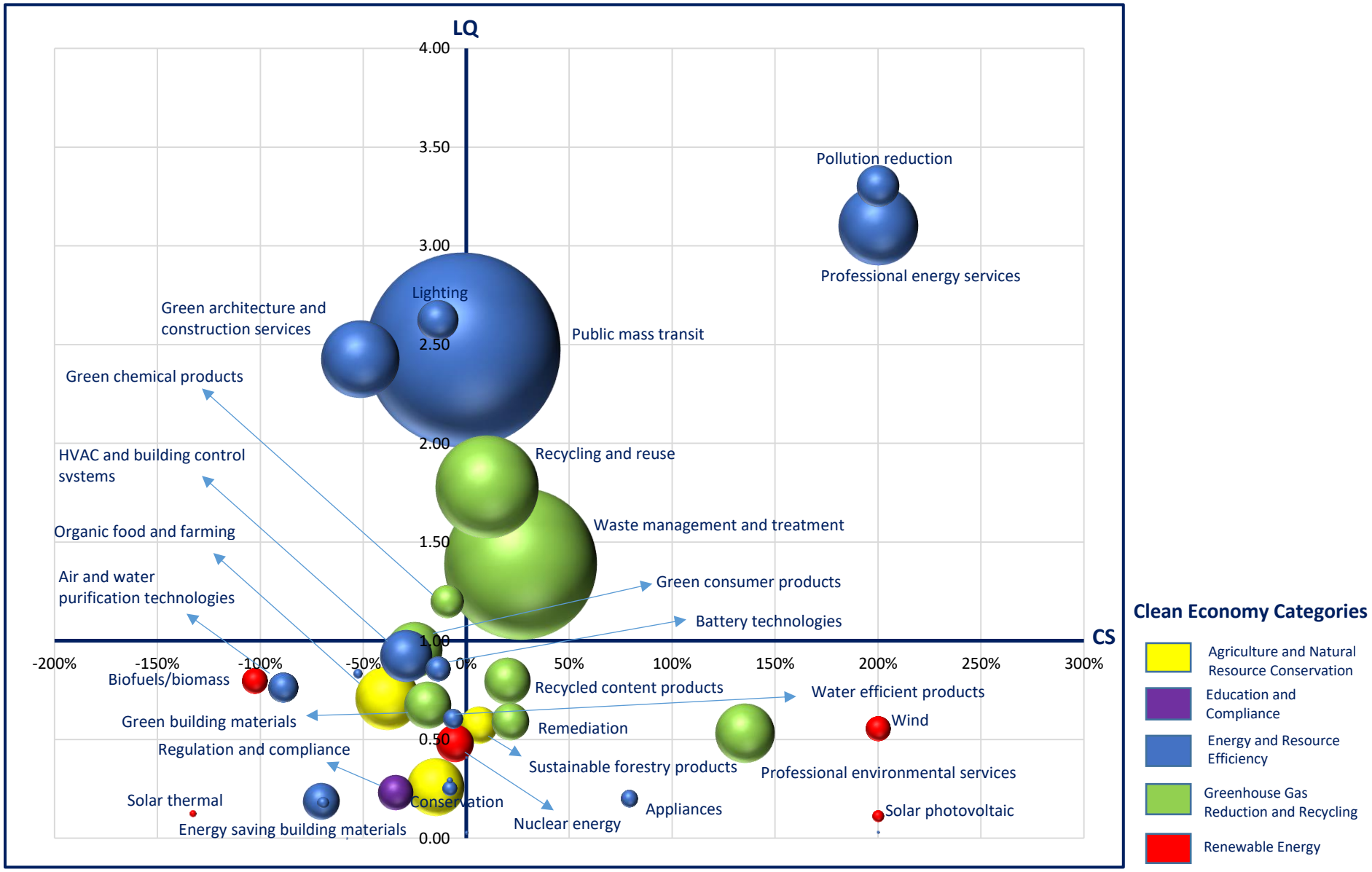
industrial average. Positive competitive shifts suggest that local factors, specific to Cook County, contributed to the growth of these segments.

Industries that appear in the upper left quadrant (high LQ-low competitive shift) represent current industrial strengths that are maturing or struggling. One major service-oriented clean economy segment (Green Architecture and Construction Services) and two major manufacturing-oriented segments (Lighting and Green Chemical Products) are located in this quadrant. Negative competitive shifts mean that these segments are not growing at the same rate as the national industrial average.

Industries that appear in the lower right quadrant (low LQ-high competitive shift) represent potential emerging local industrial strengths. One large service-oriented clean economy segment (Professional Environmental Services) and two emerging clean energy production segments (Wind and Solar Photovoltaic) appear in this quadrant. Because they are growing faster than national industry trends suggest, these industries might expand and become locally concentrated in the future.

The lower left quadrant (low LQ-low competitive shift) contains segments that are not locally concentrated, suggesting the county economy at this time does not exhibit a competitive advantage to support employment growth in these segments.

Figure 20: Regional Concentration and Regional Effects, Cook County



APPENDIX: Technical Notes and FAQs

A. Alternative Clean Economy Definitions

Products or services are clean if the predominant function serves one or both of the following goals: Conserve Energy and Other Natural Resources (products or services that conserve energy to reduce fossil fuel use and promote water, raw material, land, and species and ecosystem conservation); or Reduce Pollution (products or services that provide clean energy or prevent, treat, reduce, control or measure environmental damage to air, water and soil). The remediation, abatement, removal, transportation, or storage of waste and contaminants also are considered to reduce pollution. ***(U.S. Department of Commerce)***

Green jobs are either: (A) Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources. (B) Jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources. ***(U.S. Bureau of Labor Statistics)***

B. The Brookings-Battelle Clean Economy Database

The Brookings & Battelle team identified the green/clean economy and sectors in the following way. First, using 8-digit SIC codes they identified industries that are exclusively part of the clean economy (utilizing previous studies conducted by the Pew Charitable Trusts, Collaborative Economics, UC Berkeley, and BLS). Second, they identified clean economy firms and establishments by utilizing various public / proprietary databases. They developed catalogues of every known industry association, certification, federal grantee, venture capital recipient, patent assignee, and product list that is relevant to the clean economy. Note that this means that if a company has not won any clean economy grants, joined any green industry associations, obtained any green certifications, developed any clearly identifiable green economy patents, or received money from a clean tech venture fund, it didn't make their list. With the industry codes identified and firm lists assembled, as a third step, they found statistics on the companies and their associated establishments using Dun & Bradstreet and NETS databases.

In reporting clean economy job estimates, they classified establishments into five-categories (adopted from BLS). In addition to that, under these five categories they developed a finer-grained categorization - 39 segments designed to further narrow the class of business activity and allow for detailed analysis. Establishments were assigned to segments based on their industry code, the list used to identify them, or, in some cases, information provided by the company's website. These segments roughly correspond to traditional industry clusters that have been widely examined by regional economist and planners. For example, "Energy efficient lighting", one of the 39 segments in Brookings-Battelle database, is analyzed as "Lighting and electrical equipment" in Porter's project.

C. Alternative Measurement Methods for Clean Economic Activities

1. Process-based Method

This approach counts jobs in which workers perform industrial activities by using innovative technologies and practices, which ultimately lead to reducing the environmental impact of their establishment. Although these activities are mostly firm specific, they could be identical within or even across industries. The process approach is relevant to any industry, regardless of the good or service produced. Examples include energy use monitoring and efficiency maximizations, establishing waste management and inputs re-use protocols, or devising systems to reduce natural resource inputs.

These technologies and practices fall into one or more of four groups:

(a) Energy from renewable sources. Generating electricity, heat, or fuel from renewable sources primarily for use within the establishment. These energy sources include wind, biomass, geothermal, solar, ocean, hydropower, and landfill gas and municipal solid waste.

(b) Energy efficiency. Using technologies and practices to improve energy efficiency within the establishment. Included in this group is cogeneration (combined heat and power).

(c) Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse. Using technologies and practices within the establishment to:

- Reduce or eliminate the creation or release of pollutants or toxic compounds, or remove pollutants or hazardous waste from the environment.
- Reduce greenhouse gas emissions through methods other than renewable energy generation and energy efficiency.
- Reduce or eliminate the creation of waste materials; collect, reuse, remanufacture, recycle, or compost waste materials or wastewater.

(d) Natural resources conservation. Using technologies and practices within the establishment to conserve natural resources. Included in this group are technologies and practices related to organic agriculture and sustainable forestry; land management; soil, water, or wildlife conservation; and storm-water management.

2. Occupation-based method

This approach counts specific jobs related to energy production, conservation, emission and waste reduction and then identify those positions in businesses that are filled by environmental engineers, architects, biologists, agronomists, hydrologists, and resource recovery or reuse specialists. This measurement is based on the work employees actually do rather than the type of firm in which they are employed. As such, the green employment estimate derived would be conservative, and less likely to over-describe green jobs. Note that product and process

approaches might count green occupations associated with the production of green products and services, but not all occupations counted by these two approaches are green. The weakness of this approach is that it will undercount the support jobs that may be necessary to sustain green production activities. Knowing how green industries are staffed is another important piece of policy planning information.

D. Regional Economic Measures Used in the Study

Location Quotient (LQ)

Location quotient is an economic analysis technique used to identify the concentration of an industry sector in a local economy relative to a larger reference economy (e.g. the nation). The LQ can be considered an index of specialization indicating the expected share of an industry in the local area given the size of this industry in the reference economy. For example, if a regional economy has 15% of its employment in the manufacturing industry and the nation (reference economy) has 10% of its employment in manufacturing, the location quotient is the ratio of first percentage to the second percentage, or 1.5 (0.15 is divided by 0.10). In addition to indicating how specialized a local economy is relative to the larger economy, the location quotient is essential in determining the economic base of a local economy. Although LQ values greater than 1 mathematically indicate local concentration, industries with LQs greater than 1.25 are interpreted in this analysis as substantially regionally concentrated. These are industries that are likely to be part of the export base of the region, the further growth of which will stimulate the overall economy.

The formula for calculating the location quotient is as follows:

$$\boldsymbol{LQ} = \left(\frac{e_i}{e_t}\right) \div \left(\frac{E_i}{E_t}\right)$$

Where:
e_i = local employment in industry i
e_t = total local employment
E_i = reference (national) employment in industry i
E_t = total reference (national) employment

Besides employment, location quotients can be calculated using establishment counts. The location quotient is a static measure, depicting an industry at only one point in time. Therefore a single LQ measurement does not reflect whether an industry sector is growing or declining in importance relative to the local economy.[12]

[12] Blakely, E.J. and Leigh, N.G. (2010). *Planning Local Economic Development: Theory and Practice*. 4th Edition. Sage, Thousand Oaks, CA.

Shift-Share Analysis

Shift-share analysis is a major tool for analyzing the changes in a local economy. Similar to the application of LQ, shift-share entails designation of a reference economy (state or nation). However, differently from the LQ, shift-share analyzes change over time, essentially disaggregating the growth of an industry into three contributing parts: (1) changes due to overall national growth, (2) changes due to growth or decline nationally in a particular industry, and (3) changes due to local factors particular to the study area.[13]

Reference Region (National) Shift, also called the national growth effect, explains how much of the growth in a regional industry is attributable to overall growth of the national economy. It is based on the observation that national economic expansion or recession affects the entire economy.

Industry Mix Term represents the share of regional industry growth explained by the growth of the specific industry at the national level. Industries that are growing faster than the overall national economy are more likely to proportionally contribute to the growth of a regional economy. Thus, this component identifies industries whose local concentrations or deficits are contributing to the growth or decline of the overall regional economy.

Competitive Shift, also called the local or differential shift, is the difference in the rate of growth or decline in a local industry relative to the rate of growth or decline in that same industry nationally. This shift is the most interesting and useful of the three shifts. It explains how much of the change in a given industry is due to competitive advantages or disadvantages that the region possesses. A positive local shift means that employment in a regional industry is growing faster than the employment in that industry nationally or that the regional decline is less than the national decline. [14]

Because shift share analysis deals with job growth over time, a time frame (start year and end year) is required to perform shift share analysis.

$$\Delta \boldsymbol{L_i} = RS_i + IM_{i+} + CS_i$$

$$\boldsymbol{RS_i} = \frac{R_A^t - R_A^{t-1}}{R_A^{t-1}}$$

[13] Shuffstall, W. Economic and Community Development. Penn State Extension. http://extension.psu.edu/community/ecd/understanding-economic-change-in-your-community/shift-share-analysis-helps-identify-local-growth-engines (Accessed July 20, 2016).

[14] Blakely, E.J. and Leigh, N.G. (2010). *Planning Local Economic Development: Theory and Practice*. 4th Edition. Sage, Thousand Oaks, CA.

$$\boldsymbol{IM_i} = \left(\frac{R_i^t - R_i^{t-1}}{R_i^{t-1}} - \frac{R_A^t - R_A^{t-1}}{R_A^{t-1}}\right)$$

$$\boldsymbol{CS_i} = \left(\frac{L_i^t - L_i^{t-1}}{L_i^{t-1}} - \frac{R_i^t - R_i^{t-1}}{R_i^{t-1}}\right)$$

Where:
RS = reference region shift, IM = industry mix term, CS = competitive (local) shift, i = industry, A = all of economy, t = current time period, $t - 1$= previous time period