The New Hampshire Cleantech Market Report

February 2015

About the Author: Seacoast Economics

KPItrac, LLC provides project-based economic analysis consulting services under the trade name Seacoast Economics. KPItrac, LLC has provided economic analysis in several areas of public policy for the New Hampshire Port Authority, Department of Health and Human Services, the Community College System of New Hampshire, the NH Community Development Finance Authority and private companies.

About NH Cleantech Council

The NH CleanTech Council (NHCTC) represents and advocates for New Hampshire's cleantech and clean energy business sector, focusing on the economic benefits and jobs that can come from a vibrant clean technology industry and the policies that enable stability, competition and investment in that industry. NHCTC acts as the advocacy arm of the NH Sustainable Energy Association, a statewide non-profit (www.nhsea.org).

New Hampshire 2014 Cleantech Market Report

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Executive Summary

A business sector that has recently emerged as a creator of high-quality, well-paid jobs and economic growth, both nationally and globally, is clean technology or "cleantech." Cleantech is a general term applied to innovative technologies, services, and products that enhance environmental performance in the energy, construction, transportation, utility, and waste industries, mostly through applications that focus on energy.

Cleantech has established itself as a major long-term economic growth opportunity and it is estimated that the sector will double from a $2.5 trillion global business today to a $5 trillion one by the mid- 2020s. States like New Hampshire now have a substantial opportunity to capture a bigger share of that growth and economic opportunity, if they implement policies that strategically position themselves to take advantage of innovation, market-driven policy mechanisms, and their relative industrial strengths.

Following an extensive literature review and original analysis, this report shows that:

- Cleantech has a substantial and growing economic impact in the state already. New Hampshire today has at least 13,000 workers employed due to cleantech, but much more likely 15,000 to 20,000.
- The average annual wage in a cleantech-associated job is likely to be about 50% higher than the state average annual wage. Policymakers interested in seeing more high-paying jobs in the state would want to focus on strengthening the cleantech sector.
- Cleantech work generates a higher amount of job and economic activity in NH than the overall NH economy, on average:
  - Jobs — in NH, the economic multiplier of cleantech jobs is twice the multiplier of non-cleantech jobs; every job in cleantech adds an additional 1.4 jobs to the state's economy, while jobs in the remainder of the economy only add an additional 0.7 jobs.
  - Economic Activity — every $1 in gross state product produced by industries associated with cleantech generates an additional $1 in gross state product in NH. All other business sectors in NH only generate $0.70 in additional gross state product. That represents an almost 150% greater economic output multiplier for cleantech-associated industries.
- Cleantech applications that create energy savings within NH also provide an additional economic benefit. When businesses and consumers save money on energy by producing and using it more efficiently, that savings has a multiplier effect within the state, as it gets re-invested in other areas of the economy. For example, an Energy Efficiency Resource Standard (EERS) in NH would add a total of 2,300 jobs and $160 million in Gross State Product annually.
- New Hampshire's positioning to take advantage of cleantech compares relatively favorably to most states, ranking in the top third, but it lags when compared to most of New England. For example, New Hampshire shows relative strength in innovation measures like cleantech patents per capita, but lacks key policy drivers with big economic payoffs like an energy efficiency standard. This shows that New Hampshire has room to grow, and represents a major

In 2012, the average annual wage paid by cleantech industries in NH was $74,085.

This was approximately 50% higher than the state average annual wage of $48,775.

opportunity for New Hampshire to address relative weaknesses and significantly strengthen its economy and high-wage job growth.

- Electric lighting manufacturing is an area of cleantech work within our broader economy in which NH has a strong advantage. Areas with strong growth opportunities include computer programming for the smart grid and web-enabled energy management systems, architectural and engineering services, consulting, research and development, and waste management.
- New Hampshire spends 10.4 cents on energy to produce $1 of gross state product. The U.S. as a whole spends only 9.9 cents on energy to produce $1 of Gross Domestic Product (GDP). The economic data strongly suggest that strengthening the cleantech sector makes a state get more economic output out of their energy spending. If NH had a more robust cleantech sector, it could increase its economic activity for the same amount spent on energy.

Overall, this report finds that New Hampshire has the potential to expand its economy and employment, enhance energy security, and reduce exported energy dollars by developing policies that support the growth of the cleantech sector in the state.

Overview of Cleantech

"Clean technology" or "cleantech" describes an area of economic activity that has emerged both globally and nationally as a dynamic source of job creation and economic growth. Cleantech is a general term applied to technology, services, and products that reduce harmful environmental impacts and/or the consumption of natural resources, usually in the production of energy, but sometimes in the efficient use of water or other materials. Cleantech activity occurs most frequently in certain business sectors — including the energy, construction, transportation, utility, and waste industries — though it is also found in other sectors such as agriculture and information technology.

Figure 1: Common Areas of Cleantech

Clean Energy
Bioenergy
Solar
Wind
Geothermal
Hydro & marine
Energy Distribution & Efficiency
Smart grid
Energy storage
Buildings
Electric vehicles & transportation
Waste & Pollution
Recycling
Air pollution
Carbon capture and storage
Water Management
Water treatment
Water use efficiency
Clean Products & Services
Chemicals & advanced materials
Smart industrial production
Clean web
Agriculture
Professional services

Cleantech has only been identified as a distinct economic area for about a decade, as a group of technologies reached a point of greater maturity and broader commercial application. Investment activity in the sector experienced a period of rapid growth between 2004 and 2008 and then peaked between 2009 and 2011 due to the American Recovery and Reinvestment Act. While total investment slowed somewhat as federal funding tapered, a wide range of cleantech applications have gained a firm foothold in the marketplace, and there is broad agreement that cleantech is here to stay. The data likewise indicate that cleantech has established itself as a long-term growth opportunity.[1 2 3] The global cleantech market is valued at about $2.5 trillion a year, and is expected to double by the mid-2020s.[4]

While cleantech spans a broad range of technology and industries, the areas of greatest growth opportunity globally, nationally, and statewide include:

1. Energy efficiency;
2. Renewable energy;
3. Energy storage;
4. Smart grid and energy management software; and
5. Water management

This is supported by the 2013 report released by the consulting firm Cleantech Group, which named top innovators and trends in a report entitled "Global Cleantech 100." The top areas of business activity were in:

1 "The Market Curve: The Life Cycle Of New Technology Markets," TechCrunch, April 1, 2012, available online at http://techcrunch.com/2012/04/01/the-market-curve-the-life-cycle/

2 "Cleantech by Any Other Name…," Environmental Leader, June 26,2013, available online at http://www.environmentalleader.com/2013/06/26/cleantech-by-any-other-name/

3 "Myths and realities of clean technologies," McKinsey & Company, April 2014, available online at http://www.mckinsey.com/insights/energy_resources_materials/myths_and_realities_of_clean_technologies

4 "IPCC climate report means cleantech 'an attractive proposition for any investor'," blue&green tomorrow, April 12, 2014, available online at http://blueandgreentomorrow.com/2014/04/12/ipcc-climate-report-means-cleantech-an-attractive-proposition-for-any-investor/

1) energy efficiency, 2) water & wastewater, 3) biofuels & biochemical, 4) smart grid, and 5) energy storage.[5]

Similarly, in 2013, the most actively patented new cleantech technologies were in: 1) renewable energy, 2) high-performance materials, 3) energy storage, and 4) energy efficiency. Within renewable energy, solar and biofuels were the most actively-patented technologies and/or processes.[6] In addition, venture capitalists focused investment towards companies in the smart grid, energy storage, water, and waste management industries.

In a 2013 Ernst & Young report, authors found that between 2012 and 2013, U.S. public cleantech market capitalization grew from $27 billion to $37 billion — a significant 137% growth rate. The leading publicly-owned cleantech companies in the U.S. were those whose business focused on energy efficiency, solar, clean transportation, biofuels, and energy storage.[7]

Other overall indicators of the rapid growth and current strength in the cleantech market include:

- Over the past decade, purchases of cleantech products and services—such as renewable energy, hybrid electric vehicles, energy efficiency, and high-performance buildings—have experienced double-digit growth rates. Electric vehicle sales continue to set monthly records with sales that were ten times higher in May 2014 compared to three years ago. LED lighting installations are growing at over a 400% annual rate. [8]

CLEANTECH IN NEW ENGLAND

Vermont's 2014 Clean Energy Industry Report:

- 15,286 people were employed by the clean energy sector.
- 4.3% of the total VT workforce is in the clean energy sector

Massachusetts' 2014 Clean Energy Industry Report found:

- Cleantech/clean energy is a $10 billion industry, representing 2.5% of their GDP
- Clean energy jobs represent 2.4% of total MA workforce
- The cleantech/clean energy sector showed 48% overall job growth over the past four years.

- SVB Financial Services in its "2014 Innovation Economy Outlook U.S." noted that the strongest performing segment of what they referred to as the "innovation economy" over the past year was cleantech. In their annual survey, SVB found that cleantech companies who beat their financial targets did so by 30%, which was the highest reported metric of any sector.[9]
- Solar photovoltaic (PV) continues to be a cleantech area with significant growth and opportunity.The U.S. installed 1,330 megawatts (MW) of solar PV in Q1 2014, up 80% over Q1 2013 and accounting for three-quarters of all new electric generating capacity in the US. PV installations were forecasted to reach 6.6 gigawatts (GW) in 2014—nearly double the market size in 2012.[10]

5 "For a complete discussion of Cleantech group's methodology and list of companies. Available online at http://info.cleantech.com/GCT2013_Report_Submit.html

6 "CleanTech PatentEdge: 2013 Annual Report," IP Checkup, available online at http://www.greenpatentblog.com/wp-content/uploads/2014/04/CleanTech_PatentEdge_2013_Annual_Report.pdf_+.pdf

7 "Cleantech Industry Performance: Global cleantech public pure-play (PPP) company analysis," Ernst & Young Global Limited, August 8, 2013, available online at http://www.ey.com/Publication/vwLUAssets/EY_Cleantech_industry_performance/$FILE/EY-Cleantech-industry-performance.pdf

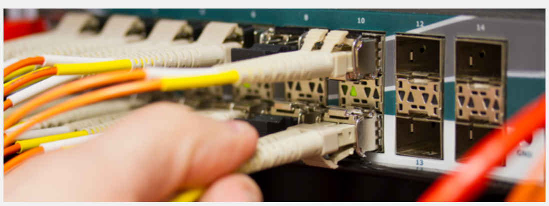
8 "U.S. Homeowners on Clean Energy: A National Survey: 2014 Poll Results & Clean Energy Growth Trends," Solar City & CleanEdge, available online at http://www.solarcity.com/sites/default/files/reports/reports-2014-homeowner-survey-clean-energy.pdf

9 "Innovation Economy Outlook, U.S.: 2014 Report," Silicon Valley Bank, 2014, available online at http://www.svb.com/pdfs/ieo/svb_ieo_us_report_2014.pdf10"

10 "Solar Market Insight Report 2014 Q1," Solar Energy Industries Association, 2014, available online at http://www.seia.org/research-resources/solar-market-insight-report-2014-q1

CLEANTECH IN NH:

Examples of innovative cleantech business in NH include SustainX located in Seabrook and FiberNext located in Concord. SustainX is a provider of grid-scale energy storage solutions for supporting a cleaner and more efficient electric grid, which increasingly includes intermittent renewable energy generation technologies. FiberNext is a fiber optic networking company that has recently begun to apply their products and services to interconnect and better enable communications systems for wind and solar facilities in NH and across the U.S.



Software development is also a major part of cleantech, also called cleanweb or softgrid. This includes NH companies such as GE Meters in Somersworth, which develops embedded software for the smart electrical meters that GE manufactures. Other major nation-wide companies like Opower, Enernoc, and Silver Spring Networks are examples of companies developing web-based energy management systems that leverage technology to manage big data and intelligent energy infrastructure networking.

The number of U.S. solar jobs grew almost 20% from 2012 to 2013 to a total of 142,700 workers. In 2014, 45% of solar-based firms expect to add new jobs.[11]

- In the 5th annual survey of the Finnish cleantech industry (Finland is regarded as having a strong cleantech economy, and its economy shares similarities the Granite State's, including a highly educated workforce and location in a high cost region), the results found that cleantech in Finland continued to grow in 2013 despite a challenging economy. Nine out of every ten companies expect to increase jobs within their cleantech business areas over the next five years. Additionally, two out of every three companies indicated they will make further investments into cleantech.[12]

11 "National Solar Jobs Census 2013," The Solar Foundation, January 2014, available online at http://www.thesolarfoundation.org/sites/thesolarfoundation.org/files/TSF%20Solar%20Jobs%20Census%202013.pdf

12 "Cleantech industry in Finland 2014: Cleantech Finland's annual cleantech survey ," Cleantech Finland, 2014, available online at http://www.cleantechfinland.com/content/cleantech-industry-finland-2014-cleantech-finlands-annual-cleantech-survey

The New Hampshire Cleantech Economy

Jobs

The New Hampshire cleantech economy is a diverse and growing piece of the state's overall employment profile. The most significant study of cleantech employment in the state in recent years was conducted by the highly-regarded Washington, DC research institute The Brookings Institution in 2010. It counted 12,886 workers employed in the NH "clean economy," up from 8,971 jobs in 2003, reflecting an overall growth rate of 44% and an annual growth rate of 5.4%.[13] This was an especially significant sector performance considering that in contrast, total NH private employment declined by 1.3% from 520,500 to 513,500 between 2003 and 2010.[14]

While there has been no further in-depth study in the economic literature in the last five years that directly reproduces that estimate in New Hampshire, other state studies present strong confirmation that the Brookings figure was likely on the mark. New Hampshire's neighbor Vermont, which shares many of the same economic characteristics and has an overlapping employment pool, conducted a detailed survey of more than 1,450 businesses to determine their cleantech jobs figure, which they pegged at 15,286 in 2014. The Bureau of Labor Statistics (BLS) within the U.S. Department of Labor also conducted a nationwide survey of 120,000 businesses for their measurement of "Green Goods and Services" (GGS) employment and found 14,011 New Hampshire jobs in this category (2.3% of total employment) in 2010, 12,309 of them in the private sector. In 2011, the same survey found 16,244 such jobs (2.7% of total employment), representing 15.9% annual growth, and with almost all of the growth in the private sector

13 "Sizing the Green Economy: A National and Regional Green Jobs Assessment." The Brookings Institution, 2011, available online at http://www.brookings.edu/research/reports/2011/07/13-clean-economy.

14 Based on data obtained from the U.S. Bureau of Labor Statistics Quarterly Census of Employment & Wages

representing 15.9% annual growth, and with almost all of the growth in the private sector.[15]

While the GGS survey data is somewhat limited as a way to characterize strictly cleantech employment — there is a substantial overlap between the two definitions, with some areas of cleantech not captured within GGS and vice versa — it does provide an added degree of confirmation that the Brookings estimate was a reasonable figure.

More importantly, however, by providing multi-year data of a similar set of employers and industries, it gives an indication of the kind of growth that the sector has been experiencing in recent years and a pathway to estimating where things stand today.

As noted above, the Brookings study found an average annual growth rate for cleantech employment in New Hampshire of 5.4% over the previous 8 years. The BLS survey found a much higher GGS growth rate between 2010 and 2011 of 16%, mostly in the private sector. Employment in New Hampshire's solar industry grew 68% between 2012 and 2013.[16] And New Hampshire's neighbor Massachusetts experienced a robust annual growth rate over the last four years, with 48% higher employment in the clean energy sector between 2010 and 2014. We can also look at these data in terms of the proportion of jobs that can be ascribed to cleantech. The Brookings study found the figure to be 2.0% in 2010. The NH GGS figure in 2010 was 2.4% and in 2011 had growth to 2.7%. For Vermont in 2014 that proportion was 4.3%. In Massachusetts it was 2.4%.

In considering all of these trends and estimating where New Hampshire cleantech employment stands today, it is clear that the Brookings figure almost certainly

15 http://www.bls.gov/news.release/ggqcew.t04.htm. The GGS survey was discontinued after 2011 due to budget cuts under sequestration.

16 "State Solar Jobs 2013," The Solar Foundation, November 2013, available online at http://thesolarfoundation.org/solarstates/new-hampshire

represents a very conservative lower bound. If one were to ignore the robust 5.4% annual employment growth rate in the state from 2003 to 2010 and the ongoing strong growth both in surrounding states and nationally since 2010, and said merely that cleantech accounts for the same proportion of total employment today that Brookings found in 2010, then one would extrapolate 13,058 cleantech-driven jobs out of New Hampshire's 652,900 total employment as of the end of 2014.[17]

However, if one assumes that the 2003-2010 Brookings growth rate continued on more or less the same pace, today New Hampshire would have 15,920 cleantech jobs. At Massachusetts' growth rate over the last four years, NH cleantech employment would be 20,300, and if one assumed that the GGS growth rate in the state from 2010 to 2011 continued and applied broadly to cleantech, the figure would be over 23,000. Especially given the national trends of investment and job growth, but also the recent historical growth patterns within New Hampshire and the regional growth rates in states that border NH and share major economic overlap, the most likely job growth rate in the last four years is at or even significantly above the state's rate from 2003 to 2010.

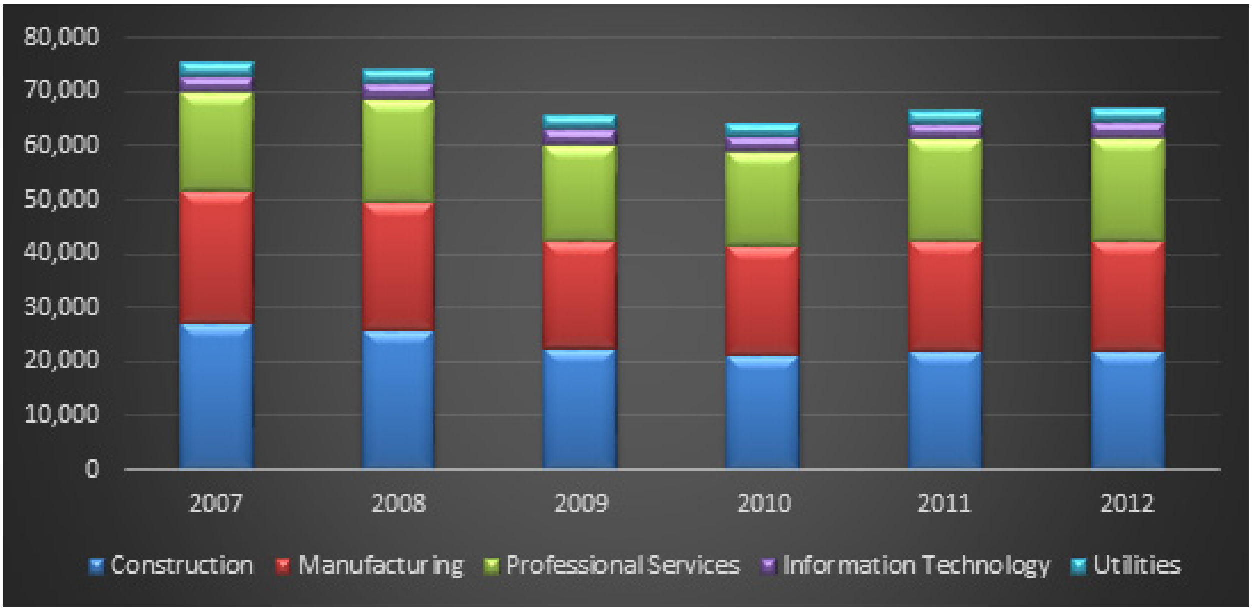
In short, it is likely that the lowest end of the range of New Hampshire cleantech employment is 13,000, with higher figures between 16,000 and 20,000 being a reasonable estimate.

What is the upper end of the range? For many jobs, it is difficult to assess what proportion of the job is created by cleantech. For an employee whose full-time position is installing residential rooftop solar units, the answer is 100%. But for an employee of FiberNext whose work was previously limited to telecommunications applications but now is increasingly spending her time on interconnecting wind energy installations, the answer is complicated and evolving. Or if a utility is deriving more of its annual revenue from energy efficiency installation, the employees directly responsible for those efficiency programs clearly owe their positions to cleantech, but to a certain degree, the rest of its workforce also benefits from—and owes some proportion of the credit for their job—to the business income that cleantech provides.

What this report can say with assurance is that cleantech applications are driving a growing proportion of revenue and business activity in a number of sectors, and are increasingly responsible for creating new jobs and retaining existing jobs. The business sectors in which most cleantech activity occurs nationally are shown below in Figure 2—this represents the total employment that would be driven by cleantech today if 100% of the jobs relied on cleantech revenue for their existence. While in 2015 cleantech is clearly not driving the bulk of revenue for some businesses in these sectors, it is safe to say that for many of them, cleantech is pervading more and more of their operations and driving more of their growth. In the coming year, the proportion of the 65,000+ total jobs in New Hampshire in these sectors derived from cleantech will continue to grow.

17 http://www.nhes.nh.gov/elmi/statistics/ces-data.htm.

Figure 2: NH Employment in Business Sectors Associated with Cleantech



Wages

It is also important to note the industries among which cleantech jobs are distributed, because the analysis conducted for this report found that jobs in New Hampshire industries associated with cleantech tend to pay relatively well.[18] In 2012, the average annual wage from businesses associated with cleantech was $74,085. This figure is nearly 50% higher than the state's private sector average annual wage of $48,775.

Table 1: NH Annual wages in 2012

Industry	Average Annual Wage
Industries associated with cleantech	$74,085
Total NH economy	$48,775

Source: Seacoast Economics, U.S Bureau of Labor Statistics

This is not to say that every job in construction or utilities is associated with cleantech. Rather, the point is that cleantech jobs fall in high-wage activities and industries, and all things being equal, the growth of cleantech will mean more hiring at high pay scales. To put it another way, if policymakers are interested in the growth of high paying jobs in the state, they will want to see the continued growth of cleantech.

Economic Multipliers

The impacts of cleantech businesses ripple throughout the NH economy. Cleantech work generates a higher amount of job and economic activity in NH than other jobs in the overall NH economy do. In NH, every job in industries associated with cleantech adds an additional 1.4 jobs to the NH economy, compared to the remainder of the NH economy (a non-cleantech job), which adds an additional 0.7 jobs to the NH economy.

18 Review Appendix A for additional discussion of the methodology and rationale for identifying industries commonly associated with cleantech lines of business.

Table 2: The Cleantech Multiplier Effect

Industries	Employment Multiplier per Direct Job (Jobs)	Gross State Product Multiplier per $1 of Direct GSP
Industries associated with cleantech	1.4	$1.00
Remainder of the NH economy	0.7	$0.70

Source: Seacoast Economics

Gross State Product (GSP) is a measure of the economic value added by business activities carried out within the state. Every $1 in gross state product produced by industries associated with cleantech generates an additional $1 in gross state product in NH. This is very robust compared to all other business sectors in NH that only generate $0.70 in additional gross state product. That represents an almost 150% greater economic output for cleantech-associated industries. Again, this is not to say that all work in these industries involves cleantech, but rather the converse, since most cleantech business falls into these highly economically productive industries, it is clear that growth in cleantech produces greater economic gains for the state than growth in other industries. Appendix A discusses these economic "ripple" or multiplier effects in greater detail.

Cleantech work that involves energy savings from projects located within NH also provides an additional economic benefit on top of the increased employment and work activity at cleantech companies. When businesses and consumers save money on energy because the production and use of energy is accomplished more efficiently, that savings has a multiplier effect within the state as well, as it gets re-invested in other areas of the economy. While this report did not consider the potential economic multiplier effect from these energy savings, other studies have explored the impact of net energy savings or avoided costs related to cleantech investment and have determined that there is a significant net positive economic impact. A 2013 study performed by the Vermont Energy Investment Corporation—which did include energy savings—found that an Energy Efficiency Resource Standard (EERS) in NH would add a total of 2,300 jobs and $160 million in Gross State Product annually by creating savings in energy that would flow through elsewhere in the economy. The cost savings to NH citizens and businesses was estimated to be $2.9 billion over a 15 year period.[19]

In sum, in terms of broad economic impact, the range of cleantech employment in the state estimated above is only the tip of the iceberg. Cleantech jobs create other jobs in the economy at twice the rate of other sectors, cleantech industry spending has almost 150% of the impact of other sectors in terms of economic output, and cleantech-driven energy savings have potentially huge impacts for other employers and consumers.

Benchmarking NH: How Do We Compare to Other States?

In order to determine how New Hampshire has been performing in cleantech relative to other states and the nation and to consider ways in which NH could strengthen its performance, NH was benchmarked in three ways: 1) cleantech leadership, 2) employment in industries commonly associated with cleantech, and 3) the ratio of total in-state energy expenditures to economic value added within the state.

This third metric is especially significant because it shows how efficiently a state is using its energy spending. Why is this important? Energy is not like other goods and services. It is not an end product that is consumed for its own sake: rather, it is an intermediate

19 "Increasing Energy Efficiency in New Hampshire: Realizing Our Potential," Vermont Energy Investment Corporation, November 15, 2013, available online at http://www.nh.gov/oep/resource-library/energy/documents/nh_eers_study2013-11-13.pdf

product that is created in order to achieve another end product, like heat in a home, light in a business, miles traveled in a vehicle, or work performed by a machine. If you spend a lot on energy to get the same amount of output in terms of work performed, your state is relatively inefficient and is wasting money that would otherwise go to boosting the economy elsewhere (as discussed above). It is like putting gas in a car. If the price at the pump goes up and you spend more to fill up, you aren't getting to travel any further, you are simply spending more money. If gas prices go down, you can drive more miles for the same expenditure. Cleantech can have an effect like making prices at the pump go down: it can make a state's energy spending more efficient, so the state sees more economic activity while spending less on energy.

Benchmark 1: Cleantech Leadership

CleanEdge, Inc. is a cleantech consulting agency that produces the U.S. Clean Tech Leadership Index. This index is produced annually and provides cleantech leadership scores for each state based on approximately 70 different indicators.[20] The report weighs a state's positioning in terms of deployment and utilization of clean technology, implementation of well-designed cleantech policy, and leveraging of capital toward cleantech both in terms of financing and human capital. While not a perfect tool, the Index gives a broad representation of how well a state is taking advantage of and driving the economic benefits of cleantech.

In 2014, the national average score was 40. California was ranked first with a score of 94 and the lowest ranked state was Mississippi with a score of 7.5. NH ranked 16th (dropping from 14th in 2013) with a score of 48; this was approximately 20% higher than the national average score but approximately 40% lower than the average score of the top 5 ranked cleantech states at 74. In New England states, the average score was 55.

20 See the study for a more detailed description of how the ranking is calculated. "2014 U.S. Clean Tech Leadership Index, " Clean Edge, July 2014, Available online at http://cleanedge.com/indexes/u.s.-clean-tech-leadership-index

Overall, the report indicates that NH, and New England overall, do slightly better than other US states in terms of leveraging cleantech efforts and policies. However, only Maine scored lower than NH in New England, indicating that there is still opportunity for the state to intensify its focus on advancing cleantech and deriving greater economic benefit.

The report gives some indications about where specifically New Hampshire policymakers should look in order to better position our state in cleantech. In the technology area, which is measured in terms of clean electricity, clean transportation, and energy intelligence and green building, New Hampshire's rank drops to 23rd in the nation, indicating that in-state deployment of renewable generation, clean vehicles, and energy efficiency is a near-term area that could be strengthened. In the capital area, New Hampshire ranked 18th, held back somewhat by a relative lack of access to venture capital, but boosted by growing intellectual capital, highlighted by an 8th overall position in cleantech patents per capita. This indicates a burgeoning strength in innovation that could potentially be leveraged into more (and more profitable) cleantech businesses.

In the policy area, New Hampshire's ranking of 14th matched its overall state ranking. CleanEdge indicated that the state's position was greatly bolstered by having a relatively well-designed Renewable Portfolio Standard (RPS), its participation in the Regional Greenhouse Gas Initiative (RGGI), and its new group net metering law. The areas that did not score highly — and which therefore represent opportunities for the state to fashion policies that would augment cleantech and boost economic returns — included lacking an energy efficiency standard, having few mechanisms to incentivize the use of advanced fuel vehicles, and having no financial instruments like renewable energy bonds or a green bank that help provide investment capital.

Table 3: Partial List of US Clean Tech Leadership Index 2014

Rank	State	Score
1	California	93.7
2	Massachusetts	79.4
3	Oregon	67
4	Colorado	66.8
5	New York	64.8
6	New Mexico	61.9
7	Washington	61.6
8	Illinois	61.5
9	Vermont	58.6
10	Connecticut	57.3
13	Rhode Island	51.1
16	**New Hampshire**	**47.9**
29	Maine	36.3
	U.S. Average	**39.8**

Source: CleanEdge, Inc.

Benchmark 2: Employment in Cleantech-Associated Industries

In this analysis, the North American Industry Classification System (NAICS) was used to identify industries commonly associated with cleantech, in order to provide another tool to suggest areas where New Hampshire is relatively weak, strong, and poised for growth. An employment concentration, also known as a Location Quotient, was then calculated for each cleantech-associated industry. Location Quotients (LQs) are a commonly used economic metric to estimate the strength of an industry within a region. It is the percentage of industry employment for a specific region (county, state) compared to the overall nation. A value of 1.0 indicates that the designated region has the same level of specialization as the nation in that industry, while a value greater than 1.0 indicates the region has a specialization or strength in that industry and a value less than 1.0 indicates that the region has a lack of specialization or weakness in that industry. Please refer to Appendix A for additional discussion of LQs.

Using LQs to compare the NH concentration of employment in industries commonly associated with cleantech with other states suggests some areas of current strength. These are industry areas where NH businesses are likely already garnering economic benefits for the state through exporting cleantech products and services, or where their baseline strength in that sub-industry shows that they would be well positioned to compete in cleantech applications if they are not already doing so.

For example, NH has significantly higher than the national average employment concentrations in software development and electronic component manufacturing. Particularly, in 2012, NH had a LQ of 6.0 for NAICS code 3351 (electric lighting equipment manufacturing). This was the highest LQ when compared to the other states evaluated and suggests that electric lighting manufacturing is an area of cleantech work within our broader innovation economy in which NH has a strong advantage. Light emitting diode (LED) lighting and other energy efficient lighting are examples of manufactured cleantech products.

The LQ comparison also suggests areas of opportunity for New Hampshire. In comparing NH with the top five ranked states in the U.S. Cleantech Leadership Index or with other states in New England, there are several areas where the state is currently relatively weak for reasons that are unclear. By evaluating why these areas are underperforming, policymakers may be able to fashion better incentives or remove regulatory obstacles that are inhibiting innovation and growth. The cleantech leadership benchmark analysis above gives a helpful starting point for looking at areas of policy, technology, and capital where New Hampshire could better position itself to grow these subsectors. Table 4 lists industries that are often associated with cleantech where NH has particular strengths or potential opportunities for further growth.

Table 4: NH Cleantech-Associated Industry Strengths and Areas for Potential Growth Listed by NAICS Code

Strengths	Opportunities for Growth	
3344 Semiconductor and electronic component manufacturing	2212 Natural gas distribution	3364 Aerospace product and parts manufacturing
3345 Electronic instrument manufacturing	2213 Water, sewage and other systems	5413 Architectural and engineering services
3351 Electric lighting equipment manufacturing	2381 Building foundation and exterior contractors	5415 Computer systems design and related services
3359 Other electrical equipment and component manufacturing	2383 Building finishing contractors	5416 Management and technical consulting services
5112 Software publishers	3251 Basic chemical manufacturing	5417 Scientific research and development services
	3336 Turbine and power transmission equipment manufacturing	5622 Waste treatment and disposal

Source: Seacoast Economics

Table 5: 2012 LQs for Top 5 States in The 2013 U.s Cleantech Leadership Index and all New England States, by 4 Digit NAICS industry code

Sector	Cleantech Associated 4-digit NAICS Industry	NH	MA	New England Average	Top 5 Cleantech Average
Utilities	2211 Power generation and supply	1.1	0.6	1.0	0.7
	2212 Natural gas distribution	0.4	1.2	0.5	0.8
	2213 Water, sewage and other systems	0.7	0.6	1.2	2.0
Construction	2361 Residential building construction	1.0	0.9	1.2	1.1
	2362 Nonresidential building construction	0.7	0.7	0.7	0.8
	2371 Utility system construction	0.6	0.5	0.6	0.7
	2373 Highway, street, and bridge construction	1.0	0.6	0.9	0.8
	2381 Building foundation and exterior contractors	0.7	0.7	0.8	1.0
	2382 Building equipment contractors	0.9	0.9	0.9	1.0
	2383 Building finishing contractors	0.9	1.0	1.0	1.2
	2389 Other specialty trade contractors	0.9	0.9	1.2	0.9

Sector	Cleantech Associated 4-digit NAICS Industry	NH	MA	New England Average	Top 5 Cleantech Average
Manufacturing	3241 Petroleum and coal products manufacturing	0.5	0.3	0.5	0.5
	3251 Basic chemical manufacturing	0.1	0.3	0.3	0.4
	3334 HVAC and commercial refrigeration equipment	0.7	0.4	0.7	0.5
	3336 Turbine and power transmission equipment manufacturing	0.2	0.6	0.5	0.8
	3339 Other general purpose machinery manufacturing	1.0	0.6	0.7	0.7
	3344 Semiconductor and electronic component manufacturing	2.8	1.6	2.1	2.2
	3345 Electronic instrument manufacturing	4.0	2.4	2.0	1.5
	3351 Electric lighting equipment manufacturing	6.0	1.8	2.9	1.1
	3353 Electrical equipment manufacturing	0.5	0.7	0.6	0.5
	3359 Other electrical equipment and component manufacturing	3.4	1.3	2.2	0.8
	3361 Motor vehicle manufacturing	n/a	0.0	0.1	0.2
	3362 Motor vehicle body and trailer manufacturing	0.4	0.1	0.2	0.5
	3363 Motor vehicle parts manufacturing	0.2	0.1	0.3	0.2
	3364 Aerospace product and parts manufacturing	0.5	0.9	1.6	0.7
	3365 Railroad rolling stock manufacturing	0.4	0.2	0.6	0.4
	3366 Ship and boat building	0.1	0.1	3.4	0.3
	3369 Other transportation equipment manufacturing	0.8	0.1	1.2	0.9
Information	5112 Software publishers	2.1	3.6	1.3	2.1
Professional & Business Services	5413 Architectural and engineering services	0.8	1.0	0.8	1.1
	5415 Computer systems design and related services	1.0	1.5	1.0	1.2
	5416 Management and technical consulting services	0.6	1.3	0.8	1.1
	5417 Scientific research and development services	0.5	3.1	0.9	1.5
	5621 Waste collection	1.1	1.0	1.4	1.2
	5622 Waste treatment and disposal	0.6	1.1	0.7	0.9
	5629 Remediation and other waste services	0.9	1.2	1.2	1.1

Source: Seacoast Economics

Table 5 lists the Location Quotients for the NAICS codes for industries commonly associated with cleantech work. NH is compared to the average of all of the New England states (CT, MA, ME, NH, RI, and VT) and also the average of the top 5 cleantech states (CA, CO, MA, NY, OR) based on the U.S. Cleantech Leadership Index. Massachusetts is also listed in its own column as it is both a New England state and a top cleantech state because of its close proximity to NH.

Benchmark 3: Economic Activity: Energy Expenditures

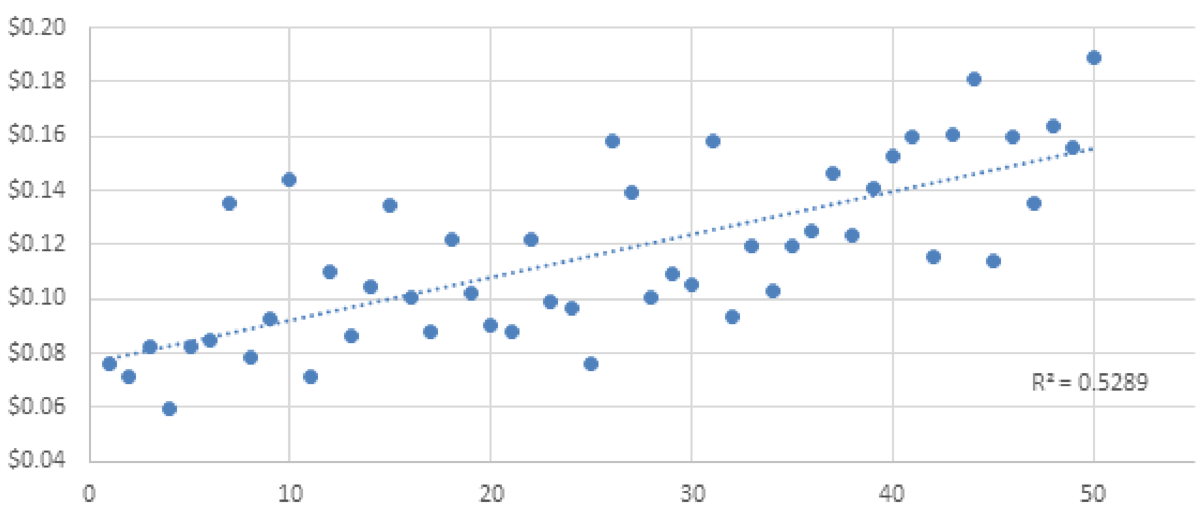
All states were benchmarked by comparing the ratio of total dollars expended on energy within the state with their gross state product. This shows the relationship between a state's total energy expenditures and its economic activity. As explained earlier, this can show how much economic activity a state is getting for its energy expenditures.

The first result of this analysis was that a strong relationship was observed between the ratio of energy expenditures to GSP and a state's U.S. cleantech leadership rank. This was expected and makes sense: states that are stronger in cleantech (as shown by their leadership rank) tend to spend relatively less on energy in comparison to their gross state product. Put another way, states that are leaders in cleantech tend to produce more economic value relative to the total amount they spend on energy, because cleantech makes your energy dollar go farther.

This relationship also held true when comparing the ratio of energy expenditures to GSP with a state's energy efficiency rank, as determined by the American Council for an Energy-Efficient Economy (ACEEE) in their annual State Efficiency Scorecard Report. Again, this makes sense, because states that rank highly for cleantech leadership also tend to rank highly in energy efficiency. And if your state is energy efficient, you are spending less on energy to get the same economic output, and therefore more on other productive economic areas.

Figure 3 is a scatter plot that shows the 2013 U.S. cleantech leadership rank on the horizontal axis and the ratio of total 2012 in-state energy expenditures to 2012 Gross State Product (i.e., energy expenditures to economic activity) on the vertical axis. NH is the dot in the red circle, which corresponds to 14 (its 2013 cleantech rank) on the horizontal axis and $0.104 (ratio of total energy expenditure to GSP) on the vertical axis.

Figure 3: 2013 U.S. Cleantech Leadership Rank vs. the Ratio of Total State Energy Expenditure to GSP



Source: Seacoast Economics

As demonstrated in the chart, the data show that cleantech ranking explained more than half of what was going on in states in their ratio of energy expenditures to economic activity: which in statistical terms is a relatively strong relationship. The plot therefore strongly supports the idea that states that are stronger in cleantech also tend to spend less on energy to get the same level of economic output. And again, another way to say that is if two states spend the same on energy but one is stronger in cleantech, that state is likely to get a lot more economic output from their spending. So all things being equal, achieving more strength in cleantech should boost economic output.

The analysis also shows that New Hampshire specifically spends 10.4 cents on energy to produce $1 of gross state product. This is a relatively weak performance compared to the U.S. as a whole, which spends only 9.9 cents on energy to produce $1 of Gross Domestic Product (GDP).

Spending more than you have to on energy indicates that you are likely misallocating resources, aka, wasting money. While this should be a deep concern to state policymakers, it can also be viewed as a major opportunity to juice a state's economic growth by strengthening the state's position in cleantech and thereby becoming more efficient in turning energy dollars into economic output.

Consider this: according to these data, if NH could achieve the kind of relatively more efficient relationship between total energy expenditures and economic activity as Massachusetts (which is a leader in New England and the nation in cleantech), then NH citizens and businesses would have spent $2 billion less on energy in 2012 for the same level of economic output. And where would that $2 billion have gone? Mostly back into the state's economy in other areas, boosting producers of other goods and services and incentivizing job creation.

This metric also indicates that in today's technology and knowledge-based economy, a per unit energy cost is not necessarily the determining factor for economic development. Policymakers tend to focus on the raw costs of energy in their states as a metric for competitiveness and economic vitality, and there is certainly value in that measure. However, for example, New York had a higher average electricity retail rate—15.1 cents per kWh, which is higher than NH's average retail rate—but showed a better ratio of total energy cost to economic productivity than NH's. In other words, New York may be spending more for their energy, but they are also getting more in terms of economic output.

Table 6 provides a summary of the measures utilized in this portion of the benchmarking, including the ratio of total in-state energy expenditures to Gross State Product, the average retail electricity price, the 2013 U.S. cleantech leadership rank, and the 2013 ACEEE energy efficiency rank.

Table 6: Summary of State Energy Cost, GSP, and Cleantech & ACEEE Ranks

State	Ratio Total Energy Cost to GSP (2012)	Average Retail Electricity Price Cents per KWH (2012)	US Cleantech Leadership Rank (2013)	ACEEE Energy Efficiency Rank (2013)
New York	$0.06	15.1	4	3
Connecticut	$0.07	15.5	11	5
Massachusetts	$0.07	13.8	2	1
California	$0.08	13.5	1	2
Delaware	$0.08	11.1	25	22
Illinois	$0.08	8.4	8	10
Colorado	$0.08	9.4	5	16
Oregon	$0.08	8.2	3	4
Washington	$0.09	6.9	6	8
New Jersey	$0.09	13.7	13	12
Maryland	$0.09	11.3	21	9
Rhode Island	$0.09	12.7	17	6
Nevada	$0.09	8.9	20	33
Minnesota	$0.09	8.9	9	11
Utah	$0.09	7.8	32	24
North Carolina	$0.10	9.2	24	24
Pennsylvania	$0.10	9.9	23	19
Arizona	$0.10	9.8	16	12
Virginia	$0.10	9.1	28	36
Wisconsin	$0.10	10.3	19	23
Florida	$0.10	10.4	34	27
New Hampshire	**$0.10**	**14.2**	**14**	**21**
Ohio	$0.11	9.1	30	18
Georgia	$0.11	9.4	29	33
Michigan	$0.11	11.0	12	12
Missouri	$0.11	8.5	45	43
Nebraska	$0.12	8.4	42	44
Tennessee	$0.12	9.3	35	3
Indiana	$0.12	8.3	33	27
Iowa	$0.12	7.7	18	12
Texas	$0.12	8.6	22	33
Kansas	$0.12	9.3	38	39
South Dakota	$0.13	8.5	36	47

Table 6: Summary of State Energy Cost, GSP, and Cleantech & ACEEE Ranks (Continued)

State	Ratio Total Energy Cost to GSP (2012)	Average Retail Electricity Price Cents per KWH (2012)	US Cleantech Leadership Rank (2013)	ACEEE Energy Efficiency Rank (2013)
Vermont	$0.13	14.2	15	7
New Mexico	$0.14	8.8	7	24
Arkansas	$0.14	7.6	47	37
Idaho	$0.14	6.9	27	31
Oklahoma	$0.14	7.5	39	37
Hawaii	$0.14	34.0	10	20
South Carolina	$0.15	9.1	37	39
Kentucky	$0.15	7.3	40	39
West Virginia	$0.16	8.1	49	46
Maine	$0.16	11.8	26	16
Montana	$0.16	8.2	31	29
Alabama	$0.16	9.2	41	39
Alaska	$0.16	16.3	46	47
Wyoming	$0.16	7.2	43	50
North Dakota	$0.16	7.8	48	51
Louisiana	$0.18	6.9	44	44
Mississippi	$0.19	8.6	50	47
US Average	**$0.10**	**9.8**		

Source: CleanEdge, U.S. Energy Information Administration, U.S. Bureau of Economic Analysis, ACEEE

Cleantech Policy Discussion

Based on these findings, New Hampshire may well have an opportunity to expand high-paying employment and overall economic output by strengthening the cleantech sector of the economy and therefore the larger associated industries of construction, information technology, manufacturing, professional services, and utilities. Specific policy considerations driven by the available economic information include:

- **Emphasize Innovation:** Policies that focus on innovation will tend to strengthen New Hampshire's cleantech sector. NH has shown relative strength in cleantech patents per capita and broader human capital measurements, reflecting a healthy environment of commercial research and development and/or an opportunity for commercialization of academic R&D. Policies that support research and development, commercialization of academic research, and investment in technology to increase business performance and efficiency will play to New Hampshire's strengths.

- **Maintain Stability:** NH cleantech policy has too often been volatile and inconsistent, as seen by the many changes made to the RPS, diverted funds from the RPS, and the often acrimonious battle to repeal NH's participation in RGGI. Even in defeating withdrawal from RGGI, legislation was passed that significantly changed how the state proceeds from RGGI are spent,[21] and the NH RPS is frequently revisited to "tweak" the definition of qualifying renewable energy, alternative compliance payment rates or the percentage level of the class requirements.[22] The siting and regulatory environment in NH is also erratic. Recently, Iberdrola Renewables withdrew its application for the proposed 75.9 MW Wild Meadows wind farm from the NH Site Evaluation Committee, stating the challenges they were facing "with the current political and regulatory climate in New Hampshire," as one of the reasons.[23] Constantly fluctuating regulation creates uncertainty and results in reduced private investment.[24] Policies that provide reasonable certainty for cleantech demand incentivize cleantech-based businesses to make investments in capital equipment and employees.

- **Utilize Competition and Market-Driven Mechanisms:** In recent years, NH has made significant progress in implementing market-driven mechanisms that support cleantech and economic growth. These include participation in the Regional Greenhouse Gas Initiative (RGGI), implementing a Renewable Portfolio Standard (RPS), and a new group net metering law. These policies have helped NH to rank higher than the national average in cleantech leadership, and as shown above, this correlates with better economic output per energy dollar spent in the state. And because these policies are implemented as market-driven mechanisms that allow price formation to both drive competition and value environmentally desirable aspects of energy systems, they are extremely efficient as public policy.

- **Focus on Key Sectors:** As discussed earlier, NH's economy shows strength in certain manufacturing markets — specifically electronics and sensors. These technologies have cleantech applications in renewable energy, energy efficiency and smart metering. This type of manufacturing is a key component for the

21 "Lynch vetoes RGGI repeal: Top senator doesn't expect an override," Concord Monitor, July 7,2011, available online at http://www.concordmonitor.com/news/4533186-95/jebbradley-regionalgreenhousegasinitia-jimgarrity

22 "Electric Renewable Portfolio Standard," NH Public Utility Commission, available online at http://www.puc.state.nh.us/sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm

23 "Iberdrola abandons Wild Meadows wind farm, raising questions about future of wind power in N.H.," Concord Monitor, May 28, 2014, available online at http://www.concordmonitor.com/news/nation/world/12150881-95/ibredrola-abandons-wild-meadows-wind-farm-raising-questions-about-future-of-wind-power-in

24 Fabrizio, Kira, "The Effect of Regulatory Uncertainty on Investment: Evidence from Renewable Energy Generation", Fuqua School of Business, Duke University, 2011, available online at http://www-management.wharton.upenn.edu/henisz/msbe/2011/4_2_fabrizio.pdf

next wave of cleantech growth. Policies that provide growth opportunity for these industries could help strengthen the employment base and provide NH with export opportunities to growing domestic and international markets. Policymakers should look to some of the areas identified in the CleanEdge Index as areas of relative weakness to find ways to help cleantech in these industries. Other areas of cleantech opportunity include computer programming for the smart grid and web-enabled energy management systems, architectural and engineering services, consulting, research and development, and waste management.

- **And on Key Technologies:** Renewable energy, smart grid, and energy efficiency are areas that can help grow employment in the construction sector. The solar industry alone employed 860 workers in NH in 2013, growing 68% from 2012.[25] This growth was despite a fluctuating Renewable Portfolio Standard program and a large diversion of money from the state's only dedicated renewable energy fund into the state's general fund. The strong growth seen in solar, and also seen throughout the nation, highlights solar as a specific area in cleantech with significant opportunity for construction and professional services sector employment. Renewable energy and energy efficiency can support the local economy through cost reductions, energy savings, and energy diversification.

- **Efficiency Can Have a Huge Economic Payoff:** Cleantech-friendly policies that also focus on energy-use management are especially important to NH, given that it is part of a region with traditionally high energy costs and a heavy dependency on external sources of energy. In 2011, NH citizens spent $6 billion on energy with 65% of that amount leaving the state as payment for imported fuels.[26] NH is particularly dependent on fuel oil, as the 6th highest per capita consumer of oil for residential use, and with 50% of NH homes utilizing oil for heating.[27] A policy that could assist in increasing NH's energy security while simultaneously growing its economy is an Energy Efficiency Resource Standard (EERS), one of the areas highlighted in the CleanEdge Index as lacking in New Hampshire. According to a recent study, an EERS could save NH citizens and business up to $3 billion in energy costs over 15 years while reducing dependency on foreign sources of energy. The enactment of such a policy is projected to add a net total of 2,300 jobs and $160 million in Gross State Product annually.[28] In general, studies have shown that these kinds of clean energy expenditures can result in a greater amount of money circulating within the local economy.[29] The analysis in this paper supports the idea that spending less on energy by strengthen cleantech would increase economic output by redirected wasteful energy spending to other, more productive uses. An example of a successful forward-looking cleantech policy change focusing on efficiency is the Home Performance with Energy Star (HPwES) Program. This program allows homeowners and businesses to pursue the most cost-effective energy efficiency opportunities, including opportunities that reduce the consumption of fuels like heating oil.[30]

25 "State Solar Jobs 2013," The Solar Foundation, November 2013, available online at http://thesolarfoundation.org/solarstates/new-hampshire

26 "Increasing Energy Efficiency in New Hampshire: Realizing Our Potential," Vermont Energy Investment Corporation, November 15, 2013, available online at http://www.nh.gov/oep/resource-library/energy/documents/nh_eers_study2013-11-13.pdf

27 Calculated from energy use data available from the U.S. Energy Information Administration for 2012.

28 See footnote 16

29 "Increasing Energy Efficiency in New Hampshire: Realizing Our Potential," Vermont Energy Investment Corporation, November 15, 2013, available online at http://www.nh.gov/oep/resource-library/energy/documents/nh_eers_study2013-11-13.pdf

30 "Energy efficiency saves all of us money," NH Business Review, April 19, 2013, available online at http://www.nhbr.com/April-19-2013/Energy-efficiency-saves-all-of-us-money/

- **Seize Opportunities, They Don't Always Come Around:** A recent utility decision—as made under NH's existing policy environment and one that may reflect a missed cleantech and consumer-beneficial opportunity—was made to upgrade the meters of the state's largest electric utility to be automated read-only rather than bi-directional smart meters. This is a major investment by the utility over the course of four years: 2013 through 2016.[31] Smart meters are rapidly being adopted by other states and improve transparency for homeowners and businesses to understand and make decisions based on the "true" cost of the electricity that they are consuming, at the time of consumption. More than 50% of the direct economic benefits from smart grid deployment are based on energy conservation resulting from pricing mechanisms such as time-of-use rates.[32] Read-only meters do not provide sufficient information to the consumer to realize these types of benefits. By simply taking advantage of the chance to utilize innovative cleantech, New Hampshire could have likely reaped much greater economic benefits from this investment.

Conclusion

The increasing strength of the cleantech sector is growing the NH economy, providing more jobs that pay a higher than average wage, and saving consumers and businesses money that is being turned into greater state economic output. New Hampshire has a significant opportunity: the state is doing relatively well on benchmarks of cleantech leadership and business intensity, but can identify areas with room for improvement, and there is now strong evidence that by further bolstering the cleantech sector through policies that focus on innovation, business certainty, market-driven mechanisms, and incentives for efficiency, New Hampshire can drive greater economic growth and expansion of high-paying jobs.

> Stability is key. Constantly fluctuating regulation creates uncertainty and results in reduced private investment. Policies that provide reasonable certainty for cleantech demand incentivize cleantech-based businesses to make investments in capital equipment and employees.

31 NH PUC Docket: DE 13-177 Public Service Company of New Hampshire 2013 Least Integrated Resource Plan does not include metering in relation to smart grid technology as discussed in pre-filed testimony of Jim Brennan on behalf of The New Hampshire Office of the Consumer Advocate, available online at http://smartgridcc.org/wp-content/uploads/2014/03/13-177-2014-02-21-OCA-DTESTIMONY-OF-J-BRENNAN.pdf

32 "Utility death spiral: Is decoupling a dumb idea?," SmartGridNews.com, June 24, 2014, available online at www.smartgridnews.com/artman/publish/Business_Business_Case/Utility-death-spiral-Is-decoupling-a-dumb-idea-6597.html

Appendix A: Definition & Methodology

Cleantech Definition

Economic analysis of the cleantech sector can be challenging. This is because cleantech is a generalized area of business activity, not a specific industry sector. Cleantech is a general term applied to goods or services that enhance environmental performance and is often applied to the energy, construction, transportation, utility, and waste industries. Examples of cleantech include: renewable energy, energy efficiency, advanced building technologies, smartgrid, carbon capture and storage, electric vehicles, unconventional natural gas, water management, and recycling. There is often a focus on new technology or increased use of information technology to enhance productivity in these areas.

In this study, the North American Industry Classification System (NAICS) was used. The NAICS system is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. The benefits of using a NAICS-based approach include relying on a widely-accepted standard that has data consistently collected by the U.S. government. It allows for benchmarking with other state and regional economies and provides information on economic data such as employment and wages. The primary drawback of this approach is while the classification system is meant to model the structure of the economy, it does not always exactly match-up with the types of businesses that are often considered to be "cleantech".

Another key design feature is that the NAICS system is organized as a hierarchy starting at a broad 2-digit moving to a 6-digit level with increasing specificity. For example, NAICS code 23 includes the entire construction sector, while NAICS code 237130 only includes firms identified as Power and Communication Line and Related Structures Construction. In this study, industries commonly associated with cleantech were identified at the 4-digit level. This was believed to provide the correct balance between an identification of cleantech businesses that was either too broad or too narrow. It is important to note that all businesses that one would not consider cleantech may be within the 4-digit defined sector or there may be businesses that are considered cleantech that are not included in the definition.

For example, this analysis excluded manufacturing related to wood products, specifically NAICS 3219 "Other wood product manufacturing." This causes the definition in this study to not capture wood pellet manufacturers and other solid biofuel product manufacturers. In this case the number of "cleantech" businesses within this NAICS code are believed to be small relative to all of the other businesses within 3219, therefore it was left out to prevent misrepresentation of that sector's contribution to cleantech. In this analysis, cleantech industry areas were identified into five broad categories: construction, manufacturing, utilities, information technology, and professional services. In future, more granular studies that use survey methodology, wood pellet and other biomass or biofuel product manufacturing businesses contributing to cleantech in NH would be included, as they certainly fall under the definition of cleantech as provided by this report.

Table 7: Industries Included in Cleantech Industry Analysis

Domain	Super-Sector	3- Digit NAICS Sector	4-Digit NAICS Sector
Goods	Construction	236 Construction of Buildings	2361 Residential building construction
			2362 Nonresidential building construction
		237 Heavy and Civil Engineering Construction	2371 Utility system construction
			2373 Highway, street, and bridge construction
		238 Specialty Trade Contractors	2381 Building foundation and exterior contractors
			2382 Building equipment contractors
			2383 Building finishing contractors
			2389 Other specialty trade contractors
	Manufacturing	324 Petroleum and coal products manufacturing	3241 Petroleum and coal products manufacturing
		325 Chemical Manufacturing	3251 Basic chemical manufacturing
		333 Machinery Manufacturing	3334 Hvac and commercial refrigeration equipment
			3336 Turbine and power transmission equipment manufacturing.
			3339 Other general purpose machinery manufacturing
		334 Computer and electronic product manufacturing	3344 Semiconductor and electronic component manufacturing
			3345 Electronic instrument manufacturing
		335 Electrical Equipment, Appliance, and Component Manufacturing	3351 Electric lighting equipment manufacturing
			3353 Electrical equipment manufacturing
			3359 Other electrical equipment and component manufacturing.
		336 Transportation Equipment Manufacturing	3361 Motor vehicle manufacturing
			3362 Motor vehicle body and trailer manufacturing
			3363 Motor vehicle parts manufacturing
			3364 Aerospace product and parts manufacturing
			3365 Railroad rolling stock manufacturing
			3366 Ship and boat building
			3369 Other transportation equipment manufacturing
Services	Utilities	221 Utilities	2211 Power generation and supply
			2212 Natural gas distribution
			2213 Water, sewage and other systems
	Information	511 Publishing Industries (except Internet)	5112 Software publishers
	Professional & Business Services	541 Professional, Scientific, and Technical Services	5413 Architectural and engineering services
			5415 Computer systems design and related services
			5416 Management and technical consulting services
			5417 Scientific research and development services
		562 Waste Management and Remediation Services	5621 Waste collection
			5622 Waste treatment and disposal
			5629 Remediation and other waste services

Location Quotients

A location quotient (LQ) is an analytical statistic that measures a region's industrial specialization relative to a larger geographic unit (usually the nation). An LQ s computed as an industry's share of a regional total for some economic statistic (earnings, GDP by metropolitan area, employment, etc.) divided by the industry's share of the national total for the same statistic. For example, an LQ of 1.0 in an industry like wholesale merchants means that the region and the nation are equally specialized in wholesale merchants; while an LQ of 1.8 means that the region has a higher concentration in wholesale merchants than the nation. Conversely, a LQ of 0.5 would mean that the region had a lower concentration of wholesale markets than the overall nation.[33]

LQs can help reveal what makes a particular region "unique" by highlighting industries that differ from the overall nation. LQs can also be used to identify the "export orientation" of an industry. A value above 1.0 would indicate that the industry is export oriented as it would be believed to be supplying more than the local needs of the region's economy. Conversely, a value below 1.0 would indicate that the industry is not export oriented. In this study, industry LQs were calculated by comparing the industry's share of regional employment with its share of national employment.

For example, NH had a LQ of 6.0 for 3351 Electric lighting equipment manufacturing. This indicates that there is an above average concentration of employees in electric lighting manufacturing relative to the overall nation and suggests that NH has a strength in this area and also that it is likely exporting products to other states or countries. In contrast, NH had a LQ of 0.2 for 3336 Turbine and power transmission equipment manufacturing. This indicates a below average concentration of employees in this industry suggesting this is an area in which NH is relatively weaker. It also indicates an opportunity for improvement, especially when compared to the LQs of leading cleantech states in this industry who had an average LQ closer to 0.8 (based on the top five ranked states in the U.S. Cleantech Leadership Index.this is an area that NH is not as strong in. It also indicates an opportunity for improvement, especially when compared to the LQs of leading cleantech states in this industry who had an average LQ closer to 0.8 (based on the top five ranked states in the U.S. Cleantech Leadership Index.

33 "What are location quotients (LQs)?" U.S Dept. of Commerce, available online at http://www.bea.gov/faq/index.cfm?faq_id=478#sthash.LuZl6qbl.dpuf

Economic Modeling

The technique used to estimate the economic activity in this study is called economic impact analysis. Economic impact analysis describes the current economic activity in a study area (such as a county, group of counties, state, or group of states) and it can be useful in estimating how a change—such as the loss of an existing industry or the addition of a new industry—would be expected to affect the wider local or regional economy in the study area. Impact analysis begins with evaluating the output of businesses included in the analysis. These expenditures (referred to as direct expenditures) trigger a series of additional spending flows throughout other sectors of the local economy as businesses spend on 1) payroll and benefits, and 2) supplies, equipment, and service contracts with local vendors (referred to as indirect expenditures). The purchase of goods and services from local vendors supports the hiring of workers at those firms and also provides funds to enable those firms to purchase additional goods and services from suppliers situated further down the supply chain.

The activity at companies involved in direct or indirect expenditures results in their employees earning salaries and wages. A portion of their wages will be spent on local goods and services at different industries including: health care, retail, and leisure (referred to as household spending or induced expenditures). This round of spending by employees helps support workers in those industries who then will spend portions of their incomes locally which, in turn, triggers another round of spending.

This entire chain of spending is referred to as the "ripple" or "multiplier" effect. The rounds of spending and re-spending do not continue indefinitely but typically diminish rapidly. The impacts of the initial economic activity rapidly leave or "leak" out of the local economy through the imports of goods and services produced in other regions, savings, spending in areas outside the local economy, and taxes.

IMPLAN (IMpact analysis for PLANing) is a system of software and databases produced by the Minnesota IMPLAN Group (MIG), Inc. that is widely used and accepted for local and regional economic modeling. IMPLAN was originally developed in 1976 by the US Forest Service, the Federal Emergency Management Agency, and the Bureau of Land Management to allow for analysis of private and public sector decisions on local, state and regional economic impacts. MIG, Inc. was formed in 1993 to privatize the development and maintenance of IMPLAN data and software. IMPLAN is currently in its third version.

IMPLAN utilizes input-output (I-O) accounts to model how the more than 500 industries that comprise the U.S. economy interact. Input-output (I-O) analysis quantifies the relationships of how industries provide input to and use output from each other. IMPLAN data and accounts follow the accounting conventions used by the U.S. Bureau of Economic Analysis (BEA) when developing an Input-Output (I-O) model of the U.S. economy as well as formats recommended by the United Nations.

Underlying data sources for the IMPLAN model include:

- U.S. Bureau of Labor Statistics (BLS)
  - Census of Wages and Employment (CEW)
- U.S. Department of Census
  - County Business Patterns
  - Annual Survey of Manufacturers (ASM)
  - Construction Spending (Value Put in Place)
- Bureau of Economic Analysis (BEA)
  - Regional Economic Information System (REIS)
  - National Income and Product Accounts (NIPA)
  - Gross State Product (GSP) series
  - Output series

The IMPLAN program uses an ordered series of steps to build the model starting with selection of a study-area. The study-area can be at the county level (including multiple counties), the state level (including multiple states), and the national level. The IMPLAN model allows substitution of data at each stage of the process which can serve to increase the robustness of the model. The model can also have its import and export functions modified and industry groupings changed. IMPLAN also allows for the creation of aggregate models consisting of industries grouped together to streamline the modeling process.

The creation of the study-area database constructs a descriptive and prescriptive model. The descriptive model describes the transfer of money between industries and institutions. This model provides data tables on regional economic accounts that capture local economic interactions. These tables describe the local economy in terms of the flow of dollars from purchasers to producers within the study-area region. The descriptive model also produces trade flows—the movement of goods and services within a study-area and the outside world (regional imports and exports).

The prescriptive model is a set of input-output multipliers that estimate total regional activity based on a change entered into the IMPLAN model. Multiplier analysis is used to estimate the regional economic impacts resulting from a change in final demand. New industries or commodities can be introduced to the local economy, industries or commodities may be removed, and reports can be generated to show the consequences (on output, employment, and value-added) of various impacts. Impacts include: output, labor income, value added, and employment. Impacts can be in terms of direct and indirect effects (commonly known as Type I multipliers), or in terms of direct, indirect, and induced effects.

Table 8: Implan Summary Measures of Regional Economic Activity

Measure	Description
Output	The value of production by industry in a calendar year. Output is measured by sales or receipts and other operating income plus the change in inventory. For retailers and wholesalers output is equal to gross margin not gross sales.
Labor Income	All forms of employment income, including employee compensation (wages and benefits) and proprietor income.
Value Added	The difference between total output and the cost of intermediate inputs. It is a measure of the contribution to Gross Domestic Product (GDP) and equals output minus intermediate inputs. Value added consists of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.
Employment	The annual average of monthly jobs in an industry and includes both full-time and part-time workers.

Implan Industry Code to Analysis Category Crosswalk

Analysis Category	Implan Industry Code	Description
Utility	31	Electric power generation, transmission, and distribution
Utility	32	Natural gas distribution
Utility	33	Water, sewage and other treatment and delivery systems
Construction	34	Construction of new nonresidential commercial and health care structures
Construction	35	Construction of new nonresidential manufacturing structures
Construction	36	Construction of other new nonresidential structures
Construction	37	Construction of new residential permanent site single- and multi-family structures
Construction	38	Construction of other new residential structures
Construction	39	Maintenance and repair construction of nonresidential structures
Construction	40	Maintenance and repair construction of residential structures
Manufacturing	115	Petroleum refineries
Manufacturing	116	Asphalt paving mixture and block manufacturing
Manufacturing	117	Asphalt shingle and coating materials manufacturing
Manufacturing	118	Petroleum lubricating oil and grease manufacturing
Manufacturing	119	All other petroleum and coal products manufacturing
Manufacturing	120	Petrochemical manufacturing
Manufacturing	121	Industrial gas manufacturing
Manufacturing	122	Synthetic dye and pigment manufacturing
Manufacturing	123	Alkalies and chlorine manufacturing
Manufacturing	124	Carbon black manufacturing
Manufacturing	125	All other basic inorganic chemical manufacturing
Manufacturing	126	Other basic organic chemical manufacturing
Manufacturing	127	Plastics material and resin manufacturing
Manufacturing	128	Synthetic rubber manufacturing
Manufacturing	129	Artificial and synthetic fibers and filaments manufacturing
Manufacturing	130	Fertilizer manufacturing
Manufacturing	131	Pesticide and other agricultural chemical manufacturing
Manufacturing	135	Biological product (except diagnostic) manufacturing
Manufacturing	214	Air purification and ventilation equipment manufacturing
Manufacturing	215	Heating equipment (except warm air furnaces) manufacturing
Manufacturing	216	Air conditioning, refrigeration, and warm air heating equipment manufacturing
Manufacturing	222	Turbine and turbine generator set units manufacturing
Manufacturing	223	Speed changer, industrial high-speed drive, and gear manufacturing
Manufacturing	224	Mechanical power transmission equipment manufacturing
Manufacturing	225	Other engine equipment manufacturing
Manufacturing	226	Pump and pumping equipment manufacturing
Manufacturing	227	Air and gas compressor manufacturing

Analysis Category	Implan Industry Code	Description
Manufacturing	232	Industrial process furnace and oven manufacturing
Manufacturing	233	Fluid power process machinery manufacturing
Manufacturing	234	Electronic computer manufacturing
Manufacturing	235	Computer storage device manufacturing
Manufacturing	236	Computer terminals and other computer peripheral equipment manufacturing
Manufacturing	237	Telephone apparatus manufacturing
Manufacturing	238	Broadcast and wireless communications equipment manufacturing
Manufacturing	239	Other communications equipment manufacturing
Manufacturing	240	Audio and video equipment manufacturing
Manufacturing	241	Electron tube manufacturing
Manufacturing	242	Bare printed circuit board manufacturing
Manufacturing	243	Semiconductor and related device manufacturing
Manufacturing	244	Electronic capacitor, resistor, coil, transformer, and other inductor manufacturing
Manufacturing	245	Electronic connector manufacturing
Manufacturing	246	Printed circuit assembly (electronic assembly) manufacturing
Manufacturing	247	Other electronic component manufacturing
Manufacturing	248	Electromedical and electrotherapeutic apparatus manufacturing
Manufacturing	249	Search, detection, and navigation instruments manufacturing
Manufacturing	250	Automatic environmental control manufacturing
Manufacturing	251	Industrial process variable instruments manufacturing
Manufacturing	252	Totalizing fluid meters and counting devices manufacturing
Manufacturing	253	Electricity and signal testing instruments manufacturing
Manufacturing	254	Analytical laboratory instrument manufacturing
Manufacturing	255	Irradiation apparatus manufacturing
Manufacturing	256	Watch, clock, and other measuring and controlling device manufacturing
Manufacturing	257	Software, audio, and video media for reproduction
Manufacturing	258	Magnetic and optical recording media manufacturing
Manufacturing	259	Electric lamp bulb and part manufacturing
Manufacturing	260	Lighting fixture manufacturing
Manufacturing	261	Small electrical appliance manufacturing
Manufacturing	262	Household cooking appliance manufacturing
Manufacturing	263	Household refrigerator and home freezer manufacturing
Manufacturing	264	Household laundry equipment manufacturing
Manufacturing	265	Other major household appliance manufacturing
Manufacturing	266	Power, distribution, and specialty transformer manufacturing
Manufacturing	267	Motor and generator manufacturing
Manufacturing	268	Switchgear and switchboard apparatus manufacturing
Manufacturing	269	Relay and industrial control manufacturing
Manufacturing	270	Storage battery manufacturing

Analysis Category	Implan Industry Code	Description
Manufacturing	271	Primary battery manufacturing
Manufacturing	272	Communication and energy wire and cable manufacturing
Manufacturing	273	Wiring device manufacturing
Manufacturing	274	Carbon and graphite product manufacturing
Manufacturing	275	All other miscellaneous electrical equipment and component manufacturing
Manufacturing	276	Automobile manufacturing
Manufacturing	277	Light truck and utility vehicle manufacturing
Manufacturing	278	Heavy duty truck manufacturing
Manufacturing	279	Motor vehicle body manufacturing
Manufacturing	280	Truck trailer manufacturing
Manufacturing	281	Motor home manufacturing
Manufacturing	282	Travel trailer and camper manufacturing
Manufacturing	283	Motor vehicle parts manufacturing
Manufacturing	284	Aircraft manufacturing
Manufacturing	285	Aircraft engine and engine parts manufacturing
Manufacturing	286	Other aircraft parts and auxiliary equipment manufacturing
Manufacturing	287	Guided missile and space vehicle manufacturing
Manufacturing	288	Propulsion units and parts for space vehicles and guided missiles manufacturing
Manufacturing	289	Railroad rolling stock manufacturing
Manufacturing	290	Ship building and repairing
Manufacturing	291	Boat building
Manufacturing	292	Motorcycle, bicycle, and parts manufacturing
Manufacturing	293	Military armored vehicle, tank, and tank component manufacturing
Manufacturing	294	All other transportation equipment manufacturing
Information Technology	345	Software publishers
Information Technology	350	Internet publishing and broadcasting
Information Technology	351	Telecommunications
Information Technology	352	Data processing, hosting, ISP, web search portals and related services
Information Technology	353	Other information services
Professional Services	369	Architectural, engineering, and related services
Professional Services	370	Specialized design services
Professional Services	371	Custom computer programming services
Professional Services	372	Computer systems design services
Professional Services	373	Other computer related services, including facilities management
Professional Services	374	Management, scientific, and technical consulting services
Professional Services	375	Environmental and other technical consulting services
Professional Services	376	Scientific research and development services
Professional Services	390	Waste management and remediation services

Appendix B: Survey

Below is a recommended survey form for future research and report methodology to measure the progress of the cleantech industry in NH over time at a granular level, such as is done in Vermont and Massachusetts. This short survey is formatted to help limit barriers to completion and provides key economic metrics for industry analysis.

Summary

Business Name (D/B/A)	
Primary Business Address	
Primary Business City	
Primary Business Zip	
Total number of business locations in NH (including primary)	
Contact Person	
Contact Title	
Contact Phone	
Contact Email	

Employment

Total number of all full and part-time employees employed in all NH locations during the last week of 2014	
If you have a peak season, provide the number of all full and part-time employees employed during that time period in 2014	
Total number of all full and part-time employees employed in all NH locations during the last week of 2013	
Total Wage Compensation for all NH employees in 2014 (Select from the following list)	<$100k $100k – $500k $500k - $1 million $1 -$2.5 million $2.5 -$5 million $5 -$7.5 million $7.5 – $10 million >$10 million
Total Wage Compensation for all NH employees in 2013 (Select from the following list)	<$100k $100k – $500k $500k - $1 million $1 -$2.5 million $2.5 -$5 million $5 -$7.5 million $7.5 – $10 million >$10 million

Cleantech Line of Business

Please provide a description of the cleantech goods or services that your company provides	
Primary NAICS code (if known)	
Percent of Revenue from Cleantech goods or services in 2014 (Select from list)	0-10% 10-25% 25-50% 50-75% 75 -99% 100%

Additional Questions

Are you planning to make new investments in your cleantech line of business in the next year?	Yes/No
Are you planning to make new investments in your cleantech line of business in the next five years?	Yes/No
Are you planning to hire new employees	Yes/No
(Increase total employment) in the next year?	1-5 5-10 10-20 20-50 50 -100 100+
If yes, by how many employees do you plan on expanding your workforce from its current size in the next year? (Select from list)	Yes/No
Please list factors in NH that accelerate the growth of your company?	
Please list factors in NH that currently limit the growth of your company?	
What is the next big thing in cleantech?	

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