Warwick Region Carbon Audit 2009–2010

The Brandywine Conservancy's
Environmental Management Center

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Executive Summary

This report was commissioned by the Lititz-Warwick Joint Strategic Plan Coordinating Committee, which meets quarterly to oversee the implementation of the regional plan. Work began on the Warwick Region Carbon Audit — comprising all of the municipalities in the Warwick School District, the WSD itself, the Lititz Sewer Authority, the Lititz recCenter and the Lititz Library — in early 2011 and was completed by the end of that year. Such a study was recommended by the Brandywine Conservancy in the Community Sustainability Assessment that was performed for Warwick Township in 2010. As the Warwick Region plans to update their comprehensive plan in 2012 (for the first time officially including Elizabeth Township in the joint effort) this report should provide an excellent foundation for an energy and climate chapter of that updated plan.

This document is comprised of two chapters, an introduction with background material; and a second which contains the results of the audit, broken down by organization and source. The audit itself is a *municipal* or *organizational* greenhouse gas emissions inventory ("audit" for short). The alternative would be a *community* audit. The difference is that the former only looks at energy use, costs and emissions resulting from organizational operations, while the latter would look at energy use, costs and emissions for the entire geographic area under study. Analogically, the former may be thought of as a census, while the latter would be considered a survey. This report is a census of the participants' energy use, costs and emissions.

The introduction begins with a call to action, noting that all of the world's national governments, all of the national academies of sciences, most of the major scientific bodies, and 97% of all climatologists accept that global warming is occurring and that it is the result of human activities. It has also been shown that every scientific "worst-case scenario" has been exceeded, as the world continues to accelerate its emissions of climate-changing pollutants. Every decade since the 1980s has been hotter, globally, than the preceding decade. Furthermore, as evidenced by the global weather calamities of 2010 and 2011, it would be difficult to believe that the climate has not *already* changed.

Simultaneous with the climate crisis is an energy crisis. Major international agencies and governments have expressed alarm at the exponential increase in annual oil consumption, driven largely by non-OECD nations[1] such as China, India, Russia and Brazil. Coupled with a plateauing of supply that may soon "peak," energy scarcity is already a fact of life for many poorer nations, and resultant energy-price volatility will continue to put pressure on import-dependent economies such as that of the U.S. and its constituent states and municipalities.

Pennsylvania has not proved to be immune from these issues. Already we see an intensification of the water cycle, with summer droughts alternating with flash flooding, causing stress to our Commonwealth's urban *and* agricultural areas. Combined with escalating international financial crises and peak oil, the stress on local economies and municipal budgets is undeniable.

However, as also noted in the "call to action," it is not too late to change our future. The climate may have changed, but we can still slow and even arrest much further change if we act quickly and decisively. Delaying action past 2017 may make the task immeasurably more dificult. It will cost financial resources

[1]The Organization for Economic Cooperation and Development, founded in 1961, is comprised of 34 primarily European and European-descended nations, plus Japan.

to transition to a green economy, but it will cost far more if humanity waits. In the power sector alone, for every $1 in clean technology investment avoided *before* 2020, a further $4.30 will be necessary *after* 2020 to compensate for the increased emissions. As they say, a stitch in time saves nine (or, in this case, $4.30).

In some ways, the Warwick Region has already answered this call to action. From 2009 to 2010, energy use declined 16% and pollution emissions by 12% (or 2,056 tonnes), resulting in cost savings of 29%, or nearly $540,000 region-wide. It is, of course, impossible to draw a trend from just two data points, but these initial results are still quite positive and should be celebrated. *Table 1* summarizes the most important results of the audit, and includes energy use (in millions of Btus, or MMBtu), emissions of global warming pollutants (in tonnes of CO_2-equivalent, or tCO_2e), cost and relative portion of emissions for which each partner is responsible. These terms are defined in *Section 2.1* on page 15.

Table 1. Total regional emissions, by organization, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

By Organization	2009				2010				% Change, 2009-2010		
	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	Cost
Elizabeth Township	512	49	0%	$ 10,363	657	61	0%	$ 13,617	28%	24%	31%
Lititz Borough	3,504	359	2%	$ 69,677	3,570	369	3%	$ 86,682	2%	3%	24%
Warwick Township	7,676	848	5%	$ 257,686	7,228	808	6%	$ 281,218	-6%	-5%	9%
Warwick School District	155,863	12,214	74%	$ 1,126,397	126,583	10,331	71%	$ 444,356	-19%	-15%	-61%
Lititz Sewer Authority	14,179	2,313	14%	$ 305,463	13,194	2,126	15%	$ 461,590	-7%	-8%	51%
Lititz Library	821	112	1%	$ 21,814	811	109	1%	$ 27,933	-1%	-3%	28%
Lititz recCenter	5,205	716	4%	$ 85,445	5,503	751	5%	$ 22,550	6%	5%	-74%
Sub-Total	**187,760**	**16,611**	**100%**	**$ 1,876,845**	**157,546**	**14,555**	**100%**	**$ 1,337,946**	**-16%**	**-12%**	**-29%**

Where to go from here? Now that this audit has been completed, there are at least two directions to go: *(a)* the first would be to follow it up with a Climate Action Plan (CAP), which sets emissions-reductions goals, determines the steps necessary to meet those goals and sets standards for annual monitoring of progress. This CAP could either be a stand-alone document or, better, a chapter of the soon-to-be-updated Joint Plan. *(b)* Expand this Municipal/Organizational Carbon Audit to a community-wide scale and devise a CAP concomitant to that scale.

Thank you. The author would like to thank all of the people in the Warwick Region who have made this report possible. Staff at every organization involved were exemplary, forthcoming, and quick to respond to data requests and requests for clarifications. The Warwick Region Carbon Audit would not have been possible without all the support given by regional staff.

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Chapter 1

Introduction

1.1 Call to Action

Global warming is the pre-eminent crisis of our times. Nothing else has the capacity to so fundamentally threaten one of the world's foundational life-support systems — a stable climate, in this case — as warming-induced climate change. Already the finger prints of climate change are apparent in increasingly extreme weather in the U.S. and abroad. The year 2010 was the hottest year on record (statistically tied with 2005), and capped the hottest decade on record (2001–2010). The year 2011, the hottest La Niña[1] on record, will likely cap another hottest decade (2002–2011). See *Figure 1.1* on the next page.

Furthermore, global warming is a time-lagged phenomenon. The climatic disruption being experienced now is the result of greenhouse gases that were emitted a generation ago. The climate pollutants being emitted today, therefore, represent the passing of a rather unusual generational baton — an overwhelming burden. For the first time in modern history, it may confidently be expected that upcoming generations will face, not greater opportunities, but greater challenges.

According to the latest climate modeling, greenhouse gas concentrations are rapidly approaching levels consistent with 3.6–4.3 °F above pre-warming average global temperatures, "which scientists believe could trigger far-reaching and irreversible changes in our Earth, biosphere and oceans," according to World Meteorological Organization Secretary-General Michel Jarraud.

One way of looking at the situation is through the lens of a "carbon budget", or level of greenhouse gas emissions consistent with a habitable world. This budget is rapidly being used up. In a November 2011 report issued by the International Energy Agency,[2] the world has, at most, five years before the global carbon budget is drained and dangerous and irreversible climate change is locked in. As described by *The Guardian* newspaper:[3]

> "If the world is to stay below 3.6 °F (2.0 °C) of warming, which scientists regard as the limit of safety, then emissions must be held to no more than 450 parts per million (ppm) of carbon dioxide in the atmosphere; the level is currently around 390ppm. But the world's existing infrastructure is already producing 80% of that 'carbon budget.' This gives an ever-narrowing gap in which to reform the global economy on to a low-carbon footing.
>
> If current trends continue, and we go on building high-carbon energy generation, then by 2015 at least 90% of the available 'carbon budget' will be swallowed up by our energy and industrial infrastructure. By 2017, there will be no room for maneuver at all — the whole of the carbon budget will be spoken for, according to the IEA's calculations."

It is cheaper to act now than to act later. The old aphorism is true: a stitch in time saves nine. As just one example of this phenomenon as it relates to global warming, the IEA warns that "delaying action is a

[1] La Niña years are typically 0.18–0.27 °F cooler than the years preceding or following them.

[2] World Energy Outlook 2011. http://www.worldenergyoutlook.org/

[3] World headed for irreversible climate change in five years, IEA warns. http://www.guardian.co.uk/environment/2011/nov/09/fossil-fuel-infrastructure-climate-change

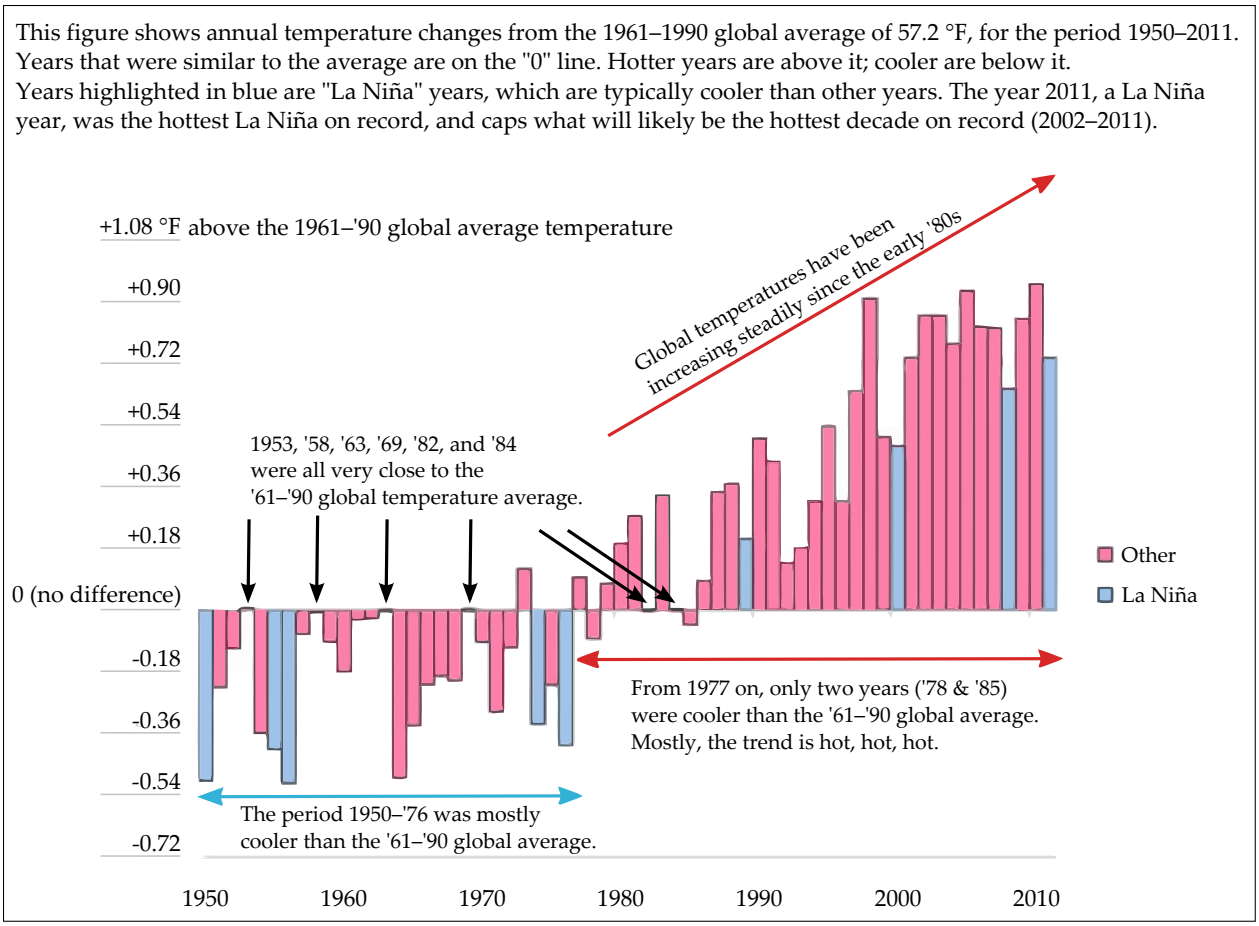

Figure 1.1. Global warming trend, 1950–2011. Annual global temperature differences from the 1960–1990 average, for the period 1950–2011. Every decade since the 1980s has been hotter than the preceding decade.

false economy: for every $1 of investment in cleaner technology that is avoided in the power sector before 2020, an additional $4.30 would need to be spent after 2020 to compensate for the increased emissions."[4] Similarly, it is possible that money might be spent now on infrastructure that is not useful in the future; for example, if people drive less in response to higher gas prices and concern over their impacts on the environment, investments in expanded roadways might be regretted.

This isn't the end of the story. In the few years remaining before our carbon budget is busted, the world has the opportunity — and arguably the responsibility — to act, to conserve the climate in which civilization grew up. Efforts to conserve energy, to use it more efficiently, and to produce it renewably must all be given our utmost support. Fortunately, each of these efforts is also valuable in its own right, for a variety of reasons. Reducing emissions of climate-damaging gases also reduces emissions of pollutants known to seriously impact human health, pollute surface waters, and harm wildlife. Reducing energy use improves our energy security by reducing our reliance on foreign sources of energy, particularly oil; and also reducing our exposure to energy price volatility, which is of increasing concern, since our economic stability is dependent on energy price stability. There are also obvious financial returns to conserving energy and using it more efficiently, and with budgets increasingly tightening, such low-hanging fruit *must* be grasped. Furthermore, even with state and federal incentives drying up, sources of renewable energy have begun to reach grid parity, meaning their installed cost per kilowatt-hour (kWh) is now directly economically com-

[4] "The world is locking itself into an unsustainable energy future which would have far-reaching consequences, IEA warns in its latest *World Energy Outlook*." 9 Nov 2011. http://www.iea.org/press/pressdetail.asp?PRESS_REL_ID=426

petitive with coal and natural gas generation (even with fossil fuels' favorable subsidies); Bloomberg News recently reported[5] that "renewable energy is surpassing fossil fuels for the first time in new power-plant investments," drawing $187 billion last year vs. $157 billion for fossil fuel energy.

In sum, the financial arguments in favor of fossil fuels and against conservation, efficiency and renewable energy no longer hold any water; the public health advantages of reducing emissions are large and obvious; and our selfish self-interest demands we reduce our reliance on increasingly unstable supplies of a key global commodity: fossil energy.

1.1.1 Global Warming in Pennsylvania

Present-day and projected future impacts of global warming in Pennsylvania are many and varied. They include an increase in 90 and 100 °F days, an increase in the number and severity of droughts, an increase in extreme precipitation events, reduced dairy production, irreversible shifts in habitat for the Commonwealth's flora and fauna, and much more.[6] One way to look at it is to imagine what our climate will be like in 30, 60 and 90 years (see *Figure 1.2* on the following page).

And this only represents the *average* climatic shift. In reality, Americans will be (as they are today) much more caught up in the impacts from increasingly severe *extreme* weather events.

1.1.2 Extreme Weather

Figure 1.3 on page 8 shows the number (and cumulative cost) of billion-dollar weather/climate disasters, annually, for the period 1980–November 2011. Twelve have been identified for 2011 so far, with two more (the pre-Halloween winter storm and wind and flood damage from Tropical Storm Lee) that may yet be added to the list. The Warwick region has not proved immune to these weather/climate disasters.

Unfortunately, this year has not been exceptional. As reported by ClimateWire:[7]

> . . . this year was not an aberration, NOAA [National Oceanic and Atmospheric Administration] Administrator Jane Lubchenco said during a speech yesterday.
>
> The seemingly endless onslaught of floods, droughts, wildfires, windstorms, blizzards and tornadoes that have marked 2011 fit within an ongoing increase in the number of natural disasters recorded in the United States, she said, citing statistics maintained by reinsurer Munich Re.
>
> And at least some of that increase appears to be driven by climate change, Lubchenco said, citing a recent report by the Intergovernmental Panel on Climate Change.
>
> "What we are seeing this year is not just an anomalous year, but a harbinger of things to come," the NOAA chief told attendees of the American Geophysical Union's fall meeting.

The recent extreme Dust Bowl conditions in the southwest (Texas in particular) are also consistent with climate models for the region. For example, the following figure (*Figure 1.4* on page 8) depicts expected wet/dry conditions for the world for the period 2060–2069.[8] A glance at the continental United States shows that much of the nation is expected to be practically desiccated, with a Palmer Drought Severity Index (PDSI) ranging from 0 (a small sliver in New England) to -4 or -8 in Texas to -20 in the Midwest. The term "Dust Bowl" is not used loosely, as the PDSI for that period was around -3, with only a very brief spike to -6.

[5] Renewable power trumps fossil fuels for first time. LA Times. http://www.latimes.com/business/la-fi-renewables-20111125,0,2421278.story

[6] Climate Change In Pennsylvania: Impacts and Solutions for the Keystone State. Union of Concerned Scientists. http://www.ucsusa.org/global_warming/science_and_impacts/impacts/climate-change-pa.html

[7] http://www.eenews.net/climatewire/2011/12/08/

[8] Similar maps have been produced for the periods 2030–2039 and 2090–2099 (see http://onlinelibrary.wiley.com/doi/10.1002/wcc.81/full). All are rather disquieting.

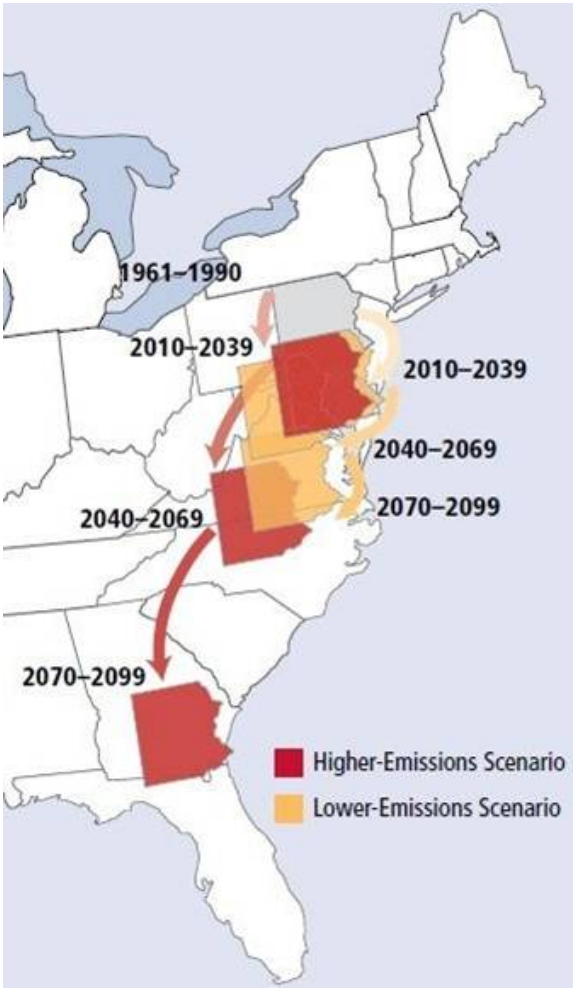

Figure 1.2. This image shows what the climate of eastern PA will "feel like" in 30, 60 and 90 years under "lower-emissions" and "higher-emissions" scenarios. To date, the world is exceeding the higher-emissions scenario, so we might expect eastern Pennsylvania by 2070 to feel like southern Georgia does today (Union of Concerned Scientists, 2008).

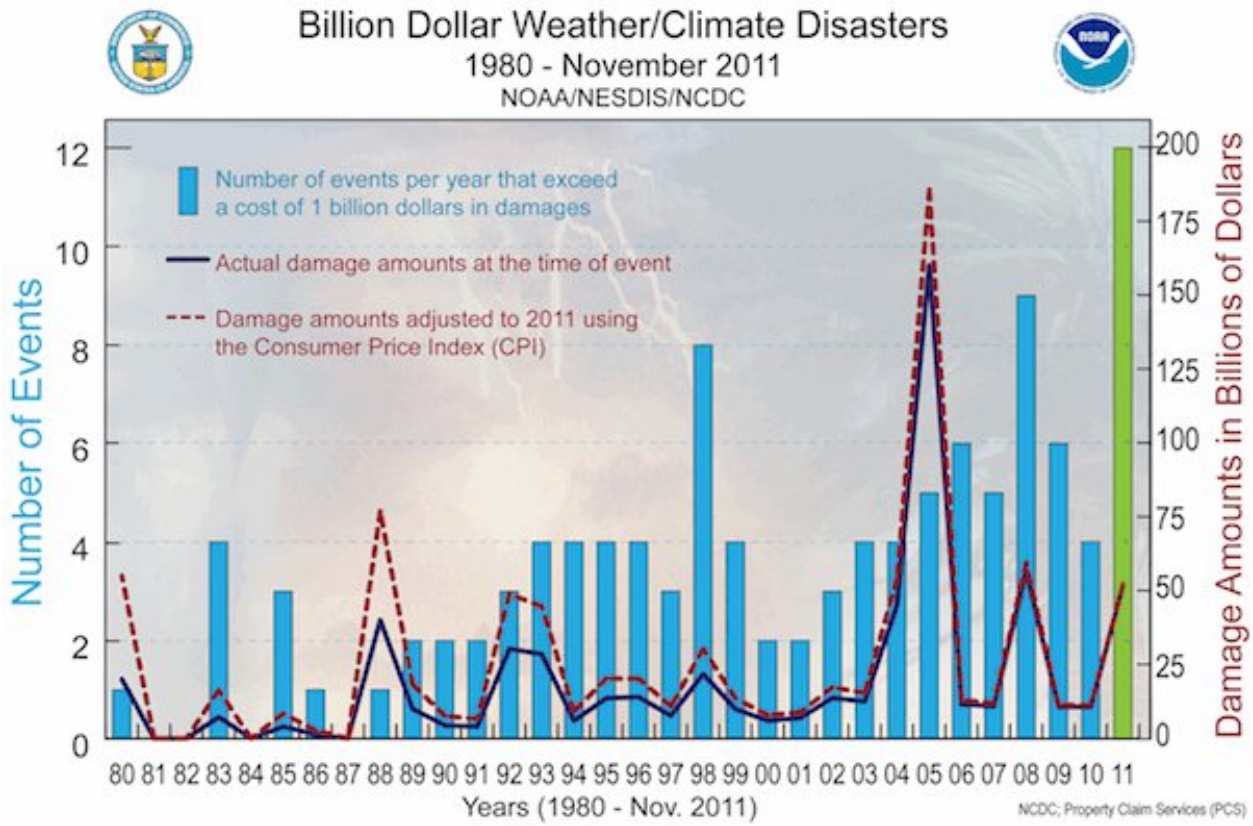

Figure 1.3. Billion-dollar weather/climate disasters, number and cumulative cost, 1980–November 2011. National Oceanic and Atmospheric Administration (NOAA), November 2011.

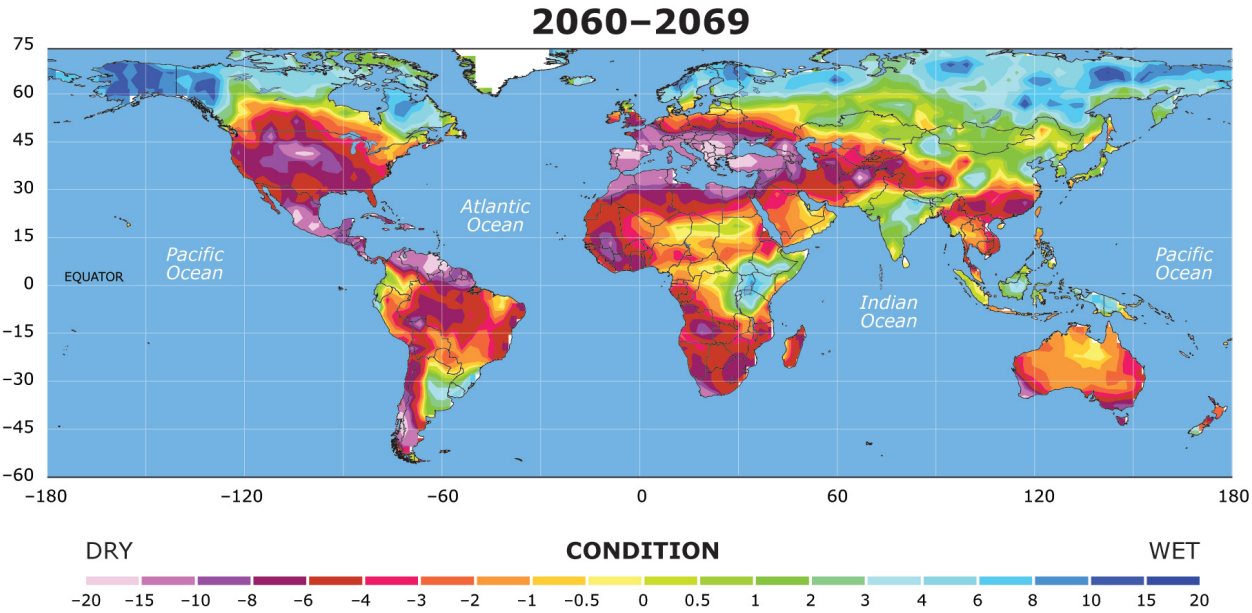

Figure 1.4. Projected global Dust Bowl conditions, mid-century. Future wet/dry conditions, where a reading of -4 or below is considered extreme drought. The PDSI in the Great Plains during the Dust Bowl spiked very briefly to -6, but otherwise rarely exceeded -3 for the decade (National Center for Atmospheric Research [NCAR], 2010).

1.1.3 Scientific Certainty & the International Consensus

Several independent surveys find that 97% of climate scientists who actively publish peer-reviewed climate research agree that humans are causing global warming (see *Figure 1.5*).[9] On top of this overwhelming consensus, National Academies of Science from all over the world also endorse the consensus view of human-caused global warming,[10] as expressed by the Intergovernmental Panel on Climate Change (IPCC). Furthermore, dozens of scientific organizations, such as the American Meteorological Society, the American Association for the Advancement of Science (AAAS), etc., have also endorsed the consensus position.[11]

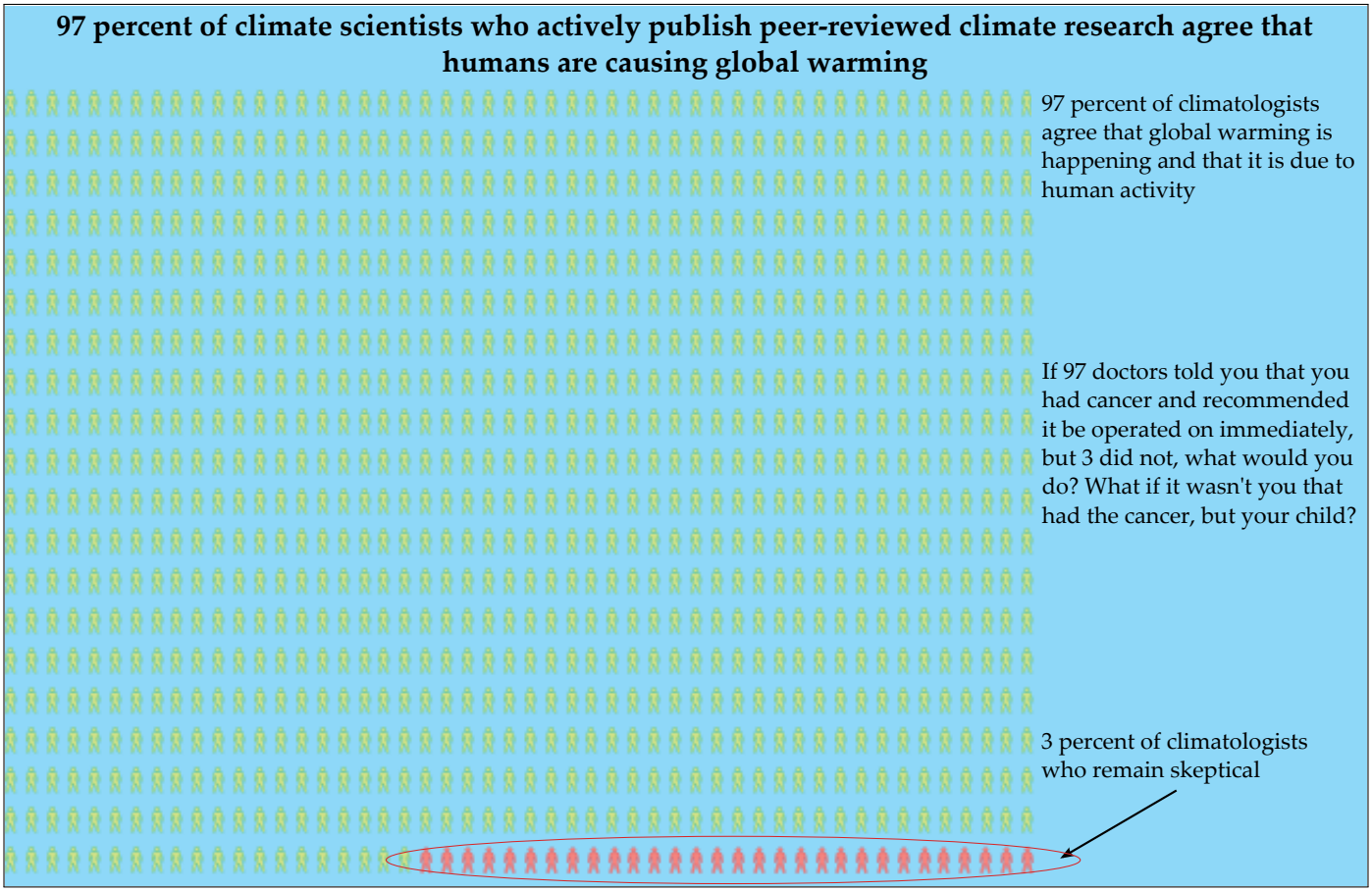

Figure 1.5. The scientific consensus on global warming.

1.1.4 Peak Oil

It has always known that the climate-altering fossil fuels burned to power civilization have been and are non-renewable. The only real surprise is that climatic tipping points have been reached at the same time as fossil fuel production tipping points. The term "peak oil" first entered the modern lexicon when Marion King Hubbert, a geoscientist with Shell Oil, successfully predicted, in 1956, the overall peak in U.S. petroleum production for 1970 (see *Figure 1.6* on the following page). He is credited with articulating the Hubbert peak theory, which states that, for any given geographical region up to and including the world,

[9] E.g., *Examining the scientific consensus on climate change*. Doran (2009). http://tigger.uic.edu/%7Epdoran/012009_Doran_final.pdf

[10] 11 have signed a joint statement endorsing the consensus position: *Joint science academies' statement: Global response to climate change*. http://nationalacademies.org/onpi/06072005.pdf

[11] See, e.g., http://www.skepticalscience.com/global-warming-scientific-consensus-intermediate.htm

the rate of petroleum production over time would resemble a bell curve. Such a curve implies a peak in production, hence "peak oil."

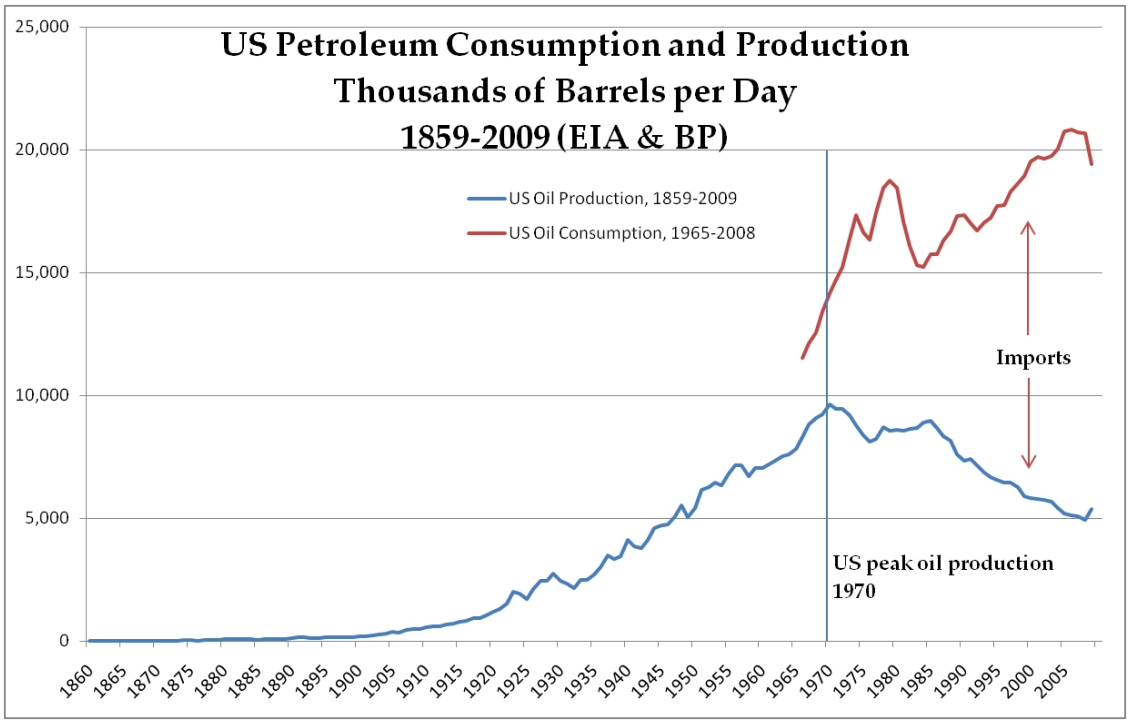

Figure 1.6. History of US oil production, from 1859; and consumption, from 1965. U.S. Energy Information Agency (EIA), 2010; BP Statistical Review, 2010).

To understand some of the implications of peak oil, one merely needs to look at the most recent oil crisis of 2007–'08. That oil crisis, along with the housing and financial collapses, led to a near-economic collapse on a global scale. Many nations' economies are still reeling from the impacts of high oil prices; in fact, according to the U.S. Energy Information Agency, the year 2011 saw a number of energy records: the first time the global benchmark (Brent crude) averaged greater than $100 a barrel for an entire year; and the first time the national average pump price for gasoline and diesel never dropped below $3 a gallon, making 2011 the year with the highest *average* fuel price in history.[12] Predictions are mixed for oil prices in 2012: on the supply side are increasing geopolitical tensions overlaid with increasing geologic constraints on the production of oil, which would indicate increasing prices; while on the demand side, European and American economies are either not growing or outright shrinking, which leads to lower demand and possibly lower prices.[13]

Figure 1.7 on the next page depicts the International Energy Agency's (IEA's) projections for oil production through 2035. What is astonishing about this chart is that total crude oil production is expected to be *flat* for the next 23 years (something that has never been seen before), even while production from currently producing fields falls off a cliff, from 60 million barrels per day (mb/d) in 2010 to around 20 mb/d in 2035: a 66% decline. To make up the loss, the IEA postulates that new crude oil will be produced — *from fields yet to be developed or found*. It is one thing to accept that new oil fields will be discovered and brought into production, but another entirely to believe that those new-found fields will *exactly* offset declines from existing fields. On top of all this, the IEA assumes that increasing supplies of "natural gas liquids" (also known as liquified natural gas, or LNG) and "unconventional oil" (a euphemism for shale oil, tar sands oil and ultra-heavy crude that must be intensively processed) will lead to a *net increase* in liquid fuels production. A reasonable reading of this chart would lead one to believe that the IEA is attempting to hide the

[12] http://www.eia.gov/todayinenergy/detail.cfm?id=4490

[13] *IEA Cuts 2012 Oil Demand Forecast, Warns of Further Decline*. 19 January 2012. http://www.businessweek.com/news/2012-01-19/iea-cuts-2012-oil-demand-forecast-warns-of-further-decline.html

ultimate decline in liquid fuels production beginning in the early part of this decade. The motivation for this is unclear.

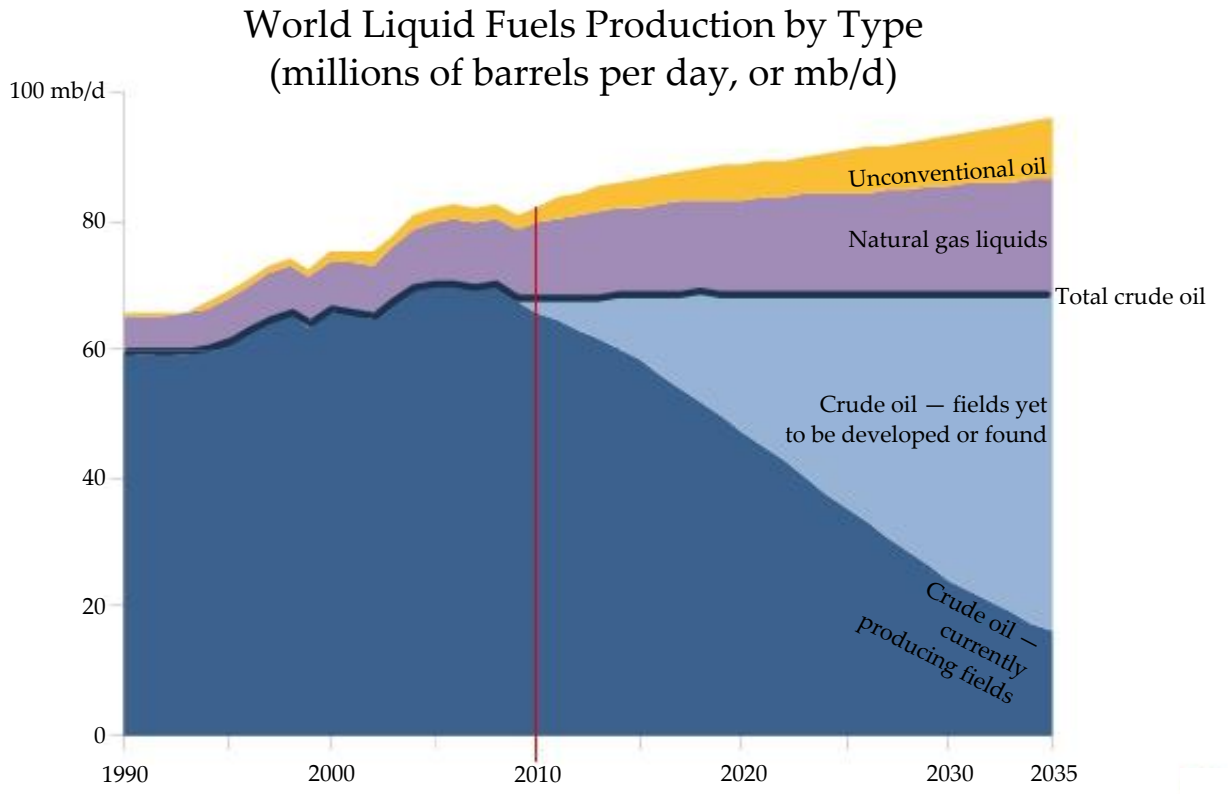

Figure 1.7. The IEA's tacit peak oil projection. The idea that crude oil production (from currently producing fields as well as fields "yet to be developed or found") could be flat for the next 25 years is a difficult one to support, *particularly* when paired with net increases in production (IEA, 2009).

Peak oil means highly volatile, and sometimes very high, oil prices. Because oil lubricates our entire global economy (accounting for over 1/3 total energy use globally), high oil prices gum up the works; peak oil places a ceiling on the rate of growth, and maybe on growth itself.

What does this mean for municipalities? For local jurisdictions and organizations with little control over such global issues, the only reasonable path forward is to improve resilience by reducing reliance on these unstable supplies of increasingly expensive energy. While year-to-year variations in cost might be up or down, the long-term trend is clear: energy prices will prove an increasing burden on local budgets and, to the extent that they negatively impact the greater economy, will also constrain revenues and increase demand for local services from an increasingly hard-pressed population.

1.2 Purpose of this document

As the saying goes, "you can't manage what you don't measure." This Carbon Audit, or greenhouse gas emissions inventory, is the first attempt by the Warwick Region (and, indeed, the first attempt anywhere in Lancaster County) to comprehensively inventory greenhouse gas emissions resulting from municipal operations. Once measured, such emissions should be tracked on an annual or biennial basis, consistent with a plan to reduce such emissions to a level determined by the various Boards and Council who commissioned this Audit. That plan could either be a stand-alone Climate Action Plan or, perhaps more appropriately, incorporated into the upcoming Lititz-Warwick Joint Strategic Plan Update (see *Section 1.2.2*).

Community Sustainability Assessment. A carbon audit was recommended by the 2009 Community Sustainability Assessment (CSA), conducted by the Brandywine Conservancy for Warwick Township. The CSA was a comprehensive review of Warwick Township's policy, planning and regulatory framework as it pertained to environmental sustainability. This recommendation was included as part of an ecosystem of supporting recommendations intended to remove obstacles, create incentives and establish standards for climate protection & restoration for Warwick Township (and, by extension, the rest of the region).

1.2.1 Municipal/Organizational Carbon Audit

This Carbon Audit is a *municipal/organizational* greenhouse gas emissions inventory, as opposed to a *community* inventory. It represents an attempt to census all of the greenhouse gases emitted through the operations of the participants. The author is confident that this goal was substantially achieved, while acknowledging that a relatively minute portion of total emissions were likely missed.

Greenhouse gas emissions are sometimes referred to by their "scope." *Scope 1* emissions are those an organization is directly responsible for, e.g., emissions from the organization's fleet, or from gas- or oil-fired water boilers located on-site. *Scope 2* emissions, generally, are those for which an organization is responsible, yet which are generated off-site, e.g., any emissions associated with electricity use. *Scope 3* emissions are all other indirect and embodied emissions over which the organization exerts significant control or influence, e.g., emissions from waste hauling services and emissions from employee commutes. Due to time constraints, this Carbon Audit includes only Scopes 1 and 2 emissions. If and when this Audit is updated, an expansion into Scope 3 may be warranted.

A community inventory would attempt to include all emissions generated by all those living in, working in and visiting the region. If the municipal inventory is a *census* of all emissions then, by analogy, a community inventory would be a *survey*, due to the impracticality of tallying each tonne of carbon produced by those living, working and playing in the region. Conducting a Community Carbon Audit would be a logical next step, having completed the Municipal/Organizational Carbon Audit.

1.2.2 2012 Lititz-Warwick-Elizabeth Joint Strategic Plan Update

Lititz Borough and Warwick Township will be updating their Joint Strategic Plan in 2012; for the first time, Elizabeth Township will be an official member of the regional plan. The last Plan update was completed in 2006; the original Plan was completed in 1999.

Much has changed since 2006. Not only did the economy enter a severe recession (the end of which is disputed, particularly with respect to municipal finances, and as understood through such indicators as home foreclosures and the unemployment rate), but also climate change as a result of greenhouse gas pollution and land-use change has risen in the public's awareness.[14] The time, therefore, is ripe for an update to the Joint Plan.

The updated Plan will include a chapter on Climate & Energy, for which this study will provide important background information. The Municipalities Planning Code, §301.1, specifically allows for comprehensive plans to include an energy conservation plan element "which systematically analyzes the impact of each other component and element of the comprehensive plan on the present and future use of energy in the municipality, details specific measures contained in the other plan elements designed to reduce energy consumption and proposes other measures that the municipality may take to reduce energy consumption and to promote the effective utilization of renewable energy sources."

Ideally, a Climate & Energy chapter would include a detailed discussion of energy use in the region, including its sources, distribution and resultant pollution; a discussion of opportunities for conservation, increased efficiency and renewable energy on a community-wide scale; a community-wide carbon audit (of which this study would be a component); a Climate Action Plan with defined reduction targets; and an analysis of economic & fiscal impacts, positive and negative, for all of the above.

[14] Yale Project on Climate Change Communication, November 2011. http://environment.yale.edu/climate/news/ClimateBeliefsNovember2011/

1.3 Methodology

The process for completing this Audit comprised, essentially, three steps:

1. Gathering energy bills (electricity, natural gas, heating oil, gasoline & diesel) from each partner organization;
2. Inputing data on energy use (kilowatt-hours [kWh], cubic feet [cf] of natural gas, gallons of fuel) and energy costs into ICLEI-USA's[15] "Clean Air-Cool Planet" (CACP) calculator, which converts the different types of energy into a common metric (MMBtu) and also multiplies them by accepted multipliers to determine their impact on the climate in tonnes of carbon dioxide-equivalent (tCO_2e);[16]
3. Tallying the results.

1.3.1 Energy Bills

Each project partner provided their energy bills for the period 2009–2010 either on a monthly or annual basis. These were then summarized into annual costs and energy use (in kWh, cf natural gas, or gallons of liquid fuel) in as detailed a manner as possible. For example, Warwick Township's liquid fuels bills were able to be broken down into administration fleet, public works fleet, off-road diesel (heavy equipment) fleet, police fleet and emergency fleet. Similarly, the Warwick School District's liquid fuels use was able to be broken down into their heavy-duty fleet and their gasoline fleet. Other partners, such as Lititz Borough, Elizabeth Township and the Lititz Sewer Authority, did not have data so fine-grained; as such, liquid fuels use for motor vehicles is reported as "vehicle fleet" for these partners.

1.3.2 Emissions Calculations

In support of this Audit, Warwick Township, Lititz Borough and Elizabeth Township split the cost of a membership in ICLEI-USA, with Warwick as the lead municipality. With this membership came the ability to use ICLEI's emissions calculator, known as "Clean Air-Cool Planet", or CACP 2009. This calculator makes use of public data to convert different energy types into emissions of tonnes of carbon dioxide-equivalent (or tCO_2e) and millions of Btus (or MMBtu). It is, for example, known that burning 1,000 cubic feet (often abbreviated mcf) of natural gas leads to the emissions of 133 lbs CO_2eand has an energy content equivalent to 1.03 MMBtu. That amount of natural-gas based energy also cost, not incidentally, about $0.91 in 2010.

The calculator also accounts for the differing emissions profiles for differing regions of the nation's energy grid. Here in the PJM (**P**ennsylvania-New **J**ersey-**M**aryland), we burn a fair amount of coal, and so each 1,000 kilowatt-hours costs us about 1,263 pounds in carbon pollution. Since this much electricity has an energy content equivalent to 3.41 MMBtus, it is $2.86\times$ more polluting than the energetically-equivalent amount of natural gas.

In an effort to make the results cross-comparable across the region, "per capita" figures were also generated. To derive these figures, the following population subsets were used: *(a)* actual population for Elizabeth and Warwick Townships, and Lititz Borough; *(b)* student population rolling average for the 2008–'09, '09–'10, and '10–'11 school years for Warwick School District; *(c)* ratepayers for the Lititz Sewer Authority; *(d)* annual patronage for the Lititz Library; and *(e)* annual membership for the Lititz recCenter .

1.3.3 Tallying the Results

Finally, the results of the Audit were tallied, the end-products of which can be seen in *Table A.1* and *Table A.2*, starting on page 26. Those tables were then analyzed using statistical and graphical software to produce the visualizations used throughout *Chapter* 2.

[15] ICLEI used to be an acronym for "International Council for Local Environmental Initiatives," but now stands for nothing.
[16] See *Section 2.1* on page 15 for definitions of the terms used here.

Chapter 2

Warwick Region Carbon Audit

This Carbon Audit was commissioned by the Lititz-Warwick Coordinating Committee, which is tasked with implementing the Lititz-Warwick Joint Strategic Plan of 2006. It was then separately authorized by the Boards of Elizabeth Township, the Warwick School District (WSD), the Lititz Sewer Authority (LSA), the Lititz Library and the Lititz recCenter, each of which have been consistent partners in regional planning efforts within the Warwick region.

The tables and charts on the following pages depict, in detail, the scale and source of the region's greenhouse gas (carbon) emissions. While every effort was made to present the data in a way that was straightforward, intuitive and useful, it bears mentioning that each of the Audit partners is unique in the region. They include a rural township, a rural/suburban township, a borough, a school district, a sewer authority, a public library and a Rec Center. Energy-use profiles for each type are quite different and, as such, the data for each partner are not necessarily directly comparable. Ideally, there would exist a pool of data from other regions of Lancaster County against which to compare; in the future, such information may be available. Items of particular interest will be called out for the reader's attention.

2.1 Regional Emissions

Figure 2.1 on the following page and *Figure 2.2* on page 17 summarize the top-level findings of the Warwick Region Carbon Audit, depicting carbon emissions for the baseline period (years 2009 & 2010) for the region, broken down by organization and source, respectively.

One thing that is immediately apparent is the significant drop in emissions (2,056 tonnes of CO_2e, or 12%) between 2009 and 2010 (costs also declined, by nearly $540,000 or 29%). While this is certainly to be celebrated, it would be incorrect to assume a trend based on two data points. 2011's emissions may be up, down or unchanged from 2010; and 2008 may have been lower, higher, or the same as 2009.

Based on the author's personal experience as an employee of Warwick Township, Lititz Borough and Elizabeth Township during the study period, it may reasonably be concluded that major contributory factors in this emissions reduction are: *(a)* electricity deregulation (beginning 1/1/2010) and resultant efforts to limit expected price increases through conservation and improved efficiency; *(b)* ongoing cost-cutting to cope with the recession's ongoing impacts on revenues; and *(c)* conservation efforts pursued for their own sake.

Table 2.1 on page 16 summarizes the energy use, emissions, and energy costs across the project partners.[1] The Warwick School District, unsurprisingly, is the largest emitter of the group. It has, by far, the largest energy budget (over $1.1 million and nearly 156,000 MMBtu in 2009); the next-largest being the Lititz Sewer Authority at just over $300 thousand and over 14,000 MMBtu, also in 2009. However, the WSD also has the lowest carbon intensity in the region, which is a metric of tonnes of carbon dioxide-equivalent emitted per million Btu of energy consumed (or tCO_2e / MMBtu), the lowest cost per unit of energy ($ / MMBtu), and the lowest cost per tonne of CO_2e emitted (see *Table 2.4* on page 18). Interestingly, the WSD also reduced its energy use, carbon emissions and costs the most between 2009 and 2010.

[1] See *Section 1.3* for details on how these metrics were derived.

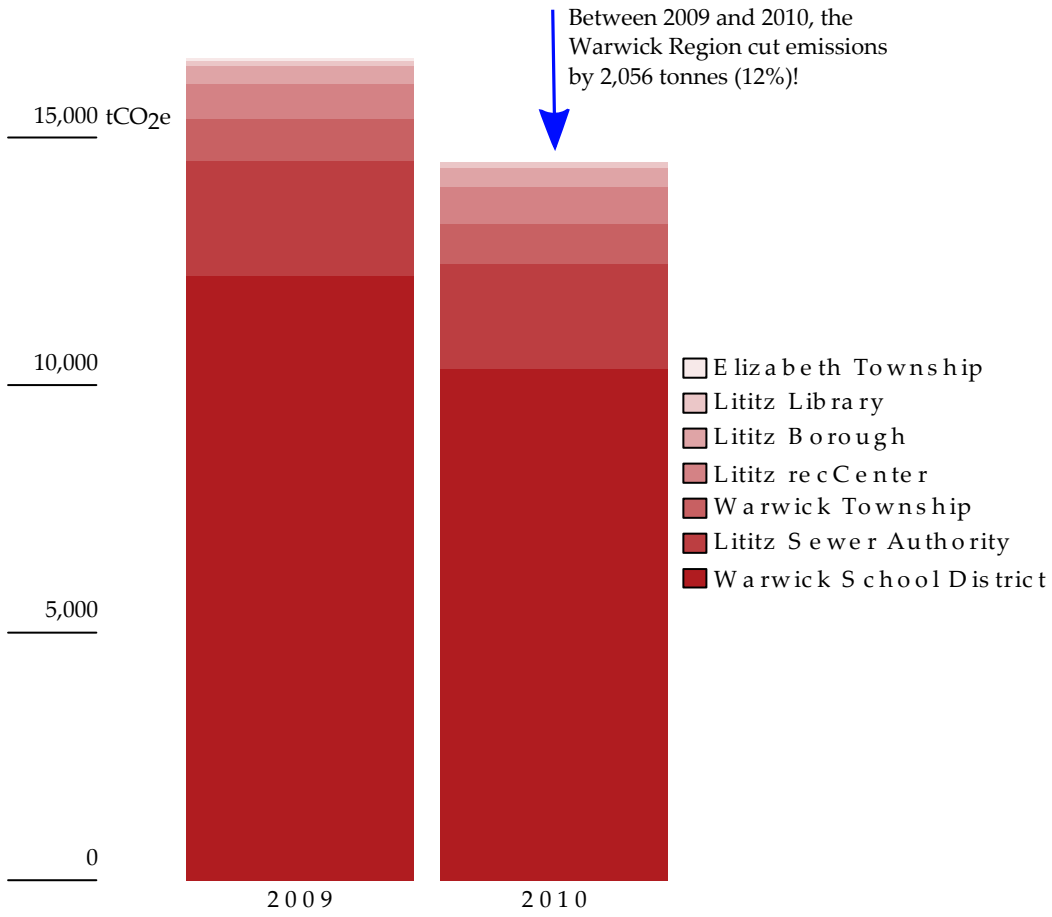

Figure 2.1. Emissions by organization, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010). The lion's share is contributed by the Warwick School District, at just over 70% of total emissions, while Elizabeth Township's emissions barely figure in. Note the significant drop in energy use and concomitant emissions between 2009 and 2010, which is likely a result of aggressive pursuit of cost savings in the face of energy deregulation.

Table 2.2 on the following page duplicates *Table 2.1*, but only for the municipal partners, which are perhaps the most directly-comparable in the region.

Some definitions. It is almost impossible to describe emissions of global warming pollutants (commonly referred to as carbon emissions) without using at least *some* technical language, the above paragraph being a prime example. To aid the reader, below is a list of commonly-used terms:

Carbon dioxide-equivalent, or CO_2e Because there are a variety of greenhouse gases, and because carbon dioxide (CO_2) is the most important, and also because most of these molecules include carbon atoms, it is common for greenhouse gas emissions to be abbreviated "carbon emissions," and for all such pollutants to be converted to their equivalent in CO_2. Methane (CH_3, emitted primarily by decaying waste and farm animals), for example, is the second most powerful greenhouse gas pollutant after CO_2, being 23–100 times as powerful, depending on the timescale in question.[2]

tonne Short for metric ton, which is equivalent to about 2,204 lbs. Metric tons ("tonnes") are used exclusively in this report.

[2]When the "global warming potential" of methane is analyzed over a 100-year period, it is considered to be 23 times more powerful than CO_2. When it is looked at over a 20-year period, it is considered to be 100 times more powerful — because its global warming power is concentrated in a shorter span of time.

tCO_2e Abbreviation for tonnes of CO_2e.

Carbon intensity This term describes the amount of carbon pollution emitted per unit of energy consumed. The lower the better. This number basically reflects the energy-density of the fuels being consumed. Natural gas (primarily methane), e.g., is very energy-dense, emitting about 117 lbs of CO_2 per MMBtu. Compare this to anthracite coal, which emits 227 lbs CO_2 per MMBtu (for an easy comparison, a gallon of gasoline, when burned, will produce about 19.4 lbs, or 19 cubic yards, of CO_2). All else being equal, it is better to burn more energy-dense (less carbon-intense) fuels whenever possible.

Million British Thermal Units, or MMBtu A Btu and, by extension, an MMBtu, is a commonly used measure of energy in the energy industry. A Btu is about the same energy as that produced by burning a match stick. Because different energy sources are measured in different ways (electricity in kilowatt-hours, or kWh; natural gas in cubic feet; gasoline and diesel in gallons; etc.), all energy types have been converted to MMBtu as the common unit of measure.[3] The average U.S. home consumes about 37.2 MMBtu's worth of electricity per year.[4]

Table 2.1. Total regional emissions, by organization, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

By Organization	2009				2010				% Change, 2009-2010		
	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	Cost
Elizabeth Township	512	49	0%	$ 10,363	657	61	0%	$ 13,617	28%	24%	31%
Lititz Borough	3,504	359	2%	$ 69,677	3,570	369	3%	$ 86,682	2%	3%	24%
Warwick Township	7,676	848	5%	$ 257,686	7,228	808	6%	$ 281,218	-6%	-5%	9%
Warwick School District	155,863	12,214	74%	$ 1,126,397	126,583	10,331	71%	$ 444,356	-19%	-15%	-61%
Lititz Sewer Authority	14,179	2,313	14%	$ 305,463	13,194	2,126	15%	$ 461,590	-7%	-8%	51%
Lititz Library	821	112	1%	$ 21,814	811	109	1%	$ 27,933	-1%	-3%	28%
Lititz recCenter	5,205	716	4%	$ 85,445	5,503	751	5%	$ 22,550	6%	5%	-74%
Sub-Total	**187,760**	**16,611**	**100%**	**$ 1,876,845**	**157,546**	**14,555**	**100%**	**$ 1,337,946**	**-16%**	**-12%**	**-29%**

Table 2.2. Municipal emissions, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

By Municipality	2009				2010				% Change, 2009-2010		
	Energy Use (MMBtu)	Emissions (tCO_2e)	% Municipal Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	% Municipal Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	Cost
Elizabeth Township	512	49	4%	$ 10,363	657	61	5%	$ 13,617	28%	24%	31%
Lititz Borough	3,504	359	29%	$ 69,677	3,570	369	30%	$ 86,682	2%	3%	24%
Warwick Township	7,676	848	68%	$ 257,686	7,228	808	65%	$ 281,218	-6%	-5%	9%
Sub-Total	**11,692**	**1,256**	**100%**	**$ 337,726**	**11,455**	**1,238**	**100%**	**$ 381,517**	**-2%**	**-1%**	**13%**

As *Figure 2.1* on the previous page depicts and as *Table 2.1* describes in greater detail, total carbon emissions declined substantially between 2009 and 2010. Energy *costs* also declined by nearly $540 thousand, or nearly 30%, the result of aggressive cost-cutting and energy-conservation policies, in the face of energy deregulation in 2010,[5] primarily at Warwick School District, the Lititz recCenter and Lititz Borough. The wholesale energy market was also quite favorable for those that actively sought new providers, as natural gas prices were at or near historic lows, thanks in part to the weak economy and the vast quantities of

[3] See *Section 1.3* for details.

[4] http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3

[5] The author began work on this report while employed by Warwick Township, Lititz Borough and Elizabeth Township, and was intimately involved in efforts to secure a new energy provider in the face of dergulation, and so knows by personal experience.

below-cost gas produced from fracturing ("fracking") in the Marcellus Shale. It is hard to know for how long these forces will be able to hold prices down, so it is important for the Warwick Region to continue, and improve upon, its exemplary energy-conservation policies.

Figure 2.2 and *Table 2.3* on the following page show the major sources of emissions in the Warwick Region. Facilities represent the overwhelming majority of energy use at 95% of the total, with vehicle fleets coming in second at 4% and street & traffic lights taking up the rear at 2%.[6] If members of the Warwick Region decided to cut energy use, cost, and emissions, they wouldn't do wrong to continue their focus on facilities. Warwick Township, the Lititz Library and the Lititz recCenter recently took this path, thanks in part to a grant from the PA DEP / U.S. DOE.[7] *Table 2.3* on the next page also shows how energy use and emissions declined between 2009 and 2010. The greatest decline has, in fact, come from facilities, which is unsurprising given the many low-hanging fruit available from this category and the relative dearth in the category of vehicle fleets (although options do exist). The decline in energy use, cost and emissions from the street & traffic lights category is likely the result of regional efforts to convert all of its traffic lights to LED.

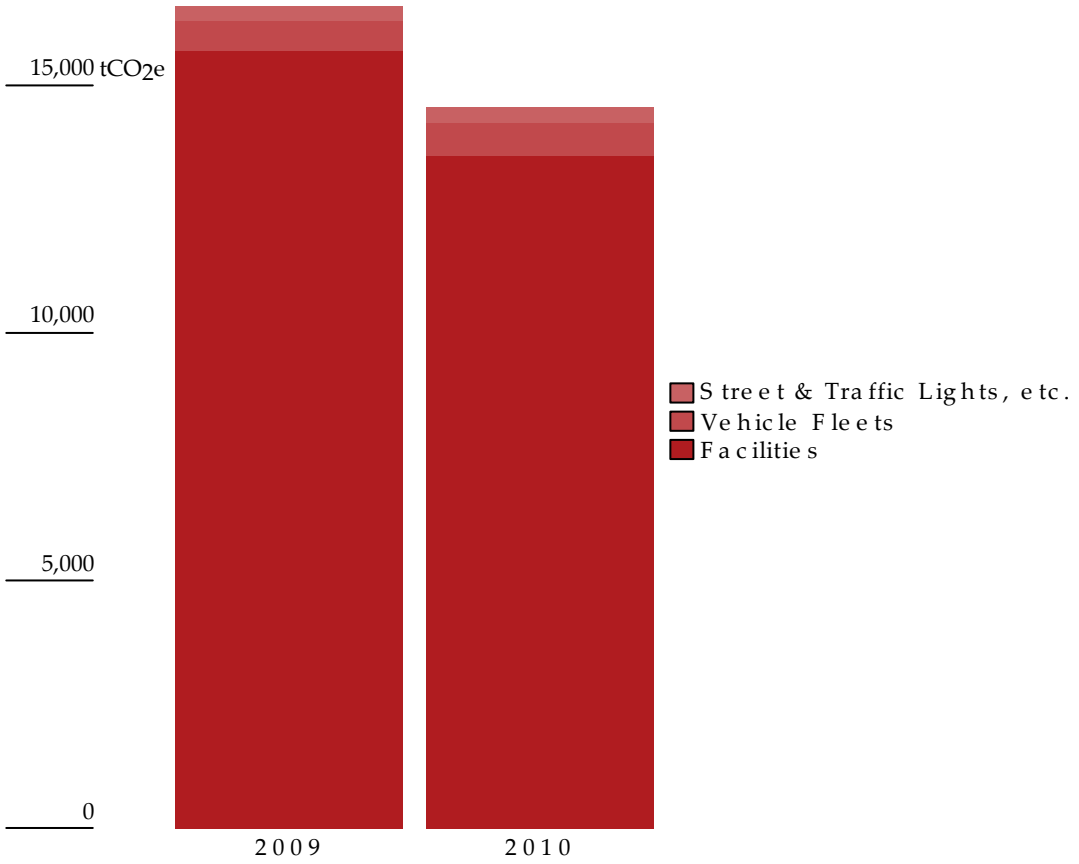

Figure 2.2. Regional emissions by source, in tonnes of CO2-equivalent (tCO2e), for the base period (2009-2010). Facilities represent 95% of energy use, vehicle fleets 4% and street & traffic lights just 2%.

Table 2.4 on the following page presents the emissions profiles in terms that make for better comparisons. Included in the table is *carbon intensity*, cost per MMBtu ("dollar intensity", if you will), cost per tCO_2e, and pounds of CO_2e per capita.[8] Note the similarities in carbon intensity for the three municipalities, and for the recCenter and library. The Warwick School District and Lititz Sewer Authority stand out as outliers, and it is clear why. Most of the WSD's energy use comes in the form of natural gas for heating their facilities,

[6] The numbers do not add up to 100% due to rounding.
[7] Emissions reductions from these steps won't be apparent until this Carbon Audit is updated with 2011 data.
[8] See *Section 1.3* for details on how these figures were derived.

Table 2.3. Emissions by source for the base period (2009–2010).

By Source	2009				2010				% Change, 2009-2010		
	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	% Regional Emissions	Cost	Energy Use (MMBtu)	Emissions (tCO_2e)	Cost
Facilities	172,962	15,699	95%	$ 1,460,762	142,458	13,590	93%	$ 907,733	-18%	-13%	-38%
Street & Traffic Lights	1,914	320	2%	$ 167,939	1,860	312	2%	$ 171,343	-3%	-3%	2%
Vehicle Fleets	12,884	592	4%	$ 248,144	13,228	653	4%	$ 258,870	3%	10%	4%
Sub-Total	**187,760**	**16,611**	**100%**	**$ 1,876,845**	**157,546**	**14,555**	**100%**	**$ 1,337,946**	**-16%**	**-12%**	**-29%**

which is reflected in their lower carbon intensity. Processing wastewater is also obviously a very energy- and emissions-intensive process.

Table 2.4. Emissions indicators by organization. Since energy-use profiles between the partners are so different, this table was generated to give some indicators that might be more directly comparable. See the text for a longer discussion.

By Organization	2009				2010				% Change, 2009-2010			
	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Elizabeth Township	0.096	$ 20.24	$ 211.49	27.83	0.093	$ 20.73	$ 223.23	34.61	-3%	2%	6%	24%
Lititz Borough	0.102	$ 19.88	$ 194.09	84.78	0.103	$ 24.28	$ 234.91	86.83	1%	22%	21%	2%
Warwick Township	0.110	$ 33.57	$ 303.88	106.51	0.112	$ 38.91	$ 348.04	100.17	1%	16%	15%	-6%
Warwick School District	0.078	$ 7.23	$ 92.22	5,707.95	0.082	$ 3.51	$ 43.01	4,864.06	4%	-51%	-53%	-15%
Lititz Sewer Authority	0.163	$ 21.54	$ 132.06	218.67	0.161	$ 34.98	$ 217.12	201.55	-1%	62%	64%	-8%
Lititz Library	0.136	$ 26.57	$ 194.77	12.35	0.134	$ 34.44	$ 256.27	11.94	-1%	30%	32%	-3%
Lititz recCenter	0.138	$ 16.42	$ 119.34	105.23	0.136	$ 4.10	$ 30.03	103.48	-1%	-75%	-75%	-2%
	0.088	**$ 10.00**	**$ 112.99**	**n/a**	**0.092**	**$ 8.49**	**$ 91.92**	**n/a**	**4%**	**-15%**	**-19%**	**n/a**

2.2 Emissions by Organization

This section summarizes the emissions profiles of each participant in the Warwick Region Carbon Audit. Note the great variety, from the highly-differentiated Warwick Township (where, surprisingly, traffic lights represent the single largest source of emissions), to a relatively even balance between facilities and fleet emissions (Lititz Borough), to facilities-dominant Warwick School District.

In order to provide a metric that most people would understand intuitively, energy-use is compared to the energy consumed by the average American household. For example, Warwick Township used about 7,228 MMBtu worth of energy in 2010, which is roughly equivalent to the energy use of 194 average American households.

2.2.1 Warwick Township

Figure 2.3 on the next page depicts the emissions profile for Warwick Township, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. Warwick Township spent nearly $260,000 on energy in 2009, and over $280,000 in 2010, using an amount of energy equivalent to that of over 206 average American households in 2009 and over 194 in 2010.

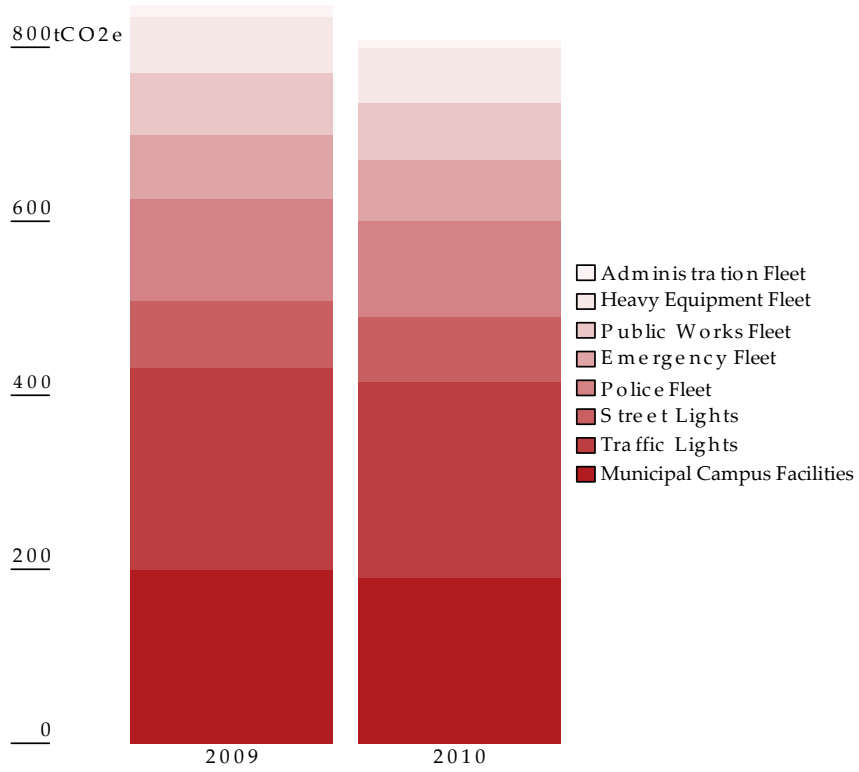

Figure 2.3. Warwick Township emissions by source, in tonnes of CO2-equivalent (tCO2e), for the base period (2009–2010).

In 2010, 28% of Warwick's emissions came from the electricity used in its traffic lights. 24% came from electricity and propane use in the Municipal Campus. 39% came from Warwick's various vehicle fleets (14% police, 9% emergency vehicles, 8% heavy equipment, 8% public works, and 1% administration). 9% of Warwick's emissions were from its street lights.

Warwick Township reduced energy use by 6% and emissions by 5% from 2009 to 2010. In that same period, costs increased 9%, underscoring the urgency of continued conservation efforts. The greatest relative reductions in energy use were from administration vehicles (-37%), propane use (-13%) and public works vehicles (-10%). Warwick Township, along with Lititz Borough, the Lititz Sewer Authority and the Lititz Public Library, joined with the Lancaster County Cooperative in late 2009 in a bid to decrease costs that, unfortunately, backfired.[9] With the two-year contract expiring at the end of 2011, 2012 will see a partial reversal of this trend in increasing electricity costs.

2.2.2 Lititz Borough

Figure 2.4 on the following page depicts the emissions profile for Lititz Borough, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. Lititz Borough spent nearly $70,000 on energy in 2009, and nearly $87,000 in 2010,[10] using an amount of energy equivalent to that of over 94 average American households in 2009 and nearly 96 in 2010.

In 2010, 55% of Lititz's emissions came from electricity and natural gas use in its facilities. 42% came from its vehicle fleet (which we have been unable to differentiate). 2% of Lititz's emissions are from its traffic lights.

[9]The bid proved unfavorable but, unfortunately, by the time that was apparent, the entities involved were legally bound to accept it. The reasons for this go beyond the scope of this document.

[10]These amounts appear artificially low, when compared with Warwick Township's figures, because energy-use and -cost data for street lights in Lititz Borough was not available. Electricity for street lights cost Warwick around $70,000 for both 2009 and 2010.

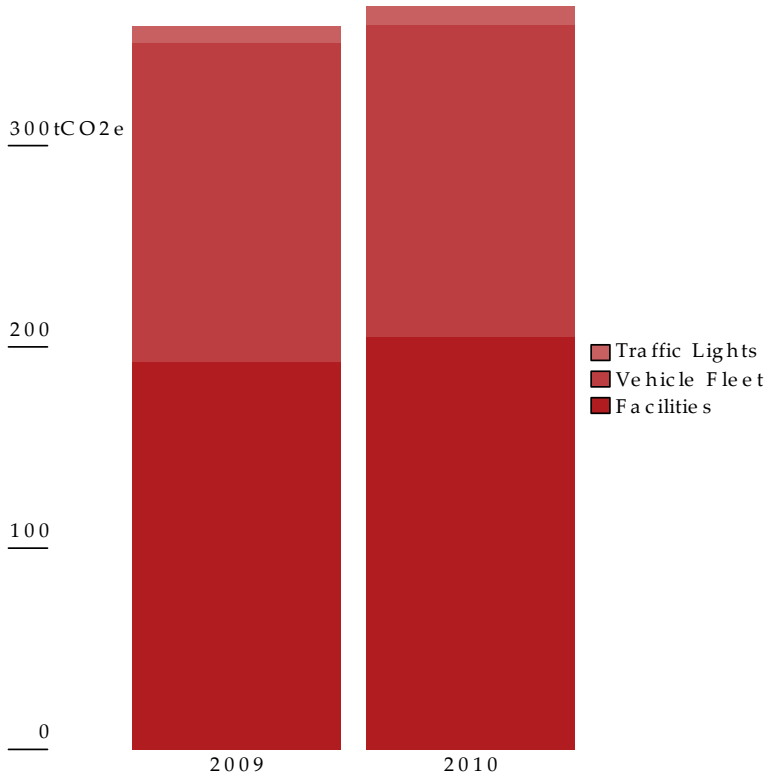

Figure 2.4. Lititz Borough emissions by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

Lititz Borough increased its energy use by 2% and emissions by 3% from 2009 to 2010. In that same period, costs increased 24%, likely a result of deregulation of the electricity markets (see note at bottom of *Section 2.2.1*).

2.2.3 Elizabeth Township

Figure 2.5 on the next page depicts the emissions profile for Elizabeth Township, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. Elizabeth Township spent over $10,000 on energy in 2009, and close to $14,000 in 2010, using an amount of energy equivalent to that of nearly 14 average American households in 2009 and nearly 18 in 2010.

In 2010, 72% of Elizabeth's emissions came from its fleet of diesel vehicles (up from 57% the year before). 23% came from electricity and oil use in its facilities (down from 37%), and 5% came from its only traffic light (down from 6%).

Elizabeth Township increased its energy use by 28% and emissions by 24% from 2009 to 2010. In that same period, costs increased 31%. It must be mentioned that Elizabeth Township uses less energy than any other project partner, including the Lititz Public Library and Lititz recCenter, so the large relative increase in consumption and cost still represents a small absolute increase for the region. Nevertheless, these data point to the importance of energy conservation as a means of budgetary conservation.

2.2.4 Warwick School District

Figure 2.6 on page 22 depicts the emissions profile for the Warwick School District, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. The WSD is an outlier in many ways. It spent over $1.1 million on energy in 2009 (60% of total regional energy expenditures), and

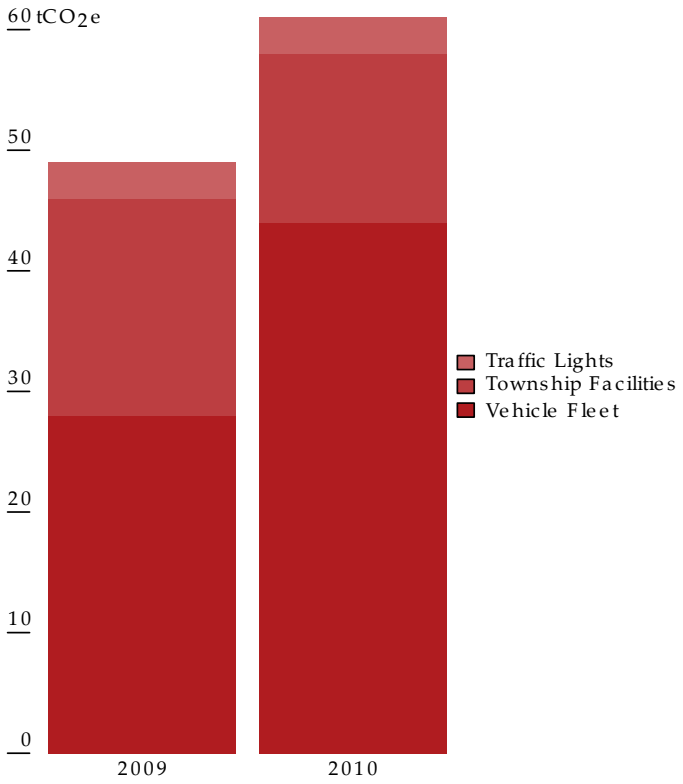

Figure 2.5. Elizabeth Township emissions by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

over $440,000 in 2010 (33% of total regional energy expenditures),[11] using an amount of energy equivalent to that of nearly 4,190 average American households in 2009 and over 3,400 in 2010. It was responsible for 74% of total regional emissions in 2009 and 71% in 2010. As can be seen in *Table 2.4* on page 18, *Emissions indicators by organization*, the school district has the lowest carbon intensity and cost per MMBtu, but also far and away the highest emissions per capita, at over 4,800 lbs CO_2e per student in 2010 (compare to the next-highest, the Lititz Sewer Authority, which had emissions of over 200 lbs CO_2e per ratepayer in that year). Education is a carbon-intensive business.

In 2010, 43% of the WSD's emissions came from electricity use in its facilities, and 57% from natural gas use. By comparison, emissions from its diesel and gasoline vehicle fleets were negligible, although its diesel fleet emited more carbon pollution that all of Elizabeth Township's municipal operations, while its gasoline fleet (school buses?) emited more than all of Lititz Borough's operations and nearly as much as Warwick's.

The Warwick School District decreased its energy use by 19% and emissions by 15% from 2009 to 2010. In that same period, costs decreased 61%, a result of deregulation and favorable market conditions vis-à-vis natural gas prices for electricity generation, which, as noted above, is primarily a result of a recent boom in natural gas production combined with a weak global and national economy.

2.2.5 Lititz Sewer Authority

Figure 2.7 on the following page depicts the emissions profile for the Lititz Sewer Authority, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. The LSA spent over $300,000 on energy in 2009, and over $460,000 in 2010, using an amount of energy equivalent to that of over 381 average American households in 2009 and nearly 355 in 2010.

In 2010, 97% of the LSA's emissions came from electricity use in its facilities, and 2% from heating oil use in its wastewater treatment plant. By comparison, emissions from its natural gas use and small diesel

[11] This is not a typo. Costs really did decline 61% between 2009 and 2010.

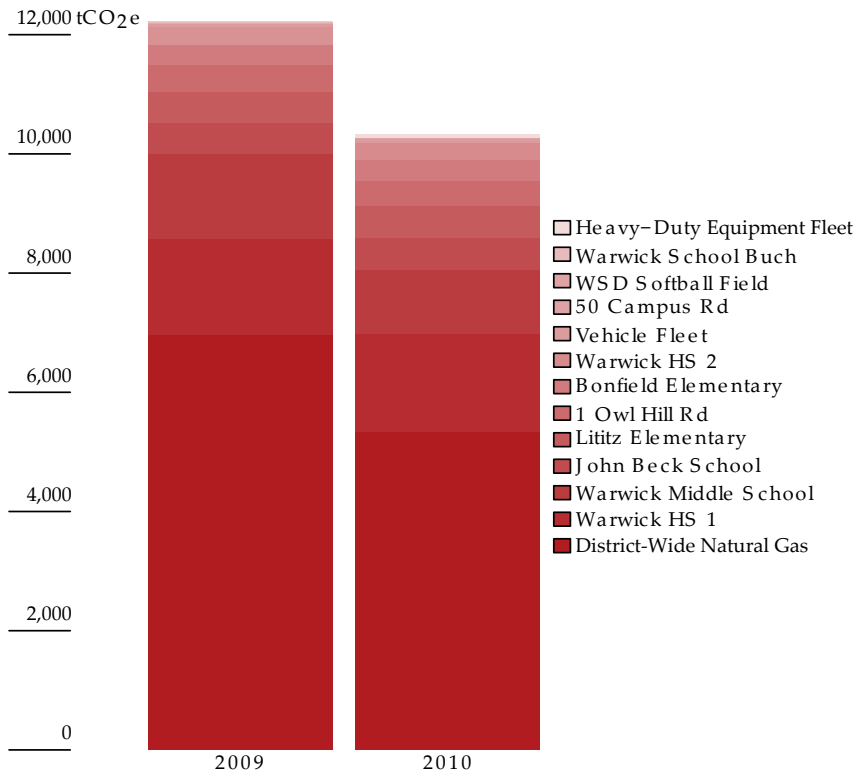

Figure 2.6. Warwick School District emissions by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

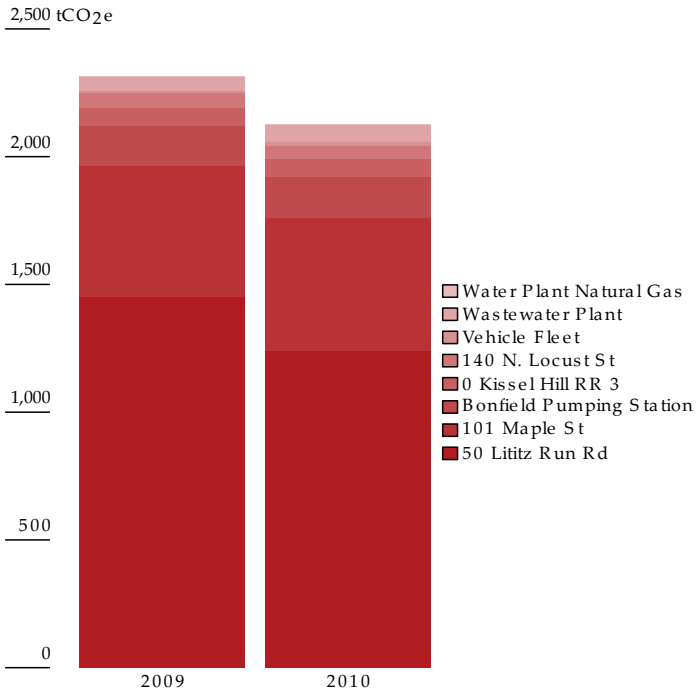

Figure 2.7. Lititz Sewer Authority by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

and gasoline fleets were negligible, in sum adding up to about 37% of Elizabeth Township's total energy use.

The Lititz Sewer Authority decreased its energy use by 7% and emissions by 8% from 2009 to 2010. In that same period, costs increased 51%, a result of large increases across the board in electricity costs despite reductions in consumption. The LSA, along with Warwick Township, Lititz Borough and the Lititz Public Library, joined with the Lancaster County Cooperative in late 2009 in a bid to decrease costs that, unfortunately, backfired (as noted above, p.18). 2012 will see a partial or full reversal of this trend.

2.2.6 Lititz recCenter

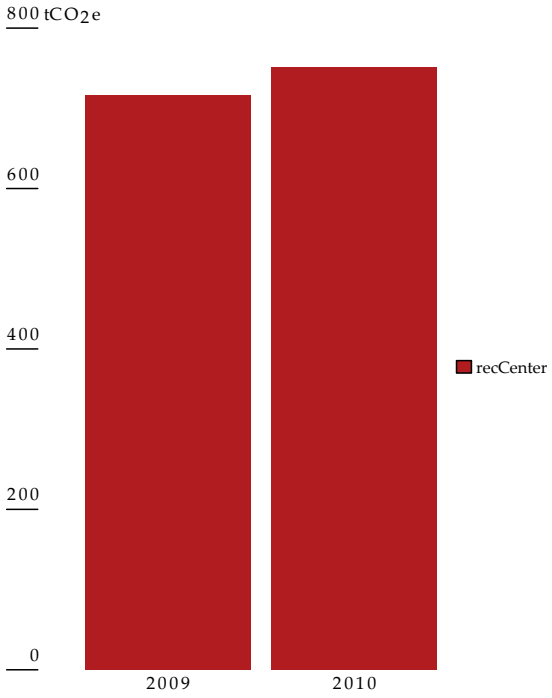

Figure 2.8. Lititz recCenter emissions by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

Figure 2.8 depicts the emissions profile for the Lititz recCenter, which is also described in greater detail in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. The recCenter spent over $85,000 on energy in 2009, and over $22,000 in 2010, using an amount of energy equivalent to that of nearly 140 average American households in 2009 and nearly 148 in 2010.

In 2010, 88% of the recCenter's emissions came from electricity use, with the remaining 12% from natural gas use.

The Lititz recCenter increased its energy use by 6% and emissions by 5% from 2009 to 2010. In that same period, costs decreased 74%, a result of deregulation and favorable market conditions vis-à-vis natural gas prices for electricity generation.

2.2.7 Lititz Public Library

Figure 2.9 on the following page depicts the emissions profile for the Lititz Public Library, which is also described in great detailer in *Table A.1* on page 26 and *Table A.2* on page 27 in the *Appendix*. The library spent nearly $22,000 on energy in 2009, and nearly $28,000 in 2010, using an amount of energy equivalent to that of over 22 average American households in 2009 and just under 22 in 2010.

In 2010, 87.5% of the library's emissions came from electricity use, with the remaining 12.5% from natural gas use.

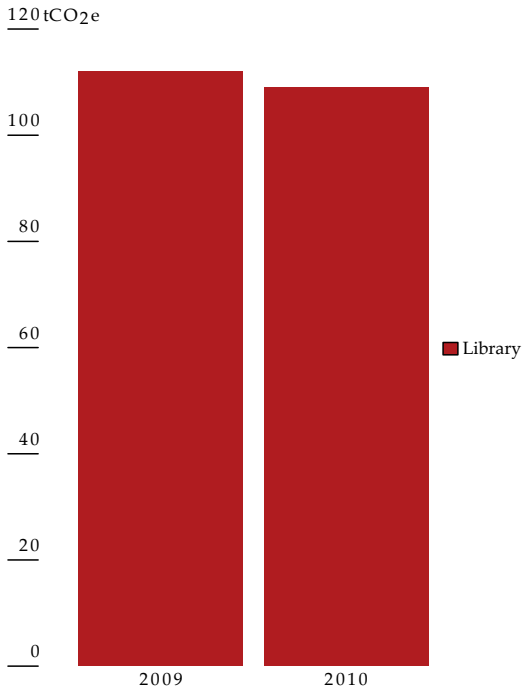

Figure 2.9. Lititz Public Library emissions by source, in tonnes of CO_2-equivalent (tCO_2e), for the base period (2009–2010).

The Lititz Public Library decreased its energy use by 1% and emissions by 3% from 2009 to 2010 (electricity use decreased while natural gas use increased). In that same period, total costs increased 28% (electricity costs actually increased 34%, while natural gas costs decreased 6%). The library, along with Warwick Township and the Lititz Sewer Authority, joined with the Lancaster County Cooperative in late 2009 in a bid to decrease costs that, unfortunately, backfired (as noted previously).

Appendix A

Detailed Tables

Table A.1 on the next page and *Table A.2* on page 27 present the complete results of the Warwick Region Carbon Audit in tabular format. The charts used in *Chapter 2* were developed from these data; "n/a" indicates that data was not available for any given entry.

Table A.1 contains the basic information gathered during the Audit process. *Table A.2* displays the various "emissions indicators" that were developed to help supply better comparisons between the partner organizations. The terms used in this latter table are defined in *Section 2.1* on page 15.

Table A.1. Total regional energy consumption, emissions, and cost data, by organization, for the base period (2009–2010).

		2009					2010					% Change, 2009-2010		
Elizabeth Township		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
Township Facilities	Electricity	86	14	29%	0%	$ 2,756	74	12	20%	0%	$ 2,857	-14%	-14%	4%
Township Facilities	Fuel Oil	52	4	8%	0%	$ 1,294	24	2	3%	0%	$ 444	-54%	-50%	-66%
Traffic Lights	Electricity	20	3	6%	0%	$ 917	20	3	5%	0%	$ 1,008	0%	0%	10%
Vehicle Fleet	Diesel	354	28	57%	0%	$ 5,396	539	44	72%	0%	$ 9,308	52%	57%	72%
Sub-Total		**512**	**49**	**100%**	**0%**	**10,363**	**657**	**61**	**100%**	**0%**	**13,617**	**28%**	**24%**	**31%**
Lititz Borough		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
Facilities	Electricity	989	166	46%	1%	$ 30,559	1,035	174	47%	1%	$ 40,826	5%	5%	34%
Facilities	Natural Gas	467	27	8%	0%	$ 6,546	527	31	8%	0%	$ 6,856	13%	15%	5%
Traffic Lights	Electricity	49	8	2%	0%	$ 4,005	55	9	2%	0%	$ 4,568	12%	13%	14%
Vehicle Fleet	Gasoline	1,250	98	27%	1%	$ 17,855	1,223	96	26%	1%	$ 21,746	-2%	-2%	22%
Vehicle Fleet	Diesel	749	60	17%	0%	$ 10,712	730	59	16%	0%	$ 12,686	-3%	-2%	18%
Sub-Total		**3,504**	**359**	**100%**	**2%**	**69,677**	**3,570**	**369**	**100%**	**3%**	**86,682**	**2%**	**3%**	**24%**
Warwick Township		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
Municipal Campus	Electricity	925	155	18%	1%	$ 21,789	905	152	19%	1%	$ 34,099	-2%	-2%	56%
Municipal Campus	Propane	626	44	5%	0%	$ 11,626	545	38	5%	0%	$ 11,031	-13%	-14%	-5%
Street Lights	Electricity	460	77	9%	0%	$ 70,614	440	74	9%	1%	$ 65,834	-4%	-4%	-7%
Traffic Lights	Electricity	1,385	232	27%	1%	$ 92,403	1,345	226	28%	2%	$ 99,933	-3%	-3%	8%
Off-Road Diesel	Diesel	790	64	8%	0%	$ 11,060	781	63	8%	0%	$ 13,405	-1%	-2%	21%
Emergency Vehicles	Diesel	909	73	9%	0%	$ 12,443	884	71	9%	0%	$ 15,134	-3%	-3%	22%
Administration	Gasoline	164	13	2%	0%	$ 2,352	108	9	1%	0%	$ 1,923	-34%	-31%	-18%
Police	Gasoline	1,504	118	14%	1%	$ 21,720	1,396	110	14%	1%	$ 24,818	-7%	-7%	14%
Public Works	Gasoline	913	72	8%	0%	$ 13,679	824	65	8%	0%	$ 15,041	-10%	-10%	10%
Sub-Total		**7,676**	**848**	**100%**	**5%**	**257,686**	**7,228**	**808**	**100%**	**6%**	**281,218**	**-6%**	**-5%**	**9%**
Warwick School District		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
50 Campus Rd	Electricity	100	17	0%	0%	$ 3,233	96	16	0%	0%	$ 1,476	-4%	-6%	-54%
1 Owl Hill Rd	Electricity	2,687	451	4%	3%	$ 79,540	2,578	433	4%	3%	$ 17,670	-4%	-4%	-78%
John Beck School	Electricity	3,182	534	4%	3%	$ 94,256	3,137	527	4%	4%	$ 33,344	-1%	-1%	-65%
Warwick Middle School	Electricity	8,471	1,422	12%	9%	$ 216,218	6,474	1,087	12%	7%	$ 48,417	-24%	-24%	-78%
Warwick HS 1	Electricity	9,580	1,608	13%	10%	$ 286,900	9,778	1,641	13%	11%	$ 67,639	2%	2%	-76%
Warwick HS 2	Electricity	1,867	313	3%	2%	$ 56,009	1,751	294	3%	2%	$ 13,448	-6%	-6%	-76%
Bonfield Elementary	Electricity	1,997	335	3%	2%	$ 64,068	2,015	338	3%	2%	$ 16,991	1%	1%	-73%
Lititz Elementary	Electricity	3,033	509	4%	3%	$ 91,407	3,191	536	4%	4%	$ 22,681	5%	5%	-75%
WSD Softball Field	Electricity	20	3	0%	0%	$ 780	19	3	0%	0%	$ 973	-5%	0%	25%
Warwick School Buch	Electricity	0	0	0%	0%	$ 131	0	0	0%	0%	$ 136	n/a	n/a	4%
District-Wide?	Natural Gas	118,787	6,965	57%	42%	$ 82,732	90,997	5,336	57%	37%	$ 80,548	-23%	-23%	-3%
Heavy-Duty Vehicles	Biodiesel	5,409	0	0%	0%	$ 135,293	760	60	0%	0%	$ 14,415	-86%	n/a	-89%
Vehicle Fleet	Gasoline	730	57	0%	0%	$ 15,830	5,787	60	0%	0%	$ 126,618	693%	5%	700%
Sub-Total		**155,863**	**12,214**	**100%**	**74%**	**1,126,397**	**126,583**	**10,331**	**100%**	**71%**	**444,356**	**-19%**	**-15%**	**-61%**
Lititz Sewer Authority		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
50 Lititz Run Rd	Electricity	8,653	1,452	63%	9%	$ 165,132	7,406	1,243	63%	9%	$ 216,476	-14%	-14%	31%
101 Maple St	Electricity	3,063	514	22%	3%	$ 71,679	3,083	517	22%	4%	$ 106,418	1%	1%	48%
140 N. Locust St	Electricity	344	58	3%	0%	$ 10,346	304	51	3%	0%	$ 11,943	-12%	-12%	15%
0 Kissel Hill RR 3	Electricity	426	72	3%	0%	$ 13,002	432	73	3%	1%	$ 18,432	1%	1%	42%
Bonfield Pumping Station	Electricity	917	154	7%	1%	$ 19,883	951	160	7%	1%	$ 32,053	4%	4%	61%
Water Plant	Natural Gas	10	1	0%	0%	$ 14,299	11	1	0%	0%	$ 14,482	10%	0%	1%
Wastewater Plant	Natural Gas	0	0	0%	0%	$ -	34	2	0%	0%	$ 44,778	n/a	n/a	n/a
Wastewater Plant	Heating Oil	654	53	2%	0%	$ 9,318	777	63	2%	0%	$ 13,232	19%	19%	42%
Vehicle Fleet	Gasoline	111	9	0%	0%	$ 1,792	98	8	0%	0%	$ 1,888	-12%	-11%	5%
Vehicle Fleet	Diesel	1	0	0%	0%	$ 12	98	8	0%	0%	$ 1,888	9700%	n/a	15633%
Sub-Total		**14,179**	**2,313**	**100%**	**14%**	**305,463**	**13,194**	**2,126**	**100%**	**15%**	**461,590**	**-7%**	**-8%**	**51%**
Lititz Library		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
Library	Electricity	585	98	88%	1%	$ 18,410	567	95	88%	1%	$ 24,721	-3%	-3%	34%
Library	Natural Gas	236	14	13%	0%	$ 3,404	244	14	13%	0%	$ 3,212	3%	0%	-6%
Sub-Total		**821**	**112**	**100%**	**1%**	**21,814**	**811**	**109**	**100%**	**1%**	**27,933**	**-1%**	**-3%**	**28%**
Lititz recCenter		**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**% Emissions**	**% Regional Emissions**	**Cost**	**Energy Use (MMBtu)**	**Emissions (tCO_2e)**	**Cost**
Lititz recCenter	Electricity	3,761	631	88%	4%	$ 80,209	3,921	658	88%	5%	$ 16,841	4%	4%	-79%
Lititz recCenter	Natural Gas	1,444	85	12%	1%	$ 5,236	1,582	93	12%	1%	$ 5,709	10%	9%	9%
Sub-Total		**5,205**	**716**	**100%**	**4%**	**85,445**	**5,503**	**751**	**100%**	**5%**	**22,550**	**6%**	**5%**	**-74%**

Table A.2. Emissions and energy costs indicators, by organization, for the base period (2009–2010).

		2009				2010				% Change, 2009-2010			
Elizabeth Township		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Township Facilities	Electricity	0.163	$ 32.05	$ 196.86	7.95	0.162	$ 38.61	$ 238.08	6.81	0%	20%	21%	-14%
Township Facilities	Fuel Oil	0.077	$ 24.88	$ 323.50	2.27	0.083	$ 18.50	$ 222.00	1.13	8%	-26%	-31%	-50%
Traffic Lights	Electricity	0.150	$ 45.85	$ 305.67	1.70	0.150	$ 50.40	$ 336.00	1.70	0%	10%	10%	0%
Vehicle Fleet	Diesel	0.079	$ 15.24	$ 192.71	15.91	0.082	$ 17.27	$ 211.55	24.96	3%	13%	10%	57%
	Sub-Total	**0.058**	**$ 14.02**	**$ 242.44**	**27.83**	**0.059**	**$ 0.84**	**$ 14.32**	**34.61**	**2%**	**-94%**	**-94%**	**24%**
Lititz Borough		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Facilities	Electricity	0.168	$ 30.90	$ 184.09	94.30	0.168	$ 2.76	$ 16.42	98.71	0%	-91%	-91%	5%
Facilities	Natural Gas	0.058	$ 14.02	$ 242.44	15.34	0.059	$ 0.84	$ 14.32	17.59	2%	-94%	-94%	15%
Traffic Lights	Electricity	0.163	$ 81.73	$ 500.63	4.54	0.164	$ 83.05	$ 507.56	5.11	0%	2%	1%	12%
Vehicle Fleet	Gasoline	0.078	$ 14.28	$ 182.19	55.67	0.078	$ 17.78	$ 226.52	54.46	0%	24%	24%	-2%
Vehicle Fleet	Diesel	0.080	$ 14.30	$ 178.53	34.08	0.081	$ 17.38	$ 215.02	33.47	1%	22%	20%	-2%
	Sub-Total	**0.102**	**$ 19.88**	**$ 194.09**	**203.93**	**0.103**	**$ 11.85**	**$ 114.64**	**209.34**	**1%**	**-40%**	**-41%**	**3%**
Warwick Township		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Municipal Campus	Electricity	0.168	$ 23.56	$ 140.57	88.05	0.168	$ 37.68	$ 224.34	86.23	0%	60%	60%	-2%
Municipal Campus	Propane	0.070	$ 18.57	$ 264.23	24.99	0.070	$ 20.24	$ 290.29	21.56	-1%	9%	10%	-14%
Street Lights	Electricity	0.167	$ 153.51	$ 917.06	43.74	0.168	$ 149.62	$ 889.65	41.98	0%	-3%	-3%	-4%
Traffic Lights	Electricity	0.168	$ 66.72	$ 398.29	131.79	0.168	$ 74.30	$ 442.18	128.22	0%	11%	11%	-3%
Off-Road Diesel	Diesel	0.081	$ 14.00	$ 172.81	36.36	0.081	$ 17.16	$ 212.78	35.74	0%	23%	23%	-2%
Emergency Vehicles	Diesel	0.080	$ 13.69	$ 170.45	41.47	0.080	$ 17.12	$ 213.15	40.28	0%	25%	25%	-3%
Administration	Gasoline	0.079	$ 14.34	$ 180.92	7.38	0.083	$ 17.81	$ 213.67	5.11	5%	24%	18%	-31%
Police	Gasoline	0.078	$ 14.44	$ 184.07	67.03	0.079	$ 17.78	$ 225.62	62.41	0%	23%	23%	-7%
Public Works	Gasoline	0.079	$ 14.98	$ 189.99	40.90	0.079	$ 18.25	$ 231.40	36.88	0%	22%	22%	-10%
	Sub-Total	**0.110**	**$ 33.57**	**$ 303.88**	**481.71**	**0.112**	**$ 38.91**	**$ 348.04**	**458.40**	**1%**	**16%**	**15%**	**-5%**
Warwick School District		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
50 Campus Rd	Electricity	0.170	$ 32.33	$ 190.18	9.66	0.167	$ 15.38	$ 92.25	9.08	-2%	-52%	-51%	-6%
1 Owl Hill Rd	Electricity	0.168	$ 29.60	$ 176.36	256.19	0.168	$ 6.85	$ 40.81	245.65	0%	-77%	-77%	-4%
John Beck School	Electricity	0.168	$ 29.62	$ 176.51	303.34	0.168	$ 10.63	$ 63.27	298.98	0%	-64%	-64%	-1%
Warwick Middle School	Electricity	0.168	$ 25.52	$ 152.05	807.77	0.168	$ 7.48	$ 44.54	616.68	0%	-71%	-71%	-24%
Warwick HS 1	Electricity	0.168	$ 29.95	$ 178.42	913.43	0.168	$ 6.92	$ 41.22	930.98	0%	-77%	-77%	2%
Warwick HS 2	Electricity	0.168	$ 30.00	$ 178.94	177.80	0.168	$ 7.68	$ 45.74	166.79	0%	-74%	-74%	-6%
Bonfield Elementary	Electricity	0.168	$ 32.08	$ 191.25	190.30	0.168	$ 8.43	$ 50.27	191.76	0%	-74%	-74%	1%
Lititz Elementary	Electricity	0.168	$ 30.14	$ 179.58	289.14	0.168	$ 7.11	$ 42.32	304.09	0%	-76%	-76%	5%
WSD Softball Field	Electricity	0.150	$ 39.00	$ 260.00	1.70	0.158	$ 51.21	$ 324.33	1.70	5%	31%	25%	0%
Warwick School Buch	Electricity	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
District-Wide?	Natural Gas	0.059	$ 0.70	$ 11.88	3,956.51	0.059	$ 0.89	$ 15.10	3,027.24	0%	27%	27%	-23%
Heavy-Duty Vehicles	Biodiesel	0.000	$ 25.01	n/a	0.00	0.079	$ 18.97	$ 240.25	34.04	n/a	-24%	n/a	n/a
Vehicle Fleet	Gasoline	0.078	$ 21.68	$ 277.72	32.38	0.010	$ 21.88	$ 2,110.30	34.04	-87%	1%	660%	5%
	Sub-Total	**0.078**	**$ 7.23**	**$ 92.22**	**6,938.23**	**0.082**	**$ 3.51**	**$ 43.01**	**5,861.03**	**4%**	**-51%**	**-53%**	**-16%**
Lititz Sewer Authority		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
50 Lititz Run Rd	Electricity	0.168	$ 19.08	$ 113.73	824.82	0.168	$ 29.23	$ 174.16	705.18	0%	53%	53%	-15%
101 Maple St	Electricity	0.168	$ 23.40	$ 139.45	291.98	0.168	$ 34.52	$ 205.84	293.31	0%	48%	48%	0%
140 N. Locust St	Electricity	0.169	$ 30.08	$ 178.38	32.95	0.168	$ 39.29	$ 234.18	28.93	0%	31%	31%	-12%
0 Kissel Hill RR 3	Electricity	0.169	$ 30.52	$ 180.58	40.90	0.169	$ 42.67	$ 252.49	41.41	0%	40%	40%	1%
Bonfield Pumping Station	Electricity	0.168	$ 21.68	$ 129.11	87.48	0.168	$ 33.70	$ 200.33	90.77	0%	55%	55%	4%
Water Plant	Natural Gas	0.100	$ 1,429.90	$ 14,299.00	0.57	0.091	$ 1,316.55	$ 14,482.00	0.57	-9%	-8%	1%	0%
Wastewater Plant	Natural Gas	n/a	n/a	n/a	0.00	0.059	$ 1,317.00	$ 22,389.00	1.13	n/a	n/a	n/a	n/a
Wastewater Plant	Heating Oil	0.081	$ 14.25	$ 175.81	30.11	0.081	$ 17.03	$ 210.03	35.74	0%	20%	19%	19%
Vehicle Fleet	Gasoline	0.081	$ 16.14	$ 199.11	5.11	0.082	$ 19.27	$ 236.00	4.54	1%	19%	19%	-11%
Vehicle Fleet	Diesel	0.000	$ 12.00	n/a	0.00	0.082	$ 19.27	$ 236.00	4.54	n/a	61%	n/a	n/a
	Sub-Total	**0.163**	**$ 21.54**	**$ 132.06**	**1,313.91**	**0.161**	**$ 34.98**	**$ 217.12**	**1,206.13**	**-1%**	**62%**	**64%**	**-8%**
Lititz Library		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Library	Electricity	0.168	$ 31.47	$ 187.86	55.67	0.168	$ 43.60	$ 260.22	53.90	0%	39%	39%	-3%
Library	Natural Gas	0.059	$ 14.42	$ 243.14	7.95	0.057	$ 13.16	$ 229.43	7.94	-3%	-9%	-6%	0%
	Sub-Total	**0.136**	**$ 26.57**	**$ 194.77**	**63.62**	**0.134**	**$ 34.44**	**$ 256.27**	**61.84**	**-1%**	**30%**	**32%**	**-3%**
Lititz recCenter		Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person	Carbon Intensity (tCO_2e / MMBtu)	$ / MMBtu	$ / tCO_2e	lbs CO_2e / person
Lititz recCenter	Electricity	0.168	$ 21.33	$ 127.11	358.44	0.168	$ 4.30	$ 25.59	373.30	0%	-80%	-80%	4%
Lititz recCenter	Natural Gas	0.059	$ 3.63	$ 61.60	48.28	0.059	$ 3.61	$ 61.39	52.76	0%	0%	0%	9%
	Sub-Total	**0.138**	**$ 16.42**	**$ 119.34**	**406.73**	**0.136**	**$ 4.10**	**$ 30.03**	**426.06**	**-1%**	**-75%**	**-75%**	**5%**