Part 1 The method and the journey

1.1 Greenhouse gas inventory methodology

> *"If you cannot measure it, you cannot improve it."*
> *— Lord Kelvin*

An international non-profit, ICLEI-Local Governments for Sustainability developed the Clean Air and Climate Protection (CACP) software package to assist municipalities in conducting a greenhouse gas emissions inventory (See www.icleiusa.org). The Village used CACP 2009 (version 2.0) released in April 2009 and its update (version 2.1) released in June 2009 to conduct this inventory.

The United State Department of Energy's new 2009-2010 Efficiency and Conservation Block Grants (EECBG) require a baseline of energy use and GHG emissions inventory and forecast. US DOE Energy Efficiency and Conservation Strategy (EECS) requires reporting of emissions reduction. CACP can assist with quantifying emissions reductions for inclusion in grant applications or reports (see www.eecbg.energy.gov).

The ICLEI methods allow a municipality to inventory its own governmental operations, its residential sector, and its business sector. A number of neighboring municipalities undertook inventories of all three sectors at once. Yet, this approach can produce results that rely heavily on national-scale models for energy and emissions, which may or may not reflect the facts for northern Westchester County.

The Village chose to restrict the scope in this first baseline inventory of emissions to its own governmental buildings, facilities, and activities for two simple reasons. The 2007 data on village's buildings and vehicles was good, available, reliable, and reasonably detailed. Secondly, conducting a thorough inventory of our own municipal emissions would us to gain in-house experience at manageable scale. Before involving Village residents and business in undertaking inventories of the much larger emissions and energy consumption patterns in our residential and business sectors, it made good common sense to conduct the examination on ourselves.

A climate impact inventory of local government operations identifies the amounts of electricity and fuel used in municipal buildings, traffic signals and streetlights, fleets and other local government operations. It also identifies other emission sources, such as employee commutation, travel, and waste generated, as well as, the village's use of fertilizer, lubricants, asphalt, paints, aerosols, and other solvents that are often overlooked in other municipal surveys. The data collected comes from the utility bills, fuel records, purchase invoices, and employee surveys. The data collected provides a baseline level of greenhouse gas emissions for which the government operations are responsible against which we can compare future performance. This baseline should provide the basis for an emissions reduction target and subsequent measures to reduce greenhouse gas emissions. The ICLEI protocol demands we use a calendar year, not a fiscal year. The baseline year we chose is 2007 (January to December), because the quantity and quality of data we could retrieve for that period was superior to earlier years. This first Greenhouse Gas Inventory creates a baseline of information about the energy consumption, costs, and resulting emissions from Village operations.

This 2007 baseline report is Milestone 1 of Croton's climate action process. We have recently appointed a Sustainability Team of citizen volunteers. The Team's role will be to make recommendations for Milestone 2, choosing a reasonable and responsible emission reduction target for 2010, and Milestone 3, establishing a strategic climate action plan to reach that target. ICLEI recommends that we update the survey every three years to measure the results of our intervening actions. We will conduct a follow up survey in 2011 of our 2010 energy data, three years after the 2007 data that is the subject of this inaugural study.

After data is collected and entered into the software, the CACP software determines emissions using specific factors (or coefficients) according to the type of fuel used. The emissions analysis focuses on a few major greenhouse gases—carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). At the completion of the inventory, the quantity of emissions from the year establishes a baseline. Readers should bear in mind that any specific number generated by this software should be seen as an approximation rather than an exact value, as the software are often uses proxies for the exact fuel-to-emission conversion.

1.2 Our research process

In May 2009, the Village Manager's office set aside a part-time staff person to assist with the data collection process for the baseline inventory. This person devoted approximately 100 hours over the summer learning the ICLEI CACP protocols, participating in the ICLEI webinars and, chiefly, researching Village records for the energy data to enter into the CACP software. In early fall of 2009, the Village Manager's office and Mayor presented the preliminary

first draft to the village staff and the Sustainability Team. The staff and Team identified areas where the CACP protocol may be overlooking emission data, resulting in an undercount. A second wave of data collection in mid-fall relied on non-CACP methods and included: (1) Surveying village employee for commutation and business travel miles, (2) Researching the use of fertilizers on village fields, (3) Estimating the volume of various solvents or products used in maintaining the village's fleet and buildings (lubricants, R22 (freon replacement), asphalt, aerosols, etc), and (4) Estimating the impact of solid waste generated by municipal employees. The addition of this second wave of emissions impacts raised the first draft's of the village "carbon tonnage" by 16%, principally due to the 412,000 miles that village employees commuted to and from their village jobs in 2007. The map in the Executive Summary omits the emissions from employee commutaiton. (See Appendix A, on our data collection and conversion methods.)

Some of the data we did have, for example, on renewable energy purchases–the village's long standing practice of purchasing a quarter of its electricity via wind power credits, on photovoltaic investments, and community projects such as encouraging residential use of compost bins and rain barrels–could not be incorporated into the ICLEI software and are not reflected in this first report. We have high confidence that we will be able to include both more complete energy and emission impact data and higher resolution data overall in later inventories. As thorough as this inventory appears to be for a village of our size, the volumes reported here represent reasonable estimates of our actual 2007 emissions. Yet this year's collection exercise has already motivated the Village to track future expenses even more closely to allow easier retrieval and analysis in the future. ICLEI is in the process of a major upgrade to CACP so future inventories will benefit from even more powerful and flexible software. In short, the next time we do this, our data should be easier to harvest and provide a more complete estimate of actual emissions, cost, and energy consumed.

The first public version of this inventory report is a preliminary second draft that includes these additional sources of greenhouse gas emissions. The final draft will be issued a short time after the publication of the preliminary draft in order to allow the final report to include any additional, relevant information. The Sustainability Team has already been hard at work investigating reasonable approaches to energy emissions reduction and selecting a reduction target tailored to Croton's very specific situation.

1.3 The journey toward sustainability

"The three questions that lay persons need to ask experts to be more literate in the environmental policy debates are (1) what can happen? (2) what are the odds? and (3) how do we know?"––Stephen Schneider (1997) http://stephen schneider.stanford.edu

The Board of Trustees of the Village of Croton-on-Hudson is committed to our becoming a more sustainable community that reduces consumption of our natural capital resources while exploiting the huge potential of our social capital resources. For help on this journey toward economic, and ultimately social sustainability, the Village joined ICLEI-Local Governments for Sustainability, an international association with national and regional offices that assists local governments in achieving local sustainable development objectives in 2008. In committing the village to advancing climate protection locally, the Village of Croton-on-Hudson has joined an international movement of more than 1000 local governments, including over 500 in the United States, that participate in ICLEI's Cities for Climate Protection (CCP) campaign.

As an ICLEI member, Croton has pledged to help reduce the negative impact of global warming and climate disruption by completing five milestones: (1) conducting a baseline emissions inventory, (2) setting an emissions reduction target, (3) developing an action plan to meet the target, (4) implementing actions in the plan, and (5) monitoring and verifying emissions reduction progress.

In completing these five milestones the Village of Croton-on-Hudson will be working to reduce local global warming, save money for our community, increase the energy efficiency of buildings and operations, and be part of a team that sets an example for the rest of the community in our efforts to protect our environment, economy, and the village. Joining ICLEI was only the first of many related steps by the Village.

In 2003, Croton became the first municipal customer of wind power from Community Wind Energy's upstate Fenner Wind farm (www.fennerwind.com) and also joined the state's Energy $mart Communities initiative.

In the spring 2009, the Village signed on to Governor Paterson's Climate Smart Communities pledge, with its goal–among others–of reducing electricity use by 15 percent from projected levels no later than 2015.

In mid-2009, the Village signed on as a charter member of the new Northern Westchester Energy Action Consortium (NWEAC). Fourteen neighboring municipalities had joined at the time of this report. With a steering

committee comprised of representatives from the municipalities elected officials and sustainability/energy panel volunteer committees, NWEAC acts as a consultant to its members on seeking grants and as a clearinghouse for a broad range of initiatives related to energy efficiency, conservation, and renewable, non-polluting energy sources. NWEAC has ongoing initiatives on energy retrofit financing for homeowners, organic waste stream studies, and smart grid demonstration projects (www.smartgridwestchester.org).

In June 2009, the Village conducted a very successful compost bin truck sale working closely with a vendor. Villagers purchased almost 200 "Earth Machines" on a single Saturday. Diverting organic kitchen or yard waste from the curbside collection to a back yard compost bin could save thousands of dollars, while sequestering carbon locally by turning organic waste into garden soil locally. The Village intends to repeat this truck sale in 2010, adding rain barrels to water a home owner's garden and conserve drinking water. (See Figure 1.)

Figure 1: Compost Bin Sale Flyer

Tipping costs are for Croton solid waste are $25 per ton. DPW staff time and hauling costs are probably another $25 per ton. So these 193 compost bins just saved (or avoided) $3,374–and that's per year! Shortly after the Compost Bin Sale Day, the vendor wrote the Village the following note: "Just so you know...if the Earth Machine composter is used properly, it can divert 700 lbs of organic waste from the waste stream (1/3 of a ton for an average 4 person household). Saturday we distributed 193 units capable of recycling 135,100 pounds of organic matter into useable soil per year. That's about 67.5 tons of matter avoided from the collection process." – Jeff Brown, President, www.ecopromo.com

Compost Bin Sale Day

Sponsored by the Village of Croton-on-Hudson

Saturday, June 20, 2009, 10 am–2 pm

Municipal Place Yard @ North Riverside Avenue, Croton-on-Hudson
(former Skatepark and current Wednesday Farmer's Market location)

Reserve by Wednesday, June 17, 4 pm, to make sure we have a bin for you!

Reserve your bin(s) to lock in the $48 sale day price.

Note: A FREE kitchen scrap bucket (a retail value of $2) will be given away with each bin reserved by Wednesday, June 17.

This is a rain or shine, cash or check only event. You must pick up your bin(s) on the day of the sale only.

$48 sale day price ($150 value)
Cash or check only

Don't delay, Reserve today! The Earth Machine is the number one selling composter in North America. The $48 "enclosed" bin features a locking lid, snap together assembly, a retrieval door, anchor pegs and a simple "how-to" book. The vendor will also offer an optional base, aerator, "Presto" bin, kitchen pail, and other seasonal accessories. The Village needs reservations for 100 bins by June 17 in order to secure this very good group discount price!

To reserve, send your name, phone number, email address, and quantity of bins desired to **jhannigan@crotononhudson-ny.gov** (use "compost bin" as subject line!), or fax this form to **914-271-2836,** or call **914-271-4781** with this information.

Yes, reserve an Earth Machine for me!

My Name _____

My Phone _____

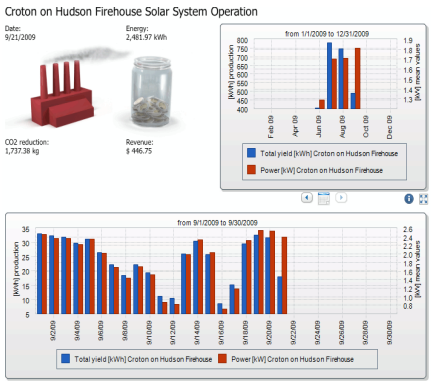
My Email _____

I want to buy Earth Machine bin(s) at $48 each on June 20, 2009 (circle quantity): **1** , **2** , **3** , __.

Village of Croton-on-Hudson *where nature happens*
www.crotononhudson-ny.gov

Also in June 2009, the Village turned on the new photovoltaic panels on the Washington Engine Company Firehouse on Grand Street. Installed by Mercury Solar Systems of New Rochelle, New York, this 6.0 kW set of panels connects to the grid for net metering using a SunPower inverter and exports that data to the web via a Sunny Boy WebBox. A New York Power Authority grant paid for the system. In its first 70 days, the system generated about 2,480 kWh of electricity. This firehouse, one of three in Croton, used 179 million Btu (52,459 kWh) of electricity in 2007 at a cost to taxpayers of $5,988. The solar electric system's output is available online for anyone to observe (See Figure 2.)

Figure 2: Photovoltaic panels on the Grand Street Firehouse



Watch the daily solar electric output of the panels on the roof of Croton's Grand Street Firehouse: http://bit.ly/Croton_Firehouse_SolarPanels (photos courtesy of Tex Dinkler and Dan O'Connor)]

In early fall 2009, the Village appointed a Sustainability Team to harness the talent, expertise, and ideas amply evident among Croton-area residents. The volunteer-run Sustainability Team is charged with helping guide the Village through the ICLEI Climate Protection milestones, as well as fostering other numerous other new efforts such as local community gardens. Specifically, the Team will be making recommendations to the Village on the ICLEI milestones that lie ahead.

In sum, we are doing quite a bit, but must do and are about to do much more.

1.4 What is next? From data to solutions

"Doing nothing about climate change is far more expensive and risky than taking strong pro-active and immediate measures."
–Sir Nicholas Stern (2007) www.hm-treasury.gov.uk/sternreview_index.htm

As noted earlier, the ICLEI process for its member municipalities is a cycle of data gathering, assessment in order to set targets and formulate action plans, and reassess whether those actions have the desired effect. This report is only the first significant step for the Village as Milestone 1, Conducting the Emissions Analysis. The next phase of work will begin immediately and involve setting a reasonable, achievable, and meaningful reduction goal for the tonnes of greenhouse gases that Village operations will emit in calendar 2010. The Village's Sustainability Team of local volunteers with relevant expertise, will be charged with delivering recommendations to the Village for a reduction target before the end of calendar 2009 for Milestone 2, Setting the Target.

Once a target is chosen, the Village must determine which particular recommendations from the Team and others to pursue toward achieving the overall strategy of reducing the greenhouse gases by Village operations and facilities. This Milestone 3, Developing the Climate Action Plan, is the heart of the process. We will include all actions our jurisdiction has already implemented since the base year and all measures our jurisdiction plans to implement in the future to meet its GHG emissions reduction target. We will consider what existing programs or policies are already reducing GHG emissions? A municipal building retrofit? Street lighting upgrades? A new residential composting program? Can these be expanded or enhanced to help meet our emissions reduction goals?

The good news is that the Village is already engaged in a host of reduction activities, many of which are not yet reflected in the 2007 data.

Any climate action plan is only as effective as the implementation. Once we have selected a reduction target and formed an action plan, we will immediately begin acting on that plan as Milestone 4: Implementing the Local Climate Action Plan. Given the timing, it may be possible for the reduction goal and subsequent action recommendations to help guide the budget preparations for the Village's next fiscal year 2010-2011 (which begins in June). The fifth and final step is Milestone 5, Monitoring Progress and Reporting Results, in which the Village revisits the original 2007 baseline in early 2011 as the data for calendar 2010 becomes available for analysis.

As the ICLEI guide for municipalities states, "*The Milestones can be undertaken concurrently, and the specific emissions reduction target and contents of the Climate Action Plan are up to your jurisdiction to determine.*"

Our challenge is clear: We need form a coherent, cohesive, coordinated plan for reducing energy cost, energy emissions, and energy consumption.

This journey we have embarked upon will affect every taxpayer in ways that mitigate future tax increases and exploit the opportunities ahead for participating in the energy-internet economy just around the corner. Before we delve into the numbers, let's take a brief look at what we will be hearing more about in 2010 and beyond.

Conservation and energy efficiency

"There are three major ways to reduce greenhouse emissions: reducing energy use, replacing fossil fuels with renewables and increasing energy efficiency. Policy instruments are available for all of them."
–Sonja Koeppel and Diana Ürge-Vorsatz (2007) www.unepsbci.org

Using less energy (conservation) and using appliances that consume less energy for the same output (efficiency) are two different but related concepts central to our efforts. Turning off unneeded lamps is conservation. Putting more efficiency bulbs into after making conservation steps is a next logical step. While the Village is studying how to use less energy throughout its operations, the same principles apply to homeowners and business proprietors. Many conservation measures can be undertaken at low or no cost (turning off what is not needed, from printers to fans and pumps etc). Many efficiency measures often require a modest investment (in better light bulbs or variable speed pump motors) and should be undertaken

after a life cycle cost benefit analysis helps to identify the energy payback period beyond which the efficiency expense has paid for itself. This payback is often relatively short (a matter of months or a few years) relative to the service life of the investment. For example, motion detector light switches for public bathrooms combined with high efficiency light fixtures might be a "conservation plus efficiency" investment with a favorable payback period, as the newer bulbs have service lives 3 to 5 times longer than the older, hotter and less efficient incandescent bulbs.

Energy and heat recovery ventilation

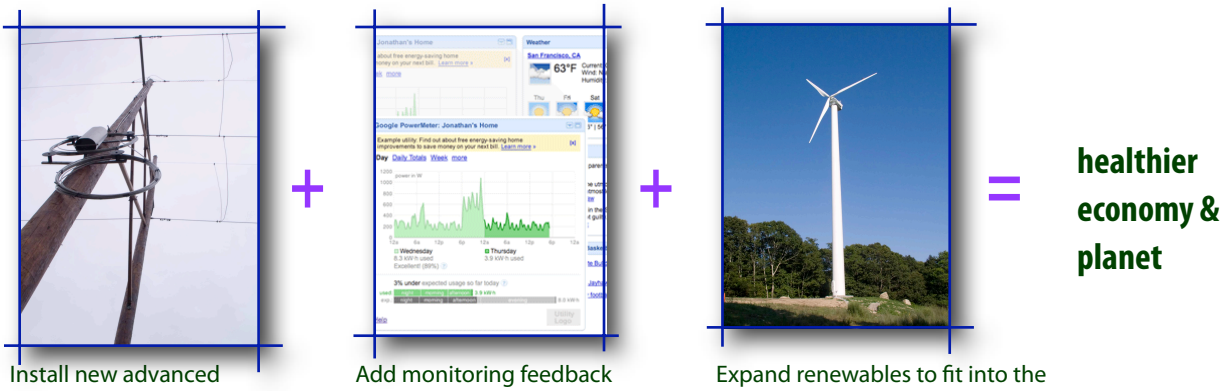
Although rare in the United States, the "passive house" is a reality in Europe, where tens of thousands have been built. The concept is also known as "low energy" or "zero energy building." These homes, office, and commercial buildings often use a simple, highly effective heat exchange system, combined with superb insulation. They take full advantage of the sun's path and daylighting. Stale air is vented to the outside, but not before all the useful heat (or cool) in it is extracted and transferred to fresh air that is drawn into the home. Ventilation upgrades for existing structures can include such technology to avoid having to bring the fresh air up or down to the desired comfort level and to avoid losing all the comfort in the stale air before it goes out the exhaust vent. (See www.nrel.gov/buildings/zero_energy.html, www.passivehouse.us, and greenfootstep.org.)

Smart grid integration and distributed generation

The nation's current electricity grid consists largely of a one-way flow of power from utilities to the consumers. If we marry internet communications technology to the existing copper wire transmission technology, we suddenly have the ability to send messages in both directions about power demand and supply from the generator and distributor to the end-user. If the grid operators know a peak in demand is coming, for example, in mid-afternoon on a scorching summer day, a smart grid could alert end-users to dial down their consumption a tiny bit and avoid having to turn on the very expensive peak power plants. The utility saves money. The consumer saves money. Smart grid technology is already well-developed and reaching the commercialization stage quite rapidly as we will see in the next two years. A smart grid with advanced metering capacities will help us spot opportunities to increase energy efficiency and reduce base loads. It will also greatly enhance our ability integrate new renewable energy sources into the power mix. A smarter grid raises the value of distributing power generation sites throughout the service areas closer to where the electricity is needed. Doing so cuts transmission line losses and provides regional stability to the grid's capacity. Distributed generation is likely to come from newer, cleaner energy sources from natural gas fired peaking plants to renewable energy installations of many kinds. (See Figure 3 below, and www.usea.org/Publications/USEA_Smart_Grid_Lunch_and_Learn.asp and www.oe.energy.gov/smartgrid, and"Combined heat and power" below.)

Figure 3: What is a smart grid?

A smart grid is an "energy internet" that marries our existing copper wire electricity infrastructure with the latest internet communication infrastructure. Because such instantaneous two-way communication allows the grid to know when power from renewables (solar, wind, etc) is available and how to ask consumers to shed demand during peak loads, the smart grid makes renewable even more viable financially and more valuable to the integrity of the entire transmission system.



Install new advanced meters to the existing grid.

Add monitoring feedback via internet for consumers.

Expand renewables to fit into the new demand response network.

Renewable energy

"Climate is what you expect. Weather is what you get."–Mark Twain

From hydro to solar and wind power, we have untapped potential for producing clean electricity here in the Empire State. Germany is less sunny than New York and has installed more than 430,000 solar electricity systems with a total nominal output of 3,800 MW (www.renewables-made-in-germany.com). The photovoltaic system on Croton's Grand Street Firehouse uses German technology (http://bit.ly/Croton_Firehouse_SolarPanels). The key to wide adoption of solar electricity is commercialization on a mass scale that will bring down the cost of photovoltaic panels. Two other sun-driven technologies are less costly than photovoltaics: Solar thermal walls heat the space inside a building by cleaver and simple movement of warmed air. Solar water heaters can drastically lower the fuel bill for domestic hot water heating. Both these technologies are at least 2,500 years old and quite cost-effective with today's newer, more durable materials.

Geothermal heat pumps and radiant heat and cooling

New geothermal heat pumps operate very efficiently in extracting heat from a deep local well and using that to produce a comfortable temperature in a new or renovated building. The new Ossining Public Library employ geothermal heating and cooling. Using radiant heat or cooling water loops in the floor (or walls) of a new or renovated structure is much more efficient than a traditional baseboard radiator or forced air system. Think how hot a radiator is to touch when the heat is on. By contrast, radiant heat operates well at a lower water temperature spread over a large surface area than a baseboard radiator and is the preferred method for distributing the heat from a geothermal heat pump. (See www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12640 and www.geoexchange.org.)

Energy co-ops

Some of us join a food co-operative to get better food at reasonable prices through the power of group purchases, regardless of where the food is actually grown. We can apply the same principle of co-operative investment and reward to renewable energy, If someone proposed that investors could earn a nice dividend for several years, and after reaching the payback period, see rapid growth in earnings, that might be attractive, If this investment entailed replacing old dirty energy sources with new cleaner ones, that might be even more attractive. Toronto's pioneering for profit WindShare Cooperative is such a venture (www.windshare.ca). Windshare produces income for its member from a major wind turbine on Toronto's waterfront. This same cooperative approach in Denmark has enabled that small nation to reduce its reliance on fossil fuels and increase wind power capacity dramatically. Today wind power provides 20% of Denmark's electricity, even though much of Denmark has only modest wind speeds. The wind power cooperative model in Europe has financed both small and large projects and can be replicated in the United States as well (www.windpowerworks.net).

Combined heat and power

Combined heat and power (CHP), also known as cogeneration, is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. Combined heat and power incorporate proven, reliable and cost-effective technologies that are already making an important contribution to meeting global heat and electricity demand. By enhancing energy supply efficiency and using waste heat and low-carbon renewable energy resources, CHP, particularly when complemented by district heating and cooling (DHC), is an important part emissions reductions strategy. The benefits stem from the fact that these applications produce energy where it is needed, avoid wasted heat, and reduce transmission and distribution network losses. (See Figure 1.6b.) Other benefits include cost savings for the energy consumer; lower CO_2 emissions; reduced reliance on imported fossil fuels; reduced investment in energy system infrastructure; enhanced electricity network stability through reduction in congestion and 'peak-shaving'; and beneficial use of local and surplus energy resources–particularly through the use of energy from waste, biomass, and geothermal resources in district heating/cooling systems.[10]

Carbon sequestration

Burning fossil fuels emits carbon to the atmosphere. Planting a tree will take carbon out of the atmosphere and put it in the ground. Composting will do the same by reducing the distance we ship organic waste and putting it into the ground below our feet. Reducing overgrazing by deer in our forests will also cause better, denser plant growth and

sequester more carbon than those denuded woods do now. If just one in five Croton households compost 100% of their organic kitchen waste, that alone is a measurable positive impact in reducing emissions. Managing the Village's street tree program and its park spaces to maximize carbon capture through fostering a robust diversity of locally indigenous plant varieties can all help as well.

Finally, as a national context, let's examine energy flows throughout our national economy for 2004 (See Figure 4.). The transmission and distribution losses alone in our electricity system are staggering.

Figure 4: US energy flowchart (as % of total use in 2004)

The left side of this chart shows, by percentage, the "input" sources of energy in the United States in 2004. That year total US energy consumption required about 96 quadrillion Btus or "quads." A quad is 10 to the 15th power Btus or a million billion Btus. The boxes in the middle of the chart show the percentages of "throughput," that is, what happens to the energy as it is converted for end use. Note that 38% of all our incoming energy is used for electricity generation. More startling, of the electricity we do generate, only one-third is actually distributed to the end user with the rest wasted in electrical generation, transmission, and distribution losses. The right side of this chart shows the total resulting lost energy from all sectors as more than 55% versus the actual useful delivered energy (about 43%). Source: Lawrence Livermore National Laboratory (2006) Energy and Environment Division. https://publicaffairs.llnl.gov/news/energy/content/energy/energy_archive/energy_flowchart_scenarios/ucrlTR204891.pdf