ENVIRONMENT

Chapter
3

Image source (this page): Dover Kohl and Associates.

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ENVIRONMENT

Average temperatures have been rising around the globe since industrialization became dependent on petroleum and coal for its principal energy source and emitted large amounts of smokestack pollutants. This change is referred to as global warming. The overwhelming consensus of scientists around the world is that global warming is contributing to climate change.

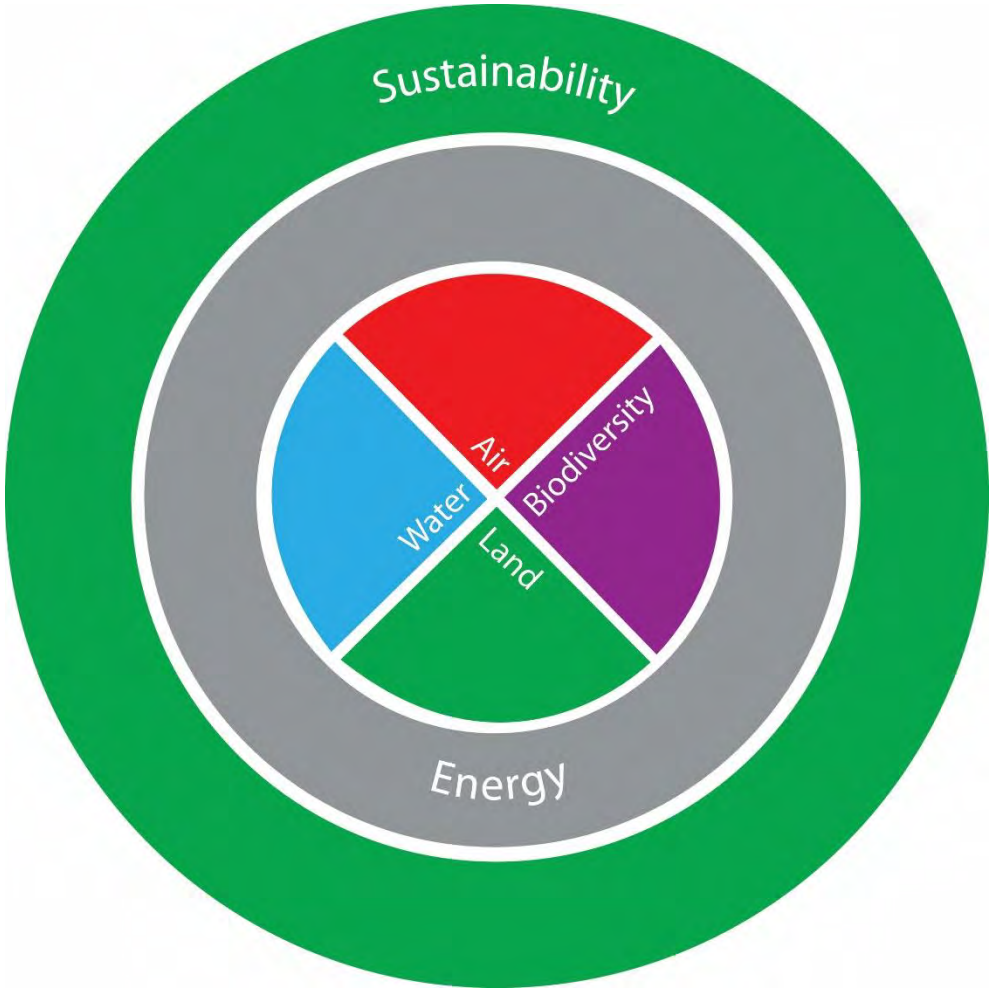
"Climate models predict that the global climate will shift in a number of ways over the next century in response to continued emissions of greenhouse gases (GHGs)." We are likely to see global average sea levels rise, rainfall patterns change, and experience more intense and frequent extreme precipitation and drought events. Indeed, we are and have been witness to these trends already. *"Most climate scientists now agree that increases in global concentrations of GHGs, largely attributable to humans, are the predominant cause of climate change. Human activities, such as driving cars, producing and consuming energy, and clearing forests"* are contributing GHG emissions into the atmosphere at a faster rate than the earth's land and water masses can absorb them.

"Climate change may have potentially catastrophic effects on both the natural and human environments as it disrupts ecosystems and threatens buildings, infrastructure, and human health. Expected shifts in climate may reduce crop yields, increase the risk of invasive species, exacerbate drought conditions," intensify flooding, "*and threaten endangered species."* (*A Performance-Based Approach to Addressing Greenhouse Gas Emissions through Transportation Planning*. December 2013. U.S. Department of Transportation. Federal Highway Administration. FHWA-HEP-14-020.)

How do communities respond in the face of such daunting challenges, not including local environmental issues such as stormwater management, land contamination, and air quality that they face on a daily basis?

As communities look to the future and think about sustainability, there are evolving technologies and innovative ideas emerging to ensure a healthy and secure future. Remembering that all natural systems are interconnected, communities are discovering for example that energy efficiency techniques can be coupled with stormwater management strategies to enhance objectives under both concepts and make gains toward sustainability quicker. (The graphic on the opposite page shows how these systems and concepts are all interconnected.)

Preserving the natural environment is essential for maintaining community sustainability. Healthy ecosystems balance economic and conservation needs by assuring adequate resources are available to meet future needs. Communities that act as environmental stewards preserve natural resources and open space; monitor energy use and seek alternate sources; maintain biodiversity; enhance water and air quality; and attempt to mitigate for the effects of climate change. (Sustainable Communities online. 2013.)



Graphic source: Land Policy Institute, Michigan State University.

GLOSSARY

Biodiversity – Biological diversity or biodiversity is the range or variety of plants, animals, and other living things in an area. It joins air, water, and land as the living component that makes up earth.

Climate Change – Any significant change in the measures of climate lasting for an extended period of time, including major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. (U.S. EPA.)

Global Warming – Recent and ongoing rise in global average temperature near the Earth's surface. It is caused mostly by increasing concentrations of greenhouse gases in the atmosphere. Global warming is causing climate patterns to change. However, global warming itself represents only one aspect of climate change. (U.S. EPA.)

Greenhouse Gases – Gases that trap heat in the atmosphere, primarily carbon dioxide, methane, nitrous oxide, and fluorinated gases. Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere over the last 150 years. The largest source is from burning fossil fuels for electricity, heat, and transportation. (U.S. EPA.)

Stormwater – Rain and snow melt that runs off surfaces such as rooftops, paved streets, highways, and parking lots that can pick up pollution and flow directly into a local water body or, it may go into a storm drain and continue through storm pipes until it is released untreated into a local waterway. Large impervious surfaces in urban areas increase the quantity of peak flows of runoff, causing flooding and other detrimental hydrologic impacts.

Vehicle Miles Traveled (VMT) – The count of miles traveled in a vehicle in a certain period of time. This measurement is valuable not only in transportation analysis but also in assessing air quality.

ENERGY AND AIR QUALITY

Modern human activity heavily relies on the combustion of fossil fuels like oil, coal, and natural gas. When fossil fuels burn they emit greenhouse gases like carbon dioxide, a major contributor to global warming. The effect of any given population can be measured by its carbon footprint, which is described as the total amount of greenhouse gas created by that population. Cities and nations around the globe are prioritizing the reduction of their carbon footprint, and consequently their negative impact on the environment.

Community greenhouse gas emissions come from a few primary sources; buildings, transportation, and waste. Sources can be direct (i.e. burning fuel in a car or a stove) or indirect (i.e. burning fuel to produce a product that is later purchased by consumers). Emitted greenhouse gases are mitigated by trees and vegetation, which break down carbon dioxide during photosynthesis.

Many communities have successfully lowered their carbon footprint on the consumption end through the adoption of policies and programs that reduce net energy use at household and community-wide levels. A companion approach focuses on the production end by investing in sources of energy that create fewer greenhouse gases.

Some other approaches to reduce a community's carbon footprint may include and are presented as techniques:

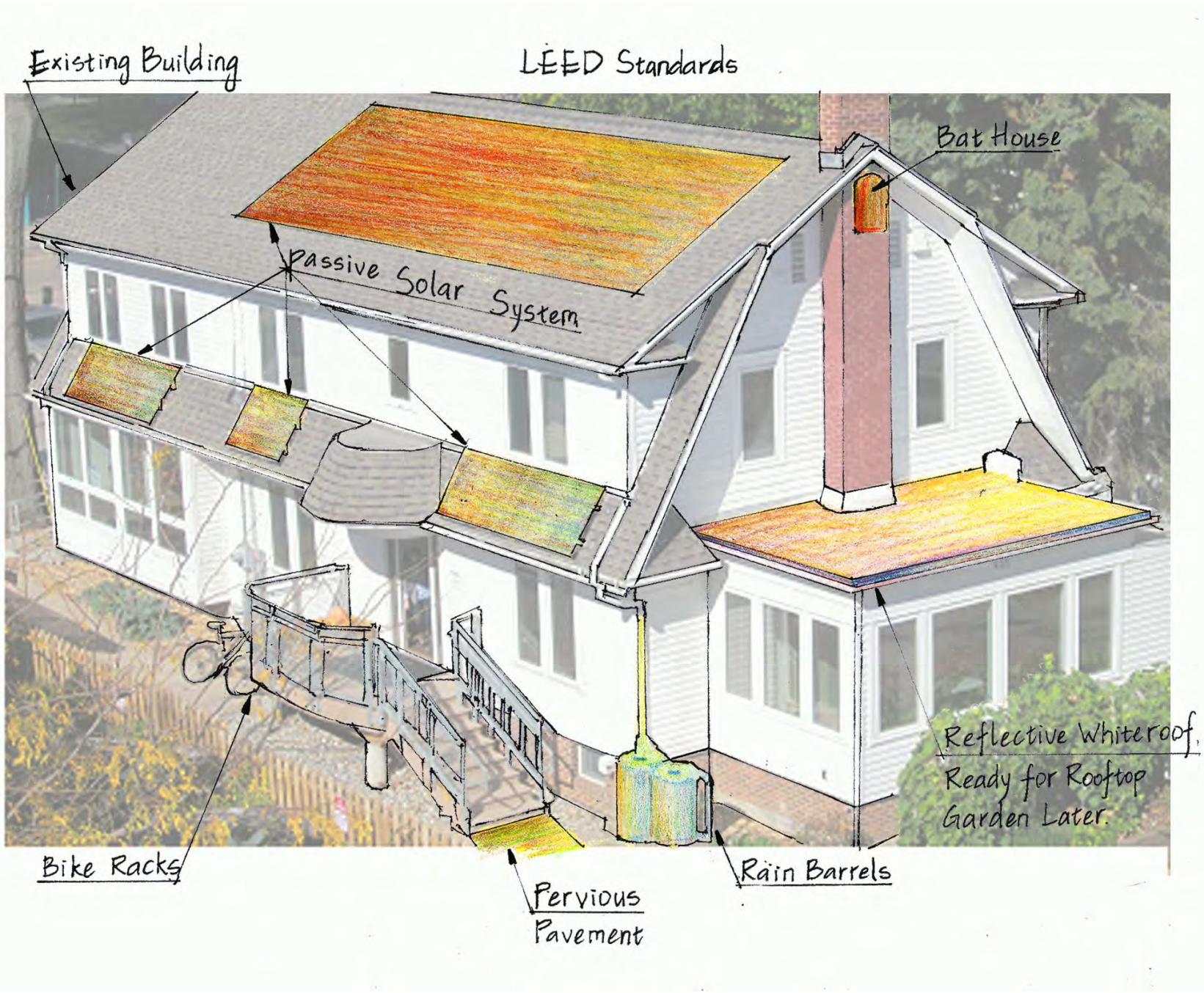
- Establishing native growth protection areas.
- Preserving and enhancing the community's tree canopy.
- Converting vehicle fleets to hybrids.
- Installing green roofs.
- Replacing street lights and internal building lights with LEDs and all appliances with ENERGY STAR approval.
- Increasing weatherization of buildings to reduce the use of air conditioning and heating.
- Constructing future buildings to higher energy-efficient standards.
- Purchasing higher percentages of electricity from renewable sources.
- Uniform street tree planning operations to increase the tree canopy.

Unlike fossil fuel-based energy production, renewable energy production methods use resources which are continually replenished, such as sunlight, wind, and geothermal heat. The absence of directly burning fossil fuels makes the net output of greenhouse gas from these methods much lower than traditional techniques. The viability of renewable energy projects is highly dependent on local weather, geography, and other conditions. (*Text adapted from the Image Flint: Master Plan for a Sustainable Flint. 2013. City of Flint.*)

On the opposite page is an illustration of the changes made to a home in a residential district that has implemented a variety of energy saving treatments and green practices to serve as a model for other homeowners and small businesses.

Image source (opposite page): Michigan Energy Options. Overlay illustration by Na Li, Land Policy Institute, Michigan State University.

Graphic source (this page): State of Maryland, Climate Change Maryland. Multiple Benefits of the Greenhouse Gas Reduction Plan. 2013.


Existing Building
LEED Standards
Bat House
Passive Solar System
Reflective Whiteroof,
Ready for Rooftop
Garden Later.
Bike Racks
Pervious
Pavement
Rain Barrels

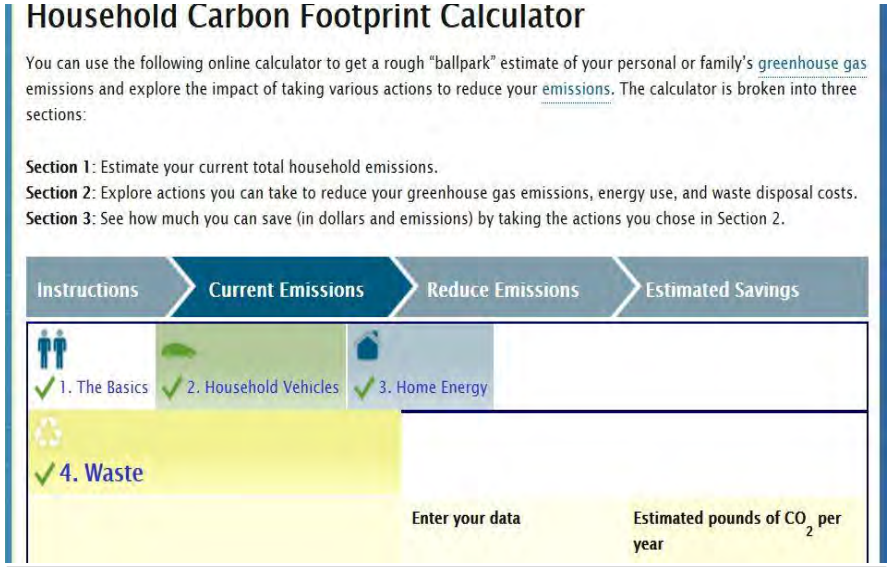
Calculating Individual Carbon Footprint Reductions

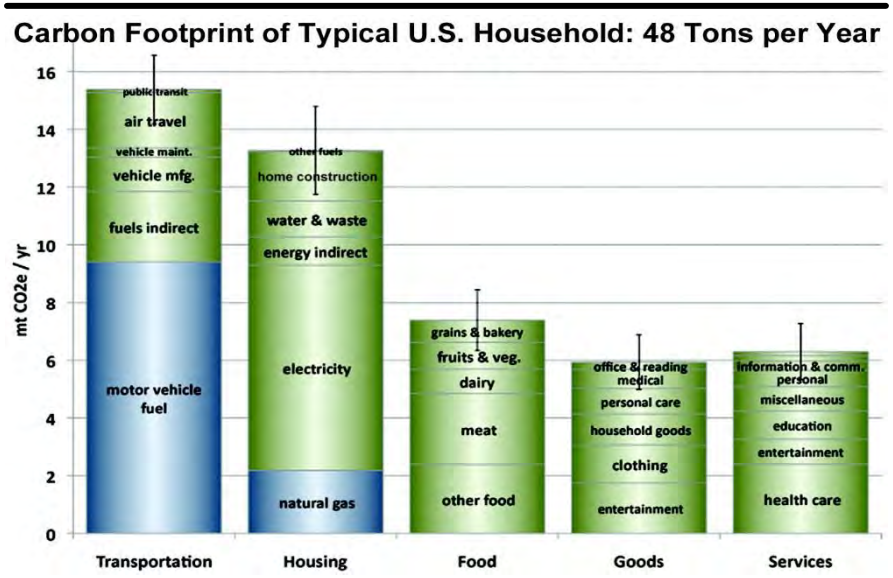
A carbon footprint is the total amount of greenhouse gases (GHG) that are produced either directly or indirectly from our activity. It can be calculated at any scale: person, household, business, or community, and for any timeframe: such as a year, or over the length of a trip.

There are many online carbon footprint calculators available and most of them consider fuel consumption for travel, energy use (e.g., electric, gas, oil), food consumption, and waste emissions to calculate a value in tons or pounds of CO2 emitted. An average household of four people emits an average of 83,000 pounds of CO2 per year (*Household Carbon Footprint Calculator. U.S. Environmental Protection Agency.*).

Once a carbon footprint is established and an individual has reduced their emissions as much as possible, they can choose to further offset their emissions through carbon offsetting programs. These programs are offered by organizations that support carbon reduction projects such as tree planting or efficiency programs.

"Because the commercial carbon trade is an emerging market, it's difficult to judge the quality of offset providers and projects. Trees don't always live a full life, sequestration projects (for the long-term containment of emissions) sometimes fail and offset companies occasionally deceive their customers. And voluntary offsets can easily become an excuse to overindulge and not feel guilty about it. Carbon offsets do, however, raise awareness about lowering the GHG world total" (How Carbon Offsets Work. HowStuffWorks.).





The U.S. Environmental Protection Agency's Household Carbon Footprint Calculator calculates a household's current carbon dioxide emissions, offers suggestions for ways to reduce them, and estimates the savings of those suggestions.

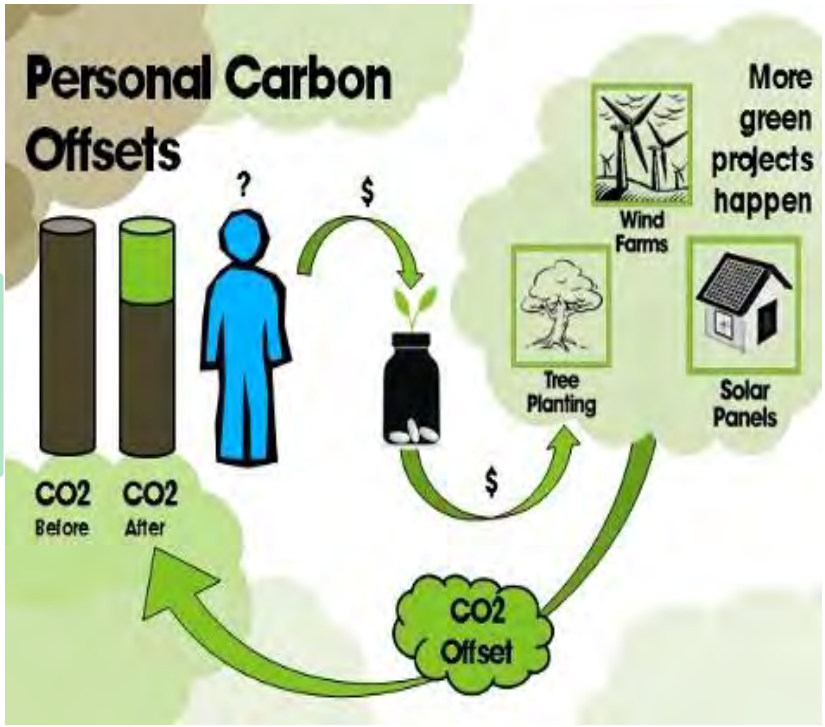
Source: Household Carbon Footprint Calculator. U.S. Environmental Protection Agency.

Once a person has reduced his/her carbon footprint to the extent possible, carbon offset programs offer an opportunity to further reduce it by supporting programs that reduce greenhouse gases.

Source: Carbon Offsets. Carbon Jar.

This chart breaks down typical household carbon dioxide emissions in metric ton by category. Transportation and housing create the bulk of emissions.

Source: "Tips on Reducing Your Carbon Footprint at Home." February 28, 2014. Manas Datta. Renewable Energy World.com.



RESOURCES

1) Household Carbon Footprint Calculator. U.S. Environmental Protection Agency.
2) What's My Carbon Footprint? The Nature Conservancy.
3) How to Reduce Your Carbon Footprint. Carbonfund.org Foundation.

Calculating Community Carbon Footprint Reductions

A carbon footprint is the total amount of greenhouse gases (GHG) that are produced either directly or indirectly from our activity. In the same way that a person can calculate his or her individual carbon footprint, so too can a community.

Understanding a community's carbon footprint is important not only for meeting greenhouse gas emissions reduction goals, it can also be an important consideration in fiscal decisions (see Governance – Balanced Budget, p. 2-37).

The ICLEI USA recently developed the *U.S. Community Protocol (Community Protocol) for Accounting and Reporting Greenhouse Gas (GHG) Emissions* to help local governments account for and report on GHG emissions. It sets the national standard and establishes requirements and recommended best practices or developing community-wide GHG emissions inventories. The Community Protocol is broken down into three steps:

1. Inventorying GHG emissions, at a minimum, including:
    a. Electric use,
    b. Fuel consumption in residential and commercial stationary combustion equipment,
    c. On-road passenger and freight vehicle travel,
    d. Energy use in drinking water and wastewater treatment and distribution systems, and
    e. Solid waste generation.
2. Gather data and quantify the emissions.
3. Develop a report.

Next steps would be to set goals for government activities, examine policies and programs to encourage reductions among residents and businesses, and lastly explore partnerships that can help accomplish both.

Table 2. Potential Community-Wide GHG Emission Sources and Associated Activities

In-boundary GHG Emissions Sources	Activities Resulting in GHG Emissions
Built Environment	
Use of fuel in residential and commercial stationary combustion equipment (e.g., boilers and furnaces)	Use of fuel in residential and commercial stationary combustion equipment (e.g., boilers and furnaces)
Industrial stationary combustion sources	
Power generating facilities	Use of electricity by the community[i]
District heating or cooling facilities	Use of district heating or cooling by the community
Industrial processes	
Refrigerant leakage	
Transportation and Other Mobile Sources [ii, iii, iv, v]	
On-road passenger vehicles operating within the community boundary	On-road passenger vehicle travel associated with community land uses
On-road freight and service vehicles operating within the community boundary	On-road freight and service vehicle travel associated with community land uses
On-road transit vehicles operating within the community boundary	
Transit rail vehicles operating within the community boundary	Use of transit rail travel by the community
Inter-city passenger rail vehicles operating within the community boundary	
Freight rail vehicles operating within the community boundary	
Marine vessels operating within the community boundary	Use of ferries by the community
Off-road surface vehicles and other mobile equipment operating within the community boundary	
	Use of air travel by the community
Solid Waste	
Operation of solid waste disposal facilities	Generation and disposal of solid waste by the community

	A	B	C	D	E	F	G	H	I	J
1	***Community-wide GHG Emissions Inventory***			INITIAL SCOPING - INCLUDED / EXCLUDED						
2	***Scoping and Reporting Tool - October 2012***			Included, Required Activities	Included, under possible reporting frameworks:				Excluded (IE, NA, NO, or NE)	
3	**Emissions Type**		**Source or Activity?**		**SI**	**CA**	**HC**	**Other**		**Explanatory Notes**
30	Water and Wastewater									
31	Potable Water - Energy Use	Operation of water delivery facilities in the community	Source							
32		Use of energy associated with use of potable water by the community	Activity	•						
33	Use of energy associated with generation of wastewater by the community		Activity	•						
34	Centralized Wastewater Systems - Process Emissions	Process emissions from operation of wastewater treatment facilities located in the community	Source							
35		Process emisisons associated with generation of wastewater by the community	Activity							
36	Use of septic systems in the community		Source AND activity							
37	Agriculture									
38	Domesticated animal production		Source							
39	Manure decomposition and treatment		Source							
40	Upstream Impacts of Community-Wide Activities									
41	Upstream impacts of fuels used in stationary applications by the community		Activity							
	Upstream and transmission and distribution (T&D) impacts of									

The *Community Profile* identifies likely sources of greenhouse gases emissions by source within communities. Other categories that cannot be seen in this table include wastewater and water, agricultural livestock, and upstream impacts of community-wide activities.

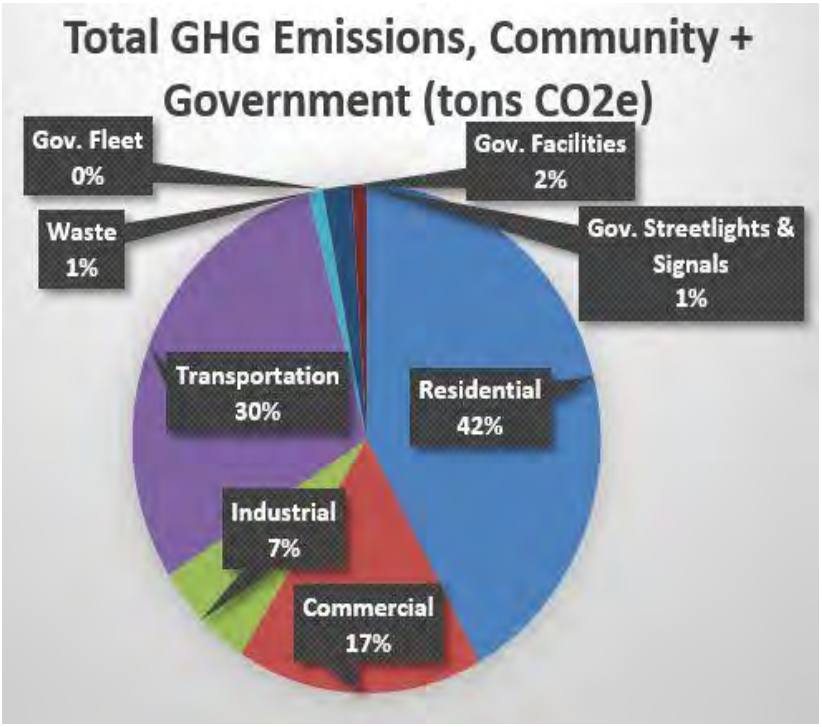
Source: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Version 1.1. July 2013. ICLEI-Local Government for Sustainability USA. P. 14.

The City of Hazel Park recently developed a Climate Action Plan. Part of the plan involved inventorying existing conditions.

Source: The City of Hazel Park Energy Action Plan. September 2012. City of Hazel Park.

The ICLEI's Community-wide GHG Emissions Inventory is an excel spreadsheet that walks a community through each emission source, quantifying emissions, and calculating the footprint.

Source: Scoping and Reporting Tool. U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. Scoping and Reporting Tool. October 2012. ICLEI-Local Government for Sustainability USA.



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1) Climate Action Planning Resources. Michigan Suburbs Alliance.
2) *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*. Version 1.1. July 2013. ICLEI-Local Government for Sustainability USA.
3) "Quantifying Carbon Footprint Reduction Opportunities for U.S. Households and Communities." 2011. Christopher M. Jones and Daniel M. Kammen. *Environmental Science & Technology*. Vol 45. No. 9. Pp 4088-4095.

Reducing Greenhouse Gas Emissions

Greenhouse gas emissions come from a variety of sources: electricity, transportation, industry and commercial, residential, and agricultural uses. While reducing emissions in one sector can have a big impact, research shows that reductions in all sectors will be needed to curb the effects of greenhouse gasses on global warming, and hence on climate change.

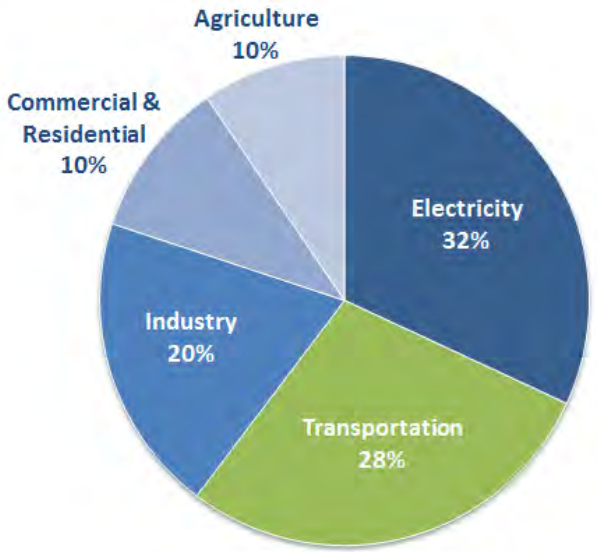
Although contributions to greenhouse gas emissions from buildings represent ten percent of total emissions, it is this sector that individuals may feel they have a more direct impact. Reductions in greenhouse gas emissions from commercial and residential activities can be achieved by reducing energy use through energy efficiency in homes and commercial buildings, making water and wastewater systems more energy efficient, reducing solid waste sent to landfills and capturing and using methane produced in current landfills, and reducing leakage from refrigeration equipment. (Commercial & Residential. Sources of Greenhouse Gas Emissions. Climate Change. U.S. Environmental Protection Agency.)

Opportunities for reductions in greenhouse gas emissions from the electricity sector include:

- Increased efficiency of power plans and fuel switching,
- Renewable energy,
- Increased energy efficiency,
- Nuclear energy, and
- Carbon capture sequestration and storage.

(Electricity. Sources of Greenhouse Gas Emissions. Climate Change: U.S. Environmental Protection Agency.)

For information on how to reduce greenhouse gas emissions from the transportation sector see Car-Alternative Choices, p. 3-31.

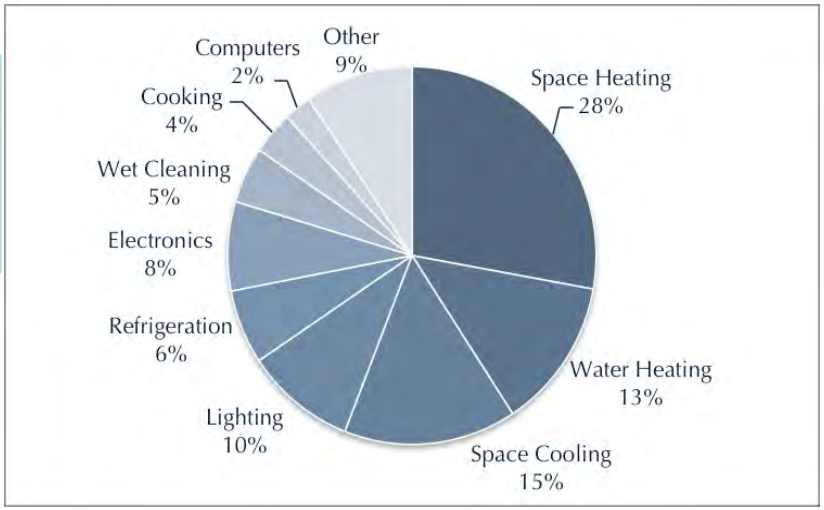


Total U.S. greenhouse gas emissions by economic sector in 2012.

Source: Sources of Greenhouse Gas Emissions. U.S. Environmental Protection Agency.

Total energy demand in the residential sector in 2012.

Source: 2011 Buildings Energy Data Book, Section 2.1.5. March 2012. U.S. Department of Energy.



Lansing Board and Water and Light's (LBW&L) first natural gas-fired power plant and first cogeneration plant, the REO Town plant, generates up to 300,000 pounds of steam per hour and 100 megawatts of electricity. The plant is among the most clean and efficient in the U.S. The $182 million project includes a new headquarters for LBW&L and restoration of an historic railroad depot.

Source: Mid-Michigan Program for Greater Sustainability.

RESOURCES

1) Center for Clean Air Policy (CCAP).
2) Smart Growth Program. U.S. Environmental Protection Agency.
3) "Chapter 4: Energy Supply." *Climate Change 2007: Working Group III: Mitigation of Climate Change*. Intergovernmental Panel on Climate Change.

Energy Efficiency

Energy efficiency simply means there is a goal to reduce the amount of energy required to do something. Energy efficiency can be optimized by using green building designs, vehicles, and appliances, and investing in alternative fuels and renewable energy to not only reduce carbon emissions, but in extreme cases can reduce energy costs by up to 50%.

Energy efficiency can be achieved through simple changes, such as purchasing products with the ENERGY STAR label and by using Low-emitting diode (LED) light bulbs. In 1992, the U.S. Environmental Protection Agency and the U.S. Department of Energy created the ENERGY STAR program, a voluntary program to reduce air pollution and protect the environment. Products that display the ENERGY STAR label use 20–30% less energy than required by federal standards and may include: computers, appliances, electronics, lighting fixtures, heating and cooling systems, and even homes and buildings. Since the implementation of this program, energy savings have steadily increased and greenhouse gas emissions have steadily decreased.

The LED light bulbs are another simple measure toward energy efficiency. The LEDs produce visible light when an electric current passes through. The LEDs are efficient by emitting light in one specific direction and being able to absorb the generated heat into a heat sink. The LEDs are also more durable than other light bulbs, with a life span of 20 years. Individual LED bulbs cost more than other light bulbs up front however, with the longer lifespan and higher energy efficiency they have a much higher return on investment.

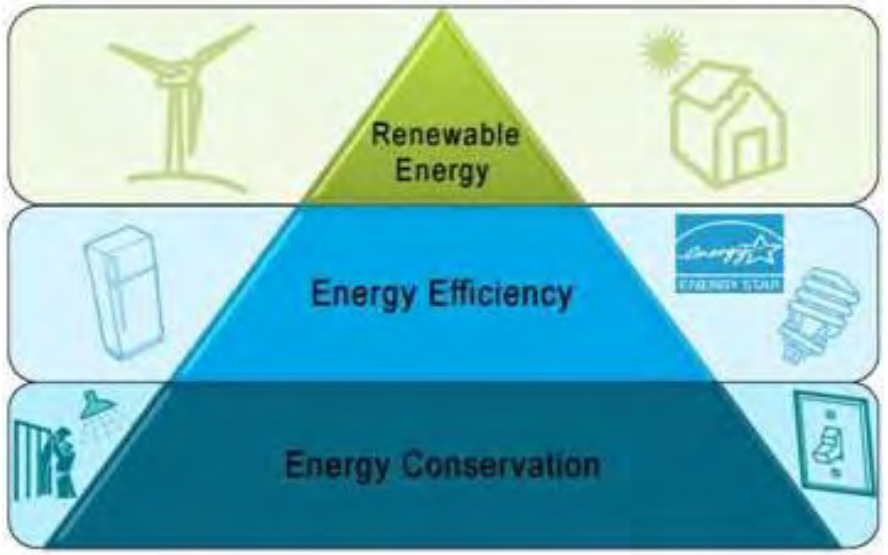
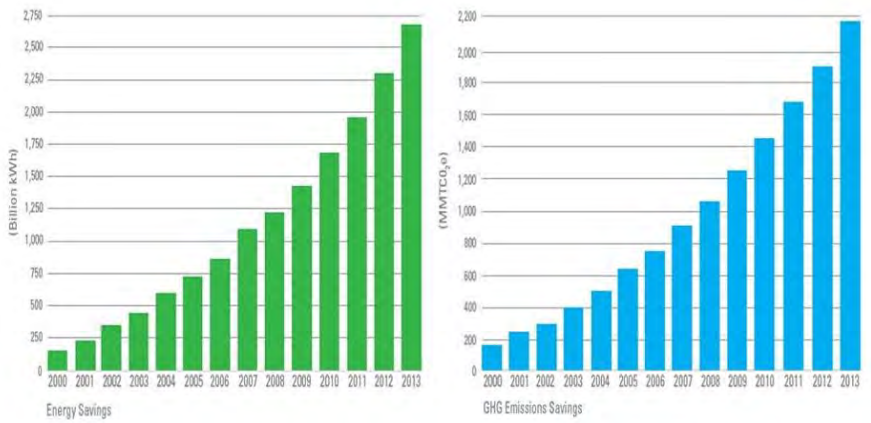


Fig. 1. ENERGY STAR Program Benefits Have Doubled in the Last Five Years



There are many ways to reduce energy production and consumption such as investing in energy conservation, energy efficiency, and renewable energy are shown here as steps to improve energy use.

Source: Energy Efficiency. Clean Air Council.

A comparison of output and lifespan of a traditional incandescent, CFL, and LE light bulb.

Source: LED Light Energy Efficiency. June 19, 2014.

Thanks to the ENERGY STAR program, $30 billion has been saved and more than 227 million metric tons of emissions have been prevented.

Source: ENERGY STAR Overview of 2013 Achievements. March 1, 2014. ENERGY STAR.

RESOURCES

1) Energy Efficiency. U.S. Department of Energy.
2) About ENERGY STAR.
3) Learn About LEDs. ENERGY STAR.

LEED and Green Buildings

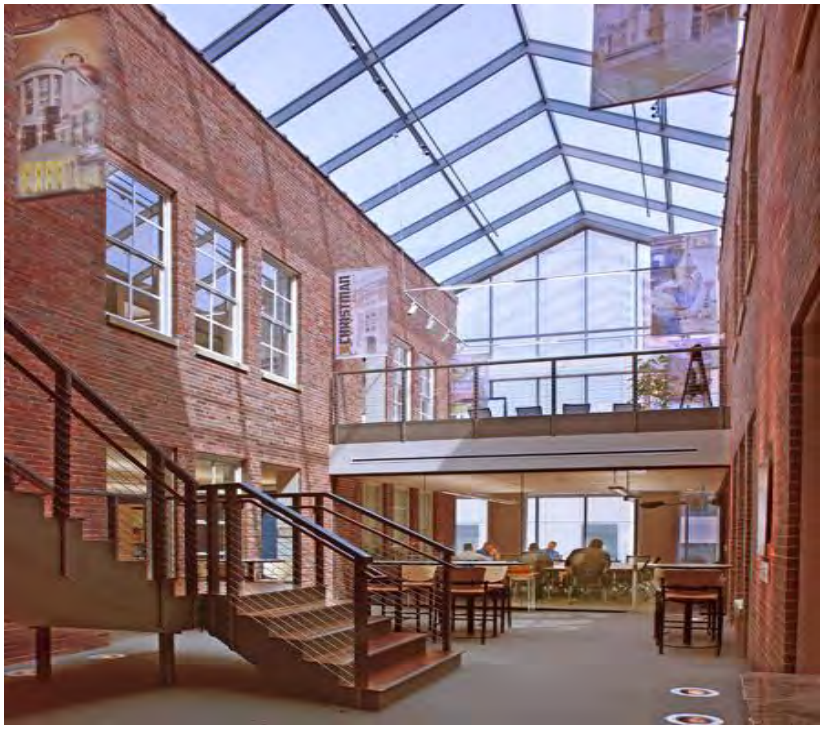
Green buildings take environmental responsibility into account by addressing resource efficiency, waste reduction, and environmental conservation in every stage of development, from design to demolition. The U.S. Green Building Council (USGBC) was created in 1993 to promote sustainability in building design. The USGBC developed the Leadership in Energy and Environmental Design (LEED) certification process to evaluate and provide credentials for green building projects. The certification process requires project teams to define their project type and choose a rating system, which provide specific credits to guide the project. Project types include: Building Design and Construction, Interior Design and Construction, Building Operations and Maintenance, Neighborhood Development, and Homes. The credit categories are part of each project type and range from sustainable sites and water efficiency, to indoor environmental quality and innovation. There are four levels of LEED certification based on point values awarded for the implementation of specific sustainable practices.

LEED certification recognizes best-in-class building design and practices and provides proof to the public of a commitment to sustainability. Not only do LEED certified and green buildings reduce human impact on the environment, they also set an example for the future of a community. Green buildings demonstrate how progress can occur without compromising current, future, or ever. However, it will cost extra money to become LEED certified, with exact fees amounts depending on size and details of the project.

According to a 2010 Green Economy Post, "in order to get $1.50 in energy savings, the building owner had to invest $400,000 on green/LEED related items; in other words, put down a $4.00 per square foot premium . . . it would take a little over 2.5 years to receive your investment back." Making green improvements and achieving LEED certification can lead to energy savings around 24-50% (USGBC) and an increase in property value.

Green buildings focus on resource efficiency, waste reduction, and environmental conservation, and see significant savings as a result.

Source: LEED Certification. Go Green Mechanisms, PVT. LDT.



The Christman Company building, located in Lansing, is the world's first triple platinum LEED project.

Source: The Christman Company Portfolio.

The LEED credit categories are to be met or exceeded by the project teams for all project types.

Source: "How LEED Certification Can Be Even So Much Better for Green Building." May 3, 2014. Bisagni Environmental Enterprise.

RESOURCES

1) LEED. U.S. Green Building Council.
2) Green Building. U.S. Environmental Protection Agency.
3) LEED. Natural Resources Defense Council.
4) "Return for Investment for Green/LEED Projects." 2010. Ed LeBard. The Green Economy Post.
5) LEED Certification Fees. USGBC.

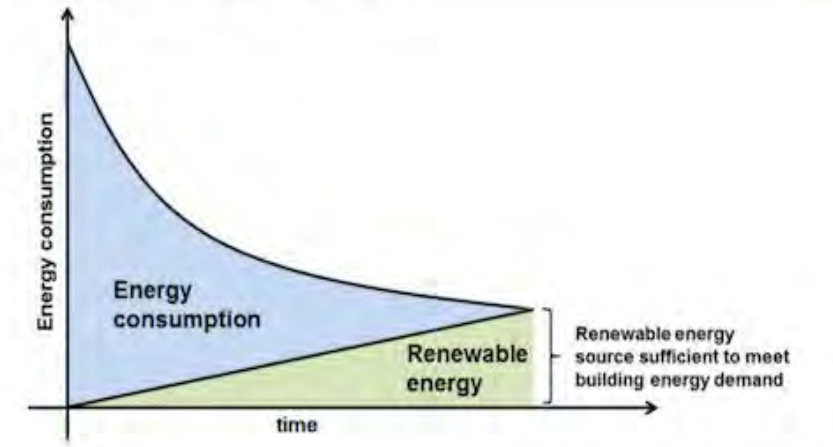
Net Zero Buildings

Net zero buildings whether a commercial building or a home are perfect examples of self-sufficiency as they produce and harvest energy on-site to address all energy needs. The energy is generated through a combination of renewable energy sources including wind and solar power, and by emphasizing efficiency as part of the interior design through the use of ENERGY STAR appliances, efficient and passive lighting, heating and cooling systems, etc. Most net zero buildings have a connection to the grid as a back-up in the event of an energy shortage or for energy storage in the case of an energy surplus.

The benefits associated with net zero buildings are many, starting with efficiency. Efficiency is incorporated into the design, construction, and operation of net zero buildings resulting in a decrease in overall energy consumption. Other benefits include reductions in carbon emissions and reliance on fossil fuels. By relying on renewable resources such as solar and wind energy, net zero buildings shift the focus away from natural gas and coal reliance, which in turn reduce carbon emissions. Finally, net zero buildings reduce energy costs because the energy needed to function is generated on-site, which over time results in a $0 energy bill.

The return on investment for net zero buildings typically ranges from six months to 10 years.

Figure 1.1 Zero Energy Building Concept



(Source: Pike Research)

This graph displays how Net Zero Buildings work to reduce energy consumption while simultaneously increasing the use of renewable energy sources over time.

Source: "Net Zero Energy Benefits, Strategies and Costs of Achieving the Next Generation of Buildings." March 11, 2014. K. Kuettel. Environmental Building Strategies.

Michigan's first Net Zero Energy home, located in Ann Arbor.

Source: "America's Oldest and Michigan's First Net Zero Energy." October 23, 2010. J. Kart. TreeHugger.com.

The Adam Joseph Lewis Center for Environmental Studies at Oberlin College, located in Ohio is not only net zero, but also has a 'living machine' which recycles wastewater for reuse.

Source: "Oberlin College: Setting a Sustainable Example in Ohio." July 8, 2008. E. Lee. Inhabitat.

RESOURCES

1) Net Zero Energy Buildings. Whole Building Design Guide.
2) 2014 Map of Zero Net Energy Verified Buildings. New Buildings Institute.
3) *Net Zero Buildings Magazine.*

Passive Haus

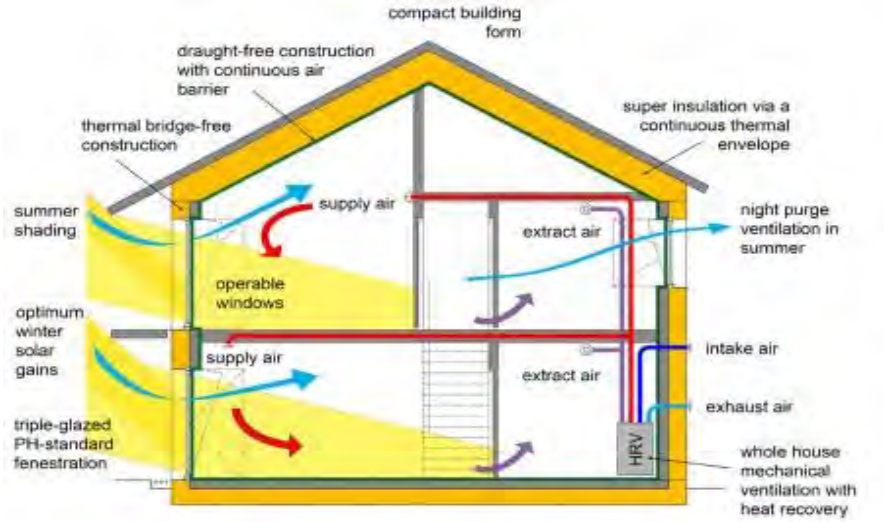
Passive Haus (Passive House) is a building standard developed in the 1990s in Germany which focuses on cost-effective thermal comfort and energy efficient design. According to the Passive House Institute, "*passive houses are praised for the high level of comfort they offer. Internal surface temperatures vary little from indoor air temperatures, even in the face of extreme outdoor temperatures.*"

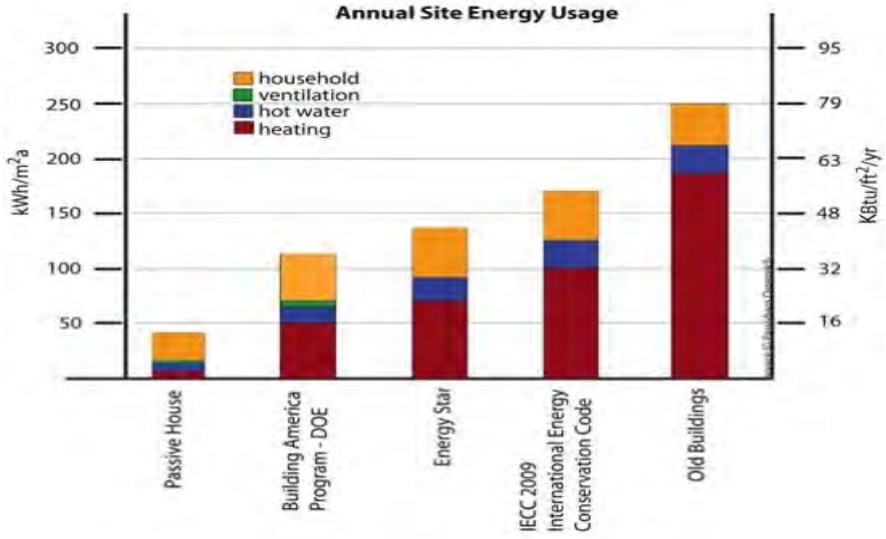
The principles of passive house design are:

- Super insulation – reduces heat transfer through walls;
- Airtightness – outside air exchange is controlled through ventilation to minimize heat loss;
- Minimal thermal bridging – higher thermal resistant insulation prevents heat loss;
- Optimization of passive solar gain – triple-pain passive windows prevent heat penetration in summer and allow heat exchange in the winter; and
- Ventilation with heat recovery – maintain air quality.

All of these features contribute to the major benefit of passive house design: extremely low energy use. Passive house design also provides comfortable indoor temperatures paired with high quality indoor air quality. Passive house design provides a superior living condition without consuming more energy and has been given the slogan, "doing more, with less." Passive house design is especially sustainable because it can be utilized in all climates around the world (Passive House Alliance).

The cost of passive house design is 7–10% more than a standard home but ultimately results in energy savings up to 70%.





This image shows how ventilation is optimized in Passive House design: super insulation, airtightness, minimal thermal bridging, passive solar gain, and heat recovery.

Source: PassiveHaus. ArchiHaus, UK.

The Jung Haus is a certified passive house, located in Oakland County, Michigan.

Source: Michigan PassiveHaus. July 15, 2013. FineHomeBuilding.

This graph displays how Passive House design compares to others in terms of annual energy use.

Source: "What's Our Excuse?" June 24, 2010. D. Bertolet. Seattle Met.

RESOURCES

1) Passive House Institute.
2) What is a Passive House? U.S. Passive House Alliance.
3) Lansing Michigan Passive House Alliance. Green Home Institute.
4) Financial Benefits of Investing in a Passive House. GO Logic.

Community Lighting

Lighting is an important element of a community. It affects walkability, traffic speeds and flow, people's willingness to go to downtowns, and public safety (traffic vs. personal safety, etc.). It can also be expensive and adds to our carbon footprint. Placement of lighting and use of green technologies can help in many of these areas.

"Appropriately-scaled and attractive lighting is a critical component of creating walkable streets. . . Increasing illumination low to the ground in public parking lots, at building entries, public plazas and transit stops create a secure and comfortable place for pedestrians. A combination of pedestrian-scaled street light fixtures and intersection street light fixtures ensure a well-lit street area and establishes a unifying element along the street. Placement of fixtures should be coordinated with the organization of sidewalks, landscaping, street trees, building entries, curb cuts, signage, etc. Light fixtures that are downcast or low cut-off fixtures prevent glare and light pollution. In order to conserve energy and reduce long-term costs, energy-efficient lamps should be used for all public realm lighting." (The Capitol Corridor Plan. 2014.)

Many homeowners, businesses, and communities are upgrading older lighting systems to LEDs (light-emitting diodes) which can be more efficient, durable, and long-lasting. However the cost of upgrading to LEDs on a large scale can be substantial.

Daylighting is an efficient building technique designed to allow natural sunlight into buildings. Through creative uses of glass and steel, buildings can use sunlight to reduce the amount of energy needed to artificially light and heat spaces. If used effectively, daylighting can be a cost-efficient and healthy way to light buildings and promote a healthy indoor environment.

Keeping the height of light fixtures low (less than 15 feet) promotes a pedestrian scale in the public realm and minimizes light spill to adjoining properties. Closely spacing light fixtures in urban areas (less than 30 feet) provides appropriate levels of illumination; however, in Neighborhood General and Edge, close spacing may not be desirable or necessary. (The Capitol Corridor Plan. 2014.) This table shows which style of lighting is best suited for each character zone.

Source: Dover-Kohl and Associates, under contract to the Tri-County Regional Planning Commission, reproduced by permission, p. 4.47.

Lighting placement and design can reduce effects of light pollution and preserve the night sky. Meridian Township has Dark Sky components in their lighting ordinance and Emmet County's The Headlands is one of only six Dark Sky Parks in the country.

Source: "New Dark Sky Park in Michigan Preserves the Night Sky for Stargazers." May 18, 2011. Andrew Michler. Los Angeles Institute of Architecture and Design.

In 1923, architect Albert Kahn designed the Cadillac Place in Detroit (Formerly General Motors Headquarters), a building with four large 15-story office towers, all having maximum exposure to natural light. Kahn's design maximized space and opened the majority of the large complex to sunlight.

Source: Cadillac Place (GM Building), New Center. Panoramino.

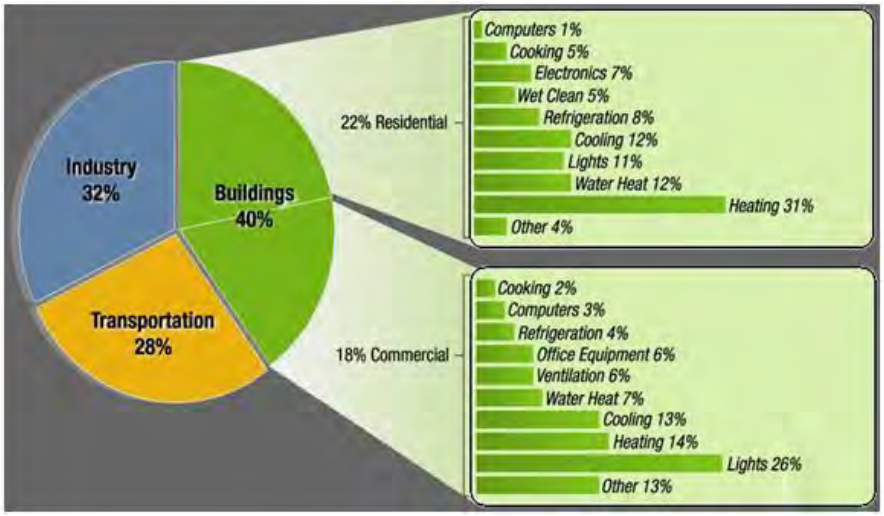
RESOURCES

1) International Dark-Sky Association.
2) Article VII: Outdoor Lighting Ordinance. Meridian Charter Township.
3) *LED Street Lighting: A Handbook for Small Communities*. Anne Kimber, Jonathan Roberts, Joel Logan, Mike Lambert. Iowa Association of Municipal Utilities.

Energy Efficiency of Existing Buildings

One way of achieving energy efficiency without starting from scratch, can be to improve upon what already exists; simple upgrades can be made toward energy efficiency through retrofitting existing buildings.

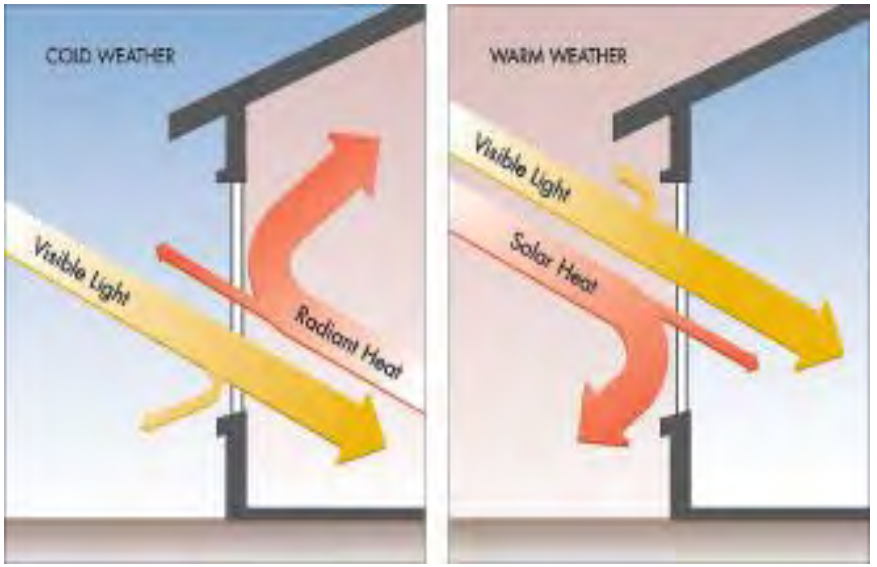
According to research from Boston University, "*existing commercial buildings currently account for 24% of US carbon emissions*" with heating, ventilation, and air conditioning (HVAC) representing most energy inefficiencies. In order to improve existing buildings, inefficiencies must be identified and evaluated, which can be done through an energy audit. Home and commercial energy audits assess the current energy use and efficiency of HVAC, lighting, insulation, windows, and appliances. Based on the results of the audit, recommendations can be made to improve the energy efficiency of the building. Audits also provide a benchmark for building performance to compare to after improvements have been made.



The following is a list of some improvements that can be made to increase energy efficiency of existing buildings:

- Install energy efficient light bulbs;
- Install low-flow sink faucets, shower heads, toilets;
- Choose eco-friendly paints, adhesives, coatings, etc.;
- Replace windows with double- or triple-paned windows;
- Replace appliances with ENERGY STAR label appliances; and
- Update HVAC systems.

Once energy efficiency improvements have been made, the return on investment is typically fully realized within three years.



This chart shows a comparison of how energy is consumed in residential and commercial buildings in the U.S.

Source: "Sustaining our Future by Rebuilding Our Past." October 28, 2009. Liam. Integrated Environmental Solutions.

Michigan Energy Options (MEO) in East Lansing is an example of an energy-efficient, existing building and operates as an energy demonstration center. MEO also provides services such as residential and commercial energy audits.

Source: Programs and Services. Michigan Energy Options.

This image depicts how dual- and triple-paned windows work efficiently to let light in, while preventing heat gain in the summer and heat loss in the winter.

Source: Energy Efficient Windows. The Window Source.

RESOURCES

1) "Building a Brighter, More Efficient Tomorrow with Energy Saving, Cost Saving Home Improvements." May 27, 2014. Michigan Department of Licensing and Regulatory Affairs.
2) Michigan Energy De monstration Centers. MEDC.

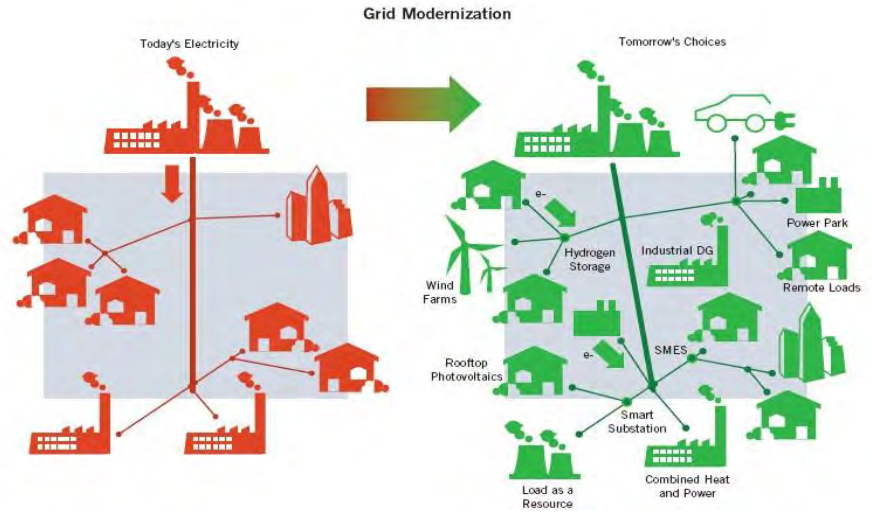
Enabling Zoning and Codes

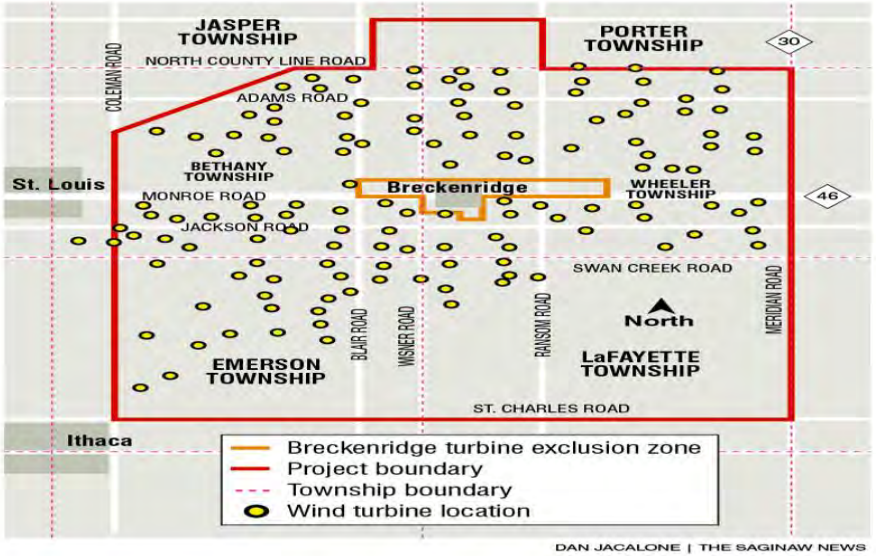
As technology continues to advance, we are being allowed to realize greater efficiencies and cost savings. One example of this is by implementing distributed energy systems, which restructure the energy grid into a self-regulating system where electricity can flow in all directions. Distributed energy systems can include renewable energy sources, such as wind; and alternative energy sources, such as solar, waste-to-energy, cogeneration or combined heat and power (CHP) and smart grids. Benefits of distributed energy systems include higher efficiency, a cleaner environment through investment in green energy, and increased reliability and faster response time.

Many green building or energy efficient retrofitting may also require changes in building codes and zoning. Examples include commercial or residential solar and wind technologies to existing buildings.

In order to capitalize on these opportunities, communities often need to update zoning and building codes and land use policies to enable and encourage such advancements. Most building codes are outdated and do not reflect new available opportunities for efficiency. For example, emergency exits signs are required to be lit at all times but policy does not take into consideration that motion sensors could help save energy and signal the light when needed. Also, in the relatively small percentage of Michigan's jurisdictions with planning and zoning authority and that have specific sections devoted to renewable or distributed energy sources, the content of the applicable sections is not necessarily consistent from jurisdiction to jurisdiction and may lead to interjurisdictional disputes.

The electricity grid will need to be updated to incorporate renewable energy found in remote locations and to support widely distributed storage devices. Finally, energy efficiency will need to be intertwined into design principles for new construction and city planning to make distributed energy systems and use affordable, realistic and effective.





This graphic depicts a traditional grid compared to a smart grid with distributed energy, which allows for energy to flow in many more directions.

Source: Smart Grid Future Capabilities. January 1, 2014. Smart Grid.

In 2011, the city of Troy began permitting active and passive solar energy systems in all zoning classifications. Pictured here is a home in Troy with solar panels.

Source: Planning and Zoning for Solar Energy. 2011. 8-8. American Planning Association.

Gratiot County implemented a county-wide zoning policy to support wind energy programs and installed three wind farms and several hundred turbines in 2011 to power 54,000 homes each year.

Source: "Michigan County Embraces Giant Wind Farms, Bucking a Trend." March 22, 2011. Weatherford, L.

RESOURCES

1) Ordinances/Bylaws. Municipal Clean Energy Toolkit. ICLEI USA.
2) Department of Energy: Building Energy Codes.
3) "Our Choice." Al Gore.

Distributed Energy

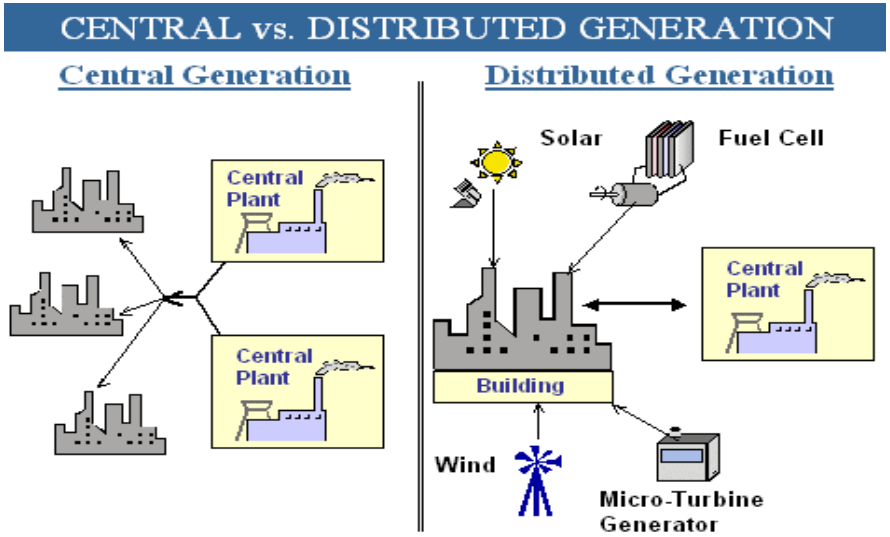
Distributed energy simply means electricity is generated from many small sources, rather than a few large ones. Distributed energy sources include cogeneration, solar energy, wind energy, vehicle-to-grid systems, location-to-grid sources (residential or commercial) and waste-to-energy systems.

Solar energy can be implemented privately, by installing solar panels and shingles on homes, or it can be implemented in a shared style called community solar. This method allows individual investors to receive solar power generated from a community solar garden in proportion to their investment. There are a variety of community solar models that provide different opportunities for individuals to invest in solar energy projects locally-owned either by utility companies, enterprises or nonprofit organizations. Solar energy overall has benefits of reducing dependency on fossil fuels and, therefore, reducing harmful emissions. Community solar has additional benefits when compared to private generation. Community solar is available to those that could not otherwise invest in solar energy, including renters, those with inadequate roofs due to size and orientation, those subject to strict building codes, etc. Community solar is an affordable way for individuals to pool resources and invest in renewable energy.

Some utilities allow solar (community or individual) or anaerobic digester customers to sell surplus energy back to the utilities under a contract and at a fixed price. This helps them meet their state-mandated 2015 renewable portfolio standard.

Waste-to-energy is a process where non-recyclable materials are converted into usable heat, electricity, or fuel, usually through a process that uses an anaerobic digester. Waste biomass materials (i.e., animal manure, food waste and natural waste materials) can also be used. The benefits of waste-to-energy systems include reducing waste production and dependency on fossil fuels, carbon emissions, methane generation at landfills, and sludge and other solid waste from wastewater treatment plants.

Waste-to-energy systems have an inherent advantage over most renewable sources in that they are not considered intermittent like wind and solar. Potential problems with intermittent distributed energy sources would need to be addressed. For example, intermittent sources may not be able to meet demand if there isn't wind or sun, lack of battery technologies that can store energy onsite until it is needed, line losses and inadequate system infrastructure. In addition, upgrading or extending interconnections to remote locations can result in significant environmental impacts and land-use conflicts.



Distributed energy is generated from smaller sources with two-way flow when excess energy is sent to the grid, whereas central energy generation is one-way dispersion from larger plants.

Source: Hands-On Activity: Windmill of Your Mind – Distributed Energy Goes to School. TeachEngineering Digital Library.

The MSU's anaerobic digester converts food wastes from the cafeterias, food production waste from Meijer's, and animal wastes from farming operations and sells electricity generated to Consumers Energy.

Source: Facilities. Anaerobic Digestion Research and Education. Michigan State University.

Michigan's first Community Solar Project is a 224-panel solar array located in Traverse City on the property of Cherryland Electric Cooperative and launched in the spring of 2013. There is an inherent demand for solar: the project sold out all the panels to the community within the first year and has plans to install more.

Source: "Community Solar Coming of Age in Michigan." May 27, 2014. A. Balaskovitz. Midwest Energy News.

RESOURCES

1) Solar Gardens Community Power.
2) *A Guide to Community Solar*. 2010. U.S. Department of Energy. Energy Efficiency & Renewable Energy.
3) Energy Recovery from Waste. U.S. Environmental Protection Agency.

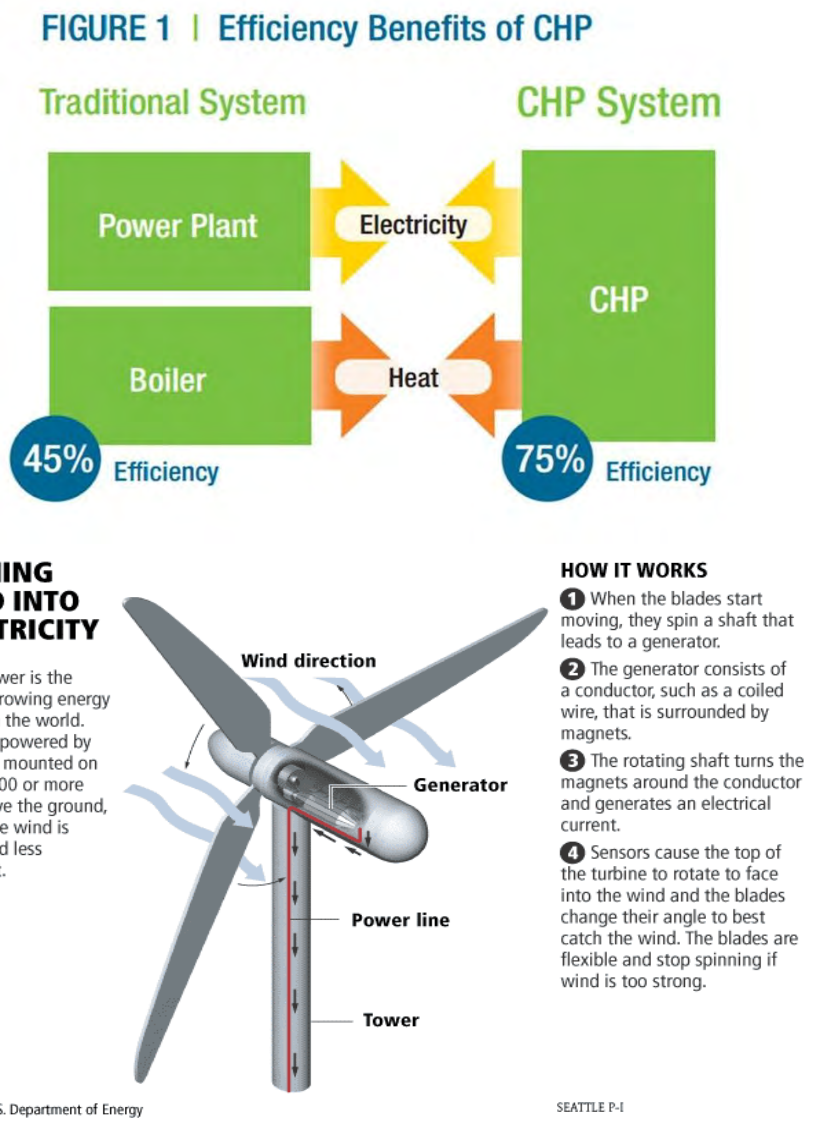
Green Utility Power

Green utility power programs provide clean energy by investing in renewable energy sources, including geothermal, solar, wind, biomass, hydro, cogeneration and waste-to-energy facilities.

Cogeneration, or combined heat and power (CHP), is the use of a heat engine to simultaneously generate heat and electricity. This heat engine recaptures excess thermal energy, which is a byproduct of electricity generation typically wasted in traditional power generation systems. The CHP is completed on-site, in one location, reducing distribution losses and allowing for system efficiencies around 80%.

Wind occurs as a result of air pressure differences from uneven solar heating, which can be harnessed to transform kinetic energy into mechanical energy. In the past, windmills were used to harvest wind to pump water for instance, and today wind turbines are being used to harvest wind to generate electricity. Wind turbines operate at least 100 feet high, typically with three rotating blades. As wind turns the blades, a shaft begins rotating that is connected to an electricity generator. Wind is a clean, renewable resource which produces no harmful pollutants; however, turbines can be noisy and destructive for winged wildlife.

Green utility power programs generate renewable energy certificates (RECs) as they generate renewable energy. According to the U.S. EPA, RECs "*represent the property rights to the environmental, social, and other nonpower qualities of renewable electricity generation.*" The RECs can be purchased to not only track renewable energy generation but to also incentivize further green utility power development.

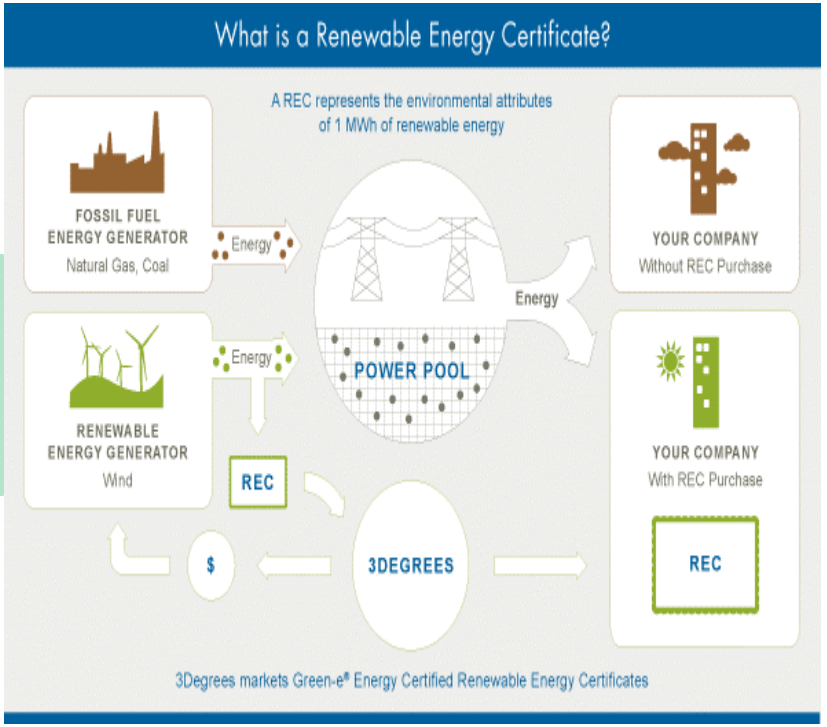


This diagram shows how both heat and electricity can be efficiently generated from CHP or cogeneration systems.

Source: Combined Heat and Power: A Clean Energy Solution. August 1, 2012. U.S. Department of Energy.

This diagram illustrates how renewable energy certificates (RECs) work in comparison to conventional energy generation.

Source: Renewable Energy Certificates. January 1, 2014. 3Degrees, Inc.



This image provides an explanation on how a wind turbine works.

Source: How Does it Work? Turning Wind into Electricity. Wind Energy. Storm Lake.

RESOURCES

1) CPH. American Council for an Energy-Efficient Economy.
2) American Wind Energy Association.
3) Energy 101 – Wind Turbines 2014 Update.
4) REC tracking and auditing: Green-e.

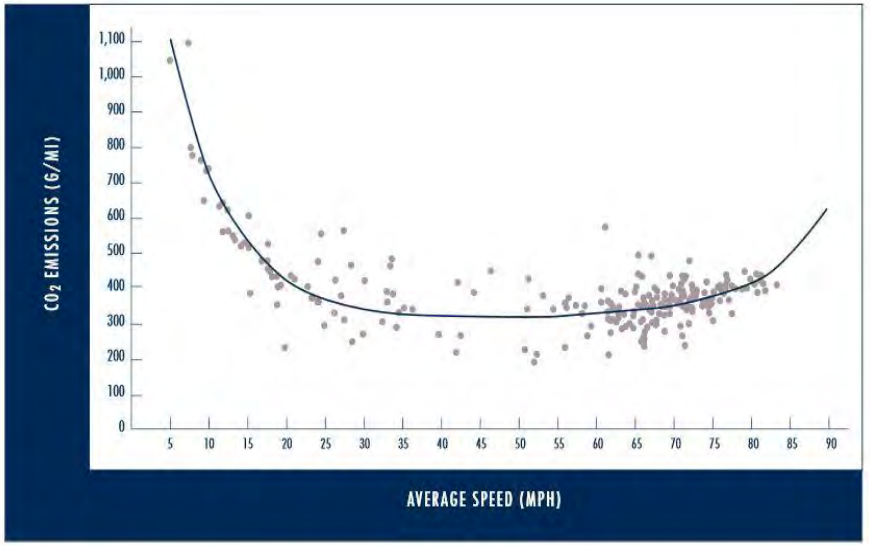
Calculating Greenhouse Gas Emission Reductions

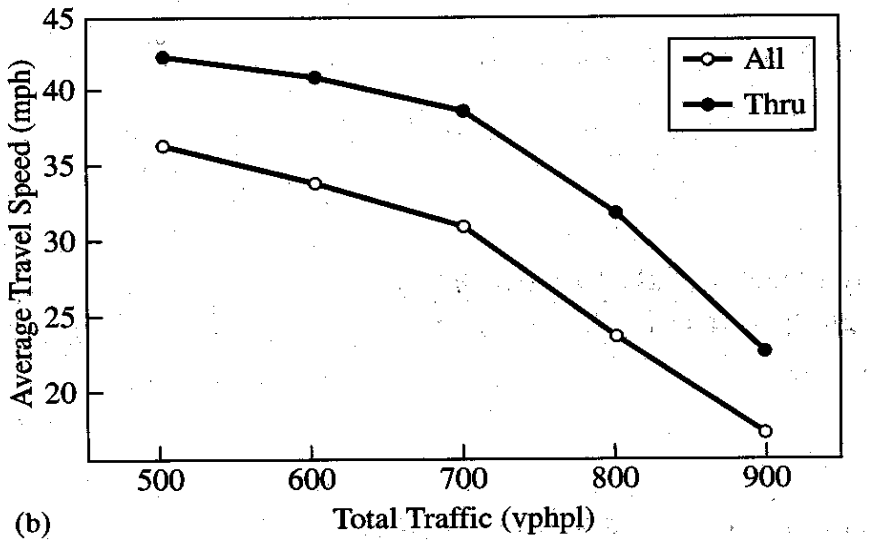
Reducing greenhouse gas (GHG) emissions is an important goal. See Reducing Greenhouse Gas Emissions, p. 3-9 and Car Alternative Choices, p. 3-31. But how can a community know if it is making an impact? There are a range of methods and resources to both quantify and qualify transportation related treatments and their impact on greenhouse gas emissions.

Studies show that decreasing vehicular speeds can lead to increased road capacity. Transportation capacity can be thought of much like rice being poured through a funnel. When the rice is poured quickly, it backs up; but when poured slower, it flows through the funnel evenly. This finding is significant not only from a capacity standpoint, but also when considering impacts on greenhouse gas emissions and road diets. Recent qualitative analysis shows that there is an optimal range for setting speeds on various types of roads to reduce emissions.

Quantitative analysis based on traffic flow theory can be used to compare emissions reductions for before and after treatment such as road diets. This method uses vehicle miles traveled (VMT) as a substitute function for delay. Simply combine the reduced VMT with the emissions factor and miles per gallon to get a comparison of before and after treatments. The Michigan Department of Transportation, through the Congestion Mitigation and Air Quality (CMAQ) project, has developed worksheets for various treatments to calculate emission reductions and cost-benefit analyses.

The U.S. Department of Energy and the Argonne National Laboratory developed a carbon and petroleum footprint calculator, GREET Fleet, to help communities assess their medium-heavy duty equipment for petroleum displacement and GHG emissions.





This graph shows greenhouse gas emissions in relation to speed. Emissions on arterials are lowest within the 20–35 mph range. This can be important information for a community when considering road diets and speed changes.

Source: "Traffic Congestion and Greenhouse Gases." Fall 2009. Matthew Barth and Kanok Boriboonsomsin. Access Magazine. Number 35.

Average emission reduction and fuel savings per day per vehicle for gasoline passenger cars as a result of a carpool program.

Source: Sample Calculation of Emission Reductions and Fuel Savings from a Carpool Program. September 2008. U.S. Environmental Protection Agency. Office of Transportation and Air Quality.

Pollutant/ Fuel	Emission Factor	Reduction in VMT	Calculations	Bene.t (Emission Reduction & Fuel Savings)
VOC	1.034 g/mi	15,000 miles	1.034 g/mi x 15,000 mi x 1 lb/454 g	34.2 lb VOC
CO	9.400 g/mi	15,000 miles	9.400 g/mi x 15,000 mi x 1 lb/454 g	311 lb CO
NOx	0.693 g/mi	15,000 miles	0.693 g/mi x 15,000 mi x 1 lb/454 g	22.9 lb NOx
PM_{10}	0.0044 g/mi	15,000 miles	0.0044 g/mi x 15,000 mi x 1 lb/454 g	0.14 lb PM_{10}
$PM_{2.5}$	0.0041 g/mi	15,000 miles	0.0041 g/mi x 15,000 mi x 1 lb/454 g	0.14 lb $PM_{2.5}$
CO_2	368.4 g/mi	15,000 miles	368.4 g/mi x 15,000 mi x 1 lb/454 g	12,172 lb CO_2
Gasoline Consumption	0.042 gal/mi	15,000 miles	0.042 g/mi x 15,000 mi x 1 lb/454 g	630 gallons gasoline

This graph shows how vehicular capacity increases as speed decreases, a counter-intuitive concept, in a typical signalized main street corridor for through vehicles. This is because there is less traffic build up and hence delay as occurs on higher speed roadways. It is also why travelers divert to slower speed roads when traffic jams occur because traffic still keeps moving, though at slower speeds.

Source: Traffic Engineering, Second Ed. Roger P. Roess, Elena S. Prassass, William R. McShane. Prentice Hall.

RESOURCES

1) Congestion Mitigation and Air Quality (CMAQ). Michigan Department of Transportation.
2) INVEST. U.S. Department of Transportation. Federal Highway Administration.
3) National Vehicle & Fuel Emissions Laboratory (NVFEL). U.S. Environmental Protection Agency.
4) MOVES (Motor Vehicle Emission Simulator). U.S. Environmental Protection Agency.

Car-Alternative Choices

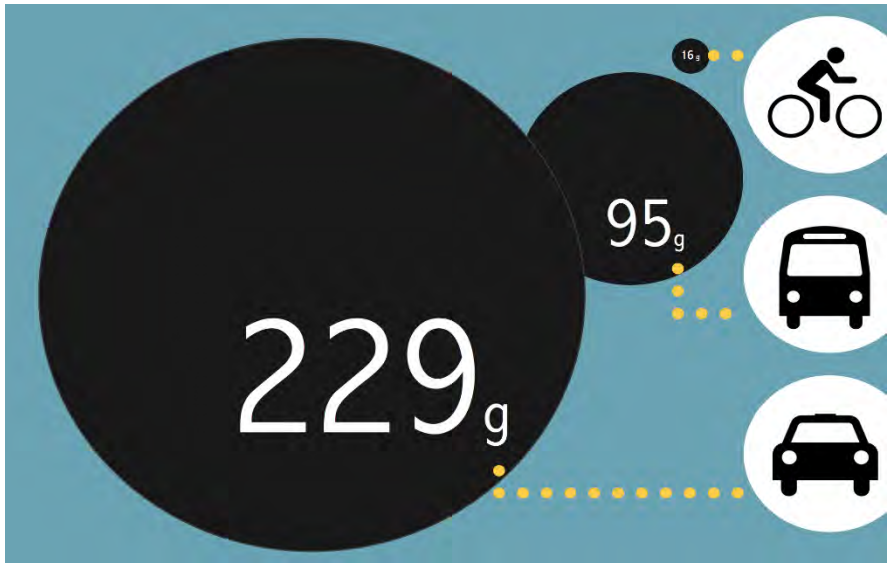
The transportation sector is one of the largest sources of U.S. greenhouse gas (GHG) emissions, which contribute to global warming. In 2012, transportation represented approximately 28% of total U.S. GHG emissions. *"The majority of greenhouse gas emissions from transportation are Carbon Dioxide (CO_2) emissions resulting from the combustion of petroleum-based products, like gasoline, in internal combustion engines. The largest sources of transportation-related greenhouse gas emissions include passenger cars and light-duty trucks, including sport utility vehicles, pickup trucks and minivans. These sources account for more than half of the emissions from the sector. The remainder of greenhouse gas emissions comes from other modes of transportation, including freight trucks, commercial aircraft, ships, boats and trains, as well as pipelines and lubricants. Greenhouse gas emissions from transportation have increased by about 18% since 1990. This historical increase is largely due to increased demand for travel and the limited gains in fuel efficiency across the U.S. vehicle fleet. The number of vehicle miles traveled by passenger cars and light-duty trucks increased 35% from 1990 to 2012."* (Sources of Greenhouse Gas Emissions. Climate Change. U.S. Environmental Protection Agency.)

While transportation continues to contribute a large percentage of U.S. greenhouse gas emissions, there are exciting opportunities for the sector to deliver significant greenhouse gas reductions. Reducing the number of vehicle miles traveled is one approach to reducing greenhouse gases from transportation. Shifting to electric hybrids, diesel, propane and other less-polluting energy sources is another way. Increasing transportation choices that are not dependent on personal vehicles includes walking, biking and using various forms of mass transit. Other approaches include improving fuel efficiency, and improving operating practices.

Percentage Changes in GHG Emissions by mode from Low, Mid, and High Mitigation Scenarios with respect to 2010 levels. Oil savings is with respect to business-as-usual.

	2035				2050			
	BAU	Low	Mid	High	BAU	Low	Mid	High
Total Impact From All Policies Strategies	14.6%	–6.50%	–29.8%	–41.5%	23.6%	–17.2%	–40.1%	–65.9%
	Percentage change for each mode							
Light-Duty Vehicles	3.50%	–17.4%	–40.4%	–50.6%	12.8%	–24.9%	–48.5%	–73.4%
Commercial Light Trucks	23.1%	0.10%	–26.1%	–37.2%	29.2%	–12.3%	–38.7%	–61.3%
Freight Trucks	51.6%	27.9%	0.10%	–12.1%	69.5%	20.8%	–6.30%	–37.9%
Freight Rail	33.5%	19.0%	3.80%	–7.20%	38.8%	–3.50%	–14.4%	–45.2%
Domestic Shipping	18.7%	1.1%	–12.4%	–23.1%	23.1%	–6.40%	–30.5%	–51.6%
International Shipping	7.70%	–7.1%	–15.0%	–22.7%	8.70%	–11.7%	–32.1%	–43.2%
Air Transportation	26.3%	8.4%	–20.3%	–44.4%	30.7%	–29.8%	–47.2%	–77.2%
Total GHG Emissions (MMT CO_2e)	2,106	1,703	1,279	1,065	2,285	1,507	1,090	622
Annual Oil Savings below BAU (mmb)	—	900	1,800	2,300	—	1,700	2,600	3,700

Note that each mode is according to the definition by the U.S. EIA; Total GHG Emissions do not include miscellaneous emissions as defined by the U.S. EIA. Negative numbers mean there is a decrease in GHG emissions compared to emissions in 2010. Also note that the percentage reduction by mode is the percentage reduction for that mode, not for the whole sector. Estimates of oil savings are approximate.

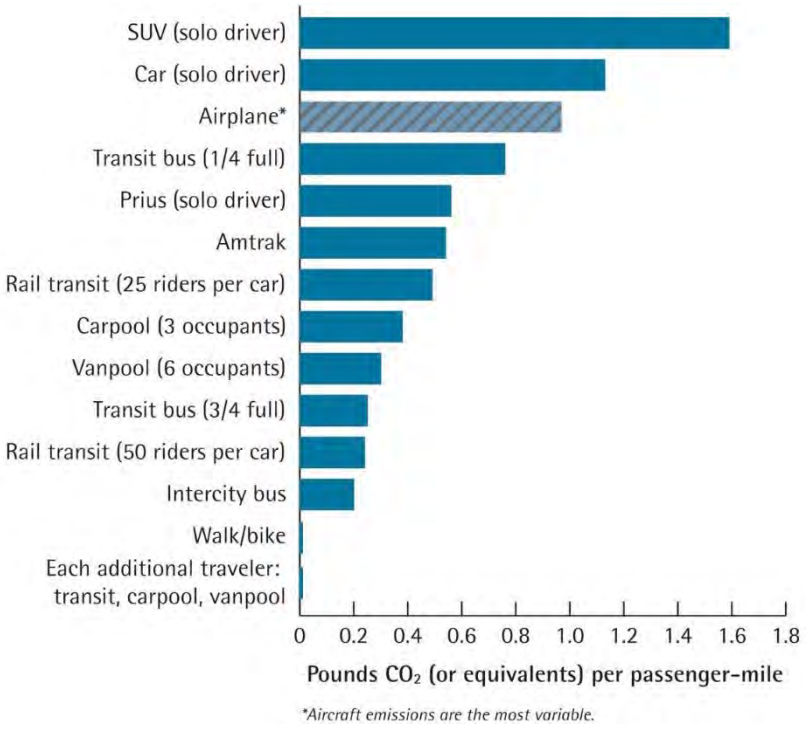


"*It is possible to cut GHG emissions from the transportation sector cost-effectively by up to 65% below 2010 levels by 2050 by improving vehicle efficiency, shifting to less carbon intensive fuels, changing travel behavior, and operating more efficiently*" including improved highway system efficiency and more compact development. This table shows the type of transportation along with impact of implemented strategies.

Source: "Reducing Greenhouse Gas Emissions from U.S. Transportation." January 2011. P. 16. David L. Greene and Steven E. Plotkin. Pew Center on Climate Change.

Transportation modes differ in their greenhouse gas emissions. This chart shows that walking, biking, and adding a traveler to an existing mode are the best strategies for reducing personal travel emissions.

Source: How Low-Carbon Can You Go: The Green Travel Ranking. Sightline Institute.



This graphic compares the annual Carbon Dioxide emissions (per passenger kilometers) required to fuel a bike, bus, and car. It includes all CO2 emissions from production, distribution, and consumption. The calculated value is based on average occupancy rates of 1.16 for cars, 10 for buses, and one for bicycles.

Source: Meeting CO2 Targets through Cycling. European Cyclists' Federation.

RESOURCES

1) *"Chapter 5: Transport and its infrastructure." Climate Change 2007: Working Group III: Mitigation of Climate Change. Intergovernmental Panel on Climate Change*.
2) Air Quality Monitoring. Travel Forecasting Resource.
3) *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions. Volume 1: Synthesis Report*. April 2010. Report to Congress. U.S. Department of Transportation.

Green Fleets

Providing for sustainable transportation options is a big and growing issue. Because of the large scope of the mobility challenge, even small-scale programs can have a positive impact on reducing petroleum consumption and emissions considering that transportation today accounts for 95% of global oil consumption and nearly 30% of world energy use. "*The convergence of rising oil prices, technological innovation, government incentives, consumer awareness, and corporate fleet sustainability planning creates new opportunities to embrace clean transportation solutions*" (Clean Energy Coalition.).

Replacing or converting vehicles that consume gasoline and diesel to alternative fuels such as propane, natural gas, ethanol, waste cooking oil, electric, and hybrid fuels is one way that businesses, institutions, and local and state government are implementing sustainability and cost savings at the same time. All types of vehicles are being tested. Everything from delivery vehicles, school busses, waste and dump trucks, and standard vehicles are being replaced or retrofitted with new technology.

As more green fleets come on line, it will be important for communities to supply the supporting infrastructure, like charging stations for electric vehicles, to keep them running.

Calculated fuel savings for a refuse truck (empty weight 16 t) during operation

Annual operating hours	1,300	1,820	2,340
Fuel savings (liters per year)	2,925	4,095	5,265
CO_2 reduction (kg per year)	7,750	10,850	13,950

Graphic from Bosch™ rexroth online content

Ann Arbor has replaced 7,000 vehicles with clean-fueled vehicles since 2000. In 2010 alone, it displaced more than 3 million gallons of gasoline. The city's goal is to reduce fuel use by 10% in 10 years through the purchase of fuel efficient and alternative fuel vehicles. This dump truck was converted from petroleum fuel to a hydraulic hybrid electric system.

Source: Greater Lansing Area Clean Cities.

In 2011, Auburn Hills was the first municipality in Michigan to adopt a comprehensive Electric Vehicle Infrastructure Ordinance and developed a model regulatory sign that is being considered as a national standard.

Source: City of Auburn Hills.

Detroit is modifying its refuse fleet with hybrid technology that optimizes fuel economy. The incremental cost of $40,000 for the hybrid retrofit has a 4-6 year payback period depending on fuel cost. Hybrid systems offer fuel cost savings (up to 25%) over the life of the vehicle and reduces maintenance costs.

Source: "Hybrid Trucks for Municipal Waste." Optimization of Detroit's Refuse Collection. Clean Energy Coalition.

RESOURCES

1) Clean Energy Coalition.
2) Plug-In Michigan.
3) Alternative Fuels & Advanced Vehicles Data Center. U.S. Department of Energy.

WATER QUALITY

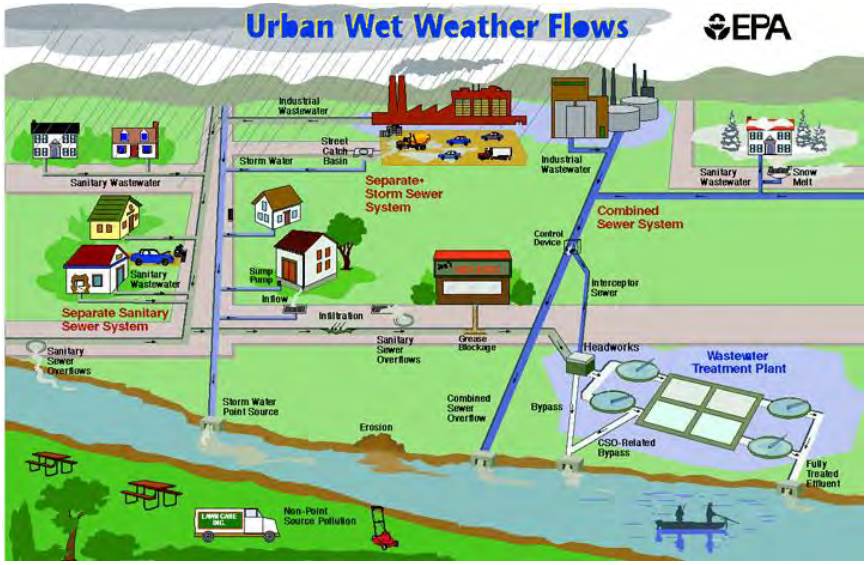
"*Water quality can be thought of as a measure of the suitability of water for a particular use, based on physical, chemical, and biological characteristics*" (U.S. Geological Survey).

There are two primary components in a water ecosystem: surface water and ground water, but there are many factors that affect the quality of each including impervious surface area, point source pollution (e.g., from factories), nonpoint source pollution (e.g. from transportation and agriculture-related activities), erosion, and land use. Managing this system for improved water quality is no small feat, especially as we consider the challenges ahead of us including: continued pollution, drinking water safety and security, and the delivery infrastructure that is aging and in need of replacement. Global warming contributes to drought, flooding, fiercer storms, fires, and erratic weather patterns and will only exacerbate these problems.

Most of the techniques related to water quality focus on stormwater management, arguably where community action can have the greatest impact. Many of the techniques presented can be adapted to scale for different needs: smaller (commercial or residential sites) or larger scales (part of restoration projects).

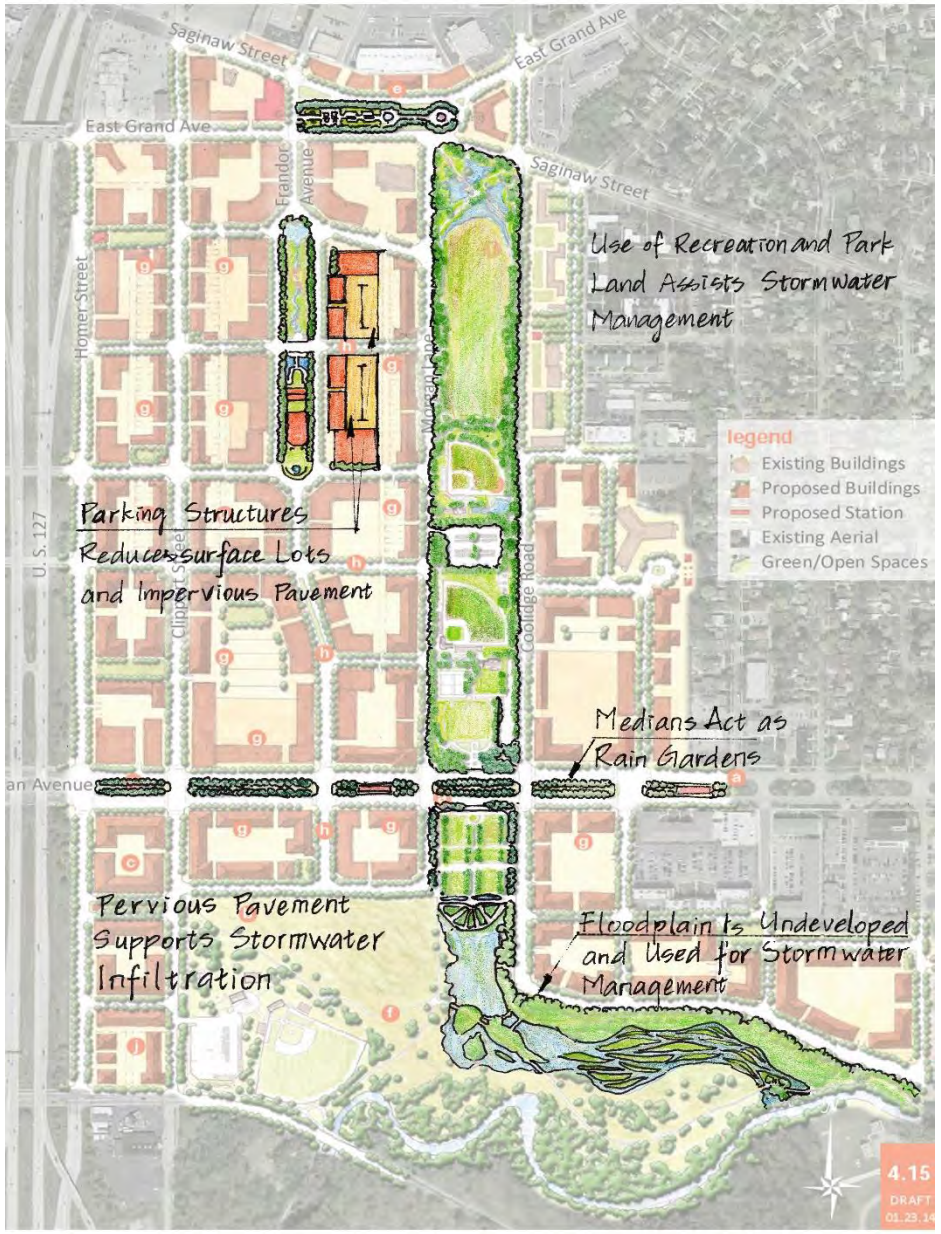
Today's philosophy toward stormwater management techniques center on treating water as closely to the source as possible and managing the changing flow regimes to allow for as much absorption as possible.

This philosophy may prove to be a major cost savings by diverting water that would otherwise go through expensive municipal stormwater systems. On the opposite page is an illustration of the changes made to a commercial development area implementing a variety of stormwater management and water quality treatments.



Graphic source (this page): U.S. Environmental Protection Agency.

Image source (opposite page): Dover-Kohl and Associates, under contract to the Tri-County Regional Planning Commission, reproduced by permission. Overlay illustration by Na Li, Land Policy Institute, Michigan State University.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Use of Recreation and Park Land Assists Stormwater Management
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Existing Buildings
Proposed Buildings
Proposed Station
Existing Aerial
Green/Open Spaces
Parking Structures Reduce Surface Lots and Impervious Pavement
Medians Act as Rain Gardens
Pervious Pavement Supports Stormwater Infiltration
Floodplain is Undeveloped and Used for Stormwater Management
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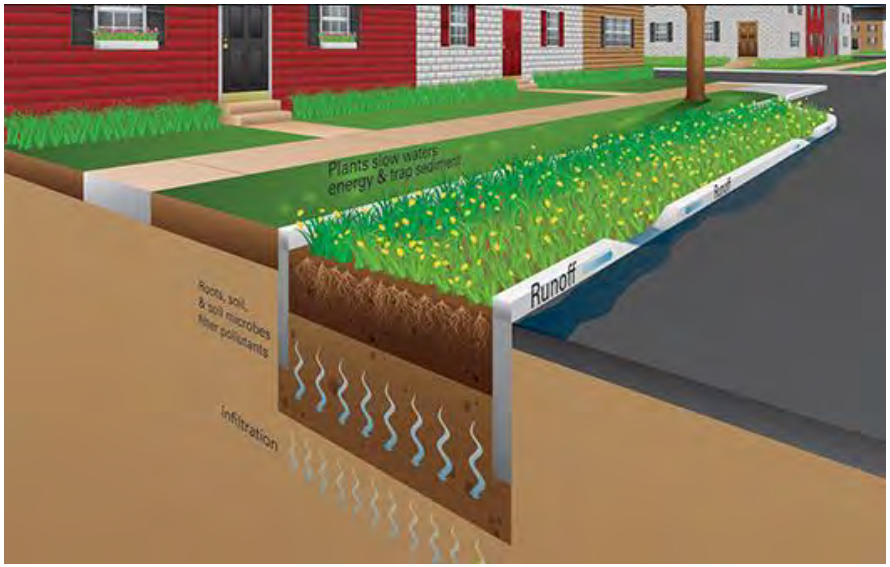
Planning and Design for Stormwater Management

"Stormwater runoff is a major cause of water pollution in urban areas. When rain falls in undeveloped areas, the water is absorbed and filtered by soil and plants. When rain falls on roofs, streets and parking lots, however, the water cannot soak into the ground. In most urban areas, stormwater is drained through engineered collection systems and discharged into nearby waterbodies. The stormwater carries trash, bacteria, heavy metals and other pollutants from the urban landscape, degrading the quality of the receiving waters. Higher flows can also cause erosion and flooding in urban streams, damaging habitat, property and infrastructure.

Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water." These include natural areas, greenways, parks and open spaces, use conservation easements for natural resource and land protection, and green streets. *"At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water."* These include rain harvesting techniques, rain gardens, bioswales, community gardens, agricultural land, bioretention facilities, rooftop gardens and use of permeable pavers (U.S. Environmental Protection Agency. Water: Green Infrastructure.).

Many of the techniques available emphasize principles of low-impact design, "*an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions."* (U.S. Environmental Protection Agency. Water: Low Impact Development.).



Drawing of stormwater being absorbed in various plants and soils before a small amount runs of the property.

Source: Urban Stream Restoration with Innovative Green Stormwater Infrastructure. Cobbs Creek Stream Corridor Restoration, Philadelphia, PA. Dewberry.

Image of a stormwater retention pond at Fairview Park in Lansing. This pond is part of a larger stormwater management project in Lansing that involves the Tollgate Drain.

Source: GoogleMaps.

Image of a bioswale that has been planted with native wildflowers in Meridian Township.

Source: Towar Rain Garden Drains. Meridian Township & City of East Lansing, Ingham County, Michigan. SEMCOG.

RESOURCES

1) Green Mid-Michigan.
2) Stormwater. Michigan Department of Environmental Quality.
3) "Chapter 12, Low Impact Development." 1999. *Stormwater Strategies: Community Response to Runoff Pollution*. Natural Resource Defense Council.
4) Green Infrastructure. U.S. Environmental Protection Agency.
5) Green Infrastructure. 2014. Southeast Michigan Council of Governments.

Daylighting Streams

Prior to industrialization, river systems were used for navigation and food. As cities became industrialized, cities began using rivers to dispose of sewage, chemicals and other waste products. Many municipalities and federal agencies also paved river bottoms and/or straightened rivers to try to manage flooding and control pollution. Bolstered by the Clean Water Acts and an awareness of the importance of natural systems, communities have begun daylighting streams or restoring rivers and streams to their natural state, uncapped and without concrete bottoms. These changes have remediated these natural water bodies and helped to restore their ecosystems to their natural state.

The Grand River in Jackson is a Michigan example of a river soiled by waste and garbage. During Jackson's birth as an industrial city, the river was largely used as a dumping station, until the residents complained of a stench in downtown. A solution was devised to straighten and narrow the river through downtown, to remove waste quicker and more efficiently. In 1936, a 2,000 foot stretch of the river in downtown was capped with concrete and covered (top right). Although the river was capped, the odorous water was still a problem in the downtown area, and six individuals have drowned in the capped portion. The river stayed this way until 2000 when the cap was removed. Now, the Grand River in downtown Jackson is clean and is a natural amenity for the community. Arcadia Creek in Kalamazoo and the Clinton River in Pontiac are two other Michigan cities where streams are now being daylighted to provide a natural amenity.

The Grand River in Jackson as its concrete cap was being removed. The river had been capped in concrete in downtown from 1937–2000.

Source: 16 Days of Jackson-Day 6 – The Grand River, Yesterday, Today, Tomorrow. 2013. How Jackson of You.

The Rouge River in Dearborn after it was converted to a concrete channel to control flooding.

Source: "Fill 'er Up" in Urban Issues. May 31, 2011. Bootstrap Analysis.

The Grand River in Jackson as it is today-uncapped and in a natural state.

Source: 16 Days of Jackson-Day 6 – The Grand River, Yesterday, Today, Tomorrow. 2013. How Jackson of You.

RESOURCES

1) "Showing Buried Streams the Daylight." *Science Matters Newsletter*. U.S. Environmental Protection Agency.
2) *Daylighting Streams: Breathing Life into Urban Streams and Communities*. Reports and Publications. American Rivers.
3) "Stream 'Daylighting' Offers Benefits, Challenges." September 3, 2013. Jay Landers. *Civil Engineering Magazine*. American Society of Civil Engineering.
4) Stream Daylighting. Center for Community Progress.

Green Roofs

Stormwater runoff is a major environmental planning challenge for many communities. Large institutional buildings can create significant amounts of stormwater runoff which can carry pollutants to natural water bodies. Green roofs are an environmental planning technique that capture stormwater on the roofs of buildings and significantly reduces the amount of water that runs off of the roof. They are roofs that are partially or completely covered in vegetation and also have a waterproof barrier to prevent leakage.

Buildings with green roofs capture rainwater at the point where it first touches the roof and use that water to nourish the living roof. As a result, contaminated water does not runoff the roof and into a storm sewer, but stays on the roof and is absorbed there.

Green roofs have many benefits other than controlling stormwater runoff. They absorb heat in warm months and act as an insulator in cold months, reducing the amount of energy needed in all seasons (EPA, 2013). Green roofs also help reduce air pollution by reducing the amount of energy a building uses for cooling, as well as absorbing pollutants in the air and soil that blow across the roof (EPA, 2013).

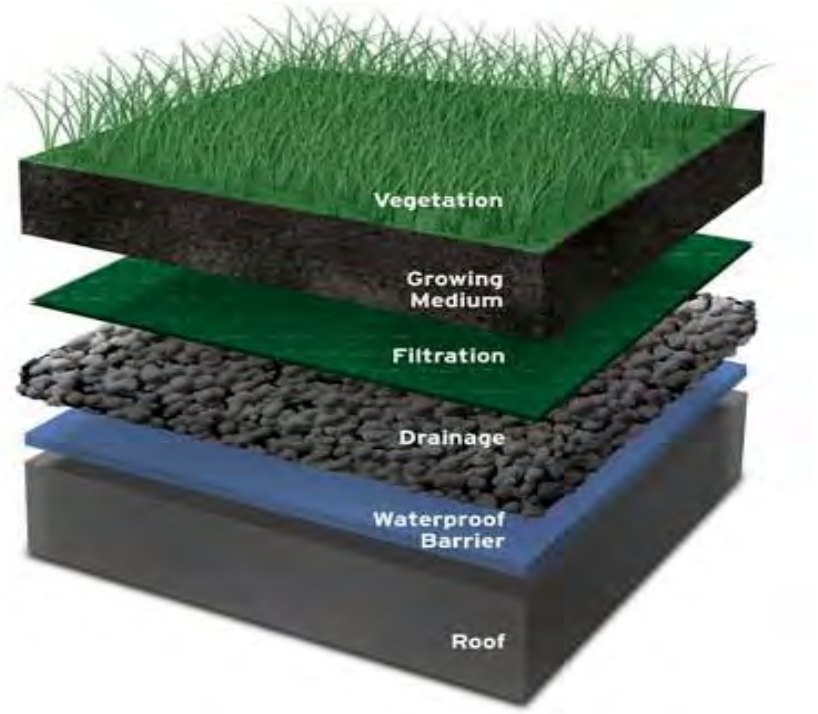
Green roofs also improve quality of life. In many areas, green roofs are treated like park spaces, with benches and other similar park amenities. They create more public open spaces and provide additional spaces for leisure in urban areas. While green roofs initially cost more than traditional roofs to install, they have the potential for significant savings over their lifetime, due to decreased energy costs and a positive impact on the natural environment (USEPA green roofs.).

Image of a green roof at a Ford manufacturing facility in Dearborn. This is the world's largest green roof measuring 10.4 acres in size. At capacity, the green roof can hold one inch of rainfall and it absorbs carbon dioxide and emits oxygen.

Source: Think Pictures.

A schematic drawing of a green roof. Compared to a black roof, a three-inch to six-inch green roof covering 10,000 feet has a Net Present Value of $2.70 per square foot per year, a payback of 6.2 years and an Internal Rate of Return of 5.2% nationally (UGSA, 2011).

Source: Greening our Rooftops. 2011. Riley, Trish. Subaru.



Green roofs atop Agro-Culture Liquid Fertilizers' headquarters in St. Johns are one of many assets of this Gold LEED-certified building.

Source: Holly Madill, Planning & Zoning Center at MSU.

RESOURCES

1) Green Roof Project. Michigan State University.
2) Green Construction. Michigan Department of Environmental Quality.
3) Green Roofs. U.S. General Services Administration.

Native Landscaping

Native landscaping is a natural method of providing green space around buildings, parking lots, and sidewalks and roadways. Native landscaping uses plants that can be found growing naturally in the area. It is effective because the plants already flourish naturally in the climate and soil of the area where they will be installed, reducing the amount of plants that will have to be replaced, or die.

Many installations of native landscaping use leafy grasses that are hearty plant species to help reduce the amount of stormwater runoff that occurs around hard surfaces. These hearty installations will create a green environment where none exists, have an aesthetic appeal, environmental benefits, and will not easily die out.

Often, native plants need less water to succeed, because they thrive naturally in the environment already. Instead of using large amounts of water to keep non-native plants alive, native plants often require relatively smaller amounts of water to thrive.

Native landscaping can be a low-cost and effective way to decorate buildings and spaces around hard surfaces to not only provide an aesthetic benefit, but environmental benefits as well. However, relative to traditional landscaping materials, they may not be competitive based on cost alone.

Native landscaping on the shore of a Michigan lake. Native plants enhance the aesthetic appeal of an area, but also reduce the amount of harmful runoff enters a water body.

Source: "Green Living: Natural Shorescaping Workshop Planned for Homeowners, Landscapers." October 20, 2011. Alyssa Merten. Mlive.com and The Muskegon Chronicle.

Native plants and grasses outside the Cranbrook Institute of Science in Bloomfield Hills. Native landscaping near large public buildings reduces the amount of stormwater runoff from rooftops.

Source: Rain Gardens & Rain Barrels. Freshwater Forum. Cranbrook Institute of Science. Michigan Museum of Natural History.

Native grasses at the Great Lakes Maritime Academy in Traverse City.

Source: John Warbach, Land Policy Institute, Michigan State University.

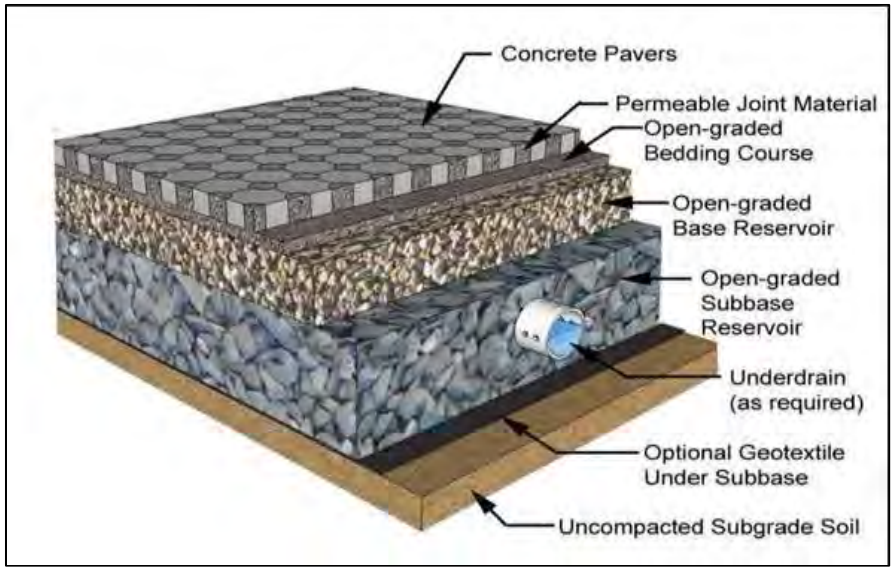
RESOURCES

1) Greenacres: Landscaping with Native Plants. Great Lakes. U.S. Environmental Protection Agency.
2) *Water-Smart Landscapes: Start with WaterSense*. 2013. USEPA.
3) "Landscaping for Water Quality: Concepts and Garden Designs for Homeowners, 2nd ed." 2004. Center for Environmental Study.

Pervious Pavement

Pervious pavers are a road engineering technique that allow rain to permeate the surface of the pavement and seep through to the ground below. This technique is especially applicable for installations in parking lots, driveways, sidewalks and roadways, where large non-permeable surfaces cause massive amounts of stormwater runoff. Available types include concrete, asphalt, pre-cast paving blocks, paving bricks and blocks with holes or shapes typically filled with sand or gravel that allow water to infiltrate the interstitial spaces.

Pervious pavement allows communities to reduce the amount of pollution from stormwater runoff that is directed into natural water bodies such as lakes, ponds, rivers, and streams. During rain events, excess rain builds up on non-permeable surfaces (e.g., roofs, concrete and vehicles) and then flows to the lowest point, usually a storm sewer drain. As the runoff flows, pollutants and sediment are carried with the water and dumped into the storm sewer. As the rainwater leaves the storm sewer system, it drains into a natural water body-usually streams or rivers. During major rain storms when large amounts of stormwater runoff are generated, large amounts of pollutants are carried with it. As a result, streams and rivers can accumulate sediment and pollution at the stormwater discharge points, which creates significant water quality challenges. It is important to slow, or better stop the stormwater runoff at the site and allow it to sink into the ground then to let it flow into lakes and streams. Permeable pavers and pervious pavement can help prevent flash-flooding and can greatly reduce the amount of sediment and pollutants that flow into natural areas.



This schematic drawing of a pervious pavement system, shows the multiple filtration layers that rainwater flows through before going into drains.

Source: Permeable Pavement. Virginia DEQ Design Specification No. 7.

A parking lot with permeable concrete at Lansing Community College in Lansing.

Source: Jeff Keesler, Planning & Zoning Center at MSU.

Image of a pervious paver demonstration showing water leaching through the pavement. Pervious pavers can divert 3-5 gallons of rainwater per minute, if properly installed and maintained.

Source: Permeable Paver Demonstration. Wikipedia.

RESOURCES

1) Introductory Sections. *Nonpoint Source Best Management Practices Manual*. 2014. Michigan Department of Environmental Quality.
2) Michigan Concrete Association.
3) Fendt Concrete Block: Permeable Pavers.
4) "Review of Permeable Pavement Systems." 2007. Miklas Scholz and Piotr Grabowiecki. *Building and Environment*. 42 (2007): 3830–3836.

Rain Gardens and Bioswales

"*Rain gardens and bioswales are landscaping features used to slow, collect, infiltrate, and filter stormwater. Differences between these systems are subtle and the terms often are used interchangeably to describe systems that achieve the end goal of reducing stormwater runoff and improving stormwater quality.*" They may be used in tandem in a larger surface water management system.

Rain gardens are smaller or residential systems. These gardens have a slight depression to help collect water and are vegetated with plants (often deep rooted, native plants) that can withstand moisture regimes ranging from flooded to dry." They are typically placed in areas where runoff from roofs, driveways, parking lots, or roads naturally collects.

Bioswales achieve the same goals as rain gardens by slowing and filtering stormwater, but are designed to manage runoff from a larger impervious areas, such as a neighborhood, commercial, or industrial developments, parking lots, or roadways. They also may be used to control the volume and quality of stormwater during major flooding events from one area to another, often ending in a rain garden. *"Because they need to accommodate greater quantities of stormwater, they often use engineered soils and are deeper than rain gardens. They are also linear systems, greater in length than width. They, too, are vegetated with plants that can withstand both heavy watering and drought.*

The effectiveness of both rain gardens and bioswales increases with increased contact time between soil and stormwater, and increased vegetative cover. This is all best achieved by using soils that can adequately slow down, infiltrate, and retain water, as well as support plant life. In areas where nutrients are a concern to water quality, soils capable of retaining high amounts of phosphorus or nitrogen should be selected, along with plants that use nutrients very efficiently."

Source: Rain Gardens and Bioswales. Soil Science of America.

A rain garden on Plainfield Avenue in Grand Rapids serves dual purposes. It filters stormwater runoff, calms traffic and also enhances the aesthetic appeal of the built environment.

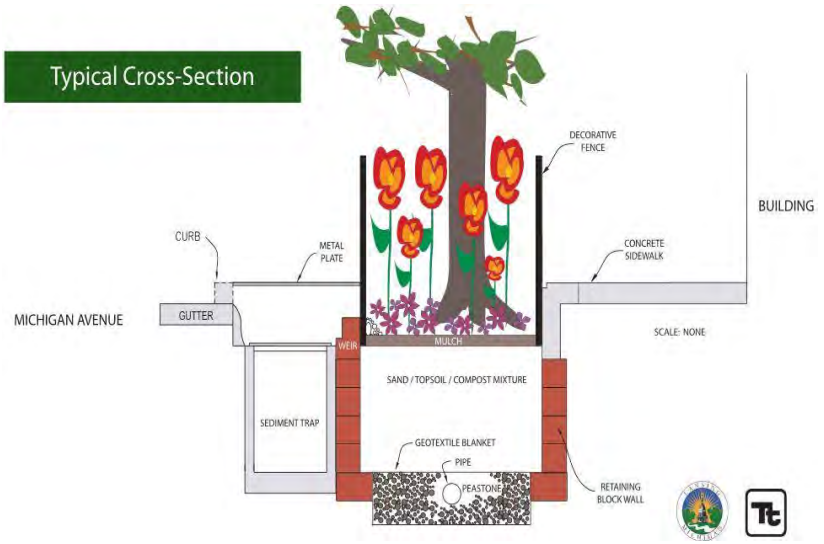
Source: Michael Smith, Michigan Department of Transportation.

Completed in 2008, the network of rain gardens along Michigan Avenue in Lansing contain interpretive signage to educate passersby about stormwater management related topics.

Source: Michigan Avenue Bioretention Facilities. City of Lansing.

Bioswale in the parking lot of the Southfield Municipal Complex.

Source: City Achievements & Initiatives. City of Southfield.



RESOURCES

1) Rain garden network.
2) Introductory Sections. Nonpoint Source Best Management Practices Manual. 2014. Michigan Department of Environmental Quality.
3) MDOT's Rain Gardens: A Green Solution to Water Pollution. Stormwater Management. Michigan Department of Transportation.
4) Grassed Swales. National Pollutant Discharge Elimination System. U.S. Environmental Protection Agency.
5) Green Macomb. Bioswales. What is a bioswale?

Rainwater Harvesting

Stormwater runoff can cause significant problems for the built environment including flash-flooding, soil erosion, pollution of natural water bodies, and overflowing municipal sewer systems. To combat these problems, rain harvesting techniques reduce the amount of water that runs off of hard surfaces by collecting excess stormwater in rain barrels or cisterns, or by diverting water away from the municipal storm sewer system from downspouts that direct water to vegetated areas.

Rain barrels are generally an individual effort to reduce runoff, but many municipalities are encouraging their use by holding rain barrel events and providing low-cost barrels and instructions on how to use them to residents. An individual using a rain barrel can reduce their water usage for things like watering plants, while a municipality with many rain barrels can reduce the amount of funds needed to treat storm water and deal with the effects of flash-flooding, resulting in cost savings.

Cisterns are similar to rain barrels, but can capture much more water and can be used to pump water into the house for toilet flushing and other grey water uses, but not for human consumption. While rain barrels are generally about 50 gallon tanks, cisterns can be as large as 1,000 gallons, can be buried in the ground, and can be equipped to pump water back into the house for grey water uses. It is noted that grey water use in buildings adds significant complexity and cost above simply using grey water for landscape irrigation.

Disconnecting downspouts is another way to combat excess stormwater runoff, but it does not capture water for later use. Instead of connecting a downspout to the storm sewer drain, disconnected downspouts divert that water to vegetated areas for absorption. A number of places (e.g., Lansing, East Lansing) already require homeowners to disconnect downspouts through their community's existing ordinances.

A rain barrel in a residential setting. Rain barrels can often collect up to 50 gallons of water from one storm and can provide garden or landscaped plants with free rainwater.

Source: Great American Rain Barrel – 60 Gallon. Eartheasy.

A rain cistern catches rainwater for use in toilet flushing and hydrating plants and landscaped areas.

Source: "Harvesting Rainwater." January 22, 2011. Mary J. Lohnes.

Image of a residential home where the downspout is not connected to the municipal storm sewer system.

Source: Downspout Initiative: $50 Rebate Program. Forest Hills Connection.

RESOURCES

1) Soak up the Rain. U.S. Environmental Protection Agency.
2) Do Your Downspouts Lead to the River? The Rouge River Project, Remedial Action Plan and Friends of the Rouge.
3) Michigan Rain Barrels.

LAND CONTAMINATION

Most land contamination is the result of historical activities such as improper handling, accidents, or practices or the disposal of toxic and hazardous materials and wastes, that have since been abandoned because of their negative impact on the quality of the environment. But their effects have been difficult for communities to manage, dealing with consequences "*ranging from abandoned buildings in inner cities to large areas contaminated with toxic materials from past industrial or mining activities.*" These sites not only have soil that is contaminated but that also leaches toxins into nearby ground and surface waters wreaking more havoc by being absorbed by plants and animals, contaminating drinking water supplies, or contaminating indoor air in buildings that sit on top of it.

Land contamination can result from a variety of intended, accidental, or naturally occurring activities and events such as manufacturing, mineral extraction, abandonment of mines, national defense, waste disposal, accidental spills, illegal dumping, leaking underground storage tanks, hurricanes, floods, pesticide use, and fertilizer application. Sites are categorized in a variety of ways, often based on the level and type of contamination and the regulations under which they are monitored and cleaned up. (See the "Categorizing Contaminated Lands" box for an overview of the common types of contaminated sites.) (Report on the Environment (ROE). Chapter 4, Contaminated Land Chapter. U.S. Environmental Protection Agency.)

Remediation of contaminated sites can be lengthy, difficult, and expensive processes but ones that communities must forge through all the same. This section offers brownfield redevelopment and blight removal as two ways to meet this challenge head on. On the opposite page is an illustrated example of redevelopment projects that have occurred in downtown Lansing.

Box 4-1. Categorizing Contaminated Lands

Superfund National Priorities List sites: These sites are seriously contaminated and include industrial facilities, waste management sites, mining and sediment sites, and federal facilities such as abandoned mines; nuclear, biological, chemical, and traditional weapons productions plants; and military base industrial sites (e.g., used for aircraft and naval ship maintenance).

Resource Conservation and Recovery Act (RCRA) Cleanup Baseline facilities: The RCRA Cleanup Baseline is a priority subset of a broader universe of facilities that are subject to cleanup under RCRA due to past or current treatment, storage, or disposal of hazardous wastes and have historical releases of contamination.

Underground storage tanks/leaking underground storage tanks: Businesses, industrial operations, gas stations, and various institutions store petroleum and hazardous substances in large underground storage tanks that may fail due to faulty materials, installation, operating procedures, or maintenance systems, causing contamination of soil and ground water.

Accidental spill sites: Each year, thousands of oil, gas, and chemical spills occur on land and in water from a variety of types of incidents, including transportation (e.g., rail, barges, tankers, pipeline) and facility releases.

Sites contaminated by natural disasters or terrorist activities: Disasters of any sort, naturally occurring or caused by humans, have the potential to contaminate lands and cause problems at already-contaminated sites.

Land contaminated with radioactive and other hazardous materials: Many sites spanning a large area of land in the U.S. are contaminated with radioactive and other hazardous materials as a result of activities associated with nuclear weapons production, testing, and research.

Brownfields: Brownfields are real property where expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Brownfields are often found in and around economically depressed neighborhoods.

Military bases and defense sites: Some of the millions of acres of land used by the Department of Defense are contaminated from releases of hazardous substances and pollutants; discarded munitions, munitions constituents, and unexploded ordnance; and building demolition and debris.

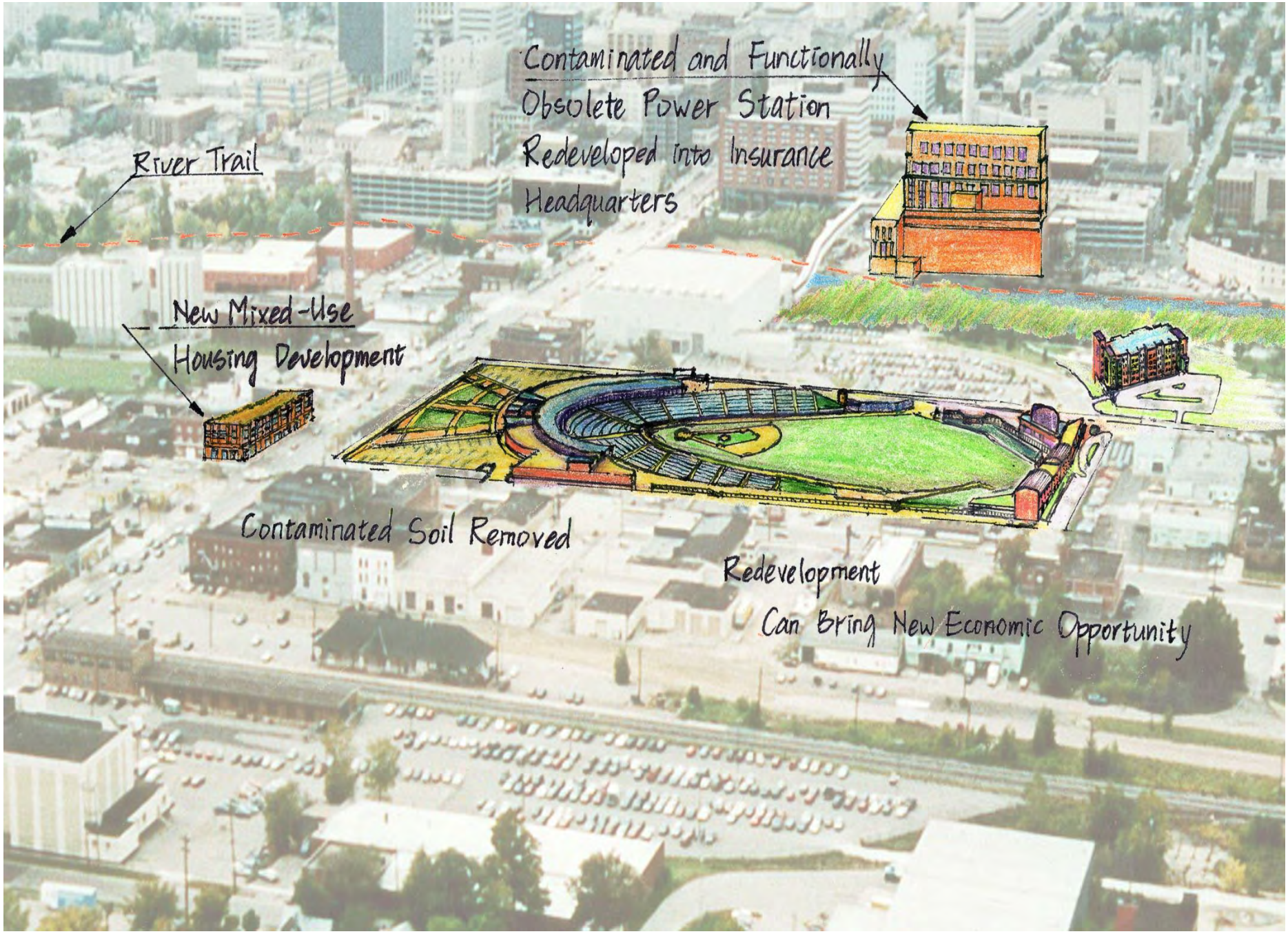
Low-level area-wide contamination: Some soil contamination problems involve low to moderate levels of contamination that encompass large geographic areas ranging in size from several hundred acres to many square miles. Low-level, area-wide contamination can occur from emissions related to past industrial operations (e.g., smelters), widespread agricultural pesticide applications, combustion of gasoline, and deterioration of lead-based paint.

Past waste management sites and illegal dumping sites: Prior to the 1970s, solid waste was typically placed in unlined landfills that were not adequately designed to prevent adverse environmental impacts to ground water or surface water. Separately, illegal dumping of materials such as construction waste, abandoned automobiles, appliances, household waste, and medical waste, has occurred for decades and still occurs because of convenience and the cost of legal disposal.

Abandoned and inactive mine lands: Abandoned and inactive mines may not have been properly cleaned up, and may have features ranging from exploration holes to full-blown, large-scale mine openings, pits, waste dumps, and processing facilities.

Graphic source (this page): U.S. Environmental Protection Agency. Report on the Environment (ROE).

Image source (opposite page): Department of Environmental Quality. Overlay illustration by Na Li, Land Policy Institute, Michigan State University.


Contaminated and Functionally Obsolete Power Station Redeveloped into Insurance Headquarters
River Trail
New Mixed-Use Housing Development
Contaminated Soil Removed
Redevelopment Can Bring New Economic Opportunity

Brownfield Redevelopment

Properties where redevelopment is hindered by the presence or potential presence of contaminants are considered brownfields. Contamination adds time, cost, and complexity to redevelopment projects. However, some of the advantages to redeveloping brownfields are reusing existing infrastructure, minimizing urban sprawl, increasing property values, and reducing health risks. Michigan has historically been one of the world's largest manufacturing centers and has many older and vacant former industrial sites that are contaminated. The photos to the right and on the next page show redevelopment of contaminated properties in Lansing into what is now Cooley Law School Stadium, the Lansing City Market and the Accident Fund Insurance Company of America Corporate Headquarters.

Large areas of contaminated and/or vacant land is an unfortunate scene in many places in the industrial Midwest and other areas of the country. Many communities have had success cleaning up brownfield sites and adapting them for other uses. In most cases a combination of federal and/or state environmental incentives were essential to making the project economical for a redeveloper.

A large-scale, local example is the City of Flint's efforts to remediate 60 acres of a former Chevrolet facility ("Chevy in the Hole") and turn it into a park. The site will have more than 1,000 new trees planted, which will help to clean the soil of contaminants by a process called phytoremediation. This is a long-term process by which plants trap contamination in their root structures, thus removing them from the soil. The trees help to reduce the direct contact risk with the soil so that the area could once again be utilized for various uses. This is an innovative redevelopment of heavily contaminated brownfield property.

With the help of a Michigan Department of Environmental Quality grant, the City of Lansing removed a large quantity of contaminated soil during the construction of then Oldsmobile Park, now Cooley Law School Stadium.

Source: Michigan Department of Environmental Quality.

Across the river, a contaminated and functionally-obsolete power station was remediated and redeveloped into the Accident Fund Insurance Company's national headquarters.

Source: Michigan Department of Environmental Quality.

Since the project's completion, other redevelopment projects have popped up around it including a mixed-used building across the street to the south, new restaurants to the southwest, a permanent farmers market to the west, and new commercial buildings to the east.

Source: GoogleMaps. 2014.

RESOURCES

1) Brownfield and Land Revitalization. U.S. Environmental Protection Agency.
2) Brownfield Grants and Loans. Land & Remediation Development. Michigan Department of Environmental Quality.
3) Brownfield Redevelopment. Development Assistance. Michigan Economic Development Corporation.

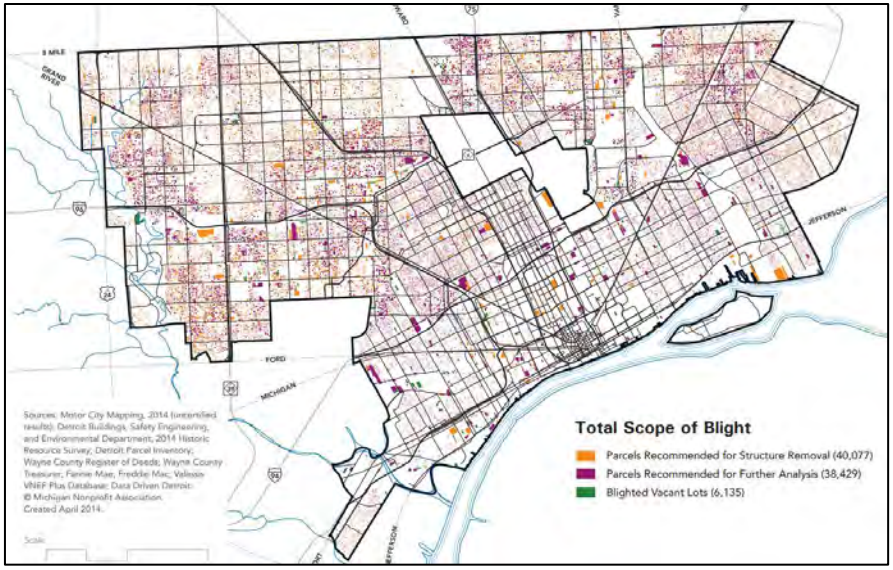
Blight Removal

Blight is used to describe urban decay, such as unsightly buildings that are in disrepair (often vacant and falling down), and trash and dumping. This type of decay can lead to becoming areas where illicit activities occur. Blight discourages new development and can lead others nearby to care less for their property. Once blight becomes pervasive in an area, then the rest of the property often deteriorates rapidly.

Many post-industrial cities in Michigan and the Midwest have problems with blight as a result of the vacuum that has been left after decades of deindustrialization and population losses. Detroit and Flint have experienced massive blight and have both shrunk to half of the size of their peak populations. As a result, vast areas of the two cities are vacant.

Vacant properties are vulnerable to vandalism, metal scrapping that leaves buildings hollow and empty shells, drug activity, arson, and other illegal and community-threatening activities.

Many post-industrial cities have begun removing blighted properties and sometimes entire neighborhoods are cleared. This provides cities with opportunities for redevelopment while reducing the number of abandoned structures. Communities are exploring a variety of options for reuse including urban agriculture. (See Urban Agriculture p. 1-171 and Community Gardens p. 1-173). Many communities are also starting Land Banks to manage these lands, clear them up, package and resell the parcels that have potential for economic reuse. Sometimes land banks remodel vacant homes, and resell them, rather than letting them become unsightly, dangerous crime incubators.



Images of the blight removal process in Flint. A badly dilapidated and abandoned home is demolished, the site is cleared, and the parcel is returned to nature.

Source: Beyond Blight: City of Flint Comprehensive Blight Elimination Framework. 2014. Pruett, Natalie. Imagine Flint.

A May, 2014 report by the Detroit Blight Removal Task Force. The Task Force seeks to stop and remove blight before it spreads to other areas.

Source: Detroit Blight Removal Task Force Plan.

A map by the Detroit Blight Removal Task Force showing the total scope of blight in Detroit. Included in the map are parcels recommended for structural removal, parcels recommended for further analysis, and blighted vacant lots in the city.

Source: Detroit Blight Removal Task Force Plan.

RESOURCES

1) Acquisition for Spot Blight Removal. U.S. Department of Housing and Urban Development.
2) Michigan Community Revitalization Program. Development Assistance. Michigan Economic Development Corporation.
3) Detroit Blight Removal Task Force.
4) Genesee County Land Bank.