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The
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for the Environment
and Sustainable
Development

Carbon Neutral





sustain

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The Institute provides a forum to conduct interdisciplinary research, applied scholarly analysis, public service and educational outreach on environmental and sustainable development issues at the local, state, national and international levels.

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Su Verde – The Proud Green Home of Louisville.
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Discussing Carbon Neutral Construction and Design

by Ed Mazria, Architect

As an architect, and founder of Architecture 2030, you have focused on buildings and the built environment as being the key to addressing greenhouse gas emissions and climate change. Why focus on buildings?

Buildings account for nearly half of all energy consumption and carbon emissions in the U.S. Globally, building operations alone are the largest energy end use sector, and emit 40% of all greenhouse gas emissions (GHGs). This figure is expected to rise as the world rapidly urbanizes. In India for example, building floor area is expected to double over the next 15 years and quadruple by 2050. China's urban population is expected to reach one billion by the year 2030, and the country is adding roughly two billion square meters of new buildings annually. To stay within the two degree Celsius warming threshold established by the Paris Agreement, all new buildings must now be designed to zero net carbon (ZNC) or nearly zero standards. We are already seeing more frequent and intense storms, floods, heat waves, and droughts everywhere and they will only get worse if the buildings sector does not act responsibly.

What is Architecture 2030 and why did you create it?

We have very little time to successfully address climate change. To meet the agreement made in Paris, global GHGs must peak by about 2020—in the next two or three years—and then reach zero by 2050.

I left my architecture practice in 2006 because of the urgency and scale of the problem and established Architecture 2030, a think tank dedicated to transforming climate change problems into real world solutions through the design of the built environment.

What opportunities do you think buildings present in reducing GHG emissions?

As building designers we are uniquely qualified to address climate change by designing buildings and built environments

that produce little to no GHGs, and by doing this, we can reverse the negative impact emissions are currently having on the environment.

Is it feasible to get to net-zero? Or is this a goal we strive for?

Not only is it feasible to design ZNC buildings today, but there are examples of ZNC buildings of almost every type in all climate zones. Designers and planners should design zero net carbon buildings and carbon neutral built environments as a rule. We have many examples that serve as excellent case studies and can be found in databases such as the Department of Energy's High Performance Buildings Database, New Buildings Institute Getting to Zero Database, Net-Zero Energy Coalition's Zero Energy Inventory, and the American Institute of Architects COTE Top Ten Awards, to name a few.

Architects and planners are at their core problem solvers and trained to make the world a better place. Due to the building sector's responsibility for its share of fossil fuel consumption and emissions, architects have a unique opportunity to solve one of the most pressing problems of our time while also creating beautiful and resilient buildings and communities. I urge them every day to embrace this opportunity.

What are the benefits of zero net carbon?

By designing new buildings to ZNC standards, and retrofitting our existing building stock to carbon neutral by the year 2050, we can play a major role in reversing the impacts of climate change – that cannot be overstated. However, the benefits of ZNC buildings go beyond climate change such as the equitable access to safe temperatures, financial sustainability, healthier and safer environments, vibrant communities, family wage jobs, homegrown economic development, and energy independence and security. There are also countless soft and hard economic benefits that make ZNC buildings a worthwhile investment for developers, owners, and tenants, such as lower vacancy rates and energy price stability.



What changes are needed in order to move us closer to ZNC buildings?

This is primarily the responsibility of architects and planners – to educate clients on the importance of ZNC buildings and their increased comfort, resiliency, and annual savings in energy and operating costs.

However, the greatest uptake of ZNC building design will come through building codes and standards that require ZNC for new construction and energy upgrades for existing buildings.

It's important to remember that any building can be ZNC today if enough on-site renewable energy is installed, and/or off-site renewable energy is purchased to meet the energy needs of the building.

What are the major challenges and roadblocks to achieving a ZNC built environment? How far can planning and design go for different types of buildings? Can renewables fill the gap?

We know that architects and designers can reduce 70-80% of the building's energy consumption (compared to a typical building in the year 2000) through design by employing low/no cost strategies – building shape, orientation and color; size and orientation of glazing; window and wall shading; proper insulation, passive solar heating and cooling systems, daylighting strategies, natural ventilation, and selecting and properly sizing energy efficient mechanical systems. Once the designer has dramatically reduced the energy consumption of a building, renewable energy sources are used to get to zero.

A major challenge arose with the popular target of Zero Net Energy (ZNE) design. ZNE buildings are typically defined as those that produce enough on-site renewable energy to operate the building annually. For dense urban environments and multi-story buildings with limited space for renewable energy systems, it is simply not possible to produce enough renewable energy on-site to meet operational demands. To address this challenge, Architecture 2030, together with New Buildings Institute and Rocky Mountain Institute, released a [Zero Net Carbon \(ZNC\) definition](#) addressing the procurement of off-site renewable energy necessary to achieve a fully carbon-free built environment.

How many buildings in the US are currently certified as being net-zero energy?

There are currently [68 buildings](#) certified by the International Living Future Institute (ILFI) as Net-Zero Energy, and New Building Institute's [Getting to Zero Database](#) lists 142 net-zero energy buildings, though many net-zero energy building projects are not certified and thus it is hard to quantify the exact number of net-zero energy buildings in the U.S. The Net-Zero Energy Coalition's database contains 4,077 residential zero energy buildings.

What is the 2030 Challenge?

The 2030 Challenge calls for an incremental reduction in the fossil fuel energy consumption of all new construction, with carbon-neutral as the standard by the year 2030. The inspiration for the 2030 Challenge came in 2002, when I practiced architecture. We had weekly knowledge sharing sessions in our office and one day we happened to be talking about climate change and a young architect asked, "what is the contribution of buildings to climate change?" At that time, building emissions data did not exist as a distinct category. We began collecting and rearranging data for the U.S. and found that buildings were the single largest contributor of CO2 emissions annually. We then issued the 2030 Challenge calling for all new buildings, developments and major renovations to be carbon neutral by the year 2030. This was followed by the 2030 Challenge for Planning, which created targets for existing buildings as well as addressing water consumption and transportation emissions, and the 2030 Challenge for Products, which addresses embodied carbon emissions, or the emissions associated with manufacturing building products and building construction.

What has the response been to the 2030 Challenge?

The targets set out in the 2030 Challenge have been adopted and are currently being implemented by 80% of the top 10 and 65% of the top 20 architecture/engineering/planning firms in the U.S. In addition, the AIA, ASHRAE, U.S. Conference of Mayors, the federal government, and many other organizations and state and local governments and agencies have adopted the Challenge.

When Architecture 2030 issued the 2030 Challenge in 2006, the AIA (American Institute of Architects) was one of the first organizations to adopt the challenge. In 2009 they launched the [AIA 2030 Commitment](#), where architecture firms pledge to target the goals of the 2030 Challenge and report their progress annually to the AIA. To date, 462 AIA member firms have joined the Commitment. By joining, firms connect with a leading group of professionals that are addressing today's most pressing issues. The Commitment has also grown beyond the U.S. reporting that 10% of all signatory firm projects (42% of total gross square footage) are located outside of the U.S. in 94 countries worldwide.

Climate change is a worldwide problem. What must happen to get worldwide participation?

Combatting climate change on a global scale requires multiple efforts. First, we need a ZNC building code that requires all new buildings and major renovations to be built to high performance standards through design and energy efficiency measures, with renewables to supply the remaining power needed. We are developing a national and international ZNC building energy code standard that will be released shortly and can be adopted by sub-national or national governments worldwide. Second, all existing buildings must be renovated



to ZNC standards by 2050. Policies are required for existing buildings to make energy efficiency upgrades at key intervention points (e.g. when buildings change hands, when buildings undergo a capital improvement cycle, etc.). Third, we must educate the building community. Architects must understand the principles of passive design strategies and not rely entirely on engineers and consultants to add “green equipment and features” to building designs. Sustainability and ZNC design can no longer be an add-on, but must be at the core of all architectural practice.

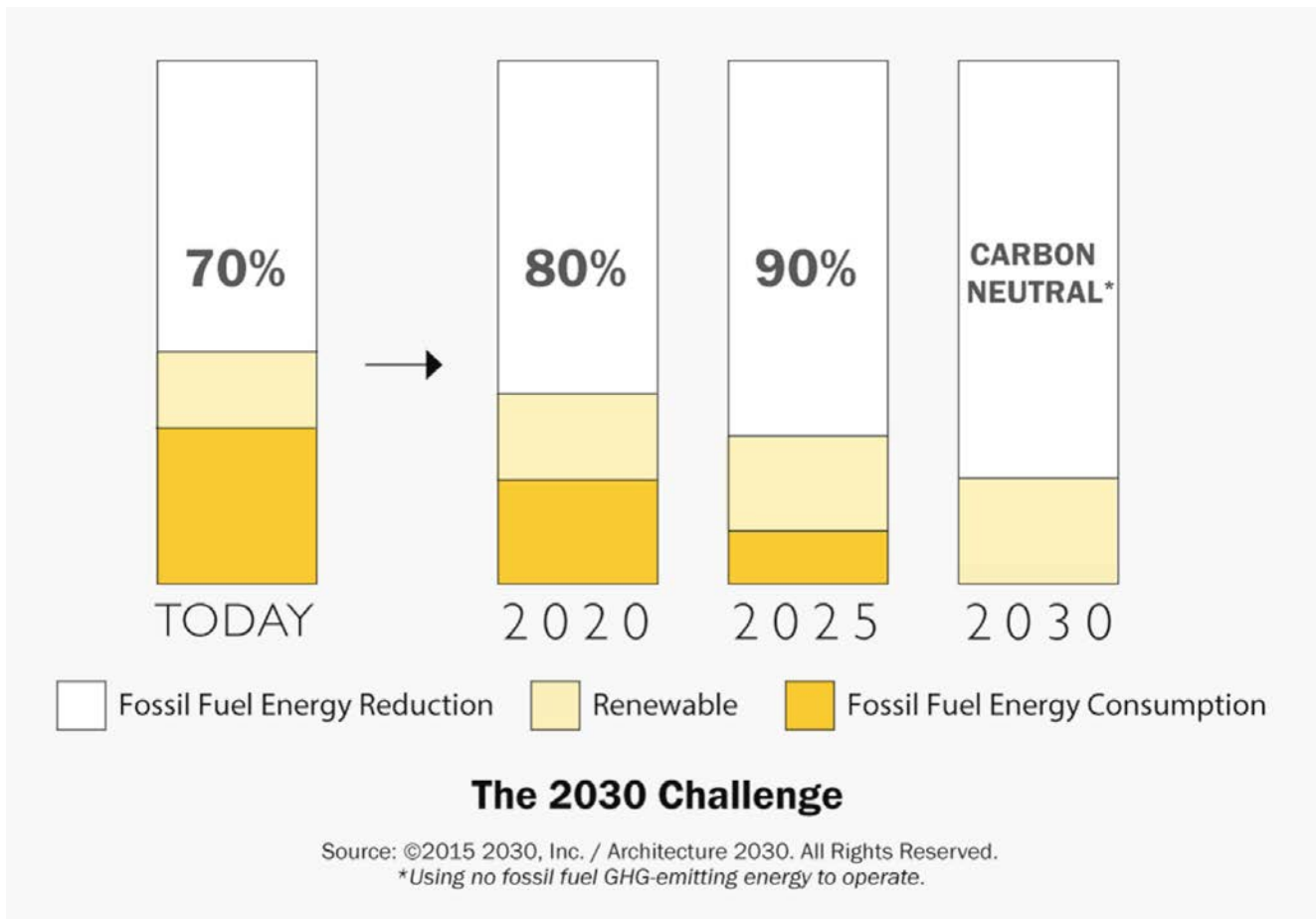
Since 2015, Architecture 2030 has collaborated to make a significant impact in China. In October 2015, Architecture 2030 and the China Exploration and Design Association Architecture Branch (CEDAAB) met with influential global design and planning leaders to initiate collaborative efforts to dramatically reduce carbon emissions in the built environment. This meeting culminated with the signing of the China Accord – a commitment to plan and design cities, towns, developments, and buildings in China to low carbon/carbon neutral standards. Since the signing of the China Accord in October 2015, 62 Chinese local design institutes (LDIs) and top international architecture and planning firms have signed the China Accord, setting “carbon neutral or near carbon neutral” as the design standard for all new building projects in China.

CEDAAB and Architecture 2030 recently co-sponsored a Zero Net Carbon (ZNC) professional training workshop in Shanghai, China. This event, which was hosted by the Tongji Architecture Design Group Co. Ltd., was the first training of its kind to prepare architects, planners, building sector professionals, and future trainers from across China to design to ZNC standards.

Architecture 2030 is also focusing its efforts in India. Much like China, India will now play a critical global role in addressing climate change and greenhouse gas emissions: by 2050, nearly 22% of new global building construction is expected to take place in India.

What is the 2030 Palette (this is very informational and useful)

The 2030 Palette is a free online platform that succinctly puts the principles and actions behind ZNC and resilient built environments at the fingertips of designers, planners, and builders worldwide. The sustainable design strategies address energy consumption and greenhouse gas emission at all scales – from regional planning to building design and details. The Palette is organized into region, city/town, district, site, and building scales. Each section contains strategies that address various sustainable design issues. The Palette provides design rules-of-thumb as well as a multitude of precedents and resources to enable the user to create carbon neutral built environments.





We recently updated the 2030 Palette with a user-friendly interface and language options in both Chinese and Spanish.

What are some other education programs that Architecture 2030 is involved with?

In addition to the 2030 Palette, Architecture 2030 has several professional and higher education programs. We worked with the AIA Seattle to create the AIA+2030 Professional Series, which is comprised of 10 four-hour sessions designed to give architects and engineers the strategies and tools they need to design ZNC buildings and give their firms a “sustainability edge” in the marketplace. We then created the complementary [AIA+2030 Online Series](#), sponsored by Autodesk and delivered through AIAU, the American Institute of Architects’ online education platform. The AIA+2030 Online Series is intended to deliver the content of the Professional Series in a more condensed, and universally accessible, manner.

Architecture 2030 has also teamed up with AIA’s Committee on the Environment (COTE) and the Association of Collegiate Schools of Architecture (ACSA) to create this year’s COTE Top Ten for Students design competition – [INNOVATION 2030](#) – a studio “design and ideas” competition that addresses the current and projected impacts of climate change. What better way to understand the future than to design for it? That is precisely what over one-thousand students and faculty, representing over 50 schools of architecture are undertaking by participating in INNOVATION 2030. This design studio experience will prepare graduates who can incorporate an understanding of energy and emissions, resilience, and climatic adaptation into planning and designing the built environment.

Additionally, Architecture 2030 just wrapped up the 2030 Curriculum Project, a two-year higher education initiative to support courses at U.S. architecture and planning schools that fully integrate lessons in energy use, emissions, and resiliency into the widest possible range of projects and topic areas, and across all year levels.

Another project undertaken by Architecture 2030 is the reduction and elimination of embodied carbon from the built environment. All of the programs and initiatives discussed above address operational carbon emissions, but the emissions associated with manufacturing building materials and building construction (commonly referred to as ‘embodied carbon’) are significant. In order to meet targets established in the Paris Agreement we must phase out all carbon emissions 2050.

To address this challenge, Architecture 2030 issued the [2030 Challenge for Products](#) in 2011, calling for incremental reductions in the embodied carbon footprint of building products. The Challenge is being expanded to include whole-building embodied carbon emissions, and is targeting zero emissions by 2050. To support this goal, Architecture 2030, together with the [Carbon Leadership Forum](#) and numerous architecture and

engineering firms and NGOs, established the [Embodied Carbon Network](#) – a number of taskforces committed to achieving a carbon neutral built environment by 2050.

Edward Mazria is an internationally recognized architect, author, researcher, and educator. His seminal research into urbanization, climate change, sustainability, energy consumption, solar energy, and greenhouse gas emissions in the built environment has redefined the role of architecture, planning, design, and building, in reshaping our world. He is the founder and CEO of Architecture 2030, a think tank developing real-world solutions for 21st century problems, and host of the AIA+2030 Professional Education Series, China Accord, the 2030 Districts movement in North American cities, the Zero Tool and Achieving Zero – a framework of incremental building sector actions to ensure a carbon neutral built environment by the year 2050. Mr. Mazria recently introduced the 2030 Palette, a revolutionary new platform that puts the principles behind carbon neutral and resilient built environments at the fingertips of architects, planners, and designers worldwide.

This past year, he delivered the Roadmap to Zero Emissions to the United Nations Framework Convention on Climate Change (UNFCCC) – a flexible approach to achieve zero CO2 emissions in the built environment by mid-century. He also issued the 2050 Imperative – a commitment to plan and design to carbon neutral standards – which has been adopted by the International Union of Architects and all regional professional organizations (representing over 1.3 million architects) in 124 countries worldwide.

Mr. Mazria's awards include: American Institute of Architects (AIA) Design Awards, American Planning Association Award, U.S. Department of Energy Awards, American Solar Energy Society Pioneer Award, Equinox Award, NWF National Conservation Achievement Award, Mumford Award from Architects/Designers/Planners for Social Responsibility Inaugural 2009 Hanley Award, Distinguished Career Award from Pratt Institute, Zia Award from the University of New Mexico, The Purpose Prize, Game Changers Award from Metropolis Magazine, American Institute of Architects Kemper Award, World Green Building Council Chairman’s Award, PLEA Award, American Solar Energy Society Horace Greely Abbott Award, and the National Council for Science and the Environment, 2018 Lifetime Achievement Award

He is a Senior Fellow of the Design Futures Council, Fellow of the AIA, Honorary Fellow of the Royal Architectural Institute of Canada, and received an Honorary Doctor of Architecture degree from Illinois Institute of Technology.

For more information visit 2030palette.org and innovation2030.net.



Davis, California: A City En Route to Carbon Neutrality

by Kerry Daane Loux,
City of Davis Sustainability Coordinator

Davis City Hall is a registered National Historic Landmark, originally constructed as Davis High School in 1927. The City is engaging in on-going retrofits to make the building carbon neutral, including consideration of fuel switching the heating and cooling system from natural gas to electricity, installation of solar panels and battery storage, window retrofits, lighting improvements, water conservation efforts and a building management system and overall net zero carbon commissioning

The urgency for carbon emission reduction has never been more profound—on a local, regional, statewide, national, and global level.

According to recent research, temperatures in Davis and the Central Valley of California are anticipated to increase 4 to 7 degrees Fahrenheit, compounded by the urban heat island effect, by the end of the century. The number of days of extreme heat (defined as 101° F or more) in Davis are anticipated to increase on average from 4 days annually to 17 days by 2050. By 2100, we will have 45 days a year of extreme heat. This increase in temperature will tax the energy infrastructure needed to keep the population cool in extreme temperatures.¹

Rising temperatures also mean that precipitation will increasingly be in the form of rain at all elevations as opposed to snowpack in the mountains. This affects the state water supply by making natural storage of fresh water less reliable and taxing water storage capacity needed for year-round agriculture and urban use at lower elevations. The volatility of precipitation combined with increased temperatures can accelerate other climate change related phenomena like droughts and fires, flooding, air quality issues and other impacts. Each of these hazards have significant consequences for the health of all people and ecosystems, but disproportionately affect the most vulnerable populations including the elderly, children, impoverished populations and the homeless.

These climate-related challenges and impacts are increasing significantly and dramatically in California, as witnessed by measurements of only 30% of average snowpack in the Sierra Nevada Mountains in February 2018, 15 days recorded over 101° F in the Central Valley in 2017, and recent ravaging California wildfires and subsequent mudslides resulting in loss of life and property throughout the state from September to December last year.¹

The City of Davis has a long history of demonstrating climate action and sustainability innovations through City policy implementation and wide-spread community advocacy. The Davis community defines sustainability as incorporating a safe, diverse and healthy environment while promoting economic resilience, social equity, and quality of life for all. We are home to the University of California at Davis, which offers a great resource of local expertise and research in climate change. However as a city nearing 70,000 population (68,111 in 2016), with approximately 25,000 residential households, we need to address carbon reduction in both the existing built environment and new development projects for transportation, energy and consumption sectors of greenhouse gas emissions reductions. Behavior change is an important component as well.

Davis, California is proactively taking steps to address climate change, anticipating risks and identifying strategies that will make the city more resilient in the future. Davis is a member of the Climate Adaptation Initiative, created by UC Davis as part of the Policy Institute for Energy, Environment, and the Economy. The group acts as the liaison between climate experts in the academic community and regional policy-makers. They, along with their committed partner organizations, are a valuable resource for identifying specific risks and working with communities to proactively implement adaptation strategies. Davis is also a founding member of the Capital Region Climate Readiness Collaborative (CRCRC), an unincorporated membership association within the Alliance of Regional Collaboratives for Climate Action (ARCCA) dedicated to local and regional coordination to respond to the challenges of climate change and create stronger, more sustainable and economically viable communities.

Reduction of greenhouse gas emissions (GHG) in the community is a key priority for city leadership and residents. Davis City Council has adopted an ambitious goal of achieving



carbon neutrality by 2050, with an interim goal of 28 percent below 1990 levels by 2020. These targets exceed the minimum statewide targets set forth by legislation.²

Plan level and project level guidance for local climate action is provided in the Draft 2017 Climate Change Scoping Plan Update released by the California Air Resources Board (ARB) in January 2017. Senate Bill 32, signed into law in 2016, establishes new statewide GHG emission targets on a steeper emissions reduction trajectory than previous legislation. Senate Bill 350 requires the Energy Commission to establish targets and meet goals to double energy efficiency in buildings, and AB 802 requires the Energy Commission to implement a statewide benchmarking program for nonresidential buildings. While SB 350 and AB 802 do not require the City to take any specific action, the city is working toward implementing these goals.

Given the challenges of addressing significant greenhouse gas emissions reduction both in planning new development projects and in retrofitting the existing residential, commercial and infrastructure framework, we are aware that as a community and municipality Davis, California is a ‘work in progress.’ This article will describe substantial actions that have been taken en route to carbon neutrality, as well as questions being asked for future steps, research needed and barriers identified.

Climate Action and Adaptation Plan and Greenhouse Gas Inventories

The City of Davis Climate Action and Adaptation Plan (CAAP) was adopted in 2010. It establishes goals, actions and interim targets toward carbon neutrality in 2050. While an effective tool, this plan is in need of an update, and the City is currently working on funding to bring the plan in alignment with current goals and statewide standards.

A comprehensive blueprint for this update to the CAAP was completed in 2017. The plan includes a new local GHG emissions offset program with an identified trajectory to carbon neutrality. Offset rates are proposed to be tied to California’s established cost of carbon. The plan will establish updates to GHG thresholds of significance that are specific, measurable and enforceable. Additionally, more robust adaptation and resilience to the adverse effects of climate change and a focus on development of renewable, zero carbon energy sources are incorporated. It is envisioned that this ‘state-of-technology’ CAAP can be a model or template for climate action planning in other communities, especially in California’s Central Valley where similar challenges exist.

Greenhouse gas (GHG) inventories for the community were completed in 2008 (based on 2006 data) and 2012 (based on 2010 data). The inventories measured local GHG emissions using the Local Governments for Sustainability Clean Air and Climate Protection software, the best tool available at the time (originally the International Council for Local Environmental Initiatives, or ICLEI standards). While a current inventory is overdue, over

the next three years we intend to prioritize substantive climate action policy development using available time and funding resources. We will use projections of metrics from the first two inventories to evaluate these actions, to be followed by a third GHG Inventory in the next 2-5 years to get back on track with regular GHG Inventory updates and projections.

The basic GHG sectors and shares of the community have not changed significantly since the previous inventories, although there have been steady GHG emissions reductions since the early 2000s. The total community emissions in 2010 were close to 350,000 metric tons of carbon dioxide equivalent (CO₂e). The largest emissions sector, by far, is transportation, with over 60% of the community total at close to 200,000 metric tons of CO₂e, including both personal and commercial vehicles.

Energy use, comprised of natural gas and electricity, for residential emissions (22.7% of annual) and commercial emissions (10.3% of annual) make up most of the remaining total. The per-household carbon footprint in Davis is estimated to be 40.8 metric tons of CO₂e.³ Total emissions for the community are projected to decrease by more than 10% over business as usual (BAU) by 2020 based on mitigation efforts in the community, increasing use of renewable and clean energy, improved gas mileage and increased percentage of hybrid and electrical vehicles, and technological advances. Clearly, though, there is still much work to be done since these projections are yet far from the Davis CAAP goal of carbon neutrality by 2050.

Recent GHG Reduction Actions

The City, in partnership with the community, has made considerable progress toward meeting the existing CAAP’s 2020 goals through policy and program implementation and has demonstrated achievable, tangible results based on the 2010 CAAP action plan. Some highlights of the City’s key GHG emissions reduction implementation programs to date include the following areas:

1. Transportation

The Davis Transportation Implementation Plan (2017) addresses local community and regional issues, and includes implementation strategies, programs and measurements to reduce daily vehicle miles traveled (VMT), increase overall efficiency of passenger vehicles, and prioritize active transportation (transit, walking and biking).

Since transportation constitutes the lion’s share of Davis community’s GHG emissions, many emissions reduction approaches have been implemented and envisioned for the near future including Transportation Demand Management (TDM), parking limits and fee structure and other programs. Davis has invested in significant street design improvements including narrowed vehicle lanes throughout the city, bike lane striping and safety lane markings, and a ‘road diet’ on a major arterial to incorporate turning lanes and bike lanes and a single lane of travel in each direction.



Electric Vehicle infrastructure is available in Davis on the UC campus, in the Downtown and at municipal facilities.



Davis has 110 miles of dedicated on-street bike lanes with safety pavement striping, color blocking identification and ‘sharrows’, and a network of greenbelt bike paths. Davis was the first city in the nation to install bike lanes over 50 years ago (1967).



Unitrans vintage double decker bus on UC Davis campus. Additional double and ‘single story’ buses are of both the London variety and new, fuel efficient models, serving 19 routes throughout Davis.

The City completed an Electric Vehicle Charging Plan in 2017, with funding from the California Energy Commission, which includes standards, requirements and guidance for EV charging stations in public and private development projects. Davis has installed public electric vehicle (EV) charging stations in various locations in the city to encourage the adoption and use of electric vehicles.

A ‘Zipcar’ car share infrastructure was initiated in 2012 and the fleet is growing annually. Additionally, Davis is served by both Lyft and Uber ride-sharing programs.

In 2014, Davis adopted its new Bicycle Plan, called ‘Beyond Platinum Bicycle Action Plan.’ Davis has been a pioneer in promoting bicycle use and building a network of connected on-street bike lanes and separated bike paths in an interconnected greenbelt system throughout the city. The city has about 110 miles of bike lanes, numerous grade separations for bicycles and pedestrians, and several bicycle and pedestrian-only railroad track and freeway under/overcrossings. The bike infrastructure exists on over 75% of Davis streets and the city’s bike commuter mode share is a nation-leading 20 %.⁴ In 1967, Davis unveiled the first bike lanes in the country, which celebrated their 50th anniversary in 2017. Recognized for its leadership, Davis was the first city to receive the Platinum level friendly community award from the League of American Bicyclists and has repeated the designation in subsequent years.

A public bike share program is being installed in Davis in May 2018. Other on-going Davis bike programs include ‘Street Smarts’, ‘Safe Routes to Schools’, ‘Safe Routes to Sports’ and a ‘Request a Bike Rack Program’ with free bike racks for downtown businesses, thus supporting a pedestrian and bike friendly community and economic development at the same time.

Transit service has been in place since the 1970s. Davis partnered with University of California Davis to create the Unitrans bus system. The service initially utilized two vintage red double-decker buses purchased from London. The vehicle fleet now includes 48 additional buses on 19 routes throughout the entire city and helps reduce car use by students and other Davis residents. The city passes through a portion of the federal transportation funds it receives to pay its share of Unitrans.

In the 1990s, Davis completed a multi-modal hub at the old train station. Complete with local art and seating made with recycled material, the hub hosts transit services from Amtrak (including the Capitol Corridor train between Sacramento and San Francisco), Unitrans, Greyhound, Yolo Bus, and Regional Transit. The hub also provides parking for hundreds of bicycles, thus encouraging bike/train commuting. UC Davis also recently expanded the campus bus transit hub to more fully serve the campus and Davis community with the 50-bus system.

Davis implemented a green fleet program beginning in the 1980s with the purchase of fuel efficient vehicles. Currently, the city has more than 20 alternative fuel vehicles in its fleet.



City of Davis greenbelts and parks form an interconnected network for recreation, active transportation and neighborhood connectivity. Davis is in the process of implementing turf conversions where appropriate to conserve water and incorporate native landscapes.



A Davis Downtown Plan is currently underway to enhance vibrancy and economic vitality.

The City is hoping to address a demonstration or pilot program for self-driving or Automated Vehicles (AV) as part of the recently initiated Downtown Plan process. Various models for the program are being explored.

2. *Land Use and Community Design*

The Davis General Plan encourages carbon reducing land use and community design components. It provides policy direction and support for resource conservation, compact community design, and energy efficiency. Examples of these policy areas include encouraging infill and compact growth within identified urban limit lines; an agricultural buffer and mitigation measures to protect ecosystems and farmland; improving alternative transportation options, active transportation mode shares and infrastructure improvement; reducing consumption and waste of non-renewable natural resources; enhancement of the urban forest and related carbon sequestration benefits; increasing access to and quality of social, recreational and cultural services; and improving air and water quality.

A new Downtown Davis plan was initiated in 2017, to be followed by a General Plan update, which is intended to create a form-based code with a systematic approach to improving energy efficiency in both new and existing buildings.

The previously noted community greenbelt network is an organizing structure for inter-neighborhood connectivity. The bicycle and pedestrian paths, parks and playgrounds, art installations, interactive exercise stations and other amenities facilitate and encourage healthy and active lifestyles.

In 2015, the City prepared a Sustainability Implementation Plan (SIP) for a multi-use innovative business, research and housing project funded by the California Strategic Growth Council. The SIP was intended to be used both for the specific development project and also as a prototype for future proposed projects. It identifies specific and measurable sustainability components to reduce GHG emissions from all key sectors including transportation, energy, water and wastewater, and solid waste. Among the key features of the SIP are customized energy efficiency and renewable energy recommendations, including Zero Net Energy (ZNE) feasibility studies and options.

Davis city staff have been integral to the initiation of the Yolo Resiliency Group, a county-wide regional collaboration to address vulnerability assessment and planning across jurisdictional boundaries and with multiple stakeholders, which will serve as a model for other integrated approaches to designing resiliency and collaboration in Northern California and other areas of the state.

3. *New Construction and Building Standards*

Davis adopted the California Green Building Standards (CALGreen) Tier 1 Reach Code in January 2011 for both residential and non-residential projects. The Reach Code adoption required California Energy Commission approval after assessing



The Davis City Hall campus is located in Davis Downtown. City Hall and Civic Center Gym were built in 1927 and renovated in the mid 1980s when the Community Chambers building and Annex were added for municipal office use. Energy and carbon conservation retrofit efforts are on-going.

and verifying Energy Efficiency Standard compliance for new construction. A requirement for Tier 2 energy component was adopted in 2017. CALGreen is a robust standard that dovetails with the International Building Code (IBC) suite of codes and regulations. This standard includes both mandatory and voluntary measures for residential and non-residential projects including site design, water use, indoor air quality, and waste diversion. Previously, the City had a Green Building Ordinance in place since August 2008.

Davis has long been a national and state pioneer in promoting green buildings, energy efficiency and sustainability. In 1972, the city adopted the Davis Energy Conservation Building Code, designed to reduce heat gain in the summer and heat loss in the winter. New homes in Davis were required to include green building features such as ceiling and wall insulation (a novel requirement at the time), north-south orientation, and limited unshaded windows. The Davis building code became the model for California's subsequent Title 24 building code.

The City currently strongly encourages all development projects to achieve Zero Net Energy (ZNE) in furtherance of a policy in the existing CAAP to work towards achieving ZNE in new construction. This will contribute towards achievement of the City's long-term carbon neutrality goal by 2050. Statewide standards will require ZNE by 2020.

In 2009, the City adopted GHG standards and thresholds of significance for new residential development projects that set a declining GHG emissions cap which was among the first project-level GHG threshold policies developed in California. Currently, staff is working on non-residential GHG standards and thresholds and updating the residential policy to meet or exceed current state guidelines.

Davis City Hall is being used as a retrofit model for increased sustainability, reduced dependence on fossil fuels and to show municipal leadership. The historic landmark was built in 1927 as the first Davis High School and, in the 1980s,

transformed to municipal use. Components of the retrofit are based on recommendations from a 2010 Energy Audit funded by the Energy Commission. Already completed are heating duct replacement and increased insulation for building envelop sealing, which resulted in 47% energy efficiency improvement.

Now envisioned are implementation of emerging technologies for energy efficiency and building controls. The heating, ventilation and air conditioning (HVAC) system will be improved using fuel switching from natural gas to electricity within the next two years. The efficient cooling system proposed, Variable Refrigerant Flow (VRF) using geothermal heat exchange, will meet increased cooling demand and eliminate carbon. New window inserts that provide energy efficiency largely equivalent to double pane windows will be installed this year to complete building envelop sealing without impacting the aesthetics or historic quality of the building.

Lighting will be upgraded to incorporate fixture replacement with LEDs, area controls, multilevel lighting controls, shut off controls with occupancy sensors, automatic daylighting controls and demand response technology. State of the art 'user-friendly' lighting levels will be analyzed and incorporated for the facility.

Distributed energy resources will be addressed on the City Hall campus. Rooftop and parking lot solar panels will be installed, which in combination with off-site renewable energy generation will provide all electricity needs for the site. Lastly, individual battery storage technology for on-site renewables are becoming increasingly viable. Not currently envisioned, but possible in future efforts is development of an energy microgrid for the City Hall campus. A microgrid employs a localized grouping of electricity sources and loads that normally operates connected to traditional centralized grid, but can disconnect and function autonomously as physical and/or economic conditions dictate.



Davis Waste Water Treatment Facility solar array.



4. Renewable Energy, Energy Efficiency and Conservation

In partnership with the Davis, County of Yolo and City of Woodland, the Valley Clean Energy (VCE) joint powers agency was formed to implement a community choice energy program, scheduled to launch summer 2018. The official locally-governed electricity provider will bring cleaner energy at competitive rates. Earnings will be reinvested back into the community by creating local green energy programs and projects.

Solar photovoltaic (PV) 2020 goals were adopted May 2016, following a significant overachievement of goals established in 2010 for completion by 2015. Currently, over 2,500 PV systems produce 29.6 MW, meeting over 60% of the community's average annual electricity demand (initial goals were 2.6MW, showing increase by a factor of ten). The goals identify a target of another 2000 rooftop PV systems installed and doubling energy generation since 2010 with an additional 21 MW to attain 4500 systems and a total of 50 MW. In the first two years of these new goals, 502 residential systems were installed in 2016 and 380 in 2017, for a total of 882 toward the goal target. In 2014, Davis adopted an ordinance that requires solar PV in certain new residential development projects. Additionally, the Davis Solar Rights Ordinance and Solar Shade Control Act protect solar access for rooftop PV installations in residential developments.

Davis installed a solar photovoltaic (PV) system at the city's waste water treatment plant in 2010 and a PV system on the Veteran's Community Center in the early 2000s. The waste water treatment plant array consists of 3,500 solar panels, covering about six acres and produces 1.7 million kWh, enough to run most of the plant's electricity demand per year. The Community Center array is approximately 12kW and offsets a majority of the building's electricity use. Additionally, since the early 1990s, instead of natural gas, the city's wastewater treatment plant uses methane gas generated at the plant to help power the plant's digesters.

The 2015 Davis Future Renewable Energy Efficiency plan (DavisFREE Final Report) developed comprehensive integrated renewable energy and enhanced energy efficiency plans. These plans are intended to guide the city in achieving climate action and energy reduction goals related to building energy usage. Using a grant from the California Energy Commission, this research project provides background demographic and building data to enable Davis to move from the present into a reduced carbon future.

For several decades, Davis has been implementing outdoor lighting retrofit pilots and projects to further research on best management practices and incorporate energy efficiency and GHG emissions reductions.

- In the early 1990s, Davis was one of the first cities in the country to pilot and then retrofit its traffic signals to LEDs.

- In 2014, Davis began replacing 2650 city-owned cobrahead streetlights with LED light fixtures, reducing energy use more than 70% over existing high pressure sodium streetlights. As part of the project, the quality of light from the LED fixtures was also evaluated, which helped advance understanding of community needs and preferences and the need to consider lighting quality when switching to LEDs. City staff have been contacted by other cities to learn more about this issue, including questions from Honolulu, Phoenix, Denver, Houston, New York and Dundin, New Zealand.
- Starting in 2014, the City approved retrofit of 1200 park and greenbelt lights in more than 20 city parks and 50 miles of greenbelts. The new LED lights are bi-level which saves 85% over existing lighting and 60% compared to equivalent LED fixtures.

Davis participates in the Yolo Property Assessed Clean Energy (PACE) program, which offers Davis residents energy efficiency and water conservation financing through CaliforniaFIRST, HERO and YGreen programs.

In 2001, Davis entered into an agreement with the Photovoltaics for Utility Systems Applications (PVUSA) to install an 86-acre solar farm and research facility on the city's former wastewater treatment plant in northeast Davis. The city off-sets the electricity use on over 45 city electricity accounts, including City Hall and many of the city's municipal water wells. The PVUSA site was designed as the first grid tied utility scale solar plant and continues to serve as an important research facility providing data on solar panel performance and longevity.

5. Water and waste water

Davis updated its Waste Water Treatment Plant to meet current discharge standards. This new plant uses a state of the art treatment process, processing significantly more water to much higher standards on a fraction of the land area previously required. Along with updated filtration methods, this plant enables the City to potentially reuse treated waste water for a variety of different purposes including habitat restoration and landscape use.

Woodland Davis Clean Water Agency was established as a regional collaborative effort to transform the local water source from exclusively ground water to predominantly surface water from the Sacramento River, providing a more reliable water source with adequate quantity and much higher quality.

Davis has completed or is underway with a number of activities designed to reduce water use at city parks, greenbelts, other open space areas and streetscapes the city maintains. These include implementing:

- A deficit based watering rather than optimum irrigation system, which results in less overall water consumption and less frequent watering in parks and greenbelts.



- A cycle soak program for irrigation systems which results in a slower application of water over a longer period of time to reduce run-off and allow more time for absorption.
- Installation of standalone controllers with SMART or central based controllers, as well as implementing a weather-based system. Nearly one-half of the city's 285 irrigation controllers are central-based.
- Flow sensing to many existing city irrigation controllers to help manage water consumption in real time, as well as automatically shutting down irrigation systems for large line and mainline breaks.

The city has continuously implemented a policy to improve the energy efficiency of the pumps and motors throughout the city's water system, thus saving energy and making the system run more efficiently.

In 2014, Davis implemented the WaterInsight program, provided by WaterSmart software. For households that want to participate, the personalized program reports detailed household water use and compares it to homes of similar size, helping residents gain a clear understanding of how water use reductions can be made.

In 2014, Davis passed an ordinance allowing installation of grey water systems in Davis homes. Grey water is water collected from sinks (excluding the kitchen sink), showers, bathtubs or washing machines that can be recycled for uses such as landscape irrigation or toilet flushing.

Davis offers free water conservation workshops for residents and businesses. These include topics such as: The ABCs of sustainable landscaping, turf removal, plant selection, optimizing irrigation systems and other topics. For part of this effort, the city partners with the UC Davis Arboretum and Public Garden to offer workshops on drought tolerant gardening.

Davis has an integrated stormwater retention system that uses stormwater runoff to recharge the groundwater, improve urban wildlife habitat and provide recreational opportunities for Davis residents. Stormwater is the water from precipitation that flows across the ground and pavement when it rains. Stormwater should mostly be rain water, but as it runs off your roof, yard, driveway, and any impervious surface, it can pick up dirt, debris, animal waste, oil, gas, fertilizers, pesticides, and other materials in its path. Impervious surfaces prevent stormwater from being absorbed and instead it runs to the storm drain system. The increased quantity of stormwater runoff can also cause stream banks to erode and increase the amount of sediment in waterbodies. Storm drains lead directly to Davis ponds, creeks and wetlands. Unlike sanitary sewers that direct water to a wastewater treatment facility before being discharged to a local water body, stormwater is discharged untreated. Any pollutant that enters the storm drain system is discharged untreated into

the waterbodies we use for swimming, fishing, and providing drinking water, and can have adverse effects on environmental habitat and people.

The Stormwater program's mission is to operate and maintain the City's storm sewer infrastructure to ensure stormwater is collected and discharged in accordance with federal, state, and local environmental regulations while protecting life and property from flooding. The program conducts outreach and education regarding pollution prevention and wildlife habitat relationships. The City of Davis has developed a Stormwater Management Plan (SWMP) to address stormwater quality and conveyance within the City's jurisdiction.



The Davis Food Coop



Davis Farmers Market in Central Park operates twice a week to provide local produce and products, entertainment and community interaction.



6. Consumption, solid waste reduction and recycling

Davis residents have many opportunities to get fresh, local, organic and natural food in the community at restaurants, groceries, farms and other sources. In the mid-1970s, Davis was one of the first cities in California to host a farmers market. Located at the downtown Davis Central Park, the thriving market is open on Saturday mornings and Wednesday afternoons. It attracts participants from local and regional farms, as well as thousands of customers. Davis Farmers Market celebrated its 40th anniversary last year. The Davis Food Coop started in the mid-70s as a small grocery-purchasing cooperative operating out of a garage. Today it serves as a full-line cooperative grocer with fresh, local organic and natural foods.

Additionally, the Davis community shows awareness of food justice and sustainably sourced foods through local organizations and advocacy groups. Cool Cuisine organizes monthly dinners highlighting vegan options at local restaurants. The Yolo Interfaith Alliance for Climate Justice promotes Meatless Mondays and Fish Fridays. The Short Term Emergency Aid Committee's (STEAC) Food Project advocates local individuals' commitment to long-term food donations and short term emergency food, rental, utility and job readiness aid to Yolo County families and individuals below the federal poverty level.

Reducing food waste has been identified as the third- most effective global strategy to reduce GHG emissions.⁵ The City began its Organics Collection Program in July 2016, adding to the established curbside green (landscape) waste collection. As of the 2017 State of the City Report, the City has collected over 5,600 tons of food scrap and yard materials waste that were otherwise slated for the landfill. New metrics based on these additional measures are being calculated, with the goal of 75% waste diversion by 2020.

Davis was one of the first cities in the country to establish a municipal curb side recycling program in the early 1970s. In 2013, based on the recognition that there is a clear connection between the movement of waste, both up and downstream, and GHG emissions, the City Council established a single-family variable rate system for solid waste services, giving residents critical feedback on their respective waste volume. In 2015, the City documented a total diversion rate of 62% of the total waste generated. This diversion rate has been achieved through a partnership with the City's waste hauler, Davis Waste Removal (DWR), which collects and recycles all mixed paper, corrugated cardboard, glass, rigid plastics, aluminum, and steel beverage and food containers. Through the city's franchise agreement with DWR, Davis residents can drop off and recycle "bulky items" such as couches, appliances and other hard to get rid of items once a year at the annual Bulky Items Drop-Off Days.

Adopted in 2007, the city's Construction and Demolition (C&D) ordinance requires all applicable construction, renovation and demolition projects to divert at least 50% of C&D waste from the landfill through recycling, reuse and/or waste reduction,

recently increased to at least 65% to meet CALGreen Tier 1 standards.

Additional waste reduction efforts include an Apartment Move-Out Waste Reduction Program, an Environmentally Acceptable Food Packaging Ordinance (addressing a ban on plastic bags) in 2013, and a Beverage Straw Ordinance in 2017. As a university community, the annual apartment program supports waste reduction at August move-out. City of Davis staff sets up donation stations at participating apartment properties and residents donate items they no longer want or need. Local non-profits groups stop by and take the items they want. The end result is that good, usable items are kept out of the trash stream. These programs have significantly reduced waste production.

7. Open Space, Habitat, Natural and Working Lands

Davis is located in close proximity to some of the richest and most productive farmland in California. In partnership with local farmers, the agricultural expertise of UC Davis, and an engaged citizenry concerned with health and well-being, the City has been a leader in addressing the relationships between agricultural food production/ consumption and GHG emissions.

Natural and working lands offer an excellent resource for GHG emissions reduction. On-going research at UC Davis and elsewhere addresses the benefits of carbon sequestration in the soil. This has the potential to significantly remove greenhouse gases from the atmosphere while avoiding new emissions. The co-benefits of climate adaptation and job creation are also possible.

The City owns conservation easements on more than 4,700 acres of private property. Since 1995, Davis has partnered with The Yolo Land Trust to facilitate more than a dozen successful Yolo County easements and also partners with Solano County Land Trust for easements within Solano County. A conservation easement is a contract with the property owner to permanently restrict the use of the property, such as for open space or agriculture, wildlife habitat or farmland mitigation for development within the city, pursuant to the Davis Farmland Preservation Ordinance. In 2000, Davis voters approved the 30-year Open Space and Protection Special Tax Fund, which provides 'revenue for the acquisition, operation, and maintenance of lands and easements for open space, habitat and agricultural uses and preservation in the areas surrounding the city.' This tax Measure O was approved by 70% of Davis voters.

The 400 acre Davis Wetlands Project is part of a growing effort throughout the Central Valley to preserve and restore native habitats and the wildlife they support. The Wetlands is one of the city's most valuable open space resources. It provides wildlife habitat, flood control, wastewater and stormwater treatment, recreation, and environmental learning opportunities. Docent lead tours are offered the first Saturday of each month. The Davis wetlands are located in north east Davis, adjacent to the wastewater treatment plant.



8. *Community Engagement*

The city has actively pursued partnerships with local community based organizations to implement sustainability related projects and programs, including Cool Davis, Valley Climate Action Center, Davis Futures Forum, Yolo Land Trust, Solano Land Trust, Davis Bicycles, and many more. Davis participates in the Yolo Climate Compact, organized by Yolo County. The Compact brings together representatives from the county, the four Yolo County cities, the University of California, Davis, and local utilities for bi-monthly meetings to share information and talk about cutting edge issues. This form of social innovation and collaboration has allowed the city to accomplish far more than would have been possible acting alone. Additionally, the city actively engages in partnerships with



Community engagement and participation.

University of California Davis experts.

Cool Davis, a local non-profit organization, was created as a follow-up to extensive public participation during the Climate Action and Adaptation Planning process. Cool Davis has a mission to help the city implement the CAAP and to sponsor activities designed to help Davis residents reduce greenhouse gas emissions. Working together under a Memorandum of Understanding between the city and Cool Davis since 2010, the collaboration has resulted in numerous activities, including participation in the Georgetown University Energy Prize project, facilitating a 2016 Solar Project Launch to roll out new solar goals and co-sponsorship of the annual Cool Davis Festival. Attended by several thousand residents each year, the free festival offers attendees tips and advice on how to reduce their impact on the environment and save money at the same time. The festival is also a showcase for Davis businesses and organizations working on sustainability and highlights performances by many local artists, musicians and volunteers.

In concert with the city, Cool Davis has created campaigns for carbon reduction employing Community-Based Social Marketing (CBSM), an approach to achieving broad sustainable behavior. CBSM combines the knowledge from psychology and social marketing to leverage community members' action to change behavior. CBSM is more than education, it entails spurring action by a community and for a community.

The city's public information office uses social media, such as the NextDoor platform, to engage residents about many topics including sustainability opportunities. Workshops, public forums, and other resources are presented by the city and local groups. The city's website provides residents and business owners with a wealth of information about sustainability policies, resources, workshops and links to related resources.

In 2008, Davis successfully piloted the Davis Low Carbon Diet Program with 100 households. Recognizing that the majority of local GHG emissions are produced by the daily activities of existing residents, the pilot was intended to test the viability of a large scale community engagement program. This program focused on providing households the necessary tools to understand their carbon footprint and identify strategies for reductions. Each household chose which strategies worked best for them, and shared their successes with other households on their teams. Pilot Program participants reported they were able to meet their GHG reduction targets and that the program was a viable education tool with practical household level carbon reduction solutions.

In 1980 and 1981, Davis was one of six cities to participate in a Pacific Gas & Electric (PG&E) sponsored pilot program designed to engage the community to reduce peak energy use. With leadership from a community advisory committee that included residents and business owners, the Davis community reduced electricity use by 20% over the two-year period, compared to electricity use in 1979. In addition, in recognition for the "Prime Time Program" (as it was called) Davis won the first ever League of California Cities sponsored Helen Putnum Award for Excellence.

Recent Awards and Recognitions

The SolSmart Gold Designation, achieved in March 2017, is the highest recognition by 'Solar Powering America by Recognizing Communities' (SPARC) for the City's achievements in becoming a more solar-friendly community. SolSmart is a national designation program, funded by the US Department of Energy Solar Energy Technologies Office.

The City of Davis received the 2016 Beacon Award program Silver Level for best management practices at the local government agency and community level. This program, administered by the Institute for Local Government's Statewide Energy Efficiency Collaborative, provides support for cities and counties in addressing climate change and sustainability. Davis was recognized for greenhouse gas emissions reductions, energy savings and other sustainability practices and implementation.



For the first year of the Cool California Challenge (2012-2013), Davis was crowned 'California's Coolest City' by the California Air Resources Board out of eight cities that were selected to begin the competition. This award entailed recruiting the most households to sign up and record energy use and transportation data during a twelve month period.

Next steps

As Davis makes further progress en route to our carbon reduction goals, the type and effectiveness of our local actions will need to evolve. We will need to address behavior change through the types of approaches already underway like Community Based Social Marketing. We will need to address which actions can be controlled locally and what needs to be tackled on a broader scale such as regional or statewide. We are taking the first steps toward regional collaboration on vulnerability assessment, working across jurisdictional boundaries and with multiple stakeholders to create resiliency and adaptation plan.

Davis is examining potential and in-progress strategies on the path to 'deep decarbonization.' These include net-zero carbon development, fuel switching efforts from carbon based fuels to electricity, carbon sequestration in natural and working lands, development of electric microgrids and battery storage, and implementation of a robust system of carbon offset funds. The transportation sector is fertile for carbon emission reductions and will be a major focus of on-going and future efforts. Currently, the City is considering adoption of new programs and ordinances in advance of the State's strategic greenhouse gas emissions reduction requirements.

While we believe we have made notable progress leading toward carbon neutrality, we also recognize that we have significant work to do with clear obstacles on our path. Some of the questions that we are asking as a community include:

1. How should the City incorporate comprehensive, integrated and proactive sustainability, climate action and energy conservation issues into clear, specific, enforceable and replicable measures throughout City plans, policies and standards?
2. What monitoring and reporting measures can be used to establish baselines, track metrics over time, and evaluate targets and success?
3. How can a risk and vulnerability assessment that proposes adaptations to adverse effects of climate change support actions toward a more resilient community?
4. What significant social equity and environmental justice issues related to sustainability, climate action and energy conservation need to be considered? How can community health benefits of sustainability and

climate action planning be articulated and incorporated as co-benefits of measures to reduce GHG emissions?

5. What community engagement strategies should be incorporated in sustainability, conservation and climate action decisions? How can community efforts, challenges and successes be made transparent and accessible to community members?

As earlier noted, given the challenges of addressing significant greenhouse gas emissions reduction both in planning new development projects and in retrofitting the existing residential, commercial and infrastructure framework, we are aware that as a community and municipality we are a 'work in progress' on the Davis path to carbon neutrality.

Kerry Daane Loux, Sustainability Coordinator for the City of Davis Community Development & Sustainability Department, is a California Landscape Architect and LEED-accredited professional. She has focused emphasis on quality of life issues, sustainable design and policy throughout her private practice and public service career. Kerry previously served on the Cool Davis Board of Directors and is currently Davis City Staff Liaison to the organization.

References

- ¹ Weather information was collected from a summary of climate change impacts at <http://climate.calcommons.org/article/central-valley-change> and from U.S. Climate Data at <https://www.usclimatedata.com> and <https://www.timeanddate.com/weather/usa/davis/historic>
- ² California legislation relating to climate change can be found on the Ca.gov website at <http://www.climatechange.ca.gov/state/legislation.html>
- ³ The CoolClimate Carbon Calculator <http://coolclimate.berkeley.edu/carboncalculator> estimates average household carbon footprints for various communities across the nation. This number includes carbon intensity of sources calculated in the cited Davis GHG Inventories (vehicle fuel, water supply, natural gas and energy use) and of additional life cycle sources (manufacturing, construction, goods supply and services, all of which total 22.3 metric tons per household.
- ⁴ From 'Next City' website article, 'What a Bike-Crazy California Town Can Teach Us About Car-Free Cities', October 21, 2015, <https://nextcity.org/daily/entry/car-free-cities-plans-biking-walkability>
- ⁵ From Drawdown Reduced Food Waste website at <http://www.drawdown.org/solutions/food/reduced-food-waste>



Shrinking Emissions & Expanding Minds at the University of Louisville

Justin Mog, PhD

Assistant to the Provost for Sustainability Initiatives, University of Louisville

The University of Louisville (UofL) took a bold step forward in 2008, when former President James Ramsey signed the university onto the American College & University Presidents' Climate Commitment, now known simply as the Carbon Commitment.¹

The Climate Leadership Network

As a member of the Climate Leadership Network², UofL is moving forward toward carbon neutrality along with over 600 other signatory institutions of higher education. Each signatory is responsible for publicly reporting their greenhouse gas (GHG) emissions and developing a Climate Action Plan to draw down those emissions to net zero. Each school gets to decide what will work for them in terms of strategies and timelines. In that sense, the Commitment is not proscriptive or one-size-fits-all, which is vital to finding truly sustainable, adaptive, locally-appropriate solutions to the climate challenge.

One of the special difficulties for academics in this work is to remain humble in our approach – i.e. to not presume we have all the answers for how others can achieve sustainable, carbon-free solutions. This tendency is compounded for those of us highly motivated by the growing sense of crisis, as the signs of climate destabilization pile up from California to Kentucky to Puerto Rico and beyond. With mounting scientific evidence stoking our anxiety, we fear that time is running out for humanity and swift action is necessary for our survival.

Yet there are no easy answers to the challenge, all institutions are slow to change, and scholars have cautioned for decades that genuinely sustainable solutions must be 'slow baked' from within - tailored to the unique internal cultures, resources, and circumstances of a particular institution or community – rather than imposed from without.³ As change agents, we must remain aware of this and pace ourselves for the marathon race toward carbon neutrality, rather than burning ourselves out in a desperate sprint to try to get there as quickly as possible by whatever means necessary.

That is not to say that the crisis is not real, nor that we can afford to take a leisurely, lackadaisical approach. On the contrary, we must remain focused, set goals, consistently measure and report our progress toward them, and use performance

management strategies to learn and grow from our inevitable mistakes along the way. In sustainability, perhaps more than any other field, it is essential that institutions of higher learning become learning institutions that are willing to try new things, to perhaps fail, to critically examine our experience, and to grow wiser in the process.

The Climate Leadership Network gives colleges and universities the structure and framework necessary to take a focused, thoughtful approach toward reducing carbon emissions through consistent public reporting, planning, and mutual support. Through the Network, we can support and learn from each other's efforts while holding each other mutually accountable for making progress. Given the non-proscriptive nature of the Commitment, if we take it seriously, we cannot help but become deeply engaged in the process and, by extension, institutions that learn over time.

Structuring for Sustainability

This has certainly been the case for us at UofL. To begin with, it was the signing of the Commitment in 2008 that launched UofL's sustainability initiatives from a fairly loose, ad hoc set of grassroots efforts to a focused, coordinated strategy for continuous improvement. Sustainability was immediately written into the university's strategic plan with metrics for monitoring progress based upon the newly emerging, comprehensive Sustainability Tracking, Assessment & Rating System (STARS) developed by the Association for the Advancement of Sustainability in Higher Education (AASHE).

In the same year, the university's former Executive Vice-President & Provost, Shirley Willihnganz, convened a new university-wide Sustainability Council with broad representation from faculty, staff, administrators, and students across UofL. One year later, at the Council's recommendation, the university created a new, full-time, PhD-level staff position to act as UofL's sustainability coordinator, a position the author has served in since its inception in 2009. Now with the support of this full-time staff member, the Council continues its work as the primary coordinating and advisory body for sustainability initiatives across the university. It has always had active committees structured around the STARS categories and it manages both UofL's STARS and GHG reporting, as well as the development and implementation of our Climate Action Plan.

The mere fact of making a good faith effort to document the emissions from a university serving over 22,500 students with over 7,000 employees on three campuses is bound to involve a wide variety of stakeholders participating in the process and paying attention, perhaps for the first time, to the pollution associated with everyday life and business as usual. Compiling UofL's initial, benchmark GHG emissions report was the author's first task as the new Assistant to the Provost for Sustainability Initiatives in 2009. It is now an annual process that pulls in data from all corners of the university, touching everything from facilities and grounds to purchasing, transportation, study abroad, dining, and solid waste. In ideal times, it is also an effort that engages students directly in learning about carbon emissions sources and university functions.

UofL's Climate Action Plan

The University of Louisville is committed to reducing GHG emissions with the ultimate goal of achieving carbon neutrality by 2050 at the latest. On September 15, 2010, UofL released its Climate Action Plan⁴, a comprehensive roadmap for achieving this goal. The Plan is a living document that continues to evolve and grow as we learn from our efforts and expand our capacity to take action throughout a four decade process of adaptive management on the road to climate neutrality. Engaging students, faculty, researchers, staff and the broader community in this process has been and will continue to be vital to its success and to our broader educational and research mission. This Plan lies at the heart of our sustainability initiatives, and it involves many steps that will help us achieve our strategic goals as well as our climate commitment. It is also the right thing to do in a world of dwindling fossil fuel resources and worsening climate crisis.

Our Plan contains sections on:

- Energy Conservation and Efficiency
- Renewable Energy
- Transportation
- Behavior Change
- Carbon Sequestration
- Carbon Offsets
- Green Purchasing
- Master Planning
- Green Building

- Composting & Horticultural Practices
- Recycling
- Food
- Financing Options
- Implementation Structure and Tracking Progress
- Communication, Education and Engagement

Through a broad, comprehensive approach designed to make simultaneous progress in all of the above areas, we intend to achieve not only the ultimate goal of carbon neutrality by 2050, but interim goals along the way. Table 1 shows established target goals for university-wide reductions in annual greenhouse gas emissions from our 2008 benchmark⁵ estimate of 192,788 Metric Tons of Carbon Dioxide Equivalent (MT eCO₂).

Table 1: Target goals for university-wide reductions in annual greenhouse gas emissions.

Goals	Timeframe	Reduction in net GHG emissions from 2008	Target maximum net annual GHG emissions (MT CO ₂ e)
Short Term	2010–2020	20%	154,230
Mid Term	2021–2030	40%	115,673
Long Term	2031–2050	100%	0

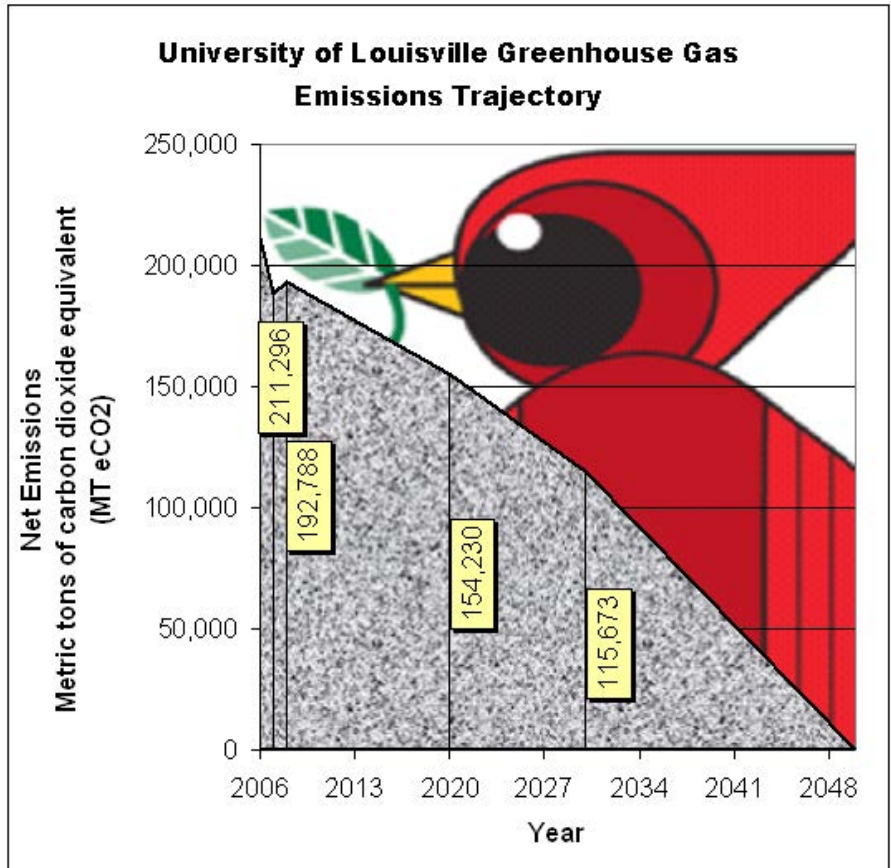


Figure 1 - UofL's Climate Action Plan outlines strategies for achieving climate neutrality by 2050.

Our plan for making progress toward climate neutrality is dynamic and multifaceted. We recognize that sustainability demands progress on multiple fronts and that lasting change cannot be achieved without coordinated efforts campus-wide. That said, it is clear that not all steps leading UofL down a path toward climate neutrality are equal in terms of cost, savings, impact on emissions, educational and awareness-raising value, or other co-benefits. To illustrate the point, Table 2 summarizes the variability in estimated carbon impact from just a handful of the over 75 specific steps outlined in our Plan.

Table 2: A sample of projects from UofL's Climate Action Plan

Project	Estimated emissions reduction (MT eCO ₂ per year)	Progress towards goal (% reduction in GHG emissions from 2008)
20% renewable energy by 2020	22,284	11.5%
Implement phase 2 of energy savings performance contract on Health Sciences Center & Shelby campuses	17,419	9%
Convert from coal to natural gas fuel at Belknap Steam & Chilled Water Plant	4,222	2.2%
Create dedicated bike lanes to connect campus to neighborhoods	3,283	1.7%
Increase fuel efficiency of the university fleet by 15%	136.3	0.7%

Prioritizing Projects

Deciding which specific actions to prioritize at any given time has been a central challenge for the Sustainability Council as we work to implement the Plan. Like most institutions, we have tended to start with the ‘low-hanging fruit’ of fairly straightforward technical fixes that will not only reduce emissions, but save money over time. Efficiency measures are a sensible place to focus initial attention. UofL’s three-phase, \$52 million energy savings performance contract with Siemens Building Technologies Inc.⁶ has been a prime example of these early efforts. Every one of the associated projects was guaranteed by Siemens to pay for itself in energy savings over the roughly 13-year life of the contract. Many of the projects also reduced maintenance costs for the university and increased comfort and functionality of campus facilities. What follows is a summary of these efforts to enhance efficiency at UofL:

- UofL's annual utility bill (electric, gas, water and sewer) has historically been over \$19.5 million. In recent years, we've spent nearly \$1 million every month of the year on energy (\$11.7 million for electricity and gas in 2011). There are tremendous cost savings and environmental benefits to be gained from using energy and water more efficiently on campus.
- UofL has made massive investments to retrofit its existing facilities in order to increase the efficiency of our operations, reduce costs, consume less energy and water, and produce less pollution as a result.

- Our \$52 million investment in efficiency stretched over three phases from 2009-2017. The project involved upgrades to over 88 buildings (6.2 million square feet) on all three UofL campuses. These improvements are projected to directly save the university over \$4.4 million every year and reduce our annual carbon dioxide emissions by over 46,000 tons (the equivalent of removing 7,690 cars from the road).
- With these improvements, UofL expects to reduce its utility bill by about \$12,086 per day.

These efforts have already produced documented results. In FY 2011-12, for example, we documented that Belknap Campus alone reduced fuel use 48%, electricity use 27%, and water use 31%. Efficiency-minded campus users helped us exceed our engineers' expectations. They had predicted fuel use to decline nearly 40% and electricity use to drop at least 20% annually.⁷

• Examples of UofL's efficiency retrofits include:

1. Efficient lighting: Installed 117,483 fluorescent lamps, 41,714 ballasts, and 1,729 exterior induction lamps. Reduces lighting energy consumption by 14% for an annual savings of over \$915,000.
2. Insulated steam valve jackets: 1,152 installed. Reduces heat loss at the valve by 90%. Saves over \$327,000/year.
3. Occupancy sensors for lighting: Installed 2,011 occupancy sensors to automatically shut off lights in vacant rooms. Reduces lighting energy consumption by 20-40%, saving over \$97,000/year.



Figure 2 – George Kirwan, UofL Physical Plant, shares some examples of efficient lighting and insulation jackets installed at UofL with a student at the 2011 Campus Sustainability Day fair.

PHOTO CREDIT: UOFL PHOTOGRAPHER TOM FOUGEROUSSE.

4. Low-flow shower heads: 616 standard shower heads were replaced with efficient 2.0 gallon/minute heads. Reduces water use by an average of 11%, saving over \$34,000/year.

5. Low-flow faucet aerators: Installed 20,426 pressure independent aerators. Reduces water consumption at sinks by an average of 58% for an annual savings of over \$159,000.

6. Efficient motors: Replaced 259 motors with new models that use an average of 5% less energy for an annual savings of over \$35,000.

7. Energy efficient belts for motors: Replaced 213 standard V-style belts with non-slipping synchronous belts with variable frequency drives. Cuts energy use by an average of 8% for a savings of over \$46,000/year.

- **History of the Project:**

- In October 2009, UofL and Siemens began work on a \$21.7 million, 13½-year performance contract to increase efficiency on Belknap Campus.

- In 2010, a second phase performance contract was agreed for the Health Sciences Center, Shelby campus, and a few more Belknap projects, involving another \$23.8 million in retrofits.

- On Feb. 5th, 2015, UofL trustees authorized spending up to \$10 million more for a third phase of the contract.⁸ In June 2015, implementation work began on \$5.4 million in improvements in lighting, heating, electrical systems, water conservation and other areas, expected to lead to another \$457,600 in annual cost savings.

- Beyond the performance contract, UofL continues to invest in energy efficiency improvements as opportunities arise. Recent projects include:

1. In summer 2017, Campus Housing upgraded to new Energy Star washing machines and dryers that consume 40% less water and 25% less electricity than the original machines which are located in all UofL residence halls.

2. In spring 2017, UofL began a pilot test of eTemp⁹ energy-saving devices on four of our commercial refrigeration units.

3. In May 2017, UofL replaced lighting with high-efficiency, cooler, brighter LEDs in portions of the Baptist Campus Center, the lobby of the Playhouse, and in the dining area of the Ville Grill, where 240 42W bulbs were replaced with 26W LEDs. At the

Ville Grill alone, this cut lighting energy use 38% for a savings of \$1268/year (2.8 year payback) before even accounting for reduced load on HVAC.

4. In 2018, UofL will use a matching federal pedestrian transportation improvement grant to improve the quality and efficiency of outdoor lighting with LEDs installed along additional Belknap campus pathways, including the Humanities canopy lighting.

Unfortunately, most of these efficiency enhancements remain invisible to campus users and were installed outside of normal business hours for the sake of expediency. While these efforts did little to disrupt campus operations, they also did little to disrupt the mindsets of our students, faculty, staff, and guests. In that sense, UofL has done a good job in reducing our carbon footprint and a poor job in raising awareness and educating the general public about why this is important and how it can be achieved. This seems like a particularly significant shortcoming, given that we are, at core, an educational institution and that the greatest challenges of tackling global climate disruption seem to be around changing minds rather than changing technologies.

While we need to lead by example, a university's most important role in addressing climate change ultimately comes down to the contributions it makes in terms of educating people, researching sustainable solutions, and influencing society, rather than reducing its own, small contribution to global GHG emissions. UofL has been making important strides in these directions, as well. Prime examples include:

- The Conn Center for Renewable Energy Research¹⁰ launched in 2009,
- The Kentucky Pollution Prevention Center¹¹ established in 1994 to help Kentucky's businesses, industries and other organizations enhance their sustainability,
- The expanded reach of the UofL Sustainability Council's Green Threads faculty workshop¹² to weave sustainability into any department's curriculum, and
- The launch of our new interdisciplinary Master's degree in Sustainability (2015) and undergraduate Major in Sustainability (2017).¹³

The challenge before us now is to connect these efforts better such that our initiatives to reduce UofL's carbon footprint are also designed from the outset as efforts to educate about climate change and its solutions, to study new ways forward, and to engage more people in the process. These types of projects are captured by the concept of Campus as a Living Laboratory for Sustainability, an initiative the UofL Sustainability Council has begun to focus more explicitly on in recent years.¹⁴

But this challenge of connection means not only changing how we install new technologies (so that they are visible,

educational, and possibly even research-oriented), but also a reprioritization of steps in our Climate Action Plan towards those which raise-awareness and influence behavior. A renewed focus on transportation choices makes particular sense at this time, given that commuting and flying represent an increasingly large portion of UofL's total carbon footprint (up to 30.4% in 2016) and that tackling transportation addresses personal habits and behaviors and, thus, cannot be altered without educating and engaging the entire campus population.

Getting UofL to Think Outside the Car

Changing commuting habits has been one of the thorniest sustainability issues for UofL, but in 2012, we finally began to crack that nut through a popular, innovative program that has flipped the incentive structure on its head. Through UofL's innovative Earn-A-Bike Program¹⁵, all students, faculty, and staff who are willing to forgo a campus parking permit for at least two years are eligible to receive a \$400 (sales tax exempt) voucher to local bike shops. Vouchers are distributed annually after participants return any current permits and receive mandatory training in bike safety and transportation cycling. Though it has been suspended in 2017-18 due to the university's extreme financial crisis, the program operated for five straight years and our intention is that it will resume. The program gained national attention in October 2014, when UofL won the AASHE Award for Best Case Study from a Large Four-Year or Graduate Institution.¹⁶

The questions before us as we developed this program were thus: In a highly car-dependent campus culture, would people be willing to give up their right to parking in exchange for a free commuter bike? What other improvements to our transportation system are necessary precursors to getting our campus community 'thinking outside the car'? These were the questions behind the experiment in changing commuting habits that we have been running at UofL. The university was prodded into radically rethinking its long-standing accommodation of car commuters by a new Campus Master Plan¹⁷ revealing that three more costly parking decks would be required to meet growing demand, and a President's Climate Commitment, which helped us discover that 22% of university greenhouse gas emissions are due to commuting alone. Meanwhile, our city had been slipping to the bottom of the American Fitness Index¹⁸ and other health rankings. Something had to be done.

We launched the Earn-A-Bike program in August 2012, as part of our efforts to reduce greenhouse gas emissions and to encourage students and employees to use bicycles for transportation. The goals of the program include:

- Reducing the vehicle miles traveled to campus (and associated pollution);
- Reducing the number of vehicles that must be parked on and around campus;
- Increasing health and activity levels within the UofL



Figure 3 – Instructor, Mary Beth Brown, from Bicycling for Louisville, and UofL's Justin Mog welcome participants to a mandatory training session for Earn-A-Bike recipients in August 2016.

PHOTO CREDIT: RILEY KNEALE.

community;

- Reducing the costs of education by saving money that students and employees would otherwise spend on gas, parking, and other automobile expenses;
- Reducing traffic congestion and accidents; and
- Rewarding individuals for not driving to campus.

The Sustainability Council fleshed out the initiative as a key component of UofL's Climate Action Plan and Bicycle Master Plan; and it administers the program today.

Enthusiasm for the Earn-A-Bike program has been outstanding. In its first five years, a total of 3744 people applied and 1908 vouchers were distributed. With no advertising, nearly 800 individuals stepped up to say they were willing to give up their right to a permit in the program's very first year. By 2015, a record 850 individuals applied for the program. With demand exceeding supply, we developed a system for prioritizing recipients based upon driving history and the likelihood of enduring transportation behavior change. The program was launched along with a whole suite of transportation improvements, including free transit service, carpool matching and incentives, campus car-sharing and bike-sharing programs, and new bike parking, lanes, and do-it-yourself fix-it stations.¹⁹ Success of the program is monitored by targeted participant surveys (see, for example, Figure 4) and by more broad-based periodic campus commuting surveys designed to gauge changes in transportation choices and willingness to consider alternatives.

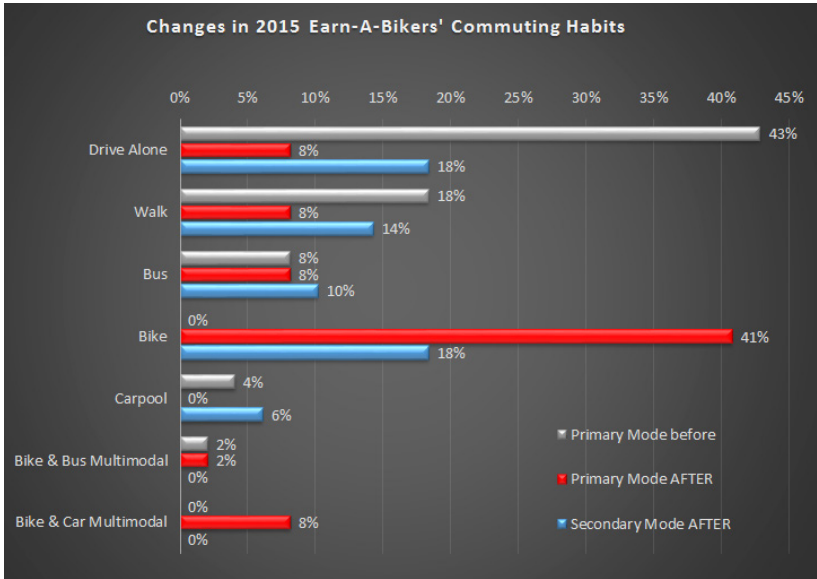


Figure 4 - Results of the 2015 Earn-A-Bike program participant survey showed a dramatic shift from driving alone to bicycling, in addition to other modes.

The Earn-A-Bike Program was written into the university’s annual base budget as a priority short-term project in our Climate Action Plan. Of the \$183,000 annual Climate Action Plan budget requested by the Sustainability Council for the first five years of Plan implementation, \$175,000 was dedicated for the Earn-A-Bike Program. Rather than distributing vouchers immediately, the first year of funding was invested in improving campus infrastructure to make the university more bicycle-friendly. Over 600 new bike parking spaces were added on all three of our campuses, with high-quality bike racks installed within fifty feet of nearly every building entrance. Five do-it-yourself bike fix-it stations with pumps and tools were installed around campus, and the first marked bike lanes were installed on campus pathways (including some path widening and curb ramps to better accommodate bikes). First year funds were also used to equip several UofL staff with work bikes and to launch a campus bike share program which now offers free daily bike checkout from eleven campus locations. Since then, annual funds have been used to:

- Provide about 400 bike vouchers worth up to \$400 (\$160,000);
- Hire instructors from Bicycling for Louisville for the ten mandatory orientation and bike safety sessions held each fall for all voucher recipients (\$500);
- Print Louisville bike maps for distribution to all participants (\$1000); and
- Maintain our bike share fleet, bike fix-it stations, and other bike infrastructure (\$13,500).

Small state grants have also been used to help fund bike education on campus.

The results of a longitudinal study of campus commuting behaviors and willingness to consider transportation alternatives demonstrate that significant progress has been made since the launch of this program. The university’s baseline transportation survey in 2010 revealed that nearly everyone (79% of employees; 65% of students) drove to campus alone and very few chose to bicycle (2% of employees; 4% of students). However, it also demonstrated encouraging interest levels in a variety of transportation alternatives, which we then incorporated into our Climate Action Plan and have now implemented through integrated programs designed around those initial findings. In 2013 and 2015, we surveyed again to explore the impacts these programs were having on how people get to campus and what might still be keeping some clinging to their car keys. Figure 5 summarizes the results. We continue to monitor

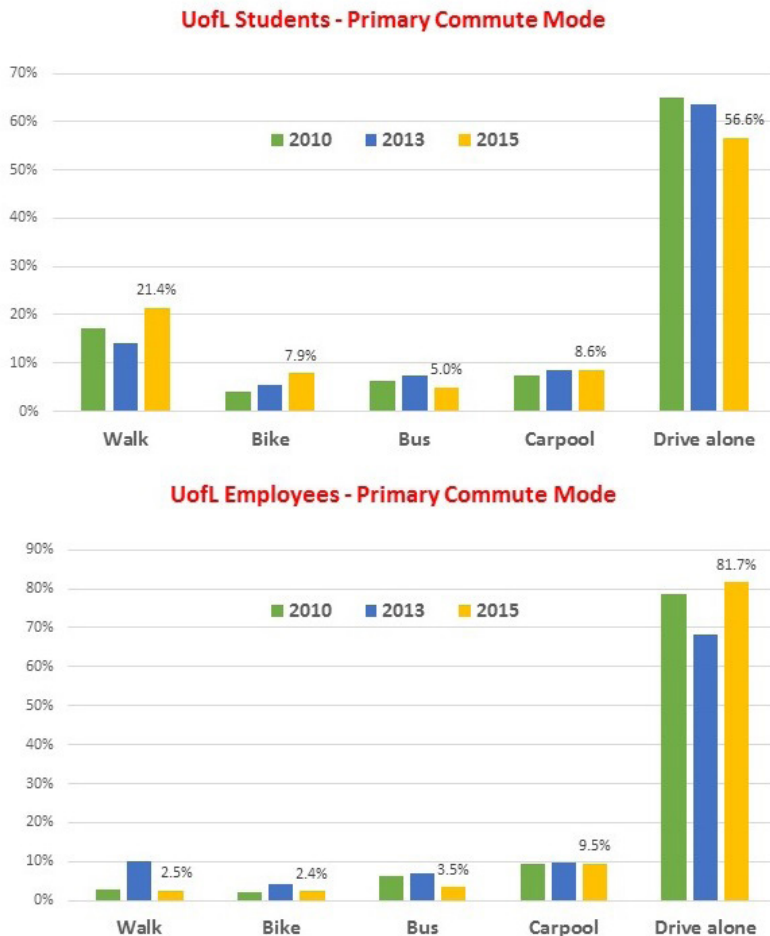


Figure 5 - Shifts in mode share for UofL commuters over time indicate a steady decline in driving as student’s primary commuting behavior. Though employees showed a similar trend initially, more have returned to driving in recent years.

changes in commuting behaviors and adjust our programs accordingly.

In addition to altering commuting patterns, the program has also generated tremendous goodwill for the university and the Sustainability Council. It is, by far, the most popular and most widely recognized sustainability initiative at UofL. It has also generated the most press, with local, regional, and national media stories.²⁰ Our efforts to encourage and support cycling has also led to UofL being named the most bicycle-friendly university in Kentucky, receiving a Silver rating from the League of American Bicyclists in November 2013 and again in 2017.²¹

Our experience demonstrates that success in altering commuting behaviors is predicated upon building maximum flexibility into the program and providing the campus population with a great diversity of sustainable solutions. Simply giving away bikes will never be enough. We had originally planned to save money and create a visual impact by ordering UofL-branded bikes in bulk and then distributing them, but we soon realized that, as with any sustainability solution, bicycles are not one-size-fits-all. Frame size is not the only issue. In the planning stages, we invited students, faculty, and staff to test-ride and evaluate a variety of commuter bike styles and we quickly discovered that comfort is highly personalized and not subject to consensus or majority opinion. We also realized that some applicants to the program may already have a bike and would prefer to get their bike fixed up and/or properly equipped for year-round commuting with lights, fenders, baskets, racks, bags, raingear, spare parts, tools, lubricant, etc.

The voucher program not only allows us to meet the highly varied needs of our students, faculty, and staff, but it allows us to directly support the local bicycling community by investing the funds in area bike shops rather than sending the money to a distant manufacturer. After the first year of the program, with only one out of three partner bike shops offering refurbished bikes, we decided in the second year to add two more partner shops which sell used bikes - a more sustainable and cost-effective option.

The Earn-A-Bike program itself, however, is not only the only thing we had to make flexible in order to truly change commuting behaviors. From the outset, it has been self-evident that we need to provide the university community with a full package of transportation alternatives, including free bus transit, bike share, car share, online ride-

matching/carpooling incentives, vanpools, and even attractive, affordable housing close to campus for students and employees. To get commuters out of their cars effectively, universities must realize that transportation decisions are based on a constellation of factors, which change throughout the years, seasons, and even days. We must design a full package of transportation alternatives that can meet the changing needs of our campus community. Though we have yet to tackle it effectively, the university has also learned that the next step in changing commuting behaviors is to adjust the disincentives for driving alone. Incentivizing alternatives is only part of the solution. Widespread change will require us to gradually reduce the quantity of convenient parking, increase parking permit rates, and ultimately move away from a system of year-long permits to more shorter-term, daily or hourly market-rate parking fees that allow for driving when necessary, but do not habitualize driving as the default mode through sunk costs.

Progress toward Climate Neutrality

UofL's efforts to implement our Climate Action Plan have been paying off for many years, as we make progress toward our goal of climate neutrality. Each spring we document our progress anew and on May 1, 2017, UofL released its latest annual Greenhouse Gas Emissions Report²², which documents that UofL's emissions continue to decline overall, despite an increase observed from 2013 to 2015. Thanks to continued vigilance, UofL reversed that trend and, in 2016, the university was able to achieve an overall reduction of 7.2% in carbon emissions from 2015. By continuing to invest in efficiency and behavior change, we have reduced emissions further. This was a vital investment for the sake of our students' futures, and, indeed, for our common future on this one shared planet.

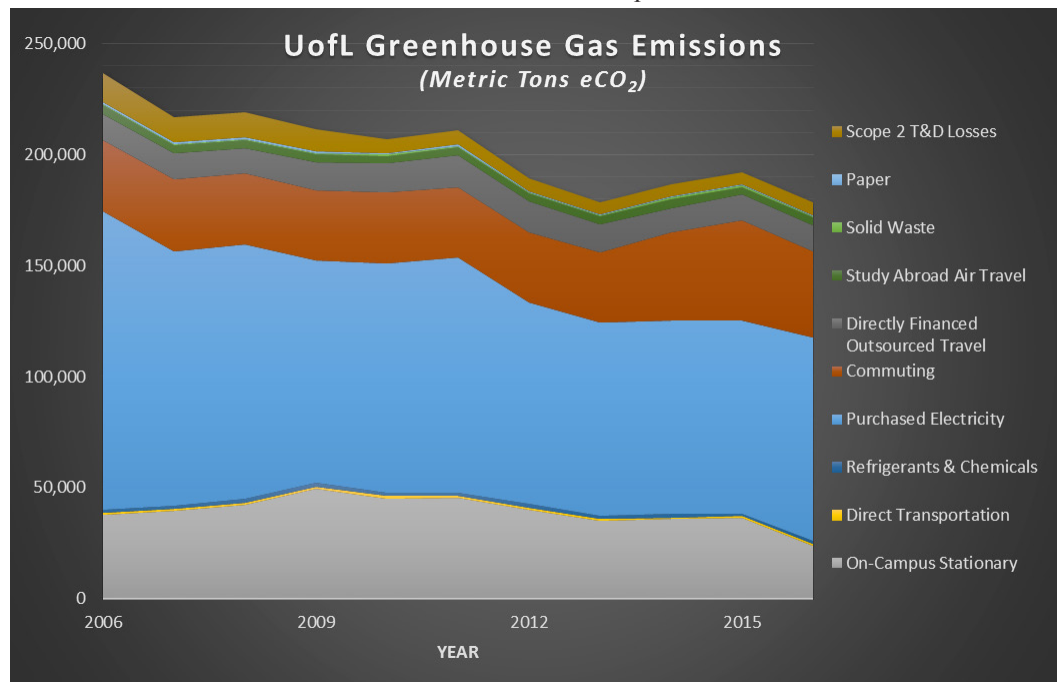


Figure 6 – Despite some vicissitudes, UofL has been successful in its early efforts to reduce greenhouse gas emissions.

Over the long-term, we have reduced our GHG emissions, even as we continue to grow in terms of physical size, campus population, and budgetary expenditures.

From 2006 to 2016, we estimate that UofL's net carbon emissions dropped nearly 25% from 236,101 to 177,704 metric tons per year.

We have also documented that UofL is well on its way to achieving our first milestone goal of a 20% reduction in emissions from our 2008 baseline by 2020. In 2016, we stood at an 18.69% reduction from the 2008 baseline. UofL decreased emissions by 40,836 metric tons of CO₂ equivalent per year since 2008. According to the EPA's greenhouse gas equivalencies calculator²³, this translates to:

- Taking 8,262 cars off the road, or 97,869,829 miles of driving, or 4,595,026 gallons of gasoline burned;
- 12,960 tons (or 1,851 garbage trucks) of waste recycled instead of landfilled;
- Emission from 4,312 average U.S. homes' annual energy use;
- 217 rail cars worth of coal burned;
- 1,447,572 incandescent lamps switched to LEDs; or the
- Carbon sequestered by 38,656 acres of U.S. forests in one year (or 1,058,312 tree seedlings grown for 10 years).

While this reduction is important and laudable, we certainly cannot rest on our laurels. We must remain vigilant, committed, and willing to invest resources in order maintain our progress and to ensure a sustained effort toward our ultimate goal of climate neutrality by 2050. We must continue to invest in emissions reduction, to innovate solutions that work in our unique urban setting, and to prioritize efficiency, behavior change, transportation alternatives and renewable energy. **The most important steps that UofL needs to take in the near-term are:**

1. **Reduce driving** through a Transportation Demand Management Plan that invests in and incentivizes alternatives, caps parking, and transitions UofL from highly subsidized annual permits to market-rate, pay-

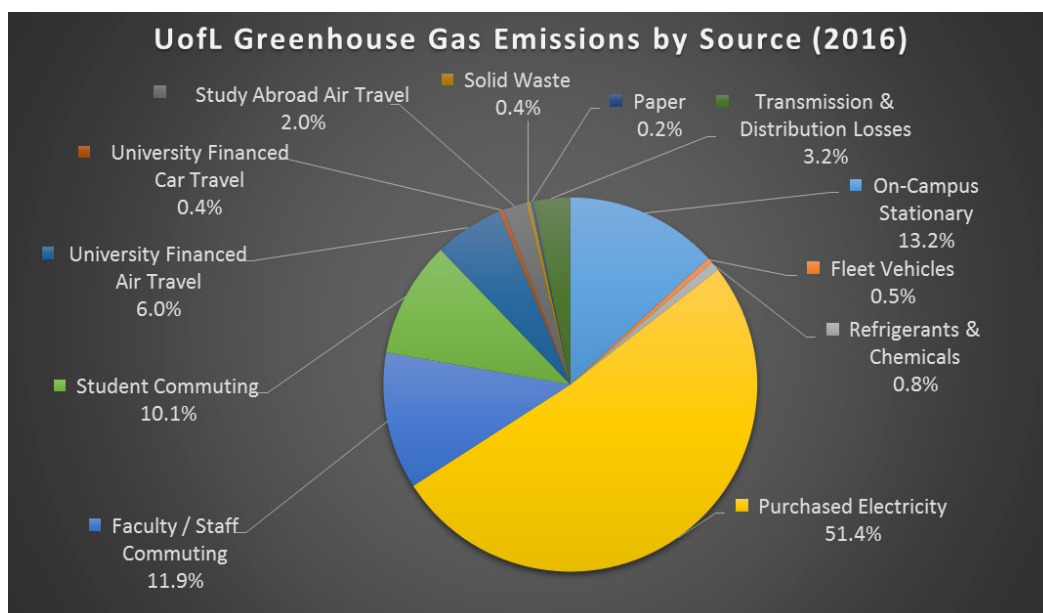


Figure 7 – By 2016, emissions from purchased electricity had shrunk to just over half of UofL's total GHG emissions, with transportation now accounting for nearly one-third of emissions. This suggests a need for renewed attention to changing transportation behaviors such as driving alone to campus and flying for university business without investing in carbon offsets.

per-use parking.

2. **Invest in large-scale renewable energy, behavior change, and energy efficiency** measures beyond the scope of the existing performance contract.
3. **Explore carbon offsetting and sequestration** solutions that would benefit our campus, community, and region.

The reductions we have been able to achieve over the years have occurred in spite of the continued growth of our university in terms of budget, employees, students, land, and building space. We've documented reductions across the board in terms of emissions per student, per capita, per square foot of building space, and per dollar of operating budget.

This encouraging news followed the two-year rise in emissions documented in our 2015 Greenhouse Gas Emissions Inventory.²⁴ That bad news, however, came on the heels of a very encouraging 2013 Greenhouse Gas Emissions Inventory²⁵, in which we estimated that emissions had already dropped over 22% from 2006 to 2013 (from 246,929 to 191,823 metric tons of carbon dioxide equivalent emitted annually, an amount equal to taking 11,600 cars off the road).

While the reductions to date are certainly worthy of note and should be celebrated, they still do not represent a steep enough decline to achieve our goal of climate neutrality by 2050. We must continue to innovate and strive for even greater reductions in years to come. And we must do so in a way that educates and inspires our campus population to take action in their own lives.

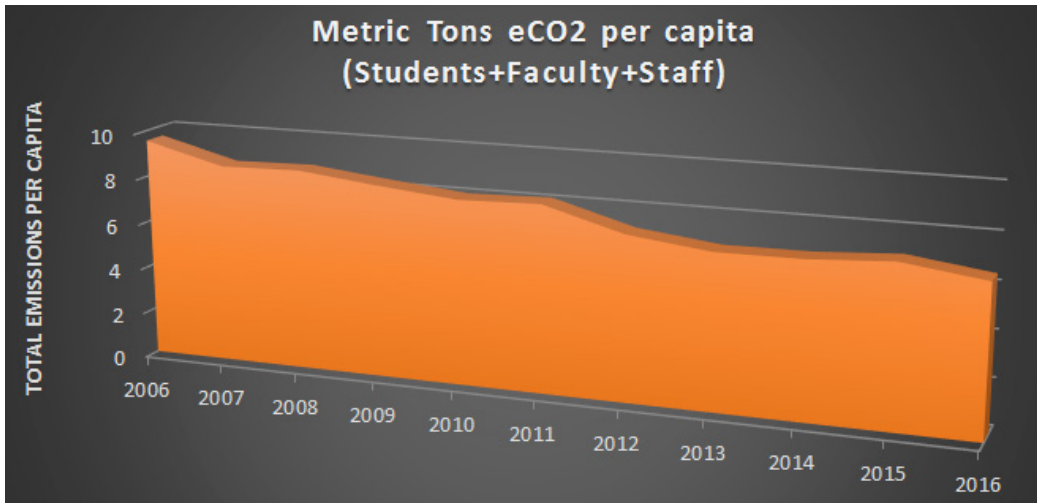


Figure 8 – UofL has managed to reduce greenhouse gas emissions, even while the university continues to grow in terms of population, physical size, and budget.

Dr. Justin Mog joined the University of Louisville administration in August 2009 as the university's first Assistant to the Provost for Sustainability Initiatives. He earned his B.S. in Environmental Studies & Geology from Oberlin College (OH) and his M.S. and Ph.D. in Land Resources from the University of Wisconsin-Madison Institute for Environmental Studies. In 2017, he was awarded the Joan Riehm Memorial Environmental Leadership Award for Sustainable Environmental Leadership in Public Service from Louisville's Partnership for a Green City.



Figure 9 – Dr. Justin Mog is a life-long bike commuter who has never held a driver's license.

PHOTO CREDIT: LOUISVILLE MAGAZINE (MARCH 2016).

References

- Alinsky, S. D. 1971. *Rules for Radicals: A Practical Primer for Realistic Radicals*. New York: Random House.
- Allen, W. J., O. J. H. Bosch, R. G. Gibson & A. J. Jopp. 1998. Co-learning our way to sustainability: an integrated and community-based research approach to support natural resource management decision making. Pages 51-59 in S. A. El-Swaify & D. S. Yakowitz (editors). *Multiple Objective Decision Making for Land, Water, and Environmental Management*. Proceedings of the First International Conference on Multiple Objective Decision Support Systems (MODSS) for Land, Water, and Environmental Management: Concepts, Approaches, and Applications. London: Lewis Publishers.
- Buenavista, G., I. Coxhead & K. Kim. 2001. Assessing the impact of a participatory, research-oriented project – results of a survey. Pages 232-257 in I. Coxhead & G. Buenavista (editors). *Seeking Sustainability: Challenges of Agricultural Development and Environmental Management in a Philippine Watershed*. Los Baños, Philippines: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development.
- Bunch, R. 1982. *Two Ears of Corn: A Guide to People-Centered Agricultural Development*. Oklahoma City, OK: World Neighbors.
- Davies, R. 1998. An evolutionary approach to organizational learning: an experiment by an NGO in Bangladesh. Pages 68-83 in D. Mosse, J. Farrington & A. Rew (editors). *Development as Process: Concepts and Methods for Working with Complexity*. London: Routledge.
- Freire, P. 1970. *Pedagogy of the Oppressed*. New York: Herder and Herder.
- Koffa, S. N. & D. P. Garrity. 2001. Grassroots empowerment and sustainability in the management of critical natural resources: the Agroforestry Tree Seed Association of Lantapan. Pages 197-217

in I. Coxhead & G. Buenavista (editors). *Seeking Sustainability: Challenges of Agricultural Development and Environmental Management in a Philippine Watershed*. Los Baños, Philippines: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development.

Lane, J. 1995. Non-governmental organizations and participatory development: the concept in theory versus the concept in practice. Pages 181-191 in N. Nelson & S. Wright (editors). *Power and Participatory Development: Theory and Practice*. London: Intermediate Technology Publications.

Lightfoot, C., O. de Guia, Jr. & F. Ocado. 1988. A participatory method for systems-problem research: rehabilitating marginal uplands in the Philippines. *Experimental Agriculture*, 24(3): 301-309.

Mosher, A. T. 1978. *An Introduction to Agricultural Extension*. New York: Agricultural Development Council.

Pretty, J. N. 1995. Participatory learning for sustainable agriculture. *World Development*, 23(8): 1247-1263.

Rubin, S. 1995. *A Basic Guide to Evaluation for Development Workers*. Oxford: Oxfam.

Uphoff, N., M. J. Esman & A. Krishna. 1998. *Reasons for Success: Learning from Instructive Experiences in Rural Development*. West Hartford, CT: Kumarian Press.

Waters-Bayer, A. 1989. *Participatory Technology Development in Ecologically-Oriented Agriculture: Some Approaches and Tools*. Network Paper No. 7. London: Agricultural Administration Unit, Overseas Development Institute.

Endnotes

1. <http://secondnature.org/what-we-do/climate-leadership/>
2. <http://secondnature.org/who-we-are/network/>
3. See Alinsky 1971; Allen et al., 1998; Buenavista, Coxhead & Kim, 2001; Bunch, 1992; Davies, 1998; Freire, 1970; Koffa & Garrity, 2001; Lane, 1995; Lightfoot, de Guia & Ocado, 1988; Mosher, 1978; Pretty, 1995; Rubin, 1995; Uphoff, Esman & Krishna, 1998; and Waters-Bayer, 1989.
4. <http://reporting.secondnature.org/cap/cap-public!700>
5. <http://reporting.secondnature.org/ghg/ghg-public!121>
6. <http://louisville.edu/energysavings>
7. <http://uoflnews.com/post/uofltoday/energy-saving-project-outpaces-its-goals>
8. <http://louisville.edu/uofltoday/campus-news/trustees-extend-energy-saving-project>
9. <http://www.getetemp.com/video>
10. <http://conncenter.org/>
11. <http://kppc.org/>
12. <http://louisville.edu/sustainability/education-research/green-threads>
13. <http://louisville.edu/sustainability/education-research/academic-programs>
14. <http://louisville.edu/sustainability/education-research/LivingLab>
15. <http://louisville.edu/sustainability/operations/earn-a-bike-program>
16. <http://louisville.edu/sustainability/uofltoday/campus-news/earn-a-bike-program-wins-national-honor>
17. <http://louisville.edu/updc/masterplan>
18. http://www.americanfitnessindex.org/docs/reports/2011_afi_report_final.pdf
19. <http://louisville.edu/sustainability/operations/transportation>
20. See, for example:
 - Earn-A-Bike program proves popular with students (UofL Today, Sept. 3, 2013): <http://louisville.edu/uofltoday/campus-news/earn-a-bike-program-proves-popular-with-students>
 - Earn-A-Bike Aims to Get the University of Louisville Cycling (HUD Sustainable Communities eNews, Feb. 2013): http://www.huduser.org/portal/sustainability/newsletter_013113_4.html#1
 - Sustainability means less cars and more free bikes (The Louisville Cardinal, August 28, 2012): <http://www.louisvillecardinal.com/2012/08/sustainability-means-cars-free-bikes/>
 - Bucks for biking: Swap car for bike and get \$400 subsidy from University of Louisville (Courier-Journal, July 25, 2012): <http://www.courier-journal.com/viewart/20120725/BETTERLIFE04/307250075/cycling-commuting-jere-downs-better-life?odyssey=tab%7Ctopnews%7Ctext%7Cbetter%20Life>
 - Students and Staff at UofL can Earn a Bike (WHAS-AM, July 25, 2012): <http://www.whas.com/cc-common/news/sections/newsarticle.html?feed=283307&article=10294969#ixzz21f71sCaj>
 - UofL offers incentive to give up parking permit (WKYT-27 Lexington, July 25, 2012): <http://www.wkyt.com/home/headlines/UofL-offers-incentive-to-give-up-parking-permit-163669826.html>
 - New college program encourages bike transportation (WAVE-3, July 25, 2012): <http://www.wave3.com/story/19115690/new-college-program-encourages-bike-transportation>
21. <http://uoflnews.com/releases/uofl-again-named-bicycle-friendly-university/>
22. <https://sharepoint.louisville.edu/sites/provost/Sustainability/Shared%20Documents/UofL-GreenhouseGasReport-2016.pdf>
23. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>
24. <http://reporting.secondnature.org/ghg/ghg-public!3828>
25. <http://reporting.secondnature.org/ghg/ghg-public!3027>



The Story of Parkview Place - Aiming for Carbon Neutrality

By Dick Bourne

Parkview Place is a “leading edge” five-unit apartment building in downtown Davis, California. This unique LEED Platinum project was developed by four senior couples interested in moving to a vibrant downtown and living as a community in a “zero net energy” (ZNE) building. All owners share an environmental commitment that has been expressed throughout the project’s history. Parkview Place, conceived in 2009 and completed in late 2013 (aerial photo above), has become our home and community, and has “overachieved” on its ZNE target. But it hasn’t been easy!

About Davis

Davis is a progressive university community with a significant history of energy efficiency and solar energy deployment. Davis was originally the site of the “University Farm” for the University of California. City population was only 3,557 in 1950, but in 1959 the Farm became the University of California, Davis. The student population grew six-fold, to 12,000 students, over the next ten years. Naturally, the City grew with the campus, mushrooming to 23,488 in 1970.

Current population exceeds 68,000, so almost two-thirds of Davis’ housing has been built since 1970. Around that time, several UCD professors and their former graduate students began an aggressive campaign to encourage energy-efficiency in new Davis housing. Leading the effort was Professor Loren Neubauer of the Agricultural Engineering Department- a pioneer in the passive solar movement who published 14 papers on passive solar principles between 1956 and 1972. Former students Marshall Hunt and Jonathan Hammond formed the Living Systems firm in 1973 and secured a grant to evaluate potential city legislation to foster energy-efficient building designs. Out of this work came the concept for a local climate-adapted, performance-based building code summarized in “A Strategy for Energy Conservation” (1974), leading later to the 1977 “Davis Energy Conservation Report.” Based largely on these papers and the advocacy of their authors, the City of Davis implemented an energy-efficiency ordinance for new homes, a solar energy ordinance for lot layout in new developments, and a retrofit ordinance that required energy efficiency upgrades when existing homes were resold.

Neubauer, Cramer, Hammond and Hunt were given an award for their work by First Lady Rosalynn Carter when she visited Davis in 1981. On the visit she also toured Village Homes, Davis’ internationally acclaimed “solar subdivision” begun by Mike and Judy Corbett in 1973. Completed in 1980, Village Homes

has for many years had Davis’ highest home resale values per square foot. Mike Corbett went on to become mayor of Davis and coincidentally, was our designer/builder for Parkview Place.

Unlike many cities of similar size, Davis has focused significantly on limiting the role of the automobile and on preserving its downtown. Until accepting a Target store in far east Davis in 2009, the City had not allowed large retailers in the city limits. Even grocery chains had to downsize their standard stores for Davis. A city official once declared on national television that all Davisites could buy groceries within a quarter mile of home. Though this was a stretch, most services are available within a short bicycle ride. And Davis is renowned as the nation’s bicycling capital, having implemented the first marked bike lanes in the US in 1967. Bike lanes are marked on all major city streets. Davis has been home to the US Bicycling Hall of Fame since 2010. With a 20% bicycle commute rate, Davis more than doubles the second ranking city (Boulder, CO at just under 10%).

The City of Davis has been actively planning for greenhouse gas reductions since 2006. The City adopted in 2010 a Climate Action and Adaptation Plan (CAAP) that sets “all-sector” community goals for GHG reduction. Also in 2010, “Cool Davis”, a grassroots volunteer citizens organization, was formed to assist the City in helping households reduce their GHG emissions, and to mobilize the community to meet the CAAP’s goal of carbon neutrality by 2050 (see companion article in this issue by Kerry Loux). Many City activities are aimed at achieving carbon neutrality by 2050. Requiring zero net energy (ZNE) for new buildings will be a major element in the City’s next CAAP.

Backdrop for Parkview Place

My wife Carol and I moved (with 9-year-old twins and a one-year old in tow) to Davis in 1978 from Lincoln, Nebraska; another “university city”, albeit a much larger one that was also



the state capital. We had lived near downtown in Lincoln, and were frequent bicyclists. In Davis we bought a contemporary flat-roofed, passive-solar home, and proceeded to add an active solar heating system. In 1993, with the twins flown afar, we built a smaller home in northwest Davis. We incorporated many innovative energy features including the compressor-less NightSky cooling system that I invented in 1979. NightSky cools water on the roof at night, and the cooled water is saved to cool the building during summer days. Our house was “discovered” in 2001 and soon nationally featured on Peter Jennings World New Tonight¹, in Sunset Magazine², and in a Sacramento Bee feature article³. In 2004 we added a PV system, but with gas heating we fell short of ZNE.

We loved life on the West Davis Pond, with views from our second-floor living level in this “upside-down house”. What a thrill to be right in the “big bird landing strip” as the many honking Canada geese zoomed low. Up on the roof, we could feel the power in their wings from the turbulence as they cruised in, just a few feet above our heads. But by 2008, with our nest truly empty, we had more house than we wanted to maintain, and made so many auto and bike rides to downtown Davis! Also, we had watched our parents decide too late to move to smaller, more convenient “last quarters.” So we opted to move downtown, toward Davis’ more and more vibrant urban core.

Our preference was a newer condo with some shared facilities and low maintenance. But there were only two such projects available. Both had only townhouse designs, and were at relatively high-traffic locations. We looked for several months before deciding in early 2009 that even if we could join an existing project, we weren’t going to be happy unless we were in a ZNE project with radiant heating and cooling.

Available throughout our search, but over-priced, was a 50’ x 120.5’ corner lot a half-block from Central Park at 4th and D Streets. On the lot was a dilapidated house reputed to be the oldest in Davis, and therefore a candidate for historic preservation⁴. The City even had a handout warning potential buyers of the property’s historic significance. But the lot had many advantages; the location was relatively quiet because 4th St. isn’t a through-street; it tees into C Street at Central Park. Even more importantly for us, the lot stretches east-west, ideal for passive solar design, and also has surprisingly clear sky above, in a city known for its large trees. Clear sky was doubly valuable, given our ambitions for NightSky and for enough PV to facilitate ZNE performance. Other considerations included a fraternity house just to the west (a needless worry) and a daycare playground for the historic church across the street (happy voices!).

Given the high cost of downtown property, and a fantasy from our youth of sharing home ownership with a few other couples, we decided to go big. Our sketches suggested we could fit at least four comfortable apartments in a project on the site, so we started looking for other couples to share our reborn fantasy. To our surprise, this step only took about two weeks, including the

commitment of enough cash to offer outright purchase, and to fund initial development work. Time had gone by and the property price was gradually falling. Several local developers had been tracking it and making low offers, but ours was enough higher to be accepted.

We hadn’t had close friendships with the other three couples but we did know them all in advance, which surely helped us assemble quickly. None of us expected that it would be nearly five years before our building would be ready for occupancy. As the long and complicated application process unfolded, it became clear that two couples were more committed than the others, and so we had 50% owner turnover before project completion. But initially, all were enthused about joining a downtown, owner-occupied ZNE project. We also felt we had a good chance of success with our application because we were not traditional developers. Instead, we were a group that would help the City achieve its stated goals of a) higher density, infill, owner-occupied downtown housing for seniors; and b) higher efficiency, “sustainable design” buildings.

The Elusive Building Permit

Soon we had a “tiger by the tail.” We began a four and a half year course through a gauntlet of citizen groups (Historical Resources Management Commission/HRMC, Planning Commission, and City Council) and City staff (Fire and Building Departments). We were surprised to find that in the liberal city of Davis our project wasn’t immediately welcomed for its obvious attributes. Some members of the HRMC seemed to feel that as new owners of the property we should be willing to restore it and convert it to a public museum, while others recognized that the building was not economically restorable. Early on, the HRMC hired at our expense a Sacramento consultant who recommended a “landmark” designation. (We maintained sanity through humor; recognizing that volunteer citizens on commissions donate their time to protect the public interest, we nonetheless joked about the Hysterical Resources Management Commission.)

At one point the HRMC asked us to submit detailed plans of what we would build, which we didn’t have yet and so had to pay to prepare. We had just selected Mike Corbett as our designer, so we authorized him to prepare a preliminary design. But later, before a final vote, the HRMC chair instructed members that they could not consider our proposed project; that instead, their decision should rest entirely on the historical significance of the existing house! So tell us again, why we needed to submit detailed designs for their review? We made clear that we intended to find a new home for the existing house if possible, and to build an artwork memorial to the famous Davis family that originally settled our site (which local artist Mark Rivera completed for us soon after occupancy-see header image). Almost a year of deliberations later, cooler heads prevailed on the HRMC and we were allowed to proceed to the Planning Commission. A helpful factor was a preliminary expression from the City Council that they valued our proposed project.

By early 2011 two of our four couples had dropped out. One couple turned 180 degrees, buying a large, beautiful, historic



ranch 20+ miles away in Vacaville. Our youngest couple, with two sons in high school, were relatively new to Davis, and wanted to settle into their own home soon. They bought in far east Davis. Both departing couples kindly agreed to wait for buyout until we had replacements; this despite the Bourne and Sue Barton/Don Morrill expressing that we would not actively seek replacements until we had City Council approval. Why bring others in until we knew we could build? But in late 2011 old friends Kay and Jerry Schimke strongly and irresistibly petitioned to join. Jerry was an invaluable contributor in all the remaining City battles.

We were proposing a three-story project, within the zoning guidelines, that would be no taller than the fraternity house next door or the church across the street. So citizen opposition from the Planning Commission took us by surprise. They expressed that our building was too tall, too big for the site, wasn't really a senior project, and was poorly named⁵. True, we didn't share a boundary with Central Park, but we would see it from all but our east-facing windows; and "Parkview Place" sounded better than Monopoly's "Park Place"! The Planning Commission voted down our project 4-3, and we were again in limbo. But we appealed to the City Council, and three weeks later, in late March 2012, we received their 5-0 approval.

After these downs and ups, our elevator became the next battleground; it was us against the Davis Fire Marshall, and he wasn't budging. We wanted a little elevator for taking groceries and packages up, and he demanded a great big elevator for taking big gurneys down, presumably laden with frail old bodies. But we weren't required to have an elevator at all. So if we didn't have to have one, why should we be forced to install one big enough for 100 apartments? The big elevator would add \$200,000 to project cost, vs. \$60,000 for the one we wanted. We started discussing this issue well before our Planning Commission rejection, and it wasn't fully resolved until the middle of 2012. At one point we considered just leaving a space for an elevator to be added in the dim future, but ultimately a council member intervened with the Fire Chief on our behalf. A solution emerged that was entangled with ADA requirements but was acceptable, and allowed us to proceed with our preferred LULA (limited use, limited application) elevator.

Through this long approval period we campaigned to familiarize our neighborhood with our plans for Parkview Place. We delivered information pieces door-to-door and held "lemonade and cookies" events on the front porch of the old house (see group photo next column). We also advertized a giveaway historic house, with our willingness to pay for a move and new foundations. The few interested parties declined after viewing the house's condition. But another important event occurred on that old front porch. After the news article about our council approval, contact from her sister in Davis led gayle yamada (no caps) and her husband David Hosley to our project. Living in Modesto, these former Davis residents wanted their near-term retirement to be here, and Parkview Place fit their desires perfectly. gayle joined us for snacks on the Peña front porch, and we all sensed a great fit. We talked at length about our wishes for Parkview Place to be a community as well as our sustainable home.



Three intrepid couples plan a compact, senior-friendly infill project on the site of the Peña family home at Fourth and D streets. From left are Carol and Dick Bourne, Sue Barton and Don Morrill and Kay and Jerry Schimke."

SUE COCKRELL/DAVIS ENTERPRISE 2012 PHOTO

After the yamada/Hosleys joined, we met weekly, typically without David who was not yet retired. We planned and guided both the developing construction plans and the organization of our community. We bonded quickly into a multi-talented working team, over and over confirming that many minds are better than one.

Detailed Design: Architecture

In 2010 we interviewed three Davis design firms and commissioned preliminary designs from two. Of these, we preferred the design by Mike Corbett. Mike, self-labeled a "master builder" rather than architect, presented a simple, elegant design in keeping with the semi-Spanish architecture of the Davis Community Church across the street. His initial design included floor plans and renderings (see photo below) that were altered very little when we proceeded through detailed design in 2012. The near-symmetrical building mostly faces north to 4th Street, with a central circulation core containing an elevator and wide stair. With 8511 square feet of occupied floor area in three stories, the building covers most of the lot. Each of the two upper floors includes two of the four 1410 square foot owner apartments. Whether on the east or west side, each owner apartment is oriented for significant through-ventilation; each has a large north-facing deck with roof overhang, for "elevated outdoor living." The west side ground floor includes a four-car garage, with four owner storage rooms behind. The east side includes an 863 square foot rental apartment, entered from the D Street side, and common rooms entered from the lobby. The rental apartment is intended to help pay property taxes, and perhaps in the future, to house a shared caregiver. The common rooms include an exercise room, a meeting room, a craft room, an entertainment room, and a full ADA bath. These rooms can function as temporary quarters for out-of-town family and guests.



Floor plans are similar for the four owner units, since plumbing risers and exterior design symmetry enforced some standardization. But each couple worked with designers to implement their own customized apartments. The Bournes' unit has one large bath, the Schimke and Barton/Morrill units have two baths, and the Yamada/Hosley unit has 1-1/2 baths. The Bourne and Yamada/Hosley units tend toward contemporary, and the other two are more traditional in their finishes, furnishings, lighting, and ceiling fans. All except the Yamada/Hosley unit, with finished concrete floors, have the same porcelain tile floors as the lobbies and stairs.

Working closely with designer Mike Corbett and structural engineer Norm Scheel, we started down a technical path with 8" of NightSky water contained on the roof under thick insulation panels, similar to our prior house but with more than twice the water depth. Norm kept saying we could do this, but it wasn't clear until we were far along that the structural costs, for both vertical and seismic loads, would be too high. So in early September 2012, about when we had hoped to start construction to beat the rainy season, we "pulled the plug" on rooftop water. We changed the design to relocate our 11,000 gallon NightSky/rainwater collection reservoir, now 38" deep, under the row of 10' x 8' owner storage rooms at the back of the garage.



Kay and Jerry Schimke look over an architect's rendering of their Parkview Place project on the site of the former Peña home.

2012 SUE COCKRELL/DAVIS ENTERPRISE PHOTO

Passive Solar Features

The simple "rectangular solid" building shape contributes to building economies, by maximizing use of the available land area while minimizing both construction cost and wall heat transfers. Mike Corbett made the building beautiful using a few simple exterior features, like the projecting decks and overhangs, the recessed corner windows, and the south side louvered awnings. Renderings and photos do not do the building justice; passing pedestrians constantly compliment the beauty of Parkview Place.

Following the traditional passive solar design path, our detailed designs included many energy-saving features; we typically went

well beyond the requirements of California's Title-24 energy code, including R50 ceilings, R21 walls, and high-performance vinyl windows. We "tuned" our window selections to maximize winter heat gain from the south while minimizing summer solar gains on the east and west. We carefully selected the casement window opening directions to maximize summer night ventilation. We also gave the building "cozy feet" by using "Formsulate", a slab edge insulation+form product developed by the Davis Energy Group. These attractive 2" thick, 12" deep insulated PVC boards include a termite stop and are left in place after the slab is poured. Passive performance benefits from the 4" first floor slab and 2" concrete toppings on the upper floors. We also used 5/8" drywall to enhance wall mass, with two 5/8" ceiling layers.

Energy Systems Design

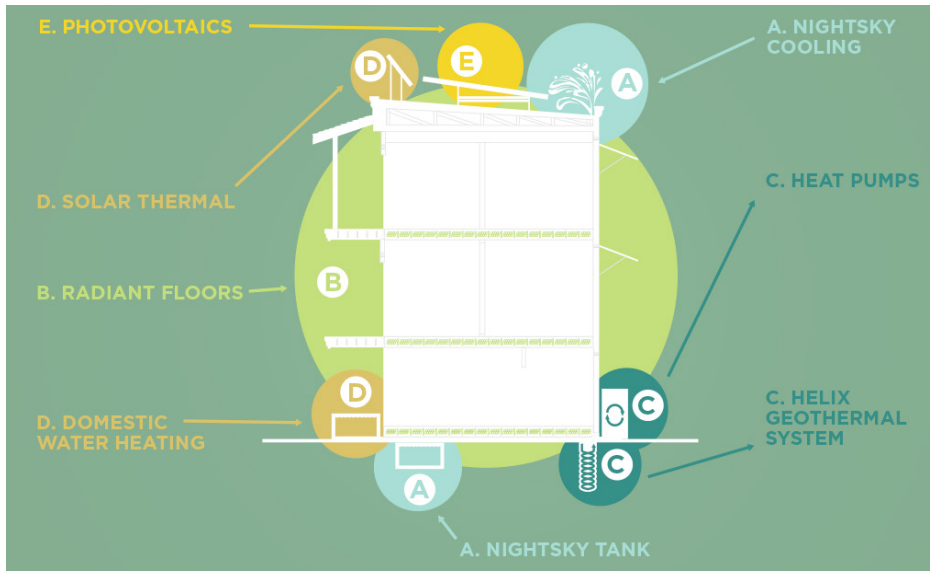
Our energy systems rely in large measure on ground-coupled water-to-water heat pumps. The heat pumps connect to radiant floors as our primary heating and cooling strategy. One heat pump also provides auxiliary water heating. Redundancies are provided by the NightSky system for cooling, and by our solar thermal system for water heating.

The Parkview Place schematic drawing below shows key energy systems components using a simplified building cross-section cut in a north-south plane. Letters correspond to major system components. (B) (the largest circle) highlights the radiant floor heating and cooling systems that deliver comfort to the interior of the building. A shared variable-speed pump moves water (warm in heating season, cool in cooling season) through closely spaced tubing in the concrete floors, under control of local thermostats. Tubing in the first floor was placed prior to pouring the floor slab. Upper floor tubing is in 2" thick concrete toppings on the wood floor structures.

The primary space conditioning system (C) uses two- 3.4 ton geothermal heat pumps and an array of helical ground heat exchangers. The water-to-water heat pumps, stacked in the garage, are coupled to 14 helical coils of plastic tubing that extend to 22 foot depth, configured in line near the building along the south and east walls. Ground temperatures are quite stable year-round compared to outdoor air temperatures, so the heat pumps operate very efficiently to extract heat from the ground in winter, and discharge heat to the ground in summer.

Water heating components (D) include a 600 gallon insulated, unpressurized storage tank under the main stair, a water heating loop off one of the heat pumps, a roof-mounted solar thermal system and connecting piping, and a large immersed heat exchanger in the domestic water tank. Pressurized cold water is heated in the heat exchanger on its way to hot water taps (showers, sinks, etc.). Only cold water is run to the kitchens, located at the back corners of the building. Flash electric water heaters at the kitchen sinks reduce water and heat loss. Dishwashers use their internal heaters.

The photovoltaic (PV) panel array (E) captures the renewable solar energy needed to achieve ZNE. 64 high-performance panels in a low-slope configuration parallel to the roof surface generate



The Parkview Place energy system design schematic.

peak output of about 17 kW. The NightSky system (A) spray-cools water on the roof while cleaning the PV panels to maintain their output. Both spray and rain water are collected at a single roof drain, and then flow through a ground-mounted filter into a site-built 11,000 gallon reservoir under the storage spaces at the back of the garage. At high rainfall rates, excess water bypasses the filter and drains through and around the GeoHelix boreholes to enhance ground heat transfer. Cooled water in the reservoir provides a secondary radiant cooling source in favorable weather conditions.

Demolition and Construction

Failing to find a new owner for the Peña house, we had it demolished after donating the stove and other artifacts to the Hattie Webber Museum, located a half block away in Central Park. Demolition was easy thanks to the dilapidated condition and wood foundation.

Since Mike Corbett doesn't use CAD, and anticipating revisions through the design process, we hired Norm Scheel's CAD-equipped office to prepare our design documents. Our original plan was to seek general contractor bids, but as the drawings emerged, Mike showed interest in building Parkview Place, and we realized this could save both time and money. Perhaps more importantly, we knew that Mike would diligently enforce his design standards during construction; and his extensive experience with the City could prove valuable through construction.

We wanted to install our ground heat exchangers while there was plenty of working space, so we made this our first construction step. Also, excavation is usually allowed before permit, so we installed these in October, 2012 (see photo below). After placing and manifolding, we backfilled with sand in the boreholes and gravel over the manifold pipes, to promote storm water drainage. The three photos below show 1) the heat exchangers being fabricated; 2) delivered, compacted and ready for drilling ("+" marks the spots!); 3) one installed, looking down into the

borehole. We expected our permit soon after placing these ground heat exchangers. But, due to considerable back-and-forth with the Building Department's out-sourced plan check consultant, we did not obtain a building permit until late December.

Due to surprisingly weak soil based on a 30' deep sample, our building needed extra wide and deep footings, but these provided an excellent base for the 4" slab. After the slab, the framing quickly rose to 3-stories. By May 2013 we were fully framed and sheathed, with windows, roofing, and stucco. We hoped for occupancy by Labor Day, but as often happens with custom construction, the work extended by months. Many issues arose during the 12 month construction phase, but Mike Corbett's experience and effective management helped us over the hurdles. Three owner apartments were occupied by early January, but various issues prevented the Yamada/Hosleys from moving in until late February. Meanwhile, we had no trouble renting the first floor apartment to Annie Henderson, a fellow senior who has become integral to our community.

LEED Platinum

From the start we wanted our project to serve as an example for others to emulate. We targeted a LEED Platinum rating from the US Green Building Council, and hired the Davis Energy Group as our LEED consultant. But we carried out much of the LEED work ourselves. We believed this approach would allow us to better understand our options and maximize our rating, by more continuously evaluating opportunities and constraints. Through the design and construction phases, and thereafter to secure the rating, our peerless and fearless LEEDers Don Morrill and Sue Barton invested countless hours toward securing our rating.

Major elements of this effort were: coordinating with Mike Corbett to select local materials to the extent possible; tracking subcontractor practices to minimize waste materials; and evaluating the costs of various potential LEED points so we would invest wisely in achieving our rating. We expected to succeed, in part because of our ZNE commitment, and in part because we anticipated many points for our sustainability features, including proximity to a large array of public transportation options: UCD "Unitrans" buses, Yolo County buses, Amtrak and Capitol Corridor trains, and the extensive Davis bike path network. Despite our confidence, we knew that our application would be carefully reviewed, that standards for many potential points felt arbitrary, and that we couldn't file our application or obtain our rating until well after occupancy.

The excellent outcome was that, more than a year and a half after first occupancy, we received notification from the USGBC of our **Platinum** LEED for Homes certification. We also learned that our point total (118.5) was the highest ever, worldwide, in the



multi-family category, and the second highest ever in the LEED for Homes program. Of course, with this news, we thought about how easily we have secured a few more points, to be on top of the world. But was it worth it? Not counting our time (mostly Don and Sue’s), we spent around \$10,000 pursuing platinum. The answer is yes; we accomplished our goal, and the platinum adds credibility to our claim that highly sustainable ZNE design can be cost-effective now.

Comfort and Energy

A living environment should provide all sorts of comfort: visual, thermal, acoustical, and psychological. To date, our occupant satisfaction level has been extremely high on virtually all counts. We all expected visual comfort, since we participated in the building design and selected our own interiors. As to thermal and acoustical comfort, the Bournes were the only Parkview Place couple to have previously experienced the quiet and steady acoustical and thermal comfort of radiant floors. All occupants now concur that their thermal comfort is the best they have ever experienced, and that it would be hard to go back to noisy, drafty forced air. Psychological comfort is also high, largely due to the sense of community we have established; it is great knowing we have close neighbors who share our interests, will keep an eye out when we are gone, and will be there for emergencies.

By the middle of our first summer, the Parkview Place PV system had generated more electricity than our project had consumed. We have consistently generated an annual surplus, as shown in the table below. (Data are not yet available for the last third of 2017, when PG&E began experiencing metering and invoicing difficulties.) To date, we have experienced more than an 18% energy surplus, despite a relatively cloudy 2016 when the surplus was slightly below 6%. The surplus has paid our meter charges and also generated a credit based on the wholesale price of electricity. We recognize that it would be wiser to use our surplus to power an electric vehicle than to sell it back to PG&E at a wholesale rate! To that end, the Yamada/Hosleys bought a Chevrolet Bolt in January 2017 and are now enjoying mostly “free” driving.

The one “discomfort” issue was impact noise transfer from tile floors to apartments below. We had hired a sound consultant before beginning detailed design, but we allowed his recommendations to be watered down before construction. Then, the drywall contractor did not follow the plans, further compromising performance. After years of discussion with all parties, we bit the bullet in mid-2017 and paid to replace all the ineffective ceilings. Needless to say, this was messy and expensive. We hope to force some repayment. Fortunately the rework has been effective.

Cost Effectiveness

Our ZNE project has repeatedly proven its value, and the integrated energy features were quite cost effective. The ground heat exchange system was installed economically and facilitated down-sized, high-efficiency heat pumps that, stacked and with all ancillary equipment, take up only 8 square feet of floor space for the whole building.

Parkview Place Energy Performance by Year

Year	PV kWh	kWh Used	kWh Unused	Surplus %
2014	27,386	22,926	4,460	19.5%
2015	29,487	23,367	6,120	26.2%
2016	25,170	23,800	1,370	5.8%
2017*	21,344	17,083	4,261	24.9%
Totals	103,387	87,176	16,211	18.6%

*First 8 months; missing data due to PG&E billing delays



Their high efficiency meant we could achieve ZNE performance with a smaller PV array. The standardized, economical radiant floor system also increases heat pump efficiency, and eliminated both the space and framing required for ducts, the duct heat losses, and the blower energy consumption of forced air systems. After completion, our final cost tabulations showed a payback of around six years for the ZNE features; but a simple payback analysis neglects our higher building value, proven recently in the resale of the Schimke unit. Also, leasing the first floor apartment was made easier by including utilities and communications systems in the rent.

Water Wisdom

Water conservation has been a major element in the Parkview Place sustainability effort. Through a combination of drought-tolerant landscaping, low-flow fixtures, rainwater capture, and re-use of gray water, we projected in the design stage that annual water consumption for our building with five dwelling units would be about 47,000 gallons compared to 136,000 for a typical new California single-family home. Unfortunately we were “ahead of the curve” with our gray water plans, which the City would not let us implement. In 2014, too late for us, the City passed an ordinance that would have allowed this feature. Our collected rainwater is reserved to replenish the NightSky system, so we do not use it for irrigation.

Governance

Becoming a supportive community within the larger Davis community was an objective from the beginning. Our community began when we formed an LLC to carry us through the entitlement process. We decided, on Mike Corbett’s advice, not to be condominiums, and so we researched other formats for “common interest developments” (CID’s). The advantage of CID’s in California is that, through the 1986 Davis Stirling Act, they allow senior new homebuyers to carry forward the lower assessed values of their prior homes, thereby reducing property taxes in their new homes. This is a particular opportunity in California, because of “Prop 13” enacted in 1978, which limits the rate at which assessed property values can be increased. Most homes that have been held for many years have assessed values far below their market values. When an existing home is sold, the sale price becomes the assessed value. So the logic for municipalities is that allowing seniors to carry their prior valuation forward frees the prior home for higher taxation. Three Parkview couples took advantage of this opportunity to limit property taxes.

Of the four CID types, we soon locked in on the Community Apartment Project (CAP) because it didn’t require us to form a permanent corporation with all the associated paperwork and governmental reporting obligations. A CAP is essentially a partnership in which “an undivided interest in land is coupled with the right of exclusive occupancy of any housing unit located on the land.”⁶ In our case, each of our four couples owns 25% of the overall project, and has the right to occupy a particular unit. Despite our early conviction that a CAP was right for Parkview

Place, we had great difficulty finding an attorney experienced with setting up a CAP. Ultimately we did find one in San Francisco, and she was instrumental in helping us develop proper governing documents.

Through the construction year of 2013, our weekly meetings mostly guided progress on the building. But we also kept focus on our need for governing documents of the CAP before move-in; the plan was to close down the LLC and begin the CAP partnership as soon as construction finances were settled. The result was 26 carefully developed pages that include an introduction, definitions and declarations, bylaws, operating rules, and miscellaneous provisions. The final document, entitled “DECLARATION AND GOVERNING DOCUMENTS ESTABLISHING PARKVIEW PLACE ASSOCIATION (an unincorporated Community Association)” were filed in the Yolo County Recorder’s Office on November 19, 2013.

Other than finding and working with various professional consultants, most of our time on the documents was spent on two “sticky wickets”: how we would make group decisions, and how we would deal with future vacancies and owner transitions. While strong believers in democracy, we were wary of the uncomfortable competition that might develop if we based our decisions on majority votes. We learned about a consensus method used in a Davis housing co-op, and after investigating, decided it was just right for us. In the “N Street Consensus Method,” if consensus cannot be reached, the dissenting parties must propose, and build consensus around, an alternative solution. These “blockers” can hold up to six partial group meetings, over at most a three month period, to build an alternate consensus. If they cannot, a super-majority, 75% of the full group, can move a solution forward.

This method has been extremely successful at Parkview Place. In more than five years of decision-making, we have never had to impose super-majority rule, nor have we ever needed more than a month to achieve consensus. Initially, we sometimes disagree, but as a meeting proceeds, we usually reach consensus before the end of the meeting. In our existence we have made decisions on hundreds of issues using the N Street Consensus Method, whose details are written into our governing documents.

We also worked hard on pathways for ownership transfer. While all four couples expected to live at Parkview Place for many years, we had to recognize that senior futures are uncertain; all of us had begun to lose treasured friends. Did we want an available interest to be sold to the high bidder? Did we want family members to have first choice? Did we want each member to have veto power over a proposed replacement? After grappling with these issues, we realized that maintaining our community was paramount, hence the following statement at the start of our CC&R’s: “The goal of the Transfer Policy is to sustain the sense of community and shared values for remaining members.”

We worked out and approved the following methodology: A member wanting/need to sell must let the others know in writing, and must find proposed buyers. Other members can



suggest buyers as well. The seller selects and submits a preferred buyer. Other members may interview the preferred buyer, and must (as a group) let the seller know whether they accept the proposed buyer- without considering sale price. If the other members reject the buyer, seller can present an alternate buyer.

While we didn't expect to face a transfer very soon, fate ruled differently. In January 2016, we were terribly saddened by our sudden loss of Jerry Schimke. Our community became vital in providing physical and psychological support to Kay. She stayed with us another 18 months, before relocating to Seattle to be close to her daughter and daughter's family. Fortunately our transfer process worked well. Several local couples showed immediate interest in the Schimke unit, but a couple just relocating to Davis quickly emerged as top candidates and they made Kay an acceptable offer. After several interviews, the remaining members enthusiastically accepted Phil and Barbara Wagner, and the transaction proceeded smoothly. The Wagners, who spend summers in Vermont, joined us in October and have very quickly become active, contributing members of our Parkview Place community.

Community Plus

All owners expressed an early interest in joining a small cohesive community. This takes effort, and thankfully no one has shirked on their community roles at Parkview Place. Weekly meetings through the design and construction phases built strong bonds, and since completion we have all enjoyed maintaining and fortifying our sense of community. We began with shared aspirations for sustainability, liberal politics, good humor, and mutual support. Through the tough times before completion, it was often humor that pulled us through and maintained our sanity.

We have become a community that on a togetherness scale probably fits between single family neighbors and a closely-knit family. We hold business meetings at least once a month to deal with maintenance and financial issues. Under the caring guidance of Sue Barton, our partner/facilitator, who is a retired psychologist, we often achieve rapid consensus. We begin meetings with "thankfuls", an always effective lead-in that reminds us how fortunate we are to share this community. We also hold a monthly social dinner, with rotating or "progressive" venue, and we have group outings to sports and cultural events. Perhaps the most telling indicator of our bonds is the obvious joy in meeting a neighbor on the stairs!

Looking Forward

One of our hopes has been that our success with Parkview Place would spread first within Davis, and then outward. But despite favorable publicity, a website, and frequent tours, we don't see that anyone has yet copied our building, our technology approach, or our organization. We do see several new high density downtown senior housing projects in Davis, but they are

neither ZNE nor "owner-developed." Things take time, and the construction industry is dominated by inertia. Unfortunately, we don't foresee the ZNE future really taking hold until contractors and technologies are ready to deliver ZNE in volume, and governing authorities require it. But the time will come...perhaps sooner in Davis.



Our community in February 2018: couples from left, Barbara and Phil Wagner, gayle yamada and Davis Hosley, Sue Barton and Don Morrill, Carol and Dick Bourne

References

1. Jennings's final words about our unique home were; "And the design? Well, it's not for everyone."
2. Sunset Magazine, September 2001, "A Laboratory for Energy Efficiency" by Peter Whitely
3. Sacramento Bee, March 9, 2002, "Feeling Energized" by Bob Masullo.
4. Narcissa Peña, the last direct descendent of the family that originally settled much of the land between Davis and Vacaville starting in the 1840's, had lived her entire life in the house, and was also the first female graduate of UC Davis.
5. On request, after the preliminary Fire Department review noted that there was already a Peña Drive in Davis, we changed Peña Place" to "Parkview Place" to avoid rescue mission confusion.
6. California Civil Code section 1351



Su Verde – The Proud Green Home of Louisville and How We Achieved Carbon Neutral

**by Sy Safi, UberGreen Spaces &
Homes**

Dreams, plans, goals, wishes, wants, needs, more, less, right, wrong, lawful, code, profitable, easy, norm, status quo.... that's quite a bit to think about – and where does it end?

Every project at UberGreen Spaces & Homes, whether it's a school, church, office, home, restaurant, hospital or existing building renovation, we think about occupant health and safety. Sounds almost cliché protocol for every organization or institution, which it should be, but has the topic been revisited lately? Are we REALLY thinking about occupant health and safety? Do we know the types of risks we are exposing ourselves to? Are we putting ourselves in an environment that is conducive of wellbeing – will it help us perform our jobs or duties at home to the best of our abilities? Do we think about the effects our decisions have outside our own world and the health and safety of other living things like wildlife, food and water sources, plants and other eco-systems?

The effects of human produced carbon are a widely discussed topic as it relates to the environment and the recorded differences in weather patterns and natural disasters. A topic we rarely discuss is the effects indoor environments have on our health and wellbeing. If we delve in a little on studies and findings we learn that on average we spend nearly 90% of our lives indoors – shocking given our natural human condition is to be outside. Our body clock runs on the sun rising and setting – the best sleep health follows that pattern and our circadian rhythm cycles the way it was designed to. We can thank Thomas Edison for creating the first commercial incandescent light, which has revolutionized life after sunset. We can also partially thank him for the detriment of our sleep health since most indoor lighting has no consideration for the color of light that goes through our optic nerve – important because it has a direct effect on the way we sleep and function throughout the day.

The EPA says our indoor air quality is 3 to 5 times worse than outside air. It is no wonder respiratory problems in children spiked from nearly nonexistent to staggering numbers beginning in the early 80's to present day. There's a plethora of studies done

on our nations drinking water and to no surprise a significant number of municipalities have harmful levels of pharmaceuticals and carcinogens in their water. Not only is it unsafe to drink but even more harmful to bathe in since it comes in direct contact with the largest organ on our body, our skin, and right into our blood stream. Breathing around this water has a harmful effect on our respiratory system – for example the toxic levels of water have higher VOC's (volatile organic compounds) when the shower is running where it gives off 10 to 20 times the safe amounts of VOC's in ppb (parts per billion).

What about the finishes in our spaces and the chemicals used in every day materials we get from the hardware store or our material suppliers? Paints, sealers, adhesives, carpets etc. much of which still have harmful chemicals constantly off-gassing in our indoor environment, have a negative effect on our immune systems, endocrine systems, respiratory and sleep health.

Let's put research aside and talk about the every day consumer -- who has high expectations whether it's a new car, pharmaceutical, smartphone, toy, blender or the next cool gadget we almost always anticipate and expect it to be that much better than its predecessor. Do we expect that from our homes and buildings year after year, next new build or renovation after the next? I think we should. Are leaky windows and doors expected, allergic reactions common to being indoors, an energy and water bill a default given, bad acoustics, outdoor noise pollution and loud mechanicals the accepted background noise and uncomfortable indoor climates as our typical interaction with spaces? I don't think so. This is just a short list of the very common complaints and feedback we hear from new clients and most people we engage with on the topic.

Almost half of our nations energy consumption goes towards powering our homes and buildings while the comfort levels and impact to our health is poor. Our value for space emphasizes more is better and superficial finishes satisfy our desires to reach certain levels of socio-economic status. The 'deciders' in society tend to be corporate entities, boards that take action according to



market dynamics rather than human or ecological consequences. We the consumers, rarely have a say in what is foisted upon us, nor do those at-risk populations who stand to suffer the most through poverty, hunger or displacement in the wake of these market successes.¹ It's our turn to become the 'deciders' of our own destiny.

Einstein once said, "We can't solve problems by using the same kind of thinking we used when we created them," so we at UberGreen Spaces & Homes decided to think a little differently about those problems and took them on as challenges. We gathered all the complaints, failures, displeasures, likes, dislikes; you name it and addressed each one until we reached the ideal – easier said than done.

What did we do? We first defined what 'ideal' meant to us. The 'ideal' would be to have a home or building that was essentially alive and operating it's own self by producing all of its energy, harvesting and treating its own water and treating its own waste while being beautiful, comfortable, healthy and in harmony with nature. Sounds like a 'Living' building because it is. We've adopted some of the worlds most credible and most stringent voluntary programs to be able to achieve the ideal in the Living Building Challenge, Passive House, the WELL Building Standard and DOE Zero Energy Ready to name a few.

Su Verde – The Proud Green Home of Louisville encompasses much of the ideal we wish for and more of what we never knew we needed or was even possible. We approached a healthy indoor environment from outside in. Positioning and designing the home on its lot to maximize natural daylight which minimizes our need for artificial lighting, saving on energy and designing the right color of light needed for circadian rhythm and good sleep health – one of the healthiest ways to increase our serotonin levels and naturally energize ourselves. Maximizing natural daylight with the right window performance specifications also helps us minimize our winter heating costs through passive heating from the sun. The average home has over a mile of cracks in it so we sealed up every opportunity for air to leak – no more drafts. Not only does this save on energy bills but it saves our structure from moisture damage and our indoor air from unchecked

contaminants, allergens and airborne pathogens – no more mold, just a super comfortable healthy indoor space.

"Oh no, don't homes and buildings need to breath??" No, they need to be properly ventilated so we install a separate balanced mechanical system called an ERV (Energy Recovery Ventilator or for us geeks an Enthalpy Recovery Ventilator) that exhausts all the stale air from the homes odor/wet rooms 24/7 and supplies fresh HEPA filtered air in the spaces we sleep and occupy the most. Imagine, the entire volume of air in your home gets changed out with fresh HEPA filtered air every three hours – side benefit, we barely have to dust.

Our beautiful interior finishes, most of which came from our local supplier and interior designer Honest Home, is free of VOC's and any harmful off-gassing in our indoor environment – including some of the furniture and local art. The average home or building in our climate zone is under insulated so we gathered the last 10 years of climate data sets from our local airbase, Bowman Field, to figure our peak heating and cooling demand loads to specifically dial in the ideal amounts of insulation in our walls, roof, windows, doors and even under the entire home. Another side benefit of the correct amount of insulation and airtight windows and doors is how QUIET the home is – you no longer hear noise from outside whether it be pedestrians, traffic or even harsh weather.

The steps we took to this point brought our energy needs down approximately 80% by just focusing on the shell of the home. Next we figured the artificial heating and cooling which creates a new challenge for sourcing the right equipment because of what we call 'micro-loads'. The challenge is most equipment in this application is too large for our needs so we found a much smaller geothermal system saving money on equipment and operating costs. We minimized our need for energy by ~80%, built a durable natural disaster proof structure and created an environment that promotes and improves occupant health, happiness and well-being. For the cherry on top we added a small solar array to generate enough electricity that off-sets the amount of energy we use for a zero dollar energy bill – hence carbon neutral. This translates to about \$400k in savings figuring in a 30 year mortgage – wow!

Wait there's more – rainwater collection that serves all the homes domestic water needs, whole-home water filtration system removing all harmful toxins and biophilic design satisfying our innate love of living things with many great indoor outdoor connections to nature through multiple levels of outdoor living and nature inspired designs.

The beauty of what we do, short of what has been described as 'miraculous' by partner clients, occupants and visitors, can be done on any scale residential, commercial and even industrial. The Bullitt Center in Seattle is one such model – a six story office building completely powered by the sun when averaged over the course of a year, with composting toilets on all six levels. It's a symbol of a revolution in modern architecture – bigger than the





majority of buildings in the US yet free from the burden of the grid in the country's least sunny major city. It's also a solution to affordable housing – this can be designed and built affordably and you can actually afford the operating and maintenance expenses. The healthy indoor environment is also a form of preventative maintenance – a regenerative space a day keeps the doctor away. Given personnel costs significantly outweigh building and operational cost, employers also benefit greatly from reduced sick days and health related costs, increased employee happiness and productivity.

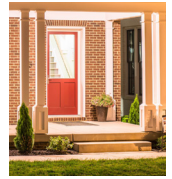
The founder of the Living Building Challenge, Jason F. McLennan, said in his book *Transformational Thought II* that “Buildings should exist only if they allow life to do what it does. They either diminish the conditions for life or create a positive framework for engagement and relationships upon which life builds and regenerates. Building design creates the opportunity to engage people and all of life in an ongoing and evolutionary relationship.” He also says “The premise behind a ‘Living Future’ is that any human activity is an opportunity to engage in a positive and healthy interrelationship with all of life.”¹

Carbon Neutral is yesterday's goal; it's our turn to give back by being Net Positive where we create all the energy and collect all the water needed and more of both to benefit others. We can also treat all our waste on site to replenish the necessary nutrients our soil needs for our food sources. By doing so, we can restore our health and happiness while restoring Mother Nature and its wonders.

Let's strive together for a *Living Future* – one that is socially just, culturally rich and ecologically restorative.

Sy Safi is a national and international award-winning sustainability designer and progressive builder in both the residential and commercial sectors.

Having grown up working in construction with his brothers and father, Sy was inspired to learn, innovate, create, and implement revolutionary practices in the built-environment. He graduated from the University of Cincinnati with a degree in Civil & Environmental Engineering. In 2006, he started GCCM Construction Services to better focus on advancing the construction industry to the 21st century by supporting and encouraging excellence in health focused design that is resilient and regenerative while restoring our natural ecosystems. To further public awareness and education, in 2012, Sy created My Green Kentucky Home, a model home that is Kentucky's first Net Zero Energy and Net Zero Water home certified LEED Platinum by the US Green Building Council. Since then, he's adopted the most stringent third-party programs in the Living Building Challenge, Passive House and the WELL Building Standard, while becoming a Department of Energy Zero Energy Ready Home Partner, a Certified Passive House Consultant, Passive House Institute US Certified Builder, WELL Accredited Professional and ADVANCE Ambassador. His mission with every project is to be socially just, culturally rich and ecologically restorative.



Sy's involvement in the green industry has a broad reach. At the request of the USGBC Kentucky Chapter director, Sy started the Greening the MLS Louisville Task Force to create true value in green homes by adding Third-Party Green Certifications and Green Features to Louisville's FlexMLS. Greening the MLS Louisville is comprised of real estate brokers, agents, lenders, appraisers, inspectors, homeowners, educators, builders, designers and more. Sy can also be found giving presentations on various subjects in sustainability and helping various non-profits and businesses improve their organizations.

References

- 1 Jason McLennan, *Transformational Thought II*



Can a University Become Carbon Neutral?

By Timothy Gutowski

This is the question we took up as a class project in 2.83/2.813 for the spring term 2016. We looked at the climate action plans of 22 colleges and universities in the U.S. (and four more in Europe), including 10 who signed the American College and University Presidents Climate Commitment (ACUPCC) and claimed they would be carbon neutral by 2016. The short answer to this question is a conditional yes. Of the 10 first movers, five are, or soon will be, carbon neutral; however, the solutions they use are not scalable, or have other issues, and the schools are arguably only able to achieve carbon neutrality because of their unique circumstances. Having said that, we should give them credit for their accomplishments.

The successful schools (all from the Northeast) are generally small, mostly liberal arts colleges in rural settings in states with below average carbon intensity electric grids (Vermont, Maine, and New York). They all appear to have a strong environmental identity and started on their carbon-neutral path as soon as the ACUPCC was signed (2007), or slightly before. They all appear to have sufficient, to significant resources including land as well as money. The most practiced solutions were, approximately in order of prominence: 1) burning wood, 2) buying carbon credits, 3) claiming sequestration from owned forests, and 4) burning syngas from cow manure. Everyone practiced some level of energy efficiency, but it was the four actions listed above that appeared to make the difference.

For larger universities with engineering and science laboratories, or with medical schools, the task is much more difficult. Second Nature, the group that is tracking the progress of the 679 signers of the ACUPCC agreement, provides data showing that “industrial-strength” universities such as MIT are about four times more carbon intensive per full-time enrollment (FTE) than the baccalaureate colleges (28 metric tons of CO₂equivalent per FTE versus 7tCO₂e/FTE). MIT currently stands at about 20tCO₂e/FTE, but our accounting is ongoing with potentially important pieces still missing (for example, institute travel, procurement, and waste).

Our acknowledgment of the success of the five schools is conditional, because each of the methods used to obtain their carbon neutral goal has some level of controversy that needs comment.

Wood burning is often assumed to be approximately carbon neutral over the long term, and can be feasible for a school if pollution is addressed, the demand is modest to reduce truck deliveries, and supply is available. Even so, wider use of wood has several issues: it is limited in supply, land intense, and would compete with cropland and affect food prices if developed on a large scale. In other words, it is not scaleable. Nevertheless, for these small applications, and from a carbon emissions point of view, burning wood cleanly is still better than using fossil fuels. It is worth noting that there are some sophisticated new technologies for burning wood including a 2MW combined heat and power biomass gasification unit at the University of British Columbia. It is also worth noting that there are remaining issues concerning the effect of harvesting on Net Primary Productivity for the decades immediately after the harvest.

The free market approach of paying someone else to reduce their emissions and claiming the credit, i.e., buying carbon credits, could be an efficient way to address this problem. The idea is to direct resources to the best opportunities. We found that four out of the five successful schools used some level of carbon credits to obtain their goal.

Note that for a small school with relatively low emissions, say 4tCO₂e/FTE (a real case), one can appear to solve the problem by buying low cost carbon credits at about \$10/tCO₂e with a resulting cost of \$40 per student per year. The chief challenges to this solution are related to risk and a potential moral hazard. That is, the effectiveness of some schemes can be hard to confirm, and potentially could lead to mischief. Morally, the Harvard philosopher Michael Sandel has argued that “turning pollution into a commodity to be bought and sold removes the moral stigma that is properly associated with it . . . [and] may undermine the sense of shared responsibility that



increased global cooperation requires.” These problems aside, if you follow this path, it requires an ongoing payment until you actually do get your carbon emissions down. For MIT, buying high quality carbon credits at \$20/tCO₂e (to reduce risk and ensure effectiveness) and assuming that full accounting puts us at 25 tons CO₂ per FTE would cost \$500 per student or a yearly total cost of \$5.5 million.

Several schools with large tracts of forested land are claiming carbon credits for increasing carbon sequestration on those lands. Although the protocols are still being worked out, the general idea is that by using improved forestry practices, one can manage a tract of land to increase the stored carbon (usually in the standing trees) over some considerable length of time, i.e., 40 to 100 years. If you have enough land, you can even sell these credits and make a profit, as at least one school said they are doing. If MIT were to try to engage in this practice, we would find ourselves at a noticeable disadvantage. Our campus land area of 68 hectares (ha) is about an order of magnitude smaller than our fellow industrial-strength university campuses. We found several examples of this carbon credit method. One was provided by the California Air Resource Board (ARB) with claims of an improvement potential of 1.56 tC/ha/yr (over 100 years) for forest in California (Willits Woods in Mendocino County). Using this number, MIT would need the land area equivalent of about 500 of our current campuses to sequester our 200,000 metric tons of CO₂ equivalent per year. That is, we would need to find this land and develop it over 100 years. (This scheme does raise some questions that need more discussion.)

Finally, two schools (both in Vermont) claimed to have developed a scheme to use syngas produced from cow manure. This plan requires, among other things, investment in a biogas digester, infrastructure to transport the gas to the school (a pipeline is preferable) and, of course, a sufficient supply of cow manure. This struck us as one of the more creative solutions. Unfortunately, we learned from one school that the current low price of natural gas has made such an investment questionable, resulting in a delay and causing that school to develop alternative options.

In comparison to the smaller schools, the bigger technical universities, with more in common with MIT, have, understandably, much higher emissions and more modest percent reductions. As mentioned earlier, the larger technical universities have roughly four times the carbon emissions per student compared to the smaller undergraduate institutions. In addition, the larger schools we studied have roughly 10 times the students (~20,000 versus ~2,000) hence the emissions from the larger universities are roughly 40 times larger (e. g., 200,000 tCO₂e versus 5,000 tCO₂). Changes in CO₂ emissions from these universities, over roughly the same length of time as the smaller institutions, ~9 years, range from an increase of 6%, to a decrease of 32%, with an average decrease of 9%. While this appears to be a much more modest reduction than the smaller first movers, in terms of absolute reductions, it is actually larger. That is 9% of 200,000

is more than three times the total emissions previously emitted by our prototypical small carbon neutral college (~5,000 tCO₂e). Hence, only looking at relative reductions could be misleading. Furthermore, using percent reduction in carbon emissions as the metric to judge improvement has an additional disadvantage in that it can favor late movers, for example those who only recently have converted from coal to natural gas for their power plant. In fact, this is part of the explanation behind the 32% decrease mentioned above. If you remove the power plant conversion from their data, we estimate the improvement is about 22%. For your information, MIT is not at all a late mover. MIT switched from coal to oil in 1935 and from oil to natural gas in 1995.

We found that the improvement strategies at the larger schools were somewhat different than those employed by the successful first movers. There was little mention of wood burning boilers, forest sequestration, and biogas from cow manure. There was a strong emphasis on energy efficiency, as with the small schools, and alternative renewable energy sources.

These renewable energy sources included photovoltaic panels, land-based wind turbines, small geothermal applications, small hydroelectric installations, and even water exchanges from deep lakes for building cooling. The general theme was to look for local opportunities and exploit them. And again, having a large land footprint is very helpful to accommodate these alternative land intensive energy sources. For those who do not have sufficient area to accommodate these projects, they could support their development at remote sites, and could possibly qualify for carbon credits. (More on this later.)

We found it difficult to assess the effectiveness of the various energy efficiency activities because the schools generally report their emissions at an aggregate level without sufficient detail to estimate these effects. However, the average energy use and carbon emissions per building area for some of these schools is far removed from current best practice, and it is reasonable to expect significant potential in this area. MIT has been working at this problem for some time with some success, but even so our current average energy use per floor area is about double best practice. It is worth pointing out that a major component of this high-energy use is our reliance on very high air exchange rates to ensure cleanliness and safety in our laboratories. And in addition, constant travel by people entering and leaving our buildings also leads to high air exchange rates. These are tough areas to address. We cannot compromise our standards for cleanliness, safety, and access, but could we meet them in alternative ways that reduce our air exchange rates with the outside? These problems need special attention if we are to be successful at reducing our building energy use.

Finally, there is the complication that successful universities are often growing. For the 11 universities for which we could gather building growth rates (in terms of floor area), we found a nominal average growth rate of about 3% per year. Yes, this is limited data, but it certainly rings true for us at MIT. A recent



article in the *MIT News* suggests that our energy demand is expected to grow by 10% by 2030. Obviously, this significantly increases the challenge to become carbon neutral.

Part of MIT's challenge is that we have already made our move to natural gas co-generation. There is no obvious renewable energy alternative that fits on campus and could meet all of our needs.

Here in Massachusetts, the biggest opportunities for renewable energy are not on our campus. They are offshore wind and hydroelectric from Québec. These options are, of course, well known, and are the subject of a recent important initiative by the Massachusetts legislature. But these will take time to develop, so in the meantime what should we (MIT) do? What we know is that many people at MIT are working on this, with new studies and more efficiency improvements in the works. But, we appear to be committed to on-campus natural gas co-generation for the next 20 years with plans to increase our capacity from 1 to 2 new 22MW turbines. So what seems clear, is that some off-site activities (e.g., carbon off-sets, and/or working with the local grid, etc.) will be necessary.

In fact, while this article was being written, MIT announced participation in a large new solar farm in South Carolina. MIT will purchase solar power said to be equivalent to 40% of the Institute's current electricity use. This seems a significant move by MIT to take these steps in a relatively short time to address climate change. Those who have done this work on our behalf are to be congratulated. At the same time, it would be very helpful if more information about these carbon reduction claims could be made available to the wider MIT community. The article in the *MIT News* claims that MIT will "neutralize" 17% of its carbon emissions through the purchase of solar energy. But it is not immediately clear how our support for the development of this solar facility is going to neutralize our emissions. One needs to differentiate between renewable energy credits, and carbon offsets. In plain English, enabling low carbon growth and actually reducing real carbon emissions are two different things. Real reductions require that a real source of carbon emissions be attenuated or shut down. Presumably this is part of how the new energy will be integrated into the local grid, but nothing was said about this. More information about this arrangement would be welcomed so we can understand the basis for these claims.

I would like to personally thank the students who worked so closely with me on this class project, in particular, Samantha Houston, the teaching assistant, Patrick Callahan and Rachel Perlman, as well as Sean Caetano, Tyler Capps, Wesley Cox, Aaron Downward, Amanda Hamlet, Matthew Hole, Patrick Linford, Jessica Press-Williams, Michael Sandford, James Slonaker, Prithivi Sundararaman, and Kevin Thomas.

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MONTGOMERY COUNTY PUBLIC SCHOOLS, ROCKVILLE, MARYLAND

FY 2016 Environmental Sustainability MANAGEMENT PLAN



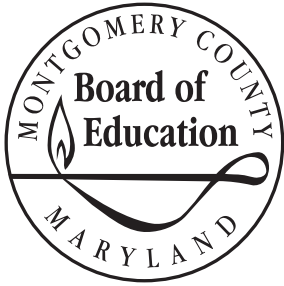
2013 DISTRICT SUSTAINABILITY AWARD WINNER
U.S. DEPARTMENT OF EDUCATION

GreenRibbonSchools



Malcolm Baldrige
National Quality Award
2010 Award Recipient





VISION

We inspire learning by providing the greatest public education to each and every student.

MISSION

Every student will have the academic, creative problem solving, and social emotional skills to be successful in college and career.

CORE PURPOSE

Prepare all students to thrive in their future.

CORE VALUES

*Learning
Relationships
Respect
Excellence
Equity*

Board of Education

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Student Member

School Administration

Mr. Larry A. Bowers
Interim Superintendent of Schools

Dr. Maria V. Navarro
Chief Academic Officer

Dr. Kimberly A. Statham
*Deputy Superintendent of
School Support and Improvement*

Dr. Andrew M. Zuckerman
Chief Operating Officer

850 Hungerford Drive
Rockville, Maryland 20850
www.montgomeryschoolsmd.org

A Letter From the Interim Superintendent

Dear Community Members:

MONTGOMERY COUNTY PUBLIC SCHOOLS (MCPS) is committed to responsible environmental stewardship. Our students and staff take pride in our conservation efforts to ensure that the earth's natural resources are preserved for present and future generations. MCPS is recognized as a national leader in sustainability and environmental stewardship. Since 2012, six MCPS schools have been recognized with the National Green Ribbon Award by the U.S. Department of Education. In 2013, MCPS was among the first 15 school districts in the nation to receive the District Sustainability Award from the U.S. Department of Education. These recognitions are a testament of our dedication to environmental sustainability.

Through the years, MCPS has made tremendous strides in reducing greenhouse gas emissions by making environmentally friendly decisions in the areas of building construction and maintenance, resource conservation, transportation, materials and waste cycles, and information technology. MCPS continues to be a leader in green and healthy-schools initiatives and integrates environmental literacy into the curriculum and instructional programs at all grade levels. These actions not only help us to make our earth a better place to live, but more importantly, help to mold our students to be responsible environmental stewards and future leaders.

The Fiscal Year 2016 Environmental Sustainability Management Plan continues to celebrate the milestones that MCPS has achieved and provides updates to the progress in the areas of environmental sustainability efforts. This document plots our path forward and conveys goals and strategies as we continue to work together with our students, staff, and community members to make our planet greener each day.

Sincerely,



Larry A. Bowers
Interim Superintendent of Schools
Montgomery County Public Schools

We teach our students the value of protecting our natural resources and being good stewards of the environment.

About MCPS

IN THE 2015–2016 SCHOOL YEAR, MCPS operated 202 schools with a student enrollment of 156,447. MCPS is a very diverse school system in terms of race/ethnicity and socioeconomics. In the 2015–2016 school year, 30.1 percent of enrollment was Non-Hispanic White, 29.2 percent Hispanic, 21.4 percent African American, and 14.2 percent Asian. Hispanic student enrollment is the fastest growing share of MCPS enrollment. Increasing socioeconomic diversity also characterizes our enrollment. In 2015–2016, 35 percent of enrollment qualifies for the Free and Reduced-price Meals program.

MCPS IS THE LARGEST SCHOOL SYSTEM IN MARYLAND and the 17th largest school system in the nation. Also, it is the most rapidly growing school system in Maryland. Since 2007, MCPS has grown by more than 18,000 students; and projections show that an additional 10,000 will enroll by 2021. This rapid pace of growth in enrollment presents a challenge in providing adequate school capacity. The Board of Education Approved *FY 2017 Capital Budget* and the *FY 2017–2022 Capital Improvements Program* total \$1.729 billion. Funds to add much-needed school capacity compete with funds needed to revitalize aging schools and provide for building system maintenance. Obtaining funding at a level commensurate with MCPS's facility needs is an ongoing challenge, as county and state funding sources are limited.

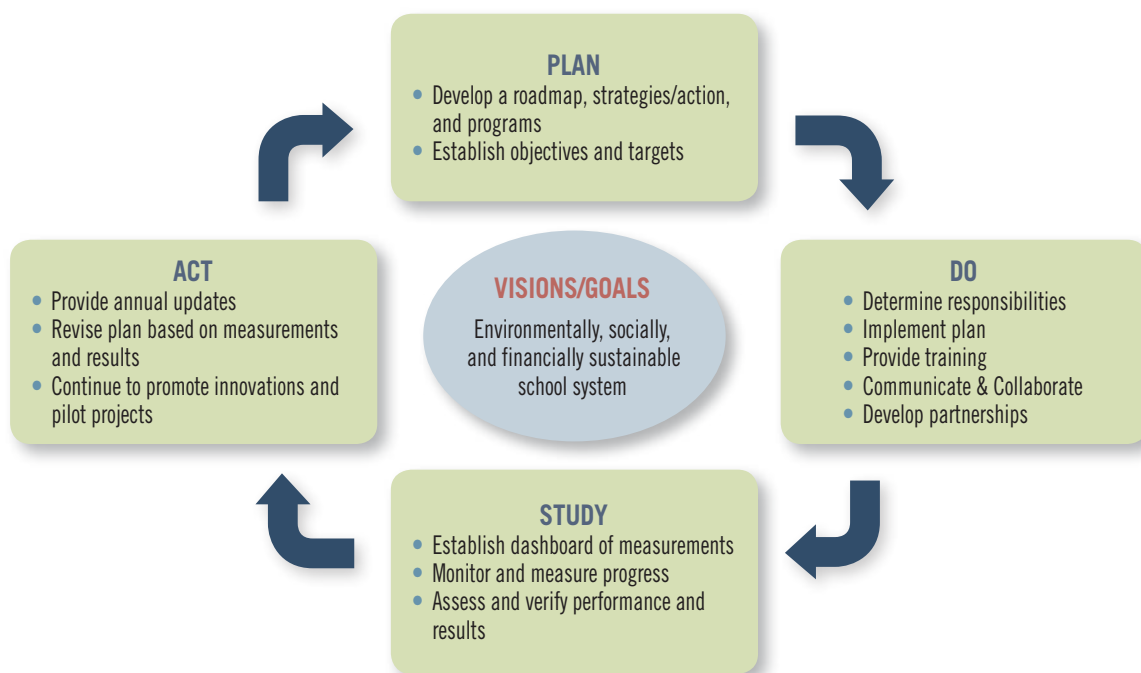
OVER THE PAST DECADE, MCPS HAS INTENSIFIED ITS COMMITMENT TO SUSTAINABILITY, which provides a solid foundation on which to build. The facility assets are approximately 25.6 million square feet, spread over 3,600 acres of real property. A vibrant community of more than 22,000 employees, consisting of teachers, administrators, and supporting service employees ensure that students receive the best education in a safe and comfortable learning environment. MCPS receives support, advice, and direction from engaged community partners and from intergovernmental agencies.

MCPS IS THE RECIPIENT OF NUMEROUS AWARDS, including the District Sustainability Award by the U.S. Department of Education (2013) and the Malcolm Baldrige National Quality Award (2010), the nation's highest Presidential honor for performance excellence, including a focus



on organizational sustainability. The U.S. Department of Education National Green Ribbon Schools (ED-GRS) Award began in the 2011–2012 school year. Since then, Northwest High School; Francis Scott Key and Sligo middle schools; and Cedar Grove, Summit Hall, and Travilah elementary schools have been proud recipients of this much-sought-after national recognition. Our schools are encouraged to seek a voluntary Maryland Green School certification each year. As of April 2016, 81 MCPS schools have been successful in fulfilling the requirements and have received the Maryland Green School certification.

About This Document



THE MCPS INAUGURAL Environmental Sustainability Management Plan was published in June 2014 to celebrate all MCPS has achieved, explain the current state, and chart a course for the next stages of our sustainability programs and practices. Building on that groundwork, this document is a continuation of our sustainability management plan. It provides updates on five categories: Student Education, Awareness, and Actions; Building Construction, Maintenance, and Operations; Energy and Natural Resource Conservation; Materials and Waste Cycles; and Transportation.

The FY 2016 Environmental Sustainability Management Plan (ESMP) updates the goals set forth in the FY 2014 ESMP, sets short-term goals, and adjusts the strategies as necessary to accomplish the long-term goals. Although

MCPS is proud of the significant progress made each day by our students, staff, and school communities to preserve our natural resources; emphasis to achieve more needs to continue in order to ensure the environmental sustainability for present and future generations.

The MCPS Environmental Sustainability Management Plan is well-aligned with The MCPS Strategic Planning Framework and the *Culture of Respect Compact*. As part of our emphasis on excellence and organizational effectiveness, based on the core values of the strategic plan, our accomplishments over four decades are a direct result of the school system's commitment to environmental sustainability and continuous improvement.

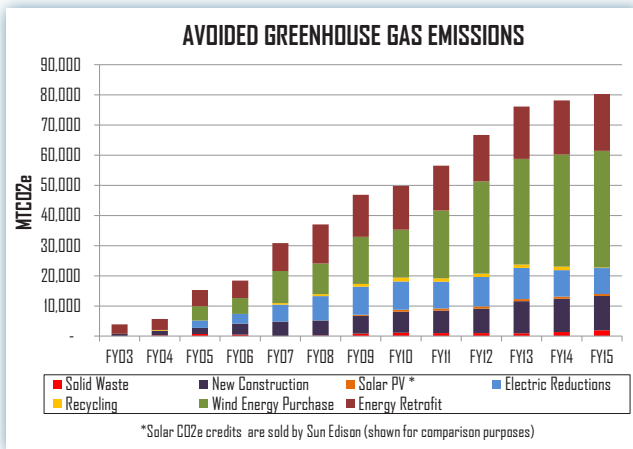
Our Impact on Climate Change

OUR EARTH IS WARMING! *Earth's average temperature has risen by 1.5°F over the past century, and is projected to rise another 0.5, to 8.6°F over the next 100 years. Small changes in the average temperature of the planet can translate to large and potentially dangerous shifts in climate and weather. Human activities have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere.*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

THE COMPREHENSIVE DISTRICTWIDE PROGRAM to reduce the impact on our environmental footprint includes recycling initiatives, energy conservation efforts, and a commitment to green construction practices in all building projects. We teach our students the value of protecting our natural resources and being good stewards of the environment.

The avoided GHG emissions in FY 2015 is the equivalent of reducing approximately 190,476,190 miles of driving by an average passenger vehicle or reducing the amount of GHG generated to power 11,000 homes for an entire year.



190,476,190 miles driven by an average passenger vehicle

11,000 homes' electricity use for one year



In FY 2015, MCPS has reduced its greenhouse gas emissions (GHG) by nearly 80,000 MTCO₂e, through a variety of environmental conservation programs and initiatives, as described in this update. These activities resulted in a carbon footprint reduction of 31 percent, compared with 2003.

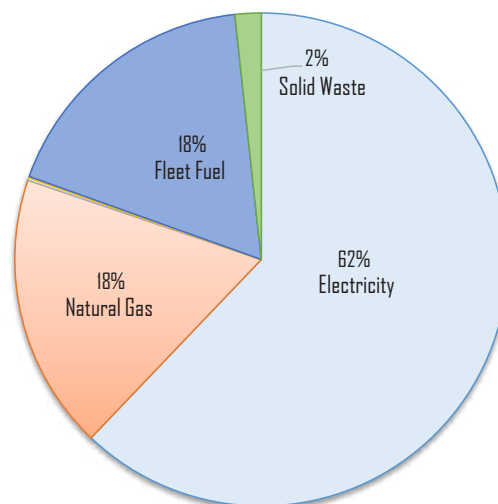
The largest contributor of GHG emissions is associated with the heating, cooling, and lighting of our schools and facilities. Electricity and natural gas account for approximately 80 percent of the GHG emissions of MCPS. Fleet fuel used for buses that drove 19,237,356 miles, to transport 101,949 students, and other service vehicles resulted in the second highest source of GHG emissions in FY 2015. The priority to reduce GHG emissions persists in the areas of building energy efficiency and fleet vehicle efficiency—the categories of greatest opportunity.

Our Vision for Sustainability

MCPS IS A STELLAR EXAMPLE of how to collaborate and be environmentally, socially, and financially sustainable across a school system. We have built a world-class education for sustainability into the curriculum and programs in order to equip our students with skills, knowledge, and an ethic of sustainability.

Our commitment to sustainability helps us create healthy learning and living environments for our students, teachers, staff, and community by integrating economic, social, and environmental considerations into all of our decisions. MCPS will continue to partner and collaborate with enthusiastic parents, engaged community partners, and intergovernmental agencies, in addition to working directly with schools to pursue our vision for environmental sustainability. As responsible environmental stewards of the earth, our students and staff conduct stream studies, create edible and perennial gardens and small-scale reforestation projects, and take part in Adopt-a-Road projects and local fairs, among others, to make our schools and living communities a better place for generations to come.

Fiscal Year 2015 GHG Emissions By Source



*Fuel oil and propane are less than 1%



“Don't Drop The Top” Poolesville ES students and staff learned about the hazards of plastic bottle tops to the environment, then collected thousands of colorful bottle tops to create this beautiful mural.

Student Education, Awareness, and Actions

Our progress

PROGRESS IN STUDENT EDUCATION, awareness, and actions since the publication of the FY 2014 Environmental Sustainability Management Plan have focused on the following areas:

- Environmental Education
- Increasing Conservation Awareness
- Conservation Actions and Participation



• Environmental Education

Our Neighborhood, Our Watershed, a National Oceanic and Atmospheric Administration (NOAA) grant-funded systemic and systematic Grade 4 initiative, is bringing a project-based learning Meaningful Watershed Education Experience to all 12,000 students by building the subject-matter capacity of approximately 350 teachers. Awarded in FY 2014, this grant is in its third year. Two-thirds of schools have participated in the module training and implemented the module; the remaining third will begin professional learning in summer 2016.



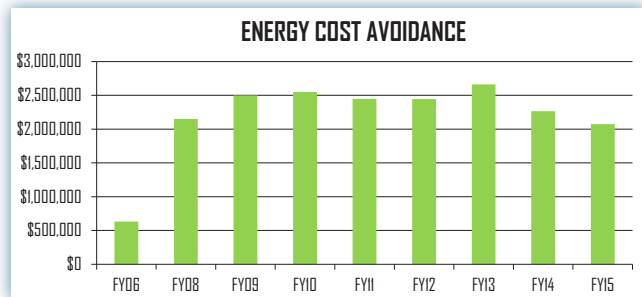
Since FY 2015, the Outdoor Environmental Educational Program (OEEP) has taken the lead in integrating Trout in the Classroom (TIC) as a systemic Meaningful Watershed Education Experience into Grade 6 classrooms by obtaining funds to gain time with teachers to provide professional learning and assist with acquiring additional grants to purchase equipment. Twenty-two middle schools are now using TIC as a project-based learning unit, involving approximately 5,000 students.

OEEP and the Department of Facilities Management are coordinating, managing, and facilitating the visits of the Maryland Agriculture Education Foundation's (MAEF) science mobile to every elementary school in MCPS over the next five-year period. The MAEF mobile has provided an environmental learning experience to approximately 15,000 students in FY 2016. It is projected that, by the end of FY 2018, 45,000 MCPS elementary school students will have had an agricultural experience on the mobile lab.

OEEP and School Energy and Recycling Team (SERT) continue to expand their use of social media platforms to inform, motivate, and reach more students, families, and school communities. Twitter™ recently has become a tool to highlight best practices in sustainability and environmental education. Additional sources for various types of gardens

and outdoor learning have been added to the OEEP website, along with several new videos to help teachers engage students in environmental Student Service Learning on the school sites.

With a focus on ensuring that outdoor environmental experiences are accessible for all students as part of an MCPS equity plan, OEEP has developed new initiatives to increase the number of underrepresented student populations engaged in OEEP programs, including priority scheduling for Title I schools in the day program, which started in FY 2014, and videos about outdoor environmental education for Spanish-speaking families, featuring Spanish-speaking parents of older students in FY 2016. Over the past two years, the participation of Title I students has increased by 50 percent in the day program. At the middle school level, MCPS developed a sustainability problem-based learning unit embedded into the Technology Systems course. The unit focuses on sustainable practices as they relate to the Maryland Voluntary Standards for Technology Education. MCPS will be developing problem-based learning units for high school science courses to align with the Next Generation Science Standards (NGSS). Many NGSS relate closely to environmental sustainability, and are expected to include problem-based learning (PBL) units where students explore and propose solutions to environmental sustainability-based problems. During the 2015–2016 school year, high schools began piloting PBL units, focused on invasive species and urban farming, in the NGSS-aligned high school biology course.



- **Increasing Conservation Awareness**

The School Energy and Recycling Team (SERT) program in the Department of Facilities Management guides and provides necessary resources to staff and students at all MCPS schools to foster a culture of conservation, with a special focus on energy efficiency and recycling in the school. Classroom activities, tool kits, videos, and friendly contests with

awards give our students rich and rewarding experiences in environmental stewardship. During FY 2014 and FY 2015, the SERT program conducted nearly 100 outreach events at schools, including energy and recycling assemblies, Let's Do Lunch events, and Read A-louds.

The SERT program staff continue to visit all schools quarterly to recognize them for exemplary behaviors and to identify opportunities to conserve energy and increase recycling. During FY 2014 and FY 2015, the SERT program staff conducted approximately 1,600 regularly scheduled school visits, in addition to providing outreach and support to student green teams. As a result of these efforts and energy-efficient improvements to schools, MCPS achieved more than \$2 million in energy cost avoidance in FY 2015.



- **Conservation Actions and Participation**

MCPS schools are encouraged to seek Maryland Green School Certification through the Maryland Association for Environmental and Outdoor Education (MAEOE). This voluntary certification program promotes learning that incorporates local environmental issues investigation and professional development with environmental best management practices and community stewardship. In the FY 2014 Environmental Sustainability Management Plan, MCPS set a goal for 50 percent of its schools to achieve this certification by 2024. Since FY 2014, 40 new schools have completed the requirements and received the Maryland Green School certification, and 28 schools have completed the recertification process to maintain their certification. As of April 2016, 81

MCPS schools are proud recipients of the Maryland Green School certification. Due to the tremendous success of the schools in pursuing and achieving the Maryland Green School Certification in the past two years, MCPS has revised the FY 2014 goal for number of schools to achieve certification by 2024, increasing it to 65 percent.



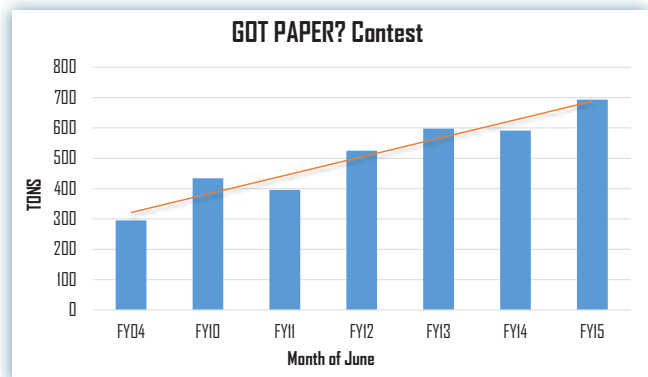
SERT continues to promote the program through various annual contests, including the following:

WATT'S UP POSTER CONTEST: Schools look forward to this popular annual contest that encourages students from Grades K through 12 and staff to create posters to demonstrate their efforts in energy and water conservation and recycling. This contest creates healthy competition among students and staff to produce artwork to increase the conservation awareness among their peers systemwide. Many schools hold poster-judging contests at their schools and submit their winning entries to the SERT contest. The posters communicate the importance of environmental conservation through the artistic talents of MCPS students and staff. The winning posters are printed and distributed systemwide to increase awareness about environmental conservation. Each year, more than 70 MCPS central office staff

participate as judges to select the winning posters. SERT received 261 entries during FY 2014 and FY 2015.

LEAD BY EXAMPLE AWARENESS CAMPAIGN: This campaign challenges all secondary schools to create a model resource conservation plan to include energy conservation and responsible recycling projects or initiatives toward a sustainable future. The SERT program encourages all MCPS middle and high schools to participate in the Lead by Example contest to further reinforce a culture of conservation and sustainability at their schools and in their communities.

Many of the entries include behavioral strategies, energy-efficiency projects, and awareness campaigns. Often, initiatives such as energy audits with recommended conservation practices, task lamps for staff, computer shutdowns, contests, recycling weight increase plans, video, and social media awareness strategies are practiced at the schools as a result of this campaign. All of these actions promote behaviors among students, staff, and the community to be responsible environmental stewards. The winning entries with proven projects and initiatives are highlighted in SERT Best Management Practices, an online resource for all schools to use as helpful conservation strategies and expectations for efficient building use and operations.



GOT PAPER? CONTEST: This contest was designed to maximize recycling opportunities before the end of the school year. The contest is held in June and provides students with opportunities to recycle as they clean out their lockers and as teachers clean out their classrooms and desks. The elementary, middle, and high school with the most paper recycled, by weight, during the month of June will be winners. This contest has proven to not only increase the paper recycling tonnage but has also resulted in a decrease in solid



waste. During the contest period in FY 2015, MCPS recycled 693 tons of paper, an increase of nearly 400 tons during the same period in FY 2004.

ENVIRONMENTAL SERVICE LEARNING: Grade 6 students participate in environmental service learning, which provides them with 10 hours of Student Service Learning (SSL) toward the Maryland State Department of Education (MSDE) graduation requirement for SSL. OEEP assists science teachers who are responsible for ensuring that the SSL hours occur by providing professional learning sessions for teachers to build their capacity to engage students. OEEP also collaborated with MCPS TV to produce professional development videos that present the “whys” and “hows” of specific environmental action projects. The three actions presented are invasive species removal, habitat construction, and growing perennial plants.

Long-Term Goals

- Increase student knowledge and engagement in environmental sustainability and sustainable practices.
- Use our buildings and grounds as tools to support education for environmental sustainability and outdoor stewardship.
- Make 65 percent of our schools Maryland Green School-certified, by 2024.
- Reduce annual greenhouse gas (GHG) emissions by 12,000 MTCO₂e through SERT school-based energy and recycling efforts, by 2024.

Short-Term Goals

- Increase participation of students in meaningful watershed education experiences through the Grade 4 and Grade 6 curricula by 3 percent, by FY 2018.
- Increase participation of high school students in local environmental issue investigation and action by 5 percent, by FY 2018.
- Continue to create action plans that drive the work forward on the MCPS Environmental Literacy Plan.
- Develop problem-based learning units for high school science courses to align with the Next Generation Science Standards (NGSS), to be completed over the course of the next three years, with full implementation of NGSS by the 2018–2019 school year.

Strategies

- Provide ongoing professional learning to build teacher capacity to teach environmental education.
- Partner with various community stakeholders to provide professional learning for teachers around environmental sustainability.
- Identify additional grant sources to provide funding for the development and implementation of professional learning.
- Continue to use social media to highlight best practices in environmental teaching and learning.

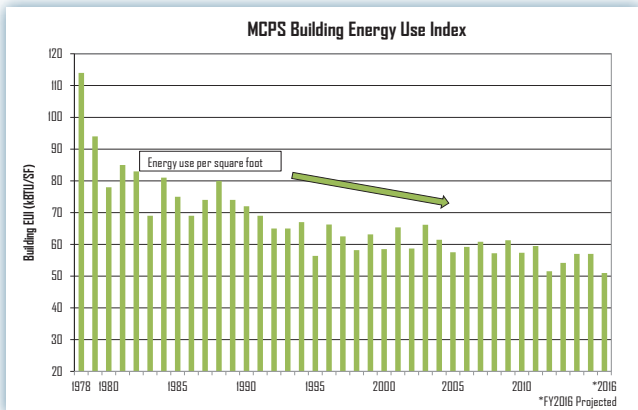
As of 2016, 81 schools are Maryland Green School certified, and six schools have received the National Green Ribbon Award

Energy and Natural Resources Conservation

Our progress

PROGRESS IN ENERGY AND NATURAL RESOURCE CONSERVATION, since publication of the FY 2014 Environmental Sustainability Management Plan, focused on the following areas:

- Solar Power Purchase Agreement
- Peak Load Management (PLM)
- Lighting and Energy retrofits
- Water conservation
- Forest conservation
- Green Power Procurement
- Building occupants
- Information technology

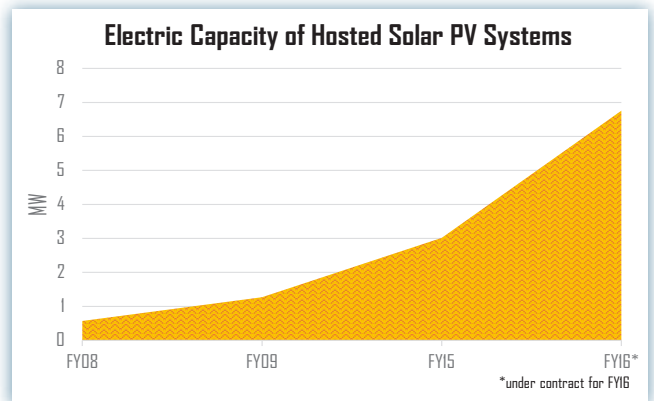


The FY 2016 projected Energy Utilization Index (EUI) for MCPS has decreased to 51 kBtu/SF, largely attributed to the joint efforts of various departments, divisions, students, and school-based staff. In FY 2015, the MCPS EUI was 58 kBtu/SF, less than half of the 1978 EUI, 30 percent less than in 1989, and 20 percent less than in 2003. This is a significant accomplishment in energy conservation efforts. The MCPS portfolio of buildings are approximately 15 percent more energy efficient than the average school energy usage of 66 kBtu/SF.

• Solar Power Purchase Agreement

MCPS has continued the development of solar power purchase agreements (PPAs) for on-site renewable energy generation. In 2009 and 2010, MCPS began hosting large-scale rooftop photovoltaic systems at eight schools, with 1,264

kilowatts of installed capacity. In 2015, rooftop solar photovoltaic systems were installed in four schools.

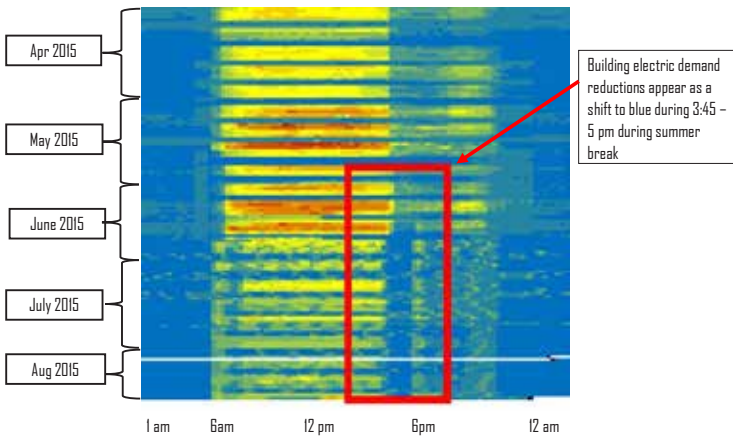


As a result, MCPS lead hosting of net-metered solar power purchase agreements among school districts in Maryland, with 3,014 kilowatts (DC) of installed capacity. The 12 school sites with photovoltaic systems are projected to produce an annual capacity charge cost avoidance of approximately \$145,000. MCPS currently has contracts to develop additional solar PPAs at four schools and an off-site ground mount installation. MCPS is committed to pursuing additional solar PPAs that provide positive financial incentives for the development of local solar PV arrays. MCPS is particularly interested in the potential of aggregate net metering using off-site solar PV systems.

• Peak Load Management

MCPS continues to manage its summer electric capacity charges through its Peak Load Management (PLM) program. The installation of advanced electric meters that record use in 15-minute intervals enhanced the ability to manage operations that affect electric demand at individual schools. During the summer, the Department of Facilities Management reviews the performance of schools at the critical hours, on a weekly basis, for compliance with PLM directives. Where compliance was not achieved or other scheduling problems were observed, corrective measures were undertaken and tracked to completion in a database. Cost avoidance for the efforts during the summer of 2015 was approximately \$1.7 million. See Electric Demand Heat Map illustration on page 10.

**Electric Demand Heat Map For A Typical High School
During Spring & Summer**



- **Lighting and Energy Retrofits**

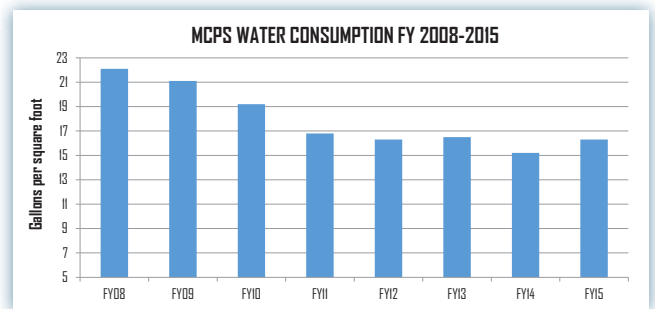
During FY 2014 and FY 2015, three retrofit lighting projects were successfully completed in the auditoriums of Quince Orchard, Northwest, and Kennedy high schools. These efforts are projected to reduce five-year auditorium lighting costs by more than 66 percent. The use of Light-Emitting Diode (LED) retrofits of auditorium and parking lot lighting is among the current best applications of the LED technology in our schools. Additional applications of LED technology are being investigated and piloted.



As stated in the MCPS Resource Conservation Guidelines, among the strategies to conserve electric use is to ensure that exterior lighting is turned off during the daylight hours. Building security lighting is programmed to be on from dusk to dawn daily. Parking lot lights are programmed to be turned off at the close of the regular school day or evening activities (by 12:00 midnight at the latest). They are programmed to be on from 6:00 a.m. to dawn. The school building service managers monitor the operation of the exterior lighting and notify the maintenance depot of any irregularities.

In 2015, MCPS continued the installation of digital astronomical time clocks to control the exterior lighting in schools. These electronic clocks have digital accuracy, daily sunrise/sunset adjustments, and seven-day capacitor backup for power outages. They are programmable through a laptop computer. Approximately 120 digital astronomical time switches were purchased for installation at schools with the old analog time switches and at schools where irregularities were reported due to malfunction of the time switches.

MCPS has a centralized energy management system (EMS) and installed Automated Temperature Control (ATC) systems to regulate central heating, ventilating, and air conditioning (HVAC) systems to maximize energy savings by remotely controlling the operation of the systems. In FY 2014 and FY 2015, 24 schools were upgraded to new EMS systems.



- **Water Conservation**

The Department of Facilities Management continues to monitor the water consumption at MCPS schools and facilities. The SERT staff conducted quarterly school visits to observe water consumption and identify water-conservation opportunities. School administration received feedback regarding issues related to building occupants' use of water. Observations regarding water wastage, due to leaks or equipment failure, were followed up with work orders for the Division of Maintenance to perform the necessary repairs.

During the winter of 2014, the Department of Facilities Management observed a very significant increase in the water bill for Damascus High School. The monthly water bill increased from an average of \$8,000 to nearly \$32,000 in a period of three months, resulting in an urgent investigation to detect the source of the leak. The collaborative efforts between the Department of Facilities Management and school staff resulted in the discovery of a large underground water main leak. The water leak was more than 20 feet below the ground surface and may not have been detected for a long period of

time without the constant monitoring process and the diligent efforts of MCPS staff. Repairs were expedited to avoid further waste of water and damage to the infrastructure.

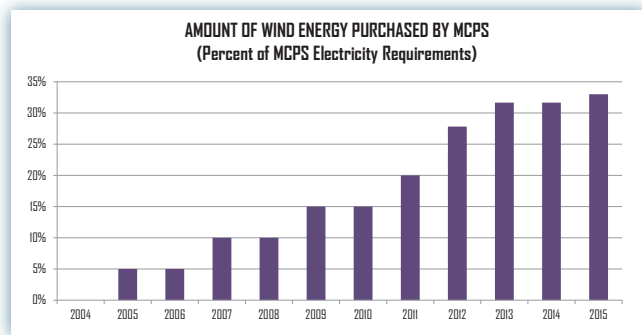
Water-efficient devices continue to be the standard on all new construction and restroom renovation projects. Since FY 2013, one new school and seven replacement schools, were built. Since 2013, restroom renovations were completed at seven high schools, 10 middle schools, and 40 elementary schools. These schools were fitted with water-efficient devices. The SERT program has focused on water conservation at the high schools because they are the largest per capita users of water, and they use large amounts for irrigation. In FY 2015, MCPS achieved more than 25 percent reduction in high school water use, compared with FY 2005.

- Forest Conservation

The Montgomery County Forest Conservation Law aims to save, maintain, and plant forested areas for the benefit of county residents and future generations. For each revitalization/expansion and addition project in the MCPS Capital Improvements Program, MCPS complies with forest conservation requirements to meet these stringent regulations. Forest-conservation measures for individual projects may include on-site retention in an undisturbed condition (on-site easement), off-site reforestation using a designated forest mitigation bank, or acquisition of an off-site protective easement for existing forested areas not currently protected. Currently, MCPS has brought under forest-conservation easements more than 44.3 acres on Board of Education property and has more than 21.8 acres of off-site forest conservation credits.

- Green Power Procurement

MCPS continues to increase its procurement of electricity and clean or renewable energy through purchase of renewable energy certificates (RECs). It is now at 33 percent. These RECs represent the carbon offsets from clean or renewable energy sources, primarily from wind and solar generators. MCPS purchases wind energy RECs to offset 20 percent of the carbon from the electricity that the school system consumes, to comply with the Montgomery County Energy Policy. MCPS purchases additional RECs that offset approximately 13 percent of our electric requirements to comply with the state of Maryland Renewable Portfolio Standards. MCPS began purchasing RECs at 5 percent in



has gradually increased the percentage of procurement. In FY 2015, the school system spent more than \$500,000 to purchase RECs.

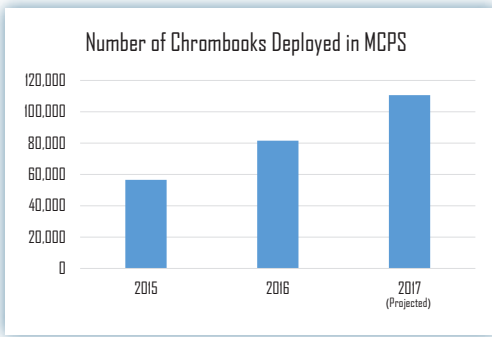
- Building Occupants

The School Energy and Recycling Team (SERT) program continues to support students and staff in all MCPS schools as they take active responsibility for reducing energy and water consumption and solid waste. Students engage in an array of SERT activities that provide productive outlets for enthusiasm and creativity to reduce environmental impacts. See the Student Education, Awareness, and Action section of this report for more information about SERT. This is a part of ongoing efforts to change the culture and promote environmental sustainability.

- Information Technology

The MCPS 2014–2016 Strategic Technology Plan provides greater access to the school system’s expanding digital curriculum and enables our instructional staff to create 21st century learning spaces in all of our schools. Since the plan was first shared in 2013, school staff has been working to integrate mobile and cloud-based technologies with technology-enriched instructional and curricular resources that engage students in more explorative and interactive learning experiences. Moreover, the integration of these technologies is facilitating easier ways to assess students’ understanding and provide them with timely feedback.

MCPS has begun a multiyear effort to provide all students with access to mobile computers and a cloud-based learning platform. In the fall of 2014–2015 school year, students in Grades 3, 5, and 6, as well as high school social studies classes began using the new technologies. Due to budget constraints, the expansion of the program was reduced in the 2015–2016 school year to Grade 4 and approximately 150 middle school classrooms. During 2016–2017 school year, MCPS projects to deploy approximately 27,000 devices for Grade 5,



remaining middle school classrooms, and a high school content area. It is projected that the cumulative deployment of devices

from 2014-2015 to 2016-2017 school years will be more than 100,000 units. The program will expand to other grades in later years.

As a result of the increased digital curriculum and access to technology directly in our classrooms, the following reductions in the overall volume of centrally printed instructional media has occurred:

- Paper use dropped by 7 million pages from FY 2014 to FY 2015.
- In FY 2016, paper use is projected to drop by 18 million pages below FY 2015.
- There is a two-year materials saving of approximately \$180,000, including paper, ink, staples, and equipment replacement parts.
- There has been less use of small printers and multifunction devices at schools.
- Paper deliveries to the schools dropped by 4,811 cartons, from FY 2014 to FY 2015.
- Approximately \$65,000 was saved in paper stock in FY 2015, due to reduced paper use.
- The total two-year savings of material costs, and the avoidance of new costs due to a reduction in the use of printed instructional media, is approximately \$447,000.

Long-Term Goals

- Maximize building energy efficiency, achieving a systemwide building energy use of 45 kBtu per square foot per year, by 2024.
- Complete installation of building energy management systems in all buildings, by 2024.
- Increase the use of renewable energy sources.
- Achieve a sustained reduction of energy use by computers and other equipment that plug in.
- Reduce greenhouse gas emissions from electricity use by 15 percent, by 2024.
- Reduce water consumption by 20 percent, by 2024.
- Reduce print instructional text by 70 percent, while expanding the use of digital curriculum and access to technology in schools.

Short-Term Goals

- Increase the capacity of hosted solar photovoltaic systems to 5 MW, by FY 2018.
- Retrofit 15 high school auditoriums and 10 gymnasiums with LED lighting, by FY 2018.
- Pilot LED lighting in other applications, as appropriate.
- Upgrade building Energy Management Systems at 25 schools, by FY 2018.
- Replace the centralized HVAC scheduling system for relocatable classrooms.
- Install and commission a replacement Utility Information Management System that benchmarks consumption, using EPA Portfolio Manager.
- Bring schools to 5 percent electric cost avoidance over baseline, by FY 2018.
- Provide anywhere-anytime access to people, information, and resources.
- Develop and expand virtual communities and online learning to connect classrooms and encourage resource-sharing among all stakeholders.

Strategies

- Incorporate LED lighting in areas most appropriate and cost-effective, including auditoriums, parking lots, and emergency and security lighting.
- The Department of Facilities Management will collaborate with schools to resolve high energy and water usage.
- Continue support of school-based energy teams by SERT, using school visits, outreach, and performance feedback to minimize energy and water-consumption waste.
- Perform comparative analysis of energy use at schools to identify energy-conserving opportunities.
- Employ energy audits and recommissioning in buildings that have sustained high levels of energy use.
- Continue to coordinate with the private sector to explore cost-effective power-purchasing agreements and other public-private partnerships that further MCPS's sustainable goals.
- Reprioritize expenditures for schools scheduled for FY 2016 Tech Mod services.
- Clean and test out-of-warranty desktop computers at schools.
- Clean/refurbish computers to prolong the life of the machine.
- Use MCPS Self Warranty team to repair computer hardware.

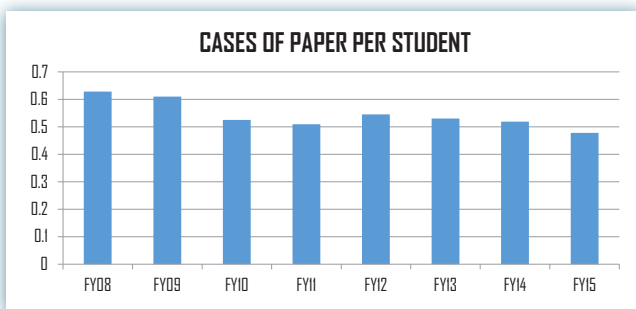
Materials and Waste Cycles

Our progress

MCPS HAS ACHIEVED significant progress in sustainable practices with materials and waste cycles. The foundation of the recycling program begins with the materials required to be recycled by Montgomery County. The four streams of material that are required to be recycled are paper/cardboard, bottles/cans, yard waste, and scrap metal. In addition, MCPS aggressively pursues the recycling of materials in the voluntary category. The list of materials that are voluntarily recycled has grown to more than 20.

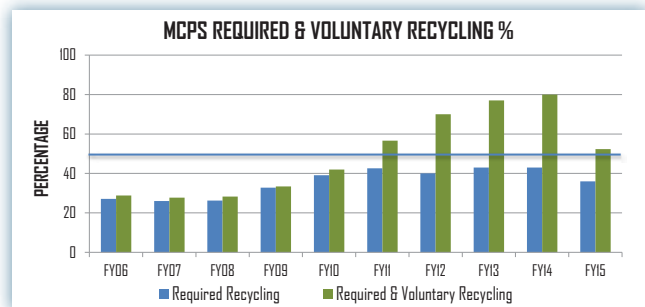
In addition to recycling, MCPS has sought to change its practices to use more sustainable materials that can be reused or recycled. For the past several years, the Division of Food and Nutrition Services (DFNS) has sought an affordable replacement to the polystyrene lunch trays. MCPS began using recyclable paperboard lunch trays in all schools during the 2014–2015 school year. The systemwide implementation of the use of paperboard lunch trays has proven to be a huge success by not only reducing the amount of solid waste generated by disposing of polystyrene trays, but also increasing monthly paper/cardboard recycling by nearly 50 tons.

While reducing solid waste, the school system is reducing the amount of waste generated in the first place and purchasing more environmentally responsible products. During FY 2015, MCPS purchased 26 million sheets of 8.5" x 11" paper, made of 30 percent recycled paper stock, to be used for printing of instructional, operational, and public information material.



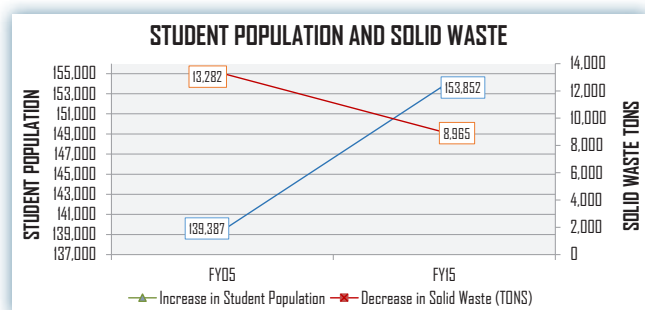
MCPS continued to make significant progress in increasing participation in recycling and decreasing solid waste in FY 2014 and FY 2015. Through increased participation,

outreach, education, and with the continued deployment of interior and exterior recycling bins, our systemwide average recycling rate for the past five years for the required recyclable materials reached 41 percent; for the required and voluntary recyclable materials, our rate reached 67 percent. This is a significant improvement compared with FY 2005, when the systemwide recycling rate was under 30 percent.



During FY 2014 and FY 2015, MCPS recycled nearly 13,000 tons of required recyclable and more than 39,000 tons of voluntary recyclable material. The reduction in the overall recycling rate in FY 2015 was due largely to the reduction in capital construction projects and material from the demolition of old school buildings.

In FY 2015, the amount of solid waste dropped by 33 percent, despite an increase of more than 17,000 in student enrollment since FY 2005. The total solid waste generated in FY 2015 was nearly 4,500 tons lower than in FY 2005. These recycling and solid-waste reduction efforts saved the school system approximately \$250,000 in FY 2015, by reducing “tipping” fees, the fee that MCPS pays for the disposal of solid waste.



In FY 2015, MCPS began recycling automotive windshield glass through the contracted windshield replacement vendor. The windshield glass recycling program is a new addition to the growing list of recyclable material that MCPS voluntarily recycles each year. Although the amount of windshield glass recycled was relatively small (4 tons), this is another demonstration of MCPS's commitment to aggressively pursue sustainable practices. As a result of our efforts in the windshield-glass recycling program, the Montgomery County Division of Solid Waste Services has amended its Annual Business Recycling and Waste Reduction Report to include windshield glass on the list of voluntary recyclables, giving other county businesses the opportunity to recycle and report the same.

Long-Term Goals

- Meet defined sustainable procurement guidelines of at least 50 percent of total goods and services purchased.
- Increase total recycling rates to 80 percent, by 2024.
- Reduce overall solid waste production by 10 percent, by adopting green procurement practices and placing further emphasis on reducing, reusing, and recycling.
- Develop protocols for increasing the reuse of materials, including electronics and computers, electronic parts,

copiers, furniture, building maintenance parts and equipment, cleaning equipment and parts, and more.

Short-Term Goals

- Achieve 70 percent recycling rate, by 2020.
- Make sure annual solid waste tonnage does not exceed 10,000 tons for FY 2017–FY 2020.
- Deploy exterior centralized recycling collection bins to an additional 20 elementary schools, by FY 2020.

Strategies

- Continue to conduct regular review of the items being procured for use in MCPS.
- Collaborate with the MCPS Procurement Unit to identify recycling opportunities as contracts are awarded for various services and products.
- Continue SERT staff school visits to provide outreach and performance feedback to continue to support school-based conservation efforts.
- Conduct a comparative analysis of recycling participation of elementary schools and deploy exterior centralized recycling collection bins where needed to encourage further participation of students, staff, and community members.
- Identify additional volume and types of material to recycle.



Building Construction, Maintenance, and Operations

Our progress

PROGRESS IN THE CATEGORY OF BUILDING construction, maintenance, and operations since the publication of the FY 2014 Environmental Sustainability Management Plan has focused on the following areas:

- Green Buildings
- Geoexchange Systems
- Storm Water Management Program
- Energy Management Systems (EMS)
- Environmental Services and Indoor Air Quality
- HVAC Replacement Program
- Green Cleaning
- Fats, Oils, and Grease
- Equipment Repair Program



• Green Buildings

MCPS developed Facility Design Guidelines in 1993 that formally standardized processes and design/construction specifications for new and revitalization projects outlined in the Capital Improvements Program. Facility Design Guidelines continues to serve as a vital tool for producing high-quality capital projects in a consistent and timely manner. In 2003, Facility Design Guidelines was updated to incorporate sustainable design features and practices that are aligned with the various categories in Leadership in Energy and Environmental Design (LEED). To achieve LEED Gold within the LEED for Schools system involves having significant features for Sustainable Sites, Water Efficiency, Energy and

Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design Process.

Facility	LEED Certification Level	Year Achieved
Great Seneca Creek ES (new)	Gold	2007
Francis Scott Key MS (replacement)	Gold	2009
William B. Gibbs, Jr. ES (new)	Gold	2010
Cashell ES (replacement)	Gold	2010
Carderock Springs ES (replacement)	Gold	2011
Cresthaven ES (replacement)	Gold	2011
Cabin John MS (replacement)	Gold	2012
Farmland ES (replacement/renov)	Gold	2012
Cannon Road ES (replacement)	Gold	2012
Seven Locks ES (replacement)	Gold	2012
Paint Branch HS (replacement)	Gold	2013
Flora M. Singer ES (new)	Gold	2013
Glenallan ES (replacement)	Gold	2014
Garrett Park ES (replacement)	Gold	2014
Beverly Farms ES (replacement)	Gold	2014
Weller Road ES (replacement)	Gold	2014
Herbert Hoover MS (replacement)	Gold	2015
Wilson Wims ES (new)	Gold	2015
Candlewood ES (replacement)	Silver	2015
Bel Pre ES (replacement)	Gold	2015
Gaithersburg HS (replacement)	Gold	2015
Rock Creek Forest (replacement)	Gold	2015

Using the updated Facility Design Guidelines, MCPS produced Great Seneca Creek Elementary School in August 2006, the first Gold-rated LEED-certified school in Montgomery County and the state of Maryland. Subsequently, in October 2008, Montgomery County and the state of Maryland passed legislation requiring a minimum of Silver rating in LEED certification for new major construction projects.

Since publishing the FY 2014 report, seven LEED Gold schools and one LEED Silver school have been added. MCPS now has 22 LEED-certified schools. In the summer of 2016,

the Montgomery County Council is expected to vote on the local version of the International Green Construction Code (IgCC) (2012 version). If approved, compliance with the IgCC will replace the county's requirement to meet LEED Silver certification. Maryland has adopted its own version of IgCC and will accept that in place of LEED Silver certification for state-funded projects. MCPS is in the process of comparing the local and state versions of IgCC with the newest version of LEED (LEED v4), which becomes mandatory in October 2016. The IgCC incorporates many of MCPS's current construction practices, but will add new requirements, such as envelope commissioning. Projects initiating design already have been registered as LEED v3, which will provide an acceptable alternative to IgCC for both state and county.

- **Geoexchange Systems**

MCPS piloted the first geoexchange system in 2001. Geoexchange, also known as geothermal, heating, and cooling systems, is one of the most energy-efficient and environmentally safe space-conditioning systems available. The geoexchange system harvests the constant ground temperature and uses the earth's mass to store energy for the purposes of heating and cooling buildings. Energy is transferred through an underground piping system between the building and ground to provide year-round heating and cooling. The system uses conventional heat pumps, similar to units found in homes, but uses the underground piping system in lieu of outdoor condenser fans. This scenario enables a building to maintain comfort conditions without using large commercial chillers and boilers. Chillers and boilers require not only annual maintenance, but also a significant space within a building. This space and maintenance avoidance tied to the overall energy efficiency results in a return on investment of 7 to 15 years for a given facility. Currently, 25 schools are being heated and cooled with the geoexchange system.

- **Storm Water Management Program**

Montgomery County is made up of eight major and more than 150 smaller watersheds. Storm water runoff from MCPS schools effects all these watersheds. These watersheds are tributaries to the Chesapeake Bay and its numerous estuaries. In stewardship to our environment, MCPS is committed to protecting and improving our natural resources and the quality of water in our local and regional watersheds and natural resources. MCPS implements on-site storm water management facilities that meet or exceed the latest

Schools with Geoexchange System	Year of Operation
Spark M. Matsunaga ES	2001
Great Seneca Creek ES	2006
Little Bennett ES	2006
Richard Montgomery HS	2007
Bells Mill ES	2009
Cashell ES	2009
Francis Scott Key MS	2009
William B. Gibbs, Jr. ES	2009
Carderock Springs ES	2010
Cresthaven ES	2010
Cabin John MS	2011
Cannon Road ES	2012
Flora M. Singer ES	2012
Garrett Park ES	2012
Paint Branch HS	2012
Seven Locks ES	2012
Beverly Farms ES	2013
Gaithersburg HS	2013
Glenallan ES	2013
Herbert Hoover MS	2013
Weller Road ES	2013
Bel Pre ES	2014
Wilson Wims ES	2014
Candlewood ES	2015
Rock Creek Forest ES	2015

federal, state, and local requirements, using environmental site design (ESD) techniques.

MCPS is a co-permittee with the county on its Municipal Separate Storm Sewer System (MS4) Permit Program. This program was recognized by the Water Environment Federation (WEF), a not-for-profit international technical and educational organization, through a cooperative agreement with the U.S. Environmental Protection Agency (EPA). Since FY 2014, progress in the storm water management program has focused on storm water facility installation and storm water facility maintenance, repair, and staff training. MCPS



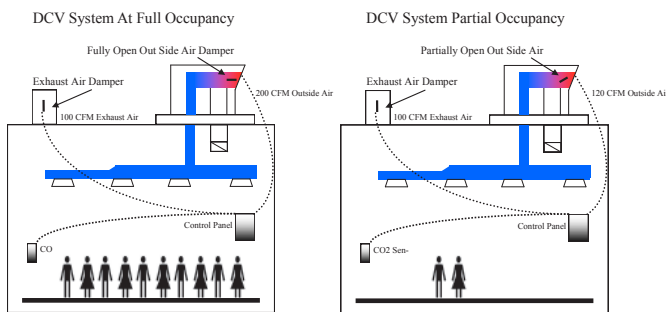
installed new storm water facilities at 10 schools in FY 2014 and 6 schools in FY 2015. MCPS spent more than \$640,000 to repair and restore more than 40 facilities in FY 2015. The school system is expected to spend more than \$530,000 to repair and restore approximately 30 facilities in FY 2016.

- **Energy Management Program**

MCPS has installed energy management systems (EMS) in most of its facilities to regulate the heating, ventilation, and air conditioning (HVAC) of the building. These systems maximize energy savings by controlling when and how the HVAC system operates. The EMS controls the HVAC systems while school is in session and minimizes usage when school is not in session. For special events and community use, schedules are consolidated and only specific areas (zones) and associated equipment are turned on, as needed.

The EMS are equipped with features to increase operating efficiency. The system regularly monitors space temperature. In the “unoccupied mode,” it determines the optimal time to turn the system on and off in order to achieve or maintain the desired set point. In many of the large gathering spaces, such as lunchrooms, gymnasiums, and auditoriums, the systems are equipped with Demand Controlled Ventilation (DCV), which allows the systems to detect occupants based on CO² levels. Ventilation (the provision of fresh air) can then be modulated to respond to the demand and reduce energy consumption. Older EMS are being converted to web-based systems with improved graphical user interfaces (GUI) that allow for better control at the school level. The EMS upgrades result in improved quality of maintenance and allow for faster response times to HVAC-related needs.

Progress in the Energy Management Program since the publication of the FY 2014 Environmental Sustainability



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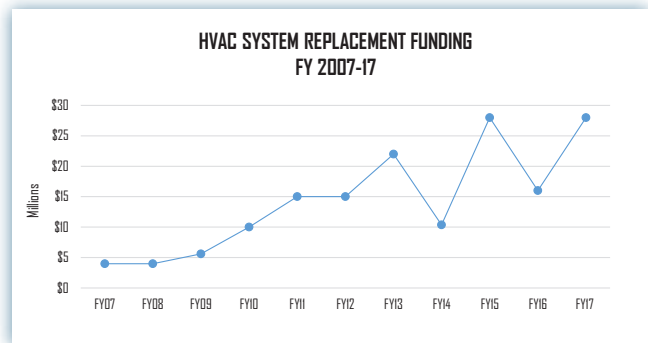
Demand Controlled Ventilation automatically adjusts the amount of outside ventilation air according to the number of occupants.

Management Plan has focused on continuous upgrades of the EMS throughout the school system. Since FY 2014, 71 schools have received energy management system upgrades. These range from graphics upgrades, to allow for web-based access, to full replacement of the EMS, to take advantage of new technologies and improve performance.

Previously, the Energy Management team supported hardware and software for nine different types of EMS. Older systems with outdated technology have been eliminated; others have been upgraded to current standards. As a result, the Energy Management team now maintains only five types of systems, resulting in improved operational efficiency.

- **Environmental Services and Indoor Air Quality**

Since the publication of the FY 2014 ESMP, the Indoor Air Quality (IAQ) and Environmental Services teams have initiated a Mold Prevention Task Force that meets weekly during the cooling season to proactively prevent mold outbreaks. During the summer of 2015, the team placed more than 350 temperature/humidity sensors in select schools to monitor the humidity and temperature. Many of the temperature/humidity sensors allow the levels to be monitored expediently from a centralized location. E-mail alerts were sent to school-based building service staff to inform them of upcoming high-humidity days. The IAQ team tested all classrooms in schools with ground floor contact for radon and developed mitigation plans to reduce the levels of radon where needed.



- **HVAC Replacement Program**

The HVAC replacement program implements the systematic replacement of HVAC equipment to maximize indoor environmental quality (IEQ) and energy performance, while reducing a significant equipment backlog. The replacement process involves a full building analysis to ensure that energy

efficiency and IEQ are optimized for each facility. MCPS has consistently highlighted the need to increase capital funding for HVAC system replacement. During FY 2014 and FY 2015, a total of 30 HVAC projects were completed. MCPS is on target to complete 16 HVAC projects during FY 2016. The FY 2017 HVAC replacement project budget is \$28 million, with a total of 13 projects to be completed.

- Green Cleaning

MCPS is committed to providing a healthy-facility environment that is conducive to student learning and employee productivity. MCPS also recognizes its social responsibility to preserve natural resources for future generations. As a result of this commitment to students, staff, and the environment, the Department of Facilities Management implemented a Healthy, High-Performance Green Cleaning Plan in FY 2014. The Green Cleaning Plan serves to inform facility managers and educate the building service staff at schools on how to fulfill “green housekeeping” requirements.



The plan documents MCPS’s commitment to purchasing and using cleaning and grounds-care products, equipment, and methods that reduce adverse impacts on public health

and the environment. Cleaning methods specified in the plan emphasize the removal of indoor pollutants, including soils, particulates, microbes, and the like, while maintaining a safe and healthy environment for all students, staff, and other building occupants.

The Green Cleaning Plan also includes details on how to implement the program, including cleaning practices, how to store cleaning products and requirements for disposal, specific methods for cleaning, custodial equipment standards, purchasing criteria, and recycling. Requirements for grounds care and the effective operation of mechanical systems also are identified. Training, involvement, and close collaboration with students, staff, and the community are key components of the program—promoting environmental principles beyond the school walls.

In 2015, more than 90 percent of cleaning products, janitorial paper, and trash bags purchased were certified as sustainable cleaning products and materials. MCPS was one of two school districts in Maryland that were recognized with the School Environmental Health Champion Award by the U.S. Environmental Protection Agency and the Maryland Environmental Health Network.

- Fats, Oils, and Grease

This program provides the installation and maintenance of grease interceptors. MCPS installed 14 grease-abatement systems in FY 2014 and 33 in FY 2015, as part of the Washington Suburban Sanitary Commission (WSSC) fats, oils, and grease (FOG) compliance program. In total, MCPS has installed more than 350 grease-abatement systems. The proper maintenance of interceptors protects the environment by preventing sanitary sewer overflows that could contaminate local water bodies and damage property. In addition, school staff is educated on best practices to minimize FOG through awareness training. The FOG best management practices are incorporated into the Family and



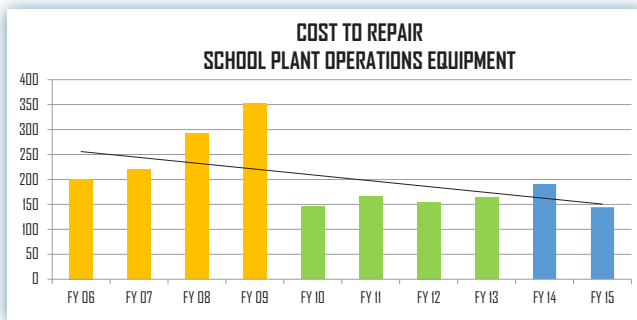
In 2015, MCPS was recognized with the School Environmental Health Champion Award by the U.S. Environmental Protection Agency and the Maryland Environmental Health Network .

Consumer Sciences (FACS) curriculum, promoting environmental stewardship communitywide.

• Equipment Repair Program

The equipment repair program performs repairs on a variety of building service and maintenance equipment annually. In FY 2014 and FY 2015, the repair program completed more than 2,700 work orders. In FY 2015, the in-house repair program resulted in—

- a 42 percent reduction in equipment repair cost, compared with FY 2006;
- significantly improved average turnaround repair time, from four weeks to nine days;
- increase in salvaging/reuse of parts;
- improved preventive maintenance to extend the life cycle of equipment; and
- capability to recycle waste materials.



The MCPS copier equipment and maintenance program, known as TeamWorks, purchases used copiers rather than new, and salvages certain components from retired copiers. In FY 2015, a total of 55 copiers were purchased used. They were refurbished and installed in MCPS offices and schools. During that same timeframe, 227 major component parts were salvaged from copiers before being recycled for plastic and metal.

Long-Term Goals

- Implement life-cycle-assessment procedures that follow International Organization for Standardization (ISO) 14040 standards, by 2020.
- Continue to refine school-facility-planning standards by implementing urban design concepts in suburban environments.

- Develop school-facility-planning standards that target compact core design and open-space preservation for each project.
- Pilot Net Zero energy building by 2022.
- Develop and implement Building Maintenance Plans for all schools, by 2024.
- Explore technological needs to achieve full mobile access and control of EMS systems.
- Explore automation of inspection programs to expedite work-order completion, by 2020.

Short-Term Goals

- Explore new design concepts that will improve educational delivery in key spaces such as STEM and TESOL classrooms, by 2017.
- Implement a facility software program that links project data spanning the design process through warranty and maintenance, by the end of 2016.
- Complete installation of FOG systems, as part of current WSSC compliance directive, by July 2016.
- Enable full web-based access and controls of EMS systems, by 2020.
- Perform continuous nonstructural maintenance to storm water facilities, including bio-retention facilities, ponds, swales, and green roofs at the intervals required by the Montgomery County Department of Environmental Protection.

Strategies

- Continue to work closely with county planners to develop projects consistent with the visions of community master plan goals.
- Continue to upgrade EMS systems.
- Provide FOG training for school-based building service staff.
- Provide Spill Prevention training to Department of Transportation and Division of Maintenance staff.
- Ensure that MCPS pumps out grease-abatement systems on a quarterly basis.
- Integrate systems with smart-meter technology, as provided by the local utility companies.

Transportation

Our progress

PROGRESS IN TRANSPORTATION since publication of the FY 2014 Environmental Sustainability Management Plan has focused on the following areas:

- Reducing carbon emissions
- Reducing operational costs
- Reducing Carbon Emissions

Currently, MCPS operates more than 1,200 buses, traveling more than 100,000 miles each day to transport our students. The Department of Transportation (DOT) continues to focus its efforts on reducing carbon emissions; environmental impacts, including air pollution; and operating costs, while promoting walking or riding bicycles to schools.



Since FY 2014, DOT has continued its effort to equip buses with catalytic converters. The catalytic converter is an emissions control device that converts toxic pollutants in exhaust gas to less-toxic pollutants by catalyzing a redox reaction (oxidation or reduction). At present, 62 percent of the school buses are equipped with catalytic converters, a significant increase from 42 percent in FY 2014.

DOT continues to make progress in preventing the release of diesel particulates into the atmosphere by installing diesel particulate filters on school buses. Diesel particulate filters have become the most effective technology to control diesel particulate emissions. In FY 2016, 85 percent of the buses

School Years	# of Bus Routes	Miles Driven	# of Students Transported
2012–2013	1,126	18,912,870	98,583
2013–2014	1,134	19,087,870	100,000
2014–2015	1,148	19,237,356	101,949

have been successfully equipped with this system to stop a significant amount of soot from being emitted and reduce carbon emissions. In FY 2014, only 78 percent of the school buses were equipped with the diesel particulate filters.

• Reducing Operational Costs

During school year 2014–2015, MCPS school buses transported 101,949 students, with a total of 19,237,356 miles driven. Although there were 324,486 more annual miles driven in the 2014–2015 school year, compared with 2012–2013; the annual number of miles driven for each transported student dropped to 189 miles in the 2014–2015 school year, compared with 192 miles per transported student during 2012–2013. DOT is able to achieve this success by routing its buses efficiently, in order to maximize the number of students transported.

Long-Term Goals

- Achieve an overall bus fleet efficiency higher than eight miles per gallon (mpg), by 2025.
- Increase the efficiency (mpg/use) of the auxiliary non-bus fleet by 20 percent, by 2024.
- Reduce transportation greenhouse gas emissions by 20 percent, by 2025.

Short-Term Goals

- Install diesel particulate filters on all school buses, by 2019.
- Install catalytic converters on all school buses, by 2019.
- Develop a comprehensive systemwide replacement plan for the Small Vehicle Fleet, by 2019.

Strategies

- Collaborate with the county to increase the connectivity of sidewalks and bike paths to our schools and offices.
- Seek new technologies to incorporate in school buses, to reduce our carbon footprint.
- Purchase most fuel-efficient buses and vehicles, including partial zero emissions, hybrids, and flex-fuel vehicles, based on emerging markets of the latest fuel-efficient vehicle technology and its affordability.
- Develop a more convenient method to generate carpool trips.

Glossary

Greenhouse Gases—Gases such as carbon dioxide that trap the earth's heat, contributing to climate change (usually measured in tons).

MTCO₂e—Equivalent metric tons of carbon dioxide, a standard measure for greenhouse gases.

Renewable Energy—Energy that comes from non-fossil-fuel-based sources that do not run out, such as wind and solar.

Fossil Fuels—Fuels that come from nonrenewable energy sources, such as gasoline and oil.

Geothermal—Geothermal energy is the heat from the earth.

Building Automation—Centralized, interlinked networks of digital hardware and software that monitor and control building environments.

Climate—A measurement in patterns of weather over long periods of time.

kBTU—A measurement of heat created by burning any material, with one BTU being the amount of heat necessary to raise the temperature of one pound of water by one degree Fahrenheit.

VOC—organic chemicals that have a high vapor pressure at ordinary room temperature.

LEED—Leadership in Energy & Environmental Design, is a green building certification program that recognizes best-in-class building strategies and practices.

Low-E—low thermal emissivity refers to a surface condition that emits low levels of radiant thermal (heat) energy.

Green Cleaning—using cleaning methods and products with environmentally friendly ingredients and procedures that are designed to preserve human health and environmental quality.

Green Procurement—Purchasing products and services that cause minimal adverse environmental impacts.

EUI—Energy use intensity expresses a building's energy use as a function of its size or other characteristics.



Acknowledgments

Development of this Plan would not have been possible without input from staff and principals across the school system.

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State Environmental Education Leadership: A 50-YEAR LEGACY

MCPS has long supported and promoted school environmental education in Maryland. Our administrators and teachers were among the principal founders of the Maryland Association of Environmental and Outdoor Education. System leadership also plays an active role in the Governor's Partnership for Children in Nature—aimed at improving and expanding opportunities for children to experience, learn about, and play in the natural world.





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