



THE CITY OF PHILADELPHIA
— OFFICE OF —
SUSTAINABILITY

MUNICIPAL ENERGY MASTER PLAN

FOR THE BUILT ENVIRONMENT





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ON THE COVER: City Hall by M. Fischetti for VISIT PHILADELPHIA



Letter from the Mayor

Dear Friends,

When I was elected Mayor, I pledged to reduce carbon emissions in Philadelphia. This commitment comes from a knowledge that climate change will disproportionately harm our most vulnerable residents and strain our local economy. With inaction at the federal government, it is up to us to lead by example.

Our work starts with a focus on our own government buildings and facilities, where we will reduce our energy use and clean our energy supply to reduce carbon emissions. The projects and initiatives presented in this plan will reduce costs, create jobs, and improve our air quality. We'll achieve our goals by making investments in energy efficiency and renewable energy. Improved energy management creates additional environmental and economic benefits for Philadelphians, such as:

- Investments in energy efficiency at libraries and recreation centers improve our City's climate resiliency by ensuring they can act as cooling centers in an increasingly hotter climate.
- Preventative maintenance in office buildings helps equipment last longer and allows City staff to detect and repair equipment before they become costly expenses.
- Transparency on City energy use through open data platforms allow for a more efficient government and provides better accountability.

Since its inception, the City of Philadelphia's Office of Sustainability has been working to improve the quality of life in all Philadelphia neighborhoods, reduce the City's carbon emissions, and prepare Philadelphia for a hotter, wetter future. With this document, we outline steps that begin to move us towards our clean energy future through City leadership, efficient operations, and strategic investments.

Thank you,

Jim Kenney

MAYOR



Mayor Kenney signing on to Sierra Club's Ready for 100% Clean Energy Campaign

Photo: Samantha Madera



GLOSSARY:

80x50: Mayor Kenney's goal to reduce Philadelphia's citywide greenhouse gas emissions 80% by 2050.

Air Quality: The degree to which air is pollution-free. Two types of air quality indicators are Sulfur Oxides (SOX), and Nitrogen Oxides (NOX).

Building Automation Systems (BAS): Control hubs for technology in buildings. They are used to change the temperature, humidity, airflow, or other environmental conditions within buildings.

Built Environment: The built environment in this plan consists of City buildings, parks, streetlights, and other City government infrastructure. It does not include City vehicles, Philadelphia Water Department facilities, or the Airport, which have separate energy planning efforts.

Electricity measurement: Electricity use is commonly measured in kilowatt-hours or kWh. Kilowatt hours are a measurement of total electricity used over a specific period, not at a given moment. In this report we also refer to electricity in megawatt-hours or MWh, which is equal to 1,000 kWh. Renewable energy systems are typically measured by their peak capacity in kilowatts (kW) and megawatts (MW). Kilowatts and megawatts are measures of electricity used at a given moment, not over time.

Greenhouse Gas Emissions (GHGs): a gas that contributes to the greenhouse effect by absorbing infrared radiation. This plan aggregates all emissions types into carbon dioxide equivalents or CO₂e. CO₂e is typically measured in kilograms (kgs) or Metric Tons (MT) and sometimes referred to in Thousand Metric Tons or kilotonnes (kT).

Heating Ventilation and Air Conditioning (HVAC): HVAC systems are equipment and systems such as air handlers, chillers and boilers that provide thermal energy to maintain environmental comfort in buildings.

Energy Performance Contracts: The Commonwealth of Pennsylvania's Guaranteed Energy Savings Act (GESA) enables public entities to enter into energy performance contracts with energy service companies (ESCOs) to implement large-scale energy improvements. The ESCO provides design and build services for energy conservation measures (ECMs) and other energy improvements, and guarantees the technical performance of the projects that it implements. GESA contracts are designed to be budget neutral.

Million British Thermal Units (MMBTU): A measure of energy equivalent to one million British Thermal Units. This plan uses MMBTU to measure thermal energy and aggregate natural gas and steam energy use.

Operations and Maintenance (O&M): A plan that includes training, cleaning, work practices, and surveillance to maintain a building's condition.

Power Purchase Agreements (PPAs): PPAs are long-term contracts where a third-party finances, installs, operates, and maintains renewable electricity generation and sells electricity to a counterparty at fixed unit cost.

Quadplex: The City's Quadplex is a term used to identify four of the City's largest downtown buildings: City Hall, the Municipal Service Building, the One Parkway Building, and the Criminal Justice Center. In 2015, the City completed a large project using an energy performance contract in these buildings (see <https://beta.phila.gov/documents/quadplex-energy-savings-case-study/>).



Energy Planning is Critical

The City of Philadelphia is committed to reducing carbon pollution, which is the biggest contributor to climate change. City buildings, facility operations, and their energy use present significant opportunities to reduce carbon pollution. The Municipal Energy Master Plan provides a roadmap of how Philadelphia's city government will lead by example on mitigating the causes of climate change by reducing energy use and costs, making operations more efficient, and advancing environmental stewardship.

Climate change is already influencing lives in Philadelphia and around the world. Globally, nearly 200 countries have committed to reducing carbon emissions through the Paris Climate Accord. In June 2017, the City reaffirmed its pledge to meet its portion of the United States' goals of the Accord, and committed to transition Philadelphia to 100 percent clean energy. This plan outlines how the City can achieve carbon reductions that will exceed the goal of the Paris Climate Accord for City buildings and makes new commitments to renewable energy.

Executing the strategies in this plan will reduce the causes of climate change, lower energy costs, create jobs, and improve air quality. The City's energy investments will aim to expand economic opportunities for Philadelphians by prioritizing local business growth and creating opportunities for disadvantaged business enterprises. This will produce a local and diverse workforce for City energy projects. By investing in Philadelphia's businesses and helping to create more jobs for Philadelphians, this plan will have benefits beyond pollution reduction and cost savings.

Powering Our Future: A Clean Energy Vision for Philadelphia

The City of Philadelphia is committed to reducing carbon pollution to create a city where all Philadelphians use clean energy that they can afford. This energy master plan is a key component of Powering Our Future: A Clean Energy Vision for Philadelphia (CEV), a long-term strategy to achieve that Greenworks goal.

Powering Our Future will highlight current and expected trends in Philadelphia's energy system and identify opportunities for the City's built environment, other government agencies, and residents and businesses to each lead on achieving Philadelphia's climate and energy goals, including Mayor Kenney's commitments to reduce carbon emissions 80 percent by 2050 and transition Philadelphia to 100 percent clean energy.

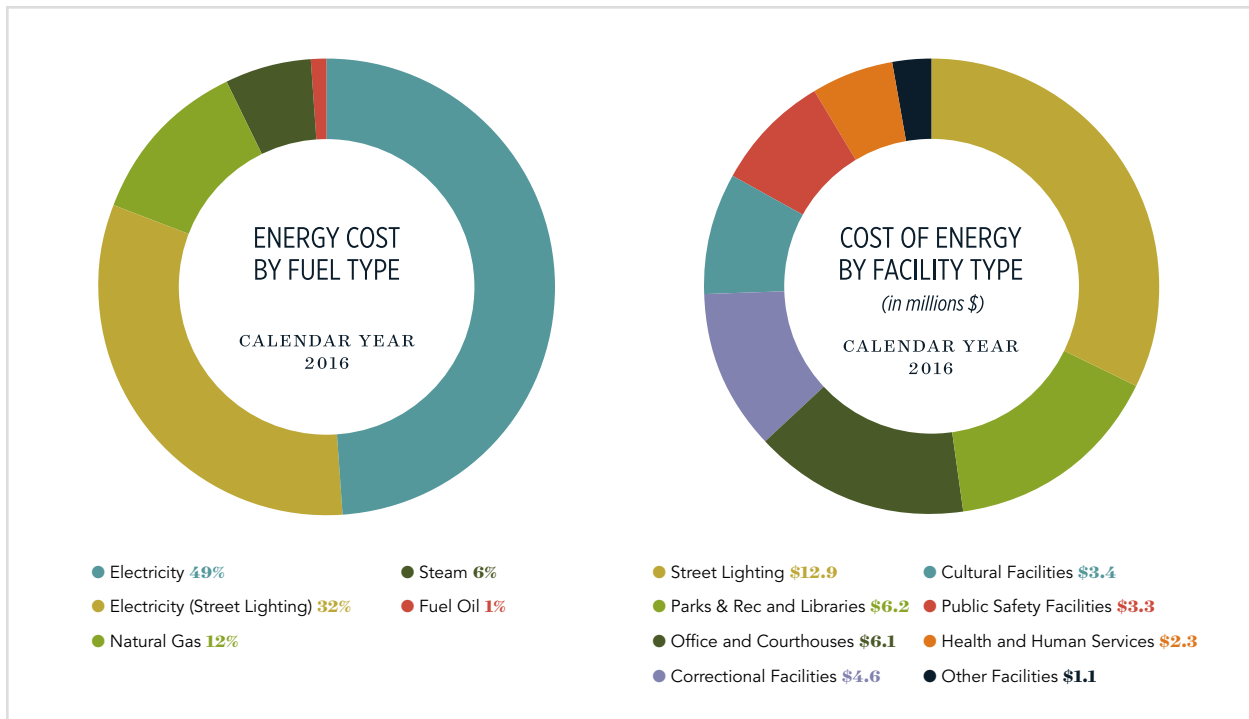
Powering Our Future will be available for public comment in Fall 2017. To learn more visit www.phila.gov/green or email sustainability@phila.gov.



The City of Philadelphia's Current Energy Management

The City of Philadelphia purchases energy to heat, cool, and power hundreds of libraries, recreation centers, police stations, and other City-owned buildings. Annually, the City spends approximately \$35 to 45 million on energy for buildings and street lighting covered by the General Fund (see scope of this report on page 7), resulting in approximately 160,000 to 220,000 metric tons of carbon dioxide-equivalent (CO₂e, a measurement of carbon contributing to global climate change). In total, those emissions account for around one percent of Philadelphia's total carbon pollution.

FIGURE 1



In 2014, the City of Philadelphia centralized energy management responsibilities and expertise, particularly for General Fund facilities, into the Energy Office within the Office of Sustainability. The mission of the Energy Office is to:

- Strategically procure cost-effective, reliable, safe, clean energy and conventional energy systems for city government.
- Promote energy conservation and efficiency within City facilities by providing education, technical expertise, and analysis of energy use.
- Develop and implement projects and programs that promote the efficient use of energy and reduce the City's environmental impact.

The City's utility costs are not fixed. Market fluctuations, weather, and operational changes in buildings cause variability and volatility. Strategic energy procurement meets a broad set of needs, and historically the City's energy procurement has prioritized transparency, low costs, and budget stability. In June 2017, Mayor Kenney committed to transitioning the City of Philadelphia to clean energy, establishing another priority for the Energy Office's strategic procurement.

**FIGURE 2** Energy Fast Facts

Largest Department Energy Consumers

- Correctional Facilities → 19%
- Streets (lighting) → 14%
- Parks & Recreation → 12%

Highest Departmental Energy Costs

- Electricity for Street (lighting) → \$13.4 million
- Electricity, natural gas, and heating oil for Correctional Facilities → \$5.3 million

Electricity

- 52% of energy used → 79% of energy costs

Natural Gas

- 40% of energy used → 15% of energy costs

Largest Buildings

- Philadelphia's largest 50 municipal buildings in General Fund → 63% of city government energy used in buildings from General Fund

The City uses a centralized approach to purchasing energy and managing energy bills. While this system is efficient for payment processing, it reduces the need for facility personnel to review utility bills and understand and manage energy use. This energy master plan sets forth strategies to better educate and incentivize City employees to manage energy in buildings they occupy.

The City's portfolio of more than 600 facilities varies greatly in purpose and energy use. For example, recreation centers and police stations function very differently, and each department has a unique approach to facility maintenance, operations, and design. The physical condition and energy performance of City assets represent significant cost-saving opportunities of which the City has only begun to take advantage. To increase energy savings in all the City's building types, the Energy Office partners with operating departments and the Philadelphia Energy Authority (PEA). These existing relationships will be critical to completing strategic investments in large facilities which can meet infrastructure needs while saving energy and reducing the City's carbon footprint.

The City has made significant progress on energy management in recent years and the Energy Office estimates it has contributed to a net benefit of approximately \$2 million annually over the past three years.

Energy Planning across Philadelphia's Funds

The City of Philadelphia manages nearly 1,000 facilities and spends almost \$100 million per year on energy used by the City's three major Funds (General, Aviation, and Water). This plan primarily addresses buildings and the built environment supported by the General Fund, which account for roughly 40 percent of Philadelphia government's emissions and energy use. The Philadelphia Water Department (Water Fund) sets energy goals through its Strategic Energy Plan, and the Philadelphia International Airport (Aviation Fund) is creating an energy plan specific to its operations. The Energy Office is partnering with both the Airport and the Philadelphia Water Department to implement these plans.



The City of Philadelphia's Energy Goals

This Municipal Energy Master Plan builds on more than a decade of work managing energy in City-owned facilities. Since 2013, the City's energy consumption has decreased, and the City's carbon footprint has been declining since 2006. If emissions reductions continue at the current pace, City facilities will exceed the goal of reducing greenhouse gas emissions 80 percent by 2050 (80x50).

Building on this strong foundation, this plan sets four new goals to help meet the Greenworks energy and climate visions:

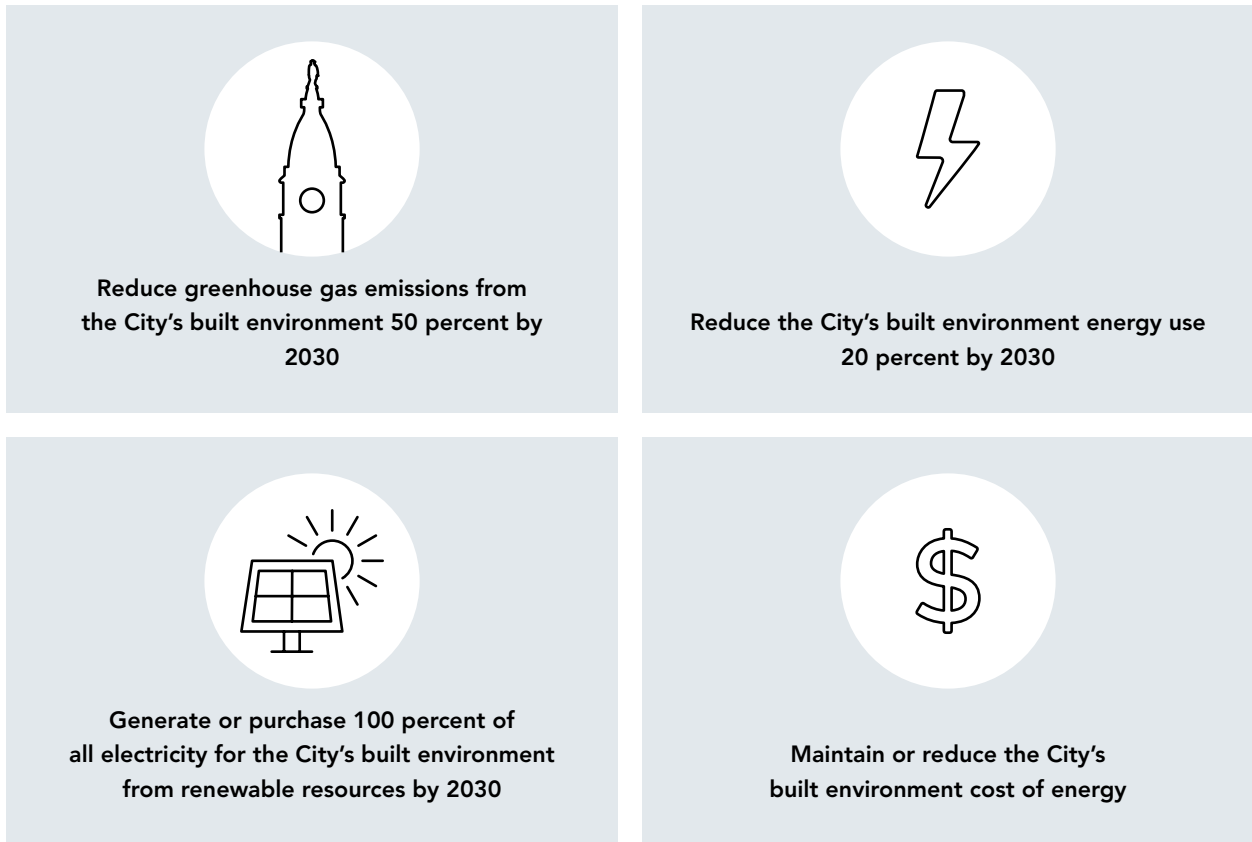


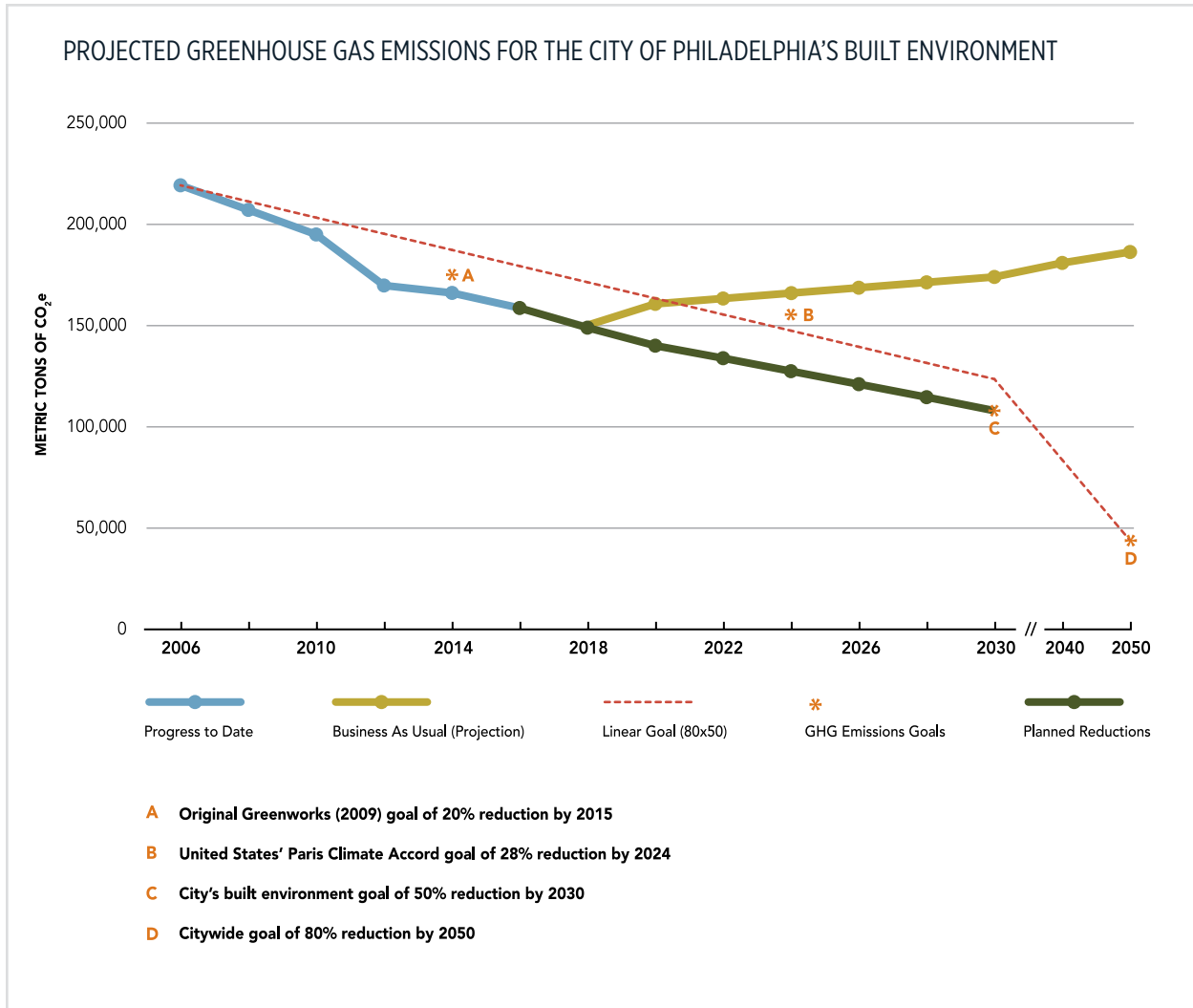
FIGURE 3

	Baseline	Current	Goal
GREENHOUSE GAS EMISSIONS	219,300 MT of CO ₂ e (2006)	166,200 (2014)	109,700
ELECTRICITY CONSUMPTION	281,300 Weather Normalized MWh (2016)	281,300 (2016)	225,000
PRIMARY HEATING CONSUMPTION	828,500 Weather Normalized MMBTU (2016)	828,500 (2016)	662,800
RENEWABLE ELECTRICITY	6% (2016)	6% (2016)	100%
TOTAL COST OF ENERGY	Fiscal Year 2016	\$42.4 Million (2016)	< \$42.4 Million

All numbers are for General Fund's facilities and street lighting.



FIGURE 4



Philadelphia municipal government greenhouse gas emissions reductions achieved to date and a business as usual projection of emissions with no actions taken. The red dotted line represents a linear path to 80x50 and the green line represents the modeled reductions with the implementation of this plan.



How We'll Achieve Our Goals

This plan establishes two strategies to achieve the goals set forth in this plan:

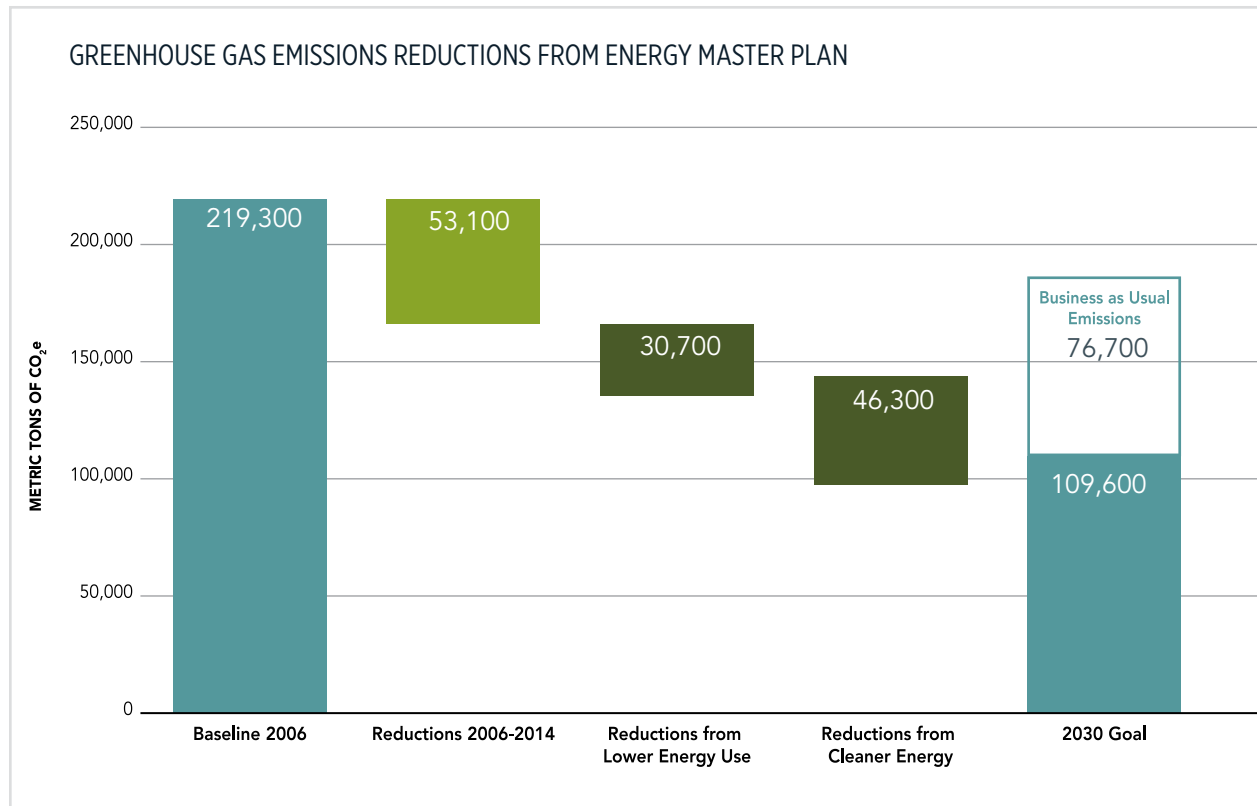
STRATEGY 1

Lower Energy Use: Eliminate wasted energy in City-owned facilities and street lighting, which will reduce the City's energy costs and carbon footprint.

STRATEGY 2

Clean Energy Supply: Ensure that energy the City purchases from the electricity grid and other sources is as low-carbon as possible, which will help spur the transition away from fossil fuel energy generation and toward clean energy.

FIGURE 5



The chart above shows progress on reducing greenhouse gas emissions between 2006 and 2014 as well as the potential emissions reductions from energy efficiency and moving to cleaner energy sources. The GHG reduction potential of these two strategies is interrelated: the City will need to make greater efficiency investments if carbon emissions from electricity grid generation do not decline as quickly as modeled. Together these strategies exceed the 50 percent GHG reduction goal for the City's built environment, and the Energy Office is committed to continuing to monitor the carbon emissions of the regional electricity grid and adjust efficiency investment strategies to meet that goal.



To develop this plan, the Energy Office met with City departments and interviewed key stakeholders to understand obstacles in municipal government and identify opportunities to reduce energy usage and move toward renewable energy. In addition, the Energy Office modeled how technology and energy efficiency best practices drawn from other cities and the private sector would reduce government energy use.

The Energy Office is leading the implementation of this plan, but the full support and participation of all City departments is critical to its success. Through the interviews and development of this plan, three necessary elements for success emerged: people, technology, and systems change. Actions will be marked with a P, T, or S to indicate which elements are needed to achieve that goal.

P **PEOPLE:** *Create a culture within City government where individuals understand their energy use and actively work to reduce their impact.*

All change starts with people, and a necessary first step to reduce City energy usage is to better connect people with their energy and cost data. The Energy Office will provide information on how to operate facilities efficiently, ensure accountability for energy waste, offer technical assistance to departments, and support professionals through energy and sustainability training.

T **TECHNOLOGY:** *Use technology to track and manage energy use, maintain reductions, and identify new opportunities in City facilities to reduce consumption and generate on-site energy.*

To achieve the Energy Master Plan goals, the City needs to install new technology and equipment in facilities and use technology to track and manage investments. Since technology is always changing, the City will continue to explore new and transformational opportunities.

S **SYSTEMS CHANGE:** *Take a long-term and holistic approach to decision-making that reduces energy use, cost, and carbon pollution and provides co-benefits to City employees, visitors, and Philadelphians.*

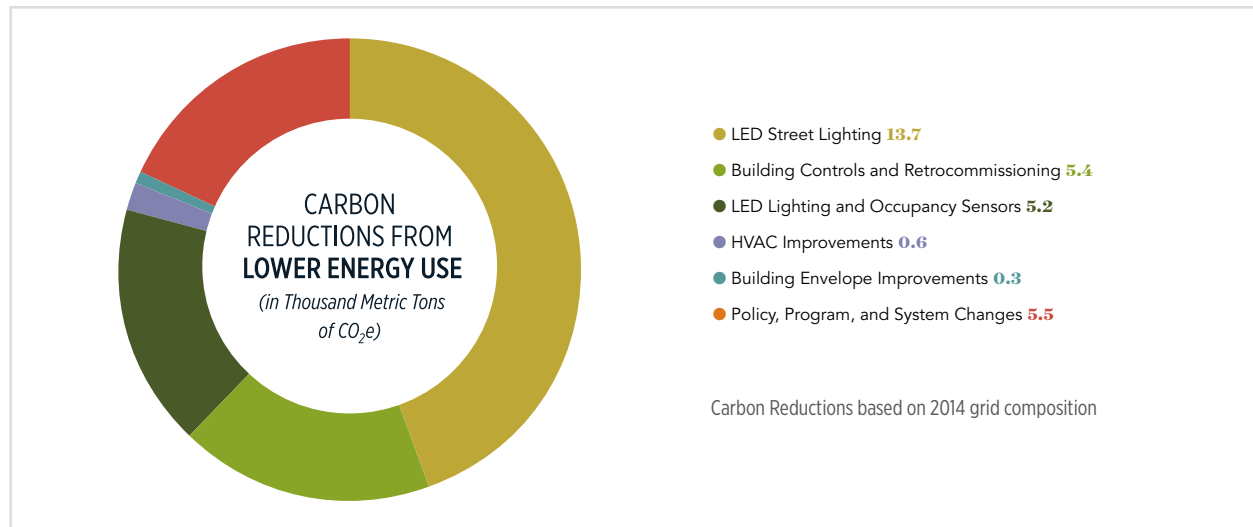
Energy investments and initiatives must be priorities throughout City government. As one of the largest energy users in the region, the City of Philadelphia has an obligation to lead by example in transitioning the regional power grid away from fossil fuel-based electricity sources toward a clean energy future.



STRATEGY 1: Lower Energy Use

Improving the energy efficiency of City-owned buildings saves money while reducing the carbon pollution causing climate change. To understand the energy-saving potential of these buildings, the Energy Office modeled and analyzed the impact of several potential energy conservation measures (ECMs), listed below. As new cost-effective energy efficiency technologies become available, the Energy Office will update the Energy Master Plan with savings estimates for those practices. The following pages list opportunities for implementing these ECMs across City facilities.

FIGURE 6



LED street lighting: Philadelphia's streets are currently lit by high pressure sodium lights. Converting to LED street lighting has the highest GHG emissions reduction potential of all energy efficiency projects in this plan.

Building retro-commissioning and controls: Retro-commissioning improves building performance to ensure that buildings operate as designed. Web-enabled controls allow buildings to shut down when unoccupied. When paired with building monitoring and maintenance programs (two key components of retro-commissioning), they can help buildings maintain peak efficiency and identify poor equipment performance.

LED lighting and occupancy sensors: More efficient lighting systems can be deployed in almost every City facility to reduce energy use and improve light quality. Occupancy sensors in appropriate spaces can increase energy savings even further.

HVAC improvements: Each City building type has unique technological opportunities to reduce energy waste. As examples, high efficiency split systems as a replacement for window units work well for fire stations, while infrared heating can help maintain comfort at vehicle repair shops. Both improvements would use less energy than existing systems.

Building envelope improvements: New roof insulation, efficient window replacements, and building weatherization and sealing can be done when major renovations are taking place. This helps insulate and hold conditioned air in buildings, reducing the need to continuously condition air.

Policy, program, and system changes: Changes to how the City operates, maintains, and makes decisions about its built environment help reduce energy use. Training for City employees and better access to information will result in better designed facilities that operate efficiently.



OPPORTUNITY: IMPROVE OPERATION PRACTICES

Not all energy projects require large funding expenditures. Expanding existing tasks, prioritizing regular maintenance, and strategically planning incremental work at facilities can lead to significant energy savings.

Establish Department Accountability for Energy Use

Currently, utility bills for each department covered by the General Fund are paid from one centralized utility budget. This makes the bill paying process easy, but does not create department accountability for utility costs. The Energy Office runs an Energy Incentive Program which allows participating departments that reduce their energy usage to retain a percentage of the resulting cost savings.

ACTIONS:

- Grow the Energy Incentive Program to increase accountability. **P S**
- Assign one leader in each department responsibility for its energy performance. **P**
- Develop department dashboards through the existing energy management database and expand regular energy use, cost, and carbon reporting to departments and City leadership. **P T**

Workforce Training

Since 2009, the City has held trainings to help employees understand green building techniques and to help building operators better manage control systems. These employee engagement and training opportunities have relied on irregular funding and staff availability. Extending training opportunities to building operators, planners, architects, and engineers throughout the year would increase the efficiency of building design and operation. Offering a more formalized training program would increase building operation continuity and integrity and help retain employees.

ACTIONS:

- Formalize existing training programs, offer trainings regularly, and invite building operators, planners, architects, and engineers to attend. **P**

Facility Utilization

Historically, the City has had limited ability to measure the comparative operation and maintenance (O&M) costs and needs for repairs in its facilities versus major investments across the citywide portfolio of facilities. To meet the goals set in this plan, Philadelphia's City government needs better information to inform decisions about maintaining, updating, consolidating, and closing existing facilities. By looking at its portfolio of facilities holistically, considering how they are used along with O&M costs, the City will be empowered to make better investment decisions.

To improve decision-making, the City is currently developing an Integrated Workplace Asset Management System (IWAMS) which will allow multiple departments access to data necessary to inform facility utilization, maintenance, repair, and investment decisions. The new comprehensive database will catalog cost data for all assets and help streamline work order data collection, enabling the City to track full cost savings from the implementation of energy efficiency projects and installation of energy-efficient equipment. The IWAMS will also enable smarter, more efficient space allocation in City-owned and -leased space.

ACTIONS:

- Use IWAMS to more accurately value energy efficiency investment and improve efficiency of space utilization in both existing building stock and future design, construction, or acquisition of space. **T S**



Maintenance and Resources

Organizations with preventive maintenance programs experience fewer unanticipated equipment problems, better building performance, and lower overall facility costs. Most City departments and facility managers primarily use a reactive approach to maintenance, which has resulted in a substantial backlog of deferred maintenance. The City's ability to eliminate the deferred maintenance backlog is severely limited by operating budget and staffing constraints. Historically, City funding and staffing levels leave little resources beyond those necessary for urgent life-safety and critical repair work.

The resulting inability to prioritize preventative and predictive maintenance limits building energy performance and slows the City's transition to new technologies. Growing the staff of City departments can ensure that projects incorporate energy-efficient design, construction, and operations, which will advance the modernization of City government.

ACTIONS:

- Transition O&M approaches to preventative and predictive maintenance and continuous commissioning. **S**
- Grow staffing and funding of maintenance, design, and construction teams to levels that allow efficient management of City assets. **P**



Operations and maintenance personnel installing LED lighting at One Parkway Building.

Photo: LeAnne Harvey



OPPORTUNITY: LARGE-SCALE ENERGY PERFORMANCE CONTRACTS

The City completed its first large-scale guaranteed energy savings project in 2015 at the Quadplex (its group of four downtown buildings), reducing City carbon emissions by 7,800 Metric Tons and energy costs by more than \$1.4 million a year. This success can be replicated through energy performance contracts at City facilities with high energy expenses and major capital needs.

To build on this work, in 2016 the Philadelphia Energy Authority in partnership with Council President Clarke introduced the Philadelphia Energy Campaign, an ambitious plan for the Philadelphia Energy Authority (PEA) to spur job creation through energy efficiency and renewable energy projects across four building sectors, including City-owned properties. Working with the PEA, the City can continue to accelerate the pace of energy performance contracting work and expand projects to invest in City facilities. In summer 2017, the PEA and City requested proposals for a large energy performance contract at the Philadelphia Museum of Art and will begin development of another performance contract project at correctional facilities later this year.

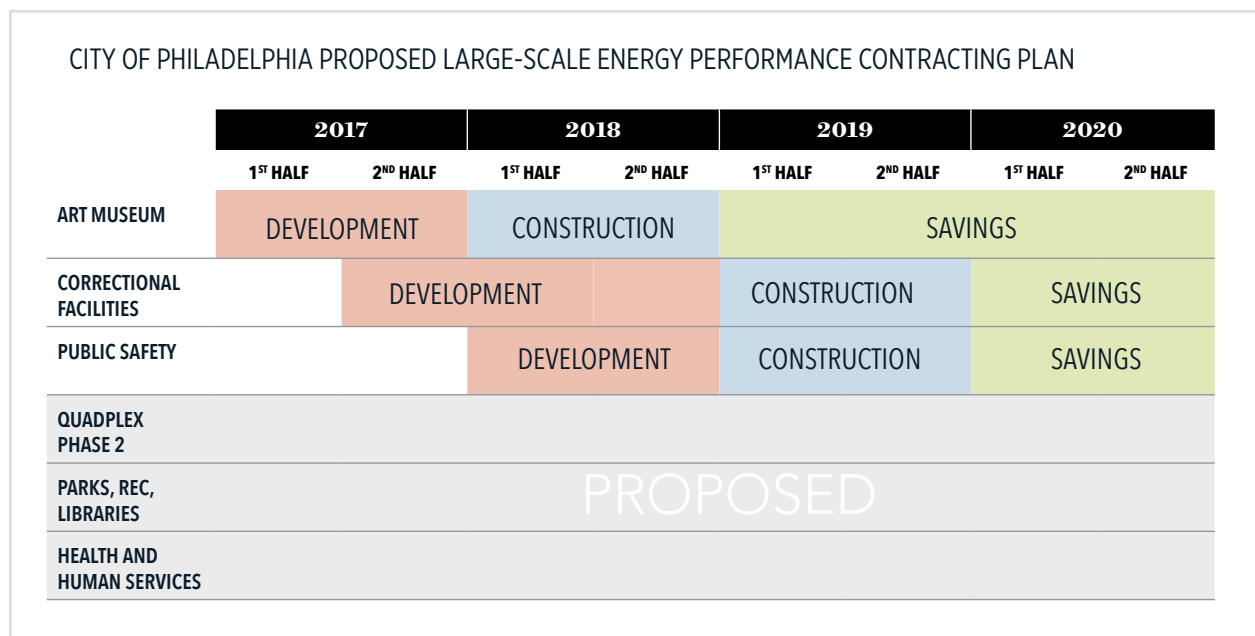
ACTIONS:

- Complete and implement performance contracts at the Philadelphia Museum of Art and other large facilities. **T S**
- Aggregate smaller facilities with common energy conservation measures for bulk implementation. **S**
- Explore opportunities for simplifying performance contracting process to enable performance contracts in small- and medium-sized buildings. **S**

What is a guaranteed energy savings project?

Under Pennsylvania’s Guaranteed Energy Savings Act (GESA), all Commonwealth municipalities may enter into contracts with Energy Service Companies (ESCOs) to develop energy efficiency projects through energy performance contracting. The legislation authorizes municipalities to use annual utility and operational savings to support project repayment over a 20 year contract term, meaning an up-front budget allocation is not necessary.

FIGURE 7





Mayor Kenney, Council President Clarke, Philadelphia City Council, and Philadelphia Energy Authority at the announcement of the Philadelphia Energy Campaign.
Photo: Bill Foster for PHL City Council

Philadelphia Energy Authority

The Philadelphia Energy Authority (PEA) was organized by City leadership in 2010 as a municipal authority with expertise in energy management and responsibilities to develop and facilitate energy projects, help with energy supply, and educate consumers on energy technologies and services. Over time, the PEA scope has grown to include broad initiatives such as the Philadelphia Energy Campaign, and collaborative projects such as energy efficiency at the Philadelphia Museum of Art. Continued collaboration between PEA and City government accelerates energy efficiency projects and helps develop an energy workforce.



OPPORTUNITY: LED STREET LIGHTING

Street lighting uses more electricity than any other City department use, making it a critical opportunity for reducing the City's carbon footprint (see page 12). The Streets Department has installed LED street lights in some areas and found that they have many advantages over conventional street light technologies, including higher energy efficiency, longer life-times, and the ability to change light levels and direction of light when paired with a control system. Other cities, including Chicago and Los Angeles, have already completed similar transitions citywide.

Replacing all the City's street lights with LEDs with a control system will cost tens of millions of dollars. To complete a budget-neutral LED street lighting retrofit that reduces energy waste and improves outdoor spaces, the City is exploring a performance contract, a joint project with PECO, or funding the investment through the capital budget process.



LED lighting in the background vs high pressure sodium lighting in the foreground on Spruce Street. In addition to considerable energy savings, LED lighting better illuminates roadways for pedestrians, bikers, and drivers.

Photo: Dominic McGraw

ACTIONS:

- Work with PECO, PEA, and other stakeholders to find a path to retrofit all street lighting with LEDs and a control system. **T** **S**



OPPORTUNITY: CAPITAL AND REBUILD PROJECTS

Capital Planning

To meet the City's environmental and economic goals, all capital projects need to include energy efficiency in their budgets. Large capital projects are required to meet the LEED Silver sustainability standard, but many City investments fall below the size threshold to trigger this requirement. Incremental investments in building envelope and HVAC equipment over time can greatly improve efficiency, but budgetary support for this work needs to be incorporated early in every project. City budgets are already constrained by years of deferred maintenance. Nevertheless, small reforms to capital project improvements can add up to large energy savings over time.

ACTIONS:

- Ensure that all Capital projects start with a budget that incorporates sustainability standards. **S**

Building Guideline Documents

In addition to budgeting for energy efficiency, the City can greatly improve its energy performance by recommending minimum efficiency standards for new investments. In 2017, the Energy Office developed guidance on how to standardize building systems, design considerations, and technology selections as part of the Rebuild initiative to update the city's libraries and recreation centers. This guidance reflects the following values:

Simplification – Buildings that are easy to operate and maintain,

Lifecycle costs – Buildings that minimize capital and operating costs over time,

Risk management – Buildings that are designed to withstand projected changes to Philadelphia's climate,

Occupant comfort – Buildings that keep occupants health and comfortable, and

Sustainable construction practices – Buildings that are constructed with their surrounding environment and neighborhood in mind.

The building guidelines combine existing City practices, national standards, and Energy Office suggestions to provide guidance on lighting, building controls, building envelope, HVAC systems, and building and site systems. The Energy Office and Department of Public Property will work together to maintain and update the guidelines as technologies and practices change.

ACTIONS:

- Complete and maintain building guideline documents to guide investments in all capital projects, including Rebuild. **T**

Deep Energy Retrofits

The tool used to evaluate energy conservation measures for this plan focused on projects that provide a short return on investment. Deeper energy efficiency retrofits and investments using holistic approaches to building retrofits can also save money and reduce energy waste. Deep energy retrofits address multiple building systems at once, rather than focusing on only lighting or only HVAC as individual projects, and result in high energy performance. When the City is implementing major renovations or new construction, it should consider how upgraded systems will work together to maximize benefits.

ACTIONS:

- Pursue deep and whole-building retrofits where possible. **T S**



OPPORTUNITY: ENERGY EFFICIENCY & SUSTAINABILITY FUND

Continuing Investments through Energy Efficiency & Sustainability Fund

In 2010, the Office of Sustainability (OOS) established the City's Energy Efficiency and Sustainability Fund (EESF), which leverages OOS's capital budget to provide internal grants to develop and implement sustainability projects in City facilities. Projects funded have included LED lighting, control systems, building envelope upgrades, and other energy efficiency improvements in facilities for nearly every City department.

ACTIONS:

- Invest EESF dollars in short-payback projects that combine OOS and department resources to provide multiple benefits for departments. **S**
- Explore the creation of a revolving loan or reoccurring funding for EESF. **S**

Expanding Departmental Support through EESF

In 2016, with the launch of [Greenworks: A Vision for a Sustainable Philadelphia](#), EESF expanded beyond its original focus on energy reduction and return on investment to incorporate additional sustainability goals, including increased occupancy comfort, improved indoor air quality, waste diversion, and climate resiliency.

The Office of Sustainability has also begun to provide technical support in addition to funding for a broad range of sustainability-focused initiatives. For example, OOS's consultants provide design for many City lighting projects and have evaluated erosion and sediment control planning for the Prison's compost facility.

ACTIONS:

- Use new EESF projects to try new technologies that provide multiple benefits to city facilities including improving air quality, resiliency, and other sustainability benefits. **S**
- Use data and analytics to identify facilities not engaged in energy efficiency and prioritize engaging them. **T**
- Continue to have the Energy Office serve as technical support for sustainability in City facilities. **P**



Through the EESF, the City has installed LED lighting in many City facilities, including Fire Engine 69, shown here.

Photo: Dominic McGraw



OPPORTUNITY: SMARTCITYPHL ENERGY

Incorporate Sustainability into Smart City Initiative

The Office of Innovation and Technology (OIT) is currently developing a comprehensive SmartCityPHL plan to guide the City's efforts to connect buildings and infrastructure using emerging technologies. One benefit of the increased connectivity is more efficient energy usage. Many cities are adding control systems to their buildings and LED street lighting retrofits that both reduce energy waste and provide other benefits. OIT, the Energy Office, and other partners should align SmartCityPHL and the City's energy and cost-savings goals.

ACTIONS:

- Include the Energy Office as a stakeholder in the SmartCityPHL project. **T S**
- Explore opportunities to improve LED street light network controls through SmartCityPHL. **T**

Building Monitoring

The Energy Office's Building Monitoring Program is helping buildings with early stages of continuous commissioning. The Energy Office currently monitors building activity for the City's four largest downtown buildings and communicates with operations personnel to reduce energy waste, troubleshoot building controls, and highlight operations practices that need attention.

The Building Monitoring Program should expand to other buildings that have completed energy efficiency projects and larger new buildings with building automation systems (BAS) that control HVAC and related building systems. With support from OIT, the Energy Office is working to:

- Update existing BAS platforms,
- Standardize features to create a consistent user experience,
- Reroute trending data to a secure source,
- Use a software platform to streamline data and identify operations issues, and,
- Provide software allowing the Energy Office to centrally monitor all networked buildings.

ACTIONS:

- Improve and expand building energy monitoring using utility bill management software, benchmarking, metering, control system infrastructure, communication with building operators, and other integrated approaches. **T**
- Enable remote operations and networking of HVAC building controls for all City buildings with that capacity. **T**

Open Data

To ensure that the City is open and transparent about its progress on initiatives and work, the Energy Office can publish data from its energy management database on the City's energy use, carbon emissions, and progress toward the goals of the Energy Master Plan. This will help keep the City accountable for energy performance (see Improve Operational Practices on page 13) and provide information to individuals and companies looking to learn from the City's work.

ACTIONS:

- Publish General Fund energy use, cost, and greenhouse gas emissions as open data, and regularly update the public on progress toward Energy Master Plan goals. **T**



STRATEGY 2: Clean Energy Supply

Cleaning the City’s energy supply and electricity grid is crucial to meeting both government and citywide greenhouse gas emission goals. In June 2017 Mayor Kenney announced a citywide goal of transitioning to 100% clean energy. To help meet this goal, the City can generate and purchase clean energy and work to influence the generation that feeds into the regional electricity grid.

Philadelphia’s electricity grid relies on a diverse supply of generation sources. In the region, most of the electricity comes from nuclear and carbon-intensive fossil fuel sources. Over the last decade Philadelphia’s regional grid has become less carbon intensive as coal power plants have been replaced by more cost-competitive natural gas and renewable power plants. The closure of coal power plants will likely continue to reduce the carbon intensity of the grid, however, further policy action at the regional and federal levels is necessary to transition the electricity grid away from fossil fuel generation.

FIGURE 8

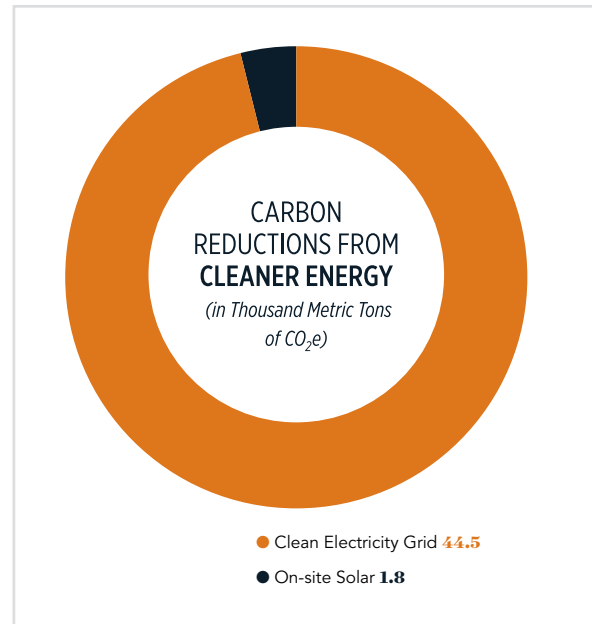
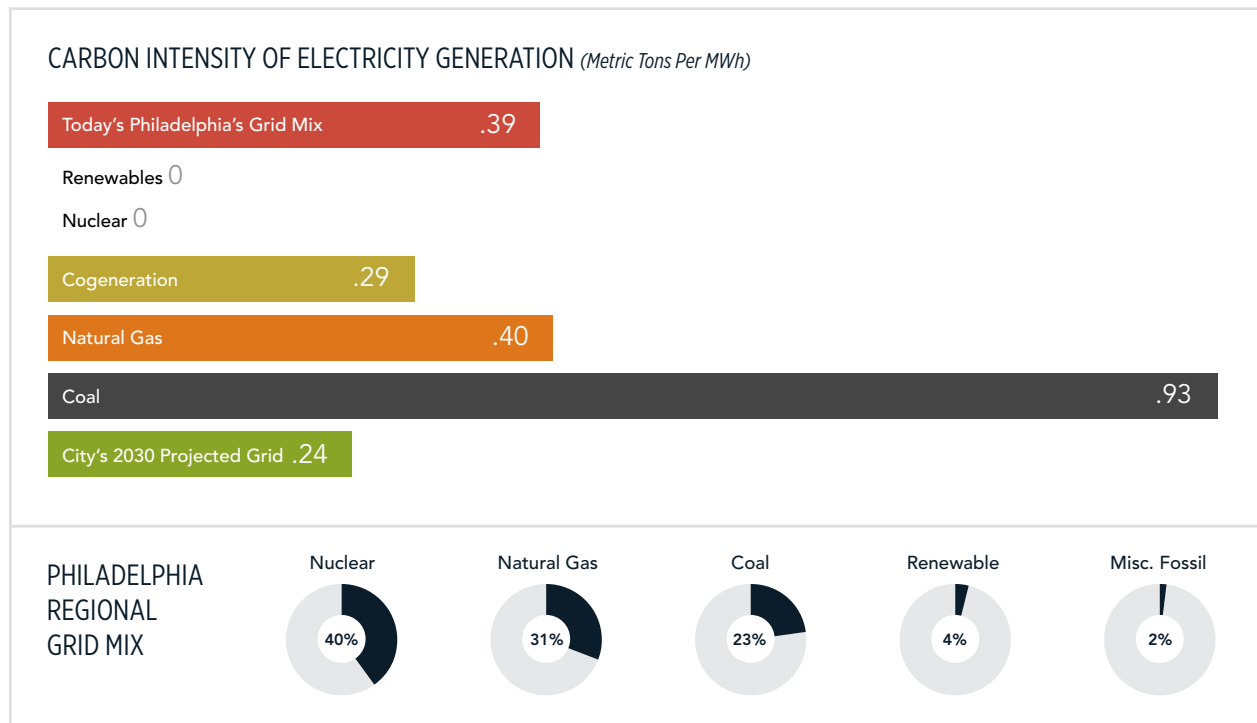


FIGURE 9



Electricity grid 2014 (RFC East) Though renewable energy makes up a small amount of Philadelphia’s regional grid mix, it is the fastest growing electricity generation nationally.



The federal and state governments hold regulatory authority over energy systems and wholesale energy markets. The City of Philadelphia can lower its carbon footprint by generating clean energy on-site and using its purchasing power to encourage utility-scale clean energy generation. In addition to leveraging its buying power, the City can continue to advocate to state and federal decision-makers to act on this issue.

A deeper discussion of how the City and residents can influence the regional grid mix is included in the forthcoming *Powering Our Future: A Clean Energy Vision for Philadelphia* (see page 5). The Energy Master Plan assumes that citywide, regional, and national efforts to clean the regional electricity grid will lower its carbon intensity at least 33 percent by 2030 (following recent trends), but includes contingencies if expected grid transformation does not occur.



A solar photovoltaic farm generating electricity. The City needs to make investments in solar projects for it to achieve its goals. Photo: U.S. Department of Energy



OPPORTUNITY: PURCHASING CLEAN ENERGY

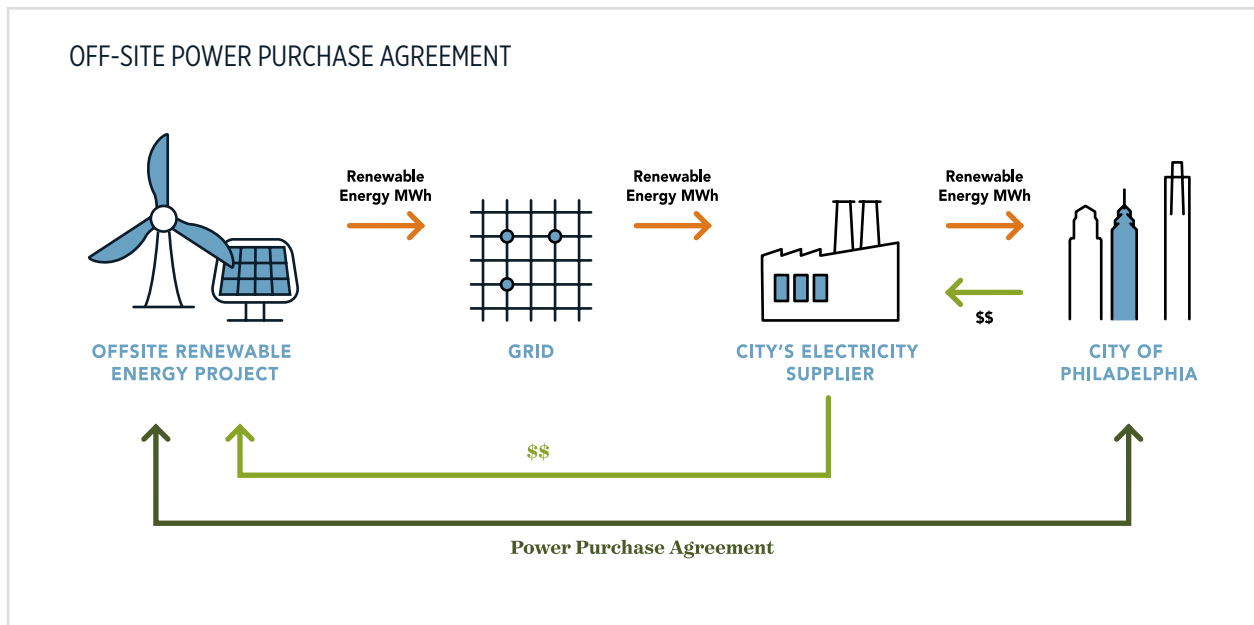
The City of Philadelphia can leverage its buying power to enter into long-term clean energy power purchasing agreements (PPAs), which help move the grid toward a lower carbon intensity. In a PPA, the City agrees to purchase and use clean energy from a regional renewable electricity generator such as a wind, solar, or hydropower plant either currently operating on the grid or to a project in planning.

In addition to helping generate clean electricity, PPAs are also a risk mitigation strategy for the City of Philadelphia. Agreeing to a set price through a PPA fixes a portion of the City’s energy costs for long periods of time, which lowers the risk of purchasing in volatile energy markets.

The City can also move toward cleaner energy by evaluating opportunities for meeting its natural gas needs from renewable natural gas or biogas sources.

While the City’s goal is to source all electricity from renewable sources by 2030, its carbon footprint will still be based on the regional grid mix. Strategies for moving the grid toward a cleaner future will be included in the forthcoming Powering Our Future (see page 5).

FIGURE 10



Off-site Renewable Energy Power Purchase Agreements (offtake PPA)

An offtake PPA is a long-term contract with a large utility-scale renewable energy project. In this arrangement, a third party would develop, finance, install, operate, and maintain a renewable energy project in the region, and electricity would be supplied to the City through the grid.

ACTIONS:

- Contract with a regional renewable energy project through a long-term Power Purchase Agreement. **S**
- Monitor alternative clean energy purchasing options such as renewable natural gas to explore options for cost-effective integration into City procurement. **S**



OPPORTUNITY: ON-SITE CLEAN ENERGY GENERATION

Solar Photovoltaic Electricity Generation

Rooftop solar photovoltaic (PV) installations on City facilities have the potential to provide renewable electricity generation for City buildings. However, rooftop solar projects remain cost prohibitive within current energy markets given the City's low unit cost for electricity. Large institutions like the City purchase electricity in bulk and pay lower electricity prices compared to the residential marketplace. In addition, regional electricity prices are near 12-year lows, making payback on solar investments more challenging.

This may change in the coming years, making solar PV projects on City buildings economically viable, just as they are for many residents today. Solar PV systems can be installed on City buildings by two methods:

On-site Solar Power Purchase Agreements (PPA)

A solar PPA is a long-term contract with a third party to finance, install, operate, and maintain a solar array on City property. Power produced by the on-site array is supplied at a price specified in the PPA and used behind the City's utility meter. These agreements allow the City to get solar pricing that includes federal tax credits for renewable energy.

Direct Solar Rooftop Purchasing

The City can also directly purchase and install solar PV systems on City-owned rooftops. Under this scenario, the City is responsible for maintaining and operating the solar arrays. The City is not eligible to receive federal tax credits for direct solar purchasing.

To prepare for potential solar investments, the Energy Office has initiated a study of City assets to understand solar PV potential. The Energy Master Plan assumes that the City will be able to cost-effectively install approximately four megawatts (MW) of solar PV on its buildings by 2030, though this number may be exceeded if market conditions improve.

While the modeling of solar PV potential for City facilities is not yet complete, current estimates show that even installing panels on all available City-owned rooftop space would not be sufficient to meet the City's electricity requirements, meaning the City will continue to purchase energy from the grid.

ACTIONS:

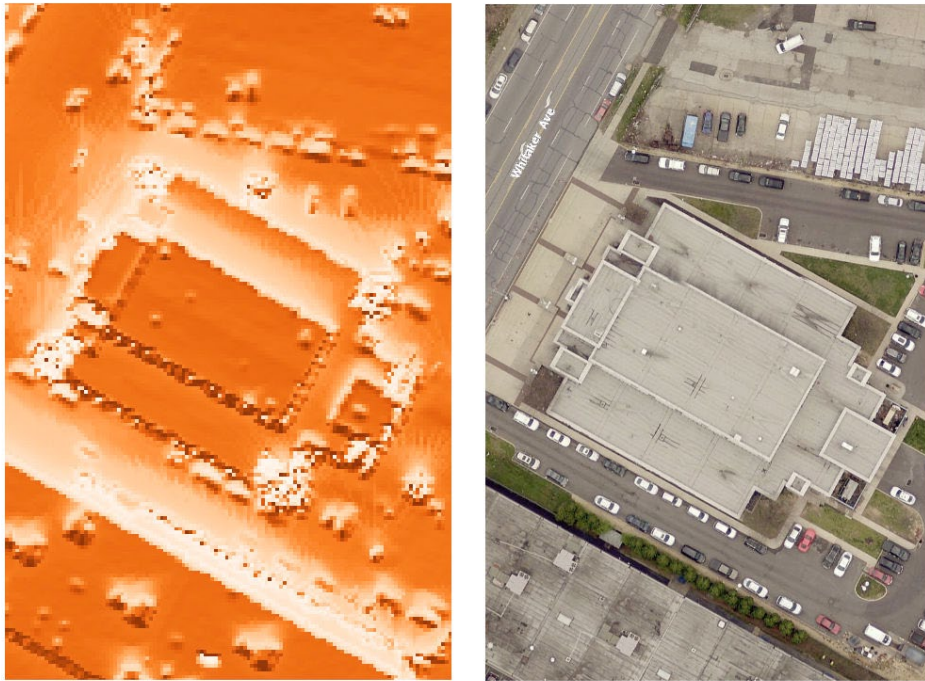
- Complete study of solar PV potential and continue to track rooftop solar PV costs and return on investment for City assets. **T S**
- Explore opportunities for simplifying the Power Purchase Agreement process for solar PV systems on the City's smaller rooftops. **S**

Renewable Heating, Cooling, and Hot Water

Geothermal exchange systems use heat pumps and the constant temperature of the ground to efficiently heat and cool facilities. City government has installed these systems at several buildings that have adequate space nearby to accommodate large geothermal wells. Solar hot water has been installed at the Riverside Correctional facility and provides hot water for sinks and showers in the facility. Solar hot water systems work well for facilities with significant hot water needs like correctional facilities.

ACTIONS:

- Evaluate geothermal exchange and solar hot water systems for cost-effective implementation at City facilities that fit these technologies. **T**



The Energy Office is reviewing the solar potential of City facilities like the 24th and 25th police district as seen above. Photo: ESRI

Energy Generation for Critical Facilities

The City of Philadelphia runs many critical facilities which require continuous operations during natural disasters or emergencies. Microgrids allow facilities to operate emergency electricity generation independent from grid supply. Combined heat and power (CHP) projects may meet the needs of some City facilities, as certain types of CHP projects can emit significantly less carbon than conventional central plant systems and serve as anchor electricity generation for microgrids.

To have significant carbon reduction benefits, CHP projects need to use the heat generated to meet thermal needs of the facility for domestic hot water, process loads, or heating and cooling. To achieve renewable energy designation, CHP projects can use biogas (such as the system in place at the Philadelphia Water Department's Northeast Water Pollution Control Plant). In addition to CHP, microgrids backed by battery technology can also provide resiliency benefits in some contexts.

ACTIONS:

- Identify on-site power generation opportunities for microgrids. At City facilities that include critical operations, consider the inclusion of combined heat and power (CHP) systems that offset existing thermal loads and can serve as anchors for resilient microgrid systems. **T S**
- Monitor clean energy technologies such as battery storage to explore options for cost-effective integration into City assets. **T S**



Conclusion and Next Steps

Mayor Kenney has set ambitious greenhouse gas and clean energy goals for all of Philadelphia. This plan outlines the opportunities available for the City of Philadelphia to reduce carbon pollution from its built environment through two strategies: lower energy use and clean energy supply. The success of this plan requires commitment from people, the implementation of technology, and the City's leadership on a strategic approach to investments.

Through the implementation of this work, the City will lead the fight against climate change by working toward the following goals for government operations:

- Reduce greenhouse gas emissions from the City's built environment 50 percent by 2030,
- Reduce the City's built environment energy use 20 percent by 2030,
- Generate or purchase 100 percent of all electricity for the City's built environment from renewable resources by 2030, and
- Maintain or reduce the City's built environment cost of energy at facilities.

As projects and programs are implemented, the Office of Sustainability and the Energy Office will regularly update the public on progress and next steps. The Office of Sustainability and the Energy Office remain committed to exploring additional opportunities and actions to achieve even deeper carbon reductions. Additionally, in the coming year, the City intends to create a plan for its vehicle fleet and release *Powering Our Future: A Clean Energy Vision for Philadelphia*, which will demonstrate how, together, we can meet our climate goals.

The task of curtailing climate change is enormous, and City operations are a relatively small, albeit influential, area where work is needed. Portions of this plan require action beyond City government, and are dependent on state and national policy changes that support clean energy and climate action. The City of Philadelphia looks forward to setting an example for, and working with, individuals, communities, and institutions as they continue their own progress on reducing climate impacts.




FIGURE 11 Co-benefits of this plan


BENEFITS FROM CITY INVESTMENTS AT FULL INSTALLATION OF ENERGY EFFICIENCY INVESTMENTS	
Improved Air Quality <i>(ANNUAL FROM CURRENT GRID)</i>	
SOX Emissions Reductions	19.1 MT
NOX Emissions Reductions	14.4 MT
Mercury Reductions	0.24 lbs
Improved Economic Conditions	
Reduced energy costs	
Jobs created	
Reduced risk to energy price fluctuations	
Improved Public Buildings and Spaces	
Better conditioned and comfortable spaces	
Improved indoor air quality	
Safety benefits from improved outdoor lighting	



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