NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL PARTNERS WITH THE CITY OF PITTSBURGH AND REGIONAL STAKEHOLDERS TO HELP DESIGN AND IMPLEMENT A 21ST CENTURY ENERGY INFRASTRUCTURE

ESTABLISHING PITTSBURGH AS A NATIONAL MODEL AND GLOBAL LEADER

Memorandum of Understanding with the City of Pittsburgh

Updated July 5, 2019

U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

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INTRODUCTION

The National Energy Technology Laboratory (NETL) is a U.S. Department of Energy (DOE) national laboratory that produces technological solutions to America's energy challenges. For more than 100 years, the laboratory has developed tools and processes to provide clean, reliable, and affordable energy to the American people.

NETL's mission is to discover, integrate, and mature technology solutions to enhance the nation's energy foundation and protect the environment for future generations. Through forward-looking research and technology development, the Laboratory's team of talented and diverse experts provide technology solutions for today and options for tomorrow.

From the moment 18th-century entrepreneurs chiseled exposed chunks of coal from the cliffs of Mount Washington in Pittsburgh, PA, affordable energy has been an engine for the City of Pittsburgh's upward economic trajectory.

NETL has partnered with the city to support innovation in its industrial and economic evolution with new ideas for safety, efficiency, and productivity. This partnership dates back to 1911 when mine safety training sessions were held at Forbes Field and has continued for more than a century. Now, as Pittsburgh celebrates its bicentennial and prepares for a third century as a great American city, NETL is playing a key role in helping develop new ideas and approaches to keeping the city on the national and international forefront of energy innovation by providing input on a range of aggressive new projects.

This paper provides an update on progress being made under a Memorandum of Understanding between the National Energy Technology Laboratory and the City of Pittsburgh towards the development of a modern energy generation and delivery system.

BACKGROUND

The City of Pittsburgh and the National Energy Technology Laboratory (NETL) are expanding upon a century-long history of collaboration to focus on a range of energy-related endeavors with goals that will benefit future generations. NETL is helping Pittsburgh elevate its technology-based economic development successes by establishing the city as a global leader in clean energy and transportation planning, modeling, and implementation.

Once known as "the smoky city," Pittsburgh's renaissance created a new technology-based backbone of industries that have reshaped the city's image, physical appearance, and outlook for the future. The newest phase of its evolution is centered upon improving its carbon emissions, energy efficiency, power generation and distribution, and transportation. NETL, a Department of Energy National Laboratory specializing in clean energy research, is lending the city its expertise and advice for moving towards these goals.

Since 1910, the federal energy research organization now known as NETL has been a sparkplug of innovation supporting the city in its energy, industrial and economic evolution with new ideas for safety, efficiency, and productivity. Now, as Pittsburgh celebrates its bicentennial and prepares for a third century as a great American city, NETL is playing key role in Pittsburgh's vision to create a 21st century energy generation and distribution infrastructure that will build upon the city's existing electrical grid and district energy systems, resulting in a network of energy districts that adapts and connects distributed energy resources with customers.

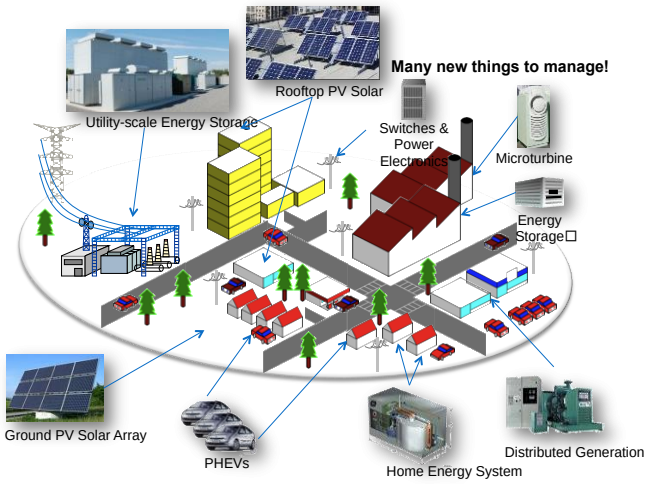

Figure 1. Thermal Energy Generation. ***Source: Green Energy Corp.***

Distributed energy resources (DERs) are smaller-scale, modular, electric and thermal energy-generation and storage devices like combined heat and power, gas turbines, microturbines, wind turbines, PV solar, batteries, fuel cells and geothermal. Coupling these energy resources with local consumers or loads creates a localized grid called an energy district (Figure 1) that is connected to but can run independently from the larger, centralized power grid to help improve power reliability and quality, increase system efficiency, enhance environmental performance, and provide grid-independence to individual end users. Multiple grids can be tied together to create a "grid of microgrids" that can further increase system reliability and resiliency.

If successful in Pittsburgh, the "grid of microgrids" concept could serve as a model for other cities adapting to the challenges of a changing energy paradigm.

This effort is part of growing movement to modernize and secure the U.S. electric power grid. For more than 140 years, the nation's electric grid consisted of large, centralized power generation coupled with long-distance transmission lines and local distribution wires in which power flowed in one direction from generator to consumer. Today, the increased penetration of DER is changing how the grid operates, resulting in two-way flows of electricity, new market forces, and the potential for improved efficiency and resiliency. DER resources such as renewable energy, combined heat and power (CHP) units, and fuel cells can reduce emissions and long-term energy costs by operating at high efficiencies (>80%) and being tightly integrated for optimized operation. In addition, such technologies help to harden the grid to natural disasters and cybersecurity threats.

MEMORANDUM OF UNDERSTANDING

On behalf of DOE, NETL signed a Memorandum of Understanding (MOU) with the City of Pittsburgh on July 17, 2015 to assist the city in implementing the "grid of microgrids" concept. Assembled to execute the MOU is a "who's who" of Pittsburgh ingenuity and leadership in energy, research, and sustainability from across the city and region. Partnering with NETL and the City are the University of Pittsburgh, Carnegie Mellon University(CMU), Duquesne Light, the University of Pittsburgh Medical Center(UPMC), Peoples Gas, Clearway Energy, RAND Corporation, the Hillman Foundation, Heinz Endowments, and the Richard King Mellon Foundation.

Under the MOU, NETL and its partners are supporting the City in:

- Creating social responsible networks of distributed energy generation and storage systems to increase resiliency, reduce carbon footprint, and improve efficiency.

- Providing a platform to accelerate adoption of advanced distributed energy resources such as microturbines, direct current power delivery, CHP, reciprocating engines, energy storage devices, photovoltaics, and wind turbines.
- Promoting advanced, smart, and socially responsible transportation infrastructure powered by local generated energy.
- Meeting the goals and objectives of the City of Pittsburgh Climate Action Plan 3.0.

Figure 2. NETL Director Dr. Grace Bochenek and Pitsburgh Mayor William Peduto sign MOU on July 17, 2015.

Pittsburgh is uniquely positioned to blaze a development trail for the concept because it has a number of existing distributed energy resources that already provide power to a range of specific organizations and institutions in separate locations around the city. The challenge ahead is to organize those existing distributed energy systems and help them interconnect through new "energy districts" within the city.

Existing and Proposed Distributed Energy Systems

The five existing distributed energy systems that the city and NETL see as energy districts that could serve as a spine for future energy district development are:

- **Pittsburgh Allegheny County Thermal (PACT) -** Established in 1983, PACT serves 55 buildings downtown, including many local government buildings, commercial and residential buildings, and offices. PACT is a supporter of Pittsburgh in the 2030 Districts project.
  Pittsburgh Allegheny County Thermal (PACT)

- **Duquesne University's Cogeneration Plant -** This combined heat and power plant is a powerful gas-fired turbine that began operations in 1997 - at the time it was more than capable of producing all of the electricity for the campus. The campus has since expanded, but today the cogeneration plant still provides electricity to 85 percent of the 50-acre campus and captured thermal energy is used for space heating and cooling (via adsorption chillers). Onsite thermal energy storage further improves system operation, allowing space cooling loads during peak times (hottest times of the day and year) to be reduced. The plant has recently been upgraded for improved efficiency and increased capacity.
  Duquesne University's Cogeneration Plant

- **Clearway Energy Center Pittsburgh -** The Clearway Energy Center in Pittsburgh began operations in 1999 and provides power to over six million square feet of commercial and residential facilities, consisting of more than 30 buildings on the North Side. NETL/DOE is partially funding a 200 kW solid oxide fuel cell (SOFC) power plant from Fuel Cell Energy at Clearway Energy Center that was craned into place in July 2018 and began operation in April 2019 with a goal to run for at least 5,000 hours to quantify long-term degradation as well as systems availability and reliability. The system will use natural gas as a fuel and produce electricity at efficiency greater than 50 percent.
  Clearway Energy Center Pittsburgh

- **Bellefield Boiler Plant -** The Bellefield Boiler Plant, also known as "The Cloud Factory", was built in 1907 to provide steam heat for Carnegie Museum. The plant previously burned both coal and natural gas, but stopped burning coal in 2009 so that it could produce cleaner fuel. Today, the plant provides heat to many buildings in Oakland, including the Carnegie Museums & Library, the University of Pittsburgh, Carnegie Mellon University, Phipps Conservatory, the University of Pittsburgh Medical Center (UPMC), and two Pittsburgh Public Schools facilities.
  Bellefield Boiler Plant

- **Carillo Street Steam Plant -** The Carillo Steam Plant opened in 2009 and is used by The University of Pittsburgh and UPMC in Oakland. The plant, made up of six high-efficiency boilers, is one of the cleanest university heating plants in the United States. The full use of the facility by Pitt and UPMC is expected to reduce annual carbon dioxide emissions by approximately 48,000 metric tons, which is nearly half of the baseline steam-related CO_2 emissions. The boiler can also transform approximately 14,000 gallons of water per hour into steam.
  Carrillo Street Steam Plant

In addition, the city is in various stages of developing seven new distributed energy /microgrid projects:

- **Uptown Energy District -** Clearway Energy and UPMC Mercy have signed an agreement to build a new steam plant to deliver heat, chilled water, and backup electricity a 28 acre site in the Lower Hill/Uptown District that includes the PPG Paints Arena and UPMC Mercy hospital. The benefits of this steam plant over multiple, stand-alone systems include higher efficiency, lower carbon emissions, and lower capital and operating costs. The agreement was approved by the City Council in early September 2016. Clearway Energy broke ground on the new generating facility in Uptown in March 2017.

- **Woods Run -** Duquesne Light Company is installing a nominal 10 MWe microgrid at their Woods Run operations center on Pittsburgh's north side. The facility will be used to investigate challenges and solutions to integrating distributed energy technologies such as photovoltaics, wind, and energy storage. The microgrid is currently under development.

- **2nd Avenue Microgrid -** Linking district energy with the modernization of the City's transportation infrastructure, the 2nd Avenue Energy District project will combine garage and rooftop photovoltaic solar and battery storage with electric vehicle charging stations along the 2nd Avenue corridor from Homestead to downtown Pittsburgh.

- **Oakland Energy District -** This UPMC-Oakland socially responsible microgrid concept is based on a design employing ultra-high resiliency and reliability that would continue electrical services to key infrastructure as well as provide the local community with shelter during extended grid outages. The Bellefield Boiler Plant has the potential to support the Oakland Energy District.

- **Brunot Island Microgrid -** This existing electric substation, a 315 MW fossil fuel power plant, is a possible site for a biogas and waste-to-energy plant. The microgrid will serve commercial districts on Pittsburgh's North Side.

- **Larimer Energy District -** a community-based microgrid that would be part of the redevelopment of a 285-acre neighborhood in Pittsburgh's East End, a plan that has been dubbed by Pittsburgh Mayor Bill Peduto to be "the greenest housing development to be built in the United States". The new buildings will be highly energy efficient and will have green space incorporated throughout the complex.

- **Hazelwood Green Energy District -** Once known as Almono, this mixed-use development in Hazelwood on a 178-acre former steel mill riverfront would operate almost exclusively on renewable-based distributed energy.
  Hazelwood Green

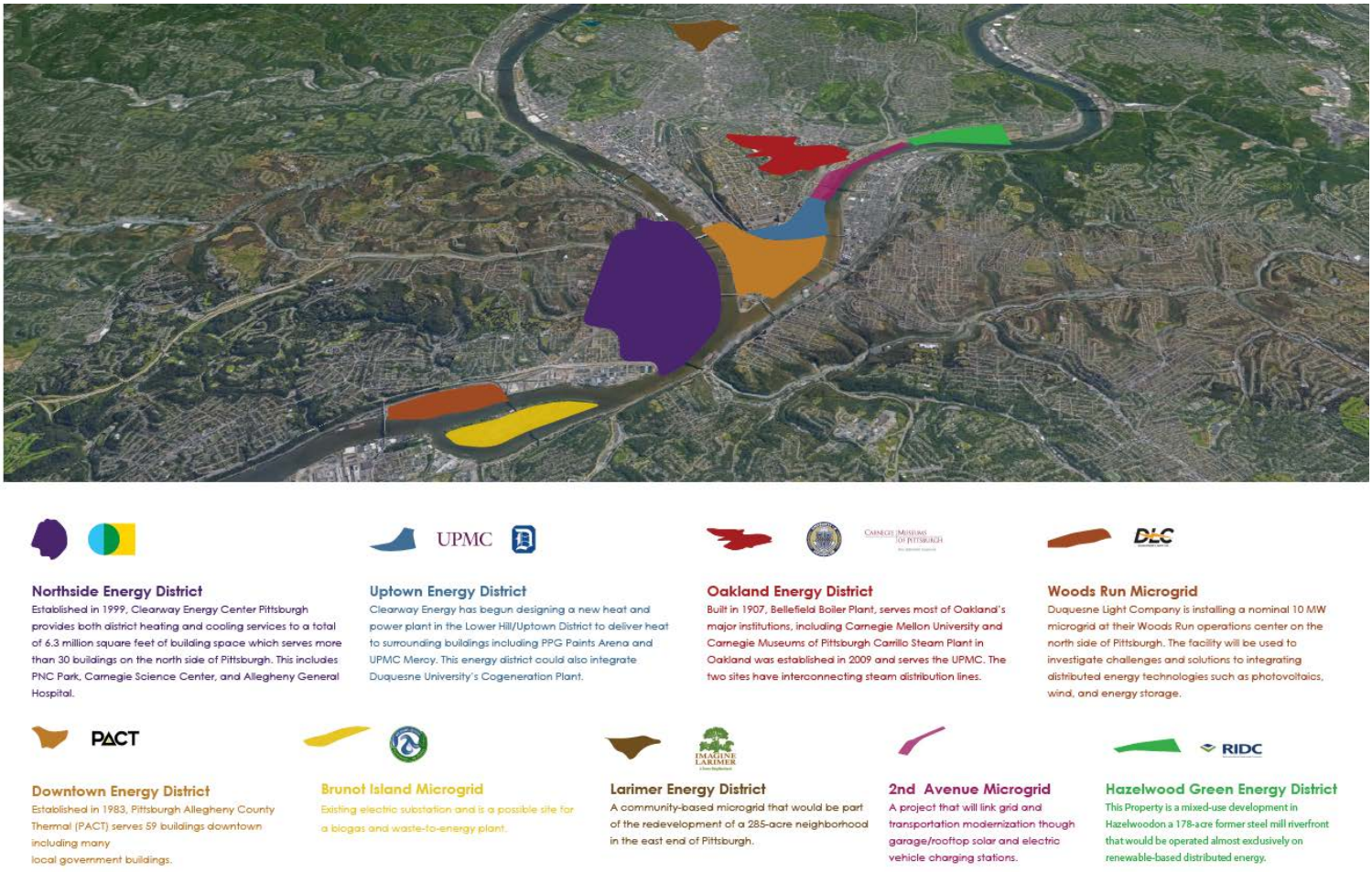

Figure 3. The location of the City of Pittsburgh's existing distributed energy sites and proposed microgrids and energy districts. The Duquesne University cogeneration plant and the Carrillo Street Steam Plant and Bellefield Boiler Plant could potentially become part of the Uptown and Oakland microgrids, respectively.

City Council and the Sports and Exhibition Authority (SEA) Services District

On December 16, 2016 the County of Allegheny, the City of Pittsburgh, and the SEA issued a Request for Proposal (RFP) for a district energy project that would provide steam to several downtown buildings and facilities including the City-County Building, the County Jail, and the David L. Lawrence Convention Center currently served by PACT. The RFP allows for a number of options including:

- A replacement central heating plant (steam and/or hot water systems) to serve some or all of the facilities specified.
- On-site, replacement boiler installations at some or all of the facilities specified.
- Combined heat and power installations at some or all of the facilities specified.

Responses to the RFP were due January 25, 2017. No additional information has been released at this time.

Benefits of Distributed Energy Systems

Having communities organized into districts that are served by locally produced low-carbon power can have reliability, efficiency, and cost benefits.

Further, distributed energy or microgrids give communities and consumers a larger role in deciding how their energy is produced in terms of lower carbon electricity and allows customers to partake in demand-response, net metering, and other programs and initiatives designed to increase the efficient and cost-effective use of electricity.

Social responsibility and community engagement are cornerstones of the city's vision for how it will generate and distribute energy in the future. Learning from the experiences of New York City and elsewhere along the east coast from Superstorm Sandy, the proposed UPMC-Oakland microgrid would ensure that critical hospital and related emergency services will be provided and will serve as a safe haven for residents of Oakland and surrounding communities to take shelter should there be a major disruption in the power grid in the Pittsburgh region.

From a community-engagement standpoint, the proposed Larimer microgrid would be part of a larger revitalization of Larimer, which is an economically and socially challenged neighborhood in Pittsburgh's East End. The microgrid will build upon the significant land use planning and sustainability efforts the community has been working on since 2012. Community-based solar offers a particularly attractive distributed energy opportunity for Larimer and other East End communities like Homewood.

MOTIVATION	BENEFIT	DESCRIPTION
INCREASED RELIABILITY	Modernize utility delivery	While efficient, the city's existing delivery system for electricity, steam, and hot/chilled water is aging and in need of modernization; microgrids will help strengthen the power system.
	Improve power quality	Distributed energy systems can better provide customers with consistent quality electricity, particularly during times of disturbances/disruptions of the grid.
IMPROVED ECONOMICS	Encourage workforce development and job creation	The creation of a grid of microgrids will further enhance and strengthen the city's existing electric power distribution infrastructure.
	Build upon efficiency of existing grid	A modern energy generation and distribution network will create job and work-force training opportunities for both skilled and semi-skilled workers.
	Drive economic development,growth, and attract investment	A modern, efficient energy network will stimulate economic development and growth by attracting further investment in the city.
ENHANCED SECURITY	Strengthen resiliency and security of energy delivery	A network of distributed energy systems that can operate independent of the existing grid will strengthen the city's energy resiliency and security.
	Prepare for future catastrophic events	Microgrids that can be islanded (isolated) from the grid provide the ability to pro-vide power to critical buildings and infrastructure during catastrophic events such as "superstorms."
IMPROVED ENVIRONMENTAL QUALITY	Reduce carbon footprint and improve environment	Distributed energy systems using a mix of renewable energy and natural gas coupled with efficiency improvements and waste heat recovery will reduce greenhouse gas emissions and improve overall environmental performance.
ACCELERATED INNOVATION	Advance new energy technologies	Microgrids and other distributed energy resources provide a venue for the research, development, demonstration, and deployment of advanced power technologies such as energy storage and advanced control systems.
	Establish city as energy innovation hub	The creation of a "grid of microgrids" will make Pittsburgh a model for the world and a hub for grid innovation and advancement.
	Enhance city as place to live, work, and visit	A cleaner, more reliable energy generation and delivery system will further enhance Pittsburgh's reputation as a "most livable city" by residents having access to clean, reliable, and affordable power in their homes.

Figure 4. Benefits that the City and its residents will accrue associated with a network of distributed energy systems.

NETL Activities under the MOU

NETL is working with the City to achieve the following goals under the MOU:

- Formulate a strategic plan to assist in the identification and adoption of district energy strategies and to provide guidance for public and private stakeholders on development of district-scale clean energy and grid design.
- Identify financial opportunities for the design and construction of district energy systems and renewable energy deployment.
- Design a policy plan that supports the development of municipal, utility, and regulatory policy needs for district energy applications and infrastructure modernization.
- Conduct an economic analysis of district-energy solutions with microgrid integration and building performance policies.
- Accelerate the growth of and access to energy jobs.
- Create a technical team to identify and prioritize high-value energy opportunities.
- Develop a research and development roadmap for rapid demonstration and deployment of new technologies.

CHP Resiliency Accelerator

NETL identified an opportunity for the City of Pittsburgh to become a partner in DOE's Office of Renewable Energy and Energy Efficiency (EERE) Combined Heat and Power (CHP) for Resiliency Accelerator. This program provides technical support for communities, cities, and other stakeholders considering CHP as one option for addressing resiliency of critical infrastructure. As a partner in the Resiliency Accelerator, EERE's CHP Technical Assistance Partnership technical team visited the City in May 2016 to tour and assess three of the city's existing combined heat and power/district heating resources: Duquesne University's cogeneration plant; NRG's North Shore cogeneration plant; and Pittsburgh Allegheny County Thermal (PACT) plant that provides steam to downtown Pittsburgh. It is anticipated that staff from the CHP TAP will visit Pittsburgh again.

Fossil-Based Distributed Energy Resource RD&D

One NETL technology that will be demonstrated under the MOU is a solid oxide fuel cell (SOFC) partially funded by DOE/NETL and developed by FuelCell Energy. The system uses natural gas as a fuel and produces electricity at efficiency greater than 50 percent. A 200 kW SOFC power system can power approximately 100 homes. When commercially available, SOFC distributed power generation systems will enhance energy security and reduce the dependence on the central electric grid. (Figure 5).

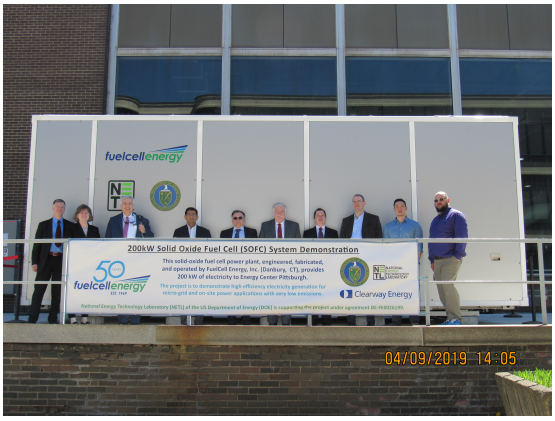

Figure 5. On Tuesday, April 9, 2019 U.S. Department of Energy Office of Fossil Energy (FE) officials joined NETL representatives to tour the prototype 200kW Solid Oxide Fuel Cell (SOFC) system in Pittsburgh's central business district that is advancing technology to provide clean, high-efficiency power from fossil fuels.

Baseline Energy Analysis

In 2017, NETL's system analysis team published the *Pittsburgh 2013 Energy Baseline* report that used 2013 residential, industrial, commercial electricity and natural gas usage data to develop energy consumption and CO_2 emission patterns in the City of Pittsburgh and surrounding areas. Figure 6 depicts residential natural gas and commercial electricity consumption in the Pittsburgh area in 2013 and shows location of existing and proposed energy districts. This

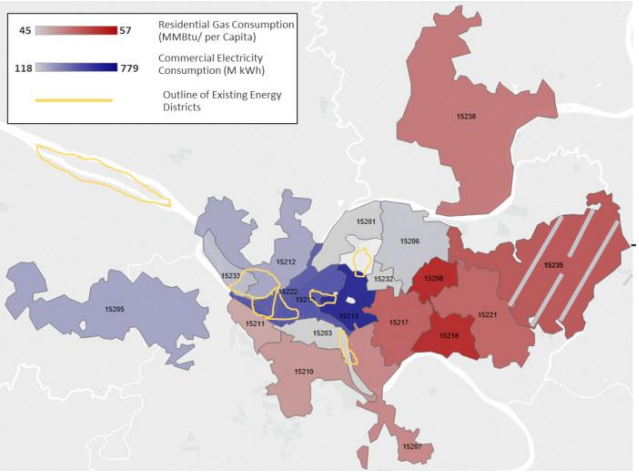

Figure 6. 2013 Residential gas and commercial electricity usage in Pittsburgh.

information can be used to identify energy use "hotspots" that could be targeted for energy efficiency programs and where the City might expand its network of energy districts and microgrids. As part of the energy baseline study, NETL is also evaluating the technical and economic applicability of a variety of distributed energy resources (DER) including fuel cells, CHP, reciprocating engines, micro-turbines, PV Solar, wind, batteries, and anaerobic digestion to the City's existing and planned energy districts. Click the link below to view the report.

Pittsburgh 2013 Energy Baseline report

Geothermal Assessment of Hazelwood Green

Leveraging funding from DOE's Geothermal Technologies Office, NETL has completed a preliminary techno-economic study of the potential for deep direct use (DDU) geothermal energy at the Hazelwood Green microgrid/energy district. In general, DDU geothermal lends itself to larger-scale, commercial applications as envisioned for the Hazelwood Green site that can optimize the value of lower temperature geothermal resources through a cascade of uses from electricity generation to direct heating and cooling. While preliminary analysis shows a lifetime capacity of more than fifty years when accessing deep (~14,000) direct use geothermal at Hazelwood Green, there was lower geothermal potential than expected. Overall, the viability of DDU geothermal at Hazelwood Green would improve under future economic and market conditions where fossil energy alternatives are more expensive, or when well development costs have been reduced. The latter is a subject of on-going NETL research.

Communication and Outreach

As part of a communication and outreach strategy, NETL worked with the City to create two videos highlighting the MOU. The first video presents a perspective on the MOU from a broad spectrum of regional stakeholders represented by Duquesne Light Company, Peoples Gas, Carnegie Mellon University, Urban Innovations, Solar Works in Pennsylvania, and ReMake Group. The second video provides a more technical narrative about microgrids and DER and includes insights from representatives of the University of Pittsburgh, NETL, Solar Works in Pennsylvania, and Duquesne Light Company. The stakeholder and technical videos can be found on NETL's official YouTube channel or on the City of Pittsburgh MOU website.

- Stakeholder video: https://youtu.be/5t9iqWl9LQ8
- Technical video: https://youtu.be/wyJ4Z_7psqE

Federal Funding Opportunities

One of the critical MOU goals that NETL has been aggressively moving forward on is identifying financial opportunitues to catalyze investment in distributed energy sytems/microgrids and supporting activities in the city. Financing is one of the bigger challenges for microgrids particularly in a region like Pittsburgh that is blessed with relatively low-cost, reliable electricity. Making a strong business case to build microgrids will require enumerating to investors the many, but often

nuanced, advantages associated with distributed energy systems including increased resiliency and reduced environmental impacts. NETL is also playing a role in the early demonstration and deployment of advanced DER to help reduce the real and perceived risks to investors of new technology associated with microgrid systems. An example is the 200 kW SOFC that is being tested at the Clearway Energy North Side facility.

Leveraging federal support with other public and private-sector funding is one approach to financing. NETL and DOE's Energy Jobs Strategies Council within the Secretary's Office have been facilitating conversations between the City and DOE's Loan Program Office to discuss loan-based financing for one or more of the City's distributed energy systems.

NETL is also tapping into funding it has received from EERE's Geothermal Technology Office in working with the City to assess potential for direct use of geothermal energy from deep resources in the eastern U.S. The Hazelwood Green site appears to be an attractive opportunity to apply deep direct geothermal as part of its overall plan to operate on a totally renewable-based microgrid.

NETL has identified a number of funding opportunities across a spectrum of federal programs including DOE's Office of Renewable Energy and Energy Efficiency (EERE), the Office of Electricity Delivery and Energy Reliability, and the National Science Foundation. NETL has teamed with the City and its partners on funding opportunities with the Department of Transportation's Smart City Challenge, DOE/EERE's Cities LEAP, and NSF's Smart and Connected Communities.

Funding Opportunity Announcements Relevant to the City of Pittsburgh MOU

Smart City Challenge

NETL was an active partner in supporting Pittsburgh's pursuit of a $50 million Smart City Challenge grant from the U.S. Department of Transportation (DOT) to improve regional transportation. Plans call for development of a full range of diverse transportation elements that improve air quality, develop new manufacturing related to smart traffic signals and tracking devices, and help to facilitate electric vehicle use. Powering of the city's electric vehicles would be accomplished through locally sourced distributed energy that would be developed under the MOU.

After having been named a finalist for the funding in March 2016, Pittsburgh became a competitor with six other cities for the grant: Austin, Texas; Columbus, Ohio; Denver, Colorado; Kansas City, Missouri; Portland, Oregon; and San Francisco, California. Pittsburgh officials made final presentations in support of the city's proposal in Washington, D.C. in June.

The successful city would receive $40 million from the Department of Transportation; $10 million from Paul G. Allen's Vulcan Inc.; $1 million in cloud service credits from Amazon Web Services; and additional funding from Mobileye, Autodesk and Alphabet's Sidewalk Labs.

The DOT announced that Columbus, Ohio won the Smart City Challenge in July, however, on October 11, 2016, the City received notice that it would receive a $10.9 million grant under the Fixing America's Surface Transportation Act (FAST Act). This grant is to be used to create "smart spines" that collect data through a network of sensors to help balance and move traffic through the city. In announcing the FAST Act Funding, the DOT pointed to the strong proposal submitted by Pittsburgh for the Smart City Challenge as one reason for awarding the $10.9 million grant.

DOE Cities Leading through Energy Analysis and Planning

NETL also supported the city's application for funding under the DOE Office of Energy Efficiency and Renewable Energy (EERE) Cities Leading through Energy Analsis and Planning (Cities-LEAP) project, which is an effort to help cities set climate goals and priorities for energy strategies, and make data-driven energy decisions. Researchers from the Laboratory's Energy Data eXchange (EDX) were partners in the proposal submitted by the city to EERE.

It was announced on August 11, 2016 that three projects were selected under the Cities LEAP program: the City of Bellevue, Washington, the City of Portland, Oregon, and the Upper Coastal Plan Council for Governments in North Carolina.

NETL has also introduced the City to DOE/EERE's Sunshot: Solar in Your Community Challenge that provided prize money to low- and moderate-income communities for developing community-based solar projects that have a high potential for replication. NETL investigated opportunities and sought funding and technical assistance for these projects in collaboration with several nongovernmental agencies, the city of Pittsburgh, and other MOU partners. This program is applicable to Larimer, Homewood, and other Pittsburgh communities.

City Actively Engaged in Climate Action

The City has been aggressively pursuing a broad spectrum of climate and energy efficiency programs since the mid-2000s that align with the goals of the MOU. These programs and activities are described below.

Pittsburgh Climate Initiative - Climate Action Plan 3.0

The Pittsburgh Climate Initiative (PCI) was founded in 2008 following adoption of the City's inaugural Climate Action Plan. PCI is a collaborative project involving City and County government, non-profits, higher education, and the business community. While the PCI was initially convened by non-profit organizational partners, in 2015 the City of Pittsburgh's Office of Sustainability assumed more of a leadership role. In this way, the greenhouse gas inventories and climate action plans completed by PCI are integrated into other planning efforts like the Comprehensive Plan and Resiliency Planning.

In May 2018, Pittsburgh City Council approved the city's Climate Action Plan 3.0, which commits Pittsburgh government to a series of climate change mitigation goals through 2030. The goals include:

- 100% renewable energy use
- 100% fossil fuel free fleet
- Divestment from fossil fuel companies
- 50% energy and water use reduction
- 50% transportation emission reduction
- Zero Waste

The City of Pittsburgh is working towards these goals to reduce Pittsburgh's greenhouse gas emissions 20% by 2023, 50% by 2030, and 80% by 2050.

Pittsburgh 2030 District

2030 Districts® were formed across North America to meet energy, water and vehicle emissions reduction targets for existing buildings and new construction. The Pittsburgh 2030 District, a strategic initiative of Green Building Alliance with boundaries in Downtown Pittsburgh and Oakland,

has met and exceeded all three reduction targets – energy, water, and transportation emissions. The Pittsburgh 2030 District has reduced its total energy and water consumption by 12.5 percent and 10.3 percent, respectively, surpassing its 2015 goal of 10 percent. It also reported a reduction in transportation emissions by 24.2 percent, exceeding its 2020 goal of a 20 percent reduction – five years early. The District, which collects and aggregates actual performance data from committed buildings within its two District boundaries, is the largest of 12 internationally recognized 2030 District cities and is the first to report that the incremental goals have been achieved and surpassed.

100 Resilient Cities Network

The 100 Resilient Cities organization is dedicated to helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century. The organization supports the adoption and incorporation of resilience planning and innovation that includes earthquakes, fires, floods, as well as other stresses that weaken cities like high unemployment, overtaxed or inefficient public transportation systems, violence, or chronic food and water shortages. By participating in activities and using resources of the network, Pittsburgh has focused on mitigating challenges created by severe weather events, such as blizzards and heavy rains. The city plans to concentrate future planning efforts on a flood management system and the expansion of green infrastructure.

DOE Better Buildings Initiative

The Better Buildings Initiative is a national leadership initiative calling on state and local officials, corporate and chief executive officers, university presidents, utilities, and other leaders to make commitments to improve the energy efficiency of their buildings and plants, save money, and increase competitiveness. The U.S. Department of Energy is expanding this initiative to engage leaders in a set of Better Buildings Accelerators designed to demonstrate specific innovative approaches, which, upon successful demonstration, will accelerate investment in energy efficiency.

The US Department of Energy launched the Combined Heat and Power for Resiliency Accelerator to support and expand the consideration of combined heat and power (CHP) solutions by states, communities, and utilities for their critical infrastructure needs. As a collaborative with stakeholders, the Resiliency Accelerator will examine the perceptions of CHP among resiliency planners, identify gaps in current technologies or information relative to resilience needs, and develop plans for communities to capitalize on CHP's strengths as a reliable, high efficiency, lower emissions electricity and heating source for critical infrastructure.

The City of Pittsburgh's partnership with the Better Buildings Challenge and its goal to reduce portfolio-wide energy intensity 20% by 2020 strengthens the City's existing commitment to sustainability. As of June 2012, the revolving Trust Fund has been put to work to retrofit the City-Council Building with energy efficient HVAC and electrical equipment, replace 10% of the City's 40,000 streetlights with LED's, install five solar thermal and one photovoltaic project, and purchase 25% of all electricity needs through green sources.

For more information, visit the Better Buildings Initiative Website.

DOE Pittsburgh Region Clean Cities

Nearly 100 local coalitions comprise the Clean Cities program, which work to cut petroleum use in

communities across the country. Clean Cities coalitions are made up of local businesses, fuel providers, vehicle fleets, state and local government agencies, and community organizations. Each coalition is led by an on-the-ground Clean Cities coordinator, who tailors projects and activities to capitalize on the unique opportunities in their communities.

The program leverages resources to create networks of local stakeholders that provide technical assistance to fleets implementing alternative and renewable fuels, idle-reduction measures, fuel economy improvements, and emerging transportation technologies.

The Pittsburgh Region Clean Cities works with vehicle fleets, fuel providers, community leaders, and other stakeholders to reduce petroleum use in transportation. In Pittsburgh, the program supports establishments of alternative fueling stations.

International Council for Local Environmental Initiatives (ICLEI) - Local Governments for Sustainability

The City is an active member of the ICLEI, the world's leading network of cities and towns committed to building sustainable futures. The organizaiton helps make cities attain a sustainable, low-carbon, resilient, ecomobile, biodiverse, resource-efficient, productive, healthy and happy, future with a green economy and a smart infrastructure.

Urban Sustainability Directors Network

Pittsburgh participates in the Urban Sustainability Directors Network. It is a peer-to-peer network of local government professionals from cities across the United States and Canada dedicated to creating a healthier environment, economic prosperity, and increased social equity. The network enables sustainability directors and staff to share best practices and accelerate the application of good ideas.

CDP (Formerly Carbon Disclosure Project)

Over the past five years, CDP has worked with more than 300 cities including Pittsburgh to manage more than 1.67 billion metric tonnes of greenhouse gas emissions. CDP's cities program demonstrates that cities are better managing their risk and increasing resiliency through more than 4,800 activities to mitigate and adapt to climate change. Pittsburgh is an active participant in CDP activities.

EcoDistricts

Pittsburgh is a participant in the program through an integrated suite of programs, learning experiences and project certification tools, EcoDistricts assists cities with urban regeneration. The organization has developed the unique EcoDistricts Protocol, a first-of-its-kind, holistic project development framework that makes addressing these challenges achievable. In August 2017, Millvale was announced by Green Building Alliance, an MOU partner, to be one of 11 communities across North America to be committed to EcoDistricts Certified, a new standard for community development.

The City Energy Project

The City Energy Project is a national initiative to create healthier and more prosperous American cities by improving the energy efficiency of buildings. Working in partnership, the Project and cities will support innovative, practical solutions that cut energy waste, boost local economies, and reduce harmful pollution. The pioneering actions of the 10 cities involved in the City Energy Project will be models for communities around the

world.

National Institute of Standards and Technology (NIST) Global City Teams Challenge

The Challenge helps communities address issues ranging from air quality to traffic management to emergency services coordination. NIST helped organize communities like Pittsburgh and innovators to create teams that will foster the spread of “smart cities” that take advantage of networked technologies to better manage resources and improve quality of life. Collaborations occur on a range of issues from disaster response to energy management to mass transit improvement.

Engagement with Other Pennsylvania Microgrid Projects

The MOU team has initiated interactions with microgrid projects in Reading, Philadelphia, and other locations in Pennsylvania. A primary purpose of this engagement is identify opportunities for collaboration with the Pennsylvania Department of Community and Economic Development and the Department of Environmental Protection. In Reading, the Berks County Industrial Development Authority (BCIDA) is developing plans for a microgid on a 155 acre brownfield site adjacent to the Reading airport. The proposed microgrid would include CHP, photovoltaics, and battery storage. NETL, DOE, and the University of Pittsburgh participated in a planning meeting for the BCIDA microgrid in Reading on July 28, 2016.

Philadelphia Industrial Development Corporation (PIDC)

The Philadelphia Industrial Development Corporation (PIDC) is leading in development of The Navy Yard, a 1,200-acre urban campus on the site of the former Philadelphia Naval Shipyard. In 2014, PIDC began an update of the energy infrastructure at The Navy Yard to improve the management of power delivery. PIDC has engaged a consortium of partners, including PECO, Penn State, GE Grid Solutions, PJM, DTE Energy, and several additional private sector partners to establish The Navy Yard as a national center for emerging smart grid and distributed generation policies, practices and technologies. A meeting was held on July 14, 2016 at the Navy Yard where a presentation on the City of Pittsburgh MOU was made.

Pittsburgh Building Benchmark Ordinance

In 2017, reporting began for Pittsburgh's Building Benchmark Ordinance. The Ordinance requires owners of non-residential buildings that are at least 50,000 ft. to report their annual energy and water usage. This increased transparency allows businesses and individuals to make informed choices related to building specifications, provides a method for tracking building efficiency and monitoring for maintenance needs, and is an important step for the City to make progress towards the 2030 District goal of reducing energy and water usage to 50% below the baseline.

REGIONAL AND NATIONAL RECOGNITION

The Partnership between NETL and the City of Pittsburgh received two awards from the Federal Laboratory Consortium (FLC) for its success cementing Pittsburgh as a global leader in next-generation energy planning and development. NETL and Pittsburgh received the 2018 FLC Award from the Mid-Atlantic Regional Awards in the State and Local Economic Development category and the 2019 FLC National Award in the State and Local Economic Development category.

The FLC awards are considered to be high-level awards amongst the National Laboratories. The State and Local Economic Development Award recognizes successful initiatives that involve partnership between state or local economic development groups and federal laboratories for economic benefit. The Partnership Between NETL and the City of Pittsburgh's winning nomination spoke to its efforts in establishing Pittsburgh as a "Clean Energy City of the Future", the utilization of microgrid technology, funding of the solid oxide fuel cell power plant on the North Side of Pittsburgh, studies conducted at Hazelwood Green for DDU geothermal energy options, and more.

CONCLUSION AND FUTURE WORK

When NETL signed an MOU with the City of Pittsburgh, it agreed to help its home town undertake a series of important activities geared toward meeting the region's future energy needs. Key goals include:

- Creating socially responsbile networks of distributed energy generation systems to increase resiliency, reduce the carbon footprint, and improvie efficiency.
- Providing a platform to accelerate adoption of advanced distributed energy resources such as microturbines, direct current power delivery systems, CHP systems, energy storage devices, photovoltaics, wind turbines, and other advanced fossil energy systems.
- Coupling advanced, smart, and socially responsible transportation infrastructures with power supplied by locally generated energy resources.
- Achieving the goals and objectives set forth in the City's Climate Action Plan 3.0.

In pursuing these goals, the Laboratory has assisted the City on a range of activities including:

- Facilitating conversations between the City and DOE's Loan Program Office in pursuit of financing opportunities for one or more of the City's distributed energy systems.
- Working with the City on participation in DOE's Geothermal Technologies Office program to assess potential for direct use of geothermal energy from deep resources in the eastern U.S.
- Collaborating with DOE EPSA by participating in activities to identify key policy and regulatory barriers to implementing the city's "grid of microgrids" concept and facilitated workshops related to the City's climate action plan.
- Coordinating outreach with the Pennsylvania Departments of Environmental Protection and Community and Economic Development and collaboration with other microgrid developments in the state.
- Creating a series of educational videos highlighting the overall vision and goals of the MOU.

NETL will continue to partner with the City to help make Pittsburgh a Clean Energy City of the Future while fulfilling the Laboratory's mission to discover, integrate, and mature technology solutions to enhance the nation's energy foundation and protect the environment for future generations.

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For more information, please visit the City of Pittsburgh MOU website