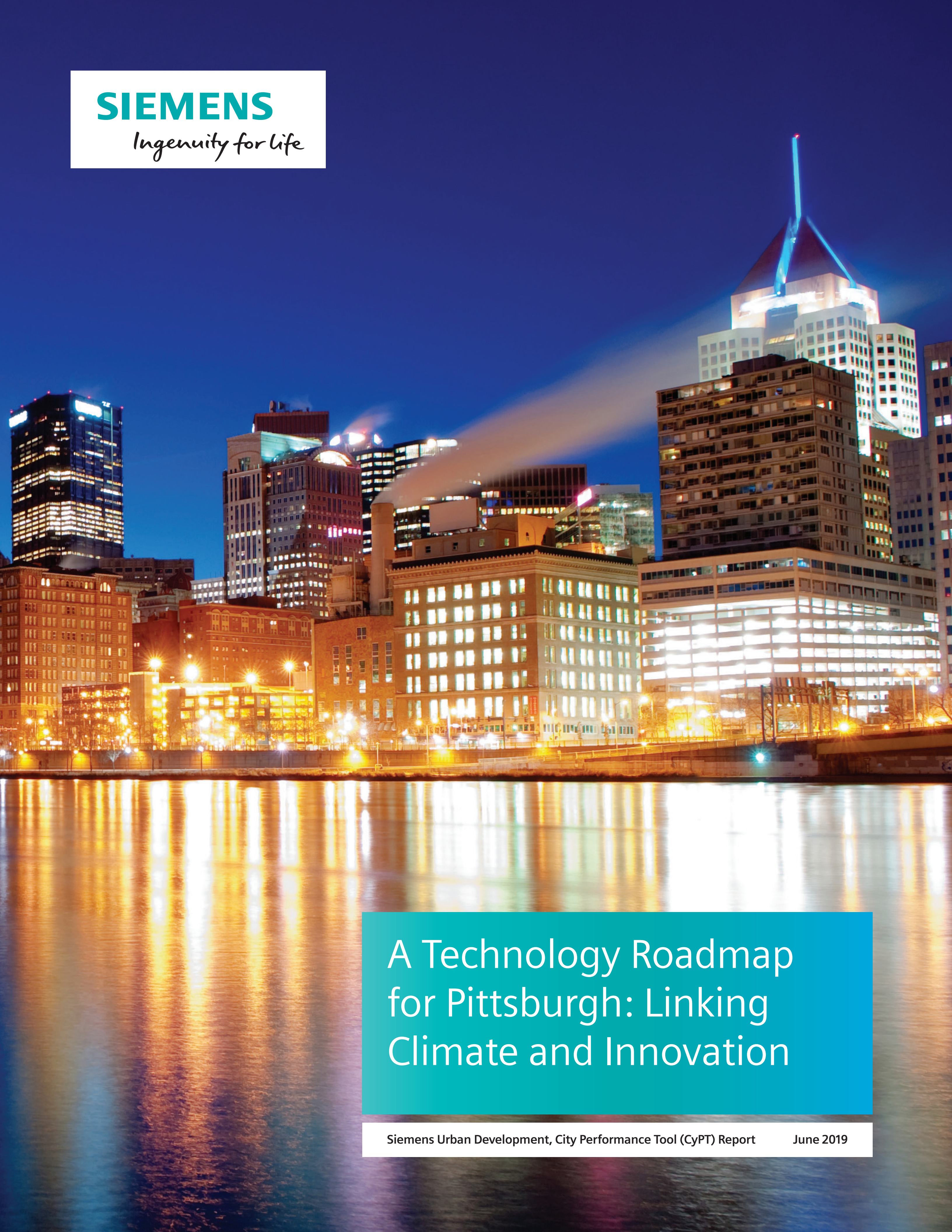

# A Technology Roadmap for Pittsburgh: Linking Climate and Innovation

Siemens Urban Development, City Performance Tool (CyPT) Report June 2019

City Performance Tool Analysis for the City of Pittsburgh

Infrastructure is the backbone of a city's economy and urban development projects help to create a livable and sustainable smart city.

**About Siemens**
Infrastructure is the backbone of a city's economy and urban development projects help to create a livable and sustainable smart city. With automated and intelligent infrastructure technologies, Siemens expertise is integrating hardware and software to improve quality of life, capacity and efficiency in metropolitan areas. Siemens established the Global Urban Development team to specifically address the needs of urban planners and to enter a structured dialogue and base-lining assessment with urban decision-makers.

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## Contents

# Executive Summary

## Introduction

Pittsburgh is a story about a city that is showing leadership in transforming its infrastructure to create jobs, clean the air and deliver on climate targets. It is also a city that recognizes where it needs broader support to deliver projects and change legislation. And Pittsburgh has the ability to convene stakeholders and build on a common sense of trust.

The City Performance Tool analysis has found a path to enable Pittsburgh to reach its emissions targets. Pittsburgh is aiming high, it plans to halve its carbon emissions ($CO_2$ eq) by 2030, 10 years from today. The city has a 2050 target, but it recognizes that getting from where it is today to 2030 requires a huge leap.

Siemens is a local job creator in the Pittsburgh region, and it wants to see positive change in the area. In this regard, it has partnered with the City of Pittsburgh to utilize its City Performance Tool to identify the technologies and timing of those technologies needed to meet its climate targets and generate a positive impact for the city in terms of carbon reductions, air quality improvements, job creation and cost.

This CyPT analysis is also a first for Siemens as the scope of the study not only includes the city but also focuses on the technology implications within the Uptown EcoInnovation Zone, where current building performance and transport options are different today from the rest of the city.

The analysis found that meeting the climate targets in this district was even a bit tougher than the wider city because its building performance was worse than the city's average and it has a higher proportion of non-residential buildings which have a higher carbon intensity. This meant that more attention was needed in this district for the actual buildings as opposed to the energy (heat and electricity) that flowed through them.

The overarching message coming from the CyPT analysis is that it is possible for Pittsburgh to meet its 2030 climate target, but that it must deliver all that it has set out to do, plus a bit more. It will need to reach beyond its city borders into the region and across the state to support the projects that can provide cleaner electricity for the grid and find partners to create demand for this new energy.

The City of Pittsburgh vision, OnePGH, has been successful in aligning stakeholders and building support for inclusive change and growth. Now Pittsburgh must become very specific about the projects it needs to deliver and put its weight behind those with the most potential for positive change. This is fundamental because, through no fault of the city, the local grid electricity mix is set to become far more carbon intensive. This means that the goal posts for Pittsburgh's climate targets have been moved further out, and the challenge becomes even harder.



City Performance Tool Analysis for the City of Pittsburgh

Pittsburgh must now deliver on all its aims, create the world's first EcoInnovation District in the Uptown District, and scale-up the thinking and learning of this district to more parts of the city - fast.

This analysis has also sought to answer other needling questions that the market often puts forward as reasons to say "no" to change, including cost, whether the grid can even deliver further electrification or if cars should be electrified given the embedded carbon in the system.

The potential here in Pittsburgh is to reduce nearly 75% of carbon emissions – exceeding the 50% mark, improve air quality and create 110,000 full-time equivalent positions for a per capita cost of $56K, which includes both capital and operating expenditures. This analysis affirmatively answers the question, that it does make environmental sense to drive an electric car in Pittsburgh even if the electricity grid mix has a high proportion of fossil-fuels. This report has even estimated the potential demand that an uptake in electric cars could have on the local grid.

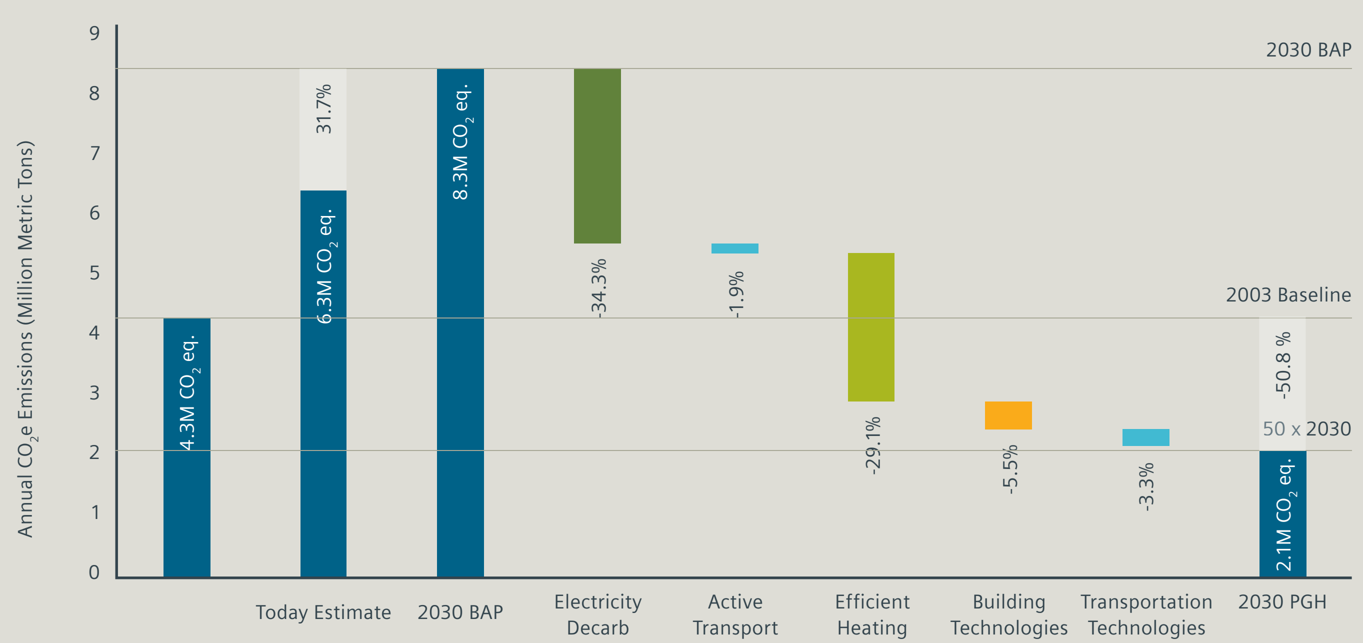
Most importantly, this work has found a route to achieve a deep carbon reduction.

# Deep Carbon Reduction Can Be Achieved

Siemens created its first project scenario based on the technologies and projects outlined within Pittsburgh's Climate Action Plan 3.0 and those targeted for the Uptown EcoInnovation District. These technologies included implementation of district heating, an increase in electric vehicles, upgrades to existing buildings and incentives to promote active transit and some take-up of some solar generation.

The results illustrated that these technologies would have a positive emissions impact, but that they were not enough to meet the city's targets alone, as the carbon intensity of the electricity grid is actually expected to increase. Siemens worked with the city team to identify other technologies that could be implemented and considered how the other technologies could be delivered at a faster rate. What this means is that the City of Pittsburgh will have to deliver its climate plan, and work even harder to decarbonize the grid and deliver more efficient heat than originally planned. These more significant changes mean that the City of Pittsburgh must look beyond its urban border to partner with the region and the state to make the needed changes – projects and legislation. Achieving this scenario would require many entities to act, including the local utility, transit operators and citizens. The local utility would need to implement more renewable power at grid level and more people and businesses would need to install rooftop solar cells. Delivering this scenario is possible, but it is not possible for Pittsburgh to do alone.

**Pathway to Deep Carbon Reductions**
50 x 2030 Scenario








# High-Performing Technologies

Out of the more than 70 technologies within the CyPT tool, there were some that generated a higher degree of impact than others in both scenarios. Energy generation technologies and technologies that could change either the city's electricity or heat mix tend to have the most impact – positive or negative. In the case of Pittsburgh, the closure of the nuclear power station already had a significant impact on the underlying base energy mix. This resulted in very good performance of onshore wind generation, rooftop PV, and grid optimization.

While the onshore wind result was valid, the city itself cannot implement projects of this scale, but it can club its demand and purchase in bulk from renewable power providers and create a market that these generators may choose to pursue. What the city could better implement was the next best performing technology, namely centralized district heating systems using combined heat and power turbine for new build.

In those projects heat is circulated in hot water along a piping system, which is re-heated at various points in the system with electricity created as a by-product. These systems are primarily natural gas based today, but the systems can transition to use cleaner fuels in the future. District heating systems are more efficient than individual boilers and have the added benefit of generating electricity and have the potential to be scaled. Other forms of heat, such as an air source heat pump, could also have a positive impact for the city, but due to the severity of local winters may need to be part of hybrid systems that includes natural gas.

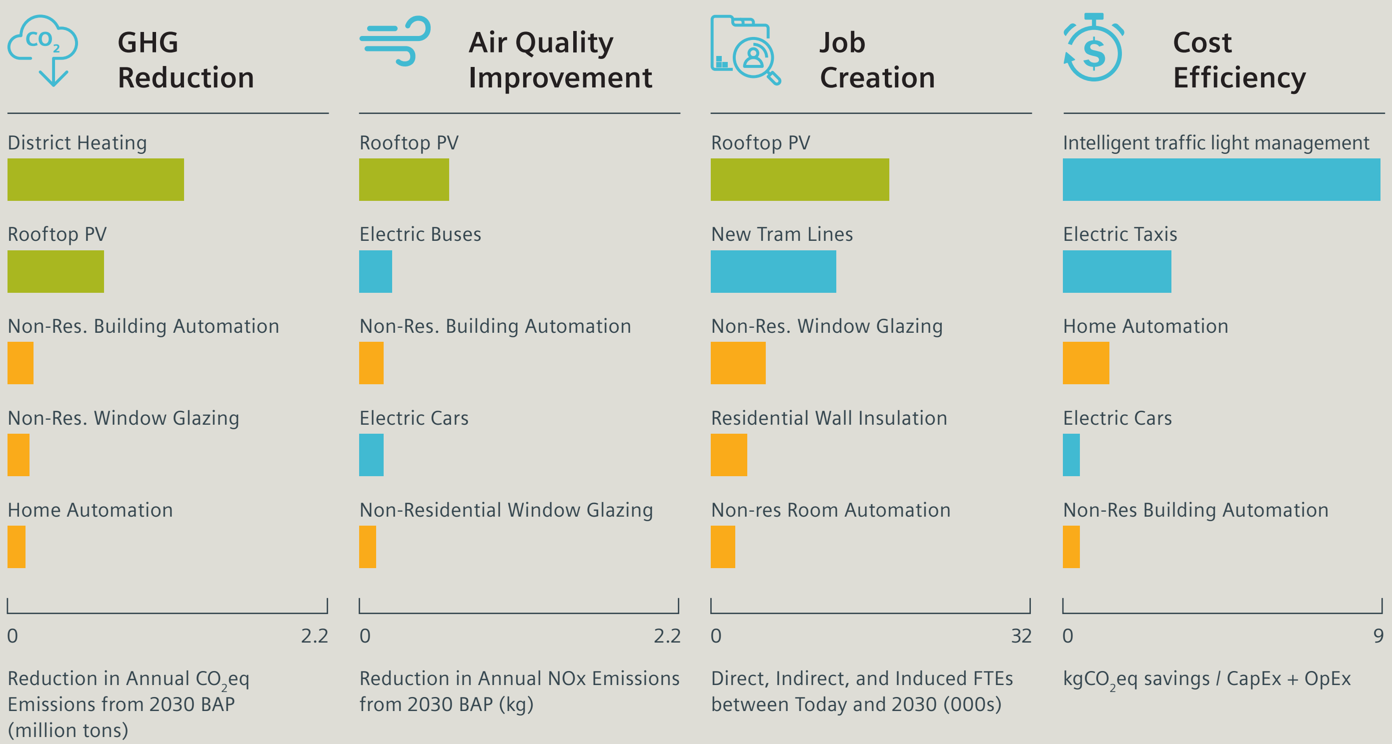
Carbon is only one of the Key Performance Indicators (KPIs) used and if one considers the other indicators then the most impactful technologies differ. The good news is technologies that reduce carbon also have a strong, positive, impact on regional air quality. The technologies that would best improve the very local air quality comes from reductions in tailpipe and boiler emissions. This means reducing vehicle journeys, moving towards electric transport and away from individual, inefficient, heating boiler systems that use natural gas as a heat-source.

Job creation occurs with all of the solutions described above. Some of the technologies are more capital intensive in the early days - like the installation of PV solar power - while others are more downstream job intensive, like delivering Ground Source Heat Pumps (GSHP).

Cost efficiency is a different KPI as it identifies where the most GHG emissions can be saved per dollar spent. Transport technologies proved to be the best performing technologies in this category because intelligent traffic light management can significantly improve the flow of traffic and thereby lessen fuel use as it is spread across the city is relatively inexpensive. Electric taxis also proved to be very cost efficient as did energy related technologies that improved grid efficiency or reduced direct losses.

Building technologies score consistently well across all the KPIs, as they reduce energy use so save the linked carbon and air pollution linked to the energy generation. They also require people to install them and they are relatively low cost. These technologies are some of the low-hanging fruit, but it requires implementation and potentially education on their value.

## High-Performing Technologies




## Pittsburgh 2030
### Climate Action Plan Scenario

**2.2M**
Potential $CO_2$eq Reduction (in metric tons) as compared to 2030 BAP

**27.9%**
Potential $CO_2$eq Reduction (%) as compared to 2030 BAP

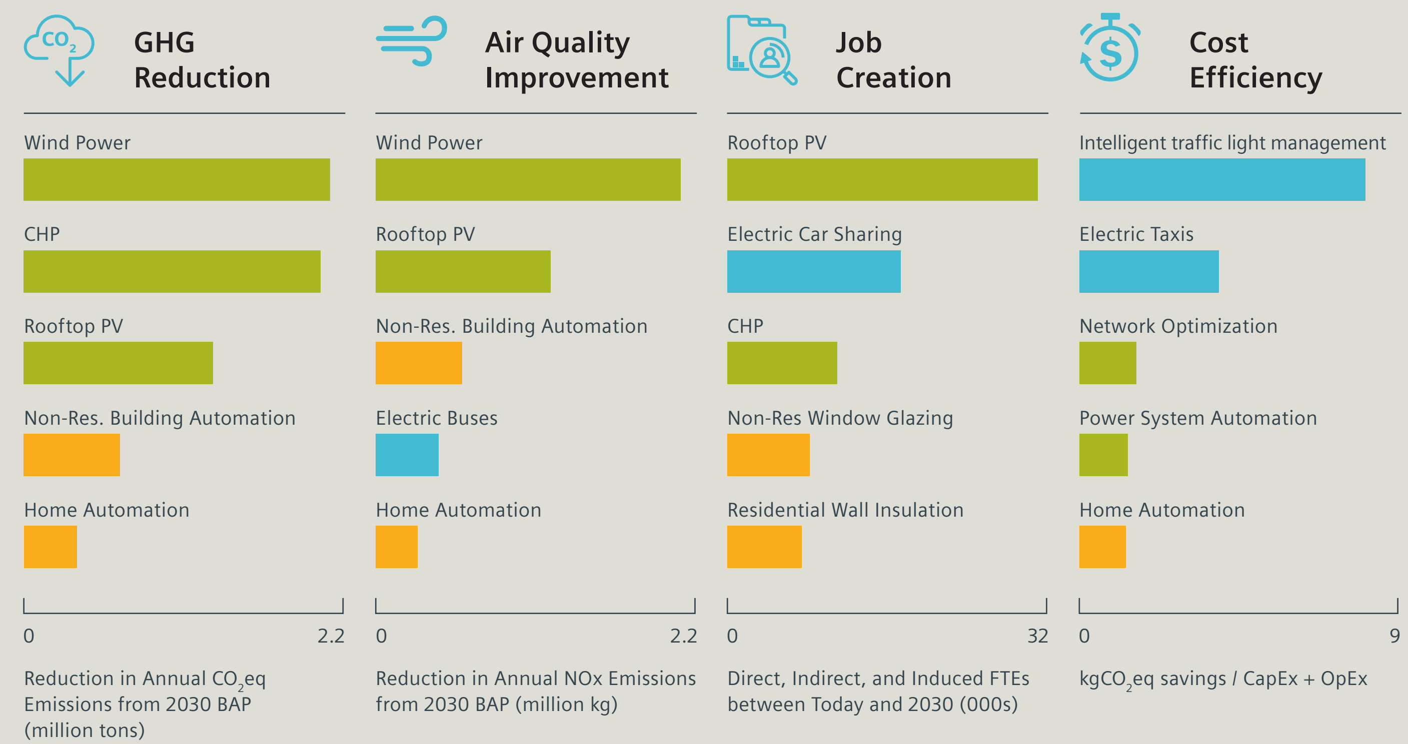
**$5B**
Capital and Operating Expenditures between Today and 2030

**47K**
Full-time Equivalents Generated between Today and 2030





## High-Performing Technologies – 50x2030 Scenario




## Pittsburgh 2030
### 50x2030 Scenario

**6.2M**
Potential $CO_2$eq Reduction(in metric tons) as compared to 2030 BAP

**74.3%**
Potential $CO_2$eq Reduction (%) as compared to 2030 BAP

**$17B**
Capital and Operating Expenditures between Today and 2030

**110K**
Full-time Equivalents Generated between Today and 2030

City Performance Tool Analysis for the City of Pittsburgh

## Conclusions

An important perspective for the projects is the knowledge that they can create new, local jobs for the residents of Pittsburgh. These projects have the potential to generate as many as 110,000 incremental full-time equivalent positions. This job number includes opportunities created via multiplier effects, e.g. jobs created indirectly or induced by the direct project investments, which could range from additional retail to restaurants. Projects like the installation of solar PV, district heating systems, and better insulation of homes will green the local grid, improve the efficiency of local heating and make homes more efficient and comfortable, all the while reducing carbon emissions and improving air quality.

The City of Pittsburgh is already showing tremendous leadership in bringing a range of stakeholders together. Now it must leverage its citizens and the aspirations of the region to bring about wider changes across Western Pennsylvania, the state of Pennsylvania and into the mid-Atlantic region. This can be achieved by delivering the projects that it can, use its own buildings as examples, clubbing together with other like-minded entities to purchase renewable power and create stronger market demand for the necessary larger-scale renewable energy projects, and advocate on the legislature needed to create the energy market needed by Pittsburgh and other cities.

The private sector also needs to recognize the change in infrastructure that Pittsburgh is aiming for and show a willingness to engage, help to build, finance and operate key projects. The story of Pittsburgh is one where the city recognizes where it can and cannot deliver and actively brings to the table the other organizations needed to catalyze change – the Uptown EcoInnovation Zone is the starting point.

**The story of Pittsburgh is one where the city recognizes where it can and cannot deliver and actively brings to the table the other organizations needed to catalyze change – the Uptown EcoInnovation Zone is the starting point.**

# Background

Led by Mayor Peduto, the City of Pittsburgh, has been a leader in defining innovation and using citywide infrastructure to improve social equity and boost the local economy – at its core are Pittsburgh's 4Ps People, Place, Planet and Performance. The city's strategy OnePGH focuses on delivery of the 4Ps through the lens of urban resilience building, and the City of Pittsburgh has defined strategies for climate, energy, waste and water. Pittsburgh's Chief Resiliency Officer is leading the efforts to deliver on these strategic aims through real projects including the Uptown Eco District. These projects are to be measured along some of the same Key Performance Indicators used by the CyPT analysis, including job creation, air quality improvement, GHG reductions and cost efficiency.

A city alone can implement small and medium-scale projects, delivery changes to its public building stock and city-controlled transport systems, but delivering larger projects requires building an alignment with regional actors, which may or may not cross state lines, state agencies and legislature. This is where Pittsburgh is excelling in its initiative to bring a number of these organizations together.

The Power of 32 is an example of this, where 32 counties comprising the greater Pittsburgh region and crossing into 3 other states, work together to target infrastructure investment into sites of regional importance to facilitate region-wide growth.

Pittsburgh has also created valuable partnerships with networks beyond Pittsburgh, including its selection by the Rockefeller Foundation's 100 Resilient Cities initiative to be one of its earliest member cities. And, a more recent success of becoming a Bloomberg American Cities Climate Challenge winner with funding to deepen Pittsburgh's efforts to tackle climate change.

More importantly, Pittsburgh is taking what it is learning through these relationships and bringing it to the city and supporting local businesses. The city has a disclosure ordinance that mandates energy performance disclosure for the largest non-residential buildings and via Pittsburgh's membership in the 2030 Districts Network it is positively supporting those building owners who wish to improve energy performance. This has resulted in voluntary building energy performance disclosure and benchmarking.

The 2030 District is one of the reasons why Pittsburgh is seeing an increasing number of LEED certified buildings, and energy performance is improving because these owners are engaging and making the necessary changes.

**Uptown EcoInnovation District**
Infrastructure takes time to change. Pittsburgh is home to many historic buildings and homes and only a small fraction of buildings will be new or renovated this year. Pittsburgh is looking to change that and to do it via a world's first by creating an EcoInnovation District in its Uptown and West Oakland communities. This EcoInnovation zone is aiming to blend an innovation zone where job growth is key, and an eco-district which plans for sustainability and resilience from the ground up.

Plans for the Uptown EcoInnovation District try to blend these two aims and include both projects to improve accessibility, such as the new bus rapid transit line, and deliver smart and efficient infrastructure such as the proposed district heating system. One of the key questions of this analysis was whether this district could be measured on its own technology merits and deliver a different result in terms of future emissions and job growth than the rest of Pittsburgh.

**Climate Targets**
Mayor Peduto's longstanding climate leadership started with his signing of the U.S. Mayor's Climate Protection Agreement in 2007, which pledged to implement climate positive projects and his signing onto the goals of the Paris Accords in 2015, one of only 12 US Mayors to do so. Mayor Peduto followed-up on the Paris Accords by signing an Executive Order in 2017 to meet the pledge to keep global warming to only 1.5 degrees Celsius.

Mayor Peduto and the City of Pittsburgh's Climate Plans have been where these ambitions are funneled into specific projects. Pittsburgh is now on its 3rd climate plan since 2008, with each subsequent plan measuring progress and building on the initial targets. Today's Climate Action Plan 3.0 targets an 80% reduction in Green House Gas Emissions by 2050. And this target was translated into the first CyPT technology scenario and set to 50% by the year 2030.





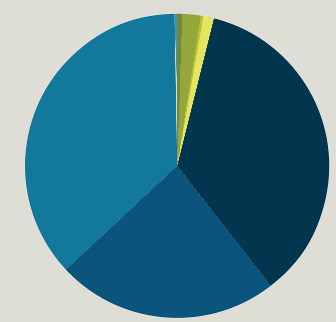
## Pittsburgh, Today to 2030

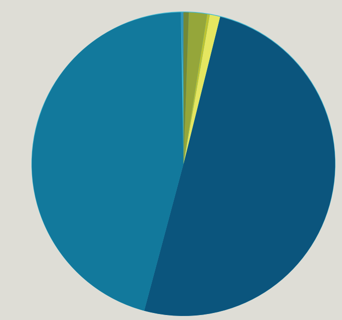
| | Today | 2030 (Business-as-Planned) |
|---|---|---|
| Population | 303,325 | 334,182 |

**Electricity Mix**

Today: **3.9% Renewable** — 2030: **3.9% Renewable**

| | 2019 | 2030 |
|---|---|---|
| Heavy fuel oil | 0.2% | 0.2% |
| Hardcoal | 36.7% | 45.6% |
| Natural Gas | 23.4% | 50.3% |
| Nuclear | 35.8% | – |
| Hydro | 1.0% | 1.0% |
| Biomass | 0.2% | 0.2% |
| Wind | 2.1% | 2.1% |
| Waste | 0.5% | 0.5% |
| Photovoltai | c, 0.1% | c 0.1% |

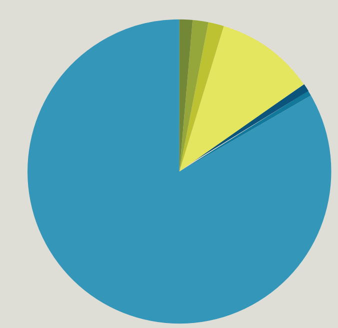


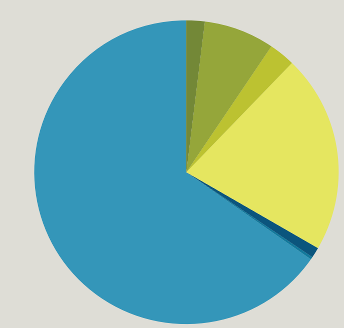


**Passenger Mode Share**

Today: **15% Transit and Active Transport** — 2030: **33% Transit and Active Transport***

| | 2019 | 2030 |
|---|---|---|
| Car | 83.3% | 65.1% |
| Motorcycle | 0.5% | 0.5% |
| Taxis and TNC's | 1.0% | 1.0% |
| Bus | 10.5% | 21.0% |
| Light Rail | 1.5% | 3.0% |
| Bicycle | 1.9% | 7.3% |
| Walking | 1.4% | 2.2% |

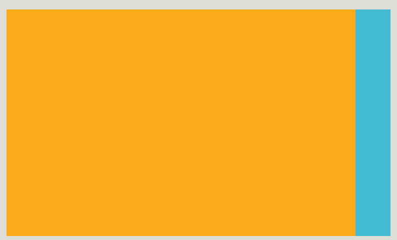


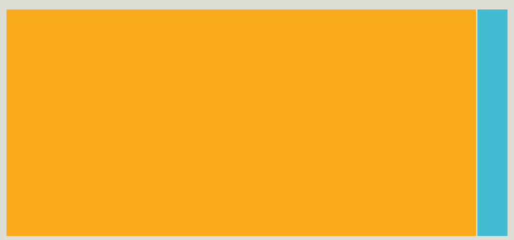


**CyPT-Estimated Annual GHG Emissions****

Today: **6.3 million metric tons (MMT)** — 2030: **8.2MMT**

| | 2019 | 2030 |
|---|---|---|
| Transportation | 0.6M | 0.5M |
| Buildings | 5.7M | 7.6M |





| | |
|---|---|
| Estimated % Increase in GHG Emissions as compared to Today** | **+29%** |
| Target GHG emissions reductions as compared to 2003 | **50%** |

* Assumption for transit mode share for 2030 is based on the goals in City's Climate Action Plan v3.0 to reduce vehicle miles traveled by 50% and increase transit commute trips by 100% by 2030.
** For energy, buildings, and transport sectors only. See the section on "City Performance Tool" for more information on the methodology and scope of the CyPT.

# City Performance Tool

City Performance Tool (CyPT) was developed by Siemens with a goal to help cities make informed infrastructure investment decisions to achieve their ambitious environmental targets. While working with the City of Pittsburgh on this decarbonization analysis, Siemens used the City Performance Tool (CyPT) to identify how technologies from transport, building, and energy sectors can mitigate carbon dioxide equivalent ($CO_2e$) emissions, improve air quality, and add new jobs.

The CyPT model has assessed environmental and economic development opportunities available to cities across the globe, including San Francisco, Copenhagen, London, Mexico City, Seoul, Los Angeles, Washington, DC, and Vienna. Siemens collaborated with each city to identify infrastructure solutions that best fit the city's energy demand and production characteristics. CyPT results help cities drive their sustainability agendas. For example, in Copenhagen, the CyPT analysis revealed that implementing 15 energy efficiency technologies in just 40 building owners' portfolios could reduce annual emissions by 10 percent.

The Copenhagen city government is now discussing ways to act on that recommendation, whether by piloting those energy efficiency technologies in a public building or by creating an incentive program to encourage building owners to retrofit their portfolios. The CyPT analysis for the City of Los Angeles, Climate LA, showed that L.A.'s greenhouse gas reduction targets for 2035 and 2050 are achievable.

Success will require transitioning to 100% generation of renewable electricity and to 45% of passenger travel by transit and active transport, through the implementation of L.A.'s and California's current policy agendas and an additional 19 infrastructure technology measures.

Emissions reductions would be accompanied by 72% improvement in air quality and almost two million local jobs. In addition, CyPT analyses for the Cities of Minneapolis and Phoenix supported the passage of a 100% renewable electricity target citywide and a more aggressive GHG reduction target by 2035, respectively.

Analysis using CyPT starts with more than 350 data inputs from a city's transport, energy and buildings sectors, including more general characteristics such as population and growth, the supply mix of electricity generation, transport modalities, and travel patterns, building energy use, and the built environment footprint.

Starting with the city's population, energy performance, and emissions baseline, the model estimates the future impacts of more than 70 technologies (only 60 percent of which are sold by Siemens) along the following three drivers:

1. **Cleaner underlying energy mix:** Shifting the energy generation mix from non-renewable to renewable energies (e.g., photovoltaics) and/or improving the efficiency of the current fossil fuel sources (e.g., Combined Cycle Gas Turbines).
2. **Improved energy efficiency in buildings, transportaton and energy distribution:** Replacing existing technologies with more energy efficient technologies. For example, replacing traditional street lighting with LEDs and/or demand-oriented street lighting.
3. **Modal shift in transportation:** Modeling changes in the modal split of the city. For example, by creating a new BRT lines, a city potentially moves passengers away from single occupancy cars and into the BRT.

The outputs of the model are $CO_2e$ emissions, nitrogen oxides (NOx), particulate matter 10 (PM10), gross full-time equivalents (FTE), and capital and operating expenses.



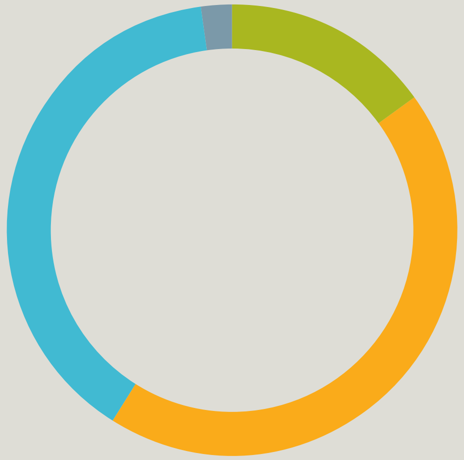
City Performance Tool Analysis for the City of Pittsburgh

## CyPT Inputs

The CyPT can be customized through more than 350 city-specific data inputs, which when combined, project how a city is expected to grow and change as its population and infrastructure expand. More than half of the inputs that go into the CyPT look at how people move around the city, live, and work.

**General (2%)**
- Population
- Geographical size
- Emissions target

**Transport (39%)**
- Annual passenger miles
- Freight ton miles
- Length of road network
- Bus, BRT, Streetcar, Lightrail, Commuter / Regional rai, Taxis, Bicycles, Cars etc.

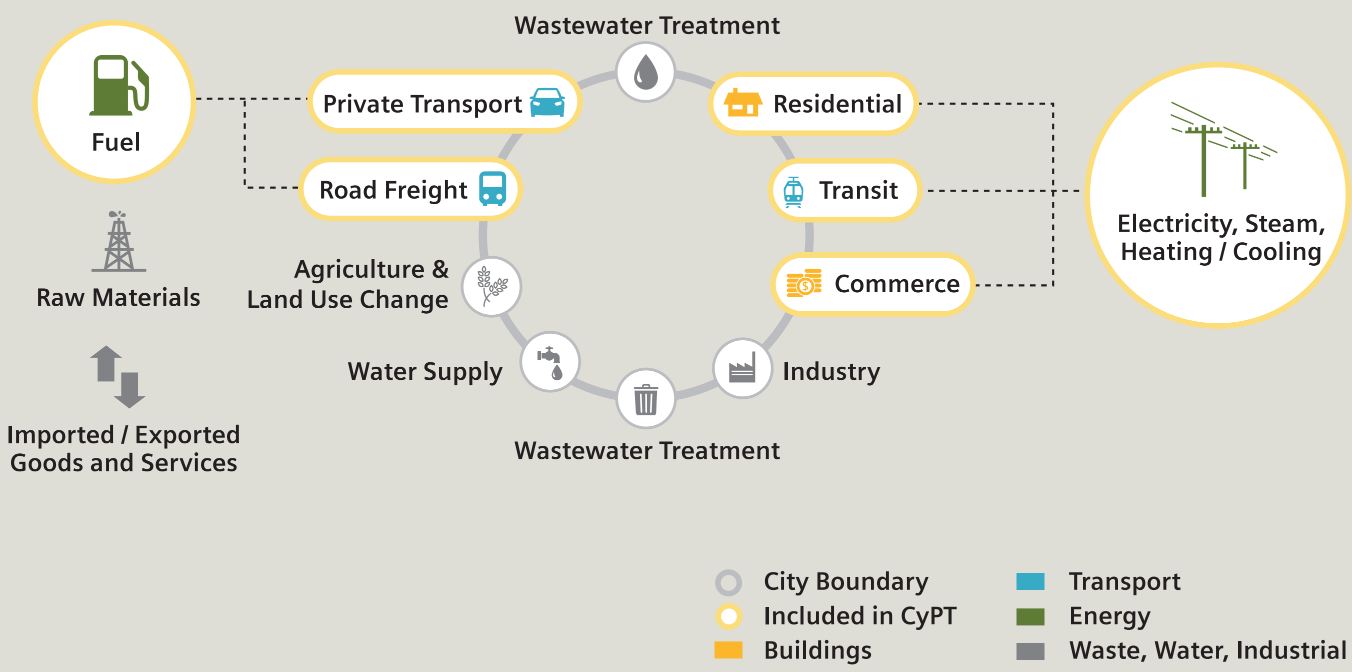


**Energy 15%**
- Electricity mix
- Heating mix
- Emissions factors for fuels

**Buildings 44%**
- Square footage by building type
- Electricty demand
- Heating demand
- Cooling demand
- End use for electricity, heating and cooling
- Building envelope

## Scope of Emissions Model

The CyPT utilizes the 2012 GPC Protocol for Community-Wide Emissions as its methodology for estimating GHG emissions. It covers Scopes 1, 2, and 3 emissions for energy generation and energy use in buildings and transportation. Essentially, this means that the CyPT takes into consideration both direct emissions occurring within the City boundaries (such as from exhaust fumes) and indirect emissions from the conversion of chemical energy to power, heat or steam of purchased energy from outside the city. The included Scope 3 emissions refer to the emissions produced as a result of fuel production and extraction. This also includes the construction and production of renewable power plants.



# Starting Position for Pittsburgh

## Emission Baseline and Business-as-Usual (BAU) Scenario

A key outcome of other CyPT projects that Siemens has delivered globally is the value of creating a set of agreed upon numbers, which incorporates data from the city, key agencies and numerous other key stakeholders. These agreed upon numbers can then be used to create a common understanding of the goals, starting position and the size of the task ahead required to meet these goals. This means that amongst organizations and the city, apples are being compared to other apples.

An outcome of the emissions baseline was a new understanding of both the city and the Siemens teams on the actual impact that the closure of a regional nuclear power station would have on the city's ability to meet its climate targets. Closure of this plant and fossil fuel based replacement generation, would result in an emissions increase of 30% by 2030. Developing this baseline will enable the city team and other stakeholders to understand the wider impact of this closure, better plan for it by supporting other cleaner energy projects and potentially even to advocate for its delay. This knowledge may also deliver the sense of urgency needed to get clean new energy projects up and running that may otherwise have languished. Given that the CyPT and most city carbon inventories consider all three emissions scopes (Scopes 1, 2 & 3) the electricity that powers nearly all buildings and is expected to power more and more transport and homes will be fundamental. This scenario will be referred to within this analysis as the Business-As-Planned.

This early insight showed the project team that measures considered within this analysis must go deeper in order to find a way for Pittsburgh to meet its climate aims.

The popularity of Pittsburgh as a place to live due to its incredible mix of university know-how, tech opportunities and medical and manufacturing excellence, also means that the population is expected to increase. The expectaion of growth and Siemens views on likely technology performance improvements have all been factored into the baseline Business-As-Planned scenario. The two key technology scenarios include the Climate Action Plan and the 50% by 2030 Deep Carbon Reduction.

These two scenarios build on each other. The Climate Action plan incorporates implementation of the technologies already included within existing strategies and funding cycles. The 50% by 2030 Deep Carbon Reduction scenario utilizes higher implementation rates of the already planned for technologies as well as others not currently being considered by the city. The aim of this scenario is to build an understanding of the technologies and scale of implementation required to reach Pittsburgh's 50% by 2030 target. Another benefit of including a wider range of technologies, is that the city can compare projects in differenent sectors, with vastly different costs and aims on a like by like basis. By considering their overall air quality, carbon reduction, job creation and cost impacts more informed decision making can be possible. These scenarios will be explored in the next sections on Buildings and Energy and Transport.





## Buildings and Energy

Cities are fundamentally comprised of buildings, and buildings in Pittsburgh account for 88% of total $CO_2$ equivalent emissions. This fact means that buildings and what powers and heats those buildings must be central to any technology roadmap leading to a 50% emissions reduction by 2030. The CyPT analysis considered the impacts across Pittsburgh of implementing key buildings (residential and non-residential) technologies and energy technologies in both the Climate Action Plan and Deep Carbon Reduction scenarios.

**Buildings**
Pittsburgh, like most other cities, is comprised mostly of residential space, but the energy intensity of that space is significantly less than that of the non-residential spaces. In Pittsburgh, residential space equates to roughly 52% of total build, but on average it uses only 25% of the total electricity and 75% of the amount of heat consumed by a non-residential building. Non-residential buildings in Pittsburgh are primarily made up off office, educational and retail space. This means that changes to non-residential space have a greater impact than those made to residential space.

Additionally, non-residential space is renovated more often or has a more active property management side than most private homes and is often faster to implement new technologies.

Building performance in Pittsburgh is mixed and the starting assumption was that only a small proportion of non-residential buildings have building management systems, room automation or high-quality glazing. Residential buildings were also assumed to have an even smaller proportion with degree of automation or even significant insulation.

If, by 2030, 50% of all homes have quality insulation and 33% embrace automation technologies coupled with modest automation in non-residential buildings, 20-25%, and 60% having improved glazing that 5.2% of total city emissions could be reduced. This is the result of the Climate Action Plan scenario, and it is relatively small compared with our findings that buildings are the largest carbon emitter. This result would mean that about 82% of total emissions (those linked to buildings) would be unchanged.

## GHG Emissions
Buildings and Energy

Annual Metric Tons of $CO_2$eq Emissions (% of Buildings)


5,684,248 **All Buildings**





## Data
Buildings and Energy

**52%**
Share of residential building stock

**1,806 ft²**
Average residential unit size

**1,503 GWh**
Total electricity consumption

**106 kBTU/ft²**
Average energy use intensity

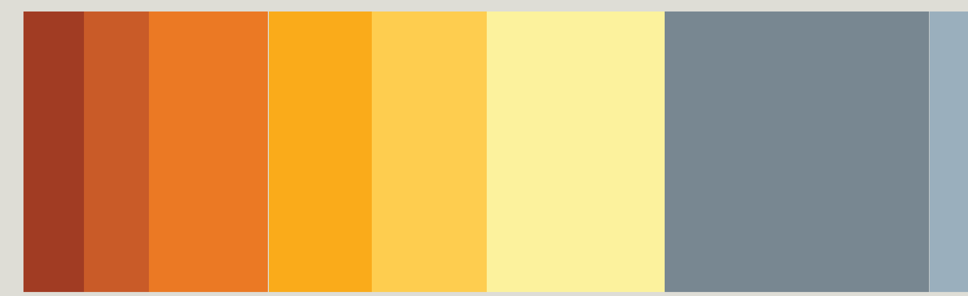
**224M ft²**
Total building footprint

**4,147 GWh**
Total electricity consumption

**145 kBTU/ft²**
Average energy use intensity

## Breakdown of square footage of commercial buildings

| | |
|---|---|
| Other Non-Residential | 6.2% |
| Warehouses and Shopping Malls | 7.1% |
| Retail | 12.2% |
| Hotels Hospitality and Leisure | 10.7% |
| Hospitals and Healthcare | 11.8% |
| K-12 and University | 18.2% |
| Office | 27.2% |
| Government | 6.7% |



## GHG Emissions
Buildings and Energy

### Residential and Non Residential Buildings

| Lever<br>% of building stock with lever | Adoption, Today (%) | Adoption 2030 (%) |
|---|---|---|
| Wall insulation (Residential) | 10 | 50 |
| Home Automation (Residential) | 5 | 30 |
| Window Glazing (NR) | 20 | 60 |
| Building Automation (NR) | 3 | 25 |
| Room Automation - Lighting + HVAC (NR) | 2 | 20 |

### Energy

| Lever | Adoption, Today (%) | Adoption 2030 (%) |
|---|---|---|
| Rooftop PV<br>(% of total electricity generated) | 0.1 | 15 |
| District Heating (Natural Gas)<br>(% of total heating demand) | 0 | 50 |

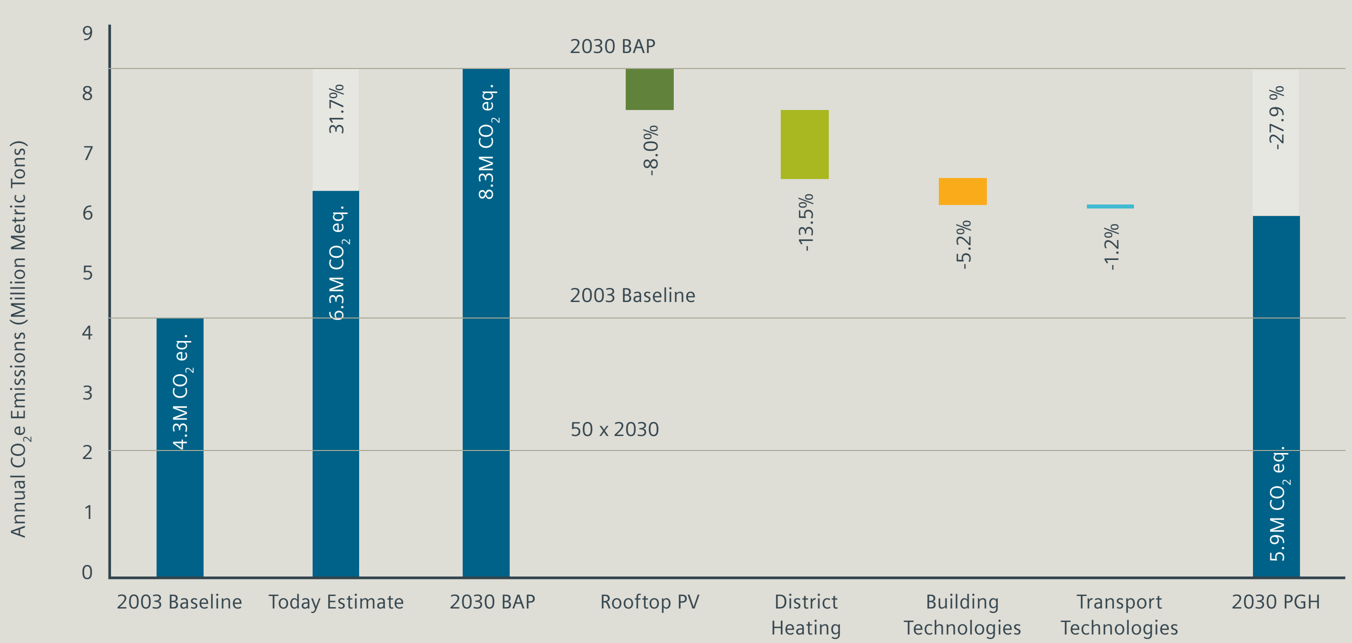
# Energy

Energy technologies, in Pittsburgh and elsewhere, have the potential to achieve far bigger wins as changes at this level feed into the overall system, so clean power going into all linked buildings would result in cleaner buildings without any changes being made to the actual buildings. Assumptions were made about the implementation of specific and impactful technologies today.

Through data collection and discussions with the city team, the understanding was that there is very little to none of installed solar electricity generation and only a very small number of district heating or steam heating projects exist.

District heating and rooftop PV are the most impactful technologies. Should 15% of local electricity come from solar and half of heating demand be met through district energy systems then 20% total $CO_2$ emissions could be reduced. Rooftop PV also scores consistently high in terms of delivering on climate targets as well as air quality and job creation.

**Pathway to Deep Carbon Reductions**
Original Scenario

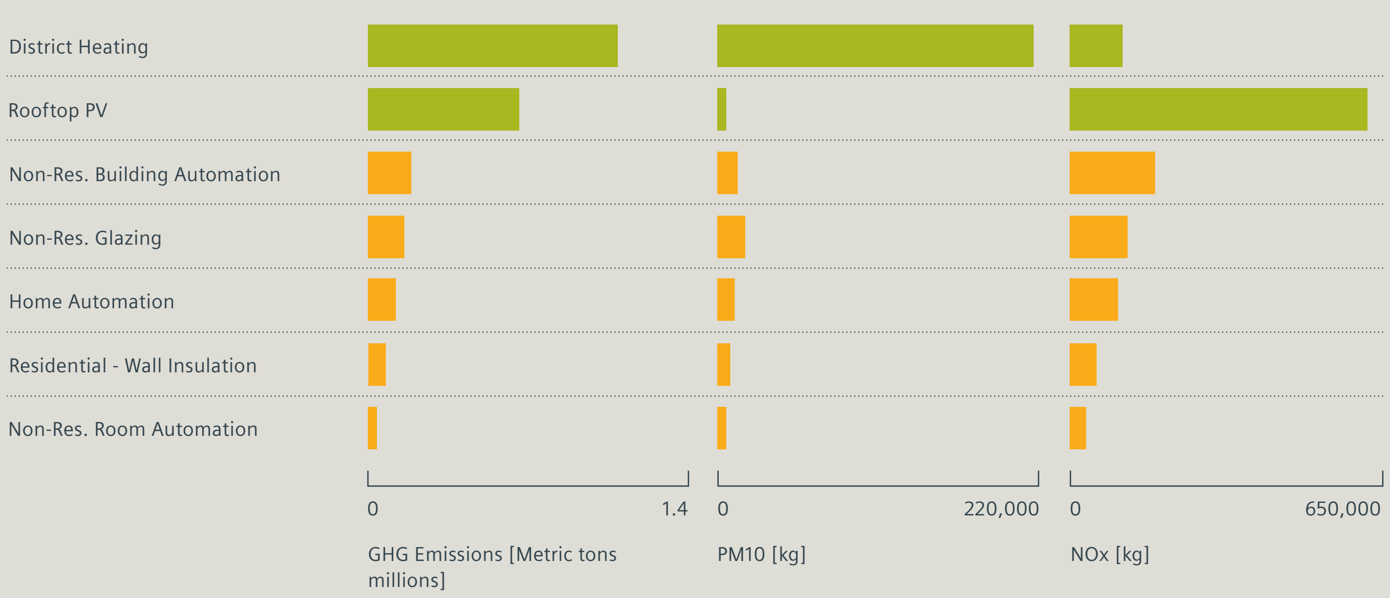


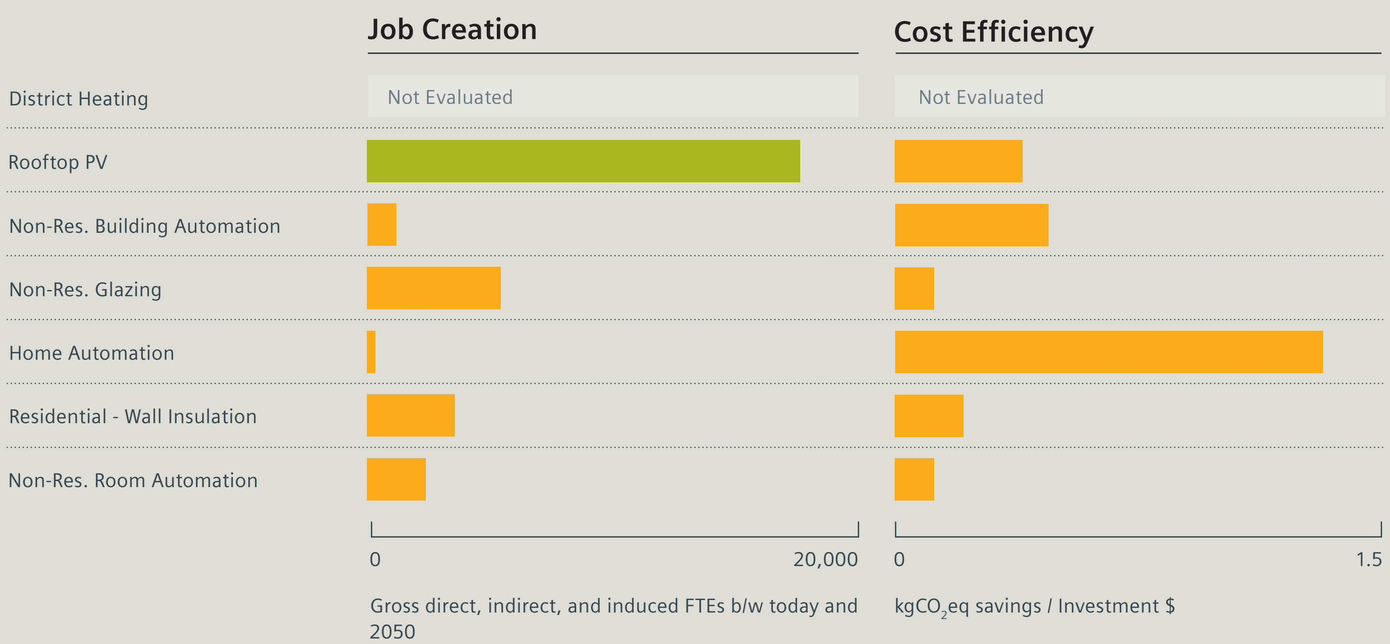





## CyPT Lever Impacts – Original Scenario. Buildings and Energy

**Reduction in Annual Emissions from 2030 Business-as-Planned**



## Deep Carbon Reduction Scenario

Should the City of Pittsburgh become even more ambitious and make more demands on citizens and local energy providers and distributors then far more significant reductions could be made. Should more people and businesses convert to electric heat generation through air source heat pumps or become part of a natural gas-based district heating system, total city emissions could be reduced by more than 30%. Reductions of nearly half a percentage point could be made if the other 50% of homes better insulated their homes. Should local energy providers venture into onshore wind then emissions could reduce by a further 26%. If the local grid were to make investments into its core infrastructure and reduce inefficiencies, then further savings are achievable.

More significant decarbonization of the grid, improving building performance and delivering more efficient heating solutions, could result in a 65% drop in city emissions.

Carbon emissions are what the City of Pittsburgh and Mayor Peduto have pledged to reduce. However, the mayor has also pledged to ensure that taxpayer money to reduce global warming is well spent, which also means that it needs to directly benefit the residents of Pittsburgh and the wider region. The technologies that would bring the most positive impact to Pittsburgh's residents would be those that create the most jobs and result in cleaner air within the city and region.

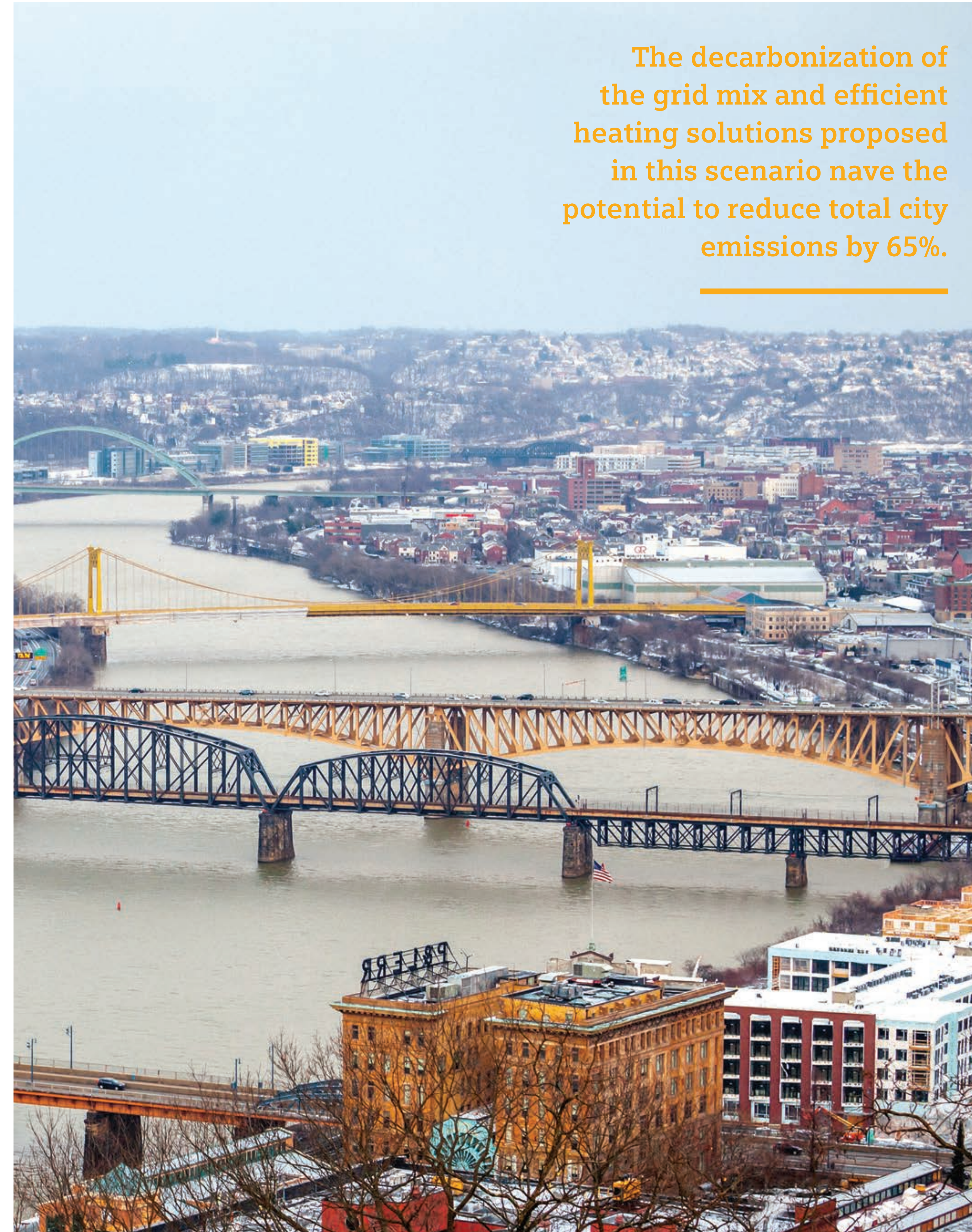
Rooftop PV implementation is one of the best performing technologies for creating local employment. Air quality in Pittsburgh would be the most improved should district and electric heating be delivered. Air quality in the region would be improved the most through the development of onshore wind. The most cost-effective technologies were those that would improve the performance of the grid.

The grid utilities would need to implement these and, as they are highly cost effective, it is possible that they could deliver an attractive business case for the grid utilities and or local utility.

The Climate Action Plan and the Deep Carbon Reduction scenarios are building on the other. They are both saying that buildings must be addressed, but that the biggest wins are changes to the systems feeding the buildings with energy and heat. Moreover, both are saying that there are jobs to be created through these changes and that citizens will benefit both economically and environmentally.

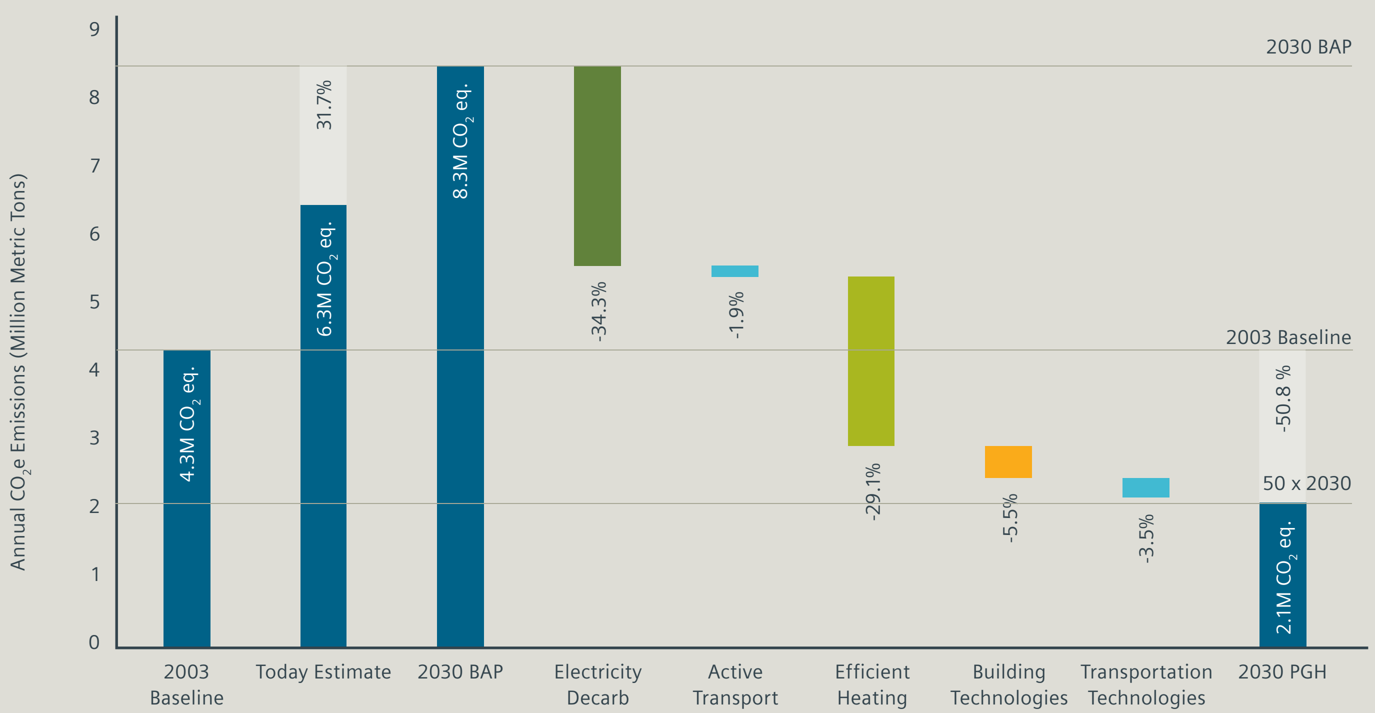


City Performance Tool Analysis for the City of Pittsburgh



**The decarbonization of the grid mix and efficient heating solutions proposed in this scenario nave the potential to reduce total city emissions by 65%.**

## Pathway to Deep Carbon Reductions
50 x 2030 Scenario




## GHG Emissions
Buildings and Energy

### Residential and Non Residential Buildings

| Lever<br>% of building stock with lever | Adoption, Today (%) | Adoption 2030 (%) |
|---|---|---|
| Wall insulation (Residential) | 10 | 100 |
| Home Automation (Residential) | 5 | 80 |
| Window Glazing (NR) | 20 | 100 |
| Building Automation (NR) | 3 | 80 |
| Room Automation - Lighting + HVAC (NR) | 2 | 80 |

### Energy

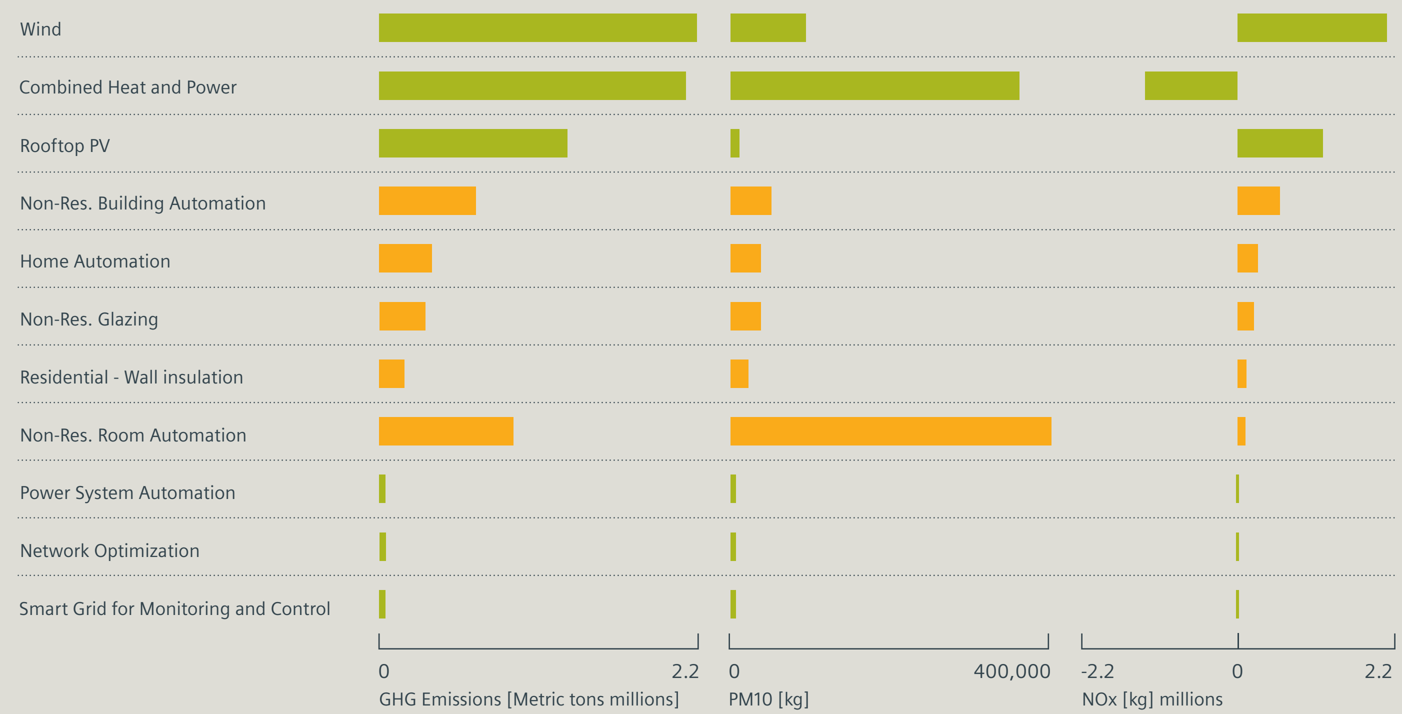
| Lever | Adoption, Today (%) | Adoption 2030 (%) |
|---|---|---|
| Wind Power<br>(% of total electricity generation) | 2.1 | 50 |
| Rooftop PV<br>(% of total electricity generation) | 0.1 | 15 |
| CHP District Heating (Natural Gas)<br>(% of total heating demand) | 0 | 50 |
| Electric Air Sourced Heat Pump<br>(% of total heating demand) | 2.6 | 35 |

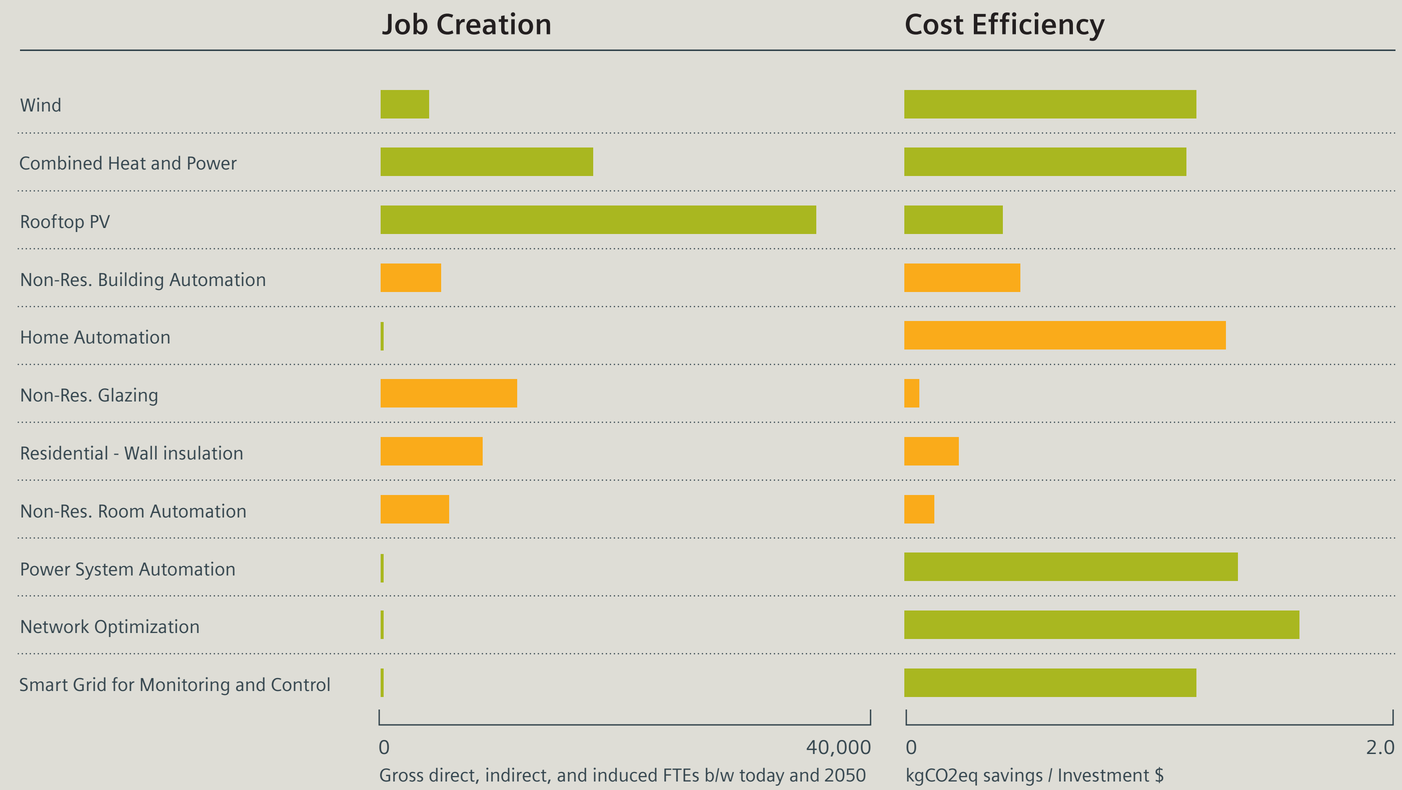




# CyPT Lever Impacts – 50x2030 Scenario. Buildings and Energy

## Reduction in Annual Emissions from 2030 Business-as-Planned



**21 mi/ person/day**
Average distance traveled per person, per day

**111,397**
No. of cars on the road

**0.8**
Cars per households

**23.9 MPG**
Average fuel economy

## Transportation

The City of Pittsburgh and the Port Authority of Allegheny County already have significant plans to improve public transport and increase ridership. Today, like in most US cities, private car-based travel is predominant at 83%, and to date there has been no deployment of electric vehicles. Transport in Pittsburgh accounts for about 12% of total carbon emissions, but likely a far higher proportion of local emissions. Pittsburgh's buses are already well-used, and they account for about 10% of all miles traveled.

This means that nearly 95% of all miles travelled occur via only two forms the private car and bus. In terms of the city's resilience, there are not many other options for travel and the city must think about how it can reduce these journeys by making other forms of transport more attractive, such as walking or cycling. Shared private transport is a new form of transport that may significantly impact how journeys across Pittsburgh are made in the future. Pittsburgh's decision to hold an electric and shared mobility workshop with key stakeholders in February 2019 demonstrated that they too are thinking about what the electrification of transport will mean to the city and how they should be planning for more shared transport.

The CyPT analysis considered both the Climate Action Plan and Deep Carbon Reduction scenarios for Pittsburgh. These technologies will work to reduce the 12% of carbon emissions produced by the transport sector in Pittsburgh. The challenge is to reduce the huge proportion of journeys being made by cars and creating incentives for modal change is key.

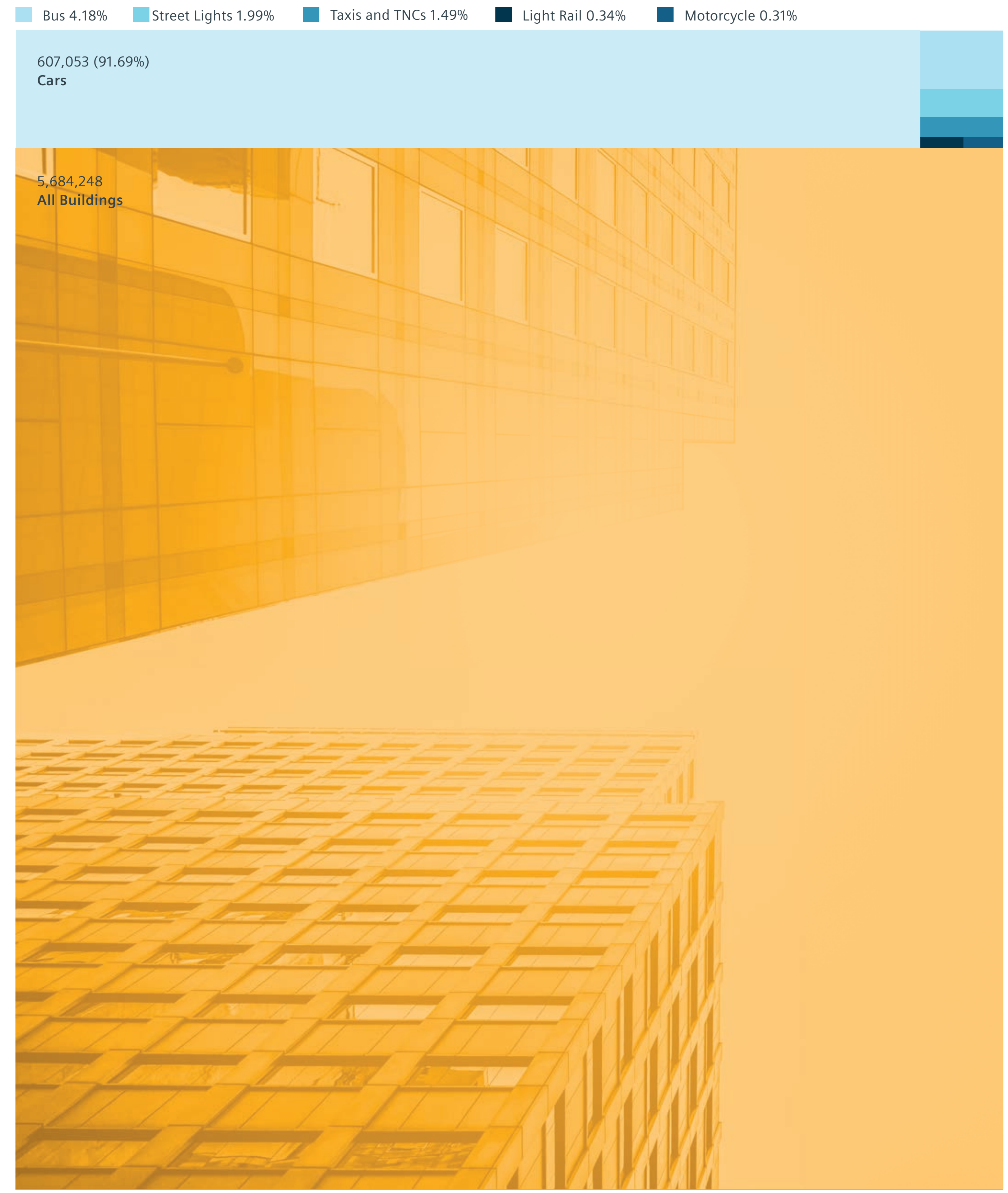
The CyPT analysis found that in the Climate Action Plan scenario the most positive impact came from electrifying cars and buses, incentivizing a modal change and boosting the number of journeys on the new commuter rail system, promoting electric car sharing and improving traffic signals could deliver a reduction of 1.2% of total city carbon emissions, or 10% of all transport emissions.





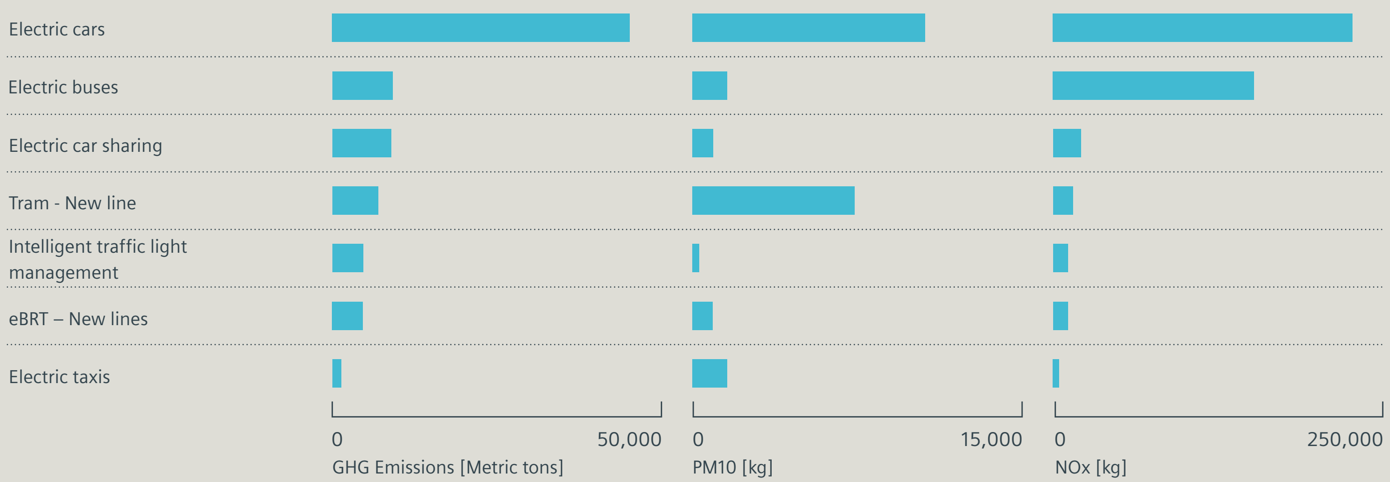
**GHG Emissions**
Buildings and Energy

Annual Metric Tons of CO$_2$eq Emissions (% of Transport)

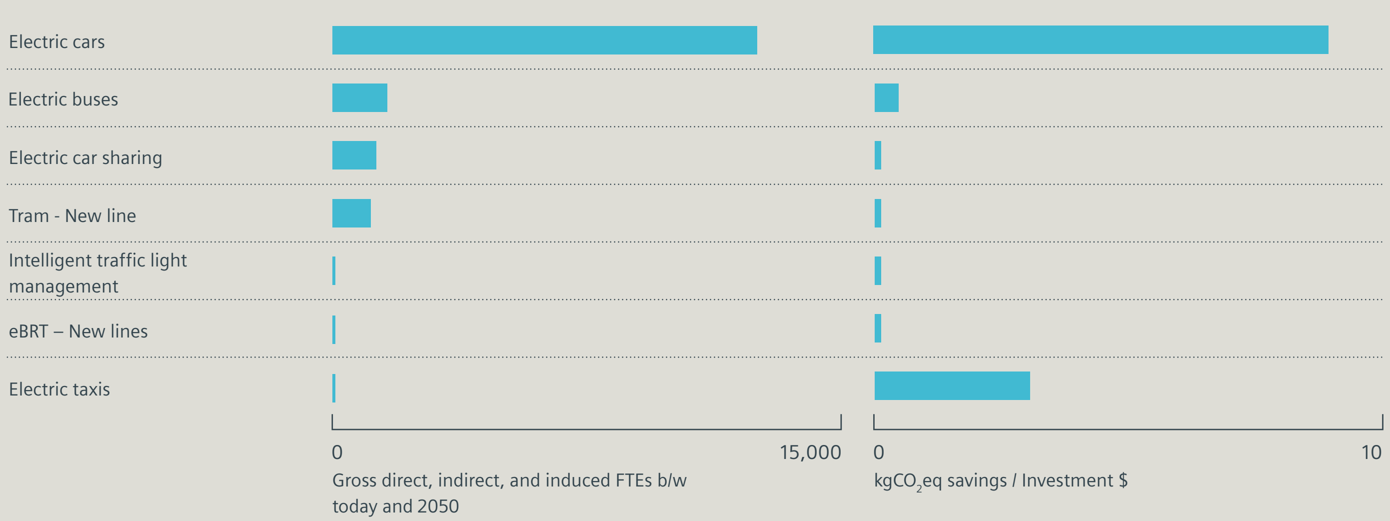


# CyPT Lever Impacts – Original Scenario. Transportation

## Reduction in Annual Emissions from 2050 Business-as-Usual




## Job Creation / Cost Efficiency




## Percentage of total annual passenger miles traveled, by mode

| | |
|---|---|
| Walking | 1.4% |
| Bicycle | 1.9% |
| Light Rail | 1.5% |
| Bus | 10.5% |
| Taxis and TNCs | 1.0% |
| Motorcycle | 0.5% |
| Car | 83.3% |



City Performance Tool Analysis for the City of Pittsburgh

## CyPT Levers – Original Scenario
Transportation

### Public Transit

| Lever | Unit | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| eBuses | % of public bus fleet | 0% | 50% |
| eBRT - New Lines | Total no. of lines | 0 | 2 |
| Tram – New Lines | Total no. of lines | 3 | 5 |

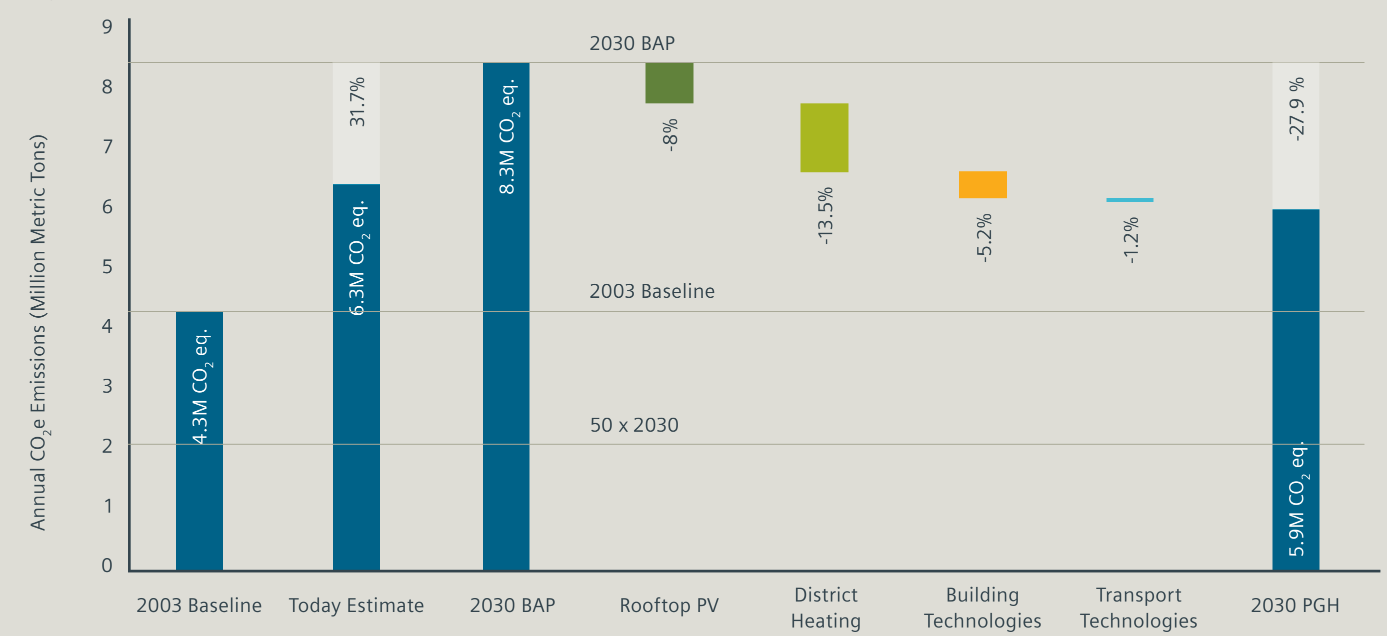
### Private Transportation

| Lever | Unit | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| Electric Cars | % of cars on the road | 0% | 35% |
| Electric Taxis | % of taxis on the road | 0% | 50% |
| Electric Car Sharing | No. of car sharing cars | 0 | 450 |

### Infrastructure

| Lever | | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| Intelligent Traffic Light Management | % of traffic lights w/ coordinated fixed time, rule-based, or adaptive control | 0% | 75% |

## Pathway to Deep Carbon Reductions
Original Scenario




# Deeper Carbon Scenario

CyPT analysis found that by increasing the implementation rates of the technologies already considered in the Climate Action Plan, such as the electrification of cars and buses, and added new technologies such as more intelligent street lights, that it could more than double its emissions reductions. Should these higher implementation rates be achieved, then a further 3.5% of emissions could be reduced equating to roughly a quarter of all transport emissions.

The technologies that best reduce carbon emissions also have the most positive potential for job creation, the modal shift to commuter rail, and air quality the electrification of cars, buses and taxis. Where there were some notable differences were on the technologies that found to be the most cost effective, including new electric bus rapid transit lines like what will be in the Uptown EcoInnovation District and Intelligent Traffic Systems, which will improve the flow of traffic and reduce emissions

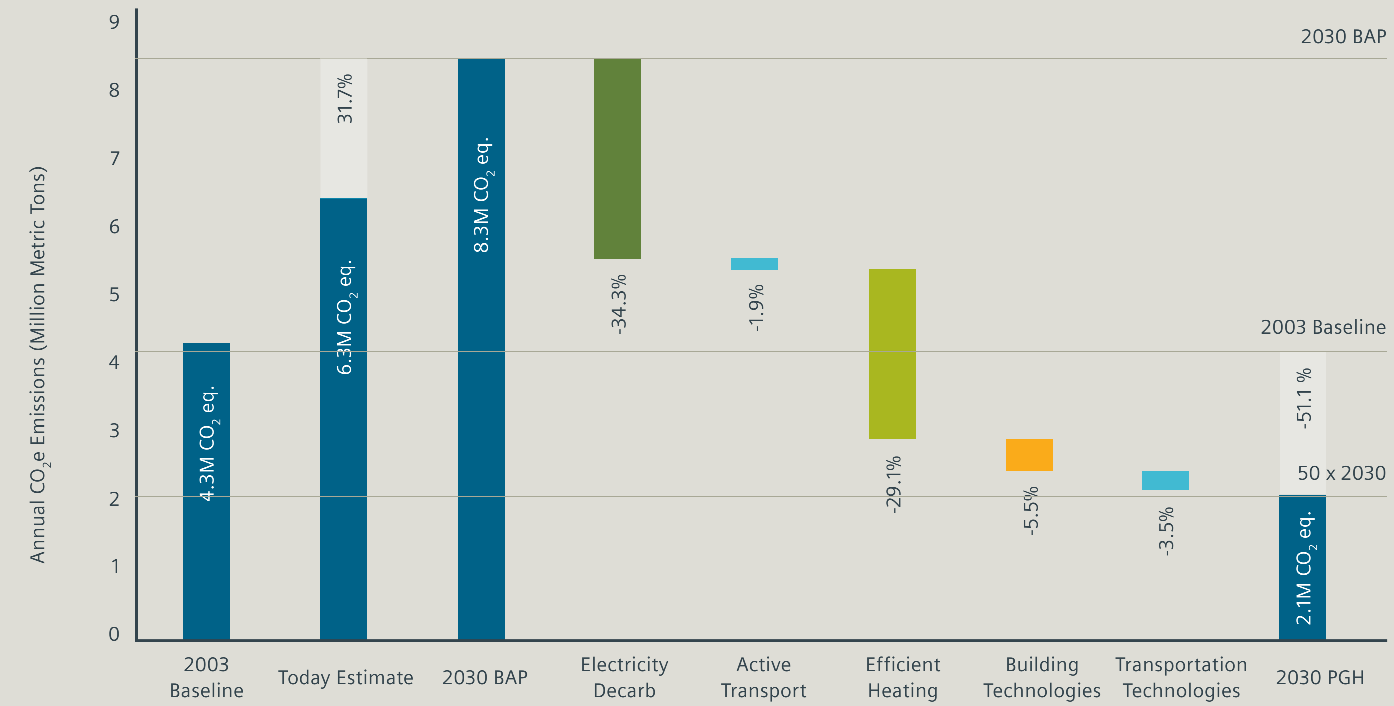
The future of electric and shared mobility in Pittsburgh is of interest as there is a local tech company testing autonomous taxis and the city is actively bringing stakeholders together to find a path to increased uptake of electric vehicles. As part of this study, Siemens used its eMobility Calculator to determine what a 30% take-up of private electric vehicles could mean for the city. The result was that even considering the impact of shared transport that there could be a 6% increase in total grid demand by 2030. This is a huge shift from the nascent levels of electric car ownership in the city today.

The CyPT analysis found that even high implementation levels of electric vehicles (public and private) well as new forms of public transit that transport emissions will only reduce by 10% or 3.5% of total emissions. This relatively low result does not mean that Pittsburgh should avoid implementing these changes, quite the opposite is true. Firstly, local air quality is hugely affected by private cars and traffic. Any effort that can be made to reduce the NOx and particulate emissions could improve health across the city.



City Performance Tool Analysis for the City of Pittsburgh

## Pathway to Deep Carbon Reductions
50 x 2030 Scenario




## CyPT Levers – 50x2030 Scenario
Transportation

### Public Transit

| Lever | Unit | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| eBuses | % of public bus fleet | 0% | 75% |
| eBRT - New Lines | Total no. of lines | 0 | 2 |
| Tram – New Lines | Total no. of lines | 3 | 5 |

### Private Transportation

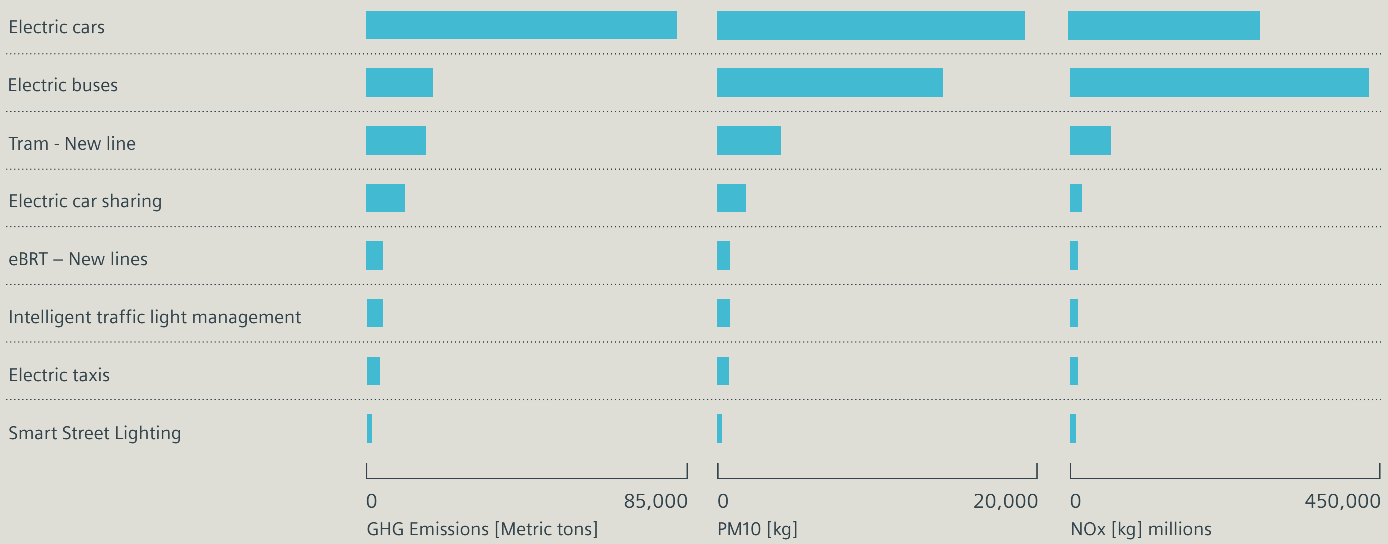
| Lever | Unit | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| Electric Cars | % of cars on the road | 0% | 75% |
| Electric Taxis | % of taxis on the road | 0% | 100% |
| Electric Car Sharing | No. of car sharing cars | 0 | 600 |

### Infrastructure

| Lever | | Adoption, Today | Adoption 2030 |
|---|---|---|---|
| Smart Street Lighting | % of street lights with LED and on demand lighting | 0% | 75% |
| Intelligent Traffic Light Management | % of traffic lights w/ coordinated fixed time, rule-based, or adaptive control | 0% | 75% |

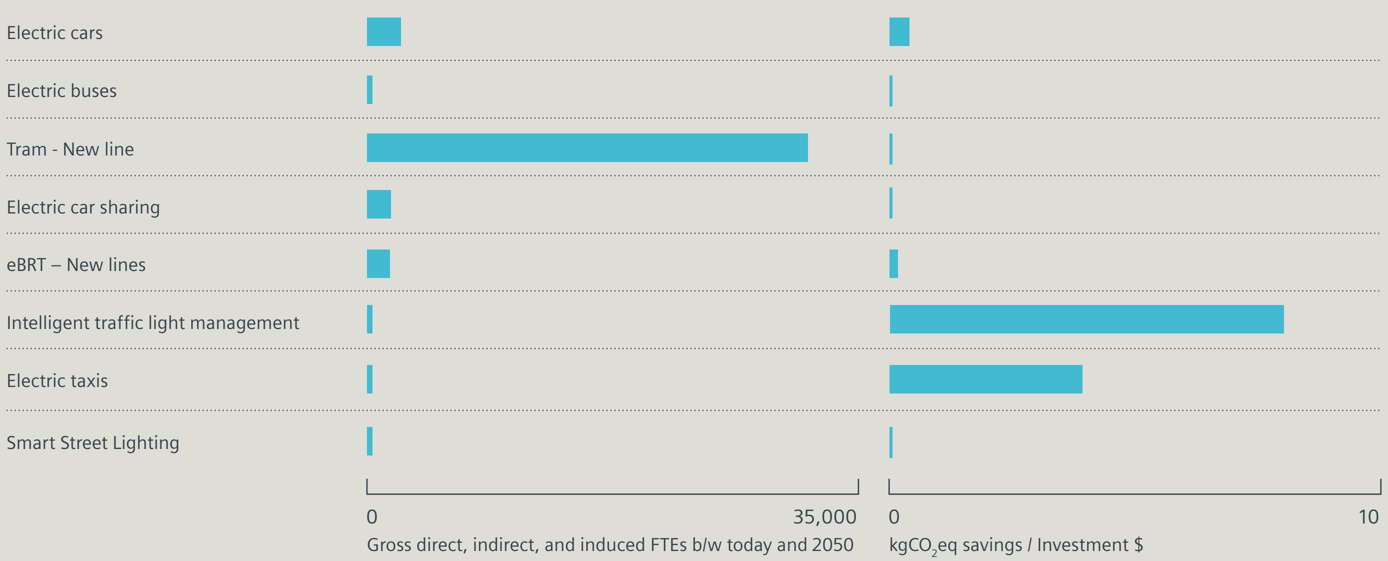
# CyPT Lever Impacts – 50x2030 Scenario. Transportation

## Reduction in Annual Emissions from 2050 Business-as-Usual



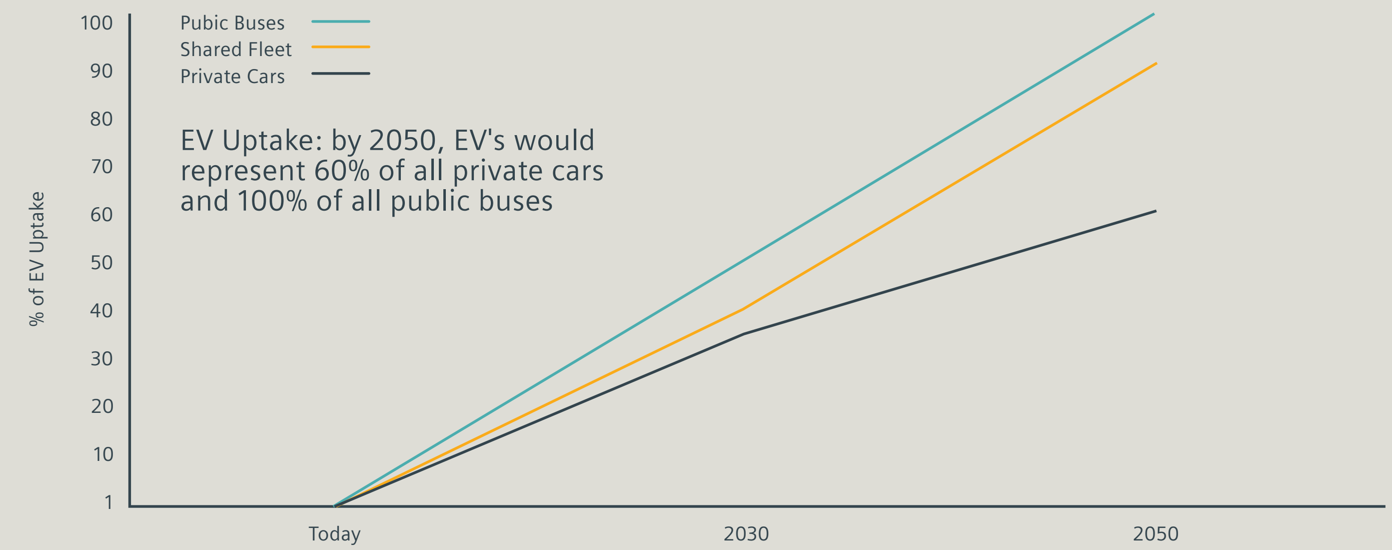

## Job Creation

## Cost Efficiency

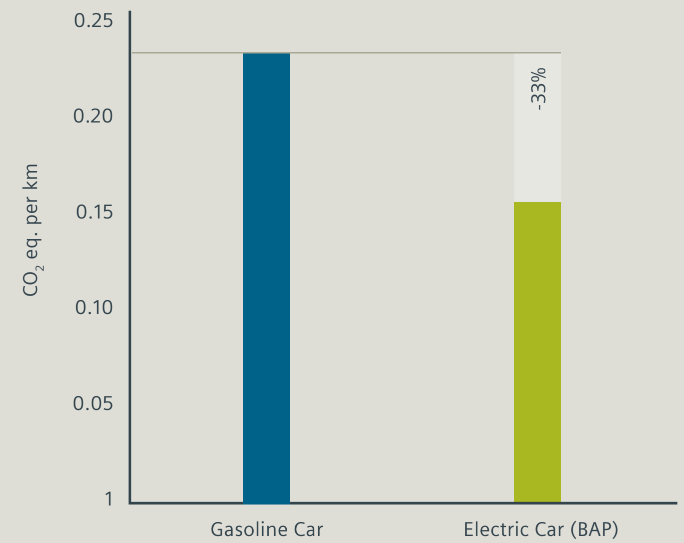


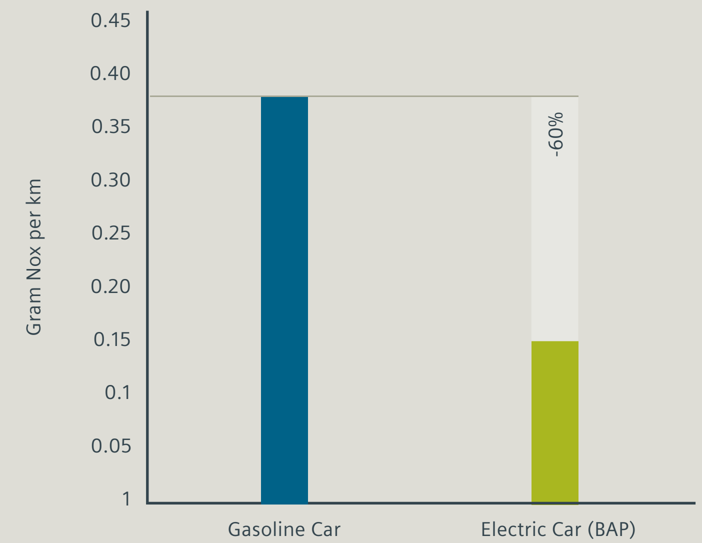

## EV Technology Trends Assumptions – Today, 2030 and 2050

### EV Uptake




## Environmental Impacts - Gasoline Car Vs. Electric Car




### By 2050...

Battery Capacity would double for private cars and shared fleets and increase by 30% for public buses

90% of charging for public buses will take place in depots.

75% of charging for private cars will continue to be in homes.

### Electric Cars

Electric cars in Pittsburgh would have lower emissions as compared to gasoline cars.

33% reduction in $CO_2$ eq. emission per km.

60% reduction in NOx emissions per km.



City Performance Tool Analysis for the City of Pittsburgh

City Performance Tool Analysis for the City of Pittsburgh

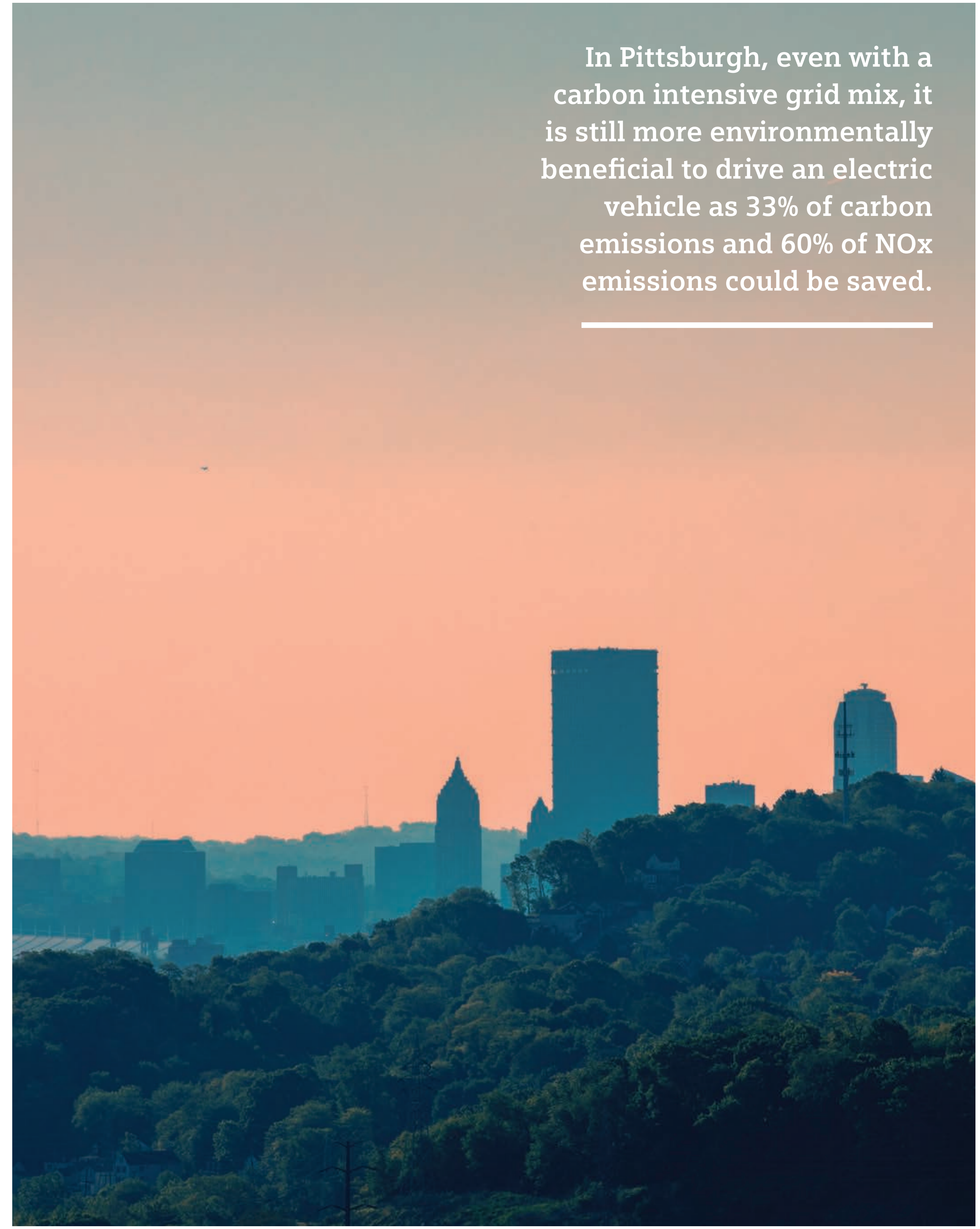

**In Pittsburgh, even with a carbon intensive grid mix, it is still more environmentally beneficial to drive an electric vehicle as 33% of carbon emissions and 60% of NOx emissions could be saved.**

Reductions of these emissions in Pittsburgh would far exceed the 3.5% of total carbon reductions. Secondly, electrifying the public bus fleet sends the signal to the market that this shift will be happening and gives confidence to the private sector to consider ways to deliver the additional grid capacity. Thirdly, should Pittsburgh work with local stakeholders to prolong the life of the nuclear power station or to encourage new renewable generation, then the emissions linked to electric vehicles would also decrease as pollutants at the local power station are included in these figures.

A key outcome of this analysis also addresses whether electrification of transport is sensible given the relative carbon intensity of the local grid mix. The CyPT found that per km driven the electric car is still far better in terms of its emissions. This difference comes from the more efficient use of energy in an electric car than in a combustion engine vehicle.

The City of Pittsburgh has interest in car sharing clubs. These have also been incorporated into the model.

It is important to also consider these changes in tandem with any improvements to public transport as they could have some degree of a positive multiplier effect in that better public transport shifts more persons away from their cars. Other changes that we cannot yet account for in the CyPT will be the popularity of shared taxis, which is another way to reduce transport emissions and significantly boost local air quality.



In Pittsburgh, even with a carbon intensive grid mix, it is still more environmentally beneficial to drive an electric vehicle as 33% of carbon emissions and 60% of NOx emissions could be saved.

# Uptown Eco-Innovation District

Pittsburgh's Uptown EcoInnovation Zone (UEZ) aims to be a global first of its kind, and this is the first of the CyPT's 40+ studies where we have considered the impacts of technology in a smaller area with a higher degree of implementation.

The UEZ is small in terms of population, less than 1% of total population, but it is centrally located, and it is a key transport and energy corridor. It utilizes more than 1% of total electricity consumption as it has a higher than average proportion of non-residential building space.

A key point here in shaping the thinking around what could be possible in terms of the UEZ's contribution to total GHG reductions will be its small size and should it implement technologies and achieve zero carbon then the reduction is still only around the 1-2% mark. However, it is the proof of concept and what could be achieved within its footprint that is important.

The CyPT analysis is only considering a small number of Key Performance Indicators for the UEZ, around carbon, air quality, jobs and cost.

Whereas the City of Pittsburgh will be creating a wider baseline for UEZ on social equity indicators, accessibility to employment – all highlighted on the Portland Sustainability Institute's diagram.

**Population**

**1,000**

(0.3% of City's population)

**Footprint**

**1.9M sq. ft.**

(0.4% of City's footprint)

**Electricity consumption**

**62,000 MWh**

(1% of City's consumption)

**Average miles traveled per person per day**

**21**

(33% lower than City's average)





# Baselining Uptown
## Portland Sustainability Institute ecodistrict performance areas


### Materials Management
- [+] Materials recovery rates
- [+] Compostables/organics recovery rates
- [+] Salvaged product resuse
- [+] Waste prevention procurement policies
- [+] Pesticide impacts
- [+] Carbon emission from waste disposal

### Habitat + Ecosystems
- [+] Previous area
- [+] Tree canopy coverage
- [+] Land cover
- [+] Carbon sequestration
- [+] Flora and fauna populations and diversity
- [?] Soil quality

### Water
- [+] Stormwater management performance
- [+] Pervious area
- [?] Potable water consumption
- [?] Wastewater treatment
- [?] Annual hydrologic balance
- [?] Runoff temperature
- [+] Pollution generating surfaces

### Energy
- [?] Annual building energy demand
- [?] Annual individual energy demand
- [+] Solar potential
- [?] Annual carbon emissions

### Access and Mobility
- [+] Walkability
- [+] Level of transit service
- [√] transit affordability
- [√] Work commute mode split
- [?] Daily vehicle miles traveled
- [?] Annual diesel emissions
- [?] Annual carbon emissions

### Community Identity
- [+] Walking distance to amenities
- [+] Quality of building stock
- [+] Quality of public space
- [+] Quality of pedestrian environment
- [+] Vacancy rates
- [+] Land use diversity and compatibility
- [+] Community input opportunities
- [+] Diversity of engaged stakeholders

### Health and Well-being
- [+] Open spaces access
- [+] Food access
- [?] Crime rates
- [+] Resident Satisfaction
- [?] Resident health statistics
- [+] Exposure to toxins
- [?] Air quality

### Equitable Development
- [√] Demographic diversity
- [√] Income levels
- [√] Housing burden
- [+] Local Jobs
- [√] Displacement

# Technology scenarios

The CyPT analysis for UEZ utilizes the Business as Planned electricity mix, which means that without any intervention the GHG emissions in this district would increase. The analysis then focuses on how aggressive the targets would need to be to nullify the impact of the changed electricity mix and to deliver the needed reductions. Three technology implementation levels were used including realistic, intermediate and aggressive.

In terms of actual implementation rates, the realistic scenario uses a higher implementation rate for electric vehicles (buses and private cars) and has a higher proportion of intersections using more intelligent traffic lights. It assumes a lower implementation rate on the energy district heating and rooftop PV as this area has a higher density of floorspace and there is relatively less roof space to effective internal space.

For Pittsburgh to deliver on its Uptown Eco-Innovation District aims, it will need to deliver the most aggressive technology scenario. It could have more impact by expanding its size and population/building footprint base. As the underlying carbon intensity of the electricity grid so high, the most benefit can be achieved by any action that reduces electricity use in buildings.

As detailed later in this document, the City of Pittsburgh is still better off if residents used electric cars rather than gasoline cars because they still reduce overall Scopes 1, 2, and 3 emissions and have zero tailpipe emissions in the city.

The CyPT analysis found that the business as usual case would see a higher increase in GHG emissions between now and 2030. This is because more of the gross floor area in this part of town is non-residential, and the carbon intensity of this space is far higher than that of residential, so it faces a higher than expected increase in emissions than the rest of the city.

Additionally the non-residential buildings in the UEZ are far more energy intensive (55%) than the average non-residential type building in Pittsburgh. This means that the starting point is lower and should only the realistic scenario be delivered then GHG emissions in 2030 would be higher than today.

The CyPT analysis found that the business as usual case would see a higher increase in GHG emissions between now and 2030.



City Performance Tool Analysis for the City of Pittsburgh

## Modeled Scenarios – Uptown District

| | Realistic | Intermediate | Aggressive |
|---|---|---|---|
| **Building technologies** | Less aggressive assuming less than 50-60% of building stock equipped with energy efficient and automation technologies | More aggressive - assuming almost 80-100% of building stock equipped with energy efficient and automation technologies | More aggressive - assuming almost 80-100% of building stock equipped with energy efficient and automation technologies |
| **Electricity Generation** | No additional energy levers (district energy and rooftop PV) modeled | 10% of electricity generation from rooftop PV | 15% of electricity generation from rooftop PV |
| **Building Heating** | No additional energy levers (district energy and rooftop PV) modeled | 20% of building heating from NG based District Heating | 50% of building heating from NG based District Heating |

## Modeled Technologies and Adoption Rates

| **Lever**<br>% of building stock with lever | Adoption, Today | Adoption, 2030 Realistic | Adoption, 2030 Intermediate | Adoption, 2030 Aggressive |
|---|---|---|---|---|
| **Residential (2) Non-Residential (3)** | | | | |
| Wall insulation (Residential) | 10% | 50% | 100% | 100% |
| Home Automation (Residential) | 5% | 30% | 80% | 80% |
| Window Glazing (NR) | 20% | 60% | 100% | 100% |
| Building Automation (NR) | 3% | 25% | 80% | 80% |
| Room Automation Lighting,HVAC (NR) | 2% | 20% | 80% | 80% |
| **Public transit (3)** | | | | |
| eBuses<br>(% of public bus fleet) | 0% | 50% | 50% | 50% |
| eBRT - New Lines<br>(Total no. of lines) | 0 | 2 | 2 | 2 |
| Tram – New Lines<br>(Total no. of lines) | 3 | 5 | 5 | 5 |
| **Private transportation (2)** | | | | |
| Electric Cars<br>(% of cars on the road) | 0% | 70% | 70% | 70% |
| Electric Taxis<br>(% of cars on the road) | 0% | 50% | 50% | 50% |
| **Transportation infrastructure (1)** | | | | |
| Intelligent Traffic Light Management<br>(% of cars on the road) | 0% | 75% | 75% | 75% |
| **Energy (2)** | | | | |
| District Heating<br>(% of heating consumption) | 0% | 0% | 20% | 50% |
| Rooftop PV<br>(% of electricity consumption) | 0% | 0% | 10% | 15% |

This is because more of the gross floor area in this part of town is non-residential, and the carbon intensity of this space is far higher than that of residential, so it faces a higher than expected increase in emissions than the rest of the city.

Additionally, within the non-residential buildings, the building in the UEZ are far more energy intensive (55%) than the average non-residential building. This means that the realistic technology scenario would not deliver any GHG reductions by 2030 and would still be higher than today's carbon estimation.

The only scenario where there is a reduction in emissions is the most aggressive scenario. In this scenario the buildings are renovated to a far higher standard, and all buildings have more insulation, better glazing and at least some degree of automation. In this scenario still not all residential and non-residential buildings are assumed to be fully automated. This is an area where there could be some additional win with a target of 100%. Transport technologies are incredibly important, particularly in terms of air quality as this area is a corridor for drivers and passengers coming from other parts of the city to move through. Journeys in this part of Pittsburgh tend to be shorter and there is a lower proportion of car ownership. The proposed UEZ scenarios do consider that more of the local vehicles are electric and that positively impacts the overall results, but to a smaller degree than would the building technologies.

The outcome of this district focused analysis is very much that the City of Pittsburgh needs to raise its already high ambitions for this and focus on making its buildings more energy efficient and enable them to utilize cleaner heat and electricity. Given that buildings in this district are already far less efficient than the Pittsburgh average, it is an area where changes would have a disproportionately higher impact than in other parts of the city.

**Connect All of the Dots: Conclusions and Technology Roadmap**

The CyPT analysis covering Pittsburgh's energy, buildings and transport sectors demonstrates that Pittsburgh has a path to meet its nearer term carbon reduction target of 50% by 2030 and getting the ccity closer to its 80% by 2050 climate goal.

Should Pittsburgh raise its already very high ambitions and growth, it could reduce Carbon emissions by 74.3%, resulting in 6.2 million fewer metric tons of $CO_2$eq. These benefits would be accompanied by 110,000 full-time equivalent positions between now and 2030 and the city would have higher quality buildings, more transport options and better air quality for its residents.

Pittsburgh has an 80% by 2050 climate aim, but the city's target of 50% by 2030 has been the central focus driving this analysis. This is a target, but it is only ten years away. There is today a real sense of urgency coming from citizens to deliver on climate targets. Meeting this target requires delivering or at least funding all of the key projects within the next 3 – 5 years through city capital programs or private partners.

| **Buildings, Today** Non-Residential - Pittsburgh | **Pittsburgh** | **Buildings, Today** Non-Residential - Uptown District | **Uptown District** |
|---|---|---|---|
| **223M ft²** Total Non-residential building footprint | **31** Average miles traveled per person per day | **1,184k ft²** Total Non-residential building footprint | **21** Average miles traveled per person per day |
| **4,147,331 MWh** Total electricity consumption | **111,397 (/0.8)** No. of cars on the road (/cars per household) | **61,000 MWh** Total electricity consumption | **367 (/0.5)** NO. of cars on the road (/cars per household) |
| **145 kBtu/ft²** Average energy use intensity | **23 mpg** Average fuel economy miles per gallon | **226 kBtu/ft²** Average energy use intensity | **23 mpg** Average fuel economy miles per gallon |

The City of Pittsburgh must use the sense of urgency happening now to raise its ambitions and deliver more than it has set out to do.

The near-term actions that we would recommend the City of Pittsburgh to focus on is enabling a greener electricity grid, providing more efficient heat, promoting electric transport and incentivizing more building efficiency upgrades.

The city will have to address all these areas because the change to the electricity mix is moving the goal posts further out, and the city's level of ambition must also move further ahead.

The city could support renewable energy generation at both the urban scale and at the regional or state level where larger projects may be possible. This means addressing, at the state level, policies that would support community energy projects or the connecting of larger scale renewable projects to the grid. The city and the Port Authority can expand its aims to deliver rooftop solar energy by starting with all their public buildings and incentivizing the private sector (residential and non-residential) to follow their lead. The city and local utility would also need to undertake an analysis on whether, and where, more renewable electricity could be brought onto the grid.

A starting place for that analysis and linked projects could be the Uptown EcoInnovation Zone where a microgrid at the local level, i.e. downstream from the substation, could balance electricity flow between rooftop solar and the new combined heat and power turbines without burdening the grid network.

District heating is a real focus for the City of Pittsburgh, and it fits well with the city's climate reality as winters can be very cold and air source heat pumps alone may not be enough to generate the thermal heat required. Delivering district heating is not carbon free, but it is more efficient than individual boilers, and there is the possibility to transition to cleaner gasses in the future.

Delivering district heating across the Uptown EcoInnovation District gives the City of Pittsburgh a place to start, where buildings are sufficiently dense to make it cost effective. There is also the opportunity to link the Uptown system to other district heating systems, such as Lower Hill and Downtown PACT, where more efficiency and scale could be achieved.

Electrification of vehicles could significantly improve air quality across the city as per km travelled an electric car today in Pittsburgh emits 33% less $CO_2$ eq and 60% NOx emissions. The projected 6% increase in grid demand to electrify 35% of private cars and 50% of buses is certainly an increase to the status quo but not an insurmountable one.

Building upgrades, particularly automation both within non-residential and residential buildings, can deliver significant emissions reductions while also enabling buildings users to save money.

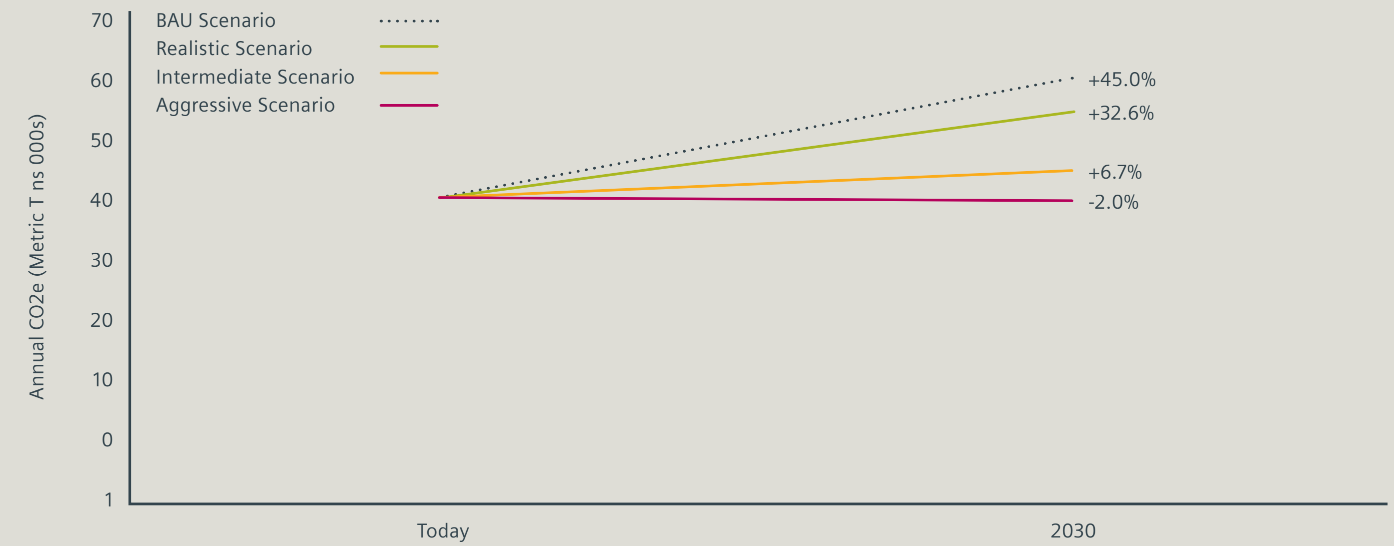
Transportation across Pittsburgh is almost all by car or bus. Any actions that could increase active transit or shift drivers onto public transit, including the new tram and bus rapid transit systems, would positively impact air quality and reduce carbon emissions.



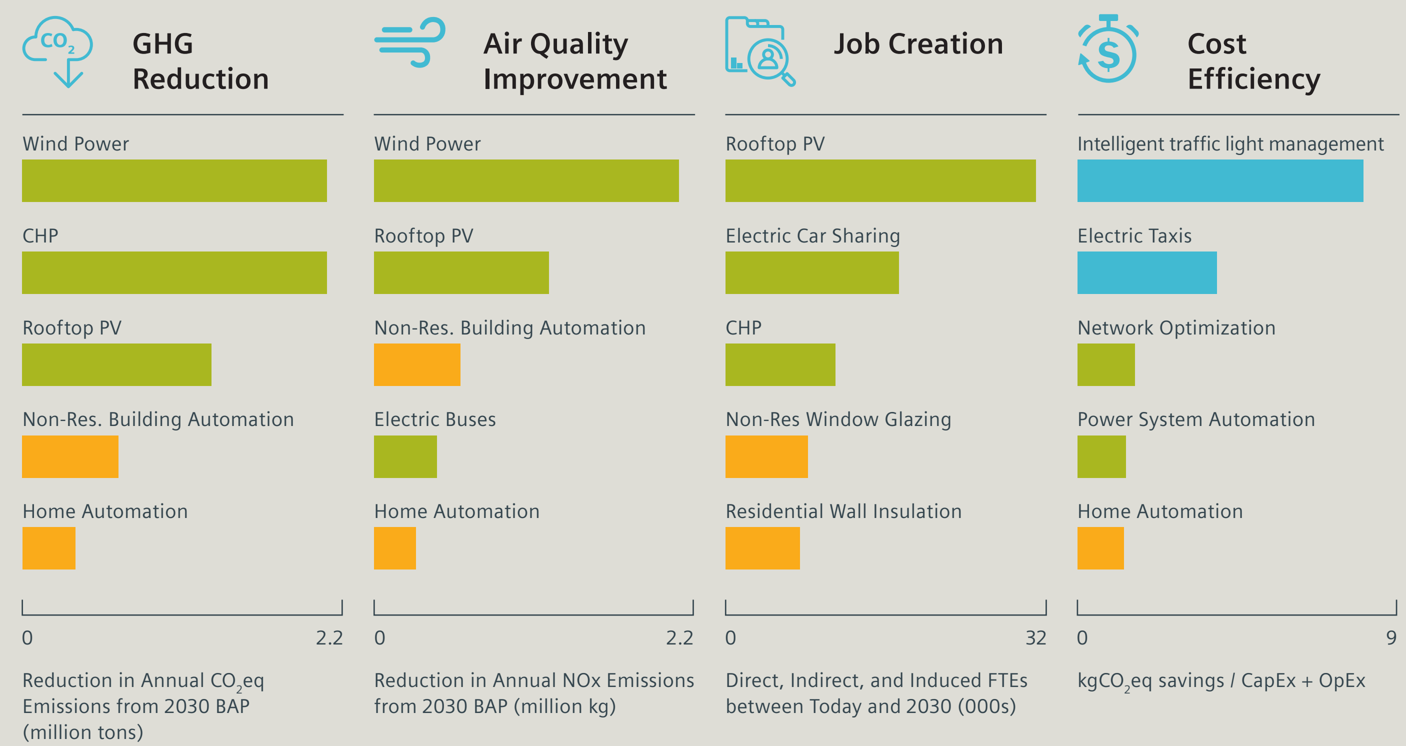
City Performance Tool Analysis for the City of Pittsburgh

## Emissions reduction scenarios for Uptown

### Emissions reduction scenarios for Uptown




## High-Performing Technologies – 50x2030 Scenario



The Intelligent Traffic System was found to be the most cost-effective technology, and this technology can be used to prioritize public buses and cyclists and further incentivize other forms of transit, improve overall traffic flows and air quality.

Critical to delivering these new projects is the knowledge that underpinning these projects is an ability to create new, local, jobs for the residents of Pittsburgh.

These projects have the potential to generate 110,000 new full-time equivalent positions.

This job number includes opportunities created via multiplier effects (e.g. jobs created indirectly or induced by the direct project investments, which could range from additional retail and restaurants. Projects like the installation of solar PV and district heating systems as well as improving the insulation of homes will green the local grid, improve the efficiency of local heating and make homes more efficient and comfortable for residents all the while reducing carbon emissions.

The City of Pittsburgh is already showing tremendous leadership in bringing a range of stakeholders together.

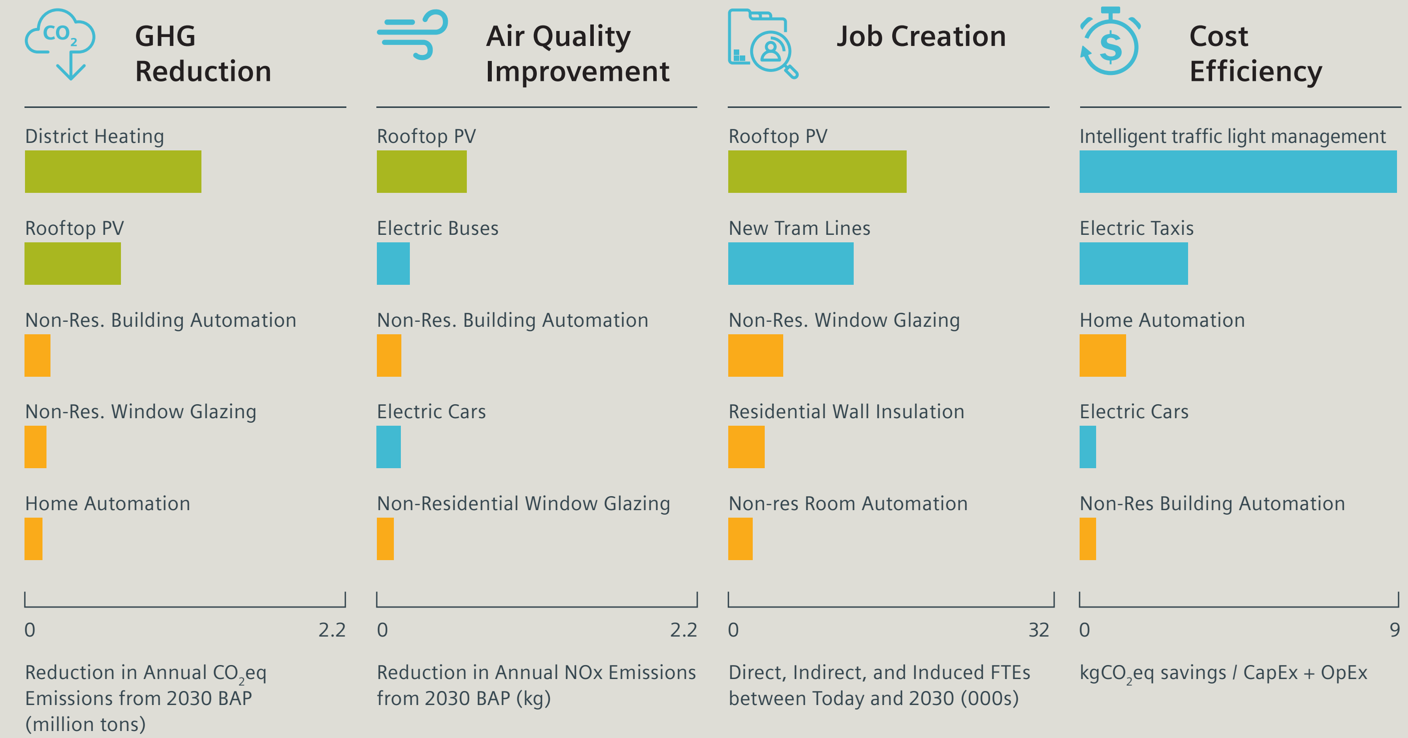
Now it must leverage its own citizens and the aspirations of the region to bring about wider changes across Western Pennsylvania, the state of Pennsylvania and into the mid-Atlantic region by delivering the projects that it can, use its own buildings as examples, clubbing together with other like-minded entities to purchase renewable power and create stronger market demand for the needed larger-scale renewable energy projects, and advocate on the legislation needed to create the energy market needed by Pittsburgh and other cities.

The private sector also needs to recognize the change in infrastructure that Pittsburgh is aiming for and show a willingness to engage, help to build, finance and operate key projects. The story of Pittsburgh is one where the city recognizes where it can, and cannot, deliver and actively brings to the table the other organizations needed to catalyze change – the Uptown EcoInnovation Zone is the starting point.

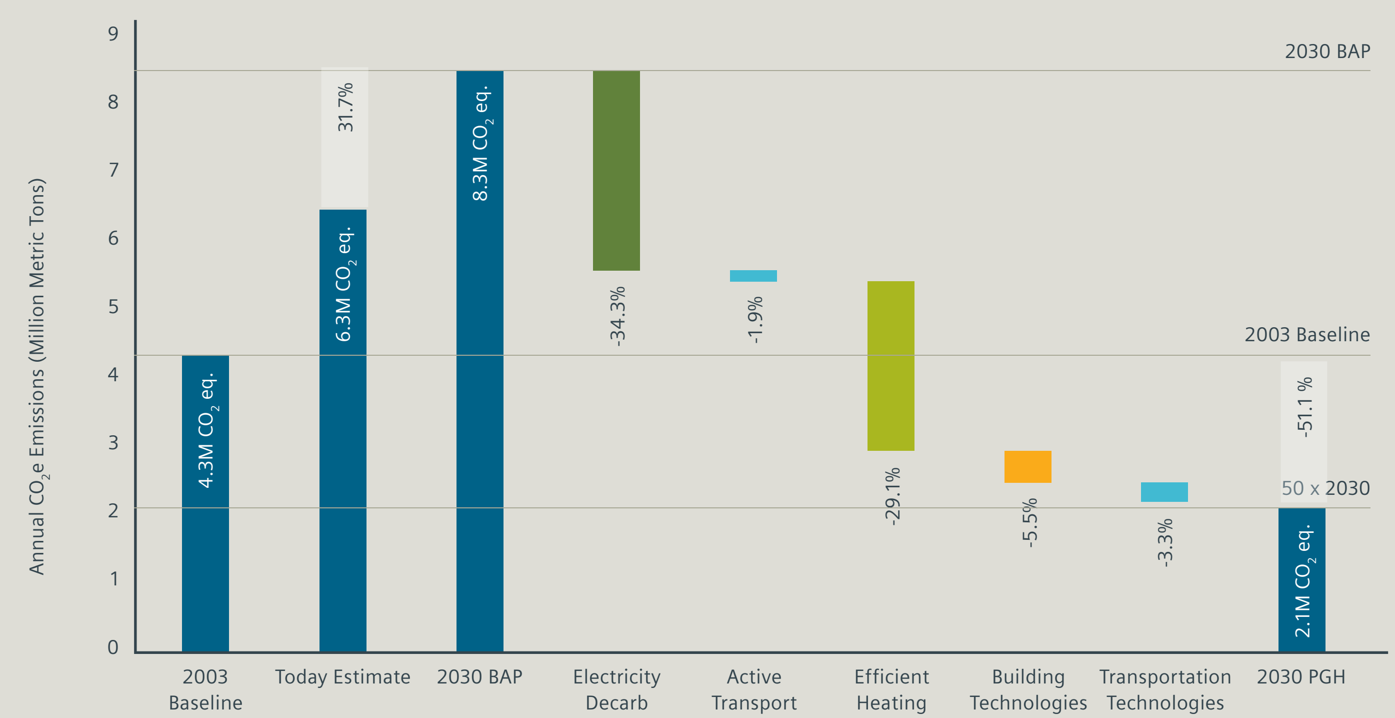




## High-Performing Technologies




### Pathway to Deep Carbon Reductions
50 x 2030 Scenario



City Performance Tool Analysis for the City of Pittsburgh

Implementing software to help understand when, where, and why electricity is being used; to provide transparency to consumers about pricing, to do predictive analytics for grid maintenance; and to incorporate alternative sources of energy (like rooftop PV panels or microgrids, which use the grid as a back-up) are just some of the reasons cites for the importance of power systems automation and smart grid monitoring and control measures – even though these measures have relatively low direct impacts on GHG reduction.

## Pittsburgh 2030
## Climate Action Plan Scenario

**2.2M**

Potential CO2eq Reduction (in metric tons) as compared to 2030 BAP

0 — 7M

**27.9%**

Potential $CO_2$eq Reduction (%) as compared to 2030 BAP

0 — 100%

**$5B**

Capital and Operating Expenditures between Today and 2030

0 — $5B

**47K**

Full-time Equivalents Generated between Today and 2030

0 — 120K

## Pittsburgh 2030
## 50x2030 Scenario

**6.2M**

Potential $CO_2$eq Reduction(in metric tons) as compared to 2030 BAP

0 — 7M

**74.3%**

Potential $CO_2$eq Reduction (%) as compared to 2030 BAP

0 — 100%

**$17B**

Capital and Operating Expenditures between Today and 2030

0 — $20B

**110K**

Full-time Equivalents Generated between Today and 2030

0 — 120K

# Appendices

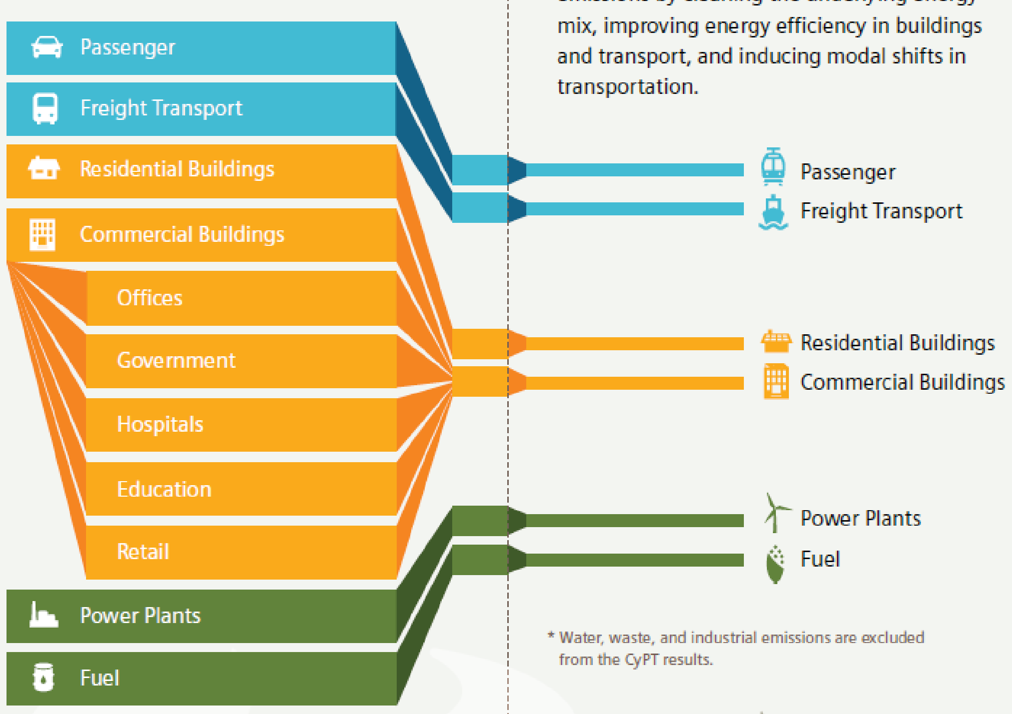
## I - CyPT Technologies

### STEP 1

**Energy Mix Analysis**
The CyPT works by using 350 city-specific data points to build an emissions baseline based on activities occurring within the city boundaries. It uses the 2012 GPC Protocol for Community-Wide Emissions to estimate emissions from residential and commercial buildings, passenger and freight transport, and energy consumption.

### STEP 2

**CyPT Results***
Once that emissions baseline is established, Siemens collaborates with a city to determine which of the 73 technologies and policy levers in the CyPT apply and at which implementation rates. Scenarios of infrastructure technologies at various implementation rates are then run through the CyPT model. Results of the model demonstrate how the CyPT levers reduce emissions by cleaning the underlying energy mix, improving energy efficiency in buildings and transport, and inducing modal shifts in transportation.




* Water, waste, and industrial emissions are excluded from the CyPT results.





## II – Description of CyPT Technologies

### Building Levers

| | | |
|---|---|---|
| Residential/ Non-residential | **Wall Insulation** | Solid wall insulation e.g. made of expanded polystyrene (EPS) can be applied to already existing buildings. Applying the rigid foams to exterior side of walls raises thermal resistance. The insulation reduces the heat gain/loss through the walls and thus minimizes the heating/cooling energy needed. Reduction of CO2e, PM10, and NOx related due to energy savings. |
| Residential | **Efficient lighting technology** | Significant electrical energy can be saved by replacing conventional luminaires by more efficient lighting fixtures and/or changing magnetic ballasts to electronic ballasts. Further reductions in power consumption can be achieved with the use of light-emitting diodes (LEDs), which also have a far higher lifespan than conventional lighting. LED solutions combined with intelligent light management systems can lower lighting costs in a building by as much as 80%. Reduction of CO2e, PM10, and NOx related due to electricity savings. |
| Residential | **Home Automation** | Home Automation allows the automatic adjustment of heating, cooling, ventilation and lighting depending on the environmental conditions and the room occupancy by applying sensors and actuators as well as control units. This reduces the energy demand of heating, cooling, ventilation and lighting. |
| Non-Residential | **Efficient lighting technology** | Electricity can be saved by replacing conventional light bulbs for room lighting by more efficient light-emitting diodes (LEDs). LEDs consume up to 90% less energy and have a longer lasting in operation hours and turn off/on cycles. LED lamps are compatible to conventional lamps and can substitute them easily. LEDs provide an equal luminosity at lower specified power. Reduction of CO2e, PM10, and NOx related due to electricity savings. |
| Non-Residential | **Heat Recovery** | Heating and cooling losses can be reduced through heat and cold recovery technologies integrated within a building's maintenance system. The technology utilizes a counter flow heat exchanger between the inbound and outbound air flow. For example, cold inbound air flow can be pre-heated by room temperature outbound air flow. The result is that fresh, incoming air requires less heat or cooling and a steady room temperature is maintained and less electricity or heat is utilized. |

| | | |
|---|---|---|
| Non-Residential | BACS Class C | Building Automation and Control System (BACS) are building technologies that can be installed in existing or new buildings.<br>An Energy Class C building corresponds to a standard BACS, which includes: Networked building automation of primary plants, no electronic room automatic or thermostatic valves for radiators, no energy monitoring. Emission reduction is achieved from the electrical power utilized in the heating & cooling of buildings, water circulation, and emissions generated through the combustion process of fuel (renewable or fossil-based). |
| Non-Residential | Energy Efficient Motors and Drives | Analyzing the drive technology in your building (fans, pumps, compressors or process plant) can lead to significant cost- and energy-savings and help reduce emissions. As an example: changing a standard 30kW motor (IE1) to an equivalent energy efficient motor (IE3) can save 3,500 kWh per year, and 2,000kg of $CO_2$ emissions. Adding variable speed drive technology will ensure motors only draw as much energy as is actually required. Reduction of $CO_2e$, $PM_{10}$, NOx are related to electrical energy savings. |

## Transport Levers

| | | |
|---|---|---|
| Passenger | Electric buses | Share of the vehicle fleet operated by battery electric vehicles. Battery electric vehicles are "zero" exhaust gas emission vehicles. Significant reduction of local emissions $PM_{10}$, NOx. A charging infrastructure is set up. The electricity used for charging is generated according to the general local electricity mix. |
| Passenger | New line – Metro | Number new metro lines at target year of average metro length, shifting passengers from all other mode according to the transportation performance of existing lines in the city. Public transport attractiveness is increased and energy demand per person kilometer is reduced together with related emissions. |
| Passenger | Electric cars | Share of conventional combustion vehicles replaced by battery electric vehicles. Battery electric cars are "zero" exhaust gas emission vehicles. Significant reduction of local emissions $PM_{10}$, NOx. A charging infrastructure is set up. The electricity used for charging is generated according to the general local electricity mix. |
| Passenger | Hydrogen Car | Share of conventional combustion vehicles replaced by hydrogen vehicles at target year. Hydrogen vehicles with fuel cell technology are "zero" exhaust gas emission vehicles. Significant reduction of local emissions $PM_{10}$, NOx. The hydrogen is generated with fuel cell technology, using the local electricity mix. A refueling infrastructure is set up. |
| Passenger | E-ticketing | Share of public transport journeys paid via smart card and integrated ticketing across all public transport modes. Improved ease of public transport due to simple procedures, better information and faster boarding, which induces a modal shift to public transport.<br>Impact on emissions reduction: Modal shift to less emitting mode of transport. Impact depends on current modal share and electricity mix. |
| Passenger | Intermodal Traffic Management | Intermodal Traffic Management focuses on interoperable multimodal Real Time Traffic and Travel Information (RTTI) services provided to drivers/ travelers – promoting change in mobility behavior from individual to public transport reducing energy demand per person kilometer. |
| Freight | Low Emission Zone | The City area is restricted to vehicles of emission classes Euro 6 and higher.<br>Impact on emissions reduction: Only vehicles with a certain level of off-gas treatment are allowed to enter the city, reducing local $PM_{10}$ and NOx emissions, as well as marginally reducing fuel consumption due to more fuel efficient operation of combustion engines. |





| | | |
|---|---|---|
| Passenger | City tolling | This lever simulates the establishment of a tolling zone in the city. Charges are obtained at a level, where the target reduction in city-internal car and motorcycle use is reached.<br>Impact on emissions reduction: Modal shift to emitting lower emissions mode of transport. Impact depends on current modal share and electricity mix. |
| Passenger | Electric taxis | Share of conventional combustion vehicles replaced by battery electric vehicles. Battery electric cars are "zero" exhaust gas emission vehicles. Significant reduction of local emissions A fast charging infrastructure is set up The electricity used for charging is generated according to the general local electricity mix. |
| Passenger | Cycling highway | Additional cycle highway kilometers per 100,000 inhabitants at the target year. The lever increases the modal share of bicycles, reducing the modal share from motorized vehicles.<br>Impact on emissions reduction: Modal shift to zero emission mode of transport. Impact depends on current modal split, the acceptance of bicycles, as well as the existing cycling infrastructure. |
| Passenger | Bike sharing | Number of sharing bikes/1000 inhabitants offered at target year resulting in a shift from all transport mode equally and lower energy demand per person kilometer together with related emissions. |
| Passenger | Electric car sharing | Number of sharing cars/1000 inhabitants at target year: model of car rental where people rent e-cars for short periods of time, on a self-service basis. It is a complement to existing public transport systems by providing the first or last leg of a journey. Resulting in fewer driving emissions due to eCar and shift to non-vehicle travel, such as walking, cycling and public transport. |

# Appendices

i. CyPT analysis for Los Angeles: "Climate LA, Technology Pathways for LA to Achieve 80x50 in Buildings and Transportation", https://w3.siemens.com/topics/global/en/intelligent-infrastructure/cypt-reports/Pages/LA-technology-pathways.aspx

ii. The CyPT utilizes the 2012 GPC Protocol for Community-Wide Emissions as its methodology for estimating GHG emissions. It covers Scopes 1, 2, and 3 emissions for energy generation and energy use in buildings and transportation. Essentially, this means that the CyPT takes into consideration both direct emissions occurring within the City boundaries (such as from exhaust fumes) and indirect emissions from the conversion of chemical energy to power, heat or steam of purchased energy from outside the city. The included Scope 3 emissions refer to the emissions produced as a result of fuel production and extraction. This also includes the construction and production of renewable power plants.

iii. Water, Waste and industrial emissions are excluded from the CyPT results.



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