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Orlando's Green Future

Technology Pathways for Building a Sustainable Future

Siemens Center of Urban Development

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About the Report

About Siemens

The innovations made possible through digital technology enable cities to magnify their true essence and boost their competitive strengths in ways they've never done before. Developing and maintaining livable, high-quality, financially sound cities, however, is a major test of our city leadership, taking great planning and effort. As cities are often limited in resources, they must engage the private sector to meet the infrastructure and planning needs to ensure equity, environmental sustainability, and economic prosperity.

Siemens established the Center for Urban Development, comprised of a dedicated team, to address specifically the needs of city leaders, their staff, and administrative agencies. The Center also seeks to serve as a transparent and useful entry point for city decision makers to enter a structured dialogue in which they can make base-line assessments of needs. Our team members understand city goals and processes and put this understanding front and center in their work. This team can work across the Siemens business divisions, and pull expertise from all over the company, even from Siemens units in other countries.

Learn more at usa.siemens.com/cities

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Color and visual guidelines

We have used colors and visual cues in powerful ways to enhance the meaning and clarity of data visualization throughout this report. Please refer to the following as you are browsing:

CO_2eq

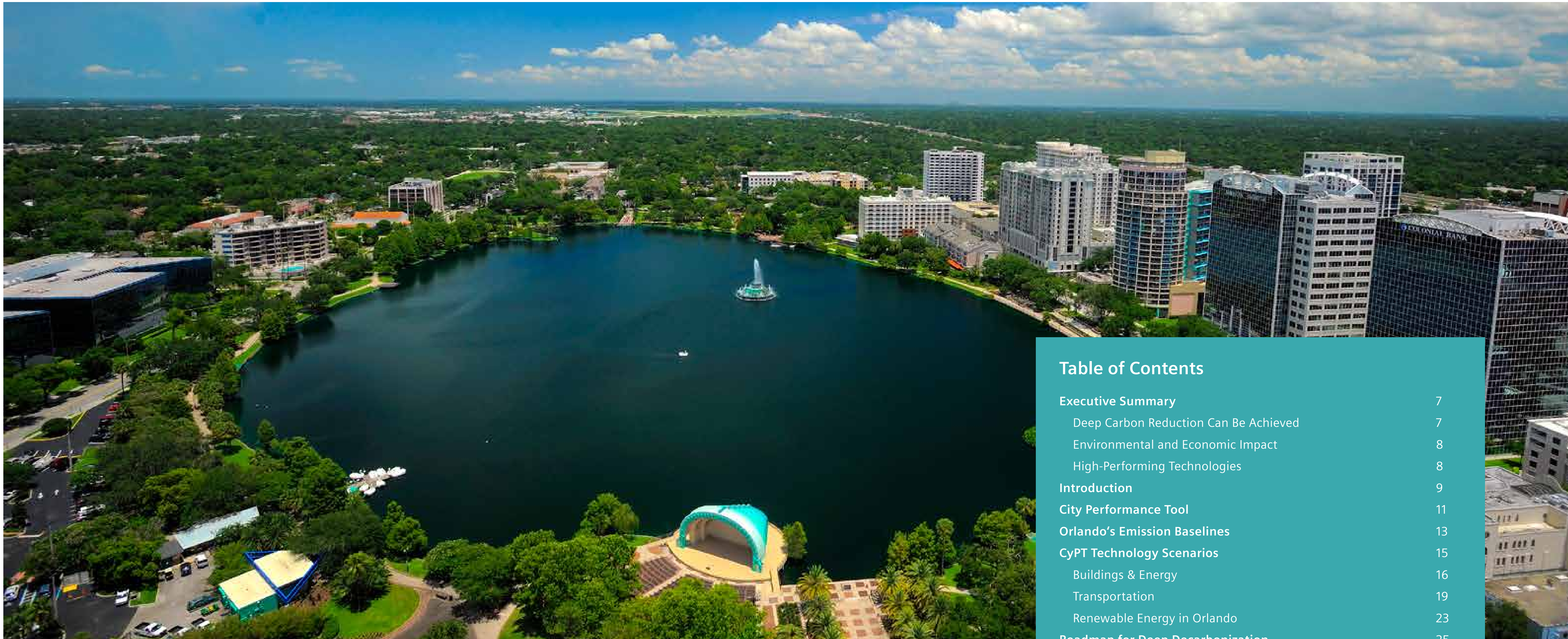
Transport

Buildings

Energy

Siemens would like to thank:

The City of Orlando, Office of Sustainability & Resilience for their support and guidance during the development of this report. Special thanks to Chris Castro (Director of Sustainability) and Brittany Sellers (Sustainability Project Manager).



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Executive Summary

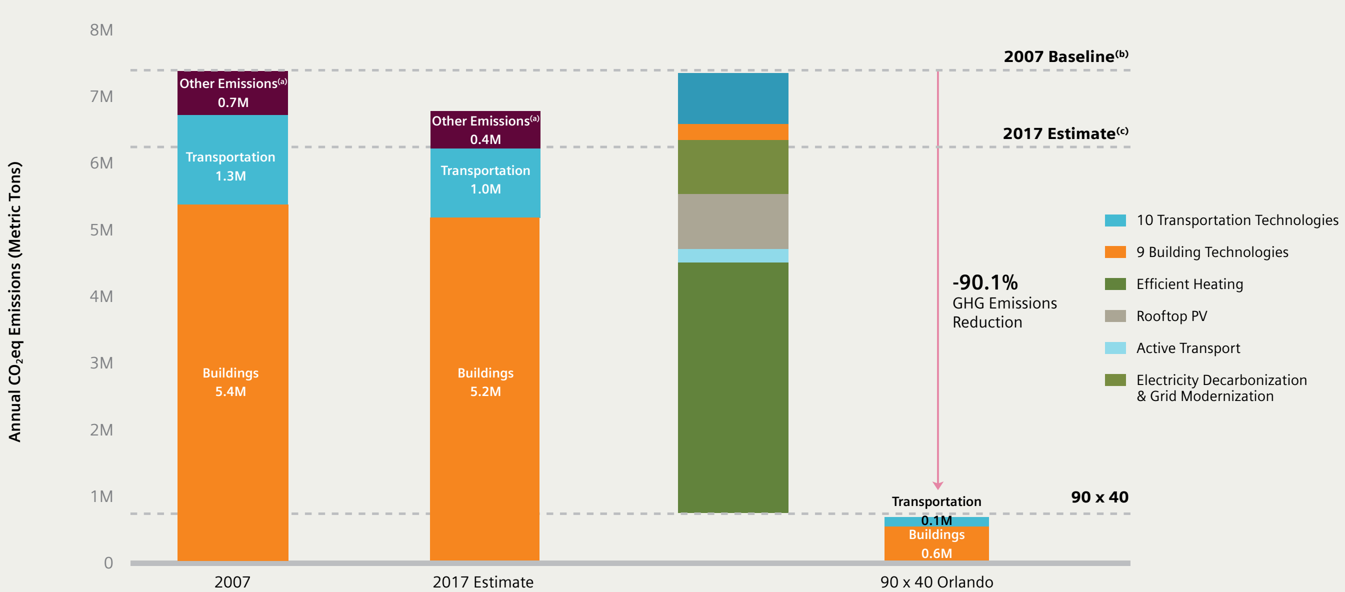
Based on a year-long collaboration between Siemens and Orlando's Office of Sustainability & Resilience, this report analyzes technology pathways to achieving the ambitious target laid out in Orlando's 2018 community action plan[1]. Using Siemens City Performance Tool (CyPT), the analysis shows that 90.1% greenhouse (GHG) emissions reduction by 2040, as compared to 2007 baseline, is achievable. The pathway to success will require aggressive policy and infrastructure implementation, including a commitment to 100% renewable electricity, transition to 31% travel by public and active transit, and 25 infrastructure technologies targeting transportation, building and energy sectors. These infrastructure technologies will electrify heating in buildings, improve building energy efficiency (e.g., through technologies like building performance optimization, building automation), and improve public and private transit (e.g., electric cars and taxis, electric buses). The analysis also quantifies economic and environmental co-benefits of implementing these technologies – creating over 103,000 local jobs and improving air quality – providing an evidence base for the City to use in prioritizing its investments.

The results and recommendations from this study will serve to inform further updates of the City's Community Action Plan. It is also a starting point for prioritizing technology and infrastructure investments and providing objective validation for many of the proposed policy recommendations outlined in the 2018 Community Action Plan Update[1].

(a) Other emissions include GHG emission from solid waste, wastewater (including electricity usage for waste and wastewater operations), industry, fugitive emissions and any other sectors not in scope of CyPT analysis. For Orlando, these emissions are obtained from the City Inventory Reporting and Information System (CIRIS) tool v2.1 2016.
(b) 2007 baseline emissions are obtained from the City Inventory Reporting and Information System (CIRIS) tool v2.1 2016
(c) 2017 Estimates for Buildings and Transportation sector are calculated from CyPT analysis by collecting over 350 data points from the City.

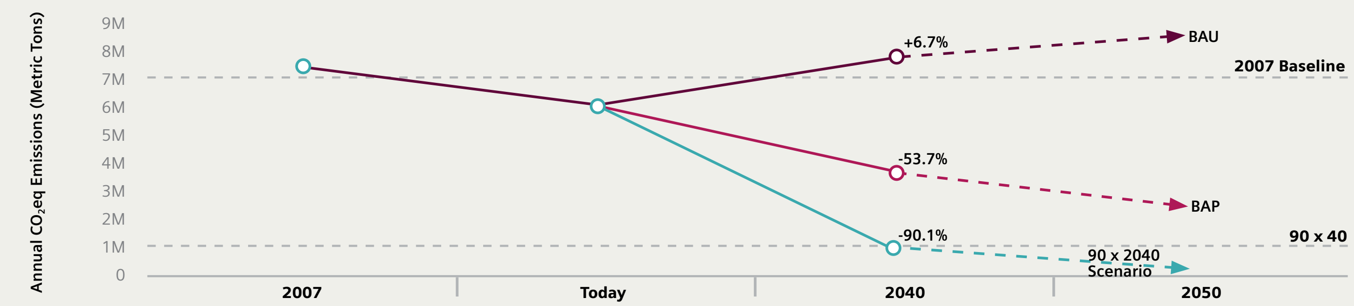
Deep Carbon Reduction Can Be Achieved

The deep carbon reduction chart highlights the baseline GHG emissions for 2007 and today from energy use in buildings and transportation. It also shows the contribution of policy and infrastructure technologies measures that will reduce Orlando's GHG emissions by 90.1% by 2040 from 2007 levels. Based on our analysis, electricity decarbonization (100% renewables if both light green and gray bars are considered) is the most impactful strategy for GHG reduction – providing 2/3rd of reductions. By itself this is not sufficient to reach the ambitious 90x40 targets set by the city, and investments in Orlando's buildings and mobility infrastructure would be needed for meeting these goals.



Environmental and Economic Impact

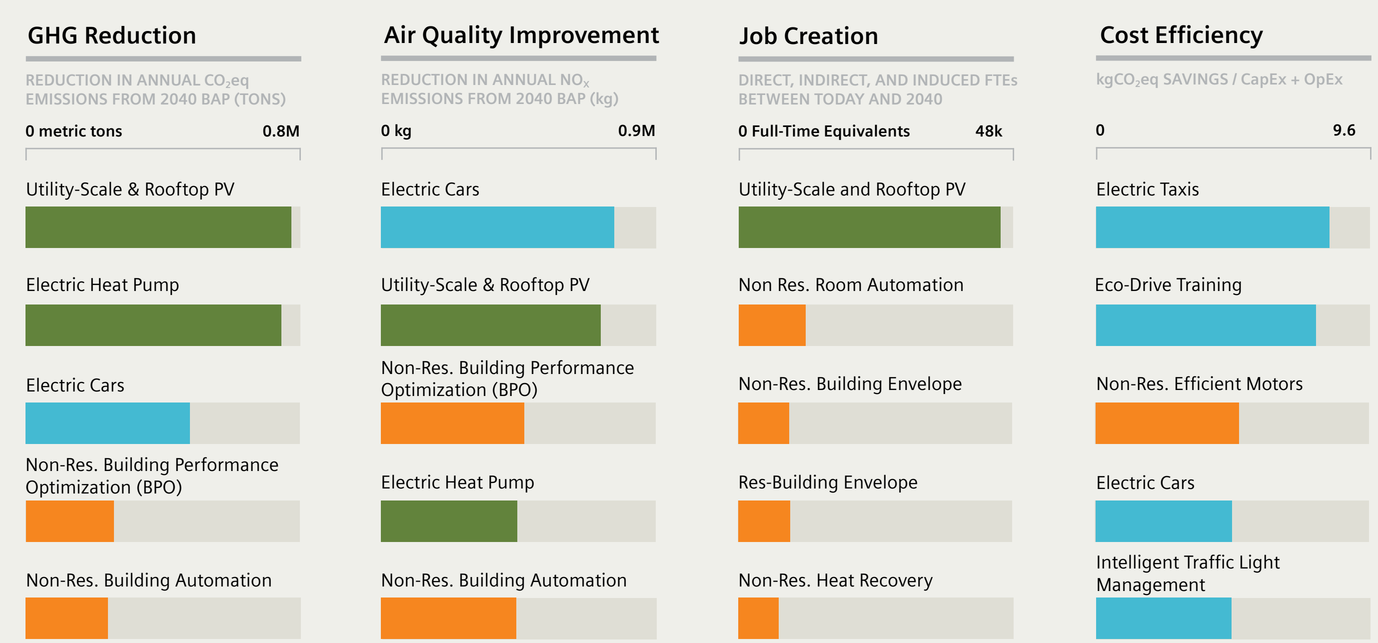
This chart presents three carbon reduction pathways when compared to 2007 baseline – 1) a status quo or business as usual (BAU) scenario (in dark pink) increases GHG emissions by 6.7% by 2040; 2)business as planned (BAP) scenario (in light pink), implementing 80% renewable grid coupled with reduction in single-occupancy car usage reduces GHG emissions by 53.7%, and finally 3) 90 x 2040 scenario under which 25 infrastructure technologies have been modeled. The final scenario is the only one that would produce enough GHG emissions reductions to reach Orlando's target by 2040 and has the potential to achieve carbon neutrality by 2050. This scenario will generate 103,000 local full-time equivalent positions between today and 2040 and cost roughly $19 billion in capital and operating expenditures.



GHG Emissions Reduction	Investments	Jobs Generated
90.1%	**$19B**	**103k**
By 2040 as compared to 2007 Baseline	Capital and Operating Expenditures between Today and 2040	Full-Time Equivalents between Today and 2040

High-Performing Technologies

The technologies that produce highest GHG reduction are air-sourced electric heat pumps, rooftop PV, electric cars and two building automation technologies. Converting 82% of cities' building to use electric heat pumps from natural gas-based heating could produce highest GHG savings but adding more solar (18% from rooftop panels and 9% from utility-scale plants) has benefits beyond GHG reduction. Rooftop PV would also improve air quality by reducing NOx emissions and create over 47,000 local jobs.



Introduction

Through Mayor Buddy Dyer's leadership, Orlando is committed to become one of the most environmentally friendly, economically and socially vibrant communities in the nation. In 2007, a citywide sustainability initiative called Green Works Orlando that unites stakeholders across the city was established to realize this goal. Through Green Works Orlando, the City leadership has been advancing Orlando's position as a leader in sustainability by delivering equally through two important lenses: progress and potential.

Since establishing Green Works Orlando initiative in 2007, the City has achieved measurable progress in sustainability. The City's Community Action Plan recognizes that in order to create a sustainable and healthy economy for the City, focus needs to be on opportunities across seven areas: clean energy, green buildings, local food systems, livability, solid waste, transportation, and water. To this end, the City has built collaboration networks of stakeholders through community engagement as well as task forces of individuals from government, the non-profit community, academia, residents, and industry with the shared vision of making Orlando a more sustainable city.

Orlando is actively working towards greening their buildings and reducing energy usage. In 2016, the City became the first Florida city to pass a Building Energy and Water Efficiency Strategy (BEWES) Ordinance requiring commercial and multifamily buildings larger than 50,000 square feet to track energy use and report results. The City has also saved over $1.6 million in annual utility spending by approving Green Bond Energy-Efficiency Project that will retrofit 55 city buildings. As a result of these efforts, today municipal buildings in Orlando use 50% less energy today as compared to 2012 and the City now has 232 certified green buildings. The energy usage awareness has impacts beyond city buildings, and homes in Orlando now consume 5% less energy as compared to 2012.

With the goal of broad-based economic development, Orlando is also focusing on creating an efficient and complete transportation system. In addition to adopting a complete streets policy, the City is also expanding public transit infrastructure by adding over 250 miles of bike lanes and introducing 600 bike-sharing bikes. As part of an alternative fuel strategy, the City has added 2,100 electric vehicles in the municipal fleet since 2012.

In 2017, under the leadership of Mayor Buddy Dyer, Orlando joined over 200 US mayors to pledge support for a community-wide transition to 100% renewable energy. Working towards this goal, the City has already taken action, ensuring 10% of municipal electricity demand is powered by solar energy.

It is no surprise that this progress has won Orlando local and national recognition. According to American Council for an Energy-Efficient Economy (ACEEE), Orlando was one of the most improved cities in the United States for energy efficiency in 2017 moving up 10 points from 2015. ACEEE's City Energy Efficiency Scorecard ranked Orlando number 20 out of 51 American cities[2].

In 2018, the City published an update to the 2013 Community Action Plan, highlighting the progress made in the last 5 years and taking the opportunity to evaluate and update goals and strategy. The report recognizes that although great things are already happening to make Orlando more sustainable every day, goals outlined in the plan are ambitious and would require efforts beyond government action alone. The City is making great strides in engaging the community and seeking help from all stakeholders, institutions, businesses, non-profits, and neighboring governments to plan for the future.

To support these efforts, Siemens collaborated with the Mayor's Office of Sustainability & Resilience to produce this report. This analysis uses City Performance Tool (CyPT) to assess infrastructure technology pathways for achieving deep carbon reductions that would enable Orlando to successfully achieve its 90 x 2040 goal outlined in the 2018 Community Action Plan. During our joint analysis, with support from the Sustainability Director and his staff, Siemens collected data from the City's transportation, building, and energy sector, to build an emission baseline for 2016 and 2040. As part of the CyPT process, Siemens also co-hosted a technology workshop with the Office of Sustainability & Resilience in which stakeholders from eight different agencies[d], including multiple departments within the City, identified policy and technology scenarios under which Orlando could reach its 90 x 2040 target.

The future impacts of the recommended policies and technologies are the subject of the rest of this report, which quantifies the performance of these recommendations against five key performance indicators: GHG emissions, nitrogen oxides (NOx), particulate matter (PM10), gross full-time equivalents (FTE), and capital and operating expenses.

(d) List of agencies and participants can be found in Appendix I

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 Orlando 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%. 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[3], showed that LA'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 Los Angeles' 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 have 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, 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% 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 and transport:** 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 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[e,4].

CyPT results are helping cities across the globe assess their environmental and economic development opportunities and drive their sustainability agendas.

(e) An FTE is a person-year of work, calculated as 2,080 hours of work in the US.

How the CyPT Model Works

STEP 1

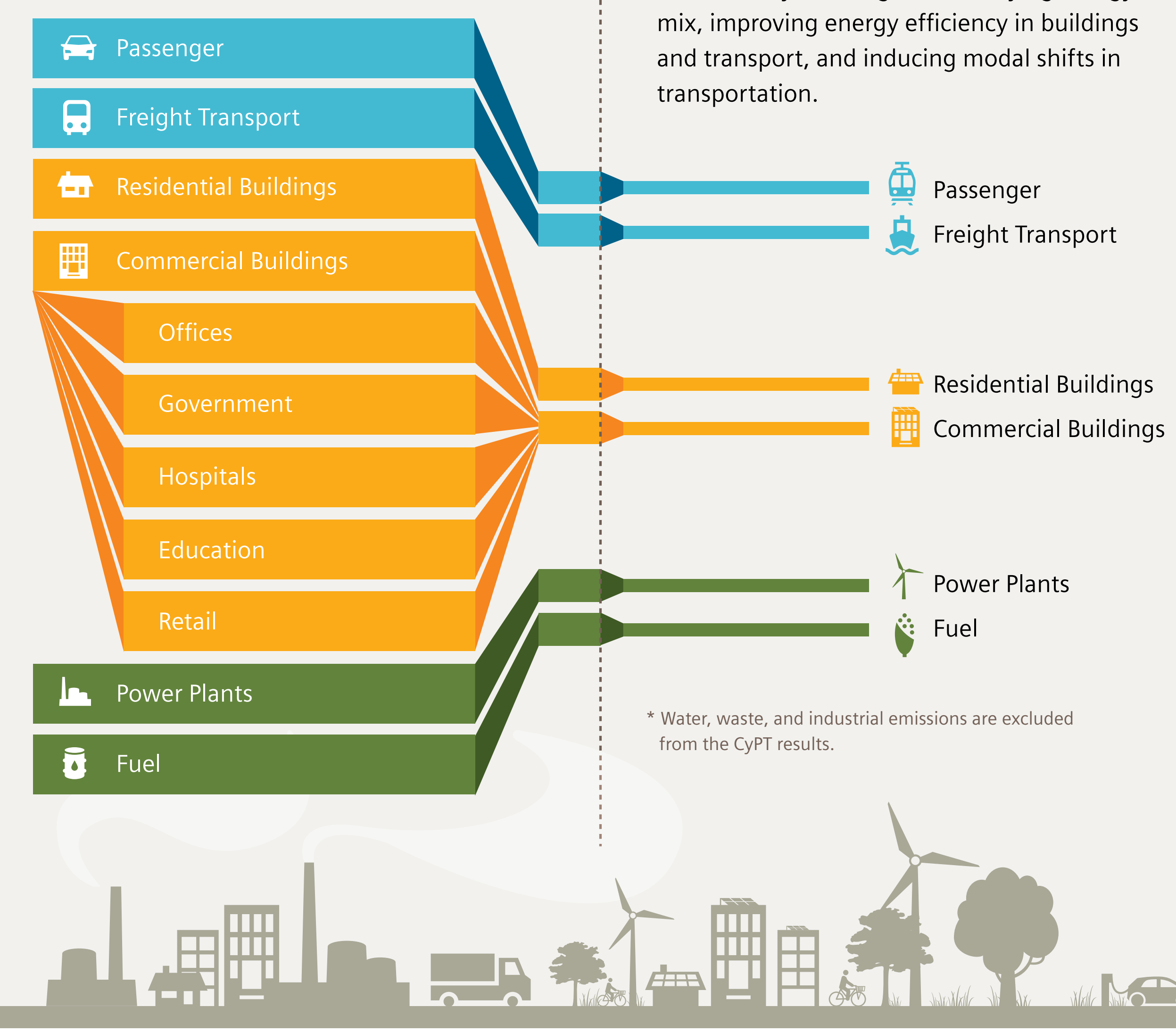
Energy Mix Analysis

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.

Orlando's Emission Baselines

Customizing the CyPT model to accurately evaluate future sustainability pathways requires a deep understanding of the City's current footprint. Drawing on publicly accessible data on how energy is generated and used in the City and how residents move around the City, work, and live, helps in understanding the sources of emissions and building an emission baseline. Next step in our analysis is to create a future scenario which builds on series of assumptions about how Orlando might grow and change between today and 2040. For this future scenario, we reviewed studies and policies which will shape the electricity grid, buildings, and transportation in the City. A few key documents that were instrumental in our analysis include the 2013 and 2018 Community Action Plans[1], Growth Projection Report[5], Central Florida Regional Freight Mobility Study[6], and Orlando Utility Commission's 2016 Ten-Year Site Plan[7]. In addition, we also worked closely with the City's Office of Sustainability & Resilience to convene a CyPT Orlando Cleantech workshop[f]. During the workshop, which was attended by over 40 participants from eight different agencies across the city, we gathered feedback and insight on prioritizing technologies for deep decarbonization in Orlando.

Based on these sources and feedback from stakeholders, our future scenario for this analysis assumes a 32% increase in Orlando's population between today and 2040, a transition to 80% of electricity generated from renewables in 2040[g], as well as a 20% increase in passenger miles traveled by public and active transit. This Business-as-Planned (BAP) scenario projects a 53% drop in GHG emissions by 2040 – falling short of the 90% reduction target set by the City and confirming that more efforts are needed to be taken by the City as well as its residents and businesses to reach these goals.

(f) List of attendees of the CyPT Orlando Cleantech Workshop held on July 2, 2018 can be found in Appendix I.
(g) Aligning with City's commitment to 100% renewable electricity by 2050, we assume a linear trend to approximately 80% renewables by 2040.

Orlando Today to 2040

Orlando has already reduced its per capita GHG emissions from 32 metric tons CO2eq per person in 2007 to 26 metric tons CO2eq per person in 2016. But to achieve its ambitious goal of 90x2040, the City in collaboration with its stakeholders needs to take bold steps to decarbonize the electric grid and ensure majority of trips by public and active transit. Our analysis draws on information from Orlando's existing plans to build emission baseline for today and 2040.

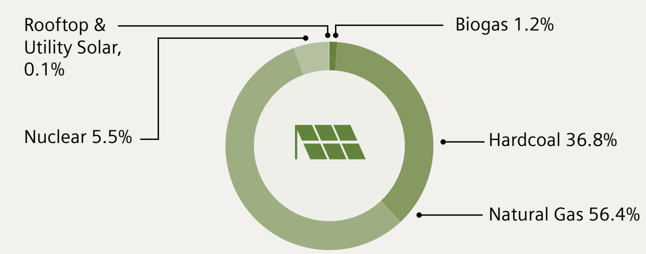
Today

POPULATION

277,173

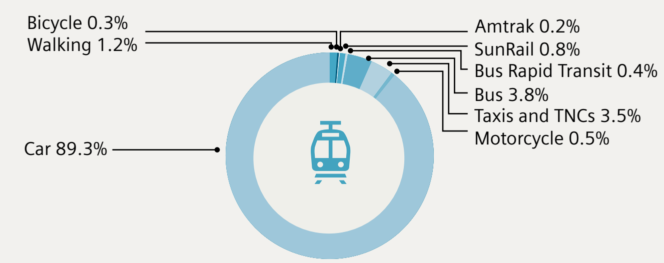
ELECTRICITY MIX

1.3% Renewable



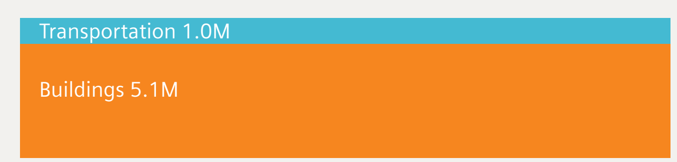
PASSENGER MODE SHARE§

10% Transit and Active Transport



CYPT-ESTIMATED ANNUAL GHG EMISSIONS*

6.2M Metric Tons



Today

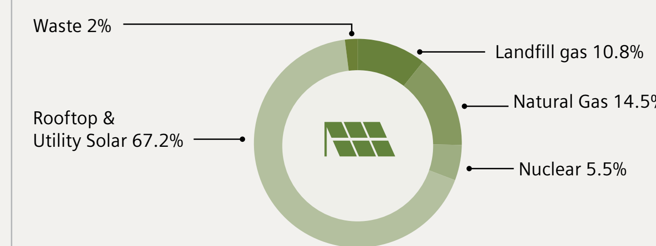
2040 (Business-as-Planned)

POPULATION

366,342

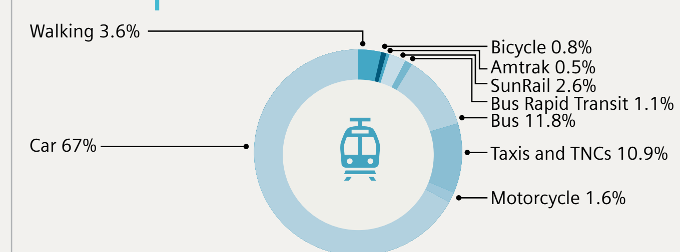
ELECTRICITY MIX

80% Renewable



PASSENGER MODE SHARE§

31% Transit and Active Transport§



CYPT-ESTIMATED ANNUAL GHG EMISSIONS*

3.5M Metric Tons

2040 Business-as-Planned

ESTIMATED %REDUCTIONS IN GHG EMISSIONS**	-53.2%
TARGET % REDUCTIONS IN GHG EMISSIONS**	-90%

§ Projections for BAP scenario assume 25% reduction in car VMT and distributing the difference amongst other active and public transit modes based on today's weightage. Assumed a 25% reduction in single-occupancy car travel, which is in line with City's 2040 Community Action Plan goal of ensuring majority of trips in 2040 are made by foot, bike, carpooling or transit.

* 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.

** As compared to 2007 levels.

CyPT Technology Scenarios

Buildings & Energy

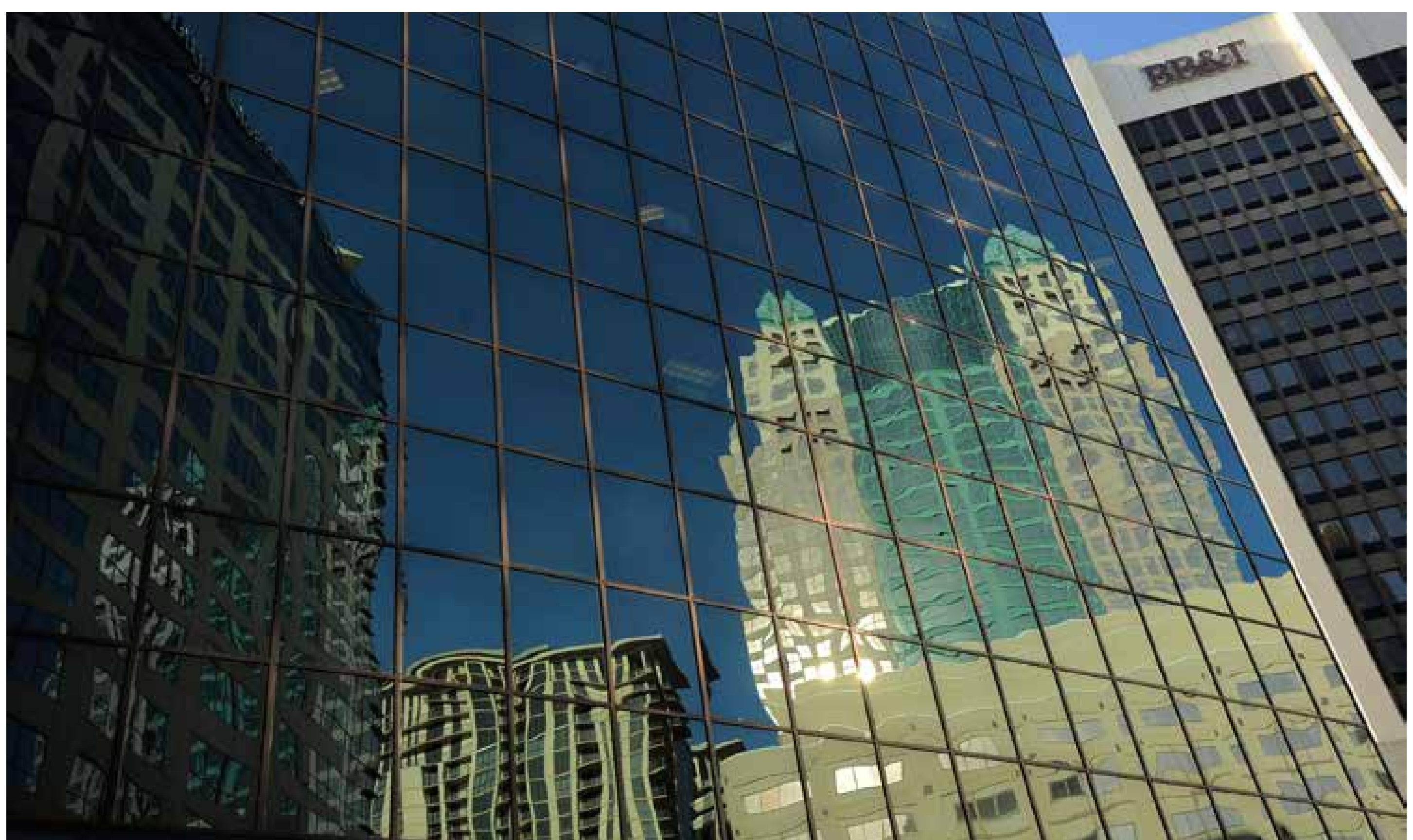
CyPT model analyzes the impact of nine building and building energy technologies that can improve energy efficiency of homes, offices, and other businesses in Orlando. Together, these nine technologies, when implemented on top of renewable grid and thermal electrification, can reduce the overall GHG emissions by 78% as compared to 2007 baseline.

Even though Orlando's year-round hot and humid climate is great for low heating costs for homes and businesses, the cooling energy usage more than makes up for it. The average energy use intensity (EUI) for homes in Orlando is 49.5 kBTU/sqft which is 4% higher than the national average for urban areas[8]. 28% of the energy used is for cooling the homes, resulting in higher than average EUI.

Non-residential buildings on the other hand have significantly larger energy footprint in the City. Average EUI of 88 kBTU/ft^2 calculated for all types of building categories around the City including offices, education, healthcare, retail, hospitality, and government is higher than both the national average[9] of 82 kBTU/ft^2 and the average for hot-humid climates of 78.9 kBTU/ft^2.

Buildings in Orlando contribute to over 84% of total GHG emissions, only 25% of which corresponds to residential buildings. This analysis shows that nine technologies targeting building energy usage and six technologies targeting the electricity and heating generation and transmission/distribution network are responsible for 231,000 metric tons of GHG emission reductions as compared to 2040 BAP scenario.

The analysis reveals that air-sourced electric heat pumps, rooftop photovoltaic (PV), and building performance optimization for non-residentials buildings are the top three measures for reducing GHG emissions. Electric heat pump is also top measure for improving air quality by reducing PM10 and NOx emissions. Transition to 80% of building heating across residential and non-residential sector from air-sourced electric heater could be a daunting task that would need intervention from policies set by local or state government. But, combined with considerably cleaner electricity, it could provide over 790,000 metric tons of GHG emission savings as compared to 2040 BAP scenario. These emission savings can be attributed to fuel switching from natural gas to electricity for space and water heating.



Buildings Data

Even though it appears as though seemingly endless network of lakes cover Orlando when viewed from air, the City has a vast footprint of built space covering the City's landscape split almost equally between homes and non-residential buildings. In CyPT analysis, we exclude airport and industrial areas but focus on energy and emission impact of Orlando's over 127,000 single and multifamily homes and over 150-million-square-footage of offices, retail space, municipal buildings, and other businesses.

Residential Data

Average Residential Unit Size

1,518 ft^2

Total Electricity Consumption

2,021 GWh

Average Energy Use Intensity

49.5 kBTU/ft^2

Non-Residential Data

Total Building Footprint

151M ft^2

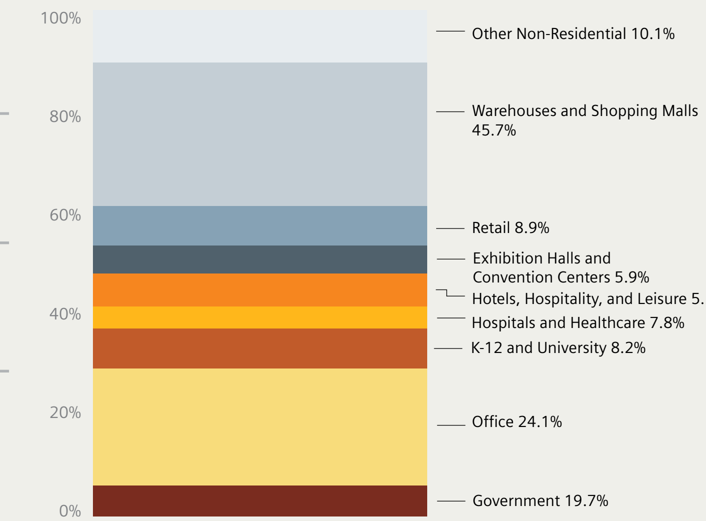
Total Electricity Consumption

3,908 GWh

Average Energy Use Intensity

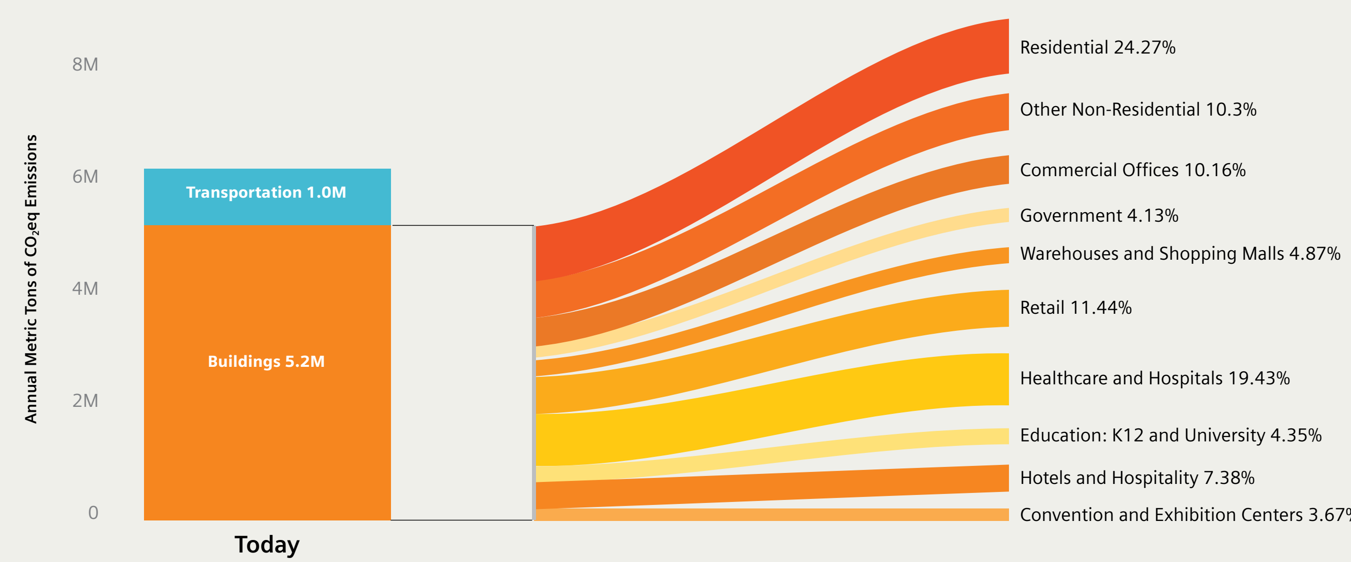
88 kBTU/ft^2

Breakdown of Square Footage of Commercial Buildings



GHG Emissions – Buildings and Energy

Buildings in Orlando contribute to over 84% of total GHG emissions, only 25% of which corresponds to residential buildings. Business-as-Planned scenario modeled for this analysis can reduce this contribution to 74% simply by inclusion of 80% renewable fuels in electricity generation.



Rooftop solar is the top technology when it comes to job creation, although manufacturing and installation of rooftop PV panels comes with an environmental and economic cost. Counting Scope 3 emissions[h] that are included in the CyPT model means counting the emissions produced during construction and transportation of photovoltaic panels, resulting in an increase in PM10 emissions by 28 thousand kg as compared to 2040 BAP scenario.

Building Performance Optimization or BPO refers to implementation of building control strategies to increase the energy efficiency of a building. Through energy monitoring, this service allows experts to measure a building's performance and compare it against benchmark values for similar building types or sizes. This information can be used to improve energy efficiency by adapting the existing control strategies to better suit usage profiles or by providing relevant information and analytics to building operation personnel.

Through energy monitoring, Building Performance Optimization allows experts to measure a building's performance and compare it against benchmark values.

(h) Although while creating baseline GHG inventory CyPT utilizes the 2012 GPC Protocol for Community-Wide Emissions methodology, there are a few key differences, especially when it comes to Scope 3 emissions. For most cities scope 3 means only T&D losses, for CyPT it means indirect emissions including T&D losses as well as upstream emissions from production of fuel (both feedstock and fuel stages). This also includes the construction and production of renewable power plants e.g. rooftop PV.26

CyPT Lever Impact Results – Buildings and Energy

Incorporating electricity produced by solar photovoltaics (both utility-scale and rooftop) and electrifying heating in buildings would provide the highest CO_2 reductions in Orlando. Installation of rooftop PV would also create most jobs (over 47,000) but isn't the most cost efficient (does not provide largest CO_2 reductions per investment dollar spent). Most cost-effective technology would be installing efficient motors for building operations in all commercial and municipal buildings in the City.

Residential + Non-Residential Buildings

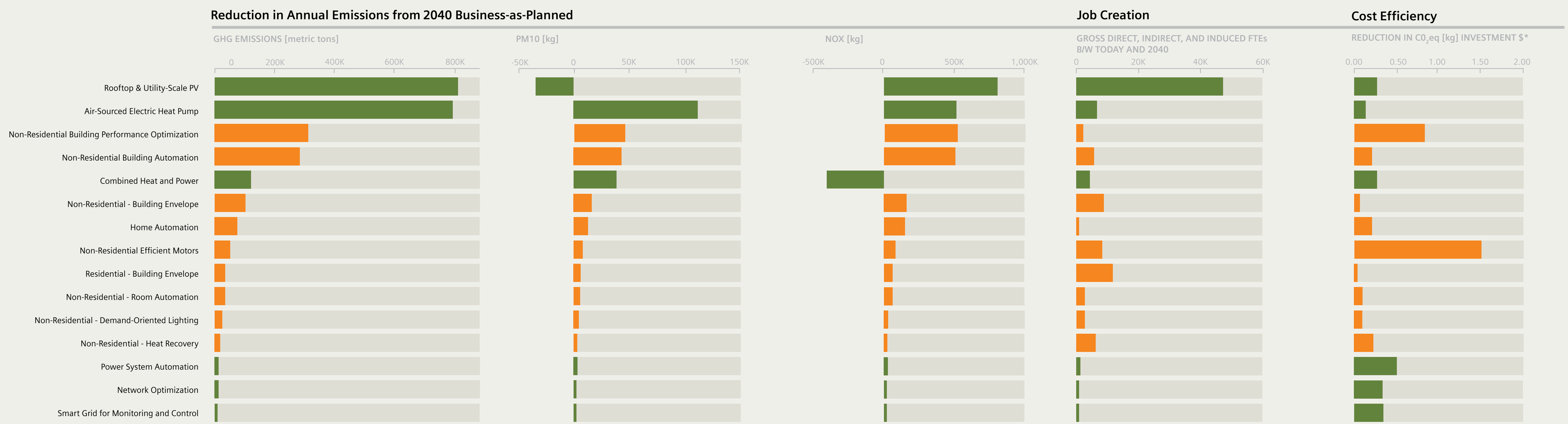
LEVER	UNIT	Adoption Today	Adoption 2040
Building Envelope (Residential)	% of building stock w/lever	40%	100%
Home Automation (Residential)	% of building stock w/lever	5%	100%
Building Envelope (NR)	% of building stock w/lever	50%	100%
Demand-Oriented Lighting (NR)	% of building stock w/lever	30%	100%
Room Automation – Lighting + HVAC (NR)	% of building stock w/lever	5%	100%
Building Automation (NR)	% of building stock w/lever	22%	100%
Efficient Motors	% of building stock w/lever	10%	100%
Heat Recovery	% of building stock w/lever	20%	100%
Building Performance Optimization (BPO)	% of building stock w/lever	5%	100%

Energy

LEVER	UNIT	Adoption Today	Adoption 2040
Rooftop & Utility Scale PV	% of total electricity generation	0.1%	27%
Combined Heat & Power	% of total heating demand	0%	18%
Electric Heat Pumps	% of total heating demand	2.9%	82%
Network Optimization	% of electric grid optimized	0%	100%
Smart Grid for Monitoring & Control	% of electric grid replaced with smart grid	0%	100%

Results – Buildings and Energy

Electrifying heating in buildings and installation of rooftop PV panels would provide the highest CO_2 reductions in Orlando. Installation of rooftop PV would also create most jobs (over 47,000) but isn't the most cost efficient (does not provide largest CO_2 reductions per investment dollar spent).



*Investment dollars refer to Capital and Operating costs required for implementing technology measures.

Transportation

Orlando's population is expected to grow by 32% by 2040 with approximately 90,000 more people set to call the City home. In addition to the residents, Orlando is one of the biggest tourist destinations not only in the US but in the world and handles over 245 tourists per resident every year. Supporting this influx of people will require a resilient, reliable, and sustainable transportation network. The City is already taking concrete steps, and between 2012 and 2018 has increased the number of miles of dedicated bike lanes, installed over 300 EV charging stations, added 78 more EVs to the City fleet, bringing the total percentage of alternative fuel vehicles in the City fleet to 13%. All new transportation strategies highlighted in 2018 Community Action Plan focus on prioritizing public and active transit and are critical to addressing the 7% fall in transit ridership between 2012 and 2018.

Currently, Orlandoans travel an average of 34 miles per person per day, over 89% of these person miles traveled come from single-occupancy vehicles. Freight also represents a significant source of emissions in the City. In 2016, over 1 million vehicle miles were traveled by trucks within the City boundary, which translates to eight ton-miles per person per day.

Today, public, private, and freight transportation combined contribute only 16% to the total emission footprint in Orlando. Our recent analysis[10] summarizing 11 deep decarbonization analysis CyPT reports in North America has shown that transportation sector contributes to roughly 30% of a city's emission baseline. In Orlando, the reduced value is not due to cleaner and more efficient transportation but due to the fact that buildings in the City have a very large energy footprint. Interesting to note is that public transit contributes only 0.5% of these emissions, the rest of the emissions are from single-occupancy vehicles and freight. According to a Central Florida Regional Freight Mobility Study[6], most of the major highways through Orlando and Orange County could see over 10,000 trucks per day in 2040, resulting in a 32% increase in ton-miles traveled through the City.

Public, Private, and Freight Transportation in Orlando

Orlandoans travel an average of 34 miles per person per day, over 89% of these person miles traveled come from single-occupancy vehicles. At 1.3 cars per household, Orlando lags the National number by 33%.

Passenger Transportation

Average Miles Traveled, Per Person, Per Day

34 miles / person / day

No. of Cars on the Road (Cars Per Household)

171,517 (1.3)

Average Fuel Economy

23.9 MPG

Freight Transportation

Freight Mode Share

Truck 96%

Freight Rail 4%

Annual Freight – Ton-Miles (Vehicle Miles Traveled)

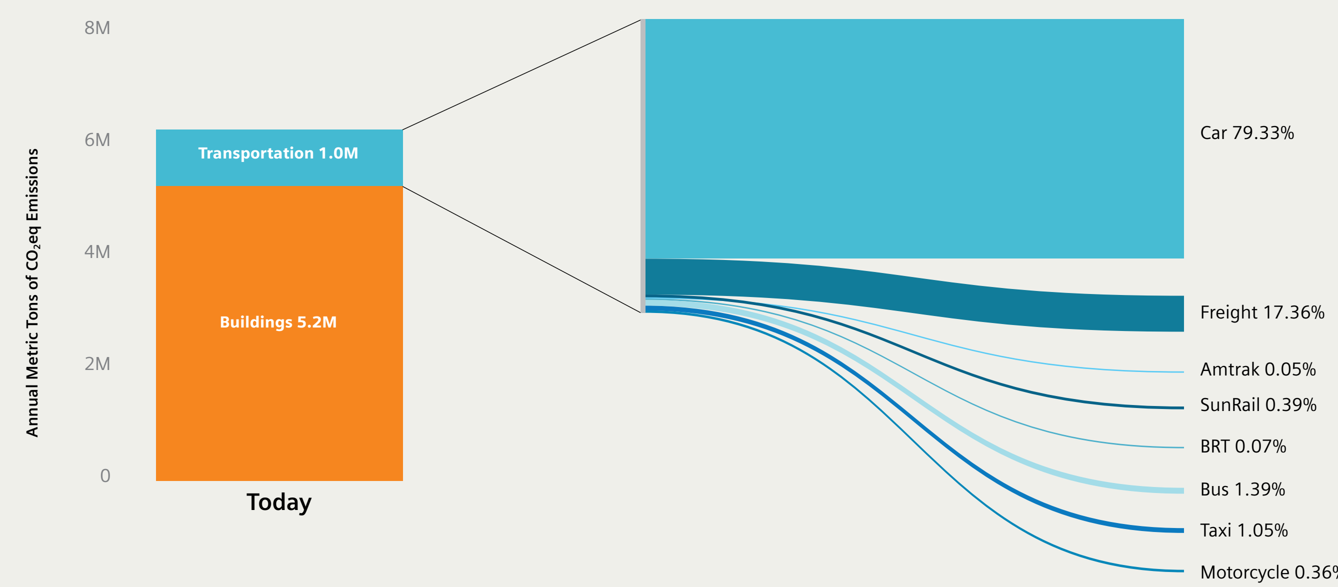
8 ton-miles / person / day
(1,065 Million VMT)

Average Feul Economy

8 miles per gallon

GHG Emissions – Transportation

In Orlando, public, private, and freight transportation combined contribute only 16% to the total emission footprint, the majority of these are from single-occupancy cars.



This analysis evaluated 10 infrastructure technologies that would reduce the impacts from public, private, and freight transportation in Orlando. The adoption rates, although aggressive, would be required in order to reach the City's ambitious GHG reduction targets. Electrification of all private cars on the road by 2040 is no small feat and would require serious commitment not only from the City and its citizens but also from the utility provider, which will have to plan for roughly 670,000 MWh of additional electricity to support this transition. In addition to electrifying private cars, this analysis also evaluates impacts of electrifying public bus fleet and adding four new electric bus rapid transit (BRT) lines on the streets of Orlando. Through these investments in public infrastructure, the City can be closer to its goal to ensure majority of the trips in 2040 are not by single-occupancy vehicles.

Electrification of transport also needs to be accompanied by significant investments in charging infrastructure for personal and transit vehicles. Our analysis shows that to support fleet electrification in Orlando, roughly 51,000 EV chargers for cars and taxis and 400 EV chargers for buses will be needed between now and 2040, which translates to installing about 47 chargers every week. In addition to electrifying transport, we also model levers that would increase the utilization of current modes, for example, expanding current electric car sharing program in the City from 15 vehicles to 1000 by 2040. Recent research[11] has shown that each shared car has the potential to replace 5 to 15 cars from the road, in Orlando this could mean reducing the number of cars on the road by 10%.

Freight transportation within the city limits produces 172,000 metric tons of CO_2e emissions. One technology analyzed in this report that tackles these emissions is the eHighway lever. This lever simulates the impact of electrifying 75% of the freight corridors, which would include installation of overhead catenary lines along corridors to allow hybrid electric or fully electric trucks to charge as they are driving, enabling long-haul transport and reducing local CO_2 and NOX emissions to close to zero.

The top performing technology in terms of emission reduction as well as job creation is the 100% electrification of the private fleet. This transition could reduce roughly 500,000 metric tons of CO_2e and could create 4,700 local jobs for installing and maintaining charging stations throughout the City. Public transit technologies such as electrification of bus fleet and new eBRT lines perform significantly worse in terms of emission reduction impacts and the result is lower usage and availability of these modes.

CyPT Levers – Transportation

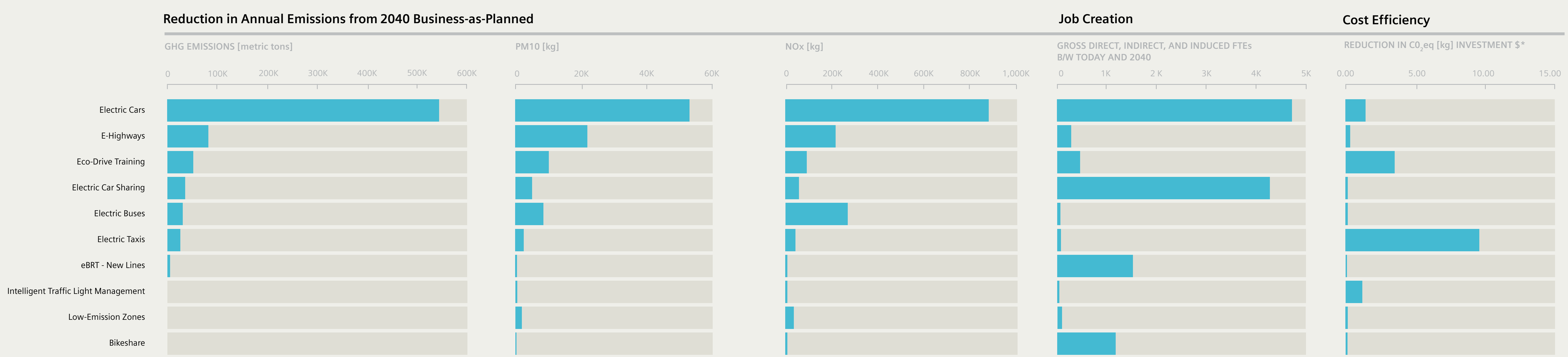
Public Transit		Adoption Today	Adoption 2040
LEVER	UNIT		
eBuses	% of public bus fleet	0%	100%
eBRT – New Lines	Total no. of lines	0	4

Private Transportation		Adoption Today	Adoption 2040
LEVER	UNIT		
Electric Cars	% of cars on the road	0.1%	100%
Electric Taxis	% of taxis on the road	0%	100%
Electric Car Sharing	No. of car sharing cars	15	1,000
Bikeshare	Total no. of sharing bikes	200	1,000
Eco Driving Training	% of drivers undergoing traning	0%	100%

Infrastructure		Adoption Today	Adoption 2040
LEVER	UNIT		
Intelligent Traffic Light Management	% of traffic lights w/coordinated fixed time, rule-based, or adaptive control	95%	100%
eHighway	% of freight corridors electrified	0%	75%
Low-Emission Zone	Minimum EURO class standard for entry	N/A	Euro VI

CyPT Lever Impact Results – Transportation

The top performing technology in terms of emission reduction as well as job creation is the 100% electrification of the private fleet. Electrification of private cars would also improve air quality by reducing PM10 and NOx concentrations in the air. Programs that provide advice on better driving techniques can minimize fuel consumption but do not require a lot of investments.



*Investment dollars refer to Capital and Operating costs required for implementing technology measures.

Renewable Energy in Orlando

Our recent report synthesizing 11 CyPT studies in North America[10] found that over 50% of the modeled emission reduction can be attributed to a greener grid that produces the majority of electricity from renewable fuels such as solar (both utility-scale and rooftop PV) and wind power. Our analysis supports studies[12] that highlight decarbonization of power as one of the three key steps to a zero-carbon city. The other two measures – optimizing efficiency and electrifying everything – both rely on a cleaner power. So, it's no surprise that in 2017, under the leadership of Mayor Buddy Dyer, Orlando joined over 200 US mayors to pledge support for a community-wide transition to 100% renewable energy[13].

Cities across the world are committing to renewable energy as the major source of electricity. According to CDP[14], as of January 2018, over 100 cities get at least 70% of their electricity from renewable sources including hydro, geothermal, solar, and wind. Nine of these cities are in North America, including Burlington, VT; Prince George, BC; and Winnipeg, MB, which are already powered by 100% renewable energy. The City of Minneapolis recently passed a resolution establishing a 100% renewable electricity goal for municipal operations by 2022 and citywide by 2030[15]. This goal is in response to the City's aggressive greenhouse gas emission reduction strategy outlined in the Climate Action Plan which seeks to reduce GHG emissions by 80% by 2050 and recommendations from our 2015 CyPT analysis[16]. Our analysis showed that it is possible for Minneapolis to achieve its 80 by 50 target if the City, its utilities, and its inhabitants work aggressively to clean the local energy supply, adopt electric transport and public transit, and improve energy efficiency in buildings.

The task the City faces to make this commitment to renewables a reality may seem daunting but collaborations between City of Orlando, Orlando Utilities Commission (OUC), and other local partners to understand challenges and opportunities could be a first step. This CyPT analysis could also serve as a resource as Orlando develops a roadmap for transitioning to 100% renewables. As of the publication of this report, OUC is in the process of updating its Integrated Resource Plan (IRP). This IRP would be based on a detailed technoeconomic feasibility analysis as well as consideration local and regional policies and would provide a roadmap to what electricity generation would look like in future. Since the IRP will not be released before this report, this report is based on many assumptions and existing studies to forecast the electricity generation mix in the City.

Utility-Scale Solar and Rooftop Photovoltaic

Florida ranks eighth in the country for rooftop PV potential but until as recently as 2016, Floridians received only 0.1% of their electricity from solar power, lagging behind Vermont (2.4%) and North Carolina (1.1%)[17]. This picture could be changing fast as technology improvements and maturity coupled with growing economies of scale are driving down costs for solar energy and battery storage in recent years. This is a trend that many anticipate will continue in the coming years, particularly for larger, utility-scale solar installations that are generally seen as less mature relative to rooftop solar installations on residential and commercial facilities. A recent study shows that up to 24% PV penetration could be cost competitive in Florida within the next decade[18] and National Renewable Energy Laboratory's (NREL) Annual Technology Baseline (ATB) anticipates utility solar capital costs will fall at a compound annual rate of 1.5% to 3% from 2018 to 2050[19]. Using this information and a few other renewable energy potential assessment studies focused on Florida[20, 21], we assumed 67.2% of the electricity generated in 2040 comes from solar energy, less than 2% of which is from photovoltaic panels on homes and businesses. We also modeled the impacts of additional 18% rooftop PV generation and 9% increase in utility-scale solar farms. Together these two assumptions would mean 7.8 TWh/year electricity production from utility scale and rooftop PV and would save the City 807,000 metric tons of CO_2eq emissions and would generate 47,000 local FTE jobs for installations and maintenance of these rooftop panels.

Waste-to-Energy

According to information collected by the City[22], Orlandoans generate 0.3 metric tons of solid waste per person annually. Apart from the potential for electricity generation from captured landfill gas, incinerating the solid waste is also an alternative source of fuel for electricity production. According to a study published at Columbia University[23], a dedicated power plan could generate 1.8 MWh/ton of electricity. Based on this information, we calculated that in 2040, Orlando could produce 213,000 MWh (or 2%) of electricity from solid waste. Adopting this route could go a long way in realizing the City's goal to become waste-free by 2040.

Landfill Gas

Landfill gases are produced by the biological breakdown of organic matter in municipal solid waste. Our study considers these landfill gases that are composed mostly of methane as a renewable source of energy. According to OUC[7], in 2015 the utility produced 93 GWh of electricity from landfill gas and plans to expand its generation capacity by additional 218 GWh. Taking this trend into account, our analysis assumes that in 2040, roughly 10% of the electricity consumed in the City would come from landfill gases.

In addition to these three renewable energy sources, during this analysis we also evaluated feasibility of wind power but did not pursue it in the final report based on feedback from the City. Wind power is not one of the abundantly available resources in Florida. Studies have shown that the on-shore wind potential (derived from average wind speed) in Florida is almost negligible[24]. However, off-shore wind power is a different story. A fact sheet published by U.S. Department of Energy (DoE) and Southeastern Wind Coalition shows that better technologies and designs could create wind turbines that have taller towers and longer blades[25]. These advancements could significantly increase potentially viable areas for wind energy especially in southeastern states of US including Florida. In the next decade, this would mean 576.1 TWh/year electricity production from off-shore wind power in Florida. In future updates of this analysis, wind power could be explored further as a viable substitute for over 90% solar-based electricity in the City.

Roadmap for Deep Decarbonization

Combining the benefits from implementing 25 technologies across building, transportation, and energy sectors could reduce Orlando's GHG emissions by 90.1% as compared to 2007 baseline – achieving its ambitious 90 x 2040 target. In addition to GHG emission reduction, these 25 technologies would generate 103 thousand gross FTEs between today and 2040, as well as improve air quality by 50% for particulate matter 10 (PM10) and by 56% for nitrogen oxides (NOx) compared to the 2050 Business-as-Planned (BAP) scenario.

A) 2007 Baseline

All reductions for the City of Orlando are measured against 2007 GHG emissions baseline from the City created using City Inventory Reporting and Information System (CIRIS)[22]. This value includes transportation and buildings emissions (in CyPT scope) as well as industrial buildings, solid waste, and wastewater (outside CyPT scope).

B) Today's Estimate

CyPT model estimates annual GHG emissions from the building and transportation sectors for today (2017) to be 6.2 million metric tons, which is a 15.9% drop from 2007. The difference in this figure as compared to Orlando's 2016 CIRIS inventory is due to a difference in accounting methodology for transportation emission and exclusion of industrial and waste emission from CyPT model.

C) 2040 BAU

Business-as-usual or BAU scenario simulates the increase in emissions considering population growth as projected by the City's growth plan and that residents and businesses will continue to act exactly as they do today. In Orlando, this scenario produces 26.9% increase in GHG emissions as compared to today but only 6.7% increase as compared to 2007 baseline.

D) Cleaner Electricity

Cleaning electricity mix to include electricity from 80% renewable fuels coupled with three grid modernization technology has the potential to reduce the GHG emissions in Orlando by over 2.6 million metric tons compared to today. Our assumption that electricity consumed in the City is 80% from renewable sources aligns with City's target of obtaining 100% of electricity from clean, renewable sources citywide by 2050.

E) Active Transport

The assumption of 25% reduction in vehicles miles travelled by single occupancy vehicles supports Orlando's 2040 goal to ensure majority of trips are made by foot, bike, carpooling or transit. This assumption would result in saving an additional 153,000 metric tons of CO_2e on top of scenario D).

F) 2040 BAP

Combined scenarios D) and E) make up the Business-as-Planned or BAP scenario, a more realistic picture of this growing City. This scenario considering a more progressive approach results in a 53.7% reduction in GHG emissions as compared to 2007 baseline and is used as a basis for modeling impacts of various technologies in this analysis.

G) Rooftop PV

80% renewable energy in the generation mix will not be sufficient to achieve the City's ambitious 90 x 2040 target. This scenario models the impacts of additional rooftop and utility-scale PV to make the grid 100% renewable and reduce GHG emissions further by 807,000 metric tons.

H) Efficient Heating

In addition to the renewable grid, we also modeled an 18% adoption rate of combined heat and power (CHP) and implementing 82% of building heating from air-sourced heat pumps. Combined, these two technologies would create more efficient heating in Orlando's buildings and would reduce GHG emissions by 11% as compared to 2040 BAP scenario.

I) Nine Building Technologies

Together with a significantly greener electricity grid and more efficient heating, nine building technologies that target energy reduction within the buildings in Orlando were modeled and would reduce emissions by an additional 2.9%.

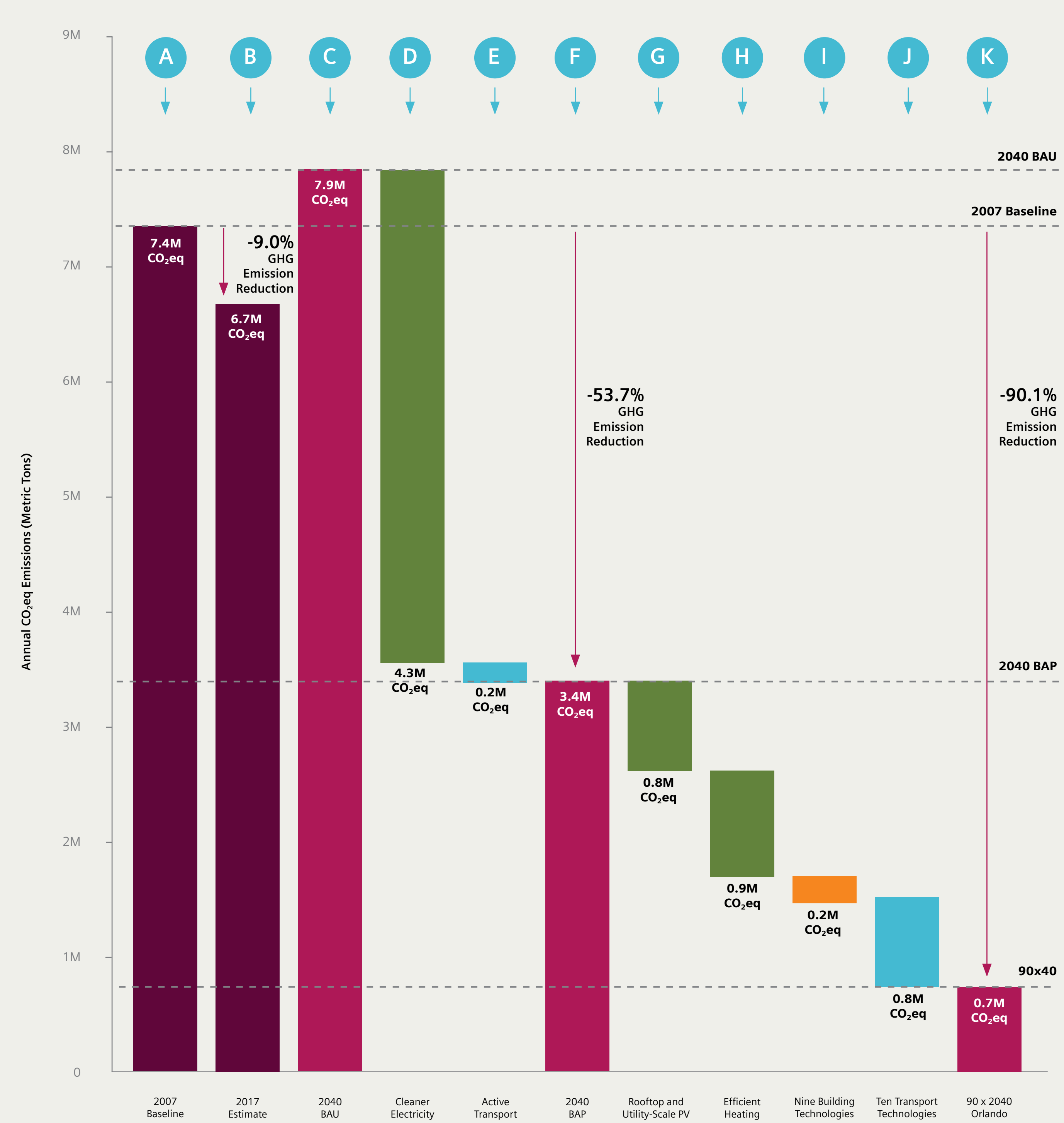
J) 10 Transport Technologies

Finally, ten transportation technologies reduce emissions by almost 10%. These technologies include 100% electrification of private fleet as well taxis, buses, and BRTs. 100% electrification of private cars is the most impactful of these 10 technologies and would reduce CO_2e emissions by 760,000 metric tons.

K) 90 x 2040 Orlando

The combined benefits of the 25 energy, buildings, and transport technologies, market forces, policy changes, and behavioral changes have the potential to reduce the City's annual CO_2e emissions by 90.1% from the 2007 baseline – achieving the 90 x 2040 goal.

Pathway to 90 x 2040



Priorities for Success

With this analysis we show that 90 x 2040 is possible for the City of Orlando. We do acknowledge that analyses are much easier to write than implement, and with this report we hope to aid the City in prioritizing technologies and strategies when creating a roadmap to success. The amount of change required for 90 x 2040 to become a reality can be overwhelming, and policies and behaviors as well as some market forces need to work together to ensure success. In addition to electricity decarbonization, three strategies arise to the top and need to be made a priority by the City of Orlando.

(1) Converting 82% of space and water heating in buildings to electric heat pumps

According to our analysis using data from the city as well as EIA's residential and commercial building energy use database, roughly 23% of energy used in Orlando's buildings is for space and water heating. Currently this need is fulfilled by a combination of natural gas furnaces and electric-resistance furnaces, both of which are highly inefficient. Research has shown that warmer climates like Orlando with average winter temperatures around 50°F are ideal candidates for air-sourced electric heat pumps[i]. In milder climates like these, the Heating Seasonal Performance Factor (HSPF), which determines efficiency of a heat pump, is shown to be up to 40% higher than rated[26]. Market adoption of electric heat pumps for 80% of citywide heat consumption is the single most impactful lever considered in this analysis. Mainly due to the City's transition to 100% renewable electricity, this adoption will contribute to over 790,000 metric tons of CO_2e saved and over 380 metric tons of NOx emissions saved.

(2) Transitioning to 100% electric car fleet

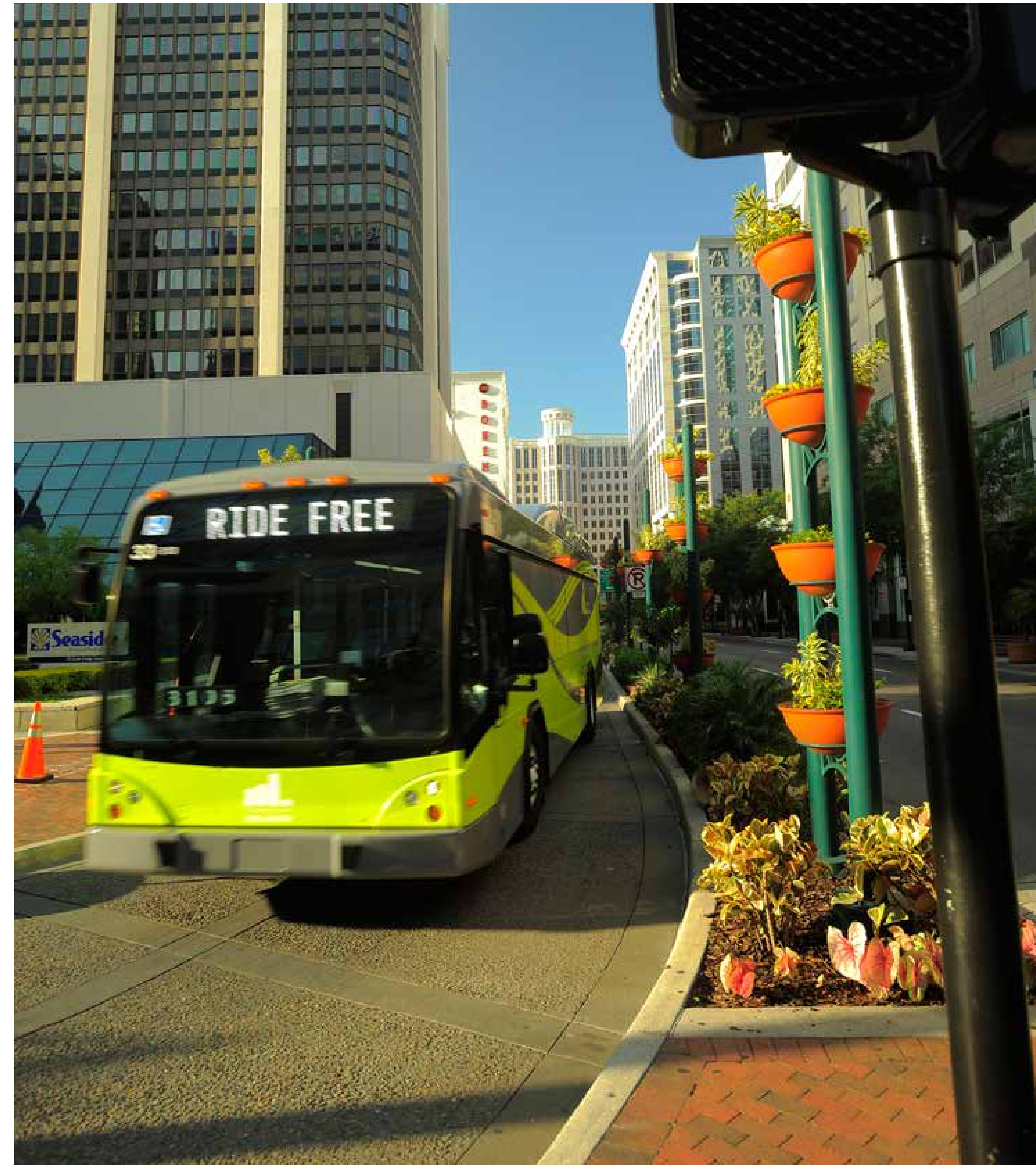
There are roughly 171,000 cars on Orlando's streets today and, given that the average life of a car on US streets is 15 to 20 years (depending on locality), it is reasonable to expect that all 171,000 of those cars – 85% of which are gasoline-powered – could be replaced by 2040. The City of Orlando has already made a commitment to transition 100% of its own fleet to alternative fuels including electric. But to incentivize the transition to a fully electric private fleet would require additional effort, e.g., the City could promote tax credits and incentives, deploy some public charging infrastructure, and work with private sector partners to reduce the difficulty of rolling out electric vehicle (EV) charging stations. San Francisco, for example, has incorporated electric vehicle charging into new buildings, mandating that developers include hookups for electric vehicles in parking spaces. Other cities are working through their utility companies to offer programs to businesses and residents to purchase EV chargers at a lower cost, and still others are setting aside land so that private sector partners can create spaces for EV charging of large, shared fleets. Investments in charging infrastructure could also promote expansion of electric car sharing programs. Studies from Innovative Mobility group at UC Berkley show that each shared car can replace between seven and 12 cars on the road, leading to a shift in behavior from private ownership and single-occupancy vehicles to shared ownership and multiple-occupancy vehicles, resulting in long-term reduction in GHG emissions and air quality improvements.

(3) Automating 100% of commercial and municipal buildings

Cost competitiveness and ease of use have enabled rapid uptake of retail home automation products, such as Nest and Ecobee. However, automating electricity and heating consumption in all buildings, especially older commercial ones, will require updating existing appliances and HVAC systems. Financing mechanisms like energy performance contracts can help overcome the barriers to capital investment required for retrofits. Many cities are contemplating point-of-sale policies, so that new owners are required to retrofit existing buildings at the time of purchase. They are also exploring offering local tax credits for home and business improvements to extend beyond the traditional rebates. In Orlando, the City is implementing a Building Energy & Water Efficiency Strategy (BEWES), which would require any city-owned building above 10,000 gross square feet and any commercial or multifamily building above 50,000 to track and report whole-building energy use. Gathering this data is the first step in benchmarking building energy usage. Through this information, services like building performance optimization or BPO can improve energy efficiency by adapting the existing control strategies to better suit usage profiles.

In the cities that are most progressive with regards to climate action, local agencies are considering policies, which mandate or offer incentives for new construction to be LEED certified. Since 2007, Orlando has committed to meeting LEED standards for all newly constructed City buildings. However, to meet the targets of 90 x 2040, all new construction will need to achieve substantially better energy performance. In Orlando this would mean continuing engagement by the City, County, and energy and construction technical experts to move building code requirements toward net-zero energy performance.

(i) Air-source heat pumps draw heat from the outside air during the heating season and reject heat outside during the summer cooling season. Essentially the outdoor air serves as the heat source in winter and heat sink in summer. Heat is moved in and out of the building using electricity with the help of a low-boiling point refrigerant through a compression cycle – much like the one in a refrigerator.



Appendices

I – CyPT Technology Workshop Participants

We would like to thank all the participants in the Technology Workshop held in the City of Orlando on July 2, 2018 for their contribution to developing deep decarbonization scenarios for the City.

Affiliations	Participants
Orlando Utilities Commission (OUC)	Byron Knibbs; Linda Ferrone; Justin Kramer; Sam Choi
Orange County Utilities (OCFL)	Renee Parker; Lori Forsman
Jacobs	Dan Kirby
LYNX	Doug Robinson
University of Central Florida	Qun Zhou; Gregory Territo; Venessa Balta Cook; Doug Kettles
City of Orlando	Chris Castro; Brittany Sellers; Ian Lahiff; Ben Stacey; Lisa Rain; Evan Novell
Urbanista Orlando	Thomas Allen
Others	Jeff Benavides; Mital Hall; Justin Vendenbroeck; Kyle Henderson; Olof Tenghoff; Wayne Allred; Michelle Benardes
Siemens	Ivan Aron; Hector Samario; Denise Quarles

II – CyPT Data Sources

Data	Reference/Contributor
Residential and Non-Residential Building Square Footage	Orange County Property Appraiser, 2014
Building Energy Consumption	CIRIS (City Inventory Reporting and Information System) for Orlando
Population and Growth Rate	City of Orlando 2015-2045 Growth Projections Report
Vehicle and Passenger Miles Travelled	SunRail, LYMMO and LYNX websites
Freight Ton-Miles Traveled	MetroPlan Regional Freight Study 2013
Electricity Fuel Mix	Orlando Utilities Commission (OUC)

III – CyPT Technologies Used in This Analysis

Building Levers		
Residential and Non-Residential Building Square Footage	Building Envelope	A high-performance building envelope can be part of the initial building design or it can be created through the renovation of an existing building. A high-performance building envelope would include insulation, high-performing glazing and airtight construction. Energy-efficient solutions can be applied to every part of the building envelope, including floors, roofs, walls, and facades, and they can also be used to reduce the energy loss of a building's technical installations (e.g., pipes and boilers).
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	Building Performance Optimization (BPO)	Building Performance Optimization (BPO) is a range of services designed to increase the energy efficiency of an EXISTING building by implementing proven building control strategies otherwise known as Facility Improvement Measures (or FIMs). BPO can improve THERMAL and ELECTRICAL energy efficiency in a building in many ways, typically via improved HVAC technology, by adapting the building to suit usage profiles or providing information and analytics for operational personnel. Reduction of CO_2e, PM10, and NOx due to energy savings.
Non-Residential	Building Automation (BACS Class B)	Energy-efficient building automation and control functions reduce building operating costs. The thermal and electrical energy usage is kept to a minimum. It is possible to estimate the efficiency of a building based on the type of operation and the efficiency class of the building automation and control systems (BACS) installed. Energy Class B includes advanced building automation and controls strategies, such as demand-based operation of HVAC plant, optimized control of motors, and dedicated energy management reporting. Reduction of CO_2e, PM10, NOx is related to thermal and electrical energy savings.
Non-Residential	Room Automation	Room Automation provides control and monitoring of heating, ventilation, and air conditioning within individual zones based upon demand, with options for automatic lighting. An in-built energy-efficiency function identifies unnecessary energy usage at the room operating units, encouraging room users to become involved in energy saving, and different lighting scenarios can be programmed. Reduction of CO_2e, PM10, NOx is related to electrical power utilized in the heating, ventilation, air-conditioning, and lighting of a building.
Non-Residential	Demand-Oriented Lighting	Demand-oriented lighting is based on presence (or motion) detection: lights are switched "on" when someone enters a given area and deactivated after a pre-defined period without movement. It is usually combined with daylight measurement. The largest energy savings can be achieved in buildings with fluctuating occupancy and, when combined with other lighting technologies, it can reduce the lighting energy use within a building by 20 to 50%. Reduction of CO_2e, PM10, and NOx due to electrical energy savings.
Non-Residential	Energy-Efficient Motors & Drives	Analyzing the drive technology in buildings (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 required. Reduction of CO_2e, PM10, NOx is related to electrical energy savings.
Non-Residential	Heat Recovery	Heating and cooling losses can be reduced through 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 used.

Transport Levers		
Public	Electric Buses	Share of the vehicle fleet that is battery-electric vehicles. Battery-electric vehicles are "zero" exhaust gas emission vehicles. Significant reduction of local emissions PM10, NOx. A charging infrastructure is set up. The electricity used for charging is generated according to the general local electricity mix.
Public	e-Bus Rapid Transit New Line (eBRT)	Share of Passenger Transport at target year provided by bus rapid transit: a high-performance public transport combining bus lanes with high-quality bus stations and electric vehicles. Faster, more efficient service than ordinary bus lines. Results in modal shift from private transport to public transport, shift from combustion engines and reduce energy demand per person km together with related emissions.
Private	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 PM10, NOx. A charging infrastructure is set up. The electricity used for charging is generated according to the general local electricity mix.
Private	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.
Private	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 trans-port.
Private	Bikesharing	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.
Private	Eco-Driver Training and Consumption Awareness	Frequent training of drivers can lead to responsible driving behavior and increase average fuel economy of fleet.
Infrastructure	Low-Emission Zones	A low-emission zone is a road/section of road, network of roads, or geographical area where entry of vehicles or driving within is restricted based on exhaust emission standards. For instance, to drive within this zone with a non-compliant vehicle would result in a daily or hourly charge. Vehicle restrictions may apply to an entire fleet or specific vehicle classes.
Infrastructure	Intelligent Traffic Light Management	Smart traffic management systems utilize sensors to monitor traffic speed and density. These systems can optimize traffic signal timings, impose speed limits, and open hard shoulders as required to maintain flow.
Freight	E-Highways	Share of hybrid diesel-electric trucks and highways with overhead power lines at target year. As soon as trucks join the e-Highway, they connect to the overhead power lines and switch into pure-electric mode. Leaving the e-Highway, the trucks switch back to using hybrid mode. Energy demand is reduced due to shift of transport to hybrid electric truck and electric transport together with related emissions.

EnergyLevers		
Generation	Wind Power	Share of electricity provided by wind power at target year changing the energy mix and its related emissions provides cleaner electricity for buildings and electric-powered transport modes.
Generation	Photovoltaic	Share of electricity provided by photovoltaic at target year changing the energy mix and its related emissions provides cleaner electricity for buildings and electric-powered transport modes.
Generation	Combined Heat and Power	Combined heat and power (CHP) is a highly efficient method of generating electrical and thermal power (heating or cooling), from a single fuel source at the point of use. CHP utilizes both the electrical energy and the heat generated through the combustion process. The heat is essentially a by-product that in other systems may be disregarded as waste. Utilization of the waste heat is a key reason why a CHP system is so efficient. CHP is the type of generation used in district heating.
Generation	Electric Air-Sourced Heat Pumps	Share of heating supplied to the City buildings coming from air-sourced heat pumps that run on electricity.
Transmission	Network Optimization	A well-structured, secure, and highly available electricity supply infrastructure. Reduces grid losses, resulting in less energy generation and related emissions to provide the demanded energy at customer side.
Distribution	Smart Grid for Monitoring and Automation	Increased network performance with intelligent control – optimization of decentralized energy resources – economically and ecologically. Possibility for bidirectional energy flow, reduces technical and non-technical grid losses in distribution and corresponding reduced energy generation and related emissions.

Endnotes

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[2] ACEEE City Scorecard, Orlando, 2017. https://aceee.org/sites/default/files/pdf/score-sheet/2017/orlando.pdf

[3] 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

[4] 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.

[5] Growth Management Plan: 2015-2045 Growth Projections Report, June 30, 2016. http://www.cityoforlando.net/wp-content/uploads/sites/27/2016/07/GMP2015-2045Projections.pdf

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