Title: Working to Pick up the PACE. Authors: Matt Cox, Caroline Golin, Xiaojing Sun, Shan Arora, Ruthie Norton, Megan O'Neil

Abstract.
Job creation is always a hot topic in economic development. Cities, states and regions have been pursuing businesses in increasingly aggressive fashion through several policy and programmatic choices, such as expanding the size of tax breaks and other incentives, many of which may contribute to financial stress within the implementing jurisdiction. The mobility of these employers complicates efforts to retain jobs and can create a zero-sum game of job swaps between jurisdictions. However, if these public investments switched from trying to attract employers to developing local industries that rely on local opportunities, the zero-sum dynamic can be mitigated and economic development can become more sustainable. In this paper, we look at the potential of one such project: the Atlanta Property-Assessed Clean Energy (PACE) financing program. This program, when launched, will provide funding for clean energy development in Atlanta's building sector. We evaluate the energy implications of this program, utilizing the Greenlink Group's RePAT model. Following that analysis, we evaluate the job creation and gross regional product implications of the Atlanta PACE program, using a tool derived from IMPLAN data and tailored to the local Atlanta context. In total, the program is expected to deliver significant regional sustainability "wins" in environmental, economic, and equity arenas by reducing waste, increasing economic growth, and expanding employment opportunities.

Introduction.
Economic development has always contained a focus on employment. However, that focus on employment has not typically involved jobs in the energy sector. Historically, this makes sense – the energy sector is traditionally capital intensive and not labor intensive, engaged in the construction and operation of centralized, out-of-the-way infrastructure that remains in service for more than 30 years (some of the United States' oldest plants are now over 100, and it is not uncommon to see proceedings to extend the lifetime of nuclear plants out to 80 years). With the energy paradigm focused on large projects that are mostly self-sufficient and away from cities, energy has not received a large focus as a jobs opportunity in urban development, particularly outside of Houston. This was wrong.

With the exception of a brief flurry of activity that centered around the American Recovery and Reinvestment Act of 2009, jobs in the energy sector as a growth area for nation has been largely relegated to either fossil fuel extraction or ignored. Certainly, the growth in shale gas and oil has received quite a bit of attention, as has the resulting employment shift driven by these technologies. Employment in these sectors have now returned to levels not seen for more than five years, indicative of the up-and-down nature of the gas and oil industry, and the fossil fuel sector in general (Bureau of Labor Statistics, 2016).

Why focus on the past? Fossil fuels are on their way to returning to being fossils – the coal industry may very well be on its deathbed (Mooney and Mufson, 2016). Clean energy is arriving, through better technologies, cost reductions, and more efficient operations. The boom in the solar and wind industries has also been well documented, with the decline in prices spurring widespread deployment in the US and globally in the past several years (IEA, 2015). Government policies have also helped move this transition, from funding the basic research, to providing tax incentives, job training, cutting regulatory red tape to reduce soft costs, and increasingly-stringent regulations on fossil fuels as more negative effects of their use have become established (Jaramillo and Muller, 2016). In part, the deployment of clean electricity generation has helped to keep power sector emissions below their 2007 peak (EIA, 2015). The use of distributed rooftop solar systems is understood as a job-creator, and one that urban areas can leverage (The Solar Foundation, 2016).

Unfairly left out of this conversation though, is perhaps the biggest contributor to the emissions reductions, and also the biggest potential contributor to local economic development – energy efficiency. Through technological progress and installations, efficiency saves businesses and homeowners money, reduces strain on the grid, provides public health benefits, and conserves water resources. It also reduces long term rates and infrastructure requirements, saving everyone on the system money – energy efficiency creates a raft of positive externalities and avoids another set of negative externalities. It's also a self-replenishing resource; when better, new technologies are available, these can be implemented to produce additional savings from the previous baseline, and maintenance efforts can also produce greater efficiency. These are all widely-recognized benefits of energy efficiency (Goldstein, 2011), and many of these same benefits accrue to distributed generation resources like solar as well. From an economics and policy analysis standpoint, efficiency's main benefit is that it achieves these benefits at lower cost than all other options (Molina, 2014). From an economic development standpoint, and what's been left out, is that it also does so with greater employment and GDP implications (Deitchman 2014), and that these jobs and productivity gains can be sustained year-to-year, which is not an opportunity with other electricity-generating resources.

This paper expands upon these ideas and looks to understand the potential of energy efficiency to deliver economic development through an analysis of a proposed Property-Assessed Clean Energy (PACE) tax lien financing program in the City of Atlanta. A combination of tools and datasets are used to achieve these research goals, including the RePAT policy analysis model and the IMPLAN I/O model. The analysis suggests that the PACE program can produce significant benefits for both public and private interests in Atlanta.

Review of PACE Financing
Property-Assessed Clean Energy tax lien financing has been used to pay for clean energy upgrades to properties since 2008, when it was first made legal in California (Brown et al., 2011). PACE is funded through a municipal bond issuance; when a building uses PACE funds to finance an upgrade, it is added to the "PACE district", which is similar to many other municipal special purpose funding approaches. Establishing PACE districts requires enabling legislation from the state. Figure 1 below

summarizes the full PACE process, as detailed by a 2011 Oak Ridge National Laboratory study.

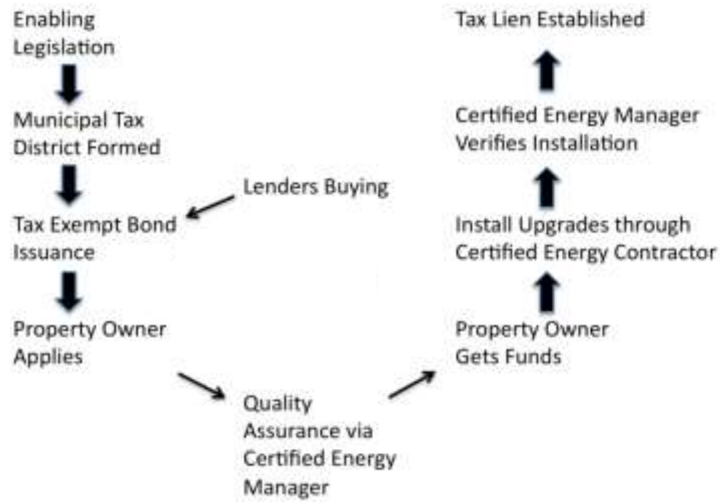


Figure 1. PACE Implementation Process (Brown et al., 2011)

In its first incarnation, PACE was primarily used to finance solar photovoltaic installations in the residential sector, allowing for 20-year repayment through property taxes. One seeming advantage for PACE is its secure status; because it is a tax lien, and therefore repaid prior to mortgage debt in the case of a foreclosure, it is a “safe” investment. These characteristics were favorably viewed by states all over the US, and PACE saw rapid adoption. However, the Great Recession and the popping of the housing bubble led to many dissatisfied lenders that realized PACE’s model placed them “second in line” for repayment, with many homes entering foreclosure; these lenders included Fannie Mae and Freddie Mac, which acted collectively to kill PACE adoption by refusing to provide mortgages for any properties that engaged in PACE. The market dominance of these two players in the residential sector succeeded in drastically slowing the use of PACE financing (Hales, 2015). However, the commercial building sector does not have an equivalent of Fannie Mae or Freddie Mac – so PACE adoption and utilization moved towards financing energy efficiency in commercial buildings.

In 2016, PACE financing is experiencing widespread implementation across the United States (Figure 2). The multi-decadal payback periods, lower-than-mortgage interest rates, and attachment of the debt to the property (as opposed to the property owner – meaning that when the property is sold, the remaining balance of the lien is simply transferred to the new owner) make PACE an attractive option to finance clean energy developments – many projects can be financed that are cash-flow positive from day one.

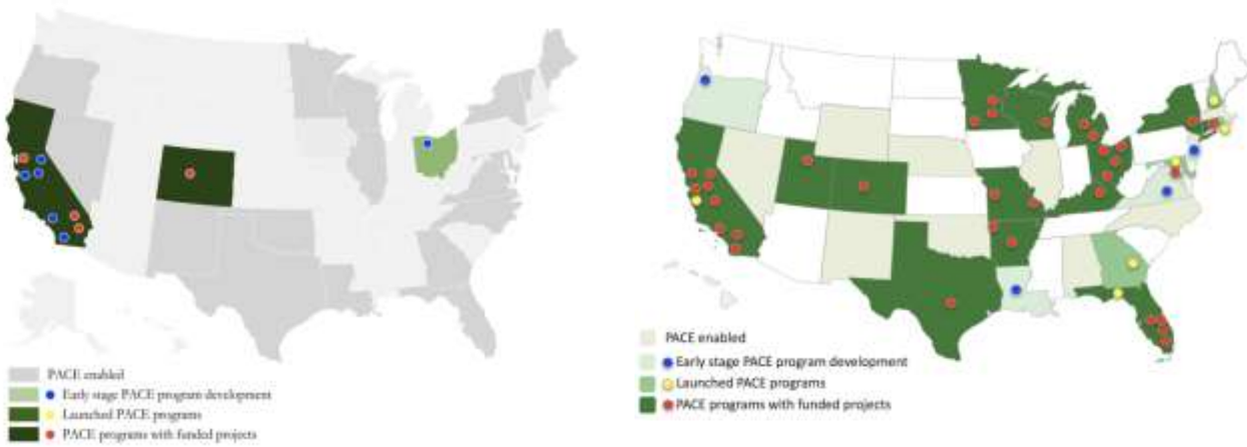


Figure 2. Commercial PACE programs in 2010 (Left) and 2016 (Right) (Pacenation.us)

PACE provides an opportunity to make low-cost financing available to a large population of commercial buildings, which studies consistently suggest is an area ripe for energy savings (Cox, Brown and Sun 2013; Sun, Brown and Cox 2015). These programs have focused on energy, and understandably, the analyses surrounding them have also focused on energy and carbon reductions. But there are other benefit streams produced by these investments, including the development of local economies and employment in industries that are not easily outsourced.

Jobs in the Energy-as-a-Service Paradigm

From a macroeconomic first-blush, the idea that reducing consumption could be a means of increasing employment and productivity is a bit counterintuitive. Energy is required to make almost every single thing in the economy happen – it is the economic activity that undergirds most other economic activity. But not all kilowatt-hours are created equal, and not all energy demands require the delivery of kilowatt-hours at all. If energy is considered as more of a service than as a commodity, the means of production open up; it's a paradigm shift that allows for a more complete valuation of energy and a view of energy as a part of a system. This was, of course, possible prior to this framing, but it's an idea foreign to many active and passive participants in the energy system. As Deitchman 2014 noted, "With rare exceptions…Americans can generally expect that their gas station will have fuel and the lights will go on when they flip the switch." Introducing the energy-as-a-service concept helps conceive of the different embedded components related to energy provided by different resources; for example, a kilowatt-hour of coal-fired electricity led to a certain amount of revenue, of GDP, of job-hours at the mine-mouth, in the supply chain, and at the generator, a certain amount of water consumption, pollutant emissions, acid rain, climate change, asthma attacks, and premature deaths. A kilowatt-hour of solar power has a different profile for the same metrics. Meeting that energy demand through energy efficiency offers a similar choice in a different fashion; in essence, we are not only faced with choices on the dirty-clean spectrum – we can use smarter.

Much research has gone into cataloguing the emissions and economic benefits of efficiency (Brown et al., 2001; Cox and Golin, 2016), but less ink has been spilled on the jobs and economic implications of relying more on cleaner power sources, and even less on smarter means of meeting energy demand. A few scholars have been particularly active in this space however. Notably, researchers at the University of Massachusetts at Amherst and Rochester Institute of Technology have published several articles in the space, which has helped establish a basis for understanding how energy efficiency can, in fact, lead to job gains. Energy efficiency improvements, particularly in the commercial and industrial sectors, regularly require the use of several trades, and are construction-intensive. These services tend to be labor-intensive, and as a result, employ a significant number of people per dollar-invested (Deitchman, 2014; Pollin, Heintz and Garrett-Peltier, 2010). These studies have demonstrated a range of 11 to 19 jobs per million-dollars invested, while traditional fossil-fuel electricity provides roughly 6 and the general economy shows near 11 (Figure 3).

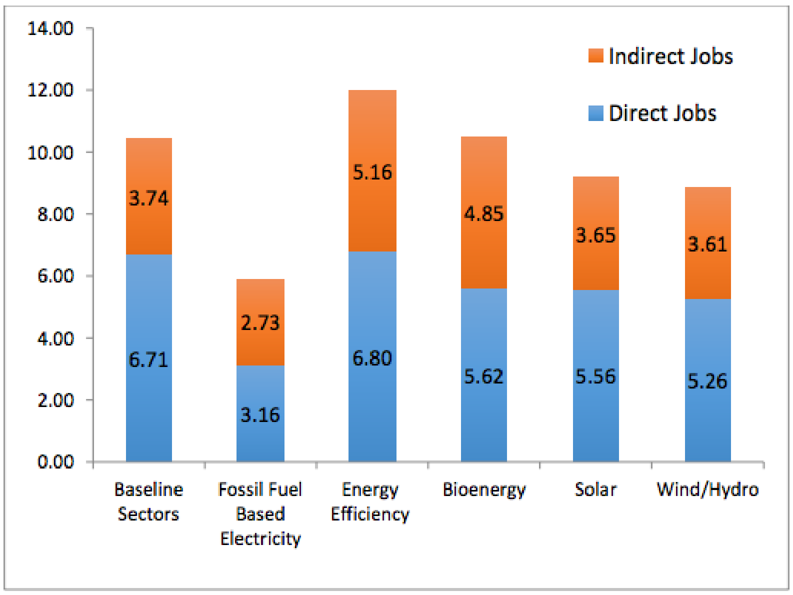


Figure 3. Jobs per Million 2010-$ Invested in Different Energy Sectors (from Dietchman 2014)

Saving energy can produce jobs, because it frequently requires an investment of capital. The economy needs to spend money to save money, and as a consequence, create many positive spillovers, including jobs. This research looks to evaluate a proposed PACE program in Atlanta using a coupled energy policy – macroeconomic impact analysis tool to provide insights on the expected outcomes of such a program.

Atlanta Commercial Energy Use Context

Commercial energy use accounts for 64% of the electricity consumption and 32% of the natural gas consumption in Atlanta (Figure 4). Many other cities see commercial energy consumption as the dominant sector (roughly similar figures are reported for New York City, Kansas City, Orlando, and others). However, Atlanta has been falling behind relative to its competitors in energy efficiency progress over the 2000-2010 time frame, where Atlanta ranked 93rd of 100 in commercial energy efficiency improvement (Cox, 2014). Recognition of this stagnation as well as a well-stated desire to be a top-tier city for sustainability (City of Atlanta, 2016) has led to the adoption of a number of policies, including the Commercial Buildings Energy Efficiency Ordinance in 2015, a benchmarking, transparency, and energy audits ordinance anticipated to combine information with market forces to drive improvements in the sector. PACE financing would be another significant effort undertaken by the City to overcome barriers to energy efficiency and place Atlanta in a position of national leadership.

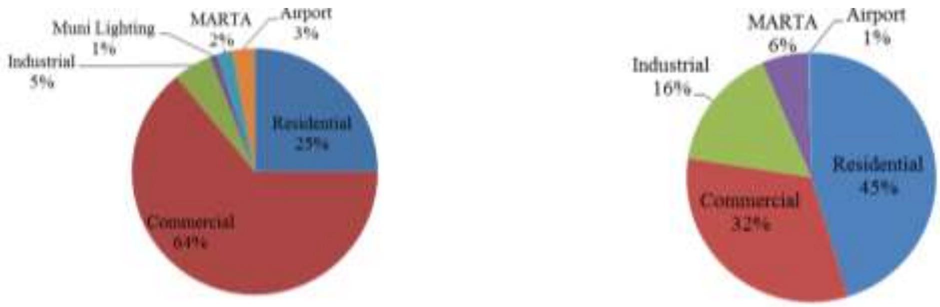


Figure 4. Energy Use in Atlanta (City of Atlanta, 2015)

Methodology.

The Atlanta PACE program proposes to spend $500 million on clean energy development. To analyze the impact of this level of funding, we first calibrate an Atlanta-specific instance of the RePAT policy analysis tool, then couple the expenditure trajectory to an Atlanta-specific economic development calculator. A brief summary of each is provided below.

RePAT

RePAT is a tool that the Greenlink Group has been developing for several years to analyze the impact of regional energy and water policy. It is a fully-coupled energy-water nexus model that solves hourly to provide high-resolution information about the operations of the energy and water systems. It has been used for several research publications (Cox and Golin, 2016; Golin and Cox 2015; Golin and Cox 2014; Cox, 2014) and its outputs have received awards at MIT and Georgia Tech. It is regularly used for policy analysis by many actors at the city and state level, including government, academia, non-profits, and private interests.

In this instance, RePAT is calibrated to the Georgia Power Company electricity generation system, where it details the operations of each power plant. Hourly load profiles and generation characteristics for the grid were developed from Georgia Power reports to the Federal Energy Regulatory Commission (FERC) and from Georgia Power's Integrated Resource Plan. FERC data is also used to characterize hourly demand in RePAT. Investment levels to reduce energy consumption are taken from Georgia Power reports to the Georgia Public Service Commission in Docket 40162. Public health and welfare values for pollutant emissions are derived from the AP2 model (Muller, Mendelsohn, and Nordhaus, 2011), which generates damage estimates for six pollutants at various emission heights for every county in the United States through a Gaussian plume/Monte Carlo simulation procedure, and the Social Cost of Carbon (Interagency Working Group on Social Cost of Carbon, 2013). The damage functions are matched to each plant with information from the USEPA Air Markets Program Database, the National Emissions Inventory, the Energy Information Administration's State Energy Data System, and Georgia Power annual reports.

PACE was modeled with the use-trajectory presented in Table 1 below. It is assumed that PACE will experience increasing market penetration for several years before demand stabilizes and as program experience grows, as has been the case in other energy efficiency financing programs. Additionally, we model the final year as experiencing an increase in demand, as the market becomes attuned to the fact that funds are nearly expired. Other financing programs, such as tax credits, have seen similar increases in demand as their phase-out dates approached, so we incorporate that into our modeling. This trajectory, while plausible, may be conservative if PACE is only used as a portion of the financing for projects or if demand exceeds expectations. Natural gas, while used for some energy services in the commercial and multifamily sectors, experiences consumption levels roughly four times less than electricity, and is also much less frequently targeted for energy efficiency in Georgia – while electricity efficiency programs have existed for decades, there are no such program for natural gas. Due to this, natural gas is modeled as receiving only 1% of commercial efficiency expenditures and 3% of the multifamily expenditures (natural gas is more prevalent in multifamily housing, although its use is still significantly less than electricity). The funding allocation for the commercial and multifamily sectors was based on current energy consumption levels in each within the City of Atlanta. Inflation is modeled at 2% per year, reducing the real dollar spend by nearly $8 million in 2026. Lastly, energy savings are modeled as declining at 5% per year, in line with observed performance (Brown et al., 1998).

Table 1. Modeled PACE Direct Expenditures (M-$, nominal)

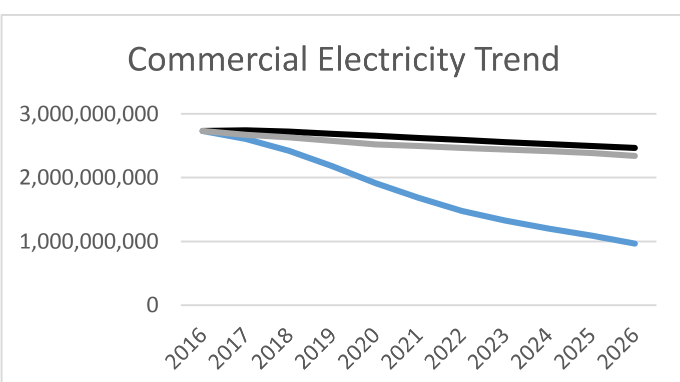
Year	Comm E Spend	Comm NG Spend	MFH E Spend	MFH NG Spend	Total Spend
2017	17.47	0.18	7.13	0.22	25
2018	24.46	0.25	9.99	0.31	35
2019	31.44	0.32	12.84	0.40	45
2020	38.43	0.39	15.70	0.49	55
2021	38.43	0.39	15.70	0.49	55
2022	38.43	0.39	15.70	0.49	55
2023	38.43	0.39	15.70	0.49	55
2024	38.43	0.39	15.70	0.49	55
2025	38.43	0.39	15.70	0.49	55
2026	45.42	0.46	18.55	0.57	65

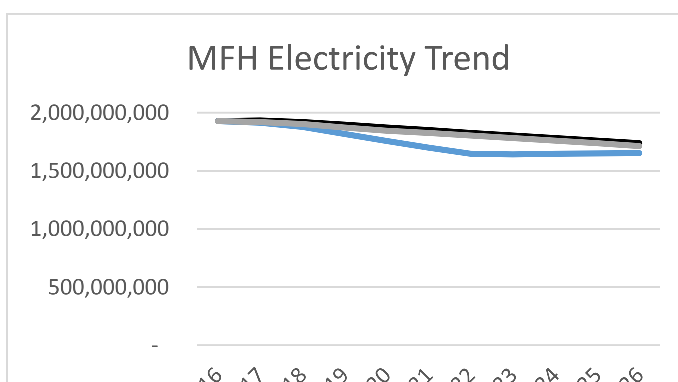
Atlanta Energy Economic Development Calculator
The Southface Energy Institute owns the Atlanta Energy Economic Development Calculator (AEEDC), which was developed using the methodologies contained in (CITE: Deitchman xxxx). AEEDC makes use of IMpact analysis for PLANning (IMPLAN) macroeconomic coefficients (IMPLAN 2015) and its input/output tables. IMPLAN's 440 sectors map directly onto the North American Industry Classification System codes if provided with a bill of goods. The sectors incorporated into the bill-of-goods for the AEEDC are derived from Deitchman 2014 and applied to Atlanta.

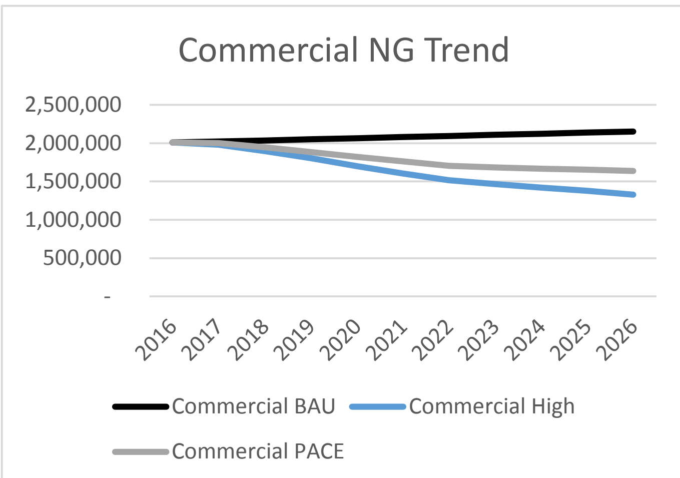
High Savings Scenario
One of the critical assumptions for this modeling is the first-year cost to save energy. For electricity savings, Georgia Power's 2016 Integrated Resource Plan provides the data necessary to calculate a trajectory for these values in both commercial and residential settings. Natural gas first-year cost values are the median value derived from a review of utility gas efficiency programs across the United States (Molina 2014). These trajectories are used for the High Savings scenario. We anticipate that these values represent an upper bound because utilities may prioritize a current low-cost set of efficiency upgrades, such as lighting, relative to what PACE is anticipated to deliver.

Low Savings Scenario
The Low Savings Scenario runs from the same baseline inputs as the High Savings Scenario, but assumes that commercial and multifamily savings will be 2x/1.5x as expensive, respectively. Commercial receives a heavier cost multiplier because the Georgia Power values reported for this sector have recently been dominated by lighting upgrades, which as noted previously, currently tend to be the lowest of low-hanging fruit for efficiency projects.

Results.
In general, PACE demonstrates a potential to reduce the energy consumed in the commercial and multifamily housing sectors in Atlanta. The commercial sector could save between 1.1 and 2.2 billion kWh and 400 to 800 billion BTUs of natural gas, while multifamily housing could see savings of 221 to 331 million kWh and 655 to 983 billion BTUs (Figure 5). In general, the commercial sector savings will be dominated by electricity savings, while multifamily housing will see a more-even distribution of savings between fuels. This closely aligns with current usage patterns, where there is proportionally less natural gas used in commercial buildings than multifamily properties. Both market segments see reductions in electricity consumption even in the Business-As-Usual case due to the anticipated impact 2015 Commercial Building Energy Efficiency Ordinance.







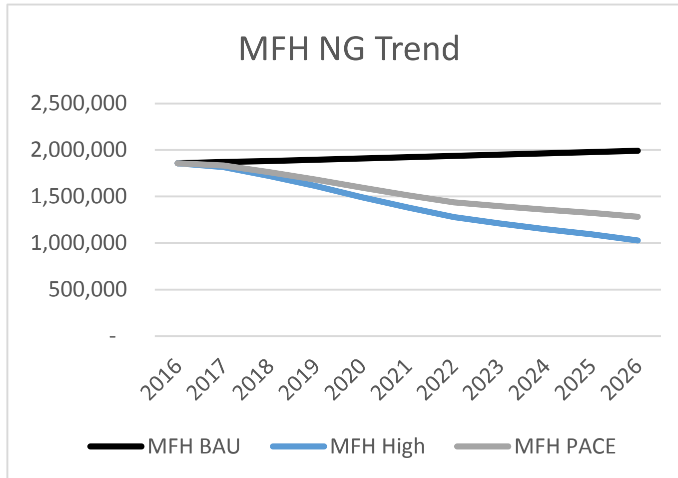


Figure 5. Electricity (kWh) and Natural Gas (MMBTU) Use through 2026.

PACE in Atlanta is likely to be a cost-effective program. The bulk of the benefits are derived from lower energy expenditures, representing savings of $395-734 million over the lifetime of the equipment installed by this financing option. Avoided public health damages represent another stream of benefits, valued at $75-149 million. Investment costs, after accounting for interest payments and discount rates, are valued at $355 million. All of this results in a benefit-cost ratio of 1.3 to 2.5 and net benefits that range from $115-528 million.

Table 2. Benefit-Cost Analysis of PACE in Atlanta

M 2013-$	Lower Energy Expenditures	Value of Avoided Emissions	Investment Costs	Benefit-Cost Ratio	Net Benefit
2020	45 to 87	12 to 24	172		
2030	197 to 365	44 to 87	355		
Total	395 to 734	75 to 149	355	1.3 to 2.5	115 to 528

In addition to the economic picture, the program also has implications for gross regional product and employment. As noted previously, energy efficiency involves labor intensive industries; as PACE drives more investment into the sector and more savings are realized, the economic development picture changes. Net effects are accounted for, meaning that the reduction in energy consumption has a corresponding negative effect for employment and GRP in those sectors. Figure 6 shows the trajectory for employment and GRP that could result from the PACE program in Atlanta. The average year in this trajectory would see an increase in net employment of 450-500 full-time equivalents and an increase in GRP of $43-46 million. Labor income (not shown) also would be expected to experience an increase of $35-40 million.

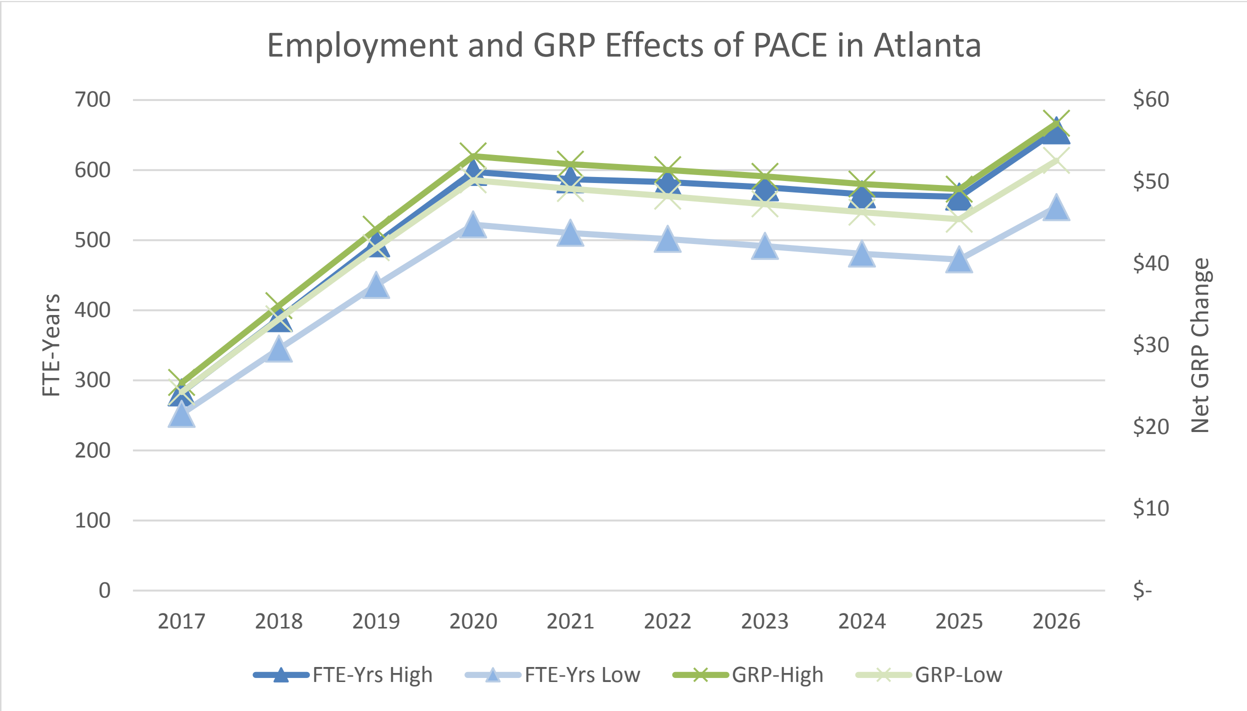


Figure 6. Change in Employment and GRP from PACE in Atlanta

Discussion.

PACE looks like a cost-effective program that would help Atlanta close the energy efficiency gap in its commercial and multifamily housing sectors by offering low-cost financing that would be attractive to market participants. The analysis shows a net benefit that is in the hundreds of millions of dollars; due to the highly pessimistic nature of the Low scenario, the true value, while likely in-between the High and Low bounds, is likely nearer to the High value. This means strong benefits for building owners, tenants, and the general public (through public health benefits of reduced emissions), as they would be beneficiaries of the program, and given the long payback periods on PACE liens, it is anticipated that all projects would be cash-flow positive from their initiation.

What's of particular interest for this paper though, is the economic development spillover implications of the PACE program. Driven by the increased demand for labor and services in the energy efficiency arena, the program isn't just delivering benefits to building occupants. PACE is increasing employment and GRP by amounts similar to or exceeding recent major corporate moves into the Atlanta area, such as Mercedes-Benz (Karkaria, 2015). However, unlike Mercedes, these are jobs that are dependent on meeting the needs of local infrastructures, which are much less mobile than corporate headquarters.

These jobs and GRP impacts fluctuate the most based on the quantity of money spent on energy efficiency in a given year. However, other factors, like cost to save a unit of energy and the price of energy in a given year also have a noticeable impact on the results. The years 2020 through 2025 see roughly the same amount of expected spending in each sector, but also experience an increase in the price of energy and the cost to save energy. Both of these factors result in slight decreases in the net economic development benefits to Atlanta in these years. All of this is true for 2026 as well, but the expected “last minute surge” in program interest and spending more than compensates for these factors in the modeling.

When compared to other energy services investments, these results show a relatively stable and reliable employment opportunity. Most supply-side means of providing energy services (like power plants) are large one-off investments, providing employment during the construction phase of the project and many fewer jobs once operations and maintenance are the focus. In this case, efficiency is different – it is meeting energy services on the demand side, and doing so incrementally in such a way that the job gains are relatively stable and maintained over the course of the decade. One of the aims of the Atlanta Commercial Buildings Energy Efficiency Ordinance is to transform market preferences to reward high performing energy-efficient buildings (City of Atlanta, 2015); if this policy goal is achieved, then these jobs may transition from being reliant on PACE funding to other privately-provided sources. Had these energy demands been met by supply-side options through the electricity and natural gas grids, the economic development impacts would have been significantly lower for Atlanta. The PACE pathway provides 3100-3800 more job-years and $100-$130M more GRP; relying on business-as-usual would also come with an increased public health price tag of $75-149M. This adds a social and economic justice angle to the story, as these costs are likely to accrue to low-income and minority populations, both as a general matter and in the specific instance of Georgia, given the location of major fossil-fuel-based power plants.

Table 3. Job and GRP Impacts of PACE vs. Business-As-Usual

	Job-Years	GRP
PACE	4560-5290	$438-468
Grid	1453	$338
Electricity	1429	$332
Natural Gas	24	$7

There is reason to be cautious with some of these values though, most notably, the increase in the cost to save energy. While it is anticipated and consistent with past experience that the cost of electricity will increase in the Atlanta area, it is less obvious that the cost to save energy will experience a corresponding increase. Economic logic would suggest that the low-hanging efficiency fruit would be first picked, and therefore the cost to save would increase over time, as shown. With technology improvements over time and the empirically-demonstrated high quantity of existing cost-effective efficiency opportunities in the Atlanta area, it is not necessarily the case that the low-hanging fruit won't be replenished by the time the first round is picked. If that were to occur, more efficiency would be available at lower cost, increasing the scale of the economic benefits from energy efficiency with the same PACE allocation. Lastly, this modeling assumed that PACE would be used to finance the entirety of the projects undertaken. If some quantity of matching funds were used, the economic *and* the development benefits would stand to increase as more dollars flowed towards productive uses.

Conclusions.

Energy efficiency is well-known for its ability to produce positive public health and private benefits. Regulators and utilities are also starting to recognize its ability to produce long-term downward rate pressure and to avoid the need to build costly new power plants and associated infrastructure. What's been less-thoroughly documented is the ability of energy efficiency to simultaneously improve the quality of life through new employment opportunities and increased GRP. In this paper, we demonstrated that the proposed PACE program in Atlanta would be cost-effective under a range of assumptions, delivering net benefits in the hundreds of millions of dollars to society, through a standard policy analysis approach using the RePAT model. We coupled the outputs of RePAT with the AEEDC to estimate the economic development impacts of PACE, and found that the proposed program would also offer several hundred new jobs per year and add tens of millions to the local economy.

PACE programs have been adopted in other cities nationally, and would benefit from similar analyses. Varying compositions of local economies, energy prices, current energy productivity, and other associated values, would produce different outcomes than discovered in this study. It is unlikely that many cities would see negative economic development results, since most power plant and electricity/natural gas supply chain employment occurs from without cities, but the magnitude of all factors and the unique circumstances of each economy mean that the results would be expected to change in different jurisdictions. Atlanta is the headquarters for Southern Company and Georgia Power, so it is not expected locales with a strong power sector corporate presence would experience significantly worse outcomes. However, areas with deep ties to manufacturing for the power sector may see different results. Additional research in different jurisdictions could uncover the untapped economic development potential of hard-to-outsource energy efficiency services.

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