

Economic, Environmental, and Resiliency Impacts of Property Assessed Clean Energy (PACE) Programs

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REMI Webinar

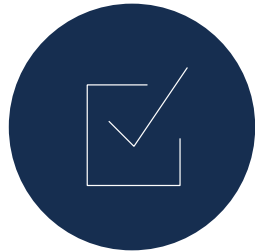
November 14, 2018

- Named one of the top 20 “world-changing” ideas by Scientific American magazine, PACE is a true public-private partnership, helping local governments achieve public policy goals around energy and resilience
- Established by state legislation in 2008, first in California, PACE was created as a tool for state and local governments to address climate change and help solve the “first-cost barrier” property owners face when investing in energy related improvements
- PACE provides financing for energy efficiency, renewable energy, water conservation, and hazard resilience improvements which are repaid via an assessment on the property owner’s property tax bill

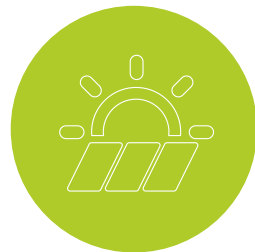
WHAT IS PACE?



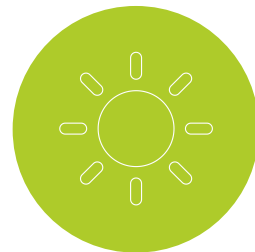
Property



Assessed



Clean



Energy

- Repaid on the property owner's property tax bill
- Based on available property equity
- Terms that match the useful life of the improvements
- Alternative to traditional, credit-based financing

Only certain improvements are eligible and must provide public benefit:

- Energy efficiency
- Renewable energy
- Water conservation
- Natural disaster resiliency

Energy EFFICIENCY



Roofing



HVAC



Insulation



Lighting



Windows & Doors

ENERGY

Generation



Solar Panels & Storage

WATER

Conservation – CA Only



Plumbing



Landscaping

SEISMIC

Retrofits – CA Only



Sesimic

HURRICANE

Protection- FL Only

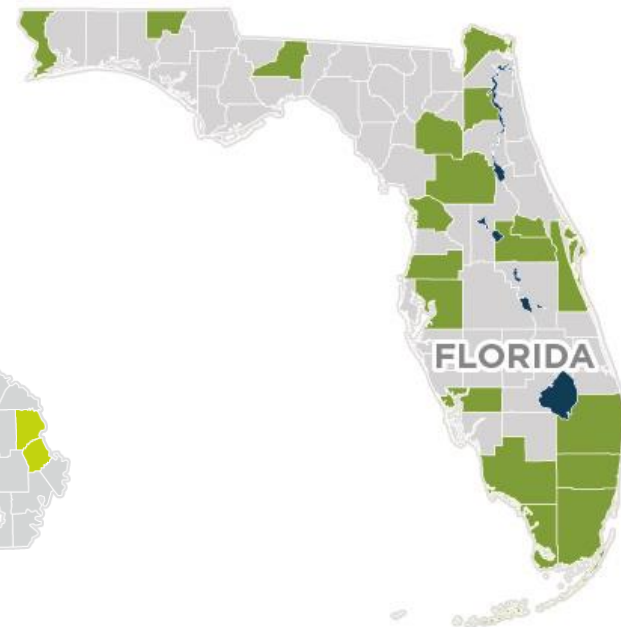
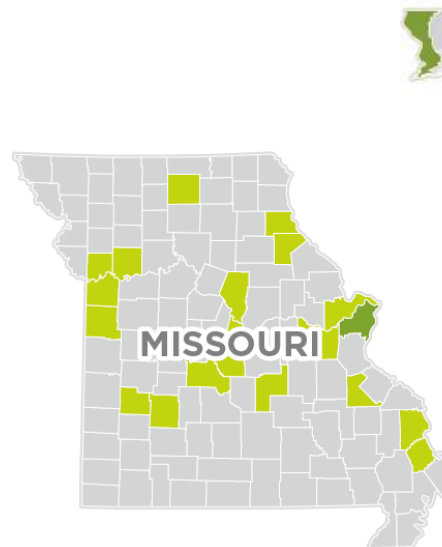


Impact Windows & Doors, Roofing

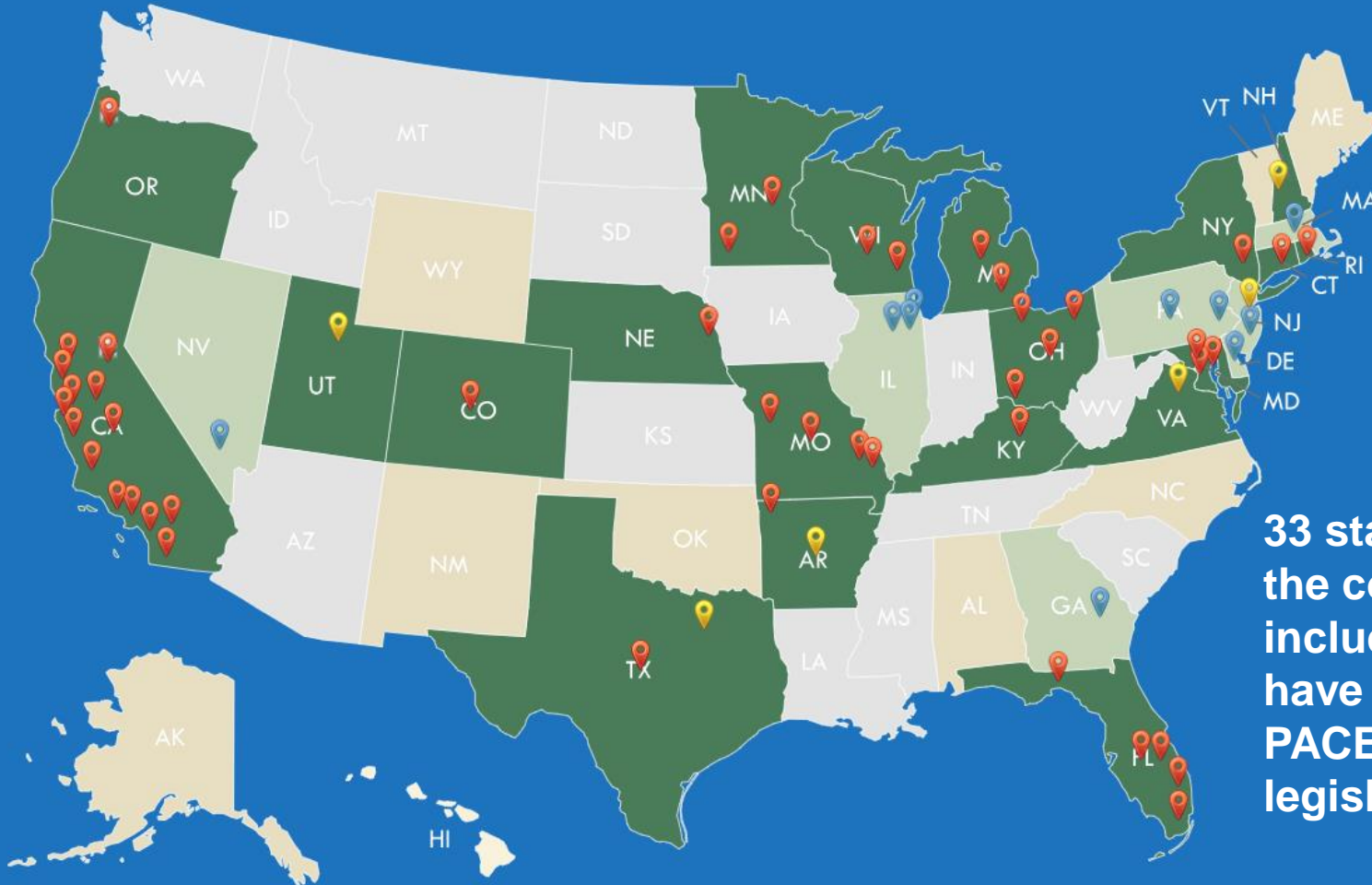
ABOUT YGRENE



- Founded in 2010, Ygrene is the leading PACE administrator in the country
- Ygrene is operational in over 500 local communities in California, Florida, and Missouri
- Ygrene has funded over \$1.3 billion to-date of clean energy, water conservation, and hazard resiliency improvements



WHERE IS PACE ENABLED?



33 states across the country, including DC, have passed PACE enabling legislation



Active program with funded projects



Launched PACE program



Program in development



PACE-enabled

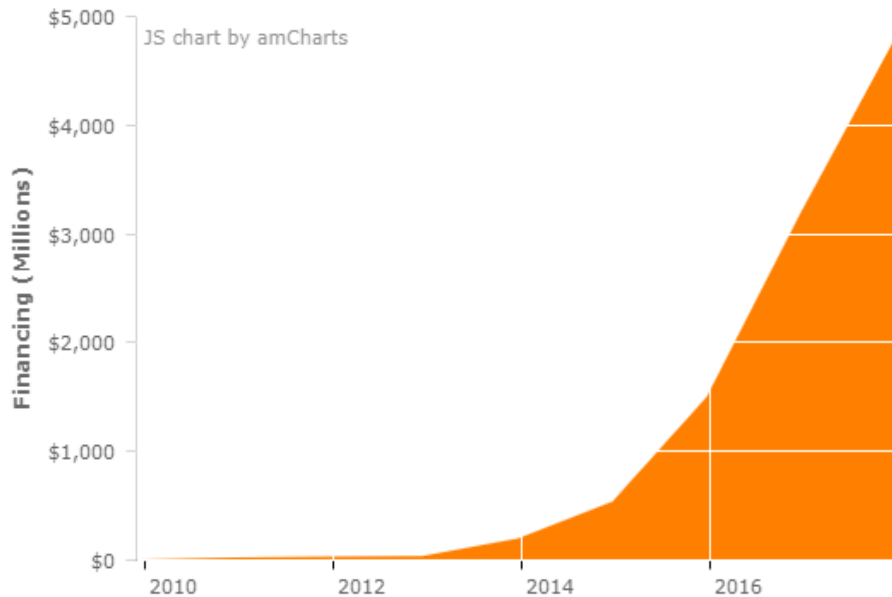
NATIONAL PACE MARKET

Since 2008, the national PACE market has accelerated tremendously

- Residential PACE Market: \$5.17 billion
- Commercial PACE Market: \$750 million

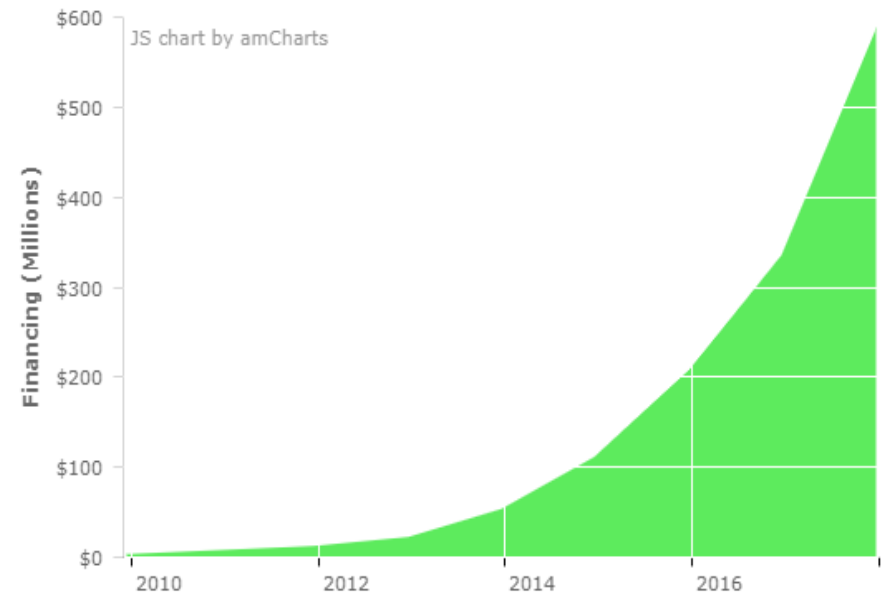
Cumulative R-PACE Financing

2010-2017



Cumulative C-PACE Financing

2010-2017



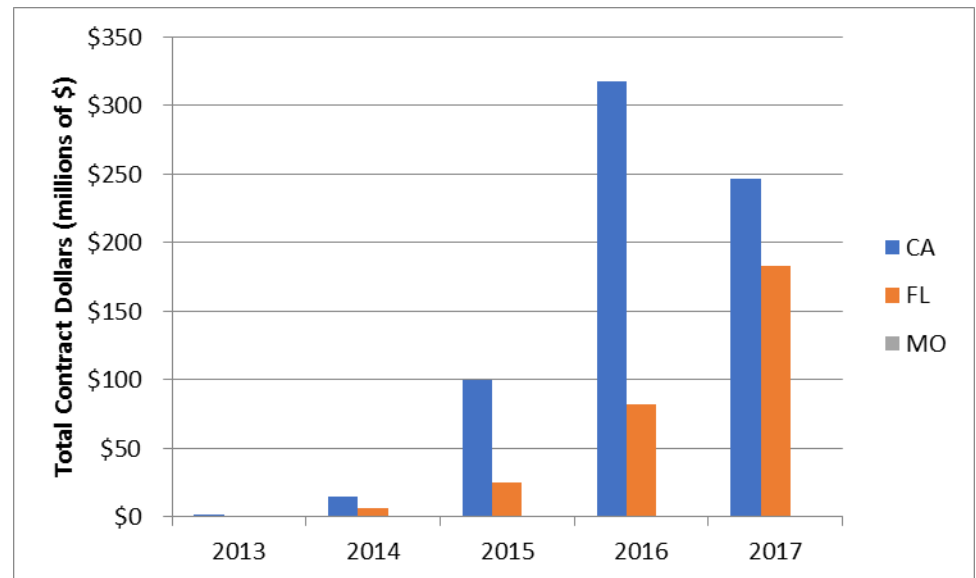
- Limited comprehensive academic research on PACE financing and its environmental, energy, and economic impacts – particularly from a public policy perspective
- Ygrene is dedicated to bettering its understanding of PACE and the role PACE plays in achieving state and local public policy goals
- University of Southern California’s Sol Price School of Public Policy and the Schwarzenegger Institute for State and Global Policy
- Engage leading USC Economics and Public Policy Professors Adam Rose and Dan Wei to perform rigorous and comprehensive analysis on PACE
- Fill an important gap in the state of knowledge about PACE programs and the environmental, economic, and resilience impacts in the communities PACE programs serve

Ygrene PACE Financing

- Provided over \$1.16 billion PACE financing since 2013
- Represent over 54,000 residential and commercial property improvement projects in CA, FL, and MO

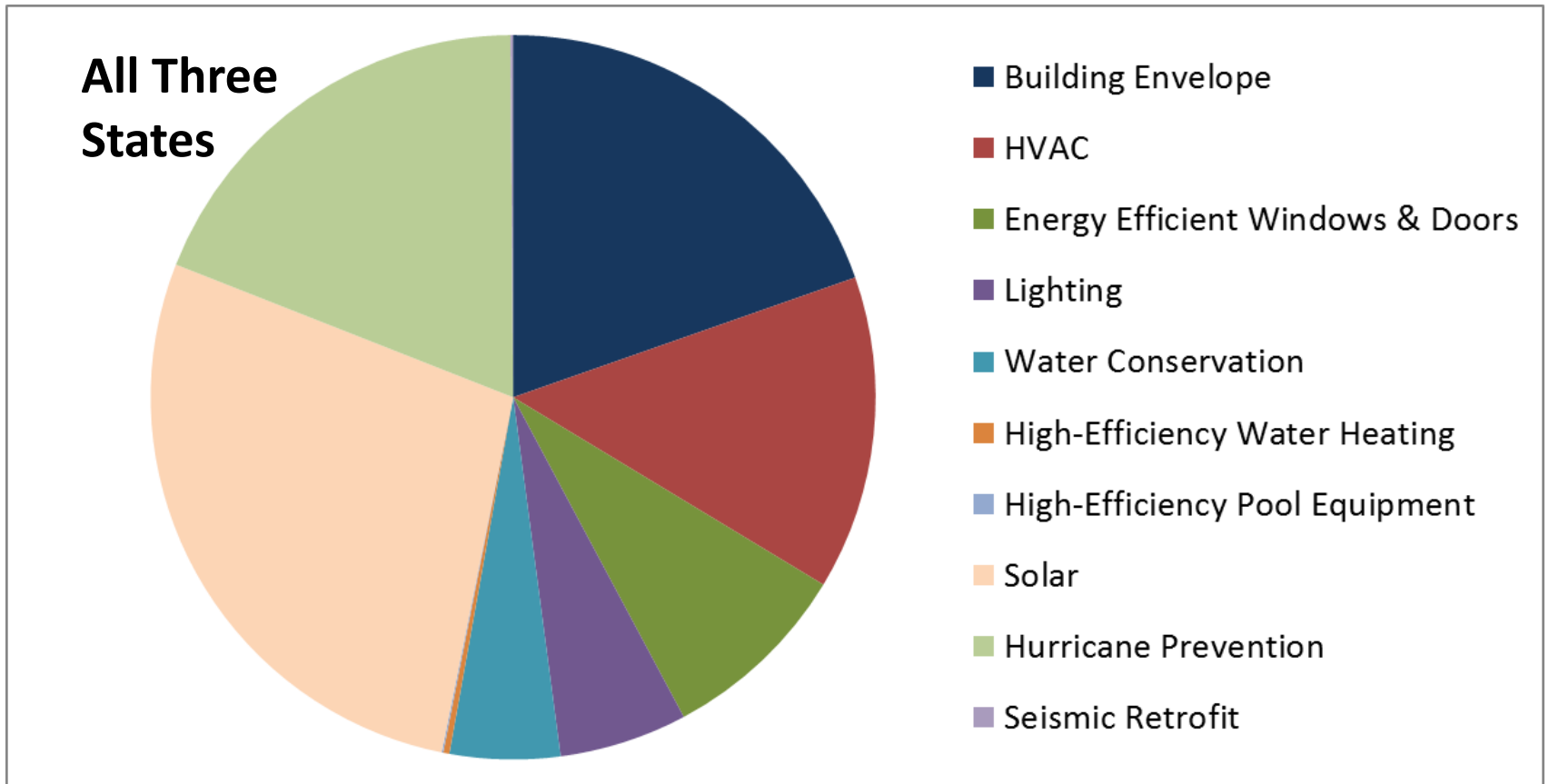
Number of Ygrene PACE Improvement Projects from 2013 to July 2018

| | |
|--------------|---------------|
| CA | 32,513 |
| Residential | 31,867 |
| Commercial | 646 |
| FL | 21,855 |
| Residential | 21,766 |
| Commercial | 89 |
| MO | 162 |
| Residential | 162 |
| Commercial | 0 |
| Total | 54,530 |
| Residential | 53,795 |
| Commercial | 735 |

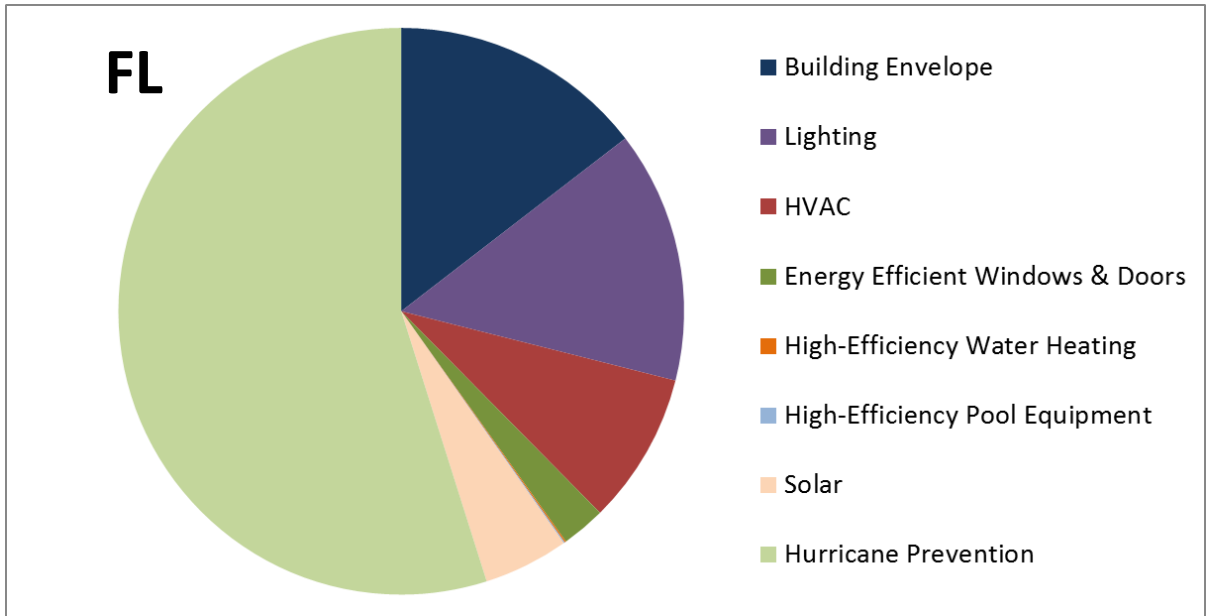
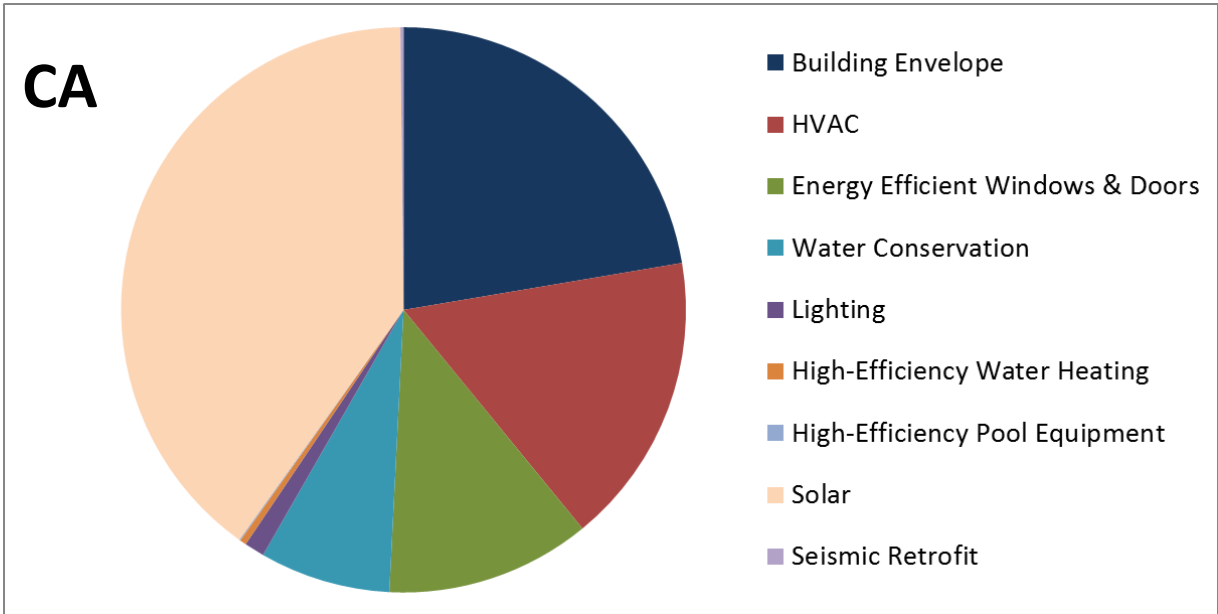


Ygrene PACE Financing

- Distribution of contract \$ of Ygrene PACE financing among various improvement categories



Ygrene PACE Financing



Contributions of PACE Financing

- Direct benefits:
 - Reduction in electricity, gas and water use; Increase in renewable electricity generation
 - Reduction in GHG emissions
 - Reduction in vulnerability to fire & earthquakes
- Co-benefits:
 - Increases in business sales revenue, GDP, personal income, and employment
 - Increases in taxes to various levels of government
 - Reduction in insurance premiums
 - Decreases in ordinary air pollutants

Data

- Ygrene Data on PACE Projects
 - Major PACE assessment characteristics (improvement type, useful life, contract amount, type of property, settlement date, etc.)
 - Financing characteristics (interest rates, amortization period, annual coupon, fees, etc.)
 - Characteristics of property (location, building area, owner type, etc.)
 - Modeled impact estimates on energy and water savings
- Supplemental data on how to divide contract dollars between construction sector and various materials/equipment manufacturing sectors
- Benefit-Cost Ratios for benefits of hazard mitigation
- Florida Office of Insurance Regulation data on wind mitigation insurance savings

Benefits of Hazard Mitigation

- PACE financing for earthquakes and hurricane mitigation yield the following benefits:
 - reduced property damage
 - reduced death and injury
 - reduced business interruption
- Estimated benefit-cost ratios for individual improvement types -- similar to the *Mitigation Saves* (4:1) Study
- Methodology
 - Earthquakes: adapted unpublished data from *Mitigation Saves 2*
 - Hurricanes: adapted Insurance Institute for Building and Home Safety (IBHS) FORTIFIED designation levels

BCRs by PACE Seismic Improvement Category

| PACE Seismic Retrofit Categories | Commercial BCR | Residential BCR |
|---------------------------------------|-------------------|-----------------|
| Seismic Foundation Strengthening | 0.57 ^a | 0.39 |
| Foundation Connection System | 1.77 ^b | 1.21 |
| Structural Connection System | 3.66 | 2.49 |
| Seismic Other/Custom | 2.18 | 1.49 |
| Lateral Systems, Moment Frames | 0.47 ^c | 0.27 |
| Lateral Systems, New Steel Columns | 0.71 ^d | 0.48 |
| Lateral Systems, Shear Walls | 1.77 ^b | 1.21 |
| Lateral Systems, Column Strengthening | 0.57 ^a | 0.39 |
| Masonry Reinforcement | 5.04 ^c | 2.92 |

^a Estimated as one-half of the BCR for “Structural strengthening of a university science building: jacket concrete columns and beams; strengthen footings” because it includes two PACE improvement categories.

^b Estimated as one-half of the BCR for “Structural and nonstructural retrofit of a hospital building: install new concrete shearwalls, enlarge foundations, nonstructural bracing” because it includes two PACE improvement categories.

^c Based on public building estimates.

^d Based on an adjustment of “Lateral Systems, Column Strengthening”, which was assumed to be a retrofit and assumed to have a 25% higher cost than New Steel Columns.

BCRs for PACE Hurricane Improvement Types

| PACE Improvements | Residential BCRs | | | Commercial BCRs |
|---------------------------------------------|------------------|-----------|---------|-----------------|
| | Worst-Case | Best-Case | Average | |
| High-Impact Windows | 0.21 | 2.54 | 1.38 | 1.43 |
| High-Impact Doors - Standard | 0.21 | 2.54 | 1.38 | 1.43 |
| Wind Resistant Roofing | 0.63 | 4.40 | 2.51 | 2.61 |
| Wind Resistant Shingles | 0.63 | 4.40 | 2.51 | 2.61 |
| Storm Shutters | 0.21 | 2.54 | 1.38 | 1.43 |
| Roof Deck Attachment Strengthening | 1.47 | 4.40 | 2.93 | 3.05 |
| Opening Protections/Garage Doors | 0.21 | 2.54 | 1.38 | 1.43 |
| Roof to Wall Reinforcement | 0.62 | 3.31 | 1.96 | 2.04 |
| Secondary Water Barrier | 0.63 | 4.40 | 2.51 | 2.61 |
| Waterproofing - Basement Membrane | 2.20 | 4.40 | 3.30 | 3.43 |
| High-Impact Doors | 0.21 | 2.54 | 1.38 | 1.43 |
| Gable-end Bracing | 0.74 | 6.94 | 3.84 | 3.99 |
| Hurricane Protection-Impact Windows & Doors | 0.42 | 2.54 | 1.48 | 1.54 |
| Hurricane Protection-Other | 1.29 | 2.57 | 1.93 | 2.00 |

Analysis Model

- REMI PI+ Model
 - 3 regions: California, Florida, and Rest of U.S.
 - 160 sectors
 - based on historical data through 2016

Linkages between Direct Costs/Savings of the PACE Programs and REMI Inputs

| Linkage | Direct Costs/Savings of the PACE Program | | Policy Variable Selection in REMI | Positive or Negative Stimulus to the Economy |
|---------|---------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 1 | Upfront Investment | | Output and Demand Block → Exogenous Final Demand (amount) for Construction sector and various relevant manufacturing sectors → Increase | Positive |
| 2 | Expenditure on PACE Administrator Fees | | Output and Demand Block → Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector → Increase | Positive |
| 3 | Expenditure on Program Fees | | Output and Demand Block → State and Local Government Spending → Increase | Positive |
| 4 | Interest Payment of PACE Assessments | | Output and Demand Block → Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector → Increase | Positive |
| 5 | Energy (Electricity & NG) and Water Savings | Commercial Sectors | Compensation, Prices, and Costs Block → Production Cost of Individual Commercial Sectors → Decrease | Positive |
| | | Residential Sector | Output and Demand Block → Consumption Reallocation (amount) → All Consumption Sectors → Increase | |
| 6 | Solar Investment Tax Credit | Commercial Sectors | Compensation, Prices, and Costs Block → Production Cost of Individual Commercial Sectors → Decrease | Positive |
| | | Residential Sector | Output and Demand Block → Consumption Reallocation (amount) → All Consumption Sectors → Increase | |

Linkages between Direct Costs/Savings of the PACE Programs and REMI Inputs

| Linkage | Direct Costs/Savings of the PACE Program | | Policy Variable Selection in REMI | Positive or Negative Stimulus to the Economy |
|---------|-------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 7 | Insurance Premium Savings | Commercial Sectors | Compensation, Prices, and Costs Block → Production Cost of Individual Industrial and Commercial Sectors → Decrease | Positive |
| | | Residential Sector | Output and Demand Block → Consumption Reallocation (amount) → All Consumption Sectors → Increase | |
| 8 | Annual Amortized Payment by PACE Assessment Borrowers | Commercial Sectors | Compensation, Prices, and Costs Block → Capital Cost (amount) of Individual Commercial and Industrial Sectors → Increase | Negative |
| | | Residential Sector | Output and Demand Block → Consumption Reallocation (amount) → All Consumption → Decrease | |
| 9 | Water Demand Decrease from the Water Supply Sector | | Output and Demand Block → Exogenous Final Demand (amount) for Water, Sewage and Other Systems sector → Decrease | Negative |
| 10 | Decrease Demand of Electricity | | Output and Demand Block → Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution sector → Decrease | Negative |
| 11 | Decreased Demand of NG | | Output and Demand Block → Exogenous Final Demand (amount) for Oil and Gas Extraction and Refining Sector → Decrease | Negative |

Analysis of Results

Energy & Environmental Impacts (entire lifetime)

Based on > \$800 million of project financing

California Ygrene PACE Projects

- 2.8 billion gallons water savings
- 3.3 billion KWh energy savings
- 3.6 billion cf of natural gas savings
- \$1 billion utility bill savings
- 1.11 million metric tons of GHG emissions reductions

Analysis of Results (cont'd)

Energy & Environmental Impacts (entire lifetime)

Based on > \$400 million of project financing

Florida Ygrene PACE Projects

- 804 million kWh electricity savings
- 400 million cf of natural gas savings
- \$94 million utility bill savings
- 445,000 metric tons of GHG emissions reductions

Analysis of Results (cont'd)

Avoided Disaster Losses of Florida PACE Hurricane Improvement Projects

| Project Implementation Year | Residential | Commercial | Total |
|-----------------------------|----------------------|--------------------|----------------------|
| 2013 | \$170,628 | \$14,071 | \$184,698 |
| 2014 | \$5,883,471 | \$508,675 | \$6,392,146 |
| 2015 | \$21,422,128 | \$329,204 | \$21,751,332 |
| 2016 | \$72,222,531 | \$1,127,828 | \$73,350,359 |
| 2017 | \$263,971,847 | \$957,525 | \$264,929,372 |
| 2018 | \$140,228,290 | \$923,796 | \$141,152,086 |
| Total | \$503,898,895 | \$3,861,098 | \$507,759,993 |

Analysis of Results (cont'd)

Annual Insurance Savings for Florida Hurricane Projects (2018\$)

| | Residential Projects | | | | Commercial Projects | | |
|--------------|----------------------|-------------|-------------|--|---------------------|-------------|-------------|
| | Average | Lower-Bound | Upper-Bound | | Average | Lower-Bound | Upper-Bound |
| 2013 | 17,232 | 8,616 | 25,848 | | 624 | 312 | 936 |
| 2014 | 270,541 | 135,271 | 405,812 | | 6,237 | 3,119 | 9,356 |
| 2015 | 1,465,810 | 732,905 | 2,198,715 | | 7,895 | 3,947 | 11,842 |
| 2016 | 5,761,945 | 2,880,972 | 8,642,917 | | 17,430 | 8,715 | 26,145 |
| 2017 | 18,110,311 | 9,055,155 | 27,165,466 | | 28,657 | 14,329 | 42,986 |
| 2018 | 9,778,862 | 4,889,431 | 14,668,293 | | 18,054 | 9,027 | 27,081 |
| Total | 35,404,701 | 17,702,351 | 53,107,052 | | 78,897 | 39,449 | 118,346 |

Total cumulative insurance savings over the entire analysis period is over \$700 million.

Analysis of Results (cont'd)

Macroeconomic Impacts

California Ygrene PACE Projects

- \$135 million average annual increase of GDP and 1,305 person-year jobs per year during up-front investment period (2013-18)
- NPV (2013-2067) of GDP impacts is \$680.3 million
- 10,270 total cumulative person-year jobs generated
- NPVs of gross output and personal income impacts are \$1,313.8 million and \$506.6 million
- NPV of non-market value of electricity generation of \$277 million

Analysis of Results (cont'd)

Macroeconomic Impacts

Florida Ygrene PACE Projects

- \$53 million average annual increase of GDP and 637 person-year jobs per year during up-front investment period (2013-18)
- NPV (2013-2067) of GDP impacts is \$635.6 million
- 12,268 total cumulative person-year jobs generated
- NPVs of gross output and personal income impacts are \$1,181.6 million and \$533.8 million
- NPV of non-market value of electricity generation of \$19.6 million

Analysis of Results (cont'd)

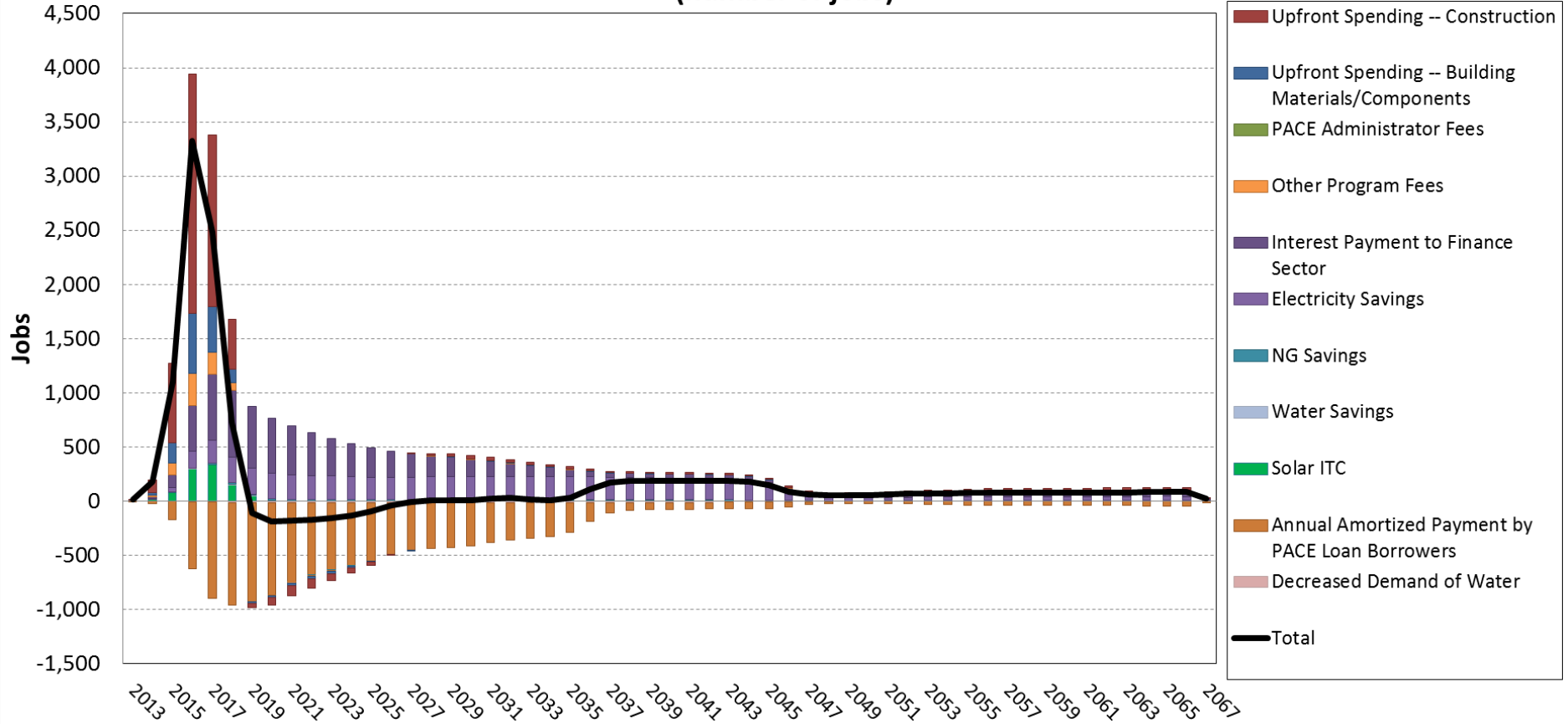
Decomposition Analysis

- Evaluate how the various factors affect the aggregate macroeconomic impact results
- Help identify major factors that affect the bottom-line results
- Conducted by running REMI simulations for each individual factor one at a time
- Use as a basis to identify influential factors to run sensitivity analysis

Analysis of Results (cont'd)

Decomposition Analysis

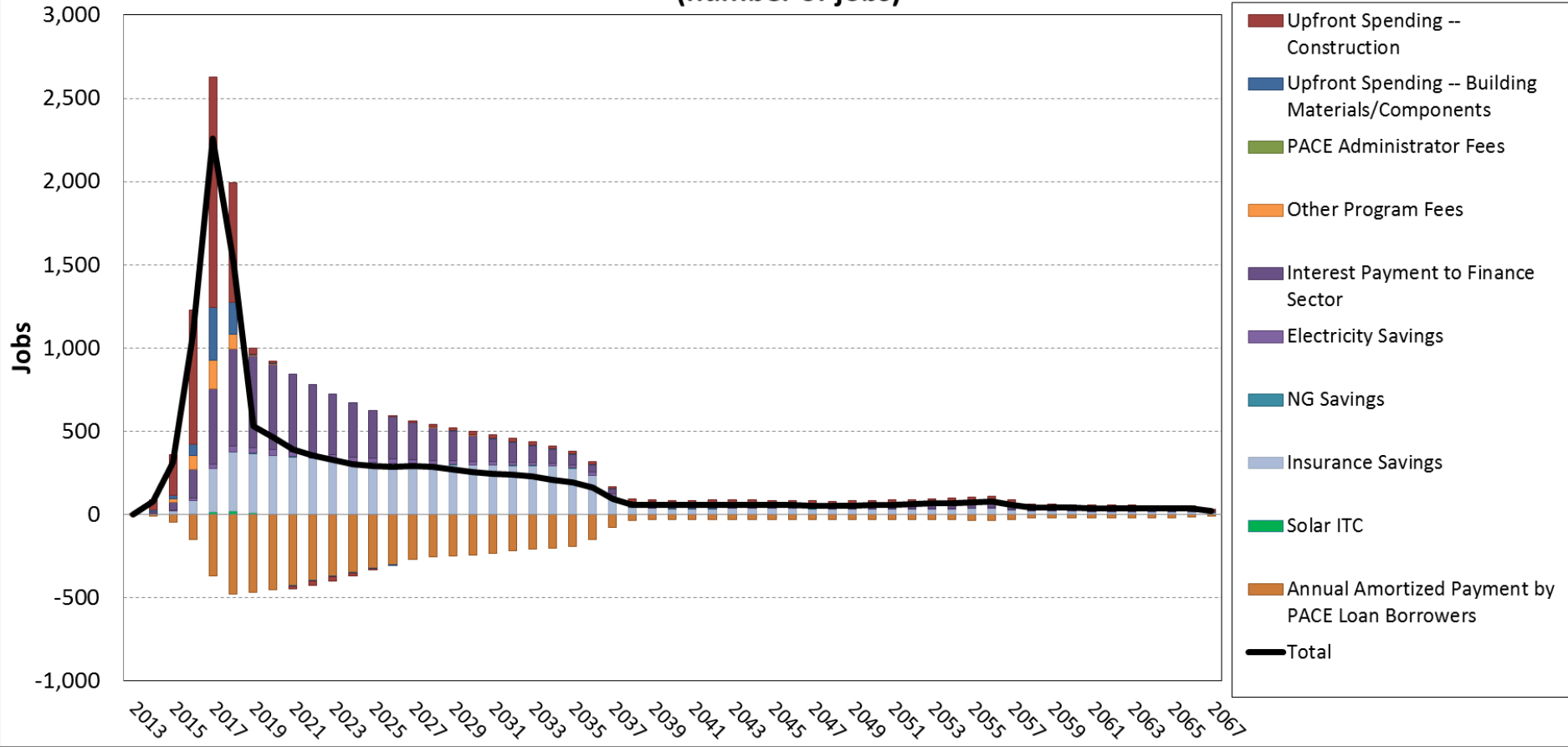
**Figure 1. Employment Impacts of California PACE
(number of jobs)**



Analysis of Results (cont'd)

Decomposition Analysis

**Figure 3. Employment Impacts of Florida PACE
(number of jobs)**



Analysis of Results (cont'd)

Sensitivity Analysis

- Sensitivity test on the assumption of dollar-for-dollar displacement of other purchases to repay PACE financing
- Alternative assumption reduces the direct offset by 10%
- Positive net employment and GDP impacts increase by about 12% in California and 6% in Florida
- NPV of non-market value of electricity generation remains the same

Analysis of Results (cont'd)

Sensitivity Analysis

- Sensitivity analyses in which we add the dampening impacts from the decreased demand for electricity and natural gas from the energy supply sectors
- For California, the NPV of GDP impacts decreases from \$680.9 million to \$300 million; employment impacts decrease from 10,270 to 5,057 person-year jobs.
- For Florida, the NPV of GDP impacts decreases from \$636 million to \$588 million; employment impacts decrease from 12,268 to 11,657 person-year jobs.

Analysis of Results (cont'd)

Summary Results for California

| Type of Impacts | GDP Impacts (million 2015\$) | Employment Impacts (person-year jobs) | Other |
|--------------------------------------------------------|---------------------------------|------------------------------------------|------------|
| Ygrene Financing Upfront Expenditures | 491.29 | 7,010 | |
| Ygrene and Other Program Fees | 54.08 | 772 | |
| Interest Payments to the Finance Sector | 486.98 | 7,019 | |
| Energy (Electricity and Natural Gas) Cost Savings | 339.60 | 7,339 | |
| Water Cost Savings | 7.86 | 174 | |
| Solar investment Tax Credit | 76.41 | 1,103 | |
| Annual Repayment of PACE Financing | -754.85 | -12,744 | |
| Decreased Demand from Water Supply Sector | -21.09 | -402 | |
| Hurricane Insurance Savings | n/a | n/a | |
| Avoided Disaster Losses | 2.36 | | |
| Water Conservation (billions of gallons) | | | 2.8 |
| Electricity Consumption Reductions (million MWh) | | | 3.3 |
| Natural Gas Consumption Reductions (bcf) | | | 3.6 |
| Non-Market Electricity Production (million 2015\$) | 141.95 | n/a | |
| Greenhouse Gas Reductions (metric MtCO ₂ e) | | | 1.11 |
| Social Cost of Carbon ^f (million 2015\$) | 42.81 | | |
| Total | 867.40 | 10,271 | n/a |

Analysis of Results (cont'd)

Summary Results for Florida

| Type of Impacts | GDP Impacts (million 2015\$) | Employment Impacts (person-year jobs) | Other |
|--------------------------------------------------------|---------------------------------|------------------------------------------|------------|
| Ygrene Financing Upfront Expenditures | 266.65 | 4,549 | |
| Ygrene and Other Program Fees | 25.91 | 444 | |
| Interest Payments to the Finance Sector | 329.11 | 6,423 | |
| Energy (Electricity and Natural Gas) Cost Savings | 32.59 | 738 | |
| Solar investment Tax Credit | 3.96 | 69 | |
| Annual Repayment of PACE Financing | -354.13 | -7,191 | |
| Hurricane Insurance Savings | 331.47 | 7,235 | |
| Avoided Disaster Losses | 507.76 | | |
| Energy Consumption Reductions (million KWh) | | | 804 |
| Non-Market Electricity Production (million 2015\$) | 10.00 | n/a | |
| Natural Gas Consumption Reductions (million cf) | | | 400 |
| Greenhouse Gas Reductions (metric MtCO ₂ e) | | | 0.45 |
| Social Cost of Carbon ^e (million 2015\$) | 21 | | |
| Total | 1,174.32 | 12,267 | n/a |

Conclusion

- PACE represents an innovative mechanism to provide affordable financing for improvements to residential and commercial properties and to achieve various other public benefits
- In addition to the direct benefits, our results indicate substantial co-benefits of PACE in terms of GDP increase, job creation, insurance savings, and disaster loss reduction
- Next step of analysis -- public policy impacts of PACE financing

Thank you!

Comments and Questions?