KRIHS
국토연구원

New Energy for New Cities

Challenges & Solutions for Building Solar Cities

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With the support of Dr. Job Taminiau and Dr. Jeongseok Seo

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FREE
Foundation for Renewable Energy & Environment
freefutures.org

NASA Video Clip

Available at: https://climate.nasa.gov/climate_resources/101/

Why Focus on Cities?

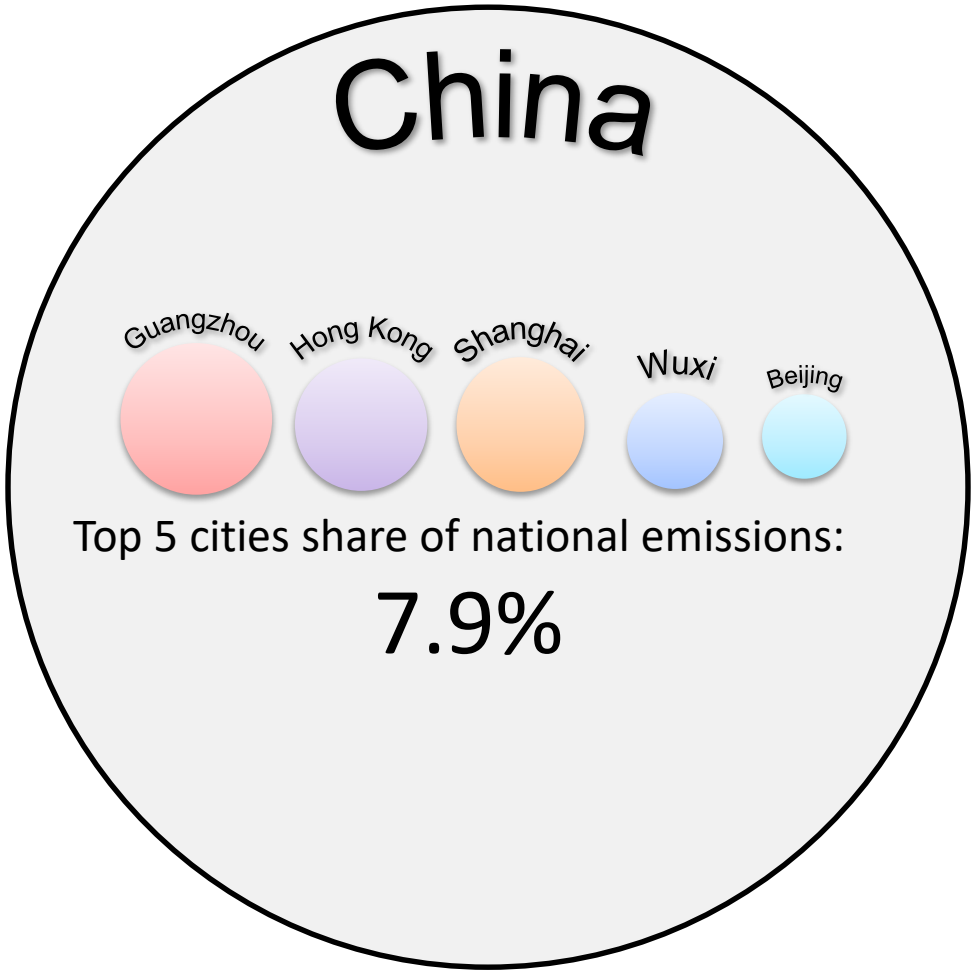
A source of our success…

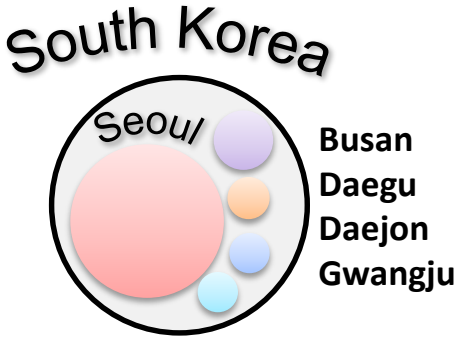
And our climate problem…

And Are Hosts of the Infrastructure for our Sustainable Future…

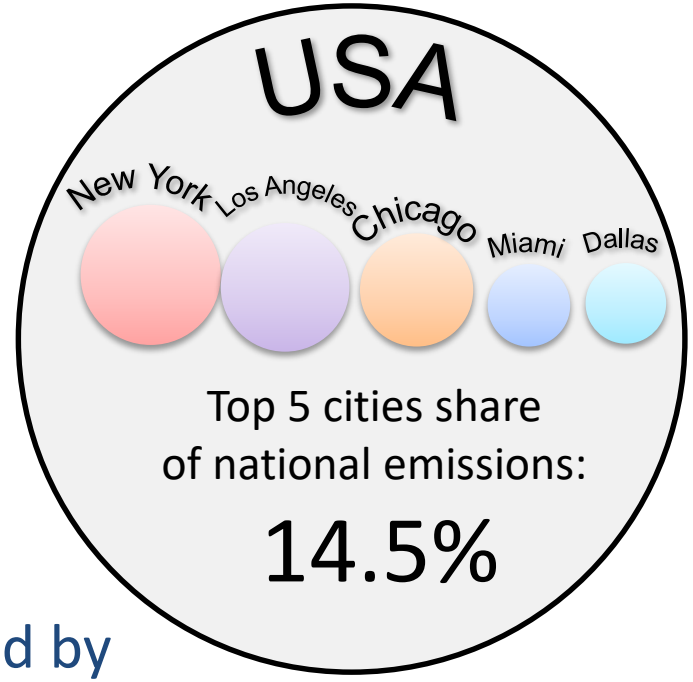
For All

Cities are the Principal source of CO_2 Emissions

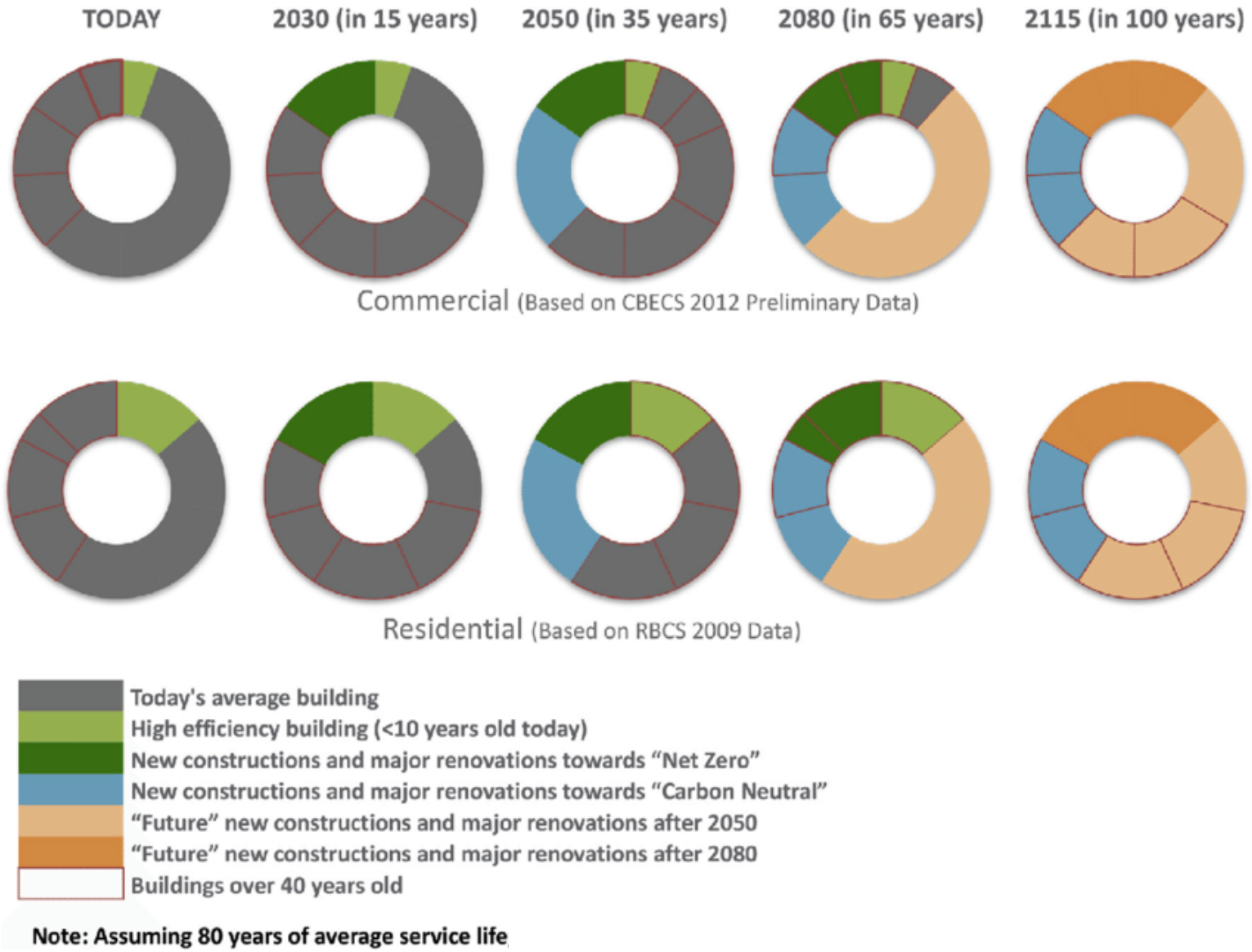




Top 5 cities share of national emissions: 55.9%



They account for 70% of the CO_2 released by human activity (IPCC, WG III, 2014)



Na Wang, Patrick E. Phelan, Jorge Gonzalez, Chioke Harris, Gregor Henze, Robert Hutchinson, Jared Langevin, Mary Ann Lazarus, Brent Nelson, Chris Pyke, Kurt Roth, David Rouse, Karma Sawyer, Stephen Selkowitz. 2017." Ten questions concerning future buildings beyond zero energy and carbon neutrality." *Buildings and Environment* (119): 169-182.

3 Energy Tools to Build reNEWable Cities

Saving & Smart Buildings
Rooftop Solar Plants
Green Energy Finance

Center for Energy and Environmental Policy
University of Delaware

Foundation for Renewable Energy & Environment
http://freefutures.org/

Smart Controls for Low-Risk, Investor-Ready Performance

EXISTING BUILDING

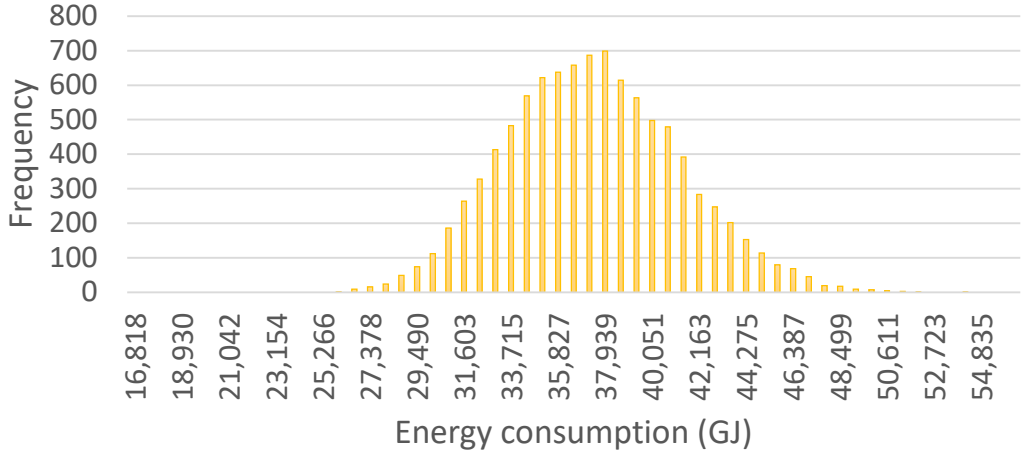
- Older technology
- High operating cost & volatile price risks
- No real-time control

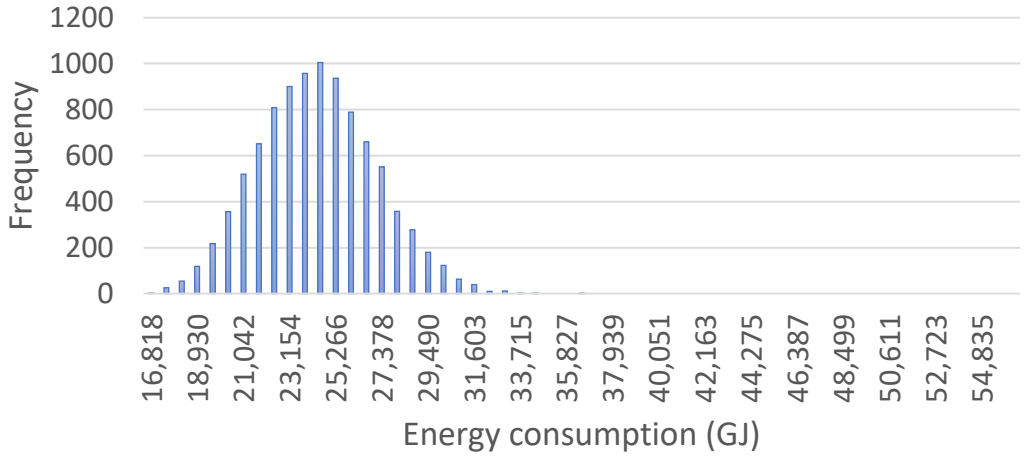
EFFICIENT RETROFIT

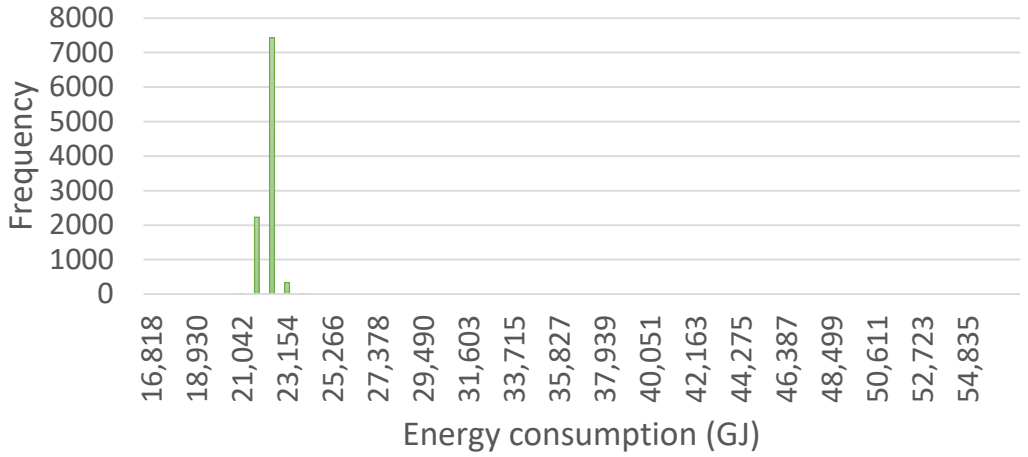
- Updated technology
- Investor-ready
- No real-time control

SMART BUILDING

- Pervasive wireless connectivity
- Analyze and act on real-time data for high performance
- Investor-ready, lowest risk profile







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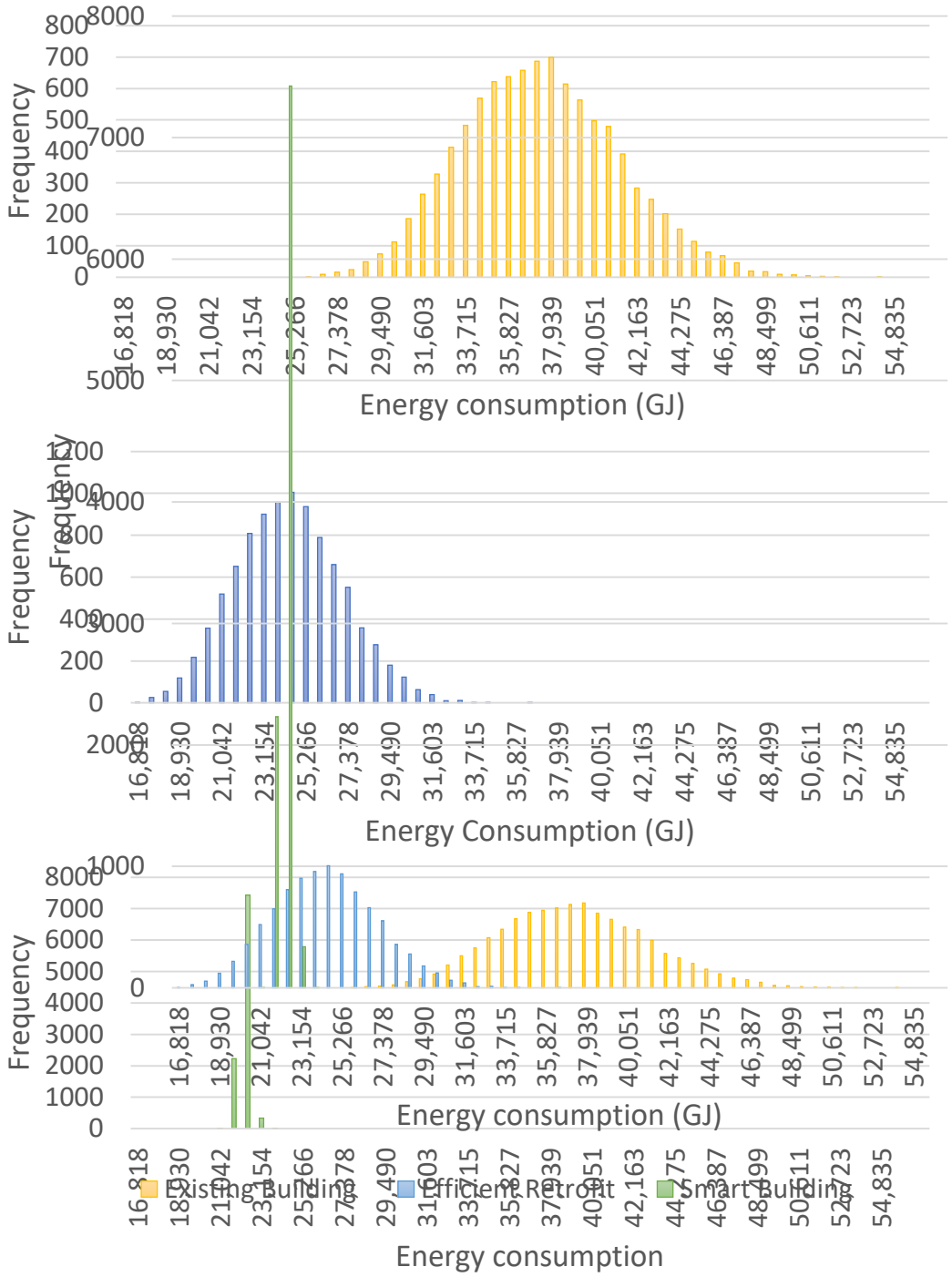
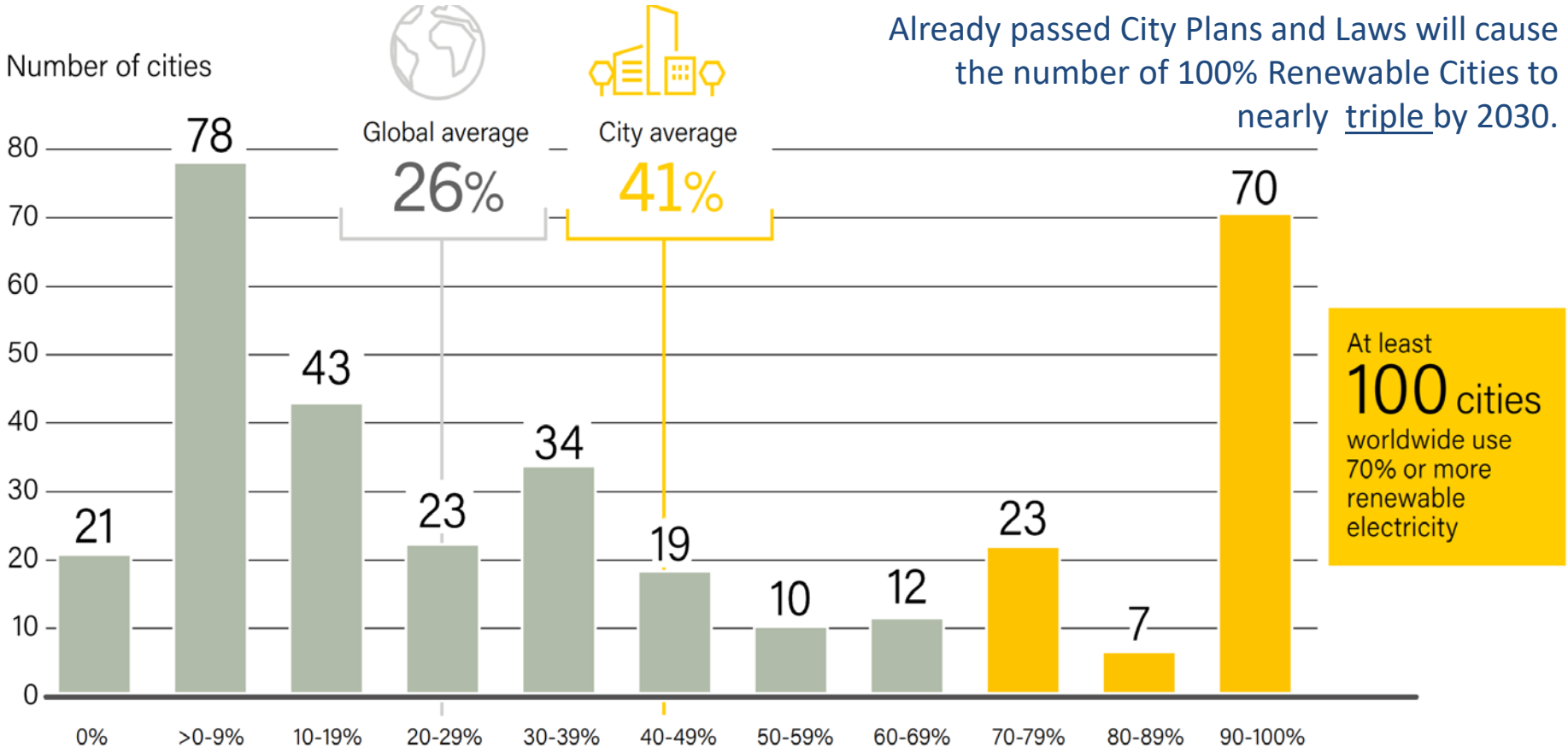


A 2ND ENERGY TOOL

Rooftop Solar Plants

Renewable Electricity Use by Cities

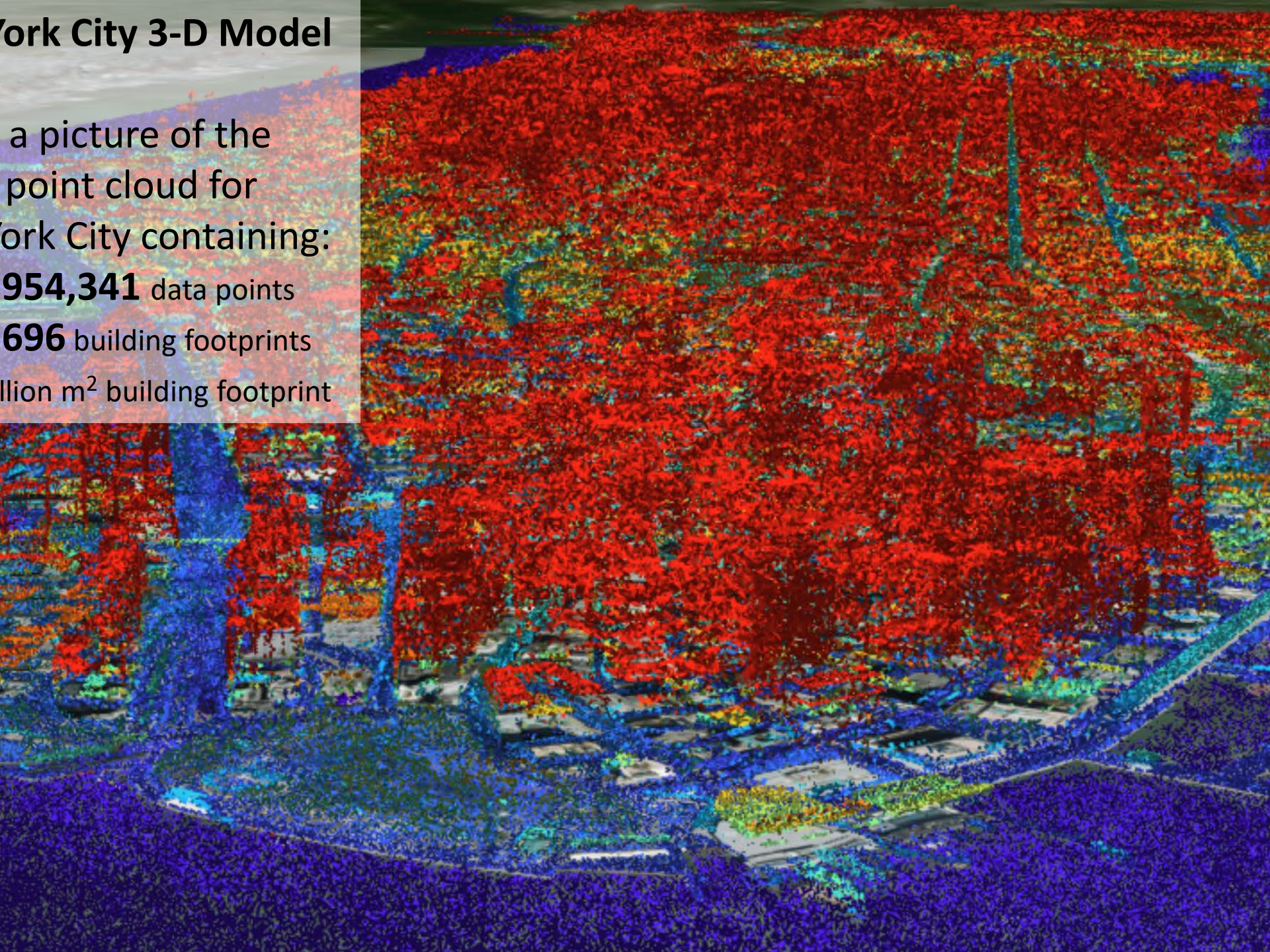


Already passed City Plans and Laws will cause the number of 100% Renewable Cities to nearly triple by 2030.

At least **100** cities worldwide use 70% or more renewable electricity

Source: REN21 (2019). Renewables in cities: 2019 Global status report.
Available at: https://www.ren21.net/cities/wp-content/uploads/2019/05/190605_City_Report_2019_web_FINAL.pdf

ork City 3-D Model



a picture of the
point cloud for
ork City containing:

954,341 data points

696 building footprints

llion m^2 building footprint

New York City 3-D Model

4,656,954,341 data points

1,082,696 building footprints

159 million m^2 building footprint

A video clip is shown here of the 3-D Model of New York City's ~1.0 mill
ion buildings being assembled

Solar City New York
10 GW$_P$ PV Plant

- Power from the Grid BEFORE 20% Building Efficiency Improvements
- Power from the Grid AFTER 20% Building Efficiency Improvements

PV Load Impact (all roof types)

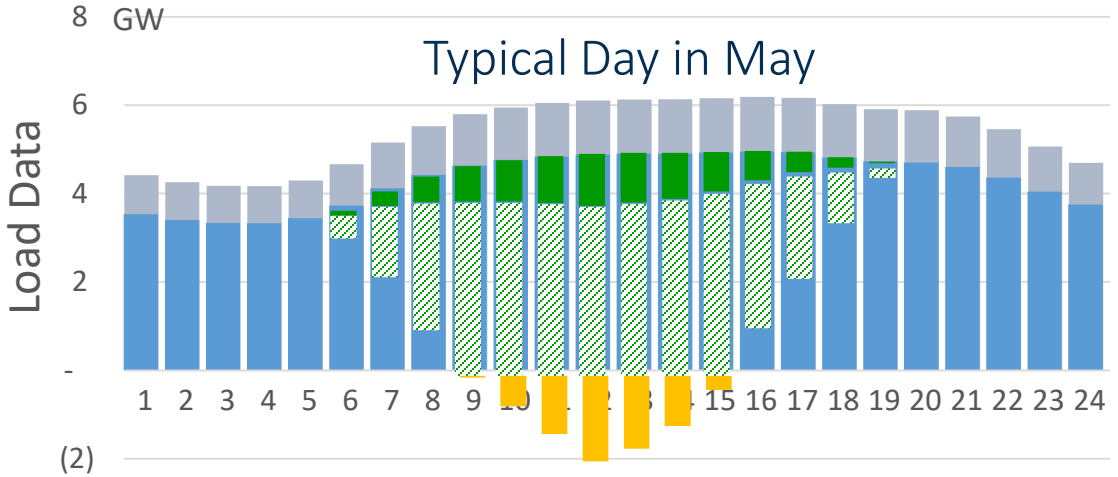
- Public Buildings (55% of the Rooftop Area of All Public Buildings)

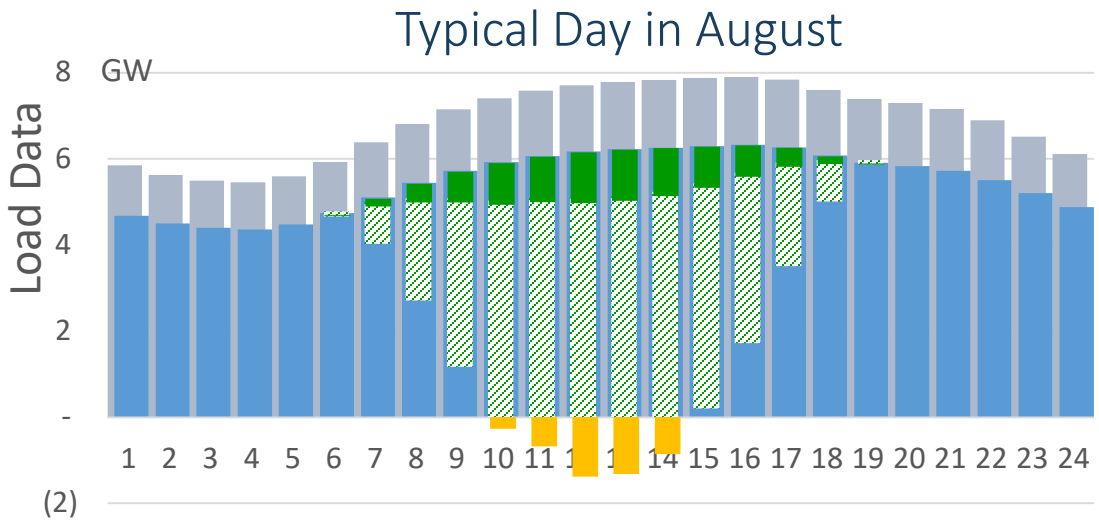
  5% of the City's Total Roof Area

- All Buildings

  56% of the City's Total Roof Area

- Surplus created by Solar City System





Sources: Load data supplied by NYISO. PV generation estimates by *SAM*, software developed by NREL. https://sam.nrel.gov/
Publications describing the method used: "Melius et al (2013), Estimating Rooftop Suitability for PV: A Review of Methods, Patents, and Validation Techniques (NREL/TP-6A20-60593); Gagnon et al (2016), Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment (NREL/TP-6A20-65298); and Byrne and Taminiau (2018), "Utilizing the Urban Fabric as the Solar Power Plant of the Future" in P. Droege ed., Urban Energy Transition: Renewable Strategies for Cities, 2nd edition (Elsevier, ISBN: 978-0-08-102074-6).

Solar City New York

Power from the Grid BEFORE 20% Building Efficiency Improvements

Power from the Grid AFTER 20% Building Efficiency Improvements

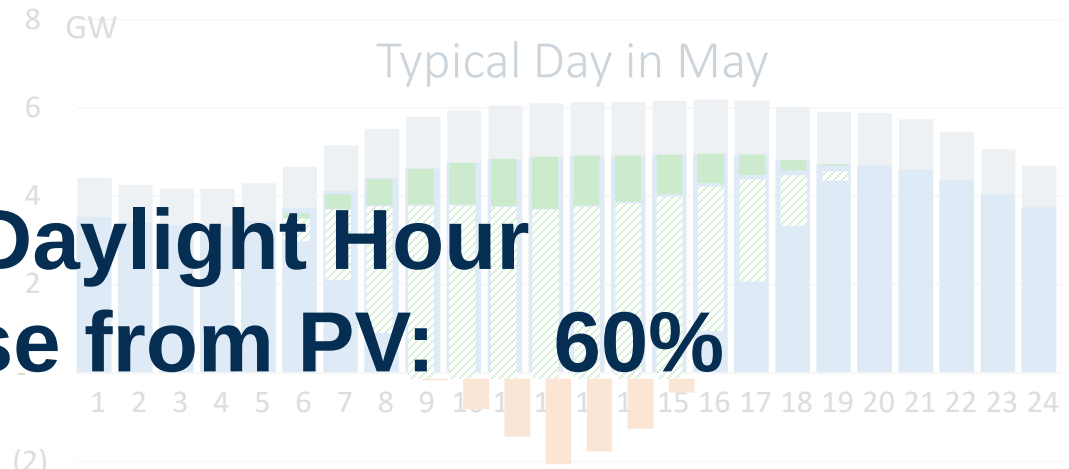
PV Load Impact (all roof types)

Public Buildings (55% of the Rooftop Area of All Public Buildings)

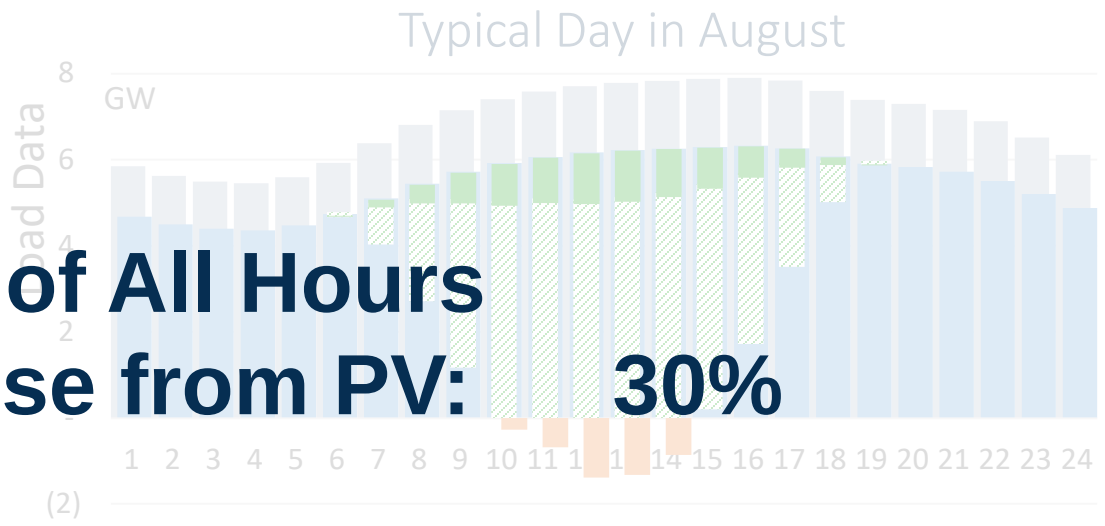
4.8% of the City's Total Roof Area

All Buildings

51% of the City's Total Roof Area



% of Daylight Hour
Electric Use from PV: 60%

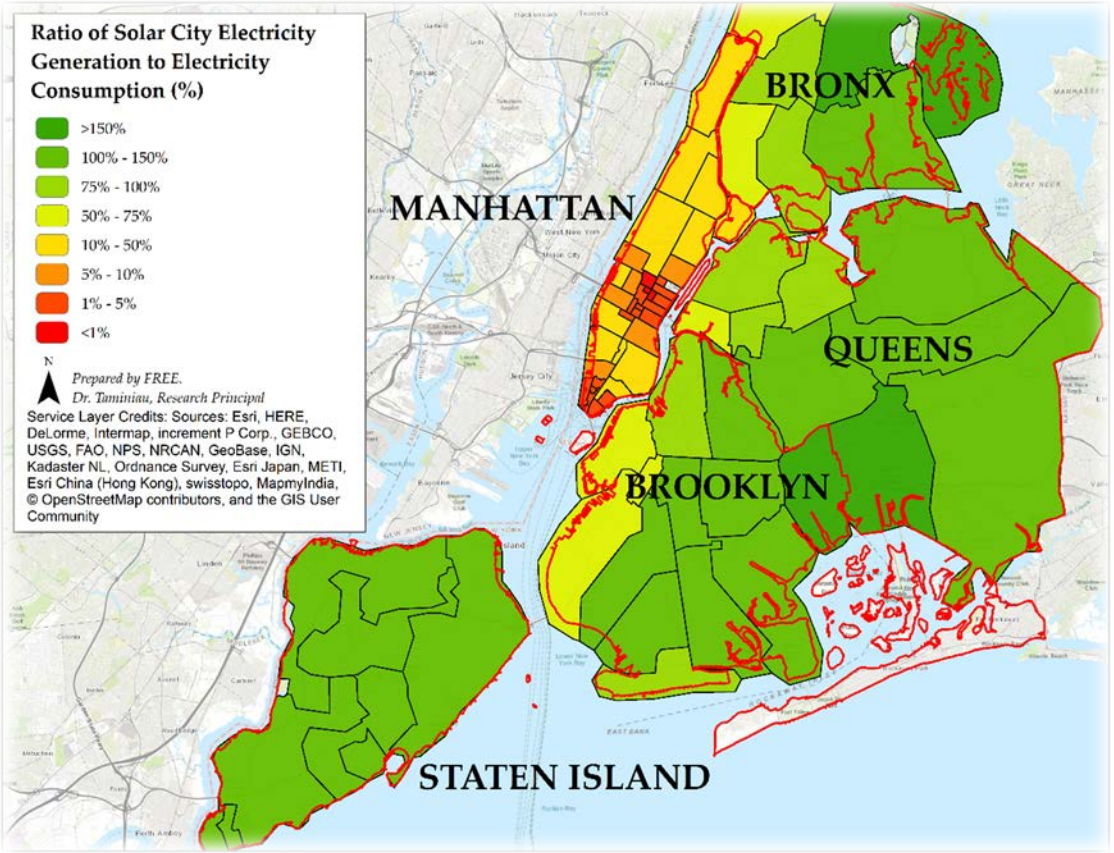


% of All Hours
Electric Use from PV: 30%

A Prosumer City

New City Relationship to Energy

- Hour-by-hour evaluation of 68 electricity networks in NYC
- Outside boroughs could supply power to Manhattan



Solar City Seoul

10.6 GW_P PV Plant

- Power from the Grid BEFORE 20% Building Efficiency Improvements
- Power from the Grid AFTER 20% Building Efficiency Improvements

PV Load Impact (all roof types)

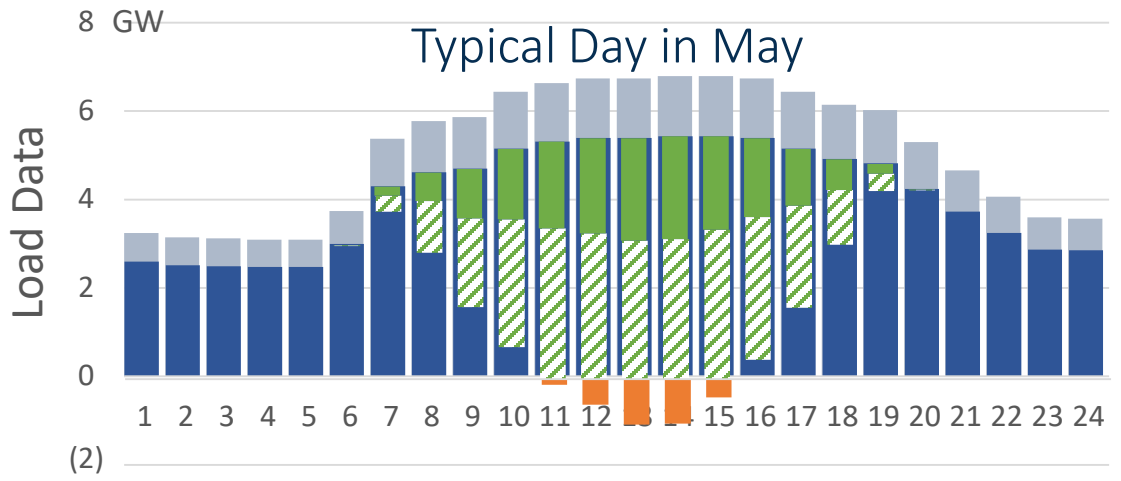
- Public Buildings (60% of the Rooftop Area of All Public Buildings)

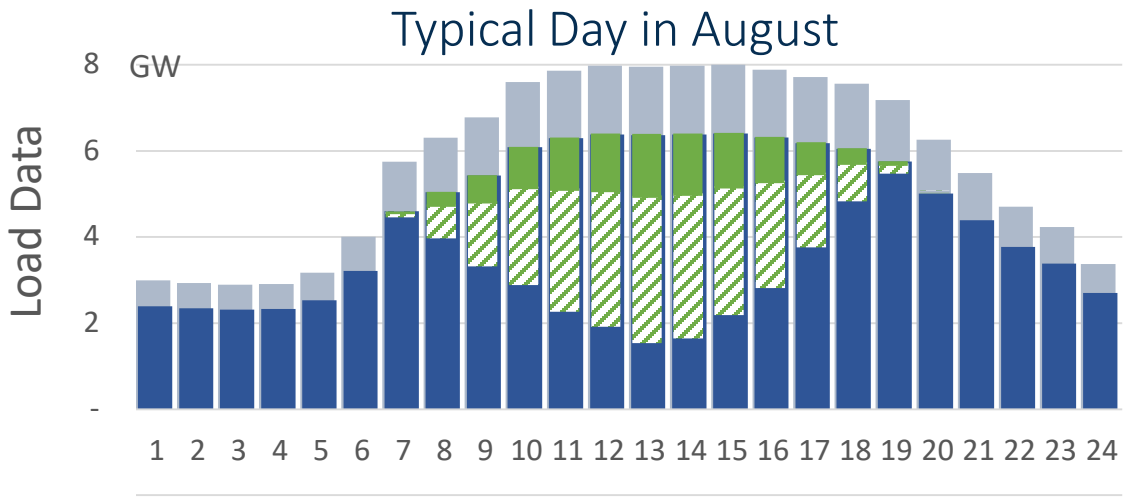
  16% of the City's Total Roof Area

- All Buildings

  45% of the City's Total Roof Area

- Surplus created by Solar City System

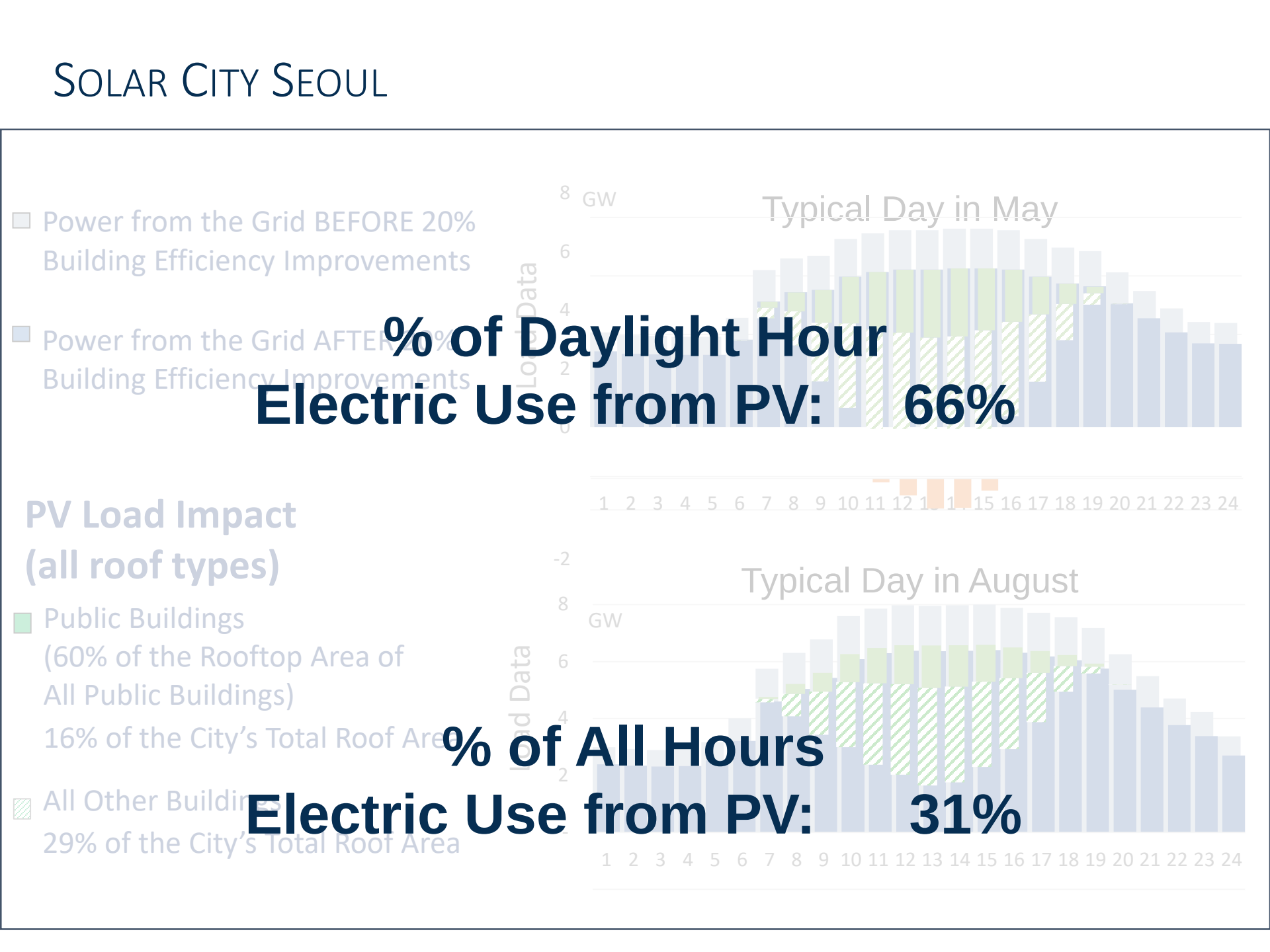




Sources: Load data supplied by KEPCO. Estimates by *SAM*, software developed by NREL. https://sam.nrel.gov/

Publications describing the method used: Byrne, Taminiau, et al (2015) "A review of the solar city concept and methods to assess rooftop solar electric potential, with an illustrative application to the city of Seoul." Renewable and Sustainable Energy Reviews 41: 830-844. See also Byrne, Taminiau et al (2016) "A solar city strategy applied to six municipalities: integrating market, finance, and policy factors for infrastructure-scale photovoltaic development in Amsterdam, London, Munich, New York, Seoul, and Tokyo." Wiley Interdisciplinary Reviews: Energy and Environment 5: 68–88 doi: 10.1002/wene.182

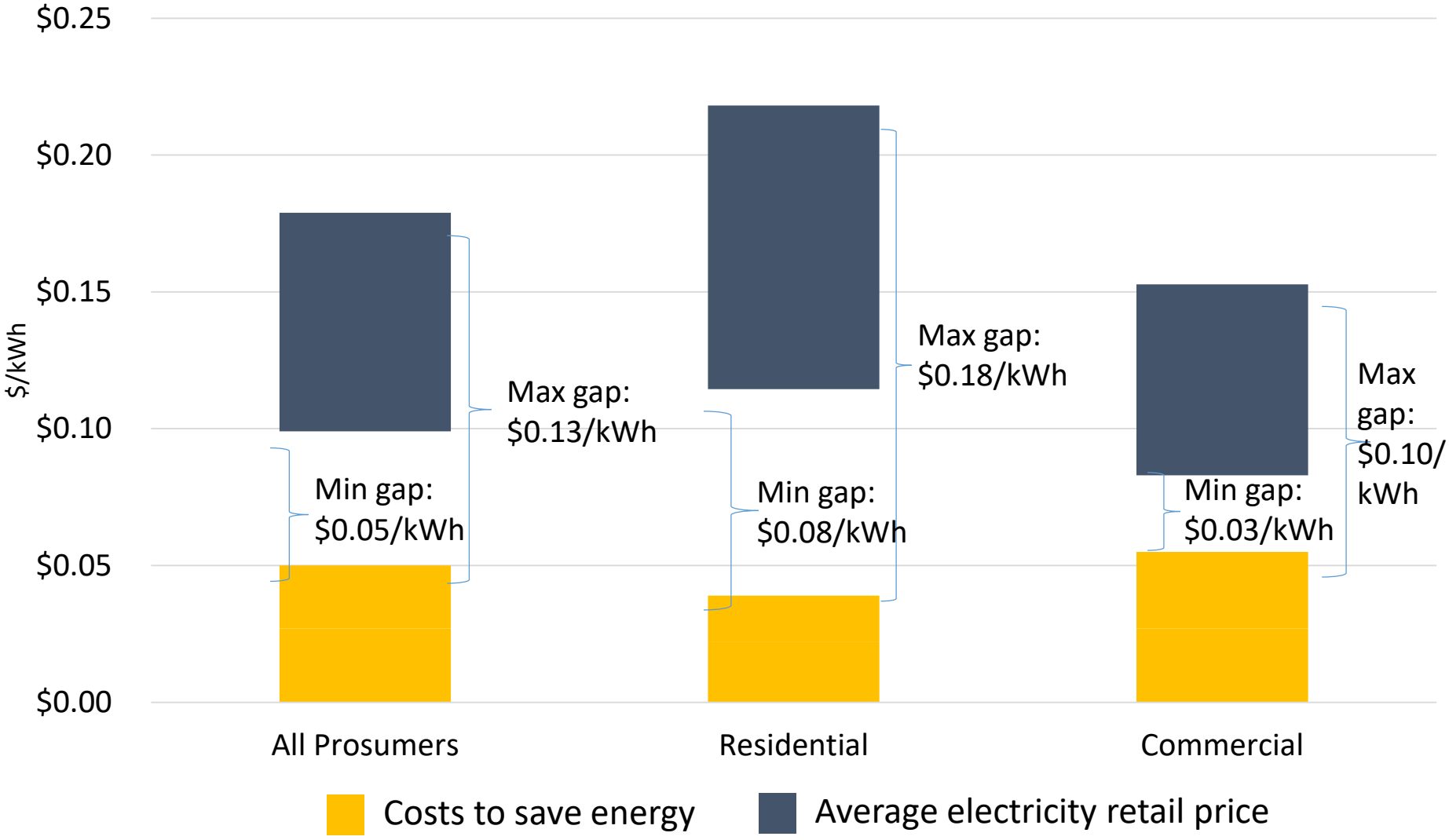
Solar City Seoul



A 3RD ENERGY TOOL

Green Energy Finance

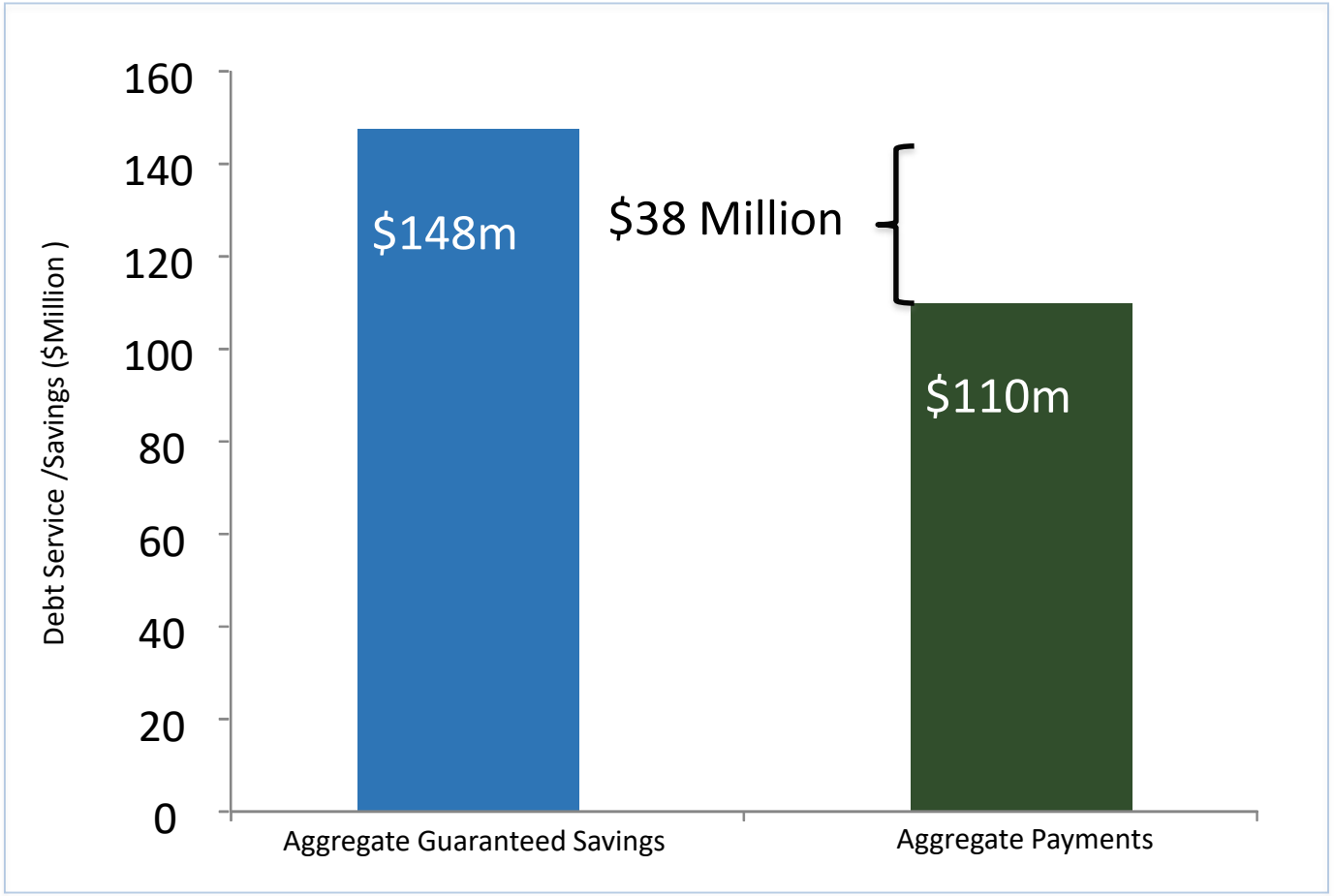
Where's the Money?



Sources: Hoffmann et al. (2018). The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009–2015. https://emp.lbl.gov/projects/what-it-costs-save-energy Electricity price data from Energy Information Administration (2019). https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

Scaling Up Negawatt Investments

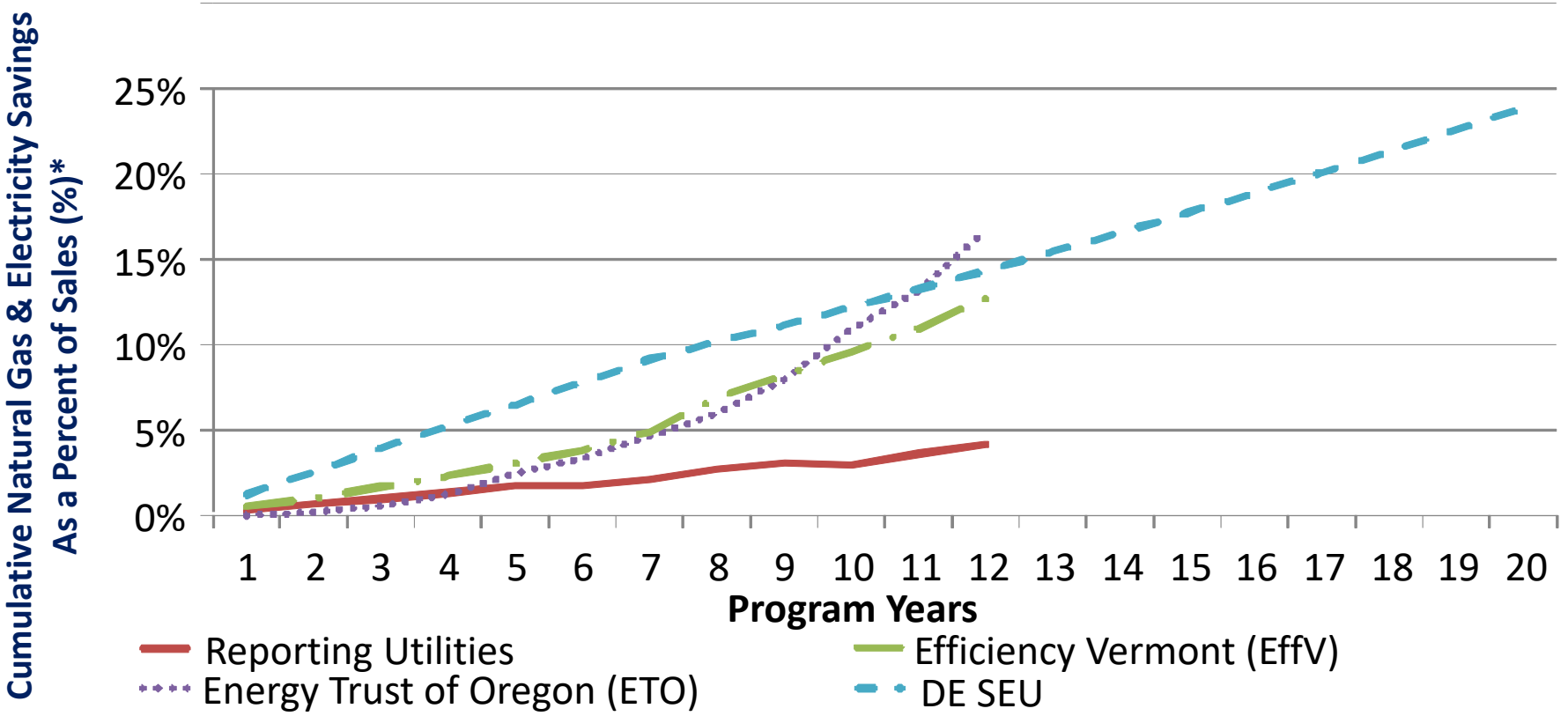
The Sustainable Energy Utility:
New Policy & New Economy for the New Climate



~ 1,000 Jobs

S&P AA+ Rating

Energy Commodity Planning Replaced by Community Energy Governance



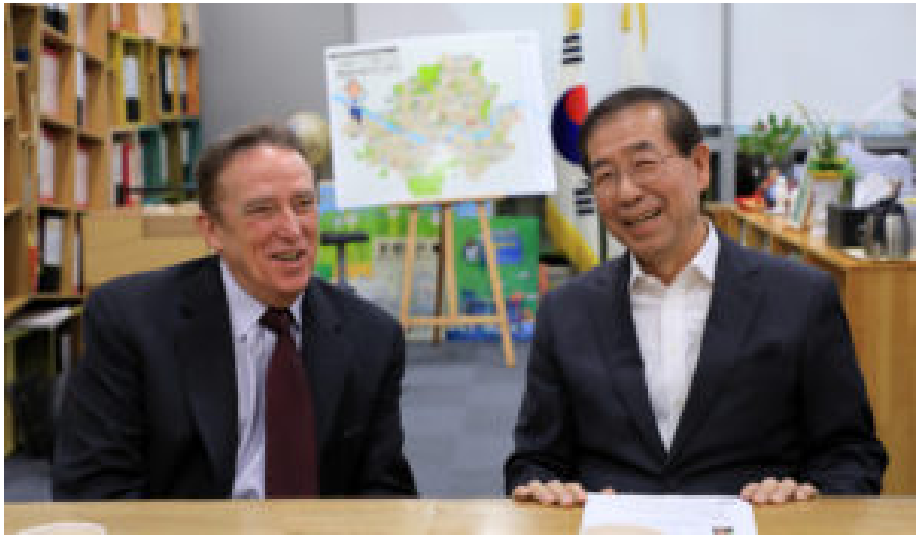
Notes: 'Reporting Utilities' includes electric utilities only; electricity savings are based on U.S. EIA Form 861, for the period 2001-2012. 'EffV' and 'ETO include natural gas and electricity savings (2001-2012). Savings for these organizations are not guaranteed. 'DE SEU' includes electricity and natural gas savings, and is based on the 2011 DE SEU 20-year bond, its rebate programs for 2009-2011, its SREC auctions for 2012-13, and its Dover SUN Park SREC purchase (2011-13). Savings from the 2011 bond sale are contractually guaranteed; bond savings by year during the 20-year bond are from Citigroup, "Post-Pricing Commentary." SREC transactions of the DE SEU are based on recorded monthly output of PV systems. Savings from its rebate programs are based on the same estimation methods used by reporting utilities.
For all organizations, electricity and natural gas sales derived from EIA Forms 176 and 861.
See Figure 5 in J. Byrne and J. Taminiau, "A review of sustainable energy utility and energy service utility concepts and applications." 2015. *WIREs Energy Environ*. doi: 10.1002/wene.171

Self-Financing Investment in Sustainability

Solar City Seoul: 1 Gigawatt Solar + 30% Conservation

Elements of the Plan:

- By 2022, 1 Gigawatt of PV – 8 times current capacity
- 30% Cut in Building Energy Use
- ~$1.5 Billion Investment
- PV as Integral Part of Daily Urban Life: 1 Million Households
- All Public Buildings Participate
- High Level of Citizen Participation



Seoul Mayor Park Won-soon and Dr. John Byrne, co-founder of FREE discuss the Seoul Solar City initiative.

http://freefutures.org/announcement/free-applauds-the-launch-of-a-solar-city-seoul/

FREE is an advisor to Seoul Metropolitan Government