
# Solar on Superstores

## How the Roofs of Big Box Stores Can Help America Shift to Clean Energy

ENVIRONMENT WASHINGTON RESEARCH & POLICY CENTER

FRONTIER GROUP

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## How the Roofs of Big Box Stores Can Help America Shift to Clean Energy


Written by:

**Gideon Weissman and Judee Burr**

Frontier Group

**Bret Fanshaw and Rob Sargent**

Environment America Research & Policy Center



Spring 2016

# Acknowledgments

Environment Washington Research & Policy Center sincerely thanks Gary Cook of Greenpeace, Bradley Dakake of Sunpower, and Benjamin Inskeep of NC Clean Energy Technology Center for their review of drafts of this document, as well as their insights and suggestions. Thanks also to Tony Dutzik and Kim Norman of Frontier Group, as well as Jeff Inglis and Lindsey Hallock, formerly of Frontier Group, and Vincent Armentano, former Frontier Group intern, for their contributions and editorial support. Additionally, Frontier Group thanks ESRI for granting the use of their ArcGIS mapping software.

Environment Washington Research & Policy Center thanks the Tilia Fund, the Barr Foundation, the John Merck Fund, Fred & Alice Stanback, the Scherman Foundation, the Arntz Family Foundation, Kendeda Foundation, Gertrude and William C. Wardlaw and the Fund for New Jersey for making this report possible.

The authors bear responsibility for any factual errors. The recommendations are those of Environment Washington Research & Policy Center. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.




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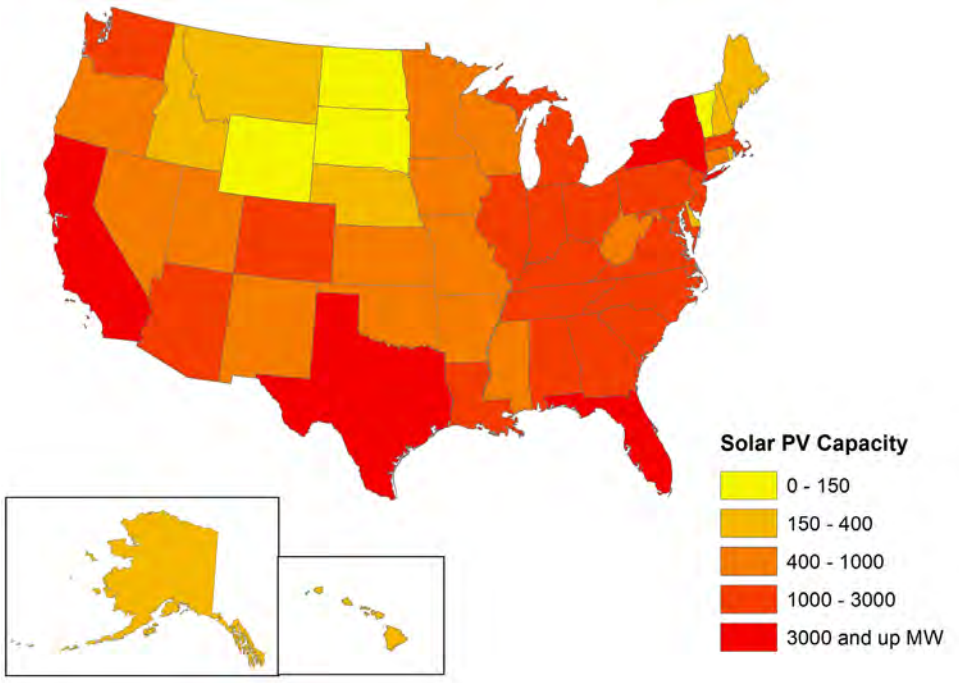
# Executive Summary

Solar energy is expanding rapidly across the United States – increasing more than 100-fold over the past decade. But, there are still many untapped opportunities to harness the nation's nearly limitless solar potential. The United States has the technical potential to produce more than 100 times as much electricity from solar photovoltaic (PV) and concentrating solar power (CSP) installations as the nation consumes each year. Given our abundant solar resources, America must take advantage of untapped opportunities to install solar technologies – like using rooftops of large superstores and "big box" retail stores as hosts for clean electricity generation.

The roofs of these large stores are perfect locations for solar panels – they are largely flat and vacant and almost always fully exposed to the sun. The big box stores, large grocery stores and malls considered in this report account for 5 percent of electricity use in the United States. Solar panels produce energy that can offset this large electricity demand while contributing to a cleaner grid. Rooftop solar power also brings benefits to the communities in which it is situated. By producing electricity close to its final point of use, distributed rooftop power reduces costs and energy losses associated with electricity transmission and distribution.

**Figure ES-1: Potential Solar PV Capacity on Big Box Stores and Shopping Centers, by State (Megawatts)**



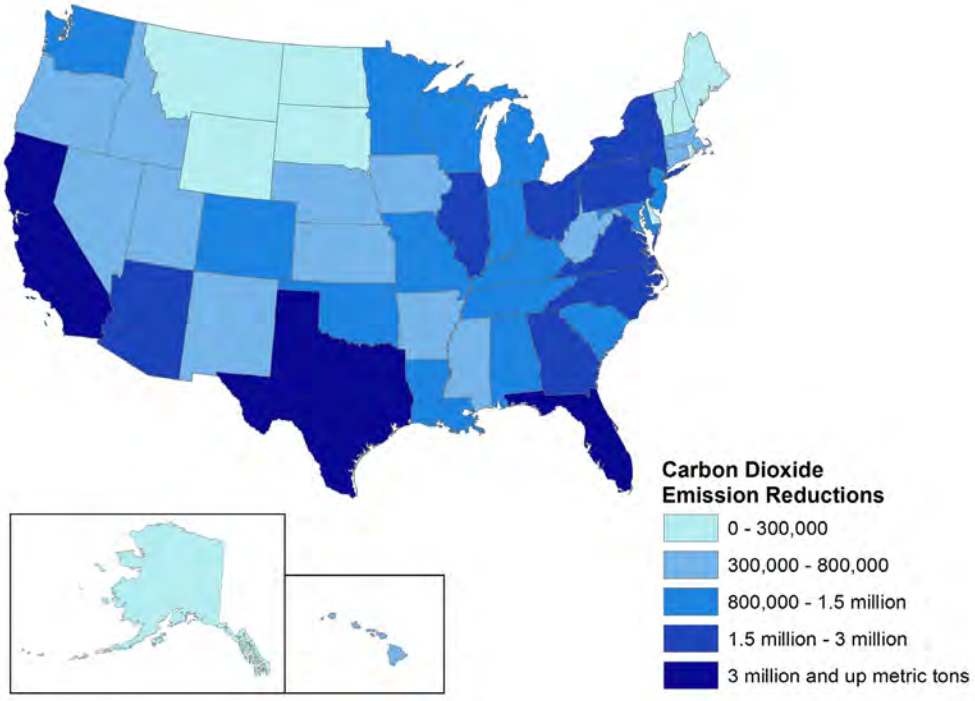
According to the National Renewable Energy Laboratory (NREL), the United States has the technical potential to generate enough electricity from rooftop solar installations alone to meet nearly a quarter of the nation's electricity demand. The United States has more than 102,000 big box retail stores, supercenters, large grocery stores and malls with more than 4.5 billion cumulative square feet of available rooftop space on which solar panels could be installed.

**The rooftops of America's big box stores and shopping centers could host 62.3 gigawatts (GW) of solar photovoltaic capacity, equivalent to the amount of electricity used by more than 7 million average U.S. homes or more than 7,500 average Walmart stores, and more than double the solar photovoltaic capacity that has been installed in the U.S. to date.** (See Appendix B for state breakdowns.)

Putting solar panels on the nation's big box grocery and retail stores creates unique benefits for the environment, electricity customers and the large commercial businesses themselves.

- Generating clean electricity from rooftop solar panels on existing commercial buildings is good for the environment. **Installing 62.3 GW of clean solar power on America's big box stores and shopping centers would reduce global warming pollution by nearly 57 million metric tons annually – equivalent to taking nearly 12 million passenger vehicles off the road**.
- Rooftop solar power is good for the grid and electricity consumers. **Producing electricity on rooftops, close to where the electricity will be used, reduces losses that happen during electricity transmission – losses that totaled an estimated 203 million megawatt-hours (MWh), or 5 percent of electricity sales in 2012.** Solar power also reduces costs by producing the most electricity during the sunniest parts of the

**Figure ES-2: Annual Reductions in Global Warming Pollution with Solar Panels on Available Big Box Stores and Shopping Centers by State (Metric Tons $CO_2$)**



day, which are often when demand for electricity peaks. This helps utilities avoid firing up expensive, peaking power plants to meet the temporary rise in demand.

- Putting solar panels on the roofs of big box stores is good for business. **Electricity produced by rooftop panels on big box stores and shopping centers could offset the annual electricity use of these buildings by 42 percent, saving these businesses $8.2 billion annually on their electricity bills.**

Many big box retail stores are already reaping the benefits of installing solar power on their rooftops.

- Of the businesses evaluated by the Solar Energy Industries Association (SEIA), Walmart, Costco, Kohl's, IKEA, and Macy's were the retail giants with the most solar capacity installed as of the end of 2015. Walmart has at least 142 MW of total on-site installed solar capacity.
- From the same survey, the top 25 companies have installed a total of 1,462 solar energy systems at business locations across the United States.
- The 10 big box companies with the largest amount of retail space in the U.S. – Walmart, Target, Home Depot, Lowe's, Sears Holdings (including Sears and KMart), Macy's, J.C. Penney, Kohl's, Costco, and TJX (including Marshall's and TJMaxx) – have enough rooftop space to host approximately 17 GW of solar capacity on their retail stores, or nearly three quarters of the United States' current solar PV capacity.
- Solar-powered businesses are saving money on their electricity bills and contributing to a cleaner and more resilient electricity grid. By installing solar panels on two California stores, Costco reported savings of $300 per day on average over three months.

Implementing local, state and federal policies that promote the growth of rooftop solar power – like net metering, third-party financing, community solar power programs, streamlined solar permitting and interconnection and tax credits and incentive programs for new solar energy markets – can spur the development of rooftop solar power on America's big box stores and help America reach its solar potential. **Officials at all levels of government should implement solar-friendly policies that help to accelerate adoption of solar energy by America's businesses.**

# Introduction

Swedish retailer IKEA is known for many things – its bold blue store buildings, build-it-yourself furniture, and store restaurants stocked with Scandinavian treats.

Clean energy might not be the first thing that comes to mind when consumers think of IKEA, but the company is working to change that by adopting bold goals for renewable energy installations on its stores – including solar power installations.

IKEA's adoption of renewable energy is driven by high goals that the company has set for its business practices. According to the company's "People and Planet Positive" sustainability strategy, IKEA is committed to generating more renewable energy than it consumes in its buildings and daily operations by 2020.[1] Of companies evaluated by the Solar Energy Industries Association (SEIA) in 2014, IKEA had the highest percentage of U.S. facilities with solar panels.[2] Today, IKEA ranks sixth among U.S. companies with more than 41 MW of total rooftop solar installed.[3]

According to a recent IKEA report on the company's sustainability practices, increasing reliance on solar power and renewable energy is both good for the environment and good for business: "This is good for people and the planet and makes good business sense, because it cuts costs and makes us resilient to fluctuating energy prices."[4]

The business case that is motivating IKEA to "go solar" – stable energy costs, improving financial returns from solar energy investments, and the imperative to reduce business and regulatory risks related to climate change – also holds true for retailers and other businesses across the United States.

Big box retailers throughout the nation are beginning to implement solar power on their vast, open rooftops, benefiting themselves and the environment. In places where local, state and federal officials have implemented policies that help business owners make sustainable energy choices, solar power is becoming an increasingly common option for commercial facilities.

This report will outline the vast rooftop solar potential represented by U.S. big box stores and the benefits of commercial rooftop solar power to these businesses and the larger community, and discuss the ways in which governments can encourage increased solar power adoption in the commercial retail sector.

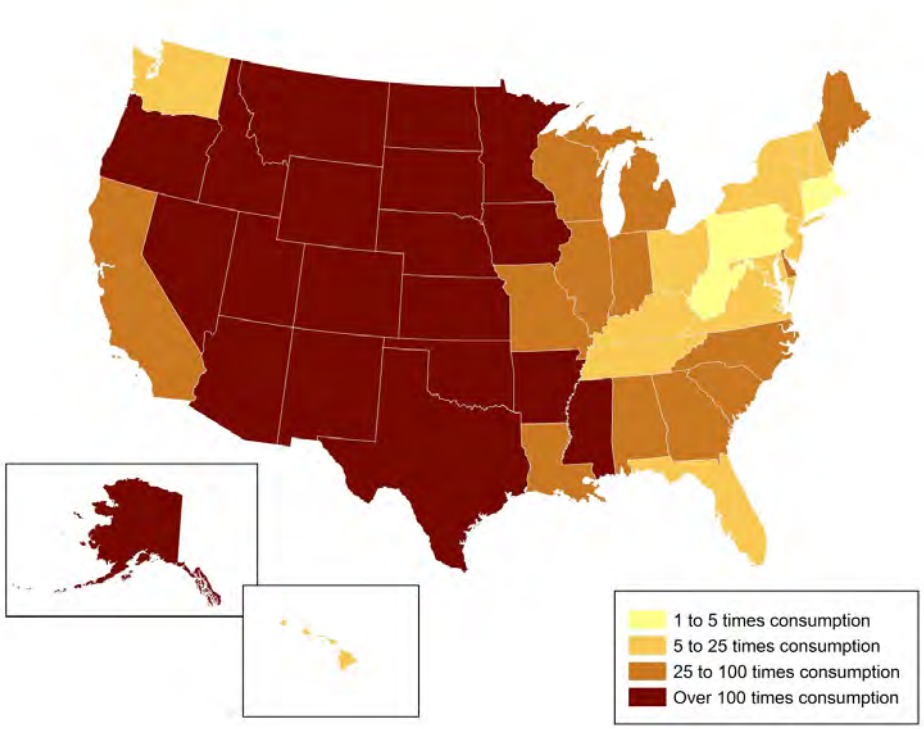
# Large Commercial Buildings Can Be a Significant Source of Solar Energy

The amount of solar energy in the United States has increased exponentially over the last decade, but the nation has barely begun to harness the nearly limitless amount of energy that it receives from the sun. We can use our existing structures to generate clean, local electricity by putting solar panels on the large, flat rooftops of commercial big box stores.

## The United States Has Vast Solar Energy Potential

The United States receives more than enough energy from the sun to meet the nation's electricity needs. Putting solar panels on big box stores is an important step towards harnessing our solar potential and meeting the nation's electricity demand with clean energy.

**Figure 1: Every State Can Meet Its Electricity Demand with Solar Power**[6]



## Every State Can Meet Its Electricity Needs with Solar Energy

The United States has the technical potential to produce more than 100 times as much electricity from solar photovoltaic (PV) and concentrating solar power (CSP) installations as the nation consumes each year, and every state has the technical potential to meet its electricity demand with solar power.[5] (See Figure 1.)

## The United States Has 100 Times More Solar Photovoltaic Capacity Than It Had in 2005

Solar power is taking off across the nation. At the end of the third quarter of 2015, the United States had more than 24 gigawatts (GW) of installed solar photovoltaic (PV) electric capacity, more than 12 times as much solar PV capacity as was installed in the country at the end of 2010.[7] (See Figure 2.)

Solar power made up 30 percent of all new electricity generating capacity that came online in the United States in the first three quarters of 2015.[9] Given the exponential growth that solar power is experiencing, it is quickly becoming a significant source of America's electricity generation.

## Solar Energy Costs Continue to Fall

The costs of solar panels have fallen year after year in every sector – for residential, commercial and utility scale installations.[10] (See Figures 3 and 4.)

Installing solar panels on commercial rooftops is becoming increasingly affordable. The Solar Energy Industries Association (SEIA) reported that the average cost of a non-residential rooftop solar energy system was $2.07 per Watt in Q3 2015, a 9 percent drop from Q3 2014.[12]

**Figure 2: Solar Power Is Growing Exponentially[8]**

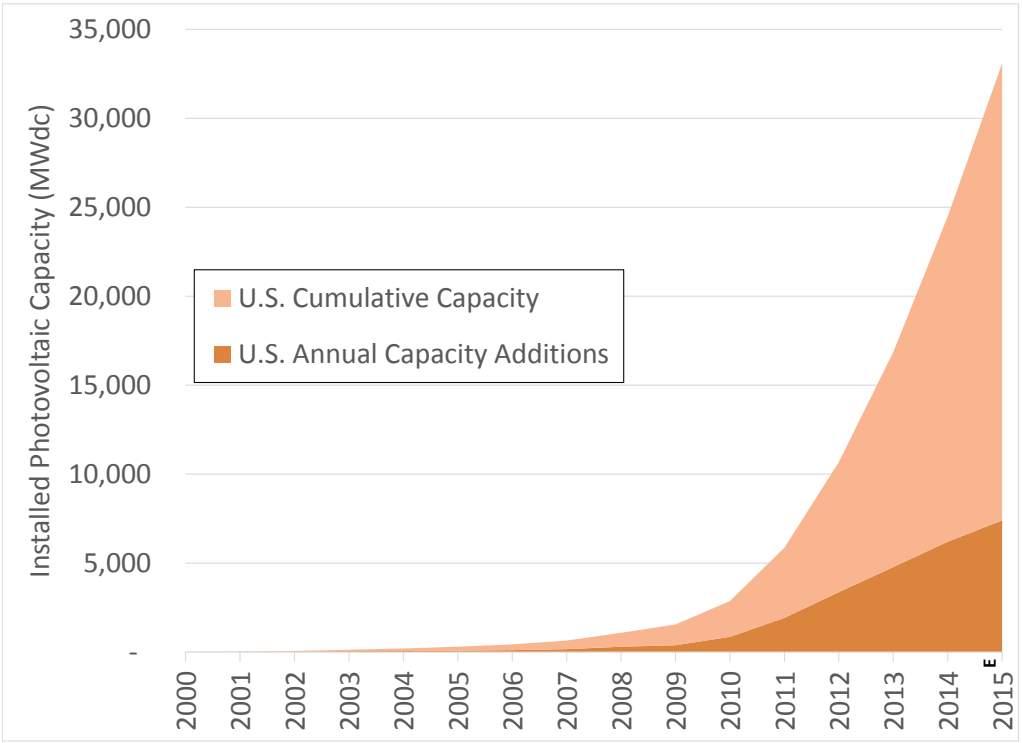
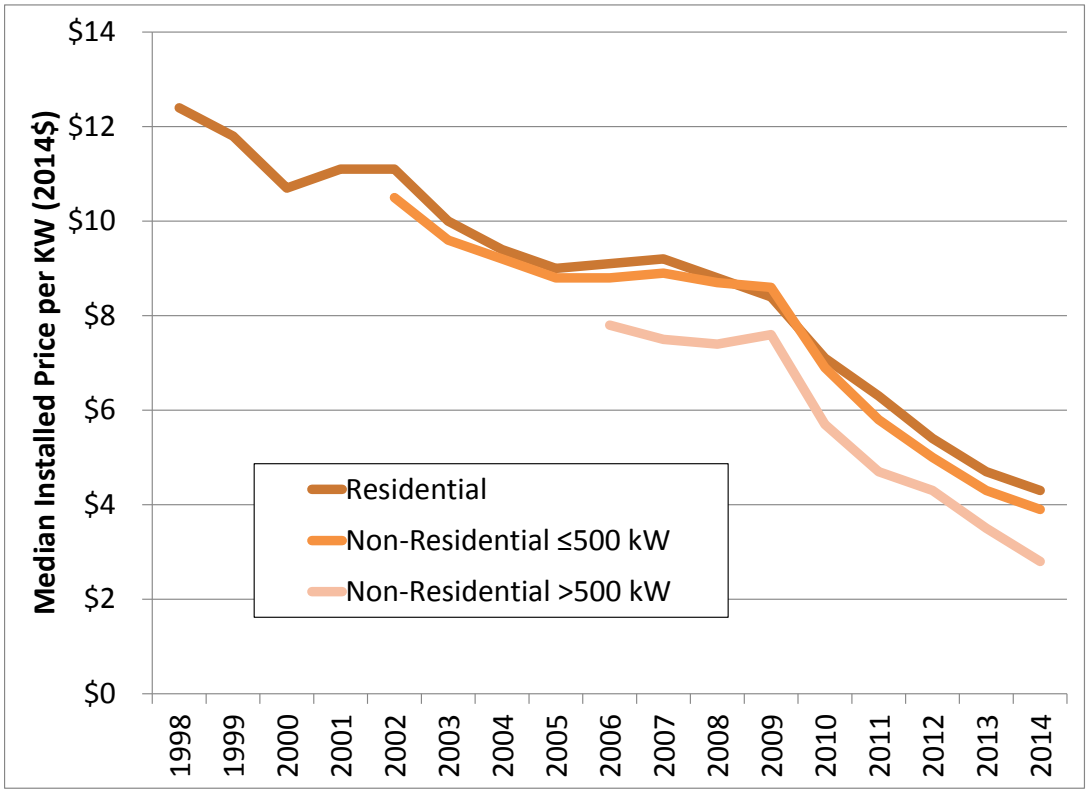


**Figure 3: The Cost of Residential and Commercial Solar PV Installations Continues to Fall**[11]




## Commercial Rooftops Can Host a Large Amount of Solar Energy

According to the National Renewable Energy Laboratory (NREL), the United States has the technical potential to generate enough electricity from rooftop solar installations alone to meet nearly a quarter of the nation's electricity demand.[13] Commercial buildings make up an important part of this potential rooftop market for solar power. As we define them in this report, the United States has more than 102,000 "big box" retail stores, supercenters, large grocery stores and malls with rooftop space that could host solar panels.[14] These stores are spread across the United States. (See Table 1.)

Big box retail stores, many of which are household names across the country, represent a significant number of U.S. stores. Superstores Walmart and Costco and grocery giant Kroger are the nation's three largest retailers with 7,453 U.S. stores and $507 billion in sales. The top five department stores – Macy's, Kohl's, Sears Holdings, Nordstrom, and J.C. Penney Co. – have 4,037 U.S. stores. The top five electronics and entertainment stores – Best Buy, the Apple Store, AT&T Wireless, Verizon Wireless and Toys "R" Us – have 11,987 U.S. stores. Bed Bath & Beyond and IKEA are two of the largest home goods stores, with 1,503 stores in the United States.[15]

Many U.S. businesses have already begun to make significant investments in solar power. As of mid-2014, the 4.5 gigawatts (GW) of commercial solar power installed in the United States accounted for 30 percent of the nation's total installed solar capacity.[16]

Table 1: Number and Average Size of Big Box Stores and Shopping Centers by Region

| Region | Number of Big Box Stores | Average Square Footage of Big Box Store |
|---|---|---|
| Northeast | 13,788 | 83,245 |
| Midwest | 15,991 | 86,138 |
| South | 45,932 | 74,726 |
| West | 26,436 | 85,909 |
| **Total** | **102,148** | **80,556** |

## SEIA's *Solar Means Business* Report Reveals America's Leading Solar-Powered Companies

At the end of 2015, the Solar Energy Industries Association (SEIA) released the fourth edition of a report ranking top U.S. businesses for their installed solar capacity.[17] SEIA reached out to Fortune 100 companies in the U.S. and other businesses "with known solar portfolios" in order to rank the companies by installed solar capacity and by number of solar installations. Their rankings show that major retailers in the United States are installing a significant amount of solar energy at their business locations.

According to the report, the 25 companies with the most on-site solar capacity installed are home to a combined 700 MW of solar capacity, with Walmart, Prologis (an industrial real estate company), Apple, Costco, and Kohl's leading the way. The 25 companies with the most total solar installations are home to 1,462 individual systems, with Walmart, Walgreens, Kohl's, Costco, Macy's and Prologis leading the way.[18]

In the 2014 edition of its report, SEIA found that IKEA had solar power installed on 87 percent of its facilities, the highest percentage of any company evaluated.[19]

## Solar Potential on America's Big Box Stores and Shopping Centers

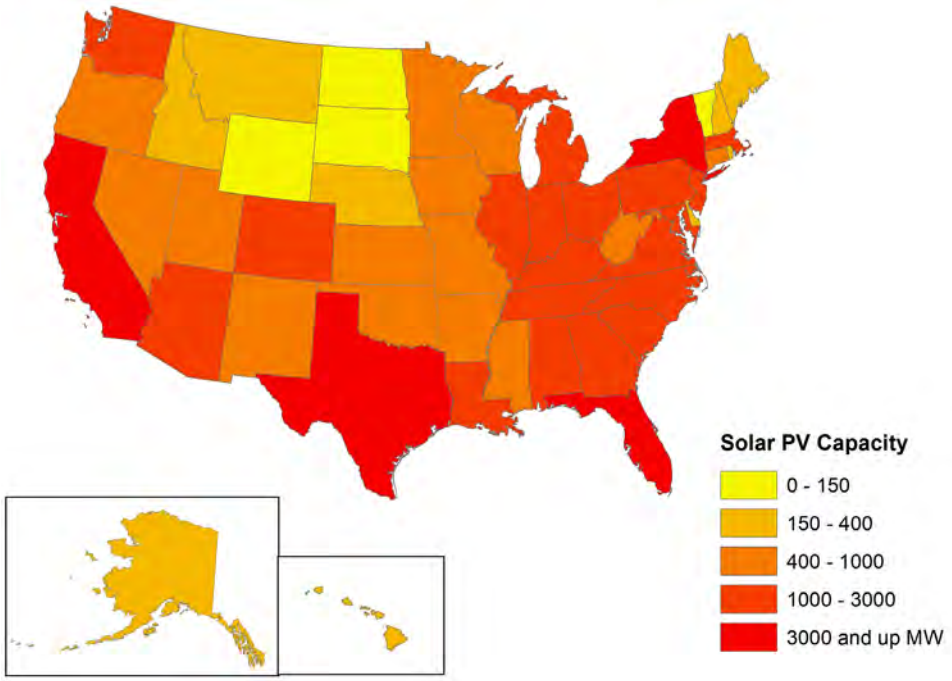
The potential of the nation's commercial buildings to host solar panels is much larger than the capacity that has already been installed. America's big box stores have more than 4.5 billion square feet of available rooftop space on which solar panels could be installed.[20]

**The rooftops of America's big box stores and shopping centers could host 62.3 gigawatts (GW) of solar photovoltaic capacity, equivalent to the amount of electricity used by more than 7 million average U.S. homes or more than 7,500 average Walmart stores, and more than double the solar photovoltaic capacity that has been installed in the U.S. to date.**[21] (See Appendix B for state breakdowns.)

The big box retail stores, large grocery stores and malls considered in this report account for 5 percent of electricity use in the United States.[22] **Electricity produced by rooftop solar panels on big box stores and shopping centers could offset the annual electricity use of these buildings by 42 percent, saving these businesses more than $8.2 billion annually on their electricity bills.**[23]

Much of the big box retail space in the United States is owned or operated in by a small number of large retail companies. The 10 big box companies with the largest amount of retail space in the U.S. – Walmart,

**Figure 4: Potential Solar PV Capacity on Big Box Stores and Shopping Centers, by State (Megawatts)**




Target, Home Depot, Lowe's, Sears Holdings (including Sears and KMart), Macy's, J.C. Penney, Kohl's, Costco, and TJX (including Marshall's and TJMaxx) – have a combined 2 billion square feet of retail space in the United States, twice the area of Manhattan.[24] These companies alone have the potential to host approximately 17 GW of solar capacity on the roofs of their retail stores, or nearly three quarters of the United States' current solar PV capacity.[25] (See Appendix B for expanded listing.)

These estimates of solar energy potential only include the rooftop space on top of these stores. Big box stores are often surrounded by parking lots and other areas that could host solar energy production. Solar panels are capable of providing shade in parking lots, some of which span several acres, while taking up no additional land and reducing vehicle fuel consumption for air conditioning use.[26] Many retailers and businesses also own large distribution warehouses that, although not included in this analysis, are also ideal locations for solar panels. By taking advantage of these additional opportunities for solar power generation, big box stores and other retail outlets could produce even more solar energy than is estimated here.

Much of the retail space of large American retailers is leased, not owned, meaning that in many cases solar installations require the involvement of the landlord. Creative financing options like Property Assessed Clean Energy (PACE) financing can help overcome some of the hurdles leased property presents. (See "New Financing Tools Can Help Businesses Overcome Hurdles to Solar Adoption" for more details.)

**Table 2. Solar Capacity Potential for America's Top 10 Big Box Stores (Excluding Grocery-Specific Chains)**

| Solar Potential Rank | Company | U.S. Retail Space (Million Sq. Feet) | Potential Rooftop Solar Capacity (MW) | Equivalent to Power Consumed by XX Thousand Households (National Avg. Household Power Use is 10.9 MWh/yr) |
|---|---|---|---|---|
| 1 | Walmart | 680 | 5,844 | 660 |
| 2 | Target | 240 | 2,062 | 233 |
| 3 | Home Depot | 206 | 1,767 | 200 |
| 4 | Lowe's Companies | 196 | 1,683 | 190 |
| 5 | Sears Holdings (Sears and KMart) | 188 | 1,614 | 182 |
| 6 | Macy's | 147 | 1,267 | 143 |
| 7 | J.C. Penney Co. | 111 | 950 | 107 |
| 8 | Kohl's | 84 | 720 | 81 |
| 9 | Costco | 70 | 601 | 68 |
| 10 | TJX (Marshall's and TJMaxx) | 62 | 530 | 60 |

## Walmart: The Nation's Largest Retailer and Commercial Rooftop Solar Power Producer


*Solar panels on a Walmart in Buckeye, Arizona. Credit: Walmart via Flickr, CC-BY 2.0*

Walmart is the largest retail store chain in the United States – and the leading big box store for installed solar generation capacity. Walmart began installing solar panels on its stores in 2005, and the company has now installed 142 megawatts of solar capacity across 348 locations (at stores and distribution centers).[27] Each installation offsets 15 to 30 percent of the electricity needs of the store on which it is sited.[28] According to the Environmental Protection Agency's Green Power Partnership rankings of organizations and governments using clean power, Walmart ranks third among retail stores, using 315,000 MWh of solar and wind generated electricity annually.[29]

More than 200 of Walmart's solar installations have been completed in partnership with the solar provider SolarCity, and Walmart has contracted with the company to install new solar power systems in 36 states by 2018. Walmart has also been a pilot tester of SolarCity's energy storage systems for businesses.[30]

Walmart has committed to use 7 billion kWh of renewable energy at its facilities around the world and to double the number of U.S. Walmart stores with solar panels by 2020.[31] With nearly 5,000 U.S. stores, Walmart has the national presence to make a significant impact on the electricity grid if it does so.[32]

# The Benefits of Scaling Up Commercial Rooftop Solar Power

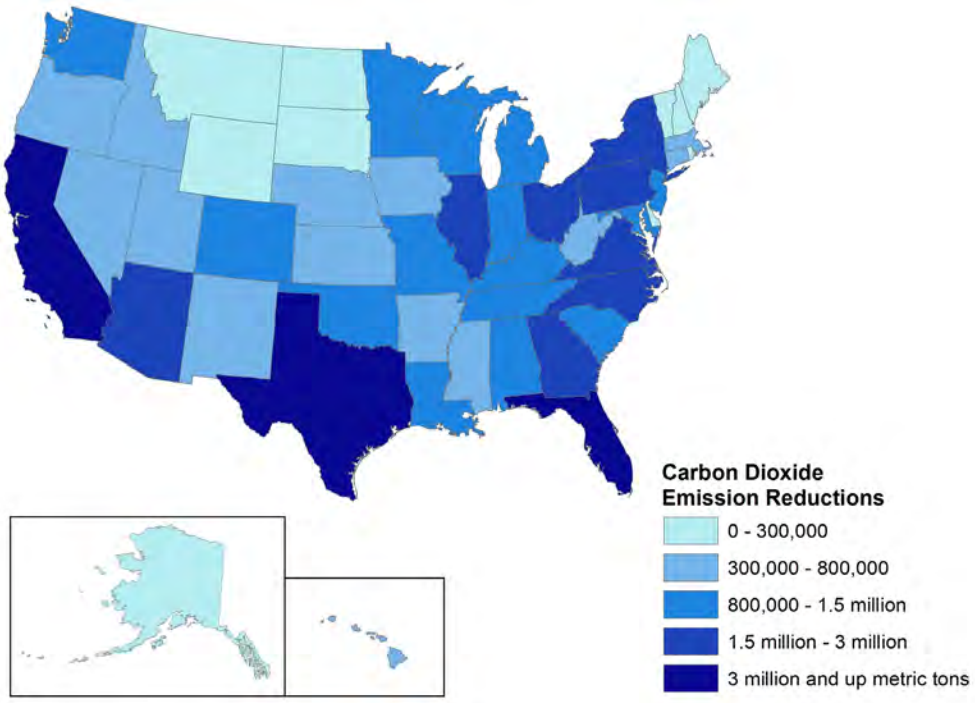
"Going solar" is good for big box stores, good for local electric grids and good for consumers. Studies show that the benefits that solar power brings to the electricity grid, our communities and the environment far outweigh the benefits solar panel owners receive through policies such as net metering.[33] Generating clean solar electricity on the rooftops of big box stores can protect all electricity customers from volatile costs and unnecessary expenses, make our electric grid more resilient, reduce climate-altering pollution and cut costs for the big box businesses themselves.

## Big Box Solar Power Brings Widespread Community Benefits

### Reducing Global Warming Pollution

Increasing the amount of solar power used in the United States will decrease the global warming pollution that comes from fossil fuel combustion. In 2014, the United States emitted 5.6 billion metric tons of carbon dioxide, second only to China; coal-fired power plants accounted for nearly one-third of those emissions.[34] Producing energy from natural gas leads to large emissions of methane, an extremely potent greenhouse

**Figure 5: Annual State Reductions in Global Warming Pollution with Solar Panels on Available Big Box Stores and Shopping Centers (Metric Tons $CO_2$)**



gas, during its production, transportation and storage – emissions that largely negate the reduced carbon dioxide emitted during combustion.[35]

Solar power generation produces no global warming pollution. Even when emissions from manufacturing, transportation and installation of solar panels are included, solar power produces 96 percent less global warming pollution than a coal-fired power plant over its entire life cycle, and 91 percent less global warming pollution than a natural gas-fired power plant.[36] By reducing the need for electricity from fossil fuel-fired power plants and by not producing significant global warming pollution itself, solar power reduces the threat posed by global warming and helps to clean the nation's air.

Installing 62.3 GW of solar power on big box stores and shopping centers would reduce global warming pollution by nearly 57 million metric tons annually

## Solar Thermal Technologies Can Expand the Potential of Commercial Buildings to Reduce Global Warming Pollution

*Solar hot water on Vermont farm, credit: Alan D. Ford*

Solar thermal technologies like solar water heating also have the potential to offset energy use on America's commercial buildings. According to the National Renewable Energy Laboratory, the energy savings potential of installing solar hot water heating systems on available residential and commercial rooftops in the United States is equivalent to the annual electricity consumption of Oregon or the electric output of five large power plants.[41] This would lead to an estimated additional annual savings of $8.4 billion in electricity costs and carbon dioxide emissions reductions of 50 to 75 million metric tons per year, or 2 to 3 percent of emissions from the residential and commercial building sectors.[42] That's the equivalent emissions reduction of taking between 10 and 16 million cars off the road.[43]

A typical solar hot water system in the United States offsets the water heating energy needs of a building by 40 to 80 percent in the United States, and since these systems usually take up less space that solar panel installations they can be a viable option on rooftops too small for photovoltaic systems.[44] Some companies like Nextility offer solar hot water heating systems to businesses and non-residential institutions through a third-party power purchase agreement (in which Nextility owns the solar thermal heating system and charges a guaranteed rate to the business on which the system is installed).[45]

Although this report only discusses the solar PV potential of America's commercial rooftops, solar thermal technologies enhance the opportunity to use solar energy to offset commercial buildings' energy consumption and greenhouse gas emissions.

– equivalent to taking nearly 12 million passenger vehicles off the road.[37]

Many major U.S. businesses are installing solar power as part of their commitments to reduce global warming pollution. IKEA – the company with the highest percentage of U.S. facilities with solar panels – announced in June 2015 that it will spend $1.13 billion on fighting global warming and has committed to eventually being powered by 100 percent renewable energy.[38] In November 2015 Walmart announced that it had fulfilled its 2010 commitment to cut 20 million metric tons of global warming pollution from its business practices by the end of 2015, in part by increasing its reliance on solar power.[39] Stop & Shop is a New England grocery store chain with more than 400 stores and 63,000 employees. In 2008, the company made a commitment to "reducing their carbon footprint by 20 percent by 2015." In that pursuit, they have installed solar power systems on 38 stores, producing enough clean electricity to power the equivalent of 730 homes yearly.[40]

## Creating a Resilient Electricity System

Rooftop solar energy also helps communities deal with the erratic weather and climatic stresses exacerbated by global warming. If transmission lines are disrupted from a severe storm or heat wave, solar energy attached to batteries can, in some circumstances, help avoid blackouts.[46] Distributed solar generation paired with microgrids – electricity systems that can operate independently of the central grid and create intentional islands – can also keep the power on after severe weather events that disrupt electricity transmission on the centralized grid.[47] Pairing smart inverter technology with solar panels also improves grid resiliency, even without the use of distributed energy storage.[48]

Solar PV panels also reduce competition for scarce water resources during times of drought, using far less water than conventional fossil fuel and nuclear power plants. The life-cycle water consumption of solar photovoltaics is 1/500$^{th}$ of the life-cycle water consumption of coal power plants and 1/80$^{th}$ of that of natural gas plants per unit of electricity produced.[49] According to a study by the Union of Concerned Scientists, a scenario with high levels of renewable energy and energy efficiency would withdraw and consume half the amount of water for electricity production as a business-as-usual scenario.[50]

Because solar PV panels do not rely on water for electricity production, communities that generate a significant amount of electricity from solar panels are less susceptible to electricity disruption during droughts. During the Midwest drought of 2012, many fossil-fuel power plants that required cooling water to operate were forced to limit or suspend electricity production.[51] The California drought caused a drop in hydroelectricity generation at the beginning of 2014, but the state's solar energy helped to compensate and guard against electricity outages.[52] Climate change will only increase the risk of drought and solar power can be a real solution to stabilize electricity production under these conditions.

## Cutting Consumer Costs

Scaling up U.S. solar electricity generation would deliver important benefits to homeowners and businesses, including low-income consumers. All electricity consumers would see less price volatility from fossil fuels and reduced losses of electricity in transmission and distribution.

An electric grid that relies more on solar power and less on fossil fuels can deliver electricity to all customers with much less fossil-fuel related volatility in the price of electricity.[53] Rooftop solar panels also capture the most solar energy during sunny periods of high electricity demand when the cost of producing electricity is normally the highest – saving money for all consumers on their power bills.

With smart public policies and declining prices, more and more people have the opportunity to benefit

from solar energy, including low-income households and those living in multi-family housing. Low income families participating in California's Single-Family Affordable Solar Homes program, for example, cut their monthly electricity bills by 80 percent on average.[54] In multi-family homes, programs that allow for "virtual net metering" can distribute the benefits of one solar installation to multiple families in a housing complex. Virtual net metering enables shared, community solar projects that allow those who are unable to install solar panels on their own properties or live in multi-family homes to "go solar."[55]

Using more distributed solar power for U.S. electricity production would also result in a more efficient electric grid. The U.S. Energy Information Administration estimated that the United States lost about 203 million megawatt-hours (MWh) of electricity in 2012 during transmission, or 5 percent of the total amount of electricity generated that year, leading us to generate more electricity than we needed, increasing costs for ratepayers and causing additional pollution.[56] Distributed solar energy on commercial rooftops avoids these losses by generating electricity at or near the location where it is used.[57] This allows more energy to go straight into homes and businesses, and avoids high-cost investments in expanding transmission capacity.

## Reducing Air Pollution

Installing solar energy on commercial rooftops can improve air quality by reducing our reliance on polluting fossil fuels for electricity. The United States generates 67 percent of its electricity from fossil fuels, including coal, natural gas and oil. Almost 40 percent of U.S. electricity came from coal in 2014.[58] Our outsized dependence on dirty fossil fuels for electricity takes a toll on public health, as these energy sources release known hazardous pollutants into the air.

Fossil-fuel fired power plants create 70 percent of U.S. sulfur dioxide emissions and 13 percent of nitrogen oxide emissions, affecting air quality in ways that harm human health.[59] Sulfur dioxide contributes to the formation of acid rain, as well as small particles in the air that can penetrate deep into the lungs and trigger respiratory diseases such as bronchitis and emphysema. Particulate pollution has been linked to increased rates of hospital admissions and premature death.[60] According to an MIT study, fine particle pollution caused 52,000 early deaths in the United States in 2005.[61] Nitrogen oxides contribute to the formation of ozone "smog." Ozone reacts with airway tissues and produces inflammation similar to sunburn on the inside of the lungs. This inflammation makes lung tissues less elastic, more sensitive to allergens and less resistant to infections.[62]

## Creating Jobs

Installing more solar power is not only good for the environment and for electricity consumers; it also creates a significant number of local jobs that cannot be outsourced.

America is already experiencing significant job growth in the solar energy industry. Nearly 209,000 Americans worked in the solar energy industry as of November 2015, a 20 percent increase from the previous year, according to The Solar Foundation's annual solar jobs census.[63] According to The Solar Foundation, growth in the solar industry from November 2014 to November 2015 was nearly 12 times faster than the national average employment growth rate.[64] Solar industry investment in the U.S. economy is almost $15 billion each year.[65]

## Big Box Stores Directly Benefit from Hosting Solar Panels

Large commercial businesses use a significant amount of electricity, taking a toll on the environment and their electricity bills. Electricity rates for commercial customers in the U.S. increased by 20 percent over the last 10 years.[66] On average, each of the nation's big box retail stores, large grocery stores and malls consumes 1,800 megawatt-hours of electricity annually and spends an average of $190,000 on their electricity bill each year. Electricity produced by rooftop panels could offset the annual electricity use of these buildings by 42 percent, saving these big box stores $8.2 billion annually on their electricity bills.[67]

Solar businesses are saving money on their electricity bills and contributing to a cleaner and more secure electricity grid. By installing solar panels on two California stores, for example, Costco reported savings of $300 per day on average over three months.[68]

Solar power provides some particular economic benefits to big box stores and other businesses:

- Because big box stores generally use most of their energy during the day, when the sun is shining, they benefit from instantaneous use of the free electricity solar panels generate. For businesses planning their economic future, solar panels also provide freedom from volatile energy prices – whether they are installed through individual financing or through a long-term power purchase agreement.
- Solar panels paired with energy storage can also reduce demand charges, which for some businesses account for more than half of their monthly electricity costs.[69] Demand charges, which are calculated from peak load times rather than monthly energy use, can be reduced by smart battery installations that supply energy at moments of high energy use.[70]
- Solar panels can indirectly lower business cooling and heating costs by shading roofs during the day, and providing insulation at night – benefits that are particularly pronounced on older warehouse buildings.[71]

## Case Study 2: Clothing Retailers Macy's, Kohl's and Target Invest in Solar Power


*Macy's in Irvine, California. Credit: Woolennium via Flickr, CC-BY-NC-ND 2.0*

Major clothing retailers Macy's and Kohl's are making significant investments in solar energy.

Among businesses surveyed in SEIA's 2015 *Solar Means Business* report, Kohl's ranks fifth in the country with more than 50 MW of solar power installed on its stores.[72] Kohl's ranks first in the nation for green power purchasing according to the Environmental Protection Agency – its purchases of solar energy credits and the solar energy production at its facilities offset 104 percent of the electricity demand at Kohl's facilities.[73] Kohl's has 161 solar power systems on its stores in 13 states, each of which offsets 20 to 50 percent of its store's energy use.[74] Its largest project in Maryland consists of more than 8,000 solar panels and generates more than 3 million kWh of electricity annually.[75]

Macy's has the seventh-highest amount of solar capacity installed on its facilities, with 20.8 MW in total.[76] Macy's has contracted with Sunpower to install solar panels at 30 locations in California.[77] By signing a power purchase agreement with Sunpower in 17 of these 30 projects, Macy's will purchase the electricity generated by the panels from Sunpower, which owns the panels.[78] This kind of third-party agreement can help businesses avoid the cost of purchasing the panels themselves, making projects more affordable. These projects alone will put 8.9 megawatts of solar power on Macy's stores and help the company reduce global warming pollution from dirty electricity sources by 88,000 metric tons over 30 years.[79]

As of December 2015, Target had nearly 15 MW of installed onsite solar capacity at 41 different locations.[80] In February 2015, Target announced plans to install rooftop solar panels on 500 U.S. locations by 2020, including plans to add solar panels to 250 Target buildings in 2015 and 2016 alone.[81]

# New Financing Tools Can Help Businesses Overcome Hurdles to Solar Adoption

The benefits of solar power are clear: it is good for the environment and can save money. Many businesses are eager to reap these benefits, as demonstrated by companies like Ikea, Walmart, Kohl's, and Macy's. But important hurdles often stand in the way of commercial solar energy installations – barriers that can be overcome with smart public policy.

Efforts to install solar energy on commercial buildings often fall victim to the inherent complexity of commercial contracts and to misaligned incentives between building owners and retail chains. Another set of challenges is in the financing realm, which for commercial customers tends to be more complicated and less standardized than for residential solar.[82] The good news is that new financing mechanisms and risk analysis tools are being developed and rolled out that can solve some of the problems of commercial solar development:

- Lack of standardization for commercial solar lease and power purchase agreements can increase the cost and hassle of "going solar" for businesses. The Solar Access to Public Capital (SAPC) working group, a project of the National Renewable Energy Laboratory (NREL), has worked with hundreds of stakeholders to develop standardized commercial power purchase agreements and lease agreements. NREL's stated goals for SAPC include minimizing due diligence cost and time, and opening the solar market to investment mechanisms including securitization.
- Many banks will not finance solar projects because there are not established standards for measuring risk and investment return.[83] The truSolar initiative, introduced by Distributed Sun, DuPont and the Rocky Mountain Institute in September 2012, aims to fix those problems by creating a standard ranking system for all of the elements in a solar project.[84]
- Businesses often lease their property, with many businesses unable to make long-term commitments that would extend over the 15- to 20-year lifetime of a solar energy system. Financing options like Property Assessed Clean Energy (PACE) financing, in which the obligation to repay a solar loan passes to the new owner when a property is sold, can ease risk in these cases. (See more on PACE in "Policy Recommendations," next page.)

As national retailers and big box stores "go solar," these large businesses can help solidify the commercial solar market, bringing about increased standardization while also lowering their own energy costs and reducing global warming emissions.

# Policy Recommendations

Policies that support rooftop solar power bring the additional environmental, economic and social benefits of local, distributed electricity to America's communities. **Officials at all levels of government must implement solar-friendly policies that help to accelerate America's commercial solar energy adoption.** These should include:

- *Adopting and preserving strong interconnection and net metering policies* – These policies ensure that businesses are appropriately compensated for the electricity that they export to the grid, allow them to move seamlessly between producing their own electricity and using electricity from the grid, and make solar power an affordable business investment for big box stores. In states or utility territories without strong net metering programs, carefully implemented CLEAN contracts (also known as feed-in tariffs) and value-of-solar payments can play an important role in ensuring that consumers receive a fair price for solar energy, so long as the payments fully account for the benefits of solar energy and are sufficient to spur participation in the market.

- *Extending or maintaining state-level solar energy tax credits* – State level tax credits for solar energy are important supports for state commercial solar energy markets. States should offer property tax exemptions that exclude the value of solar equipment from the assessed property value on which homeowners and business owners must pay taxes. States should also offer sales tax exemptions for the sale of solar panels and solar hot water heating equipment, which lowers the up-front cost of buying the equipment.

- *Enabling third-party sales of electricity* – Although businesses that choose to purchase their own solar panels can reap the benefits of faster installation and no monthly payments, alternate "third-party" financing options – like power-purchase agreements and solar leases – have been a particularly important way for businesses to install solar panels on a large scale. These arrangements allow third-party companies to own the panels and help businesses avoid the high up-front costs of solar panel purchases. States should allow companies that install solar panels to sell electricity to their customers without subjecting them to the same regulations as large public utilities.

- *Adopting financing programs like Commercial PACE*– Creative financing options that provide businesses with low up-front costs and long-term repayment options are important for the commercial solar industry. For example, commercial Property-Assessed Clean Energy (PACE) financing programs allow local governments to pay the up-front cost of commercial solar projects, with the expenses repaid by the businesses in their property taxes.[85]

- *Allowing and encouraging community solar programs* – Community solar programs allow people who may not be able to install solar panels themselves to invest in a solar installation sited away from their private properties and share credit for the electricity produced by the solar panels and sent back to the electric grid.[86] Partnering with businesses and non-profit organizations to establish a community solar projects at the local level can be a creative source of financing for solar projects on commercial rooftops.[87]

- *Streamlining solar permitting and instituting affordable permitting fees* – The "soft costs" associated with solar power – costs such as those associated with installing the system, completing paperwork, and paying taxes and permitting fees – typically make up more than half of the total cost of an installed commercial solar energy system.[88] Local governments should work to reduce these costs, accelerate the time it takes to obtain a permit for a solar installation, ensure that permitting rules do not hinder the installation of solar panels, and streamline the paperwork necessary to get a permit.
- *Encouraging electric utilities to adopt solar-friendly rate structures* – Under some rate structures, utilities bill electricity customers in a way that minimizes the savings that they can recoup from rooftop solar energy generation.[89] Regulators should investigate the impacts of rate plans on solar energy adoption and support those that improve the economics of installing solar power for business owners.
- *Enforcing the requirements of the Clean Power Plan* – The federal government should enforce the standards of the Clean Power Plan to reduce global warming emissions 30 percent below 2005 levels by 2030. It should also emphasize programs like the Clean Energy Investment Program, which incentivizes the states' early deployment of solar, wind and low-income energy efficiency. States should establish effective plans for meeting or surpassing the goals of the Clean Power Plan, with clean and renewable sources of energy such as solar power playing a leading role. Investing in commercial solar power will play a key role in reaching the levels of renewable energy adoption that will be necessary to reach these goals.

# Appendix A: Methodology

## Solar Capacity and Generation on Commercial Buildings

To estimate the technical potential for solar PV systems on large commercial buildings in the United States, we used the U.S. Energy Information Administration's 2012 Commercial Building Energy Consumption Survey (CBECS) to determine the square footage of large commercial buildings. We defined large commercial buildings using CBECS microdata and the following selection criteria in order to capture large "big box" retail and grocery store buildings that could host solar panels: buildings over 25,000 square feet with the principal building activities of "food sales," "strip shopping malls," "retail (other than mall)," and "enclosed mall." We excluded buildings of these types with more than 15 floors. This left us with 102,147 big box retail stores, grocery stores and malls to evaluate.

The tables below display characteristics of these big box stores by building activity type and region.

**Table A-1: Number of Big Box Buildings and Shopping Malls by Region and Building Activity Type**

| Region | Food Sales | Strip Shopping Malls | Enclosed Malls | Retail (Other than Malls) | Grand Total |
|---|---|---|---|---|---|
| Northeast | 3,124 | 6,386 | 109 | 4,169 | 13,788 |
| Midwest | 802 | 7,872 | 198 | 7,119 | 15,991 |
| South | 2,222 | 25,148 | 497 | 18,065 | 45,932 |
| West | 2,822 | 12,950 | 266 | 10,398 | 26,436 |
| Grand Total | 8,971 | 52,356 | 1,070 | 39,750 | 102,148 |

**Table A-2: Total Square Footage of Big Box Buildings and Shopping Malls by Region and Building Activity Type (Millions of Square Feet)**

| Region | Food Sales | Strip Shopping Malls | Enclosed Malls | Retail (Other than Malls) | Grand Total |
|---|---|---|---|---|---|
| Northeast | 185 | 556 | 93 | 314 | 1,148 |
| Midwest | 29 | 655 | 147 | 546 | 1,377 |
| South | 78 | 1,828 | 334 | 1,192 | 3,432 |
| West | 207 | 926 | 244 | 895 | 2,271 |
| Grand Total | 499 | 3,965 | 819 | 2,947 | 8,229 |

**Table A-3: Total Estimated Rooftop Square Footage by Region and Building Activity Type (Millions of Square Feet)**

| Region | Food Sales | Strip Malls | Enclosed Malls | Retail (Other than Malls) | Grand Total |
|---|---|---|---|---|---|
| Northeast | 185 | 504 | 41 | 248 | 978 |
| Midwest | 19 | 587 | 101 | 485 | 1,192 |
| South | 70 | 1,678 | 273 | 1,066 | 3,087 |
| West | 175 | 884 | 130 | 806 | 1,996 |
| Grand Total | 449 | 3,653 | 546 | 2,605 | 7,253 |

Using Microsoft Access, we used CBECS microdata to divide the total floor space in each building by the number of floors in each building. This gave us an estimate of rooftop space available on each building and of total rooftop space on large commercial buildings in each U.S. census division.

We then apportioned the total rooftop space on big box stores in each region to each state according to the percentage of the regional population living in each state in 2012 using the U.S. Census Bureau's American Community Survey 5-Year Estimates.

This yielded 7.2 billion square feet of rooftop area on the selected large retail, grocery store and shopping mall buildings in the United States. We assumed that 65 percent of this rooftop area is suitable for rooftop solar energy systems in designated "cool" climates and 60 percent in "warm" climates, per a 2008 study by Navigant Consulting for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*.[90] In calculating this number, Navigant took into account factors such as trees and other shading on residential and larger buildings, roof tilt and orientation, and the room needed on roofs between solar panels and taken up by other objects such as chimneys and fan systems.

This yielded 4.5 billion square feet of rooftop area available and appropriate for rooftop solar PV systems. We assumed solar panel efficiency of 18.5 percent, per the 2008 Navigant Consulting report for the National Renewable Energy Laboratory, *Rooftop Photovoltaics Market Penetration Scenarios*.[91] This efficiency corresponds to an estimated solar power density on commercial buildings of 13.7 megawatts per million square feet of available rooftop space, accounting for space needed for ancillary equipment.[92] This yielded the result that these commercial rooftops could host 62.3 gigawatts of solar PV capacity.

To estimate electricity generation from rooftop solar panels on big box stores in each state, we used state-specific rooftop solar PV capacity factors implied by the data in the National Renewable Energy Laboratory's *U.S. Renewable Energy Technical Potentials* report.[93] (NREL's capacity factor accounts for DC-AC inverter efficiency, as well as losses associated with wiring, maintenance and other factors.)[94] We multiplied the potential big box store solar capacity in each state by the solar capacity factors reported by NREL and the number of hours in a year to estimate the solar generation by state by year. For Alaska and Hawaii, we used the national average capacity factor based on the NREL data, as specific estimates of rooftop solar generation in these states were unavailable.

A similar methodology was used to calculate the potential solar capacity of individual big box store companies in Table 2. Because there are no available estimates of rooftop space for each company listed,

we assumed that retail space is equivalent to total rooftop space. For big box retailers where the majority of locations are single-floor standalone retail locations, this calculation may result in an underestimate of total rooftop space because retail space does not include the parts of a building devoted to warehouses, shipping and packing, or office space. For retailers whose stores tend to have more than one floor, or are located within a multi-story mall, this calculation may result in an overestimate of total roof space. We assumed that 62.5 percent of each store's calculated total rooftop space is available for rooftop solar energy systems, based on the average of warm and cool climate available space factors in the previously cited Navigant/NREL report, *Rooftop Photovoltaics Market Penetration Scenarios*. Based on the same report, we calculated that 13.7 MW of solar capacity could be installed per million square feet of available space.

## Electricity Consumption of Big Box Stores

To estimate the electricity consumption and annual electricity expenditures of big box stores in each state, we calculated electricity consumption statistics by building activity type and region from the 2003 Commercial Building Energy Consumption Survey (CBECS) and applied those to buildings of the same type and within the same region in the 2012 CBECS. This estimate was necessary because the U.S. EIA has not yet released updated 2012 statistics on energy consumption of commercial buildings (as of December 2015); only the data on commercial building characteristics has been released (which we used to estimate rooftop space on big box stores). We then apportioned the estimated electricity consumption of big box stores in each region to each state according to the percentage of the region population living in each state in 2012 using the U.S. Census Bureau's American Community Survey 5-Year Estimates.

To estimate annual electricity expenditures by big box stores in each state, we multiplied our state-specific estimates of big box store electricity consumption by 2013 state commercial electricity rates.[95]

## Global Warming Emissions Reductions

When solar panels generate electricity, they displace some other source of electricity on the grid. The type of electricity production that is offset by solar power depends on several factors: regional variations in the electricity resource mix, the degree to which solar energy offsets new versus existing generation capacity, the relative price of competing forms of electricity generation (including marginal prices), and the way in which solar energy is integrated into the grid, among others.

To estimate carbon dioxide emission reductions from solar energy generation on big box stores, we assumed that solar energy added to the grid would offset fossil fuel generation only, and would offset coal and gas-fired generation in proportion to their contribution to each state's particular electricity mix, as defined by the regional electricity grids that serve that state.

Emission reduction rates for each state were based on the actual electricity generation mixes in 2013 for the EIA EMM regions of which they are a part. The EIA's Annual Energy Outlook 2015 provided data on actual annual electricity generation and emissions for coal and natural gas power plants in each EIA region in 2013 (compiled from EIA Form 759). We assigned each EMM region to one of the interconnection regions identified by the North American Electric Reliability Corporation (NERC), using maps of EMM regions and NERC regions. We estimated an emissions factor for fossil fuel-fired generation for each NERC region, using the generation and emissions data for the constituent EMM regions.

To arrive at an emissions factor for each state, we determined the percentage of electricity sales in each state that come from within each NERC region, using data from U.S. Department of Energy, Energy Information Administration, *Electric Power Sales, Revenue, and Energy Efficiency Form EIA-861*, 29 October 2013. State emission factors were created by multiply-

ing each state's percent of sales per NERC region in 2012 by each region's emission factor. The use of a constant emission factor for each state masks hourly variations in the carbon intensity of electricity on the grid, meaning that the estimates in this report do not fully reflect the ways in which additional solar energy might affect hourly dispatch of different electricity generators in each region of the country.

NERC regions could not be identified for utilities responsible for a total of 1.5 percent of electricity sales nationally, including for the states of Alaska and Hawaii. For the state of Alaska, we divided annual carbon dioxide emissions from coal and natural gas sources in the electric power industry by total electricity generation from coal and natural gas sources in the electric power industry. For the state of Hawaii, most electricity is generated from petroleum (70 percent of electricity generated in 2013 came from petroleum sources). For that reason, we calculated Hawaii's emission factor by dividing annual carbon dioxide emissions from petroleum by annual electricity generation from petroleum. For both Alaska and Hawaii, we used the 2012 emission factor for 2013, based on available data.[96]

To estimate total emissions savings numbers for each state, we multiplied big box store solar generation for that scenario by the emission factor for that state and year. National estimates for each year were based on a sum of all state estimates.

# Appendix B: Tables

### Table B-1: Solar Potential on Big Box Stores, By State[97]

| State | Big Box Store Rooftop Space (million ft2) | Potential Solar Capacity on Big Box Stores (MW) | Annual Potential Big Box Solar Generation by State (GWh) | Equivalent to Power Consumed by XX Thousand Households (National Avg Household Power Use is 10.9 MWh/yr) | By XX Wal-Marts (10,320 MWh/year) |
|---|---|---|---|---|---|
| Alabama | 129 | 1,056 | 1,306 | 120 | 127 |
| Alaska | 20 | 175 | 216 | 20 | 21 |
| Arizona | 178 | 1,459 | 2,230 | 205 | 216 |
| Arkansas | 78 | 699 | 875 | 80 | 85 |
| California | 1,034 | 8,497 | 11,911 | 1,093 | 1,154 |
| Colorado | 140 | 1,244 | 1,704 | 156 | 165 |
| Connecticut | 63 | 562 | 630 | 58 | 61 |
| Delaware | 24 | 216 | 251 | 23 | 24 |
| District of Columbia | 16 | 145 | 172 | 16 | 17 |
| Florida | 508 | 4,176 | 5,408 | 496 | 524 |
| Georgia | 261 | 2,148 | 2,716 | 249 | 263 |
| Hawaii | 38 | 310 | 382 | 35 | 37 |
| Idaho | 43 | 387 | 486 | 45 | 47 |
| Illinois | 228 | 2,033 | 2,325 | 213 | 225 |
| Indiana | 115 | 1,028 | 1,187 | 109 | 115 |
| Iowa | 54 | 483 | 581 | 53 | 56 |
| Kansas | 51 | 452 | 590 | 54 | 57 |
| Kentucky | 117 | 1,040 | 1,215 | 111 | 118 |
| Louisiana | 122 | 1,002 | 1,215 | 111 | 118 |
| Maine | 23 | 209 | 239 | 22 | 23 |
| Maryland | 156 | 1,386 | 1,616 | 148 | 157 |
| Massachusetts | 116 | 1,032 | 1,173 | 108 | 114 |
| Michigan | 176 | 1,569 | 1,716 | 157 | 166 |
| Minnesota | 95 | 842 | 966 | 89 | 94 |
| Mississippi | 80 | 656 | 811 | 74 | 79 |
| Missouri | 107 | 949 | 1,172 | 108 | 114 |

## Table B-1 (continued): Solar Potential on Big Box Stores, By State[97]

| State | Big Box Store Rooftop Space (million ft2) | Potential Solar Capacity on Big Box Stores (MW) | Annual Potential Big Box Solar Generation by State (GWh) | Equivalent to Power Consumed by XX Thousand Households (National Avg Household Power Use is 10.9 MWh/yr) | By XX Wal-Marts (10,320 MWh/year) |
|---|---|---|---|---|---|
| Montana | 27 | 244 | 286 | 26 | 28 |
| Nebraska | 33 | 290 | 366 | 34 | 35 |
| Nevada | 75 | 616 | 929 | 85 | 90 |
| New Hampshire | 23 | 207 | 231 | 21 | 22 |
| New Jersey | 155 | 1,384 | 1,593 | 146 | 154 |
| New Mexico | 57 | 468 | 722 | 66 | 70 |
| New York | 343 | 3,052 | 3,493 | 320 | 338 |
| North Carolina | 257 | 2,286 | 2,813 | 258 | 273 |
| North Dakota | 12 | 107 | 127 | 12 | 12 |
| Ohio | 205 | 1,829 | 2,001 | 184 | 194 |
| Oklahoma | 101 | 898 | 1,197 | 110 | 116 |
| Oregon | 106 | 946 | 1,004 | 92 | 97 |
| Pennsylvania | 224 | 1,998 | 2,230 | 205 | 216 |
| Rhode Island | 19 | 166 | 185 | 17 | 18 |
| South Carolina | 125 | 1,024 | 1,280 | 117 | 124 |
| South Dakota | 15 | 129 | 160 | 15 | 16 |
| Tennessee | 171 | 1,522 | 1,846 | 169 | 179 |
| Texas | 678 | 5,574 | 7,282 | 668 | 706 |
| Utah | 77 | 682 | 908 | 83 | 88 |
| Vermont | 11 | 98 | 107 | 10 | 10 |
| Virginia | 216 | 1,920 | 2,290 | 210 | 222 |
| Washington | 187 | 1,662 | 1,675 | 154 | 162 |
| West Virginia | 50 | 443 | 491 | 45 | 48 |
| Wisconsin | 101 | 902 | 1,025 | 94 | 99 |
| Wyoming | 16 | 139 | 184 | 17 | 18 |
| **United States** | **7,253** | **62,341** | **77,515** | **7,111** | **7,511** |

## Table B-2: Electricity Savings, Money Savings and Emissions Reductions from Solar Power on Big Box Stores, by State

| State | Global Warming Pollution Offset by Reaching Big Box Store Solar Potential (thousand metric tons CO2) | Could Offset XX Percent of Big Box Store Electricity Usage in State | Could Save $XX on Annual Electricity Spending (millions of $) |
|---|---|---|---|
| Alabama | 1,037 | 39% | $137 |
| Alaska | 151 | 45% | $34 |
| Arizona | 1,578 | 51% | $220 |
| Arkansas | 709 | 42% | $70 |
| California | 8,484 | 47% | $1,694 |
| Colorado | 1,203 | 50% | $168 |
| Connecticut | 313 | 34% | $92 |
| Delaware | 219 | 39% | $26 |
| District of Columbia | 151 | 40% | $21 |
| Florida | 3,097 | 40% | $508 |
| Georgia | 2,153 | 39% | $271 |
| Hawaii | 301 | 41% | $130 |
| Idaho | 338 | 45% | $36 |
| Illinois | 1,927 | 47% | $189 |
| Indiana | 1,023 | 47% | $114 |
| Iowa | 554 | 49% | $49 |
| Kansas | 498 | 54% | $57 |
| Kentucky | 991 | 39% | $104 |
| Louisiana | 981 | 38% | $109 |
| Maine | 119 | 35% | $28 |
| Maryland | 1,412 | 39% | $173 |
| Massachusetts | 574 | 35% | $167 |
| Michigan | 1,490 | 45% | $190 |
| Minnesota | 919 | 47% | $91 |
| Mississippi | 645 | 39% | $82 |
| Missouri | 943 | 51% | $103 |

## Table B-2 (continued): Electricity Savings, Money Savings and Emissions Reductions from Solar Power on Big Box Stores, by State

| State | Global Warming Pollution Offset by Reaching Big Box Store Solar Potential (thousand metric tons CO2) | Could Offset XX Percent of Big Box Store Electricity Usage in State | Could Save $XX on Annual Electricity Spending (millions of $) |
|---|---|---|---|
| Montana | 208 | 42% | $27 |
| Nebraska | 345 | 52% | $31 |
| Nevada | 661 | 50% | $84 |
| New Hampshire | 114 | 34% | $31 |
| New Jersey | 1,377 | 35% | $204 |
| New Mexico | 543 | 52% | $70 |
| New York | 1,714 | 35% | $536 |
| North Carolina | 2,225 | 42% | $246 |
| North Dakota | 122 | 49% | $11 |
| Ohio | 1,735 | 45% | $187 |
| Oklahoma | 1,013 | 45% | $93 |
| Oregon | 717 | 38% | $87 |
| Pennsylvania | 1,941 | 34% | $206 |
| Rhode Island | 92 | 34% | $24 |
| South Carolina | 1,018 | 39% | $126 |
| South Dakota | 148 | 51% | $14 |
| Tennessee | 1,477 | 41% | $185 |
| Texas | 4,466 | 41% | $584 |
| Utah | 639 | 48% | $76 |
| Vermont | 52 | 33% | $16 |
| Virginia | 1,856 | 40% | $183 |
| Washington | 1,192 | 36% | $130 |
| West Virginia | 428 | 37% | $40 |
| Wisconsin | 944 | 47% | $110 |
| Wyoming | 130 | 48% | $16 |
| **United States** | **56,965** | **42%** | **$8,180** |

## Table B-3: Solar Capacity Potential for America's Top 24 Big Box Stores (Excluding Grocery-Specific Chains)[98]

| Solar Potential Rank | Company | U.S. Retail Space (million sq feet) | Potential Rooftop Solar Capacity (MW) | Equivalent to Power Consumed by XX Thousand Households (National Avg Household Power Use is 10.9 MWh/yr) |
|---|---|---|---|---|
| 1 | Walmart | 680 | 5,844 | 660 |
| 2 | Target | 240 | 2,062 | 233 |
| 3 | Home Depot | 206 | 1,767 | 200 |
| 4 | Lowe's Companies | 196 | 1,683 | 190 |
| 5 | Sears Holdings (Sears and KMart) | 188 | 1,614 | 182 |
| 6 | Macy's | 147 | 1,267 | 143 |
| 7 | J.C. Penney Co. | 111 | 950 | 107 |
| 8 | Kohl's | 84 | 720 | 81 |
| 9 | Costco | 70 | 601 | 68 |
| 10 | TJX (Marshall's and TJMaxx) | 62 | 530 | 60 |
| 11 | Burlington Coat Factory | 42 | 363 | 41 |
| 12 | Best Buy | 40 | 347 | 39 |
| 13 | Office Depot | 37 | 314 | 35 |
| 14 | Bed Bath & Beyond | 32 | 277 | 31 |
| 15 | Dick's Sporting Goods | 32 | 272 | 31 |
| 16 | Menard | 30 | 257 | 29 |
| 17 | Gap (Gap, Banana Republic, Old Navy, Piperlime, Athleta, and Intermix) | 29 | 252 | 28 |
| 18 | Nordstrom | 27 | 231 | 26 |
| 19 | Staples | 25 | 211 | 24 |
| 20 | Ascena Retail Group (Lane Bryant, maurices, dressbarn, Catherines and justice) | 21 | 179 | 20 |
| 21 | BJ's Wholesale Club | 21 | 177 | 20 |
| 22 | IKEA | 12 | 106 | 12 |
| 23 | Toys "R" Us | 5 | 42 | 5 |
| 24 | Foot Locker | 4 | 36 | 4 |
| | **Total** | **2,339** | **20,103** | **2,271** |

## Table B-4: Solar Capacity Potential for Top Big Box Stores with Current Installed Solar Capacity for Comparison[99]

| Solar Potential Rank | Company | U.S. Retail Space (million sq feet) | Potential Rooftop Solar Capacity (MW) | Existing Solar Capacity (MW) (From *SEIA Solar Means Business 2015*, where available) |
|---|---|---|---|---|
| 1 | Walmart | 680 | 5,844 | 141.99 |
| 2 | Target | 240 | 2,062 | 14.94 |
| 6 | Macy's | 147 | 1,267 | 20.78 |
| 8 | Kohl's | 84 | 720 | 50.21 |
| 9 | Costco | 70 | 601 | 50.75 |
| 14 | Bed Bath & Beyond | 32 | 277 | 17.34 |
| 19 | Staples | 25 | 211 | 13.66 |
| 22 | IKEA | 12 | 106 | 41.41 |

# Notes

1 IKEA, *People & Planet Positive: IKEA Group Sustainability Strategy for 2020*, accessed at web.archive.org/web/20150706064018/http://www.ikea.com/ms/en_GB/pdf/people_planet_positive/People_planet_positive.pdf, 5 July 2015.

2 Solar Energy Industries Association, *Solar Means Business 2014: Top U.S. Commercial Solar Users*, 2014.

3 Solar Energy Industries Association, *Solar Means Business 2015: Top U.S. Commercial Solar Users*, 2015.

4 IKEA, *Sustainability Report FY15*, available at ikea.com/ms/en_US/img/ad_content/2015_IKEA_sustainability_report.pdf, 2015.

5 This includes potential solar power generation from rooftop solar panels, large utility-scale solar installations, and concentrating solar power plants. Judee Burr and Lindsey Hallock, Frontier Group, Rob Sargent, Environment America Research & Policy Center, *Star Power: The Growing Role of Solar Energy in America*, November 2014.

6 Ibid.

7 SEIA, *U.S. Solar Market Insight: U.S. Installs 1.3 GW in Q3, Headed Toward Record-Breaking 2015*, archived at web.archive.org/web/20160201203850/http://www.seia.org/research-resources/us-solar-market-insight.

8 Historic capacity: Shayle Kann et al., GTM Research and SEIA, *U.S. Solar market insight report - 2014 year in review*, 10 March 2015; 2015 capacity additions: 2015 capacity additions are based on preliminary estimate (noted "E") of 7.4 GW solar additions in 2015: SEIA, *U.S. Solar Market Prepares for Biggest Quarter in History,* available at seia.org/news/us-solar-market-prepares-biggest-quarter-history, 9 December 2015.

9 Shayle Kann et al., GTM Research and SEIA, *U.S. Solar Market Insight Executive Summary Q3 2015*, December 2015.

10 Utility-scale installations are considered to be those larger than 1 MW in size.

11 Galen Barbose and Naïm Darghouth, Lawrence Berkeley National Laboratory, *Tracking the Sun VIII: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States*, August 2015.

12 Q3 2015 data: Shayle Kann et al., GTM Research and SEIA, *U.S. Solar Market Insight Executive Summary Q3 2015*, December 2015; Q3 2014 data: Shayle Kann et al., GTM Research and SEIA, *U.S. Solar Market Insight Executive Summary Q3 2014*, 2014.

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