

Soot to Solar

Illinois's Clean Energy Transition

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More information about UCS and the Climate and Energy Program is available on the UCS website: www.ucsusa.org/clean-energy.

This report is available online (in PDF format) at [www.ucsusa.org/soottosolar.org].

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[EXECUTIVE SUMMARY]

Clean energy is poised for rapid growth in Illinois thanks to the Future Energy Jobs Act (FEJA), Illinois Public Act 99-0906. Passed in December 2016, FEJA improved the state's existing Renewable Portfolio Standard and increased the state's Energy Efficiency Portfolio Standard. The resulting growth in energy efficiency and renewable energy can replace generation from retiring coal plants and allow Illinois to benefit from the federal wind and solar tax credits before they expire.

Coal and nuclear power have historically dominated Illinois' power sector. As in many other states, however, the economic competitiveness of Illinois' aging and inefficient coal power plants is in decline. Coal's share of Illinois' electricity generation decreased from 47 percent in 2007 to 32 percent in 2016. During that time, 21 generators at 12 coal plants were retired (EIA 2018a).¹

As Illinois moves away from coal, investments in the state's diversity of renewable energy resources are increasing. With 4,464 megawatts (MW) of wind currently installed, enough to cover the needs of more than 1 million households, the state ranks sixth in the nation. Another 473 MW of wind power are under construction as of August 15, 2018. Illinois currently has close to 90 MW of installed solar in the state, enough to power more than 12,700 Illinois homes. The opportunity for growth in Illinois solar is strong, as it represents only 0.07 percent of the state's electricity generation, as of August 15, 2018.

The Union of Concerned Scientists (UCS) conducted this analysis to gauge the public health, economic, and social equity gains that could result by replacing coal power plants in Illinois with clean energy technologies such as wind, solar, energy efficiency, and energy storage. The more quickly Illinois closes its aging, polluting coal plants and transitions to clean energy and energy efficiency, the greater the public health and economic benefits for local communities across the state. UCS also wants to help ensure that the clean energy transition in Illinois benefits pollution-burdened and lower-income communities. Communities of color in particular have historically faced environmental injustices including disproportionate exposure to toxic air pollutants such as coal plant emissions.

This analysis examines five coal plants in Illinois through case studies on the costs and benefits of a replacement strategy that prioritizes local renewable energy sources combined with energy storage. We hope that this analysis will help local communities fully capitalize on new Illinois solar programs; strengthen community voices calling for clean energy; aid in efforts to retire old, polluting coal plants in communities; and support the redevelopment of former coal plant sites that resonates with communities' values and needs.

¹ Representing 3,311 megawatts of nameplate capacity.

Methodology

UCS conducted a multi-layered analysis of Illinois' energy future, evaluating scenarios before and under FEJA as well as two scenarios including additional coal plant retirements. Using the Regional Energy Deployment System (ReEDS)—a power-sector model developed by the National Renewable Energy Laboratory—we analyzed four scenarios:

- **Pre-FEJA baseline:** assumes existing policies without FEJA and the early retirement of the Clinton and Quad Cities nuclear power plants.
- **FEJA scenario:** assumes existing policies including FEJA, with its subsidy for and continued operation of Quad Cities and Clinton nuclear plants.
- **Waukegan and Edwards coal plant retirements:** Layers over the FEJA scenario and retires both the Waukegan and Edwards coal plants early.² Both plants are also examined in the case studies accompanying the full report (online at www.ucsusa.org/soottosolar).
- **Dynegy-Vistra coal plant retirements:** Layers over the FEJA scenario and retires all eight of Dynegy-Vistra's financially struggling MISO plants before the end of their expected design lives.³

To look more deeply at how coal plant retirements can present opportunities for shifting to clean renewable energy, we modeled the solar and energy storage potential at the Waukegan plant site and within the community. To determine whether there would be any reliability issues with the retirement of the existing Waukegan generation, we contracted PowerGEM to conduct a grid reliability study. Lastly, we partnered with the Clean Air Task Force to conduct a public health analysis of Illinois coal plants.

In this analysis we found that Illinois is on track to a cleaner electricity sector. With additional coal plant retirements this transition will accelerate, improving public health and spurring new investment in local communities across the state. The transition to renewable energy, energy storage, and energy efficiency also lowers household electricity bills, reduces carbon emissions, and leads to a more diversified portfolio of cleaner energy resources in the state's electricity mix.

ADVERSE PUBLIC HEALTH IMPACTS DECREASE IF COAL PLANTS ARE RETIRED SOONER:

- Retiring the Waukegan and Edwards coal plants before 2030 avoids an estimated cumulative total of 104 incidents of chronic bronchitis, 124 cardiovascular and respiratory hospital admissions, 178 asthma-related emergency room visits, 264 heart attacks, and 431 premature deaths.
- The pre-2030 retirement of six Dynegy-Vistra units avoids an estimated cumulative total of 260 incidents of chronic bronchitis, 278 cardiovascular and respiratory admissions, 408 asthma emergency room visits, 592 heart attacks, and nearly 1,000 premature deaths.

SOLAR PLUS ENERGY STORAGE BRINGS MULTIPLE BENEFITS:

- The analysis shows that building additional new renewable energy capacity and energy efficiency measures under FEJA will drive \$1.3 billion in energy efficiency improvements⁴ and \$3.4 billion in capital investments in Illinois.
- As a result, total installed renewable energy capacity in Illinois is projected to reach more than 8,890 MW by 2030 under successful implementation of FEJA.
- Renewables, storage, and energy efficiency can play a major role in replacing the generation from the Waukegan and Edwards coal plants and the eight MISO Dynegy-Vistra coal plants. The new technologies would allow Illinois to reduce emissions by 33 to 51 percent by 2030 in the coal plant retirement scenarios and would save consumers an average of \$93 to \$102 per year on their electricity bills.

² Prescribed dates for the coal retirement cases can be found in the technical appendix, online at www.ucsusa.org/soottosolar.

³ The Dynegy-Vistra scenario includes the following coal plants: Baldwin, Coffeen, Duck Creek, Edwards, Havana, Hennepin, Joppa, and Newton. Full details of the retirement dates for each coal plant unit can be found in the technical appendix.

⁴ Assuming a 7 percent discount rate.

- A combination of solar, storage, and load reduction through energy efficiency could provide a stable supply of electricity at the closed plant site and the surrounding area in Waukegan. The benefits of investing in a utility-scale energy storage system to replace the existing Waukegan plant exceed the costs, and this approach represents a practical, economical option that takes into account land availability, electricity reliability issues, and environmental concerns.

NO RELIABILITY ISSUES EMERGE UPON THE CLOSURE OF THE WAUKEGAN COAL PLANT:

- We found that the combination of solar, storage, and load reduction through energy efficiency can provide a stable supply of electricity to replace existing generation at the Waukegan plant.
- The existing oil-burning combustion turbines at the Waukegan plant were installed in 1968 and are currently used only a few hours per year, making a storage plant far more economical in terms of total life cycle cost. The life cycle cost of deploying a storage peaker plant is lower than replacing the old combustion turbines with new ones of the same size.
- The Waukegan coal plant can be closed with no impacts on electricity reliability. The on-site combustion turbines can also be retired and replaced with energy storage while maintaining local reliability.
- Replacing the existing Waukegan plant with local investments in energy efficiency, solar, and energy storage will provide significant public health and economic benefits for residents and businesses, with no adverse impacts on reliability.

COMMUNITY ENGAGEMENT IS IMPORTANT IN PLANNING FOR A CLEAN ENERGY TRANSITION:

- In the five case studies included in this report, we explore the community-level economic, public health, and land impacts at three closed plant sites (Crawford, Fisk, and Wood River) and at two operating plant sites (Edwards and Waukegan) with the support and input from community groups in the respective areas. We collaborated with community members and organizations to ensure that local voices are at the center of the conversation about redeveloping coal plant sites and the need to develop fair and equitable transition plans.
- The impact of a coal plant closure is different in each community, but clean energy is often part of the solution for community members and elected officials interested in job creation and tax revenues.
- Communities face several shared challenges to site reclamation and reuse of coal plant sites, including those associated with a decreased tax base and varying degrees of job loss. Redevelopment is complicated, since it takes place through a continuum of actions that are controlled by public, private, and community actors.
- Community groups are developing strategies to work with municipalities to build capacity to plan for the closure, facilitate transparent stakeholder engagement, and create a streamlined redevelopment process that maximizes benefits to the community.

Public Health and Economic Benefits of Renewable Energy

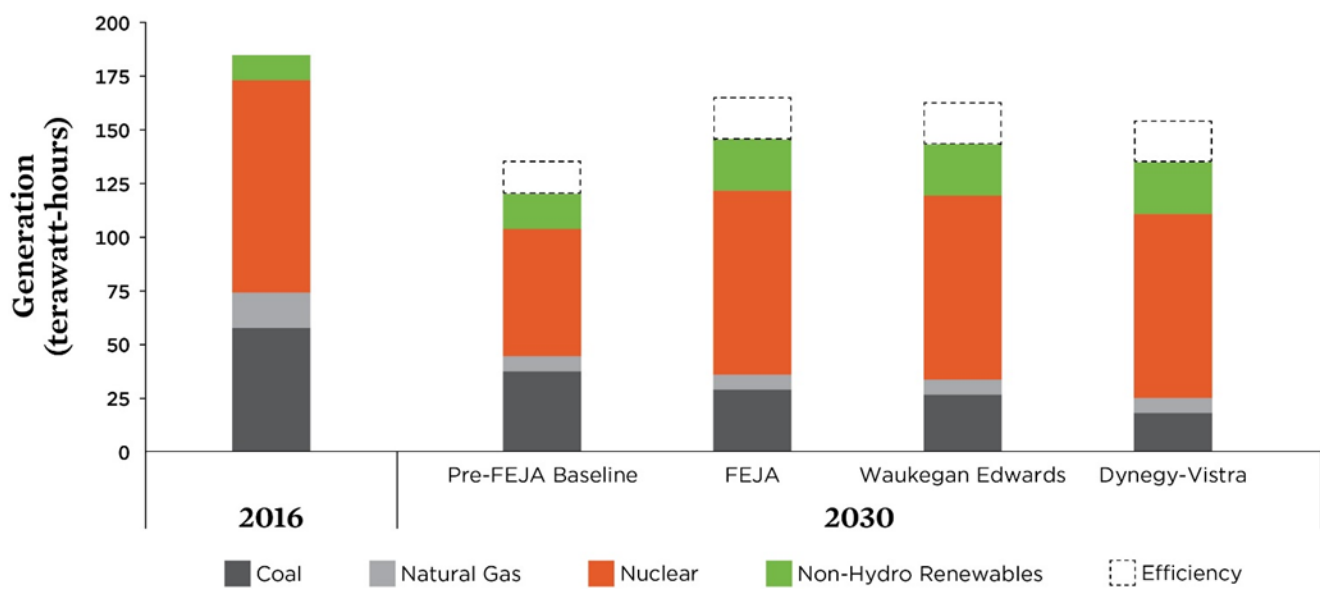
In all scenarios modeled, renewable energy generation and energy efficiency increase when coal generation is retired (Figure ES-1).

- **By implementing FEJA and retiring coal plants, Illinois achieves a cleaner and more diversified generation mix.** In the FEJA scenario, both renewable generation and energy efficiency increase to meet the state’s renewable and efficiency targets. Renewable generation rises to 17.9 percent of electricity sales in 2030. Nuclear energy is also higher in the FEJA scenario compared with the pre-FEJA baseline scenario due to the Clinton and Quad Cities plants remaining open.
- **New renewable energy capacity from FEJA drives a total of \$3.4 billion in capital investments in Illinois, while energy efficiency improvements due to FEJA spurs another \$1.3 billion in investments.**⁵ In the FEJA scenario, Illinois adds 1,300 MW of new wind capacity and 3,406 MW of new solar capacity above the pre-FEJA baseline scenario by 2030.
- **Greater emissions reductions occur under both coal retirement scenarios.** These emissions reductions are facilitated by the renewable energy and efficiency policies in FEJA. By 2030, carbon emissions reach 33 percent below 2016 levels for the Waukegan Edwards scenario and 51 percent below 2016 levels for the Dynegy-Vistra scenario.

⁵ Assuming a 7 percent discount rate.

- **Clean energy growth in Illinois spurred by additional coal retirements is achievable and affordable.** Under the coal retirement scenarios, annual savings for a typical household range from \$93 to \$102 per year by 2030.

FIGURE ES-1. **FEJA and Additional Coal Retirements Diversify Illinois' Electricity Mix, Compared with 2016**



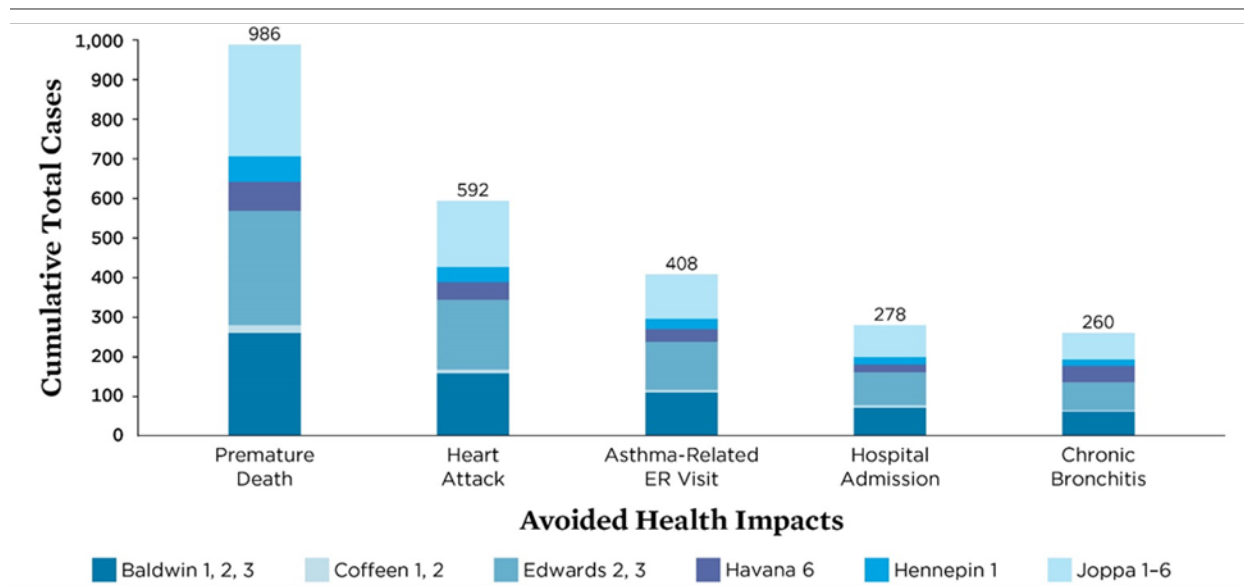
By 2030, Illinois will have undergone a dramatic shift away from coal. An energy future without the Future Energy Jobs Act, the pre-FEJA baseline, shows a generation mix still heavily dependent on coal in 2030. FEJA consists of renewable energy and energy efficiency policies that help Illinois transition more quickly to a more diversified portfolio of cleaner energy resources, as shown in the FEJA, Waukegan Edwards, and Dynegy-Vistra scenarios.

Public Health Benefits of Plant Closures

Illinois' coal plants have significant negative public health impacts. In 2016 alone, air pollution from Illinois coal plants led to an estimated more than 2,300 asthma attacks and more than 350 premature deaths. Closing coal plants before 2030 greatly decreases the negative public health impacts caused by these plants (Figure ES-2). Additionally, reducing coal use is a primary method of limiting carbon emissions that lead to climate change and the associated public health problems including intense heat waves, flooding and waterborne diseases, and higher ozone pollution levels in the warmer months. Low-level ozone pollution can have serious health effects, especially for the elderly, children, and individuals with respiratory illnesses.

- **FEJA brings large carbon dioxide (CO₂) emissions reductions and reduces other air pollutants like sulfur dioxide (SO₂) and nitrogen oxides (NO_x).** Under the FEJA scenario, electricity-related CO₂ emissions in Illinois are 22 percent below the pre-FEJA baseline scenario in 2030. NO_x emissions are reduced by 36 percent, and SO₂ by 35 percent.
- **Illinois has considerable opportunity to reduce carbon emissions and other air pollutants.** Retiring additional coal plants accelerates carbon emissions reductions by 28 percent for the Waukegan Edwards scenario below the pre-FEJA baseline scenario and by 48 percent for the Dynegy-Vistra scenario. Cumulatively from 2016 through 2030, CO₂ emissions in these scenarios are 141 million to 156 million tons less than in the pre-FEJA baseline scenario, equivalent to taking 30 million to 33 million cars off the road (EPA 2017). Under these two scenarios, NO_x emissions are 40 to 61 percent lower in 2030 than the pre-FEJA baseline scenario, while SO₂ emissions are 45 to 57 percent lower.
- **Reducing NO_x, SO₂, and CO₂ emissions leads to a range of respiratory and cardiovascular health benefits and fewer premature deaths.** NO_x contributes to smog (ground-level ozone) and NO_x and SO₂ contribute to soot (fine particulate matter), which exacerbate asthma and other heart and lung diseases and can result in significant disability and premature death. Closing plants prior to 2030 under the Dynegy-Vistra scenario, for example, greatly reduces these and other public health impacts.

FIGURE ES-2. Cumulative Health Impacts Avoided through Pre-2030 retirement of Dynegy-Vistra's MISO Coal Plants in Illinois



Closing Dynegy-Vistra coal plants before 2030 greatly decreases the adverse public health impacts caused by the plants.

Note: Because the Dynegy-Vistra scenario does not include Duck Creek, Newton, or Hennepin 2 retiring prior to 2030, these plants and units are not reflected in the above chart.

Benefits of Solar and Energy Storage

Solar, storage, and load reduction by energy efficiency can individually or together provide a stable supply of electricity at the Waukegan plant site and the surrounding area. Our analysis estimates the cost of investing in the solar plus storage hybrid systems, and the electricity bill savings and payback period for customer-owned systems. The development of energy storage facilities also brings potential tax revenue and economic development for communities.

- **The financial benefits of solar plus storage, accompanied by load reduction by energy efficiency, exceed the costs.** The initial capital cost of installing a utility-scale energy storage system (assuming a 16 MW four-hour duration lithium-ion battery) is \$14.3 million. Over the 25-year project lifetime, financial benefits total \$19.1 million, including \$6.9 million of avoided transmission costs and \$12.1 million of capacity revenues, for a net benefit of \$4.8 million.
- **Investing in solar could significantly lower consumer electricity bills.** Most homes and businesses in the Waukegan area could cut their electricity bills by more than half by investing in solar energy (Figure ES-3). Stronger climate policies and expanded use of time-varying electricity rates could further improve the economics of solar plus storage systems and reduce peak demand.
- **Combining solar with investments in energy efficiency would result in even greater electricity bill savings for customers.** When energy efficiency and solar energy are combined, a household in the Waukegan area could save 66 percent annually on its electricity bill.

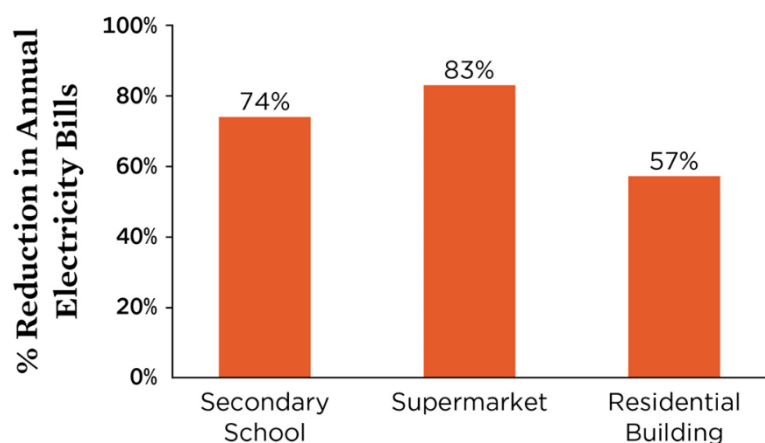
Closing the Waukegan Coal Plant While Ensuring Reliability

The Waukegan Generating Station is the largest source of SO₂ and mercury emissions in Lake County, Illinois. Waukegan residents, anchored by the community group Clean Power Lake County, have been advocating for a just retirement and transition plan for the plant for nearly a decade due to the negative health impacts caused by burning coal. Our analysis finds that concern over electricity reliability is not an obstacle to closing the Waukegan coal plant.

- **The Waukegan coal plant can be retired with no impacts on grid reliability.** We found that generation from the two remaining coal units can be reliably replaced with an equivalent amount of generation located anywhere in the 13 states served by the grid operator PJM.
- **Existing oil-burning combustion turbines on site at the Waukegan plant would need to be replaced with 100 MW of capacity to ensure electricity reliability.** The combustion turbines are old, operate only a few hours of the year, and can be readily replaced with investments in efficiency and clean energy technologies. These investments could be made at the Waukegan site or with clean energy options like solar, storage, demand response, efficiency, and other distributed generation located across many cities and towns surrounding downtown Chicago.⁶

⁶ While natural gas turbines could have been the primary solution for replacement in the past, solar plus storage is an increasingly competitive option as prices continue to drop. In addition, investment tax credits for solar and storage, solar renewable energy credits, and other climate policies make the clean energy option even more economical.

FIGURE ES-3. Investing in Solar Significantly Lowers Consumer Electricity Bills



Most homes and businesses in the Waukegan area could cut their electricity bills by more than half by investing in solar energy.

Note: Under Illinois's current electricity rate structure, PV plus storage is not cost effective compared with the PV-only option, and there is currently no significant difference in savings between the two options in secondary schools, supermarkets, or residential buildings.

The Importance of Community Engagement

The case studies that accompany the Soot to Solar report (online at www.ucsusa.org/soottosolar) feature specific communities in Illinois with recently closed coal plants or with coal plants that may soon be facing closure. The opportunities and challenges vary from place to place, because no two coal transitions—and communities—are alike.

With adequate time and resources, transition plans can be developed that include (1) provisions for remediation and redevelopment at the plant and at sites associated with it (such as coal ash impoundments); (2) contingencies for lost local tax revenues; and (3) opportunities for local economic diversification, worker training, and the creation of new, well-paying jobs.

For community engagement to be truly meaningful, it must include proactive, sustained outreach that allows for community input and removes barriers to participation in government processes. Engagement must be characterized by robust communication and responsiveness to community concerns.

Recommendations

UCS offers several recommendations for Illinois to accelerate its clean energy momentum and lead the region to a new sustainable energy future:

- **Facilitate community involvement.** State and local policymakers, utilities, and power plant owners must meaningfully engage with stakeholders, especially communities of color and low-income residents living near coal plants, to ensure that equitable and just transition plans are established. These plans should include provisions for remediation and redevelopment at the plant and at sites associated with it (such as coal ash impoundments); contingencies for lost local tax revenues; and opportunities for local economic diversification.
- **Adopt policies that support the deployment of energy storage.** Illinois should consider policy options that incorporate the value of energy storage into future solar projects and reward solar projects that include energy storage, so that Illinois can fully realize its clean energy potential and integrate increasing quantities of renewable energy.
- **Design electricity rate structures that encourage customers to invest in solar and energy storage and reduce peak demand.** Less than 1 percent of ComEd and Ameren customers utilize the hourly pricing programs currently offered. Successful deployment of time-varying rates may require utilities to offer additional options such as time-of-use rates. Customer outreach and education is also crucial, with transparent communication by utilities to outline the ways in which customers can modify their everyday behaviors to maximize savings on electricity bills.

The more rapidly Illinois closes its aging, polluting coal plants and transitions to renewable energy and energy efficiency, the greater the public health and economic benefits will be for local communities across the state. With additional policies to incentivize clean energy development, Illinoisans can gain even larger public health, economic, environmental, and community benefits.

[SECTION I]

Introduction

Coal, together with nuclear power, has traditionally dominated Illinois's power sector, providing 48 percent of the state's electricity generation in 2007 (EIA 2009). However, pollution from coal plants brings a range of negative health impacts on surrounding communities as well as globally. Moreover, the economic competitiveness of Illinois's aging and inefficient coal power plants is, like coal plants elsewhere across the nation, in decline (Richardson et al. 2017). Insufficient pollution controls to protect public health, combined with increasing competition from cleaner, lower-cost alternatives such as renewable energy and energy efficiency, are leading to coal plant retirements across the country (Rogers 2017).

Clean energy is poised for rapid growth in Illinois thanks to the Future Energy Jobs Act (FEJA), Illinois Public Act 99-0906 (Illinois General Assembly 2016). Passed in December 2016, FEJA improved the state's existing Renewable Portfolio Standard (RPS) and increased the state's Energy Efficiency Portfolio Standard. The resulting growth in energy efficiency and renewable energy can replace generation from retiring coal plants and allow Illinois to benefit from the federal wind and solar tax credits before they expire. The shift from coal-powered electricity to renewable energy and energy efficiency projects spurred by FEJA is not just cost-effective for reducing pollution from power generation, but also results in significant public health benefits, including reductions in respiratory and cardiovascular disease, and premature deaths. Clean energy policies like FEJA can help bring coal plants off line sooner than the expected retirement of the plant due to age, leading to important public health benefits as communities escape the burden caused by these plants years sooner than planned.

Illinois would benefit substantially, in a number of ways, from the closing of additional coal plants. This would especially benefit low-income communities and communities of color given their proximity to these facilities. Cities and states need to prepare for the next wave of coal plant retirements and work with local community members to determine options for site redevelopment and to avoid an overdependence on natural gas, thus ensuring the benefits of transitioning to clean energy can flow equitably to communities.

The Union of Concerned Scientists (UCS) conducted this analysis to gauge the public health, economic, and social equity gains that could result by replacing coal power plants in Illinois with clean energy technologies such as wind, solar, energy efficiency, and energy storage. The faster Illinois closes its aging, polluting coal plants and transitions to clean energy and energy efficiency, the greater the public health and economic benefits for local communities across the state.

This analysis examines five coal plants in Illinois through case studies on the costs and benefits of a replacement strategy for coal plants that prioritizes local renewable energy sources combined with energy storage. We hope that this analysis will help local communities fully capitalize on new Illinois solar programs; strengthen community voices calling for clean energy; aid in efforts to retire old, polluting coal plants; and support the redevelopment of former coal plant sites that resonates with communities'

values and needs. UCS hopes this study will help ensure that the clean energy transition in Illinois benefits pollution-burdened and lower-income communities.

Background

THE SHIFT FROM COAL-POWERED TO CLEANER ELECTRICITY GENERATION

Since 2007, Illinois has been taking steps to shift its generation mix away from coal and toward wind and solar, with their economic and health benefits. In 2007, Illinois laid the foundation for solar and wind power growth when it passed its RPS targeting the procurement of 25 percent renewable energy by 2025. Then, in 2016, Illinois passed FEJA, rapidly moving renewable energy and energy efficiency development forward. FEJA will lead to the potential development of an estimated 4,300 megawatts (MW) of renewable energy capacity and will keep Illinois on track to meeting and exceeding its RPS goals.

The recent transition in Illinois's generation mix offers both economic and health benefits. Nearly 120,000 Illinoisans are already working in the clean energy sector as of 2016 (Clean Jobs Midwest 2017), which includes more than 93,000 energy efficiency jobs. In addition, thanks to FEJA, thousands more jobs will be created. Through 2017, the wind industry alone injected \$4.5 billion of capital investment into Illinois's economy and supported more than 2,000 jobs (AWEA 2018). An additional 3,500 jobs in the solar industry have also been created (SEIA 2018a). Coal's share of Illinois's electricity generation decreased to 32 percent in 2016 (EIA 2017a). From 2007 to 2016, 21 units at 12 coal plants in Illinois were retired, representing 3,311 MW of capacity (EIA 2018b).⁷

As Illinois moves away from coal, investments in the state's renewable energy resources are increasing. With 4,464 MW of wind currently installed, enough to cover the needs of more than 1 million households, and with another 473 MW under construction, Illinois ranks sixth in the nation for installed wind capacity (AWEA 2018)⁸. Solar development is also starting to take off in Illinois with 87 MW of installed capacity (SEIA 2018a), enough to power more than 12,700 Illinois homes (SEIA 2018b).

Several key policies and programs are driving the transition away from coal and toward a cleaner and more sustainable electricity mix. Here we look at existing policies, the potential for additional coal plant closures, and the health benefits at stake.

FUTURE ENERGY JOBS ACT OF 2016

FEJA was passed in December 2016 and includes a meaningful fix to the state's existing 25-percent-by-2025 RPS by consolidating its funding mechanisms. Previous mechanisms had hindered progress toward meeting the standard, and the changes now ensure stable and predictable funding for renewable energy projects built in Illinois. Additionally, FEJA increased the state's Energy Efficiency Portfolio Standard targets, requiring the two major utilities in Illinois to further reduce energy use. Commonwealth Edison (ComEd) is required to achieve a cumulative 21.5 percent reduction in energy use, and Ameren Illinois will have to reduce by 16 percent, both by 2030. To ensure that these benefits are accessible to all communities, these utilities will spend a minimum of \$33 million per year on energy efficiency programs for low-income customers (Elevate Energy 2018). Energy efficiency is one of the most cost-effective ways to combat climate change, create jobs, and lower electric bills for consumers.

FEJA also included a Zero Emission Standard to subsidize two of Exelon's nuclear plants (Clinton and Quad Cities) in Illinois to prevent their closure. The Zero Emission Standard enables Exelon to earn credits based on the economic value of the avoided carbon emissions from these facilities using the federal social cost of carbon, which represents the avoided economic damages from climate change. The total number of credits is capped according to a yearly budget formula (resulting in approximately \$235 million for 2018-2019), and the program lasts for 10 years.

Other important clean energy provisions in FEJA include:

- Creation of a community solar program, allowing those unable to build solar on their roofs to subscribe to a shared project in their community.

⁷ 0.3 percent of the state's total 2007 coal nameplate capacity as of 2007.

⁸ AWEA accessed and data collected on August 15, 2018.

- Creation of the Illinois Solar for All program, which provides incentives for rooftop solar projects for low-income residents and solar installations on public facilities and nonprofits serving low-income families. Incentives will be provided to community solar projects that are owned 100 percent by low-income electricity customers.
- A carve-out for brownfield solar development, encouraging solar installation on land contaminated by pollution.

COMMUNITY SOLAR

FEJA creates the state’s first community solar program, which enables residents not able to build solar on their roof to subscribe to a shared project in or near their community. For example, consumers who either live in apartment buildings, can’t afford to install solar, don’t have the space, or are limited by local zoning laws can subscribe to a solar project at a local church, school, or business. Community Solar Subscribers purchase or lease solar panels and receive a credit on their monthly electric bill for the energy produced by their share of the project.

ILLINOIS SOLAR FOR ALL

The Illinois Solar for All program is a comprehensive low-income solar deployment and job training program, which will open access to the solar economy for thousands of Illinois residents (Illinois Clean Jobs Coalition 2018). This program will:

- Provide funding to train and employ residents representing specific populations. For example, Solar for All is paired with a solar installer jobs training pipeline with a goal that 50 percent of trainees will come from environmental justice communities, communities disproportionately affected by environmental hazards and social inequities. The program will bring living-wage employment opportunities in a rapidly growing industry and will create 2,000 jobs for people returning from the criminal justice system and alumni of the foster care system.
- Provide long-term financial relief to families struggling with high and unpredictable energy costs.
- Offer a source of clean, local energy sited in communities that have been disproportionately impacted by fossil fuel power generation (Grid Alternatives and Vote Solar 2018).

BROWNFIELD DEVELOPMENT

The majority of brownfield sites, land whose potential for redevelopment is complicated by the presence or potential presence of hazardous contaminants, are abandoned or underused industrial or commercial land (EPA 2018a). The benefits of brownfield remediation and redevelopment include removal of contaminants, the opportunity to leverage private investment and create businesses and jobs, and the opportunity to return these abandoned sites to active use, which increases a community’s tax revenue (Delta Institute 2016).

With FEJA, the RPS now contains specific quantity-based targets for renewable energy credits (RECs) from new brownfield site solar projects. RECs are a market-based instrument that verifies the energy has been generated from renewable resources. A REC is issued for every megawatt-hour (MWh) of electricity generated from a renewable energy source, like wind or solar, and can be sold or traded separately from the electricity itself. FEJA requires that 2 percent of the RECs procured by the Illinois Power Agency must be from brownfield solar projects. Developing brownfield solar projects in Illinois will help return blighted or contaminated land to productive use while enhancing public health and the well-being of Illinois residents.

Potential for Additional Coal Plant Closings

Illinois currently has 15 operating coal plants (S&P Global 2018), but many face uncertain futures because of their age, inefficiencies, lack of pollution controls, and difficulty competing economically with cleaner energy options.

DYNEGY-VISTRA

Dynegy (recently bought by Vistra), a Texas-based company, owns eight MISO-connected coal plants in central and southern Illinois with a combined nameplate capacity of 5,862 MW; most of these are at risk of closing because of lower-cost alternatives

and limited growth opportunities.⁹ As a result, Dynegy-Vistra is seeking government intervention. For example, the company proposed unsuccessful state legislation in 2017 that would have resulted in increased revenues for its uncompetitive plants, subsidies that would be paid for by ratepayers through higher electricity rates. In addition, Dynegy-Vistra has petitioned the Illinois Environmental Protection Agency to rewrite the state's Multi-Pollutant Standard—a 2006 clean air standard for coal plants. The proposed changes would create annual caps on tons of SO₂ and NO_x emitted by the entire coal fleet rather than emission rates applied to smaller groups of power plants. The resulting change could allow Dynegy-Vistra to close newer plants equipped with modern pollution controls—but more expensive to operate—and instead run older and dirtier plants more frequently.

A recent analysis found that the eight Dynegy-Vistra plants in central and southern Illinois can be retired in the near term while preserving the minimum amount of power-generating capacity needed for the regional grid. The output from the plants can be feasibly and reliably replaced with a cost-effective mix of wind, solar, natural gas, and nuclear (NRDC 2018). Doing so would lower residents' and businesses' electricity bills as well as deliver significant economic and health benefits to all of central and southern Illinois.

WAUKEGAN

Waukegan is the largest source of SO₂ and mercury emissions in Lake County, Illinois, despite the plant owner, NRG Energy, installing new pollution control measures a few years ago as part of a lawsuit settlement. Toxic coal ash is stored in pits near the lakefront, also part of an ongoing lawsuit.

The Clean Power Lake County Campaign is made up of community members and health, faith, and environmental groups that have been fighting for a just retirement and transition plan for the Waukegan coal plant for several years, which includes retraining opportunities for coal plant workers, job opportunities for other community members, and a comprehensive stakeholder process to facilitate site remediation and redevelopment. Clean Power Lake County's goals include securing a retirement date for the plant, establishing a just transition plan for local workers including retraining for clean energy jobs, facilitating conversations about the sale and reuse of the lakefront site, and identifying opportunities for energy efficiency and clean energy projects that can create jobs for local residents and tax revenue for Waukegan and Lake County (Clean Power Lake County n.d.).

Inequitable Public Health Impacts from Coal Plants

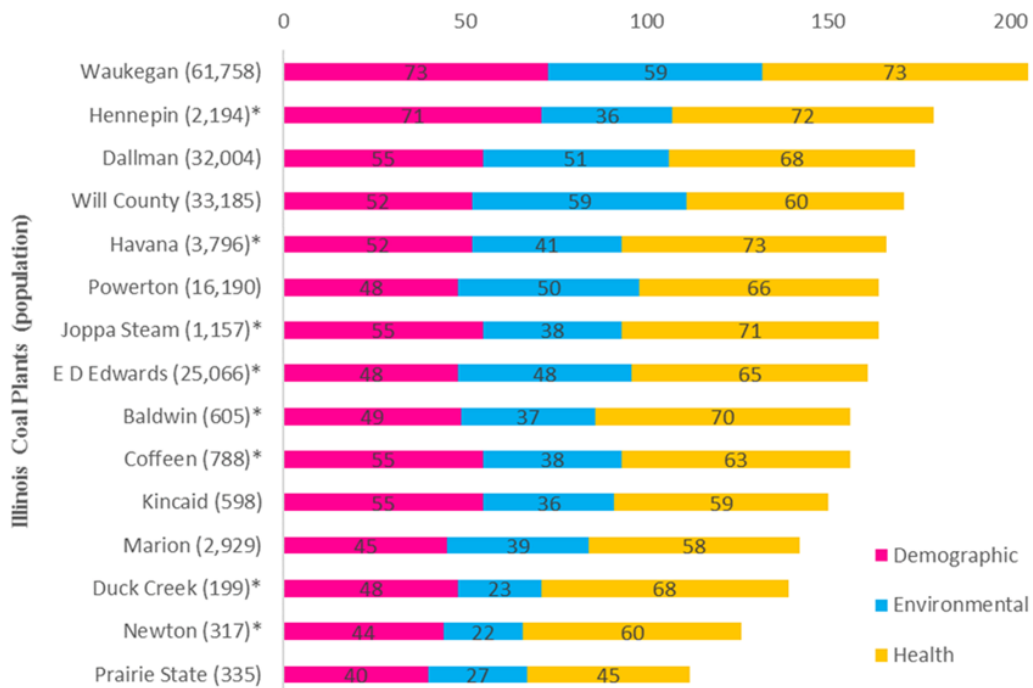
Power plants' emissions contribute to air pollution and climate change and substantially affect human health. The electricity sector is the largest source of sulfur dioxide (SO₂) emissions, which contribute to haze and acid rain; this pollution can also cause breathing problems, particularly among the young, the elderly, and those with asthma (EPA 2016a). Power plants are the second largest source of nitrogen oxides (NO_x), which can contribute to asthma attacks (EPA 2016b). Coal-fired power plants are also direct sources of fine particulate matter (PM 2.5), which contributes to the formation of soot in the atmosphere and additional health risks.

Coal plants are frequently located in low-income communities that often have large non-white populations. Negative public health and environmental impacts from coal's emissions are disproportionately felt by these communities of color. In addition to being exposed to relatively high levels of air pollution, coal plant communities are often burdened with coal ash—containing heavy metals such as mercury, arsenic, selenium, chromium, and cadmium—which is a large barrier to the redevelopment of many coal plant sites (EPA 2018b). The long site-cleanup process is sometimes led by community members, but often the plant owner holds on to the site and it remains empty, un-remediated and undeveloped (Raimi 2017).

⁹ The Mid-Continent Independent System Operator (MISO) is a non-profit organization delegated by the Federal Energy Regulatory Commission to operate the electric grid in a large portion of the central United States.

Figure 1 shows the Cumulative Vulnerability Index (CVI) for the three-mile radius buffers around operating Illinois coal plants,¹⁰ ranked from highest to lowest with population shown in parentheses for each buffer. The buffer around the Waukegan Generating Station has the largest population, the highest CVI, and the highest EJ Index¹¹ for every environmental indicator of any operating coal plant in Illinois. Of the eight coal plants owned by Dynegy-Vistra that we look at in this report, the Hennepin and Havana stations have the highest CVI from that group.

FIGURE 1. Demographic, Environmental, and Health Vulnerability for Communities in a Three-mile Radius of Operating Illinois Coal Plants



The CVI for the three-mile radius buffers around operating Illinois coal plants, ranked from highest to lowest and population is shown in parentheses for each buffer. The asterisks denote a Dynegy-Vistra owned plant.

SOURCE: FLORES ET AL. 2017 (WITH DATA FROM THE NATIONAL AIR TOXICS ASSESSMENT)

¹⁰ The CVI is a method for combining demographic and environmental information. It aggregates the demographic and environmental indicator percentiles from EJSCREEN (see following footnote) and supplements them with an aggregate of several health indicators. The CVI represents the cumulative socioeconomic and environmental hazard burden in a single metric (Krieger et al. 2016), where groups of indicators are treated equally. For instance, the burdens from environmental pollution are given the same weight as the susceptibility suggested by demographics.

¹¹ The Environmental Protection Agency’s EJSCREEN includes demographic indicators, such as the percentage of the population that is low income or minority, and environmental indicators, such as air quality and proximity to traffic or superfund sites. Environmental Justice Indexes used in EJ Screen can be found here: www.epa.gov/ejscreen/environmental-justice-indexes-ejscreen.

Illinois's Clean Energy Transition

The implementation of FEJA will drive significant development of renewable energy and energy efficiency projects, resources that are not just cost-effective for reducing pollution from power generation but also result in significant public health benefits. However, Illinoisans' public health calls for more improvement more quickly. Additional coal plants need to be retired, beyond what will be retired as a result of FEJA. These retirements would especially benefit low-income communities and communities of color, given their proximity to where facilities are located. Cities and states need to prepare for the next wave of coal plant retirements and work with local community members to determine options, discuss site redevelopment, and avoid an overdependence on natural gas in order to ensure that the benefits of transitioning to clean energy flow equitably to communities.

Methodology

To analyze and compare different Illinois energy futures through 2030, including several coal retirement scenarios and the impact of FEJA, we used a modified version of the Regional Energy Deployment System (ReEDS).¹² ReEDS is a power-sector dispatch model that simulates the electricity-supply mix that would meet electricity demand in the future throughout the contiguous United States at the lowest overall system cost while meeting reliability, environmental, and other legal requirements. The assumptions in our version of the model are based on:

- Information used by the Energy Information Administration for the *Annual Energy Outlook 2018* (EIA 2018c).
- Data from the Department of Energy's *Wind Vision Report* (DOE 2015).
- The National Renewable Energy Laboratory's 2017 Standard Scenarios reports (NREL 2017).
- Updated data on recent retirements of existing power plants and new power plants under construction (see the technical appendix online at www.ucsusa.org/sootsolarappendix for more information).

For this analysis we modeled several scenarios to analyze the impact of FEJA and additional coal retirement scenarios on the electricity generation mix, emissions, and economic impacts in Illinois:

- **Pre-FEJA baseline.** We first modeled a pre-FEJA baseline scenario with no new state or federal policies beyond those in place as of February 2018. For our pre-FEJA baseline scenario, we modeled Illinois with a broken RPS, efficiency savings limited by rate caps to 1.1 percent per year,¹³ and the early retirement of the Quad Cities and Clinton nuclear plants—essentially modeling Illinois policies as if FEJA had not been approved in late 2016.
- **FEJA scenario.** Our FEJA scenario includes state and federal policies through February 2018; all of the FEJA policies (including the Illinois RPS, Energy Efficiency Portfolio Standard, and new build requirements for wind and solar) and the continued operation of the Quad Cities and Clinton nuclear power plants that received temporary financial support under the law. In the FEJA scenario the ReEDS model chooses to retire some select coal plants in Illinois early based on economics (see the technical appendix for more information).

¹² ReEDS is a power-sector dispatch model developed by the National Renewable Energy Laboratory. See www.nrel.gov/analysis/reeds/.

¹³ The energy efficiency assumption is a proxy for state or utility action; it is needed because the ReEDS model does not include choices on energy efficiency.

- **Two coal retirement scenarios.** Each of the coal retirement scenarios layers additional coal plant retirements onto the FEJA scenario. In addition to the coal plant retirements chosen by the ReEDS model in the FEJA scenarios, these two coal retirement scenarios prescribe additional retirement dates for (1) Waukegan and Edwards coal plants, and (2) eight Dynegy-Vistra MISO coal plants, respectively.

Results

ECONOMICS AND EMISSIONS—STATE-WIDE

FEJA AND ADDITIONAL COAL REQUIREMENTS WILL LEAD TO LOWER EMISSIONS AND MORE CLEAN ENERGY INVESTMENTS

With the results of FEJA plus additional coal plant retirements, Illinois can accelerate its shift toward cleaner, low-carbon energy resources. Under the pre-FEJA baseline scenario—that is, without these most recent policies to incentivize energy efficiency and renewable energy—coal generation is projected to increase (after an initial decline) through 2030 (Figure 2). Without FEJA, renewables and energy efficiency increase by a modest amount, and nuclear generation decreases due to the Clinton, Quad Cities, and Dresden plants retiring during the forecast period.¹⁴ Under the FEJA scenario, certain coal-fired units retire before their original retirement date. FEJA reduces fossil fuel–based generation and results in a 27 percent decrease in CO₂ emissions by 2025 and a 22 percent decrease by 2030, compared to the pre-FEJA baseline scenario levels.

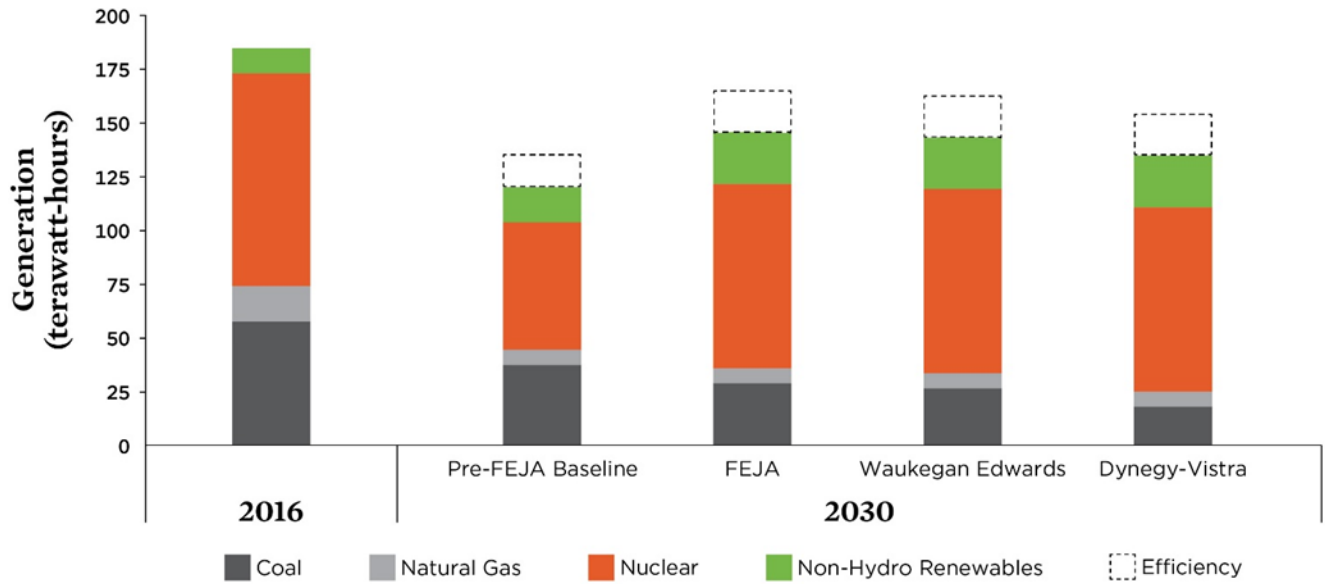
By contrast, the FEJA scenario and both coal retirement scenarios result in cleaner and more diversified generation mixes. With FEJA, both renewable generation and energy efficiency increase to meet the state’s renewables and efficiency targets. Renewable generation rises to 17.9 percent of electricity sales in 2030 under FEJA (compared to 11.2 percent without FEJA), and energy efficiency investments result in a 13 percent reduction in statewide electricity demand by 2030^{15 16} (compared to 9.8 percent reduction in the pre-FEJA baseline scenario).

¹⁴ In all cases, we included Unit 2 of the Dresden plant (867 MW) retiring in 2029 after reaching a 60-year lifetime. We assumed that all existing nuclear reactors will receive one 20-year license extension from the Nuclear Regulatory Commission to allow them to operate for 60 years. While it is possible that existing reactors could receive another license extension beyond 60 years, the commission has approved none to date.

¹⁵ Neme, Chris. (principal, Energy Futures Group), discussion with the authors. April 2018.

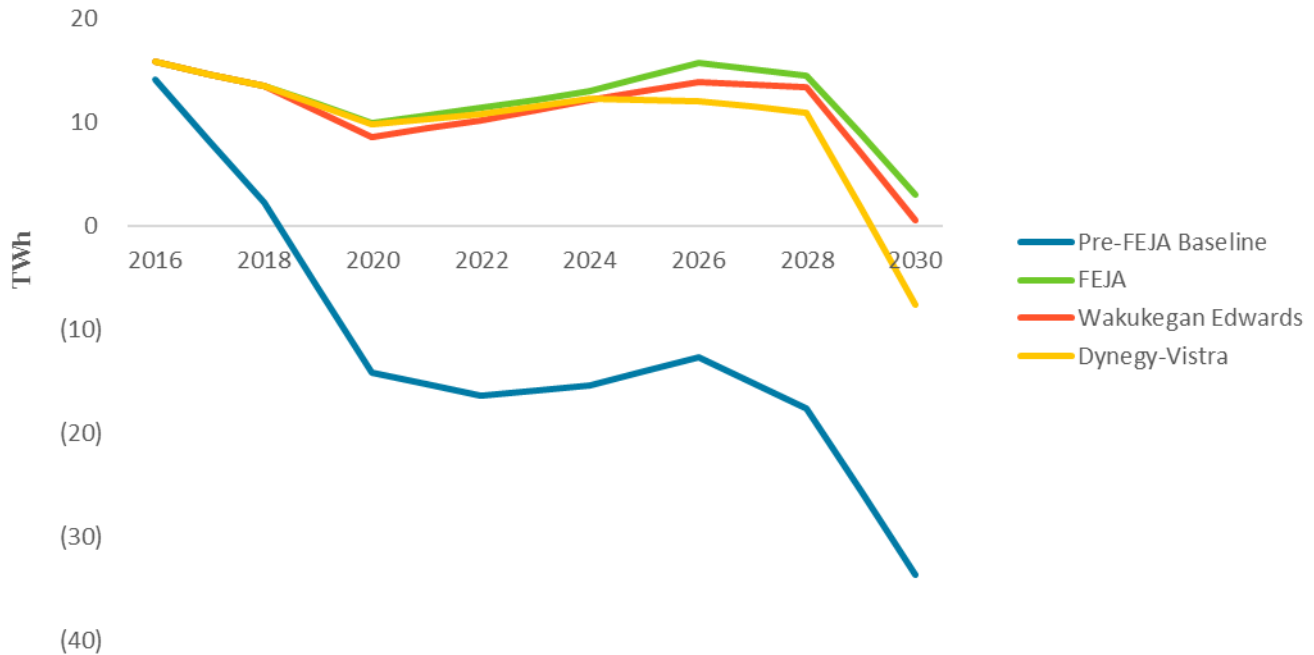
¹⁶ Illinois Energy Efficiency Stakeholder Advisory Group (ILSAG). 2018. Energy efficiency dockets. Chicago, IL. Online at www.ilsag.info/energy-efficiency-dockets.html, accessed August 15, 2018.

FIGURE 2. FEJA and Additional Coal Retirements Diversify Illinois' Electricity Mix, Compared with 2016



By 2030, Illinois will have undergone a dramatic shift away from coal. An energy future without the Future Energy Jobs Act, the pre-FEJA baseline, shows a generation mix still heavily dependent on coal in 2030. FEJA consists of renewable energy and energy efficiency policies that help Illinois transition more quickly to a more diversified portfolio of cleaner energy resources, as shown in the FEJA, Waukegan Edwards, and Dynegy-Vistra scenarios.

FIGURE 3. FEJA Allows Illinois to Remain a Net Exporter of Electricity until 2030, Even with Additional Coal Retirements



Because of renewable energy and energy efficiency investments and nuclear subsidies under FEJA, Illinois can prolong its status as an electricity-exporting state in the FEJA scenario and the Waukegan Edwards and Dynegy-Vistra scenarios.

Illinois currently generates considerably more electricity than it consumes and sells its surplus electricity to surrounding states. Due to renewable energy and energy efficiency investments and nuclear subsidies under FEJA, Illinois prolongs its status as an electricity-exporting state under the FEJA scenario and the Waukegan Edwards and Dynegy-Vistra scenarios. Under these scenarios, we found that by 2025 Illinois exports 9 to 11 percent of its electricity to other states, compared to importing 10 percent of its electricity without FEJA. Illinois remains a net exporter of electricity until 2030 under FEJA. Without FEJA, Illinois would transition from being a net exporter of electricity to a net importer in 2019 to make up for the loss of in-state capacity (Figure 3).¹⁷

FEJA does allow for some out-of-state renewable electricity generation to meet Illinois’s RPS. Under FEJA, Illinois may procure RECs from projects located in Illinois or in nearby states (Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Wisconsin). However, while projects in Illinois automatically qualify for REC procurement, projects in nearby states must satisfy a set of public interest criteria established by the Illinois Power Agency, and their costs cannot be recovered through rates approved by a state utility commission to be eligible for procurement. Based on these limitations, we capped the amount of RECs assumed to

¹⁷ The generation mix, including the levels of imported and exported electricity, results from the model’s calculations for meeting electricity demand in Illinois and across the country at least cost, subject to reliability and other constraints that are based on assumptions described in the technical appendix, online at www.ucsusa.org/sootsolarappendix.

come from projects in nearby states to 20 percent, an assumption that we then cross-checked with stakeholder groups for reasonableness. The RPS applies to investor owned utilities.

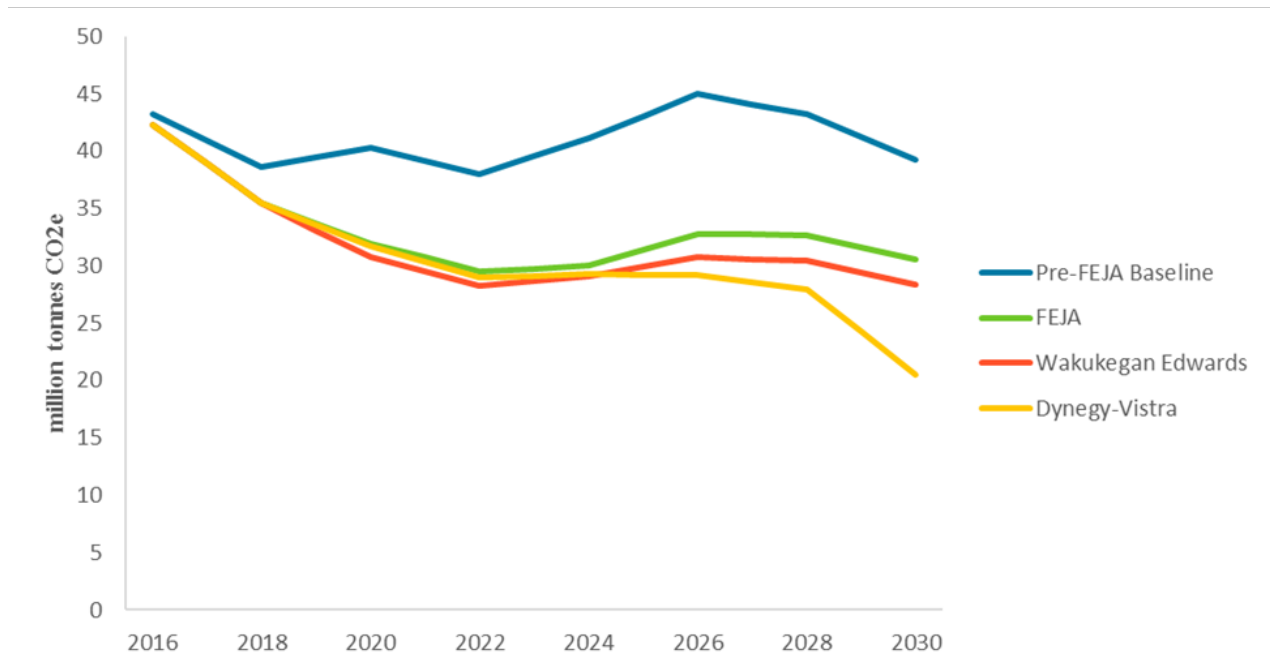
EMISSION REDUCTIONS IN ILLINOIS

Under FEJA, electricity-related CO2 emissions in Illinois decrease from 31.4 million tons in 2025 to 30.5 million tons in 2030—nearly a 22 percent reduction in 2030, putting Illinois on the path to becoming a national leader in cutting carbon emissions. Retiring additional coal plants further reduces carbon emissions in 2030, by 28 percent for the Waukegan Edwards scenario and by 48 percent for the Dynegy-Vistra scenario (Figure 4). Cumulatively from 2016 through 2030, FEJA and the two coal retirement scenarios result in a 122- to 156-million-ton reduction in CO2 emissions. The lower CO2 emissions directly reflect the state’s cleaner generation mix spurred by renewable energy and energy efficiency policies (see Figure 2).

Even greater emission reductions occur under both coal retirement scenarios, helped by the renewable energy and efficiency policies in FEJA (see Figure 2). By 2030, electricity sector CO2 emissions are 33 percent below 2016 levels under the Waukegan Edwards scenario and 51 percent under the Dynegy-Vistra scenario. Coal generation is 29 percent lower in the Waukegan Edwards scenario than in the pre-FEJA scenario by 2030, and 52 percent lower in the Dynegy-Vistra scenario.

In addition to reducing CO2 emissions, FEJA and both coal retirement scenarios also help cut emissions of other air pollutants—including SO2 and NOx—primarily through the reduction in coal-fired electricity generation from older and inefficient plants. Under FEJA and the additional coal retirement scenarios, NOx emissions are 40 to 61 percent lower in 2030 than without FEJA, while SO2 emissions are 45 to 57 percent lower.

FIGURE 4. FEJA and Additional Coal Retirements Lower Carbon Emissions in Illinois



In our analysis, without FEJA, power plant CO2 emissions in Illinois initially decline and then increase in the 2022–2026 time frame as coal generation increases in this scenario. CO2 emissions decrease under FEJA, reduced by nearly 22 percent in 2030. Retiring additional coal plants further reduces carbon emissions, to 28 percent for the Waukegan Edwards scenario and 48 percent for the Dynegy-Vistra scenario (below the pre-FEJA baseline scenario) in 2030.

CLEAN ENERGY INVESTMENTS INCREASE UNDER FEJA

To meet the RPS under FEJA, Illinois will add 1,300 MW of new wind capacity and 3,406 MW of new solar capacity above the pre-FEJA baseline scenario by 2030. Without FEJA, renewables and energy efficiency do increase by a modest amount to take advantage of the federal tax credits for renewables and due to decreases in cost of these technologies. However, building additional new renewable energy capacity and energy efficiency measures under FEJA will drive \$3.4 billion in capital investments in Illinois, as well as \$1.3 billion in energy efficiency improvements.¹⁸ As a result, total installed renewable energy capacity in Illinois is projected to reach more than 8,890 MW by 2030 under FEJA. The Waukegan Edwards and Dynegy-Vistra scenarios resulted in similar levels of renewable energy investment.

A CLEANER ENERGY SUPPLY IS AFFORDABLE

The clean energy growth in Illinois spurred by FEJA and additional coal retirements is not only achievable but also affordable. The average monthly electricity bill for a typical household under the FEJA scenario is 6 percent lower in 2025, amounting to an annual savings of about \$84. Savings, which grow over time under FEJA as renewables and energy efficiency ramp up to higher levels, reach \$100 per year for the average household (8.6 percent) by 2030 (Figure 5).

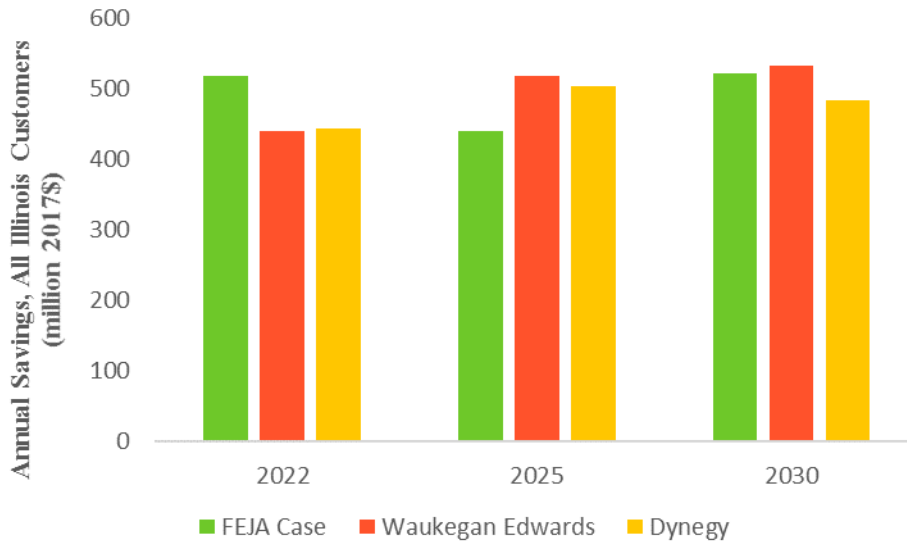
Accelerating the retirement of additional coal plants along with FEJA results in consumer savings. Due to the investments in energy efficiency from the Energy Efficiency Portfolio Standard, both coal retirement scenarios show similar consumer electricity bill reductions as the FEJA scenario, an annual savings of \$102 in the Waukegan Edwards scenario and \$93 in the Dynegy-Vistra scenario by 2030.

In our analysis of the four scenarios, we also examined some of the broader financial impacts on the electricity system in Illinois—including net effects on electricity bills for all customer classes, investments by participants in energy efficiency programs, and net costs for power generators and distributors.¹⁹ In 2025, FEJA results in savings of \$919 million, or 5 percent of total electricity system costs. These policies continue to generate financial savings over time. In 2030, the net savings are \$1.3 billion, a decrease of 7.9 percent in total electricity system costs. Cumulatively from 2016 through 2030, the policies under FEJA and the coal retirement scenarios lead to net savings for the electricity system of \$8.2 to \$9.8 billion.

¹⁸ Assuming a 7 percent discount rate, based on recommendations outlined in OMB 2014.

¹⁹ Electricity costs in the cases including FEJA are based on the average monthly consumption of 684 kWh for a typical residential customer in 2022, falling to 675 kWh in 2030 because of energy efficiency investments to meet the Energy Efficiency Portfolio Standard. Average monthly consumption is 7 percent lower than the pre-FEJA baseline scenario in 2030 (728 kWh) because of stronger energy efficiency requirements.

FIGURE 5. Clean Energy Saves Illinois Residents Money



The FEJA scenario leads to consumer electricity bills in 2030 that are 8.6 percent lower on average than in the pre-FEJA baseline scenario, saving Illinois customers nearly \$522 million per year. Energy efficiency helps consumers save electricity, and more renewable energy helps diversify the electricity mix and limit potential impacts from increases in natural gas prices. Because of greater investments in energy efficiency from a stronger Energy Efficiency Portfolio Standard, the FEJA scenario and the coal retirement scenarios throughout the forecast period result in greater consumer electricity bill savings than in the pre-FEJA baseline scenario.

BENEFITS OF LESS AIR POLLUTION

Reducing NO_x, SO₂, and CO₂ emissions leads to tangible health and environmental benefits. NO_x contributes to smog, and NO_x and SO₂ contribute to soot, which exacerbates asthma and other heart and lung diseases and can result in significant disability and premature death (EPA n.d.). CO₂ emissions contribute to global climate change, which leads to sea level rise, extreme weather such as heat waves, droughts, heavy downpours, and to other climate impacts that can impair human health and safety.

SO₂ and NO_x emitted by coal plants lead to the formation of particulate matter, and NO_x also combine with volatile organic compounds in the presence of sunlight to create dangerous ground-level ozone. People with high levels of exposure to these pollutants can experience irritation of the throat and lungs, difficulty breathing, increased asthma symptoms, additional respiratory illnesses, cardiovascular disease, and premature death.

Public Health Impacts State-Wide

Health-Dollar Savings

Using the same methodology applied by the US Environmental Protection Agency in its impact assessment for the Clean Power Plan, we estimated the monetized savings from reducing these pollutants (EPA 2015).²⁰ The combined carbon and health-dollar benefits of the avoided emissions of CO₂, SO₂, and NO_x show large benefits to Illinois. Under the FEJA scenario, the climate and public health benefits are more than \$650 million on average each year from 2015 to 2030, and \$765 to \$811 million for the two coal retirement scenarios. Cumulatively through 2030, these benefits range from \$5.5 to \$6.5 billion²¹ across the three scenarios. It is also notable that these health benefits are in addition to the net financial benefits for the electricity sector of more than \$8.2 billion, noted earlier.

Public Health Improvements—Pre-FEJA Scenario

The Clean Air Task Force (CATF), through its Powerplant Impact Estimator Software Tool, provided data to us on the public health impacts of Illinois coal plants (Clean Air Task Force 2018).²² For a given year of operations, CATF estimates various health endpoints for each plant. Using this data, we determined the cumulative avoided health impacts from retiring Illinois coal plants.

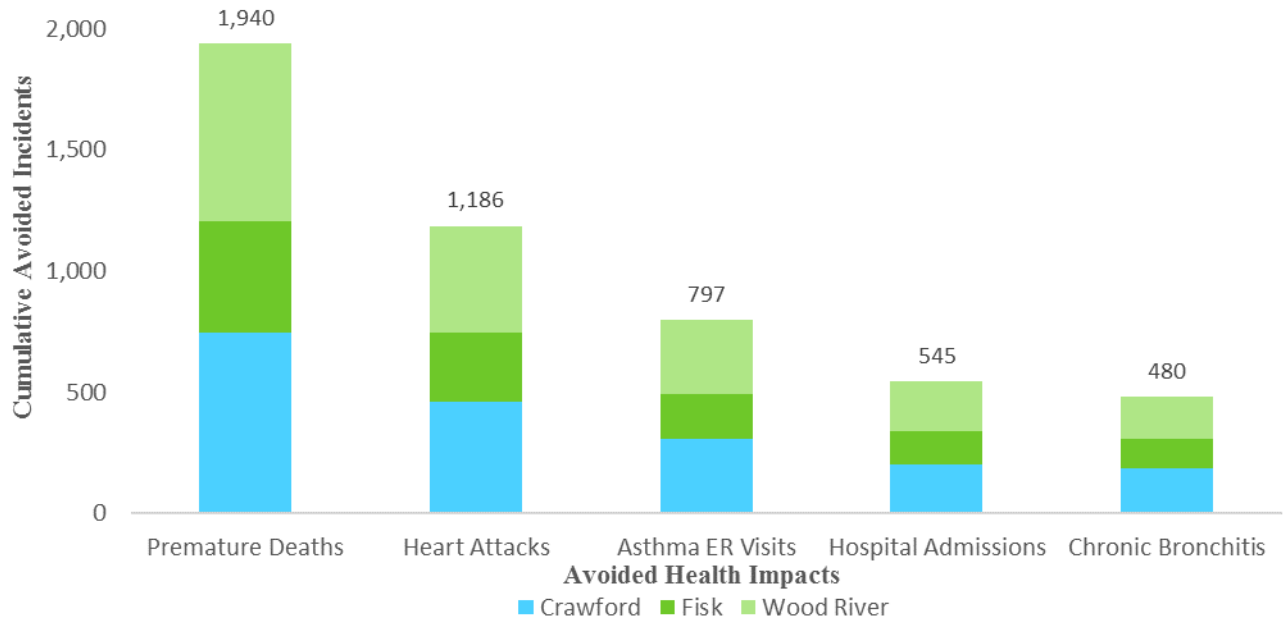
Illinois has already made significant progress reducing coal-fired power plant health impacts. For example, the graphic below (Figure 6) shows that the retirement of the Crawford, Fisk, and Wood River power stations (which has already taken place) avoided numerous health impacts that would have occurred had the plants operated at historical levels through the year 2030. Located in or near the population centers of Chicago and greater St. Louis, the closure of these plants represents a significant victory for public health and air quality.

²⁰ The health benefits are calculated based on “benefit per ton estimates for SO₂ and NO_x,” reported in Tables 4-7, 4-8, and 4-9 of OAQPS 2015. See the technical appendix, online at www.ucsusa.org/sootsolarappendix, for values and additional information.

²¹ This is the net present value from 2022 through 2030 using a 7 percent discount rate, based on recommendations outlined in OMB 2014.

²² Since 2000, the Clean Air Task Force has issued studies based on work by Abt Associates, the EPA’s health benefits consultant, relying on peer-reviewed, published methodology to quantify the deaths and other adverse health effects attributable to the fine particle air pollution resulting from power plant emissions.

FIGURE 6. Cumulative Avoided Health Impacts: Retiring Crawford, Fisk, and Wood River Plants Prior to 2030



2010 health impact data were utilized for Crawford and Fisk, and 2012 data were used for Wood River. We discuss these plants in detail in our case studies.

PUBLIC HEALTH IMPROVEMENTS—FEJA SCENARIO

While Illinois has recently seen a reduction in coal use, the coal-fired power plants that continue to operate still cause significant harm to public health (Table 1).

**TABLE 1. Annual Health Impacts of Illinois Coal Plants
Based on 2016 Operational Levels**

Health Impact	Incidents
Premature Deaths	356
Heart attacks	215
Acute bronchitis	203
Chronic bronchitis	85
Asthma attacks	2,335
Asthma emergency room visits	147
Cardio hospital admissions	68
Respiratory hospital admissions	33
Upper respiratory symptoms	1,820
Lower respiratory symptoms	2,412
Work loss days	17,274
Restricted activity days for children	102,836

Under the FEJA scenario, certain coal-fired units retire before their original retirement date. Our calculations show these early retirements leading to additional avoided public health impacts, including a cumulative total of 298 avoided premature deaths, 181 avoided heart attacks, 124 avoided asthma emergency room visits, 85 avoided cardiovascular and respiratory hospital admissions, and 168 avoided incidents of chronic bronchitis (Table 2).

TABLE 2. Coal Plant Retirement Dates Advanced by FEJA and Resulting Avoided Health Impacts, Cumulative through 2030

Plant	Unit #	Retirement Date with FEJA	Avoided Premature Deaths	Avoided Heart Attacks	Avoided Asthma ER Visits	Avoided Hospital Admissions	Avoided Chronic Bronchitis
Edwards	2, 3	2022 (instead of after 2030)	288	175	120	82	166
Joppa	3	2028 (instead of 2030)	10	6	4	3	2
Total			298	181	124	85	168

Because CATF reports health impact data at the plant level, we derived the numbers for Joppa Unit 3 by assigning a share of the Joppa plant’s total health impacts to Unit 3 based on the unit’s percentage of the plant’s megawatt-hours generated in 2016.

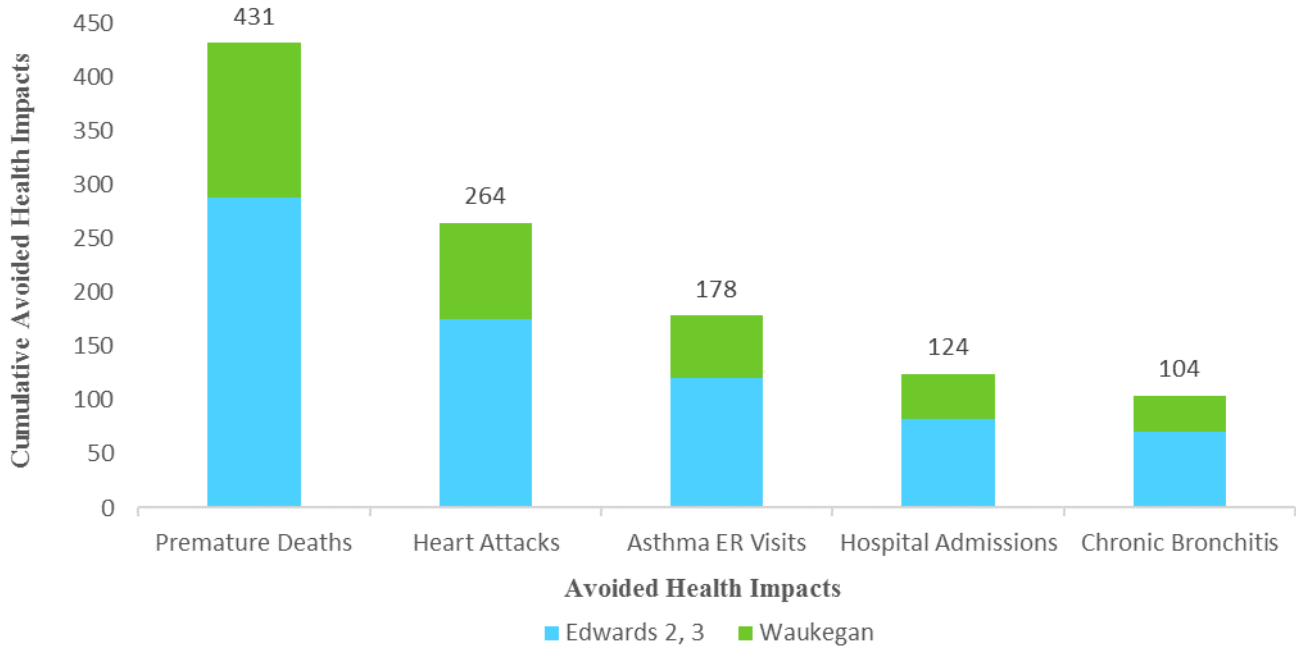
PUBLIC HEALTH IMPROVEMENTS—ADDITIONAL COAL PLANT RETIREMENTS

WAUKEGAN EDWARDS SCENARIO

Accelerating additional coal plant retirements will avoid even more public health impacts, improving Illinoisans’ health even sooner. In the Waukegan-Edwards scenario, we selected retirement dates for the units in consultation with stakeholders, including external reviewers from the Environmental Law and Policy Center and the Natural Resources Defense Council. Full details of the retirement dates under each scenario can be found in Table TA-4 and Table TA-5 in the technical appendix.

Taking both plants together, retiring these units early avoids a cumulative total of 431 premature deaths, 264 heart attacks, 178 asthma emergency room visits, 124 cardiovascular and respiratory hospital admissions, and 104 incidents of chronic bronchitis (Figure 7).

FIGURE 7. Cumulative Public Health Benefits of Waukegan-Edwards Scenario



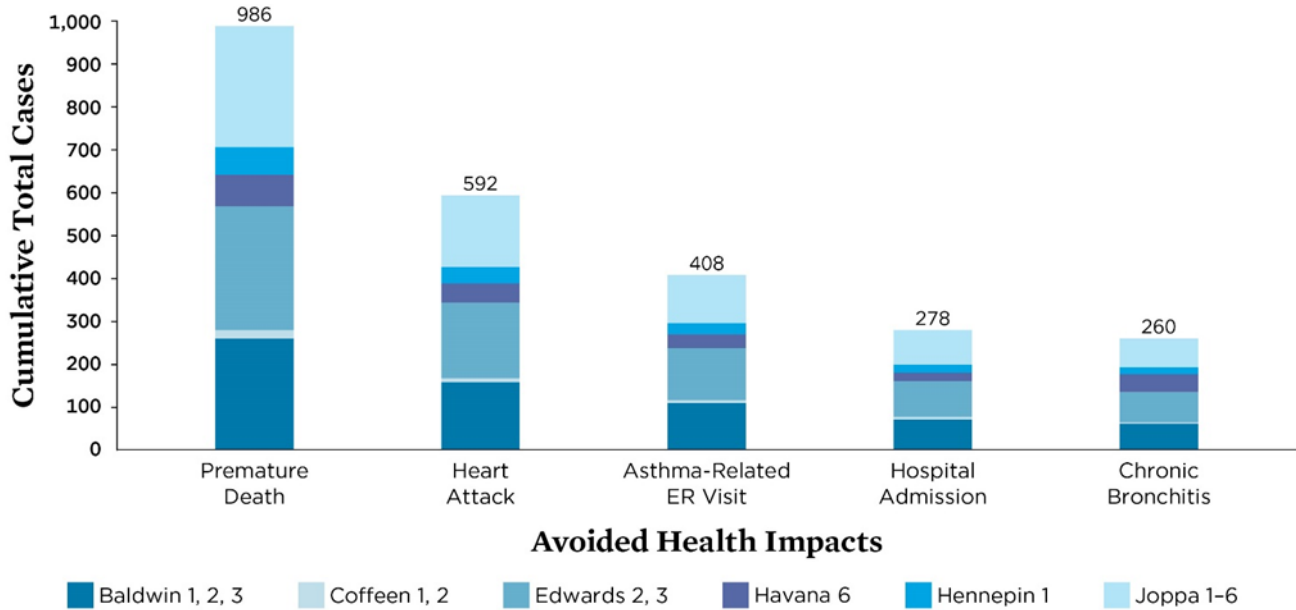
Closing the Waukegan and Edwards coal plants greatly decreases public health impacts attributable to the two plants.

DYNEGY-VISTRA SCENARIO

For the Dynegy-Vistra scenario, retirement dates for units were generated by the ReEDS model or selected by us based on the age of the units and consultation with stakeholders. Closing these units early produces the cumulative avoided health impacts displayed in Figure 8 below, compared to health impacts that would result if the units operate at their 2016 levels through 2030.

In sum, the pre-2030 retirement of six Dynegy units avoids nearly 1,000 premature deaths, 592 heart attacks, 408 asthma emergency room visits, 278 cardiovascular and respiratory hospital admissions, and 260 incidents of chronic bronchitis.

FIGURE 8. Cumulative Health Impacts Avoided through Pre-2030 Retirement of Dynegy-Vistra’s MISO Coal Plants in Illinois



Closing Dynegy-Vistra coal plants before 2030 greatly decreases the adverse public health impacts caused by the plants.

Note: Because the Dynegy-Vistra scenario does not include Duck Creek, Newton, or Hennepin 2 retiring prior to 2030, these plants and units are not reflected in the above chart.

Impacts of Closing the Waukegan Plant

RELIABILITY ASSESSMENT

We focused on one operating plant to assess whether reliability issues exist in retiring the plant. We chose the Waukegan plant because the buffer around the Waukegan Generating Station has the largest population, the highest CVI, and the highest EJ Index for every environmental indicator of any operating plant in Illinois (Flores et al. 2017). Waukegan residents, led by the group Clean Power Lake County, have been pushing for the plan to be retired and a just transition plan put in place to improve the public health and wellbeing of the community. Opponents of closing the plant have argued it needs to keep operating for grid reliability.

PJM, the regional authority managing the grid, studies grid reliability needs at the time of the highest energy use, as this is when reliability issues are most sensitive to a retirement. UCS retained PowerGEM, an engineering firm with experience preparing reliability studies of the electric grid, to conduct a Waukegan Generation retirement study to determine whether any reliability issues emerge for the Chicago and northern Illinois region if all the existing Waukegan generation were to be retired. In its study, PowerGEM assumed the transmission system as it is expected to be in the summer of 2022 and used the related data files provided by PJM.

PowerGEM looked at the impact of retiring 783 MW, made up of three components: Waukegan 7 (328 MW) a coal unit that came into service in 1958, Waukegan 8 (354 MW), a second coal unit that came into service in 1962, and the Waukegan oil-fired combustion turbines (four combustion turbines operating with a capacity of 101 MW), that came into service in 1968 but only operated about five hours in 2017 (a 0.05 percent capacity factor).

The Waukegan Generation retirement study replaced this 783 MW with an equal amount of generation spread evenly across the existing power plant locations in the 13 states served by PJM, an approach similar to PJM's own studies of future retirements of power plants. The results show that the two coal units could be retired with no impacts on reliability, and that retiring the combustion turbines would require replacement of 100 MW to prevent reliability problems. While the PowerGEM study demonstrated an acceptable resolution of the issue with 100 MW of additional capacity at the Waukegan location, the 100 MW could also be addressed with clean energy options like solar, storage, demand response, efficiency improvements, and other distributed generation located across many cities and towns surrounding downtown Chicago.

SOLAR AND ENERGY STORAGE POTENTIAL

A dramatic decrease in the cost of solar photovoltaic (PV) and battery storage and the investment tax credit for those technologies have made solar-plus-storage systems accessible to utilities and residential and commercial customers. To help understand the economic feasibility of installing solar and energy storage, UCS used HOMER Pro, a tool for energy system optimization and financial analysis specifically designed to analyze distributed generation and microgrids at the customer and local levels. We analyzed the economic feasibility of (1) installing utility-scale storage at the Waukegan plant site and surrounding area, and (2) investing in behind-the-meter storage combined with solar and energy efficiency at two types of commercial buildings and a typical single-family home in Waukegan. For customer-owned systems we estimated the cost of investing in the solar-storage hybrid systems, the electricity bill savings, and the payback period. For utility-scale storage systems, we quantified the reliability and transmission benefits and the increase in capacity revenue. We also examined how investments in energy efficiency and solar energy facilities developed due to FEJA could contribute to peak load reduction in the area. Our financial analysis assumes that the investments are made in 2021 and the projects have a 25-year lifetime (as is typical for financial calculations).

For the utility-scale analysis, we used ComED’s hourly load profile collected by PJM to reflect the actual hour-to-hour load changes in the Waukegan area. We also used assumptions for a four-hour duration lithium-ion battery storage system under a peaking plant replacement use case from Lazard (Lazard 2017) and solar PV cost and performance assumptions from the National Renewable Energy Laboratory (NREL 2017). For the behind-the-meter analysis, we used a region-specific hourly load profile by building type from the DOE’s OpenEI database, a specification for a battery product currently available in the market, and the PV cost and performance assumptions from the HOMER’s technology library. The data sources and descriptions can be found in the online technical appendix at www.ucsusa.org/sootsolarappendix.

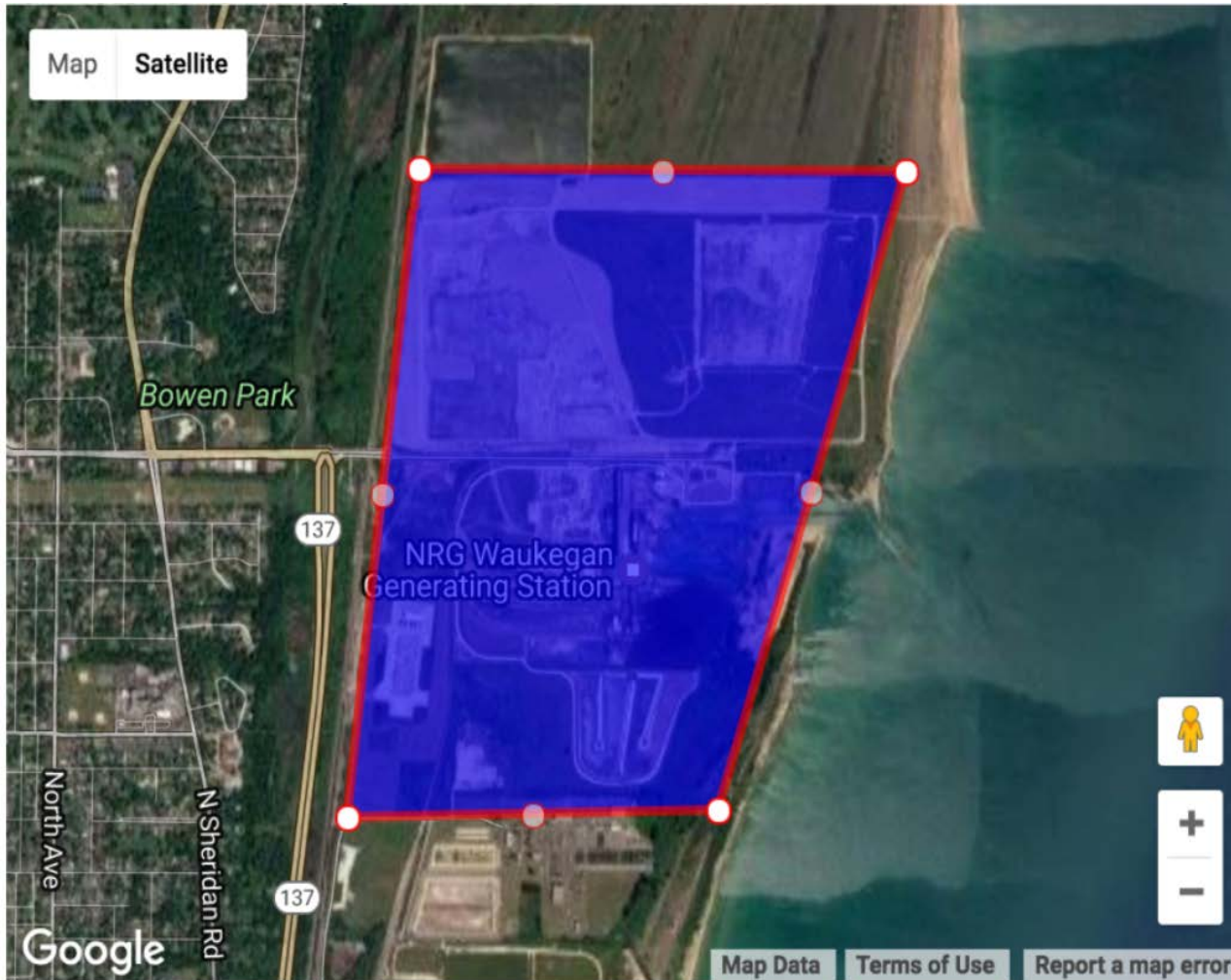
LAND AVAILABILITY ASSESSMENT

To determine the amount of land available to develop solar and storage on the coal plant sites, we conducted a land availability analysis of the Crawford, Edwards, Fisk, Waukegan, and Wood River sites. The plant locations were first identified using the satellite view in Google Maps. We then used a Google Maps area calculator tool to mark the boundaries of the sites, including any apparent coal ash disposal areas, which generated the total area of each site in square feet. We then selected assumptions for the space required per MW of storage and solar based on real-world projects.²³

The assessment shows the larger area around the Waukegan generating station (Figure 9). The total utilizable area around the Waukegan Generating Station is 26,000,000 square feet; the percent of land required for 10 MW of solar is 8 percent; the solar potential is 119 MW ac; and the percent required for 10 MW, 40 MWh of energy storage is 0.02 percent.

²³ Additional assumptions for the space required per MW of storage and solar can be found in the technical appendix, online at www.ucsusa.org/sootsolarappendix.

FIGURE 9. Land Area Around the Waukegan Generating Station



Boundaries of the Waukegan Generating Station created with a Google Maps area calculator tool.

UTILITY-SCALE STORAGE ANALYSIS

The power flow analysis conducted by PowerGEM found that the 682 MW Waukegan coal plant could be retired without any impact on grid reliability (Gass 2017). In the unlikely event that both transmission lines and the combustion turbine peaker plant were offline during the hottest day of the year, the grid would only need an additional 100 MW of power to prevent an outage. The modeling found that if an overload were to occur, possible locations would be the Des Plaines, Dresden, and Crawford transformers. The HOMER modeling then determined that efficiency and renewable energy investments made under FEJA will contribute to grid reliability and peak demand reduction after the Waukegan coal plant is retired.

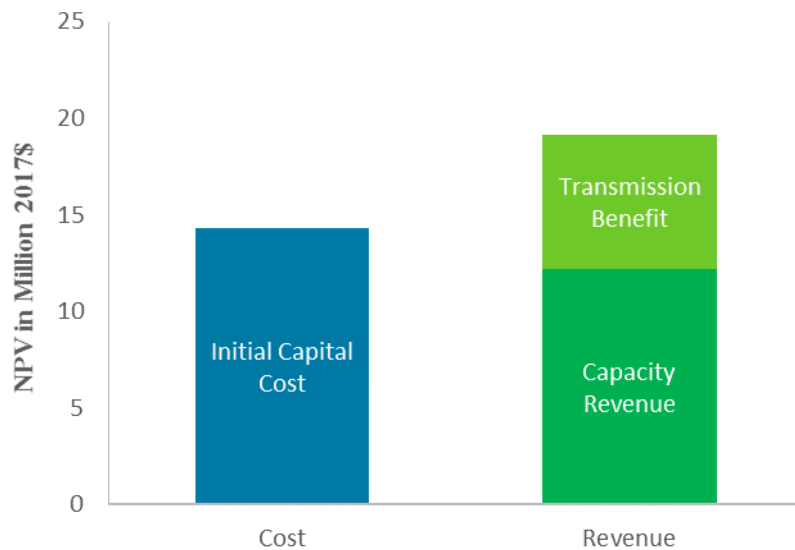
These results indicate that clean energy technologies and efficiency can maintain grid reliability in both daily and emergency operations after a coal plant is retired. Solar, storage, and load reduction by energy efficiency could, individually or together, provide a stable supply of electricity at the closed-plant site and the surrounding areas. The size of storage required to fill

the capacity shortage during the peak without energy efficiency is 71 MW.²⁴ Assuming that ComEd meets its energy efficiency targets required under FEJA, only 23 MW of storage would be needed to replace the existing oil-burning combustion turbines and resolve any reliability issues. If efficiency investments are combined with solar deployment required under FEJA and the solar facilities in the surrounding area could cover 5 percent of the load, only 16 MW of storage would be needed. Without any service access, the 16 MW battery storage system designed to meet peak electricity demand, known as a storage peaker plant, would occupy around just 9,000 square feet of land, equivalent to the size of four tennis courts. See the technical appendix for the detailed technology combinations of replacement alternatives and the method for the land size estimation.

In addition to reliability benefits, there are other economic values such as capacity revenues and transmission benefits from the deployment and operation of the storage peaker plant. We calculated that the area could realize \$548,576 in avoided transmission costs and \$1 million of capacity revenues on an annual basis. Over the 25-year project lifetime, investments in storage could result in \$19.1 million of avoided transmission costs and capacity revenue (Figure 10). This is a conservative estimate, since it may be possible to tap into additional revenue streams, such as energy arbitrage or providing ancillary services that maintain electric reliability and support the transmission of electricity, including frequency regulation and spinning and non-spinning reserves.

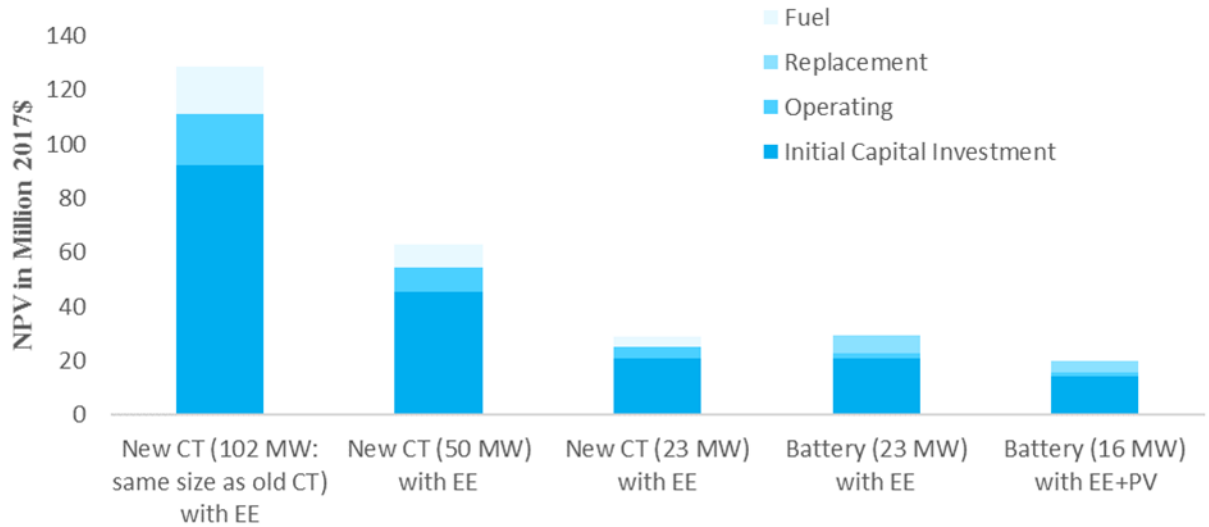
The existing combustion turbines at Waukegan were built in 1968 and are currently used only a few hours per year. When reviewing replacement options for the future, we compared the option of replacing the old combustion turbines with new combustion turbines of the same size (102 MW). Our results showed that a storage plant is far more economical in terms of total life-cycle cost. Even if there were additional costs for battery replacement caused by frequent use of the storage peaker plant with real-time price dispatch, the life-cycle cost of deploying a storage peaker plant is lower than replacing the old plant with new combustion turbines (Figure 11).

FIGURE 10. Benefits Exceed Cost of Investing in a Utility-scale Energy Storage System



²⁴ The Homer model found 71 MW of storage as an optimal size with an allowance of 0.0048 percent of unmet electric load. It is also possible to design a system completely without any unmet load. When the size of storage is exactly 100 MW, the unmet load will be 0 percent. Since adding 29 MW to serve 0.0048 percent of unmet load is cost-inefficient, the model presented 71 MW as the final optimal solution.

FIGURE 11. Cost of Deploying Storage is Lower than Replacing with New Combustion Turbines (CTs)



BEHIND THE METER ANALYSIS

We analyzed possible solar-plus-storage systems for three types of buildings: a secondary school, supermarket, and single-family house in Waukegan. We also analyzed the required investment, the expected annual bill savings, and the payback period for these building types.

Potential system sizes and the combinations among technologies vary across customer types because their hourly consumption patterns affect which technology choices are the most economical (Table 3). The economics of PV is determined by the correlation between the time periods when solar energy is available and those when customers actually use electricity. We assumed that these systems would qualify for the Illinois net-metering program and the federal solar investment tax credit, which provide significant incentives for customers to install PV systems.²⁵ Illinois residents and businesses can receive additional financial benefits through the state's solar renewable energy credits (SRECs) market. When SRECs are included, the economics of solar PV improve, and the payback period is reduced by three to 10 years.

²⁵ Under ComED's service territory, net metering is available for residential and commercial customers who have generators up to 2,000 kW. The solar investment tax credit is currently a 30 percent federal tax credit against the tax liability of residential and commercial investors in solar energy property. It is scheduled to ramp down to 26 percent in 2020 and to 22 percent in 2021, and stay at 10 percent in 2022 and thereafter.

TABLE 3. Economics of Solar and Storage Options by Customer Type

Building Type (Peak Load)		Option*	Initial Investment** (2017\$)	Annual Bill Savings (2017\$)	Project Payback (Years)	
					Without SRECs***	With SRECs
Commerical	Secondary school (1,236 kW)	PV (1,500 kW)	\$2.09M	\$209K	11	8
		PV (1,507 kW) + storage (304 kWh)	\$2.18M	\$210K	12	9
	Supermarket (386 kW)	PV (969 kW)	\$1.35M	\$135K	11	8
		PV (965 kW) + storage (26.4 kWh)	\$1.35M	\$136K	11	8
Residential	Single family house (4 kW)	PV (965 kW) +	\$9K	\$818	11	7
		PV (4.5 kW) + storage (13.2 kWh)	\$12K	\$822	24	14

* Storage is recommended for adoption only when peak load reduction is required.

** Our financial analysis assumes that the investments are made in 2021 and the projects have a 25-year lifetime. Federal investment tax credit and storage (22 percent in 2021) are applied to the initial investment calculation. Schools or non-profits do not pay tax so that they cannot be eligible for the investment tax credit. However, they can deal with it through a third-party ownership such as a lease or a power purchase agreement.

*** The eligibility and the block prices of Illinois's SRECs market can be found in the technical appendix.

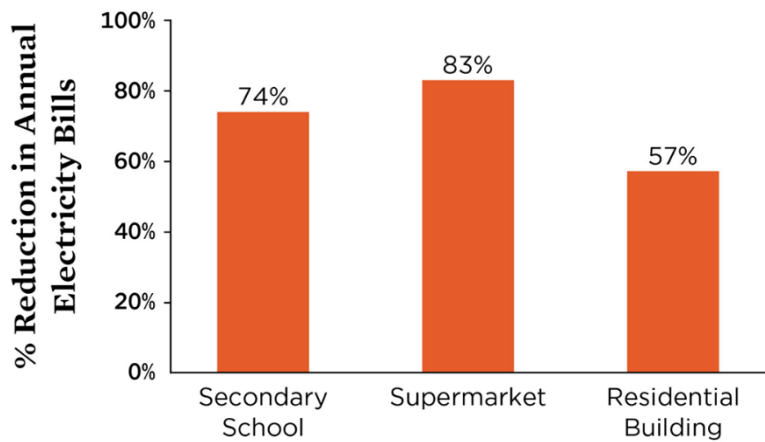
Investing in solar can significantly lower consumer electricity bills. In most cases, investing in solar PV resulted in significant electricity bill savings for consumers that paid back the initial capital cost of the system in 11 to 12 years. On a percentage basis, most homes and businesses in the Waukegan area could cut their electricity bills by more than half (Figure 12). However, the economic incentives for residential and small commercial customers (with PV systems of up to 10 MW) to invest in storage are minimal. Most are not on real-time energy pricing, and none are assessed a demand charge, both of which reward shifting of load into lower demand portions of the day. Therefore, there is little motivation to invest in battery storage to shift electricity consumption from higher-cost peak hours to lower-cost off-peak hours. However, strengthening climate policies in support of a carbon price and the RPS could lead to changes in rate structure and thus improve the economics of storage.

Time-varying rates can play a major role in driving renewable energy and energy storage development. By providing a price signal to indicate when electricity is clean and less expensive, these rate structures incentivize customers to shift their consumption toward times of the day when clean energy resources are more plentiful. This, in turn, provides utilities with additional incentives to invest in zero-emission energy resources such as wind and solar to meet this demand.

The offering of time-of-use rates in Illinois would allow customers to take full advantage of the growing penetration of renewable energy in the state. As solar and wind development continues to grow in Illinois, time of use rates could allow customers to choose to align their electricity use time when renewable generation is highest, which would translate to economic and public health benefits.

Combining solar with investments in energy efficiency would result in even greater electricity bill savings for customers. A 2017 analysis by the National Renewable Energy Laboratory found that a typical household in Illinois could potentially save 19 percent of its electricity costs through energy efficiency measures (NREL 2017b). If a household in Waukegan achieves this level of energy efficiency, it could realize \$273 of savings annually. When efficiency is combined with PV, \$943 could be saved (Figure 13).

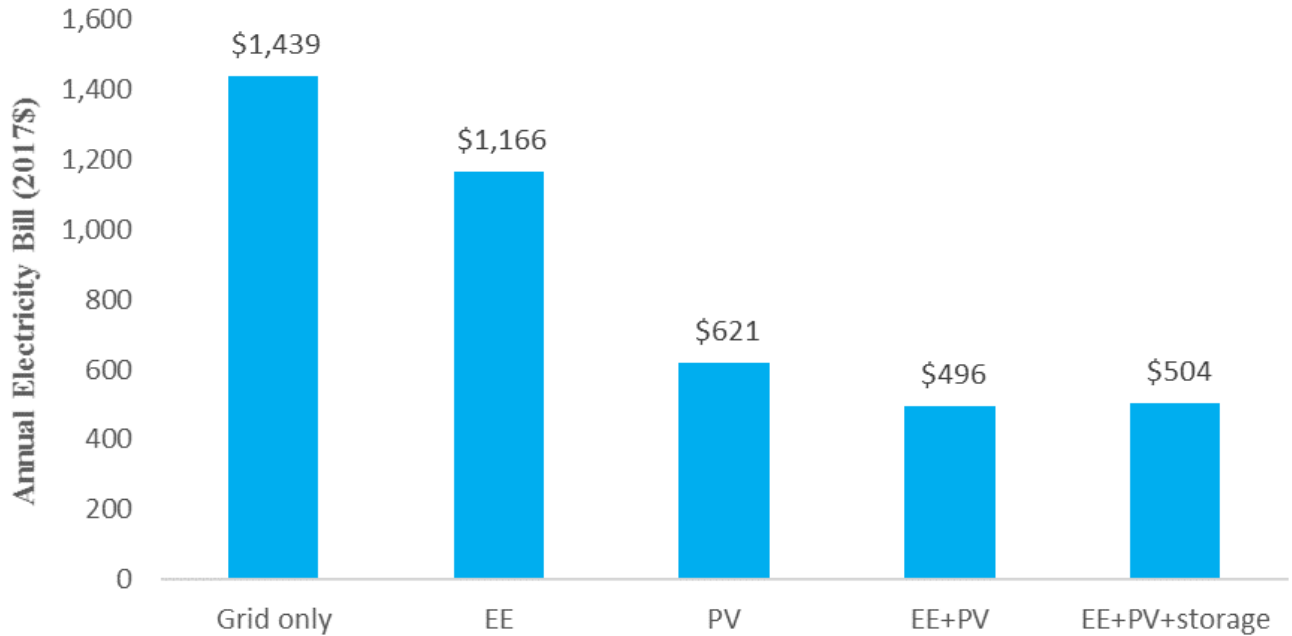
FIGURE 12. Investing in Solar Significantly Lowers Consumer Electricity Bills



Most homes and businesses in the Waukegan area could cut their electricity bills by more than half by investing in solar energy.

Note: Under Illinois's current electricity rate structure, PV plus storage is not cost effective compared with the PV-only option, and there is currently no significant difference in savings between the two options in secondary schools, supermarkets, or residential buildings.

FIGURE 13. Combining Solar with Investments in Energy Efficiency Results in Additional Bill Savings



Combining solar and energy efficiency results in additional annual electricity bill savings for a typical household in Waukegan. The analysis shows annual savings in 2021 and thereafter.

Case Studies

We completed case studies for five coal plants, which include Waukegan, Fisk, Crawford, Wood River, and E.D. Edwards, with the support and input from community groups in the area and the use of land availability mapping tools. The case studies look at the costs and benefits of a replacement strategy for coal plants that prioritizes local renewable energy sources combined with energy storage. The case studies can be found online at [ucsusa/soottosolar](https://www.ucsusa.org/soottosolar).

Conclusions

Our analysis shows that Illinois will receive significant clean energy benefits from FEJA, which is currently law. However, more can be done. Additional coal retirements will drive investments in renewable energy and energy efficiency in Illinois, reduce household electricity bills, reduce CO2 emissions, and help diversify the state's electricity mix. Solar, storage, load reduction by energy efficiency, and dynamics among the three are capable of providing a stable supply of electricity at the closed plant site and the surrounding area in Waukegan.

Illinois is on track to a cleaner electricity sector, and with additional coal plant retirements this transition will accelerate. Accelerating the transition away from coal to renewable energy, energy storage, and energy efficiency in Illinois will improve public health and spur new investment in local communities across the state. There are also several further important conclusions.

- **Adverse public health impacts decrease if coal plants are retired sooner.** Coal plants harm public health. Replacing them with solar, energy storage, and energy efficiency prevents numerous adverse health impacts, including respiratory and cardiovascular impacts and premature deaths. Clean energy policies like FEJA bring coal plants off line sooner, which reduces the public health burden caused by the plants.
- **There is a tremendous opportunity to replace coal plants with clean energy.** Renewables, storage, and energy efficiency could help replace the generation from the Waukegan and Edwards coal plants and the eight MISO Dynegy-Vistra coal plants, while allowing Illinois to reduce emissions and save consumers money. The benefits exceed the costs of investing in a utility-scale energy storage system to replace Waukegan; and considering land availability, reliability issues, and environmental concerns, storage is a great option to have at the closed Waukegan plant site.
- **The Waukegan coal plant can be closed with no impacts on electricity reliability. On-site combustion turbines can also be retired and replaced with energy storage, maintaining electric reliability.** Closing the Waukegan plant and replacing it with local investments in energy efficiency, solar, and energy storage will provide significant public health and economic benefits for residents and businesses, with no adverse impacts on reliability.
- **Consumers need incentives to add storage systems.** Changes in rate structure and tariffs are needed to increase the penetration of smaller-size storage systems. This includes other revenue streams which would improve the economics of storage such as energy arbitrage or providing ancillary services that maintain electric reliability and support the transmission of electricity, including frequency regulation and spinning and non-spinning reserves.

Policy Recommendations

To ensure that all communities reap the benefits of Illinois's clean energy transition and can close or redevelop coal plant sites in their communities, UCS recommends the following.

Policies that support energy storage development:

- To accurately determine the economics of behind-the-meter battery storage, building owners and managers must have access to their property's detailed energy usage history.

- Illinois regulators should consider policy and market options to incorporate the value of storage into future solar projects developed in the state. Some states have already proposed or implemented measures that would reward solar projects that include energy storage.
- Time-of-use rates should be offered to residential customers, which will give solar owners the economic incentive to store solar production during off-peak hours and discharge it when electricity prices are higher. This shift should be paired with extensive consumer outreach and education efforts so that customers can reap the full benefits of lower electricity bills.
- Illinois policymakers can play a critical role in removing technical and market barriers to wide-scale deployment of energy storage by focusing on the most important research priorities, by conducting studies or hosting policy sessions on issues including improving energy storage systems integration, lowering capital costs of installing energy storage systems, and determining the value of storage services (Lewis et al. 2018).

Changes to rate design:

- Currently, less than one percent of ComEd and Ameren customers utilize the hourly pricing programs offered by those utilities.
- Utilities should offer well-designed and user-friendly time-of-use rate options, which can benefit the grid operator, consumers, and the environment. The complexity of the hourly-pricing programs currently offered by Illinois utilities may be prohibitive to many users.
- Therefore, time-of-use pricing programs should be offered that have fewer daily price fluctuations, allowing the user more consistency in making consumption decisions.
- Utilities should pursue programs that protect certain customer groups, such as low-income households, the elderly, and the chronically ill who are at risk from disproportionate effects caused by the introduction of a different rate structure. For example, utilities can ensure that customers pay no more than what they did under the previous rate structure and are exempt from high rate charges that may occur during extreme hot and cold weather events (McNamara, Jacobs, and Wisland 2017).

Community involvement:

- State and federal policymakers, utility regulators, power grid operators, utility companies, and power producers should work with communities to ensure an equitable and just transition to cleaner forms of energy and make appropriate resource planning, grid investment, and policy choices. The specifics of a just transition plan look different for every community, but should include retraining opportunities for coal plant workers, job opportunities for other community members, and a comprehensive stakeholder process to facilitate site remediation and redevelopment (Delta Institute 2018). The plans should also prioritize renewable energy and energy efficiency, which can help maintain reliability and affordability while cutting harmful pollutants. Storage should also be encouraged for the additional energy resilience it provides.
- Utilities, coal companies, and all levels of policymakers must engage meaningfully with affected stakeholders—especially coal-dependent communities, coal plant workers, affected communities of color, and low-income residents living near coal plants—to ensure that transition plans are in place prior to the closure of a coal-fired power plant. With adequate time and resources, plans can be developed that include provisions for (1) remediation and redevelopment at the plant and at sites associated with it (such as coal ash impoundments); (2) contingencies for lost local tax revenues; and (3) opportunities for local economic diversification, worker training, and the creation of new, well-paying jobs.
- Policymakers, clean energy advocates, and other stakeholders must work with community members to ensure that local voices are at the center of the conversation about closing coal plants in Illinois. For community engagement to be truly meaningful, it must include proactive, sustained outreach that allows communities to comment and removes barriers to their participation in government processes. Engagement must be characterized by two-way communication through which communities are truly listened and responded to.

The faster Illinois closes its aging, polluting coal plants and transitions to clean energy and energy efficiency, the greater the public health and economic benefits will be for local communities across the state. With additional policies to incentivize the development of renewable energy and energy storage in the state, Illinoisans can gain even larger public health, economic, environmental, and community benefits.

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