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REPORT

THE HEALTH BENEFITS OF THE ILLINOIS FUTURE ENERGY JOBS ACT

The Future Energy Jobs Act, passed on December 1, 2016 by the Illinois General Assembly and signed into law by first-term Republican Governor Bruce Rauner, will have two primary impacts on the state's power sector: (1) driving growth in new renewable energy and increasing energy efficiency savings, and (2) retaining generation from existing nuclear units that are financially vulnerable.[1] These developments will, in turn, have a large impact on public health in Illinois and throughout the Midwest. Renewable energy and energy efficiency are critical, cost-effective resources for reducing pollution from power generation, and encouraging their growth leads to a range of improved human health outcomes. Although nuclear energy cannot be considered a clean energy resource (see sidebar), this report focuses solely on the air pollution released by fossil fuel plants that directly harm human health.

This report analyzes the public health impacts of implementing the Future Energy Jobs Act and concludes that passage and implementation of the legislation will bring significant benefits for public health. Between 2018 and 2030, the Future Energy Jobs Act would help cumulatively avoid 132,960 lost work days, 17,890 asthma attacks, 1,100 asthma-related emergency room visits, 780 hospital admissions, 1,650 heart attacks, and up to 2,800 premature deaths.[3]

Implementing the Future Energy Jobs Act Would in 2018 Help Avoid:

7,950	1,070	70	50	100	UP TO 160
LOST WORK DAYS	ASTHMA ATTACKS	ASTHMA EMERGENCY DEPARTMENT VISITS	HOSPITAL ADMISSIONS	HEART ATTACKS	PREMATURE DEATHS

Between 2018 and 2030, as the standards strengthen over time, the Future Energy Jobs Act Would Help Avoid:

132,960	17,890	1,100	780	1,650	UP TO 2,800
LOST WORK DAYS	ASTHMA ATTACKS	ASTHMA EMERGENCY DEPARTMENT VISITS	HOSPITAL ADMISSIONS	HEART ATTACKS	PREMATURE DEATHS

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BACKGROUND

Illinois is a key player in the Midwest's regional power sector as a net exporter of electricity to other states. In 2015, approximately half of Illinois's electricity generation was sourced from nuclear power, followed closely by coal at 38 percent.[4] Coal generation is responsible for substantial amounts of greenhouse gases, air pollution like smog and soot, and other hazardous emissions.[5]

Although coal and nuclear plants have historically generated the bulk of electricity in Illinois, both resources are being financially challenged by low natural gas prices, falling renewable energy costs, reduced electricity demand from energy efficiency savings, and improved air quality standards.[6] Consequently, coal's share of electricity generation in Illinois declined dramatically from 43 percent in 2014 to 38 percent in 2015. As coal generation declined, wind and natural gas generation increased to 5.5 percent and 5.6 percent, respectively—up from 5 percent and 2.7 percent in 2014.[7]

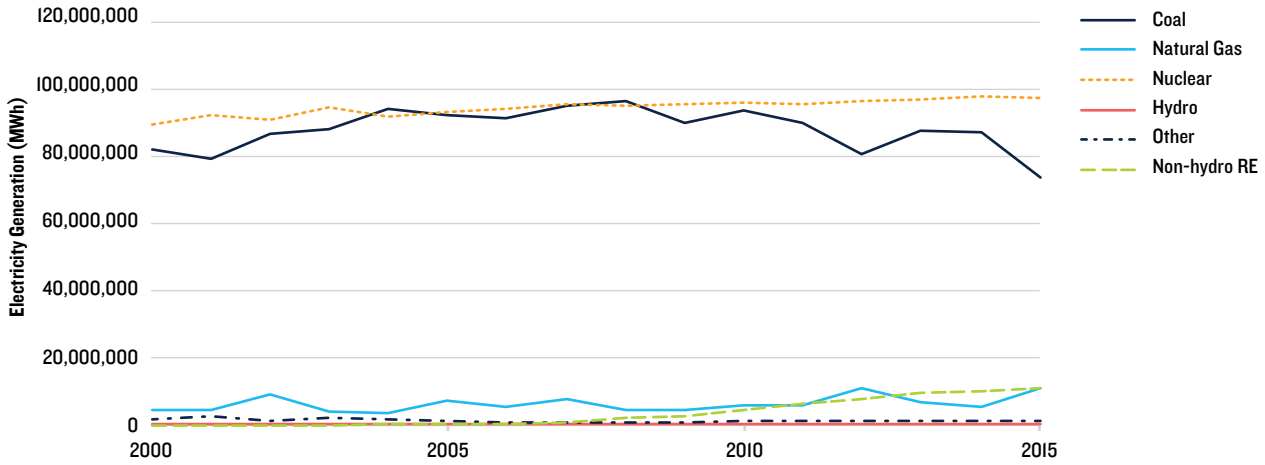
In order to ensure that clean energy and its associated benefits would become a cornerstone of Illinois's energy future, the Illinois Power Agency Act of 2007 created a renewable portfolio standard (RPS) and an energy efficiency portfolio standard (EEPS) that required the state's electric utilities to deliver increasing levels of renewable energy and energy efficiency savings.[8] The RPS requires the state's investor-owned utilities and the alternative retail suppliers (ARES) that serve those utilities' customers to procure 25 percent of their electricity sales from renewable generation by 2025. The EEPS stipulates that these same utilities must also reach annual incremental energy efficiency savings equivalent to 2 percent of sales by 2016 and into perpetuity. However, a recent evaluation of the RPS and EEPS, led by the state's Department of Commerce and Economic Opportunity, has revealed that Illinois will likely fail to achieve the original policy intent of these standards by a wide margin, due in part to critical flaws in the standards' design.[9] By underdelivering on clean energy development, Illinois has been forgoing cleaner air, job creation and associated economic growth, a more resilient electric grid, and customer bill savings.

Illinois's recent clean energy stagnation demonstrated the clear need to fix and strengthen its vital clean energy standards in a manner that meaningfully reduces harmful air pollution, helps combat climate change, safeguards communities, drives economic investment in the state's burgeoning clean energy economy, and generates savings for households and businesses.[10]

Recognizing these policy challenges, the Illinois Clean Jobs Coalition—made up of environmental organizations and environmental justice organizations, consumer advocates, health experts, clean energy entrepreneurs and business leaders, and other groups— formed to revive progress on renewable energy and energy efficiency in the state. In 2015, the Coalition backed the introduction of the Clean Jobs Bill (SB 1485/HB 2607) in an effort to reform and expand the state RPS to 35 percent renewable energy procurement by 2030 and boost the EEPS to achieve a cumulative 20 percent reduction in electricity sales by 2025 from 2014 to 2016 levels.[11] In addition to generating an estimated $1.6 billion in consumer savings and 32,000 clean energy jobs through the life of the standards, these policies would help spur the deployment of new, emissions-free energy efficiency savings and renewables generation, thereby displacing some of the generation otherwise required from fossil fuel plants to meet demand.[12,13] By significantly reducing harmful air pollution emissions, this reduction in fossil fuel generation will yield positive health outcomes for Illinois residents.

Toward these goals, the Coalition engaged with other key stakeholders—including the state's incumbent power generators and electricity distribution entities—to reach an agreement to advance clean energy. During these discussions, Exelon Corporation, the owner of Illinois's nuclear fleet, made public statements regarding the economic vulnerability of several of its plants.[14] In June 2016, Exelon announced it would initiate the process of retiring Clinton Power Station and Quad Cities Generating

ILLINOIS GENERATION MIX



Station, citing the plants' combined loss of approximately $800 million over the past seven years.[15] The company began notifying the relevant power grid operators and federal agencies of its plans to retire the plants. It had also said that unless legislation was passed that provided adequate support for the nuclear plants before December 2016, its decision to close the plants would have likely become binding and irreversible.[16] After continued negotiations throughout the Illinois legislature's brief fall legislative session, the bill passed both chambers of the General Assembly December 1st, 2016 and was signed by Governor Rauner the following week on December 7th.

The provisions contained in the final bill, the Future Energy Jobs Act, reform and expand renewable energy and energy efficiency requirements. Specifically, the bill specifies that Commonwealth Edison (ComEd) and Ameren Illinois (Ameren)—the two electric investor owned utilities in the state—are required to achieve new, greater energy efficiency savings through 2030. The final legislation also aligns the utilities' economic interests with the achievement of deeper, more persistent efficiency savings through performance-based incentives. With regard to renewable energy, the legislation maintains the state's original RPS targets, fixes the structural issues with the RPS, and requires the state's investor-owned utilities to invest in and fund long-term contracts to procure wind and solar energy from new in-state projects. The bill also retains Exelon's Clinton Power Station and Quad Cities Generating Station (Units 1 and 2) through a zero-emissions credit (ZEC) program that provides an additional revenue stream for the otherwise economically challenged plants for up to 10 years. A more detailed description of these provisions are shown in Table 1 below. There are other provisions included in the bill that do not explicitly impact the generation mix (e.g. job training programs) and therefore lie outside of the scope of this analysis.

In weighing the public health impacts of the Future Energy Jobs Act, this report narrowly considers the health consequences of particulate matter emitted by coal-fired power plants (and more specifically, particulate matter less than 2.5 microns in aerodynamic diameter, or PM 2.5—commonly called soot pollution). If retired, nuclear generation would likely have been replaced in part by generation from existing resources both in Illinois and other states to balance regional power needs. Given the region's current electricity generation portfolio, it is likely that fossil fuels would have provided a large portion of the replacement for retiring nuclear generation.[19] The significant expansion of energy efficiency and renewable energy in the state, as a result of the Future Energy Jobs Act, will drive down generation and emissions from fossil fuel plants in Illinois and throughout the Midwest.

The air pollution from coal-fired power plants, including particulate matter, poses serious human health risks. It can aggravate asthma and exacerbate respiratory symptoms, as well as increase the incidence of nonfatal heart attacks and, in some cases, premature death.[20] These health impacts can also have economic ramifications such as increased hospital admissions and lost work days.[21] Coal and natural gas plants also produce significant greenhouse gas emissions that cause dangerous climate change. Illinois is already experiencing the impacts of climate change, including increased fatal heat waves, exposure to allergens, severe floods, agricultural disruption, and drinking water issues.[22] High-humidity heat events like the Chicago heat wave of 1995, which claimed more than 700 lives, may occur as often as once every two years by 2050.[23] In sum, continued emissions from fossil fuel plants present a complex set of human health and climate change challenges in both the short and long term.

TABLE 1: KEY FUTURE ENERGY JOBS ACT PROVISIONS

Category	Description
Energy Efficiency	• ComEd to achieve 21.5% cumulative persistent energy efficiency savings in 2030 relative to average electricity sales from 2014-2016 with an intermediate 17% target in 2025.[17] • Ameren to achieve 16% cumulative persistent energy efficiency savings in 2030 relative to average electricity sales from 2014-2016 with a 13% target in 2025.[18]
Renewable Energy	• Investor owned utilities to achieve 25% renewable energy procurement relative to electricity sales of all retail electric customers by 2025 and into perpetuity • By 2030, Illinois Power Agency to procure at least 8 million MWh of renewable energy from qualified new projects developed after June 1, 2017 through Renewable Energy Credit (REC) procurement, with intermediate procurement targets in 2020 and 2025. • Investor owned utilities to satisfy the remainder of their RPS obligation through the procurement of RECs from existing or new projects in Illinois or neighboring states.
Nuclear Energy	• Illinois Power Agency to procure nuclear-only "zero emissions credits" for approximately 20,000,000 MWh of energy from qualified nuclear facilities based on the Social Cost of Carbon and forward energy and capacity prices, subject to an annual cap of $235 million. • Zero Emissions Standard sunsets after 10 years, with an option to terminate the program after 6 years.

RISKS AND IMPACTS FROM NUCLEAR POWER ON PUBLIC HEALTH AND THE ENVIRONMENT

The majority of U.S. nuclear reactors are aging and approaching the end of their 60-year operating licenses. Many are facing substantial economic and operational challenges. NRDC is not opposed to nuclear power in principle, and acknowledges its low-carbon attributes in a warming world. But we also acknowledge nuclear energy's significant safety, global security, environmental and economic risks. These risks include the toxic radioactivity from spent nuclear fuel, which must be isolated from people and the environment for many thousands of years; the risk of severe reactor accident with widespread contamination of the environment from radioactive pollution; pollution from uranium mining and nuclear fuel fabrication, radioactive waste disposal and nuclear weapons proliferation. The Nuclear Regulatory Commission must stringently regulate the entire nuclear fuel cycle, including the mining and milling of uranium, reactor decommissioning, and the final disposal of radioactive wastes. NRDC favors more practical, economical, and environmentally sustainable approaches to reducing carbon emissions, through energy efficiency and renewable energy sources. Until these risks are properly mitigated, nuclear power should not be a leading strategy for diversifying America's energy portfolio and reducing carbon pollution. NRDC has worked for decades to reduce the risks associated with nuclear power.

For more detail on NRDC's work to mitigate the risks associated with nuclear power, please see https://www.nrdc.org/issues/minimize-harm-and-security-risks-nuclear-energy.

METHODOLOGY

This analysis focuses on the public health impacts of particulate matter air pollution and does not consider other public health impacts from the power sector, such as ozone smog–forming and hazardous air pollution from coal plants and radiation hazards from nuclear plants. The public health findings described here were generated by converting the generation mix impacts of the increased clean energy efficiency and renewable energy provisions in the Future Energy Jobs Act, as well as the retained generation from the at-risk nuclear units, into quantitative environmental benefits and public health effects. This analysis used damage-per-MWh estimates derived from the Powerplant Impact Evaluator (PIE) model, which incorporates the same peer-reviewed methodology used by the U.S. Environmental Protection Agency (EPA).[24] The analysis was conducted in two parts. To determine the impacts of the Future Energy Jobs Act, assumptions had to be made about the projected generation changes that would occur both without the policy and with it. Table 2 details these assumptions.

To provide a range of results across different assumptions about the future of the electricity generation mix, assumptions also had to be made about how changes in renewable energy, energy efficiency, and nuclear generation—as detailed in Table 2 below—will impact the fossil fuel generation mix. Two generation displacement scenarios were analyzed using damage-per-GWh estimates from the PIE model.[28,29] In the main scenario presented in this report, each zero-emitting MWh displaces 0.5 MWh of coal generation (i.e., 1:0.5 displacement). The 50/50 displacement ratio was chosen as a balanced displacement scenario. In a second scenario, each incremental MWh of renewable energy, nuclear generation, and energy efficiency savings primarily displaces coal, based on coal's current share of fossil generation in Illinois and neighboring states.[30] Specifically, each incremental zero-emitting MWh displaces 0.93 MWh of coal (1:0.93), with the remaining 0.07 MWh displacing natural gas–fired generation (corresponding to the ratio of coal and natural gas generation in 2014) or imports. Such a scenario would produce even greater health benefits for the region, and detailed results of both scenarios are presented in Appendix B.

Additionally, the analysis makes the simplifying assumption that displacement will occur uniformly at coal plants throughout the region, rather than attempting to determine how each individual power plant would be affected. The Clean Air Task Force (CATF) then used damage-per-GWh estimates derived from the PIE model to convert these simplified coal generation projections into avoided health effects from the displacement of coal generation with zero-emitting generation and efficiency savings. The analysis takes into account generating units and populations in Illinois as well as those in the neighboring states of Iowa, Indiana, Kentucky, Minnesota, Missouri, and Wisconsin.

TABLE 2: ASSUMED IMPACTS OF THE FUTURE ENERGY JOBS ACT

Projected Generation Impacts of Future Energy Jobs Act *(All values are relative to a scenario without the Act)*

	2018	2020	2022	2024	2026	2028	2030
Renewables Generation (GWh)[25]	2,000	4,000	4,800	5,600	6,400	7,200	8,000
Energy Efficiency Savings (GWh)[26]	614	2,400	4,079	6,039	7,500	8,713	9,815
Nuclear Generation (GWh)[27]	24,880	24,880	24,880	24,880	24,880	24,880	24,880

The corresponding carbon pollution reductions that will result from full implementation of the Future Energy Jobs Act, compared with a scenario without the plan and relative to 2014 levels, were also calculated under each of these two displacement scenarios.

Further detail on the methodology is provided in Appendix A.

RESULTS

This analysis quantifies the public health benefits from implementing the Future Energy Jobs Act under the simplifying assumptions specified above.[31]

Compared with a scenario without the Plan, the Future Energy Jobs Act will achieve the following:

- In 2018, it will help reduce particulate matter air pollution enough to prevent up to 7,950 lost work days, 1,070 asthma attacks, 70 asthma emergency department visits, 50 hospital admissions, 100 heart attacks, and up to 160 premature deaths;
- Cumulatively between 2018 and 2030—as the clean energy standards strengthen over time and benefits accelerate—the plan will help prevent up to 132,960 lost work days, 17,890 asthma attacks, 1,100 asthma emergency department visits, 780 hospital admissions, 1,650 heart attacks, and up to 2,800 premature deaths in total.
- It will reduce annual carbon pollution by up to 32 million tons in 2030. This reduction from business as usual translates to about 13 million tons below 2014 levels, accelerating Illinois's transition to a low-carbon economy.[32]

The Future Energy Jobs Act will protect thousands of people—particularly vulnerable populations such as children and the elderly—from premature deaths, heart attacks, emergency room visits, asthma attacks, and lost work days.

Table 3 provides detailed findings of the health impacts under the 50/50 scenario. Fixing and strengthening the state's clean energy standards will help produce significant health benefits—particularly for vulnerable populations such as children and the elderly—to the extent that this emissions-free energy displaces coal generation and avoids the associated harmful public health impacts of that generation. These benefits will grow significantly between 2018 and 2030 as the requirements of the standards ramp up. The Future Energy Jobs Act is also projected to produce significant carbon pollution reductions from the power sector in Illinois and throughout the region.

TABLE 3: THE HEALTH BENEFITS OF THE FUTURE ENERGY JOBS ACT [33]

Projected Health Impacts of Future Energy Jobs Act
(1 MWh Zero-Emitting: 0.5 MWh Coal Displacement)

	2018	2030	Cumulative
Avoided Premature Deaths	60 to 160	100 to 260	1,090 to 2,800
Avoided Non-Fatal Heart Attacks	100	150	1,650
Avoided Hospital Admissions	50	70	780
Avoided Asthma ER Visits	70	100	1,100
Avoided Asthma Attacks	1,070	1,660	17,890
Avoided Lost Work Days	7,950	12,340	132,960

CONCLUSION

Illinois finds itself at a critical juncture in its energy future. Regional and national power sector trends are encouraging investment in resources like natural gas and renewables while challenging the economics of coal and nuclear. These forces have deep impacts on Illinois's generation mix, which is inextricably linked to residents' health. The Future Energy Jobs Act will help drive significant public health benefits in the state and the region—especially for children and the elderly—by reducing dangerous air pollution from coal-fired power plants. The legislation also puts Illinois in an excellent position to capitalize on the federal renewable energy tax credits, meet the goals of the Clean Power Plan, and unlock billions of dollars in economic growth. The Future Energy Jobs Act is a major step forwards in Illinois energy and climate policy and ensures that Illinois is able to take advantage of the public health and environmental benefits of a low-carbon future for decades to come.

Acknowledgements

The health impacts analysis in this report was made possible through the generous time and effort of Conrad Schneider of the Clean Air Task Force and David Schoengold of MSB Energy Associates. The authors would also like to thank Brian Urbaszewski of the Respiratory Health Association and Steve Clemmer of the Union of Concerned Scientists, as well as Matthew McKinzie, John Walke, and Amanda Levin of the Natural Resources Defense Council, for their review and feedback on this report.

ENDNOTES

1 For a full description of the final bill, see http://www.ilga.gov/legislation/billstatus.asp?DocNum=2814&GAID=13&GA=99&DocTypeID=SB&LegID=96125&SessionID=88.

3 These results assume that every megawatt-hour (MWh) of additional clean energy resources and nuclear retention from the implementation of the Future Energy Jobs Plan will displace 0.5 MWh of coal generation and its associated particulate matter (PM 2.5) emissions. More about the generation displacement ratio and underlying assumptions is explained in the Methodology section. This analysis is confined to analyzing the renewable energy, energy efficiency, and nuclear provisions of the bill.

4 Energy Information Administration (hereinafter EIA), "Electricity: Detailed State Data," last updated October 2016 (with final annual data for 2015), available at http://www.eia.gov/electricity/data/state.

5 Illinois Department of Commerce and Economic Opportunity, *State of Illinois: Goals Status Report for Energy Efficiency and Renewable Energy,* Illinois Energy Roadmap Project, February 2016. According to EIA, Illinois coal plants produced 4.25 percent of all domestic electric sector CO_2 emissions in 2013. *See:* EIA, "State Carbon Dioxide Emissions," last updated November 2016 (with final data for 2014), available at http://www.eia.gov/environment/emissions/state/.

6 Linn, J., D. Burtraw, and K. McCormack, "An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future," Resources for the Future, June 2016, available at http://www.rff.org/files/document/file/RFF-DP-16-21.pdf.

7 EIA, "Electricity: Detailed State Data."

8 *See* Illinois Department of Commerce and Economic Opportunity, *State of Illinois: Goals Status Report,* for a full description of the renewable portfolio standard and energy efficiency portfolio standard requirements. Many states have implemented renewable portfolio standards and energy efficiency portfolio standards and reaped myriad benefits from their implementation. For richer descriptions of these programs and benefits, *see:* Wiser, R., et al., "A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards," Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory, 2016, NREL/TP-6A20-65005, http://www.nrel.gov/docs/fy16osti/65005.pdf. *Also see:* Steinberg, D., and O. Zinaman, "State Energy Efficiency Resource Standards: Design, Status, and Impacts," National Renewable Energy Laboratory, May 2014, http://www.nrel.gov/docs/fy14osti/61023.pdf.

9 Illinois Department of Commerce and Economic Opportunity, *State of Illinois: Goals Status Report*.

10 "Clean Jobs Illinois," Clean Jobs Midwest, March 2016, http://www.cleanjobsmidwest.com/state/illinois/. Energy efficiency jobs are a particularly strong and growing part of Illinois's economy. The Midwest Clean Jobs report shows that approximately 90,000 workers were employed in the energy efficiency sector in Illinois in 2015, more than all other areas of the clean energy sector combined.

11 "The Illinois Clean Jobs Bill," Illinois Clean Jobs Coalition, last updated 2016, http://ilcleanjobs.org/bill/. Coalition members are working to improve public health, help consumers, better the environment, and create tens of thousands of new clean jobs across the state. The coalition's original Clean Jobs Bill also includes a greenhouse gas cap-and-invest program that directs additional revenues toward clean energy development and related economic development priorities.

12 Citizens Utility Board, "CUB Analysis: IL Clean Jobs Bill Would Save Consumers $1.6 Billion—Expert Modeling Analysis Reveals Big Gap Between Clean Jobs Legislation, Exelon Bill," April 16, 2015, http://www.citizensutilityboard.org/newsReleases20150416_CleanJobsModeling.html.

13 The Future Energy Jobs Plan will be a critical driver of new clean energy in the region. At the same time, the electric power sector will continue to shift toward lower-emitting resources due to a host of factors, including but not limited to: implementation of the Clean Power Plan, the extension of the federal renewable energy tax credits, declining renewables costs, and the update to the Cross-State Air Pollution Rule. Given the significant uncertainty regarding all of these factors, and in particular Clean Power Plan state implementation and the corresponding emissions pathways in the region and across the nation, this analysis does not attempt to examine the interaction of the Future Energy Jobs Bill with those policies and other factors.

14 "Exelon Announces Early Retirement of Clinton and Quad Cities Nuclear Plants," Exelon press release, June 2, 2016, http://www.exeloncorp.com/newsroom/clinton-and-quad-cities-retirement.

15 Ibid.

16 Watt, Anthony, "December Is Exelon's Point of No Return for Cordova Site," Dispatch-Argus QCOnline, September 6, 2016, http://www.qconline.com/news/local/december-is-exelon-s-point-of-no-return-for-cordova/article_ed214f91-0d69-592f-9c75-9ab451079fed.html.

17 These targets and sales exclude large industrial customer load due to the language in the bill that exempts large industrial customer from participation in the energy efficiency targets.

18 *Ibid.*

19 *See, e.g.:* EIA, "Fort Calhoun Becomes Fifth U.S. Nuclear Plant to Retire in Past Five Years," Today in Energy, October 31, 2016, http://www.eia.gov/todayinenergy/detail.php?id=28572.

20 U.S. Environmental Protection Agency (hereinafter EPA), "Health and Environmental Effects of Particulate Matter (PM)," https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm, accessed October 18, 2016.

21 EPA, "Integrated Science Assessment for Particulate Matter," December 2009, https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=216546; *see also* EPA, "Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter," December 2012, https://www3.epa.gov/ttnecas1/regdata/RIAs/finalria.pdf. A discussion of the economic valuation of health impacts can be found in section 5.6.5.

22 EPA, "Climate Impacts in the Midwest," last updated September 2016, https://www.epa.gov/climate-impacts/climate-impacts-midwest.

23 Klinenberg, E., *Heat Wave: A Social Autopsy of Disaster in Chicago* (Chicago: University of Chicago Press, 2002). Hayhoe, K. et al., "Climate Change, Heat Waves, and Mortality Projections for Chicago," *Journal of Great Lakes Research* 36, supp. 2 (2010): 65-73, http://www.bioone.org/doi/abs/10.1016/j.jglr.2009.12.009?journalCode=jglr.

24 Abt Associates, "Technical Support Document for the Powerplant Impact Evaluator Software Tool," July 2010, http://www.catf.us/resources/publications/files/Abt-Technical_Support_Document_for_the_Powerplant_Impact_Estimator_Software_Tool.pdf.

25 This estimate may be conservative because it assumes the only new renewables generation driven by the Future Energy Jobs Bill are directly as a result of the IPA procurement, as specified in Table 1. Additional renewable resources may need to come online in order to satisfy the full requirements of the 25% by 2025 target.

26 This estimate may be conservative because it assumes that all industrial customers (10% of ComEd's load and 25% of Ameren's load) opt out of the energy efficiency requirements. On the other hand, the estimates also assume that there are no constraints on savings implementation due to either cost-effectiveness or spending cap constraints.

27 Although the Zero Emission Standard sunsets in 2027, we assume Clinton and Quad Cities will remain online through 2030 due to policy or market factors (e.g. a carbon policy or an increase in natural gas prices would improve the financial viability of the plants); the impacts would also be the same if these units were replaced by additional energy efficiency savings or renewables generation.

28 The scenarios and results presented in this report are not intended to be a prediction of the future of the regional generation mix; instead, they are intended to illustrate the health impacts of implementation of the Clean Jobs Bill across a wide range of plausible outcomes. The displacement of coal generation was an analytical choice, though a logically justifiable one; power sector modeling was beyond the scope of this report.

29 The displacement ratio can also be interpreted simply as the MWh of coal displaced, with the remaining MWh of zero-emitting generation displacing other generation that has no health impacts on the region examined (i.e. some combination of natural gas or imported generation). The health impacts of stack emissions from natural gas combined cycle generation are minor compared to coal and are not examined here, and upstream impacts were also beyond the scope of this analysis.

30 The coal/natural gas ratio was approximately 93:7 in aggregate in 2014 for Illinois and the six states directly bordering it. *See:* EIA, "Electricity: Detailed State Data."

31 For reference, the seven-state population is about 34.5 million adults and 12 million children.

32 The Clean Power Plan, which sets the first-ever limits on carbon pollution from power plants, was finalized in August 2015. In February 2016, the Supreme Court granted an unprecedented stay of the CPP, putting a temporary pause on implementation until legal challenges are resolved. In September 2016, the United States Court of Appeals for the District of Columbia Circuit heard challengers' arguments against the Clean Power Plan. Despite legal and political uncertainty, many states are continuing to move forward in their clean energy transition, and the Future Energy Jobs Bill represents just such a step for Illinois. For more information on how renewables and energy efficiency can help Illinois cut CO_2 emissions and meet its Clean Power Plan targets, *see:* Natural Resources Defense Council, "An Illinois Pathway to Cutting Carbon Pollution," August 2015, https://www.nrdc.org/sites/default/files/CPP-Illinois-Compliance-IB.pdf.

33 The results presented in this table represent central effect estimates; health impact projections rely on damage functions that contain uncertainties not expressly provided in these results. For more on the damage functions utilized by the PIE model and the uncertainty embedded in the methodology, *see:* Appendices B and C (pages 35–69) of the model documentation: Abt Associates, "Technical Support Document for the Powerplant Impact Estimator Software Tool", July 2010, available at: http://www.catf.us/resources/publications/view/137.

APPENDIX A

ANALYTICAL METHODS

The public health findings described in this report were generated by converting Illinois's Future Energy Jobs Bill into quantitative environmental and public health benefits, based on analyses conducted by Clean Air Task Force (CATF) and MSB Energy Associates. Natural Resources Defense Council (NRDC) provided inputs and assumptions regarding the generation mix impacts of the Plan, and determined the fossil generation impacts and the corresponding carbon pollution changes that would result from implementation of the Next Generation Energy Plan. CATF then used these estimates of fossil generation reduction to calculate the avoided health impacts of implementing the Bill.

CATF projected the public health impacts that would result from the Future Energy Jobs Bill from 2018 to 2030. They analyzed the annual health impacts that will likely be seen when Illinois implements the Future Energy Jobs Bill. Avoided fossil generation (or, in the case of retiring nuclear generation, increased fossil generation) is measured relative to a 2014 baseline. Although several coal plants in the region may retire in the next few years, full implementation of the Bill ensures that generation is not replaced by ramp-up of other coal-fired power plants. Health impact estimates from the analysis include Illinois as well as downwind areas outside of the state. A large portion of the impacts will likely be felt in-state, however, given Illinois's position as a net exporter of electricity generation, as well as the large population centers likely to be affected by pollution emissions.

CATF then used the Powerplant Impact Evaluator (PIE) model[1] to calculate the health impacts per MWh of coal generation based on 2014 levels. The health impacts per MWh are then used to calculate the impacts of potential changes in coal generation as a result of the proposed legislation. The PIE model was developed by Abt Associates, the consulting firm used by the U.S. Environmental Protection Agency to assess the health benefits of federal air pollution regulations. The PIE model employs the same peer-reviewed methodology used by the U.S. EPA, which is widely accepted in the scientific community. Further information on the PIE model is provided in a later section.

The PIE model uses data on the emissions from each coal-fired power plant in the geographic area under consideration, based on each plant's reports to the Environmental Protection Agency's Continuous Emissions Monitoring Site (CEMS) database. This emissions data is combined with weather data and atmospheric chemistry to determine each plant's contribution to the concentration of air pollutants in the atmosphere. The model uses these concentrations as inputs into a set of equations that relate pollutant levels to specific adverse health effects. These equations are derived from the peer-reviewed health studies of dose-response relationships used by EPA in assessing the benefits of its air pollution regulations.[2] Running the PIE model thus produces estimates of each coal plant's annual health impacts in each county affected by the plant's emissions. Combining these county-level results provides health impacts on a state-wide level. A more detailed description of the PIE model is given at the end of this Appendix.

Illinois is a significant net exporter of electricity. It is quite difficult to model the exact impacts of state policies on regional electricity markets. To address this, CATF assumed that the power being exported or imported from Illinois would, for the most part, impact generating units located in those states that directly border Illinois: Iowa, Indiana, Kentucky, Minnesota, Missouri, and Wisconsin. CATF treated those seven states as a single block and calculated the health impacts per unit of coal generation from the entire block.

To estimate health impacts of future reductions (or increases) in coal-fired power generation, CATF calculated the health impacts per MWh of generation for both in-state and out-of-state generation. First, CATF determined the health impacts caused by coal plants in Illinois and throughout the 7-state region in 2014 and ran the model using 2014 emissions data. Second, CATF divided the health impacts of Illinois's coal-fired generation by the amount of MWh generated in Illinois from coal in 2014 to produce estimates of per-MWh health impacts caused by coal plants in the state.

Finally, CATF multiplied the estimated impacts per MWh of coal generation for Illinois and the surrounding states by the MWh changes in coal generation and coal-generated imports by year resulting from the Future Energy Jobs Bill. This calculation produced the annual health impact figures set forth in Table 3 of the report.

DESCRIPTION OF POWERPLANT IMPACT EVALUATOR (PIE) MODEL METHODOLOGY

PIE was developed specifically to estimate the health and economics of electric generating units (EGUs) in the United States focusing on the impacts of particulate matter less than 2.5 microns in aerodynamic diameter (PM2.5)—an air pollutant that has been linked to a variety of serious health effects, including asthma attacks, chronic bronchitis, hospital admissions, and premature mortality.

1 *See* Abt Associates Inc., *Technical Support Document for the Powerplant Impact Evaluator Software Tool*, July 2010, http://www.catf.us/resources/publications/view/137.

2 For more on the damage functions utilized by the PIE model and the uncertainty embedded in the methodology, please see Appendices B and C (pages 35-69) of the PIE technical support document.

To estimate the PM2.5-related benefits associated with reducing emissions from EGUs, the PIE model first calculates the impact on ambient air quality, and then using the results from epidemiological studies, it estimates the number of adverse health impacts (e.g., avoided deaths), and then finally it estimates the associated economic benefits. This three-step process is the standard approach for evaluating the health and economic benefits of reduced air pollution. EPA used this approach when evaluating the National Ambient Air Quality Standards (U.S. EPA, 2006), the Clean Air Act (U.S. EPA, 1999b), the benefits of reducing greenhouse gases (Abt Associates Inc., 1999), the health effects of motor vehicles (U.S. EPA, 2000; 2004), and other major regulations.

Abt Associates developed the PIE tool to support assessments of the human health benefits of air pollution changes and their associated economic benefits. PIE is the result of years of research and development, and reflects methods that are based on the peer-reviewed health and benefits analysis literature.

PIE is based on a damage function approach, which involves modeling changes in ambient air pollution levels, calculating the associated change in adverse health effects, such as premature mortality, and then assigning an economic value to these effects. For changes in the concentrations of particulate matter and ozone, this is typically done by translating a change in pollutant levels into associated changes in human health effects.

A PIE analysis relies on first estimating a reduction in air pollution emissions. The determination of the emission reduction occurs outside of PIE and is used as input to the PIE analysis. After the user enters this information into PIE, the model then estimates:

1. the reduction in ambient PM2.5 levels in each county in the continental United States; and
2. the associated reduction in the incidence of various adverse health effects.

The process of calculating the effects on public health involves health impact functions, which are derived from concentration-response functions reported in the peer-reviewed epidemiological literature. A typical health impact function has four components:3

1. an effect estimate, which quantifies the change in health effects per unit of change in a pollutant, and is derived from a particular concentration-response function from an epidemiology study;
2. a baseline incidence rate for the health effect;
3. the affected population; and
4. the estimated change in the concentration of the pollutant.

For detailed information on each step, see the technical support documentation for the PIE model.4 The result of these functions is an estimated change in the incidence of a particular health effect for a given change in air pollution. Examples of health effects that have been associated with changes in air pollution levels include premature mortality, hospital admissions for respiratory and cardiovascular illnesses, and asthma exacerbation.

Finally, the calculation of total benefits involves summing estimated benefits across all non-overlapping health effects, such as hospital admissions for pneumonia, chronic lung disease, and cardiovascular-related problems.

3 See pages 2-4 of the PIE technical support document for an overview of this methodology.

4 Abt Associates Inc., *Technical Support Document for the Powerplant Impact Evaluator Software Tool*, July 2010, http://www.catf.us/resources/publications/view/137.

APPENDIX B: SUPPLEMENTAL RESULTS

The results presented here are intended to provide more information regarding the intermediate steps of the calculations.

The intermediate health impacts, relative to a scenario in which coal generation stays constant at 2014 levels, are presented in Tables B1 and B2 for the two different displacement scenarios. The impacts of the legislation, presented in Table 3 and Table B3, are calculated as the difference between a scenario with the bill ("Clean Power Additions, Nuclear Retainment") and a scenario without the bill ("No Clean Power Additions, No Nuclear Retainment").

TABLE B1: PROJECTED HEALTH IMPACTS OF GENERATION CHANGES, 50% DISPLACEMENT
Relative to a Scenario where Coal Generation Remains Constant at 2014 Levels

Projected Health Impacts of Generation Changes *(1 MWh: 0.5 Coal Displacement)*

Efficiency and Renewables:	No Clean Power Additions			Clean Power Additions			Clean Power Additions		
Nuclear:	No Nuclear Retainment			No Nuclear Retainment			Nuclear Retainment		
	2018	2030	Cumulative 2018-2030	2018	2030	Cumulative 2018-2030	2018	2030	Cumulative 2018-2030
Premature Mortality	-58 to -149	-58 to -149	-757 to -1943	-52 to -134	-17 to -42	-422 to -1082	6 to 16	42 to 107	335 to 861
Nonfatal Heart Attacks	-90	-90	-1,164	-80	-25	-673	9	64	491
Hospital Admissions	-42	-42	-548	-38	-12	-317	4	30	231
Asthma ER Visits	-60	-60	-774	-53	-17	-448	6	43	327
Asthma Attacks	-968	-968	-12,580	-866	-275	-7270	102	693	5309
Lost Work Days	-7192	-7,192	-93,499	-6,437	-2,042	-54,038	756	5,150	39,461

TABLE B2: PROJECTED HEALTH IMPACTS OF GENERATION CHANGES, 93% DISPLACEMENT
Relative to a Scenario where Coal Generation Remains Constant at 2014 Levels

Projected Health Impacts of Generation Changes *(1 MWh: 0.93 Coal Displacement)*

Efficiency and Renewables:	No Clean Power Additions			Clean Power Additions			Clean Power Additions		
Nuclear:	No Nuclear Retainment			No Nuclear Retainment			Nuclear Retainment		
	2018	2030	Cumulative 2018-2030	2018	2030	Cumulative 2018-2030	2018	2030	Cumulative 2018-2030
Premature Mortality	-108 to -277	-108 to -277	-1,402 to -3,601	-97 to -248	-31 to -79	-781 to -2005	11 to 29	77 to 198	621 to 1,595
Nonfatal Heart Attacks	-166	-166	-2,156	-148	-47	-1,246	17	119	910
Hospital Admissions	-78	-78	-1,015	-70	-22	-587	8	56	428
Asthma ER Visits	-110	-110	-1,435	-99	-31	-829	12	79	606
Asthma Attacks	-1,793	-1,793	-23,311	-1,605	-509	-13,473	188	1,284	9,839
Lost Work Days	-13,328	-13,328	-173,263	-11,928	-3,785	-100,138	1,400	9,543	73,125

Finally, to determine the health impacts of full implementation of the bill compared to a scenario without the bill, the impacts are measured between the scenario with Clean Power Additions and Nuclear Retention and compared to the scenario with No Clean Power Additions and No Nuclear Retention. The impacts for the 50/50 case are presented in the body of the report, and the impacts of the 93 percent coal displacement case are presented in Table B3 below. All numbers in Table 3 and Table B3 are rounded to the nearest 10.

TABLE B3: PROJECTED HEALTH IMPACTS OF FUTURE ENERGY JOBS BILL, 93% COAL DISPLACEMENT

Projected Health Impacts of Future Energy Jobs Bill (*1 MWh Zero-Emitting: 0.93 MWh Coal Displacement*)			
	2018	**2030**	**Cumulative**
Avoided Premature Deaths	120 to 310	190 to 480	2,020 to 5,180
Avoided Non-Fatal Heart Attacks	180	280	3,070
Avoided Hospital Admissions	90	130	1,440
Avoided Asthma ER Visits	120	190	2,040
Avoided Asthma Attacks	1,980	3,080	33,150
Avoided Lost Work Days	14,730	22,870	246,390