

JOINT STATE GOVERNMENT COMMISSION

General Assembly of the Commonwealth of Pennsylvania

COMPREHENSIVE STUDY ON THE USE OF WIND TURBINES IN PENNSYLVANIA:

A STAFF STUDY

January 2016



Serving the Pennsylvania General Assembly Since 1937

REPORT

Comprehensive Study on the Use of Wind Turbines in Pennsylvania

Project Manager:	Ron Grenoble, Staff Attorney
Staff:	Mark Bogush, Law Clerk (until August 2015) Bryan DeWalt, Public Policy Analyst Michelle Kreiger, Administrative Assistant

Joint State Government Commission

Room 108 Finance Building
613 North Street
Harrisburg, PA 17120-0018

Telephone: 717-787-4397
Fax: 717-783-9380
E-mail: jntst02@legis.state.pa.us
Website: <http://jsg.legis.state.pa.us>

The Joint State Government Commission was created in 1937 as the primary and central non-partisan, bicameral research and policy development agency for the General Assembly of Pennsylvania.¹

A fourteen-member Executive Committee comprised of the leadership of both the House of Representatives and the Senate oversees the Commission. The seven Executive Committee members from the House of Representatives are the Speaker, the Majority and Minority Leaders, the Majority and Minority Whips, and the Majority and Minority Caucus Chairs. The seven Executive Committee members from the Senate are the President Pro Tempore, the Majority and Minority Leaders, the Majority and Minority Whips, and the Majority and Minority Caucus Chairs. The Executive Committee selects a chairman of the Commission from among the members of the General Assembly.² Historically, the Executive Committee has also selected a Vice-Chair or Treasurer, or both, for the Commission.

The studies conducted by the Commission are authorized by statute or by a simple or joint resolution. In general, the Commission has the power to conduct investigations, study issues, and gather information as directed by the General Assembly.³ The Commission provides in-depth research on a variety of topics, crafts recommendations to improve public policy and statutory law, and works closely with legislators and their staff.

A Commission study may involve the appointment of a legislative task force, composed of a specified number of legislators from the House of Representatives or the Senate, or both, as set forth in the enabling statute or resolution. In addition to following the progress of a particular study, the principal role of a task force is to determine whether to authorize the publication of any report resulting from the study and the introduction of any proposed legislation contained in the report. However, task force authorization does not necessarily reflect endorsement of all the findings and recommendations contained in a report.

Some studies involve an appointed advisory committee of professionals or interested parties from across the Commonwealth with expertise in a particular topic; others are managed exclusively by Commission staff with the informal involvement of representatives of those entities that can provide insight and information regarding the particular topic. When a study involves an advisory committee, the Commission seeks consensus among the members.⁴ Although an advisory committee member may represent a particular department, agency, association, or group, such representation does not necessarily reflect the endorsement of the department, agency, association, or group of all the findings and recommendations contained in a study report.

¹ Act of July 1, 1937 (P.L.2460, No.459); 46 P.S. §§ 65-69.

² *Id.* § 1; 46 P.S. § 65.

³ *Id.* § 2(a); 46 P.S. § 66(a).

⁴ Consensus does not necessarily reflect unanimity among the advisory committee members on each individual policy or legislative recommendation. At a minimum, it reflects the views of a substantial majority of the advisory committee, gained after lengthy review and discussion.

Over the years, nearly one thousand individuals from across the Commonwealth have served as members of the Commission's numerous advisory committees or have assisted the Commission with its studies. Members of advisory committees bring a wide range of knowledge and experience to deliberations involving a particular study. Individuals from countless backgrounds have contributed to the work of the Commission, such as attorneys, judges, professors and other educators, state and local officials, physicians and other health care professionals, business and community leaders, service providers, administrators and other professionals, law enforcement personnel, and concerned citizens. In addition, members of advisory committees donate their time to serve the public good; they are not compensated for their service as members. Consequently, the Commonwealth of Pennsylvania receives the financial benefit of such volunteerism, along with the expertise in developing statutory language and public policy recommendations to improve the law in Pennsylvania.

The Commission periodically reports its findings and recommendations, along with any proposed legislation, to the General Assembly. Certain studies have specific timelines for the publication of a report, as in the case of a discrete or timely topic; other studies, given their complex or considerable nature, are ongoing and involve the publication of periodic reports. Completion of a study, or a particular aspect of an ongoing study, generally results in the publication of a report setting forth background material, policy recommendations, and proposed legislation. However, the release of a report by the Commission does not necessarily reflect the endorsement by the members of the Executive Committee, or the Chair or Vice-Chair of the Commission, of all the findings, recommendations or conclusions contained in the report. A report containing proposed legislation may also contain official comments, which may be used to construe or apply its provisions.⁵

Since its inception, the Commission has published more than 350 reports on a sweeping range of topics, including administrative law and procedure; agriculture; athletics and sports; banks and banking; commerce and trade; the commercial code; crimes and offenses; decedents, estates, and fiduciaries; detectives and private police; domestic relations; education; elections; eminent domain; environmental resources; escheats; fish; forests, waters, and state parks; game; health and safety; historical sites and museums; insolvency and assignments; insurance; the judiciary and judicial procedure; labor; law and justice; the legislature; liquor; mechanics' liens; mental health; military affairs; mines and mining; municipalities; prisons and parole; procurement; state-licensed professions and occupations; public utilities; public welfare; real and personal property; state government; taxation and fiscal affairs; transportation; vehicles; and workers' compensation.

Following the completion of a report, subsequent action on the part of the Commission may be required, and, as necessary, the Commission will draft legislation and statutory amendments, update research, track legislation through the legislative process, attend hearings, and answer questions from legislators, legislative staff, interest groups, and constituents.

⁵ 1 Pa.C.S. § 1939.



General Assembly of the Commonwealth of Pennsylvania

JOINT STATE GOVERNMENT COMMISSION

Room 108 – Finance Building
Harrisburg, Pa 17120

717-787-4397
Fax 717-783-9380

REP. FLORINDO J. FABRIZIO

Chairman

SEN. JOHN C. RAFFERTY, JR.

Vice Chairman

EXECUTIVE COMMITTEE

Senate Members:

JOSEPH B. SCARNATI, III

President Pro Tempore

JACOB D. CORMAN, III

Majority Leader

JAY COSTA, JR.

Minority Leader

JOHN R. GORDNER

Majority Whip

ANTHONY H. WILLIAMS

Minority Whip

ROBERT B. MENSCH

Chair, Majority Caucus

WAYNE D. FONTANA

Chair, Minority Caucus

House Members:

MICHAEL C. TURZAI

Speaker

DAVID L. REED

Majority Leader

FRANK J. DERMODY

Minority Leader

BRYAN D. CUTLER

Majority Whip

MICHAEL K. HANNA

Minority Whip

SANDRA J. MAJOR

Chair, Majority Caucus

DAN B. FRANKEL

Chair, Minority Caucus

Administrative Staff:

GLENN J. PASEWICZ

Executive Director

YVONNE M. HURSH

Counsel

January 19, 2015

Dear Members of the General Assembly of Pennsylvania:

The Commission is pleased to announce the release of *Comprehensive Study on the Use of Wind Turbines in Pennsylvania: a Staff Study*, in response to House Resolution No. 925 of 2014 that directed the Joint State Government Commission to study the use of wind turbines across the Commonwealth.

The report examines several aspects related to wind turbines and other sources of electric power generation, including laws and regulations regarding construction and operation, environmental effects of energy sources, and government subsidies and tax policies.

The report is available on our website, <http://jsg.legis.state.pa.us>.

Sincerely,

A handwritten signature in blue ink that reads "Glenn Pasewicz".

Glenn Pasewicz
Executive Director
Sincerely,

TABLE OF CONTENTS

INTRODUCTION	9
OWNERSHIP & OVERSIGHT	19
Wind Turbines in this Commonwealth.....	19
Oversight of Wind Turbines	20
<i>Department of Environmental Protection.....</i>	20
<i>Pennsylvania Game Commission.....</i>	21
<i>Pennsylvania Public Utility Commission.....</i>	22
<i>Pennsylvania Municipalities Planning Code.....</i>	22
<i>U.S. Fish & Wildlife Service</i>	24
<i>U.S. Department of Transportation</i>	25
Decommissioning	25
SOURCES AND AMOUNTS OF SUBSIDIES	27
Overview.....	27
Wind Turbines	29
<i>Rural Energy for America Program</i>	29
<i>Tribal Energy Program.....</i>	30
<i>U.S. Tax Expenditures.....</i>	30
<i>Pennsylvania Renewable Energy Program-Geothermal & Wind Projects</i>	31
<i>Alternative Energy Production Tax Credit Program.....</i>	32
<i>Excepted Subject of Local Taxation.....</i>	32
<i>Energy Development Authority.....</i>	33
Coal.....	34
<i>Clean Coal Technology Export Promotion & Interagency Coordination</i>	34
<i>U.S. Agency for International Development</i>	34
<i>U.S. Department of Energy</i>	35
<i>U.S. Tax Expenditures.....</i>	36
<i>Pennsylvania Industrial Development Authority</i>	38
<i>Sales & Use Tax.....</i>	38
<i>Realty Transfer Tax.....</i>	38
Natural Gas	39
<i>U.S. Department of Energy</i>	39
<i>Gas Hydrate Production Incentive</i>	39
<i>U.S. Tax Expenditures.....</i>	39
<i>Pennsylvania Alternative Energy Capital Investment Program</i>	40
<i>Resource Manufacturing Tax Credit</i>	41
<i>Keystone Opportunity Zone, Keystone Opportunity Expansion Zone & Keystone Opportunity Improvement Zone Act.....</i>	41
<i>Realty Transfer Tax.....</i>	42

<i>Sales & Use Tax</i>	42
<i>Strategic Development Area Job Tax Credit</i>	42
<i>Pennsylvania Economic Development Financing Authority Tax Exempt Bond Program</i>	42
Nuclear	42
<i>U.S. Department of Energy</i>	42
<i>U.S. Tax Expenditures</i>	44
Oil	45
<i>Petroleum Reserves</i>	45
<i>Limits on Liability</i>	45
<i>U.S. Tax Expenditures</i>	45
<i>PA Sales & Use Tax</i>	46
IMPRINT ON ACREAGE AND WILDLIFE	47
Acreage Imprint	47
<i>Wind Turbines</i>	48
<i>Natural Gas</i>	50
<i>Coal</i>	52
<i>Nuclear</i>	54
<i>Oil</i>	55
<i>Hydropower</i>	57
<i>Solar</i>	57
Wildlife Impact	57
<i>Wind Turbines</i>	58
<i>Natural Gas</i>	62
<i>Coal</i>	64
<i>Nuclear</i>	67
<i>Oil</i>	68
<i>Hydropower</i>	70
<i>Solar Panels</i>	71
Nuisance Claims against Wind Farms	71
<i>Flicker Effect</i>	72
<i>Aesthetic Concerns and Property Values</i>	72
<i>Validity of Nuisance and Trespass Claims</i>	73
TURBINE INTEGRATION WITH ELECTRIC GRID	75
Operating Reserves	80
Wind Production and Integration/Grid Reliability	81
Costs of Wind Turbines	84
REGULATIONS	87
ALTERNATIVE ENERGY PORTFOLIO STANDARDS ACT	89
Progress of Wind Energy in Relation to the Act.....	89
Clean Power Plan	91

APPENDIX A	House Resolution No. 925.....	95
APPENDIX B	Federal Laws Possibly Applicable to Wind Energy Development	97
APPENDIX C	Counties with Regulatory Wind System Ordinances by Source.....	99
APPENDIX D	Model Wind Ordinance for Local Governments.....	103
APPENDIX E	Pennsylvania Natural Diversity Inventory Environmental Review Flow Chart	123

INTRODUCTION

House Resolution No. 925⁶ mandated a comprehensive study of the use of wind turbines in Pennsylvania. The resolution specifically inquired into

- ownership and oversight of wind turbines;
- sources and amounts of subsidies for energy;
- imprint acreage of energy and the effects thereof on wildlife;
- impact of wind turbines on the electrical grid;
- state regulation of wind energy; and
- wind's progress as alternative energy.

Wind power has been harnessed for different uses since the dawn of history. Boatmen became sailors as long as 7,000 years ago, and ever since then innovative people have continually improved their ability to turn wind into energy. Windmills have powered water pumps, grain mills, and even pipe organs. In 1850, the U.S. Wind Engine Company began manufacturing windmills that soon became as indigenous to the landscape of the American West as windmills are to Holland's.⁷ In the years since 1850, as the Industrial Age evolved into the Information Age and as innovations led to new materials and technologies, the energy industry has vastly improved wind turbine designs and capabilities.

Rapid interest and investment in the development of new energy sources were prompted by the fossil fuel crises of the closing decades of the 20th century. Wind, along with solar, geothermal, and other renewable resources became increasingly popular solutions to traditional problems concomitant with fossil fuels: shortages, market volatility, geopolitical volatility, and the ever-present threat of pollution degrading the global environment.

It is the health of the environment that is a fundamental consideration when people are given choices about energy use. Despite the reputation of environmental harmlessness ascribed to renewables, the collection and use of any energy source generates consequences to the natural environment.⁸ These externalities prompt the decision that policy makers, energy producers, and ultimately consumers face when they weigh consequences against the goods and services provided by different energy sources.

⁶ Sess. of 2014; app. A, *infra* p. 95.

⁷ Energy.gov, History of Wind Energy, <http://energy.gov/eere/wind/timeline/history-wind-energy> (last visited Jan. 14, 2016).

⁸ *Infra* pp. 47-73.

To help grow the renewable energy sector, governments, environmental groups, and many others encourage research, development, and use of renewables like wind through subsidies, grants, and tax policies.⁹ Such market development strategies were not unknown prior to the burgeoning popularity of renewables; government policies have subsidized energy production, including energy derived from nonrenewable sources, for at least 100 years.¹⁰

In examining the aspects of Pennsylvania's energy portfolio listed in House Resolution No. 925, the Commission found several items that may be of interest to the General Assembly. First, no Commonwealth statutes or regulations specifically apply to wind energy.¹¹ Second, the electric power grid that serves the Commonwealth, with adequate transmission expansion and additional regulating reserves, does not anticipate any significant problems operating with up to 30 percent of its energy provided by wind and solar power.¹² Third, Pennsylvania energy companies comply with Pennsylvania's Alternative Energy Portfolio Standards Act.¹³

Table 1 shows the ranking of states' wind power generation according to three categories: megawatts production capacity, absolute growth in megawatts production capacity from December 31, 1999 to December 31, 2014, and the percentage of the total U.S. megawatt production from wind turbines that each state produces. Texas is by far the largest provider of wind power, accounting for over one-fifth of total U.S. wind power production. The next largest provider is California, which, at less than 7 percent, provides less than half that of Texas. Pennsylvania ranks 16th, with a capacity slightly greater than 2 percent of the U.S. total.

Most states' wind generated power came online after 1999. Twelve states, Texas, California, Iowa, Minnesota, Kansas, Colorado, Wyoming, New Mexico, Nebraska, Wisconsin, Vermont, and Alaska had turbines connected to the grid prior to 1999. Texas and California had the largest growth in wind power capacity.

⁹ *Infra* pp. 27-46.

¹⁰ Cong. Budget Office, Testimony: Fed. Fin. Support for Fuels & Energy Techs. 4 (Mar. 13, 2013), available at https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/43993_EnergyTechnologies_one-column.pdf.

¹¹ *Infra* p. 87.

¹² *Infra* p. 82.

¹³ *Infra* pp. 89-90.

Table 1
United States
Wind Power Electricity Capacity¹⁴
in Megawatts (MW)
1999 - 2014

	State	State Wind Turbine Megawatt production	State Absolute in MW produced from 1999 - 2014	Percent of United States total electricity production
1	Texas	14,098	13,914	21.9%
2	California	5,917	4,301	6.8
3	Iowa	5,688	5,446	8.6
4	Oklahoma	3,782	3,782	6.0
5	Illinois	3,568	3,568	5.6
6	Oregon	3,153	3,128	4.9
7	Washington	3,075	3,075	4.8
8	Minnesota	3,035	2,762	4.4
9	Kansas	2,967	2,966	4.7
10	Colorado	2,593	2,571	4.1
11	North Dakota	1,886	1,886	3.0
12	New York	1,748	1,748	2.8
13	Indiana	1,744	1,744	2.8
14	Michigan	1,525	1,524	2.4
15	Wyoming	1,410	1,337	2.1
16	Pennsylvania	1,340	1,340	2.1
17	Idaho	973	973	1.5
18	New Mexico	812	811	1.3
19	Nebraska	812	809	1.3
20	South Dakota	803	803	1.3
21	Montana	665	665	1.0
22	Wisconsin	648	625	1.0
23	West Virginia	583	583	0.9
24	Missouri	459	459	0.7
25	Maine	440	440	0.7
26	Ohio	435	435	0.7
27	Utah	325	325	0.5
28	Arizona	238	238	0.4
29	Hawaii	206	204	0.3
30	New Hampshire	171	171	0.3
31	Maryland	160	160	0.3
32	Nevada	152	152	0.2
33	Puerto Rico	125	125	0.2

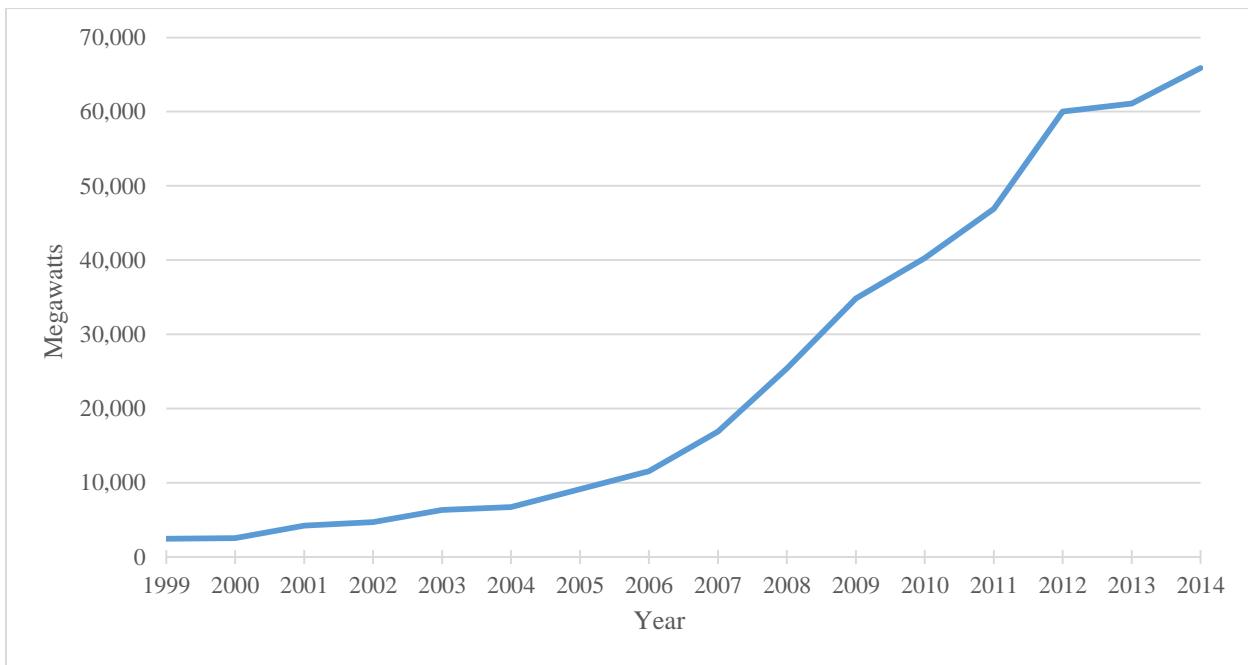
¹⁴ States that do not have wind turbines connected to the electrical grid are excluded.

	State	State Wind Turbine Megawatt production	State Absolute in MW produced from 1999 - 2014	Percent of United States total electricity production
34	Vermont	119	113	0.2
35	Massachusetts	107	107	0.2
36	Alaska	62	61	0.1
37	Tennessee	29	29	--
38	New Jersey	9	9	--
39	Rhode Island	9	9	--
40	Delaware	2	2	--
41	Arkansas	0	0	--
	Total	65,879	63,407	

Source: Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, *Installed Wind Capacity by State*, August 12, 2015, http://apps2.eere.energy.gov/wind/windexchange/docsinstalled_wind_capacity_by_state.xls.

There has been a steady increase of wind-generated electricity since 1999. At that time, slightly fewer than 7,000 megawatts of capacity were produced by wind power. By the end of 2014, this had grown to slightly more than 65,000 megawatts of capacity. The increase, which accelerated in 2006, grew at a rate of about 4,225 megawatts of capacity per year, as illustrated in Figure 1.

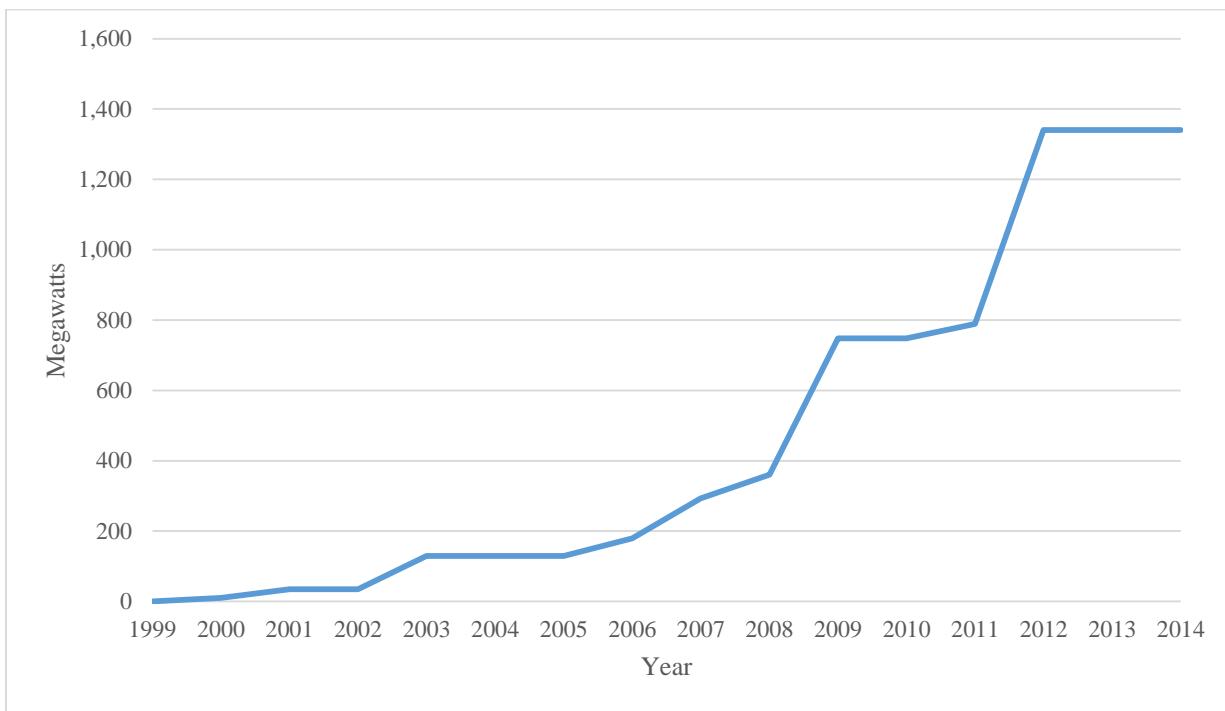
Figure 1
United States
Wind Power Capacity
in Megawatts
1999 – 2014



Source: U.S. EIA data analyzed by Commission staff. Data available at <http://www.eia.gov/electricity/>.

Pennsylvania's rate of growth was much steeper. At the close of 1999, Pennsylvania had only 129 megawatt hours of capacity. By the close of 2014, Pennsylvania's capacity had grown to 1,340, an average rate of increase of 86.5 megawatt hours per year. Dramatic increases occurred in 2008-2009 and 2011-2012.

Figure 2
Pennsylvania
Wind Power Capacity
in Megawatts
1999 – 2014



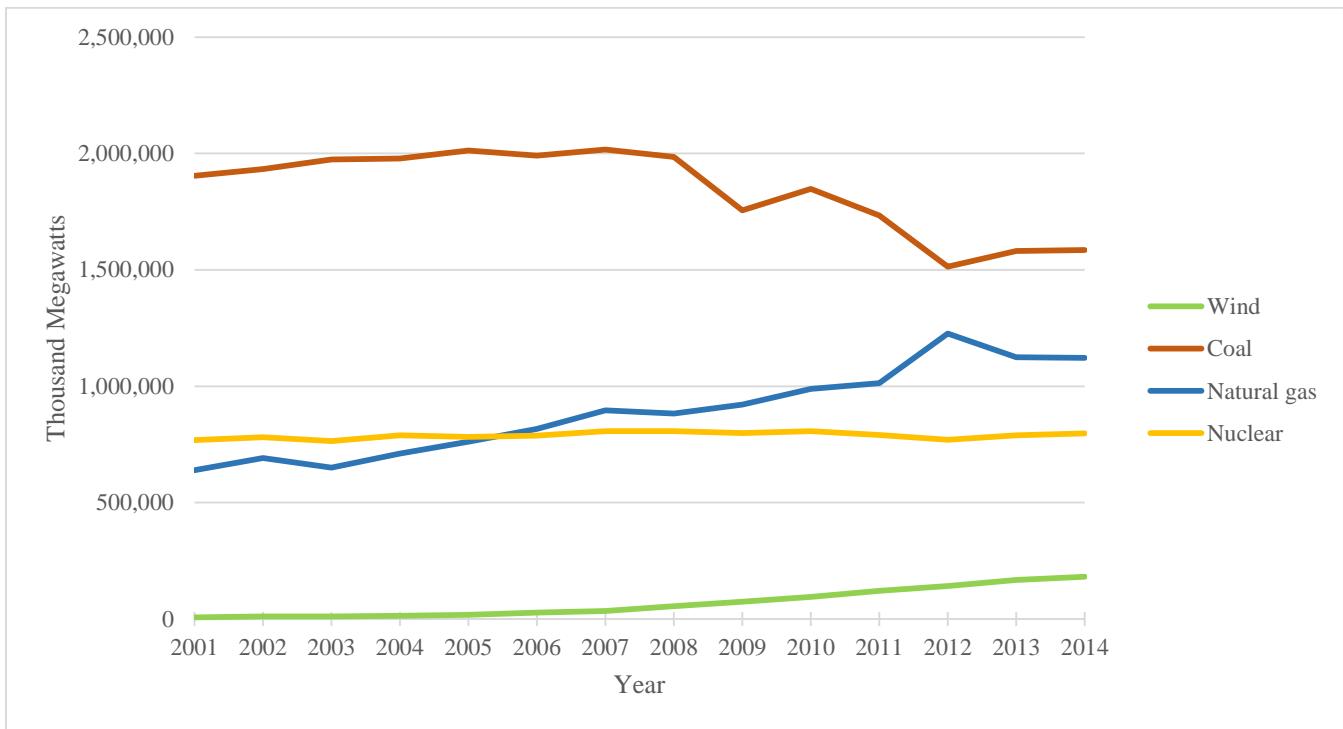
Source: U.S. EIA data analyzed by Commission staff. Data available at <http://www.eia.gov/electricity/>.

Despite the robust growth of wind power generation since the early 2000s, wind accounts for a fraction of the electricity generated by other energy sources like coal, natural gas, and nuclear.

To put this all in perspective, the U.S. consumed slightly more than 4 billion megawatts of electricity in 2014. Coal produced almost 1.6 billion megawatts of the 4 billion. Natural gas produced the second-largest amount of electricity with 1.2 billion megawatts, followed by nuclear sources that produced nearly 800 million megawatts. Wind turbines produced approximately 182 million megawatts of electricity, just over a tenth of what coal produced.

Coal's dominance in the energy sector has been weakening since 2008, while wind, natural gas, and nuclear experienced proportionately rapidly large growth or slower, steadier upticks in usage. (See Figure 3.)

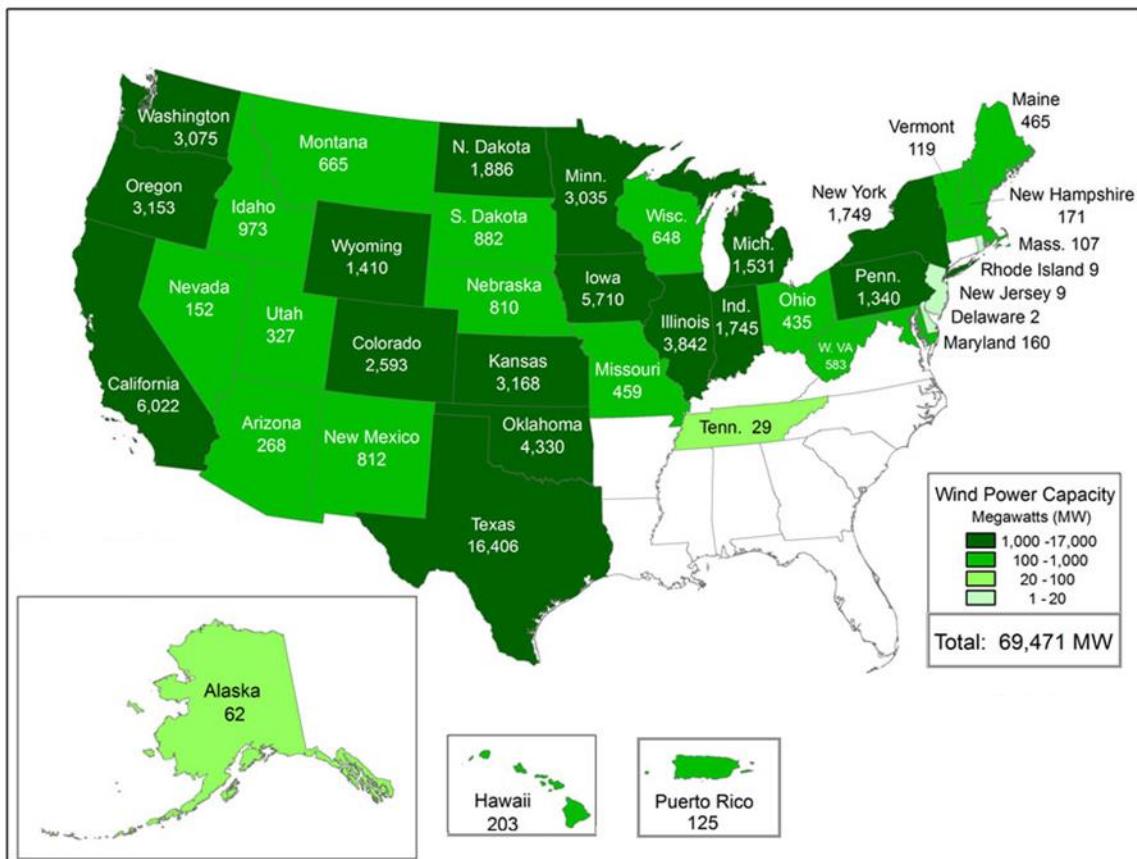
Figure 3
U.S. Trends in Power Generation
By Energy Source
2001 - 2014



Source: U.S. EIA data analyzed by Commission staff. Data available at <http://www.eia.gov/electricity/>.

Figure 4 shows the states' wind power capacity as of November, 2015.

Figure 4
States Wind Power Capacity
2015



Source: National Renewable Energy Laboratory, U.S. Department of Energy, "Current Installed Wind Power Capacity (MW)," http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp, (accessed January 15, 2016).

From a peak of 2 billion megawatts produced in 2008, coal production declined substantially and, by 2014, produced slightly below 1.6 billion megawatts. On average, coal's production dropped by almost twice the rate that wind's increased. Coal's average rate of decrease was 24.5 million megawatts while wind's average rate of increase was 13.5 million megawatts. The total change over the years 2001 to 2014 was an increase of 175 million megawatts from wind and a decrease of 318.3 million from coal. Similar to wind's increase, the number of megawatts produced from natural gas saw a steady increase over the period, rising at a rate of 37 million megawatts per year for a total increase of 428.8 million. Nuclear power was relatively stable. With a relatively nominal increase of just over 2.1 million megawatts, the total change for nuclear was an increase of 28.2 million. (See Table 2.)

Table 2
U.S. Electricity Consumption
in Thousand Megawatts
By Energy Source
2014

	Wind	Coal	Natural gas	Nuclear
Total U.S. Consumption	181,791	1,585,697	1,121,928	797,067
Change from 2001	175,054	(318,259)	482,798	28,241
Average annual rate of change in thousand megawatts	13,466	(24,481)	37,138	2,172

Source: U.S. EIA, Electricity Data Browser, "Net generation from electricity plants for United States, monthly," <http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2>

OWNERSHIP & OVERSIGHT

Wind Turbines in this Commonwealth

There are 720 wind turbines in the commonwealth.¹⁵ They are owned or operated by 13 energy companies as shown in Table 3:¹⁶

**Table 3
Wind Turbine Operators
in Pennsylvania
2015**

Wind Turbine Operators	No. of turbines
Algonquin Power Company ¹⁷	25
BP Wind Energy ¹⁸	88
Community Energy ¹⁹	12
Duke Energy Renewables ²⁰	65
E.ON Climate & Renewables, N. A.	35
EDF Renewable Energy ²¹	19
Energy Power Partners ²²	2
EverPower Wind Holdings ²³	138

¹⁵ PennFUTURE, *Energy*, <http://www.pennfuture.org/content.aspx?SectionID=192#Forward> (2015).

¹⁶ *Id.*

¹⁷ A subsidiary of Algonquin Power & Utils. Corp.. *Algonquin, Overview*, <http://www.algonquinpowercompany.com/overview> (2015).

¹⁸ Operates this as a wholly-owned affiliate for j. venture partners, BP and Sempra US Gas & Power. Press Release, BP, BP and Sempra US Gas & Power Announce Full Commercial Operation of Largest Wind Farm in Pa. (Jan. 8, 2013), available at <http://www.bp.com/en/global/corporate/press/press-releases/bp-and-sempra-us-gas-power-announce-full-commercial-operation-of-largest-wind-farm-in-pennsylvania.html> (last visited May 9, 2015).

¹⁹ Community Energy identifies Babcock & Brown and Central Hudson Energy Group as co-owners. *Community Energy, Bear Creek Wind Farm*, <http://www.communityenergyinc.com/wind-solar/wind/bear-creek-wind-farm/> (2015).

²⁰ Pt. of Duke Energy's Commercial Businesses. *Duke Energy Renewables, Wind Power Projects*, <http://www.duke-energy.com/pdfs/Wind-Power-Projects-Fact-Sheet.pdf> (Apr. 2014).

²¹ "Formerly enXco[,] EDF Renewable Energy is the U.S. subsidiary of EDF Energies Nouvelles." *EDF Renewable Energy, Corp. Structure*, http://www.edf-re.com/about/corporate_structure/ (last visited Apr. 30, 2015); *EDF Renewable Energy, Chestnut Flats Wind Project*, http://www.edf-re.com/files/uploads/Chestnut_Flats_Profile_8-2012.pdf (2012).

²² Talen Energy announced an agreement to sell this asset to Energy Power Partners. *Talen Energy*, <http://talenenergy.investorroom.com/2015-06-26-Talen-Energy-Announces-Agreement-to-Sell-Renewable-Energy-Business> (June 26, 2015).

²³ Trireme Energy Holdings, Inc., is the parent. *Everpower, 10-Yr. Anniversary Rep. 30*, available at <http://everpower.com/wp-content/uploads/2014/07/EverPowerAR12.5web.pdf>. Terra Firma Capital Partners.

Wind Turbine Operators	No. of turbines
Iberdrola Renewables ²⁴	110
Infigen Energy ²⁵	40
NextEra Energy Resources ²⁶	87
NRG Energy ²⁷	32
The AES Corporation	67

Oversight of Wind Turbines

Department of Environmental Protection

Wind farms in Pennsylvania are regulated by the Department of Environmental Protection, whose oversight of turbines monitors and regulates the effects on water and wetlands caused by road building and construction activities. When a wind turbine operator seeks to site turbines in Pennsylvania, it “needs to complete a Pennsylvania Natural Diversity Inventory Environmental Review and attempt to resolve any conflicts with the required agencies before submitting the permit application to the department.”²⁸ The inventory is used to screen projects “for potential impacts to threatened, endangered, special concern species and special concern resources in” the commonwealth,²⁹ and is the department’s primary source of information during the permit review process.³⁰ Anticipated potential impacts that are identified during the inventory evaluation require further review for a recommendation or clearance letter from the U.S. Fish and Wildlife Service or one of the other Pennsylvania agencies.³¹ Agencies’ recommendations can include implementation of avoidance and conservation measures as contingent to the department’s approval of the application.³²

²⁴ The U.S. division of Iberdrola, S.A.. Iberdrola Renewables, *Business Overview*, <http://iberdrolarenewables.us/business-overview.html> (2015).

²⁵ The 12 turbines listed w/Community Energy are really co-owned by Infigen Energy rather than Babcock & Brown. Infigen, *Our Business*, <http://www.infigenenergy.com/our-business.html> (2015). Infigen Energy was previously called Babcock & Brown Wind Partners. *Id.*, *Tax Information*, <http://www.infigenenergy.com/investors/tax-information.html>. Infigen Energy agreed to sell its U.S. wind energy business to Primary Wind Power. Press Release, Infigen Energy, Infigen Announces Sale of U.S. Wind Business (July 15, 2015); available at <http://www.infigenenergy.com/media/docs/15-07-15-Infigen-Announces-Sale-of-US-Business-79fa6ad1-6efe-4d26-867c-53268b12231e-0.pdf>. This transaction was expected to close shortly before this rep. is published. *Id.*

²⁶ Subsidiary of NextEra Energy, Inc.. NEXTERA ENERGY RESOURCES, *Who We Are*, <http://www.nexteraenergyresources.com/who/index.shtml> (2015).

²⁷ These assets were acquired from Edison Mission Energy. NRG, *News Release*, <http://investors.nrg.com/phoenix.zhtml?c=121544&p=irol-newsArticle&ID=1914623> (Apr. 1, 2014).

²⁸ Office of Pollution Prevention & Energy Assistance, Pa. Dep’t of Envtl. Prot., *PA Energy*, http://www.portal.state.pa.us/portal/server.pt/community/pa_energy/10407 (2015).

²⁹ Pa. Nat. Heritage Program, http://www.gis.dcnr.state.pa.us/hgis-er/PNDI_Introduction.aspx (last visited Sept. 9, 2015). These resources are protected by: U.S. Fish & Wildlife Serv., Pa. Game Comm’n, Pa. Fish & Boat Comm’n and Pa. Dep’t of Conservation & Nat. Res.. *Id.* The list of species inventoried by the program is available at <http://www.naturalheritage.state.pa.us/Species.aspx>.

³⁰ Office of Field Operations, Pa. Dep’t of Envtl. Prot., Policy for Pa. Nat. Diversity Inventory (PNDI) Coordination During Permit Rev. & Evaluation i (May 25, 2013), available at <http://www.gis.dcnr.state.pa.us/hgis-er/hgis/021-0200-001%20PNDI%20Policy.pdf>.

³¹ Pa. Nat. Heritage Program, http://www.gis.dcnr.state.pa.us/hgis-er/PNDI_Receipt.aspx. The Pa. agencies are identified *supra*, note 29.

³² *Id.*

Pennsylvania Game Commission

The Pennsylvania Game Commission (PGC) manages the commonwealth's wildlife.³³ Absent "compulsory state regulations, the" PGC "developed a Wind Energy Voluntary Cooperative Agreement with wind developers" providing "guidance and consistency to understand, avoid, minimize, and mitigate potential impacts on the state's wildlife resources."³⁴ Most, if not all, wind developers voluntarily agreed to cooperate with the PGC, and wind energy projects on state game lands are "reviewed and approved within strict accordance of Title 34 Game & Wildlife Code, but also reviewed to ensure the protection and conservation of the Commonwealth's wildlife resources."³⁵ The PGC board of commissioners "must make final approval for any proposed action relating to windmill projects on Game Lands."³⁶

A Wind Energy Voluntary Cooperation Agreement between the PGC and cooperating developers of wind energy is essentially this:³⁷

1. The cooperator will notify the PGC of any potential wind energy development sites.
2. Both parties may support the use of other potential funding mechanisms that reduce the overall costs associated with the Cooperator's monitoring requirements.
3. The parties will share all relevant information concerning wildlife resources under the commission's jurisdiction in and around the project area and the potential adverse impact to those resources.
4. The PGC will provide the cooperator with the results of all its internal reviews and provide written comment and or meet with the cooperator and share the results of the Pennsylvania Natural Diversity Inventory, and all pre and post-monitoring methods and recommendations on how best to avoid and reduce direct and indirect impacts to birds and mammals.
5. The PGC will consult with the cooperator to determine the risk level for monitoring and survey efforts.
6. The cooperator will submit study plans for all pre and post-construction surveys for the PGC's review and approval.
7. The cooperator will use all reasonable and feasible generally accepted wind industry and PGC best management practices relevant to the conservation of wildlife resources during construction and subsequent operation of the wind-energy facility.
8. The PGC will permit the cooperator's designated biologist to collect all bats, birds, and state listed threatened or endangered species throughout the project while conducting the PGC's approved monitoring plan and mortality protocol.
9. The PGC won't pursue liability against the cooperator for any incidental takings of the Commonwealth's bird and mammal resources for which it has purview under

³³ 34 Pa.C.S. §§ 103, 322.

³⁴ Pa. Game Comm'n, *Wind Energy*,

<http://www.portal.state.pa.us/portal/server.pt?open=514&objID=613068&mode=2> (last visited May 10, 2015).

³⁵ Div. of Env'l. Planning & Habitat Prot., Pa. Game Comm'n, *State Game Lands Dev.*, <http://www.portal.state.pa.us/portal/server.pt?open=514&objID=1865848&mode=2#Guidelines> (Mar. 25, 2005).

"A comprehensive 2-year pre-construction, and 2-year post-construction monitoring proposal for measuring the potential adverse impacts to birds and bats shall be developed by the Applicant and approved in writing by the" comm'n. *Id.*

³⁶ *Id.*

³⁷ Pa. Game Comm'n, Wind Energy Voluntary Cooperation Agreement Amend. I (July 26, 2013), available at <http://www.portal.state.pa.us/portal/server.pt?open=514&objID=613068&mode=2>.

- state law resultant from wind energy development and operations if the cooperator continues to comply with this agreement in good faith.
10. The PGC's recommendations or decisions under this agreement do not supersede any comments, decisions, or recommendations of the U.S. Fish & Wildlife Service.
 11. The cooperator will coordinate access with PGC staff to its wind energy facilities to ensure both parties' compliance to this agreement.
 12. Either party may terminate this agreement upon notification.
 13. Release of information will typically be by mutual consent.
 14. If not in default, the cooperator may assign this agreement.
 15. Required and permitted notices, demands and requests under this agreement must be written.
 16. This agreement is between the parties and their permitted successors and assignees.
 17. This agreement may include schedules.
 18. Amendments to this agreement must be written and signed by the parties.
 19. Its protocols include:
 - a. Pre- & post-construction monitoring of birds
 - b. Pre- & post-construction sampling of breeding birds & raptors
 - c. Pre- & post-construction monitoring of bat populations
 - d. PGC Endorsed Best Management Practices for Wind Energy Facilities
 - i. Construction
 - ii. Operations
 - iii. Decommissioning

Pennsylvania Public Utility Commission

Alternative Energy Portfolio Standards Act.³⁸ The Public Utilities Commission oversees Pennsylvania's Alternative Energy Portfolio Standards Act, which requires electric generation and distribution companies to sell to retail customers electricity generated in specified percentages from alternative energy sources.³⁹ Energy derived from wind power is one of these alternative energy sources.⁴⁰ “[A]ppropriate and reasonable health and safety standards to ensure uniform and proper compliance with this act by owners and operators of facilities generating energy from alternative energy sources” are required to be established by Department of Environmental Protection in cooperation with the Department of Labor and Industry.⁴¹ Department of Environmental Protection is required to “ensure that all qualified alternative energy sources meet all applicable environmental standards”.⁴² The Pennsylvania Game Commission and Department of Environmental Protection are required to cooperatively “monitor the performance of all aspects of this act.”⁴³

Pennsylvania Municipalities Planning Code

The Pennsylvania Municipalities Planning Code authorizes municipalities to regulate land development⁴⁴ and enact “zoning ordinances to implement comprehensive plans and to accomplish any of the purposes of” the code.⁴⁵ Municipal, multimunicipal, or county comprehensive plans

³⁸ This is discussed more fully, *infra* pp. 89-90.

³⁹ Act of Nov. 30, 2004 (P.L.1672, No.213), § 3; 73 P.S. § 1648.3.

⁴⁰ *Id.* § 2; 73 P.S. § 1648.2.

⁴¹ *Id.* § 6; 73 P.S. § 1648.6.

⁴² *Id.* § 7(b); 73 P.S. § 1648.7(b).

⁴³ *Id.* § 7(c); 73 P.S. § 1648.7(c).

⁴⁴ Act of July 31, 1968 (P.L.805, No.247), § 501; 53 P.S. § 10501.

⁴⁵ *Id.* § 601; 53 P.S. § 10601.

may “promote . . . the effective utilization of renewable energy sources.”⁴⁶ Zoning ordinances regulate uses of land and structures including the latter’s “[s]ize, height, bulk, location, erection, construction, repair, maintenance, alteration, razing,” and “removal,” but must “be generally consistent with the municipal or multimunicipal comprehensive plan”.⁴⁷ This leads to wide discretion in the oversight of wind turbine facilities with local governmental oversight often from township zoning boards; however, zoning would “not apply to any proposed building, or extension thereof, to be used by a public utility corporation, if the Pennsylvania Public Utility Commission” decides “that the present or proposed situation of the building in question is reasonably necessary for the convenience or welfare of the public.”⁴⁸

Model Wind Ordinance for Local Governments

In 2006, Pennsylvania developed a model local ordinance for wind energy facilities through a collaborative effort involving several state departments and stakeholder groups. The purpose of the model is to provide local governments with a general template for permitting wind energy facilities that they may change and adapt to fit their own needs. The initial model ordinance was completed in the spring of 2006 and updated later the same year. The document covers the three ways in which local governments may regulate land use within their borders: zoning ordinances; subdivision and land development ordinances (SLDO); and inherent municipal “police” powers for protecting public welfare.⁴⁹

The model zoning ordinance defines what constitutes a wind energy facility and provides exemplary appropriate zones for wind energy as a permitted or conditional use.⁵⁰ A comprehensive set of standards to construct, operate, and decommission a wind energy facility appears in the model’s subdivision and land development ordinance.⁵¹ Several of the model’s provisions for wind facility characteristics include:⁵²

- Design and Installation⁵³
- Setbacks⁵⁴
- Public Disturbances⁵⁵

⁴⁶ *Id.* § 301.1; 53 P.S. § 10301.1.

⁴⁷ *Id.* § 603(b), (j); 53 P.S. § 10603(b), (j). “In any municipality, other than a county, which enacts a zoning ordinance, no part of such municipality shall be left unzoned.” *Id.* § 605; 53 P.S. § 10605. “When a county adopts a comprehensive plan and any municipalities therein have adopted comprehensive plans and zoning ordinances, Commonwealth agencies” must “consider and may rely upon comprehensive plans and zoning ordinances when reviewing applications for the facilities.” *Id.* § 619.2(a); 53 P.S. § 10619.2(a).

⁴⁸ *Id.* § 619; 53 P.S. § 10619.

⁴⁹ Energy.gov, Model Wind Ordinance for Local Gov’ts, <http://energy.gov/savings/model-wind-ordinance-local-governments> (last visited Sept. 16, 2015). This model appears in app. D, *infra* p. 103.

⁵⁰ Energy.gov, *supra* note 49.

⁵¹ *Id.* The model is for commercial wind energy facilities as opposed to stand-alone systems for residential or farm use. *Id.*

⁵² *Id.*

⁵³ Gen. criteria related to safety & construction codes as well as visual appearance.

⁵⁴ Min. required distance between wind turbines & other structures.

⁵⁵ Possible adverse effects of wind farm operation: rd. damages & repair liability; interference with television, radio, telephone & similar signals; shadow flicker; and noise.

“Additional sections of the model ordinance address local emergency services, insurance requirements, facility decommissioning, site restoration, abandonment, and dispute resolution. The ‘police’ power model covers the same topics as the model SLDO in a slightly different format.”⁵⁶

U.S. Fish & Wildlife Service

The U.S. Fish & Wildlife Service (the Service), a bureau of the U.S. Department of the Interior, is the primary federal agency responsible for conservation and management of the country’s fish and wildlife resources and enforcement of federal wildlife laws. The Service plays an important role in the oversight of energy production where it interacts with the ecology of fish and wildlife.

The Service uses multiple authorities to review proposed energy projects. Pursuant to the Endangered Species Act (ESA), the Service provides a list of federally-designated threatened and endangered species, as well as critical habitats, that are known to occur or may occur in the vicinity of a proposed project to a developer and consults on any listed species or critical habitats occurring there. If a project is proposed on private lands and federally-listed threatened or endangered species or critical habitats are likely to be affected, then the Service may assist the developer with applying for an incidental take permit under Section 10(a)(1)(B) of the ESA.⁵⁷

This act generally forbids endangered wildlife species to be “taken,”⁵⁸ in other words, harmed or killed.⁵⁹ A state may enact a law or regulation that is more restrictive than this law but not less so.⁶⁰

[U.S. Fish & Wildlife] Service biologists may provide information on migratory birds and impacts to their habitats under the Migratory Bird Treaty Act (MBTA), and may work with project proponents to develop plans that identify and address impacts to migratory birds. Some projects may involve more specific activities by Service biologists, depending on the energy resource being developed. For example:

- The Service uses the Land-based Wind Energy Guidelines to provide technical assistance to both private developers and federal agencies developing wind facilities on public and private lands. Technical assistance recommendations to reduce impacts to wildlife and their habitats may include information on siting individual turbines, best management practices for construction and operational modifications. A Bird and Bat Conservation Strategy may be compiled by a developer in order to document potential impacts to wildlife and their habitats, actions taken to avoid and reduce impacts, and any other conservation measures implemented.

⁵⁶ Energy.gov, *supra* note 49.

⁵⁷ U.S. Fish & Wildlife Serv., Dep’t of Interior, Energy Dev., <http://www.fws.gov/ecological-services/energy-development/energy-project-review.html> (last updated May 5, 2015).

⁵⁸ 16 U.S.C.A. § 1538.

⁵⁹ *Id.* § 1532(19). Harm “may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.”

50 C.F.R. § 17.3.

⁶⁰ 16 U.S.C.A. § 1535(f).

- A wind developer may decide to apply for an Eagle Take Permit under the Bald and Golden Eagle Act. The Service may help the developer to draft an Eagle Conservation Plan that can assist developers in avoiding and minimizing impacts to eagles, and can assist a developer in collecting the information that is required to apply for an Eagle Take Permit.⁶¹

The federal Migratory Bird Treaty Act of 1918 made it a misdemeanor to kill a migratory bird if it is a native species.⁶² Additionally, the Bald and Golden Eagle Act makes it criminal to take those eagles.⁶³ Although a wind power developer may voluntarily adhere to the Land-based Wind Energy Guidelines, such cooperation does not relieve the developer from its responsibility to comply with laws and regulations; “[H]owever, if a violation occurs the Service will consider a developer’s documented efforts to communicate with the Service and adhere to the Guidelines.”⁶⁴

U.S. Department of Transportation

The Secretary of Transportation requires “adequate public notice of the proposed construction of a structure when the notice will promote safety in air commerce; and the efficient use and preservation of the navigable airspace and of airport traffic capacity at public-use airports.”⁶⁵ This notice allows the Federal Aviation Administration to “[d]etermine whether the effect of proposed construction or alteration is a hazard to air navigation” and “[n]otify the aviation community of the construction or alteration of objects that affect the navigable airspace, including the revision of charts, when necessary.”⁶⁶ The requisite notice applies to construction of structures that are more than 200 feet above the ground.⁶⁷

Decommissioning

Wind turbines that are no longer in use are subject to a process known as decommissioning. “Decommissioning is the cessation of wind energy operations and removal of all associated equipment, roads, and other infrastructure. The land is then used for another activity.”⁶⁸ Absent state decommissioning laws, regulations, and guidelines, oversight of decommissioning wind turbines falls to the many local governments. In 2006, the Commonwealth created a model local ordinance in consultation with local governments and trade associations.⁶⁹

The model calls for the decommissioning within 12 months of end of a wind turbine’s useful life by removal of the turbine, buildings, cabling, electrical components, roads, foundations, and associated facilities at the owner and operator’s expense.⁷⁰ Unless the land owner does not want the surface to be restored, the operator of the turbine would be required to grade and reseed. While the wind turbine is operational, the operator would be required to periodically have an independent and certified professional engineer estimate the cost of decommissioning and report his findings to the municipality. A percentage of the cost of decommissioning would be required

⁶¹ U.S. Fish & Wildlife Serv., *supra* note 57.

⁶² 16 U.S.C. §§ 703, 707.

⁶³ 16 U.S.C.A. § 668. Take means to kill, molest or disturb. *Id.* § 668c.

⁶⁴ U.S. Fish & Wildlife Serv., Dep’t of Interior, *U.S. Fish & Wildlife Serv. Land-Based Wind Energy Guidelines* vii, 6 (2012), available at http://www.fws.gov/ecological-services/es-library/pdfs/WEG_final.pdf.

⁶⁵ 49 U.S.C.A. § 44718(a). Failure to file the subject notice subjects one to a civ. penalty. *Id.* § 46301(a).

⁶⁶ 14 C.F.R. § 77.5.

⁶⁷ *Id.* § 77.9(a). The height could be lower if it is close to a runway or heliport. *Id.* §§ 77.9(b), 77.17.

⁶⁸ U.S. Fish & Wildlife Serv., *supra* note 64, at 52.

⁶⁹ Energy.gov, *supra* note 49.

⁷⁰ The model ordinance presumes this to occur if no electricity has been generated for 12 continuous months.

to be posted and maintained by a bonding company or chartered lending institution. The deposit would be released upon decommissioning.

SOURCES AND AMOUNTS OF SUBSIDIES

Overview

This section details subsidies from the federal government and the Commonwealth for wind turbines, coal, natural gas, nuclear, and oil. Because governmental subsidies can be direct, indirect, temporary, and indefinite, and may apply to consumers, producers, distributors, and the discrete market sectors, it is difficult to comprehensively catalogue all subsidies. For example, a number of the subsidies that apply to wind turbines would also apply to other renewable sources of energy. Although considered separately, a number of the subsidies that apply to natural gas also apply to oil. The examples of the subsidies in this report are primarily those that target specific sources of energy. Other examples of the subsidies excluded from this report are those that target specific technologies and performance characteristics or efficiencies that could rely upon several sources of energy.

Some subsidies are direct expenditures to consumers or producers while others are tax expenditures that can benefit the same parties by reducing their tax liability with the government forgoing collection of that revenue. Another form of subsidy is expenditure for research and development via governmental programs and laboratories as well as grants to academe and the private sector. Government also lends money and guarantees loans in programs that also act as a subsidy because it is the lender itself or is otherwise able to lower the expense of borrowing.⁷¹

For federal subsidies, the most recent fiscal year that has been analyzed is 2013. “Direct expenditures were slightly more than tax expenditures . . .”⁷² Renewables received the biggest expenditure with solar and wind each getting approximately the total that biomass, geothermal, hydropower and other renewable sources received combined. For the other three sources, natural gas and petroleum liquids received the most followed by nuclear and coal. (See Table 4.) Most of the funding from U.S. Department of Energy is direct investment, with approximately 75 percent of that for efficiency and renewable energy.⁷³

⁷¹ U.S. Energy Info. Admin., Dep’t of Energy, *Dir. Fed. Fin. Interventions & Subsidies in Energy in Fiscal Yr. 2013*, ix-xi (2015), available at <http://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf>. The tax breaks can be in the form of a credit, deduction, deferral, preferential rate and exclusion. *Id.* at 8.

⁷² *Id.* at 7.

⁷³ *Id.* at 30.

Table 4
U.S. Quantified Energy Specific Subsidies & Support by Type, Fiscal Year 2013⁷⁴
(in \$ millions)

Beneficiary	Direct Expenditure	Tax Expenditure	Research & Development	Fed. & Rural Utilities Serv. Electricity	Total
Coal	\$74	\$769	\$202	\$30	\$1,075
Refined Coal		10			10
Natural Gas & Petroleum Liquids	62	2,250	34	--	2,346
Nuclear	37	1,109	406	109	1,660
Renewables	8,363	5,454	1,051	176	15,043
Biomass	332	46	251	--	629
Geothermal	312	31	2	--	345
Hydropower	197	17	10	171	395
Solar	2,969	2,076	284	--	5,328
Wind	4,274	1,614	49	--	5,936
Other	209	--	380	5	594

Currently, the federal government policies toward subsidies differ from those of the period 1950-2010. During that period almost half of the subsidies came in the form of tax policy, which includes special exemptions, allowances, deductions, and credits related to the federal tax code. Oil producers received approximately 44 percent from all types of incentives during these years, most of which was through tax policy. Almost half of research and development incentives were directed toward nuclear power. (See Table 5.)

Table 5
Summary of Federal energy incentives, 1950-2010⁷⁵
(in \$ billions)

Incentive	Oil	Natural Gas	Coal	Hydro	Nuclear	Renewables	Geothermal	Total	Percent
Tax	\$194	\$106	\$35	\$13	--	\$44	\$2	\$394	47%
Regulation	125	4	8	5	16	--	--	158	19
Research & Development	8	7	36	2	74	24	4	153	18
Market Activity	6	2	3	66	--	2	2	80	10
Governmental Services	34	2	16	2	2	2	--	57	7
Disbursements	1	--	7	2	-18	2	--	-6	-1
Total	369	121	104	90	73	74	7	837	100

⁷⁴ *Id.* at xv.

⁷⁵ Mgmt. Info. Servs., 60 Yrs. of Energy Incentives 1 (2011), available at http://www.nei.org/corporatesite/media/filefolder/60_Years_of_Energy_Incentives__Analysis_of_Federal_Expenditures_for_Energy_Development_-_1950-2010.pdf. The estimates are in 2010 constant dollars; renewable are primarily wind & solar. *Id.* Regulation includes mandates and governmentally-funded oversight. *Id.* at 7. Market activity includes construction and operational costs borne by the fed. gov't. *Id.* at 8. It also includes relevant leasing & resource mgmt.. *Id.* Governmental servs. are for federally provided infrastructure & disbursements are grants. *Id.* at 8-9.

Federal tax preferences for fuels and energy technologies date from 1916, when they were first established for oil and natural gas.⁷⁶ Rather than promoting efficiency or the use of renewable sources, “[f]rom 1916 to the 1970s, federal energy-related tax policy focused almost exclusively on increasing the production of domestic oil and natural gas . . .”⁷⁷ The focus of tax policy shifted in 2005 to increase energy efficiency, and tax preferences for renewable sources were added in 2008.⁷⁸ By fiscal year 2013, approximately 74 percent of the estimated budgetary costs for these preferences were directed toward increasing energy efficiency and renewable sources.⁷⁹ In 2013, about half of federal support for direct investments, loans, and loan guarantees also was directed toward energy efficiency and renewable sources.⁸⁰ Most of the energy sector funding from the U.S. Department of Energy is direct investment, with just over half supporting energy efficiency and renewable sources.⁸¹

Wind Turbines

Rural Energy for America Program

Renewable Energy Systems. This program offers financial assistance for renewable energy systems⁸² and includes wind.⁸³ Financial assistance is in the form of loan guarantees and grants for agricultural producers and rural small businesses to purchase renewable energy systems to produce and sell electricity.⁸⁴ Grants are limited to 25 percent of the cost and loan guarantees are limited to \$25 million with a combined limitation of grant and loan guarantee to 75 percent of the cost of the project.⁸⁵ The grants for renewable energy systems are for requests of a minimum of \$2,500 and a maximum of \$500,000 per application, with a maximum grant allowed to one entity in the same fiscal year limited to \$750,000.⁸⁶ There is currently annual mandatory funding of \$50 million and discretionary funding of \$20 million.⁸⁷

Energy audits and renewable energy development assistance. A portion of the annual mandatory funding under Renewable Energy Systems is set aside to assist agricultural producers and rural small businesses as encouragement to use renewable energy technologies and resources by granting funds for renewable energy assessments.⁸⁸

⁷⁶ Cong. Budget Office, *supra* note 10, at 1.

⁷⁷ *Id.* at 4.

⁷⁸ *Id.*

⁷⁹ *Id.*

⁸⁰ *Id.*

⁸¹ *Id.* at 7-8.

⁸² 7 U.S.C.A. § 8107(a)(2).

⁸³ *Id.* § 8101(15), (16). The most recent grantees in Pa. for renewable energy were all for solar. http://www.rd.usda.gov/files/RDREAPGrantAwards_06_10_15.pdf (June 10, 2015).

⁸⁴ 7 U.S.C.A. § 8107(c)(1).

⁸⁵ *Id.* § 8107(c)(3). The minimum amount for a loan guarantee is \$5,000. 7 C.F.R. § 4280.129. The maximum percentage of the loan guarantee depends on the amount of the loan. *Id.*

⁸⁶ *Id.* § 4280.114(a).

⁸⁷ 7 U.S.C.A. § 8107(g).

⁸⁸ *Id.* § 8107(b), (g)(2)(A). The portion amounts to \$2,000,000.

Tribal Energy Program

U.S. Department of Energy “provides financial and technical assistance that enables Native American tribes to evaluate and develop their renewable energy resources”, including wind.⁸⁹ This program is not summarized because “[t]here are no energy-related projects in Pennsylvania funded by” it;⁹⁰ the program has funded 38 wind projects.⁹¹

U.S. Tax Expenditures

Tax expenditures “provide beneficial treatment to taxpayers” in the form of “credits, deductions, deferrals, preferential rates, and exemptions” or exclusions.⁹²

Small Wind Turbines (Residential). Homeowners in the United States are eligible to receive a tax credit for making energy efficiency improvement to their residences.⁹³ A small wind turbine may qualify provided that it has a nameplate capacity of no more than 100 kilowatts. The tax credit includes installation costs.⁹⁴ The allowed “credit against the tax imposed . . . for the taxable year” is 30 percent “of the qualified small wind energy property expenditures made by the taxpayer during” the tax year.⁹⁵

Small Wind Turbines (Business). A small business energy investment tax credit is available for business (similar to the one for residences). A qualifying small wind turbine must have a nameplate capacity of not more than 100 kilowatts.⁹⁶ The amount of “the energy credit for any taxable year is the energy percentage of the basis of each energy property placed in service during such taxable year”, which is 30 percent for a qualified small wind energy property.⁹⁷

Electricity produced from certain renewable resources (Wind). A renewable electricity production credit for any taxable year is available for a 10-year period whence a qualified facility is originally placed in service for electricity produced by the taxpayer and sold to an unrelated person during the same tax year in an amount equal to the product of 1½¢ multiplied by the kilowatt hours of electricity.⁹⁸ To qualify for this production credit, a wind facility must have been originally placed in service after 1993, but its construction must have begun before 2015.⁹⁹ This credit has been renewed numerous times after its original enactment in 1992, with the most recent renewal coming at the end of 2015.¹⁰⁰ The tax credit phases down for wind facilities commencing construction after 2016 with a reduction of 60 percent for those constructed in 2019.¹⁰¹

⁸⁹ U.S. Dep’t of Energy, Tribal Energy Program, <http://apps1.eere.energy.gov/tribalenergy/> (last updated Sept. 8, 2015).

⁹⁰ *Id.*, http://apps1.eere.energy.gov/tribalenergy/projects_state.cfm/state=PA (last updated Apr. 6, 2015).

⁹¹ *Id.*, http://apps1.eere.energy.gov/tribalenergy/projects_technology.cfm (last updated June 18, 2013).

⁹² U.S. Energy Info. Admin., *supra* note 71, at 7-8.

⁹³ 26 U.S.C.A. § 26D; ENERGY STAR, Fed. Tax Credits for Consumer Energy Efficiency, http://www.energystar.gov/about/federal_tax_credits (last visited Sept. 19, 2015).

⁹⁴ *Id.*, Fed. Tax Credits: Small Wind Turbines (Residential),

http://www.energystar.gov/about/federal_tax_credits/small_wind_turbines (last visited Sept. 19, 2015).

⁹⁵ 26 U.S.C.A. § 25D(a).

⁹⁶ *Id.* § 48. This doesn’t apply after 2016. *Id.*

⁹⁷ *Id.*

⁹⁸ *Id.* § 45. The amount gets adjusted for inflation and phased out. *Id.* The most recent credit amount for wind is 0.023¢/kilowatt hour of electricity.

⁹⁹ *Id.*

¹⁰⁰ Energy.gov, Renewable Prod. Tax Credit (PTC), energy.gov/savings/renewable-electricity-production-tax-credit-ptc (last visited Jan. 12, 2016).

¹⁰¹ *Id.*

New clean renewable energy bonds. These bonds “are to be used for capital expenditures incurred by governmental bodies, public power providers, or cooperative electric companies for one or more qualified renewable energy facilities”, which includes wind.¹⁰² The annual credit is 70 percent of the amount of credit to holders of qualified tax credit bonds.¹⁰³ The allocation of the bonds is one-third each to public power providers, governmental bodies and cooperative electric companies.¹⁰⁴ The total national bond limitation is \$2.4 billion.¹⁰⁵

Qualified energy conservation bonds. These bonds are issued by state or local government for capital expenditures incurred for “rural development involving the production of electricity from renewable energy resources” or any qualified facility, which includes wind.¹⁰⁶ The annual credit is 70 percent of the amount of credit to holders of qualified tax credit bonds.¹⁰⁷ The allocation of the bonds to the states is in proportion to their populations.¹⁰⁸ The total national bond limitation is \$3.2 billion.¹⁰⁹

Accelerated cost recovery system. Depreciation for exhaustion, wear and tear of property used in the trade or business, or held for the production of income is accelerated from the straight line method with an applicable recovery period of five years for equipment using wind energy to generate electricity.¹¹⁰

Pennsylvania Renewable Energy Program—Geothermal & Wind Projects

This program is jointly administered by Departments of Community and Economic Development and Environmental Protection under Commonwealth Financing Authority to “grant and loan funds to promote the use of alternative energy in Pennsylvania.”¹¹¹ The current interest rate for this program is 5 percent.¹¹² A matching investment is required for funds awarded.¹¹³ Under this program, a loan of \$300,000 was made to a limited liability company in County of Bucks to purchase new equipment. Other grants ranging from \$100,000 to \$12.7 million were

¹⁰² 26 U.S.C.A. § 54C.

¹⁰³ *Id.* § 54C(b).

¹⁰⁴ *Id.* § 54C(c).

¹⁰⁵ *Id.* Unused allocations reverted to Internal Rev. Serv. for reallocation and the serv. accepted applications last year for those reallocations. Internal Rev. Serv. Notice 2015-12, available at <http://www.irs.gov/pub/irs-drop/n-15-12.pdf> (last visited Sept. 20, 2015). In 2009, a corp. was allocated \$7,000,000 of these bonds as a cooperative electric co. for a wind project in Berlin. New Clean Renewable Energy Bonds—2009 Allocation, available at http://www.irs.gov/pub/irs-tege/ncrebs_2009_allocations_v1.1.pdf (last visited Sept. 20, 2015).

¹⁰⁶ 26 U.S.C.A. § 54D.

¹⁰⁷ *Id.* § 54D(b).

¹⁰⁸ *Id.* § 54C(e).

¹⁰⁹ *Id.* § 54C(d). This bond enables qualified governmental issuers to borrow money at attractive rates to fund qualified conservation purposes and then issue debt at extremely low rates. Energy.gov, Qualified Energy Conservation Bonds, <http://energy.gov/eere/slsc/qualified-energy-conservation-bonds>; <http://www.irs.gov/pub/irs-drop/n-15-12.pdf> (last visited Sept. 21, 2015).

¹¹⁰ 26 U.S.C.A. § 168.

¹¹¹ Pa. Dep’t of Community & Econ. Dev., Renewable Energy Program (REP) – Geothermal & Wind Projects, <http://community.newpa.com/programs/renewable-energy-program-rep-geothermal-wind-projects/> (Aug. 4, 2015).

¹¹² *Id.*, CFA Interest Rates, <http://community.newpa.com/commonwealth-financing-authority-cfa/cfa-interest-rates/> (last visited Sept. 19, 2015). This rate adjusts quarterly. *Id.*

¹¹³ *Id.*, *supra* note 111.

made to limited liability companies and corporations for wind farms and wind turbine projects in five other counties.¹¹⁴

Businesses, economic development organizations, political subdivisions, and individuals are eligible for this financial assistance.¹¹⁵ Funds may be used to acquire and clear land, construct buildings, purchase and install equipment and energy facilities, prepare feasibility plans, pay for permits, and administer the grant.¹¹⁶ The maximum amounts for loans depends upon how many jobs will be created and the type of system or project.¹¹⁷ The maximum amount for grants depends on how many jobs will be created and whether the grant is for a project or feasibility study.¹¹⁸ Applications are evaluated from the following criteria:¹¹⁹

1. The level of matching investment
2. Technical and financial feasibility
3. Energy savings
4. Amount of alternative energy produced
5. Number and quality of jobs to be created
6. Readiness of the project
7. Soundness of land and water usage
8. Environmental benefits
9. Origin of equipment for the project

Alternative Energy Production Tax Credit Program

The total amount of credits for fiscal year 2015-16 is limited to \$2 million¹²⁰ and the credit will not be approved after the 2016 tax year.¹²¹

Excepted Subject of Local Taxation

In counties of the 2d class A through 8th classes and cities and cities electing to become subject to Consolidated County Assessment Law, “wind turbine generators or related wind energy appliances and equipment” are not “considered or included as part of the real property in

¹¹⁴ Commw. Fin. Auth., Approved Projects—Energy Programs 3, http://community.newpa.com/wp-content/uploads/library/programs_and_funding/commonwealth_financing_authority/approved_projects/Approved_Projects_Energy_Programs_7_8_15.pdf (July 14, 2015). A ltd. liability co. also received a grant of \$6,000,000 from this auth. for a wind project in Cnty. of Cambria under the alt. & clean energy program. *Id.* at 4. The alt. & clean energy program is similar to the renewable energy program; however, the former program is currently out of funds so that the auth. is not accepting applications under that program. Pa. Dep’t of Community & Econ. Dev., Alt. & Clean Energy Program, <http://community.newpa.com/programs/alternative-clean-energy-program-ace/> (Aug. 4, 2015).

¹¹⁵ Pa. Dep’t of Community & Econ. Dev., *Renewable Energy Program Geothermal & Wind Projects: Program Guidelines* 1 (2014), available at http://community.newpa.com/download/programs_and_funding/program_guidelines/Renewable_Energy_Geothermal_Wind_Guidelines_2014.pdf.

¹¹⁶ *Id.* at 1-2.

¹¹⁷ *Id.* at 3.

¹¹⁸ *Id.* at 4.

¹¹⁹ *Id.* at 5.

¹²⁰ Act of July 9, 2008 (P.L.1873, No.1) Spec. Sess., § 706(a)(4); 73 P.S. § 1649.706(a)(4).

¹²¹ *Id.* § 709; 73 P.S. § 1649.709.

determining the fair market value and assessment of real property used for wind energy generation.”¹²²

Energy Development Authority

The authority is authorized to finance projects by lending and guaranteeing loans and grant funds for research projects.¹²³ The projects are ones in Pennsylvania, which cannot be effectively funded using privately available resources, relating to:

- (1) basic and applied research concerning energy use, renewable energy resources and energy extraction, transmission, storage or conversion;
- (2) limited scale demonstration of innovative or commercially unproven technology to promote the production, use or conservation of energy; or
- (3) activities to promote or remove obstacles to the utilization and transportation of Pennsylvania energy resources, including but not limited to limited scale synthetic fuel facilities and the conversion or technological improvement of industrial, commercial or agricultural systems to utilize Pennsylvania coal or renewable energy resources¹²⁴

The authority publishes its plan to allocate and distribute financial and technical assistance, identifying the various classes of projects to be provided that assistance and periodically updates and revises its plan.¹²⁵ “Pennsylvania projects that could potentially qualify for funding from the Authority include solar energy, wind, low-impact hydropower, geothermal, biomass, landfill gas, fuel cells, IGCC, waste coal, coal-mine methane and demand management measures.”¹²⁶

The authority’s self-described “mission is to promote the development and use of Pennsylvania’s clean, indigenous energy resources and to stimulate economic development and job creation in Pennsylvania’s growing energy sector in an environmentally beneficial manner.”¹²⁷ The 2014 Financial Assistance Offering made \$12.5 million of funding available as grants and loans, capped at \$500,000 per project.¹²⁸ Criteria for specific solicitations vary, but the following criteria are generally considered for all deployment projects:¹²⁹

¹²² 53 Pa.C.S. §§ 8801, 8811(b)(5). Instead, “[t]he valuation of real property used for wind energy generation for assessment purposes shall be developed by the county assessor utilizing the income capitalization approach to value.” *Id.* § 8842(b)(2).

¹²³ Act of Apr. 9, 1929 (P.L.177, No.175), § 2806-C; 71 P.S. § 720.6. Funding for the auth. may come from fed. grants and contracts, reasonable fees and charges it collects, borrowing, appropriations, gifts and settlements. *Id.* “The aggregate principal amount of bonds and notes” issued by the auth. is ltd. to “\$300,000,000 outstanding at any one time” and must mature w/in 40 yrs.. *Id.* § 2807-C(a), (e)(1); 71 P.S. § 720.7(a), (e)(1). The transfer of and income from these bonds is not taxed by the Commw.. *Id.* § 2810-C(a); 71 P.S. § 720.10(a). Excessive amounts credited to Energy Dev. Fund are transferred to the treasury’s Gen. Fund. *Id.* § 2811-C(c); 71 P.S. § 720.7(a), (e)(1).

¹²⁴ *Id.* § 2801-C; 71 P.S. § 720.1. The auth.’s accounts & books are audited every two yrs. by the auditor gen.. *Id.* § 2813-C; 71 P.S. § 720.13.

¹²⁵ *Id.* § 2809-C; 71 P.S. § 720.9. “Specifically, the authority shall consider increasing coal production and the use of renewable fuels and in energy efficiency in buildings and industry in establishing its priorities.” *Id.*

¹²⁶ Pa. Dep’t of Envtl. Prot., PEDAGrant Announcement Mailing List (2015).

¹²⁷ Pa. Energy Dev. Auth., Annual Rep. 2013-14 1, <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-102929/0120-BK-DEP4460%20combined.pdf>.

¹²⁸ *Id.* at 1-2.

¹²⁹ Pa. Dep’t of Envtl. Prot., *The Pa. Energy Dev. Plan* 9 (2014).

- Potential to expand the market for Pennsylvania's indigenous energy resources
- Potential to enhance Pennsylvania's energy independence and security through diversification
- Significance of environmental benefits
- Promoting efficiency or increasing production from alternative and renewable sources
- A new business applying a next phase clean, advanced technology with potential for wide-scale applicability
- Potential economic benefits for the state
- Technical feasibility and cost effectiveness
- Land use consistent with local zoning and planning and Keystone Principles

Criteria for research projects are similar and the following criteria are generally considered:¹³⁰

- Significance of contribution to alternative energy resource development
- Consistency of research objective with authority goals
- Significance of environmental benefits
- Practicality of application of the technology
- Soundness of research methodology
- Qualifications of research director and staff
- Potential for economic competitiveness of technology
- Applicability to state energy resources
- Likelihood of leading to Pennsylvania's energy independence and security through diversification
- Comparison of potential costs and benefits

The Commonwealth has hundreds of years of known coal reserves, ranks 2nd nationally in natural gas production and 19th nationally in crude oil production, and has enough wind to power homes for approximately one-third of its population.¹³¹

Coal

Clean Coal Technology Export Promotion & Interagency Coordination

This is a federal statutory initiative authorizing interagency coordination “to expand the export and use of clean coal technologies” and specifying duties of the U.S. Secretary of Energy to facilitate this export to “regions where these technologies could be important”.¹³²

U.S. Agency for International Development. The agency is authorized to have a clean coal technology transfer program to reduce the balance of trade deficit by this export and develop markets that need to use “coal in an environmentally acceptable manner”.¹³³ The agency is authorized to provide financial assistance to support these projects.¹³⁴

¹³⁰ *Id.*

¹³¹ *Id.* at 5.

¹³² 42 U.S.C.A. § 13361.

¹³³ *Id.* § 13362.

¹³⁴ *Id.* See also U.S. Agency for Int'l Dev., *Cleaner Air for 400,000 Residents in India*, <https://www.usaid.gov/results-data/success-stories/cleaner-air-400000-residents-india> (last updated Jan. 5, 2015).

U.S. Department of Energy

Office of Fossil Energy. The National Energy Technology Laboratory (NETL), the primary field center of the Office of Fossil Energy, is in the lead of coal energy programs overseen by the office. NETL's "integrated Coal Program focuses on retaining the benefits of continuing to use coal to produce electric power."¹³⁵ Although its Coal Program supports fundamental research and development through smaller grants, the laboratory's primary focus is on applied research and development that will develop clean coal technologies for rapid deployment in the energy marketplace.¹³⁶ The "Coal and Coal-Biomass to Liquids program effort is focused on technologies to foster the commercial adoption of coal and coal-biomass gasification and the production of affordable liquid fuels and hydrogen with excellent environmental performance."¹³⁷ Its "Gasification Systems Program is developing advanced technologies to reduce the cost and increase the efficiency of producing coal syngas."¹³⁸ NETL was budgeted \$50 million for its coal research and development out of the \$400 million appropriated in fiscal year 2015 to the Office of Fossil Energy's Clean Coal and Carbon Management Research Program.¹³⁹

NETL is also leading the Clean Coal and Carbon Management Research Program,¹⁴⁰ which includes research and development and demonstrations.¹⁴¹ The program cooperates with industrial and academic research on commercial scale cost-effective carbon capture, storage, and efficiency-improvement technologies integrated with coal-fired power generation.¹⁴² There are "more than 400 active projects within the" program's "research and development portfolio", with multi-year investments totaling approximately \$2 billion from the department and \$700 million from the private sector.¹⁴³ The demonstration portfolio includes approximately \$2 billion from the department and multiples of that from the private sector.¹⁴⁴ The fiscal year 2015 program's "research and development budget is \$400 million."¹⁴⁵ The budgetary request for fiscal year 2016 is \$369 million which would be a 7.7 percent reduction from fiscal year 2015.¹⁴⁶

Carbon Capture & Storage Research & Development Program. During the past five fiscal years, the department has been spending close to \$200 million annually on this program.¹⁴⁷ At least 70 percent of the funds were to be "used only to fund projects on coal-based gasification

¹³⁵ Nat'l Energy Tech. Lab., U.S. Dep't of Energy, Coal., <http://www.netl.doe.gov/research/coal> (last visited Oct. 6, 2015).

¹³⁶ *Id.*, Coal Research FAQs, <http://www.netl.doe.gov/research/coal/faqs> (last visited Oct. 6, 2015).

¹³⁷ *Id.*, Coal & Coal-Biomass to Liquids, <http://www.netl.doe.gov/research/coal/energy-systems/fuels/coal-and-biomass-to-liquids> (last visited Oct. 6, 2015).

¹³⁸ *Id.*, Coal Gasification Sys., <http://www.netl.doe.gov/research/coal/energy-systems/gasification> (last visited Oct. 6, 2015).

¹³⁹ *Id.* One of the laboratory's research sites is Pittsburgh. *Id.*,

http://www.netl.doe.gov/File%20Library/Publications/others/NETL_Flyer.pdf (last visited Oct. 14, 2015).

¹⁴⁰ *Id.*, *supra* note 136.

¹⁴¹ *Id.*

¹⁴² *Id.*

¹⁴³ *Id.*

¹⁴⁴ See *id.*

¹⁴⁵ *Id.*

¹⁴⁶ Office of Fossil Energy, U.S. Dep't of Energy, FY 2016 Budget Request 4 (Feb. 2, 2015), available at http://energy.gov/sites/prod/files/2015/02/f19/FY16_budget_rollout%202-2-15.pdf.

¹⁴⁷ 42 U.S.C.A. § 15961(a); Nat'l Coal Council, Fossil Forward (June 23, 2015), available at <http://www.nationalcoalcouncil.org/NCC-Presentations/Fossil-Forward-USEA-June-2015.pdf>. Carbon capture and storage "is the process of capturing and storing or re-using carbon dioxide from coal-fired power plants and industrial sources." Office of Fossil Energy, U.S. Dep't of Energy, *DOE-Sponsored Educ. Ctr. Hosts Int'l Meeting on CCS*, <http://energy.gov/fe/articles/doe-sponsored-education-center-hosts-international-meeting-ccs> (June 30, 2014).

technologies”¹⁴⁸ with financial assistance to projects likely “to improve the competitiveness of coal among various forms of energy”.¹⁴⁹

The University Coal Research Program. Approximately 16 percent of the office's annual research and development “funding goes to academic institutions. Typically between \$2.4 million and \$5 million is available annually” with supplemental funding coming from private companies.¹⁵⁰ Private companies also provide funding to help leverage federal dollars in some of these projects.

Small Business Research. The office participates in the department's Small Business Innovation Research and Small Business Technology Transfer programs, through which “federal agencies with large research and development budgets set aside funding for competitions among small businesses only. Small businesses that win awards in these programs keep the rights to any technology developed and are encouraged to commercialize the technology.”¹⁵¹ The office is managing 68 of these projects valued at \$23 million, which are being conducted in carbon capture and storage, coal and biomass utilization, gasification of coal and biomass, sensors and controls for coal-fired plants and other conventional and unconventional resources.¹⁵²

U.S. Tax Expenditures

Tax expenditures “provide beneficial treatment to taxpayers” in the form of “credits, deductions, deferrals, preferential rates, and exemptions” or exclusions.¹⁵³

Electricity produced from refined and Indian coal. This is a production credit applied per ton, some of which gets phased out or adjusted based on sale price.¹⁵⁴ As recently as fiscal year 2013, this credit was valued at \$40 million.¹⁵⁵

As recently as fiscal year 2013, these two credits were valued at \$180 million; however, some of them have been finally allocated.¹⁵⁶

Qualifying advanced coal project credit. The general business investment credit ranges from 15-30 percent for a qualified investment in the taxable year.¹⁵⁷ The aggregate credits for certified projects is limited to \$2.55 billion.¹⁵⁸

Qualifying gasification project credit. The general business investment credit was 20 percent or 30 percent for a qualified investment in the taxable year.¹⁵⁹ The aggregate credits for certified projects is limited to \$650 million.¹⁶⁰ This

¹⁴⁸ 42 U.S.C.A. § 15962(b)(1)(A).

¹⁴⁹ *Id.* § 15962(d)(2)(B).

¹⁵⁰ Office of Fossil Energy, *supra* note 146, U. Coal Research, <http://energy.gov/fe/science-innovation/clean-coal-research/crosscutting-research/university-coal-research> (last visited Oct. 14, 2015).

¹⁵¹ *Id.*, Small Business Research, <http://www.energy.gov/fe/science-innovation/clean-coal-research/crosscutting-research/small-business-research> (last visited Oct. 16, 2015).

¹⁵² *Id.*

¹⁵³ U.S. Energy Info. Admin., *supra* note 71, at 7-8.

¹⁵⁴ 26 U.S.C.A. § 45.

¹⁵⁵ U.S. Energy Info. Admin., *supra* note 71, at 13-14.

¹⁵⁶ U.S. Energy Info. Admin., *supra* note 71, at 12-13.

¹⁵⁷ 26 U.S.C.A. § 48A(a).

¹⁵⁸ *Id.* § 48A(d)(3)(A).

¹⁵⁹ *Id.* § 48B(a).

¹⁶⁰ *Id.* § 48B(c)(1)(C).

technology converts a product from coal “or other materials which are recovered for their energy or feedstock value into a synthesis gas composed primarily of carbon monoxide and hydrogen for direct use or subsequent chemical or physical conversion.”¹⁶¹

Qualifying advanced energy project credit. This credit for any taxable year equals 30 percent of the qualified investment for such taxable year with respect to a project to produce property designed to capture and sequester carbon dioxide emissions.¹⁶² The total amount of credits allocated under the program were limited to \$2.3 billion¹⁶³ but, as recently as fiscal year 2013, the estimated tax expenditure for coal-related projects was \$1 million.¹⁶⁴

Amortization of pollution control facilities. This deduction is for “the amortizable basis of any certified pollution control facility based on” periods of 60 or 84 months, depending upon when the coal-fired plant was placed in service.¹⁶⁵ As recently as fiscal year 2013, this credit was valued at \$400 million.¹⁶⁶

Special rules for mining and solid waste reclamation and closing costs. Taxpayers are permitted current deductions for future mining reclamation in the amounts that would be incurred if the reclamation costs were performed currently. These amounts are deemed deposited in a sinking fund that earns interest at specified, apparently pre-tax rates. The fund is then used to measure whether the taxpayer has claimed too great a deduction.¹⁶⁷

Allowance of deduction for depletion. The allowance for depletion and for depreciation of improvements as a deduction in computing taxable income for coal mines is 10 percent.¹⁶⁸ Percentage depletion effectively provides a lower rate of tax with respect to coal and lignite.¹⁶⁹

Deduction and recapture of certain mining exploration expenditures. Before the beginning of the developing stage of the mine, expenditures to ascertain the location and quality of any mineral is deductible from taxable income, but this does not apply to expenditures to acquire and improve depreciable property or if the 10 percent coal mine depletion is allowed.¹⁷⁰ The expensing of exploration and development costs relating to coal encourages more investment in coal than would occur under a neutral system.¹⁷¹

Gain or loss in the case of coal. Disposal of domestically mined coal held for more than one year is considered a gain or loss rather than as ordinary income, but the depletion percentage is disallowed if the maximum rate of tax imposed on a net capital gain is less the maximum rate

¹⁶¹ *Id.* § 48B(c)(2). The eligibility for this credit expired as this rep. was about to be published. *Id.* § 48B(d)(2).

¹⁶² *Id.* § 48C.

¹⁶³ *Id.*

¹⁶⁴ U.S. Energy Info. Admin., *supra* note 71, at 14.

¹⁶⁵ 26 U.S.C.A. § 169.

¹⁶⁶ U.S. Energy Info. Admin., *supra* note 71, at 12.

¹⁶⁷ 26 U.S.C.A. § 468.

¹⁶⁸ *Id.* § 613.

¹⁶⁹ U.S. Dep’t of Treasury, *Gen. Explanation of the Admin.’s Fiscal Yr. 2013 Revenue Proposals* 122 (2012), available at <http://www.treasury.gov/resource-center/tax-policy/Documents/General-Explanations-FY2013.pdf>.

¹⁷⁰ 26 U.S.C.A. § 617(a)(1).

¹⁷¹ U.S. Dep’t of Treasury, *supra* note 169, at 120. A neutral system exists when tax policy does not affect taxpayers’ investment decisions.

for ordinary income.¹⁷² Qualified fuels include gas produced from coal seams and synthetic fuels produced from coal.¹⁷³ The capital gain treatment of coal and lignite royalties encourages more investment in their production than would occur under a neutral system.¹⁷⁴ As recently as fiscal year 2013, this credit was valued at \$90 million.¹⁷⁵

Payment of benefits for pneumoconiosis. Benefits payable for disability due to black lung are not “income for purposes of the Internal Revenue Code of 1986.”¹⁷⁶ In fiscal year 2013, this income security tax expenditure was valued at \$30 million.¹⁷⁷

Pennsylvania Industrial Development Authority

The authority “provides low-interest loans and lines of credit through certified economic development organizations . . . for eligible businesses that commit to creating and/or retaining jobs and for the development of industrial parks and multi-tenant facilities.”¹⁷⁸ The funding may be used with other private and public financing.¹⁷⁹ A mining enterprise “involved in the extraction of coal” is an eligible business.¹⁸⁰ Financing for mining enterprises would typically be for machinery and equipment costs.¹⁸¹ The authority may issue bonds to mature within 20 years.¹⁸² Excessive funds in Industrial Development Fund are required to be released and transferred to the treasury’s General Fund.¹⁸³ Income from the bonds is not taxed by the Commonwealth.¹⁸⁴

Sales & Use Tax

The tax of 6 percent of the purchase price is not imposed upon “[t]he sale at retail or use of coal.”¹⁸⁵

Realty Transfer Tax

The State tax of 1 percent “of the value of the real estate” is not imposed upon recording “[l]eases for the production or extraction of coal . . . and assignments thereof.”¹⁸⁶

¹⁷² 26 U.S.C.A. § 631(c).

¹⁷³ *Id.*

¹⁷⁴ U.S. Dep’t of Treasury, *supra* note 169, at 124.

¹⁷⁵ U.S. Energy Info. Admin., *supra* note 71, at 13.

¹⁷⁶ 30 U.S.C.A. § 922(c).

¹⁷⁷ U.S. Energy Info. Admin., *supra* note 71, at 14.

¹⁷⁸ Pa. Ind. Dev. Auth., Program Guidelines 1 (2015), available at http://community.newpa.com/download/programs_and_funding/program_guidelines/PIDA_Guidelines-2015F.pdf.

¹⁷⁹ *Id.*

¹⁸⁰ *Id.* at 2.

¹⁸¹ See *id.* at 3. Unless the useful life of the equipment is a shorter period, the period for repayment may be up to 10 yrs.. *Id.* at 6.

¹⁸² Act of May. 17, (1956) 1955 (P.L.1609, No.537), § 5.1; 73 P.S. § 305.1.

¹⁸³ *Id.* § 8; 73 P.S. § 308.

¹⁸⁴ *Id.* § 10.1; 73 P.S. § 10.1.

¹⁸⁵ Act of Mar. 4, 1971 (P.L.6, No.2), §§ 202, 204(18); 72 P.S. §§ 7202, 7204(18).

¹⁸⁶ *Id.* §§ 1102-C, 1102-C.3(22); 72 P.S. §§ 8102-C, 8102-C.3(22).

Natural Gas

U.S. Department of Energy

The department’s “Natural Gas research program develops technological solutions for the prudent and sustainable development of our unconventional domestic resources.”¹⁸⁷ The budgetary request to research and develop natural gas technologies for fiscal year 2016 is \$44 million, which would be a 75.2 percent increase from fiscal year 2015.¹⁸⁸ This increase would fund collaboration with the Environmental Protection Agency and the U.S. Geological Survey on environmentally prudent development and to detect, reduce, and quantify methane emissions from the infrastructure and value chain.¹⁸⁹ There is also collaborative research and development to advance scientific understanding of gas hydrates and develop technology to safely and efficiently recover natural gas from the naturally occurring combination of natural gas and water.¹⁹⁰

Gas Hydrate Production Incentive

The U.S. Department of the Interior is authorized to grant royalty relief for natural gas produced from gas hydrate resources under an eligible lease under the Outer Continental Shelf Lands Act or a lease issued for onshore federal lands in Alaska if issued prior to 2016 with production commencing prior to 2018.¹⁹¹

U.S. Tax Expenditures

Tax expenditures “provide beneficial treatment to taxpayers” in the form of “credits, deductions, deferrals, preferential rates, and exemptions” or exclusions.¹⁹²

Amortization of geological and geophysical expenditures. Any geological and geophysical expenses paid or incurred to explore or develop gas within the United States is allowed as a deduction ratably over the 24-month period beginning on the date paid or incurred.¹⁹³

Accelerated cost recovery system. The depreciation deduction allowed for the exhaustion, and wear and tear of property used in business, or held for the production of income is accelerated to periods of either seven or 15 years, depending upon whether it is an Alaskan natural gas pipeline or a natural gas gathering or distribution line, and its dates of usage and placement in service.¹⁹⁴ As recently as fiscal year 2013, the estimated tax expenditure for natural gas distribution pipelines was \$100 million.¹⁹⁵

¹⁸⁷ Energy.gov, *DOE's Shale Gas & Hydraulic Fracturing Research*, <http://www.energy.gov/fe/articles/does-shale-gas-and-hydraulic-fracturing-research> (Apr. 26, 2013).

¹⁸⁸ Office of Fossil Energy, U.S. Dep’t of Energy, FY 2016 Budget Request 4 (Feb. 2, 2015), available at http://energy.gov/sites/prod/files/2015/02/f19/FY16_budget_rollout%202-2-15.pdf.

¹⁸⁹ *Id.* at 13.

¹⁹⁰ Nat'l Energy Tech. Lab., U.S. Dep’t of Energy, Gas Hydrates R&D Program, <http://www.netl.doe.gov/File%20Library/Research/Oil-Gas/Prog099.pdf> (2015).

¹⁹¹ 42 U.S.C.A. § 15909.

¹⁹² U.S. Energy Info. Admin., *supra* note 71, at 7-8.

¹⁹³ 26 U.S.C.A. § 167(h). As recently as fiscal year 2013, the estimated tax expenditure for this depreciation was \$100,000,000, but this amount includes oil. U.S. Energy Info. Admin., *supra* note 71, at 21.

¹⁹⁴ 26 U.S.C.A. § 168.

¹⁹⁵ U.S. Energy Info. Admin., *supra* note 71, at 21.

Income attributable to domestic production activities. A deduction of 9 percent of the lesser of the qualified production activities income of the taxpayer or taxable income for the taxable year is allowed to take into account the gross receipts of the disposition but not distribution of natural gas.¹⁹⁶

Capital expenditures. Intangible drilling and development costs for gas wells may be deducted as expenses rather than depreciated from capital over time.¹⁹⁷

Passive activity losses & credits for working interests in gas property. Passive activity excludes any working interest in any gas property which the taxpayer holds directly or through an entity that does not limit the liability of the taxpayer for that interest.¹⁹⁸ If a taxpayer has any loss for any taxable year from a working interest in any gas property that is treated as a loss which is not from a passive activity, then any net income from the property for any succeeding taxable year is treated as income of the taxpayer that is not from a passive activity to the extent the amount of the credits does not exceed the regular tax liability of the taxpayer for the taxable year that is allocable to net income.¹⁹⁹ In other words, owners of working interests can offset losses from passive activities against active income instead of carrying them forward to apply against passive income in succeeding years.

Allowance of deduction for depletion. Gas wells are allowed a regulated deduction in computing taxable income reasonably allowing “for depletion and for depreciation of improvements, according to the peculiar conditions in each case”.²⁰⁰ The allowance for depletion ranges from 10-22 percent of the gross income from the property excluding any rents or royalties paid or incurred by the taxpayer in respect of the property.²⁰¹

Pennsylvania Alternative Energy Capital Investment Program

Department of Transportation “is authorized to establish a competitive grant program to implement capital improvements deemed necessary to support conversion of a local transportation organization's fleet for use of an alternative energy source, including compressed natural gas.”²⁰² Criteria to award grants would minimally include “feasibility, cost/benefit analysis and project readiness.”²⁰³ The amount of money for this program is limited to \$60 million from Public Transportation Trust Fund.²⁰⁴

¹⁹⁶ 26 U.S.C.A. § 199.

¹⁹⁷ *Id.* § 263(c). As recently as fiscal year 2013, the estimated tax expenditure for this deduction was \$550,000,000, but this amount includes oil wells. U.S. Energy Info. Admin., *supra* note 71, at 20.

¹⁹⁸ 26 U.S.C.A. § 469(c)(3).

¹⁹⁹ *Id.* As recently as fiscal year 2013, the estimated tax expenditure for this credit was \$20,000,000, but this amount includes oil property. U.S. Energy Info. Admin., *supra* note 71, at 21.

²⁰⁰ 26 U.S.C.A. § 611(a).

²⁰¹ *Id.* § 613A. The allowance may not exceed 100% of the taxpayer's taxable income from the property. *Id.* § 613(a). A 100% limit could offset the entire net income so that no tax would be owed.

²⁰² 74 Pa.C.S. § 1517.1(a)

²⁰³ *Id.* § 1517.1(b). This was enacted to further “the Commonwealth's energy policy, which includes becoming independent from overreliance on foreign energy sources,” by establishing a program “to promote reliance on or conversion to alternative energy sources, including the vast natural gas supply” here. Act of Nov. 25, 2013 (P.L.974, No.89), preamble.

²⁰⁴ 74 Pa.C.S.A. § 1506(e)(5).

Resource Manufacturing Tax Credit

For the period after 2016 and before 2043, the tax credit is 5¢ “per gallon of ethane purchased and used in manufacturing ethylene in this Commonwealth by a qualified taxpayer.”²⁰⁵ Ethylene “is derived from natural gas and petroleum.”²⁰⁶ The credit is applicable “up to 20% of the qualified taxpayer’s qualified tax liabilities incurred in the taxable year for which the credit was approved”, but a granted tax credit makes that qualified taxpayer “ineligible for any other tax credit provided under” the Tax Reform Code of 1971.²⁰⁷

Keystone Opportunity Zone, Keystone Opportunity Expansion Zone & Keystone Opportunity Improvement Zone Act

Personal Income Tax. A person located in a designated subzone is allowed an exemption from the tax imposed by Article III of the Tax Reform Code of 1971 for several classes of income.²⁰⁸ The exemption applies to pass-through entities for net income from the operation of a qualified business received by a resident or nonresident of a subzone attributable to business activity conducted within a subzone, net gains or income derived from the sale, exchange or other disposition of real or tangible personal property located in a subzone and net gains or income derived from rents received by a person to the extent that income or loss from the rental of real or tangible personal property is allocable to a subzone.²⁰⁹

Corporate Net Income Tax. A pipeline or natural gas company that is a qualified business engaged in manufacturing or processing may claim a credit against and up to the tax imposed by Article IV of the Tax Reform Code of 1971 for tax liability attributable to business activity conducted within an applicable subzone in the taxable year.²¹⁰

Capital Stock Franchise Tax. A pipeline or natural gas company that is a qualified business engaged in manufacturing or processing may claim a credit against and up to the tax imposed by Article VI of the Tax Reform Code of 1971 for tax liability attributable to the capital employed within an applicable subzone in the taxable year.²¹¹

Job Tax Credit. A pipeline or natural gas company that is required to apportion income in accordance with Tax Reform Code of 1971 and is a qualified business may apply to the Department of Revenue for a job creation tax credit against the personal income, corporate net income or capital stock—franchise taxes imposed by the code for all full-time jobs created within an applicable subzone.²¹² For tax year 2015 and through 2018, the tax credit is \$1,250 per job; however, the allowable credit is limited to 50 percent of the tax liability of the qualified business and the department is limited to approving a total \$1 million of these credits in a given year.²¹³

²⁰⁵ Act of Mar. 4, 1971 (P.L.6, No.2), § 1703-G(a); 72 P.S. § 8703-G(a); act of July 2, 2012 (P.L.751, No.85), § 30(6).

²⁰⁶ *Id.* § 1702-G; 72 P.S. § 8704-G.

²⁰⁷ *Id.* § 1704-G; 72 P.S. § 8702-G;

²⁰⁸ Act of Oct. 6, 1998 (P.L.705, No.92), § 512; 73 P.S. § 820.512.

²⁰⁹ *Id.* The exemption may not be carried back or forward from yr. to yr. & is inapplicable to a pipeline or nat. gas co. that would qualify as a regulated investment co. under Art. IV or as a holding co. under Art. VI of the Tax Reform Code of 1971. *Id.*

²¹⁰ *Id.* § 515; 73 P.S. § 820.515.

²¹¹ *Id.* § 516; 73 P.S. § 820.516.

²¹² *Id.* § 519; 73 P.S. § 820.519. This tax credit is unavailable for a job created in a subzone resultant from a business relocating from elsewhere in the Commonwealth. *Id.*

²¹³ *Id.* If too much is approved, the approval would be *pro rata*. *Id.*

Realty Transfer Tax

The State tax of 1 percent “of the value of the real estate” is not imposed upon recording “[l]eases for the production or extraction of natural gas and assignments thereof.”²¹⁴

Sales & Use Tax

The tax of 6 percent of the purchase price is not imposed upon “[t]he sale at retail or use of natural and manufactured and bottled gas when purchased directly by the user for his own residential use”.²¹⁵

Strategic Development Area Job Tax Credit

A pipeline or natural gas company that is required to apportion income and is a qualified business may apply to the Department of Revenue for a strategic development area job creation tax credit against the personal income, corporate net income or capital stock-franchise tax for all full-time jobs created within a strategic development area in the taxable year.²¹⁶ The credit is \$1,250 per job but may not exceed half the tax liability and may not be carried back nor forward.²¹⁷ The department is limited to allocating \$1 million annually for this credit.²¹⁸

Pennsylvania Economic Development Financing Authority Tax Exempt Bond Program

Facilities furnishing gas locally are eligible for tax-exempt financing.²¹⁹ The minimum amount of a loan is \$400,000.²²⁰ Since 1989, rates have averaged 46 percent of the prime interest rate.²²¹

Nuclear

U.S. Department of Energy

Office of Nuclear Energy. The office primarily advances “nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate.”²²² Its research objectives include:²²³

²¹⁴ Act of Mar. 4, 1971 (P.L.6, No.2), §§ 1102-C, 1102-C.3(22); 72 P.S. §§ 8102-C, 8102-C.3(22).

²¹⁵ *Id.* §§ 202, 204(5); 72 P.S. §§ 7202, 7204(18).

²¹⁶ *Id.* § 2939-C; 72 P.S. § 9939-C.

²¹⁷ *Id.*

²¹⁸ *Id.*

²¹⁹ Pa. Dep’t of Community & Econ. Dev., Pa. Econ. Dev. Fin. Auth. Bond Financing 1 (2009), available at http://community.newpa.com/download/programs_and_funding/program_guidelines/PEDFA_Bond_Financing_guidelines-09.pdf.

²²⁰ *Id.* at 3.

²²¹ Pa. Dep’t of Community & Econ. Dev., Pa. Econ. Dev. Fin. Auth. Tax Exempt Bond Program, <http://community.newpa.com/programs/pennsylvania-economic-development-financing-authority-pedfa-tax-exempt-bond-program/> (last visited Nov. 6, 2015).

²²² Energy.gov, Mission, <http://www.energy.gov/ne/mission> (last visited Nov. 10, 2015).

²²³ *Id.*

- Development of technologies and other solutions that can improve the reliability, sustain the safety, and extend the life of current reactors.
- Development of improvements in the affordability of new reactors to enable nuclear energy to help meet the Administration’s energy security and climate change goals.
- Development of sustainable fuel cycles.

The Office “has a diversified portfolio of research and development programs” and allocates funding for research and development to “national laboratories, universities, and industry in support of” its “mission”.²²⁴ The Idaho National Laboratory “leads research, development and demonstration projects to help the nation maintain and expand its use of nuclear energy.”²²⁵

Loan guarantee. Loan guarantees of up to 80 percent of the project cost of advanced nuclear energy facilities are available from U.S. Department of Energy.²²⁶ There must be a reasonable prospect of repayment and the obligation may not be subordinate to other financing.²²⁷ Repayment is due within the shorter time frame of 30 years or 90 percent of the projected useful life of the financed asset.²²⁸ Administrative expenses for the guarantees are covered by fees collected by the department.²²⁹ The projects “must avoid air pollutants and employ new or significantly improved technologies”.²³⁰ “Under this Solicitation” the department “will make available up to \$12.5 billion in loan guarantee authority”,²³¹ but the total principal amount of a guaranteed loan is limited to \$4 billion.²³² Criteria used to evaluate in application include, among others:²³³

1. The necessity of the federal loan guarantee
2. Appropriateness of the project site
3. Level of departmental review under National Environmental Policy Act
4. Whether the guaranteed obligation is expected to be senior-secured debt
5. Best use of the guarantee
6. The project sponsor’s experience in the development of these projects
7. Extent of partial guarantees and co-lenders

Next Generation Nuclear Plant Project. This U.S. Department of Energy project is designed to construct and operate a prototype plant including a nuclear reactor to generate electricity, produce hydrogen, or both.²³⁴ The department’s Office of Nuclear Energy, Science and Technology is managing this project with the Idaho National Laboratory as the lead

²²⁴ *Id.*, Fuel Cycle Research & Development, <http://www.energy.gov/ne/fuel-cycle-technologies/fuel-cycle-research-development> (last visited Nov. 10, 2015).

²²⁵ Idaho Nat’l Lab., INL Research Areas, <https://www.inl.gov/research-programs/> (last visited Nov. 10, 2015).

²²⁶ 42 U.S.C.A. §§ 16512(c), 16513(b)(4).

²²⁷ *Id.* § 16512(d).

²²⁸ *Id.* § 16512(f).

²²⁹ *Id.* § 16512(h)(1).

²³⁰ *Id.* § 16513(a).

²³¹ Loan Programs Office, U.S. Dep’t of Energy, Fed. Loan Guarantees for Advanced Nuclear Energy Projects 1 (updated Apr. 22, 2015), *available at* http://energy.gov/sites/prod/files/2015/05/f22/Advanced-Nuclear-Energy-Projects-Loan-Guarantee-Solicitation_COMPLETE_22....pdf. “Of that amount, \$2,000,000,000 is available exclusively for advanced nuclear facilities for the ‘front-end’ of the nuclear fuel cycle. The remaining \$10,500,000,000 is available for nuclear power facilities.” *Id.* at 2.

²³² 42 U.S.C.A. § 16515(a).

²³³ Loan Programs Office, *supra* note 231, at 8. More detailed evaluation criteria for the program, technology & fins. appear in 10 C.F.R. § 609.7.

²³⁴ 42 U.S.C.A. § 16021.

laboratory.²³⁵ The project's cost is shared with a consortium of appropriate industrial partners, and the plant will be sited in Idaho.²³⁶ The project is targeted to be completed in 2021 with \$1.25 billion being appropriated for research and construction during the initial decade concluding with fiscal year 2015 and the necessary amounts for the succeeding fiscal years.²³⁷

Nuclear Energy University Programs. Graduate fellowships are funded as part of the department's "ongoing commitment to educating the next generation of nuclear scientists and engineers. Fellowship recipients receive up to \$155,000 over 3 years to help pay for their graduate studies and research."²³⁸ Scholarships are awarded to undergraduate students for one year in the amount of \$5,000 to bolster "the number of students earning degrees in nuclear science and engineering and related fields."²³⁹

Nuclear Fuels Storage & Transportation Planning Project. The Project "has initiated activities to prepare for the large-scale transportation of used fuel to one or more" interim storage facilities.²⁴⁰ It "is engaging with state regional groups, other governmental organizations, and Native American tribal members to complete the procedures for: providing funding and technical assistance pursuant to the Nuclear Waste Policy Act of 1982 for public safety and emergency preparedness programs; routing and communications; and the development of preliminary routes for shipments of used nuclear fuel."²⁴¹

U.S. Tax Expenditures

Tax expenditures "provide beneficial treatment to taxpayers" in the form of "credits, deductions, deferrals, preferential rates, and exemptions" or exclusions.²⁴²

Special rules for nuclear decommissioning costs. Payments made by the taxpayer to a Nuclear Decommissioning Reserve Fund are allowed as a deduction (along with the nuclear decommissioning costs with respect to which economic performance occur) during the taxable year; however, some of the amount distributed from the fund would be included in the gross income of the taxpayer for that taxable year and the gross income of the fund itself is taxed 20 percent annually.²⁴³ As recently as fiscal year 2013, this deduction was valued at \$1.1 billion.²⁴⁴

²³⁵ *Id.* § 16022.

²³⁶ *Id.*

²³⁷ *Id.* § 16025.

²³⁸ Nuclear Energy Univ. Program, U.S. Dep't of Educ., Fellowships, https://neup.inl.gov/Shared%20Documents/FY12_S%20and%20F_Factsheet.pdf (last visited Nov. 10, 2015).

²³⁹ *Id.*, Scholarships, https://neup.inl.gov/Shared%20Documents/FY12_Scholarship_Factsheet.pdf (last visited Nov. 10, 2015).

²⁴⁰ Energy.gov, Nuclear Fuels Storage & Transportation Planning Project, <http://www.energy.gov/ne/fuel-cycle-technologies/nuclear-fuels-storage-transportation-planning-project> (last visited Nov. 10, 2015).

²⁴¹ *Id.*

²⁴² U.S. Energy Info. Admin., *supra* note 71, at 7-8.

²⁴³ 26 U.S.C.A. § 468A.

²⁴⁴ U.S. Energy Info. Admin., *supra* note 71, at 22.

Oil

Petroleum Reserves

Strategic Petroleum. This is a supply of crude oil for emergency usage due to a severe energy supply interruption for a significant duration that would adversely impact the national economy or safety.²⁴⁵ The budgetary request for fiscal year 2016 was \$257 million, which would be a 28 and one-half percent increase from fiscal year 2015.²⁴⁶

Northeast Home Heating Oil. This is a supply of ultra-low sulfur distillate “for homes and businesses in the northeastern United States should a disruption in supplies occur.”²⁴⁷ The product could be sold if the energy supply is severely disrupted because the price differential between No. 2 heating and crude oil highly increased above a five-year rolling average during the heating season or there is a regional supply shortage of significant scope and duration.²⁴⁸ The budgetary request for fiscal year 2016 was \$7.6 million, which would be the same amount from fiscal year 2015.²⁴⁹

Gasoline. This reserve makes the energy infrastructure more secure and resilient by strengthening regional fuel resiliency in the northeastern United States.²⁵⁰

Limits on Liability

The total liability of each responsible party for a vessel or a facility from which oil is discharged upon navigable waters or adjoining shorelines is limited for the removal costs and damages for each incident.²⁵¹ The limitation for vessels ranges from \$950 per gross ton or \$800,000 to \$3,000 per gross ton or \$22 million.²⁵² The limitation for facilities and deep water ports are \$75 million and \$350 million, but the limitations can be adjusted regulatorily and they do not apply for gross negligence, willful misconduct and the violation of an applicable federal operational regulation.²⁵³

U.S. Tax Expenditures

Tax expenditures “provide beneficial treatment to taxpayers” in the form of “credits, deductions, deferrals, preferential rates, and exemptions” or exclusions.²⁵⁴

²⁴⁵ Energy.gov, Strategic Petroleum Reserve, <http://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve> (last visited Nov. 13, 2015).

²⁴⁶ Office of Fossil Energy, U.S. Dep’t of Energy, FY 2016 Budget Request 4 (Feb. 2, 2015), *available at* http://energy.gov/sites/prod/files/2015/02/f19/FY16_budget_rollout%202-2-15.pdf.

²⁴⁷ Energy.gov, Heating Oil Reserve, <http://energy.gov/fe/services/petroleum-reserves/heating-oil-reserve> (last visited Nov. 18, 2015).

²⁴⁸ *Id.*, Northeast Home Heating Oil Reserve—Guidelines for Release, <http://energy.gov/fe/services/petroleum-reserves/heating-oil-reserve/northeast-home-heating-oil-reserve-guidelines> (last visited Nov. 18, 2015).

²⁴⁹ Office of Fossil Energy, U.S. Dep’t of Energy, FY 2016 Budget Request 4 (Feb. 2, 2015), *available at* http://energy.gov/sites/prod/files/2015/02/f19/FY16_budget_rollout%202-2-15.pdf.

²⁵⁰ *Id.*, Northeast Gasoline Supply Reserve, <http://energy.gov/fe/services/petroleum-reserves/northeast-regional-refined-petroleum-product-reserve> (last visited Nov. 18, 2015).

²⁵¹ 33 U.S.C.A. § 2704.

²⁵² *Id.*

²⁵³ *Id.*

²⁵⁴ U.S. Energy Info. Admin., *supra* note 71, at 7-8.

Amortization of geological and geophysical expenditures. Any geological and geophysical expenses paid or incurred to explore or develop oil within the United States is allowed to major integrated oil companies as a deduction ratably over the 7-year period beginning on the date paid or incurred.²⁵⁵

Income attributable to domestic production activities. For oil related qualified production activities income, a 6 percent deduction of the lesser of the qualified production activities income of the taxpayer or taxable income for the taxable year is allowed.²⁵⁶

Capital expenditures. Intangible drilling and development costs for oil wells may be deducted as expenses rather than depreciated from capital over time.²⁵⁷

Passive activity losses & credits for working interests in gas property. Passive activity excludes any working interest in any oil property which the taxpayer holds directly or through an entity that does not limit the liability of the taxpayer for that interest.²⁵⁸ If a taxpayer has any loss for any taxable year from a working interest in any oil property that is treated as a loss which is not from a passive activity, then any net income from the property for any succeeding taxable year is treated as income of the taxpayer that is not from a passive activity to the extent the amount of the credits does not exceed the regular tax liability of the taxpayer for the taxable year that is allocable to net income.²⁵⁹ In other words, owners of working interests can offset losses from passive activities against active income instead of carrying them forward to apply against passive income in succeeding years.

Allowance of deduction for depletion. Oil wells are allowed a regulated deduction in computing taxable income reasonably allowing “for depletion and for depreciation of improvements, according to the peculiar conditions in each case”.²⁶⁰

Pennsylvania Sales & Use Tax

The tax of 6 percent of the purchase price is not imposed upon “[t]he sale at retail or use of . . . fuel oil when purchased directly by the user thereof solely for his own residential use” and “gasoline and other motor fuels”.²⁶¹

²⁵⁵ 26 U.S.C.A. § 167(h). As recently as fiscal year 2013, the estimated tax expenditure for this depreciation was \$100,000,000, but this amount includes natural gas. U.S. Energy Info. Admin., *supra* note 71, at 21.

²⁵⁶ 26 U.S.C.A. § 199(d)(9).

²⁵⁷ *Id.* § 263(c). As recently as fiscal year 2013, the estimated tax expenditure for this deduction was \$550,000,000, but this amount includes natural gas wells. U.S. Energy Info. Admin., *supra* note 71, at 20.

²⁵⁸ 26 U.S.C.A. § 469(c)(3).

²⁵⁹ *Id.* As recently as fiscal year 2013, the estimated tax expenditure for this credit was \$20,000,000, but this amount includes natural gas property. U.S. Energy Info. Admin., *supra* note 71, at 21.

²⁶⁰ 26 U.S.C.A. § 611(a).

²⁶¹ Act of Mar. 4, 1971 (P.L.6, No.2), §§ 202, 204(5), (11); 72 P.S. §§ 7202, 7204(5), (11).

IMPRINT ON ACREAGE AND WILDLIFE

Despite their many differences in cost, efficiency, and environmental impacts, all forms of energy require the use of land during their production. As Pennsylvania continues to develop land across the state, the amount of land dedicated to power production may have to be carefully considered and weighed against other uses such as human habitation or forest preservation. Comparing energy sources based on land use is difficult because each power source requires varying levels of land for resource extraction, siting power plants, and transmission of energy. Because the amount of land associated with a power source alone is not necessarily a good indicator of environmental impact, information on how each power source interacts with its surroundings and the native wildlife of the area are important factors to consider as well.

Environmental impacts can occur at various stages in the development and production of energy. The land in and around a production site, as well as the native wildlife of the area, may experience negative impacts during the construction and site development stage, during operations, during potential malfunctions and after decommissioning the site.

Acreage Imprint

During the construction of any energy facility, excavation and clearing are the primary land impacts. Erosion, loss of topsoil, subsidence and deforestation are all potential direct effects of any energy facility construction project. Noise and air pollution are likely. Depending on the type of energy involved, waterway diversion, reservoir construction and other riparian alterations may occur. Direct, permanent impacts include land physically occupied by infrastructure such as physical plant, access roads, substations, and service buildings.

The table on the next page characterizes the impact and sustainability of seven different energy sources and estimates their leveled cost of energy.²⁶² The table is based on the impact for each energy source to produce one terawatt-hour of energy, which is equivalent to producing one million megawatts for a single hour. The land use column includes the footprint of generating the power and the land to mine the fuel; it excludes the footprint of waste disposal, which would inflate the size of land impacted for coal, nuclear and biomass. Safety is the probability of a fatal accident occurring at each type of energy facility; it excludes chronic health problems associated with energy production.

The amount of emissions generated is calculated by the amount of carbon dioxide produced by each energy source for the entire life cycle of the technology. While coal and biomass are both documented as the only fuels producing solid waste, there is no mention on the amount of water waste created. Unlike solid waste, the table does not provide a numerical value for the amount of radioactive or toxic waste produced by each energy source, but a ranking for the radiotoxic volume is listed. After evaluating these and other factors, nuclear, natural gas, wind, and hydropower were

²⁶² Levelized cost is the cost of building and operating a generating plant over the financial life cycle of a plant.

the most sustainable and cost effective energy sources, while coal and biomass were noted as scoring the lowest. (See Table 6.)

Table 6
Impact and Sustainability of
Seven Energy Sources per terawatt-hour²⁶³
2015

Energy Source	Emissions (ton CO ₂)	Electricity Cost (US Dollar)	Land Use (km ²)	Safety (fatalities)	Solid Waste (ton)	Radiotoxic Waste Volume
Coal	1,001,000	\$ 100.10	2.1	161	58,600	mid
Natural Gas	469,000	\$ 65.60	1.1	4	NA	low
Nuclear	16,000	\$ 108.40	0.1	0.04	NA	high
Biomass	18,000	\$ 111.00	95	12	9170	low
Hydro	4,000	\$ 90.30	50	1.4	NA	trace
Wind	12,000	\$ 86.60	46	0.15	NA	trace
Solar	46,000	\$ 144.30	5.7	0.44	NA	trace

Wind Turbines

One of the difficulties in gauging the effect of wind energy facilities on land use is separating human perception of turbine size from how much land one actually uses. Part of the reason turbines appear to take up large amounts of land is attributable to the height of the turbines. The common 1.5 megawatt model can extend beyond 328 feet and its blades sweep through an acre of airspace surrounding the turbine.²⁶⁴ Compounded by wind farms' common placement on mountain ridges in Pennsylvania, this height ensures that they are highly visible from a long distance. The spacing between each wind turbine also contributes to how wind turbines may be perceived as taking up more land than they really are, since many wind developers place seven blade diameters of space, or roughly 2100 feet between each turbine.²⁶⁵ Including the foundation, the ground space taken up by the larger 5MW wind turbines is between 42 and 65 square feet.²⁶⁶ Despite the striking profile of wind turbines, most of the environmental footprint left by wind farms is the result of new road development, rather than the concrete turbine pads and supporting electrical equipment or transmission paths.²⁶⁷

²⁶³ Barry W. Brook & Corey J. A. Bradshaw, *Key Role for Nuclear Energy in Global Biodiversity Conservation*, 29 Conservation Biology 702, 707 (2015), available at <http://onlinelibrary.wiley.com/doi/10.1111/cobi.12433/epdf>.

²⁶⁴ The Wind Power, http://www.thewindpower.net/turbine_en_54_ge-energy_1.5s.php (last visited Nov. 21, 2015).

²⁶⁵ Sci. Daily, *Better Turbine Spacing for Large Wind Farms*, www.sciencedaily.com/releases/2011/01/110120111332.htm (Feb. 7, 2011).

²⁶⁶ Mark Z. Jacobson, *Rev. of Solution to Global Warming, Air Pollution, & Energy Sec.*, 2 Energy & Envtl. Sci. 148, 161 (2009), available at <https://web.stanford.edu/group/efmh/jacobson/Articles/I/ReviewSolGW09.pdf>.

²⁶⁷ *Id.* Recently, a found. was dug in Kan. for a wind turbine approximately 300 feet high. The found. is 50 feet in diameter and 10 feet deep for 420 square yards of concrete with 40 tons of rebar and a 5-ton steel cage with bolts 5-feet long held in the concrete to be attached to the base of the turbine. Paul Kessinger, *Wind Farm Progresses*, Marysville Advocate, http://www.marysvilleonline.net/news/article_15f95ea3-bb46-5580-b359-818715a946b3.html (Oct. 7, 2015).

In forested areas, there are additional land impacts where a clearing is made around each turbine. The average permanent direct impact value reported was 0.74 acre per megawatt, while temporary disturbances contributed about 1.73 acre per megawatt of installed capacity.²⁶⁸ Combining these figures provides an average total direct impact area of 2.47 acres per megawatt of installed capacity; however, the size of individual wind projects may vary significantly. The difference between total land associated with a wind project and the direct impact demonstrate that land use can be quantified in very different ways depending on what is being measured.

A relatively recent study on land requirements of modern wind turbines included data from and analysis of 172 wind projects across the United States to gauge accurate estimates of land use at wind energy facilities.²⁶⁹ The study analyzed land by directly impacted land figures, which contain both temporary and permanent land disturbances.²⁷⁰ It was noted that total land area associated with the project might be as high as 86¼ acres per megawatt of installed capacity, but that much of this land is unlikely to be disturbed.²⁷¹

“According to the American Wind Energy Association, wind projects on ridgelines can require as little as 2 acres per megawatt.”²⁷² While estimates of land use vary, researchers viewed 319 wind turbines to estimate that the amount of land disturbed averaged 1.9 acres per turbine in a forested setting.²⁷³ Using an approximation of the megawatt capacity from wind farms in Pennsylvania²⁷⁴ and the estimate of land disturbed by a turbine in a forested setting, the amount of land directly disturbed here by wind turbines and related infrastructure can be estimated at 2,669 acres. As much as 115,101 acres of land may be associated with wind energy facilities.

The only clearing of land for a wind farm is whatever is required to access the site to install and maintain the turbines. During the construction of a wind energy project, excavation and clearing are the primary land impacts. Either permanently or temporarily, approximately 90% of the direct impact area is for access roads and the turbine foundations (or the staging areas during construction, which are left to regrow over time).²⁷⁵ Fields or grasslands cleared during wind farm construction would require 2-3 years to return to their original conditions while other environments, such as forested areas, would take decades to recover. Little data currently exists on the average amount of forest cleared during turbine installation or how wildlife in the vicinity of a wind farm is impacted from construction noise and activity.²⁷⁶

While soil erosion can result from improperly installed or poorly landscaped wind farms, the damage to the land used for wind energy projects is minimal, with no solid wastes or fuel

²⁶⁸ Paul Denholm *et al.*, *Land-Use Requirements of Modern Wind Power Plants in the U.S.* 10 (2009), available at <http://www.nrel.gov/docs/fy09osti/45834.pdf>.

²⁶⁹ *Id.* at 1.

²⁷⁰ *Id.* at 2-3.

²⁷¹ *Id.* at 10.

²⁷² Mass. Exec. Office of Energy & Envtl. Affairs, Wind Energy: Facts, <http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/wind/wind-energy-facts.html#p> (2015). This would refer to the direct impact area.

²⁷³ Nels Johnson, *Pa. Energy Impacts Assessment* 32-33 (2010), available at http://www.nature.org/media/pa/tnc_energy_analysis.pdf. Approximately 74% of this area is for the turbine pad with the remaining 26% cleared for the associated infrastructure. *Id.* at 33. The indirect impact is estimated to be another 13.4 acres of fragmented forests changing wildlife habitat. *Id.* In other words, this assessment indicates that the area for the well pad & associated infrastructure needs to be increased more than seven-fold to assess the impact on forested habitat.

²⁷⁴ Pennfuture, Energy, <http://www.pennfuture.org/content.aspx?SectionID=192> (last visited Sept. 5, 2015).

²⁷⁵ Denholm *et al.*, *supra* note 268, at 13.

²⁷⁶ Nat'l Research Council of the Nat'l Acads., *Envtl. Impacts of Wind Energy Projects* 103-22 (2007), available at <http://www.nap.edu/catalog/11935/environmental-impacts-of-wind-energy-projects>.

residues remaining behind after a turbine is decommissioned.²⁷⁷ Land nearby wind energy projects can be left open or reused for other purposes such as the grazing of cattle, forestry, or agriculture. Wind farms also provide a source of income for land owners in the form of lease payments or royalties.²⁷⁸

Natural Gas

Extraction of previously unreachable stores of natural gas located within Pennsylvania's Marcellus shale rock formation have become accessible in the last decade due to advances in horizontal drilling technology combined with hydraulic fracturing. Fracking involves pumping large amounts of water mixed with sand and other fluids into the shale formation under high pressure to fracture the rock, releasing natural gas which is collected near the surface.²⁷⁹ Pennsylvania's recent access to large pockets of natural gas has proliferated its use as an affordable and efficient energy source. Our Commonwealth has approximately 7,788 active Marcellus shale gas wells, primarily located in the throughout the northeastern and southwestern regions of the state.²⁸⁰

As with other energy sources, natural gas development involves extensive earth disturbance to create the infrastructure needed for extraction. Land is mainly used for access roads, drilling pads and pipelines. During the construction of a drilling pad, trees from the site are cleared and the ground is leveled.²⁸¹ Noise from the site and traffic disruptions from trucks transporting fracking fluid are potential irritants to nearby residents. During the pre-production stages of a multi-well pad, there were an estimated 500-1,500 days of industry activity, with high noise levels occurring intermittently.²⁸² Operation of drills can produce air pollution in the form of dust particles that disturb nearby animals, people, and water sources. Depending on the equipment involved, the earth in the area can become severely compacted and may have reduced ability to support plant life in the future.²⁸³

While the occurrence of erosion, loss of soil productivity and landslides are possible consequences of natural gas development, these effects can be limited through the use of best management practices in the form of preventative measures at a well site. Erosion and sediment control requirements under state law apply to any earth disturbance associated gas activities under Pennsylvania Code.²⁸⁴ Gas operators proposing earth disturbance activities must develop and implement a written Erosion and Sediment Control Plan when earth disturbance activities will

²⁷⁷ U.S. Envtl. Prot. Agency, *Land Resource Use*, <http://www.epa.gov/cleanenergy/energy-and-you/affect/land-resource.html> (last updated Sept. 25, 2013).

²⁷⁸ Mass. Exec. Office of Energy & Envtl. Affairs, *supra* note 272.

²⁷⁹ U.S. Energy Info. Admin., Dep't of Energy, Nat. Gas Explained, http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_environment (last reviewed Nov. 4, 2014). The large amount of water used may affect other usage and habitats. *Id.* Mismanaged fluids can contaminate surrounding areas. *Id.* Wastewater must be treated prior to disposal or reuse. *Id.* Injection of wastewater underground causes earthquakes and nat. gas can leak from these sites. *Id.*

²⁸⁰ StateImpact Pa., Shale Play, <http://stateimpact.npr.org/pennsylvania/drilling/> (last visited Nov. 22, 2015).

²⁸¹ U.S. Energy Info. Admin., *supra* note 279.

²⁸² SHIP, The Basics—Operations, <http://www.shale-gas-information-platform.org/categories/operations/the-basics.html> (last visited Sept. 8, 2015). A multi-well pad is almost twice the size of a soccer field and can be reduced to almost the size of a soccer field when partially reclaimed. *Id.*

²⁸³ U.S. Envtl. Prot. Agency, Nat. Gas (Oct. 8, 2012-Sept. 15, 2015), <https://web.archive.org/web/20150915164453/http://epa.gov/cleanenergy/energy-and-you/affect/natural-gas.html> (accessed in the Internet Archive).

²⁸⁴ 25 Pa. Code § 102.5(c).

result in total earth disturbance of 5,000 square feet or more or if the earth disturbance activity has the potential to discharge into water classified as high quality or exceptional value water.²⁸⁵

When a drilling pad is built, a 3.5 to 7 acre area is covered with a layer of crushed limestone that provides a stable surface to support drilling equipment and infrastructure.²⁸⁶ While estimates of land use vary, researchers viewed 242 Marcellus well pads to estimate that the amount of land disturbed averaged 8.8 acres per well pad in a forested setting.²⁸⁷ Using these figures and data on unconventional, operator well pads in the state, the direct impact of shale gas wells and infrastructure in Pennsylvania can be estimated at 32,067 acres.²⁸⁸ Additional land associated with the natural gas industry is attributable to power plants though figures on the size or number of natural gas fired power plants were not located, but the average footprint for one is estimated to be between 20 and 40 acres.²⁸⁹

Development permits granted in 2011 show that roughly half of pads were sited on agricultural land, indicating that the degree of environmental impact will vary depending on the terrain. Almost all natural gas extraction sites are developed on private lands and their drilling pads typically contain 1-2 gas wells.²⁹⁰ “[T]he trend toward multi-well pads is tempered by the reality that the number of wells per well pad is still hovering between two and three state-wide”, at least as recently as 2011.²⁹¹

One of the largest impacts of Marcellus shale development occurs in state forests. A 2014 report estimated that 1,486 acres of state forest have been converted to facilitate gas development including roads, infrastructure, well pads, and pipelines.²⁹² Pennsylvania’s section of the Marcellus shale lies underneath 1,538,548 acres of state forest.²⁹³ Leases issued by the Commonwealth currently total 385,630 acres but have the potential to increase by 286,620 acres through private leases where the Commonwealth does not own the subsurface rights.²⁹⁴ Part of the concern for these forested regions stems from the disruption of the oldest forest growth in state as opposed the younger forests likely to found on private lands that were once associated with agriculture.

The road work in the creation of gas wells on state forests is extensive. Over 130 miles of preexistent roads in state forests have been improved or upgraded and 30 miles of new roads have

²⁸⁵ *Id.* § 102.4(b)(2).

²⁸⁶ Pa. Dep’t of Conservation & Nat. Res., *Shale-Gas Monitoring Rep.* 37-38 (2014), available at http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20029147.pdf.

²⁸⁷ Johnson, *supra* note 273, at 9-10. Approximately 35% of this area is for the well pad with the remaining 65% cleared for the associated infrastructure. *Id.* at 10. The indirect impact is estimated to be another 21.2 acres of fragmented forests changing wildlife habitat. *Id.* at 10-11. In other words, this assessment indicates that the area for the well pad & associated infrastructure needs to be more than tripled to assess the impact on forested habitat.

²⁸⁸ Office of Oil & Gas Mgmt., Pa. Dep’t of Envtl. Prot., Operator Well Pads, http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Well_Pads (last visited Sept. 27, 2015).

²⁸⁹ Nat. Gas Supply Ass’n, *Comparison of Fuels Used for Electric Generation in the U.S.*, <http://www.ngsa.org/analyses-studies/beck-data-rev/> (2013).

²⁹⁰ Margaret C. Brittingham *et al.*, *Shale Gas Dev.*, 8 The Wildlife Prof 122, 23-24 (2014).

²⁹¹ Pa. State Extension, Nat. Gas, *Multi-Well Pads in the Marcellus Shale*, <http://extension.psu.edu/natural-resources/natural-gas/news/2011/10/multi-well-pads-in-the-marcellus-shale> (posted Oct. 23, 2011). This source places the amount of drilling outside of state & nat’l forests at 90%. *Id.*

²⁹² Pa. Dep’t of Conservation & Nat. Res., *supra* note 286, at 4, 10, 53, 69.

²⁹³ *Id.* at 22.

²⁹⁴ *Id.* The total acreage subject to gas development is 672,250. *Id.*

been constructed for gas development activities.²⁹⁵ Development of shale gas has led to the construction of 191 infrastructure pads “[i]n the core gas state forest districts” covering 785.6 acres.²⁹⁶ Another 458.8 acres have been cleared to construct or widen the right of way for pipelines.²⁹⁷

A typical shale-gas well pad is approximately 3.5 to 7 acres.²⁹⁸ The permanent size of a well pad can shrink to 1.5 acres after drilling is completed and land is reclaimed.²⁹⁹ Once a site undergoes reclamation, it is typically seeded with non-native cold-season grass and clover. While reseeding may provide a place for wildlife to hide, it does not replicate young plant growth associated with a regenerating forest that is a home to numerous species, such as the state bird, the ruffed grouse.³⁰⁰ Similarly, pipelines are primarily seeded with grass and clover, which provide pathways for bear and deer but do not replicate early successional forest, which has been declining in eastern forests.³⁰¹ Over 80 percent of gas wells have not undergone some form of restoration even if natural gas has already been extracted at the site.³⁰² It is expected that the delay in restoring natural gas sites is due to the possibility of sites being redeveloped in the future.

Coal

No federal governmental agency currently publishes nationwide figures for the number of acres disturbed by coal mining. According to the National Mining Association, the amount of land that has been mined to produce coal in the U.S. amounts to approximately five million acres though these figures seem outdated.³⁰³ During the latest five-year period, bituminous coal in Pennsylvania has been mined beneath 31,234 acres and 96 miles of stream.³⁰⁴ “Of these stream miles, 39 miles belong to streams that experienced mining-induced flow loss or pooling somewhere along their channel.”³⁰⁵ By adding up figures relating to land permitted in 2014 there was a total of 48,797 acres, although land use figures relating to anthracite extraction were not listed.³⁰⁶

Extraction below ground results in less ground disturbance but comes with a different set of risks. Older mines are usually excavated using room-and-pillar method where columns of coal remain after coal extraction to keep the mine stabilized.³⁰⁷ More recent underground mines employ a technique known as long-wall mining, which uses equipment to remove the entire coal seam while hydraulic presses hold up the ceiling.³⁰⁸ These mining techniques can lead to ground

²⁹⁵ *Id.* at 4, 43.

²⁹⁶ *Id.* at 45.

²⁹⁷ *Id.* at 50.

²⁹⁸ *Id.* at 37.

²⁹⁹ SHIP, *supra* note 282.

³⁰⁰ Brittingham *et al.*, *supra* note 290, at 26.

³⁰¹ *Id.*

³⁰² *Id.*

³⁰³ Nat’l Mining Ass’n, Fast Facts, http://nma.dev2.networkats.com/statistics/fast_facts.asp (last visited Nov. 24, 2015). “[M]ost of the land not under active mining has been or is being reclaimed to the standards set by law.” *Id.*

³⁰⁴ Stephan J. Tonsor *et al.*, *The Effects of Subsidence Resulting from Underground Bituminous Coal Mining EX-2* (2008-13), available at

http://files.dep.state.pa.us/Mining/BureauOfMiningPrograms/BMPPortalFiles/Act%2054/0.4_Executive%20Summary_FINAL.pdf. <http://www.portal.state.pa.us/portal/server.pt?open=514&objID=1149978&mode=2>.

³⁰⁵ *Id.*

³⁰⁶ Pa. Dep’t of Envtl. Prot., *2014 Bituminous Surface Mines Reporting Prod.—Listed by Cnty.*, available at http://files.dep.state.pa.us/Mining/BureauOfMiningPrograms/BMPPortalFiles/Annual_Reports/BituminousAnnualReports/2014/2014BituminousSurfaceMines_ListedbyCounty.pdf.

³⁰⁷ William E. Edmunds, *Coal in Pa.* 16 (2002), available at

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_014594.pdf.

³⁰⁸ *Id.* at 16-17.

subsidence where the ground level lowers as a result of coal having been mined underneath.³⁰⁹ The coal mining industry uses a range of engineering techniques to design the layout and dimensions of its underground mine workings so that surface subsidence can be anticipated and controlled. Despite the preventative measures being taken in modern mines, previously abandoned mines can subside in the form of sinkholes or troughs causing damaged housing and infrastructure above ground.³¹⁰

Subterranean mine fire is a possible environmental impact of underground coal mining but is a rare occurrence. These fires can be extremely difficult to stop and may burn for many years, resultant in toxic emissions that can last for decades as experienced in Centralia.³¹¹ Where mining takes place below ground, the surface area can be simultaneously used for other uses including, cattle grazing and growing crops with limited disruption to the existent land use.

When best practices are conducted by mine operators, studies of the immediate environment are carried out several years before a coal mine opens in order to define the existing conditions and to identify potential problems. For each site a reclamation plan is designed and approved for each coal mine, covering the period from the start of operations until after mining has finished.³¹² Mine reclamation activities take years to be completed. The several steps to reclaim surface mines include shaping and contouring spoil piles, replacement of topsoil, seeding with grasses and planting trees.³¹³ Underground mines reclaim the area after stabilizing tailings ponds while mining and accounting for surface subsidence.³¹⁴ “As always, surface and groundwater must be protected from acid drainage and metal components higher than the ambient water levels.³¹⁵

There has been considerable research on reclamation practices associated with coal mining in the eastern United States. Early efforts at mine reclamation used exotic grasses and legumes, which were affordable and grew quickly.³¹⁶ These practices allowed quick stabilization of the mine to minimize impacts on soil and water quality.³¹⁷ After the 1990s, restoring wildlife habitat increasingly became the goal for post-mining land use which led to exotic shrubs and low value trees being planted.³¹⁸ More recently using native species in reclamation has become a goal of conservation groups, but its practice is limited due to cost.³¹⁹

³⁰⁹ Tonsor *et al.*, *supra* note 304, at I-10, available at http://files.dep.state.pa.us/Mining/BureauOfMiningPrograms/BMPPortalFiles/Act%2054/01_Sec1_FINAL.pdf.

³¹⁰ Pa. Dep’t of Envtl. Prot., Technical Guide to Mine Subsidence, <http://www.dep.state.pa.us/msi/technicalguidetoms.html#9pics> (2015).

³¹¹ Bureau of Abandoned Mine Reclamation, Pa. Dep’t of Envtl. Prot., *The Centralia Mine Fire* 11-14, <http://files.dep.state.pa.us/Mining/Abandoned%20Mine%20Reclamation/AbandonedMinePortalFiles/Centralia/CentraliaFrequentlyAskedQuestions.pdf#nameddest=F> (last visited Nov. 24, 2015). “The mine fire has been burning the remaining coal beneath Centralia Borough for over 50 years” and “could burn for over 100 years.” *Id.* at 3.

³¹² Nat’l Mining Ass’n, Reclamation, <http://www.nma.org/index.php/land/reclamation> (last visited Nov. 23, 2015).

³¹³ *Id.*

³¹⁴ *Id.*

³¹⁵ *Id.*

³¹⁶ David A. Buehler & Katie Percy, *Coal Mining & Wildlife in the E. U.S.: A Literature Rev.* 25 (2012), available at <http://www.appalachianwildlife.com/Coal%20Mining%20and%20Wildlife%20in%20the%20Eastern%20United%20States-final%20draft.pdf>.

³¹⁷ *Id.*

³¹⁸ *Id.* at 26.

³¹⁹ *Id.*

Nuclear

As with other energy sources, construction of a nuclear power plant may require the removal of trees on the site and disrupt local wildlife.³²⁰ Common impacts of nuclear power plants include damage to nearby water sources from the intake and release of water used as a coolant and during steam generation.³²¹ The industry employs a variety of designs to help the waste heat dissipate before reintroducing water to streams through the use of closed water systems or cooling towers to help the heat dissipate into the surrounding atmosphere.

“A large area surrounding nuclear power plants is restricted and guarded by armed security teams.”³²² These buffer regions are owned by the plant and “are generally left as open space to minimize security risks.”³²³ In the United States, “nuclear power plant areas are divided into an owner-controlled buffer region, an area guarded by armed security teams and restricted to select plant employees and monitored visitors, and a vital area with further restrictions.”³²⁴

The size of a nuclear energy facility can vary from one to five square miles depending on the type of power plant and the cooling system employed.³²⁵ Of land used for nuclear power, only 50 to 100 acres “may actually be disturbed during plant construction.”³²⁶ The average land used by a Pennsylvania nuclear energy facility (including buffer zone and associated infrastructure) was calculated to be approximately one square mile with additional one and three-quarter square miles associated with transmission lines.³²⁷ One researcher estimated that the full impact of one nuclear power station could extend up to 20.5 square kilometers, when enrichment plant, ore processing, uranium mining and disposal of nuclear waste are included in the calculations.³²⁸

Discussing the land impact of nuclear power is incomplete without mentioning the large waste storage requirements of the nuclear industry, which produces over 2,000 tons of radioactive spent fuel each year.³²⁹ This waste is the result of enrichment of uranium ore into fuel and the operation of nuclear power plants and its disposal has proven a matter both logically and politically complex. The two most common types of radioactive waste consist of low-level waste and spent fuel.³³⁰

Low-level waste (LLW) consists of items that have come in contact with radioactive materials, plant hardware, and wastes from reactor cooling and water cleanup systems.³³¹ LLW is

³²⁰ N.Y. State Energy Research & Dev. Auth., *Comparison of Reported Effects and Risks to Vertebrate Wildlife from Six Electricity Generation Types in the N.Y./N. Eng. Region* 3-2 (2009).

³²¹ *Id.* at 3-3.

³²² U.S. Energy Info. Admin., Dep’t of Energy, Nuclear Explained, http://www.eia.gov/energyexplained/index.cfm?page=nuclear_environment (last reviewed Nov. 12, 2015).

³²³ Jacobson, *supra* note 266, at 161.

³²⁴ *Id.*

³²⁵ SAIC Energy, Env’t & Infrastructure / R.W. Beck, Inc., *Comparison of Fuels Used for Electric Generation in the U.S.—Study Details*, http://www.ngsa.org/download/analysis_studies/beck%20enviro%20factors%20%20updated.pdf (updated 2013).

³²⁶ U.S. Nuclear Regulatory Comm’n, Generic Envtl. Impact Statement for License Renewal of Nuclear Plants 2.3.1, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/v1/part02.html#_1_26 (last updated Mar. 29, 2012).

³²⁷ *Id.*, Table 2.1.

³²⁸ Jacobson, *supra* note 266, at 161.

³²⁹ Nuclear Energy Inst., On-site Storage of Nuclear Waste, <http://www.nei.org/Knowledge-Center/Nuclear-Statistics/On-Site-Storage-of-Nuclear-Waste> (last visited Aug. 21, 2015).

³³⁰ U.S. Energy Info. Admin., *supra* note 322.

³³¹ *Id.*

normally temporarily stored on site before being compacted and packaged in 55-gallon drums being shipped to specially designed and licensed disposal sites.³³² Almost all low level radioactive waste “decays to background levels within 100 years or less”, making disposal easier than spent fuel.³³³ States secure their own disposal capacity for LLW generated within their boundaries by siting their own disposal facilities or by forming waste compacts that are responsible for siting regional disposal facilities, with packaging and transportation of LLW regulated by the U.S. Department of Transportation and Nuclear Regulatory Commission.³³⁴

Spent fuel is produced during reactor operations. Fission products and radioactive elements that build up during regular operations prevent the continued use of the fuel assembly.³³⁵ Currently, the spent fuel is stored on site, either in steel-lined, concrete vaults filled with water or in above-ground steel or steel-reinforced concrete containers with steel inner canisters.³³⁶ Originally, disposal of spent fuel in a deep-geological repository was planned.³³⁷ However, because of delays in establishing a permanent repository or developing interim storage facilities, nuclear power plants are currently storing their spent fuel on-site.³³⁸ Without significant impact on the environment, licensees may store spent fuel on-site for scores of years after ceasing reactor operation.³³⁹

When a nuclear power plant is decommissioned, some equipment and structural materials also become radioactive waste, which is “stored at the closed plants until an appropriate disposal site is opened.”³⁴⁰ The length of time it takes after nuclear power station is decommissioned before the land is available for reuse is uncertain. In the case of decommissioning by entombment or at the site of a prior accident, the land may not be available for reuse at all within a given century.³⁴¹

Oil

Pennsylvania’s long history with oil production dates back to 1859 when Edwin Drake created the world’s first commercially successful oil well.³⁴² Over 350,000 oil and gas wells have been drilled throughout Pennsylvania.³⁴³ There are still many conventional wells operating in the state.³⁴⁴ After being extracted from the ground, crude oil is typically refined into heating or fuel products, such as gasoline.³⁴⁵ In addition to the standard uses, Pennsylvania Grade Crude is a

³³² U.S. Nuclear Regulatory Comm’n, *supra* note 326, at 2.2.4.3, 2.2.4.4.

³³³ Nuclear Energy Inst., *supra* note 329.

³³⁴ *Id.*, Fact Sheets, <http://www.nei.org/Master-Document-Folder/Backgrounders/Fact-Sheets/Disposal-Of-Commercial-Low-Level-Radioactive-Waste> (2014).

³³⁵ U.S. Nuclear Regulatory Comm’n, *supra* note 326, at 2.2.4.3, 2.2.4.4.

³³⁶ U.S. Energy Info. Admin., *supra* note 322.

³³⁷ U.S. Envtl. Prot. Agency, Nuclear Energy (July 25, 2008-Oct. 12, 2015), <https://web.archive.org/web/20150905082916/http://www.epa.gov/cleanenergy/energy-and-you/affect/nuclear.html> (accessed in the Internet Archive).

³³⁸ U.S. Nuclear Regulatory Comm’n, Spent Fuel Storage in Pools & Dry Casks Key Points & Questions & Answers, <http://www.nrc.gov/waste/spent-fuel-storage/faqs.html> (last updated Apr. 13, 2015).

³³⁹ *Id.*

³⁴⁰ U.S. Envtl. Prot. Agency, *supra* note 337.

³⁴¹ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-28.

³⁴² Pa. Dep’t of Envtl. Prot., Oil & Gas Well Drilling & Prod. in Pa. (2011), <https://thompson.house.gov/sites/thompson.house.gov/files/PA%20DEP%20Oil%20and%20Gas%20Well%20Drilling%20and%20Production.pdf>.

³⁴³ *Id.*

³⁴⁴ *Id.*

³⁴⁵ Kathy J. & Thomas Flaherty, III, *Oil & Gas in Pa.* 20-21 (2014), http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_014593.pdf.

waxy, high-quality oil used in the production of machine lubricants, cosmetics, and pharmaceuticals.³⁴⁶

Conventional oil well pads are smaller than those used for Marcellus shale and use close to an acre of land well.³⁴⁷ Conventional wells are created by vertically drilling 1,500 to 21,000 feet down in sandstone formations.³⁴⁸ Because conventional wells are shallower than Marcellus shale wells they are not reliant on hydraulic fracturing to access oil and gas, although fracturing might still be used to increase production.³⁴⁹ Due to their smaller size, conventional wells can be sited close to parks, roadsides, residential houses and other types of public or private land.³⁵⁰ Drilling conventional wells takes close to two weeks.³⁵¹

While there are oil wells scattered throughout the state, traditionally oil production was concentrated in Warren and McKean counties near the New York border with additional wells in Washington and Beaver counties.³⁵² While conventional oil wells in the state produce only a few barrels each week,³⁵³ Pennsylvania's total crude oil production totaled 6,692,000 barrels in 2014.³⁵⁴ There are over 11,000 active oil wells in Pennsylvania.³⁵⁵

No land use figures could be obtained for oil wells alone; one report on oil and gas wells shows that over 50,000 new wells have been drilled annually since 2000 in central North America.³⁵⁶ These wells totaled seven million acres of land devoted to oil and gas energy development between 2000 and 2012.³⁵⁷ While making the report, researchers examined industry data and satellite imagery of eleven states and three Canadian provinces.³⁵⁸ The purpose of the study was to show how the development of oil and gas had large cumulative impacts on land over time. The study also detailed the type of land being used for oil and gas production.³⁵⁹ Roughly half the acreage developed for oil and gas production in the 12-year period were grasslands.³⁶⁰ Agricultural land made up 40 percent, while 10 percent was forested.³⁶¹ The report estimated that the amount of crop production lost to drilling totaled 120,200,000 bushels of wheat or about 6 percent of the wheat produced in the region in 2013.³⁶²

³⁴⁶ *Id.* at 21.

³⁴⁷ *Id.* at 13.

³⁴⁸ Pa. Indep. Oil & Gas Ass'n, Pa. Oil & Gas, <http://www.pioga.org/education/pa-oil-and-gas/> (2015).

³⁴⁹ *Id.*

³⁵⁰ *Id.*

³⁵¹ *Id.*

³⁵² Pa. Dep't of Envtl. Prot., *supra* note 342.

³⁵³ *Id.*

³⁵⁴ U.S. Energy Info. Admin., Dep't of Energy, Petroleum & Other Liquids, https://www.eia.gov/dnav/pet/pet_crpdn_adc_mbbl_a.htm (release date Nov. 30, 2015).

³⁵⁵ Pa. Indep. Oil & Gas Ass'n, *supra* note 348.

³⁵⁶ Brady W. Allred *et al.*, *Ecosys. Servs. Lost to Oil & Gas in N. Am.*, 348 Sci. 401 (2015), <http://catskillcitizens.org/learnmore/Science-2015-Allred-401-2.pdf>.

³⁵⁷ *Id.* at 401-02.

³⁵⁸ *Id.* at 401.

³⁵⁹ *Id.*

³⁶⁰ *Id.* at 402.

³⁶¹ *Id.*

³⁶² *Id.* at 401.

Hydropower

Depending on the size of the hydroelectric generators and the topography of the land, the size of the reservoir created by a hydroelectric project can vary widely. Hydroelectric plants in flat areas tend to require much more land than those in hilly areas or canyons where deeper reservoirs can hold more volume of water in a smaller space.³⁶³ It is estimated that a single reservoir providing water for a 1300 MW hydroelectric power plant around requires about 650 square kilometers, which is approximately 50 square kilometers per 100 MW installed.³⁶⁴

A reservoir and dam can also change natural water temperatures, water chemistry, river flow characteristics, and silt loads.³⁶⁵ All of these changes can affect the ecology and the physical characteristics of the river. Reservoirs occasionally cover natural areas, agricultural land or archeological sites. During large scale projects construction of a dam may also result in the displacement of people.³⁶⁶ Overall the physical impacts of a dam and reservoir, the operation of the dam, and the use of the water can change the environment over a much larger area than the area covered by a reservoir.

Solar

While not widely used in Pennsylvania, photovoltaic (PV) solar panels have become a more practical option for small scale electric generation in recent years due to decreasing production costs.³⁶⁷ Sunnier regions of the United States can make better use of solar technology, however Pennsylvania's share of solar power is growing. Currently there are 249 MW of installed capacity in Pennsylvania.³⁶⁸

Overall land use figures relating to solar are insufficient to compare to other power sources. Almost all installed PV panels are on rooftops so that they do not contribute to land use.³⁶⁹ For ground based, small scale PV facilities likely to develop in Pennsylvania, the direct area used by solar infrastructure is 5.9 acres per MW of installed capacity while total area would be 8.3 acres per installed MW.³⁷⁰ The area required for one 160 W PV panel is 1.9 square meters.³⁷¹

Wildlife Impact

In addition to impacting the land and water quality of a region, energy sources can also damage local wildlife through various direct and indirect methods. While each form of power generation has differing effects on the environment, there are also some commonalities including: wildlife mortality from infrastructure collision, displacement and loss of habitat at power generation and resource extraction sites, potential increases in predator populations or introduction of invasive plants, and adverse health effects related to air and water emissions.

³⁶³ Nat'l Renewable Energy Lab., U.S. Dep't of Energy, *Renewable Electricity Futures Study* (Vol. 2) 8-20 , <http://www.nrel.gov/docs/fy12osti/52409-2.pdf> (2012).

³⁶⁴ Jacobson, *supra* note 266, at 161.

³⁶⁵ Nat'l Renewable Energy Lab., *supra* note 363, at 8-26 to 8-27.

³⁶⁶ *Id.*

³⁶⁷ Solar Energy Indus. Ass'n, State Solar Policy (last visited Aug. 15, 2015).

³⁶⁸ *Id.*

³⁶⁹ Jacobson, *supra* note 266, at 161.

³⁷⁰ Sean Ong *et al.*, Land-Use Requirements for Solar Power Plants in the U.S. 18-19 (2013), available at <http://www.nrel.gov/docs/fy13osti/56290.pdf>.

³⁷¹ Jacobson, *supra* note 266, at 161.

Wind Turbines

The main advantages associated with wind turbines' interaction with wildlife is their lack of air or water emissions during operation. While this means wind energy sources do not contribute to a range of environmental issues such as air pollution, river and stream damage, climate change, and mercury bioaccumulation, this technology also has disadvantages. Several impacts of wind energy facilities on wildlife are shared with other energy sources including animal displacement and habitat fragmentation at the site of the turbines and direct avian mortality from interaction with transmission lines.³⁷² While some forms of power generation pose a risk to all local wildlife, wind turbines primarily affect two categories of wildlife: birds and bats. The main risk posed to these animals from wind energy is collision with the turbine blades, though it is still uncertain about the level of risk presented. Nineteen surveys at 11 wind energy sites using a protocol from Pennsylvania Game Commission that were done 2007-2011 revealed estimates of an annual rate of fatal collisions for four birds and twenty-five bats at each turbine site.³⁷³ Counting the utility-scale wind turbines currently operating in the state at 718,³⁷⁴ the total annual mortality estimate is calculated as 2,872 birds and 17,950 bats (based on the estimates from the surveys).

Bats. The growing development of wind farms in Pennsylvania represent an increased risk to bat populations throughout the state. Following a protocol from Pennsylvania Game Commission, the annual mortality rate is estimated to average around 25 bats per wind turbine.³⁷⁵ Bat populations are exceptionally vulnerable to turbines because their low reproductive rates limit their ability to recover from population clashes.³⁷⁶ Bats also collide with television towers and other human-made structures.³⁷⁷

As with birds, many bat mortalities occur from collisions with turbine blades, however others could be internal injuries caused by the severe change of air pressure near the turbine blades.³⁷⁸ Over the years, researchers studying wind farms have been able to provide more accurate mortality estimates by adjusting for interference from scavenging animals which feed on fallen bats, and the efficiency of searchers who have difficulty locating small bats. Some wind development operators have not agreed to and do not share mortality data with the Pennsylvania Game Commission making it difficult to understand the full impact of wind turbines across the state.³⁷⁹

Bats play an important role in the ecosystem due to the large volume of insects a colony can eat; "a single colony of 150 big brown bats has been estimated to eat nearly 1.3 million pest insects each year".³⁸⁰ A decrease in the local population of insects can allow farmers to save

³⁷² N.Y. State Energy Research & Dev. Auth., *supra* note 320, at S-1, S-4.

³⁷³ John Taucher *et al.*, *Pa. Game Comm'n Wind Energy Voluntary Cooperation Agreement 3d Summary Rep.* v, 20-21, 28-29 (2012), available at <http://www.portal.state.pa.us/portal/server.pt?open=514&objID=613068&mode=2>.

³⁷⁴ This total omits the Wind Project at Turkey Point as that serves the dairy. *Supra* p. 19 n.22.

³⁷⁵ Taucher *et al.*, *supra* note 373, at v, 20.

³⁷⁶ Bat Worlds, Bat Reprod., <http://www.batworlds.com/bat-reproduction/> (2013).

³⁷⁷ Dara N. Orbach & Brock Fenton, *Vision Impairs the Abilities of Bats to Avoid Colliding with Stationary Obstacles*, 5 PLoS ONE 1 (2010), available at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2976695/pdf/pone.0013912.pdf>.

³⁷⁸ Erin F. Baerwald *et al.*, Barotrauma Is a Significant Cause of Bat Fatalities at Wind Turbines, 18 Current Biology R695 (2008), available at http://ac.els-cdn.com/S0960982208007513/1-s2.0-S0960982208007513-main.pdf?_tid=0361dcd8-a284-11e5-863b-00000aacb361&acdnat=1450112538_e912088d139c177847bd8cf4dddf4357.

³⁷⁹ Taucher *et al.*, *supra* note 373, at 2.

³⁸⁰ Justin G. Boyles *et al.*, *Econ. Importance of Bats in Agric.*, 332 Sci. 41 (2011), available at <https://www.fort.usgs.gov/sites/default/files/products/publications/23069a/23069a.pdf>.

money by spending less on pesticides.³⁸¹ A local population of bats can save farmers an estimated \$74 per acre in averted pesticide costs.³⁸² These saving are estimated to be \$3,700,000,000 or more per year across North America.³⁸³

For sites that followed Pennsylvania Game Commission monitoring protocols, the majority of all bat activity documented occurred within the first five hours of nightly monitoring.³⁸⁴ This information is important to determine the best times to implement minimization efforts.³⁸⁵ Bat fatalities increase on nights with low wind speeds,³⁸⁶ and typically increase immediately before and after the passage of storm fronts.³⁸⁷ Weather patterns might be a predictor of bat activity and fatalities, and mitigation efforts that focus on these high-risk periods could reduce bat fatalities.

There has been preliminary success using acoustic deterrents to prevent bat collisions at wind turbine sites, however the method is still being adjusted.³⁸⁸ In some studies it has been documented that risk to bats could be lowered substantially by reducing the amount of turbine operating hours during times associated with low wind speeds, when bats are most active.³⁸⁹ This practice could be implemented by increasing the minimum wind speed, at which the turbine's blades start.³⁹⁰ In one study testing this method, nightly reductions in bat fatalities ranged from 53 to 87 percent with marginal power loss.³⁹¹ While reduction in bat fatalities can be achieved with reduction in power production, it is unknown how cost effective this method might be.

Tree dwelling species of bats appear to be the most vulnerable to the turbines and comprise approximately 75 percent of the bat specimens recorded at wind farms.³⁹² While the exact reason for bats' attraction to wind turbines is unknown, research suggests that the bats are drawn to tall structures seeking locations to roost, insects to prey on, and social interaction with other bats.³⁹³ Three migratory tree-roosting species³⁹⁴ are the majority of bats reported killed at wind facilities in most regions of North America. While these three species are not classified as threatened, higher collision patterns among certain species may change as more facilities are developed and studied. In Pennsylvania, Hoary bats comprised the largest proportion of documented bat mortality.³⁹⁵ Monitoring conducted at high risk sites indicate that a large majority of all bat activity occurred from July 1 to September 30.³⁹⁶ A smaller numbers of bat fatalities occur during spring

³⁸¹ *Id.* at 41-42.

³⁸² *Id.*

³⁸³ *Id.* at 42.

³⁸⁴ Taucher *et al.*, *supra* note 373, at iv, 15. Similarly, a large majority of bat activity occurred from July 1-Sept. 30. *Id.* at iv, 14-15, 47.

³⁸⁵ *Id.* at iv, 14.

³⁸⁶ *Id.* at 15.

³⁸⁷ Edward B. Arnett *et al.*, *Relationships between Bats & Wind Turbines in Pa. & W. Va.: An Assessment of Fatality Search Protocols, Patterns of Fatality, & Behavioral Interactions with Wind Turbines* 76, 87 (2005), available at <http://www.batsandwind.org/pdf/postcompatbatfatal.pdf>.

³⁸⁸ *Id.* at vi, 49.

³⁸⁹ *Id.* at 42, 48, 50.

³⁹⁰ *Id.* at 15-16, 50.

³⁹¹ Edward B. Arnett *et al.*, *Effectiveness of Changing Wind Turbine Cut-in Speed to Reduce Bat Fatalities at Wind Facilities: 2008 Annual Rep.* 3, available at http://www.batsandwind.org/pdf/Curtailment_2008_Final_Report.pdf.

³⁹² Taucher *et al.*, *supra* note 373, at 23.

³⁹³ Paul M. Cryan *et al.*, *Behavior of Bats at Wind Turbines*, 111 PNAS 15126, 15129 (2014), available at <http://www.pnas.org/content/111/42/15126.full.pdf>.

³⁹⁴ Hoary, eastern red, and the silver-haired.

³⁹⁵ Taucher *et al.*, *supra* note 373, at 23.

³⁹⁶ *Id.* at 26-27.

migration for some species at some facilities.³⁹⁷ However, the seasonal fatality peaks noted above may change as more facilities are developed and studied.

Bat populations may be exceptionally vulnerable to turbine collisions due to a higher reported mortality than birds and a low reproductive rate.³⁹⁸ Complicating matters, bat populations are already threatened by White Nose Syndrome,³⁹⁹ a fungus that has spread across Pennsylvania over the last seven or eight years and resulted in the decline of bat species.⁴⁰⁰ This fungus disrupts the bats' hibernation cycles by depleting the vital energy reserves bats need to survive winters.⁴⁰¹ The threat wind turbines present to bat populations is not well understood at this time due to limited information on the size or location of bat populations in Pennsylvania and elsewhere.

Raptors. A major source of concern surrounding wind turbines throughout the country is their impact on raptors, which includes nationally valued birds such as eagles and red tailed hawks. California's Altamont Pass Wind Energy Facility has become infamous for high raptor collision rates with the turbines.⁴⁰² In Pennsylvania, no eagle mortality has been reported by an operating wind turbine and the impact of raptor fatalities has been minimal with estimates of raptor mortality as low as three percent of bird carcasses recovered.⁴⁰³ It is also thought that the rate of raptor collisions can be kept low by continuing to site future wind turbines away from areas with raptor populations.⁴⁰⁴

Songbirds. Public concern over protecting bird populations from collisions with wind turbine blades has grown since the industry's inception, though the level of risk to bird populations remains debated. Recent estimates for Pennsylvania are four birds killed at each turbine per year.⁴⁰⁵ When choosing sites for wind farms, the abundance of birds in the area and their behavior are important factors when assessing potential risk. One large mortality event occurred in Pennsylvania in 2011, where a combination of weather conditions and lighting at a nearby substation is thought to have caused the death of 258 birds, including two dozen blackpoll warblers, which are on the state's endangered species list.⁴⁰⁶ This event and others caused by similar circumstances could likely be avoided by following lighting best management practices recommended by Pennsylvania Game Commission.⁴⁰⁷

Across North America small passerines, commonly known as songbirds and the most common type of bird in North America, account for the majority of bird fatalities found at wind energy facilities.⁴⁰⁸ For all wind energy facilities currently in operation, it is estimated that

³⁹⁷ *Id.* at 26-28.

³⁹⁸ Bat Worlds, Bat Reproduction, <http://www.batworlds.com/bat-reproduction/> (last visited Dec. 3, 2015).

³⁹⁹ U.S. Fish & Wildlife Serv., Dep't of Interior, White-Nose Syndrome.org, <https://www.whitenosesyndrome.org/about-white-nose-syndrome> (last visited Dec. 3, 2015).

⁴⁰⁰ Taucher *et al.*, *supra* note 373, at 13.

⁴⁰¹ U.S. Fish & Wildlife Serv., *supra* note 399, at <https://www.whitenosesyndrome.org/faq/what-are-signs-white-nose-syndrome>.

⁴⁰² K. Shawn Smallwood & Carl Thelander, *Bird Mortality in the Altamont Pass Wind Resource Area*, Cal., 72 J. Wildlife Mgmt 215 (2008), available at http://altamontsrc.org/alt_doc/r51_smallwood_thelander_bird_mortality_in_altamont_pass_2008.pdf.

⁴⁰³ Taucher *et al.*, *supra* note 373, at v, 29.

⁴⁰⁴ Smallwood & Thelander, *supra* note 402, at 222. This source also suggests exploring safer designs. *Id.*

⁴⁰⁵ Taucher *et al.*, *supra* note 373, at v, 28.

⁴⁰⁶ *Id.* at 43-45.

⁴⁰⁷ *Id.* at 44.

⁴⁰⁸ Wallace P. Erickson *et al.*, *A Comprehensive Analysis of Small-Passerine Fatalities from Collision with Turbines at Wind Energy Facilities* (2014), available at <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0107491>.

between 134,000 and 230,000 songbird fatalities are caused by wind turbines annually or a rate of 2.10-3.35 passersines per MW of installed capacity.⁴⁰⁹ Passerines migrate during the night at altitudes higher than turbines blades.⁴¹⁰ It is thought that songbirds are vulnerable to collisions with any tall structure when poor weather conditions force them to fly at lower altitudes.⁴¹¹ Risk to birds may be greatest when taking off or landing, as well as at places where wind turbines border on resting sites of migratory birds.⁴¹² Current turbine-related fatalities are unlikely to affect the bird population trends of most North American songbirds,⁴¹³ although this risk may have to be reevaluated as wind energy development increases in Pennsylvania.

While the wind industry has taken active steps to mitigate bird collisions with wind turbines, preventive tactics vary in their success. It was once thought that if monopole designs for wind turbines replaced the lattice structure of older models there would be a corresponding reduction in collisions once birds could no longer roost on the turbines.⁴¹⁴ However, bird collisions with turbines have only risen as turbine sizes have increased.⁴¹⁵ It was estimated that between 140,000 and 328,000 birds are killed annually at monopole turbines in the United States.⁴¹⁶ Another proposed mitigation technique, using ultraviolet paint to make turbines more noticeable to birds, has not been proven effective.⁴¹⁷

Wind turbine effects on birds do not appear to have much regional variation between the east and the west.⁴¹⁸ The national average is estimated to be an annual, mortal collision rate of 4.12 birds per installed MW.⁴¹⁹ The major outlier is California which has the highest mortality rate in the country at 18.76 collisions per MW.⁴²⁰ Mortality rates also vary depending on the season; in Pennsylvania, a large share of bird mortality has occurred during spring and fall, which corresponds to migration patterns.⁴²¹

The effect of wind energy facilities on bird populations should not be dismissed but put into context with other human-related sources of bird mortality including collisions with communication towers and buildings and windows, which range between 365,000,000 and 998,000,000 million avian deaths annually.⁴²²

⁴⁰⁹ *Id.*

⁴¹⁰ The Wildlife Soc'y, *Impacts of Wind Energy Facilities on Wildlife & Wildlife Habitat* 18 (2007), available at <http://wildlife.org/wp-content/uploads/2014/05/Wind07-2.pdf>

⁴¹¹ *Id.*

⁴¹² *Id.*

⁴¹³ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-33, 3-34.

⁴¹⁴ Nat'l Wind Coordinating Collaborative, Wind Turbine Interactions with Birds, Bats, & their Habitats: A Summary of Research Results & Priority Questions 5, http://www1.eere.energy.gov/wind/pdfs/birds_and_bats_fact_sheet.pdf (2010).

⁴¹⁵ Scott R. Loss *et al.*, *Estimates of Bird Collision Mortality at Wind Facilities in the Contiguous U.S.*, 168 Biological Conservation 201, 206-07 (2013), available at http://www.minetrix.se/files/wind_turbines_mortality.pdf.

⁴¹⁶ *Id.* at 205. The mean estimate is 234,012 birds. *Id.*

⁴¹⁷ D.P. Young, Jr., *et al.*, *Comparison of Avian Responses to UV-Light-Reflective Paint on Wind Turbines* 15-16 (2003), http://www.west-inc.com/reports/fcr_nrel.pdf.

⁴¹⁸ Loss *et al.*, *supra* note 415, at 204. Apart from these two regions, Cal. is a little higher and the great plains are a little lower. *Id.*

⁴¹⁹ *Id.*

⁴²⁰ *Id.* Conversely, the estimate for the great plains is an average of 1.81 mortal collisions per MW. *Id.*

⁴²¹ Taucher *et al.*, *supra* note 373, at 32.

⁴²² Scott R. Loss *et al.*, *Bird-Building Collisions in the U.S.: Estimates of Annual Mortality & Species Vulnerability*, 116 The Condor 8, 18 (2014), available at <http://www.bioone.org/doi/pdf/10.1650/CONDOR-13-090.1>.

[O]ur results support the conclusion that building collision mortality is one of the top sources of direct anthropogenic mortality of birds in the U.S. Among other national estimates that are data-driven and systematically derived, only predation by free-ranging domestic cats is estimated to cause a greater amount of mortality. Major sources of direct anthropogenic bird mortality currently lacking systematically derived estimates include collisions with automobiles and other vehicles, collisions and electrocution at power lines, and poisoning caused by agricultural chemicals, lead, and other toxins.⁴²³

With so much uncertainty regarding the total impact of human development on avian populations, the benefits of a renewable and nonpolluting energy source should be carefully considered and weighed against the potential loss of animal life. “As human populations and numbers of buildings increase in the U.S. and globally, actions to reduce bird mortality from building collisions will be necessary at all types of buildings.”⁴²⁴

Natural Gas

Habitat fragmentation occurs when large areas of natural landscapes are intersected and subdivided by other, usually anthropogenic, land uses leaving smaller patches to serve as habitat for various species. As human activities increase, natural habitats, such as forests, are divided into smaller and smaller patches that have a decreased ability to support viable populations of individual species. Although many human and natural activities result in habitat fragmentation, gas exploration and development activity can be extreme in their effect on the landscape. Numerous secondary roads and pipeline networks crisscross and subdivide habitat structure. Landscape disturbance associated with shale-gas development infrastructure directly alters habitat through loss, fragmentation, and edge effects, which in turn alters the flora and fauna dependent on that habitat. The fragmentation of habitat is expected to amplify the problem of total habitat area reduction for wildlife species, as well as contribute towards habitat degradation.⁴²⁵

Habitat fragmentation rather than habitat loss is the primary way the natural gas industry is affecting wildlife because well sites can break up interior forest by creating more forest edges.⁴²⁶ Interior forest is distinguished from edge forest as being at least 100 meters away from human disturbance such as a road or housing development, and provides habitat for a variety of wildlife species including those that avoid contact with humans.⁴²⁷ The expected result of these changes is a shift in animal populations. Wildlife that live near forest edges and can easily adapt to human presence⁴²⁸ could benefit because their preferred habitat is expanded. Forest interior species that require more specific habitats will likely be displaced and experience a population decline.⁴²⁹

⁴²³ *Id.* (citation omitted).

⁴²⁴ *Id.* at 21.

⁴²⁵ E. T. Slonecker *et al.*, *Landscape Consequences of Nat. Gas Extraction in Bradford & Washington Cntrs., Pa., 2004–10* 9–10 (2012), available at <http://pubs.usgs.gov/of/2012/1154/of2012-1154.pdf>.

⁴²⁶ *Id.*

⁴²⁷ *Id.* at 10.

⁴²⁸ E.g., blue jays, deer, and raccoons.

⁴²⁹ Brittingham *et al.*, *supra* note 290, at 25.

In addition to forest fragmentation, pipelines⁴³⁰ also can change how animals interact with their environment. These pipelines represent several ecological risks to wildlife including allowing greater human access to undisturbed habitats, increasing the spread invasive species, and acting as barriers to wildlife movement and migration routes. It is still largely unknown how pipeline corridors effect the reproduction of various animal species.

As with any fossil fuel, combustion emissions from natural gas contribute to risks for acidic deposition and climate change.⁴³¹ At the power plant, the burning of natural gas produces nitrogen oxides and carbon dioxide, but in lower quantities than burning coal or oil.⁴³² Methane, a primary component of natural gas, can leak from wells and gas pipes; these leaks are the source of 23% of total United States methane emissions.⁴³³ At sites where natural gas is produced but cannot be transported economically, the gas is flared to limit methane from leaking into the atmosphere.⁴³⁴

Natural gas flaring produces CO₂, carbon monoxide, sulfur dioxide, nitrogen oxides, and many other compounds depending on the chemical composition of the natural gas and depending on how well the gas burns in the flare. Natural gas wells and pipelines often have engines to run equipment and compressors which produce additional air pollutants and noise.⁴³⁵

Compared to electricity generation from other fossil fuels, burning natural gas in combustion turbines requires very little water; however, natural gas-fired boiler and combined cycle systems require water for cooling.⁴³⁶ “When power plants remove water from a lake or river, fish and other aquatic life can be” injured or “killed”.⁴³⁷ “[T]he water used in natural gas boilers and combined cycle systems is often discharged into lakes or rivers” when too polluted and hot to continue to use as coolant.⁴³⁸ During electricity transmission, birds are at risk of colliding with or becoming electrocuted by power lines.⁴³⁹

Many wildlife impacts of natural gas extraction are not understood, such as how fracking fluid interacts with water environments when discharged into streams or rivers. “[H]ydraulic fracturing fluid may contain potentially hazardous chemicals” that “can contaminate surrounding areas” when released.⁴⁴⁰ To understand the full impact of natural gas development, future research should focus on events that could “lead to contamination of fresh water, such as equipment failure, illegal activities, accidents, chemical migration, and wastewater escape, as well as cumulative ecological impacts of shale development.”⁴⁴¹

⁴³⁰ “Pipeline construction was the source of most of the increase in forest patch number.” E. T. Slonecker *et al.*, *supra* note 425, at 26.

⁴³¹ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-24 to -25.

⁴³² *Id.* at 3-8, 3-19, 3-22, 3-25 to -26.

⁴³³ U.S. Energy Info. Admin., Dep’t of Energy, Nat. Gas Explained, http://www.eia.gov/Energyexplained/?page=natural_gas_environment (last reviewed Nov. 4, 2014).

⁴³⁴ *Id.*

⁴³⁵ *Id.*

⁴³⁶ U.S. Envtl. Prot. Agency, *supra* note 283.

⁴³⁷ *Id.*

⁴³⁸ *Id.* “This discharge usually requires a permit and is monitored.” *Id.*

⁴³⁹ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at S-2, 3-4. This moderate, potential risk is “common to all forms of electricity generation”. *Id.*

⁴⁴⁰ U.S. Energy Info. Admin., *supra* note 433. “Hydraulic fracturing ” also “causes small earthquakes”. *Id.*

⁴⁴¹ Sara Souther *et al.*, *Biotic Impacts of Energy Dev. from Shale: Research Priorities & Knowledge Gaps*, 12

Frontiers in Ecology & Env’t 330, 337 (2014), available at https://www.researchgate.net/publication/264416275_Biotic_impacts_of_energy_development_from_shale_research_priorities_and_knowledge_gaps._Front_Ecol_Environ.

Coal

Compared with other methods of power generation, relatively little current information exists on the direct wildlife impacts caused by coal extraction.⁴⁴² Most recent research has focused on harmful practices of mountaintop coal removal, however this method of extraction is not widely practiced in the Pennsylvania. Mountain-top removal can result in large volumes of unwanted rock moved to adjacent valleys, where streams and habitat can be buried.⁴⁴³ While both above and below ground mines affect wildlife, the former threatens animals more directly through the removal of their habitats.

Surface mining such as strip or open-pit mining involves the clearing of natively vegetated areas, causing native wildlife to be either killed or displaced to adjacent areas.⁴⁴⁴ Wildlife mortality is most likely when the species in question is too small or is a slow-moving species unable to avoid mining equipment such as invertebrates, reptiles, amphibians, and small mammals.⁴⁴⁵ Displacement of wildlife occurs when animals move into adjacent areas once their own habitat is lost.⁴⁴⁶ Reproduction among displaced species may be interrupted during the first breeding season in a new habitat.⁴⁴⁷ Chances of survival may also decrease because a larger pool of animals is in competition for resources and greater predation rates while wildlife adjusting to new surroundings.⁴⁴⁸

Animal reactions to post-mining reclamation can vary depending on the habitat requirements of the animal in question, the presence of a nearby population to recolonize the mine site, and the structure and composition of the vegetation after reclamation.⁴⁴⁹ While studies on wildlife response usually focus on documenting the number of a given species in the area of a post-reclamation mine, this provides only limited information on the quality of the restored habitat.⁴⁵⁰ Some habitats, such as grasslands, are relatively easy to restore and have successfully recreated a habitat suitable for numerous species of songbird and raptor use.⁴⁵¹ However forest environment is not always restored to the same conditions, which is undesirable in light of declining populations of forest animals.⁴⁵²

Not all negative effects to wildlife from coal are the result of mines currently in operation. “Office of Surface Mining has identified more than 500 abandoned mining sites in the” mid-Atlantic region.⁴⁵³ Acid mine drainage from abandoned mines is a problem that can lead to lower quality habitats and affect all wildlife including fish and aquatic organisms.⁴⁵⁴ Acid mine drainage

⁴⁴² David A. Buehler & Katie Percy, *Coal Mining & Wildlife in the E. U.S.: A Literature Rev.* 9 (2012), available at <http://www.appalachianwildlife.com/Coal%20Mining%20and%20Wildlife%20in%20the%20Eastern%20United%20States-final%20draft.pdf>.

⁴⁴³ *Id.* at 7.

⁴⁴⁴ *Id.* at 9-10.

⁴⁴⁵ *Id.* at 9.

⁴⁴⁶ *Id.*

⁴⁴⁷ *Id.* at 10.

⁴⁴⁸ *Id.*

⁴⁴⁹ *Id.*

⁴⁵⁰ *Id.*

⁴⁵¹ *Id.* at 12.

⁴⁵² *Id.* at 13. In other words, scrub-shrub birds live in grasslands, but the forest dwelling birds won’t benefit unless and until the habitat is reforested.

⁴⁵³ U.S. Envt’l Prot. Agency, Mid-Atl. Water, <http://www3.epa.gov/reg3wapd/nps/mining.html> (last updated Oct. 20, 2015).

⁴⁵⁴ *Id.*

is created from water coming into contact with abandoned mines.⁴⁵⁵ This runoff dissolves heavy metals such as copper, lead and mercury into ground and surface water.⁴⁵⁶ “About 4,785 miles of streams that have low pH in the mid-Atlantic have been impacted by extraction of resources, primarily coal.”⁴⁵⁷

Acid mine drainage impairs the habitat of fish and other aquatic species,⁴⁵⁸ including salamanders, water bugs and other insects.⁴⁵⁹ Federally listed freshwater mussels can also be adversely affected.⁴⁶⁰ Acid mine drainage can result in reduced population levels and lowered reproduction and growth rates.⁴⁶¹ Office of Surface Mining estimated that at least \$3,800,000,000 “would be needed to remedy all of the known acid mine drainage sites within the” mid-Atlantic region.⁴⁶² “The estimated time seems to be from 6 to 11 years to restore a stream from” dead “to a fully functional recreational fishery.”⁴⁶³ One form of active treatment involves installing a water treatment plant, where the acidic water is first dosed with lime to neutralize the acid and then passed through settling tanks to remove the sediment and particulate metals.⁴⁶⁴

While coal mining can have serious impacts on animals, the emissions of coal fired power plants also can adversely affects wildlife, such as through the acidification of water resources.

Acid rain can harm forest ecosystems by directly damaging plant tissues. One of the best examples of direct damage involves the leaching of nutrients from the needles of red spruce, which has contributed to their decline in forests throughout the eastern United States. In other cases, acid rain can combine with other pollutants, such as ozone, to⁴⁶⁵

damage vegetation, increasing their vulnerability to pests.⁴⁶⁶ “Acid deposition can also affect forest ecosystems indirectly by changing the chemistry of forest soils.”⁴⁶⁷ Acid deposition releases aluminum into the water around trees damaging their roots and impairing their ability to absorb nutrients.⁴⁶⁸

Nitrogen deposition is also dangerous to wildlife habitats including coastal waters.⁴⁶⁹ The effects include high mortality rates among estuarine and marine plants and animals, along with a loss of biological diversity.⁴⁷⁰ Nitrogen deposition also impairs important habitats like seagrass

⁴⁵⁵ *Id.* Acid mine drainage is metal-rich water formed from the chemical reaction between water and rocks containing sulphur-bearing minerals. *Id.*

⁴⁵⁶ *Id.*

⁴⁵⁷ *Id.* Pa. has “about 2,200 stream miles impacted.” *Id.*

⁴⁵⁸ *Id.*

⁴⁵⁹ U.S. Fish & Wildlife Serv., Dep’t of Interior, Ecological Servs., <http://www.fws.gov/northeast/ecologicaleservices/energycoal.html> (last updated July 20, 2015).

⁴⁶⁰ *Id.*

⁴⁶¹ U.S. Envt'l Prot. Agency, *supra* note 453.

⁴⁶² *Id.*

⁴⁶³ *Id.*

⁴⁶⁴ *Id.*

⁴⁶⁵ U.S. Envl. Prot. Agency, *Human Health & Envlt. Effects of Emissions from Power Generation*, <http://www3.epa.gov/captrade/documents/power.pdf> (last visited Dec. 29, 2015).

⁴⁶⁶ *Id.*

⁴⁶⁷ *Id.*

⁴⁶⁸ *Id.*

⁴⁶⁹ *Id.*

⁴⁷⁰ *Id.*

beds that provide shelter from predators and are essential nurseries for numerous marine species.⁴⁷¹ Large amounts of nitrogen in the water can also promote the growth of algal blooms,⁴⁷² which kill large numbers of fish from its toxicity and by depleting oxygen levels in the water.⁴⁷³

Emissions from power plants are the largest source of mercury pollution in the United States.⁴⁷⁴ Mercury can be transmitted to the environment from raindrops, dust or simply be deposited by air.⁴⁷⁵ Some of this mercury is conveyed into Pennsylvania's water supply where it is converted into methylmercury by microorganisms.⁴⁷⁶ As recently as 2005, power plants released a total of 53 tons of mercury into the atmosphere.⁴⁷⁷ Since that time, plant operators have been regulatorily required to reduce mercury emissions by 90 percent.⁴⁷⁸

Birds and mammals that eat fish are more exposed to methylmercury than any other animals in water ecosystems.⁴⁷⁹ Similarly, predators that eat fish-eating animals are also at risk and methylmercury continues to travel up the food chain.⁴⁸⁰ Effects of methylmercury exposure on wildlife can include mortality, reduced fertility, slower growth and development and abnormal behavior that affects survival, depending on the level of exposure.⁴⁸¹ In addition, research indicates that the endocrine system of fish, which plays an important role in fish development and reproduction, may be altered by the levels of methylmercury found in the environment.⁴⁸²

"Coal ash is" the leftover solid waste produced when coal is burned at power plants and is "one of the largest types of industrial waste generated in the United States."⁴⁸³ In 2014, 129,684,142 tons of ash are estimated to have been produced by coal burning power plants.⁴⁸⁴ In the past, fly ash was released into the air through the smokestack but is now captured by pollution control devices.⁴⁸⁵ In the United States, coal combustion products that are not reused are generally stored on site in ponds or placed in landfills.⁴⁸⁶

⁴⁷¹ *Id.*

⁴⁷² E.g., red tides.

⁴⁷³ *Id.*, Nutrient Pollution, <http://www.epa.gov/nutrientpollution/effects-environment> (last updated Oct. 5, 2015).

⁴⁷⁴ *Id.*, Mercury & Air Toxic Standards (MATS), <http://www3.epa.gov/mats/powerplants.html> (last updated Nov. 19, 2015).

⁴⁷⁵ *Id.*, Mercury (Sept. 11, 2005-Sept. 17, 2015),

<https://web.archive.org/web/20150917192832/http://www.epa.gov/mercury/about.htm> (accessed in the Internet Archive).

⁴⁷⁶ Agency for Toxic Substances & Disease Registry, U.S. Dep't of Health & Human Servs., *Public Health Statement for Mercury* 1.2, 1.3, 1.4, <http://www.atsdr.cdc.gov/ToxProfiles/tp46-c1-b.pdf> (1999).

⁴⁷⁷ U.S. Envtl. Prot. Agency, *supra* note 465.

⁴⁷⁸ *Id.*

⁴⁷⁹ *Id.*, *Mercury Study Rep. to Congress O-3* (1997), available at <http://www3.epa.gov/airtoxics/112nmerc/volume1.pdf>.

⁴⁸⁰ *Id.*

⁴⁸¹ *Id.* at O-3, 2-6.

⁴⁸² K. Fynn-Aikins *et al.*, *An Evaluation of Methyl Mercury as an Endocrine Disruptor in Largemouth Bass*, http://fl.biology.usgs.gov/posters/Ecotoxicology/Mercury_in_Bass/mercury_in_bass.html (last modified Dec. 14, 2012).

⁴⁸³ U.S. Envtl. Prot. Agency, Coal Ash Basics, <http://www.epa.gov/coalash/coal-ash-basics> (last updated Mar. 11, 2015).

⁴⁸⁴ Am. Coal Ash Ass'n, *2014 Coal Combustion Product (CCP) Prod. & Use Survey Rep.*, <https://www.acaa-usa.org/Portals/9/Files/PDFs/2014ReportFinal.pdf> (last visited Dec. 14, 2015).

⁴⁸⁵ Duke Energy, Particulate Control Techs.<https://www.duke-energy.com/environment/air-quality/particulate-control-technologies.asp> (last visited Dec. 14, 2015).

⁴⁸⁶ *Id.*, Solid Waste, <https://www.duke-energy.com/environment/solid-waste.asp> (last visited Dec. 14, 2015).

Environmental concerns of ash leaching into and contaminating groundwater and the rupture of a large impoundment of ash led to more stringent storage requirements.⁴⁸⁷ The largest ash spill in the country occurred in 2008 when a Tennessee Valley Authority barrier collapsed, releasing millions cubic meters of ash into the Emory River in Tennessee.⁴⁸⁸ Efforts to reduce ash spills and find a more beneficial use for the waste have led to its reuse in concrete and cement products.⁴⁸⁹ Ash is also reused in structural fills and embankments, mine filling, snow and ice control, and waste solidification.⁴⁹⁰ In 2014, approximately 48 percent of all coal combustion products were reused.⁴⁹¹

Nuclear

Unlike fossil fuel generated electricity, nuclear power plants do not release greenhouse gases during their operation that could contribute to climate change.⁴⁹² Mining uranium can lead to direct mortality and habitat loss. Runoff from mine tailings can sicken or kill wildlife exposed to it. As with other types of power plants, nuclear energy facilities incur a moderate risk to migratory birds through collisions with cooling towers and other tall infrastructure.⁴⁹³ Transmission lines used by power plants can cause bird mortality either from collision or electrocution.⁴⁹⁴ Additional impacts can include reduced habitat for plants and animals and disruption of animal transit routes.⁴⁹⁵

Power plant designs also require a nearby water source for steam production and as reactor coolant.⁴⁹⁶ Surface waters contain aquatic organisms that may be injured or killed through their interactions with the power plant. Operation of a condenser cooling system can entrap and entrain aquatic organisms.⁴⁹⁷ Nuclear power plants discharge materials allowed by their individual wastewater permits such as heavy metals and salts which build up in the water systems.⁴⁹⁸ These water pollutants, as well as the higher temperature of the water discharged from the power plant, can negatively affect water quality and aquatic life.⁴⁹⁹ Generally no aquatic organisms survive at plants with closed-cycle cooling that recirculate water through cooling towers, although the volumes of water withdrawn are relatively low.⁵⁰⁰ Discharges from the plant heat rejection system may affect the receiving body of water through heat loading and chemical contaminants, most notably chlorine. Heated effluents can kill aquatic organisms directly by either heat shock

⁴⁸⁷ U.S. Envtl. Prot. Agency, Final Rule: Disposal of Coal Combustion Residuals from Electric Utils., <http://www.epa.gov/coalash/coal-ash-rule> (last updated Oct. 21, 2015).

⁴⁸⁸ *Id.*, Summary of Past & Current EPA Response Activities Regarding the TVA Kingston Coal Ash Spill, <http://archive.epa.gov/pesticides/region4/kingston/web/html/summary.html> (last updated June 9, 2015).

⁴⁸⁹ *Id.*, Coal Ash Reuse, <http://www.epa.gov/coalash/coal-ash-reuse> (last updated July 8, 2015).

⁴⁹⁰ Am. Coal Ash Ass'n, About Coal Ash, <https://www.acaa-usa.org/About-Coal-Ash/CCP-FAQs> (2014).

⁴⁹¹ Am. Coal Ash Ass'n, *supra* note 484.

⁴⁹² Nuclear Energy Inst., Life-Cycle Emissions Analyses, <http://www.nei.org/Issues-Policy/Protecting-the-Environment/Life-Cycle-Emissions-Analyses> (2016).

⁴⁹³ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-29.

⁴⁹⁴ *Id.*

⁴⁹⁵ U.S. Nuclear Regulatory Comm'n, *supra* note 326, at 2.3.

⁴⁹⁶ *Id.* at 2.2.

⁴⁹⁷ *Id.* at 2.3.5. Aquatic organisms that are too large to pass through the intake debris screens may be trapped against them, which can lead to injuries or suffocation or harm large numbers of fish and large invertebrates. Other aquatic organisms are small enough to pass through the debris screens will travel through the cooling system in a process called entrainment. *Id.*

⁴⁹⁸ *Id.* at 2.3.3.

⁴⁹⁹ *Id.* at 2.3.3, 2.3.5.

⁵⁰⁰ *Id.* at 2.2.3, 2.3.2.

or cold shock.”⁵⁰¹ In addition, a number of indirect stresses associated with thermal discharges can increase the incidence of disease, predation, or parasitism.⁵⁰²

While the day-to-day operations of a nuclear power plant pose little risk to most nearby forms of wildlife, an incident involving the release of high levels of radiation on the scale of the Chernobyl or Fukushima would affect an entire ecosystem for an undetermined amount of time. Research conducted at sites of high radiation indicate that chronic exposure to radiation results in genetic damage and increased mutation rates in reproductive and non-reproductive cells in animals.⁵⁰³ Population sizes and numbers of species are generally lower in areas of high contamination in Chernobyl and Fukushima.⁵⁰⁴

It is possible that some species are not affected, and at Chernobyl others even appear to increase in numbers over time, presumably in response to more available food and shelter and fewer predators.⁵⁰⁵ Many species show evidence of genetic damage stemming from acute exposures and the differences observed between Fukushima and Chernobyl suggests some species may show the consequences of mutation accumulation over multiple generations.⁵⁰⁶ A more likely scenario occurring in the United States involves the limited release of radioactive emissions following an accident at a nuclear plant.

Oil

The main risk from onshore oil extraction is animal mortality and habitat loss from contact with accidental spills or reserve pits where drilling muds and waste fluids are stored.⁵⁰⁷ “Depending on state regulations oil operators are allowed from 30 days to one year” to close a reserve pit.⁵⁰⁸ Offshore oil extraction can harm the environment and wildlife through accidental discharge of oil, drill cuttings, and production water though the effects are generally localized.⁵⁰⁹ Birds and bats can be injured or die from collisions with offshore oil platforms and toxics. Studies in the Gulf of Mexico show that periodic collisions with oil and gas platforms can occur for migrating birds.⁵¹⁰ “The exposure is greatest during the migratory seasons and with conditions of low visibility.”⁵¹¹ Both onshore and offshore oil drilling can lead to bird mortality from contact with harmful emissions or flared gases.⁵¹²

The transportation of oil is one of the largest impacts associated with oil production due to the widespread contamination possible in the event of an accidental spill.⁵¹³ Oil is primarily transported through the use of tankers, barges, and pipelines.⁵¹⁴ Accidents can occur with any

⁵⁰¹ *Id.* at 2.3.5.

⁵⁰² *Id.*

⁵⁰³ Timothy A. Mousseau & Anders P. Moller, *Genetic & Ecological Studies of Animals in Chernobyl & Fukushima*, 105 J. Heredity 704, 705 (2014), available at <http://jhered.oxfordjournals.org/content/105/5/704.full.pdf+html>.

⁵⁰⁴ *Id.* at 707.

⁵⁰⁵ Nat. Sci. Research Lab., Museum at Tex. Tech. Univ., *Chernobyl, 25 Years Later: Biological Legacy of a Nuclear Meltdown* (2011-12), available at <http://www.nsrl.ttu.edu/about/Outreach/Chernobyl%20Exhibit.pdf>.

⁵⁰⁶ See generally Mousseau & Moller, *supra* note 503.

⁵⁰⁷ U.S. Fish & Wildlife Serv., Dep’t of Interior, Reserve Pits,

<http://www.fws.gov/contaminants/documents/reservepitsbirdmortality.pdf> (2009).

⁵⁰⁸ *Id.* In Pa., an oil operator has up to 270 days to close a reserve pit after drilling. *Id.*

⁵⁰⁹ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-21.

⁵¹⁰ *Id.* at 3-22.

⁵¹¹ *Id.*

⁵¹² *Id.*

⁵¹³ *Id.* at 3-21 to -22.

⁵¹⁴ *Id.* at 3-21.

method of transportation and release oil into the surrounding environment resulting in injury or death to exposed wildlife as well as habitat loss.⁵¹⁵ Many of the largest offshore oil spills occur in areas of heavy ship traffic and from the months of January to March, when stormy weather contributes to shipping accidents.⁵¹⁶ In aquatic environments, containing spills is difficult and costly as it spreads. “Each year an average of 14 million gallons of oil are released into fresh and salt waters in and around the United States from more than 10,000 accidental spills.”⁵¹⁷

The adverse effects experienced by animals in contact with oil is known as oil intoxication.⁵¹⁸ While virtually any species can be affected by oil toxicity, aquatic bird species are most commonly endangered by oil spills.⁵¹⁹ They are particularly vulnerable to spills since oil can coat the feathers of birds disrupting their buoyancy and insulation can result in mortality from drowning or hypothermia.⁵²⁰ Cleaning the feathers of contaminated birds is a highly labor intensive project but possible through soaking feathers in hot water and by using dishwasher detergent to clean the feathers.⁵²¹ Oil can have similar harmful effects on the pelts of sea otters.⁵²²

Since many major spills occur during winter months when birds are concentrated at wintering sites, high numbers of aquatic birds can be affected by a single spill.⁵²³ While the feathers of oiled birds may be one of the most noticeable symptoms, birds who have ingested oil from preening may have serious internal injuries and dehydration.⁵²⁴ If a bird returns to its nest after contact with oil, it risks contaminating their eggs leading to difficulty hatching and higher rates of embryonic mortality.⁵²⁵

The effects of burning oil are similar to coal since both are fossil fuel as it releases multiple emissions that cause regional and global wildlife effects include the release of greenhouse gases and nitrogen deposition.⁵²⁶ Since oil has a lower mercury content than coal, burning oil has a decreased risk for mercury bioaccumulation in the environment.⁵²⁷ There are several negative environmental impacts derived from the cooling system used by oil burning power plants.⁵²⁸ As with coal and nuclear power stations birds may collide with the cooling towers or other vertical structures causing injury or mortality.⁵²⁹ Intake from nearby water sources can trap and injure small aquatic organisms.⁵³⁰ Releasing the water after used for cooling can cause chemical disruptions to aquatic wildlife.⁵³¹

⁵¹⁵ *Id.*

⁵¹⁶ Pa. Game Comm'n, Wildlife Disease Reference Library–Oil Toxicity, <http://www.portal.state.pa.us/portal/server.pt?open=514&objID=1725211&mode=2> (2013).

⁵¹⁷ *Id.*

⁵¹⁸ Mich. Dep't of Nat. Res., Oil Intoxication, http://www.michigan.gov/dnr/0,4570,7-153-10370_12150_12220-27243--,00.html (2015).

⁵¹⁹ *Id.*

⁵²⁰ *Id.*

⁵²¹ *Id.*

⁵²² Pa. Game Comm'n, *supra* note 516.

⁵²³ *Id.*

⁵²⁴ *Id.*

⁵²⁵ *Id.*

⁵²⁶ N.Y. State Energy Research & Dev. Auth., *supra* note 320, 3-22.

⁵²⁷ *Id.*

⁵²⁸ *Id.* at 3-20.

⁵²⁹ *Id.* at 3-2, 3-3.

⁵³⁰ *Id.* at 3-3.

⁵³¹ *Id.*

Hydropower

The construction of hydropower plants can alter sizable portions of land when dams are constructed and lakes are created, flooding land that might have previously been agricultural or wildlife habitat. Dammed reservoirs are used for multiple purposes, such as agricultural irrigation, flood control, and recreation, so that not all wildlife impacts associated with dams can be attributed to hydroelectric power. However, hydroelectric facilities can still have a major impact on aquatic ecosystems. Common impacts of hydropower dams involve fish and other organisms being injured on turbine blades though there are of methods to minimize the impact, including fish ladders and in-take screens.⁵³²

There is a large potential impact on wildlife during the creation of a hydroelectric dam, as aquatic and terrestrial habitats are both disrupted during construction.⁵³³ When the reservoir is filled with water, previously terrestrial habitat is lost and animals are displaced to adjacent areas, which can effect hundreds of acres.⁵³⁴ Aquatic animals such as fish are also disrupted, as lands associated with spawning, foraging, and nesting are altered or destroyed.⁵³⁵ These alterations in the environment may decrease biodiversity or population size.

Hydroelectric projects can fragment rivers into discreet segments; block access to seasonally important aquatic habitats; degrade the functions and values of those habitats for fish and wildlife that depend on them; and, disconnect coastal rivers from the sea thereby blocking fish migrations.⁵³⁶ The effects can impact the safe and effective passage of fish through the project; cause fish to be entrained into the turbines; drain stream reaches and reduce stream watersheds resultant in loss of aquatic habitat; and, impact wetlands and nesting birds.⁵³⁷

While hydropower dams do not pollute water in the traditional sense, they impact rivers altering the temperature and chemical makeup of water that is stored behind and released by dams.⁵³⁸ Releases must be carefully controlled or water levels downstream can drop and animal and plant life can be harmed. In addition, reservoir water is typically low in dissolved oxygen and colder than normal river water. Releasing colder water can have negative impacts on downstream plants and animals.

Hydroelectric dams are unusual compared to other forms of energy generation because they also pose a high level of risk to animals once they are decommissioned.⁵³⁹ When the reservoir is drained, downstream habitats are affected by the sediments released and aquatic life that reside near the dam lose their artificially created habitat.⁵⁴⁰ Decommissioning a dam can result in high levels of fish mortality and greater predation rates while some fish are trapped in shallow pools of water.⁵⁴¹

⁵³² U.S. Energy Info. Admin., Dep't of Energy, *Hydropower Explained*, http://www.eia.gov/energyexplained/index.cfm?page=hydropower_environment (last reviewed Oct. 5, 2015).

⁵³³ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-30.

⁵³⁴ *Id.* at 3-29, 3-30.

⁵³⁵ *Id.*

⁵³⁶ U.S. Fish & Wildlife Serv., Dep't of Interior, Ecological Servs., <http://www.fws.gov/northeast/ecologicaleservices/energyhydro.html> (last updated July 20, 2015).

⁵³⁷ *Id.*

⁵³⁸ U.S. Energy Info. Admin., *supra* note 532.

⁵³⁹ N.Y. State Energy Research & Dev. Auth., *supra* note 320, at 3-32.

⁵⁴⁰ *Id.*

⁵⁴¹ *Id.*

Solar Panels

Overall, the effects of photovoltaic solar panels on wildlife is thought to be low compared to other forms of electric generation since they produce no air or water emissions.⁵⁴² Like other forms of electric generation, setting up a solar energy facility will make that land inaccessible to some wildlife causing habitat loss or fragmentation as well as displacing animals from the area.⁵⁴³ Some of the effects can be limited by keeping ground disturbances to a minimal level or placing solar panels on top of buildings or other existing infrastructure.

Recent media reports document some instances of birds incinerating after flying through solar energy facilities in south western regions of the country.⁵⁴⁴ This occurred at facilities using a different method of energy technology called Concentrating Solar Power, which is designed to focus thermal energy from the sun to generate electricity. This form of solar energy is unlikely to be developed in Pennsylvania because of the specific siting requirements needed to construct such facilities, which need large areas of flat land exposed to large amounts of sunlight. In desert areas, photovoltaic panels can result in wildlife mortality because of birds striking panels, which are mistaken for water due to its reflective surface.⁵⁴⁵ Due to the recent implementation of the technology, it remains unknown how solar panels interact with non-desert environments.

Nuisance Claims Against Wind Farms

During construction, all types of energy production facilities have the potential to create noise, disrupt traffic and temporarily annoy the community in which it is being built. Wind farms are prime suspects for nuisance claims due to their aesthetic presence, noise generation, and flicker effect. Turbine constructors are not immune to claims of nuisance or trespass, and are generally aware of the issues that bring about these legal claims. During construction, developers often take noise and vibration emissions into consideration, conducting various tests and site examinations to ensure their facilities fall within the ordinances and regulations of the locality in which the facility resides.⁵⁴⁶ Despite precautions developers take in selecting turbine locations, legal action can be brought by private citizens whose property neighbors the farms; the two most likely lawsuits regarding wind turbines include private nuisance claims and trespass to land.⁵⁴⁷

⁵⁴² U.S. Envt'l Prot. Agency, Clean Energy (July 24, 2008-Oct. 12, 2015), <https://web.archive.org/web/20150905082210/http://www.epa.gov/cleanenergy/energy-and-you/affect/non-hydro.html> (accessed in the Internet Archive).

⁵⁴³ *Id.*

⁵⁴⁴ E.g., John Upton, *Solar Farms Threaten Birds*, Scientific Am. (Aug. 27, 2014), <http://www.scientificamerican.com/article/solar-farms-threaten-birds/>.

⁵⁴⁵ Rebecca A. Kagan *et al.*, *Avian Mortality at Solar Energy Facilities in S. Cal.: A Preliminary Analysis* 2, 17, <http://alternativeenergy.procon.org/sourcefiles/avian-mortality-solar-energy-ivanpah-apr-2014.pdf> (2014).

⁵⁴⁶ Jason L. Richey & Jacquelyn S. Bryan, *Do Wind Farms Constitute a Nuisance or Trespass?*, Constr. L. Aug. 6, 2013, at 4, available at http://www.klgates.com/files/Publication/9c884fb1-1a50-4899-a27e-095fee690901/Presentation/PublicationAttachment/63ce333e-90c8-48be-9c22-0f8bbde0aefb/Construction_Law_Supplement.pdf.

⁵⁴⁷ *Id.*

Flicker Effect

There has been relatively little analysis of the human impacts of wind-energy projects in the United States. Wind-energy facilities often are highly visible. Potential irritants of wind turbines include the potential noise and observed movement of the turbine blades. As the blades of a wind turbine rotate in sunny conditions, they cast moving shadows through windows causing rapid changes in light intensity, called shadow flicker.⁵⁴⁸ Shadow flicker is different from a related strobe-like phenomenon that is caused by intermittent reflection of the sunlight from the rotating blades.⁵⁴⁹ Shadow flicker can be a nuisance to nearby humans, and its effects need to be considered during the design of a wind-energy project.

According to a wind energy association, shadow flicker can be predicted by modeling and proper siting; planting vegetation minimizes flicker.⁵⁵⁰ The rate at which wind turbine shadows flicker is below the frequency that is normally associated with seizures.⁵⁵¹ Given the frequency of the flickering caused by the wind turbine rotation, it should not cause a significant risk to health. Mitigation measures could include shutting down the turbines when necessary or the complainant could use window blinds when necessary.⁵⁵²

Aesthetic Concerns and Property Values

Wind-energy projects can be compatible with many recreational activities, but concerns may arise when they are close to recreational activities for which the enjoyment of natural scenery is an important part of the experience. Historic, sacred, and archeological resources can be harmed by direct impacts that affect the integrity of the resource or future opportunities for research and appreciation. The experience of certain historic or sacred sites or landscapes can also be indirectly affected by wind-energy projects, especially if particular qualities of the surrounding landscape have been documented as important to the experience, interpretation, and significance of the proximate historic or sacred site.

Residential areas near wind farms may be undesirable, due to noise generated by the turbine blades which can be equated to a noise level in between running air conditioner and a refrigerator 300 meters away.⁵⁵³ Worries of wind turbines affecting property values are common to home owners, however a study in Massachusetts found relatively little difference between home sales located near wind farms and similar transactions within five miles of 41 wind turbines.⁵⁵⁴

⁵⁴⁸ U.K. Dep’t of Energy & Climate Change, *Update of UK Shadow Flicker Evidence Base 5*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48052/1416-update-uk-shadow-flicker-evidence-base.pdf (last visited Dec. 15, 2015).

⁵⁴⁹ *Id.* at 6.

⁵⁵⁰ *Id.* at 17. “[S]hadow flicker issues are less common in the United States than in Europe.” *Id.*

⁵⁵¹ *Id.*

⁵⁵² *Id.* at 48.

⁵⁵³ Gen. Elec. Co., GE Reps., <http://www.gereports.com/post/92442325225/how-loud-is-a-wind-turbine> (2015).

⁵⁵⁴ Carol Atkinson-Palombo & Ben Hoen, *Relationship between Wind Turbines & Residential Prop. Values in Mass. 1-2* (2014), available at https://emp.lbl.gov/sites/all/files/lbnl-6371e_0.pdf.

Validity of Nuisance and Trespass Claims

[N]o Pennsylvania appellate court has yet issued a published decision on the viability of a nuisance or trespass cause of action against a wind farm. An examination of current Pennsylvania law and decisions from other states indicates that a private nuisance cause of action against a wind farm in Pennsylvania may not be viable. A private nuisance is a non-trespassory invasion of another's private use and enjoyment of its land. In Pennsylvania, the invasion must be (1) be either "(a) intentional and unreasonable, or (b) unintentional and otherwise actionable under the rules controlling liability for negligent or reckless conduct, or for abnormally dangerous conditions or activities" and (2) cause the plaintiff "significant harm"⁵⁵⁵

The harm would be significant if it were seriously annoying or intolerable instead of inconvenient or annoying.⁵⁵⁶ A public nuisance does not exist unless a nuisance exists and affects the community at large and not merely the complaining parties.⁵⁵⁷ The law regarding trespass to land claims, as exemplified by the Restatement Second of Torts, §165, is:

One who recklessly or negligently, or as a result of an abnormally dangerous activity, enters land in the possession of another or causes a thing or third person so to enter is subject to liability to the possessor if, but only if, his presence or the presence of the thing or third person upon the land causes harm to the land, to the possessor, or to a thing or third person in whose security the possessor has a legally protected interest.⁵⁵⁸

Under the Second Restatement of Torts and existing case law in Pennsylvania, asserting trespass causes of action against wind farms will likely be unsuccessful. Policy also guides the concern of the courts. Given the past rulings or lack of decisions within Pennsylvania regarding nuisance or trespass claims against a wind farm, future decisions pertaining to this topic will be weighed against growing support for renewable energy. Future reasonableness determinations in regard to nuisance claims will be weighed against the wind farm's utility and the gravity of the harm claimed. Given the standing of current law in Pennsylvania, successful causes of actions involving nuisance and trespass claims are unlikely to occur so long as wind farms fall within the regulations of the local authorities in which they are located.

⁵⁵⁵ Richey & Bryan, *supra* note 546. “[S]ignificant harm” is that sort of harm “that would be suffered by a normal person in the community or by property in normal condition and used for a normal purpose.” *Id.* https://emp.lbl.gov/sites/all/files/lbln-6371e_0.pdf.

⁵⁵⁶ *Karpia v. Russo*, 676 A.2d 270, 273 (Pa. Super. Ct. 1996).

⁵⁵⁷ *Id.* at 274-75.

⁵⁵⁸ *Id.* at 275.

TURBINE INTEGRATION WITH ELECTRIC GRID

The electric grid consists of large power plants that deliver electricity to substations, where power is then distributed to homes across and out of the state.⁵⁵⁹ However, electricity cannot be stored during periods of low demand for use during periods of high demand; nor can it be stored for inevitable disruptions outside the control of producers.

[E]lectricity cannot be stored in any appreciable quantities, and thus must be produced as needed. To provide electricity on demand, electric system operations have to be planned and conducted with that goal in mind. Lacking storage and responsive demand, operators must plan and operate power plants and the transmission grid so that demand and supply exactly match, every moment of the day, every day of the year, in every location.⁵⁶⁰

Most of the nation's enormous power needs are supplied by coal, natural gas, and nuclear energy, which face two challenges in meeting market demands. Power producers wrestle with abrupt changes in consumer demand or supply to maintain sufficient capacity to meet market conditions. Further, traditional power plants have the disadvantage of costly and lengthy start-up times.

When a shutdown occurs, large power plants, particularly those fueled by coal, might take hours or even days to regain full output. Natural gas power plants have the benefit of ramping up or reducing output quickly but still depend on the required wind for integration of electricity from wind turbines, thus rendering wind power a viable but variable electricity producing method. Although wind power is variable, it serves as a gap filler power generation method, along with other renewable energy sources, to supplement the traditional power infrastructure when necessary.⁵⁶¹

Wind power generation is on the increase nationwide and within the Commonwealth. In 2012, wind was responsible for four percent of the nation's electricity.⁵⁶² Consumption of nonrenewable resources is offset through the increased use of smart grids, which integrate renewable resources into current grid infrastructure.

The Federal Energy Regulatory Commission (FERC) regulates the interstate transmission of oil, natural gas, and electricity.⁵⁶³ “[T]he Commission encouraged utilities to join regional

⁵⁵⁹ Anne Ju, *Adding Renewable Energy to Power Grid Requires Flexibility*, Cornell Chron., Mar. 31, 2015, available at <http://news.cornell.edu/stories/2015/03/adding-renewable-energy-power-grid-requires-flexibility>.

⁵⁶⁰ Div. of Energy Mkt. Oversight, Fed. Energy Regulatory Comm'n, *Energy Primer* 36 (2015), available at <http://www.ferc.gov/market-oversight/guide/energy-primer.pdf>.

⁵⁶¹ Am. Wind Energy Ass'n, Explore the Issues, <http://www.awea.org/Issues/Content.aspx?ItemNumber=4544> (last visited July 16, 2015).

⁵⁶² Brad Plumer, *What Happens If You Add Lots of Wind and Solar Power to the Grid?*, Wash. Post, Sept. 23, 2013, available at <https://www.washingtonpost.com/news/wonk/wp/2013/09/25/what-happens-if-you-add-lots-of-wind-and-solar-power-to-the-grid/>.

⁵⁶³ Fed. Energy Regulatory Comm'n, What FERC Does, <http://www.ferc.gov/about/ferc-does.asp> (updated June 24, 2014).

transmission organizations which would operate the transmission systems and develop innovative procedures to manage transmission equitably.”⁵⁶⁴ This rule requires that each public utility involved in the transmission of electricity in interstate commerce begin the process of creating and participating in a regional transmission organization.⁵⁶⁵ This rule set forth the minimum characteristics and functions for all participants, with the purpose being the promotion of “efficiency and reliability in the operation and planning of the electric transmission grid and ensuring non-discrimination in the provision of electric transmission services.”⁵⁶⁶ A regional transmission organization⁵⁶⁷

- ensures reliability of the grid;
- operates the grid in a defined geographical area;
- instantaneously balances supply and demand;
- operates competitive, nondiscriminatory markets;
- nondiscriminatorily interconnects generators; and
- plans for regional expansion of transmission.

The PJM Interconnection is an example of such a regional transmission organization. Beginning in 1927 as a power pool for three utilities serving customers in Pennsylvania and New Jersey, PJM became a fully functioning, independent system operator in 1996 and was designated a regional transmission organization in 2001.⁵⁶⁸ “PJM provides open access to the transmission and performs long-term planning. In managing the grid, PJM centrally dispatches generation and coordinates the movement of wholesale electricity in all or part of 13 states and the District of Columbia. PJM’s markets include energy, capacity and ancillary services.”⁵⁶⁹ Before retiring a unit, a generator owner must request the deactivation from PJM so that systemic reliability can be analyzed.⁵⁷⁰ PJM is responsible for managing an electric grid serving over 61 million people;⁵⁷¹ its service map is illustrated in Figure 5.⁵⁷²

⁵⁶⁴ *Id.*, Elec. Power Markets: Nat'l Overview, <http://www.ferc.gov/market-oversight/mkt-electric/overview.asp> (last updated Nov. 3, 2015.)

⁵⁶⁵ 18 C.F.R. § 35.34.

⁵⁶⁶ *Id.*

⁵⁶⁷ Div. of Energy Mkt. Oversight, *supra* note 560, at 58.

⁵⁶⁸ Fed. Energy Regulatory Comm'n, Elec. Power Markets: PJM, <http://www.ferc.gov/market-oversight/mkt-electric/pjm.asp> (last updated Nov. 17, 2015).

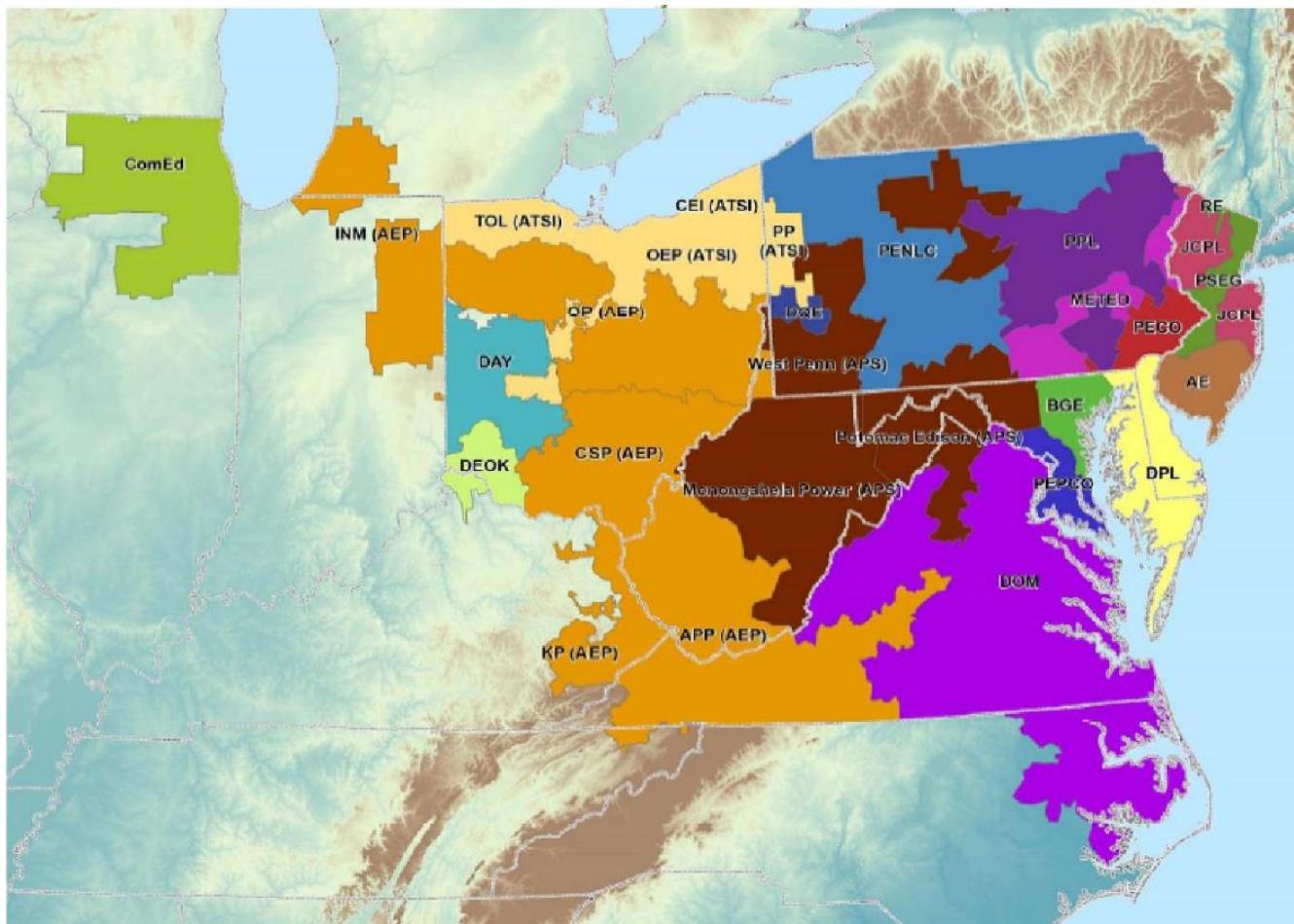
⁵⁶⁹ Div. of Energy Mkt. Oversight, *supra* note 560, at 93. The states are Del., Ill., Ind., Ky., Md., Mich., N.J., N.C., Ohio, Pa., Tenn., Va. & W. Va.. *Id.*

⁵⁷⁰ *Id.* at 97.

⁵⁷¹ PJM, Who We Are, <http://www.pjm.com/about-pjm/who-we-are.aspx> (last visited Nov. 19, 2015).

⁵⁷² *Id.* Figure 5 shows service areas for PJM Interconnection, <http://www.pjm.com/~/media/about-pjm/pjm-zones.ashx> (last visited June 12, 2015).

Figure 5
PJM Service Map
2012



Source: FERC, “Electric Power Markets: PJM,” website. Available at <http://www.ferc.gov/market-oversight/mkt-electric/pjm/elec-pjm-footprint.pdf>

With generators feeding power into the grid using a multitude of sources from several states, upgrading grid technology allows for increasingly accurate energy production and forecasting. Grid modernization, integration of renewables, and the creation of a smart grid has become the focus of both FERC and PJM. Title XIII of the Energy Independence and Security Act of 2007 calls for smart grids to have:⁵⁷³

⁵⁷³ Fed. Energy Regulatory Comm'n, Smart Grid, <http://www.ferc.gov/industries/electric/indus-act/smart-grid.asp>, (last updated Oct. 24, 2014).

1. increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid;
2. dynamic optimization of grid operations and resources, with full cybersecurity;
3. deployment and integration of distributed resources and generation, including renewable resources;
4. development and incorporation of demand response, demand-side resources, and energy efficiency resources;
5. deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation;
6. integration of "smart" appliances and consumer devices;
7. deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal storage air conditioning;
8. provision to consumers of timely information and control options;
9. development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid; and
10. identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.

Smart grid enhancements add digital technologies to the grid, and enable the real-time coordination of supply and demand resources.⁵⁷⁴ Existent grid infrastructure already incorporates elements of smart functionality, however this use is currently limited to balancing supply and demand of electricity. Smart grids can increase this monitoring and implementation of new technology, overseeing not only supply and demand, but the integration of smart technology to every aspect of electric generation, including the monitoring of environmental impact, market enhancement, and improvement in efficiency, which may lead to lower costs. "Key capabilities of a smart grid system incorporate the integration and aggregation of distributed energy resources, demand response and large scale renewable energy sources."⁵⁷⁵

PJM has implemented upgrades such that current grid technology could handle an infusion of renewable energy without significant infrastructure changes.⁵⁷⁶ One of the main issues grid operators would have to overcome is "demand response": the electrical grid's response to increased demand by consumers; the goal being to integrate additional renewables into the grid while keeping natural gas and other non-renewable plants down from peak production status. Keeping non-renewable plants from their peak production provides the benefits of lower operational costs and pollution.⁵⁷⁷

⁵⁷⁴ *Id.*

⁵⁷⁵ J. Research Ctr., Eur. Comm'n, *Smart Grid Projects in Eur.: Lessons Learned & Current Devs.* 10 (2012 update), available at

http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/documents/Id-na-25815-en-n_final_online_version_april_15_smart_grid_projects_in_europe_-_lessons_learned_and_current_developments_-2012_update.pdf.

⁵⁷⁶ See Plumer, *supra* note 562.

⁵⁷⁷ *Id.*

Reliably integrating renewables into the grid requires a constant balancing of electricity generation with consumer demand.⁵⁷⁸ Electricity must be generated when it is being consumed; grid operators forecast demand and schedule electrical generators to meet this demand as well as to ensure electrical reserves sufficient to respond to forecast errors and systemic disturbances.⁵⁷⁹ The measure of success is frequency, which is 60 Hz in North America.⁵⁸⁰ When generation exceeds demand, the Hz rises; conversely, when demand exceeds generation, the Hz decreases.⁵⁸¹ That is to say loss of transmission line or large power plant (called acceptable dynamic performance of the grid) in the seconds up to one minute following the loss is critical to system reliability. Dynamic performance changes due to increased renewables, wind included, could have a substantial impact on all aspects of renewable integration.⁵⁸²

Through National Renewable Energy Laboratory, U.S. Department of Energy sponsored a study in 2010 of wind and solar integration in the eastern region of the United States.⁵⁸³ Its key findings include:⁵⁸⁴

1. High penetrations of wind generation (between 20 and 30 percent) of the electrical energy requirements are technically feasible with significant expansion of the transmission infrastructure.
2. New transmission will be required for all the future wind scenarios; planning for this transmission is imperative because it takes longer to build new transmission capacity than it does to build wind plants.
3. Without transmission enhancements, substantial curtailment, or shutting down of wind generation would be required for scenarios of 20 percent or greater electricity production.
4. Interconnection-wide costs for integrating large amounts of wind generation are manageable with large regional operating pools and significant market, tariff, and operational charges.
5. Transmission helps reduce the impacts of the variability of the wind, which reduces wind integration costs, increases reliability of the electrical grid, and helps make more efficient use of the available generation resources.
6. Wind generation displaces carbon-based fuels, directly reducing carbon dioxide emissions. Emissions continue to decline as more wind is added.

Increasing the amount of electricity wind power creates on the grid creates a variable problem, that being the variable nature of wind itself. Reliable delivery of electricity to consumers requires a continuous process of scheduling and altering electrical generation in response to evolving demand.⁵⁸⁵ “Sufficient amounts of wind generation increase the variability and uncertainty in demand that power system operators face from day to day or even from minute to minute.”⁵⁸⁶ The study also tackled the issue of reserves required in a grid that implemented upwards of 20 percent renewables, stating the following:

⁵⁷⁸ Cf. N. W. Miller et al., *W. Wind & Solar Integration Study Phase 3--Frequency Response & Transient Stability: Exec.Summary 1* (2014), available at <http://www.nrel.gov/docs/fy15osti/62906-ES.pdf>.

⁵⁷⁹ Id.

⁵⁸⁰ Id.

⁵⁸¹ Id. at 4-5.

⁵⁸² Id. at 27.

⁵⁸³ EnerNex Corp., *E. Wind Integration & Transmission Study 15-16* (revised 2011), available at <http://www.nrel.gov/docs/fy11osti/47078.pdf>.

⁵⁸⁴ Id. at 27-28.

⁵⁸⁵ Id. at 40.

⁵⁸⁶ Id.

With large amounts of wind generation, additional operating reserves are needed to support interconnection frequency and maintain balance between generation and load. Because the amounts of wind generation in any of the operating areas, for any of the scenarios, dramatically exceed the levels for which appreciable operating experience exists, the study team conducted statistical and mathematical analyses of the wind generation and load profile data to estimate the additional requirements.⁵⁸⁷

Operating Reserves

“In bulk electrical systems operations, different types of generation reserves are maintained to support the delivery of capacity and energy from resources to loads in accordance with good utility practice.”⁵⁸⁸ There are several types of reserves required for system operations:⁵⁸⁹

Contingency Reserves. Reserves to mitigate a “contingency,” which is defined as the unexpected failure or outage of a system component, such as a generator, a transmission line, a circuit breaker, a switch, or another electrical element. In the formal NERC definition, this term refers to the provision of capacity deployed by the balancing authority to meet the disturbance control standards . . . and other NERC and regional reliability organization contingency requirements.

Operating Reserves. That capability above firm system demand required to provide for regulation, load forecasting error, forced and scheduled equipment outages, and local area protection. This type of reserve consists of both generation synchronized to the grid and generation that can be synchronized and made capable to serving load within a specified period of time.

Regulating Reserves. An amount of reserve that is responsible to automatic generation control . . . and is sufficient to provide normal regulating margin. Regulating reserves are the primary tool for maintaining the frequency of the bulk electric system at 60Hz.

Spinning Reserves. The portion of operating reserve consisting of (1) generation synchronized to the system and fully available to serve load within the disturbance recovery period that follows a contingency event; or (2) load fully removable from the system within the disturbance recovery period after a contingency event.

Researchers found that increasing the wind production to levels of 20 percent or more increased the amount of operating reserves required to support interconnection frequency and balance the system in real time.⁵⁹⁰ In this research, contingency reserves were not “directly affected, but the amount of spinning reserves assigned to regulation duty must increase because of the additional variability and short-term uncertainty of the balancing area demand.”⁵⁹¹ Researchers

⁵⁸⁷ *Id.* at 41.

⁵⁸⁸ *Id.*

⁵⁸⁹ *Id.*

⁵⁹⁰ *Id.*

⁵⁹¹ *Id.*

concluded the following in regard to reserve requirements with substantial amounts of wind generation:⁵⁹²

- The assumptions made about how the Eastern Interconnection will be operated in 2024 played an important role in minimizing the additional amounts of spinning reserve that would be required to manage the variability of large amounts of wind generation.
- The large size of the market areas assumed in the study allows substantial benefits of geographic diversity to be realized.
- The pooling of larger amounts of load and discrete generating resources via regional markets also realizes diversity benefits. The per-unit variability of load declines as the amount of load increases; larger markets also have more discrete generating units of diverse fuel types and capabilities for meeting load and managing variability.
- With real-time energy markets, changes in load and wind that can be forecast over a short interval—10 minutes in EWITS, 15 to 20 minutes in current practice—are compensated for through economic movements of participating generating units. Because load changes over 10-minute intervals can be accurately forecast, they can be cleared in a subhourly market.
- The fastest changes in balancing area demand—on time scales from a few to tens of seconds—are dominated by load, even with very large amounts of wind generation.
- Incremental regulating reserve requirements are driven by errors in short-term (e.g., 10 to 20 minutes ahead) wind generation forecasts.
- Data from the Eastern Wind Data Study can be used to characterize both variability and uncertainty for a defined scenario. With more wind generated over a larger geographic area, percentages of aggregate wind variability and uncertainty decrease. These quantitative characterizations are useful for estimating incremental reserve requirements.
- Current energy market performance shows that, on average, subhourly market prices do not command a premium over prices in the day-ahead market. Consequently, the hourly production simulation will capture most of the costs associated with units moving in subhourly markets, and the spinning reserve requirements for regulation and contingency will appropriately constrain the unit commitment and dispatch.

Wind Production and Integration / Grid Reliability

Generation displacement depends on the location and amount of wind that is being created and implemented into the grid.⁵⁹³ The primary effect of wind power generation is to offset that of conventional sources; with larger wind power production, the amount of displacement increases.⁵⁹⁴ Researchers found production costs for energy are reduced greater by wind in areas with higher overall costs.⁵⁹⁵ Because wind energy cannot be dispatched to meet needs during system stress,

⁵⁹² *Id.* at 43.

⁵⁹³ *Id.* at 44.

⁵⁹⁴ *Id.*

⁵⁹⁵ *Id.* This is partially due to energy costs being higher in the eastern portion of the interconnection. *Id.*

only a small portion of the capacity of wind farms can be counted on for serving peak loads. Reliability for the electric grid thus equates to having sufficient generation capacity to meet the forecasted load. Understanding the practical effect of wind power on the grid is also critical for capital investment.

A recent publication reviewed the operations and potential integration of renewables into the grid.⁵⁹⁶ The study found “that the PJM system, with adequate transmission expansion and additional regulating reserves, will not have any significant issues operating with up to 30% of its energy provided by wind and solar generation.”⁵⁹⁷ The study made several notable statements:⁵⁹⁸

- Although the values varied based on total penetration and the type of renewable generation added, on average, 36% of the delivered renewable energy displaced PJM coal fired generation, 39% displaced PJM gas fired generation, and the rest displaced PJM imports (or increased exports).
- No insurmountable operating issues were uncovered over the many simulated scenarios of system-wide hourly operation and this was supported by hundreds of hours of sub-hourly operation using actual PJM ramping capability.
- There was minimal curtailment of the renewable generation and this tended to result from localized congestion rather than broader system constraints.
- Every scenario examined resulted in lower PJM fuel and variable Operations and Maintenance (O&M) costs as well as lower average Locational Marginal Prices (LMPs). The lower LMPs, when combined with the reduced capacity factors, resulted in lower gross and net revenues for the conventional generation resources. No examination was made to see if this might result in some of the less viable generation advancing their retirement dates.
- Additional regulation was required to compensate for the increased variability introduced by the renewable generation. The 30% scenarios, which added over 100,000 MW of renewable capacity, required an annual average of only 1,000 to 1,500 MW of additional regulation compared to the roughly 1,200 MW of regulation modeled for load alone. No additional operating reserves were required.
- In addition to the reduced capacity factors on the thermal generation, some of the higher penetration scenarios showed new patterns of usage. High penetrations of solar generation significantly reduced the net loads during the day and resulted in economic operation which required the peaking turbines to run for a few hours prior to sun up and after sun set rather than committing larger intermediate and base load generation to run throughout the day.
- The renewable generation increased the amount of cycling⁵⁹⁹ on the existing fleet of generators, which imply increased variable O&M costs on these units. These increased costs were small relative to the value of the fuel

⁵⁹⁶ Gen. Elec. Int'l, PJM Renewable Integration Study (2014), available at <http://www.pjm.com/~/media/committees-groups/subcommittees/irs/postings/pris-executive-summary.ashx>.

⁵⁹⁷ *Id.* at 6-7.

⁵⁹⁸ *Id.* at 7.

⁵⁹⁹ “Cycling refers to the operation of electric generating units at varying load levels.” Nikhil Kumar, Intertek, Should You Care about Power Plant Cycling? (Dec. 26, 2012), <http://www.intertek.com/blog/2012-12-26-power-plant-cycling/>.

displacement and did not significantly affect the overall economic impact of the renewable generation.

GE Energy Consulting recommended “that PJM develop a method to determine regulation requirements based on forecasted” renewable production.⁶⁰⁰ Additionally, wind’s impact on the electrical grid specifically offsets coal and natural gas electricity generation.⁶⁰¹ Wind and solar resources offset more expensive generation resources, causing lower emissions and pollutants due to reduced operation of thermal generation resources.⁶⁰²

Study results show that the short-term variability in PJM load net renewables during a given hour is highly dependent upon the amount of wind and solar generation output during that hour. If the wind and solar generation is at a low level, then their contribution to variability is small and the need for regulation is dominated by load variability. However, if the wind and solar generation is high, then wind and solar variability dominate and more regulation is required. In an effort to minimize system operating costs, it would be prudent to only procure enough regulation to cover actual system needs each hour, as a function of wind and solar output each hour.⁶⁰³

Best industry practices relevant to PJM include:

- Sub-hourly scheduling and dispatch, for both internal (within RTO and within utility) and for scheduling on external interconnections with other balancing authorities, improves performance relative to sub-hourly variability.
- Consider separating regulation requirements into regulation up and regulation down if there is a shortage of regulation for certain hours, if there is a disproportionate need for a certain type of regulation, or if there is a desire to more finely tune regulation requirements.
- Have operating reserve requirements set by season or by level of expected variable generation, instead of a static requirement that changes infrequently.
- Use demand response to provide some reserves.
- Consider using contingency reserves for very large but infrequent wind and solar ramps.
- Require wind and solar generators to be capable of providing AGC.
- Implement a centralized forecasting system for wind and utility-scale solar that offers day-ahead, very short term (0-6 hours), short-term (6-72 hours), and long-term (3-10 days).
- Ensure that short-term wind and solar forecasting systems can capture the probability of ramps, or implement a separate ramping forecast.
- Institute a severe weather warning system that can provide information to grid operators during weather events.
- Monitor the use of confidence intervals on forecast data and consider adjusting them periodically based on actual performance.

⁶⁰⁰ Gen. Elec. Int’l, *supra* note 596, at 8. Short-term day to day forecasting could be used. *Id.*

⁶⁰¹ *Id.* at 18-19.

⁶⁰² *Id.*

⁶⁰³ *Id.* at 43-44.

- Integrate the wind and solar forecasts with load forecasts to provide a “net load” forecast.
- Institute requirements for data collection from wind and solar generators that can be used to track forecast performance.⁶⁰⁴

Offsetting non-renewable energy production methods would be significant for environmental change. A potential infusion of as much as 35 percent renewables could sharply reduce natural gas and coal’s share of the energy creation market and would also cut carbon-dioxide emissions from the grid by as much as 45 percent.⁶⁰⁵ The additional integration of renewables into the grid would result in cycling of coal powered and natural gas plants.⁶⁰⁶ This process promotes wear and tear on the plants and increases production cost by as much as \$157 million; however, this is a relatively nominal amount in comparison to the fuel savings of around \$7 billion by switching to wind and solar.⁶⁰⁷

Costs of Wind Turbines

Integrating wind and other renewable energy sources in the grid is not an inexpensive endeavor. The upfront costs are substantial, however the benefits would likely be seen quickly. Elements such as site surveying and preparation, through decommissioning need to be considered when calculating the potential costs of land based wind turbines. Several studies in recent years analyzed the cost of wind energy in the United States. A detailed cost per turbine and per megawatt and kilowatt hour was produced to project the future costs of installed wind turbines for both land-based and offshore turbine locations.⁶⁰⁸

Land-based wind project cost estimates were derived primarily from installed project data and supplemented with outputs from NREL’s Wind Turbine Design Cost and Scaling Model. Because of the absence of installed or operating offshore wind projects in the United States, the offshore reference project data were estimated from proposed U.S. projects and market data from the existing international offshore wind industry. The assumed wind resource regime for the offshore reference plant is comparable to that of the U.S. North Atlantic Coast. The land-based reference project was assumed to have a moderate wind resource regime and location within the interior region of the United States.

As domestic and global wind markets mature, information about component-level costs are increasingly available. To manage and organize this component-level cost data, NREL has developed a system cost breakdown structure (SCBS) for land-based and offshore wind projects. A SCBS is able to break an entire wind project into smaller, more specific components (e.g., gearbox and generator). It provides a standardized approach to characterizing total lifetime expenditures for wind projects at the component level, including both physical (e.g., materials, labor, and equipment) and financial (e.g., insurance, profit, and carrying charges) costs. Each

⁶⁰⁴ *Id.* at 42-43.

⁶⁰⁵ Plumer, *supra* note 562.

⁶⁰⁶ *Id.*

⁶⁰⁷ *Id.*

⁶⁰⁸ C. Moné *et al.*, 2013 *Cost of Wind Energy Rev.* (2015), available at <http://www.nrel.gov/docs/fy15osti/63267.pdf>.

level of the SCBS hierarchy represents an increasingly detailed look at the project components.

The three major component cost categories and many subcategories are represented in these figures including wind turbine (e.g., wind turbine components), balance of system (e.g., development, electrical infrastructure, assembly and installation), and financial costs (e.g., insurance and construction finance). From these data, it is clear that the breakdown of wind turbine component and installation costs varies greatly between land-based and offshore turbines. For example, the majority of the land-based project cost (68%) is in the turbine itself whereas the turbine makes up only 32% of the offshore reference project cost.⁶⁰⁹

From this report, a turbine cost can be split into the many components of its construction. Researchers developed a formula for calculating the cost of turbines, both offshore and land-based. Calculations were based on the leveled cost of energy (LCOE).⁶¹⁰

LCOE is a metric used to assess the cost of electricity generation and the total plant-level impact from technology design changes. LCOE can be used to compare costs of all electricity generator types, as long as the same formula and calculations are used for each type. Use of LCOE is especially important for technologies, where there is a constant tradeoff between maintaining or reducing capital investment and increasing energy capture, like wind and solar power.

There are four basic inputs into the LCOE equation. The first three—capital expenditures, operational expenditures, and annual energy production—enable this equation to capture system-level impacts from design changes (e.g., taller wind turbine towers). The total costs of financing are represented by the fourth basic input—a fixed charge rate—that represents the amount of revenue required to pay the carrying charges on an investment during the expected project life per year. For this analysis, the life of a wind project is assumed to be 20 years.⁶¹¹

Although technical, the four factors outlined above by the NREL are critical in determining the most accurate cost of turbine to date. In 2012, the United States installed 13.1 gigawatts of turbine capacity, at an installed cost of \$1,940/kW.⁶¹² This installed cost, weighted against the aforementioned factors, resulted in a total LCOE of \$73/MWh.⁶¹³ A breakdown of percentage of cost per turbine is detailed in Figure 6.⁶¹⁴

⁶⁰⁹ *Id.* at 5.

⁶¹⁰ *Id.* at 3.

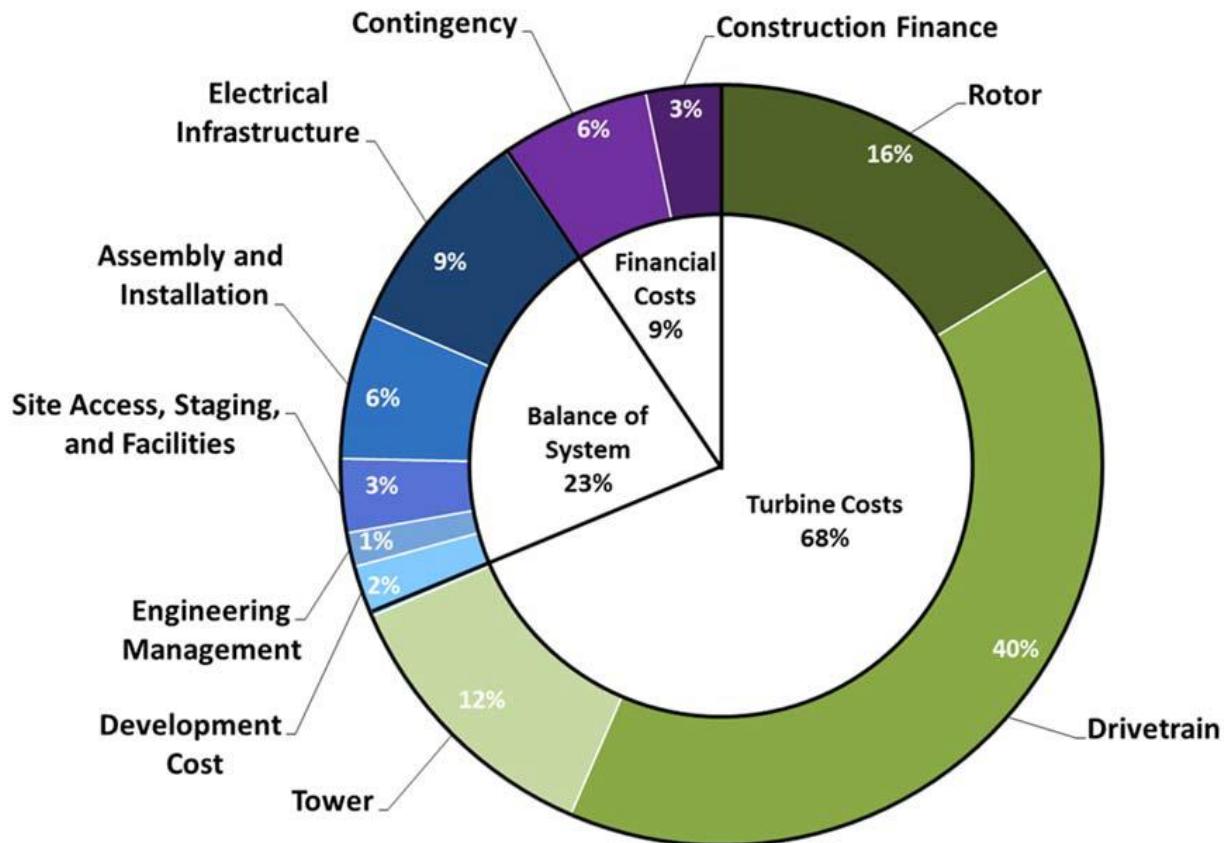
⁶¹¹ *Id.* at 13 (footnote omitted).

⁶¹² *Id.* at 23.

⁶¹³ *Id.*

⁶¹⁴ This image outlines all detailed costs involved with the installation of on-land wind turbines. Similar images can be accessed for detailed costs of off-shore turbines form the same rep.

Figure 6
Capital Expenditures
NREL's Land-based Wind Plant Reference Project
2013



Source: C. Moné, A. Smith, B. Maples, and M. Hand, "2013 Cost of Wind Energy Review," National Renewable Energy Laboratory, 6. Available at: <http://www.nrel.gov/docs/fy15osti/63267.pdf>

REGULATIONS

The oversight of wind energy is related elsewhere in this report.⁶¹⁵ There are no Commonwealth regulations, permit processes, setbacks, fees and end-of-life cycle disposal specifically related to wind energy. Department of Environmental Protection regulates impacts on the environment rather than specific sources of energy. Any regulation of impacts on wetlands, erosion and sedimentation, and earth disturbance activities apply to a wind energy development the same as it would on any other kind of development. In other words, the scale and location of the development matter rather than the fact that it is a wind energy development.

A Pennsylvania Natural Diversity Inventory Environmental Review is done to screen for potential impacts to species that are endangered, threatened or of special concern.⁶¹⁶ These species are protected accordingly by Department of Conservation and Natural Resources, Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission and U.S. Fish and Wildlife Service.

Pennsylvania Municipalities Planning Code authorizes municipalities to regulate land development and enact zoning ordinances.⁶¹⁷ Any requisite setbacks and decommissioning regulations would be through local ordinances. Pennsylvania's a model local ordinance for wind energy facilities appears in Appendix D.⁶¹⁸

⁶¹⁵ *Supra* pp. 20-26.

⁶¹⁶ A flowchart of this review appears in app. E, *infra* p.123.

⁶¹⁷ Municipal governments in the Commw. that have done so appear in app. C, *infra* p. 99.

⁶¹⁸ App. D, *infra* p. 103.

ALTERNATIVE ENERGY PORTFOLIO STANDARDS ACT

Progress of Wind Energy in Relation to the Act

Alternative Energy Portfolio Standards Act requires electric distribution companies or generation suppliers to sell retail customers an annually increasing amount of electric energy from alternative energy sources.⁶¹⁹ The act is implemented by Pennsylvania Public Utility Commission in cooperation with Department of Environmental Protection.⁶²⁰ An independent entity administers the program to certify, track and report alternative energy credits.⁶²¹

At the time of publication, the minimum percentage of the electric energy sold by distribution companies or generation suppliers is 5½ percent that must be generated from Tier I alternative resources, which include wind power.⁶²² In 2020, the minimum percentage requirement for electric energy generated from Tier I alternative resources maxes out at 7½.⁶²³ There are slightly higher percentage requirements for the electric energy required to be sold from Tier II alternative sources.⁶²⁴

The act is implemented through alternative energy credits, which can be self-generated or purchased.⁶²⁵ Excessive alternative energy credits in one year may be reserved for either or both of the next, two subsequent reporting years.⁶²⁶ Alternative compliance payments are imposed on companies and suppliers having inadequate alternative energy credits.⁶²⁷

For the most recent data obtained,⁶²⁸ all electric distribution companies and generation suppliers complied the act's AEPS requirements and no alternative compliance payments were

⁶¹⁹ Act of Nov. 30, 2004 (P.L.1672, No.213), § 3; 73 P.S. § 1648.3.

⁶²⁰ *Id.* § 7; 73 P.S. § 1648.7.

⁶²¹ *Id.* § 3(e)(2); 73 P.S. § 1648.3(e)(2).

⁶²² Pa. Pub. Util. Comm'n, *2013 Annual Rep.: Alt. Energy Portfolio Standards Act of 2004* 2 (2014), available at http://www.puc.state.pa.us/electric/pdf/AEPS/AEPS_Ann_Rpt_2013.pdf. Other Tier I alternative energy sources are solar photovoltaic & thermal, low-impact hydropower, geothermal, biologically derived methane gas, fuel cells, biomass & coal mine methane. Act of Nov. 30, 2004 (P.L.1672, No.213), § 2; 73 P.S. § 1648.2. The requisite percentage can be increased quarterly “to reflect any new biomass energy or low-impact hydropower resources that qualify as a Tier I alternative energy source”. 66 Pa.C.S. § 2814(c).

⁶²³ Act of Nov. 30, 2004 (P.L.1672, No.213), § 3(b); 73 P.S. § 1648.3(b). At the time of publication, the minimum percentage of the electric energy sold by distribution companies or generation suppliers is an additional 0.25% that must be generated from solar photovoltaic technologies, which are also Tier I alternative resources; in 2020, the minimum percentage requirement for electric energy generated from solar photovoltaic technologies maxes out at an additional 0.5%. *Id.*

⁶²⁴ *Id.* § 3(c); 73 P.S. § 1648.3(c). These percentages are 8.2 now maxing out at 10 in 2020. *Id.* Tier II alternative energy sources are waste coal, distributed generation sys., demand-side mgmt., large-scale hydropower, mun. solid waste, by-products of pulping & wood manufacturing process & integrated combined coal gasification technology.

Id. § 2; 73 P.S. § 1648.2.

⁶²⁵ *Id.* § 3; 73 P.S. § 1648.3.

⁶²⁶ *Id.*

⁶²⁷ *Id.* These payments go into sustainable energy funds and are solely used for projects to increase electric energy generated from alternative resources. *Id.*

⁶²⁸ The 2013 reporting yr..

required.⁶²⁹ Alternative energy credits may originate inside and outside of the Commonwealth but must originate within “the entire PJM Interconnection, LLC (regional transmission organization) area. For the 2013 reporting year, 40 percent of Tier I and 62 percent of Tier II” alternative energy credits “originated from generation facilities located in Pennsylvania. Recent analysis of proposed and existing resources indicates sufficient Tier I resources are available through the 2014 reporting year and Tier II through the 2021 reporting year.”⁶³⁰ For the 2013 reporting period, 57.6 percent of the alternative energy types to meet the Tier I obligations was wind.⁶³¹ “PJM has substantial existing and proposed renewable generation capacity”, and existent Tier I resources are estimated to be adequate now while Tier II resources are estimated to be adequate through 2021.⁶³² Table 7 sets forth the act’s percentage sales requirements.

Table 7

Overview of AEPS Percentage of Sales Requirement by 2021					
Year	Period	Tier I			Tier II
		Total	Solar PV	Non-Solar	
1	June 1, 2006 – May 31, 2007	1.5%	0.0013%	1.4987%	4.2%
2	June 1, 2007 – May 31, 2008	1.5	0.0030	1.4970	4.2
3	June 1, 2008 – May 31, 2009	2.0	0.0063	1.9937	4.2
4	June 1, 2009 – May 31, 2010	2.5	0.0120	2.4880	4.2
5	June 1, 2010 – May 31, 2011	3.0	0.0203	2.9797	6.2
6	June 1, 2011 – May 31, 2012	3.5	0.0325	3.4675	6.2
7	June 1, 2012 – May 31, 2013	4.0	0.0510	3.9490	6.2
8	June 1, 2013 – May 31, 2014	4.5	0.0840	4.4160	6.2
9	June 1, 2014 – May 31, 2015	5.0	0.1440	4.8560	6.2
10	June 1, 2015 – May 31, 2016	5.5	0.2500	5.2500	8.2
11	June 1, 2016 – May 31, 2017	6.0	0.2933	5.7067	8.2
12	June 1, 2017 – May 31, 2018	6.5	0.3400	6.1600	8.2
13	June 1, 2018 – May 31, 2019	7.0	0.3900	6.6100	8.2
14	June 1, 2019 – May 31, 2020	7.5	0.4433	7.0567	8.2
15	June 1, 2020 – May 31, 2021	8.0	0.5000	7.5000	10.0

Source: Pa. Pub. Util. Comm’n, *supra* note 622, at 2.

⁶²⁹ Pa. Pub. Util. Comm’n, *supra* note 622, at ii.

⁶³⁰ *Id.* Alternative energy credits “eligible for use in Pennsylvania may also be eligible to meet alternative energy requirements in other states. However, provisions are in place to ensure credits are used only once.” *Id.* at 9.

⁶³¹ *Id.*, at 5, 6. The next highest alternative energy type to meet the Tier I obligations was landfill gas, which was 25.9%. *Id.* In other words, wind and landfill gas were 83½% of the alternative energy types retired to meet Tier I obligations and seven other types were the remaining 16½%.

⁶³² *Id.* at 17-18.

Clean Power Plan

The finalized version of President Obama's Clean Power Plan was released last year, with a major goal of reducing carbon dioxide emissions by 32 percent below 2005 levels by 2030.⁶³³ Environmental Protection Agency established "final emission guidelines for states to follow in developing plans to reduce greenhouse gas" emissions "from existing fossil fuel-fired electric generating units".⁶³⁴ Specifically, the agency established:

- 1) carbon dioxide emission performance rates for two subcategories of existing fossil fuel-fired electric generating units;
- 2) state-specific CO₂ goals reflecting the emission performance rates; and
- 3) guidelines for the development, submittal and implementation of state plans that establish emissions standards or other measures to implement the emission performance rates.⁶³⁵

The ramp up of wind energy production is a significant cost-effective solution to reducing emissions within the United States and Pennsylvania. "[W]ind is increasingly economically competitive with other resource types" and is expect to have an electric generation capacity that more than triples by 2040.⁶³⁶ Wind energy has consistently become an effective way to reduce emissions while increasing the amount of renewable energy available to consumers. The image below outlines the share of the lowest cost mix by 2030 derived from recent data of U.S. Energy Information Administration.⁶³⁷

⁶³³ U.S. Envtl. Prot. Agency, Clean Power Plan, <http://www.epa.gov/cleanpowerplan/fact-sheet-clean-power-plan-numbers> (last updated Aug. 13, 2015).

⁶³⁴ Carbon Pollution Emission Guidelines for Existing Stationary Sources: Elec. Util. Generating Units, 80 Fed. Reg. 64662 (Oct. 23, 2015) (to be codified at 40 C.F.R. pt. 60).

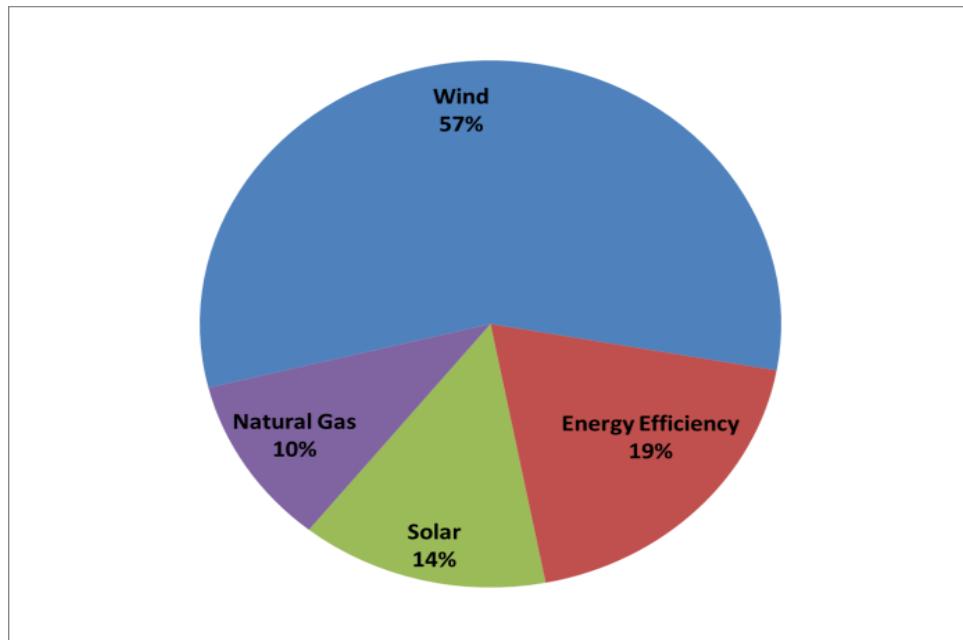
⁶³⁵ *Id.*

⁶³⁶ U.S. Energy Info. Admin., Dep't of Energy, *Analysis of the Impacts of the Clean Power Plan* 36 n.27 (2015), available at <http://www.eia.gov/analysis/requests/powerplants/cleanplan/pdf/powerplant.pdf>.

⁶³⁷ Am. Wind Energy Ass'n, EIA Analysis Shows Wind is Most Cost Effective Option for Clean Power Plan Compliance 1-2, <http://awea.files.cms-plus.com/AWEA%20report%20on%20EIA%20CPP%20analysis%20July%202015.pdf> (last visited Aug. 10, 2015).

Department of Environmental Protection expects to submit the Commonwealth's final Clean Power Plan to U.S. Environmental Protection Agency in September 2016.⁶³⁸

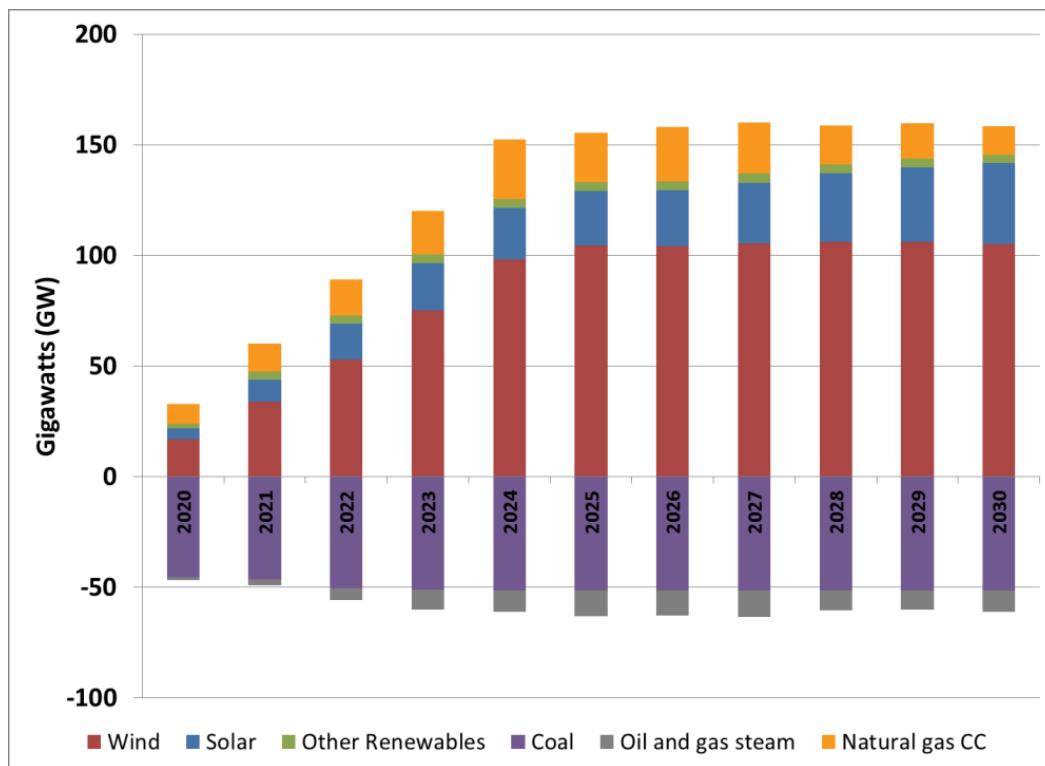
Figure 7
Forecast for
Projected Lowest Cost Energy Mix
2030



⁶³⁸ Pa. Dep't of Envtl. Prot., Clean Power Plan (Sept. 9, 2015), available at <http://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/ClimateChange/Clean%20Power%20Plan%20Presentation%20-%20Sec.%20John%20Quigley%20-%2009092015.pdf>.

Figure 8 details the national, cumulative change in generation mix through 2030, using the administration's Clean Power Plan forecast, with natural gas being the primary compliance source until it is overtaken by wind in the early to mid-2020's.⁶³⁹

Figure 8
Clean Power Plan Forecast
Energy Generation by Source
2020-2030



⁶³⁹ Figures 7 & 8 are reproduced from Am. Wind Energy Ass'n, *supra* note 637, at 2, 3.

APPENDIX A House Resolution No. 925

PRIOR PRINTER'S NO. 3856

PRINTER'S NO. 4072

THE GENERAL ASSEMBLY OF PENNSYLVANIA

HOUSE RESOLUTION

No. 925

Session of
2014

INTRODUCED BY RAPP, OBERLANDER, SANKEY, MUSTIO, COHEN, MURT,
BLOOM, BENNINGHOFF, FLECK, R. MILLER, WATSON AND MOUL,
JUNE 26, 2014

AS REPORTED FROM COMMITTEE ON ENVIRONMENTAL RESOURCES AND
ENERGY, HOUSE OF REPRESENTATIVES, AS AMENDED,
SEPTEMBER 15, 2014

A RESOLUTION

- 1 Directing the Joint State Government Commission to conduct a
- 2 study and report on the scale and impact of wind turbines in
- 3 this Commonwealth.
- 4 WHEREAS, Wildlife conservation and energy efficiency should
- 5 be major considerations in the development of viable sources of
- 6 alternative energy; and
- 7 WHEREAS, Wind turbines were once assumed to have no adverse
- 8 environmental impacts, however, onshore wind energy facilities
- 9 have been reported to kill thousands of bats and birds and
- 10 require the clearing of large areas of land; and
- 11 WHEREAS, Many onshore and offshore wind energy facilities are
- 12 being planned and constructed without adequately considering the
- 13 potential or actual effects on wildlife; and
- 14 WHEREAS, Research and guidance are required before
- 15 potentially negative impacts on wildlife become severe and
- 16 irreversible; therefore be it

1 RESOLVED, That the House of Representatives direct the Joint
2 State Government Commission to conduct a comprehensive study on
3 the use of wind turbines in this Commonwealth; and be it further
4 RESOLVED, That the Joint State Government Commission include
5 in its study the number of wind turbines in this Commonwealth,
6 who owns them, which agencies oversee wind turbines and what
7 happens to them when they are decommissioned; and be it further
8 RESOLVED, That the Joint State Government Commission list
9 sources and amounts of subsidies for wind turbines, AS COMPARED
10 TO OTHER SOURCES OF ENERGY, SUCH AS COAL, NATURAL GAS, NUCLEAR
11 AND OIL; and be it further
12 RESOLVED, That the Joint State Government Commission include
13 in its study wind turbines' imprint acreage and their effects on
14 wildlife, AS COMPARED TO OTHER SOURCES OF ENERGY, SUCH AS COAL,
15 NATURAL GAS, NUCLEAR AND OIL; and be it further
16 RESOLVED, That the Joint State Government Commission study
17 wind turbines' impact on the electric grid; and be it further
18 RESOLVED, THAT THE JOINT STATE GOVERNMENT COMMISSION REVIEW
19 ANY CURRENT REGULATIONS, PERMIT PROCESSES, SETBACKS, FEES AND
20 END OF LIFE CYCLE DISPOSAL REQUIREMENTS RELATED TO WIND ENERGY
21 REQUIRED BY THE DEPARTMENT OF ENVIRONMENTAL PROTECTION AND OTHER
22 STATE AGENCIES; AND BE IT FURTHER
23 RESOLVED, THAT THE JOINT STATE GOVERNMENT COMMISSION REPORT
24 ON THE PROGRESS OF WIND ENERGY IN RELATION TO THE ACT OF
25 NOVEMBER 30, 2004 (P.L.1672, NO.213), KNOWN AS THE ALTERNATIVE
26 ENERGY PORTFOLIO STANDARDS ACT; AND BE IT FURTHER
27 RESOLVED, That the Joint State Government Commission report
28 its findings to the Governor's office and the General Assembly
29 within one year of the adoption of this resolution.

APPENDIX B

Federal Laws Possibly Applicable to Wind Energy Development

Federal Laws Possibly Applicable to Wind Energy Development	
Topic	Law
Farmland protection policy	7 U.S.C.A. §§ 4201-4209
Protection & conservation of wildlife	(Bald & Golden Eagles) 16 U.S.C.A. §§ 668-668d ⁶⁴⁰
	(migratory & insectivorous birds) 16 U.S.C.A. §§ 701-719c ⁶⁴¹
	(endangered species) 16 U.S.C.A. §§ 1531-1544 ⁶⁴²
National trails system	16 U.S.C.A. §§ 1241-1251
Coastal zone management	16 U.S.C.A. §§ 1451-1466
Soil & Water Resources Conservation	16 U.S.C.A. §§ 2001-2009
Water pollution prevention & control	33 U.S.C.A. §§ 1251-1388
	(floodplain mgmt. & prot. of wetlands) 42 U.S.C.A. §§ 4321-4370h
Noise	42 U.S.C.A. §§ 4901-4918 ⁶⁴³
Clean air	42 U.S.C.A. §§ 7401-7671q ⁶⁴⁴
Aviation safety	49 U.S.C.A. § 44718 ⁶⁴⁵

⁶⁴⁰ This act prohibits unpermitted takings of bald or golden eagles. 16 U.S.C.A. § 668(a).

⁶⁴¹ This act prohibits unpermitted taking migratory birds & waterfowl. *Id.* §§ 703(a), 718a(a).

⁶⁴² This act prohibits taking endangered species of fish or wildlife, damaging or destroying endangered species of plants & violating pertinent regulations. *Id.* § 1538(a).

⁶⁴³ Quiet Communities Program is administered nationwide through grants to states, local gov'ts & authorized reg'l planning agencies. 42 U.S.C.A. § 4901(c)(1).

⁶⁴⁴ Portions of the Clean Air Act are applicable to energy development.

⁶⁴⁵ This regulates standards to determining obstruction of navigable airspace & requires notification.

APPENDIX C

Counties with Regulatory Wind System Ordinances by Source

Counties with Regulatory Wind System Ordinances by Source ⁶⁴⁶			
County	Municipal Government	Ordinance	Ordained
Adams	Conewago	Code § 155-136 ⁶⁴⁷	
	Tyrone	Ordinance No. 2010-01 ⁶⁴⁸ Ordinance No. 2011-3 ⁶⁴⁹	10-10-10 10-12-11
Berks	Washington	Code § 131-70(G) ⁶⁵⁰	08-27-10
Blair	Frankstown	Ordinance No. 100207-D ⁶⁵¹	01-01-07
	Logan	Code Ch. 27, Pt. 14 ⁶⁵²	11-09-06
Bradford	North Towanda	Zoning Ordinance §§ 500.82, 500.83 ⁶⁵³	07-02-13
Bucks	Haycock	Zoning Ordinance § 404(H18) ⁶⁵⁴	06-03-08
	Springfield	Ordinance No. 173 ⁶⁵⁵	01-05-15
	Warrington	Mun. Code Ch. 27, Pt. 27 ⁶⁵⁶	06-24-14
Butler	Adams	Ordinance No. 141 ⁶⁵⁷	02-28-11
	Butler	Code § 300-32(A) ⁶⁵⁸	12-21-09
Cambria	Portage	Ordinance No. 2010-2 ⁶⁵⁹	04-07-10
Columbia	Briar Creek	Zoning Ordinance § 1103.27 ⁶⁶⁰	09-02-14

⁶⁴⁶ U.S. Dep’t of Energy, WINDEXchange, [#links \(last updated Nov. 24, 2015\).](http://apps2.eere.energy.gov/wind/windexchange/policy/ordinances.asp?page=5&field=state&order=desc)

⁶⁴⁷ Conewago Twp., Adams Cnty., Code § 155-136, <http://www.ecode360.com/10711979>.

⁶⁴⁸ Tyrone Twp., Adams Cnty., Ordinance No. 2010-01 (2010), available at <http://www.adamscounty.us/Munic/TyroneTwp/Documents/Ordinance%20No.%202010-01.pdf>.

⁶⁴⁹ *Id.*, Ordinance No. 2011-3 (2011), available at <http://www.adamscounty.us/Munic/TyroneTwp/Documents/Ordinance%202011-3%20Limited%20Agribusiness%20Amendment%20to%20Zoning%20Ord.pdf>.

⁶⁵⁰ Wash. Twp., Berks Cnty., Code § 131-70(G), available at <http://ecode360.com/11678925>.

⁶⁵¹ Frankstown Twp., Blair Cnty., Ordinance No. 100207-D, available at <http://www.blairco.org/FrankstownTwp/Pages/TownshipWindmillOrdinance.aspx> (last visited May 26, 2015).

⁶⁵² Logan Twp., Blair Cnty., Code Ch. 27, Pt. 14, available at <http://www.ecode360.com/28663193>.

⁶⁵³ N. Towanda Twp., Bradford Cnty., Zoning Ordinance §§ 500.82, 500.83 (2013), available at <http://www.puc.state.pa.us/pcdocs/1236573.pdf>.

⁶⁵⁴ Haycock Twp., Bucks Cnty., Zoning Ordinance § 404(H18), amend. available at [http://www.haycocktwp.com/PDF/ordinances/106-110/Ord_\(110\).pdf](http://www.haycocktwp.com/PDF/ordinances/106-110/Ord_(110).pdf).

⁶⁵⁵ Springfield Twp., Bucks Cnty., Ordinance No. 173 (2015), http://www.springfieldbucks.org/uploads/ord173_adopted2015.01.05.pdf.

⁶⁵⁶ Warrington Twp., Bucks Cnty., Mun. Code Ch. 27, Pt. 27, available at <http://www.ecode360.com/30419007>.

⁶⁵⁷ Adams Twp., Butler Cnty., Ordinance No. 141 (2011), <http://www.adamstwp.org/generator/assets/Ordinance%20141.pdf>.

⁶⁵⁸ Butler Twp., Butler Cnty., Code § 300-32(A), <http://ecode360.com/14207615>.

⁶⁵⁹ Portage Twp., Cambria Cnty., Ordinance No. 2010-2 (2010), <http://www.portagetwp.com/Documents/Ordinances/Ord%202-2010%20Wind%20Turbines.pdf>.

⁶⁶⁰ Briar Creek Borough, Columbia Cnty., Zoning Ordinance § 1103.27 (2014), <http://www.briarcreekboroughpa.com/zbsep14.pdf>.

Counties with Regulatory Wind System Ordinances by Source ⁶⁴⁶			
County	Municipal Government	Ordinance	Ordained
	Mount Pleasant	Ordinance 48-11 ⁶⁶¹	2011
Crawford	Cussewago	Zoning Ordinance § 309 ⁶⁶²	2014
Dauphin	Conewago	Zoning Ordinance § 1001(14) ⁶⁶³	12-25-99
Erie	Millcreek	Ordinance No. 2009-4 ⁶⁶⁴	04-28-09
	Erie	Zoning Ordinance §§ 305.52, 305.53 ⁶⁶⁵	01-21-10 02-03-10
Fayette	31 of the 42 muns. ⁶⁶⁶	Zoning Ordinance § 1000-876 ⁶⁶⁷	07-23-09
Lancaster	Lititz	Zoning Ordinance, § 425 ⁶⁶⁸	
	Manheim	Zoning Ordinance § 2522 ⁶⁶⁹	09-30-14
	Manor	Zoning Ordinance § 302.5 ⁶⁷⁰	05-03-10
Lebanon	--	“Subdivision and Land Development Ordinance No.49	12-05-13
	South Londonderry	Zoning Ordinance § 486 ⁶⁷¹	11-12-13
Luzerne	Black Creek	Zoning Ordinance § 316 ⁶⁷²	--
Lycoming	--	Zoning Ordinance § 3230C.1 ⁶⁷³	02-24-11

⁶⁶¹ Mount Pleasant Twp., Columbia Cnty., Ordinance 48-11, available at <http://www.mtpleasantcolumbiapa.org/Documents/48%20-%20Large-Scale%20Commercial%20Wind%20Farms.pdf>.

⁶⁶² Cussewago Twp. Crawford Cnty., Zoning Ordinance § 309 (2014), <http://www.crawfordcountypa.net/pls/portal/docs/PAGE/CRAWFORDCOUNTYGOVERNMENT/LOCALZONINGORDINANCES/CUSSEWAGO%20ZONING%20ORDINANCE%20FINAL%202014.PDF>.

⁶⁶³ Conewago Twp., Dauphin Cnty., Zoning Ordinance § 1001(14) 2007), <http://conewagotownship.com/resolutions/res/2302-027.pdf>.

⁶⁶⁴ Millcreek Twp., Erie Cnty., Ordinance No. 2009-4 (2009), http://millcreektownship.com/portals/0/pdf/ordinances/ordinance_2009_4.pdf.

⁶⁶⁵ Erie City, Erie Cnty., Zoning Ordinance §§ 305.52, 305.53 (2005), [http://www.erie.pa.us/Portals/0/Content/Ordinances/Zoning/Zoning%20Ordinances%20\(updated%202010-02-03\).pdf](http://www.erie.pa.us/Portals/0/Content/Ordinances/Zoning/Zoning%20Ordinances%20(updated%202010-02-03).pdf).

⁶⁶⁶ Excludes cities of Uniontown & Connellsville, boroughs of Perryopolis & Ohiopyle & twps. of Connellsville Township, Henry Clay, Menallen, Stewart, South Union, Washington & Wharton. Fayette Cnty., Zoning & Planning, <http://www.co.fayette.pa.us/planningzoning/Pages/ZoningandPlanning.aspx> (2010).

⁶⁶⁷ *Id.*, Zoning Ordinance § 1000-876, http://www.co.fayette.pa.us/planningzoning/Documents/fayettecountyzoning11_2006.pdf (2006).

⁶⁶⁸ Lititz Borough, Lancaster, Cnty., Zoning Ordinance § 425 (2010), http://www.lititzborough.org/sites/lititzpa/files/file/file/zo_codified_version.pdf.

⁶⁶⁹ Manheim Twp., Lancaster Cnty., Zoning Ordinance § 2522 (2014), <http://www.manheimtownship.org/documentcenterii.aspx>.

⁶⁷⁰ Manor Twp., Lancaster Cnty., Zoning Ordinance § 302.5 (2001), <http://www.manortwp.org/files/Manor%20Township%20Zoning%20Ordinance%20-20Amended%20through%20May%202010.pdf>.

⁶⁷¹ S. Londonderry Twp., Lebanon Cnty., Zoning Ordinance § 486 (2013), <http://www.southlondonderry.org/uploads/6/1/2/6/61268441/sltofficialzoningordinance.pdf>.

⁶⁷² Black Creek Twp., Luzerne Cnty., Zoning Ordinance § 316 (2012), http://blackcreektownship.org/cms/assets/_core/file/Adopted%20Black%20Creek%20Township%20Zoning%20Ordinance%20April%202013.pdf.

⁶⁷³ Lycoming Cnty. Zoning Ordinance § 3230C.1 (1991), http://www.lyco.org/Portals/1/PlanningCommunityDevelopment/Documents/zoning/lycoming_co_zoning_ord_feb2011.pdf.

Counties with Regulatory Wind System Ordinances by Source ⁶⁴⁶			
County	Municipal Government	Ordinance	Ordained
Montour	Valley	Zoning Ordinance ⁶⁷⁴	08-13-08
Potter	--	Ordinance No. 1-2008, art. 12 ⁶⁷⁵	2008
Somerset	--	Subdiv. & Land Dev. Ordinance § 1006 ⁶⁷⁶	08-13-13
Tioga	--	Subdiv. & Land Dev. Ordinance § 711 ⁶⁷⁷	08-13-13
Wayne	Damascus	Zoning Ordinance § 428 ⁶⁷⁸	2013
	Palmyra	Zoning Ordinance § 125-30 ⁶⁷⁹	11-05-12
Westmoreland	Mount Pleasant	Ordinance 47-11 ⁶⁸⁰ Ordinance 48-11 ⁶⁸¹	12-09-11
Wyoming	Tunkhannock	Zoning Ordinance § 705 ⁶⁸²	06-02-11

⁶⁷⁴ Valley Twp., Montour Cnty., Valley Twp. Zoning Ordinance (2008), <http://valleytownshippa.net/wp-content/uploads/2014/10/Wind-Generator-Ord.pdf>.

⁶⁷⁵ Potter Cnty. Ordinance No. 1-2008, art. 12 (2008), www.pottercountypa.net/planning/saldo/Article12.doc.

⁶⁷⁶ Somerset Cnty. Subdiv. & Land Dev. Ordinance § 1006 (2013), http://www.co.somerset.pa.us/files/plan_files/suborder.htm.

⁶⁷⁷ Tioga Cnty. Subdiv. & Land Dev. Ordinance § 711 (2013), http://www.tiogacountypa.us/Departments/Planning_Commission/Documents/SALDO%20-%20Final%208-13-13.pdf.

⁶⁷⁸ Damascus Twp., Wayne Cnty., Zoning Ordinance § 428 (2013), <http://damascustwp.org/ord/ZONING.pdf>.

⁶⁷⁹ Palmyra Twp., Wayne Cnty., Zoning Ordinance § 125-30 (2012), <http://www.palmyrawayne.org/ordinances/zoning.pdf>.

⁶⁸⁰ Mount Pleasant Twp., Westmoreland Cnty. Ordinance 47-11 (2011), <http://www.mtpleasantcolumbiapa.org/Documents/47%20-%20Small%20Wind%20Energy%20Systems.pdf>.

⁶⁸¹ *Id.*, Ordinance 47-11 (2011), <http://www.mtpleasantcolumbiapa.org/Documents/48%20-%20Large-Scale%20Commercial%20Wind%20Farms.pdf>.

⁶⁸² Tunkhannock Borough, Wyo. Cnty., Zoning Ordinance § 705, <http://tunkboro.com/sites/tunkboro.com/files/ordinances/zoning2011.pdf>.

APPENDIX D

Model Wind Ordinance for Local Governments

Model Wind Ordinance for Local Governments⁶⁸³

The attached sample model ordinances are updated versions, originally created by a work group of the Governor's Office, DEP, DCNR, PA State Association of Township Supervisors, County Commissioners Association, Wind Energy Associations and Penn Future with the assistance of DCED. They are intended for use as general templates for municipalities to review and adapt to their own particular needs. Please keep in mind that these sample model ordinances are merely models, and should be used only as a guide in developing or amending your own ordinances as they pertain to wind energy facilities. No assurances are made regarding the enforceability of any ordinance. Each municipality should confer with its own solicitor regarding such matters.

The Pennsylvania Municipalities Planning Code (MPC) provides two essential tools for use by municipalities to regulate land use within their borders; zoning ordinances and subdivision & land development ordinances (SDLO). In addition, municipalities may enact ordinances under their inherent "police" powers to protect public health, safety and welfare. All of these ordinances may be used, in one form or another, in guiding the development of wind energy facilities in Pennsylvania's municipalities.

Zoning is purely optional on the part of municipalities, but is the sole means by which a municipality may establish specific areas of the municipality in which wind energy facilities may be permitted or prohibited. Subdivision and land development ordinances, while not appropriate for identifying the areas of the municipality in which such uses will or will not be permitted, do provide the municipality with a significant amount of control over such issues as set-backs, roads, layout of facilities etc.

THE FOLLOWING MODEL ORDINANCES HAVE BEEN PREPARED TO COVER THE ALTERNATIVE SCENARIOS LISTED ABOVE. THEY ARE INTENDED TO SERVE AS MODELS AND SHOULD BE INDIVIDUALIZED TO MEET EACH MUNICIPALITY'S SPECIFIC NEEDS.

⁶⁸³ Energy.gov, *supra* note 49.

MODEL 1:

ZONING ORDINANCE AMENDMENT FOR WIND ENERGY FACILITIES

The following sample amendment (or variation thereof) may be used where an existing zoning ordinance is to be amended to include provisions for siting of Wind Energy facilities. Such an amendments must be adopted in accordance with Sections 609 and 610 of the MPC.

(Municipality) Ordinance No. _____
An Ordinance Amending Ordinance No. _____ of
(municipality), known as the (municipality) Zoning
Ordinance, providing for the regulation of Wind Energy
Facilities.

The _____ [municipality] hereby amends Ordinance No. _____ known as the
_____ [municipality] Zoning Ordinance, by adding the following:

Sec. 1. Sec _____ of Ordinance No. _____ is hereby amended to add the following definitions:
“Wind Energy Facility” means an electric generation facility, whose main purpose is to supply electricity, consisting of one or more Wind Turbines and other accessory structures and buildings, including substations, meteorological towers, electrical infrastructure, transmission lines and other appurtenant structures and facilities. The term does not include stand-alone Wind Turbines constructed primarily for residential or farm use.

“Wind Turbine” means a wind energy conversion system that converts wind energy into electricity through the use of a wind turbine generator and includes the nacelle, rotor, tower and pad turbine, if any.”

Sec. 2. A Wind Energy facility shall be considered a _____ {permitted use, conditional use or special exception} in the following zones _____ [select the appropriate zone].

(If a conditional use or special exception is selected, standard language and desired conditions should be added here.)

MODEL 2:

SUBDIVISION AND LAND DEVELOPMENT ORDINANCE PROVISIONS FOR WIND ENERGY FACILITIES

The following sample amendment to a Subdivision and Land Development Ordinance (SLDO) provides a comprehensive set of standards for the erection, operation and decommissioning of such facilities, permitting the municipality to meet its goal of encouraging alternative/renewable energy while minimizing negative impacts by the development of such energy generating facilities. The Subdivision and Land Development Ordinance amendment must be adopted in accordance with sections 504-506 of the Municipalities Planning Code.

AN ORDINANCE AMENDING ORDINANCE NO. _____, KNOWN AS THE SUBDIVISION AND LAND DEVELOPMENT ORDINANCE OF *(MUNICIPALITY)*, TO PROVIDE FOR THE REGULATION OF WIND ENERGY FACILITIES

Ordinance No. _____, known as the [municipality] Subdivision and Land Development Ordinance is hereby amended by adding the following Chapter _____.

Sec. 1. This Chapter shall be known as the Wind Energy Facility Ordinance for _____ [municipality].

1. PURPOSE

The purpose of this Chapter is to provide for the land development, construction, operation and decommissioning of Wind Energy Facilities in [municipality], subject to reasonable conditions that will protect the public health, safety and welfare.

2. DEFINITIONS

- A. “Applicant” is the person or entity filing an application under this Ordinance.
- B. “Facility Owner” means the entity or entities having an equity interest in the Wind Energy Facility, including their respective successors and assigns.
- C. “Operator” means the entity responsible for the day-to-day operation and maintenance of the Wind Energy Facility.
- D. “Hub Height” means the distance measured from the surface of the tower foundation to the height of the Wind Turbine hub, to which the blade is attached.
- E. “Occupied Building” means a residence, school, hospital, church, public library or other building used for public gathering that is occupied or in use when the permit application is submitted.

- F. "Turbine Height" means the distance measured from the surface of the tower foundation to the highest point of the turbine rotor plane.
- G. "Wind Turbine" means a wind energy conversion system that converts wind energy into electricity through the use of a wind turbine generator, and includes the nacelle, rotor, tower, and pad transformer, if any.
- H. "Wind Energy Facility" means an electric generating facility, whose main purpose is to supply electricity, consisting of one or more Wind Turbines and other accessory structures and buildings, including substations, meteorological towers, electrical infrastructure, transmission lines and other appurtenant structures and facilities.
- I. "Non-Participating Landowner" means any landowner except those on whose property all or a portion of a Wind Energy Facility is located pursuant to an agreement with the Facility Owner or Operator.

3. APPLICABILITY

- A. This Ordinance applies to all land development plans which provide for Wind Energy Facilities to be constructed after the effective date of the Ordinance, except that this Ordinance is not intended to apply to stand-alone Wind Turbines constructed primarily for residential or farm use.
- B. Wind Energy Facilities constructed prior to the effective date of this Ordinance shall not be required to meet the requirements of this Ordinance; provided that any physical modification to an existing Wind Energy Facility that materially alters the size, type and number of Wind Turbines or other equipment shall comply with the provisions of this Chapter.

4. LAND DEVELOPMENT REQUIREMENTS

- A. No land development plan providing for the construction or erection of a Wind Energy Facility or addition of a Wind Turbine to an existing Wind Energy Facility shall be approved unless such plan has complied with the requirements of this Chapter.
- B. Any physical modification to an existing and permitted Wind Energy Facility that materially alters the size, type and number of Wind Turbines or other equipment shall require land development approval under the Subdivision and Land Development Ordinance of _____ [municipality]. Like-kind replacements shall not require a permit modification.

5. ADDITIONAL LAND DEVELOPMENT PLAN REQUIREMENTS

- A. The land development plan shall demonstrate that the proposed Wind Energy Facility will comply with this Chapter and the PA Uniform Construction Code, Act 45 of 1999 as amended, and the regulations adopted by the Department of Labor and Industry.

- B. The land development plan, in addition to the other requirements of the Subdivision and Land Development Ordinance of _____ [municipality] shall contain the following:
1. A narrative describing the proposed Wind Energy Facility, including an overview of the project; the project location; the approximate generating capacity of the Wind Energy Facility; the approximate number, representative types and height or range of heights of Wind Turbines to be constructed, including their generating capacity, dimensions and respective manufacturers, and a description of ancillary facilities.
 2. An affidavit or similar evidence of agreement between the property owner and the Facility Owner or Operator demonstrating that the Facility Owner or Operator has the permission of the property owner to apply for necessary permits for construction and operation of the Wind Energy Facility.
 3. Identification of the properties on which the proposed Wind Energy Facility will be located, and the properties adjacent to where the Wind Energy Facility will be located.
 4. A site plan showing the planned location of each Wind Turbine, property lines, setback lines, access road and turnout locations, substation(s), electrical cabling from the Wind Energy Facility to the substation(s), ancillary equipment, buildings, and structures, including permanent meteorological towers, associated transmission lines, and layout of all structures within the geographical boundaries of any applicable setback.
 5. Documents related to decommissioning, including a schedule for the decommissioning and financing security.
 6. Other relevant studies, reports, certifications and approvals as may be reasonably requested by the _____ [municipality] to ensure compliance with this Chapter.

6. DESIGN AND INSTALLATION

A. Uniform Construction Code

To the extent applicable, the Wind Energy Facility shall comply with the Pennsylvania Uniform Construction Code, Act 45 of 1999 as amended, and the regulations adopted by the Department of Labor and Industry.

B. Design Safety Certification

The design of the Wind Energy Facility shall conform to applicable industry standards, including those of the American National Standards Institute. The Applicant shall submit certificates of design compliance obtained by the equipment manufacturers from Underwriters Laboratories, Det Norske Veritas, Germanischer Lloyd Wind Energies, or other similar certifying organizations.

C. Controls and Brakes

All Wind Energy Facilities shall be equipped with a redundant braking system. This includes both aerodynamic overspeed controls (including variable pitch, tip, and other similar systems) and mechanical brakes. Mechanical brakes shall be operated in a fail-safe mode. Stall regulation shall not be considered a sufficient braking system for overspeed protection.

D. Electrical Components

All electrical components of the Wind Energy Facility shall conform to relevant and applicable local, state and national codes, and relevant and applicable international standards.

E. Visual Appearance; Power Lines

1. Wind Turbines shall be a non-obtrusive color such as white, off-white or gray.
2. Wind Energy Facilities shall not be artificially lighted, except to the extent required by the Federal Aviation Administration or other applicable authority that regulates air safety.
3. Wind Turbines shall not display advertising, except for reasonable identification of the turbine manufacturer, Facility Owner and Operator. *[Insert size limit if desired]*.
4. On-site transmission and power lines between Wind Turbines shall, to the maximum extent practicable, be placed underground.

F. Warnings

1. A clearly visible warning sign concerning voltage must be placed at the base of all pad-mounted transformers and substations.
2. Visible, reflective, colored objects, such as flags, reflectors, or tape shall be placed on the anchor points of guy wires and along the guy wires up to a height of ten feet from the ground.

G. Climb Prevention/Locks

1. Wind Turbines shall not be climbable up to fifteen (15) feet above ground surface.
2. All access doors to Wind Turbines and electrical equipment shall be locked or fenced, as appropriate, to prevent entry by non-authorized persons.

7. SETBACKS

A. Occupied Buildings

1. Wind Turbines shall be set back from the nearest Occupied Building a distance not less than the greater of the maximum setback requirements for that zoning classification where the turbine is located* or 1.1 times the Turbine Height, whichever is greater. The setback distance shall be measured from the center of the Wind Turbine base to the nearest point on the foundation of the Occupied Building.

**(reference to zoning only to be used where the municipality has a zoning ordinance.)*

2. Wind Turbines shall be set back from the nearest Occupied Building located on a Non-participating Landowner's property a distance of not less than five (5) times the Hub Height, as measured from the center of the Wind Turbine base to the nearest point on the foundation of the Occupied Building.

B. Property lines: All Wind Turbines shall be set back from the nearest property line a distance of not less than the greater of the maximum setback requirements for that zoning classification where the turbine is located* or 1.1 times the Turbine Height, whichever is greater. The setback distance shall be measured to the center of the Wind Turbine base.

**(reference to zoning only to be used where the municipality has a zoning ordinance.)*

C. Public roads: All Wind Turbines shall be set back from the nearest public road a distance of not less than 1.1 times the Turbine Height, as measured from the right-of-way line of the nearest public road to the center of the Wind Turbine base.

8. WAIVER OF SETBACKS

- A. Upon request, the governing body may grant partial waivers of setback requirements hereunder where it has determined that literal enforcement will exact undue hardship because of peculiar conditions pertaining to the land in question and provided that such waiver will not be contrary to the public interest.
- B. The governing body may take into consideration the support or opposition of adjacent property owners in granting waivers of setback requirements hereunder.

9. USE OF PUBLIC ROADS

- A. The Applicant shall identify all state and local public roads to be used within the _____ [municipality] to transport equipment and parts for construction, operation or maintenance of the Wind Energy Facility.
- B. The _____ [municipality's] engineer or a qualified third party engineer hired by the _____ [municipality] and paid for by the Applicant, shall document road conditions prior to construction. The engineer shall document road conditions again thirty (30) days after construction is complete or as weather permits.
- D. The _____ [municipality] may bond the road in compliance with state regulations.
- D. Any road damage caused by the applicant or its contractors shall be promptly repaired at the Applicant's expense.
- E. The Applicant shall demonstrate that it has appropriate financial assurance to ensure the prompt repair of damaged roads.

10. LOCAL EMERGENCY SERVICES

- A. The Applicant shall provide a copy of the project summary and site plan to local emergency services, including paid or volunteer Fire Department(s).
- B. Upon request, the Applicant shall cooperate with emergency services to develop and coordinate implementation of an emergency response plan for the Wind Energy Facility.

11. NOISE AND SHADOW FLICKER

- A. Audible sound from a Wind Energy Facility shall not exceed fifty (55) dBA, as measured at the exterior of any Occupied Building on a Non-participating Landowner's property. Methods for measuring and reporting acoustic emissions from Wind Turbines and the Wind Energy Facility shall be equal to or exceed the minimum standards for precision described in AWEA Standard 2.1 - 1989 titled *Procedures for the Measurement and Reporting of Acoustic Emissions from Wind Turbine Generation Systems Volume I: First Tier*. The municipality may grant a partial waiver of such standards where it has determined that literal enforcement will exact undue hardship because of peculiar conditions pertaining to the land in question and provided that such waiver will not be contrary to the public interest.
- B. The Facility Owner and Operator shall make reasonable efforts to minimize shadow flicker to any Occupied Building on a Non-participating Landowner's property.
- C. The governing body may take into consideration the support or opposition of adjacent property owners on granting waivers of noise and shadow flicker restrictions.

12. SIGNAL INTERFERENCE

The Applicant shall make reasonable efforts to avoid any disruption or loss of radio, telephone, television or similar signals, and shall mitigate any harm caused by the Wind Energy Facility.

13. LIABILITY INSURANCE

There shall be maintained a current general liability policy covering bodily injury and property damage with limits of at least \$1 million per occurrence and \$1 million in the aggregate. Certificates shall be made available to the _____ [municipality] upon request.

14. DECOMMISSIONING

- A. The Facility Owner and Operator shall, at its expense, complete decommissioning of the Wind Energy Facility, or individual Wind Turbines, within (12) twelve months after the end of the useful life of the Facility or individual Wind Turbines. The Wind Energy Facility or individual Wind Turbines will presume to be at the end of its useful life if no electricity is generated for a continuous period of twelve (12) months.
- B. Decommissioning shall include removal of Wind Turbines, buildings, cabling, electrical components, roads, foundations to a depth of 36 inches, and any other associated facilities.
- C. Disturbed earth shall be graded and re-seeded, unless the landowner requests in writing that the access roads or other land surface areas not be restored.
- D. An independent and certified Professional Engineer shall be retained to estimate the total cost of decommissioning (“Decommissioning Costs”) without regard to salvage value of the equipment, and the cost of decommissioning net salvage value of the equipment (“Net Decommissioning Costs”). Said estimates shall be submitted to the _____ [municipality] after the first year of operation and every fifth year thereafter.
- E. The Facility Owner or Operator shall post and maintain Decommissioning Funds in an amount equal to Net Decommissioning Costs; provided, that at no point shall Decommissioning Funds be less than twenty five percent (25 percent) of Decommissioning Costs. The Decommissioning Funds shall be posted and maintained with a bonding company or Federal or Commonwealth chartered lending institution chosen by the Facility Owner or Operator and participating landowner posting the financial security, provided that the bonding company or lending institution is authorized to conduct such business within the Commonwealth and is approved by the _____ [municipality].
- F. Decommissioning Funds may be in the form of a performance bond, surety bond, letter of credit, corporate guarantee or other form of financial assurance as may be acceptable to the _____ [municipality].

- G. If the Facility Owner or Operator fails to complete decommissioning within the period prescribed by Paragraph 17(A), then the landowner shall have six (6) months to complete decommissioning.
- H. If neither the Facility Owner or Operator, nor the landowner complete decommissioning within the periods prescribed by Paragraphs 17(A) and 17(G), then the _____ [municipality] may take such measures as necessary to complete decommissioning. The entry into and submission of evidence of a Participating Landowner agreement to the _____ [municipality] shall constitute agreement and consent of the parties to the agreement, their respective heirs, successors and assigns that the _____ [municipality] may take such action as necessary to implement the decommissioning plan.
- I. The escrow agent shall release the Decommissioning Funds when the Facility Owner or Operator has demonstrated and the municipality concurs that decommissioning has been satisfactorily completed, or upon written approval of the municipality in order to implement the decommissioning plan.

15. PUBLIC INQUIRIES AND COMPLAINTS

- A. The Facility Owner and Operator shall maintain a phone number and identify a responsible person for the public to contact with inquiries and complaints throughout the life of the project.
- B. The Facility Owner and Operator shall make reasonable efforts to respond to the public's inquiries and complaints.

16. REMEDIES

- A. It shall be unlawful for any person, firm, or corporation to violate or fail to comply with or take any action which is contrary to the terms of the ordinance, or any permit issued under the ordinance, or cause another to violate or fail to comply, or to take any action which is contrary to the terms of the ordinance or any permit issued under the ordinance.
- B. If the _____ [municipality] determines that a violation of the Ordinance or the permit has occurred, the _____ [municipality] shall provide written notice to any person, firm, or corporation alleged to be in violation of this Ordinance or permit. If the alleged violation does not pose an immediate threat to public health or safety, the _____ [municipality] and the parties shall engage in good faith negotiations to resolve the alleged violation. Such negotiations shall be conducted within thirty (30) days of the notice of violation.
- C. If, after thirty (30) days from the date of the notice of violation, the _____ [municipality] determines, in its discretion, that the parties have not resolved the alleged violation, the [municipality] may institute civil enforcement proceedings or any other remedy at law or in equity to ensure compliance, as provided in Section ____ of Ordinance No. ____ of _____ [municipality] known as the _____ [municipality] Subdivision and Land Development Ordinance.

MODEL 3: FREE STANDING ORDINANCE

The following sample ordinance provides a comprehensive set of standards for the erection, operation and decommissioning of wind energy facilities, permitting the municipality to meet its goal of encouraging alternative/renewable energy while minimizing negative impacts by the development of such energy generating facilities. This model is enacted under the "police" power authority of the municipality.

AN ORDINANCE REGULATING THE CONSTRUCTION, OPERATION AND DECOMMISSIONING OF WIND ENERGY FACILITIES

1. TITLE

This Ordinance shall be known as the Wind Energy Facility Ordinance for _____ [municipality].

2. PURPOSE

The purpose of the Ordinance is to provide for the construction, operation and decommissioning of Wind Energy Facilities in _____ [municipality], subject to reasonable conditions that will protect the public health, safety and welfare.

3. DEFINITIONS

- A. "Applicant" is the person or entity filing an application under this Ordinance.
- B. "Facility Owner" means the entity or entities having an equity interest in the Wind Energy Facility, including their respective successors and assigns.
- C. "Operator" means the entity responsible for the day-to-day operation and maintenance of the Wind Energy Facility.
- D. "Hub Height" means the distance measured from the surface of the tower foundation to the height of the Wind Turbine hub, to which the blade is attached.
- E. "Occupied Building" means a residence, school, hospital, church, public library or other building used for public gathering that is occupied or in use when the permit application is submitted.
- F. "Turbine Height" means the distance measured from the surface of the tower foundation to the highest point of the turbine rotor plane.
- G. "Wind Turbine" means a wind energy conversion system that converts wind energy into electricity through the use of a wind turbine generator, and includes the nacelle, rotor, tower, and pad transformer, if any.

- H. "Wind Energy Facility" means an electric generating facility, whose main purpose is to supply electricity, consisting of one or more Wind Turbines and other accessory structures and buildings, including substations, meteorological towers, electrical infrastructure, transmission lines and other appurtenant structures and facilities.
- I. "Non-Participating Landowner" means any landowner except those on whose property all or a portion of a Wind Energy Facility is located pursuant to an agreement with the Facility Owner or Operator.

4. APPLICABILITY

- A. This Ordinance applies to all Wind Energy Facilities proposed to be constructed after the effective date of the Ordinance, except that this Ordinance is not intended to apply to stand-alone Wind Turbines constructed primarily for residential or farm use.
- B. Wind Energy Facilities constructed prior to the effective date of this Ordinance shall not be required to meet the requirements of this Ordinance; Provided that any physical modification to an existing Wind Energy Facility that materially alters the size, type and number of Wind Turbines or other equipment shall require a permit under this Ordinance.

5. PERMIT REQUIREMENT

- A. No Wind Energy Facility, or addition of a Wind Turbine to an existing Wind Energy Facility, shall be constructed or located within _____ [municipality] unless a permit has been issued to the Facility Owner or Operator approving construction of the facility under this Ordinance.
- B. The permit application or amended permit application shall be accompanied with a fee in the amount of \$ _____.
- C. Any physical modification to an existing and permitted Wind Energy Facility that materially alters the size, type and number of Wind Turbines or other equipment shall require a permit modification under this Ordinance. Like-kind replacements shall not require a permit modification.

6. PERMIT APPLICATION

- A. The permit application shall demonstrate that the proposed Wind Energy Facility will comply with this Ordinance.
- B. Among other things, the application shall contain the following:
 1. A narrative describing the proposed Wind Energy Facility, including an overview of the project; the project location; the approximate generating capacity of the Wind Energy Facility; the approximate number, representative types and height or range of heights of Wind Turbines to be constructed, including their generating capacity, dimensions and respective manufacturers, and a description of ancillary facilities.

2. An affidavit or similar evidence of agreement between the property owner and the Facility Owner or Operator demonstrating that the Facility Owner or Operator has the permission of the property owner to apply for necessary permits for construction and operation of the Wind Energy Facility.
 3. Identification of the properties on which the proposed Wind Energy Facility will be located, and the properties adjacent to where the Wind Energy Facility will be located.
 4. A site plan showing the planned location of each Wind Turbine, property lines, setback lines, access road and turnout locations, substation(s), electrical cabling from the Wind Energy Facility to the substation(s), ancillary equipment, buildings, and structures, including permanent meteorological towers, associated transmission lines, and layout of all structures within the geographical boundaries of any applicable setback.
 5. Documents related to decommissioning including a schedule for decommissioning.
 6. Other relevant studies, reports, certifications and approvals as may be reasonably requested by the _____ [municipality] to ensure compliance with this Ordinance.
- C. Within (30) days after receipt of a permit application, the _____ [municipality] will determine whether the application is complete and advise the applicant accordingly.
- D. Within sixty (60) days of a completeness determination, the _____ [municipality] will schedule a public hearing. The applicant shall participate in the hearing and be afforded an opportunity to present the project to the public and municipal officials, and answer questions about the project. The public shall be afforded an opportunity to ask questions and provide comment on the proposed project.
- E. Within one hundred and twenty (120) days of a completeness determination, or within forty-five (45) days after the close of any hearing, whichever is later, the _____ [municipality] will make a decision whether to issue or deny the permit application.
- F. Throughout the permit process, the Applicant shall promptly notify _____ [municipality] of any changes to the information contained in the permit application.
- G. Changes to the pending application that do not materially alter the initial site plan may be adopted without a renewed public hearing.

7. DESIGN AND INSTALLATION

A. Design Safety Certification

The design of the Wind Energy Facility shall conform to applicable industry standards, including those of the American National Standards Institute. The Applicant shall submit certificates of design compliance obtained by the equipment manufacturers from Underwriters Laboratories, Det Norske Veritas, Germanischer Lloyd Wind Energies, or other similar certifying organizations.

B. Uniform Construction Code

To the extent applicable, the Wind Energy Facility shall comply with the Pennsylvania Uniform Construction Code, Act 45 of 1999 as amended and the regulations adopted by the Department of Labor and Industry.

C. Controls and Brakes

All Wind Energy Facilities shall be equipped with a redundant braking system. This includes both aerodynamic overspeed controls (including variable pitch, tip, and other similar systems) and mechanical brakes. Mechanical brakes shall be operated in a fail-safe mode. Stall regulation shall not be considered a sufficient braking system for overspeed protection.

D. Electrical Components

All electrical components of the Wind Energy Facility shall conform to relevant and applicable local, state and national codes, and relevant and applicable international standards.

E. Visual Appearance; Power Lines

1. Wind Turbines shall be a non-obtrusive color such as white, off-white or gray.
2. Wind Energy Facilities shall not be artificially lighted, except to the extent required by the Federal Aviation Administration or other applicable authority that regulates air safety.
3. Wind Turbines shall not display advertising, except for reasonable identification of the turbine manufacturer, Facility Owner and Operator. *[insert size limit if desired]*.
4. On-site transmission and power lines between Wind Turbines shall, to the maximum extent practicable, be placed underground.

F. Warnings

1. A clearly visible warning sign concerning voltage must be placed at the base of all pad-mounted transformers and substations.
2. Visible, reflective, colored objects, such as flags, reflectors, or tape shall be placed on the anchor points of guy wires and along the guy wires up to a height of ten feet from the ground.

G. Climb Prevention/Locks

1. Wind Turbines shall not be climbable up to fifteen (15) feet above ground surface.
2. All access doors to Wind Turbines and electrical equipment shall be locked or fenced, as appropriate, to prevent entry by non-authorized persons.

8. SETBACKS

A. Occupied Buildings

1. Wind Turbines shall be set back from the nearest Occupied Building a distance of not less than the maximum setback requirements for that zoning classification where the turbine is located * or 1.1 times the Turbine Height, whichever is greater. These setback distances shall be measured from the center of the Wind Turbine base to the nearest point on the foundation of the Occupied Building.

* (reference to zoning only to be used where the municipality has a zoning ordinance)

2. Wind Turbines shall be set back from the nearest Occupied Building located on a Non-participating Landowner's property a distance of not less than five (5) times the Hub Height, as measured from the center of the Wind Turbine base to the nearest point on the foundation of the Occupied Building.

B. Property lines: All Wind Turbines shall be set back from the nearest property line a distance of not less than the maximum setback requirements for that zoning classification where the turbine is located or * 1.1 times the Turbine Height, whichever is greater. The setback distance shall be measured to the center of the Wind Turbine base.

* (reference to zoning only to be used where the municipality has a zoning ordinance)

C. Public Roads: All Wind Turbines shall be set back from the nearest public road a distance of not less than 1.1 times the Turbine Height, as measured from the right-of-way line of the nearest public road to the center of the Wind Turbine base.

9. WAIVER OF SETBACKS

- A. At the request of the applicant, the governing body may grant partial waivers of the setback requirements under Sections 8 (A)(2) (Occupied Buildings on Non-participating Landowner's property), 8 (B) (Property Lines) and 8 (C) (Public Roads) of this ordinance where it has determined that literal enforcement will exact undue hardship because of peculiar conditions pertaining to the land in question and provided that such waiver will not be contrary to the public interest.

- B. The applicant shall submit a signed notarized document from the property owner(s) that they are in agreement with the applicant's request for a waiver of the setback requirements under Section 9 (A)(2) and 9 (B) of this ordinance. This document shall stipulate that the property owner(s) know of the setback requirements required by this Ordinance, describes how the proposed Wind Energy Facility is not in compliance, and state that consent is granted for the Wind Energy Facility to not be setback as required by this Ordinance.
- C. Any such waiver shall be recorded in the Recorder of Deeds Office for the County where the property is located. The waiver shall describe the properties benefited and burdened, and advise all subsequent purchasers of the burdened property that the waiver of setback shall run with the land and may forever burden the subject property.

10. USE OF PUBLIC ROADS

- A. The Applicant shall identify all state and local public roads to be used within the _____ [municipality] to transport equipment and parts for construction, operation or maintenance of the Wind Energy Facility.
- B. The _____ [municipality's] engineer or a qualified third party engineer hired by the _____ [municipality] and paid for by the Applicant, shall document road conditions prior to construction. The engineer shall document road conditions again thirty (30) days after construction is complete or as weather permits.
- C. The _____ [municipality] may bond the road in compliance with state regulations.
- D. Any road damage caused by the Applicant or its contractors shall be promptly repaired at the applicant's expense.
- E. The Applicant shall demonstrate that it has appropriate financial assurance to ensure the prompt repair of damaged roads.

11. LOCAL EMERGENCY SERVICES

- A. The Applicant shall provide a copy of the project summary and site plan to local emergency services, including paid or volunteer Fire Department(s).
- B. Upon request, the Applicant shall cooperate with emergency services to develop and coordinate implementation of an emergency response plan for the Wind Energy Facility.

12. NOISE AND SHADOW FLICKER

- A. Audible sound from a Wind Energy Facility shall not exceed fifty (55) dBA, as measured at the exterior of any Occupied Building on a Non-participating Landowner's property. Methods for measuring and reporting acoustic emissions from Wind Turbines and the Wind Energy Facility shall be equal to or exceed the minimum standards for precision described in AWEA Standard 2.1 - 1989 titled

Procedures for the Measurement and Reporting of Acoustic Emissions from Wind Turbine Generation Systems Volume I: First Tier.

- B. The Facility Owner and Operator shall make reasonable efforts to minimize shadow flicker to any Occupied Building on a Non-participating Landowner's property.

13. WAIVER OF NOISE AND SHADOW FLICKER PROVISIONS

- A. At the request of the applicant, the governing body may grant partial waivers of the noise and shadow flicker requirements under Section 12 (A) of this ordinance where it has determined that literal enforcement will exact undue hardship because of peculiar conditions pertaining to the land in question and provided that such waiver will not be contrary to the public interest.
- B. The applicant shall submit a signed notarized document from the property owner (s) that they are in agreement with the applicant's request for a waiver of the noise and shadow flicker requirements under Section 12 (A) of this ordinance. This document shall stipulate that the property owner (s) know of the sound or flicker limits in this Ordinance, describes the impact on the property owner(s), and state that the consent is granted for the Wind Energy Facility to not comply with the sound or flicker limit in this Ordinance.
- C. Any such waiver shall be recorded in the Recorder of Deeds Office of the County where the property is located. The waiver shall describe the properties benefited and burdened, and advise all subsequent purchasers of the burdened property that the waiver of sound or flicker limit shall run with the land and may forever burden the subject property.

14. SIGNAL INTERFERENCE

The Applicant shall make reasonable efforts to avoid any disruption or loss of radio, telephone, television or similar signals, and shall mitigate any harm caused by the Wind Energy Facility.

15. LIABILITY INSURANCE

There shall be maintained a current general liability policy covering bodily injury and property damage with limits of at least \$1 million per occurrence and \$1 million in the aggregate. Certificates shall be made available to the _____ [municipality] upon request.

16. DECOMMISSIONING

- A. The Facility Owner and Operator shall, at its expense, complete decommissioning of the Wind Energy Facility, or individual Wind Turbines, within (12) twelve months after the end of the useful life of the Facility or individual Wind Turbines. The Wind Energy Facility or individual Wind Turbines will presume to be at the end of its useful life if no electricity is generated for a continuous period of twelve (12) months.

- B. Decommissioning shall include removal of Wind Turbines, buildings, cabling, electrical components, roads, foundations to a depth of 36 inches, and any other associated facilities.
- C. Disturbed earth shall be graded and re-seeded, unless the landowner requests in writing that the access roads or other land surface areas not be restored.
- D. An independent and certified Professional Engineer shall be retained to estimate the total cost of decommissioning ("Decommissioning Costs") without regard to salvage value of the equipment, and the cost of decommissioning net salvage value of the equipment ("Net Decommissioning Costs"). Said estimates shall be submitted to the _____ [municipality] after the first year of operation and every fifth year thereafter.
- E. The Facility Owner or Operator shall post and maintain Decommissioning Funds in an amount equal to Net Decommissioning Costs; provided, that at no point shall Decommissioning Funds be less than twenty five percent (25 percent) of Decommissioning Costs. The Decommissioning Funds shall be posted and maintained with a bonding company or Federal or Commonwealth chartered lending institution chosen by the Facility Owner or Operator and participating landowner posting the financial security, provided that the bonding company or lending institution is authorized to conduct such business within the Commonwealth and is approved by the _____ [municipality].
- F. Decommissioning Funds may be in the form of a performance bond, surety bond, letter of credit, corporate guarantee or other form of financial assurance as may be acceptable to the _____ [municipality].
- G. If the Facility Owner or Operator fails to complete decommissioning within the period prescribed by Paragraph 17(A), then the landowner shall have six (6)
- H. If neither the Facility Owner or Operator, nor the landowner complete decommissioning within the periods prescribed by Paragraphs 17(A) and 17(G), then the _____ [municipality] may take such measures as necessary to complete decommissioning. The entry into and submission of evidence of a Participating Landowner agreement to the _____ [municipality] shall constitute agreement and consent of the parties to the agreement, their respective heirs, successors and assigns that the _____ [municipality] may take such action as necessary to implement the decommissioning plan.
- I. The escrow agent shall release the Decommissioning Funds when the Facility Owner or Operator has demonstrated and the municipality concurs that decommissioning has been satisfactorily completed, or upon written approval of the municipality in order to implement the decommissioning plan.

17. PUBLIC INQUIRIES AND COMPLAINTS

- A. The Facility Owner and Operator shall maintain a phone number and identify a responsible person for the public to contact with inquiries and complaints throughout the life of the project.

- B. The Facility Owner and Operator shall make reasonable efforts to respond to the public's inquiries and complaints.

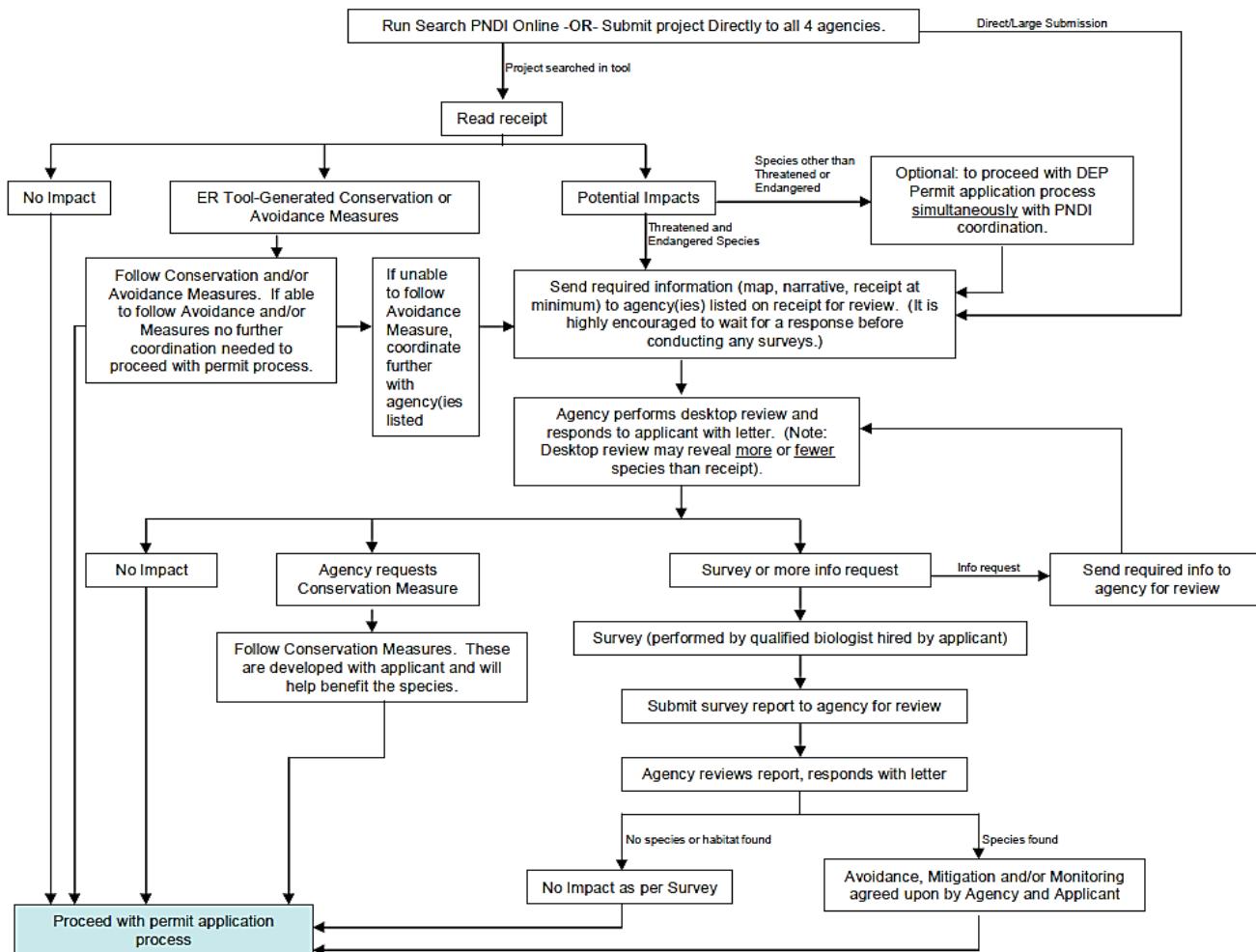
18. REMEDIES

- A. It shall be unlawful for any person, firm, or corporation to violate or fail to comply with or take any action which is contrary to the terms of the ordinance, or any permit issued under the ordinance, or cause another to violate or fail to comply, or to take any action which is contrary to the terms of the ordinance or any permit issued under the ordinance.
- B. If the _____ [municipality] determines that a violation of the Ordinance or the permit has occurred, the _____ [municipality] shall provide written notice to any person, firm, or corporation alleged to be in violation of this Ordinance or permit. If the alleged violation does not pose an immediate threat to public health or safety, the _____ [municipality] and the parties shall engage in good faith negotiations to resolve the alleged violation. Such negotiations shall be conducted within thirty (30) days of the notice of violation.
- C. If after thirty (30) days from the date of the notice of violation the _____ [municipality] determines, in its discretion, that the parties have not resolved the alleged violation, the _____ [municipality] may institute civil enforcement proceedings or any other remedy at law to ensure compliance with the Ordinance or permit.

APPENDIX E

Pennsylvania Natural Diversity Inventory Environmental Review Flow Chart

Pennsylvania Natural Diversity Inventory Environmental Review Flow Chart⁶⁸⁴



⁶⁸⁴ Pa. Nat. Heritage Program, Pa. Nat. Diversity Inventory Envtl. Rev. Flow Chart, <http://www.gis.dcnr.state.pa.us/hgis-er/hgis/PNDI%20Flow%20Chart.pdf> (last visited Jan. 16, 2015).