Strategy 2:

Increase Kentucky's Use of Renewable Energy

GOAL	**Goal: By 2025, Kentucky's renewable energy generation will triple to provide the equivalent of 1,000 megawatts of clean energy while continuing to produce safe, abundant, and affordable food, feed and fiber.**

The goal for *Strategy 2* is part of Kentucky's Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that states that "by 2025, Kentucky will derive at least 25 percent of its projected energy demand from energy efficiency, renewable energy and biofuels while continuing to produce safe, affordable and abundant food, feed and fiber."

INTRODUCTION

Energy from renewable resources benefits the environment while creating economic opportunities – the "green collar" jobs – for businesses, industry and rural communities. Renewable energy is one component of a three-part vision (*Strategies 1,2 and 3*) to provide 25 percent of Kentucky's energy needs by 2025 through energy efficiency, renewable energy and biofuels. To achieve this goal, the commonwealth must aggressively invest in the development of its renewable energy resources.

Renewable energy provides users, utilities, and communities many benefits beyond its direct energy services. These include:

- Distributed energy security – renewable energy systems operate on a smaller scale than centralized power plants and can be dispersed throughout transmission infrastructures.
- Energy independence – energy generated from renewable resources reduces the state's reliance on imported oil and natural gas.
- Improved environmental quality – relative to conventional power production, renewable energy systems reduce air pollutants, generate less thermal pollution and emit fewer greenhouse gases into the atmosphere.
- Economic investment – developing renewable energy markets diversifies local economies and creates employment opportunities for research, manufacturing and businesses.
- Job creation – growing the renewable energy sector will bring new technologies to market and create new "green collar" jobs.

Renewable energy refers to energy resources that are naturally replenishing and virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time (EIA, 2008). Examples of renewable energy resources in Kentucky include hydroelectric, landfill gas, biomass, solar and wind energy. For discussion in this strategy, renewable energy does not include biofuels derived from plant materials, which are discussed separately in *Strategy 3*.

Kentucky's Renewable Energy Today

Kentucky's current use of renewable energy resources is limited. According to the EIA, of the 98.8 million megawatt hours of electricity produced in Kentucky in 2006, 92.3 percent was from coal-fired sources, 2.6 percent from hydroelectric stations and 0.5 percent from other renewable resources (EIA, 2008b).

As shown in Table 2, renewable electricity generation in Kentucky today is dominated by hydroelectric resources (85 percent) with smaller amounts provided by wood waste (12 percent) and landfill methane (three percent) utilization. Kentucky does not have readily accessible reservoirs of steam, hot water or hot dry rocks for the production of electricity from geothermal resources.

Table 2: Kentucky Renewable Electric Power Industry Statistics (EIA, 2008b)

2006 Generation	Thousand Megawatt-Hours	Percent of State Total
Total Renewable Net Generation	**3,052**	**3.1**
Geothermal	-	-
Hydro Conventional	2,592	2.6
Solar	-	-
Wind	-	-
Wood/Wood Waste	370	0.4
MSW Biogenic/Landfill Gas†	88	0.1
Other Biomass	2	-

†Kentucky has no significant generation from municipal solid waste (MSW).

Kentucky's Renewable Energy Opportunities

Relative to other parts of the nation, Kentucky does not have significant sources of utility-scale renewable energy. Biomass and hydropower have the greatest potential for high capacity applications, but the state's limited exposure to strong winds, clear sunshine and deep waters implies that the majority of renewable energy systems will be widely distributed and relatively small in scale.

Solar Energy

Kentucky does not receive sufficient direct sunlight to make concentrating solar power a viable option today, but it does receive ample amounts of solar radiation for photovoltaic and solar heating applications (U.S. Department of Energy, Alternative Energy Resources in Kentucky). In this regard, the lack of significant development of solar energy in Kentucky is not because of a lack of solar energy resource, but rather, a reflection of historical economic conditions which have favored fossil-based energy resources.

The solar resources available to Kentucky and much of the United States greatly exceed those of Germany, which leads the world with grid-tied photovoltaic installations, reaching 1,328 megawatts in 2007. Perhaps even more significant, over 40 percent of the German market consists of systems below ten kilowatt capacity (Solarbuzz, 2008 Report).

Solar Photovoltaic Electricity

The state's primary energy consumption in 2025 could be reduced by 12.6 trillion Btu through the widespread deployment of solar photovoltaic (PV) systems. A report from the University of

Kentucky estimates that widespread deployment of 470 megawatts of solar photovoltaic electricity could reduce the state's primary energy consumption in 2025 by 6.3 trillion Btu if 6-kilowatt systems were installed on one out of every five new homes built between 2008 and 2025 (Colliver et al., 2008). Although a similar analysis was not conducted for commercial and industrial sectors, it is reasonable to assume that installed capacity in these sectors would meet or exceed residential growth (SEIA, 2008).

A PV solar capacity of 940 megawatts is high by today's standards, however there are strong signs of explosive growth and investment in the U.S. solar industry. Between 2001 and 2006, domestic shipments of photovoltaic cells and modules increased an average of 50 percent each year (EIA, 2007b) and, whereas approximately 150 megawatts of solar PV was installed in the U.S. in 2007, an additional 800 to 1,500 megawatts of PV capacity is expected each year by 2011 (Koot, 2008).

In Kentucky, a 6-kilowatt grid-tied PV system could be expected to generate about 7,500 kilowatt-hours of electricity over the course of a year. In a region where household electricity consumption averages nearly 1,200 kilowatt-hours per month, approximately half of a home's annual electricity consumption would come from solar power (EIA, 2001). Today, solar PV systems cost about $7-$10 per watt of capacity installed. Thus a 6-kilowatt system would be on the order of $50,000 without incentives or tax credits. Solar PV systems are eligible for a federal tax credit of 30 percent of the system costs. The cost of photovoltaic energy is high today, but newer more efficient solar cells are coming to market to help lower prices. The goal of the DOE's Solar America Initiative is to make solar cost-competitive with conventional electricity by reducing residential solar costs from 32¢ per kilowatt-hour in 2005 to 10¢ per kilowatt-hour by 2015 (DOE, 2008b).

Many state and local governments are pursuing PV installations on public buildings. To do this successfully, sound public policy, financial incentives, and committed program administrators are required. The most common benefits associated with public-sector solar programs include (Cory et al., 2008):

- PV can reduce utility peak summer demand.
- PV offers predictability of future utility expenses.
- PV reduces greenhouse gas (GHG) emissions.
- Public-sector PV stimulates the market and motivates other sectors to deploy solar.
- PV promotes the creation of local jobs.
- PV can provide emergency power benefits for critical municipal services during and directly after a disruption to the electrical grid.

Solar Thermal Hot Water

Energy used for water heating is a significant portion of the total energy demand in the commercial and residential sectors. In 2004, water heating in the residential sector consumed about 23 percent of all residential natural gas use, eight percent of all residential electricity use, and about 12 percent of total residential energy expenditures. Nationwide, about eight percent of all end-use natural gas is used to heat water in commercial and residential buildings. Solar water heating (SWH), which uses the sun to heat water directly or via a heat-transfer fluid in a collector, may be particularly important in its ability to reduce natural gas use (Denholm, 2007).

According to the University of Kentucky analysis, if one in five new housing units built between 2008 and 2025 includes solar water heating, the state could reduce its primary energy consumption in 2025 by 2.0 trillion Btu. Many non-residential applications also exist, including swimming pool heating, laundromats, hotels, dormitories, multi-family dwellings, and places with significant food preparation or processing. In total, these applications could amount to 70 percent of residential capacity (McMullen et al., 2008), bringing the total potential for solar water heating in Kentucky to 3.4 trillion Btu.

Wind Energy

Electricity generated from wind is becoming one of the least costly and most readily deployed options for new generation. In 2007, wind projects accounted for nearly 30 percent of all new power generating capacity in the United States. A 2008 report by the U.S. Department of Energy finds that the United States possesses enough affordable resources to contribute 20 percent wind energy to the nation's electricity supply by 2030 (DOE, 2008c).

The Wind Energy Resource Atlas of the United States associates most areas of Kentucky with a class 1 or class 2 wind power designation. A wind power class represents a range of wind power densities (W/m^2) that is likely to be encountered at an exposed site in the area. Large wind turbine applications require class 3 or better wind power. Class 2 areas are considered marginal and class 1 areas are generally unsuitable. Small areas of class 3 wind power are found along the mountain ridges in the extreme southeastern part of Kentucky.

Citing data from a 1991 study by the U.S. Department of Energy's Pacific Northwest National Laboratory, the American Wind Energy Association estimates that Kentucky has 19 square miles of class 3+ areas that are not under land-use or environmental restrictions. Developing these areas and accounting for the potential of small wind systems, Kentucky is believed to have the capacity to generate 34 megawatts of wind energy power on average. Operating over the course of a year, this renewable resource could reduce the state's (primary) energy consumption by 3.2 trillion Btu (Colliver et al., 2008).

Large-scale wind projects in other states have encountered resistance to such issues as:

- Avian and bat mortality rates along migratory routes.
- Sight line obstructions of notable vistas.
- Arbitration of property easements and downstream wind shielding.
- Adverse effects on localized temperature and moisture, especially around agricultural lands.

These issues are likely to diminish in proportion to the smaller size of the wind farms anticipated in Kentucky, but further consideration is justified in order to facilitate development of the wind industry in the state.

Combined Heat and Power

In 2001, the Domtar paper mill near Hawesville, KY installed a combined heat and power system fueled almost entirely from biomass. The system has the capacity to produce 88 megawatts of electricity and one million pounds of steam per hour by burning "black liquor" and other wood byproducts from the plant. Capable of operating at almost 86 percent efficiency, the integrated system requires 23 percent less fuel than typical onsite thermal generation and purchased electricity. The project was recognized by the U.S. Environmental Protection Agency and the Department of Energy with a 2005 Energy Star Combined Heat and Power (CHP) Award.

Biomass Energy

Biomass is plant matter such as trees, grasses, agricultural crops, or other biological material. It can be used as a solid fuel, or converted into liquid or gaseous forms for the production of electric power, heat, chemicals or fuels. Biomass-based electricity generation is considered a relatively cost-effective renewable technology for Kentucky, but the economics generally require placement of the electric generation facility near the feedstock fuel source.

Municipal solid waste (MSW) power plants burn solid refuse from relatively large urban centers. While this type of power plant can be economically feasible, many concerns have been raised about the environmental safety of burning a multitude of domestic, commercial and industrial waste products. This risk can be mitigated by using relatively homogenous waste streams, such as scrap from manufacturing processes, or by presorting the waste content. Kentucky burns negligible amounts of MSW for the generation of electricity.

Landfill Gas

In 2003, East Kentucky Power Cooperative (EKPC) opened the first landfill gas power plant in Kentucky. The plant makes electricity by collecting and burning methane gas in combustion engine-generators. Methane is a natural byproduct of the decomposition of organic waste and a powerful greenhouse gas. By burning methane, landfill gas plants not only supply renewable energy, they also prevent methane from entering the atmosphere. Today, EKPC operates five landfill gas power plants across the state. With a total generating capacity of 16 megawatts, the plants provide enough electricity to power about 8,000 homes.

Landfill gas (LFG) power plants are a variant of MSW technology, where gas from the decomposition of waste is used to fire turbines for electric generation. Municipal solid waste landfills are the second largest source of human-related methane emissions in the United States, accounting for nearly 23 percent of these emissions in 2006. At the same time, methane emissions from landfills represent a lost opportunity to capture and use a significant energy resource. Landfill gas consists of about 50 percent methane, the primary component of natural gas, about 50 percent carbon dioxide, and a small amount of non-methane organic compounds. Using LFG helps to reduce odors and other hazards associated with LFG emissions, and it helps prevent methane from migrating into the atmosphere and contributing to local smog and global climate change (EPA, 2008).

Kentucky has five active LFG power plants and a sixth project is under construction. The five active sites have a combined generating capacity of 16 megawatts (EPA, 2008b). The state's largest landfill, Louisville's Outer Loop, diverts a portion of its methane gas for direct use in a nearby industrial park. An additional 18 candidate sites and 12 potential sites are identified in the EPA's database. The theoretical potential of these resources could reduce the state's energy consumption by 5.9 trillion Btu (Colliver et al., 2008).

The decomposition that occurs underground in landfills can be engineered using anaerobic digester (AD) systems. Anaerobic digesters, often referred to as methane digesters, are amenable to biomass resources having high moisture contents. Byproducts from Kentucky's wastewater treatment facilities, ethanol and distiller industries and livestock operations could be converted into biogas using AD technology. Besides energy production, anaerobic digesters offer other benefits including odor reduction, reduced greenhouse gas emissions, and potential pathogen reductions.

A 2003 assessment of wastewater AD plants in Wisconsin concluded that the technology can be cost effective for plants treating at least one million gallons per day (Vik, 2003). According to the USDA, the long-term success of AD systems in the livestock industry has been more limited. In many cases, the AD systems failed, not because of technological shortcomings but because the owner was unwilling to continue with the necessary operation and maintenance. Nonetheless, renewed interest in AD technology over the past five years has led to an increase in the number of vendors marketing complete systems. The most cost effective designs are likely to be installed at larger animal feeding operations and directly use the biogas produced on site. Biogas systems are less complex and thus cheaper to install and operate compared to systems that generate electricity (USDA, 2007).

Woody Biomass

Kentucky has great potential for producing renewable energy from woody biomass (Figure 12). Wood energy sources might include woody residues from primary and secondary forest industries (such as bark, sawdust, slabs, trimming and edgings, etc.), residues from logging (tops, unmerchantable sections of stemwood), urban wood residues, woody energy plantations, and a portion of net forest growth that is not currently utilized.

Kentucky is ranked as one of the top five states in the production of industrial wood residues (1.59 million dry tons per year). However, most of these residues, primarily from sawmills, are already utilized as boiler fuel, horse bedding, landscape materials/ mulch, charcoal, and other products. The National Biomass Partnership (NBP) estimates that 3.5 million dry tons per year of underutilized biomass is available beyond what is being produced by Kentucky forest industries. The majority comes from logging residues associated with current harvest levels (1.95 million tons), but the removal of unmerchantable trees and underbrush for fuel deduction thinnings (1.21 million tons) and the diversion of urban residues (0.34 million tons) would also play a role. The NBP believes that another 3.78 million dry tons per year could be realized by using 25 percent of the land not cropped or enrolled in the Conservation Reserve Program to grow short rotation woody crops like hybrid poplar or willow, assuming a nominal biomass yield of 4.5 dry tons per acre per year (NBP, 2007).

Maker's Mark Distillery

Maker's Mark Distillery is a straight Kentucky bourbon whisky maker that has had an annual average growth rate of 12 to15 percent over the last 15 years. To allow for further growth and expansion, Maker's Mark had to solve the problem of disposal of its still byproducts (a water/grain mix that's left over after the alcohol is removed from the mash). Traditional disposal uses a Dry House which takes the raw (approximately 10 percent solids) still byproducts and evaporates the water to leave about 80-90 percent solids that can be sold as an animal feed called distiller's dried grains (DDG). Unfortunately, the burgeoning fuel ethanol industry has resulted in a glut of DDG. The over-supply of DDG plus the tremendous amount of energy consumed by a Dry House convinced Maker's Mark that they needed to find a new method to treat their still byproducts.

Maker's Mark chose a 'green' method of treatment. After three years of research, they chose a high-rate anaerobic system from Ecovation Inc. This system captures waste heat used to pre-heat lake water for the mashing process, produces a 42 percent solids animal feed, and most important, produces enough methane gas to replace up to 30 percent of the natural gas used by the plant. Any organics not converted to methane in the anaerobic digester are processed through an aerobic wastewater treatment plant, leaving water pure enough to return to the waters of the commonwealth.

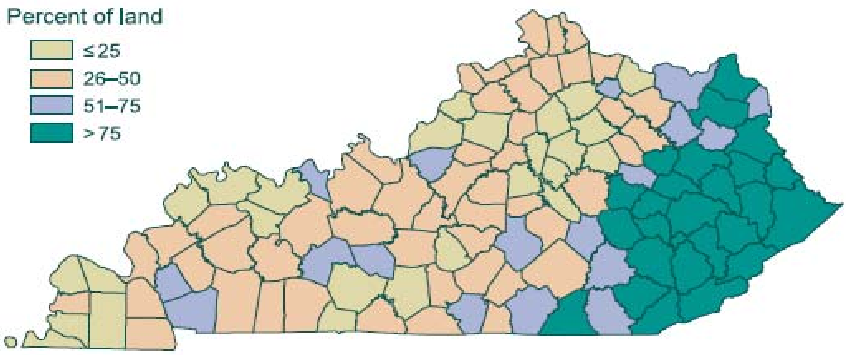


Figure 12: Forested Land Covers 12 million acres (47 percent) of Kentucky (Turner, 2008)

Failure to protect Kentucky's forests from over-harvesting and poor management practices will jeopardize one of the state's largest resources for renewable energy. The woody biomass identified in the National Biomass Partnership report comes from low value sources that are not in direct conflict with Kentucky's wood product industries. However, additional pressures from an emerging energy sector could easily create conflict between the two industries and harm the forest resource base. The use of these resources, in particular the net growth of merchantable trees, will require careful harvests to protect the forests. A renewed focus on forest management education and land-use policies will be necessary to ensure that Kentucky can provide a truly sustainable supply of woody biomass for all its needs.

The net growth of merchantable trees could yield an additional 1.9 million dry tons of biomass potential annually. According to Kentucky's 2004 Forest Inventory and Analysis, Kentucky forests are annually growing more biomass than is being removed. The analysis concludes that approximately one billion board feet of sawtimber, equivalent to 1.9 million dry tons per year, is available from the net growth of merchantable trees (Turner, 2008). Net growth is defined as growth beyond what is removed either through harvesting or loss of forest acreage.

In total, approximately 9.18 million dry tons of biomass potentially could be annually harvested, recovered, or specifically grown for biomass fuel in Kentucky without diverting biomass from existing uses. Assuming a heating value of 8,000 Btu per dry pound, this resource could provide up to 147 trillion Btu of renewable energy potential each year; however, capitalizing on the entirety of this resource is unlikely, despite being technically feasible.

The utilization capacity will eventually be determined by the marketplace with pressure anticipated from carbon management and renewable energy policies at the state and/or federal level. Lacking additional economic analysis and recognizing that only a portion of this resource will be developed, it is assumed that Kentucky's forests will contribute 66.9 trillion Btu of energy in 2025. This is approximately two and a half times more biomass energy than what is being utilized today (EIA, 2008c).

An advantage to woody biomass material is that it can be used to produce a variety of end-use products such as fuels, chemicals and power. It can be burned directly or converted into combustible fuels using thermal and/or chemical processes (Badger et al., 2007). While woody biomass is generally more cost-effective when co-fired with fossil fuels, this approach introduces a number of material handling and material compatibility issues. A bigger concern for older plants is permitting. Many facilities currently operate under permits that were grandfathered in when environmental regulations were strengthened. Such permits often limit the types of fuels they are allowed to burn. As long as they continue to operate as dictated by the original permit, they are not required to upgrade the facility. This creates a possible disincentive for incremental changes even if the outcome is an improvement in overall emissions (Badger et al., 2007b).

It is important to note that the potential for cellulosic ethanol identified in *Strategy* 3 does not include the 66.9 trillion Btu per year of woody biomass resources described above. Woody biomass could conceivably be used to produce either electricity or transportation fuel. The end use will be dictated by the market economics defined in part by material and land availability, consumer demand, emerging technologies, financial incentives and government policy. Utility companies will be more favorably inclined to policies that are positive and certain. The current federal Renewable Fuels Standard requires 36 billion gallons of renewable fuels to be used by 2022, of which 16 billion gallons must come from cellulosic resources (RFA, 2008).

Hydroelectric Power

In 2008, the Kentucky legislature authorized the Kentucky River Authority to promote private investment in the installation of hydroelectric generating units on all existing constructed and reconstructed Kentucky River dams under its jurisdiction (LRC, 2008).

The potential for new hydroelectric generation in Kentucky is likely to occur at sites that have an existing impoundment or minimally invasive run-of-river projects. Hydropower development is difficult because of competing uses for water, concerns for fish and wildlife, and the potential for impact by drought. In 1998, the Idaho National Laboratory (INL) conducted a resource assessment of the undeveloped hydropower potential in Kentucky. Forty-seven of the 51 sites assessed in the study already have some type of dam or impoundment, and 65 percent were considered small hydropower, less than 10 megawatts. The total undeveloped hydropower potential was 439 megawatts (INL, 1998).

Large hydro projects require very long lead times and large capital investments, and usually generate significant stakeholder opposition. Three new hydroelectric projects have been announced and two are in the early stages of development that utilize existing infrastructure. The projects range from five megawatts to 105 megawatts with a total generating capacity of 262 megawatts (Overland, 2008).

Assuming a quarter of the 701 megawatts identified in these two reports is developed and assuming a 40 percent capacity factor for hydro, Kentucky could replace 5.4 trillion Btu of fossil-based fuels. The additional capacity represents a 24 percent increase over the 2006 hydropower generation and would bring the state's total hydropower potential to 35.0 trillion Btu.

Hydropower

In 2006, Lock 7 Hydro Partners, LLC began renovating the dormant turbine-generators at Lock and Dam 7 on the Kentucky River near Harrodsburg, KY. Renamed the Mother Ann Lee Hydroelectric Station, the plant consists of three turbines with a total electricity generating capacity of more than two megawatts. The hydro plant is one of only a few dozen to be certified by the Low Impact Hydro Institute for minimizing its environmental impacts on fish, wildlife and other resources. Once fully renovated, Mother Ann Lee is expected to generate 8.3 million kilowatt-hours a year, which is roughly the amount of electricity consumed by 800 U.S. households in a year.

Renewable Energy Markets

Mechanisms for promoting renewable energy include voluntary and mandatory markets. Mandatory markets exist where policy decisions, such as state renewable portfolio standards, dictate that electric service providers include a minimum amount of renewable energy in their electricity supply. To promote portfolio diversification, many states establish set-aside or "carve outs" for higher cost technologies. Without carve-outs, an RPS will generally exhaust low-cost technologies first before maturing other markets (Clean Energy Group, 2008).

Kentucky does not currently have a Renewable Portfolio Standard (RPS). The matter was formally reviewed in the PSC Case 2007-00477 in which the PSC advised that the structure of an RPS as well as the reliability and cost effectiveness of an energy portfolio containing increasing amounts of renewable energy should be reviewed and evaluated. (PSC, 2008b). In setting an RPS for Kentucky consideration must be given to both jurisdictional and non-jurisdictional energy service providers and how the RPS is applied to each.

Voluntary consumer decisions to purchase electricity supplied from renewable energy sources represent a powerful market support mechanism for renewable energy development. Beginning in the early 1990s, a small number of U.S. utilities began offering "green power" options to their customers. Green power represents renewable energy resources and technologies that provide the highest environmental benefit. Customers often buy green power for avoided environmental impacts and to support its greenhouse gas reduction benefits. Many Fortune 500 companies, local, state and federal governments, and a growing number of colleges and universities purchase green power to demonstrate their commitment to the environment and to lead by example (EPA, 2008c).

In Kentucky, all electric utilities regulated by the PSC offer green power to their utility customers. Green power is purchased in blocks of kilowatt-hours with price premiums ranging from 1.67 to 2.75 cents per kilowatt-hour. The 2006 average residential price for electricity in Kentucky was 7.02 cents per kilowatt-hour.

As an alternative to green power, or where green power is not available, individuals and organizations can support renewable energy development by purchasing Renewable Energy Certificates (RECs). A REC represents the property rights to the environmental, social, and other non-power qualities of one megawatt-hour of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable generation source (EPA, 2008d). RECs provide buyers flexibility in procuring green power across a diverse geographical area, but do not necessarily support local renewable energy projects.

Incentives

Recognizing the benefits of renewable energy, many state, local, utility and federal programs offer incentives to reduce up-front costs. The biggest incentives generally exist in states having a renewable portfolio standard.

Incentives based on installation and system costs are fairly common. These include rebates, tax credits, and tax exemptions. Although easy to implement, these types of incentives are often short-lived and offset a relatively small portion of the initial price.

Performance-based incentives are inherently more complex, but offer greater potential for reimbursement. With this approach, incentives are generally paid out over time based on system production. The incentive could be a direct per kilowatt-hour payment like that used for feed-in tariffs or an indirect payment such as the market value placed on a tradable REC. A feed-in tariff, also known as a renewable energy payment, is a premium rate that is guaranteed over a long-term contract for the generation of renewable energy. With tradable instruments like RECs, the market is left to determine the price.

Challenges to Renewable Energy Production

Financial

Renewable energy markets, until they mature, need predictable, long-term incentives and policy support to function in the near term. A significant barrier to the wide-spread adoption of renewable energy systems is that initial costs are high while the financial savings from avoided energy purchases are low.

Kentucky has not had a major driver to help encourage the use of renewable energy. Only recently were utility-scale, renewable energy facilities included in state tax incentive financing. In 2007, Kentucky passed the "Incentives for Energy Independence Act" which provides incentives for companies that construct, retrofit or upgrade a facility to generate electricity from renewable energy resources. To qualify, the renewable energy facility must generate at least one megawatt of power (50 kilowatts for solar) and incur a minimum capital investment of $1 million (LRC, 2007).

Through 2008, state-wide incentives for homeowners and businesses to install renewable energy systems are limited to the federal tax credit for solar energy contained in the Energy Policy Act of 2005. The credit, recently extended through 2016, covers 30 percent of the cost of a solar PV or solar hot water system up to $2,000. In 2009, the cap will be removed for PV systems only (TIAP, 2008).

Beginning in 2009, Kentucky will offer a tax credit up to $500 for homeowners and up to $1,000 for businesses to install renewable energy systems utilizing wind and solar energy. Relative to the required capital investment, the tax credits are too small to significantly move the market. In order to grow the renewable energy markets in Kentucky, the incentives need to be better aligned with cost-based rates.

Regulatory

Renewable energy, by its nature, is closely tied to the strategy of distributed generation – producing electricity near its point of use. Distributed generation (DG) can provide system-wide benefits in the form of a diversified fuel mix and ease the strain on utility transmission and distribution networks. Often cited impediments to successful development of distributed generation are (PSC, 2008):

- Historically low electricity prices.
- Redundant technical requirements that increase interconnection costs.
- Utility standby charges for backup power.
- Arbitrary electricity prices for systems outside of net metering policies.
- Lack of standard siting requirements.

Two key prerequisites for developing distributed generation projects include the availability of uniform interconnection standards and net metering rules. They are fundamental to the issue of access to the grid on a basis of economic cost.

Standard interconnection rules establish clear and uniform processes and technical requirements that apply to utilities within a state. These rules reduce uncertainty and prevent time delays that clean distributed generation systems can encounter when obtaining approval for electric grid connection. States that modified interconnection rules focusing only on net-metered systems have found these changes were insufficient to encourage renewable DG. This is largely due to the small capacity limits on net-metered systems, which limits larger DG systems from accessing the grid for back-up power.

Kentucky does not have a state-wide interconnection standard although the matter is under review. The PSC initiated Case 2008-00169, in response to Senate Bill 83 of the 2008 Regular Session, to establish interconnection and net-metering guidelines for retail electric suppliers (PSC, 2008). In February 2008, the EPA completed a research project to assess existing state interconnection rules for their DG friendliness. The EPA deemed Kentucky's interconnection standards to be unfavorable (EPA, 2008e) .

The federal government has provided some degree of guidance to states on interconnection policy. Federal Energy Regulatory Commission (FERC) Order 2006, adopted in May 2005, includes three levels of review of DG systems up to 20 megawatts in capacity. Although FERC's interconnection rules for small generators are unlikely to have much impact on distribution-level interconnection (which is generally governed by states), the commission has stated that it hopes states will adopt its rules – with necessary modifications – to promote a more unified interconnection policy around the United States (IREC, 2007).

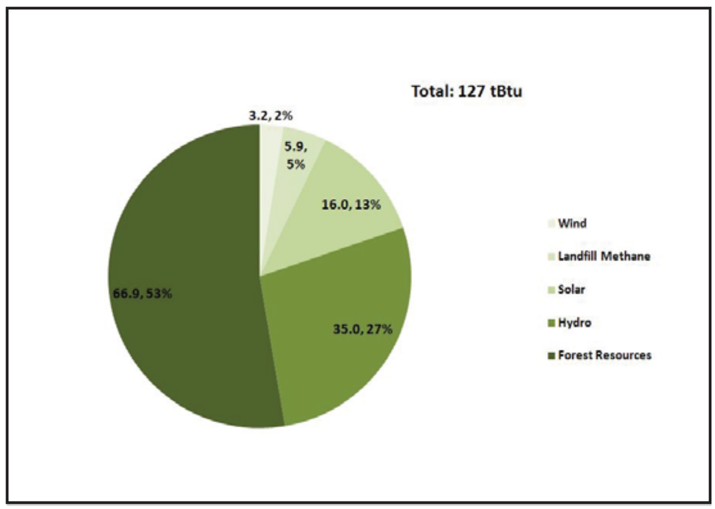
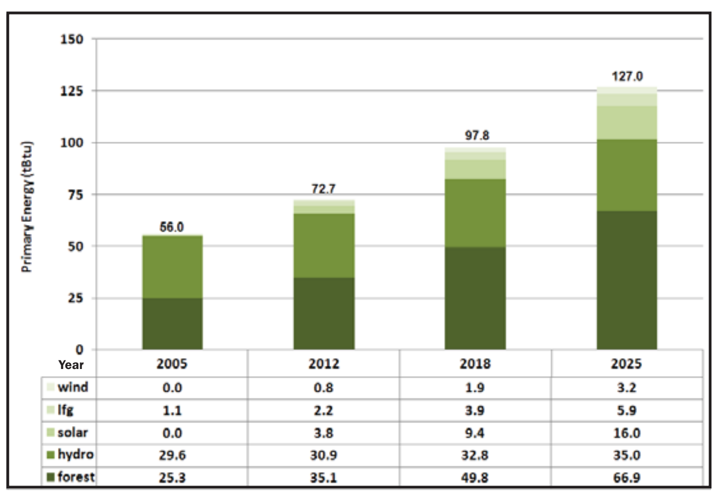


Figure 13: 2025 Renewable Energy Potential for Kentucky

Net metering is an important tariff issue for DG systems whereby a customer's electric meter can run both forward and backward in the same metering period and the customer is charged only for the net amount of power used. By definition, true net metering calls for the utility to value distributed power generation at the retail rate using one meter. It is a low-cost and easily administered means of promoting direct customer investment in renewable energy.



Year	2005	2012	2018	2025
wind	0.0	0.8	1.9	3.2
lfg	1.1	2.2	3.9	5.9
solar	0.0	3.8	9.4	16.0
hydro	29.6	30.9	32.8	35.0
forest	25.3	35.1	49.8	66.9

Figure 14: Renewable Energy Targets to 2025
[1] (2005 data: EIA, 2008c)

Kentucky requires net metering for solar, wind, biomass or biogas, and hydro-energy systems with a generating capacity less than 30 kilowatts. If the cumulative generating capacity of net-metered systems reaches one percent or less of a utility's single-hour peak load during the previous year, the PSC may limit the utility's obligation to offer net metering. Kentucky's net metering law allows for excess electricity to be "rolled over" as credit against future consumption, but credits are not transferable when service is discontinued.

Fully Developing Kentucky's Renewable Energy Potential

Using forecast data from the EIA, the University of Kentucky report estimates the state's energy consumption in 2025 will be 2,815 trillion Btu. To achieve a 25 percent goal, Kentucky will need to provide 704 trillion Btu of energy in the form of energy efficiency, renewable energy and biofuels.

The resources identified in *Strategy 2* amount to 127 trillion Btu of renewable energy potential (Figure 13). Combined with 511 trillion Btu from energy efficiency (*Strategy 1*) and 66 trillion Btu from biofuels (*Strategy 3*), Kentucky can realistically achieve a Kentucky REPS goal of 25 percent by 2025.

Using a linear growth model, cumulative targets by resource for the years 2012, 2018 and 2025 are presented in Figure 14. Acknowledging that much of the future resource potential will be in the form of electricity, the units in Table 3 are presented in site-based megawatt-hours.

The 127 trillion Btu of renewable energy identified in *Strategy 2* does not include agricultural crops and crop residues applied toward biofuels production. Nor does it include renewable energy applications that were not addressed in the reference materials such as methane production from animal feeding operations and wastewater treatment facilities.

Clearly, more potential is available and will become available as technologies improve and the markets mature. If climate change legislation is passed and monetary penalties are tied to carbon emissions, many forms of renewable energy generation may become cost competitive and economically attractive.

The primary impediment toward the development of Kentucky's renewable energy potential today is economic viability. The energy potential can be realized using commercially available technologies which can be deployed quickly and scaled over time. Consequently, there is not a significant rationale to delay implementation of Kentucky's renewable resources if appropriate policies and incentives are created to ensure an adequate return on investment.

Developing appropriate policies and mechanisms to spur development of Kentucky's renewable energy sector will require further study. Currently, there are 26 states with mandatory renewable portfolio standards and another six with non-binding goals. To date, no broad, open-ended feed-in tariffs have

Table 3: Renewable Electricity Generation Targets to 2025

Renewable Resource	Thousand Megawatt-Hours (MWh)			
	Existing[1]	2012	2018	2025
Total Generation	**3,052**	**4,509**	**6,694**	**9,244**
Wind Energy	0	69	172	293
LFG / Biogas	88	191	347	528
Solar PV	0	272	679	1,154
Hydropower	2,592	2,708	2,883	3,087
Forest Biomass	372	1,268	2,613	4,182

[1] Existing generation from Table 2.

been created in the U.S., but revisions to RPS policies, necessary to meet increasingly aggressive environmental and economic development goals, have trended toward incorporating elements of feed-in tariffs (Rickerson et al., 2008).

Were Kentucky, on the other hand, to enact an incentive system that depends on tradable RECs, it must be well designed or projected revenues from Renewable Energy Credit (REC) sales will not be reliable enough or great enough to meet capital requirements. A well-designed market must include an adequate penalty for non-compliance to support sufficient REC prices and the requirement for long-term REC contracting. This type of structure provides predictable and sufficient REC revenue streams that better match the life-cycle of federal tax incentives and power purchase agreements (Overland, 2008).

ACHIEVING THE GOAL:

By 2025, Kentucky's renewable energy generation will triple to provide the equivalent of 1,000 megawatts of clean energy while continuing to produce safe, abundant, and affordable food, feed and fiber.

Near-Term Actions (1-3 years)

1. State government will lead by example by requiring new or substantially renovated public buildings to utilize renewable energy as a percentage of total energy consumption.

    - The High Performance Building Committee established in HB 2 (LRC, 2008) will establish renewable energy targets for 2012, 2018, and 2025 for new or substantially renovated buildings.
    - The requirements will escalate over time to reflect the state's renewable energy and energy efficiency goals.
2. The EEC will recommend policies and incentives necessary to achieve the state's renewable energy goal. The analysis will:

    - Analyze economic risks relating to carbon emissions and carbon mitigation strategies (*Strategy 6*).
    - As part of implementing the REPS for all suppliers of retail electric power, establish a timeframe for compliance and incremental percentages that will diversify the state's energy supply.
    - Evaluate the costs and benefits to ratepayers and taxpayers of achieving an RPS through different funding mechanisms (PBF, REC trading, feed-in tariff, tax incentives, etc.).
    - Recommend incentive programs necessary to stimulate the deployment of non-electric renewable resources (solar hot water, LFG, woody biomass, etc.).
    - Incorporate and suggest changes to existing state incentives for renewable energy systems (e.g., HB 1 and HB 2).
3. The PSC will develop state-wide interconnection guidelines for renewable energy systems.

4. Kentucky will review its policies and regulations to encourage the responsible use of woody biomass.

    - The Division for Air Quality will examine the rules for New Source Review with the EPA to reduce barriers for distributed generation projects that introduce new fuel sources, yet reduce total annual emissions (e.g., co-firing with biomass).
    - The Division of Forestry will review forestry and land-use policies and regulations to ensure that Kentucky has a sustainable supply of biomass for both its wood and power industries.

Mid-Term Actions (4-7 years)

1. Kentucky will review and make adjustments to its renewable energy policies and incentive programs as capacity grows.
2. Kentucky will amend its interconnection guidelines to allow renewable energy systems up to two megawatts.
3. Kentucky will implement forestry and land-use policies and/or regulations to ensure that Kentucky has a sustainable supply of biomass for its wood and power industries.

Long-Term Actions (>7 years)

1. Kentucky will annually align its renewable energy policies and incentive programs to be compatible with the state's renewable energy goal.

IMPLEMENTATION SCHEDULE

The rate of implementation of the renewable energy resources identified in *Strategy 2* will be greatly influenced by policy and incentives established at the state and federal level. Without intervention, significant movement in the renewable energy sector is unlikely. The recent trend in escalating energy prices will encourage greater adoption of renewable energy systems, but substantial growth in the market will require aggressive government policies that monetize the true costs of fossil energy consumption and send clear price signals to renewable energy markets.

ENVIRONMENTAL BENEFITS & LIMITATIONS

Electricity generation is the dominant industrial source of air emissions in the United States today. Fossil fuel-fired power plants are responsible for 67 percent of the nation's sulfur dioxide emissions, 23 percent of nitrogen oxide emissions, and 40 percent of man-made carbon dioxide emissions. These emissions can lead to smog, acid rain, and haze. In addition, these power plant emissions increase the risk of climate change. Renewable energy is receiving increased attention by environmental policymakers because renewable energy technologies have significantly lower emissions than traditional power generation technologies (EPA, 2008f).

Biomass power plants emit nitrogen oxides and a small amount of sulfur dioxide. The amounts emitted depend on the type of biomass that is burned and the type of generator used. Biomass contains much less sulfur and nitrogen than coal; therefore, when biomass is co-fired with coal, sulfur dioxide and nitrogen oxides emissions are lower than when coal is burned alone. Although the burning of biomass also produces carbon dioxide, the primary greenhouse gas, it is considered to be part of the natural carbon cycle of the earth. The plants take up carbon dioxide from the air while they are growing and then return it to the air when they are burned, thereby causing no net increase except for the energy used in agricultural production and gathering and preparation of the biomass as feedstock.

Burning landfill gas produces nitrogen oxides emissions as well as trace amounts of toxic materials. The amount of these emissions can vary widely, depending on the waste from which the landfill gas was created. The carbon dioxide released from burning LFG again is considered to be a part of the natural carbon cycle of the earth. Producing electricity from LFG avoids the need to use non-renewable resources to produce the same amount of electricity. In addition, burning LFG prevents the release of methane, a potent greenhouse gas, into the atmosphere.

The combustion of solid waste for energy raises similar concerns about hazardous air pollutants. Without proper emission control devices or sufficient presorting, the contents used to fuel MSW power plants, including any toxic materials, can be released into the air.

Air emissions from hydroelectric power are negligible because no fuels are burned. However, if a large amount of vegetation is growing along the riverbed when a new dam is built, it will decay in the lake that is created, causing an initial buildup and release of methane, a potent greenhouse gas.

Emissions associated with generating electricity from solar and wind technologies are negligible because no fuels are combusted.

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