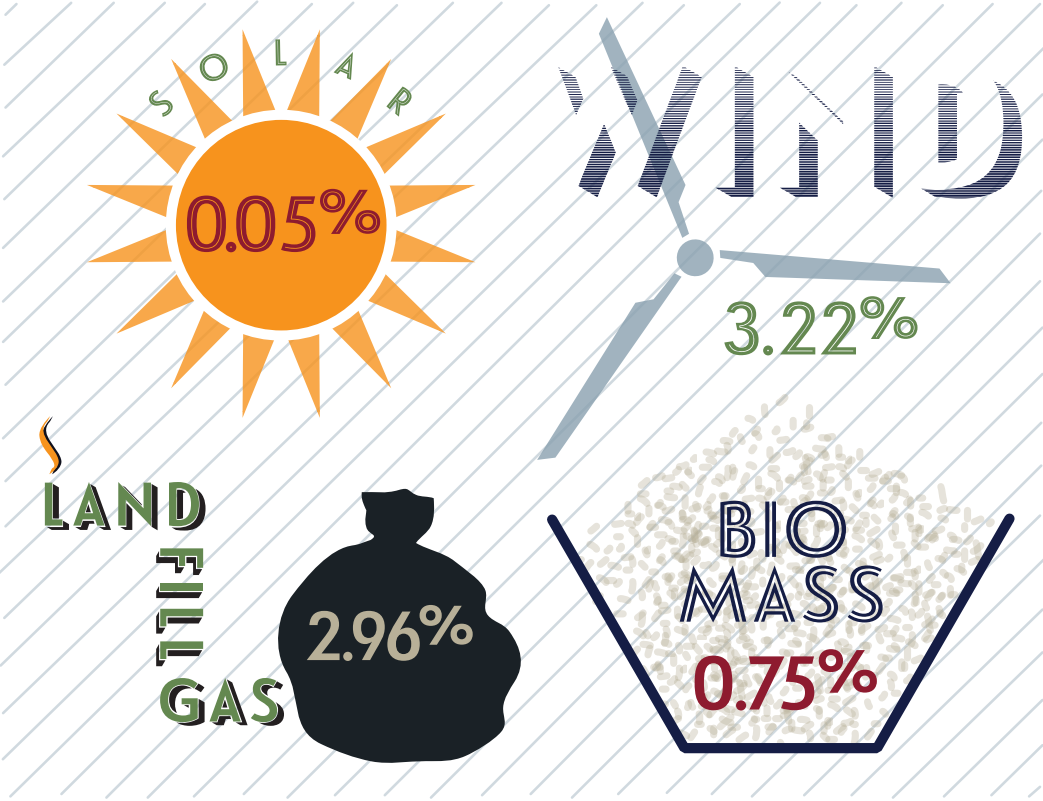
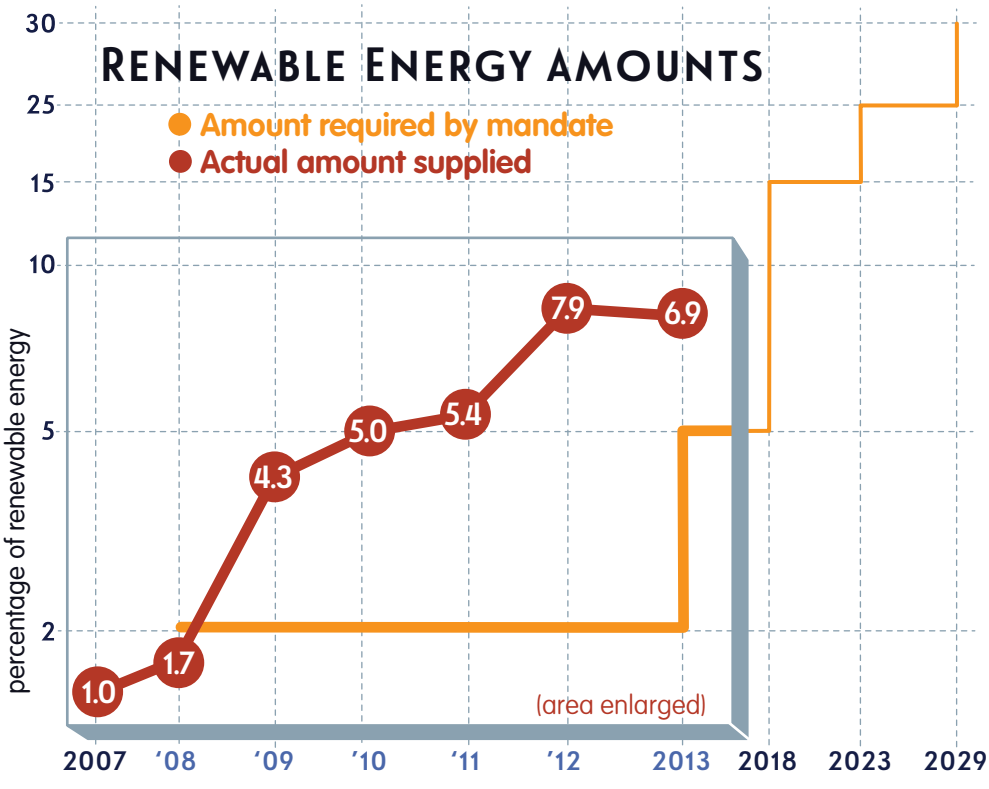
Renewable Energy Report

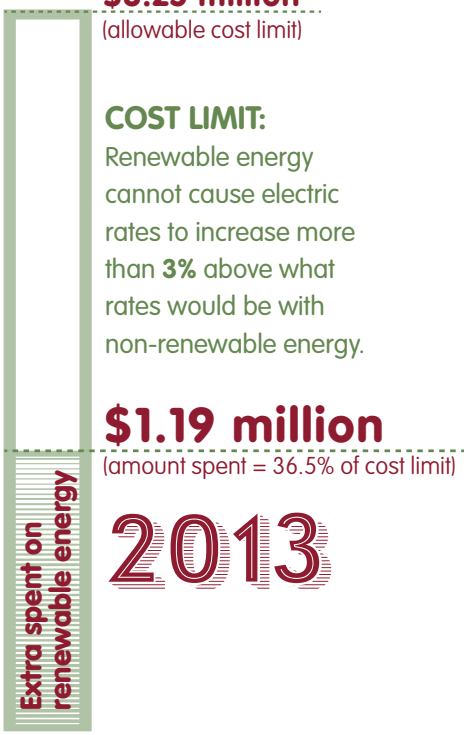
COLUMBIA WATER & LIGHT

6.97%

of all energy sources for 2013 were renewable, **exceeding goal** of 5%.







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2014 Renewable Energy Report

Columbia Water & Light

In November 2004, Columbians approved a renewable energy ordinance for the city's power supply portfolio. The ordinance mandates Columbia Water & Light purchase increasing levels of energy from renewable resources. Each year, the utility is required to submit a plan outlining compliance with the ordinance. The Water & Light Advisory Board and the Environment and Energy Commission reviewed the report. The Columbia City Council approved the report after holding a public hearing.

Summary

Columbia Water & Light has been pursuing renewable energy sources since the mandate was passed by voter approval in 2004. In 2013, Columbia had 6.97% of the electric portfolio generated from renewable sources. The renewable portfolio comes from wind (3.22%), landfill gas (2.96%), biomass (0.75%) and solar (0.05%). The total amount exceeds the requirement for 2013 of 5% by 1.97%. The additional cost is 36.5% of what is allowed by the renewable energy ordinance. The following is a summary of the renewable energy accomplishments:

- 2005: The first renewable energy was delivered to Columbia through a short-term contract for landfill gas energy from Illinois.
- 2007: Columbia started receiving wind energy from Bluegrass Ridge.
- 2008: The landfill gas to energy project was completed in Columbia. The Columbia Power Plant started burning waste wood along with coal. The Solar One program was launched.
- 2009: Columbia started receiving landfill gas energy from Jefferson City.
- 2010: Three additional solar projects were added to the Solar One program.
- 2011: Columbia started receiving solar energy through a long-term contract with the Free Power Company.
- 2012: Columbia started purchasing wind energy from Crystal Lake.
- 2013: Installed a third generator at the Columbia Landfill Gas Energy Plant

Renewable Energy Ordinance Requirements

The renewable energy ordinance was revised by the Columbia City Council on January 6, 2014. The percentage of required renewable energy increased from 10% to 15% by 2018, from 15% to 25% by 2023 and set a new goal of 30% by 2029.

The city shall generate or purchase electricity generated from eligible renewable energy sources at the following levels:

1. 2% of electric retail sales by December 31, 2007
2. 5% of electric retail sales by December 31, 2012
3. 15% of electric retail sales by December 31, 2017
4. 25% of electric retail sales by December 31, 2022
5. 30% of electric retail sales by December 31, 2028

The cost of the renewable energy mandated in the ordinance must not increase electric rates more than 3% higher than the electric rates attributed to the cost of electricity generated from 100% non-renewable sources. The full text of the Renewable Energy Standard and the approved list of renewable resources are listed in the appendix of this report.

2013 Renewable Energy Production Amounts

Month	System Total MWH	Bluegrass Wind MWH	Crystal Lake Wind MWH	Jeff City Landfill MWH	Columbia Landfill MWH	Waste Wood MWH	Free Power Solar MWH	Net Metered & Solar One MWH	TOTAL Renew MWH	Monthly % of System	Annual % of System
1-13	101,588	1,492	3,038	1,723	1,196	71	23.99	5.55	7,549	7.43%	7.43%
2-13	90,544	1,392	1,418	1,817	964	1,194	27.26	6.31	6,819	7.53%	7.48%
3-13	95,182	1,334	1,740	1,650	803	280	31.37	7.54	5,846	6.14%	7.04%
4-13	84,918	1,360	2,771	2,050	743	688	36.24	10.82	7,659	9.02%	7.49%
5-13	92,147	13,006	2,454	1,803	923	986	41.09	11.95	7,525	8.17%	7.62%
6-13	103,711	1,093	1,898	1,561	1,201	694	46.59	13.30	6,506	6.27%	7.38%
7-13	115,604	667	1,846	1,498	1,194	1,086	49.21	14.29	6,355	5.50%	7.06%
8-13	118,489	534	1,189	2,035	984	1,161	48.02	13.18	5,964	5.03%	6.76%
9-13	103,749	775	2,023	2,010	1,017	1,115	43.12	11.74	6,994	6.74%	6.76%
10-13	88,624	1,309	1,756	1,938	1,576	652	36.74	10.72	7,278	8.21%	6.89%
11-13	88,152	1,561	1,845	1,942	1,557	0*	25.33	7.59	6,938	7.87%	6.97%
12-13	105,775	1,162	2,213	1,813	1,168	1,044	15.33	6.79	7,422	7.02%	6.97%
Total MWH	1,188,483	13,985	24,189	21,840	13,326	8,971	424.29	119.77	82,855		
% of Total		1.18%	2.04%	1.84%	1.12%	0.75%	0.04%	0.01%	6.97%		

*Waste wood was not used at the Columbia Power Plant in November while it was down for regular maintenance.

Renewable Energy Portfolio Overview

Columbia system load: 1,188,483 megawatt hours
Renewable energy total: 82,855 megawatt hours or 6.97%

- Bluegrass Ridge wind energy: 1.18% of electric system @ $67.76/MWH
- Crystal Lake wind energy: 2.04% of electric system @ $56.76/MWH
- Jefferson City landfill gas: 1.84% of electric system @ $53.05/MWH
- Columbia landfill gas: 1.12% of electric system @ $47.38/MWH
- Waste wood: 0.75% of electric system @ $38.11/MWH (fuel cost only)
- Free Power Solar: 0.04% of the electric system @ $54.95/MWH
- Net Metered Customer Production & Solar One: 0.01% of the electric system. The retail rate for net metered energy was $94.40/MWH. Solar One program costs were covered by customers subscribing to the program.

Costs of Renewable Energy

As outlined in Section 27-106(b) of the Renewable Energy Standard ordinance, renewable energy cannot cause electric rates to increase more than 3% above what rates would be with non-renewable energy. The 3% impact on rates limit is determined as 3% of total revenue from regulated rate sources. The City of Columbia has a fiscal year that does not match the calendar year outlined in the Renewable Energy Standard. Renewable energy costs for this report include information from the January through September period of the prior fiscal year along with the October through December information from the current fiscal year. For calendar year 2013, the additional cost to address the renewable portfolio requirement was $1,186,609 and the limit was $3,253,064, as outlined in the following tables. The extra money spent on renewable energy was 36.5% of what was allowed according to the ordinance.

Cost of 2013 Renewable Energy Portfolio

Renewable Resource	Impact on Rates
Columbia landfill	($99,945)
Jefferson City landfill (Ameresco)	($39,967)
Bluegrass Ridge wind (Associated Electric)	$491,836
Crystal Lake wind (NextEra Energy)	$930,389
Solar (Free Power)	$7,841
Wood at Columbia Power Plant	($144,792)
Net Metered Photovoltaic Production	$4,512
Total Renewable Resource Impact on Rates	$1,149,874
2013 Photovoltaic Rebates to Customers	$43,305
2013 Capacity Credit for Wind Resources	($6,570)
Total 2013 Renewable Standard Impact on Rates	$1,186,609

*This service tracks and verifies Renewable Energy Credits

Maximum Renewable Portfolio Cost Calculations

Revenue Source	January – September (FY13)	October – December (FY14)
Residential	$34,795,068	$9,767,336
Commercial/Industrial	$41,031,744	$12,534,584
Street Lights	$390,908	$130,335
Public Authority	$6,383,241	$2,096,288
Inter-Departmental	$997,076	$308,899
Total Revenue During Calendar Year 2013		$108,435,479
3% Impact Limit on Rates		$3,253,064

Calculating Renewable Energy Costs

Renewable and non-renewable energy prices are divided into resources with similar characteristics compared and evaluated according to these similar characteristics.

1. Base Load Resources
   - *a.* A dispatchable resource that provides capacity and energy at a high capacity factor, on a year-round basis.
   - *b.* Current non-renewable base load resources
     - *i.* Sikeston
     - *ii.* Nearman
     - *iii.* Iatan II
     - *iv.* Prairie State – units 1 and 2
   - *c.* Current renewable base load resources
     - *i.* Columbia landfill gas plant
     - *ii.* Ameresco landfill gas plant contract
   - *d.* All-in cost (capacity, energy and transmission) comparisons are calculated for a monthly average cost per megawatt hour. The cost per megawatt hour variance between each renewable resource and non-renewable resources are applied to the total monthly megawatt hour output of each renewable resource to determine the annual renewable cost variation. The average non-renewable cost in 2013 was $54.88/MWH
     - *i.* Columbia landfill gas plant
       - Produced 13,326 megawatt hours
       - The average cost was $47.38/MWH
     - *ii.* Jefferson City (Ameresco) landfill gas plant
       - Produced 21,840 megawatt hours
       - The cost was $53.05/MWH
2. Intermittent Resources

a. A limited or non-dispatchable resource that may provide capacity and energy.
b. Current renewable intermittent resources
    i. Bluegrass Ridge wind
    ii. Crystal Lake wind
    iii. Free Power
    iv. Net metered customer production
    v. Solar One
c. All-in cost (energy and transmission) for intermittent resources will be compared to the appropriate Midwest Independent System Operator's (MISO) Locational Marginal Price (LMP) for energy at the pricing node where Columbia Water & Light takes delivery of the energy. The renewable cost per megawatt hour will include any additional fees invoiced under the contract, such as transmission costs. The cost per megawatt hour variance between the renewable energy and the market energy will be applied to the total megawatt hour output of the renewable resources to determine the annual renewable cost variation.
    i. Bluegrass Ridge: This resource in not in MISO so a fixed charge for transmission to MISO is necessary in addition to the purchase price. For calendar year 2013, the average day-ahead Columbia LMP for the hours when the wind resources were producing energy was $32.59 per megawatt hour. The total cost of energy, including transmission, was $67.76 per megawatt hour. The difference in these two values is the renewable cost of $35.17 per megawatt hour.
        - Produced 13,985 megawatt hours
        - The cost was $67.76/MWH of which $35.17/MWH represents the additional renewable expense.
    ii. Crystal Lake: This resource is in MISO so no fixed transmission charge exists. This contract requires Columbia Water & Light to pay for "deemed" energy. Deemed energy is energy that would have been produced had Columbia Water & Light not requested production curtailment due to a negative LMP. A negative LMP means that Columbia Water & Light would be paying the energy market to take the energy. Columbia Water & Light currently requests curtailment at negative ten dollars (-$10.00). For calendar year 2013, the average real-time Crystal Lake LMP for the hours when the wind resources were producing energy was $18.30 per megawatt hour. The total cost of energy, including deemed energy, was $56.76 per megawatt hour. The difference in these two values is the renewable cost of $38.46 per megawatt hour.
        - Produced 24,189 megawatt hours
        - The cost was $56.76/MWH of which $38.46/MWH represents the additional renewable expense.
    iii. Free Power: These photovoltaic systems are connected with the Columbia Water & Light electric distribution system, so they operate behind the meter in MISO. For calendar year 2013, the average day-ahead Columbia LMP for the hours when the Free Power solar resource was producing energy was $36.47 per megawatt hour. The Free Power contract price is $54.95 per megawatt hour. The difference in these two values is the renewable cost of $18.48 per megawatt hour.
        - Produced 424.29 megawatt hours
        - The cost was $54.95/MWH of which $18.48/MWH represents the additional renewable expense.
    iv. Net metered customer production: These customer-owned photovoltaic developments are also connected with the Columbia Water & Light electric distribution system, so they operate behind the meter in MISO. For calendar year 2013, the average day-ahead Columbia LMP for the hours when the customer-owned solar resources were producing energy was $36.81 per megawatt hour. The initial retail energy price is $94.40 per megawatt hour. The difference in these two values is the renewable cost of $57.59 per megawatt hour.
        - Produced 78.35 megawatt hours
        - The retail rate for net metered energy was $94.40/MWH of which $57.59/MWH represents the additional renewable expense.
    v. Solar One: Voluntary customer subscriptions pay for the cost of this energy.

3. Load Following and/or Ancillary Service Resources
a. The Columbia Power Plant is a resource that serves multiple functions. This resource does not provide energy production on a year round basis and should not be considered as a base load resource. For comparison of non-renewable and renewable energy costs, only the variation in the cost of fuel will be utilized for this resource. Adjustment will be made for BTU content of each fuel source to determine a cost per megawatt hour. The variance between the cost per megawatt hour of non-renewable fuel and cost per megawatt hour of renewable fuel will be

applied to the total megawatt hour output attributed to the renewable fuel to determine the annual renewable cost variation.

i. Energy cost of coal is $54.25/MWH

ii. Energy cost of wood

- Produced 8,971 megawatt hours
- The cost was $38.11/MWH

4. Peaking Resources

a. All electric utilities are required to maintain resources to meet the megawatt system peak requirements plus a reserve requirement. This capacity requirement is typically met with the lowest cost resource available. The cost is calculated and/or paid on a per megawatt basis, not on a megawatt hour basis. These resources fulfill a specific requirement that typically does not include energy production. Non-renewable capacity resources are the Columbia Energy Center, two natural gas generators at the Columbia Power Plant and Columbia's distributed generation projects. There are no renewable resources that are in place only for capacity purposes. For the purpose of evaluating non-renewable versus renewable energy costs, capacity resources are excluded from the calculations.

5. The total additional cost of renewable energy is the sum of the calculations described in section 1, 2 and 3 above.

2013 Renewable Energy Portfolio Details

Bluegrass Ridge Wind Energy

Columbia started receiving wind power from turbines near King City, Missouri on September 5, 2007. The Columbia contract is for one ninth of the electric output from the Bluegrass Ridge Wind Farm from Associated Electric Cooperative. At the maximum output, Columbia Water & Light could receive up to 6.3 megawatts. In 2013, Columbia received 13,985 megawatt hours of power from this contract or 1.18% of the electric portfolio. The amount of wind energy Columbia receives is variable. There is a fixed transmission cost for this energy, so it is more expensive when less energy is received. The average cost for 2013 for wind power from the Bluegrass Ridge Wind Farm was $67.76 per megawatt hour.

Crystal Lake Wind Energy

Columbia Water & Light has a 20 year contract for 21 megawatts of power produced at the Crystal Lake III Wind Energy Center located in Hancock County, Iowa. In 2013, the utility received 46,176 megawatt from NextEra Energy Resources. The University of Missouri purchased 24,038 megawatt hours of the contracted energy from the utility. This arrangement can be terminated by either party at any time. Columbia Water & Light's portion of the contract was 24,189 megawatt hours which represents 2.04% of the electric supply. The total cost of energy, including deemed energy, was $56.76 per megawatt hour. The fixed cost of the wind energy delivered to Columbia started at $42.50 per megawatt hour in 2012 and increased to $43.50 in 2013. It will go up to $44.50 in 2014 and increase to $45.00 in 2015 and stay at that level for the remaining years of the contract. This long-term contract allows Columbia Water & Light to lock in a favorable price for wind energy to meet future renewable energy requirements.

Jefferson City Landfill Gas

Columbia Water & Light has a 20-year power purchase agreement with Ameresco for 3.2 megawatts of energy from the landfill gas plant at the Jefferson City landfill. Columbia started receiving energy from the plant in April 2009. The total amount of energy received in 2013 was 21,840 megawatt hours which is 1.84% of the electric portfolio. The utility paid $53.05 per megawatt hour for the electricity. Both Columbia and Jefferson City are located within the Midwest Independent System Operator's territory so transmission fees do not substantially change the cost of the energy.

Columbia Landfill Gas

The Columbia Landfill Gas Energy Plant was constructed within the $3 million budgeted amount through the 2006 bond issue. Electricity is generated by using the gas created from decomposing waste at the landfill. The amount of energy received from the Columbia Landfill Gas Energy Plant is fairly consistent aside from times when there is routine maintenance work. A third generator was added in October 2013 since the amount of gas generation had increased with the addition of a bioreactor. The plant can currently generate 3.1 megawatts of renewable power. In 2013, the landfill gas plant produced 13,326 megawatt hours of energy which was 1.12% of Columbia's energy portfolio at a total cost of $47.38 per megawatt hour. With a full year of the third generator running, the estimated annual production amount is 18,000 megawatt hours. There is room for a fourth generator to be installed when the gas production increases. With four generators, electric production could grow to over 2% of Columbia's energy portfolio over the next several years.

Wood Fuel at the Columbia Power Plant

Columbia Water & Light started burning waste wood along with coal at the local power plant in 2008. The wood chips are from residual waste produced from Missouri sawmills. The wood is a by-product so it is considered a carbon neutral energy source. Using this form of biomass has allowed the utility to address lower emission requirements and rate the effectiveness of a biomass fuel source.

In 2013, the Columbia Power Plant as a whole produced 7.6% of the city's electric portfolio from coal, natural gas and waste wood. Only 6.3% of Columbia's energy was produced from burning coal and waste wood at the plant and the rest was from natural gas. Of the coal/wood electricity produced, the city is using a 15% mixture of waste wood along with the coal. The energy produced by waste wood was 8,971 megawatt hours which is 0.75% of Columbia's electric portfolio.

The fuel cost per megawatt hour of power produced for waste wood was $38.11 while coal during that same time period was $54.25. Determining the other related costs of producing energy from waste wood is complicated. The Columbia Power Plant is used as a capacity resource and provides a number of different functions. The plant does not have one dedicated function like the Columbia landfill gas plant. The operations and maintenance costs are not accounted for by the generating unit and the fuel type at the Columbia Power Plant. The operations and maintenance costs for wood and coal are similar. The fuel cost for waste wood is lower than coal so using a wood mixture is a cost effective option for the utility at this time. Moving to a higher percentage of waste wood would require changes to the existing coal handling equipment.

There are several older generating units at the Columbia Power Plant that will need to be upgraded, replaced or retired to meet future regulatory requirements. Columbia Water & Light has completed research to determine the options available and the cost of the upgrades. The Biomass Combustion and Multi-Pollutant Emission Study was completed in 2011. It showed that the equipment could be updated to meet future regulations and to burn biomass. A condition assessment report of the existing equipment at the plant was completed in 2013. It showed the power plant's solid fuel fired units were generally in good condition and with some investment could reliably remain in service for another 10 to 15 years. The 2013 Integrated Resource Plan assumed that two of the solid fuel fired units would be retired in 2015 due to age and proposed emission requirements. However, there is a benefit to maintaining local generation for reliability purposes. If it is financially feasible, the final plan for the power plant could include additional pollution control equipment and an increased use of biomass.

To further evaluate the effectiveness of burning more biomass at the plant without changing any of the equipment, biomass products have been investigated. In October 2012 a test burn of 176 tons of a miscanthus based product was conducted. The miscanthus pellets were susceptible to moisture which caused them to disintegrate. By the time the pellets arrived at the stokers, they had broken into small pieces that ignited at the stoker outlets. Power plant staff reduced the amount of pellets which provided better results but the fireballs were never eliminated. Based on the lessons learned from the first test burn, a permit was secured for a 2014 test burn of an engineered biomass product that is more durable and water resistant.

Free Power

The Columbia City Council approved a lease agreement with the Free Power Company, Inc. in December 2010 for the electricity generated from photovoltaic modules at $54.95 per megawatt hour. In 2013, the Free Power solar projects produced 424.29 megawatt hours which are 0.04% of Columbia's electric portfolio. The systems are located at the COLT Railroad's Transload Facility and are rated at 0.33 megawatts. Free Power has not made any new installations in 2013. Columbia Water & Light is only paying for the electricity generated from the panels.

Net Metered Customer Production

The Columbia City Council passed an ordinance in 2007 to allow customers to enter into a net metering agreement with Columbia Water & Light. There are currently nineteen photovoltaic net metering sites for a total of 0.108 megawatts. In 2013, the estimated output of the net metered sites was 78.35 megawatt hours and the estimated renewable cost was $4,512.

A net metering arrangement keeps track of the amount of electricity being consumed or being produced for the Columbia system by the customer. At the end of the month, the customer is billed for the difference or the 'net' amount of electricity used over the month. Columbia Water & Light credits the net metering customer's account for the electricity provided to the Columbia system at the following rates:

- Solar: Columbia Water & Light will pay the customer's current electric rate for the delivered solar generated electricity when the utility retains the Renewable Energy Credits (REC). If the customer wants to keep the solar RECs, the customer

will receive a credit based on the avoided average energy market price at the Columbia pricing node. There is a 100 kilowatt capacity cap on the net metering arrangement.
- Other: For non-solar renewable generated energy, the customer shall receive a credit based on the avoided average energy market price at the Columbia pricing node.

An Interconnection and Net Metering Agreement must be in place for the customer to receive a credit for the energy they deliver to Columbia Water & Light. For billing periods in which the net energy is less than zero, credits for the amount of net energy will be applied to the account. Credits can be carried over and applied to the next billing cycle except for the March billing in which any credits remaining after the March billing will be removed without compensation to the customer.

Columbia Water & Light offers a one-time $500 per kilowatt rebate for qualifying photovoltaic systems up to ten kilowatts. If a customer is installing a larger system, they can appeal to the Columbia City Council to allow a larger rebate. Customers installing a solar water heating system can qualify for up to $800 in rebates. In calendar year 2013, $43,305 in solar electric system rebates were provided for nine systems totaling 0.059 megawatts.

Solar One

Columbia Water & Light started the Solar One program in November 2008 as a way for customers to have an affordable way to invest in local solar energy projects. At the time the program was started the price of solar panels did not fall below the cost threshold in the renewable energy ordinance. This prohibited the utility from starting projects with rate payer funds so the voluntary program was established. Solar One helped the community start developing local projects which led to Columbia receiving national attention for being a supporter of solar energy.

Energy for the Solar One program is generated through solar systems located on city-owned property or at Columbia businesses. Columbia Water & Light partners with local businesses since commercial buildings have large roof tops with good solar exposure. Businesses can also take advantage of incentives for installing solar panels that are not available to the utility. After the business installs a system, Columbia Water & Light purchases the solar energy through a power purchase agreement. The cost of these power purchase agreements is paid for by customers who voluntarily pay an extra $3.35 a month.

In fiscal year 2013 the installations at the West Ash Water Pumping Station, Quaker Oats and Bright City Lights were rated at 0.0328 megawatts and produced 41.42 megawatt hours of electricity. Subscriptions to the Solar One program raised $8,891 and the purchased power costs were $8,350. The money raised by Solar One donations is kept within the Solar One account and is not used for other utility or city projects. Columbia Water & Light's staff is reviewing the Solar One program and researching different options for customer based solar energy programs. The Solar One program could be combined with a community solar program in 2014.

Renewable Energy Education

Advancing Renewables in the Midwest

On March 28, 2013, the 8th annual Advancing Renewables in the Midwest conference hosted 174 attendees. Topics included the electric utility of the future, Austin Energy's net metering approach, the Clinton Foundation's energy efficiency program implemented through employers and highlights of renewable projects across the country along with energy efficiency projects. The conference was hosted by Columbia Water & Light, the University of Missouri's Department of Soil, Environmental and Atmospheric Sciences and the Missouri Department of Natural Resources. The 2014 conference will be held at the University of Missouri on April 8.

Columbia Area Career Center

Energy from the sun is helping to power the Columbia Area Career Center and provide a learning opportunity for its students. In 2007, Columbia Water & Light purchased photovoltaic panels for the Columbia Area Career Center. Students are now using the solar data in their studies of science and technology. The 2 kilowatt photovoltaic system installed by Columbia Water & Light generates around 2,700 kilowatt hours of electricity for the building. There are also six, 10-watt solar panels and one, 50-watt solar module at this site. Information about the amount of solar radiation, temperature, wind speed and humidity are all available to the students at the Columbia Area Career Center.

Future Renewable Energy Production

It is estimated that over 6.9% of Columbia's electric portfolio will come from renewable resources in 2014. This will surpass the renewable energy ordinance mandate of 5%. The amount of renewable energy should be similar to 2013.

2014 Estimated Renewable Portfolio

Project	Location	Amount of Energy	%of Portfolio	Cost
Bluegrass Ridge	King City, MO	14,000 MWH	1.12%	$67/MWH
Crystal Lake wind energy	Hancock County, IA	26,000 MWH	2.08%	$44/MWH
Jefferson City landfill gas	Jefferson City, MO	21,000 MWH	1.68%	$53/MWH
Columbia landfill gas	Columbia, MO	18,000 MWH	1.44%	$48/MWH
Waste wood at power plant	Columbia, MO	6,000 MWH	0.48%	$36/MWH *
Free Power Solar	Columbia, MO	500 MWH	0.04%	$55/MWH
Net Metered Customer Production & Solar One	Columbia, MO	120 MWH	0.01%	$94/MWH for net metered, Solar One paid by customer subscriptions

*Wood generated energy costs are only for the fuel source

Appendix

Historical Renewable Energy Data

2007 Renewable Energy Production Amounts

Month	Total System MWH	Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Total Renew MWH	Monthly % of System	Annual % of System
9-07	104,618	592				592	0.6%	
10-07	91,357	1,030				1,030	1.1%	
11-07	84,135	1,153				1,153	1.4%	
12-07	97,985	969				969	1.0%	
TOTAL	378,095	3,744				3,744		

2008 Renewable Energy Production Amounts

Month	System Total MWH	Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Solar MWH	Total Renew MWH	Monthly % of System	Annual % of System
1-08*	102,167	1,080					1,080	1.1%	1.1%
2-08*	95,852	671					671	0.7%	0.9%
3-08*	89,178	798					798	0.9%	0.9%
4-08*	83,215	782		158			940	1.1%	0.9%
5-08*	85,467	485		185			670	0.8%	0.9%
6-08*	104,001	321	672	802			1,795	1.7%	1.1%
7-08*	116,895	250	874	594			1,718	1.5%	1.1%
8-08*	111,956	229	1,279	821			2,329	2.1%	1.3%
9-08*	92,891	539	1,204	765			2,508	2.7%	1.4%
10-08	83,693	1,169	998	243		0.265	2,410	2.9%	1.5%
11-08	82,509	646	1,216	0		0.362	1,862	2.3%	1.6%
12-08	98,719	1,205	1,039	334		0.294	2,578	2.6%	1.7%
TOTAL	1,146,543	8,128	7,282	3,902	0	1	19,313		

* Cracked blades on the wind turbines lowered production amounts for 9 months for a total of approximately 5,557 megawatt hours.

Note: Solar energy amounts were not included in the totals due to the small amount.

2009 Renewable Energy Production Amounts

Month	System Total MWH	Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Solar MWH	Total Renew MWH	Monthly % of System	Annual % of System
1-09	101,445	979	1,167	853		0.369	2,999	3.0%	3.0%
2-09	83,491	933	1,043	670		0.459	2,646	3.2%	3.1%
3-09	84,038	2,807	1,236	146		0.643	4,189	5.0%	3.7%
4-09	80,857	3,208	1,216	0	1,220	0.610	5,644	7.0%	4.4%
5-09	84,508	2,696	1,083	379	1,427	0.807	5,585	6.6%	4.8%
6-09	104,689	761	1,181	75	1,711	0.831	3,728	3.6%	4.6%
7-09	106,500	480	1,145	175	1,583	0.812	3,383	3.2%	4.4%
8-09	107,081	691	1,113	102	1,729	0.746	3,635	3.4%	4.2%
9-09	89,941	533	402	576	1,590	0.606	3,101	3.4%	4.1%
10-09	83,335	1,279	44	854	1,769	0.373	3,946	4.7%	4.2%
11-09	79,725	1,439	695	76	1,849	0.356	4,059	5.1%	4.3%
12-09	99,645	992	551	1,265	1,352	0.221	4,160	4.2%	4.3%
TOTAL	1,105,255	16,798	10,876	5,171	14,227	7	47,079		

In 2008, the amount of wind energy Columbia received was low due to some of the turbine blades cracking. Due to this shortfall of energy, Associated Electric Cooperative provided the first 6.3 MW of energy produced from the wind farm for March, April and May of 2009 and again in January, February and March of 2010.

2010 Renewable Energy Production Amounts

Month	System Total MWH	Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Solar MWH	Total Renew MWH	Monthly % of System	Annual % of System
1-10	106,770	2,088	1,090	1,119	982	0.233	5,279	4.9%	4.9%
2-10	92,910	2,132	1,112	734	1,656	0.352	5,634	6.1%	5.5%
3-10	86,980	3,327	1,219	623	2,002	0.539	7,172	8.2%	6.3%
4-10	80,544	1,798	1,151	368	1,914	0.694	5,232	6.5%	6.3%
5-10	90,412	1,018	1,135	0	2,212	0.735	4,366	4.8%	6.0%
6-10	114,129	746	1,253	367	1,846	0.781	4,213	3.7%	5.6%
7-10	123,263	523	1,127	495	1,556	0.741	3,702	3.0%	5.1%
8-10	128,815	688	911	773	1,890	0.819	4,263	3.3%	4.8%
9-10	95,840	1,154	832	804	1,744	1.372	4,535	4.7%	4.8%
10-10	83,554	1,107	966	690	2,037	1.335	4,801	5.7%	4.9%
11-10	81,674	1,691	1,196	866	2,058	1.262	5,812	7.1%	5.1%
12-10	100,461	1,068	1,060	593	1,811	0.541	4,533	4.5%	5.0%
TOTAL	1,185,352	17,340	13,052	7,432	21,708	9	59,541		

In 2008, the amount of wind energy Columbia received was low due to some of the turbine blades cracking. Due to this shortfall of energy, Associated Electric Cooperative provided the first 6.3 MW of energy produced from the wind farm for March, April and May of 2009 and again in January, February and March of 2010.

2011 Renewable Energy Production Amounts

Month	System Total MWH	Bluegrass Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Solar MWH	Total Renew MWH	Monthly % of System	Annual % of System
1-11	104,370	1,050	1,255	950	2,018	0.7	5,274	5.1%	5.1%
2-11	89,644	1,369	1,043	1,305	1,931	1.2	5,649	6.3%	5.6%
3-11	88,683	1,358	1,269	1,380	2,220	1.9	6,229	7.0%	6.1%
4-11	79,860	1,646	1,187	985	1,685	2.4	5,505	6.9%	6.2%
5-11	88,794	1,363	1,301	0	2,099	2.8	4,766	5.4%	6.1%
6-11	111,595	1,312	771	814	1,510	3.2	4,410	4.0%	5.7%
7-11	137,604	631	1,133	1,389	1,632	3.3	4,788	3.5%	5.2%
8-11	124,170	531	1,116	1,929	1,956	3.0	5,535	4.5%	5.1%
9-11	90,389	874	604	1,350	1,679	2.7	4,510	5.0%	5.1%
10-11	84,257	1,260	1,344	497	1,870	2.4	4,973	5.9%	5.2%
11-11	81,591	1,968	1,299	37	2,033	1.1	5,338	6.5%	5.3%
12-11	92,894	1,407	1,362	1,182	2,215	3.0	6,170	6.6%	5.4%
TOTAL	1,173,851	14,769	13,684	11,818	22,848	28	63,148		

2012 Renewable Energy Production Amounts

Month	System Total MWH	Bluegrass Wind MWH	Columbia Landfill MWH	Waste Wood MWH	Jeff City Landfill MWH	Crystal Lake Wind MWH	Solar MWH	TOTAL Renew MWH	Monthly % of System	Annual % of System
1-12	97,016	1,764	1,260	1,201	2,219	0	5.7	6,450	6.6%	6.6%
2-12	87,788	1,352	1,261	1,129	2,057	1,496	8.7	7,303	8.3%	7.4%
3-12	86,349	1,730	1,442	693	1,661	8,646	19.6	14,192	16.4%	10.3%
4-12	81,262	1,331	1,334	0*	1,887	9,014	21.2	13,584	16.7%	11.8%
5-12	99,813	1,323	1,218	0*	1,749	7,483	28.5	11,791	11.8%	11.8%
6-12	111,843	1,218	1,227	0*	1,658	2,177	29.3	6,310	5.6%	10.6%
7-12	137,598	734	1,328	542	1,551	935	27.8	5,118	3.7%	9.2%
8-12	120,822	661	1,326	1,234	1,719	873	28.4	5,841	4.8%	8.6%
9-12	93,415	756	1,140	722	1,476	885	31.1	5,010	5.4%	8.3%
10-12	86,334	1,418	1,156	443	1,890	1,576	23.0	6,506	7.5%	8.2%
11-12	83,778	1,324	1,300	0*	1,702	1,467	27.9	5,821	6.9%	8.1%
12-12	94,136	1,246	1,248	0*	1,860	1,447	19.8	5,821	6.2%	7.9%
Total MWH	1,180,154	14,844	15,240	5,964	21,429	35,998	271	93,746		
% of Total		1.26%	1.29%	0.51%	1.82%	3.05%	0.02%	7.94%		

*Waste wood was not used at the Columbia Power Plant while it was down for maintenance and a condition assessment in the spring and during the fall, natural gas was used to generate electricity.

Approved Sources of Renewable Energy

The following sources of renewable energy were approved by the Columbia City Council in March 2006 as sources of compliance with the Renewable Energy Standard ordinance.

Wind Energy: All electricity generated through wind power would qualify as a renewable resource, including wind energy that is stored in any form for later use as electrical power.

Solar Energy: All active solar energy systems would qualify as a renewable resource, including solar photovoltaics, solar water heating, solar space heating, and any other method of using the sun that requires 'active' collection techniques. In this regard 'passive' solar heating, or systems which do not employ the use of mechanical equipment to move or distribute the heat, would not be considered as eligible items.

Biomass Energy: Biomass energy is typically considered to be derived from plants which have accumulated solar energy through photosynthesis. This definition, however, is somewhat open-ended as virtually all our current fossil fuels are derived from plants, even though their life span may have occurred in the geologic past. To create a definition of biomass that would correspond with its commonly understood meaning, biomass energy is considered to be energy derived from plant origin, considering only those plants that have been harvested within the recent past, certainly within the last 100 years.

Columbia Water & Light suggests that eligible biomass energy specifically include (but not be limited to) the following materials:

- Landfill Gas
- Paper based products, such as cardboard and newsprint
- Wood and wood wastes
- Cellulose based products that originate from trees or shrubbery
- Other materials that come directly from trees or plants.

In the event that an energy source would be derived from a mixture of biomass and other non-renewable materials Columbia Water & Light would make a rigorous assessment to determine what energy content of the fuel is biomass derived, and only claim that portion for compliance with the renewable energy ordinance.

Hydropower: By all definitions, hydropower fits the definition of renewable power in that it is renewed by the earth's water cycle.

Geothermal Power: Columbia Water & Light considers that geothermal power, or any energy that may be extracted from the earth, is eligible as a renewable resource. This would only be in reference to active mechanical systems that extract the heat energy from the earth. Passive systems would not be eligible under this definition. It would be the utility's responsibility to provide details on what constitutes energy provided through geothermal power on a case-by-case basis.

Green Tags: The Green Tag system that has originated throughout the country allows a utility to make purchases of Green Tags and thus participate in the development of green, or renewable, energy without actually receiving that energy in the utility's system. In such situations the developer of the renewable resource is paid an agreed-to amount for the Green Tag for each Megawatt-hour sold; however, the electricity is not delivered to the utility. Thus Green Tags simply represent the value of the renewable portion of the project or the premium that is above the cost of conventional electricity project. Green Tags are commonly sold and traded across the US.

Although this works for other utilities, Columbia Water & Light has every intention of complying with the renewable energy ordinance by finding sources located close enough to Columbia that the power can be transmitted into our system. In the future, however, the higher compliance requirements may force the utility to look at Green Tags as an option. Columbia Water & Light would pursue this avenue only as a last resort and would seek approval before purchasing renewable energy in this manner.

Future Projects: The above list is not intended to be final because there may be new sources of power that could be a renewable resource in the future. Columbia Water & Light could come back to the city's governing bodies in the future should a new renewable resource come available.

City of Columbia Ordinance Section 27-106: Renewable energy standard

(a) The city shall generate or purchase electricity generated from eligible renewable energy sources at the following levels:

(1) Two (2) percent of electric retail sales (kWhs) by December 31, 2007;
(2) Five (5) percent of electric retail sales (kWhs) by December 31, 2012;
(3) Fifteen (15) percent of electric retail sales (kWhs) by December 31, 2017; and
(4) Twenty-five (25) percent of electric retail sales (kWhs) by December 31, 2022.
(5) Thirty (30) percent of electric retail sales (kWhs) by December 31, 2028.

(b) This renewable energy shall be added up to these kilowatt hour levels only to the extent that it is possible without increasing electric rates more than three (3) percent higher than the electric rates that would otherwise be attributable to the cost of continuing to generate or purchase electricity generated from one hundred (100) percent non-renewable sources (including coal, natural gas, nuclear energy and other nonrenewable sources).

(c) Eligible renewable energy generation may be provided by wind power, solar energy, bio-energy sources or other renewable sources which meet the environmental criteria approved by the city council after review by the environment and energy commission and the water and light advisory board. Electricity purchased from on-site renewable energy systems owned by Columbia Water & Light customers ("net metering") may be included within the calculation of the levels required in subsection (a).

(d) Renewable energy generation sources located within Missouri may receive referential consideration in the selection process.

(e) Each year prior to February 1, the water and light department shall publicly release a renewable energy plan detailing a proposal for how the city would comply with this section during the following year. The plan will explain the city's due diligence in pursuing renewable energy opportunities and detail all cost assumptions and related utility rate calculations, except with regard to confidential information that may be withheld pursuant to state law. The plan will then be reviewed by the environment and energy commission and water and light advisory board and submitted to the city council for approval following a public hearing.

(Ord. No. 18196, § 1, 8-16-04; Ord. No. 21935, § 1, 1-6-14)

Editors Note: Ord. No. 18196, passed by city council on Aug. 16, 2004, called for election; said ordinance was passed by the voters on Nov. 2, 2004.

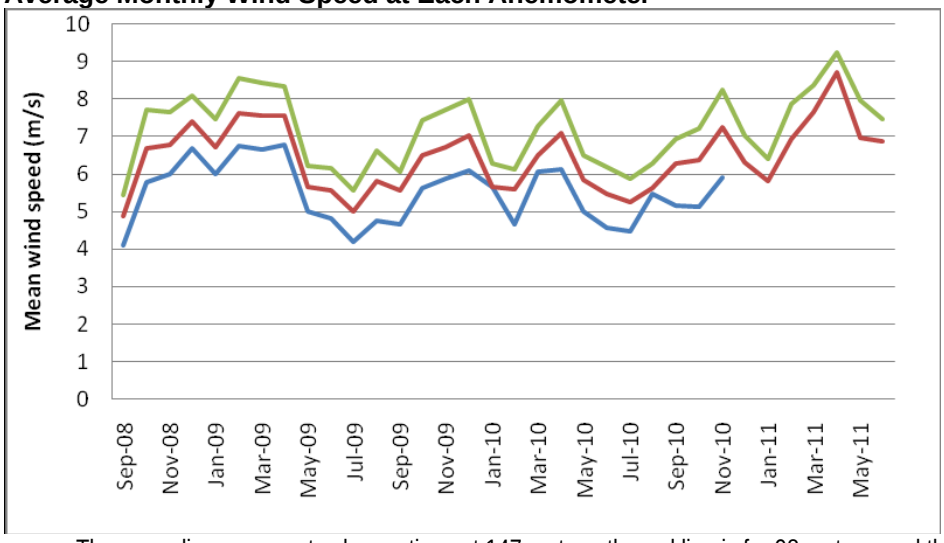
Secs. 27-107--27-110. Reserved.

Columbia Wind Speed Study

The University of Missouri's Atmospheric Sciences Department collected wind speed data for the City of Columbia at the KOMU tower on Columbia's south side from 2008 through 2011. The anemometers are no longer collecting accurate data so the study was ended.

The data was collected to evaluate the wind speeds for utility scale wind generation in Columbia. The site for the anemometers was placed in an open area of land with minimal obstructions at two different heights. In each case it can be seen that the average annual wind speed observed at the tower sites is significantly lower than that estimated in the AWS Truewind map of Missouri. The difference is of the order of 0.7 meters per second at the 70 meter level and 0.4 meters per second at the 100 meter level. These differences are similar to those found at other sites around the state.

Average Monthly Wind Speed at Each Anemometer



The green line represents observations at 147 meters, the red line is for 98 meters, and the blue line shows the measurements at 68 meters.

68 Meter Tower: As time goes on the instruments suffer declining performance and those operating at the 68 m height became too inconsistent to determine accurate observations in December 2010.

Note: One meter equals 3.28 feet, one meter per second equals 2.237 miles per hour