National Renewable Energy Laboratory
Innovation for Our Energy Future

Appendices

Rebuilding Greensburg, Kansas, as a Model Green Community: A Case Study

NREL's Technical Assistance to Greensburg June 2007 – May 2009

Lynn Billman

Technical Report
NREL/TP-6A2-45135
November 2009

Link to Report

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401
303-275-3000 • www.nrel.gov

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Contract No. DE-AC36-08GO28308

Prepared under Task No. IDKS.1070

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Acknowledgments

The report *Rebuilding Greensburg, Kansas, as a Model Green Community: A Case Study, NREL's Technical Assistance to Greensburg June 2007 – May 2009*, was written by Lynn Billman who was the project lead for the feasibility studies and technical assistance that NREL provided to advise the city of Greensburg on energy efficiency in buildings; district heating and cooling; renewable resources such as wind, solar, and biomass; and alternative transportation (vehicles, fuels, and infrastructure).

The appendices include supporting studies, presentations, and ordinances provided by many NREL employees and subcontractors who spent many hours and days in Kansas and Golden, Colorado, to conduct the studies including NREL employees: Mary Werner, Andy Walker, Ren Anderson, Shanti Pless, Paul Torcellini, Jim Green, Chris Gaul, Phillip Shepherd, Trudy Forsyth, and Gerry Harrow; and subcontractors: John Thornton, Consultant; Alex Lukachko, Building Science Consulting; Steve Bolibruck, IBACOS; Building Science Corporation; and Thomas A. Wind, Wind Utility Consulting.

NREL would also like to acknowledge the extensive help from the following organizations: Greensburg GreenTown, Greensburg, Kansas; Professional Engineering Consultants, Wichita, Kansas; Berkebile Nelson Immenschuh McDowell Architects, Kansas City, Missouri; BTI-Greensburg John Deere Dealership, Greensburg, Kansas; Sunflower Electric Power Corporation, Hays, Kansas; Southern Pioneer Electric Company, Ulysses, Kansas; U.S. Department of Agriculture, Rural Development; U.S. Department of Homeland Security, Federal Emergency Management Agency; and State of Kansas, Kansas Corporation Commission.

Rebuilding Greensburg, Kansas, as a Model Green Community: A Case Study

NREL's Technical Assistance to Greensburg
June 2007 – May 2009

Supporting Studies, Presentations, and Ordinances (All documents used with permission)

Appendices are available for download online at:
www.eere.energy.gov/buildings/greensburg/publications.html.

Appendix A: Cross Cutting Information

A.1 Renewable Resource Availability in Greensburg

Mary Werner
National Renewable Energy Laboratory

National Renewable Energy Laboratory

A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

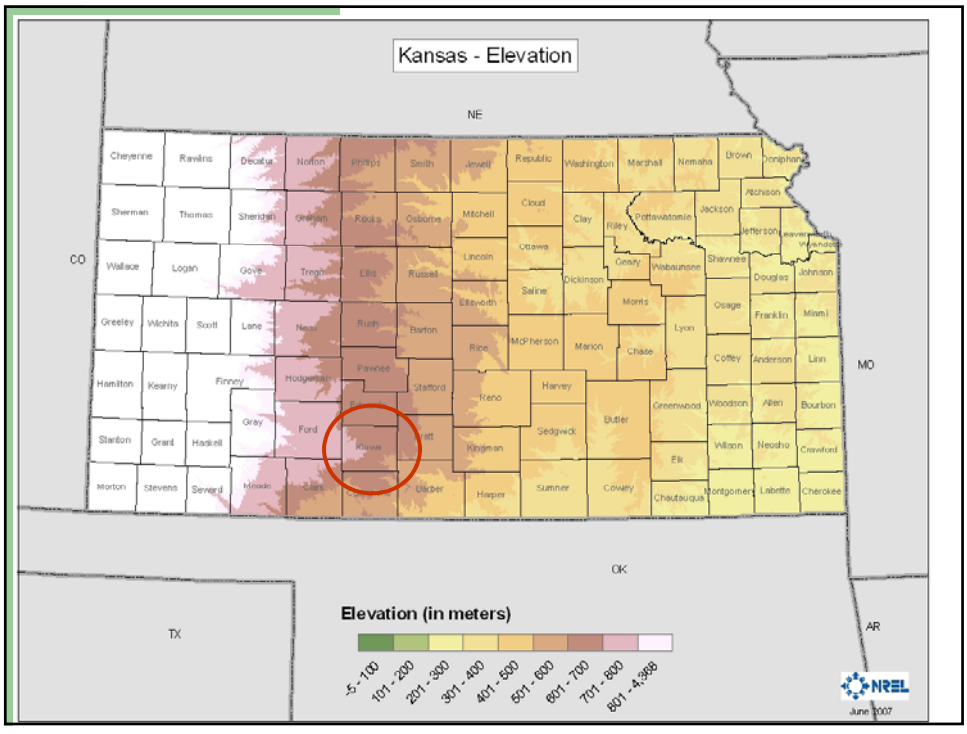
Innovation for Our Energy Future

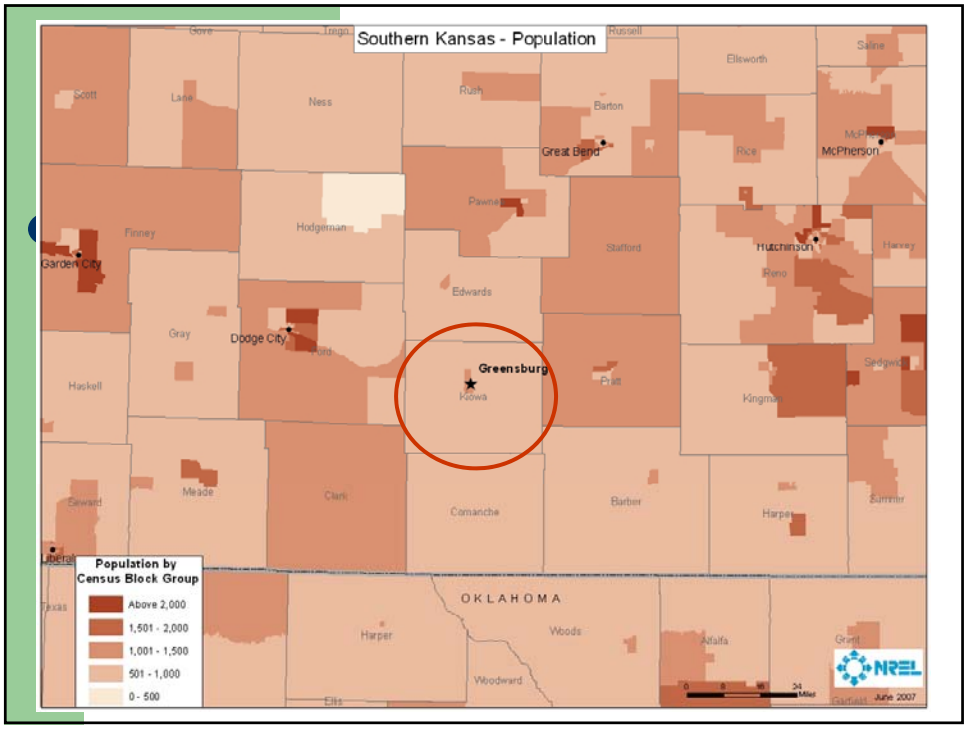
Renewable Resource Availability in Greensburg

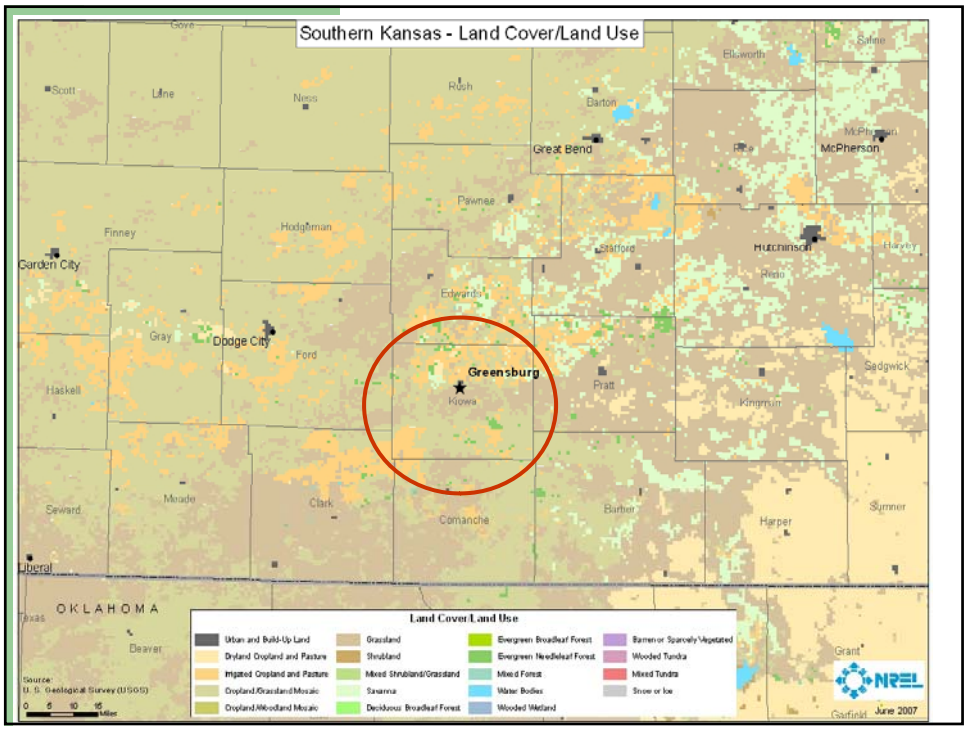
Prepared by the National Renewable Energy Laboratory (NREL)

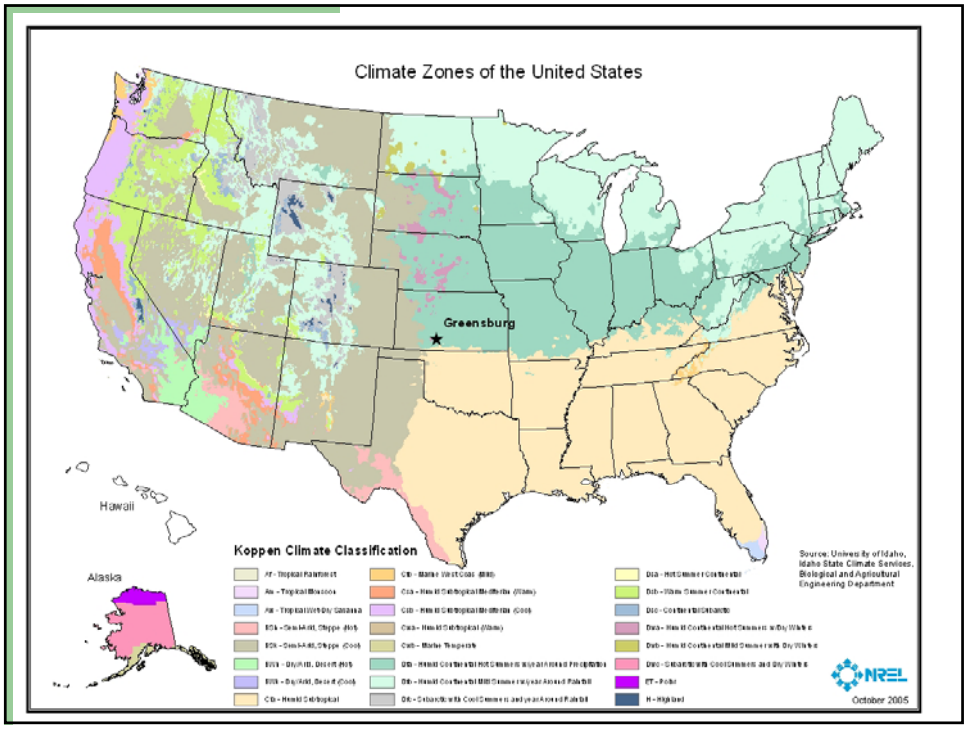
June 8, 2007

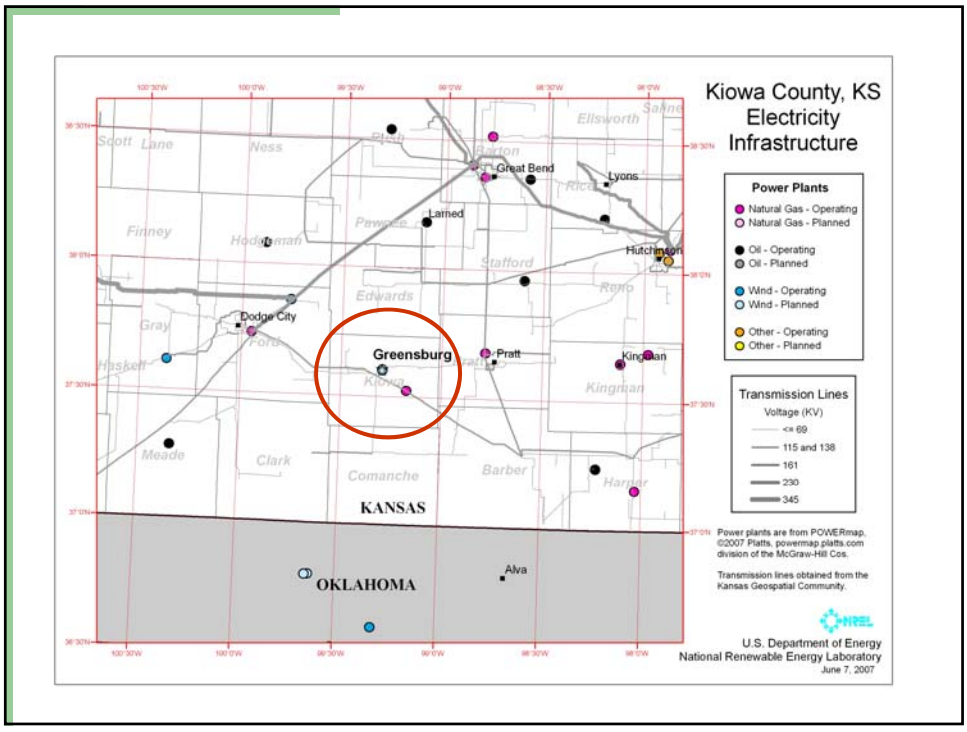
NREL is operated by Midwest Research Institute • Battelle

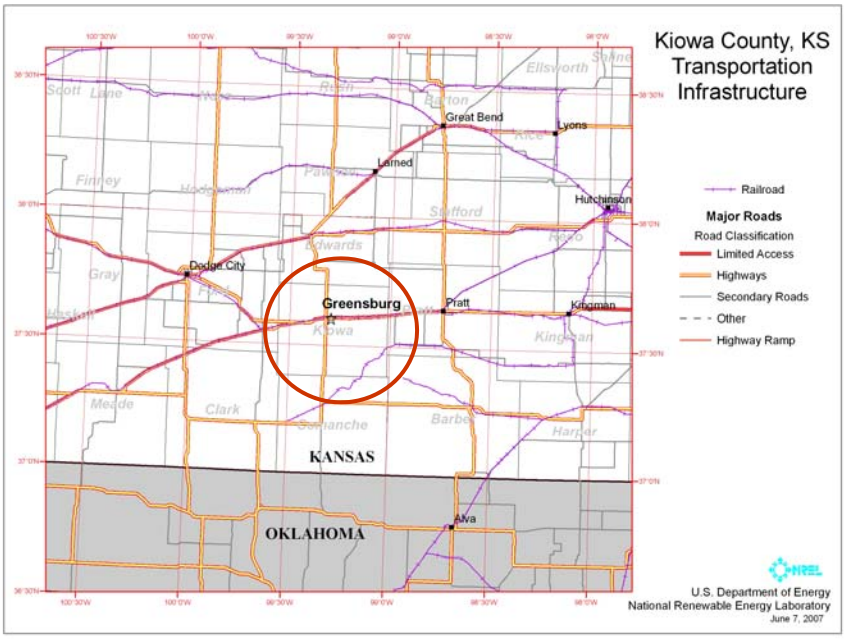



Southern Kansas - Population
Greensburg
Great Bend
McPherson
Hutchinson
Garden City
Dodge City
Liberal
OKLAHOMA
Population by Census Block Group
Above 2,000
1,501 - 2,000
1,001 - 1,500
501 - 1,000
0 - 500
NREL
June 2007

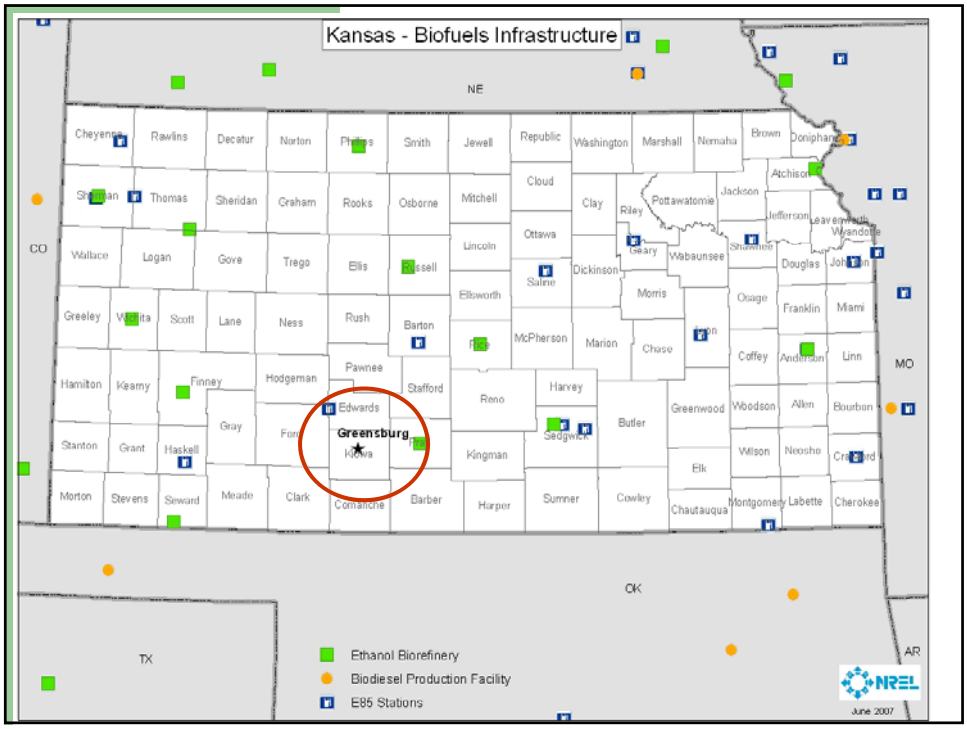

Southern Kansas - Land Cover/Land Use
Greensburg
Great Bend
McPherson
Hutchinson
Garden City
Dodge City
Liberal
OKLAHOMA
Land Cover/Land Use
Urban and Build-Up Land
Dryland Cropland and Pasture
Irrigated Cropland and Pasture
Cropland/Grassland Mosaic
Cropland/Woodland Mosaic
Grassland
Shrubland
Mixed Shrubland/Grassland
Savanna
Deciduous Broadleaf Forest
Evergreen Broadleaf Forest
Evergreen Needleleaf Forest
Mixed Forest
Water Bodies
Wooded Wetland
Barren or Sparsely Vegetated
Wooded Tundra
Mixed Tundra
Snow or Ice
Source: U.S. Geological Survey (USGS)
NREL
June 2007

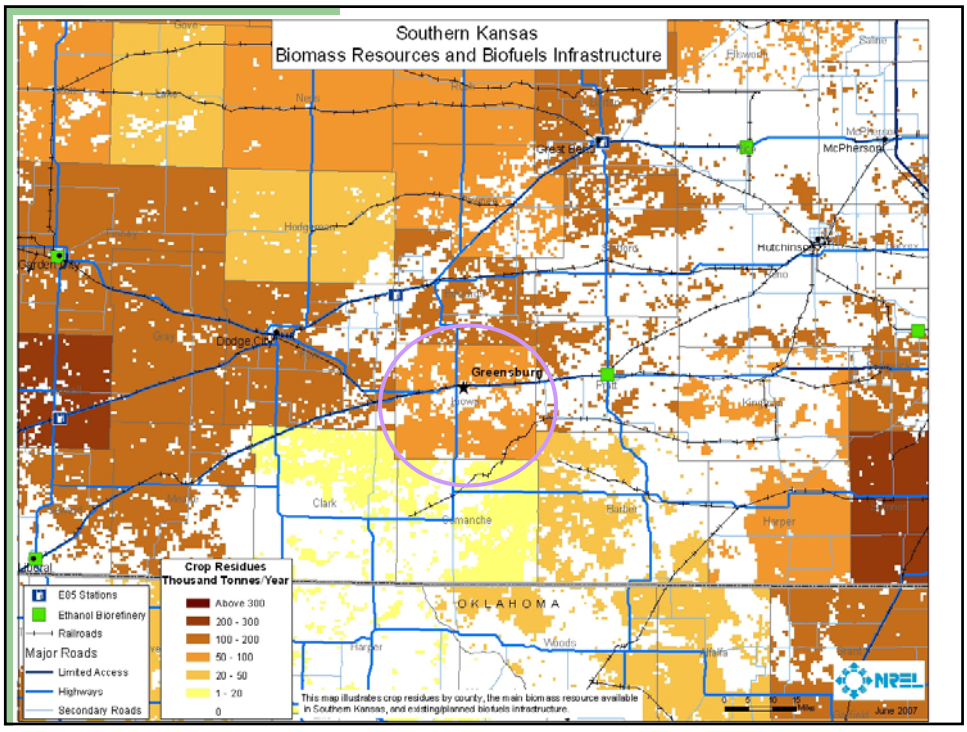

Climate Zones of the United States
Greensburg
Hawaii
Alaska
Koppen Climate Classification
Source: University of Idaho, Idaho State Climate Services, Biological and Agricultural Engineering Department
NREL
October 2005


Kiowa County, KS
Electricity
Infrastructure
Power Plants
Natural Gas - Operating
Natural Gas - Planned
Oil - Operating
Oil - Planned
Wind - Operating
Wind - Planned
Other - Operating
Other - Planned
Transmission Lines
Voltage (KV)
<= 69
115 and 138
161
230
345
Great Bend
Lyons
Larned
Hutchinson
Dodge City
Greensburg
Pratt
Kingman
KANSAS
OKLAHOMA
Alva
Power plants are from POWERmap, ©2007 Platts, powermap.platts.com division of the McGraw-Hill Cos.
Transmission lines obtained from the Kansas Geospatial Community.
U.S. Department of Energy
National Renewable Energy Laboratory
June 7, 2007



Biofuels / Biomass


Kansas - Biofuels Infrastructure
NE
CO
OK
TX
MO
AR
Greensburg
Ethanol Biorefinery
Biodiesel Production Facility
E85 Stations
June 2007


Southern Kansas
Biomass Resources and Biofuels Infrastructure
Greensburg
McPherson
Hutchinson
Dodge City
Clark
Comanche
Barber
Harper
OKLAHOMA
E85 Stations
Ethanol Biorefinery
Railroads
Major Roads
Limited Access
Highways
Secondary Roads
Crop Residues
Thousand Tonnes/Year
Above 300
200 - 300
100 - 200
50 - 100
20 - 50
1 - 20
0
This map illustrates crop residues by county, the main biomass resource available in Southern Kansas, and existing/planned biofuels infrastructure.
June 2007

County	Corn*	Corn Ethanol (Gal)*	Soybeans**	Biodiesel (Gal)	Cellulosic Biomass***	CRP Land****
Kiowa	23,500	2,608,500	12,500	562,500	60,135	53,337
Comanche	N/A	N/A	N/A	N/A	10,084	43010
Clark	1,000	111,000	600	27,000	16,777	52,114
Barber	2,300	255,300	6,600	297,000	32,690	21,018
Pratt	55,700	6,182,700	24,500	1,102,500	136,725	47,750
Ford	43,100	4,784,100	12,800	576,000	120,880	59,469
Edwards	56,300	6,249,300	22,100	994,500	124,295	34,101

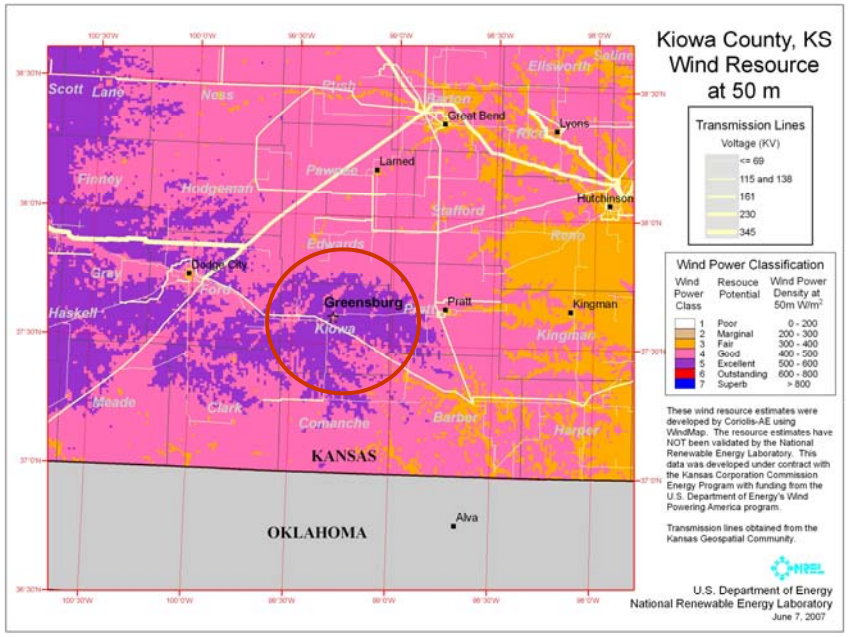
* Corn grain, harvested acres in 2006. Assuming 30% of grain is devoted to ethanol production.

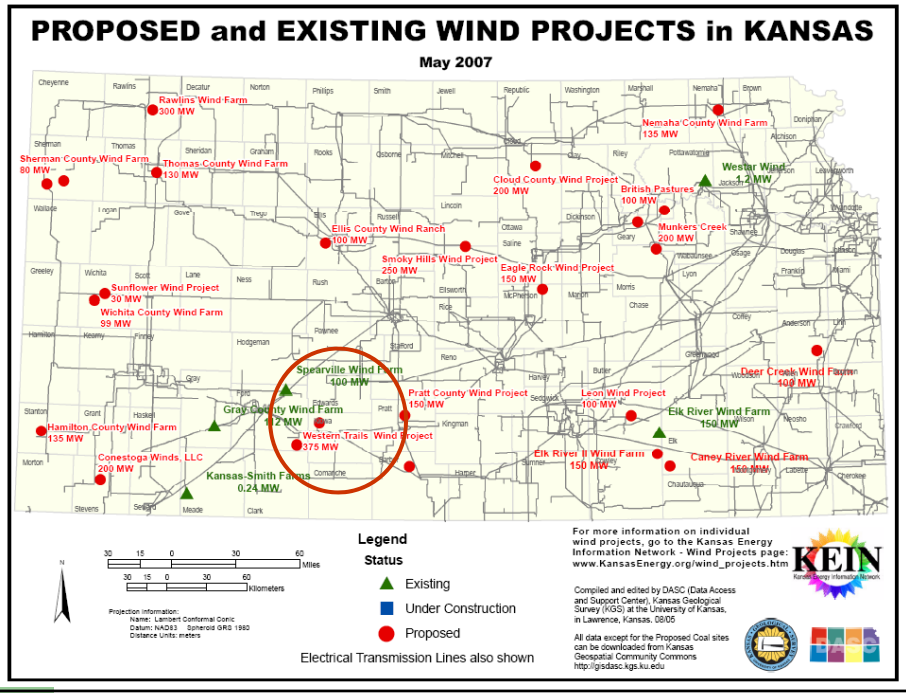
** Harvested acres in 2006

*** Crop residues (dry tonnes/year), 2002

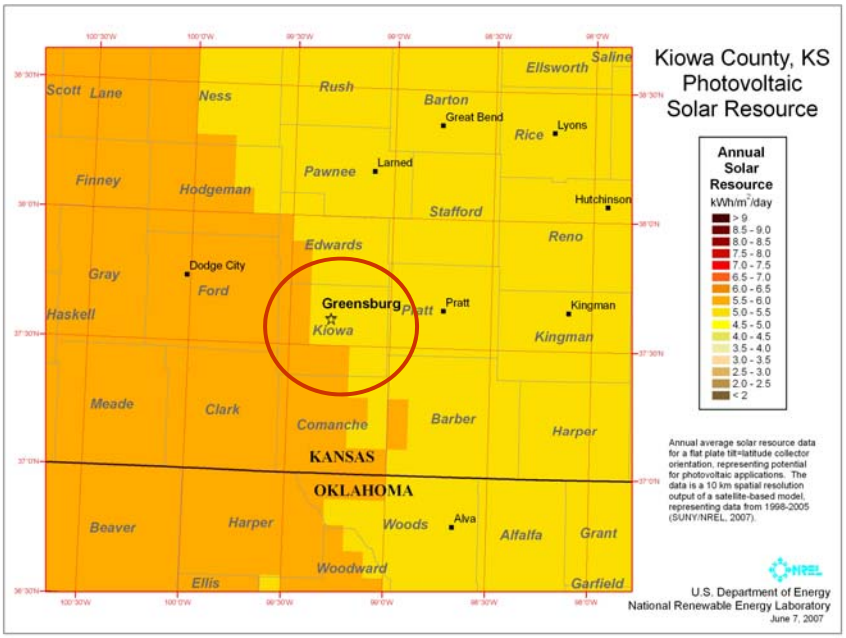
**** Conservation Reserve Program (CRP) land as of July 2003, in acres. Median estimated mature yield of switchgrass for this area is ~ 4.5 dry tons/acre/year

Wind

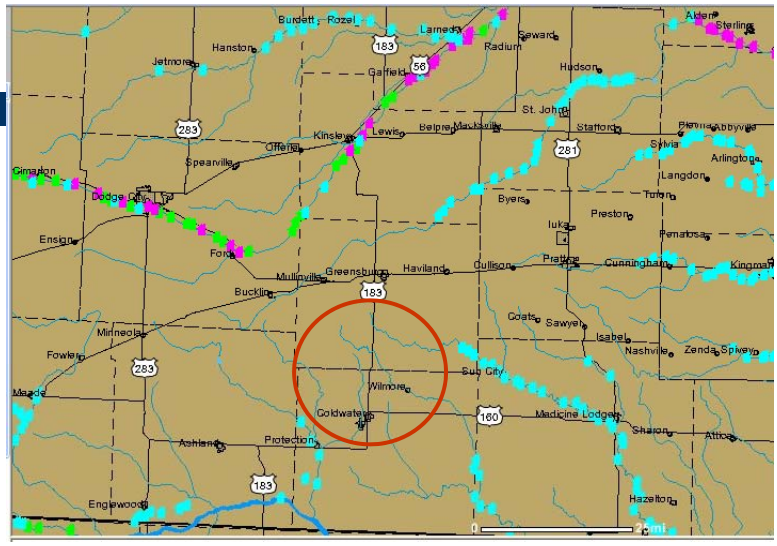

Kiowa County, KS
Wind Resource
at 50 m
Transmission Lines
Voltage (KV)
<= 69
115 and 138
161
230
345
Wind Power Classification
Wind Power Class
Resouce Potential
Wind Power Density at 50m W/m²
1 Poor 0 - 200
2 Marginal 200 - 300
3 Fair 300 - 400
4 Good 400 - 500
5 Excellent 500 - 600
6 Outstanding 600 - 800
7 Superb > 800
These wind resource estimates were developed by Corrolis-AE using WindMap. The resource estimates have NOT been validated by the National Renewable Energy Laboratory. This data was developed under contract with the Kansas Corporation Commission Energy Program with funding from the U.S. Department of Energy's Wind Powering America program.
Transmission lines obtained from the Kansas Geospatial Community.
U.S. Department of Energy
National Renewable Energy Laboratory
June 7, 2007
Great Bend
Lyons
Larned
Hutchinson
Dodge City
Greensburg
Pratt
Kingman
Alva
KANSAS
OKLAHOMA
Scott
Lane
Ness
Ellsworth
Saline
Finney
Hodgeman
Stafford
Reno
Edwards
Gray
Ford
Haskell
Kiowa
Meade
Clark
Comanche
Barber
Harper


PROPOSED and EXISTING WIND PROJECTS in KANSAS
May 2007
Rawlins Wind Farm
300 MW
Sherman County Wind Farm
80 MW
Thomas County Wind Farm
130 MW
Nemaha County Wind Farm
135 MW
Cloud County Wind Project
200 MW
Westar Wind
1.2 MW
British Pastures
100 MW
Munkers Creek
200 MW
Ellis County Wind Ranch
100 MW
Smoky Hills Wind Project
250 MW
Eagle Rock Wind Project
150 MW
Sunflower Wind Project
30 MW
Wichita County Wind Farm
99 MW
Spearville Wind Farm
400 MW
Pratt County Wind Project
150 MW
Leon Wind Project
100 MW
Deer Creek Wind Farm
400 MW
Gray County Wind Farm
112 MW
Elk River Wind Farm
150 MW
Hamilton County Wind Farm
135 MW
Western Trails Wind Project
375 MW
Conestoga Winds, LLC
200 MW
Kansas Smith Farms
0.24 MW
Elk River II Wind Farm
150 MW
Caney River Wind Farm
150 MW
Legend
Status
Existing
Under Construction
Proposed
Electrical Transmission Lines also shown
Miles
Kilometers
Projection Information:
Name: Lambert Conformal Conic
Datum: NAD83 Spheroid GRS 1980
Distance Units: meters
For more information on individual wind projects, go to the Kansas Energy Information Network - Wind Projects page:
www.KansasEnergy.org/wind_projects.htm
KEIN
Kansas Energy Information Network
Compiled and edited by DASC (Data Access and Support Center), Kansas Geological Survey (KGS) at the University of Kansas, in Lawrence, Kansas, 08/05
All data except for the Proposed Coal sites can be downloaded from Kansas Geospatial Community Commons
http://gisdasc.kgs.ku.edu

Solar


Kiowa County, KS
Photovoltaic
Solar Resource
Annual
Solar
Resource
kWh/m²/day
> 9
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2
Annual average solar resource data for a flat plate tilt=latitude collector orientation, representing potential for photovoltaic applications. The data is a 10 km spatial resolution output of a satellite-based model, representing data from 1998-2005 (SUNY/NREL, 2007).
U.S. Department of Energy
National Renewable Energy Laboratory
June 7, 2007
Scott
Lane
Ness
Rush
Barton
Great Bend
Ellsworth
Saline
Rice
Lyons
Finney
Hodgeman
Pawnee
Larned
Stafford
Hutchinson
Reno
Edwards
Gray
Dodge City
Ford
Haskell
Greensburg
Kiowa
Pratt
Kingman
Meade
Clark
Comanche
Barber
Harper
KANSAS
OKLAHOMA
Beaver
Harper
Woods
Alva
Alfalfa
Grant
Woodward
Ellis
Garfield

Hydro



In Summary

• Wind	Yes
• Solar	Maybe
• Ethanol Production	Likely
• Biodiesel Production	Maybe
• Geothermal – High Temp	Not likely
• Geothermal – Low Temp	Likely
• Hydro	Not likely

A.2 Summary: Financial Incentives for Energy Efficiency and Renewable Energy

Lynn Billman
National Renewable Energy Laboratory

Financial Incentives for Energy Efficiency and Renewable Energy: Introduction[1]

Updated 3-26-08

The attached charts summarize some essential information on financial incentives for energy efficiency and renewable energy at the Federal level and for the State of Kansas. While I believe this information is accurate and up-to-date as of March 26, 2008, financial incentives for energy are constantly changing.

The best source of information for federal and state financial incentives in energy efficiency and renewable energy is www.dsireusa.org. this database is maintained by the North Carolina State University Solar Center. Additional information on alternative fuel and vehicle incentives can be found at the Alternative Fuel Data Center website for the National Renewable Energy Laboratory: *www.eere.energy.gov/afdc/progs/fed_summary.php/afdc/US/0*.

The attached information also include a summary of information on energy savings performance contacts, which are applicable to energy efficiency and sometimes renewable energy project financing in all market sectors.

Lynn Billman
National Renewable Energy Laboratory
Lynn_billman@nrel.gov

[1] Best website for federal and state incentives on Energy Efficiency and Renewable Energy: www.dsireusa.org

Financial Incentives for Energy Efficiency and Renewable Energy: Residential Sector, Greensburg[1]

Updated 3-26-08

There are many sources of financing for residents in Greensburg (see USDA office, SBA, local bankers, Kansas Housing, etc.) These notes pertain ONLY to financial incentives for energy efficiency and renewable energy costs.

Type/Name	*Technologies*	*Amount / Maximum / Notes*	*Timing*
Residential Solar and Fuel Cell Federal Tax Credit	Solar photovoltaics, solar water heat, fuel cells	You can take a tax credit of 30% of the total costs of solar photovoltaic system up to a cap of $2000; same for a solar hot water system, and a person can take both. Also, you can take 30% of the total cost of a fuel cell system, up to a cap of $500 per 0.5 killowatt. http://www.irs.gov/pub/irs-pdf/f3468.pdf Tax Relief and Health Care Act of 2006 (H.R. 6111) under Title II Energy Tax Provisions	Valid on systems installed before December 31, 2008
Residential Energy Efficiency Federal Tax Credit	Water heaters, furnaces, boilers, heat pumps, air conditioners, building insulation, windows, doors, roofs	You can take a tax credit of 10% of the cost of building envelope improvements, up to a $500 limit; various details apply. http://www.irs.gov/newsroom/article/0,,id=154657,00.html	Valid on systems installed before December 31, 2008
Energy Efficient Mortgages (federal insured or conventional)	Energy efficiency measures	You can benefit from energy-efficient financing whether you're buying, selling, refinancing, or remodeling a home. If you're looking to buy an energy-efficient home, you can qualify for a better, more comfortable home because with lower utility costs, you can afford a slightly larger mortgage payment. You can also obtain financing to make energy-efficient improvements to an older home before moving in or to your existing home. You can apply for energy-efficient financing through a government-insured (USDA, HUD/FHA, or VA) or conventional loan program. There are two types of energy-efficient mortgages (EEMs): one for a new home and one for an existing home. With an EEM, you can purchase or refinance a home that is already energy efficient, or you can purchase or refinance a home that will become energy efficient after energy-saving improvements are made. Most energy-efficient financing programs offer both types of EEMs, as well as home-improvement loans for making energy-efficiency upgrades to your existing home. http://www.eere.energy.gov/consumer/your_home/designing_remodeling/index.cfm/mytopic=10380 http://www.fsec.ucf.edu/en/consumer/buildings/homes/ratings/eem/	n/a
Kansas Energy Efficiency Loan Program	Energy efficiency measures, including efficient appliances	For low-income homeowners, Kansas Housing Resources Corp will provide 50% of the loan amount needed to make energy efficient improvements, at zero interest, up to $7,500. Rest of the loan comes through Sunflower Bank. Lowers interest rate to make energy efficiency improvements more affordable. Also, weatherization grants available. http://www.kshousingcorp.org/programs/KEEP.shtml http://www.kshousingcorp.org/display/files/News%20Releases/08DOEWXGRANT.pdf	n/a

[1] Best website for federal and state incentives on Energy Efficiency and Renewable Energy: www.dsireusa.org

State Property Tax Exemption	Wind, solar thermal electric, photovoltaic, biomass, hydropower, geothermal, landfill gas	100% of investment is exempted from property taxes in Kansas. Does not apply to solar hot water. Kansas Statute KSA 79-102(11)	n/a

Financial Incentives for Energy Efficiency and Renewable Energy: Business Sector[1]

Updated 3-26-08

Type/Name	*Technologies*	*Amount / Maximum / Notes*	*Timing*
Federal Grant and Guaranteed Loan Program (USDA 9006)	Energy efficiency technologies, solar, wind, biomass, geothermal, hydrogen, fuel cells using renewable fuels	25% of eligible project costs (grants and guaranteed loans together, see below, cannot exceed 50% of eligible project costs). Maximum grant for renewable energy projects is $500,000; maximum grant for energy efficiency improvements is $250,000. http://www.rurdev.usda.gov/rbs/farmbill	Annual application process and competition. FY008 process has deadlines of April 15 and June 16, 2008.
Federal Tax Credit	Solar, some geothermal, fuel cells, microturbines	30% of the total costs of solar systems (photovoltaic electricity and hot water), solar hybrid lighting, and fuel cells, and 10% for geothermal electric, direct use geothermal, and microturbines. Excludes geothermal heat pumps. Other restrictions and requirements apply. http://www.irs.gov/pub/irs-pdf/f3468.pdf	Valid on systems installed before December 31, 2008
Federal Tax Credit	Wind, biomass, geothermal electric, landfill gas, others	2.0 ¢/kwh for wind, geothermal, closed-loop biomass; 1.0 ¢/kWh for landfill gas and others. Applies to first ten years of operation. http://www.irs.gov/pub/irs-pdf/f3468.pdf	Valid on systems installed before December 31, 2008
Federal Tax Credit	Energy efficient homes	$2,000 for homes certified to reduce energy consumption by 50% relative to the International Energy Conservation Code standard and meet minimum efficiency standards established by the Department of Energy. Rules are slightly different for manufactured compared to site-built homes. http://www.irs.gov/pub/irs-drop/n-06-27.pdf http://www.irs.gov/pub/irs-drop/n-06-28.pdf	Valid on homes occupied before December 31, 2008
Federal Tax Deduction	Energy efficiency measures	$0.30 to $1.80 per square foot of the building, depending on technology and amount of energy reduction. Applies to commercial buildings only. www.eere.energy.gov/buildings/info/tax_incentives.html	Valid on systems installed before December 31, 2008
Federal Corporate Depreciation (Modified Accelerated Cost-Recovery System)	Solar, wind, geothermal, fuel cells, microturbines, and solar hybrid lighting	Investments can be depreciated over five years. http://www.dsireusa.org ; see Federal incentives section.	
State Property Tax Exemption	Wind, solar thermal electric, photovoltaic, biomass, hydropower, geothermal, landfill gas	100% of investment is exempted from property taxes in Kansas. Does not apply to solar hot water. Kansas Statute KSA 79-102(11)	

[1] Best website for federal and state incentives on Energy Efficiency and Renewable Energy: www.dsireusa.org

Financial Incentives for Energy Efficiency and Renewable Energy: Public and Non-Profit Sector[1]

Updated 12-11-07

These notes pertain to public sector projects, including those owned by the city, a municipal utility, rural electric coop, state government, and tribal government. For other nonprofits, financial incentives for sustainability are hard to find. One possibly useful website is:
http://foundationcenter.org/pnd/tsn/tsn.jhtml?id=137700001 – why non-profits should be green
http://www.kresge.org/content/displaycontent.aspx?CID=59 -- grants from a foundation for the extra planning costs to design a green building for governments, historic, etc.

Type/Name	*Technologies*	*Amount / Maximum / Notes*	*Timing*
Clean Renewable Energy Bonds (CREBs) (Federal Loan Program)	Solar photovoltaics, wind, biomass, solar thermal electric, geothermal electric, landfill gas, others	For government entities, municipal cooperatives, tribes. CREBs are intended to provide governmental entities and electric cooperatives with the ability to obtain interest-free financing of certain renewable energy projects by providing the investors with a tax credit in lieu of interest. They deliver an incentive comparable to the production tax credit that is available to private renewable energy project developers and investor-owned utilities. The electric cooperative or bond issuer would issue the CREBs and sell them to bondholders. With a conventional bond, the Issuer must pay interest to the bondholder. But with a tax credit bond, the Issuer does not make interest payments. The federal government provides a tax credit to the bondholder in lieu of the Issuer paying interest to the bondholder. Projects are selected by the Treasury, with smaller projects given priority. http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US45F&State=federal&currentpageid=1&ee=1&re=1 http://www.elpc.org/energy/farm/crebs.php http://www.irs.gov/irb/2007-14_IRB/ar17.html http://www.nreca.org/documents/publicpolicy/cleanrenewableenergybonds.pdf	Was available once. Not certain this will be available again. Checking.
Renewable Energy Production Incentive (Federal grant)	Solar, wind, biomass favored	Financial payments for electricity produced and sold by new qualifying renewable energy generation facilities, for first ten years of operation. Annual payment depends on the size of the project, the number and size of the pool of applicants, and the federal appropriation for the year. For example, Lamar, Colo got ½ cent/kwh or $64,000 in 2006. http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=US33F&State=federal&currentpageid=1&ee=1&re=1 http://www.eere.energy.gov/repi/	Available annually
Corporate Federal Tax Deduction for Your Builder	Energy efficiency measures	This is a tax deduction for your builder of $0.30 to $1.80 per square foot of the building, depending on technology and amount of energy reduction. www.eere.energy.gov/buildings/info/tax_incentives.html	Valid on systems installed before December 31, 2008

[1] Best website for federal and state incentives on Energy Efficiency and Renewable Energy: www.dsireusa.org

New Construction ESPC

ESPC can be used to incrementally improve the efficiency of planned and funded building construction projects without using capital appropriations to reimburse the ESCO.

First, the agency, ESCO, and architect (perhaps with the general contractor, if selected) meet and form a consensus about the baseline (non-improved) building design and energy use. At a minimum, the baseline building must meet existing energy codes and standards.

Then the ESCO "audits" the baseline design, perhaps through simulation in conjunction with review of any baseline equipment and building material selections. The ESCO suggests more energy efficient materials and systems (windows, insulation, chillers, boilers, air handling equipment, etc.), and the incremental costs and savings are presented.

All parties (ESCO and agency at a minimum) then negotiate and come to agreement on the incremental costs and savings, and confirm that the savings will pay for the incremental costs over a reasonable contract term. The new, more efficient equipment and materials become part of the building design, and their costs are allocated to the ESCO and the general contractor (GC).

The costs are allocated by comparing the total incremental cost increases to the costs of building systems and materials, and several items are identified for the ESCO (rather than the GC) to purchase and install. In this way, the ESCO might buy a complete chiller and several air-handling units, while the GC purchases more efficient windows and wall insulation. Although the building now costs more to construct than the inefficient building, the value of the GC's contract does not go up since some costs are borne by the ESCO. The ESCO coordinates the installation of its equipment with the GC in much the same manner as a GC subcontractor.

This process allows each party to buy complete systems, since one can't typically buy an incremental improvement (lower kW/ton for example) separate from the system (chiller, etc.). The ESCO uses its own funds to buy its systems, and is not paid any capital dollars.

Once the building is constructed and accepted, the ESCO is paid from the incremental savings of all energy efficiency upgrades to the baseline design. Extending the previous example, the ESCO would be paid for the incremental savings generated by the chiller, air-handling units, windows, and wall insulation. Although the ESCO did not purchase all those systems, it invested the equivalent money in the systems it purchased and installed. The ESCO is responsible for the performance (and usually the M&V) of all the systems and materials from which it derives payments. The building owner takes title to the ESCO-purchased equipment at the end of the ESPC term.

Financial Incentives for Alternative Fuels and Vehicles[1]

Updated 2-21-08

United States (Federal) Incentives and Laws

Alternative Fuel Infrastructure Tax Credit

Section 1342 of the Energy Policy Act of 2005 provides a tax credit equal to 30% of the of cost alternative refueling property, up to $30,000 for business property. Qualifying alternative fuels are natural gas, propane, hydrogen, E85, or biodiesel mixtures of B20 or more. Buyers of residential refueling equipment can receive a tax credit for $1,000. For non-tax-paying entities, the credit can be passed back to the equipment seller. The credit is effective on equipment put into service after December 31, 2005. It expires December 31, 2009 (hydrogen property credit expires in 2014).

This legislation also extends the Tax Deduction Timeline that was established by EPAct 1992, Section 179, and extended by the Working Families Tax Relief Act of 2004.

In May 2006, the Internal Revenue Service (IRS) published Form 8911, which provides a mechanism to claim the infrastructure tax credit. Owners who install qualified refueling property on multiple sites can utilize the credit for each property. The instructions define what is considered qualified property and the value of the credit. See IRS Form 8911 at http:///*www.irs.gov/pub/irs-pdf/f8911.pdf.*

Alternative Motor Vehicle Credit

Section 1341 of the Energy Policy Act of 2005 provides a tax credit to buyers of new alternative fuel vehicles placed in service as an alternative fuel vehicle after January 1, 2006. The legislation provides for a tax credit equal to 50% of the incremental cost of the vehicle, plus an additional 30% of the incremental cost for vehicles with near-zero emissions (SULEV or Bin 2 for vehicles <14,001 lb GVWR). The IRS has issued two notices to establish rules for manufacturers and qualified vehicle buyers to claim the credit. The Current Tax Credits table at *www.eere.energy.gov/afdc/vehicles/hybrid_electric_tax_credits.html* has information on certified vehicles and available credits.

The credit is available on the purchase of light-, medium, and heavy-duty vehicles and fuel-cell, hybrid, and dedicated natural gas, propane, and hydrogen vehicles. Light-duty lean burn diesel vehicles are also eligible.

Vehicles are subject to the following incremental cost limitations:

- $5,000: 8,500 GVWR or lighter
- $10,000: 8,501 - 14,000 GVWR
- $25,000: 14,001 - 26,000 GVWR
- $40,000: 26,001 GVWR and heavier

For non-tax-paying entities, the credit can be passed back to the vehicle seller. The tax credit can be applied to vehicle purchases made after December 31, 2005. The credit expires December 31, 2010.

IRS Notice 2006-9 (*www.irs.gov/pub/irs-drop/n-06-09.pdf*), issued in January 2006, establishes procedures for manufacturers to certify to the IRS that a vehicle meets requirements to claim the credit and the amount of the credit for which the vehicle is eligible.

IRS Notice 2006-54 (*www.irs.gov/pub/irs-drop/n-06-54.pdf*), issued in June 2006, extends the Qualified Alternative Fuel Motor Vehicle (QAFMV) tax credit to vehicle conversions. This IRS guidance states that new or used vehicles, placed in service as alternative fuel vehicles after January 1, 2006, qualify for the tax credit when the conversion system manufacturer has received a certificate of

[1] This information is taken directly from DOE's EERE Alternative Fuels & Advanced Vehicles Data Center at *www.eere.energy.gov/afdc/progs/fed_summary.php/afdc/US/0*.
Also check this complete database of incentives*: www.dsireusa.org*

conformity from the EPA or California Air Resources Board. This guidance also establishes that manufacturers (conversion system installers) must provide certification to the IRS that a vehicle is eligible for a tax credit. The IRS must then provide the manufacturer with acknowledgement that a vehicle qualifies for the credit. The credit is taken by the buyer of a vehicle, and IRS Form 8910 should be used to claim the credit. The credit cannot be sold or transferred but can be carried forward by the seller for use in later years.

This legislation replaces the Clean Fuel Vehicle Property Tax Deduction previously available to purchasers.

Hybrid Motor Vehicle Credit
Section 1341 of the Energy Policy Act of 2005 provides a tax credit for light-duty hybrid vehicles (<8,501 lb GVWR) based on their improved fuel economy and their life-time fuel savings potential. The IRS will certify vehicles for the credit and publish qualifying credit amounts as vehicles are certified. The Current Tax Credits table has the most recent information from the IRS.

The fuel economy portion of the credit is based on the following efficiency gains over model year 2002 baselines.

- 125%-149%: $400
- 150% -174%: $800
- 175%-199%: $1,200
- 200%-224%: $1,600
- 225%-249%: $2,000
- 250%+: $2,400

The conservation credit increases the fuel economy credit based on the following lifetime fuel savings:

- 1,200-1,799 gal: $250
- 1,800-2,399 gal: $500
- 2,400-2,999 gal: $750
- 3,000 gal+: $1,000

To qualify for the credits, the vehicles must meet at least Bin 5 standards if they are up to 6,000 lb GVWR, or Bin 8 standards if the vehicles are 6,001 lb-8,500 lb GVWR.

Heavy-duty hybrid vehicles are subject to the following incremental cost limitations:

- <14,001 GVWR: $7,500
- 14,001-26,000 GVWR: $15,000
- 26,001+ GVWR: $30,000

This tax credit replaces the tax deduction previously available to purchasers under the Clean Fuel Vehicle Property guidance. This tax credit expires December 31, 2010.

The IRS issued guidance to automobile manufacturers in January 2006. Specifically, this notice provides procedures for a vehicle manufacturer to certify to the Internal Revenue Service both that the vehicle meets certain requirements for the credit and information to calculate the amount of the credit allowable with respect to that vehicle. See Notice 2006-9 at *www.irs.gov/pub/irs-drop/n-06-09.pdf*.

Clean School Bus USA
Clean School Bus USA reduces operating costs and children's exposure to harmful diesel exhaust by limiting bus idling, implementing pollution reduction technology, improving route logistics, and switching to biodiesel. In fiscal year 2005, the program offered $7.5 million in cost-shared grants to help school districts upgrade their diesel fleets. The Energy Bill of 2005 utilizes this EPA program to grant up to 50% cost share (depending on the age and emissions of original bus) to replace school buses with ones that operate on alternative fuels or low-sulfur diesel, or up to 100% for retrofit projects. $55 million are authorized for both 2006 and 2007,

and "such sums as necessary" for 2008-2010. More information is available on the Clean School Bus USA site at *www.epa.gov/cleanschoolbus/index.htm.*

Biodiesel and Ethanol (VEETC) Tax Credit
The American Jobs Creation Act of 2004 (Public Law 108-357) created tax incentives for biodiesel fuels and extended the tax credit for fuel ethanol. The biodiesel credit is available to blenders/retailers beginning in January 2005. It also established the Volumetric Ethanol Excise Tax Credit (VEETC), which provides ethanol blenders/retailers with $.51 per pure gallon of ethanol blended or $.0051 per percentage point of ethanol blended (i.e., E10 is eligible for $.051/gal; E85 is eligible for $.4335/gal). The incentive is available until 2010.

Section 1344 of the Energy Policy Act of 2005 extended the tax credit for biodiesel producers through 2008. The credits are $.51 per gallon of ethanol at 190 proof or greater, $1.00 per gallon of agri-biodiesel, and $.50 per gallon of waste-grease biodiesel. If the fuel is used in a mixture, the credit amounts to $.0051 per percentage point ethanol or $.01 per percentage point of agri-biodiesel used or $.0050 per percentage point of waste-grease biodiesel (i.e. E100 is eligible for $.51 per gallon).

For more information, read IRS Form 637 (*www.irs.gov/pub/irs-pdf/f637.pdf*) and IRS publication 510 (*www.irs.gov/pub/irs-pdf/p510.pdf*).

Non-Urbanized Area Formula Program
The Non-Urbanized Area Formula Program assists in the maintenance, development, improvement, and use of public transportation systems in rural and small urban areas; helps people in non-urbanized areas get transportation to health care, shops, school, employment, pubic services, and recreation; assists in the development and support of intercity bus transportation; and more. The program provides funding for capital, operating, and administrative purposes to state and local governments, non-profit organizations, and public transit operators. For more information, read the Federal Transit Administration's FY 2007 Budget Request at *www.irs.gov/pub/irs-pdf/p510.pdf* or call the Federal Transit Administration's Office of Resource Management and State Programs at (202) 366-2053.

Kansas Incentives and Laws
Last Updated May 2007

The following information is taken directly from DOE's EERE Alternative Fuels & Advanced Vehicles Data Center and can be accessed by going to *www.eere.energy.gov/afdc/incentives_laws.html* and clicking on the state of Kansas on the map.

Kansas is the proud home of the Kansas City Regional Clean Cities Coalition (www.kcenergy.org/transportation.html). Coordinator contact information is listed below.

Alternative Fuel Refueling Infrastructure Tax Credit
The state offers an income tax credit for alternative fuel refueling stations placed in service after January 1, 2005, and before January 1, 2009. The tax credit, worth up to 40% of the total amount, may not exceed $160,000. For any refueling station placed in service after January 1, 2009, the amount may not exceed $100,000. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made.
www.kcc.state.ks.us/energy/alt_fuels.htm

Renewable Fuel Retailer Incentive

Beginning January 1, 2009, a licensed retail motor fuel dealer may receive a quarterly incentive for selling and dispensing renewable fuels, including biodiesel. Qualified motor fuel dealers are eligible for up to $0.065 for every gallon of renewable fuel sold and up to $0.03 for every gallon of biodiesel sold, if the required threshold percentage is met. The threshold percentage for the incentive payment will increase on an annual basis from 10% for renewable fuel and 2% for biodiesel in 2009 to 25% beginning on January 1, 2024. Funds will be allocated from the Kansas Retail Dealer Incentive Fund.

'Biodiesel' is defined as a renewable, biodegradable, mono alkyl ester combustible liquid fuel derived from vegetable oils or animal fats that meets the specifications adopted by rules and regulations of the Secretary of Agriculture pursuant to current law. The specification must meet the American Society for Testing and Materials (ASTM) specification D6751-07 for biodiesel fuel (B100) blend stock for distillate fuels, but may be more stringent regarding biodiesel quality and usability. 'Renewable fuels' are defined as combustible liquids derived from grain starch, oil seed, animal fat, or other biomass; or produced from biogas source, including any non-fossilized, decaying, organic matter which is capable of powering spark ignition machinery.

Point of Contact

Cindy Mongold
Public Service Administrator II
Kansas Department of Revenue
Phone (785) 296-7048
Fax (785) 296-4993
cindy_mongold@kdor.state.ks.us
www.ksrevenue.org

Alternative Fuel Vehicle (AFV) Tax Credit

The state offers an income tax credit worth up to 40% of the incremental or conversion cost for qualified AFVs placed into service after January 1, 2005, as outlined in the chart below. Qualified AFVs include vehicles that operate on a combustible liquid derived from grain starch, oil seed, animal fat, or other biomass, or produced from a biogas source.

GVWR	Credit
Less than 10,000 lbs.	Up to $2,400
10,000 to 26,000 lbs.	Up to $4,000
Over 26,000 lbs.	Up to $40,000

Alternatively, a tax credit in an amount not to exceed the lesser of $750 or 5% of the cost of the AFV is available to a taxpayer who purchases an original equipment manufacturer AFV. This credit is allowed only to the first individual to take title of the vehicle. For motor vehicles capable of operating on E85, the individual claiming the credit must provide evidence of purchasing at least 500 gallons of E85 between the time the vehicle was purchased and December 31 of the next calendar year. This tax credit should be deducted from the taxpayer's income tax liability for the taxable year in which the expenditures are made. In the event the credit is more than the taxpayer's tax liability for that year, the remaining credit may be carried over for up to three years after the year in which the expenditures were made.
www.kcc.state.ks.us/energy/alt_fuels.htm

Biodiesel Production Incentive

A biodiesel fuel production incentive is available in the amount of $.30 per gallon of biodiesel fuel sold by a qualified Kansas biodiesel fuel producer. The incentive is payable to producers from the Kansas Qualified Biodiesel Fuel Producer Incentive Fund. Funding will be

made available for the production of biodiesel fuel beginning July 1, 2007.

Ethanol Production Incentive

The Kansas Qualified Agricultural Ethyl Alcohol Producer Fund enables qualified agricultural ethyl alcohol producers to apply for a production incentive with the Department of Revenue. If an ethyl alcohol producer who was in production prior to July 1, 2001, increases production capacity by an amount of 5,000,000 gallons over the producer's base sales, $0.075 may be collected for each gallon sold to an alcohol blender that is in excess of the producer's base sales (up to 15,000,000 gallons). Producers who start production on or after July 1, 2001, and who have sold at least 5,000,000 gallons to an alcohol blender may receive $0.075 for each gallon sold (up to 15,000,000 gallons).

Point of Contact
Patricia Platt
Public Service Administrator II
Kansas Department of Revenue
Phone (785) 291-3670
Fax (785) 296-2703
patricia_platt@kdor.state.ks.us

Regional Biofuels Promotion Plan

Kansas has joined Indiana, Iowa, Michigan, Minnesota, Ohio, South Dakota, and Wisconsin in adopting the Energy Security and Climate Stewardship Platform Plan (Platform), which establishes shared goals for the Midwest region, including increased biofuels production and use. Specifically, the Platform sets the following goals:

- Produce commercially available cellulosic ethanol and other low-carbon fuels in the region by 2012;
- Increase E85 availability at retail fueling stations in the region to 15% of stations by 2015, 20% by 2020, and 33% of all fueling stations in the region by 2025;
- Reduce the amount of fossil fuel that is used in the production of biofuels by 50% by 2025;
- By 2025, at least 50% of all transportation fuels consumed by the Midwest will be from regionally produced biofuels and other low-carbon transportation fuels.

The Platform also establishes a regional biofuels corridor program. The program directs state transportation, agriculture, and regulatory officials to develop a system of coordinated signage across the region for biofuels and advanced transportation fuels and to collaborate to create regional E85 corridors. The program requires standardized fuel product coding at fueling stations as well as increased education for retailers about converting existing fueling infrastructure to dispense E85. The state transportation, agriculture, and regulatory officials are required to report their corridor implementation plans to the Midwest Governors Association by April 1, 2008.

Idle Reduction Weight Exemption

Any vehicle or combination of vehicles equipped with idle-reduction technology may exceed the state's gross and axle weight limits by up to 400 pounds to compensate for the additional weight of the added idle reduction technology.

Point of Contact
Tom Whitaker
Executive Director
Kansas Motor Carriers Association
Phone (785) 267-1641
Fax (785) 266 -6551
tomw@kmca.org
www.kmca.org

E85 Tax Rate Reduction and Definition

Effective January 1, 2007, the motor vehicle fuel tax rate on E85 fuel is at least $0.17 per gallon, until July 1, 2020. On and after July 1,

2020, the tax on E85 fuel will be a minimum of $0.11 per gallon. E85 is defined as an alternative fuel that is a blend of denatured ethanol and hydrocarbon that typically contains 85% ethanol by volume, and must contain at least 70% ethanol by volume and complies with American Society for Testing and Materials (ASTM) specification D5798-99.

Biofuels Use

A 2% or higher blend of biodiesel must be purchased for use in state-owned diesel powered vehicles and equipment, where available, as long as the incremental price of biodiesel is not more than $0.10 per gallon as compared to the price of diesel fuel. Further, individuals operating state-owned motor vehicles must purchase fuel blends containing at least 10% ethanol, as long as these fuel blends are not $0.10 per gallon more than the current price per gallon of regular gasoline fuel.

Low-Speed Vehicle Access to Roadways

A low-speed vehicle is defined as any four-wheeled electric vehicle whose top speed is greater than 20 miles per hour (mph) but not greater than 25 mph and is manufactured in compliance with the national highway and traffic safety administration standards for low-speed vehicles in Title 49 of the Code of Federal Regulations Title 49, Part 571.500. Low-speed vehicles may only travel on roads with a posted speed limit of 40 mph or less and must be appropriately licensed.

A.3 Presentation: Renewable Energy Screening, Town of Greensburg, Kansas

Andy Walker
National Renewable Energy Laboratory

NREL National Renewable Energy Laboratory

A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Innovation for Our Energy Future

Renewable Energy Screening
Town of Greensburg, KS
National Renewable Energy Laboratory

Andy Walker
National Renewable Energy Laboratory

Optimization

- Identify the least cost combination of renewable energy technologies for Greensburg, KS

Renewable Energy Technologies Considered

- Photovoltaics (solar electricity)
- Wind Power
- Solar Ventilation Air Preheating
- Solar Water Heating
- Solar Thermal/Solar Thermal Electric
- Biomass Heat/Biomass Electric
- Daylighting

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Optimization Problem

Objective: Minimize Life Cycle Cost ($)

Microsoft Office Excel Spreadsheet function: SOLVER

- **Precision:** value of energy use 0.0 +/- 0.0001
- **Convergence:** change in life cycle cost less than $0.0001 for five iterations
- **Quadratic Extrapolation** to obtain initial estimates of the variables in one-dimensional search
- **Central Derivatives** used to estimate partial derivatives of the objective and constraint functions
- **Newtonian Search** Algorithm used at each iteration to determine the direction to search.

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Geographical Information System (GIS) Datasets

- NREL Datasets:
  - solar radiation 40x40 km grid
    - Horizontal, South-facing vertical, tilt=latitude
  - Wind Energy 200mx1000m grid
  - Biomass Resources
  - Illuminance for Daylighting
  - Temperature and Heating Degree Days
- Purchased Datasets
  - utility rates for each service territory (Platts)
  - State and utility incentives and utility policy (from DSIRE)
  - Temperature and Heating Degree Day (NREL)
  - City Cost Adjustments (RS Means & Co)
- Location Independent
  - Installed Hardware Costs from NREL technology databook
  - Economic Parameters (discount rate, inflation rate)

Selected Resource Information

Latitude	38.91667
Longitude	-111.7936
Heating Degree Days (65F)	4791
Cooling Degree Days (65F)	1628
Annual Average Solar tilt=lat (kWh/m2/day)	5.2
Annual Maximum Solar tilt=lat (kWh/m2/day)	6.3
Annual Average Solar horiz (kWh/m2/day)	4.6
Annual Average Wind Power Density (W/m2)	400
Annual Solar Vent Preheat Delivery (kWh/m2/yr)	557
Annual min Direct Solar on E/W 1-axis tracker (kWh/m2/day)	3
Biomass, total residues within 50 miles (tons/year)	1920000

Biomass Resource Breakdown

Within 50 mile radius:	
Crops	803000
Manure	432
Forest	1700
PrimMill	0
SecMill	750
Urban	10200
Landfill	2900
DWWT	135
Energy crops on CRP land	1101000
Total	**1920117**

Illuminance data for Daylighting Calculation

Illuminance Values (klux-hr)

March	9am	32
	11am	70
	1pm	85
	3pm	73
	5pm	38
June	9am	38
	11am	78
	1pm	102
	3pm	101
	5pm	77
Sept	9am	20
	11am	62
	1pm	87
	3pm	85
	5pm	58
Dec	9am	10
	11am	41
	1pm	53
	3pm	39
	5pm	8

Economic Parameters

Discount Rate	4.6%	
Fuel Escalation Rate	2.0%	
Electric Escalation Rate	2.0%	

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Results of Life Cycle Cost Optimization: Technology Sizes

Photovoltaics Size (kW)	Wind Capacity (kW)	Solar Vent Preheat Area (ft2)	Solar Water Heating Area (ft2)	Solar Thermal Area (ft2)	Solar Thermal Electric (kW)	Biomass Boiler Size (M Btu/h)	Biomass Cogeneration Size (kW)	Daylighting Office Utility Skylight/Floor Area Ratio	Daylighting Warehouse Skylight/Floor Area Ratio
10	0	15258	29,179	0	0	0	0	3.968%	3.036%
0	957	0	0	0.00	0.00	1.34	101	0.000%	0.000%

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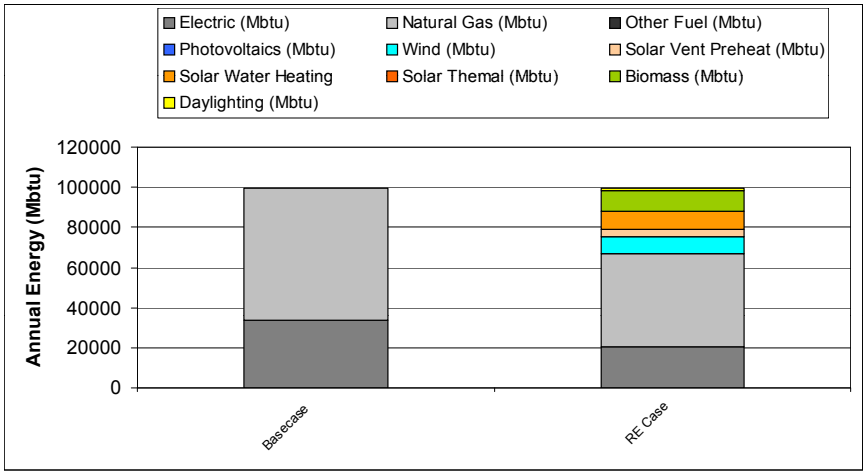
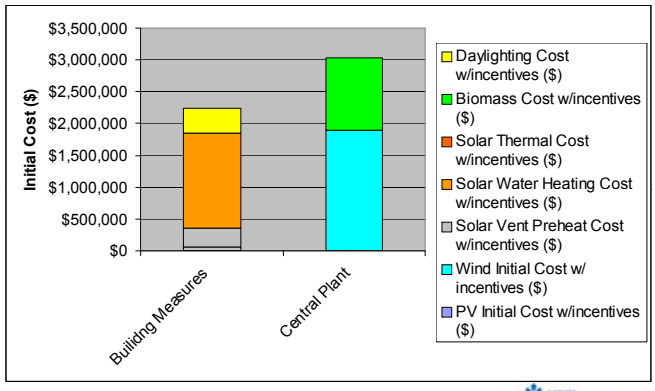
Annual Energy from Each Technology (with Basecase)



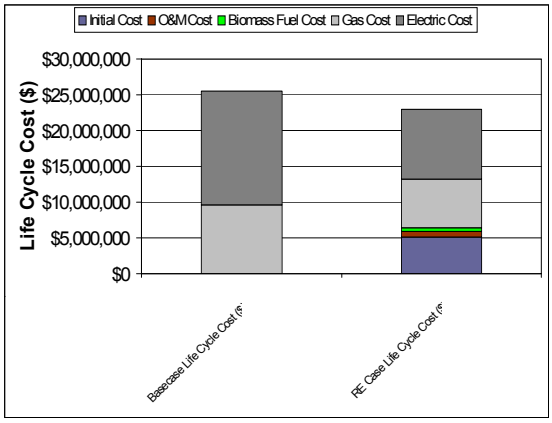
Initial Costs for Each Technology

	PV Initial Cost w/incentives ($)	Wind Initial Cost w/ incentives ($)	Solar Vent Preheat Cost w/incentives ($)	Solar Water Heating Cost w/incentives ($)	Solar Thermal Cost w/incentives ($)	Biomass Cost w/incentives ($)	Daylighting Cost w/incentives ($)	Total Initial Cost ($)
Builidng Measures	$59,216	$0	$305,167	$1,491,055	$0	$0	$388,709	$2,244,146
Central Plant	$1,238	$1,888,910	$0	$0	$0	$1,135,832	$0	$3,025,979
Total	$60,453	$1,888,910	$305,167	$1,491,055	$0	$1,135,832	$388,709	$5,270,126



Life Cycle Cost of Net Zero Case versus BaseCase

Name	Basecase Life Cycle Cost ($)	RE Case Life Cycle Cost ($)
Initial Cost	$0	$5,178,576
O&M Cost	$0	$689,759
Biomass Fuel Cost	$0	$575,533
Gas Cost	$9,579,065	$6,766,870
Electric Cost	$15,882,976	$9,690,919
Total	**$25,462,040**	**$22,901,657**



Photovoltaics

Photovoltaics
not cost effective
demonstration on school only

Building Name	Photovoltaics Size (kW)	PV Initial Cost w/incentives ($)	Net Metering up to (kW)	Avoided Cost ($/kwh)	PV Annual Energy Delivery (kWh/year)	Capacity Factor ()	PV Annual Utility Cost Savings ($)	PV Annual O&M Cost ($/year)
Courthouse	0	$0	100	0.03	0	0.0%	$0	$0
Library	0	$0	100	0.03	0	0.0%	$0	$0
sheriff	0	$0	100	0.03	0	0.0%	$0	$0
County Health Dept	0	$0	100	0.03	0	0.0%	$0	$0
County Extension Office	0	$0	100	0.03	0	0.0%	$0	$0
Hospital	0	$0	100	0.03	0	0.0%	$0	$0
Fairgrounds bldgs	0	$0	100	0.03	0	0.0%	$0	$0
Museum	0	$0	100	0.03	0	0.0%	$0	$0
City Hall	0	$0	100	0.03	0	0.0%	$0	$0
Fire/Police	0	$0	100	0.03	0	0.0%	$0	$0
High school	10	$59,216	100	0.03	14615	16.7%	$1,315	$88
Elem/Middle School	0	$0	100	0.03	0	0.0%	$0	$0
Gym and field bldgs	0	$0	100	0.03	0	0.0%	$0	$0
Post Office	0	$0	100	0.03	0	0.0%	$0	$0
USDA Service Center	0	$0	100	0.03	0	0.0%	$0	$0
Kansas State Hwy Office	0	$0	100	0.03	0	0.0%	$0	$0
USDA Housing Office	0	$0	100	0.03	0	0.0%	$0	$0
Mental Health Center	0	$0	100	0.03	0	0.0%	$0	$0
Twilight Theater	0	$0	100	0.03	0	0.0%	$0	$0
Assisted Living Residence	0	$0	100	0.03	0	0.0%	$0	$0
Senior Citizen housing	0	$0	100	0.03	0	0.0%	$0	$0
Residential	0	$0	100	0.03	0	0.0%	$0	$0
Commercial	0	$0	100	0.03	0	0.0%	$0	$0
Sum of Building Measures	**10**	**$59,216**		**0**	**14615**		**$1,315**	**$88**
Central Plant	**0**	**$0**	**100**	**0**	**0**	**0.0%**	**$0**	**$0**

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Technology Characteristics
Photovoltaics

Initial Cost	$8,730.00	$/kW	RS Means Green Building Project Planning and Cost Estimating, 2006
O$M	0.006	$/kWh	Renewable Energy Technology Characterizations, EPRI TR-109496, 1997.C185
BOS Efficiency	0.77		PVWatts documentation www.nrel.gov

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Wind Power

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Technology Characteristics
Wind Power

Wind Turbine Efficiency	35%	
Capital Cost	$926	$/m2 swept area
O&M Cost	7.9	$/year/kW
Power/Area	0.46	kW/m2
Capital Cost	2000	$/kW

http://www.eia.doe.gov/cneaf/solar.renewables/rea_issues/wind.html

http://www.pge.com/suppliers_purchasing/new_generator/incentive/avail

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Wind Energy

Building Name	Wind Capacity (kW)	Wind Annual Energy Delivery (kWh/year)	Capacity Factor (%)	Wind Annual Cost Savings ($)	Wind Annual O&M Cost ($/year)	Wind Payback Period (years)
Central Plant	957	2,533,894	30.23%	$276,194	$7,560	7.0

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Solar Ventilation Air Preheat

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Technology Characterization
Solar Ventilation Air Preheat

Initial Cost	20	$/sf			
O&M Cost	0				
	Warehouse Area (sf)	**Bldg Core Area (sf)**	**No-skylight area (sf)**	**Office Area (sf)**	**Utilities Area (sf)**
Ventilation Rate (cfm/sf)	0.12	0.12	0.12	0.12	0.12

Solar Ventilation Air Preheating

Building Name	SVP Ventilation Rate (CFM)	Solar Vent Preheat Area (ft2)	Annual Gas Savings (therms/year)	Annual Utility Cost Savings ($/year)	Solar Vent Preheat Cost w/incentives ($)	Solar Vent Preheat Payback Period (years)
Courthouse	2,880	720.0	1,590	$1,288	$10,080	7.8
Library	505	126.3	279	$226	$1,769	7.8
sheriff	264	66.0	146	$118	$924	7.8
County Health Dept	204	51.0	113	$91	$714	7.8
County Extension Office	156	39.0	86	$70	$546	7.8
Hospital	10,800	2,700.0	5,961	$4,828	$37,800	7.8
Fairgrounds bldgs	2,100	0.0	0	$0	$0	#DIV/0!
Museum	1,200	300.0	662	$536	$4,200	7.8
City Hall	324	81.0	179	$145	$1,134	7.8
Fire/Police	420	105.0	232	$188	$1,470	7.8
High school	9,600	2,400.0	5,299	$4,292	$33,600	7.8
Elem/Middle School	5,880	1,470.0	3,245	$2,629	$20,580	7.8
Gym and field bldgs	1,920	480.0	1,060	$858	$6,720	7.8
Post Office	240	60.0	132	$107	$840	7.8
USDA Service Center	240	60.0	132	$107	$840	7.8
Kansas State Hwy Office	240	60.0	132	$107	$840	7.8
USDA Housing Office	240	60.0	132	$107	$840	7.8
Mental Health Center	1,320	330.0	729	$590	$4,620	7.8
Twilight Theater	1,080	0.0	0	$0	$0	#DIV/0!
Assisted Living Residence	2,520	630.0	1,391	$1,127	$8,820	7.8
Senior Citizen housing	13,080	3,270.0	7,220	$5,848	$45,780	7.8
Residential	116,220	0.0	0	$0	$0	#DIV/0!
Commercial	9,000	2,250.0	4,968	$4,024	$31,500	7.8
Sum of Building Measures	**180,433**	**15,258.3**	**33,688**	**$27,287**	**$213,617**	

Solar Water Heating

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Technology Characterization
Solar Water Heating

Hot Water as Fraction of Total Building Energy		
Office	0.089506	
Education	0.21942	
Health Care	0.262063	
lodging	0.403771	
public assembly	0.153914	
food service	0.112016	
food sales	0.042623	
warehouse	0.052219	
other 15.3	0.08885	
all	0.152486	

source: DOE/OBT Energy Databook

SDHW Efficiency	0.4	
Cost	73	$/sf
O&M Cost	0.005	% of initial cost
Aux efficiency	0.8	

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Solar Water Heating

Building Name	Solar Water Heating Area (ft2)	Solar Water Heating Gas Savings (therms/year)	Solar Water Heating Annual Utility Cost Savings ($/year)	Solar Water Heating Cost w/incentives ($)	Solar Water Heating O&M Cost ($/year)	Solar Water Heating Payback Period (years)
Courthouse	0	0	$0	$0	$0	#DIV/0!
Library	0	0	$0	$0	$0	#DIV/0!
sheriff	45	134	$109	$2,280	$16	24.7
County Health Dept	34	104	$84	$1,762	$13	24.7
County Extension Office	26	79	$64	$1,347	$10	24.7
Hospital	1,825	5,492	$4,449	$93,262	$666	24.7
Fairgrounds bldgs	0	0	$0	$0	$0	#DIV/0!
Museum	0	0	$0	$0	$0	#DIV/0!
City Hall	55	165	$133	$2,798	$20	24.7
Fire/Police	71	214	$173	$3,627	$26	24.7
High school	1,622	4,882	$3,954	$82,900	$592	24.7
Elem/Middle School	994	2,990	$2,422	$50,776	$363	24.7
Gym and field bldgs	324	976	$791	$16,580	$118	24.7
Post Office	41	122	$99	$2,072	$15	24.7
USDA Service Center	41	122	$99	$2,072	$15	24.7
Kansas State Hwy Office	41	122	$99	$2,072	$15	24.7
USDA Housing Office	41	122	$99	$2,072	$15	24.7
Mental Health Center	223	671	$544	$11,399	$81	24.7
Twilight Theater	0	0	$0	$0	$0	#DIV/0!
Assisted Living Residence	426	1,282	$1,038	$21,761	$155	24.7
Senior Citizen housing	2,210	6,652	$5,388	$112,951	$807	24.7
Residential	19,640	59,102	$47,873	$1,003,604	$7,169	24.7
Commercial	1,521	4,577	$3,707	$77,718	$555	24.7
Sum of Building Measures	**29,179**	**87,808**	**$71,125**	**$1,491,055**	**$10,650**	

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Solar Thermal/Solar Thermal Electric

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Technology Characterization
Solar Thermal/Solar Thermal Electric

Solar Thermal cost	50	$/sf	
O&M cost	$0.127	$/therm/year	
Efficiency	0.33		
Cost of thermal storage	$1,465	$/therm	http://www.nrel.gov/csp/troughnet/pdfs/3516.pdf
Hours per day of solar collection	6		
Cogen Cost	1650	$/kW	
cogen Efficiency	0.3		
Boiler Capacity Factor	0.85		
Hx effectiveness	0.7		
Federal Production tax credit	0.01	$/kwh	

Solar Thermal/Solar Thermal Electric
…found not to be cost effective

Solar Thermal Area (ft2)	Solar Thermal Cogeneration Size (kW)	Solar Thermal Gas Savings (therms/year)	Solar Thermal Electric Delivery (kWh/year)	Solar Thermal Annual Utility Cost Savings ($/year)	Solar Thermal Cost w/incentives ($)	Solar Thermal O&M Cost ($/year)	Solar Thermal Payback Period (years)
0	0	0	0	0	$0	$0	#DIV/0!

Biomass Energy

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Technology Characterization
Biomass Energy

Biomass heating value	100	therms/ton
Boiler Cost	500000	$/MBH
Cogen Cost	1650	$/kW
Fuel Storage and Handling	250000	$/MBH
Boiler Efficiency	0.75	
cogen Efficiency	0.3	
Boiler Capacity Factor	0.85	
Hx effectiveness	0.7	
fixed cost per ton	20	
trucking cost	1	$/sq mile/ton
Federal Production tax credit	0.01	$/kwh
Biomass O&M Cost	15000	$/yr/Mmbtuh
http://www.eia.doe.gov/oiaf/analysispaper/biomass/index.html		

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Biomass Energy

Building Name	Biomass Boiler Size (M Btu/h)	Biomass Cogeneration Size (kW)	Biomass Gas Savings (therms/year)	Biomass Electric Delivery (kWh/year)	Biomass Capacity Factor	Biomass Annual Utility Cost Savings ($/year)	Tons of Fuel Used	per ton fuel cost ($/ton)	Biomass Cost w/incentives ($)	Biomass O&M Cost($/year)
Central Plant	1	101	78,769	754,248	85.0%	$139,228	1,330	$24.08	$1,135,832	$20,101

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Daylighting

Daylighting at East Range Warehouse
Schofield Barracks, Hawaii

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Technology Characterizations
Daylighting

	Lighting levels	
Office	30	fc
Warehouse	15	fc
Utility	30	fc
skylight transmittance	0.7	
lightwell transmittance	0.5	
Coefficient of Utilizatio	0.55	
Coefficient of Utilizatio	0.45	
Luminous Efficacy Ele	100	lumens/wat
Roof U-value	0.1	btu/hr/F
Skylight Uvalue	0.5	btu/hr/F
Cooling COP	3.5	
Heating Efficiency	0.8	
Skylight Cost	25	$/sf
Controls cost	0.25	$/sf floor ar

Daylighting

Building Name	Daylighting Office Utility Skylight/Floor Area Ratio	Daylighting Warehouse Skylight/Floor Area Ratio	Total Skylight Area (ft2)	Annual Electric Savings (kWh/year)	Annual Natural Gas Savings (therms/year)	Daylighting Cost w/incentives ($)	Daylighting Annual Cost Savings ($/year)	Daylighting Payback Period (years)
Courthouse	2.3%	3.4%	473.4	37,418.2	(272.1)	$16,634	$3,147	5.3
Library	4.6%	3.5%	137.2	5,243.8	(78.9)	$4,271	$408	10.5
sheriff	4.8%	3.6%	73.3	2,737.4	(42.2)	$2,273	$212	10.7
County Health Dept	4.8%	3.6%	57.0	2,114.8	(32.8)	$1,765	$164	10.8
County Extension Office	4.8%	3.6%	43.8	1,616.9	(25.2)	$1,355	$125	10.8
Hospital	4.8%	3.6%	3,031.0	111,942.4	(1,742.6)	$93,776	$8,663	10.8
Fairgrounds bldgs	3.8%	3.1%	481.5	21,907.8	(276.8)	$15,536	$1,747	8.9
Museum	4.3%	3.3%	303.7	12,481.4	(174.6)	$9,592	$982	9.8
City Hall	4.7%	3.6%	89.5	3,360.2	(51.5)	$2,777	$261	10.7
Fire/Police	4.7%	3.5%	114.9	4,357.1	(66.1)	$3,574	$339	10.6
High school	4.7%	3.5%	2,624.0	99,596.2	(1,508.6)	$81,600	$7,742	10.5
Elem/Middle School	4.7%	3.5%	1,607.2	61,002.7	(924.0)	$49,980	$4,742	10.5
Gym and field bldgs	3.9%	3.1%	449.3	20,018.0	(258.3)	$14,433	$1,592	9.1
Post Office	4.8%	3.6%	66.8	2,488.3	(38.4)	$2,071	$193	10.7
USDA Service Center	4.8%	3.6%	66.8	2,488.3	(38.4)	$2,071	$193	10.7
Kansas State Hwy Office	4.8%	3.6%	66.8	2,488.3	(38.4)	$2,071	$193	10.7
USDA Housing Office	4.8%	3.6%	66.8	2,488.3	(38.4)	$2,071	$193	10.7
Mental Health Center	4.2%	3.3%	329.8	13,735.0	(189.6)	$10,446	$1,083	9.6
Twilight Theater	4.3%	3.3%	276.7	11,228.8	(159.1)	$8,718	$882	9.9
Assisted Living Residence	3.6%	2.9%	549.8	26,326.0	(316.1)	$17,944	$2,113	8.5
Senior Citizen housing	0.0%	0.0%	0.0	0.0	0.0	$0	$0	#DIV/0!
Residential	0.0%	0.0%	0.0	0.0	0.0	$0	$0	#DIV/0!
Commercial	3.0%	1.1%	1,230.1	94,981.1	(707.2)	$45,753	$7,975	5.7
Sum of Building Measures	**4.0%**	**3.0%**	**12,139.5**	**540,020.9**	**(6,979.2)**	**$388,709**	**$42,949**	

Thank You!