Approved: Carl Dean Holmes
Date 2-3-99

MINUTES OF THE HOUSE COMMITTEE ON UTILITIES.

The meeting was called to order by Chairperson Rep. Carl Holmes at 9:05 a.m. on January 29, 1999 in Room 522-S of the Capitol.

All members were present except:

Committee staff present: Lynne Holt, Legislative Research Department
Mary Torrence, Revisor of Statutes
Jo Cook-Whitmore, Committee Secretary

Conferees appearing before the committee:

Others attending: See Attached List

Chairman Holmes asked for bill introductions. Rep. Sloan moved a bill be introduced on non-public municipal utilities as a committee bill to increase the number of people who can belong to those. Motion was seconded by Rep. Loyd. A question was raised about whether that bill had already been done last year. The answer was that the bill in question died in the Senate. Motion carried.

The Chair introduced Jerry Lonergan, Executive Director of the Kansas Electric Utilities Research Program. Mr. Lonergan's presentation was about the renewable energy initiative that has been in place since 1994. It is one of the real successes they like to talk about as far as a good example of how private and public and university partnerships can work together to achieve some positive and significant results for the state of Kansas. (Attachment 1, 1-1 to 1-5)

Dr. Richard Nelson, Kansas State University, spoke on biomass research (Attachment 1, 1-6 to 1-23).

Donna Johnson, President of Pinnacle Technology, Inc., spoke on wind research (Attachment 1, 1-24 to 1-28).

Mr. Lonergan concluded the KEURP presentation with information from a Kansas survey (Attachment 1, 1-29 & 1-30).

The KEURP presentation concluded with responses to questions from the committee.

Rep. Sloan moved the minutes of the January 25 and January 26 meetings be approved. Rep. Johnson seconded the motion. Motion carried.

Meeting adjourned at 9:50 a.m.

Next meeting is Monday, February 1 at 9:00 a.m.

HOUSE UTILITIES COMMITTEE GUEST LIST

DATE: January 29, 1999

NAME	REPRESENTING
J.J. Long	UCU
Dave Holthaus	Western Res.
LES EVANS	WRI
Marc Hamann	Division of the Budget
Richard Nelson	KSU -
Jim Ploger	KCC
DONNA JOHNSON	Pinnacle Technology
JERRY LONERGAN	KEURP
STEVE KEARNEY	AMI
WALKER HENDRIX	CURB

Kansas Electric Utilities Research Program: ***Renewable Energy Initiative Overview***

January 28, 1999 Presentation

Utilities Committee

Kansas House of Representatives

HOUSE UTILITIES

DATE: January 29, 1999

ATTACHMENT 1

Kansas Electric Utilities Research Program:
Renewable Energy Initiative Overview

January 28, 1999 Presentation

Utilities Committee

Kansas House of Representatives

KEURP mission ...

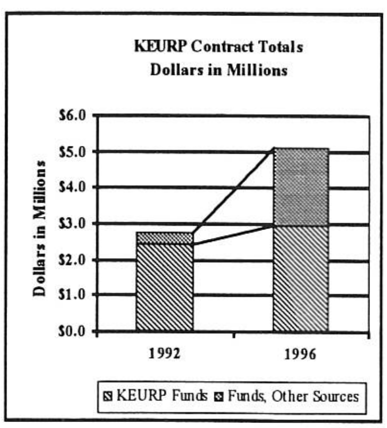
... a cooperative venture performing applied research to proactively seek and deliver technologies enhancing the value of electric services to its members, utility customers and the state of Kansas.

- Executive Committee
- Technical Committee
- Advisory Groups

Research Projects include:

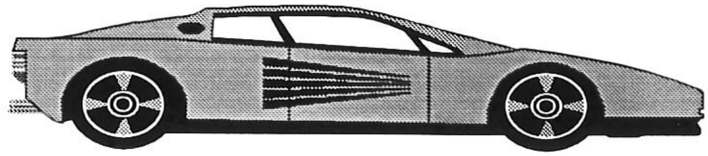
- Electric Vehicle demonstration, on-road and off
- Power Quality - utilities and their customers
- KS small and medium sized airport electrification
- Oil well retrofit performance evaluation
- Electric and magnetic field studies
- Technology assessment studies

Research Investment



- Total contract dollars almost doubled from 1992 to 1996
- Time period when nationally utility support for research declined 31 percent (GAO)
- Over $3 million of the $5.2 million were to Kansas firms or universities
- considering residential customers *only* KEURP cost about $.11 per month

Kansas ElectroRally 1999



- Saturday, May 8 at Cessna Stadium on the Wichita State University campus
- Teams from 35 high schools having designed and built electric racecars and will attempt to complete the most laps in 60 minutes
  - hands-on experience with electric transportation technology
  - students work side-by-side with electric utility professionals
  - teachers incorporate this knowledge into future classroom activity
  - today's students are the consumers of tomorrow

KEURP Renewable Energy Initiative

- Assess the potential and feasibility of replacing an imported product (Wyoming coal) with clean Kansas resources
  - Biomass
  - Wind
  - Solar
- Acquire an understanding of Kansans' knowledge about and interest in renewable energy

Kansas Renewable Energy Research and Development Plan -1994

- **Biomass**
  - energy crop feasibility
  - statewide assessment of crops and applications
- **Wind**
  - identify wind farm sites
  - conduct data collection and wind farm modeling
- **Solar**
  - utility training and education
  - off-grid PV demonstration opportunities
- **Cross-cutting Issues**
  - green pricing potential

An Assessment of the Feasibility of Electric Power Derived from Biomass and Waste Feedstocks For Kansas Electric Utilities

November 1998

KRD-9513

KEURP Renewables R&D

Coriolis/Kansas State/Heritage

Project Sponsors

- **Kansas Electric Utilities Research Program (KEURP) Topeka, Kansas**
- **Kansas Corporation Commission Energy Program Topeka, Kansas**
- **Western Regional Biomass Energy Program (WRBEP)**

KEURP Renewables R&D

Coriolis/Kansas State/Heritage

KRD-9513

Project Team

- Joe King, AIA, Jay Hutton, Coriolis
  Lawrence, Kansas
- Richard Nelson, PhD, Kansas State University
  Manhattan, Kansas
- Mark Hannifan, Heritage Technologies
  Leawood, Kansas

KRD-9513

Other Project Participants

- USDA's Blacklands Research Center (BRC)
  - Dr Verel Benson - Dr Jim Kiniry
- Kansas State University
  - Dr Wayne Geyer - Dr Mike Langemeier - Dr John Fritz
- Oak Ridge National Laboratory (ORNL)
  - Dr Mark Downing - Dr Robin Graham
- KEURP Representatives
  - Bob Fackler (Western Resources) - Alex Hapka (KCP&L)
- Others
  - Alan Teel, Chariton Valley Project (Iowa)
  - George Wiltse, Appel Consultants

Background

- National and global interest in renewable energy driven primarily by environmental concerns
- KEURP Renewable Energy Research Program initiated in 1994
- Biomass and wind energy are primary renewable energy resources that have been investigated
- Biomass project begun in fall of 1996
- Goal of identifying lowest cost opportunity for biomass fueled electric power generation in Kansas

Existing Biomass Fueled Generation

- Currently, no biomass-fueled generation exists in Kansas
- Minimal biofuel generation in the Great Plains states (ND,SD, NE, MN, IA, MO, OK)
- Much of the Southeast, Great Lakes, and Northeastern portions of the United States as well as California have significant biofuel generation mostly from wood wastes, but also from municipal solid waste and agricultural processing residues

The Status of Biomass Energy

Overview

KEURP's *Kansas Renewable Energy Research and Development Plan*, includes the following broad objectives related to biomass:

- develop a more detailed assessment of the quantity, quality, and spatial distribution of biomass resources;
- determine the energy and capacity value of biomass-derived electrical production; and
- help KEURP utilities understand available biomass fueled generating technologies.

KEURP Renewables R&D   Coriolis/Kansas State/Heritage

Plantation Biomass

The Plantation Biomass Concept

- Began with ORNL in 1978
- Test plots at over 100 different locations
- Switchgrass and Poplar dominant species in ORNL program
- Plantation concept has dual uses of fuel and fiber

KEURP Renewables R&D   Coriolis/Kansas State/Heritage

Factors Affecting Concept Viability

- Biomass fuel cost
- Cost of competing fuel source(s)
- Land requirements
- Transportation from field to plant
- Future land rents
- Environmental impacts
- Global warming - Government policy

Biomass Fuel Cost

- Edge-of-field cost projections vary widely from a low of around $1.50 to a high of $4.00 + ($/MBtu)
- Factors affecting biomass cost:
  - yield
  - land cost
  - operational efficiency
  - material inputs
  - cost of money

Land Requirements and Availability

- **Each MW of base load biomass plant requires around 1,000 acres of dedicated land (+/- 50%)**

Land Area Required to Support Biomass Electric Power

Plant Size (MW)	Conversion Efficiency (%)	Biomass Energy (Btu/lb)	Net Biomass Yield (dry tons/ acre/yr)	Annual Plant Factor (%)	Tons Required (per day)	Acres Required	Land Use Efficiency (%)	Square Miles Required
10	30%	8000	2	65%	171	20237	85%	37.2
10	50%	8000	2	65%	102	12142	85%	22.3
10	30%	8000	4	65%	171	10119	85%	18.6
10	50%	8000	4	65%	102	6071	85%	11.2
10	30%	8000	6	65%	171	6746	85%	12.4
10	50%	8000	6	65%	102	4047	85%	7.4

Transportation

- **Transportation can add $5.00 - $10.00 per ton or more to the cost of biomass ($0.30 - $0.60/ MBtu)**
- **Transportation is affected by distance, density of land dedicated to biomass, method and handling steps, season and duration of harvest**

Fraction of Land Area Required for Varying Plant Size and Haul Distance

Plant Size (MW)	Conversion Efficiency (%)	Net Biomass Yield (dry tons/ acre/yr)	Annual Plant Factor (%)	Acres Required	Land Use Efficiency (%)	Square Miles Required	Fraction of Land Area 25 Mile Max. Haul	Fraction of Land Area 50 Mile Max. Haul
10	30%	4	65%	10119	85%	18.6	0.9%	0.2%
10	50%	4	65%	6071	85%	11.2	0.6%	0.1%
50	30%	4	65%	50594	85%	93.0	4.7%	1.2%
50	50%	4	65%	30356	85%	55.8	2.8%	0.7%
100	30%	4	65%	101187	85%	186.0	9.5%	2.4%
100	50%	4	65%	60712	85%	111.6	5.7%	1.4%

Environmental Impacts of Biomass

- **Potential environmental benefits**
  - reduced soil erosion (rainfall and wind)
  - reduced surface and subsurface nutrient and pesticide migration
  - restoration of degraded soils
  - carbon sequestering in the root system more extensive than annual crops
  - reduced global warming emissions (closed carbon cycle)
  - improvement of local air quality through a reduction of SOx and NOx
- **Potential environmental problems**
  - large-scale monocrops do not create a diverse ecosystem
  - impact of applied nitrogen for yield improvement (may be better than alternatives)
  - herbicides/pesticides (same argument)

Future Land Rents

- Current grain prices are very low
- Grain is a global commodity and many future events could push grain prices up
  - Population growth
  - Diet changes
  - Buying power
  - Land availability
  - Government subsidies and land use policies
  - Technology limits
- A persistent rise in real grain prices would tend to increase the rent for land producing biomass for energy
- This analysis did not rigorously evaluate biomass cost sensitivity to varying future grain prices, although the models developed have the capability
- This implies a real need to tie biomass production to the CRP program

Embodied Energy

Plantation Biomass

- How renewable is biomass energy?
- Growing, harvesting, transporting ,and processing biomass all require significant fossil fuel inputs
- Energy "embodied" in producing biomass includes direct energy in the form of fuels, fertilizers, and chemicals, and indirect energy in the form of energy required to manufacture and maintain equipment
- The Energy Profit Ratio (EPR) is the ratio of the energy value of the crop divided by the sum of all direct and embodied energy inputs
- Evaluating embodied energy and EPR's was a major goal of this project
- Other researchers have calculated EPR's for biomass energy crops ranging from 10 to 30+ at the field edge

KEURP Renewables R&D

Coriolis/Kansas State/Heritage

Which Energy Crops for Kansas

Plantation Biomass

- Which energy crops promise the lowest cost, highest EPR, and greatest environmental benefits?
- Herbaceous energy crops (HEC)
  - Switchgrass
  - Big bluestem
  - Reed canarygrass
  - Gamagrass
  - Indiangrass
- Short rotation wood crops (SRWC)
  - Black locust
  - Silver maple
  - Sycamore
  - Siberian elm
  - Eastern cottonwood and hybrid poplar

KEURP Renewables R&D

Coriolis/Kansas State/Heritage

Plantation Biomass

Herbaceous Energy Crops (HEC)

- Switchgrass (*Panicum virgatum*)

  Strengths:
  - Record yields of 15 tons per acre in Alabama
  - Yields of 14+ tons per acre on small test plots near Manhattan (Fritz)
  - Extensive field trials by DOE in several locations in U.S.
  - Promising research on switchgrass genetics with potential of further increases in yields
  - An efficient C4 user of water and nitrogen
- Weaknesses:
  - Moderately difficult to establish
  - Requires significant nitrogen fertilizer for high yields
  - Annual (or twice per year) harvest lowers EPR
  - Best if harvested after frost, causing potential for lodging
  - Concern about ash and silica affect on boilers

Plantation Biomass

Short Rotation Woody Crops (SRWC)

- Black locust (*Robinia pseudoaccacia*)

  Strengths:
  - Best overall SRWC performer in extensive field trials (Geyer)
  - Tolerant of a wide range of soils
  - Drought tolerant
  - Significant genetic diversity offers potential
  - Higher density and lower moisture content at harvest
  - Leguminous
  - Coppices well
  - Other potential uses could reduce risk

  Weaknesses:
  - The locust borer
  - Tendency to root sprout
  - Research on improvement curtailed, image competition w/ hybrid poplar

Agricultural Land Management Alternatives with Numerical Assessment Criteria (ALMANAC)

- Developed by the Blacklands Research Center to simulate switchgrass and black locust growth/yields
- ALMANAC uses a daily time step to simulate plant growth based on:
  - weather
  - erosion-sedimentation
  - herbicide/pesticide fate
  - tillage
  - hydrology
  - nutrient cycling
  - soil temperature
  - crop and soil management

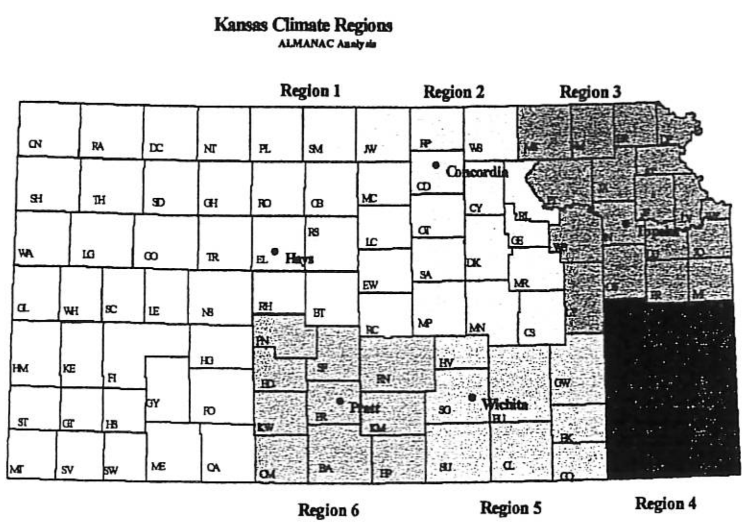
Analysis Strategy

- Select area to be analyzed (24" + precipitation/yr, US Hiway 283) and identify soils and soil series
- Select climate zones (6) and match soils within each climate zone
- Use ALMANAC to simulate energy crop and conventional commodity crop production within each climate zone on each soil series with stress-driven nitrogen application
- Use standard management practices for a 24-year period
- Derive output of yields and environmental variables
- Develop a custom EXCEL Workbook to estimate production cost and embodied energy

Analysis Strategy

- Evaluate switchgrass and black locust cost based on two land access scenarios-
  - Price to provide profit equal to that from most profitable grain
  - Access to CRP land at 40% of CRP payment rate
- Use SSURGO and Landcover in ARCInfo or ARCView to determine production (land area x yield)
- Identify potential biomass power generation sites and determine plant gate and boiler mouth fuel costs
- Summarize quantified environmental impact of bioenergy crops versus conventional grain crops

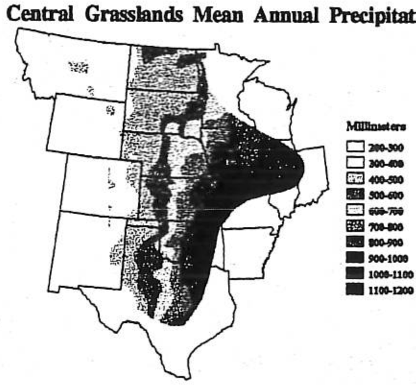
Kansas Climate Regions



Kansas Soils and Precipitation

- SSURGO database obtained in quadrangle files from DASC (KU)
- Climate regions reflect Kansas temperature and rainfall patterns

Central Grasslands Mean Annual Precipitation

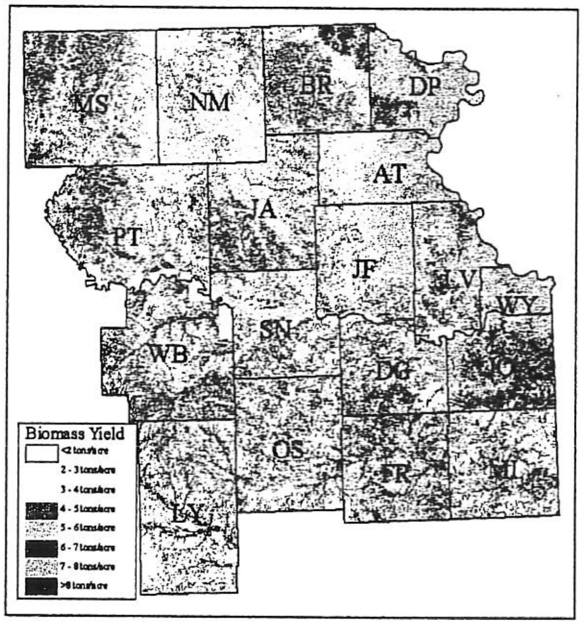


Cost and Availability of Biomass at the Field Edge

- Data presented in tabular and map format
- By county, by soil series
- Divided by land potentially eligible for CRP (EI>8) and all other land
- Cost presented in $/MBtu at the field edge, detailed breakdown available
- Results permit "prospecting" for promising regions
- Results yield some interesting insights:
  - Biomass can not compete with soybeans
  - Lower EI in regions 1 and 2 limit land availability of the CRP scenario

Plantation Biomass

Switchgrass Yield - NE Kansas



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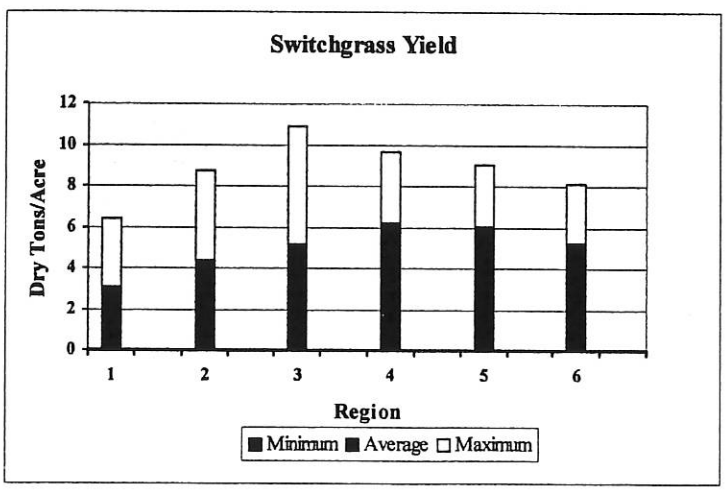
Plantation Biomass

Switchgrass Yields



- Average yields over 24 years range from 1 to 3 dt/acre on low yield sites and 4 to 8 dt/acre on high yield sites

KEURP Renewables R&D

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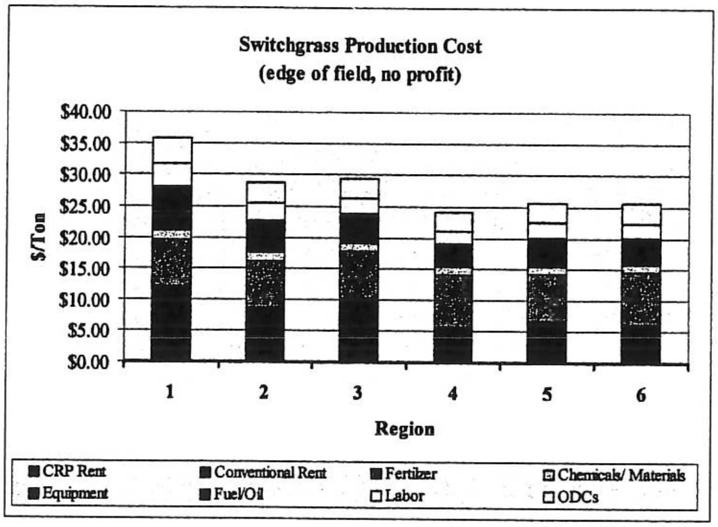
1-18

Plantation Biomass

Switchgrass Production Cost



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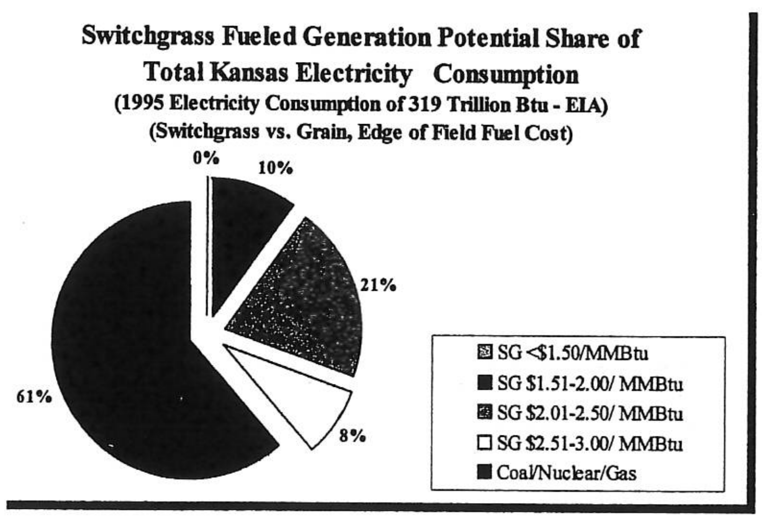
Plantation Biomass

Switchgrass' Potential Share of Kansas's Generating Fuel (vs. Grain)



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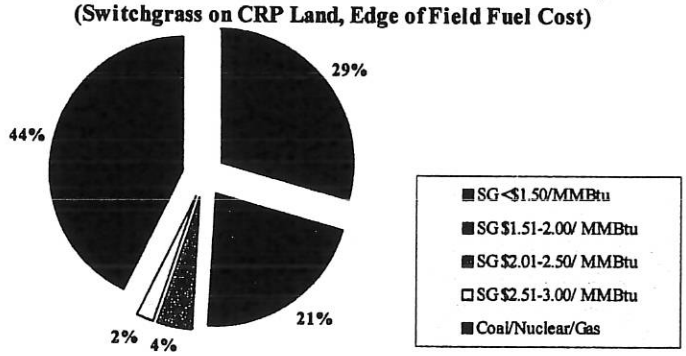
Plantation Biomass

Switchgrass' Potential Share of Kansas Generating Fuel (on CRP land)

Switchgrass Fueled Generation Potential Share of Total Kansas Electricity Consumption
(1995 Electricity Consumption of 319 Trillion Btu-EIA)
(Switchgrass on CRP Land, Edge of Field Fuel Cost)



Plantation Biomass

Identifying Most Promising Regions and Plant Sites

- Identify regions with concentrations of lowest cost biomass
- Identify case study plant for co-firing
- Estimate biomass volume at acceptable price increment(s) within acceptable haul distance

KEURP Renewables R&D

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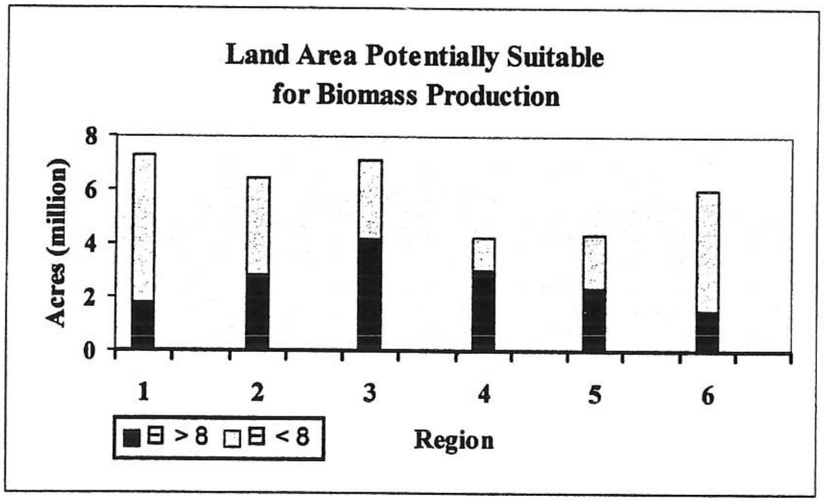
Plantation Biomass

Land Potentially Suitable for Biomass



KEURP Renewables R&D

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Plantation Biomass

Co-firing at Jeffrey Energy Center

Table 2.11.1 Jeffrey Switchgrass Source and Cost for 2% and 5% Co-firing (CRP Land)

58,730 tons required for 2% cofire, 146,788 for 5% cofire (as determined by BIOPOWER)

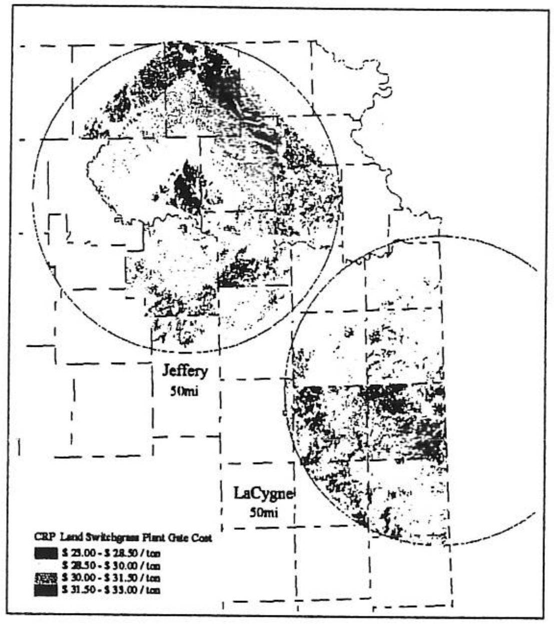
County	Soil Series	Acres (total in Co.)	Yield (average dry tons/acre)	Harvested Production (dry tons, 50% of land)	Biomass Cost (edge of field $/d.t.)	Average Transport Cost ($/d.t.)	Plant Gate Cost ($/d.t.)	Ton Miles
2% Co-fire								
Shawnee	Dwight	2,138	5.09	5,4441	$21.05	$6.75	$27.79	149,397
Pottawatomie	Pawnee	8,920	5.57	24,855	$23.36	$4.68	$28.03	168,168
Wabaunsee	Florence	29	4.27	62	$22.49	$5.62	$28.11	1,001
Jackson	Pawnee	3,689	5.57	10,279	$23.36	$4.84	$28.19	86,019
Jackson	Burchard	15	5.60	41	$23.54	$4.77	$28.31	314
Wabaunsee	Pawnee	327	5.57	911	$23.36	$5.09	$28.45	9,930
Shawnee	Pawnee	359	5.57	1,001	$23.36	$5.10	$28.46	11,034
Wabaunsee	Pawnee	12,170	5.57	16,141	$23.36	$5.60	$28.96	258,049
Total/Average Ton				**58,730**	**$23.14**	**$5.16**	**$28.31**	**683,912**
Average per MMBtu					**$1.46**	**$0.33**	**$1.79**	**0.74**
5% Co-fire (add to above)								
Wabaunsee	Pawnee	12,170	5.57	17,770	$23.36	$5.60	$28.96	284,092
Pottawatomie	Martin	1,138	6.29	3,579	$24.14	$4.98	$29.12	35,044
Shawnee	Dwight	150	5.09	4,254	$21.05	$8.11	$29.15	174,629
Pottawatomie	Pawnee	1,256	5.57	62,455	$23.36	$5.98	$29.33	1,233,670
Total/Average Ton				**146,788**	**$23.22**	**$5.64**	**$28.87**	**2,558,095**
Average per MMBtu					**$1.47**	**$0.36**	**$1.82**	**1.10**

KEURP Renewables R&D

Coriolis/Kansas State/Heritage

Plantation Biomass

Lowest Cost Switchgrass on CRP Land Near Jeffrey and LaCygne Generating Plants



Plantation Biomass

Co-firing Biomass May Be the Lowest Cost Renewable Electricity Option in Kansas

For the best case scenarios using switchgrass as a co-fire material in Kansas, a green pricing program may need to raise $0.01 to $0.015 for each kWh of switchgrass-fired electricity in order to compete with coal.

Current Biomass Research (KCC)

1) Reducing the Cost of Biomass Energy by Monetizing Environmental Benefits, 2) Higher value markets

- **Quantifying the environmental benefits of planting switchgrass buffer strips in Marion and Perry Reservoir Basins**
  - Reduced reservoir sediment loading yielding better surface and subsurface water quality and reduced loss of storage capacity
  - Reduced nutrient and pesticide loading to the reservoir
  - Sustainability of the soil base in these watersheds
  - Improved wildlife habitat
  - Economic comparison versus current cropping practices
- **Identify higher value markets for biomass**
  - Residential space and water heating

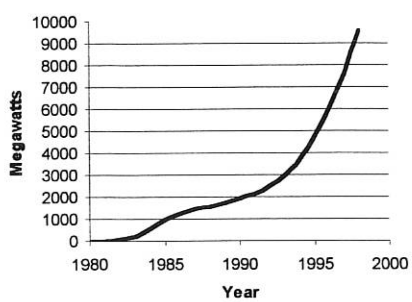
Future Biomass Research (KCC)

- **The Research Team is working with the KCC, Dept's of Agriculture, Health &Environment, Wildlife and Parks, Water Office, State Conservation with the following goals:**
  - Identify specific sites in the Perry Basin that would offer the greatest environmental benefit if planted to switchgrass, with projected yields of 5 tons/acre or greater
  - Work with county agencies and individual farmers to encourage enrollment in CRP buffer strip program with potential for energy harvest
  - Work with state and federal agriculture and energy policy decision makers to make them aware of impact of continuing federal plantation biomass tax credit and allowing use of CRP enrolled land for biomass production
  - Conduct co-firing test burns at Western Resources Jeffrey Energy Center
  - Continued investigation of potential for other biomass energy markets, including residential space and water heating and ethanol production

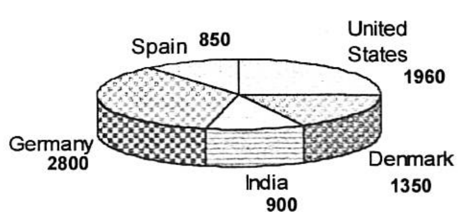
KEURP Wind Energy Project

Presentation by:
Pinnacle Technology, Inc.
Lawrence, Kansas 66044
(785) 832-8866
donnaj@pinnaclet.com

Wind Energy is Exploding Worldwide



1998 Wind Generating Capacity (MW)



These 5 countries represent 82% of the world wind power market

For comparison, Western has a generation capacity of 5300 MW

1-24

US Wind Potential (from AWEA)

Rank	State	Billions of kWh	Jobs # Potential	Wind Impact Potential (Billion $ Revenue)
1	North Dakota	1,210	363,000	30.2
2	Texas	1,190	357,000	29.8
3	Kansas	1,070	321,000	26.8
4	South Dakota	1,030	309,000	25.8
5	Montana	1,020	306,000	25.5
6	Nebraska	868	260,000	21.7
7	Wyoming	747	224,000	18.7
8	Oklahoma	725	217,000	18.1
9	Minnesota	657	197,000	16.4
10	Iowa	551	165,000	13.8
11	Colorado	481	144,000	12.0
12	New Mexico	435	130,000	10.9
13	Idaho	73	21,000	1.8
14	Michigan	65	19,000	1.6
15	New York	62	18,000	1.6
17	**California**	**59***		

Where 90% of the US wind farms are located

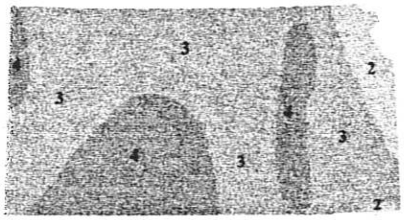
US Wind Power by State (Megawatts - August 1998)

California	1615
Minnesota	133
Texas	43
Hawaii	10.8
Vermont	6.1
Iowa	2.2
Wyoming	1.2
Wisconsin	1.2
Michigan	0.6
Massachusetts	0.6
Alaska	0.2

KEURP's Work To Date

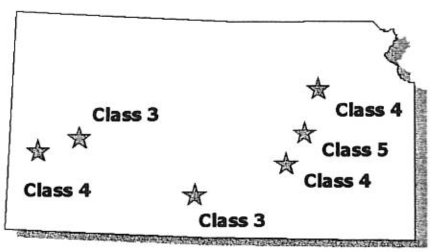
- Site Selection - 6 Sites Chosen
- Data Collection - 2 Years
- Wind Data Education Project
- Data Assessment
- Vendor's Conference
- Data Analysis and Modeling
- Green Marketing Study
- Wind Demonstration Business Plan
- Micrositing

1987 Baseline Wind Map

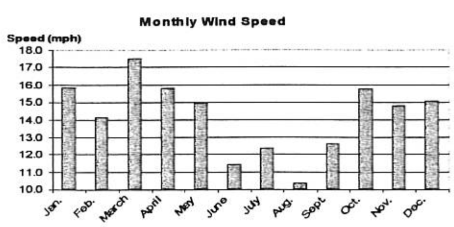


One 750 kW turbine will power:	**Class 3**	**170 Homes**
	Class 4	**225 Homes**
	Class 5	**270 Homes**

Site Selection - *6 Sites Monitored*



Average Monthly Wind Speed



Note: A 2.5 mph wind speed increase approximately doubles the power output

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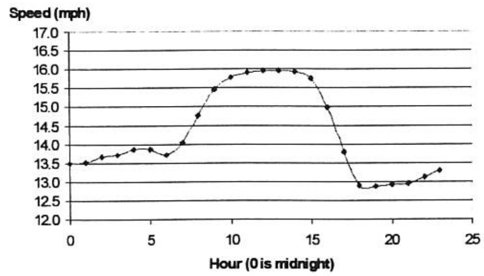
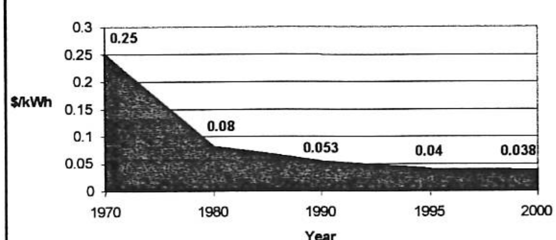
Annual Hourly Wind Speed



Current Turbine Design

- 2 or 3 Blades
- Blade tip to blade tip is the size of half a football field
- 175 - 200' tall
- Reliability is high
- High tech composite materials and electronic controls
- Designed to use about 30% of the available wind energy at a cost of about $800 per rated kW

Cost of Wind Energy



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Why Doesn't Kansas Have Wind Energy?

- Low cost of electricity in Kansas
- Wind is intermittent - needs to be used with other sources of power (can be used for 30% of a regions power)
- Concern about Kansas weather - strong gusty winds, lightening, icing, hail
- State laws and policies are not as favorable as other states
- Public sentiment strongly supports wind energy but this has not translated to community activism

Kansas Survey - energy issues

Issue of energy to Kansans is compelling in its insignificance .... Bob Glass, KU

- as a whole we do not know that much about energy, electricity, or the industry
- Kansans take their utility service for granted - it is good and it is always there
- Inaccurately feel wind and solar energy is cheaper then coal produced energy (by 75 and 72 percent respectively)
- Reluctant to trust the utility companies

Kansas survey - green pricing

- Have learned a lot over these past four years -
- initially 59 percent of all surveyed willing to pay
- not realistic - intuitively and from practical experience
- any Kansas effort will require significant up front investment in education and marketing
- Set of research criteria resulted in, given a specific and visible wind turbine project, well marketed and with a strong education component between 8 and 15 percent of Kansans would participate at $10/month
- *statewide $1.4 million to $17 million year*

Photovoltaic Research

- Remains an expensive technology
- Fairly standard off-the-shelf technologies
- Remote site applications most feasible
- KEURP:
  - Workshop for utility professionals
  - software critique and evaluation
  - ***Very excited about the Milford wetland PV demonstration project - using PV to pump water to flood wetlands***

Renewable Energy presentation

January 29, 1999

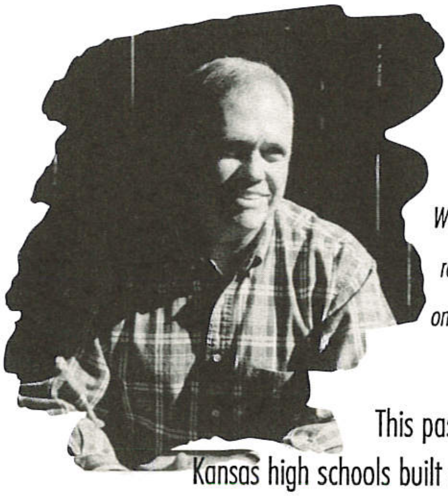
... according to the most enthusiastic estimates, wind energy could supply 20 percent of the nation's electricity in 18 years ...

Science Digest

From the Executive Director

KEURP

October, 1997



Welcome to the first "Letter from the Executive Director". In an effort to promote the activities and research of the Kansas Electric Utilities Research Program (KEURP), similar letters will be prepared on a periodic basis that highlight completed projects. I hope you find them interesting and informative.

This past winter, in classes ranging from physics to automobile technology, student teams at eleven Kansas high schools built electric cars under rules and guidelines established by Electrathon America. With design information and under the tutelage and professional expertise of Jeff Simpson, SunLectric Company (*under contract with the Kansas Electric Utilities Research Program*) student teams were recruited–they each raised funds necessary for the car material, designed, and built the vehicles.

The cars as described by Electrathon America are "single person, lightweight, aerodynamic, high efficiency, electric vehicles with three or four wheels of at least 16 inch diameter, the cars are powered by deep cycle lead acid battery packs not exceeding 64 pounds." Other than a few guidelines, student teams are allowed the flexibility to design their own vehicle.

Of the eleven schools involved in the project, nine raced in Manhattan on Tuesday, June 24. The race track was a quarter mile oval and the object of the event was to complete as many laps as possible in a one hour time frame.

Kansas ElectroRally – Race Results:

High School	*Total Laps Completed*
Paola	98 (*just under 25 miles pr. hour*)
Bonner Springs	85
Galena	75
Trego	75
Medicine Lodge	53
Riverton	49
Ulyssess	43
NE Magnet – Wichita	37
Pretty Prairie	19

* *Leavenworth and Olathe South built cars but did not feel they were race ready.*

Trophies were presented to the 1st, 2nd, and 3rd place finishes. Each competitor and their coach received a participant's medallion. An award was given to the car identified by the judges and inspectors as best designed (Trego High School). Volunteers and judges also gave the school spirit award to Pretty Prairie.

The mix of high schools participating represented both urban and rural areas. Every attempt was made to recruit two high schools from each KEURP member's service territory. The breadth of involvement included both boys and girls, athletes, theater participants, and scholars – it is an event in which any student willing to invest the time and effort can participate. One footnote to the high school teams that competed was the involvement of an all-girl team from Pretty Prairie (*there were no boys in the school's physics class*).

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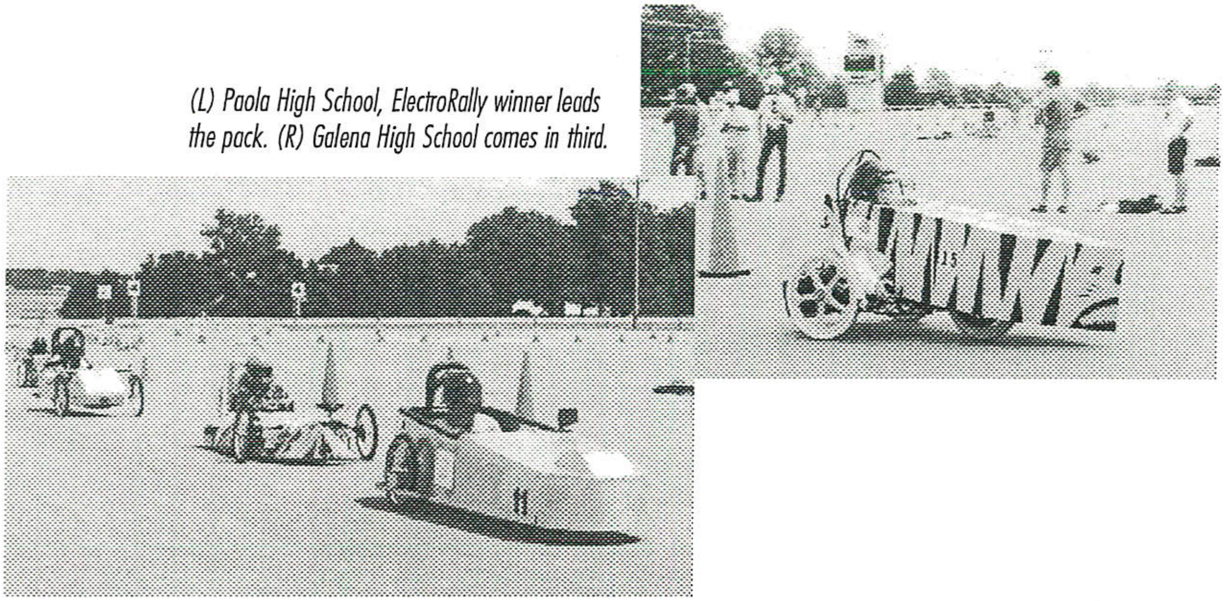
(L) Paola High School, ElectroRally winner leads the pack. (R) Galena High School comes in third.



For KEURP members, a partial list of accomplishments identified from the race include:

- Hands-on experience for students, teachers, parents, and volunteers with electric transportation technology;
- Opportunity (at practically all schools) for participants to work side-by-side and interact with electric utility professionals;
- Teachers can incorporate the knowledge from the experience into future classroom activity so that technology transfer from the event is continuous;
- The high school student teams represent the consumers and decision-makers of the future, they have been exposed to electric technologies, have the understanding that electric vehicles are becoming viable transportation options, and have shared a very positive experience with their Kansas utility companies.

Mission: KEURP is a cooperative venture performing applied research to proactively seed and deliver technologies enhancing the value of electric services to its members, utility customers, and the State of Kansas.

For additional information call 785-354-1821 or visit the KEURP website at: www.keurp.ittc.ukans.edu/keurp2/index.html

Topping off a successful race day was Don Rathbone, Dean of Kansas State University's Engineering College, announcing his intention to start a scholarship program in conjunction with the race. I cannot begin to list the teaching professionals, parents, and utility people that helped the teams at the local level – but, from KEURP's perspective thanks go to; Mike Faler and Mike Crawford, Western Resources, Inc.; Manhattan Mayor Bruce Snead; Dr. Andrea Hall, Midwest Research Institute; John Reinhart, race announcer; and Beverly Radfield, Dodge-Carroll Electronics. Teresa and Matt Songs, and Nancy and Clare Lonergan deserve thanks for the smooth pre-race registration process and directing lap counting and tabulation.

Be sure and mark down April 24, 1998 on your calendar for the Second Kansas ElectroRally to be held in Great Bend at the 31 Show. See you then!

Jerry Lonergan

The Kansas Electric Utilities Program (KEURP) current membership is: KGE, A Western Resources Company; KPL, A Western Resources Company; Kansas City Power and Light Company; Midwest Energy, Inc.; Sunflower Electric Power Corporation; The Empire District Electric Company; and WestPlains Energy.

Kansas ElectroRally - 1999: *School Participants, January 1999*

Advance Class (schools with previous race experience)

- Bonner Springs HS
- Clearwater HS
- Columbus HS
- Ellsworth HS
- Emporia HS
- Galena HS
- Great Bend HS
- Hanston HS
- Hays HS
- Hoisington HS
- Medicine Lodge HS
- Olathe North HS
- Paola HS
- Riverton HS
- Scott Community HS
- Sterling HS
- Ulysses HS
- Wichita Northeast Magnet

Novice Class (first year to race)

- Blue Horizon HS (Garden City)
- Campus HS (Haysville)
- Colby HS
- Concordia HS
- Deerfield HS
- Hutchinson - Cosmosphere Academy
- Leavenworth HS
- Lenora HS
- Mulvane HS
- Olathe East HS
- Topeka HS
- Shawnee Height HS
- Wheatland HS (Grainfield)
- Wichita North HS
- Wichita South HS

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Kansas Wind Program

KGE, A Western Resources Co.; KPL, A Western Resources Co.; Kansas City Power & Light Co.; Midwest Energy, Inc.; Sunflower Electric Power Corporation; The Empire District Electric Co.; and WestPlains Energy

KANSAS ELECTRIC UTILITIES RESEARCH PROGRAM

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The results of the KEURP two-year wind data collection project presented in this report are the product of a most rewarding process that involved the cooperation and dedicated effort of professionals at electric utility companies, universities, private businesses, and federal and state governments. The work is an excellent example of how partnerships enhance the quality of research designed to reduce risks associated with adopting new technologies. Many organizations are to be thanked, including the KEURP member utilities; Regents University participants - Emporia State University, Fort Hays State University, Kansas State University, Pittsburg State University, University of Kansas and Wichita State University; the Kansas Corporation Commission, advisor to KEURP; AWS Scientific, Albany, New York; Coriolis, Lawrence; Electric Power Research Institute, Palo Alto, California; Heritage Technologies, Overland Park; Jones Seel Huyett, Topeka; Kearney Law Office, Topeka; MarketAide Services, Salina; National Renewable Energy Laboratory, Golden, Colorado; Pinnacle Technology, Lawrence, and the Utility Wind Interest Group, Arlington, Virginia. A special thank you to KEURP ***Renewable Energy Task Force*** *members Tom Bozeman, Bob Egbert, Mike Engel, Bob Fackler, Bob Glass, Alex Hapka, Tom Hestermann, Larry Holloway, Richard Nelson, Frank Potter, Don Reinert, Rod Sobieski, Bill Studyvin and Paul York, for their continued support of the KEURP renewable energy initiative.*

*KEURP was selected in a national competition to receive funding support for the wind data collection project through the U.S. Department of Energy's Utility*Wind Resource Assessment Program (U*WRAP). A significant share of KEURP's expenses were covered thanks to DOE. If not for these funds (administered by the Utility Wind Interest Group), the scope and quality of data collection would have been quite smaller. U*WRAP was, and hopefully will continue to be, an important contribution to wind generation development in this country.*

Jerry Lonergan
Executive Director, KEURP
August 1998

Zond Z-750 kW Turbines in Lake Benton, MN

INSIDE THIS REPORT

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Wind Energy in Kansas

Wind is an abundant renewable energy resource with excellent potential for electricity generation. The term "renewable energy" refers to any source of energy, such as wind, solar, or biomass, that will not be depleted in any reasonable time frame. By convention, renewable energy sources are also environmentally friendly.

KEURP is a cooperative venture funded by Kansas electric utility companies. The organization's mission is to seek and deliver technologies that enhance the value of electricity services to its members, utility customers, and the state of Kansas. In 1994, KEURP created a renewable energy research and development plan that recommended the creation of a program to assess the potential of wind energy in the state.

In 1996, KEURP, in partnership with the UtilityWind Interest Group (UWIG), established wind data assessment sites at six promising locations in the state (see Figure below for general locations). Over the course of two years, beginning in June 1996, hourly wind speed, direction, shear (change of wind speed with height above the ground) and turbulence were monitored. The six sites were the highest ranked among 25 good potential wind farm sites selected by Coriolis and Heritage Technologies under a KEURP contract. Teams from Kansas State University and Wichita State University analyzed the data collected during the course of this project. Pinnacle Technology, Inc. developed estimates of the total electrical generating capacity at each of these sites, economic models and a business case analysis for turbine demonstrations.

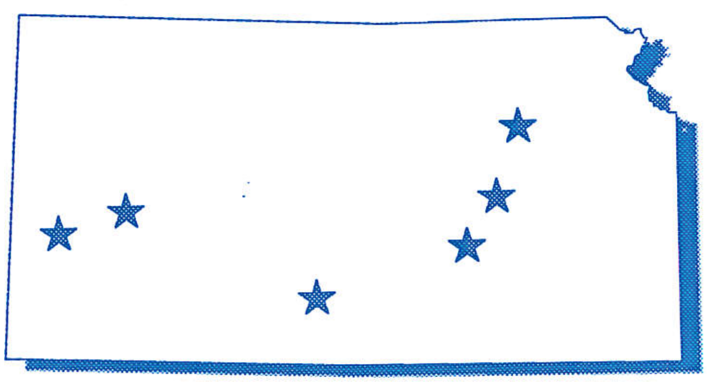

Figure 1. Wind data collection sites in Kansas

This report summarizes the data collected at a height of 10 meters (30 feet) over the last 2 years. It also provides the reader with general facts about wind energy development in the United States and the rest of the world.

Wind as a Fuel

Wind has been used for centuries as a source of energy. For hundreds of years, all water transportation used wind for fuel as sailing ships navigated the oceans. Wind power has been used to pump water for livestock and homes, grind grain, and in later years, provide electricity for homeowners. In the past 10 years, new wind turbine designs have dramatically increased the efficiency with which electricity can be harvested from the wind. Nationally, the research focus in this last decade has been on developing turbine technologies for large utility scale wind generation rather than small residential applications.

There are many wind characteristics that directly impact wind turbine performance. The uniqueness of the wind at each site indicates the need to measure wind speeds and profile local wind characteristics, over multiple years. Examples of specific wind issues include:

- Wind energy increases dramatically with wind speed. The energy available in a 13 mph wind is more than double the energy available in a 10 mph wind.
- Wind speed generally increases with height above the ground. Therefore, modern, large wind turbines are over 170 feet tall compared with old windmills, which were 20 - 30 feet tall.
- There are tremendous daily, seasonal and yearly

(Continued on page 3)

Flowind Turbines in Altamont Pass, California
From NREL PIX - Photo by Warren Gretz

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Energy From The Wind

Before electricity was available in rural areas, simple windmills like this were extensively used to pump water. From NREL PIX - Photo by the United States Department of

Wind as a Fuel

(Continued from page 2)

changes in the amount of wind energy available at a specific location.

- There can be large differences in available wind energy over a small area.

Besides the wind resource, utilities have to deal with numerous issues related to: access to the site, environmental and avian concerns, ground conditions, and access to existing transmission lines. The higher costs associated with current renewable technologies represent another challenge facing companies considering wind projects.

These issues impact wind turbine selection. To ensure economical operation, longevity, high efficiency, low maintenance, and seamless integration of power into the Kansas electric grid, a thorough understanding of all of these issues at each site is critically important.

In the late 1800's, when electric power was first being introduced, the high cost of rural electric transmission lines directed much effort into the design of windmills capable of producing electric power. In 1888, Charles F. Brush in Cleveland, Ohio designed the first electricity-generating windmill in the U.S. By the turn of the century, U.S. windmill production was in its prime. In 1900, half the market for windmills was supplied by the Aermotor Company in Chicago, which claimed to have 800,000 mills in service in the U.S. More than half had been in operation for 40 years or more. In a time when electricity was not available in rural areas, windmills were ideal for pumping water, and producing small amounts of electricity. The depression years had a twofold impact on the development of windmills: hard economic times caused a severe drop-off in sales of new windmills, and transmission lines for the distribution of electric power were extended in even the most rural areas, making rural electric use practical.

With the development of extensive transmission line networks and a seemingly endless supply of cheap electricity from hydroelectric and fossil fuel burning power plants, the development of wind resources effectively came to a halt. However, the outlook for wind energy is changing. Wind is one of the most abundant and economical renewable resources. For areas with strong, consistent winds, technological advances in wind turbine design and rising fossil fuel costs promise to make wind a viable electrical generating alternative in the U.S. within ten years.

Modern wind turbines bear little resemblance to the windmills, which still dot the landscape in rural areas (see photo on left). With a few notable exceptions such as the 1941 1.25 MW Smith Putnam wind turbine operated near Rutland, Vermont, the majority of wind turbines built before 1970 were small units designed for water pumping and battery charging. Although a broad, small-windmill market still exists, modern strong, lightweight materials have allowed development of very large, 300 kW to 1.5 MW, reliable wind turbines, which, with a good wind resource, can generate and deliver power directly to the electric grid.

Wind turbines today come in two basic forms: horizontal axis wind turbines, such as the Buffalo Ridge, turbines shown on the front page of this newsletter, and vertical axis wind turbines, also called Darrieus turbines after their French inventor, G.M. Darrieus, and sometimes "eggbeaters" for their unique shape. For a variety of reasons, most large wind turbines in production today are three bladed horizontal axis units.

Modern, reliable (available 98% of the time) wind turbines are designed to use about 30% of the available wind energy at a cost of $800-$1000 per rated kW. Theoretically, the total wind energy available in the United States is about 30 times the annual U.S. energy consumption. It is only practical to use a small part of this energy resource, but the potential is still enormous.

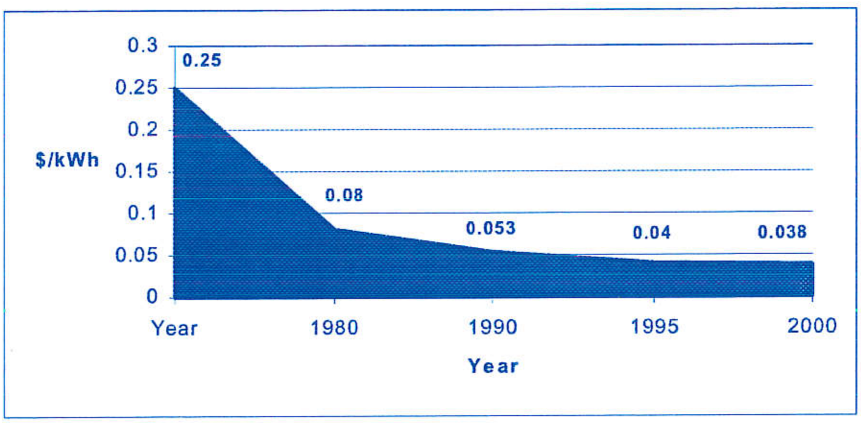
Worldwide wind power generation exceeded 4900 megawatts in 1995, with a majority of recent turbine sales going to Europe. Wind power can currently be produced for about $.05 - $.06 cents per kilowatt hour (kWh) and prices are expected to fall into the 4 cents per kWh range by

(Continued on page 4)

(Continued from page 3)
the end of the decade. The Department of Energy (DOE) is supporting new developments in wind turbine technology. The DOE's goal is to have electricity for $.025 cents per kWh in 15 mph winds by the year 2000.

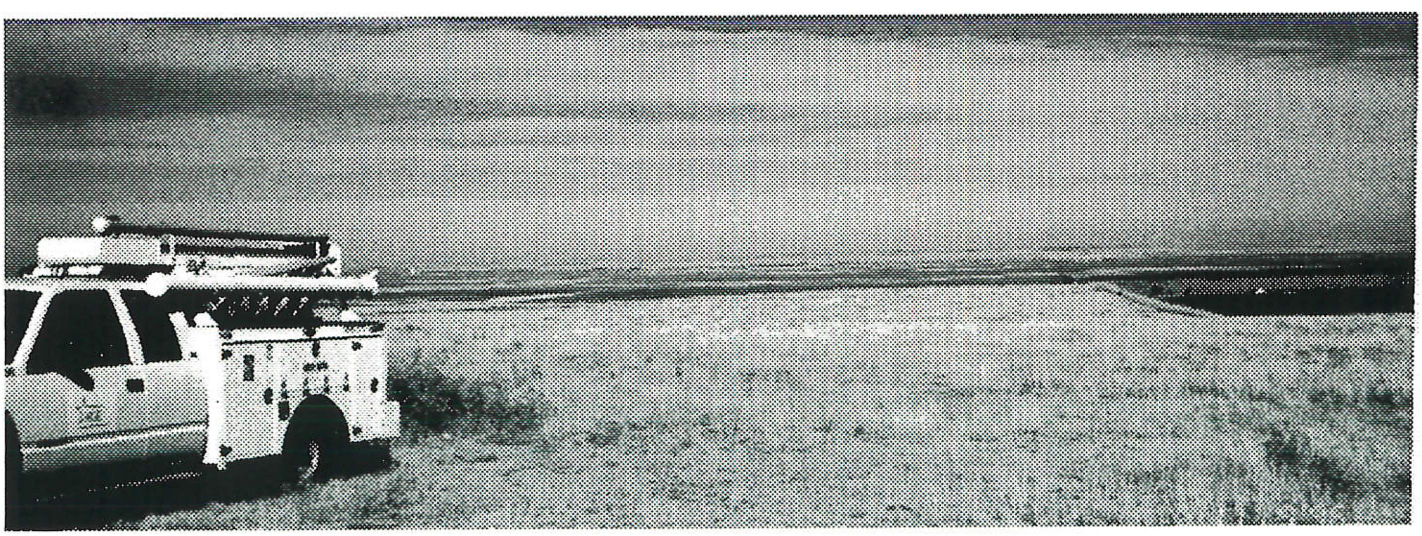
The cost of wind power varies from site to site depending upon several factors including average wind speed, variable weather conditions, transmission line costs, and maintenance costs. Extreme winds, lightning and icing are three specific weather related factors that impact wind turbine selection and cost in Kansas. Transmission lines add to the overall cost per kWh to generate electricity from wind power, but similar costs are inherent to all power plants. Fossil fuel fired and nuclear plants have the advantage of reliability and consistency. Although the wind "fuel" is free, winds suitable for power production may not be available when the power is needed most. Overall, the average price for electricity produced by coal in the United States is $.04 per kWh – the average price for electricity produced by wind power is approximately $.05/$.06 per kWh.

Cost Reduction of Wind Energy with Time
(from Swezey and Wan, "The True Cost of Renewables", NREL 1995)



Wind History

- 950 AD - Eastern Persia - First recorded description of a windmill used to pump water and drive mills.
- 1100 - 1200 AD Efficient horizontal axis windmills are developed in Europe.
- 1300-1400 AD Tower-mills with the windmill free to rotate at the top of the tower are developed in the Netherlands.
- 1854 Invention of the American "Halliday Standard" self-governing windmill used widely in the U.S. to pump water.
- 1888 The Brush windmill built in Cleveland, Ohio is the first windmill designed to generate electricity.
- 1941 - The world's first megawatt scale wind turbine, the Smith-Putnam wind turbine, begins operation.



Broad expanses of Kansas land are very suitable for wind energy development.

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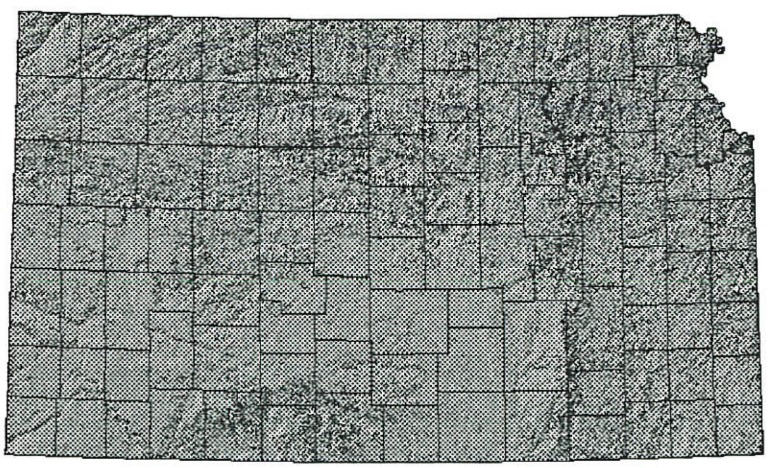
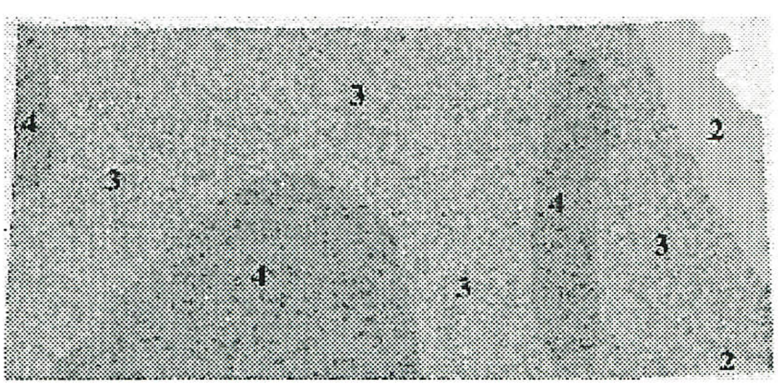
Overview of the Kansas Wind Energy Program

Over the past 20 years the assessment of wind energy resources in the United States was accomplished primarily using existing meteorological data obtained from National Weather Service stations. Prior to the Kansas Wind Assessment conducted by KEURP, a DOE published report contained results of analyses of data collected from over 3000 sites, primarily airports, across the United States. The DOE report included wind resource maps listing average wind speeds categorized by class, from Class 1 (very little wind) to Class 7 (extremely strong winds). In terms of wind power, any area having a wind classification of Class 4 or higher is potentially suitable for energy production. The map for Kansas (bottom left of page) shows the various areas of the state and their approximate wind classes. Land sites for all states are classified based on average wind speeds. More detailed information containing site-specific wind speeds and wind direction needed to be collected prior to making any decision to install wind turbies in Kansas.

In 1995, the electric utilities that comprise the membership of KEURP initiated an investigation into the Kansas wind potential for generating electricity. According to the American Wind Energy Association, Kansas has the third highest wind energy potential in the nation, following North Dakota and Texas.



Kansas topographic map. Map was prepared by the Kansas Geological Survey and can be found at www.gisdasc.kgs.uknas.edu/kanview/slope/ks_slope.html



Baseline map of Kansas wind resouces by class. From Wind Energy Resource Atlas of the United States. 1987. Pacific Northwest Laboratory, Washington. DOE/CH10094-4. (e.g. 4 = Class 4)

Kansas has broad expanses of open plains and high ridges. The high ground coupled with a lack of trees, urban areas, or large individual buildings serves as an excellent source for relatively straight, high-speed winds. To the left is a topographical map of Kansas. Ridges and higher elevations are dark on the map. Locating elevated areas was a very basic starting point for determining high wind sites. The Coriolis-Heritage Technologies team ranked 25 high wind sites in Kansas, which met selected criteria for eventual wind farm development. That report was presented to the KEURP Renewable Energy Task Force in late 1995.

To obtain the long term monitoring data required, KEURP applied to the Utility Wind Interest Group for funding in a national competition in which DOE funds would be awarded to selected utilities for wind resource assessments. Through this program, KEURP successfully obtained the financing required to install a wind data collection tower at six of the highest ranked sites in the state and analyze the data for a period of 2 years. KEURP matched DOE funds at $1.50 for every $1.00 from DOE.

After negotiations were completed and leases signed, crews with Western Resources, Inc. (later maintained by a Western subsidiary Westar Business Services, Inc.) installed the 40 meter (130 feet) tilt-up towers at each location. Costs were greatly reduced by using tilt-up towers (see photo on next page) which are supported only by guy wires, do not require a concrete foundation, and can be easily lowered for maintenance and repair.

Six anemometers were mounted on each 40 meter tower to take hourly measurements of wind speed. Wind direction, temperature and solar radiation, were also measured. Two anemometers were installed at 10 meters (33 ft), two at 25 meters (82 feet) and two at 40 meters (130 feet). Data were collected for a two-year period. Additional equipment installed on each tower included a data logger to record the data and a solar powered telephone system programmed to call and send data to a computer at a local collection point. Kansas State University and Wichita State University collected and analyzed the data and provide a quarterly summary to KEURP and AWS Scientific.

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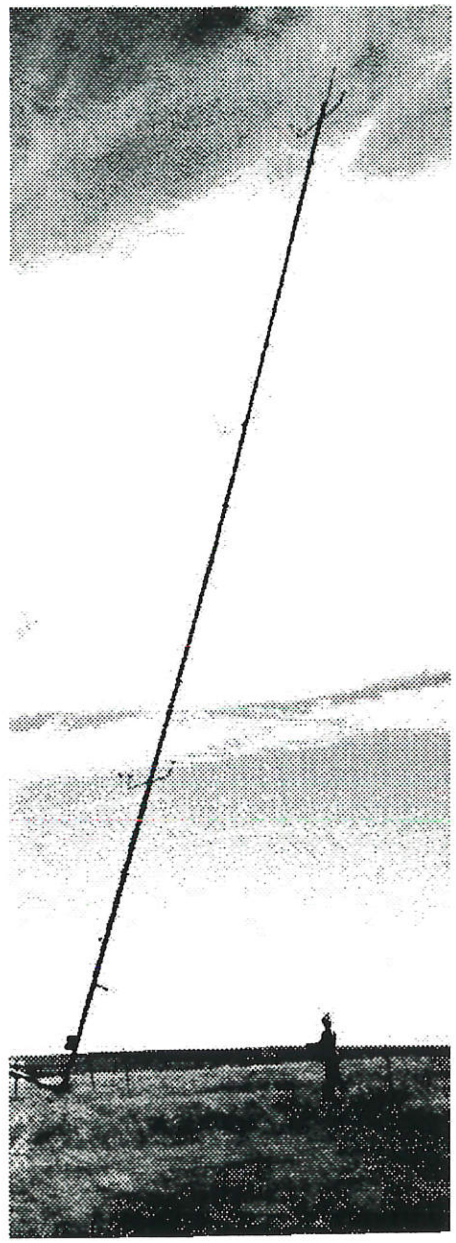
10 Meter Data Overview

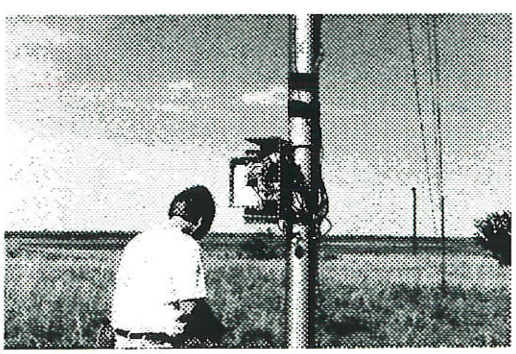


The remainder of this report summarizes the data collected at 10 meters (33 ft.) from each of the six Kansas sites monitored by KEURP. The top of each page shows the wind classification and the average annual wind speed for each site, along with the wind power (based on air density and wind speed). Two of the six sites are categorized as Class 3, three sites are Class 4 and one site is Class 5. Prior to this study, which used modern methods and 40 meter towers, the highest ranked site in Kansas was a Class 4 site. It is important to note that wind speed increases with height; however, all data reported are those at 10 meters. KEURP is permitted to keep the higher elevation site data confidential for three years. It has chosen to do so, to allow members to retain strategic knowledge while deciding to install turbines. Detailed below is the anticipated power output from installation of a single large wind turbine with 30% efficiency installed at a height of 50 meters:

- Class 3 site would produce 1,600,000 kWh per year of electricity – enough to power 170 average homes
- Class 4 site would produce 2,100,000 kWh per year of electricity – enough to power 225 average homes
- Class 5 site would produce 2,5000,000 kWh per year of electricity – enough to power 270 average homes

There are five summary figures on each page. The top left figure is a map indicating the location of the selected site. The top right figure is a graph showing the average hourly wind speeds over the course of the day. In general, the wind is calm in early morning and picks up speed over the course of the day. The left middle figure is a wind rose, which shows the yearly percentage of time that the wind blew from a particular direction. The meaning of the name Kansas is "land of the South wind," and that is often the predominant wind direction. The right middle graph is the monthly average wind speed. In general, Kansas has stronger winds in the spring and fall, and lighter winds in the summer.

The final graph is the overall distribution of wind speeds at the site. The graph shows the percentage of time the wind blew at each speed. One important reference number to describe the curve is the Weibull coefficient. The reference average for wind is typically 2.3 and anything higher indicates more consistent wind speeds. Wind distribution is very important since the power available increases exponentially with wind speed; therefore, a wind speed increase from 12 mph to 13 mph increases the amount of electricity produced by the turbines by approximately 25%. Every mile per hour difference in average wind speed is crucial to the ultimate cost of electricity derived from wind.



The figures on this page show the installation of the cell phone and data acquistion system (left) and tilt-up, wind assesment towers (right) used in this study.

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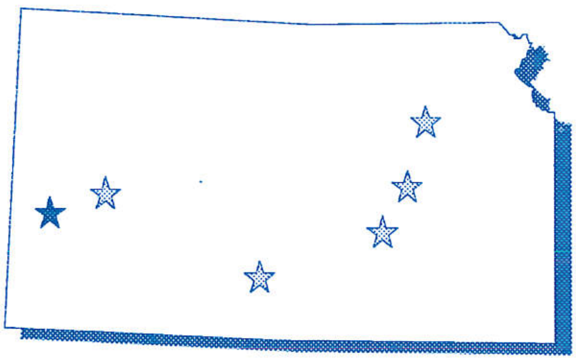
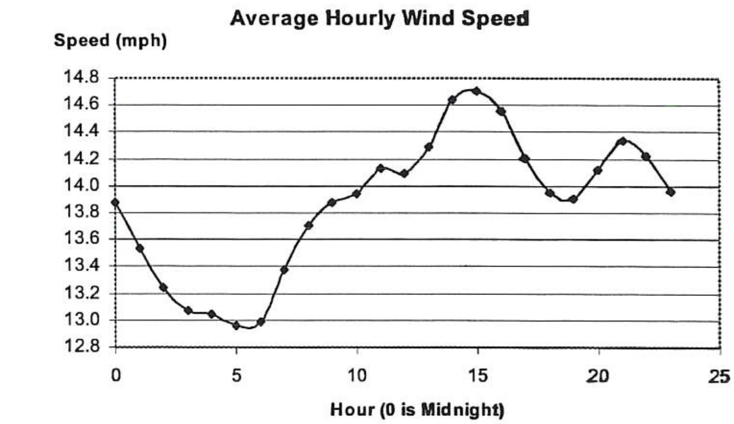
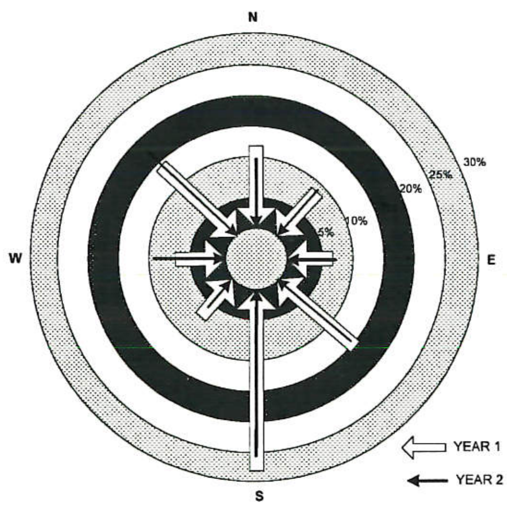
Southern High Plains Site 1

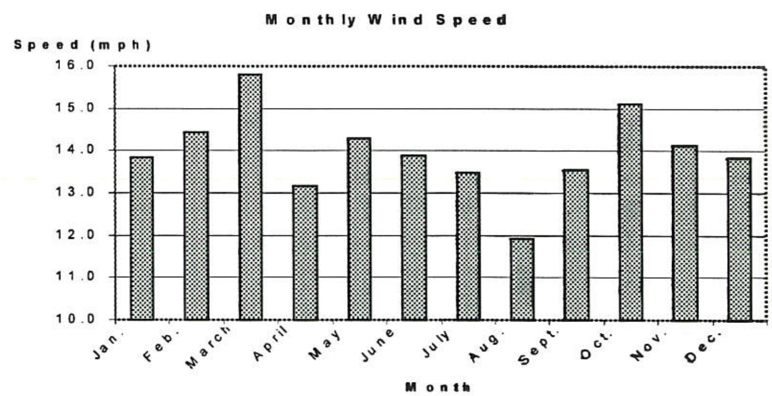
Class 4 Site (July 96 - December 97)
Average = 13.9 mph Power Density = 218 W/m^2

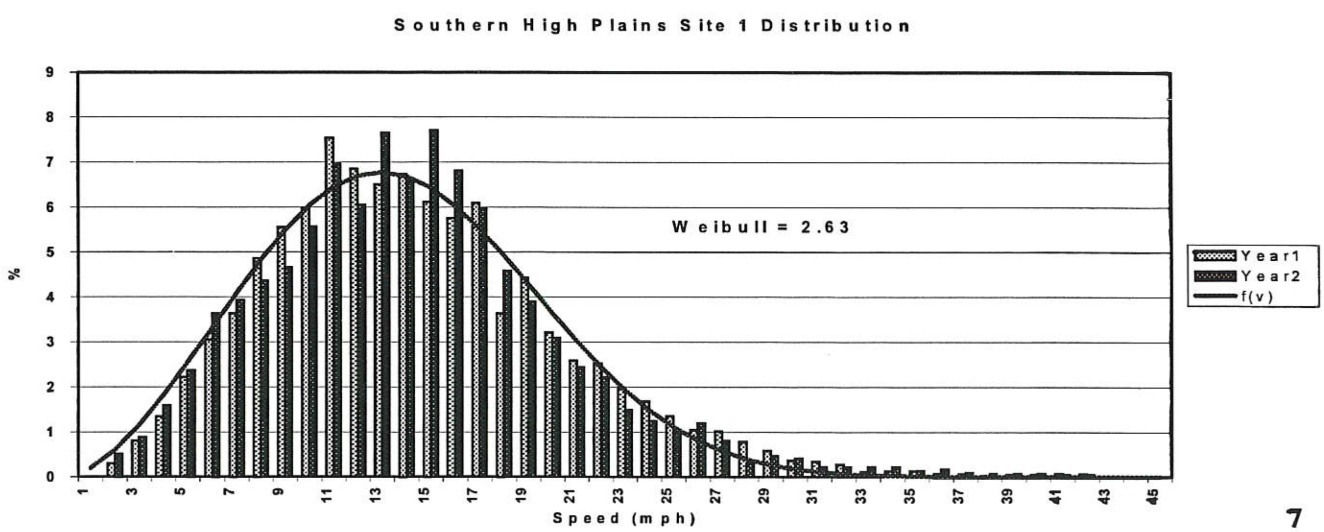
Summary The highest average month at this site was March with an average wind speed of 15.8 mph. The lowest was 11.9 mph during August. Hourly average wind speeds as high as 45 mph were recorded. Overall, 15 percent of the time the hourly average was over 20 mph and 28 percent of the time the hourly average was under 10 mph.











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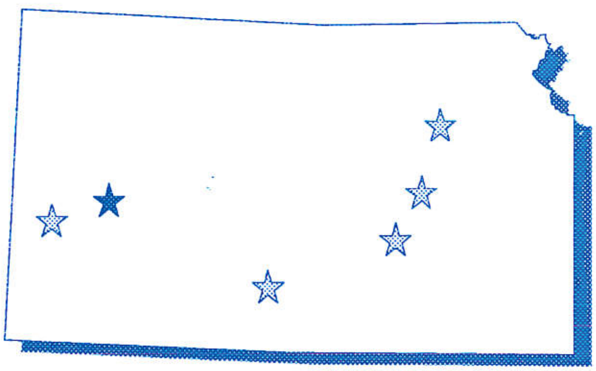
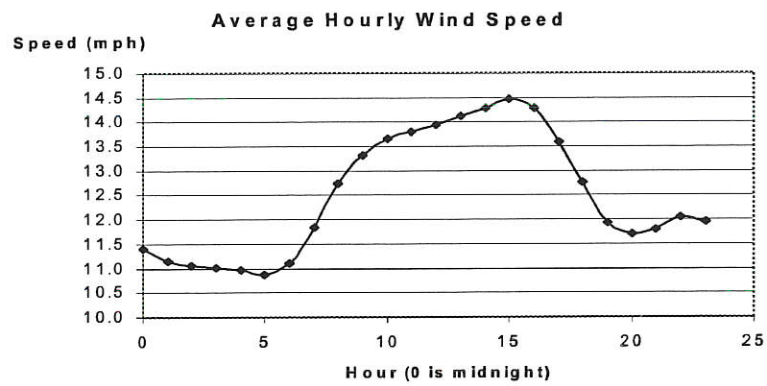
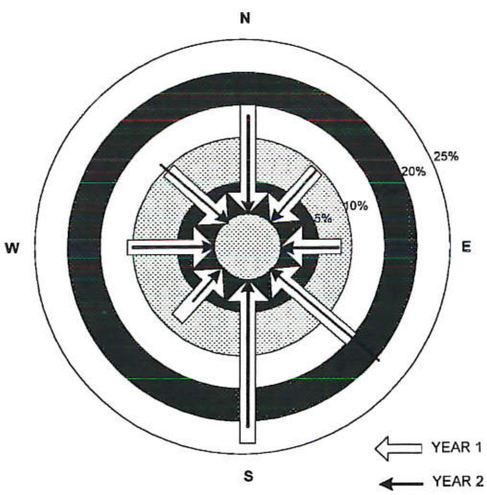
Southern High Plains Site 2

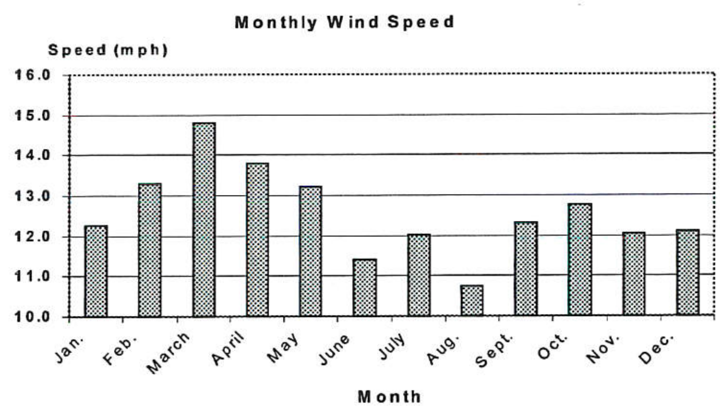
Class 3 Site (April 96 - December 97)
Average = 12.7 mph Power Density = 188 W/m^2

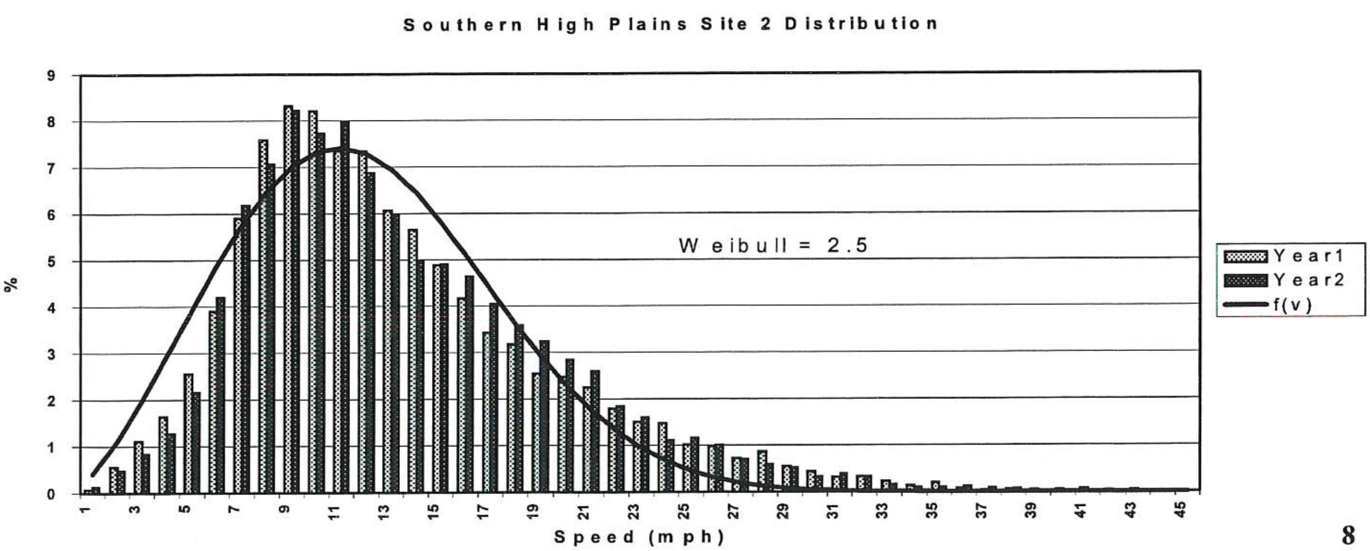
Summary The highest average month at this site was March with an average wind speed of 14.8 mph. The lowest was 10.8 mph during August. Hourly average wind speeds as high as 44 mph were recorded. Overall, 12 percent of the time the hourly average was over 20 mph and 40 percent of the time the hourly average was under 10 mph.









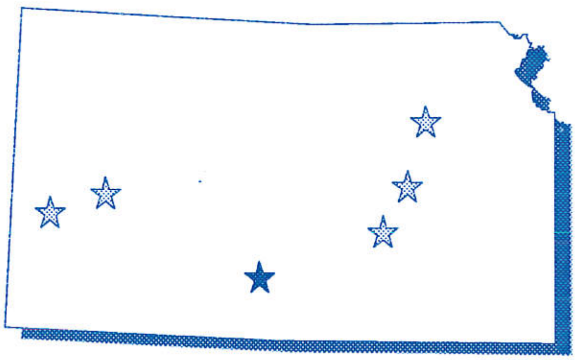


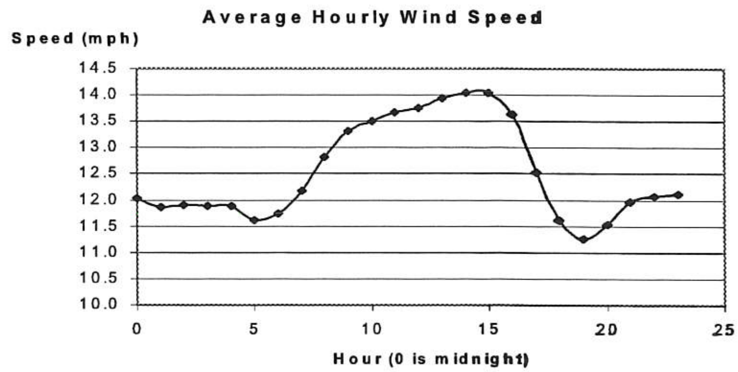
1-41

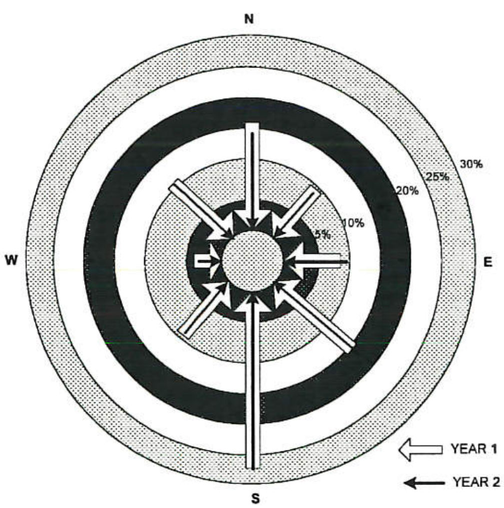
Red Hills Site

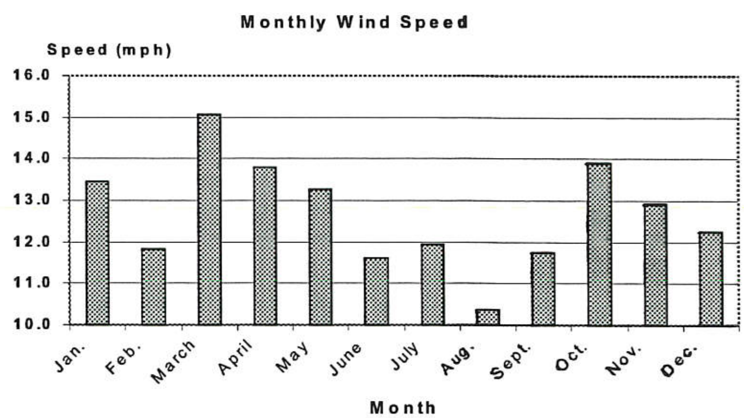
Class 3 Site (July 96 - December 97)
Average = 12.8 mph Power Density = 187 W/m^2

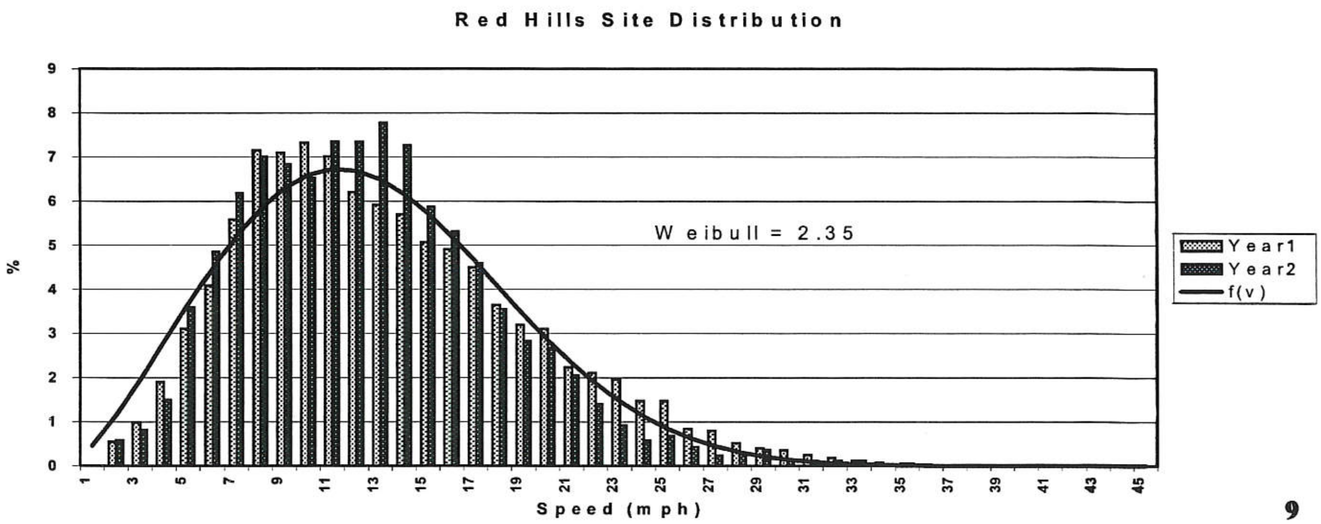
Summary The highest average month at this site was March with an average wind speed of 15.1 mph. The lowest was 10.4 mph during August. Hourly average wind speeds as high as 41 mph were recorded. Overall 11 percent of the time the hourly average was over 20 mph and 38 percent of the time the hourly average was under 10 mph.







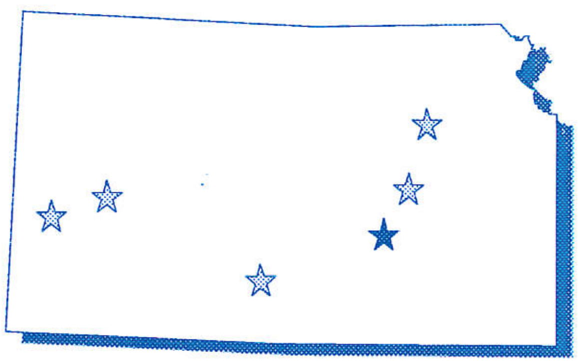


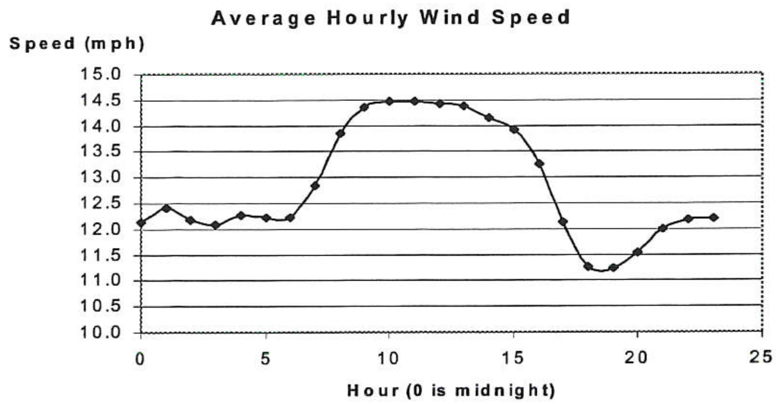


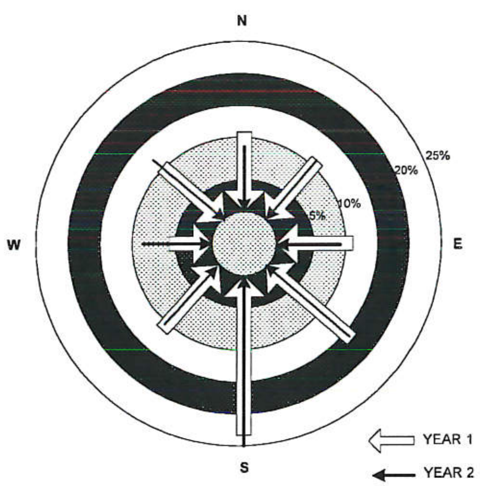
Flint Hills Site 1

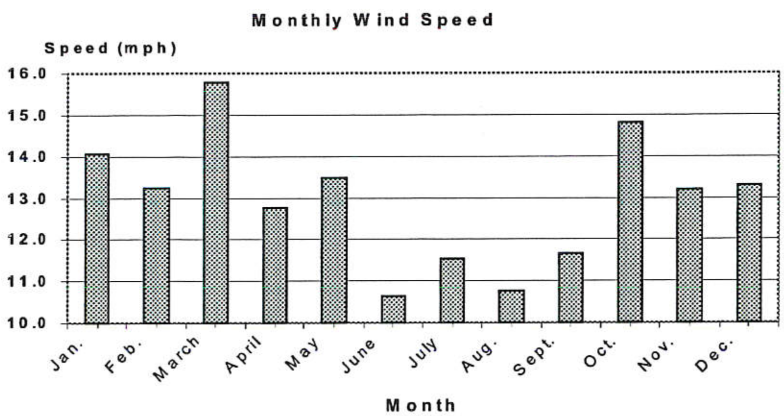
Class 4 Site (July 96 - December 97)
Average = 13.1 mph Power Density = 207 W/m^2

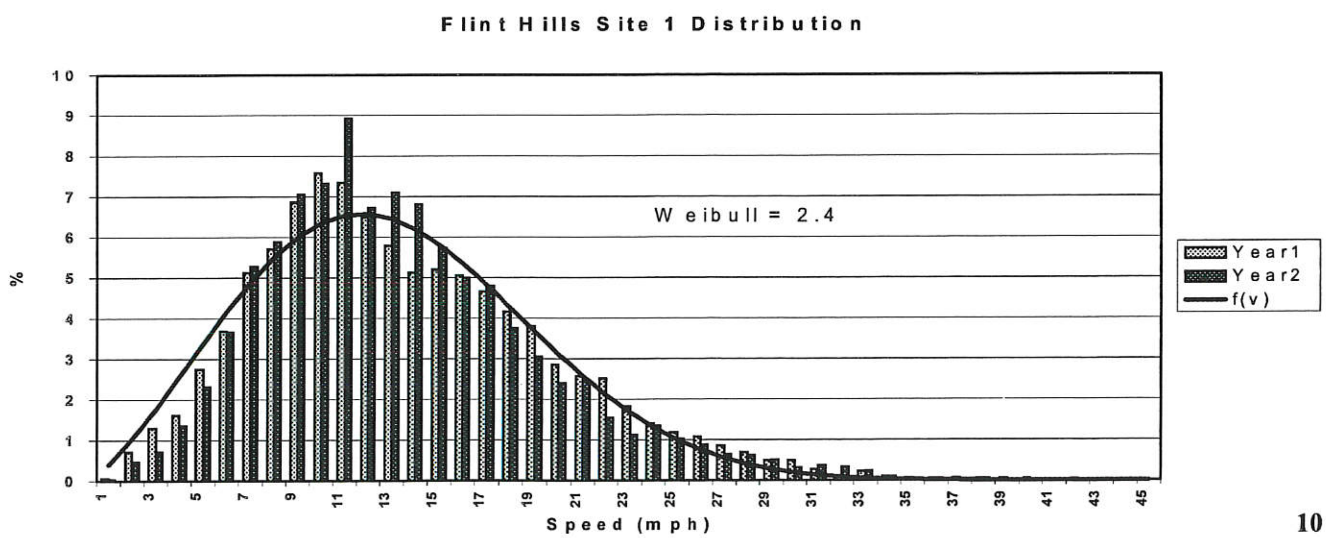
Summary The highest average month at this site was March with an average wind speed of 15.8 mph. The lowest was 10.6 mph during June. Hourly average wind speeds as high as 42 mph were recorded. Overall, 12 percent of the time the hourly average was over 20 mph and 36 percent of the time the hourly average was under 10 mph.









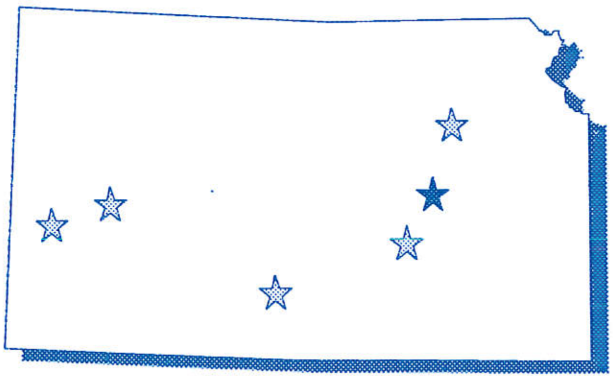


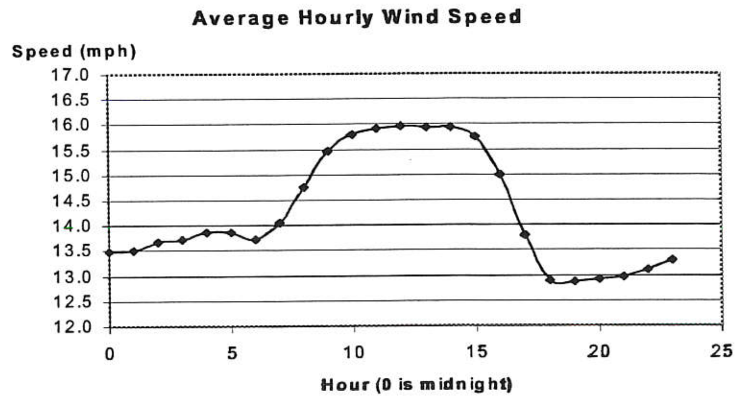
1-43

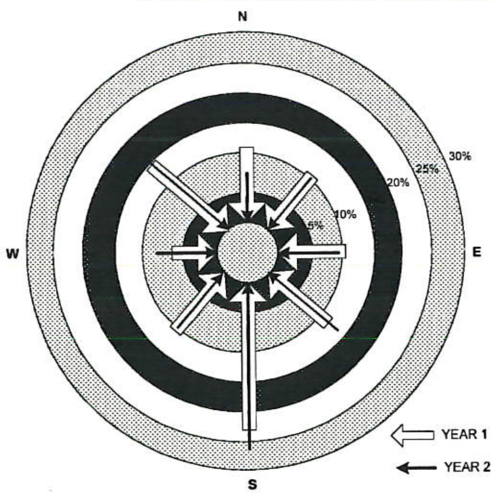
Flint Hills Site 2

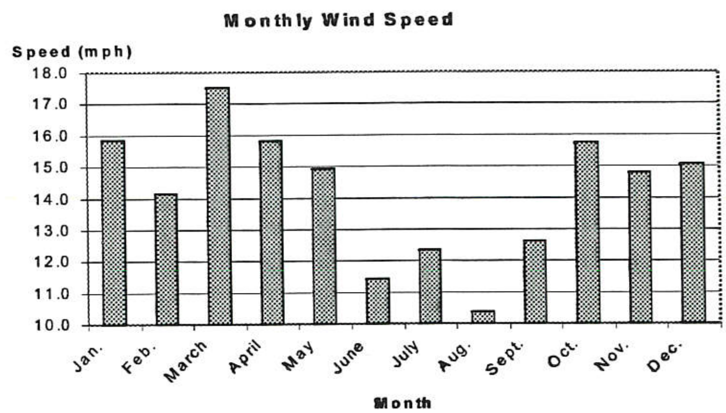
Class 5 Site (July 96 - December 97)
Average = 14.3 mph Power Density = 268 W/m^2

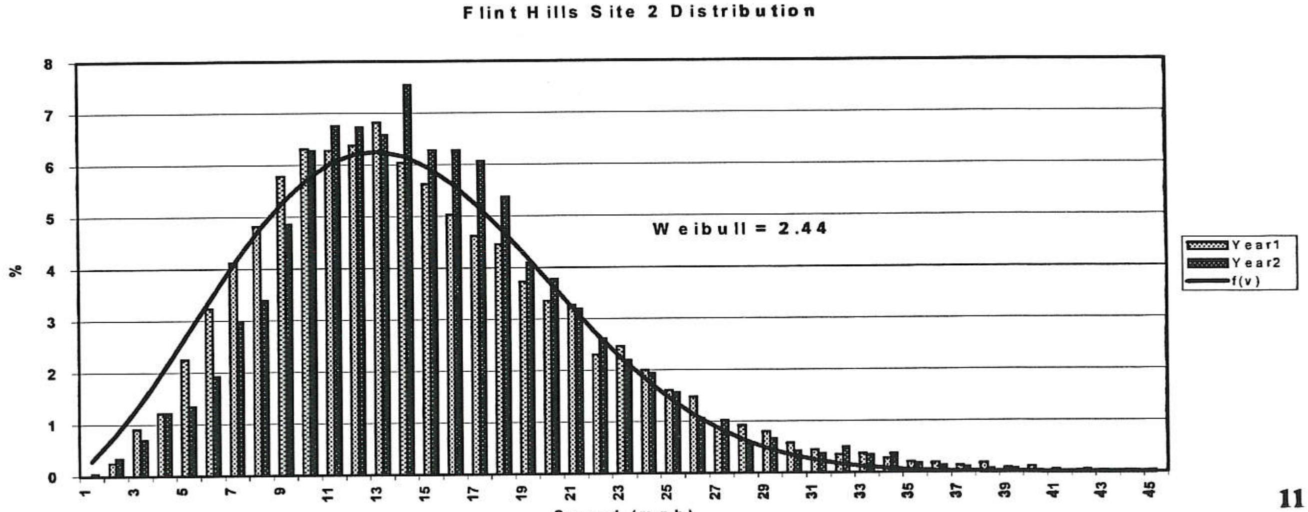
Summary The highest average month at this site was March with an average wind speed of 17.5 mph. The lowest was 10.4 mph during August. Hourly average wind speeds as high as 47 mph were recorded. Overall, 18 percent of the time the hourly average was over 20 mph and 28 percent of the time the hourly average was under 10 mph.









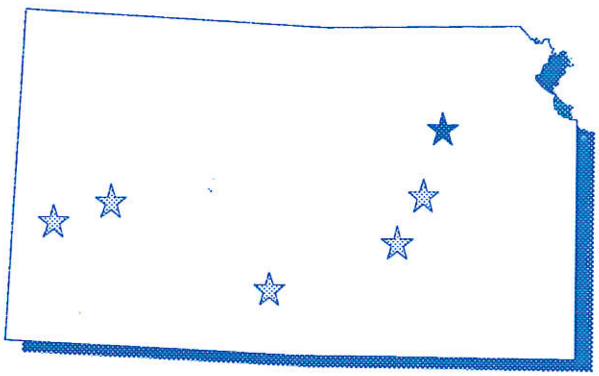


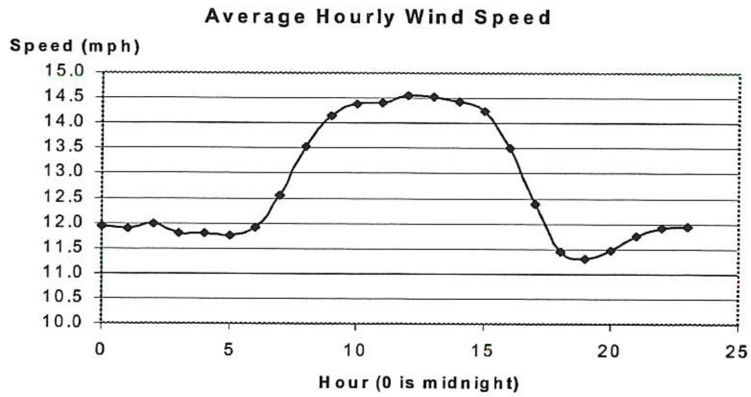
1-44

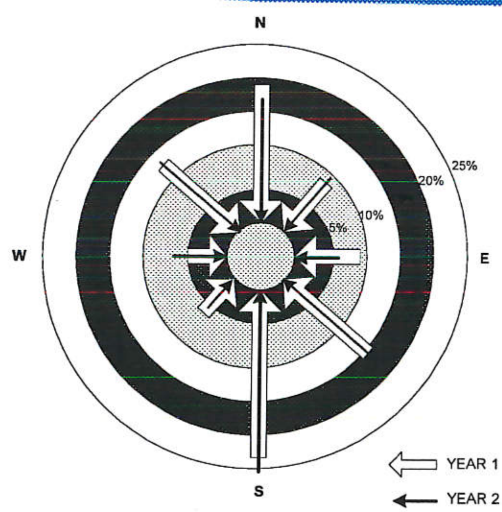
Flint Hills Site 3

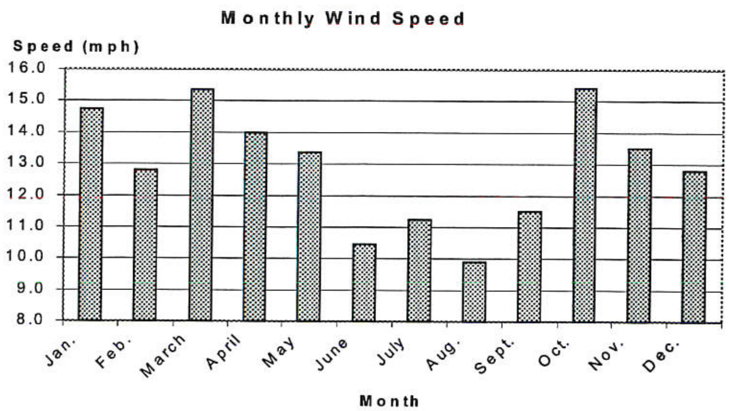
Class 4 Site (July 96 - March 98)
Average = 13.0 mph Power Density = 208 W/m^2

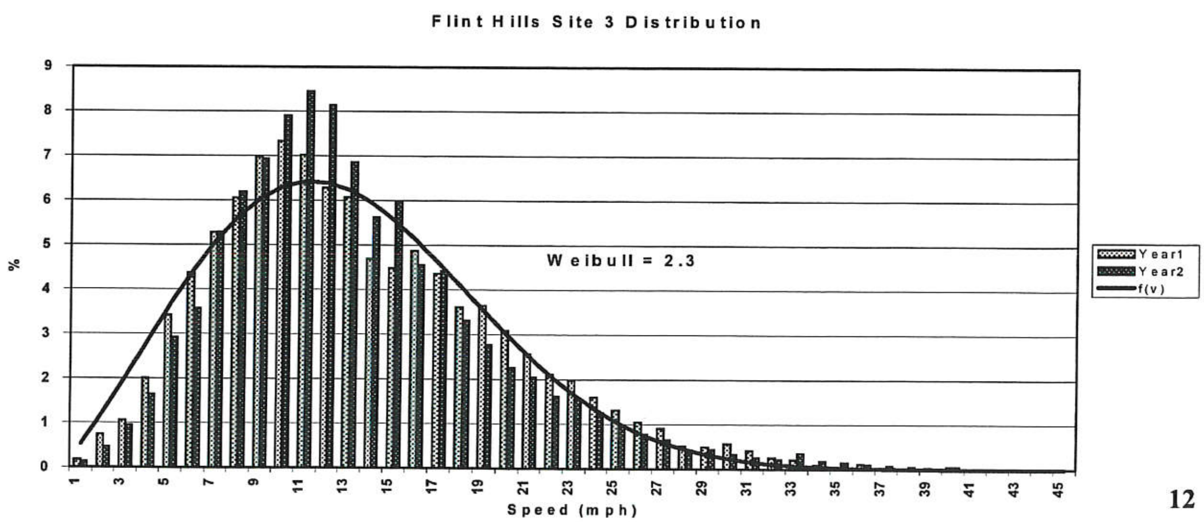
Summary The highest average months at this site were March and October with an average wind speed of 15.4 mph. The lowest was 9.9 mph during August. Hourly average wind speeds as high as 44 mph were recorded. Overall, 12 percent of the time the hourly average was over 20 mph and 38 percent of the time the hourly average was under 10 mph.

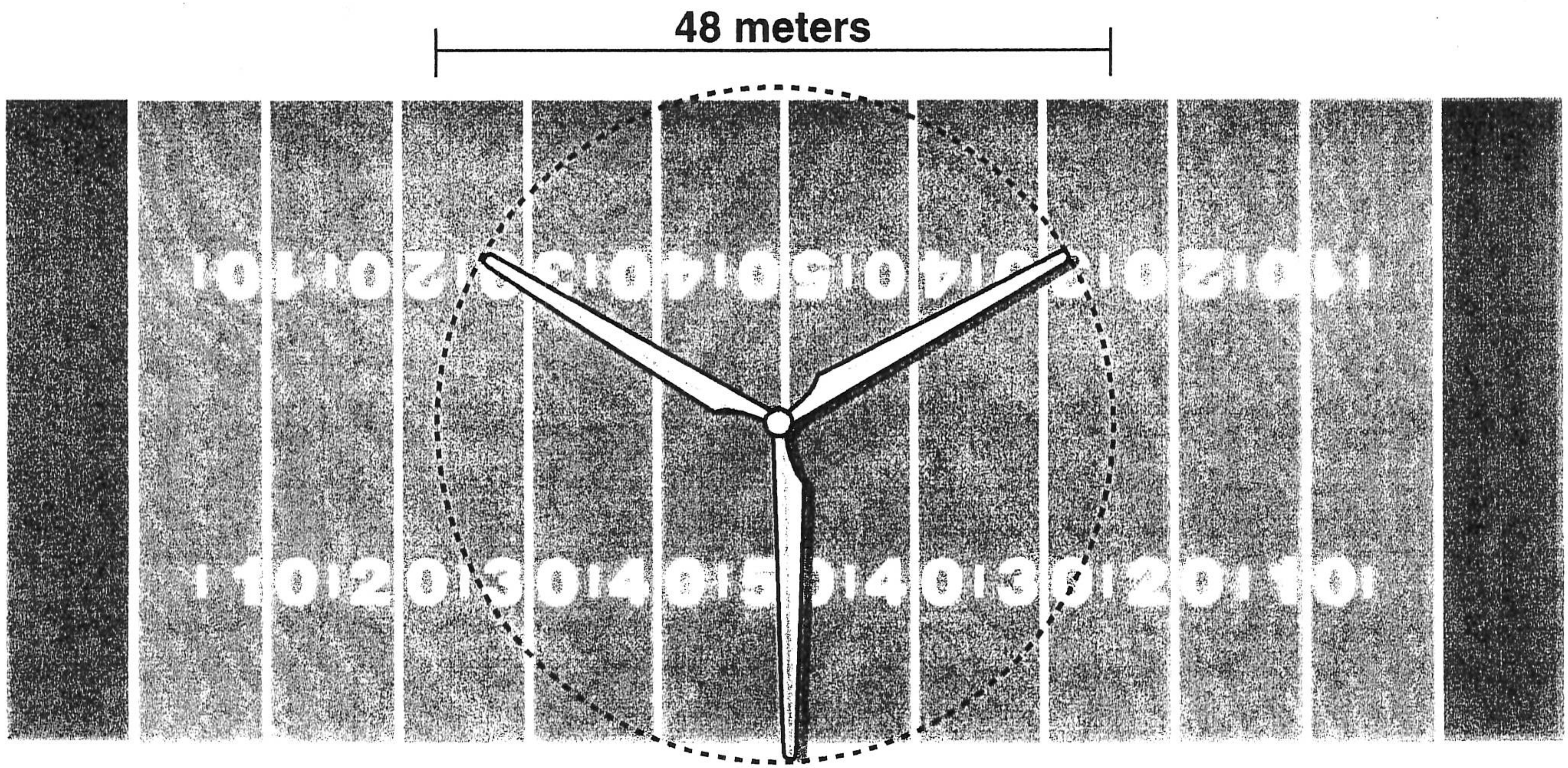




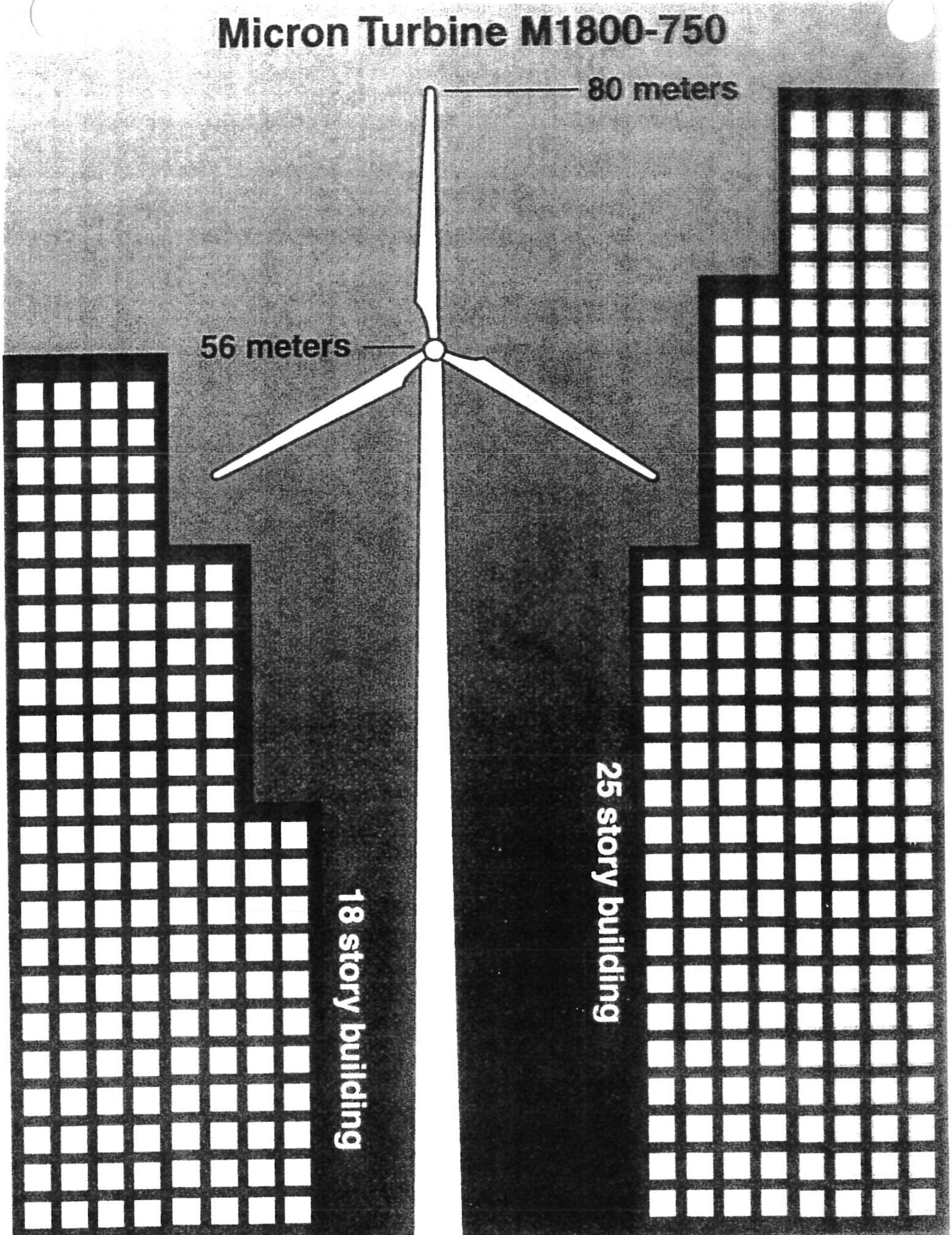








Micron Turbine M1800-750


Micron Turbine M1800-750
80 meters
56 meters
18 story building
25 story building

1-47