Westar Energy®

and

Applied Energy Group, Inc.

SCHOOL LOAD PROFILE MODELING 101

by

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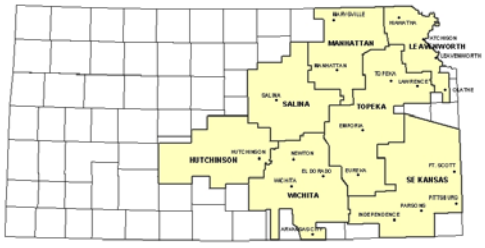
Westar Energy: A Kansas Electric Utility

Service Territory



- Kansas' largest electric provider
- More than 647,000 customers
- Service territory covers more than 11,000 square miles
- Nearly 6,000 MW of generation
- About 36,500 miles of transmission & distribution lines
- About 2,000 employees

Westar: 2003 Load and Capability

TOTAL SYSTEM CAPACITY	MWs
+ Accredited Generating Capacity	5,929.2
+ Capacity Purchases	59.0
- Capacity Sales	(583.0)
= Total System Capacity	5,405.2

TOTAL SYSTEM PEAK RESPONSIBILITY	
+ Projected System Peak Load	4,784.0
- Interruptible	(220.0)
+ Firm Sales	13.0
- Firm Purchases	(180.0)
= Total System Peak Responsibility	4,397.0

CAPACITY MARGIN 1,008.2 MWs

CAPACITY MARGIN (%) 18.7%

Westar: 2002 Utility $sales

	2002	2001	% Change
Residential	$ 442,106	$ 419,492	
Commercial	385,375	380,277	
Industrial	242,847	244,392	
Total	**$1.07 billion**	**$1.04 billion**	**2.5%**
Network Integration	60,132	--	
Other	46,693	50,669	
Total Retail	**$1.17 billion**	**$1.09 billion**	
Power Marketing/Wholesale & Interchange	245,746	212,347	
Total	**$1.4 billion**	**$1.3 billion**	**8.8%**

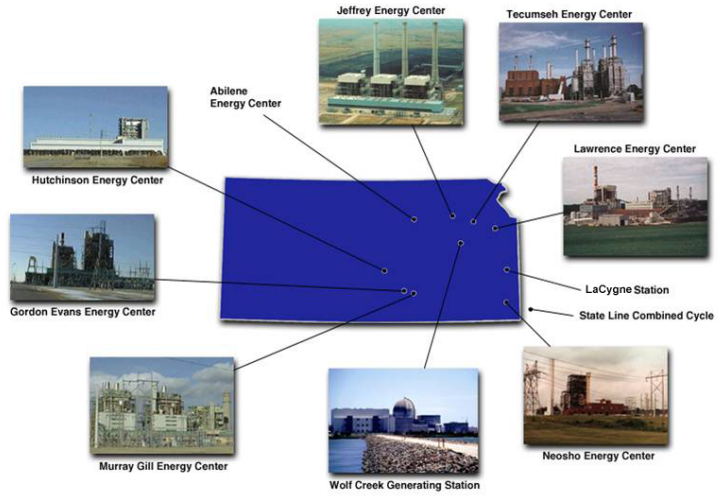
In thousands except totals

Westar: 2002 Utility Energy Sales

	2002	2001	% Change
Residential	6,170	5,755	
Commercial	6,817	6,742	
Industrial	5,451	5,617	
Other	106	107	
Total retail	**18.5 million MWh**	**18.2 million MWh**	**1.8%**
Wholesale & Interchange	9,115	7,547	
Total*	**27.7 million MWh**	**25.8 million MWh**	**7.3%**

In thousands except totals. *Does not include network integration or power marketing because these activities are not related to electricity we generate.

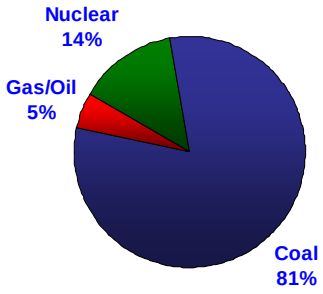
Westar Energy Centers



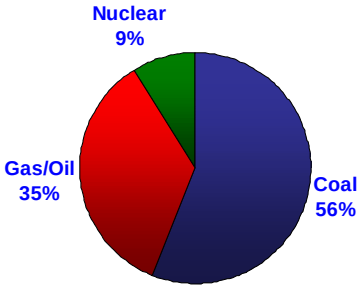
Westar's Diverse Fuel Mix

Minimizes exposure to volatility in price and supply

Fuel Mix By MWh of Generation (2002)



Fuel Mix By MW of Capacity



- Gas fuel requirements for native load hedged through mid-2004
- Coal fuel requirements for native load procured through year-end 2004

Kansas: A Hotbed of Education

- 5 pm demands (CP Hour) during school sessions (late August/early September) vs. System Peak (CP)
  - KGE Service Area
    - Rate Class EIS 64 MW school-in; 43 MW CP
    - All-Electric (TESC) 3.5 MW school-in; 3 MW CP
  - KPL Service Area
    - Rate Class SCHL 57 MW school-in; 38 MW CP
    - Universities 50 MW school-in; 48 MW CP
      - K-State, Kansas U., three others
- TOTAL: 5 pm NCP 175 MW = 4% of 4,300 System Peak
- TOTAL: 5 pm CP 132 MW = 3% of 4,300 System Peak

Westar School Load

- School loads have NOT been typically coincident with System Peak (CP)
  - System Peak occurs in late July/early August when weather is most severe (100+ degrees)
  - Schools in summer sessions (school-out) during CP
- Question: What if system peak and weather peaks occurred later when schools were in full session; or What if schools shifted sessions earlier?

Westar School Load Impact Potential

- Potential impact of full-session school load (school-in) could be significant
- How to estimate potential impact?
  - Estimate current Schools contribution to System Peak
  - Model School loads if full-session and comparable weather conditions
  - Estimate sensitivity of school loads to weather for normal and extreme weather conditions

Westar Schools – Load Data Management

- Revised Sample Design based on Summer 2000 (July/August) average monthly kWh, stratified using Dalenius & Hodges and Neyman Allocation
- Load data collected/analyzed for Summer (June through September) 2001 and 2002
- Load data validated to ensure complete set of data (minimal editing), with major migrations re-stratified. Outages were patched.
- Ratio Estimation used to scale class data to summer seasonal billed kWh (except KPL Universities, considered a 100% sample of 11 sites with 12 recorders)

Westar Schools – Load Data Management

- **Sample Sizes:**

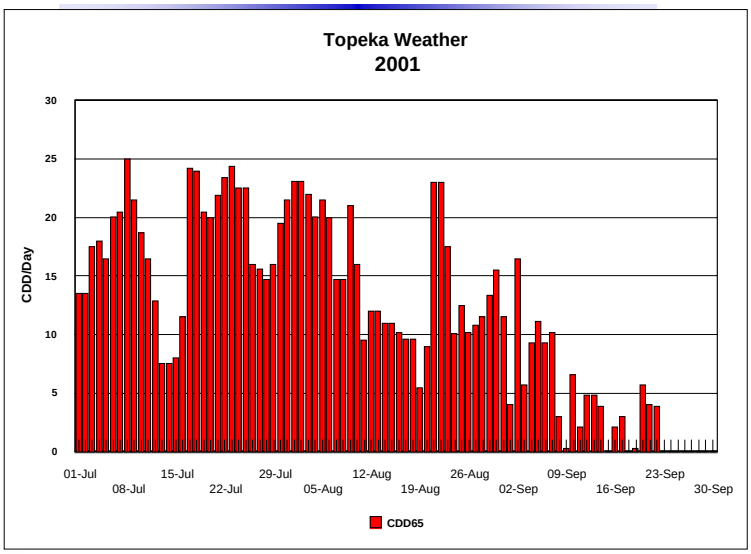
	2001	2002	All	Notes
EIS	48	46	51	New 2001 Sample
TESC	41	26	43	2002 Data problem
SCHL	68	60	75	
Univ's	11	11	11	12 recorders from various sampling/rate classes)

- 2001 Data loss factors: 5% for EIS, TESC; 10% for SCHL
- 2002 Data loss factors: 10% for EIS; 20% SCHL; 40% TESC

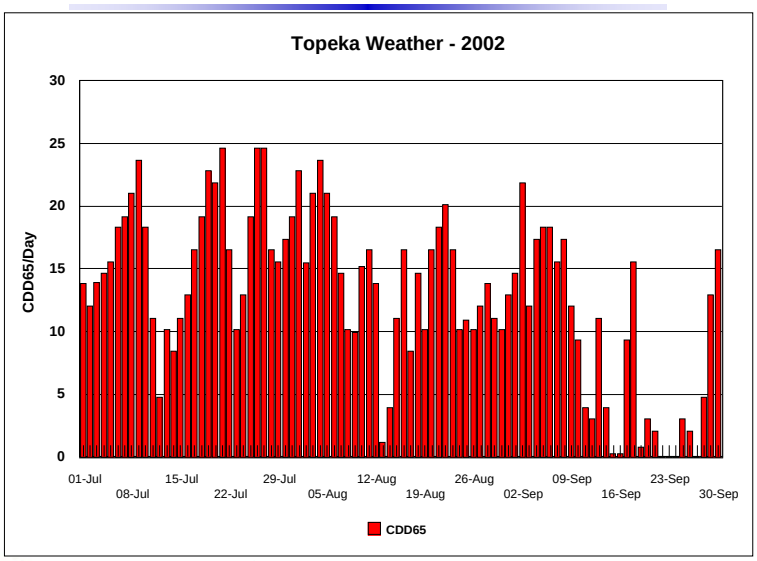
Westar Schools Analysis Methods

- Several Methods were used to determine best one(s)
  - 1. Comparison Day Analysis
    - Select school-in Days comparable to System Peak Days (school-out)
  - 2. Combined Regression Analysis
    - Apply dummy variable to indicate school-in vs. school-out
  - 3. Period Regression Analysis
    - Separate regressions during school-in and school-out
  - 4. Hybrid Analysis: combination

Topeka Weather



Topeka Weather



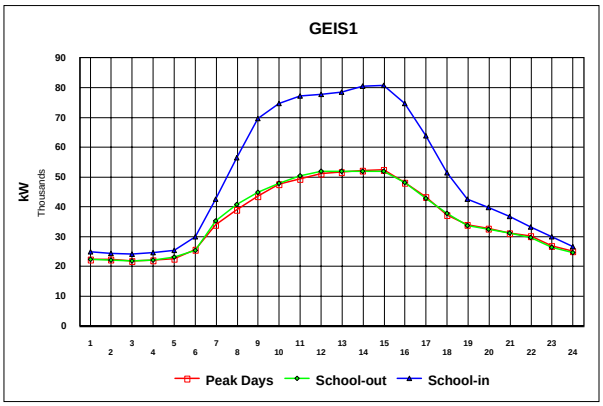
Westar Schools Analysis

- 1. Comparison Day Analysis
  - 2001
    - School-in (Aug 21-23) had 11.2 CDD
    - School-out (July 24,25,30) with 11.5 CDD
    - System Peak days (July 30, Aug 2) CDD of 11.3 – about the same, No weather adjustment needed.
  - 2002
    - School-in (Sept 4-6) had 8.0 CDD's (75 base)
    - School-out (July 10, 30, 31) with 8.3 CDD
    - System Peak days (July 26, Aug 1) CDD of 13.7 – more severe! Need weather adjustment.

Typical School Load Profiles

✦ KGE EIS Class Load Profile

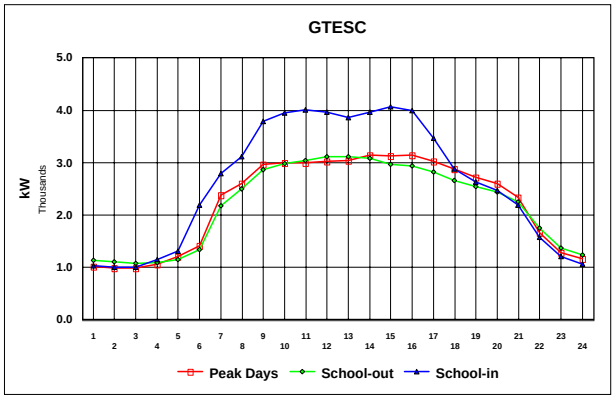
- **Typical school types**
- **School-in 2001 peak of ~ 80 MW**
- **School-out and System Peak Day each ~ 51MW**
- **Comparable weather, but not normalized**



Typical School Load Profiles

✦ KGE TESC Class Load Profile

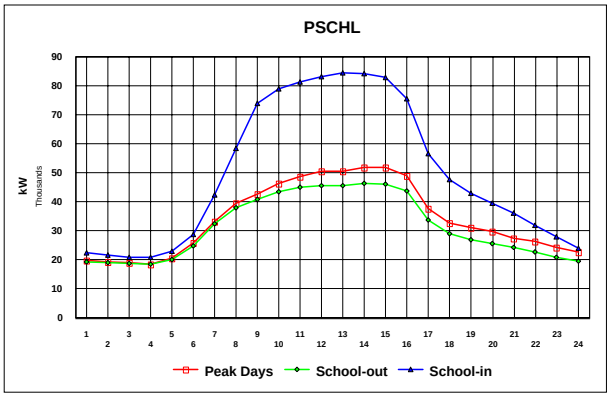
- **All-electric Schools**
- **School-in 2001 peak of ~ 4 MW**
- **School-out and System Peak Day each ~ 3.1 MW**



Typical School Load Profiles

✦ KPL SCHL Class Load Profile

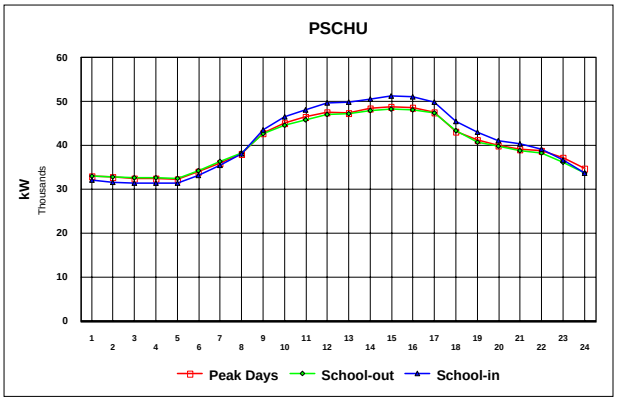
- **Typical School Types**
- **School-in 2001 peak of ~ 83 MW**
- **School-out ~ 47 MW; System Peak Day ~ 52MW**



Typical School Load Profiles

✦ KPL Universities Class Load Profile

- **Large KPL Universities**
- **School-in 2001 peak of ~ 51 MW**
- **School-out and System Peak Day each ~ 48MW**
- **More comparable Summer sessions**



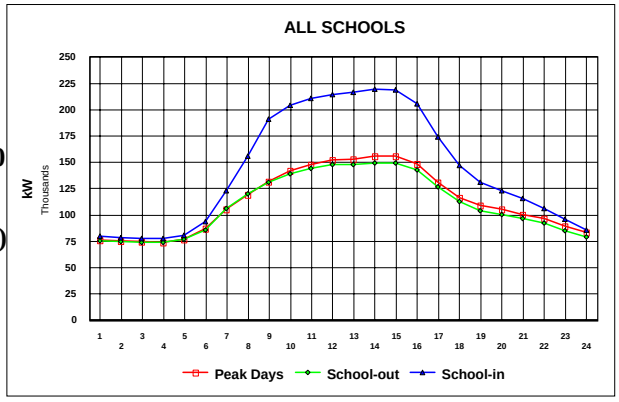
Typical School Load Profiles

- All School Classes Load Profile

• School-in 2001 peak of ~ 220 MW

• School-out and System Peak Day 150 - 155 MW

• School-in (175 MW) vs. School-out / CP (5pm) (125 MW) difference of about 50 MW



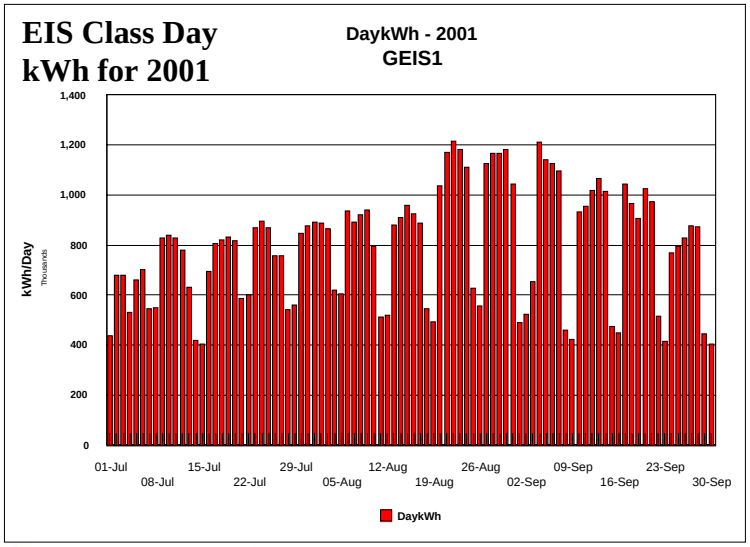
Westar Schools Comparison Day

- 2001 Results very good due to comparable weather days
- 2001 estimate of school-in vs. school-out on system peak day approximately 50 MW (1.2% of Westar System Peak)
- 2002 results not as good, requires weather adjustment
- Comparison Day results work best when days compare well!!!
- Need basis for weather adjustment

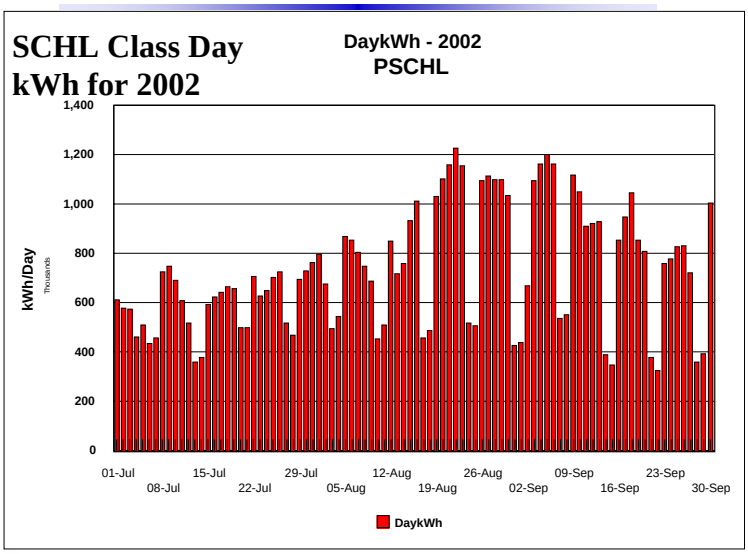
Westar Schools Analysis

- 2. Combined Regression Analysis
  - Determine school-in vs. school-out boundary date
    - First cut: examine kWh/day, more stable than kW
  - Perform regressions to predict (A) Daily kWh and (B) kW at 5 pm vs. (a) CDD65, (b) Max Daily Temperature and (c) Average Daily Temperature
  - Examine regression residuals to confirm school-in vs. school-out vs. "partial-session"
  - Each Class could have a different boundary date
  - Plot Actual vs. Predicted to confirm model
  - Only use weekday non-holiday data for July 1 – September 30.

Westar Schools Analysis



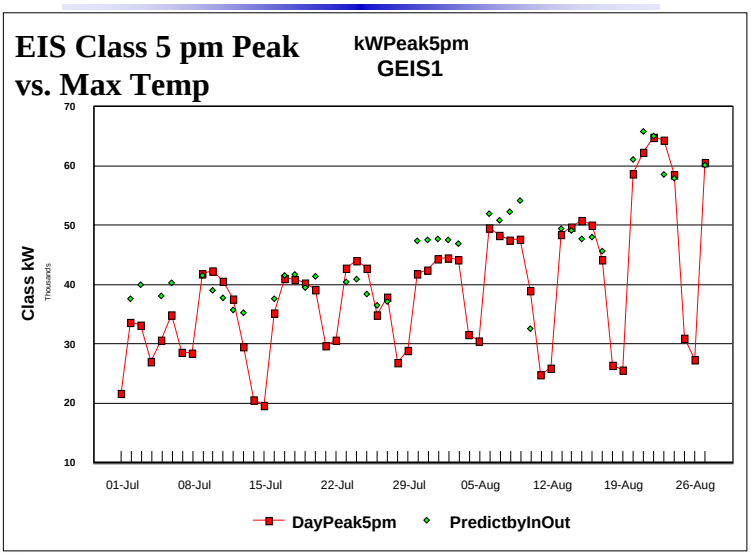
Westar Schools Analysis



Westar Combined Regression Analysis

- For all Classes, schools were clearly at full-load (in session) after August 17, 2001 and August 18, 2002
- While sessions officially started one week later, preparation for school caused loads to be at/near full levels a week earlier
- For all Classes, schools were clearly NOT in session before August 3, 2001 and August 4, 2002
- Period of August 3-17, 2001 and August 4-18, 2002 were partial sessions, with higher loads than school-out and lower than school-in

Westar Combined Regression Results



Westar Combined Regression Results

- Max Temp was the best predictor for 5 pm weekday peaks
- Westar uses 12-hour average temperature for planning analysis, which produced comparable regression results.
- Dummy variable was not adequate to capture weather variability, only to determine boundary and approximate level of partial-session load level
- Partial-session about 50% of difference between school-in and school-out loads.

Westar Schools Analysis

- 3. Period Regression Analysis
  - Separate regression analysis for school-in, school-out and partial session periods
  - Perform regressions to predict (A) Daily kWh and (B) kW at 5 pm vs. (a) CDD65, (b) Max Daily Temperature and (c) Average Daily Temperature
  - Use regression coefficients to determine weather-sensitivity of each period (school-in, school-out and partial-session)
  - Results for partial session for both years were marginal or failed due to few number of days and little weather variability in 2001.

Westar Schools Period Regression Results

Period Regression Coefficients for 2002: Class kW increase per one degree increase in max temperature

Class	School-Out coefficient	School-in coefficient
EIS	538	928
TESC	55.2	43.4
SCHL	455	800
Univs	357	423

Westar Schools Analysis

- 4. Hybrid Results – Final
  - Use Comparison Days to create base load profiles for each day type (System Peak/out-school and in-school)
  - Apply coefficients from Period Regression results to adjust each day type to system peak day weather and normal (30-year average) weather
  - 2002 Results were considered better because regressions performed better, data was more recent and weather was closer to normal
  - 2001 estimated normalized impact 47 MW
  - 2002 estimated normalized impact 59 MW

Westar Schools Analysis 2002 Results

NORMALIZED 5 PM SYSTEM-COINCIDENT PEAKS			
	School Out	Increment	School In
Class	(MW)	(MW)	(MW)
EIS	44.2	31.1	75.4
TESC	3.7	0.4	4.1
SCHL	33.7	22.7	56.4
Univs	46.3	5.2	51.4
TOTAL	128.0	59.3	187.3
Sys Peak	4,300	4,359	4,359
% Sys Peak	3.0%	1.4%	4.3%

Westar Schools Analysis Conclusions

- Comparison Day Analysis can work if you are lucky enough to have comparable weather results
- Most reliable method is Comparison Day Analysis, with period regression results used to adjust/normalize for weather
- Combination regression can be used to identify school-in vs. school-out boundary and partial session kW estimate
- For Westar, their system peak would be affected by about 59 MW, or 1.4%, if the system peak and full school sessions coincided