Weather and Irrigation Normalization Technical Workgroup

December 3, 2007

Agenda

- Changes at the Agency
- Weather normalization proposals
- Irrigation normalization proposals
- Data cleaning proposals

Changes at the Agency

- In 2006 Customer Service (KS) organization formed
  - Common Power and Transmission functions consolidated at the Agency level
    - Focus on SOC compliance
    - Groups include load forecasting, metering, billing, and contract administration
  - Intended to give one view of the customer across the Agency

Contract High Water Mark
Weather Normalization adjustment

- Customer 2010 Actual Total Retail load will be weather normalized utilizing
  - Weather impact coefficients from forecast models
  - 2010 actual weather variables
  - Most recent 30 yr historical average weather variables

- Example
  - 2010 Actual TRL = 5000 MW, CDD adjustment= 175 MW, HDD Adjustment= -220 MW
  - 2010 Weather Adjusted TRL = 2010 Actual TRL + CDD Adjustment + HDD Adjustment
  - 2010 Weather Adjusted TRL (using example values)
    - 4955 MW= 5000 MW + 175 MW – 220 MW

Weather Adjustment

- HDD Adjustment = a_{HDD} * (HDD_{Normal} – HDD)
- CDD Adjustment = b_{CDD} * (CDD_{Normal} – CDD)

- HDD Example (colder year than normal)
  - HDD Coefficient (a_{HDD}) = 11.0 MW/HDD
  - 2010 Actual HDD = 1900
  - Normal HDD = 1880

  - HDD Adjustment = 11.0 * (1880 – 1900) = -220 MW

Coefficients and Loads are Examples Only and Do Not Reflect Any Individual Customer

Objectives in Modeling Weather Impacts

- Equitable, verifiable, transparent method consistent with industry practices
- System wide application of the same method
- An implementable and cost effective method for both the customers and BPA
- A good normalization method which may/may not be different from forecasting practices

Typical Functional Form

- KWh= f(residential, commercial, industrial, irrigation)
- Residential KWh= f(weather, house size, appliance mix, number of people per household, age of household, etc)
- Commercial KWh= f(weather, type of business, building size, number of employees, etc)
- Industrial KWh=f(economy, number of employees, fuel type, output of industry)
- Residential Kwh=(a*temperature + b*sqft …..)

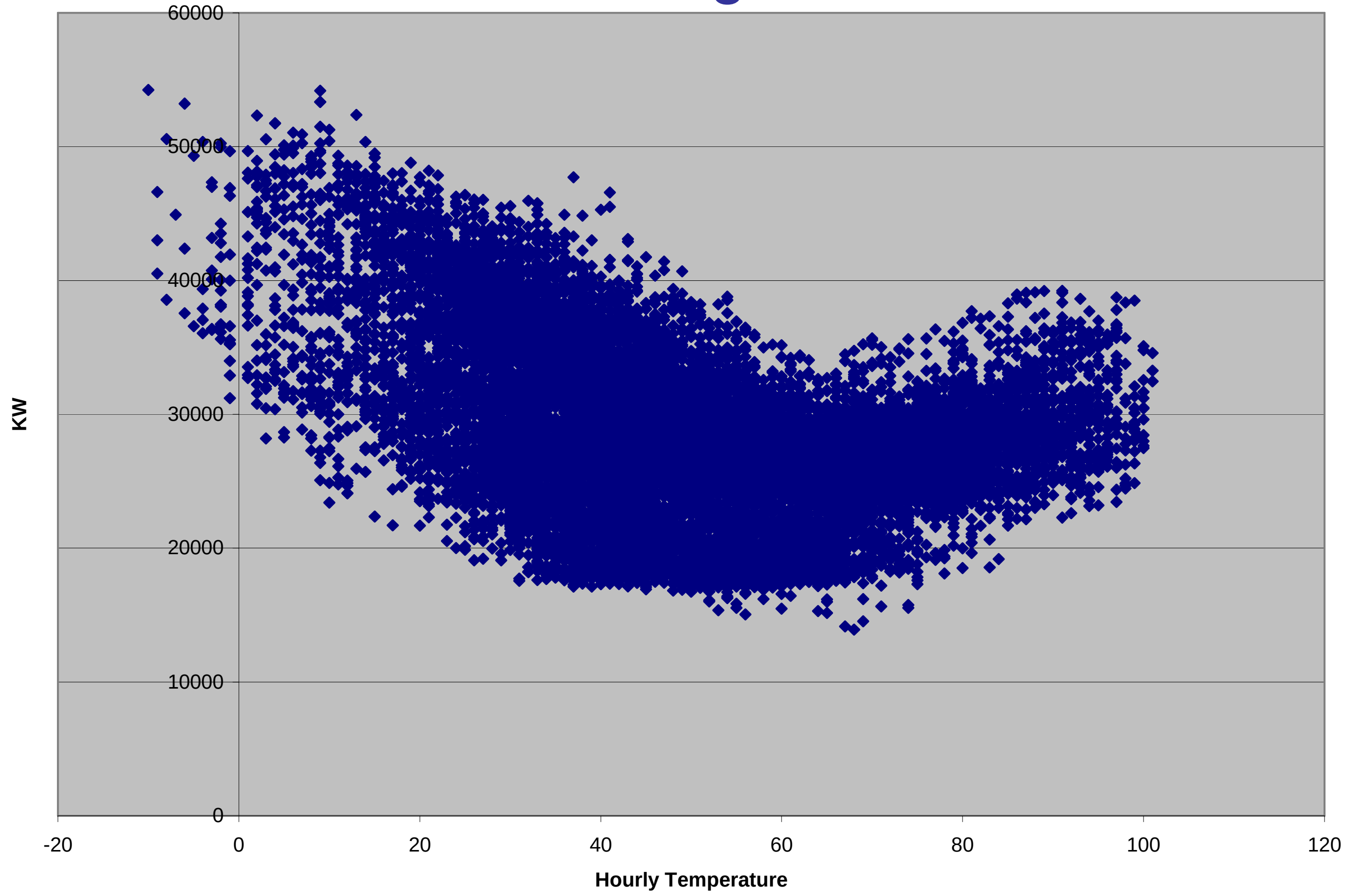
Fundamental Weather impacts captured in the daily temperatures

- Temperature is modeled not weather
- On a monthly basis
  - Wind speed is included in temperatures
  - Cloud cover is included in temperatures
  - Precipitation is included in temperatures
- All weather values are not available at all weather stations
- Some measures are more subjective than others

Conclusion 1

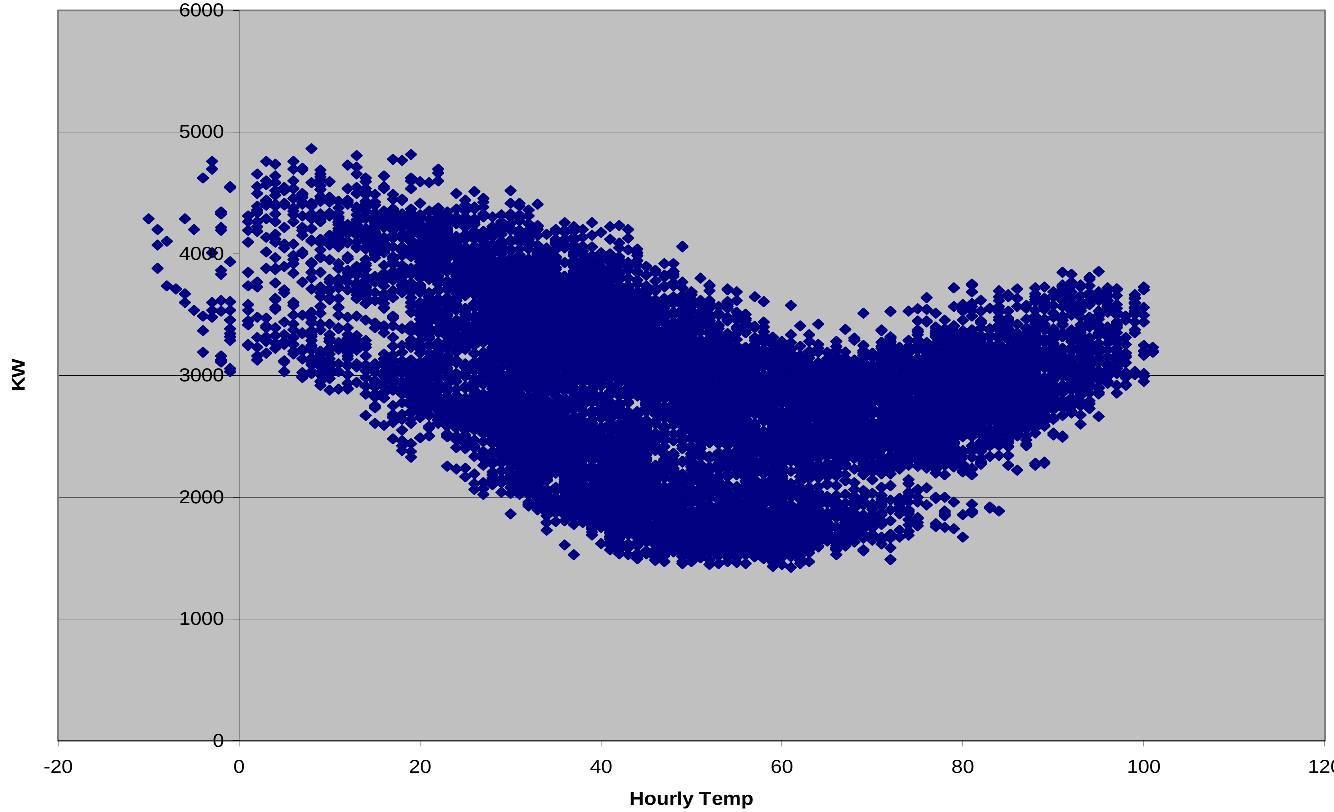
- For weather normalization it is most important to have the temperature coefficients as accurate as possible.
- Other factors, such as people per household, holiday lighting, hours of daylight are captured in indicator variables

Western City Load
Jan 2006 through Oct 2007



Typical pattern showing load movement with temperatures
Widely dispersed, clear heating and cooling patterns

Eastern City Load
Jan 2006 through Oct 2007

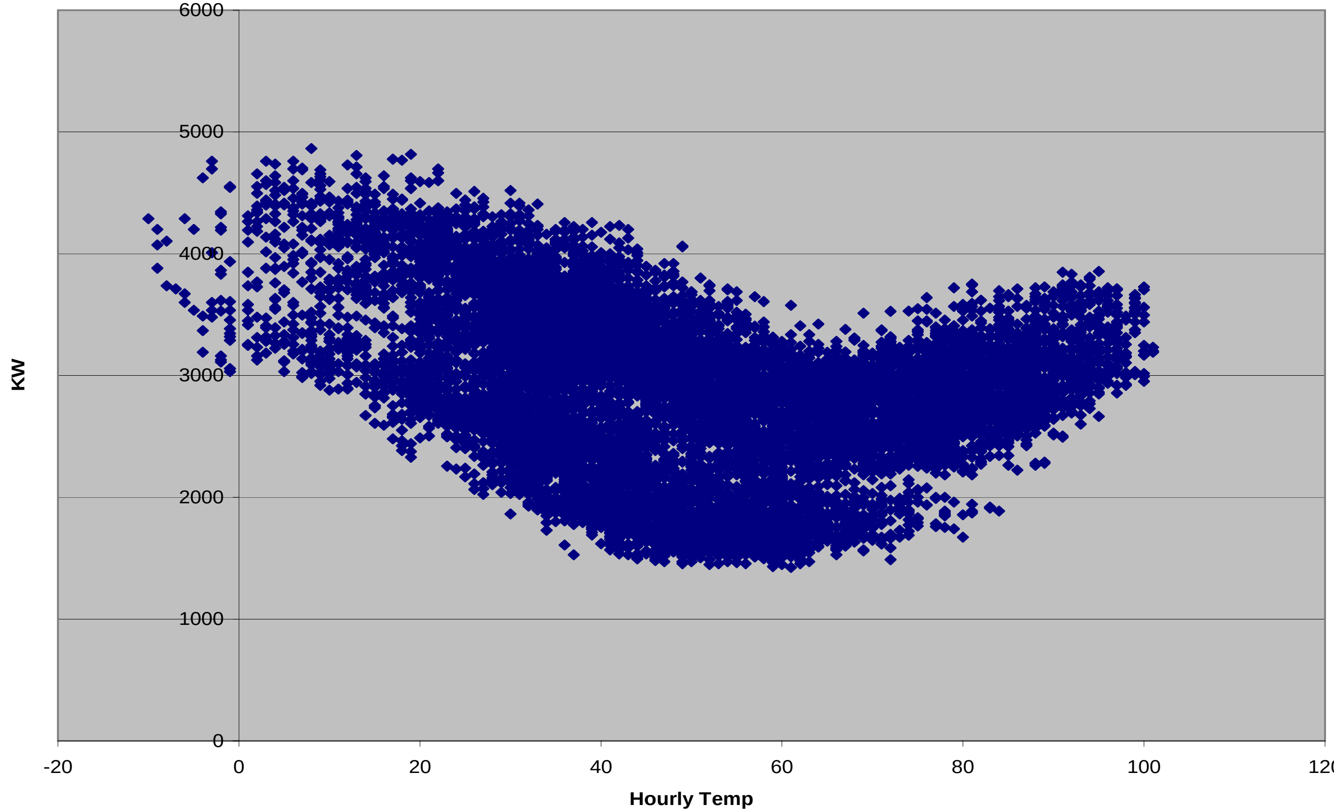


Typical pattern showing load movement with temperatures
Widely dispersed, clear heating and cooling patterns

Conclusion 2

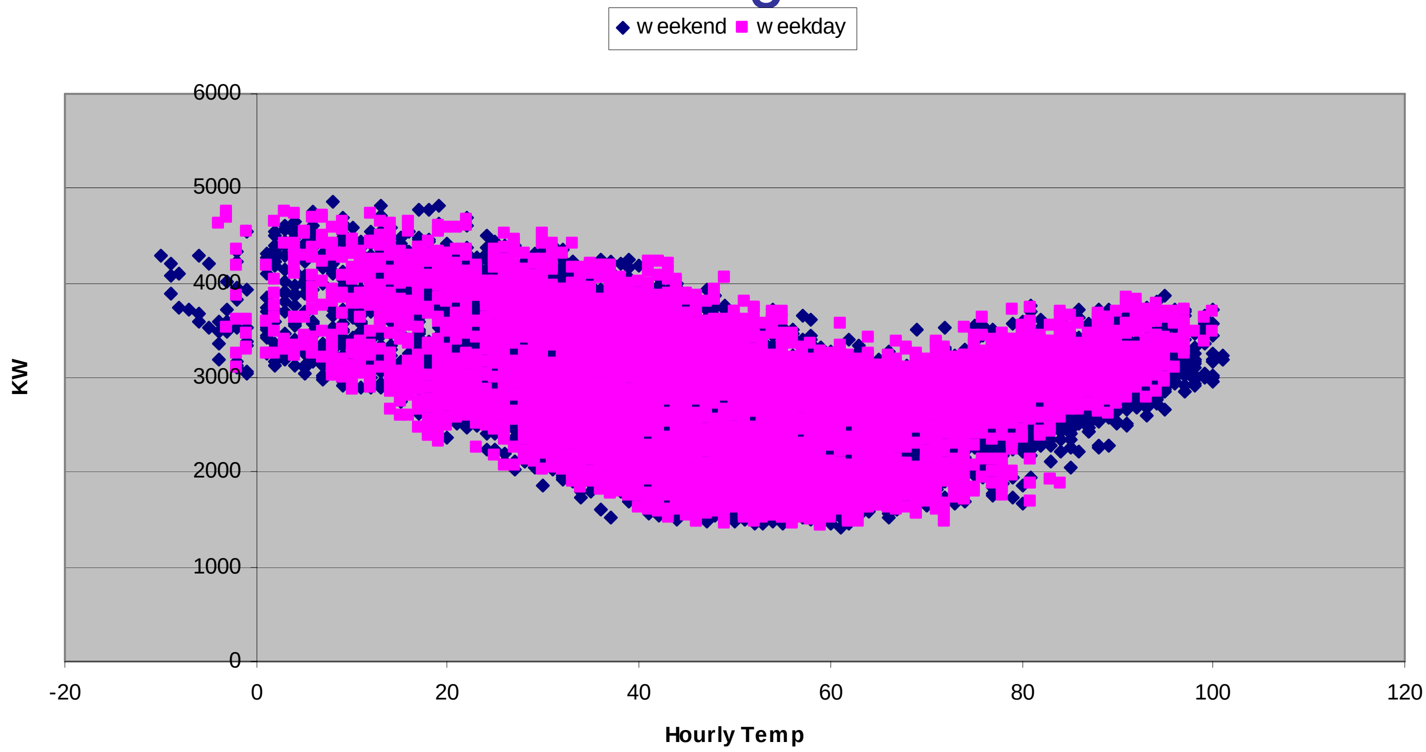
- Most customers exhibit a similar energy response to temperatures
- A similar normalization process is possible for all customers.

Eastern City Load
Jan 2006 through Oct 2007



Typical pattern showing load movement with temperatures. However, further review shows additional impacts to consider

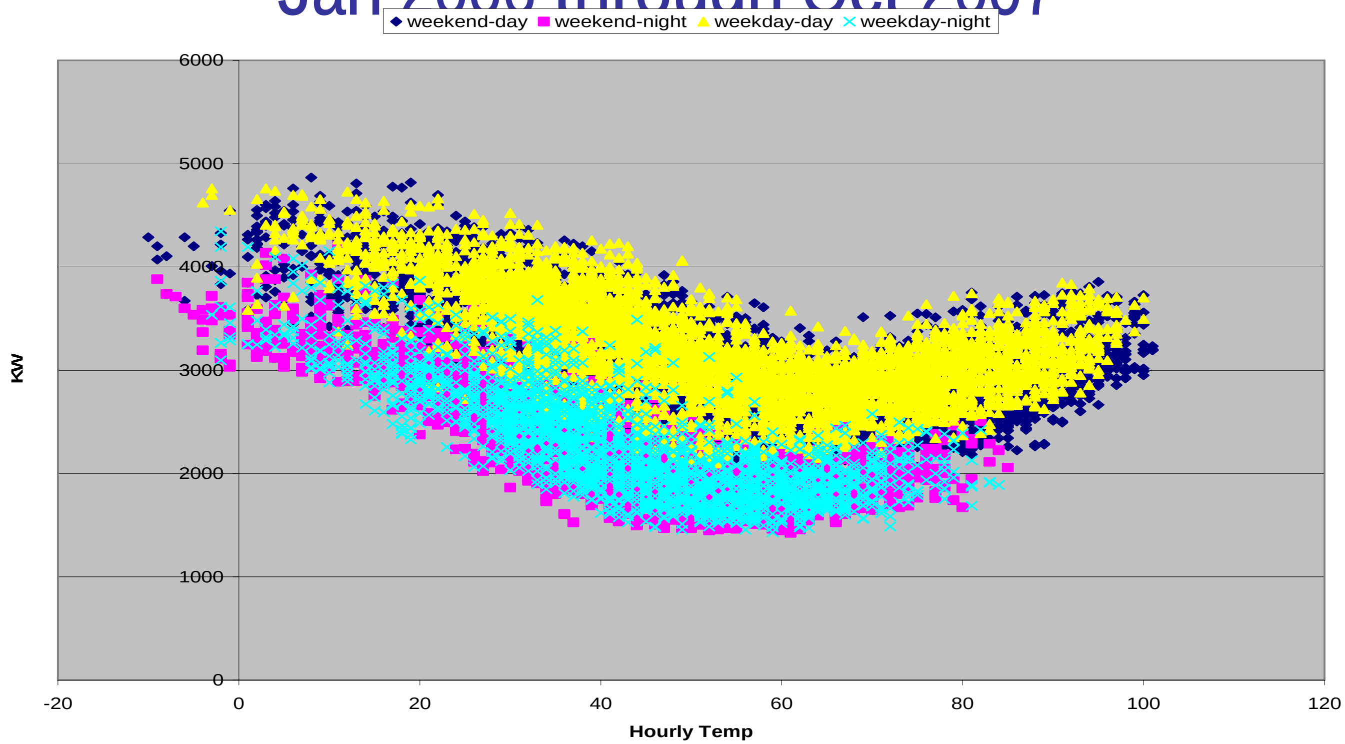
Eastern City Load
Jan 2006 through Oct 2007



Some detail shows more.

Weekday and weekend patterns are not particularly different

Eastern City Load
Jan 2006 through Oct 2007



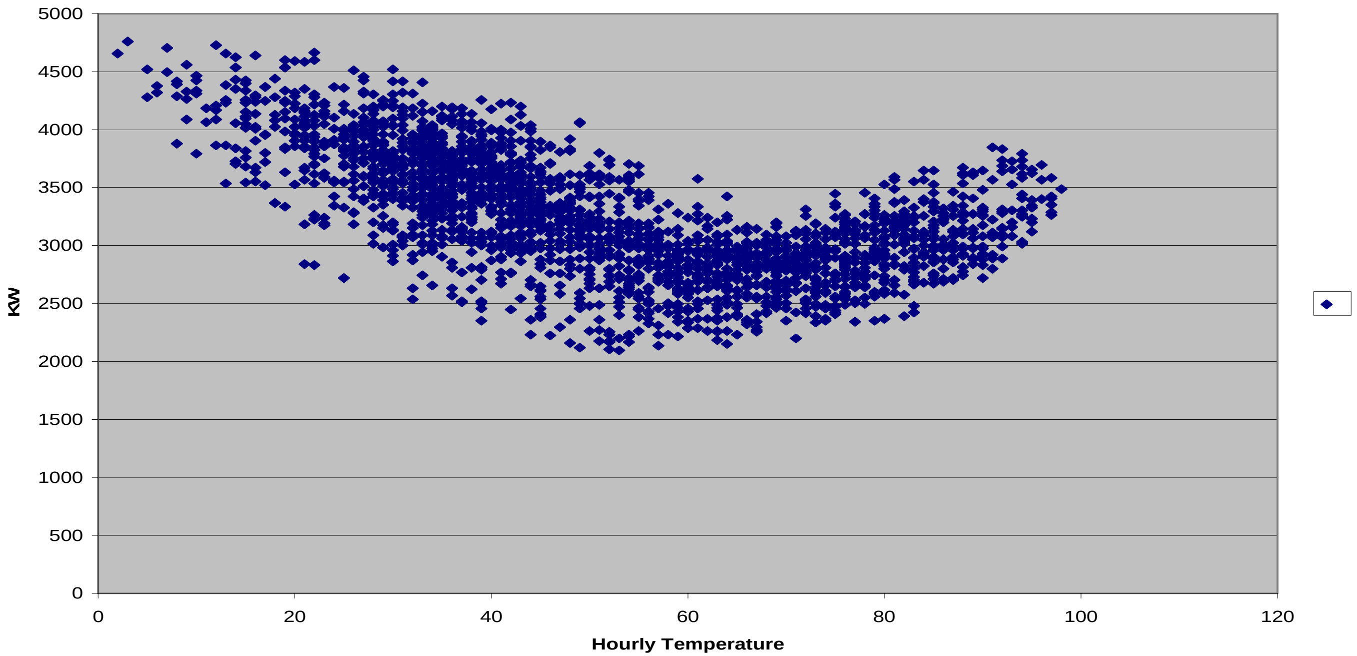
Additional detail shows more.

Day and night load levels account for most of hourly dispersion yet response to temperature is not particularly different

Conclusion 3

- For residential and commercial type customers loads differ from day to night but response to temperatures will be very similar.

Eastern City Weekday Daytime only Load
Jan 2006 through Dec 2006

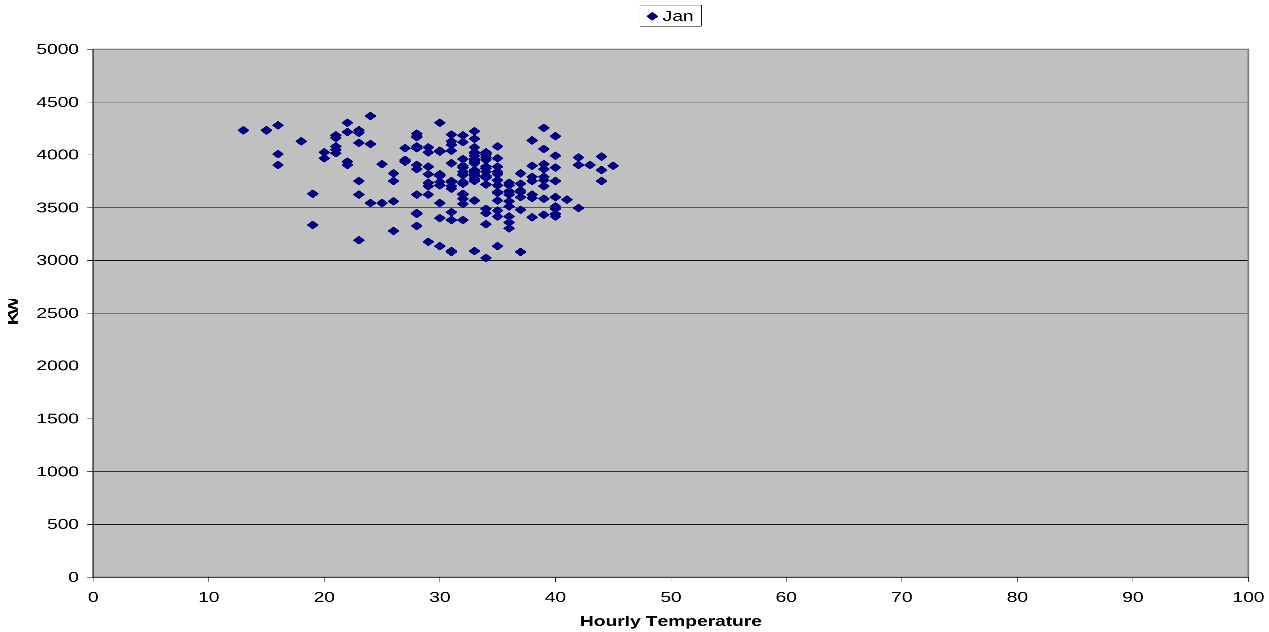


Working with weekday only daytime loads and temperatures also shows some interesting patterns.

Weekdays- Tuesdays through Thursdays

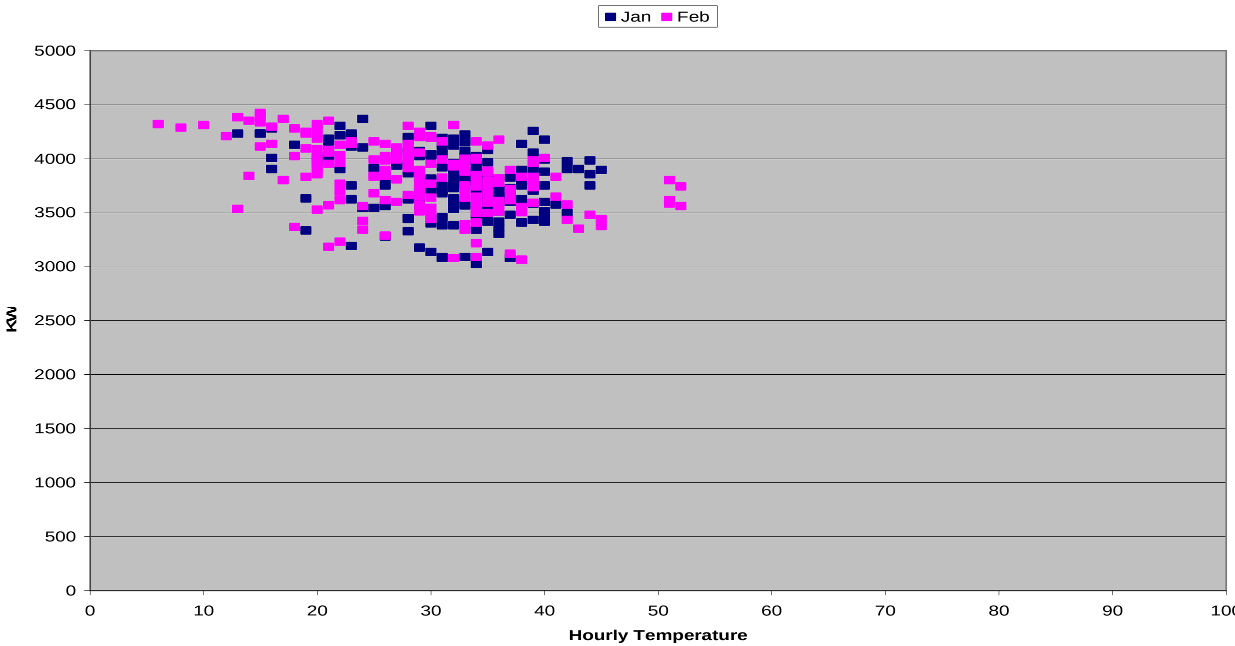
Daytime- 7:00 am through 10:00 pm

Eastern City Weekday Daytime only Load Jan 2006



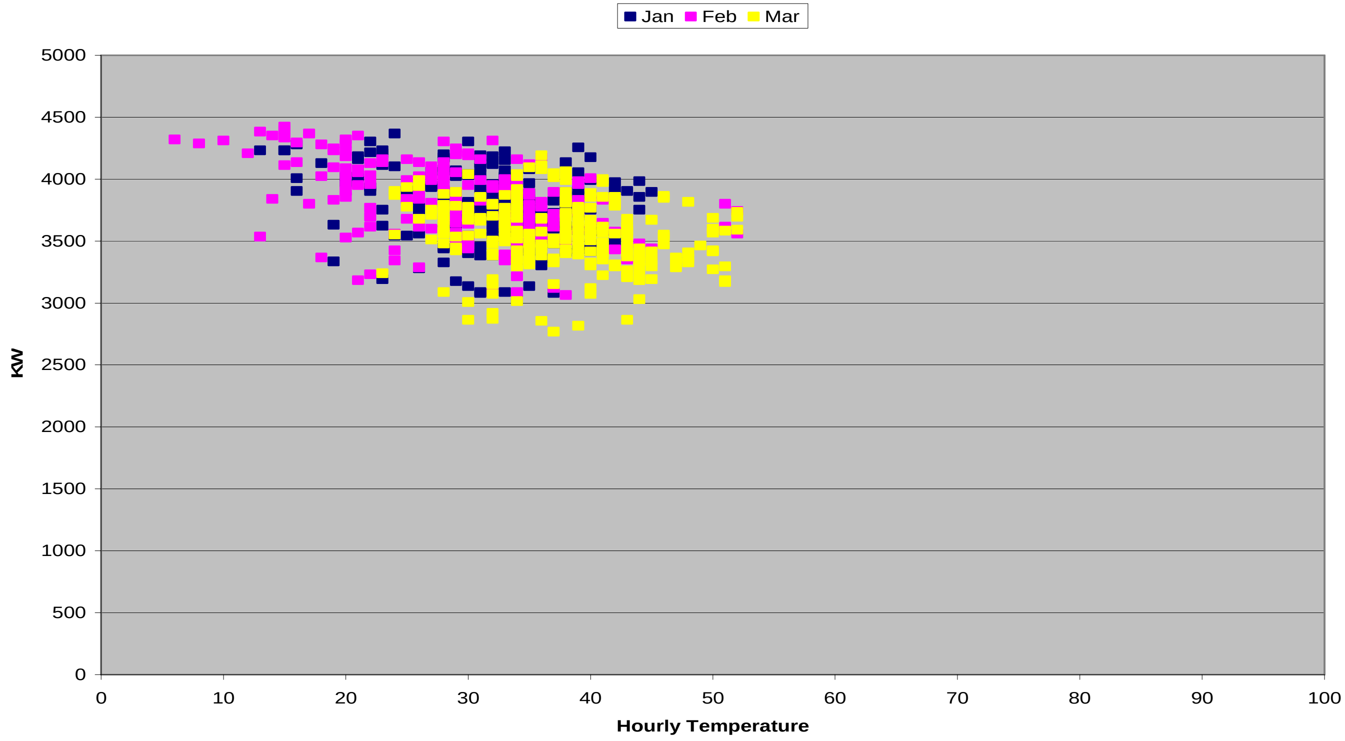
January loads behave as expected

Eastern City Weekday Daytime only Load
Jan 2006 through Feb 2006



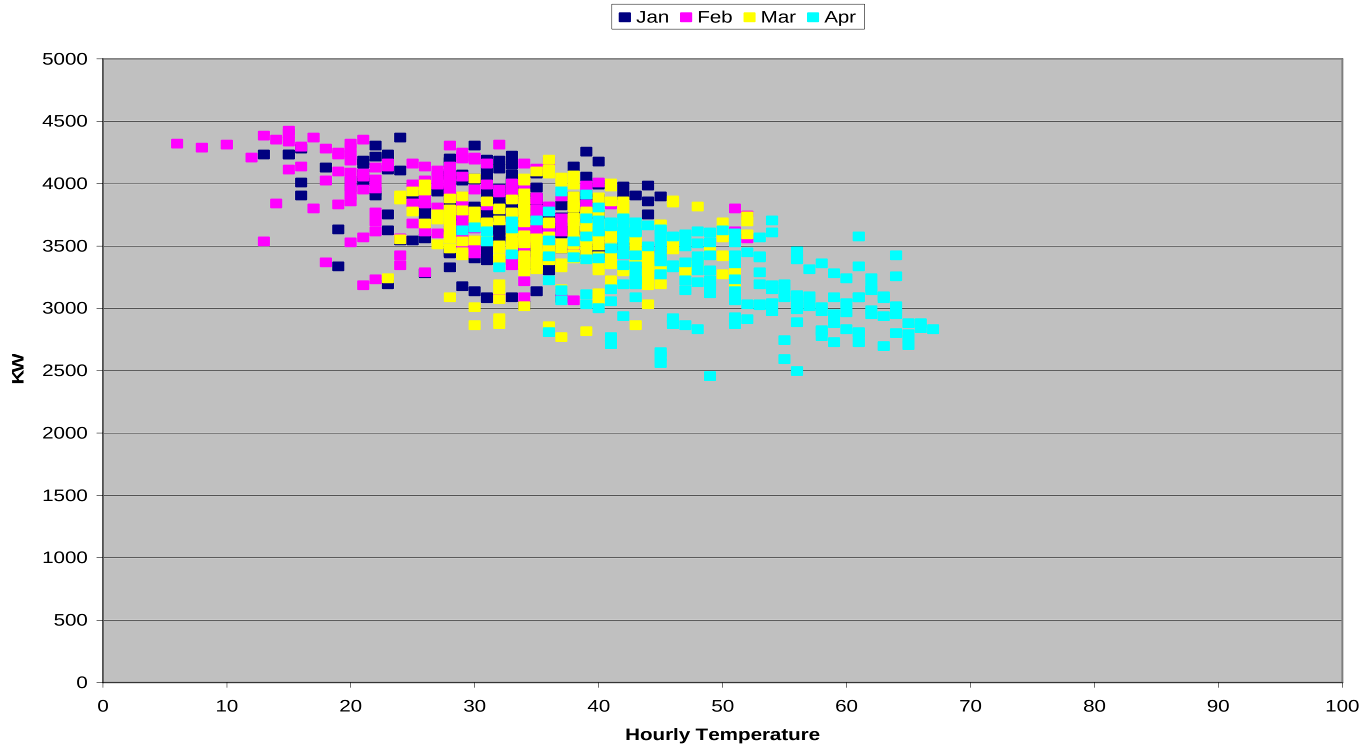
Similar behavior is seen as the winter continues into February

Eastern City Weekday Daytime only Load Jan 2006 through Mar 2006



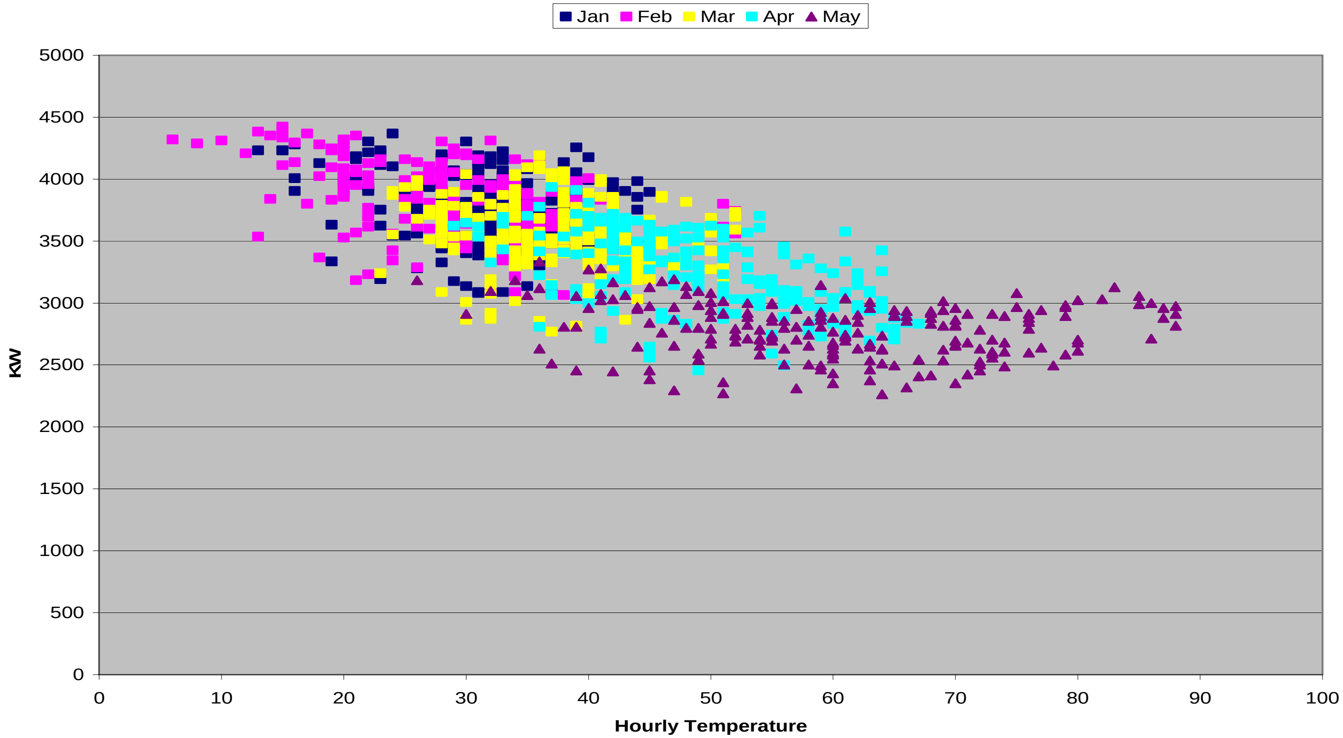
Load levels continue to drop as the temperatures rise in March however, there is probably some change also due to decreased lighting

Eastern City Weekday Daytime only Load Jan 2006 through Apr 2006



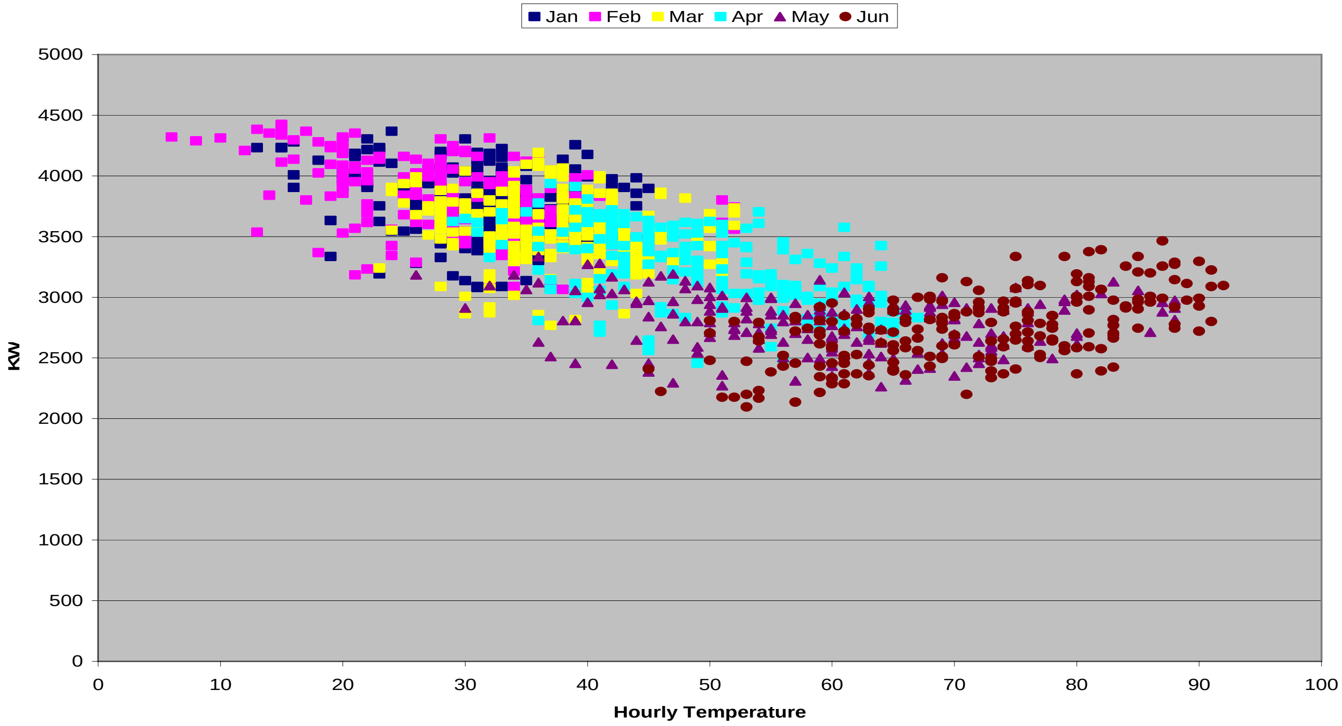
A continue of the pattern is seen into April. Interestingly as the temperatures get around 55 degrees and above there is less change. Also, in April if the temperature hits 70 degrees there is no air conditioning going on.

Eastern City Weekday Daytime only Load
Jan 2006 through May 2006



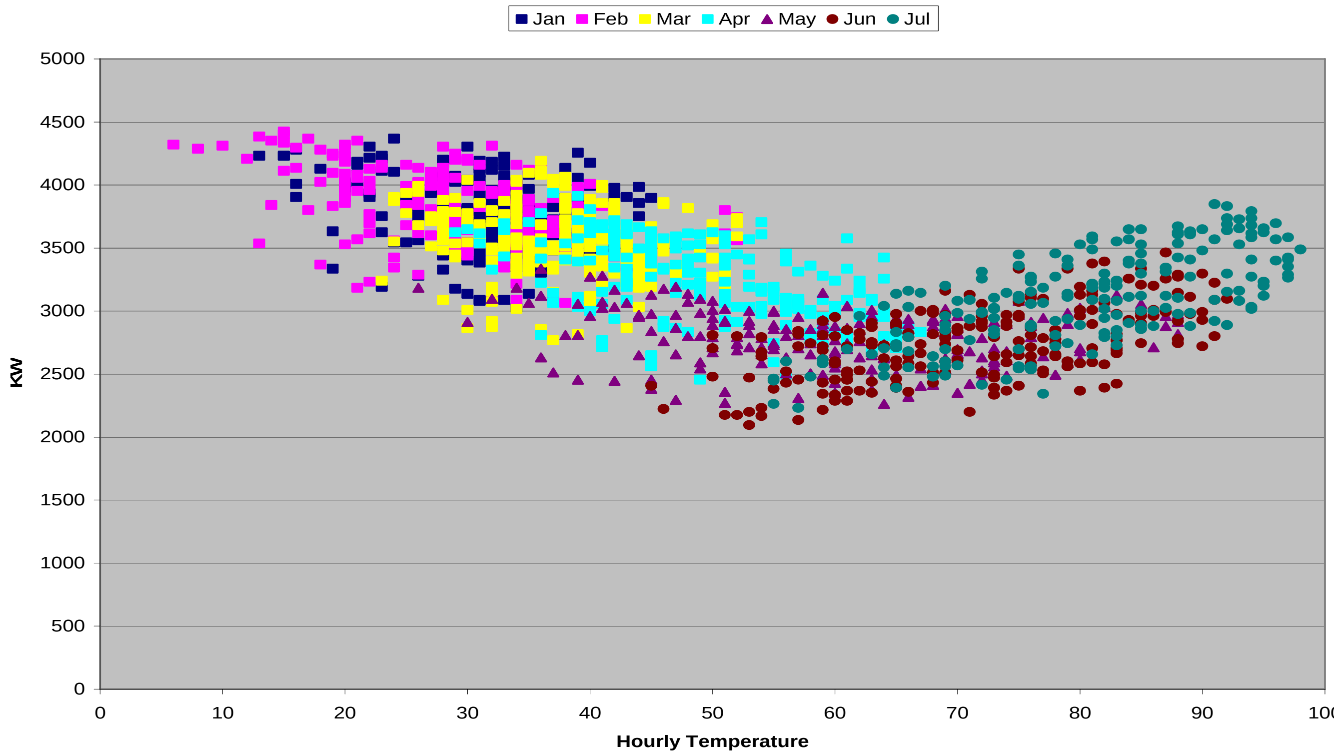
In May you can see the effects of heating continuing and the start of cooling. Also, you will notice a lower load level as the lighting requirements drop

Eastern City Weekday Daytime only Load
Jan 2006 through Jun 2006



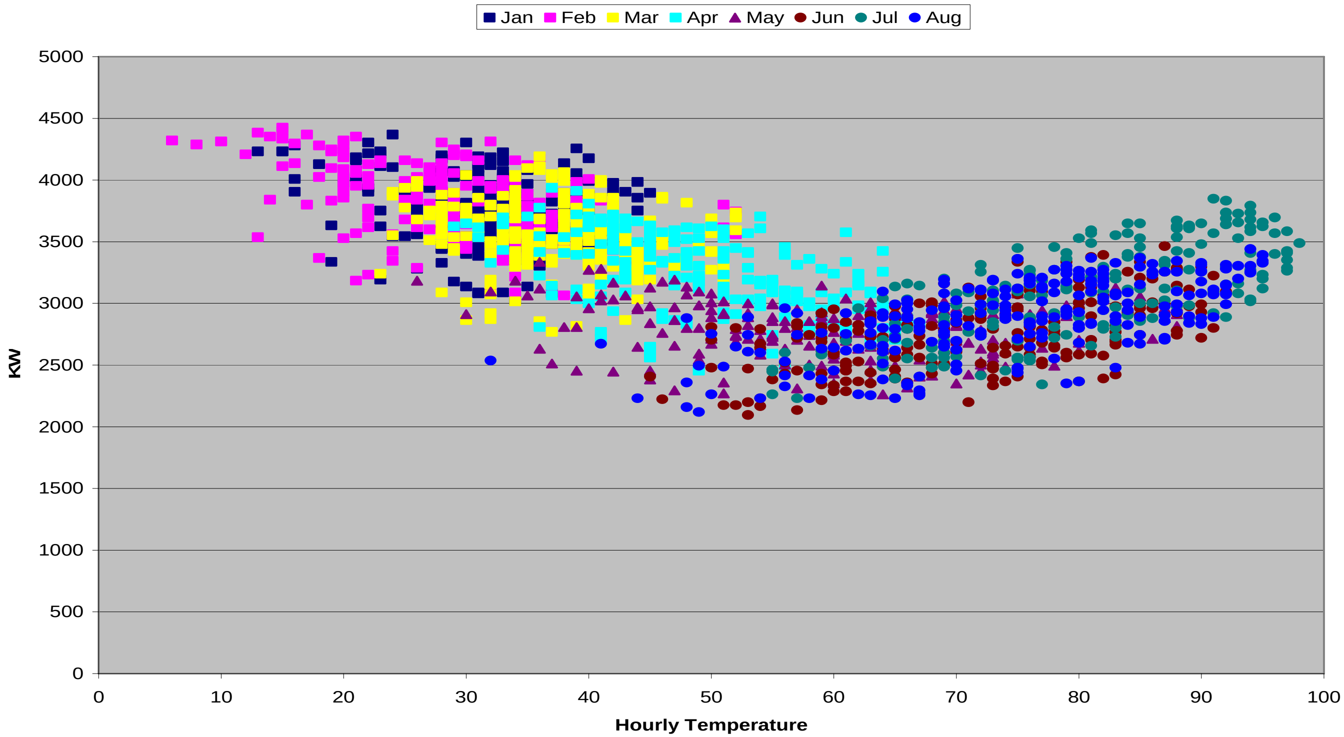
More air conditioning impacts are seen in June. Also at temperatures that use to have associated heating loads we are now not seeing any

Eastern City Weekday Daytime only Load
Jan 2006 through Jul 2006



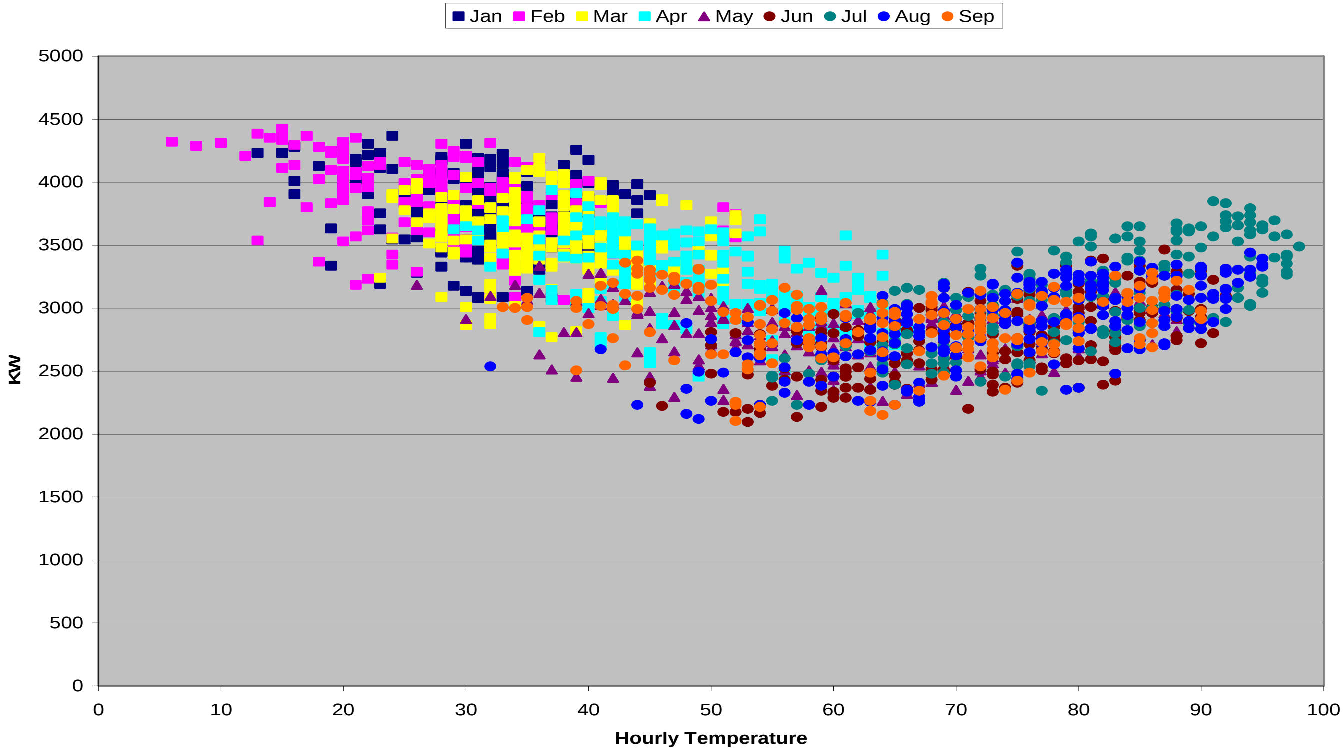
Summer air conditioning load continues to show a relationship to temperatures

Eastern City Weekday Daytime only Load Jan 2006 through Aug 2006



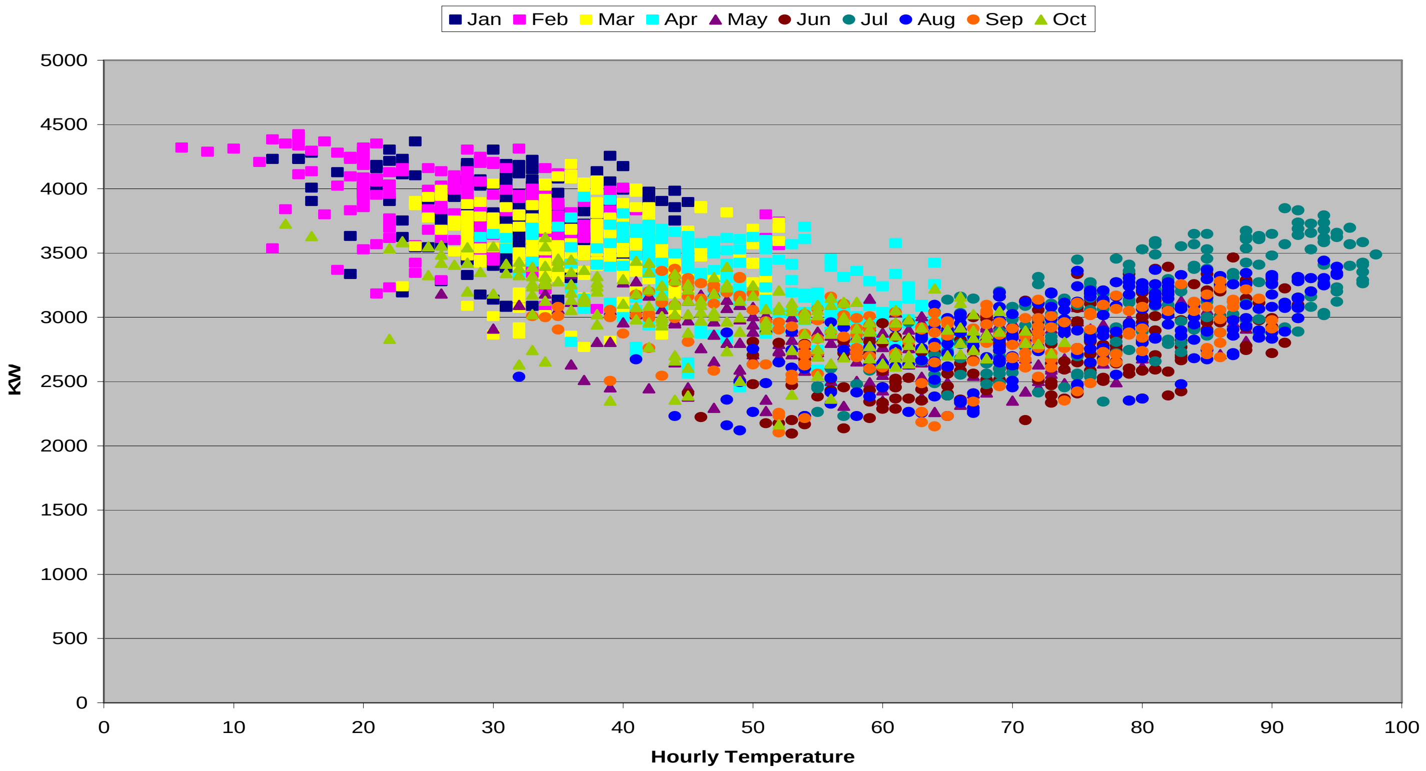
Air conditioning continues into August

Eastern City Weekday Daytime only Load Jan 2006 through Sep 2006



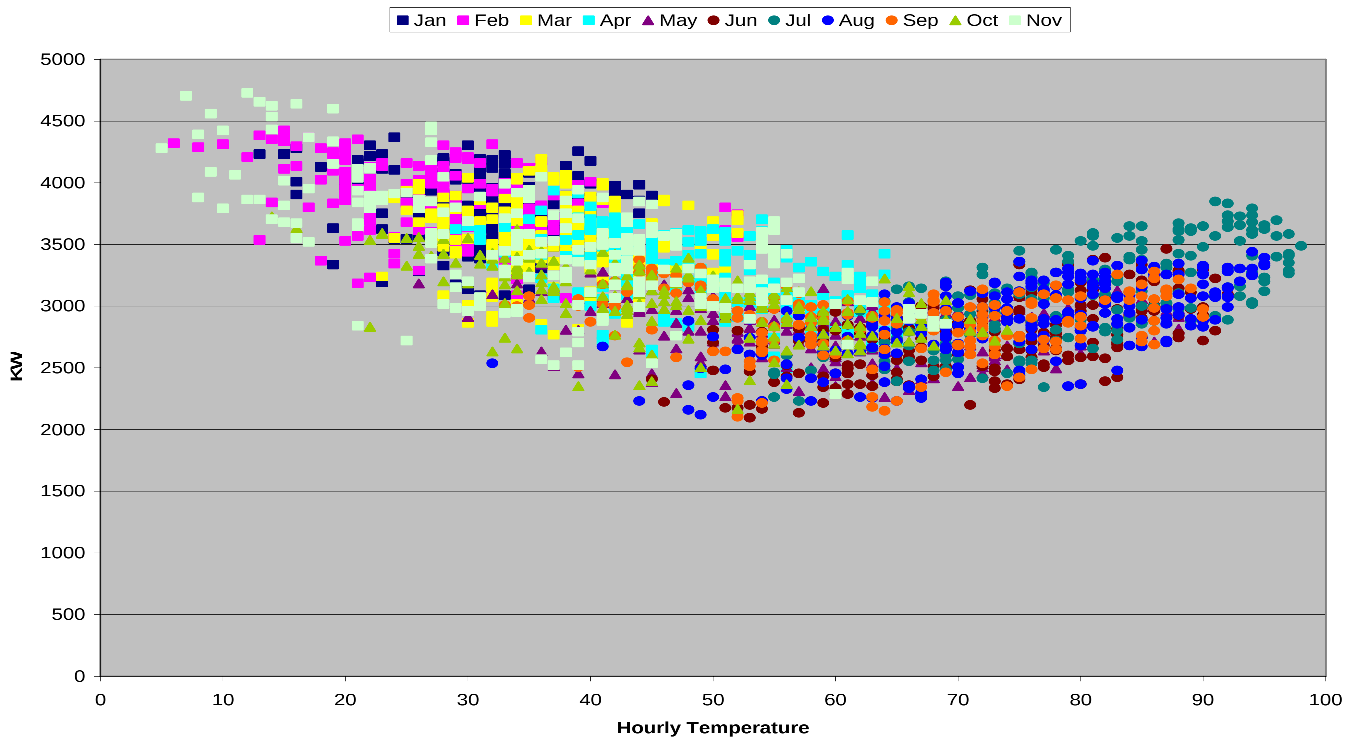
In September we see the beginning of the heating load return with cooler temperatures

Eastern City Weekday Daytime only Load Jan 2006 through Oct 2006



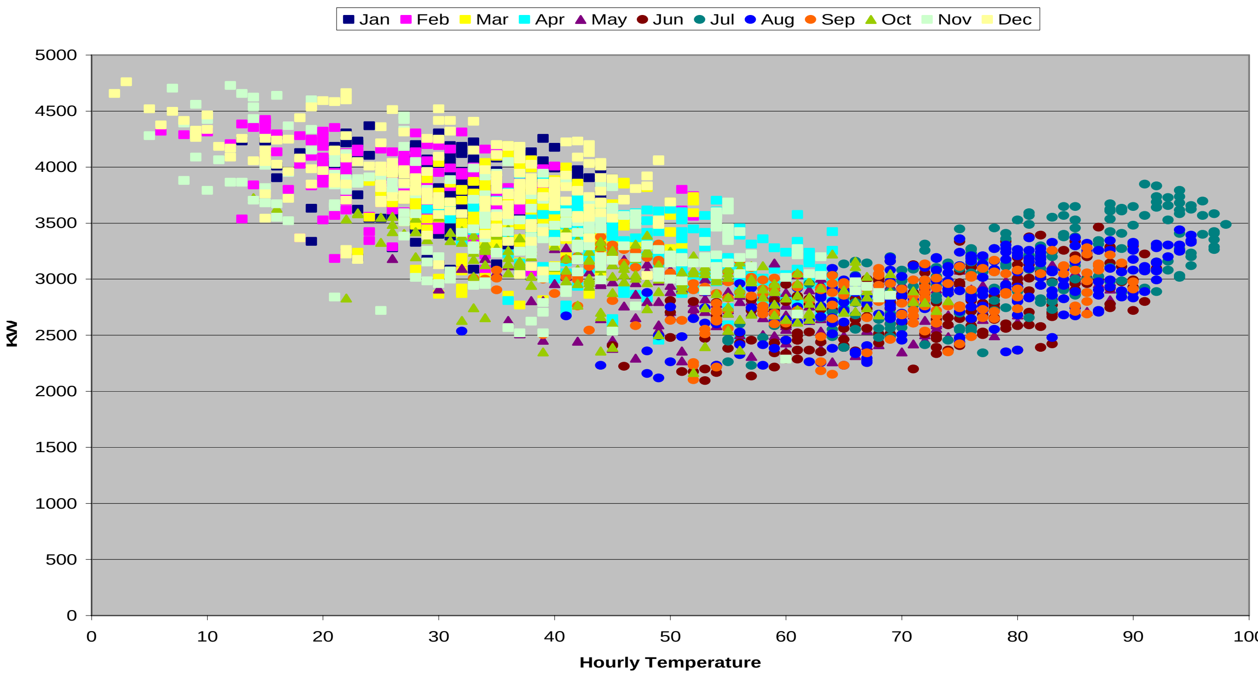
October also shows the heating and cooling pattern over the month

Eastern City Weekday Daytime only Load
Jan 2006 through Nov 2006



November moves back into the pattern seen in the last winter

Eastern City Weekday Daytime only Load Jan 2006 through Dec 2006

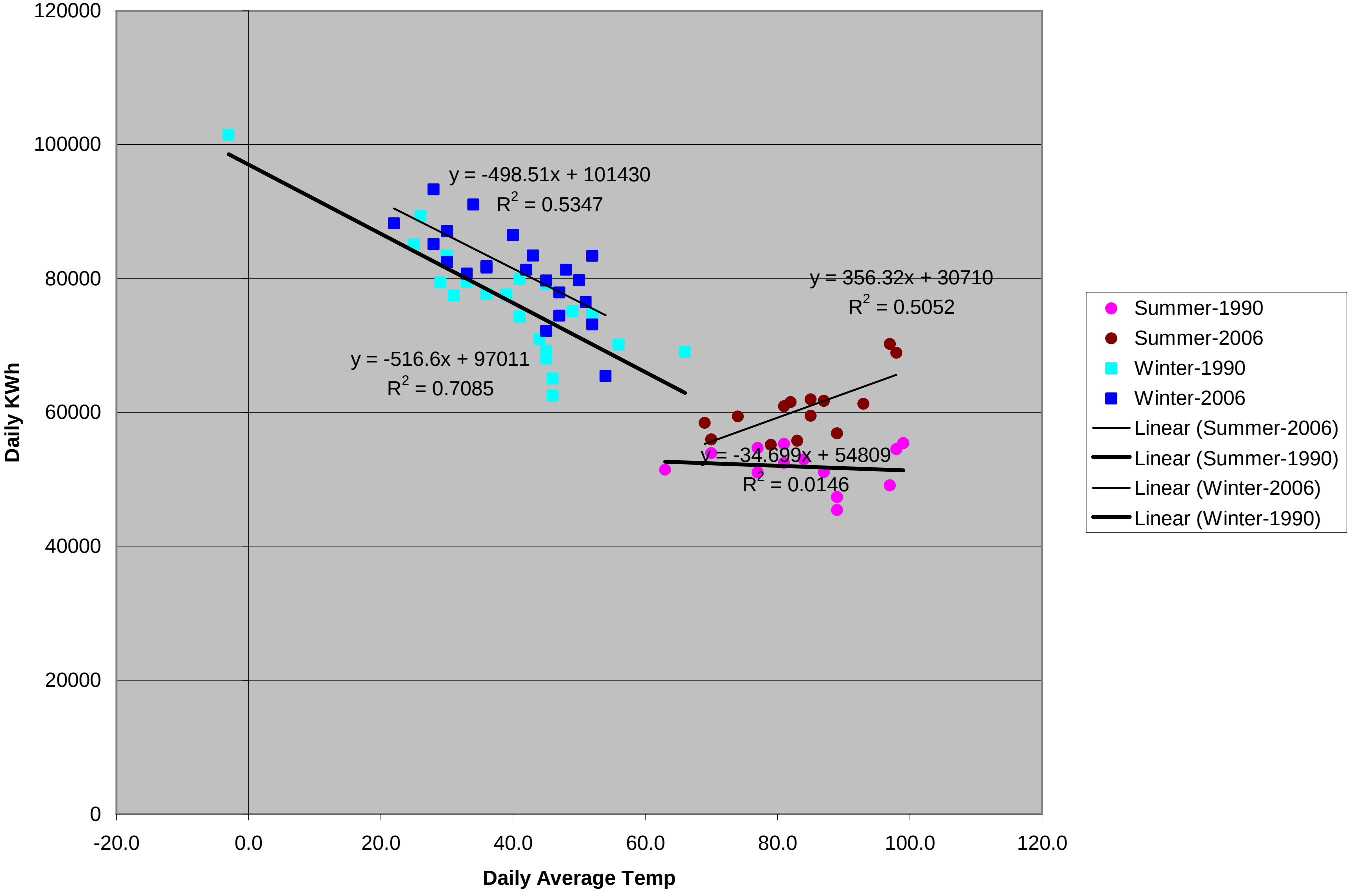


December shows that year after year the heating pattern continues through the season

Conclusion 4

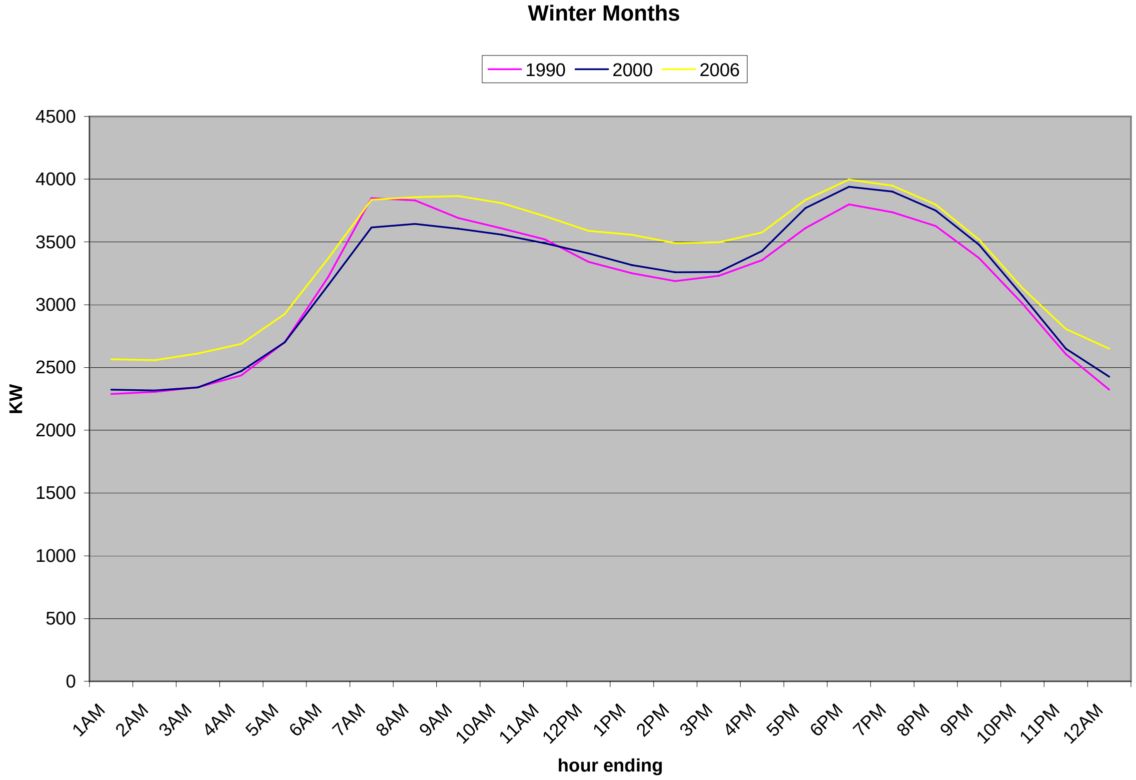
- Energy response to temperature is similar by season. There is little monthly difference. Models sufficiently fit to the seasons capture the energy response to temperature.

Eastern City
Temperature response changes over time



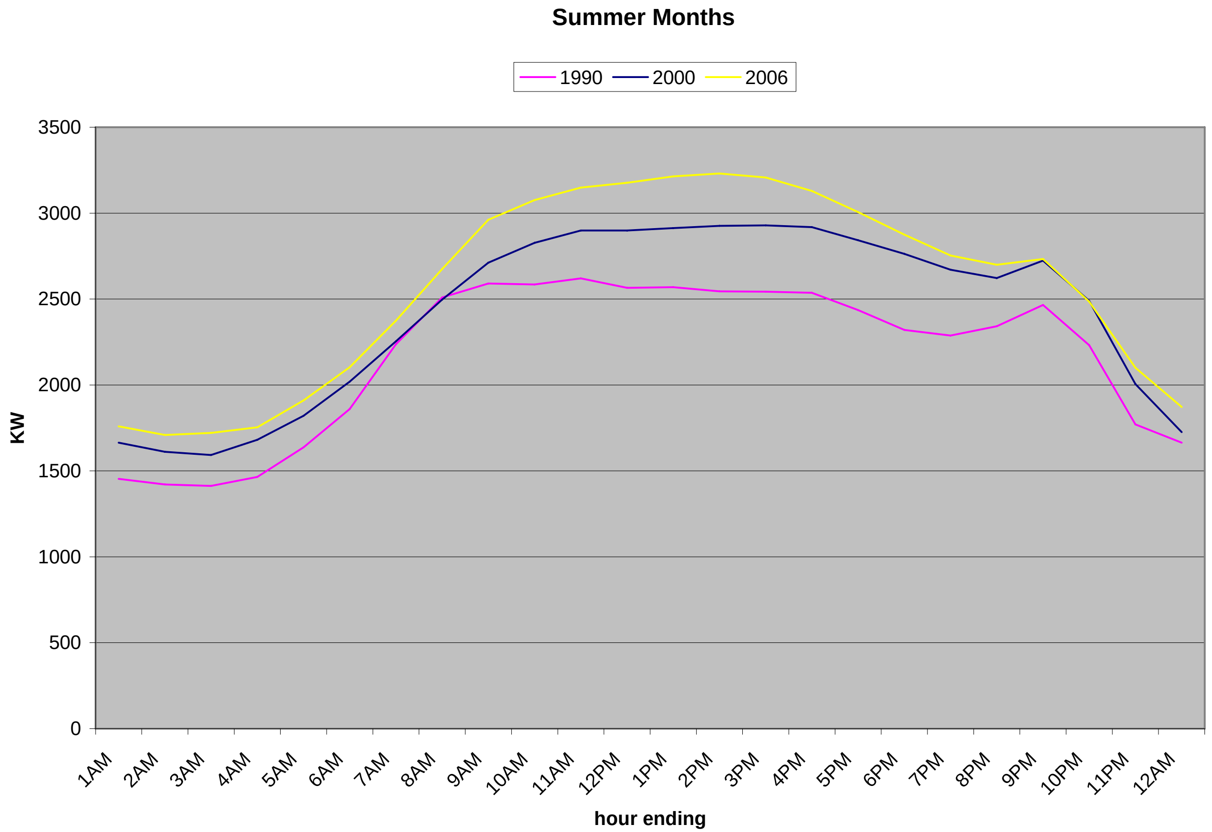
Summer impacts definitely changing due to increasing air conditioning penetration.

Eastern City
Seasonal Average Daily Load Shape



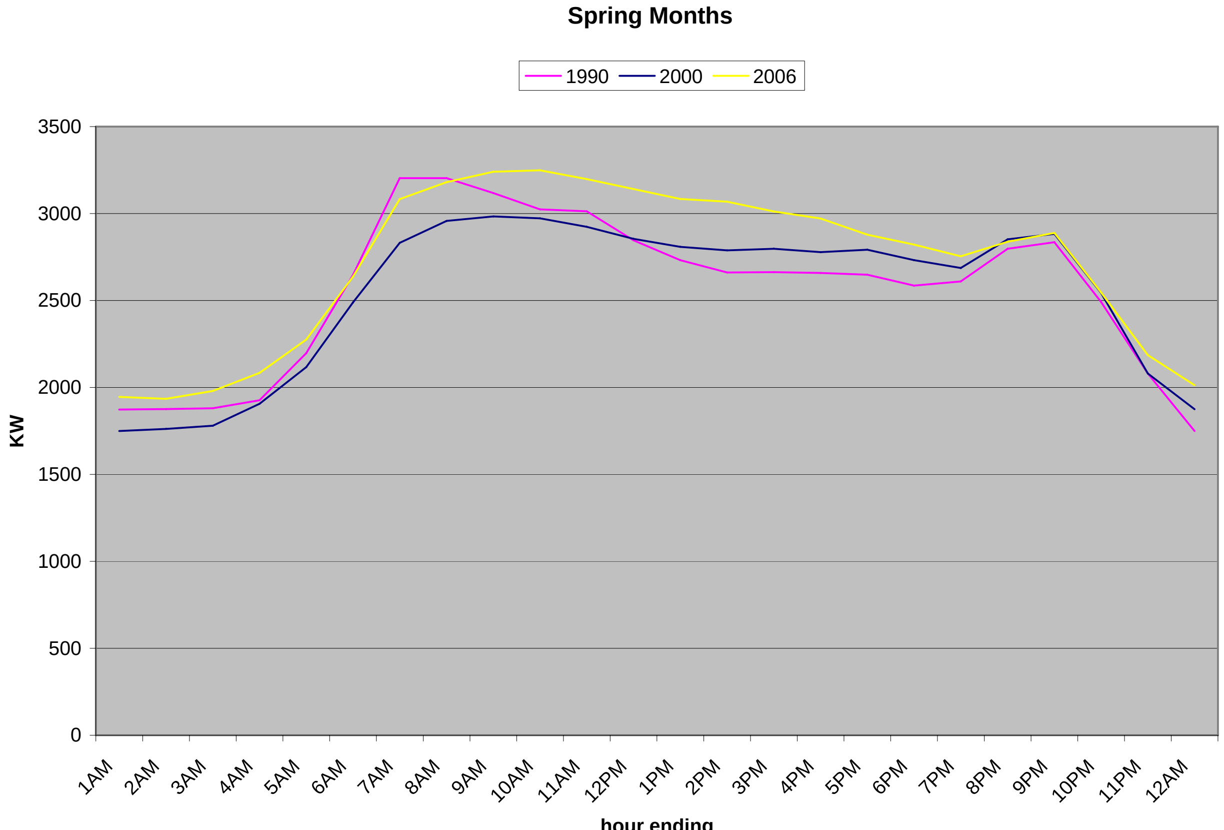
Winter shapes about the same and there may be some loss of electric space heating equipment

Eastern City
Seasonal Average Daily Load Shape



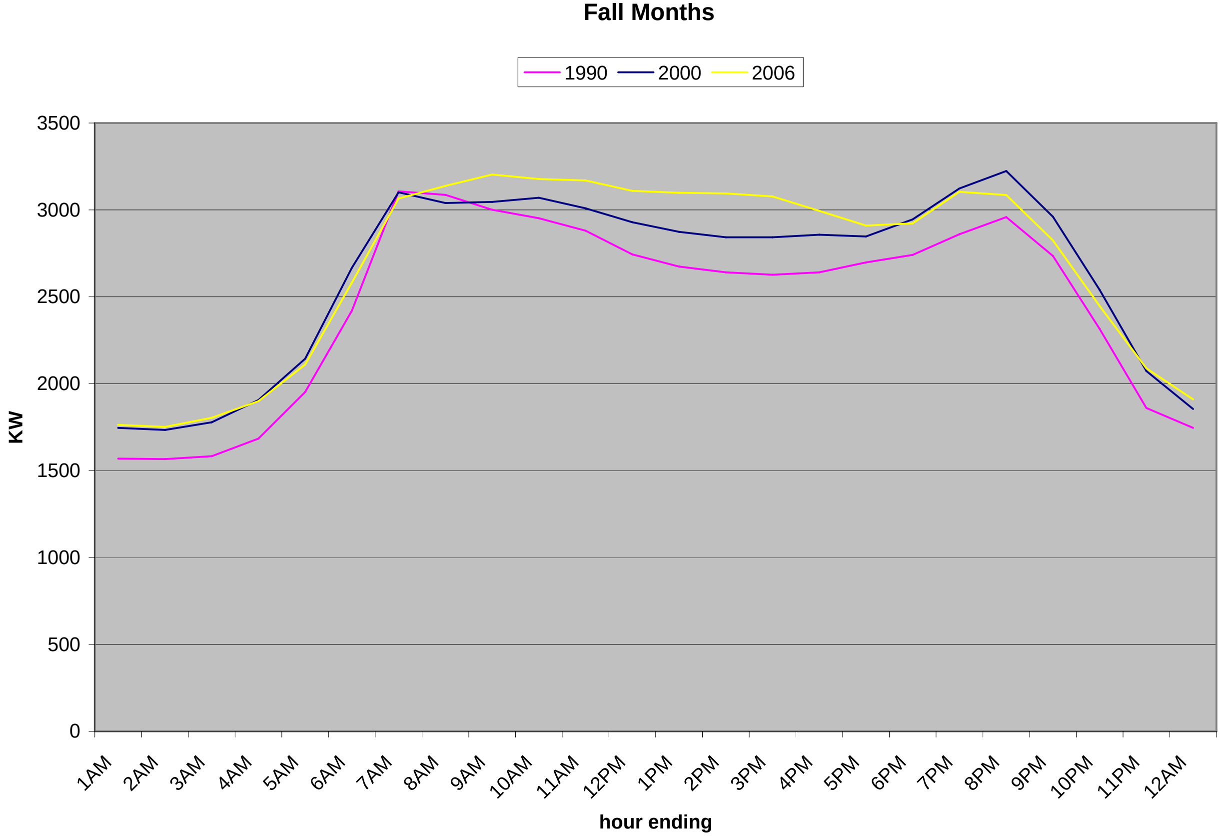
Summer shapes definitely changing due to increasing air conditioning impact

Eastern City
Seasonal Average Daily Load Shape



Spring shape slightly changing. Often shows changes due to commercial customer air conditioning penetration. Commercial customers typically start and end air conditioning earlier and later in the year than residential customers.

Eastern City
Seasonal Average Daily Load Shape



Fall shape also slightly changing. Likely also due to commercial customer air conditioning penetration.

Conclusion 5

- Change in relationship between energy and temperature occurs over time with the preferences for space conditioning equipment. Developing the data on more recent time periods captures what is currently happening.

Calculating Degree Days is Important

- Due to the linear nature of the energy to temperature relationship, calculating degree days (DD) is critical

Weather normalization mathematical form   Y= coefficient * DD

Standard Base DD calculation.

- •Heating DD (HDD) = 65-Average Temperature
- •Cooling DD (CDD) = Average Temperature-65

•Non-standard Base of 55 would give more CDD than a base of 65, thus reducing the coefficient when estimating it over the entire data set. This lower coefficient is then applied to specific periods resulting in incorrect daily and monthly calculations for each period.

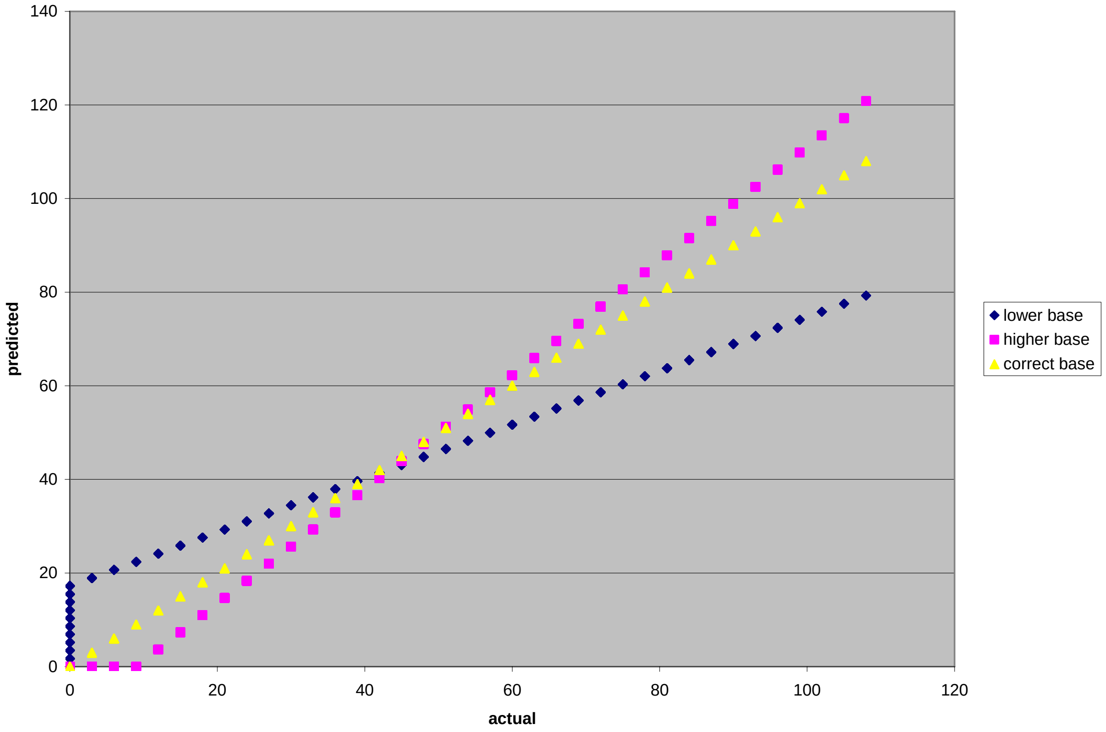
•For example

- •Real values: weather coefficient 3 kw per CDD, temperature 80, CDD base65=15, weather impact 45 kw.
- •Incorrectly modeled values: weather coefficient 1.72 kw per CDD, temperature 80, CDD base55=25, weather impact 43 kw.

Calculating Degree Days is Important

Not all consumers respond to temperature at 65 degrees

Degree Days can be calculated at any base value



Test dataset showed that when using the correct base the measured impact and the predicted are equal (yellow line)

Using a lower base overestimated the weather impact at lower temperatures and underestimated the impact at higher temperatures (blue line)

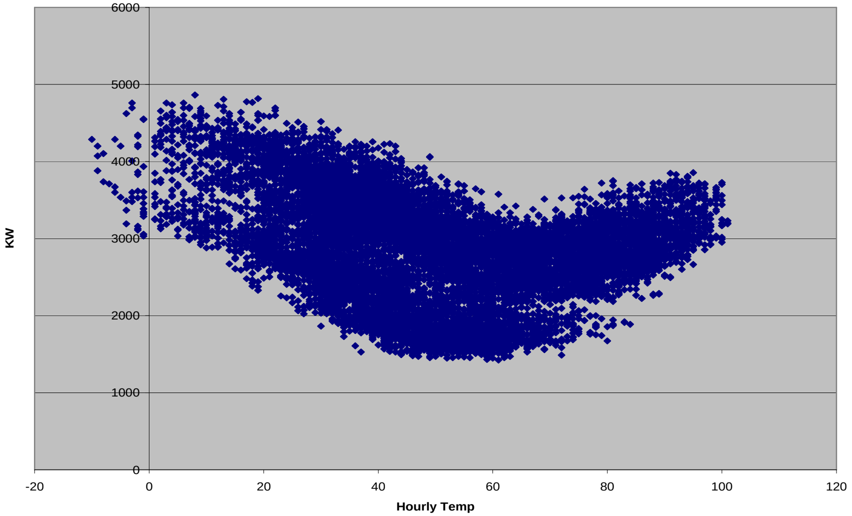
Using a higher base gives the opposite condition. (red line)

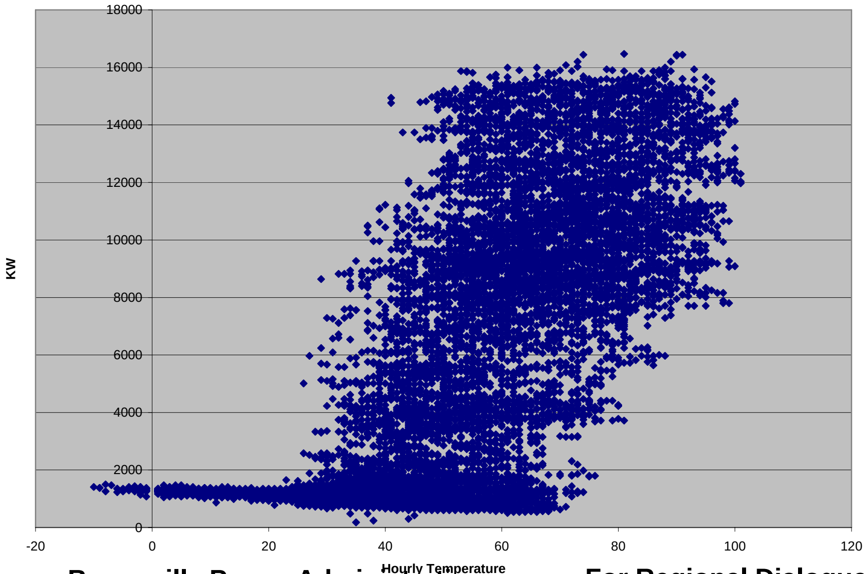
Regardless of the direction, using an incorrect base temperature in calculating DD gives an incorrect weather impact.

Conclusion 6

- The determination of the base temperature is important. Test data showed that using either higher or lower base temperature gives an incorrect estimate. Using the base temperature with the best statistical fit gives the most correct estimate of weather impacts.

Weather Impacts on Customer Classes



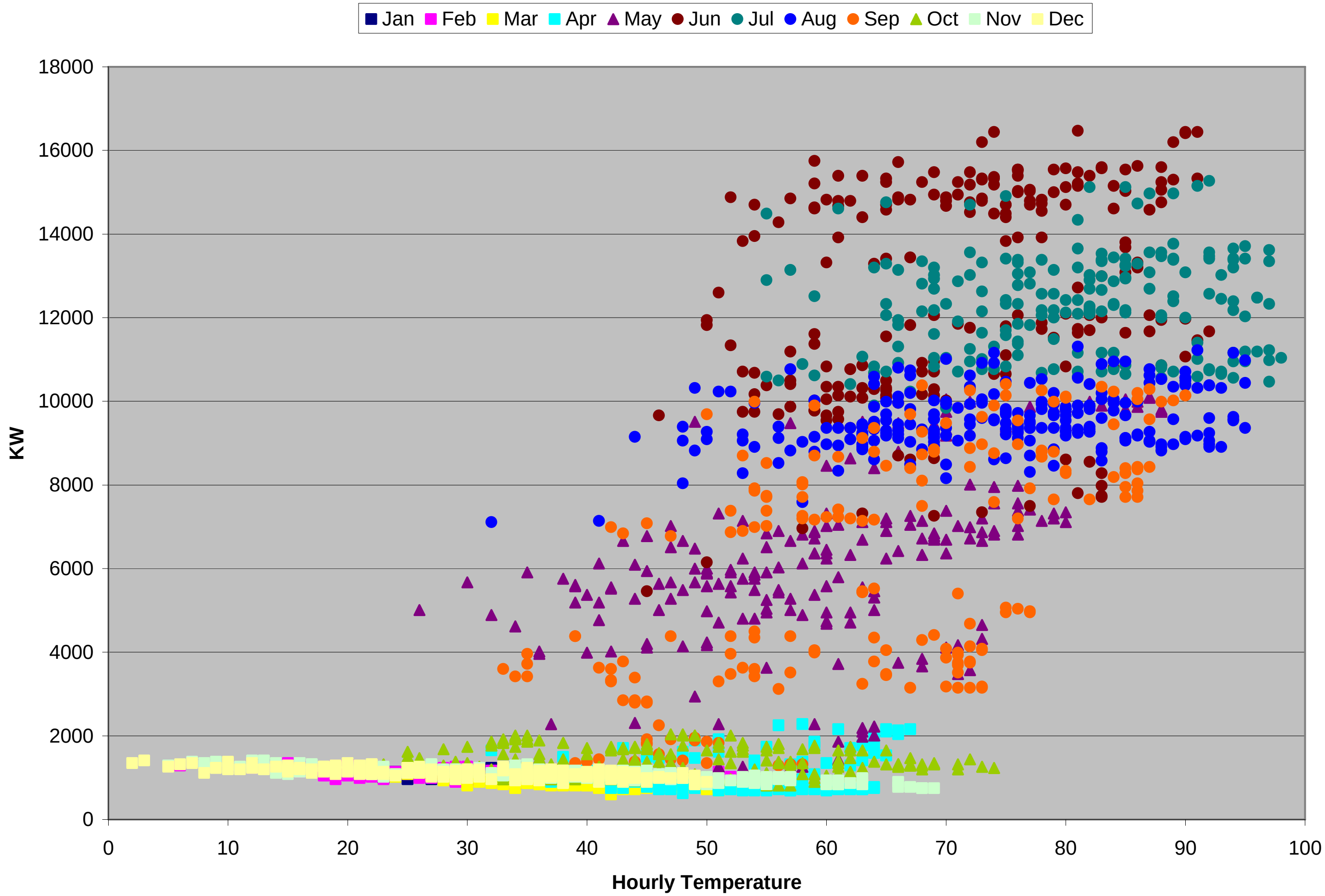


Delivery points with a majority of load by common customer types do not show similar energy to weather relationships.

Top Graph shows eastern city loads and weather relationship

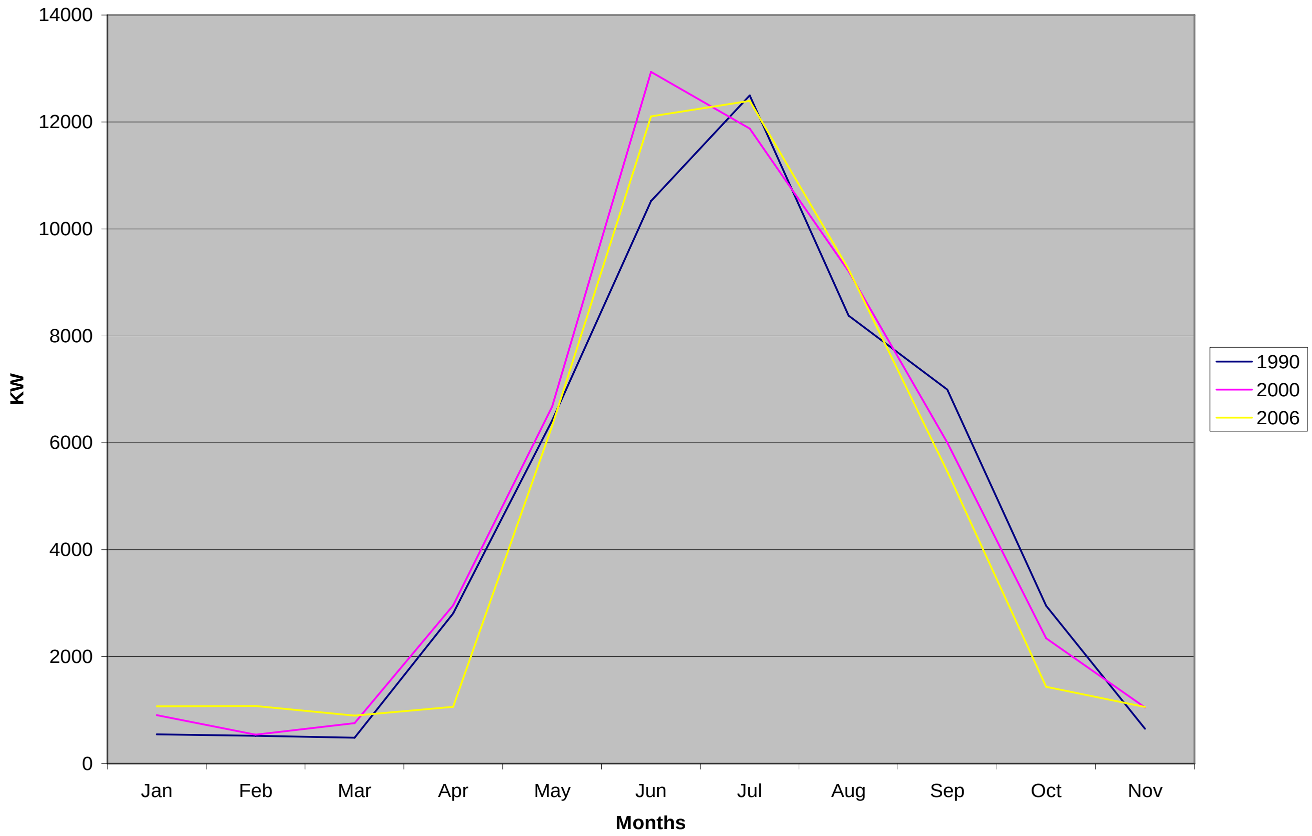
Bottom graph shows eastern mainly irrigation loads delivery point.

Weather Impacts on Customer Classes



A closer look shows very little if any linear relationship between loads and temperatures on a monthly basis in summer months for the irrigation area.

Weather Impacts on Customer Classes



Monthly patterns for irrigation loads don't show the typical city load shape. Often the variability in the monthly shape occurs in the early part of the season as rainfall impacts the pumping requirements.

Conclusion 7

- Irrigation impacts are typically different from the temperature impacts of other customer groups. This impact is not temperature affected and is best modeled by the irrigation normalization proposal.
- Wind impacts on generators would be similar and best modeled through the anomalies adjustment.

Weather Normalization Summary

- Given the important aspects of weather normalization (energy to temperature relationships) BPA captures the correct measures .
- The application of this method across all customers will assure an equitable, verifiable, and transparent treatment.
- Wind and its impact on generation are best treated as an anomaly adjustment where applicable and not a weather adjustment

Irrigation Normalization

- Reporting (Getting the data)
  - Customers will be required to submit monthly irrigation data via an updated BPA Form 110 (financial & statistical data report).
  - The reporting period for irrigation will be extended to include May and September data.

- Historical Years (How to calculate normal irrigation)
  - Use the updated BPA Form 110 for 2008-2010 and get the missing data from 2005-2007 from the necessary customers.
  - BPA proposes using the last 5 year average for the normal weather value

- Included Customers (Who gets the adjustment)
  - BPA proposes that all customers who complete the BPA Form 110 and supply the necessary irrigation data get the irrigation adjustment.

Financial & Statistical report (Annual summary)

FINANCIAL AND STATISTICAL REPORT

Customer Name: United Electric

Report for Calendar Year: 2007

CERTIFICATION

We hereby certify this report is in accordance with the accounts and other records of the system and reflect the status of the system to the best of our knowledge and belief.

Signature of Office Manager or Accountant	Date	Signature of Manager	Date

Part A: Statement of Operations

ITEM	2007
1. Operating Revenue & Patronage Cap.	$0
2. Power Production Expense	$0
3. Cost of Purchased Power	$0
4. Transmission Expense	$0
5. Distribution Expense - Operation	$0
6. Distribution Expense - Maintenance	$0
7. Consumer Accounts Expense	$0
8. Consumer Service & Information Expense	$0
9. Sales Expense	$0
10. Administrative & General Expense	$0
11. Operation & Maintenance Exp. (2-10)	**$0**
12. Depreciation & Amortization Expense	0
13. Tax Expense - Property	0
14. Tax Expense - Other	0
15. Interest on Long-Term Debt	0
16. Interest Charged to Construction - Credit	0
17. Interest Expense - Other	0
18. Other Deductions	0
19. Cost of Electric Service (11-18)	**$0**
20. Patr. Capital & Operating Margins	**$0**
21. Nonoperation Margins - Interest	0
22. Allowance for Funds Used During Construction	0
23. Income (Loss) from Equity Investments	0
24. Nonoperation Margins - Other	0
25. Generation and Transmission Capital Credits	0
26. Other Capital Credits & Patronage	0
27. Extraordinary Items	0
28. Total Patr. Capital or Margins (20-27)	**$0**

Part B: Data on Transmission and Distribution Plant

ITEM	2007	ITEM	2007
1. New Services Connected		5. Miles Transmission	
2. Services Retired		6. Miles Dist. Overhead	
3. Total Services in Place		7. Miles Dist. Underground	
4. Idle Services		8. Total Miles Energized	0

PART C. BALANCE SHEET

ASSETS AND OTHER DEBITS	2007	LIABILITIES AND OTHER CREDITS	2007
PROPERTY ACCOUNTS		**MARGINS & EQUITIES**	
1. Total Utility Plant in Service		25. Memberships	
2. Construction Work in Progress		26. Patronage Capital	
3. Total Utility Plant (1 + 2)		27. Operating Margins-Prior Years	
4. Accum. Provision for Depreciation and Amort		28. Operating Margins-Current Year	
5. Net Utility Plant (3 - 4)	**$0**	29. Non Operating Margins	
INVESTMENT AND FUND ACCOUNTS		30. Other Margins and Equities	
6. Nonutility Property - Net		31. Total Margins & Equities (25 thru 30)	**$0**
7. Investments in Subsidiary Companies		**LONG TERM DEBT**	
8. Invest. in Assoc. Org.		32. Long-Term Debt	
9. Invest. in Economic Development Projects		**OTHER NONCURRENT LIABILITIES**	
10. Other Investments		33. Oblig. Under Capital Leases - Noncurrent	
11. Total Other Property & Invest. (6 thru 10)	**$0**	34. Accumulated Operating Provisions	
CURRENT AND ACCRUED ASSETS		35. Total Other Noncurrent Liabilities (33 + 34)	**$0**
12. Cash-General Funds		**CURRENT & ACCRUED LIABILITIES**	
13. Cash-Construction Funds-Trustee		36. Notes Payable	
14. Special Deposits		37. Accounts Payable	
15. Temporary Investments		38. Consumers Deposits	
16. Notes Receivable-Net		39. Current Maturities Long-Term Debt	
17. Accounts Receivable		40. Current Maturities Long-Term Debt-Econ. Dev	
18. Materials & Supplies - Electric and Other		41. Current Maturities Capital Leases	
19. Prepayments		42. Other Current & Accrued Liabilities	
20. Other Current & Accrued Assets		43. Total Current & Accrued Liabilities (36 thru 42)	**$0**
21. Total Current & Accrued Assets (12 thru 20)	**$0**		
22. Regulatory Assets	0	44. Other Deferred Credits	
23. Other Deferred Debits	0		
24. Total Assets & Other Debits (5+11+21 thru 23)	**$0**	45. Total Liabilities & Other Credits (21+23+27+36+38)	**$0**

Financial & Statistical report (Monthly detail)

FINANCIAL AND STATISTICAL REPORT														Customer Name: United Electric Period Ending: December 31, 2007		
			MONTHLY DATA													
	CLASSIFICATION		JANUARY *(a)*	FEBRUARY *(b)*	MARCH *(c)*	APRIL *(d)*	MAY *(e)*	JUNE *(f)*	JULY *(g)*	AUGUST *(h)*	SEPTEMBER *(i)*	OCTOBER *(j)*	NOVEMBER *(k)*	DECEMBER *(l)*	MAX/TOTAL *(Columns a thru l)*
1.	**Residential Sales** ***exclude seasonal***	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
2.	**Residential Sales** ***Seasonal***	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
3.	**Irrigation Sales**	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
4.	**Commercial Sales** *≤ 1,000 kVA*	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
5.	**Commercial Sales** *>1,000 kVA*	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
6.	**Industrial Sales** *≤ 1,000 kVA*	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
7.	**Industrial Sales** *>1,000 kVA*	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
8.	**Public Street & Highway Lighting Sales**	a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
9.		a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
10.		a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
11.		a. No. Consumers													0
		b. kWH Sold													**0**
		c. Revenue													$0
12.	TOTAL No. Consumers (lines 1a - 9a)		0	0	0	0	0	0	0	0	0	0	0	0	0
13.	TOTAL kWh Sold (lines 1b - 9b)		0	0	0	0	0	0	0	0	0	0	0	0	0
14.	TOTAL Revenue (lines 1c - 9c)		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
15.	Other Electric Revenue		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
16.	kWh - Own Use														0
17.	TOTAL kWh Purchased														0
18.	TOTAL kWh Generated														0
19.	Peak Demand - kW	☐ Coincident													0
		☐ Non-Coincident													0

Data Cleaning Considerations

- There may be issues with customer meter reads in 2010. BPA will continue the current practices to fill missing data points or bad reads.
- When meter readings are not available due to meter hardware failure or data is determined to be invalid due to meter malfunction or calibration/configuration error, BPA will estimate the erroneous readings in accordance to BPA's Settlement Estimation Procedures
- This is consistent with utility best practices.