



Technical Workshop Load Forecasting

January 24, 2006



Agenda

- Preliminary Industrial Energy Sales Forecast
 - State by State
 - Mix and Growth by Sector – 2007 and 2017
 - Sector by Sector Model Review
- Hourly Load Forecast
 - General Model Specification by Jurisdiction
 - Forecast Process
 - Improvements in the Process
 - System Coincident Peak Demand & Jurisdiction Contribution Results
 - State Peak Demands
 - Next Steps
- Price Elasticity
 - Price Elasticity in Current Models
 - Econometric Elasticity Calculations
 - Price Reaction of Customers Who Called About the Rate Change
 - Elasticity Among Customer Sub-Groups
 - Potential Further Research



Preliminary Industrial Energy Sales Forecast



Overview

Order of Presentation

- **Utah**
- **Oregon**
- **Wyoming**
- **California**
- **Idaho**
- **Washington**

Content for each State

- **Mix and Growth by Sector – 2007 and 2017**
- **Sector by Sector Model Review**



Utah Industrial Forecast

Kevin Cline



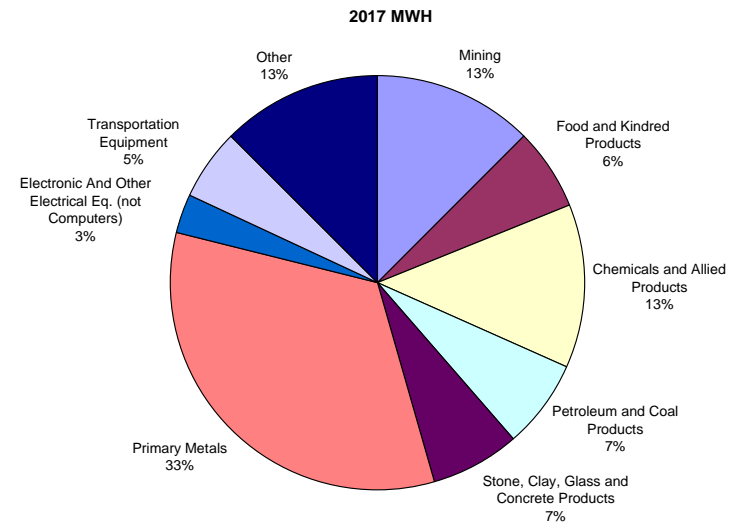
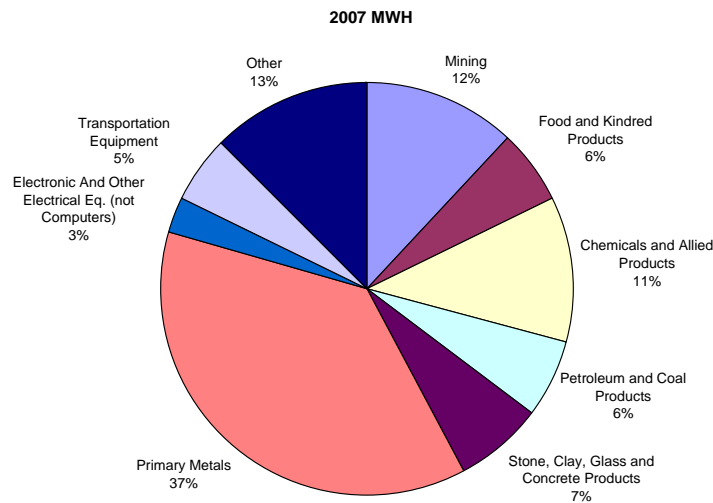
Utah Industrial Mix

Sector

Mining
 Food and Kindred Products
 Chemicals and Allied Products
 Petroleum and Coal Products
 Stone, Clay, Glass and Concrete Products
 Primary Metals
 Electronic And Other Electrical Eq. (not Computers)
 Transportation Equipment
 Other

Growth Rates

	1997-2004	2007-2017
Mining	4.91%	2.08%
Food and Kindred Products	6.30%	2.14%
Chemicals and Allied Products	-8.59%	2.63%
Petroleum and Coal Products	-0.50%	2.54%
Stone, Clay, Glass and Concrete Products	6.30%	1.44%
Primary Metals	1.27%	0.34%
Electronic And Other Electrical Eq. (not Computers)	4.05%	2.65%
Transportation Equipment	1.62%	1.88%
Other	-0.17%	1.42%
Total	0.13%	1.44%



Utah – Mining (SIC 12, 13, 14)

Dependent variable annual MWh in SIC 12, 13, 14

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	(2,401)	45,368	(0.05)	0.9583
	UT_COAL_TON	25,330	5,323	4.76	0.0001
	TIME_TREND	13,865	3,193	4.34	0.0003
	R-squared	0.9604			
	Adjusted R-squared	0.9566			

Explanatory variables

UT_COAL_TON is Global Insight forecast for the amount (in millions of tons) of steam coal delivered to the Mountain #1 region (includes UT) from the Uinta Coal Basin (includes UT)

TIME_TREND is a time trend that increases by one each year

Major Customers

Canyon Fuel (Sufco Mine, Skyline Mine, Dugout Canyon Mine), Energy West (Deer Creek Mine, Rilda), Conoco-Phillips, Tom Brown Inc., Inland Resources, Resolute Natural Resources, Simplot Phosphates, ExxonMobil Corp.

Utah – Mining (SIC 12, 13, 14)

Other Variables Considered

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

National industrial production index for SIC 12,13,14 (Global Insight forecast, no state-level index was available)

Historical data 1982-2005

Utah - Food and Kindred Products (SIC 20)

Dependent variable annual MWh in SIC 20

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	(296,245)	55,147	(5.37)	-
	IPI_20	4,991	691	7.22	-
	NG_PRICE	18,879	5,676	3.33	0.0034
	MA(1)	0.9	0.1	7.63	-
	R-squared	0.9615			
	Adjusted R-squared	0.9557			

Explanatory variables

IPI_20 is the Global Insight forecast for the national industrial production index for the food and kindred products sector

NG_PRICE is the Global Insight forecast for industrial end-user natural gas prices for the Mountain #1 region (includes UT)

MA(1) is a first-order moving average term

Major Customers

Seaboard Foods LLC, Smith's, Malt-O-Meal, Pepperidge Farms, American Nutrition, Western Quality Foods, Moroni Processing, Interstate Brands Corp

Utah - Food and Kindred Products (SIC 20)

Other Variables Considered

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

Utah state industrial production index for SIC 20 (Global Insight forecast)

Historical data 1982-2005

Utah - Chemicals and Allied Products (SIC 28)

Dependent variable Natural log of annual MWh in SIC 28

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	13.6	1.2	11.70	-
LOG(IPI_28)	0.6	0.2	4.07	0.0007
LOG(ELEC_P)	(0.9)	0.2	(4.80)	0.0001
MWH_28_02	(0.2)	0.0	(4.36)	0.0004
MWH_28_03	(0.3)	0.0	(8.15)	-
MA(1)	0.8	0.1	5.39	-
R-squared	0.9806			
Adjusted R-squared	0.9753			

Utah - Chemicals and Allied Products (SIC 28)

Explanatory variables

LOG(IPI_28) is the natural log of the Global Insight forecast for the national industrial production index for the chemicals sector

LOG(ELEC_P) is the natural log of the Global Insight forecast for industrial end-user electricity prices for the Mountain #1 region (includes UT)

MWH_28_02 and MWH_28_03 account for the fact that US Magnesium was reclassified from SIC 28 to SIC 33 in July 2002, affecting sector energy in both years

MA(1) is a first-order moving average term

Major Customers

AMPAC (WECCO), Praxair, Fresenius USA Inc., Great Salt Lake Minerals, ATK Thiokol, Geneva Nitrogen, Huish Detergents, Intrepid Potash, Cargill Salt, Morton Salt

Other Variables Considered

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

Historical data 1982-2005

Utah - Petroleum and Coal Products (SIC 29)

Dependent variable annual MWh in SIC 29

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	99,344	63,301	1.57	0.1322
	IPI_29	5,734	709	8.09	-
	ELEC_P	(11,410)	1,334	(8.55)	-
	UT_COAL_TON	(6,694)	1,475	(4.54)	0.0002
	R-squared	0.9545			
	Adjusted R-squared	0.9476			

Explanatory variables

IPI_29 is the Global Insight forecast national industrial production index for the petroleum and coal products sector

ELEC_P is Global Insight forecast for industrial end-user electricity prices for the Mountain #1 region (includes UT)

UT_COAL_TON (see Mining)

Major Customers

Flying J Refinery, Holly Corp., Encana, Chevron USA Inc., Silver Eagle Refining-WX, Inc., Staker & Parsons Co.

Utah - Petroleum and Coal Products (SIC 29)

Other Variables Considered

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

Historical data 1982-2005

Utah - Stone, Clay, Glass and Concrete Products (SIC 32)

Dependent variable annual MWh in SIC 32

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	(73,650)	109,873	(0.67)	0.5112
	IPI_32	5,264	868	6.06	-
	RE_PRICE(-2)	(29,002)	9,119	(3.18)	0.0052
	MA(1)	0.9	0.1	11.79	-
	R-squared	0.9559			
	Adjusted R-squared	0.9486			

Explanatory variables

IPI_32 is the Global Insight forecast for the national industrial production index for the stone, clay, glass and concrete sector

RE_PRICE(-2) is the ratio of the Global Insight forecasts for electric prices to natural gas prices for industrial end-users in region Mountain #1 (includes UT), lagged two years

MA(1) is a first-order moving average term

Major Customers

Holcim, Ash Grove Cement, Graymont Western (formerly Continental Lime), Owens-Corning, Chemical Lime

Utah - Stone, Clay, Glass and Concrete Products (SIC 32)

Other Variables Considered

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Historical data 1982-2005

Utah - Primary Metals (SIC 33)

Dependent variable annual MWh in SIC 33

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	1,133,682	514,617	2.20	0.0401
	IPI_33	21,702	4,480	4.84	0.0001
	RE_PRICE(-1)	(227,128)	39,034	(5.82)	-
	MWH_33_02	(562,505)	154,037	(3.65)	0.0017
	R-squared	0.8762			
	Adjusted R-squared	0.8567			

Explanatory variables

IPI_33 is the Global Insight forecast for the national industrial production index for the primary metals sector

RE_PRICE(-1) is the ratio of the Global Insight forecasts of the electric prices to natural gas prices for industrial end-users in region Mountain #1 (includes UT), lagged one year

MWH_33_02 represents Geneva Steel's substantial energy-use reduction in 2002

Major Customers

US Magnesium, Kennecott Utah Copper, Geneva Steel, Western Zirconium, Nucor Steel, Cerro Wire & Cable, Cerroflow Products, Pacific States Cast Iron

Utah - Primary Metals (SIC 33)

Other Variables Considered

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Historical data 1982-2005

Utah - Electronic and Other Electrical Eq. (not Computers) (SIC 36)

Dependent variable annual MWh in SIC 36

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	363,986	2,368,383	0.15	0.8794
	IPI_36	973	268	3.63	0.0017
	AR(1)	0.99	0.07	13.95	-
	R-squared	0.9790			
	Adjusted R-squared	0.9769			

Explanatory variables

IPI_36 is the Global Insight forecast for national industrial production index for the electronic and electrical equipment (not computers) sector

AR(1) is a first-order autoregressive term

Major Customers

Fairchild Semiconductors, Varian, Compeq, Bay Bridge Corporate LLC, Alliant Techsystems

Utah - Electronic and Other Electrical Eq. (not Computers) (SIC 36)

Other Variables Considered

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

Historical data 1982-2005

Utah - Transportation Equipment (SIC 37)

Dependent variable annual MWh in SIC 37

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	225,843	56,732	3.98	0.0007
	TIME_TREND	6,081	3,319	1.83	0.0819
	AR(1)	0.7	0.2	3.10	0.0056
	R-squared	0.9394			
	Adjusted R-squared	0.9333			

Explanatory variables

TIME_TREND is a time trend that increases by one each year

AR(1) is a first-order autoregressive term

Major Customers

Autoliv, Alliant Techsystems, Williams International, Parker-Hannifan, Allied Aftermarket

Utah - Transportation Equipment (SIC 37)

Other Variables Considered

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

National industrial production index for SIC 37 (Global Insight forecast)

Utah state industrial production index for SIC 37 (Global Insight forecast)

Historical data 1982-2005

Utah - Other

Dependent variable annual industrial MWh after subtracting all forecasted sectors

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	CONSTANT	9,431	29,568	0.32	0.7529
	SUM_MWH	0.1	0.0	24.42	-
	MA(1)	0.5	0.2	2.64	0.0154
	R-squared	0.9835			
	Adjusted R-squared	0.9819			

Explanatory variables

SUM_MWH is the summed annual MWh from all the forecasted sectors

MA(1) is a first-order moving average term

Utah - Other

Other Variables Considered

Electricity price (Global Insight forecast) for industrial end-users for region Mountain #1

Natural gas price (Global Insight forecast) for industrial end-users for region Mountain #1

Ratio of electricity price and natural gas price (see above)

National industrial production index for Miscellaneous Products (Global Insight forecast, no state-level forecast available)

Historical data 1982-2005



Oregon Industrial Forecast

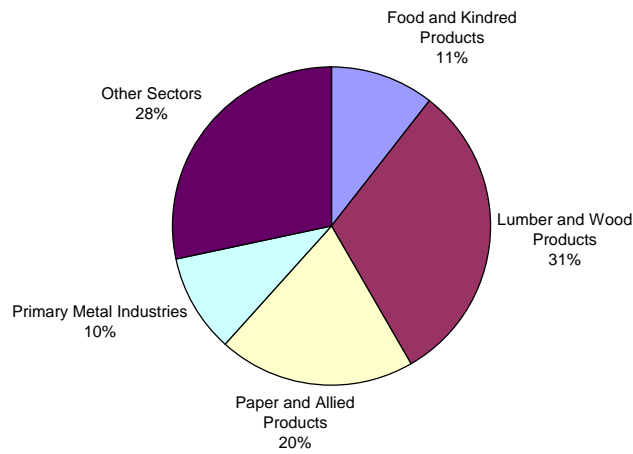
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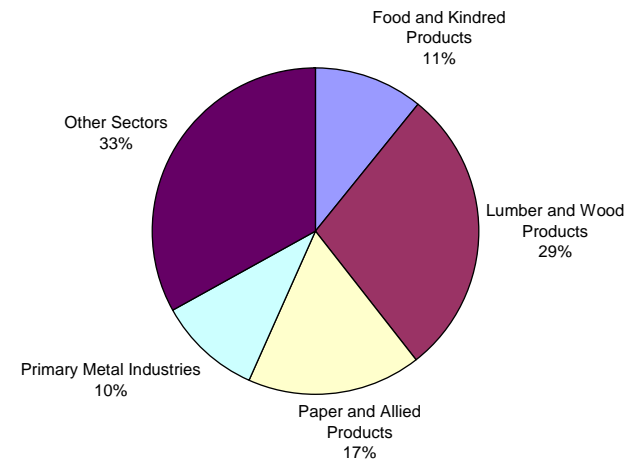
Oregon Industrial Mix

Sector	Average Annual Growth Rates	
	1997 to 2004	2007 to 2017
Food and Kindred Products	-1.9%	1.9%
Lumber and Wood Products	-4.0%	0.8%
Paper and Allied Products	-10.7%	0.1%
Primary Metal Industries	-1.9%	2.1%
Other Sectors	-2.2%	3.2%
Total	-5.0%	1.6%

2007 Industrial Mix



2017 Industrial Mix



Oregon - Food and Kindred Products (SIC 20)

- **Dependent Variable**

- Annual mWh sales for Sector 20; Differenced

- **Model**

Parameter	Estimate	StdErr	tValue	Probt
MU	5336	2173	2.46	0.0141
Emp_SIC20	17799	6485	2.74	0.0061

R-Squared 0.9575
Adjusted R 0.9575

- **Explanatory Variable**

- Emp_SIC20: Total annual employment of SIC 20 establishments; Differenced

- **Customers**

- Bear Creek Operations, Nabisco Inc, National Frozen Foods, Norpac Foods Inc, Oregon Freeze Dry, Smith Frozen Foods

Oregon - Food and Kindred Products (SIC 20) cont.

- **Other Variables Considered**
 - Ratio of electricity price and natural gas price
 - Total Oregon Food and Kindred Products Industries Employment
 - National Food and Kindred Products IPI
 - By Most Manufacturing Sectors: National Employment, National IPI, National PPI, National Real Consumer Spending
- **Historical data** 1977-2004

Oregon - Lumber and Wood Products (SIC 24)

- Dependent Variable
 - Annual MWh sales for Sector 24
- Model

Parameter	Estimate	StdErr	tValue	Probt
MU	343988	152250	2.26	0.0239
MA1,1	-0.6	0.2	-3.54	0.0004
New_OR_Wood_Products_24	6199	1237	5.01	<.0001
Closed_Old_24	36275	4994	7.26	<.0001
Closed_New_24	4486	964	4.66	<.0001
	R-Squared	0.9144		
	Adjusted R	0.9037		

- Explanatory Variables
 - MA1: Moving average of annual MWh sales from the previous period
 - Closed_Old_24: Annual count of active sector 24 customers who opened before 1980 and closed before 2004
 - Closed_New_24: Annual count of active sector 24 customers who opened after 1980 and closed before 2004
 - New_OR_Wood_Products_24: Oregon Industrial Production Index for lumber and wood products
- Customers
 - Boise Building Solutions, Collins Products, Jeld-Wen, Medite Div Sierrapine, Roseburg Forest Products, Timber Products, Weyerhaeuser Company

Oregon - Lumber and Wood Products (SIC 24) cont.

- **Other Variables Considered**
 - Ratio of electricity price and natural gas price
 - Total Oregon Lumber and Wood Products Employment
 - By Most Manufacturing Sectors: National Employment, National IPI, National PPI, National Real Consumer Spending
- **Historical data** 1977-2004

Oregon - Paper and Allied Products (SIC 26)

- Dependent Variable
 - Annual MWh sales for Sector 26
- Model

Parameter	Estimate	StdErr	tValue	Probt
MU	-345853	569705	-0.61	0.5438
MA1,1	-0.6	0.2	-3.08	0.0021
Closed_Old_26	64240	18685	3.44	0.0006
Closed_New_26	37193	6809	5.46	<.0001
Emp_SIC26	111193	60452	1.84	0.0659
	R-Squared	0.836		
	Adjusted R	0.8155		

- Explanatory Variables
 - MA1: Moving average of annual MWh sales from the previous period
 - Closed_Old_26: Annual count of active sector 26 customers who opened before 1980 and closed before 2004
 - Closed_New_26: Annual count of active sector 26 customers who opened after 1980 and closed before 2004
 - Emp_SIC26: Total annual employment of SIC 26 establishments in Oregon
- Customers
 - Georgia Pacific Corporation, Grigsby Bros Paper Box, Western Pulp Products, Weyerhaeuser Company

Oregon - Paper and Allied Products (SIC 26) cont.

- **Other Variables Considered**
 - Ratio of electricity price and natural gas price
 - Total Oregon Paper and Allied Products Employment
 - By Most Manufacturing Sectors: National Employment, National IPI, National PPI, National Real Consumer Spending
- **Historical data** 1977-2004

Oregon - Primary Metal industries (SIC 33)

- Dependent Variable
 - Annual MWh sales for Sector 33; Differenced

- Model

Parameter	Estimate	StdErr	tValue	Probt
MU	1540	2592	0.59	0.5526
MA1,1	0.3	0.2	1.8	0.0720
New_OR_Primary_Metals_33	2304	561	4.1	<.0001
R-Squared	0.9229			
Adjusted R	0.9199			

- Explanatory Variables
 - MA1: Moving average of annual MWh sales from the previous period
 - New_OR_Primary_Metals_33: Oregon Industrial Production Index for primary metals; Differenced
- Customers
 - Alcan Products Corporation, Columbia Steel Casting, Oregon Metallurgical Corporation, Schlosser Casting, Teledyne Wah Chang

Oregon - Primary Metal Industries (SIC 33) cont.

- **Other Variables Considered**
 - Ratio of electricity price and natural gas price
 - Total Oregon Primary Metal Industries Employment
 - By Most Manufacturing Sectors: National Employment, National IPI, National PPI, National Real Consumer Spending
- **Historical data** 1977-2004

Oregon - Other Sectors

- Dependent Variable
 - Total annual MWh sales for Other Sectors

- Model

Parameter	Estimate	StdErr	tValue	Probt
MU	-547753	191939	-2.85	0.0043
AR1,1	0.6	0.2	3.61	0.0003
NA_IPI_Glass_glass	12893	2216	5.82	<.0001
	R-Squared	0.9035		
	Adjusted R	0.8993		

- Explanatory Variables
 - AR1: Total annual MWh sales of the previous year
 - NA_IPI_Glass_Glass: National Industrial Production Index for glass
- Customers
 - Eastman Kodak, Entek, Evanite Fiber Corp, Hewlett Packard, Owens Illinois Inc

Oregon - Other Sectors cont.

- **Other Variables Considered**
 - Ratio of electricity price and natural gas price
 - Total Oregon Industrial Sales minus the Other Sector
 - Total Oregon Durable and Non-Durable Employment
 - Lumber and Wood Product IPI, Paper and Allied Products IPI, Metals IPI
 - By Most Manufacturing Sectors: National Employment, National IPI, National PPI, National Real Consumer Spending

- **Historical data** 1977-2004



Wyoming Industrial Forecast

Pete Eelkema

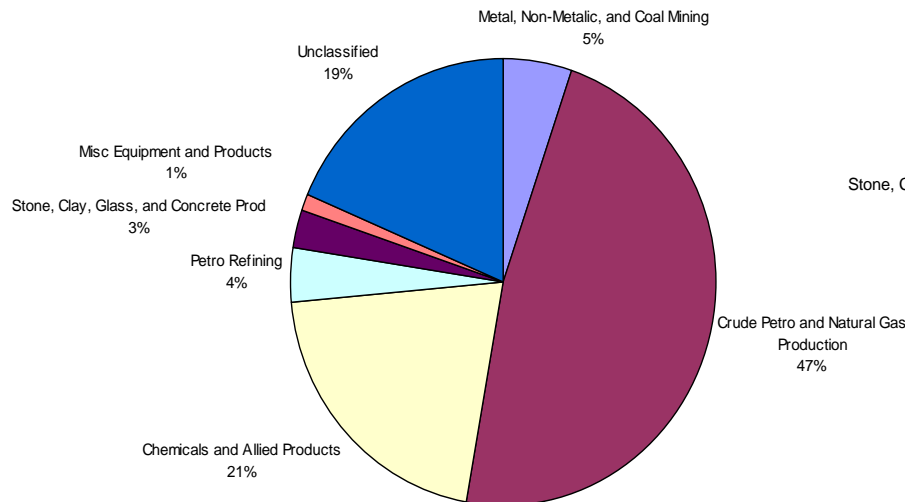


Wyoming Industrial Mix

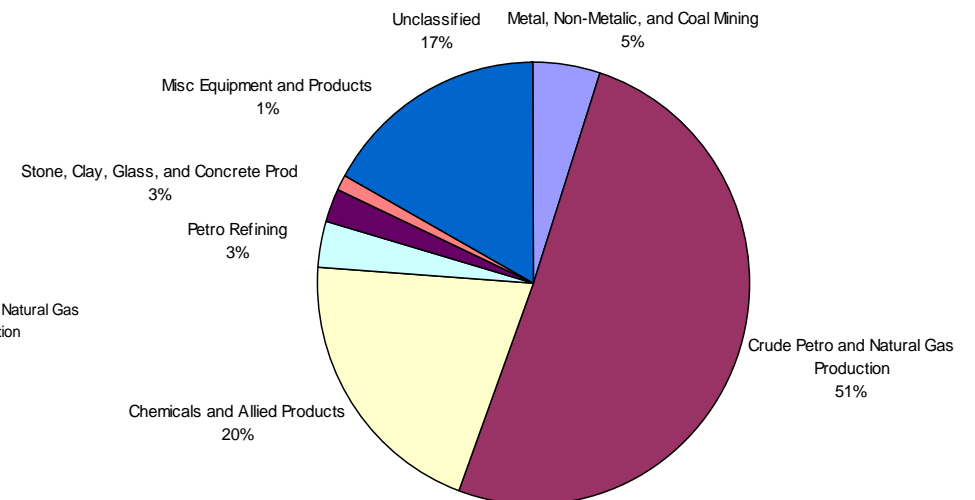
Growth Rates

Sector	1997-2004	2007-2017
Metal, Non-Metallic, and Coal Mining	-2.3%	3.2%
Crude Petroleum and Natural Gas Production	3.7%	4.3%
Chemicals and Allied Products	-0.5%	3.0%
Petroleum Refining	3.5%	1.7%
Stone, Clay, Glass, and Concrete Prod	-3.2%	2.0%
Misc Equipment and Products	-5.9%	2.2%
Unclassified	-2.4%	2.1%

2007 MWh



2017 MWh



Eastern Wyoming - Mining - No Coal (SIC 10 & 14)

Dependant Variable Annual MWh in SIC 10 and 14, 1991 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	-34,875	34,864	-1.00	0.3285
	IPI1014	93,663	32,082	2.92	0.0082
	AR(1)	0.85	0.07	12.27	0.0000
	R-squared	0.9235			
	Adjusted R-squared	0.9162			

Explanatory Variables

Constant

IPI1014

Industrial Production Index for SIC 10 through 14

AR(1)

Autoregressive term of order 1

Other Dependent Variables Considered

Relative electric to natural gas price and trend

Major Customers

Power Resources, OCI Wyoming, General Chemical, and Solvay Soda Ash

Eastern Wyoming – Coal Mining (SIC 12)

Dependant Variable Annual MWh in SIC 12, 1987 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	-58,987	105,068	-0.56	0.5834
	IPI12	260,390	106,095	2.45	0.0278
	DUMMY80to96	127,048	9,243	13.74	0.0000
	DUMMY1993	46,476	14,883	3.12	0.0075
	R-squared	0.9621			
	Adjusted R-squared	0.9539			

Explanatory Variables

Constant

IPI12

Industrial Production Index for SIC 12

DUMMY80to96

Equal to 1 for years 1980 to 1996, 0 otherwise

DUMMY1993

Equal to 1 in 1993, 0 otherwise

Other Dependent Variables Considered

Relative electric to natural gas price, average annual national coal price, and trend

Eastern Wyoming - Crude Petroleum and Natural Gas (SIC 13)

Dependant Variable Annual MWh in SIC 13, 1992 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	1,533,657	15,360	99.85	0.0000
	Wellhead Price	57,630	8,946	6.44	0.0001
	MA(1)	-0.997	0.13	-7.57	0.0000
	R-squared	0.6580			
	Adjusted R-squared	0.5896			

Explanatory Variables

Constant

Wellhead Price

National wellhead natural gas price

MA(1)

Moving Average term of order 1

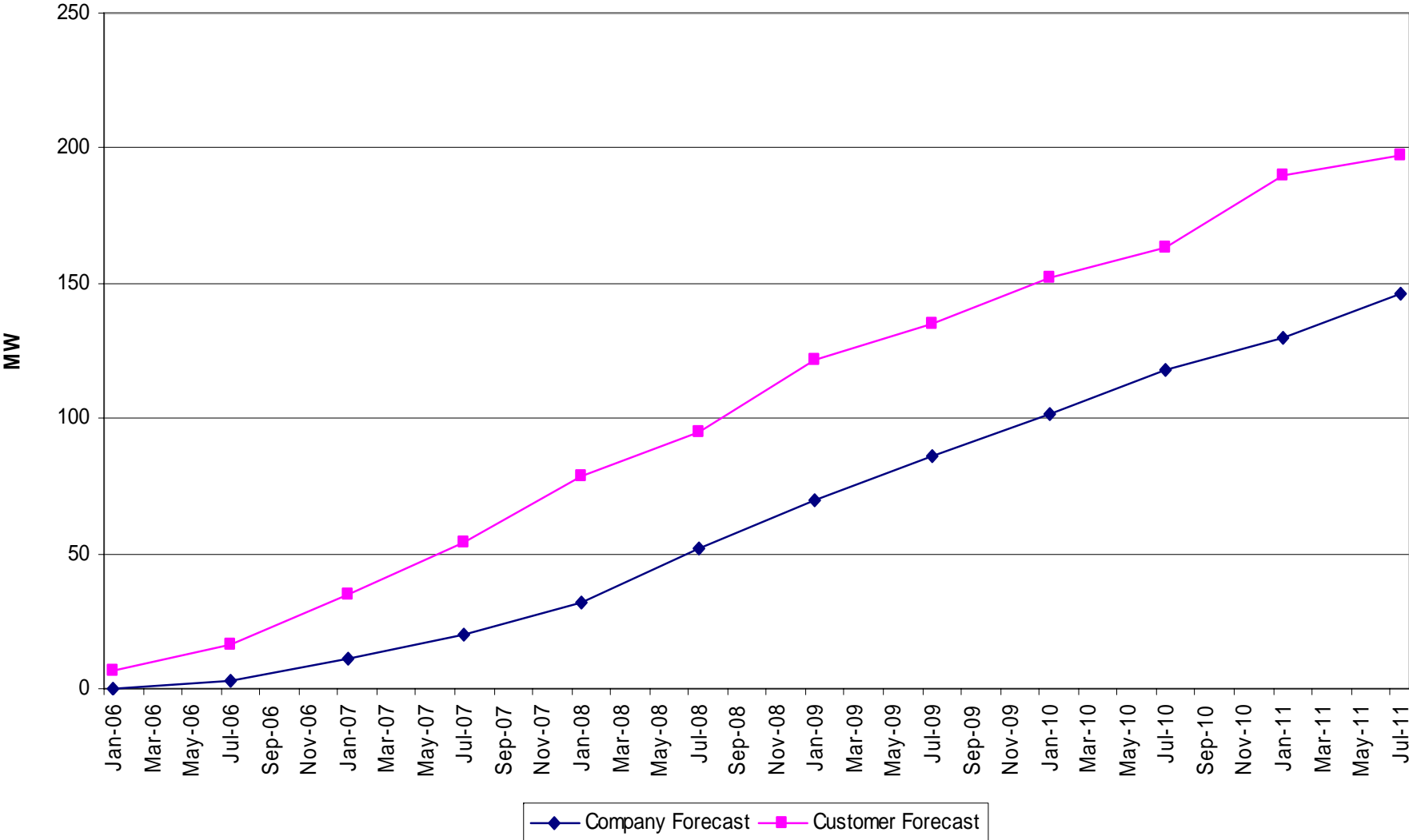
Other Dependent Variables Considered

Relative electric to natural gas price, trend, and Industrial Production Index for SIC 13

Major Customers

Anadarko, Merit Energy, Phoenix Production, Howell Petroleum, Kinder Morgan, Little America, and Marathon Oil

Eastern Wyoming - Large Customer Forecast



Other Adjustments

Assumed a 20 MW reduction in 2009, 2019, and 2029 to reflect field depletion

Eastern Wyoming - Chemical and Allied Products (SIC 28)

Dependant Variable Annual MWh in SIC 28, 1992 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	375,610	473,777	0.79	0.4508
	IPI28	831,318	338,306	2.46	0.0395
	DUMMY1996	-118,526	18,747	-6.32	0.0002
	AR(1)	0.90	0.21	4.28	0.0027
	MA(2)	-0.99	0.00	-234,802	0.0000
	R-squared	0.9345			
	Adjusted R-squared	0.9018			

Explanatory Variables

Constant

IPI28

Industrial Production Index for SIC 28

DUMMY1996

Equal to 1 in 1996, 0 otherwise

AR(1)

Autoregressive term of order 1

MA(2)

Moving Average term of order 2

Other Dependent Variables Considered

Relative electric to natural gas price and trend

Major Customers

Exxon, FMC, and Church and Dwight

Eastern Wyoming - Petroleum Refining (SIC 29)

Dependant Variable Annual MWh in SIC 29, 1981 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	126,754	66,201	1.91	0.0736
	IPI29	139,667	65,528	2.13	0.0489
	DUMMY9296	-113,340	4,681	-24.21	0.0000
	DUMMY9799	-52,799	6,972	-7.57	0.0000
	DUMMY2000	-30,830	6,298	-4.90	0.0002
	DUMMY2004	-66,829	6,375	-10.48	0.0000
	AR(1)	0.72	0.14	5.00	0.0001
	MA(4)	-0.90	0.04	-21.84	0.0000
	R-squared	0.9923			
	Adjusted R-squared	0.9889			

Explanatory Variables

Constant

IPI29

Industrial Production Index for SIC 29

DUMMY9296

Equal to 1 in years 1992 to 1996, 0 otherwise

DUMMY9799

Equal to 1 in 1997, 1998, and 1999, 0 otherwise

DUMMY2000

Equal to 1 in 2000, 0 otherwise

DUMMY2004

Equal to 1 in 2004, 0 otherwise

AR(1)

Autoregressive term of order 1

MA(4)

Moving Average term of order 4

Eastern Wyoming - Petroleum Refining

Other Dependent Variables Considered

Relative electric to gas price and trend

Eastern Wyoming - Other Industrial

Dependant Variable Annual MWh not in SIC 10, 12, 13, 14, 28, and 29, 1977 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	922,954	301,878	3.06	0.0058
	RELATIVE ELEC	-4,770,186	2,509,457	-1.90	0.0705
	DUMMY1992	434,841	134,300	3.24	0.0038
	TREND	26,350	7,724	3.41	0.0025
	AR(1)	0.54	0.19	2.77	0.0112
	R-squared	0.7662			
	Adjusted R-squared	0.7237			

Explanatory Variables

Constant	
RELATIVE ELEC	Relative national electric price to national gas price
DUMMY1992	Equal to 1 in 1992, 0 otherwise
TREND	Time trend that increases by 1 each year
AR(1)	Autoregressive term of order 1

Other Dependent Variables Considered

Annual Residential sales and annual Commercial sales

Western Wyoming - Mining (SIC 10, 12, 13, & 14)

Dependant Variable Annual MWh in SIC 10, 12, 13, and 14, 1985 to 2004

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	585,659	381,499	1.54	0.1443
	IPI1014	1,672,620	692,819	2.41	0.0281
	DUMMY9504	-732,365	100,983	-7.25	0.0000
	TREND	-30,653	16,422	-1.87	0.0804
	R-squared	0.9183			
	Adjusted R-squared	0.9029			

Explanatory Variables

Constant

IPI1014

Industrial Production Index for SIC 10 through 14

DUMMY9504

Equal to 1 in years 1995 through 2004, 0 otherwise

TREND

Time trend that increases by 1 each year

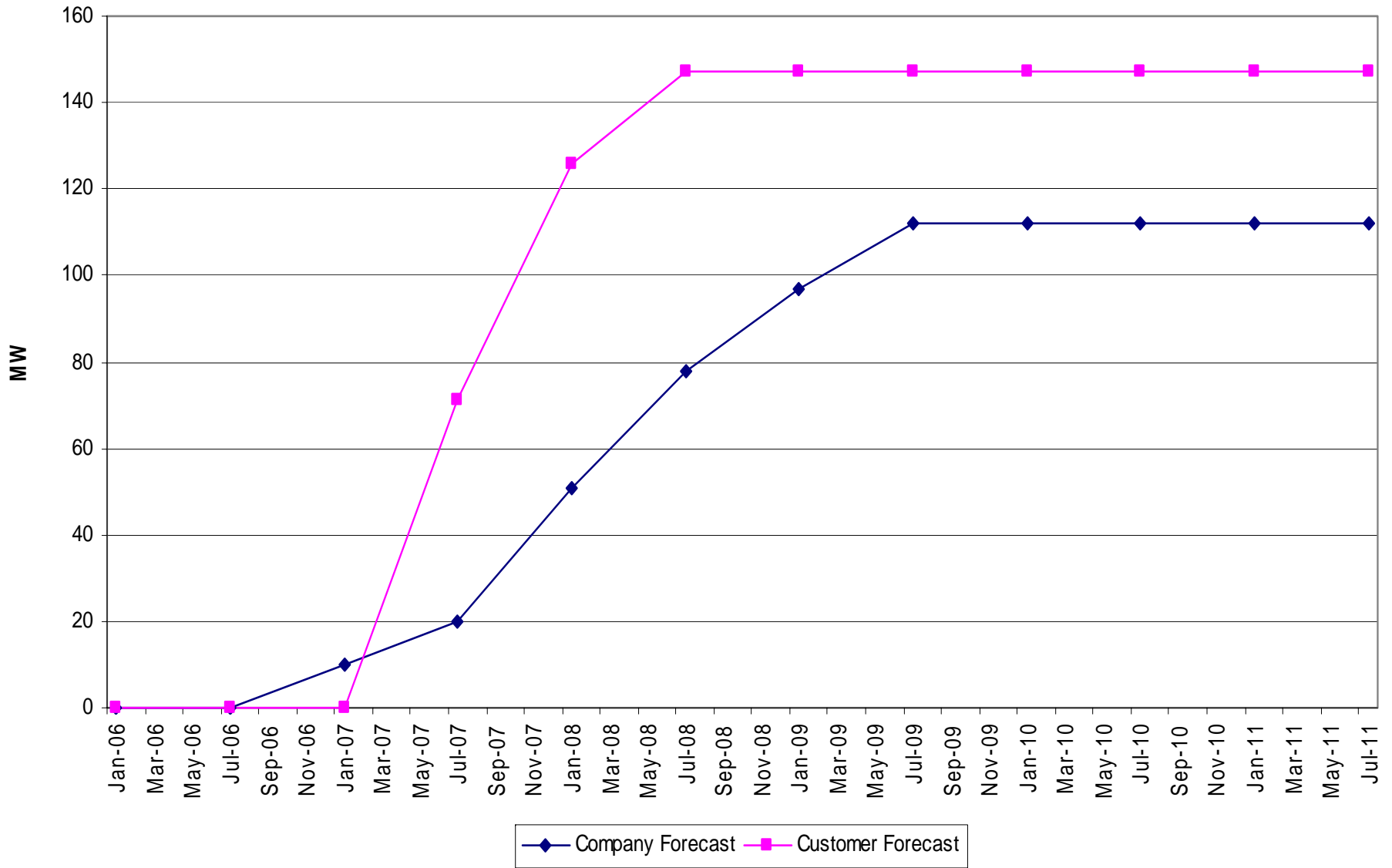
Other Dependent Variables Considered

Relative electric to natural gas price, natural gas price, Industrial Production Index for SIC 12, and Industrial Production Index for SIC 13

Major Customers

Chevron, Williams Field Services, Amoco, and Merit Energy

Western Wyoming - Large Customer Forecast



Western Wyoming - Other Industrial

Dependant Variable

Annual Industrial MWh not in SIC 10, 12, 13, and 14, 1997 to 2004

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	5,780	28,027	0.21	0.8384
SIC Mining	0.1318	0.0259	5.10	0.0000
DUMMY1991	166,368	52,120	3.19	0.0039
MA(1)	0.40	0.20	2.00	0.0567
R-squared	0.7425			
Adjusted R-squared	0.7103			

Explanatory Variables

Constant

SIC Mining

DUMMY1991

MA(1)

Annual Industrial MWh in SIC 10, 12, 13, and 14

Equal to 1 in 1991, 0 otherwise

Moving Average term of order 1

Other Dependent Variables Considered

Relative electric to natural gas price, annual Residential sales, annual Commercial sales, and trend



California Industrial Forecast

Pete Eelkema

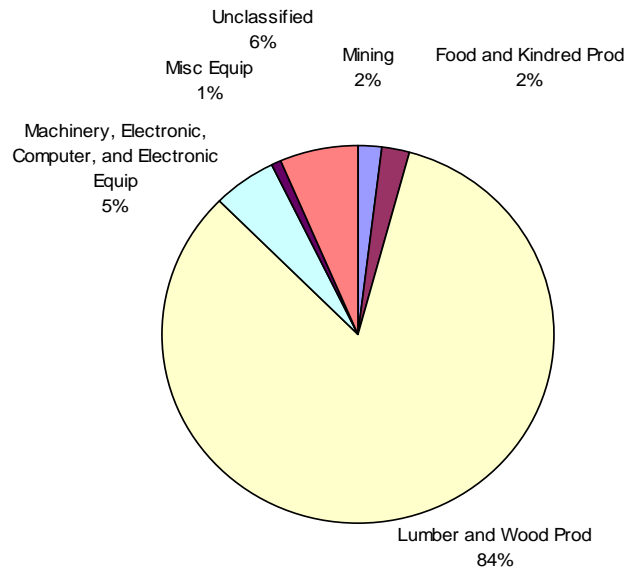


California Industrial Mix

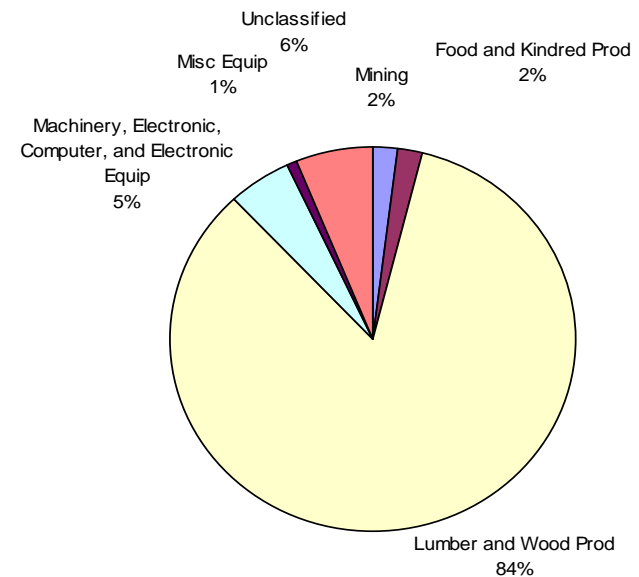
Growth Rates

Sector	1997-2004	2007-2017
Mining (Metal and Nonmetal, except fuel)	-10.7%	0.0%
Food and Kindred Products	-13.9%	0.0%
Lumber and Wood Products	-2.0%	0.7%
Machinery, Electronic, Computer, and Electronic Equipment	-11.8%	0.0%
Misc Equipment	-14.1%	0.0%
Unclassified	-14.1%	0.0%

2007 MWH



2017 MWH



California - Lumber and Wood Products (SIC 24)

Dependant Variable		Annual MWh in SIC 24, 1977 to 2004			
Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
	Constant	-1,037	15,725	-0.07	0.9477
	IPI24	931	163	5.71	0.0000
	DUMMY1983	-12,952	2,821	-4.59	0.0000
	DUMMY1992	-8,299	2,809	-2.96	0.0048
	DUMMY1998	-14,130	2,786	-5.07	0.0000
	TREND	-1,155	298	-3.88	0.0003
	AR(1)	0.85	0.06	13.87	0.0000
	R-squared	0.9190			
	Adjusted R-squared	0.9089			

Explanatory Variables

Constant	
IPI24	Industrial Production Index for SIC 24
DUMMY1983	Equal to 1 in 1983, 0 otherwise
DUMMY1992	Equal to 1 in 1992, 0 otherwise
DUMMY1998	Equal to 1 in 1998, 0 otherwise
TREND	Time trend that increases by 1 each year
AR(1)	Autoregressive term of order 1

California Lumber and Wood Products

Other Dependent Variables Considered

Relative electric to gas price

Major Customers

Roseburg Forest Products, Timber Products, and Hambro Forest Products

California - Other Industrial

Dependant Variable		Annual Industrial MWh not in SIC 24, 1997 to 2004				
Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.	
	Constant	11,732	976	12.03	0.0000	
	DUMMY19971998	9,844	2,551	3.86	0.0008	
	AR(1)	0.48	0.19	2.54	0.0184	
	MA(6)	-0.90	0.05	-17.66	0.0000	
	R-squared	0.7163				
	Adjusted R-squared	0.6793				

Explanatory Variables

Constant

DUMMY19971998

Equal to 1 in 1997 and 1998, 0 otherwise

AR(1)

Autoregressive term of order 1

MA(6)

Moving Average term of order 6

Other Dependent Variables Considered

Relative electric to natural gas price, MWh in SIC 24, annual Residential sales, annual Commercial sales, and trend



Idaho Industrial Forecast

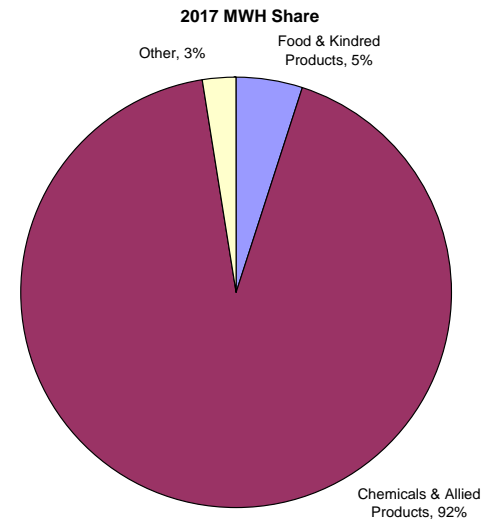
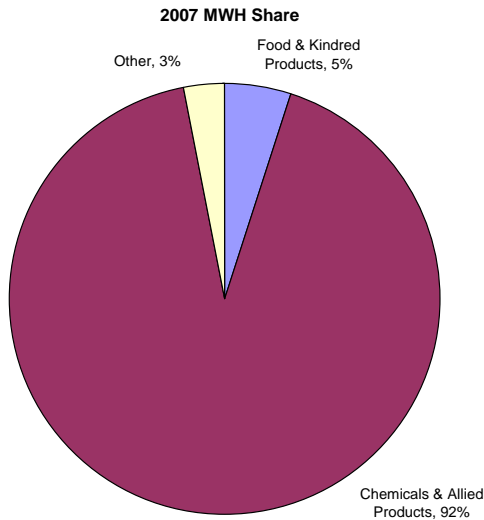
Glen Booth



Idaho Industrial Mix

Growth Rates

Sector	1997-2004	2007-2017
Food & Kindred Products	1.7%	0.2%
Chemicals & Allied Products	-0.2%	0.0%
Other	-9.0%	-1.8%
Total	-0.3%	0.0%



Idaho - Chemicals & Allied Products (SIC 28)

Dependent Variable

Annual MWh in SIC 28

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	781,514	224,319	3.48	0.0023
IPI28	7,854	2,414	3.25	0.0040
DUM8286	-326,365	54,556	-5.98	0.0000
R-squared	0.9456			
Adjusted R-squared	0.9402			

Explanatory Variables

IPI28 is the National Industrial Production Index for Basic Chemicals
(Idaho Basic Chemicals Index was not available)

DUM8286 is a dummy variable for the irregularity in historical data

Idaho - Chemicals & Allied Products (SIC 28)

Other Variables Considered

Industrial Relative Price Electricity to Natural Gas Price – Mountain

Time Series used to Develop Model

1982-2004

Major Customers

Monsanto, Agrium, Kerr McGee

Idaho - Food & Kindred Products (SIC 20)

Dependent Variable

Annual MWh in SIC 20

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	22,886	26,875	0.85	0.4051
IPI20	640	253	2.53	0.0206
DUM8296	-29,377	4,752	-6.18	0.0000
MA(3)	-0.94	0.05	-19.49	0.0000
R-squared	0.9221			
Adjusted R-squared	0.9098			

Explanatory Variables

IPI20 is the Idaho Industrial Production Index for Food Manufacturing

DUM8296 is a dummy variable for the irregularity in historical data

MA(3) is a third-order moving average term

Idaho - Food & Kindred Products (SIC 20)

Other Variables Considered

- Relative Price Electricity to Natural Gas Price – Mountain Industrial
- Annual MWh in SIC20 for the prior year

Time Series used to Develop Model

1982-2004

Major Customers

Basic American Foods, Idaho Fresh Pak, Idaho Supreme Potato,
Idaho Pacific Corporation, Norsun Food Group, Nelson Ricks Creamery

Idaho - Other

Dependent Variable

Annual MWh Other

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-57,228	41,358	-1.38	0.1834
DUM0204	-23,487	2,427	-9.68	0.0000
MWHMAJ	0.05	0.01	8.33	0.0000
AR(1)	0.96	0.04	26.78	0.0000
R-squared	0.9745			
Adjusted R-squared	0.9703			

Explanatory Variables

MWHMAJ is the MWh for Idaho Major Industries SIC 20 and SIC 28

DUM0204 is a dummy variable for the irregularity in historical data

AR(1) is a first-order autoregressive term

Idaho - Other

Other Variables Considered

- Relative Price Electricity to Natural Gas Price – Mountain Industrial
- Annual Other MWh for the prior year

Time Series used to Develop Model

1982-2004

Major Customers

Idaho Travertine Corporation, J&K Water Corporation



Washington Industrial Forecast

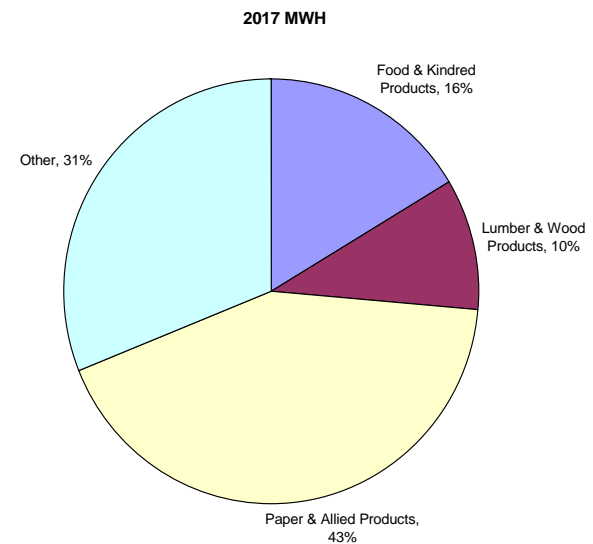
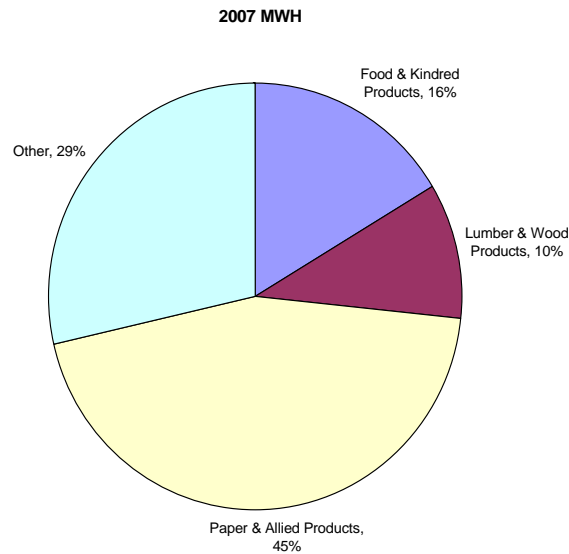
Glen Booth



Washington Industrial Mix

Growth Rates

Sector	1997-2004	2007-2017
Food & Kindred Products	-2.0%	1.1%
Lumber & Wood Products	-0.5%	1.1%
Paper & Allied Products	0.3%	0.6%
Other	-0.1%	1.9%
Total	-0.3%	1.1%



Washington - Paper & Allied Products (SIC 26)

Dependent Variable

Annual MWh in SIC 26

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	286,518	99,258	2.89	0.0088
IPI26	1,786	974	1.83	0.0811
AR(1)	0.81	0.07	12.33	0.0000
R-squared	0.9380			
Adjusted R-squared	0.9321			

Explanatory Variables

IPI26 is the Washington Industrial Production Index for Paper & Paper Products

AR(1) is a first-order autoregressive term

Washington - Paper & Allied Products (SIC 26)

Other Variables Considered

- Relative Electricity Price to Natural Gas Price – Pacific Industrial

Time Series used to Develop Model

1980-2004

Major Customers

Washington - Food & Kindred Products (SIC 20)

Dependent Variable

Annual MWh in SIC 20

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	13,473	19,973	0.67	0.5077
IPI20	803	421	1.91	0.0710
DUM9294	32,649	8,495	3.84	0.0010
MWH20(-1)	0.48	0.16	3.05	0.0063
R-squared	0.9018			
Adjusted R-squared	0.8871			

Explanatory Variables

IPI20 is the Washington Industrial Production Index for Food Manufacturing

DUM9294 is a dummy variable for the irregularity in historical data

MWH20(-1) is the annual MWh in SIC20 for the prior year

Washington - Food & Kindred Products (SIC 20)

Other Variables Considered

- Relative Electricity Price to Natural Gas Price – Pacific Industrial

Time Series used to Develop Model

1980-2004

Major Customers

Tyson Foods, Tree Top, Del Monte, Welch Foods, Seneca Foods

Washington - Lumber & Wood Products (SIC 24)

Dependent Variable

Annual MWh in SIC 24

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	38,376	28,342	1.35	0.1901
IPI24	835	182	4.59	0.0002
AR(1)	0.93	0.07	14.14	0.0000
R-squared	0.9512			
Adjusted R-squared	0.9466			

Explanatory Variables

IPI24 is the Washington Industrial Production Index for Wood Products

AR(1) is a first-order autoregressive term

Washington - Lumber & Wood Products (SIC 24)

Other Variables Considered

- Relative Electricity Price to Natural Gas Price – Pacific Industrial

Time Series used to Develop Model

1980-2004

Major Customers

Jeld-Wen, Alexandria Moulding, Inc., Layman Lumber Company

Washington - Other

Dependent Variable

Annual MWh Other

Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	11,252	8,775	1.28	0.2131
MWHR(-1)	0.99	0.05	21.16	0.0000
R-squared	0.9532			
Adjusted R-squared	0.9510			

Explanatory Variables

MWHR(-1) is the annual Other MWh for the prior year

Washington - Other

Other Variables Considered

- Relative Electricity Price to Natural Gas Price – Pacific Industrial
- MWh for Washington Major Industries SIC 20, SIC 24 & SIC 26

Time Series used to Develop Model

1980-2004

Major Customers

Shields Bag & Printing, Graham Packaging, TransAlta Centralia



Hourly Load Forecast

Mike Rife



Agenda

- General Model Specification by Jurisdiction
- Forecast Process
- Improvements in the Process
- System Coincident Peak Demand & Jurisdiction Contribution Results
- State Peak Demands
- Next Steps

General Model Specification by Jurisdiction

- Hourly kW by jurisdiction is the forecasted entity
- Forecast drivers
 - Moving average term (Average of the last 8,760 hourly kW values)
 - Represents jurisdiction trend growth year-over-year
 - Amount of average sunlight per day for the month
 - Represents lighting load
 - Cooling degree days with a 65 and an 85 (or 80) degree base
 - Represents A/C load and the non-linear response of load to temperature
 - Cooling degree days lagged three hours
 - Represents a “build-up” effect of structure heat gains
 - Minimum morning temperature during the summer
 - Represents the amount of over-night structure heat retention (more over-night heat retention \Rightarrow more A/C requirements)
 - Humidity

General Model Specification by Jurisdiction

- Forecast drivers (cont'd)
 - Heating degree days with a 57 and 37 degree base
 - Represents electric heating load and the non-linear response of load to temperature
 - Maximum temperature for the day before
 - Represents the amount of structure heat gain
 - With a higher heat gain yesterday then the amount of heat in the structure is more after over-night heat loss \Rightarrow less heating requirements in the morning
 - Binary Variables (those variables having a value of zero or one)
 - Season of the year – seasonal base load differences
 - Month of the year – monthly base load differences
 - Day of the week – day-type base load differences
 - Hour of the day – hourly load differences
 - Weeks of the year – changing weekly base load over the year
 - Holidays – Holiday base load differences

General Model Specification by Jurisdiction

- Forecast drivers (cont'd)
 - Crossed-Binary Variables
 - Day and Season – seasonal and day-type base load differences
 - Day and Hour – day-type load shape differences
 - Month and Hour – monthly load shape differences
 - Season and Hour – seasonal load shape differences
 - Holiday and Hour – holiday load shape differences
 - Week and Hour – weekly load shape differences over the year

Utah Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	1.005	106.12	<0.0001
Sunlight	114.79	1.82	0.0682
CDD 65 Base	16537	74.46	<0.0001
CDD 85 Base	3376.54	6.67	<0.0001
CDD 85 Base – lagged 3 hours	10508	22.59	<0.0001
CDD 65 Base – lagged 3 Hours	6786.44	30.48	<0.0001
HDD 57 Base	3559.60	23.51	<0.0001
HDD 37 Base	1108.50	4.73	<0.0001
HDD 58 to 65	2063.53	3.91	<0.0001
Summer Low Humidity	-1480.71	-11.40	<0.0001
Maximum Temperature Day Before	-948.28	-6.77	<0.0001
Minimum Morning Temperature	5960.72	39.69	<0.0001
R ²	0.967		

- Indicates that each additional degree adds
 - Approximately 35 MW during the summer
 - Approximately 7 MW during the winter
 - Reflects that space cooling is dominant

Oregon Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	0.326	17.07	<0.0001
Sunlight	67.93	1.79	0.0735
CDD 65 Base	4907.33	27.56	<0.0001
CDD 80 Base	7414.97	21.34	<0.0001
CDD 85 Base – lagged 3 hours	9590.37	25.66	<0.0001
HDD 57 Base	10287	70.69	<0.0001
HDD 37 Base	6326.08	15.49	<0.0001
Summer Low Humidity	-904.64	-5.15	<0.0001
Maximum Temperature Day Before	-2902.07	-24.26	<0.0001
Minimum Morning Temperature	2372.97	14.88	<0.0001
R ²	0.937		

- Indicates that each additional degree adds
 - Approximately 22 MW during the summer
 - Approximately 16 MW during the winter

Idaho Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	0.447	21.61	<0.0001
Sunlight	-53.362	-2.29	0.0217
CDD 65 Base	1467.57	22.09	<0.0001
HDD 57 Base	597.81	14.41	<0.0001
HDD 30 Base	793.04	11.04	<0.0001
Summer Low Humidity	420.34	7.23	<0.0001
Maximum Temperature Day Before	-123.47	-3.61	<0.0001
Minimum Morning Temperature	1337.36	26.03	<0.0001
R ²	0.884		

- Reflects that each additional degree adds
 - Approximately 2 MW during the summer
 - Approximately 1 MW during the winter

East Wyoming Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	0.540	35.87	<0.0001
Sunlight	-361.595	14.81	<0.0001
CDD 65 Base	1345.152	12.59	<0.0001
CDD 80 Base	-133.697	0.62	0.5364
CDD 65 Base – lagged 3 hours	542.807	5.00	<0.0001
HDD 57 Base	878.129	22.65	<0.0001
Maximum Temperature Day Before	-24.977	-0.59	0.5574
Minimum Morning Temperature	420.218	7.11	<0.0001
R ²	0.608		

- Reflects that each additional degree adds
 - Approximately 2 MW during the summer
 - Approximately 1 MW during the winter
- Reflects some A/C saturating effects at temperatures greater than 80 degrees

Washington Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	0.348	14.04	<0.0001
Sunlight	71.656	4.73	<0.0001
CDD 65 Base	3970.476	68.64	<0.0001
CDD 85 Base	1574.261	9.64	<0.0001
CDD 85 Base – lagged 3 hours	4468.982	29.65	<0.0001
HDD 57 Base	2387.715	59.33	<0.0001
HDD 37 Base	13.41.979	21.38	<0.0001
Summer Low Humidity	-807.441	-15.66	<0.0001
Maximum Temperature Day Before	-1971.402	-50.87	<0.0001
Minimum Morning Temperature	981.527	24.75	<0.0001
R ²	0.935		

- Reflects that each additional degree adds
 - Approximately 10 MW during the summer
 - Approximately 4 MW during the winter

California Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	1.807	50.08	<0.0001
Sunlight	83.55	16.79	<0.0001
CDD 65 Base	196.84	9.10	<0.0001
CDD 85 Base	378.01	6.86	<0.0001
CDD 85 Base – lagged 3 hours	106.63	2.11	0.0347
HDD 57 Base	569.72	34.39	<0.0001
Summer Low Humidity	134.92	5.83	<0.0001
Maximum Temperature Day Before	-268.69	-16.87	<0.0001
Minimum Morning Temperature	185.85	8.78	<0.0001
R ²	0.829		

- Reflects that each additional degree adds
 - Approximately 1 MW during the summer
 - Approximately 1 MW during the winter

West Wyoming Primary Variables and Statistics

Variable	Coefficient	t-value	p-value
Moving Average	0.1157	23.08	<0.0001
Sunlight	-3.688	-0.62	0.5368
CDD 65 Base	-65.972	-3.81	<0.0001
HDD 57 Base	55.804	4.11	<0.0001
Summer Low Humidity	-65.196	-4.90	<0.0001
Maximum Temperature Day Before	-412.697	-29.63	<0.0001
Minimum Morning Temperature	50.0898	3.22	0.0013
R ²	0.461		

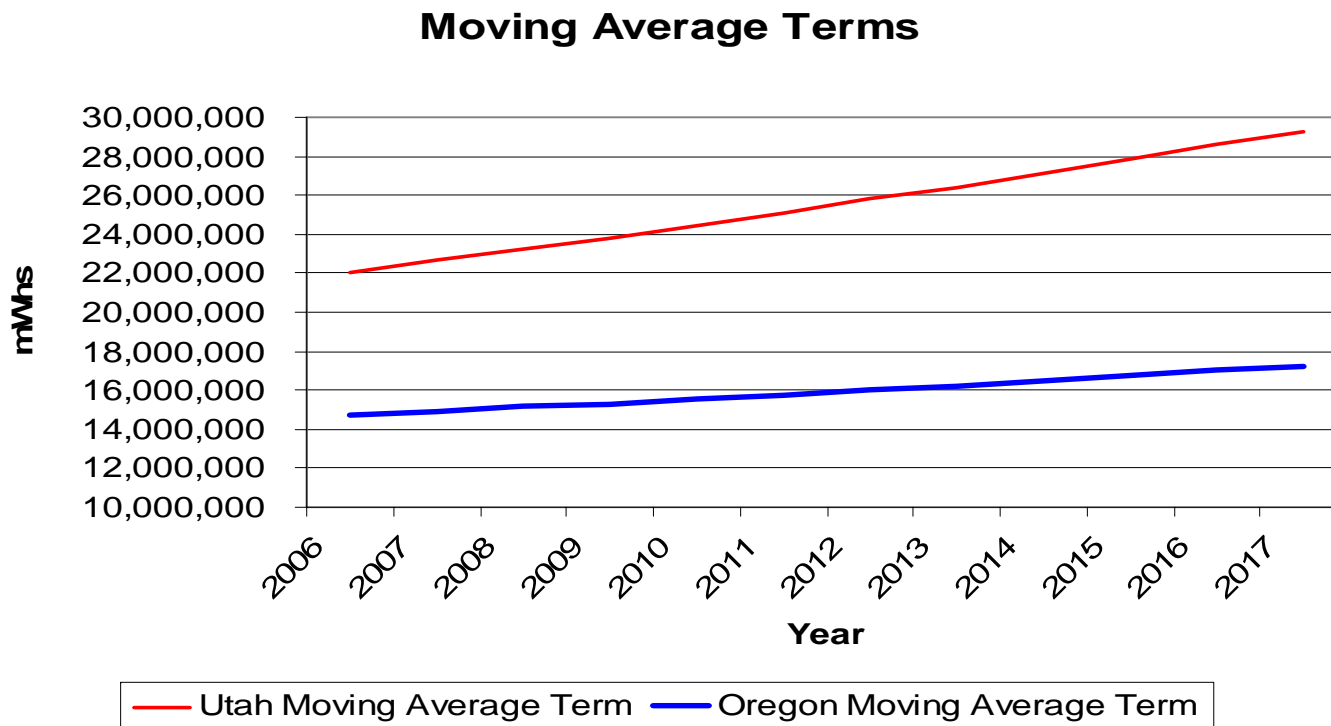
- Reflects very little weather responsiveness
- Reflects the dominant industrial load in the region

Forecast Process

- Estimation period from 2002 through 2004 for each jurisdiction
 - Supported statistically as the optimal time period, on average
- Normal cooling degree days, heating degree days, humidity, and temperatures assumed during the forecast horizon
- Binary variables occur as in the forecast horizon
- Moving Average term continues in the forecast horizon and approximates growth over the forecast horizon
- Heavy load, light load, and super peak hours by season are adjusted to grow as the average growth rate for these hours of weather adjusted loads in order to continue trends in load shape changes
- Sum of hourly loads generated from the model is compared to the total energy forecast implied by REEPS, COMMEND, the industrial econometric forecast, and the other electric sales forecasts
- Each hour is adjusted by straight ratio such that the sum of the hours for each year equals the total energy forecast from the end-use and econometric models

Some Details of the Process

- Moving Average Term
 - Represents the underlying trend growth in hourly demand due to economic factors and growth in non-weather responsive electrical usage
 - Annual average growth in this term is approximately 2.6% for Utah and 1.4% for Oregon



Some Details of the Process

- Load Shape Adjustments
 - Year is divided into four seasons
 - Shoulder (April and October)
 - Spring/Summer (May, June and September)
 - Summer (July and August)
 - Winter (November through March)
 - Hour of the day is divided into 3 time periods
 - Heavy Load (Monday through Saturday)
 - 8 AM to 10 PM
 - Super Peak (Monday through Saturday)
 - 1 PM to 8 PM during Summer and Spring/Summer
 - 8 AM to 11 AM and 5 PM to 8 PM during Shoulder and Winter
 - Light Load
 - All Other Times

Some Details of the Process

- Load Shape Adjustments (cont'd)
 - Forecasted growth rates of these periods are calculated for each season and time period
 - Initial Findings
 - For Utah Summer growths reflect increased air conditioning but light loads for Spring/Summer and Winter indicates that further analysis may be needed.
 - For Oregon conservation is reflected by growth during shoulders and off-peak times. Still more analysis may be needed.

Season	Hour Type	Utah	Oregon
Shoulder	Heavy Load	2.4%	1.6%
Shoulder	Light Load	1.8%	1.4%
Shoulder	Super Peak	2.5%	1.8%
Spring/Summer	Heavy Load	2.5%	1.6%
Spring/Summer	Light Load	2.9%	1.5%
Spring/Summer	Super Peak	2.7%	1.5%
Summer	Heavy Load	3.1%	1.5%
Summer	Light Load	2.6%	1.5%
Summer	Super Peak	3.6%	1.4%
Winter	Heavy Load	2.5%	1.4%
Winter	Light Load	2.8%	1.6%
Winter	Super Peak	2.5%	1.2%

Improvements Made in the Process

- For each jurisdiction models were constructed for each year from 1992 through 2004
 - From these models weather adjusted hourly loads were calculated for each year and jurisdiction
 - These weather adjusted loads were the basis of adjusting the forecast for load shape changes
- Initial steps were taken to separate the model into several models one for each jurisdiction
 - Improve programming
 - Will allow for more flexibility and review in modeling each jurisdiction separately

Forecast Results – Summer Coincident Peak Demand

Summer Coincident Peak Demand Growth Rates

Jurisdiction	Weather Adjusted	Actual		Projected
	1994 – 2004	1994 – 2004		2005 – 2017
California	0.7%	-1.7%		1.4%
Idaho	- 0.7%	0.2%		0.8%
Oregon	- 0.2%	- 0.2%		1.3%
Utah	4.5%	4.3%		3.7%
West Wyoming	- 5.8%	- 5.6%		3.4%
Washington	1.2%	0.9%		1.1%
East Wyoming	0.2%	0.5%		2.6%
System	1.6%	1.6%		2.5%

- Utah forecasted increase reflects air conditioning increases in the residential customer class
- Wyoming increase reflects increased industrial load
- California increase reflects increased tourism

Forecast Results – Winter Coincident Peak Demand

Winter Coincident Peak Demand Growth Rates

Jurisdiction	Weather Adjusted	Actual	Projected
	1994 – 2004	1994 – 2004	2005 – 2017
California	0.5%	- 1.5%	1.3%
Idaho	1.5%	- 0.3%	1.0%
Oregon	- 1.0%	- 0.6%	1.2%
Utah	3.9%	3.3%	2.5%
West Wyoming	- 2.8%	- 1.9%	3.5%
Washington	0.4%	1.8%	0.8%
East Wyoming	- 0.7%	- 0.3%	2.6%
System	0.9%	1.0%	1.9%

- Utah’s growth reflects little gains in space heating during the forecast period
- Wyoming gains are similar to the summer increases which reflects increased industrial loads

Forecast Results – State Peak Demand

State Historical and Forecasted Growth Rates

Jurisdiction	Weather Adjusted Peak Demand	Actual Peak Demand	Peak Demand	Weather Adjusted Energy	Actual Energy	Energy
	1994 -2004	1994 -2004	2005 - 2017	1994 - 2004	1994 - 2004	2005 – 2017
California	1.0%	0.6%	1.3%	0.7%	0.6%	1.3%
Idaho	0.3%	0.1%	1.0%	0.2%	0.1%	1.1%
Oregon	-0.2%	-0.6%	1.2%	-0.4%	-0.6%	1.5%
Utah	4.0%	4.0%	3.6%	3.1%	4.0%	2.6%
West Wyoming	-5.2%	-5.1%	3.5%	-5.4%	-5.1%	3.4%
Washington	1.0%	1.8%	0.8%	0.9%	1.8%	1.2%
East Wyoming	-0.2%	-0.5%	2.8%	-0.2%	-0.5%	2.6%

- Utah’s gain reflects summer peaking for the state
- Washington and Oregon increase in peak demand is less than energy increase which reflects continued efficiency and small increases in electric heating saturations for some sectors within the residential and commercial classes.

Next Steps

- Some refinements of forecast
- Continue separating program and model into the seven separate jurisdictional models/programs
- Implement Multivariate Adaptive Regression Splines (MARS) Technique
 - Procedure in a statistical software package known as B34S
 - Technique that will choose the “best” splines and interaction terms through stepwise regression methods of all possible temperature breakpoints and interactions.
 - Allows for different temperature breakpoints across jurisdictions
 - Allows for different temperature breakpoints for day of the week, month of the year, etc.
 - This technique will continue the practice of treating each jurisdiction uniquely due to different customer mix and load shapes



Price Elasticity

Will O'Shea



Price Elasticity Agenda

- Price Elasticity in Current Models
- Econometric Elasticity Calculations
- Price Reaction of Customers Who Called About the Rate Change
- Elasticity Among Customer Sub-Groups
- Potential Further Research

Price Elasticity in Current Models



Price Elasticity Incorporated into Long Term Models

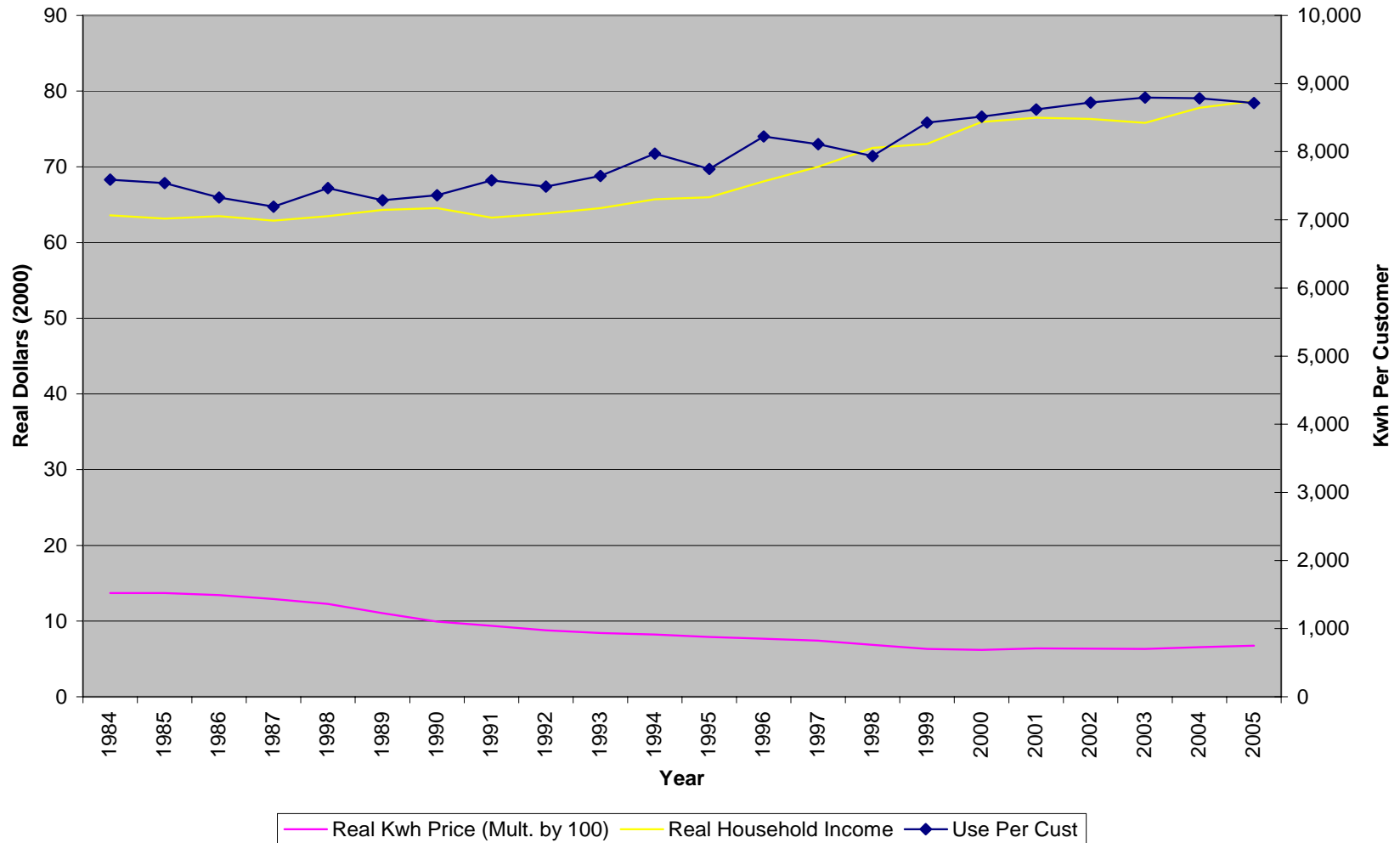
- Electricity price elasticity set to approximately -0.1 in REEPS and COMMEND
- Electricity price expectations based on Global Insights forecast
 - Real prices are not expected to grow faster than inflation over next 30 years
- Removing price elasticity from Utah REEPS model would have a very slight (i.e., a hundredth of a percent) effect on the growth rate

Econometric Calculation of Elasticity



Increasing Use Per Customer and Real Income with Decreasing Real Price Per kWh

Use per Customer, Price, and Income



Econometric Elasticity Calculation

- Goal
 - Refresh econometric model with recent data including new price structure
- Method
 - Annual observations from 1982 to 2005
 - Sales, customers, and prices from Company records, weather from NWS, gas prices from DOE
 - Use per customer, prices, and income variables are log transformed
 - Functional form:
 - Use Per Customer = $f(\text{Real Current Price, Real Household Income, CDD, HDD, Real Natural Gas Price, Lagged Use Per Customer}) + \text{error}$
- Results
 - Short-term price elasticity: -0.05
 - Long-term price elasticity: -0.09
 - R-square: 0.93
 - kWh price, gas price, income, and HDD were insignificant at $\alpha = 0.05$
 - Not unexpected given previous findings (i.e., August 2004)
 - Overall these results support previous findings indicating a small elasticity value



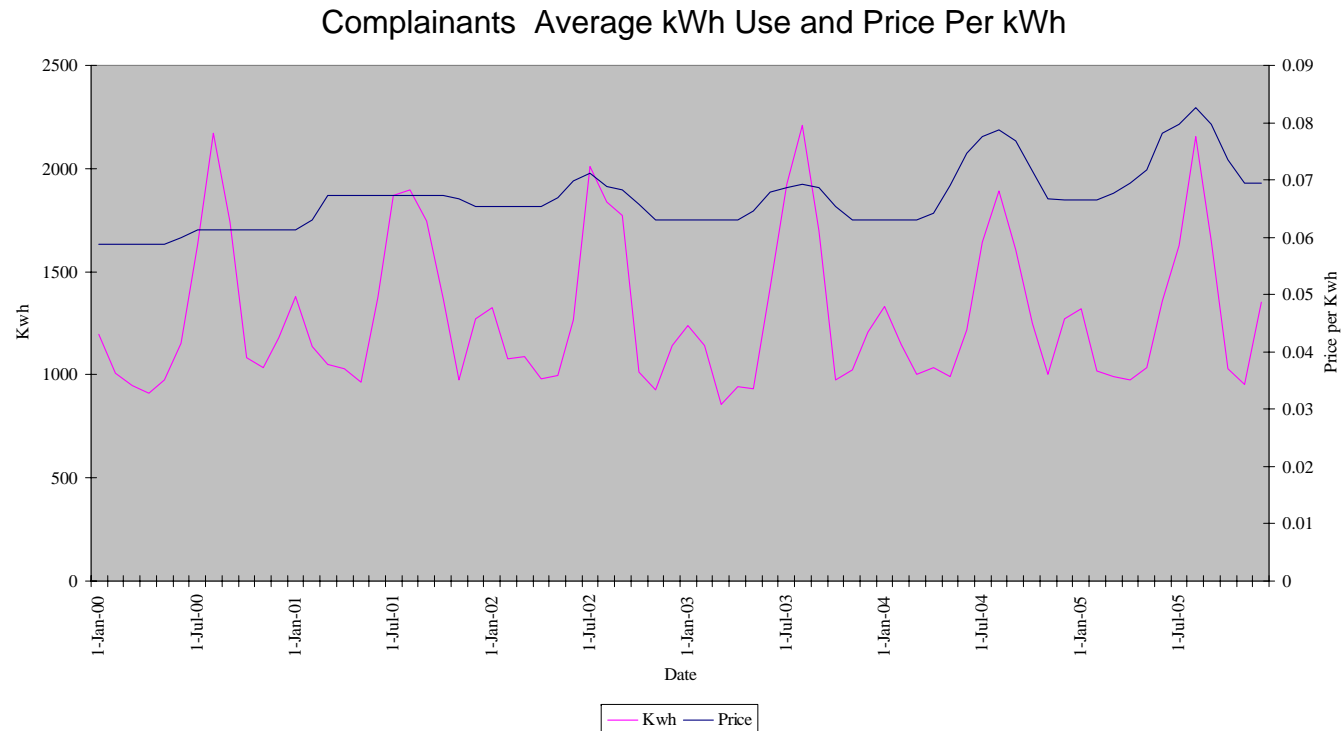
Customers Who Reacted to the New Prices and Their Usage Behavior



Customers Who Called About the Tiered Rates

- Customers who call the Commission to file a complaint or those who call the Company with an issue irresolvable by Customer Service are tracked through an escalated resolution process
- Goal
 - Customers making such a complaint have had a documented reaction to the prices, as such, this analysis would test if this group may have changed their usage behavior in response to price
- Customers
 - Of all complaints, 77 callers cited price issues in 2004
 - 13 of the 77 had sufficient usage histories available for analysis
- Method
 - Regress log average monthly kWh onto:
 - Log average real price
 - Lag log average real price (elasticity term)
 - Lag log average monthly kWh
 - HDD and CDD

Complainant Elasticity Results



- Non-significant price elasticity
- 2005 use appears as high as previous years; 2004 had much lower CDD
- These results suggests that, despite dissatisfaction with rates, enough to file a complaint, customers appear to not change their behavior



Elasticity Among Customer Sub-Groups



Cluster Elasticity Analysis

- Goal
 - Group customers into similar usage patterns over the past six years to discover elasticity among sub-groups
- Customers
 - Of all active customers, 136,042 were selected based on a usage history with no monthly use less than 55 kWh and a start date before July 1999
- Descriptive Statistics

	Mean Kwh	Median Kwh	Percentile Kwh	
			1%	99%
<hr/>				
Customers In Analysis				
Six-Year All Months	861	763	208	2511
Six-Year Summer Months	1063	902	199	3332
All Customers Active in 2005				
2005 All Months	813	714	160	2502
2005 Summer Months	1041	880	145	3427

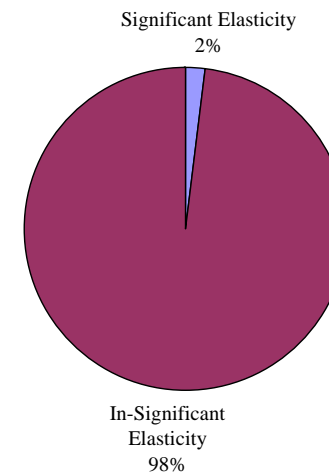
Two-Stage Analysis Method

- Cluster analysis
 - Groups individuals into clusters based on distances defined by input variables
 - Group individual customers into 500 clusters based on:
 - Six-year monthly average kWh use
 - Six year monthly standard deviation of kWh use
 - Average summer use for 2000 to 2005
 - Average winter use for 2000 to 2005
 - kWh increase from spring to summer for 2000 to 2005
- Regression analysis of price elasticity
 - Select all clusters of 500 or more customers, i.e., 23 clusters
 - Roll remaining clusters into one group
 - Regress cluster log transformed mean monthly kWh use onto:
 - Log cluster mean monthly price per kWh
 - Lag log cluster mean monthly price per kWh (elasticity term)
 - Lag log cluster mean monthly kWh
 - HDD and CDD

Cluster Elasticity Analysis Results

- Price Elastic Clusters with summer usage
 - Cluster 121
 - Customers: 1,490
 - Elasticity: -2.51
 - Summer Mean: 1,096
 - Cluster 363
 - Customers: 505
 - Elasticity: -0.95
 - Summer Mean: 2,340
- Estimate total elasticity
 - Weigh cluster elasticities by total average summer kWh use

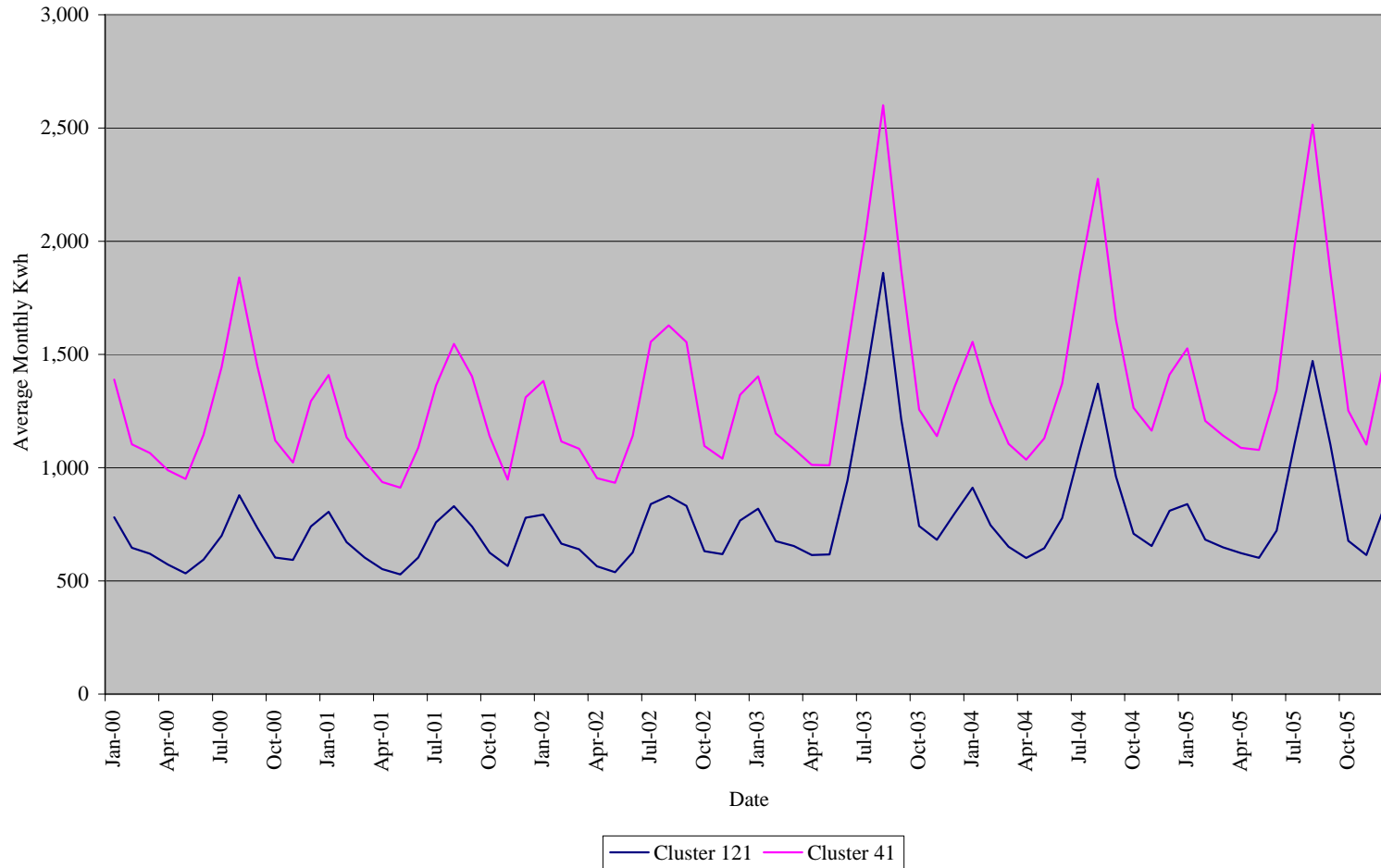
Total Average Summer kWh



Cluster	Proportion of Total Summer Monthly Average	Weighted Elasticity	Weighted Elasticity
Cluster 121	1.1%	-2.501	-0.028
Cluster 363	0.8%	-0.946	-0.008
Remaining	98.1%	0.0	0.0
Total Elasticity			-0.036

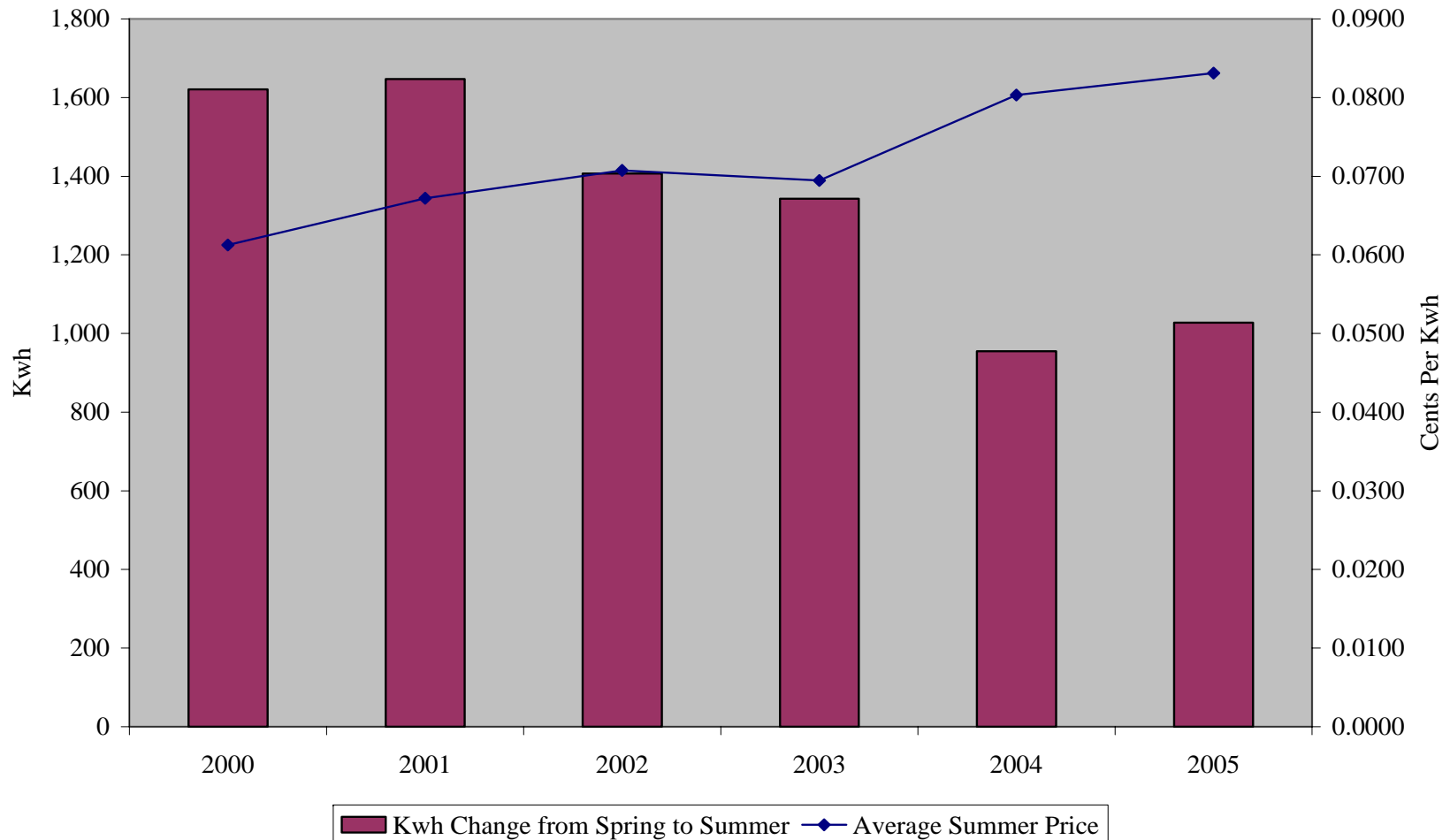
Comparison of Price In-Elastic and Elastic Clusters' Mean Monthly kWh

Six-Year Monthly Time Series by Cluster



Cluster 363 Appears to Respond to Price Increases

Kwh Change From Spring to Summer and
Cents per Kwh for Cluster 363



Conclusion of Cluster Elasticity Analysis

- Customers included in analysis appear representative of population
- Elasticity exists among small subsets of the customer population
- Small and large use customers did not produce an elastic cluster
 - Too small to make a big bill difference
 - Too large, i.e., wealthy, to be concerned about bill increase
- Weighted total elasticity value consistent with other results
 - Very small price elasticity



Potential Further Research



Next Steps

- Multi-method price elasticity analyses appear to converge around a small elasticity value – as is currently used
- On going monitoring of customer reactions to price as additional data become available
- Current analysis also suggests other opportunities for continued analysis around causal factors distinguishing customers' behavior
 - What drives elasticity among customers identified as elastic?
 - Why do clusters with similar profiles (e.g., 41 and 121) react differently?
 - What other customer behavior is revealed by cluster analysis?
- Other suggestions?