Building Leadership Excellence

people resources solutions

Sustainability and Smart Grid

Implementing a Non-residential Smart Metering System

May 1-4

PaperCon 2011

Northern Kentucky Convention Center

RETHINK PAPER:
Lean and Green

Smart Grid

Popular Topics in the News

- Smart Grid
- Smart Meter
- Micro Grid
- Distributive Generation

Most talk is about household demand management – change of lifestyle in exchange for potentially lower power bills

People move decisively when incentives are high enough relative to risk and effort

Only possible when permitted by regulators / legislators

Smart Grid

Deregulated Ohio Electric Choice

- People moving for 10-20% off 55-60% of their bill or 5-10% utility discount
- One time; no effort; little risk

Smart Meter Requires Active Participation

➢ Residential Issues

- Many will not do it especially with the peak hour penalties
- Actual bill could be higher
- Demand shift is the only choice for most

Smart Grid For Industrial Facilities

Industrial Opportunities Can Advantage Current Behavior

- Reduce and manage energy cost (on a real time basis)
- Control electric costs (Make vs. Buy)
- Monitoring electric system (more granular – Dashboard)
  - Monitoring will improve process/operation
  - Facilities have business choices for management of electric supply/demand

Properly set up and managed electric power costs can be minimized

Ideally capped to fuel cost and conversion factor

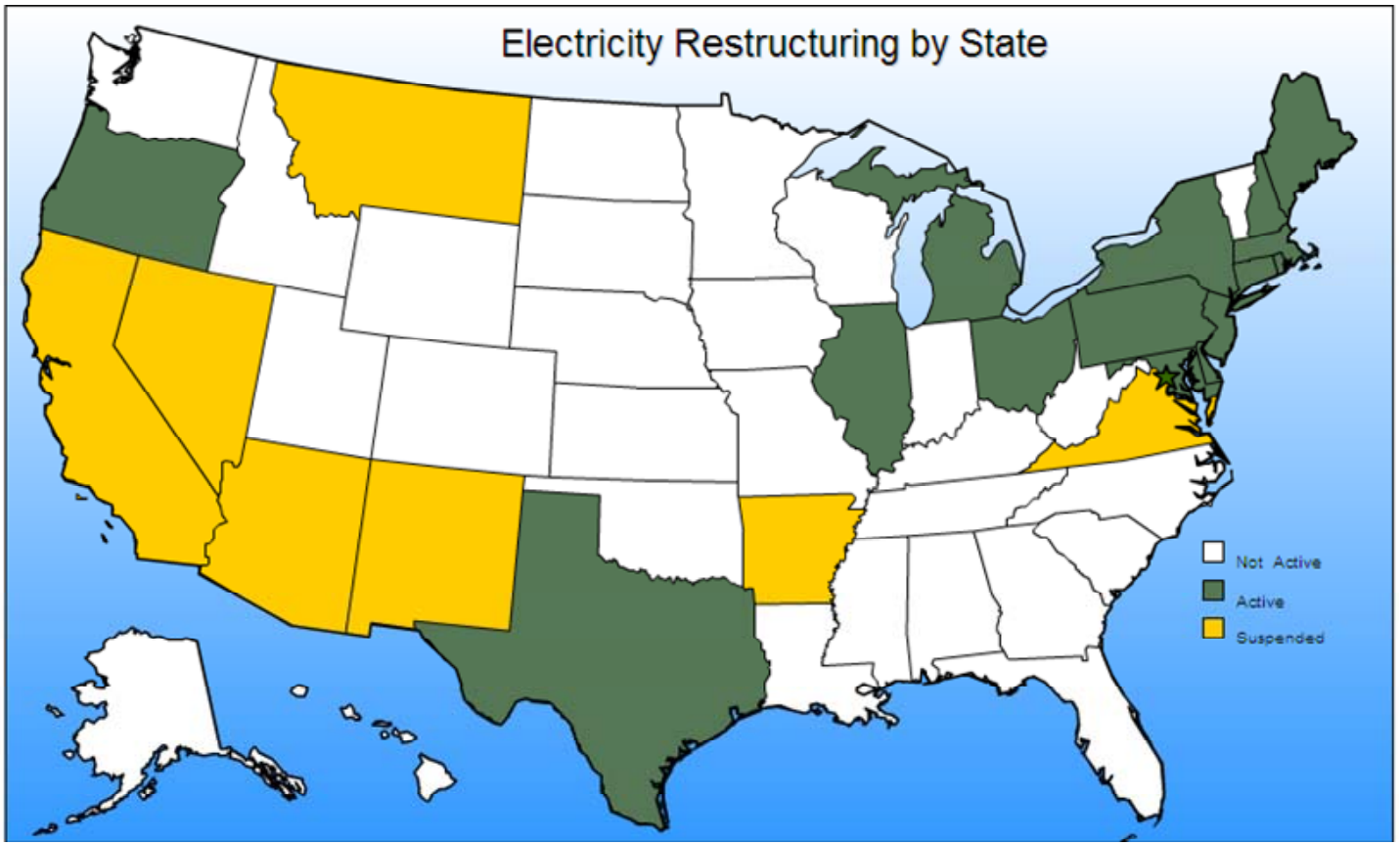
Smart Grid For Industrial Facilities

Can We Do It?

- Regulatory
  - Located in deregulated state (PUC and State Legislature)

Smart Grid For Industrial Facilities

Source eia.doe.gov
Data as of September 2010



Active =
Pricing monopoly eliminated

Smart Grid For Industrial Facilities

Can We Do It?

- Regulatory
  - Located in deregulated state (PUC and State Legislature)
  - If no - Can you negotiate a “deal” with utility and PUC?
  - Located in an ISO
  - Enabling/incenting environment (PUC and State Legislature)

Smart Grid For Industrial Facilities

Can We Do It? (cont.)

- Effectively
  - Current grid interface
    - Distribution level or transmission level
  - Node pricing history
  - Current electric tariff
  - Smart metering tariff
  - Flexibility of facility to manage load

Smart Grid For Industrial Facilities

Can We Do It? (cont.)

- Technically
  - Available data stream from power system
  - Convert data to information
  - Depth of utility operation

Smart Grid For Industrial Facilities

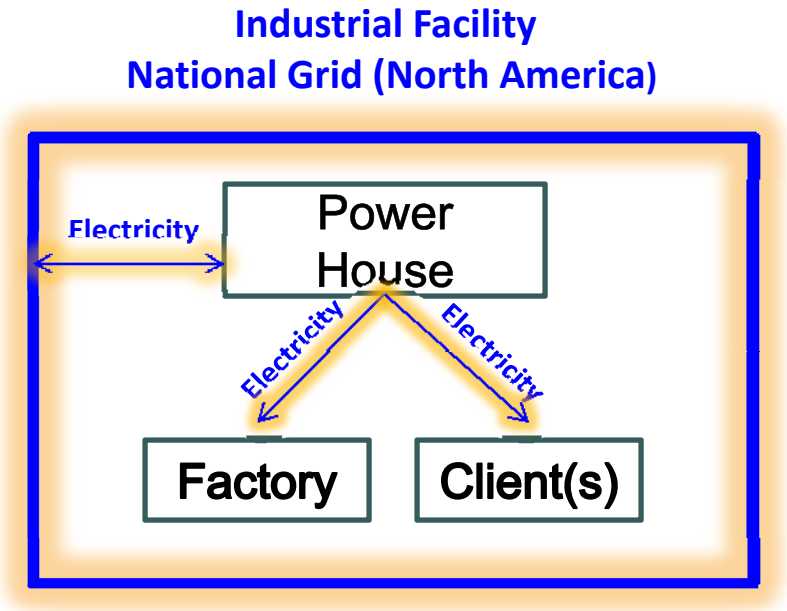
Electric Grid

- Perfect World
  - Buy low
  - Sell high
- Real Time Grid Pricing
  - Is a perfect world
  - Demand based pricing
  - Little to no inventory
- Imperfections (Necessary)

  Rules and Regulations
  - FERC
  - NERC
  - ISO's
  - Tariff requirements (Utility Commissions and Utilities)
- Impact perfect real time price model

Smart Grid For Industrial Facilities

Smart Grid requires willingness to manage exposure



- Source of Steam (Boilers)
- Sources of Electricity
  - Grid
  - From steam; gas, oil, solar, wind, fuel cell, on site

Sourcing electricity is an economic decision

Smart Grid For Industrial Facilities

Evaluate Your Facility

- Grid Interconnect
- Utility Complex
  - Steam capacity match to demand
  - Electric generating capacity match to demand
  - Flexibility
  - Fuel source
  - Conversion factor
  - Incremental cost to produce
  - Current utility agreement

Smart Grid For Industrial Facilities

Evaluate Your Facility

- Process Flexibility
  - Controlled load management
  - Operational shift to off peak
  - Conservation opportunities
  - Options to store energy
    - Work in progress
    - By product
    - Finished goods

Smart Grid For Industrial Facilities

Evaluate Your Facility

- Key Questions
  - Deregulated state
  - Demand flexibility
  - MW production costs vs. grid pricing profile
  - MW production costs vs. current tariff
  - Exposure management vs. stability of tariff
  - Can facility zero tie (Now)
    1. Self supply generation
    2. Protect price upside
  - Utility potential for development of additional electric generation

Smart Grid For Industrial Facilities

Evaluate Your Facility

- Smart Grid Transition
  - 20% technical
  - 80% regulatory

Smart Grid For Industrial Facilities

SMART Evaluation

Excess coal fired steam capacity

Mismatched generation vs. steam requirements

Captive utility substation at transmission voltage

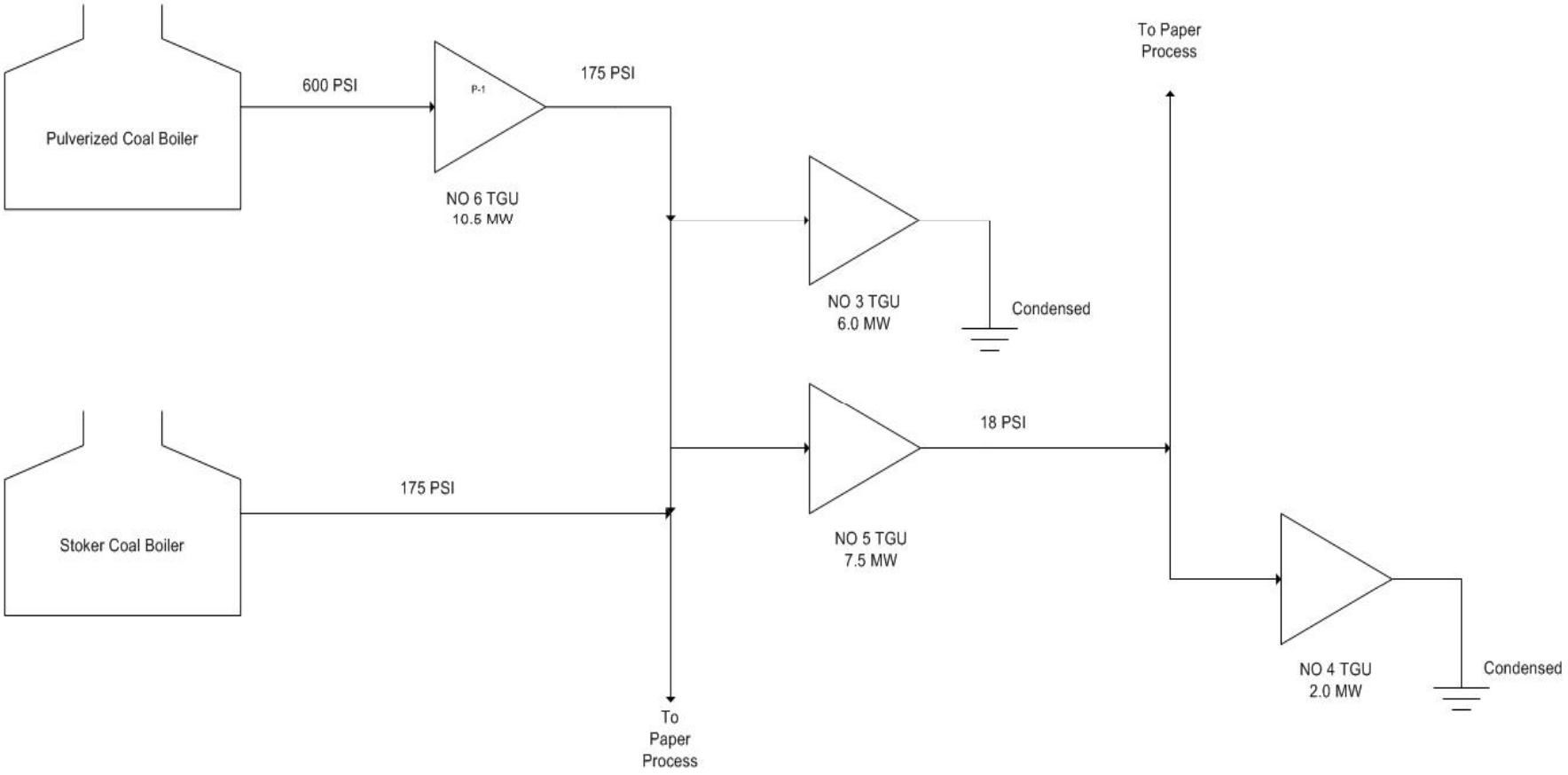
Ten years of real time utility agreement

- Risk and flexibility skills
- Knowledge of hourly pricing

Deregulated state

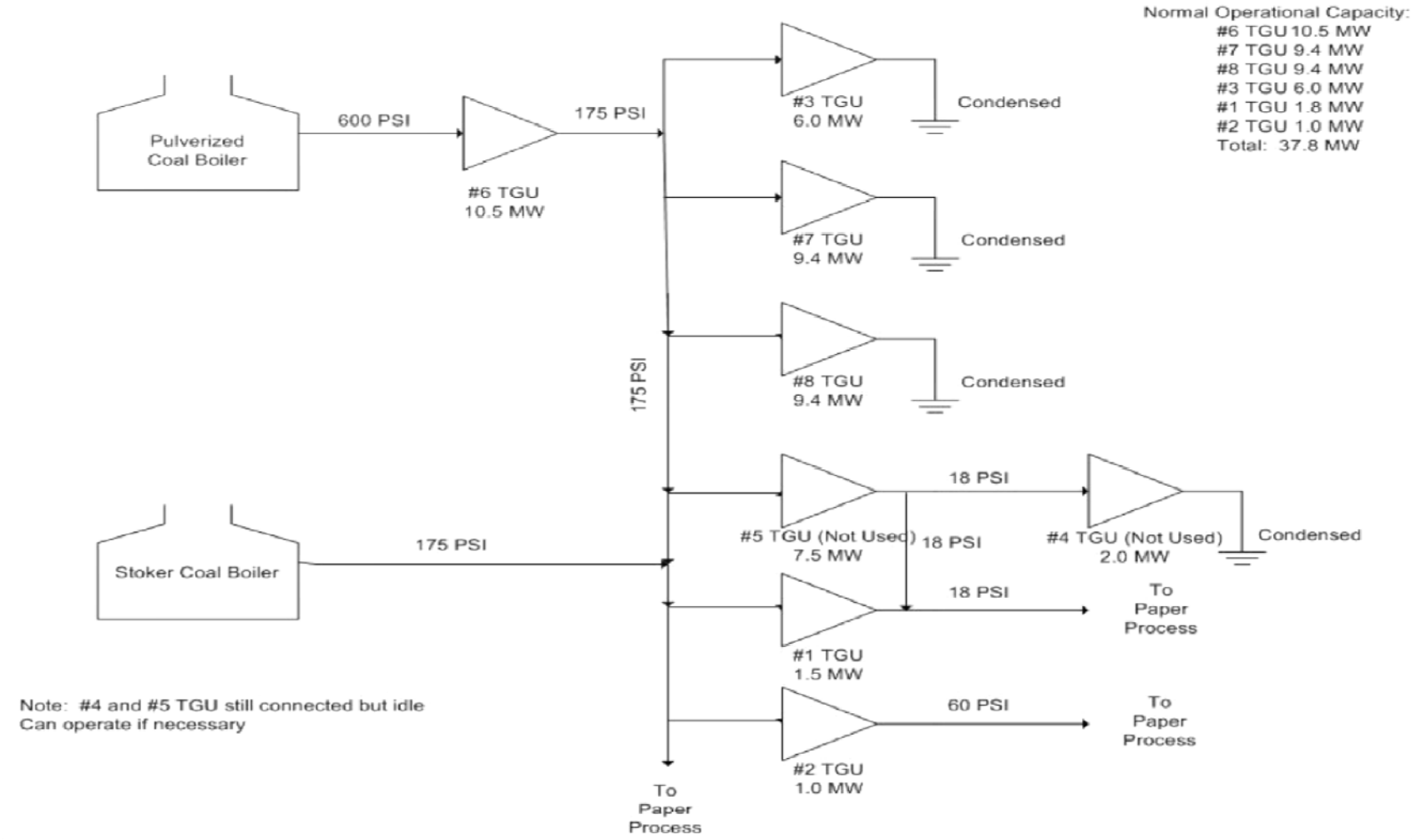
Smart Grid For Industrial Facilities

SMART Papers Power Complex – Pre July 2009

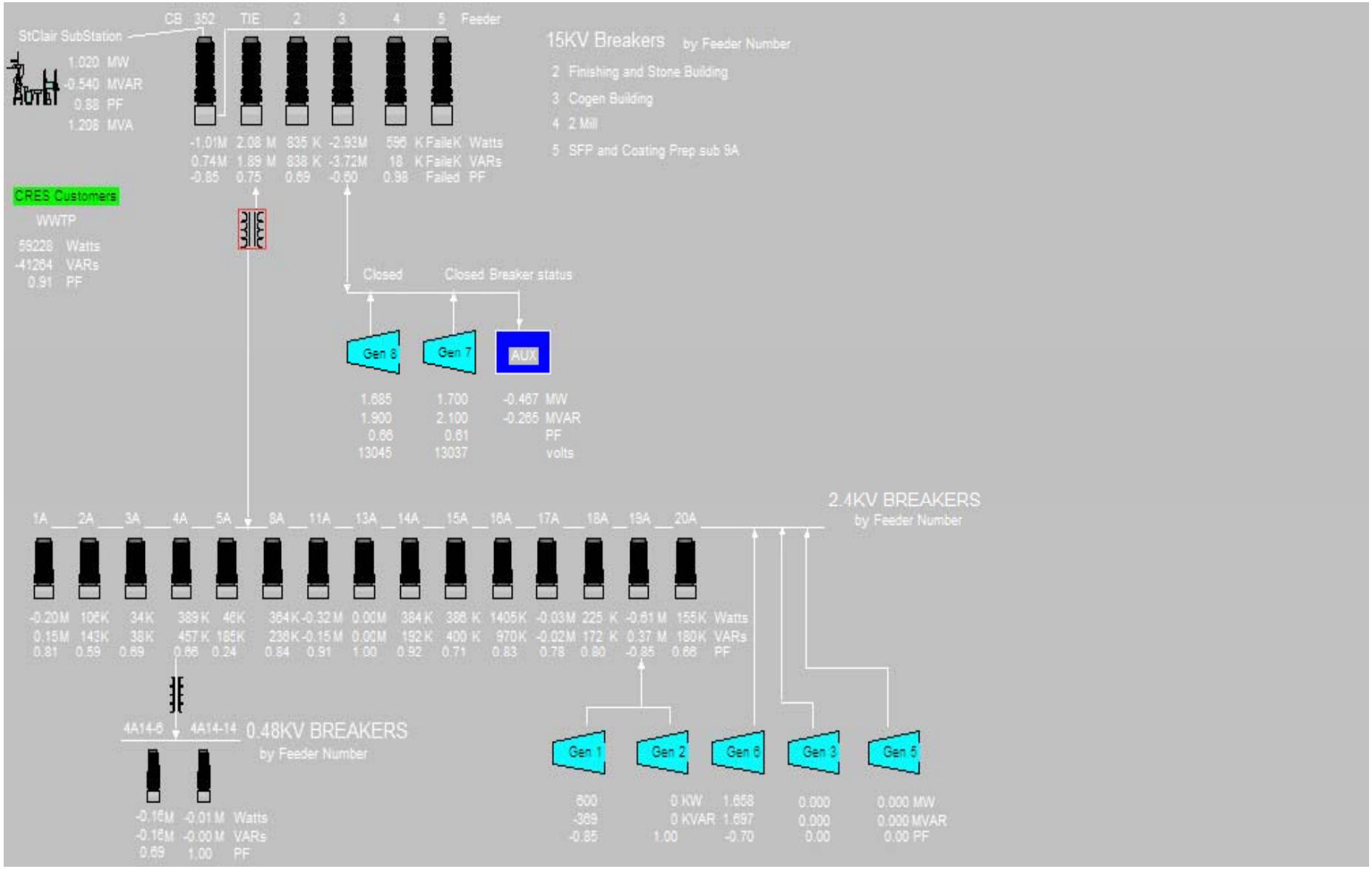


Smart Grid For Industrial Facilities

SMART Papers Power Complex – Post July 2009



Smart Grid For Industrial Facilities



Smart Grid For Industrial Facilities

SMART Project

Beyond the Turbines!

LGIA MISO

Dual node (gen/load) MISO – Capable to buy/sell - Unique

Purchased substation from utility – Get to transmission level

Installed real time meters at substation – Monitor

- Required by utility – Cross check utility

Formed and registered as a CRES – Purchase at wholesale

Contracted power marketer – Monitor ISO weekly billing, Day ahead bidding, PPAs

PI Historian / SMART reporting – Data –> Information

Operator interface to grid – Price

Calculated marginal buy/sell – Really understand your facility

Focused on conservation – ROI is improved

Smart Grid For Industrial Facilities

How It Works

Boiler(s) on line to feed process steam

Utility operators monitor grid real time

Decision

- Buy
- No buy
- Sell

Hourly decisions

Results hourly historical

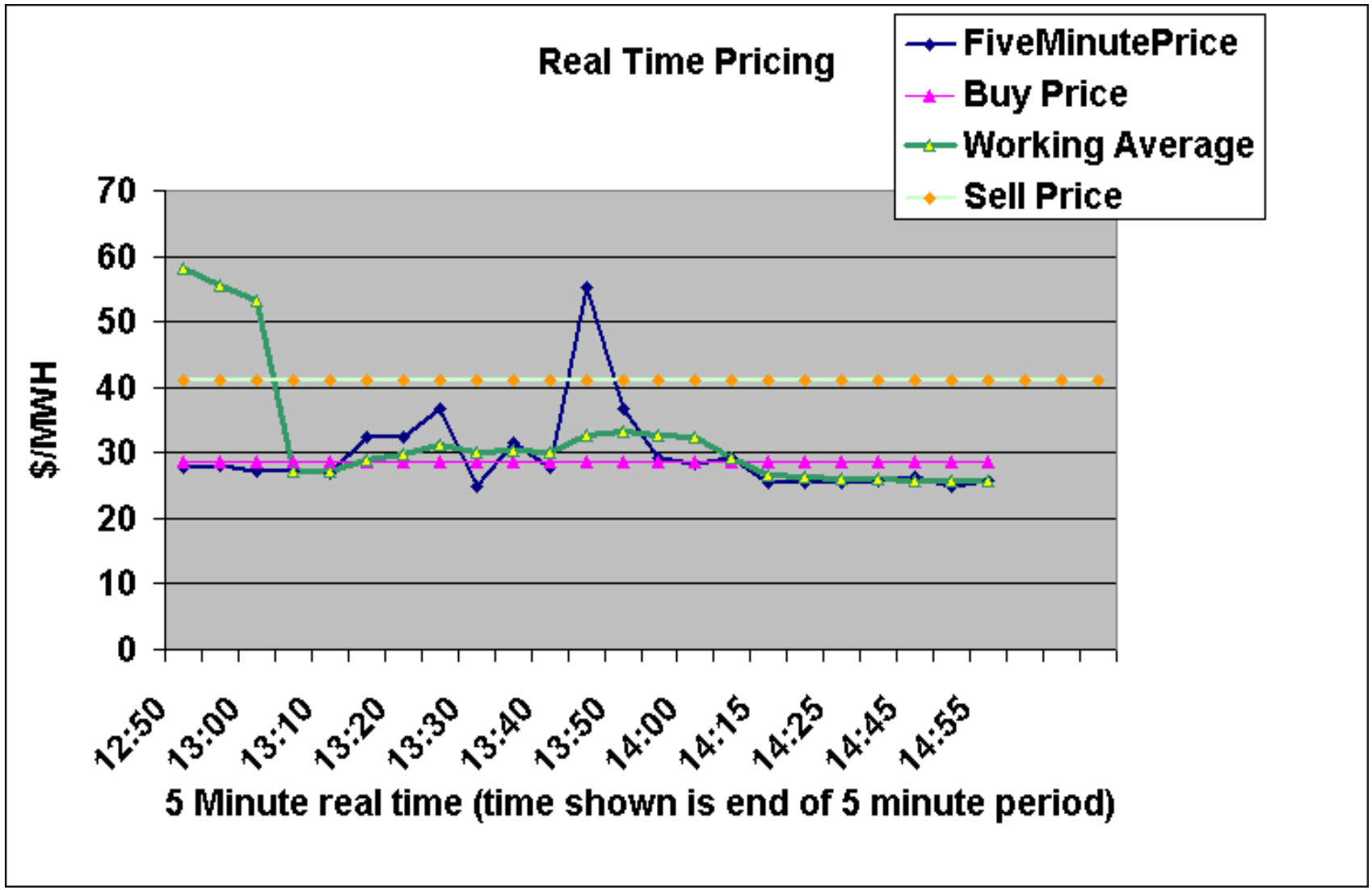
- Total generation
- Average of twelve 5 minute prices

Communicate to operators

- Trends
- Power Marketer Model
  - Sale –> Day ahead, Real time
  - No Buy –> Zero mode
  - Buy mode

OPERATOR INFORMATION

Smart Grid For Industrial Facilities



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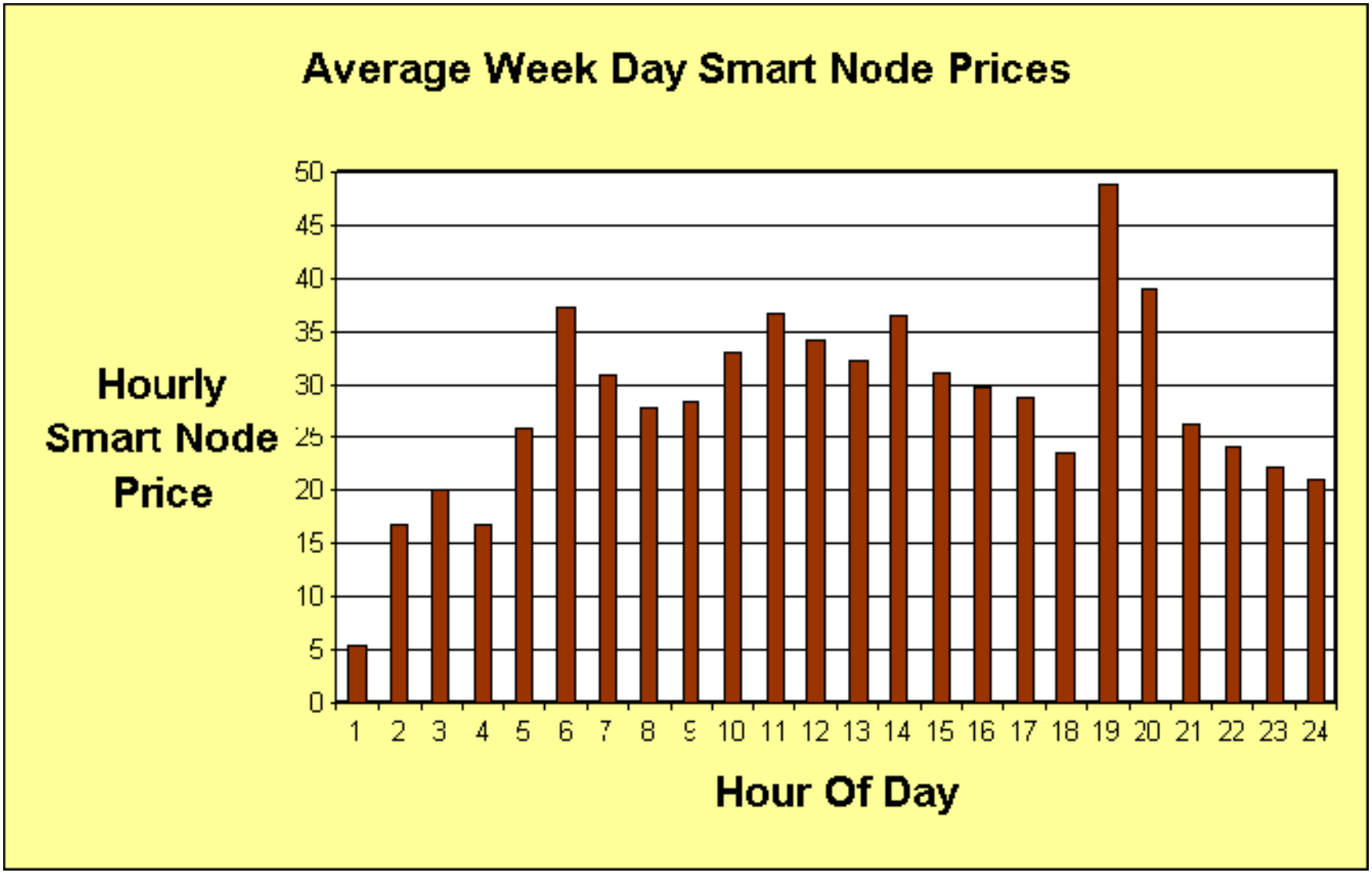

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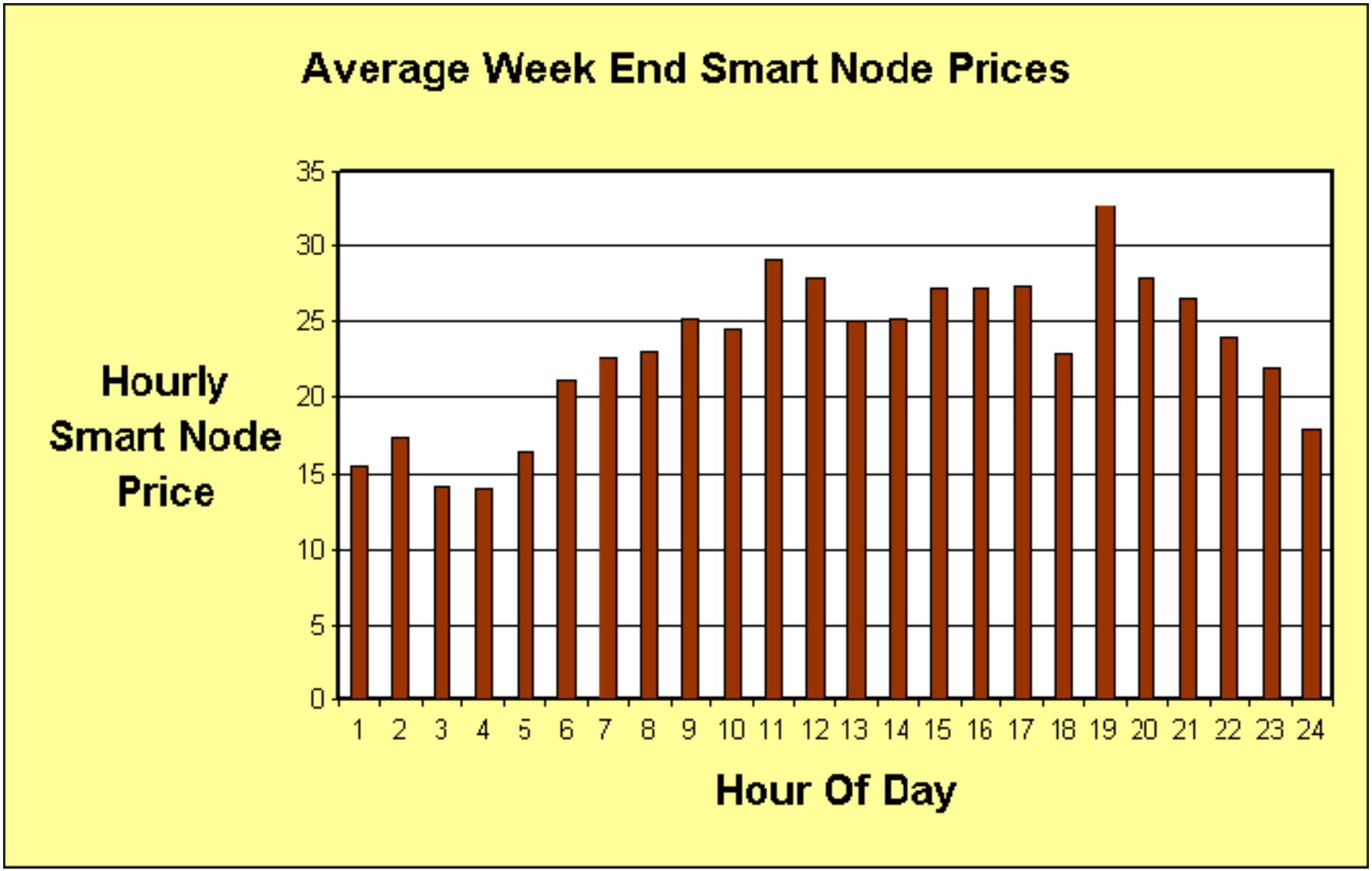


Smart Grid For Industrial Facilities

		E MW	F MVAR	G PF	H MVA
20J:9005	**Tieline (+ = buy)**	3.75	-0.72	0.99	3.86
	Generation				
78:J2280	Process Turbines (- sign = generate)	-1.04	0.50	-0.90	
73:J0240	TG3	0.00	0.00	0.00	
75:J0312	TG5	0.00	0.00	0.00	
76:J0312	TG6	0.92	2.28	-0.37	
97:W1010	TG7	-0.00	0.00	1.00	
98:W1010	TG8	0.80	3.80	0.18	
78:MILLTOTGENMW.C	**Total Generation**	2.76	5.58		
	Utilities Consumption				
78:J2145	10 Boiler (cir 1A)	-0.22	0.16	0.85	
78:J2210	Boiler Plant (cir 11A)	-0.31	-0.15	0.91	
78:J2180	69 & 70 Air Compressors (cir 13A)	0.00	0.00	1.00	
78:J2235	14 Boiler substation (cir 17A)	-0.05	-0.02	0.97	
78:J1672	480V Steam Plant (cir 4A14-6)	-0.15	-0.14	0.74	
78:J1677	480V Turbine Plant (cir 4A14-14)	-0.01	-0.00	0.91	
	Condensing Turbine Process	-0.22	-0.19	78:CONDTURBAUXMW.C	
	10 Boiler FD Fan	-0.022			
	Total Utilities Consumption	-0.95	-0.41	78:SMARTPOWERELECUSEMW.C	
78:SMARTPAPERSELECUSEMW.C	**Process Consumption by Difference**	-5.63	-4.55	= -(Tieline + Total Generation + Utilities Consumption)	

Other Measurements (not in the balance)
CB 352 Grid Interconnect
78:J2010 -3.70 0.83 -1.00

Condensing Turbine Area net (minus is to mill)
78:J2035 -0.58 -3.61 -0.15

go to MW trend

go to MVAR trend

Version 5-4-10

Smart Grid For Industrial Facilities

Trends
Refiner KW Trends

Smart Papers Electric Meters

Paper Mill Overview

	KW	UNLESS NOTED	
Paper Consumption by Difference	**-5.70**	**MW** Trends	
Paper Consumption by Direct Meter	**5.31**	**MW**	
SFP	218		2400V Breaker 18A
SFP/Clay Slurry	467		13.2 Kv Feeder 5
#9 PM Stock Preparation Total	**684**		calculation
#5 Disk Refiner	151		2400V Breaker 20A
Wet End Systems	1301		2400V Breaker 16A
Lineshaft/DC drives/pulpers/Kady Mixers	339		2400V Breaker 15A
Auxilliary Services	352		2400V Breaker 14A
Rental Chiller/Shift Maintenance	0.0		2400V Breaker 3A
Basement Services by difference	230		calculation
No. 1 Sub Station		394	2400V Breaker 4A
Turbine Plant		-0.01 MW	480V Breaker meter
#10 Boiler Precipitator/Misc.		-0.15 MW	480V Breaker meter
#10 Boiler FD Fan Motor		5	480V Breaker meter
#9 Paper Machine Total	**2359**		calculation
Casting/RW #6,7,14/Roll Wrap/CMS /Sheeters #7,8,16/Carrier/Embossers/Main Office	988		13.2 Kv Feeder 2
Sheet Packing/Sheeter #9	138		2400V Breaker 2A
RW #1,11/Plant Protection/Mill DC Power	33		2400V Breaker 5A
Converting Total	**1208**		calculation
Mill Water Supply (River, Filtered, #1&#2 35#/all 100#)	**404**		2400V Breaker 8A
#61 Air Compressor/PD/#2 Mill/#3&4 35# Mill Water	**622**		13.2 Kv Feeder 4
Paper Consumption by Direct Meter @ WWTP	114413	**W**	480V Breaker meter @ WWTP

MANAGEMENT INFORMATION

Smart Grid For Industrial Facilities

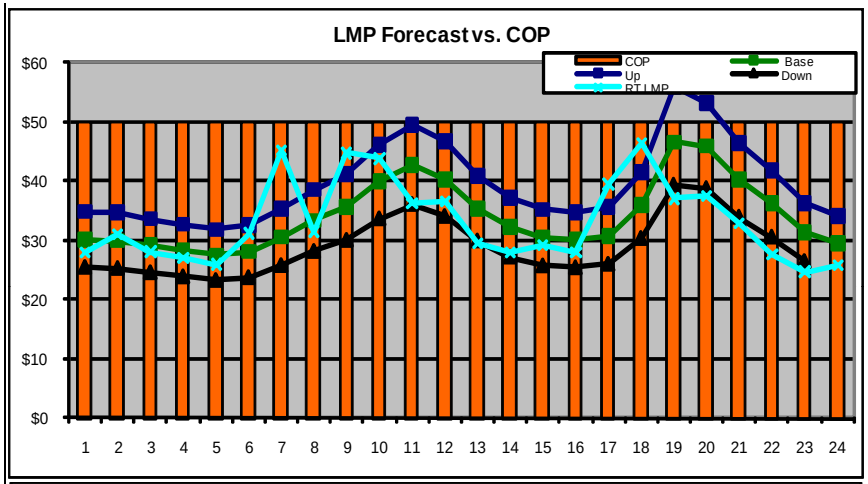
Smart Papers Day-Ahead Report 2/12/2011

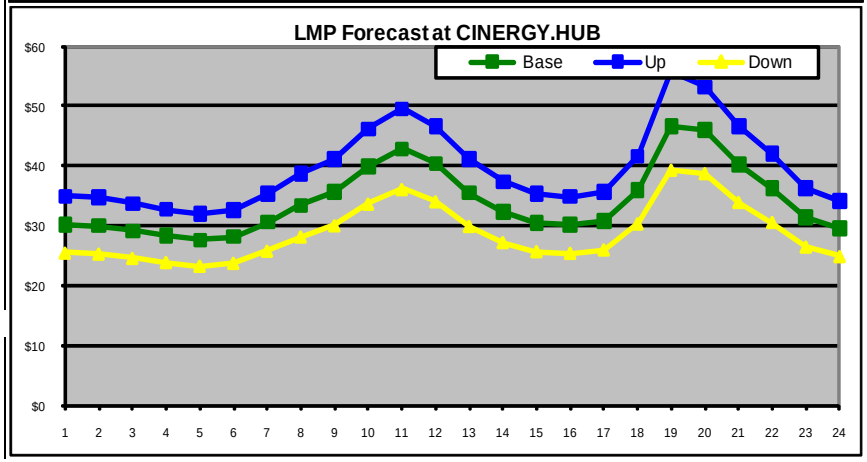
Hour Ending	CIN.SMARTGEN DA LMP Fcst	CIN.SMARTGEN Day Ahead	CIN.SMARTGEN Real Time	CIN.SMARTGEN Only Day Ahead	CIN.SMARTGEN Only Real Time	CIN.SMARTGEN RT LMP Fcst
HE 1	30.19	0	0	10	10	27.98
HE 2	29.99	0	0	10	10	31.01
HE 3	29.13	0	0	10	10	28.14
HE 4	28.31	0	0	10	10	27.01
HE 5	27.57	0	0	10	10	25.95
HE 6	28.15	0	0	10	10	31.18
HE 7	30.57	0	0	10	10	45.20
HE 8	33.39	0	0	10	10	31.51
HE 9	35.61	0	0	10	10	44.82
HE 10	39.93	0	0	10	10	43.86
HE 11	42.81	0	0	10	10	36.21
HE 12	40.38	0	0	10	10	36.66
HE 13	35.47	0	0	10	10	29.56
HE 14	32.28	0	0	10	10	27.96
HE 15	30.49	0	0	10	10	29.17
HE 16	30.13	0	0	10	10	28.03
HE 17	30.82	0	0	10	10	39.54
HE 18	35.98	0	0	10	10	46.40
HE 19	46.65	0	0	10	10	37.09
HE 20	45.97	0	0	10	10	37.64
HE 21	40.25	0	0	10	10	33.00
HE 22	36.26	0	0	10	10	27.74
HE 23	31.38	0	0	10	10	24.76
HE 24	29.49	0	0	10	10	25.83
24 Hr MWh Total	$34.22	0				$33.18
Peak Hr MWh Total	587	0				
Off-Peak Hr MWh Total	234	0				
Total $						
$/MWh						

Market Data

Offer Price	$	50.00									
	LMP			**COP**		**Fcst MISO Rev**		**Fcst Cost**		**Fcst Margin**	
On-peak CIN.SMARTGEN	$	36.69	**Day Ahead**	$	50.00	$	-	$	-	$	-
Off-Peak CIN.SMARTGEN	$	29.28	**Real Time**	$	50.00	$	-	$	-	$	-
On-peak Cin Hub	$	35.60				$	-	$	-	$	-
Off-Peak Cin Hub	$	28.59									
			Only Day Ahead	$	50.00	$	8,212.00	$	12,000.00	$	(3,788.00)
			Only Real Time	$	50.00	$	7,962.50	$	12,000.00	$	(4,037.50)

Scheduling Notes/Operational Issues





Smart Grid For Industrial Facilities

Power Marketer Daily Purchase Activity

Unit	Date	DA Bid MW	DA Cleared Demand	DA Cost	RT Metered MW	RT Deviation from DA	RT MW Dev. Cost LMP	Total Energy Revenue
CIN.SMARTLOAD	2/1/2011	-	-	$-	28.00	28.00	$1,121.45	$ 1,121.45
	2/2/2011	-	-	$-	50.00	50.00	$1,342.83	$ 1,342.83
	2/3/2011	-	-	$-	37.00	37.00	$1,648.83	$ 1,648.83
	2/4/2011	-	-	$-	47.00	47.00	$1,823.69	$ 1,823.69
	2/5/2011	-	-	$-	9.00	9.00	$319.86	$ 319.86
	2/6/2011	-	-	$-	-	-	$0.00	$ -
	2/7/2011	-	-	$-	40.00	40.00	$1,190.43	$ 1,190.43
	2/8/2011	-	-	$-	35.00	35.00	$981.62	$ 981.62
	2/9/2011	-	-	$-	29.00	29.00	$1,598.33	$ 1,598.33
	2/10/2011	-	-	$-	30.00	30.00	$1,282.19	$ 1,282.19
	2/11/2011	-	-	$-	37.00	37.00	$1,574.18	$ 1,574.18
	2/12/2011	-	-	$-	33.00	33.00	$1,006.66	$ 1,006.66
	2/13/2011	-	-	$-	42.00	42.00	$1,009.92	$ 1,009.92
	2/14/2011	-	-	$-	35.00	35.00	$1,071.28	$ 1,071.28
	2/15/2011	-	-	$-	89.00	89.00	$2,508.53	$ 2,508.53
	2/16/2011	-	-	$-	126.00	126.00	$2,947.23	$ 2,947.23
	2/17/2011	-	-	$-	124.00	124.00	$3,183.13	$ 3,183.13
	2/18/2011	-	-	$-	102.00	102.00	$3,326.20	$ 3,326.20
	2/19/2011	-	-	$-	54.00	54.00	$2,284.22	$ 2,284.22
	2/20/2011	-	-	$-	49.00	49.00	$1,703.96	$ 1,703.96
	2/21/2011	-	-	$-	53.00	53.00	$3,354.92	$ 3,354.92
	2/22/2011	-	-	$-	59.00	59.00	$2,504.80	$ 2,504.80
	2/23/2011	-	-	$-	34.00	34.00	$1,447.48	$ 1,447.48
	2/24/2011	-	-	$-	59.00	59.00	$2,383.67	$ 2,383.67
	2/25/2011	-	-	$-	69.00	69.00	$2,431.99	$ 2,431.99
	2/26/2011	-	-	$-	85.00	85.00	$2,707.06	$ 2,707.06
	2/27/2011	-	-	$-	81.00	81.00	$2,393.13	$ 2,393.13
	2/28/2011	-	-	$-	-	-	$0.00	$ -
	3/1/2011	-	-	$-	-	-	$0.00	$ -
	3/2/2011	-	-	$-	-	-	$0.00	$ -
	3/3/2011	-	-	$-	-	-	$0.00	$ -
	Total		-	$-	1,436.00	1,436.00	$49,147.59	$ 49,147.59

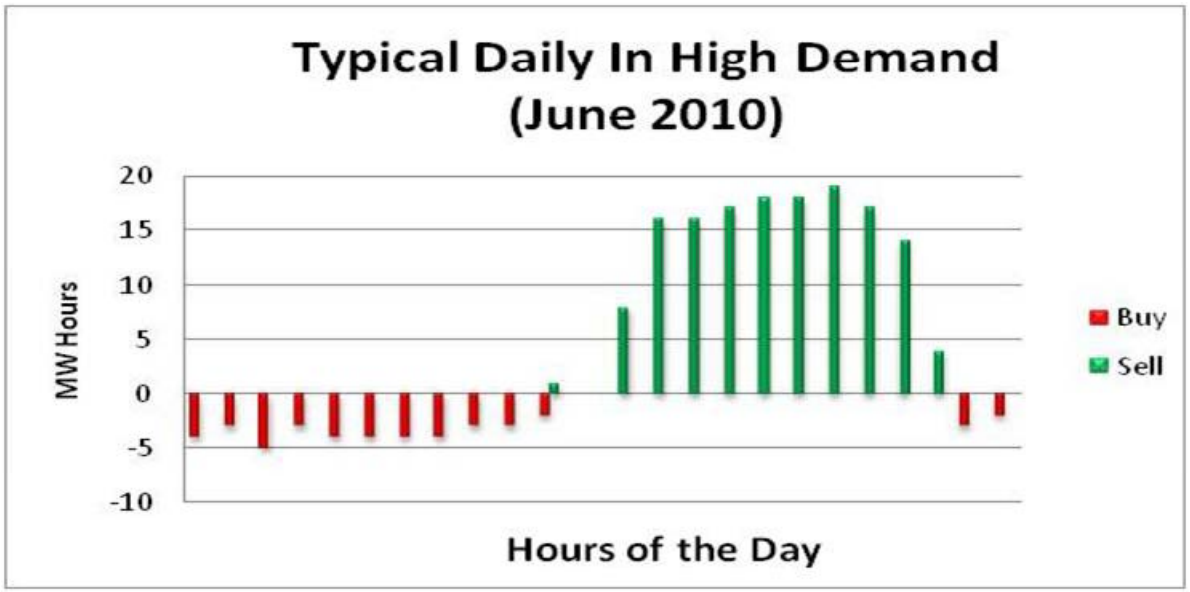
Smart Grid For Industrial Facilities

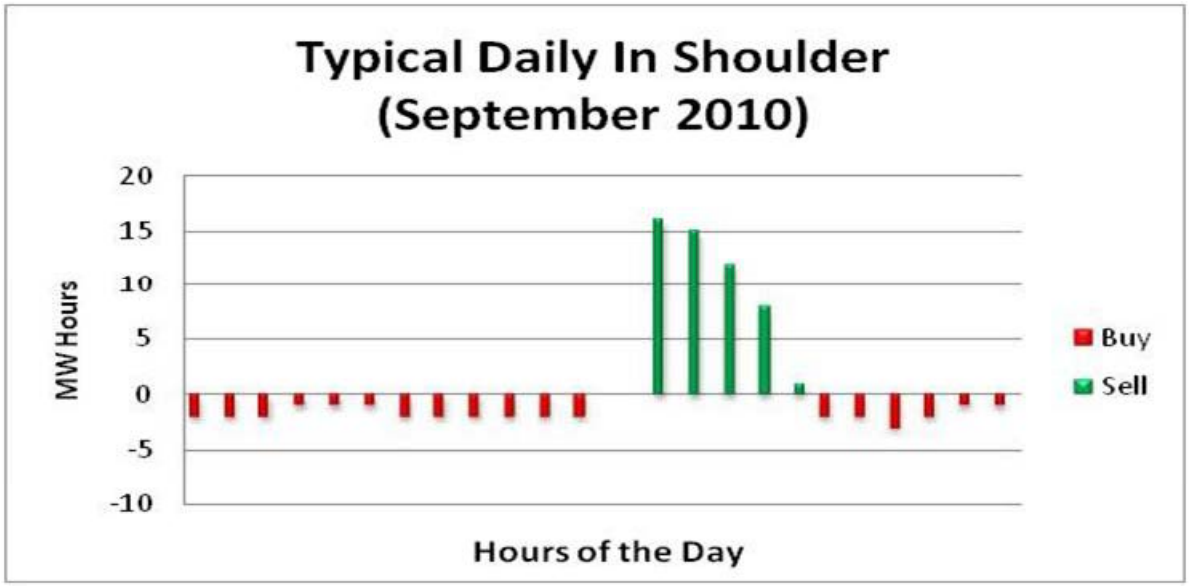
Power Marketer Daily Sales Activity

Unit	Date	DA Offered MW	DA Cleared MW	DA Revenue	RT Metered MW	RT Deviation from DA	RT MW Dev. Cost LMP	Total Energy Revenue
CIN.SMARTGEN	2/1/2011	(240.00)	-	-	(26.00)	(26.00)	(1,053.72)	(1,053.72)
	2/2/2011	(240.00)	-	-	(2.00)	(2.00)	(44.95)	(44.95)
	2/3/2011	(240.00)	-	-	(45.00)	(45.00)	(1,993.13)	(1,993.13)
	2/4/2011	(240.00)	(50.00)	(2,674.60)	(33.00)	17.00	2,170.49	(504.11)
	2/5/2011	(240.00)	-	-	(36.00)	(36.00)	(1,780.73)	(1,780.73)
	2/6/2011	(240.00)	-	-	(6.00)	(6.00)	(161.67)	(161.67)
	2/7/2011	(240.00)	-	-	(5.00)	(5.00)	(133.55)	(133.55)
	2/8/2011	(240.00)	(80.00)	(4,377.00)	(44.00)	36.00	1,377.44	(2,999.56)
	2/9/2011	(240.00)	(80.00)	(4,493.40)	(85.00)	(5.00)	623.17	(3,870.23)
	2/10/2011	(240.00)	(70.00)	(3,729.80)	(62.00)	8.00	29.58	(3,700.22)
	2/11/2011	(240.00)	(10.00)	(532.90)	(52.00)	(42.00)	(2,068.03)	(2,600.93)
	2/12/2011	(240.00)	-	-	(3.00)	(3.00)	(67.32)	(67.32)
	2/13/2011	(240.00)	-	-	-	-	-	-
	2/14/2011	(240.00)	-	-	(4.00)	(4.00)	(112.91)	(112.91)
	2/15/2011	(240.00)	-	-	(1.00)	(1.00)	(80.76)	(80.76)
	2/16/2011	(240.00)	-	-	-	-	-	-
	2/17/2011	(240.00)	-	-	-	-	-	-
	2/18/2011	(240.00)	-	-	-	-	-	-
	2/19/2011	(240.00)	-	-	-	-	-	-
	2/20/2011	(240.00)	-	-	-	-	-	-
	2/21/2011	(240.00)	-	-	-	-	-	-
	2/22/2011	(240.00)	-	-	-	-	-	-
	2/23/2011	(240.00)	-	-	(31.00)	(31.00)	(943.92)	(943.92)
	2/24/2011	(240.00)	-	-	(29.00)	(29.00)	(1,658.09)	(1,658.09)
	2/25/2011	(240.00)	-	-	(15.00)	(15.00)	(639.69)	(639.69)
	2/26/2011	(240.00)	-	-	-	-	-	-
	2/27/2011	(240.00)	-	-	(1.00)	(1.00)	(28.36)	(28.36)
	2/28/2011	-	-	-	-	-	-	-
	3/1/2011	-	-	-	-	-	-	-
	3/2/2011	-	-	-	-	-	-	-
	3/3/2011	-	-	-	-	-	-	-
	Total		(290.00)	(15,807.70)	(480.00)	(190.00)	(6,566.15)	(22,373.85)

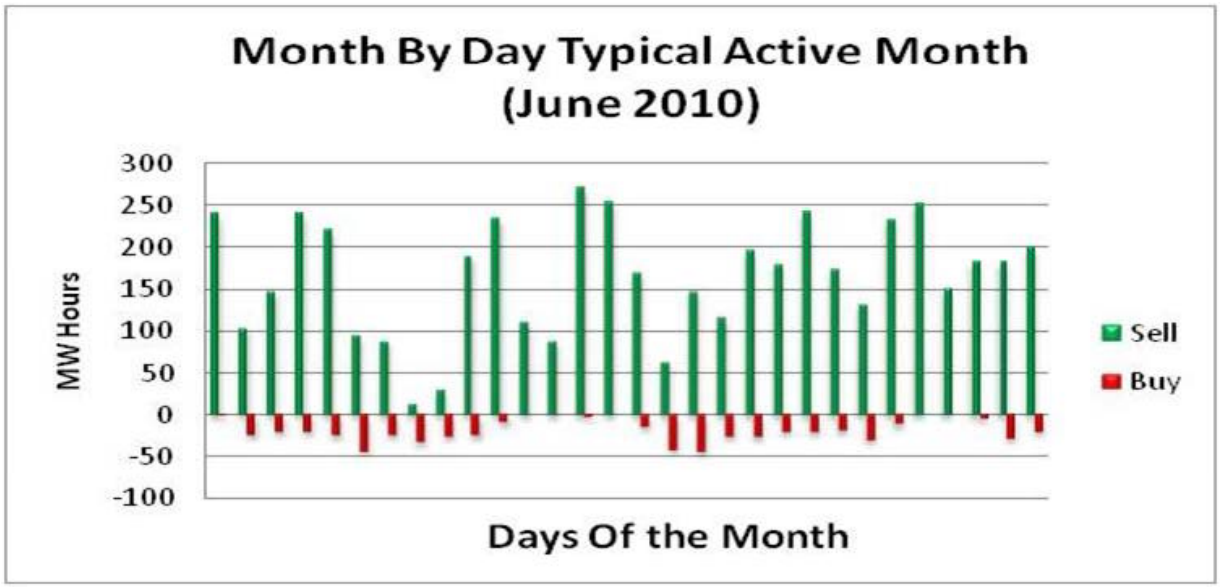
ACTIVITY AT GRID NODE

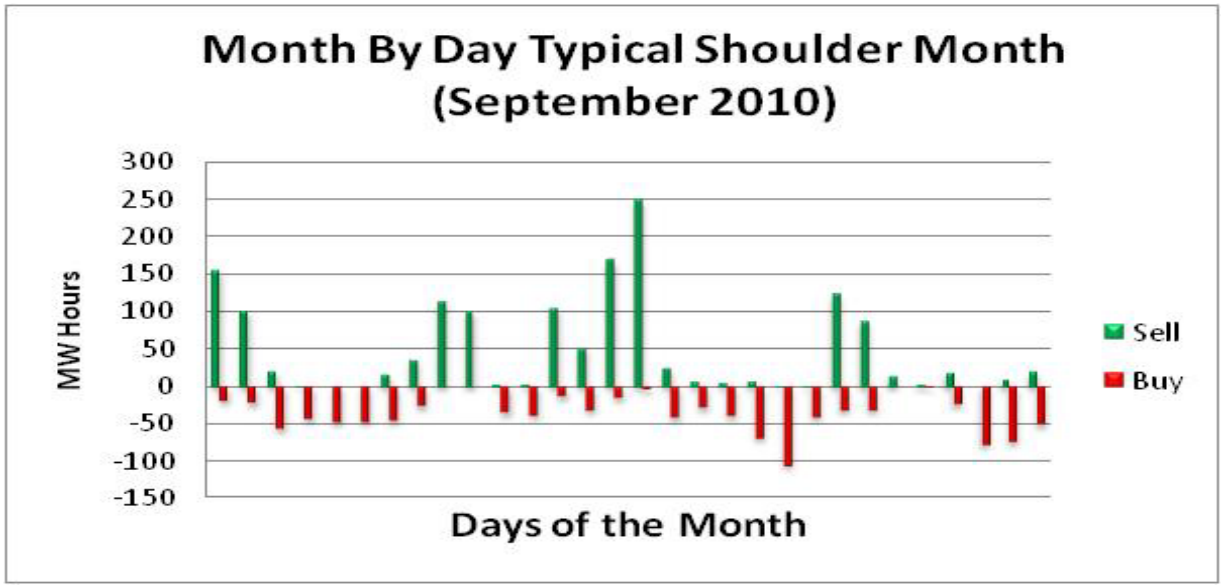
Smart Grid For Industrial Facilities





Smart Grid For Industrial Facilities





Smart Grid For Industrial Facilities

Cost / Revenue Items Associated with Smart Grid

Fuel bill

Weekly MISO settlement (ISO)

Monthly non-bypassable Duke bill

Schedule II charge monthly

Peak MISO charge monthly

Capacity sales

Ancillary services sales

Smart Grid For Industrial Facilities

Benefits to SMART Papers

Shoulder months

- Lowered variable energy costs 10-20%

Remote waste water plant

- Self-sourcing by CRES reduced cost by 60%

Peak months

- Power sales into peaks revenue at a positive margin

Significantly improved understanding of costs of steam and electricity

Significantly revised operating strategy of utility

Monitoring of electric system flags process and operating changes immediately

- Utility operators are engaged and reactive
- Energy conservation activity has higher ROI

More opportunities arise regularly

Paradigms shattered in a good way

Smart Grid For Industrial Facilities

Benefits to Others

Provide node stability

Electric grid management by economics of price

Reduced emissions

Smart Grid For Industrial Facilities

What To Watch For On Your Project

There is no manual or cook book – Be flexible – Overcome obstacles

Regulations are regulations

- You are the tail, not the dog – Rates, pricing, fees, changes

Understand charges beyond electric wholesale cost

Get to transmission level – Reduce non-bypassables – Demand issues

Develop your operational model – How will you act?

Understand your marginal costs

- Can vary across load profile
- Average is dangerous to optimization
- Fuel + conversion to MW

System to manage your exposure

Smart Grid For Industrial Facilities

What To Watch For On Your Project (cont.)

Conservation – Means more

- Power parasitic
- Plant/process

Real time data and information

Empower your operators