

Leveraging Load Research and Customer Consumption Data to Improve Circuit Utilization

AEIC

Annual Load Research Conference
St Louis, Missouri

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Presentation Agenda

1. Why Is Distribution Utilization Important?

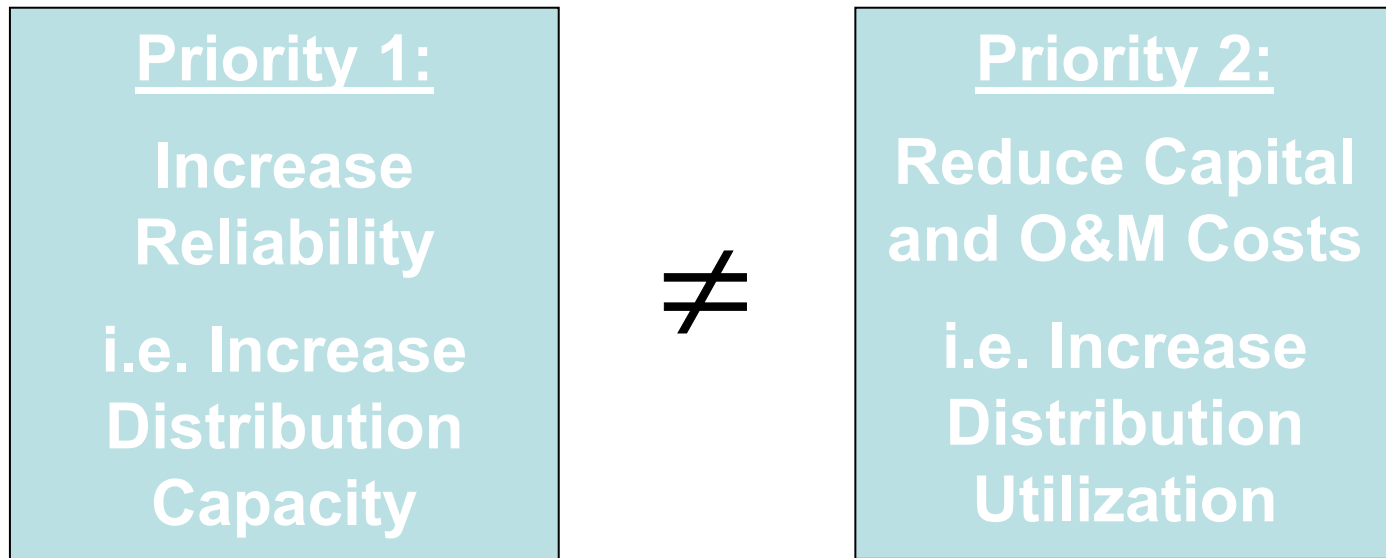
2. Overview of Methodology, Required Data & Systems

3. Case Study: Idaho Power Company

4. Case Study: East Coast Utility

Why Is Distribution Utilization Important?

The Irreconcilable Conflict



Or is it?

Perhaps both are possible, with a more precise and granular understanding of system utilization

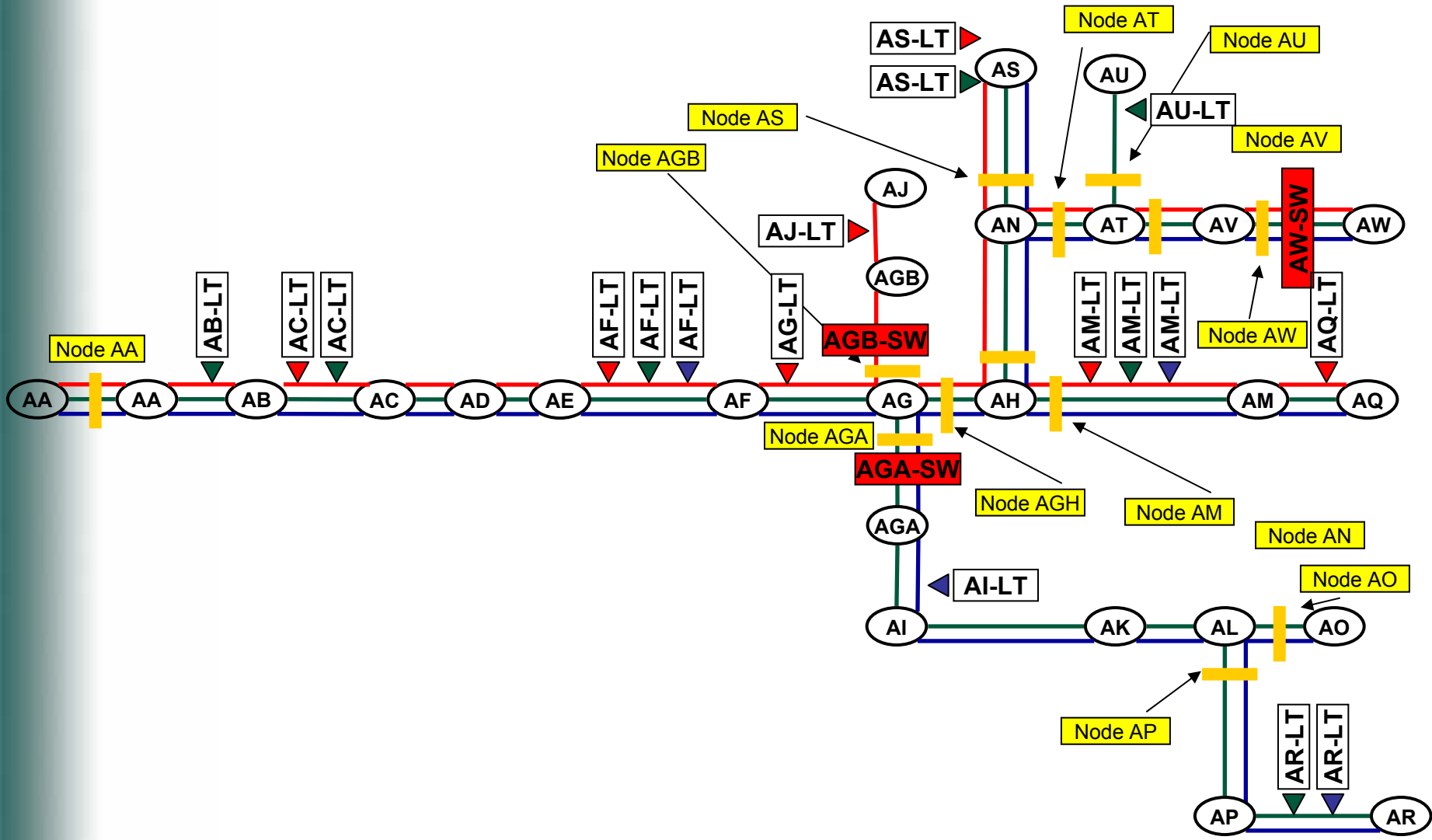
What are we Discussing Today?

- Using load research data, combined with other information around the utility, to estimate hourly load patterns for distribution assets.
 - *The goal is to improve distribution asset utilization*
- This is an important, often overlooked, use of the valuable load research data.
- We are presenting our approaches and findings at utilities around the U.S. and would be happy to provide a complementary presentation at your utility

Circuit Devices

- **Customer Transformer:** a device (usually single phase) that steps the voltage down from the circuit to a level appropriate for delivery into a customer's premises. There are anywhere from 1 to 10 customers attached per transformer. Some transformers connect to two phases, while others will connect to three.
- **Primary Transformer:** a transformer (usually three phase) that is used to step the voltage of a feeder down to provide power for a downstream section of a feeder. This can occur when large portions of a feeder require lower voltage levels.
- **Capacitor:** an electrical device used to store electrical energy, and to release it back into the power system when required. Capacitor perform a stabilizing function in an electric circuit.
- **Fuse:** a device that will heat up, melt and electrically open the circuit after a period of prolonged abnormal current flow.
- **Recloser:** an automatic, high-voltage electric switch that will automatically return to normal after disturbance has passed.
- **Regulator:** a device used to maintain constant voltage levels across a distribution network
- **Switch:** a device that alters the direction of current flow on a circuit
- **Conductor:** the wire that conduct the current down a circuit. Conductors are usually treated in sections and are rated to carry at specific level of current. For Wire Vision, it remains to be determined whether it will be sufficient to sectionalize conductors only when the conduct size changes.

Hierarchy



What Do Our Business Users Do?

Distribution System Operators:

- Monitor conditions on the circuits;
- Perform load switching to ensure reliability;
- Manage planned outages and conduct planned switching;
- Respond to faults, failures and maintenance requests.

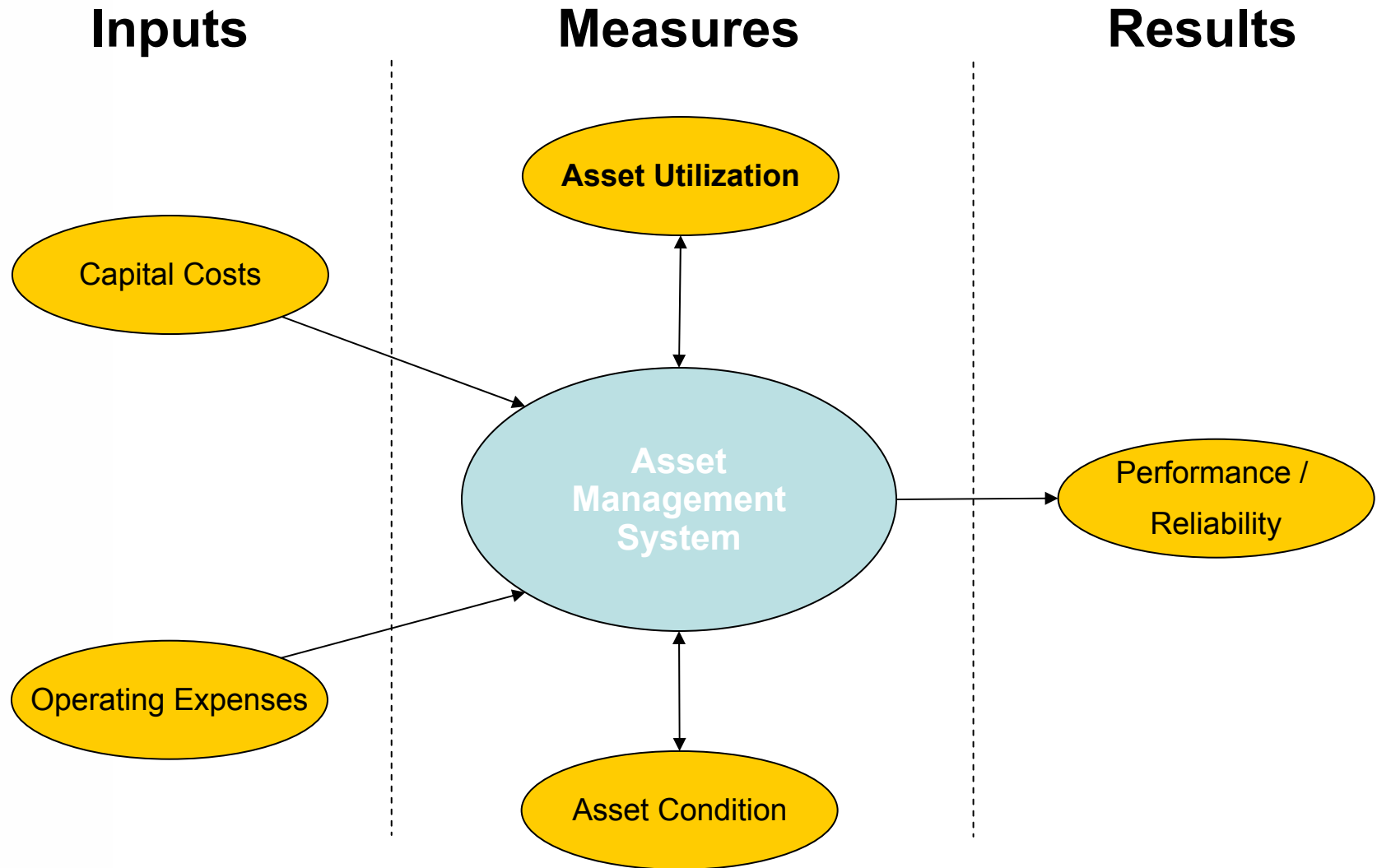
Distribution System Planners:

- Run short-term annual load flow analysis;
- Identify short-term activities needed to maintain reliability;
- Run long-term forecasts and load flow analysis;
- Model new system additions needed to maintain reliability or serve new load;
- Monitor progress of planned activities.

How is this Estimation Currently Done?

- Wide variety of approaches, but basic approach:
 - Meter peak demand upstream for a substation or feeder
 - Allocate this peak to the devices below the meter using nameplate capacity
 - Do load flow analysis on the results

Everyone talks about asset management, so what is it in simple terms?



So gaining a better understanding system utilization requires more hourly or sub-hourly metering, right?

Not Necessarily...

- Can you tell where your customers are on your distribution network?
- Is billing meter data from your customers accessible?
- Do you have at least some existing interval metered customers or SCADA metered points?
- Do you believe that statistics and sampling are real?
- Do you believe that metering is not as easy, affordable, or reliable as it may appear?

The answer to the metering question is not *all* or *none*,
but somewhere in between
(although much closer to none than you may think)

Overview of Methodology

Segment

Segment customer billing data by customer type, region, and weather zone

Profile

Develop weather-sensitive load profiles for each segment using load research samples

Forecast

Develop individual hourly load forecasts for every customer using weather variables

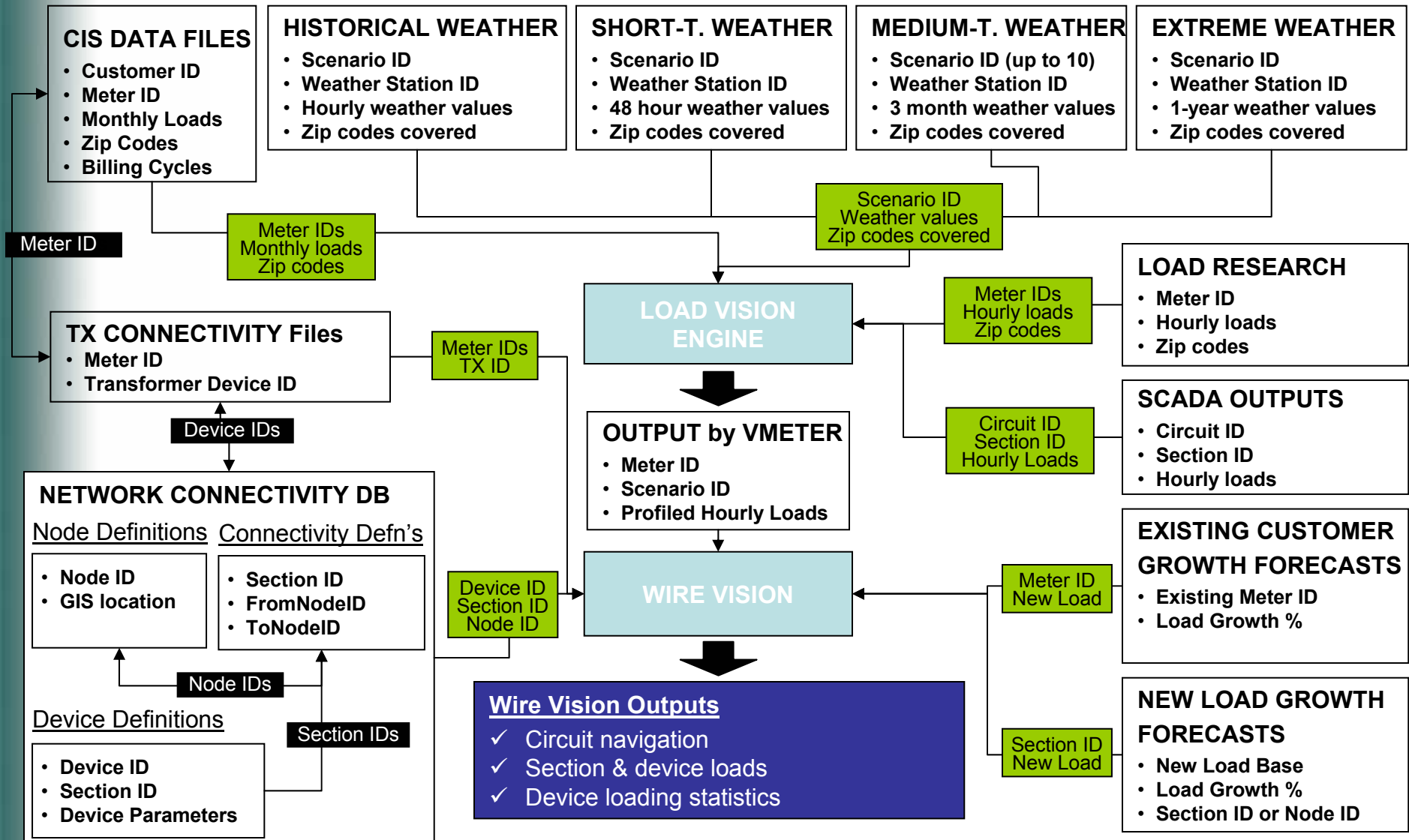
Aggregate

Aggregate load results from GIS hierarchy and compare and calibrate to SCADA data.

Analyze

Compare hourly load forecast at any feeder point and phase with GIS conductor & device ratings

Generic Wire Vision Data Flow Diagram



Using Load Research Data: Segmentation

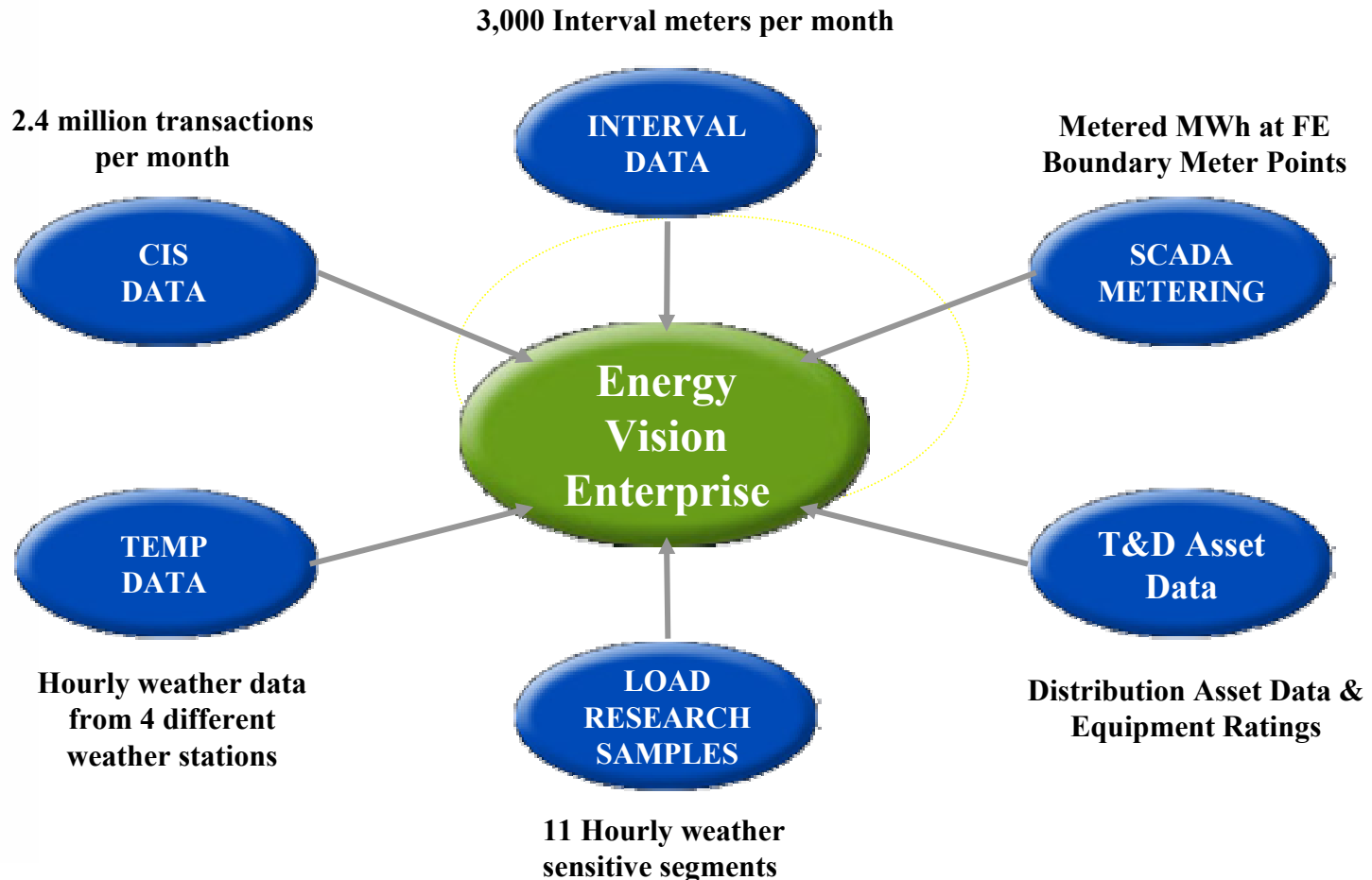
- The finer the aggregation, the more important is correct segmentation
 - Transformer vs. System
 - Segmentation must be practical
 - Best measures:
 - ✓Rate Class
 - ✓Geography
 - ✓Seasonal consumption patterns
 - ✓Load Factor
 - ✓Others?

Using Load Research Data: Diversity

- The finer the aggregation, the more important is correct diversity:
 - Using a sample of 200 customers to create a profile for a small transformer will bias results towards too flat
 - Using a sample of 20 customers to create a profile for a large circuit will bias results towards too peaky
- Our approach is to employ monte-carlo simulation using load research data and profile segmentation to derive diversity factor at time of peak.

What does this actually look like in practice?

First Energy's Settlement and Asset Optimization System

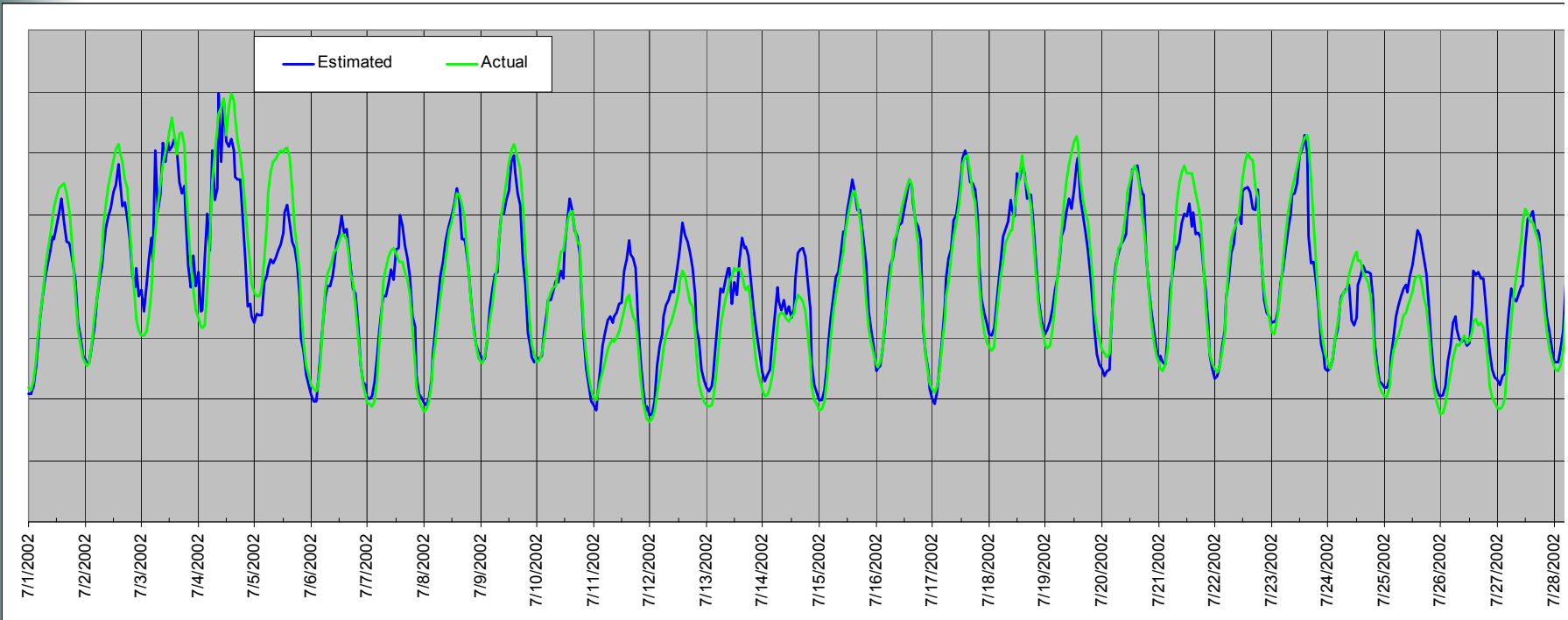


Two key questions everyone asks

- How accurate are the results?
- How does this create value?

What kind of results can be achieved?

-- Circuit bottom-up load estimate vs. SCADA metering --
July 2002



Accuracy achieved at circuit level

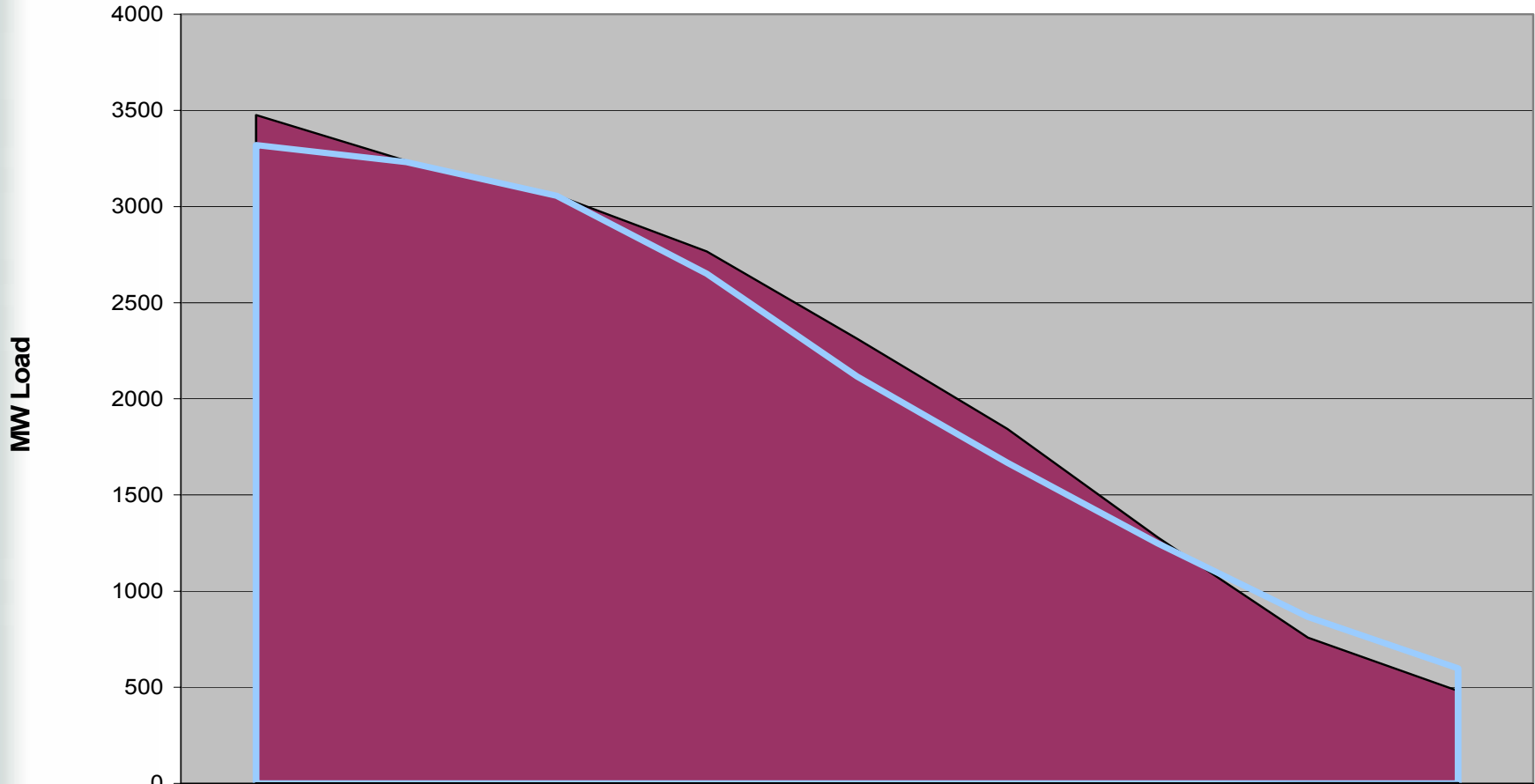
Absolute Peak Mean Error kW Comparison by Time Period

	Estimate vs. SCADA (%)	Estimate vs. Profiled SCADA (%)
Yearly	0.22	0.58
Seasonal	5.77	4.77
Monthly	7.55	7.21
Weekly	8.78	6.45
Daily	10.79	6.29

Absolute Peak Mean Error calculated as $\text{Avg.}(\text{ABSOLUTE}(\text{EstimatedPeak}-\text{ActualPeak}) / \text{ActualPeak}) / \text{Count} * 100 \%$

Feeder Utilization – Thermal vs Voltage Constraints

Feeder Utilization and Load Served as % of Total Load

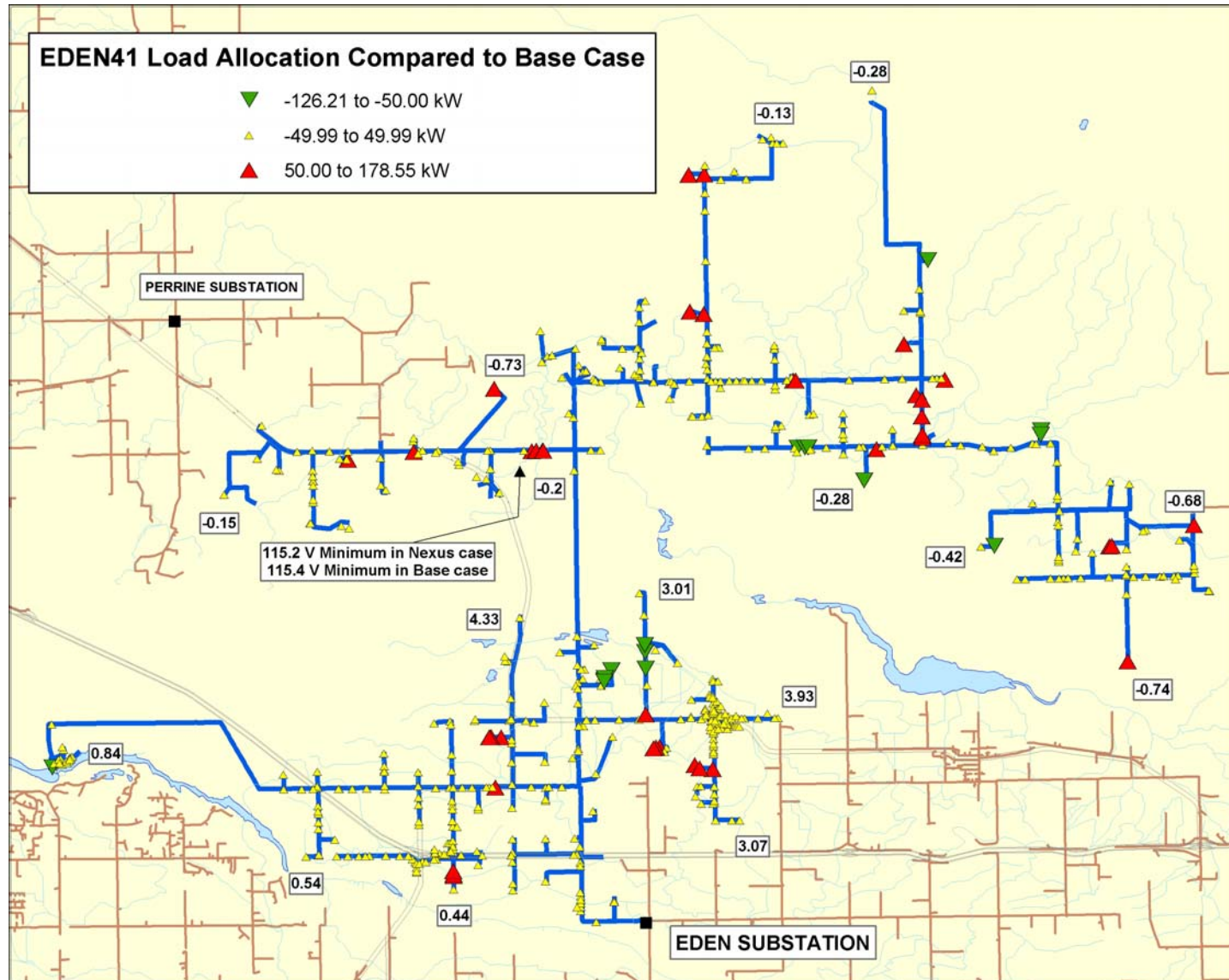


Utilization	130%	120%	110%	100%	90%	80%	70%	60%	50%
2004 MW Load	3476	3238	3059	2767	2313	1844	1280	758	481
2002 MW Load	3320	3230	3057	2650	2116	1668	1248	866	598
% Total Load	4%	7%	12%	21%	34%	47%	63%	78%	86%

Load allocation results for 5 feeders compared to engineering models

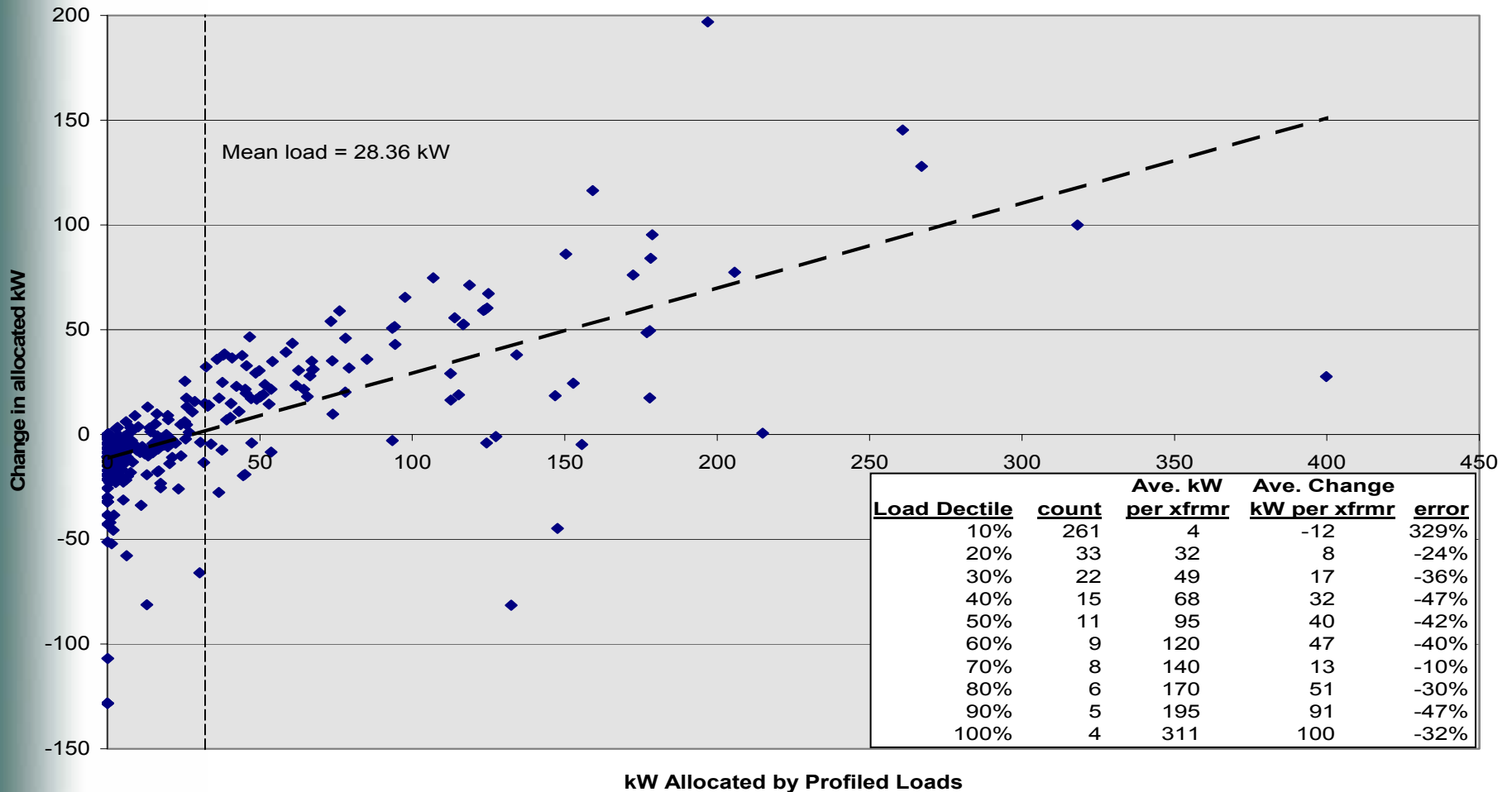
Feeder	% Load Allocation Change	Single Max kW Change	Device Loading Change	Lowest Voltage Error	Ave. Volt Change on Feeder
SAMN-041	36%	89	72% base 51% new	9.5%	0.5
EDEN-041	33%	179	103% base 76% new	-0.2%	0.3
BOBN-041	42%	-213	93% base 56% new	-0.4%	0.3
BOIS-020	79%	1,441	51% base 80% new	-0.6%	0.0
EMET-012	37%	-678	106% base 130% new	2.7%	0.1

Load reallocation in GIS & engineering models



Load reallocation – use types and size

EDEN-041 02 July 2002 Peak Hour Load Allocation Methodology Comparison



Load reallocation – time variations in load profiles

BOBN41
Peak case
Feb 7, 7AM

Allocation Method	Wire Vision	kVA method
Minimum Voltage	116.4 V	115.8 V
Feeder Load	10,321 kVA	10,317 kVA

BOBN41
Near-Peak case
Feb 7, 6AM

Allocation Method	Wire Vision	kVA method
Minimum Voltage	115.9 V	115.9 V
Feeder Load	10,231 kVA	10,229 kVA

Model Results – construction project decisions

Model results and budget impacts

- Larger construction projects are more apt to be affected
- Capacity projects near the middle to end of voltage-limited feeders
- When affected, projects change 1-5+ years in timing
- Load mix and seasonal use
- Forecast loads in Planning Processes combine with growth

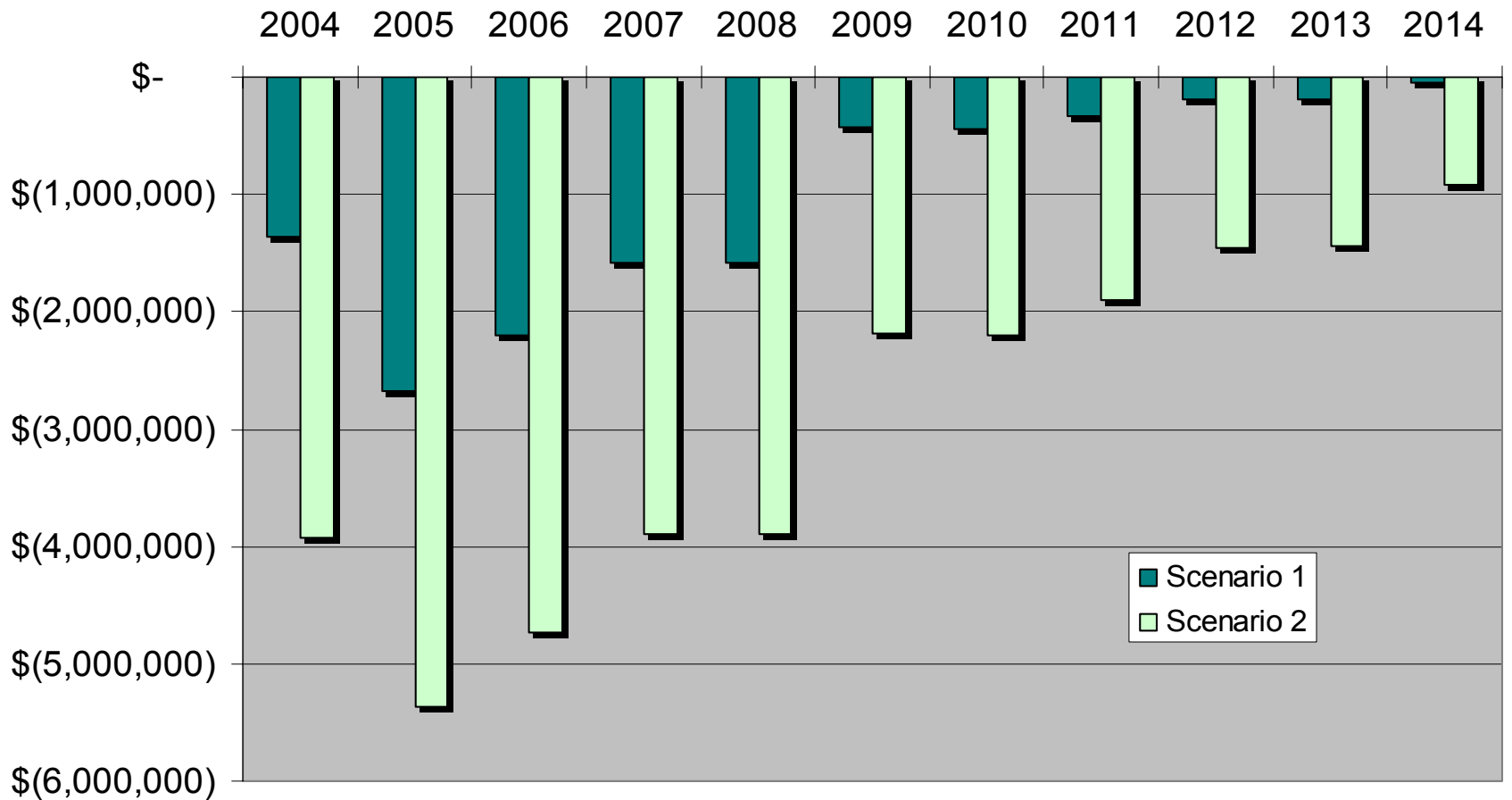
Bottom-line: Capital budget savings for 5 feeders

- Original 2005 capital budget included \$US 1.9M for 10 projects for 5 feeders included in study area
 - 6 projects, \$925,000 were not affected
 - 1 project, \$150,000 accelerated 1 year
 - 1 project split, \$170,000 deferred 2 years
 - 2 projects, \$250,000 deferred 3 years
 - 1 project, \$450,000 deferred at least 5 years

- NPV of \$US 234,809 or 12.4% of capital budget
- 46% of 2005 capital budget deferred

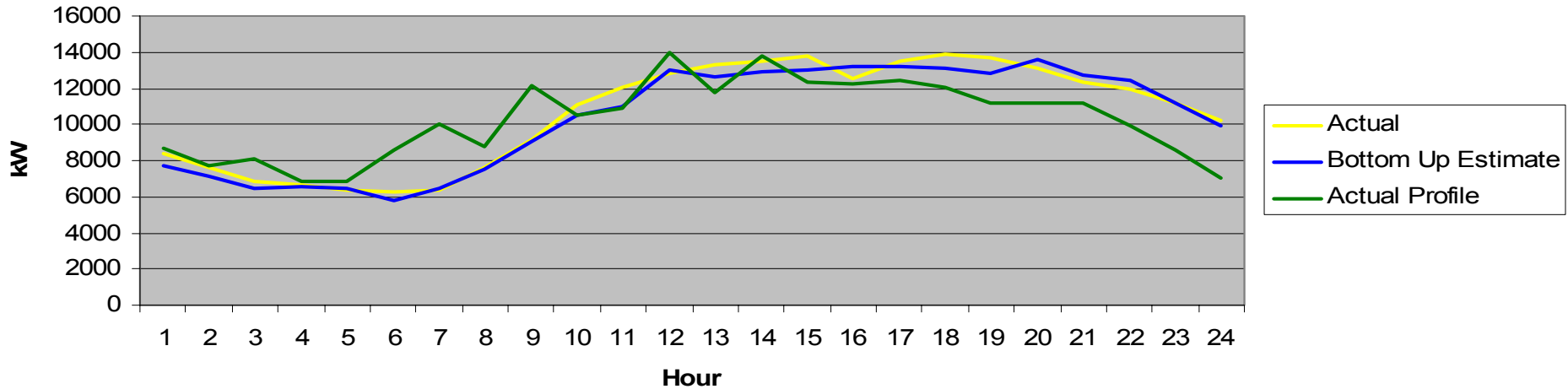
Overall Expected Impact – Improved Models

Change in Cash Flow Requirements
With Implementation of Wire Vision

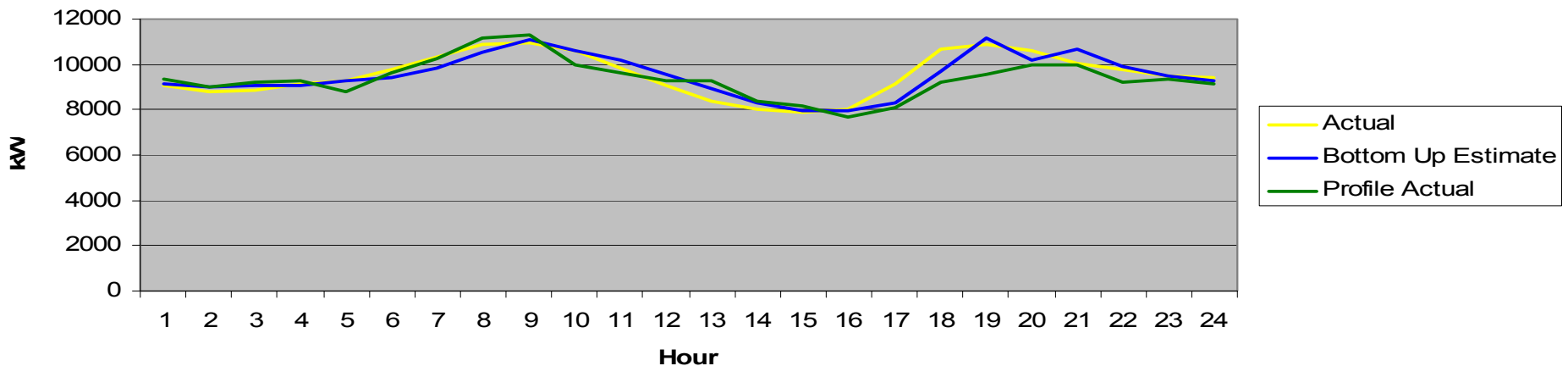


Summer & winter peak day comparison

Peak Day (7/4/2002)

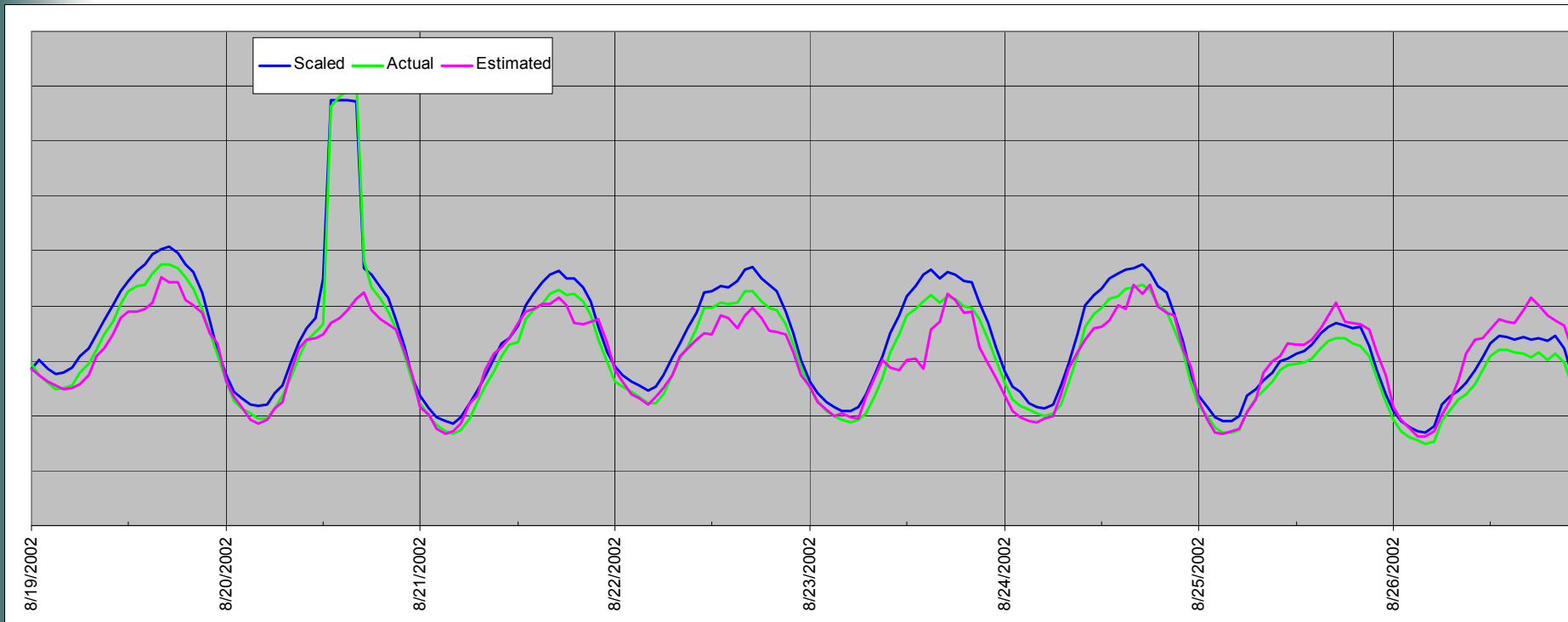


Coldest Day (12/31/2001)



Accuracy achieved “downstream” on feeder

-- Bottom-up load estimate vs. SCADA results --
Sub-metered capacitor bank located 2/3 down circuit



Average Mean Error prior to calibration: 10.81%

Average Mean Error after calibration: 8.8%

How do these results affect decisions: Comparison of engineering model results for a sample feeder

	Original Model Results	Refined Model Result	Diff %
Source Load	10,352	10,426	0.1%
Phase A Load	486.4 A	556.6 A	14.4%
Phase B Load	400.3 A	440.6 A	10.1%
Phase C Load	509.3 A	408.8 A	19.7%
Source kVAR			
Phase A	646.3	526	19%
Phase B	-158	346	119%
Phase C	947	213	123%
End Voltage (V)			
Phase A	111.4	109.6	1.6%
Phase B	122.9	124.5	1.3%
Phase C	100.6	115.6	14.9%

Wire Vision Cost Justification

	# UNITS/YR.	EQUIPMENT SAVINGS/YR	LABOR SAVINGS/YR	CUST REDUCED OUTAGE VALUE/YR
RIGHT SIZING TRANSFORMERS	5,800	\$116,000		
SUMMER PEAK OUTAGES				
LINE TRANSFORMERS	100	\$24,000	\$30,000	\$12,500
FUSE OPERATIONS	21		\$4,200	\$10,500
RECLOSERS	3	\$22,500	\$1,800	\$60,000
REGULATORS	4	\$20,000	\$4,800	\$30,000
SUBSTATION TRANSF	1		\$35,000	\$40,000
TOTALS	5,929	\$182,500	\$75,800	\$153,000
ANNUAL GRAND TOTAL		\$411,300	Annual Savings	
ANNUALIZED COST				
ANNUALIZED PRGM COST		\$90,000		
PGRM MAINTENANCE		\$50,000		
PGRM USE TIME		\$48,000		
COST/BENEFIT		\$223,300	Positive Benefit Per Year	

Questions and Answers