Best Practices - Validation, Editing and Estimation

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Agenda

- Background
- Project Overview
- Study Results
- Best Practice Guidelines
- Future Directions

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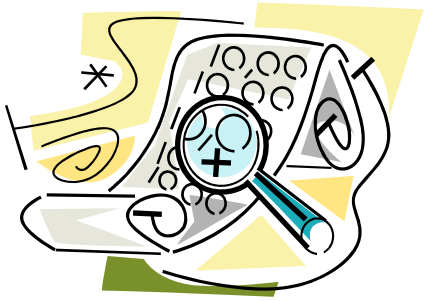
Load Research Background

- Emergence of Load Research in 1960's/1970's
- 1978 Public Utility Regulatory Policy Act (PURPA)
- Increased interval load data and metering equipment improvements ➔ standard validation and editing practices evolved
- Regulatory standards ➔ Quality control of data supporting rates and other applications



Key Definitions

- Standards
  - What is required to do?
- Capabilities
  - What can be done?
- Practices
  - What is actually done?

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Project Overview

- Purpose:
  - Compile best practices for VEE
- Approach:

	Guideline / Protocol Review	Software Review	Survey of Industry Practitioners
Standards	●		●
Capabilities		●	
Practices			●

- Additional team members:
  - Joe Lopes
  - Santosh Lamichhane

Fundamental Steps in Preparing Data

- Base Data Characteristics
  - Get to know your data
- Validation
  - Identify problem data
- Editing
  - Exclude or patch gaps in data
- Estimation
  - Data modeling

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Base Data Characteristics

Step	Example
Data in Standard or Local Time	EST, EDT
Dates for Data	Start/End dates; holidays identified
Data Resolution (interval length)	5,15,60 minute intervals
Data Units	kW, kWh; totals, averages
Data Categories	Sector; premise or end-use
Sample/Population	AMI, small sample, large sample

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Validation Steps

Step	Description
Bill Matching Test	Compare period energy and demand to billing parameters (exc. AMI)
Sample Parameter Matching Test	Compare data to sample design statistic
Daily Usage Test	Check consistency of daily usage, compare to historical benchmarks or regression predictions for weather-sensitive loads
Outage Test	Check indicators of outages from recorders, outage flags, external schedule
Zero Test	Check for any zeroes where there should be none (end-use or some customers may be ok)
Pattern Test - Spike Test	Check for highs, successive intervals, historical pattern, load factors
Pattern Test - Trough Test	Check for lows, including zero, successive intervals test, historical pattern, load factors

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Editing and Estimation Steps

Step	Description
Data Exclusion	Exclude data failing validation or during outages -criteria based on use of data and sample size
Data Patching	Replace missing or zero intervals with appropriate data values (smoothing, short-term copying, longer-term copying) -criteria should be set for amount to be patched and method used for patching
Data Modeling	Replace gaps in data using average or modeled data by day type, customer/end use type (regression and weather-modeling) -criteria should be set for calculating averages or modeling

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Industry Review – Guidelines/Protocols

- North American Energy Standard Board (NAESB)
  - Established a protocol for VEE, contained in their Uniform Business Practices for Unbundled Electricity Metering (NAESB, 2000)
  - Co-sponsored and commissioned by the Edison Electric Institute (EEI)
- RTOs/ISO protocols
  - Some use NAESB (MISO, PJM), some a subset (CAISO, ISO-NE), some undefined (US: NYISO, SPP; Canada: AESO, IESO)
- AEIC (Load Research Manual) – endorses NAESB

Industry Review – Standards/Protocols

Validation Type		Guideline / Protocol										Software				Industry Practitioners				
		AEIC Load Research Manual	AESO	CISO	ERCOT	IESO	ISO - New England	MISO	NYISO	PJM	SPP	DNV GL LRS	Oracle Utilities Load Analysis (formerly Lodestar)	MV-90	PC-IDEAS	AMI Intervals	C&I Census or Samples	Residential Samples	End-Use Samples	Best Practices
Bill Matching Test		●																		
Sample Parameter Matching Test																				
Daily Usage Test		●		●			●	●		●										
Outage Test																				
Zero Test							●													
Pattern Test	Spike Test	●		●			●	●		●										
	Trough Test																			
Data Estimation Type																				
Data Exclusion																				
Data Patching																				
Data Modeling																				

Industry Review – Software Systems (Capabilities)

- Load Research Packages with VEE
  - DNV GL's Load Research System (LRS)
  - Itron's MV-90
  - LODESTAR
  - PC-IDEAS

- Meter Data Management System (MDMS) Packages
  - Itron's Enterprise Edition (IEE)
  - Landis & Gyr's Gridstream (formerly Ecologic's)
  - Oracle's Utilities MDMS
  - Elster's EIServer MDMS
  - Aclara Software (formerly Nexus Energy Software)
  - Siemens EnergyIP MDMS system

Industry Review – Software Systems (Capabilities)

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Bill Matching Test		●										●			●					
Sample Parameter Matching Test																				
Daily Usage Test		●		●			●	●		●		●	●	●	●					
Outage Test												●		●	●					
Zero Test							●					●	●	●	●					
Pattern Test	Spike Test	●		●			●	●		●		●	●	●	●					
	Trough Test														●					
Data Estimation Type																				
Data Exclusion												●	●	●	●					
Data Patching												●	●	●	●					
Data Modeling												●	●		●					

Survey of Industry Practitioners

- Variety of Load Research Dimensions
  - Utility Customer Segment
    - Residential
    - Commercial
    - Industrial
  - Categories of data processed for Load Research
    - AMI
    - Large Customer/Census
    - Small Load Samples
    - End-Use Load Samples
  - Use of software programs to process

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Survey Results

Validation Type		Guideline / Protocol										Software				Industry Practitioners				Best Practices
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Bill Matching Test		●										●			●	●	●	●		
Sample Parameter Matching Test																	●	●		
Daily Usage Test		●		●			●	●		●		●	●	●	●	●	●	●		
Outage Test												●		●	●	●	●	●		
Zero Test							●					●	●	●	●	●	●	●	●	
Pattern Test	Spike Test	●		●			●	●		●		●	●	●	●	●	●	●		
	Trough Test														●	●	●	●		
Data Estimation Type																				
Data Exclusion												●	●	●	●	●	●	●	●	
Data Patching												●	●	●	●	●	●	●	●	
Data Modeling												●	●		●	●	●	●	●	

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Survey Results: Lessons Learned

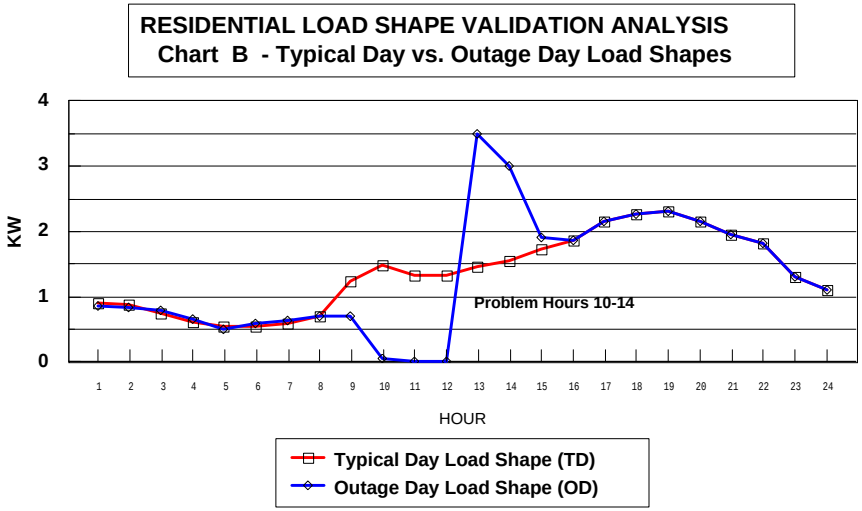
- Overwhelming AMI data resulting in use of MDMS and increased need for setting parameters appropriately
  - Parameters may be set to address billing needs, but may not be sufficient for load studies
  - Load researchers are working with metering departments
- Zero values, even if from outages, may need to be patched
- Utilities tend to spend more care validating and editing larger customers (census) since they are unique, rather than smaller (samples)

Best Practices: Base Data Characteristics

- Check/confirm characteristics:
  - Standard/Local time
  - Date span
  - Resolution, interval
  - Data units
  - Category (AMI vs. census vs. sample

Best Practices: Validation

- Validation should:
  - Identify potential problem data automatically
    - Inaccurate, missing, outages, anomalies/outliers
  - Only flag a small percentage for further review and edit decisions
  - Have consistent criteria
  - Minimize Errors:
    - Type I Error - Reject good data
    - Type II Error - Accept bad data
    - *Type II Error is more serious*



Best Practices: Editing

- Edit Patching Techniques
  - Judicious use of patching
  - Consistent criteria essential
  - Maintain natural variability of data
  - Edit by Exclusion
    - Easiest to apply
    - Risks insufficient data and bias
    - Alternative may be time consuming

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Best Practices At a Glance

Validation Type		Guideline / Protocol										Software				Industry Practitioners				
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Sample Parameter Matching Test																	●	●		
Daily Usage Test		●		●			●	●		●		●	●	●	●	●	●	●		●
Outage Test												●		●	●	●	●	●		●
Zero Test							●					●	●	●	●	●	●	●	●	●
Pattern Test	Spike Test	●		●			●	●		●		●	●	●	●	●	●	●		●
	Trough Test														●	●	●	●		
Data Estimation Type																				
Data Exclusion												●	●	●	●	●	●	●	●	●
Data Patching												●	●	●	●	●	●	●	●	●
Data Modeling												●	●		●	●	●	●	●	

Where is VEE going?

- Interval data collected from Automatic Metering Infrastructure (AMI) systems is rapidly increasing, outstripping traditional validation, editing and estimation (VEE) procedures
  - More data, more standards, more quality control
  - Change in computing methods; distributed resources
- AMI data collected via MDM Systems
  - Ability to automate some VEE in MDMS
  - Validation by purpose; load research, energy efficiency, voltage optimization, revenue protection

Acknowledgements

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  - Electric Service Provider staff
- DNV GL Project Team:
  - Joe Lopes
  - Tim Hennessy
  - Santosh Lamichhane
  - Claire Palmgren

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