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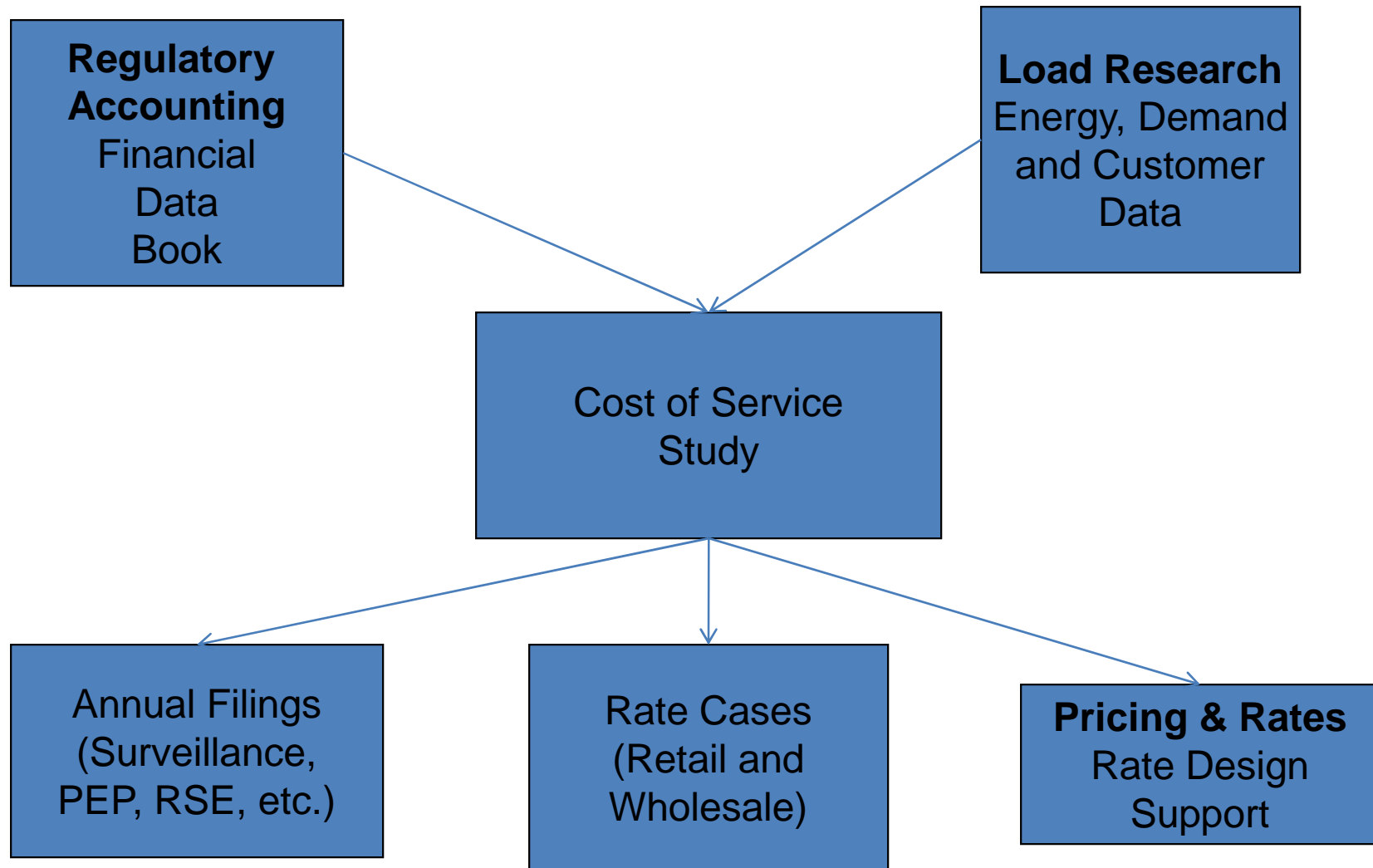
NCP Calculation Methods Analysis

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for 2011 AEIC Annual Conference



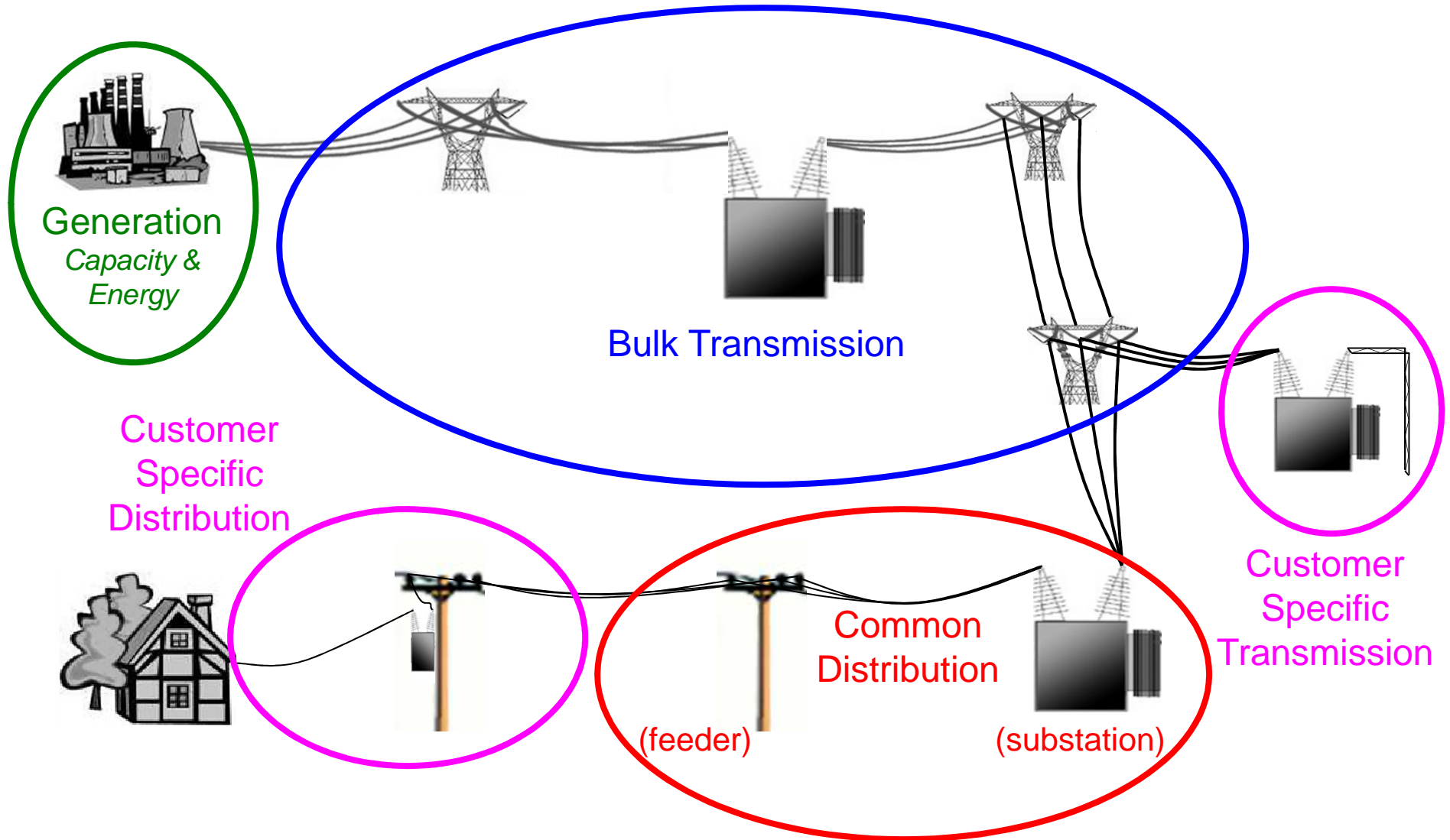
Outline

- Objective
- Linear Regression
- Sample Diversity
- Mean Per Unit
- Comparison between the methods
- Conclusions



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POWER FLOW DIAGRAM



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Functions and Cost Classifications

Function

Cost Classification

Production	Demand Related Energy Related
Transmission	Demand Related
Distribution	Demand Related Customer Related
Customer Accounting, Assistance, & Sales	Customer Related

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Objective

Predict the total annual NCP for residential customers in order to better allocate the cost of transformers and lines to residential customers



Method1: Linear Regression

Linear Regression

- Model individual NCP (max kW) and billing energy (kWh) using sample data
- Predict individual NCP in population
- Sum all predicted NCPs in total

Year 2007	Rate A			Rate B		
# of Population	85,000			65,000		
Stratified Samples	20	20	20	30	25	20

Simple Linear Regression

$$kW_{NCP} = \alpha + \beta * kWh + \varepsilon$$

where α, β are regression coefficients,
 kW_{NCP} is the individual NCP,
 kWh is the billing energy,
 ε is the residual.

Model1	Annual NCP (YNCP)	Max monthly billing energy (MaxkWh)
Model2	Annual NCP (YNCP)	Annual total billing energy (AnukWh)
Model3	NCP by month (MNCP)	Monthly billing energy (MthkWh)

Statistics

□ Adjusted R-Square

$$Adj R^2 = 1 - (1 - R^2) \frac{n-1}{n-p-1}$$
$$R^2 = 1 - \frac{SS_E}{SS_T}$$

□ Percent error (Error%)

$$Error\% = \left| \frac{y - \hat{y}}{y} \right| \times 100\%$$

□ Mean Squared Error (MSE)

$$MSE = \frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2$$

□ Mean Absolute Percentage Error (MAPE)

$$MAPE = \frac{1}{n} \sum_{i=1}^n \left| \frac{y_i - \hat{y}_i}{y_i} \right|$$

General Residential Rate

Model	Adjusted R-square	MSE	Error%	MAPE
1. YNCP vs. MaxkWh	0.81	1.06	0.008	31.46
2. YNCP vs. AnukWh	0.84	0.90	0.013	31.70
3. MNCP vs. MthkWh	(0.43, 0.86)	(0.78, 2.25)	(0.35, 11.05)	(55.9, 144.59)



Method2: Sample Diversity Factor

Sample Diversity Factor

- DF is defined by

$$DF = \frac{\left(\sum_{i=1}^n D_i \right)_{grp}}{\left(D_{\max} \right)_{grp}},$$

where n = number of individuals in the group

D_i = maximum demand of the i^{th} individual

D_{\max} = maximum demand of the group

SDF (continue)

$$DF_{rate} = \frac{(\sum NCP)_P}{(NCP)_P} \approx \frac{(\sum NCP)_P}{(\overline{NCP})_P}$$

↓

$$\overline{DF_{rate}} = \frac{(\sum NCP)_S}{(\overline{NCP})_S}$$

↓

$$(\sum NCP)_P \approx (\sum NCP)_P = \overline{DF_{rate}} * (\overline{NCP})_P$$

The true DF of rates can be close estimated by the sample DF. Therefore, the total annual NCP approximately is equal to the multiplication of the sample DF and the estimated rate NCP.

Is DF stable?

Year	Sample DF (Rate A)	Total CDD (Rate A)	Sample DF (Rate B)	Total HDD (Rate B)
1	2.00 (3)	2,177 (2)	2.12 (1)	2,422 (5)
2	1.89 (4)	1,856 (5)	2.01 (3)	2,721 (2)
3	2.09 (1)	2,185 (1)	1.37 (5)	2,641 (3)
4	2.08 (2)	1,925 (4)	2.04 (2)	2,534 (4)
5	1.83 (5)	2,142 (3)	1.57 (4)	2,920 (1)



Method3: Mean Per Unit

Mean Per Unit

- DF is defined by

$$MPU = \frac{\left(\sum_{i=1}^n D_i \right)_{grp}}{n},$$

where n = number of individuals in the group

D_i = maximum demand of the i^{th} individual

D_{\max} = maximum demand of the group


How MPU NCP Calculated

Obs	strata	weights	_FREQ_	avgmaxkw	wt_ncp
1	01	0.39019	20	6.8941	2.68998
2	02	0.38097	20	10.1270	3.85805
3	03	0.22885	19	12.1776	2.78681

Average Max kW per customer> **9.33484**

Annual Max # of Population: 81037

Proposed Max NCP kW = 9.33484* 81037 = **756,467**

- 
- In general, any change from the current method results in
 - Decrease in ROI for Residential rates
 - Increase in ROI for Commercial & Industrial
 - Trend is same for each year reviewed

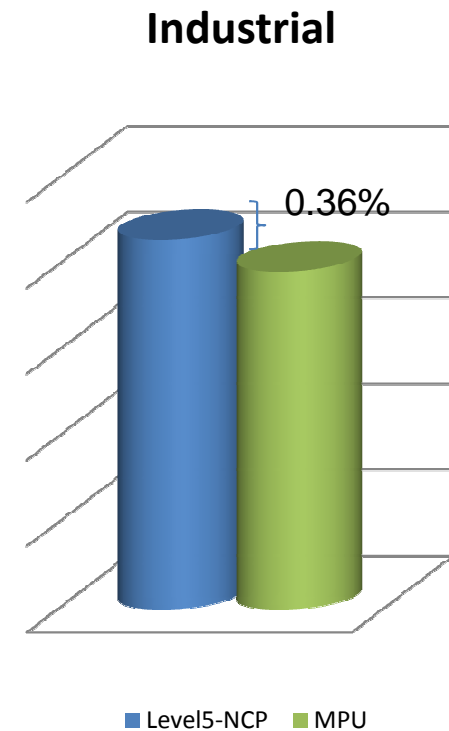
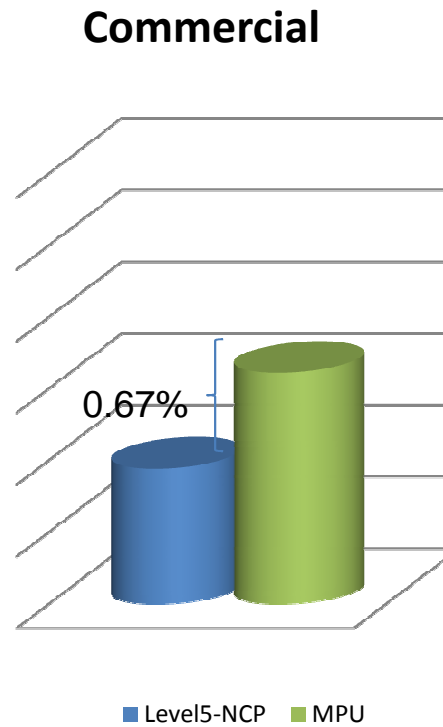
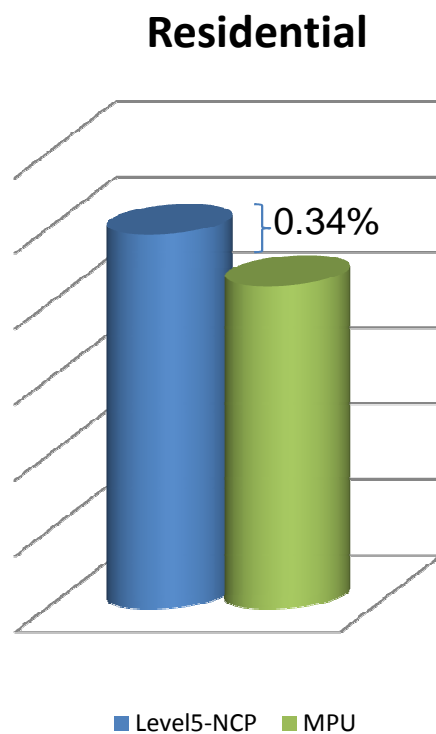
Comparison for 2007

Rate A	Estimated NCP
Regression	694,009
SDF	661,956
MPU	695,680
Orig	303,287

Rate B	Estimated NCP
Regression	779,456
SDF	698,502
MPU	763,347
Orig	209,206

2007 Percent of ROI

- compare original method vs. MPU

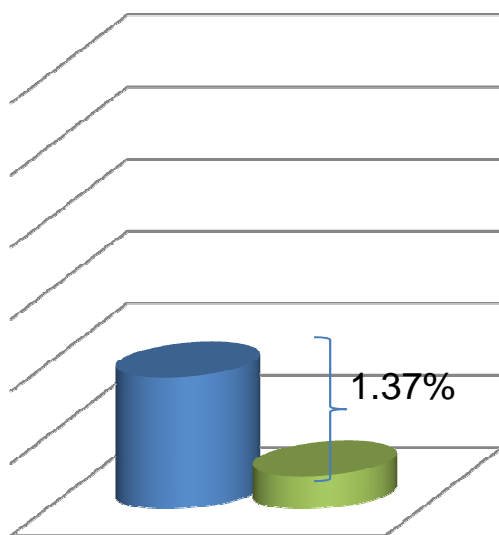


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2009 Percent of ROI

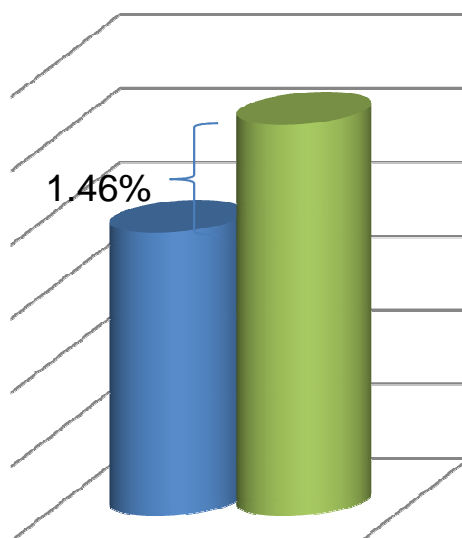
- compare original method vs. MPU

Residential



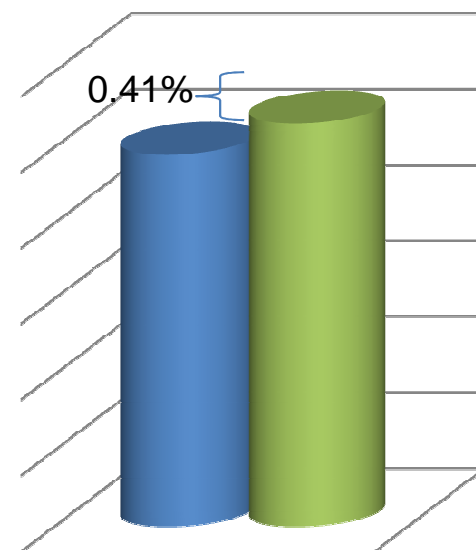
■ Level5-NCP ■ MPU

Commercial



■ Level5-NCP ■ MPU

Industrial



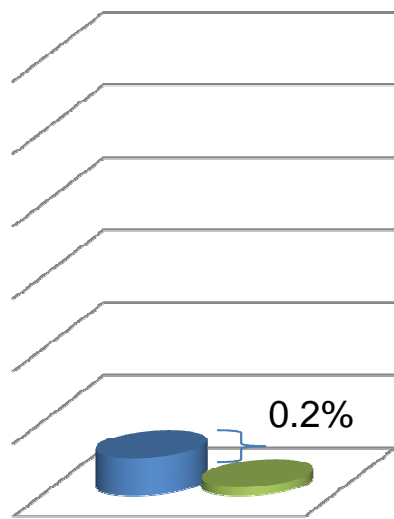
■ Level5-NCP ■ MPU

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2010 Percent of ROI

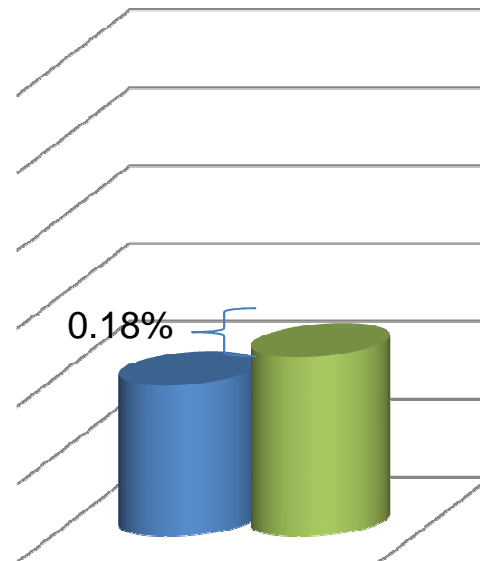
- compare original method vs. MPU

Residential



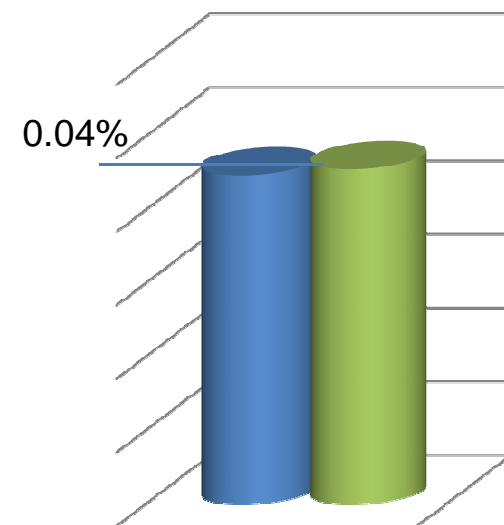
■ Level5-NCP ■ MPU

Commercial



■ Level5-NCP ■ MPU

Industrial



■ Level5-NCP ■ MPU

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Comparison (Continue)

Regression Method:

- Advantages:
 - Data are available before load development
 - Applies multiple statistical criteria to choose optimal model
 - Train, validate and test model
- Disadvantages
 - Results can be influenced by outlier points and data quality

Comparison (Continue)

SDF Method:

- Advantages:
 - Mimics the concept of regulatory load development using sample statistics to estimate population parameter
- Disadvantages
 - DF varies from year to year and from month to month
 - Lacks interim validation step (i.e. no way to validate the accuracy of the prediction)
 - Needs to wait until the development are completed

Comparison (Continue)

MPU Method:

- Advantages:
 - Simple and easy to implement
- Disadvantages
 - Results can be influenced by outlier points and data quality



Questions?