

# On the Impact of Demand Response: Load Shedding, Energy Conservation and Further Implications to Load Forecasting

Dr. Tao Hong, SAS

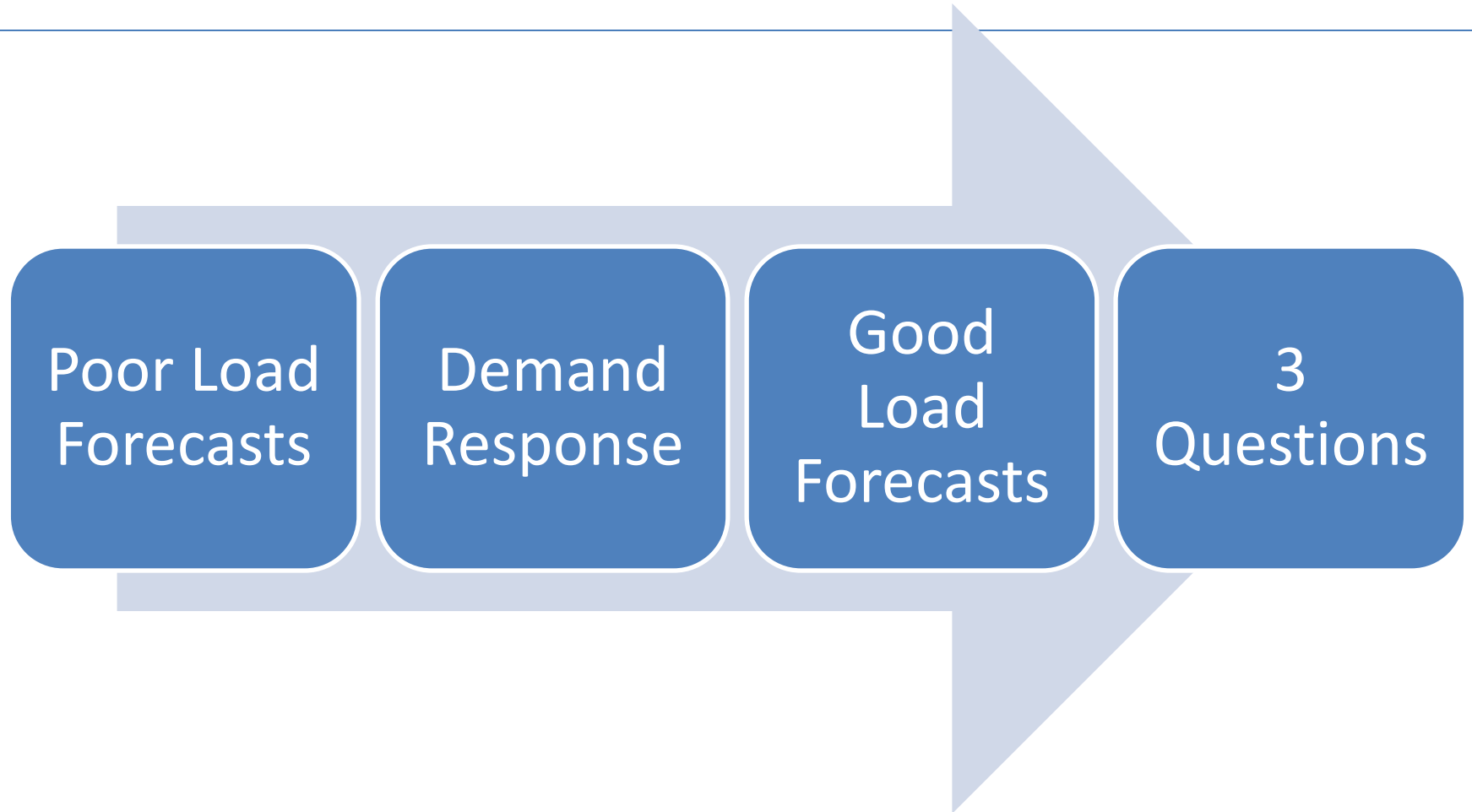
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# Agenda

- Background
- Load Shedding
- Energy Conservation
- Further Implications to Load Forecasting
- Summary



# Background – A Long Story



# Background – DR Activities

- From 2005 to 2007
  - 1297 DR hours
  - 290 periods
  - 252 days

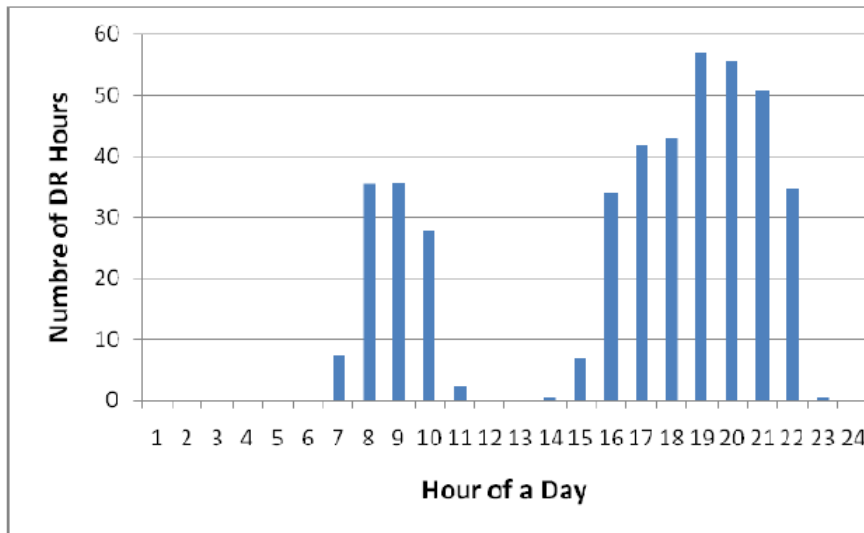


Fig. 1. Summary of DR activities by hour.

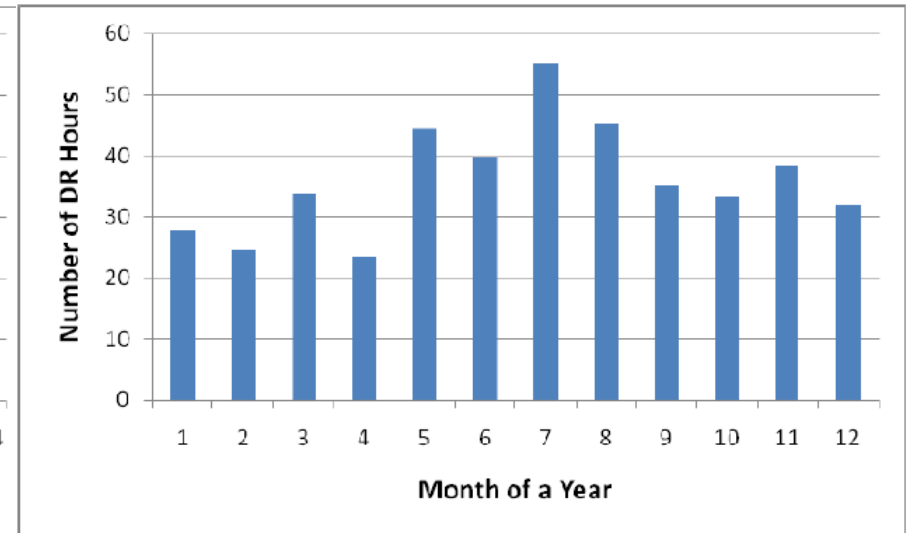


Fig. 2. Summary of DR activities by month.



# Background – Three Questions

- Did we really cut the peak?
- Did these activities affect our revenue?
- Did these activities impact our load forecasting processes?

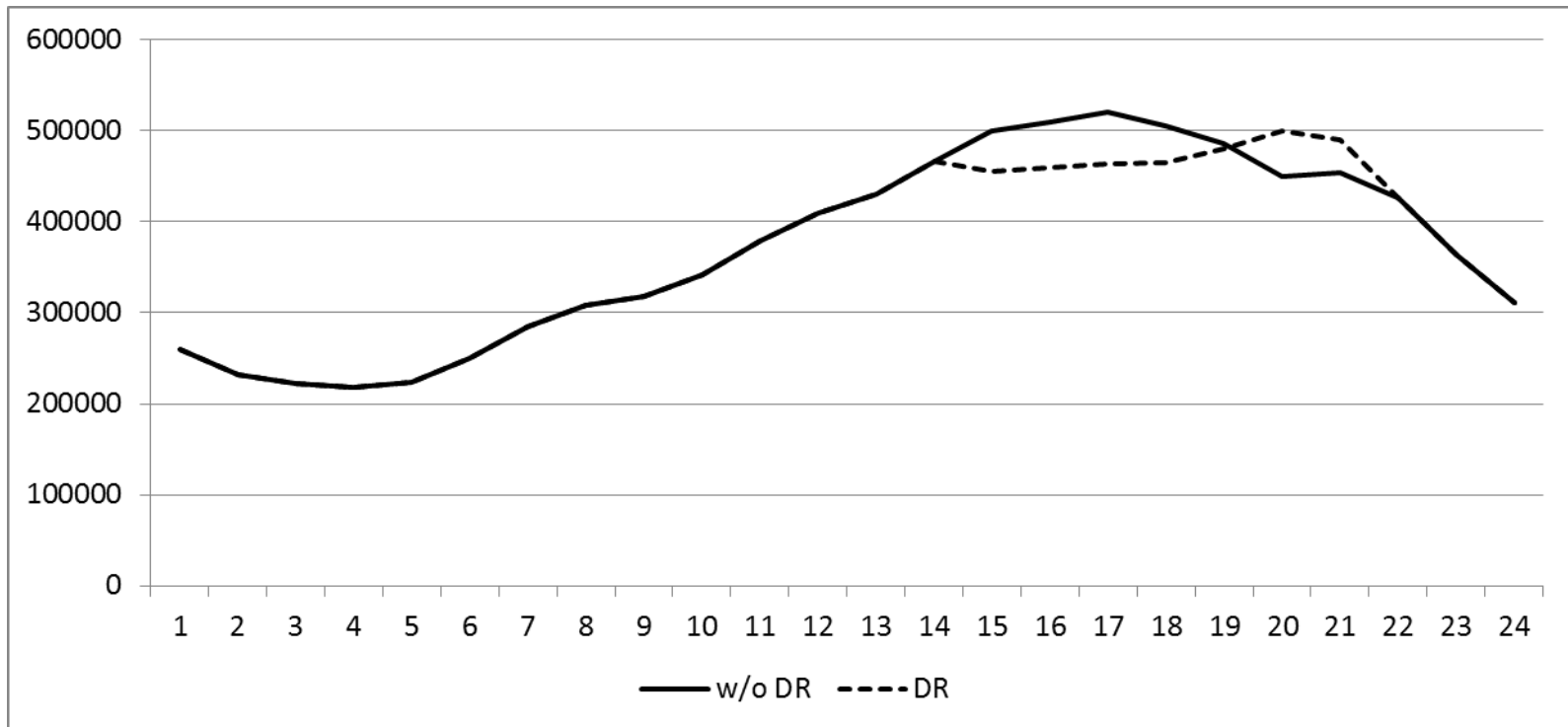
# Load Shedding – Analysis

- Assumption
  - Bounce-back effect
  - One hour after DR
- Data
  - Regular
  - DR
  - PostDR
- Model
  - Naïve Multiple Linear Regression Model

$$E(\text{Load}) = \beta_0 + \beta_1 * \text{Trend} + \beta_2 * \text{Day} * \text{Hour} + \beta_3 * \text{Month} + \beta_4 * \text{Month} * T + \beta_5 * \text{Month} * T^2 + \beta_6 * \text{Month} * T^3 + \beta_7 * \text{Hour} * T + \beta_8 * \text{Hour} * T^2 + \beta_9 * \text{Hour} * T^3$$



# Load Shedding – Ideal Case



# Load Shedding – What’s Wrong?

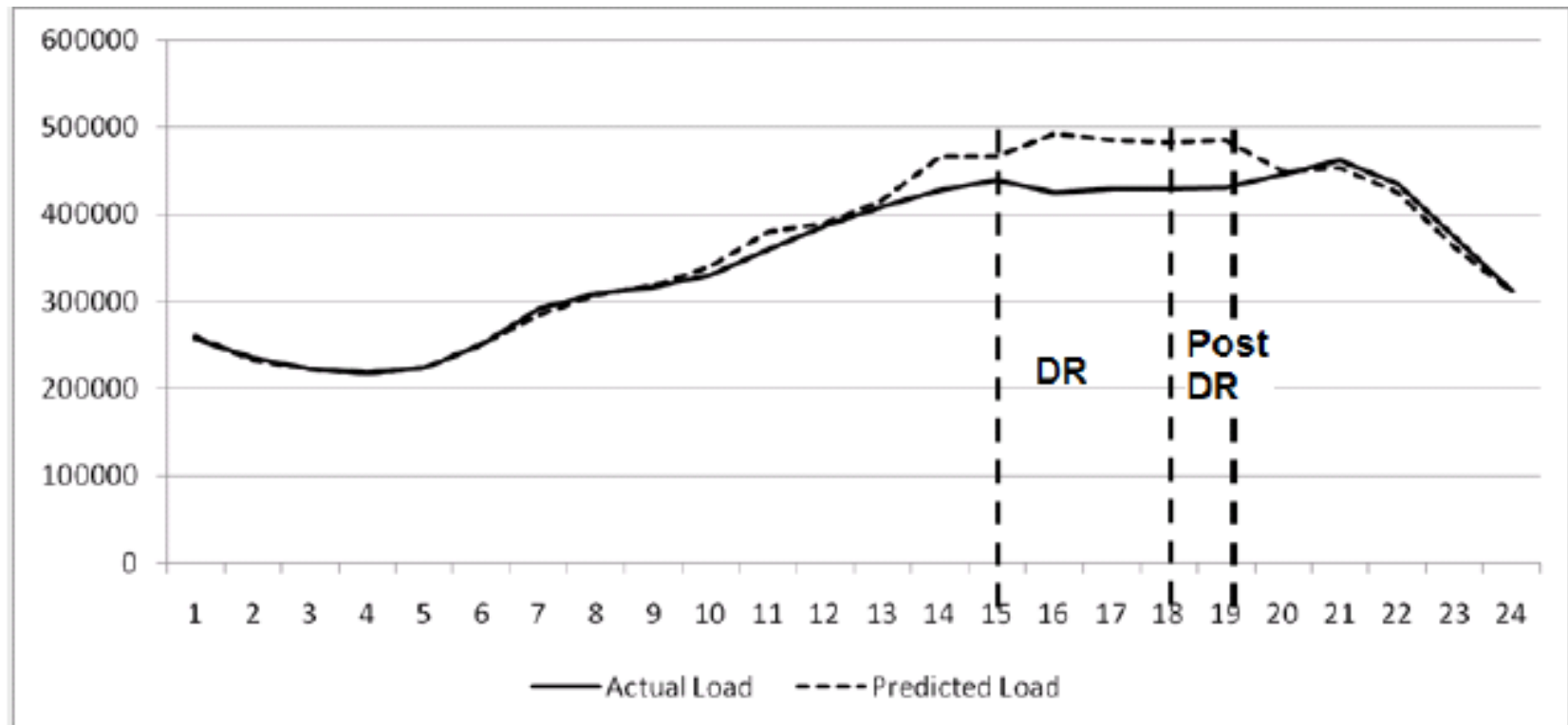


Fig. 3. A load shedding example.





# Load Shedding – Possible Reasons

- No bounce-back effect
  - Wrong assumption
  - Industrial customer
- Inaccurate model
- Bad data

# Energy Conservation

- In 3 years (2005-2007)
  - 4.86GWh saved during DR hours
  - 3.32GWh picked up after DR hours
  - 1.54GWh net saving in 3 years
  - 0.51GWh per year
  - 0.016% of annual consumption

**Saved ONE hour of electricity per year!**

# Further Impact to Load Forecasting

- Accuracy

	One Day Ahead	One Week Ahead
w/o special hours	4.95	5.01
All hours	4.98	5.04

- Process

- Label DR hours
- Develop two forecasts to quantify DR impacts

# Summary

- For this particular (NOT in general) utility, based on a Naïve MLR model:
  - Peaks were effectively cut
  - Not hurting revenue
  - Forecast can be improved by excluding the special hours
- However
  - DR programs need to be differentiate
  - Data quality affects the analysis
  - Model needs to be further improved to draw solid conclusion

# Summary

- For this particular utility, based on a Naïve MLR model:
  - Peaks were effectively cut
  - Not hurting revenue
  - Forecast can be improved by excluding the special hours
- In general, utilities need to
  - Enhance data quality, label different DR programs
  - Develop two forecasts to quantify DR impact
  - Develop very accurate models to draw solid conclusions



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