

EnergyAustralia's Time of Use- Based Pricing Initiatives:

Sample Design, Customer Acquisition and
Demand Response Analysis Using SAS
Software

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EnergyAustralia[™]
We're on it

Electricity Distribution Issues

Analogy of Electricity Distribution Costs and Revenue - Water Pipe



**Network Revenue =
Water flowing
through pipe**

**Network
Costs =
Capacity,
diameter of
pipe**

- Largest gush of water (**electricity demand in kW**s) to go through the pipe at any point determines size of pipe (network capacity) - **COSTS**
- Volume of water flowing through pipe over time (**electricity consumption in kWh**s) - **REVENUE**

Overview

Products

Sample Plan

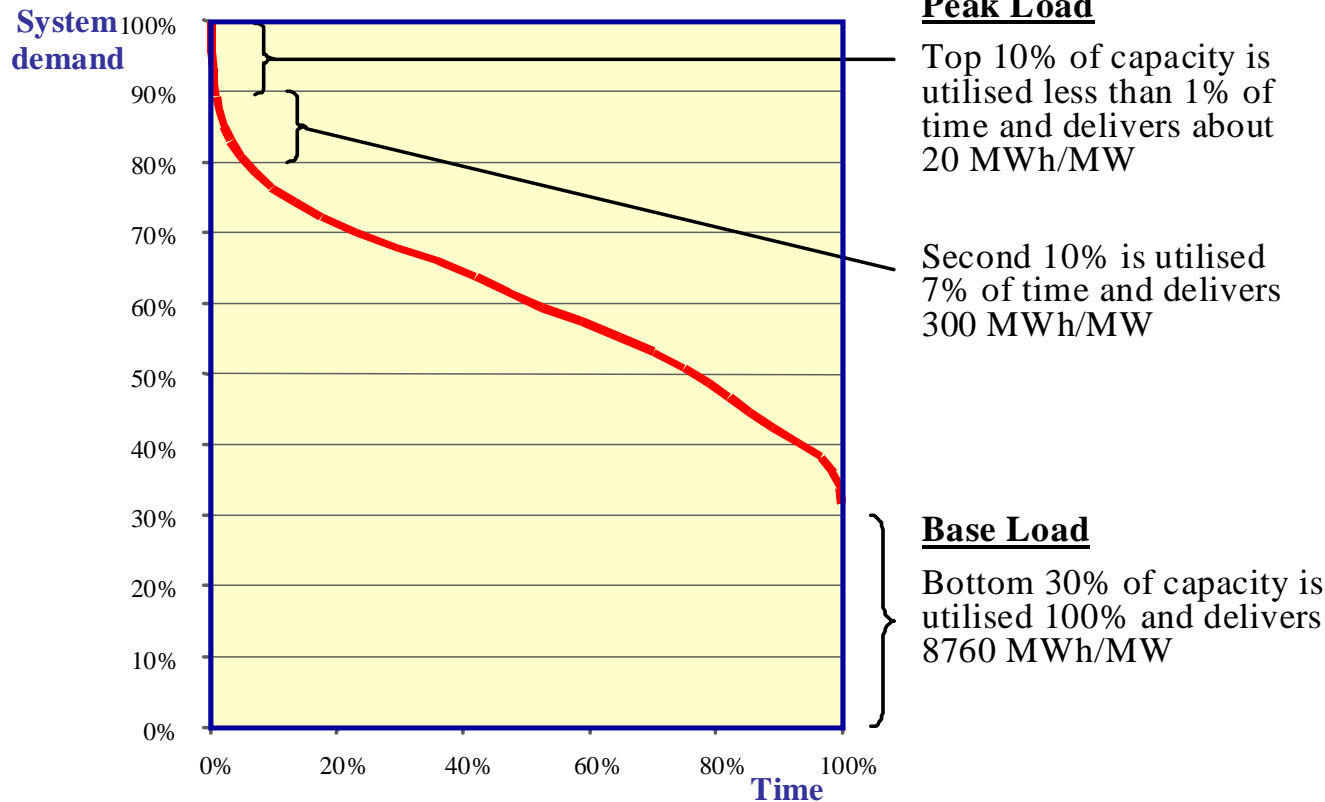
Recruitment

DPP Events

Analysis

Drivers of Demand Management

Peak Demand Problem



- Air conditioning drives peak demand increase, high capital augmentation network costs

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SPS Background

- Do you care about your current electricity usage?
- Would you use your air conditioner less **for a few hours of the year** if electricity price **10-20** times higher (but cheaper for rest of time)?



Strategic Pricing Study (SPS)

- Test new tariff products – **Dynamic Peak Prices (DPP)**, assess take-up potential
- Measure peak load reductions from price signals to estimate capital and maintenance deferral, lower energy costs
 - Need to know price elasticities

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How does DPP tariff work?

Events

- Max. 12 DPP events per year (4 per month)
- Events from ½ hr to 4 hrs duration
- Retail and Network each call 6 events

Notification

- Normally 24hrs notification but minimum 2 hrs
- Via in-house display (where applicable), SMS, phone message, and/or email

Meters/In-house Displays

- Smart meter installed with GPRS comms
- Power line carrier technology to connect in-house display to meter via power point

IN-HOUSE DISPLAY



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SAS and SPS Sample Design

Get Target Populations
Data from Billing System



Adjust Annual Usage for
No. of Bill Days



Convert into
Consumption "Bins"



Send to Specific Load
Research Program for
Stratification

Eg. SPS ORIGINAL SAMPLE PLAN EXTRACT

TARGET POPULATION: Residential below 40MWh per annum

STRATIFICATION	EXPERIMENT GROUP					
	Control Group	Information Only	Seasonal ToU	DPP Med: With In-House Display	DPP High: With In-House Display	DPP High: Without In-House Display
Annual Consumption (kWh)						
2,000 - 5,400	33	33	36	56	47	47
5,401 - 9,000	33	33	36	56	47	47
9,001 - 40,000	33	33	36	56	47	47
Total	99	99	108	168	141	141



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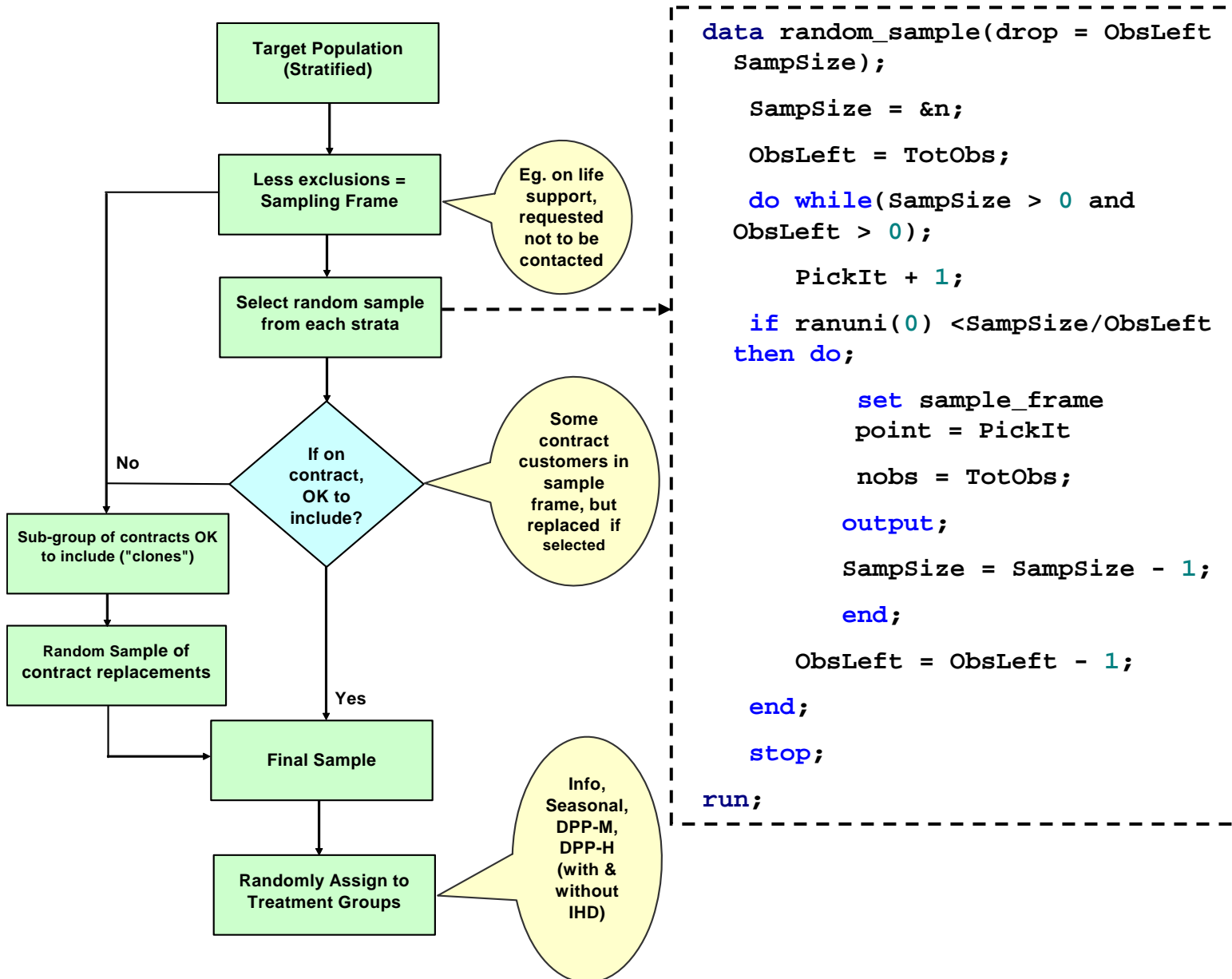
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Customer Acquisition Process – Logic Flow



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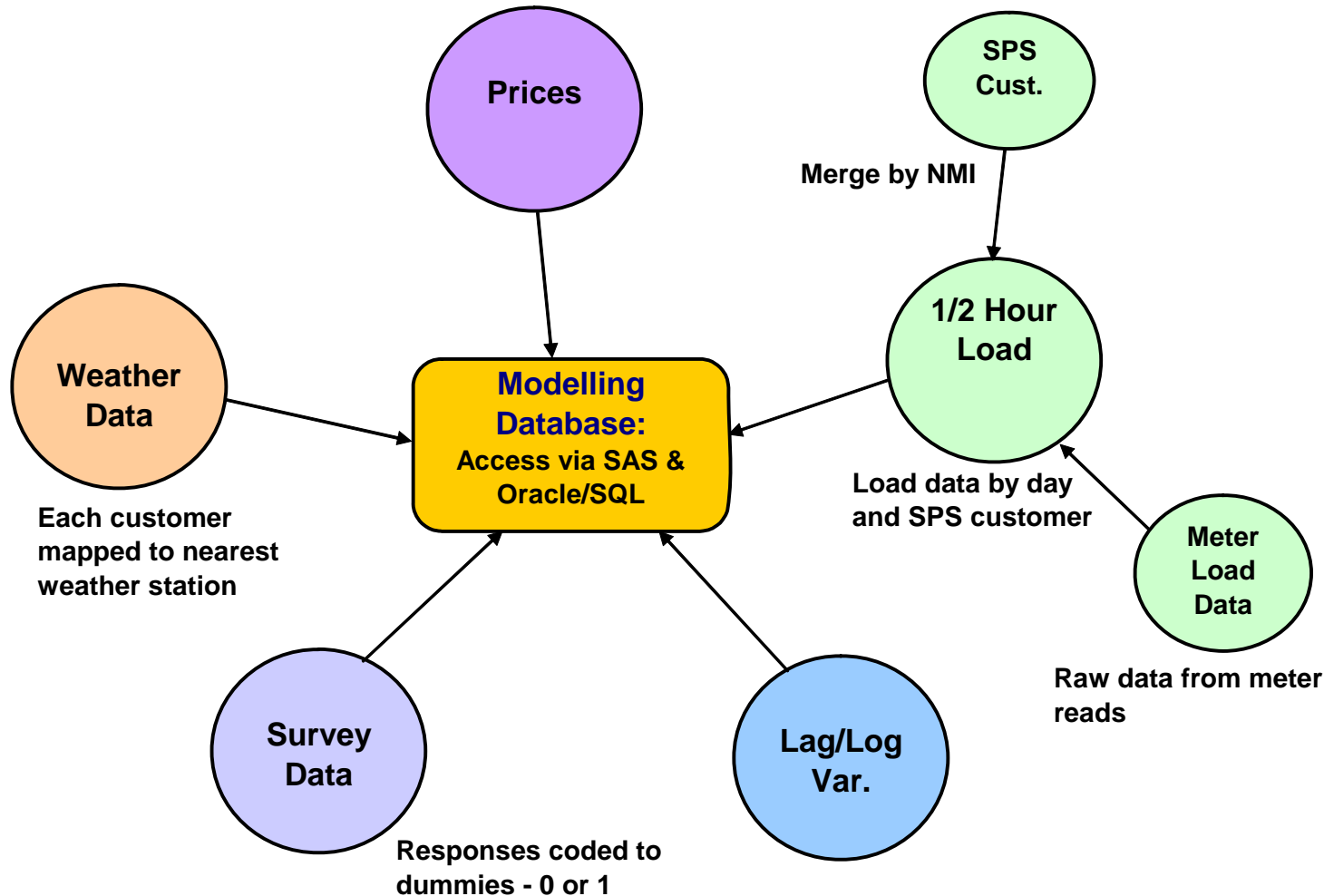
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SPS Data – Data Flow Diagram

- **Set-up:** IT architecture - build, program and automate process for ongoing research



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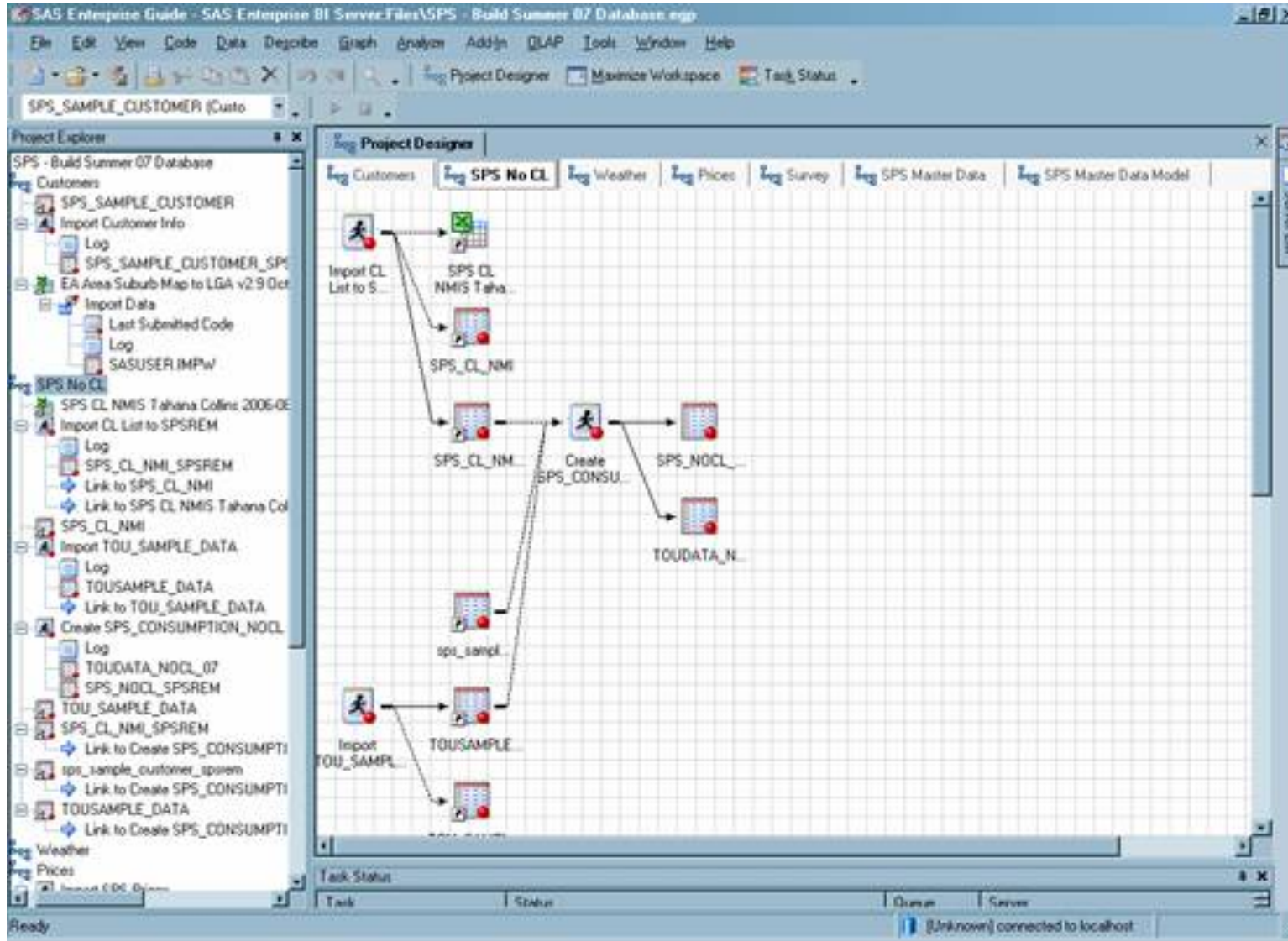
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Data

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SPS Data - Software

- SAS Enterprise Guide is now being used to compile database



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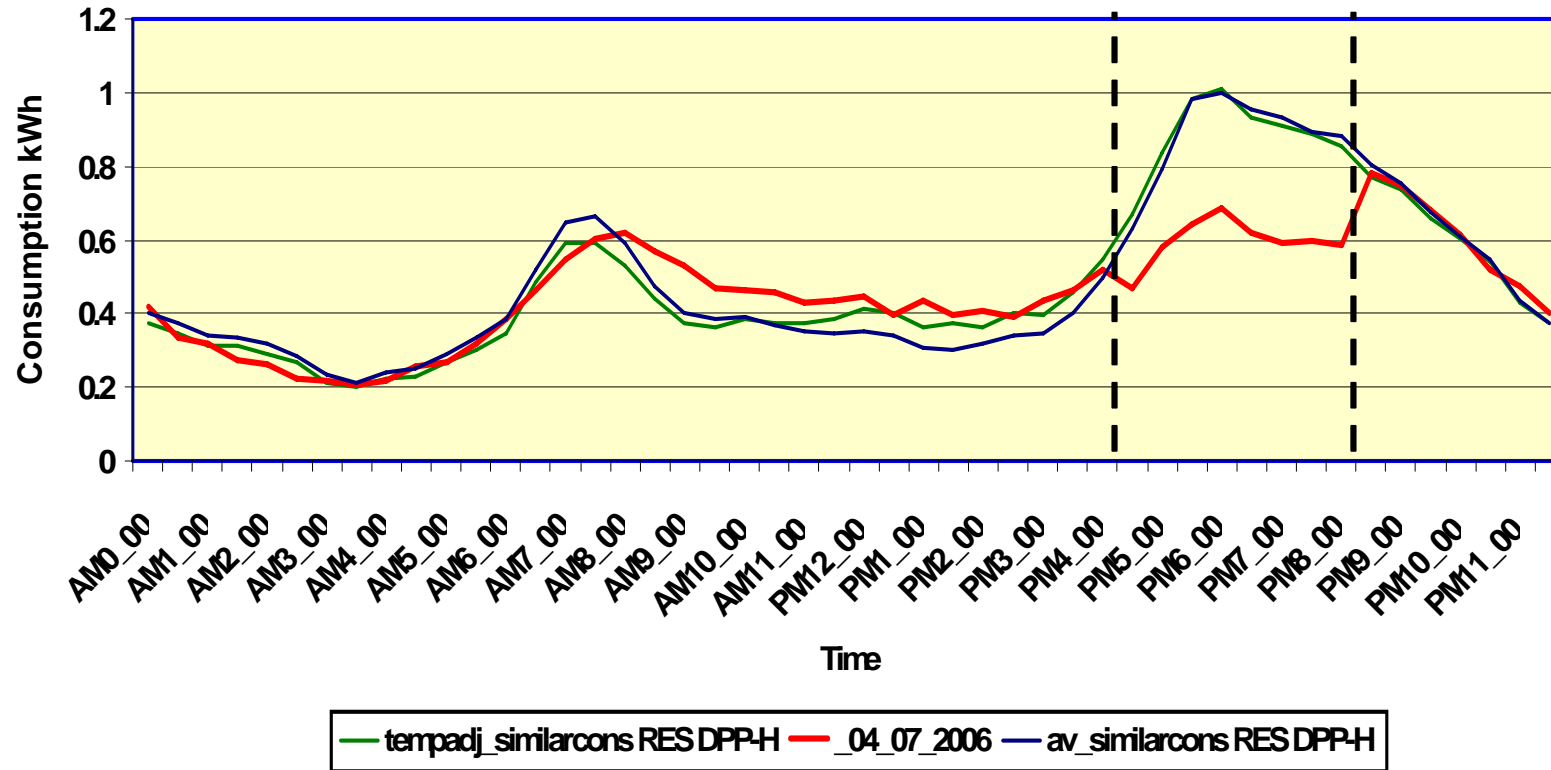
Data

Analysis

Example of Impact on Load Curve: DPP High (Event 2)

Residential

DPP Event vs Similar Days
Res: DPP High



- DPP-day load curve compared to similar day load curves (adjusted by temperature sensitivity in each half-hour period)
- Base SAS/Enterprise Guide used to generate curves, regressions for temp. adjusting

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SPS Analysis: Econometric Methodology

- Research, advice from Professor Robert Bartels (University of Sydney)
- **Non-linear Generalised Leontief approach** – inconsistent results, possibly due to parameter restrictions
- **Constant Elasticity of Substitution (CES) models** – first difference, system of equations estimated using SUR
- **Fixed effects and random effects** panel data modeling
 - One-way fixed effects for each individual customer
 - Coefficients for each stratum weighted to reflect population
- Double-log functional form
 - Price elasticities measured from coefficients
 - Dynamic models with lagged terms to address autocorrelation, robust SEs
- Impact estimator built to convert elasticities to peak consumption reductions
- Variety of SAS Procedures used for analysis

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SPS Analysis: SAS ETS Procedures

```
proc model data=Load;  
  LNY = A + B1*dif(X1) +  
        B2*dif(X2);  
  LNZ = B + B1*dif(X1) +  
        B2*dif(X3);  
  if Sample=a;  
  fit LNY LNZ/ sur  
  outest=Load_Out;  
run;
```

```
proc panel data = Load  
  outest = Load_out;  
  model LNY = LNX1 X2 X3 X4  
        LNY_1 LNY_5  
  / ranone fixone BP;  
  id CustomerID Date;  
run; *EXPERIMENTAL
```

Advantages

- Flexible (interactive terms)
- Transform variables directly in equation (log, lag, diff)
- Can use subsetting if

Disadvantage

- Not set up for panel

Advantages

- Handles unbalanced panel
- Can create lags (new proc)
- More options than Proc TSCS Reg, Proc Mixed

Disadvantage

- No interactive terms, no multiple equations, no subsetting,

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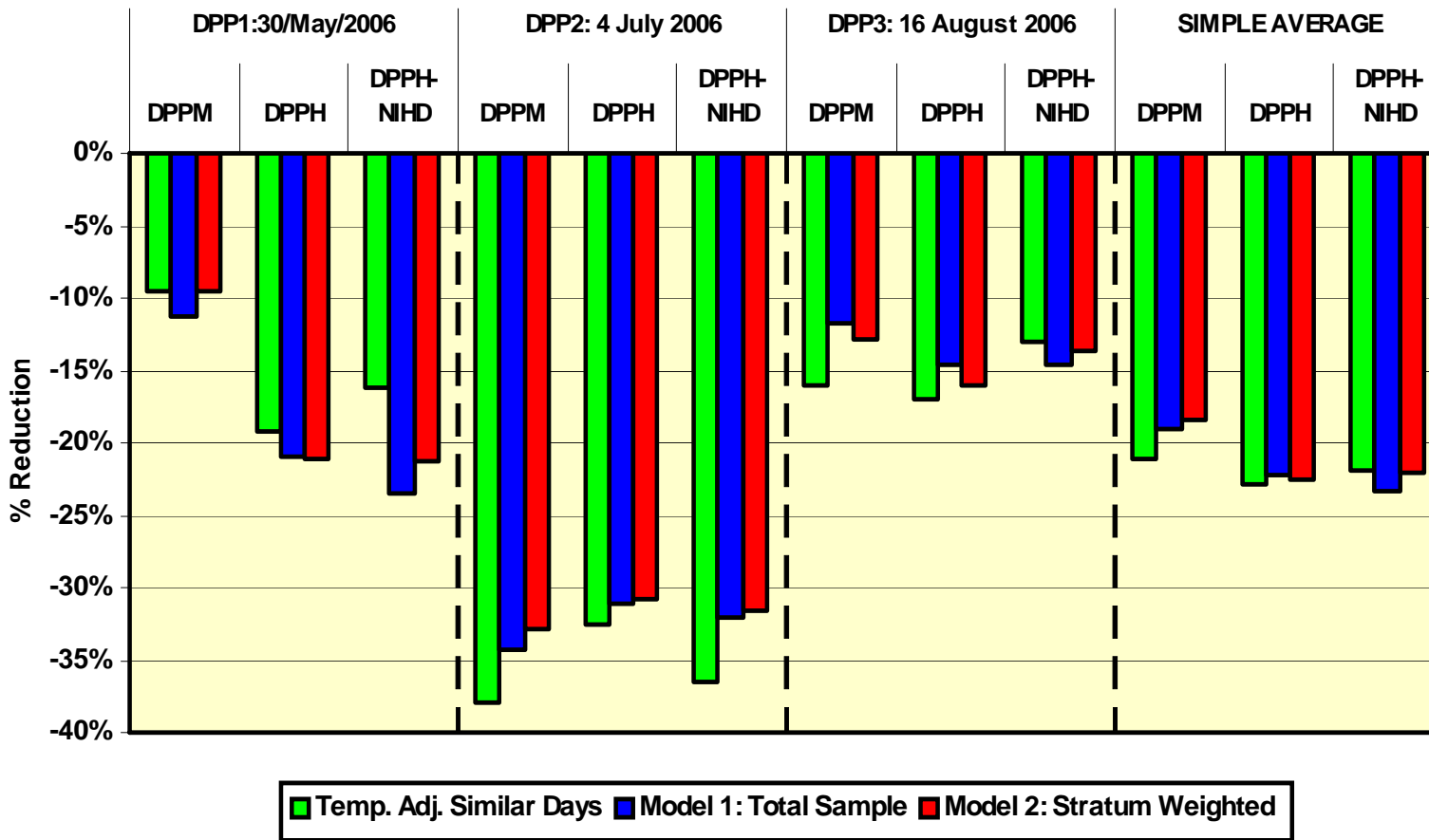
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Residential Results – Comparison of Methods

- Temperature-adjusted comparisons to similar days and panel data models produced similar results – WINTER 2006

RESIDENTIAL - DPP PERIOD % CONSUMPTION REDUCTION Comparison of Temperature-Adjusted Graph and Econometric Methods



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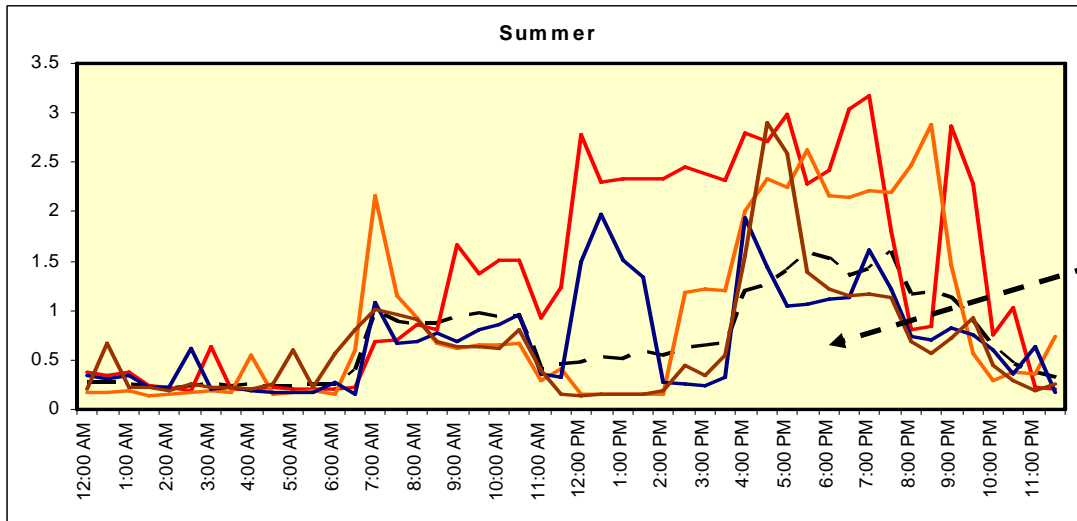
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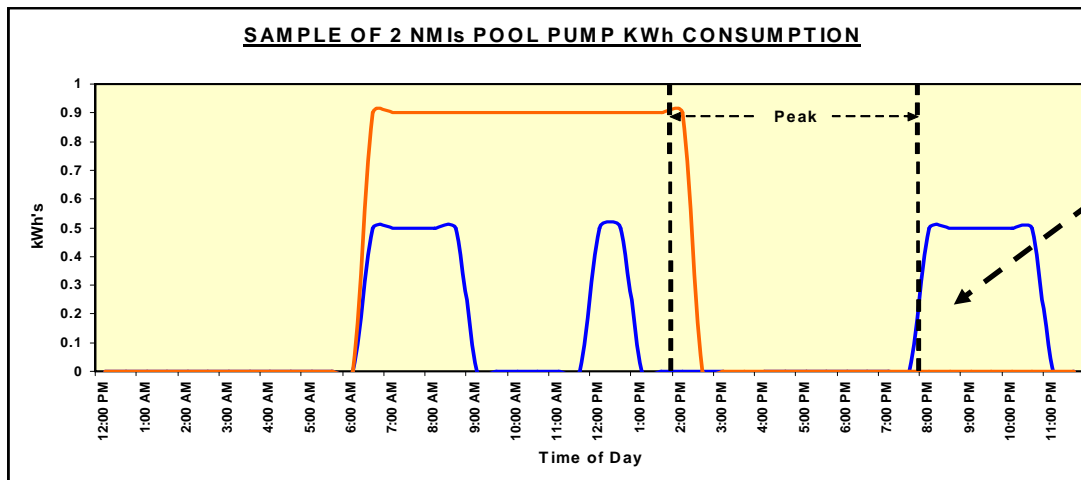
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Future Load Research Using SAS

- Train neural networks in SAS Enterprise Miner to recognise load profiles such as pool pumps



Pick out
pool pump
profile



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Conclusion

- Initial SPS residential winter results encouraging, too early for policy conclusions. Could be some “Hawthorne effect” – final results may be lower
- On average, residential customers reduce DPP load by around 19-23% for DPP tariffs
- Average business response lower than residential. Business is heterogeneous group
- More results released when available
 - Summer results important
- Information on customer response to price changes (price elasticities) important for any business

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