

Generation of Domestic Electricity Load Profiles

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Objectives

Design of high time resolution models for domestic electricity demand in Ireland

- Stochastic profiles at thirty minute intervals
- Capable of modelling individual dwelling types
- Other socio-economic variables (dwelling size, no. of occupants, occupancy, appliance holdings)
- Used alongside renewable energy technology models

Background

- PhD student at Dublin Institute of Technology, Ireland
- Work feeds into an overall project to investigate energy policy scenarios for micro-generation in domestic dwellings in Ireland (groups: micro-generation technology modelling, demand modelling, behavioural, policy analysis, future scenario modelling)



Current Methodologies

Macro-Economic (top-down)

Multiple Regression (bottom-up)

Neural Networks

Conditional Demand Analysis

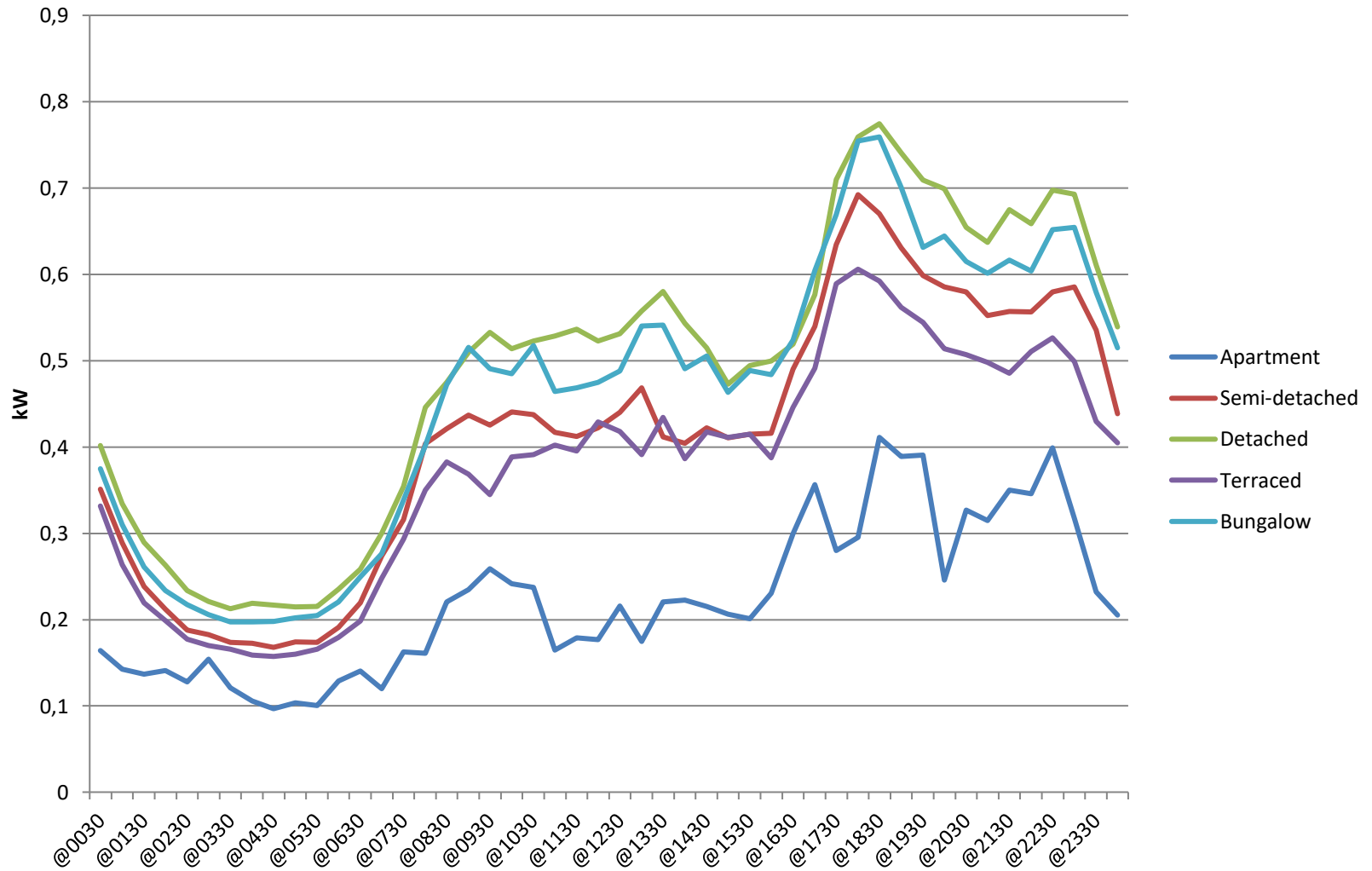
Engineering models

Autoregressive

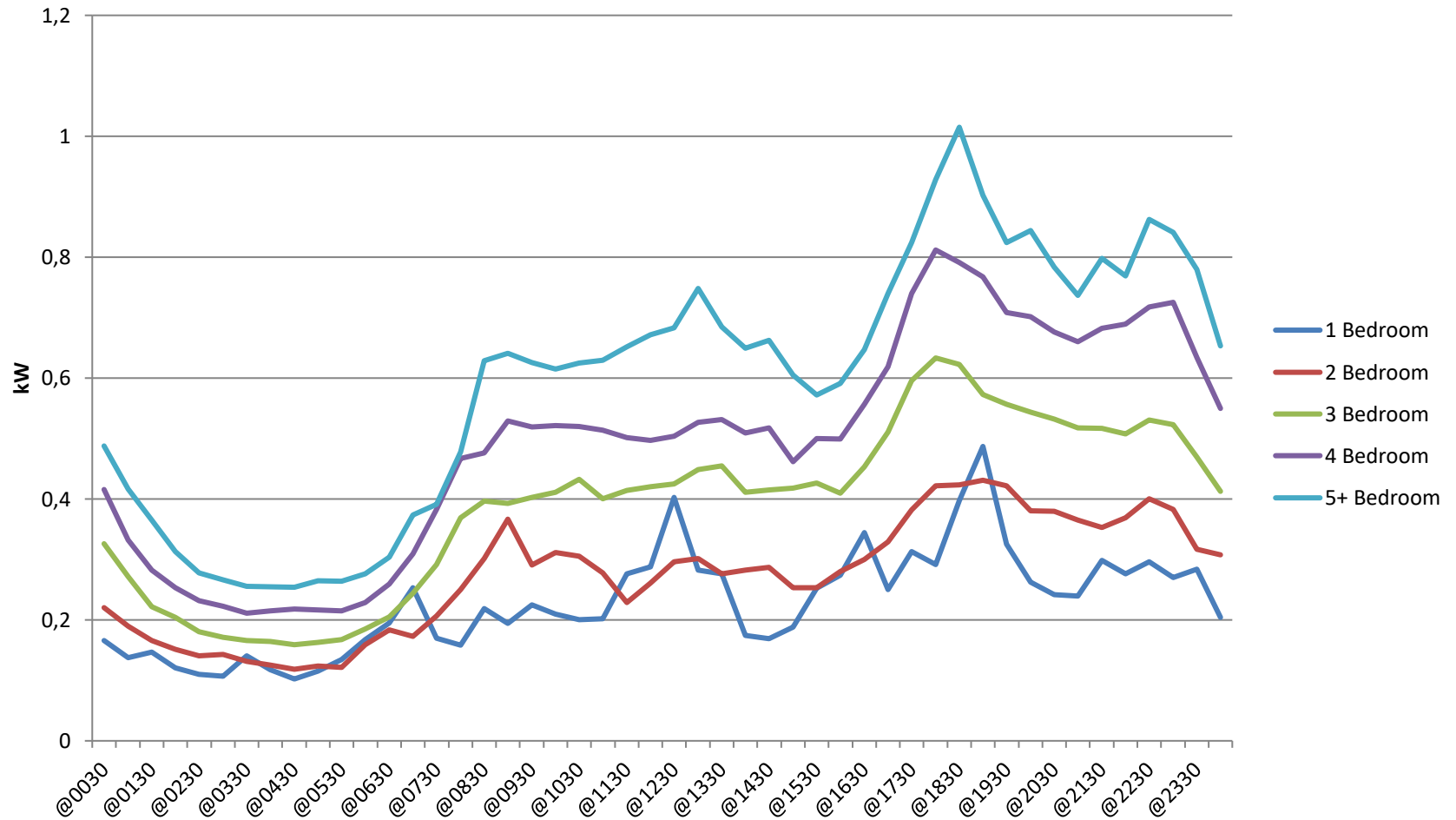
Average Load Profiles

- Smooth load across the day
- Predictable peaks in morning and evening time
- Small base load over night

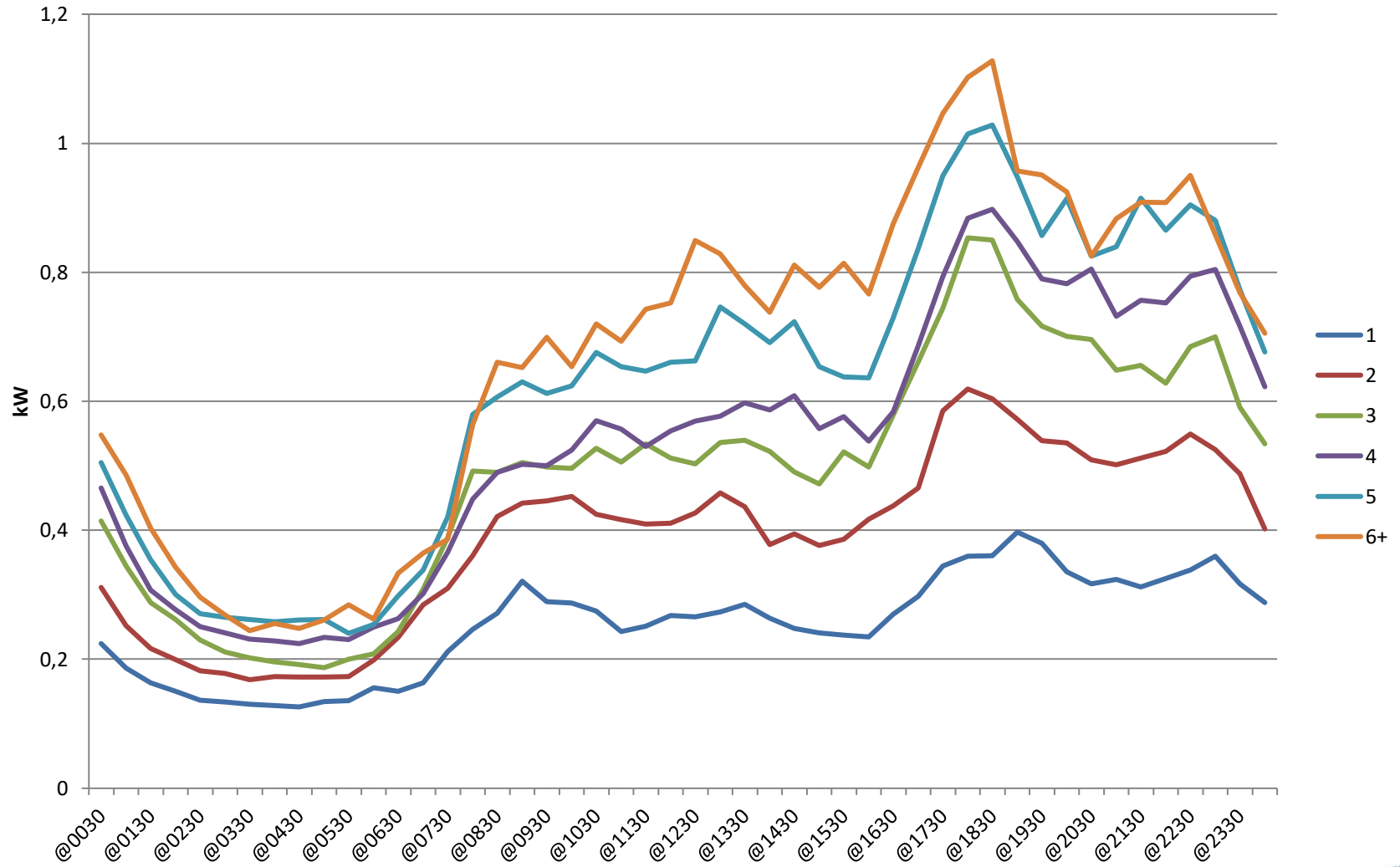
Average electricity load profile by dwelling type



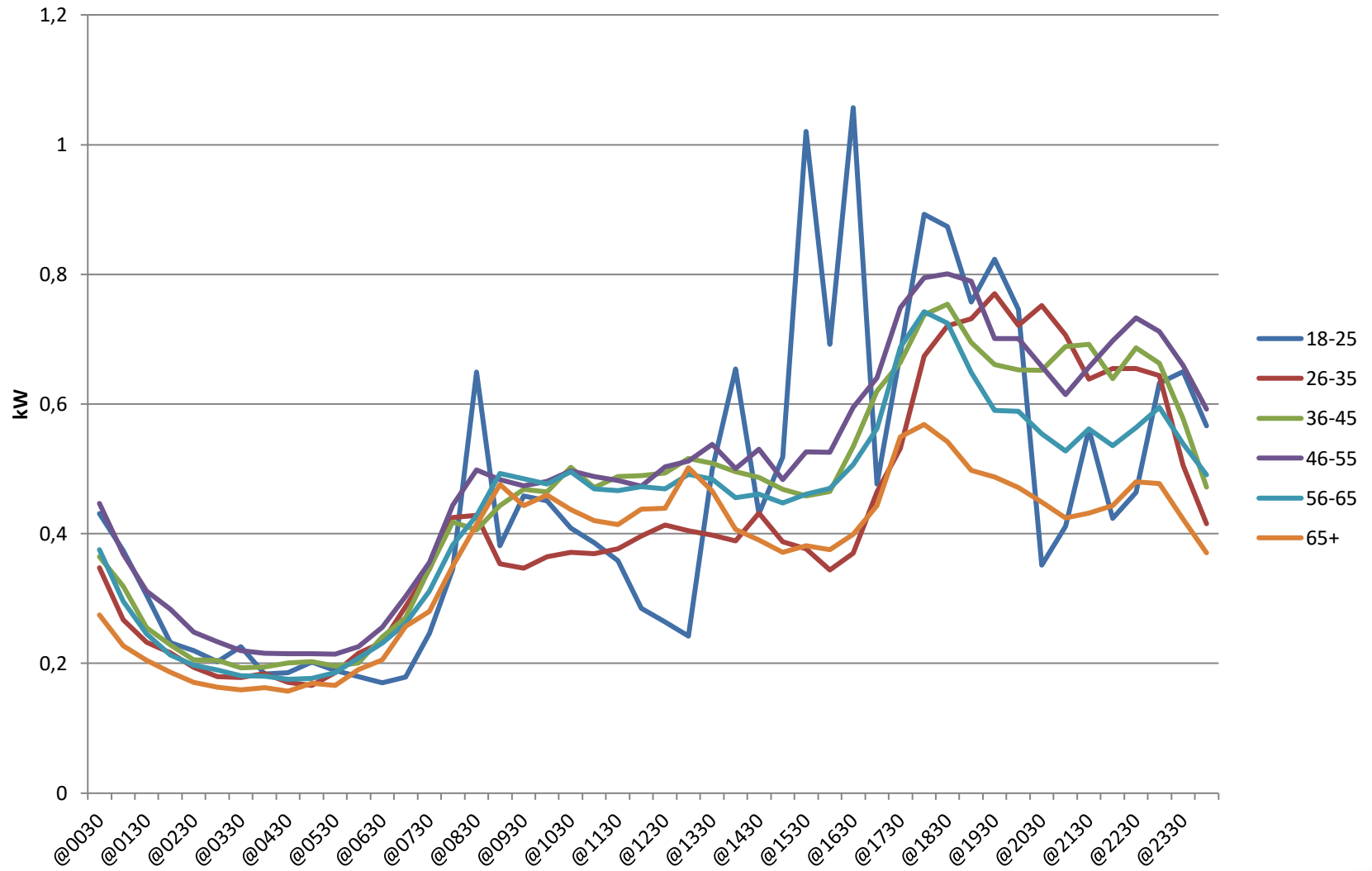
Average electricity load profile by No. of bedrooms



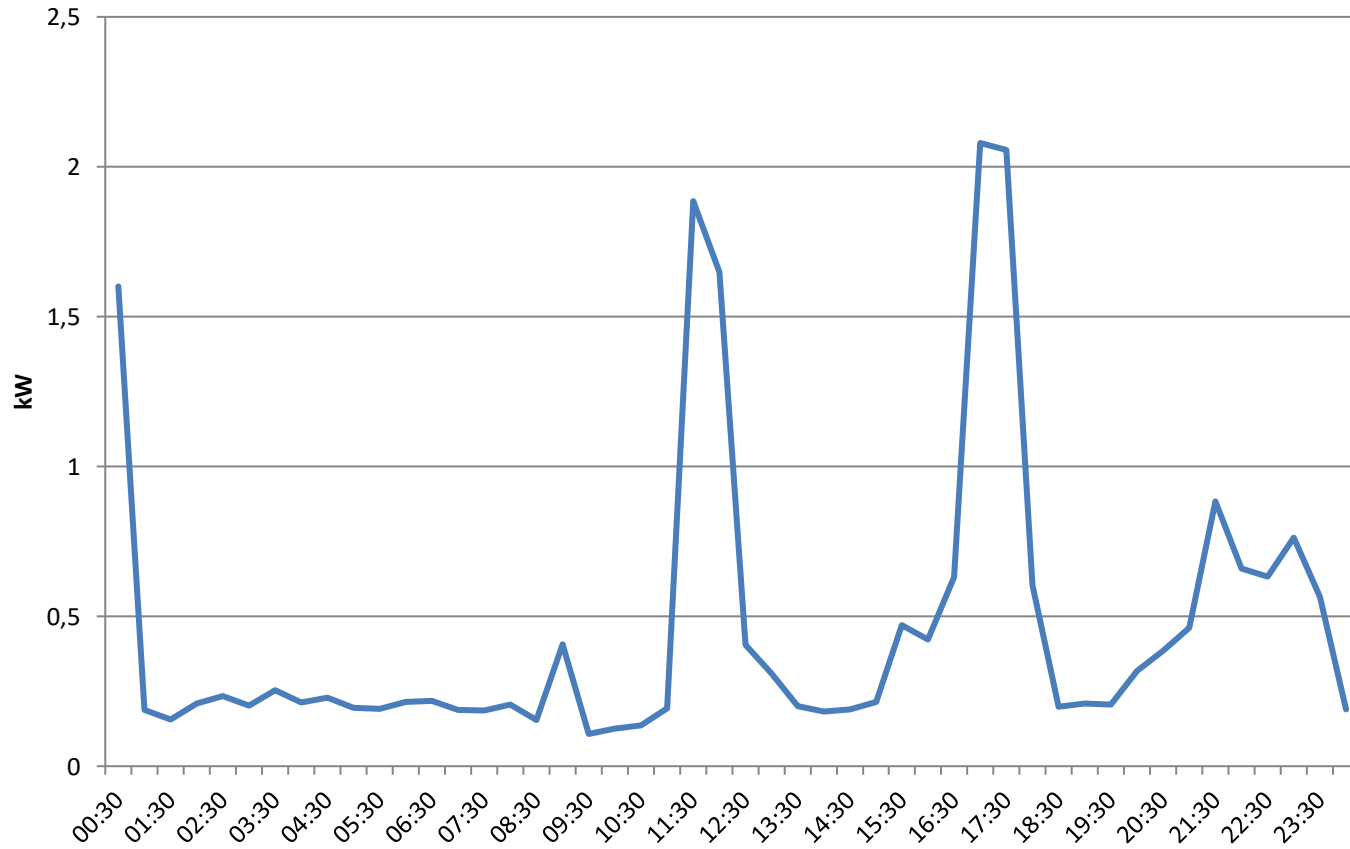
Average electricity load profile by no. of occupants



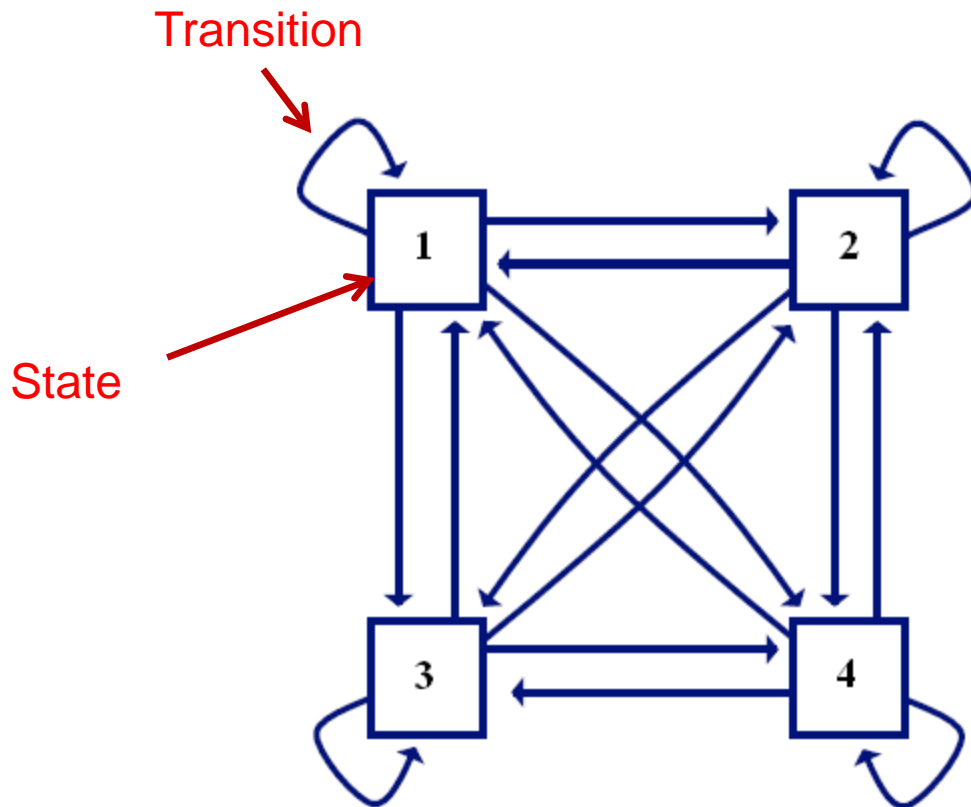
Average electricity load profile by HOH age band



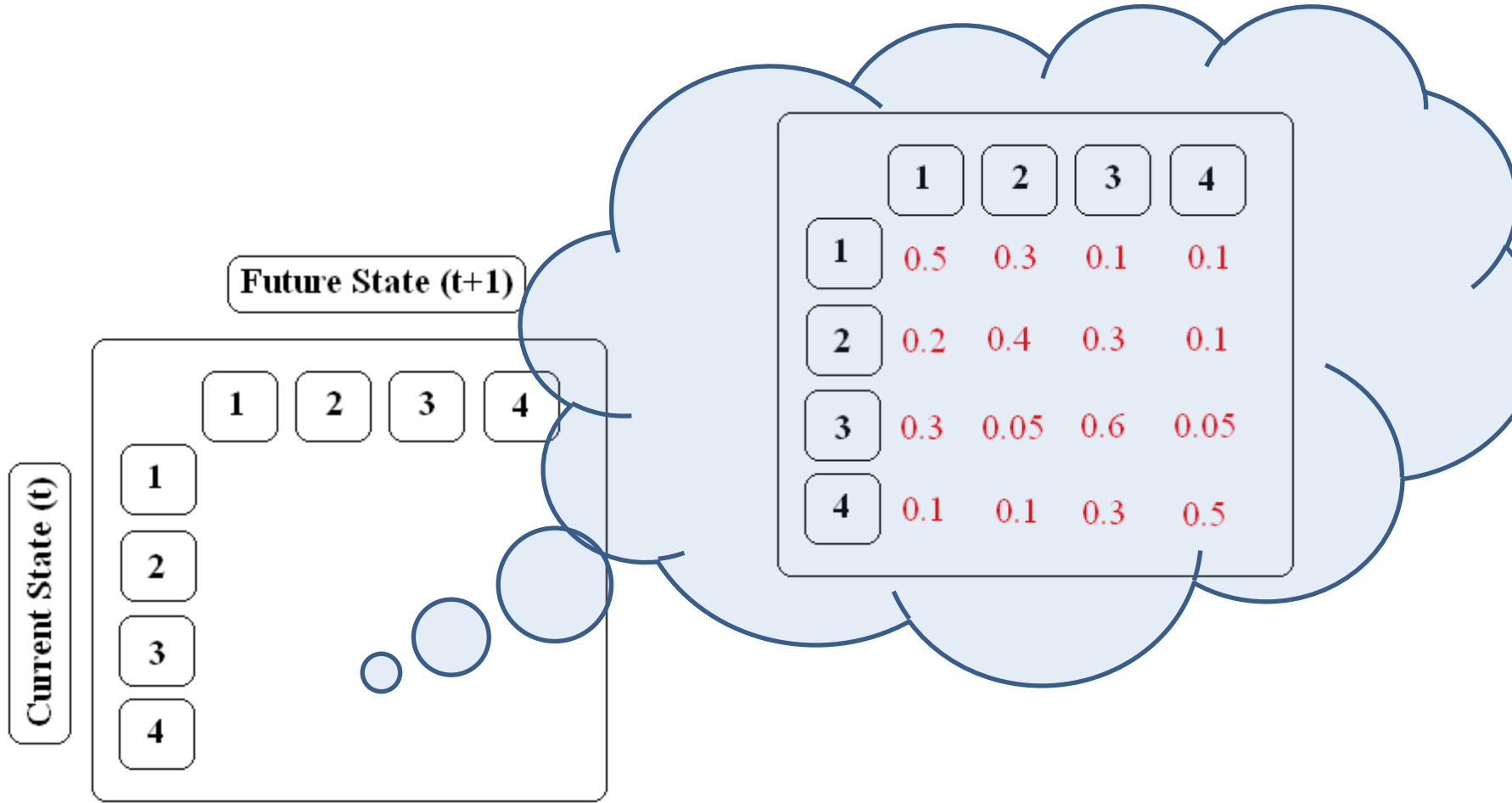
Stochastic Load Profile



Markov Chain



Markov Chain

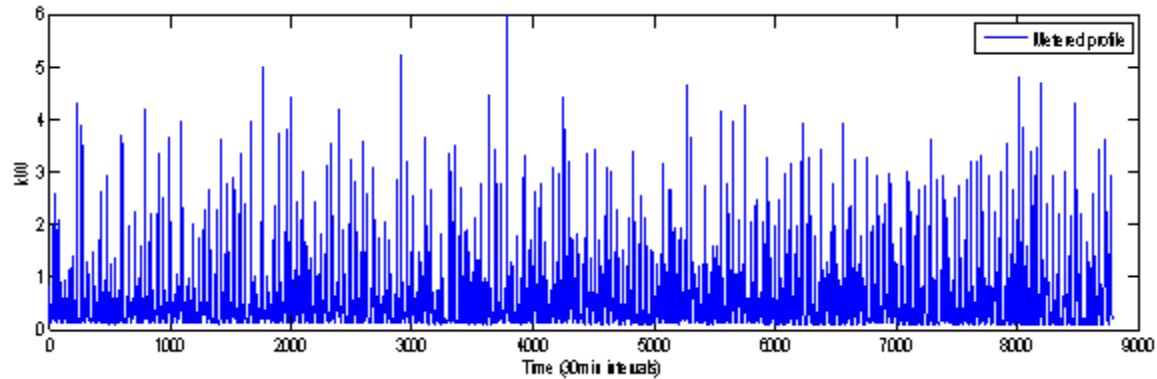


Markov Chain

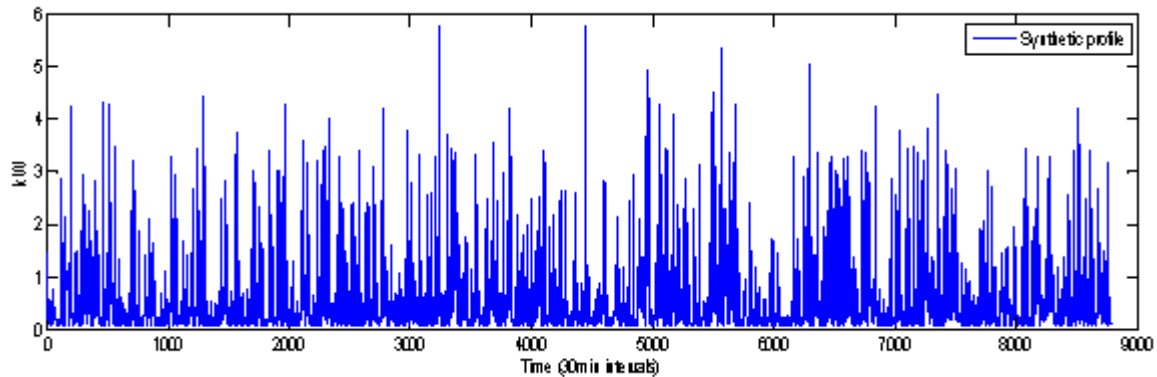
- Six months data metered at 30 minute intervals for five individual dwellings in Ireland
- A first order model with 24x24 probability matrix chosen
- Sampling based on mean and standard deviation for Ireland

Metered and Synthetic load profiles over six month period

Metered Profile



Synthetic Profile



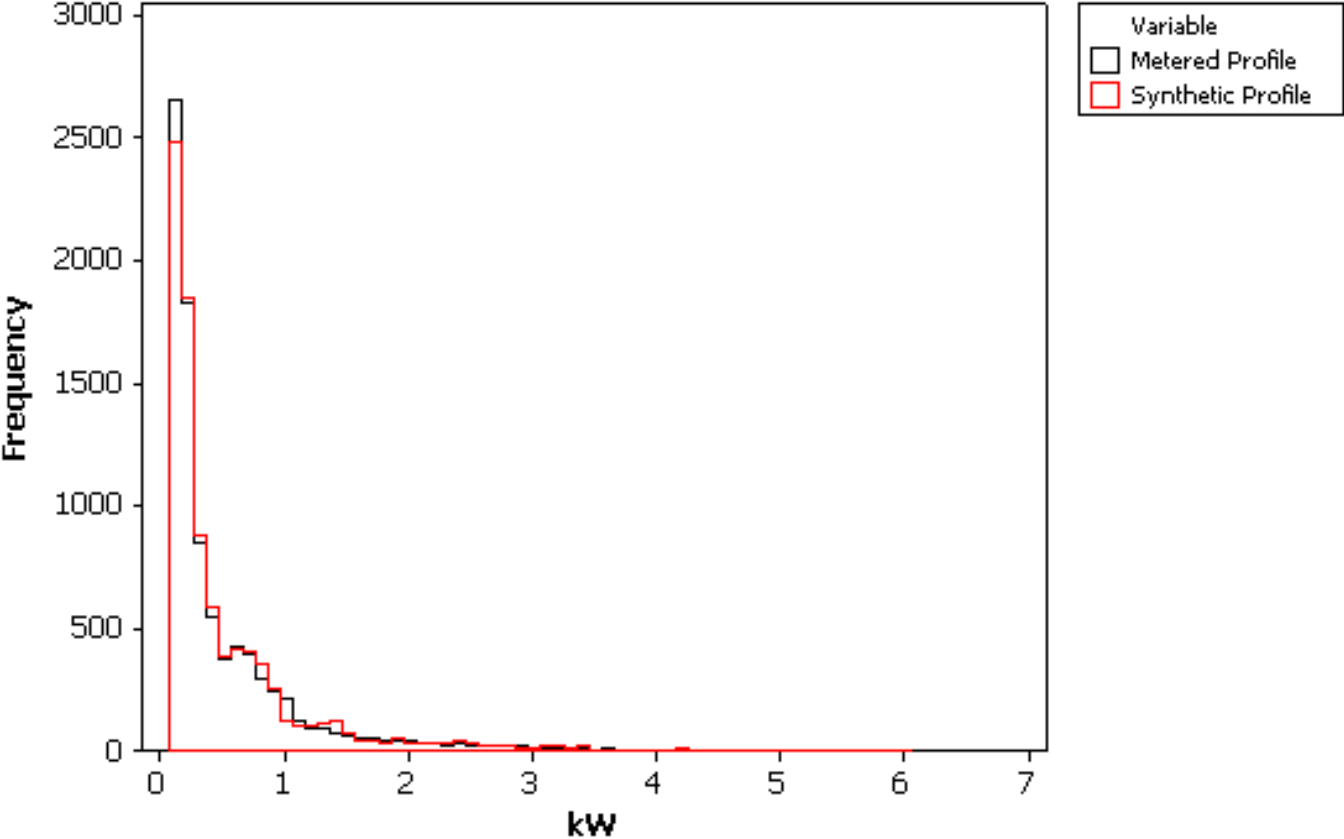
Comparative Tests

- **Statistical Properties**
 - Mean
 - Standard Deviation
 - Max & Min values
 - Distribution parameters
- **Time Domain Analysis**
 - Mean & 95% Confidence Intervals
- **Frequency Domain Analysis**
 - Spectral Density Functions

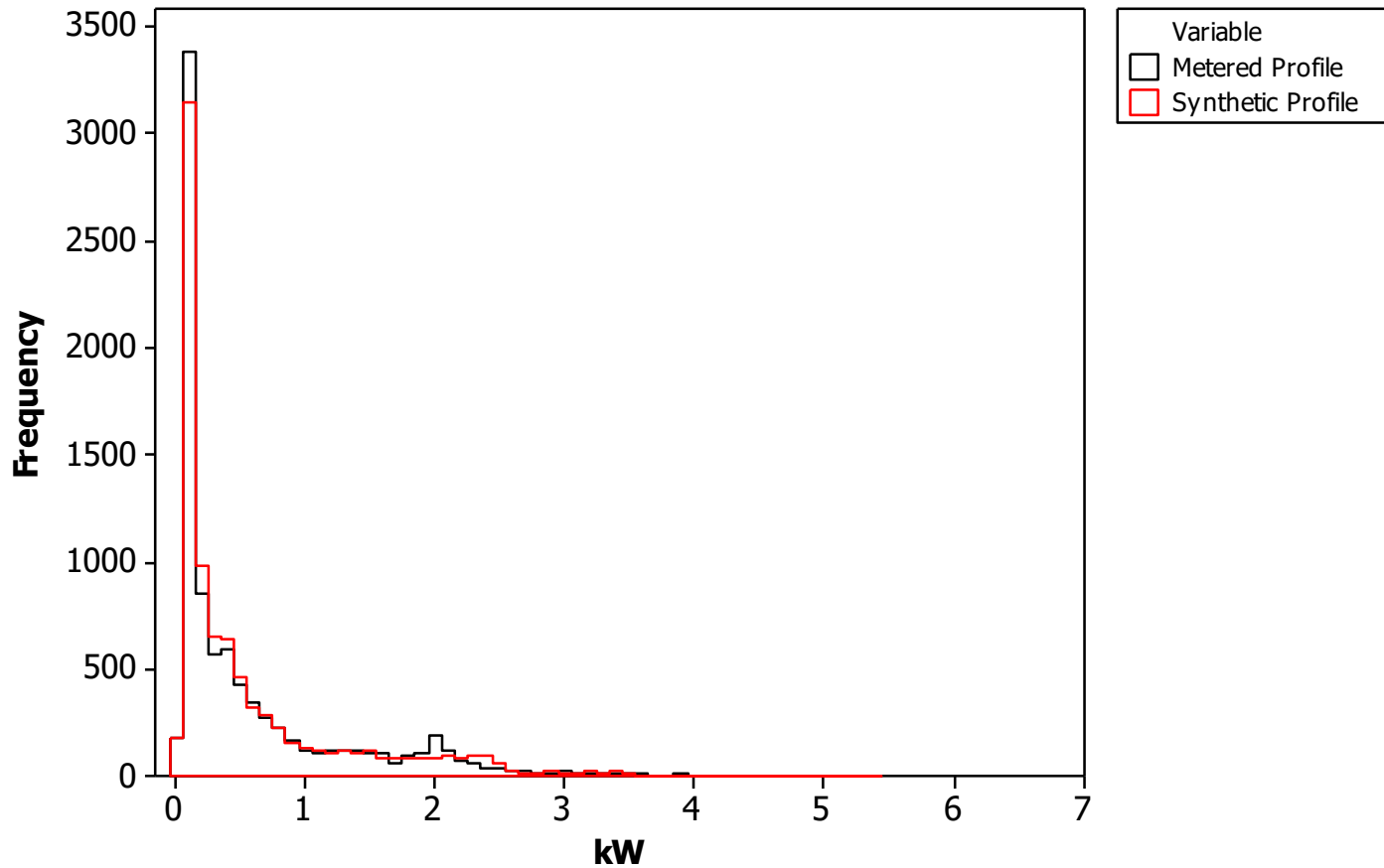
Results

	<i>Detached</i>	<i>Semi-detached</i>	<i>Bungalow</i>	<i>Terraced</i>	<i>Apartment</i>
Mean (metered)	0.4901	0.5834	0.7460	0.6510	0.1397
Mean (synthetic)	0.5073	0.5917	0.7661	0.6583	0.1436
STD (metered)	0.5969	0.7265	0.7578	0.7023	0.1976
STD (synthetic)	0.6300	0.7477	0.7930	0.7198	0.2021
Max (metered)	5.9820	5.4400	6.6060	5.5980	3.6980
Max (synthetic)	5.7638	5.3840	7.3146	6.4895	3.4000
Min (metered)	0.0800	0	0	0	0
Min (synthetic)	0.0503	0.0002	0.0110	0.0504	0.0001

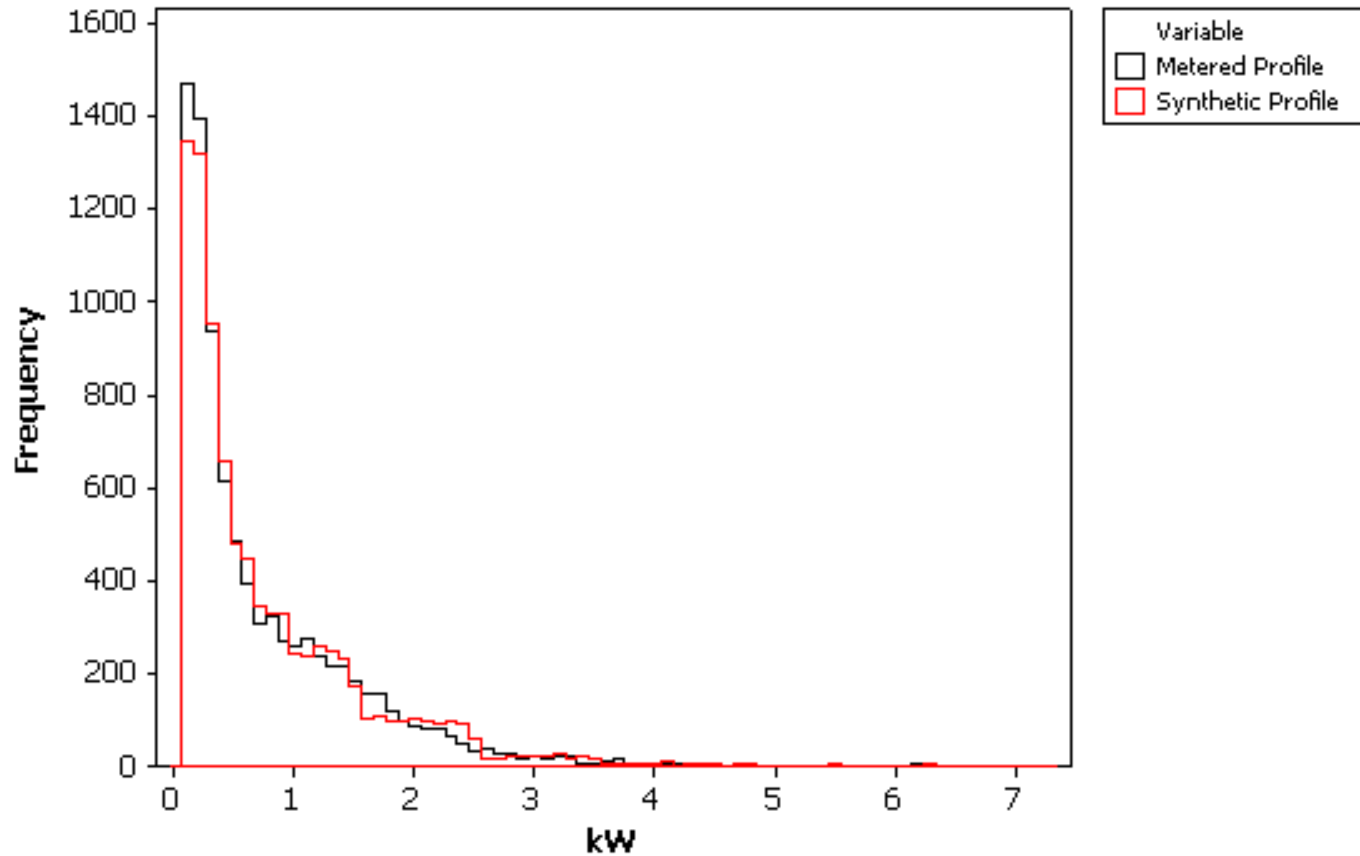
Frequency Histogram – Detached Dwelling



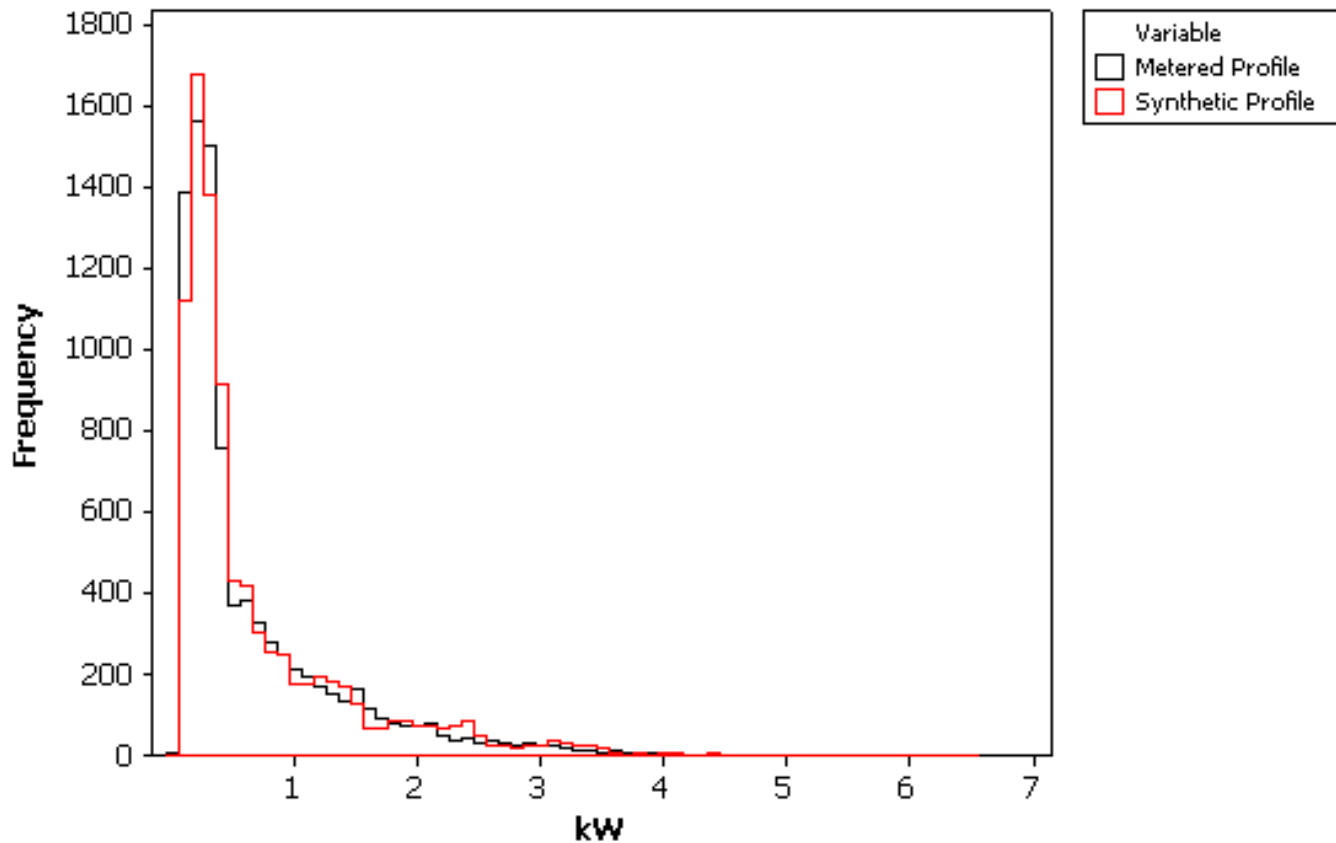
Frequency Histogram – Semi-Detached Dwelling



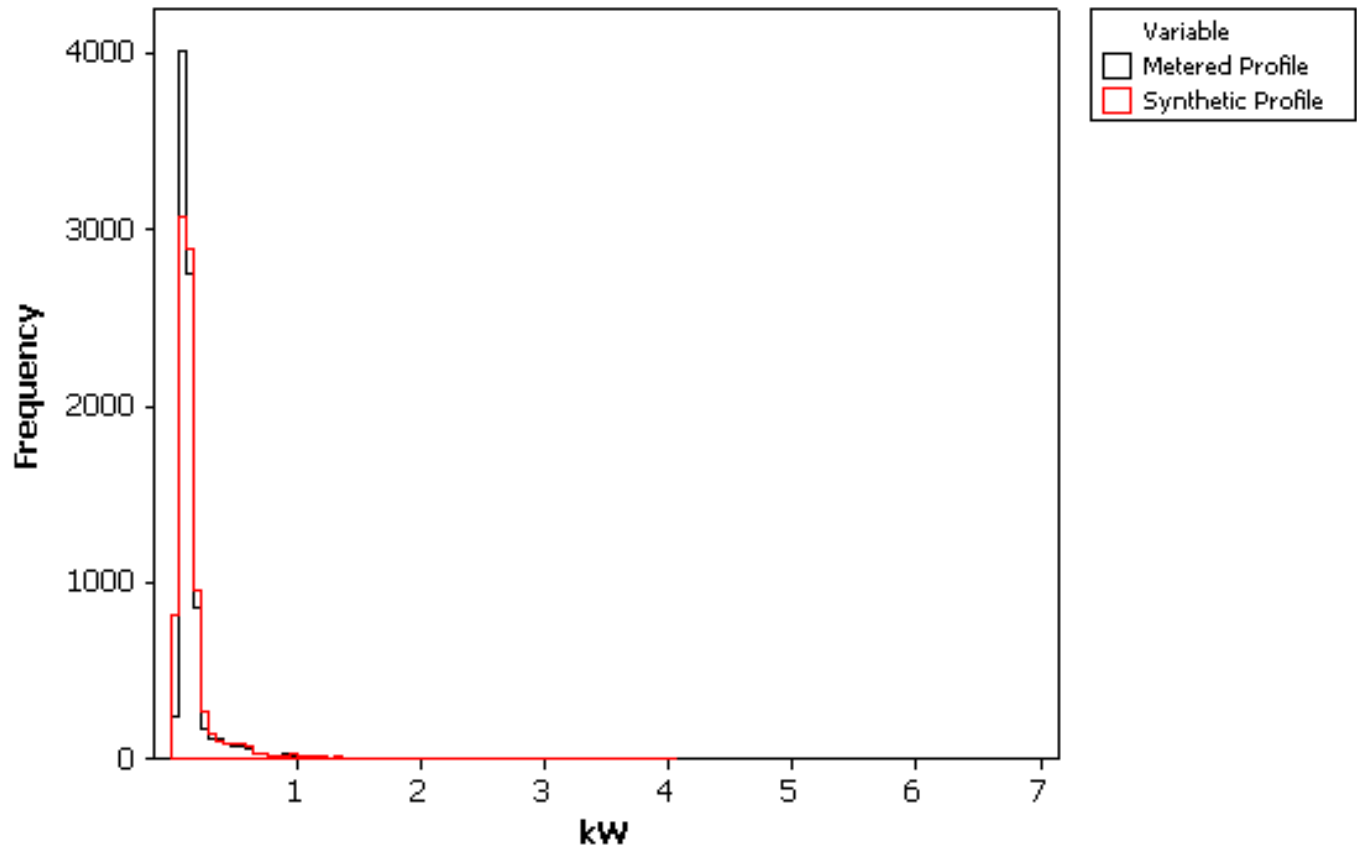
Frequency Histogram – Bungalow Dwelling



Frequency Histogram – Terraced Dwelling



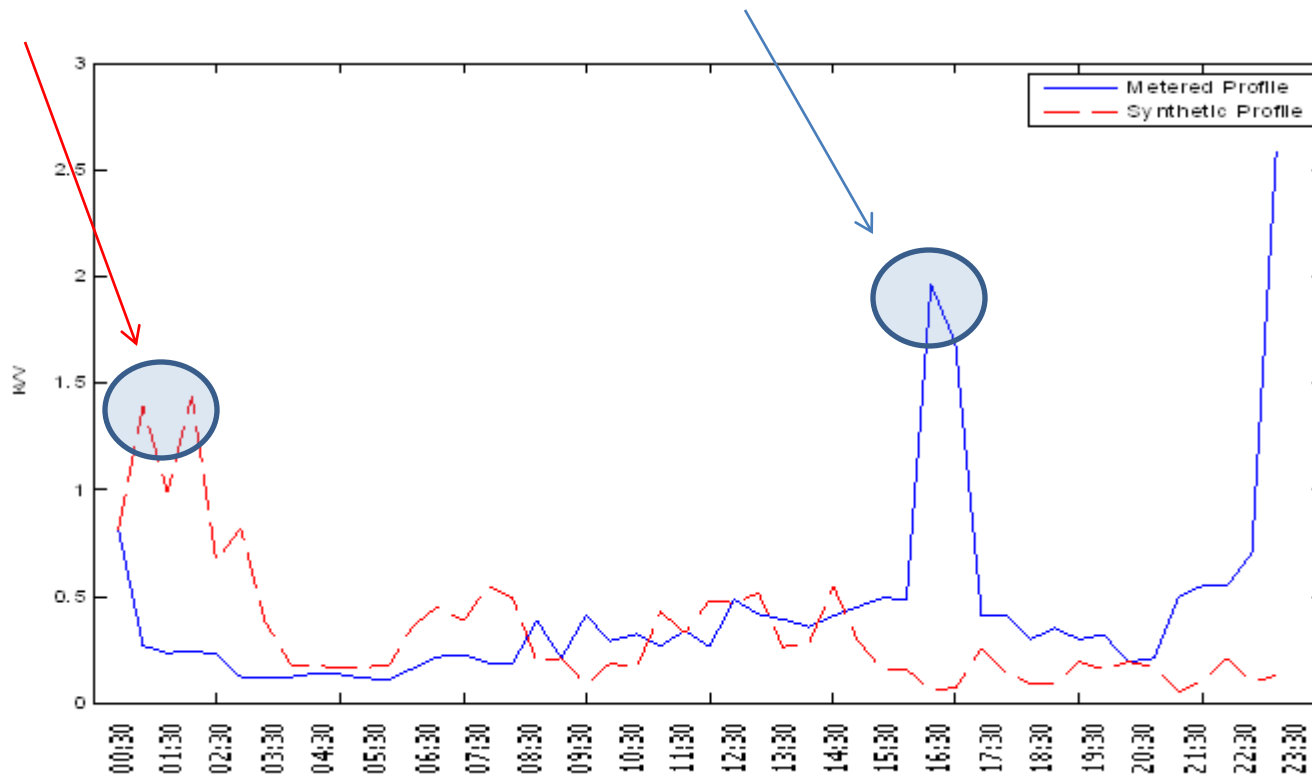
Frequency Histogram – Apartment Dwelling



Time distribution of electricity consumption over a random day – Detached Dwelling

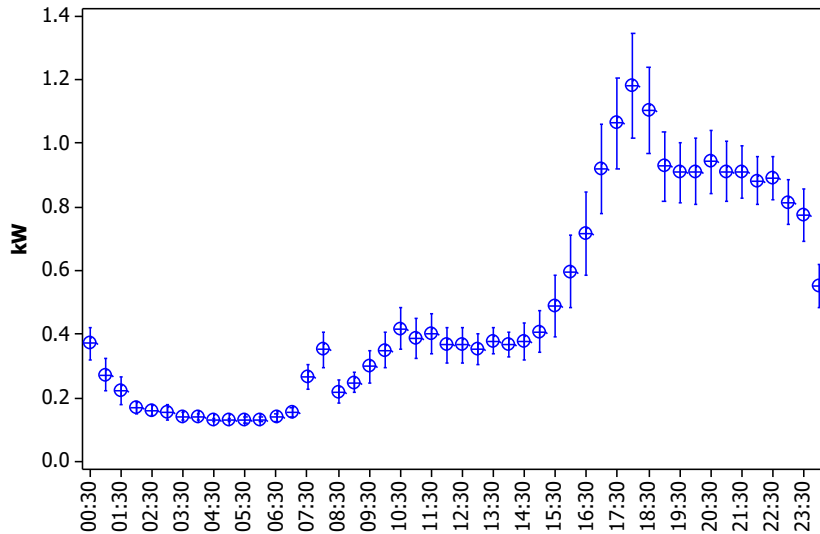
Synthetic profile predicts pk. in the early morning

Metered profile has pk. around 4.30pm in the evening

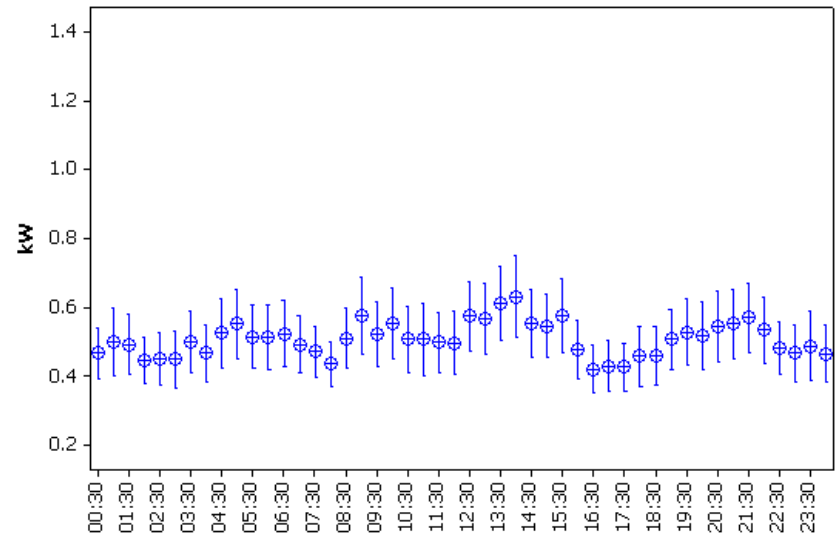


Time Domain - Daily Mean & 95% Confidence Intervals

Metered Data

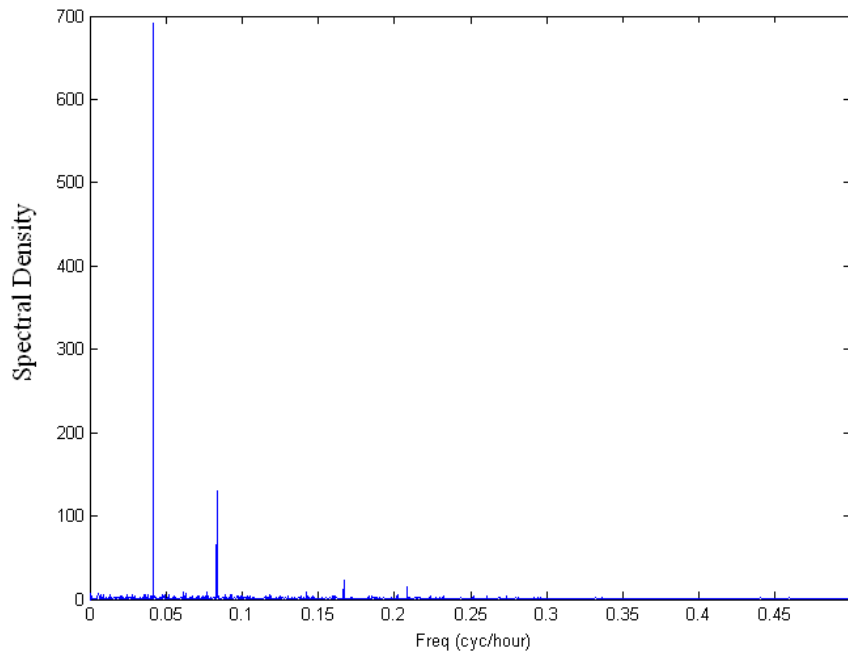


Synthetic Data

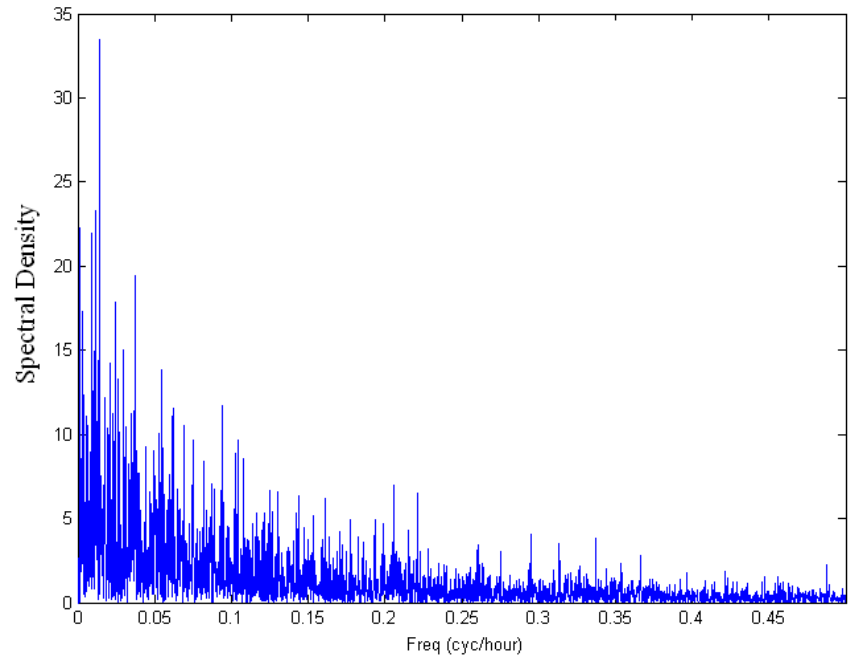


Frequency Domain – Detached Dwelling

Metered Data



Synthetic Data



Conclusions

- Markov chain is a stochastic modelling technique used to generate synthetic sequences
- Can preserve certain statistical properties such as mean, standard deviation, max & min parameters between sequences
- Unable to model the timing of peak electricity consumption as shown in the time and frequency domain

Thank You & Any Questions

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