FLEXIBLE DEMAND – PRIORITY LOADS AND POTENTIAL IMPACTS FOR AUSTRALIA

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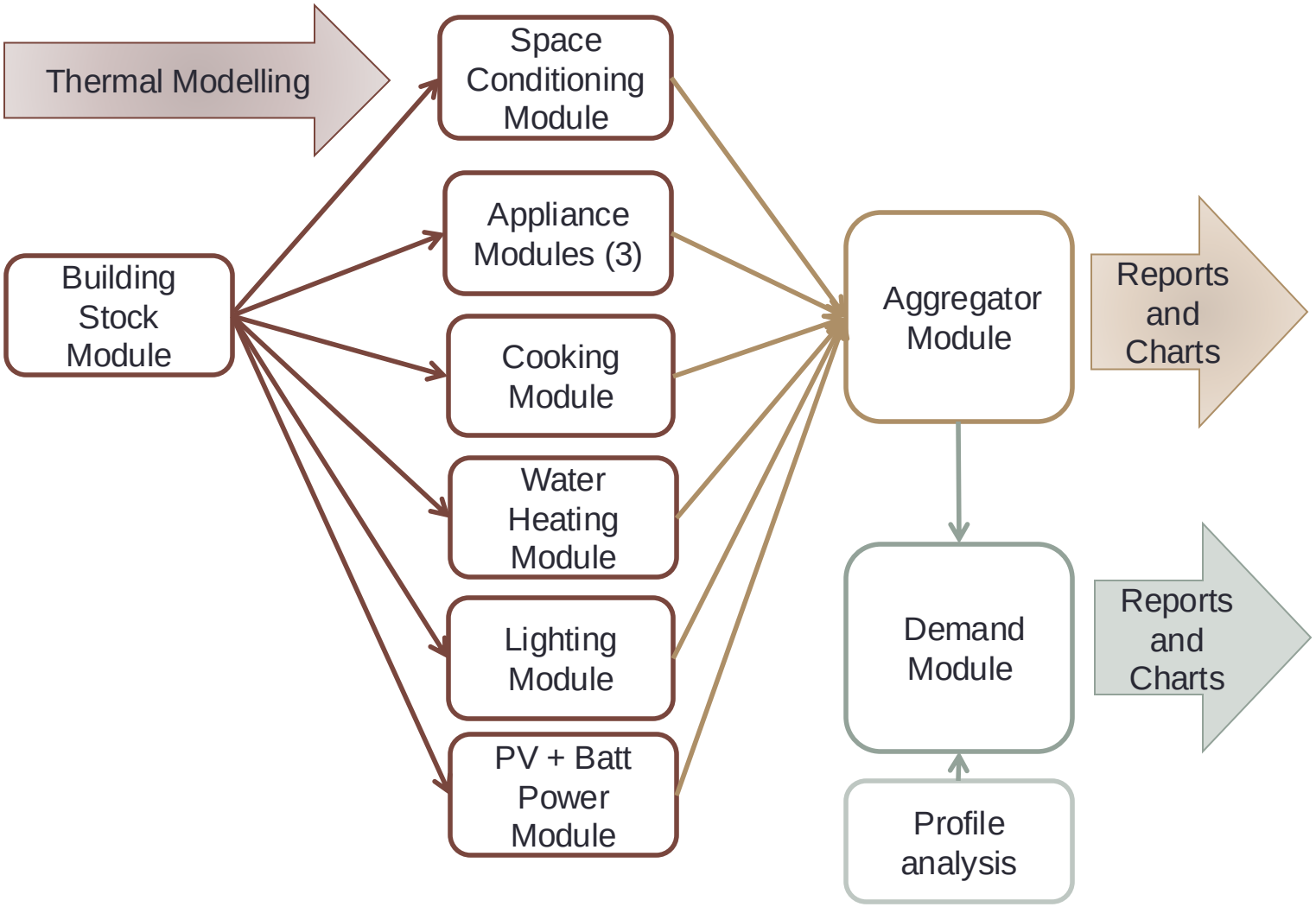
Context

- Managing electricity demand will be challenging due to increasing consumption from electrification and behind-the-meter generation:
  - Strategies exist but depend on many factors, including the climate, consumer behaviour, technology and market conditions
  - Focus is on load shaving and load shifting, to help reduce peak demand and act as a solar sponge for local PV generation

- Based on work done for the Australian Government from 2014 to 2021
  - Using the updated Australia and New Zealand Residential Baseline Study (RBS)
  - RBS is a sales, stock and energy characteristics bottom-up model
  - Combined with hourly demand projections by day type (weekday/weekend), season, year, region, and end-use technology

Overview of Model: Structure

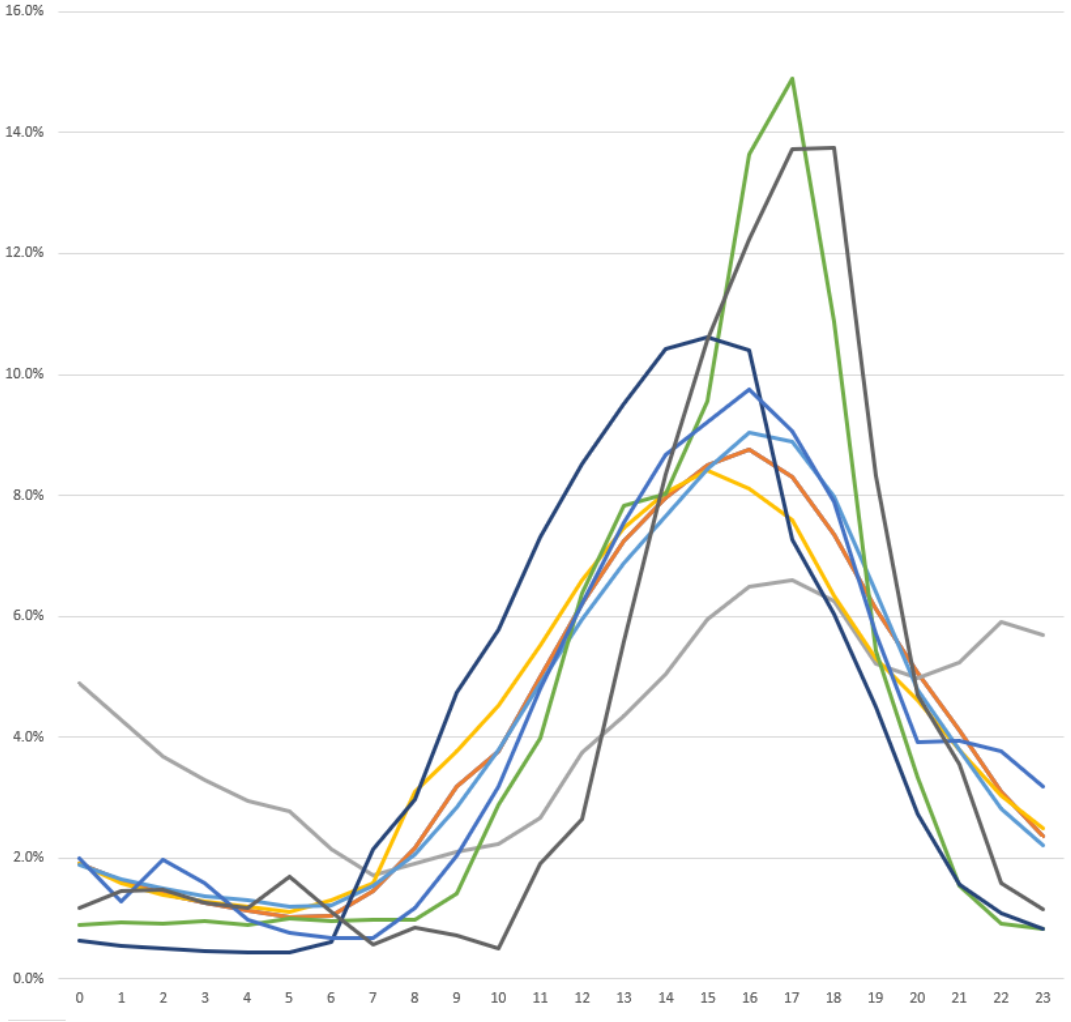


Power Demand Model

- The RBS model was enhanced by applying demand profiles that allocate annual energy usage by equipment and mode to each:
  - hour of the day
  - month of the year
  - region (8 Australian states/territories and New Zealand)

- Demand profiles were developed
  - analysing the circuit-level half-hourly energy consumption loads from 6,300 sites across Australia over two years to March 2020
  - similar data were also obtained for New Zealand

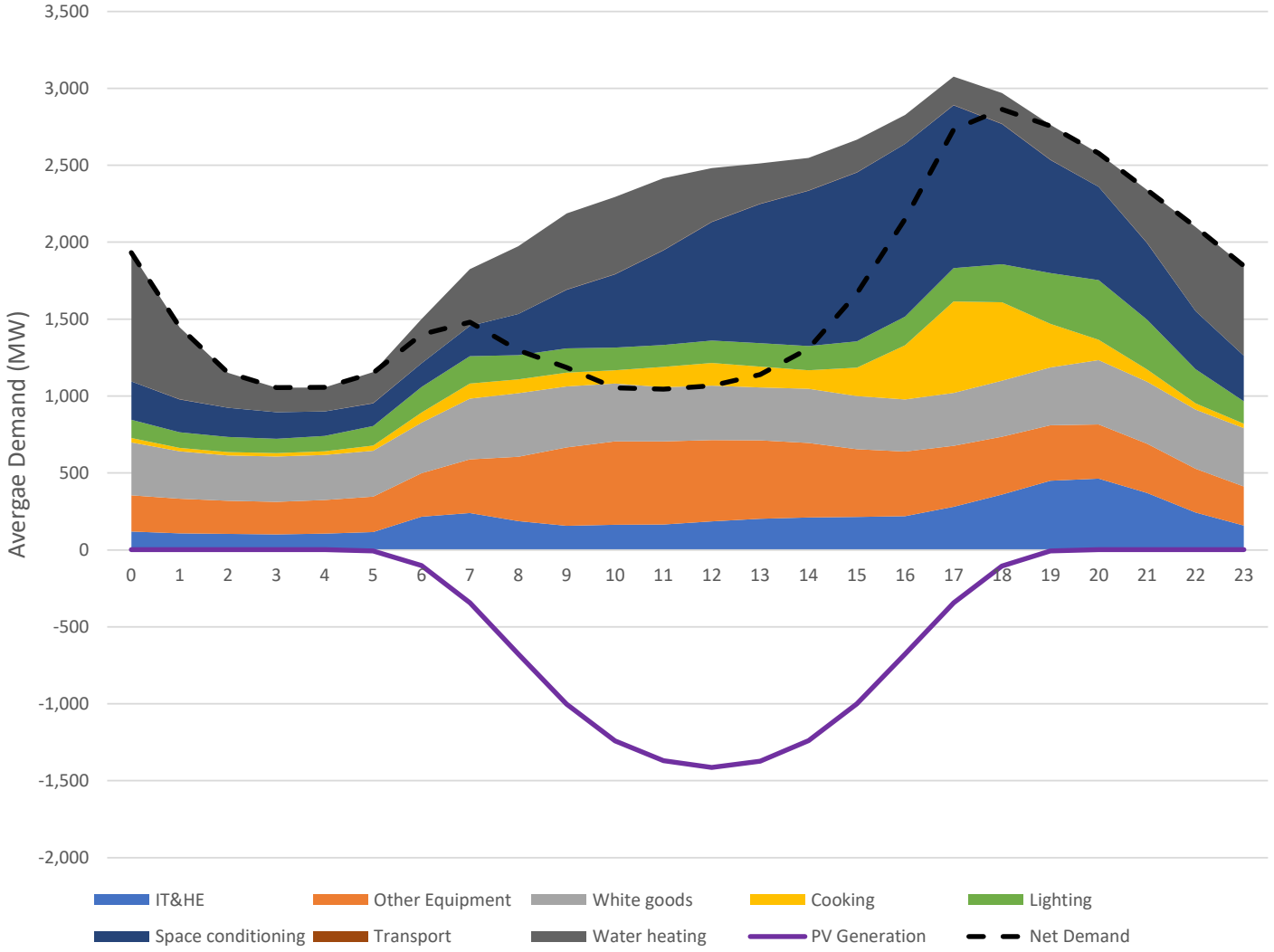
Example Profile: Non-ducted AC, Jan, Cooling mode, Weekday by region



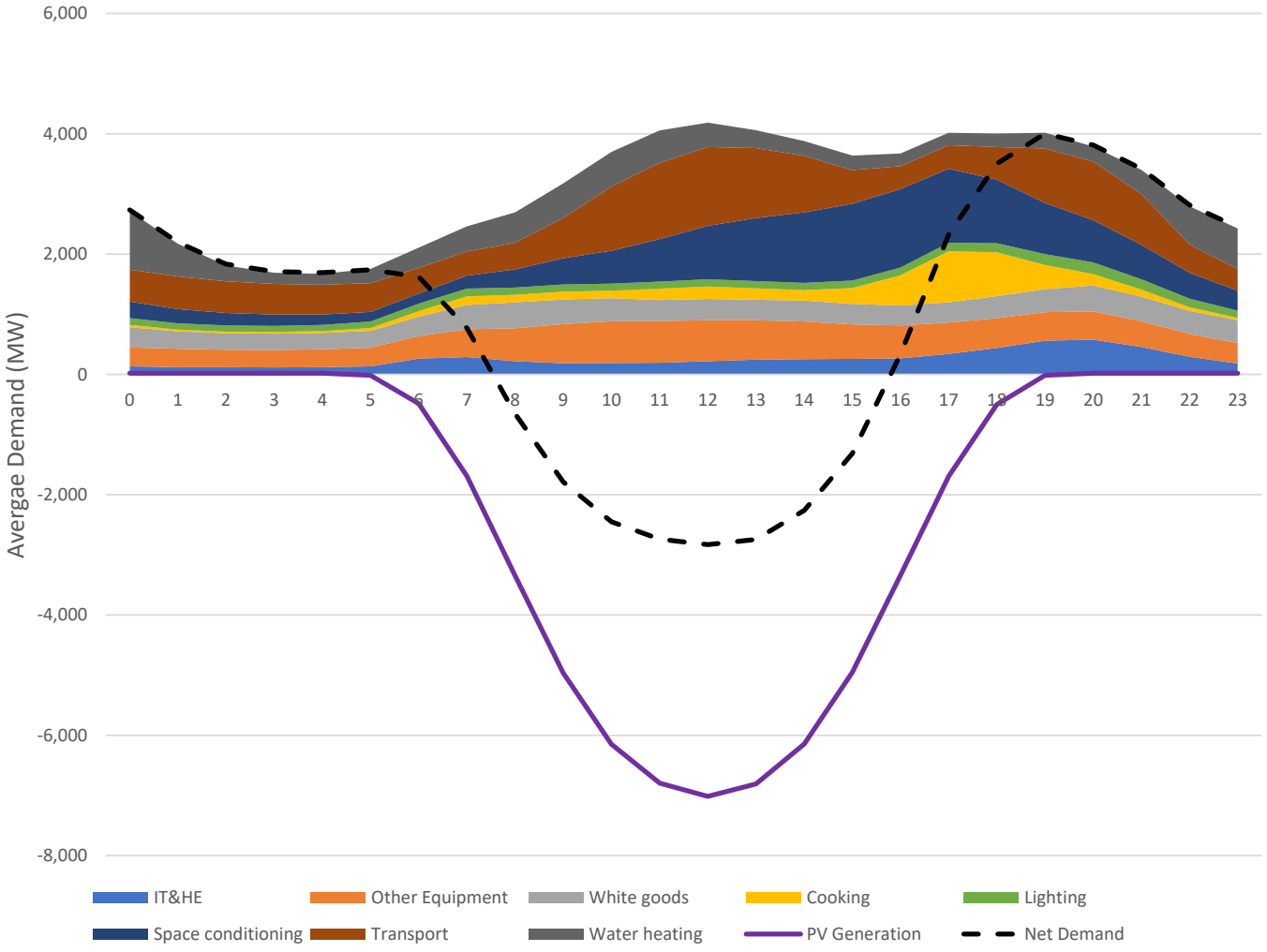
Average power

- Using the estimated proportion of average power demand for each product
- The Annual Energy Consumption (AEC) is proportioned to each typical day type (by month and week/end day) and then proportioned over the 24-hour period. The basic calculation is shown in the equation:
  - $Pwr_{R,G,M,s,d,h} = P_{s,d,h} \times AEC_{R,G,M}$
- Where:
  - AEC $_{R,G,M}$ is the annual energy consumption for mode M, product G in region R
  - *P* is the proportion of energy consumption in:
    - *s* season, from 1 and 4 (numbers represent summer, winter, autumn and spring)
    - *d* day type, from 1 and 2 (representing weekday and weekend day)
    - *h* hour of the day, from 1 to 24, representing the hours of the day
  - *Pwr* is the average energy consumption over one hour, expressed as kWh/h or kW

NSW Residential electricity demand by end-use in 2020 (summer, weekday)



NSW Residential electricity demand by end-use in 2040 (summer, weekday)



End-use demand and key flexible loads

End-use demand and key flexible loads, NSW 2040 (summer, weekday, 1900 AEST)

End-use	Key Flexible loads	End-use Demand (MW)	Load Demand (MW)
IT&HE		560	
Other Equipment		477	
	Battery chargers (mobility)		52
	Pool Pump		46
White goods		382	
	Clothes dryers		12
	Clothes washers		68
	Dishwashers		43
	Freezers		40
	Refrigerators		220
Cooking		401	
PV Generation		-15	
Lighting		179	
Space conditioning		851	
	AC ducted		348
	AC non-ducted		405
Transport		905	
	Electric Vehicle (EV) charging		905
Water heating		263	
	Electric Water heater- Med/Large		157
Total Net Demand		4,004	
Total Flexible Demand Potential			2,297

Impact of flexible demand

- Estimate the future impact of flexible demand
  - Proportion connected (PC). Over the next 15 years newly installed appliances and equipment will be network connected and enable smart control.
  - Proportion load controlled (PL). A proportion of the available average load of these connected devices will be shifted or shaved, due to user override or conditions
- Basic formula
  - Pwr controlled = Pwr * PC x PL
  - PC = 0.5, 50% of the targeted customer equipment is estimated to have a network connection in 2040
  - PL = 0.5 for load shifting and 0.2 for load shaving

Flexible demand potential

Estimated load shifted in 2040 at peak time in NSW (summer, weekday, 1900 AEST)

Load Category	Demand shifted (MW)
Battery chargers (mobility)	13
Pool Pump	12
Clothes dryers	3
Clothes washers	17
Dishwashers	11
Electric Vehicle (EV) charging	226
Electric Water heater- Med/Large	39
Total	321
% of total peak residential load	8%

Estimated load shaved in 2040 at peak time in NSW (summer, weekday, 1900 AEST)

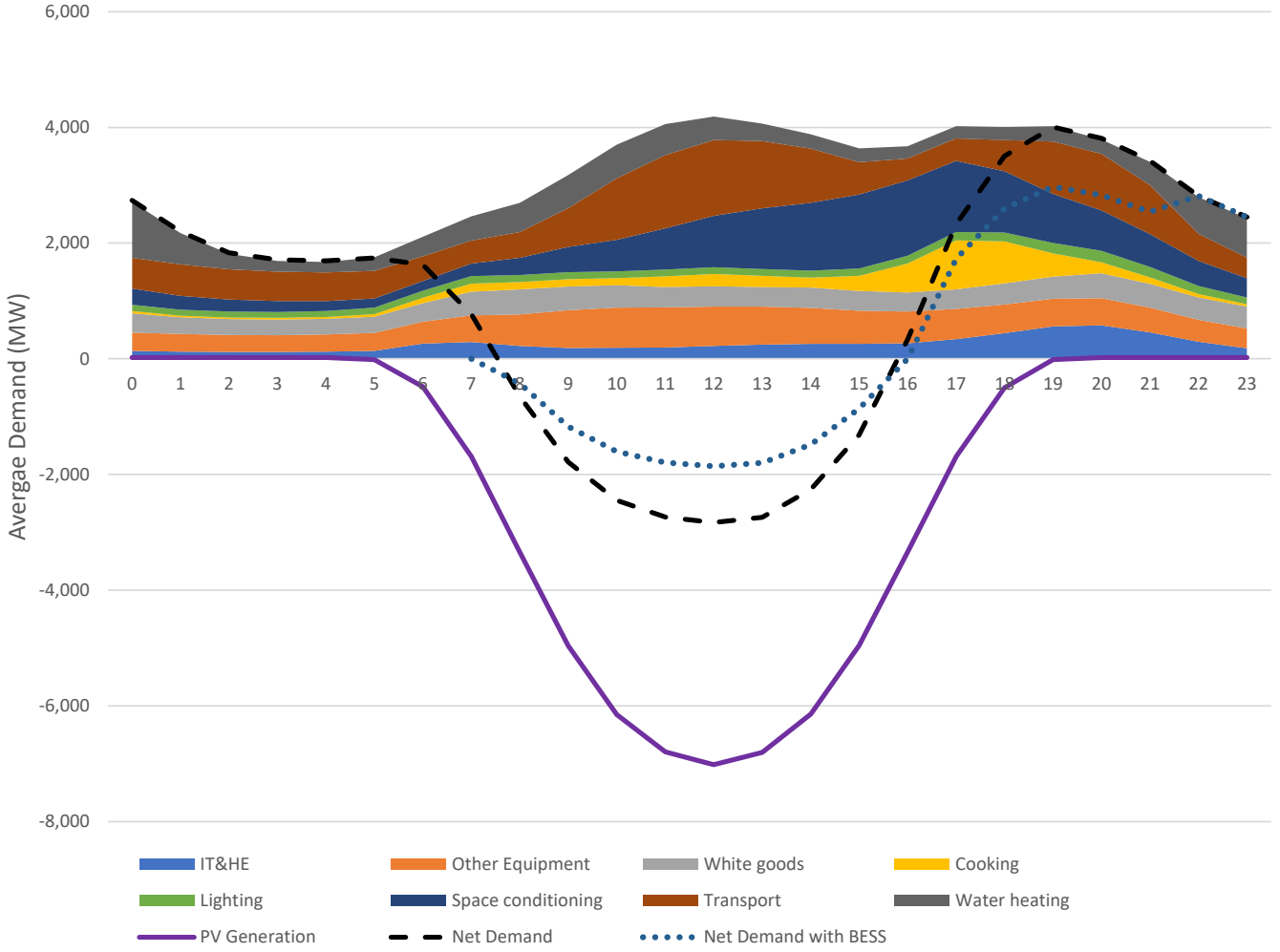
Load Category	Demand shaved (MW)
Freezers	4
Refrigerators	22
Air conditioners (AC) ducted	35
AC non-ducted	41
Total	101
% of total peak residential load	3%

Battery energy storage systems

- Very high penetration of solar PV in Australian households
  - Current installed rooftop PV capacity of 3.1 GW
- Significant contribution by BESS to flexible demand strategies
  - By 2040, projections of 2,000,000 BESS (AEMO step change scenario)
- For NSW in 2040
  - BESS is projected to be 600,000 in 2040. This represents 16% of households in NSW and would provide up to 1,000 MW of total storage capacity
  - the potential peak demand reduction at system peak (1900 AEST) would be 1,000 MW in 2040, or 26% of the peak residential demand

BESS impacts

NSW Residential electricity demand by end-use in 2040 (summer, weekday) with BESS



Conclusions

- Flexible demand potential in NSW
  - 11% of the average net residential peak demand in NSW could be reduced using conservative assumptions
- The priority loads for both peak shifting and shaving
  - Electric vehicle (EV) charging and electric water heater systems represent over 60% of the flexible demand opportunity.
  - Air conditioning is the next largest opportunity with 18%.
- BESS flexible demand strategies
  - could produce an additional 26% reduction in residential peak demand relative to the baseline case in 2040
- Enabling this flexible demand opportunity will require policies and standards to ensure new appliances such as EV chargers, air conditioners and pool pumps have demand response capabilities.