

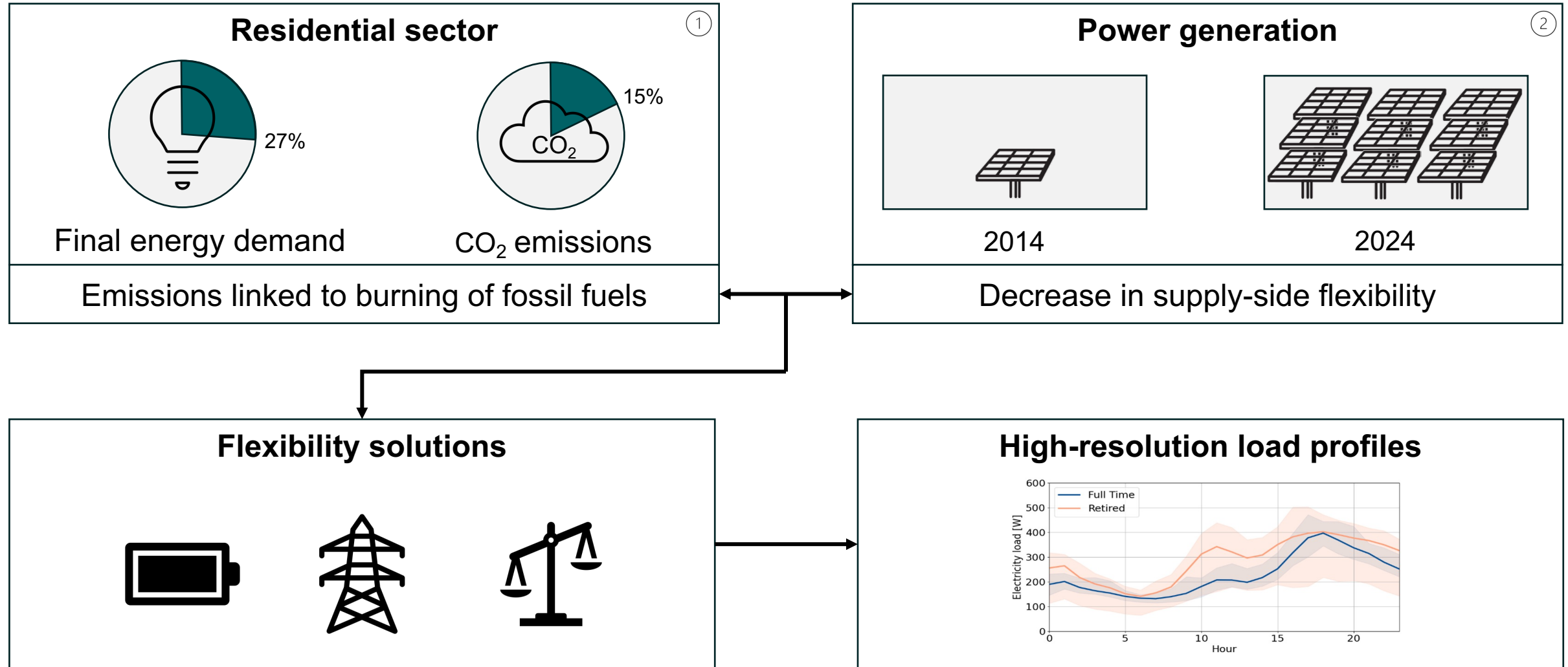


Overcoming standard load profiles: Heterogeneity and stochasticity in residential energy demand

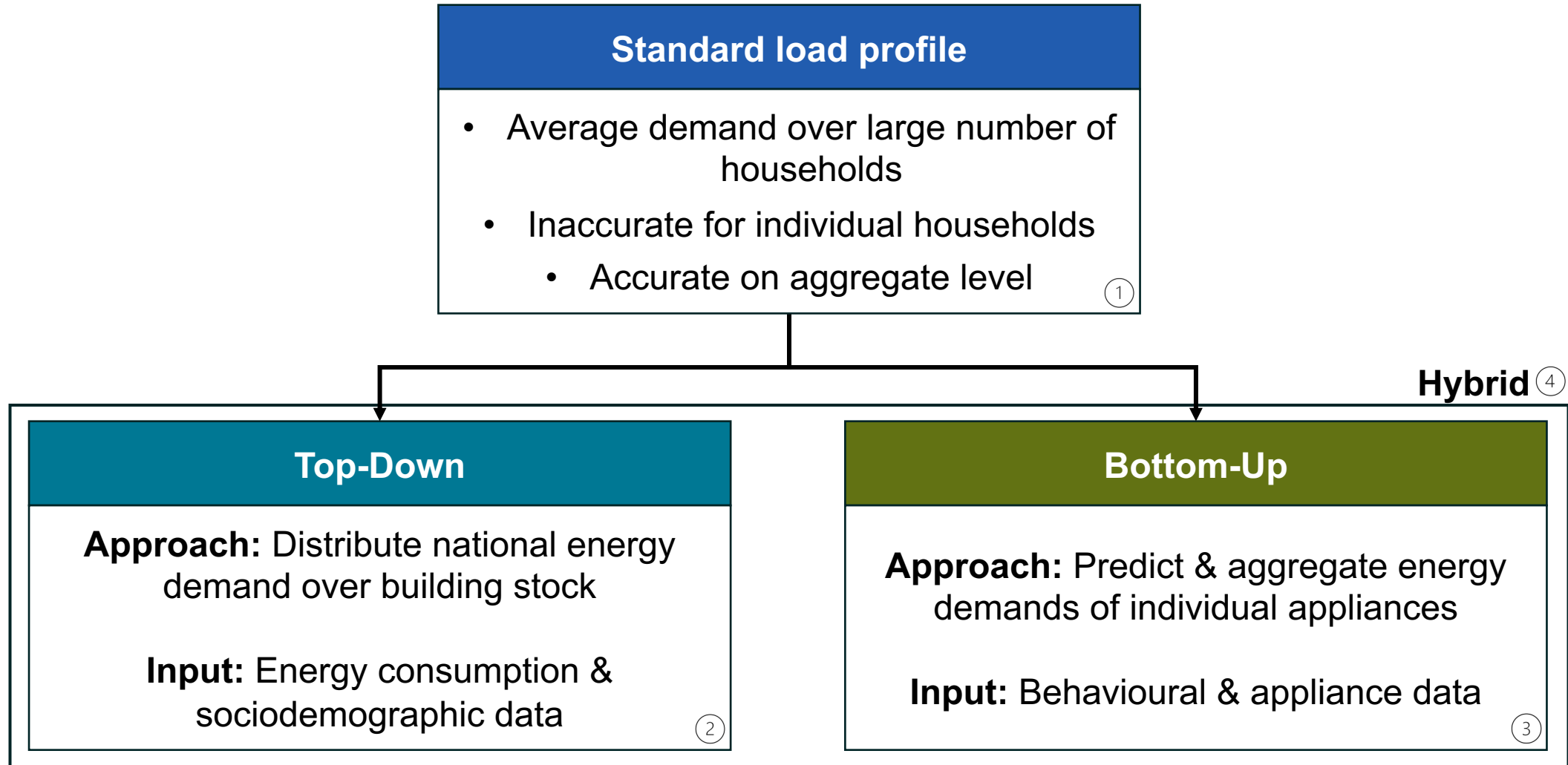
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Prof. Russell McKenna

Enerday Conference
Dresden, 04.04.2025

Why do we need a better understanding of residential energy demand?



Predicting residential energy demand



Residential energy demand models

Study	Osman 2023	Anvari 2022	Maria 2022	Chen 2022	Pflugradt 2022	McKenna 2016	Fischer 2016	This project
	✓	✓	✓	✓	✓	✓	✓	✓
	✓			✓	✓	✓	✓	✓
				✓		✓	✓	✓
Stochasticity	✓	✓	✓	✓		✓	✓	✓
Heterogeneity	—		—	—		—	—	✓
								✓

Project aim

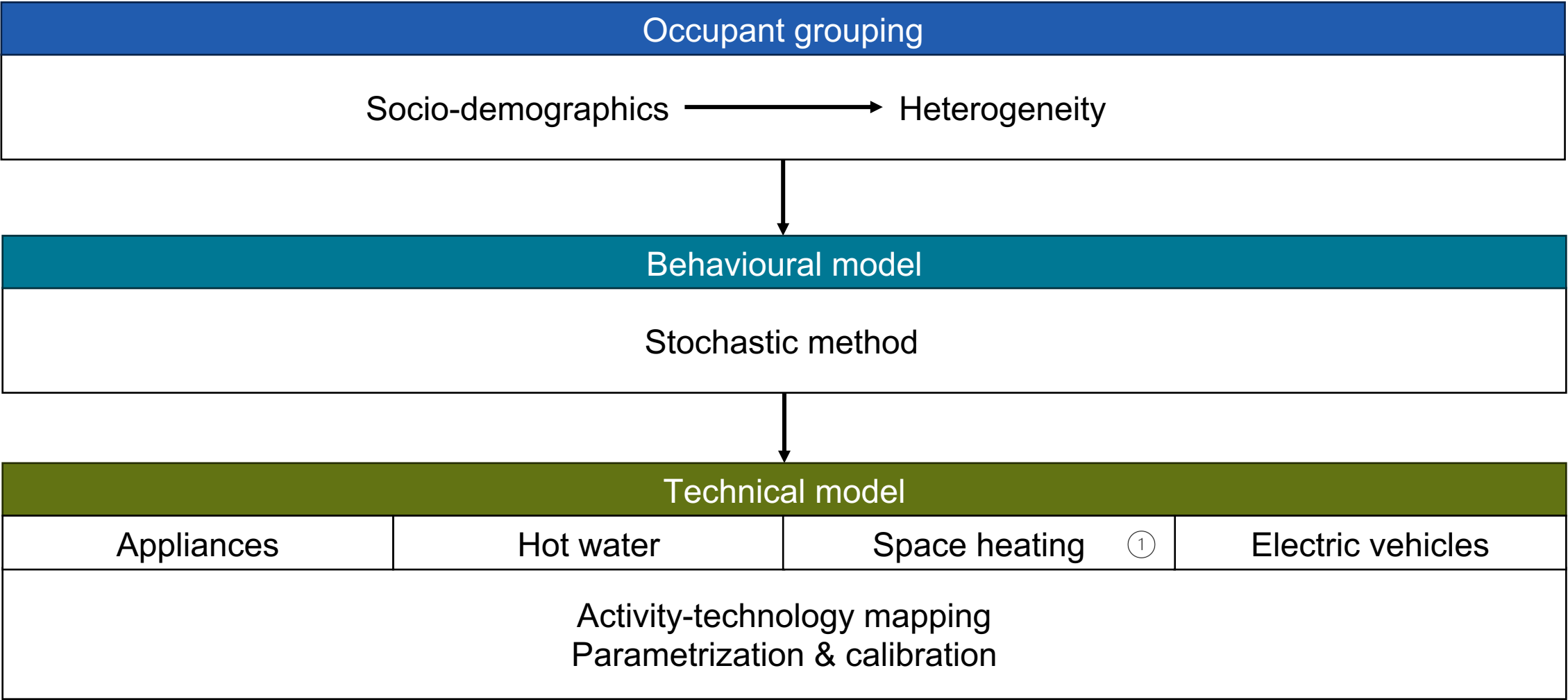
Create integrated stochastic load profiles for residential buildings

Objectives

- Introduce heterogeneity between occupant groups
- Integrate impact from electric vehicles on residential energy demand



Project overview



Swiss Time Use Survey 2024

- Format:
 - Questionnaire → Occupant grouping
 - Diary → Behavioural model
- Granularity: 29 activities
- Survey size: 1,318 participants
- Survey period: 28 days



Occupant grouping & activity data preparation

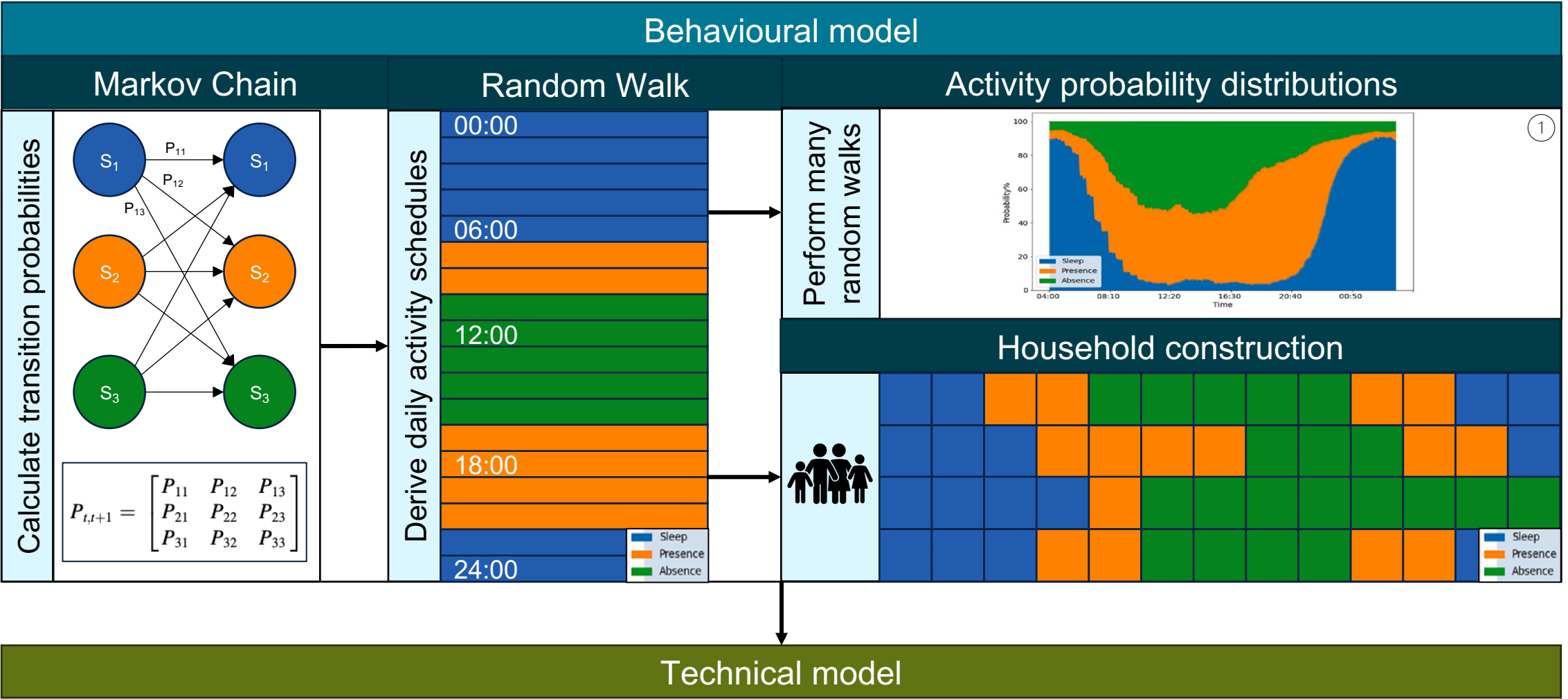
Occupant grouping							
Working age						Retired	Underage
Children			No children				
Full time	Half time	Unemployed	Full time	Half time	Unemployed		
8 occupant groups							

Activity data preparation	
Presence	Cooking
Absence	Work/Study
Sleeping	Cleaning
Hygiene	Digital leisure
• 10-minute resolution • Split between weekdays & weekends	
8 household activities	

Behavioural model

Technical model

Behavioural model

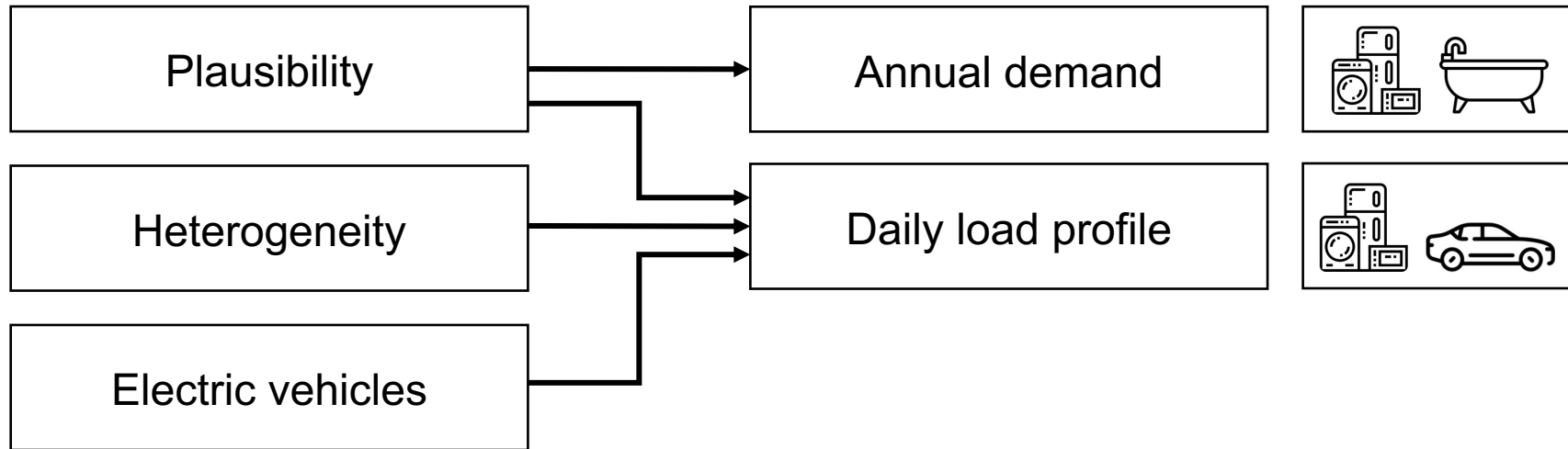


Technical model overview

Technical model			
Appliances	Hot water	Space heating	Electric vehicles
• Link: Activity-technology mapping • Drivers: Specific energy consumption, use probability			• Link: Active presence • Drivers: Ambient irradiance
Appliances	Hot water	Space heating ①	Electric vehicles
• Link: Swiss building archetypes • Drivers: Ambient temperature, insulation levels			
Appliances	Hot water	Space heating	Electric vehicles
• Link: Arrival time • Drivers: Commuting distance, vehicle efficiency, charging speed			

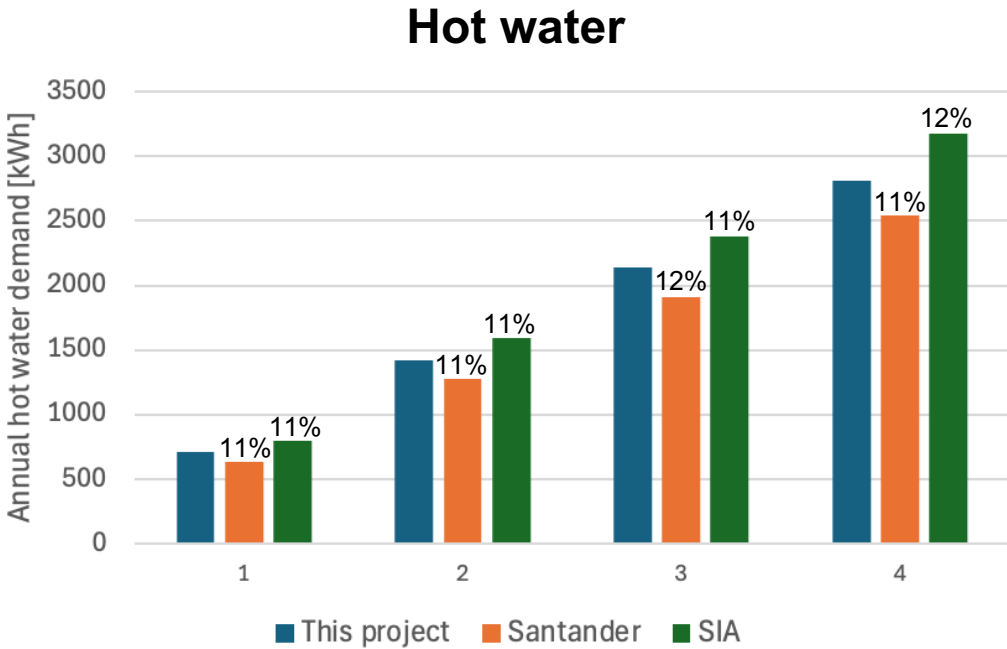
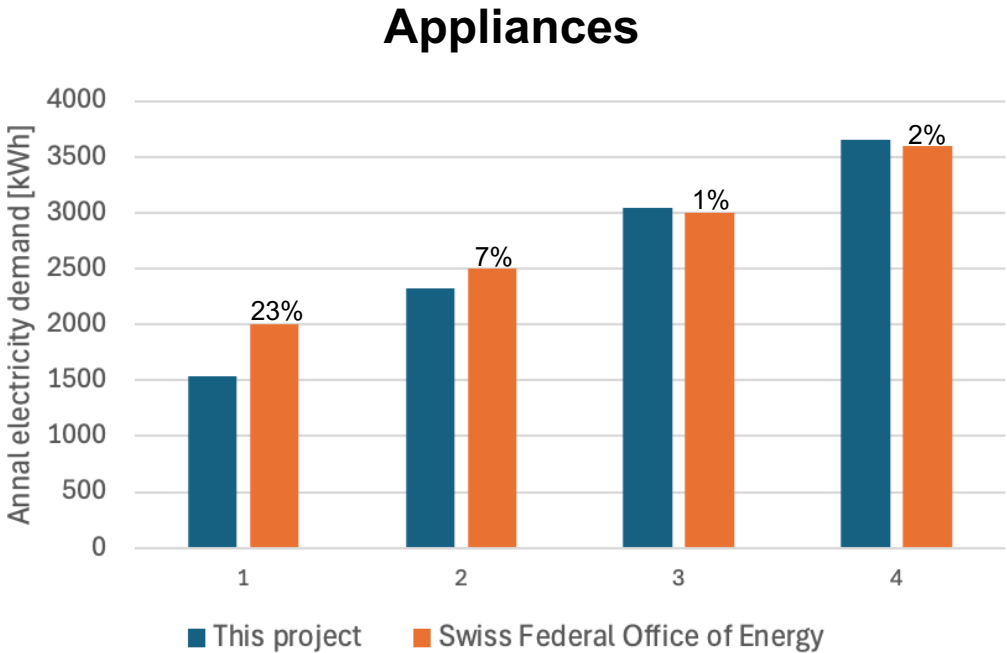


Results overview

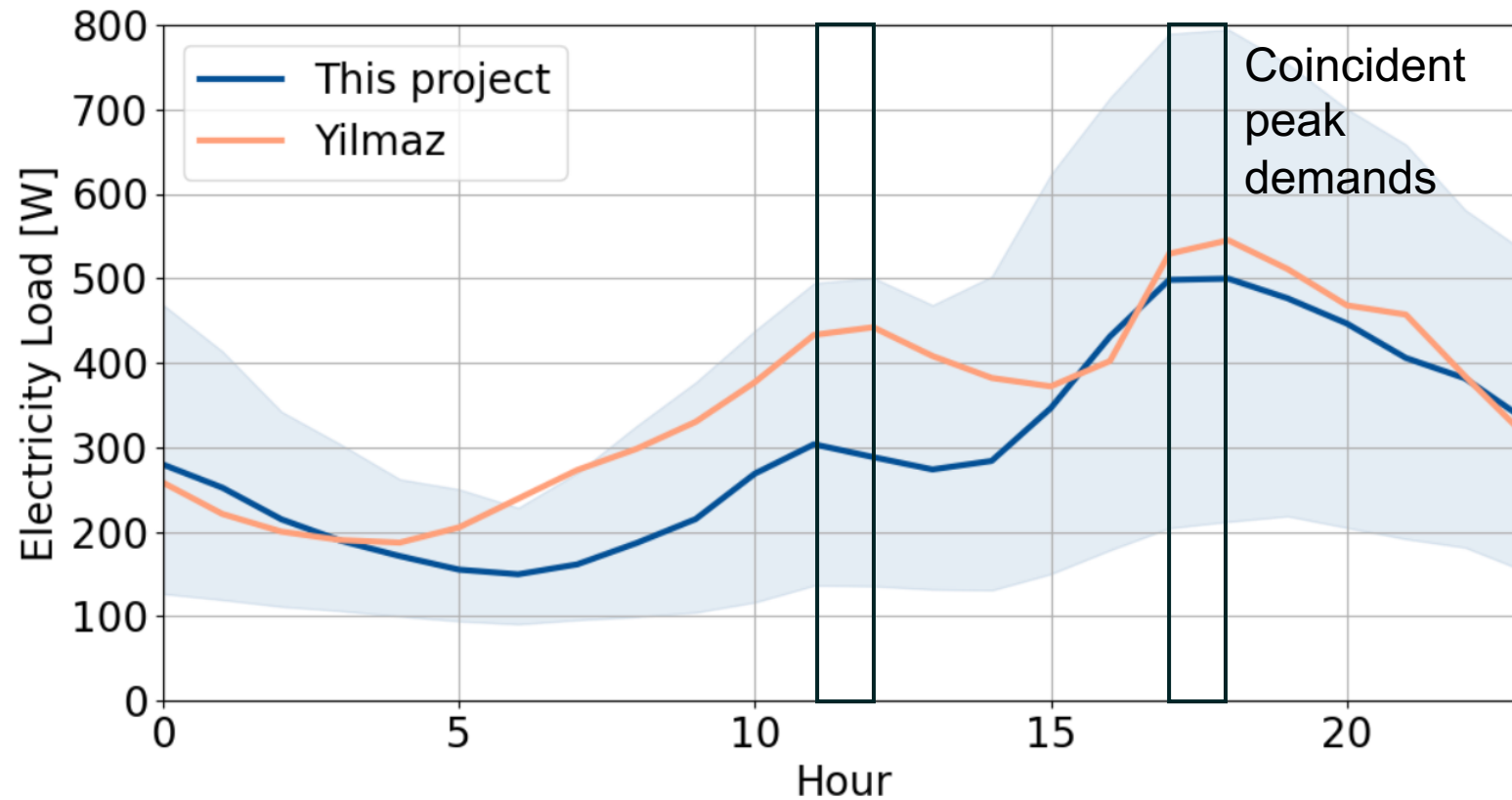


- All results based on 100 households' annual demand predictions
 - Thick lines: Mean over all households
 - Shaded areas: Range of predicted demands

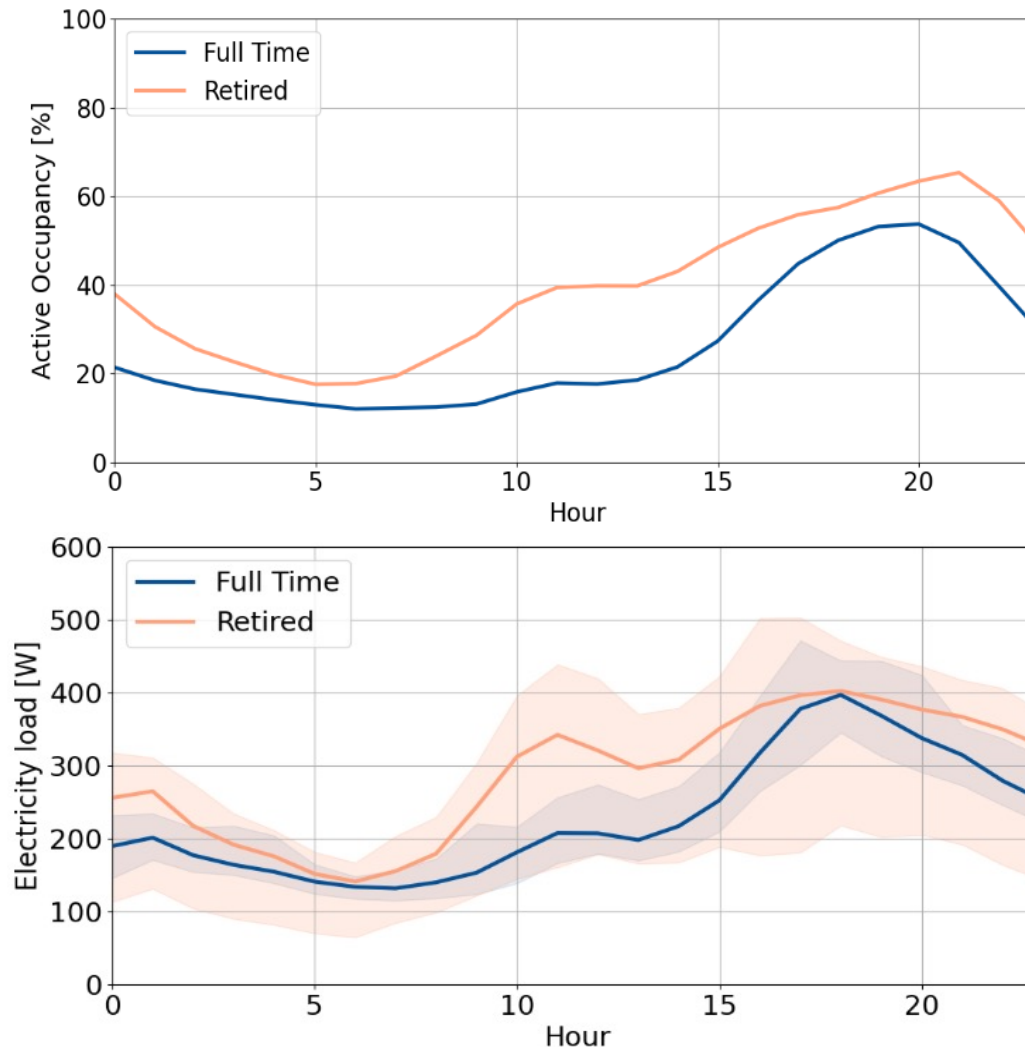
Close alignment between modeled and observed annual demands



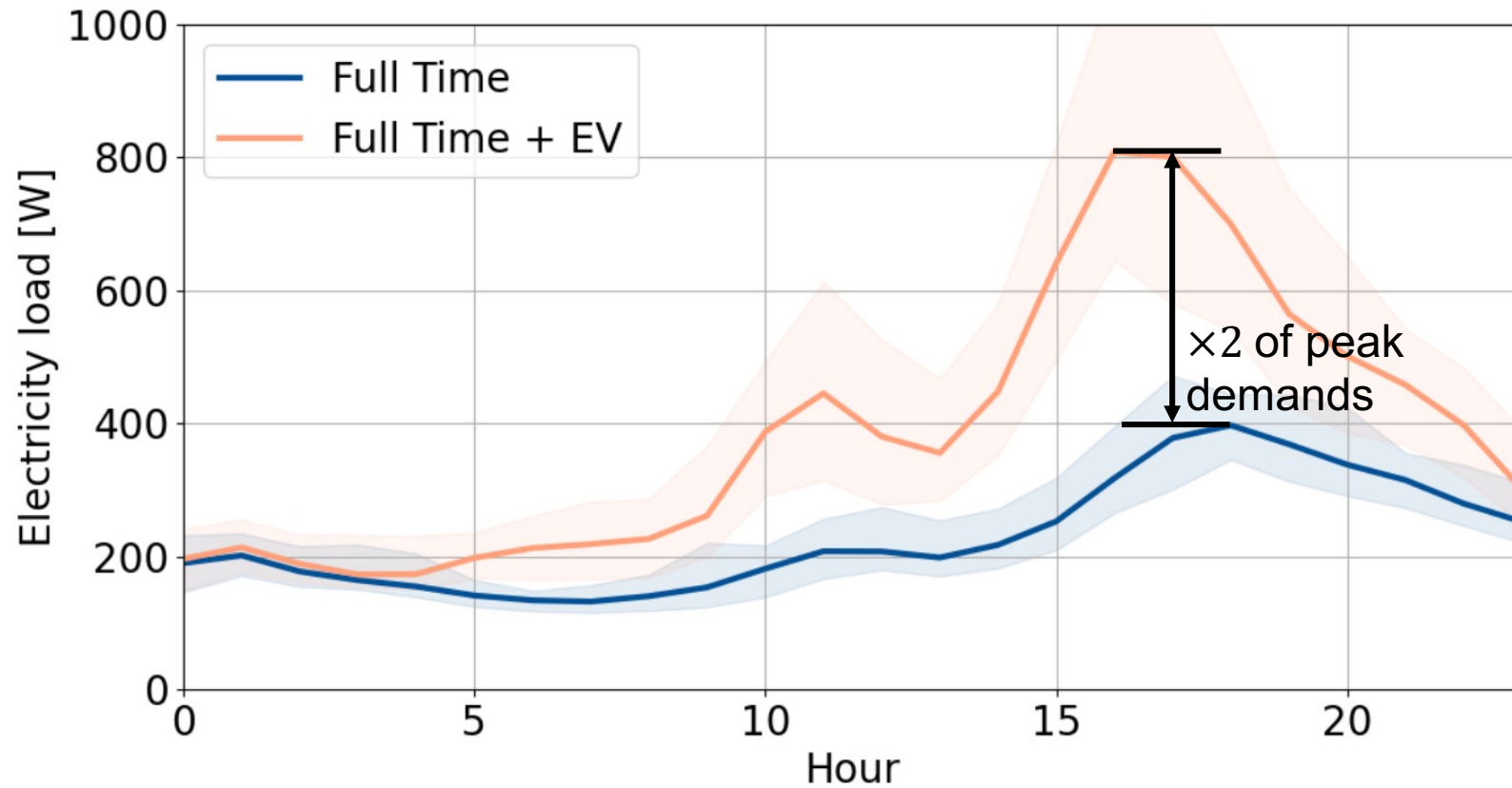
Similar daily load profile shapes



Household heterogeneity leads to significant demand differences



Electric vehicles double residential peak demands



Summary, limitations & further research

Summary

Validation

- Annual demands & daily profile in line with measured data

Findings

- Heterogeneity leads to significant demand differences
- Electric vehicles double peak demands

Limitations

- Use of German Time Use Survey (TUS) for children

Further research

- Further integration of space heating model
- Comparison of EV demands with Swiss mobility studies



Discussion

Bibliography

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