

Utilising time of use surveys to predict water demand profiles of residential building stocks: Irish case study for domestic hot water



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electricity research centre



□ Energy and environmental performance of EU buildings:

□ EU 20/20/20

□ EPBD Directive 2010/31/EU

□ Integration of renewable energy sources?

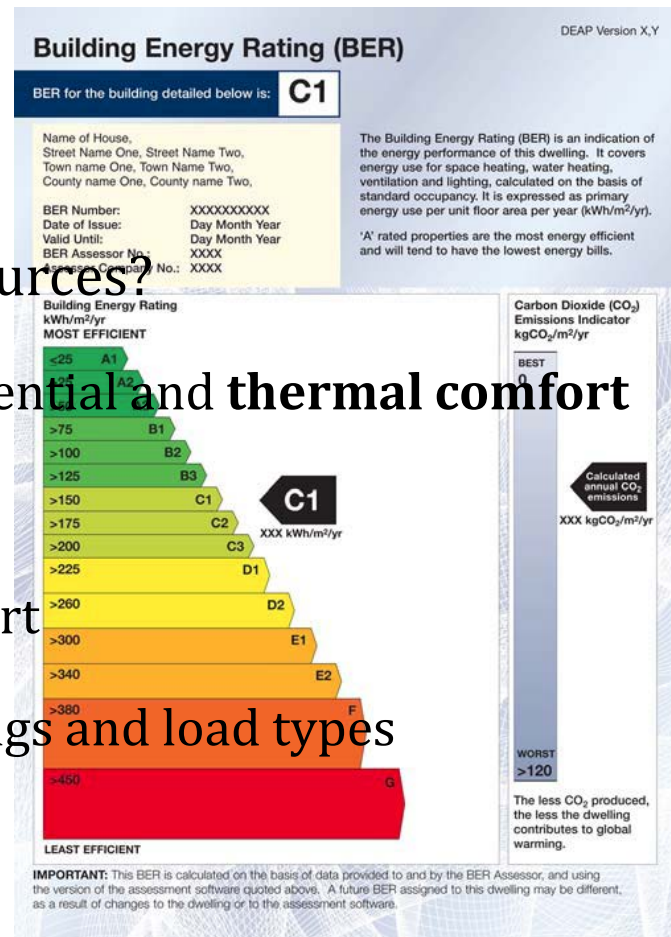
→ Assess **electrical load shifting potential** and **thermal comfort**

□ Electrical load output

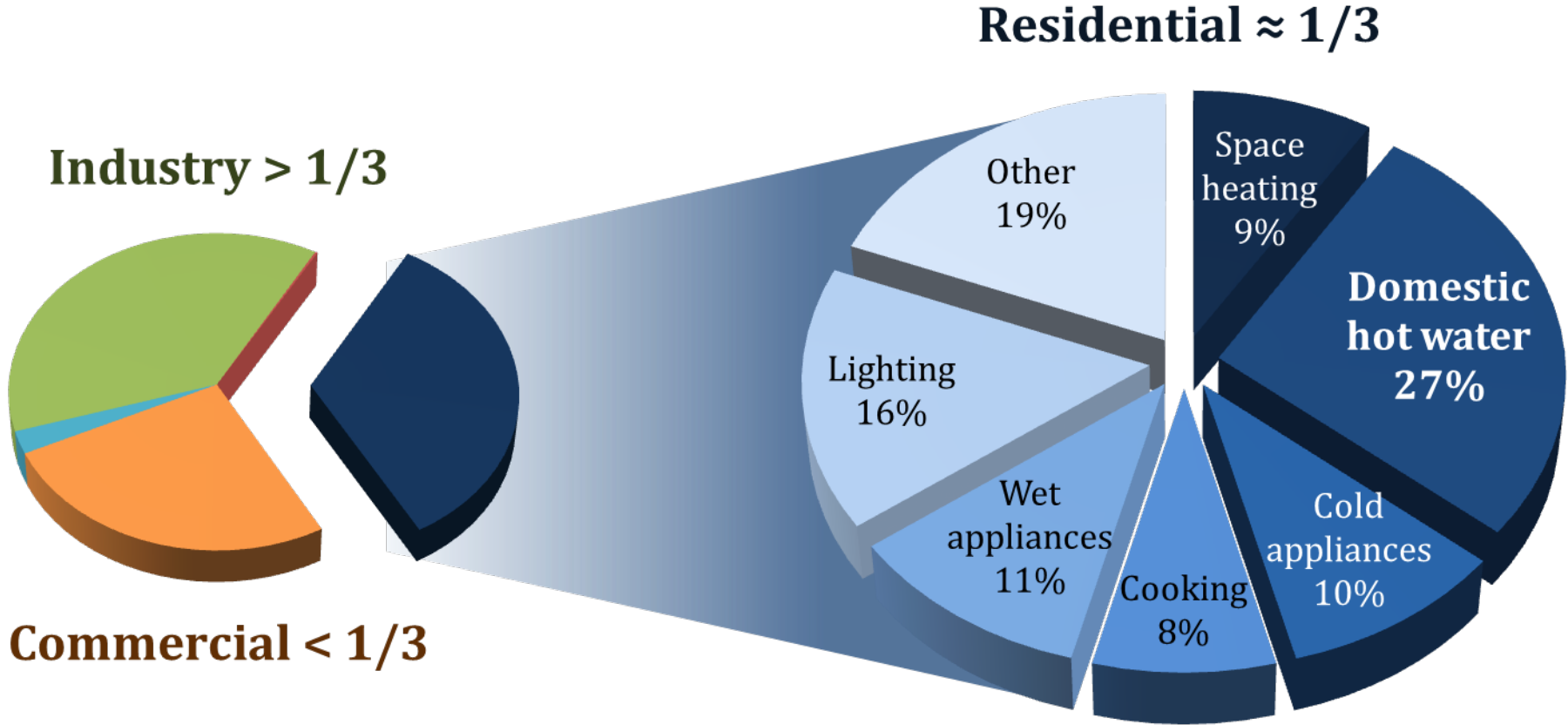
□ Parameters affecting thermal comfort

□ Representative of a group of dwellings and load types

□ High space & time resolutions



Residential electricity end-use: Irish case study



Source: SEAI, 2013

- EPBD reference dwellings → building **archetype** models

- Building archetype definition:

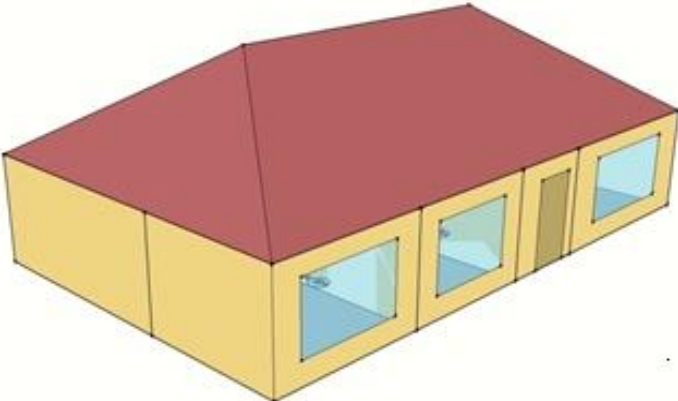
- Form
 - Envelope
 - System
- } EPBD reference dwellings

- **Operational data (high space & time resolutions)**

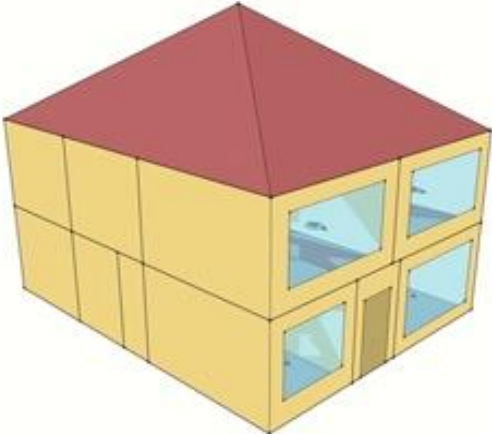
- **Occupancy & activity**
 - **Domestic hot water demand**
 - Electrical equipment use
 - Natural ventilation
- } **Time-of-Use Survey (TUS) activity data**

EPBD Irish reference dwellings

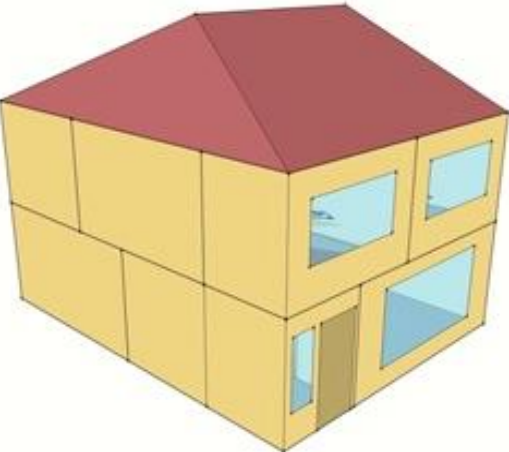
Bungalow



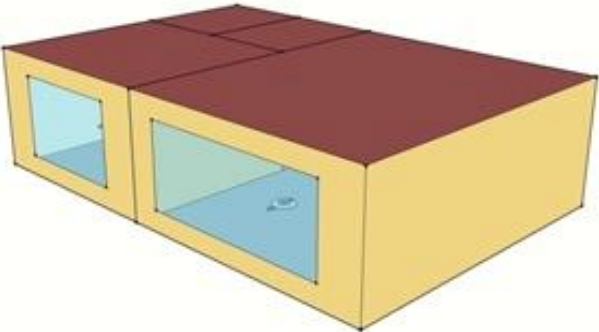
Detached



Semi-
Detached



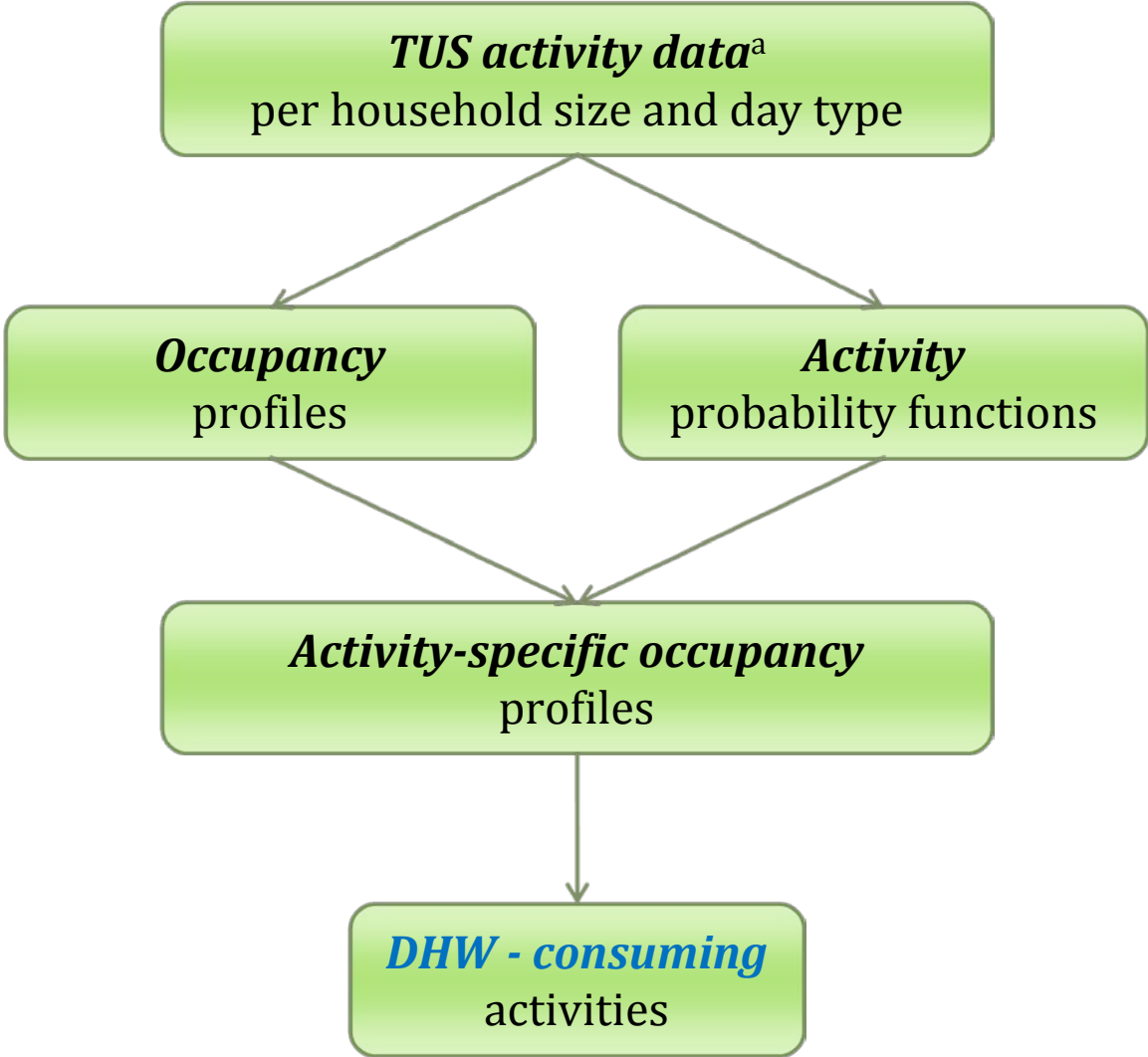
Apartments



Operational data: household size and DHW consumption

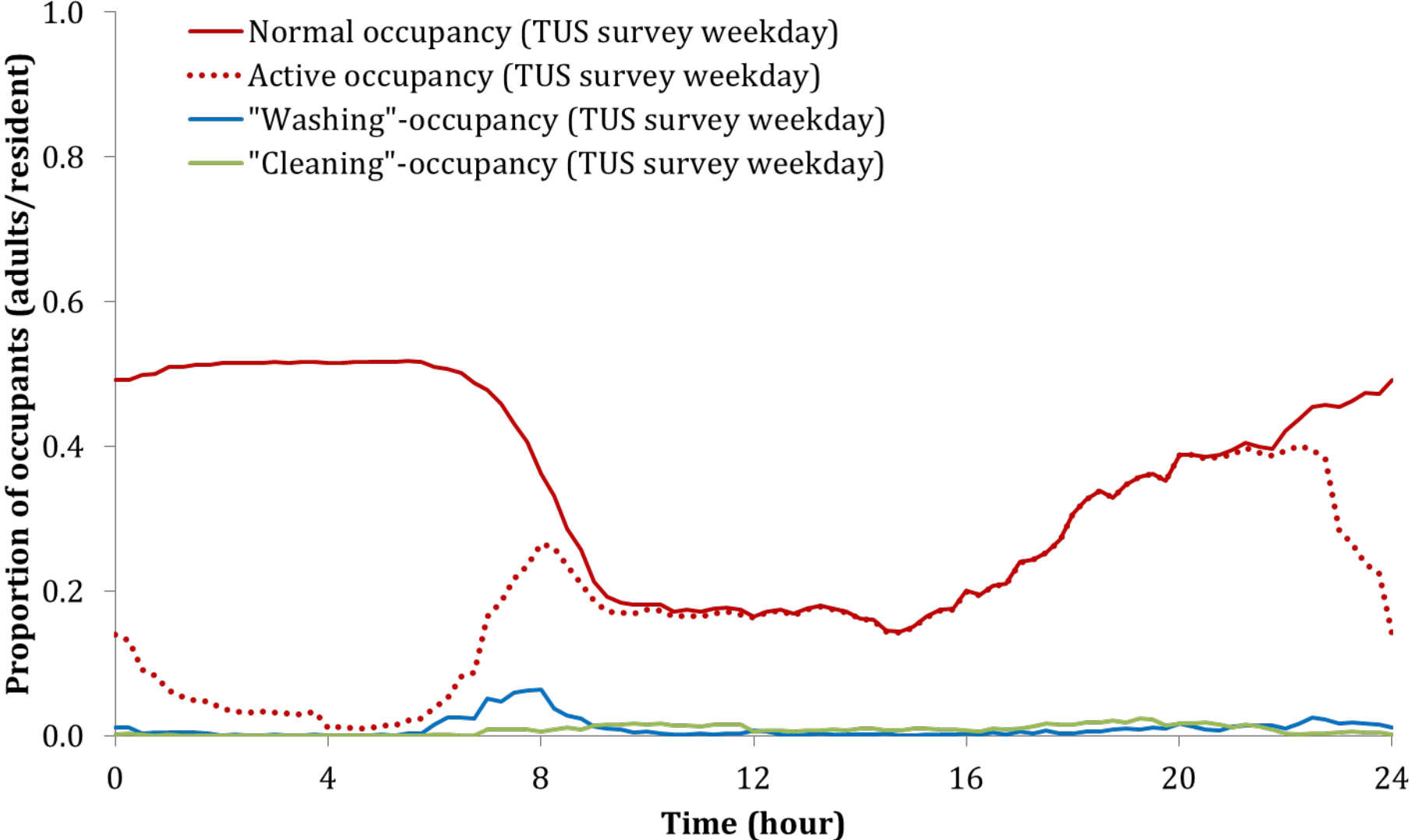
Dwelling type	EnergyPlus		DEAP	
	Household size	DHW consumption (L/day-resident)	Household size	DHW consumption (L/day-resident)
Bungalow	3	37.0	3.0	35.2
Detached	≥4	32.3	4.4	32.4
Semi-detached	3	37.0	3.6	33.8
Flats	2	43.0	1.7	42.7
National average	3.4	36.6	3.4	35.0

- Variations of DHW consumption:
 - Monthly → UK SAP 2009
 - Weekly → IEA SHC, Task 26
 - Daily → TUS survey activity data

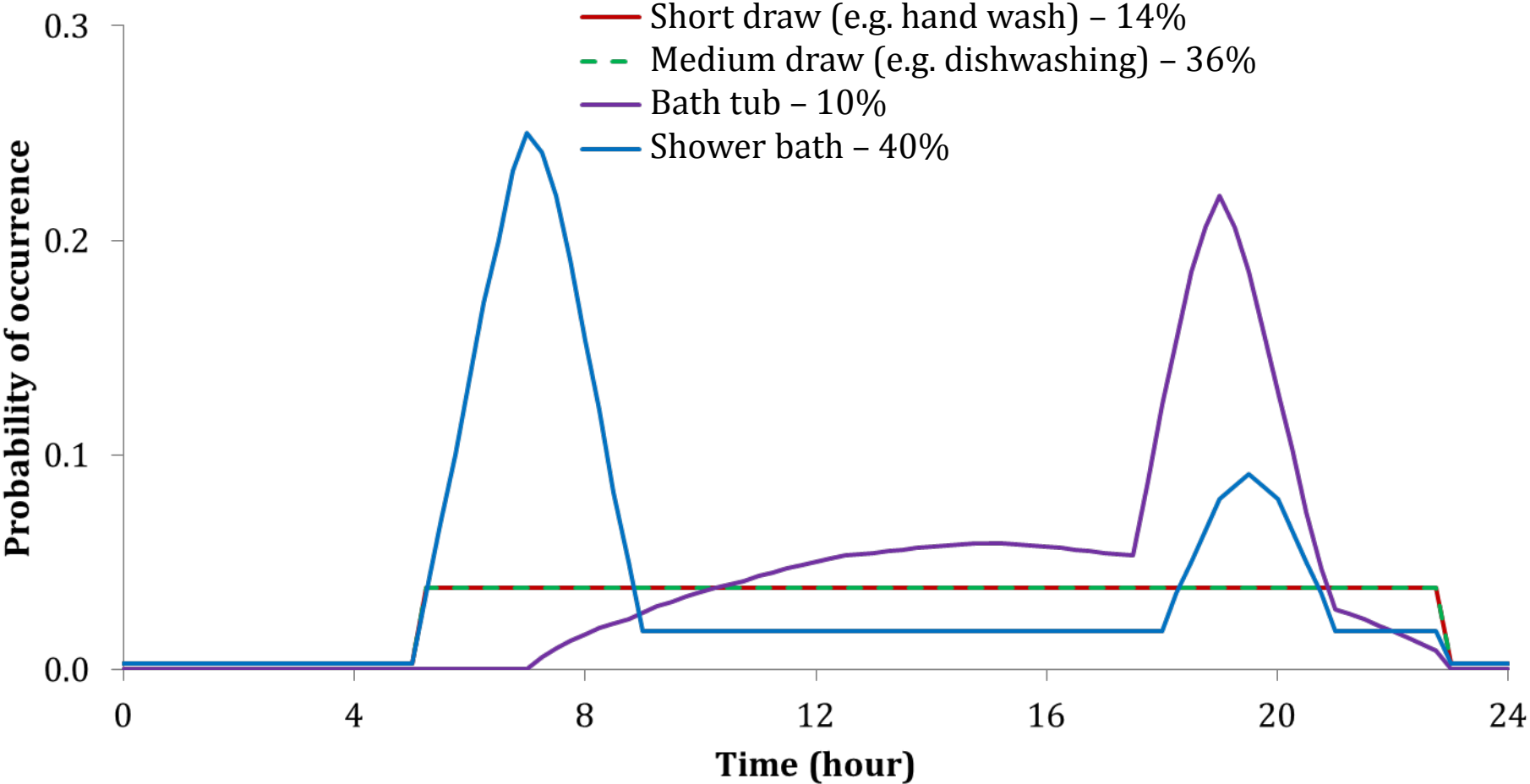


^a ESRI, Time-Use Survey In Ireland 2005

Operational data: activity-specific occupancy profiles

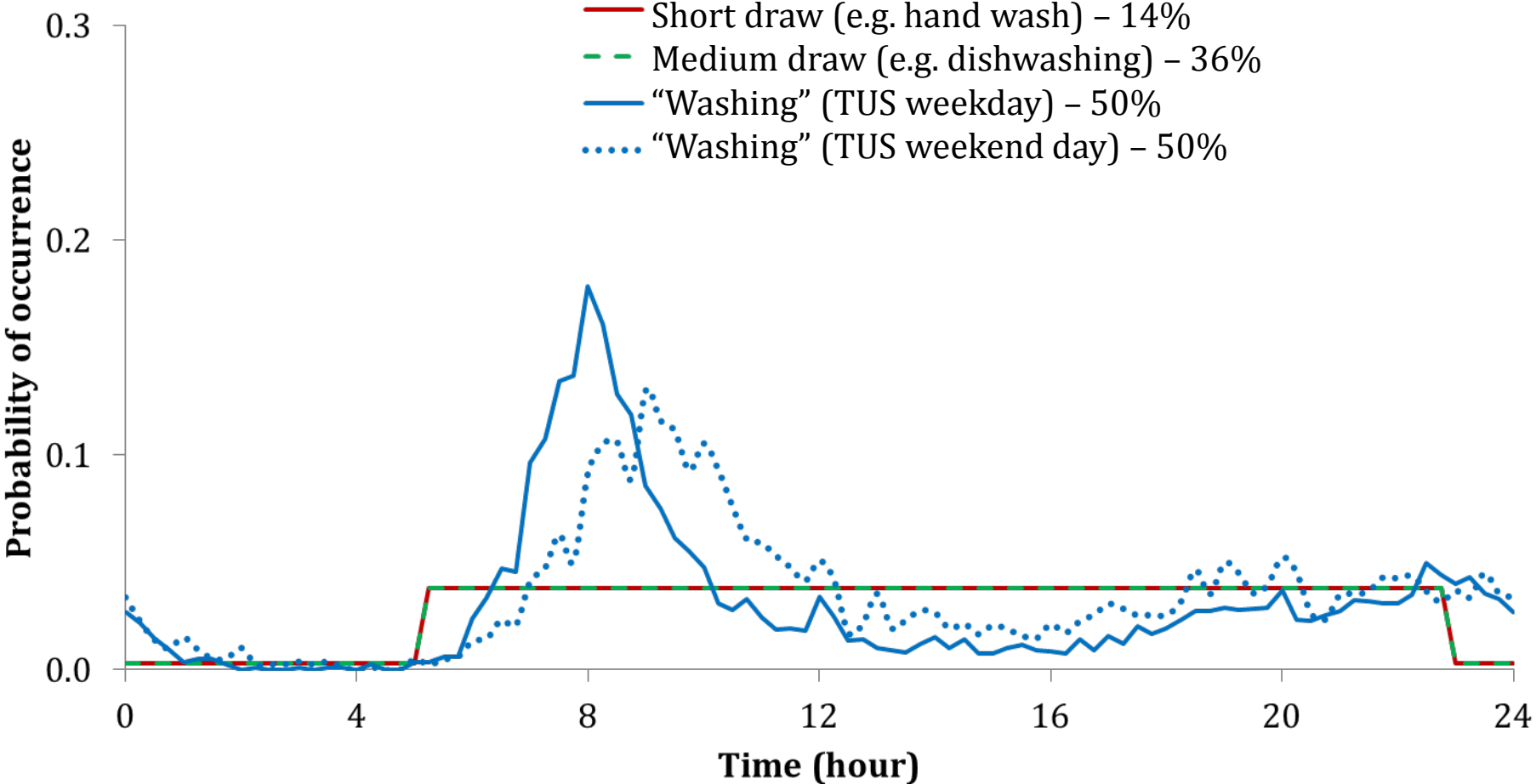


Generic probability distribution of DHW draw categories



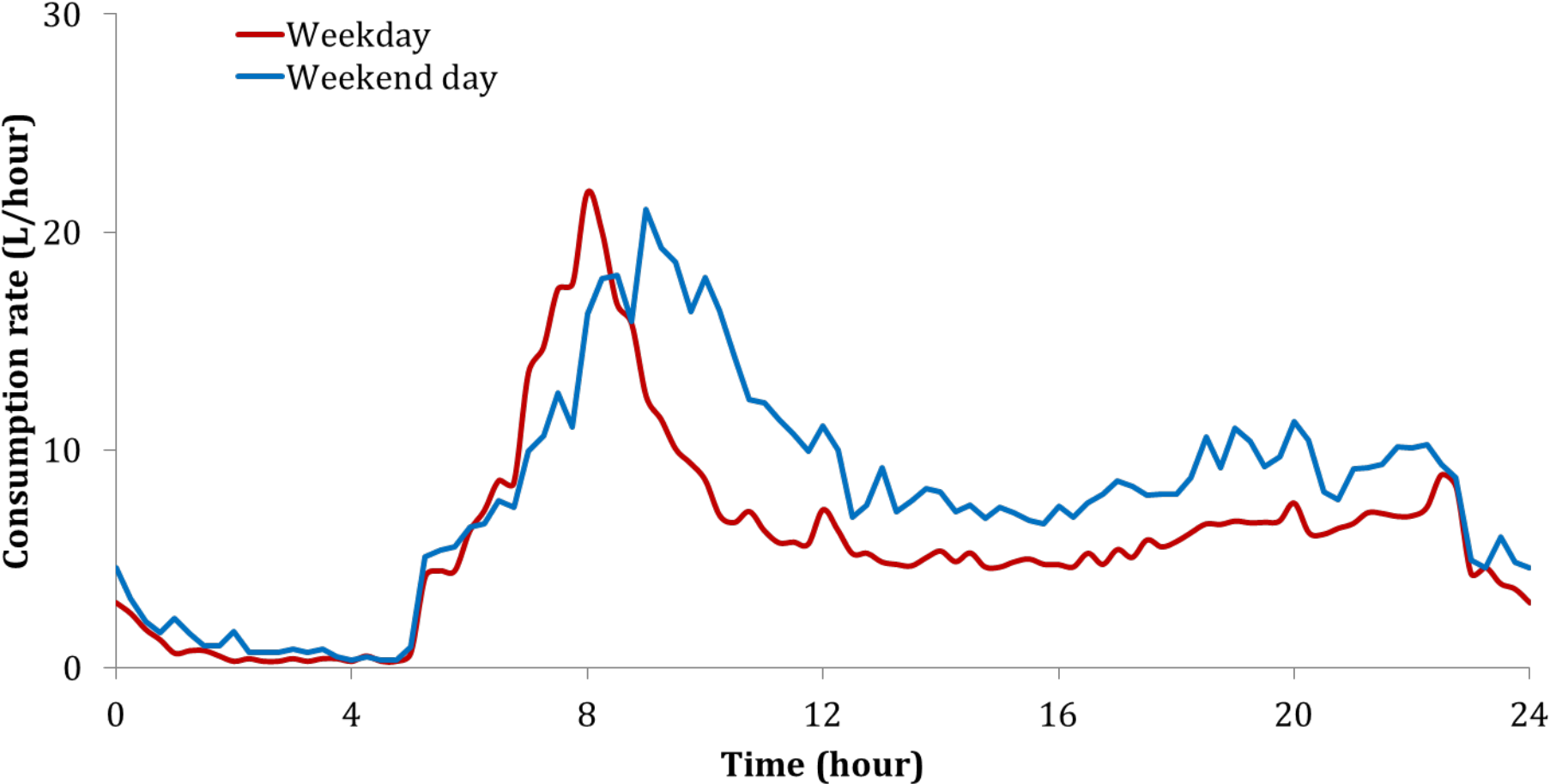
Source: Jordan & Vajen, 2011

Tailored probability distribution of DHW draw categories

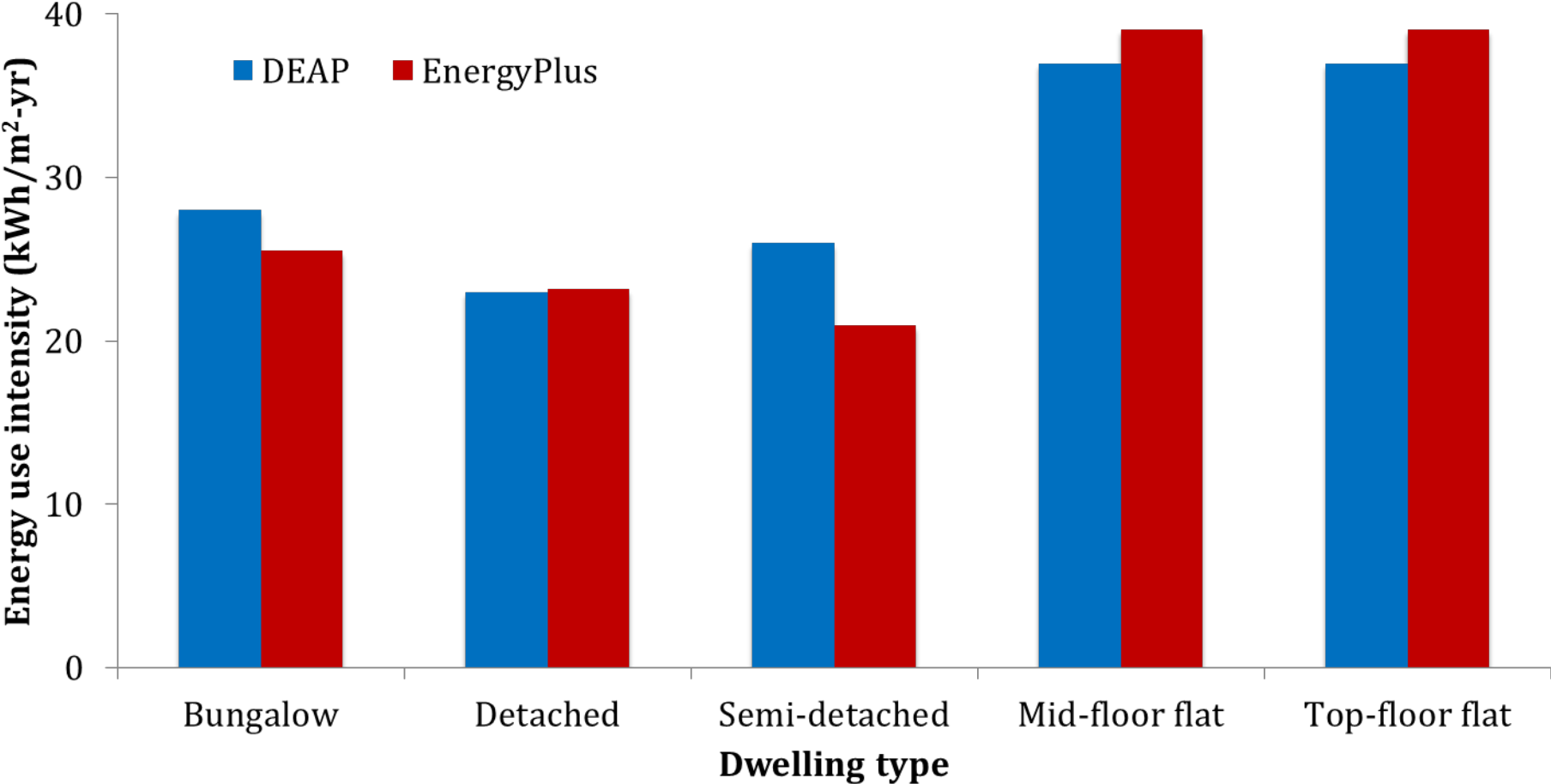


Source: Jordan & Vajen, 2011

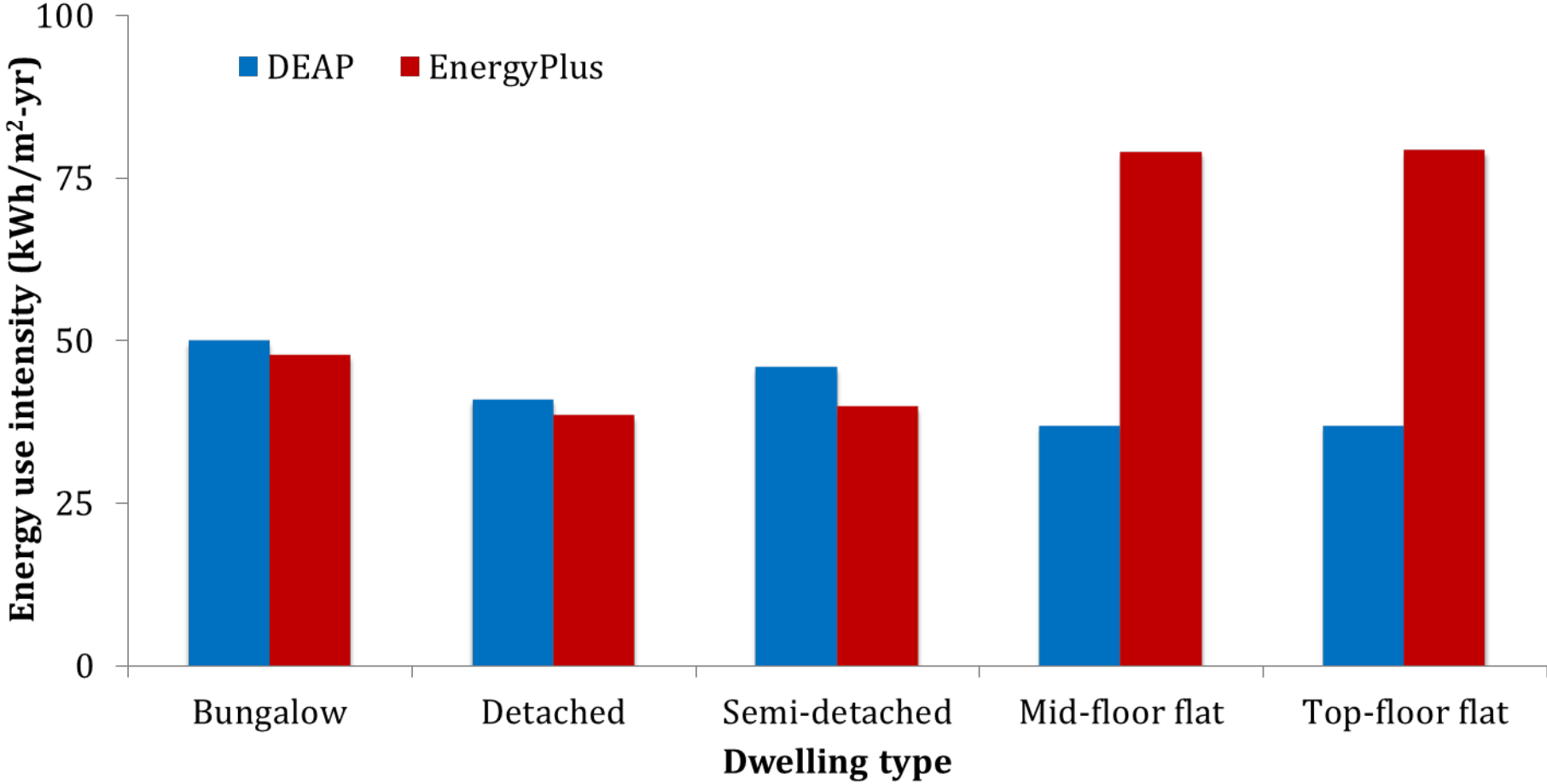
DHW daily consumption



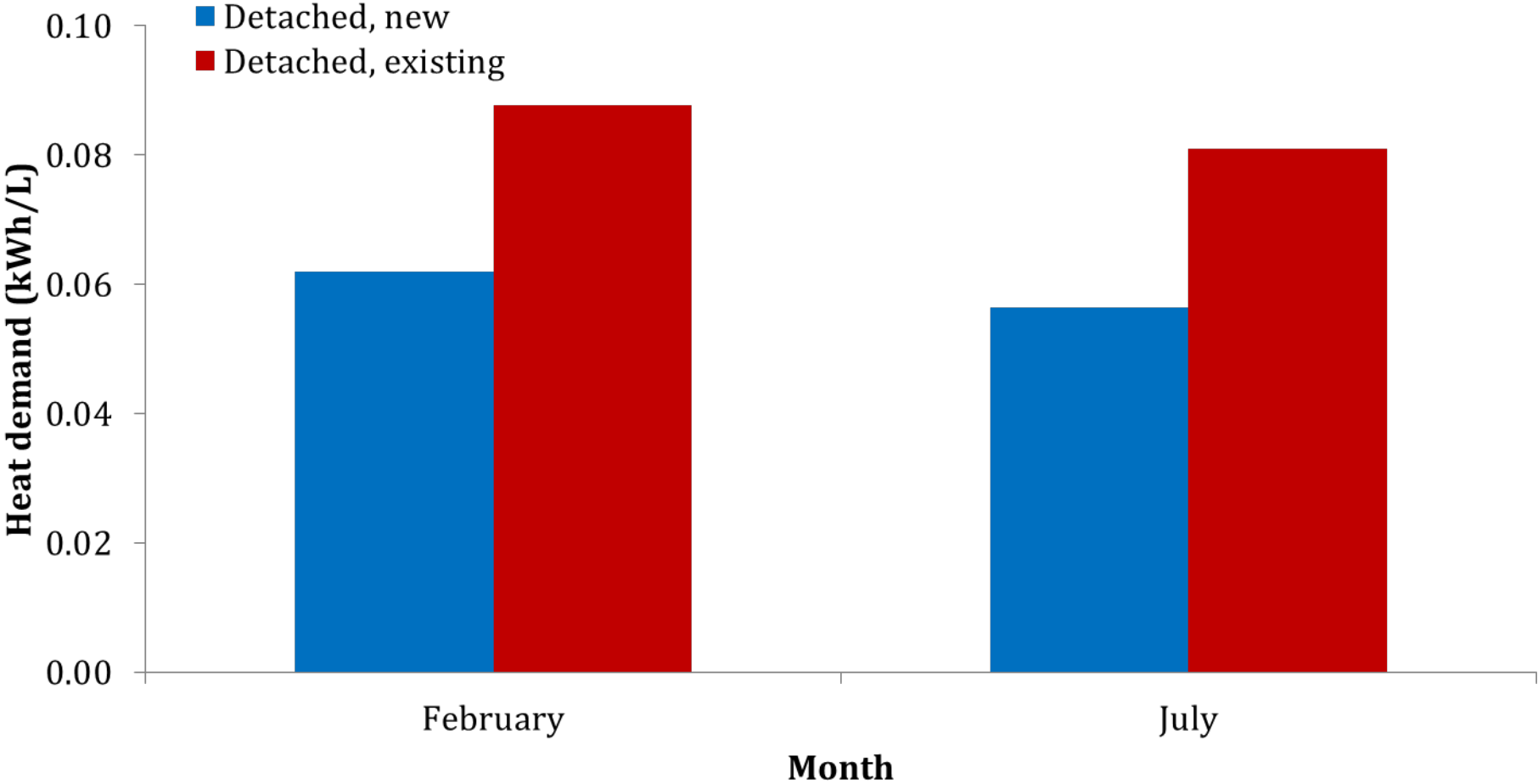
DHW annual energy use intensity: new dwellings



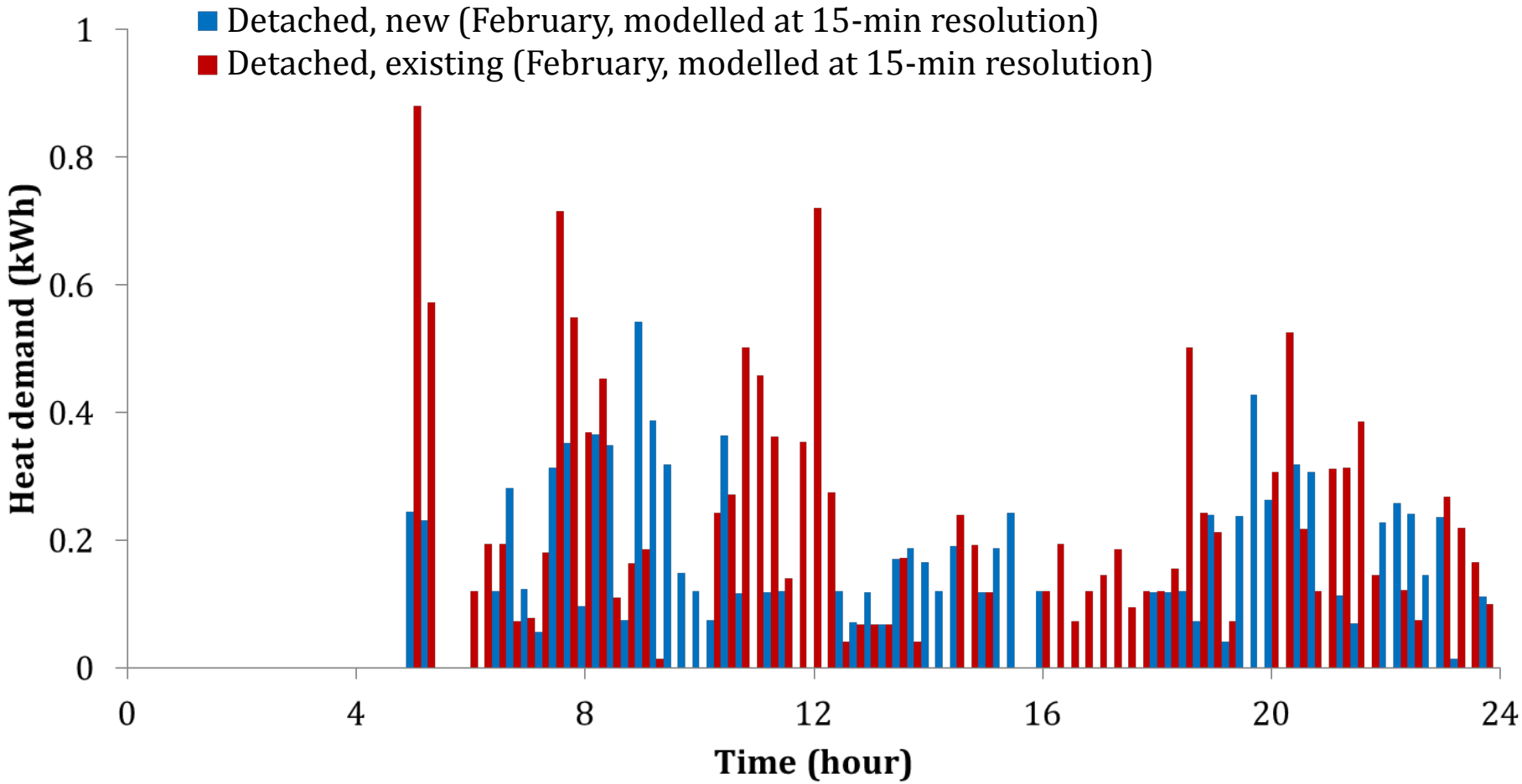
DHW annual energy use intensity: existing dwellings



Average daily heat demand for DHW heating



Average daily heat demand profiles for DHW heating



- Methodology to predict **DHW consumption**, based on **TUS data**
- Verification of annual EUI against EPBD standard assessment
- **Variations** of energy performance at **national scale**, at a **sub-hourly level**

- **Resolution** of the TUS data used
- **Electrification** of water heating systems
- Assessment of the **flexibility** resource at national scale

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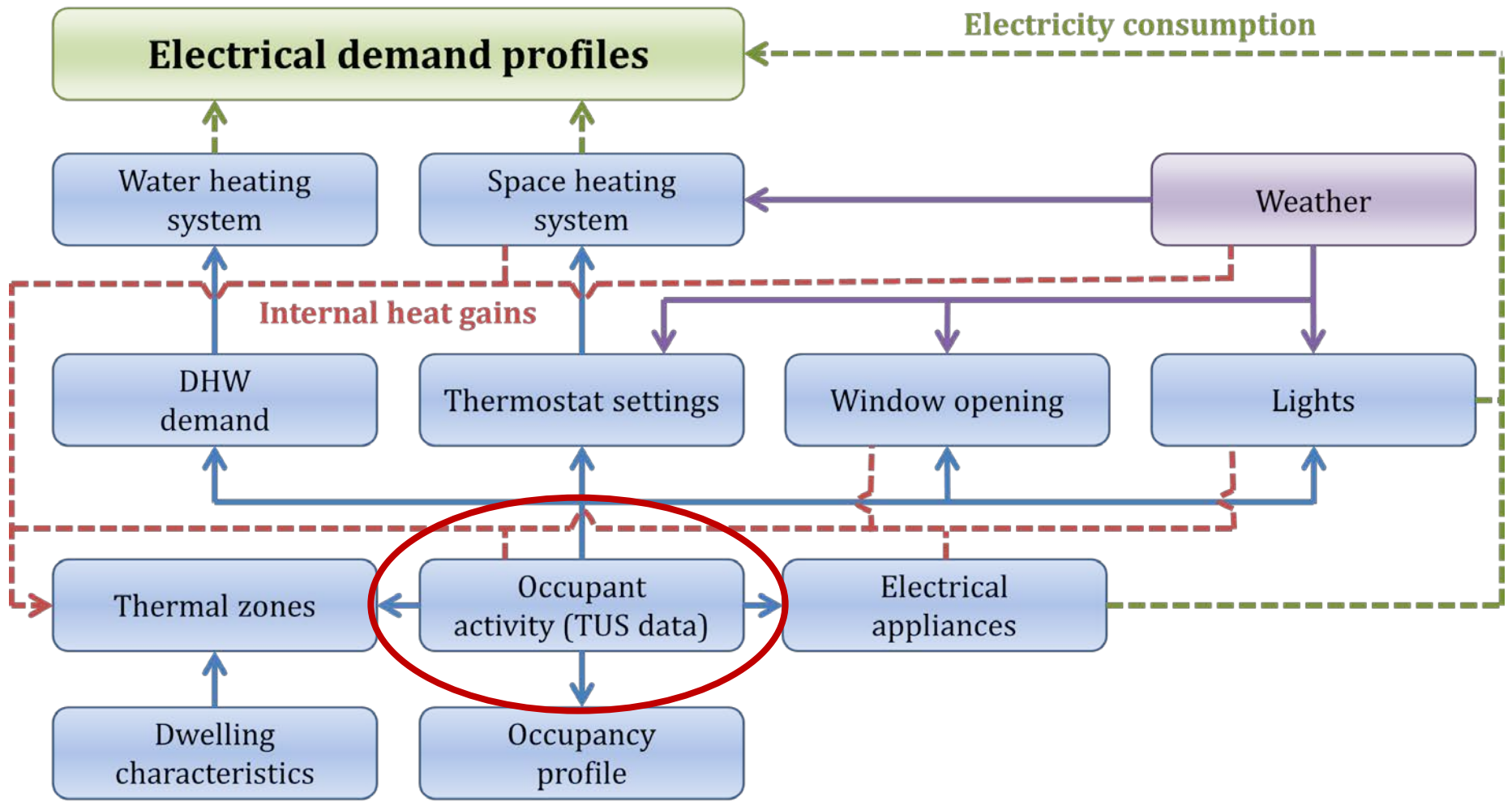


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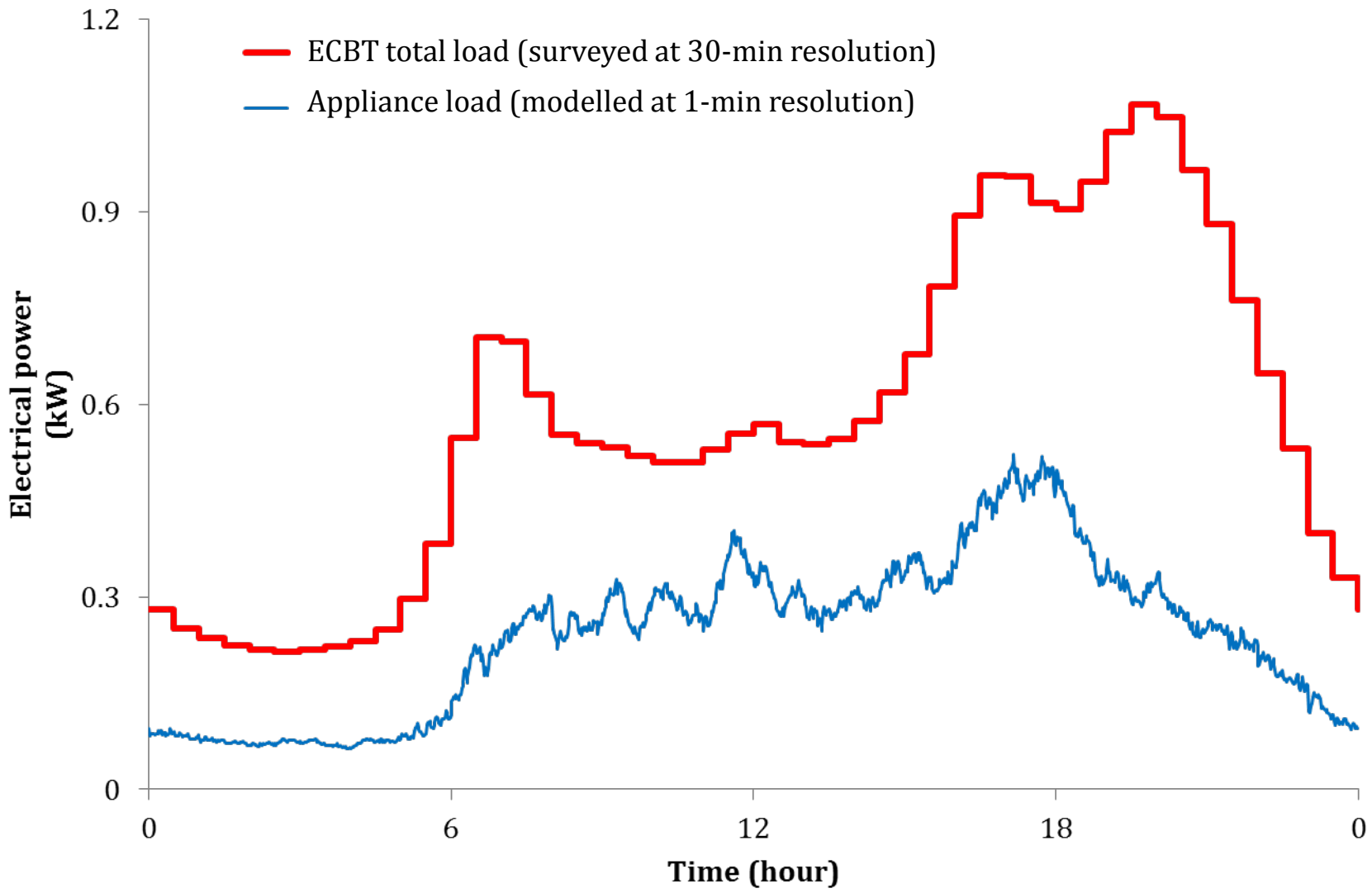
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Appendix_Modelling methodology: operational data

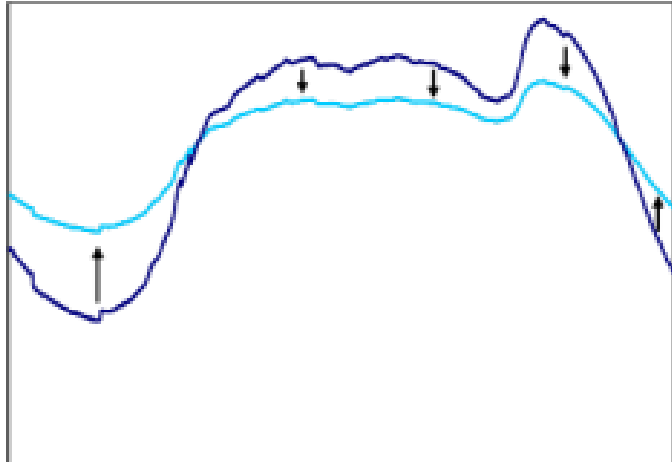
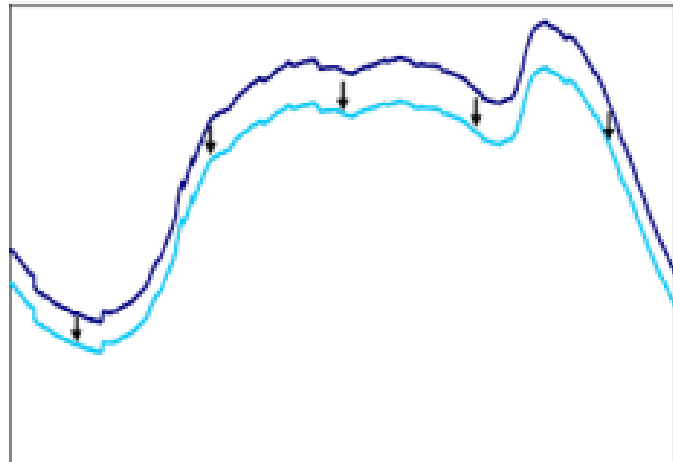


Appendix_Operational data: electrical appliances use profiles



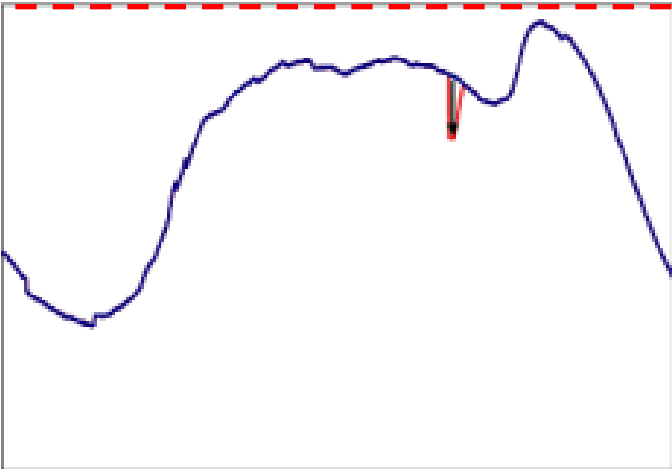
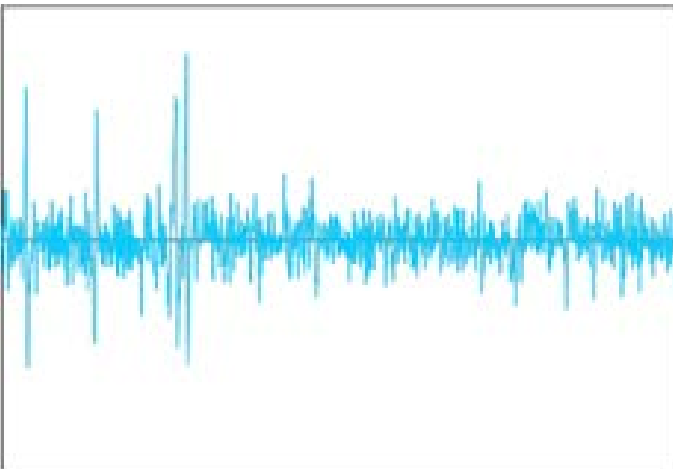
Appendix_DSM? Electrical load shifting?

Energy efficiency



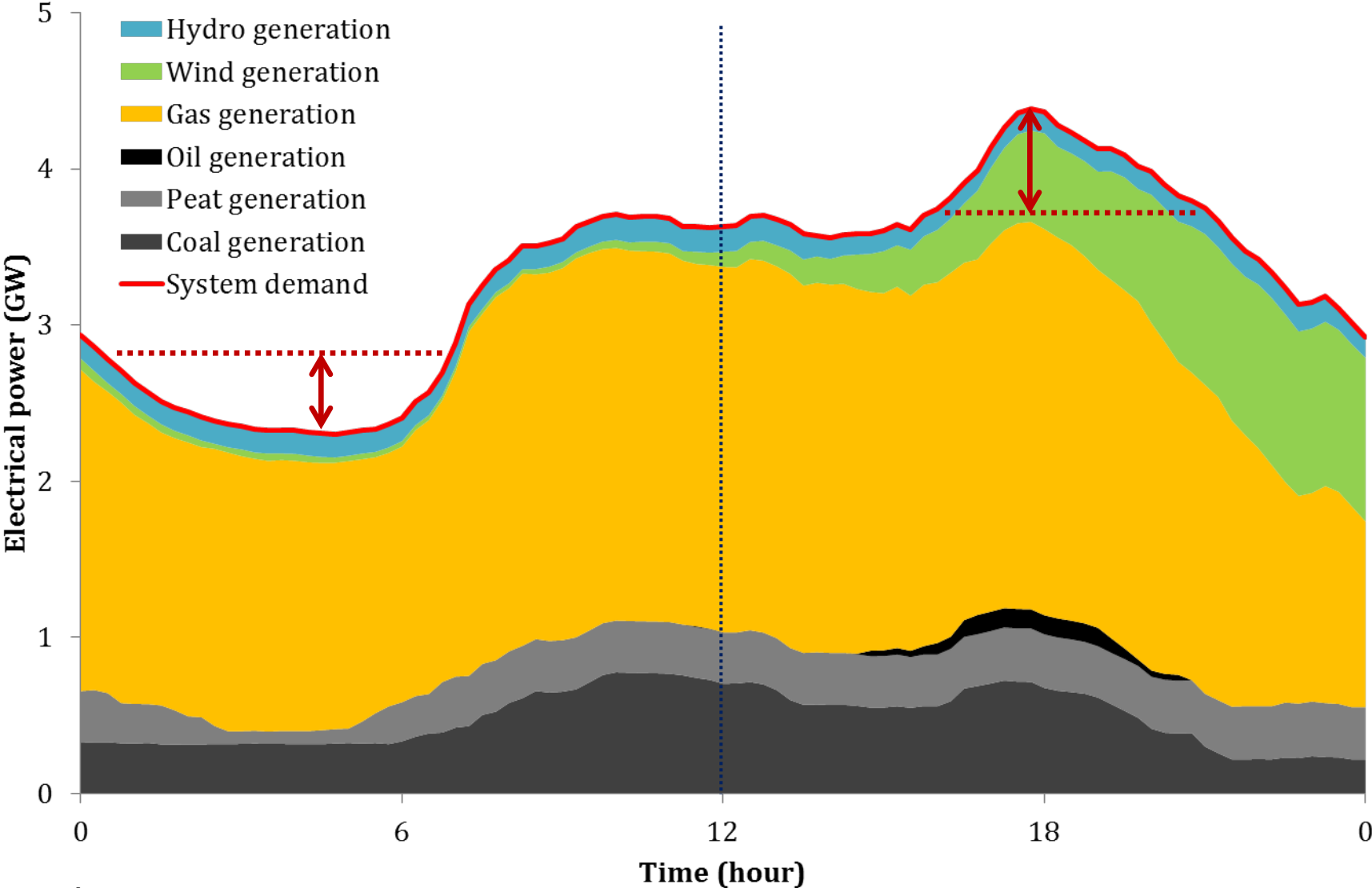
Peak management

System frequency regulation



Reserve

Appendix_Power supply-demand mismatches



Source: Eirgrid

Appendix_Average daily and maximum heat demand for DHW heating

Dwelling type, construction period	Average daily heat demand (kWh/L)		Maximum heat demand over a 15-min interval (kWh at "time")	
	February	July	February	July
Bungalow, new	0.063	0.057	3.36 at 20:15	3.39 at 08:15
Detached, new	0.062	0.056	3.45 at 09:00	3.44 at 07.45
Semi-detached, new	0.062	0.057	3.45 at 05:00	3.40 at 08:30
Top-floor flat, new	0.064	0.058	3.35 at 10:00	3.36 at 08:45
Mid-floor flat, new	0.064	0.058	3.39 at 08:30	3.37 at 08:00
Bungalow, existing	0.100	0.094	3.78 at 05:00	3.70 at 05:00
Detached, existing	0.088	0.081	3.71 at 05:00	3.67 at 05:00
Semi-detached, existing	0.102	0.095	3.66 at 05:00	3.65 at 05:00
Top-floor flat, existing	0.108	0.103	3.72 at 05:00	3.62 at 05:00
Mid-floor flat, existing	0.108	0.106	3.67 at 05:00	3.47 at 05:00