Supplementary Material for "Assessing the Impact of Occupant Behavior on Residential Building Performance: A Case Study of Window Operation"*

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1. Description

This supplementary material provides additional information on the experimental dataset (Section 2), reports the parameters of the selected logistic regression models used in the IDA ICE–MATLAB co-simulation framework (Section 3), and describes the detailed procedure for setting up IDA ICE–MATLAB co-simulations (4). It is provided to support the transparency and reproducibility of the results presented in the main manuscript [1]. Researchers who wish to use the coefficients presented in this document are kindly requested to cite the original manuscript [1].

2. Experimental dataset

This section provides additional details on measured window-opening behavior across apartments and winter seasons to supplement the classification results reported in the main manuscript [1]. In particular, Figs. 1a and 1b show, respectively, the distributions of window-opening event durations and the number of window-opening events per day, for each apartment and winter season. For Fig. 1a, outlier points are omitted from the visualization to improve readability. However, all analyses in [1] are based on the full dataset.

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For consistency with the main manuscript, we refer to each window-opening/-closing model for each occupant as an Occupant Behavior (OB) profile. Each OB profile corresponds to one monitored apartment–winter-season dataset: OB1 (Apartment 2, 2020–2021), OB2 (Apartment 2, 2021–2022), OB3 (Apartment 3, 2020–2021), OB4 (Apartment 4, 2020–2021), OB5 (Apartment 4, 2022–2023), and OB6 (Apartment 4, 2023–2024).

Overall, opening-duration patterns resulting from the co-simulation are broadly consistent with the measured data for the corresponding occupant profiles. For example, OB2 and OB6 occasionally produce large total daily opening durations in co-simulation, consistent with the long durations observed for those apartment–years in the monitored data (Fig. 1a). On the other hand, for a small number of profiles (e.g., OB5), the co-simulation overpredicts openings/day, but they doe not affect the maximum NEI cases or the main conclusions.

3. Window operation model coefficients

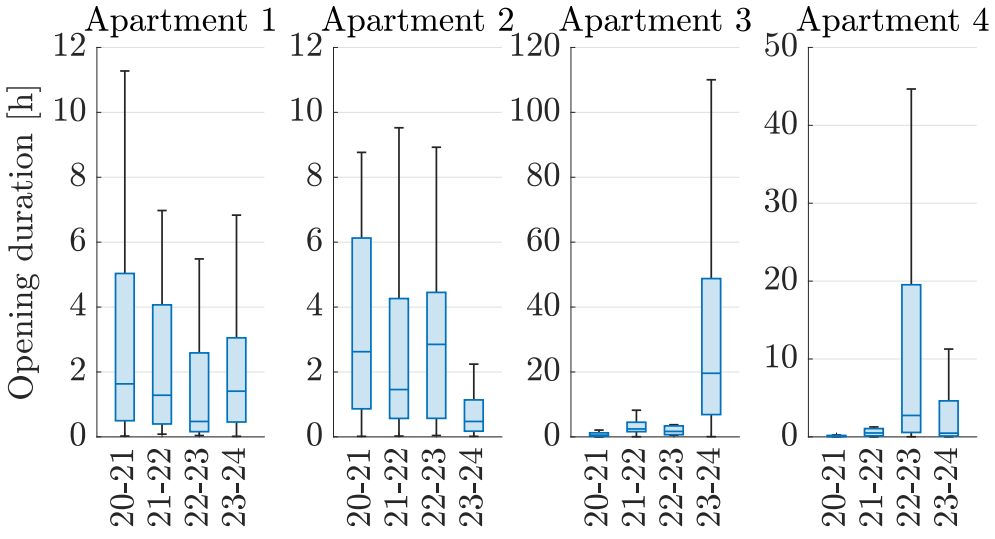
This section reports the estimated intercepts and coefficients for the window-opening and window-closing models developed in [1] and corresponding to the six OB profiles defined in Section 2.

Table 1: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 2, derived from data collected between October 2020 and February 2021.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	-2.919	-2.954	-2.884	0.535	0.329	0.74
α_{DS2}	-0.912	-0.93	-0.894	1.089	0.99	1.188
α_{DS3}	-2.732	-2.761	-2.704	-	-	-
$\beta_{\mathrm{T_{indoor}}}$	-	-	-	-0.413	-0.47	-0.355
$\beta_{\mathrm{log(CO_2)}}$	1.798	1.784	1.812	0.177	0.107	0.246
$\beta_{\mathrm{T_{outside}}}$	1.72	1.705	1.735	-0.309	-0.38	-0.238
β_{DHI}	-0.705	-0.724	-0.686	0.494	0.381	0.607

4. Details of the IDA ICE–MATLAB co-Simulation environment

In our implementation, data exchange is performed through IDA ICE's channel-based co-simulation mechanism, using the Import/Export modules



(a)

(b)

Figure 1: Box plots of (a) window-opening event duration [h] and (b) the number of window-opening events per day, shown by apartment and winter season (Oct–Feb, 2020–2024).

Table 2: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 2, derived from data collected between October 2021 and February 2022.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	0.217	0.202	0.231	0.935	0.890	0.980
α_{DS2}	-0.372	-0.387	-0.357	0.837	0.803	0.872
α_{DS3}	-2.759	-2.793	-2.725	0.231	0.171	0.291
$\beta_{\mathrm{T_{indoor}}}$	0.284	0.272	0.295	0.216	0.197	0.235
$\beta_{\mathrm{log(CO_2)}}$	0.566	0.556	0.577	0.094	0.050	0.137
$\beta_{\mathrm{T_{outside}}}$	0.421	0.410	0.432	-1.051	-1.074	-1.027
β_{DHI}	0.437	0.426	0.447	-0.005	-0.014	0.024

Table 3: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 3, derived from data collected between October 2020 and February 2021.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	0.489	0.477	0.501	-	-	-
α_{DS2}	-0.146	-0.158	-0.134	0.6	0.482	0.717
α_{DS3}	-2.631	-2.658	-2.603	0.654	0.302	1.006
$\beta_{\mathrm{T_{indoor}}}$	0.804	0.794	0.814	-0.308	-0.382	-0.235
$\beta_{\mathrm{log(CO_2)}}$	0.138	0.131	0.146	-	-	-
$\beta_{\mathrm{T_{outside}}}$	-0.276	-0.288	-0.264	-0.412	-0.552	-0.272
β_{DHI}	-	-	-	-	-	-

linked to external storage. This functionality is accessed from MATLAB via the IDA library (`idalibN`). Specifically, MATLAB creates and opens two storage (channels): one for data transfer from IDA ICE to MATLAB and one for communication from MATLAB to IDA ICE. The simulation is initiated from MATLAB by launching IDA ICE by loading the model and executing the simulation. During the co-simulation loop, MATLAB retrieves the variables exported by IDA ICE at each synchronization step and computes the window-operation action for the selected behavior profile. The resulting window operation action is then sent back to IDA ICE and held until the next update.

Table 4: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 4, derived from data collected between October 2020 and February 2021.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	0.655	0.64	0.669	-	-	-
α_{DS2}	-1.853	-1.874	-1.831	-	-	-
α_{DS3}	-4.053	-4.088	-4.017	-1.74	-2.506	-0.974
$\beta_{\mathrm{T_{indoor}}}$	-0.417	-0.433	-0.401	-	-	-
$\beta_{\mathrm{log(CO_2)}}$	1.346	1.334	1.359	-0.238	-0.46	-0.015
$\beta_{\mathrm{T_{outside}}}$	1.691	1.673	1.708	0.863	0.534	1.192
β_{DHI}	-0.493	-0.504	-0.481	-0.462	-0.632	-0.292

Table 5: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 4, derived from data collected between October 2022 and February 2023.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	-0.89	-0.911	-0.869	0.109	0.074	0.143
α_{DS2}	0.3	0.286	0.313	0.413	0.388	0.437
α_{DS3}	0.094	0.078	0.11	0.564	0.538	0.589
$\beta_{\mathrm{T_{indoor}}}$	0.372	0.357	0.387	-0.413	-0.434	-0.391
$\beta_{\mathrm{log(CO_2)}}$	-0.047	-0.06	-0.035	-0.195	-0.216	-0.175
$\beta_{\mathrm{T_{outside}}}$	0.92	0.906	0.934	-0.852	-0.877	-0.827
β_{DHI}	0.375	0.364	0.385	-0.004	-0.02	0.012

References

[1] M. Farjadnia, A. Fontan, M. Molinari, and K. H. Johansson, "Assessing the Impact of Occupant Behavior on Residential Building Performance: A Case Study of Window Operation," manuscript submitted for publication, 2026.

Table 6: Estimated intercepts and coefficients of the window-opening and window-closing models of Apartment 4, derived from data collected between October 2023 and February 2024.

	Opening action			**Closing action**		
Drivers	Coeff.	Conf. interval 2.5%	97.5%	Coeff.	Conf. interval 2.5%	97.5%
α_{DS1}	-0.996	-1.018	-0.974	-0.053	-0.087	-0.019
α_{DS2}	-0.248	-0.261	-0.234	0.603	0.571	0.635
α_{DS3}	0.757	0.742	0.771	0.526	0.499	0.553
$\beta_{\mathrm{T_{indoor}}}$	0.147	0.138	0.155	-0.104	-0.12	-0.089
$\beta_{\mathrm{log(CO_2)}}$	0.185	0.176	0.193	0.064	0.044	0.085
$\beta_{\mathrm{T_{outside}}}$	0.523	0.514	0.532	-0.855	-0.876	-0.834
β_{DHI}	0.308	0.297	0.32	0.448	0.431	0.466