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A Two-Step Time-Series Data Clustering Method for Building-Level Load Profile

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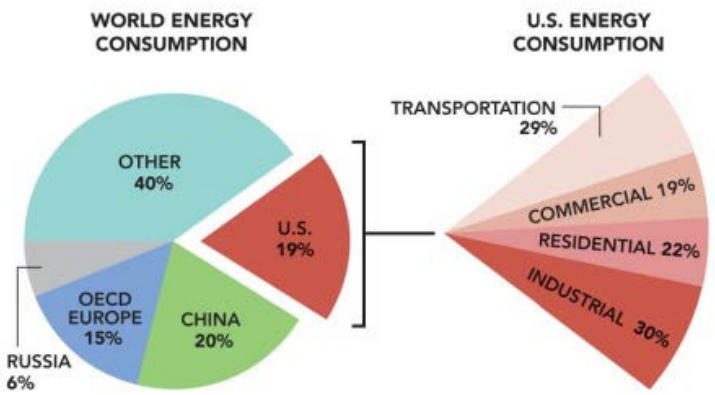
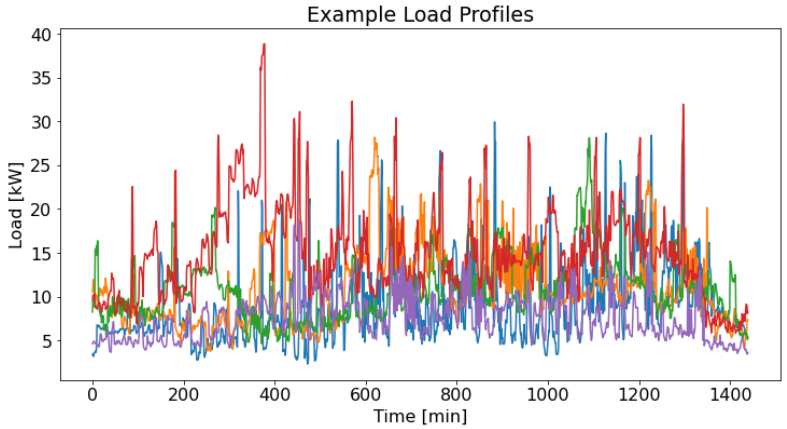
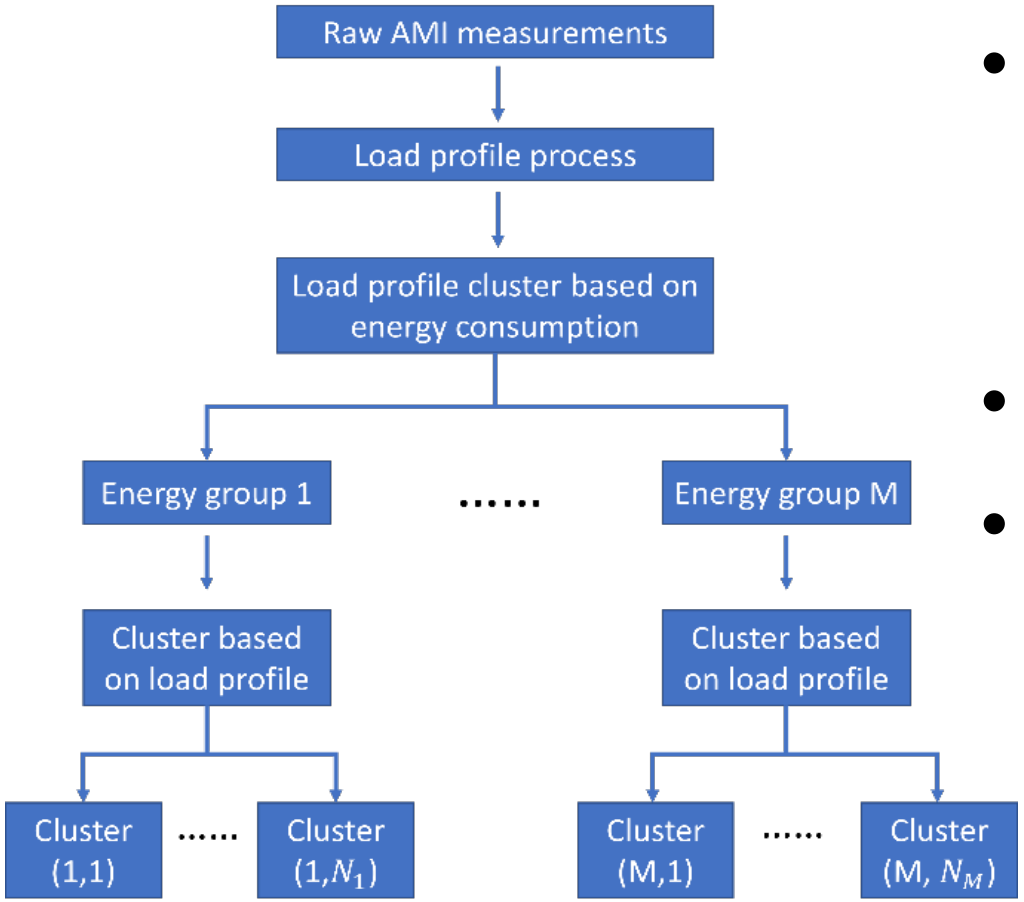
Background

- Buildings have great potential to participate in demand response in distribution system operation
- Cluster the load profiles into different groups by load patterns
- Grid operators can send demand response signal to the customer cluster with a higher chance to respond at different time





Proposed Solution



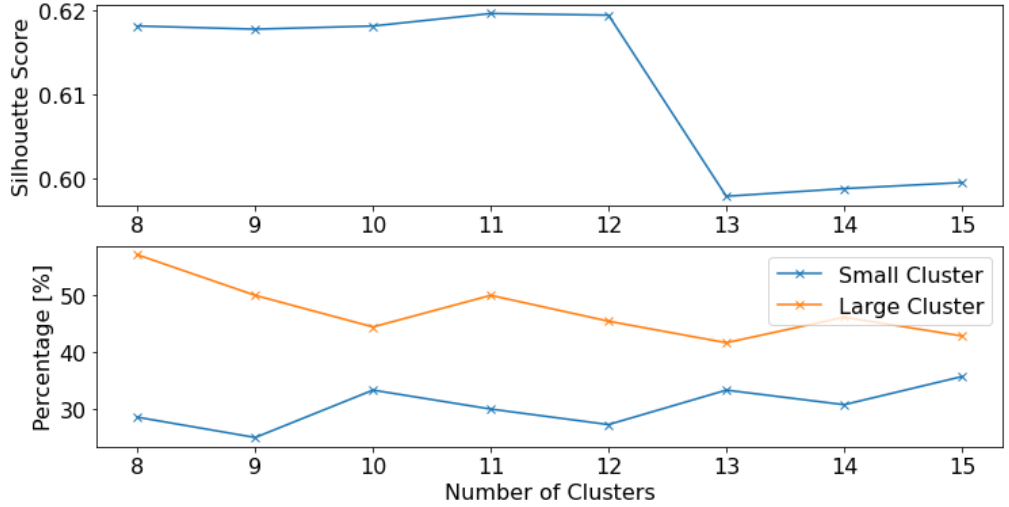
- Load profile clustering algorithm:
  - Energy consumption level clustering
  - Load pattern clustering
- K-Means clustering method
- Silhouette index

$$s(ii) = \frac{b(ii) - a(ii)}{max\{a(ii), b(ii)\}} \qquad a(ii) = \frac{1}{n_{C_i} - 1} \sum_{j \in C_i, ii \neq jj} d(i, ijj)$$

$$b(ii) = min\left(\frac{1}{n_{C_j}} \sum_{j \in C_j} d(i, ijj)\right), j \neq i, j \in (1, \ldots, k)$$

Proposed Solution

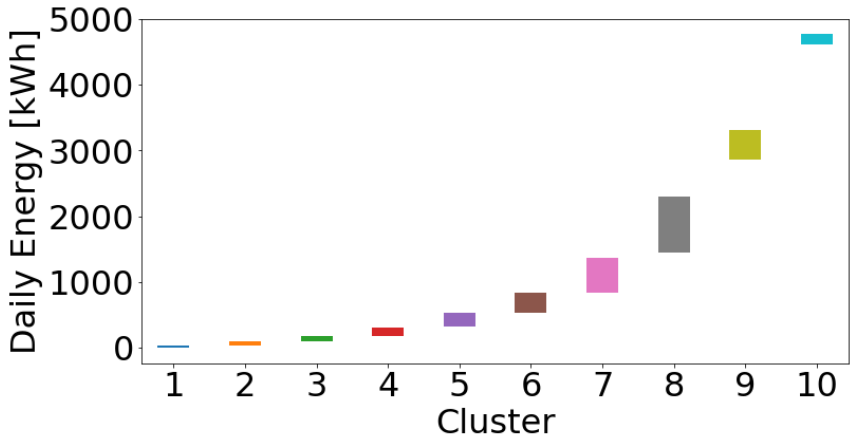
- K-Means parameter selection:
  - Silhouette score evaluation
  - Cluster size evaluation
- Multilayer perceptron (MLP):
  - New income data processing
  - Parameter selection



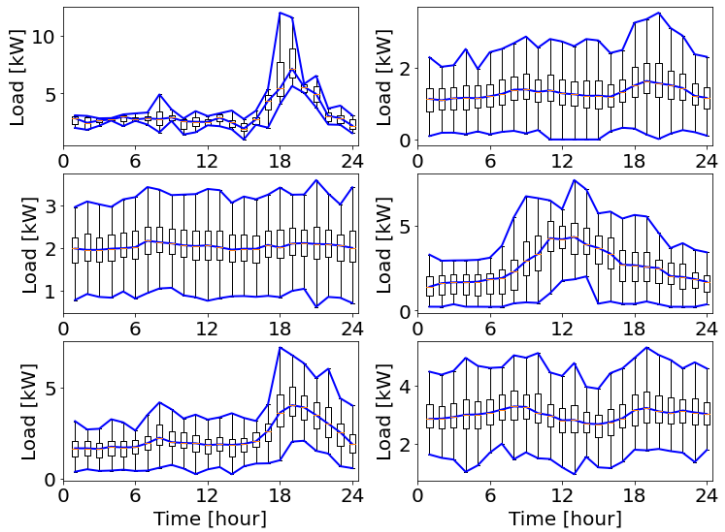
Silhouette score		Number of hidden layers			
		3	5	7	9
Number of cells in each layer	4	0.36	0.59	0.34	0.58
	5	0.16	0.25	0.25	0.26
	6	0.01	0.25	0.22	0.23
	7	0.23	0.24	0.15	0.19
	8	0.15	0.21	0.17	0.24
	9	0. 11	0.25	0.15	0.28

Case Study

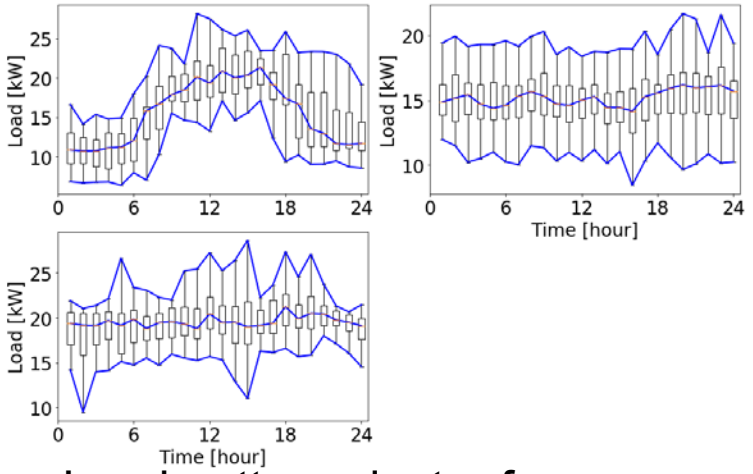
- Utility's actual AMI measurements:
  - 7000 building-level load profiles
  - Hourly resolution
  - Clustering for daily profiles



Energy clustering results

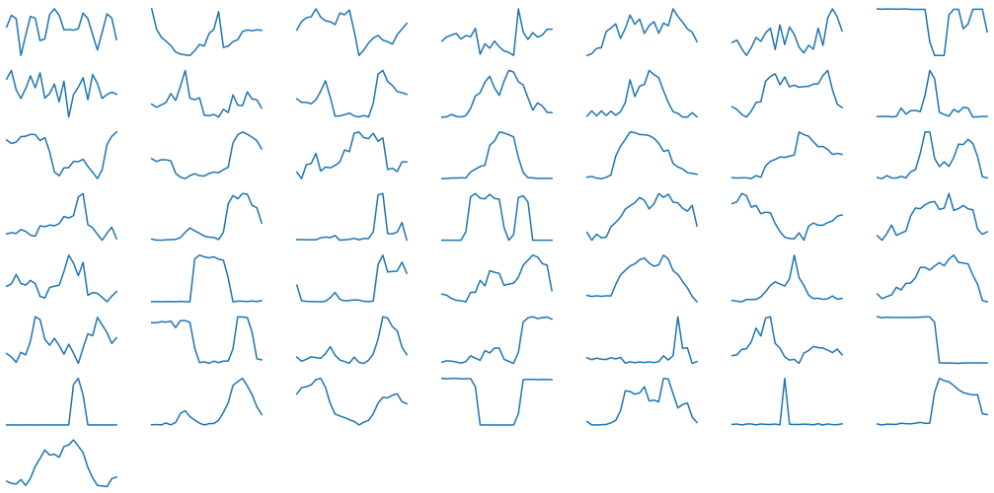


Load pattern cluster for energy group 1

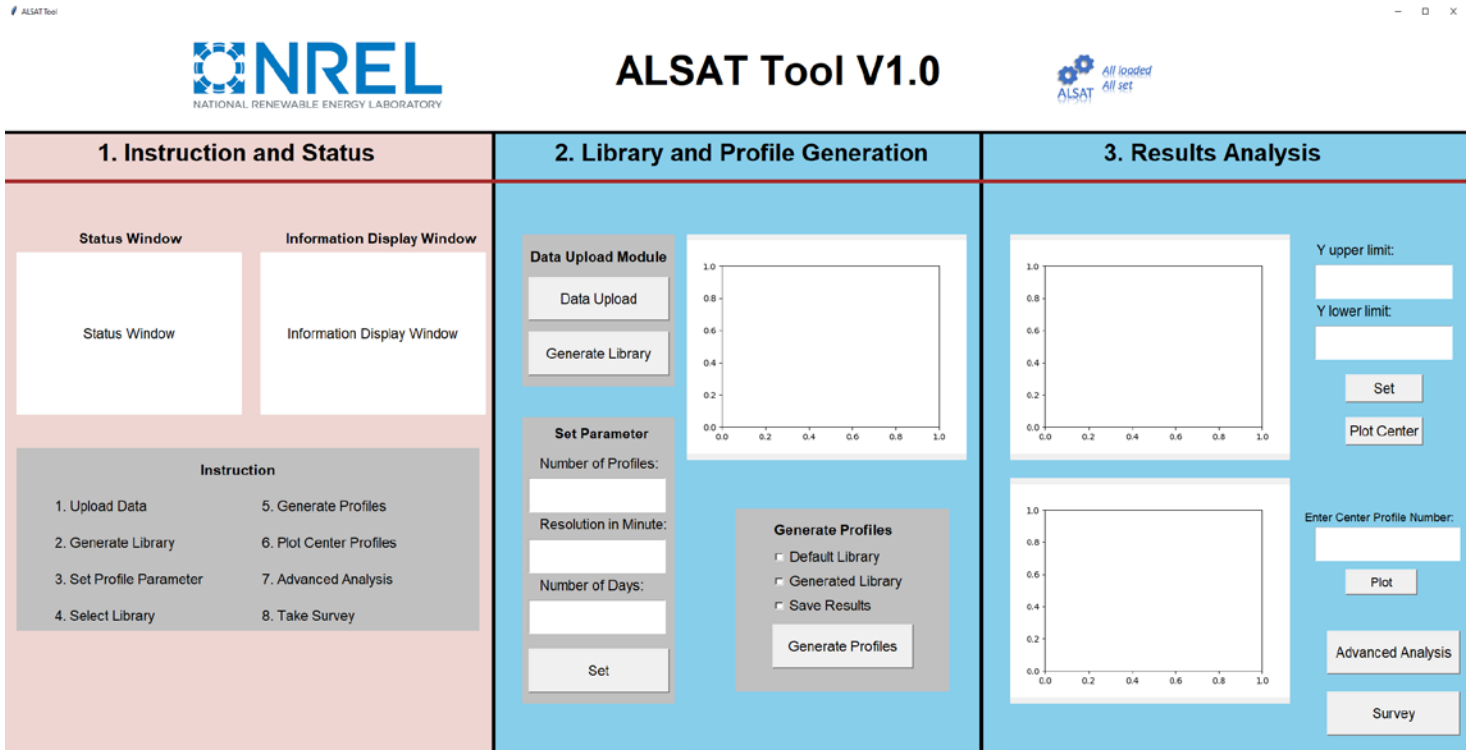


Load pattern cluster for energy group 2

Results

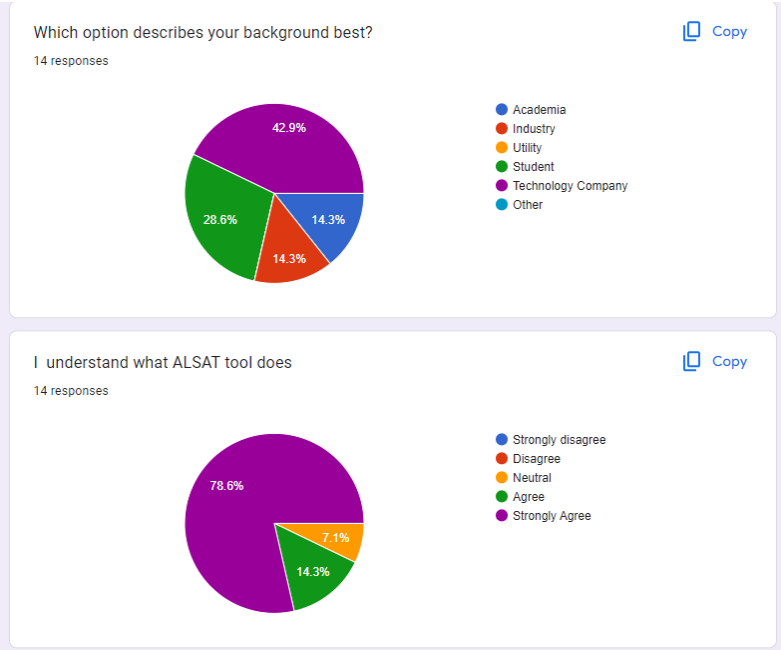


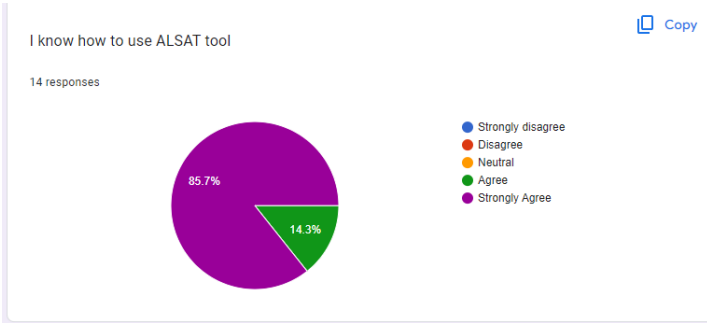
50 representative profiles are selected

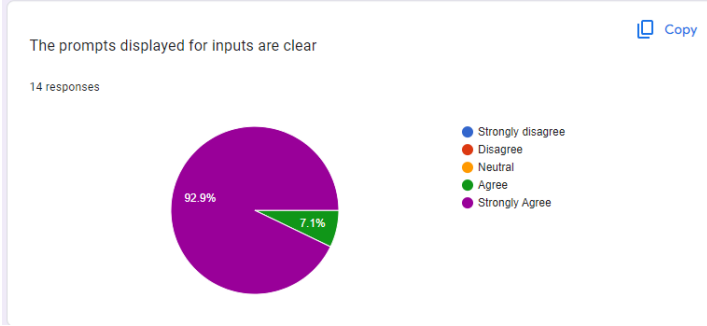


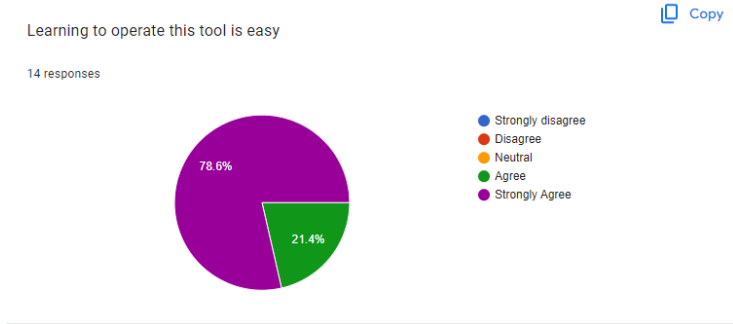
Graphic user interface for this tool

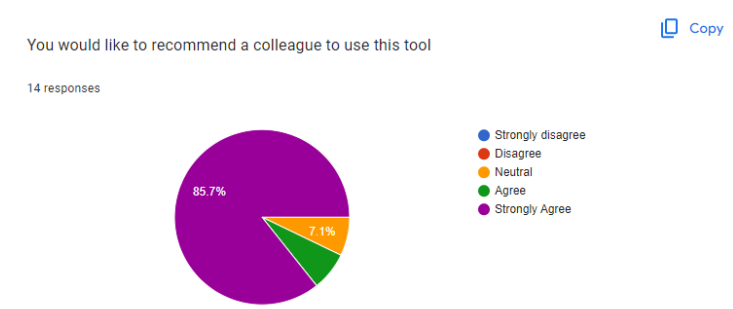
Future Work











- Improve the graphic user interface based on feedback
- Develop methods to quantify the demand response capability in each load profile cluster
- s

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