DTU Management Engineering
Department of Management Engineering

Smart Meter Analytics for Consumption Profiling

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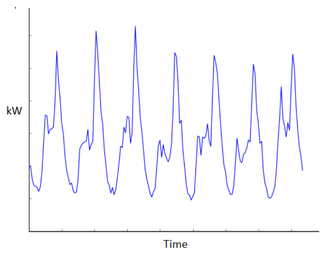
Smart Meters

Over the past decade smart meters for electricity consumption measurement have received large attention. The European Commission has set up goals for roll out of smart meters [1], which are expected to play a significant role in reducing energy consumption. This poster describes a structured review [2] of current research methods and learnings using electricity smart meter data for consumption classification with the aim of quantifying the current state of smart meter analytics



Method

This structured review applies Okolis 8 step method for structured reviews [3] modified to 7 steps here. The method is described for information sciences but is also applicable in an analytical setting. The structure followed:

1: **Purpose of the literature review.**
2: **Protocol and training.** Ensure consistency, alignment, and reproducibility.
3: **Searching for literature.** Explicitly describe the search for literature.
4: **Practical screen.** Crude inclusion and exclusion of articles; if in doubt the article should be included.
5: **Quality appraisal.** Screen for exclusion, and explicitly define the criteria for judging articles.
6: **Data extraction and synthesis of studies.** Systematically extract the applicable information of the identified articles and combine the facts.
7: **Writing the review.**

Waterfall statistics

30 search phrases was applied using Thomson-Reuters Web-of-Science. It resulted in the following paper reduction waterfall.

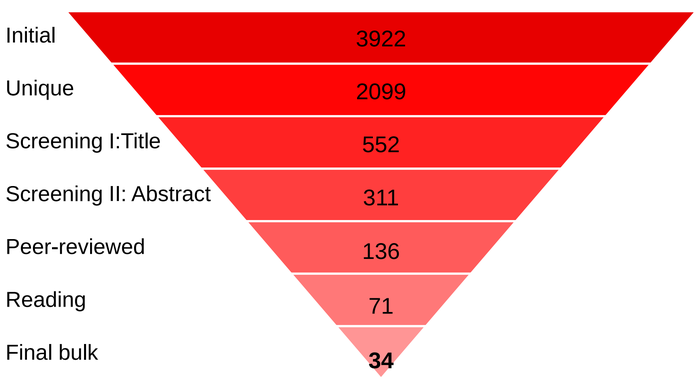


Figure 1: Waterfall statistic for the paper review.

The final number of peer-reviewed papers included in the review is 34. These papers all complied to the quality appraisal criterion: **smart meter data should be applied for end-user consumption classification.** Smart meter consumption data can be binned into 10 distinct categories based on topic.

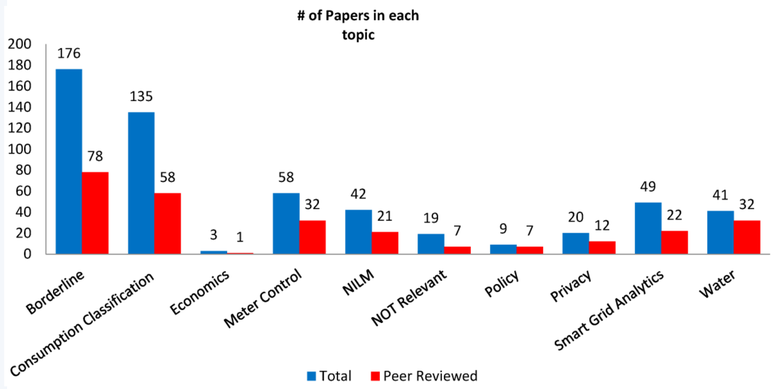


Figure 2: Topic distribution of smart meter journal papers

Clustering and Validation

Most prevalent clustering and validation techniques identified in the review process

Classification	Validation
K-Means	Davies-Bouldin Indicator
hierarchical	Cluster Dispersion Indicator
fuzzy k-means	Dunn
Follow-The_leader	Silhouette
Mixture Model	Entropy
Neural Network	MIA

Danish Smart Meter Data

SydEnergi

Electric utility, smart meter data at household level. Covering green area “6” on figure 3.

260.000+ meters from industry and Residence. 1 hour recording interval (of these 220.000 have 15 minutes recordings) of the entire 2011 year.

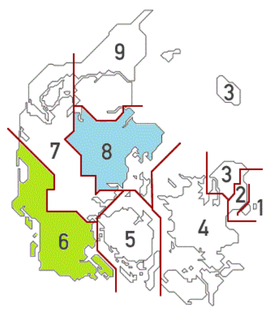


Figure 3: Denmarks 9 main postal area.

Affald Varme Aarhus

District heat utility, smart meter data, aggregated to heat exchange level. Covering blue area “8” on Figure 3.

53 Heat Exchange Stations, covering districts with district heat supply.
Recording interval, 5 min and 60 min, from January 1st 2016 – May 1st 2017.
Entire city of Aarhus, suburban and rural areas included.
Figure 4 shows Affald Varme Main grid layout.

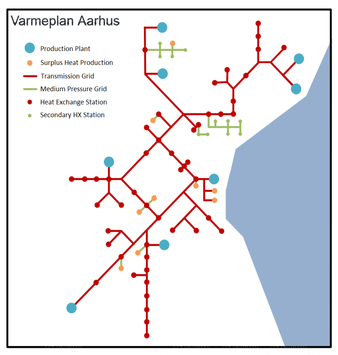


Figure 4: Metro style overview of Affald Varme main district heat grid.

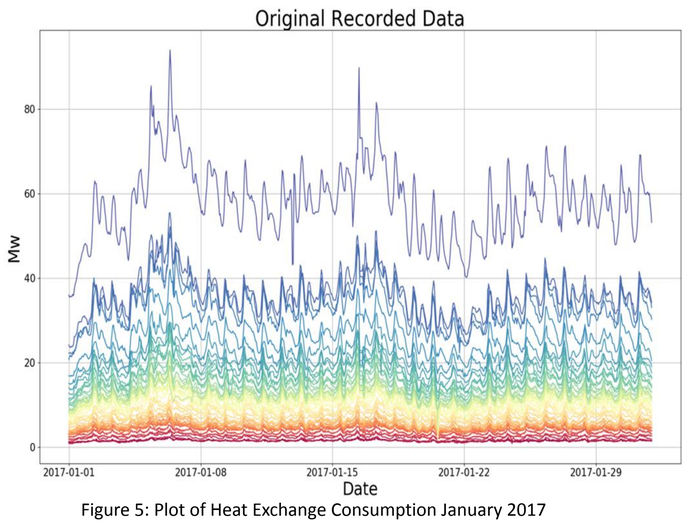
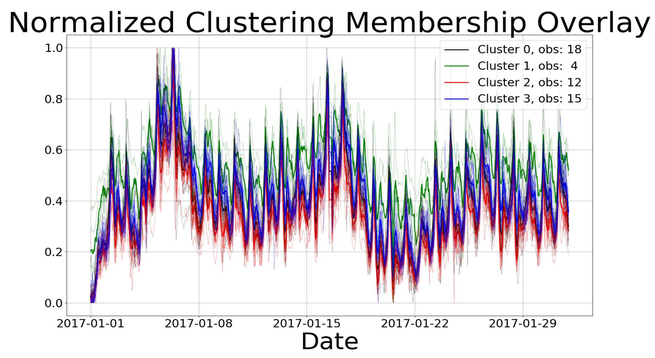
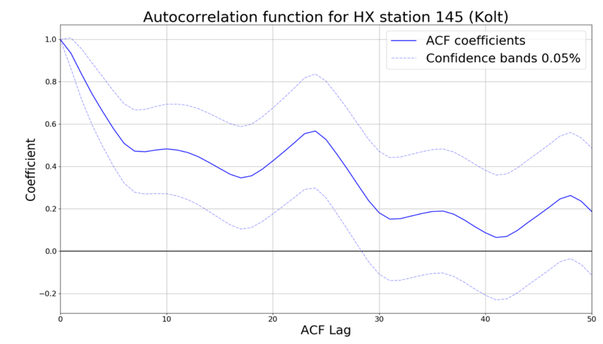


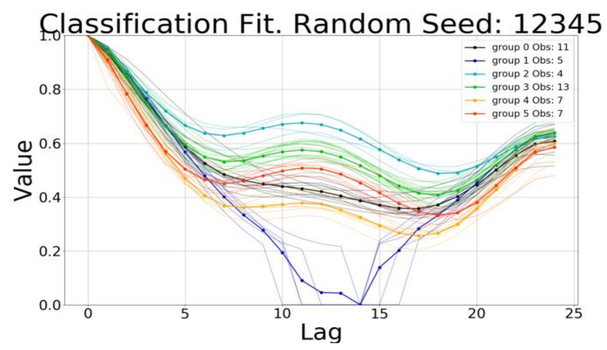
Figure 5: Plot of Heat Exchange Consumption January 2017

Clustering

Reduced cluster dispersion vs normalized data, by leveraging time series information through autocorrelation feature extraction [4].







Acknowledgements

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References

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2 Tureczek. Alexander M, Nielsen. Per S. Structured Literature Review of Electricity Consumption Classification Using Smart Meter Data Alexander. Energies 2017:1–19. doi:10.3390/en10050584.

3 Okoli, C. A guide to conducting a standalone systematic literature review. *Commun. Assoc. Inf. Syst*. **2015**, *37*, 879–910.

4 Tureczek. Alexander M, Nielsen. Per S, Madsen. Henrik, Brun. Adam. Clustering of District Heat Heat Exchangers Using Smart Meter Data. Under review The International Journal Energy.