An information extraction-based approach to estimate residential water-related energy from single-point smart meter data

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An information extraction-based approach to estimate residential water-related energy from single-point smart meter data

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Abstract: Planning and management strategies for water and energy systems are key for meeting future demands under population growth, urbanization, changing economic and climate conditions, and emerging technologies. Given the water-energy nexus, interest has raised towards the design of coordinated water-energy interventions to manage urban water and energy end use demands - including that of the residential sector – and ultimately foster both water and energy conservation and use efficiency. On this respect, while sub-daily resolution data gathered via advanced metering infrastructures and intelligent sensors installed at the household/building scale enables recording water uses with a finer granularity than in the past, new models that adequately facilitate our understanding of water and energy demands and their inter-dependencies are needed. In this work, we propose an information extraction-based approach to estimate residential water-related electricity for heating purposes. Our approach relies only on the knowledge of fine resolution (e.g., 1 min sampling frequency) water and electricity data collected by two single-point, non-intrusive, water and electricity meters. We first process the data to detect water use events, compute time and consumption-based features for each event. We then use Iterative Input Selection, a variable selection algorithm for data-driven models, to determine the optimal subset of features needed to build a regression model that estimates the end-use electricity used for heating water, for each use event. We use extremely randomized trees as nonparametric regression models. Results from an application of the onto data collected from a single household in Canada show that our approach can estimate the water-related electricity used from the instant hot water unit at each consumption event with an accuracy of over 90%. In addition, we demonstrate that a joint analysis of water and electricity data collected via smart meters can help unpacking the electricity use related to specific water end-uses, such as clothes washers.

Keywords: water-energy nexus; smart meter; water-related energy; demand management; input variable selection.