Forecasting Natural Gas Demand using Hierarchical Frameworks

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Natural gas consumption data can be hierarchically organized to improve demand forecasting. Gas distribution companies must provide enough gas to meet the demand expected at the most aggregate level of the hierarchy (total consumption of the system). Individual consumers burn gas as needed at the least level of aggregation (personal-use gas). Forecasts at each of these levels are relied on for economical and sustainable operation of the pipeline network, however, it is often the case that consumption data at one or both aggregate levels of interest are not available. This work evaluates the effectiveness of applying grouped time series structures of varying complexity to the problem of gas demand forecasting. We present our framework by selecting hierarchical structures representing gas consumption of 100,000 customers located in the western United States. Individuals are grouped into hierarchies using temporal and spatial information, as well as historical consumption trends. All series within the hierarchy are modeled simultaneously using multi-parameter linear regression. Novel coherence constraints are determined to manage overlapping and inconsistently spaced cycle-billing observations and enforced throughout hierarchies using an optimal-combination reconciliation technique. Effectiveness of this forecasting framework is shown in a temporal disaggregation application, with daily consumption at the lowest level of aggregation being the target hierarchy. This framework for forecasting natural gas demand produces a 12.4% MAPE evaluated over a three-year period and is the most accurate disaggregation result as shown in the case studies included in this work.