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Presentation Title: Understanding Urban Energy Patterns: A Behavioral Approach Coupling Buildings and Transportation Modeling

Abstract: Knowing accurate load patterns on the urban electric grid can help us design and use electric power efficiently. Existing research typically estimates the load patterns through building systems, which calculate them based on aggregate-level building features like building age and occupancy by building type. However, existing approaches ignore two important points that could lead to an inaccurate estimation of electricity load on the electric grid: (1) Lacking a heterogeneous behavioral perspective, human activities which generate electricity demand could vary within the same type of building (e.g. residential buildings with different household size/composition would have different cooking or heating habits, and flexible schedules shift electricity usage periods at work). (2) Missing estimates of new charging demands (e.g. growth in electric vehicles (EVs)). Considering these, we propose an agent-based modeling framework that integrates building and transportation systems, and connects people's activities in different buildings with transportation system simulation. The framework also simulates people's heterogeneous occupancy plans (i.e., arriving/leaving time) in different buildings and EV charging demand. Inside buildings, people's electricity usage (e.g., lighting, heating, etc.) is considered by population group, identified by key sociodemographic characteristics. To demonstrate the proposed framework, we identified population groups with different activity patterns from the American Time Use Survey and a typology study. The grouping was applied to a case study area, San Francisco County, to generate daily activity schedules for the population. Then, traffic simulation tool BEAM took the generated activity schedules and road network to simulate mobility patterns and update activity schedules with traffic conditions and EV charging. Finally, total electricity consumption was calculated with updated building occupancy, in-building activities and EV charging. The proposed framework is expected to estimate electricity loads on the electric grid more accurately and inform power system management design by considering heterogenous human activities and preferences plus new electricity demand.