Large Language Models as Decision-Making Agents in Energy Systems: The Case of an Agentic AI Home Energy Management System in Austrian Households

Reda EL MAKROUM[1,*], Sebastian ZWICKL-BERNHARD[1,2], Lukas KRANZL[1], Hans AUER[1,2]

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User-facing energy transition technologies face persistent adoption barriers driven by interaction complexity and steep learning curves, limiting widespread deployment despite technical maturity. Recent advances in large language models (LLMs) and agentic AI frameworks, where LLMs serve as autonomous reasoning engines coordinating multi-agent workflows, now offer capabilities to fundamentally transform how users interact with energy systems through natural language. Home energy management systems (HEMS) present a compelling case study for demonstrating these capabilities, as HEMS adoption remains limited despite substantial residential demand response potential, with existing interfaces requiring users to translate everyday preferences into technical parameters and provide precise inputs for optimization algorithms.

This paper addresses the following research question: ***How can an agentic AI system for home energy management be designed and developed, and how does its scheduling performance compare to optimization-based benchmarks?***

We present an agentic AI HEMS where LLMs autonomously coordinate multi-appliance scheduling from natural language requests through to schedule execution. The system [1], illustrated in Figure 1, employs a hierarchical multi-agent architecture where one orchestrator coordinates three specialist agents for household appliances, integrating real-time price data and calendar constraints to enable dynamic scheduling without hardcoded workflows.

Evaluation using real Austrian day-ahead electricity prices validates that the system achieves cost-optimal scheduling matching mixed-integer linear programming benchmarks. The demonstrated approach establishes proof of concept for LLM-based autonomous coordination in energy systems, with direct applicability to building-level distributed resource management, district-scale optimization, and autonomous market participation in flexibility platforms. All system components are released as open source to enable reproducibility and further development [2].

[1] Energy Economics Group, TU Wien, Gußhausstraße 25 – 29, Vienna, Austria
[2] Industrial Economics and Technology Management, NTNU, Gløshaugen, Alfred Getz vei 3, Trondheim, 7491, Norway

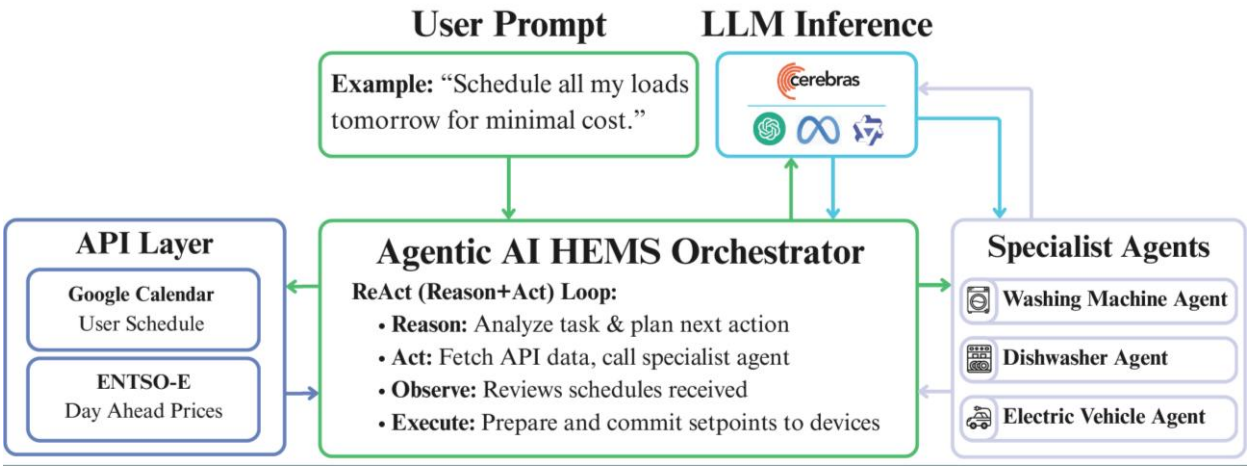

Figure 1: Graphical Abstract of the Agentic AI HEMS.

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