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EPRI GRANT PROPOSAL-1

Proposal Title:	**AI- Based Home Energy Management System (AI-HEMS)**
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Submitted by

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PROJRCT REPPORT
On Prototyping AI Based Home Energy Management System

Proposal Summary

The AI-Based Home Energy Management System (AI-HEMS) leverages cutting-edge Information Communication Technologies (ICT) to optimize home energy consumption, requiring minimal user interaction while maintaining comfort and convenience. This innovative system offers substantial benefits for both consumers and utility companies, making it a significant advancement in the field of smart home technology. By integrating advanced algorithms, AI-HEMS not only automates energy management but also ensures privacy and security, presenting a comprehensive solution for modern energy challenges.

2. Benefits

For Consumers:

- **Cost Savings:** AI-HEMS significantly reduces utility bills by optimizing electricity consumption. The system uses advanced algorithms to determine the most efficient times to use appliances and other electrical devices, ensuring that energy is consumed when it is least expensive. This optimization is achieved through real-time data analysis and predictive modeling, allowing consumers to benefit from lower energy costs without compromising on their comfort or lifestyle.
- **Privacy Protection:** Ensures privacy by masking energy usage patterns through intelligent algorithms. The system anonymizes data to prevent third parties from inferring personal habits or routines, thereby safeguarding user privacy. This feature is particularly important in an era where data security is a major concern, ensuring that users can trust AI-HEMS with their sensitive information.

For Utility Companies:

- **Demand Reduction:** Reduces peak power demand, contributing to more efficient energy distribution. By shifting energy consumption to off-peak times, AI-HEMS helps in flattening the demand curve, reducing the strain on the electrical grid during peak hours. This not only improves the efficiency of energy distribution but also reduces the need for expensive infrastructure upgrades.
- **Load Diversity:** Enhances the load diversity factor, balancing energy loads across the grid. This balance ensures that no single source or region is overburdened, leading to a more stable and reliable energy supply. By promoting a diverse and balanced energy load, AI-HEMS helps utility companies manage their resources more effectively.
- **Grid Stability:** Improves overall grid stability by predicting and managing energy consumption patterns. The predictive capabilities of AI-HEMS allow utility companies to

anticipate energy needs and adjust supply accordingly, minimizing the risk of blackouts or other disruptions. This proactive approach to energy management is crucial for maintaining a stable and reliable grid.

3. Project Progress

a. Student Involvement: Daniel Lambo, an Electrical Engineering and Computer Science (EE&CS) student, commenced work on the AI-HEMS project in September 2023. His dedication over two semesters (Fall 2023 and Spring 2024) has propelled the project to 80% completion. Daniel's contributions have been pivotal, including:

- **Algorithm Development:** Creating sophisticated algorithms that form the backbone of the AI-HEMS system, capable of real-time decision-making and energy optimization. These algorithms analyze data from various sensors and devices to optimize energy use continuously.
- **ICT Integration:** Integrating various ICT components to ensure seamless communication between the system's hardware and software, enabling efficient data processing and action. This integration is essential for the system's functionality, ensuring that all components work together harmoniously.
- **Preliminary Testing:** Conducting tests to ensure the system's reliability, efficiency, and user-friendliness. These tests are crucial for identifying potential issues and areas for improvement before full-scale implementation. By rigorously testing the system, Daniel has ensured that AI-HEMS is robust and ready for real-world deployment.

b. Presentations and Recognition:

- **February 2024:** Daniel presented the AI-HEMS project to Tennessee Valley Authority (TVA) officials during a meeting organized by Dr. M. Dweik, Vice President of Research and Economic Development. The project received positive feedback, highlighting its potential for real-world application and its innovative approach to energy management. TVA officials noted the system's capability to address current energy challenges effectively, recognizing the project's innovative approach and practical applications.
- **March 2024:** Daniel showcased the project at the University-wide STEM Day. The project earned second place, with judges from the industry recognizing its innovative use of AI and ICT to address energy management challenges. This accolade underscores the project's relevance and the quality of the work done, demonstrating its potential impact on the field of energy management.

4. Future Work

The future work for AI-HEMS involves several enhancements:

- **User Interface Improvements:** Enhancing the user interface to make it more intuitive and user-friendly. This includes developing a more responsive and visually appealing design,

as well as incorporating feedback from initial users to ensure that the system meets their needs.

- **Advanced Testing:** Conducting extensive tests to ensure the system works flawlessly in various real-world scenarios. This includes stress testing the system under different conditions to ensure its reliability and performance.
- **Expanded Functionality:** Integrating additional features such as renewable energy sources and battery storage systems. This will make AI-HEMS more versatile and capable of managing a wider range of energy resources.