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IoT Based System via Disaggregation and Blockchain to Enable a Community Scale Microgrid

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Abstract

The electricity industry is going through a systemic transformation shift away from traditional fossil-fuel generating resources to renewable resources, particular solar and wind generation. Furthermore, there is a move toward a decentralized system, relying more on the "distributed" energy resources ("DERs"). Currently, in order to dynamically encourage demand response, utilities typically discourage customers to use energy by day ahead pricing. However, in order to level the Duck curve in California an hourly dynamic **T**ime of **U**se (**TOU**) pricing is needed, and there is a need to encourage consumer participation. Therefore a new system paradigm with blockchain and NILM using a device called SEADS has been proposed.

- Our objective is:
  - To encourage customers to add more generation and battery storage and to engage in whole sale market
  - To enable consumers to respond to demand response scenarios in in a dynamic way

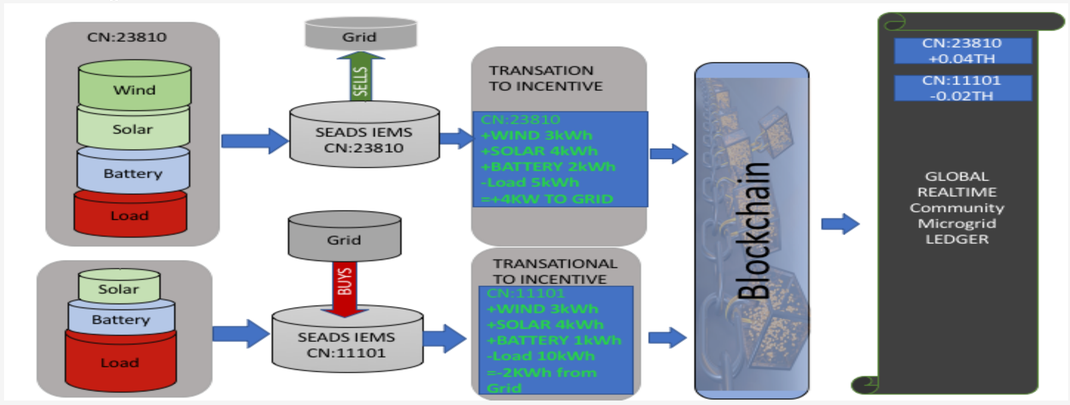
Smart Energy Analytic Disaggregation System (SEADS)

SEADS is a IoT system designed to disaggregate household electricity usage so that the consumers can get informed about their **real-time** appliance energy consumption. Managing and predicting loads is especially important in case of a microgrid with renewable sources.

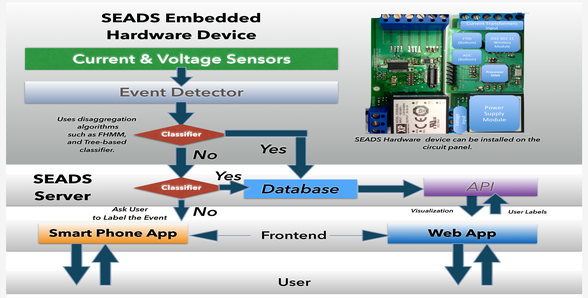
- Incentivizes consumers in how and when to use electricity to flatten the duck curve
- A ledger has been maintained by SEADS to include appliance power consumption, the solar/ wind generation, and battery storage utilization
- Consumer has been incentivized from a macro whole sale to the microgrid level using a voting mechanism that is calculated based on the kWh generation storage and consumption on an hourly bases. An aggregator based on block chain controls HVAC, Storage, Generation to maximize consumer rewards while minimizing the cost of utility for the aggregator.

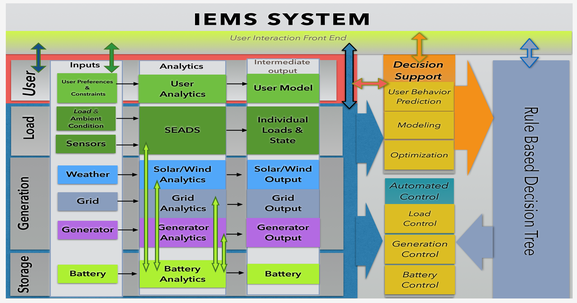
System Architecture

The proposed system is a combination of hardware and software systems. At the heart of it is SEADS which uses current transformers and samples voltage and current from all individual components of the DER including wind, solar, battery and detailed appliance level load data. This data is used to calculate power and energy on minutely bases. This data then gets fed to a module to identify the market prices of electricity and to buy or sell energy via block chain microtransations. All the data is broadcasted to a ledger.



SEADS provides the disaggregated detailed data such as HVAC, Dryer, EV,etc.to an Intelligent Energy Management System. The objective of the system is running the microgrid with lowest cost, or maximized earning. Market rate is decided based on the availability of the resources.





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Acknowledgments

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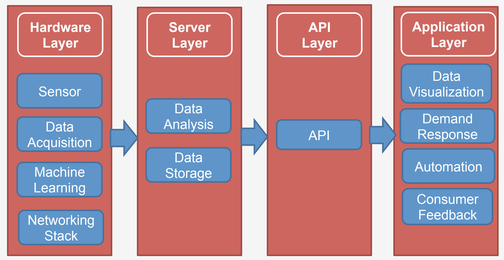
SEADS Architecture

SEADS has the following structural components:



Hardware Layer

- Measures current through a CT sensor and voltage at a single point on a circuit panel at 8kHz.
- Determines the state of the appliances via NILM algorithms.

Objective

- Utilities has recently struggle to keep up with flattening the duck curve in recent years. The duck curve in california has created a 13000MW ramp up over 3 hours for spinning reserves.
- Using block chain technology and IoT we can provide incentives for the customers to participate in the electricity market.

Conclusion

- The increase in distribute resources has created an opportunity for the customers in the electricity market to participate more actively in the market
- An IEMS system with combination of software and hardware can use blockchain technology to incentivize dynamic participation customers in the electricity markets.