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Smart Home Energy Management - Functionalities and Architecture of HEMS: A Review

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Abstract :

Energy management in homes receives significantly greater attention in the quest to incorporate more sustainable energy resources. “With the growing cost of energy and the ever-increasing demand, we and our home have to become clever to keep the bills down. Smart grid systems are envisioned to be a component of this endeavour towards a better usage of energy production and distribution infrastructure. The Home Energy Management System (HEMS) may be seen as the cornerstone in this attempt. Its major purpose is to offer energy management services for effective monitoring and administration of electricity production, power conservation, as well as energy storage technologies created inside the smart home. With the function of being both, a crucial link in transmission infrastructure for balancing the electric grid and a surveillance device in private residences, the technology utilised becomes essential to address.

Keywords- Energy, management, technology, smart grid, transmission, conservation, HEMS

Introduction :

Our world has entered a new digital age as a result of the asymptotic growth in technology”. Our daily lives are becoming more dependent on electronic devices, which raises the bar for a reliable source of electrical energy. Increasing demand has driven up the price of electricity as a unit of usage. India is adamant about producing enough electricity to keep pace with the country's rapidly developing economy. Multiple issues have only been exacerbated as a result of the power industry's reconstruction. The demand for energy is expanding at an accelerating rate, which may one day outpace the adoption of traditional power producing technologies. Scientists throughout the globe have been alarmed by this assumption, which has led them to offer alternatives including demystifying energy sources like coal, natural gas oil, fossil fuels etc., but their usage has resulted in severe environmental effect, higher costs, and more risks to human safety. Over the next several decades, India's electricity shortfall is expected to intensify. The country's electricity industry is plagued by low generating capacity and significant transmission and distribution losses. This led to a change in the scientists' attention

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to researching ways for preserving and generating an alternate source of electricity production. Since new electrical and technological equipment are being introduced all the time, they have had a huge influence on people's quality of life and boosted their desire to use electricity sustainably in their homes. The complexity and disadvantages of traditional instrumentation methods necessitate the use of intelligent systems powered by microprocessors and computers to monitor and operate current large-scale power systems. The current demand-supply imbalance cannot be solved alone by these sophisticated technologies, which constitute the foundation of the smart grid. As a result, a Home Energy Management System is needed (HEMS). In order for a HEMS to be really adaptable, it must be able to utilise power in the house. Users can observe what devices are doing and can remotely'reach in' and switch them on/off or otherwise alter their functionality. Domestic energy conservation tends to be intermittent and non-autonomous in most cases. Optimization benefits are substantial when energy use is automated. The HEMS is now in use at Devices such as data network sensors and flexible computing platforms are used in the house to ensure an effective management process. – HEM prioritises the consumption of load in terms of cost and energy availability.

Electrical Grid

As its name suggests, an electrical grid is a complicated network of interconnections that transports energy from generators to end users, who then utilise it for their everyday requirements. From tiny local designs, they have developed into networks that span hundreds of kilometres and link millions of homes and businesses. There are three primary components to the grid system, which is made up of innumerable complicated connections.

1. 1.Generation of electricity
2. 2.Transmission
3. 3.Distribution

A. Conventional Grid System

An HV (high voltage) transmission system linked major power plants to a distribution system that directly supplied customers' needs in the conventional electric power grid. To create energy, generating plants employed steam turbines powered by fossil fuels and hydro turbines with high inertia turbines. Local and regional transmission systems expanded into a big linked network that had to be operated and planned in coordination.

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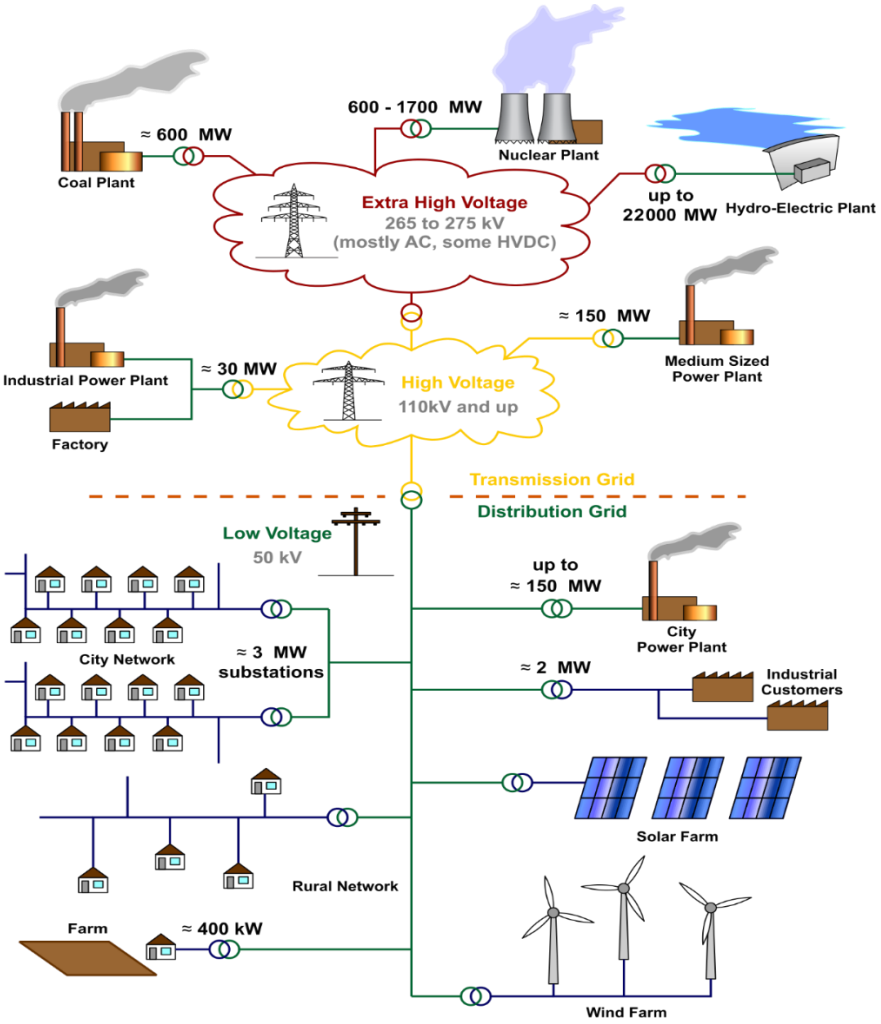

Image Source : https://en.wikipedia.org/wiki/Electrical_grid

Some technological breakthroughs have been made to satisfy the supply-demand equilibrium because of the limitations of this system, such as its deteriorating infrastructure and its lack of capacity to handle small scale renewable sources of energy. However, the technical advancements in the bulk power grid, such as employing HVDC, FACTS, and distributed generating systems, have proven to be ineffective efforts at modernising the grid system. Consequently. Grid configuration as seen above is the most basic. There are many more systems linked to the grid in reality, but this graphic may serve as a visual representation of how intricately intertwined even a basic grid can be for conceptual purposes.

B. Smart Grid System

Smart grids have emerged as a result of the regular grid's shortcomings and subsequent improvements. There may be a solution in the form of a smart grid. In order to improve upon

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the electrical grid of the twentieth century, a "smart grid" uses two-way communications, as well as a variety of operational and energy-saving measures such as smart metres, smart appliances, renewable energy resources, and energy-efficient resources. Deliveries may be enhanced if power and data were to travel in both directions.

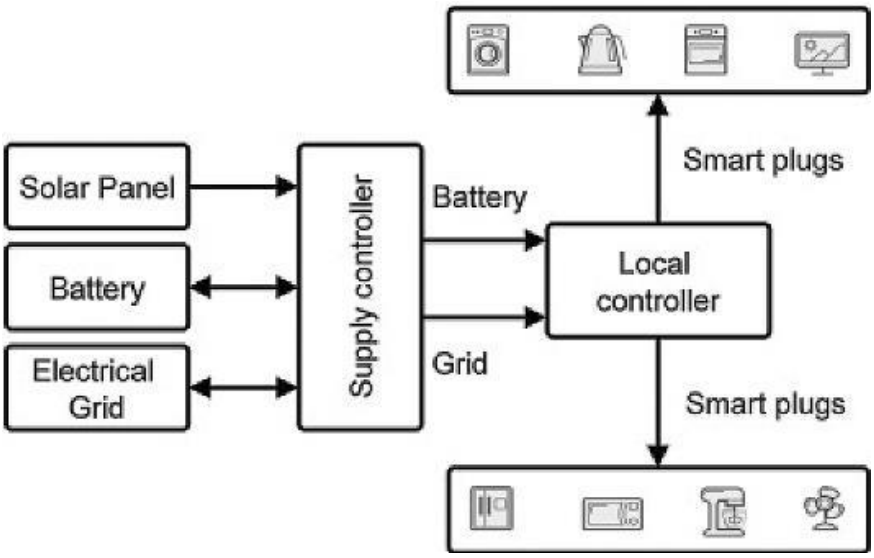

Fig. 5 Overall architecture of a representative HEM, Source : https://www.researchgate.net/figure/Overall-architecture-of-a-representative-HEM_fig3_342880357

The power business would be able to see and manage more of the system in real time and space if it had a smart grid. In order to maximise efficiency, the smart grid will facilitate real-time data exchange. All time scales of grid management could be accommodated, from microsecond-scale high-frequency switching devices to minute-scale changes in wind and solar output to a decade-scale future impact of carbon emissions from power generation.

Home Energy Management System

Concept of HEMS

"A Home Energy Management System (HEMS) is a technological platform made up of hardware and software components that enables users to track and regulate their household's energy use and output, both manually and automatically. Advanced Metering Infrastructure (AMI) devices have triggered a reliable communication mechanism between power utilities and residential customers under the umbrella of grid design.

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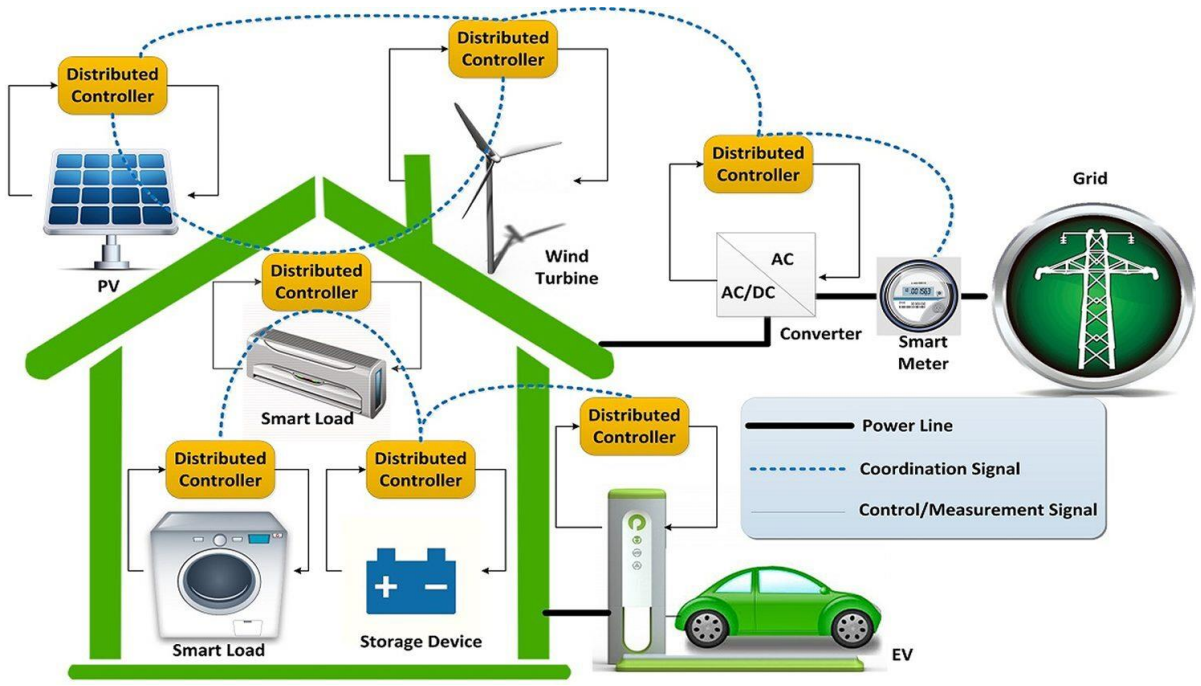

Image source : https://www.solarchoice.net.au/blog/home-energy-management-systems-a-smart-way-to-save/

There was an opportunity to include principles of economic incentives for a smart home to manage the demand-side resource by transitioning between peakload and off-peak periods as a technique to cut power costs via this communication channel. The interplay between the grid operators, utilities, and consumers is the key to all of the upcoming Smart Grid technologies working together. The primary goal of using HEMS is to provide the customer more control and visibility over how much energy they use, as well as the ability to utilise that energy more efficiently. Customers must be aware of how much energy is being used in their homes in order to do this, which can only be done if the whole house is monitored for energy use.

Functionalities of HEMS

The main goal of HEMS is to improve energy efficiency in homes and buildings. Additional goals may include electric utility benefits, such as controlling energy usage to reduce peak demand and support load shifting. To achieve these goals, the HEM needs to have certain functionalities and features explained below and shown in Fig 4".

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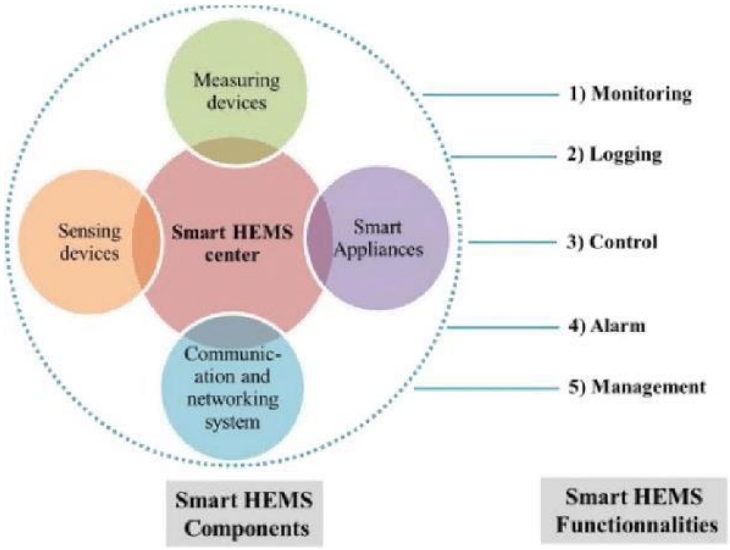

Fig. 4, Functionalities of HEMS, Source : https://www.researchgate.net/figure/Functionalities-of-HEMS-102_fig1_337602626

Devices and appliances in the house must be monitored and controlled by HEMS. Monitoring provides access to up-to-the-minute data on patterns of energy use in real time. A web interface or a phone/tablet application may be used to access device information. When you log, you keep track of how much power each device uses and save that data. Analyzing demand response (DR) based on real-time pricing is part of this feature set. The system must be able to employ an optimization strategy to intelligently react to DR signals and distribute resources to the residences in an effective manner for improved DR support. User control of the gadget in its most basic form should be accessible to the user. Control may be automated if the management system supports smart scheduling. In addition, equipment may be controlled locally or remotely via a variety of means. Information management: in the age of the smart grid, this Various gadgets may offer information on energy use at various granularities. When dealing with massive volumes of data, HEMS should be able to do so quickly and effectively. Here, alerts are created and sent to the smart HEMS centre, which has data on fault locations, kinds and other characteristics.

Conclusion

To begin, this research provides a detailed picture of how critical effective energy management is to society as a whole. As the need develops, the existing grid system, notwithstanding its current flaws, will simply lead to further problems as the demand grows. More people may be

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educated about switching to a more environmentally friendly system thanks to the rise of the smart grid and its developments. There are several features in HEMS that allow for energy use to be tracked, controlled, and managed in this manner. From a variety of options, the IOT-based Home Energy Management System (HEMS) emerges as the most effective option. Smart home management systems, despite their flaws that may be remedied, look to be a viable option.

References

1. Bandana Mahapatra, Anand Nayyar, "Home Energy Management System (HEMS): Concept, Architecture, Infrastructure, Challenges and Energy Management Schemes", Energy Systems, 2019.
2. Helia Zandi, Teja Kuruganti, Edward A Vineyard, David Fugate, "Home Energy Management Systems: An Overview", 9th International Conference on Energy Efficiency in Domestic Appliances and Lighting, 2018.
3. Bilal Mubdir, Asaad Al-Hindawi, Noor Hadi, "Design of Smart Home Energy Management System for Saving Energy", European Scientific Journal, Vol 12, No. 33, November 2016.
4. Jongbae Kim, Jinsung Byun, Daebeom Jeong, Myeong-in Choi, Byeongkwan Kang, Sehyun Park, "An IoT-Based Home Energy Management System Over Dynamic Home Area Networks", International Journal of Distributed Sensor Networks, 2015.
5. Mohammadreza Daneshvar, Mahmoud Pesaran, Behnam Mohammadi-ivatloo, "Transactive Energy in Future Smart Homes", The Energy Internet, 2019.
6. Yonghong Ma, Baixuan Li, "Hybridized Intelligent Home Renewable Energy Management System for Smart Grids", Sustainability, 2020.
7. Hartono BS, Sri Paryanto Murshid, Sapto Prajogo, "Review: Home Energy Management System in a Smart Grid Sceme to Improve Reliability of Power Systems", 2nd International Tropical Renewable Energy Conference, 2017.
8. Soren Aagard Mikkelsen, Rune Hylsberg Jacobsen, "Securing the Home Energy Management Platform", 2015. International Journal of Engineering Research & Technology (IJERT)