Microsoft

AI for Earth Grantee Profile

Symbiosis Institute of Technology

Smart meter data analytics

Summary

Smart electricity meters generate a wealth of data that can be used to improve energy management, enabling both reduced costs and reduced carbon emissions. Archana Chaudhari, JRF at the Symbiosis Institute of Technology (SIT), Symbiosis International (Deemed University) in Pune, India, with support from Dr. Preeti Mulay, is developing incremental clustering algorithms to take advantage of this wealth of data. When applied to smart meter and socioeconomic data, these algorithms will predict demand and peak loads; identify regional, seasonal, and community patterns in consumption; enable utilities to align generation with anticipated demand to reduce waste; and help consumers to plan their own electricity usage for lower demand and reduced carbon emissions.

Enabling better energy management for utilities and customers

According to the World Resources Institute (WRI), energy-related emissions make up more than two-thirds of India's overall emissions and represent more than three times the next largest source (the industry sector). Of the country's energy sector emissions, 77 percent are from electricity generation, making this a key target for reductions to meet India's climate, or nationally determined contribution (NDC), commitments.

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Despite this, India's emissions are still comparatively low on a per-capita basis, and the very size of the nation's population and the scope for them to increase make the country's emissions of global concern. India's emissions from the energy sector are the fourth largest in the world (behind China, the United States, and the European Union), and rising.

One of the challenges facing India's energy sector is the capacity of the grid to accommodate renewable energy. As the country invests in renewable energy to meet national targets, it will have a potential surplus rather than shortfall in electricity. Yet, it faces technical constraints in using that energy. According to analyst

firm Brookings, to avoid curtailing renewable energy generation, the country needs "a stronger grid, cheap storage, and the ability to shift load to match supply conditions."

In parallel with these challenges, in India today utility companies still rely on manual electricity meters to track consumption at residential and industrial locations. Local utility companies send employees to read these meters each month, and then generate monthly electricity bills. This system does not provide the utilities with insight into electricity consumption patterns, for example, based on time-of-day usage, nor does it enable consumers to understand their electricity consumption as part of the larger picture of electricity availability.

Smarter energy management with smart meter data analytics

For Archana Chaudhari, smart electricity meters combined with machine learning analytics represent a key opportunity to address these issues. This combination can provide insights that will help utilities better understand energy usage in real time, streamline the process of energy distribution, and ultimately reduce both electricity waste and carbon emissions. Consumers can also benefit by understanding peak usage, and potentially shifting loads to periods of lower-emission generation.

> Chaudhari aims to combine smart meters, cloud storage, and algorithmic data analysis to unlock efficiency in India's national energy grid.

Smart meters are electronic devices that record and transmit customer energy consumption data to utilities in time intervals of one hour or less. In addition to saving the laborious process of manual meter readings, smart meters enable utilities to monitor energy usage in real time. Furthermore, they generate a huge volume of incremental data.

It is this data that Chaudhari is interested in. Specifically, she is exploring how she can use smart meter data analytics to improve energy management. Her approach combines both the data generated by smart electricity meters and related socioeconomic data, including the weather conditions at the meter installation sites, customer data, geographic information, demographic data, and sustainability data. Given the volume of data and the number of data types involved, smart meter data analytics are highly complex. Through a Microsoft AI for Earth grant, Microsoft Azure will provide the processing power necessary to handle the data analytics. Chaudhari will conduct research in three phases:

1. Generate data from real-world smart meters in specific locations in India (validated for performance and quality against comparable data from the Commission for Energy Regulation Smart Metering Project in Ireland).

2. Use Azure Machine Learning to build the preliminary learning model, using incremental clustering algorithms—intelligent algorithms that incrementally cluster new data as it is added. For this research, Chaudhari will use a Correlation-Based Incremental Clustering Algorithm (CBICA) and a Closeness Factor-Based Algorithm (CFBA) to cluster data based on both consumer electricity consumption and utility energy generation, with the goal of designing targeted demand response programs.

3. Use Azure Stream Analytics to ingest new data in real time and compare it with historical data for analytic computations, making the results available immediately.

The system will support advanced customer segmentation based on energy consumption patterns, energy efficiency benchmarking, and root cause analysis to help customers improve energy efficiency. Chaudhari foresees using the data to better understand electricity requirements within specific regions and communities. Ultimately, her goal is to quantify potential reductions in both electricity consumption and carbon emissions:

- For utilities, by identifying peak demand, forecasting overall energy demand, and improving energy flexibility. This could help them make better use of existing generating capacity and intermittent renewable sources of energy to match highly variable demand, rather than building more power stations to cover anticipated peaks, and wasting energy at times of lower demand.

- For consumers, by better understanding energy consumption to enable savings in terms of energy and costs.

The analysis will identify potential reductions in two ways: (1) direct reductions, where the analytics lead to savings in energy and/or reduced emissions through decreased electricity consumption or reduced generation; and (2) indirect reductions, where cost savings enable reinvestment in energy efficiency or renewable resources.

Potential for broader application

Chaudhari is currently working with a utility in Kalwa, Thane (a metropolitan region on the outskirts of Mumbai) that uses a range of electricity sources, including hydro, solar, and conventional generation, as well as a Pune-based non-governmental organization (NGO), Prayas Energy Group, to collect data and improve the algorithms. In the longer term, she hopes to apply this approach more broadly, both geographically (conducting analyses in several other countries worldwide) and to other types of smart meters, such as those used with natural gas and water.

About the project team

With a Bachelor's degree in Computer Engineering and a Master's degree in Engineering, Archana Chaudhari is a Junior Research Fellow at the Symbiosis Institute of Technology, Symbiosis International (Deemed University) in Pune, India. Chaudhari endeavors to address the issue of energy wastage on the national grid. As part of her PhD, she has taken on this project to deploy smart meter data analytics across metropolitan cities in India under the guidance of Dr. Preeti Mulay, Associate Professor, Symbiosis Institute of Technology, Pune, India. They plan to publish her findings in two journal articles before the end of 2019, prior to deploying the solution.

Resources

Websites

Microsoft AI for Earth

Microsoft environmental sustainability

Press

"Green warriors from India receive Microsoft AI for Earth grants to enable a sustainable future." Microsoft News Center India. November 2018.
https://news.microsoft.com/en-in/features/microsoft-ai-for-earth-grant-recipients-india/

References

Subrata Chakrabarty. By the Numbers: New Emissions Data Quantify India's Climate Challenge. World Resources Institute. August 8, 2018. India. Climate Watch. Washington, DC: World Resources Institute.

Navroz K. Dubash, Ankit Bhardwaj. Guest post: India's emissions will double at most by 2030. Carbon Brief. August 22, 2018. Rahul Tongia. Embarrassment of riches? The rise of RE in India and steps to manage "surplus" electricity. Brookings. June 15, 2018.