Building on belief

Transformation in the Electric Utilities Sector

Driving efficiency and intelligence with data and advanced analytics

Abstract

The electric utilities sector is undergoing a global transformation spearheaded by technology-driven improvements in operations and active customer participation in the energy ecosystem. Such transformation generates large volumes of data from new field devices, software systems, and stakeholders. Data is also generated from existing enterprise systems such as geographical information systems (GIS), asset management systems (AMS), network management systems (NMS), and customer information systems (CIS). A systematic analysis of such data can provide valuable insights into improving operational efficiency and business resilience, leading to better decision-making.

This paper discusses how data can be a game changer for electric utilities and the need for a cross-functional and persona-based data analytics platform.

The Wave of Change Impacting Electric Utilities

Driven by decarbonization, digitalization, and decentralization, electric utilities are witnessing a paradigm shift in grid operations and control[1]. Distributed energy resources (DERs) are added to networks for generation, consumption, and storage, thereby changing unidirectional power flows to bidirectional ones. Solar and wind generators are connected at all voltage levels and battery storage units are interlinked to manage excess energy in grids. Electric vehicles (EVs) with fast and regular charging units are also being added to the grid.

As agility, automation, and real-time interactions become crucial, several systems will be in demand simultaneously—virtual power plants, microgrids, demand response management systems, GIS, advanced distribution management systems (ADMS), distributed energy resource management systems (DERMS), and meter data management systems (MDMS).

In moving from a regulatory to a deregulatory regime, utilities are evolving from service providers to service enablers with data at their disposal. The rise of the internet of things (IoT), blockchain, and DERs have accelerated this trend further.

[1] Emergency Preparedness Partnerships; The Three Ds of Power Sector Evolution; https://emergencypreparednesspartnerships.com/three-ds-power-sector-evolution/

Data and Analytics for Electric Utilities

The dynamic topology of the grid demands real-time decision-making. In addition, handling multiple constraints like trading, balancing, and stability while operating the network, adds to the complexity of managing the grid. Inadequate data storage and processing capabilities and a lack of a common data model spanning customers, assets, operations, etc., result in limited data utilization. Moreover, insufficient data sets (structured and unstructured) create multiple sources of truth and restrict the availability of ready-to-use data.

Furthermore, the limited integration of enterprise core systems such as billing, CRM, ERP, and more with operational systems like SCADA, GIS, and AMS leads to manual cleansing, consolidation, and curation of data and isolated maintenance protocols. Above all, electric utilities are challenged by an aging infrastructure and the overwhelming demand for Industry 4.0 solutions.

As utility applications historically evolved in silos, gaps among different applications and their data sets are common. For example, to identify consumers whose current power consumption is greater than a specific value and who have also not paid their bills for a certain period, utilities need to collate data from the operational parameters of smart meters and outstanding invoices. Similarly, determining the predictive proximity of overhead conductors from nearby vegetation that needs data from GIS, AMS, and satellite imagery, is another way utility firms can close the gap across applications. Besides the two instances mentioned above, electric utilities can conflate outage data from smart meters and OMS to pinpoint and direct field personnel to the exact span or location of an outage.

Asset management, including performance monitoring of assets, is another area of focus for data analytics. Electric utilities mostly employ conventional inspection methods like condition monitoring, SCADA monitoring, and tracking outages through the OMS to manage their assets. Although such tracking provides operational insights about the assets, details of the asset exterior, including leakages, damages, and more, are often overlooked. Such critical analysis is possible by considering other relevant data like asset images, fault data, environment data, and financial costs involved with asset failure.

Besides asset management, stakeholder expectations in an analytics solution vary in the utilities sector. While a CXO may want to understand prospective capital and operational expenditure (CAPEX and OPEX) investments, a network operations manager may be more interested in network reliability indices or service level agreements (SLAs). Similarly, a field engineer may be interested in detailed asset condition metrics and customer-level energy consumption patterns.

Benefits of Data Analytics for Electric Utilities

The benefits of harnessing data include preventive rather than reactive maintenance, resulting in optimized maintenance costs, less rework, little to no breakdowns and grid failures, reduced compensation pay out due to accidents/outages, and more accurate decision-making. Several techniques based on a combination of business rules, algorithms, machine learning, data mining, statistical analysis, and more can be used to derive inferences from multiple data sets. This includes historical, transactional, and real-time data feeds. Linking different systems through meaningful common identifiers will be key to developing such analytics. In the future, post-mortem reports on grids can be replaced with prescriptive and predictive analytics in a dynamically changing operational environment. Tangible outputs in dashboards, charts, heat maps, and tabular representations will simplify decision-making, while different what-if analyses will provide a massive leverage to operations, planning, and strategy.

The Need for a Data Governance Module

To develop cross-functional insights, making sense of assets and data across systems are critical. This also means seamless integration across operational and information technology (OT-IT) systems and data exchange with third parties. Such integration may be achieved by bringing data from multiple sources onto a single repository and then processing the same further, based on requirement.

Since existing applications have historically been developed and operated as silos, there must be a concentrated effort of sanitizing disparate and disintegrated data sets into an integrated, compatible, and standardized model. This will involve planning the database architecture according to required data sets, proper mapping, rule-based automated cleansing and execution, and creating logical data sets if some are missing. A data governance model is necessary to take care of standardizing data ingestion processes, processing, updating, publishing, and archival for maintaining the data quality and usage.

A Data Analytics Platform for Electric Utilities

A platform for such analytics will have to extract and store data from multiple systems. Some of these will be structured data from enterprise systems like GIS, asset management, and CIS, while some will be semi-structured data from file-based systems or third parties. Others will be unstructured such as e-mails and image data. The extracted data will then be cleansed, curated, and merged to make it suitable for various reports, analytics, and dashboards required by various decision makers, including CXOs, operational staff, managers, and customers. This will make decision-making easier while reducing manual effort, improving accuracy, and increasing efficiency.

A conceptual architecture of such a platform is illustrated in Figure 1 below:

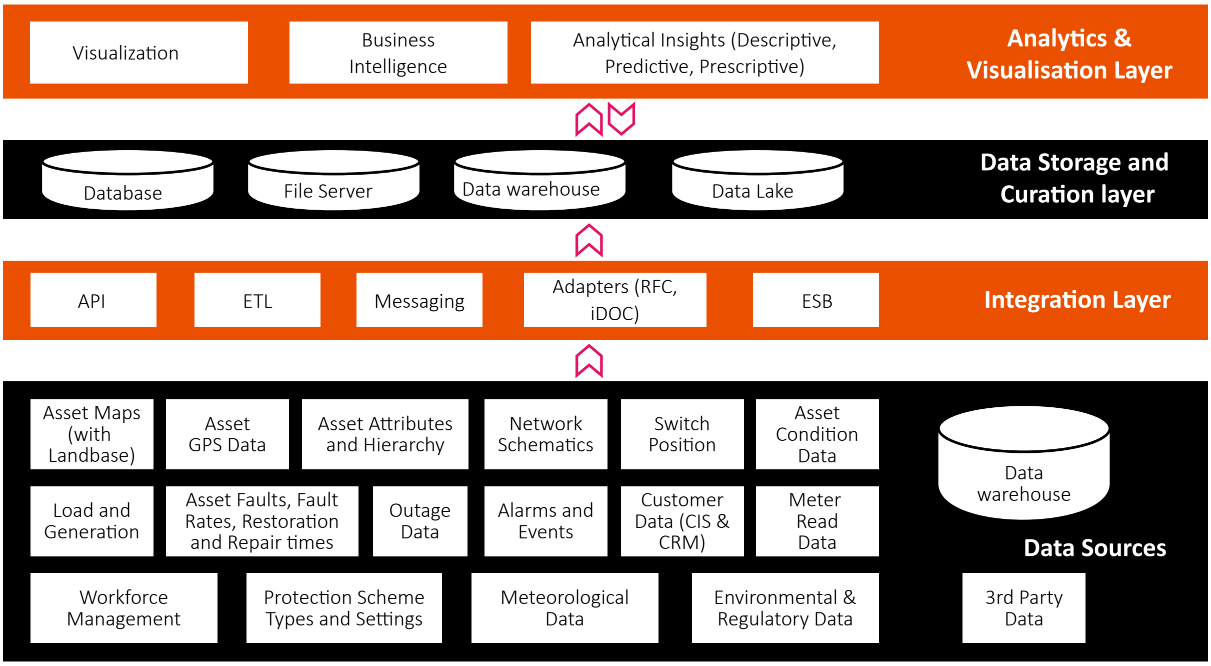

Figure 1: Conceptual architecture of an analytics platform

The platform will consist of multiple layers:

- Data sources: The lower layer is the data source that may include internal and external data.
- Integration layer: This layer may comprise application programming interfaces (API), extract transform load (ETL), or extract load transform (ELT) processes, database connections, messaging queues, tool adapters, or enterprise service bus layers such as eWay IBM WebSphere, SISCO utility integration bus (UIB), and more.
- Data storage curation layer: This layer consists of cleansed and curated data partially or fully ready to be used by the analytics layer. Such data may be in a database, data warehouse, file server, or data lake.
- Analytics layer: Here, business intelligence, logic, and analytical tools are used to derive meaningful inferences and insights from the data. Such inferences may be further used to visualize data and insights in the form of dashboards, graphs, and charts.

Conclusion

The data platform, as described in this paper, will thus shift the decision making and operations of utilities from reactive and proactive (routine) to predictive and prescriptive. As more and more data are processed through AI and ML models, utilities can gain deeper, accurate, and real-time / near real-time insights on network, assets, incidents, consumers, and deregulated environments. Besides, costs and risks will also reduce considerably. Additionally, persona-based reporting and visualization will ease work processes to a large extent.

By improving efficiency and accuracy, enhancing asset performance, and reducing rework costs, the integrated data analytics platform can add significant value to the business of electric utilities.

About the authors

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Anupam Chakraborty is an Industry Advisor and a Domain Consultant for Utilities at TCS. He leads the grid modernization initiative and spearheads a couple of strategic initiatives on machine vision and smart meter analytics for the Utilities Business Unit. Anupam has nearly 27 years of operational, management, and consultancy experience spanning IT and electricity utility environment, electricity distribution, transmission, generation (including renewable energy and alternate sources), customer relationship management, commercial and financial functionalities, and business enterprise development. He has worked on multiple USAID projects and smart initiatives in his earlier assignments. He holds an electrical engineering degree from the Indian Institute of Engineering Science and Technology, Shibpur, India and completed the Executive Post Graduate Diploma in Business Management from the Indian Institute of Management, Indore, India.

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