BIG DATA FOR SMART POWER NETWORKS

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Abstract: This paper offers an overview of big data analytics for smart power networks and investigates the applications of big data analytics within smart power networks, focusing on the concept, technical challenges, techniques and tools for collecting, inspecting and visualising big data solutions ina smart power network context

Index Terms: Big Data; Smart Power Networks; Big Data Analytics; Power Grid.

I. INTRODUCTION

Over the course of the fourth industrial revolution, electricity consumption has changed in practice and nature. Global demand for energy is growing fast, leading to an even faster-growing demand for power. In the past, power supplies only tracked demand patterns, but looking forward, as more renewable poweris merged into the network, consumption will also need to be controlled, ensuring a balance between supply and demand [1]. With the increase of big data sources like smart meters and sensors, information from the power networks can now be obtained at frequent intervals to attain fine-grain monitoring and scheduling. The enabling of big data analytics within power networks provides an immense amount of data at different time periods. Analytical systems are vital for handling the growing amount of data and for mining more valued information from power networks. Existing network infrastructures suffer from unreliability due to the deficiency of controlled monitoring, smart analytics, and automation technologies.Recent studies have identified smart power networks as potentially a pivotal solution to these problems, in that by introducing Information and Communication Technologies (ICT) into power networks and integrating the data of all users (utility and consumers) proficiently, a sustainable, safe and cost-efficient supply of electricity can be guaranteed [2],[3]. Smart power networks comprise computers, controls, automation, and new technologies and equipment which, employed together, enable the system to respond quickly to altering power generation and demand [1]. Up to now, smart power networks and big data have usually been researched separately (for example, [4–6] and [7,8]); there have been few published analyses of the use of big data in smart power networks.

II. BIG DATA BENEFITS IN SMART POWER NETWORKS

Big data is defined as verylarge and unstructured information sets, which are therefore challenging to filter using traditional on-hand data processing applications [9]. 'Big' refers to the amount of data, its diversity, and the speed with which it is created (i.e. volume, variety, and velocity) [9,10]. In order to recognise the future role of big data within power networks, it is first essential to define the term 'smart grid'. This term was first proposed by Vu *et al* [11], who argue that a 'smart' safety and control structure is needed to maintain the dependability of the electrical grid, identifying that data stream and information management are fundamental parts of the smart grid.

The mainbenefits of big data in smart power networks include:

A. Stability and Reliability

Safety is a major priority in a power network. Examples of the safety benefits of big data include voltage stability, event detection, post-event analysis, and oscillation detection. With the emergence of big data analytics, it is possible to explore its capabilities for improving outdated monitoring and detection approaches [2].

B. Asset Utilization

In order to maximise asset utilization, organisations need to stay ahead of maintenance problems; the best way to do this is through useful insights gained from big data analytics. For instance, smart analytics can help companies recognise engine life cycle patterns. Analytics can also support a fast response to breakdowns and inefficiencies [12,13].

C. Customer Experience

Smart meters have recently begun to be deployed in public buildings, private houses and other places worldwide [14]. Smart meters enable quicker demand response, energy utilisation, real-time pricing methods, fraud detection, and forewarning of blackouts. All these applications need advanced analytics and ICT.

III. CLOUD PLATFORMS FOR BIG DATA ANALYSIS

Cloud computing is an emerging technology, widely popular due to its benefits in several areas. Chang et al [21] studied non-cloud and cloud big data with regards to data storage, performance, reliability and efficiency. They found that performance time is lower

for cloud-based big data, but non-cloud-based big data is more reliable and efficient. Sensors obtain various data and spread it to the cloud sub-systems via an application programming interface (API) and a transmission power system. The main stakeholders (e.g. operators, third party service providers, utility companies) can query the data uploaded in the cloud for many applications.

The advantages of this framework are many and include interoperability, cost sharing, security and distributed management [3]. Figure 1 illustrates a purposive cloud platform infrastructure for smart power networks, whereby data flows from power generation to end users. Valuable information is generated at each step in the power flow. Once analytics have been carried out on the collected data, both consumers and the utility itself can make informed choices based on the resulting insights.

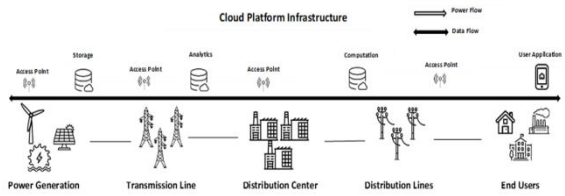


Fig 1. Framework for Cloud Platform Infrastructure in Smart Power Networks

To date, several industrial cloud platforms have been utilised for smart power network big data, such as: Google PowerMeter [22], a platform to trail the end users' energy utilization, constructed on the cloud platform Google APP Engine; and InterPSS [23], an web application grounded on open source power system simulation, aimed at evolving a cloud data based simulation network for applications in smart power networks. Other cloud computing platforms have been applied including Predix, Chord, MindSphere, etc. [23-25]

CONCLUSION

The status of big data has been investigated in terms of its research and engineering applications. Big data technologies are being developed along with smart power networks to make people's daily lives more efficient and manageable. This paper has discussed the benefits and applications of big data analytics in the power grid. It has also highlighted the frameworks for cloud platform infrastructure necessary for managing and storing the big data collected from different sensors and meters across the power network. Arguments have been made for cloud platforms needing to be revised and tailored to meet the future demands of big data. Finally, challenges and future opportunities regarding the exploitation of big data in smart power networks have been summarized.

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