Software: A Key "InGRIDient" For the Energy Transition

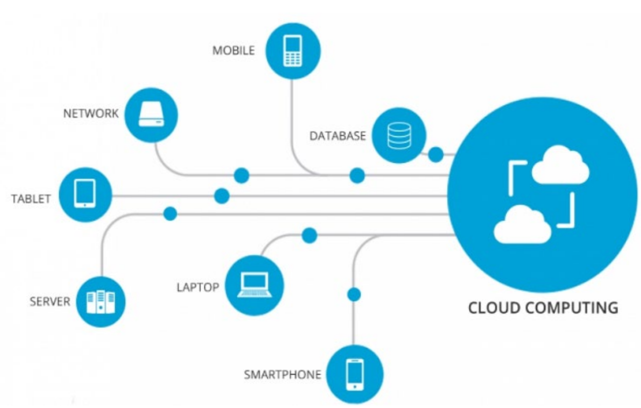
By Alexander Chmelev, Partner, GEC

Every industry has been or will be transformed by software.

Over a decade ago, Marc Andreesen famously said in his WSJ article that "...Software Is Eating the World." [1] And so far, he has been right. While that's true for many sectors of the economy – retail, finance, entertainment, telecommunications, to name just a few, there are outliers. Until recently, the transformation of the energy industry by software has not been as widespread. However, increased understanding and urgency around climate change, combined with greater demand for energy and electrification have produced the requisite appetite for change. The last century has seen few technical innovations in how energy is produced, however, the fundamental sources of energy production have remained the same – hydrocarbons, wind, solar, hydro and nuclear. The energy industry has generally lagged other industrial sectors in the adoption of automation and digital technologies.

Some of the more popular theories to explain this reluctance to change include decision making in the hands of the aging workforce: "my grandpa did it this way!"; high risk of failure of mission critical equipment; sheer capital intensity of the projects; deeply integrated dependencies on specialized equipment based on legacy architectures, etc. Instead of debating what those reasons are, it's more interesting to focus on what's presently driving the change: ubiquity of innovation in search of product – market fit and ease of deployment and scalability in software, all enabled by cloud-based technologies.

Cloud-based Technology in Everyday Life



While the Energy Transition to cleaner and more sustainable energy sources to combat climate change is rampant these days, the industry is undergoing another, less often discussed transition, from legacy hardware and analog, human-driven operations to intelligent operations driven by use case specific software products.

Unlike hardware, where R&D processes are lab centric and innovation cycles tend to be long, modern software development techniques allow for rapid experimentation to optimize efficiencies of existing hardware systems as well as to run simulations to discover new hardware solutions. Hardware innovation tends to be dependent on improvements in properties of physical materials and design of complicated mechanisms where the time and cost of trial and error are relatively high.

Software based innovation cycles are much shorter. With the proliferation of on-demand cloud-based services (AWS, Azure, GCP) offering Infrastructure as a Service ("IaaS)" and Platform as a Service ("PaaS") solutions, a software startup can focus its time and resources on application development without having to worry upfront about digital infrastructure provisioning and management. As a business and its userbase scale, the organization can instantly grow the infrastructure to meet requisite demand without upfront capital investment. In turn, the development team can leverage widely available Software Development Kits (SDKs) and common API driven development frameworks for virtually any computational application. As a result, the time and cost requirements to bootstrap and deploy new applications have been greatly diminished. It used to take years to develop a new software product whereas now a new application can be developed within months.

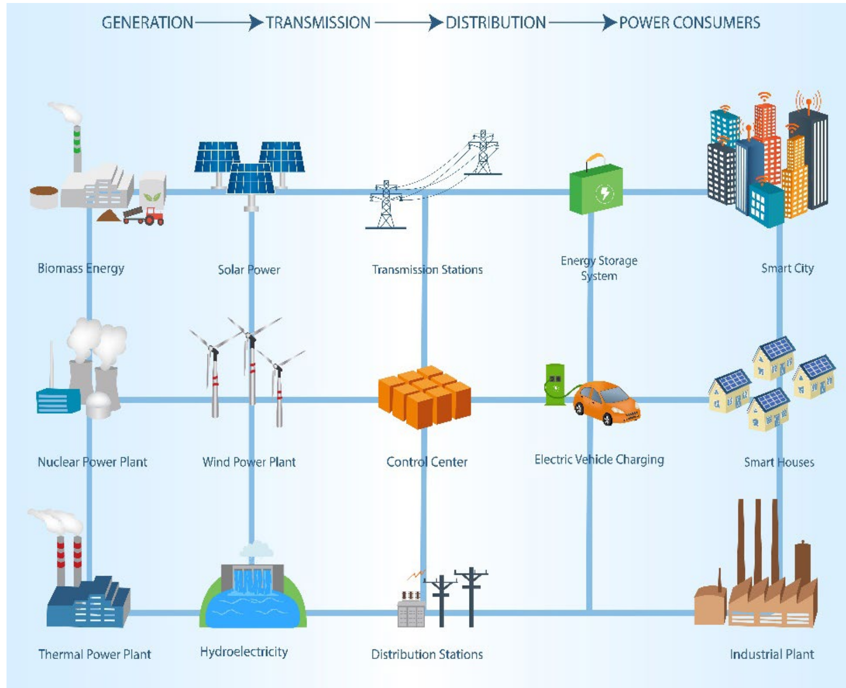
With the help of software, even those legacy hardware platforms can become intelligent and a step change improvement in productivity can quickly be realized without additional capital investment.

Role of Software in Energy Systems

Software can be developed bespoke to make any system or mechanism smarter, which tends to increase efficiencies and optimize operations. For example, the power grid has been called "The most complex machine built by man". [2]

The power grid in the US has evolved over more than 100 years since the first alternating current line was built in 1896 to connect Niagara Falls to Buffalo, NY. 70% of our country's transmission lines and transformers are over 25 years old.[3] The Grid was build based on centralized designs meant for a less dynamic world with more predictable supply and demand patterns. However, the power needs of today are more sophisticated. Interconnection and coordination of intermittent and widely distributed renewable power generation (solar, wind, etc.) with distributed energy storage (utility scale or residential batteries) introduce even more operational complexity. Dealing with this complexity requires flexible, intelligent controls with near instant decision making and response times. Instead of relying on traditional centralized generation, the Grid must intelligently operate and incorporate millions of decentralized power generation and storage nodes. This is analogous to the internet where billions of interconnected devices form a network of nodes providing data compute and storage capabilities.

Power Grid: Web of Interconnected Nodes



The Grid in essence is becoming the 'Web" of interconnected nodes, whose primary purpose is not transmitting information encoded in electronic signals but acting in a coordinated fashion to transmit electrons for power. Just like the Internet relies on the TCP/IP protocol to route information, the grid of the future will rely on common protocols to ensure power generation and consumption are properly coordinated and routed from source to destination. Furthermore, individual energy consumers can also play their part. For example, an industrial plant can shut down or idle certain non-critical operations to temporarily reduce their power demand to accommodate intermittency of generation or save on the electrical bill during periods of high prices. A household can reduce its power consumptions at certain hours or sell back excess solar energy to the grid. **Software is a key inGRIDient to make all this work.**

Distributed Energy, Decentralized Ledger

The rapid adoption of yet another software technology – Blockchain, can expand the possibilities further. Blockchain is a distributed digital ledger technology that allows participants from around the world to interact, transact and agree on the single source of truth about the state of the ledger without any middlemen. Furthermore, a call or an input to the blockchain, can trigger automatic execution of a "smart contract" – a certain predetermined set of program code that can in turn trigger interactions between parties, including transactions, assets, or information exchange.

Of course, today the most widely known and one of the oldest applications of the blockchain technology is Bitcoin. The underlying software protocol of Bitcoin is not sufficiently programable and composable to implement the intriguing blockchain use cases described above. Instead, Bitcoin's popularity is due to its growing appeal as a "store of value", which is why it's often dubbed as "digital gold". This sentiment is driven by the "scarcity" of Bitcoin argument. The underlying protocol cryptographically guarantees that there can only ever exist 21 million Bitcoin, and approximately 19 million have already been mined (created) as of the date of this writing. [4] Furthermore, the process of mining and operating the Bitcoin network, also known as "Proof of Work", is very computationally intensive and is predominantly performed by dedicated data centers or "farms" of specialized computers. Proof of Work is very energy and capital intensive. In fact, the entire global network of Bitcoin nodes consumes more power than certain countries. Nevertheless, the "always on" energy intensity of bitcoin data centers makes them a very good "base load" for the electrical grid. The operators of these data centers can enter into a Demand Response contract with the local utility and agree to power down instantly when called upon during the times of peak demand. Furthermore, bitcoin mining data centers can be located near sources of renewable energy, allowing asset owners to monetize excess electricity.

Applications of blockchain for the Energy Transition are fascinating. Consumers on the grid can trade energy with other consumers directly, bypassing their local utilities. A household with excess renewable energy can sell electricity to another consumer without physical access to renewable sources. Electric vehicles can act as distributed energy storage systems by storing and selling some of the electricity in their batteries to the grid while parked. More broadly, applications built on blockchain can eliminate supply chain inefficiencies by automatically settling payments based on certain criteria between vendors, contractors, suppliers and end customers. Bitcoin mining can stabilize the Grid and incentivize development of renewable energy assets in remote areas. Finally, because distributed ledger on blockchain offers a transparent, public, and immutable source of truth, consumers and suppliers can track origin and Green House Gas emission intensity of goods, including energy sources, as well as track carbon credits and renewable energy certificates.

Data and Computation Abound

The digitalization momentum of the Energy Industry is only expected to accelerate. Fueled by advancements in connectivity, computational power, and amount of available data for analytics, these trends are accelerating.

For example, in 2017, IBM estimated that 90% of all the data in the world has been generated within only the past two years. [5] Greater connectivity of mobile and Internet of Things (IOT) devices are producing ever increasing amount of data, which is readily accessible.

Continued persistence of Moore's law is geometrically driving down the cost of storing and processing all this data. Advances in machine learning and artificial intelligence techniques make the data more actionable and software systems more capable.

For decades, software investing has been primarily the domain of early-stage venture capital. This is changing rapidly and particularly in the vertical enterprise software space. While almost every new company and technology comes with some "venture" and "technology" risks, vertical B2B industrial software can quickly cross the "startup" chasm.

This is possible when a company develops a tool or a solution representing a "better mouse trap" to solve existing everyday problems or eliminate inefficiencies of the status quo in the industrial processes. In many cases, new markets do not need to be created; incumbents do not need to be disrupted. Product-market fit is evident. Instead, a new software product can be developed using proven, widely available cloud-based technologies to automate, streamline, track and bring forward actionable intelligence to legacy workflows underpinned by paperwork, spreadsheets or worse - inaction. **That's low hanging fruit.**

Take Cumulus Digital Systems, an Industrial SaaS software company, for example:

Case Study: Cumulus Digital Systems

Use of software allows industrial facilities, such as power plants, data centers, refineries, solar and wind farms to digitalize their operations to improve safety, increase efficiency and productivity of assets, lower operating costs and reduce energy consumption. The Cumulus WorkFlow™ platform manages any work activity and integrates with virtually any sensor or tool with compatible connectivity. WorkFlow is designed to be the digital foreman on the job site by keeping track of every step of critical work activities. The platform integrates checklists, photos, location information, and data from connected tools and sensors to provide a comprehensive picture of work quality and project status.

This technology creates the "built world" equivalent of an electronic medical record for each unit of work performed. Information is provided in real time, anywhere in the world. Problems are flagged as they occur which allows for invaluable monitoring of performance and accuracy. The system maintains detailed, auditable records of the who, when, and how of work.

Cumulus digitizes manual work that is mission-critical, high volume, and difficult to automate. The company was first incubated within Shell when it identified the opportunity to improve the quality and productivity of safety-critical bolted connection workflows. Today, as an independent company backed by GEC, Cumulus' technology is used to configure and visualize mission-critical work activities across a wide range of industries.

Representative Workflows

Companies like Cumulus quickly gain best-known enterprises as their customers and de-risk their technology. With a proven value proposition and customer traction, they are ready to profitably scale. These companies no longer need venture capital, they need growth capital and processes in place to capture their addressable markets and drive broad customer adoption. In 2017, the Economist published an article titled "The world's most valuable resource is no longer oil, but data". [6] With the benefit of hindsight, it's easy to agree.

Contact GEC to learn more:

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[1] The Wall Street Journal, Why Software is Eating the World, August 2011

[2] Phillip F. Schewe, The Grid: A Journey Through the Heart of Our Electrified World, 2007

[3] EIA, Major Utilities Continue to Increase Spending on U.S. Electric Distribution Systems, July 2018

[4] Blockchain.com

[5] IBM Cloud Object Storage, June 2017

[6] The Economist, The World's Most Valuable Resource is No Longer Oil, but Data, May 2017

