Optimising DERs: Artificial intelligence and the modern grid

AI | The optimal integration of distributed energy resources such as solar, battery storage and smart thermostats becomes an ever-more complex and pressing question. Rahul Kar, general manager and VP for New Energy at AutoGrid Systems looks at the role artificial intelligence can play in smarter energy networks

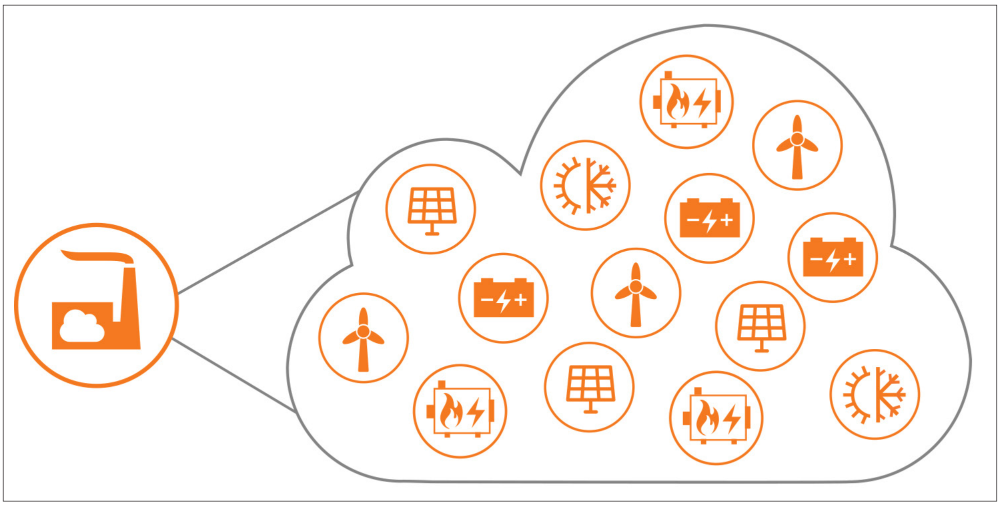
The modern electric grid is an engineering marvel and millions depend on it for reliable and on-demand power supply. The grid is becoming greener with the growing retirement of fossil fuel generation and the penetration of renewable energy, energy storage, electric vehicles (EVs), and a variety of other networked distributed energy resources (DERs). Such growth of DERs will continue at a rapid pace in the near future with rapidly reducing costs, favourable policies and increased customer adoption.

Integrating these DERs optimally — while maintaining grid reliability, delivering value, and maintaining customer preferences — is not an easy problem to solve. Especially considering that conventional methods have failed, simply because of the complexity involved and the need for scale.

Where utilities, grid and energy market operators once had to coordinate 9,000 power plants (and used supercomputers!) in the United States to match demand with supply, in the not-too-distant future, almost every rooftop will have a generating PV system coupled with storage. Coordinating across millions of such distributed systems will be impossible to solve using traditional computational systems.

Enter artificial intelligence (AI) for the modern grid, which uses a combination of three key technical elements to solve this problem: 1. machine learning for recognising patterns to forecast supply and demand; 2. high performance computing for optimisation; and 3. a modern Internet of Things (IoT) infrastructure to monitor and control the connected DERs.

With the right approach, the AI can aggregate all the DERs into a virtual power plant (VPP), that in essence is able to displace conventional sources of generation — thus mitigating harmful emissions and climate change consequences. And with cloud computing, which enables distributing and parallelising computations for forecasting and optimisation, these AI-based systems are cost effective as well.


Credit: AutoGrid

Many distributed assets are orchestrated to run the grid where once a limited number of centralised, large generators would have done.

The power behind trillions of data points

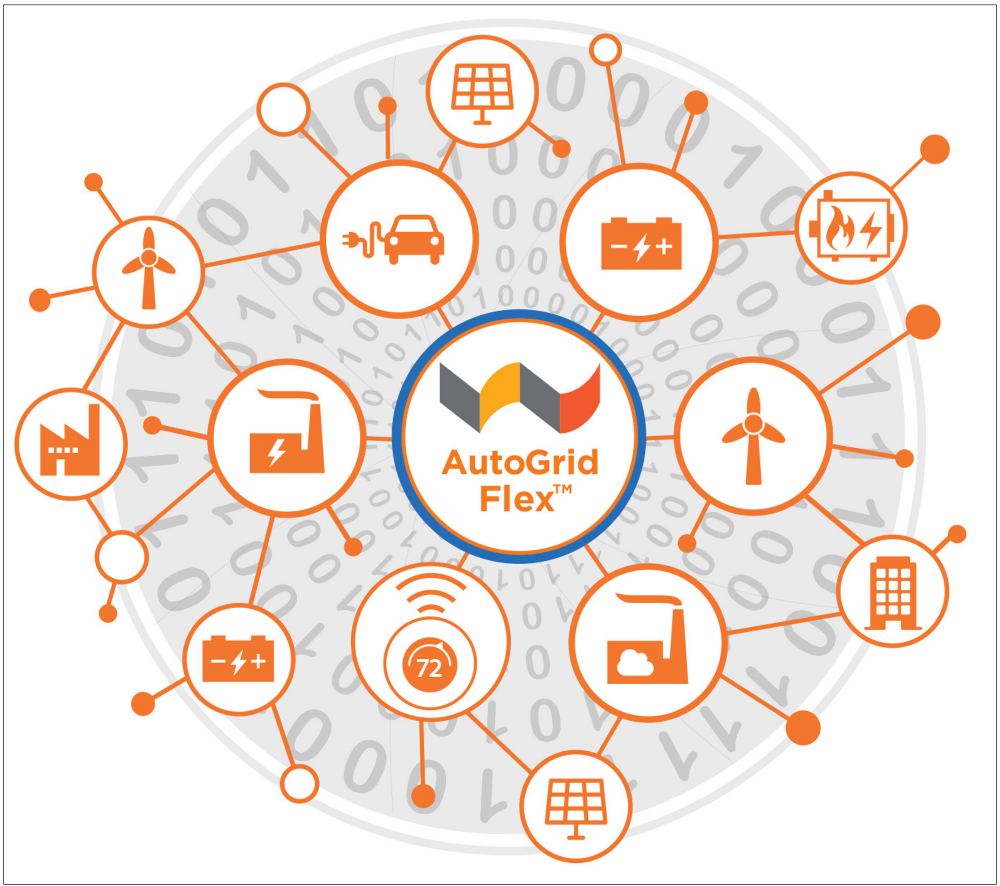
Connected assets — from household thermostats to large grid-connected solar farms — produce data every second on how much energy they consume or generate. There is immense value to the grid if this data is intelligently collected, aggregated, analysed, and enables decision-making by grid operators.

For example, using machine learning algorithms, one can forecast if a transformer will get overloaded or if there will be congestion in a certain part of the grid. Not only is this helpful for long-term grid planning, but it also offers real-time situational visibility alongside control of other DERs to mitigate any power quality issues.

Forecasts typically serve as critical inputs to downstream control and optimisation modules used by utilities and energy companies to drive enhanced grid operations. Examples of this include leveraging software applications to schedule customer demand response, reserve battery state of charge, or to guide operations of combined heat and power facilities to improve grid performance.

What is optimal?

Take a typical city street as a simplistic example, where you might find a house



Credit: AutoGrid

Flexibility is the name of the game

with a solar photovoltaic (PV) system and an energy storage asset, a large office building, and a hospital with a backup generation system. Let's say they are all enrolled in a utility demand response programme. Each building on the street has its own unique energy needs, ranging from the everyday to the critical, different rate tariffs, and varying abilities to moderate energy consumption. Given the capability to predict and control the consumption patterns of each building, would you choose to save on the energy bill for the end consumer or participate in demand response events for the utility and get paid? How about doing both? What is the optimal strategy?

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This is not a straightforward problem to solve because the economic optimal control is often not intuitive and rule-based approaches typically fail to scale. Imagine doing this, not just on one street, but for every utility feeder or substation, where many also have DERs like solar contributing to the grid energy mix.

This is where AI is able to handle the complexity and drive scale — load and generation forecasts feed into optimisers that provide outputs on the best way to operate. For example, for the battery in your home, the optimisation ensures that you can not only save on your bill but also make money from demand response incentives.

In the real world, scalability is essential for a comprehensive AI energy application. The modern grid, with an ever-changing pattern of generation and consumption, needs control strategies that account for the specific constraints of each site (for example, not turning off critical backup in a hospital).

At the same time, there is tremendous potential to create enough grid flexibility with control of on-site DERs. In other words, AI unlocks the flexibility of the assets and combines them in such a way that they become a reliable and dispatchable source of capacity for grid use — a virtual power plant (VPP)!

Grid operators can then utilise the aggregated DER portfolio to make decisions — either to delay building expensive infrastructure (non-wires alternatives) or reduce system peak to avoid turning on fossil-fuel based reserves. Complex solutions like wholesale market trading, ancillary services and increasing hosting capacity for renewables may also address this issue.

Intelligent use of AI

Ultimately, the success of any AI solution depends on combining industry subject matter expertise with data intuition and ingenuity. Co-locating energy experts with software engineers and data scientists leads to better training, testing, validation, and deployment of AI models. Discipline around data ingestion, quality, scalable software architecture and massive real-time processing capabilities are key in any energy AI application.

Going forward, the energy industry's need for AI solutions will intensify, as the grid becomes more distributed, with a growing number and types of DERs being deployed every year. Sustainability goals driven by compelling economics are already challenging the 'art of the possible' when it comes to energy infrastructure. Managing a growing machine as complex as the grid requires AI solutions that are scalable, robust, and DER-agnostic. That way we make the smart grid even smarter. ■

Turn to p.92 for the second part of this #SmartSolarStorage2020 double-bill feature exploring the cutting-edge technologies enabling greater integration of solar on to the grid

Author

Rahul Kar is responsible for revenue growth, product development, solutions design and delivery of the New Energy business unit at AutoGrid, which has developed a platform for integrating all distributed energy resources using cutting-edge analytics and in-depth energy data science. He has over 15 years of experience developing and successfully delivering innovative energy solutions for industries, utilities and the government.

Digitising the solar revolution

Blockchain | Our ability to generate renewable energy is scaling up fast, and solutions to integrate that energy will rely on technologies like blockchain to help keep new solutions on track. Power Ledger's executive chairman and co-founder, Dr Jemma Green, looks at the role blockchain plays within her company's platform to integrate and automate solar energy trading and balancing


Credit: Power Ledger

Power Ledger's blockchain platform has been used since 2018 to track renewable energy trading between 18 households in Fremantle, Western Australia

With the COVID-19 lockdown still in effect, our team has been working from home more frequently. This has given me pause to observe the solar panels on roofs in my neighbourhood.

It's inspiring to see so many people embracing a renewable energy source, but I'm reminded that no matter how good its products are, the success of any business is largely determined by economic conditions.

That's an insight I saw played out many times during my career with J.P. Morgan in London. And it's influenced my work in environmental sustainability to help create Power Ledger – an energy trading platform that uses blockchain technology to record and track renewable energy transactions.

Power Ledger's mission is to deliver clean, low-cost and resilient distributed energy markets by providing a market mechanism for energy trading and fostering the economic conditions for its long-term success.

Because despite the best intentions of environmentalists, simply swapping grid power for solar panels or replacing coal-fired power stations with wind farms creates grid instability. Unless the right economic conditions are created and sustained, renewable energy may cause as many problems as it solves.

And digital solutions like Power Ledger's blockchain-facilitated energy trading platform, which can dispatch battery-sourced energy in the peak, and stabilise the grid, seem to be in the right place at the right time.

So, while the socially distant view of my neighbours' renewables reminds me of the green energy sector's many challenges, I'm also fired with the belief that our sector finally has an enormous opportunity in its grasp.

Solar panels and algorithms

Over many years the global energy sector has been transitioning from a centralised system with a small number of very large power plants, to a distributed cleaner electricity grid. On a macro scale, we are seeing wind, solar and even wave-based renewable technologies supplementing and replacing coal and gas fired power stations. And on the micro level, solar panels, smart meters and battery storage are alleviating demand on the fossil fuel-powered grid.

The opportunity Power Ledger has identified is to link the macro of green energy production to the micro through a trading platform that businesses and everyday consumers can use to trade energy peer-to-peer and to the market to stabilise the system. There are many possible configurations.

A household with solar panels can sell excess power to a neighbour. A household with a battery can sell services to the grid to keep it stable. Another household using the Power Ledger platform can choose to source its power from an external renewable source. Businesses can do the same, either selling their excess renewable power or using the platform to tap into a green source.

Even those without solar panels can

still access renewables from sellers in the Power Ledger network and its partner retailers.

All of this is made secure and convenient through the Power Ledger platform's use of blockchain technology to record and track energy transactions. This allows for greater transparency, increased automation and reduced possibility of human error.

For energy retailers, the blockchain-enabled platform improves efficiencies by enabling peer-to-peer (P2P) transactions, virtual power plants (VPP) from small batteries combining, renewable energy certificate trading, as well as energy provenance tracking.

The apex of all of this is to create an economically viable market for renewable energy, driven by secure peer-to-peer trading that fosters true demand.

Power Ledger in action

Blockchain technology can create a decentralised market for VPPs and P2P energy trading as it can handle transactions and payments on both sides of the meter, in real time, at a lower cost to all involved. Using a blockchain can facilitate cross-retailer trading and settlement too, fostering network market effects such as greater liquidity and efficiency in the market.

An example of our technology's potential is Power Ledger's partnership with green energy retailer ekWateur in France using our blockchain-enabled product Vision, which certifies the origin and source of renewable energy and allows customers to choose their own mix.

More than 220,000 electricity meters across France are gaining access, so that households can choose their power sources, including renewables like wind farms and neighbouring solar panels. Every transaction is securely traced and tracked and the whole process is made as simple as possible for users.

Whilst the ekWateur partnership is just one example of the power of sharing energy, it also demonstrates the new products and services being built on top of the grid.

Generating virtual power plants

Grid stabilisation services have historically come from traditional energy sources like coal and gas-fired power plants. But as there are fewer of these and more solar the grid is becoming unstable.

Batteries, coupled with the Power Ledger platform's VPP feature, allows

A rooftop solar installation in Bangkok, Thailand, where the Power Ledger technology has been introduced

Credit: Power Ledger

energy stored to be dispatched to stabilise the grid. This arrangement encourages more people to use blockchain-enabled trading technology, creating a larger network of users that bolsters the economic viability of renewables and provides a low-cost and stable energy system.

This is more than simply placing solar panels on a roof or installing a smart meter – this is an entirely new marketplace of energy trading that can be activated with the flick of a switch.

The benefits of using blockchain

The reason Power Ledger has based its trading platform on blockchain technology is twofold: firstly, it's secure and fast and secondly, it creates new efficient markets.

Through blockchain, users can trace and verify that they are receiving energy from renewable sources and have confidence that their financial transactions are being securely recorded and enabled.

More crucially, blockchain connects smaller buyers and sellers together in a low-cost fashion and allows for faster settlement compared to longer settlement periods with the current energy market. With blockchain, settlement can be achieved in real-time.

The advantage of simplicity, speed and security is that consumers can embrace the technology quickly and become part of a growing global network, creating more demand and opportunities for fulfilment.

This allows the marketplace to grow and provide a viable and reliable economic base for the renewable energy sector.

Creating green economies of scale

To build the operating system of the new energy marketplace, we need to ensure the existing infrastructure has the required supporting technologies.

With Power Ledger's energy trading platform now in use in Australia and nations such as France and Thailand, the technology is helping to redefine how energy is distributed, managed, traded, used and governed.

Blockchain technology has the potential to transform the energy sector as it improves transaction efficiency, enables price setting and allows for energy to be traded easily peer-to-peer.

The next challenge is that of scale – to deploy blockchain enabled trading of energy across as many networks and sectors of the market as possible.

Whilst Power Ledger is seeing successful take up of its technology offering, I believe the time is ripe for more rapid shifts in energy systems and markets.

My hope is that the challenges faced by the renewables sector in the coming years will not be how to grow, but how to keep up with the demand for growth.

Author

Dr Jemma Green is the executive chairman & co-founder of Power Ledger, a blockchain technology company focused on revolutionising green energy generation and distribution. With a background in investment banking and sustainability, Dr Green was a 40under40 winner in 2016 and in 2018 received the EY Fintech Entrepreneur of the Year award.