Digitalisation and its impact on the solar energy industry

Business processes | Digital technologies have the potential to transform the solar industry as it continues to seek greater efficiencies and lower costs. But as Dana Olson writes, a lack of both digital skills and mindset within organisations are key barriers to realising the full benefits of the technologies now available

Credit: skytron energy

A suite of digital technologies is now available to the solar industry that could transform the way the industry operates

The solar industry is constantly changing. Over the next 30 years, DNV GL forecasts that solar will play an integral role in the the electricity mix, with solar PV forecasted to make up 40% of electricity generation by 2050.

Advances in technology and the remarkable decrease in component cost are accelerating the progress of the solar industry. Over the past decade, we have seen the cost of solar panels fall significantly, making solar energy a competitive solution for electricity generation in many markets already. Solar is expected to be the lowest cost option for electricity in many parts of the world over the next three decades. But with this cost decrease comes mounting pressure for this industry to do more with less and find new ways to remain competitive.

As we consider the distributed nature of solar PV, the efficiency to scale from utility projects down to small residential systems has required the development of digital tools and mechanisms. From software for system design to the financial transactions that enable them, solar has demonstrated many times over that efficiency and market scale come from the utilisation of digital tools. Digital technologies have been responsible for much of the growth in the solar industry to date. As we look to the future, it is evident that digitalisation will play a significant part in solving the industry's challenges.

Defining the phases of digital transformation

Part of decoding the significance of digitalisation is to develop a well defined understanding of what this term means and how it is currently used. Digitalisation has become a trendy buzzword, often overused and poorly understood. Therefore, we must go beyond the hype to understand digital transformation like any other vital business process. Once we establish a clear understanding, it will be easier to create future roadmaps to further advance the solar industry.

We define digitisation as the process of converting information into a digital format, making it easier to preserve, access, share, and analyse data. Once we have information in digital form, we can then handle and benefit from it in ways not previously accessible.

The next phase in the process is digitalisation itself, which is the use of digital technologies to change a business process and enhance efficiency and revenue. Digital technologies include software, sensors, electronic hardware, and communications technologies. Digitalisation allows one to develop further, more sophisticated, technological tools to reduce the cost and increase the efficiency of processes, while making better, more consistent business decisions.

The final phase lies with digital transformation, which uses the many digital technologies along this path to change a business model and provide new revenue and value-producing opportunities. Transformation is enabled by digitisation and digitalisation to extract further value from the transition based on having the data and tools necessary to address new business opportunities. Digital transformation often substantially reduces market barriers and may increase efficiency beyond that previously possible.

DNV GL recently surveyed approximately 1,900 energy industry professionals from start-ups to large corporations – to examine their current progress in digitalisation, uncover which digital technologies are making an impact, establish what barriers the industry is facing and identify how organisations can take advantage of the many opportunities that digitalisation presents. This survey data has then been used to evaluate the digitalisation of the solar industry, especially relative to the larger energy industry as a whole.

Current progress toward digitalisation of the solar industry

Our research reveals that 40% of respondents in the solar industry have digitalisation as a core part of their publicly stated strategy. However, just 20% of the surveyed solar organisations feel more advanced than the industry in their application of digitalisation.

Overall, large companies were more likely to have digitalisation as a core

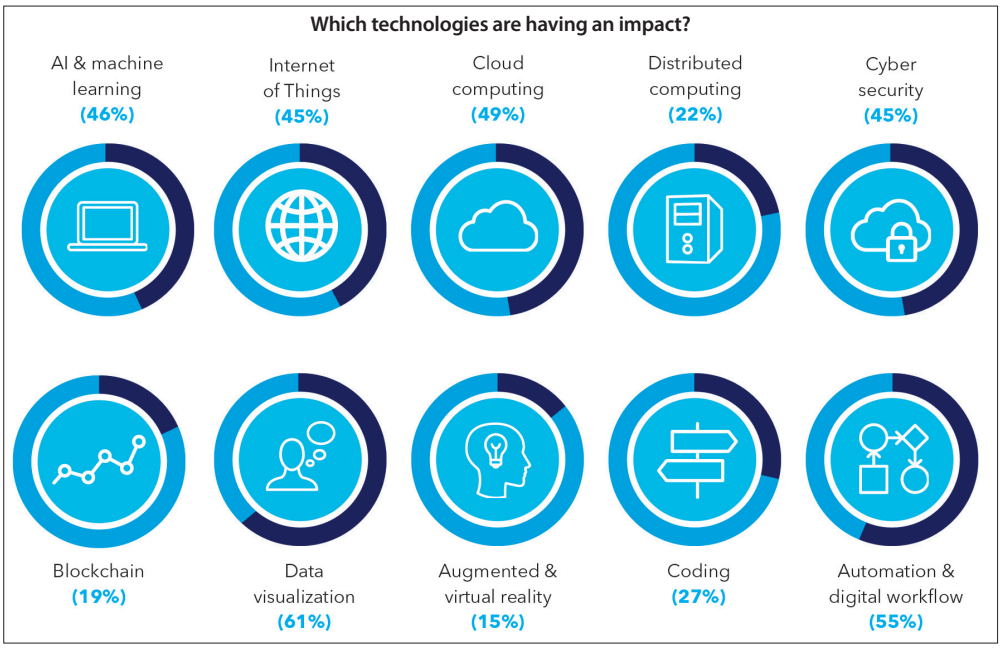

Figure 1. Percentage of respondents who said the following technologies were having an impact on their organisations

part of their public strategy, with small companies less publicly focused on digitalisation. This could indicate that large organisations are leading the way in digital maturity. However, when asked whether digitalisation was included in their internal strategy, the findings were reversed with smaller companies more focused on digitalisation internally than large organisations. This suggests that larger companies might be more concerned with creating a public digitalisation strategy than building digitalisation into their core business processes.

In today's security-conscious world, it is not surprising that cyber security is the most established focus of digitalisation. Overall, the survey found that 40% of respondents consider their organisation to be advanced in cyber security. Automation follows closely behind and is also widely implemented, with only 10% of respondents not taking advantage of its capabilities at all. The survey found the most common applications of digital workflow and automation are asset optimisation, product and process improvement, planning and strategy.

However, implementation is only one part of the picture; the real value in any technology deployment is being able to prove the impact it has on an organisation. Positively, 67% of respondents say automation and digital workflow is already having a significant impact on the energy industry, and this figure rises to 93% for large organisations.

Technology at a glance

To address value in terms of what digital tools or technologies are being assessed and implemented in the solar industry today, we reviewed the responses on the perceived value of these technologies.

Cloud computing

Our research indicates that the solar industry is leading the way when it comes to cloud computing with 35% of respondents saying their organisations were advanced in this technology. Much of this is the result of system design and layout tools, SCADA monitoring, and some financial asset management software offering cloud-based tools. The opportunities for moving more development, monitoring, O&M and finance tools to the cloud is very important to continuing to improve efficiency, lower cost and enable big data methods.

Drones

Compared to the energy industry as a whole, drones, aerial imaging, and image analysis are already having a greater impact in the solar industry. There are dozens of drone providers worldwide, who can offer lower inspection costs with higher resolution on finding panel and system defects, and support O&M practices, whilst further lowering associated inspection costs. Additional services are offered for pre-construction site surveys and inspections as well as construction monitoring. These are all supported by remote drone imaging technologies, but are further enabled by big data and machine learning methods for image analysis in the cloud.

Internet of Things

The energy industry considers IoT (Internet of Things) an important skillset to have in the future. While we are flooded with IoT innovations for our homes, significant progress is already at play in well-instrumented solar plants today; in such examples, sensors fitted to PV systems feed information back to operators on the irradiance, temperature and performance of systems, which is then coupled to detailed performance data at the inverter level. The resolution therein is increasing with the use of string inverters to better gauge the performance of strings relative to one another. Extracting the relevant data and utilising methods to inform plant and grid operators alike will lead to continuous improvements in the operation and further integration of solar assets.

Blockchain

The perceived value of blockchain technology is higher in the solar industry at 12% than the 8% across the whole energy

Big data and machine learning technologies can be applied to data collected by drones to monitor plant performance

Credit: Skycatch

industry. Blockchain technologies envision a future of decentralised energy transactions, renewable energy provenance, metering and billing. While there was substantial interest over the last few years, blockchain technologies are not yet having significant effects on the solar industry. Those that are making initial progress in this space are working toward enabling distributed, peer-to-peer marketplaces in which energy transactions can occur outside of more traditional consumer-utility models.

Technology needs in the solar industry

The solar industry is presently using a range of technologies that include a significant amount of automation enabled by digital workflows. This includes the advanced analytics, IoT and cloud computing described above. However, other opportunities will require additional investment by industry and researchers alike.

Machine learning and advanced data analytics are high-profile topics regarded as offering substantial value today and in the future. Data cleaning and algorithm training will be invaluable for the development of new tools and for establishing connections between measured and simulated performance data. Advanced data analytics, enabled by machine learning will help derive additional value from rich operational datasets and enable enhanced forecasting models.

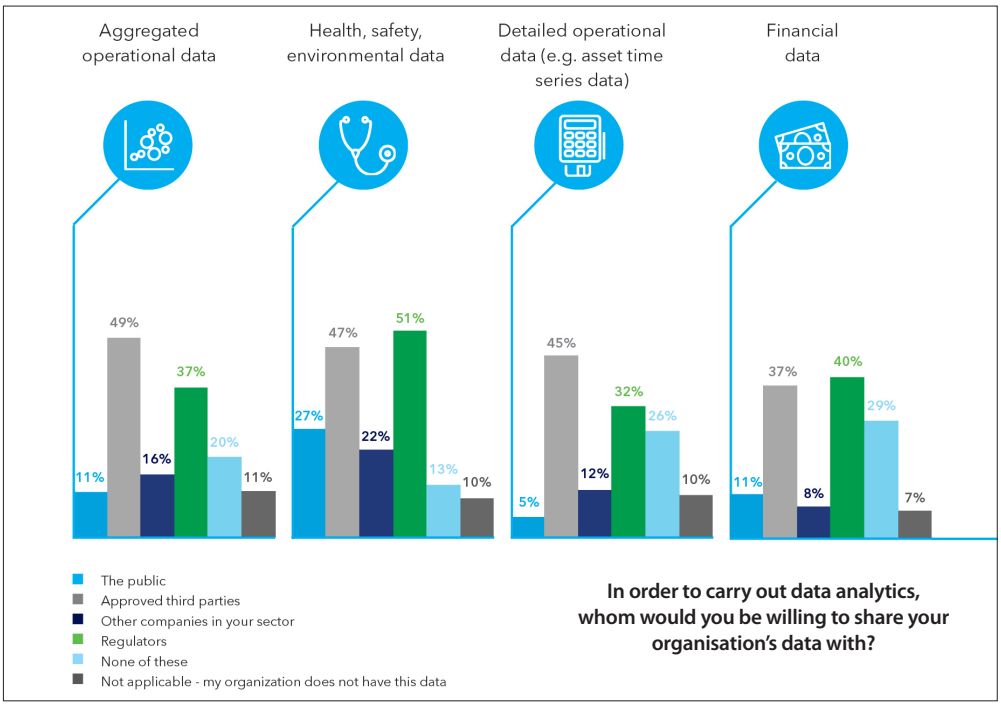

Figure 2. Organisations are more willing to share certain datasets than others, potentially missing out on opportunities to transform business processes

Enabling dynamic and responsive solar assets

As indicated in the DNV GL Energy Transition Outlook (ETO), we forecast that solar will account for 40% of all electricity generation by 2050. This will fundamentally require a digital transformation in and of itself, due to the massive change in grid dynamics that will accompany this change in generation mix from traditional generation capacity to variable renewables of solar and wind, with hydro and more flexible thermal generation. Energy storage and demand response will help to balance load with more variable generation profiles thereby enabling solar and wind to thrive. However, in this future scenario, coordination and forecasting will be paramount. Two way, low latency communication will be required to enable a majority of the electricity from solar and wind, which is addressed through generation forecasting, solar/wind plant design, and responsive inverter capabilities.

Energy storage is already taking hold as a low-cost alternative to deploying peaker plants in some parts of the world, with an increasing number of solar+storage plants making their way as well. Solar+storage assets help to mitigate short-term uncertainty in generation profiles, however they must have clear indications from the IoT on the system itself as well as grid and market indicators to make decisions on operation; when to charge and discharge based on the forecasted energy and market conditions.

The distributed nature of solar in particular, leads to systems ranging from hundreds of megawatts to just a few kilowatts in utility and residential systems, respectively. As such, digitalisation is paramount for coordination across systems and grids, toward enabling a dynamic, integrated system that will operate with increased resilience as variable renewables continue to increase their presence on grids across the globe.

One of the single largest barriers facing the renewable ecosystem and addressing our climate crisis lies in accessing the substantial amount of capital required to deploy this much new renewable capacity. Improving the transparency and integration of system design, construction and operation will lower the financial risk to capital providers, lower the barrier to new providers, lower costs to all energy consumers, and allow solar assets to be built more rapidly to keep up with the energy transition and help meet our building climate crisis.

Furthermore, machine learning algorithms will leverage these large datasets in order to benchmark asset performance across large numbers of diverse assets. Understanding performance and reliability across the diverse landscape of PV system components and designs from hundreds of suppliers, installers and sponsors remains a challenge that will offer myriad insights and lower technology and system performance risks in the future.

Additional areas of opportunity for digitalisation include: mobile connectivity for field workflows to automate data collection on mobile and table devices, integration and communication of digital tools through APIs, the development of digital twins for remaining-life calculations and reliability forecasts, and platform businesses that enable data sharing between asset owners, operators and investors.

Barriers to digital transformation – data and security

With vast amounts of data now widely available, new investment efforts to gather this data are no longer a priority. Our research indicates that the energy industry believes it has the necessary data to enable digitalisation, with only three in 10 respondents considering data gathering as a higher priority. However, two-thirds of the respondents cite extracting value from the data they hold as a high priority.

Collaboration is a key success factor for digital transformation, but our research suggests the energy industry is currently being held back by data security concerns with data sharing considered as unappealing for most respondents and just one in 10 saying they would be willing to share their organisation's data in the public domain. The exception to this is for 'health, safety, environmental data'.

In preventing data sharing, the energy industry restricts access to new market entrants who may bring transformative solutions to add value to the existing data. The barriers decrease when it comes to sharing data with approved third parties and regulators, with around half of participants saying that they would be willing to share aggregated operational data with third parties and 37% with regulators.

If we want to enhance the speed of digitalisation and encourage adoption of new technologies, we need to cultivate honest conversation in the industry. As an industry, we need to be open to sharing not only our data but also our experiences, successes and challenges for the common benefit of the energy industry and the public, which relies on our services.

Data and analytics will be the foundation of solar integration and scale. Understanding how data interacts beyond our physical models is paramount for leveraging massive operational and financial datasets in order to continue driving down the cost, increasing the value and increasing the deployment of solar assets. However, we will not fully realise the benefits of the digital transformation if the data is compartmentalised in a way that prevents one from identifying relationships and leveraging these toward continued efficiency improvements in development, operation and financing. Data security must be paramount. Data must be protected through trusted methods to ensure cybersecurity and secure communication protocols. This is an area that must be addressed to ensure data stewards are enabled to share data efficiently.

A key challenge with digital transformation is keeping pace with technological change and user adoption rates. Technology uncertainty was called out as a specific concern within the solar industry. Standardisation across methodologies and technologies is observed as a particular barrier given the rapid development of products and technologies.

People and digital skills

The overall industry responded that a lack of digital skills and lack of digital mindset are the main barriers to digitalisation. Our research shows unanimous recognition that digital skills training is needed, with 91% of participants regarding it fundamental for their organisation to invest in digital skills training, and 71% considering this important for immediate investment.

While this is the case for some respondents in solar, only 13% of those in the solar industry ranked this as their number one concern. Perhaps this could be attributed to the average age of the solar industry workforce. In contrast to the energy industry as a whole, the survey established that the group sampled had more people in the 19-37 age-group bracket than any other industry. It is possible that as solar is a relatively young industry, many in solar may have the required skillsets to better take advantage of digitalisation.

When questioned about the skillsets that were required or lacking within their organisations, 71% of respondents said that they need more employees with combined domain and digital expertise, with 18% claiming to not have any employees with this combined skillset currently. Creativity was also ranked highly, with 65% of respondents saying that they need employees with creative problem-solving skills among their workforce.

We also explored the digital skillsets considered the most important for the energy industry to have among its workforce. Data science came out on top followed by big data analytics, at 41% and 35% respectively. Even though data science

was cited as the most sought-after skill, currently only 23% of respondents stated that the role of data scientist exists within their organisation.

Uncertainty in new solar technologies stood out as clear barriers compared to the industry as a whole, with 35% of the respondents citing this as a barrier to digitalisation. This finding was unsurprising. In an industry moving as rapidly as solar, a range of new digital technologies is still unproven. The industry will need to continue to work hard to create compelling use cases that demonstrate the impact of implementing new technology and prove its viability.

Similarly, a lack of industry standards was of higher concern than the energy industry average. Although the solar industry is making attempts at standardisation, it is not as advanced as other industries. Defining a framework based on digital tools will ensure the industry can grow to the next level with the transparency needed to enable rapid growth.

Looking to the future

A key challenge for digital transformation is keeping pace with technological change and user adoption rates. Our research indicates that certain technologies, which for many years were considered emerging, are now seen as mainstream, for example cloud computing and machine learning that will help derive additional value from rich operational datasets. Drone and aerial imaging and analysis are already beginning to reduce the cost of siting, contraction and operation. Newer technologies such as blockchain, augmented reality and virtual reality are still in their infancy and are not currently having a significant impact within the organisations of our respondents.

As the solar industry strives to reduce costs and do more with less, successful digital transformation will be critical to offering innovation that improves efficiency and thereby maximising performance and financial yield. Finally, the relationships across datasets will inform bankability, reduce performance risk and thereby increase revenue for solar assets.

The transformative effects of digital technology are clear. However, digital transformation of the energy industry is not simply applying technology and leveraging big data. To realise the true value of digital transformation, we need to recruit and train employees so that they are prepared with the right attitude, skills and mindset to embrace the opportunity that digitalisation affords the solar industry. ■

This report is based on a global survey of 1,919 energy industry professionals, conducted by Foresight Factory in December 2018 and January 2019. The respondents represent a range of business sizes from start-ups to large corporates and a range of functions within the industry, from board-level executives to senior engineers, developers and financiers.

Author

As global segment leader, solar energy at DNV GL, Dana Olson is responsible for solar innovation and technology development activities to address the evolving needs of the solar industry. Before joining DNV GL, he was a technology manager at the U.S. Department of Energy Solar Energy Technologies Office, where he managed and led programmes and consortia focused on PV module technologies, testing and reliability. Prior to this he was a senior scientist at the National Renewable Energy Laboratory, leading efforts on new materials and designs for PV technologies. He served as an intelligence community fellow during his postdoctoral appointment at Sandia National Labs. He completed his Ph.D. at the Colorado School of Mines in materials science.