accenture

COMMERCIAL OPTIMIZATION FOR RENEWABLES

Moving from maximizing production to maximizing margin per megawatt-hour

CONTENTS

EXECUTIVE SUMMARY

The proportion of renewable electricity generation in the European Union (EU) is now over 30%.[1]

In many countries, including Spain, Portugal, Denmark, the United Kingdom, Ireland and Germany, most of the electricity from renewable sources is produced from wind and solar. Variable renewables will make up a growing share traded in electricity markets. In addition, more renewables will be generated without the guarantee of feed-in-tariffs/feed-in-premiums, with contracts indexed to market prices or from merchant plants. Renewable generators are now more exposed to price variability. Increasing shares of variable generation in the system can result in greater curtailment and congestion costs. However, renewables are now competitive to natural gas and coal generation. There is also the opportunity of the growing volume of balancing and ancillary service markets required by systems with a larger share of variable generation. Renewable generators are shifting from a focus on production capacity to concentrating on getting the most margin per megawatt-hour. To achieve this, additional capabilities in commercial optimization are required.

This research study focused on the potential of digital technologies to improve three key commercial optimization processes:

Energy Portfolio Planning and Management

Commercial Activities and Operations

Back-office Activities

In the past, many renewable generators outsourced a significant portion of these activities to electricity traders/power marketers. With more volatile electricity prices, increasing curtailment and the growing balancing markets, leading renewable generators are taking control of some of these activities. They are using digital to access real-time operational data and developing advanced analytics capabilities to support decision making.

In the commercial optimization processes, the most important digital technologies include big data analytics, cloud and artificial intelligence (AI). Robotic process automation (RPA) is also seen as a strong technology, to specifically address the back office and the selling and buying processes.

Our analysis of digital technologies against process areas resulted in five main themes:

Energize the business with data—basic and advanced data concepts

Risk management and hedging

Boost a data-driven approach with big data analytics and data governance

Automation for back-office and auto-trading execution

Forecasting, simulation and optimization models

Table 1 describes the digital capabilities that could offer renewable generators a competitive advantage in raising margin/MWh in increasingly competitive electricity markets.

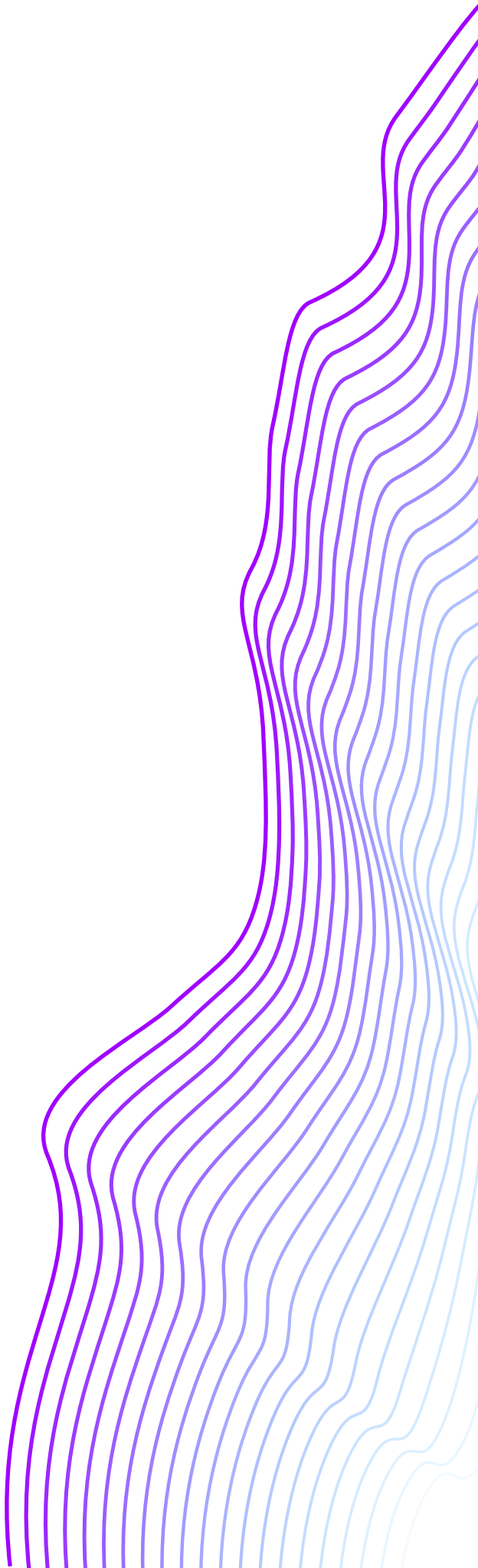
Table 1. Digital commercial optimization capabilities.

Big Data Analytics	Ability to aggregate and make available high-quality data Forecasting analysis Advanced analytics and visualization capabilities Decision-making support Optimization capabilities
Cloud	Flexible computing capacity Multiple data accessible in a timely manner Single view of data in a distributed and scalable computing environment
Robotics Process Automation (RPA)	Automated tasks execution Analysis automation
Artificial Intelligence (AI)	Forecasting capability integrated with machine learning Simulation capability integrated with maching learning Prompt market insights Advanced scenario and impact analysis through machine learning Integrated machine learning algorithms in the risk models Optimization capabilities

INTRODUCTION

Commercial optimization for renewables is evolving rapidly as the power generation industry deals with the changes and challenges around market integration and the scale and distribution of assets.

Digital transformation is the driver that can help generators address these challenges and achieve higher value by managing generation assets in new ways to improve flexibility and performance. Digitalization is already transforming core power generation processes such as asset management and workforce management. In the future, the ability for digital to move the integration of commercial optimization processes to the next level is a key factor that will distinguish the industry's successful players. The extension and re-design of the digital experience could allow businesses to tap into the scale of currently available technology and create close collaboration between people and technology, empowering operations with technology-enabled, high-impact capabilities. The study presented in this report aims to identify the most relevant capabilities for commercial optimization processes, and to highlight how these capabilities could help overcome the challenges renewable energy companies face in improving margin per megawatt-hour.



CONTEXT: EUROPEAN ELECTRICITY MARKETS

The European Union (EU) Electricity Directive and Electricity Regulation establishes rules on how electricity markets operate in member countries, to support an increasing share of variable renewables in the grid. Although the country electricity markets in the EU operate independently, there is increasing convergence in the design with day-ahead and intraday markets, and a growing ancillary services market. We wanted to provide some brief context for the commercial optimization perspective by providing an overview of EU markets where the share of variable renewables is changing the necessary capabilities for market participants to successfully compete.

Electricity markets components

Most European electricity markets are highly liquid. For example, the markets in Spain, Italy and the United Kingdom all have more than 300 participants.

Spot markets

- **Day-ahead market:** Trading involves sellers (typically, generators) and buyers (typically, suppliers) agreeing on contracts for the delivery of power the following day.
- **Intraday market:** Within the day, the market offers participants an opportunity to modify the injection and withdrawal commitments.
- **Balancing services market:** The transmission operator procures services to balance demand and supply and confirm the security and quality of electricity supply across the transmission system. The balancing services markets vary significantly by market, given the different sources of generation and flexibility and demand loads. Example services include Frequency Response, Reactive Power, Demand Turn-up or Turn-Down, Congestion, and Constraints.

With the increase in variable generation, there is also growth in the types of balancing services products being developed, the volume procured and the participants in these markets. Previously, balancing services were primarily provided by conventional generation. This is no longer the case, with renewable generators and battery storage able to participate.

Variable renewable generators primarily participate in the day-ahead market, submitting their forecasts and managing unbalancing penalties. However, given the availability of real-time operational information and storage that can help make variable generation more "dispatchable," we expect to see more renewable generators participating in the intra-day market.

Forward markets

The forward electricity market is the place for the negotiation of forward electricity contracts with delivery and withdrawal obligation, where participants may sell/purchase future electricity supplies.

Other contracts

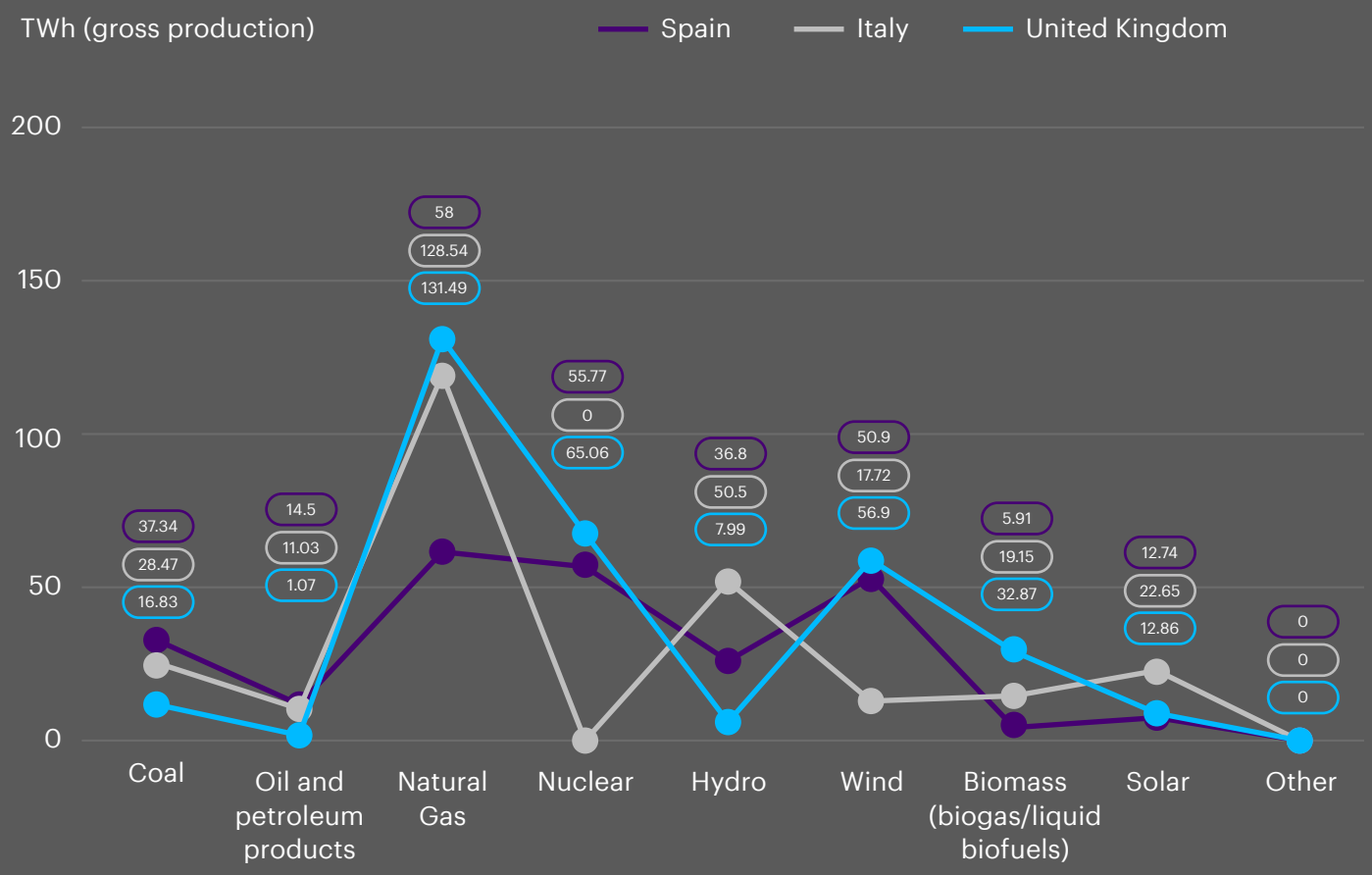
In addition, market participants can purchase and sell electricity outside the power exchange offer system, negotiating bilateral contracts. Renewables development in Europe was supported by feed-in-tariffs and feed-in-premiums, so most renewable electricity producers have locked in prices for much of their volume. In the past few years contract structures have changed, passing more risk onto renewable generators and exposing more volume to electricity prices.

Generation mix and interconnection

The renewables mix varies significantly across markets. This report is for renewable generators operating in markets with a large share—more than 20%—of variable generation. However, even within these markets there are significant differences in the generation mix which impact how the markets operate. For example, markets with more hydropower, such as Spain, will leverage hydropower to support its variable renewables. Other markets, like the United Kingdom, rely on nuclear, natural gas and demand-side response to support increasing levels of variable generation.

To illustrate these differences, Figure 1 compares the electricity mix of Italy, Spain and the United Kingdom.

Figure 1. Comparison of electricity generation mix of selected countries (2018).



Source: European Commission – Eurostat, Energy Statistics 2018.

Although the electricity markets in Europe are independent, they have varying levels of interconnection which also impact how the markets operate. For example, Italy has interconnections with France, Slovenia, Austria, Switzerland, Greece, Malta and Montenegro. Italy is much more connected compared to the United Kingdom, which has interconnections with France, the Netherlands and Ireland. Italy is also more connected than Spain, which has interconnections with France, Morocco and Portugal.

METHODOLOGY

This study examines the impact of a pre-defined set of digital technologies on renewable generators' commercial optimization processes. It is based on an analysis of information collected through a survey of leading renewables companies, combined with insights from Accenture, additional analysis and follow-up interviews.

The study participants are renewables companies with assets and businesses across Europe, the United States and Latin America, distributed across multiple energy sources including solar, wind, hydro and biomass, and battery storage.

As illustrated in Figure 2, the steps taken to develop and produce this study were as follows:

1. A survey conducted with representatives of the renewables companies in our sample, asking them to assess the impact of various digital technologies on key business processes in the commercial optimization area. The interviews and survey evaluated which methods, tools or technologies are currently in place, which processes in scope are outsourced, and related controls.

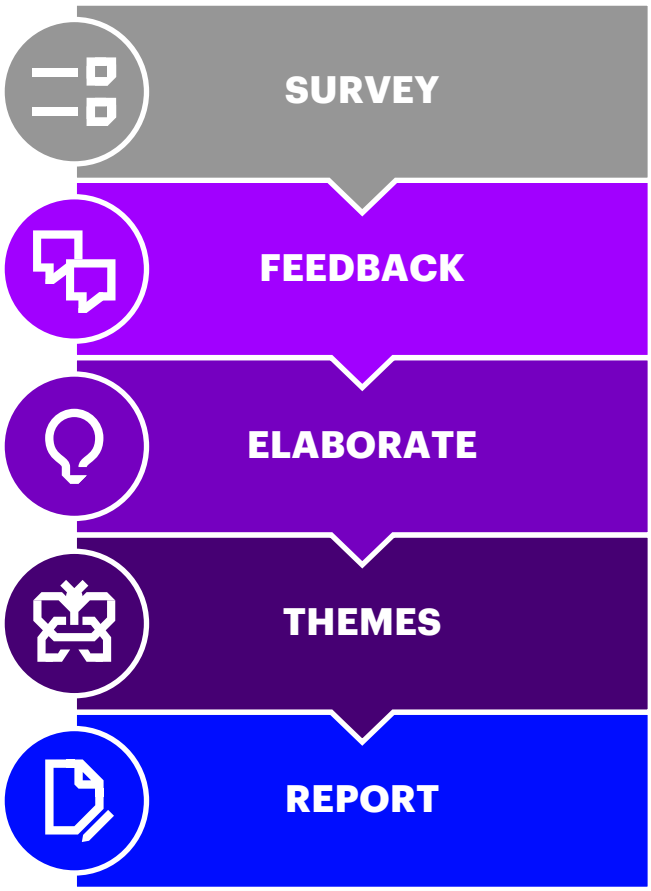
2. Interactions with participants were carried out at their company locations to gain detailed explanations and capture additional relevant information. Feedback was collected and stored for further analysis.

3. The results were analyzed and the aggregated survey results summarized on an anonymized basis.

4. Our analysis of the information allowed us to identify the most relevant themes currently top of mind in the renewables industry.

5. Accenture collaborated with various industry experts to examine, articulate and enrich the key themes to develop this report.

Figure 2. Study methodology.



BUSINESS PROCESS AND DIGITAL TECHNOLOGY SCOPE

The study focused on three key macro processes in the commercial optimization area:

Energy portfolio planning and management: Facilitates the optimization of generation production and portfolio management.

Commercial activities and operations: Confirms that the strategy and activities for the execution of the generation program and optimization of the portfolio are carried out.

Back office: Consists of all activities carried out for the administrative management of the contracts, monthly/yearly closing, claims management, counterparty and credit risk management.

These macro processes were divided into eight detailed sub-processes (see Figure 3).

Figure 3. Commercial optimization business process.

Energy Portfolio Planning and Management

Generation Production Planning

- Forecasting and scheduling long-, medium- and short-term production for renewables, including activities related to hydrology forecast, weather prediction, etc.
- Coordinating with the generation unit and system operator to overhaul plant plans.

Market Analysis and Price Forecasting

- Performing market analysis (analyze and monitor fundamentals of commodity markets and execute market modeling and simulation).
- Producing long-, medium- and short-term price forecasting, with the aim to support the optimization of sales and production portfolio and support risk management activities.

Portfolio Management

- Elaborating the budget and energy margin forecasts.
- Identifying business opportunities to improve portfolio growth.
- Managing the portfolio with the aim to hedge, adjust and optimize the margin.
- Monitioring KPIs, target and performance.

Commercial Acivities and Operations

Commercial Strategy

- Defining long-term commercial strategy in the energy markets, liasing with market analysis and price forecasting.
- Defining the quarterly, monthly, weekly, daily and hourly pricing strategy in the wholesale and spot markets to maximize margin.
- Monitoring the position in the market and elaborating daily forecast and ex-post analysis.

Commercial Activites

- Managing electricity selling (and buying) processes in wholesale and spot markets.
- Ensuring revenues and margins within risk range limits defined by company guidelines.

Commercial Operations

- Ensuring the execution of generation programs and real-time market participation.
- Monitoring real-time production.
- Managing unbalances.
- Managing communcations with the plants and with the transmission system operator.

Back-office

Back-office and Compliance

- Administrative management of contracts for purchase/sale of energy.
- Executing meeting, settlement and invoicing, and claim management.
- Performing monthly/yearly closing.
- Producing internal and compliance reporting.

Counterparty and Credit Risk Management

- Commercial management in the entrance and in withdrawal of counterparties.
- Managing, within assigned limits, the exposures to counterparties and the credit risk.

The operating model for commercial optimization varies significantly across organizations, from fully in-house to fully outsourced, as the activities include the interface between the two functions of operations and trading. As shown in Figure 4, our study participants had one of two high-level operating models:

- **In-house operating model:** Participants who manage the commercial optimization business process internally. They may have dependencies on external data providers (market prices, external forecasting data, counterparty ratings) while the process ownership remains internal.
- **Partially outsourced operating model:** Participants who run a hybrid operating model where some of the business processes, particularly around price forecasting and commercial activity, are provided by third parties. However, the participants also expressed a desire to develop these capabilities and move the activities in-house.

The study highlighted, from one side, that renewable generators with an in-house operating model have a clear distinction between the energy manager function and asset manager function, and the two functions are fully integrated with clear roles and responsibilities. From the other side, it was noted that companies that outsource part of their business do not have this differentiation, as they generally have only an asset management (or asset operations) function and varying degrees of power marketing capability to manage end-to-end commercial optimization processes.

Figure 4. Operating models of study participants—internal vs. external.

	IN-HOUSE	PARTIALLY OUTSOURCED
Generation Production Planning	Internal*	Internal*
Market Analysis and Price Forecasting	Internal**	External
Portfolio Management	Internal	Internal
Commercial Strategy	Internal	Partially Internal
Commercial Activity	Internal	External
Commercial Operation	Internal	Partially Internal
Commercial and Financial Back Office and Compliance	Internal	Internal
Counterparty and Credit Risk Management	Internal***	Internal***

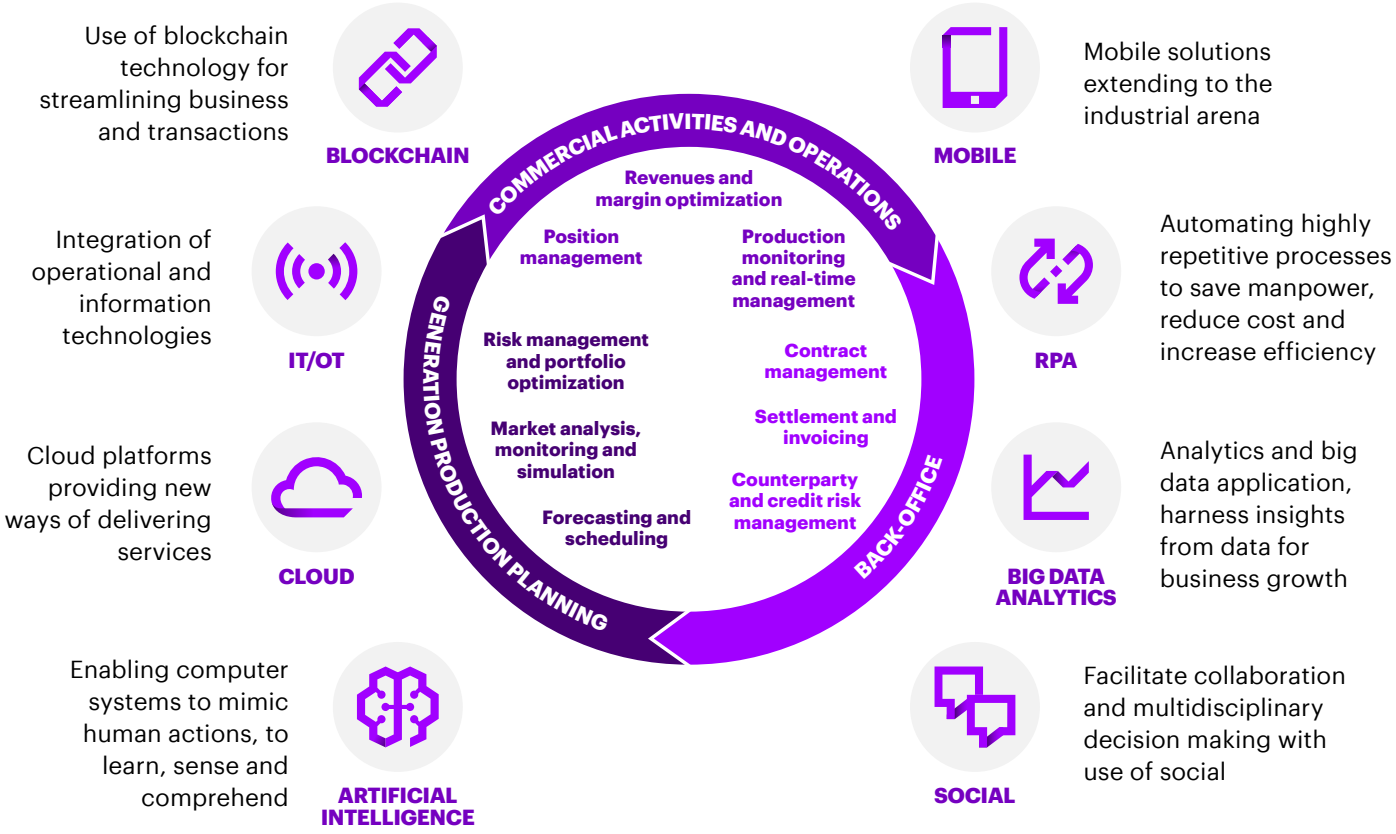
* External dependencies on meteorological forecasting data and generation production data

** External dependencies on market price data

*** External dependencies on counterparty rating from external rating agencies

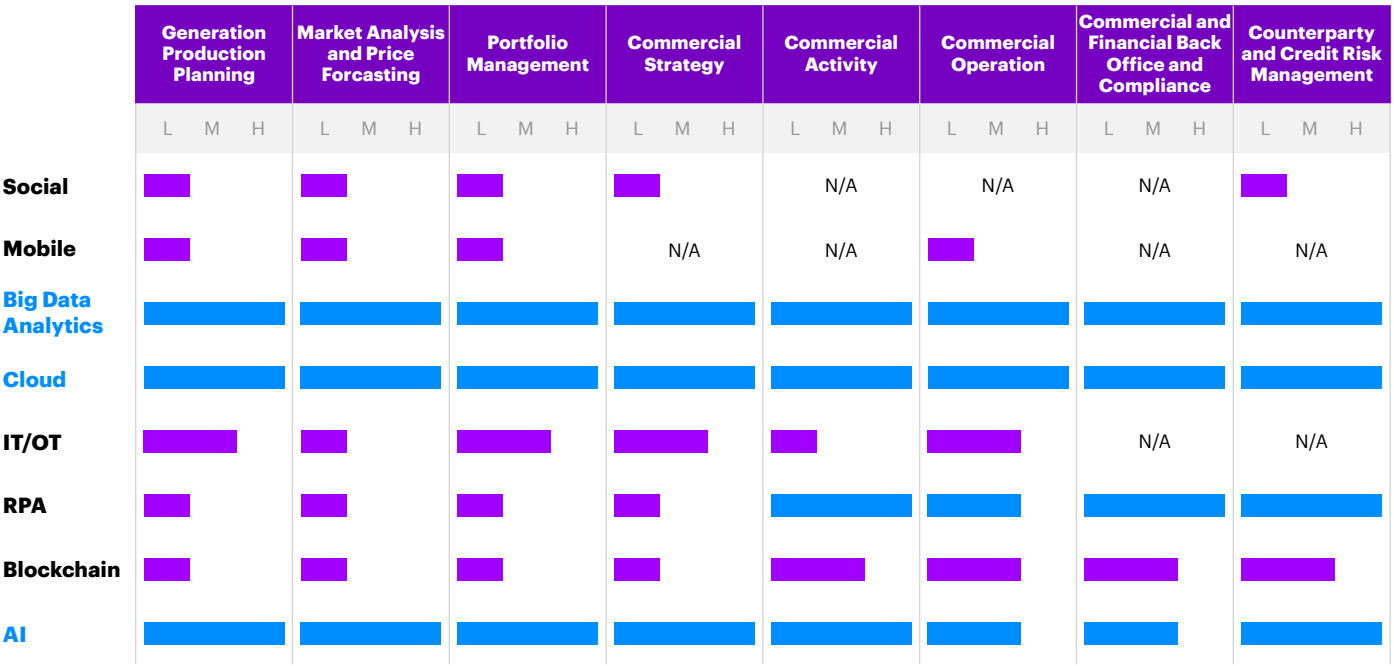
The impact of digital on these processes were evaluated by study participants. The evaluated digital technologies are described in Figure 5. These technologies can play a key role in addressing the needs and challenges specific to commercial optimization, by aiding and supporting the digital capabilities that underpin the various business processes.

Figure 5. Digital technologies evaluated in the study.



Survey participants assessed the impact of the digital technologies on processes across the end-to-end commercial optimization value chain. They also evaluated the priorities and opportunity size eventually presented by digital transformation initiatives. Responses were based on the degree of internal priority around adopting a given technology, and the disruptive impact on business processes. The aggregated results are summarized in Figure 6, where the level of relevance (L: Low, M: Medium, H: High) on each process has been reported for each digital technology.

Figure 6. Relevance of digital technologies to commercial optimization business processes.



Note: Length of bar indicates impact of digital technology as assessed by study participants – blue bar highlights the most relevant technologies.

The overwhelming majority of respondents reported that analytics, cloud and AI are by far the most relevant and impacting technologies. In fact, the impact of these technologies is high across all the business processes, with a minor exception for the commercial operations and the commercial and financial back-office and compliance processes, where the impact for AI is medium.

RPA is seen as a strong technology to address specifically back-office and commercial activities.

IT/OT was not highlighted as a priority in the survey responses; however, further interviews, follow up and Q&A sessions with participants reflected the relevance of IT/OT convergence, especially for commercial operation business process. In a poll of 22 executives across 14 leading renewable generators in Europe, 83% answered "yes" to the question: “Are you able to access and consume real-time plant data to incorporate into the commercial optimization process?”

As a final comment from the survey results—social, mobile and blockchain were not assessed as high-impacting technologies across the commercial optimization business processes.

FIVE DIGITAL THEMES OF COMMERCIAL OPTIMIZATION

In most power markets around the world, renewables plants are already playing under the same market rules as conventional generation. Significant capacity is operating under power purchase agreements (PPAs), but profile management and deviations still require the development or improvement of commercial optimization operations. Soon, more flexible markets will be developed to balance and integrate ever-increasing renewables capacity. In combination, these factors mean that operations should be further developed to underpin plant performance in the power markets. Renewables companies are already facing several big challenges in adapting their commercial optimization operations to market dynamics and competition.

Key challenges

- **Data management and data governance:** Capabilities to capture data from markets, assets, competitors and counterparts, and to manage real-time, complex algorithms using AI and advanced analytics to support end-to-end commercial optimization processes and activities.
- **Cloud:** Reducing on-site infrastructure costs and achieving computational flexibility by migrating suitable technologies and applications to the cloud.
- **Analysis and planning:** Improving and automating forecasting for weather, production, market prices, demand, competitor strategies, technology mix and resources input, including by implementing new data visualization capabilities and facilitating more powerful simulation engines.
- **Market execution:** Adapting processes and applications to new market operations requirements by automating transactions and engagement with markets and counterparts in real time using advanced analytics and machine learning.
- **Hedging and risk management:** Calculating portfolio positions considering production volatility and integrating PPA hedge positions. Also improving risk metrics using advanced analytics and the computational capacity provided by cloud big data platforms, and using simulation engines to evaluate new hedging structures and strategies.
- **Back-office automation:** Standardizing processes to implement robots and maximize automation and efficiency in reporting, settlement and other back-office processes.

In the following pages we set out and examine five digital themes that address these challenges and support commercial optimization.

THEME 1

Energize the business with data

Why is it important?

In terms of commercial optimization, renewables companies' ability to capitalize on performance now depends on effective collection, access, management and utilization of data from assets, information providers and the wider market.

What are the challenges?

The ability to collect, access historical and near real-time data, and process it in a full and timely manner—one compatible with specific business process timelines—is a prerequisite for generating the greatest possible value from data and understanding the opportunities for improving operating and financial results.

What is the solution?

Companies need to have an appropriate IT infrastructure—one that allows effective data management and the prompt, easy use of data to generate tangible value. In this context, IT/OT convergence, cloud, big data analytics infrastructure and mobile solutions are the technologies with the most relevant digital impact to help address data exploitation needs across all business process.

Real-time monitoring and unbalancing reduction

Business issue

Lack of tools to maintain control of power production in real time to react immediately in case of unbalancing.

Solution

Implementation of real-time system to collect production data from plants, compare it with a planned production program and generate alerts with visual indicators in case of unbalancing, including the related amounts.

Benefits

- Full monitoring of power generation unit production.
- Immediate visualization of any unbalancing between the planned and actual production.
- Reduction of unbalancing penalties to be paid, thanks to prompt reaction.

By way of context, data derived from external sources such as a transmission system operator (TSO), clearinghouse or information provider, and data from internal sources including plants and other business units requires constant measurement and control. With internally-derived data—and specifically data from plants—this requires the adoption of hardware and software that detect any changes of state through direct monitoring of physical devices, processes and events. Operational technology (OT) allows companies to acquire and control data generated by their plants. The ability to monitor electricity production from plants is crucial for renewables companies to monitor and assess equipment health in near-real-time, to detect and address performance shortfalls, and evaluate unbalancing compared to the production program. The integration and convergence of data into the IT infrastructure allows companies to manage all in real time. In fact, a mature OT infrastructure should collect data by sensors directly "from the field," submit that data into an OT-controlled environment where data security breaches are reduced. The efficient integration of IT and OT allows accurate information to be optimally delivered to a cloud IT infrastructure, to feed the appropriate monitoring dashboards which supports commercial operations activities. For example, this provides near-real-time data to optimize the short-term program of the production unit and can also be in combination with a battery energy storage system (BESS).

Today, companies are seeing constant expansion in the operational data stemming from IT/OT convergence and in the external data from multiple sources.[2] Cloud and big data analytics are two technologies that allow companies to manage these rising volumes of data and facilitate the application processes that leverage this data with the required flexibility. In particular, cloud infrastructure services are delivered to companies on a consumption basis via an automated self-service model. The providers of these cloud services offer flexibility in composing the precise set of services to meet customers' business and IT requirements, including aspects such as elastic scalability and computing capacity, constant availability, fault tolerance and fast disaster recovery. In addition, cloud facilitates a comprehensive set of security services to establish a fully controlled environment including policies, monitoring, role-based access, patching and back-up. Together, these capabilities position cloud as the "on-ramp" to the agile enterprise, facilitating the move from a capital-intensive, cumbersome and high-maintenance cost environment to a responsive, capital-light and business-led solution. For these reasons, in the survey results respondents identified cloud from "high impact" to "mandatory" for all the processes.

Finally, the need to have constant, immediate access to data and the related tools requires the adoption of mobile solutions. This confirms data is readily available for quick business decision making, while also improving collaboration and reducing the dependency on physical location. For example, the ability to act from a remote location or outside of office hours may be critical in managing dynamic processes, including activities that run 24/7 such as active position management, bidding and power dispatch.

THEME 2

Boost data-driven approach with big data analytics and data governance

Why is it important?

Data has been a vital asset for decades. Today, companies need to get the most value from their data by moving toward becoming fully data-driven in their business processes and their approach to decision making.

What are the challenges?

The challenges of generating the full value from data include the availability of analytical capabilities and issues around data quality. The need to define and deliver quality data, retention policy, data identification and data organization, and the capability to explore and promptly process the data are mandatory for monitoring, reporting, analysis purposes and to trigger business action.

What is the solution?

Big data analytics is the combination of leading-edge technology and advanced analytical practices to provide data-driven actionable insights. This creates a platform for cost-effective data management and data governance solutions, and allowing rapid, agile business decisions through data visualization and analytics capabilities.

Energy management analytics

Business issue

- Data spread among different and heterogeneous sources that prevents comprehesive analysis.
- Data analysis and presentation on office automation tools and not shared in a structured way among departments.

Solution

Design and implementation of a unique big data platform on the cloud for reporting, dashboarding, data visualization, self-service business intelligence, and enabling forecasting, simulation and optimization capabilities.

Benefits

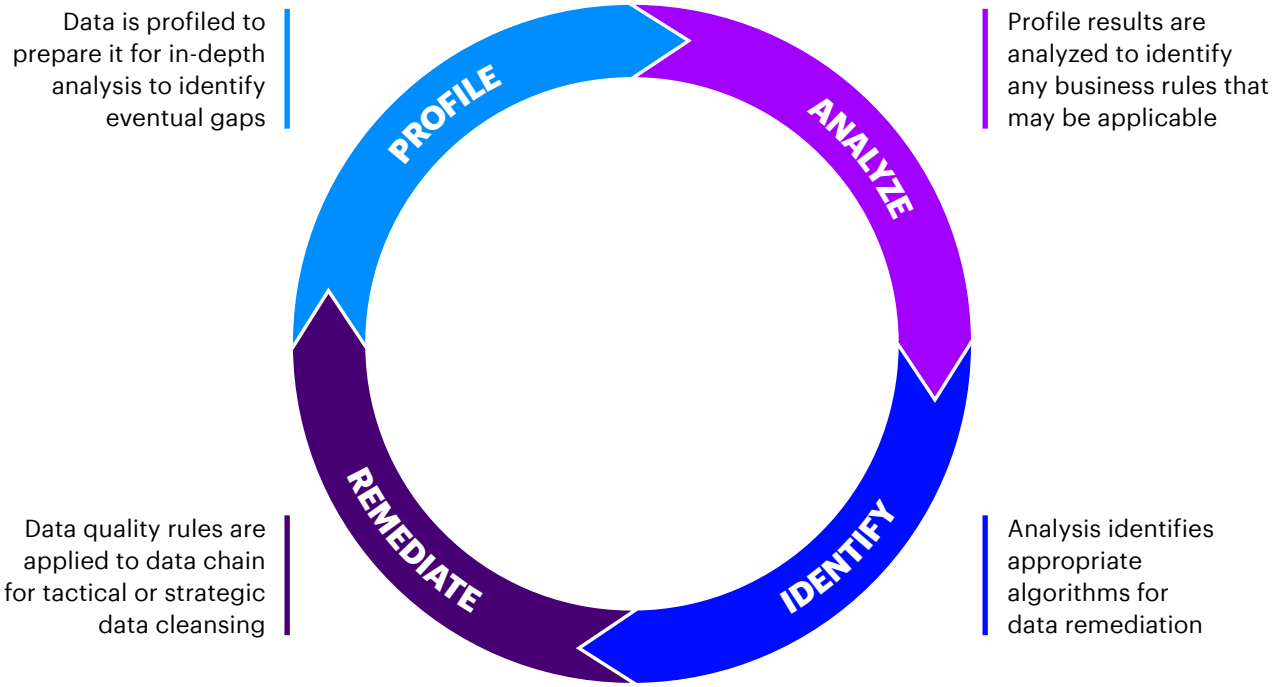
- Guarantee data quality and data governance.
- Improve data usability.
- Scalability and flexible computing capacity.
- Enabling data exploration, advanced analysis and modeling for the data scientist.

Big data analytics solutions allow companies to aggregate and manage a wide range and varying volumes of data types, bringing the ability to handle a multitude of velocity needs and different degrees of data veracity. In addition, the application of data exploration methodologies and visualization capabilities can facilitate rapid data discovery and visual interaction, allowing the generation of even more valuable insights.

Renewables companies should tap into big data, leveraging cloud-based models to support large-scale analysis. The businesses' IT capabilities should be geared to manage the end-to-end data supply chain from sources to consumption, producing analytics according to the nature of the business (whether batch or in near-real time). In practice, some analyses requiring data transformation via batches or elaboration run at specific frequencies; for example, for risk metrics evaluation on the contract portfolio. On the other side, in real-time scenarios, an effective approach is to undertake both data ingestion and consumption at nearly the same time to produce near-real-time outcomes; for example, for simulations that support market operations and decision making on the spot market. A well-designed modern application architecture should address both scenarios, cutting time to consumption and helping confirm data quality and lineage.

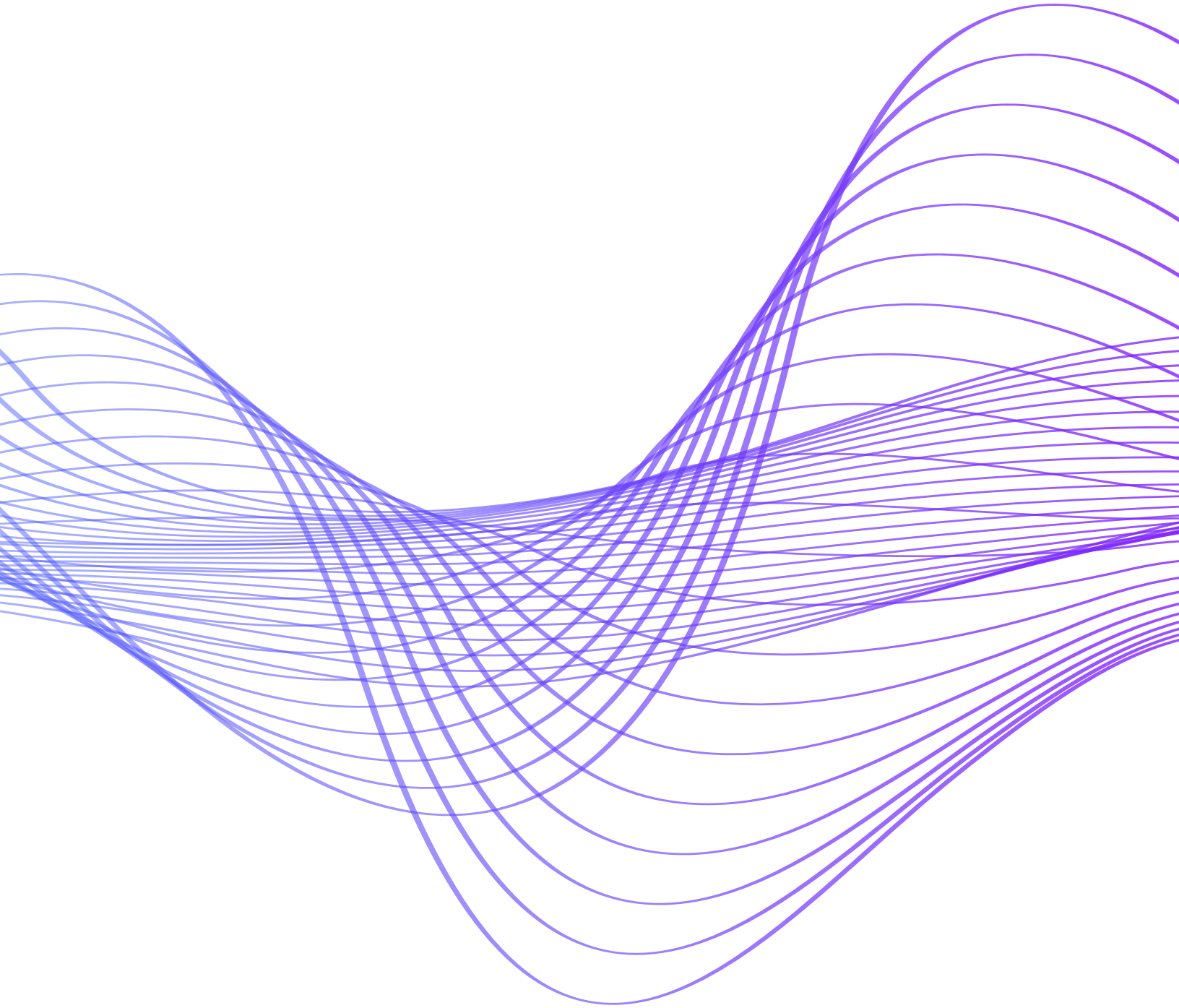
These two attributes—data quality and data lineage—are key pillars of data governance, since they satisfy the requirement of having attested accurate and fully traceable data at the disposal of the business processes that consume it from an internal and external perspective. Companies should obtain affordable data in line with business requirements and undertake a set of processes to cleanse it before consumption. This can be done through a quality management approach where data is assessed on three dimensions: accuracy, completeness and consistency.

Figure 7. Data quality process flow.



Data quality management is not a one-off exercise, as business and technological capabilities require constant maintenance of quality. As a result, it is an iterative process involving people, processes and technologies, which can be segmented into four clearly-defined steps, as illustrated in Figure 7.

The rising importance of analytics and the urgency of producing accurate results have also given rise to the role of chief data officer (CDO)—a new C-level post responsible for the data strategy of the entire organization—and the rollout of "data stewards" at every level. A data steward is responsible for data lineage, and the role involves monitoring and tracking the end-to-end data supply chain all the way from data sources to destinations through all stages of data transformation.



THEME 3

Forecasting, simulation and optimization models

Why is it important?

Power markets are evolving to integrate renewable capacity, with providers developing new services to capture demand and improve generation flexibility. At the same time, providers are making use of the new technologies to provide real-time information and automate demand management and balance mechanisms. As market rules develop, they are converging to create a level playing field for conventional and renewable generation. Considering these trends, renewables generators should develop commercial operations to underpin plant performance and revenue generation in the evolving power markets.

What are the challenges?

From this perspective, the development of analytical capabilities to support market operations and decision making is a key lever for companies looking to play in the markets and optimize plant performance. Forecasting, simulation and optimization are vital analytical capabilities for market participants.

Production forecasting using data on weather forecasts, technical availability and plant historical performance is not a new requirement for renewable assets. For several years, companies have been investing in developing models to reduce deviations and avoid penalties. However, what is new is the need to provide real-time adjustments to the production programs to actively participate in the intraday, balancing and flexibility markets.

What is the solution?

The massive computational capacity provided by big data platforms—together with advanced analytics and AI algorithms—are key drivers in developing weather and production forecasting models to be closer to real-time operations. As a result, these levers also allow wind and solar PV plants to participate in the wholesale markets, to be active players in ancillary services by evolving market strategies, and reduce deviations to minimize penalties and optimize margin.

Other key levers in designing and improving bidding operations for renewable plants include forecasting and simulation of market variables, prices, demand, TSO flexibility requirements and other market players' behavior. Cloud big data platforms introduce greater flexibility and help accelerate market simulations to support bidding decisions even in real-time markets.

There will also be an additional step forward in rolling out analytics capabilities once storage enters the field of play. All the previously described capabilities will play a significant role in enhancing storage, in combination with plant production in the power markets. Market simulation and optimization engines—developed and tailored for every market and player—can be key tools for driving revenues amid strong market competition.

Intermittent renewables and BESS integration

Business issue

Optimize the operation of intermittent renewable production units in combination with battery energy storage system (BESS).

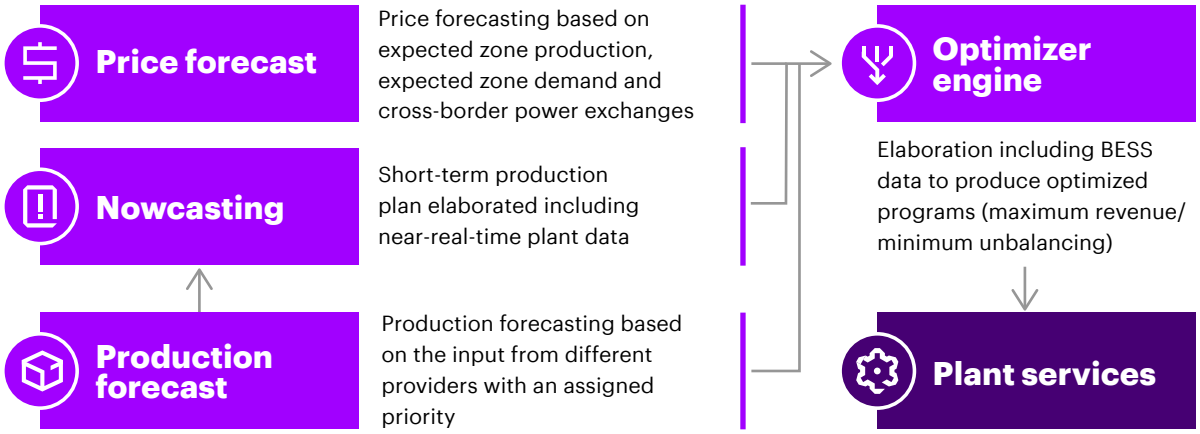
Solution

Implementation of a platform-based analytics solution for renewable production forecasting and short-term program optimization, combining the use of BESS and considering price forecasting input.

Benefits

- Improved accuracy on short-term production program, reducing forecasting error up to 50%.
- Increased revenue.
- Unbalancing cost reduction of up to 20%.

Elements of solution



Wind production forecast

Business issue

Improvement of multi-horizon wind production forecast by combining data from several weather forecast data sources (3D meshes), each one with different data and time granularity.

Solution

In production for 13 wind farms, the model is scalable globally and able to dynamically process millions of data points for each execution, delievering in a few minutes a production forecast for the next 36 hours. Supported by a big data real-time architecture, the solution is a key piece to make smarter decisions taking into a account business impact, such as smarter bidding strategies on energy markets, better control of regulation penalties and setting the basis for combined power generation strategies.

Benefits

Improvement of forecast accuracy by around 20% vs. previous forecast, based on the wind farm's weather control tower data.

Solution element: Weather forecast modeling

Timestep

5-10 minutes

Grid spacing 10-20 km

Variables at the surface:

Temperature

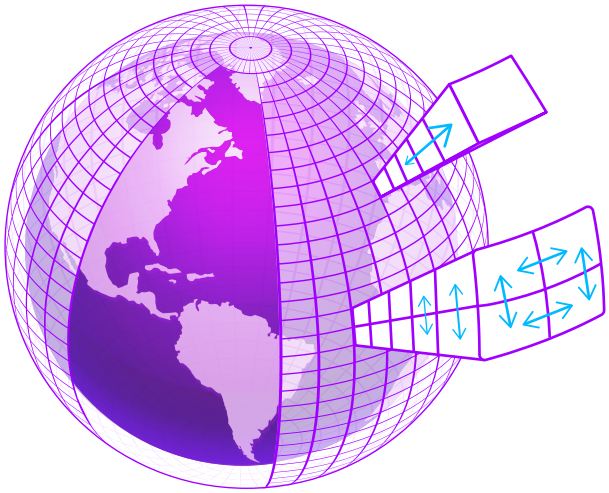
Humidity

Pressure

Moisture fluxes

Heat fluxes

Radiation fluxes



Vertical exchange between levels

Horizontal exchange between columns

Variables in the atmospheric column:

Wind vectors

Humidity

Clouds

Temperature

Height

Precipitation

Aerosols

Integrated data sources: GFS (Global Forecast System), WRF (Weather Research and Forecasting), ECMWF (European Centre for Medium-Range Weather Forecasts), Real-time data from wind power generator.

THEME 4

Risk management and hedging

Why is it important?

For many years, renewables companies' revenues have been guaranteed by subsidies and tariffs designed to confirm a minimum electricity price. With the drop in renewable generation costs, many countries have started changing their industry regulations to force renewables to operate in the wholesale market under the same rules as conventional generation. The result is that revenues can no longer be guaranteed.

What are the challenges?

The market risk for renewable assets is a combination of weather-related volume risk and power price volatility. Due to the different strategies used to measure, manage, mitigate and hedge risk, market exposure is structured into long-term and short- to medium-term positions.

What is the solution?

In this evolving situation, renewables companies should develop internal processes and capabilities to deal with their exposure to market risk. Irrespective of whether companies externalize their risk management and hedging, investment in internal capabilities is needed to make the appropriate decisions over every timescale.

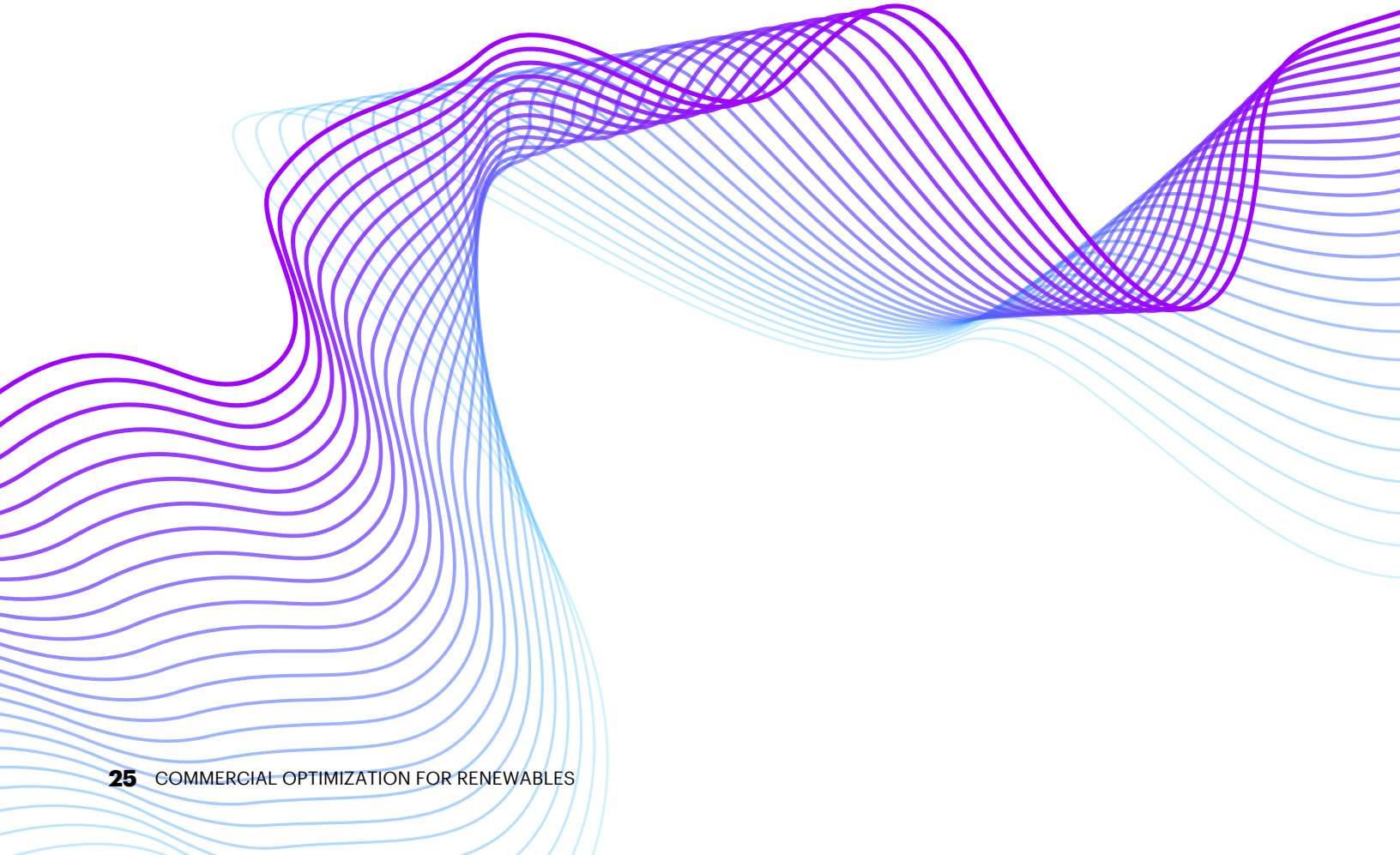
The capabilities and in-house functions companies must build include the ability to:

- Calculate current and future portfolio positions, using forecasts of weather variables such as wind and radiation to estimate production exposure to volume risk.
- Measure market risk exposure, projecting wholesale price volatility to the future.
- Simulate the impact of different hedging strategies over the portfolio position from the short to long term.

All these capabilities described are based on analytic calculations, where the availability of big data platforms to integrate advanced analytic models will be key to the creation of the company framework.

Over the short- to medium-term timescale, advanced analytic models that are calculating portfolio positions need to capture production volatility based on weather forecast variables. Given the vast number of variables per hour that these AI-based advanced analytics models can capture and manage—typically more than 3 or 4 million for wind production forecasting, for example—this is a task that only solutions based on big data platforms can handle. In the long term, weather volatility and production forecasting should be smooth and can be forecasted using a set of scenarios. Similar functional needs and technical and analytical requirements should be considered when forecasting wholesale price volatility.

In terms of hedging strategies, in recent years PPAs have been renewables companies' preferred option for dealing with long-term exposures. However, the lack of liquidity and transparency, together with the premium fees being levied, have pushed companies to seek alternative hedging instruments to lower risk. Financial hedging instruments are available in the market, and while hedge structuring is provided as a service by trading companies, banks and other agents, our view is that renewables companies should develop their own models to simulate and evaluate the value of the hedging strategies being offered. Simulation engines based on advanced analytic models are key to confirming the effectiveness of hedging instruments in relation to the risk position.



THEME 5

Automation for back-office and auto-trading execution

Why is it important?

Commercial optimization processes are a combination of non-automatable, intellectual-based activities and other activities conducive to various levels of automation. The latter grouping ranges from a diverse array of rules-based, high-volumes activities to more complex tasks that cover core processes, where a degree of human judgment is typically required.

What are the challenges?

The current challenges around commercial optimization processes underline the value of automating them. Rules-based activities are typically structured and include repetitive tasks that are performed periodically, include routines and controls, and are prone to human error. From an operational point of view these activities can require intensive manual effort. In addition, the human errors to which they are liable can impact business outputs or even—in the worst-case scenarios—create a risk of non-compliance. This category of activity includes back-office tasks such as contract management and administration, transaction invoicing, settlement and confirmation, and claims management.

On the other side, the more complex activities require intelligence and a combination of capabilities to execute them successfully, and typically result in a higher level of business impact. Examples include capturing real-time changes in daily operations, generating actionable insights to automate trading operations, and authenticating and validating transactions in a secure manner.

What is the solution?

With the activities appropriate for automation, RPA, AI and blockchain are the key technologies that may allow renewables companies to tackle the challenges in their existing commercial optimization business processes.

Looking across the various processes, numerous activities are suitable for automation to varying degrees in the three key areas of energy portfolio planning and management, commercial activities and operations, and back office. This automation can be achieved through the application of the three technologies called out above, and as shown in Figure 8. The automatable activities are highlighted in the figure, while those activities that do not lend themselves to automation are greyed out. The figure also identifies the key two or three automation drivers for each set of business processes.

Figure 8. Automation propensity of commercial optimization business processes.

Energy Portfolio Planning and Management

Generation Production Planning

- Forecasting and scheduling long-, medium- and short-term production for renewables, including activities related to hydrology forecast, weather prediction, etc.
- Coordinating with the generation unit and system operator to overhaul plant plans.

Market Analysis and Price Forecasting

- Performing market analysis (analyze and monitor fundamentals of commodity markets and execute market modeling and simulation).
- Producing long-, medium- and short-term price forecasting, with the aim to support the optimization of sales and production portfolio and support risk management activities.

Portfolio Management

- Elaborating the budget and energy margin forecasts.
- Identifying business opportunities to improve portfolio growth.
- Managing the portfolio with the aim to hedge, adjust and optimize the margin.
- Monitioring KPIs, target and performance.

Commercial Activities and Operations

Commercial Strategy

- Defining long-term commercial strategy in the energy markets, liasing with market analysis and price forecasting.
- Defining the quarterly, monthly, weekly, daily and hourly pricing strategy in the wholesale and spot markets to maximize the margin.
- Monitoring the position in the market and elaborating daily forecast and ex-post analysis.

Commercial Activities

- Managing electricity selling (and buying) processes in wholesale and spot markets.
- Ensuring revenues and margins within risk range limits defined by company guidelines.

Commercial Operations

- Ensuring the execution of generation programs and real-time market participation.
- Monitoring real-time production.
- Managing unbalances.
- Managing communcations with the plants and with the transmission system operator.

Back-office

Back-office and Compliance

- Administrative management of contracts for purchase/sale of energy.
- Executing meeting, settlement and invoicing, and claim management.
- Performing monthly/yearly closing.
- Producing internal and compliance reporting.

Counterparty and Credit Risk Management

- Commercial management in the entrance and in withdrawal of counterparties.
- Managing, within assigned limits, the exposures to counterparties and the credit risk.

RPA can be used to complete repetitive, structured, rules-based tasks and automate business processes at scale. When it comes to undertaking routine and high-volume tasks, the advantage of RPA is clear: the robot or "bot" acts similarly to an efficient, effective human employee who is able to conduct tasks repeatedly. Bots are programmed to toggle between different office tools, systems and email programs to complete a variety of automatable tasks. For activities of this kind, bots are highly efficient and effective: they can be operational all the time or can be programmed to run on a batch basis outside of working hours based on business requirements. In either case, they can complete the activities in a short timeframe, thereby improving operational efficiency.

Further benefits of RPA are that it eliminates human error and is programmed to fully comply with related procedures, which improves accuracy and control. RPA also can automatically identify and flag any inconsistencies with the rules, meaning human efforts can be focused on the tasks that only people can manage.

Invoicing process automation

Business issue

Significant manual effort spent validating and closing daily invoicing. Lack of accurate metrics around invoicing generation processes and potential for human error.

Solution

Implementation of qualitative and quantitative control checks to automatically scan invoices and identify issues for appropriate remediation. If all control checks are successfully passed, the bot posts the invoice into the accounting system.

Benefits

- Manual effort reduction.
- 24/7 operational.
- Reducing processing time per ticket of ~200%.
- Improve data accuracy and eliminate the risk of human error.

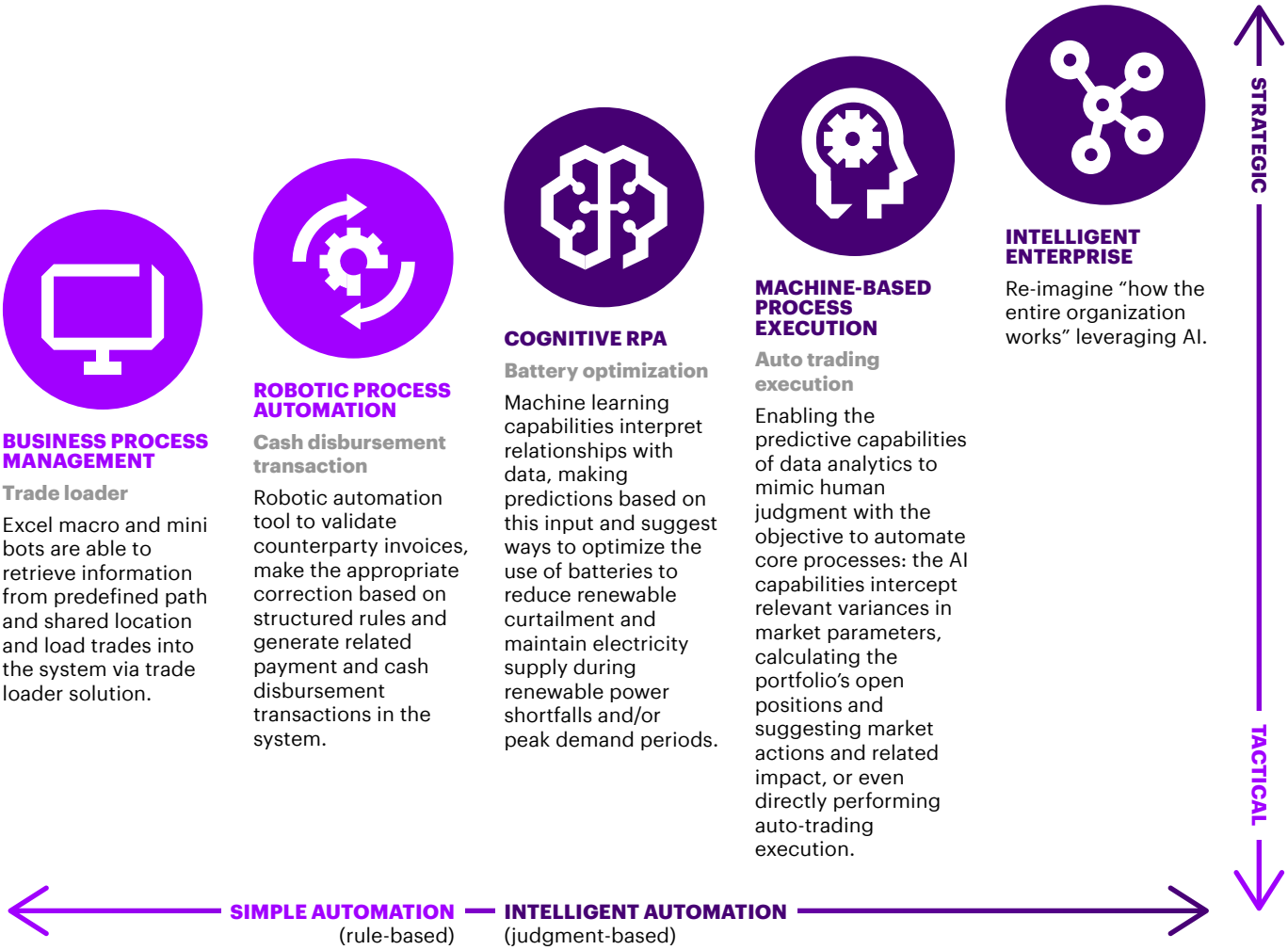
The back-office processes consist predominantly of administrative activities involving recurring tasks. These are the types of activity where RPA can have a relevant impact, such as invoicing and settlement processes. In fact, bots can be configured to automatically validate counterparty invoices and initiate the related payment and cash disbursement transactions within the appropriate tools. As well as eliminating human error, this application of RPA can increase the operational efficiency and effectiveness, while also allowing the company—from one perspective—to generate resource capacity to focus to more value-added activities, and from the other to maintain strong controls and oversight. The use of bots can also be applied to the other process areas where tasks are identified in Figure 9 as being conducive to automation.

The complexity of a process plays an essential role in determining the level of impact an RPA solution will have. Generally, automation of any activity that is not rule-based or structured requires the introduction of additional capabilities based on self-learning, autonomy and intellectual judgment, moving into an AI application. In fact, all automation solutions are on a curve that starts with simple spreadsheet macros, batch programs and mini bots, and goes all the way up to advanced applications ranging from cognitive RPA to more extensive intelligent enterprise.

The more advanced applications provide the ability to interpret and find new relationships between data sets, allowing the predictive capabilities of data analytics to be refined through machine learning, and automating human judgment to help boost productivity. For example, to support fast, effective bidding activities and portfolio management, operators could use AI capabilities to intercept relevant variances in market parameters, calculate the portfolio's open positions, automatically suggest market actions, and assess the related impact or even directly perform auto-trading execution.

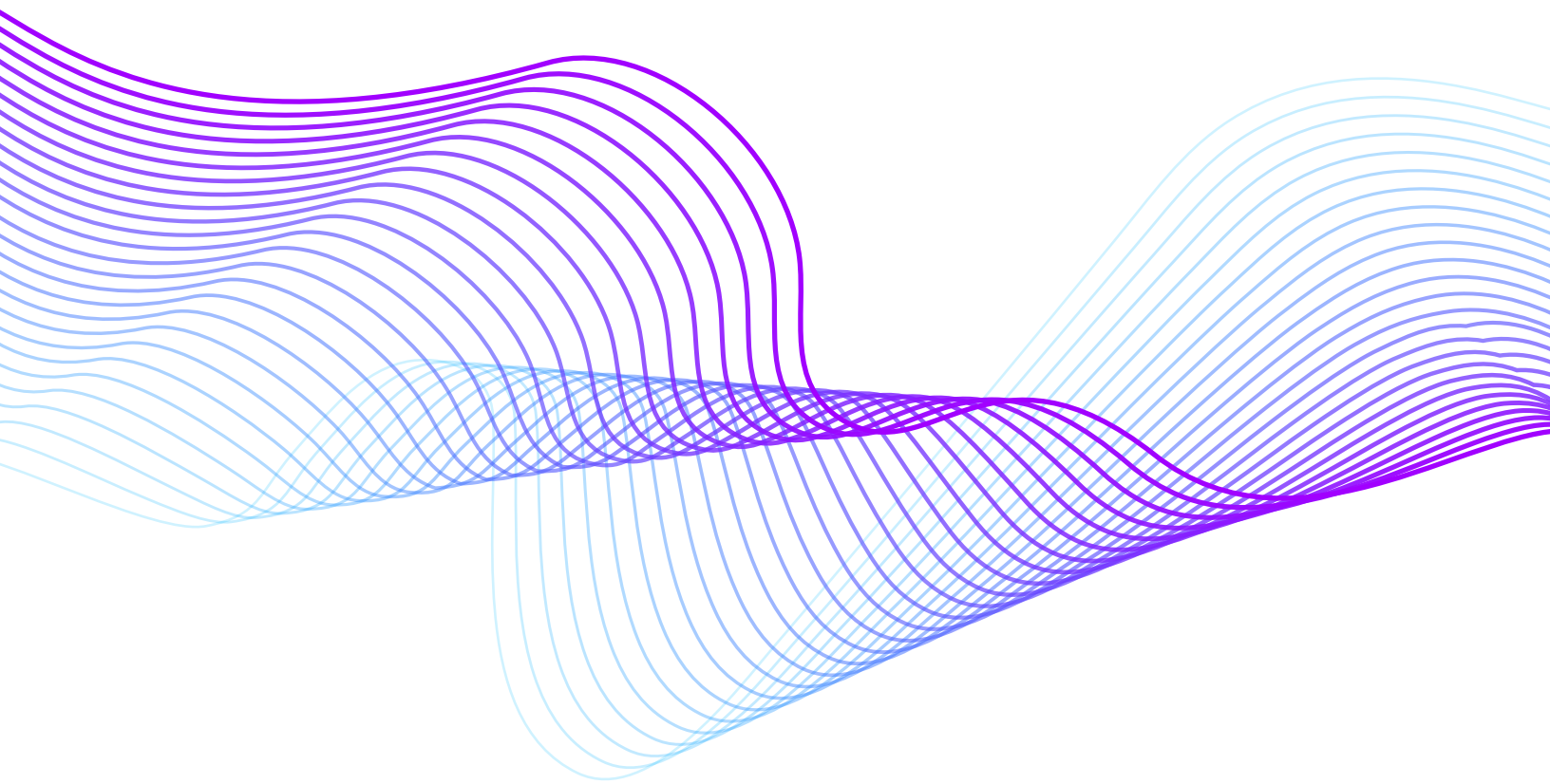
AI could also be used in production planning and scheduling, helping improve the use of BESS with renewable technologies. Machine learning capabilities now make it possible to apply solutions that can collect data and learn from what happened in the past, make predictions based on this input, and—for example—suggest ways to enhance the use of batteries to reduce renewable curtailment and maintain supply during renewable power shortfalls and/or peak demand periods. Similarly, in the context of the intelligent enterprise, AI could also support execution of a company's pricing strategy in the wholesale and spot markets.

Figure 9. Different levels of automation technologies.



What's more, combining RPA and AI in a secure cloud-hosting environment could help companies create an efficient virtual assistant that, powered by natural language processing capabilities, could understand the context of a conversation and end-user intent during a live interaction. Virtual assistants can retrieve, consume and interpret multiple data sets quickly and automatically, respond promptly and provide a streamlined mechanism for completing forms, logging information and completing transactions, thereby improving efficiency and allowing the human worker to focus more on higher-value, people-centered activities. The role of virtual assistant aims to re-imagine the business through human and AI collaboration—a new approach that uses AI to bring out the full power of people, moving from simple automation into the co-creation and collaboration between people and machines. Figure 9 sets out the different degrees of automation now possible, from basic automation to sophisticated and highly-integrated AI-based solutions.

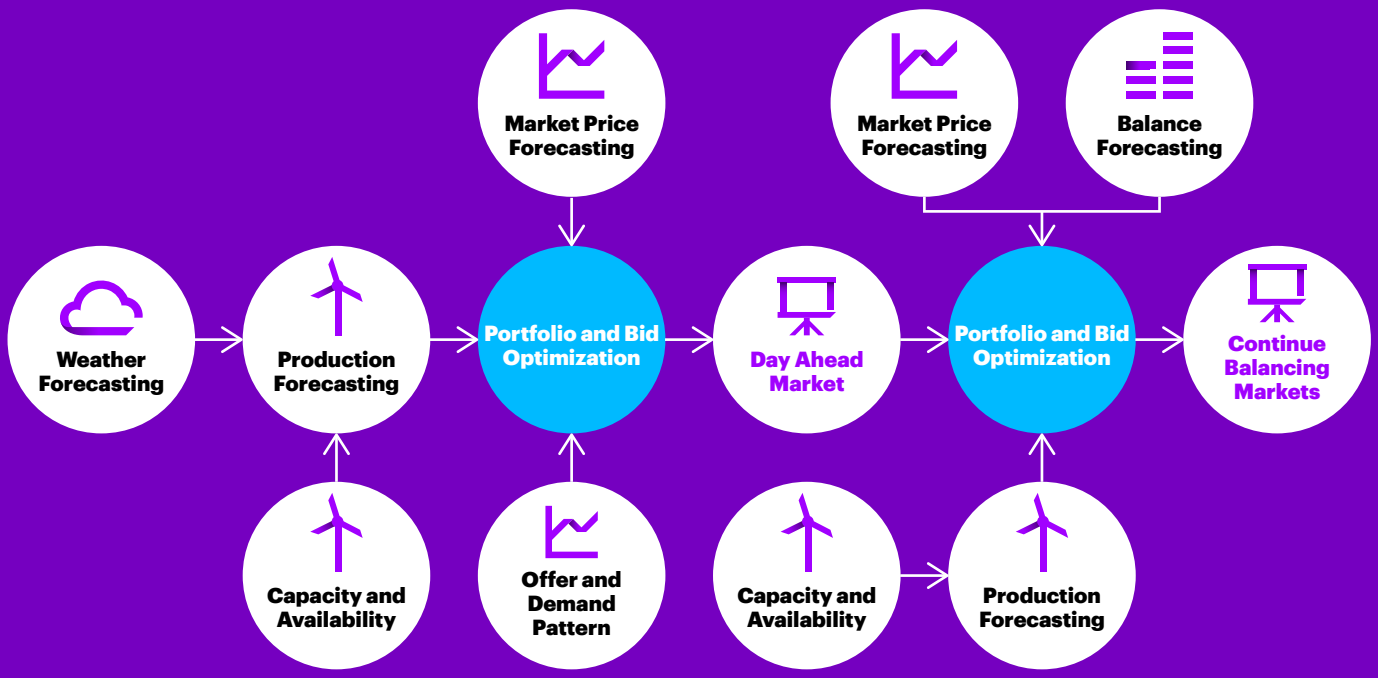
Finally, the adoption of blockchain through distributed ledger technology could allow a renewables company to improve the way transactions are processed with a clearinghouse, (TSO) or other third party. In cases where trades, settlement, payments and exchanges of certificates still rely on time-consuming and partially manual processes, transactions can be costly and difficult to reconcile. Distributed ledger technology could address these issues by facilitating new ways to share data and the automation of peer-to-peer operations, settlement, finance and accounting processes. Outcomes include improved productivity, transaction authentication and security (with cryptographic algorithms based on key encryption), and reductions in arbitrage risk and data-sync issues.



THE END-TO-END COMMERCIAL OPTIMIZATION JOURNEY

Commercial optimization is the end-to-end integration of the themes in this report. Analysis of data from multiple sources and advanced analytic algorithms facilitate smarter market decisions. Automation, supported by AI, acts on these decisions with automated bidding operations, market-confirmed nominations, forecasting and calculations of deviations.

Figure 10. The renewables intelligent commercial optimization journey.



The end-to-end commercial optimization journey is supported by a big data architecture platform.

Optimization starts with the development of a wholesale market bidding strategy for the day-ahead market that incorporates:

- **Weather forecasting:** The ability to use multiple weather forecasting services/tools and combine these sources into an internal model that optimizes weather forecasting for the local areas.
- **Production forecasting:** The ability to automatically run multi-horizon production forecasts for wind farms and solar plants that consider data from several weather forecast data sources—each one with different data and time intervals, granularity, and real-time and planned asset availability.
- **Market price forecasting:** The combination of stochastic and fundamental models to forecast day-ahead market price and spreads between the day-ahead market and the balancing markets.
- **Offer and demand pattern:** Analysis and forecasting of system-balancing position and direction; combining and executing the intersection between system demand forecasting and power production curve based on market players' historic behavior.

The wholesale market bidding strategy is input into a simulation tool where bidding strategies are evaluated and a smarter bid is built. The data architecture platform communicates with the market operator and integrates bids.

Optimization continues with the intraday bidding operations:

- Day-ahead market results, prices and programs are uploaded into the platform.
- Every few minutes, weather forecasting data and plant availability are uploaded and refreshed into the platform.
- Based on updated data, the system automatically runs production forecasting models and calculates deviations from day-ahead, market-confirmed nominations.
- Considering balancing-markets forecasting, potential smart decisions are made to define bidding strategy to solve deviation and reduce penalties using the different market alternatives.

IMPLICATIONS FOR RENEWABLES PLAYERS

From the output of the interviews and further follow up with the companies, it is clear digital technologies are vital to maximize commercial optimization processes. During this study, we have seen how technology is able to contribute to process optimization and ultimately to improve the margin per megawatt-hour. The most impacting digital capabilities are highlighted in Table 2.

Table 2. High-impact capabilities enabled by digital technologies.

		Cloud	AI	Big Data Analytics	IT/OT Convergence	RPA	Blockchain	Mobile	Social
Energy Portfolio Planning and Management	Generation Production Planning	Flexible computing capacity Multiple data accessible in timely manner Single view of data in a distributed, scalable computing environment	Forecasting capability integrated with machine learning Simulation capability integrated with machine learning Prompt market insight Advanced scenario and impact analysis Integrated machine learning algorithms in the risk models Optimization capabilities	Ability to aggregate and make available high quality data Forecasting analysis Advanced analytics and visualization capabilities Decision-making support Optimization capabilities	Asset performance monitoring Plants data acquisition				
	Market Analysis and Price Forecasting								
	Portfolio Management								Data collection and information exchange Collaboration
Commercial Activities and Operations	Commercial Strategy								
	Commercial Activities				Asset performance monitoring Plants data acquisition	Automated tasks execution Analysis automation	Exchange operation automation Authenticate transaction in a secure manner	Reduce dependency on physical location Data visualization and monitoring on mobile	
	Commercial Operations								
Back Office	Commercial and Financial Back Office								
	Counterparty and Credit Risk								

Based on our study results, we have identified three main actions renewables leaders should consider on their path forward:

- **Implement data capabilities to become a fully data-driven organization:** Renewables companies have embarked on the journey to become data-driven organizations by developing capabilities to aggregate data from multiple sources and making high-quality data available for advanced visualization tools to facilitate decision making. However, in a poll of 22 executives across 14 leading renewable generators in Europe, when asked about their journey to become a data-driven company, the most common response made by approximately half the respondents was that they had a "structured approach but limited in terms of the processes covered."

  From an infrastructure perspective, not all companies have reached a full cloud and big data analytics to support real-time data availability. In the same poll, when asked about their journey to cloud, more than half of the respondents were less than half of the way there. The recommendation supported by the output of this study is to adopt a scalable, flexible infrastructure to boost computational capacity, with data accessible in a timely manner, especially in the context of ever-increasing volume and complexity of data from many sources.

- **Develop forecasting and simulation capabilities based on multiple dimensions:** Combining weather, production and market forecasting capabilities will put utilities in the position to optimize weather forecasting of multiple areas, run multi-horizon production forecasts from several data sources and forecast market prices. Machine learning capabilities interpret relationships between forecasting data, making simulations and suggesting prompt insights to take smarter bidding decisions. Adopting such capabilities is crucial to improve revenue and for "beating the margin" per megawatt-hour. Renewables leaders should grow these technologies to take advantage of the profit opportunity.
- **Automate business processes leveraging AI potential:** Robotic automation allows tasks to be executed quicker, at any time and without error. The combination with AI expands the range of automation to more complex activities based on data interpretation and predictive analytics. Renewables companies should tap into these technologies to improve process effectiveness and efficiencies and reinforce margin increase.

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