The Bionic Energy Network

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Preface

Every energy network utility that we speak with recognizes the crucial importance of digital technologies for growing its business. Yet few of these companies are satisfied with the results that they have seen so far. And even fewer feel that they have been able to derive robust, sustainable advantage.

This reckoning comes at a time when energy networks are facing growing pressure from many directions: regulation, which squeezes returns; the advent of distributed energy resources, which require new technological and operational approaches; and climate change, which has brought about more-frequent extreme weather events and crises, such as wildfires.

BCG's research and experience show that, regardless of the industry, the most digitally advanced companies are blending new technologies with their human capabilities. These so-called bionic companies consistently come out on top, achieving operational and financial metrics that are better than those of their competitors.

The following collection of articles, written by my colleagues over the past two years, sheds light on how bionic energy network utilities are addressing some key challenges that are confronting the industry, including transitioning to renewable energy; managing assets, the workforce, and vegetation; and reducing energy losses and debt. As these articles demonstrate, bionic energy networks have achieved superior business outcomes by combining the best of what technology and human expertise have to offer.

We hope that these perspectives open up opportunities for your energy network.

Philip Hirschhorn
Managing Director and Senior Partner
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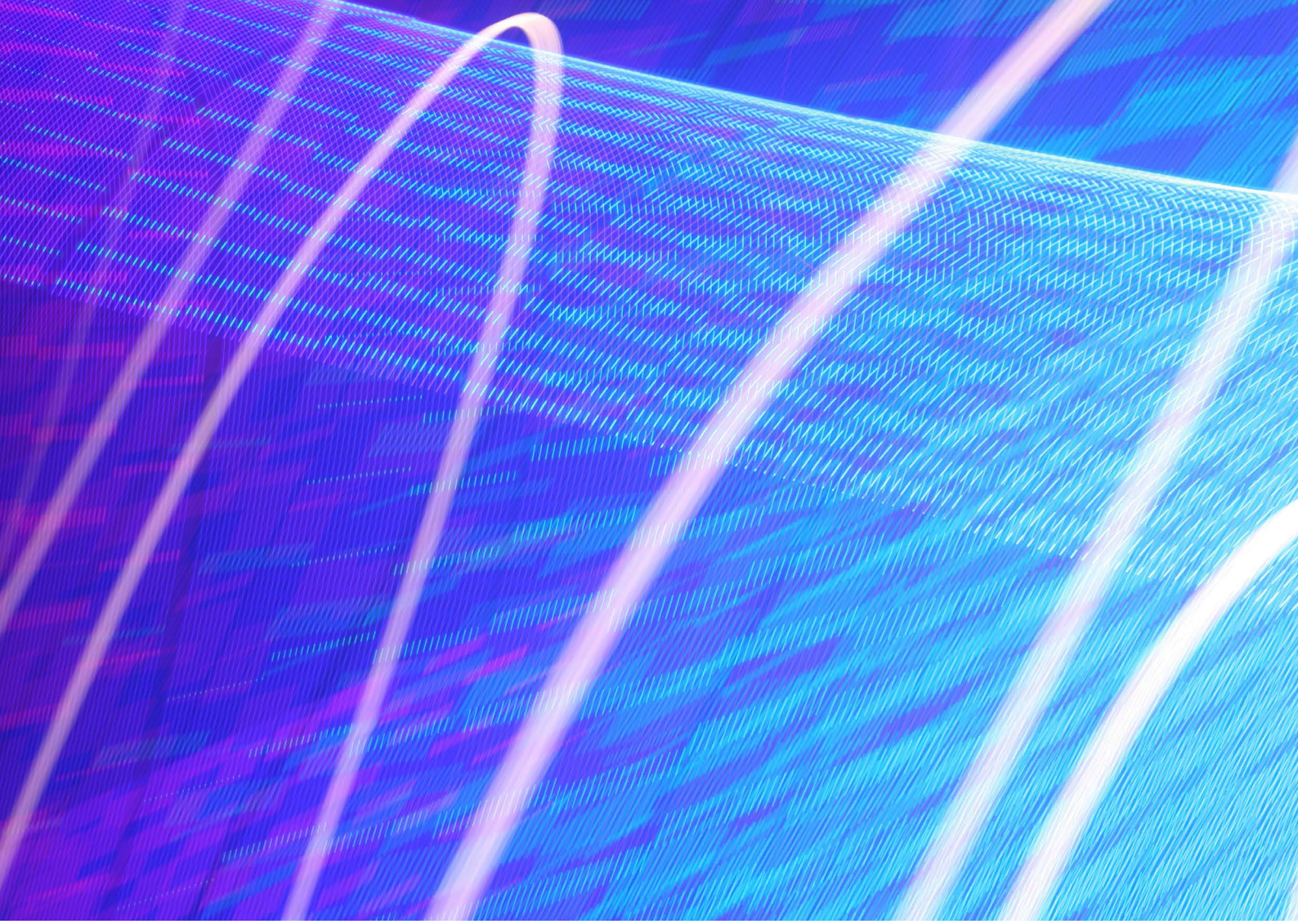

Why Technology Alone Is Not Enough

By Philip Hirschhorn, Oxana Dankova, and Pavla Mandatova

As companies contemplate business after the pandemic, executives of energy network utilities are recognizing that there is an opportunity to accelerate the adoption of digital technology in order to build smarter, more resilient, and more customer-responsive networks.

Energy networks are under growing pressure from many directions: regulation, which squeezes returns; climate change, which increases the frequency of wildfires and other extreme weather events; and distributed energy resources, which impose new technical requirements.

A wide variety of digital technologies have the potential to relieve these pressures: drones, satellites, and light detection and ranging (LiDAR) imagery can map an energy network and identify defects; artificial intelligence can help process the imagery and predict asset failures; advanced distribution management systems can orchestrate network flows; and robotic process automation can make the back office more efficient and productive.

Many energy networks are pursuing digital initiatives using these and other technologies. Yet, despite their efforts—and considerable investments—few companies feel that they are realizing the full potential of digital transformation at scale. Most struggle to move beyond pilot programs to having real business impact.

Energy networks' less-than-satisfying outcomes have common sources:

- Implementing new technology without a clear understanding of how it will translate into benefits
- Failing to help a team change itself and its processes to get the most out of the technology
- Seeking to implement digital change on a technology platform that isn't flexible enough for today's rate of change

Energy networks can overcome these challenges by becoming bionic.

What Is a Bionic Network?

A bionic energy network melds technology with human expertise to create business outcomes worth more than the sum of these parts. In a bionic organization, four elements work together. (See Exhibit 1.)

- **Purpose and strategy** set the direction. They inspire and align rapidly moving autonomous teams because they establish "an unbroken chain of why" that links the work that teams do to the business outcomes required.
- **Business outcomes** are specific goals that fall into three categories: bionic operations, personalized customer experiences, and new offers and services. For energy networks, creating bionic operations is the most relevant of the three, although personalized customer experiences are becoming more important.
- **Human enablers** include the right mix of talent, an organization structure, cross-functional teams, and new ways of working that will transform the business. For example, the bionic energy network requires talent with a variety of skills—user experience designers to improve the employee or customer experience, as well as data scientists to organize data and develop and train algorithms. The bionic network achieves the right mix by retraining the existing team and hiring new employees.
- **Technology enablers** encompass the modern stack of modular, flexible—often cloud-based—systems that underpin the new digital processes running the network. The enablers also include the suite of technologies—such as satellite and LiDAR imagery, drones, artificial intelligence, and network sensors—that provide the data that is the lifeblood of a bionic energy network.

How to Become a Bionic Network

The bionic journey begins with the energy network identifying the business outcomes that it wants to achieve, rather than focusing on use cases or applications of specific technologies. The challenge is to reframe the starting point. Rather than asking which new tool should be added, the network asks what business need or problem must be solved and how can the company's capabilities, human and technological, combine to deliver the solution. By starting with clear outcomes in mind, the approach becomes targeted and relevant, leveraging the full mix of technological capabilities and human expertise. Energy networks should pursue six main business outcomes to realize the benefits of new technologies. (See Exhibit 2.)

The next step in the journey involves identifying the human and technology enablers needed to achieve a few prioritized business outcomes, rather than trying to build a suite of technology or implementing new ways of working across the business. The company can then progressively expand its initiatives to achieve other business outcomes, building momentum that eventually leads to having bionic capabilities across the organization.

Transforming Vegetation Management

Vegetation management provides a good example of how the bionic approach can work. All too often, companies implement LiDAR technology in their vegetation management process, only to find that it adds cost without improving compliance very much.

Exhibit 1 - Blending Technology and Human Expertise Improves Business Outcomes

Source: BCG analysis.

Exhibit 2 - Energy Networks Should Pursue Six Main Business Outcomes

Building the right network	Properly managing existing assets	Equipping the network with the right technology	Getting the most out of existing resources	Focusing on customers	Providing functional support digitally
10% Uplift in net present value	**10%–15%** Reduction in spending on asset maintenance and replacement	**15%–95%** Reduction in the number of ground inspections	**Up to 50%** Increase in workforce utilization	**40%** Reduction in call volume via chatbots and AI	**20%–40%** Reduction in transactional workload
5% Uplift in internal rate of return	**20%–30%** Reduction in spending on vegetation management	**10 days to a few minutes** Reduction in the time needed to access the network when the work is planned	**20%–30%** Increase in team efficiency	**10 days to 20 seconds** Reduction in the time required to connect a new service	**40%–60%** Reduction in time from procurement to payment
	Up to 40% Reduction in the system average interruption frequency index	**70%** Percentage of circuits with remote response and self-healing capabilities	**10%–40%** Reduction in logistics costs		**70%** Reduction in supplier base
			>50% Reduction in administrative workload due to workflow automation		**Up to 50%** Reduction in managerial time spent on recruiting activities

Source: BCG analysis.

Note: AI = artificial intelligence.

Instead, companies should first identify the business outcome that they want to achieve: for instance, a 30% reduction in vegetation management costs without increasing network risk. That step raises a series of questions that companies should ask themselves. For example:

- How do we quantify the risks—to human life and property—of vegetation-induced outages and crises, such as wildfires?
- How do we determine when to treat vegetation so that we can manage the risks yet minimize the number of visits? How can we predict vegetation growth and when vegetation will affect the network?
- Which data—including LiDAR, satellite, and ground imagery; weather information; and vegetation species data—should we analyze in aggregate to predict growth?
- What information architecture is needed for reaching informed conclusions from a variety of data using artificial intelligence algorithms?
- How do we change the processes and contracting models with our vendors so they can treat vegetation in the right way at the right time?
- Which experts—data scientists, designers, and developers—do we need on a cross-functional team to deliver the new vegetation management process and help arborists?

The answers to these questions reveal the combination of the technology and human enablers required to achieve the desired business outcome.

The Benefits of Becoming a Bionic Energy Network

The cost-reduction benefits of adopting a bionic approach are substantial. Bionic energy networks have reduced replacement expenditures by 10% to 15%, cut vegetation management costs by 20% to 30%, increased workforce utilization by more than 50%, and reduced contact-center call volumes by 40%.

In addition, bionic networks experience substantial improvements in customer outcomes: the time to make connection offers falls from weeks to seconds, and reliability measures rise significantly for targeted parts of the network.

Perhaps most important, working in a bionic energy network leads to more engaged and productive employees with a real sense of purpose.

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Electrifying Your Digital Transformation

By Justin Dean, Matthew Sundberg, Anil Podduturi, Charles Gildehaus, Philip Hirschhorn, Oxana Dankova, and Pavla Mandatova

Despite major investments in digital transformation programs, many energy network utilities have yet to capture the full potential of digital in their core operations. Even companies with the most promising initiatives have grappled with a wide variety of challenges, including a lack of focus, funding constraints, and legacy IT systems.

Using a bionic approach is critical to achieving better results. Bionic networks are able to unlock more value from their digital transformation journey because they take four key steps. They prioritize areas for digital initiatives, create a roadmap for digital products, and deliver products using agile ways of working. At the same time, they build a foundation that supports the transformation program.

Prioritizing Areas for Digital Initiatives

Some energy networks develop a plan for digitally transforming the entire company before they begin to execute. But a plan this comprehensive can take months or even years. By contrast, bionic networks identify the areas of their operations that are most critical for achieving their business priorities. After planning and executing initiatives for these areas, bionic networks move on to the next-most-critical operations area, and so forth.

> **This approach works because bionic networks have a clear understanding of their key business goals—whether they want to reduce operating expenditures, for example, or improve customer satisfaction.**

These networks also have an end-to-end, top-down view of where they are losing value and where friction exists. As a result, bionic networks know where they can get the greatest bang for their buck. For example, they may start with residential billing and payments and then move on to storm-response operations or new-customer connections.

Creating a Roadmap for Digital Products

Most energy networks have no shortage of digital product ideas. But in many cases, it's unclear how these products will help advance operations to the target state and improve key performance indicators. Moreover, most networks have only a limited understanding of how a potential product depends on other digital products, legacy IT systems, and other ongoing initiatives. As a result, many networks deploy a number of different point solutions, each of which addresses a specific problem in isolation. Because point solutions fail to take related issues into account, they typically turn out to be complex and ineffective. Networks may even spend time and resources on digitizing operating processes that are suboptimal.

Bionic networks take a different approach. They begin by reimagining their core operations as digital operations and estimating the value that a digital transformation program would bring. This approach essentially establishes a North Star that networks can use to create a roadmap. This plan details the development sequence of digital products, itemizes any required IT or process changes, and identifies the back-end infrastructure that's needed to enable digital capabilities. With the roadmap in hand, bionic networks are able to clearly articulate how digital products are linked to business priorities and the future state of their operations, as well as how these investments will benefit both customers and shareholders.

Delivering Products Using Agile Ways of Working

When defining the scope of digital products, energy networks often aim to implement them across the entire company in one fell swoop, planning multiyear projects that not only entail long lead times to create value but also have significant execution risk. At the same time, companies rely too much on third-party vendors to deliver IT solutions and focus too little on various elements that are critical to success: value, processes, data, user adoption, and organizational change. Consequently, digital products often fail to realize their full potential and come in over budget.

In contrast, bionic networks focus on delivering digital products as they are set out in the roadmap. They use an iterative approach and agile teams to reduce both lead times and execution risk.

Define and build MVPs. Bionic networks define a minimum viable product (MVP) for each digital product they pursue. The MVP has a standalone business case and a delivery timeline of six to nine months. When defining an MVP, networks focus relentlessly on usability, value creation, and technical feasibility. They also carefully think through exactly what's needed to build an MVP, including the data and user interface, as well as the business processes that need to be changed. As a result, the MVP definition includes not only a list of requirements but also visual mockups and early prototypes.

All these considerations and decisions are critical for deciding whether to build or buy—and, in the case of the latter, finding the most appropriate vendor. In many cases, the best answer is to do both: purchase some critical components from third parties and build other components in-house.

After launching an MVP, bionic networks continue to evolve the product and release updates, each supported by its own business case.

> **Key to this approach is establishing a product mindset, as opposed to a project mindset.**

Continuously build, test, and learn. When building an MVP, a bionic network's product team uses agile sprints and takes a continuous build-test-learn approach to reduce the greatest risks around usability, value creation, and technical feasibility. It tests prototypes early and often to identify missing features and technical issues. And it gets feedback from users and customers frequently during the development process to help ensure that the product will be adopted. Reaching out to users and customers also

makes it more likely that the operations staff in the field will buy in.

Deploy multidisciplinary, minimum viable teams. Bionic networks recognize that creating a multidisciplinary, minimum viable team to oversee each digital product is key to successfully delivering an end-to-end solution. Such teams include experts from the business and IT units, as well as resources from digital centers of competence (including product managers, user experience designers, and data scientists), all of whom bring a unique perspective to solving the problems at hand.

Building the Foundation While Creating Value

To successfully scale a digital program, it's critical to establish a solid foundation that includes governance and funding, a data and digital platform, and digital capabilities and talent. Bionic networks build the foundation as they go, rather than all at once upfront. The value created by the digital products provides the needed funding.

Governance and Funding. For energy networks, the challenges of governing and funding digital programs are daunting—and the larger the effort, the greater those challenges are.

Bionic networks recognize that, first and foremost, the success of each program requires input from a wide variety of functions, not just one. For this reason, bionic networks create a multidisciplinary board to oversee digital transformation programs.

The board's responsibilities include allocating funds to digital products. But instead of fully funding a digital product at the beginning, the board unlocks the funding incrementally. The first round of funding comes after the roadmap is defined, the second is provided after the business case is validated, and so forth. Thus, funding is provided as major assumptions are confirmed, the potential for value is proved, and success becomes more likely.

Bionic networks place a strong emphasis on creating value. For this reason, the board tracks the value of MVPs throughout development. If it becomes clear that an MVP is not likely to deliver on its business case, the board can stop funding or force a change in direction.

The board also oversees quality and technical governance, ensuring that the development processes and user experiences of the various digital products are standardized, aligned, and connected. As a result, there's little risk that product teams will stray from the approved processes, and there's no ongoing battle to manage overlap in scope and extract synergies from the digital portfolio.

A Data and Digital Platform. Building a data and digital platform at energy networks includes modernizing the IT, grid, and advanced-metering infrastructure. Traditionally, companies have done this work before launching a digital transformation program, but this approach can be inefficient if the new architecture does not fit the companies' digital needs.

> **Bionic networks create roadmaps for digital products and the foundation simultaneously, so that the platform is built at the same pace as the digital products.**

Bionic networks also create a digital platform team to implement a data and digital platform that enables future digital products to quickly and easily (and cost-effectively) access legacy IT systems and data. The team comprehensively manages data quality and extracts back-end synergies across a full portfolio of digital products. Moreover, it sets up test environments so prototypes can be quickly constructed for build-test-learn cycles.

What's more, bionic networks do not use traditional methods for providing IT support. With the dramatic increase in the number of services and releases that must be monitored and supported, an agile mindset and ways of working, along with DevOps processes and tools, are key. In addition, bionic networks create DevOps teams that are responsible for developing services end to end.

Digital Capabilities and Talent. For each digital product, bionic energy networks source talent from both internal and external avenues to best meet their needs. The talent has a broad variety of capabilities, including tech, design, and business skill sets. Internally, bionic networks invest in focused training, learning journeys, and upskilling programs to make people effective in their new roles. Externally, maintaining a set of carefully vetted vendors to help supplement internal resourcing and fill gaps can ensure that digital products are not delayed.

Attracting and retaining digital talent can be one of the greatest challenges for energy networks, so thinking holistically about the employee value proposition and talent acquisition strategy can help build a pool of digital talent over time to serve the needs of the bionic network.

Digital transformation is a complex undertaking. To succeed, it's critical to follow a rigorous approach that focuses on developing digital products, building a foundation, and changing processes simultaneously. Bionic networks are best positioned to capture the value that a digital transformation has to offer.

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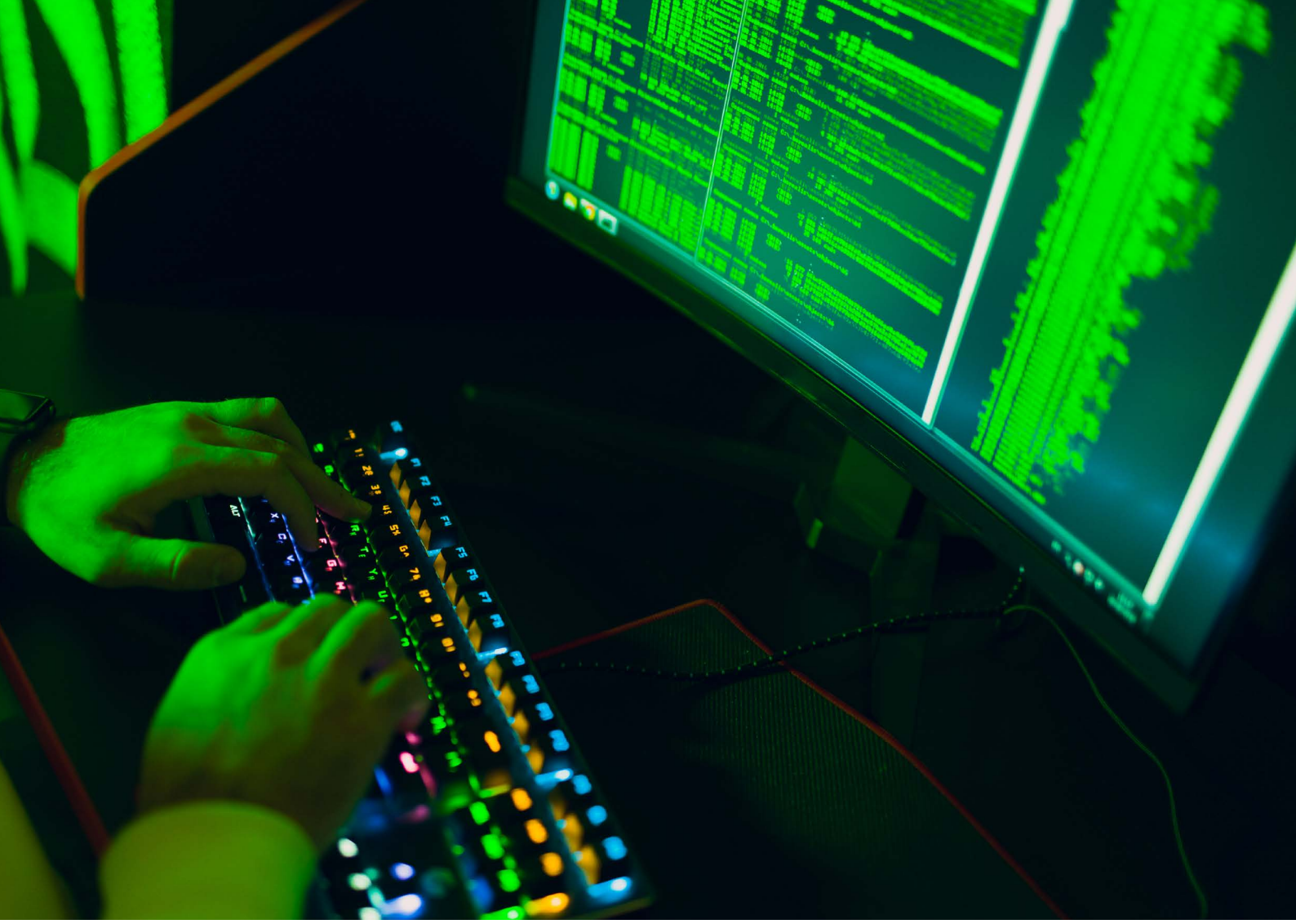

The Energy Transition Needs Next-Gen Network Planning

By Oxana Dankova, Will Vandenberg, Kim Kennewell, Christian Wagener, Thomas Baker, and David Viljoen

The challenges of network planning are intensifying for energy distribution networks worldwide, as various trends—including the rise in the number of electric vehicles, the growth in behind-the-meter generation, and the increase in demand from new energy-hungry industries—create big shifts in supply and demand as well as a whole new level of complexity.

These challenges are compounded by distribution networks' and other ecosystem players' need to continue making major decisions related to asset replacement and investment. These ecosystem players include energy retailers, small-scale renewables developers, and EV charging networks. Their decisions will further impact the patterns of supply and demand in the distribution network.

> **Clearly, the planning efforts of all players in the distribution ecosystem would benefit from better coordination and transparency.**

But the traditional planning method—energy networks forecasting demand in an area and building capacity after coordinating with local planners and developers—is not suitable for this challenge. What's needed is next-generation planning: an ecosystem-wide collaborative planning effort that facilitates scenario-based decision making that considers the implications for low-voltage networks.

How Next-Generation Network Planning Works

Next-generation network planning leverages advanced analytics and modular technology platforms to facilitate better multiparty collaboration and scenario-based decision making. This planning involves three successive sets of analytical activity: visualizing the current state, simulating future scenarios, and optimizing investment and ecosystem decisions.

To achieve the required business outcome, the technology must be designed for and integrated into the way people work from day one. It's critical to consider upfront how human decision makers will interact with the algorithm and supplement it with their expertise. In our experience, a customized platform-based solution with a transparent built-for-purpose algorithm facilitates the best outcomes.

Although there are no off-the-shelf solutions on the market yet, the technology required to implement a bespoke solution is mature. Cloud-based infrastructure means computational capacity is within easy reach; AI, simulation, and optimization algorithms are significantly faster and more flexible than in the past decade; and there has been considerable development in easily implemented human interfaces.

So, the primary focus should not be on selecting technology but on integrating the technology and algorithms with human decision making. The most advanced energy networks are using a bionic approach, with a cross-functional team to perform each set of analytical activity and to configure the output to facilitate business engagement and adoption along the way.

Visualize the Network's Current State

Energy networks should begin by creating a visualization that shows a network's current economics, performance, and constraints in one place. When creating this visualization, it's important to consider what types of decisions are being made, what is being solved, and the types of data that are needed.

Rather than trying to build a visualization that addresses every possible business problem, companies should start with a few of the most important use cases. That way, it will be possible to create value with the first minimum viable product.

The use cases will differ depending on the business context of a particular network. Some networks may want to focus first on significantly accelerating the approval process for new customers so their service can be connected more quickly. Others may look to identify the priority feeders to replace with standalone power systems. And still others may want to develop a platform for the network-retailer-developer ecosystem to coinvest in community batteries, EV chargers, or microgrid developments.

The ideation team that is assigned to work on the visualization solution should be a cross-functional group, with representatives from asset management, the control room, network operations, distributed energy resources management, the new-connections team, and finance and regulatory departments. The ideation team should also include relevant external stakeholders, such as energy retailers or renewables developers, depending on the use case.

> **The ideation team should brainstorm to identify what matters most for the business outcome, the decisions that could be made differently, the key variables and constraints, and, therefore, what could be valuable to visualize.**

A cross-functional product team then should develop digital tools that enable interacting with the data. Among other things, the product team's activities identify what is required to give users confidence in the validity of the analytics and provide the foundation for the technical design of the visualization and user interface prototypes.

It is also at this point that the hunt for data should begin. Companies often wait to start developing a visualization until the data is perfect, but there is more value in understanding the implications of data quality issues and incorporating this knowledge into the design and use of the analytics.

Simulate Future Scenarios

To turn the visualization into a solution that can be used in the future, networks need to understand what their physical constraints and their economics will be at a granular level in a variety of future situations. We recommend simulating multiple scenarios using a variety of factors (such as growth in demand, an uptick in rooftop solar photovoltaic panels and storage devices, and changes in EV penetration and users' charging behaviors). Physical simulations of a network provide a sense of the technical constraints, while economic simulations provide insight into the network's economics and the implications for broader societal outcomes.

These kinds of simulations require greater sophistication on the part of technologies and the people using them. Digital twin simulation technology is key. It enables business users to intuitively build a digital representation of the network and interact with the scenario models. A scenario model and its interface should be flexible enough for users to adapt the constraints to changing technologies and regulations. At this stage, a scenario model does not include algorithms that can prevent or minimize breaches of these constraints. Any violations, therefore, are highlighted rather than resolved. This combination of flexibility and visibility facilitates iterative improvement of a scenario model.

From a product development perspective, the focus needs to shift from engineering precision to what matters for decision making. It's important to keep in mind that the most detailed level of information should not automatically be used.

> **The key is to identify the minimum level of detail that will enable decisions to be made differently and with sufficient confidence.**

It's also important for a scenario model to be able to quantify the impact (for example, the risk) of various constraints and other changes consistently across a broad variety of scenarios. That makes it possible to identify the chief ways to influence the outcomes and choose the ways worth investing in. By ensuring scenario management and governance, the analysis behind investment decisions can be repeated and audited.

To enable multiple players in the ecosystem to participate in scenario modeling, the digital twin should be built on a platform that facilitates collaboration and that has specific interfaces customized for different users. Given that the platform will be used by external ecosystem players, it's extremely important to ensure that it is cyber resilient.

Optimize Investment and Ecosystem Decisions

After a variety of future scenarios have been simulated, it may be beneficial to add an optimization engine to the scenario models to enhance the human decision making. The beauty of adding a mathematical optimization engine is that it can compare multiple combinations of the various pricing and tariff levers that are available to the network and the broader ecosystem. By bringing the best potential solutions to the attention of the human decision makers, an optimization engine helps them select and iteratively refine the most-suitable solutions.

Networks (and investors) will need to shift their focus. Increasing the regulated asset base can no longer be depended on to generate returns. Companies need to widen their lens, optimizing investments across the ecosystem to achieve good outcomes for both themselves and society at large.

We recommend that networks deploy a white-box optimization engine, which makes outputs transparent to ecosystem players. A white-box engine also makes it possible to evaluate the potential design tradeoffs of various scenarios. The amount of detail, particularly for constraints, that's built into a scenario model can be weighed against the amount of time it takes to generate a scenario.

It's also important for users to be able to modify the objective function, or goal. That way, users can compare optimization solutions that focus on one of the three goals: the least cost to serve, the greatest level of distributed energy resources that the grid can integrate, or the fewest interruptions for each customer. These solutions can then be compared with options that weight each outcome equally.

Collaborative ways of working are as important in investment optimization as they are in scenario modeling. The insights generated by the analytics should be used to support decision making by the network, its customers, energy retailers, developers, and other ecosystem participants. This approach opens the door to innovative solutions and helps build a shared vision among stakeholders.

Developing a bionic approach to next-generation network planning is not a one-off exercise, nor should it be a long journey before a network sees results. Networks that deploy an agile approach, follow the principles of lean product development, and unlock value quickly have an opportunity to take a leading role in shaping the future of the distribution grid. But only by harnessing the power of data and technology in combination with collaboration can they make this a reality. This approach will promote better outcomes—cleaner, reliable energy at a lower cost for customers; better investment decisions for the networks and other ecosystem players; and a more coordinated energy transition for all.

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Let's Get Digital in Asset Management

By Santiago Gallego, Alfonso Abella, and Oxana Dankova

Over the past several years, many energy network utilities have sought to apply the power of data and digital technologies to asset management. Some of these attempts have been successful. They have increased network reliability while reducing total maintenance costs by 15% to 25%, optimized design projects to achieve the same or better outcomes while costing 50% less, and cut power losses that arise from technical issues by 15%.

But many energy networks have struggled to progress at speed and capture value from their investments. Three factors hinder their advancement: poor data quality, complex and intertwined legacy IT and operations technology systems, and difficulties modifying how networks make and execute daily asset decisions. As a result, these companies are facing falling demand, an increase in off-the-grid energy sources, and, potentially, deteriorating revenues.

Energy networks can blunt the impact of these trends. By taking a bionic approach to leveraging advanced data analytics and applying digital technologies, operators can significantly improve how they manage their most critical assets.

What's Different About Bionic Energy Networks

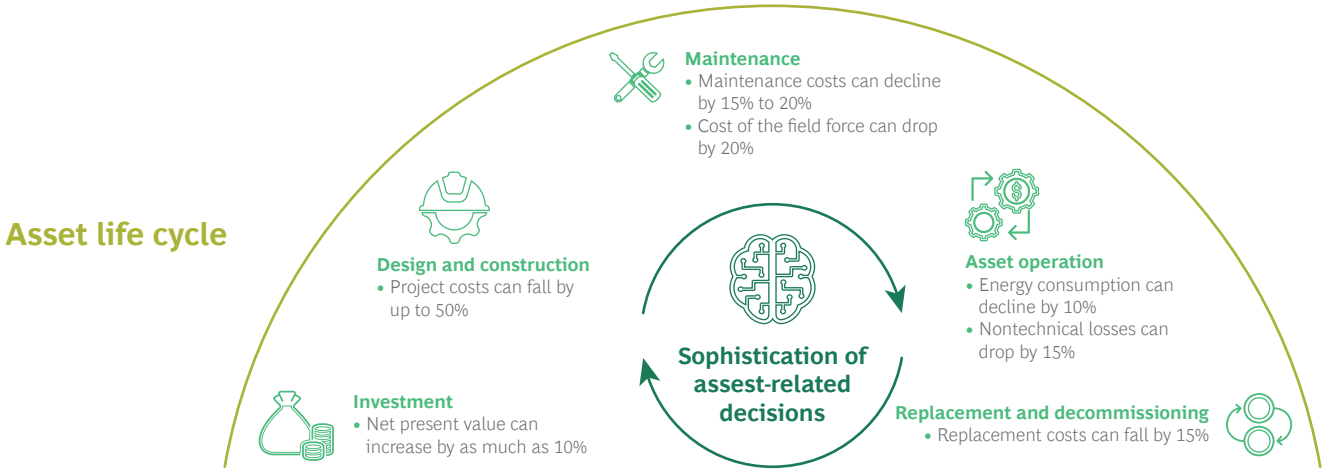
Traditionally, energy networks think holistically when designing an asset management system, creating comprehensive blueprints and documentation that meet the specifications of the International Organization for Standardization. This approach often leads to a lot of time and money spent on cleansing data, testing technologies, and building new IT systems. After three to five years, many of these companies haven't achieved the expected improvements in asset management.

Bionic energy networks take a different approach. They bring to bear human expertise along with best-in-class technology to improve asset decision making. These companies do not attempt to replace their people's expertise with a black box that uses artificial intelligence (AI). Instead, they combine human know-how with technology, data, and advanced analytics to create optimal decision models and build decision-making capabilities.

First, bionic networks prioritize a small number of specific business outcomes that are critical for the network and imagine ambitious targets. For example, a network may decide to reduce spending on transformer maintenance by 20% to 30% while improving network reliability, or it may target halving overhead operating expenses without increasing asset risk.

Second, for each asset needed to achieve a business outcome, bionic networks rethink and rebuild the decision model used for each stage of the asset's life cycle: investment, design and construction, maintenance, asset operation, and replacement and decommissioning. This effort involves identifying the specific data, analytical techniques, and technology enablers. When companies leverage granular asset data and advanced analytics to make decisions across their assets' life cycles, they have the capability to make the most optimal decisions and have reached a level of asset management maturity that BCG calls 4.0. By making optimal decisions, networks can cut field force costs by 20%, reduce nontechnical losses by 15%, and lower replacement costs by 15%. (See the exhibit.)

Bionic Networks Benefit by Rethinking Their Decision Model for Each Stage of an Asset's Life Cycle



Source: BCG analysis.

For example, it's useful to rethink and rebuild a decision model that predicts when an asset will need maintenance. The model can help networks optimize the tradeoffs between multiple variables: the criticality of the asset, the economic impact of the decision, the ways that the asset can potentially fail, and the availability of the data needed to monitor the asset. A predictive model may make sense for transformers in grids and gas pumps in gas pipelines because those assets play a critical role in business results.

Third, bionic energy companies bring together multidisciplinary teams to iteratively build new capabilities that are needed to optimize the decision models. Led by representatives from the business side of the company, these teams focus on creating value quickly and improving the experience for the teams and customers. They deploy advanced analytics and AI to optimize decisions for assets at each stage of their life cycles. The teams build capabilities not only in the areas of data science and human-centered design but also in leadership skills.

Companies ensure teams' success with persistent funding models and governance support.

Fourth, bionic energy networks identify and implement the right technology enablers—for example, cloud-based infrastructure, data platforms, and digital user interfaces—that are required to achieve each specified business outcome.

Fifth, to maximize the business impact and return on investment, bionic networks change their operating model and business processes. For example, when real-time transformer monitoring is implemented in an asset control center, it requires redefining the asset maintenance plan and developing processes that enable asset management teams to send work orders to field workers in short time frames.

Asset maintenance, operation, and replacement decisions can all benefit from the bionic approach. With the help of algorithms, networks are better able to predict potential failures, prioritize inspections, optimize asset performance, and reduce the time to deploy.

For example, an electricity network wanted to significantly reduce the amount of money it spent on maintaining and replacing transformers. A cross-functional team reviewed the overall decision model and identified typical failure modes and the data required to optimize decision making. The team used computer vision and text mining to extract additional data, which was then fed into an advanced analytics predictive model. The team also redefined the business processes and employees' roles and responsibilities, codesigned digital interfaces, and trained workers to apply the new model. Overall, these efforts—from running the diagnostic to developing new ways of working—reduced total expenditures by more than 20%. And they took less than eight months.

How to Start Building Bionic Asset Management Capabilities

Networks should first determine the business outcomes they wish to achieve and prioritize them. Companies should then chart a journey to bionic asset management.

Where to Go. Which areas offer the largest potential for improvement, considering the current asset management maturity level, spending levels, and cost-reduction opportunities? On the basis of this assessment, companies can prioritize a few business outcomes and define the actions and time frames needed to achieve them.

Identifying the use cases, communicating the business ambition, and maximizing the return on investment will all be critical to succeeding.

How to Get There. While technology is undeniably important, companies that achieve bionic outcomes typically focus 70% of their effort on people capabilities and business processes, only 20% on technology, and 10% on algorithms. When it comes to asset management specifically, energy networks should take these steps:

- **Review and reimagine the decision models used for asset investment, operation and maintenance, and replacement.** Networks that use advanced analytics can develop the insights needed for more-informed asset decisions. And having an understanding of real-time asset health and of the potential impact of asset failures can significantly improve a network's ability to maintain and replace assets.

- **Assess the need to evolve the operating model.** To engineer a transformation that captures the most value, companies need to review business processes end to end and make corresponding changes to the operating model. That will allow them to effectively integrate new digital technologies via drones, sensors, and automating equipment such as digital substations.

- **Set up an asset control center.** Companies also need to set up a control center that's equipped with a real-time dashboard and a decision-making engine. The technology not only enables predictive maintenance but also allows asset managers to run simulations that will reveal the best strategies for maximizing asset availability and yields.

How to Accelerate the Pace of Change. Networks should pilot a decision model with the data on hand and make changes as needed. To accelerate the pace of change, it's critical to ensure that the organization adopts the new digital capabilities and ways of working.

Companies do not need to apply every newly developed decision model to every asset class. Deploying a new model takes resources and effort. Thus, there needs to be a clear business case and a sizable business outcome for every initiative that's undertaken. Bionic companies focus on building the capabilities that can best drive the desired business outcomes. That means boosting only some capabilities to a 4.0 maturity level.

As it becomes increasingly critical to optimize decisions across the asset life cycle, business outcomes should drive the implementation of advanced analytics and digital technologies. This approach will likely require many energy network companies to rethink their digital strategies, but good asset management will depend on it.

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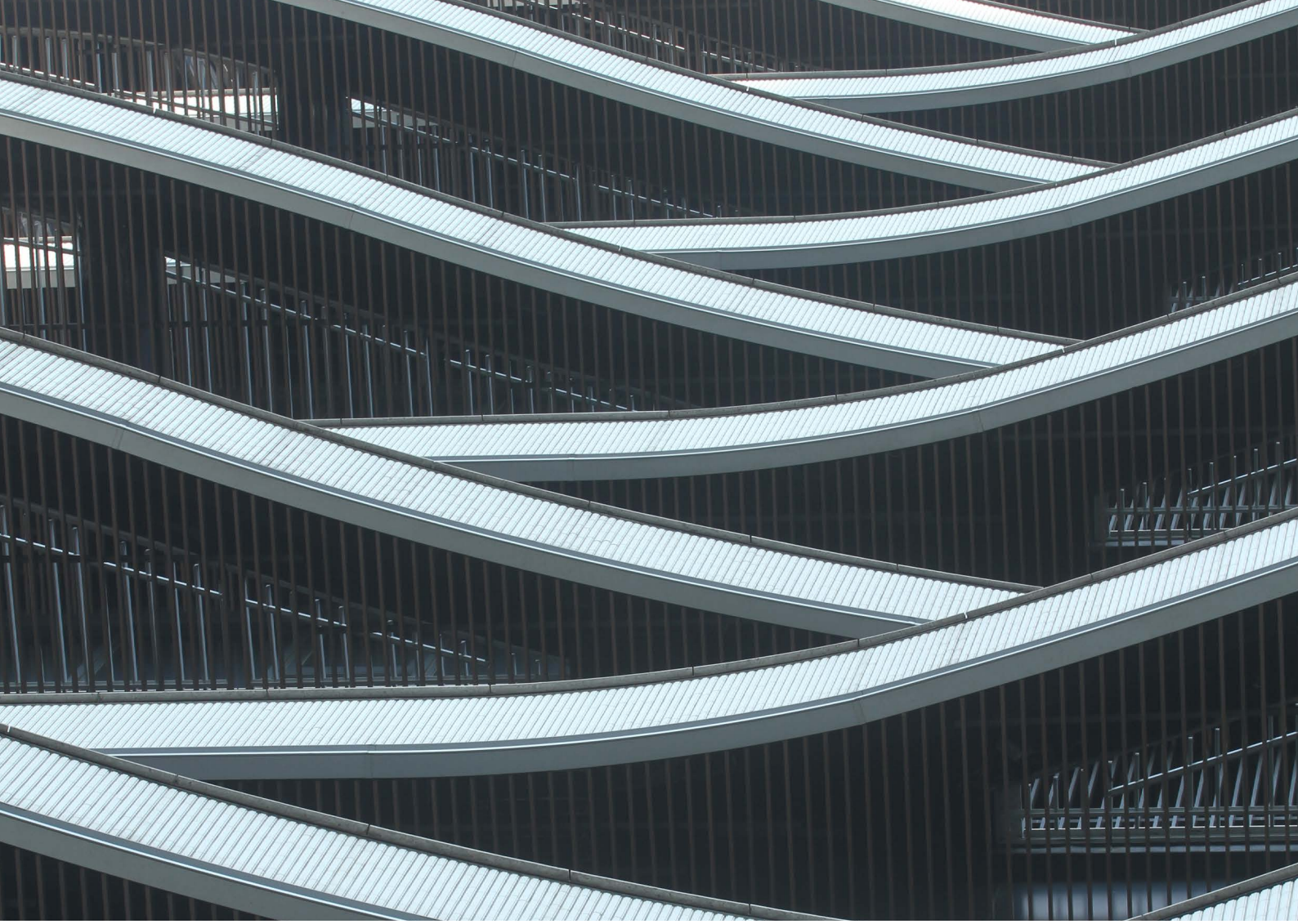


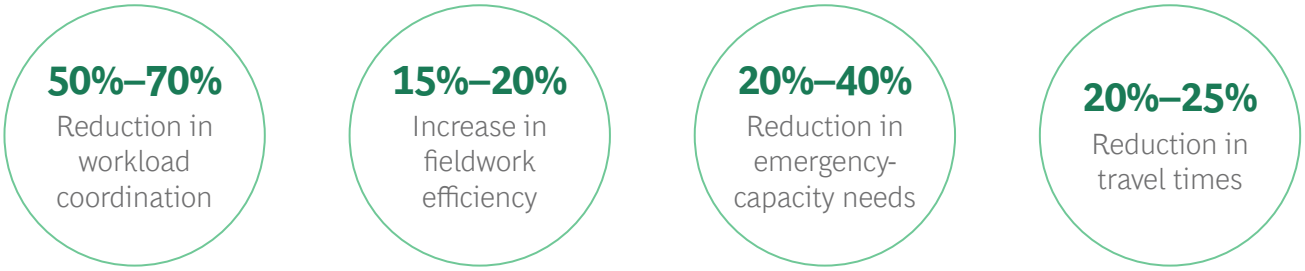
Making Workforce Management Systems Work for You

By Mate Gerecs, Alfonso Abella, Desmond Kheng, Balázs Kotnyek, and Ferdinand Varga

Digital workforce management (WFM) systems are a vital necessity for energy network utilities that are saddled with manpower challenges. This is especially true when field teams make up the largest part of their workforce. Yet many WFM solutions have not lived up to their promise.

To get the greatest benefit from WFM systems, energy networks should take a bionic approach to selecting and implementing them. The right solution implemented in a bionic fashion can not only dispatch field teams more efficiently but also help increase the amount of work that they accomplish. (See the exhibit.)

Workforce Management Solutions Provide Significant Efficiencies



Source: BCG analysis.

Note: The impact of a workforce management solution will depend to a large extent on a company's current tools and practices.

No less important, implementing a WFM system using a bionic approach can help an energy network respond to challenges in critical situations. Networks that were using such systems during the pandemic were able to adopt social-distancing and contact-tracing practices, both of which proved key to their resilience. Customers, too, can benefit: outages can be shorter and more predictable, service calls can be completed faster, and emergencies can be handled better.

Here are four guidelines for selecting and implementing WFM systems.

Make Sure That the Desired Business Outcomes Lead the Way

A WFM solution chosen by IT often fails to deliver the needed functionality; as a result, the system isn't used. Instead, business leaders should lead the way, articulating a compelling business case that explains how a new system will enhance workforce-related processes and productivity. This is critical for ensuring that the system has the functionality needed to meet business targets.

Business leaders should also oversee the implementation, which should mostly focus on change management. According to BCG's research, the most successful digital transformations focus 70% of their efforts on building capabilities and transforming the business, 20% on selecting the appropriate technology and IT stack, and 10% on developing the algorithms. Employees from operations also need to be involved so that they can help fit the solution to their needs, learn how to use the new technology, and commit to it.

Look for a System That Combines Strengths

Many WFM system vendors want to eliminate human involvement in the scheduling and dispatching processes; they think that the technology knows better. But human judgment needs to be involved to avoid rigidity. To have the best of both worlds, employees from the business, IT, and data management functions need to jointly create workflows and procedures that harmonize the network's human and technological capabilities most effectively.

A well-designed WFM solution allows scheduling and dispatching supervisors to work with the algorithms throughout the scheduling and dispatching process. For example, the system should enable supervisors to run potential scenarios in the planning phase. Then, in the scheduling and dispatching phase, the system should allow for quick workload adjustments (for example, pushing noncustomer-facing jobs to a week later) and short-term capacity adjustments (such as, permitting cross-depot staffing) to optimize how much work the field team can handle in a certain job setting and in a certain time period. A top-quality system also learns continuously from input provided by the users. By monitoring the number of times an employee runs late or works overtime, for example, the system can learn to ask questions about the employee's workload.

Choose a Customizable Platform Solution

Most WFM systems today are off-the-shelf solutions with rather rigid workflows, structures, and processes. Tailoring these to the energy industry and a network's specific business and regulatory needs can be difficult, time consuming, and costly.

How Successful Companies Focus Their Transformation Efforts

Building capabilities and transforming the business

Selecting the appropriate technology and IT stack

Developing the algorithms

Rather, companies should consider purchasing a platform solution that can be customized from one of the newer WFM system vendors. These platforms can help minimize integration requirements, saving implementation costs and time. These platforms also make upgrades easier. That's an important consideration given energy networks' increasing appetite for launching additional services, which can add new workflows and information needs for the field teams.

Take an End-to-End Approach

Many energy networks start by implementing a solution that addresses the least efficient part of their scheduling and dispatching process or a particular point of friction, such as managing client appointments. But these are partial solutions that may be hard to develop further. It's also possible that they won't fit well with additional solutions that are required to address other functionality needs, resulting in costly integration efforts.

To avoid these problems, networks need to have a thorough understanding of the underlying, end-to-end business processes and an overall ambition for the end state before they define the business requirements of the WFM solution. Some networks opt for modular systems that can be phased in as a workaround. But those solutions will create greater value if knowledge of the end-to-end business processes is acquired first.

Getting a WFM solution to deliver is a daunting task that requires considerable commitment and effort. But the payoffs—greater efficiencies and significantly better customer service—make it well worth the effort.

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Cutting More Data and Fewer Trees

By Oxana Dankova, Alfonso Abella, Konark Singh, Carolyn Ford, Joe Butler, Hanna King, and Santiago Gallego

As global temperatures rise, the threat of wildfires is growing worldwide. Energy network utilities play an important role in mitigating this impact of climate change by minimizing the risk of fires that are due to overgrown or falling vegetation near power lines.

Vegetation management is not a new focus for energy networks. In fact, given the amount of money that networks spend on vegetation management (the largest operating expenditure for most networks), clearly, it's a top priority for many. But there's still room for improvement.

Companies can bolster their vegetation management decisions by combining advanced analytics with a clear understanding of what drives value and better ways of working. By taking this approach, some energy networks have reduced costs by 20% to 30% without increasing risk. They have also held more-informed discussions with customers and regulators and significantly improved employee engagement and performance.

The bionic approach to vegetation management has four facets.

Start with Clear and Ambitious Business Outcomes

Energy networks should begin by focusing on the business outcomes that they want to achieve, rather than on the latest features of a technology. It's important to understand how leveraging data and analytics can help accomplish the following goals:

- **Focusing Spending on High-Risk Areas and the Best Treatment Methods.** By concentrating resources in areas with the greatest hazards, companies can reduce risks in those areas.
- **Lowering Inspection and Audit Costs.** Networks can reduce costs by automating inspections and audits, a step that also allows networks to fine-tune the frequency of these activities and collect higher-quality data.
- **Optimizing Cutting Cycles.** By predicting tree growth and adjusting cutting intervals, networks can reduce the volume of trees that are cut and the frequency with which they are cut without increasing risk.
- **Deploying Contractors Strategically.** Companies can use contractors more effectively by telling them exactly when and where to cut or remove trees, which can also eliminate unnecessary travel, scoping, and treatment costs.
- **Securing Better Prices from Contractors.** Networks can help their contractors become more efficient by improving resource planning, remotely scoping and planning work, avoiding duplicate audits, and minimizing contractor travel. Contractors, in turn, can lower their prices.
- **Tracking Contractors' Performance More Effectively.** Companies can collect fieldwork data in close to real time, which enables optimal monitoring of contractors' performance.
- **Engaging with Regulators More Efficiently.** Networks can engage with regulators on the basis of outcomes (that is, the risks they've addressed) rather than inputs (such as how frequently they cut trees and how far they travel). This is key to achieving better outcomes for customers.

Focus on Delivering Value Fast

Energy networks should use agile ways of working to deliver minimum viable products. For example, cross-functional teams could build predictive models for vegetation growth in test-and-learn iterations. Agile ways of working are usually more efficient and effective than the traditional approach.

One energy network developed a predictive model for vegetation growth using light detection and ranging (LiDAR) and rolled it out with field contractors in six months. Although the development team kept refining the model, improving the digital interface and adding functionality, the company was able to capture most of the savings in the first year.

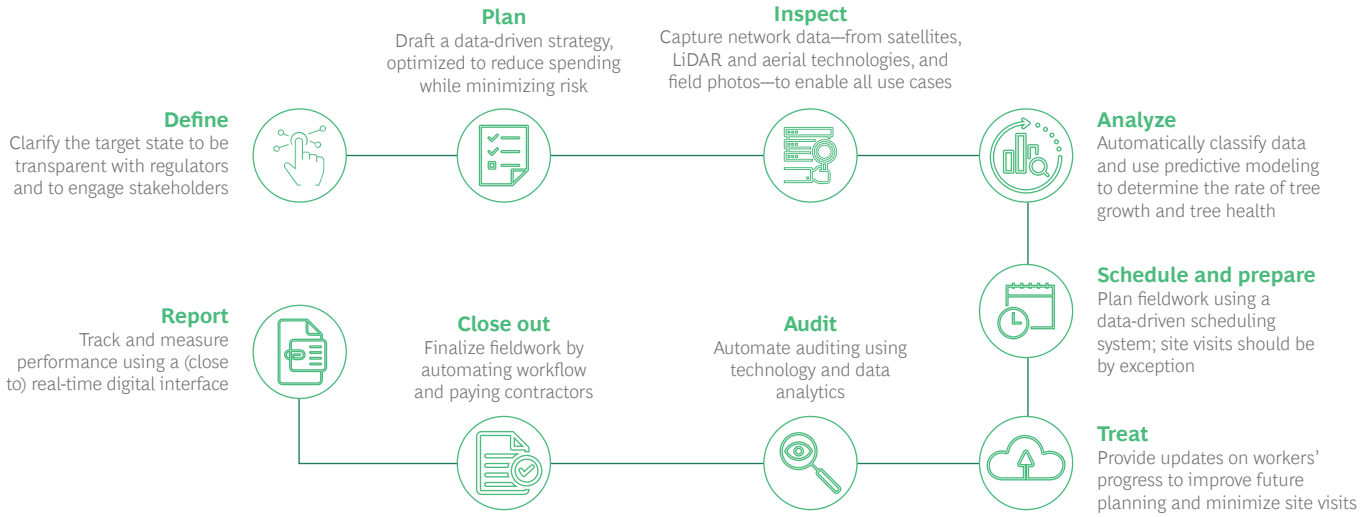
Another network introduced an AI-enabled app that let employees, contractors, and even customers to take pictures of hazardous trees. The app collects key data and assigns the trees a criticality score for backlogging and ranking for work execution. The app enabled efficiencies in the short term while the development team worked on end-to-end optimization and predictive modeling in the medium term.

Take an End-to-End Perspective

It's critical to design a vegetation management system with an end-to-end process in mind, rather than a specific technology, since applicable technologies are evolving very quickly. For some energy networks, combining granular field-based data with publicly available data on vegetation species and weather has proved the most efficient approach to building a system; others have preferred using LiDAR or aerial photography. Yet another option is multispectral high-resolution satellite stereoscopic imagery, which is reaching maturity.

Instead of waiting for the best technology—and missing opportunities to save potentially hundreds of millions of dollars—networks should start mapping out how the process should work to achieve the company's goals. (See the exhibit.) That includes determining which data capture and analytics technologies can best deliver the insights needed to measure the current state of vegetation, predict vegetation growth and health, and define treatment priorities. The audit performed at the end of the process provides data that should be used to fine-tune the strategy, creating a continuous feedback cycle.

Design a Data-Driven Vegetation Management System End to End



Source: BCG analysis.

Note: LiDAR = light detection and ranging.

Make Contracting Relationships More Collaborative

Strong contractor collaboration, including joint planning and bilateral data sharing, is critical to enable improved vegetation management. However, energy networks should go further, creating strategic, long-term relationships with contractors and collaborating with them on a day-to-day basis. Networks should also provide incentives for contractors to provide more precise estimates of the volumes of trees in need of treatment. Such information enables networks to refine their predictive models. To offset potentially smaller work volumes, some networks are reducing the number of contractors that they use.

Contractors are also starting to deploy predictive analytics to be better informed about future work volumes when they enter into negotiations with a network. Networks that don't have the same level of knowledge as their contractors are leaving money on the negotiating table. And networks that have the knowledge but don't share it with their contractors take the risk that the contractors will bake additional resources into their work estimates to be on the safe side.

Networks should also be more transparent with contractors regarding costs. By using cost modeling to determine the network's vegetation management expenses and then sharing that information with their contractors, networks can help contractors provide more accurate cost estimates.

To ensure that the new process is a win for both sides, it's important for networks to rethink the way they engage, collaborate, and share data with contractors. We have found that networks that have better visibility into their needs can offer contractors a more precise view on the volume of work, secure better prices, and reduce spending on contractors by 20% to 30%.

We expect utility vegetation management to undergo massive and exciting changes as the latest technologies open a variety of improvement opportunities. Networks that wish to create impact from the beginning should start with the business outcome and iteratively implement solutions, keeping an end-to-end perspective in mind.

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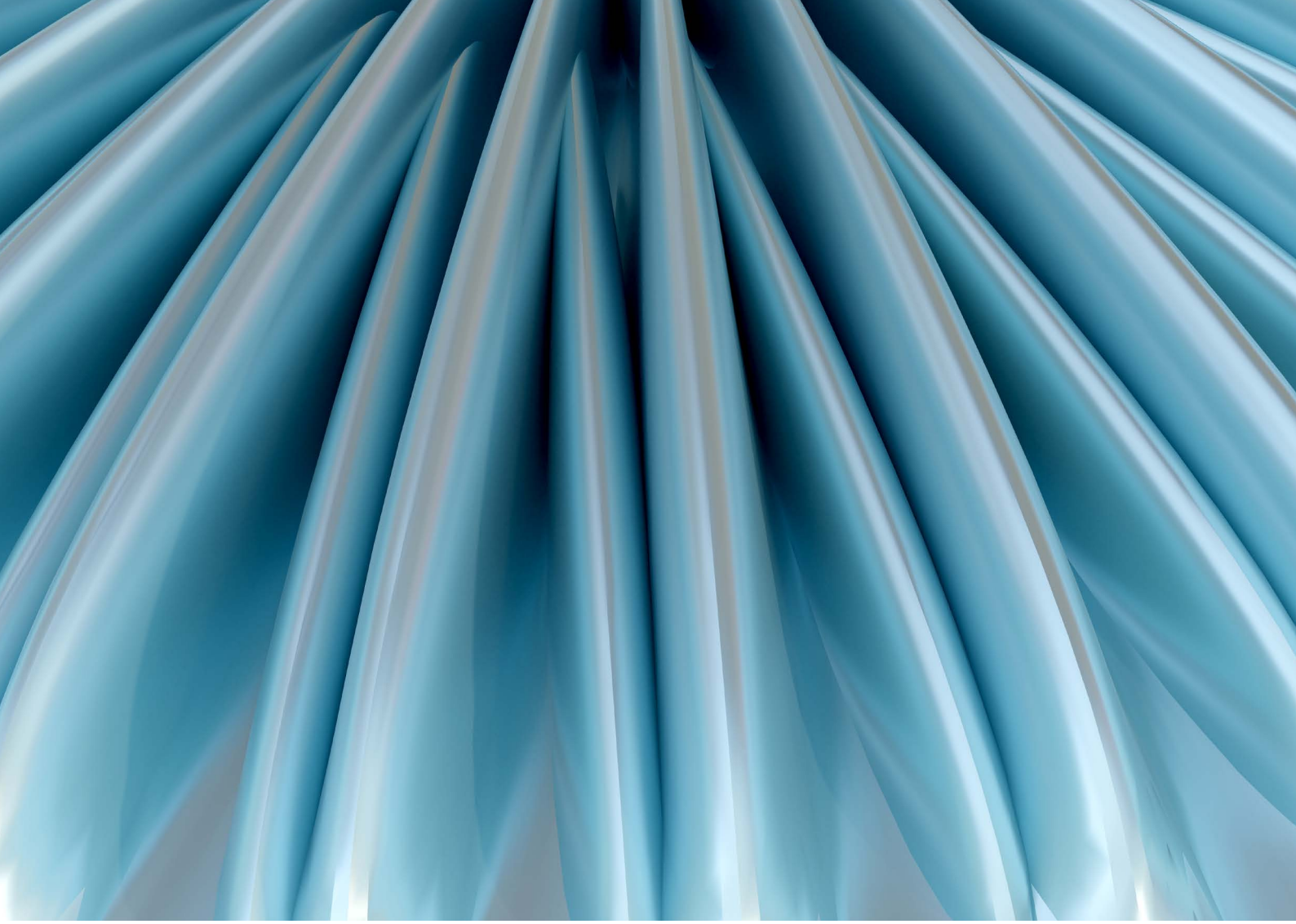

A Better Way to Reduce Energy Losses and Bad Debt

By Magín Yañez, Angel Martinez, Alfonso Abella, and Sudhanshu Gupta

Energy network utilities face two major challenges: power losses that arise from fraud and technical issues, and bad debt that results from customers failing to pay their bills. Many networks struggle with these issues because they don't understand the root causes. Bionic energy networks have been more successful tackling these challenges because they take a comprehensive approach that leverages the best capabilities of technology and people.

Managing energy losses and bad debt in this way can bring substantial benefits. For example, an energy network in India reduced its energy losses from 12.5% to 8.5% over two years. In just six months, a Colombian network reduced its losses by 0.9 percentage points and debt by 0.7 percentage points, which amounted to more than $14 million in value. And a network in Chile reduced its annual bad debt by 20%, which translated into a revenue increase of $3 million over 18 months.

Here, we take a look at how bionic energy networks address power losses and bad debt, while simultaneously improving the customer experience.

Using Technology to Tackle the Challenges

Bionic networks address energy losses and nonpayment issues by identifying the root causes across the value chain, end to end. Key to that effort are the following actions, which bionic networks take in combination with process improvements and change management initiatives.

- **Deploying an Analytics Engine and a Dashboard to Visualize Energy Balances.** Bionic networks use an analytics engine to power a dashboard that maps assets, energy flows, and transmission losses in real time. These tools enable companies to identify and localize where major energy losses are occurring, detect imbalances between the total amount of energy supplied and consumed, and segment customers by consumption level.

- **Using Predictive Modeling to Identify Fraud.** Predictive models make it possible to identify many fraud cases with limited inspection resources. They can also help detect power losses resulting from an infrastructure setup or upgrade, which can create inconsistencies across databases. The predictive models, which typically use more than 100 data variables from the field, self-correct by adjusting the search parameters. B2B fraud-detection engines often identify power theft among business customers by comparing actual energy consumption with predicted consumption. And B2C engines typically identify power theft among residential customers on the basis of customer or neighborhood data. Networks use this information to determine which inspections should be done first.

- **Deploying Capital Expenditure Prioritization Tools to Reduce Power Losses in a Sustainable Manner.** Capex prioritization tools help bionic networks determine which assets and IT systems should be upgraded to cut energy losses and which technological solutions should be invested in to prevent theft. These tools include equipment that is able to detect taps on wires and aerial-bundled cables that short-circuit when hooked up through an illegal line.

- **Using Predictive Analytics to Address Collection Issues.** Bionic networks use predictive analytics to reduce collection costs, increase proceeds, and speed up the collection process—all while keeping the customer experience positive. A collection customization engine segments customers according to their payment propensity. Since such an engine operates in real time, it's able to identify the most suitable and effective collection action for each customer.

A bionic network company may concurrently use fraud-detection and collection-optimization engines, as well as other tools, to fine-tune its overall strategy to combat fraud and nonpayment. Using the engines in combination with each other make it possible to determine which personalized actions to pursue for a particular group of customers, whether business or residential, on the basis of certain characteristics and context. This approach also enables companies to identify which customers are committing fraud and which are likely to end up paying their bills. And given these findings, companies can come up with actions that are likely to be more effective with specific customers.

Putting the Right Human Capabilities in Place

To ensure that their digital solutions are successful, bionic networks also put in place the needed human capabilities via the right organization structure, processes, skills, and talent.

When implementing a fraud-detection engine, for example, bionic networks develop a structured incentive system for meter-reading crews, especially in neighborhoods flagged by the engine. When implementing new processes for improving collections and reducing energy losses, bionic networks launch actions through the optimal channel (digital or human assisted, or both) to maximize the chances of payment and the detection of theft.

To optimize the effectiveness of call center agents, the networks provide them with key information about the customer, AI-driven recommendations, dynamic scripts, and simulation engines, all of which help steer the interactions. After systematically validating what works well for each customer group and retraining the AI algorithms with information gleaned from industrialized feedback loops, these networks create a rich catalog of potential actions that agents can take to improve results.

All these digital tools are essential for training and enabling the frontline teams in charge of collections and theft detection.

Bionic energy networks have a very good understanding of their potential to reduce energy losses and debt related to nonpayment, and they are able to develop a portfolio of coordinated initiatives and clear capex-allocation criteria. This portfolio includes clear and realistic reduction targets, a prioritized plan with accountability and KPIs, an optimized allocation of required investments, and employees committed and empowered to drive change. Other networks would benefit greatly from this approach.

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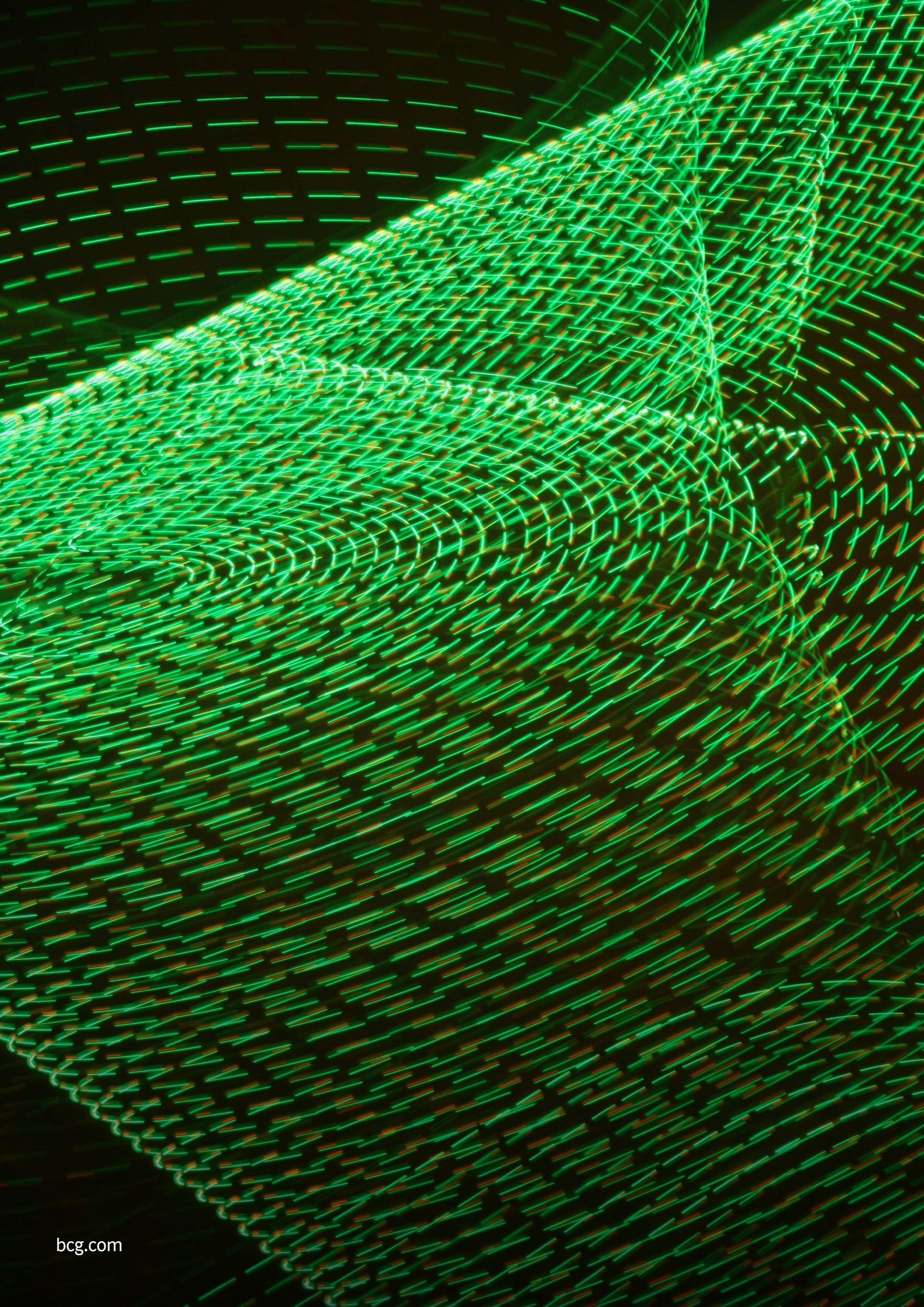

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