cognizant®

Building the utilities of the future: a clear roadmap for a complex journey

Utility operators are currently facing the most significant opportunity—and challenge—of their careers.

They know that 'keeping the lights on' for their customers means modernizing grids, transitioning to clean resources, and improving resilience in the face of mounting threats as climate change accelerates.

For today's customer, though, 'keeping the lights on' is just one point on a growing list of expectations. 'Smart' homes, cost-of-living pressures and personalized digital services mean that they now demand tailored service at a lower cost.

To meet those demands, utility providers must embrace technology without sacrificing regulatory compliance—or efficient service delivery. It's a transition that will require them to simultaneously navigate tightening regulation, the threat of cyberattacks, and entirely new business models.

Utility operators need a trusted technology partner to meet a challenge of this scale, and ensure they don't just keep up with the utility ecosystems of the future, but help define them.

It's a multi-dimensional puzzle that Cognizant knows how to solve.

Tackling the sector's most pressing challenges

Utility operators provide an essential service. Come rain or shine, customers will need water, power, and heat. The sector has historically been immune to volatile economic shifts, but increasing demand paired with climate-related outages threaten that security.

The Electric Power Research Institute (EPRI), a Washington D.C.-based nonprofit, estimates that data centers could consume up to 9% of U.S. electricity generation by 2030, more than double their current consumption. At the same time, the U.S. is experiencing double the weather-related outages compared to 2000-2009, costing businesses $150 billion each year.

When combined with changing consumer expectations, increased electric vehicle adoption and the electrification of heating, these pressures mean that modernization is more than a competitive edge––it's essential for survival.

Utility industry trends shaping new business models

Energy consumer activism

- Increased awareness and desire to control own energy consumption
- Increased desire to communicate with utilities through digital channels
- Rise of prosumers - Consumers are involved more in generating their own power and also feed it back to the grid

New business models

- Falling costs for technologies such as solar PV, battery storage, LED-lighting etc.
- New business models accelerating technology adoption, including leasing
- Increased maturity in digital enablers such as big data, cloud and mobility

Grid modernization

- The electric grid is undergoing a digital makeover. Utilities are embracing AI, machine learning, and other advanced technologies to optimize grid operations. This allows for better forecasting of electricity demand, more efficient distribution of power, and faster response times to outages

Energy transition

- Energy and climate regulation - from 2020 to 2030, competing mechanisms, national mechanisms and long term uncertainty
- Increasing focus on climate risk, including incorporating carbon emissions and climate effects in financial analysis

Distributed energy resources

- Distributed energy resources (DERs) are changing the traditional, centralized model of electricity generation
- Solar panels, wind turbines, and battery storage systems are increasingly being installed at homes and businesses

Cyber security

- As electric utilities become increasingly reliant on digital technologies, they also become more susceptible to cyberattacks.
- Malicious actors target these vulnerabilities and perform ransomware attack to disrupt grid operations, steal customer data, or hold critical infrastructure

Regulatory changes

- Regulatory frameworks are being adjusted to incentivize renewable energy adoption and grid modernization projects that support decarbonization goals
- Regulations are also being shaped to promote grid resilience in the face of extreme weather events and cyberattacks

Century-old infrastructure

Utilities worldwide are grappling with the limitations of outdated systems and equipment. In 2015, the US Department of Energy found that 70% of power transformers alone were over 25 years old, and two-thirds of circuit breakers hadn't been changed in over 30 years.

Much of the country's decades-old infrastructure will struggle to meet modern demands, and now present a serious risk to service reliability. Before they're able to adopt new technologies, utilities need to adopt modernized infrastructure that can support integration.

Legacy grids are past the halfway point of their expected useful lives. Built before the widespread transition to renewable energy sources, few are equipped to handle the energy peaks and troughs that come with renewable energy sources such as solar and wind power. Many utilities providers are integrating clean energy programs within their existing infrastructure—some find that legacy grids struggle to accommodate variable energy production.

Practical solutions already exist. Methods like advanced reconductoring replace existing power lines with cables made from lighter materials that hold more aluminum. It's one change that nearly doubles transmission capacity and expedites grid expansion, which is often slowed by regulatory hurdles.

Growing customer expectations

Today's consumers expect reliable, personalized, and sustainable services, greater control over their energy usage, and lower costs.

The rise of the 'prosumer'—consumers who also generate their own energy—has further complicated the landscape for utility providers, who now have to adapt the power grid to accommodate two-way power flow.

Utility providers still need to supply reliable service, but now they also need to offer transparent communication, greener energy options, and a market for prosumers. According to a recent report from the U.S. Energy Information Administration, average residential electricity prices will reach a three-decade high in 2025. The more control consumers have over their consumption, the more they can manage their costs.

While renewables are among the cheapest energy sources in many geographies, generating them via legacy grids presents some serious challenges. Renewable energy generation is intermittent, with solar and wind power relying on the right weather conditions. Unless providers adopt batteries and renewable peaker plants to account for peaks and troughs, today's grids could struggle to maintain steady frequencies and meet demand.

There are opportunities to increase supply: researchers at the Department of Energy estimate that 2600 gigawatts of generation capacity is currently 'queuing' for connection to the grid. An estimated 95% of that capacity comes from renewable sources, but queues will only grow longer unless the grid's transmission capacity increases.

Mounting regulatory pressures

According to its published historic Climate Agenda, the US government is aiming for 100% carbon pollution-free electricity by 2035, placing the utility sector under increasing regulatory pressures to reduce emissions.

Alongside environmental compliance, regulators also expect utilities to improve safety standards, and—like consumers—encourage the adoption of renewable energy sources.

To remain compliant without sacrificing productivity, utilities need to be proactive about their compliance strategies. At Cognizant, we've seen the benefits of proactive compliance firsthand—helping utilities extract more value from their data and deploying large language models (LLMs) to craft more efficient compliance infrastructure.

Without that technology- and data-driven approach, utilities will struggle to balance compliance and profitability.

Fixed operational mindset

As energy demand increases alongside pressure from climate, consumers and regulators, operational efficiency becomes critical for utilities to remain profitable and competitive. Companies can respond by managing resources more efficiently, reducing avoidable costs, and leveraging advanced technologies. In order for those strategies to succeed, though, they need to address underlying operational culture challenges.

Utility operations have historically been characterized by rigid structures and processes and diligent, loyal talent. Professionals often spend the bulk of their careers with one organization, committed to providing an essential service to their local communities. Adopting agile practices and new technology without addressing their impact on employees could disengage talent and extend the learning curve.

Operational transformation on the scale that's now required necessitates a mindset shift, and a significant investment in Organizational Change Management. By guiding utilities through the cultural and operational shifts required for modernization, Cognizant has helped some of the world's largest energy providers embrace change and navigate a smooth transition.

A clear vision: Defining the future of utilities

The complexity of the modern utility landscape doesn't mean utilities need to enter survival mode. Instead, technology offers utility companies a path to more efficient, profitable operations– if they're willing to innovate.

The future of utilities lies with intelligent, connected grids that communicate and interact. Services that are greater than the sum of their parts can offer efficient, reliable and sustainable services.

Those "parts" have already become clear:

Smart grids

Utility companies that invest in grid modernization through increased telemetry and grid management technology that will meet growing power demands while maintaining service quality and resilience.

Today's investment in modernization will pay dividends tomorrow–a modern, intelligent grid integrates diverse energy sources and real-time data to remain resilient in the face of energy peaks, troughs, and interruptions.

The grid of the future is coming into focus. While it looks slightly different from company to company, every modern grid capitalizes on a few vital technologies:

- **Internet of Things (IoT):** More advanced smart meters have already found their way into most American homes. Sensors aren't limited to residential use cases, though. The latest generation of smart meters has significantly increased the edge computing power and sensing capability at utility providers' disposal. When deployed across the grid, they're able to collect and transmit live data that enables providers to act as soon as disruption takes place or proactively maintain their field resources.
- **Artificial intelligence and machine learning solutions:** AI and machine learning can reduce operational costs and disruption even further by unlocking predictive maintenance, demand forecasting, and optimizing energy resources. Humans cannot analyze the huge volumes of data gathered by an influx of IoT sensors and advanced telemetry. Still, AI can–crunching vast amounts of data on demand, grid requirements and weather variation. That insight makes it possible to determine the optimal combination of renewable sources, stored energy, distributed energy resources, and more.
- **Cloud computing:** Cloud technology exponentially increases operators' processing power and elasticity, allowing them to accommodate the masses of data that make AI and machine learning so valuable. With added processing power, operators can model new processes without spending time and resources on hardware procurement, installation and maintenance.

The IEA calculates that digital technologies could minimize the harmful impact of grid variability by over 25% by 2030. It's unsurprising, then, that over half (57%) of energy & utilities companies already use AI in their sustainability efforts.

Empowered prosumers

The modern utilities end-user is fueling the transition to renewable energy. They are no longer just passive electricity consumers, but active energy contributors. With the rise of decentralized energy systems such as solar panels, wind turbines, and other localized energy sources, these prosumers become microgenerators, exporting power to the grid when their production exceeds their needs.

Cognizant has worked with operators to capitalize on this evolution by ensuring the grid can support the drastic shift in how electricity is distributed and consumed—a system in which electricity flows both ways. They must transition to distribution system operators (DSOs) that distribute and manage electricity generated by multiple sources to its final consumers.

The development of microgrids further supports this decentralization, enabling localized energy production and consumption that can operate independently, or in conjunction with the main grid. This approach improves energy efficiency, provides greater flexibility, reduces transmission losses, and enhances energy security.

Integrated Energy Management Systems (EMS)

Future-focused utility providers are going beyond traditional usage monitoring to generate utility bills. Instead, they are integrating smart meters into platforms that moderate energy use in buildings, supply chains, product design, transportation, and plant equipment.

Integrated EMS reduces costs by matching energy use to weather conditions, building occupancy, and usage patterns. It provides early warning and proactive remediation of problems with energy-consuming equipment and infrastructure, such as windows and thermostats. These systems provide comprehensive visibility and control, facilitating better decision-making and resource management.

A key component of EMS is the next generation of advanced metering infrastructure, known as Advanced Metering Infrastructure 2.0 (AMI). AMI 2.0 offers higher sample rates and improved telemetry, intelligence, and communication standards. More frequent sampling and more granular intelligence makes it possible to provide the tailored energy management service that consumers have come to expect. The same data can be packaged in user interfaces to boost customer engagement, showing consumers exactly how much energy they're using, and where it comes from.

Energy storage solutions

Energy storage technologies, like batteries play a vital role in stabilizing energy supply, storing excess energy during low-demand periods and releasing it during peak demand.

More efficient storage solutions ensure a reliable and continuous energy supply, supporting the integration of renewable energy sources and enhancing grid resilience. Storage solutions can be implemented on the grid and on-premises at consumers' homes, helping manage costs and improve energy efficiency.

Agile utility managers empowered by data

Utility managers are at the forefront of of an energy transition that impacts their customers' homes, wallets and lives. To steward that transition, they'll need to navigate operational change and maintain regulatory compliance–all while adopting new technologies. Effective leadership and strategic planning are essential for successful modernization efforts. Utility managers must balance the need for innovation and the strategic investment it requires with the imperative to maintain reliability, service quality and competitive pricing.

The role of the plant manager has transformed from traditional oversight to a more dynamic, data-driven decision-making role. CRM systems now play a pivotal role in customer engagement and satisfaction, and data-driven grid management is now essential for enhancing resilience and service delivery.

Enhanced cybersecurity protection

According to the International Energy Agency, 80% of US households now use smart meters. That represents an incredible amount of data that legacy providers must now process and store in their systems, and with new technology and more data comes the increased risk of cyberattacks.

Operational systems that comprise essential infrastructure are now coming under attack from growing threat vectors, requiring an evolving suite of protections and controls to safeguard these assets.

The current suite of tools has focused mainly on detecting threats and notifying if the software can be updated. The next generation of security controls is now introducing automated threat detection, response and recovery, and preventative protection.

Cognizant has worked with utilities to take a two-pronged approach to cybersecurity. a top down, threat-based attack to protections as well as a bottom up NIST based approach to formalized controls to architecting cybersecurity controls.

Over the next 10 years we will see utility transformation in IT, operations, people and business model...

IT Transformation

- OT/IT Convergence
- AI, Automation & Prediction
- More Sensors and Data Points
- Real-Time Data and Situational Awareness
- Breakdown of Data
- Open, Standards-Based Architecture
- Cybersecurity Alertness
- Aging Assets and Evolving Technologies

Operations transformation

- Electrification of Everything
- Increased DER Penetration
- Two-way Power Flows
- Integration of Real-Time Sensor Data
- Customer Driven EV Adoption
- Sectionalized and Island Capable Grid Segments
- More Control Center Interaction with 3rd parties (DER)
- Smart Inverter

People transformation

- Digital Worker
- Aging Workforce and Evolving Skillsets
- Workforce Optimization Algorithms
- Digital Training Tools
- Human Computer Interface
- Direct Digital Interaction
- Digital Training Simulators

People business model & policy transformation

- Evolving Regulatory
- Incentivized DER Behavior
- Utility Alignment
- Transactive Energy Markets
- Blockchain for Peer-to-Peer Energy
- Federal and State Alignment on Policy
- Agility and Adaptability

The energy grid of the future

Distributed energy generation and storage
Enhances self-sufficiency in energy production, enabling customers to generate and in. locally sourced power back sell clean, locally sourced power back to the grid

Smart micro grid
Builds energy self-sufficiency and supports affordability during periods of price volatility

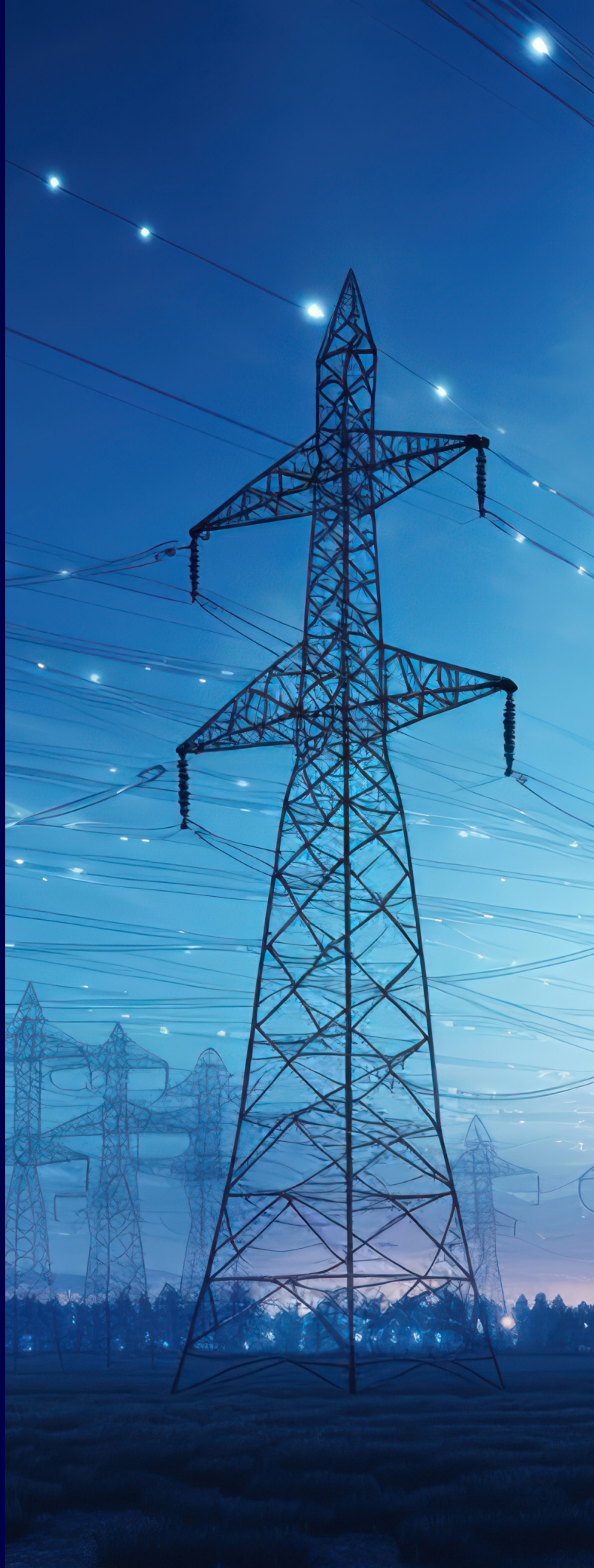
Modernized electric grid
Promotes energy resilience and security through the utilization of distributed energy resources, sophisticated control systems, bi-directional communication, and widespread deployment of smart devices

Carbon-free generation
Ensures a carbon-free future through multiple, innovative clean power sources (hydroelectric, solar, wind) and large-scale storage solutions (batteries, pumped hydroelectric)

Vehicle to grid integration
Facilitates real-time management of customer energy and renewable generation by serving as a comprehensive storage solution for the wider grid

Smart homes
Handles customer billing and offers advantages such as grid demand response by real-time optimization of power consumption

Electrified transport and charging infrastructure
Reduces customers' carbon footprint through clean transport and shipping



Guiding the Future: Cognizant's Blueprint for Utility Success

For all the challenges that utility providers currently face, the road to the sector's future is full of opportunities. Balancing resilience, demand, reliability, sustainability and cost is possible thanks to technological developments – and the cybersecurity tools that must accompany them.

Leading the way

In 2022, Cognizant partnered with a major US utility company to move its operations onto mapping and spatial analytics company ESRI's utility network. The utility company serves 3.5 million customers and 6,500 employees, manages $39 billion in assets, and generates over $8 billion in revenue. It operates 72 billion kilowatt-hours of electricity through 90,000 miles of electric and gas lines, across four jurisdictions.

The 18-initiative transformation project was a massive undertaking involving a new GIS strategy, roadmap, business case, and high-level design. Part and parcel of that effort was an initiative to boost employee experience and productivity—to do it, we found ways to incorporate generative AI, human-machine augmentation, and process automation across multiple business units.

The overall project cost $65 million over three years.

Prior to the transformation, we began with a Distributed Energy Resource (DER) pilot project. Cognizant's team architected edge devices for active management of solar inverters—a crucial challenge for future utilities in managing DER growth and integration.

The pilot's success enabled the utility to mitigate voltage violations, track hidden loads, improve load forecasting, and significantly increase solar hosting capacity. In more technical terms, the project employed over 220,000 DER management power factor control actions to enhance customer voltage, releasing 16 MW of new load-serving capacity and 18 MW of new DER hosting capacity.

By taking a scalable approach, Cognizant unlocked immediate business value to establish stakeholder trust, all while gaining the deep organizational understanding needed to build the broader project roadmap.

Taking the Next Step

The Utility of the future will leverage data, emerging technologies and will empower its customers and employees

Field Workforce receives real time updates with augmented personalized reporting.

Improved technician efficiency that can spend more time on problem solving.

Virtual and LLM agents automate call centers and provide personalized consumer experience based.

Smart Meter systemic intelligence and machine learning enables utilities to offer detailed consumer energy management.

Drones and robots autonomously identify defects, predict failures and inspect assets.

Smart wires combine with machine learning to enable real time power dispatching and optimization.

Machine Learning forecasting anticipates supply and demand peaks.

Sensors and machine learning allows for by the minute adjustments.

Utilities that embrace these innovations won't face a fight for survival - they'll set a new standard for services that form the foundation of modern life.

The utility provider of the future will deploy technology from the field to the customer support center, such as:

- Edge devices like drones will enable proactive maintenance that prevents equipment-related outages, guides infrastructure investment, and improves field inspection safety.
- Smart wires guided by machine learning can ensure an even distribution of power across the grid—forecasting supply and demand to deliver the consistent energy customers expect.
- Virtual agents powered by LLMs – and informed by data gathered from smart meters will provide a more personalised, responsive customer experience than ever.

While those examples are enticing, utility managers still need to 'keep the lights on' today. It's unrealistic to expect them to manage today's challenge alongside a digital transformation journey that both safeguards cybersecurity, and delivers on the promise of innovations in utility technology.

That's why Cognizant supports companies through their transition to the utilities of the future – so the lights stay on today, and stay on tomorrow.

We're specialists in:

- Roadmap design: Developing long-term implementation strategies for technology adoption and integration.
- Cybersecurity Compliance and Risk Management Frameworks: Protecting systems and people in the new digitized context.
- Enhanced Monitoring and Reporting for Sustainability and Environmental Impact: Improving compliance strategies and operational risk mitigation.
- Change Management Training and Support: Facilitating smooth transitions and maximizing stakeholder engagement.
- Process Improvement: Studying current process flows to make business-modeled improvements, creating efficiency from the utility warehouse to the back-end systems that run a utility.
- EU Consulting Strategic Control Points: Providing advisory and implementation services around geospatial systems, enterprise asset management, AMI, and ADMS/DERMS.
- IOT Utility Services: Providing cutting-edge IoT solutions that drive smarter, more connected operations driven by data. Our IoT strategies enable a predictive and proactive approach to maintenance, asset management, energy management, water management and grid security.

Overcoming adoption hurdles and engaging an IT consulting partner like Cognizant is crucial for achieving a sustainable and efficient future. Partner with Cognizant to navigate the energy transformation and secure your place among the utilities of the future.

Authors

Manish Khubchandani,
Client Partner,
Energy and Utilities

Somjyoti Mukherjee,
Senior Director, Utilities
Global Solution Leader

Srinivasan Rengachari,
Director Consulting,
Energy and Utilities

References

1. Cognizant - Energy Management
2. Cognizant – How to Build Smart Grids for the renewable energy transition
3. Cognizant - The urgent path toward grid modernization
4. ETA - Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection | Energy Markets & Policy
5. Forbes - Data Centers and Electricity Demand
6. IEA - Unlocking smart grid opportunities in emerging markets and developing economies
7. IEA - Electricity 2024 - Analysis and forecast to 2026
8. New York Times - Electric Grid Modernization
9. Utility Dive - US Electricity Prices Rise
10. WaterISAC - Weather-Related Power Outages

World Headquarters

300 Frank W. Burr Blvd.
Suite 36, 6th Floor
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Toll Free: +1 888 937 3277

European Headquarters

280 Bishopsgate
London
EC2M 4RB
Phone: +44 207 297 7600

India Operations Headquarters

5/535, Okkiam Thoraipakkam,
Old Mahabalipuram Road,
Chennai 600 096
Tel: 1-800-208-6999
Fax: +91 (01) 44 4209 6060

APAC Headquarters

1 Fusionopolis Link, Level 5
NEXUS@One-North, North Tower
Singapore 138542
Phone: +65 6812 4000

WF3168641