Advanced Metering Infrastructure (AMI) Grid-Edge Computing Report

March 21, 2022

Niagara Mohawk Power Corporation d/b/a National Grid

Docket No. 20-M-0082

nationalgrid

Contents

1. Executive Summary

In its *Order Adopting Terms of Joint Proposal, Establishing Rate Plans and Reporting Requirements*,[1] the New York State Public Service Commission ("Commission") directed Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or the "Company"), in consultation with Department of Public Service Staff ("Staff"), to prepare and file this Grid-Edge Computing Report (this "Report"). Consistent with the Commission's direction, this Report details how the Company "intends to implement and utilize Advanced Metering Infrastructure ("AMI") grid-edge computing and intelligence, allow customers to access their data over their home area network ("HAN"), allow third parties authorized by customers to access such data, and otherwise address the anti-competition concerns raised by Mission:data Coalition Inc. ("Mission:data")."[2]

National Grid is poised to be one of the first utilities in the nation to deploy next-generation AMI technology (commonly referred to as smart meters) with an embedded grid-edge computing platform. This innovation enables a range of use cases not possible with the previous generation of AMI, unlocking new value for customers and the Company. The grid-edge computing platform mitigates technology obsolescence risk by enabling new benefits and expanding AMI functionality that can be incorporated over time (*e.g.*, through software updates rather than through additional hardware or costly infrastructure solutions).

The Company is eager to deliver innovative features, such as appliance-level load disaggregation and a real-time power meter, for customers. These new products will deliver insights to help customers improve their home awareness, home reliability, and energy management with better convenience and control. The Company anticipates this technology will provide even more benefits as grid modernization efforts accelerate, delivering improved energy efficiency and peak demand management. Such data is also expected to provide valuable operational information (*e.g.*, allowing customer service representatives to resolve customer questions more effectively) and system management benefits (*e.g.*, determine electric vehicle ("EV") charger usage patterns for load forecasting).

Additionally, the Company supports customer-authorized access to energy usage data by third-party developers and distributed energy resource ("DER") providers, which has the potential to expand market-based delivery of new solutions. In this way, the Company sees new potential to leverage the grid-edge computing platform animating the market for new energy products and services. The Company looks forward to continued work with third parties to deliver new benefits and accelerate decarbonization efforts.

This Report presents the Company's plan to implement the next generation AMI technology, including details on the associated customer experience (*e.g.*, HAN capabilities, customer authorized energy data sharing). The Company also offers an initial conceptual governance

[1] Case No. 20-E-0380, *et al.*, Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Niagara Mohawk Power Corporation d/b/a National Grid for Electric and Gas Service, *Order Adopting Terms of Joint Proposal, Establishing Rates and Reporting Requirements* (January 20, 2022) (hereinafter, "NMPC Rate Order").
[2] *Id.* at 105.

framework for this technology, which is in its early stages of development. As the grid-edge computing platform evolves, the Company anticipates the potential to unlock new use cases or functionality. The Company looks forward to continuing to iterate as the technology matures, opening the door for future innovation.

2. Introduction

National Grid's vision is to be at the heart of a clean, fair, and affordable energy future. With regulatory approval[3] to deploy AMI, the Company takes another step toward delivering on that vision for customers by deploying approximately 1.7 million electric AMI meters and 640,000 AMI-enabled gas modules. The Company's AMI project marks the beginning of a new era for customer energy control and convenience.

As part of the order approving the Company's AMI proposal, the Commission described how the AMI investment can provide benefits to customers and the system, while also advancing clean energy goals:

- **Customer Benefits:** "[T]he deployment and use of AMI can be harnessed to transform the relationship between National Grid and its electric and gas customers."[4]

- **Operational/System:** "This presents an opportune time to upgrade to AMI while avoiding the costs of replacing the existing [automated meter reading] AMR meters in kind."[5]

- **Clean Energy:** "AMI is an important and valuable contribution to enabling the Company to assume the role of the [Distributed System Platform] DSP, to increasing use of DERs to support system operation, to increasing the use of measures such as [volt-VAR optimization] VVO to reduce energy use and emissions, and to facilitating customer access to products and services provided by third-parties."[6]

The Commission also emphasized the importance of the proposed grid-edge computing capabilities:

> The Commission recognizes advancements to AMI meters that allow for grid-edge computing at the meter. Analytics of what is occurring at the customer and distribution system level, which was historically done at the back-office, can now be done at the meter. Such capabilities allow for a more dynamic and flexible operation of the electric system.[7]

The Company's first proposed use case for the grid-edge computing capabilities is a customer-facing application focused on delivering energy insights and load disaggregation information through the Company's website and a new mobile application. The Commission found this use case beneficial, noting:

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[3] Case Nos. 17-E-0238, et al., Proceeding on Motion of the Commission as to the Rates, Charges, Rules and Regulations of Niagara Mohawk Power Corporation d/b/a National Grid for Electric and Gas Service (hereinafter, "NMPC 2017 Rate Case Docket"), *Order Authorizing Implementation of Advanced Metering Functionality with Modifications* (November 20, 2020) (hereinafter, "AMI Order").
[4] AMI Order at 26.
[5] *Id.* at page 36.
[6] *Id.* at page 27.
[7] *Id.* at page 33.

> …customers will have the ability to access on demand, real-time data through home-area network devices and a mobile device application. There is no additional cost to customers to use the mobile device application. This application is a valuable innovation as it eliminates the financial burden of a customer needing to purchase a home-area network device to receive real-time granular usage data.[8]

Based on the AMI Order, the Company executed a contract with the Company's down-selected AMI vendor for an end-to-end AMI solution – the culmination of a years-long competitive procurement event. The vendor was selected for a variety of reasons, including the strength of the technology roadmap, which featured the AMI grid-edge computing platform.

The Company looks forward to implementing the AMI solution and leveraging the grid-edge computing capabilities to enhance benefits for customers, the grid, and to take further meaningful action toward achieving clean energy goals. Consistent with the Commission's direction in the NMPC Rate Order, Section 3 of this Report provides an overview of grid-edge computing technology and the Company's implementation plans, including customer and third-party access to energy usage data. Section 4 addresses some of the concerns raised about the new technology, provides an overview of innovative opportunities grid-edge computing can enable, as well as a potential framework that can be used to guide the Company, customers, and third parties as grid-edge computing capabilities evolve. Finally, Section 5 sets forth the Company's recommendations and proposed next steps.

[8] *Id.* at 31.

3. Grid-Edge Computing Overview

Edge computing is a distributed computing architecture that puts the computing resources at, or close to, the sources of information, while also leveraging components of a centralized service (*e.g.*, cloud computing, utility back-office systems, *etc.*). Processing data close to the source of information is particularly beneficial in network-constrained systems such as AMI, because the edge computing can process data and send packets of results over the network, rather than transmitting large volumes of raw data (*i.e.*, reduce file transfer size requirements for a given application).

The goal of edge computing is to use information and processing occurring at the edge and couple it with information and processing occurring at cloud/back-office to meet customer needs and enhance business operations. Examples of edge computing devices with storage, processing, and networking hardware in other industries include mobile devices, medical devices/sensors, manufacturing sensors, and sensors on micro-mobility (*e.g.*, electric scooters) hardware.

Here, the Company's electric AMI solution incorporates an edge computing platform. These resources will work in concert with back-office systems, unlocking a range of use cases not possible with the previous generation of AMI, as described below. While the AMI gas modules do not include edge-computing capabilities, the Company envisions enabling advanced AMI-enabled gas use cases, such as gas demand response or time-varying rates ("TVR"), using hourly interval data and analytics (*e.g.*, gas load disaggregation) in back-office systems.[9]

The following sections detail how the Company intends to implement and utilize the grid-edge computing platform, allow customers to access their energy usage data over the HAN, and allow customers to share their data with authorized third parties.

3.1. System Details

3.1.1. Meter Hardware

The AMI meters include three separate components: 1) hardware-isolated metrology; 2) hardware-isolated communications interface; and 3) hardware-isolated edge computing environment. The separation of these components is a key design feature, as it helps to ensure the benefits of the grid-edge computing platform neither disrupt the meters' core function (*i.e.*, generating accurate bills for customers)[10] nor create a cybersecurity vulnerability for customers or the system. Figure 3-1 below provides a high-level overview of the major system components. In addition, the individual system components have been designed to meet the

[9] *See* NMPC 2017 Rate Case Docket, *Advanced Metering Infrastructure (AMI) Benefits Implementation Plan* (filed January 19, 2021) at Sections 5.1.3-5.1.5, and 5.4.2.

[10] *Cf.* NMPC 2020 Rate Case, *Staff Reply in Support of the Joint Proposal*, at 10 (filed November 5, 2021) ("[I]t is important to recognize that the AMI meters serve the primary purpose of ensuring that Niagara Mohawk can accurately quantify the customer's utility usage. Other purposes are secondary and cannot interfere with this primary function.")

expected 20-year asset life of the electric AMI meter – an important consideration addressing obsolescence concerns.[11]

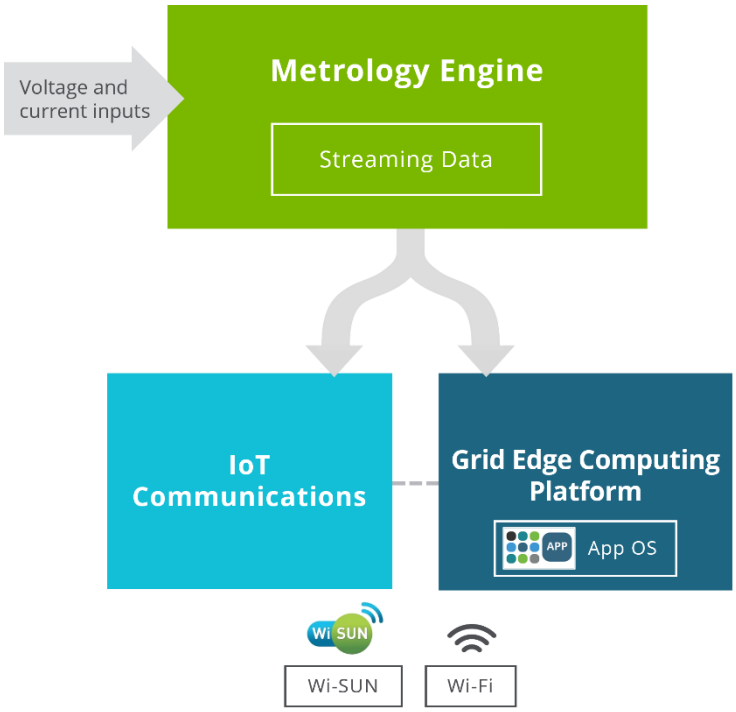

Figure 3-1: Hardware-Isolated Meter Components

The Metrology Engine within the meter receives a variety of data regarding the customer's energy use, including voltage, current, reactive power, and waveforms inputs. The Metrology Engine contains the associated relevant firmware, isolated from the Grid-Edge Computing Platform and Internet of Things ("IoT") Communications firmware, to ensure the reliability of the measurement and billing capabilities. The IoT Communications interface then receives the energy usage data from the Metrology Engine and provides reliable, secure transmission of the data to the Company's back-office systems over the Wi-SUN network for billing purposes.

The Grid-Edge Computing Platform provides a sandboxed environment for the execution of applications using the computing power of the Edge Intelligence Card ("EIC"). The Grid-Edge Computing Platform also provides access to the embedded Wi-Fi radio for consumer-facing applications, as well as an interface to the Wi-SUN platform for utility-facing grid applications.

The hardware architecture described above is designed to minimize cybersecurity risk, while providing flexible grid-edge computing capabilities that can meet Company and customer needs over the life of the meter. By operating in a sandboxed environment, applications are not able to disrupt the core functions of the meter, disrupt network communications of the AMI backhaul network, or access out-of-bounds features, such as the remote disconnect switch. In addition,

[11] For example, the platform is remotely upgradable and future-ready for 20-year life. Linux kernel, application operating system, uses common coding language Java. Metrology and communications firmware are remotely upgradable.

robust security practices are implemented across the system to provide additional security backstops throughout the application lifecycle, described below.

3.1.2. Platform Ecosystem

The grid-edge computing capabilities of the AMI meters establishes a platform ecosystem that includes important roles for both the AMI vendor and the Company. As depicted in Figure 3-2, below, the respective roles encompass global functions required to implement consumer-facing and grid-facing applications.

Figure 3-2: Major Components of the Grid-Edge Computing Lifecycle

The following application-related functions fall under the purview of the AMI vendor:

- **Developer Ecosystem:** To get started, application developers will request access to the suite of tools and resources, referred to as the app studio or development toolkit. Once access is granted, which will include a nominal one-time or recurring fee based on options selected, developers will have access to a Java-based application development environment, including a software development toolkit ("SDK"), optional accompanying hardware, learn-to-code resources, and an anticipated online community/web forum for developers.
- **App Lab:** All applications must then pass a qualification test before the application is qualified for publication on the AMI vendor's application marketplace, regardless of whether the applications are developed by the Company (or on behalf of the Company as part of a request for proposal ("RFP")), or separately by a third-party developer. The qualification test service, including source code review and run-time analysis, performed by the AMI vendor assesses whether the edge application meets the cybersecurity and resource usage standards. The testing also confirms that the application does not affect the meters core operational functionality.
- **App Marketplace:** Applications that qualify through the AMI vendor's qualification testing process (*i.e.* the App Lab) will then be available to the Company via the AMI vendor's App Marketplace – a global universe of all qualified applications available to the Company. The AMI vendor will use the App Marketplace to catalog applications, track versioning, and ensure device compatibility. Edge applications developed by third parties and offered by the AMI vendor via the App Marketplace will be subject to contractual arrangements between the application developer and the AMI vendor, which is anticipated to include a revenue-share component. Likewise, applications developed by, or on behalf of the Company through an RFP, will be acquired consistent with the

Company's procurement process. In situations where the Company has issued an RFP, the Company will contract directly with the app developer and the app will either be available on the App Marketplace or on National Grid's App Manager.

The following application-related functions fall under the purview of the Company:

- **Available Applications:** The Company serves as the administrator of application provisioning and registration; secures application import, distribution, and installation onto devices; manages the application lifecycle (*e.g.*, version control, updates, and decommissioning); and facilitates app-related payment processing, as applicable for paid applications.
- **App Customer:** Customer front-end interface to manage enrollment (*i.e.*, opt-in) in available applications. Customers will be able to browse available applications and choose to opt-in to the ones they are interested in. Applications may be available at no cost or potentially for a small one-time or recurring fee, depending on the application. The Company anticipates the number of customer-facing applications to increase as the ecosystem continues to mature.

3.1.3. Cybersecurity

Today's customers expect a more dynamic and flexible electric system that is increasingly reliable, supportive of decarbonization and a system that enriches them with insights that can help drive efficient energy use. As a result, there is increased reliance on Information Technology ("IT") systems and digitization to meet these expectations. This trend creates new opportunities, but also increases challenges from a cybersecurity perspective. Systems and technologies that were once not connected to the internet are now becoming interconnected to meet changing expectations. As systems become more interconnected, the attack surface and associated attack vectors for potential malicious actors also grows. Therefore, solutions must be developed with security in mind and take into consideration the changing threat landscape.

Cybersecurity threats are on the rise. They include actions ranging from criminal enterprises pursuing monetary gain and extortion, to nation state actors with the objective of corporate espionage, critical infrastructure disruption and destruction. Recent attacks, such as the Colonial Pipeline ransomware incident, illustrate the disruptive and potentially destructive nature of a cyber attack.

The Company's approach to cybersecurity considers the risk posed by cyber-enabled fraud, data breach, enterprise IT disruption and critical infrastructure disruption. The approach is threat-informed and risk-based, aligned to industry standards and best practices. The National Institute of Science and Technology Cyber Security Framework ("NIST CSF") is the foundation of the Company's cybersecurity approach and is represented in the functions below:

- **Identify:** Develop an organizational understanding to managing cybersecurity risk to systems, people, assets, data, and capabilities enabling an organization to focus and prioritize its efforts, consistent with its risk management strategy and business needs.

- **Protect:** Develop and implement appropriate safeguards to ensure delivery of critical services, delivering proactive safeguards to protect users, information and networks from compromise.

- **Detect:** Develop and implement appropriate activities to identify the occurrence of a cybersecurity event, enabling the detection of user, information and network compromise or breach.

- **Respond and Recover:** Develop and implement appropriate activities to capture and contain a potential intrusion and maintain plans for resilience and to restore capabilities or services to recover and return to normal business operations.

By understanding and prioritizing controls in the Identify, Protect, Detect, Respond and Recover functions, the Company's approach to cybersecurity can be balanced with the threats faced and the risk posed by threats should they materialize.

3.2. Customer Access

To meet the diverse expectations and needs of its customers, the Company envisions a range of AMI features and products that will be available to customize the energy experience. As described in the Company's AMI Customer Engagement Plan,[12] the proposed Customer Energy Management Platform ("CEMP") will serve as the integrated hub of these features and products.

The baseline experience for customers who receive a new smart meter will be built around the interval data supplied by AMI, with additional functionality, as described below, available to customers on an opt-in basis. For electric customers, 15-minute raw interval data will be available on the CEMP every 30-45 minutes, with validated bill-quality data available within 24 hours. For gas customers, raw, unvalidated, hourly interval data will be available every 8 hours, with validated bill-quality data available within 24 hours.

The Company believes the interval data will unlock a variety of new customer features, beyond the current customer experience. For example, as set forth in the AMI Customer Engagement Plan, Appendix A, the Company identified several CEMP features, including usage data visualization, personalized energy insights and tips, and integrations with energy efficiency/demand load management programs. Customers will also be able to begin customizing their experience by enrolling in configurable and proactive customer alerts, such as high-usage alerts, delivered over the customers preferred communication channel (*e.g.*, email or Short Message Service ("SMS") text). The Company will also explore other non-digital communication channels.

Moreover, as detailed in the Company's Benefits Implementation Plan[13] Section 4.2.1, the Company will leverage a third-party vendor with industry-leading expertise to deliver many of

[12] *See* NMPC 2017 Rate Case Docket, *Advanced Metering Infrastructure (AMI) Customer Engagement Plan* (May 20, 2021).
[13] *See* NMPC 2017 Rate Case Docket, *Advanced Metering Infrastructure (AMI) Benefits Implementation Plan* (January 19, 2021).

these features. The Company will be rolling features out to customers following an agile development framework to provide iterative improvement, incorporating new AMI-related features, and customer feedback into future releases.

The Company is excited to leverage the grid-edge computing platform to supplement this core AMI customer experience with more sophisticated offerings. By using edge computing resources, software running on the meter can ingest high resolution meter data and provide enhanced analytics tailored for individual customers.

Initially, the Company will use the AMI edge computing platform to provide customers a mobile application with appliance-level load disaggregation and usage accounting. The Company plans to make a version of this edge computing-based load disaggregation available to all residential customers who wish to opt-in. With this functionality, packets of data containing the load disaggregation results will be backhauled over the AMI network, providing appliance-level accounting of electric appliance usage for a range of devices, such as heating, ventilation, and air conditioning ("HVAC") units, refrigerators, pumps, and laundry, as well as smaller appliances, such as toasters, irons, and microwaves. The results can then be integrated into the CEMP or mobile application, as highlighted in Figure 3-3 below. The Company is also exploring additional customer interface channels for such information, including non-digital options (*e.g.*, paper home energy reports).

Customers will also have access to a real-time load disaggregation solution, available on an opt-in basis. Given the intensive data needs of providing this data to customers in real-time, the system needs access to a higher bandwidth, lower latency network than what the AMI network can provide. To enable this use case, customers can elect to connect the embedded AMI Wi-Fi radio to their home Wi-Fi network. The Wi-Fi-enabled HAN connection can then be used to stream data from the customer's meter to the appropriate systems for customer display. Customer's will be able to access this information either through the CEMP or a mobile app on their smartphone, as shown in Figure 3-4.

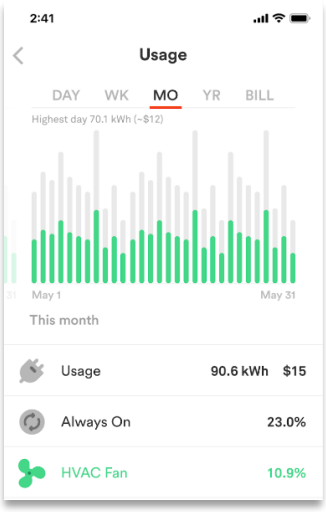

Figure 3-3: Sample Appliance-Level Load Disaggregation Mobile App Feature (AMI Network Backhaul)

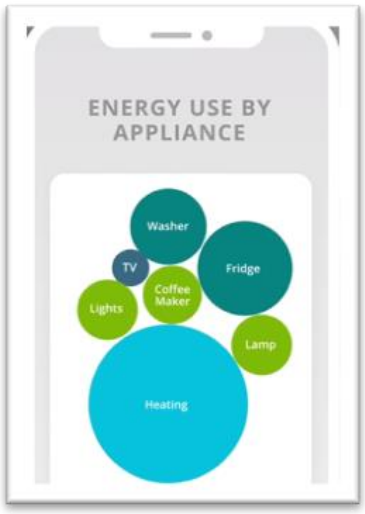

Figure 3-4: Sample Appliance-Level Load Disaggregation Feature (Wi-Fi Connected)

Likewise, the Company sees value in providing customers access to a real-time Power Meter (energy monitor) as part of a mobile application or on the CEMP. The Company believes that this will help customers better understand their electricity usage and how it changes throughout the day or by season. In this way, customers can see energy usage at any moment, and track down energy-intensive uses by observing power consumption when things turn on and off. Like the real-time load disaggregation described above, the intensive data needs of providing high-resolution (*i.e.*, sub-second) data to customers in real-time, requires the customer to connect the embedded AMI Wi-Fi radio to their home Wi-Fi network.

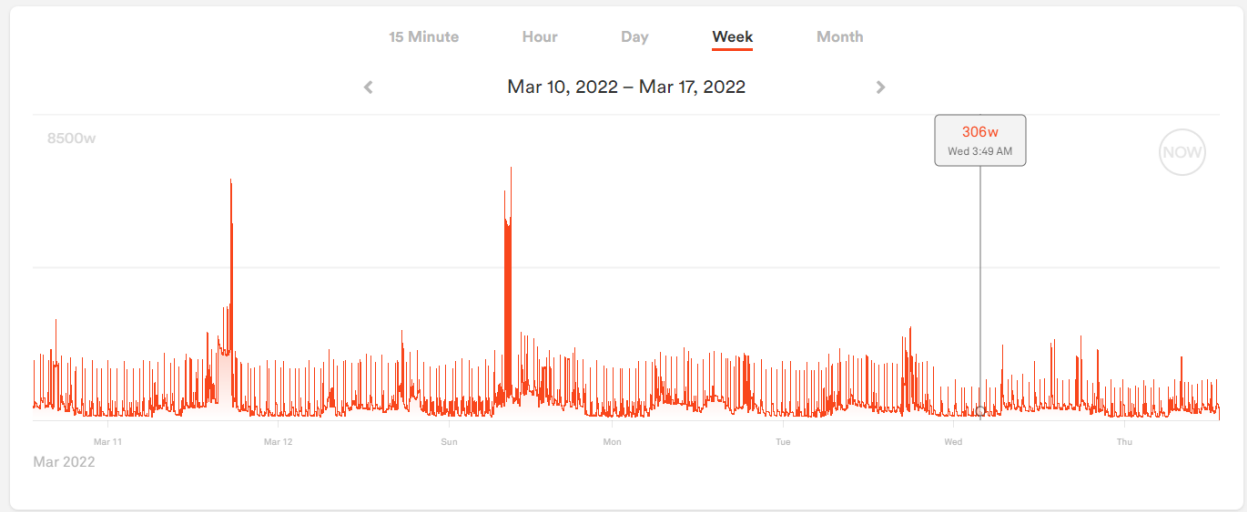

Figure 3-5: Sample Real-time Power Meter

As part of its AMI back-office system design and integration, the Company is evaluating key implementation design decisions for this functionality. The Company will provide customers

with self-service options to activate the Wi-Fi transceiver to pair their meter with the Wi-Fi-enabled HAN through the CEMP.

In the future, the Company plans to build on the above features. For example, software running in the edge-computing environment can be used to trigger alerts when the home's usage trend is high during a time window (*e.g.*, monthly, weekly, hourly). Alerts can be sent to the Company's CEMP over the AMI network and can also trigger in-app alerts directly to the homeowner via the real-time energy monitor application described above, if the customer has opted into this functionality. The Company believes this capability will be particularly useful in a future state with TVR.

Figure 3-6: Sample Energy Notifications

The Company also anticipates providing energy data for smart-home devices. The Company is excited to help customers adopt smart-home technology and believes customers will find value through increased choice, convenience, and control of their energy usage. The Company will provide customers with detailed education materials, as part of the Company's three-phased AMI Customer Engagement Plan. Additional discussion on envisioned future grid-edge applications is provided is Section 4.3, below.

3.3. Third-Party Access

The Company supports animating the market for energy products and services by connecting customers to third-party vendors who can help supplement customer needs with new and innovative offerings. The Company is also committed to protecting customers' privacy. Toward this end, the Company will only collect, process, retain, use, and disclose smart meter energy usage data for National Grid utility-related business purposes, or as specified by a customer's express consent to disclose such information to a third-party using secure transfer protocols. The Company views third-party access in two categories: 1) data access; and 2) edge computing platform access. Additional details for each category are described below.

3.3.1. Data Access

Third parties will have several options to gain access to energy usage data, including:

- Green Button Connect My Data ("Green Button Connect");
- Electronic Data Interchange ("EDI"); and
- Integrated Energy Data Resource ("IEDR").

The three options are separate, but related protocols, and are likely to evolve as IEDR development progresses.

The industry-led Green Button Connect initiative is the suggested method for customers to grant access to their energy data to qualified third parties. Green Button Connect provides a national energy data format and can eliminate the need for third-party service providers to support various utility protocols and standardizes the customer authorization process. With Green Button Connect, customers can securely authorize designated third parties to send and receive data on the customer's behalf. The Company launched its Green Button Connect program in March 2021 in Upstate New York. This functionality will be refined to accommodate AMI data and deployed as a key feature of the CEMP. Customer-authorized third-party data sharing through the Green Button Connect functionality will enable increased market participation and competitive customer offerings.

In general, the onboarding process involves third parties submitting their Green Button Connect registration form online, a utility representative reviewing the form and contacting the third-party regarding next steps. Once the initial step is complete, third parties will execute the required Data Security Agreement ("DSA") and registration forms. The third-party will then be listed on the Green Button Connect platform as an authorized entity with whom a customer can share energy usage data. With customer consent, data transfers are nearly instantaneous depending on the capabilities of the third-party to transfer and accept the requested data.

Customers will have the opportunity to use Green Button Connect to authorize the transfer of their smart meter data to third parties using either the Company's website or a third-party website, where available. Having multiple channels to connect customers with third parties will enable greater opportunities for third-party access to customer-authorized data sharing. Below is a depiction of the two means in which customers will be able to authorize and begin to share their smart meter data using the Green Button Connect capabilities. The design and process will be simple and easy for customers to understand, register, and share data. Please see Figure 3-7: Green Button Connect Authorization Process Flow below.

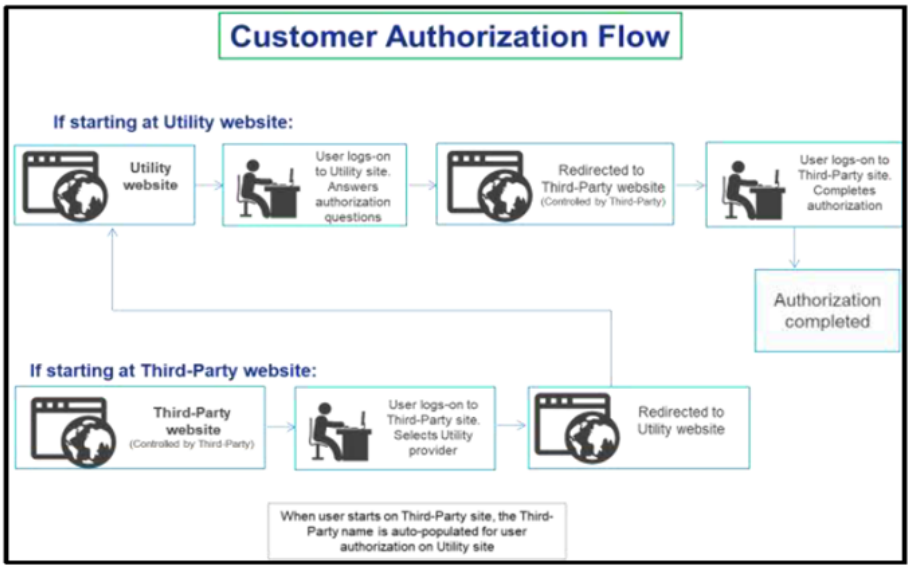

Figure 3-7: Green Button Connect Authorization Process Flow

The Company also uses EDI to send information to energy service companies. This service is used primarily for bulk data transfers to competitive energy suppliers. EDI is expected to evolve with the increase in data volume that will be available through the implementation of AMI.

Green Button Connect and EDI are designed to share billing-quality, interval data with qualified third parties. The protocols are not currently designed to support the high-resolution data or detailed analytics outputs (*e.g.*, appliance-level load disaggregation data) made possible with a grid-edge computing environment. The Company will evaluate the business case justification and technology options that would be required to enable sharing such data, as well as the careful consideration of customer security and data privacy. The Company is also open to future discussions with policymakers and interested stakeholders on this topic.

The Company and its New York affiliates, KeySpan Gas East Corporation d/b/a National Grid and The Brooklyn Union Gas Company d/b/a National Grid NY (collectively "National Grid NY Companies"), along with the Joint Utilities of New York, are actively working with the New York State Energy Research and Development Authority ("NYSERDA") on the development of the state-wide IEDR platform. This data-sharing platform is expected to mature to become the single source of energy related data in New York. As the IEDR website notes:

> The IEDR Program is following a development approach that identifies and prioritizes stakeholder use cases that provide the greatest value to New York residents as the State achieves its nation-leading climate goals. IEDR Program activities will be continually framed through the evaluation and prioritization of use cases.[14]

[14] https://www.nyserda.ny.gov/All-Programs/Integrated-Energy-Data-Resource/Use-Case-Development

Currently, the National Grid NY Companies are supporting the development of the initial set of use cases, identifying the associated data requirements, and providing input to the RFP process for the IEDR platform provider.[15] The Company anticipates integrating AMI interval data with IEDR; however, the high-resolution data and detailed analytics associated with the grid-edge computing platform are beyond the currently envisioned use cases.

3.3.2. Grid-Edge Computing Platform Access

As mentioned, the Company is excited about the innovative opportunities enabled by the grid-edge computing platform, and it recognizes third parties are likewise interested in developing applications as part of the enhanced computing capabilities of the AMI meter. The Company envisions the following pathways for evaluating future applications:

- **AMI vendor:** Third-party developers can follow the AMI vendor process to gain access to the developer ecosystem described in Section 3.1, above. Developers onboarding through this process would then gain access to a suite of tools and resources, including a Java-based application development environment to create applications using device simulator and/or real hardware following the AMI vendor's defined criteria.
- **National Grid Procurement Process:** In the future, the Company may define certain use cases or features and choose to contract with a third-party developer to build the requested functionality. In this scenario, the Company would issue an RFP, open for competitive bids consistent with the Company's procurement processes, to select a third-party developer to work with.
- **REV Connect-like process:** Building off the existing REV Connect framework, the Company also envisions open innovation sprints that leverage the grid-edge computing platform to drive value for customers and the grid. Figure 3-8 below illustrates the current REV Connect Innovation Priorities and Opportunities, which align well with potential future opportunities leveraging the platform.

[15] NYSERDA, as the IEDR program sponsor, has the responsibility for soliciting proposals and selecting the IEDR platform provider on behalf of the State.

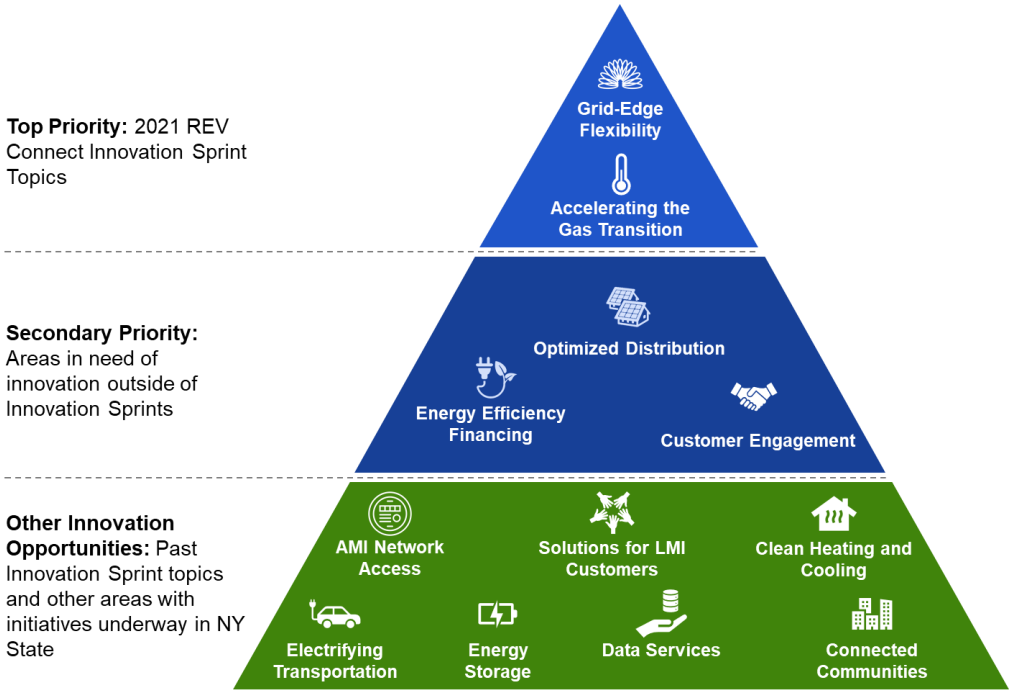

Figure 3-8: REV Connect Innovation Priorities and Opportunities[16]

Regardless of the pathway for onboarding, all developers will access the same developer ecosystem, and all applications will be subject to the same rigorous requirements during the App Lab certification/qualification process. In addition, all developers and applications will be subject to the Company's cybersecurity and data governance requirements, as well as applicable Commission rules and regulations. These steps are required to minimize the potential for the introduction of cybersecurity risk onto the platform and ensure the proper protections of customer data throughout the application lifecycle.

Applications developed in conjunction with the AMI vendor will be subject to the standard terms of the App Marketplace, while applications developed through Company procurement process will be subject to the master agreement with the AMI vendor and the contractual arrangements between the Company and the developer. The Company also recommends further discussion among interested stakeholders to determine the appropriate process for applications developed through a REV Connect-like process.

[16] Source: https://nyrevconnect.com/innovation-opportunities/

4. Discussion

4.1. Conceptual Framework for Platform Governance

The Company provides the following discussion on platform governance to enhance the shared understandings and conceptual framework within which policymakers and interested stakeholders can collaborate to deliver innovative solutions leveraging the grid-edge computing platform.

In recent years, digital platforms have risen to prominence as a highly efficient and productive business model. Digital platforms can be defined as "…a set of digital resources—including services and content—that enable value-creating interactions between external producers and consumers."[17] There are many variations of digital platforms (*e.g.*, two-sided marketplaces, such as ride-hailing services like Uber and Lyft or vacation rentals like Airbnb and VRBO), though the potential of the platform model has not yet been fully realized by the utility industry.

The introduction of next generation AMI presents an opportunity for utilities to apply learnings from other industries and associated academic research on the increasing presence of digital platforms in modern life. Successful platforms are durable and get stronger over time when they work, likely due to several factors:

- **Reduce Barriers to Entry:** Platforms can dramatically lower the market entry point for vendors. For example, Amazon provides a marketplace platform with many customers. Third-party vendors can simply sign up to sell on Amazon, rather than make their own marketplace website.

- **Competition:** Platforms promote market-based competition. On major platforms, commodity vendors compete on the basis of efficiency and customer satisfaction and specialized vendors can now have access to major markets. This benefits customers through increased competition and choice.

- **Governance:** Platforms need to provide governance, but assets are commonly provided by third parties or end-users (*e.g.*, Uber does not own the cars).[18]

Successful platforms create opportunities for third parties to participate in and add to the value creation of interactions on the platform. Recent research articulates benefits of this approach, finding:

> In areas where platforms have gained traction, the ability of a platform to encourage the development of a variety of content…and to integrate that content into a seamless user experience has become crucial in determining a platform's success. Thus, it is in the best interest of platform providers to make their

[17] Constantinides, Panos & Henfridsson, Ola & Parker, Geoffrey, *Platforms and Infrastructures in the Digital Age. Information Systems Research*, 29. 10.1287/isre.2018.0794, at 1 (2018).
[18] Van Alstyne, Marshall, *How Platforms Change Structure and Strategy*, (2016), available at https://youtu.be/e5B9pfuVrMU.

platforms attractive and effective development environments for third-party content providers.[19]

With platform capabilities through grid-edge computing taking shape with AMI, additional work is ongoing to define an appropriate governance structure and develop requirements to guide implementation. There are many factors to consider when developing an appropriate governance structure. For example, given the sensitive nature of energy usage data that will be available on the platform, customer privacy and security are key factors. As such, the Company believes any third parties accessing customer data or accessing platform elements must adhere to National Grid Data Governance and Cybersecurity requirements described in Section 3.3.2, above. Likewise, access to the grid-edge computing development platform will be governed by the AMI vendor to ensure any grid-edge computing applications do not affect the Meter Engine metrology or otherwise create a cybersecurity vulnerability. However, recognizing the benefits of animating the market for third-party products and services, the Company also understands developers need opportunities to access the platform in a fair manner.

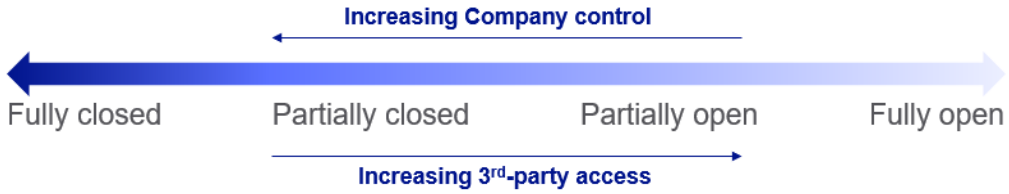

Figure 4-1: Platform Governance Spectrum

This dynamic of opposing forces between open and closed platform governance, as shown in Figure 4-1, creates tradeoffs for any point along the spectrum. The Company proposes managing those tradeoffs by working with policymakers and interested stakeholders to develop a holistic governance framework. One can broadly define governance with regard to three main facets:

- How decision rights are divided between the platform owner and third-party developers;
- The type of formal and informal control mechanisms used by the platform owner (*e.g.*, gatekeeping, performance metrics, processes that developers are expected to follow); and
- Incentive structures.[20]

Given the complexities of the grid-edge computing platform, it is important to consider how best to apply the open-closed spectrum. Grid-facing and customer-facing applications serve distinct objectives and should exist at different points along the spectrum. The Company is the primary customer for grid-facing use cases, which requires a high degree of control over the types of applications implemented. Within customer-facing applications, there is a range of technology

[19] Tan, Burcu and Anderson, Edward G. and Parker, Geoffrey, *Platform Pricing and Investment to Drive Third-party Value Creation in Two-Sided Networks* (September 29, 2016), available at SSRN: https://ssrn.com/abstract=2959165 or http://dx.doi.org/10.2139/ssrn.2959165.
[20] Constantinides, Panos & Henfridsson, Ola & Parker, Geoffrey, *Platforms and Infrastructures in the Digital Age. Information Systems Research*, 29. 10.1287/isre.2018.0794 at 3 (2018).

primitives that could be considered separately to allow for proper treatment of customer privacy and security.

At the data layer, the grid-edge computing platform provides raw, high-resolution (*i.e.*, on the order of magnitude of kHz) current and voltage readings. That raw data could be processed by a set of value-added analytics, enabling sharing of synthesized data and intelligence through the grid-edge computing platform. Distributed computing applications could then be built on top of the raw data, or the synthesized intelligence. Such applications may also leverage additional capabilities in the meter, such as the Wi-Fi radio for real-time data access or to connect with behind-the-meter smart devices. The associated computing and networking resources must be managed in a way that allows multiple stakeholders to orchestrate their service and content needs.

Within a given product or service segment, there are composability trade-offs of having one agreed upon provider for a given service versus a competitive environment of multiple providers. Segmenting the potential addressable market across multiple, non-standardized offerings has the potential to limit interoperability to other services. For example, if the platform uses one load disaggregation application, then additional services (*e.g.*, improved distribution planning by analyzing customer usage patterns for things like EVs and heat pumps) can be built on top of a standardized set of outputs more easily than coordinating across multiple providers.

In a future state where: 1) third-party developers can develop customer-facing applications, and 2) a sufficient number of third-party developers exist and are interested in pursuing that path, then one must consider the resulting user experience and business case. For certain services, the incremental value is likely to diminish as the number of similar applications increases. Continuing with the load disaggregation example, what is the value to a customer of the third best, or fifth best, or tenth best, load disaggregation application? Less sophisticated or less accurate competitors could create unnecessary customer confusion, which has the potential to increase operating costs, such as an increase in call volume to the Company's Customer Contact Centers. Accordingly, the Company views curation as a key platform function. In this way, the point on the spectrum in Figure 4-1 represents the degree of curation, where customers could choose between a set of offerings that have met certain performance criteria.

More broadly, governance of the Company's grid-edge computing platform could have implications for AMI implementation by the other Joint Utilities. As peer utilities implement grid-edge computing platforms, it is important to recognize that many implementation details are likely to be company-specific, based on the selected AMI vendor. Certain functionality or applications may also be specific to an AMI vendor. The Company recommends further exploring any utility-specific considerations for proper treatment in the governance framework. Additional discussion regarding previously expressed stakeholder concerns is provided in Section 4.2, below.

4.2. Addressing Stakeholder Concerns

Interested stakeholders have previously expressed interest in the potential value of an AMI-enabled grid-edge computing platform, as well as concerns about the need for grid-edge

computing platform regulations. The Company appreciates stakeholder input and wishes to address these concerns directly. The following table summarizes stakeholder concerns, as the Company understands them, and provides an accompanying Company response.

Generally, the Company understands stakeholder concerns to include:	**The Company offers the following commentary in response:**
• Protection of ratepayer interests, ensuring customers receiving the full benefits of this technology, and potential limitation of customer choice for competitive DER products and services	As the platform enables a range of customer- and grid-facing use cases, there are many platform benefits that the Company plans to deliver (*e.g.*, load disaggregation and energy insights described in Section 3.2, above and grid modernization applications to operate the grid in a more efficient manner described in Section 4.3, below). This Report details an industry-leading platform approach. The Company believes the platform can also serve as a model to other utilities of how to use these innovations to deliver on decarbonization targets. As the Company's Net Zero by 2050 Plan states: "Climate change is the greatest challenge facing the world, our country, and our region. National Grid supports our states' goals in reducing greenhouse gas emissions economywide. We recognize that decarbonizing our electric and gas systems will require resolving many questions and seeking new partnerships, technologies, energy policies, utility regulatory models, and transformative investments. Though we do not have all the answers, we are eager to collaborate on solutions and to step up in addressing these challenges."[21]
• Protection of a competitive marketplace for third-party DER providers	The Company's approach to customer engagement, described in detail in the AMI Customer Engagement Plan, generally follows a "data to insights to action" framework, using data and analytics to drive customer traffic to various potential actions that a customer could take to save energy and money. Many actions include referring a customer to a third-party service. For example, AMI data can be used to help guide customers to the National Grid Marketplace to buy third-party products or increase program referrals to third-party DER providers, such as through the Solar Marketplace.[22]

[21] *See* National Grid, *Our Plan: National Grid Net Zero by 2050 Plan* available at https://www.nationalgridus.com/media/pdfs/our-company/netzeroby2050plan.pdf

[22] *See* National Grid Marketplace available at https://uny.home.marketplace.nationalgridus.com/solar_energy.html.

	The Company believes grid-edge computing will expand the competitive market for third-party energy service providers even further. The Company is already working with the AMI vendor and innovative third-party developers to deliver the scope described in Section 3, above. Going forward, the Company is eager to work with third-party developers who can help deliver cost-effective business cases in the areas of opportunity shown in Figure 3-8, above, and beyond.
• Public policy questions about fair competition and the boundaries of regulated and unregulated services	The Company's believes that the grid-edge computing platform solves long-standing hardware scalability issues that have limited the home energy monitoring space. Previously, to gain the functionality described in Section 3.2, above, customers would have to purchase a home energy monitor and pay a qualified electrician for installation. Such a solution all but guarantees that only a small subset of affluent "prosumer" customers can benefit from such solutions. The Company's and State's commitment to equity and environmental justice to provide opportunities for a diverse range of customers, including low-to-moderate income ("LMI") customers, and Environmental Justice Communities ("EJCs") indicate that solving those scaling issues need to be a priority. The Company believes that the best, and arguably only, viable path to do so is with next generation AMI. As such, a key platform design objective for the Company is maximizing the number of customers who can benefit from this technology. The work described in Section 3.2, above represents significant progress in delivering on this objective and the Company looks forward to continuing to expand these efforts. The Company views this progress not as an encroachment on unregulated services, but instead as collective progress of integrating third-party market innovations with State- and Company-delivered energy programs and services, to better serve all customers. The Company believes integrating solutions is mutually beneficial for all parties: • Company and State delivered programs benefit from market innovations; • Customers, regardless of income or ability to pay for a market solution, can access more sophisticated solutions; and

	• Third-party service providers now have a new channel and revenue stream to scale their solutions.
• Potential for self-dealing	The Company's conduct is governed by the comprehensive affiliate rules in Appendix 16 of the NMPC Rate Case Joint Proposal. The affiliate rules in Appendix 16 address, among other things, issues such as: use of Company assets by affiliates (§ 1.2.5); sharing of customer information (§ 1.6.4); and the requirement that the Company treat affiliates and non-affiliates providing services to customers comparably (§ 1.6.5). These rules—which are integral to the Joint Proposal—provide a framework that protects against any potential discrimination and self-dealing.

4.3. Proposed Future Use Cases

As described in the Company's Benefits Implementation Plan, Section 5.2, the Company will further evaluate the future functionalities (*e.g.*, proof of concept) as the Company implements the AMI solution. To the extent the functionalities merit implementation, the Company will include incremental funding requests and justification, as appropriate, in future proceedings.

Table 4-1: Potential AMI-Enabled Future Functionalities

Functionality	Description	Technology Dependencies
Grid Mapping/Locational Awareness	Algorithms allow meters to define their location at a transformer and feeder level to better collate GIS data while providing enhanced insights to load forecasting, voltage and outage management systems.	Grid-edge computing application, integration with Grid Modernization functionalities
Bypass Theft Detection	Theft detection uses real-time, high resolution analysis of data from power flows rather than anecdotal alarms and alerts to detect customer energy theft through meter tamper/bypass as well as direct connection of loads to the low-voltage wiring.	Grid-edge computing application
Intelligent Voltage Monitoring	Intelligent Voltage Monitoring enables voltages on the distribution network to be analyzed at the meter level, to optimize the asset life of transformers while ensuring power delivery at acceptable voltage ranges and power quality standards. Exceptions are reported.	Grid-edge computing application
Distributed Outage Detection	Analytics are performed at the meter to identify power on/power off signals along with voltage data to quantify power outages for segments of the distribution system, which are then integrated into an OMS to support service restoration.	Grid-edge computing application, OMS integration
Temperature monitoring	Detecting a rise in temperature in a meter socket can alert utilities prior to a potential fire or possible over-heating concern.	Grid-edge computing application
Arc sensing	Electrical arc sensing on both the customer- and grid-facing components supports safety and reliability benefits by proactively identifying anomalies and unsafe conditions.	Grid-edge computing application

High-Impedance Detection	Identification of high-impedance points in the distribution network, including at the meter, which can result in voltage complaints, connection failures, and even fire in some cases.	Grid-edge computing application
Broken Neutral Detection	Detects broken neutral and poor ground conditions as they are developing on the customer side of the transformer so that potential safety problems can be identified and corrected as quickly as possible.	Grid-edge computing application
Active Demand Response	Autonomous demand management locally and intelligently by integrating with customer HAN devices to support demand reduction in accordance with utility demand events. Integration with EV charging stations can provide additional demand benefits while facilitating electrification.	Grid-edge computing application with HAN integration

These use cases reflect the initial roadmap of the grid-edge computing platform as proposed by the AMI vendor and the Company. The Company is eager to learn of additional opportunities that may be available as the platform ecosystem matures.

5. Conclusion

AMI is a foundational investment for achieving the shared vision of the clean-energy future. National Grid further recognizes that the next generation capabilities of the AMI meters' grid-edge computing platform will drive additional benefits for customers and the grid. This Report, consistent with the Commission's direction in the NMPC Rate Order, describes those new capabilities and the Company's plans to leverage the technology to drive further benefits. Toward that end, the Company looks forward to continued dialogue with interested stakeholders.

6. Appendix

6.1. Appendix A: Illustrative Cybersecurity Requirements

The table below provides a list of illustrative cybersecurity compliance requirements that are typically included in a vendor technical questionnaire for vendor response during Procurement events:

A8	Compliance
A8.1	Can you demonstrate compliance with security regulations, laws and legislation, if applicable (i.e. SOX, DPA, Privacy, SHE, NERC CIP, HIPPA/HITECH)
A8.2	Do you hold independently assessed certifications (i.e. ISO 27001, Safe Harbor, PCI, TIER)
A8.3	Please provide a copy of the latest assurance report (i.e. ISAE 3402, SSAE 16 "SOC 2") for the systems that will host / support National Grid. For SaaS service providers, the same reports will be required from software provider and hosting provider(s). If you use other subcontractors who will have an access to NG data classified as confidential or above - the same reports will be required
A8.4	Contractual. Please confirm that the vendor accepts a Right-to-Audit clause in the final contract
A8.5	Contractual. Please confirm that the vendor agrees to providing a vendor funded yearly ISAE 3402, SSAE 16 “SOC 2” reports - Same as A8.3?
A8.6	Contractual. Please confirm that the vendor agrees to providing a vendor funded yearly independent, third party penetration test of its solution
A8.7	Contractual. Please confirm that the vendor agrees to providing a vendor funded quarterly independent, third party network authenticated vulnerability scan of its solution