Fibocom
PERFECT WIRELESS EXPERIENCE

Whitepaper

Smart Meters and IoT: Enhanced Energy Management for a Sustainable Future

Introduction

In the era of digital transformation, IoT (Internet of Things) technologies have quickly become a staple of smart industries, being deployed across scenarios as diverse as factories, smart housing, and the ground-up development of smarter cities. However, there are few areas where they are likely to have greater impact than in the global power sector.

Worldwide, the demand for IoT-driven smart energy solutions is increasing, driven largely by concerns about sustainability from consumers, corporations, and governments alike. A growing body of legislation governing energy usage and “net-zero” emissions adds to the energy efficiency imperative, positioning the smart energy and technology sector for rapid growth in the coming years.

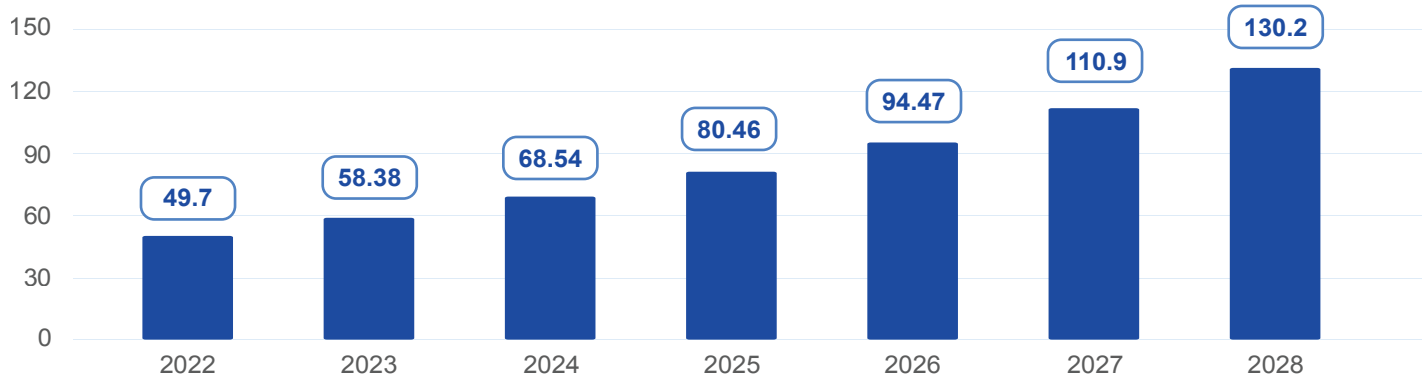
Because of these factors, power and utility companies are increasingly turning to “smart grid” technologies to achieve fine-scale control of power systems. Using IoT-enabled smart meters, power companies can analyze, monitor, and manage the grid in real time. This allows them to dynamically respond to changes in demand and supply, boosting their service delivery capabilities and helping them optimize resources and infrastructure.

The result is a revolutionized energy management system. One that combines the benefits of efficiency and responsiveness with the ability to meet environmental impact targets and produce energy in a way that is both smarter and more sustainable.

Smart Electricity Demand and the Smart Metering Market

In 2023, the value of the global smart grid technology market sat at USD 58.38 billion, and that number is expected to keep growing, reaching USD 130.2 billion by 2030 (Figure 1).

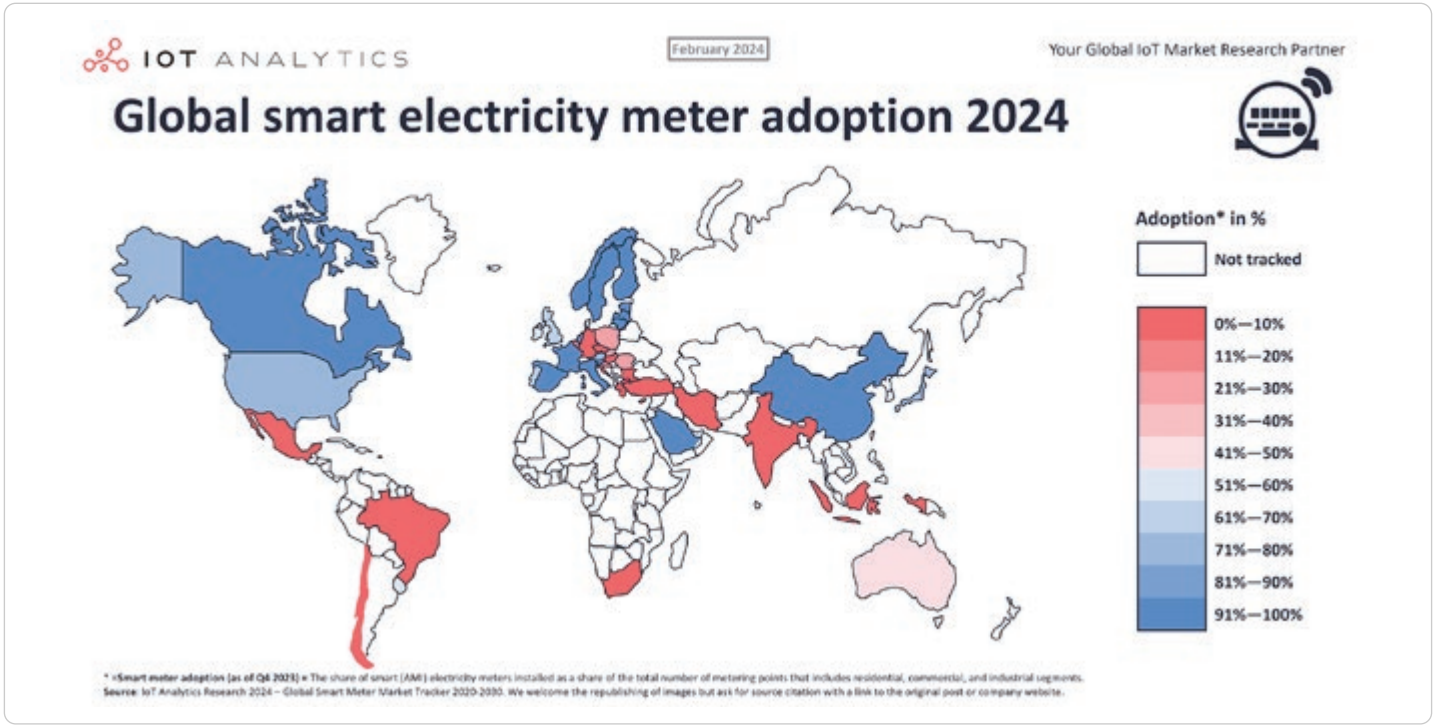
Figure 1: Smart grid technology market size worldwide from 2022 to 2028
(in billion U.S dollars)



Source: Statista 2024

Smart meters make up a significant portion of that demand, as utility providers worldwide are increasingly investing in smart metering systems. The extent of smart meter deployment varies on a region-by-region basis, as shown in Figure 2.

Figure 2: Global smart electricity meter adoption 2024



Source: IoT Analytics

In general, regional adoption can be broken down into three typical cases:

- Regions where smart meter adoption is still lagging (largely in Africa and Latin America)
- Regions where smart meter coverage has reached 20%–50%, and relevant technical standards have been formulated. This category includes Europe, the Middle East, and parts of Asia-Pacific (APAC). For example, smart meter deployments across Europe as a whole reached 47% by the end of 2023[1].
- Regions where widespread coverage of the first generation of smart meters has been achieved, and development towards the next generation is already underway. This category includes several countries in the APAC region (which is anticipated to reach 67% market penetration by 2030), some European countries, and North America (77% market penetration as of the end of 2023).

Global smart meter rollout

Global estimates place the total number of electric meter devices at around 2.5 billion. Data from IoT analytics shows that around 43% of these devices are smart meters, and that smart meter deployment (including electricity, water, and gas) totalled 1.06 billion units worldwide as of 2023.

This means there is still a gap of 1.5 billion or more smart electricity meters to address before the entire energy meter market becomes 100% IoT integrated.

As these figures suggest, the smart meter market is expected to continue growing rapidly in the coming years. Current estimates place the market value of the entire advanced metering infrastructure (AMI) market at USD 17.46 billion in 2024, and this figure is expected to reach USD 31.82 billion by 2029[2].

Footnote:

1 - Smart electricity meter market 2024: Global adoption landscape

2 – Mordor Intelligence - Advanced Metering Infrastructure Market Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029)

Key trends and market drivers

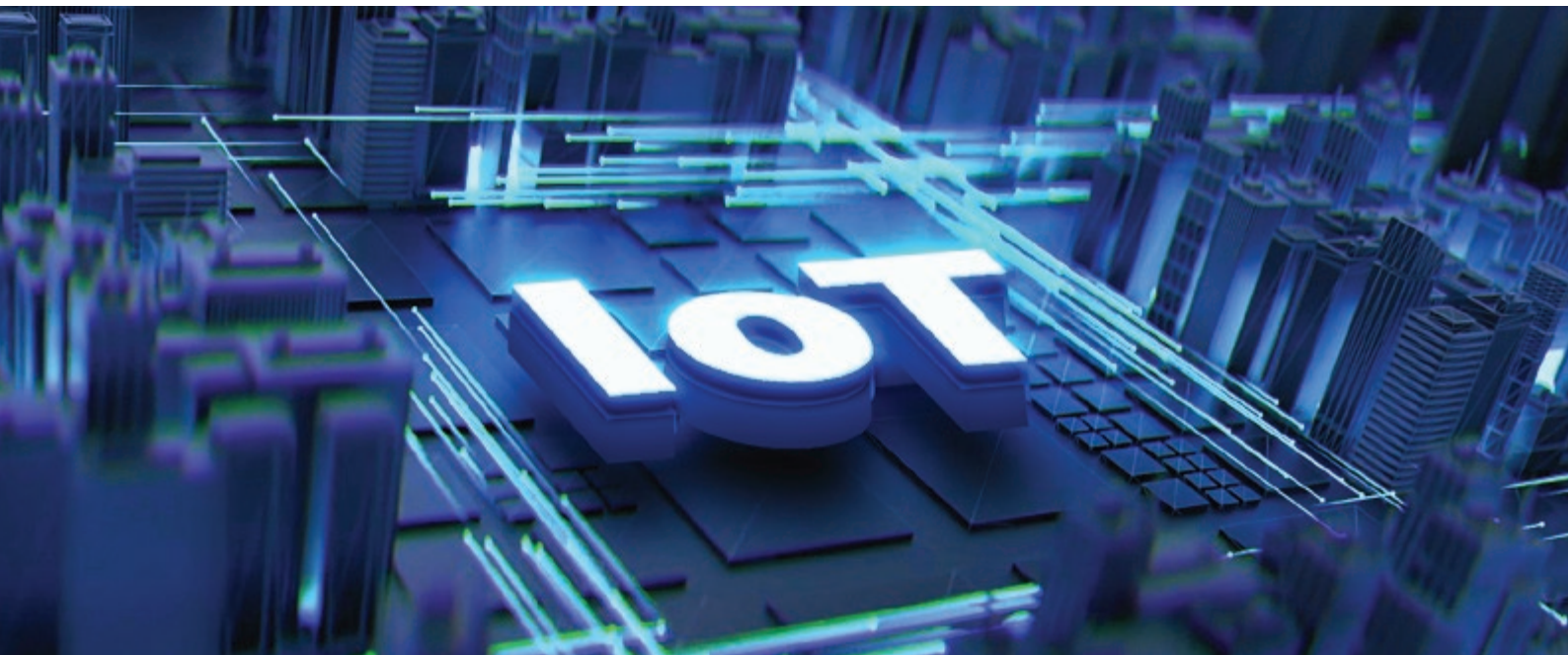
There are a number of key factors underlying the explosive growth of the smart meter market.

Firstly, deploying smart infrastructure offers power companies a distinct market advantage. Devices like smart meters represent comprehensive energy management tools that provide the data needed to boost operational efficiency and reduce energy wastage. This also means that the companies that adopt these technologies are positioning themselves at the forefront of a developing trend — one that will continue to evolve and improve their operations as the smart energy IoT market becomes more intelligent.

The growing adoption of next-generation cellular technologies, like 5G and 5G RedCap, is another factor that supports this trend. As cellular networks become more efficient and widespread, the task of installing wireless smart meters becomes quicker and easier. Metering and power companies are no longer required to deploy or maintain a dedicated communications network themselves. Instead, they can rely on existing cellular infrastructure, including that of previous generations, making it possible to quickly implement new smart metering systems.

Combined with decreasing cellular tariffs as providers tap into the burgeoning IoT market, this makes wireless solutions increasingly cost-effective and convenient, both for the companies themselves and for downstream service providers and customers.

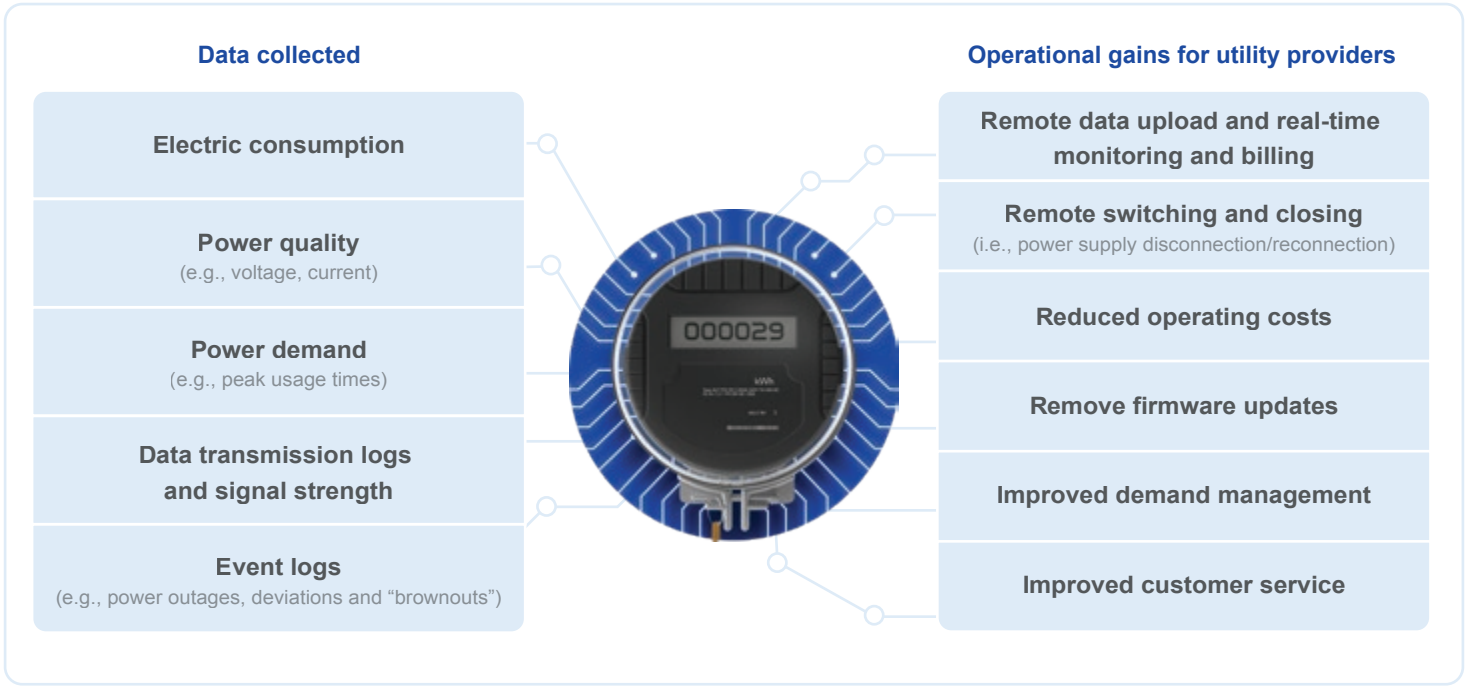
Because of these factors, smart grid market growth, and smart meter adoption, is expected to continue in coming years, retaining an annual growth rate of around 10%.



Understanding Smart Metering Architecture

As the core devices of Advanced Metering Infrastructure (AMI), smart meters are designed to collect an extensive array of data to be transmitted back to utility providers. This includes data on electricity consumption, power quality, demand and supply, and other factors, summarized in Figure 3.

Figure 3: Smart metering architecture



The data collected by each device will depend on the needs of users and utility companies, but in general, smart meters can be broken down into four broad types, each designed to meet specific use cases:

Pre-paid meters

Pre-paid meters allow end users to pay for electricity in advance and monitor their own usage. Power is typically automatically disconnected when credits run out and reconnects when the user updates their balance.

IEC smart meters

IEC smart meters are designed according to International Electrotechnical Commission (IEC) standards to ensure accuracy, interoperability, and safety. These meters are also designed with advanced measurement capabilities in mind, including power quality parameters.

Three-phase meters

Three-phase meters are used to measure electricity consumption in three-phase systems, typical of high-load industrial and commercial settings. These meters generally measure a wide range of power quality factors, including voltage, current, and harmonic distortion.

Gateway meters

Gateway meters serve as communication hubs or “concentrators” that collect data from multiple smart meters. That data is then transmitted to utility provider head-end systems, reducing the need for communication with individual meters, and boosting the efficiency of the overall smart meter system.

Data transmission

The data collected by smart electricity meters is typically processed in one of two ways: direct transmission to utility enterprise head-end systems, or collection by smart meter gateways before being transferred onward.

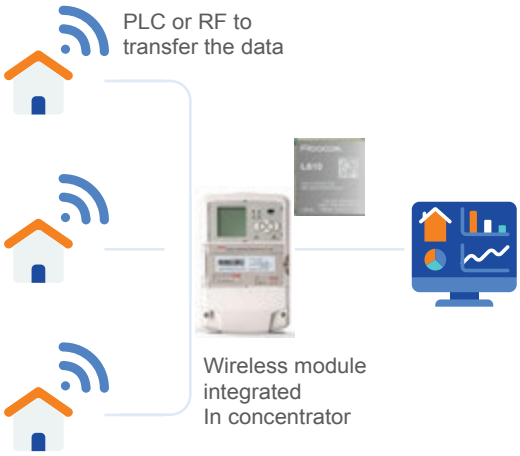
Though it is possible for data to be transmitted using wired infrastructure (e.g., Power Line Communication (PLC)), ideally data transmission is accomplished wirelessly, often using Low-Power Wide Area Networks (LPWANs) to conserve meter battery life.

Increasingly, cellular solutions (using 2G, 3G, 4G, or 5G) are being used as the go-to technology for communication with individual smart meters, and between smart meters and gateways. The broad geographic coverage of cellular networks, their security, and the reduced installation costs associated with using them make them an attractive option for utility providers. Figure 4 provides a simplified overview of two typical smart meter system architectures:

Figure 4: Smart meter system architecture

Wireless module integrated

Architecture 1:
Smart meters integrated with module can transfer the data directly to the management platform



Wireless module integrated

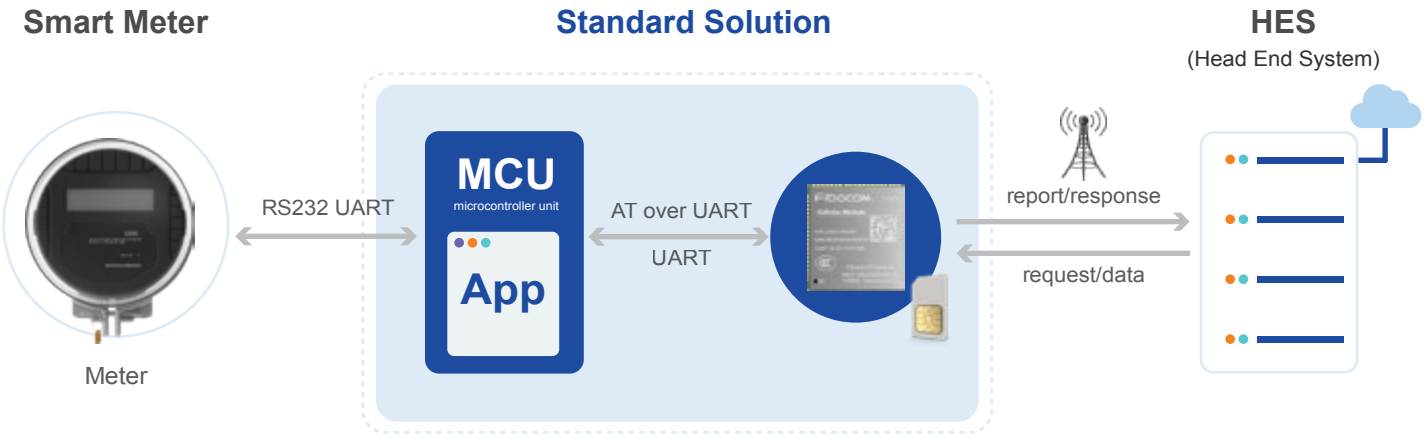
Architecture 2:
Smart meters using PLC or RF technology to upload the data the concentrator then sending the data to management platform by concentrator.

The efficiency of smart metering systems is therefore highly reliant on the quality, regularity, and reliability of wireless data communication through these networks.

Hardware architecture for wireless modules

As core components of this communications ecosystem, Fibocom's IoT wireless communication modules are designed to ensure optimal data connectivity across all smart grid applications. Figure 5 illustrates the role of a wireless communication module in smart meter deployments.

Figure 5: Hardware Architecture for Wireless Modules



In this figure, the smart meter's microcontroller unit (MCU) processes data recorded by the electricity meter, handles communication protocols, and connects to the communication module via a UART (universal asynchronous receiver-transmitter) peripheral. The communication module then transmits the data received to the utility's head-end system using wireless communication technologies (e.g., cellular).

Using this stream of data, the utility company is empowered to manage the network in real time and can respond quickly to any changes in the status of individual electricity meters.

Supporting Seamless Smart Meter Deployments

To ensure smart meter systems function optimally under all conditions, Fibocom modules include several additional key features.

“Last Gasp” support

Smart meters are typically designed to detect when power loss occurs, allowing them to transmit data in a “last gasp” event. Fibocom modules support “last gasp” functionality with the following features:

- Stored power can be used to send data via either SMS or TCP/UDP (Transmission Control Protocol/User Datagram Protocol) using low-power-optimized LTE-M communications. This allows up to three UDP messages to be sent, ensuring crucial data reaches utility providers in the event of a power outage.
- “Last gasp” functionality only activates in the event of power outage (not during module power cycle reset).
- “Last gasp” functionality can be enabled or disabled using dedicated AT commands, allowing utility providers complete control over when the functionality is activated and used.

Comprehensive communication protocol support

Fibocom's built-in and external protocol stacks adapt multiple communication protocols for the electricity meter industry, including:

- IPv4, IPv6
- TCP and UDP servers and clients
- HTTP/HTTPS, FTP/FTPS, CoAP, MQTT over SSL/TLS v1.2, NTP

This enables Fibocom modules to handle data transmission over varied networks, ensuring seamless and secure communication between smart meters and utility servers.

Security, firmware upgrade, and SIM management features

Fibocom modules offer a range of additional services tailored to the smart meter industry. These include:

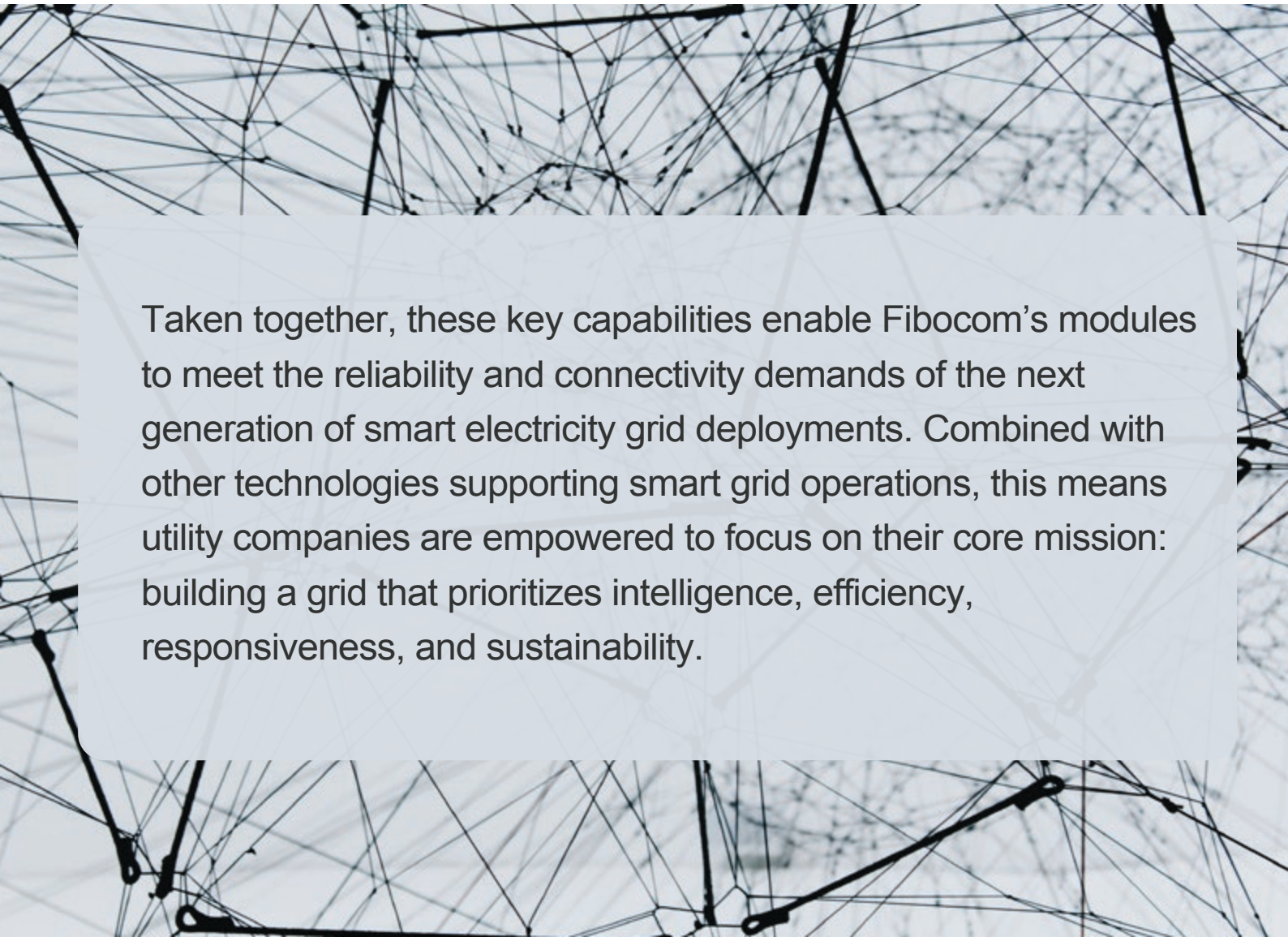
- Ensuring secure and authenticated network connections with support for PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol).

- Facilitating easy and efficient remote firmware updates via FOAT (Firmware Upgrade Over AT using USB/UART) and DFOTA (Delta Firmware Update Over-The-Air).
- Enabling flexibility and scalability in managing cellular connectivity with eSIM/eUICC (Embedded Subscriber Identity Module / Embedded Universal Integrated Circuit Card) technology. This ensures reliable communication and optimal performance across diverse deployment scenarios and geographical regions.

Wide range of connectivity options

Fibocom offers a wide range of modules, ensuring smart meter projects can be tailored to local network conditions and the needs of individual utility companies. This includes modules suited for 2G, 3G, and 4G deployments, as well as Cat M modules.

Meanwhile, Fibocom's 5G NR (New Radio) and 5G RedCap modules support companies implementing or testing advanced smart metering solutions and other scenarios requiring high speed and real-time communications.



Taken together, these key capabilities enable Fibocom's modules to meet the reliability and connectivity demands of the next generation of smart electricity grid deployments. Combined with other technologies supporting smart grid operations, this means utility companies are empowered to focus on their core mission: building a grid that prioritizes intelligence, efficiency, responsiveness, and sustainability.

Fibocom Modules

Designed with a spectrum of technologies, scenarios, and requirements in mind, Fibocom's versatile communication modules are already making smart grid deployments a reality for power companies across the globe.

5G NR module

FG650-EAU/LA

- High-performance 5G, Sub-6 IoT module that supports both 5G standalone (SA) and non-standalone (NSA) networks
- Compatible with 3GPP Release 15 standards, providing better 5G experience
- Supports 5G NR/LTE/WCDMA network standards
- Standard LGA form factor, rich interface, and high reliability
- Professional reference design and ongoing, responsive technical support to assist with streamlined product development
- Optimized power consumption
- Supports multiple operating systems (Linux/Android/Windows), greatly boosting utility across varied IoT and energy sector applications.

5G RedCap module

FG132-GL/NA

- High-performance 5G RedCap wireless module, designed specifically for IoT applications
- Dual-mode support for 5G RedCap and 4G LTE
- LGA form factor and compact size (32mm x 29mm x 2.4mm)
- Low latency and low power consumption for 5G
- Rich functionality interfaces to greatly expand application scenarios
- IoT industry reference designs and customer development support
- 3GPP Release 17 compliant
- For use in mid-level IoT applications including energy applications, industrial gateways, FWA terminals, and security monitoring.

LTE Cat 4 modules

NL668-EAU/EU/AM/LA/JP

- Cellular capability: 4G, 3G, 2G
- LTE Cat 4 module suitable for varied IoT applications
- Supports LTE TDD, LTE FDD, WCDMA, and GSM
- LCC + LGA, MiniPCIe and M.2 form factors available
- LTE wireless, and compact size (32mm x 29mm x 2.4mm)

LTE Cat 1 bis modules

L610-EU/LA/IN

- Cellular capability: 4G, 2G
- High performance LTE Cat 1 bis IoT module with ultra-high cost efficiency
- LCC + LGA form factor and compact size (31mm x 28mm x 2.35mm)
- Pin-to-pin compatible with LTE Cat 4 modules NL668 and L716, allowing maximum flexibility in migrating between different technologies at the lowest cost
- Supports a rich array of industry-standard interfaces and multiple IPs for seamless connectivity across a wide range of e-metering IoT use cases
- Highly suitable for use across a range of low- and mid-rate IoT scenarios

MC610-EU/LA/IN

- Cellular capability: 4G, 2G
- High performance LTE Cat 1 bis IoT module
- LCC + LGA form factor and compact size (24.2mm x 26.2mm x 2.1mm)
- Supports LTE, GSM dual-mode communication, as well as VoLTE, Audio, Recording, SMS and additional functions
- Includes universal interfaces such as USB/UART/SPI/I2C to meet demand across various IoT applications
- Highly suitable for use across a range of low- and mid-rate e-metering IoT scenarios

MG661-EU/LA

- Cellular Capability: 4G
- High-performance LTE Cat1 bis IoT module
- LCC + LGA form factor and compact size (17.7mm x 15.8mm x 2.4mm)
- Equipped with rich network protocols and integrated with multiple universal interfaces
- Supports a large variety of drivers and software functionalities, including mainstream operating systems like Windows, Android, Linux, to meet diverse application demands in the IoT industry.
- Positioned for the mid-to-low data rate IoT market for use in applications such as e-metering and industrial IoT

Cat M modules

MA510-GL

- Cellular capability: LTE-M 450MHz supported
- High-performance IoT module
- LCC + LGA form factor and compact size (22.2mm x 20.2mm x 2.1mm)
- Supports LTE Cat-M1/Cat-NB2/EGPRS, covering power classes 2 and 3
- Rich network protocol integrations such as MQTT/CoAP/LwM2M, and multiple standard industrial interfaces, including UART/USB/I2C/I2S
- Suitable for e-metering IoT applications with low power consumption, and for smaller smart infrastructure/grid devices

Building the Future of Smart Grid Technology with Fibocom

Today's advanced smart grid deployments are just the first steps in creating the energy infrastructure that will carry the industry forward for years to come. Fibocom, in collaboration with leading innovators in the IoT and smart meter industries, is proud to help shape that future. By providing high-speed communication modules, we support utility providers in achieving their efficiency, environmental, and service delivery goals. And in the process, to deliver on the promise of a smarter, more sustainable global energy future.