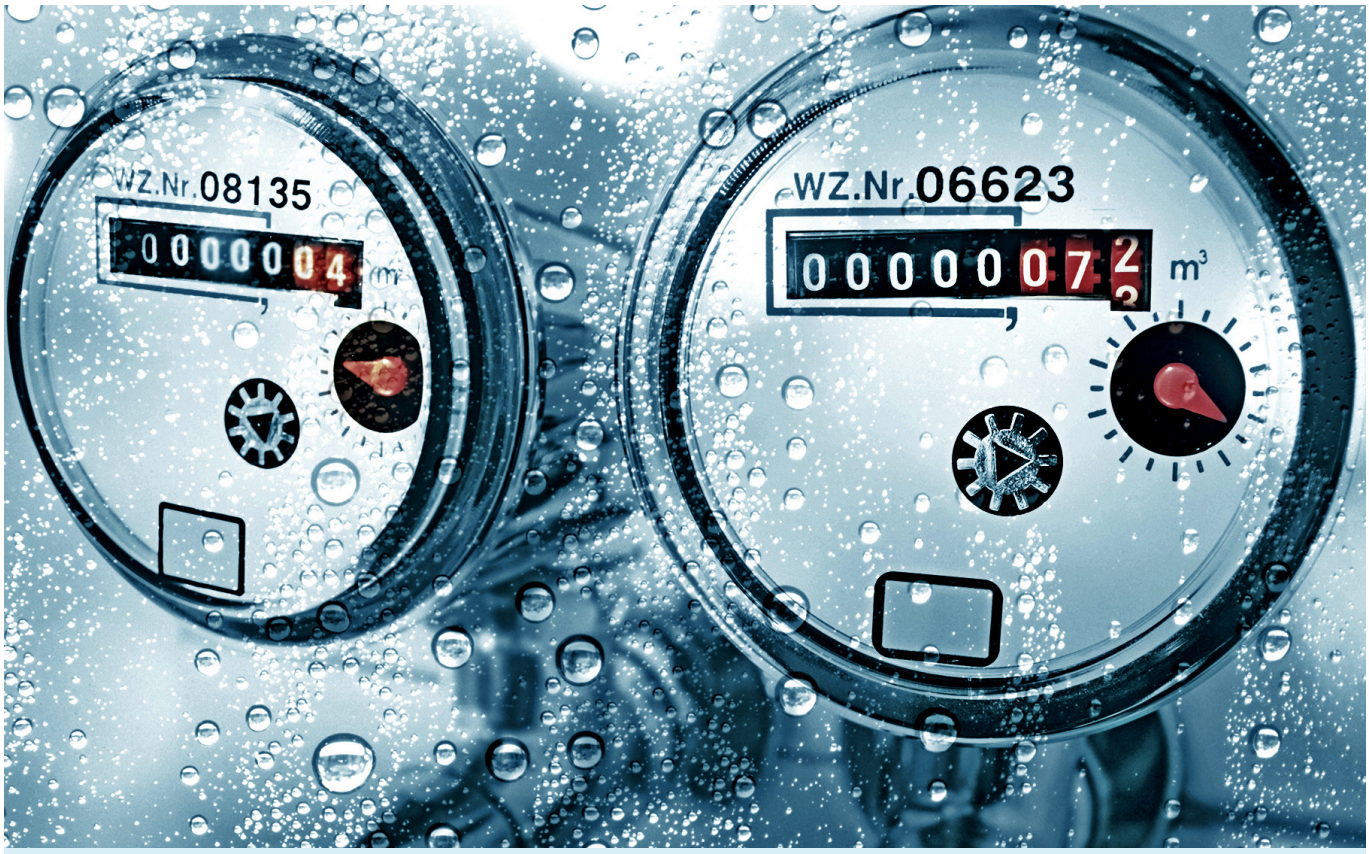

How eSIMs are securing paths to new revenues in smart metering

Smart metering of water, gas and electricity are to play a vital role in how utilities and energy grid players modernise, enhance sustainability and improve customer service. The key to achieving these outcomes boils down to timely, accurate and secure data to meet the demand for energy efficiently, write James Moar and Steffen Sorrell from Kaleido Intelligence

The energy industry is being transformed by the need to reduce environmental impact. According to the **IEA**[1], the energy sector contributed to 40% of global emissions in 2019. Concerns over the increasing levels of carbon emissions have driven political commitments globally to invest in more renewal sources and infrastructure that includes smart meters and opening more distributed energy generation as well as electrification of the transport sector. The global expansion of smart meters is driven partly by such regulations, due to the need to use data around power consumption and demand to better manage renewable energy sources.

Surprisingly, the biggest blocker in decarbonising the electric grid is the lack of connectivity and shared standards, not the lack of new renewable energy resources. The energy sector needs a secure, scalable way to identify the growing number of clean energy resources, verify attributes about them such as location, capabilities and financial relationships, and manage permissions and/or behaviours based on those attributes.

In many cases, this means expanding the Internet of Things (IoT) into many corners of the energy market for this efficient use of data. In the metering arena, ▶

1 IEA (2021), Greenhouse Gas Emissions from Energy: Overview, IEA, Paris
https://www.iea.org/reports/greenhouse-gas-emissions-from-energy-overview

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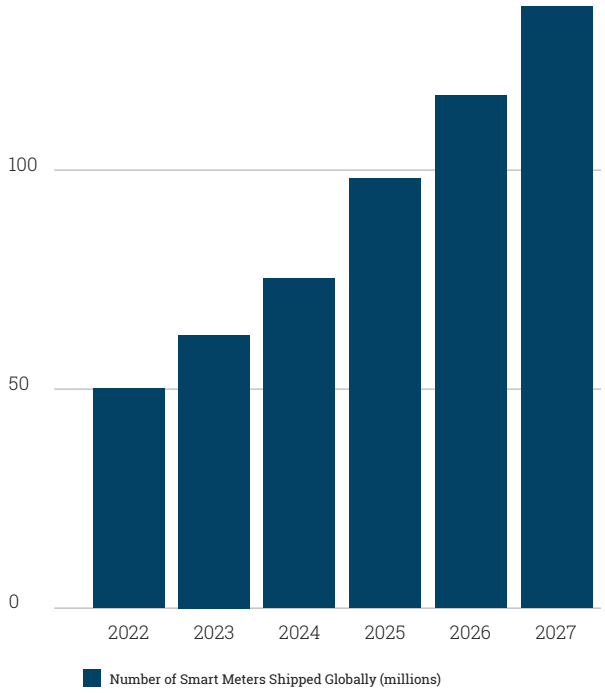
Global Smart Meter Shipments, 2002-2027
Source: Kaleido Intelligence



smart meters have emerged to provide this data to utility companies. While the utilities sector is no stranger to technology, the connectivity and data boom of recent years has the potential to provide reliable, real-time data, often in many contexts where this may not have been possible before. As more governments mandate the use of smart meters across the globe, we expect more than 136 million smart meters to be shipped in 2027.

At the core of a smart meter is the application that provides accurate readings of the energy consumed. This reporting can be real-time data and being able to reliably monitor energy usage allows a range of benefits. For utility companies, these devices bring the ability to re-distribute with demand, sending energy to where it is needed within the grid. The richness of meter data, and crucially its transmission helps electricity grids to avoid brown-outs, in which energy is constrained, as well as identification of fraud and wastage. In the water and gas industry, meter data is used to identify leakage and frauds to enable accurate charging.

Smart meters roll-outs are multi-year programmes with the metering device needing to serve long service lifespans of 10-15 years. Through this service lifespan, physical maintenance and updating of smart meters can also be costly, typically amounting to between US$70-100 for a call-out fee per meter. As a result, device manufacturers and grid operators need to embrace how best to choose connectivity, administer over-the-air updates and maximise data exchange – all of which can ease the challenges involved in maintaining and utilising smart meters. Further, there is a fine balance between provisioning solutions with enough capacity to meet the needs of increased data traffic in the future. A primary consideration hence becomes battery life, requiring a power-efficient mix of hardware, applications and network. embedded SIMs (eSIMs) are one technology being implemented to address all the above considerations and bring more of IoT's benefits to the utilities industry.

What is eSIM?

eSIMs are a form of SIM which do not take the form of a removable card, but an embedded chip that is soldered directly onto the device circuit board. Typically known as an embedded universal integrated circuit card (eUICC) in its hardware form, it also brings standards-based functionality to allow the subscriber profile to be changed via remote updates, without the need to change any physical component on the device.

Why eSIMs in smart metering?

eSIM technology is widely regarded as the next evolutionary step in smart meter cellular enablement. The removal of a physical SIM card brings the following operational features and benefits:

- **Remote provisioning and updates:** With eSIMs, smart meters can be deployed globally with ▶

ease without requiring local MNO SIM cards as the connectivity can be provisioned over-the-air at any point in the deployment. This means meter manufacturers need to maintain a single stock keeping unit (SKU) that streamlines production and reduces costs.

- **Profile changes:** eSIMs allow the remote manager to switch the meter's connection between mobile network operators (MNOs) as required, ensuring the longevity of the device regardless of the cellular or energy suppliers involved, as well as providing additional coverage where necessary to enhance connectivity reliability. The ability to update SIMs over-the-air means that physical access to the SIM is not needed to enable and manage the meter's connectivity.

- **Increased device reliability:** eSIMs do not need to be physically changed, removing the need for a SIM tray. This not only greatly reduces possibilities for tampering, but also helps to make the meter more durable by removing a source of possible ingress for dust or water where environmental conditions may demand so – for example in water meters. In other metering devices, eSIMs bring benefits to reduce corrosion and vibration. These combine to increase overall device reliability.

eSIMs can enhance smart metering deployments by providing that continuity of service, as well as simplifying deployments. The ability to change cellular profiles means that it is possible to manufacture a single line of meters for deployment anywhere in the world, and then configure them for local deployments after manufacture, typically when deployed. Should a given operator provide poor coverage or stop providing coverage for a given location, then the eSIM profile can be changed to another operator that does provide coverage there with ease, and no physical contact is required. The device can support multiple cellular technologies (2/3/4/5G/LTE-M), and being able to switch profiles means that the device can stay in operation for a longer time.

Accelerating scale with the rise of new connectivity

Remote SIM provisioning (RSP) enables late-stage personalisation – meaning smart meters can be shipped, on a mass market scale, directly to the installation locations, where the correct network profile can be downloaded over the air (OTA) upon connection to the GSMA Remote SIM Provisioning for M2M system. If a change of MNO is subsequently required, OTA remote provisioning can again be used to remove an existing profile and download a new network profile directly to the device. Smart metering manufacturers and utilities should look for a fully GSMA-accredited SAS platform like **Kigen**'s.

The dispersed and often inaccessible nature of smart meters once deployed means that energy efficiency is a critical consideration. The ability to switch from an international or roaming ▶

When metering data can be trusted and available in real-time, a whole range of new business models and opportunities are available for the smart metering ecosystem

connection to a local connection allows for more consistent use of power saving mode (PSM) and extended discontinuous reception (eDRX), which are often not included in roaming agreements. eSIMs can allow these modes to be deployed for LTE-M IoT devices much more readily than narrowband IoT (NB-IoT), which cannot utilise eSIMs without modification, and thus relies on roaming capabilities.

This has implications for power consumption, as only 25% of NB-IoT roaming agreements tracked by **Kaleido Intelligence** support either PSM or eDRX modes of operation. Therefore, being able to switch to a local profile through an LTE-M smart meter can bring power savings over NB-IoT in the long run, where devices are not needed to be continuously connected. This can be taken even further if the eSIM is replaced with an integrated eSIM (iSIM), and made part of the overall chipset rather than being its own standalone silicon requiring additional power from the board.

Where low bandwidth is an issue there are some challenges in NB-IoT limitations, but this is actively being progressed through the work of WG7 (GSMA Working Group 7) development to enhance eUICC accessibility and reduce pain points. In particular, the upcoming SGP.32 specification from WG7 is looking into removing the dependence of the standard on SMS, which NB-IoT requires custom adaptations to support. This will allow eSIMs for NB-IoT, already a key technology in smart metering. In addition, the SGP.32 can make switching between eSIM providers simpler, making multi-stakeholder deployments easier to manage and reducing dependence on a single RSP provider. This is vital in the smart metering space to ensure meters spread over large areas can be connected, which a single network partner may not be enough for. The ability to switch providers will in turn reduce the need for fallback technologies to be built into the devices, a common feature of low power wide area network (LPWAN) connectivity to date.

Use of eSIM in smart meters also provides strong benefits for the end-user of the smart meter as well, as profiles can easily be switched when changing energy suppliers, avoiding the need for hardware changes and removing another cause of vendor lock-in for consumers as well.

Beyond connectivity

As we discussed earlier, ultimately connectivity and eSIMs are a means towards the outcome to reduce wastage of resources whose societal value is becoming ever more important. Data thus transmitted from the smart metering devices need to be secure at source, in-flight and for use by applications beyond the point-to-point, single- ▶

player or individual systems. To unlock the full potential of data it needs to be authenticated and uniquely identifiable. This opens up a broader set of IoT assets – particularly those generating and also transmitting renewable energy back to the grid. Such value-add from data is only possible if the reporting instruments in the network are fully trusted.

This is another benefit for eSIMs and iSIMs: eSIMs offer tamper-proof, robust security that can be leveraged in other portions of the device, most particularly in the form of a root of trust for secure device identity management. The GSMA IoT SAFE standard is one such way of ensuring that continuity. In addition, because it relies purely on the SIM itself and public-private key cryptography, IoT SAFE's security layer adds minimal data overhead for the transmissions.

Typically such authentication has involved a high degree of custom or proprietary approaches which are not suitable for all IoT devices; Increasingly, security by design is becoming something of a mantra for IoT. However, proprietary design solutions to security problems may impede connectivity, so using the eSIM as a root of trust is a strong and scalable alternative to bespoke processes. This can then provide end-to-end encryption and security of smart metering transmissions. Making use of a technology standard such as IoT SAFE for the identity of smart meters and other connected assets within the grid is a vital verification tool to allow trusted and scalable use of these technologies, and simplifies device management.

When metering data can be trusted and available in real-time, a whole range of new business models and opportunities are available for the smart metering ecosystem. The recent partnership between Kigen, **KORE** and **Energy Web** is a strong example of this kind of a model – Kigen innovated with its eSIM operating system to use the eSIM's root of trust with an on-board secure key generation coupled with the IoT SAFE approach as part of its OPEN IoT SAFE initiative, which combines IoT SAFE with the **IETF**'s Enrolment over Secure Transport publication. Supported by the widely used transport layer security (TLS) stacks across all embedded, auto and Linux class devices, this solution brings the best practices from the internet and combines with Energy Web's crypto token to enable global connections via KORE's networks.

IoT SAFE forms the basis of the system, but several use cases will need to be additional features on top of the specification's provisions. IoT transactions that have financial implications particularly need advanced forms of security. In the case of the Kigen-KORE-Energy Web partnership, the tokens and associated meter readings are then registered ▶

on the blockchain by Energy Web to provide a mechanism to track renewable energy credits registered to the electricity grid. In bringing this capability to other verticals, eSIM users should still be aware of the data security requirements of any particular industry, which may require additional security features to those provided by IoT SAFE. However, with mechanisms similar to OPEN IoT SAFE, these can be added with minimal disruption to the overall transaction process.

The ability to secure and individually identify energy transactions can also enable new business models through the data provision process. For utilities, real-time monitoring of supply and demand can enable dynamic pricing, giving end users the truest possible picture of the cost of their energy. This can both save users money based on the price of energy usage at the time, and enable the incentivisation of energy usage when the grid is at its greenest. On the supply side, Energy Web's blockchain system allows the supply of green energy to be treated as a financial asset, making the supply of green energy something that energy suppliers can bid for, increasing competition and the amount of green energy supplied to the grid.

eSIMs can also help save utility companies money earlier on in the value chain. The ability to produce a single product and localise it in the field via eSIM ▶

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can bring large efficiency gains on its own, but these are magnified with the use of an iSIM. Without the need for a separate component from the main system-on-a-chip (SoC), iSIMs can save metering companies on material costs of manufacture, as well as consuming less power than a standalone eSIM chip. This makes iSIMs particularly attractive for longer-term deployments, but in the short term will require the metering company to determine its connectivity relationships earlier in the device design and deployment cycle. However, the involvement of connectivity management in the overall device design process should be a priority in any case, as the data is valuable in many ways to both the meter manufacturer and the energy supplier.

Conclusion

eSIMs can provide a large number of benefits to the smart metering industry, bringing operational efficiencies to the energy grid, as well as giving utility companies and meter providers the tools they need to simplify both service provisioning and meter roll-out. However, the nature of smart meter deployments presents challenges that will require a change in many business models, which providers need to be prepared for to make the best use of this technology.

This is particularly important with future-proofing and the longevity expectations of the utilities industry. The need to have meters in the field for more than ten years presents a challenge for long-term connectivity and lifecycle management, with many companies struggling with the business models required for such long-term deployments. eSIMs can simplify this by allowing the connectivity and any attendant data provision to be offered on an as-a-service basis. This simplifies the inclusion of any additional data requirements, as with Energy Web's use of blockchain to record energy usage, because connectivity can be part of a more flexible form of service provision without affecting the overall deployment.