GSMA

IoT and Essential Utility Services:
Nepal market case study

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Introduction

GSMA Intelligence forecasts that smart utilities Internet of Things (IoT) connections will total 3.5 billion globally by 2030, up from 1.7 billion in 2021. Growth will be particularly strong in low- and middle-income countries (LMICs), where many companies are still in the early stages of their IoT journeys. In Sub-Saharan Africa, for example, smart utilities connections will increase almost six-fold between 2021 and 2030, reaching 152 million. By 2030, utility solutions will account for nearly 30% of IoT connections in the region.

Mobile-enabled digital solutions are uniquely placed to address the challenges facing utility sectors, including water shortages, lack of sanitation, unreliable power and insufficient waste management. IoT is pivotal to many digital solutions, often working in tandem with other mobile technologies.

This case study is one of five detailed market case studies examining IoT deployments in 17 key use cases across five verticals: energy, water, transport, sanitation and waste management. It also examines broader market conditions and enablers of IoT solutions.

This case study is a stand-alone document, but can also be read alongside two recent GSMA reports on IoT deployments:

— *IoT for Development: Use Cases Delivering Impact* – this report provides a more detailed discussion of the solution architecture for IoT, data on the connectivity options in 62 LMIC markets in Sub-Saharan Africa and South and Southeast Asia, and discusses use cases across the climate, health, agriculture and humanitarian sectors.

— *IoT and Essential Utility Services: Opportunities in Emerging Markets* – this report summarises the IoT opportunity across the the utilities sectors and draws together lessons from the five market case studies.

The 17 IoT use cases we examined are in no way an exhaustive list, but were selected as the use cases most likely to be implemented in the five markets we reviewed, and have significant benefits for utility providers and customers. Annex 1 provides additional details on the use cases and key benefits that can be expected from IoT deployments.

This case study begins by discussing the national context and trends across use cases before turning to discuss the sector verticals and key IoT deployments identified within them.

Market context

Figure 1

Key data on Nepal's mobile market

Nepal	
Mobile penetration[a]	68%
Mobile internet penetration[b]	44%
Smartphone adoption[c]	57%
Made or received a digital payment	29%
GSMA Mobile Connectivity Index (MCI) score (out of 100)[d]	50
LPWANs:	None launched

Notes on indicators: a) defined as unique mobile subscribers as a percentage of the population, b) defined as unique mobile internet subscribers as a percentage of the population, c) percentage of connections, d) the GSMA Mobile Connectivity Index measures the performance of 170 countries – representing 99% of the global population – against key enablers of mobile internet adoption: infrastructure, affordability, consumer readiness and content and services. More details can be found at: mobileconnectivityindex.com.

Source: GSMA Intelligence for all indicators except "made or received digital payment", which is from the World Bank's Findex Database 2021. Data accurate as of December 2022.

There is an increasing push to accelerate digitisation in Nepal. This is led by government policy, including the adoption of IoT technologies across the utility sectors. Key ministries are publishing strategies and frameworks to guide digital adoption. Examples include:

— The Digital Nepal Framework (DNF), which outlines the Government of Nepal's approach to supporting the advancement of ICT across different industries, including the utility sectors. It presents several ideas on how IoT can be used to expand access and drive efficiencies.

— The Nepal Electricity Authority (NEA) recently unveiled their Digital NEA strategy, which outlines a plan to deploy smart grid and smart meter technologies.

— "Innovation and Technology Adaptation" is one of the key pillars of the Ministry of Water Supply and Sanitation (MWoSS) Development Plan 2016–2030, which spells out the investments needed to deliver clean water and sanitation for all.

For these policies to reach their potential, Nepal will need to make progress on many of the dimensions important to IoT deployments. There are no low-power wide area networks (LPWANs)[1] in the country, and one in five people still live in areas without 4G coverage. Furthermore, mobile operator strategies are still largely geared towards the consumer segment and smartphone-based services. Important players also have a small presence in the IoT ecosystem, such as system integrators and local hardware providers, which

means IoT start-ups must either take on these responsibilities themselves or form partnerships with international companies. Nepal's mobile penetration (68%) is relatively high compared to regional and income group peers, which gives innovators developing IoT solutions the opportunity to use technology that works with SMS or USSD.

Deployments across use cases

Our research found evidence of IoT deployment across Nepal's utility sectors. While most projects are still in early stages, there are plans to scale up deployments in several areas over the next few years. The development sector, in particular the Asian Development Bank (ADB), has been key to accelerating the use of IoT. There is also a growing number of start-ups and other private sector companies accelerating IoT adoption in Nepal.

However, there are still challenges to be resolved, particularly the procurement of affordable hardware. The lack of LPWANs is a clear barrier to IoT deployments in some areas (e.g. smart water metering), while connectivity needs to be enhanced to support drone applications. There is also more work to do on the policy side, an area where Nepal lags other countries. For example, IoT deployments in Nepal have been delayed because the Nepal Telecommunications Authority (the regulator) is still working on their numbering plan.[2]

1. For a detailed discussion of network specifications and their attributes, see: GSMA. (2023). *IoT for Development: Use Cases Delivering Impact*.
2. Nepali Telecom. (2022). "NTA Allows M2M SIM Cards for CAAN and DHM".

Figure 2

Heatmap of IoT in Nepal's utilities sectors

	Focus areas			
Energy	Smart metering	Smart grids	Microgrids	PAYG cooking
Water	Smart metering	Water ATMs	Water treatment	Supply network monitoring
Sanitation	Wastewater monitoring	Smart toilets	Pit fill level monitoring	-
Waste management	Smart bins	Smart recycling	-	-
Transport	Smart public transport systems	Electric vehicles (EVs)	Asset tracking	Drones for deliveries

NASCENT — INTERMEDIATE — ADVANCED

Factors assessed	Number of deployments, suitability of connectivity options, hardware avaibility, number of solutions provider, funding requirements

Source: Authors' assessment based on market research and interviews with key actors

Energy

The adoption of IoT in Nepal's energy sector is driven by the NEA, the state-owned utility company that provides electricity to around 4.8 million homes. The NEA is working closely with the ADB to modernise Nepal's electricity grid and tackle problems such as inadequate power generation and poor distribution and transmission infrastructure. The NEA's initial foray into IoT has focused on collecting real-time information from end consumers by deploying smart meters. This will be supported by solutions that combine IoT connectivity and GIS software to track poles, transformers, cables and household connections. This will help engineers gather actual data on the location and performance of NEA assets to support load management and develop future smart grid applications (e.g. distributed energy resource management).

However, scaling smart meter deployments presents a funding challenge. The ADB has estimated it will cost $500 million to deploy five million smart meters in Nepal. Hardware represents a major part of this expenditure. While some countries have used this as an opportunity to create jobs and scale local production,[3] Nepal lacks manufacturing facilities and has been using smart metering equipment manufactured in China by Yantai Dongfang Wisdom Electric Company. These hardware issues pose similar problems for the use of smart meters within microgrid deployments, which are found across rural and mountainous areas where it is challenging to extend the national grid.[4] Further complications may arise from the NEA's plan to license radio frequencies as part of their smart meter deployments.[5] Nepal is an outlier among the case study countries in this regard. Energy utilities in other countries have partnered with connectivity providers that can manage mobile networks and provide services such as SIM management for smart meter deployments, areas where most utilities lack experience.

Spotlight 1
IoT deployments in Nepal's energy sector

Smart meters: Around 100,000 smart meter installations in the Ratnapark and Maharajgunj Distribution Centers have been completed and the NEA reports that results are very encouraging.[6] Deployments have also begun in other parts of Kathmandu Valley, with plans to scale deployments in the capital over the next few years.

Microgrids: Solar microgrid provider Gham Power partnered with Ncell to deploy smart meter technology in homes in two rural villages of eastern Nepal. As part of this project, mobile money was integrated for bill payment with eSewa's digital wallet, which helped to reduce Gham Power's operational costs and improve the viability of solar microgrids.[7]

Clean cooking: ATEC sells their IoT-enabled eCook induction stove in Nepal via distributors. By fitting the stove with a SIM card, ATEC can show users real-time information on electricity usage, payment status and carbon offset data. Moreover, it allows ATEC to use a PAYG model whereby the stove locks if the user does not keep up with payments. This opens induction stoves to a much wider market, reducing the use of polluting and unsafe fuels while also supporting the Government of Nepal's "Electric Stove in Every House" programme.[8]

3. TechEconomy.ng. (18 July 2022). "Mojec Using Smart Metering Technology to Solve Nigeria's Power Problems".
4. According to the World Bank, 90% of Nepal's population has access to electricity, with the NEA aiming to achieve universal electricity access by 2024.
5. Nepali Telecom. (2 October 2022). "NEA to Get Frequency for Smart Meters, Rs 1.20 Crore Per MHz".
6. Nepal Electricity Authority. (2022). *Annual Report 2021/2022*.
7. Bhattarai, B. (2020). "Gham Power lessons learned from the rural electrification micro grid project in Nepal". *GSMA Mobile for Development Blog*.
8. Around two thirds of households in Nepal still use solid biomass fuels such as firewood, dung cakes and agricultural residue for cooking

Water

In Nepal, non-revenue water (NRW) is more than 40% on average in urban areas, according to government figures. The national Water Supply, Sanitation and Hygiene Sector Development Plan to 2030 has set a target of less than 25% NRW by 2030. IoT technologies are beginning to play a role in network monitoring and control, as demonstrated by the use of supervisory control and data acquisition (SCADA) software in the Melamchi Tunnel construction. However, smart water meters have yet to be installed in households. The absence of LPWANs in Nepal is one reason for this. Without low-power networks, smart meter batteries need to be replaced sooner, undermining the business case. Cellular M2M networks in Nepal are also unlikely to be able to provide the propagation and coverage required to connect meters. As in other countries, hardware costs are also an obstacle.

Spotlight 2

Monitoring Kathmandu's major pipelines with IoT

The Ministry of Water Supply and Sanitation (MWoSS) is working with the ADB to improve access to clean water. Part of their work involved constructing the 27 kilometre Melamchi Tunnel, which can supply Kathmandu with 170 million litres of water per day. The construction was the first effort in Kathmandu to use SCADA software, which collects data from local sensors and other IoT devices installed in the tunnel to enable remote monitoring and control. This will help to identify leaks and other issues that will accelerate repairs and reduce NRW.

IoT start-ups also have a role in helping water providers meet their NRW targets. This segment of the market remains underdeveloped in Nepal, but there are signs this is changing with the support of donor funding. For example, Diyalo, a grantee of the GSMA Innovation Fund for Digital Urban Services, is working with Tokha Brihat Drinking Water and Sanitation User Committee to reduce water leakages by automating water production using IoT technology and water sensors at water pump sites. The deployment is supported by Gham Power, a previous Innovation Fund grantee, highlighting the virtuous circle of grant funding when allocated efficiently.

Sanitation

Our research indicates that IoT adoption in Nepal's utilities sectors is lowest in the sanitation sector. The only IoT deployment identified was a small number of smart toilets in Kathmandu. There is a more pressing need for smart sanitation services in rural areas of Nepal, where open defection rates are higher. However, lower incomes in rural areas mean it would likely be more difficult to fund the maintenance of toilets by charging people to use the service – the model used in Kathmandu. Other funding models are therefore required to scale IoT solutions.

Wastewater management is also a major issue in Nepal since much of the wastewater is disposed of without treatment. Kathmandu Valley is the only municipality that has a properly functioning wastewater treatment system, albeit with significant capacity constraints. Elsewhere, municipalities rely heavily on decentralised wastewater treatment. While IoT is absent from these systems, a range of other innovative approaches are used to support community-based solutions in Nepal.[9,10]

Spotlight 3

Affordable smart toilets in Kathmandu

Aerosan Toilets is a donor-led initiative involving experts from Canada and Nepal that has constructed seven toilets in Kathmandu containing sensors to automate flushing and cleaning, thereby improving cleanliness and reducing maintenance. The solution services 1,500 to 2000 customers per day who are charged Rs 15 ($ 0.10) to use the facility.

9. ENPHO. (2021). "DEWATS in Nepal".
10. Shrestha, K. (2008). *Decentralised wastewater management using constructed wetlands in Nepal*. WaterAid.

Waste management

The use of IoT for waste management in Nepal has largely been centred in Kathmandu where rapidly urban growth and scarce public resources has made it increasingly challenging to meet growing demand for waste collection. Municipalities have experimented with smart bins, but functionality was limited to monitoring temperature and air pollution levels. The bins therefore proved ineffective in reducing the one-third of waste that is currently being burnt at home or discarded on the streets.[11] To have a greater impact, smart waste management solutions require a more holistic approach, combining data from vehicle trackers with fill level sensors on waste bins to improve the efficiency of waste collection. These solutions are more complicated to deploy and require greater investment than current smart bin installations in Nepal, which are constrained by budgets and the absence of local smart waste solution providers. Mobile apps and digital platforms are likely to play a more important role in improving citizen engagement in waste collection and segregation in the next few years (e.g. Blue Waste to Value, Doko Recyclers and Khaalisi.com). These solutions, which are cheaper and simpler to implement, are gaining traction.

Spotlight 4

Smart bins and illegal waste dumping

Smart bins: In 2019, Kathmandu Metropolitan City (KMC) installed 60 smart bins that cost Rs 600,000 each (around $5,000). The dustbins had solar-powered displays containing sensors to provide information on temperature and air pollution levels, as well as USB charging slots. However, the deployment was criticised by some residents who said the bins were rarely used because most people did not know what they were.[12]

Waste collection: Nepal Waste Map is a data collection system that relies on Open Street Map (OSM) trackers and user-inputted data to visualise waste collection routes and illegal waste dumping. The project is supported by the UK Foreign, Commonwealth & Development Office (FCDO), The Asia Foundation and Development Initiatives.

Transport

The use of IoT solutions in Nepal's transport sector has mostly centred on the use of drones for deliveries. This is largely driven by the challenges of transporting goods on the ground in Nepal, where 80% of the population lives in rural areas and there are large mountainous regions. The drone market in Nepal is heavily reliant on donor funding, which is driving strong interest in the use of drones for medical deliveries. While connectivity can be a barrier to drone deployments, progress is being made in other areas, such as building technical expertise and developing specialised hardware, including by local companies such as Prokura Innovations.

Compared with drones, there is much more limited activity in Nepal with other IoT applications that can improve the delivery of goods, such as asset tracking. Global manufacturers of asset tracking devices remain absent from the country due to a lack of channel partners to sell their solutions. This should begin to change, however, as there are signs that mobile operators are starting to develop their IoT strategies. For example, Ncell recently launched a fleet management solution. Asset tracking has similar connectivity requirements and is likely to be another early use case for Nepalese operators, with existing networks capable of supporting these applications.

Looking ahead, there is likely to be interest in Nepal in other transport-related IoT applications, such as EV charging stations, which form an important part of the government's plans to meet net-zero targets.[13] There are also plans to invest in improved public transport systems, including a new metro rail service and electric buses, which creates opportunities to use IoT and other digital technologies to improve the integration of different transport modes.

11. World Health Organization and Kathmandu University. (2020). Technical Report on Health Impacts and Economic Analysis of Air Pollution in Kathmandu Valley.
12. Ojha, A. (28 June 2019). "Kathmandu Metropolitan City spent millions on smart dustbins. No one is using them.". *Kathmandu Post*.
13. Onlinekhabar. (30 August 2022). "NEA launches drive to open 51 charging stations across Nepal from Kathmandu".

Spotlight 3

Drone delivery of mdeical supplies by WeRobotics and Nepal Flying Labs

On average, it takes six to eight hours to travel between a hospital and healthcare facility in rural Nepal. This leads to shortages of essential medicines and explains why it can take so long to test patients for diseases like tuberculosis (TB) since patient samples can only be tested at diagnostic labs in major cities.

In response, WeRobotics and Nepal Flying Labs teamed up to deploy a drone solution that would deliver test samples between Pyuthan Regional Hospital and Bhingri Public Health Center. This involved repurposing an industrial DJI Matrice 600 drone to create a medical cargo drone. The M600 costs around $5,000, whereas drones from specialist cargo drone start-ups can cost between $40,000 and $75,000.[14]

Due to connectivity challenges, WeRobotics and Nepal Flying Labs had to build a custom wireless network in the 2.4 GHz band to support their drone solution, an additional expenditure. This reflects the challenges around latency and network availability in Nepal. Still, the trial proved successful, significantly reducing travel times and setting up the companies for a wider deployment.

Drone-assisted sputum sample collection is now operational in eight of 12 health posts in the Pyuthan and Sworgadwari municipalities of the Pyuthan district. To date, more than 150 drone flights have been carried out, delivering more than 1,000 sputum samples from remote health facilities to regional hospitals for rapid testing.

14. WeRobotics. (11 September 2019). "WeRobotics now offers cargo drone solutions".

Annex 1: Use cases considered in the research

Sector	Use case	Description	Benefits	Device(s)
Energy	Smart metering	• Accurately records and automatically transmits energy usage data in real time	• No longer need to send staff to customers' premises to read their meter or rely on customers to report the meter reading themselves • Allows utilities to introduce time-based tariffs to manage demand • Allows for alternative energy planning and modelling • Allows for cost savings, energy theft monitoring, etc.	Meters
	Smart grid	• Tracks the distribution network in real time, providing measurements of voltage sags, swells, interrupt information and other metrics	• Enables energy companies to redirect resources when demand on the grid is increasing • Find and resolve faults more quickly, improving the customer experience • Reduced risk of fines from service level agreement (SLA) breaches	Sensors (e.g. current, voltage)
	Microgrids	• Sensors embedded on solar photovoltaic (PV) installations (e.g. a microgrid run by a smallholder or large-scale solar farm) to monitor production and distribution	• Avoids fossil fuel-derived emissions (mostly coal) • Optimises power consumption at residential and industrial premises by using stored energy (rather than relying on the grid)	Meters, sensors (e.g. current, voltage)
	PAYG cooking and SHS	• IoT-enabled devices include connected LPG cylinders and electromagnetic induction stoves • Solutions collect usage data and relay information to users (e.g. reminders to charge battery, make payments)	• Make services more affordable for poor consumers because they can make micropayments • Enables credit scoring for unbanked users • More effective revenue collection for service providers	Meters, sensors (e.g. temperature), GPS

Sector	Use case	Description	Benefits	Device(s)
Water	Smart metering	◦ Accurately records and automatically transmits water usage data in real time	◦ Lower staff costs and improved reading accuracy ◦ Leaks are easier to identify and fix, enabling utilities to reduce their NRW costs ◦ Introduce new services (e.g. a PAYG option for lower income customers) ◦ Provides visibility into water contamination and pH levels	Meters
	Water ATMs	◦ ATMs automatically dispense water for which customers prepay ◦ ATMs are IoT-enabled, allowing real-time monitoring	◦ Provides visibility into the volume of water dispersed and number of users ◦ Measures leakage and water quality ◦ Some solutions combine water ATMs with a water treatment solution for purifying water	Meters, connected water purifiers, pH sensors
	Water treatment	◦ Tracks filter usage to ensure filters are replaced on time to avoid contaminants entering the system ◦ Measures the chemical properties of downstream water	◦ Helps to prevent compliance issues by keeping alkalization of water within permissible levels and avoiding potential health risks ◦ Reduces system downtime and maintenance	Connected water purifiers, pH sensors, oxidation reduction potential (ORP) sensors
	Supply network monitoring	◦ Monitors water pressure and flow in pipes to detect leaks and predict bursts ◦ Measures the temperature of the output of the safety valve, which falls rapidly before leakage occurs	◦ Enables the early detection of faults to avoid unscheduled shutdown and maintenance ◦ Improves uptime of water pipe network	Water flow meter, sensors (pressure, temperature)
Sanitation	Wastewater monitoring	◦ Placing sensors in sewer lines and waterways to monitor the flow of sewage, breakage and leakage	◦ Improves understanding of pathogen levels in rivers ◦ Improves understanding of sewage value for upcycling	Sewer level monitoring sensor, acoustic sensor, camera
	Smart toilets	◦ Provides insights into public toilet usage and cleanliness	◦ Automates toilet cleaner, reducing maintenance needs	Ambient monitoring sensor, motion sensors
	Pit fill level monitoring	◦ Use of IoT devices to monitor and send alerts on fill levels and overflows ◦ Can be combined with real-time tracking of service vehicles	◦ Ensures safer and more efficient disposal of faecal sludge for a cleaner and healthier city	Fill level sensor, vehicle tracker

Sector	Use case	Description	Benefits	Device(s)
Waste management	Smart bins	◦ Enables the location and fill level of waste containers to be monitored remotely ◦ Often combined with real-time tracking of service vehicles	◦ When a waste container is almost full, an alert is set to arrange a pickup even before the pre-scheduled time ◦ Understanding the geography of emptying patterns helps to forecast future needs	Trackers (container, vehicle, workforce), fill level sensor, temperature sensor
	Smart recycling	◦ IoT devices can be used to weigh recyclable waste ◦ More sophisticated machinery can be used to automate waste segregation	◦ Increases recycling rates ◦ Reduces open degradation of organic waste (and the growth of microorganisms)	Scales, sensors (e.g. ultrasonic, colour), servomotor
Transport	Smart public transport	◦ Real-time tracking of public transport vehicles allows transport operators and commuters to see where vehicles are ◦ Transport operators can receive additional data on how vehicles are driven	◦ Passengers benefit from a more predictable and reliable public transport service ◦ Enriches the quality of long-term public transport and urban planning ◦ Onboard cameras can improve driver and rider safety	Vehicle tracker, CCTV cameras
	EVs	◦ Sensors on EVs to monitor fuel consumption and routing ◦ EV charging point sensors provide location beacons for passing EVs	◦ CO2 savings from substituting fossil fuels for electricity and embedding sensors in EVs ◦ Charging point sensors avoid wasted emissions from searching for a charging point	Charging point sensors, EV sensors
	Asset tracking	◦ IoT devices can be attached to shipping containers, trailers, pallets and even individual packages to monitor transportation	◦ Reduces lost items ◦ Helps companies ensure their products are being transported under the right conditions	Trackers and sensors (e.g. temperature, humidity, moisture)
	Drones for deliveries	◦ Drones can be used to deliver items (e.g. medical supplies) from one location to another	◦ Provides a more environmentally friendly and efficient delivery service (in certain conditions) compared with traditional methods	Light detection and ranging (LiDAR) sensors, GPS/ GNSS, gyroscopes, accelerometers

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