

Closing the last mile connectivity gap in India's Smart Metering Roll Out

A LoRaWAN® approach for remote and connectivity challenged deployments



Executive summary

India's smart metering program is rapidly expanding under RDSS, but achieving meter installation targets alone is not sufficient.

A significant last-mile connectivity challenge persists in remote villages, hilly terrain, forested regions, low-density feeder networks, and difficult-to-access meter locations where conventional communication technologies often struggle to provide reliable coverage.

Existing connectivity options such as NB-IoT, RF Mesh, PLC, and cellular networks each have proven strengths but also face limitations in sparsely populated and geographically challenging areas. These limitations include dependency on telecom coverage, higher recurring operating costs, infrastructure density requirements, and reduced reliability in difficult terrain, resulting in connectivity gaps, SLA challenges, and increased operational costs for DISCOMs and AMISPs.

LoRaWAN® offers a complementary connectivity layer designed specifically for long-range, low-power, low-bandwidth applications. Operating on unlicensed spectrum and requiring only a limited number of gateways, LoRaWAN® can extend AMI coverage into areas where traditional technologies are either unavailable or economically unviable. Its utility-controlled deployment model, low recurring costs, and ability to support large geographic coverage make it particularly well suited for rural and low-density smart metering deployments.

LoRaWAN® can serve as a complementary connectivity layer for residual coverage-gap areas, particularly in remote and low-density deployments.



A techno-commercial approach that selects connectivity based on geography, meter density, infrastructure availability, and lifecycle economics can help utilities maximise connectivity, improve operational efficiency, and accelerate rural digital inclusion while ensuring cost-effective smart metering deployment at scale.

The problem: A widening last-mile gap

India's AMI rollout is the largest in the world by volume, but installation and connection are not the same thing. As deployment pushes into remote villages and hill terrain, the technologies that work in dense clusters are stalling at the last mile, concentrated in exactly the circles where revenue loss is highest.



150M/250M

Meters installed against the national RDSS target

Source: Earth Energy Log, “India Smart Meter Rollout 2026: 250 Million Target Milestone Tracking,” June 2026



~80,000

Meters installed per day at current pace, target 100,000/day

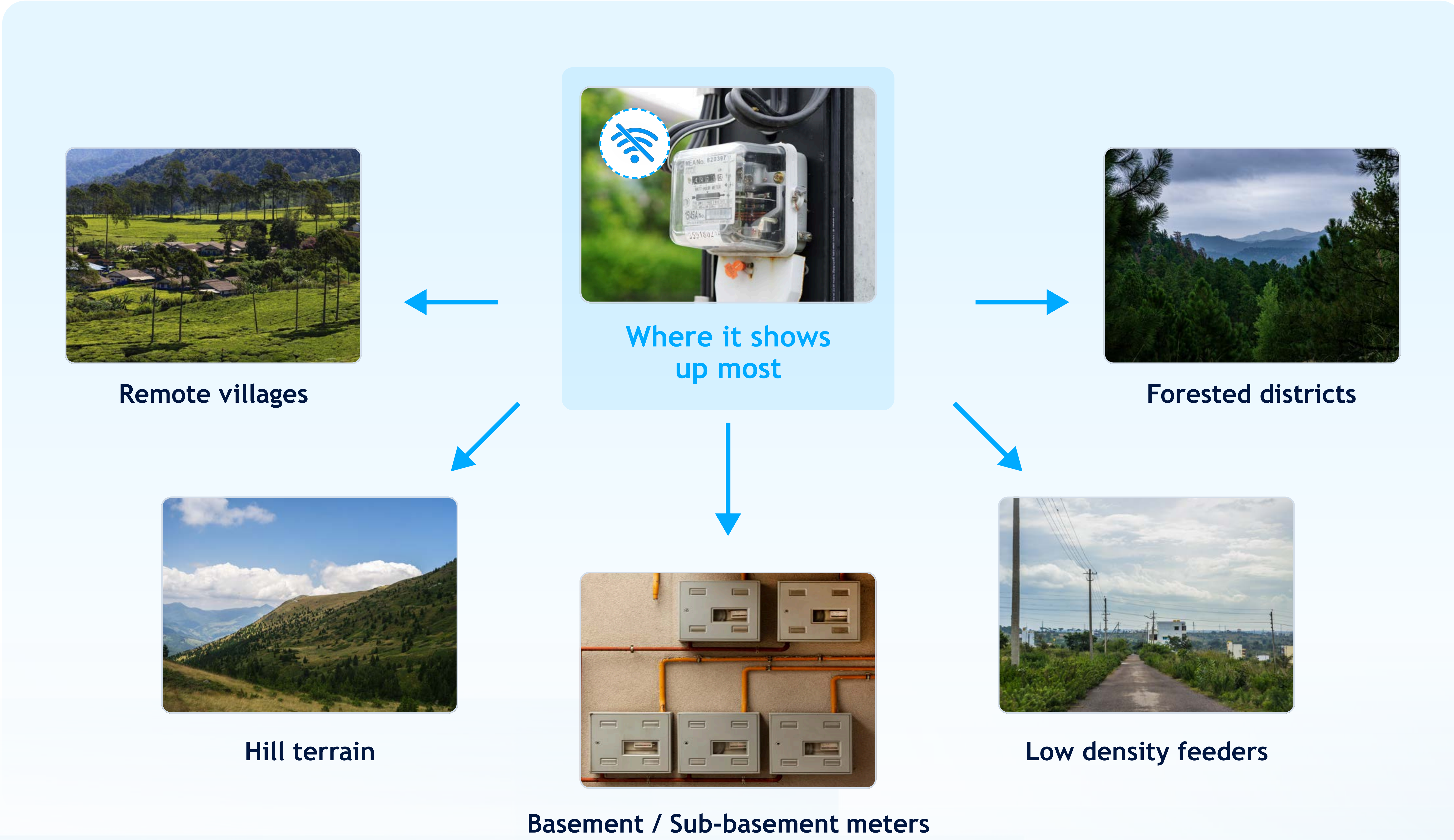
Source: Power Line Magazine, “Powering Ahead: Smart Metering Progress under the RDSS,” April 2025



8-10 years

Typical AMISP contract life over which a bad connectivity choice compounds

Source: Probus, “Smart Metering Rollout Under RDSS: What Every DISCOM Needs to Know in 2026,” March 2026



NB-IoT deployment considerations across different environments

Deployment considerations for RF Mesh in low-density areas



Coverage dependency: Relies on telecom network availability, which remains limited in many rural and hilly regions and is outside DISCOM/AMISP control.



Recurring cost: Each meter incurs ongoing SIM data charges throughout the 8-10 year contract period, creating a significant long-term OPEX burden.



Third-party ownership: Connectivity infrastructure is owned by telecom operators, reducing the utility's ability to drive coverage expansion where needed.



Density dependent: Requires enough nearby meters for reliable hop-by-hop communication; performance drops in sparse rural areas.



Higher rural deployment cost: More infrastructure is needed per connected meter as density decreases, reducing cost efficiency.



Terrain limitations: Coverage and reliability can be affected by hills, obstructions, and complex building layouts.

Deployment conditions can influence connectivity coverage and implementation across remote and low-density environments: A subset of meters – often concentrated in the DISCOM's hardest-to-serve and highest-loss circles – remain unconnected or unreliably connected long after installation, creating SLA shortfalls, manual meter-reading fallback costs, and disputes between DISCOMs and AMISPs.

Why LoRaWAN® fits the remaining gap

LoRaWAN® is designed to support connectivity needs across remote, geographically dispersed and low-density deployment environments: Long-range, low-bandwidth, battery-powered telemetry over unlicensed spectrum, using a gateway-based architecture suited to long-range, low-bandwidth, battery-powered telemetry over unlicensed spectrum.



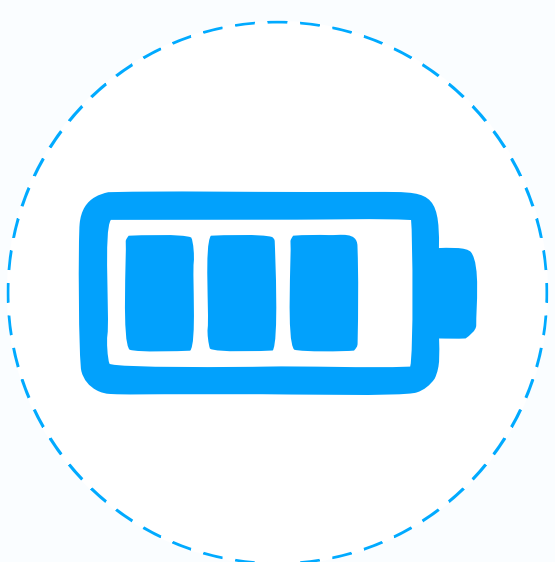
Long range

Typical LoRaWAN® coverage can range from several kilometres to 10-15 km or more under favourable rural line-of-sight conditions. A single, well-sited gateway – particularly one placed on elevated ground – covers an entire sparse rural feeder that would need dozens of RF mesh relay points.



Low recurring cost

LoRaWAN® operates in unlicensed spectrum, which means there is no per-SIM, per-meter data charge which leads to potentially lower lifecycle connectivity costs in suitable deployments.



Multi-year battery life

LoRaWAN's radio protocol is designed around infrequent, small-payload transmissions, endpoint devices can operate for many years on a single primary battery cell. Battery life may exceed 10 years and can reach higher durations under specific metering duty cycles and deployment conditions.



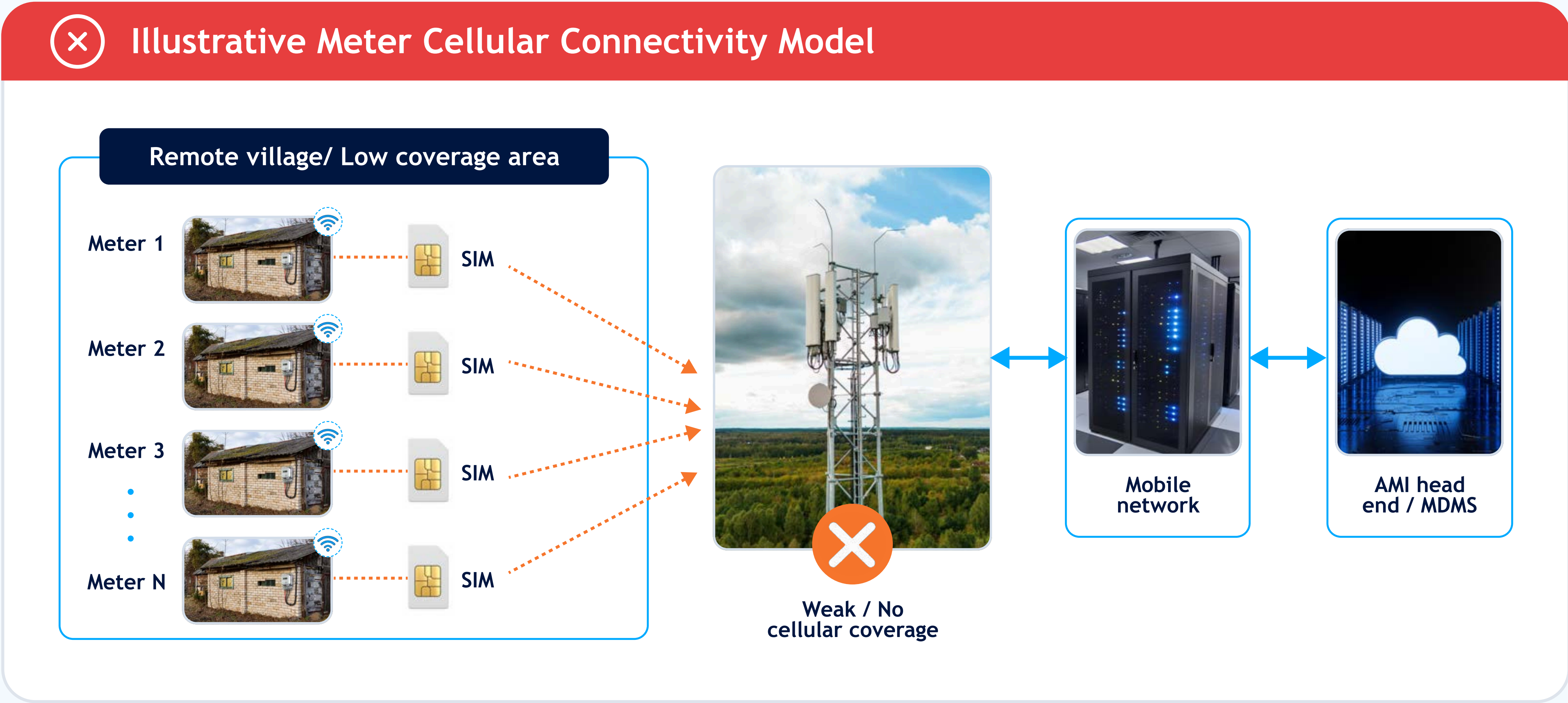
DISCOM-owned infrastructure

Like PLC and RF mesh, the network infrastructure – gateways and, where used, relay nodes – is owned and controlled by the DISCOM or AMISP rather than a third-party telecom operator, which keeps investment decisions and coverage priorities in the utility's hands.

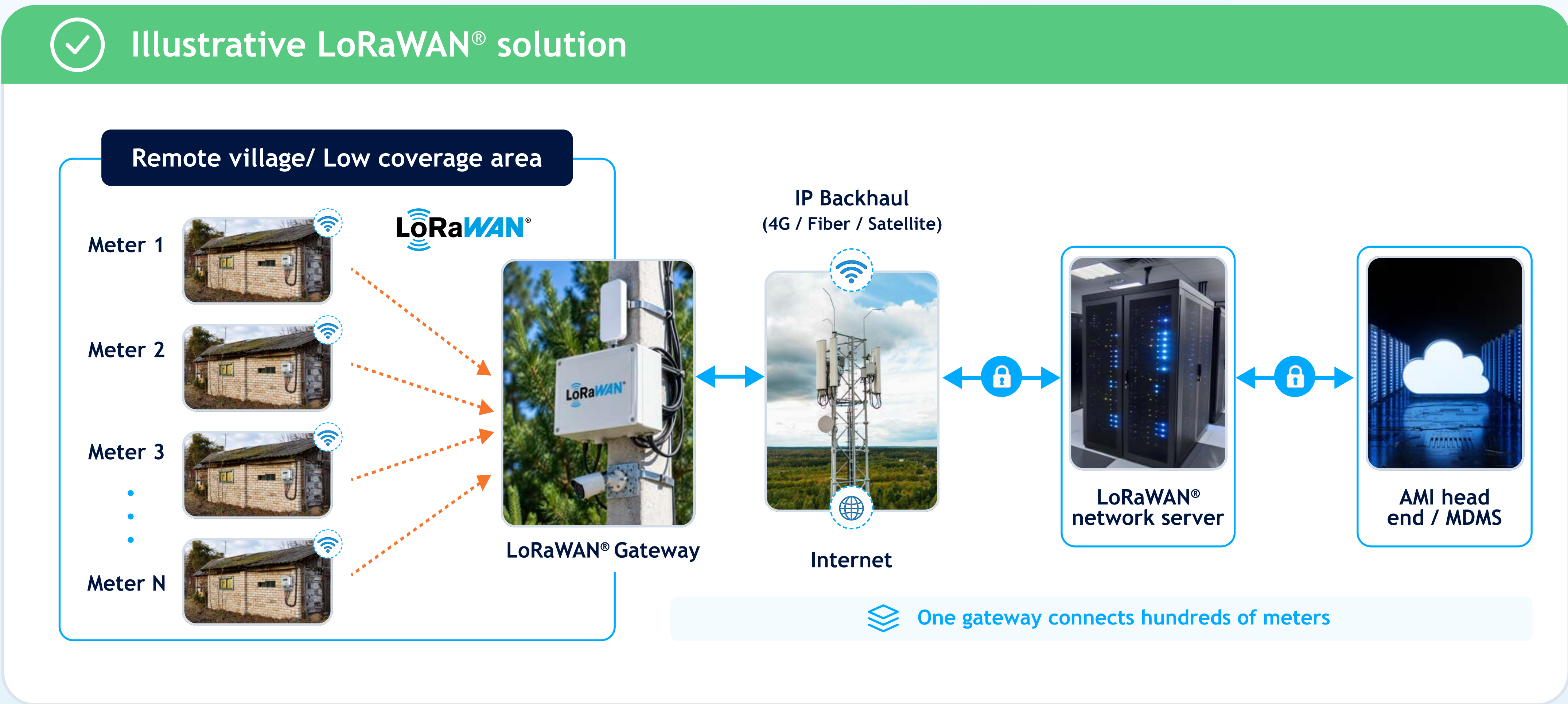


Bridging the last mile with LoRaWAN®

In remote and rural regions, smart meters are often dispersed across large geographic areas where cellular coverage is weak, unavailable, or economically unviable. LoRaWAN® addresses this challenge through a shared connectivity model, enabling hundreds of meters to communicate with a single gateway over long distances. This extends AMI network reach, improves data reliability, and significantly reduces per-meter communication costs.



- ✗ Key challenges
- Cellular coverage not available in remote areas
 - Per-meter connectivity increases lifecycle TCO in remote deployments
 - High dependency on mobile operators
 - Inconsistent connectivity and data gaps
 - High SIM management and operational overhead



- ✓ Key benefits
- Works in remote areas where cellular does not reach
 - Shared infrastructure may reduce cost per meter
 - One gateway connects hundreds of meters
 - Lower operational complexity and SIM management
 - Reliable, secure and scalable connectivity

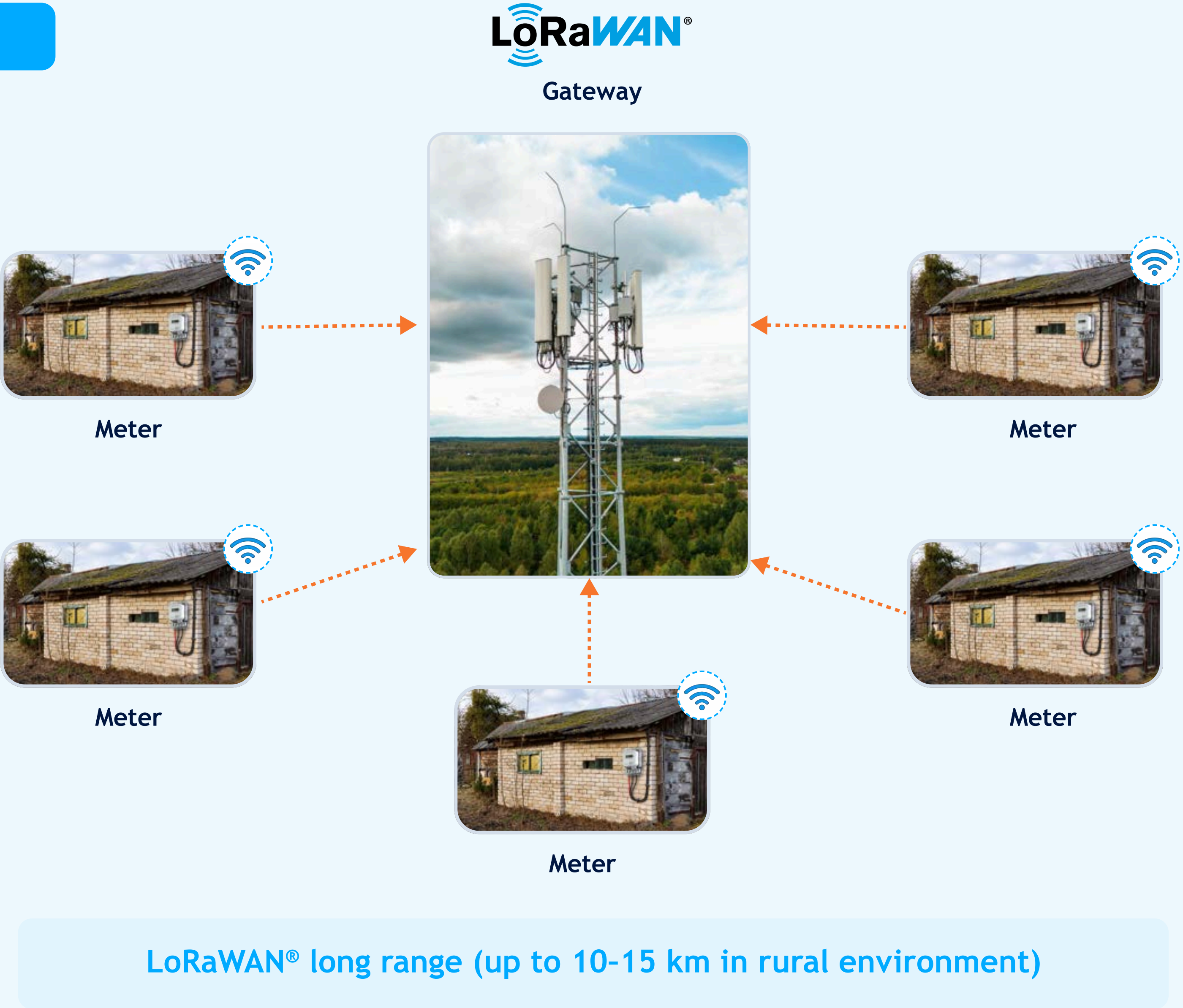
Rural scenario - Meters spread across a large area

In many rural regions, homes are scattered across wide distances with low population density.

- Example:
- 500 meters spread over 5-10 km²
 - Houses may be 500 m to 2 km apart
 - Few or no mobile towers nearby
 - GSM / NB-IoT signal availability may vary by location

Rural GSM / NB-IoT connectivity considerations

- Low population density
- Limited commercial viability for operators
- Fewer towers and backhaul links
- Terrain and vegetation further reduce signal strength



Connectivity Models for Smart Metering

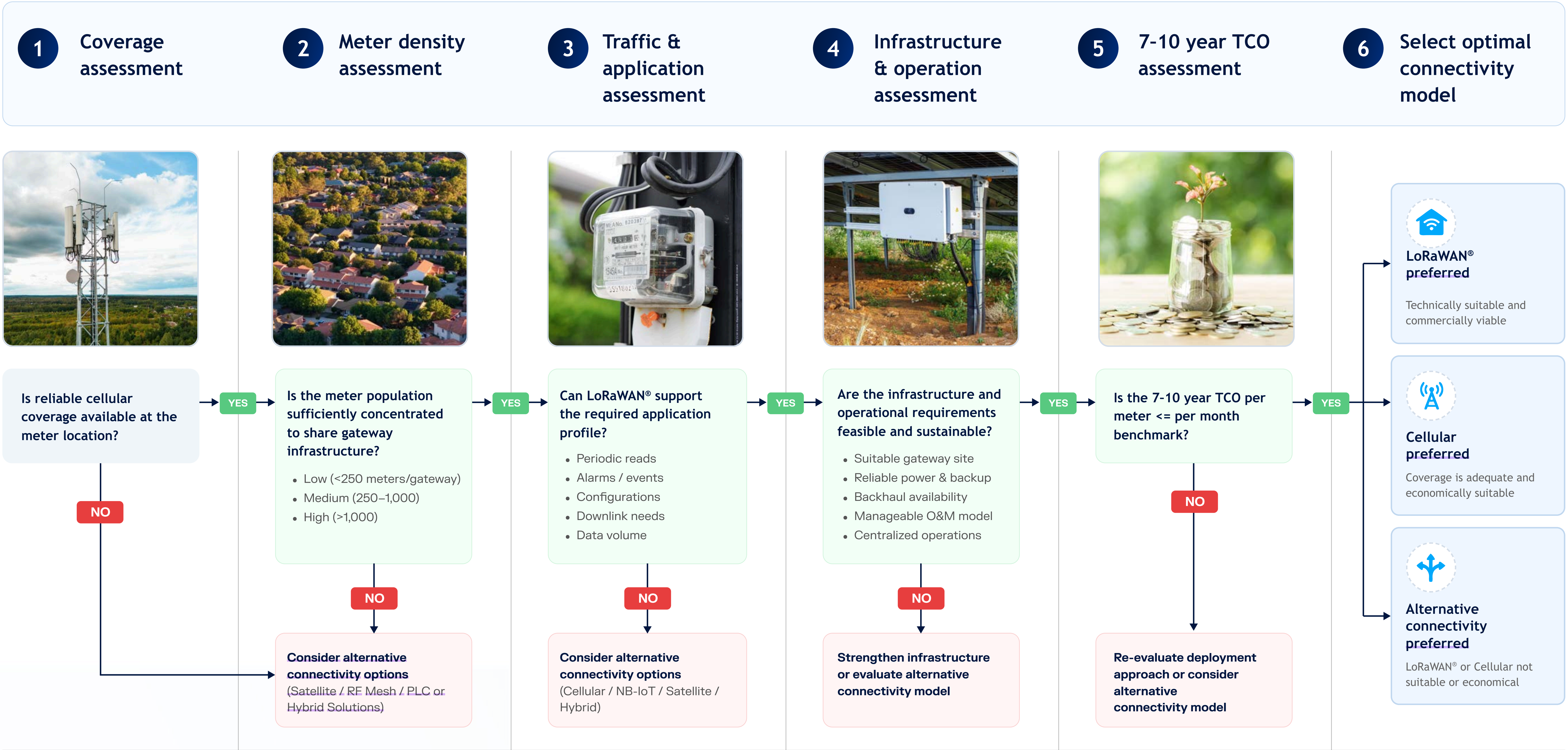
LoRaWAN® (Long Range Wide Area Network) was purpose-built for exactly the conditions that break NB-IoT and RF mesh: Long-range, low-bandwidth, battery-powered telemetry over unlicensed spectrum, deployed from a small number of gateways rather than dense infrastructure or third-party towers.

Criterion	PLC	RF Mesh	4G / Cellular	NB-IoT	LoRaWAN®
Typical rural range	Limited to LV feeder length	100m-2km per hop; may degrade in low density	Wherever tower coverage exists	Wherever telecom NB-IoT coverage exists (limited in India)	3-15 km per gateway, line-of-sight dependent
Recurring cost model	Owned infrastructure; typically no per device connectivity charge	Owned infrastructure; typically no per device connectivity charge	Per-SIM, per-meter data charges for contract life	Per-SIM charges; carrier- dependent	Low – unlicensed spectrum, owned gateway infrastructure
Infrastructure ownership	DISCOM / AMISP	DISCOM / AMISP	Third-party telecom operator	Third-party telecom operator	DISCOM / AMISP / Licensed LoRaWAN® operators
Dependence on grid power quality	High – performance tied to LV network condition	Limited dependence	Limited dependence	Limited dependence	Limited dependence
Coverage in hilly / forested / low-density terrain	May not be applicable beyond LV network	Coverage depends on mesh density and node placement	Depends on available tower coverage	Depends on availability of NB-IoT coverage	Strong – designed for long-range point-to-multipoint in sparse terrain
Battery life at endpoint	May not be applicable (line-powered)	Moderate	Moderate to low (radio-heavy)	Moderate	Long – multi-year on primary cell, low duty cycle
Deployment lead time in remote areas	Requires sufficient node placement to maintain connectivity	Requires dense node placement to sustain hops	Dependent on telecom tower availability	Dependent on telecom network availability	Fast – single gateway can cover a wide rural radius
Best-fit zone	Dense urban feeders with healthy power quality	Dense urban / semi-urban clusters	Areas with reliable existing tower coverage	Areas with confirmed NB-IoT coverage	Remote villages, hilly terrain, low meter density, coverage-gap pockets

No single technology is optimal across every part of a DISCOM's service territory, and this paper does not argue otherwise. PLC remains sensible where power-line quality is good and cable runs are manageable; RF mesh remains cost-effective in dense clusters; 4G is a reasonable choice wherever tower coverage is already strong. The case for LoRaWAN® is specifically about the residual pockets – remote villages, hill terrain, low meter density.

Techno-commercial decision framework

Smart meter connectivity should be selected based on the characteristics of each deployment area rather than adopting a single connectivity technology across all locations. The proposed framework evaluates coverage, meter concentration, application requirements, infrastructure availability and lifecycle cost before determining the most appropriate connectivity option.



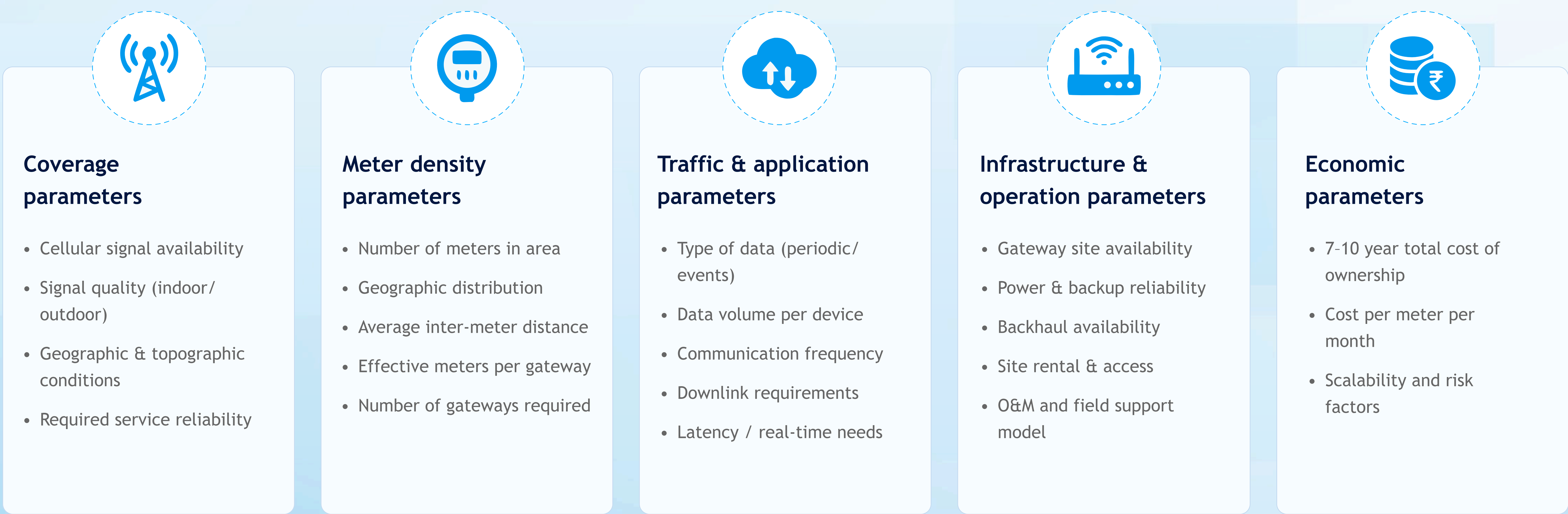
Decision principles



Benchmark reference



Key parameters for decision



Conclusion

LoRaWAN® can enable last-mile connectivity for remote smart metering



Enabling rural digital inclusion: Smart metering must extend beyond areas where conventional connectivity is readily available. Across electricity, gas and water, LoRaWAN® can provide a cost-effective connectivity option for remote and low-density rural deployments where cellular connectivity is difficult to reach or economically justify.



Rural utility deployments often have a different operating and communication profile from dense urban environments. Where the requirement is primarily for regular meter readings, consumption information, alarms, events and essential remote operations, a **low-bandwidth connectivity** model can provide an effective and economical solution.



Urban and rural deployments can have different connectivity requirements. Regulatory and technical frameworks can account for these differences and support **fit-for-purpose connectivity** where appropriate levels of service, security, reliability and interoperability can be achieved.

FINAL RECOMMENDATION

Enabling fit-for-purpose connectivity for rural smart metering

can unlock the next wave of digital utility infrastructure and become a meaningful enabler of the **Viksit Bharat** digital roadmap.



Remote villages



Hilly & forested areas



Low density metering



Difficult terrain



Last-mile connectivity

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