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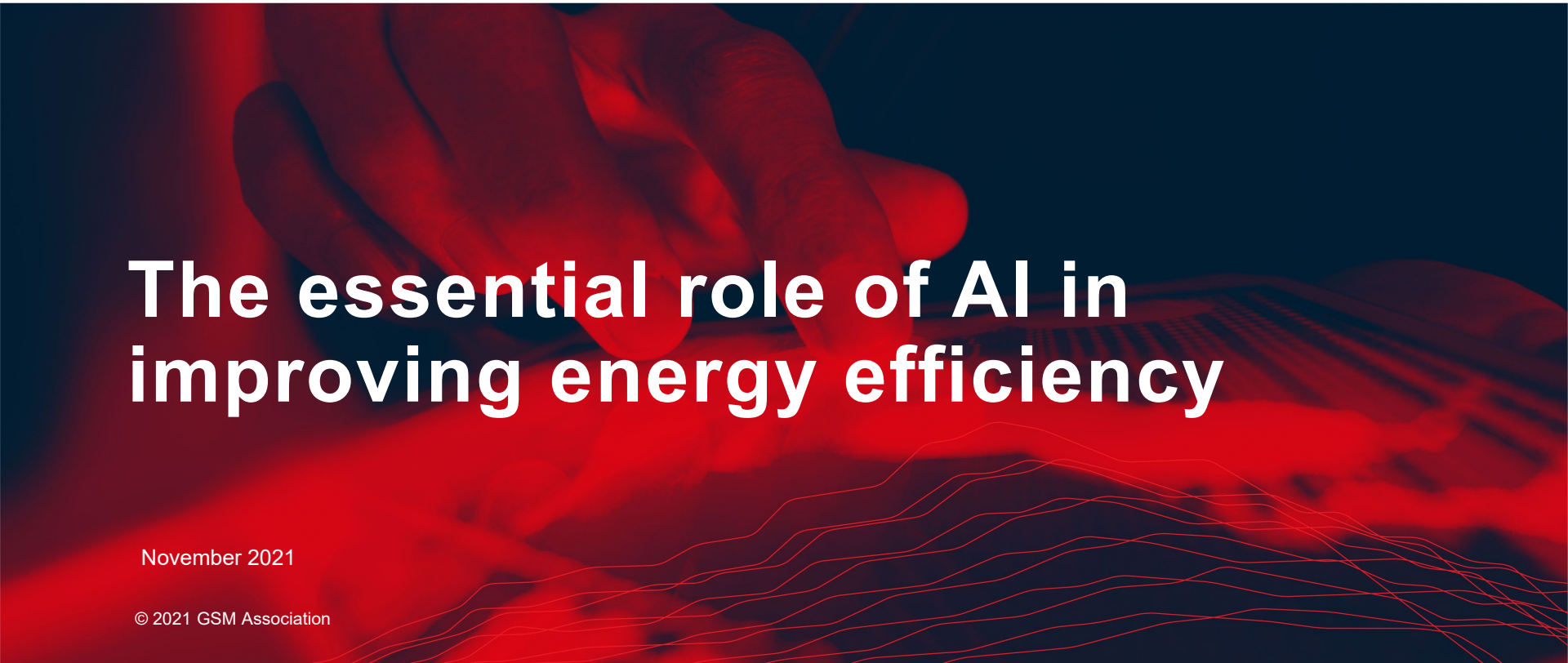

The essential role of AI in improving energy efficiency

November 2021

The GSMA represents the interests of mobile operators worldwide, uniting more than 750 operators with nearly 400 companies in the broader mobile ecosystem, including handset and device makers, software companies, equipment providers and internet companies, as well as organisations in adjacent industry sectors. The GSMA also produces the industry-leading MWC events held annually in Barcelona, Los Angeles and Shanghai, as well as the Mobile 360 Series of regional conferences.

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GSMA Intelligence is the definitive source of global mobile operator data, analysis and forecasts, and publisher of authoritative industry reports and research. Our data covers every operator group, network and MVNO in every country worldwide – from Afghanistan to Zimbabwe. It is the most accurate and complete set of industry metrics available, comprising tens of millions of individual data points, updated daily.

GSMA Intelligence is relied on by leading operators, vendors, regulators, financial institutions and third-party industry players, to support strategic decision-making and long-term investment planning. The data is used as an industry reference point and is frequently cited by the media and by the industry itself.

Our team of analysts and experts produce regular thought-leading research reports across a range of industry topics.

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This report was authored by GSMA Intelligence and supported by Nokia.

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Context

Energy efficiency

- In the context of wireless networks, energy efficiency can be defined in various ways: how much energy is needed to deliver one unit of data; to serve one connection to supply one base station; or to produce one unit of revenue.
- Each measure has its advantages and disadvantages, so the choice becomes a question of balance. Only taking into account the total amount of used energy would be unfair and biased as more data than ever before is being transferred across mobile networks.
- While energy use can be a significant cost, it is also an area with many opportunities for operating expense (opex) savings if the required capital investments/upgrades are made to network equipment.

Artificial intelligence and machine learning

- Artificial intelligence (AI) and machine learning (ML) are delivering new capabilities and efficiency improvements to operators in more ways than ever before. They allow network equipment to perceive, reason, intuit and provide new ways for solving technical challenges.
- Holistic and end-to-end AI and ML can provide a ubiquitous system-level approach that improves energy efficiency across hardware, software and algorithms.
- Energy management is significantly data heavy and operators cannot efficiently process information and make real-time decisions at scale without the use of AI.
- This becomes particularly important with 5G networks given that average customer data usage on 5G is structurally higher (5–10×) compared to LTE, which puts commensurate pressure on energy consumption.

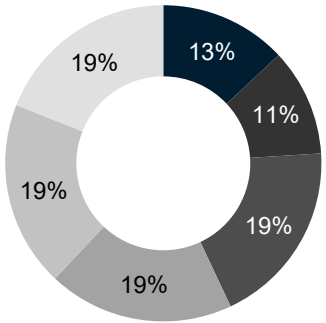
Telecoms sector

- By the end of 2021, the telecoms industry will serve more than 5.3 billion unique mobile subscribers worldwide, equivalent to 70% of the population.
- The mobile sector has worked collaboratively to create an industry-wide climate action roadmap to achieve net-zero greenhouse gas (GHG) emissions by 2050, in line with the Paris Agreement, with over 30% of carriers having made public commitments.

Research methodology

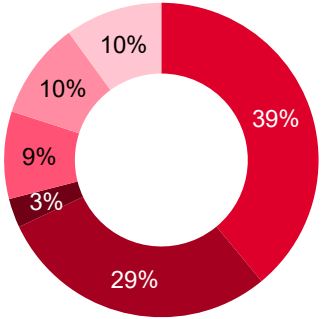
- Between June and July 2021, GSMA Intelligence surveyed 103 respondents across 45 markets. The survey consisted of 13 topics related to AI and energy efficiency.
- GSMA Intelligence also added several demographics-related questions to make sure the final results are representative.
- GSMA Intelligence also conducted 11 research interviews with vendors and network operators to gain the latest insights, complementing the survey findings with qualitative analysis.

How many mobile subscribers does your operation directly serve? (Percentage of respondents)



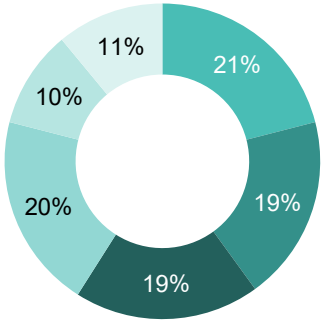
- Less than 5 Million
- 5 Million to 9.99 Million
- 10 Million to 24.99 Million
- 25 Million to 49.99 Million
- 50 Million to 100 Million
- Greater than 100 Million

In which region are you based? (Percentage of respondents)



- Asia Pacific
- Europe
- Greater China
- Latin America
- The Middle East and Africa
- North America

Which of the following best describes your role with your company? (Percentage of respondents)



- C-level
- VP
- VP equivalent
- Director
- Manager
- Subject matter expert

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Key findings

67%	Two thirds of network professionals expect energy costs to increase in the next three years.
83%	The majority of network professionals rate energy efficiency as extremely or very important to their network transformation strategy.
78%	Almost 80% of network professionals expect AI-driven solutions to be an extremely or very important part of their network transformation strategy.
79%	Around four fifths of network professionals expect fundamental or significant improvements to AI-driven energy efficiency solutions in the next five years.
2%	Two percent of network professionals have already implemented AI-driven network optimisation and shutdowns in their network. However, 50% are in the planning and testing phase, suggesting an impending rise in live deployments.

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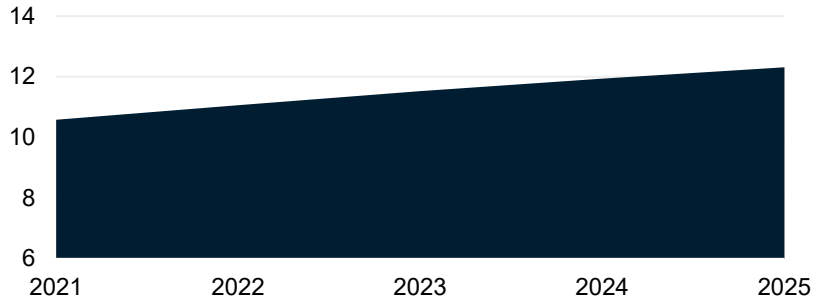
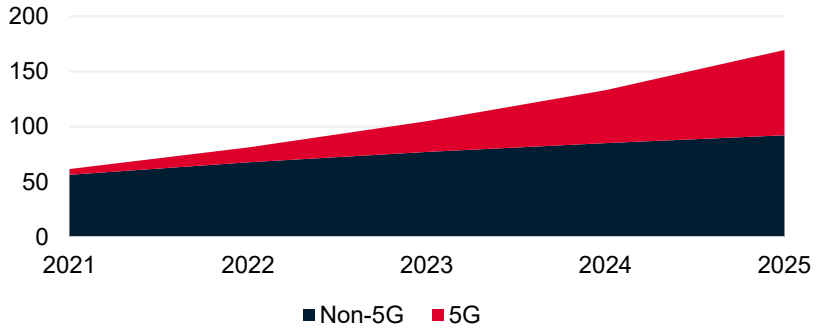
Drivers behind the urgency: enormous pressure expected on mobile networks

Number of cellular connections, 2021–2025
Billion



Source: GSMA Intelligence

Mobile Data Traffic, 2021–2025
EB/month



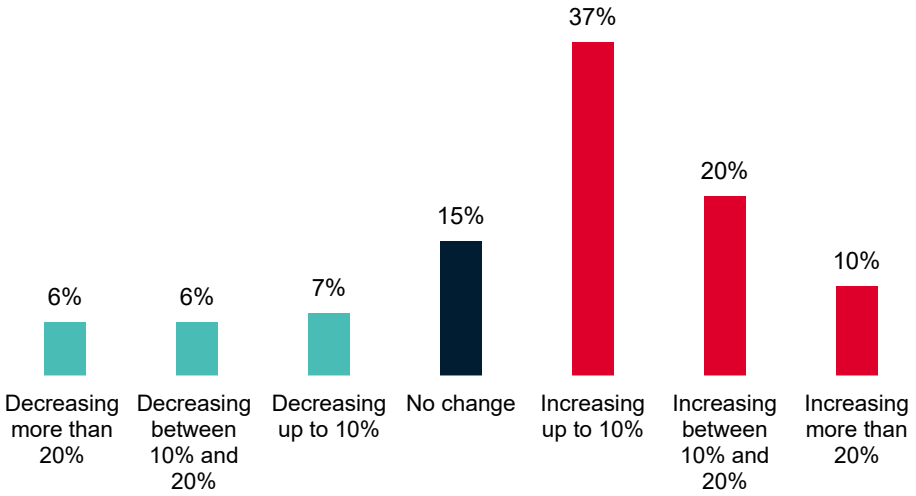
Source: Ericsson

- **Increasing demand for connectivity.** 5G upgrades will accelerate post pandemic. By 2025, GSMA Intelligence expects the number of 5G mobile connections to reach around 2 billion, or 20% of the global customer base. These subscribers are likely to have monthly data consumption rates higher than those on LTE. Traffic rates are also rising on LTE. The growing number of connections and amount of data traffic is expected to increase demand for energy.
- **Higher output requirement, more complex networks.** Power saving has been a tough challenge since as far back as the 2G era. With the arrival of 5G, massive MIMO and large output power requirements will exacerbate this challenge. The network complexity and density required to service the increasing number of connections and data traffic means massive MIMO and large output power requirements will further increase energy demands.
- **2.2 billion 5G connection by the end of 2025.** GSMA Intelligence's 5G forecast has been updated to reflect the latest view of the global market, including the high pace of rollouts despite the impact of the Covid-19 pandemic.

Energy is the only major opex element expected to increase within the next three years

- According to our survey, 67% of operators expect their energy costs to increase in the future. Operators already have enough drivers from purely a financial perspective to improve energy efficiency.
- Due to ever-increasing electricity prices, more and more operators are making considerable efforts to reduce their energy consumption from base stations.
- Early readings suggest that absolute power consumption of a 5G base station is significantly higher than that of 4G base stations. Although 5G is more energy efficient than previous wireless technologies, absolute energy consumption is greater because of higher traffic demand and complex new 5G use cases. With carbon emissions being a top concern for industry participants, regulators, investors and customers, there is ample motivation to reduce consumption as well as to shift to renewables.

How do you expect your network energy costs to change in the next three years?
Percentage of respondents

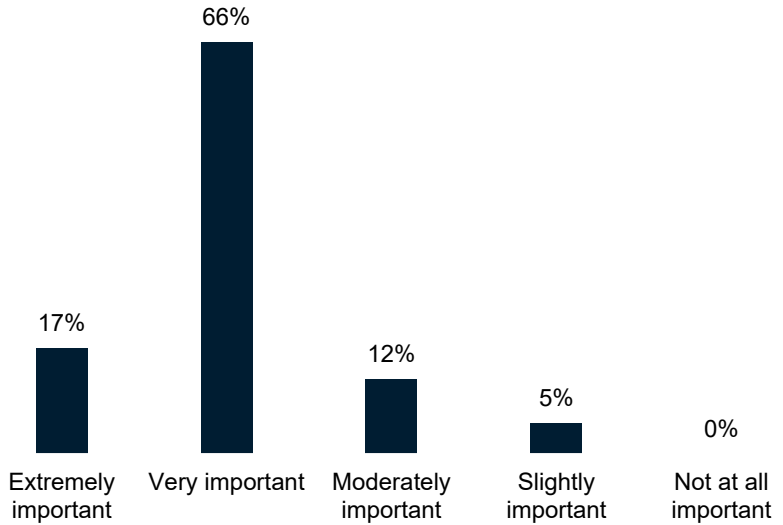


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Green is a strategic imperative

- The vast majority (83%) of surveyed operators stated that energy efficiency is an extremely or very important part of their network transformation strategy. Energy efficiency places among the top three transformation drivers. Several factors are contributing to the momentum for energy efficiency: improving cost functions; meeting stakeholder and regulatory expectations; and supporting external PR requirements.
- To comply with these green expectations and improve cost functions, leading operators have recently implemented significant improvements and new processes:
  - Data is being harvested to identify the critical weaknesses of networks. Network equipment does not usually measure energy consumption. To address this, operators are considering building comprehensive data pipelines and deploying smart sensors.
  - Many operators have started a complex green transformation plan with a new team, with an accountable high-authority leader and ambitious and tangible KPIs. These cross-functional teams are helping operators to break down silos, focus on green network transformation and implement the latest sustainable technologies.

How important is energy efficiency in your network transformation strategy?
Percentage of respondents

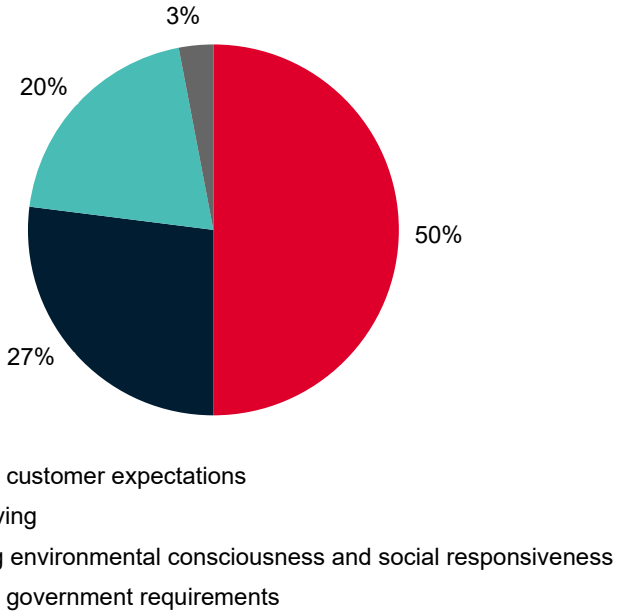


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Operators are being pulled from all directions

- Operator network CO_2 emissions have become an urgent business problem driven by various factors: government requirements; investor and/or customer expectations; marketing; and cost functions. For most operators, their energy efficiency strategy is being influenced by a combination of these factors.
- Identifying the primary goal of operators in their network energy efficiency strategy is especially useful for vendors. For half of the surveyed operators, fulfilling customer expectations (both consumer and enterprise) is the main driver.
- Fulfilling customer expectations and showing environmental consciousness together account for 70% of operators' primary goal when it comes to their network energy efficiency strategy. Effective communication from operators is therefore crucial.
- It is essential that network operators measure energy use, maintain up-to-date datasets on energy efficiency, and communicate their progress and vision more transparently.

What is the primary goal driving your network energy efficiency strategy?
Percentage of respondents

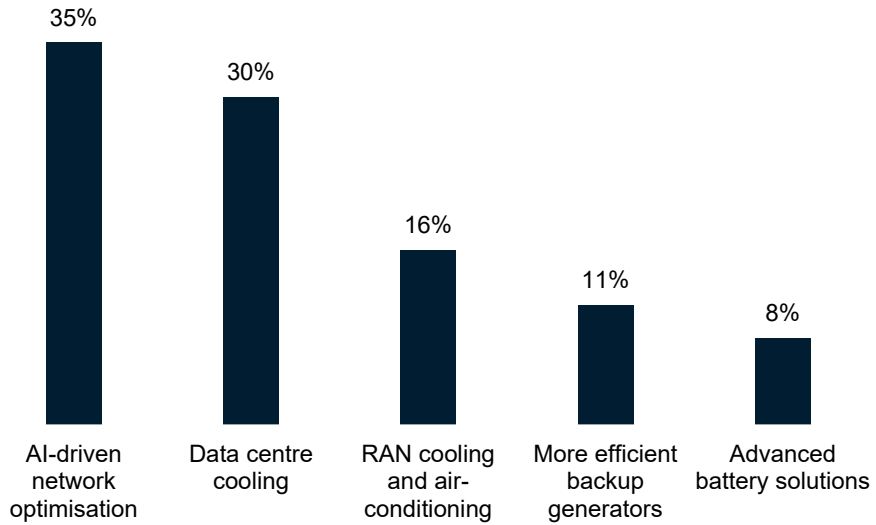


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Effective ways to improve energy efficiency

- Operators put the most trust in advanced AI-based network optimisation for improving their network energy efficiency, compared to other solutions.
- While most of the improvements around energy efficiency are time- and resource-intensive and often require efforts outside of operators' capabilities, AI-driven network optimisation solutions are quick to deploy and have favourable financing options.
- AI- and ML-driven solutions can help operators not only to quickly reduce the carbon footprint of their networks, but also to process their data efficiently and translate it into actionable insights.
- Unlike other hardware and capital expense (capex) intensive solutions (such as batteries, diesel generators or cooling systems) AI-driven solutions offer a scalable option with a favourable return on investment.

According to your expectations, what is the most effective improvement for energy efficiency?
Percentage of respondents

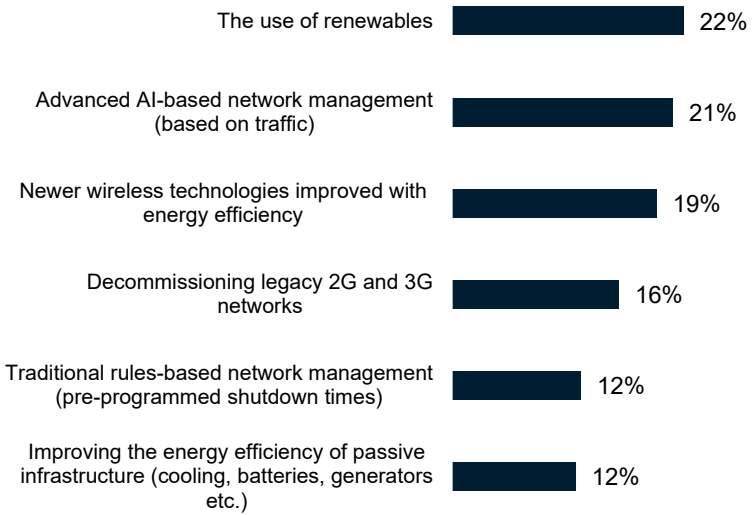


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Ways to become a green network

- To reduce their environmental footprint, operators can improve energy efficiency and/or use more renewable energy. If available, the use of renewable energy sources is a quick and effective way to reduce environmental footprints while not requiring heavy investments.
- In terms of reducing their environmental footprint, operators have the greatest expectations for renewables. What pushes renewables to the top of the list are their immediate effect on carbon reduction, the lack of risk of quality of service being impacted and the marginal capex requirements. The use of renewables is closely followed by the use of AI (which is the top measure for reducing energy consumption).
- While energy efficiency improvements work a similar way everywhere, the use of renewables heavily depends on external factors, such as climate, regulatory environment, availability and the price of renewable energy through the grid.
- Diesel generators have traditionally been the most economical way to generate electricity in off-grid or bad-grid scenarios. Solar is now an option for replacing diesel as a result of two developments: the price of photovoltaic panels has decreased and base station battery solutions have become more advanced.

Which strategy/method do you expect to reduce the environmental footprint of your network the most?
Percentage of respondents



Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

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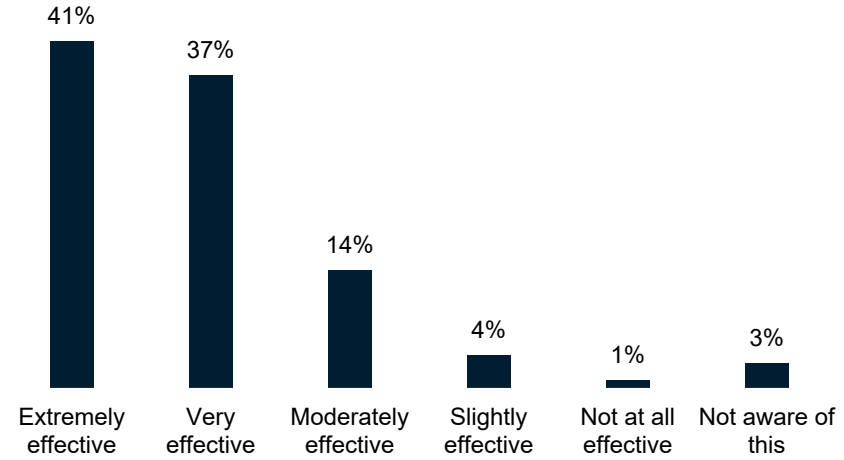
AI: just hype or a long-lasting solution?

- Energy management and optimisation is a particularly data-intensive area. As AI allows vast amounts of data from different sources to be analysed quickly and efficiently, it expands the potential for several energy-saving opportunities across the whole network.
- If the algorithm can assess data related to real-time demand, traffic patterns and network resource availability, AI can enable quick, automated decision-making to facilitate a huge variety of use cases. This includes managing and allocating resources in a more energy-efficient manner or even planning new networks more efficiently.
- Operators are expected to handle a constantly increasing amount of information in the future with regard to their network operations. AI will become increasingly important for efficiently analysing, processing and translating this data into actionable insights.

How effective are AI-driven energy efficiency improvements as a part of your network energy efficiency/sustainability strategy?
Percentage of respondents

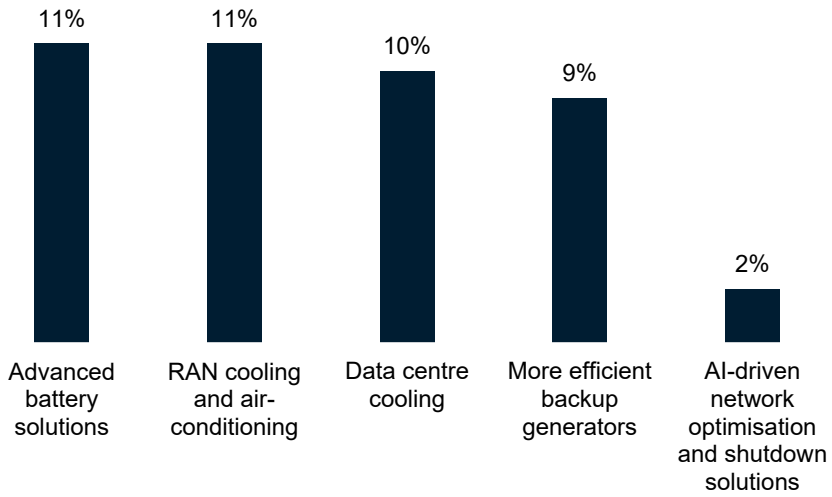


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

AI-driven network optimisation is not prevalent

- The first dedicated large-scale deployments of AI-driven energy management solutions began in 2017–2018. Such solutions are less mature compared to other energy efficiency improvements: only 2% of network operators said they have reached a commercial deployment phase with AI-driven energy management solutions.
- AI-driven network management applications are not a new concept, but many vendors and network operators have recently launched energy management solutions that leverage AI and advanced data analytics to optimise energy consumption.
- The end-to-end digitisation of network infrastructure has been the key enabler for AI implementation so far. AI algorithms require a wide range of data and the lack of data availability is currently the biggest constraint. Until operators are able to harvest more data and control different network elements remotely, the growth of AI-driven solutions is limited.

Which of these energy efficiency improvements have reached a commercial phase at scale?
Percentage of respondents

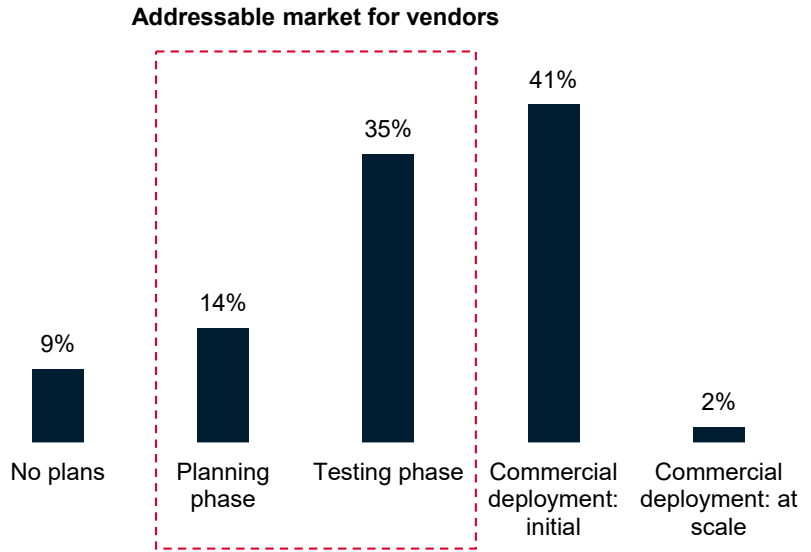


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Still a long way to go for AI in energy management

- Using AI-driven optimisation solutions to reduce carbon footprints is on the agenda for many global operators.
- According to our survey, almost 10% of operators are taking a risk by having no plans at all for AI-driven network optimisation to improve energy efficiency.
- Despite operators being aware of the importance of energy efficiency, fewer than half said they had reached commercial deployment.
- Except for the small proportion of those that have reached commercial deployment at scale, most operators are still in the process of planning, testing and initial deployments.

How far along are you in your work on AI-driven network optimisation?
Percentage of respondents

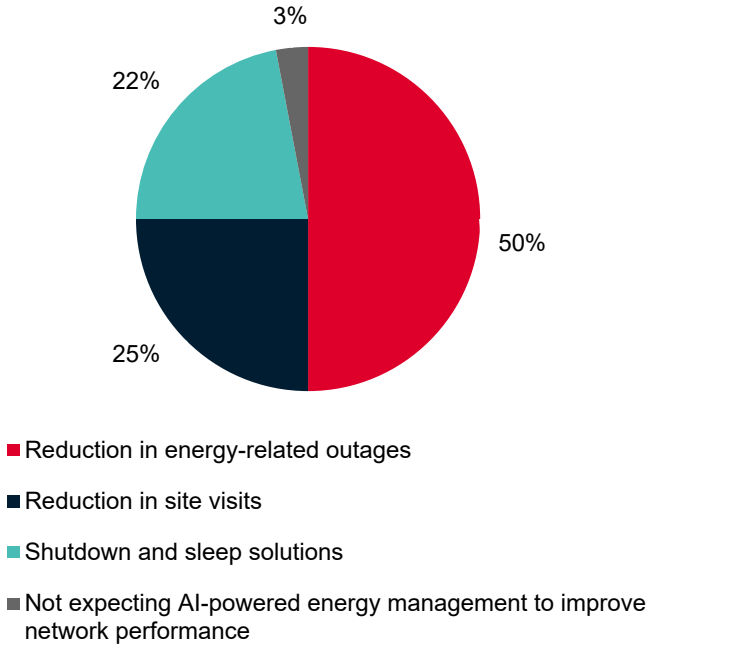


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

AI leads to a more balanced network energy profile

- AI-driven shutdown and sleep solutions can forecast data traffic based on historical patterns, weather, events nearby and other factors, before identifying the necessary thresholds and activation and sleep periods. Based on the information, the algorithm can shut down power amplifiers, transceivers and other larger network elements to save energy.
- Besides shutdown solutions, AI will be able to improve energy efficiency with new features: load balancing; more intelligent beam forming; reducing interference; and better spectrum utilisation.
- Reduction in site visits and energy-related outages can help to save on unnecessary transportation and fuel consumption. Site visits and the refilling of generators' diesel tanks require significant resources from operators and their vendors, as these site are often located in hard-to-reach areas.
- Even a short unexpected disruption to mobile services (including the loss of voice, data and/or messaging services) can harm the consumer experience significantly. These network outages are caused by energy-related issues, so more effective energy management would help improve the quality of service and customer satisfaction.

Which aspect of AI-powered energy management solutions will have the greatest improvement on your network performance?
Percentage of respondents

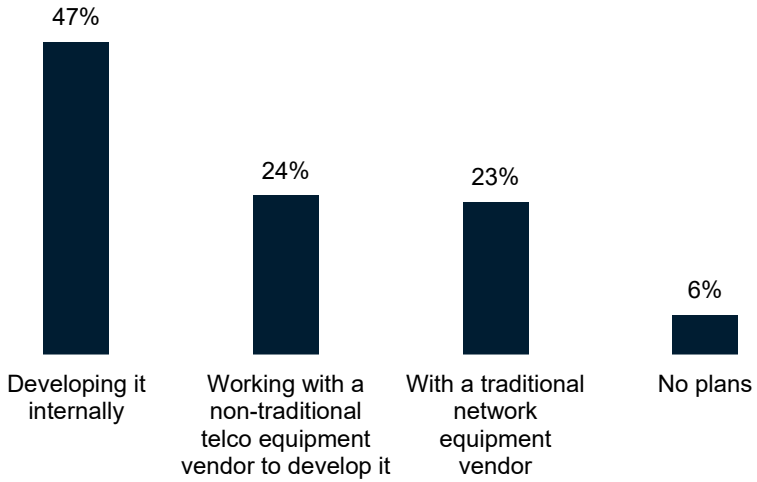


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Best ways to deploy AI-driven optimisation solutions

- Unlike physical network equipment, AI-driven network optimisation software can be acquired from different sources. This includes the operator developing it internally or even purchasing it as a service. Compared to hardware, software has a lower market entry cost, and less commitment and capex-heavy investment are needed to develop network optimisation software.
- A few network operators have already started to build their own solutions. China Unicom, China Telecom, Elisa Automate and KT have relied on their own data and started to develop their own platforms.
- Traditional network equipment vendors can rely on their previous experience in network optimisation, which includes planning and using AI in other areas of the network, and offer an integrated solution with other existing network optimisation software features.

How do you deploy AI-driven network optimisation and shutdown solutions to improve energy efficiency?
Percentage of respondents

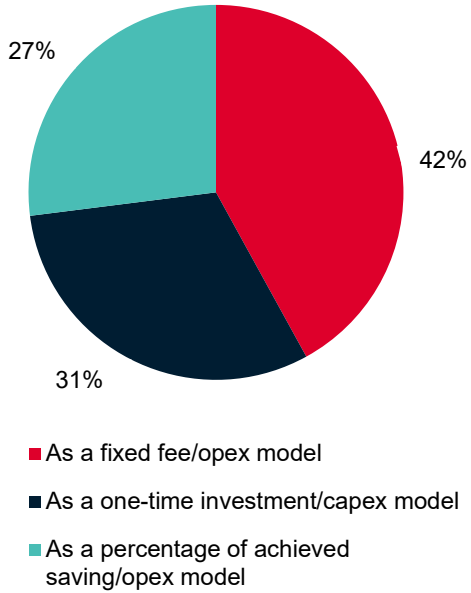


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Various ways to pay for AI-driven energy saving solutions

- Unlike many other products that operators purchase, such as antennas, batteries or fibre-optic cables, AI-driven energy saving solutions are unique and heavily depend on individual deployment scenarios.
- The enormous diversity between each operator's regulatory environment, climate and status of legacy networks means vendors have to offer unique and customisable solutions.
- Commercial model innovation and offering the right, tailored value structure is essential to market AI-driven solutions effectively. Each commercial model has its advantages and disadvantages. Vendors should tailor their solutions to each operator's financial circumstances.
- There will be no dominant business model and suppliers will need to be flexible. The most popular commercial model, payment as a fixed opex fee, is ideal for planning payments. The one-time investment model accommodates the traditional purchase model. The outcome-based model is best for operators that are risk-averse.

How would you prefer to pay for energy saving solutions?
Percentage of respondents

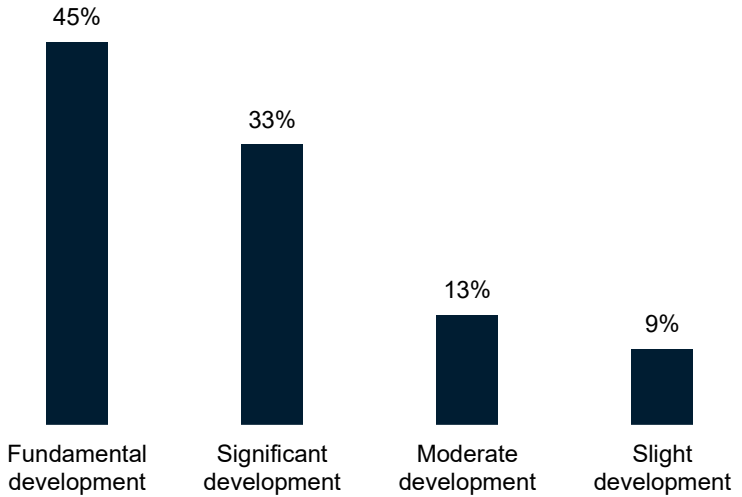


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

AI is the driving force for network transformation

- Currently the application area of AI-driven energy efficiency solutions is focusing on shutdown solutions in the radio access network (RAN). Base stations are the 'low-hanging fruit' for such applications, as they account for more than 70% of total energy consumption.
- Operators are expected to start using AI outside of the RAN and offer more than just shutdown solutions, including:
  - predictive maintenance and enhanced troubleshooting to reduce the number of site visits and save on fuel and human resources
  - network planning support to not only save on resources but also create a more optimal end result
  - optimised fuelling and reduction of generator run hours
  - equipment lifetime optimisation (from a broader sustainability perspective).
- Operators' optimistic expectations are driven by the combination of new AI use cases, the addition of advanced functions and the potential to increase savings after the wide-scale integration of passive infrastructure in AI-based energy management.

How do you see AI-driven network optimisation and shutdown solutions improving most in the next five years?
Percentage of respondents

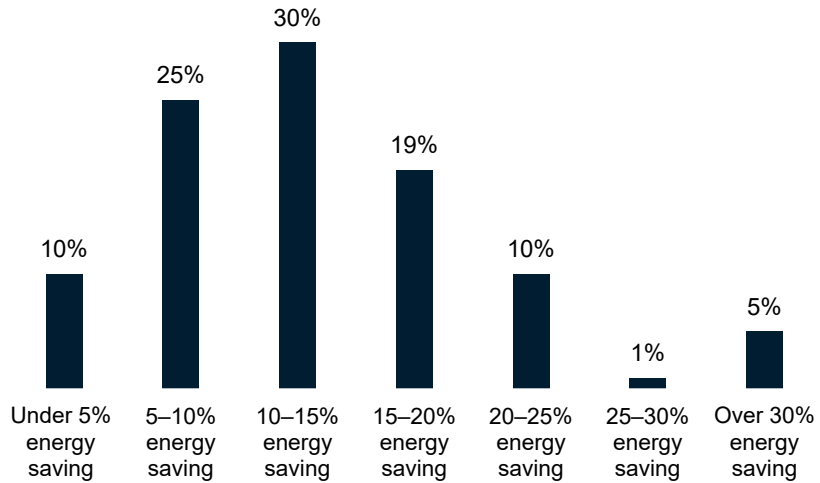


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Most operators expect significant savings in the next two years

- There is significant optimism about the performance of AI-driven network management solutions within the operator community.
- The use of AI and ML is not particularly new, but relatively few operators (2%) have reached large-scale commercial deployment. Of those that have launched commercially, most have focused on shutdown solutions in the RAN.
- AI- and ML-driven applications are following the same S-shaped adoption curve as most new technologies. After the first wave of innovators, the early adopters and early majority are expected to drive adoption of the new technology to scale.
- The three main reasons why the impact of AI- and ML-driven solutions on energy efficiency will accelerate are:
  - the availability of more real-time data from adding more sensors, especially to passive infrastructure
  - new and more advanced AI algorithms
  - more complex and data-intensive energy management because of increased data traffic from 5G and more diverse deployment scenarios.

Over the next 24 months, what level of energy saving do you expect from your AI-driven energy management solutions?
Percentage of respondents

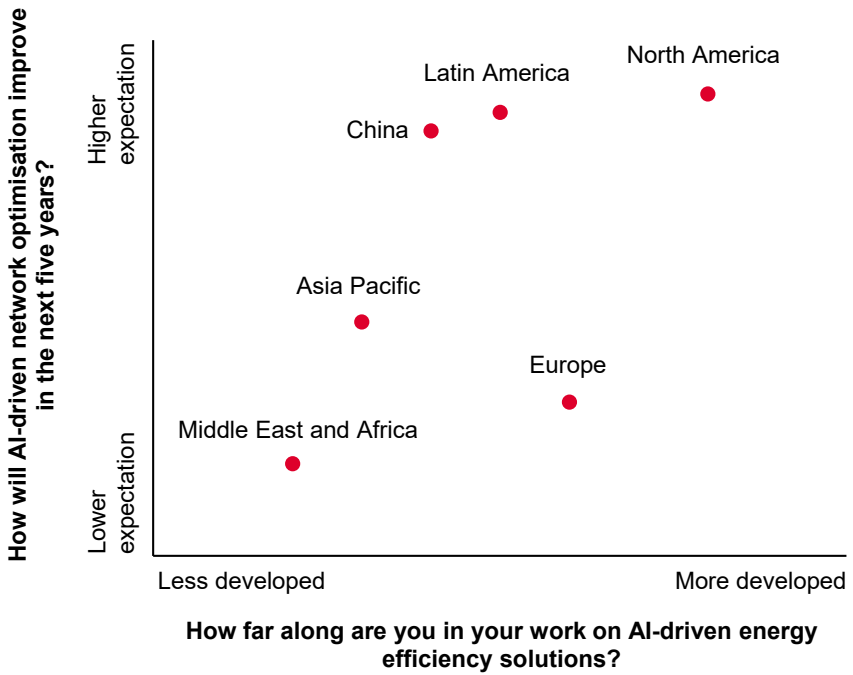


Source: GSMA Intelligence AI and Energy Efficiency Survey 2021

Regional differences: the greater the AI experience, the greater the expectations

- The correlation between operators' AI experience and their expectations indicates that operators are satisfied with the early results of AI-driven network optimisation. The initial trials, tests and early deployments have had promising results.
- Network operators from North America are the most optimistic regarding the impact of AI. They also have the most experience, being at the vanguard of AI usage in networks.
- Passive infrastructure (especially air-conditioning) and the use of diesel are responsible for a significant share of energy consumption and CO_2 emissions. Thus, regions with warmer climates and higher diesel use have the highest potential efficiency gains, such as the in the Middle East and Africa.

Operators' expectations and their current progress with AI



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Key trends

- **Use of AI in design.** Network design is the foundation of energy-efficient networks. Operators are deploying a wide range of new cells during the start of the 5G era, including mmWave cells and small cells integrated into street furniture, street lamps or even indoor sites. Propagation analysis and site selection is a complex and labour-intensive task; AI can help here, not just to speed up the process but also to make it more accurate. An AI algorithm first creates a propagation map, then after some additional input from the operator an optimal network configuration can be reached. Initial on-site performance checks can feed input back into the algorithm to validate and fine-tune the network planning.

- **No need to test that much, physically.** Operators have historically spent a significant amount of resources to test their service quality. Constant testing and mapping of users' experience under different conditions at different times of the day is essential to provide high-quality telecoms services. With the help of AI, operators can reduce the size of testing crews, their travel time and the related petrol and electricity costs. Network tuning and virtual test drives can rely on real-time traffic data, as every user can become a test drive, and AI can help to form actionable insights for the operators and reduce the need for physical test drives.

- **Energy management is data-centric and AI/ML is needed do it efficiently.** In 2021, AI- and ML-driven applications have mostly focused on shutdown solutions in the RAN, but energy management should be addressed in an end-to-end manner. RAN optimisation is just the first step; operators are expected to have an overall understanding of all their data and to use holistic solutions. To achieve this, the full digitisation of the network infrastructure is needed, with sensors and site controllers on every network element. Most operators are currently working to achieve this holistic view and to build their data pipelines, including both active and passive infrastructures.

- **Passive infrastructure is the dark hole.** Depending on the climate and the quality of the electricity grid, passive infrastructure, especially air-conditioning, is responsible for a significant part of operators’ energy use. Network equipment does not usually measure energy consumption and many parts of the passive infrastructure simply lack metering. Most operators currently have limited information on their passive infrastructure, such as the efficiency of their diesel generators and rectifiers. Even if the equipment has metering capacity, recording the data would be labour intensive and not in real time. After operators deploy the required sensors and build the data pipelines, they will be able to have a view of the energy usage from passive infrastructure and increase the impact of AI.

Key trends

- **Europe is at the forefront of green networks.** European operators are committed to leading the global transition towards a zero-carbon economy – this includes supporting national climate change policies and the European Green Deal. For example, Telia has bolstered its sustainability commitment with new goals, while Deutsche Telekom has brought forward its climate deadlines. The German operator is aiming for neutrality for in-house emissions by 2025 (previously 2030) and to achieve net-zero status across its whole supply chain by 2040 (10 years earlier than originally planned). The CEOs of 13 telecoms firms were among the 26 initial signatories of the European Green Digital Coalition – a cross-sector agreement to take action to support the green and digital transformation of the EU. The chief executives committed on behalf of their companies to take action to:
    - invest in the development and deployment of greener digital technologies and services that are more energy- and material-efficient
    - develop methods and tools to measure the net impact of green digital technologies on the environment and climate by joining forces with NGOs and relevant expert organisations
    - co-create, with representatives of other sectors, recommendations and guidelines for the green digital transformation of these sectors that benefit the environment, society and economy.
- **Green industry-wide actions are gaining more importance.** The mobile sector's support for SDG 9: Industry, Innovation and Infrastructure of the UN's Sustainable Development Goals also has knock-on effects on the other goals, including SDG 13: Climate Action. Mobile technology contributes to SDG 13 by improving energy efficiency, bringing about changes in behaviour and reducing GHG emissions. Research from the GSMA and the Carbon Trust shows that mobile technologies can help avoid 10× more emissions than they cause. The GSMA and operators have developed an industry-wide climate action roadmap to achieve net-zero GHG emissions by 2050, in line with the Paris Agreement. More than 50 mobile operators now disclose their climate impacts and GHG emissions via the internationally recognised CDP global disclosure system. These include regional operators BT, Deutsche Telekom, KPN, Proximus, Telefónica and Vodafone, which were acknowledged for their climate efforts at the CDP's Europe Awards 2021, along with Cellnex and Nokia.

Market outlook on intelligent automation for energy efficiency

5G and the evolution of wireless infrastructure

- Data traffic is booming, with more complex networks and an increased number of devices.
- 5G's new spectrum range requires more complex optimisation.
- Traditional analytics tools cannot efficiently handle 5G's new and diverse services such as network slicing.

Enhanced use of AI algorithms

- AI can enable intelligent and automated actions at scale.
- It can also continually improve through self-learning.
- AI algorithms can be scaled, improved and updated in almost real time.

- AI-based power-saving solutions are constantly improving and receiving new functions to solve the problem of high-power consumption in base stations and to improve the efficiency of existing power-saving solutions. These can be achieved with the help of several AI capabilities, such as data perception and data traffic and network capacity. In addition, AI accelerators can help to provide rapid AI training for network element operation and maintenance.
- Network prediction, strategy adjustment and optimisation, and real-time KPI and performance monitoring would form a closed loop in an AI-based power-saving solution. This could help operators to find a balance between power saving and network performance with fewer human interactions, increasing efficiency and reducing the number of human errors. Especially at this early point in the 5G era, it is imperative for operators to keep up with the increasing demand in network traffic without disrupting the user experience. Network operators cannot efficiently process information and make real-time decisions at scale without the use of AI. As energy consumption is a key opex element for all operators, those that are currently not planning to use AI-driven energy management risk having a long-term competitive disadvantage.

Barriers and constraints for AI-driven energy efficiency solutions

	Multi-vendor environment	Lack of experts	Data ownership	Privacy and security
Drivers behind the issue	• Energy management solutions are closely connected to other network management platforms. • System integration can lead to obstacles being hidden when an operator is harmonising data-heavy solutions.	• Even larger operators can fall short of the required amount of talent, knowledge and capacity to allow them to execute the necessary transformation. This can then threaten their long-term competitiveness.	• Regulations regarding data residency vary between each country. Vendors are protective of their intellectual property and are hesitant to give full access of their data to operators to run algorithms on their premises.	• In the 5G era, security risks are greater than before because of the combination of cloud, data and IoT security threats.
Ways to overcome	• Vendors are currently working on new standards, harmonisation and processes to scale their solutions and enable mix-and-match.	• Major vendors can already collect experience with AI-driven network management functions and have a significant global pool of experts.	• Vendors have started to offer a wide selection of deployment option for each scenario. • Vendors can offer flexibility and AI-as-a-service or energy-saving as a service option.	• Larger vendors can offer a high level of standards, local experts and knowledge of the local environment.

Diversity in data residency: one size doesn't fit all

- Different network providers operate in different regulatory environments from a data-residency perspective, so vendors should offer a wide range of operational and commercial models for their AI-driven solutions. Flexible operational models can allow network operators to tailor solutions to satisfy local regulatory requirements while improving energy efficiency and contributing to CO_2 emissions reduction targets.

On the premises of the service provider	Public cloud	Vendor's own cloud
In case of a difficult regulatory environment or an operator's strict data management requirements, vendors can use operators' own infrastructure with limitations or in a federated-learning form.	Operators can use the local public cloud provider to run AI-driven services.	Vendors can provide comprehensive, turnkey solutions.

- **More control over the data**
- **Less exposure**
- **Harder to implement**
- **Ideal in a stricter regulatory environment**

- **Less control over the data**
- **More exposure**
- **Easier to implement**
- **Ideal in a more liberal regulatory environment**

Quotes from operators

*"*Optimizing energy utilization and driving energy efficiency in networks is massively complex. Despite the challenges, we will not shy away from meeting our environmental and sustainability responsibilities. We see big data, intelligent solutions, automation and new hardware and software solutions as being just some of the levers operators, vendors and partners need to embrace together.*"*

Head of Dynamic Energy Management Team, Europe

"We see automated capacity management – such as shutdowns and sleep modes – as a quick win in reducing energy demand. We are doing it in parallel with more transformational initiatives."

Technical Director, the Middle East

"Energy efficiency is an integral part of our network transformation strategy as well as our climate action strategy. AI-driven algorithms and modelling can enhance site resource configuration to optimize energy efficiency of on-site equipment."

Network Solutions Senior Director, Philippines

"We are strongly embedding energy efficiency throughout our value chain and are keen to develop AI-driven smarter and intelligent networks."

Principal Energy Insights Manager, Europe

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