Perspective

Open platforms are critical to operators' sustainability goals

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1. Executive summary

Telecoms operators are under unprecedented pressure to reduce their energy consumption and greenhouse gas (GHG) emissions, in order to achieve demanding targets for operating cost reduction and sustainability.

Sustainability strategies are multi-faceted and involve every part of the organisation, but energy efficiency in network and IT infrastructure plays a vital role. Networks and data centres account for around 85% of a Tier-1 operator's Scope 1 and 2 emissions and energy costs, and while modern technologies, such as 5G radios, are more energy-efficient than older systems, rising volumes of data traffic, together with increasing density of networks and edge data centres, will cancel out those gains if operators do not adopt radical new measures to understand and manage energy consumption and emissions.

Many operators have set ambitious sustainability targets and have begun to implement efficiency measures in networks and IT. However, so far, many have been physical measures such as decommissioning legacy networks, or have addressed just one network domain, such as the RAN. To maximise the impact of energy-efficiency strategies, it is critical that operators adopt digital strategies that harness open cloud-based platforms and advanced data analytics enabled by artificial intelligence (AI) and deep learning. Such platforms can support a wide range of applications to monitor, manage and predict energy use across an operator's networks and IT infrastructure, providing a holistic and proactive approach to energy efficiency.

Operators are increasingly aware of the need for open, cloud-based and multi-domain platforms if they are to hit their efficiency targets. In a recent survey of 62 Tier-1 operators, conducted by Analysys Mason, 35% said that AI-enhanced power management tools were one of their two top priorities for energy efficiency, and 31% said the same about cloud-based traffic management. However, there are still barriers to adoption of these new digital strategies. The most important relate to the siloed approach of most current systems. Almost 40% of the survey respondents, for instance, said that a lack of consistent data and analytics across multiple network and IT domains was a barrier to adoption, and therefore to achieving optimal energy-efficiency.

As their energy pressures intensify, operators are working with ecosystem partners to establish the requirements for a next-generation, cloud-based energy management platform that will maximise the effects of using tools such as AI and machine-learning (ML). The six key requirements identified by the operators in the survey are:

- an open cloud-based platform that maximises responsiveness and allows operators to access a broad base of innovations
- a holistic approach to energy management spanning all networks and IT
- a flexible cloud-based approach to software, that allows updates and actions to be implemented quickly and consistently
- a system that delivers sizeable results so that energy impacts can be assessed rapidly and accurately
- a system that provides clear data on network performance and how that may be affected by energy-efficiency measures, so that trade-offs can be minimised.

A fully open cloud platform, as opposed to a closed telco or vendor cloud, increases the impact of a holistic energy management system on all these operator KPIs, according to over 75% of operators, and facilitates the introduction of AI as new tools emerge.

It is important for operators to adopt a future-proofed strategy. An open cloud platform allows them to implement immediate measures that will deliver some benefits now, and expand the range of tools as new solutions emerge from the ecosystem. For instance, many operators have already cloudified their packet core, but will wait a few years before virtualising the RAN. If they implement the RAN on the existing open cloud platform, the impact of energy efficiency systems will be further amplified.

In order to win board-level support, it is crucial for operators to be able to quantify the benefits they will achieve from their new digital energy strategies. Some early adopters are starting to share their results, and the impact will only be increased as tools mature and, in the case of AI/ML, as operators amass more data over a longer period of time to support learning models.

Analysys Mason's survey identified 12 operators that had invested sufficiently in cloud-based energy management platforms to be able to provide some early quantitative findings. On average, they had achieved energy savings of 29% in networks and IT from these platforms and digital tools, combined with new power sources such as renewables, typically over a 3-year period. The most dramatic improvements were derived from implementing holistic cloud-based energy monitoring, to replace previous siloed data systems; and from moving from static to dynamic power control systems, including near-real time decisions on base station sleep/wake. Some of the improvements reported included a 52% improvement in energy data visibility, and an 18% reduction in network power cost as a direct result of AI.

As more operators start to invest in similar projects and to measure the impact, there will be an acceleration of adoption as confidence grows and the ecosystem broadens. This will be vital if the industry is to reduce energy consumption and emissions, challenges that will only become more business-critical as the decade progresses.

2. Telecoms operators are under pressure to reduce their carbon emissions and energy consumption

Telecoms operators and the wider ICT sector account for a relatively small share of global greenhouse gas (GHG) emissions and electricity consumption (~1.4% and 4%, respectively, in 2020)[1,2] but the sector's carbon emissions and electricity consumption have steadily increased over the past 15 years.[3] A radical decoupling of carbon emissions from electricity consumption, and an overall reduction in energy consumption is therefore required for the ICT sector to mitigate this upwards trend in carbon emissions.

Consequently, telecoms operators worldwide are facing increasing pressure, from a growing number of economic and stakeholder demands, to improve their sustainability and energy efficiency. Their most immediate concerns, and the ones that technology can address most directly, relate to the cost of energy. Efforts and actions to improve energy efficiency, however, are also important as part of the strategy to reduce Scope 1 and 2

1 In comparison with other industries (for example, the agricultural and transport sectors) accounted for 18.4% and 16.2% of GHG emissions, respectively, in 2020.

2 ICT Sector Electricity Consumption and Greenhouse Gas Emissions – 2020 Outcome by Jens Malmodin, Nina Lövehagen, Pernilla Bergmark, Dag Lundén: SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4424264.

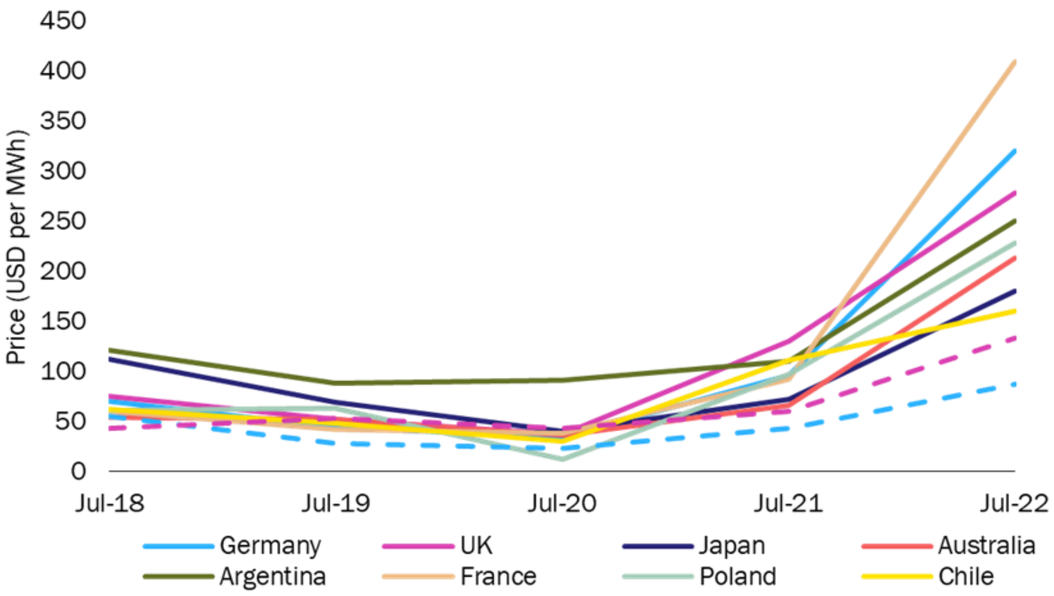
3 At the current rate, the ICT sector is unlikely to meet the goal set by industry bodies such as the International Telecommunication Union (ITU), GSM Association (GSMA) and the Science-based Targets Initiative (SBTi) to reduce GHG emissions by 45% between 2020 and 2030.

emissions and achieve such broader sustainability goals. Energy efficiency is of strategic importance to operators for the following reasons.

Increasing economic pressure

Energy costs account for a significant proportion of telecoms operators' operational expenses (20–40% according to the GSMA[4]). Recent geopolitical events and the COVID-19 pandemic have also put pressure on the global supply of natural gas, resulting in a significant increase in electricity wholesale prices in 2022 (Figure 2.1). These prices are unlikely to return to pre-2022 levels, as the global transition to a low-carbon economy will probably add further upwards pressure on costs.

Figure 2.1: Wholesale electricity price, selected countries, July 2018 to July 2022



Source: Analysys Mason

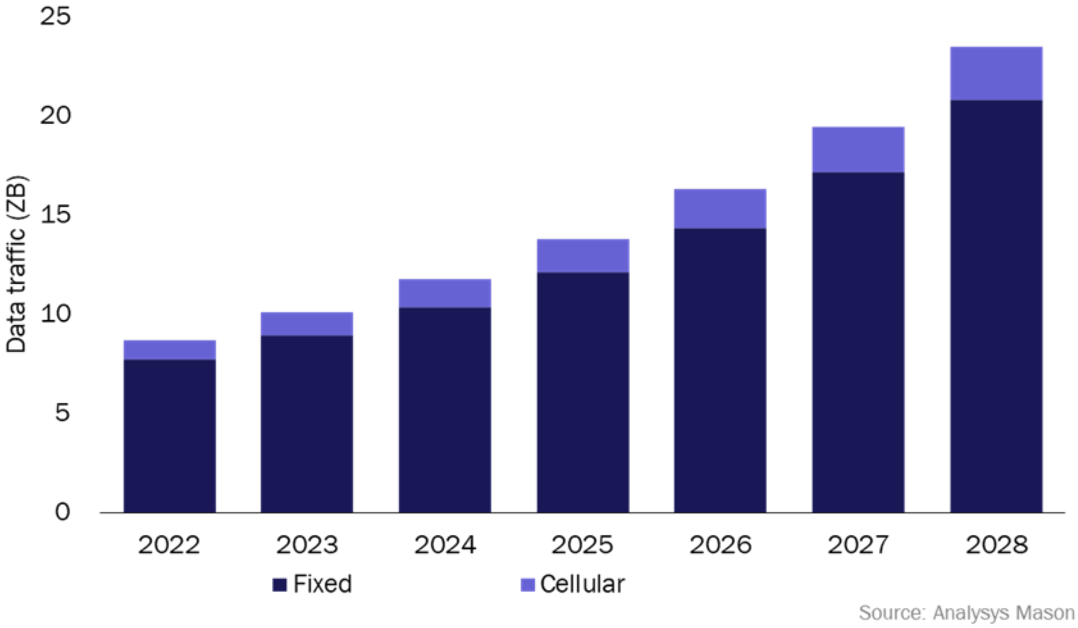
In addition, while the digitalisation and dematerialisation of the economy supported by telecoms network connectivity (alongside the digital services and platforms provided by other ICT parties) has been a key contributor to the sustainable development of industrial sectors,[5] it has also contributed to significant data traffic growth over the past few years, driving increasing energy usage for telecoms operators.

The increase in data traffic is likely to continue as the roll-out of high-speed broadband networks (for example, FTTx, 5G) enables further improvements in latency and bandwidth and expands the range of digital applications, both for consumers (for example, 4K–8K video streaming, metaverse services, in-vehicle infotainment, cloud gaming) and for businesses (for example, CCTV cameras equipped with artificial intelligence (AI), remote control of industrial machinery, telemedicine, augmented-reality (AR) and virtual reality (VR) support for industrial operations). Analysys Mason estimates that fixed and cellular network data traffic will continue to increase at CAGR of 17.9% and 18.8% respectively between 2022 and 2028 (Figure 2.2).

4 Mobile Net Zero: State of the industry on Climate Action 2023 – GSMA.

5 The Global e-Sustainability Initiative (GeSI), a cross-industry sustainability initiative creating and enabling digital solutions, has estimated that the ICT sector has the potential to enable a 20% reduction in global GHG emissions by 2030. GeSI SMARTer2030.

Figure 2.2: Total annual cellular and fixed data traffic, worldwide, 2022–2028



Concerns are growing among telecoms operators that increasing energy prices, combined with growing network energy usage, may result in spiralling energy costs going forward, driving the need to achieve improved network and operational energy efficiencies.

Mobile RAN already accounts for around 70% of an operator's energy consumption and whilst 5G was designed to be more energy efficient compared to previous generations of mobile technologies, rising number of cell sites and antenna elements (to support increasingly high-frequency/short signal range spectrum for 5G), cloud infrastructure and user devices compared to 4G means that without intervention, adding 5G to existing legacy networks could see energy usage increase significantly.

Therefore, transitioning to more energy-efficient networks should be a key priority for operators because savings can reverberate across the whole value chain. By reducing energy costs and protecting themselves from energy price spikes, operators could increase profitability and, ultimately, be able to pass those savings to customers, gaining a competitive advantage.

Tightening of legislation

Policy makers in many regions are strengthening their environmental reporting regulations, including the EU, the Middle East, the UK and the USA. In the long term, it is expected that operators in all regions of the world will need to abide by stricter emission disclosure requirements. Therefore, it is important that all telecoms operators increase their efforts to tackle emissions, particularly if they want their sustainability positioning to be viewed as credible.

Growing pool of environmentally conscious investors

Increasingly, investors are recognising that companies managing environmental factors (such as those related to the reduction of greenhouse gas (GHG) emissions) may be better positioned to create long-term value for shareholders. The rapidly growing value of funds related to environmental, social and governance (ESG) initiatives over the past few years illustrates this trend: Bloomberg estimated that ESG assets exceeded USD35 trillion in 2020 (up from USD22.8 trillion in 2016) and could surpass USD50 trillion worldwide by 2025.[6] As a result, operators have significant incentive to establish strong environmental credentials (for example, emissions reporting and commitments to reducing GHG emissions) to continue to attract investment and reduce the cost of capital.

Changes in consumer buying behaviour

Increasing consumer awareness and concerns about environmental issues implies that 'green' credentials have become an important consideration for operators to retain existing or attract new subscribers. A survey of mobile subscribers conducted by Analysys Mason in 2023 indicated that 22% of respondents based in Europe and the USA cited 'green' credentials as an important factor when choosing a new mobile plan.[7]

2.1 Operators are pursuing a range of initiatives to reduce emissions – some are reporting reductions, but progress across the wider industry is slow

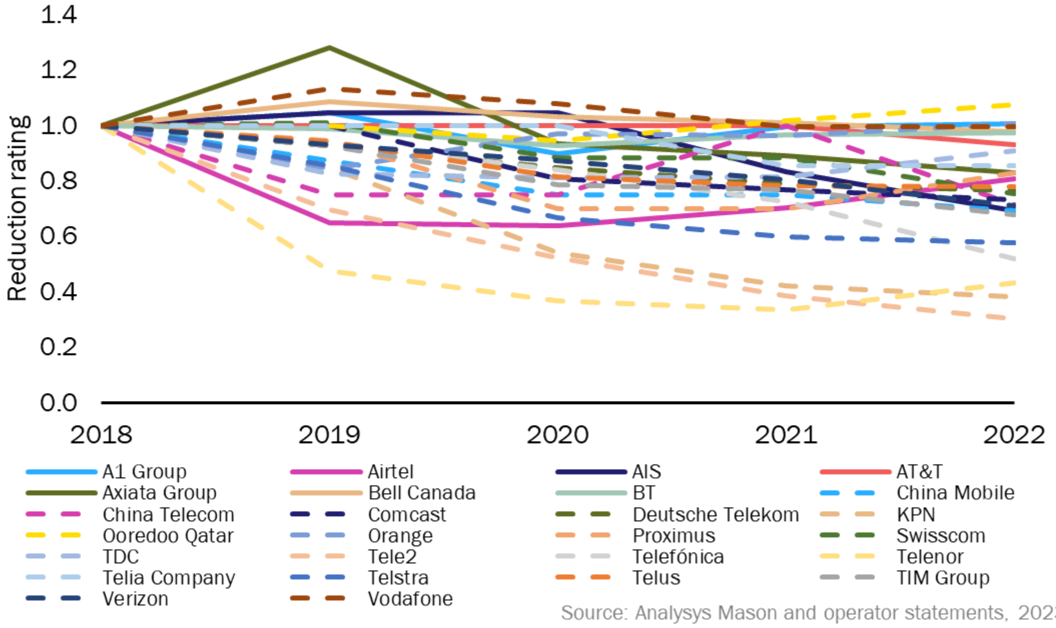
Many operators have set targets to reduce carbon emissions (particularly those for reaching net-zero), which are commonly presented as their main long-term sustainability vision. Targets are often in line with commitments to intergovernmental initiatives such as the Paris Agreement. These targets include limiting global warming to 1.5 degrees, reducing emissions by 50% 2030 and setting national 'net-zero' targets for 2050. Some ambitious operators have introduced nearer-term Scope 1 and 2 decarbonisation targets for as early as 2029.

However, many telecoms operators are yet to create plans for consistent GHG emission reductions across the entire value chain. A small proportion of operators have reduced their Scope 2 emissions (by purchasing and self-generating electricity from renewable sources), while the path to reducing Scope 1 emissions has been much slower (Figure 2.3). Although Scope 1 emissions commonly account for the smallest proportion of an operator's total carbon footprint, many are struggling to reduce their reliance on fossil fuels.

6 ESG Assets Rising to USD50 Trillion Will Reshape USD140.5 Trillion of Global AUM by 2025, Finds Bloomberg Intelligence | Press | Bloomberg LP.

7 Analysys Mason Research consumer survey 3Q 2023.

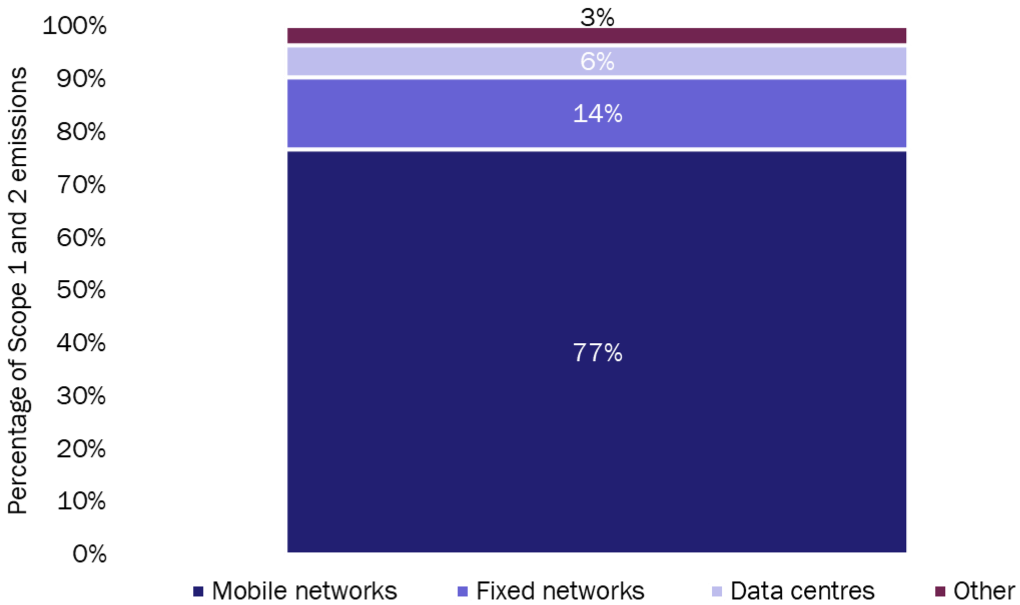
Figure 2.3: The current progress for Scope 1 emission reductions for a sample of global operators[8]



Source: Analysys Mason and operator statements, 2023

A few operators are starting to break down their emissions by technology in Scopes 1 and 2. Figure 2.4 shows the estimates offered by Telus of Canada, which show that the main focus of energy efficiency initiatives for a Tier 1 operator needs to be on the access networks, especially the RAN.

Figure 2.4: Breakdown of Scope 1 and 2 emissions, Telus, 2022



Source: Telus

8 2018 is taken as the base year and given a value of 1. Operators in the graph have reported Scope 1 emissions data between 2018–2022, without a change in reporting style. Source: Analysys Mason tracker of operator statements on ESG https://www.analysysmason.com/research/content/reports/supporting-esg-goals-ren01/

Similarly, Orange Group says that networks and IT account for 85% of its Scope 1 and 2 emissions while the rest is related to buildings, shops and vehicles.[9]

Even though general progress has been slow, operators can implement various initiatives and solutions to reduce their overall energy use and Scope 1 and 2 emissions. These initiatives can be categorised to support three main sub-objectives pursued by operators:

- improving the energy efficiency of their network infrastructure
- reducing energy consumption of their operations
- looking for alternative ways to source and store renewable energy.

Many operators worldwide are still in the process of developing a clear roadmap of initiatives to help achieve those objectives, but some are actively implementing a variety of measures (Figure 2.5).

Figure 2.5: Approaches to, and examples of, initiatives taken by telecoms operator groups to reduce their GHG emissions and energy consumption

Approach	Examples of initiatives
Network infrastructure efficiency	• **Deutsche Telekom:** decommissioning old wireless and copper networks from service (2G and 3G) • **Tele2:** implementing free-cooling systems to reduce dependency on synthetics refrigerants • **Telefónica:** increasing the use of power saving features during periods of low traffic and using AI/ML tools and automatic traffic prediction • **Vodafone:** using AI algorithms in passive infrastructure, enabling the company to optimise energy use and cooling • **Etisalat:** sharing sites and power with other operators in Egypt
Alternative ways of sourcing and storing energy	• **BT:** establishing renewable power purchasing agreements (PPAs) to lock in a cost-competitive price for renewable energy over a long-term contract (usually 10–20 years) • **Deutsche Telekom:** implementing fuel-cell technology into operations
Operational efficiency	• **AT&T:** phasing out vehicles with combustion engines and reducing fleet emissions • **Deutsche Telekom:** optimising energy use in buildings with LED lighting and IoT motion sensors

Source: Analysys Mason

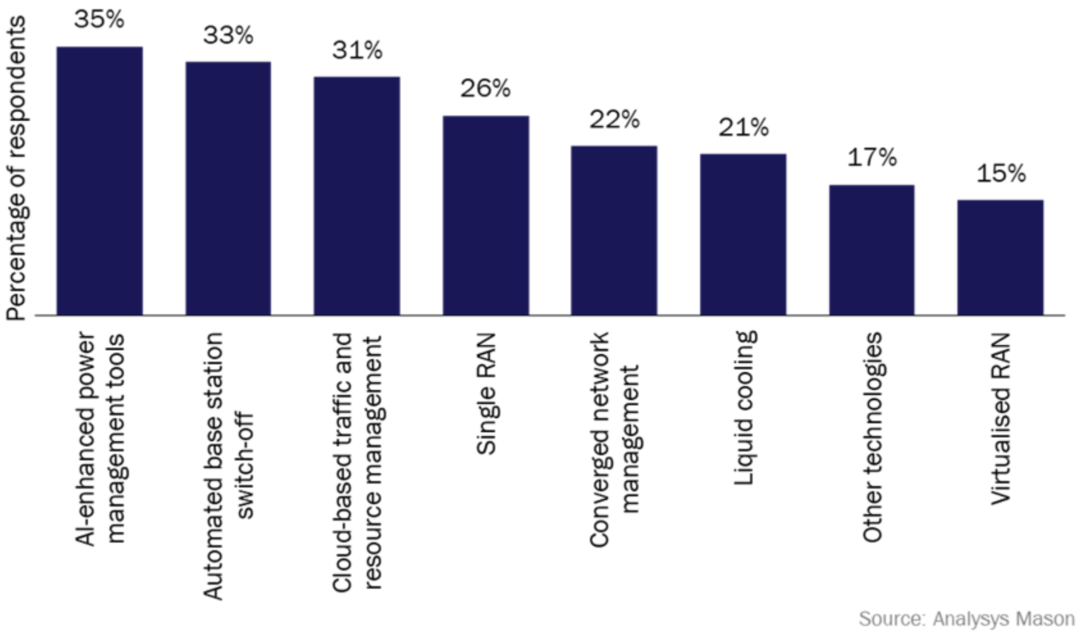
3. The energy management technologies and solutions adopted by operators have had limited success so far

Most of the strategies listed above are conventional, physical measures rather than digital initiatives. While important, they will not, on their own, achieve the reductions that most operators need. As pressures to reduce

9 https://newsroom.orange.com/orange-steps-up-efforts-to-reduce-energy-consumption-across-europe/

energy consumption and emissions grow, more operators will adopt digital energy management technologies and solutions to support their sustainability and efficiency objectives. According to a survey conducted by Analysys Mason, many operators expect to use AI, automation and cloud-based solutions to support energy efficiency in their network and data centre operations (Figure 3.1). Among 62 operators, 35% said that AI-enhanced power management tools were a top 2 priority for energy efficiency while one-third said the same for automation in base station on/off, and 31% for cloud-based resource management.

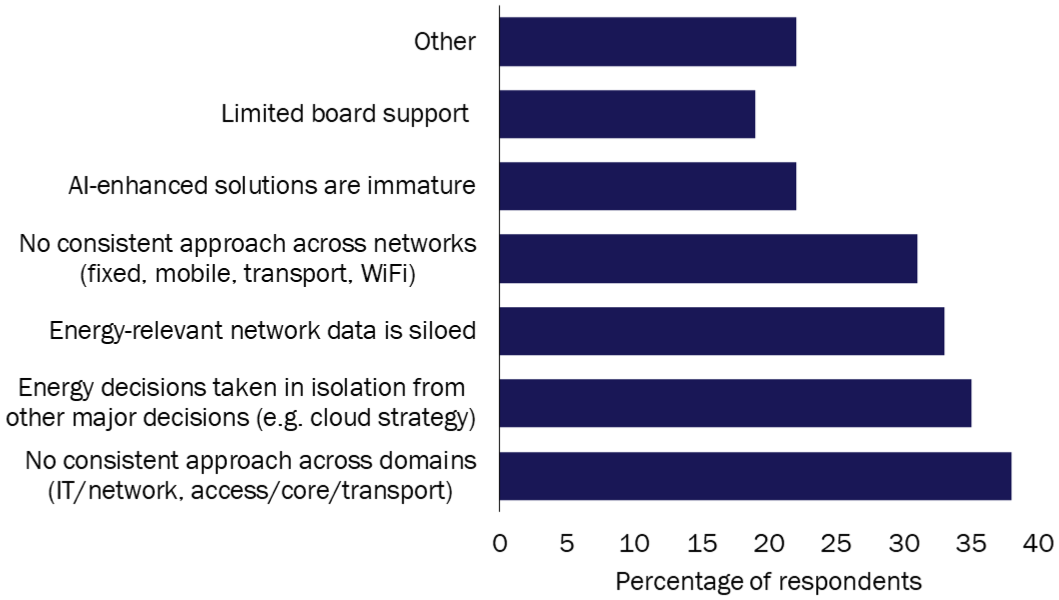
Figure 3.1: Technologies that operators expect to implement to reduce energy consumption in network and data centres [62 operators responded, each selected their two most-important factors][10]



However, for many operators there have been severe limitations on the effectiveness of first-generation energy management systems (Figure 3.2). In some cases, these limitations have deterred operators from adopting energy management technologies, while in other cases operators have made large investments to implement digital solutions without seeing significant improvement in their energy consumption and emissions.

10 Question: "Which technologies do you expect to implement within 3 years to help increase energy efficiency in networks and data centres?".

Figure 3.2: Barriers to achieving energy efficiency and emissions reduction goals within networks and data centres (62 operators responded, each selected two factors)[11]



Source: Analysys Mason

The operator survey revealed the main reasons for the limited results that most operators have achieved from first-generation energy management systems. The four disadvantages that were most commonly highlighted all relate to one overall challenge – the siloed nature of most operators' networks and data, which makes it impossible to monitor, manage and proactively plan energy consumption across the entire organisation. Almost 40% of operators said they had not achieved a consistent approach across different network and IT domains; 35% said decisions about energy consumption were not aligned with decisions about other aspects of resource and operations; over one-third said that the data they needed to make smart energy decisions was siloed and fragmented between different locations and applications; and that they had not achieved a consistent approach between different networks such as cellular, fibre or Wi-Fi.

The challenges these operators have encountered are because first-generation energy management solutions have generally been inflexible and non-dynamic. For instance, most equipment deployed by operators has some energy-saving features, such as base stations with automated on/off and sleep modes during periods of low traffic. However, these solutions work within pre-defined and static parameters that often do not align with real usage patterns, which can reduce potential savings and compromise quality of service.

AI-based solutions are emerging that enable operators to increase the effectiveness of traditional energy-saving features by supporting automated analysis of very large amounts of data relating to real-time traffic patterns and network resource availability, learning from past experiences. This allows for real-time decisions on how different elements of the network can be operated while optimising energy usage. Energy savings can then be dynamically adjusted to align with network performance and customer experience; ensuring that it meets operators' goals and KPIs. However, according to Analysys Mason's survey, 22% of operators felt that AI-

11 Question: "What are the most significant barriers, in your organisation, to achieving your energy efficiency and emissions reduction goals in networks and data centres?"

enhanced technologies are still immature and unable to provide the full range of stated benefits to support emissions reductions.

The potential of automated and AI-based energy management solutions is severely limited by the siloes that operators have identified. The power of AI is maximised when it can analyse disparate, cross-network and cross-domain data sets to yield meaningful insights. That will be important to ensure that the efficiencies AI enables significantly outweigh the energy that AI systems may consume through intensive data processing. Siloed data makes it challenging to leverage AI to the maximum, or to implement energy management solutions that can take a holistic view of energy consumption in different domains and networks. Storing data in silos also increases the time taken to generate insights and limits its ability to inform both business and energy-related decisions.

Another challenge relates to the lack of temporal data from 5G deployments, which are in their early days. Data from LTE networks cannot be parametised to model 5G network behaviour, nor data from 5G NSA networks to model 5G SA. To build confidence as quickly as possible, it will be important for AI systems to be able to access as much relevant data as possible in a short time, from multiple sources including partners.

3.1 Operators need a clear framework of 'green' KPIs

To measure the impact of energy management technologies and initiatives on an operator's carbon emissions and environmental goals, it is crucial for operators to establish a clear framework of relevant 'green' key performance indicators (KPIs). Several standards bodies and non-profit organisations have defined a range of green indicators explicitly for the ICT industry. These aim to improve the tracking of the environmental impact and energy efficiency of an operator's ICT equipment and network facilities, and go beyond the use of the absolute carbon emissions and energy consumption metrics. However, despite the existence of ICT-specific indicators, there is currently no standard practice about how operators can effectively use indicators to track carbon emissions and energy efficiency across their entire network and operations. In addition, the way that operators collect, analyse and manage emissions and power consumption data are non-standardised and often fragmented.

Operators need for a platform that can provide them with a set of indicators offering end-to-end visibility of energy usage across networks and operations, and can help collect and visualise data effectively to provide data-driven guidance on the implementation of the most effective initiatives to reduce emissions. Ultimately, this can help support operators in meeting their long-term environmental and development visions.

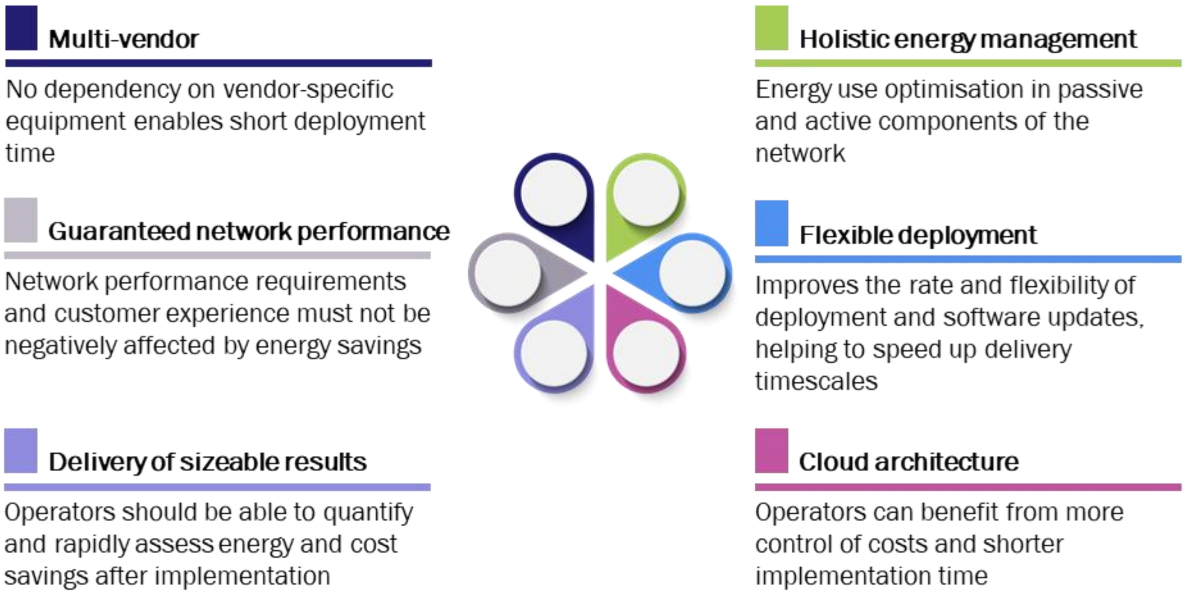
4. Sustainable digital transformation is essential to support operator energy efficiency goals

Operators face a range of challenges on their path to sustainable networks and business operations, and many of these can be addressed by the adoption of cloud-native technology, which in turn helps to enable highly automated, flexible and holistic data platforms that can optimally leverage AI. A cloud platform is the starting point for massive data learning and holistic energy management, and these technologies have the potential to improve data collection, observability and flexibility, while allowing operators to develop a common and interlinked approach across all domains and networks. However, in order to maximise the benefits of cloudification and to effectively support energy-saving strategies, operators must adopt a platform approach that equips them with the advanced tools, open interoperability and rich data required to monitor and action their sustainability strategies. Only then can an operator's cloudification journey reduce their carbon footprint and maximise their energy and cost savings.

4.1 Sustainable digital transformation is essential to support operator energy efficiency goals

To successfully drive progress towards sustainability goals, it is vital for operators to adopt an open cloud strategy that supports the technologies and processes that will help achieve sustainability objectives. The diagram in Figure 4.1 demonstrates the major considerations or benefits of cloudification that operators hope to achieve to improve the sustainability of their networks, based on an open cloud platform capable of supporting AI and massive data analytics and learning. These factors are essential in maximising efficiency gains and building the most sustainable networks. They will also help to manage those elements of the network that cannot be cloudified, such as mobile antennas, in the most sustainable way, for instance with automated wake-up/sleep processes controlled by AI, for base stations and access points.

Figure 4.1: Key benefits that operators hope to achieve from their ideal cloud-based energy-saving solution

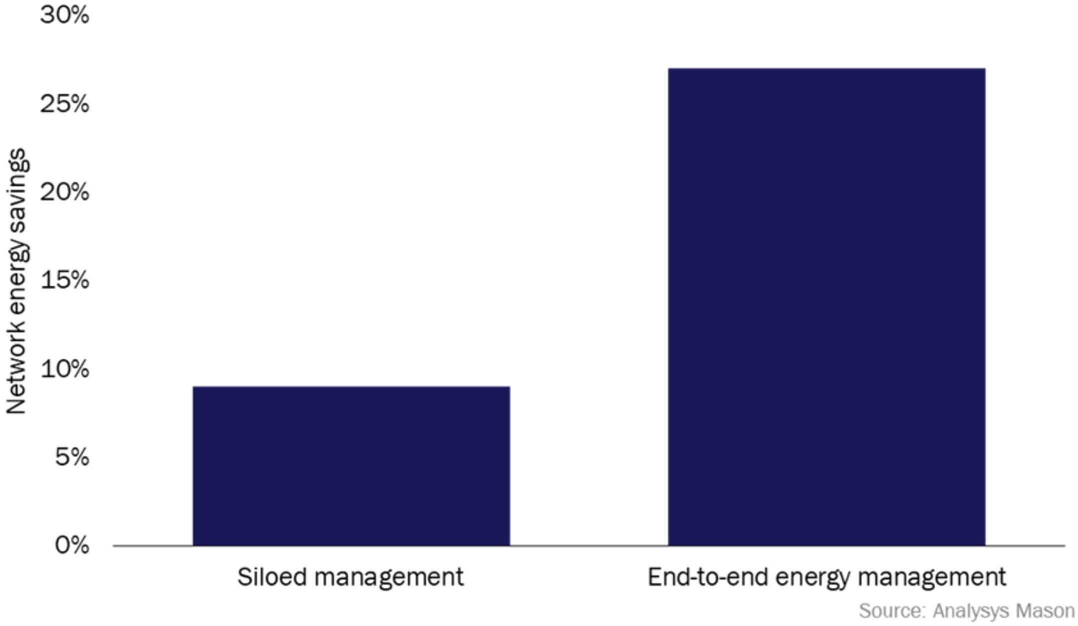


Source: Analysys Mason

Multi-vendor. Operators value an approach that enables them to access innovation from a wide range of hardware and software providers.

Holistic energy management is also one of the main goals operators aim to achieve from implementing an open, flexible cloud platform that optimises the use of a wide range of data tools to improve energy efficiency. As discussed in section 3.0, one of operators' main challenges in sustainability relates to the lack of consistent approach across domains and networks (Figure 4.2). Holistic control, monitoring and data processes across different domains and networks can create a common architecture and increased interoperability between different domains and networks. Systems can then be built that draw on common data resources, and expose common control functions, across all domains, allowing operators to track progress, make decisions and implement actions from a centralised location. This makes information easier to digest, allowing for better planning, greater visibility on network-wide initiatives, and leads to more effective actions.

Figure 4.2: The difference between anticipated network energy savings achieved with a siloed domain-based approach and an end-to-end approach – consensus estimates of 62 operators



Flexible deployment. One of the most immediate impacts of hybrid cloud is that it enables flexible deployment, allowing operators to easily scale and update their networks. This supports dynamic energy management techniques such as deciding on base station wake/sleep in response to real-world traffic patterns rather than pre-set parameters such as time of day. A hybrid or multi-cloud approach will be important to maximise the flexibility and resilience of the systems.

Cloud architecture and SDN. By transitioning to software-defined networks (SDN), operators are increasing their use of general-purpose compute, which compared to specialised processing can be implemented or updated more quickly and from a central location. In conventional networks, operators require new physical RAN and core equipment to make use of new standards or capabilities. However, by using general-purpose open cloud servers, operators can update their infrastructure largely in software. Operators can therefore reduce the amount of new hardware needed to update their networks, reducing hardware wastage and also the emissions and costs relating to integrating that hardware.

Sizeable results and de-siloing: Cloudification is also extremely important in supporting operators with their 'data dilemma'. 33% of operators consider the siloed nature of energy data in their networks to be a critical barrier to reaching their energy and emissions reduction goals. This refers to both data being siloed across domains and networks, but they also suffer from siloed information about other indicators, such as their renewable energy mix, energy prices, the performance of cell site renewables and batteries, the environmental costs of call outs, or KPIs for network performance. A sustainable cloud architecture can provide a common platform where this data can be collated, analysed and actioned upon, holistically and in an automated way. This then allows operators to make the most informed decisions to improve their sustainability, whilst also being able to report it clearly and have visibility on progress. These techniques allow results of various decisions to be assessed very rapidly, many results collated, and sizeable learnings achieved.

Guaranteed network performance. Other important targeted benefits are to allow many vendors' software and tools to be easily deployed via the open platform (see below), and of course, it is essential that energy efficiency is not achieved at the expense of network performance and quality of experience. By correlating many types of network, traffic and energy data in the open platform, it becomes easier for operators to strike the optimal balance between network performance and energy savings.

4.2 Operators must adopt a holistic and open cloud platform to achieve the optimum level of sustainable innovation

In order to maximise network energy saving and reductions in emissions, operators must not just migrate to the cloud, but ensure that the platform is open. This will greatly amplify the foundational benefits of cloudification by supporting open application and inter-domain interfaces, open frameworks and data sets, and access to a broad innovation base. A common and open platform approach is the only way to achieve a strategy that manages energy efficiency in every domain in a consistent way, and that can relate ESG decisions to the rest of the network and IT, to understand the impact (and trade-offs) holistically. A cloud platform must be open and container-based and offer deep levels of observability for both cloud-native functions (CNFs) and virtualised network functions (VNFs) in an operator network as well as their IT and cloud footprint.

An effective and open cloud platform can drive a range of additional energy and sustainability management benefits for operators. These include the following.

- **Maximising cloud flexibility and agility.** Workloads and traffic can be managed dynamically across multiple networks.
- **Optimising use cases and workloads.** Can be located in different parts of the cloud and network depending on their performance demands, and allocated to smart network interface cards (NICs) or other dedicated processing to improve efficiency.
- **Dynamic sleep.** Facilitates flexible and dynamic powering-down of applications, cloud infrastructure or individual processors when idle.
- **Effective distribution of core functions.** For example, pulling the user plane function to where it is best-placed to achieve the optimal latency/energy efficiency balance.
- **Enables full automation.** Facilitating zero-touch optimisation and the automated powering-down of hardware.
- **Improved service agility and hardware lifetime.** Non-dedicated hardware can be used, resulting in less hardware wastage and need for upgrades/updates. Dedicated processors are only used for certain tasks.
- **Improved data observability.** Allows for improved and simplified data collection and aggregation from a range of networks, domains and sources to track progress and improve decisions.
- **Enables use of open-source software.** Third-party tools and solutions from multiple vendors can be integrated with the platform and can act on data exposure, and to facilitate access to open consensus-driven data sets and energy KPI definitions.
- **Fault detection/resolutions.** Improved analytics and observability support the move towards no call outs/zero-touch provisioning.

- **Introduction of AI.** Facilitates the introduction of AI, provides the observability required for an AI solution to act and can then manage the cloud resources effectively for that AI.

- **Improved controllability of energy assets.** For example, battery power, solar panels, wind turbines. Management of these additional assets must be consistent and centralised.

- **Some of these benefits, such as improved data observability, agility, flexibility, and dynamic sleep, are inherent in cloud-based platforms.** However, all of these benefits can be maximised when a platform is open and allows third-party applications and tools to integrate and deliver actions based on exposed data. As a result, it is essential that operators consider the openness of their cloud platforms because openness will ensure the deepest, most holistic and most flexible approach to reaching sustainability goals.

Analysys Mason's research demonstrates that an open and holistic platform approach not only delivers a range of additional benefits, but also more effectively supports operators in achieving their core cloud-driven sustainability goals, delivering additional benefits on top of those of the cloud itself. The effectiveness of a platform approach compared to that of closed telco cloud (or vendor-proprietary cloud) in each of these areas is demonstrated in Figure 4.3.

Figure 4.3: Assessment of the impact on energy efficiency of an open and holistic cloud platform compared to a closed data centre or telco cloud[12]

	Closed telco cloud	Open cloud platform
Multi-vendor	●●◐○○	●●●●◐
Holistic energy management	●●●○○	●●●●◐
Guaranteed network performance	●●●●○	●●●●●
Flexible deployment	●●○○○	●●●●●
Delivery of sizeable results	●●●○○	●●●●◐
Cloud architecture	●●●◐○	●●●●●

Source: Analysys Mason

4.3 The open cloud platform approach will facilitate the introduction of AI, where appropriate

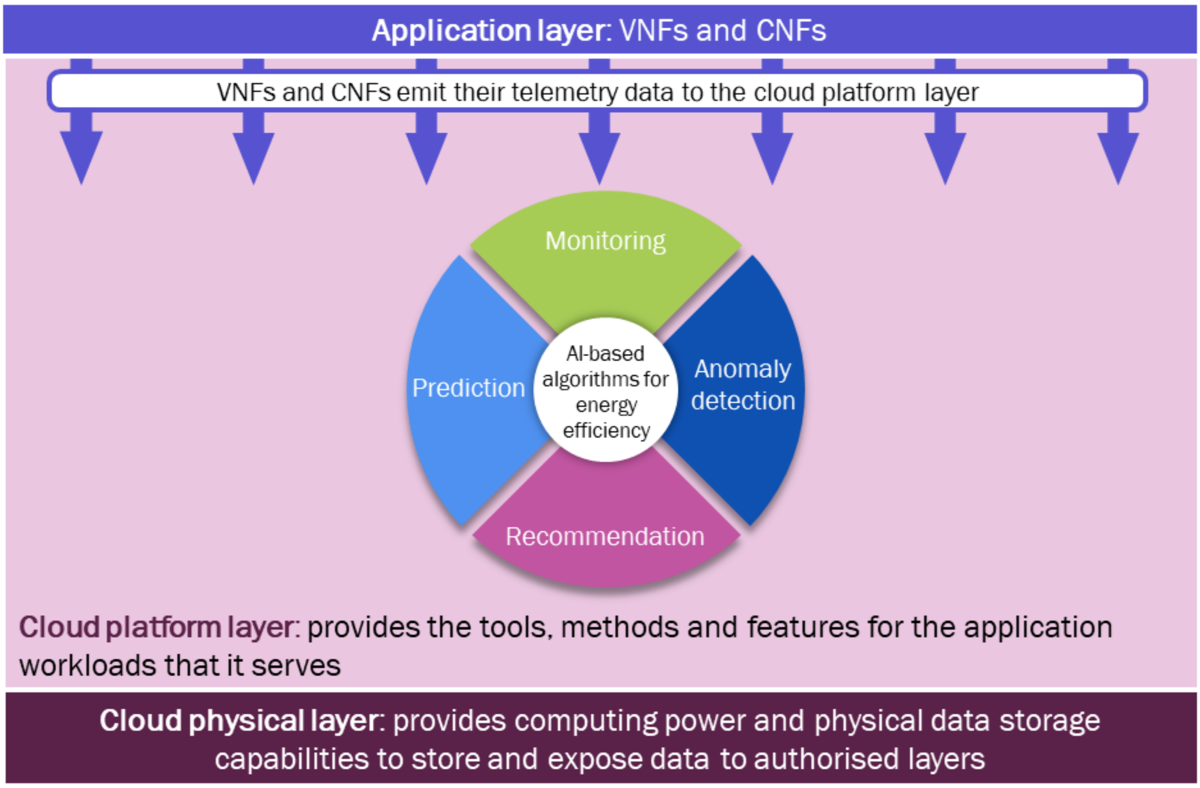
In addition to driving flexible, agile and automated network environments, a cloud-based network platform creates an enabling environment for the use of AI to further facilitate energy-efficient networks. The intelligence that can be derived from AI-based algorithms running within the platform or provided by third-party tools will

12 Respondents to the Analysys Mason operator survey were asked to estimate the level of impact on energy efficiency, on a scale of 1 to 5, of achieving the key technology changes outlined above.

be driven by the consolidated and cross-domain data stored within and exposed by the platform. This intelligence therefore provides a well-rounded view of the network to ensure that actions taken to manage energy consumption in one part of the network do not compromise performance in other parts of the network or the overall service quality and customer experience.

A cloud-based network platform can create a common repository for the collection, storage, analysis and exposure of telemetry data related to network functions operating within this platform and other network components operating outside the platform (Figure 4.4). This telemetry data (known as observability data for CNFs) provides valuable information such as type and volume of traffic being carried and other network and IT related data. This data can be analysed to help understand the trends associated with the energy consumption across the network. However, getting to these insights using traditional analytical workflows will prove challenging given the large data volumes and the speed of analysis that needs to occur to drive power savings.

Figure 4.4: A cloud platform that embeds AI to analyse network, IT and multi-cloud data to improve energy consumption



Source: Analysys Mason

AI-based algorithms can address this challenge. AI techniques such as machine and deep learning can be used to train models using massive volumes of data from the network stored within the cloud platform. These trained models can define the behaviour of the network and its components, and the minimum energy levels they will need in various traffic conditions including high, medium and low traffic volume scenarios to perform optimally. The model can then be applied to network data within the platform in real time to monitor and detect any anomalies between traffic and power consumptions levels and once an anomaly occurs, an automation workflow can be triggered to save energy. Other factors such as overall service performance can also be modelled alongside power and traffic levels to ensure that decisions taken based on AI model and other insights do not have a negative impact on service quality levels.

These models can also make predictions and based on their training recommend the actions to take. For example, an AI-based algorithm can be used to automatically reduce energy consumption of an NFV data centre by dynamically adapting the power of the data plane VNFs based on the traffic they are carrying. The algorithm can also be used to move workloads from one cloud to another in order to reduce CO_2 footprints while maintaining performance and regulatory compliance

Some operators have applied AI-based solutions within a cloud platform either commercially or in trials. For example, Cosmote of Greece ran a trial AI-driven solution and achieved 14% savings, on average, over a 24-hour period with a peak saving of 35% during the lowest periods of traffic.[13] The majority of these implementations address energy savings within specific layers of the network such as base stations (e.g. an Orange research project has found that deploying AI at cell sites can reduce power consumption by 5–7%, with current data based on 4G and 5G NSA[14]), or NFV data centres (e.g. Intracom[15]). However, by extending the modelling capabilities of AI systems to include power consumption levels across multiple network environments, operators can position themselves to achieve more effective energy saving solutions.

Although AI solutions are not unique to cloud environments, their impact will be magnified when combined with the open, holistic and dynamic capabilities of open cloud-based dynamic energy management, as described above.

4.4 The RAN is the most energy-hungry element of a network, and Open RAN will address some challenges in the future

For most operators, the RAN will be the last network domain to be cloudified and with a few exceptions, virtualised RAN (vRAN) is some years away. Analysys Mason forecasts that it will be 2026 before more than half of operators have embarked on vRAN.[16] However, since the RAN accounts for as much as 70% of telecom network energy and cost, operators are interested to apply the benefits of cloud-based energy management to this domain as platforms mature. As well as potentially driving a TCO saving of 22%, the move to vRAN/Open RAN could also provide a route to greener networks, bringing cloud platforms to the entire mobile network, increasing network flexibility, agility and function exposure.

Figure 4.5 highlights the level of energy savings that the operators surveyed by Analysys Mason expect, to achieve on average within 3 years of deploying vRAN. As in other domains, an open vRAN cloud platform will maximise the benefits, when compared to a proprietary vRAN.

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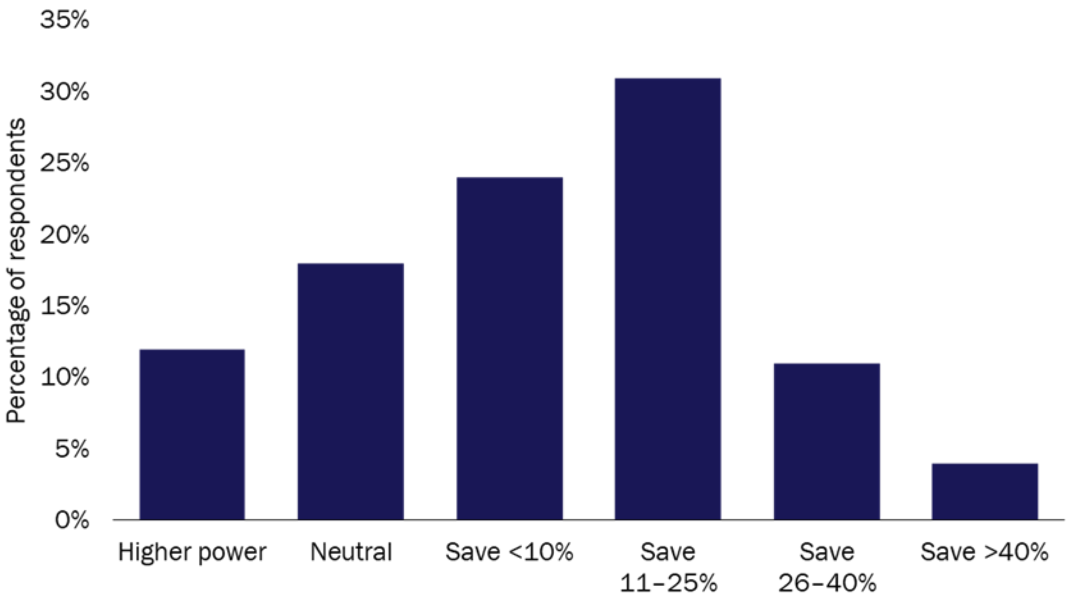
13 Source: TMForum (https://inform.tmforum.org/research-and-analysis/case-studies/cosmote-trials-ai-driven-nfv-energy-savings-to-deliver-more-sustainable-5g-edge-computing).

14 www.orange-business.com/en/blogs/greening-telecoms-network.

15 www.intracom-telecom.com/en/products/telco_software/big_data_ai/cognitiva.htm.

16 www.analysysmason.com/research/content/reports/ran-worldwide-forecast-rma18.

Figure 4.5: Expected energy savings from vRAN (% of operators expecting savings within 3 years of deployment – n=82)



Source: Analysys Mason

As well as providing greater control, flexibility and automation in the network, virtualised and open RANs are expected to drive more opportunities for network sharing, allowing operators to share radio infrastructure on a per site basis, improving resource utilisation and energy efficiency. Combined, these potential benefits could drive significant energy savings, with most operators expecting energy savings of 11–25% within 3 years of their vRAN deployments, according to Analysys Mason's operator survey of September 2023. At the same time, the cloudification of the RAN also brings further benefits in terms of hardware lifecycles and less wastage.

In order for operators to maximise the TCO, energy efficiency and sustainability benefits of vRAN/open RAN, the networks must be supported by an open, hybrid cloud platform that supports massive data learning and flexibility. This will allow all the benefits of the platform approach to translate deeper into operator networks, significantly increasing their efficiency. However, migration to vRAN is a huge effort and it is important that operators do not wait until they are ready to deploy vRAN before then adopt cloud-based energy systems. Instead, they must ensure their cloud platform is future-proofed so that it can support vRAN when that becomes commercially viable for the operator, while targeting near-term efficiencies in other domains in the meantime.

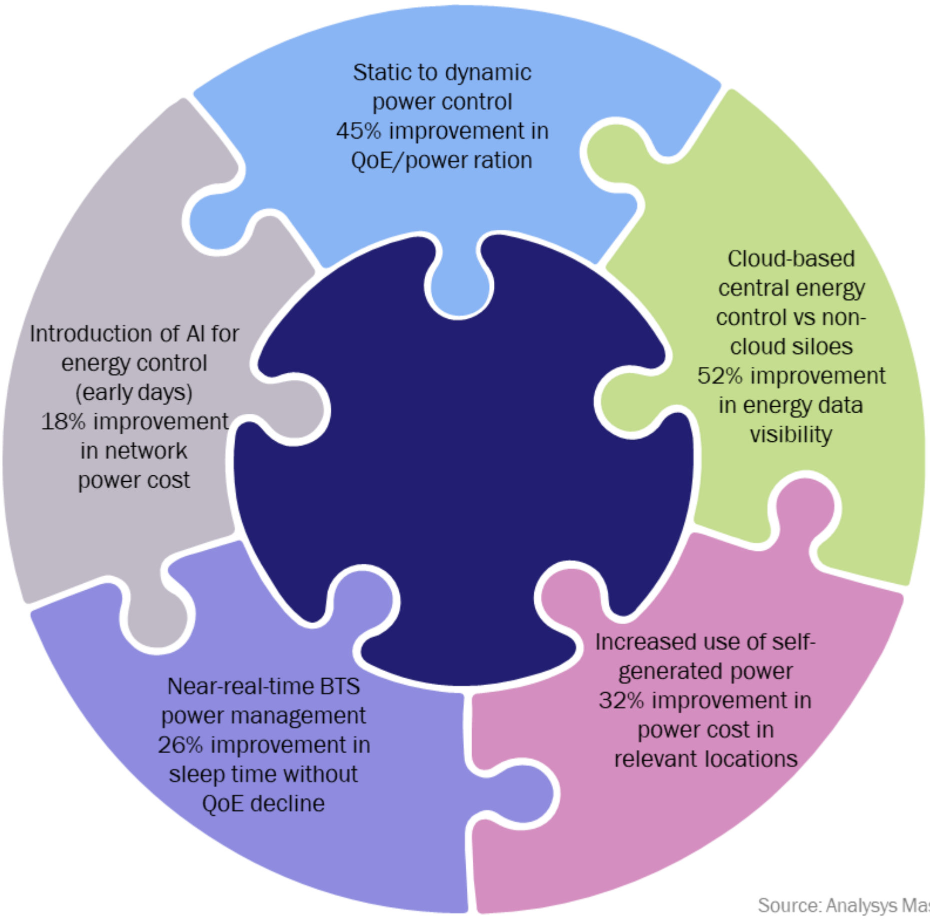
5. Early adopters are starting to quantify the energy efficiency benefits of open cloud platforms

As we have described in this paper, an open cloud platform can have a significant impact on an operator's strategy to reduce energy consumption and emissions. In the near term, the most important contribution it makes, in the views of the operators surveyed by Analysys Mason, is to break down data and domain siloes and allow for a holistic view of energy usage across every element of networks and data centres, and end-to-end, top-to-bottom observability of the effect of different actions and mitigations. This enables operators to maximise the impact of any strategies they adopt to reduce energy consumption.

The platform can therefore deliver short term wins, and its openness enables new vendors, applications and tools to be added over time without disrupting the foundations, to enhance the effectiveness of the energy efficiency strategy still further and ensure it remains aligned with other key objectives such as strong network performance. For instance, increasingly sophisticated degrees of AI/ML may be implemented to improve learning, prediction and decision-making, while some operators will deploy Open RAN functions on their cloud in future, delivering yet more benefits.

However, these strategies still represent cost and risk for operators, which may struggle to gain board-level executive support (one of the main barriers identified in Figure 3.2) if the benefits cannot be proven and quantified. These are early days both for operator open cloud platforms and for comprehensive energy efficiency strategies that span all domains and networks. However, some of the early movers in deploying open cloud platforms for sustainability are starting to share the results of their initiatives. Analysys Mason's survey identified 12 operators that had invested sufficiently in these platforms to be able to provide some early quantitative findings about the impact on energy efficiency. The most important factors are illustrated in Figure 5.1, with the average improvements that these operators reported as a result of five significant energy efficiency initiatives, four of them related to holistic software and cloud platforms and the fifth to alternative sources of power.

Figure 5.1: Average improvements over a 2-year period related to selected energy efficiency levers (average results based on 12 operators that have initiated these strategies in 2021 or earlier



Source: Analysys Mason

The most dramatic quantified improvements in energy cost and efficiency were identified, by this base of operators, in migrating from siloed viewing and managing of energy-relevant data, to cross-domain cloud-based energy control. On average, in the first 2 years, the 12 operators achieved more than 50% better visibility of energy data and impacts across networks and data centres, through holistic data strategies, leading to more meaningful decisions.

Another important migration was from static to dynamic power control. A cloud-based system was able to change parameters on the fly rather than relying on inflexible, pre-set assumptions, and this resulted, on average, in a 45% improvement in a very important metric for operators – not simply power efficiency, but the ratio between power efficiency and network quality of experience (it is clearly essential that energy efficiency measures are not implemented at the cost of user experience).

The impact of AI is only just starting to be quantified and only 9 of the 12 respondents had implemented these technologies for sufficient time to be able to report quantitative results. In these early stages, they had already seen an 18% improvement, on average, in overall network power costs, compared to non-AI solutions.

As more operators start to invest in similar projects and to measure the impact, there will be an acceleration of adoption as confidence grows and the ecosystem broadens. Already, large operators such as Deutsche Telekom are starting to feed some of the knowledge and insights they have gained from their projects into cross-industry forums, which will help to deliver a common set of frameworks, data sets and KPIs to simplify adoption and reduce risk for other operators in future.

6. Recommendations for operators

Achieving optimal energy efficiency across all network and data-centre operations is increasingly business-critical for operators, in order to reduce operating costs, improve quality of experience and improve sustainability. It is important that operators act quickly, putting in place measures that can deliver immediate results, but also investing in an open cloud-based platform on which future technologies can be layered relatively simply as they emerge, increasing the overall impact of the energy systems.

- **Identify technologies and initiatives that are available now** and quantify the near-term impact, in terms of implementing energy management systems, that will increase efficiency while preserving quality of experience, and amplifying the effect of any non-software strategies such as increasing use of renewable or self-generated energy sources.

- **Ensure that all these short-term measures are implemented within an open, enterprise-wide, cloud-based platform.** This will enable emerging technologies and tools, such as AI/ML, to be added in a seamless manner as these developments become mature and as the operator can quantify the likely impact. The operator will gain access to a broad base of innovation and experience in energy management.

- **The open cloud platform should be carefully future-proofed so that every network and data centre domain can be added progressively as the business case permits.** For instance, many operators will initially apply energy efficiency measures to the core and IT operations, which are likely to be cloudified first, and then achieve even greater efficiencies as they add vRAN and transport in future

7. About the authors

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Rupert Wood (Research Director) is the lead analyst for our *Fibre Infrastructure Strategies* and *Wireless Infrastructure Strategies* research programmes. His research covers the following areas: the evolution of operators' investment priorities; operator business structures; business models for FTTP and convergence; fixed broadband technologies; the economic impact of digital transformation; capex forecasting; and network traffic forecasting. He has extensive experience of advising senior management on strategic issues.

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