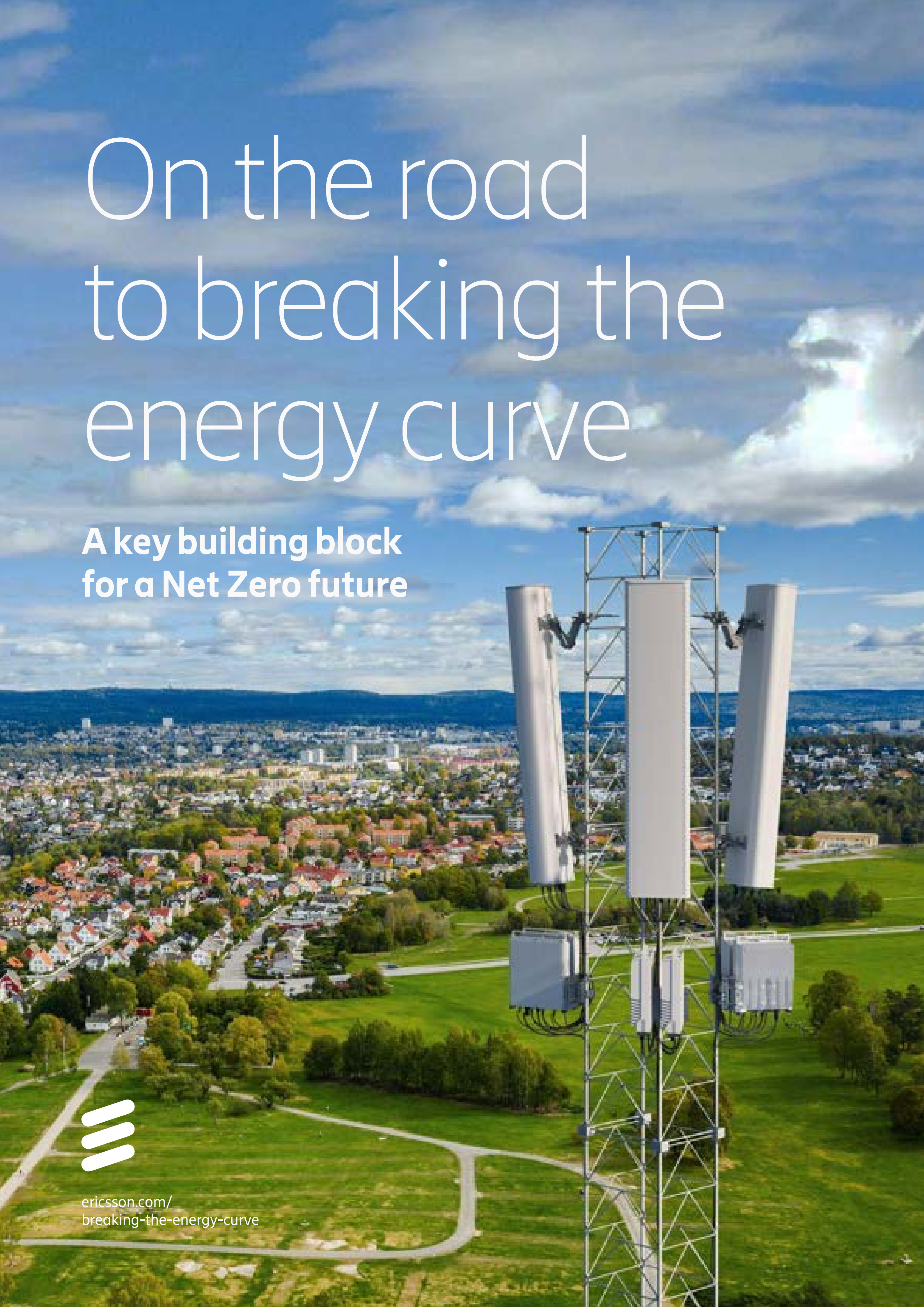
On the road to breaking the energy curve

A key building block for a Net Zero future



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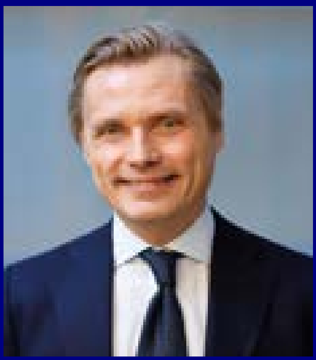
breaking-the-energy-curve

Foreword



Fredrik Jejdling
Executive Vice President
and Head of Business Area Networks

Every sector of society must work together to reach the global climate and energy challenge. Net Zero is the North Star of climate action and focusing on mobile networks will be key for the industry. Breaking the energy curve of mobile networks will have the benefit of reducing energy use, costs and environmental impact.

Ericsson has set the ambition to be Net Zero across our value chain by 2040. The first major milestone in 2030 will be to reduce supply chain and portfolio in use emissions by 50% and be Net Zero in our own activities at the same time.

Since our last report, where we focused on achieving energy savings in the transition from 4G to 5G networks, we've continued to learn and explore.

We drive sustainability in networks through improved energy efficiency in our solutions and integration of renewable energy sources, while increasing performance with more innovation and accelerating the build of nationwide fully performing 5G.

As one example of this in practice, we have the ambition to reduce the energy consumption of a typical new site by approximately 40% between 2021 and 2025. Together with the transition to more renewable energy sources in mobile networks, the resulting CO_2 emissions per site can potentially be reduced by around 70%.

At Ericsson we have both the experience and foresight to plan, deploy and operate networks that prioritize performance and generate energy and cost savings.

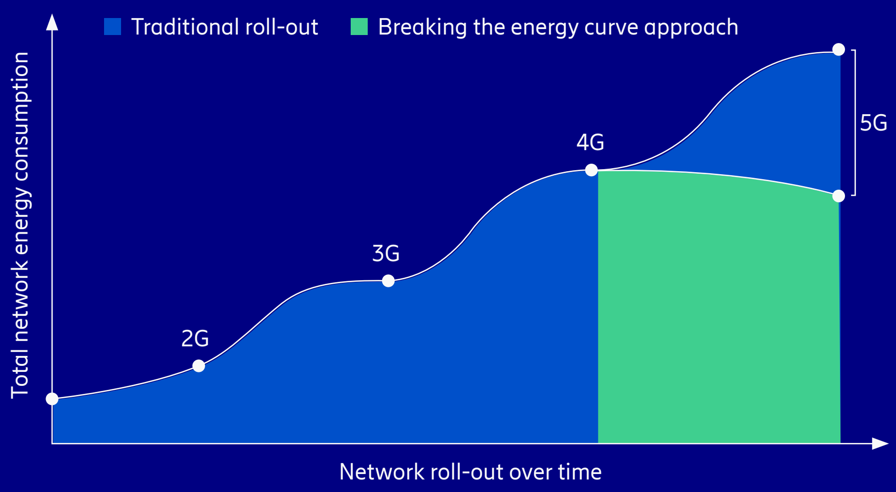
5G is here, and while the expansion of this connectivity continues and the benefits of an energy conscious, future-proof portfolio are evident, it's simply not enough on its own just to dramatically reduce energy consumption for entire mobile networks.

We cannot continue with a 'business as usual' approach. We must take advantage of wider network changes and modernization as opposed to piecemeal swap-outs. We must utilize the latest technology advances to enable energy-saving functionalities to the fullest and consider our energy sources.

To put it simply, we need to think differently.

At Ericsson we have both the experience and foresight to plan, deploy and operate networks that prioritize performance and generate energy and cost savings. By taking a holistic view of network evolution, expansion and operation, we have advanced our approach to break the upward trajectory of energy consumption in mobile networks.

Figure 1: Breaking the energy curve in mobile networks



Enabling Net Zero

The ICT industry plays a decisive role in enabling the critical and exponential climate action demanded today by investors and regulators, and has the potential to reduce total global industrial emissions by up to 15%. These demands are spurred on by intensifying pressures from consumers, customers and the wider supply chain.

To meet these demands and align with the global 1.5°C ambition set by the Paris Agreement, businesses must adopt a full value-chain approach to setting climate targets according to a Net Zero timeline – with a commitment to halve total emissions by 2030 and reach a Net Zero state by 2050.

In order to reach Net Zero, it is important to reduce energy consumption and break the curve.

Net Zero

Net Zero describes a state where, for all greenhouse gas emissions emitted, the same amount is absorbed from the atmosphere. As the North Star of ICT climate action, the ITU (International Telecommunications Union) Net Zero standard sets a pathway for ICT businesses to set Net Zero targets and strategies, and provides the sector with the actions needed to achieve this.

By following the ITU Net Zero standard, which both integrates the ICT sector decarbonization trajectory developed by the ITU and aligns with Ericsson's blueprint to breaking the energy curve, ICT businesses can reach a critical 2030 intermediate target by:

- reducing and avoiding emissions, for example by reducing energy consumption
- transitioning to 100% renewable energy sources
- abating small, residual fossil fuel emissions through permanent carbon removal in accordance with the ITU standard

Reaching Net Zero by 2050 also demands action that goes beyond energy efficiency, and covers embodied carbon in product development, content of recycled materials, increased circularity, and reduced footprint of software, as well as developing supply chain targets and partnerships that quantify the business impact on other sectors. Energy efficiency will not take us all of the way.

According to Ericsson's research, mobile networks represent about 0.2% of the global carbon emissions, and about 0.6% of global electricity use. The demand on mobile networks will continue to grow and without action, energy use and related emissions will too. However, the link to increased energy consumption is not so much one of increased subscriptions and traffic growth, but of the deployment of new frequency bands and network equipment, reflected in increasing population coverage with multiple mobile generations. This is a critical area where, together, the industry can make a difference.

Championing renewable energy

In order to reach Net Zero, it is important to reduce energy consumption and break the curve. Where energy consumption is responsible for 20–40% of operational expenditure (opex) for communications service providers, Ericsson's research shows that if the entire ICT industry switched to renewable energy sources for all of its electricity requirements, the carbon footprint could be reduced by 80%.

According to Ericsson's research, mobile networks represent about 0.2% of global carbon emissions and 0.6% of global electricity use.

0.2%

With the growing demand for mobile networks to handle more data than ever, there is a unique opportunity to combat emissions. While Ericsson works to consistently improve network energy performance, to reach Net Zero, service providers also need to transition to renewable energy – and the action needs to start now. Service providers around the globe are telling us how important energy and sustainability criteria are to purchase decisions. Reducing demand – and subsequent consumption – of energy encourages renewable energy production, and is an important step in simplifying the transition to renewable sources.

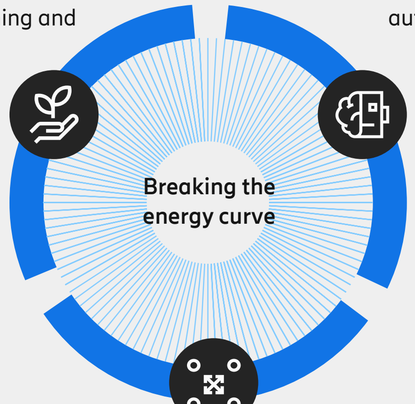
Our evolving approach to breaking the energy curve

While from a global perspective, mobile networks have a low impact on electricity use and carbon emissions; energy use and costs, as well as the carbon footprint have rightfully become some of our industry's largest challenges. This is mainly due to the need to expand network capacity to meet exponential traffic growth.

Every service provider has their own set of network evolution ambitions. However, the industry cannot proceed with the same approach from a decade ago. Globally, Ericsson has seen service providers hesitate to activate energy-reducing software solutions, whether this is due to perceived complexity or the potential impact on classic network performance indicators. Yet to 'break the energy curve', we must challenge how we plan, deploy and run mobile networks.

Since the previous edition of this report, 5G has been deployed globally in over 200 live networks. As we move towards 2025, Ericsson believes it is possible to scale up 5G, while simultaneously reducing total network energy consumption. We have streamlined our approach into three core elements:

Figure 2: Ericsson's approach to breaking the energy curve



Sustainable network evolution

Many service providers are entering a scaling phase as they already run a 5G network, and our insights can help while we consistently work to improve the energy performance of our products.

Network planning and operations need to evolve to cater for achieving business targets and sustainability ambitions with the lowest energy consumption possible. By applying a work process that prioritizes a holistic view of all perspectives, including an evaluation of organizational objectives and network realities, the resulting network evolution plan becomes the foundation to achieve the desired outcomes.

Expand and modernize

Executing a sustainable network evolution plan with a stepwise 5G expansion provides an opportunity to modernize existing networks with low energy consumption and carbon emissions. Expanding sites with new 5G solutions often includes deploying new frequency bands, which requires adding more equipment. To avoid increasing energy consumption, the installed equipment needs to be modernized. This is key to changing the energy consumption trajectory in mobile networks. With a combined view of investments and operating costs, our latest generations of multi-band and massive multiple-input and multiple output (MIMO) radios, and basebands can help service providers to cut energy consumption and greatly improve their energy costs and total cost of ownership going forward.

Operate intelligently

As traffic varies daily, the use of energy-saving applications is fundamental to adjusting the capacity of mobile networks to match demand and to delivering the best user experience with the lowest energy use. This can be achieved through a portfolio of tools and capabilities including the latest artificial intelligence and machine learning (AI/ML) – as well as automation solutions which can help to reduce perceived complexity barriers. Ericsson is well equipped to support service providers in keeping energy use and carbon emissions at a minimum, with zero-touch problem solving and predictive energy management.

Ericsson recommends that mobile networks are planned, built and operated with precision. By working through all three steps of our approach, it is possible to break the energy curve in mobile networks.

Sustainable network evolution

Embrace a holistic view of company targets and network realities to allow for network planning and operation-supporting business and sustainability ambitions.

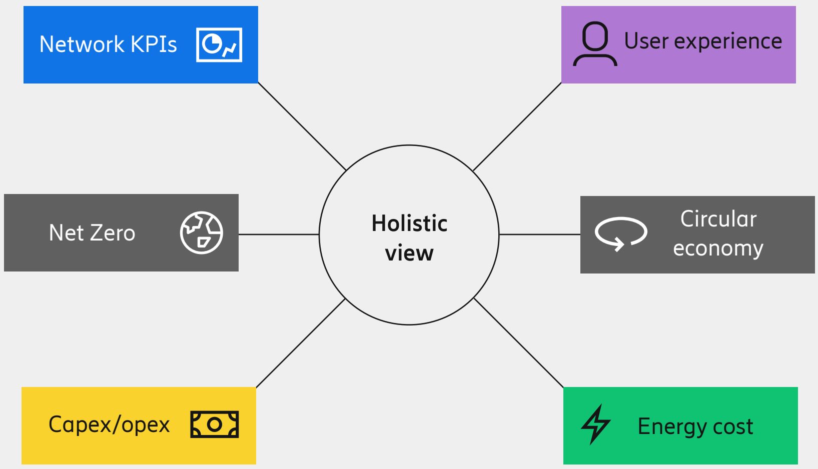
To run a sustainable network while meeting business and operational targets, taking a holistic view to network evolution planning is non-negotiable.

The reality is often that organizations within a company have different steering objectives, so a working process that prioritizes a holistic view of the solutions is needed. Traditional areas where conflicts may arise for a service provider are targets for network KPIs (blue in Figure 3), user experience (purple), capital investments and operational expenditures (yellow) and energy cost (green).

In most cases, traditional network KPIs are measured and used as a reward system for operational departments. The nature of a good radio network today, based on data delivery, is very different from networks supporting circuit switch voice on 2G and 3G networks. By expanding the focus on network performance to include user experience and its correlation towards energy consumption, we see new opportunities to optimize RAN energy efficiency.

Ericsson provides consultative services to assist in the deployment and optimization of energy efficiency functionality, while observing savings and balancing potential impact on network KPIs and user experience.

Figure 3: A holistic approach to meeting business and sustainability targets



Holistic solutions for network evolution

Networks have many indicators which can observe small deviations in characteristics that are not even noticeable from an end user perspective. If the network engineers are only measured on classical network performance indicators, there will be an inbuilt resistance to activate functionality that could reduce energy consumption. Service providers need a method for making decisions about running networks in the optimal manner, while guiding future investments that could reduce total cost ownership (TCO) over time.

With more service providers comitting to Net Zero targets as well as focusing on managing energy costs, the complexity increases. Often, this is combined with increasing circular economy aspirations such as prolonged hardware lifetimes. So, proof points and plans that align with pre-established company targets are required.

Environmental sustainability is also a factor for consumers, in addition to the traditional "telecom values" such as performance or coverage.

To embrace sustainability targets, the traditional areas above must also encompass a new holistic view to reach the most efficient solution from an overall company perspective. This requires that the organizational objectives are evaluated together to see the full potential from both business and environmental viewpoints.

We recommend that network planning encompasses all aspects of core, transport and radio access equipment, as well as site equipment (including power systems and energy sources). A sustainable network evolution must also consider the utilization of renewable energy sources such as wind and solar, as well as high-capacity batteries for energy storage.

Prioritizing RAN energy efficiency

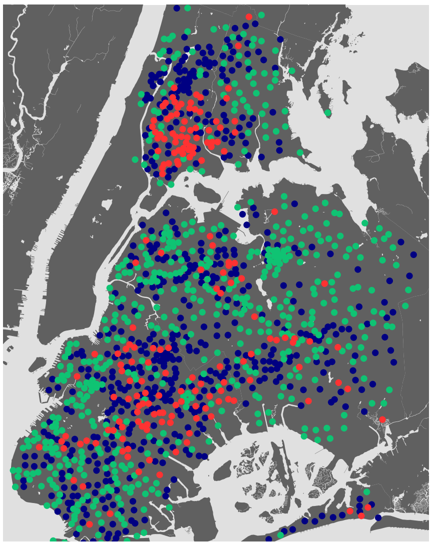
The nature of RAN is to provide nationwide coverage and service capacity. As the coverage and capacity offered by a single radio is limited, this is achieved by deploying thousands of radio sites, which can often be a factor of 10,000 or more when compared to the number of core network nodes. Therefore, the RAN with its active and passive equipment represents more than 75% of the service provider's network energy consumption. Service providers will continue to prioritize RAN energy efficiency as it is the only way to keep energy consumption under control, while delivering an excellent user experience.

Energy metering provides observations of the actual energy consumption inside all RAN hardware on a node level and creates a good baseline for future actions.

Figure 4: Network realities

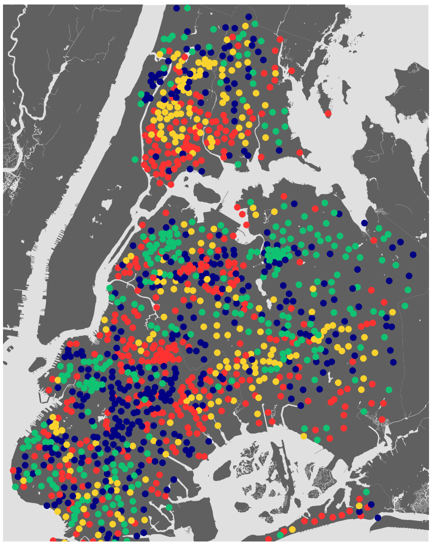
Traffic segment (% total data volume)

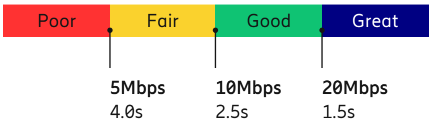
● 25% high ● 50% mid ● 25% low



User experience

● Poor ● Fair ● Good ● Great





Throughput 'at click'
Time-to-content

Service providers can optimize site build and energy-saving policies based on a site's traffic reality in a given network.

We have long been using energy performance to measure energy efficiency. By exploring the relation between "wanted performance" and "energy consumption", we can observe deviations on cluster or site level. When different activities are executed in the cluster, we can observe how energy performance is changing over time.

Site traffic volume and user experience

Each site has a special role in a network cluster. To provide a good understanding of the network and how each site relates to the overall network performance, the recommendation is to observe the network status during the most loaded periods to ensure that potential capacity bottlenecks are identified. If no internal process is in place to observe network reality, Ericsson recommends to apply the following two types of observations: traffic volume per site, and user experience per site. Together they can assist service providers in finding valuable insights. By using an easy-to-understand view, service providers can define strategies for network deployment and operation, such as to recommend how to apply energy-saving software functionality with better precision.

Any network consisting of many physical sites follows a similar distribution of traffic load per site. Ericsson recommends categorizing sites (or sectors) in three traffic segments:

- the red traffic segment contributes to 25% of total traffic volume in the sites with the highest load of the observed network
- the blue traffic segment includes all sites that provide the next 50% of total traffic volume (red and blue together identify sites that bring 75% of network data volume)
- the remaining 25% of the network data volume belongs to the green traffic segment with low traffic load

Network realities explored

Traffic load varies across nodes in the network and over time. Energy savings are achieved by proper dimensioning of radios and deployed frequency bands for example, as well as using software to scale power consumption with traffic. An important result from this study is to identify "the most valuable sites" (Figure 4 – left, red and blue traffic segments), and ensure these operate with efficient network equipment.

The service providers also needs to understand how the network performance is experienced by the end users. The most important aspect from a user perspective is to have a reliable minimum performance. Ericsson's studies show that a good proxy for user experience is to observe downlink (DL) speed when the network is mostly loaded. The observations could be called "time to content" since it represents the time taken for the user to reach their desired content. Ericsson has developed specific observation counters for ease of data extraction. When a site reports DL speeds below predefined thresholds for downloads of the most common applications, we grade the site (or sector) to determine improvement areas. This offers an overall view of current network status, and helps guide the operational department to reducing energy consumption.

Via the traffic split (Figure 4, left picture) we can find sites with significantly lower traffic volumes (green sites). Typically, 50-70% of the sites belong to the green segment. If these sites are correlated with user experience observations (Figure 4, right picture), we can see sites that have great performance in busy hours, indicating that the site is over-deployed when it comes to activated frequency bands and deployed radio units. This is one example of how to identify sites where extended energy savings settings can be applied, such as putting parts of the hardware in sleep mode or turning off radios.

With a sustainable network evolution plan in place, the network observations can be used to ensure traffic performance and define different operational strategies for energy savings across the network clusters and sites.

In summary, upgrading the network evolution plan is the foundation of the approach to breaking the energy curve.

Expand and modernize

Effective modernization of existing networks is essential when scaling 5G to reduce the mobile network total energy consumption.

To reduce energy consumption when scaling up 5G, modernizing the existing equipment is vital. Multi-band technology allows the functionality of several radio units to be combined into a single physical unit for existing frequency bands. The energy efficiency, size and weight can be improved by integrating more components into the same radio.

With the new generation of multi-band radios, we can add frequency bands while reducing the amount of radio units and energy consumption. Since site lease contracts are often stipulated by site footprint (number of units, volume and weight), a modernization to more compact and energy-efficient site builds can reduce TCO significantly. However, the current challenge is that it is not always the same service providers' budgets that control the network TCO. Therefore, we recommend service providers improve the ability to include all costs from their company, including opex from energy cost and site rental, and pair this with the modernization of the existing infrastructure on site.

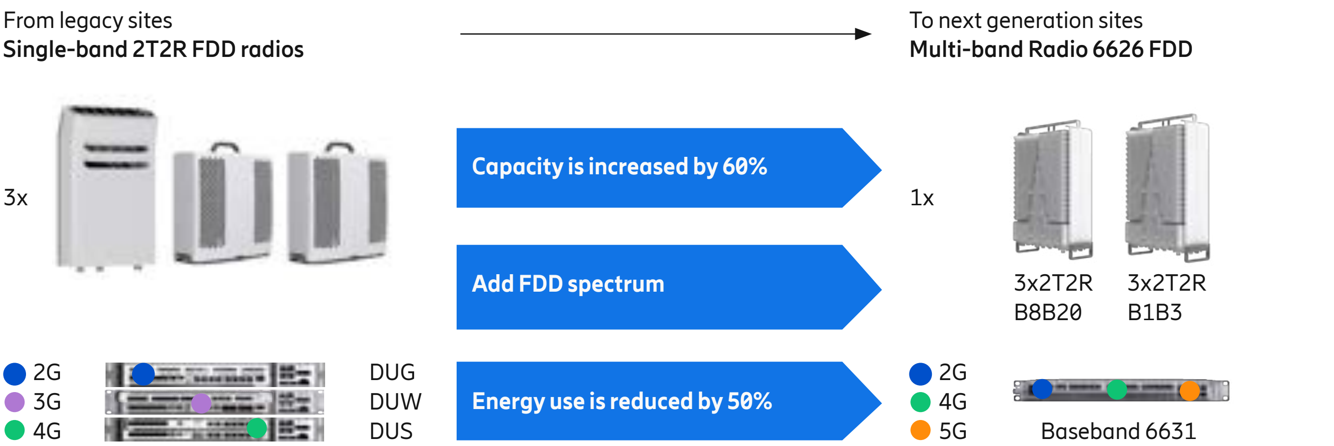
Adding more spectrum through modernization

Modernization can both help to add both spectrum and capacity, as well as reducing energy consumption. Advancements in Ericsson Silicon allow Ericsson to combine multiple frequency bands into a single remote radio unit. In this example, the Radio 6626 enables one radio unit to replace six single-band radios.

The legacy site to the left in Figure 5, has nine radios using three frequency bands. Combined with the three basebands, the site supports 2G, 3G and 4G. This configuration is replaced by two Radio 6626 in combination with one multi-standard baseband 6631. The modernized site will have 60% higher capacity with 50% lower energy consumption, half the radio weight and one-third of the of the size, while adding an additional FDD frequency band. It will also support 5G on existing frequency bands while 3G is removed.

The transition from 4G to 5G involves a significant increase in RAN equipment processing requirements. Energy efficiency is top of our agenda and – together with increased capacity demands – it guides development of new components, products and features. For example, the purpose-built Ericsson Silicon processing hardware is designed to meet these performance demands. It plays a key role in creating high-performing and lightweight products and has increased energy efficiency by a factor of 10 from 2016 to 2022.

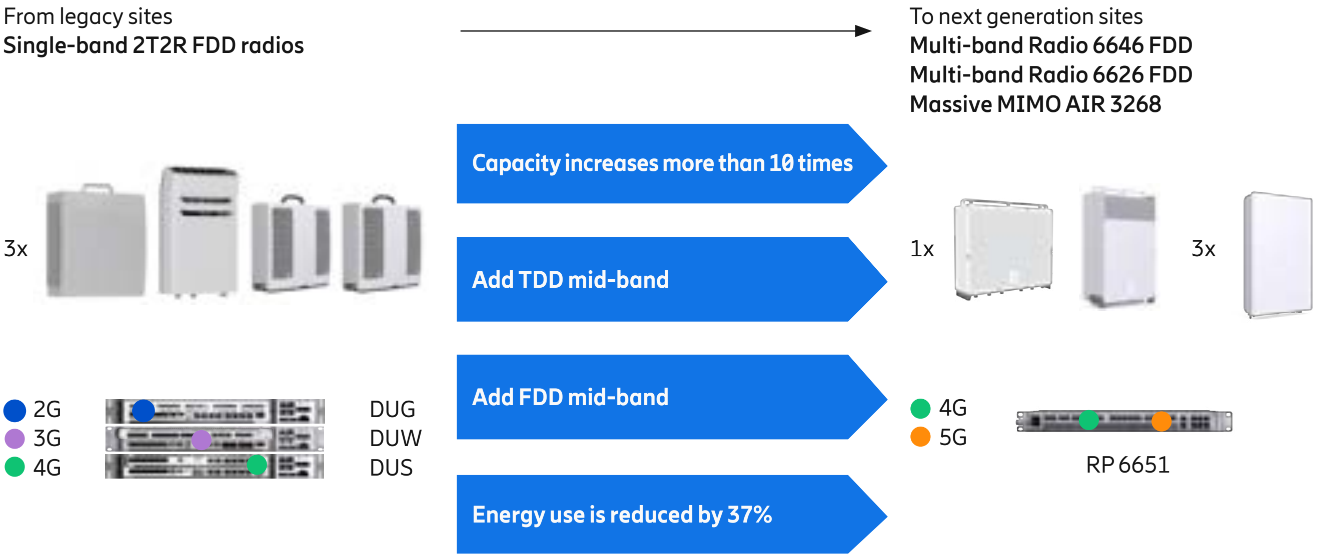
Figure 5: Site expansion and modernization – adding FDD spectrum



Capacity	1
Energy consumption (kWh)	100%
Spectrum [MHz]	900, 1800, 2100

Capacity	x1.6
Energy consumption (kWh)	50%
Spectrum [MHz]	800, 900, 1800, 2100

Figure 6: Site expansion and modernization – adding 5G mid-band and FDD spectrum



Capacity	1
Energy consumption (kWh)	100%
Output power per sector	400W
Spectrum [MHz]	800, 900, 1800, 2100

Capacity	>10x
Energy consumption (kWh)	63%
Output power per sector	680W
Spectrum [MHz]	700, 800, 900, 1800, 2100, 3500

During recent years, Ericsson has taken significant steps to improving the energy efficiency of Massive MIMO radios by up to 50% and our multi-band radios by up to 20% compared to the earlier generations. At the same time, our basebands are 30–60% more energy efficient than competitors when delivering the same capacity. Together, this sets us on a good path towards significantly reducing the power consumed per delivered GB.

The new network performance demands require increased spectral efficiency and flexibility. Massive MIMO technology allows service providers to deliver a powerful 5G experience nationwide.

The Ericsson Massive MIMO radio solutions are divided into three segments:

- **Capacity** covers the most capacity-demanding sites and provides superior performance in all deployments.
- **Coverage** targets deployments with large inter-site distances, such as suburban or rural areas with a smaller spread of users in the vertical domain.
- **Compact** covers sites where there are constraints on the deployment. It prioritizes TCO and ensures that mechanical properties are in line with site constraints, such as size and weight.

Choosing the right segment while scaling 5G mid-band will ensure the best user experience with optimal energy consumption.

It is also important to use software capabilities to avoid adding more new hardware:

- Carrier Aggregation expands mid-band coverage with the help of low band. By moving data to a more energy-efficient 5G band where service providers often have a 100 MHz carrier, the energy per transferred bit can be reduced by a factor of 10 while improving user experience.
- Innovative solutions, like Ericsson Spectrum Sharing, offer service providers a way to deploy 5G on existing 4G band without sacrificing performance, by reusing pre-deployed hardware – enabling nationwide 5G coverage from day one.

Adding mid-band Massive MIMO and modernizing FDD band

Adding 5G Massive MIMO on mid-band does not need to increase the energy consumption.

The legacy site to the left of Figure 6 has 12 radios and supports 4 frequency bands with 2G, 3G, and 4G. This configuration is upgraded to two multi-band and multi-sector radios, and three Massive-MIMO radios. In this example the radio 6626 is a 2-band, 3-sector radio that replace 6 single band radios to provide 4G capacity. Radio 6646 is a 3-band, 3-sector radio which will provide a coverage layer for 4G while adding one new FDD 5G band. Finally, the AIR 3268, an ultra-lightweight Massive MIMO radio, is for the new 5G TDD frequency band. The modernized site will have 5 radios and more than 10 times higher capacity with about one-third lower energy consumption. This forward-looking site configuration will significantly boost both 5G coverage and mid-band (3.5GHz) performance in an energy-efficient way and scale up standalone deployment.

An efficient mobile network requires fewer sites and less energy. Automated, optimized networks across fewer sites lower the environmental impact and cost less to run.

Commissioning, maintaining and upgrading sites traditionally required engineers to visit the site to work on it, with the obvious carbon footprint impact of transportation. Increased automation for virtual drive tests, monitoring, root-cause analysis, and remote upgrades significantly reduces the need to spend time on site.

Operate intelligently

Leverage AI/ML and automation for maximized traffic performance of deployed hardware with minimized energy use.

With mobile networks being deployed to meet expected peak traffic demands for the next three to five years, more capacity than needed will be provided for most hours of the day. Variation in traffic load is inherent in mobile networks, such as day and night differences or short variations down to the millisecond level. Our energy-reducing software solutions make use of these load variations and allows the power consumption to vary up to 97% between full traffic and no traffic (Figure 7).

Energy-saving functions and features are available for all radio access technologies and enable large savings in networks today.

Regarding functions that act on millisecond range, our recommendation is to always have them activated. Features deactivating larger shares of components or equipment, such as antenna branches or cells, enable the largest savings when optimized on an individual cell level. However, we also observe a hesitation to deploy these solutions in networks today due to the potential impact on network performance indicators or perceived complexity to manage them effectively.

To take full advantage of energy-saving functionalities, we must challenge the way we operate mobile networks. To achieve the wanted savings with optimized user experience, careful management of network performance and energy saving actions is required.

A key issue in solving the energy efficiency puzzle in mobile networks is to have an end-to-end view of the entire network and its elements, including both passive and active site infrastructure. Passive infrastructure represents the support ecosystems which keep radio sites up and running, including batteries, power supply units and climate control units.

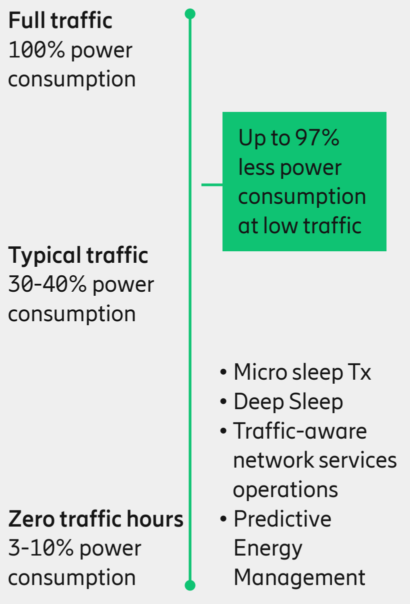
There is also the complexity of different power sources being connected into the passive infrastructure, where utilization of diesel generators or solar panels, for example, might complement grid electricity. The energy behavior of these infrastructures would change based on load and traffic trends.

To manage mobile networks efficiently, we must capitalize on the fact that different regions, clusters and sites need unique energy-saving protocols. This is where data, AI and ML will streamline different automation schemes to transform network operations.

We believe there are three important pillars that intelligent operations towards sustainable networks stand on today:

- maximizing the power of data to boost automation
- working holistically on energy-saving actions whilst keeping the user experience at optimal levels
- establishing platforms focusing on sustainable operations through predictiveness, automation and orchestration

Figure 7: Portfolio-wide innovations



Customer case
Ericsson and Indosat: Building a greener network

Challenge

- Indosat wanted to reduce emissions while increasing data traffic
- To achieve a more sustainable network by aggressive LTE spectrum migration and Ericsson Radio System modernization

Solution

- Energy-saving features decreased overall consumption
- Hardware, software and related services were upgraded to build a modular RAN
- Ericsson Energy Infrastructure Operations (EIO) was used to manage all energy-related assets efficiently

Impact

- The solution achieved the highest spectral efficiency in all of Jakarta and produced more traffic on fewer sites than competitors
- There were energy savings of around 20-30% compared to the old equipment
- Energy bills were reduced additionally by up to 3.6% and CO_2 emissions by 4% on the sites where the EIO solution is deployed

1. Maximizing the power of data to boost automation
Automation is a critical part of the digital network transformation. The active network elements are already able to report power consumption alongside other performance data over the management interface. However, the energy optimization of passive infrastructure is often overlooked, as energy spent on this equipment is hard to measure and control.

To maximize the power of automation, we must capture data and digitalize the complete site ecosystem enabling intelligent measurement and control. Deployment of site controllers, smart sensors and enclosures on passive infrastructure will be key, enabling remote measurement and control of power systems, cooling systems and renewable energy sources. The combined data will enable correlations to be identified between site load and traffic trends versus the energy behavior of passive infrastructure elements, where holistic energy-saving actions can be defined and deployed per site.

2. Working holistically on energy-saving actions whilst keeping the user experience at optimal levels
The introduction of AI and automation into the management of mobile networks will harness the power of data generated across the network infrastructure and enable autonomous optimization.

Network orchestration towards energy efficiency based on changing traffic and usage profiles while providing optimal user experience will be the critical balance; intelligent operations will be the differentiator.

Predictive RAN Energy Optimization
Different criteria sets and business logic can be implemented in radio units and cells, based on traffic and utilization predictions, combined with user experience observations. Orchestrating energy-saving actions must involve considering different traffic profiles with geographical realities, which are deployed on a spread of radio access technologies and frequency bands. This is essential in providing coverage and capacity in an energy-efficient manner.

As an example, the Ericsson Predictive Cell Energy Management solution reduces energy spend at site level based on an AI/ML and automation architecture. The predictive engine identifies which RAN cells that can have energy-saving actions applied, such as cell locking, deep sleep activation or RAN feature configuration, without impacting network quality and user experience. Multiple criteria sets and energy-saving thresholds can be deployed for daytime vs. nighttime and different network clusters.

The solution complements existing RAN features with customized energy-saving actions, reducing an additional 2-8% on network level. Applied in an Asian Tier-1 network with over 350 million subscribers, the savings potential amounted to USD 15 million per year and 100 kilotonnes of CO_2 emissions across the full network. Another example is the Ericsson AI-Powered MIMO sleep mode feature. It adds an additional ~5% of energy savings on on top of manual settings for the same feature. However, the biggest value comes from an increased acceptance

Figure 8: AI/ML solutions and their applications to the network

Predictive RAN Energy Optimization
AI/ML for RAN performance with energy optimization

Predictive Infrastructure Energy Optimization
AI/ML to operate each site's infrastructure

Site Energy Profiling
AI/ML to enable anomoly detection and predictive operations

Power Source Optimization
AI/ML for site power optimization and ROI improvement

and use of the MIMO sleep mode feature through the simplified activation since many operational departments wouldn't otherwise prioritize the manual work needed to fine tune the parameter settings.

Predictive Infrastructure Energy Optimization
Having digitalized the site infrastructure, we can utilize the same principles as in RAN optimization to manage many critical elements in the site in a more efficient manner. We can run climate control units on the site with AI/ML that dynamically adjust cooling settings based on temperature trends and heat-resisting factors. We can turn off power supply units based on traffic load and utilization trends synergized with RAN energy optimization actions. Similar applications can optimize diesel generator run hours in relation to other available energy sources.

Site Energy Profiling
With the gathered end-to-end network data, it is possible to create correlations based on traffic load and infrastructure performance that can be used to benchmark the energy efficiency of similar sites and predict anomalies.

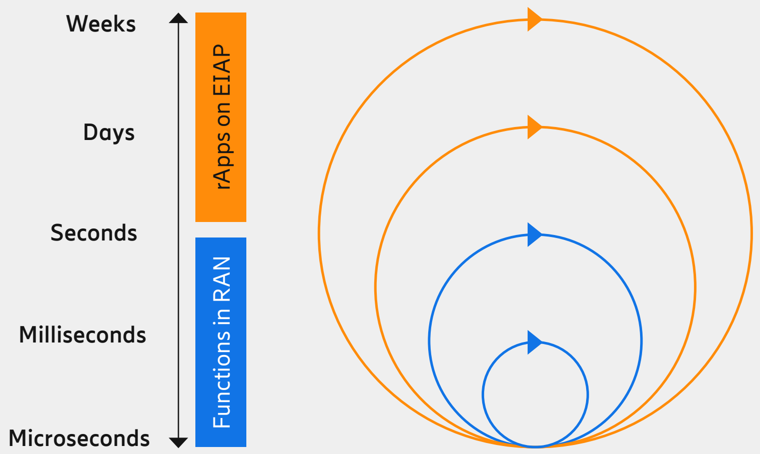
The Ericsson Node/Radio Power Efficiency Map solution measures energy efficiency per site and analyzes each site against dimensioning, hardware, software and radio frequency for a detailed understanding of any inefficiency's root cause. Our Energy Profiling uses a predictive model to identify anomalies based on trend analysis of AC and DC energy meter data coming from site controllers.

Power Source Optimization
ML algorithms help increase utilization of high-capacity lithium-ion batteries or renewable energy sources instead of relying on grid or fuel-based energy sources.

For example, the Ericsson Infrastructure Operations Power Source Optimization solution uses AI/ML to predict the best available energy source on the site based on cost, load and energy source availability trends including site battery autonomy detection. This reduces grid usage during expensive tariff zones, diesel generator run hours, and improves return on investment for renewable sources.

3. Establishing platforms focusing on sustainable operations through predictiveness, automation and orchestration
Going forward, usage of common Service Management and Orchestration (SMO) platforms with sets of powerful sustainability automation applications will emerge.

Figure 9: Control loops for RAN automation



Through our SMO, the Ericsson Intelligent Automation Platform (EIAP), we have extended the rApp - RAN automation applications - concept to also automate existing, purpose-built 4G and 5G RAN networks, in addition to Open RAN and Cloud RAN.

We are accelerating our development of rApps that increase operational efficiency and network performance in the areas of Network Evolution, Network Deployment, Network Optimization and Network Healing. These rApps enable cognitive, AI/ML-based, powerful automation applications with large energy and carbon emission reductions potential. Our solutions cover fast and slow control loop scenarios with use cases that can be delivered as a radio feature, a network service, rApp or combination of them. The objective is to increase efficiency and performance by executing AI in both control loops, where we can have centralized automation capabilities to enable complex decisions with rApps through predictive models, complemented with distributed automation functions at RAN level where implementations can be done in real time. (See Figure 9).

As an increasing amount of data and measurements come from telecom networks, AI and automation expand the potential for high-impact, energy-saving and carbon emissions reduction opportunities. The ability to analyze vast amounts of data relating to traffic patterns, real-time demand, and network-resource availability allows for quick, automated decisions to be taken to enable a number of use cases to create needed efficiencies. Continuous innovation on applications and business logics using AI and automation will enable the sustainable networks of the future.

Customer case
Deutsche Telekom (DT) and Ericsson driving towards sustainable 5G

Challenge
Identify and validate both cost and energy-efficient solutions based on consumption and increased usage of renewable energy sources

Solution
- Addition of a wind turbine to the Dittenheim site, which was already part-powered by solar panel energy
- Integration of additional energy sources such as fuel cells will soon replace the need for emergency diesel generators

Impact
- The turbine can provide up to five kilowatts of additional power, as a second renewable energy power source
- Initial tests showed that on windy days, more renewable energy could be generated than was consumed by site operations

About Ericsson

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans the following business areas: Networks, Cloud Software and Services, Enterprise Wireless Solutions, Global Communications Platform, and Technologies and New Businesses. It is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's innovation investments have delivered the benefits of mobility and mobile broadband to billions of people globally. Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.
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