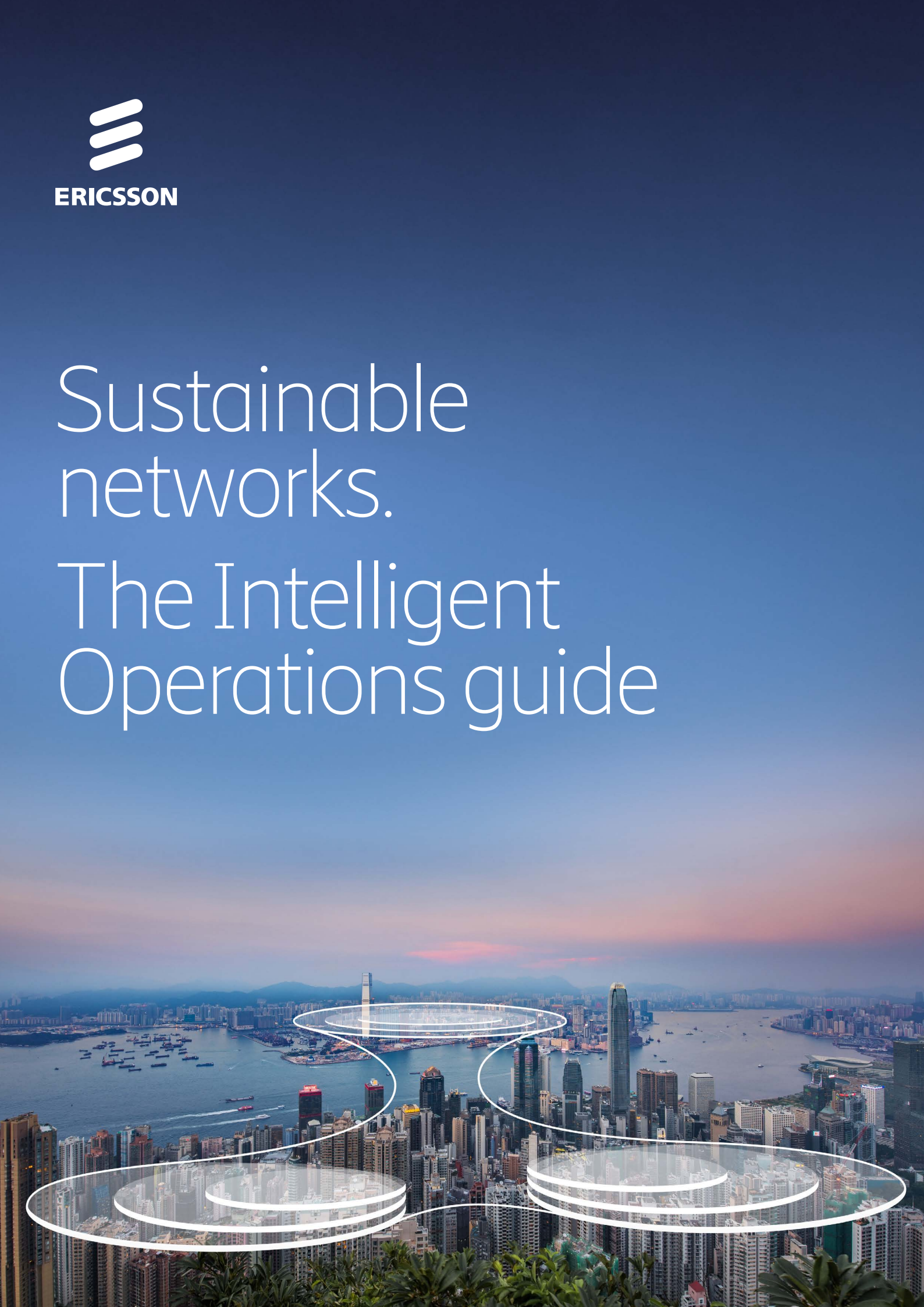
ERICSSON

Sustainable networks.

The Intelligent Operations guide



Content

Why operate intelligently. How can we make mobile networks able to save energy and improve user experience?

Energy cost has become in the last years one of the highest operating costs for communications service providers (CSPs). GSMA estimates that energy accounts for 45% of network OPEX and 15–20% of total operational spend for an average telco [1]. This makes reducing energy consumption a target for both sustainability and network operation ambitions, and in the long term, a strategic criterion for CSPs evolution plans.

However, many CSPs still hesitate to activate energy-saving software solutions. This is due mainly to the potential risk of impacting traditional network performance indicators and the complexity of the features configuration (based on multiple parameters and thresholds). With the traditional approach, CSPs will not be able to control energy consumption to achieve their targets. CSPs must evolve how to plan, deploy, and run mobile networks.

This call for change brings great opportunities to CSPs. It is possible to improve user experience while reducing energy consumption. In this report you will discover the solutions that leading CSPs are implementing in their journey to high performing programmable networks, more autonomous and energy conscious.

We are pushing the technology and hardware boundaries for a conscious energy use and user experience targets. Our vision of programmable networks offers a dynamic and flexible framework that allows for real-time adjustments and optimizations based on current network conditions and demands. By leveraging 5G advanced software [2] and automation powered with AI, these networks can intelligently manage resources, ensuring that energy consumption is minimized without compromising performance or user experience.

"Sustainability and energy efficiency are key for designing mobile networks today. The programmability of the high-performing network will enable its evolution into an intent-driven, autonomous system, capable of supporting diverse service needs. This transformation will be powered by AI".

Erik Ekudden
SVP Head of GF Technology & CTO, Ericsson

"Just like an organism, networks will never waste their resources and energy. When resources are not needed, they'll sleep to preserve energy. These networks will be intent-based saving energy and securing seamless user experience at the same time".

Sibel Tombaz
Head of PL Cloud & Purpose-built 5G RAN, Ericsson

1. Telco AI: State of the Market, Q2 2024
2. Explore the latest solutions of Ericsson 5G Advanced

01 Our journey to break the energy curve

In the Ericsson report "On the road to breaking the energy curve" we provide recommendations on how mobile networks are planned, built, and operated with precision and sustainability in mind. Our approach consists of three steps or core pillars:

- Sustainable network evolution
- Expand and modernize
- Operate intelligently

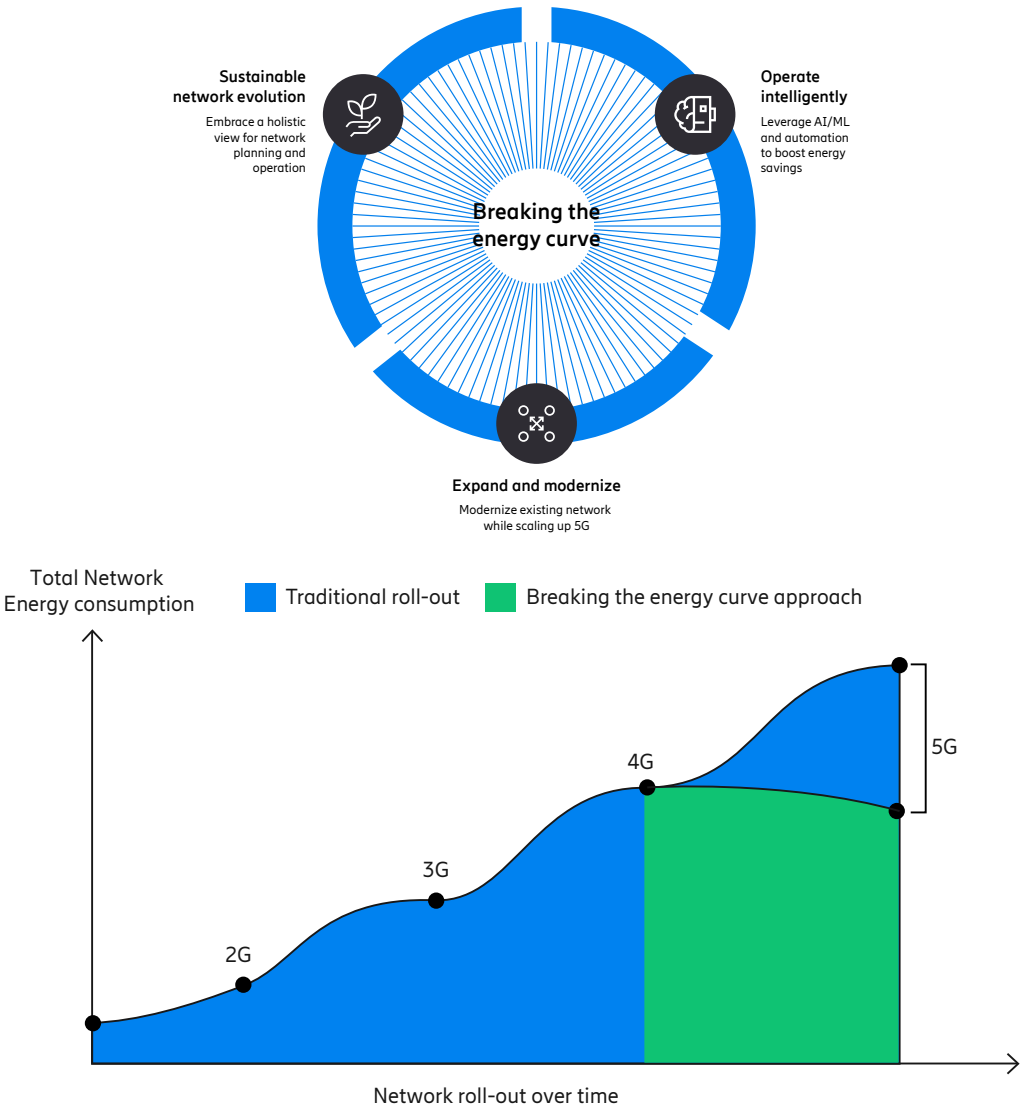


Figure 1: Ericsson´s approach to break the energy curve

In the report "Sustainable networks. The RAN modernization guide", we have described how effective modernization of existing networks is essential when scaling 5G to reduce the mobile network total energy consumption with the latest hardware and software technology innovations.

The evolution of our tailor-made Ericsson silicon has resulted in enhanced energy performance enabling better sleep modes and increased processing capabilities. Additionally, our efficient power amplifiers utilizing GaN technology and advanced filter technology have significantly reduced internal energy loss. Effective heat dissipation management from critical components has been achieved through the development of innovative thermal solutions that don´t require fans. Incremental energy savings are anticipated with the integration of hardware-near algorithms to fine-tune hardware components. From a RAN software perspective, multiple traffic-aware features have unlocked additional daily savings per radio unit while securing user experience.

By operating intelligently, CSPs will leverage on the traffic variation to save energy by adapting the capacity to the current demand to prevent the waste of resources.
AI and Automation technologies will also simplify network operations and boost optimizations at scale. In our approach, we follow three principles for sustainable operation:

- Applying network insights to use energy saving functionality more optimized.
- Connecting and getting data from all parts of the network, including passive infrastructure elements such as rectifiers, batteries, and HVAC systems to enable the use of energy-saving functions throughout the network.
- AI/ML automation to boost energy savings while securing performance.

In this report "Sustainable networks. The intelligent RAN operations guide", we describe our view on transforming networks operations while evolving networks to be programmable. With Programmable, intent-driven networks, Ericsson is allowing operators to achieve both energy performance and sustainable growth.

02 The role of AI in RAN optimization

Energy performance is one of the key areas where AI is applied in mobile networks [3]. The complexity of a multi-objective scenario such as reducing energy consumption and keeping user experience, trade-offs balancing, and using the traffic predictions to prevent non desired impacts, makes AI based solutions well suited to improve both network performance and energy efficiency.

To save energy at a radio level, operators use several techniques, the most frequent strategy is to activate radio energy-saving features such as: Cell Sleep Mode, MIMO Sleep Mode and more. These features need to be activated and deactivated according to the dynamic changes in traffic per sector and per site, which entails a huge complexity.

To understand better this complexity, let´s look at a single radio base station site of a modern CSP. This hub of connectivity houses radio units that deploy distinct "sectors," each radiating targeted radio waves towards specific areas. These sectors employ unique "carriers" " for different generations of radio technologies, that also seamlessly can switch between technologies (4G, 5G) to deliver optimal mobile service. The same radios can also be used for earlier 2G and 3G technologies. From a performance management perspective, analyzing our physical site's traffic reveals distinct patterns across different times of day (day, night, evening). Zooming out to a weekly or monthly view, we see seasonality impacting traffic, with fluctuations across months. Therefore, we need a dynamic solution to adjust in real time to the changes in traffic and to the types of service.

Communications Service Providers are keen to reduce energy consumption in the active and passive equipment without impacting user experience and network resilience. AI technology will be essential to achieve these improvements in the more complex scenarios.

Based on Ericsson's long experience on working with AI, there are three main categories of use cases where AI adds unparalleled value and high ROI:

- **AI unique uses cases.** There are unique corner case scenarios where AI tools will give added benefits, which include prediction, anomaly detection, analysis, and so on.
- **High complexity use cases.** One example is the link adaptation feature. This functionality is designed for situations where there are multiple factors to be considered to find the best signal modulation for optimal transmission.
- **Multi-objective use cases.** These use cases involve seeking an optimal solution under complex constraints and trade-offs. For instance: handling handover choices while maintaining certain network KPIs and maximizing energy savings while improving user experience.

AI driven automation will be critical in the high complexity use cases such as multifrequency network deployments and the multi-objective use cases such as improving user experience and reducing energy consumption. The predictive capabilities of AI based solutions can boost energy savings without compromising user experience.

Moving towards AI-native RAN unlocks significant advantages:

- **Scalability:** AI can handle a growing number of complex intents efficiently, unlike rule-based systems that can´t manage higher-levels of complexity.
- **Optimized decision-making:** AI can make real-time decisions based on vast amounts of data, leading to more efficient and optimal network operations.

3. AI journey in RAN report

2.1 Accelerating AI in RAN for energy performance: The Telenor project

In a move to advance AI and ML technologies in the telecommunications industry, Telenor and Ericsson Research have established a three-year research partnership to explore, develop, and test cutting-edge AI/ML solutions for enhancing RAN energy efficiency. Under this partnership, two collaboration projects have been initiated. The first project focuses on developing an AI agent to control RAN energy-saving features in a closed loop. The second project, as a continuation of the first one, aims to apply trustworthy AI with a focus on explainable AI and causal AI.

AI agents increase energy savings while keeping performance

The joint team has identified a specific use case for the AI agent: a closed-loop control of parameters for LTE cell sleep mode, managing the dynamics between parameters and KPIs across a multilayer network, and adapting to site traffic patterns at different times of the day.

In the solution, we have developed an AI agent controlling LTE cell sleep mode parameters of L26 in multi-band NR NSA every quarter-hour in a closed loop based on ENM observability. With reinforcement learning, Sim2Real, world model, and safety shield as key components of the intelligence, the AI agent is trained using simulations and Telenor Norway data.

The solution is successfully demonstrating reduced network energy consumption and is ready for live testing. The progress achieved reflects the development and deployment of advanced ML technologies and careful risk management, enabled through the strategic innovation partnership between Ericsson and Telenor.

All energy savings were achieved without negatively impacting network quality, as measured by customer throughput. An energy consumption saving of 4% is achieved for the L26 radio cell when the agent is handed over control of cell sleep mode (compared to best practice). Time in active sleep mode increases from 4 to 7 hours on average.

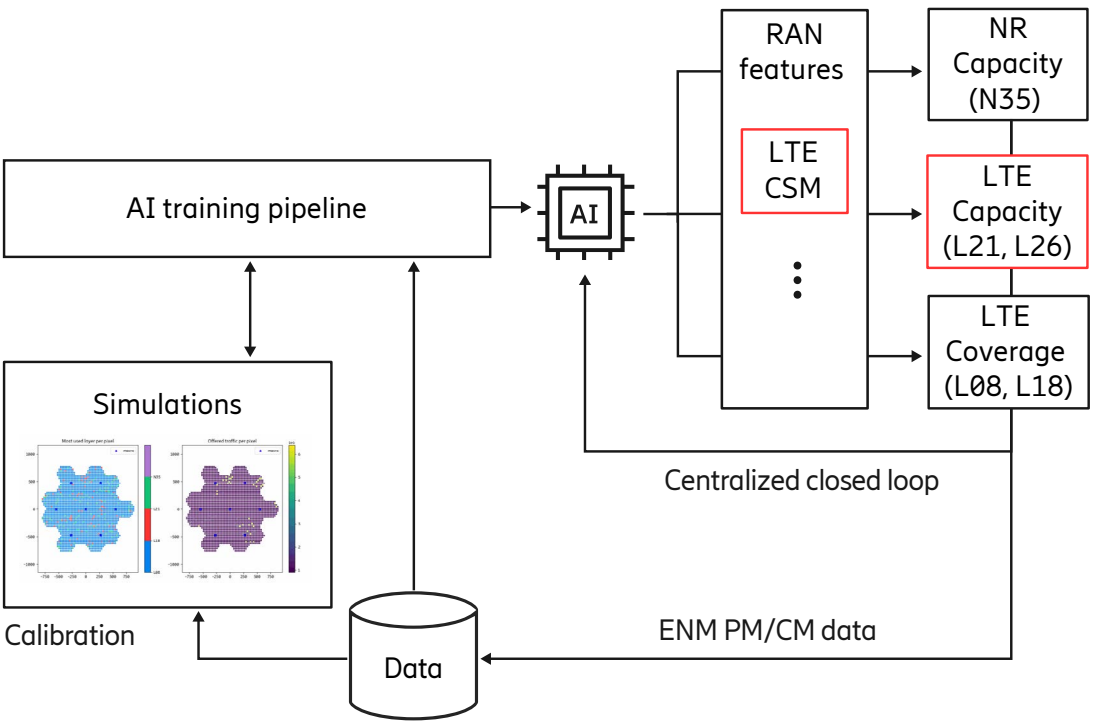


Figure 2: AI agent implemented to configure LTE energy saving features

This use case and preliminary results on energy-throughput performance were presented in the GSMA 'Telco AI state of the Market' Report. Once validated in trial, the method will be expanded to control more frequencies beyond L26.

The figure 2 illustrates the centralized closed loop to control where the AI agent controls the cell sleep mode activation of the radio cells based on real-time network performance and state, adjusting parameters dynamically. Cell sleep mode is enabled in the radio cells during low activity periods, handing over traffic to other radio cells within the coverage area.

The AI agent is trained, continuously learns from millions of trial-and-error attempts in a network simulator with historical data and real-time network information such as performance metrics, throughput, and load. The AI agent learns from its actions and the corresponding effects on network quality, ensuring a continual improvement cycle.

The following figure shows the performance of the different agents evaluated and showcases the trade-offs between energy consumption and throughput performance. The graph shows the gains achieved in terms of sleep time in hours in relation to the probability keeping the user throughput. The agents evaluated fall into three categories: Optimal for energy savings and performance (dark green area), optimal for performance but suboptimal for energy savings (blue area), optimal for energy savings but suboptimal for keeping performance (light green area).

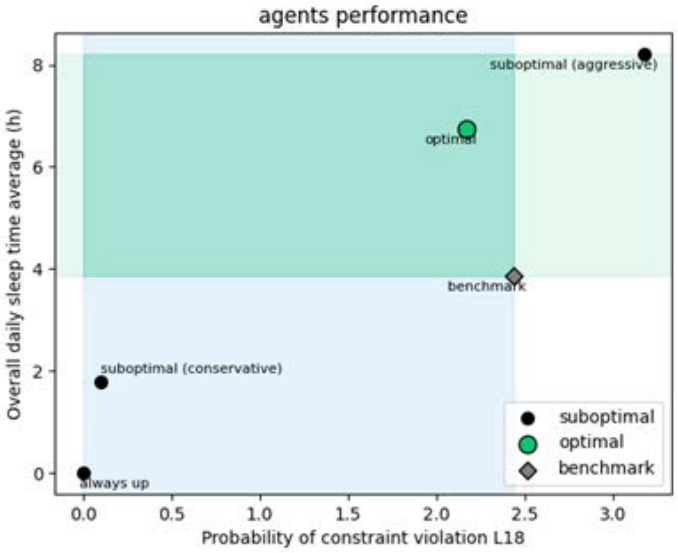


Figure 3: AI agents' performance evaluation.

Creating a trustworthy AI framework with explainable AI

The second project with Telenor aims to develop the foundations for a Trustworthy AI framework in the Telecommunication industry to enhance the reliability and transparency of AI/ML systems deployed in networks thus enabling and enhancing customer trust. It consists of Explainable, Causal and Human-Centric AI work to improve the trustworthiness of AI-driven solutions for network automation by applying explainable and causal AI methods and then validating user trust in AI.

The objective is to provide explanations of the AI agent's recommended actions. Explaining the factors that led to the AI agent's decision is expected to help users assess the correctness of the agent, thereby increasing trust in the AI itself and facilitating its further adoption.

This work complements the first project by extending it with explainability for reinforcement learning and causality methodologies.

This work focuses on three main activities:

- **Explainability:** Development and application of Explainable Reinforcement Learning (XRL). With data evaluation, explainable RL methods will provide insights into the agent's behavior such as why a particular action is taken, the conditions that trigger certain actions and the key factors influencing decisions, and the identified corner cases.
- **Causality:** Development and integration of Causal Modelling methodologies. By observing the data from the field, the causal mechanism identifies causal relationships in data and generates counterfactual, adding more insights.
- **Human-Centric AI:** Assessment of the drivers of human trust in AI. All the obtained insights, obtained by implementing explainability and causality activities, are evaluated by an engineer.

Ultimately, with the result of this evaluation, the AI model will be improved.

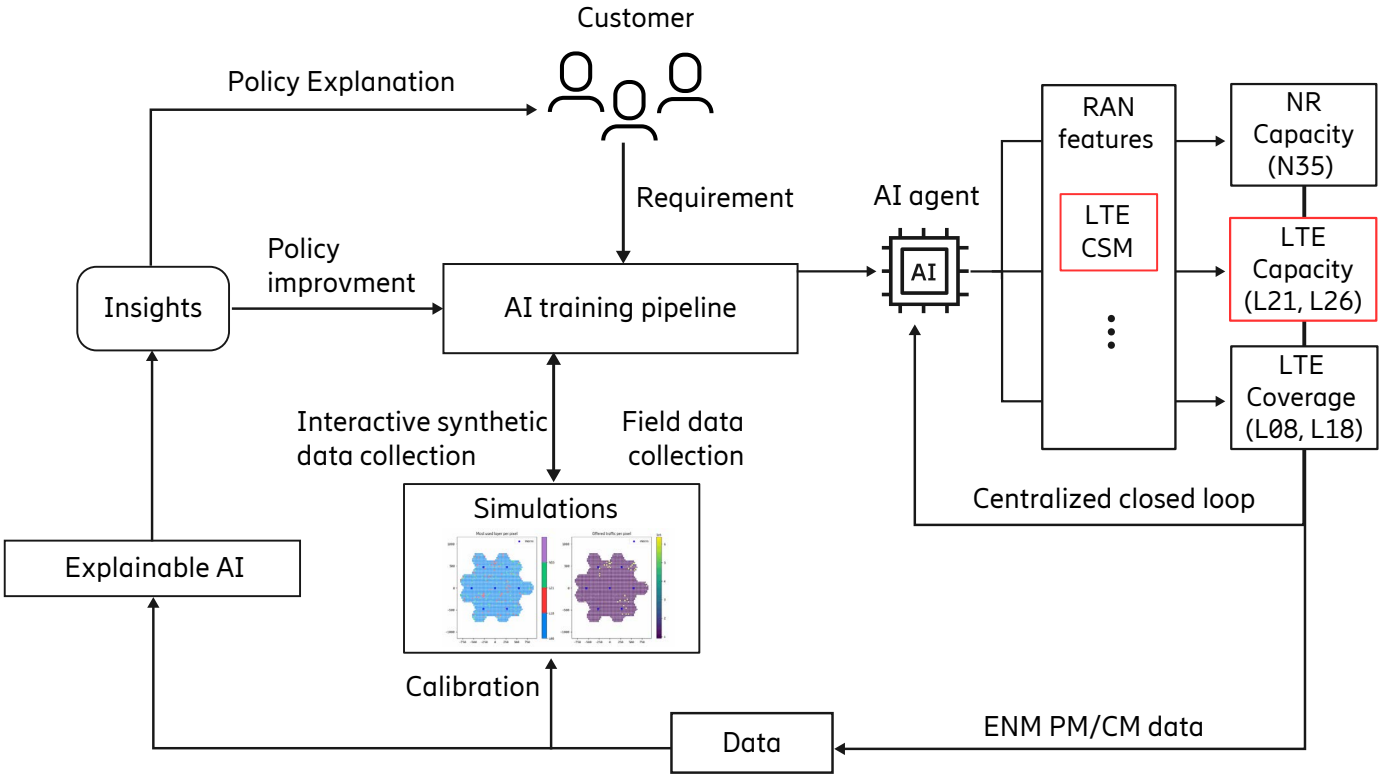


Figure 4: Elements to create a trustworthy AI model

"We believe that co-creating innovations with Ericsson Research and Development on energy efficiency and state-of-the-art AI positions Telenor to harness the value potential of our operational data. This collaboration supports us in reaching our ambitious sustainability goals, while also advancing industry standards on safe and trustworthy AI systems for network automation."

Ieva Martinkenaite
SVP, Head of Research & Innovation, Telenor

03 Optimizing Energy Performance

The target for network optimization cannot be defined solely as reducing energy consumption. CSPs are not interested in purchasing equipment to switch it off; they need to provide continuous service and coverage. To achieve optimal performance, CSPs aim to adjust installed capacity to real-time traffic demand without affecting user experience. Network capacity is typically deployed to handle peak traffic during the busiest hours, resulting in over-capacity for most of the day. Software functionality is employed to align network capacity with traffic demand. The challenge lies in transitioning from individually tuned energy-saving features to an orchestrated approach that allows the network to follow the capacity demand curve, delivering the desired performance without wasting energy or requiring additional hardware.

The figure below illustrates how radio resource optimization can synchronize capacity to the instantaneous traffic load [4].

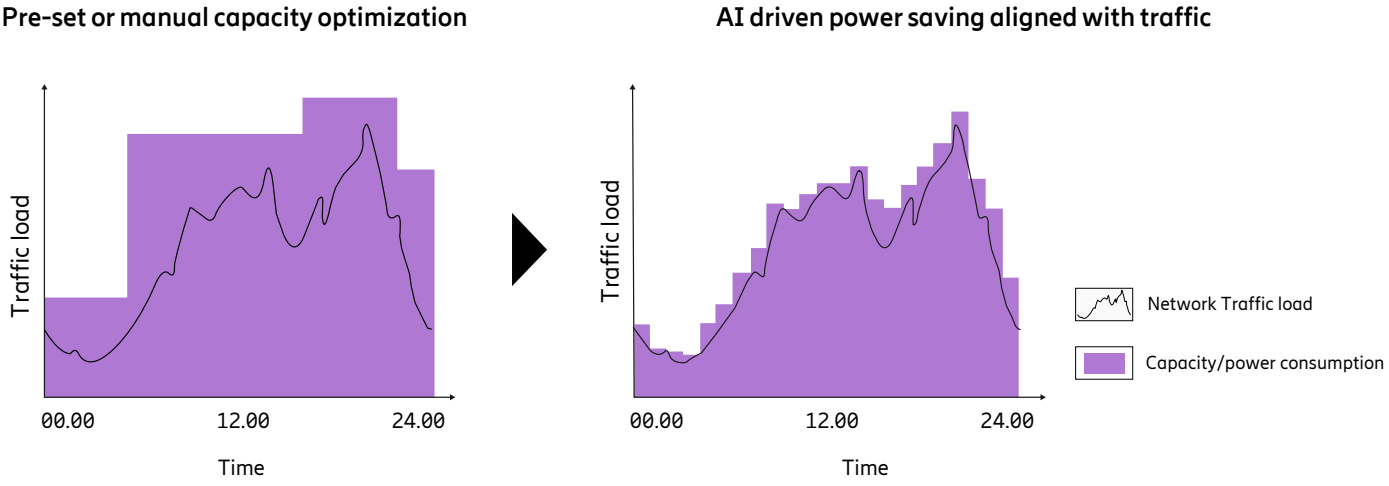


Figure 5: Optimizing energy performance with AI and automation vs. manual configuration

Redefining the best network

We consider energy performance to be a triad comprised of three elements: network performance, energy consumption, and user experience.

As service providers focus on securing network energy performance and achieving sustainability targets, the best network no longer means just fast and reliable. It's time to redefine the 'best network' as a network built not just around high performance, but also with due consideration to sustainability and energy efficiency. The industry needs to recognize that while network KPIs are important and must be kept in mind, the foremost priority should be optimizing networks based on delivering the wanted user experience.

4. Figure adapted from the one used by Emmanuel Kolta (GSMA principal analyst)

Challenges for energy performance optimization:

- **Securing performance levels while executing energy saving features.** Many CSPs today successfully use energy saving software to make significant energy and opex savings in their networks. Though, to preserve network KPIs, in most networks the functionality is not used to its fullest potential. In addition, the user experience depends on a combination of network performance and the applications running in the user equipment. To increase the energy savings with secured performance levels in the RAN require enhanced capabilities such as observability and service awareness, with user experience in focus.
- **Energy counters not available in old equipment.** Observability is a vital factor to optimize energy performance and requires information about performance indicators and energy use from multiple network parts. The availability and accuracy of both counters and data collection pose a challenge where older equipment may not have compatible counters, making pertinent data collection difficult with a need to complement the data with indirect measurements for instance based on estimates of energy consumption values. Additionally, there is an inherent challenge in balancing the granularity of energy data. As an example, energy meters may only provide site-level understanding of energy consumption, and this level of granularity does not provide actionable information that can be used to effectively manage energy consumption.
- **Fixed and static settings increase operation complexity.** The data traffic in a specific radio base station site varies largely with daily, weekly, and seasonally variations. Also, the location of a site has large impact on the traffic levels and variations. The dynamics in traffic make it challenging to use fixed settings and thresholds in energy saving features to the secure both the performance levels and to achieve optimal energy savings for each site. By applying insights from network data, sites and service areas can be segmented into different categories, each with its own settings and thresholds. This will help improve performance levels and savings. The challenge to realize these improvements lies in the enhanced operational complexity as the settings require manual handling and follow-up which may become an obstacle for an effective implementation.
- **Interoperability and orchestration between different energy-saving solutions ensuring the best selection for every scenario.** Ericsson and other vendors are providing a great number of energy-saving solutions to support service provider's ambition to save energy. The increasing number of solutions provide a large variety in how to combine functionality that switch off parts of equipment, complete frequency bands and equipment, as well different levels of sleep with varying reactivation times. The challenge is further increased by the complexity of alternatives for different radio access generations and frequency layers. Without interoperability and orchestration between the different energy saving solutions it is difficult to ensure the best selection of features to achieve the largest energy savings for each scenario.

The role of benchmarking to improve energy performance

Through performance counters it is possible to extract, for example, data volume per site, energy consumption and user experience, and then structure the data into different segments. By assessing the data it's then possible to extract actionable insights, such as identifying areas where more capacity will be needed and areas where more aggressive energy-saving feature settings can be applied to achieve larger energy savings, while still delivering a great user experience.

Benchmarking provides context for establishing baselines, setting realistic targets, evaluating performance and progress. Ericsson has several data-driven collaboration programs with service providers, such as the Ericsson Network Benchmark. These programs use network insights to improve network performance and energy use and provide observability of the impact of the different actions in the network.

These are the building blocks for effective network energy performance benchmarking:

- Observability: Identifying relevant metrics is crucial for observing energy consumption and service efficiency, laying the groundwork for network evolution and goal setting. Establishing baselines allows for continuous evaluation and target setting, ensuring progress tracking over time.
- Gaining insights: Capturing and reporting energy data is essential for effective energy management, enabling informed decision-making and performance evaluation.

- Target setting: Setting improvement targets based on network evolution, energy savings, and sustainability objectives facilitates progress toward energy performance goals, aligning with broader network ambitions.
- Choice: Optimizing for energy performance while maintaining user experience is paramount, necessitating a balance between energy efficiency and service quality. Granular counters are indispensable for measuring energy consumption accurately, providing insights into areas for upgrade and informing decisions on network modernization strategies, including hardware and software upgrades, and the deployment of AI and ML for optimization.

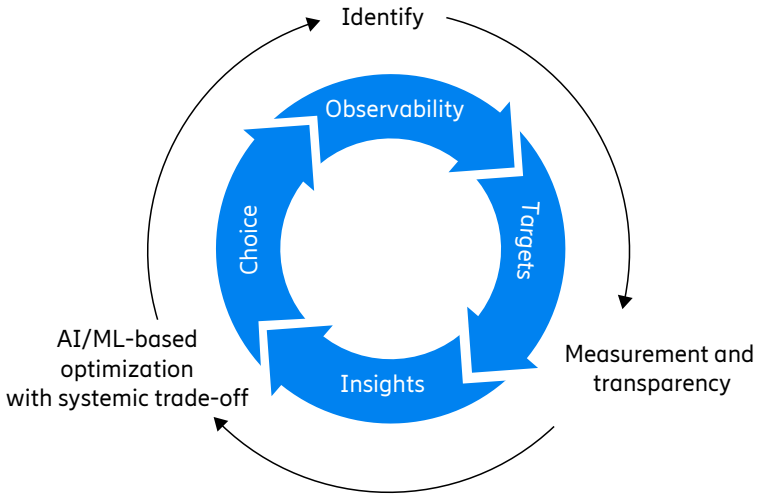


Figure 6: Energy performance benchmarking process.

04 Ericsson´s versatile energy solutions adapted to CSPs needs

The telecommunications industry is increasingly aware of the need to reduce energy consumption for climate and operational cost reduction. However, CSPs are hesitant to activate energy-saving features due to concerns about impacting traditional performance KPIs. Numerous software functionalities allow turning off network capabilities, including antenna branches, radios, and compute units. Baseband capabilities are being enhanced to improve energy efficiency with energy-aware traffic steering and scheduling. These functionalities are effective when managed and controlled to minimize impact on KPIs.

Ericsson is addressing the energy challenge for CSPs by providing a range of automated energy solutions tailored to their specific needs, transforming RAN energy management to be more intelligent and transparent. These solutions are designed to be future-proof, ensuring seamless evolution and adaptation of the network platform over time. This approach allows CSPs to reduce energy consumption while maintaining high network performance and user experience, enabling energy performance optimization.

Ericsson's holistic solution for automation relies on both distributed real-time and centralized non-real-time automation. Moving beyond self-optimization networks (SON) architecture towards intent-driven architecture of programmable networks.

Service based solutions will provide a higher level of customization and shorter time to market, while platform evolution and software-based solutions are better suited for a long-term evolution with improved network capabilities and simplified lifecycle management. Services offering is evolving to rApps so that CSPs can decide between traditional SON architecture and the new Service Management and Orchestration (SMO) architecture realized with the Ericsson Intelligent Automation Platform [5] (EIAP). There are solutions for today´s and tomorrow´s network, is the CSP choice to decide when and how to tackle on the energy performance optimization.

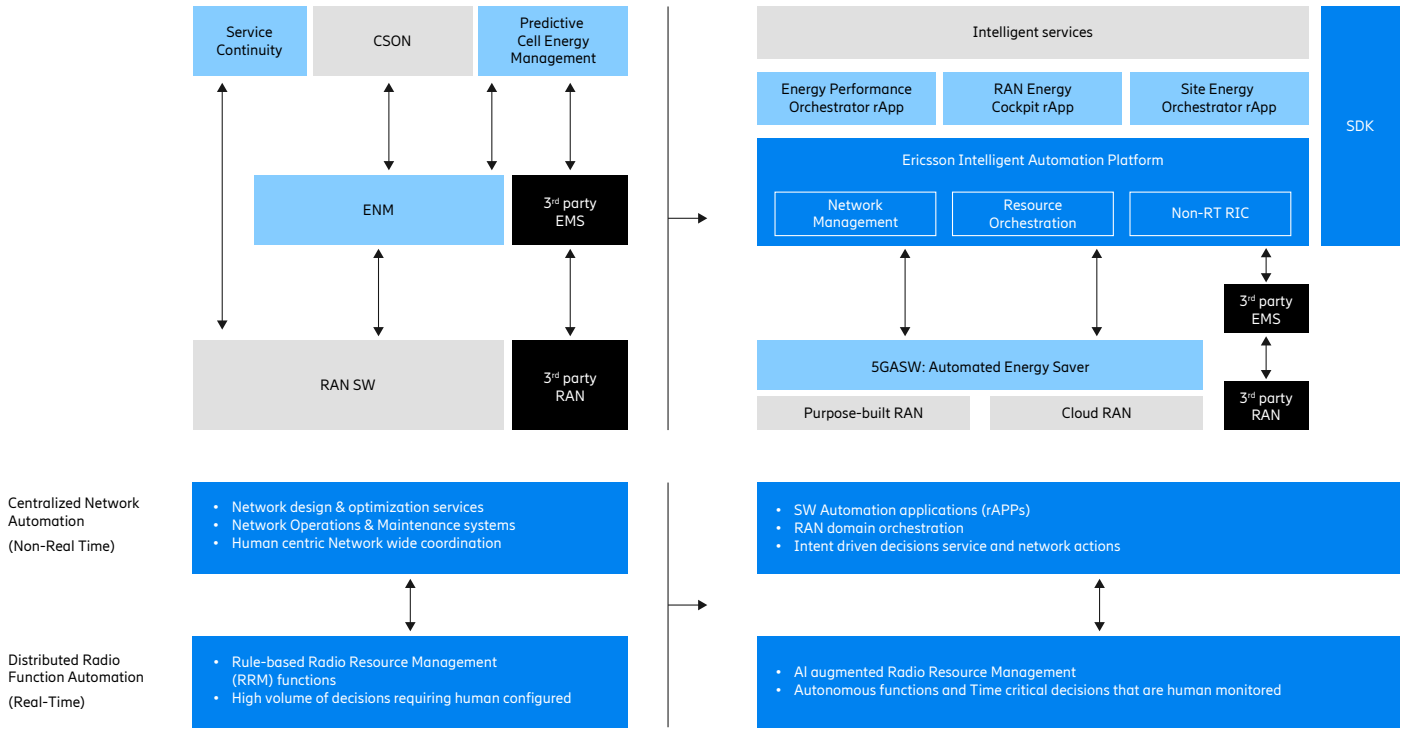


Figure 7: Ericsson´s solutions to improve energy performance in SON and Open RAN architectures

In the figure above, we show at the left solutions in the SON architecture and at the right in the Open RAN architecture. In the following chapters, we will deep dive in both type of solutions while showing our customers´ successful implementation.

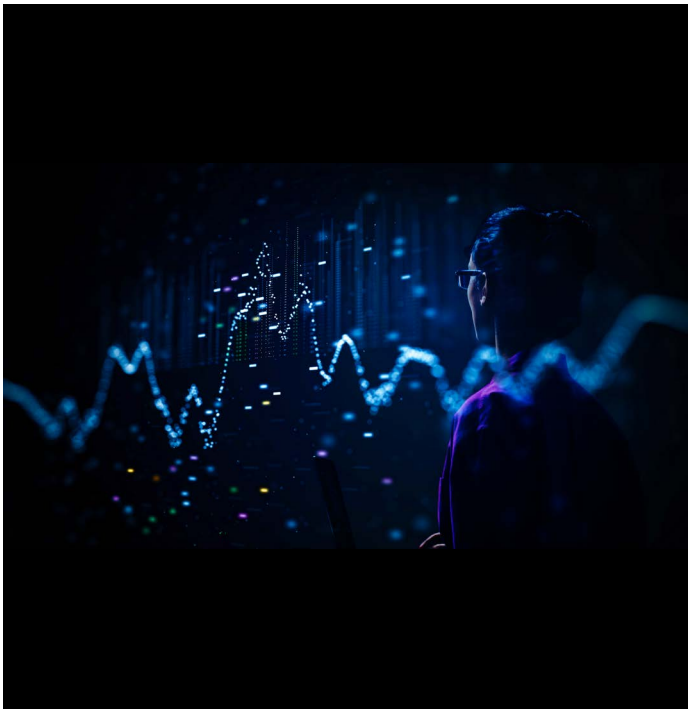
5. Intelligent Automation Platform improves performance - Ericsson

4.1 Optus journey to improve energy performance with automation

Optus and Ericsson have a long history of collaboration introducing state-of-art Hardware and Software features to realize energy efficiencies across the mobile network to support achieving OPTUS sustainability and energy consumption goals.

Optus and Ericsson took few steps further to incorporate intelligent operation in relation to Energy Savings by introducing 5G "Deep Sleep Mode Automation" into the network.

Optus and Ericsson continue to advance their collaboration journey by developing innovative energy saving features in Radio Access Network (RAN) technology, starting from "Deep Sleep Mode Automation", continuing with Booster Carrier Sleep Mode, Massive MIMO Sleep Mode and with intent-based features like Automated Energy Saver in future. This journey towards full automation and dynamic management of energy saving framework aims to deliver substantial RAN energy savings while improving user experience, reinforcing OPTUS and Ericsson commitment to sustainable and efficient network operations.



The energy challenge

OPTUS has a growing focus on energy saving to achieve its goal of reducing Scope 1 and 2 emissions by 25% by 2025 (from a 2015 baseline). Considering that 70% of network energy consumption is from the RAN domain , there was a crucial need for RAN-focused energy efficiency solutions. At the same time, OPTUS brand is focused on speed leadership and customer experience.

Balancing between these two targets cannot be simply done with manual operation of energy savings features and this is where the challenge lies.

Although the two basic features "5G Deep Sleep Mode" and "5G Cell Locking" were both available since quite some time ago, there was a need to intelligently manage these two features and unlock their full potential for energy savings with minimum compromise to user experience.

Solution

Deep Sleep Mode Automation solution is a customized solution developed to overcome this challenge. Booster Carrier Sleep is the global solution automating deep sleep that Optus will be using moving forward in the ongoing journey towards the fully automated and dynamic energy management framework.

This customized solution is using Ericsson's RAN features "5G Radio Deep Sleep Mode" and "5G Cell Locking". It aims to reduce energy consumption in 5G Active Antenna radios Units (AAUs) as well as Remote Radio Units (RRUs) by triggering both features during low traffic and deactivating them during high traffic hours. The solution was implemented across OPTUS network on one of the dominant 5G spectrum bands (N40, or 2300MHz) in metro areas.

Results

Direct measurements of energy counters from Ericsson RAN showed a 24% reduction in energy consumption of 5G N40 (2300MHz) layer after launching "Deep Sleep Mode Automation" across the network.

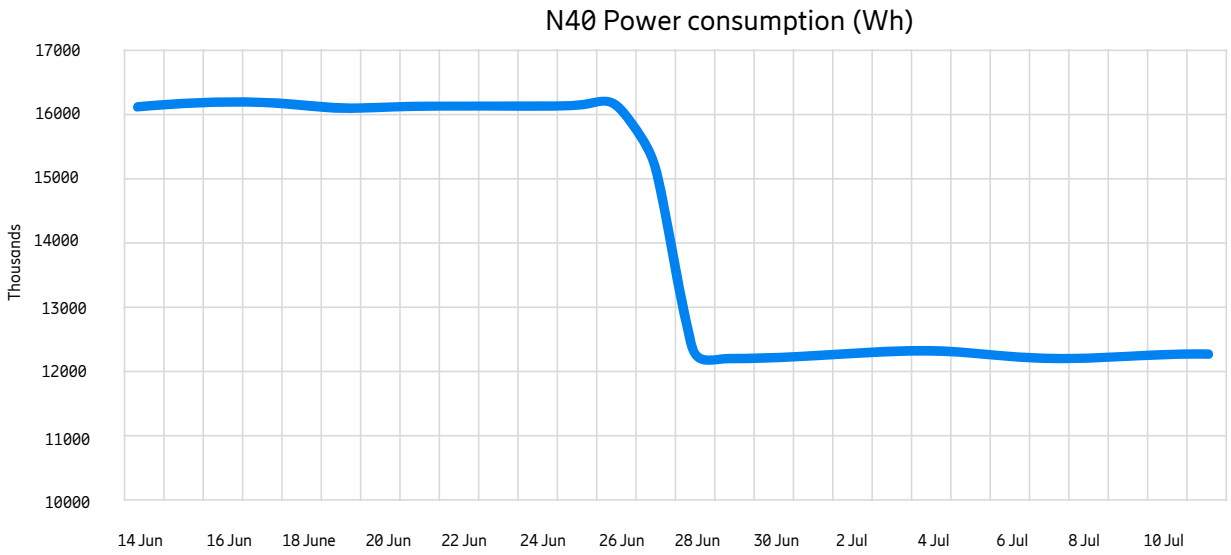


Figure 8: Optus energy saving results by operating intelligently

Energy consumption was reduced by 3,800 KWh/Day across the network on 2300MHz layer after introducing "Deep Sleep Mode Automation".

CO2 emission was reduced by 2,520 KgCO2e/Day across the network on 2300MHz after introducing "Deep Sleep Mode Automation".

"Optus is working with Ericsson on the cutting edge technology and leveraging on automation to continue our commitment toward energy efficiency improvement and sustainability. We are very proud of this initiative and the contribution it will have on reducing CO2 emissions."

Kent Wu
VP, Access Network Strategy, Planning and Quality, Optus

05 How Programmability can make networks more sustainable

Programmable networks offer a dynamic and flexible framework that allows for real-time adjustments and optimizations based on current network conditions and demands. By leveraging advanced software and automation, these networks can intelligently manage resources, ensuring that energy consumption is minimized without compromising performance or user experience. The operations team will be empowered to achieve their targets.

Programmable networks are intent-driven

The role of an intent is to communicate requirements, goals, constraints, and preferences to an autonomous system [TMForum, intent based automation]. Today configuration parameters tell the system what to do, but by moving towards intents the operations of RAN can be much more efficient. Energy efficiency features today primarily focus on load or other metrics that while easy to measure are not so interesting from a business point of view and break the control loop between business targets and system actions. Intents allow directly feeding business requirements into the system which creates a closed loop from business targets to system actions, simplifying both operations and analysis.

Intent driven automation enables an additional abstraction layer in mobile networks to feed the business targets into the system and translate those business targets into actionable configurations of the system. For example, massive MIMO sleep mode reacts to the load in the cell but the business target is probably more concerned with the user experience which maps uniquely to the cell-load depending on the cell characteristics. We call these business targets intents.

The three new technology capabilities for RAN programmability are service- aware, AI native, and intent driven. Without these new capabilities, the operations team can´t possibly manage multiple services guaranteeing SLAs in real time and consider the energy performance at the same time.

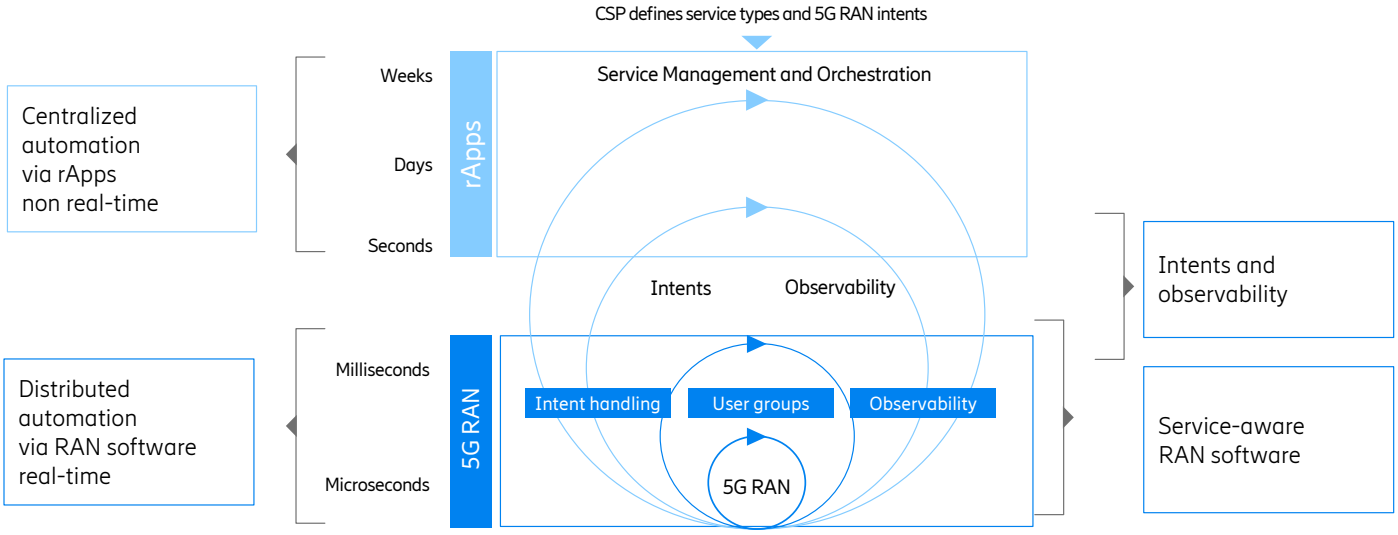


Figure 9: Intent driven networks architecture in the RAN

5.1 5G Advanced software is a starting point to programmable networks

In the RAN domain, we are making the RAN capable of understanding CSPs intents. This shift enables CSPs to adapt the behavior of networks to achieve their business targets while reducing operations complexity. We are building a horizontal SW layer common for both cloud and purpose-built RAN deployments to enable any architecture of the CSP choice and openness. This new SW layer is named Ericsson 5G Advanced (5GA) software.

In this new automation architecture, the SMO is an important element of programmability and the combination of both non- real time (rApps) and real time (radio) functionality will cover all the uses cases for advanced intelligent automation with limited complexity in an efficient and sustainable way.

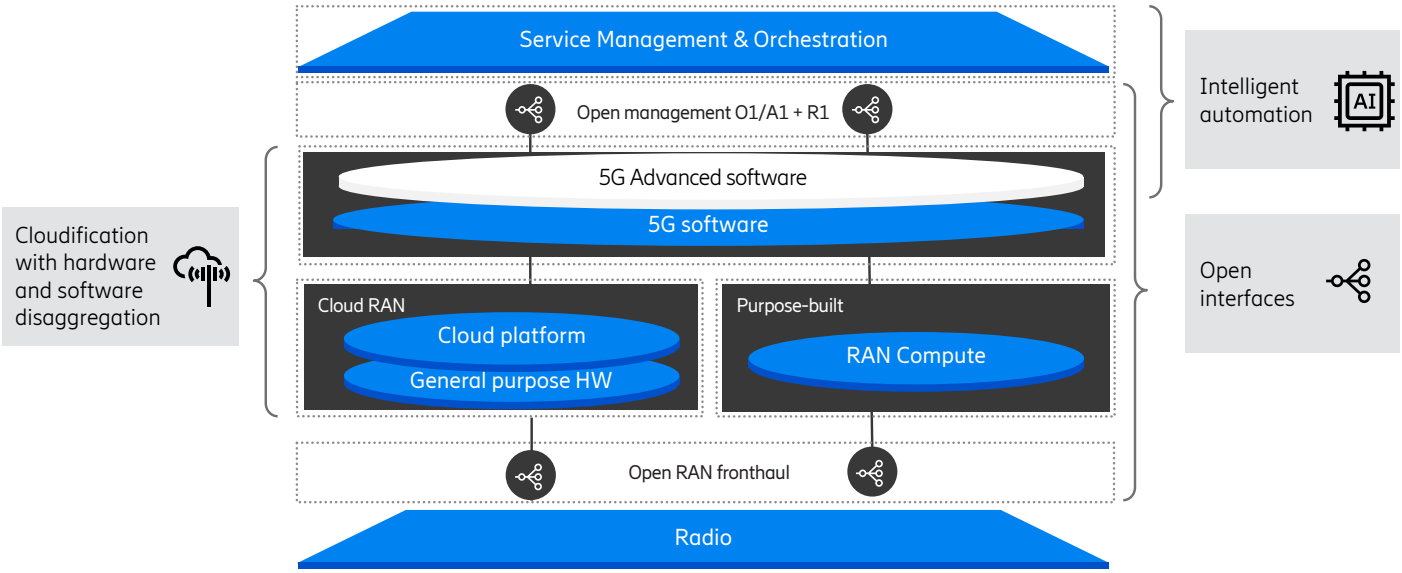


Figure 10: High Performing Programmable Networks open architecture

Focusing on the basebands, AI-powered functionality is capable to solve multidimensional problems with potential trade-offs, and the observability of the service performance is a key enabler for new revenue generation with differentiated connectivity. As example: Our scheduler can make 14 billion of calculations per second with the feature Interference Sensing that can improve the throughput by 22%.

5GA software is providing these new RAN programmable capabilities for new revenue generation and OPEX reduction from energy (reducing energy consumption) and operations cost (with intelligent automation). This software will further optimize energy performance with enhancements in the scheduler for symbol and slot allocation optimization.

5.2 The three layers to improve energy performance

There are three layers, in this new architecture, that play a role to improve RAN energy performance:

- **Energy saving RAN software features** in real time enable the smart use of the network assets. This includes antenna branch shut off, full radio sleep, minimized use of power amplifiers between transmission slots etc. These components can be viewed as complex on/off switches to the lightbulb, with the ability to react to conditions like traffic load. Some examples are Massive MIMO sleep and Booster Carrier Sleep.
- **Distributed automation** also resides in the RAN software, known as 5G Advanced software. It receives intents and enables dynamic configuration and orchestration of the different energy-saving RAN features in flexible time while seeing the full impact on the traffic in the specific node. Energy performance functionality in this layer is implemented by Automated Energy Saver. [6]
- **Centralized automation** resides in the rApps hosted in the Service Management and Orchestration platform (SMO). This layer takes decisions based on neighboring node performance to balance the overall system. It can receive multiple intents and communicates with the distributed automation layer. By doing that, it can both help to predict local surges due to traffic migration and safeguard against impacts due to decisions taken on neighboring sites. Energy Performance Orchestrator is the Ericsson rApp that implements energy performance optimization.

This architecture enables to achieve improved energy performance at scale, at network level.

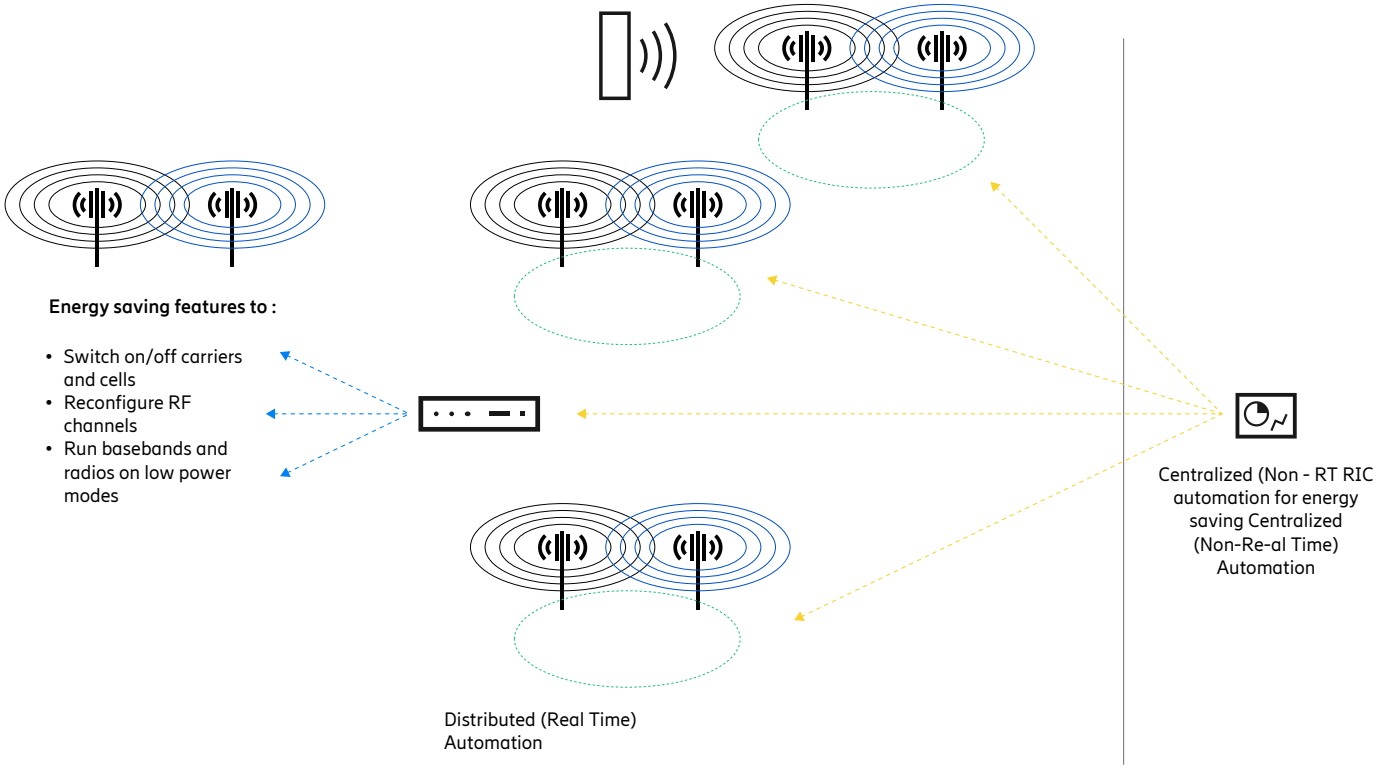


Figure 11: The three layers to improve energy performance

6. rApp

Automated Energy Saver

Automated Energy Saver (AES) is a functionality implemented in the distributed automation layer in the 5G Advanced SW. AES' role is to orchestrate the individual energy saving functionality to fulfil an intent.

The intent is received in the form of wanted user experience for a minimum percentage of user sessions (ie. X Mbps or more for at least Y % of sessions).

For AES and for other use cases, Ericsson calculates user experience by filtering on sessions that are important for the users, such as VoIP, consuming news, mails, videos etc. excluding shorter and smaller sessions that are typical of background traffic. This type of information is part of the Ericsson´s Network benchmarking report.

After receiving the intent, AES figures out the ideal configuration for the energy saving features while seeking to ensure the intent. This distributed architecture allows AES access to very fast and fine granular data to prevent traffic impact more accurately.

We will stepwise introduce functionality as part of the intent-based AES solutions, such as massive MIMO Sleep Mode and Booster Carrier Sleep.

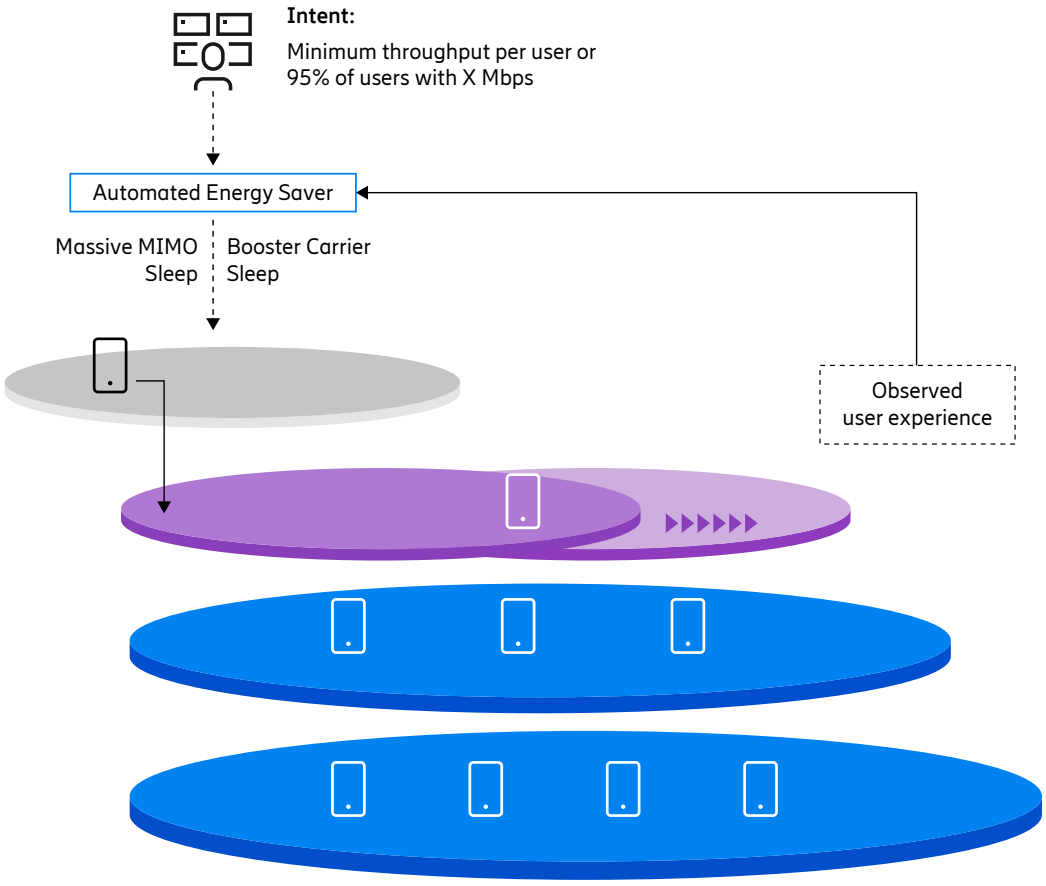


Figure 12: Automated energy saver overview

Energy performance orchestrator rApp

The Energy Performance Orchestrator (EPO) rApp, running on an SMO-platform, enables centralized automation to improve energy performance. This setup provides a comprehensive network view and aligns intents across the network. By combining distributed and centralized automation, operators benefit from both a broad network perspective and detailed traffic insights.

This centralized automation will handle multiple intents, ensuring they do not degrade below set limits due to energy efficiency features, this limits the potential downsides and enables operators to pursue energy efficiency more aggressively.

With centralized automation functionality, the next step for CSPs beyond KPI guarding, will be to balance energy performance and user experience across neighboring nodes, guiding distributed automation loops towards the global optimum and ensuring energy features do not impact the lower bounds of the intents.

The Automated Energy Saver receives as input simple intents. These intents are used to continuously adjust the energy efficiency features´ parameters to meet these intents. With centralized automation, provided by EPO, more complex intents can be managed.

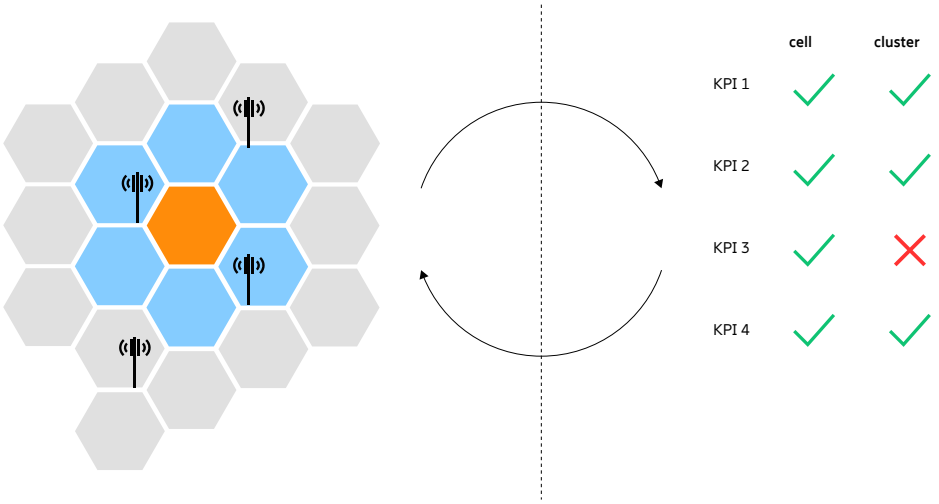


Figure 13: Centralized automation in combination with distributed automation

5.3 Telstra's commitment: Enhancing user experience with sustainability

Telstra, in collaboration with Ericsson, is the first operator in the Southern Hemisphere to successfully launch Automated Energy Saver (AES) Ericsson and Telstra launch Energy Saver for 5G network, a first-of-its-kind energy management feature, in the commercial network. This innovative solution enables Telstra to manage network operations based on defined business intents in an advanced, intelligent, and automatic fashion. Seamless customer experiences are maintained by optimizing resources and energy consumption on a real time basis from observed traffic flows.

Enabling high-performing programmable networks are becoming increasingly essential to unlock the full potential of 5G with new advanced services, more efficient operations, and enhanced customer experience. Intent-based automation is a key technological pillar of programmable networks. It brings a new operations paradigm where operators can use service-related metrics such as user throughput inputs to the radio access network rather than setting radio parameters manually. This makes AES, part of Ericsson's 5G Advanced capabilities, a pivotal feature in the move toward programmable networks.

Automated Energy Saver implementation and trial results

Automated Energy Saver (AES) functionality receives intent as an input. The intent set in this case is a minimum user throughput for a certain percentage of users in a node. It then orchestrates and optimizes the NR Massive MIMO (M-MIMO) Sleep function by dynamically finding ideal thresholds for activating or deactivating antenna branches without compromising the service quality or network performance. In the trial cluster comprising of 6 radio nodes, intent was configured on the node to maximize energy savings from NR M-MIMO Sleep feature while ensuring at least 70 Mbps downlink throughput for 90% of users. AES utilized cell and node-level user experience throughput metrics to make decisions about adjusting Physical Resource Block (PRB) utilization thresholds. Performance was monitored using counters for sleep time and energy consumption.

AES was observed to maintain the set intent whilst achieving **~30%** additional sleep time in the trial sites. This resulted in aggregated additional savings compared to the baseline NR M-MIMO Sleep feature. The highest energy saving

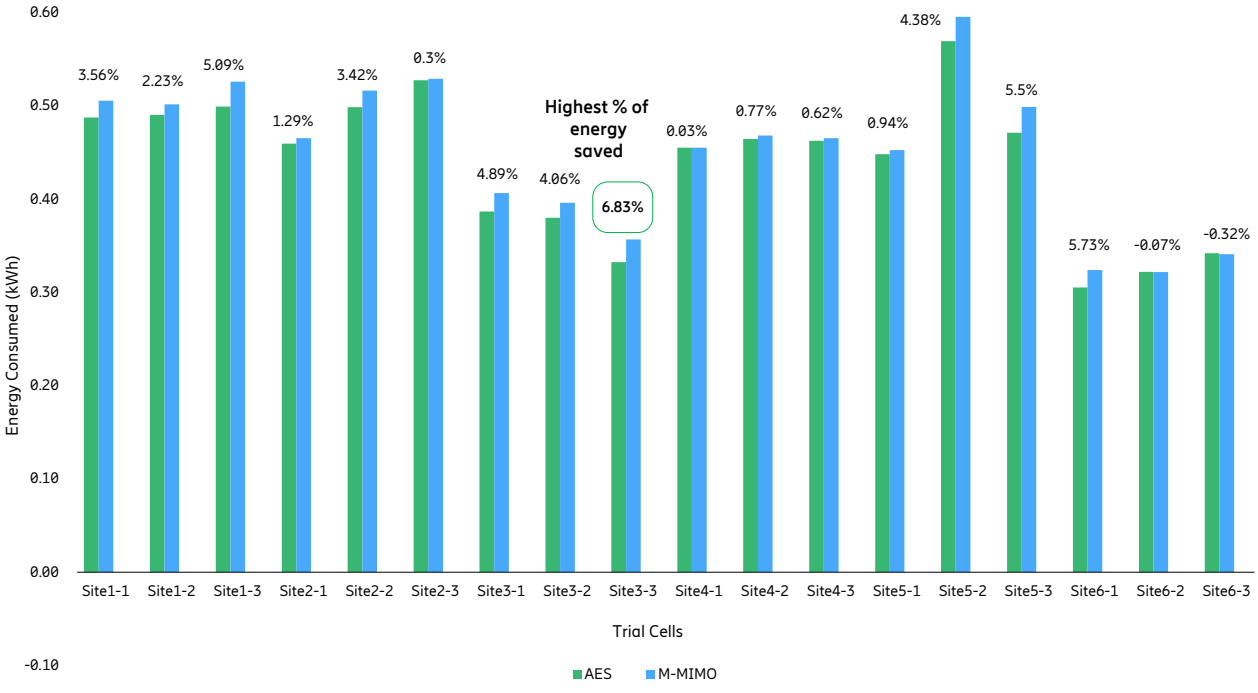


Figure 14: Automated Energy Saver vs M-MIMO Sleep – Energy saved (%)

recorded in a trial cell was approximately **6.8%**. As illustrated in the plots, these additional savings were achieved due to AES dynamically adjusting sleep conditions whenever the average user throughput exceeded the defined intent, thereby enabling extra sleep time.

Equally important, cells were observed to be less likely to enter sleep mode when user experience fell below the set intent. The key finding is that periods of sleep are dictated by the value of the configured intent and the unique traffic patterns/load of each node. Thus, AES simplified RAN energy optimization by natively handling the trade-off between user experience and energy consumption.

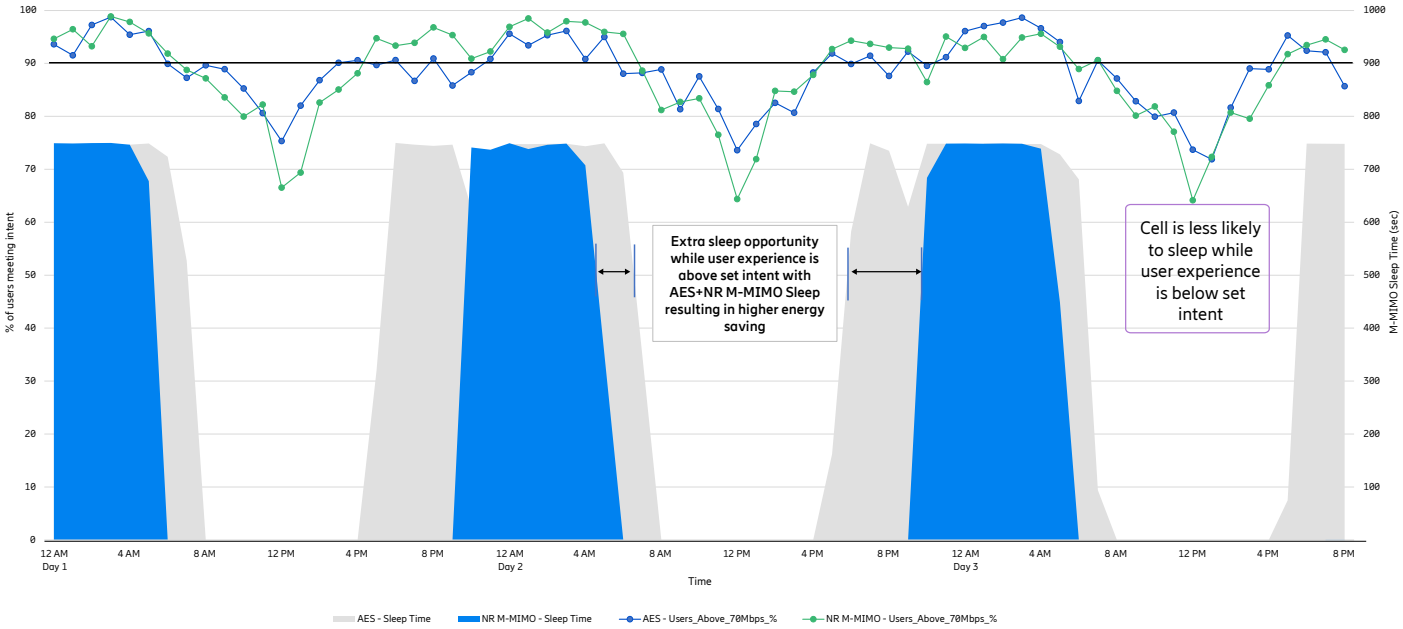


Figure 15: Automated Energy Saver vs NR M-MIMO Sleep

Future collaboration between Ericsson and Telstra for more intelligent and energy efficient networks

As the first 5G Advanced energy-saving feature deployed in Telstra's network, AES represents the start towards a more advanced, intelligent, and automated network that can enable more sustainable operations. By deploying intelligent systems that autonomously manage energy, Telstra continues to lead in network and service innovation while balancing energy savings with customer experience.

Ericsson's strategic partnership with Telstra is vital in the transition towards programmable, intelligent, performance-based networks. This collaboration leverages Ericsson's advanced technology and expertise in network automation to support Telstra's vision of an efficient and sustainable 5G infrastructure.

"Achieving Telstra's ambition to reduce scope 1 and 2 emissions by 70% and scope 3 emissions by 50% by 2030 requires a combination of decommissioning legacy and implementing new energy efficient technology in our network. Ericsson's Automated Energy Saver feature is an important step on our roadmap to enabling intent driven outcomes, and in this case balancing energy savings while maintaining a desired customer experience."

Channa Seneviratne
Executive for Technology Engagement Advancement, Telstra

5.4 DNB is enhancing Malaysia´s 5G network with Automated Energy Saver

Digital Nasional Berhad (DNB) serves as the sole wholesale network provider in Malaysia, offering 5G infrastructure access to the country's six mobile network operators (MNOs). As the exclusive 5G network host for these MNOs, it is crucial for DNB to maintain a sustainable and energy-efficient network without compromising user experience. This initiative aims to reduce energy costs and align DNB's sustainability targets with governmental expectations.

DNB faced significant challenges in its efforts to lower power consumption within its network. Primarily, reducing energy usage involved trade-offs that could adversely affect user experience and downlink throughput, which is unacceptable in a competitive 5G landscape. Additionally, determining the optimal thresholds and timing for activating energy-saving features was complex due to daily and sectoral traffic pattern fluctuations. This variability made it difficult to minimize the impact on network performance while implementing necessary energy-saving measures. Moreover, continuously adjusting these thresholds as traffic patterns evolved required substantial engineering resources and rigorous analysis to maintain a delicate balance between energy efficiency and network performance.

DNB´s unique challenges

- DNB's NR network involves One Layer of 3.5 GHz spectrum to provide NR services and B28 as the anchor layer. The implementation of Energy saving features comes with a trade off on user experience, coverage. So, the challenge for the DNB network is unique – How can we save energy and reduce CO2 Emissions with less impact on Network KPIs as 3.5 GHz is the only NR Layer in DNB?
- Given DNB is a Multi-operator Core Network (MOCN), the traffic trends of each MNO is unique. Thus, finding the right thresholds, time window/s and configuration for energy saving features is almost impossible, advanced automation is needed.

AES implementation and results

Ericsson's latest 5G-Advanced innovation to reduce energy costs while maintaining user experience was leveraged to strike the balance between energy savings and optimum user experience. With the AES, it was possible for DNB to define the minimum user experience of the site. This helped in simplifying RAN operations of energy optimization by automatically recommending thresholds of energy saving features by natively balancing between user experience and energy and help in maximizing energy savings.

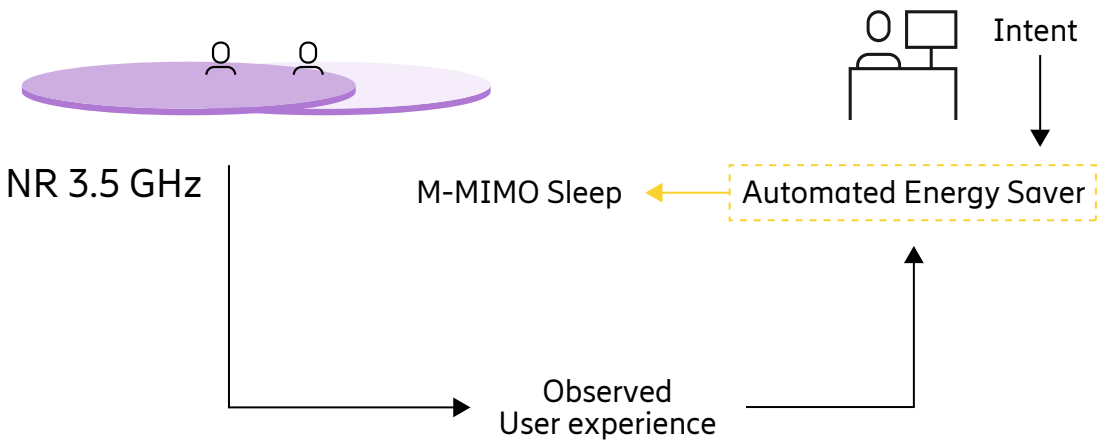


Figure 16: Simplified Network settings enabled by AES

With the AES feature DNB was able to have up to 4.8% average Power savings in the site where AES was implemented. The highest power savings goes up to 7.4% on few sites. It was observed that there were opportunities to save energy throughout the day, and that the AES was able to adjust the thresholds automatically within the thresholds set for user experience.

AES is able to do this because it continuously evaluates the best parameter configuration in real time, improving network adaptability while reducing operational efforts.

On the sites where AES was implemented, the result shows that average of 1.531 kWh were saved per site during the period of activation.

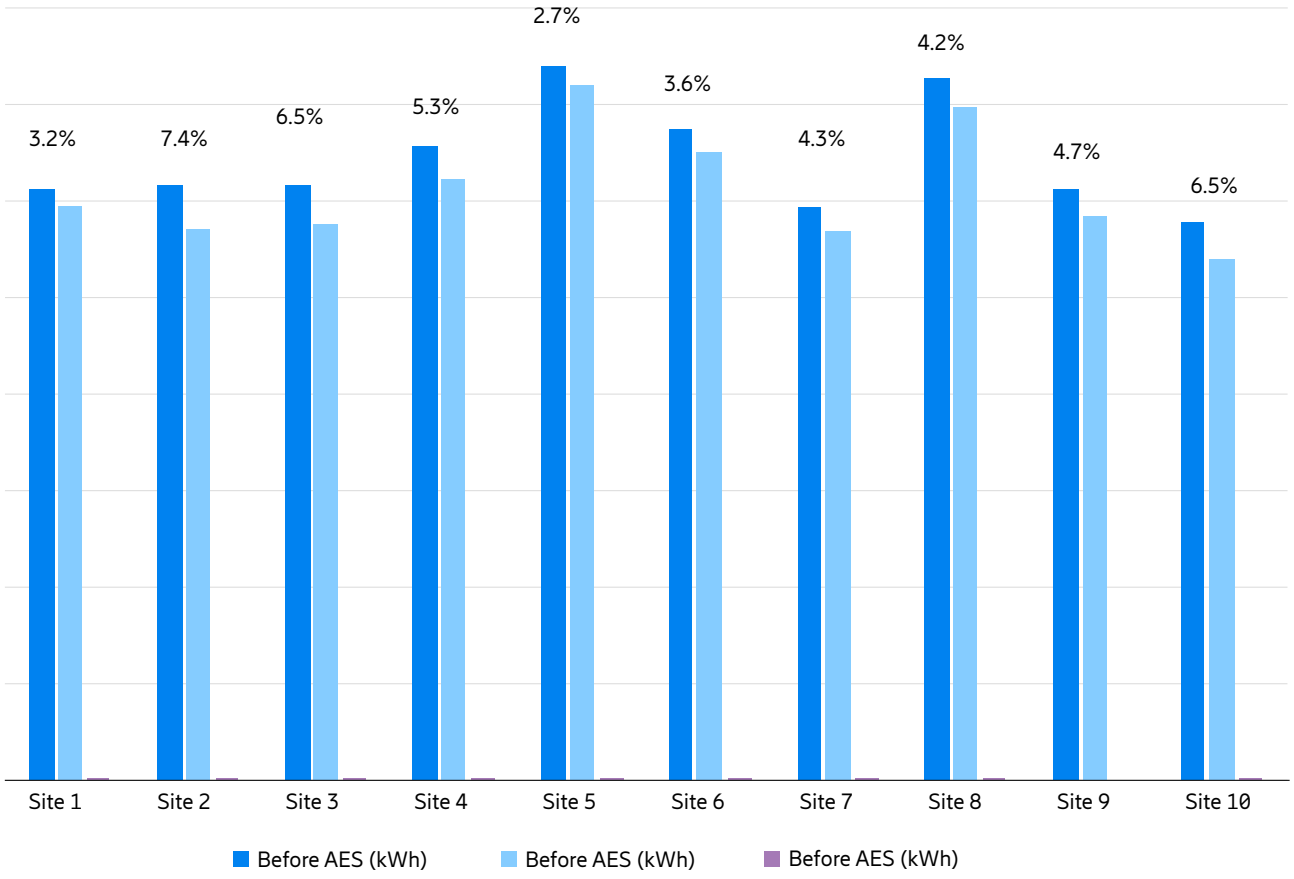


Figure 17: Trial results on AES enabled sites

Automated Energy Saver is the first 5G Advanced feature deployed in DNB's network. With AES DNB has started the transformation towards an intent driven RAN network to operate intelligently and save energy with no impact on user experience.

"I am proud to see DNB's 5G network continuing to be a pioneer in the region by being the first in Southeast Asia to deploy the functionality of the Automated Energy Saver (AES), which is just one of the many 5G Advanced capabilities supported by our network. The advanced automation will allow us to monitor and manage user experience while granting us the ability to boost energy savings with reduced operational complexity. This means the network will be sustainable by being energy efficient while maintaining undiminished network performance."

Ken Tan
Chief Technology Officer, DNB

5.5 Swisscom 5G journey commitment to performance and sustainability

Swisscom and Ericsson have partnered to deploy 5G network in Switzerland [7]. 5G is the most efficient technology and 5G Standalone architecture (SA) maximizes energy efficiency. In April 2019, Swisscom launched commercial 5G in Europe, achieving numerous milestones with Ericsson. Today, Swisscom provides 5G coverage to 96% of the Swiss population and continues to expand. In May 2021, Swisscom and Ericsson committed to a 5G Standalone (SA) rollout, enhancing network performance, and introducing new use cases.

Swisscom is committed to achieving net zero emissions by 2035 achieving a carbon-neutral value chain and reducing energy consumption in its infrastructure by implementing energy-efficient technologies. This commitment aligns with Swisscom's recognition of setting ambitious goals to reduce emissions across its operations.

The combination of both targets resulted in the decision to implement Automated Energy Saver functionality in Swisscom's RAN to ensure both performance and zero energy waste.

7. The Swisscom 5G story - A vision for 5G - Ericsson

Automated Energy Saver test results

As part of its sustainability drive, Swisscom, in collaboration with Ericsson [8], conducted field tests on the Automated Energy Saver (AES) feature within its RAN network. This AES feature, designed to enhance energy efficiency, optimizes power consumption by implementing a sleep mode in NR Massive MIMO configurations without compromising network performance.

The test was designed to compare the energy savings of NR Massive MIMO in it's default configuration with NR Massive MIMO augmented by the Automated Energy Savers algorithm for activating/deactivating the functionality.

The key performance indicators (KPIs) used to evaluate AES effectiveness included pmConsumedEnergy and pmMassiveMimoSleepTimeTxMute, keep track on energy consumption and the active duration of the sleep mode, respectively.

The test results demonstrated a significant achievement in energy efficiency. During AES activation, the sleep mode active duration increased by around 49%, highlighting the system's enhanced responsiveness and energy conservation during lower traffic periods. AES feature yielded a 2% reduction in energy consumption across the cluster, with even higher savings observed on nodes with heavier traffic loads.

Moreover, AES became a shift to more dynamic handling of Massive MIMO Sleep Mode thresholds further supported Swisscom's sustainability goals by adapting to real-time network demands.

49% increase time on sleep mode in low traffic

2% cluster energy savings in the trail securing KPIs

Future Rollout

The test results align closely with Swisscom's sustainability goals by providing measurable energy savings while maintaining network integrity. Based on these positive outcomes, Swisscom plans test AES feature in a larger area of its network, marking another step toward a greener and more efficient telecommunications infrastructure. The anticipated wider rollout of AES, expected in 24Q4, represents Swisscom's continued investment in sustainable innovation and energy-efficient solutions within its operations.

"We've been working closely with Ericsson for over 10 years with a great amount of trust and success. This will enable us to not only offer our customers the best customer experience, but also to place an even greater focus on sustainability and innovation."

Gerd Niehage
CTIO Swisscom

8. Swisscom and Ericsson – strategic partnership | Swisscom

06 Services powered with AI to maximize energy savings

While AI can boost energy performance, its execution brings new challenges for the CSPs.

AI implementation complexity challenges are:

- Serving RAN data to ML, efficiently and sustainably.
- Understanding DataOps and use cases.
- Resource limitations and latency requirements.
- Data locality, hardware-optimized models, managing the lifecycle of the model.

Our service solutions reduce barriers to boosting energy performance using AI on Ericsson´s platforms to execute AI-based models and algorithms. In this chapter, we will explore some of these solutions that can be applied in Ericsson and multi-vendor radio networks. These service-based solutions offer CSPs a unique opportunity for customization based on specific and ad-hoc needs.

AI based automation provides additional gains with data-driven self-management. The system will be able to gather network data and update the existing configuration without human intervention, this will release the operations team from this time consuming updating task.

6.1 Intelligent RAN Power Saving solution with a tailored approach

Intelligent RAN Power Saving solution is part of the Service Continuity suit also known as AI-apps. This service aims to pre-empt and predict events in CSP networks to act before they occur. This approach is also applied to energy efficiency. The energy efficiency algorithms (AI-APPs) use AI/ML to predict network traffic and activate or deactivate radio hardware features (Deep Sleep) and software features (Booster Carrier Sleep). These features require varying activation times, with hardware features needing a few seconds and software features requiring less time.

The algorithm is being refined through the experience gained from multiple networks. With over 10 customer cases globally in trial and commercial deployments

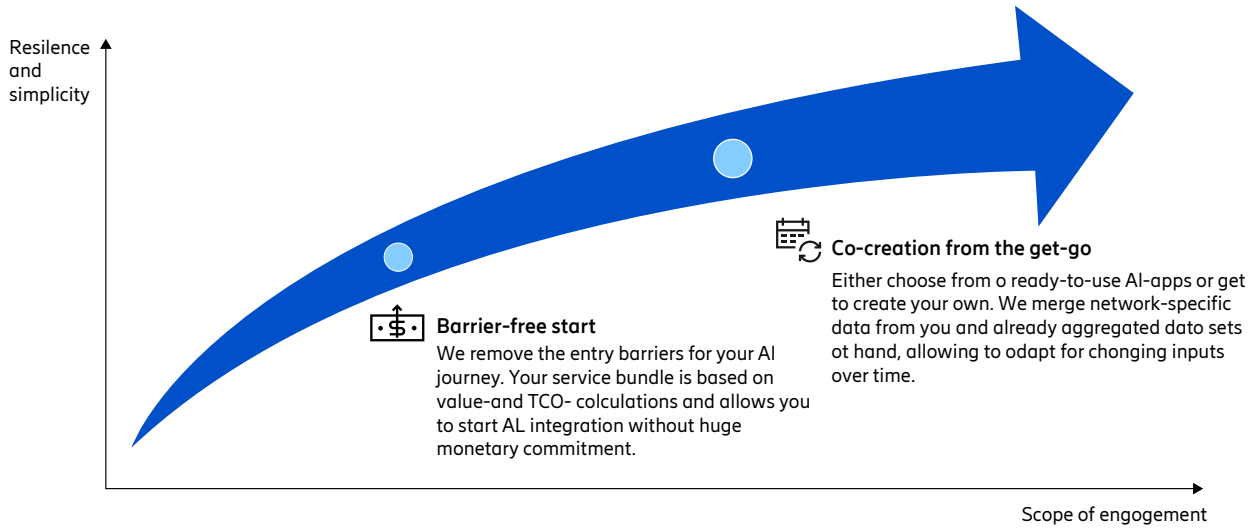


Figure 18 : AI journey made easy with network services

How it works

Coverage and target cell concepts in a pre-deployment data study based on PM counters are extracted from CSP network and analyzed by dedicated Data Scientist Team. Output of this is the classification of cells and the input to ML algorithm training. In this way the resulting artifact is tailored on CSP network by definition: in fact, data are inherently warrantying the customized service approach.

Once the algorithm is ready, it will be deployed to continuously compare real-time network data with traffic predictions from the ML algorithm. If the algorithm predicts energy savings and the network data confirms low traffic, it will send a command to put the node circuitry to sleep. This technology, embedded in Ericsson's silicon-based processors, can switch off all digital signal processing parts of the radio, achieving up to 90% reduction in energy consumption compared to average radio nodes.

When traffic is predicted to return to normal levels, the algorithm will wake the node and resume normal activity. The algorithm also monitors the impact on cells that remain active, ensuring they can handle the traffic shifted from the sleeping cells. It is crucial to monitor the energy consumption of these active cells to ensure overall energy savings.

All these functions are managed by the Ericsson services platform, where the application/algorithm runs. The platform is essential for this service delivery, connecting directly to nodes to gather performance counters and configuration data, and also receiving configuration information from the Network Management layer, such as the Element Manager.

6.2 Umniah AI-based solution to improve energy efficiency in Jordan

Since its launch in 2005, Umniah, a subsidiary of Beyon Group, has been recognized as one the fastest growing and reliable telecommunications providers in the region's most competitive markets, offering a wide variety of transformative high-quality mobile, Internet, and enterprise solutions.

Umniah has partnered with Ericsson to deploy Service Continuity functionality, which is based on Artificial Intelligence and Machine Learning capabilities enabling reduction in energy consumption in network operations through its smart Power Saving AI apps while securing network performance.

This partnership to deploy Ericsson's cutting-edge AI/ML solutions will significantly reduce energy consumption across Umniah's network operations in Jordan and deliver a remarkable advancement in the telecom industry's efforts towards environmental sustainability.

Intelligent RAN Power saving solution implementation and results

The solution uses a machine learning prediction model that continuously analyzes real-time network data. Through intelligent closed-loop decision-making capabilities, it determines whether to deactivate, activate, or maintain network component-controlling parameters based on the data and activity in neighboring cells. This enables precise energy management and operational efficiency without compromising network or service performance. Additionally, it results in reductions in carbon dioxide emissions and simplifies operations.

The solution was deployed in the live commercial network reducing energy consumption without impacting user experience.

The deployment comes after a successful proof-of-concept (PoC) where Ericsson's Intelligent RAN Power Saving solution, part of Ericsson's Service Continuity AI app suite, demonstrated about 20 percent on 5G daily power saving capabilities.

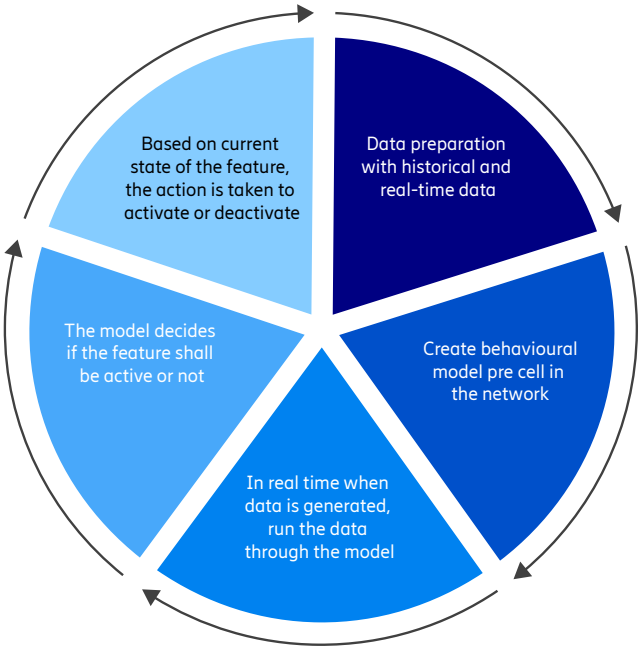


Figure 19: Closed loop implementation for Intelligent RAN Power Savings

"The collaboration with Ericsson signifies a crucial step forward in our commitment to sustainability and technological innovation. The positive outcomes of the initial proof-of-concept were clear, and we are eager to see the benefits of this AI-enhanced power-saving technology on a larger scale. The implementation of Ericsson's Service Continuity Power Saving solution is not just about cost savings—it is about taking meaningful action towards reducing our environmental footprint and building a greener future."

Alaa Ibrahim
Chief Technical Officer, Umniah Jordan

6.3 Energy Efficiency Map

This solution provides an energy efficiency map to understand the energy efficiency both at network level and radio node level granularity. Applying AI clustering technology, the sites are classified in different energy efficiency ranks. It monitors the energy efficiency and identifies autonomously the root cause of network inefficiencies.

This solution has two deployment options: as a tailored algorithm (Node Radio Power efficiency map) in the service continuity offering or as an rApp (Ericsson RAN Energy Cockpit) deployed in the Ericsson Intelligent Automation Platform (Ericsson implementation of the O-RAN Service Management and Orchestration platform).

This application follows several steps to improve energy efficiency:

- **Visualize the overall network energy efficiency with site granularity** – not only is site energy consumption considered, but also GB/kWh and other traffic metrics (such as data volume and average users/cell).
- **Understand the root cause of inefficiencies** – this is an automated process to identify and isolate the cause. configuration issues impacting performance and consumption, and hardware and software issues.
- **Provide recommendations for resolution** – once the cause has been identified, it is then shown in the web portal to alert the monitoring team, who will decide the next steps for the resolution such as implementing the recommendation or sending the actionable recommendation to the networks' operations team or opening a Trouble Ticket. For some scenarios, automatic resolution (closed loop) can be enabled such as parameter configuration.

The application is able to produce as output not only a map of efficiency distribution through the network, but also a report in which results of fault isolation scripts are reported and overall recommendations toward the CSP Operation team are delivered through a web page dedicated to CSP Operational team where OPIs and other indications are reported.

Node Radio Power Efficiency Map service or Ericsson RAN Energy Cockpit rApp changes the way in which energy efficiency is managed. Energy efficiency is a way not only of reducing OPEX but also to improve performance and drive the faults fix process in a preemptive way, before an alarm is raised by the nodes.

Cell energy efficiency status visualized in a defined rank

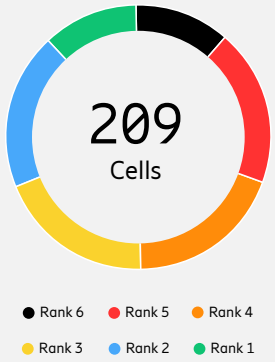


Figure 20: Energy efficiency map at site level. Cell energy efficiency status visualized in a defined rank

The main benefits are:

- Reduced OPEX with less operations cost and reduced time to resolution.
- Optimized CAPEX since it identifies over-dimensioning scenarios
- Improved network performance with the actions to fix network issues identified there are both energy efficiency and performance improvements.

6.4 Predictive Cell Energy Management Solution for multivendor RAN

Predictive Cell Energy Management (PCEM) is an innovative solution that minimizes radio access network (RAN) energy consumption across multivendor environments. Using advanced AI techniques, PCEM dynamically establishes optimal thresholds that conserve energy without impacting network performance.

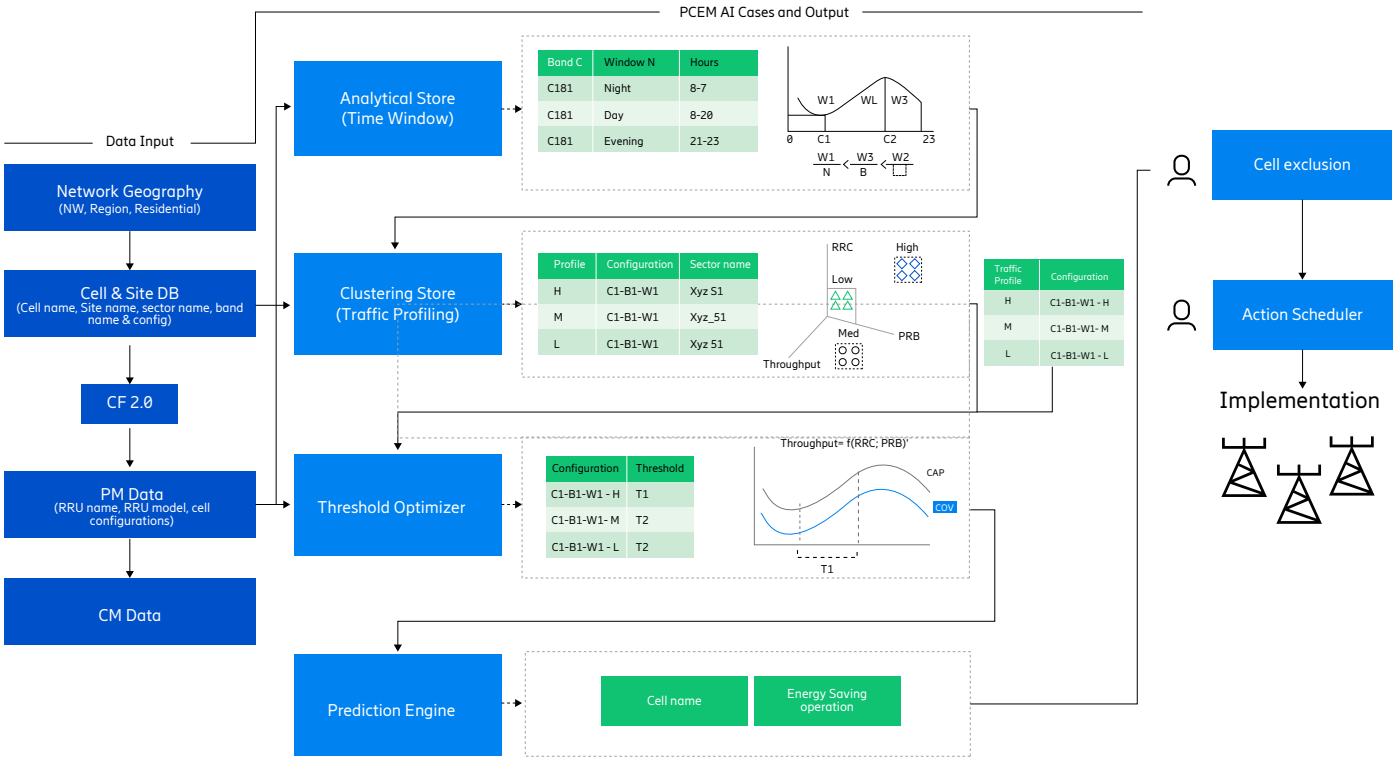


Figure 21: PCEM Solution overview

The more consumption of traffic is there on the network, the more will be the energy requirements. The measurement of the treatment by PCEM is done by comparing the energy consumed by the network with respect to the data volume it is providing to the customers. In simple terms, PCEM lowers the consumption by switching off the unnecessary equipment at certain time windows without affecting the data traffic consumption in the network. The below shown figure for a non-Ericsson vendor (Fig 8a) and Ericsson (Fig 8b) shows that for each data point on a graph showing energy consumption (in kWh v/s data traffic (in Gb), the absolute consumption as well as the slope is lower when PCEM is working in the network compared to the baseline behaviour which is the last week before the deployment or trial.

The higher the network traffic consumption, the greater the energy requirements. PCEM measures its effectiveness by comparing the energy consumed by the network to the data volume provided to customers. PCEM reduces energy consumption by deactivating unnecessary equipment during specific time windows without impacting data traffic. The next figures illustrate that for each data point the energy consumption (in kWh) versus data traffic (in Gb), both the absolute consumption and the slope are lower when PCEM is active in the network compared to the baseline behaviour observed in the week before deployment.

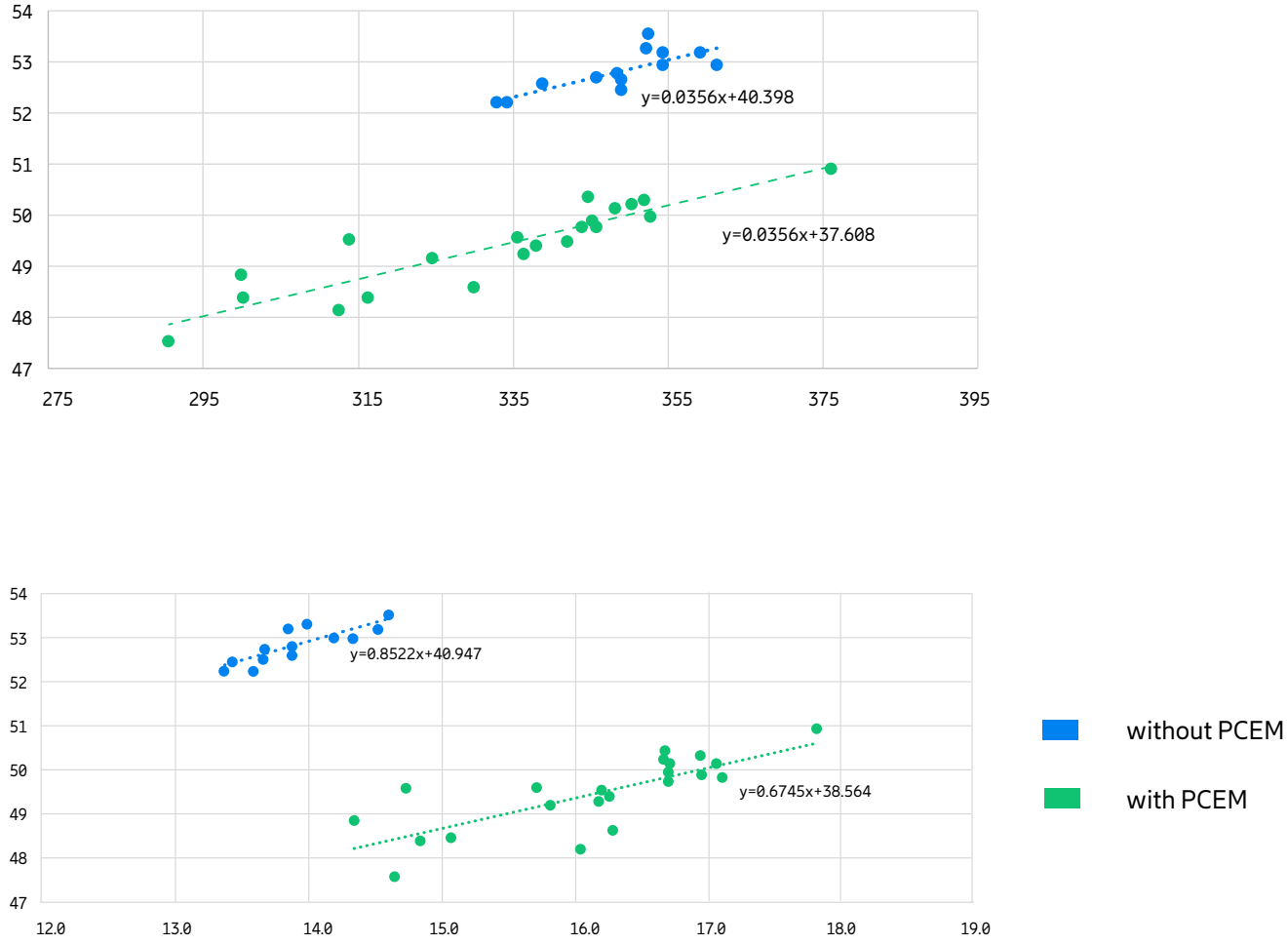


Figure 22: Graphs showing energy consumed versus traffic volume. Reduced energy consumption after PCEM deployment with non-Ericsson and Ericsson radios

PCEM has been deployed in multiple countries/regions for various customers and we have gained satisfactory results. The below table shows some of the results in the field

Region of deployment	Technology	Vendors	Energy saving (per day over network)
Brazil	4G, 3G	Ericsson	4.6%
UK	4G	Other vendor	5.9%
Croatia	4G, 5G	Ericsson	5%

Figure 23: Energy savings with PCEM in multivendor RAN

6.5 TDC NET deploys Predictive Cell Energy Management for energy performance

TDC NET is a leading mobile infrastructure provider in Denmark with a strong commitment on the climate change and have partnered with Ericsson with an ambition on technology leadership and enabling the green transition towards sustainable future.

The challenge: Energy savings without impacting network KPIs

As part of the plans towards Science Based Target initiative (SBTi) validated 2030 net zero target, TDC NET is taking actions to reduce the energy consumption in the RAN, while maintaining superior customer experience. Beside expanding the mobile network with the most recent energy efficient hardware, TDC NET has decided to implement Ericsson's Predictive Cell Energy Management (PCEM) solution which, through AI and automation, is set to achieve higher energy efficiency in the RAN while maintaining the expected KPI performance of the network.

The solution

Reducing the energy consumption of the RAN is a complex optimization task due to the dynamic nature of site build, traffic patterns and the underlying importance on maintaining the required KPI performance of the network. The PCEM solution enables TDC NET to set the desired network priorities, based on which the AI modules can identify the best energy saving action to take on a specific cell at a specific moment in time. The solution considers the historical trend and traffic analysis to maximize the energy savings, which is then complemented with real-time monitoring of the network KPIs to avoid any impacts to the customer experience.

The result

The deployment of PCEM was implemented initially at 4G frequency layers across 58% of the network. We observed a reduction in energy consumption when transmitting similar data volumes in the network, estimated as energy efficiency improvement of 6% kWh/GB for the addressable scope. Crucially, these reductions were achieved with no visible impact on network performance and customer experience.

PCEM solution is enabling a reduction of energy consumption without impacting the network performance by leveraging on AI technology and its prediction capabilities. It is estimated that with the current scope of PCEM implementation, TDC NET would be saving ~800MWh/year across the targeted sites, expect to lead to a reduction of ~135Tons of CO2e for 2024.

Further action is needed towards higher reductions of the energy consumption and achieving the sustainability goals. TDC NET will continue the efforts in enhancing the initial results and exploring the AI approach on energy efficiency features in the RAN to further improve the energy performance and thus the CO2e footprint of the network.

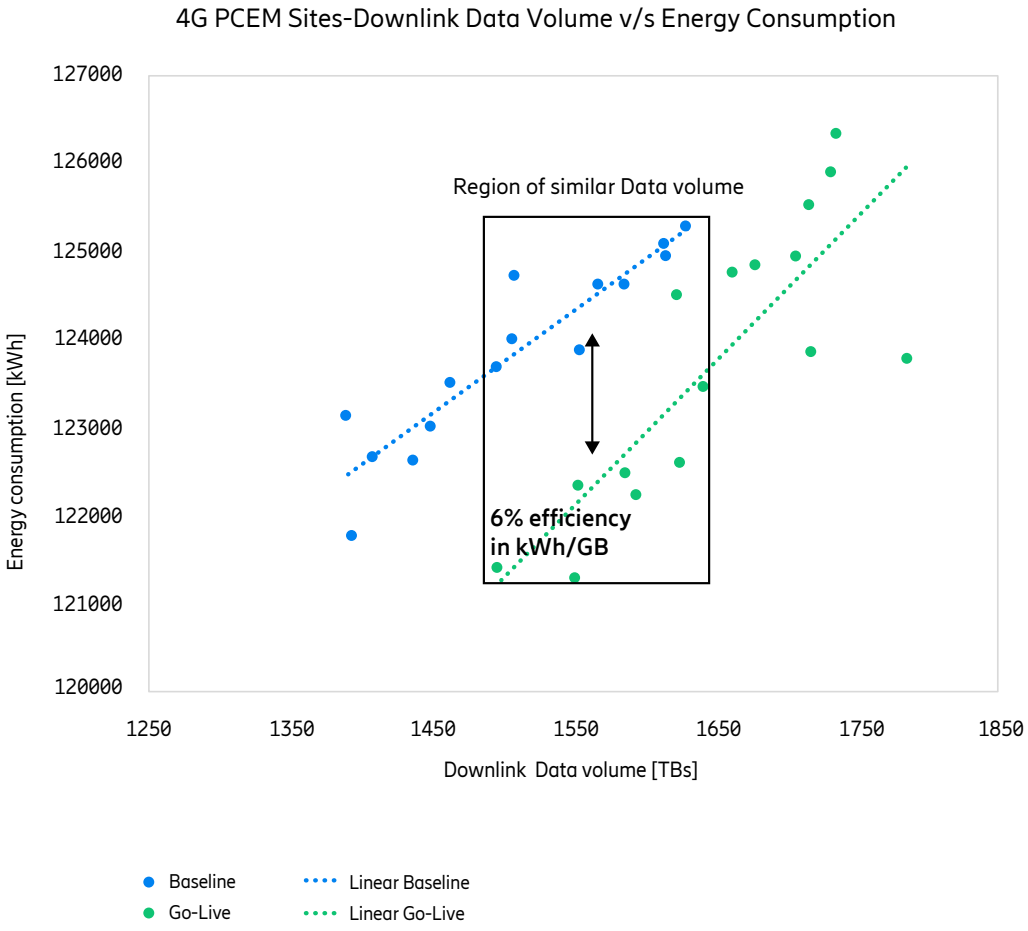


Figure 24: PCEM results in TDC NET

"We are very pleased to continue our strong mobile partnership with Ericsson to build out our leading position in the market and ensure the country's best network experience. By testing and deploying AI and automation-based solutions, we aim to enhance energy efficiency and user experience in our network operations".

Peter Søndergaard Andersen
Vice President, Head of Sustainability, TDC NET

07 Site solutions innovations beyond energy efficiency

RAN Site portfolio in Ericsson is dedicated to enabling sustainable infrastructure for cell-sites especially focusing on energy, energy storage, interconnect solutions, security and renewables. Each of these areas have dedicated product line-ups within Ericsson to also enable Open RAN infra.

Utilities companies are under big pressure to be able to answer the energy demand. For this reason, they are targeting mobile network operators to support in their challenges, they are offering benefits as reward, these benefits are either special prices for energy or rewards. Energy consumption comes as an opportunity to join these incentive programs.

Our solutions go beyond energy efficiency since they enable CSPs not only to reduce the energy cost but also to gain new revenue, becoming an energy player and participating in the energy market.

Grid challenges

An increase in the use of electric energy source is stepping up demand on the power grid. The ongoing transition to renewable energy sources, which vary in output, makes it more important to match power generation with consumption.

With the shift to fossil-free energy generation and electrification, power grid owners also need support to meet new challenges emerging from this ongoing transformation in energy generation and consumption.

Main forces challenging grid robustness are:

- Bottlenecks in electrical transmission capacity
- Growing share of intermittent energy sources such as solar photovoltaic/wind globally
- Reduction in the share of rotating mass for electricity balancing in the power grid.

In the transition of the power grids, enlarging the energy reserve capacity is imperative to ensure stability, making the balancing of every electricity grid the new norm. For power grid owners to meet this they can receive support with various energy ancillary services from stakeholders in the energy ecosystem.

How can energy provider manage the grid to be in balance?

Energy provider can today control the balance by two variants, price or/and incentives. With price the energy provider can steer the consumption to be very expensive during high demand hours and with incentives (ancillary services) motivate energy consumers to avoid consuming at high demand hours.

Telecom network site owners, who own and control the passive equipment at the site with energy storage capability including renewables, can utilize the energy storage possibilities to avoid consumption from the grid when the grid has high demand, and they can also be part of the energy ecosystem and participate in the various energy ancillary services.

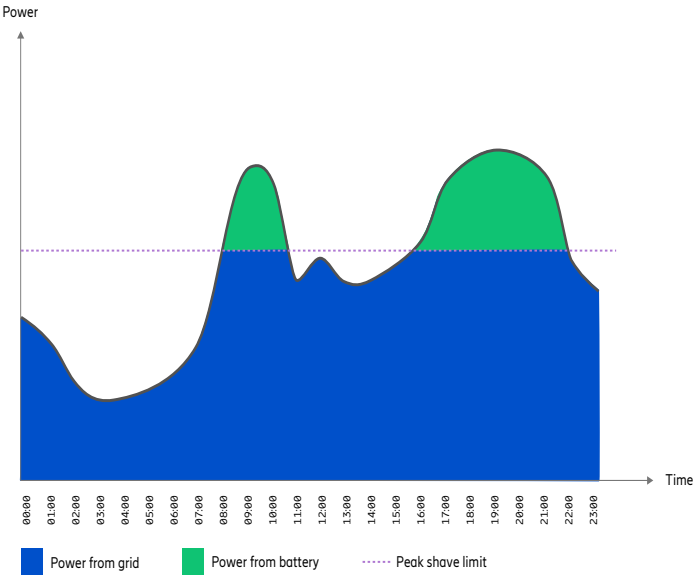
Networks need to minimize its energy consumption while maximizing the use of stored energy at network sites including renewables, which requires a transition toward an intelligent energy setup and an integrated approach to energy management and orchestration.

How can CSPs reduce the overall energy consumption with Smart Site solutions

Ericsson OPEX features in commercial operation show significant reductions in energy bills through deploying methods like peak shaving, load-shifting features and using hybrid energy with onsite renewables and lithium batteries.

Peak shaving solution

Depending on the market, some countries have huge difference between the high price and low price on the tariff for electricity. Some has also higher tariff if peak consumption exceeds threshold defined by energy provider. With peak shaving CSPs can avoid higher tariff and peak by taking the power from the energy storage during high load hours and by that reduce OPEX.



Overview

- Peak shaving limits power outtake from grid
- Remaining power is drawn from battery

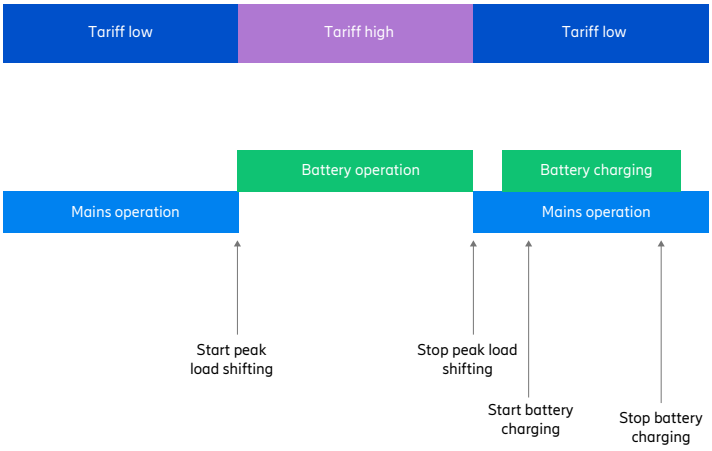
Benefits

- Helps reduce peak power/demand charges from utilities
- AC mains breaker size can be minimized

Figure 25: Energy peak shaving solution

Load-shifting features

Another way to reduce OPEX is to shift when CSPs need to consume energy from the grid. If consumption can be taken from the energy storage when the electricity tariff is high and reload the energy storage when the electricity tariff is low, can in some markets give a good reduction. This is when the solution is running on peak load shifting.



Overview

- Load shifting disconnects entire RAN load from grid and operates on battery at defined time(s)
- Battery recharge can be schedule for low or very low tariff periods

Benefits

- Avoids high traiff periods

Figure 26: Energy load shifting solution

What are the different strategies followed by CSPs to reduce energy cost

CSPs have always the need to make sure the network is up and running to the lowest cost, therefore cost reduction is always on the agenda. Peak shaving or Load-shifting give the CSPs option to reduce energy cost in a scheduled way but with Site Energy Orchestration CSPs will have better options to not only reduce cost but also gain revenue based on the load consumption in their network.

Beyond energy efficiency: Site Energy Orchestration

Ericsson's Site Energy Orchestration (SEO) [9] is designed to support our customers in addressing the new challenges that come with the transformation in energy generation and consumption.

Site Energy Orchestration AI based software can be provided as a service part of the service continuity suit. In the short-term, it will be provided as an rApp deployed on the EIAP [10] (Ericsson´s implementation of the SMO).

Site Energy Orchestration solution is built of a combination of machine learning (M/L) and AI applications and acts as an interface between global networks and the energy grids. The solution gives service providers cost control, to reduce energy OPEX without affecting the user experience and incentive, giving service providers a possibility to participate in various energy ancillary services.

The solution enables service providers to cluster hundreds or thousands of sites and orchestrate the network sites in the best way by reduction of energy or participating in ancillary services. It also enables a combination of programable freedom depending on the difference in the utility market regulation. CSPs with network crossing through country boarders will be able to adjust the solution according to the regulation in the country.

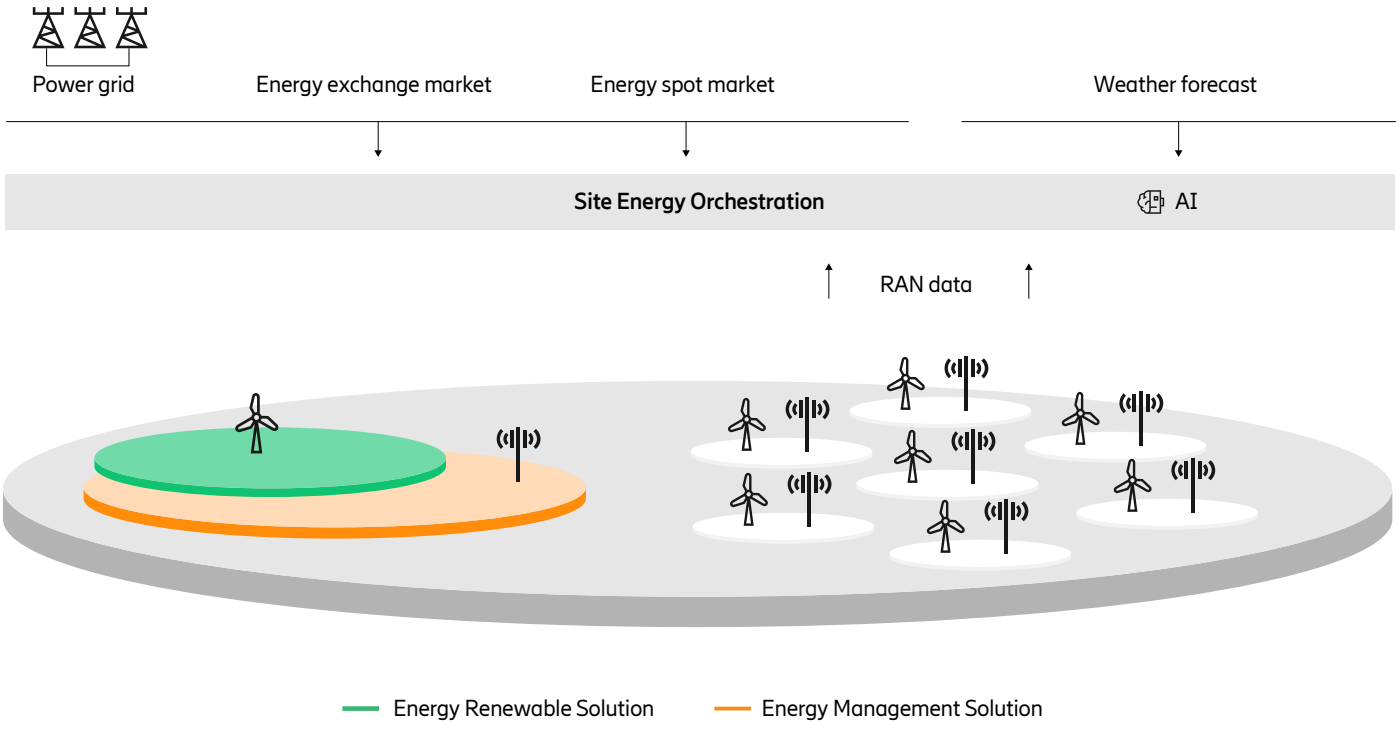


Figure 27: Site Energy Orchestration solution

9. Intelligent Site Energy Orchestration Solutions - Ericsson
10. Ericsson Intelligent Automation Platform

Results in the field

Thanks to the deployment of this solution a CSP in north America could lower their cost significantly by applying peak load shifting feature both in summer and winter time. When adding peak shaving in combination with peak load shifting, OPEX is further reduce.

The smart Energy site trials in the north america market demonstrated more than 20% daily savings in energy costs

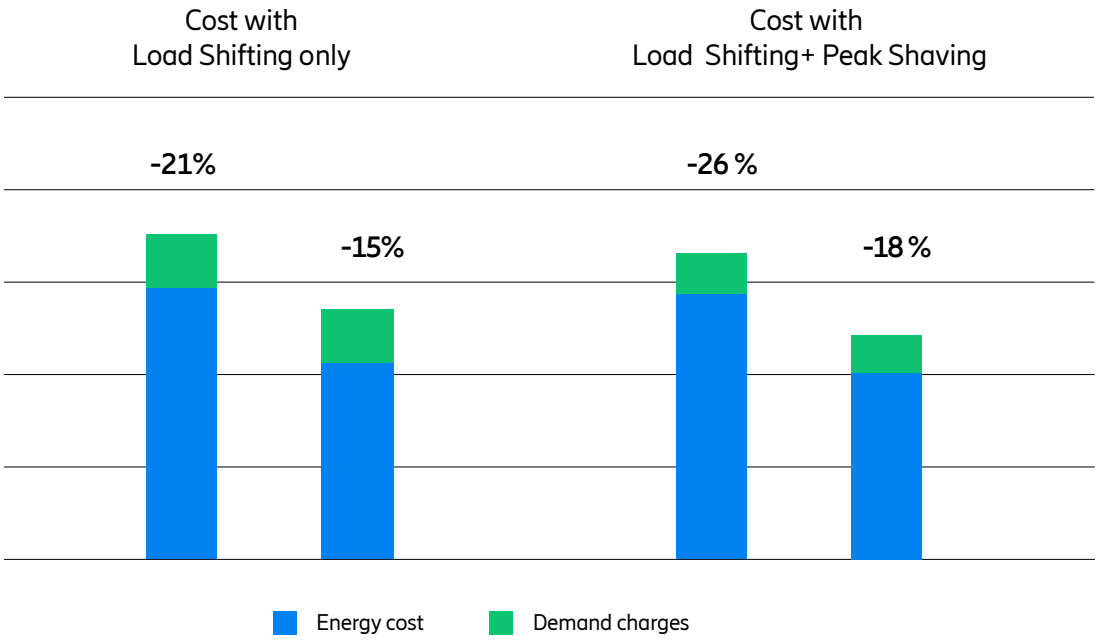


Figure 28: Smart Energy Site solution results in a North America Mobile Network

08 Key takeaways and recommendations

Key takeaways

Enable energy performance optimization with high-performing radio networks	New software functionalities will allow CSPs to efficiently scale-up or scale-down network capacity to the traffic load. High-performing, energy efficient radio network equipment can dynamically adapt with the finest granularity to prevent any energy waste. Ericsson´s tailor-made silicon is the foundation of our high-performing radio network with yearly improvements on energy efficiency, enabling better sleep modes, and increased processing capabilities.
Intent-driven automation with AI will secure user experience and reduce energy consumption	Networks operations shift towards intent-driven networks will bring multiple benefits, including improved user experience and reduced energy consumption. This new operations paradigm will allow CSPs to simply state their multiple objectives or intents (i.e securing user experience and reduce energy consumption) while the RAN handles complex processes and actions. AI technology will help in high-complexity scenarios evaluation with multiple optimization objectives and potential trade-offs.
Evolving to programmable networks will help CSPs to achieve business and sustainability targets	The introduction of differentiated connectivity with performance-based services is a game changer for operators, securing user experience while optimizing energy consumption. Ericsson's vision of programmable networks represents a holistic approach to energy performance, embedding it into every use case and scenario. This strategy addresses the immediate need for reduced energy consumption and secured user experience as week as paves the way for a more sustainable and adaptable network infrastructure in the future.

Actionable recommendations for CSPs

01

Define new metrics to redefine the best network

Ericsson believes that it is time for the industry to redefine what is considered as the best network, moving beyond the traditional metrics of speed and coverage, and instead focusing on developing networks that are high-performing, energy-efficient and sustainable.

02

Enable holistic observability across the entire network

Observability is a vital factor to optimize energy performance and requires information about performance indicators and energy use of different radio technologies from multiple network parts. This includes active telecom equipment, such as radios and baseband units, as well as from site-support systems, such as rectifiers and cooling units. This information is typically available from data counters through embedded systems in the network. This holistic view is important because focusing on radio performance alone is insufficient to accurately assess the energy performance of the mobile network.

03

Improve energy performance with benchmarking

The introduction of differentiated connectivity with performance-based services is a game changer for operators, securing user experience while optimizing energy consumption. Ericsson's vision of programmable networks represents a holistic approach to energy performance, embedding it into every use case and scenario. This strategy addresses the immediate need for reduced energy consumption and secured user experience as week as paves the way for a more sustainable and adaptable network infrastructure in the future.

04

Leverage your energy assets to reduce costs and gain new revenue

Mobile network site owners, who control passive equipment with energy storage capabilities, including renewables, can use these storage options to avoid grid consumption during high demand periods. They can also join the energy ecosystem and participate in various ancillary services. CSPs can turn energy challenges into opportunities by becoming energy players.

05

Secure interoperability and orchestration between different energy-saving solutions

Ericsson and other vendors are providing a great number of energy-saving solutions to support service provider's ambition to save energy. The increasing number of solutions provide a large variety in how to combine functionality that switch off parts of equipment, complete frequency bands and equipment, as well different levels of sleep with varying reactivation time. Without interoperability and orchestration, it is difficult to ensure the best selection of features to achieve the largest energy savings for each scenario. Ericsson´s proposed architecture with 5G Advanced software, SMO and rApps ensure both orchestration and interoperability between different functionality and vendors.

06

Empower your operations team with AI-based automation solutions

Network complexity is further driving the need to use automated solutions with AI/ ML to operate the networks. Communications Service Providers are keen to improve energy performance in the active and passive equipment without impacting user experience and network resilience. AI based automation provides additional gains with data-driven self-management. The AI system will be able to gather network data and update the existing configuration without human intervention, relieving the operations team from this time-consuming updating task. Ericsson can provide both services and software-based solutions.

07

Identify what use cases can benefit the most from AI technology

High-complexity scenarios with multiple optimization objectives and potential trade-offs require the use of AI. The predictive capabilities of AI based solutions can boost energy savings without compromising user experience. In the CSPs' AI journey, it will be essential to focus on leveraging AI whenever gains are more significant and legacy solutions can be seamlessly replaced to maximize the return of investment (ROI

08

Evolve networks to be intent-driven and programmable

Programmable networks can manage the complex interaction of assets, site-specific optimizations, and ongoing maintenance by reducing the operational effort with the intent definition at network level. Intents abstracts the complexity of underlying processes and allows CSPs to interact with the system more intuitively telling "what to achieve" instead of the "how". This shift will also enable performance-based business models in a cost-efficient way.

Intent-driven and AI powered networks can provide the most optimized solution for multi-objective targets such as securing user experience and optimize energy consumption. Combined centralized and distributed automation will manage multiple objectives or intents. Ericsson is pushing the technology boundaries for a conscious energy use and user experience targets.

Ericsson's high-performing, programmable networks provide connectivity for billions of people every day. For nearly 150 years, we've been pioneers in creating technology for communication. We offer mobile communication and connectivity solutions for service providers and enterprises. Together with our customers and partners, we make the digital world of tomorrow a reality.

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