2020

REDUCING THE COST OF BASE STATION ENERGY

Contents

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1 Introduction

According to data from GSMA[1], **telecoms networks contribute 2-3% of total global carbon emissions**. To make matters worse, demand for voice and data traffic fluctuates throughout the day and night, often by significant margins, and so in turn does power consumption. Traditionally, however, power supply remains constant, which leads to inefficiencies in terms of wasted energy and, of course, cost. Of course, this also has a significant impact on operators' carbon footprint and corporate responsibility (CR) goals.

The GSMA has reported that energy consumption typically "constitutes 20–40% of network OPEX" (GSMA Future Networks – Energy Efficiency: An Overview). These costs are not evenly distributed: the Radio Access Network (RAN) is the single largest contributor, accounting for nearly 60% of the total[2]. The RAN is an obvious candidate for efforts to decrease energy consumption and hence costs.

The Radio Access network energy bill is a large OPEX element that is expected to grow.

Mobile operators use more than

€72 billion

On energy for their Radio Access Network (*

Network energy costs make up

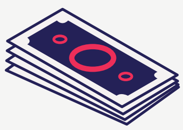
~60 %

On mobile operators electricity bill (**

Operators have branded

kWh per GB

As the KPI to watch



Out of the network OPEX budget

~10 %

Is spent on energy (***

*) Nokia, **)Vodafone, ***)Tefficient
[1]https://www.gsma.com/futurenetworks/wiki/energy-efficiency-2/
[2]https://www.researchgate.net/publication/276140368_Energy-Efficient_Base-Stations_Sleep-Mode_Techniques_in_Green_Cellular_Networks_A_Survey

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Some network base stations do now have power management tools, whereby power supply can be moderated at known times of the day. However, this is a passive and static way to manage power supply, meaning that any unexpected surge in traffic demand – during an event, for example – can leave a location with poor service, or no service at all.

They are also subject to poor reaction times to unpredictable events, and lack any granularity in terms of more subtle differences within locations, for example, a shopping centre and a residential area. Clearly, these tools are inefficient when it comes to not only reducing costs for service providers, but also carbon emissions. Increasingly, enterprises are under scrutiny to meet corporate responsibility (CR), and environmental, challenges, which adds another requirement for better power management of base stations.

Furthermore, the rollout of 5G networks will only make matters more pressing. 5G densification refers to the increased number of base stations required to provide the required Quality of Service (QoS) and capacity. Not only does 5G require more base stations, each unit also requires more energy to power it, which in turn increases OPEX further. Of course, increased energy usage also raises emissions, with further environmental impact and, ultimately, creating further CR concerns.

So, not only is there a risk that densification will increase OPEX, it will also have the side effect of negatively impacting reputational and environmental indicators. CSPs are becoming increasingly worried about this issue – at the recent 5G Core Network Summit in Madrid, several speakers noted that environmental impact had become a key concern. So, one problem can easily have repercussions for another; micro issues can escalate into macro problems.

Operators urgently need to find ways in which to contain and reduce these costs to ensure return on future investments while meeting coverage commitments and obligations.

This paper will outline a solution to these challenges.

2 Base stations and energy consumption

Radio Access Networks (RANs) are estimated to account for 20–40% of network OPEX, according to the GSMA[1]. This accounts for hundreds of millions of Euros that CSPs are paying in energy costs to run their RAN. The GSMA also estimates that 5G networks could double and even triple energy consumption, compared to existing networks, meaning that it will become a significant challenge – not just in terms of managing and minimising OPEX, but also in terms of carbon footprint and sustainability.

So, what's the largest consumer of energy? According to a research paper by Yan et al[3], smartphones and the LTE wireless network are responsible for the majority of total service energy consumption. Smartphones are the main energy consumer for web browsing and IM applications, whereas the LTE wireless network is the main consumer for heavy data applications such as video play, video chat and VR applications, the paper found.

Meanwhile, another paper by Pihkola et al[4] shows that 57% of all power consumption can be assigned to base stations. Given that Elisa alone has more

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than 30,000 base stations just in Finland that adds up to a significant cost centre for operators.

Worse, the problem is growing because increased data consumption also correlates with power[2,3]. Since data traffic is rising exponentially, not only is power too in absolute terms (despite gains in energy efficiency for data transfer / gigabyte of new cell tech[3]), but power at each site will also grow based on the new traffic norms.

According to a recent Ericsson Mobility Report[5], for example, mobile data traffic grew 68% year-on-year in 3Q19, and 12% quarter-on-quarter. Clearly, mobile data traffic is growing rapidly driven by smartphone subscriptions and an increasing average data volume per subscription, fuelled primarily by more viewing of video content.

Other studies have also pointed out that the energy consumption of the mobile access network becomes significant when video content is downloaded using mobile devices.

The Pihkola study also included an estimate of the overall energy consumption of Finnish mobile network operators during the years 2010–2017. The overall energy consumption of all operators in Finland was estimated at around 0.6 TWh/a in 2017. This corresponds to 0.7% of the total annual electricity consumption for the whole of Finland in 2017 (85.5 TWh/a). In aggregate, energy consumption has a direct cost, often running into the hundreds of millions of Euros.

[3]Yan et al, Modeling the Total Energy Consumption of Mobile Network Services and Applications
[4]Pihkola et al, Evaluating the Energy Consumption of Mobile Data Transfer—From Technology Development to Consumer Behaviour and Life Cycle Thinking
[5]Ericsson Mobility Report – Mobile Traffic Q3 2019

3 5G energy consumption

Around the world, operators are preparing to launch, or are already launching, 5G services, while governments such as those of China, Japan and South Korea are investing significant resources into building them. 5G goes way beyond traditional connectivity. It will enable a range of new uses cases in IoT and M2M with ultra-fast, low latency and high reliability connectivity.

However, these benefits also bring new challenges. While throughput and efficiency of data transmission is getting better, more cells and more data will also mean an increased power consumption in the RAN. Thousands more cells are required for 5G coverage so managing and optimising energy consumption becomes an even more important challenge.

Mobile operators are looking to support higher levels of data usage while providing a high-quality experience. They must do this profitably while servicing many markets. Small cell densification helps achieve this, while keeping OPEX at a manageable level. Of course, more cells means more power consumption.

Furthermore, there are likely to be more parties to manage. TowerCos and others are investing in 5G infrastructure in order to take their own opportunities provided by 5G. But although there may be shared network resources, the problem of power consumption still remains and becomes more complex to manage among more parties.

Similarly, there are national initiatives to create shared access networks, which makes this a problem for the country at large, not just an individual operator or infrastructure provider – for example Mexico's open-access mobile network provider Red Compartida is already approaching the 50% national coverage milestone.

4 What is the ‘RAN’ problem?

The RAN is switched 'on'

100% of the time,

BUT NOT ALWAYS IN USE.

The Radio Access Network has been in use since the start of cellular technology, evolving through all stages of its development (1G to 5G). It consists of the base stations and antennae that provide connectivity to an area, as well as a controller. A device is wirelessly connected to the core network, and the RAN transmits its signal to various wireless endpoints over the network

Today’s RAN architectures – particularly in digitally transformed networks – separate the user plane from the control plane into different network elements. This separation of the control plane and data plane will be an essential aspect of the flexible 5G RAN, as it aligns with SDN and network functions virtualisation. RANs have evolved since their beginning to support multiple-input, multiple-output (MIMO) antennas, large spectrum bandwidths and multi-band carrier aggregation.

One of the problems with the RAN though is that it is inherently inefficient. It’s switched ‘on’ 100% of the time, but not always in use. One solution is to switch base stations on or off during ‘peak’ and ‘off peak’ times. However, this is a generic power saving mode, and could impact off-peak service performance leading to delays in restoring full capacity and patchy coverage. It does nothing to take into account different buildings, such as a stadium, within a coverage area, nor any unpredicted spikes – or dips – in demand. But there is a better solution.

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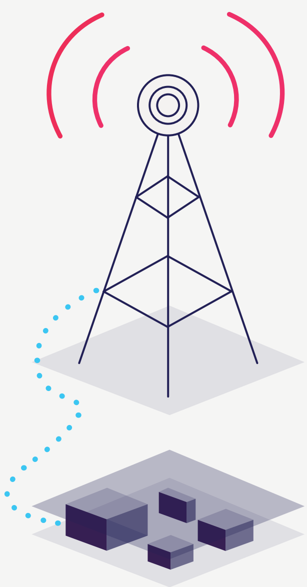
5 What's the solution?

Elisa Automate has developed a novel solution, **Intelligent Energy Saver** to address this problem. Intelligent Energy Saver, or IES, uses standard reporting feeds from the RAN to determine activity levels within each cell. This data is processed and a constantly learning patent-pending algorithm is applied to determine a power saving profile that can be applied to individual base stations. **Machine Learning** (ML) enables this to be refined through the processing of further data and new profiles to be generated that more accurately predict demands – and therefore allow further optimisation of operational profiles.

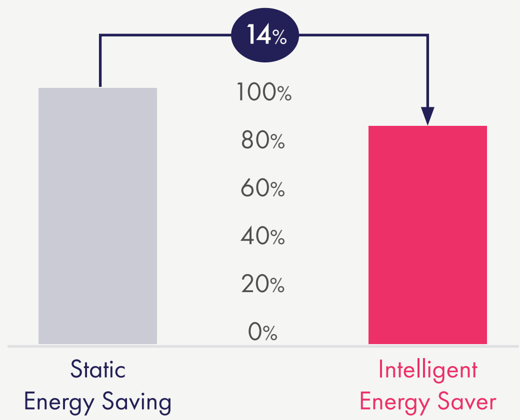
Elisa Automate utilise machine learning to save RAN energy without reducing network quality.



~60 %

Predictive intelligent energy saving plans deployed in the network.

Energy OPEX



-1200 tones of CO_2 emissions

saved per 10 000 base stations. Which equals to roughly 1800 round trips from London to New York*

*) Source: ICAO Uniting Aviation

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Busy Hour Physical Resources Block (BH PRB) utilisation shows how much a cell is being utilised – from 0–100% utilisation rate. "Busy Hour" equates to the hour of the day at which the cell is the busiest, based on data volume. Typically, this is around 9pm when users are often at home accessing streaming services, such as web browsing, video streaming, IM, and so on.

IES uses a Profile-Based Shutdown Algorithm – a proprietary algorithm that calculates when the performance of a site is "too low" to meet demand and therefore when there is a need for increased performance. In essence, it measures the performance of cells in a specific way to determine whether or not each site delivers as expected. The Tukko rule is then applied to check performance once IES has been deployed.

It also uses Closed-loop automation. This means that the data collected regarding cell utilisation is processed by machine learning tools in order to 'learn' the specific usage patterns of each cell. For example, a cell in a holiday resort, or a remote location will have a different pattern from one in a business district.

Once the cell usage has been monitored over a period of days or weeks, IES applies a new profile to the cell. This 'powers down' the cell during periods of inactivity or low usage. Consumption continues to be monitored on an on-going basis, so that the control rules can be continually refined.

Because the algorithm is constantly learning and being updated, it leads to far more efficient energy usage in base station estates. And, because it's automated, there is less manual intervention required, generating additional opportunities for savings and for deploying resources to other tasks. As a result, energy consumption can be managed more effectively.

In tests to date, IES has enabled Elisa, a leading mobile operator, to make mobile network energy OPEX savings of up 14%. For Elisa, with tens of thousands of cells in Finland alone, this adds up to significant savings in operational costs.

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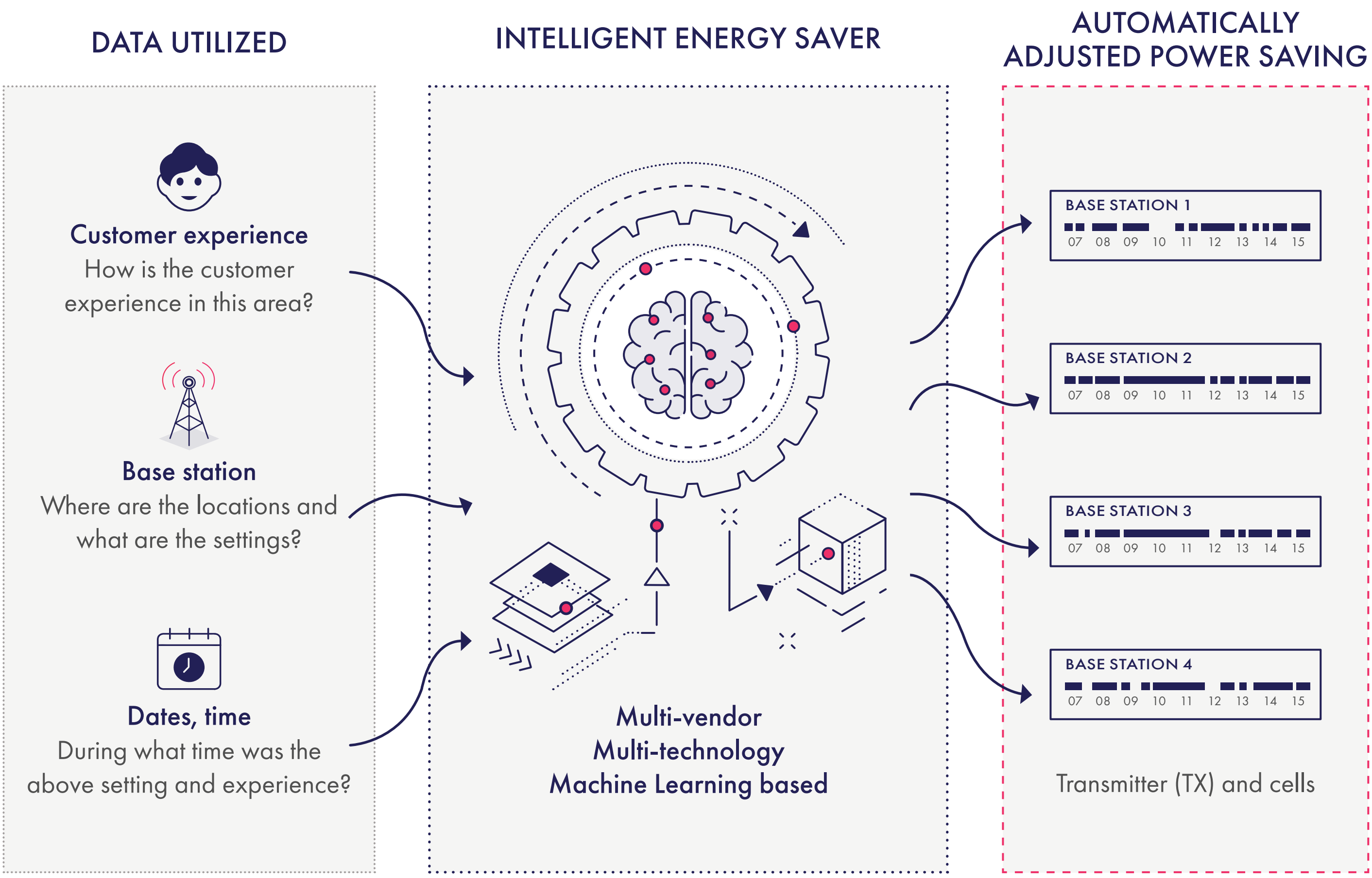
In addition, IES has enabled Elisa to cut CO2 emissions by around 1,200 tons for every 10,000 base stations – equivalent to roughly 1,800 round trips from London to New York[6].

A further benefit of the Elisa solution is that it is vendor agnostic. Unlike solutions from RAN providers such as Huawei, Ericsson and Nokia, – which often bundle their own energy saving solutions with large hardware contracts – Elisa Automate is multivendor, and so provides a flexible and open solution that can operate within existing architectures.



6 Conclusion

Base stations account for a significant proportion of operator energy usage each year – 57% by one estimate[3]. This is a significant OPEX cost for operators, and has further implications for carbon footprint, sustainability and corporate responsibility issues. The introduction of 5G, and the densification it entails, along with increased power consumption, allied to increasing mobile data traffic, means that this issue will only get worse.

Existing generic power consumption management tools are inefficient, slow to respond and don't take into account sub-location issues or unpredictable events.

Elisa Automate, on the other hand, uses an AI algorithm to constantly monitor and learn the power consumption patterns of each base station, and modifies power management to ensure optimum efficiency of base stations. Calculations show that Elisa can provide savings of 14%, which when applied to annual costs, and the industry as a whole can add up to significant OPEX savings. In addition, this contributes to organisational, and national / international sustainability goals, carbon footprint reduction targets and corporate responsibility targets.

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Are you interested in how you can save energy cost with the machine learning Intelligent Energy Saver or utilise network automation?

Get in touch with us for a noncommittal discussion.

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