Ericsson White Paper
GFTL-23:001893 Uen
February 2024

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Innovative Energy sharing

Content

Introduction

This white paper discusses the evolution necessary for enabling energy sharing. It traces the progression from current energy solutions in the Information and Communication Technology (ICT) sector to a future ecosystem about 2030. This ecosystem involves multiple sectors contributing to energy sharing in society, where power and connectivity act as trusted partners when needed the most.

Readers are encouraged to explore this white paper to grasp the following key points:

1. ICT sites have the potential to support the power grid with energy ancillary services, utilizing energy storage at the sites. This provides ICT site owners with opportunities to generate new revenues.
2. ICT sites can play a role in local microgrids, enhancing resilience by having local power. This ensures that connectivity services remain operational.
3. The facilitation of energy sharing becomes crucial in crisis situations, especially as more services become digitalized and dependent on connectivity.

Exploratory activities are underway, including collaborations in these areas. This white paper will reference ongoing joint efforts across industries and sectors to enable energy.

What is energy sharing, and what can be anticipated from it?

The ultimate goal is to establish the capability to share energy generated and stored within a specific geographical area, particularly during instances of power grid disconnection. In light of the evolving climate situation, societies worldwide are encountering novel crisis scenarios. The increasing reliance on connectivity services, driven by 5G and 6G technologies, demands a continuous and available energy supply. This necessitates significant enhancements in the power grid, as depicted in Figure 1:

- **Decarbonization:**
  A concerted effort is made to reduce greenhouse gas emissions in power generation.
- **Decentralization:**
  The energy market transforms into an extensive multi-point system with two-way energy transfer distribution.
- **Digitalization:**
  The new multipoint setup for both power generation and the energy market underscores the requirement for numerous measuring points.

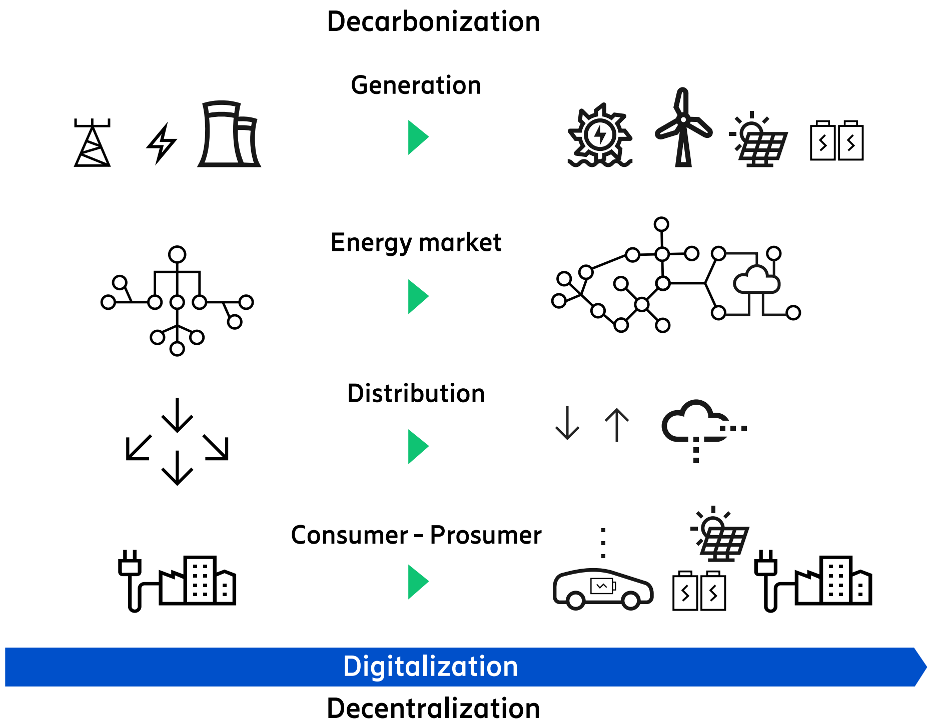

Figure 1: Power grid transformation

Power grid challenges and how ICT can support

With an increasing shift toward fossil-free energy generation and electrification, power grid owners require assistance in addressing the emerging challenges brought about by the transformation in energy generation and consumption. Key factors posing challenges to grid robustness include:

- bottlenecks in transmission capacity
- growing share of intermittent energy sources such as solar photovoltaic/wind
- reduction in the share of rotating mass for electricity balancing in the power grid

In the transformation of the power grid, enlarging the energy reserve capacity is imperative to ensure stability, making the balancing of every electricity grid the new norm. The ICT industry and other sectors can play a role in fortifying the power grid. Digitalization and smart energy orchestration have the potential to capture small energy generations from energy communities and establish innovative business models. This reinforcement can be examined from both sustainability and intent perspectives, as illustrated in Figure 2.

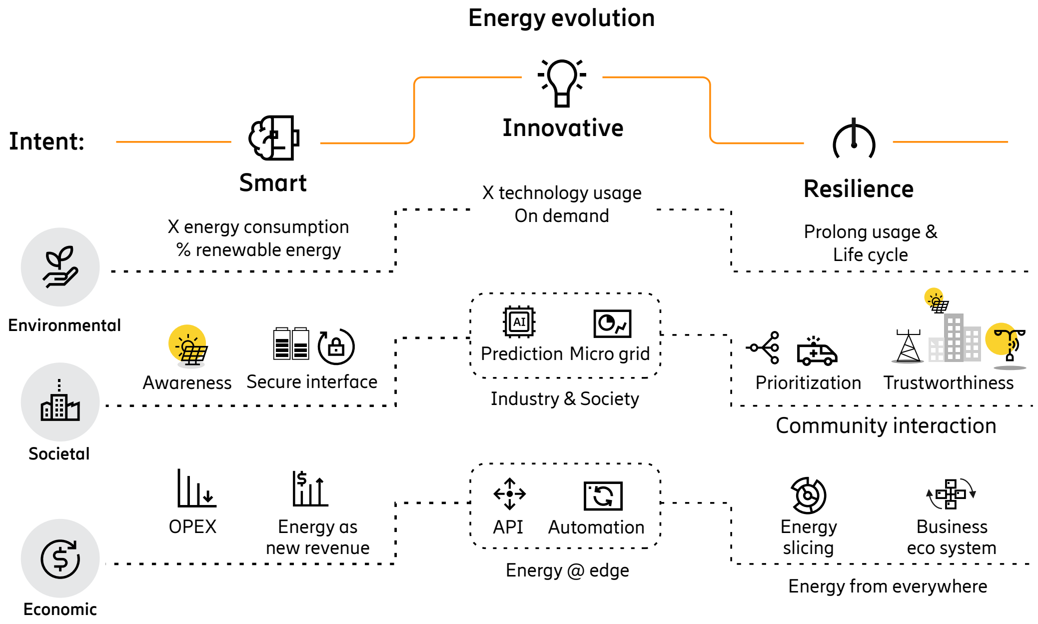

Figure 2: Build resilient energy from everywhere (Ericsson 2023)

A robust business model for stakeholders involves providing sustainable support to the energy market, which is crucial for ensuring the long-term reliability of energy and connectivity services for society. Transparency and awareness persist in propelling technological innovation and fostering conscientious energy behavior, benefiting the environmental perspective.

The ultimate goal of energy resilience is to tap into energy sources from diverse locations, where industry and society collaboratively unlock the potential of all energy resources. A collaborative approach among stakeholders fosters innovation, leading toward autonomous application programming interface (API)-based data exchange to enhance energy operational efficiency.

The energy evolution necessitates an interplay of various functional areas, and the ICT sector, along with other stakeholders, can contribute significant value to this transformative process.

Transforming the energy ecosystem

In the new distributed energy setup, new opportunities emerge for key stakeholders:

Power grid owners can receive support with various energy ancillary services from stakeholders in the energy ecosystem. In addition, they can utilize connectivity, whether public or private, to enable remote operations control of substations and line monitoring, especially as they become increasingly sensor-driven edge networks – cellular technology, therefore, offers a cost-effective implementation (enabled by 5G and edge cloud).

Read more Getting the energy utilities industry connected - Ericsson

ICT site owners, who own and control the passive equipment at the site with energy storage capability, can gain new revenues from the energy market, as further exemplified below.

Unlocking new revenue streams with energy orchestration

Telecom utilizes real-time technologies and has been digitalized for a long time, making it ready to leverage automation in network operations through artificial intelligence (AI) technologies. Smart connected sites enable the remote management of the available energy situation and power supply at ICT sites.

As telecom development progresses toward energy-aware edge services [1], combining active and passive site infrastructure with energy assets at the ICT site, energy optimization can be based on factors like the energy consumption of traffic paths for mobile networks and edge clouds.

Advancements in battery technologies allow ICT sites to transform the usage of batteries, shifting from providing power backup to becoming dynamic assets that enable new revenue options.

Aggregating the battery capacity available at a cluster of sites opens the possibility of supporting power grid owners with energy ancillary services related to balancing frequency and voltage. In energy markets where the grid owner controls power on/off, known as demand response services, the ICT industry can offer support, leveraging its national coverage of existing energy storage capacity. The deregulation of the energy market can even allow new stakeholders to enter, disrupt, or reinforce the energy market.

Fact box:
Energy storage for the global energy market is forecasted to grow at a 28 percent yearly rate from 24 GWh in 2021 to 278 GWh in 2031 [2]. An existing ICT site could, by dual use and leveraging installed battery capacity, support part of this need and thus be used to balance the power grid.

Example:
The Swedish Frequency Containment Reserve-Disturbance (FCR-D) upmarket is 558 MW [3] and ICT (30.000 sites) could temporarily reduce consumption and support 90 MW (3 kW/site) [4] with little need for additional battery capacity. The capability to deliver back to the grid with the existing power feed (3x16 A) can give up to 360 MW (64 percent) but then an additional energy storage of 80 Ah/site is needed. The entire need for FCR-D down for Sweden, 165 MW [5], can be supported by the ICT sector by only charging existing battery backup.

Energy optimization with hybrid energy usage

The climate situation has spurred investment in renewable sources such as wind and solar. Most of the anticipated growth in renewable sources is expected in China, North America, and Europe before 2030 [6], likely driving growth in innovative solutions to build smart interconnections between ICT and the power grid.

Further challenges of balancing the grid require larger energy storage capacity. The differences between power generation from renewables (mid-day to afternoon) and the consumption peak (late afternoon and evenings), the so-called "duck curve," continue to increase [7]. This situation impacts conventional energy sources as it becomes a financial loss to operate when renewable power generation peaks.

AI-based solutions can be used to influence the behavior of when and how energy is consumed and to perform proactive analysis and prioritization when using hybrid energy sources at the ICT sites, considering both traffic volume forecasts and the lowest cost/energy scheme. Digital twins are another helpful way to virtually represent different entities on a site, for example, base stations, hybrid energy sources, weather forecasts, power grid, and so on, for scenario simulation to understand the effects on users and impacts from the use of hybrid energy sources The output can be used for reinforcement learning of AI models used to reduce energy consumption, optimizing the value from hybrid energy sources.

Furthermore, ICT networks can identify various anomalies in the power supply used by the communication network and share them with the grid owner for appropriate actions.

Enhanced microgrid energy interaction

A transformer sub-station measures existing power usage but has less knowledge about potential energy generation downstream in the far edge. 5G connectivity can enable better granularity and possibilities to determine where renewable energy sources are situated and their status. An all-communicating, digitalized power system creates incentives to adjust production and usage.

Energy storage supports grid balancing, and virtual orchestration can increase the usage of small energy resources. With bi-directional power systems, ICT sites will become a much bigger opportunity for the power grid and, with that, a greater potential for additional income streams for ICT site owners.

A microgrid supplying electricity to a small geographical area, either in isolation through autonomous mode or grid-connected, presents an opportunity for interconnection with ICT sites for seamless services to build a more holistic solution and become more flexible and resilient. This is achieved by enabling the capability to leverage local power generation and energy storage in the geographical area. Such interconnection opens up several new creative use cases and eases automation execution by establishing common and secure APIs.

While being off-grid, prioritization of both users and functionality will be needed, as well as new commercial models with the producers of local renewable energy creating new billing schemes, including for end users.

Combining the above functionality with the energy storage capabilities and bi-directional power systems increases the ICT sites' potential to target additional income streams, thus becoming a competitor in the grid services marketplace and making a significant contribution to the stability of the stand-alone grid, being able to react fast to changes in the microgrid.

With the digitalization of critical infrastructure such as the power grid and connectivity networks, new sophisticated cybersecurity threats will arise, and AI will be pivotal in facing the challenges to come.

Ecosystems provide resilient energy for society

Extreme weather situations pose a significant challenge to critical infrastructure, prompting power grid owners to devise diverse strategies. Among these strategies are public safety power shutoffs (PSPS) aimed at preventing the escalation of wildfires. Additionally, careful planning involves determining the duration of PSPS, spanning days [8], to facilitate the coordination of backup energy generation and storage.

In addressing power outages caused by weather, enhancing the resilience of the power grid becomes essential. The conventional approach involves the electricity utility industry working on its own solution, typically entailing a lengthy deployment period of a decade and expenditures reaching billions of dollars. Is there an alternative? A new approach is imperative. The historical ICT convergence is becoming more flexible by moving from a hardware (HW)-centric to an HW-agnostic approach, for example, using cloud technology. Rapid changes in traffic patterns have led to the development of software-defined networks (SDNs), network function virtualization (NFV), and zero-touch networks. Parallels can be drawn to characteristics of the power grid, including rapid changes in power generation and consumption, and decades of experience in the ICT industry. This wealth of experience should be leveraged to develop a digitalized platform in the electricity utility industry.

Considering the evolution of the ecosystem within industries and sectors during the 5G journey, a broader awareness and interconnection with energy-related assets should be based on a similar ecosystem model. This approach aims to leverage and strengthen a resilient and reliable energy system for everyone. An increasing number of enterprises are introducing sensor-driven business operations in need of critical communication services. Similarly, an isolated terra system can be applied to the power system to increase the resilience level. Consequently, power grid owners will care even more about potential outages, measured as the value of lost load (VoLL) in the power grid.

The rationale for energy sharing in solidarity can be illustrated by a few examples highlighting the value of avoiding power outages:

Saving lives – Seamless communication facilitates drone ambulances to arrive with vital medical care equipment, subsequently locally recharging [9] for the next mission.

Ensuring access to safe water – Electric power ensures the operation of pumps for drinking water and sewage.

Securing financial transactions – A reliable energy supply guarantees uninterrupted transactions for daily necessities like food and supplies.

ICT as a trusted partner – An electric vehicles (eVehicles) arrives and recharge an ICT site to ensuring connectivity persists for a few crucial hours after a disaster when needed the most.

Communication services connect the community and can be pivotal for resilience throughout a crisis to enable unified energy sharing.

This means that power and connectivity infrastructure must collaborate seamlessly to become trusted partners when needed the most. New policies should guide the evolution, transforming the existing demand for energy backup into a versatile energy storage solution, ensuring prolonged connectivity services for communities while also serving as an energy ancillary service.

What will a full-scale solution mean?

A full-scale solution will require new support systems and common communication platforms, as well as a change to the processes and procedures of operations, like improved lifecycle management of equipment. While adhering to ensure all systems can operate in a safe manner, the infrastructure providers must consider reliable-available-resilient (RAR) perspectives when building networks and system setups. Robustness-maintainability (RM) must be ensured to gain efficiency in operations and infrastructure business that is durable by nature. [10]

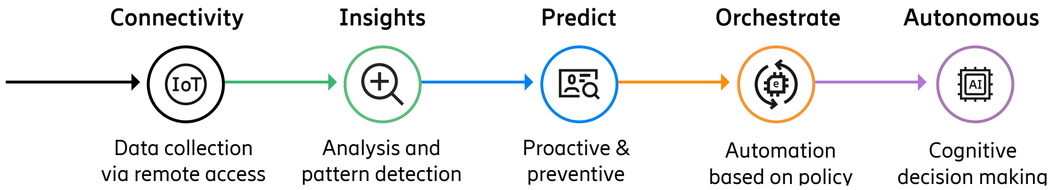

Figure 3: Maturity steps in the digitalization journey

The ICT sector has made significant progress on the digitalization journey, now striving for business-intent-driven operations with zero-touch automation (see Figure 3).
Harnessing the full potential of digitalization through the convergence of both telecom and the power grid presents new opportunities for society.

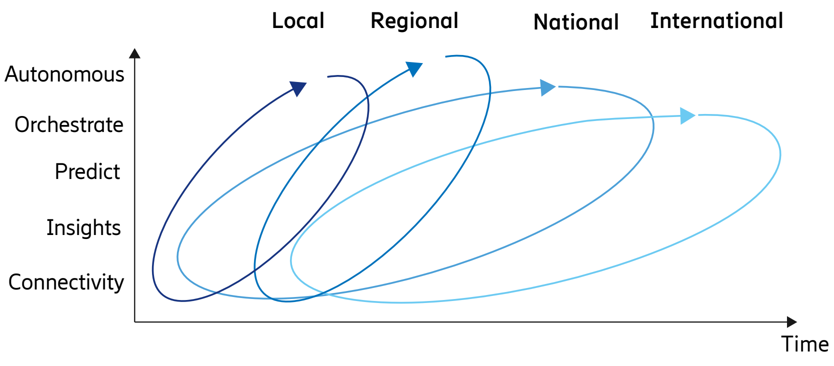

Figure 4: Deployment of smart autonomous operations

Both ICT networks and power grids operate at local, regional, national, and international levels. Each will need to have its own decision loops in a smart autonomous operations environment, as shown in Figure 4. This marks the beginning of a transition toward resilient energy in both networks.

Expansion to new sectors such as eVehicles, real estate, and so on, can be pursued once the initial steps have been made to connect an even larger energy ecosystem of energy generation, storage, and load.

New standards, regulations, and marketplaces can be collaboratively developed, leveraging expertise from each sector and engaging in policy advocacy. The preparations for energy sharing will unfold with variable scope and cadence in different regions.

Conclusion

Energy for ICT versus ICT for energy

ICT has, until now, predominantly employed the power grid in a unidirectional manner. Now a bidirectional value chain allows the electrical utility sector to leverage the ICT sector for both grid resilience and business-related connectivity services. By doing so, both industries can collectively contribute to Goal 9 of the United Nations Sustainable Development Goals to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation." Foremost it's the governments and policy makers that set the requirements as well as the cadence such as the US authorities [11].Power and connectivity can become trusted partners to address the climate crisis and the increasing electrification. The three evolution steps to support sustainability and intent in the energy evolution are:

Firstly, ICT site owners can become providers of energy ancillary services, enabling new revenue opportunities using clusters of ICT sites running alternatively on battery or the grid.

Secondly, ICT site owners should start building smart interconnections and leverage hybrid power and bidirectional energy at their sites.

Thirdly, actions must be initiated for making deep integrations for true resilient energy needed to prioritize energy consumption for what and by whom.

Coherent visions covering policies and technologies across sectors can make perspectives come to life and ensure durable infrastructure business following the ongoing engagements in energy sharing in society.

Glossary

A	Ampere
Ah	Ampere hours
AI	Artificial Intelligence
API	Application Programming Interface
CSP	Communication Service Provider
eVehicles	electric Vehicles
FCR-D	Frequency Containment Reserve-Disturbance
GWh	Giga Watt hours
HW	HardWare
ICT	Information Communication Technology
ICT site owners	Who owns the infrastructure at the site. Often a CSP or Tower company
kW	kilo Watt
MW	Mega Watt
NFV	Network Function Virtualization
PSPS	Public Safety Power Shutoffs
RAR	Reliable-Available-Resilient
RM	Robustness-Maintainability
SDN	Software-Defined Network
VoLL	Value of Lost Load

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Authors

Anette Höglund is the Strategy Execution Driver for energy at the Ericsson CTO office. She has combined the perspectives of new business opportunities, product management and deployments in the field as well as development in different areas since she joined Ericsson in 1995. Höglund aligns Ericsson's technology strategy for energy solutions and evaluates the energy opportunity space with customer project collaborations. She holds an M.Sc. in management from Henley Business School, University of Reading, United Kingdom.

Johan Pettersson joined Ericsson in 1993 and currently serves as the Strategic Product Manager for remote site management. For the past 10 years, he has mainly been working with power and energy-related products linked to site equipment and the ability to monitor and reduce energy consumption at sites. He also drives Ericsson's business-wide energy program, whose purpose is to execute the technology strategy solution approved by the Ericsson Technology Board. Pettersson holds a B.Sc. in electrical engineering from Uppsala University, Sweden.

Erik Sanders is a Product Manager for AI and automation. He joined Ericsson in 2005 as an engineer in the 3G RAN area and continued with hardware development for radio base stations. In his current role, he drives innovation programs for Ericsson in the area of machine learning and reasoning. Sanders holds an M.Sc. in mobile communication from Linköping University, Sweden.

Helene Hallberg is a senior specialist in energy-efficient radio systems who joined Ericsson in 1988. She is involved in energy-efficiency development and collaboration across the company, as well as in energy-related regulatory discussions and standardization activities. She is also a delegate in the International Electrotechnical Commission Technical Committee standardization of electricity supply systems encompassing transmission and distribution networks with their network interfaces. She has also filed a patent in the energy-efficiency area. Hallberg studied electrical engineering at a technical college in Stockholm, Sweden.

Nele Nõgisto is an Energy System Developer, focusing on technology innovation for ICT sector, such as energy storage systems and renewable energy applications. She has a background in Product Safety testing, regulatory certification and measurement technologies.