SUSTAIN-6G

6G for Sustainability - A Customer Perspective

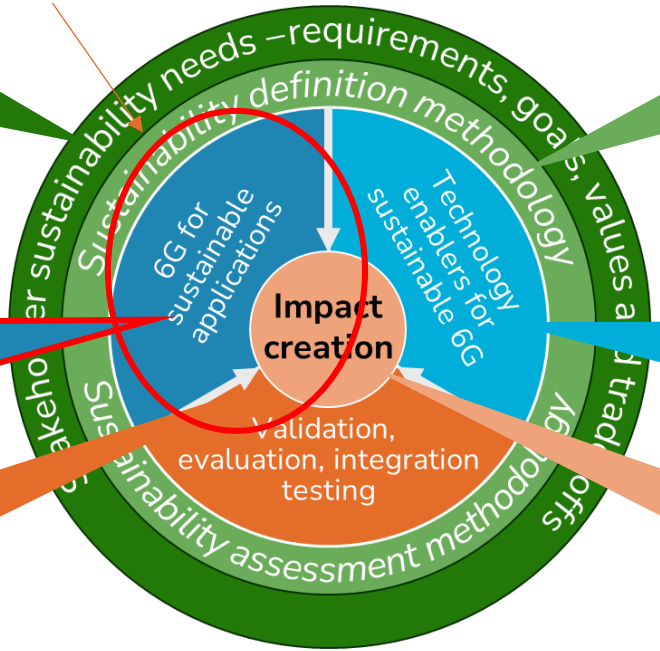
Siemens

Recall of the Sustain 6G project objectives

Influence *WHAT* "sustainability" means in 6G context

2nd order: answer *operator and enterprise needs* on integrated E2E solutions

Support *Nokia's ESG visibility* in European context



Define *HOW* "sustainability" metrics are defined and measured

1st order: drive key asset *sustainable technologies* in collaboration with operators

Influence European regulation & STD roadmap on sustainability

Context and motivation – 6G perspective

- Mobile network innovation is now driven by global sustainability goals (UN SDGs), moving **beyond just technical performance**.
- "**6G for sustainability**" offers new ways to enhance economic, social, and environmental benefits for industries.
- Critical sectors like **energy**, **agriculture**, and **e-health** can leverage 6G to significantly reduce emissions and optimize resource use.
- Achieving 6G's full sustainability potential for verticals requires **holistic strategies and supportive policies**, not just technology.

Context and motivation – Customer perspective

Global Imperatives

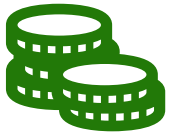
Climate Change & Resource Scarcity: Rising pressure to reduce carbon emissions and optimize resource use.

Regulatory Landscape: Increasingly stringent sustainability regulations.

Industry Challenges

Operational Inefficiencies*:* High energy consumption, waste generation, and outdated infrastructure.

Innovation Pressure: Need to integrate digital and sustainable technologies to remain competitive.



Strategic Motivation

Value Creation: Sustainability as a driver for innovation, cost reduction, and brand differentiation.

Risk Mitigation: Proactive sustainability reduces exposure to regulatory, reputational, and supply chain risks.

Three verticals

AGRICULTURE

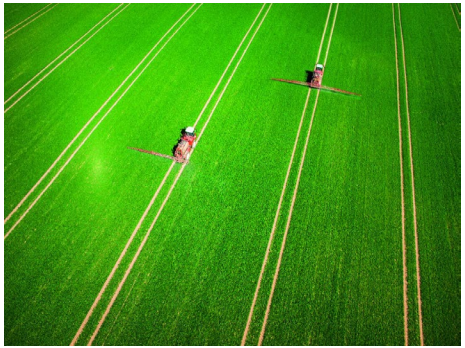
To empower farmers with real-time, data-driven tools that improve productivity and sustainability while bridging the rural digital divide.

Values

- Optimize resource use (e.g. water)
- Enable access to smart farming for small growers
- Promote environmentally responsible practices
- Foster synergy between farmers, tech providers

Stakeholders

- Farmers and growers
- Agricultural machinery operators and technicians
- Agronomic advisors and data scientists
- AgroTech companies and edge/cloud service providers



Three verticals

SMART GRID

To create a flexible, resilient, and sustainable energy system that integrates renewables and empowers local energy actors.

Values

- Ensure grid stability even under fault conditions
- Enable sustainable use of distributed energy resources
- Optimize infrastructure and operational costs
- Support dynamic energy markets and demand response

Stakeholders

- Transmission and Distribution System Operators
- Flexibility Service Providers / Local Energy Market operators
- DER owners and prosumers
- Regulatory authorities

Three verticals

E-Health

To deliver high-quality, personalized healthcare remotely while safeguarding data privacy and enabling equitable access.

Values

- Expand access to healthcare regardless of location
- Ensure secure and consent-based data handling
- Enable new business models & medical competence
- Reduce travel and resource use in healthcare delivery

Stakeholders

- Healthcare providers (hospitals, clinics, surgeons)
- Patients, consumers and insurers
- Medical device and software companies
- Regulators and data protection authorities

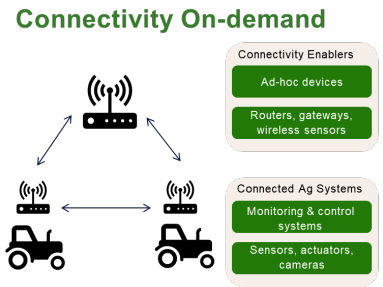
6G for sustainable applications - Agriculture

Connectivity on Demand: Temporary Connectivity Solutions in Rural Areas

Challenge:
Smart agriculture in rural areas faces a lack of high-speed, reliable connectivity.

Solution:
Temporary, on-demand connectivity reduces the need for permanent infrastructure in remote areas.

Intelligence:
Collaborative, plug-and-play solutions adapt to diverse environments, boosting efficiency and resource management.

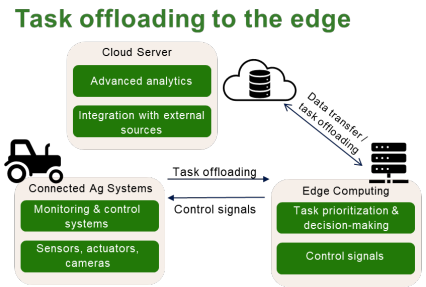


Task offloading to the edge for critical, resource-demanding tasks

Challenge:
Resource-intensive smart agriculture tasks are expensive and energy-demanding for devices.

Solution:
Offloading critical processing tasks to nearby edge computing infrastructure.

Intelligence:
Software-managed task prioritization ensures secure, low-latency communication and maintains service performance.

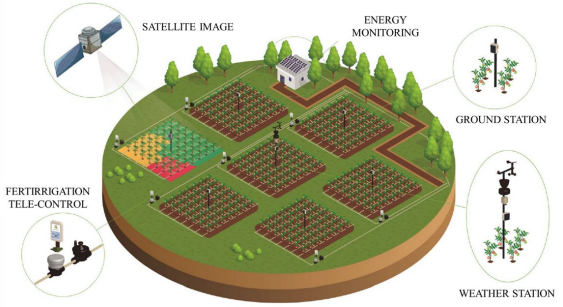


Agriculture data vs. information

Challenge:
Vast agricultural data is difficult to analyze due to complexity, correlation, and contextual variations.

Solution:
Real-time data contextualization and automated decision-making for crop management operations.

Intelligence:
AI driven transformation of raw data into actionable insights and forecasts, optimizing communication and processing.



6G for sustainable applications - Smart Grid

6G enabled grid balancing services

Challenge:
Grid instability from distributed renewables and EV charging demands real-time balancing.

Solution:
A 6G-enabled, distributed communication-control infrastructure orchestrates diverse DERs for grid balancing services.

Intelligence:
AI-supported decision-making and predictive dispatch, leveraging distributed edge intelligence for dynamic and real-time coordination of DERs..

Resilient grid section operation

Challenge:
Ensure resilient grid operation also during communication losses.

Solution:
A 6G-enabled strategy employs intelligent Distributed LV Grid units to actively coordinate grid flexibilities for resilient operation.

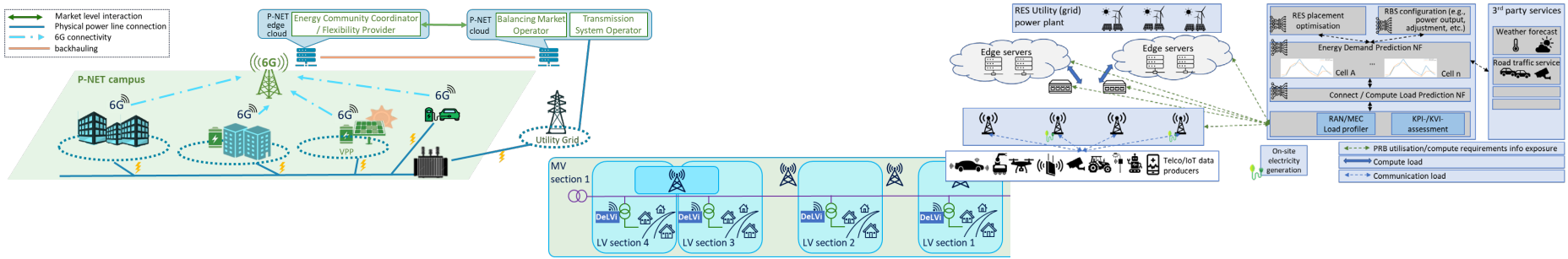
Intelligence:
6G-enabled units autonomously cluster to coordinate flexibility, ensuring grid resilience during communication failures.

Joint planning of 6G / smart grid

Challenge:
Flexible, stable power for ICT and grid, integrating volatile renewables.

Solution:
Joint 6G and grid planning integrates localized, renewable microgrids, storage, and decentralized coordination for adaptive energy provisioning.

Intelligence:
Jointly optimizing mobile network and smart grid operations for cost-effectiveness, using AI-driven energy management systems.



6G for sustainable applications – e-Health

Concurrent pre-operative surgical/engineering planning

Challenge:
Remote surgical planning and training demands real-time, lossless, and secure sharing of complex medical data (e.g., VR models).

Solution:
High-accuracy, synchronized communication links with dedicated data protection and security.

Intelligence:
VR-enabled collaboration for enhanced diagnosis, treatment, and critical decision-making, significantly reducing delays.

Remote Rehabilitation Assessment

Challenge:
Rehabilitation is often inaccessible and costly, especially for remote or mobility-limited patients.

Solution:
A personalized, home-based rehabilitation framework integrates real-time camera feeds, AI motion assessment, and XR for guided exercises.

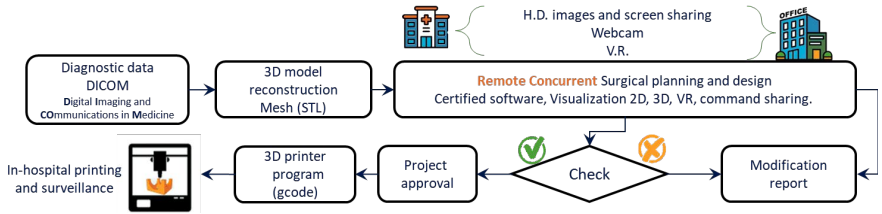
Intelligence:
6G powers real-time AI video analysis and XR for personalized feedback and remote expert oversight.

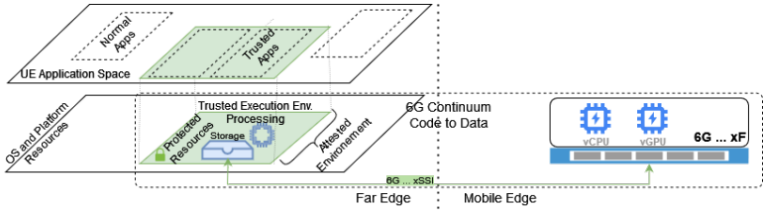
Medical data federation

Challenge:
Securely sharing and locally processing attested medical data for advanced diagnosis in cloud-based e-health.

Solution:
Network-level medical data federation with built-in data provenance, privacy, and hardware-accelerated security.

Intelligence:
6G-assisted, privacy-aware data federation enables in-situ processing through distributed data planes and secure network slices.





Sustainability Needs and Technical Requirements

- A preliminary list of sustainability needs has been identified for all nine Use Cases.

Environmental		Social		Economic	
1st order effects	2nd order effects	1st order effects	2nd order effects	1st order effects	2nd order effects
More accurate application of water, fertilisers, and pesticides	Lesser environmental impact of agriculture	Enhanced efficiency and productivity in farming	Higher crop yields	Optimised resource use, reduced waste	Lower operational costs for farmers
Shorter data processing time of edge devices	Lower overall energy usage due to less time in use	Increased system uptime	Better food safety and availability		
Increased energy consumption of edge devices		Cost of maintaining privacy of the collected data		Initial installation cost and ongoing maintenance costs	

- Based on the goals and needs of each Use Case, the preliminary ICT requirements were specified.

Parameter/ Scenario	Max. latency (ms)	Throughput (Mbit/s)	Range (km)	Gaps
Coordinated unloading	50	2-8	~1	Local connectivity on demand needed WiFi is not reliable
In-field data sharing	100	2 – 8	~2	Local connectivity on demand needed WiFi is not reliable
Remote support over HMI	100	2- 8	Cloud	Global Connectivity needed no service available in White spots
OTA SW updates	100	2- 8	Cloud	Global Connectivity needed no service available in White spots
Remote support over video transmission	100	25	Cloud	Global Connectivity needed no service available in White spots
Live alerts over M2I	20	Up to 100	~2	Global / local Connectivity needed no service available in White spots

Takeaway

Key Takeaways	6G is more than a technology leap - it's a **strategic enabler** for sustainability across verticals.
	Agriculture, **Smart Grid**, and **E-Health** showcase how 6G can deliver measurable **environmental**, **social**, and **economic** benefits.
	Temporary connectivity, edge computing, resilient communication, and AI-driven insights are critical to **bridging gaps in underserved areas and sectors**.
Sustainability Impact (not complete)	**Environmental**: Reduced emissions, optimized resource use, and lower energy consumption, etc.
	Social: Improved access to healthcare, digital inclusion in rural areas, and enhanced public services, etc.
	Economic: Cost savings, new business models, and increased operational efficiency, etc.

SUSTAIN 6G

Thank you for your attention!

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