SUSTAIN-6G

Programme overview, with a focus on telecoms services for the energy utilities

Acknowledgements

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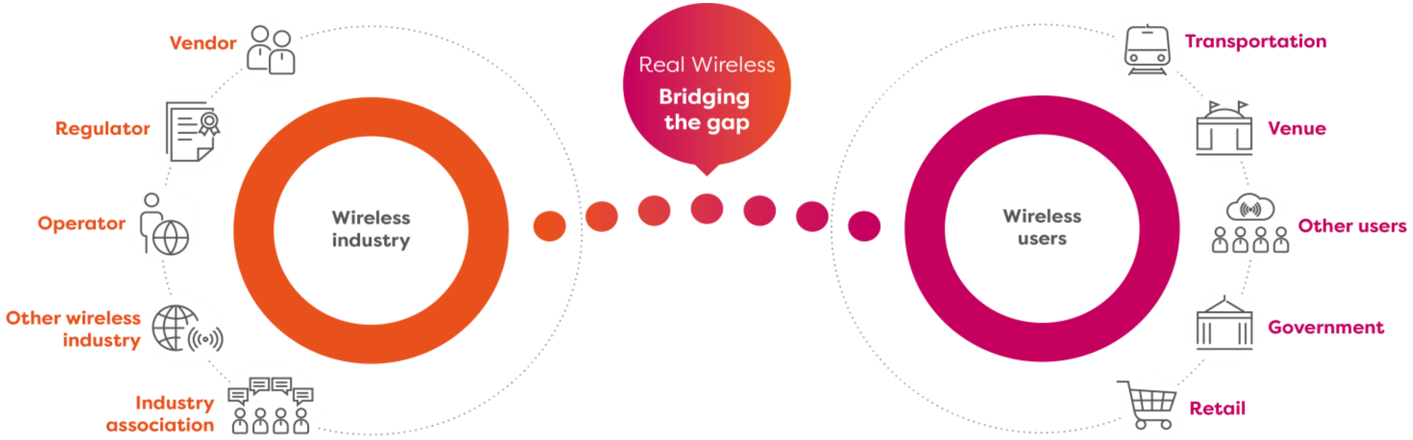
  - Among **Real Wireless** staff and associates:
    - Damian Bevan (Corresponding author:- damian.bevan@real-wireless.com), Julie Bradford, Abhaya Sumanasena, Tasos Karousos, Adrian Grilli
  - **Sustain-6G** smart grid expert colleagues:
    - Kim Schindhelm (Siemens), Daniel Hauer (Siemens), Imane Oussakel (EDF), Vincent Audebert (EDF)
  - Plus the wider **Sustain-6G team**... (see later slide)

Real Wireless bridges the gap

- Leading independent expert wireless advisory firm
- Technology and business of wireless
- Real Wireless builds bridges between the wireless industry and wireless users



Help the wireless industry to better understand and meet the needs of its customers

Help wireless users to get the best from wireless technologies to benefit business

Sustain-6G:- Overview

Project Management

- ***Coordinator: Christoph Schmelz, Nokia, DE***
- Technical Manager: Olivier Bouchet, Orange, FR
- Innovation Manager: Anastasius Gavras, Eurescom, DE

Timeline

- 01.01.2025 – 30.06.2027 (2.5 years)

Budget & Effort

- Total funding 13 M€
- Total effort ~40 full-time contributors over project runtime

Consortium

- 24 partners from 10 European countries
- 7 telecommunication (operators and manufacturers), 4 large vertical industry, 5 academia (universities and research institutes), 8 SME (vertical and telecommunication sectors)

More

- EU Call: SNS-2024-STREAM-B-01-07 Sustainability Lighthouse
- Website: https://sustain-6g.eu
- https://www.linkedin.com/company/sustain-6g/
- https://www.youtube.com/@SUSTAIN-6GProject
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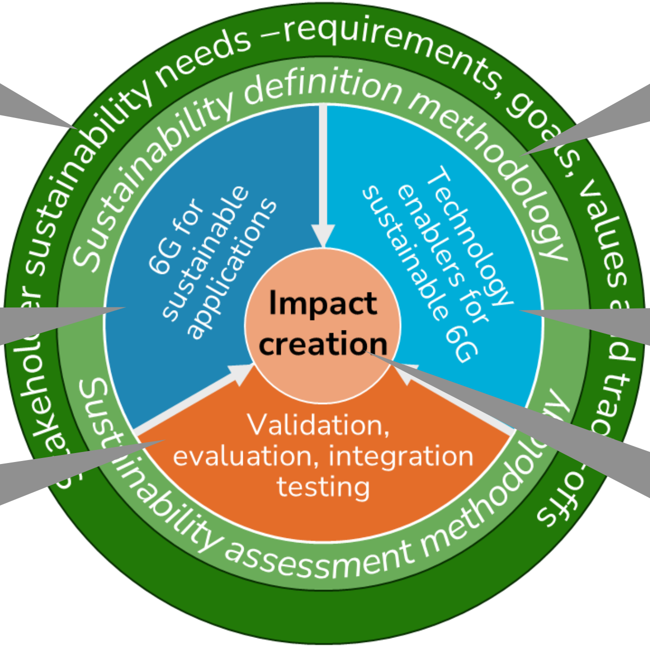
Motivation

Key questions on sustainability in the context of 6G

What is "sustainability"?

How can 6G help to make vertical applications sustainable?

How can "sustainability" be implemented?



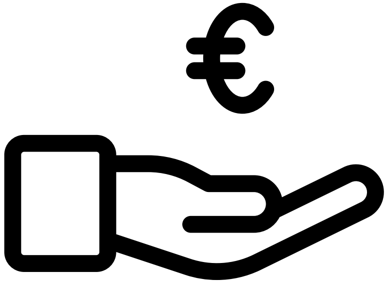
How can "sustainability" be quantified?

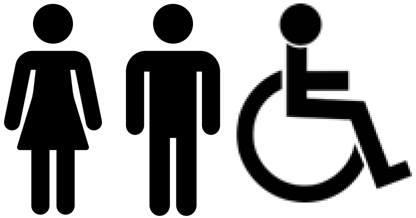
Which technical enablers make 6G sustainable?

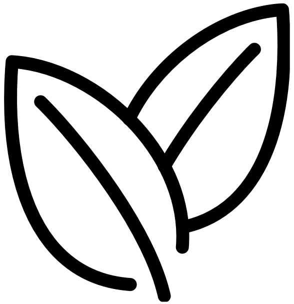
What do standards and regulation need to fully integrate sustainability in 6G?

Sustainability pillars

Economic sustainability	Social sustainability	Environmental sustainability







Sustainability aspects

Sustainable 6G

6G for sustainability

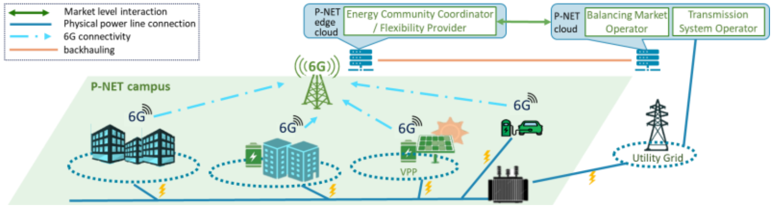
'First order' effects

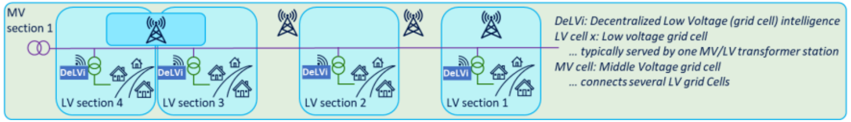
'Second order' effects

Resulting six sustainability dimensions

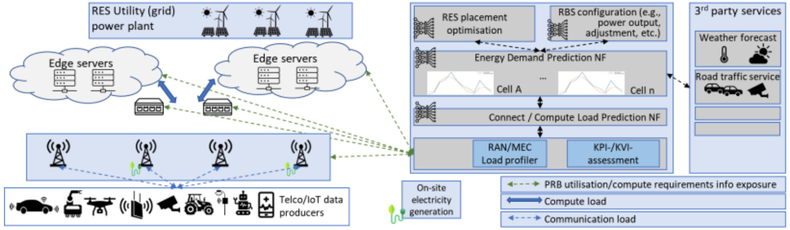
‘Verticals’ and ‘Use Cases’

- Various ‘**Vertical Use Cases**’ (UC) are defined for detailed study/ trials/ demonstrations within the project (in addition to **consumer eMBB**)
  - The UCs (three each), which are defined in S6G are in the vertical sectors of ‘**Agriculture**’ (AG), ‘**Smart Grid**’ (SG) and ‘**Telemedicine**’ (TM)



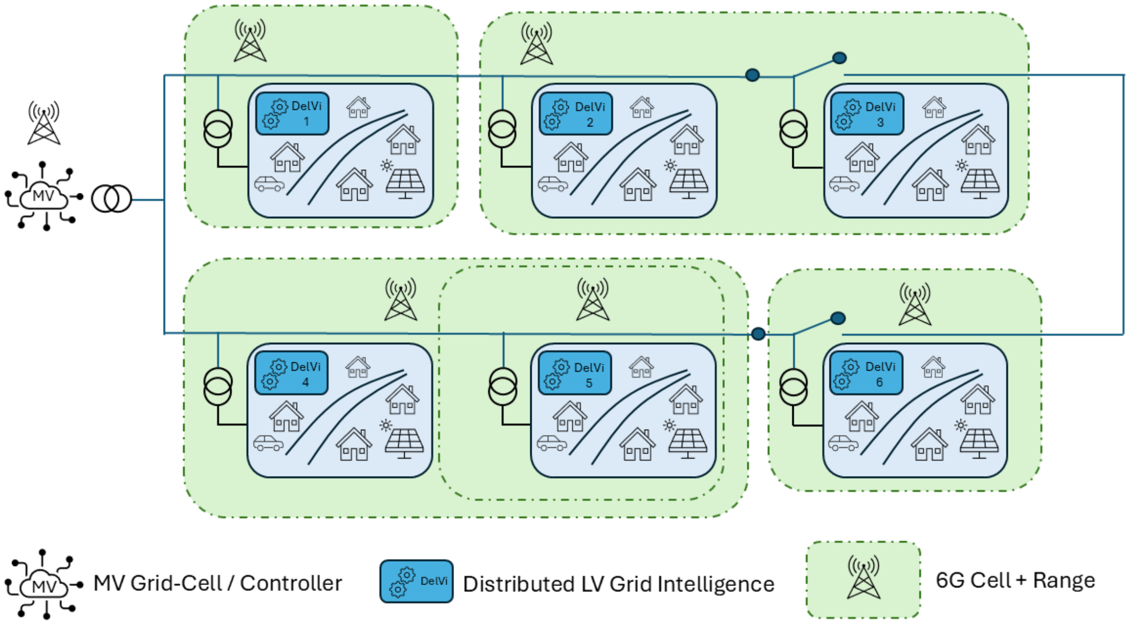


- We will focus here on the **Smart Grid** use cases, which themselves focus on the **LV distribution grid**
  - **SG1:** *6G enabled grid balancing services from distribution grid assets* (Owner: P-NET)
  - **SG2:** *Resilient Grid Section Operation* (Owner: SAG-AT)
  - **SG3:** *Joint Planning of 6G / Smart Grid Infrastructures* (Owner: WINGS)



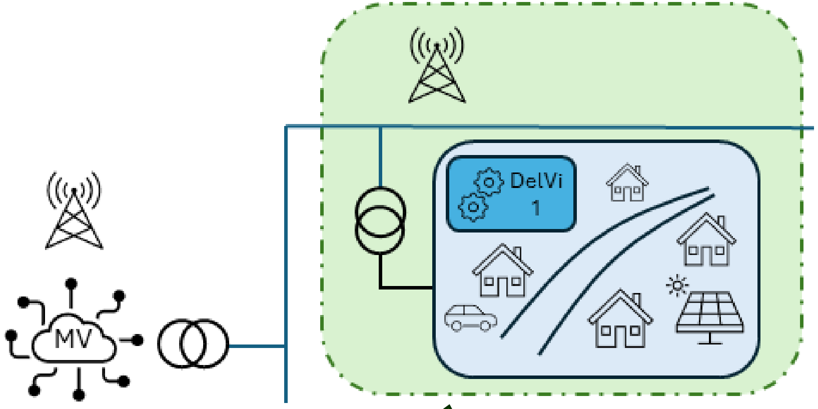
SG2 - Resilient Grid Section Operation

- **LV grid controllers** ('DeLVi' or 'DS') use 6G to talk to each other and to their 'MV Grid-Cell/ Controller' (CS)
  - The CS sets the 'nominal' operation, but DSs can negotiate amongst themselves to trade energy
- If there is a fault ***in the 6G wireless network***, the desire is for DSs to still be able to talk to each other if physical connectivity still exists (e.g. they are connected to the same gNodeB)
  - This has been proposed as a new use case into 3GPP standards (**S1-253317**), in order to set new 6G requirements
- Siemens have capability to simulate all manner of likely scenarios using their **BIFROST platform**



LV grid sections – setting comms requirements

- It is the **LV grid sections** which are of main focus on Sustain-6G
  - **MV grid** may already include operational telecoms for monitoring and control, perhaps employing **private wireless networks**
  - However, we might expect that >90% of comms traffic in the future smart grid will be for **LV grid sections**
- Key questions regarding LV grid section telecoms **requirements**:
  - Availability (3,4,5-nines??)
  - Power resilience/ mains holdover (72 hours??)
  - Cybersecurity (NIS?)
  - Backwards compatibility/ expected lifespan (decades??)
  - Latency (ms)
  - Datarates (Mbps)
  - Data volume (Mbps/sq-km)
  - Others?



These LV grid sections (400/240V) are the principal zones of focus within the Sustain-6G project

Cui bono?

- Who **benefits** from this high quality connectivity for the LV grid?
    - e.g. UK Clean Power '**CP30**' and 2050 '**Net Zero**' targets will benefit (i.e. to the benefit of Planet Earth')
- But who would **pay**?
    - Taxpayers/ billpayers will end up paying, but through what mechanism? At what **cost premium** (e.g. for resilience)?
    - Will there be a '**market failure**' requiring government/ regulator intervention to unblock?
- How might the **connectivity** be organised?
    - Solution(s) might be Private4/5/6G, MNO, LEO or ESN network etc.
    - The aim of Sustain-6G is to define '**reference scenarios**' for the LV smart grid, and study 'sustainability' of appropriate **candidate telecoms solutions**

Q&A/ discussion

- We welcome your **inputs** and **feedback**!
- Are we asking the right sorts of **questions**?
  - Utility **telecoms requirements** for LV grid sections?
  - Who **benefits**, who **pays**, what **telecoms solutions**?
- Are there any **additional requirements** from the smart grid use cases which the audience might have in mind, which could be proposed into **6G standards**?
  - Remembering that within the Sustain-6G consortium we have access to **3GPP representatives**, including via **MNOs** and **equipment vendors**

SUSTAIN 6G

Co-funded by
the European Union

Disclaimer: This work is Co-funded by the European Union under Grant Agreement 101191936. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of all SUSTAIN-6G consortium parties nor those of the European Union or the SNS JU (granting authority). Neither the European Union nor the granting authority can be held responsible for them.

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Backups

Facts & Figures

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Telco

Vertical industry

Academia

SMEs

Motivation

The "Six Dimensions" of Sustainability in the context of 6G

	€ $ ¥ £ Economic	Social	Environmental
Sustainable 6G	Long-term business viability & scalability Market competition & innovation Industry collaboration & partnerships Cost efficiency & resource optimisation Economic growth Regulatory framework & policy support	Bridging the digital divide (accessibility) Trustworthiness & Responsible AI Stakeholder engagement Ethical business practices Social well-being Cultural diversity Technology ethics	Net zero network design, deployment and operation Use of renewable energy sources Environmental data collection Storage and analysis Material usage and circularity Environmental Total Cost of Ownership
6G for Sustainability	Digital transformation Innovative business models Workforce development Opportunities for SMEs Value network integration Global reach Social & economic inclusion	Digital equity Services with high societal value Personal privacy and data protection Ethical business practices Reliable, resilient and accurate information Support for democratic values	Vertical-specific environmental challenges Biodiversity & geodiversity impact Optimisation of natural resources Monitor & reduce emissions Supply chain improvements Smart energy management Sustainable mobility

Sustainable 6G "by design" needs a holistic approach

New SUSTAIN-6G terminology

First order effects

Direct economic, societal or environmental effect associated with the existence of an ICT based solution, and generic processes supporting the deployment and operation of the ICT based solution.

- *These could be positive and/or negative for a stakeholder.*
- *Examples include, the raw materials acquisition, production, use and end-of-life treatment stages.*

Second order effects

Effect induced by the use and application of ICT based solution which includes economic, societal or environmental changes. These could be positive and/or negative for a stakeholder.

- *Target the intended purpose of use of ICT technology in the vertical sector and consider broader effects that the technology might trigger in society that we do not have full control over.*
- *Examples include reduced GHG emissions from reduced travel due to the use of ICTs, more efficient agriculture thanks to ICT solutions.*

Identified sustainability themes as basis for sustainability needs

Environmental sustainability		Social sustainability		Economic sustainability	
First order effects	**Second order effects**	**First order effects**	**Second order effects**	**First order effects**	**Second order effects**
GHG emissions/carbon footprint in different phases from material extraction, manufacturing, use, to the end of life	Changes in GHG emissions through user behavioral changes, optimized processes and improved operational efficiencies (reduced congestion and emissions from traffic, travel substitution)	Security and privacy concerns where data breaches and cyberattacks can lead to financial losses, legal liabilities, and damage to reputation, in addition to the direct harm to people	Better, more accessible/democratized and efficient healthcare, education and other life enhancing services through connectivity	Costs associated with implementing new technologies (e.g., AI, edge computing, mMIMO, and THz communication, infrastructure upgrades, training, system integration and radio spectrum	Efficiency and productivity gains and cost savings in businesses from energy and resource efficient technologies and digitalization
Energy consumption at device, network and component levels and consumption reductions	Changes in energy consumption and/or energy efficiency due to adopting connectivity-enabled services into business operations or user activities	Increased leisure time and improved conditions for the workforce from increased automation in product development, deployment and operation of networks and infrastructures	Usability of the system and viability of the service proposition from the user perspective through perceived latency and other quality measures in vertical use cases	Increased operational costs due to stricter environmental regulations and more complex technologies, and long-term cost saving due to eco-friendly innovations	High initial investment costs from upfront costs for installing infrastructure and costs of devices to be used in verticals
Resource consumption, scarcity of resources including metals, minerals, water, land, etc.			Societal acceptance tied to ethical and regulatory clarifications, backlash against perceived environmental harm		Market expansion from new digital services and revenues from verticals and increased market value through sustainable practices and compliance

Objectives

1. Identify and understand sustainability needs and values
2. Define methodologies for sustainability definition and assessment
3. Enhance integration of vertical UCs with 6G and enabling technologies to jointly reduce footprint and maximise handprint
4. Enhance 6G technologies to reduce footprint and increase handprint
5. Validate, evaluate, and demonstrate sustainability value
6. Impact generation, sustainability guidelines and strategic roadmap

Objectives

1 **Identify and understand sustainability needs and values**
Review, consolidate and define sustainability goals, values, indicators based on stakeholder requirements
Build a comprehensive inventory of 6G and relevant vertical UCs' concepts, technologies, components including their relevant KPIs and sustainability indicators

2 **Define methodologies for sustainability definition and assessment**
Review and enhance concepts, processes, methodologies, and tools for holistically defining and assessing sustainability

3 **Enhance integration of vertical UCs with 6G to jointly reduce footprint and maximise handprint**
Analyse, develop and deliver vertical UCs integrating 6G and enabling technologies to improve sustainability values
Develop and deliver Sustainability Management Plane (SMP) to enable E2E integrated sustainability-driven operation across network and vertical domains

4 **Enhance 6G technologies to reduce footprint and increase handprint**
Develop and deliver solutions and enhancements for selected 6G technologies and components towards sustainability improvements, by reducing 6G footprint and increase handprint in vertical sectors

5 **Validate, evaluate, and demonstrate sustainability value**
Validate 6G technologies on their impact to sustainability (positive / negative)
Evaluate and demonstrate methodologies, concepts, and solutions on applicability, implementability, and wrt. sustainability impact

6 **Impact generation, sustainability guidelines and strategic roadmap**
Create impact through dissemination, standardisation, exploitation, by consolidating outcomes towards guidelines, best practices, business models and a strategic (standardisation and regulation) roadmap, to drive the development of 6G in a sustainability-integrated direction

6G for sustainable applications - Smart Grid

6G enabled grid balancing services

Renewable energy resources (energy, wind) + electric vehicle charging imposes distributed stochastic generation and consumption, requiring real-time balancing (monitoring & control) of the distribution network and distributed energy resources for resilience, stability and security.

- Proposed solutions requests real-time procurement of Fast Frequency Response (FFR) sourced from flexible assets at the grid's edge, and operations such as ML-based optimal power flow, to maintain system frequency
- Utilise Internet of Things (IoT)-enabled distributed energy resources at the edge of the smart grid to provide artificial inertia and leverage the features of 6G and cloud/edge IoT computing continuum to apply real-time adjustments for grid stability. Further the application of **AI-based digital twin approaches** for adjustment forecasting will be investigated

Resilient grid section operation

Resilient smart grids (power sources including wind, solar, fossil etc.) must efficiently deliver electricity while minimising disruptions (flexible adjustments) such as overloads and blackouts

- Proposed solutions include r**eal-time monitoring and control** of electricity flow (local + interacting + synchronisation), aided by **data analytics and predictive modelling**, requiring adaptable communication technology
- Grid with self-awareness and prioritisation mechanisms (Distributed Low-Voltage intelligence DeLVi), solutions to reduce energy consumption
- Communication solutions with **data rate adaptability and flexibility**, minimisation of restarts and connection losses to core infrastructure

Joint planning of 6G / smart grid infrastructures

Power supply for flexible and adaptive ICT implementations (including multiple network layers, technologies) requires flexibility itself, and must be able to handle local power generation as well as potential volatility of (renewable) power availability

- **Micro-grids** offer a cost-effective solution for electricity demand management with leveraging localised power supply through deployment at cell sites or edge computing nodes, flexibility optimising electricity flows through innovative Energy Management Systems (EMS), involving local energy storage to ensure reliability during grid outages.
- Requires alignment of the operational interests of the mobile network and the smart grid with location specific optimisation to maximise cost-effectiveness (e.g. traffic-aware offloading of network load and advanced sleep mode operations)