HEXA-X-II WP1 D1.1 Deliverable

D1.1 Environmental, social and economic drivers and goals for 6G - sum up slides

Hexa-X-II

hexa-x-ii.eu

Introduction

WP1 and D1.1 objectives

WP1 - Objectives

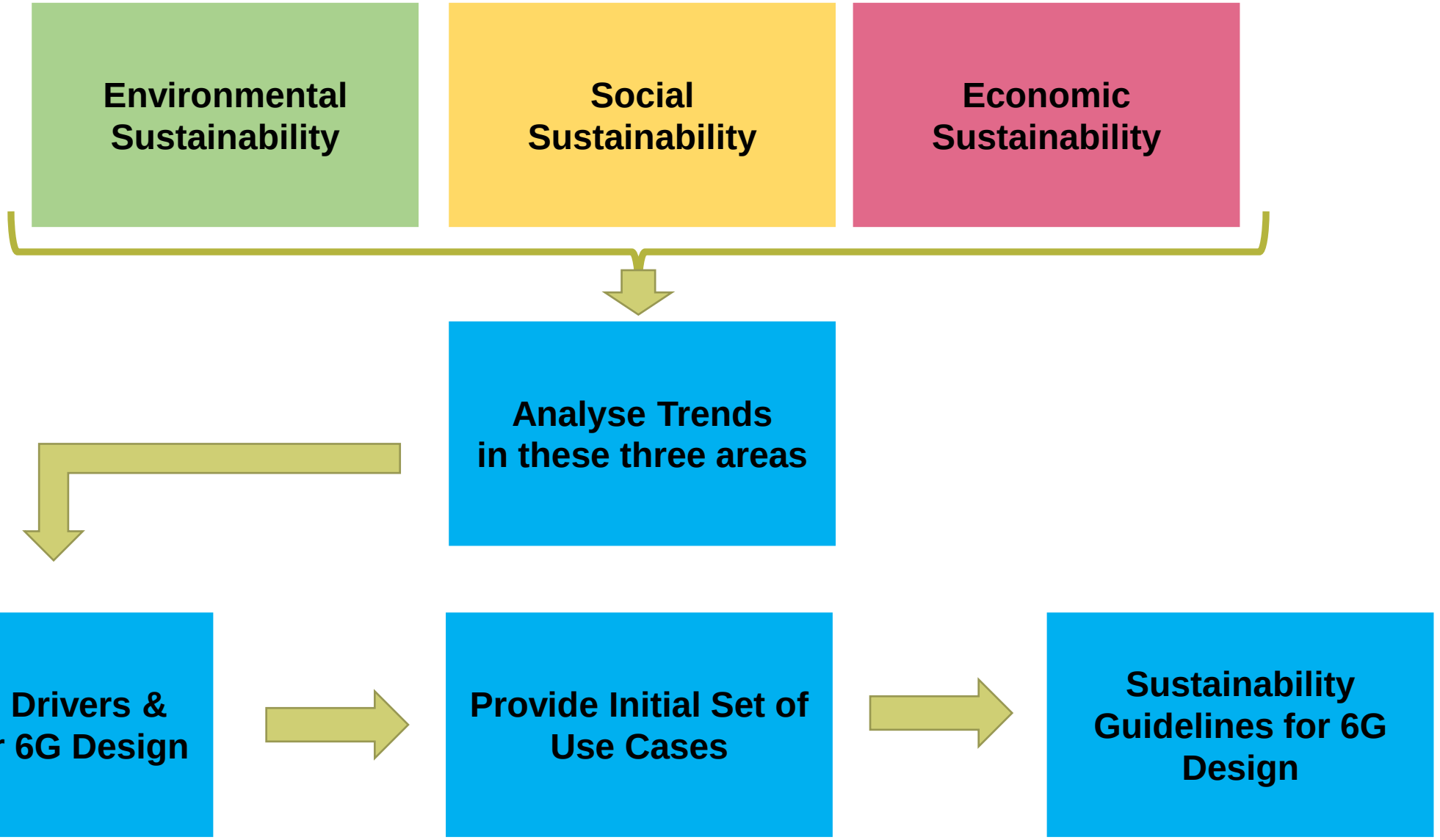
Overall Objective

WP1 will set the prerequisites to define a 6G system

- **Acting as enabler for environmental sustainability**
- **Providing value for the society**
- **Being economically sustainable**

Objective 1	Ensure foundation of 6G design will integrate environmental, social and economic sustainability
Objective 2	Define use cases and determine requirements to drive 6G design
Objective 3	Connect HEXA-X-II with the business ecosystem & anchoring 6G in society

D1.1 – Objectives



Sustainability Guidelines for 6G Design

Environmental Sustainability

Environmental Sustainability

- **Environmental sustainability** as key consideration in the planning, architecture, and operation of 6G networks
- **Holistic Approach to Different Footprints and Trade-offs**:
  - Consider different footprints (carbon, water, resources, land, biodiversity, etc.) and trade-offs between sustainability factors
  - Adopt a fully comprehensive life cycle assessment (LCA) approach to 6G equipment and devices
- **Alternative Materials:**
  - Avoid hazardous substances in 6G infrastructure components
  - Comply with RoHS and REACH regulations
- **Design 6G equipment to be modular and durable:**
  - Extend hardware lifespan, customize easily, scale efficiently, speed up repair and maintenance processes leading to increased system availability and reduced downtime
  - Reduce waste generation by enabling reusability and recycling

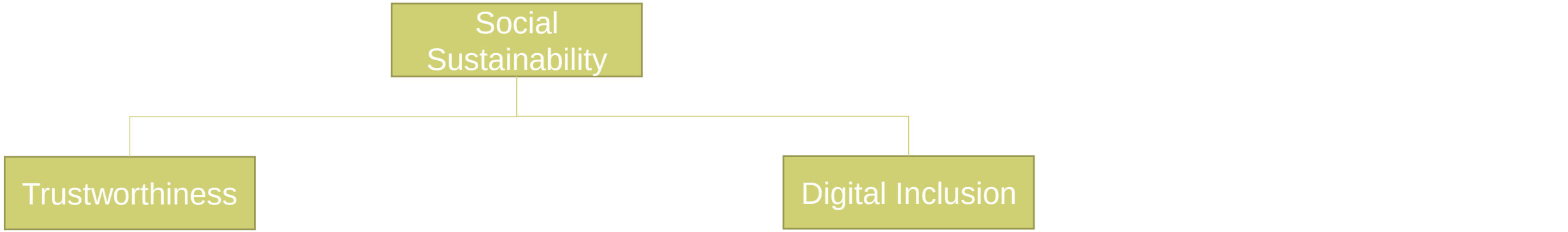
Environmental Sustainability

- **Energy Efficiency:**
  - Minimize energy consumption in production and operation phases
  - Use low-power components, optimize network architecture and protocols, implement energy-efficient algorithms and management systems
  - Optimize equipment and processes, reduce fluorinated gases, conserve energy and water
- **Energy Sourcing:**
  - Incorporate renewable and fossil-free electricity
- **Cloud Computing and Automation:**
  - Reduce energy consumption linked to data transmission by implementing edge computing
  - Move processing power closer to end users/devices, particularly IoT devices, to minimize data transmission
  - Implement automated systems to manage network and device states according to demand
- **Circularity Practices:**
  - Adopt circularity practices in 6G network production and operation
  - Use renewable resources, such as bioplastics and green energy
  - Promote reusing, refurbishing, recycling, and repairing components
  - Design equipment for easy disassembly and responsible end-of-life disposal

Sustainability Guidelines for 6G Design

Social Sustainability

Social Sustainability



- Based on safety, security, privacy, reliability and resilience
- Other related terms in ICT:
  - Availability: coverage and capacity
  - Accountability
  - Cybersecurity
  - Digital security
  - Trustworthy AI

- ”Equitable, meaningful, and safe access to use, lead, and design of digital technologies, services, and associated opportunities for everyone, everywhere”.
- Independent of e.g.,
  - Geographical area,
  - Gender,
  - Culture,
  - Health,
  - Educational level / IT literacy, and
  - Governing officials.

Social Sustainability

- Objective:
  - Make 6G socially sustainable and
  - 6G technologies to support social sustainability
- Social sustainability aspects for making 6G networks socially sustainable are **Trustworthiness** and **Digital Inclusion**.
- Main drivers have been identified:
  - 6G solutions and networks need to be cyber-secure and respect end-users privacy;
  - AI-based approaches need to be clear, transparent and keep the human in the loop / require interaction with human operators when critical decisions need to be taken so that accountability, and thus trust, can be maintained;
  - 6G networks need to be flexible and adjustable in terms of capacity and coverage depending on the areas and the end-users' characteristics, as well as the criticality of the offered solutions, e.g., e-health aspects vs. entertainment;
  - 6G solutions need to be non-discriminatory, e.g., take into account IT literacy and culture of all types of end-users; and
  - 6G network availability in terms of both coverage and capacity needs to be ensured at certain levels (depending on the services offered) to maintain people's trust in digital capabilities and services.

Sustainability Guidelines for 6G Design

Economic Sustainability

Economic Sustainability

- **Economic sustainability** refers to practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community.
- **Economic sustainability** needs a context supporting sustainable growth, making business in a sustainable way, but also supporting other business being sustainable.
- **Economic sustainability** is also sometimes used as a concept that applies at both organizational and national level, in principle referring to the ability for that organization or nation to survive over time, which from an economic perspective means having more income than expenses.
- Key identified terminology includes business model, butterfly diagram, circular economy, corporate social responsibility, dematerialization, economic growth, business ecosystem, open value configuration, productivity, servitization, stakeholders, and sustainable business model innovation.

Economic Sustainability

The following trends were observed in economic sustainability:

- Sustainable realization of productivity growth.
- Co-creating the Fourth Industrial Revolution.
- Endeavour to net zero.
- Identifying new business opportunities from enablement effect of helping other sectors to reach their sustainability targets.
- Preparing for environmental sustainability regulations.
- Preparing for taxes in the transition to a greener and more sustainable economy.
- Adapting to uncertain operational environment.
- Connecting with social sustainability.
- Automation and AI driving change in the labor market.

Economic Sustainability

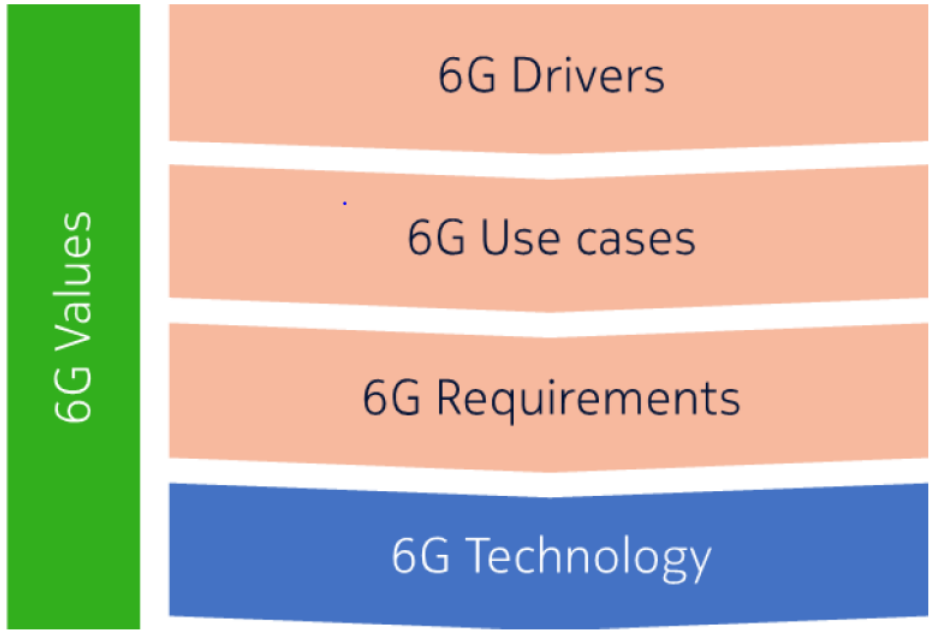
Drivers and goals for 6G and resulting sustainability guidelines for 6G design from economic sustainability perspective:

1) **Value-based 6G design:** 6G should be designed in a manner that it brings economic value beyond users/buyers to community supporting socially just transition and providing opportunity for different stakeholders to harness converging technologies to create an inclusive, human-centered future.
2) **Sustainable 6G business model innovation:** In the 6G era, sustainability is imperative to economic success. 6G should be developed to solve major sustainability challenges while being sustainable. Sustainability will be the source of value, which is an opportunity for the mobile communication sector to rethink its existing business models and take sustainability to the core of future business models.
3) **Open value configurations via 6G:** 6G needs to be developed encouraging innovation via open value configurations and sharing economy models which allows stakeholders to innovate and create new collaborative business models for the whole 6G ecosystem.
4) **Sustainable competitive advantage via correlated/holistic sustainability perspective in 6G:** 6G development needs to identify the complex interdependencies and trade-offs between environmental, social and economic sustainability in order to develop a new correlated sustainability perspective to reach long-term competitive advantage in the new 6G ecosystem.
5) **Monetizing with 6G in challenging business environment:** 6G needs to bring return on investment in different environments including supporting the varying density of users, data and energy usage while operating under increasing environmental sustainability requirements, which calls for different business models.
6) **Preparing for mitigating risks with 6G:** 6G development and deployment need to prepare for protecting stakeholders from the increasing risks in the changing operational environment including environmental risks (e.g., climate action failure, extreme weather, and biodiversity loss) and social risks (e.g., debt crises, geoeconomic confrontations, digital inequality and cybersecurity).

Sustainability Guidelines for 6G Design

Use Cases

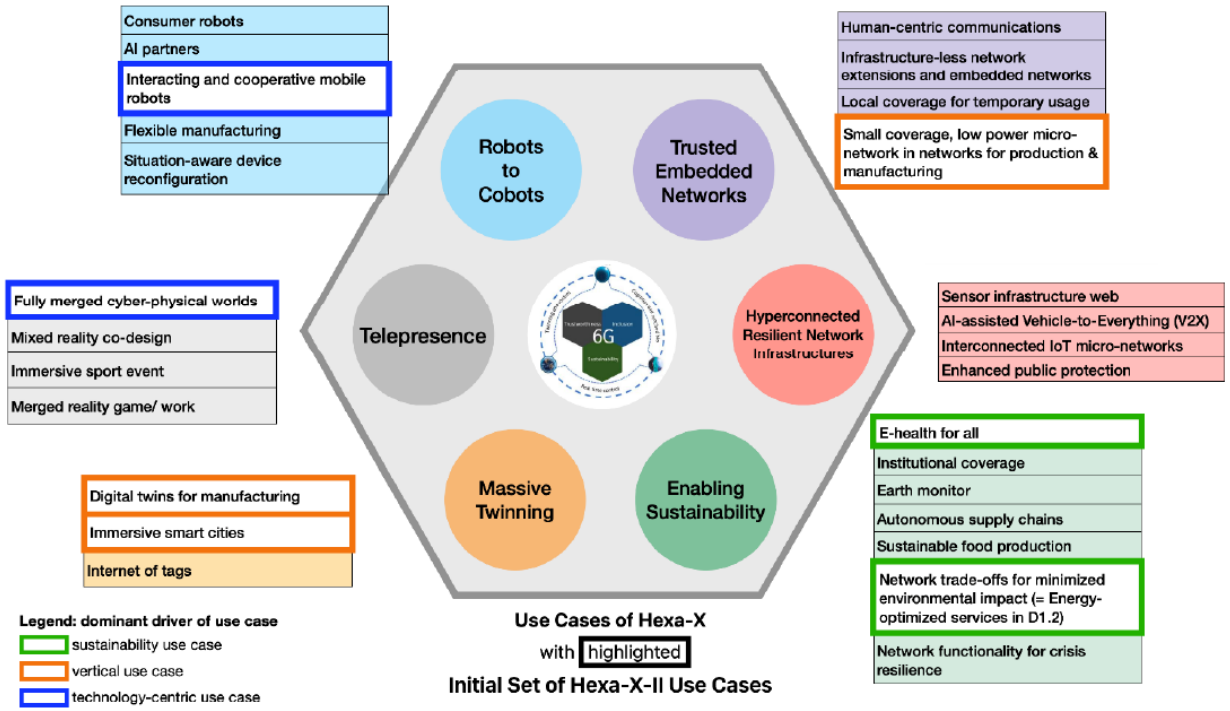
Use cases and Values



- 6G drivers derive from environmental, social, and economic sustainability values, but also from pure technology drivers.
- Hexa-X-II objective is to not only achieve 6G for sustainability but as well to define sustainable 6G.
- This means for any use case; **sustainability aspects need to be considered as requirements** of the technology in the sense that negative impacts must be minimized regardless of whether there are positive impacts as an output value or side effects of executing a use case.

Initial Set Use Cases

- The initial set of use cases is based on Hexa-X use cases. Hexa-X use cases were selected to represent real-life applications of the physical, human, and digital worlds, to support one or more applications of these three worlds, and to apply to one or more verticals.



- **Technology-centric use cases**
  - Interacting and cooperative mobile robots
  - Fully merged cyber-physical worlds
- **Vertical use cases**
  - Digital twins for manufacturing
  - Immersive smart cities and small coverage
  - Low power micro-network for production & manufacturing),
- **Sustainability use cases**
  - E-health for all
  - Network trade-offs for minimized environmental impact

Way forward

- This initial set of Hexa-X-II use cases will be amended and extended.
- For a complete, coherent, and instructive set of use cases that helps to develop the 6G system, we will be proposing a new way of thinking use cases centered around the following questions:

    1. What end user need are we addressing?
    2. Why are current technologies not enough to solve the problem?
    3. What innovations should 6G bring?

- This enhanced methodology to analyse 6G use cases will be anchored in a deep understanding of the specific problems to be solved, the limitations of current technologies, and use of innovative capabilities, to ensure an appetite for new 6G services is clearly present from the early days of 6G deployments.

Summing up & next steps

Summary

- ✓D1.1 provides a summary of existing guidelines and works on sustainability and the different definitions and terms used
- ✓D1.1 works out the different trends in environmental, social, and economic sustainability and does a projection about 10 years in the future to analyse the current trends when 6G will start.
- ✓D1.1 provides drivers and goals for 6G and an initial set of use cases
- ✓Finally, D1.1 provides the “Sustainability Guidelines for 6G Design”; this is the Hexa-X-II WP1 outcome to be used for all other WPs within Hexa-X-II.
  - ➢Please note, this is the first outcome, and the work will evolve thanks to the feedback and work exchanges with the other WPs in the project

Next Steps - upcoming deliverables

Deliverable	Content of the deliverable		
D1.2 – 6G use cases and requirements (December 2023)	Provide a consolidated view on use cases and requirements for 6G	+ Present a scenario for channel model	+ Give first insights on the business and revenue model for 6G ecosystem
D1.3 – Environmental and societal impacts of 6G (March 2024)	Provide a comprehensive view of the business ecosystem (Including the identification of key stakeholders)	+ Provide a analysis of the challenges and risks to meet environmental, economic and social sustainability	+ Give first view on social acceptance
D1.4 – 6G Value, requirements and ecosystem (April 2025)	Provide the final analysis on the value to be created by 6G for society & people (incl. environmental and economic sustainability)	+ Provide the final set of use cases and requirements	+ Present the outcome of various exchanges with the ecosystem

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6GSNS

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