# Sustainability in 6G: Needs, Methodologies & Vertical Integration – Sustain 6G Webinar "A Tech Perspective"

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# Agenda

1. Recall of the Sustain 6G project objectives
2. Business model evolution
3. Sustainability by design
4. Towards an inclusive eco-design approach
5. Minimize the energy consumption of products
6. Conclusion

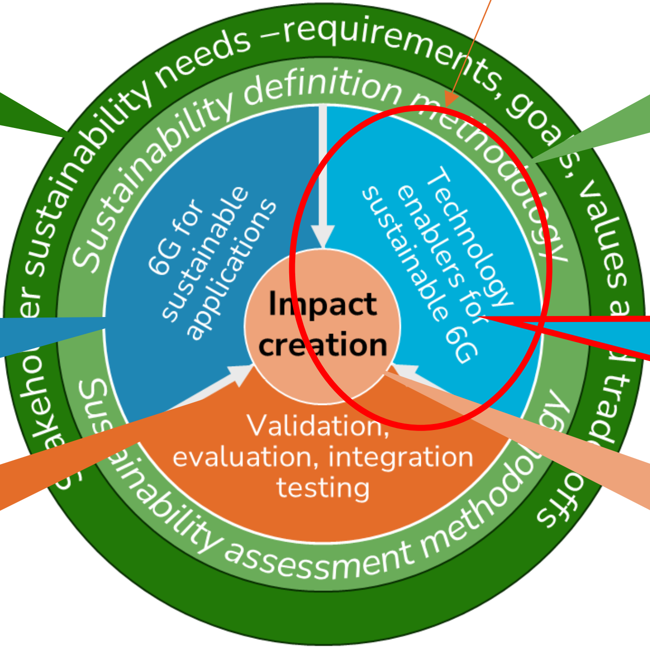
# Recall of the Sustain 6G project objectives

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

Handprint: answer *operator and enterprise needs* on integrated E2E solutions

Support *Nokia's ESG visibility* in European context

**FOCUS**

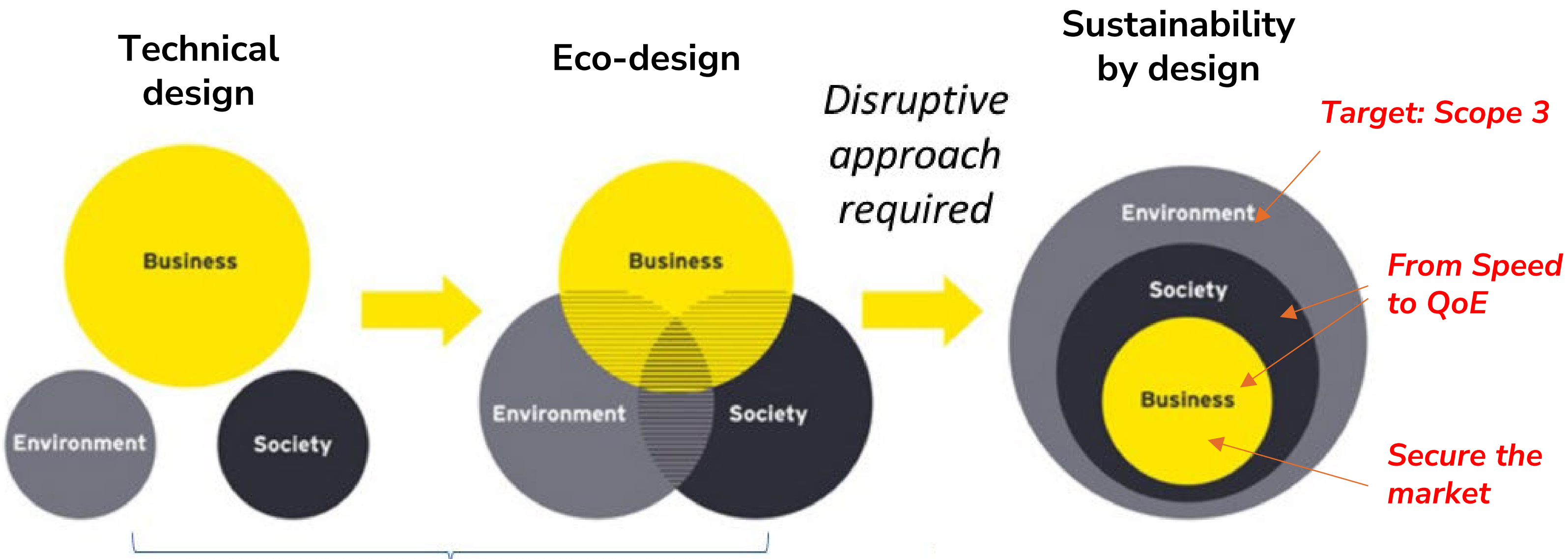



Define *HOW* "sustainability" metrics are defined and measured

Footprint: drive key asset ***sustainable technologies*** in collaboration with operators

*Influence European regulation* & STD roadmap on sustainability

# Where is the market?




More speed, more capacity to attract clients

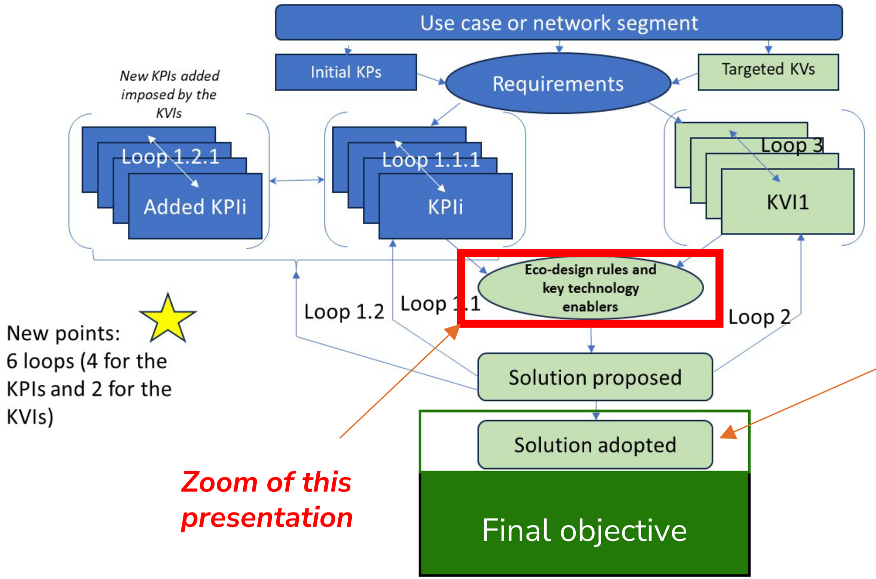
**New business model!**

***From a "push market" to a "pull market"***

# Sustainability by design

“Sustainability by design” means: adopt key value indicators and key performance indicators to identify an absolute optimized product solution.

Example of a sustainability by design methodology




Start with a market segment or a use case for verticals, and propose a convergent method to converge towards the best solution

Take into account the physical limits of a technology by adopting a technology complementary approach and take into account interdependencies of sub-segments

# Towards an inclusive eco-design approach (I)

- Need to follow the eco-design rules for an optimal sustainable design

### *Eco-design rules*

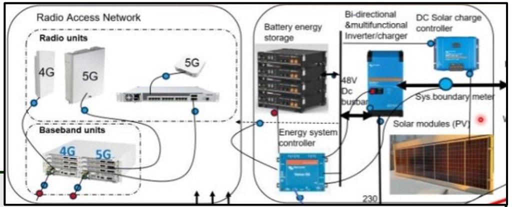
Life Cycle Assessment
Minimize Resource use
Designed for durability
Designed for disassembly
Adopt clean production techniques
Optimize packaging
Designed for Energy savings
Plan for End-of-life
Avoid Hazardous substances
Comply with environmental standards

System as a chipset

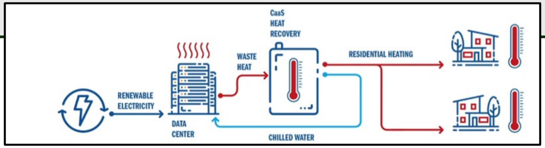
Don't use critical materials

Respect laws & standards

### *Two directions*




- **Reduce the electricity demand to reduce the electricity bill:** Associate, when required, a micro-grid associated with an energy management system to reduce the electricity demand to the national electricity grid.
- **Wasted energies:** Minimize the wasted energies through a conversion or through an exploitation of these energies for societal or economic purposes.



# Towards an inclusive eco-design approach (II)

- Need to follow the eco-design rules for an optimal sustainable design

### *Eco-design rules*

Target low footprint

Long life time

Life Cycle Assessment
Minimize Resource use
Designed for durability
Designed for disassembly
Adopt clean production techniques
Optimize packaging
**Designed for Energy savings**
Plan for End-of-life
Avoid Hazardous substances
Comply with environmental standards

Circular economy

### *Key technology enablers*

Cloud native sustainability
AI societal & economic sustainability
Eco-SW
Energy efficient orchestration
Service-based architecture

**Primary list**
Enabling technologies structuring a product

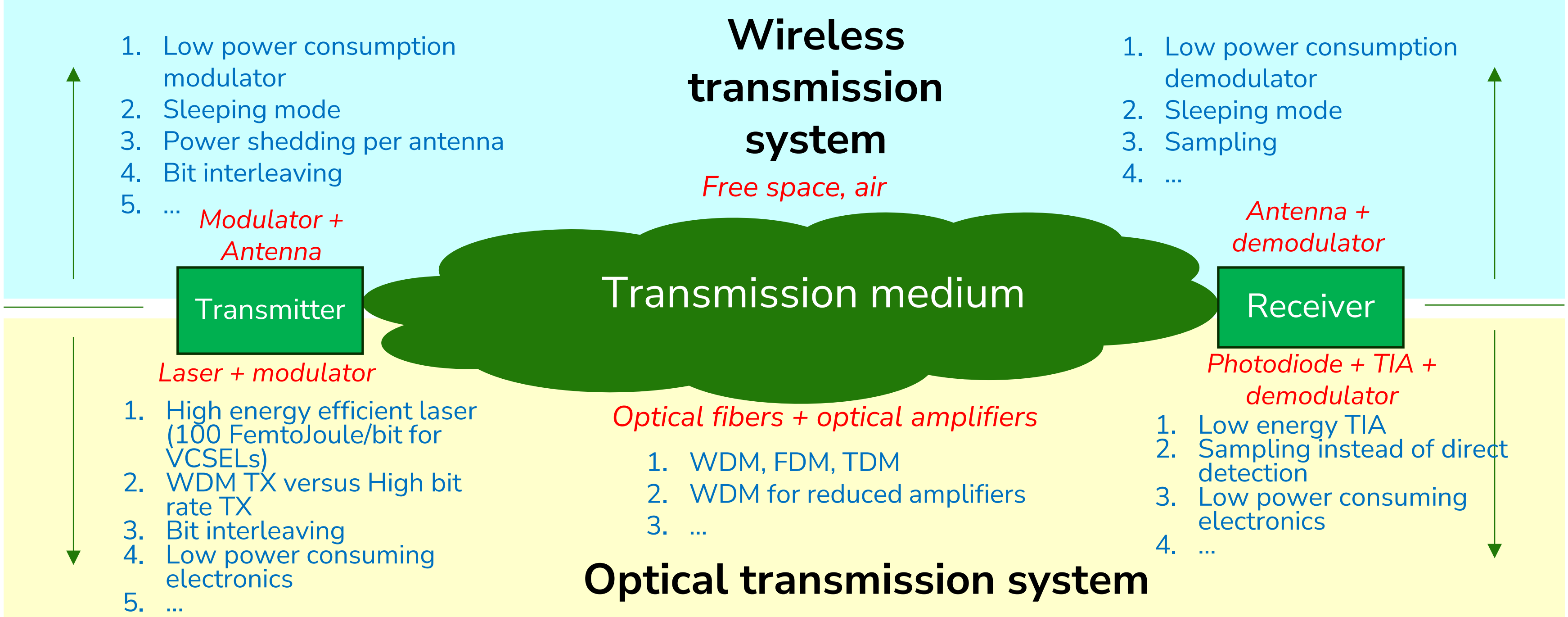
**Secondary list**
Complementary technologies that can be put on the top of the primary technology

Green Data Centers
Energy Aware Kubernetes
Power management
Green AI
Serverless computing
Eco-management
Channel/Symbol shutdown

***A fondamental approach***

# Key technology enablers: primary versus secondary

## Example1: Transmission system at the physical layer




Primary key technology

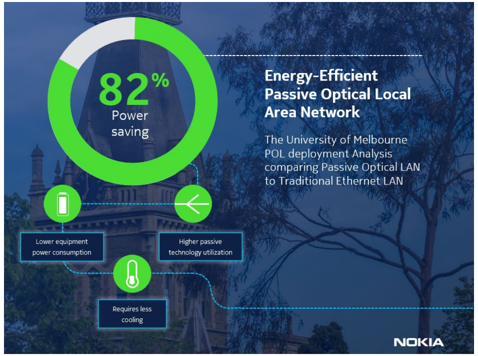
Secondary key technology

# Minimize the energy consumption of products

## Example2: Passive Optical Network from the State of the Art

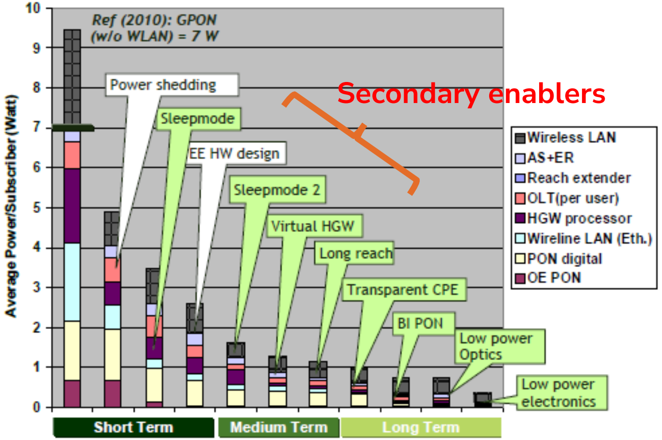
- **Example of technology adopted in the GreenTouch project (2010 – 2015) exploiting primary and secondary key technology enablers.**
- Technology investigated: GPON (Primary key technology enabler).
- Main criteria: long life cycle of zero energy optical fibers and optical couplers for low power consuming network infrastructure.
- PON used in POL solution demonstrated up to 80% of energy consumption wr to a classical Ethernet LAN.

***Primary technology: PON***




***From a presentation of NI in 2022***

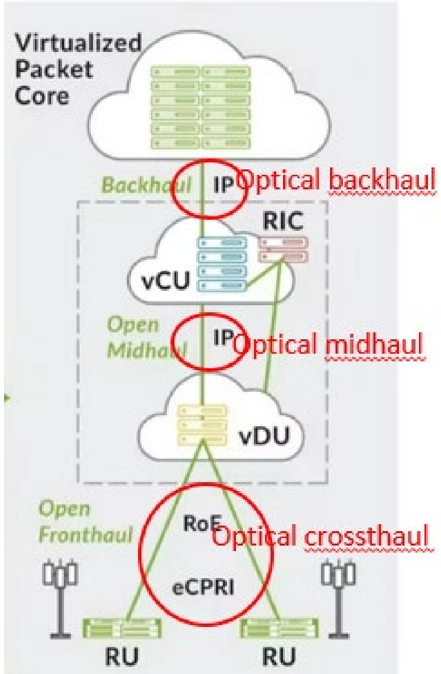
***Secondary key technology enablers***




***From the GreenTouch project (2010-2015)***

# Minimize the energy consumption of products

## Example 3: virtual RAN




RU : Radio Unit
eCPRI : evolved Common Public Radio Interface
RIC: RAN Intelligent Controller
vCU: virtual Central Unit
vDU: virtual Distributed Unit
RoE: Radio over Ethernet

### Radio Unit

| Key technology enabler or/and Key eco-design Rule | Environmental impact | Societal impact | Economic impact |
|---|---|---|---|
| **Cell sites** | | | |
| Sleeping mode | Reduction of the energy consumption. Efficient in the rural part. | Risk for acceptability if the "on" state takes too much time. Can be attractive in case of high energy cost | Energy cost reductions |
| Power schedding (dynamic adaption to the power of the antenna) | [illegible] the energy [illegible] | Risk for acceptability if [illegible] "on" state takes too [illegible] time. Can be [illegible]ctive in case of [illegible] energy cost | Energy cost reductions |
| Tracking optimised | [illegible] Tracking sopped for fixed IoT. | [illegible]visible. Contribute [illegible] $CO_2$ emission reduction. | Energy cost reductions |
| Option optimisation (6, 7&, 7b, 7c) | Trade-off between the physical bit rate and the energy spent for a pre-processing. It can contribute to have a very low power consumption cross-haul. | Not visible. Contribute to the $CO_2$ emission reduction. | Energy cost reductions |
| Micro Grid | Contributes to reduce significantly the electricity demand to the grid. Reduce the global national figure (x $CO_2$/kWh). | Potential energy cost reduction leading to lower connectivity prices. Improvements in resilience / reliability. | Energy cost reductions. Relax constraints in other sectors (transport, industry, …) Improvements in resilience / reliability Boost the renewable energy market. |
| Liquid cooling | Reduces [illegible] energy co[illegible] cooling. | [illegible]ergy cost [illegible]ding to [illegible]ctivity [illegible]provements [illegible] | Mandatory technology for e.g. sleeping regimes without impacting the reliability. Reduction of outages, improvements in resilience / reliability |
| AI for the EMS | Contributes to optimise the energy delivery and reduces the energy demand. | Potential energy cost reduction leading to lower connectivity prices. Improvements in resilience / reliability. | Booster for the market. Improvements in resilience / reliability |
| Storage | Provides a stabilisation of the electricity delivery and contributes to better exploit the local production. | Potential energy cost reduction leading to lower connectivity prices. Improvements in resilience / reliability. | Improvements in resilience / reliability. Cost trade-offs to be investigated. |

Sleeping mode

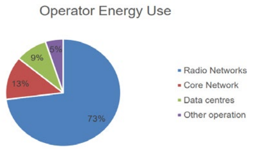
AI for EMS

***Some key technology enablers per sub-segment***

### CrossHauling

| Front-haul / Cross-haul / Mid-haul | | | |
|---|---|---|---|
| Point to point | Point to point communication between the cell site and the vDU. | Not visible. | Exploitation of existing fibres. |
| WDM | Reduced use of material due to less fibre installations. | Reduced impact by construction / installation. | Less expensive solution with respect to the point-to-point solution. Protection can be proposed. |
| PON | Reduced use of material due to less fibre installations. | Reduced impact by construction / installation. | Extend the market of PONs. |
| Optical Ring | Low power consumption solution offering new functionalities with respect to PONs like a self-protection in bi-directional rings. | Reduced impact by construction / installation. Potential energy cost reduction leading to lower connectivity prices. | Provides new features like direct connections between antennas. Can contribute to minimise the traffic in central. |
| WDM TRX | Exploitation of the optical parallelism to reduce the [illegible] consumption of TRX. | Can contribute to have a latency independent to the traffic load. | Can open new market perspectives. |
| Bit interleaving | Re[illegible] to[illegible] co[illegible] | [illegible]ergy cost [illegible]ading to [illegible]ectivity prices. | Can be efficient in PON for the DS. |
| Towards dedicated resources | Can contribute to adopt the physical bit to the exact demand at the antenna side. | Not visible | Can reinforce the market. |

WDM TRX

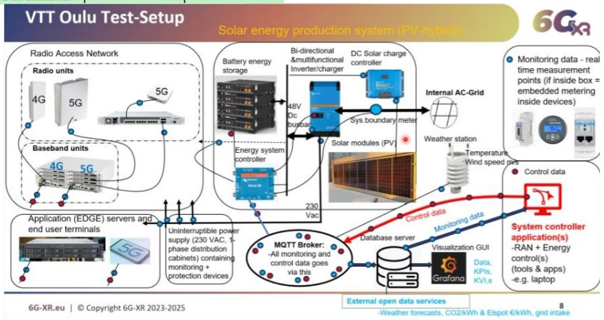



### DU/CU

| vDU & vCU | | | |
|---|---|---|---|
| Sleeping mode | Effective reduction of the energy consumption. Efficient for sleeping data. | Potential energy cost reduction leading to lower connectivity prices. | Can be important for increasing the market. |
| Liquid cooling | See above | See above | See above |
| Data management helped by AI | Reduction of energy co[illegible]tion for (operati[illegible]a transfer. | Potential energy cost reduction leading to lower connectivity [illegible]vements [illegible] | New features / business opportunities, booster for the market. |
| AI for Energy Management System (EMS) | Contr[illegible] electri[illegible] reduces then the electricity demand to the grid. | [illegible]rgy cost [illegible]ding to lower connectivity prices. Improvements in resilience / reliability. | Booster for the market. Improvements in resilience / reliability |

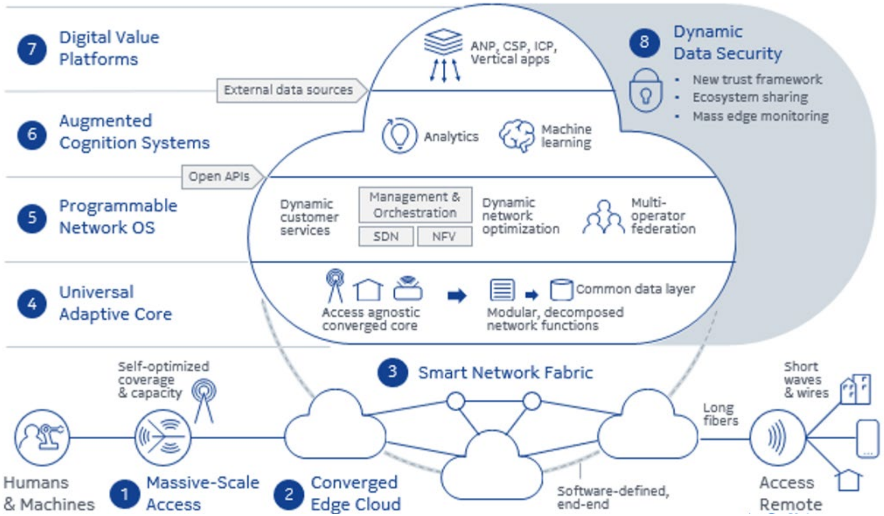
Liquid cooling

### Micro-Grid at RU



# Conclusion

- **Need to address all the layers of a network for a strong impact.** Environmental, societal and economic criteria and driving the sustainable design.
- Per network segment at the physical layer:
  - **Access points:** Go beyond the RF technologies (Wi-Fi, BLE, …) and **envisage also optical technologies** (additional energy savings demonstrated in different scenarios)
  - **Fixed access:** Go beyond the incremental evolution of PONs. Envisage secondary technologies and a roadmap to provide concrete perspectives.
  - **RAN and vRAN including the cloud:** This is the most important technology to optimize (73% of an electricity bill of operators). We need here to act at the RU, XH, DU, MH and CU levels. Need to select what should be the primary technologies at the physical layer mainly, and what could be the secondary technologies for all the network layers. **Need to have an heterogenous approach.**
  - **Metro and Core:** Less critical at the ICT level, but these network segments will have to support **highest capacities.** So, need to grow in capacity to support in particular a gen AI. **Optical technologies remain fundamental in this segment.**




**Need to integrate a responsible AI.** If AI can help the ICT to provide energy savings, it is important to associate to this gain its additional energy consumption. We need also to identify the resources that need to be used for an optimal design.

SUSTAIN 6G

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