‘Greening’ Future Wireless Networks

One6G’s Lecture 6 – Sustainability in 6G

Ljupco Jorguseski | 15-06-2023

Opening Statement

Will talk about…

‘Green/Sustainable Wireless Networks’

Will not talk about…

‘Wireless Networks for Green/Sustainable World’ (although very very important)

Outline

- TNO Introduction
- NGMN’s Green Future Networks Project
- 3GPP Standardisation Work on Green Wireless
- Outlook towards 5G Advanced/6G
- APPENDIX (Greener Fiber, End-to-end energy data sharing)

TNO: Dutch Research & Development Institute

Established by Dutch law in 1932 as a statutory organization with **independent position** that allows to give objective, scientifically founded judgments.

TNO connects people and knowledge to create innovations to strengthen the competitiveness of companies and the welfare of society in a sustainable way. Hence, **'Innovation for Life'!**

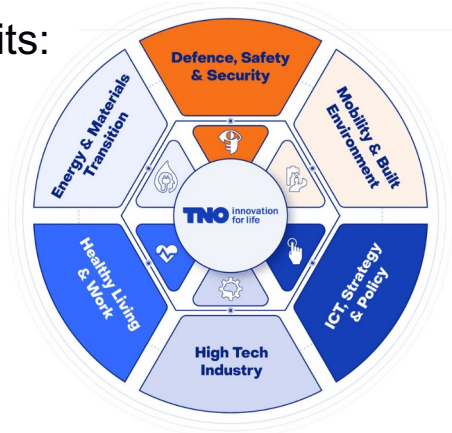
TNO targets **4 societal** challenges:

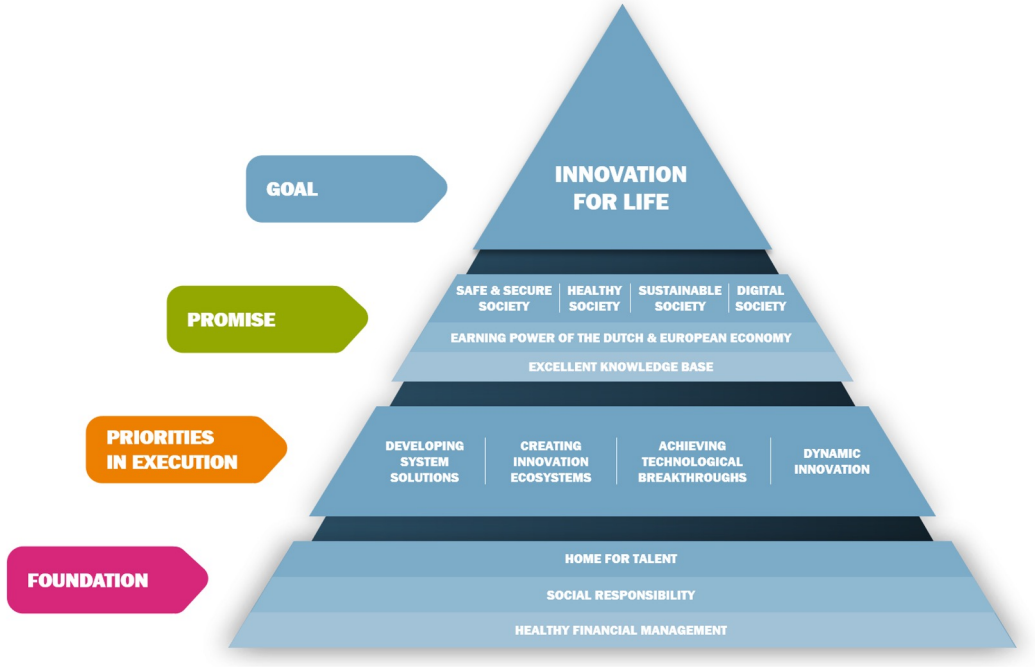
1) **safe and secure**
2) **healthy**
3) **sustainable**
4) **digital**

TNO is not-for-profit, with € 590 mln revenues and 3.900 staff (2022)

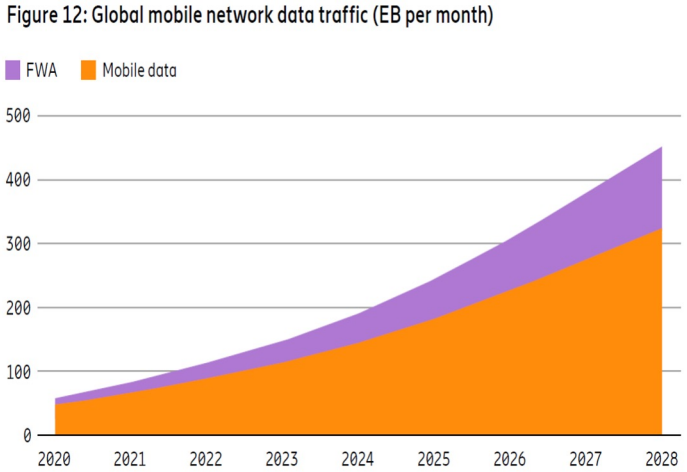
TNO's activities are organized in 6 units:

- **Energy & Materials Transition**
- **Defence, safety and security**
- **Healthy Living & Work**
- **High Tech Industry**
- **ICT, Strategy & Policy**
- **Mobility & Built Environment**

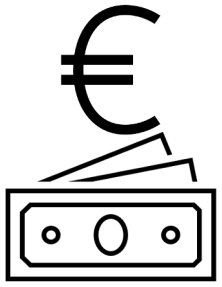




Why NGMN’s Green Future Networks Project?



Source: Ericsson Mobility Report November 2022



OPEX & Customer

NGMN: Sustainability is one of Beyond 5G/6G pillars

July 2021

July 2021

Jan. 2023

'Sustainability' Sub-Project

Jan. 2022

Feb. 2023

'Metering' Sub-Project

Available from - https://www.ngmn.org/publications.html

NGMN: Energy Efficiency Sub-Project

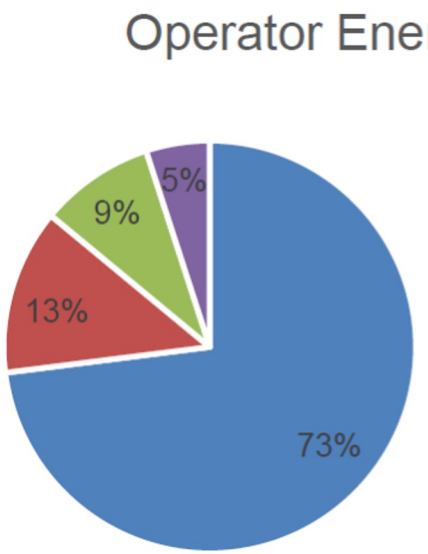
Dec. 2021

+ 2023 + 2024

Solutions for lowering wireless network energy consumption!

Available from - https://www.ngmn.org/publications.html

Where to save energy (high potentials)?



- Radio Networks
- Core Network
- Data centres
- Other operation

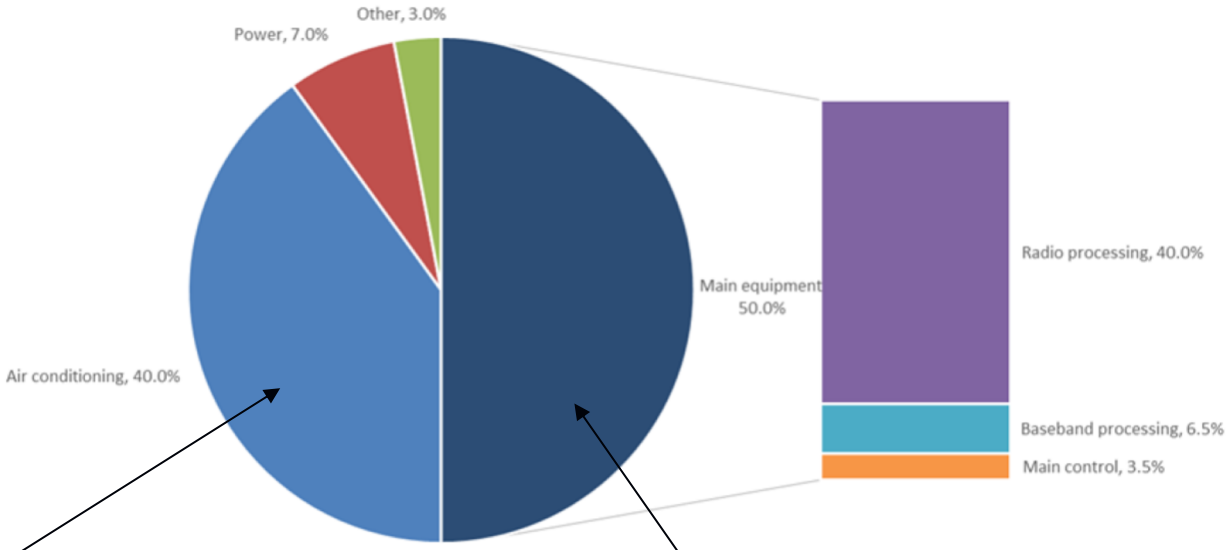


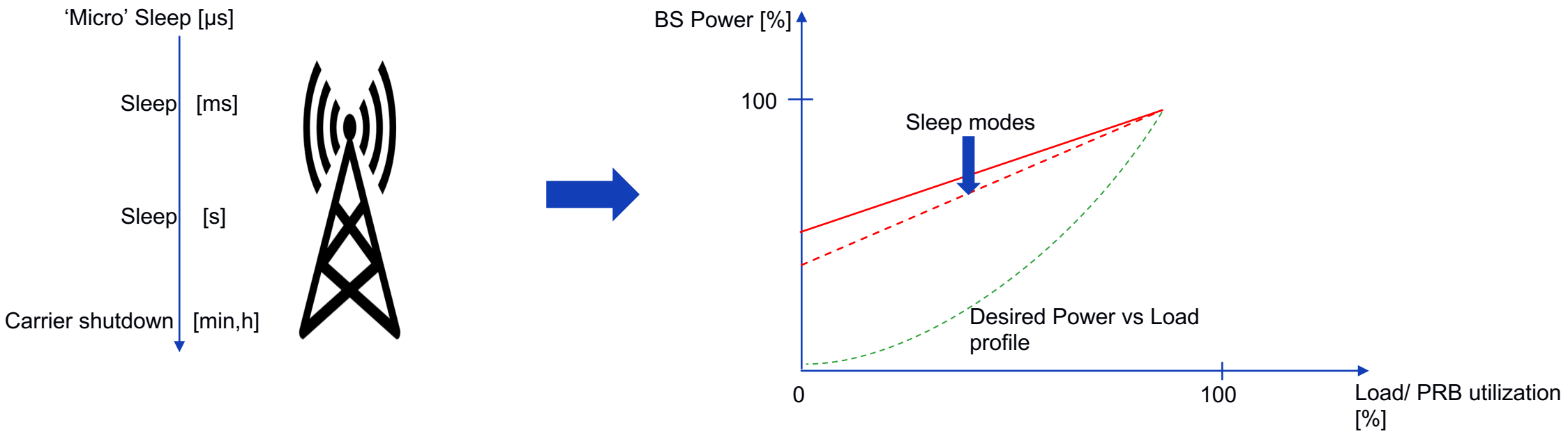
Figure 4: Power consumption of base station.

Energy efficient
cooling techniques

Energy Efficient HW
Energy Efficient SW/Functions (see next slides)

https://www.ngmn.org/wp-content/uploads/211009-GFN-Network-Energy-Efficiency-1.0.pdf

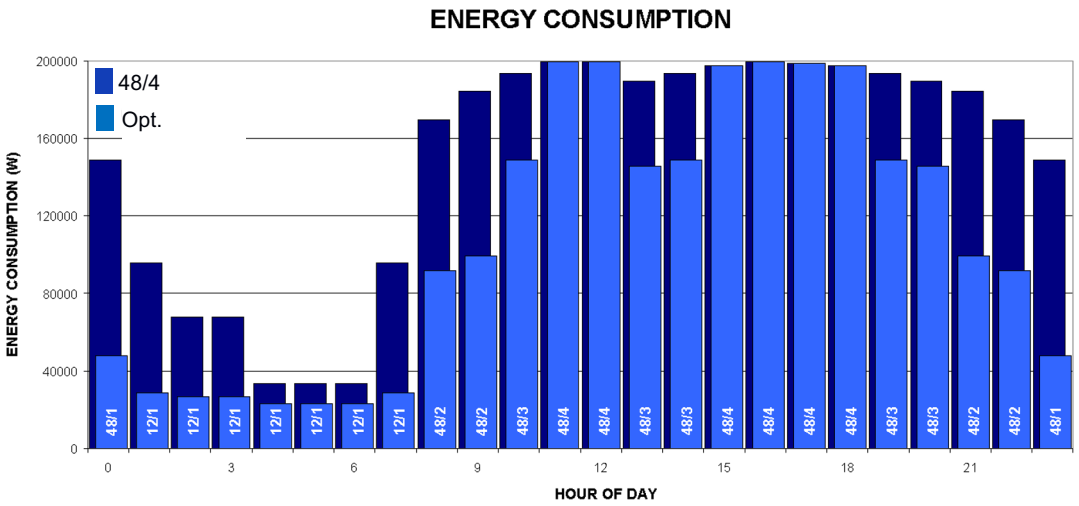
BS's Energy Efficient SW Functions



A GLOBAL INITIATIVE

Aims at facilitating this SW functions!

3GPP started ‘Greening’ already with 4G

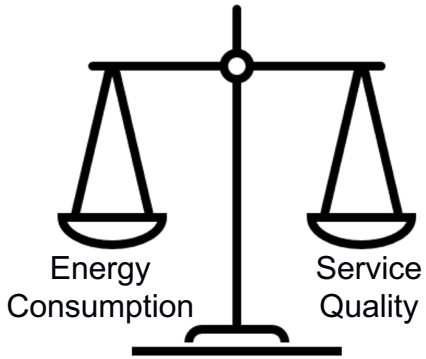


Carrier/site shutdown for a given performance target follows daily traffic profile. Simulations showed good energy saving potential (see 3GPP TR 32.826/Release 10).

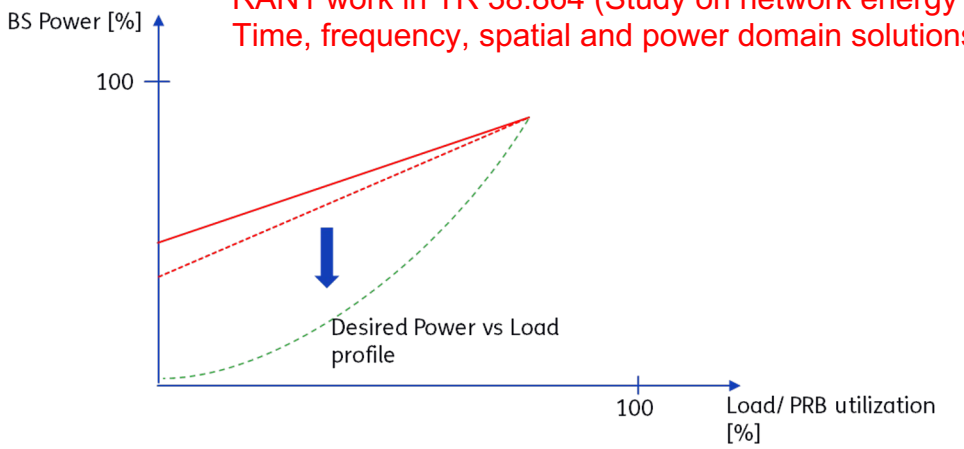
‘Lean’ 5G carrier design e.g. less signaling overhead and more possibilities to switch ON/OFF carrier components for better scaling with traffic level.

4G → 5G

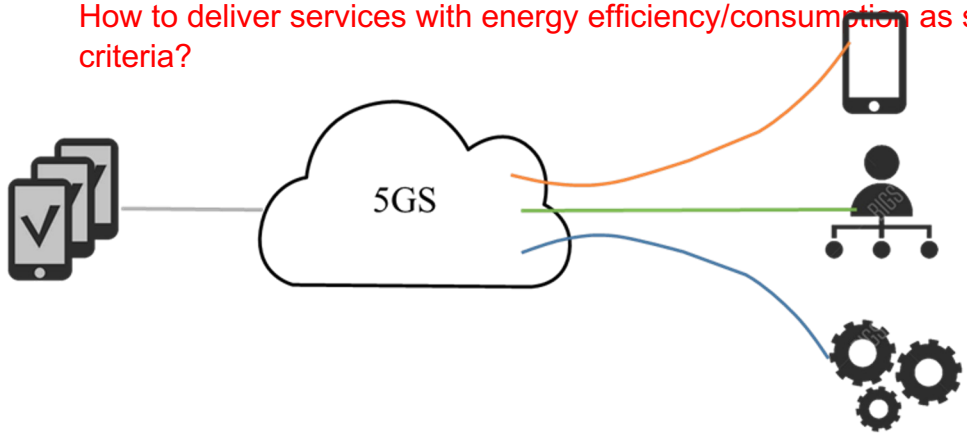
Latest 3GPP ‘Greening’ work examples



RAN1 work in TR 38.864 (Study on network energy savings in NR):
Time, frequency, spatial and power domain solutions



SA1 work in TR 22.882 (Study on Energy Efficiency as service criteria):
How to deliver services with energy efficiency/consumption as service criteria?



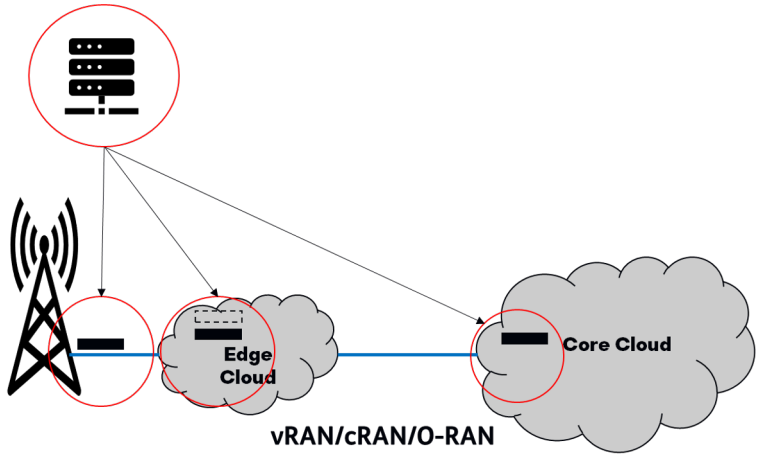
TR 38.864 and TR 22.882 are available via 3GPP.org

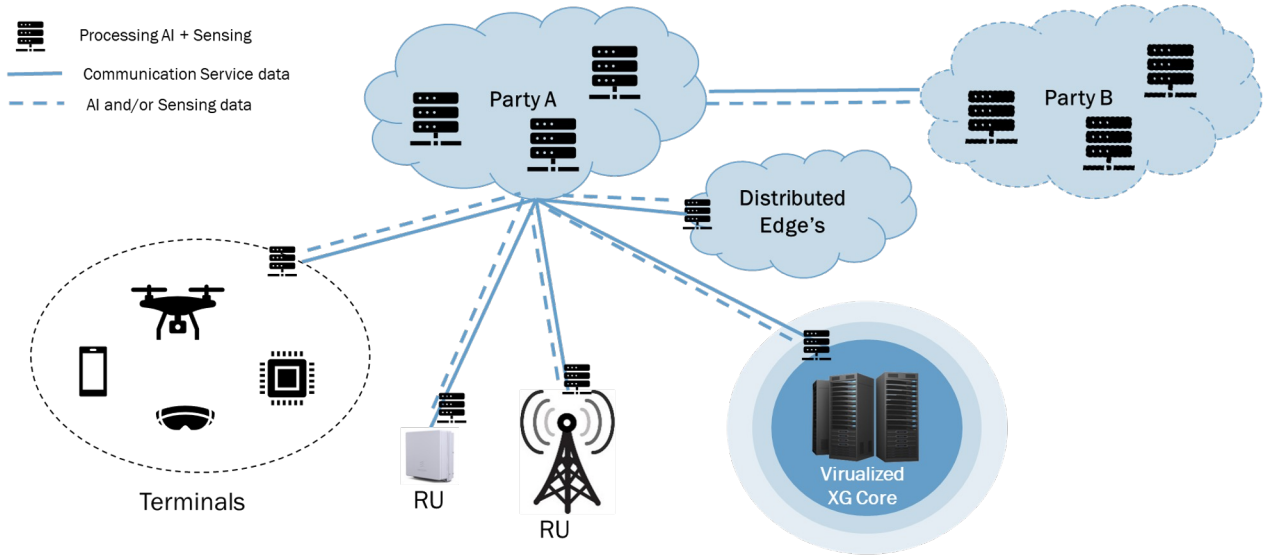
‘Greening’ future networks remains priority

Challenge 1:
Energy consumption optimization for disaggregated/virtualized RAN

Challenge 2:
Energy consumption optimization including AI + Sensing

Challenge 3:
End-to-end visibility of energy consumption & carbon footprint in disaggregated and multi-party system





Thank you for your attention!

Any Questions?

Ljupco Jorguseski
+31 6 51 21 95 60
ljupco.jorguseski@tno.nl

APPENDIX

Additional TNO activities – Greener Fiber

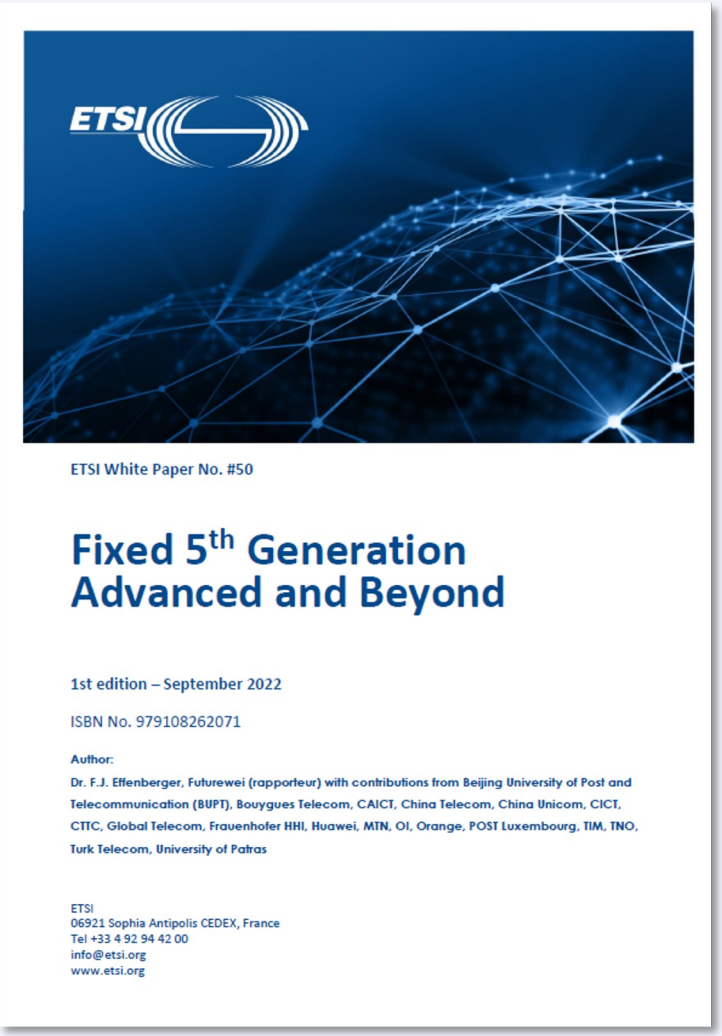
ETSI F5G Advanced and Beyond whitepaper:

Within an end-to-end optical network for FTTH, about 2/3 of the energy is consumed by the optical access network (60% ONU, 7% OLT) and 1/3 by the core and aggregation network

Energy saving options

Network Level	Equipment Level	High level design
Network architecture optimization Energy aware switching/routing	Higher bitrate: lower energy per bit Power saving schemes Co-packaged optics Dynamic energy saving in transport networks	Dynamic placement of power-hungry tasks Exploiting residual capacity in the existing light-paths Co-existence of different technologies and generations of optical networks

For many of these we need good insights in the actual energy consumption in the network. We need to measure.



APPENDIX

Additional TNO activities – E2E energy data sharing