# How fiber can make Future Networks greener

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**Teun van der Veen | Senior Consultant Networks**

NGON &
5G Transport

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# How Fiber can make Future Networks greener

1. Making fiber greener means reducing energy consumption
2. The green evolution of fiber networks
3. Measuring energy consumption in E2E (fiber) networks
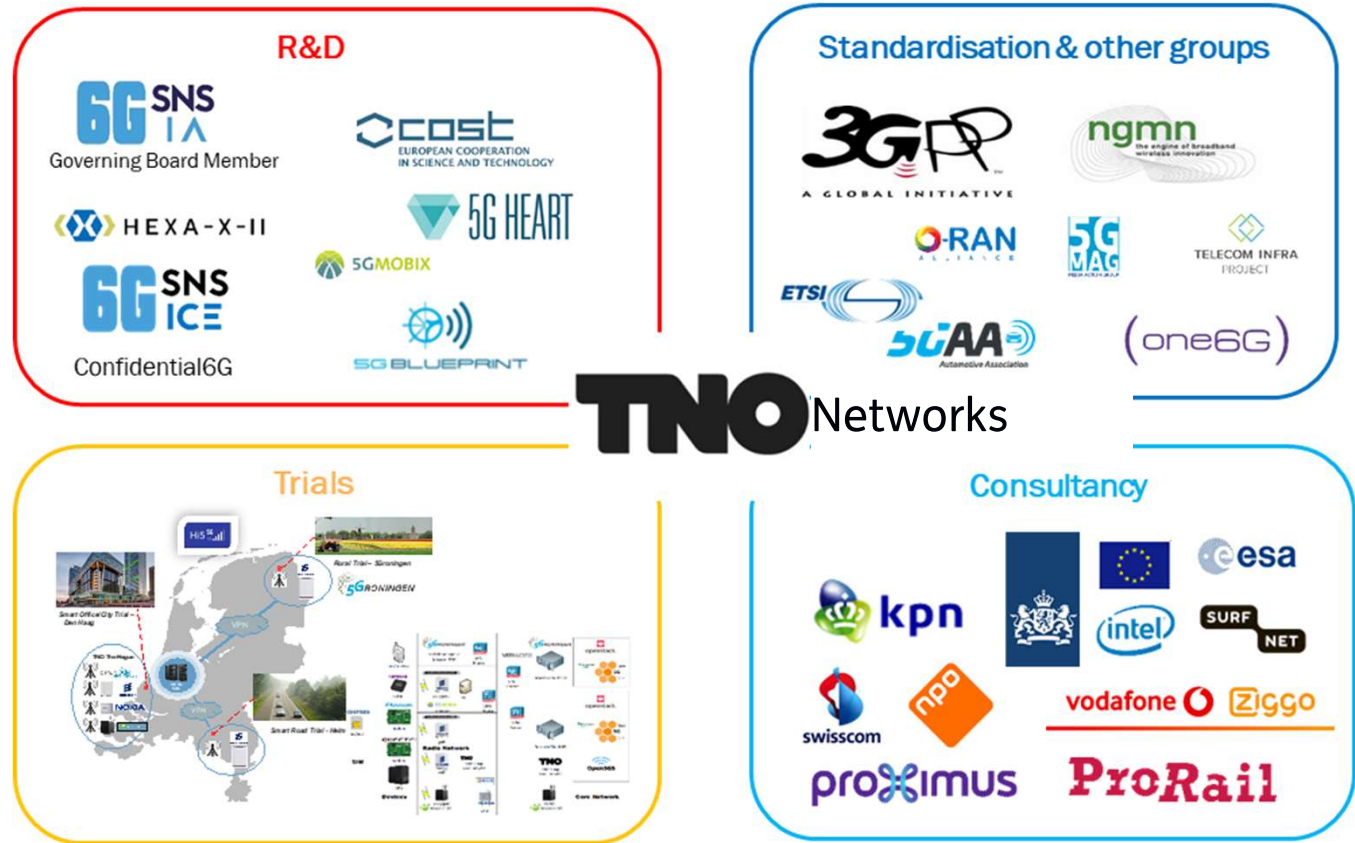4. Let's do this together
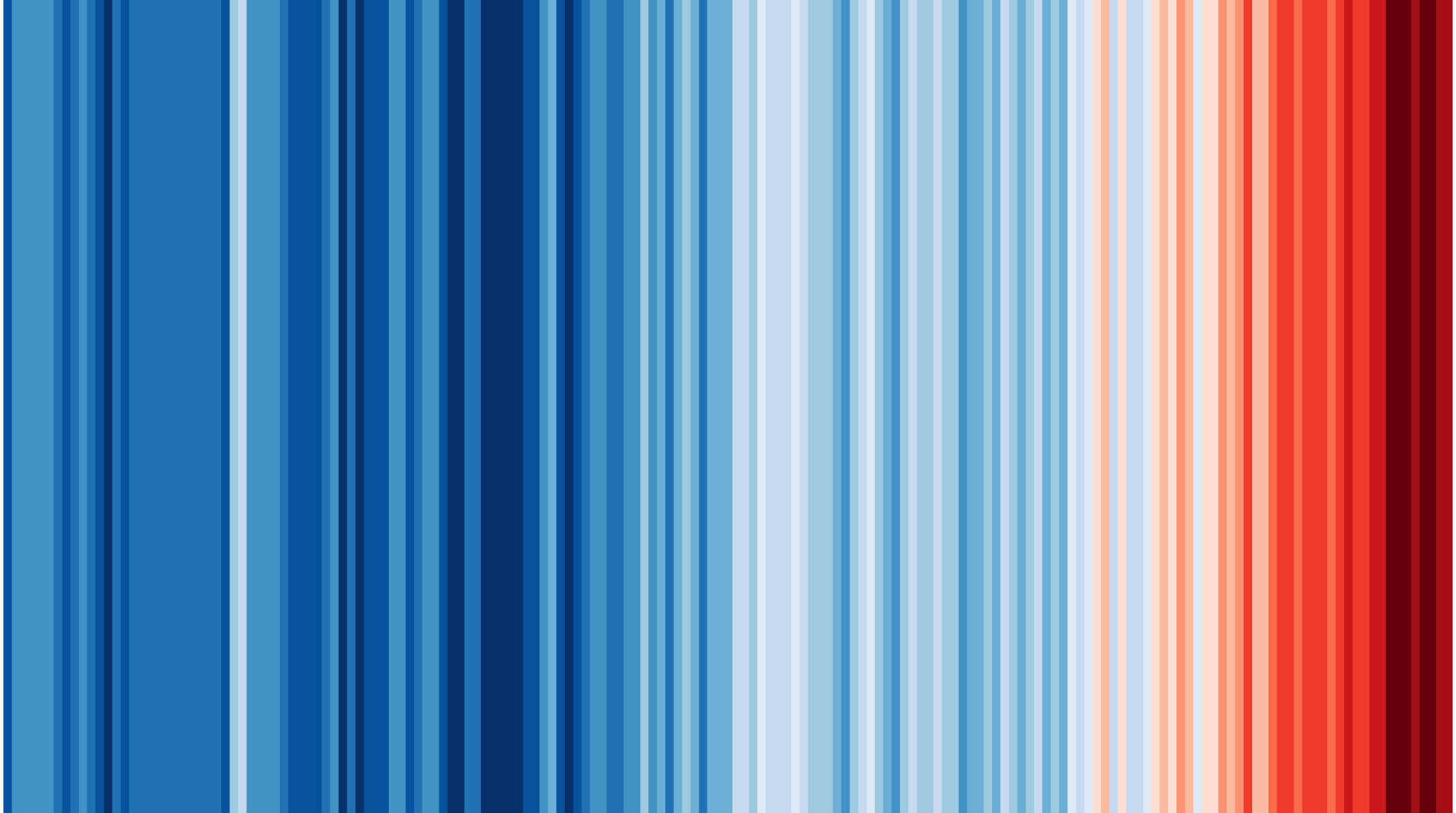
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# TNO and Networks

**TNO:** Independent research organisation in the Netherlands that focuses on applied science

**TNO Selected Key figures 2022:**

- Human Capital    3897 employees
- Revenue          590.7 Meuro
- Carbon Footprint 176 kT CO2-eq

(source TNO Annual Report 2022)

Credit: Professor Ed Hawkins (University of Reading)          https://showyourstripes.info/l/globe/

# What is the CO2e footprint of this guy?

- Difficult to establish CO2e footprint for a video stream (depends on many factors, e.g. resolution, device, country...)

- Simplify:

  - Data traffic mostly video traffic

  - CO2e emission of data traffic primarily due to electricity

Approach:

- Focus on electricity consumption of the ICT sector as a whole



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# Electricity usage by the ICT sector is significant

EU action plan on digitalising the energy system (europa.eu)

The ICT sector accounts for approximately **7%** of global electricity consumption, and it is forecast to rise to 13% by 2030. This energy footprint currently represents 3-5% of global carbon emissions, putting it on a par with the aviation sector.

Freitag et. al. "suggest that global emissions from ICT are as high as **2.1%–3.9%**"

The ICT sector accounts for between **2-4%** of global GHG emissions across its lifecycle

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Although numbers vary, we conclude that:

- ICT sector contributes significantly to global energy usage and GHG emissions

- Transition to zero-emission ICT sector needed

- Sourcing renewable energy alone is not enough

- Networks are in turn a significant part within the ICT sector

Let us zoom in on the electricity usage of network service providers

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# Reducing electricity usage is a key target for network service providers

- Electricity usage causes significant GHG emissions

- For a typical network service provider, scope 2 emissions are much higher than scope 1

  - Scope 1: Direct emissions (e.g. fuel)

  - Scope 2: Electricity

  - Scope 3: Value chain emissions

- Scope 2 attractive target: Electricity can be directly influenced

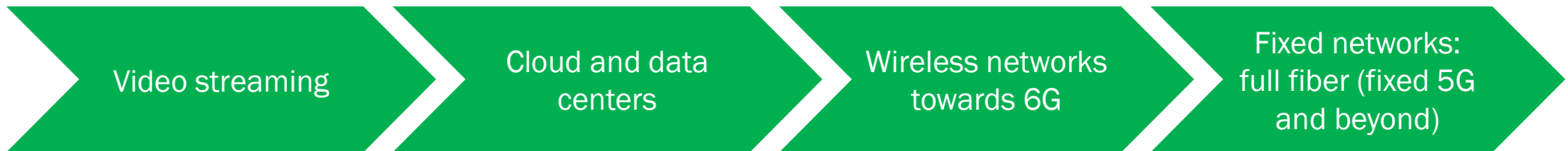  - Proof by example: KPN (source: KPN integrated Annual Report 2022)
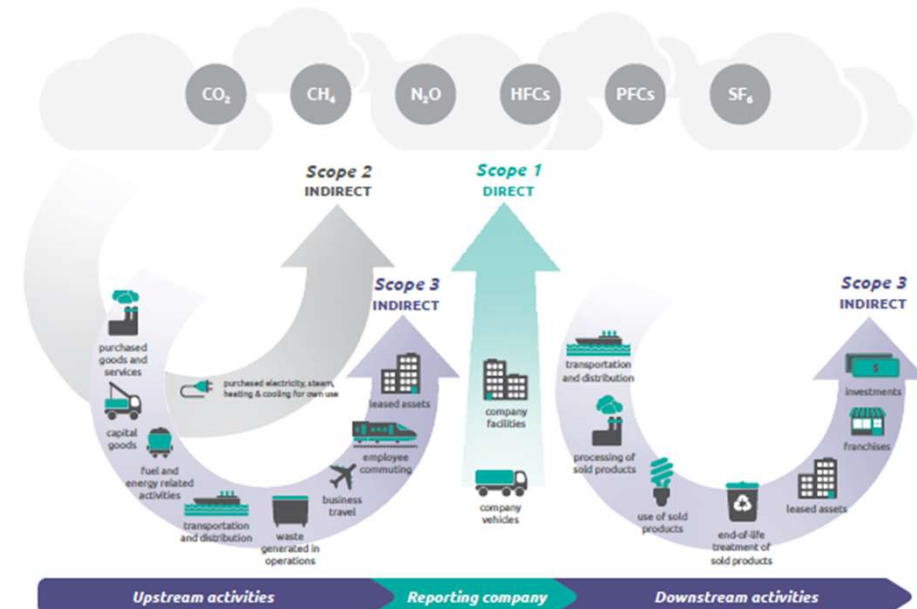


Source: WRI/WBCSD Corporate Value Chain (Scope 3) Accounting and Reporting Standard (PDF), page 5.

| | 2022 | 2021[1] | 2010 base year |
|---|---|---|---|
| Gross scope 1 and scope 2 location based | | | |
| Scope 1 NL (direct own emissions) | 11.9 | 13.1 | 58.8 |
| Scope 2 NL (indirect own emissions) | 207.0 | 241.2 | 347.0 |

# Reducing electricity usage in full fiber networks requires an E2E view

| Video streaming | Cloud and data centers | Wireless networks towards 6G | Fixed networks: full fiber (fixed 5G and beyond) |

Internet traffic consist mainly of video (over 80%)

How to reduce energy in encoding, transport decoding, rendering…?

E2E integration of (edge) data centers and the energy system.

How to create computation flexibility and green resource management among infrastructure providers?

Everything connected drives mobile (5G/6G) evolution. Full fiber required to support further data traffic growth in both mobile and fixed.

How to further optimise energy reduction in 5G/6G networks? How to reduce energy consumption to make fiber "greener"?

**What can we do in the network/ NGON segments  (wireless/fixed networks)?**

# Evolution of fiber networks: Green by design?

- Consumers and business still demand higher bandwidths

- Promise of new services and use cases (virtual presence, industrial applications, over 30 use cases in ETSI F5G)

- Greener networking is an explicit dimension of fiber network evolution



https://www.etsi.org/images/files/ETSIWhitePapers/ETSI-WP-50-F5G-Advanced-and-Beyond.pdf
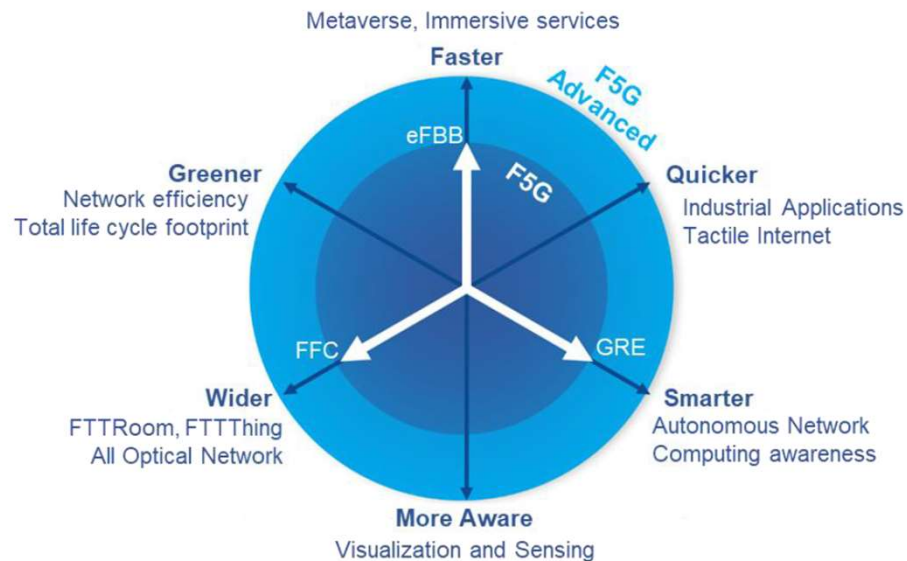
# Various options to make fiber greener

**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<br>Energy aware switching/routing | Higher bitrate: lower energy per bit<br>Power saving schemes<br>Co-packaged optics<br>Dynamic energy saving in transport networks | Dynamic placement of power-hungry tasks<br>Exploiting residual capacity in the existing light-paths<br>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.

ETSI White Paper No. #50

**Fixed 5th Generation Advanced and Beyond**

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Author:
Dr. F.J. Effenberger, Futurewei (rapporteur) with contributions from Beijing University of Post and Telecommunication (BUPT), Bouygues Telecom, CAICT, China Telecom, China Unicom, CICT, CTTC, Global Telecom, Frauenhofer HHI, Huawei, MTN, OI, Orange, POST Luxembourg, TIM, TNO, Turk Telecom, University of Patras

ETSI
06921 Sophia Antipolis CEDEX, France
Tel +33 4 92 94 42 00
info@etsi.org
www.etsi.org

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# Example: Power savings in PON networks in ETSI F5G

- ITU-T suggest various power savings techniques

- For new full fiber specifications e.g. ETSI F5G, these could be included as use cases/ scenarios

- E2E power saving management and reporting will likely be part of such specifications
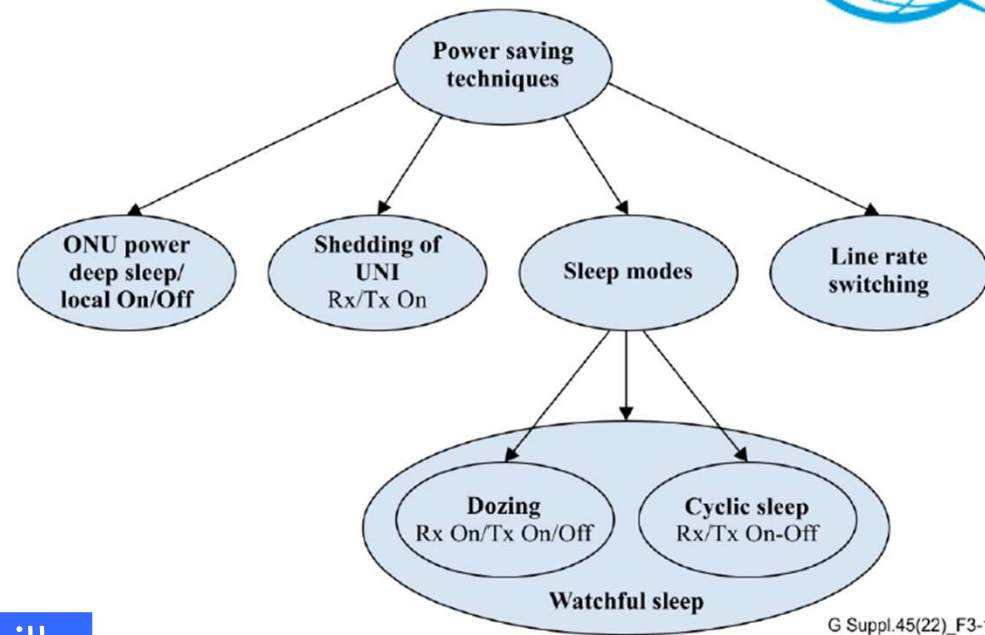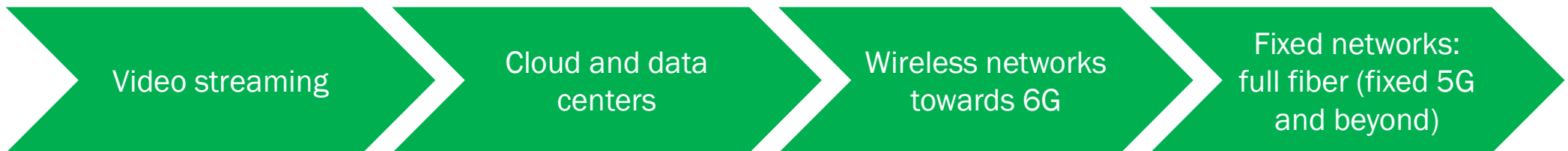
Measurement of energy consumption will support (complex) trade-offs between energy reduction, quality and stability



Figure 7-1 – Taxonomy of power-saving techniques

# Measuring energy consumption should happen in the entire E2E chain

Exigence Horizon Europe/SNS proposal: "Localised" initiatives are not enough

Measurements in fiber network should tie in with the entire chain:



| Video streaming | Cloud and data centers | Wireless networks towards 6G | Fixed networks: full fiber (fixed 5G and beyond) |
| --- | --- | --- | --- |

**Greening of Streaming:**

(real-time) Measuring energy consumption in scope

**Hyperscalers**

Optimising energy usage is essential

**NGMN:**

" An accurate metering system is a prerequisite"

**ETSI F5G:**

Elaborating green dimension of F5G Advanced.

# Benefits of measuring energy consumption in the network

Energy consumption measurement in fiber networks brings a myriad of opportunities, e.g:

Support behavioural change:
- Full transparency towards end-users

Effective policy monitoring and interventions
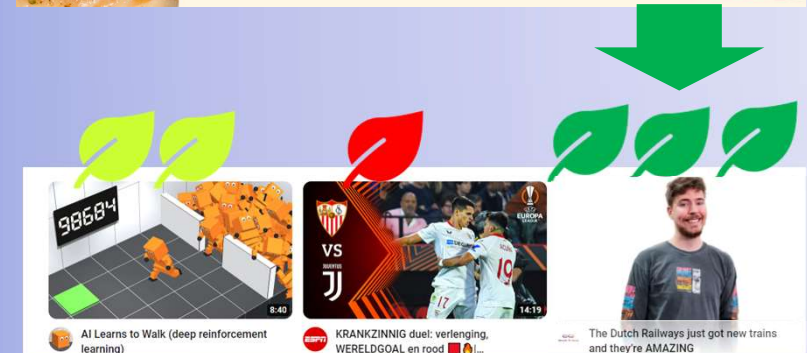- Standardised, real time metrics

Multi-factor Network optimisation for energy efficiency
- Exposing new optimisation parameter.
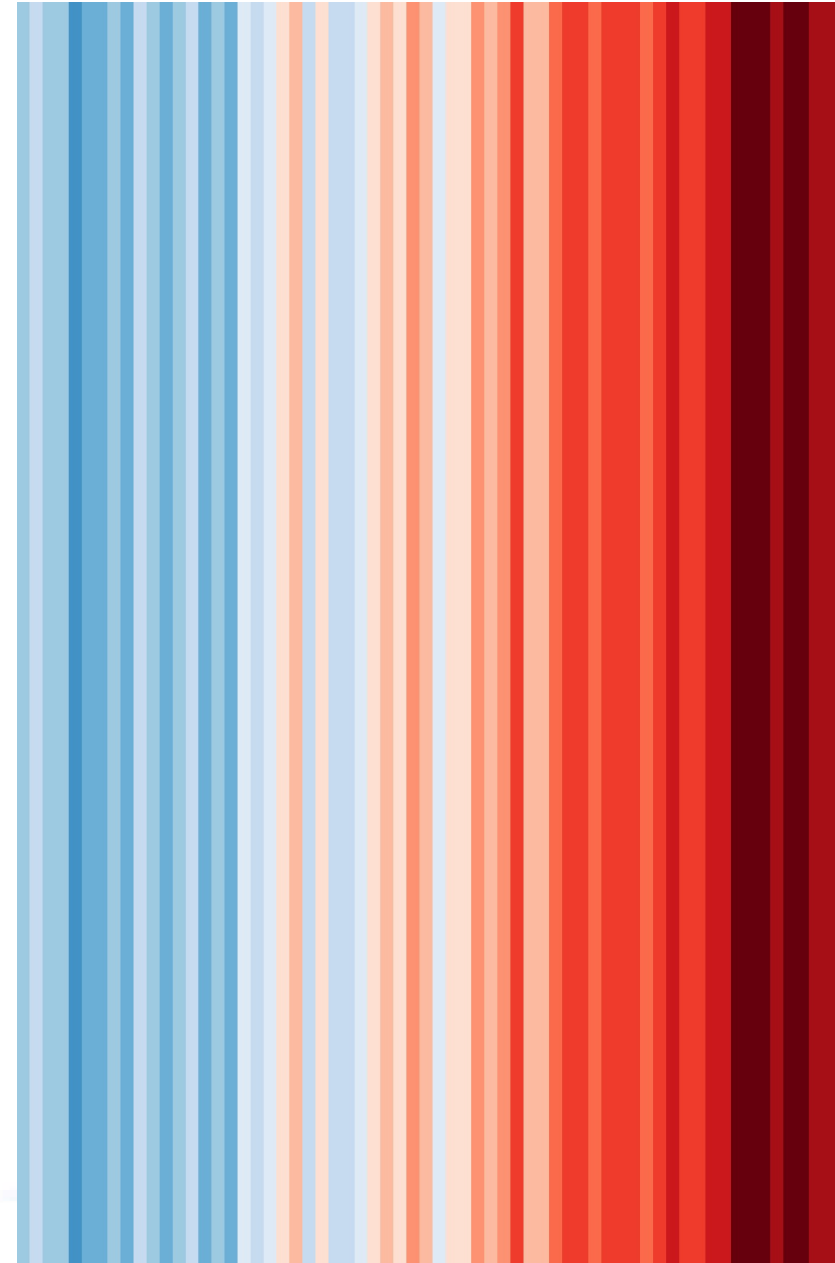


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# Prevent the rebound effect:
# It's all about absolute reductions

# Fiber evolution should make Future Networks greener

- Let's cut ICT energy consumption in half within 10 years

- Let's reduce the energy consumption in the next evolution of fiber networks – and there are various options to do so

- Let's measure energy usage throughout the E2E chain and exploit a myriad of opportunities

## Let's do this – together!

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Teun van der Veen
+31 6 537 43 590
teun.vanderveen@tno.nl