From Energy to Greenhouse Gas Emissions

– next steps towards environmental impact

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Problem Statement

- Networking industry is currently pursuing a multitude of energy efficiency and energy savings optimizations.
- These will help reduce operational costs.
- Yet, while necessary, they might not be sufficient for GHG emissions targets being reached!
- The path from energy efficiency & savings to GHG emissions reductions must be established.

From energy savings to GHG emissions reductions

Category of action	Direction of change	Key actions
Energy consumption	↘	- Getting the right metrics (scope, granularity, frequency) and target values in place, - Working on the most impactful EE and ES features (metrics proven), - Energy proportionality (idle power reduction, equipment / link shut-downs, managing always on features, end-to-end impacts of infrastructure shut-downs) - Establishing energy and carbon budgets at the right granularity
Carbon intensity of used energy	↘	- Smart, distributed, renewable-powered energy grid networking reqs. [3, 4] - APIs for synchronization with energy grids for better scheduling, planning and resilience in carbon aware routing and traffic steering, [5, 6] - Enabling user and supply side carbon awareness
Traffic load	↘	- Enablers for managing the rebound effect (link to carbon constraints) [7, 8] - Network architecture and protocol considerations: multicast, decentralization, cloudification, congestion & QoS vs peak-load designs, - Signaling towards applications of network capacity & limits
Infrastructure expansion	↘	- Managing embedded (manufacturing) emissions, Total Cost of Ownership (TCO), - Infrastructure sharing and circularity (reuse, refurbish,...) [9, 10] - Dynamic network capacity management vs. designing for peak load, - Longer lifespan of products (maintainability, repairability, observability)

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Thanks!

Questions / feedback?

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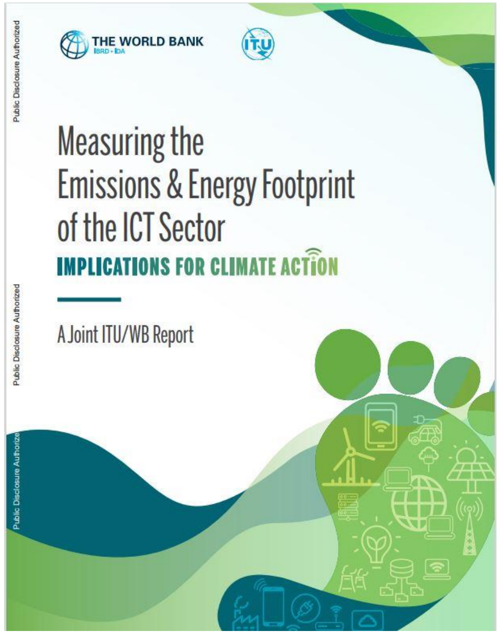
Backup Slides

ICT sector energy consumption & GHG emissions - status quo [1, 2]

- In 2020, ICT sector used ~4% of global electricity and emitted ~1.4% of GHGs.
- ICT sector emissions (%) tend to follow the global trend, somewhat increasing, not decreasing.
- ICT sector has a relatively good renewable energy use.
- Electricity consumption and GHG emissions are not aligned with data growth rates, which are much higher.
- Per subscriber energy consumption is stable while emissions tend to decrease due to renewable energy use.

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ICT sector electricity consumption and greenhouse gas emissions – 2020 outcome

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ICT sector energy consumption & GHG emissions - the future [1, 2]

- We are seriously off-course to meet the GHG emission reduction targets to meet the Paris Agreement goals: ICT Sector must halve its emissions by 2030 (ITU-T) !
- Most operators & vendors have net-zero pledges, and we are expected (soon required) to report on them.
- Renewable energy transition is not projected to make up for the delta in emissions trajectories.
- One-third of the world population (2.6 billion people) remain unconnected to the Internet. Bridging this divide sustainably, while subscriber numbers rise, is a priority.
- Networks enable new trends like digital twins, metaverse and pervasive AI which would increase digitalization impacts dramatically.

Prioritizing high-impact actions on energy

- Establishing energy and GHG emissions related metrics: at what granularity, scope, domain?
  - *Metrics and measurements should help decision making and control for energy use / GHG emissions optimizations: how often, how fast? Or only for company reporting?*
  - *What is the link to network management and orchestration functions?*
- Energy proportionality through reduced idle power as well as dynamic configuration decision making based on utilization.
  - *Are all the required utilization metrics & measurements and control protocols in place? Are end-to-end impacts of local port/line card/node shut-down clear?*
  - *Are new use cases and technologies (AI, IoTs & sensing) encouraging an always-on mode of operation and how to deal with them?*
- Can we establish caps & limits on energy consumption, based on energy carbon intensity as well as utilization profiles?
  - *Energy and carbon budgets.*

How can we support the renewable energy transition?

- Investigating networking requirements and protocol designs for smart, distributed, renewable energy-powered grids,
- Initiatives for networks to use low carbon-intensity energy
  - *Prioritizing locally generated renewable energy use in network operations: cost-effective & carbon-effective choices!*
  - *Interconnections / APIs and protocols between energy grids and networks for better scheduling, planning and resilience,*
  - *Carbon-aware routing and traffic steering,*
  - *Robust networking protocols for use with intermittent energy supplies?*
- Enabling user and supply side carbon awareness
  - *How can networks help users and content providers make carbon-aware decisions?*

Traffic related actions for GHG emissions reductions

- How can the rebound effect be managed effectively?
  - *When something becomes more affordable (cost & GHGs), it gets used more!*
  - *What would it take for users and content providers to limit usage and what should these limits be? Can the network play a role?*
- Network architecture and protocol considerations:
  - *Multicast vs. unicast traffic, is there a preference for environmental impact?*
  - *Distributed vs. centralized architectures and hierarchy: do they help?*
  - *Impact of cloudification on network traffic, where to compute?*
  - *Are non-blocking architectures needed everywhere, all the time? How can we move away from designing for peak load? Multiplexing is a fundamental telecommunications technology along with QoS (when implemented fairly).*
- How can we ensure that new use cases and innovations take network traffic impact into account and not only the other way around?

Infrastructure related actions for environmental impact

- Although smaller, compared to the use phase emissions, embedded (embodied) emissions are part of the network GHG emissions impact.
  - *Every infrastructure expansion has cost and GHG impact as well as material (circularity) impact.*
- Network capacity planning: not designing for peak load & using QoS.
- Can infrastructure sharing be a viable strategy?
  - *Use case / context specific pros & cons analyses would be needed.*
- Longer lifespan for products and services reduces impact.
  - *Circularity principles provide dual benefits (maintainability, repairability, observability, reuse, reduce,…)*
  - *What are the implications for network protocols?*
- Is cloudification the answer? *Not really, but why not?*

Additional considerations

- Network footprint covers more than GHG emissions: land, water and materials use as well as biodiversity loss are also pushing the planet to its limits and have feedback loops to climate change.
- That means materials efficiency and circularity matter, as well as how these materials are sourced (land/water use, pollution, species extinction and eco-system degradation).
- It is harder to frame the impact of networking on these elements of environmental sustainability as compared to GHGs.
- In addition to the environmental aspects of sustainability, social and economic aspects also play a key role, enabling or hindering the adoption of environmental sustainability initiatives.