Alliance for IoT
and Edge Computing
Innovation

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Optimizing methodology to measure avoided emissions in ICT for Green scenarios

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Updated methodology report

- **Update of the CO2 footprint methodology report (Sept 2023):** avoided emissions, recycling (and reuse tbd), testing
- **Cooperation between AIOTI with ITU-T SG5 and ETSI TC EE** on aligning with revisions that ITU-T SG5 and ETSI TC EE are doing on future updates of: L.1480: "Enabling the Net Zero transition: Assessing how the use of information and communication technology solutions impact greenhouse gas emissions of other sectors"
- **Provided as AIOTI input** to European Green Digital Coalition (EGDC)
- On 15 December 2023, webinar "Future AIOTI steps for calculating carbon emissions in LC phases" took place and where among others CERTH demo has been presented: "Energy consumption & emissions monitoring& assessment platform (ENIGMA)"
- On 7 February public **webinar** presenting the report and **two use cases applying the methodology**:
  - "Remote monitoring of screw connection of wind turbines – Analysis of the potential CO2 emission reduction with a smart ICT solution in wind power plants" by Fraunhofer IIS
  - "iSeeIce: sensors for better winter maintenance" by NTNU

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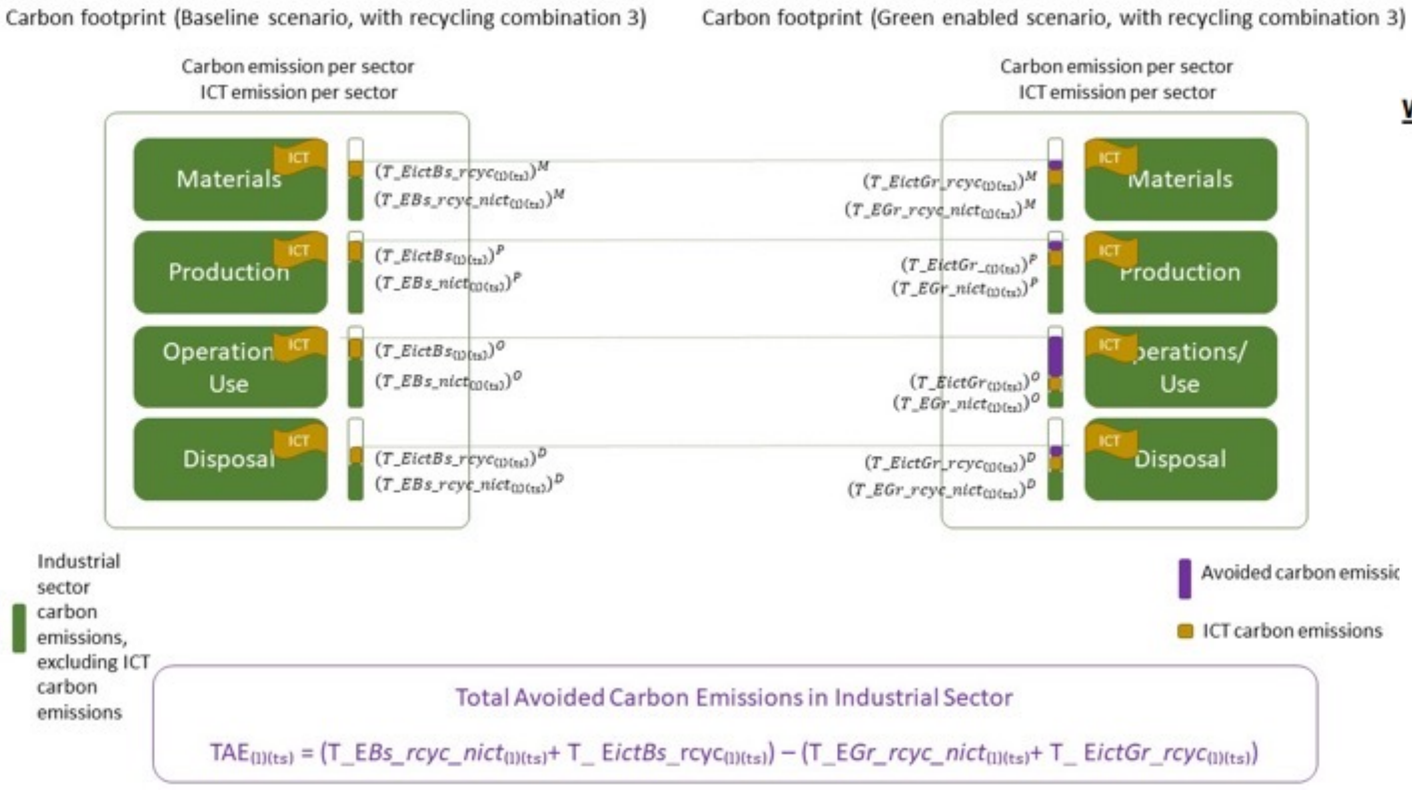
Section 6.4.3.2: AIOTI input on total avoided carbon emissions in vertical sectors, when applying ICT for recycled (with closed loop recycling) products



$$T\_EBs\_rcyc\_nict_{(l)(ts)} = \sum_{m=1}^{LBs\_nict} EBs\_nict^{M}_{(m)(l)(ts)} - \sum_{m=1}^{LBs\_nict}\left(R_{Bs\_nict_m} * EBs\_nict^{M}_{(m)(l)(ts)}\right) + \sum_{m=1}^{LBs\_nict}\left(R_{Bs\_nict_m} * E_{cpr\_Bs\_nict_m}\right) + T\_EBs\_nict^{P}_{(l)(ts)} + T\_EBs\_nict^{O}_{(l)(ts)} + \sum_{m=1}^{LBs\_nict} EBs\_nict^{D}_{(m)(l)(ts)} - \sum_{m=1}^{LBs\_nict}\left(R_{Bs\_nict_m} * EBs\_nict^{D}_{(m)(l)(ts)}\right)$$

Where:

1. $T\_EBs\_rcyc\_nict_{(l)(ts)}$ Total Carbon Emission Scenario, for recycled Baseline scenario (*Bs_cir*), but excluding the carbon emission of the applied ICT infrastructure, i.e., carbon emissions of *ictBs*, for: (1) the complete LC phases, excluding the Reuse phase, (2) for a certain Load and (3) for a type of service, e.g. follow the classification specified by ITU-T for 5G type of services;
2. $T\_EictBs\_rcyc_{(l)(ts)}$ Total recycled ICT Carbon Emission for Baseline Scenario, i.e., *ictBs*, for: (1) the complete LC, excluding the Reuse phase, (2) for a certain Load and (3) for a type of service, e.g. follow the classification specified by ITU-T for 5G type of services;
3. $T\_EGr\_rcyc\_nict_{(l)(ts)}$ Total ICT Carbon Emission Scenario, for recycled Green enabled scenario (*Gr_rcyc*), but excluding the carbon emission of the applied ICT infrastructure, i.e., carbon emissions of *ictGr*, for: (1) the complete LC, excluding the Reuse phase, (2) for a certain Load and (3) for a type of service, e.g. follow the classification specified by ITU-T for 5G type of services;
4. $T\_EictGr\_rcyc_{(l)(ts)}$ Total recycled ICT Carbon Emission for Green enabled Scenario, i.e., *ictGr*, for: (1) the complete LC, excluding the Reuse and Recycle phases, (2) for a certain Load and (3) for a type of service, e.g. follow the classification specified by ITU-T for 5G type of services;

5. $E_{cpr\_Bs\_nict_m}$ represents GHG emissions of the circularity process of each product/component (*m*) of the recycled Baseline scenario assuming that: (1) $R_{Bs\_nict_m}$=1 (complete product is recycled) and (2) excluding the carbon emission of the applied ICT infrastructure, i.e., carbon emissions of *ictBS*.
6. $R_{Bs\_nict_m}$: represents the recycling rate of the material of each product/component (*m*) used for the recycled Baseline scenario, excluding the materials used for the ICT infrastructure;

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Source: AIOTI: https://aioti.eu/wp-content/uploads/2023/09/AIOTI-Carbon-Footprint-Methodology-Report-Final-R2.0.pdf

Example of methodology applied to the use case

Smart monitoring of screw connections Q-Bo® with mioty® radiocommunication for wind turbines

Goal of the case study:

- **reduce maintenance efforts**
- **reduce the loss of wind energy production because of maintenance works**

⇨ **define the adequate ICT enabling system for this purpose**

Baseline	Assumptions on the maintenance case	Onshore (per maintenance)	Offshore (per maintenance)	CO2 emissions because of the replacement energy over the service lifetime
	8h - loss of effective energy production to be replaced (MWh)	1.679.692	245.280	
	CFP of the replacement energy (Energymix) (kgCO2eq)	503.907.600	73.584.000	
	(tCO2eq)	503.908	73.584	11.549.832

with ICT system	Assumptions: positive effects due to the ICT enabling system	avoided CO2eq emission Onshore	avoided CO2eq emission Offshore	total avoided CO2eq emissions
	Case 1: avoid 10 maintenances (tCO2eq)	5.039.076	735.840	5.774.916
	Case 2: avoid 5 maintenances (tCO2eq)	2.519.538	367.920	2.887.458

Full presentation can be found here: https://aioti.eu/aioti-webinar-presenting-iot-and-edge-computing-carbon-footprint-measurement-methodology-report/iot-and-edge-computing-carbon-footprint-measurement-methodology-webinar-agenda/

__Note:__ Equation specified by AIOTI, in the "__IoT and Edge Computing Carbon Footprint Measurement Methodology R2__" report is used in order to derive these calculations

Recommendations and Conclusions

- **Smart use** of **clean digital technologies** can serve as a **key enabler** for climate action and environmental sustainability
- **Technology** can improve energy and resource efficiency, facilitate the circular economy, lead to a better allocation of resources; reduce emissions, pollution, biodiversity loss and environmental degradation
- The ICT sector must **ensure** the environmentally sound design and deployment of digital technologies by minimising the ICT (IoT and Edge computing) carbon footprint (e.g., PCF):
  - **Measurement of the benefits** provided by ICT in carbon reduction is a struggle ➔ initiatives as EGDC can help
  - Use of **standardised connectivity related metrics/parameters** related to carbon footprint, in order to be used by stakeholders to compare and evaluate the benefit of different connectivity solutions in reducing the carbon footprint of industrial sectors
  - Include scope3 impacts in the CO2e (CO2 equivalent) footprint (e.g., PCF) calculation
- Usage of digital technologies (e.g. monitoring and controlling energy usage) for **an indirect reduction of greenhouse emissions** due to, as an example, manufacturing
- An important path to realise carbon reduction is **to increase awareness and information** for the citizens to reduce energy and carbon footprint and **increase the incentives** for citizen to realize this reduction
- **Recycling** is not only **reducing the dependency on primary raw materials**, but it is as well **reducing the carbon emissions of products and systems:**
  - However, important is to **distinguish what are the benefits of recycling from the benefits of applying ICT to reduce carbon emissions in industry scenarios,**
- **The definition of an agreed and aligned methodology** to measure the total avoided carbon emissions in industry scenarios, when applying ICT, is a key requirement for the success of deploying ICT solutions to reduce carbon emissions in industry scenarios

Next Steps

- Investigating the Life Cycle reuse phase and its dependency to other LC phases
- Apply the equation in testbeds, use cases and EC funded projects
- Proposed guidelines to implement the equations that are included in the report presented to vertical AIOTI WGs to implement in their testbeds and use cases
- **Cooperation with ITU-T SG5 and ETSI TC EE and aligning with ITU-T SG5 L.1480, (revised version), possible input:**

Step 3 – Modelling, data collection and calculation

⇨ 3.1) Quantify the second order effect of each assessed ICT solution through:
- Identifying the overall usages of the ICT solution while separating modifying and rebound usages (clause 10.3.1.1);
- Quantifying the aggregated first order effect of the ICT solution(s) (clause 10.3.1.2);
- Quantifying the change of GHG emissions due to changes in the reference activities (clause 10.3.1.3);
- Deriving the net effect of the ICT solution(s) in a standalone scenario (clause 10.3.1.4).

⇨ 3.2) Quantify the combined induced effect of several ICT solutions addressing the same emissions (clause 10.3.2);

⇨ 3.3) Assessment of higher order effects including quantification (clause 10.3.3)

- Clause 10.4 Interpretation of results
  - 10.4.1 Evaluation of the applied method
- Clause 10.5 Reporting
- Clause 11. Assessment of the effect of specific ICT solution(s) implemented in a specific context

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Thank you for listening

Any questions?

You can email us at sg@aioti.eu

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