EGDC Case study: 5G port

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Case Study Methodology

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EUROPEAN GREEN DIGITAL COALITION

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The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors.

The secretariat of the European Green Digital Coalition is managed by the consortium of the European Parliament Pilot Project for the EGDC, funded by the European Commission, namely the leading associations GeSI, the European DIGITAL SME Alliance, DIGITALEUROPE, ETNO and GSMA, working together with Carbon Trust, Deloitte, and Sustainable ICT Consulting.

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1 Introduction

The European Green Digital Coalition (EGDC) is an initiative of companies, supported by the European Commission and the European Parliament, based on the request of the EU Council, which aims to harness the enabling emission-reducing potential of digital solutions to all other sectors.

The main aim of the EGDC is to maximise the sustainability benefits of digitalisation within the ICT sector, while supporting sustainability goals of other key sectors such as energy, transport, agriculture, and construction. The Coalition recognises the need for science–based methods to estimate the reduction and avoidance of greenhouse gas (GHG) emissions by specific ICT solutions across sectors. This will accelerate the sustainability and circular transitions of these sectors while contributing to an innovative, inclusive and resilient society.

To support the EGDC, a set of case study calculators are developed to provide a practical example of calculating the net carbon impact of a green digital solution in line with the European Green Digital Coalition (EGDC) methodology. This work aims to support the members of the EGDC with Action 2 of the EGDC Declaration.

This case study methodology accompanies the '5G Port' case study calculator and provides further details, additional context and transparency around the case study calculator to ensure the outcomes of the case study are interpreted and used correctly.

Disclaimer for European Parliament Pilot Project – European Green Digital Coalition (EGDC) Case Studies

The following disclaimer is intended to provide clarity and context for the case studies prepared as part of the EP Pilot Project, which have showcased the net carbon impact of specific digital solutions using the EGDC ICT Methodology developed during the project:

1**. Purpose of the Case Studies:**
The case studies served multiple purposes, including:

- **Development of the Methodology:** They contributed to the development of the EGDC ICT Methodology. These case studies were conducted concurrently with the methodology's creation and served as a valuable testing ground for its initial formulation.
- **Application Examples:** They provided practical examples of how the methodology can be applied to real-life use cases. These case studies were essential in demonstrating the practicality and effectiveness of the methodology when applied to concrete situations.
- **Identification of Improvement Areas:** By conducting these case studies, we aimed to highlight parts of the calculation in need of improvement. They shed light on the challenges and limitations inherent in using available data and indicated the necessary steps to move towards best practices in assessing net carbon impacts.

2. Data Quality as a Key Determinant:
It is imperative to emphasize that data quality is a fundamental determinant of the quality and reliability of the case studies. The accuracy and completeness of the data used significantly influence the outcomes and findings of these case studies.
It is essential to acknowledge that the data available for each case study may differ in terms of accuracy, granularity, and coverage. As a result, the case studies may not necessarily represent the best practice application of the EGDC ICT Methodology. Instead, they reflect the application of the methodology at various stages of data availability.

3. Liability for Errors/Omissions:
While reasonable steps have been taken to ensure that the information contained within the case studies is correct, the EGDC gives no warranty and makes no representation as to its accuracy. We accept no liability for any errors or omissions that may be present in the case studies, methodology, or related information. Users and readers are advised to exercise their judgment and seek further clarification if needed, as the information provided may evolve over time and depend on external factors beyond our control.

4. Appropriate Use of the Case Study Calculators:
The case study calculators are intended for educational and informational purposes. They rely on certain assumptions and input data to generate results. The results of the calculators are specific to the implementation of the ICT solution and may not be representative for other implementation contexts. As such, it is imperative for users to refrain from directly extrapolating these results to ICT solutions or implementation contexts that may seem conceptually similar.

Instead, users are advised to use the calculators as a means to understand the practical application of the EGDC ICT Methodology, thereby equipping themselves with the knowledge required to develop customized calculators specifically tailored to their unique ICT solutions and implementation circumstances.

In conclusion, these case studies provide valuable insights into the calculation of the net carbon impact of digital solutions through the practical application of the EGDC ICT Methodology. However, it is vital to exercise caution when interpreting the results, considering the variances in data quality and the evolving nature of the methodology. The findings are indicative of the methodology's potential and its room for refinement as we work towards more accurate and comprehensive assessments of net carbon impacts.

5. Non-alignment of the Ericsson 5G port case study:

Please not that due to the lack of data to estimate first order effects of the solution implementation, this study does not fully align to the EGDC ICT methodology. All results from the calculator should be treated as illustrative.

2 Methodology

Ericsson 5G port	
Assessment Objective	The assessment is intended to understand the net carbon impact of the implementation of the Ericsson 5G port solution in a single implementation context in a pilot at one of the Port Livorno cargo terminals. Furthermore, the aim of the assessment was also to test the EGDC ICT Sector Guidance for Net Carbon Impact Assessments and identify sector-specific methodological considerations. The assessment is ex-post based on collected data.
Description of solution	The Ericsson 5G port solution addresses the efficiency and sustainability of handling and processing general cargo at Port Livorno in Italy. It was deployed in 2017 as part of the Livorno Living Lab, one of the five testing grounds for the European Union's COREALIS Port of the Future project. The COREALIS project proposes a framework for cargo ports to handle upcoming capacity, traffic, efficiency and environmental challenges, by leveraging innovative digital solutions. The Ericsson 5G-enabled solution addresses the efficiency and sustainability of port operations by using control module RTPORT for managing cargos, enabled through the installation of a 5G network. The entire Ericsson 5G-enabled solution applies across vessel and truck loading and unloading activities and yard movements by forklifts. The scope of activities included in the carbon calculator is limited to the yard movements of forklifts which led to fuel and CO_2 saving. Other activities for vessel or truck loading and unloading did not impact emissions as forklifts and cranes ran for the same duration during shifts. As such, the digital components of interest are the RTPORT software, 5G network and use of VR/AR which allow for streamlined data processing and optimisation of the forklifts' movement of freight. The Ericsson 5G port solution has potential to be deployed in other ports processing cargo freight which have the infrastructure required to implement a network connection and whose operations involve the use of vehicles such as forklifts. The contributors to the solution were the solution developers Ericsson and port Livorno operational team that facilitated the testing.

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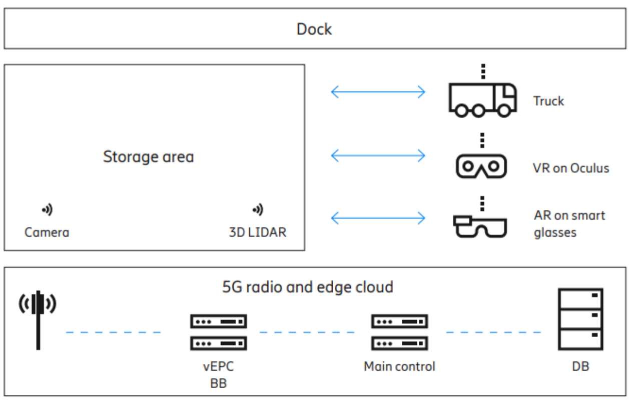
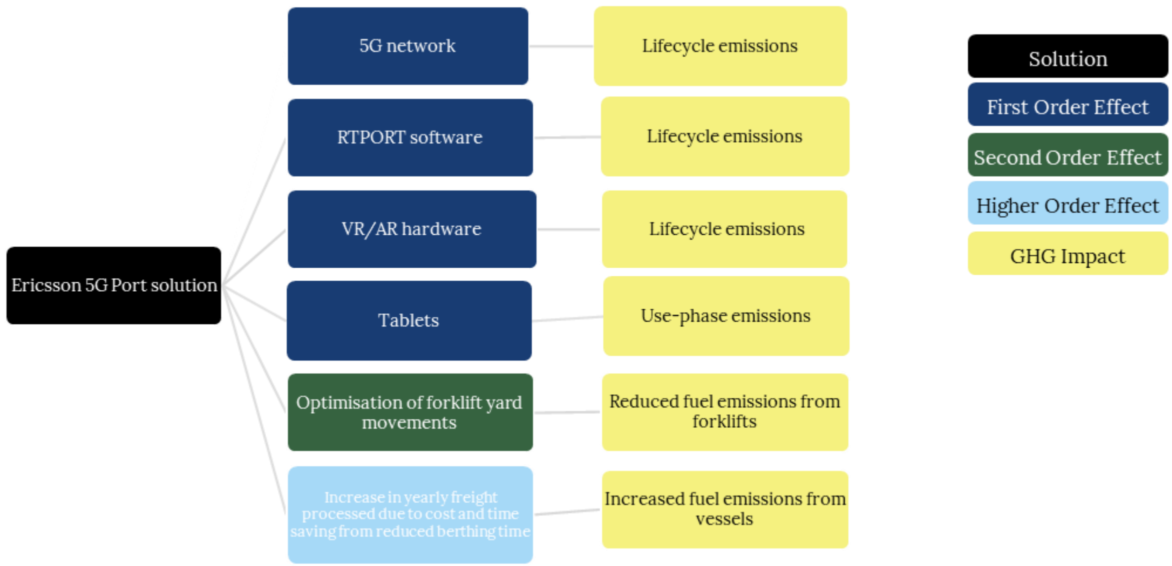
Solution Boundary	
	Digital components of the solution: • **RTPORT** software provides real-time processing capabilities and a staging environment. • **5G network** enabling the implementation of the RTPORT logistics management software and real-time data processing. The 5G network presents key characteristics of speed, increased capacity and reliability which would not have been achieved through a 4G network. A 4G network would not enable the same functionalities for the application of the RTPORT software which requires instant data transfer and connectivity of on-field equipment. • The RTPORT software **interacts** with: - the **oneM2M platform** for forklifts and data collection; and -the **Port Monitoring System** (MonI.C.A) for the visulation of available forklifts, their status and the assigned cargo. Interaction between RTPORT and MonI.C.A optimises the vehicle-call process. This is achieved by reducing the total number of movements per general cargo unit and reducing the time to find a forklift on the yard to carry out the required operation. - **Tablets** used by the forklift drivers, connected to 5G network. To provide a realistic virtual testing environment for all functions and applications, the digital twin of the cargo terminal of the Italian port of Livorno was developed. **VR simulations** were used to acquire statistics on loading operations and test the software for the positioning of the freights. **Non-digital components:** Yard vehicles (forklifts)

The 5G-based control module manages cargo operations in real-time



Functional Unit	The functional unit chosen is tCO_2 saved per freight ton per year. The unit per ton of freight was chosen to allow for comparison across ports of different capacities. The tonnage of freight processed in a year captures the port's scale of freight cargo activities and has a direct impact on the fuel consumed by the forklifts.
Assessment Boundary	The solution was deployed at the Lorenzini terminal of Port Livorno, in Italy over the period 2017-2020/2021. Port Livorno is one of the largest maritime ports in the Mediterranean with an annual freight capacity of around 30 million tons.
Reference scenario	The reference baseline scenario measures forklift time for yard movements in 2017, prior to the 5G solution implementation. In this scenario, forklift drivers manually deliver waybills to the terminal offices to register the unloaded freight and the forklift trajectories have not been optimised. This baseline was chosen in accordance with the data measured by Ericsson in the context of the COREALIS project. Data was collected on the field at the Lorenzini terminal to acquire typical metrics of: - forklift usage timings, - daily distance in kilometres travelled by forklifts, - forklift fuel consumption per hour.
Description of 1st order effects	Embodied emissions are captured in a qualitative manner in this document as follows. 1st order effects were not quantified in the calculator as these were out of scope of the original COREALIS study. The scale of proxies required to cover these data gaps was such that first order effects have been excluded from the calculator. Factors which would need to be considered to calculate first order emissions of a similar use case, include direct emissions associated with the whole lifecycle of the solution: -implementing the 5G network, -network usage, -running the RTPORT software (including emissions from the production, use and disposal of associated hardware for VR/AR applications – cameras and sensors), - using the tablets which act as interfaces (emissions from the production, use and disposal of the devices). Emissions associated with network usage were estimated and excluded on the basis that these are below the 5% materiality threshold.
Categorisation of digital technologies	The key components of the digital Ericsson port solution include the following*:*

	B • **AR/VR** • **RTPORT module** • **oneM2M plateform** • **Port Monitoring System** • **Tablets** **C** • **5G Network**
Description of 2nd order effects	**Positive 2nd order effects:** The RTPORT digital solution allows goods to be registered digitally in real time, replacing the previous off-line procedure when forklift drivers delivered waybills manually to the terminal offices. The instant transfer of data also allows forklift yard movements to be optimised, resulting in a decrease in forklift usage for the same amount of freight processed.
Description of higher order effects	• **Rebound effects from using the solution:** The treatment of rebound effects applied in this methodology is the same as adopted by the COREALIS impact assessment report: "When it comes to vessels' berthing time, the time saving obtained by 5G-enabled use cases could either lead to more vessels calling at the port, or to a reduction of costs, due to less time spent on operations. In this analysis, we assume that the vessel number does not change, but there is a cost saving for berthing and overall time spent in port vessels calling at the selected terminal. With the use of further automated equipment provided by terminal operators, the automated quay cranes may increase time productivity by 20–25 percent, estimated as a reduction of a quarter of berthing time of vessels." Therefore, in the context of this assessment, whilst the solution leads to increased efficiency of operations, the possibility a resulting increase in yearly freight processed and associated increase in CO_2 emissions are excluded.

Mapping of all effects	
	
Description of calculation	**1st order effects:** The first order effects calculation captures the embodied emissions for the digital solution. These were excluded in the first iteration of the Ericsson calculator as these were not included in the context of the COREALIS study. The COREALIS study is based on data captured up to 2021, at which point the pilot of the solution at Livorno port ended. No further data collection was possible for the purpose of the EGDC case study, beyond the historical COREALIS data provided by the solution developer. These were captured in a qualitative manner in the methodology document in the *Components of the solution and 1st order effects* section. As we are unable to ascertain whether the excluded 1st order effects are below a 5%

	materiality, this study does not fully align to the EGDC ICT methodology. All results should be treated as illustrative. **2nd order effects calculation:** The second order effects calculation captures CO_2 savings achieved through the digital solution, by optimising yard movements of forklifts and automating cargo data processing. To calculate the carbon saving from the solution, the calculator measures the difference in activity hours per year of the forklifts before and after the implementation of 5G. To the total time saving we apply the hourly diesel consumption of forklifts (13L/h) to capture the diesel saved from the solution implementation. Finally, an emissions factor for the forklift diesel (2.6 t/m3) was applied to reach the final figure of 148 CO_2 ton/year saved at Port Livorno. **Higher order effects:** The higher order effects calculation captures the rebound effects, that is, a potential increase in total emissions as a result of the digital solution. Our calculator excludes this rebound effect as the time saved in forklift activity does not result in increased cargo ships processed, as informed by Ericsson. This is because the time saved decreases the daily shifts for forklifts from 14h to 12h for the same amount of cargo. This brings the duration of daily shifts for forklifts to match that of the tower cranes. Therefore, as a result of their increased efficiency, forklifts see a decrease in daily activity rather than an increase in the number of cargo ships processed.
Net Carbon Saving Impact of the Solution	Total carbon saving impact: **111 tCO_2e / year** 1st order: Not calculated 2nd order: 111 tCO2e / year Savings from reference scenario (%): **19% forklift fuel saved** Saving per functional unit: **3.48 tCO_2e/freight mil tonnage/year** The decreased usage constitutes a saving in forklift fuel of 19% per year for yard movement activities and a 19% decrease of CO_2 emissions.
Uncertainty and sensitivity analysis	The overall data quality is fair to good. Due to the reliance on primary data, reliability, activity and geography representativeness is largely good. As actual data collection was run over limited timeframes, temporal representativeness and completeness of data set are fair to poor. The sensitivity of second order effects has a high sensitivity to forklift fuel usage and associated emissions factor.
Assumptions	Key assumptions made in the calculations: • The methodology excludes rebound effects as the time saved in forklift activity does not result in increased cargo ships processed, as informed by Ericsson.

	This is because the time saved decreases the daily shifts for forklifts from 14h to 12h for the same amount of cargo. This brings the duration of daily shifts for forklifts to match that of the tower cranes. Therefore, as a result of their increased efficiency, forklifts see a decrease in daily activity rather than an increase in the number of cargo ships processed. • The scope of activities included in the carbon calculator is limited to the yard movements of forklifts which led to CO_2 saving as other activities for vessel or truck loading/unloading did not impact emissions as forklifts and cranes ran for the same duration during shifts.
Data sources	**Key data sources used in the calculations:** • The data was collected by Ericsson the context of the Livorno Living Lab project which implemented the 5G port solution in 2017. • The port statistics, specifically the annual cargo freight processed at port Livorno, were sourced from the Italian Ministry for Infrastructure and Transport. • The emissions factor used for the forklift fuel was the diesel CO^2 emissions coefficient provided by ISPRA of 2.6t/m^3.
Input adjustments and key considerations for usage of results	**Inputs for other ports:** - Total annual freight tonnage (t/year) **Override options:** - Forklift fuel consumption per hour (m3/h) - Total forklift fuel usage (m3/year) - Hours per year of forklift activity (h/year) - Emissions factor of forklift fuel (tCO2) Items to consider when applying this case study is the nature of the freight handled at the port will affect handling times by the forklifts as well as the order for moving freight. In the case of Livorno, the order is pre-arranged and freight is labelled accordingly. This ensures the process has less variability in the daily procedures carried out to move cargo freight. In other ports a rebound effect may need to be considered, where the increased efficiency of forklift activity would lead to more cargo freight being processed annually at the port. Increased port activity would lead to an increase in overall emissions which would need to be considered when calculating the impact of the solution. The pandemic resulted in reduced cargo traffic over the period 2020/21 due to lockdown measures and the slowed global economic climate, resulting in a lower annual freight tonnage processed for that period.

	Due to the context of the COVID-19 pandemic which imposed social distancing, the post 5G implementation data was collected over 2020/21 using VR simulation to map forklifts movements, to minimise the impact of changes to operating conditions. A key consideration when reviewing this case-study is that the basis of this case-study is the COREALIS research project and its impact assessment report which captured data measured in 2017 and in 2020/21. The data sample captured annual forklift activity, which in the case of the Lorenzini terminal at Livorno relates to a single forklift. As such, the numerical output from the calculator should be treated as indicative. The purpose of the overall case study is to capture an understanding of the factors which would need to be considered and measured for application to other similar use cases.

'Do no harm' criteria	In line with the UN Sustainability Framework, it has been assessed that the 5G Port Solution does not negatively impact other areas such as ecosystems, management of resources, communities and livelihoods or working conditions.
	
	As part of the COREALIS Port of the Future project, Ericsson has assessed the impact of the Livorno Living Lab digital solutions against the Sustainable Development Goals:
	
	• The 5G-enabled transformations of the port processes directly influence:
	  ▪ SDG 8 (Decent Work and Economic Growth),
	  ▪ SDG 9 (Industry, Innovation and Infrastructure), - SDG 11 (Sustainable Cities and Communities),
	  ▪ SDG 12 (Responsible Consumption and Production) and,
	  ▪ SDG 13 (Climate Action).
	
	• Other impacts are:
	  ▪ SDG 4.4 (Vocational Skills) relevant to the port workforce, where the transformative role of 5G can enhance job tasks, tools and competence profiles.
	  ▪ SDG 14 (Life below water) addressed as part of the port's ambition to protect the marine and coastal ecosystems.
	  ▪ SDG 17 (Partnerships for the Goals) relevant to the Port of Livorno approach on public-private partnerships and cooperation.

Key areas for improvement	Within the scope of this work, there was no verification of the data undertaken and the calculator is based on the assumption the data provided by the solution is correct. The following areas should be considered for improvement. • Completeness of the study The first order effects of the following components should be quantified: - implementing the 5G network,

	- network usage, - running the RTPORT software (including emissions from the production, use and disposal of associated hardware for VR/AR applications – cameras and sensors), - using the tablets which act as interfaces (emissions from the production, use and disposal of the devices). • Data sample size Observations across a larger fleet of forklifts sample as well as across multiple port terminals would ensure a more robust sample collection. Data points should also be collected continuously over a larger time period to cancel out seasonality effects.

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