EGDC Case study: Dassault 3DS DELMIA

April 2024

Case Study Methodology

Provided by: Dassault-Systèmes

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.

This deliverable has been produced by the consortium of the European Parliament Pilot project for the EGDC.

Global Enabling Sustainability Initiative (Coordinator)

DIGITALEUROPE

European Telecommunications Network Operators' Association

European DIGITAL SME Alliance

SUB-CONTRACTORS

Carbon Trust

Deloitte

GSMA

Sustainable ICT Consulting

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 on 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 'Dassault 3DS DELMIA' 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.

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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.

2 Methodology

DELMIA 3DS Apriso software	
Assessment Objective	The assessment is intended to determine to what extent the DELMIA 3DS manufacturing operations management solution can have a net positive impact on the manufacturing sector when implemented in a specific context. 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 case study is based on the implementation of the solution in one context, namely the manufacturing operations of trains in a site in France. The assessment is ex-post based on collected data. The calculator considers additional manufacturing environments, for automobile and aviation production lines. Please note that when selecting these options in the calculator, results will not be aligned to the EGDC ICT methodology as calculations for these are based on secondary data.
Solution Description	Dassault Systèmes provides digital 3D visualisation software solutions through its 3DEXPERIENCE platform. The DELMIA brand of Dassault Systèmes is a portfolio of solutions for digital manufacturing. These solutions include digital process planning, robotic simulation and human modelling technology. DELMIA Apriso is a Manufacturing Operations Management/Manufacturing Execution System (MES) tool. DELMIA Apriso captures all the core functionalities of Manufacturing Execution Systems (MES), in addition to expanded Manufacturing Operations Management (MOM) capabilities. These include virtual modelling of factory floor operations and integrated quality, material synchronisation and maintenance. Manufacturers can access real-time, data-driven KPIs to measure productivity, better manage production lines, manage material flows and cycle times, enhance production systems and drive real-time manufacturing processes. Carbon

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	savings are enabled by the optimisation of manufacturing processes and early identification of faults. Most material is the reduction in product reworks required due to lower non-conformity rates which enables energy savings and reduced scrap waste. The DELMIA 3DS solution is currently deployed across a number of manufacturing environments across the globe in the following industries: Transportation & Mobility, Aerospace & Defence, Marine & Offshore, High Tech and Industrial Equipment. There are no immediate boundaries to its application beyond the requirement of connectivity to a network.
Solution Boundary	• **Database Server (**Minimum for 10 users or less: Core i5 (6th generation) CPU (4 cores), or equivalent; 16 GB of RAM); • **DELMIA Apriso Application Server** to run DELMIA Apriso applications (minimum for 10 users or less: Core i5 (6th generation) CPU (4 cores), or equivalent; 16 GB of RAM; 20 GB of free hard drive space after meeting the software requirements (50+ GB if running the database server on the same machine as DELMIA Apriso); Network connection). • **Desktop (PC) Client** (Minimum requirement: Core i3 (6th generation) CPU, or equivalent; 8 GB of RAM) • **Operating systems** (Microsoft Windows Server) • **Database engines** (SQL Server or Oracle environments) • **Network**

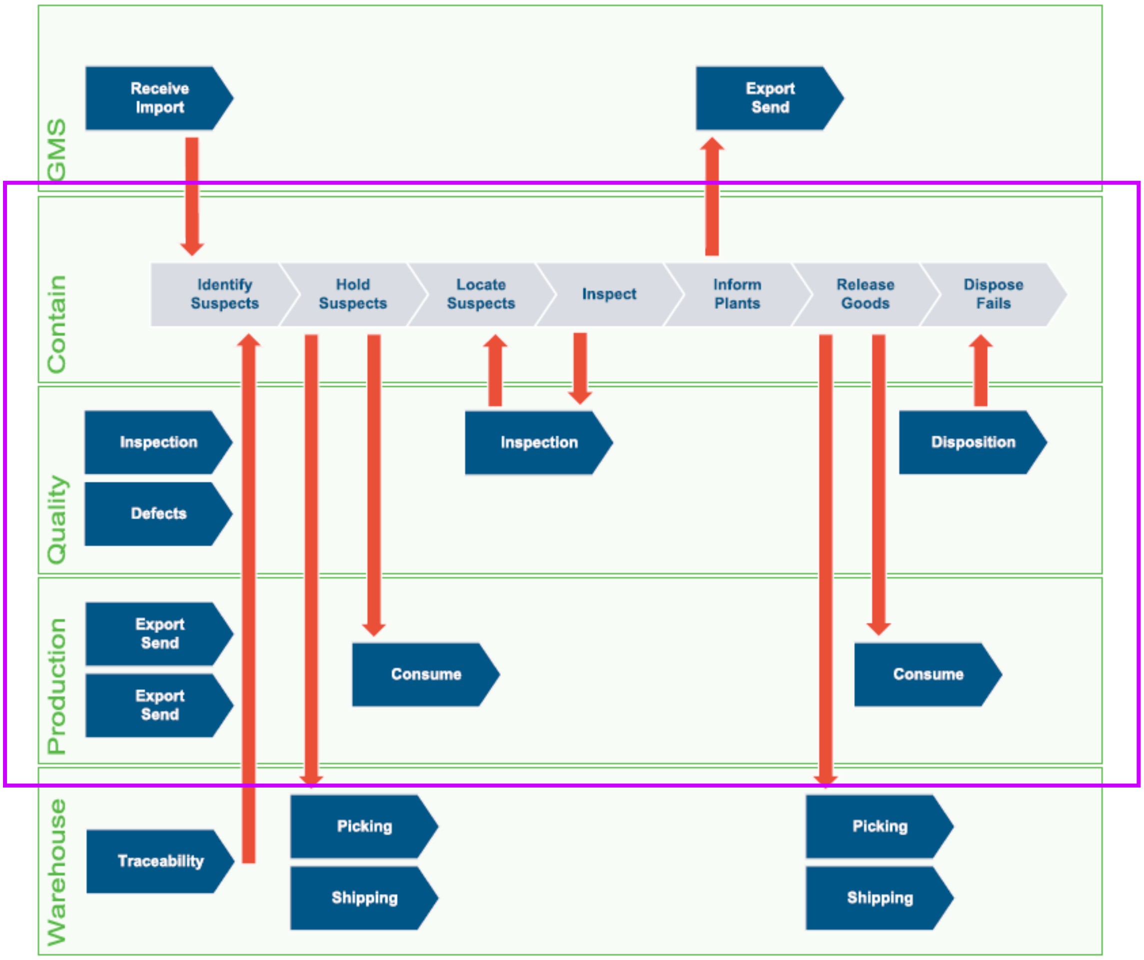
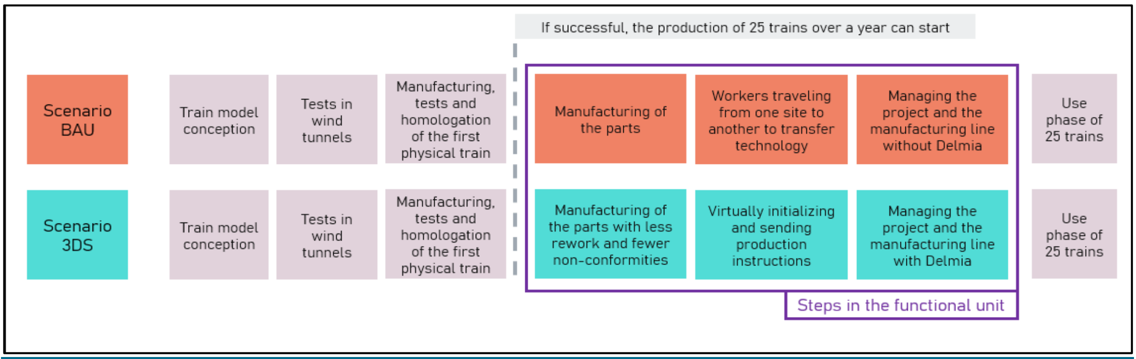


Figure 1 Containment Manager in the context of other DELMIA Apriso modules in a single plant



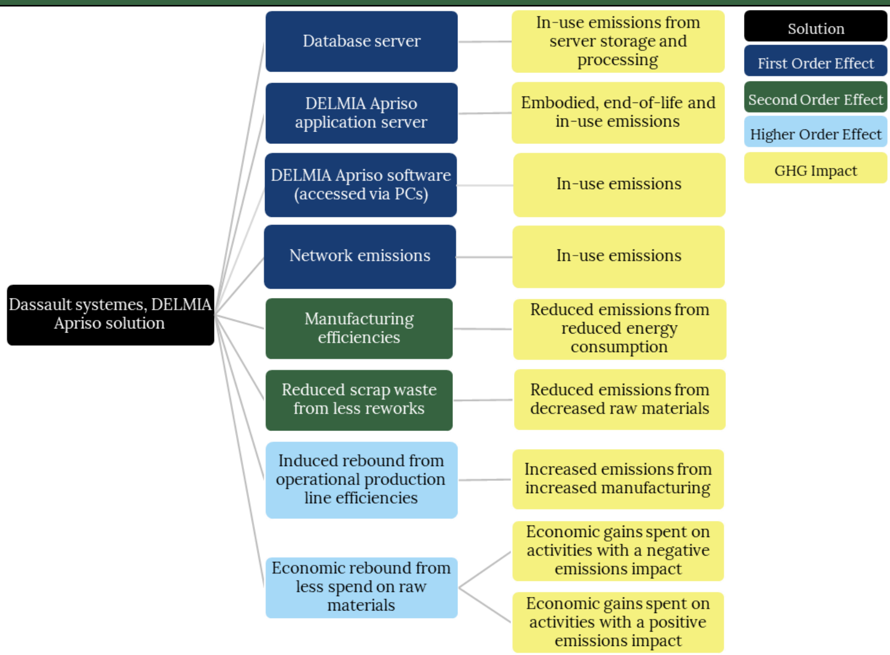
Functional Unit	Functional unit chosen is the number of vehicles produced annually. Final calculator output captures the annual carbon savings enabled by the solution per vehicle manufactured. This allows

	for comparison across manufacturers of each vehicle type.
Assessment Boundary	The scope of the project lifetime included in the study is 2014-2019. The initial use case provided by the solution owner is applied to the production line of a train manufacturer in France. Due to data confidentiality, much of the data was estimated by the solution owner, such as the rate of non-conformity and the attribution factors (used in the solution emissions calculations).
Reference scenario	The reference scenario chosen for the EGDC calculator corresponds to the use case provided by Dassault, produced in partnership with a third-party advisor. This use case studies the application of DELMIA 3DS to the production and quality control processes of a French train manufacturer. The baseline before implementation is 2014 and the scope of the project lifetime included in the study is 2014-2019. The reference scenario is the average construction of trains, focusing on the production of train parts. The manufacturing steps of a train on a production line consist of manufacturing train parts, workers travelling between sites to transfer technology and the management of the project and line manufacturing. This scenario results in scrap being generated from non-conformities and reworks for faulty parts, physical demands for knowledge and resource sharing and the time involved in managing the project and production line. Post implementation, processes are more efficient, and defaults are flagged earlier in the production process, reducing the amount of rework required on machined products and scrap waste.
Description of 1st order effects	Emissions generated by DELMIA 3DS for the development of the DELMIA Apriso software is estimated by calculating DELMIA 3DS's Scope 3 capital goods emissions attributed to the purchase of hardware used in software development (desktops, laptop computers and servers) and attribution of Scope 1 & 2 emissions to capture the additional energy use for the software development. Additional manufacturer emissions the use of the DELMIA 3DS solution considers the following:

	• Use of Database Server, • Use of DELMIA Apriso Application Server for running DELMIA Apriso applications, • Use of Desktop (PC) Client • Use of Operating systems (Microsoft Windows Server), • Use of Database engines, • Network use. The emissions associated with the above components from the manufacturer's use of the DELMIA 3DS solution are estimated by calculating the attribution of Scope 3 capital goods (desktops, laptop computers and servers) emissions associated with the use of the DELMIA software attribution of Scope 1 & 2 for energy use relevant to running the DELMIA 3DS software.
Categorisation of digital technologies (A) = ICT Service (B) = Service specific building block (C) = Common ICT devices, services, infrastructure	**Category A** • DELMIA Apriso Application Server **Category B** • Database Server **Category C** • Desktop (PC) Client • Operating systems • Database engines • Network
Description of 2nd order effects	**Production:** The DELMIA 3DS solution delivers Manufacturing Execution System (MES) capabilities to improve resource management by synchronising planning with production. This improves efficiency of operations, improving energy efficiency of the production line. **Quality control:** The DELMIA 3DS solution helps speed up defect reporting with greater accuracy, allowing users to report visual quality defects from 3D models with greater accuracy. Detecting defects earlier on in the production process allows for reduced scrap waste and decreased emissions associated with reworking products.

<table>
<tr><td>Description of higher order effects</td><td>Negative higher order effects: potential rebound effect
Increased efficiency of manufacturing operations could lead to greater production capacity for the factory. If annual production was to increase this would increase annual emissions overall. This would constitute a negative higher order effect. The optimisation of defect reporting along the train production line, and more efficient material management reduces scrap waste and may reduce company costs by decreasing the purchase of raw materials. These cost savings, in the medium to long term, could be spent on alternative activities that have a positive or negative GHG emissions impact, or economic rebound. The cost savings could also enable the growth of manufacturing operations, resulting in an increase in train production volume and therefore higher absolute GHG emissions.

These effects were not observed in the DELMIA 3DS implementation case and as such were excluded.

Positive higher order effects:
No positive higher order effects identified.</td></tr>
<tr><td colspan="2">Mapping of all effects</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Description of calculation</td><td>1st order effects calculations:
Emissions associated with production of the solution software and hardware as well as emissions associated with manufacturer's use of software and associated hardware.</td></tr>
</table>

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	Please refer to the last section of this document for the full list of assumptions and consideration points on the applied approach. **Solution emissions – development:** These are calculated as an attribution factor of Dassault 3D's Scope 1 & 2 emissions for energy use and Scope 3 capital goods emissions for hardware. Attribution factor of 1% was determined by Dassault and team of experts as the proportion of DELMIA's revenue earned for this project over 3DS's overall revenue over the life of the project. **Solution emissions – use:** In the I Care – 3DS Avoided emissions calculation tool, these are calculated as an attribution factor of 0.01% of the Manufacturer's Scope 1 & 2 emissions allocated for energy consumed and 1% of Scope 3 Capital goods emissions for associated hardware use. Attribution factors were determined by external I Care consultants as a hypothesis. The EGDC calculation tool estimates these as the emissions associated with the energy required to power four servers for seven hours a day over 5 days a week. As no further information was accessible, this is an estimation of the actual number of servers in place however the calculation tool offers the possibility to adjust this variable. **2nd order effects calculations:** Please refer to the last section of this document for the full list of assumptions and consideration points on the applied approach. **Avoided emissions from reduced scrap waste** This is calculated by estimating the carbon emissions associated with the mix of materials used in a vehicle. **Avoided emissions from reduced energy consumption** This is calculated by applying the weighted average carbon intensity of the difference in manufacturer energy use between the baseline business as usual and the 3DS scenario. The weighted average carbon intensity of energy use is estimated by applying different energy source emission factors in proportion to the manufacturer's energy mix percentages.
Net Carbon Saving Impact of the Solution	The net carbon saving impact of the solution provided by the calculator is to be taken as indicative only.

	Due to the lack of first-hand data available from the manufacturer, including for confidentiality reasons, many of the underlying assumptions are estimates. The purpose of the calculator and accompanying methodology is therefore to provide an informed view of the variables which need to be considered and measured to estimate the net carbon saving impact of a similar manufacturing solution. The initial use case provided by the solution owner which is applied to a train manufacturer in France estimated the net carbon impact as follows: **Net carbon savings enabled for the train use case in the case of 25 vehicles produced**: Total annual net carbon savings impact: 5,175 tCO_2e/year 1st order effect emissions: 94.8tCO_2e/year 2nd order effect savings: 5,269 tCO_2e/year Annual carbon savings per functional unit: 207 tCO_2e/ vehicle produced.
Qualitative data uncertainty and sensitivity analysis	The overall data quality for first order emissions is fair, with relatively precise energy consumption data. The data is assessed as poor where large assumptions have been made due to the solution developer's lack of access to manufacturer data due to information confidentiality. Efforts should be made to improve the activity data on the manufacturer's server emissions, manufacturer's scope 3 emissions and the server energy use to make it specific to the activity. The sensitivity analysis shows the impact of varying the inputs to the net impact calculation in different implementation contexts. The sensitivity of second order emissions is relatively low, on average +/-0.44%, to variations in average masses of materials, their associated emissions factors, and the solution's energy consumption. The activity data on the energy consumption of the reference scenario and the DELMIA 3DS scenario are the most sensitive inputs. When the activity data for the reference scenario energy consumption is varied by -5%, the net carbon impact decreases to 2,344 tCO_2e. Alternatively when the activity data is varied by +5%, the net carbon impact increases to 8,005 tCO_2e. The percentage change of the solution's net carbon impact when varying this parameter is – 54.69 % and 54.69% respectively. Overall, the solution's annual carbon savings impact figure of 5,175 tCO_2e has a sensitivity of +/- 2,830 tCO_2e, when assessing different implementation contexts with varying activity data. It should be noted that the analysis performed is not a quantitative uncertainty analysis. By providing a more granular view of data quality, which builds on the data quality

	assessment, this analysis highlights areas of uncertainty within the calculation using a qualitative assessment framework. It can however be used to feed into a quantitative uncertainty analysis using guidance from the Greenhouse Gas Protocol on Quantitative Inventory Uncertainty: https://ghgprotocol.org/sites/default/files/2022-12/Quantitative%20Uncertainty%20Guidance.pdf
Assumptions	**Scope of study** In the case of the *I Care - 3DS – Avoided emissions calculation tool*, the scope of the study is the application of the DELMIA 3DS Apriso software solution to a French train production line. The **total avoided carbon emissions** enabled by the solution are captured as the **avoided emissions** less the **solution emission**. Avoided emissions consider the following: • Savings from better manufacturing efficiency – less energy consumed (1,058 tCO2e avoided from specific use case) and less scrap and less consumed raw materials (4,211 tCO2e avoided from specific use case) • Savings from reduced travels to transfer technology from one site to another (0.09 tCO2e avoided from specific use case) • Savings from more time efficient manufacturing line and project management (0 tCO2e avoided from specific use case) The EGDC calculator considers different vehicle types manufactured: trains, plane and cars across different European countries: France, Germany, Spain, Slovakia, Italy, Czech Republic (see following assumptions for rationale). The scope of the EGDC calculator is limited to the estimated avoided emissions from savings from better manufacturing efficiency (less energy consumed and less scrap waste). The purpose of this is to focus on the areas of impact which are most material to the manufacturers. **List of all key assumptions made in the calculations** • Assumptions made on the % of material mix for each vehicle type based on available industry literature for specific vehicle series. • Assumptions made on the % empty space of each vehicle type is based on volume calculations from vehicle specification sheets. • Specific vehicles selected for dimensions and material mix are TGV (Train eg), Plane (Airbus 320), Car

	(Peugeot 308). These were selected for comparibility with the initial TGV manufacturing case as these are products with manufacturing lines in France. • Countries selected for country drop-down on the basis of largest passenger car production in Europe to proxy for materiality and relevance of manufacturing footprint in the area. • Assumption that the use of the DELMIA Apriso solution makes it possible to reduce the scrap rate by 2%, from 7% to 5%. This rate was applied from the I Care – 3DS avoided emissions calculation tool as the rate of non-conformity of machined products that require rework. Due to the lack of first-hand data available from the manufacturer, including for confidentiality reasons, this rate is an indicative value estimated by the consultants who supported 3DS in the construction of the avoided emissions calculation tool. The 3DS DELMIA Operations Engineering (Digital Manufacturing) results in less mistakes when producing train parts from raw material such as aluminium. This results in less material waste being realized, because the manufacturing process is optimised partially through the virtual twin. The assumption made is that the use of DELMIA makes it possible to reduce the scrap rate from 7% to 4% (optimistic scenario) vs 5% (conservative scenario). In order to increase the accuracy for future use of the EGDC calculator, we have included the option to manually override the reduced scrap rate and include recommendations in this report for solution users to robustly measure actual waste reduction. • Avoided emissions – energy: Energy consumed in the 3DS scenario is estimated by applying a multiplier that is the rate of non-conformity of machined products that require rework in the 3DS scenario over that same rate in the BAU scenario. This assumes that the change in energy use between the two scenarios is proportional to the change in the amount of work carried out on the machined products. For increased accuracy and best practice, actual energy usage should be measured as captured in the *Key areas of improvement* section of this report. Due to the indicative nature of the rate of rework, the proportional energy efficiency is the same accross vehicles.

	• Materials recylcing rates: in line with the *I Care – 3DS Avoided emissions calculation tool,* apply European average recycling rates.
Data sources	• ICare-3DS - Avoided emissions calculation tool x Delmia • *EU passenger car production -* [*ACEA - European Automobile Manufacturers' Association*] • *Aluminum, plastic, glass, steel emission factors :* [*Base Carbon ADME*] • *Natural gas, domestic fuel, heat network, other gas emissions factors:* [*Base carbone ADEME*] • *Electricity emission factors:* [*EEA 2020*]
Input adjustments and key considerations for usage of results	**Calculator tab required inputs** • Country selection – amends emissions factor for electricity in manufacturer energy mix • Vehicle selection – amends vehicle materials mix and % empty space • Manufacturer annual output, measured in vehicles produced annually • Manufacturer BAU annual energy consumption **Calculator tab optional adjustments** • Material mix per vehicle (% aluminum, plastic, glass, steel) • Business as usual scrap rate • Manufacturer energy mix • Materials recycling rates
'Do no harm' criteria	"The focus on the net carbon impact assessment is the effect on climate change of GHG emissions, however, a digital solution should also consider its other environmental impacts. This methodology aligns to the environmental objectives set out in the EU Taxonomy and provides a qualitative assessment that organisations should complete to determine that no significant harm is done to these objectives. Demonstration that a solution does no significant harm to these objectives is a requirement to be determined as a green digital solution." (EGDC methodology) The six environmental objectives as defined by the EU Taxonomy are as follows: 1. Climate change mitigation 2. Climate change adaptation

	3. Sustainable use and protection of water and marine resources 4. Transition to a circular economy 5. Pollution prevention and control 6. Protection and restoration of biodiversity and ecosystems The DELMIA 3DS Apriso solution contributes to objectives 1, 4 and 5 by reducing manufacturer emissions through energy and scrap waste savings and does not harm objectives 2 (does not hinder climate change adaptation), 3 (does not negatively impact the use of water or marine resources) or 6 (application in existing manufacturing environments, therefore no implied negative impact to biodiversity and ecosystems).
Key areas of improvement	Consideration for improvement of the carbon calculator output: **Data availability and quality** Case studies are selected on the basis of the assessment of data availability during interviews with the solution owner. This is prior to any data being shared with us and as such limits our visibility over actual data quality. Moreover, the assurance of data provided by the solution owners is not in scope of this study. For this reason, the following section outlines what should be measured by similar solution case owners when considering the impact of their solutions. **Data coverage:** Key to improving the quality of the calculator output is accessing the required data to inform the impact assessment. This will involve close collaboration with the end-user manufacturer to capture the following measures over the project lifetime: - **Estimating avoided scrap waste:** Measure annual tonnage of scrap waste prior and post solution implementation. Best practice should where possible segregate measures by waste streams so as to have an accurate view of the avoided waste per specific material, here: aluminum, steel, glass, plastic. - **Solution emissions – development:** Attribution of capital goods Scope 3 emissions should be based on the Scope 3 capital goods for the year the specific hardware used was purchased. For the present case study, emissions for all scopes were provided from the 2019 CDP report. Due to the low level of materiality of these emissions, the lack of further data and to provide an order of magnitude of emissions, the 2019 data was included. A full product carbon footprint should also consider emissions linked to the delivery of the hardware to Dassault. Due to the

	immateriality of these emissions in the current study, these have not been captured here, however this is a point to consider for completeness of approach. - **Solution emissions – use:** Estimate energy consumed by solution hardware. Determine the number of users and server capacity to estimate annual energy use. Associated emissions are estimated by applying the weighted average emissions factor of the manufacture's energy mix to the estimated energy use. - **Avoided emissions – energy:** Direct measurement of manufacturer energy use, segregated to the relevant production process under study. Data points should be continuously captured over the years of implementation to provide sufficient granulariy and any changes in the factory environment taken note of in order to robustly attribute any variations in energy use to the solution. **Calculator output - estimating net carbon saving impact:** The net carbon saving impact of the solution provided by the calculator is to be taken as indicative only. Due to the lack of first-hand data available from the manufacturer, including for confidentiality reasons, many of the underlying assumptions are estimates. The purpose of the calculator and accompanying methodology is therefore to provide an informed view of the variables which need to be considered and measured to estimate the net carbon saving impact of a similar manufacturing solution. **Conservative estimations:** The I Care – 3DS Avoided emissions calculation tool provides two approaches: one with conservative estimations in the absence of actual data and another with softer assumptions. The EGDC study has solely considered the conservative assumptions to limit overstating potential impact.