Joint Demonstrator on Interoperability

(November 2021)

How the exchange of CO2 data along the value chain and across countries can work on a standardized basis

Secure and managed data interoperability among inter and intra-company manufacturing platforms offers significant opportunity for improved, end-to-end industry productivity and precision. Motivated by the value of data interoperability across platforms and borders, Plattform Industrie 4.0 and its US partner CESMII – The Smart Manufacturing Institute together with Labs Network Industrie 4.0 developed a first joint demonstrator to show interoperability among different intercompany data collection systems. Inter-platform data interoperability is significantly complex when accounting, for example, managing selected data from multiple entities, the differences in platforms that need to be networked or data security in storage and transit. Carbon reporting is an important industry-wide, national and international application area in which data interoperability is a key enabler for achieving easy end-to-end data collection and processing. Applying the demonstrator to this use case contributes not only to international interoperability, but also to the commitment of both countries to reduce CO2 emissions in manufacturing.

Demonstrator proves interoperability of Asset Administration Shell (AAS) and Smart Manufacturing Profile (SMP)

Against growing expectations towards companies from clients, regulators, and further stakeholders to report on their carbon emissions, also on product level and in higher frequency, manufacturers face digital hurdles: Different data systems cannot communicate with each other and data is hardly ever automatically transmitted from one company to the other. Even inhouse, it can be a challenge to gather data on a standardized basis. In addition, achieving reporting on product level demands high complexity and detailed data collection and allocation.

This is exactly where the demonstrator comes in and shows: It is possible for data to be networked via interoperable digital solutions. By using an established open standard (OPC UA) and a connection to the cloud (UA Cloud Library, developed by the OPC Foundation and CESMII) the use case proves that data collection systems for assets in production – the Asset Administration Shell (Plattform Industrie 4.0) and the Smart Manufacturing Profiles (CESMII) – are interoperable. This means that emission data generated during production can be collected digitally and made available via open standardized interfaces – across platforms, company sites and countries.

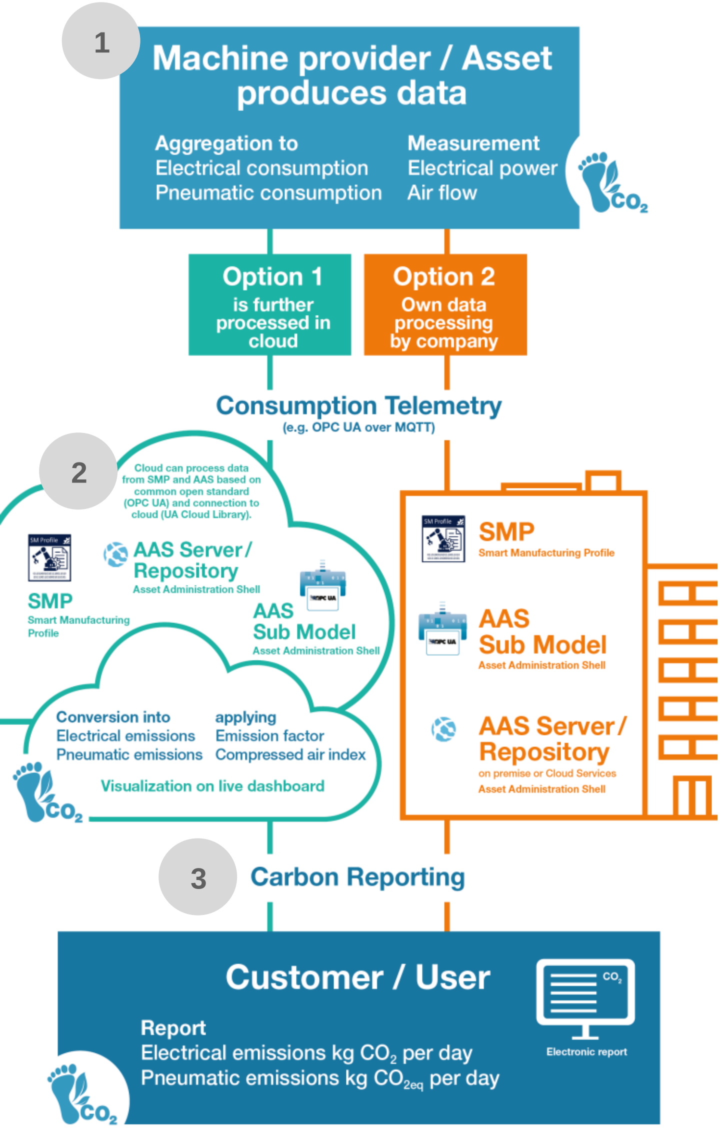
Joint Factsheet

in cooperation with

In the demonstrator, carbon emissions generated during production – so-called Scope 1 and 2 emissions – are measured and calculated. When the product is passed on to a customer, these documented carbon emissions are sent along the value chain. This is an important step to include Scope 3 emissions in the overall calculation, i.e., the emissions from the entire supply chain (upstream and downstream), which are responsible for about 80 % of emissions in manufacturing (source: „Die Zukunft der globalen Wertschöpfung“, S. 14, CDP Europe/Systain Consulting gmbh, 2014). Therefore, a baseline for calculating product-specific carbon footprints is established.

A closer look

The demonstrator focuses on data generated during production (which forms part of an entire life cycle). It shows Option 1 „Cloud processing“: A manufacturer uses a paid service (from e.g. a cloud provider) to centrally collect the data and calculate the CO2 emissions. The service then provides the generated digital twins of the machine directly to the customer of the machine for further use, e.g. for compiling a carbon reporting on product level. In Option 2, manufacturers generate and calculate the data themselves. They directly share the data through the AAS / SMP applications with their customers.



(1) Machine / Asset: To keep the demonstration simple, only the electrical power and compressed air consumption of a demo machine are measured: A small conveyor belt transports a plastic box from left to right. A robot can also turn the box around or change its position using compressed air. A controller and an OPC UA server are running in the machine. A gateway sends OPC UA data from the machine to an edge of cloud-hosted MQTT broker; at the same time, the gateway protects the machine via a firewall.

(2) Telemetry / Cloud: The data of the machine is processed and forwarded automatically to the cloud. Since both the Asset Administration Shell and the Smart Manufacturing Profile leverage OPC UA, the solution is interoperable.

(3) Carbon Reporting: An AAS for the machine is created on-the-fly on a server which includes the carbon report. The report can be downloaded and viewed through an AAS viewer (e.g. AASX Package Explorer) from anywhere in the world. The data is updated in regular intervals, too.

You want to learn more about product carbon footprint calculations?

The calculations of the demonstrator are based on the GHG Protocol (Greenhouse Gas Protocol), which is a widely used standard for carbon reporting. Only selected formulas have been applied to this demonstrator: the “German electricity mix” and “German compressed air”. They were selected in cooperation with ZVEI. The ZVEI is working on the topic of calculating and reporting the product carbon footprint in the Show-Case „PCF@Control Cabinet“. For more information or if you want to participate, please contact Stefan Schork: stefan.schork@zvei.org

Conclusion & Outlook

The demonstrator is a pilot project: The cooperation partners put theory into practice for the first time and create a basis for further discussion. Feedback and results will feed into future projects of the cooperation’s working groups and continued international standardization, promoting interoperability and sustainability.

Call for feedback: We would be very happy if you answer three short questions about the demonstrator. Thank you very much for your cooperation! Link to Feedback form

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Appendix I: Input for specific emission factor of the German electricity mix

(1) Consideration of the individual greenhouse gases that contribute to climate change

Spezifische Emissionsfaktoren für den Deutschen Strommix

Schadstoff	Einheit	1990	2000	2019
Schwefeldioxid	g/kWh	4,796	0,569	0,196
Stickstoffdioxid	g/kWh	1,055	0,490	0,373
Staub	g/kWh	0,745	0,026	0,009
PM_{10}	g/kWh	nicht berichtet	0,023	0,009
Kohlenmonoxid	g/kWh	0,389	0,205	0,176
Kohlendioxid*	kg/kWh	0,764	0,644	0,408
Lachgas	g/kWh	0,020	0,015	0,011
Methan	g/kWh	0,016	0,030	0,183
NMVOC	g/kWh	0,013	0,014	0,014
Quecksilber	mg/kWh	0,028	0,015	0,007

(2) Multiplication of these greenhouse gases with the characterization factors from the publication of the Intergovernmental Panel on Climate Change (Assessment Report AR5 from 2014 - see GHG Protocol https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20(Feb%2016%202016)_1.pdf)
and adding all of them = 514,9 g CO2-e (g CO2 equivalents)

	Characterization factor in kg CO2-e/kg	g/kWh (Emission factors for German electricity mix 2019)	Emission contribution in g CO2-e/kWh
CO2	1	408	408,0
CH4	28	0,183	5,1
NOx	265	0,384	101,8
NMVOC	4,23	0,014	0,06
Total			514,9

(3) The carbon footprint of 1 kWh of electrical power consumed from the German power grid is therefore 0,515 kg CO2-e / kWh (2019, UBA).

Formula: CF [kg CO2-e] = Energy Consumption of the Machine [kWh] * 0,515 [kg CO2-e/kWh]

Source: *German Federal Environment Agency = Umweltbundesamt (UBA): https://www.umweltbundesamt.de/themen/luft/emissionen-von-luftschadstoffen/spezifische-emissionsfaktoren-fuer-den-deutschen*

Appendix II: Input for specific emission factor of the German Compressed Air

(1) LCA database (Ökobilanz-Database): for 1 m³ of "Compressed Air Production @ 700 kPa Gauge" (= 7 bar)" a specific power requirement of 0.7663 MJ (MegaJoule) of was determined (Source: https://ecoinvent.org/ https://ecoinvent.org/the-ecoinvent-database/data-releases/ecoinvent-3-6/)

-> Converted = approx. 0,213 kWh /m³ Compressed Air (@ 7Bar)

(2) Energy Consumption for the usage of compressed air (@ 7Bar)

-> E [kWh] = 0,213 kWh/ 1.000 Liter * X (l/min) * Period length Y (min).

Formula: CF [kg CO2-e] = Energy Consumption for compressed Air [kWh] * 0,515 [kg CO2-e/kWh] (carbon footprint of 1 kWh of electrical power consumed from the German power grid)