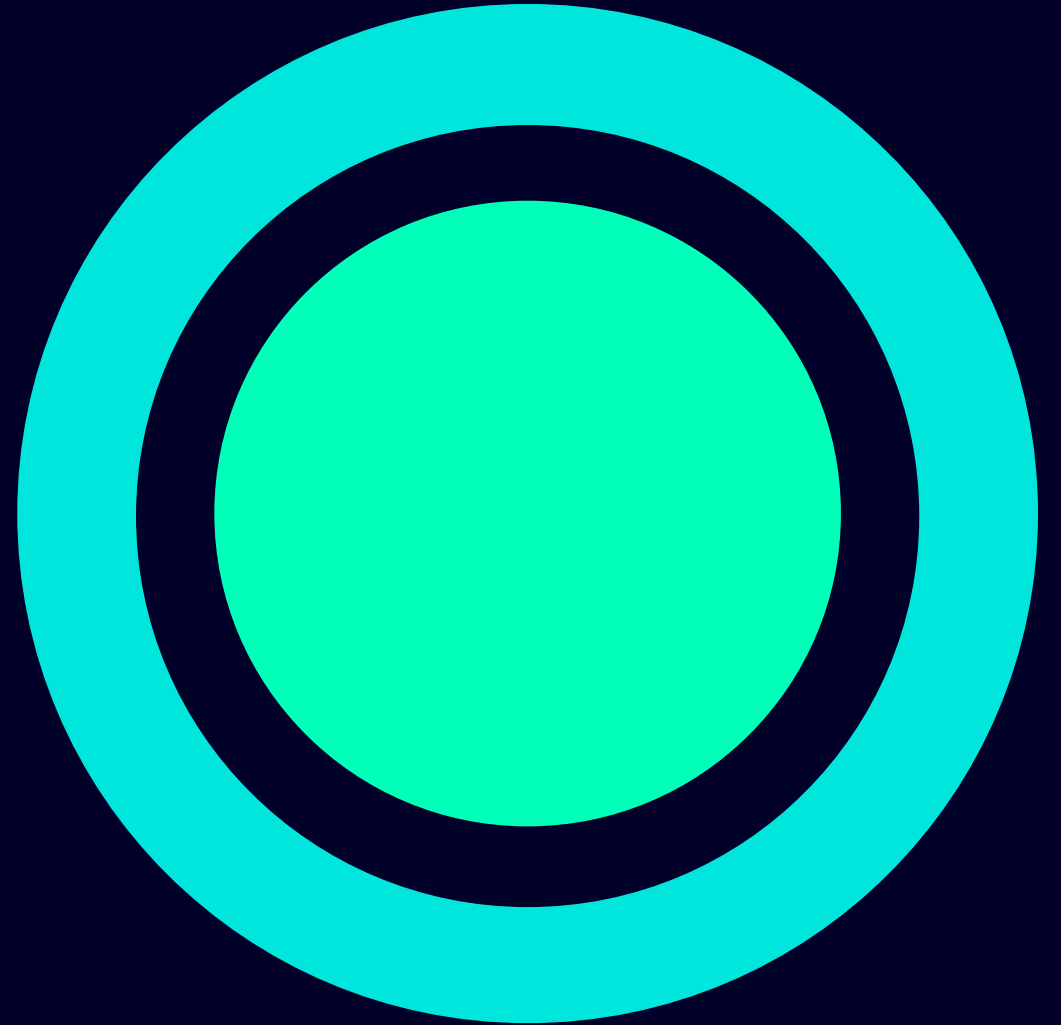


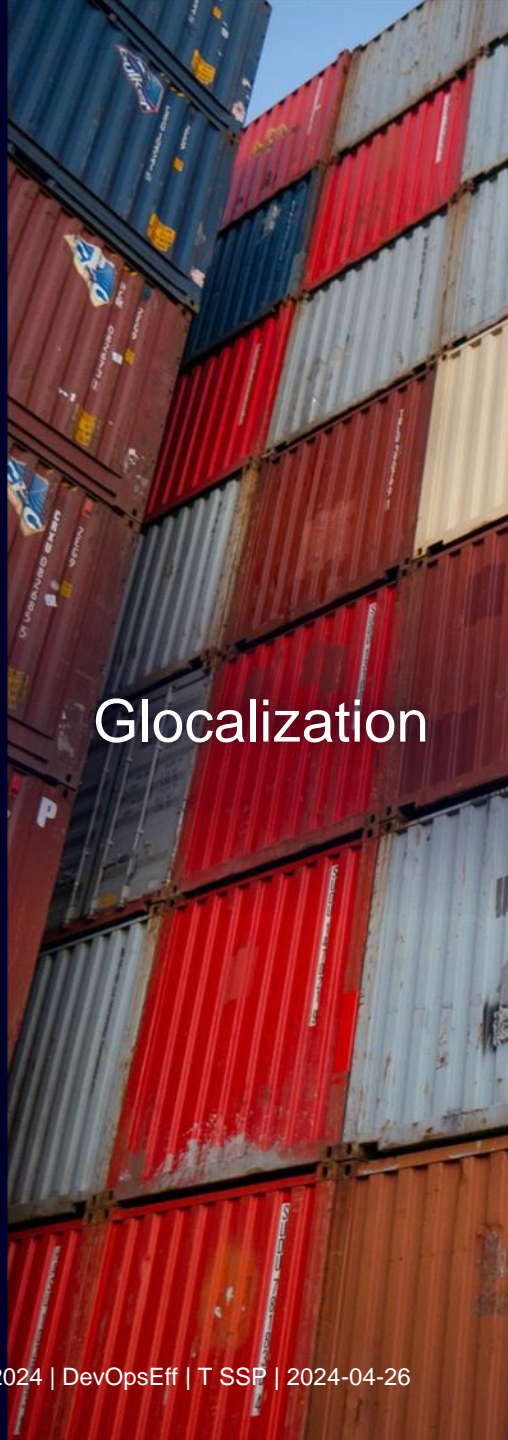
Sustainable Software Engineering

Green principles for Software
Engineering





Climate
Change



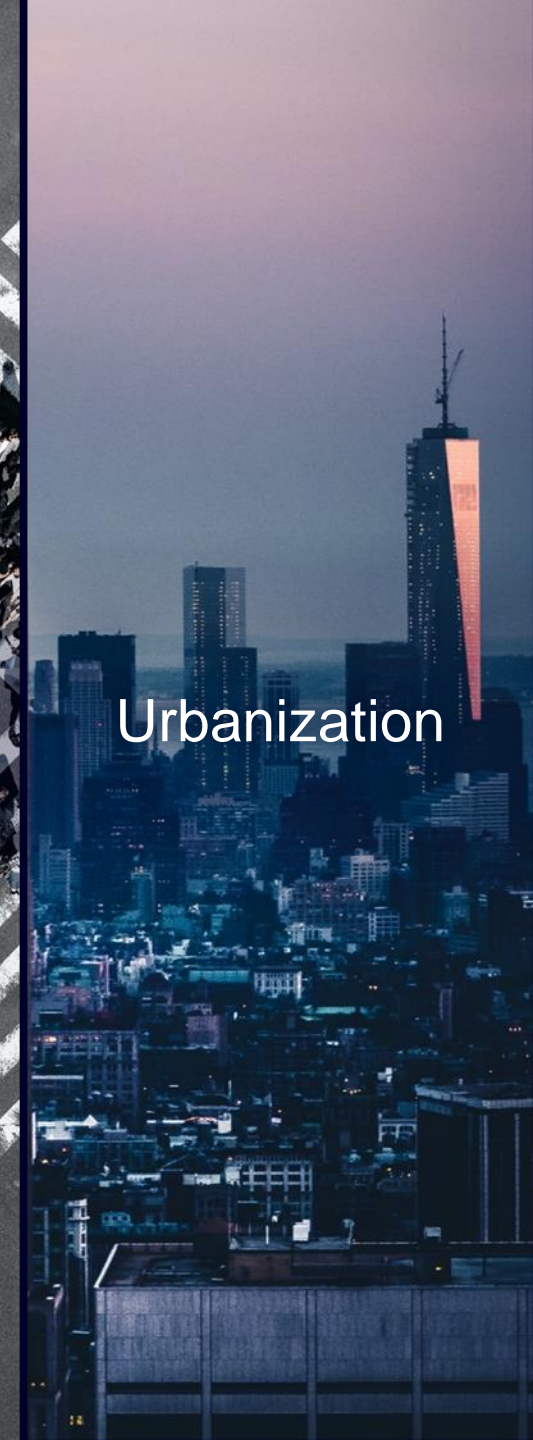
Glocalization



Digitalization



Demographic
Change



Urbanization

United Nations - Transforming our World: The 2030 Agenda for Sustainable Development



<https://sdgs.un.org/goals>

We see a growing demand towards sustainable business for various stakeholders

Legal requirements



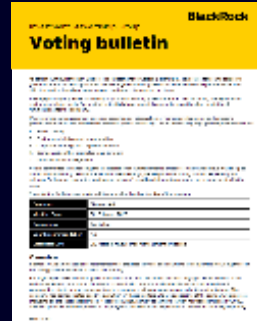
Many new international **sustainability legislations are currently under development** EU Taxonomy, Value Reporting Foundation, CSRD, Green Deals

Customer requirements



More and more of our customers require **suppliers to comply with Ecovadis and NQC qualifications** or individual surveys

Investor requirements



Investors are **focusing increasingly also on ESG criteria**, incl. building own reports

Employee requirements



Being a **sustainability leader** is relevant to **attract young talents** and **retain current employees**

Public opinion



Sustainability is a key topic in many societies and the **public expects companies to do their part**

CSRD: Corporate Sustainability Reporting Directive, NQC: provider of surveys on sustainability in supply chains for automotive industry

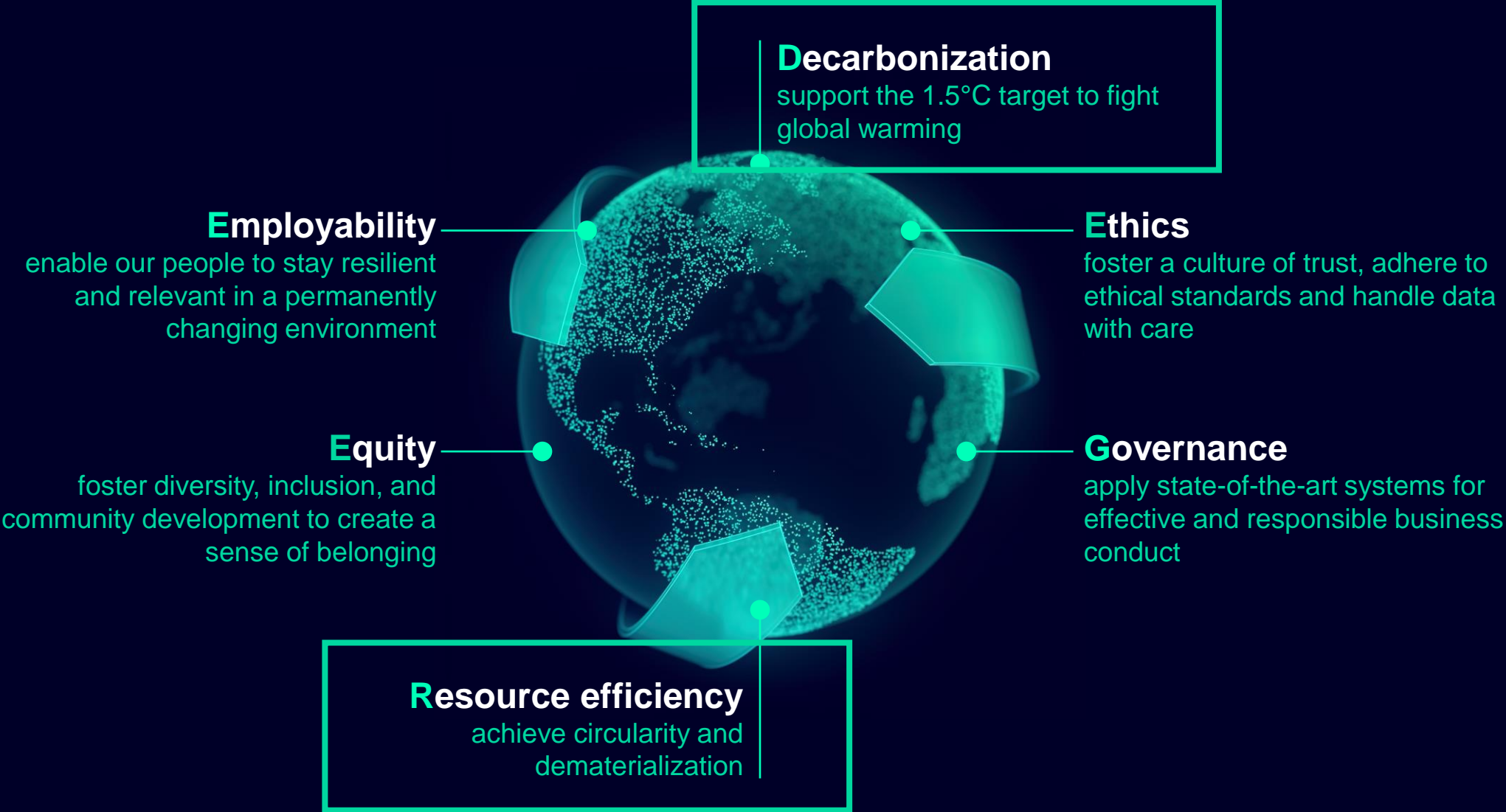


“Sustainability is in our very DNA. It’s not optional. It’s a business imperative

Based on our successful track record, we’re now setting ourselves even more ambitious targets. We’ll accelerate our efforts and raise the bar to create considerably more value for all our stakeholders. Sustainable business growth goes hand in hand with the value we create for people and our planet.”

*Judith Wiese, Chief People and Sustainability Officer (CPSO),
and Member of the Managing Board of Siemens AG*

We need to take a comprehensive – 360-degree – view of sustainability from every angle. Our **DEGREE** framework sets clear priorities for Sustainability at Siemens



CCT Software Systems and Processes (SSP)

Mastering the Digital Transformation at Scale

Architecture and Paradigms
for Future Systems

SaaS Architecture
Management and Evolution

Sustainable Software Engineering
and industrial-grade DevOps

Engineering and
Validation of
Intelligent Systems

Ecosystems and Marketplace
Technologies

Siemens Xcelerator
Technical Pioneering

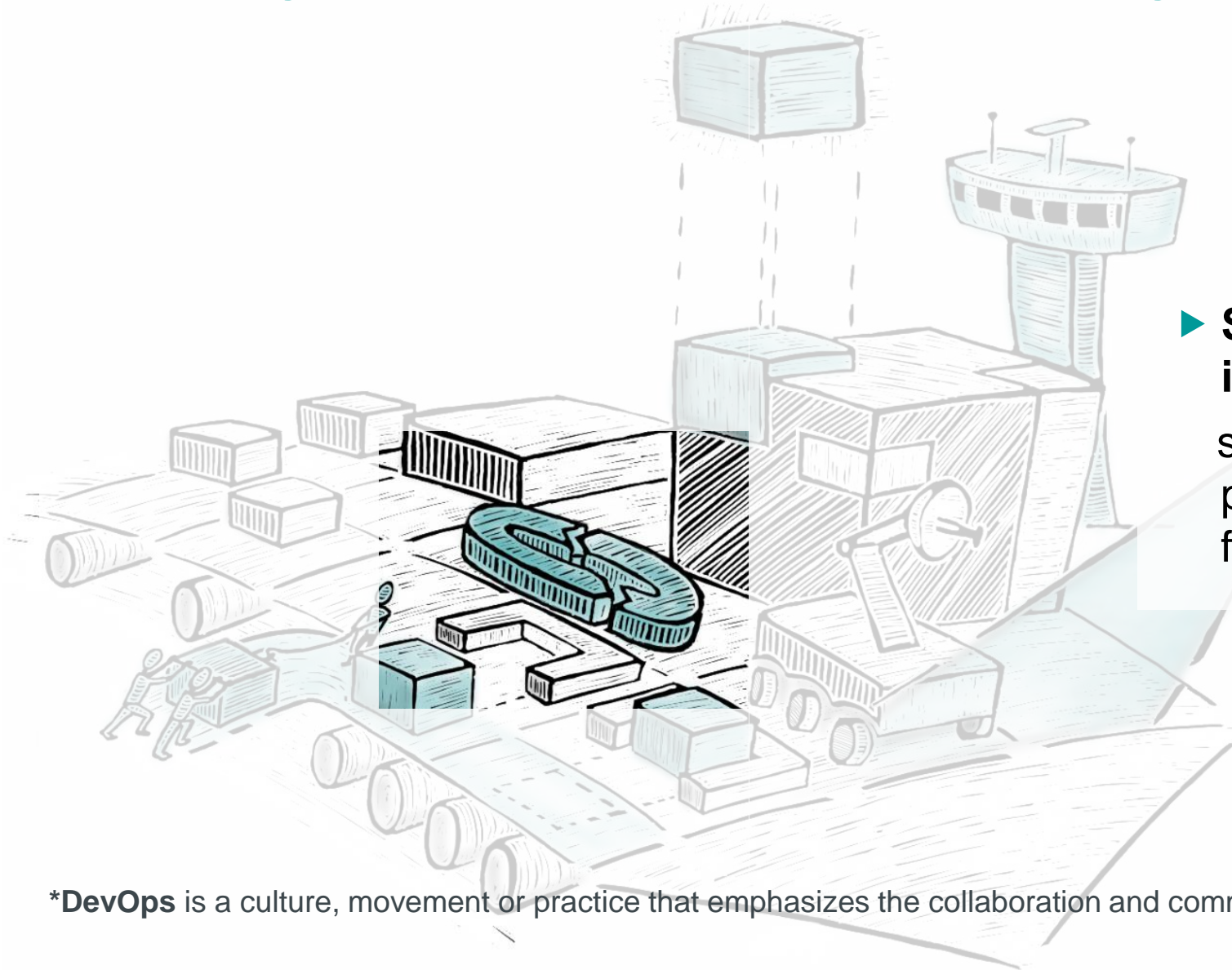
SCOPE

Research, pre-development and transfer of **innovative software technology and methodology** to **enable, speed up and scale digitalization** at Siemens.

OUT OF SCOPE

- Standard business consulting, not targeted at digital innovation

The CCT SSP module Sustainable SW Engineering and industrial-grade DevOps focuses on the “How” of Digitalization

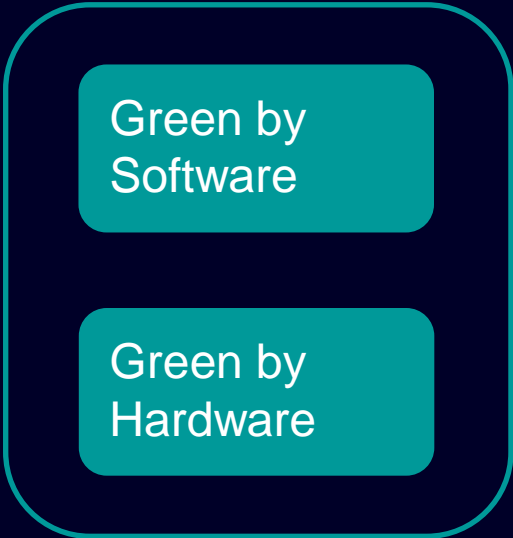


► Sustainable SW Engineering & industrial-grade DevOps*

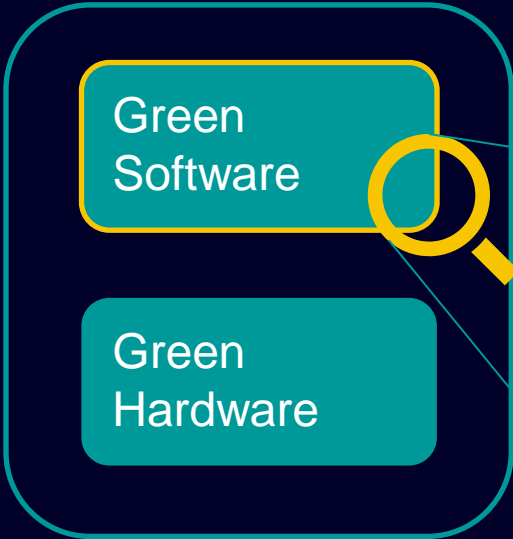
scales development agility, speeds-up product delivery, and establishes a feedback cycle for product innovation

***DevOps** is a culture, movement or practice that emphasizes the collaboration and communication of both software developers and IT.

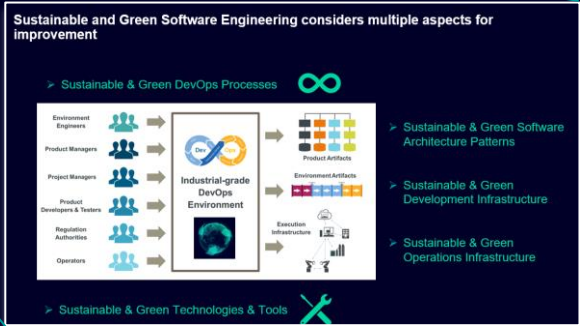
Green digital offerings cover both effects of our Siemens solutions as well as our own Siemens solutions



+



How can we convince our customers that we also care about the way our software is designed and developed?



Greening by IT:
 Reduced carbon emissions at a customer's target system (building, factory, ...) realized by our digital offerings

Greening of IT:
 the way we develop our digital offerings and its effect on the operation phase (e.g. the energy consumption of the digital offering itself)

CO2 Footprint numbers for Software are continuously growing and are a significant contributor to CO2 and need to be considered

Global trends in digital and energy indicators, 2015-2021

	2015	2021	Change
Internet users	3 billion	4.9 billion	+60%
Internet traffic	0.6 ZB	3.4 ZB	+440%
Data centre workloads	180 million	650 million	+260%
Data centre energy use (excluding crypto)	200 TWh	220-320 TWh	+10-60%
Crypto mining energy use	4 TWh	100-140 TWh	+2 300-3 300%
Data transmission network energy use	220 TWh	260-340 TWh	+20-60%

Consumption	CO ₂ e (lbs)
Air travel, 1 passenger, NY↔SF	1984
Human life, avg, 1 year	11,023
American life, avg, 1 year	36,156
Car, avg incl. fuel, 1 lifetime	126,000
Training one model (GPU)	
NLP pipeline (parsing, SRL)	39
w/ tuning & experimentation	78,468
Transformer (big)	192
w/ neural architecture search	626,155

Table 1: Estimated CO₂ emissions from training common NLP models, compared to familiar consumption.¹

1) <https://www.iea.org/reports/data-centres-and-data-transmission-networks>
 2) Strubell, Emma, Ananya Ganesh, and Andrew McCallum. "Energy and policy considerations for deep learning in NLP." *arXiv preprint arXiv:1906.02243* (2019)

Urgency increases due to first standard released and missing approaches for calculating decarbonization effects for software and automation

ISO Certification process approved

Green Software Foundation

-> development of an industry standard for calculating the Software Carbon Intensity

[The Software Carbon Intensity \(SCI\) Specification v.1.0](#)

Measuring software emissions is the biggest pain point for members of the Foundation. Last year, we announced the Alpha version of the SCI specification at COP26, a method for measuring software emissions built by software practitioners. Since then, COP26 members of the SCI team have further honed the specification to incorporate feedback. [During COP27](#), we shared the 1.0 release of the SCI specification, which is fast becoming the industry standard for measuring software emissions.

[The latest advances in Green Software | GSF](#)

[ISO/IEC DIS 21031 - Information technology — Software Carbon Intensity \(SCI\) specification](#)

US Senate introduces bill to

-> Request to measure environmental impact of AI

What obligations are provided under the bill?

The bill provides that within two years after its enactment, the Environmental Protection Agency (EPA) must, in collaboration with the National Institute of Standards and Technology (NIST), and the Office of Science and Technology Policy (OSTP), conduct a study on the environmental impact of artificial intelligence (AI).

The bill also requires NIST to convene a consortium of stakeholders to identify future measurements, methodologies, standards, and other appropriate needs, to measure and report the environmental impact of AI.

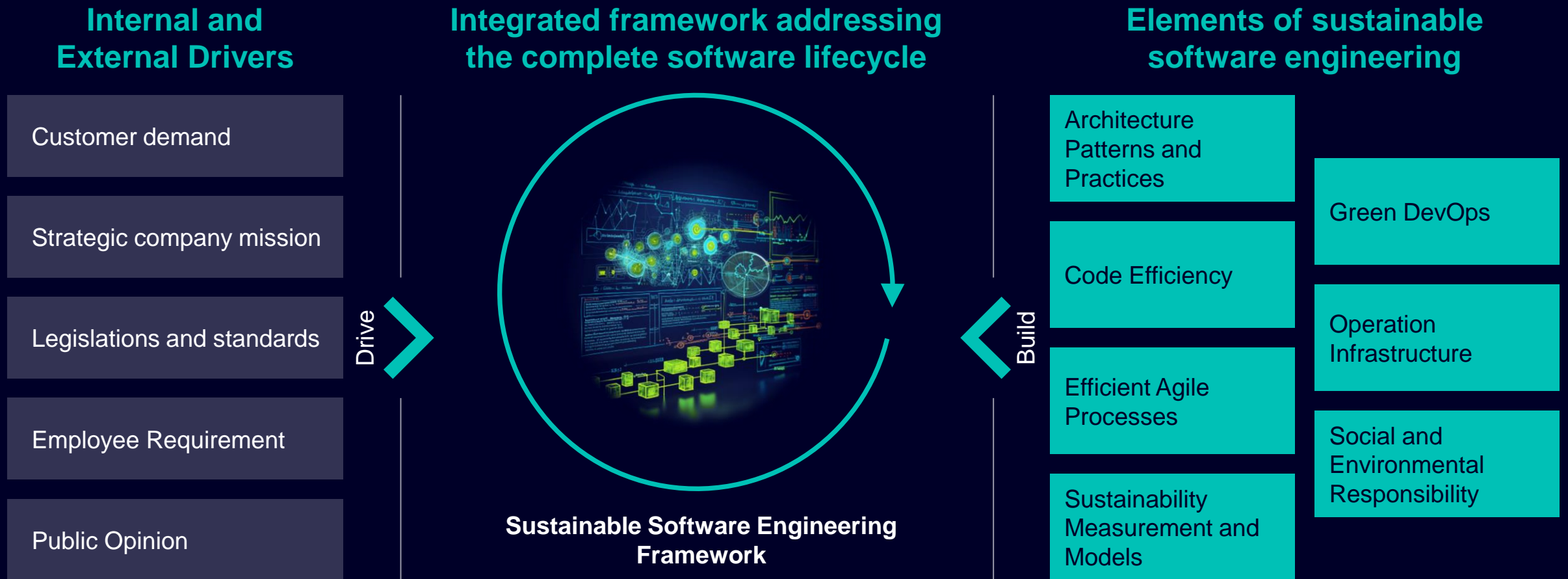
In addition, the bill provides for the establishment of a voluntary reporting system on the environmental impacts of AI by NIST, alongside guidelines for voluntary reporting entities on how to report under such system.

Finally, the bill outlines the plan for the submission of a report, four years after the enactment of the bill, by the EPA and NIST among others, with legislative recommendations to mitigate the negative or promote the positive impacts of AI.

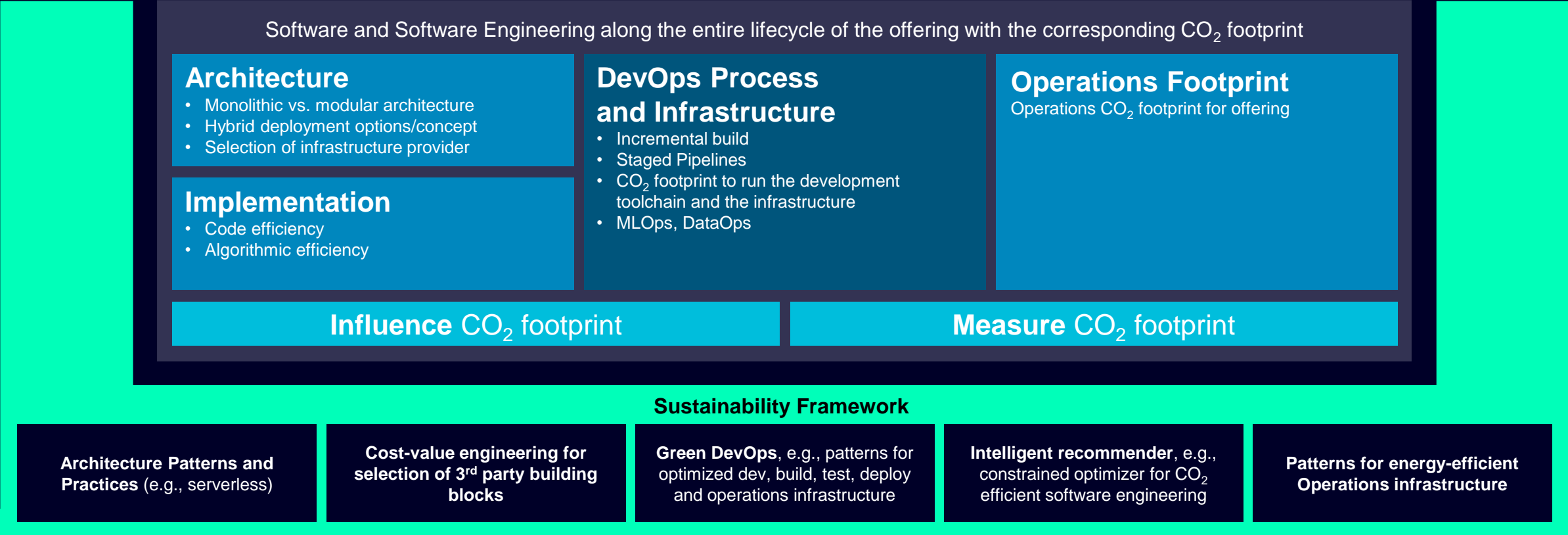
[USA: Bill on the environmental impacts of AI introduced to Senate | News post | DataGuidance](#)

Sustainable Software Engineering

Driven by T SSP in close collaboration with Siemens BUs and T TFs



Our Vision: Develop a Framework establishing Sustainability as core built-in quality of Software Engineering as well as of our Digitalization Offerings



Optimized Carbon Efficiency of Offering

How: Sustainable Operation starts with creating transparency for power consumption as prerequisite for identifying potential improvements

Provide Guidance

Recommender to improve sustainability for your project

- Use specific patterns for this type of software
- Provide deployment and configuration guidance
- Use similar projects as reference

Potential Levers

Project related influence levers in architecture, dev and ops.

- Type of software
- Architecture Patterns
- Code Efficiency
- Operational Infrastructure
- Green DevOps
- Agility

Evaluate Sustainability impact

Create Certainty

Sustainability Transparency

- Fine grain insights of power consumption per software component
- Enables comparison of different patterns via deltas of different versions
- Comparable numbers
- Dashboard



- Rolled-out and updated via SCORE and XO - no additional project effort required.
- Enables Siemens to establish a software sustainability baseline – How much CO2 of this type of software is good or bad?

That's your numbers!

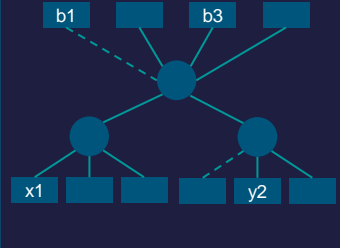
Project Data

Project/Product specific data collected during Dev and Ops.

- CPU, Memory, IO
- Physical Location
- Client Usage
- Build-Time
- Change-Time
- Training-Time (MLOps)



Models 1.0



General Data

General data to transform usage into CO2 Footprint.

- CPU to Watt
- Source of electric energy
- Energy cost of network traffic
- Average energy consumption of developer laptop
- Data center footprint




Green Software Foundation

Siemens as steering committee member

A non-profit organization as part of the Linux Foundation with various international members (Thoughtworks, Accenture, Github, Microsoft, etc.) founded in 2021

We Represent the Global Software Industry


-  Our members operate in over **190 countries**
-  with a global workforce of over **1.5 million people**
-  Five of our members are **FORTUNE Global 500** companies

Our steering members

accenture | avanade | BCG X | GitHub | Globant | intel | Microsoft | NTT DATA | SIEMENS | thoughtworks | UBS


Our general members

AVEVA | University of BRISTOL | Container Solutions | Goldman Sachs | INTESA SNNIOLO | KERING | LEADERS FOR CLIMATE ACTION | TEXAS STATE UNIVERSITY | THE EXPLORERS | THE GREEN WEB FOUNDATION | Time for the Planet | Shell | Supercritical | SYNGENIO AG | virtasant | vmware | WallTime

 greensoftware.foundation

GREEN SOFTWARE:

"Green software is software that is responsible for emitting fewer greenhouse gases. Our focus is reduction, not neutralization"


Mission

Build a trusted ecosystem of people, standards, tooling and best practices for creating and building green software.


Vision

Change the culture of building software across the tech industry, so sustainability becomes a core priority to software teams, just as important as performance, security, cost and accessibility.

<https://greensoftware.foundation/>

Green Software Foundation

A non-profit organization as part of the Linux Foundation with various international members (Thoughtworks, Accenture, Github or Microsoft)

Some highlights of the foundation's work

- Standardization efforts **Software Carbon Intensity (SCI) Specification¹⁾**
Calculating a rate of software emissions as alternative to the Greenhouse Gas (GHG) protocol's measurement of total emissions
- Green software patterns **Open-source database for software patterns²⁾**
for AI, cloud applications and web applications
- Learning material for software practitioners related to green software³⁾

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Our general members

AVEVA, 3, Government of Ontario, Cognate Solutions, Goldman Sachs, INTEL, SANGHVI, KBRING, LEADSCAPE FILTER, TEXAS STATE UNIVERSITY, THE EXPLORES, THE GREEN WEB FOUNDATION, virtasant, vmware, WellTime

Green Software Foundation | greensoftware.foundation

Green Software Principles

- Energy Efficiency**
Consume the least amount of electricity possible
- Hardware Efficiency**
Use the least amount of embodied carbon possible
- Carbon Awareness**
Do more when the electricity is clean and less when it's dirty

Green Software Foundation | greensoftware.org

creative commons

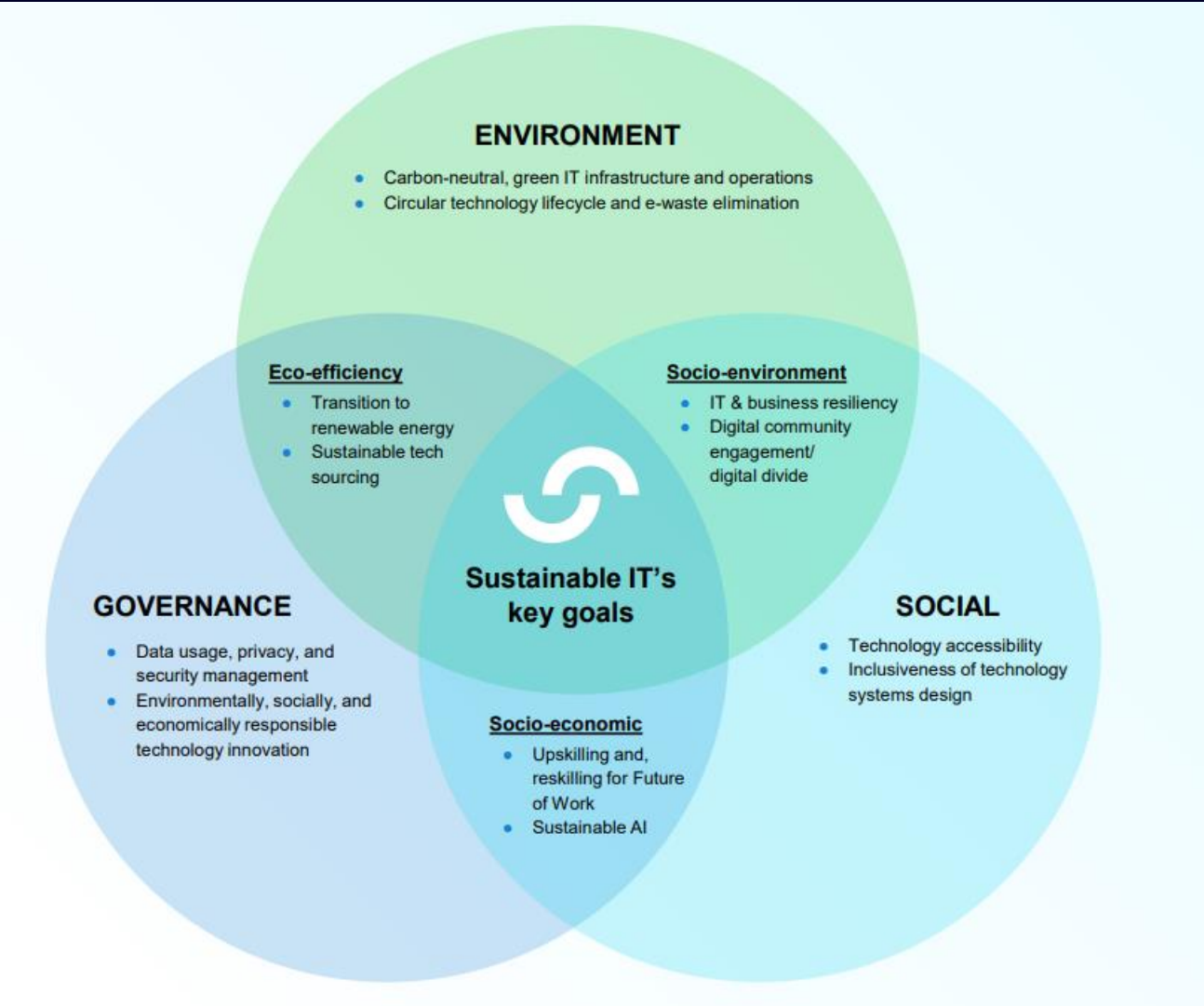
1) https://github.com/Green-Software-Foundation/software_carbon_intensity 2) <https://patterns.greensoftware.foundation/>
3) <https://learn.greensoftware.foundation/> 4) <https://learn.greensoftware.foundation/practitioner/introduction/>

Advancing Sustainability for our Organization and the World with SustainableIT.org



Advancing Global Sustainability through Technology Leadership

Our mission is to unite the world's largest community of technology and sustainability leaders to define sustainability transformation programs, author best practices and frameworks, set standards and certifications for governance, provide education and training, and raise awareness for IT-centric ESG programs that make their organizations and the world sustainable for generations to come.



ECO DIGIT – BMWK-funded project

Facts and Key Figures

- **Goal:**
 - Develop, validate, and provide an automated evaluation environment (test bed) that transparently discloses key figures and data on resource consumption, CO2e emissions, etc., for software applications available for testing at any time.
 - The project considers various contemporary software applications in operation in the following deployment scenarios: cloud platforms, mobile networks, end devices, and edge computing.

- Funded project: BMWK – GreenTech call ‘22
- Project phase: 06/2023 – 05/2026

- Consortium Partners:
 - adesso SE
 - Öko-Institut e.V.
 - Gesellschaft für Informatik e.V.
 - Open Source Business Alliance (OSBA)
 - Siemens AG

Gefördert durch:



Bundesministerium
für Wirtschaft
und Klimaschutz

aufgrund eines Beschlusses
des Deutschen Bundestages

ECO DIGIT

Enabling green COmputing and DIGItal Transformation



GESELLSCHAFT
FÜR INFORMATIK





Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology



OSB Open Source
Business



ScaleUp
Technologies



ALLIANCE
Bundesverband für digitale Souveränität e.V.

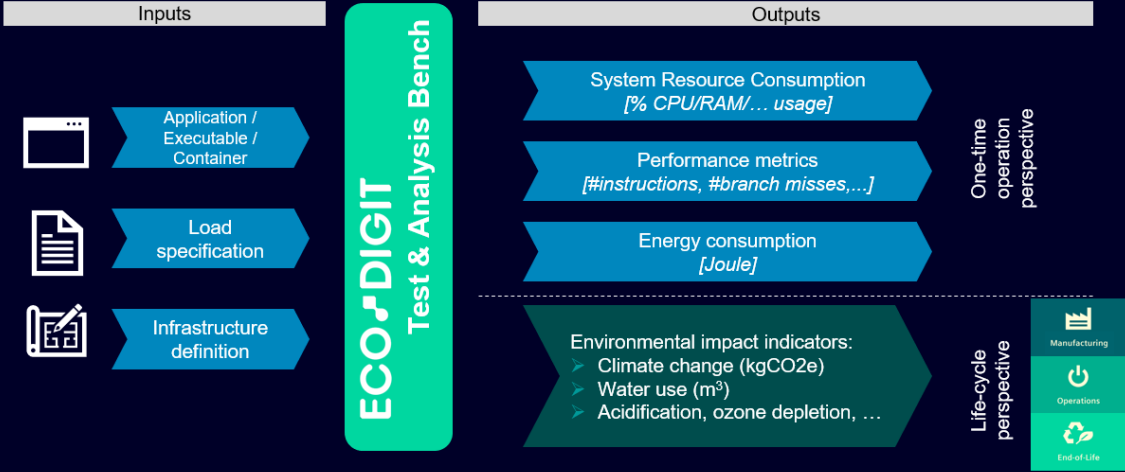
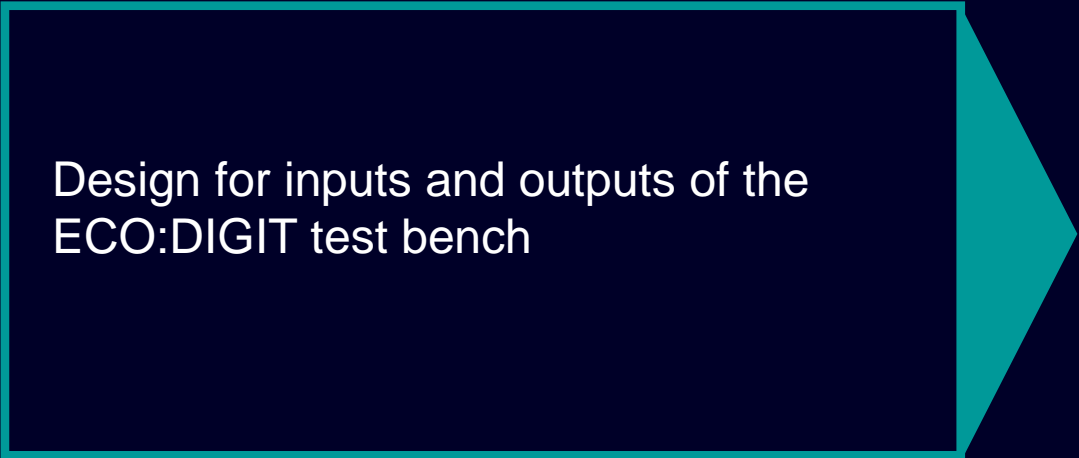
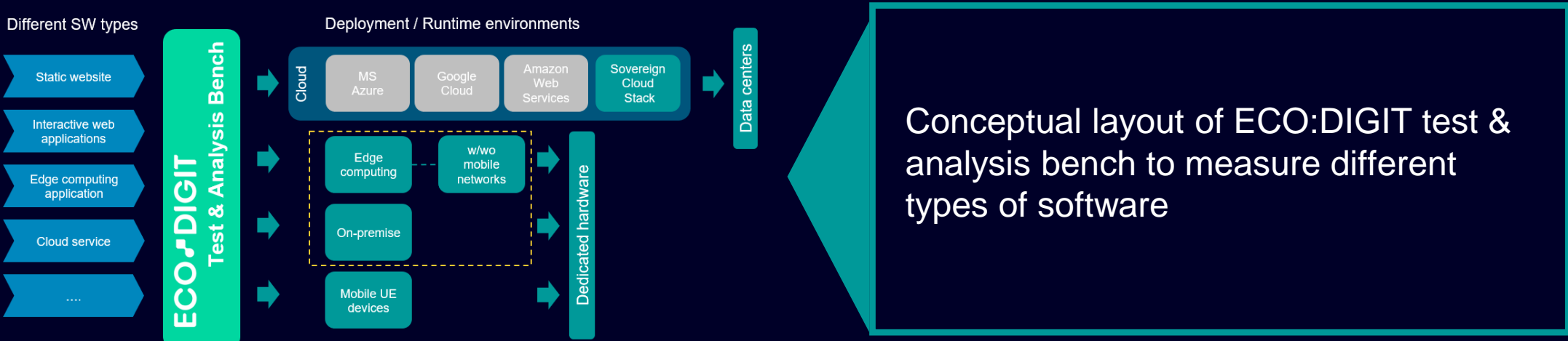


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SIEMENS

Lifecycle Assessment Method drives testbed setup and design



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