

Thin[**gk**]athon

Sustainability in software development



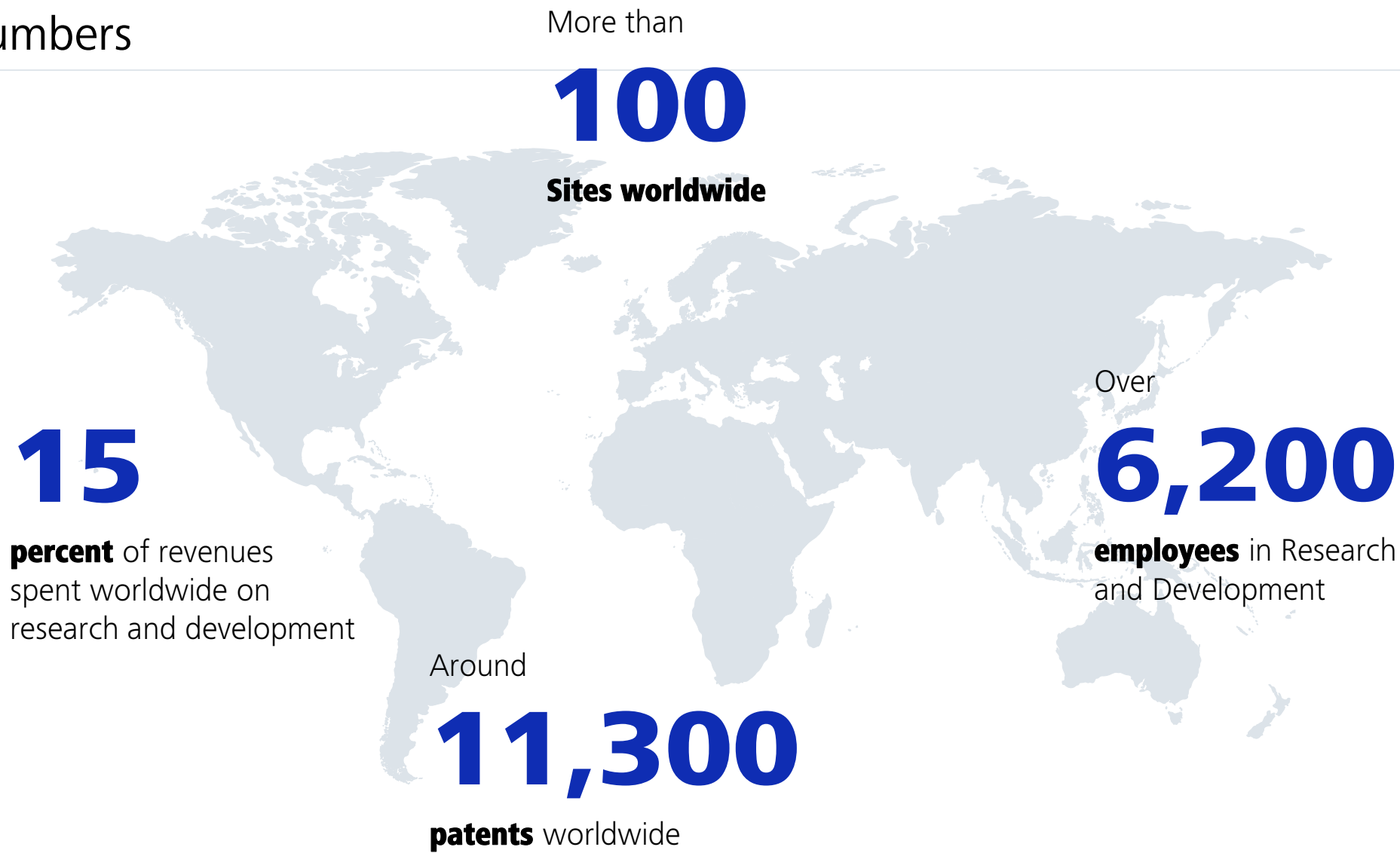
Roswitha Gostner
Hendrik Lösch

31. Mai 2024



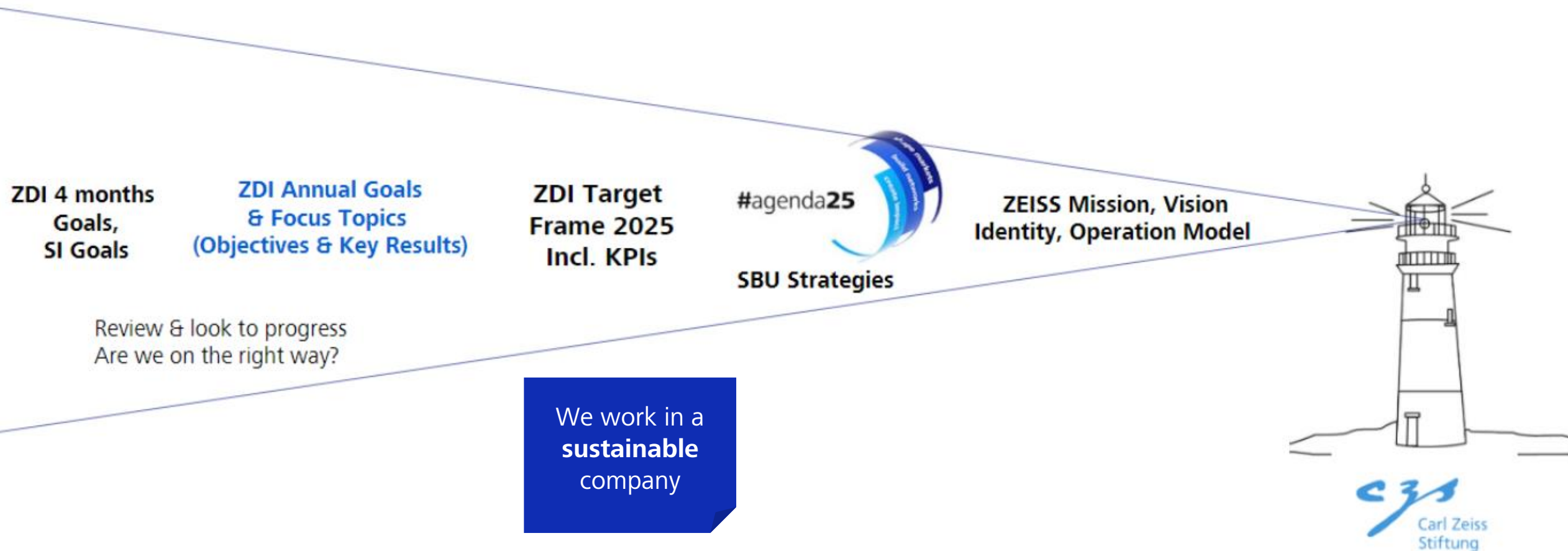
Introduction

ZEISS in Numbers



Introduction

ZEISS Digital Innovation



Introduction

Sustainability at ZEISS



72%

Reduction in carbon emission
compared to the 2018/19 Fiscal year

343

product managers receiving
training on green product design

26%

Reduction in energy use
relative to value added compared
to the 2018/19 Fiscal year



34%

Reduction in water consumption
relative to value added compared
to the 2018/19 Fiscal year

35%

waste reduction
relative to value added compared
to the 2018/19 Fiscal year



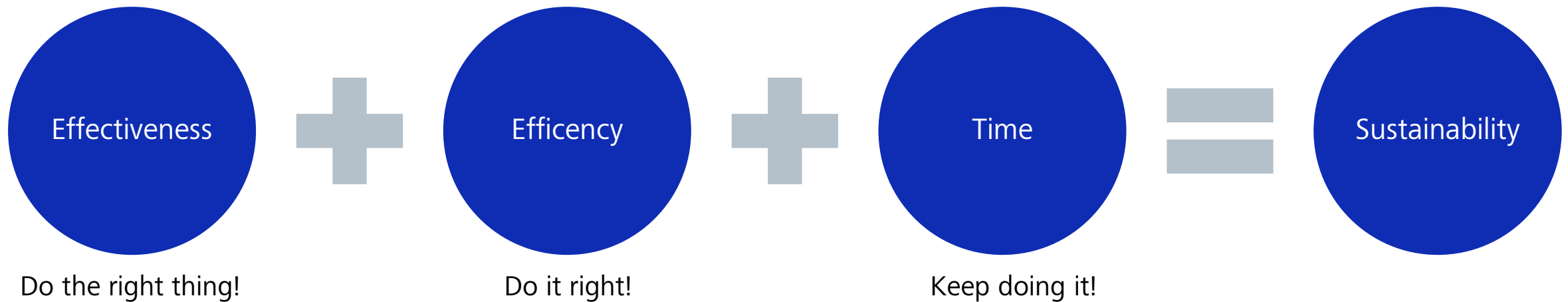
**The best way to
predict the
future is to
invent it**

Alan Kay

The Challenge

Introduction to the topic

Sustainability?



Introduction to the topic

ESG Approach for Sustainability Reporting



An approach to investing that recommends taking environmental issues, social issues and governance issues into account when deciding which companies to invest in.

Environmental

Examines the impact of the company on nature and the environment.

- **Energy Efficiency**
- Water Management
- **Greenhouse Gas Emissions**
- Biodiversity Loss
- Deforestation / Reforestation
- ...

Social

Examines how a company interacts with employees, suppliers, customers and society.

- Employee safety and health
- Working Conditions
- Diversity
- Equity and Inclusion
- Conflicts and Humanitarian Crisis
- ...

Governance

Includes a company's internal control systems, practices and procedures.

- Corporate Governance
- Preventing Bribery and Corruption
- Diversity of Board of Directors
- Executive Compensation
- Cybersecurity
- ...

The Role of Software Development

Different perspective



Sustainability by Software

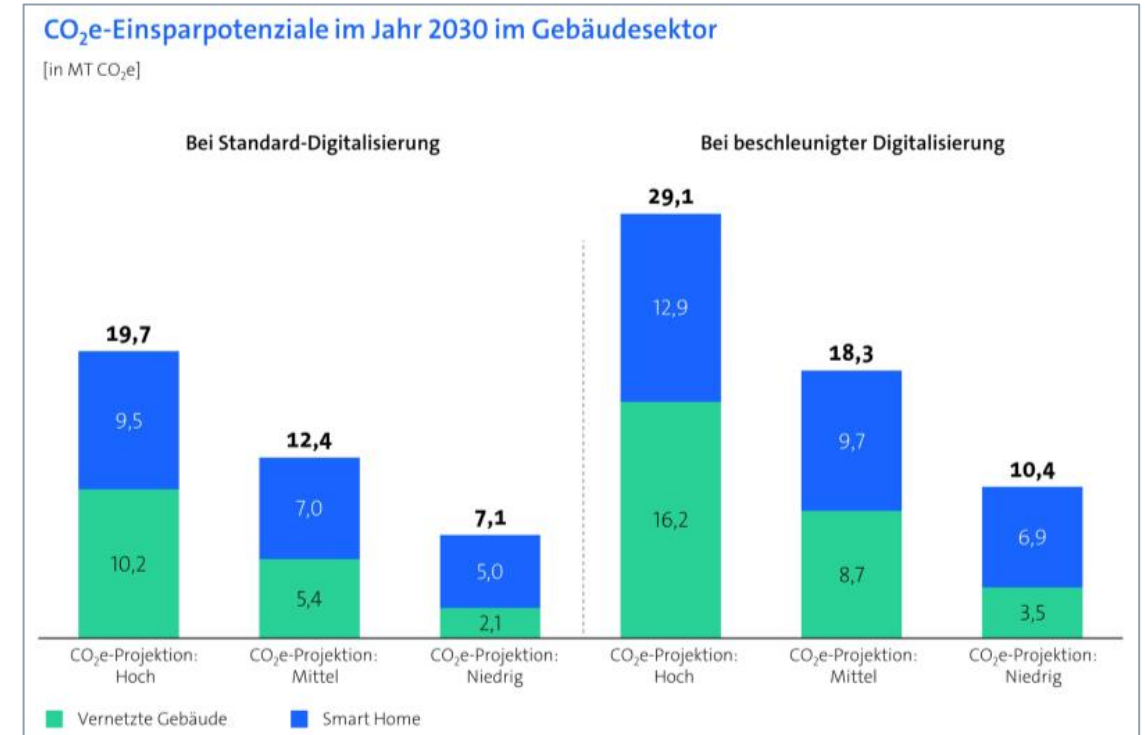
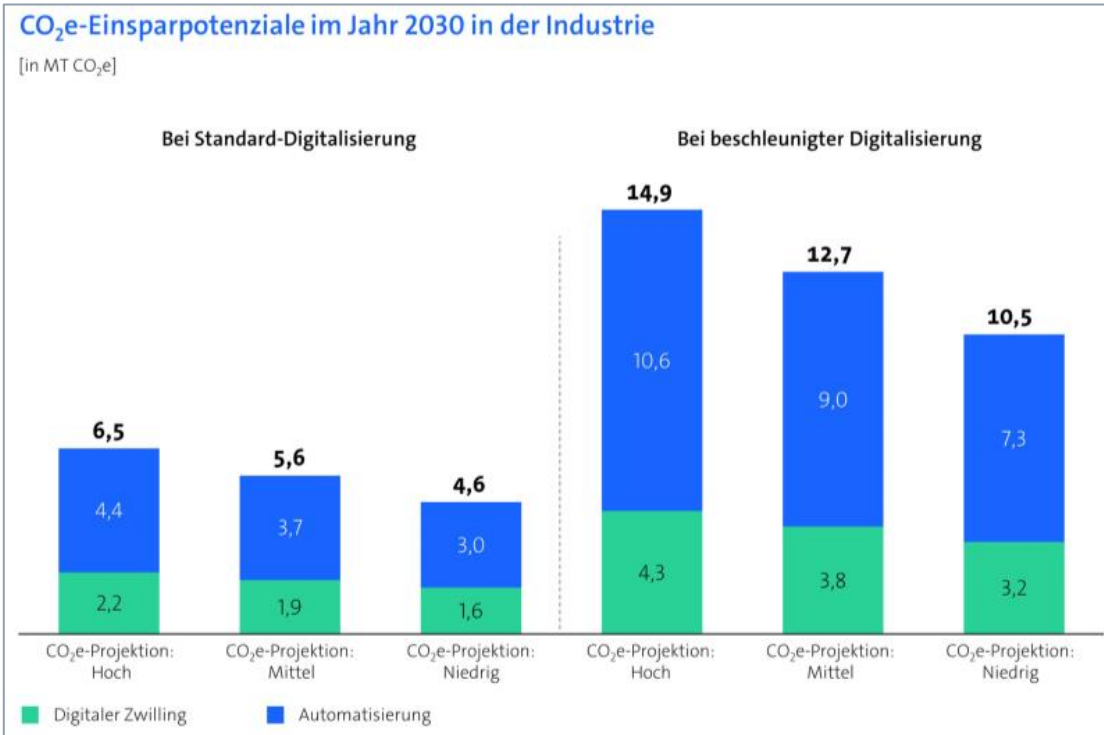
involves leveraging software to promote sustainable practices and reduce environmental impact, which can help organizations reduce their environmental footprint and promote responsible business practices.

Sustainability in Software

involves using sustainable practices in the design and development of software, such as using energy-efficient hardware or adopting agile development methodologies, to reduce the environmental impact of software development and promote responsible business practices.

The Role of Software Development

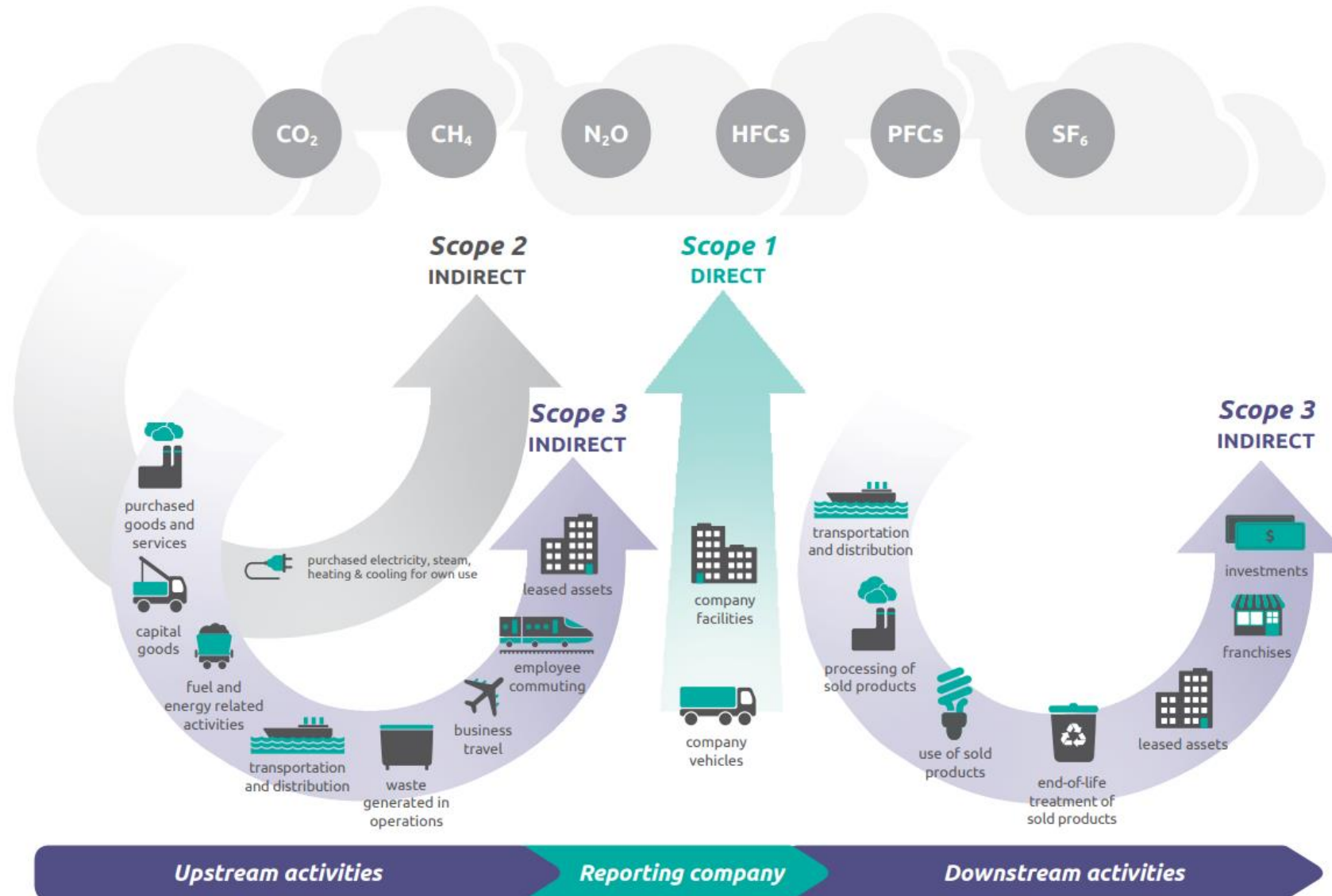
Sustainability by Software



Bitkom's overarching goal is to make Germany a leading digital location, drive forward the digital transformation of the German economy and administration, strengthen digital sovereignty and achieve broad social participation in digital developments.

The Role of Software Development

Reporting Scopes



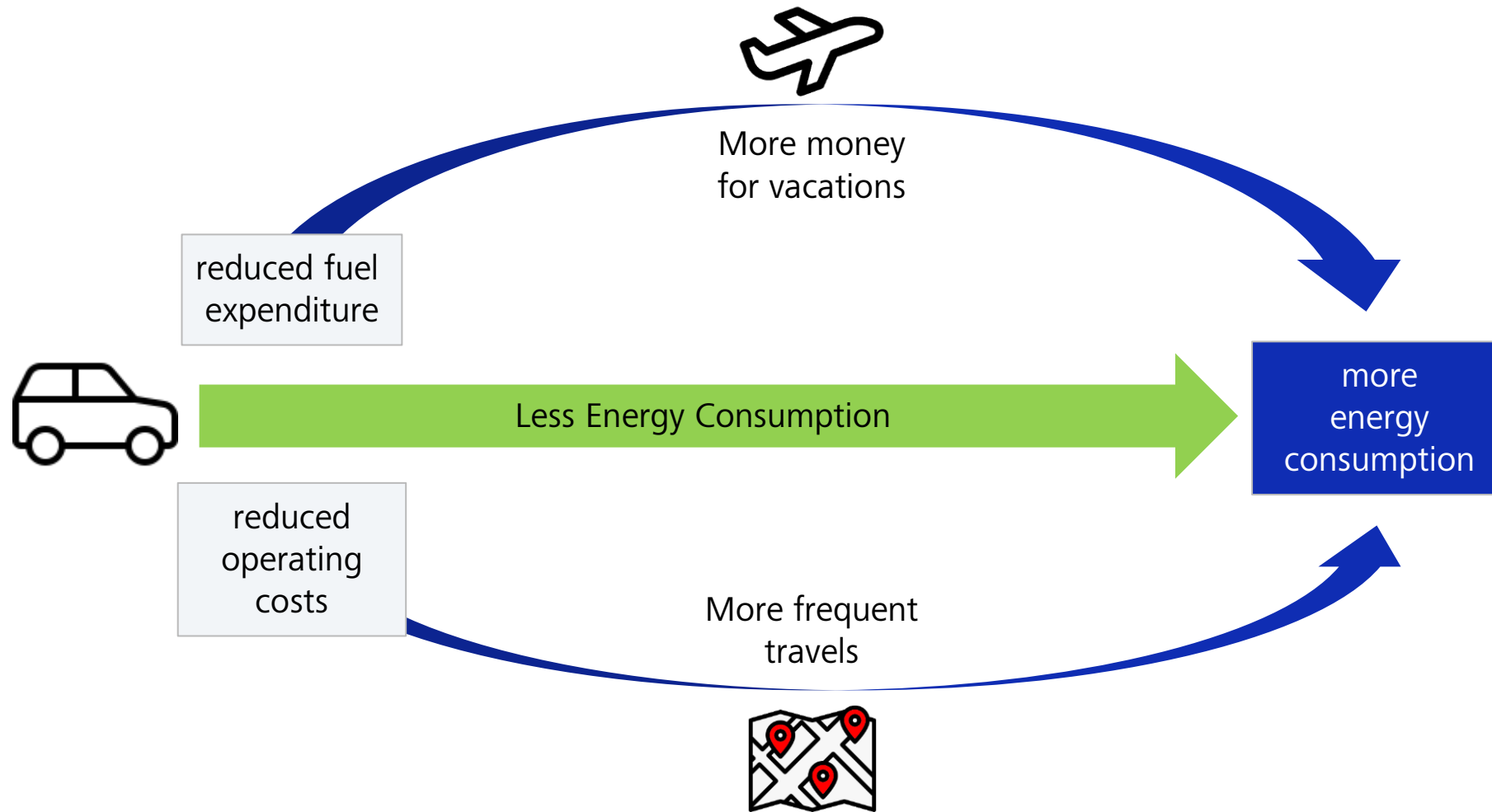
Mandatory reporting required
by **2025** refers to Scope 1 & 2

GHG is a common standard used in ZEISS

Image Source: [link](#)

The Role of Software Development

Beware of the Rebound Effect!



Source: <https://ukerc.ac.uk/publications/the-rebound-effect-an-assessment-of-the-evidence-for-economy-wide-energy-savings-from-improved-energy-efficiency/>

The Role of Software Development

Microsofts energy consumption



Table 8 – Energy intensity (MWh/revenue \$M)

	FY20	FY21	FY22	FY23
Electricity consumed within the organization (MWh)	10,770,714	13,621,517	18,153,454	23,567,502
Revenue (\$M)	143,015	168,088	198,270	211,915
Electricity consumption normalized by revenue (MWh/\$M)	75	81	92	111

The Role of Software Development

Different perspective



Sustainability by Software

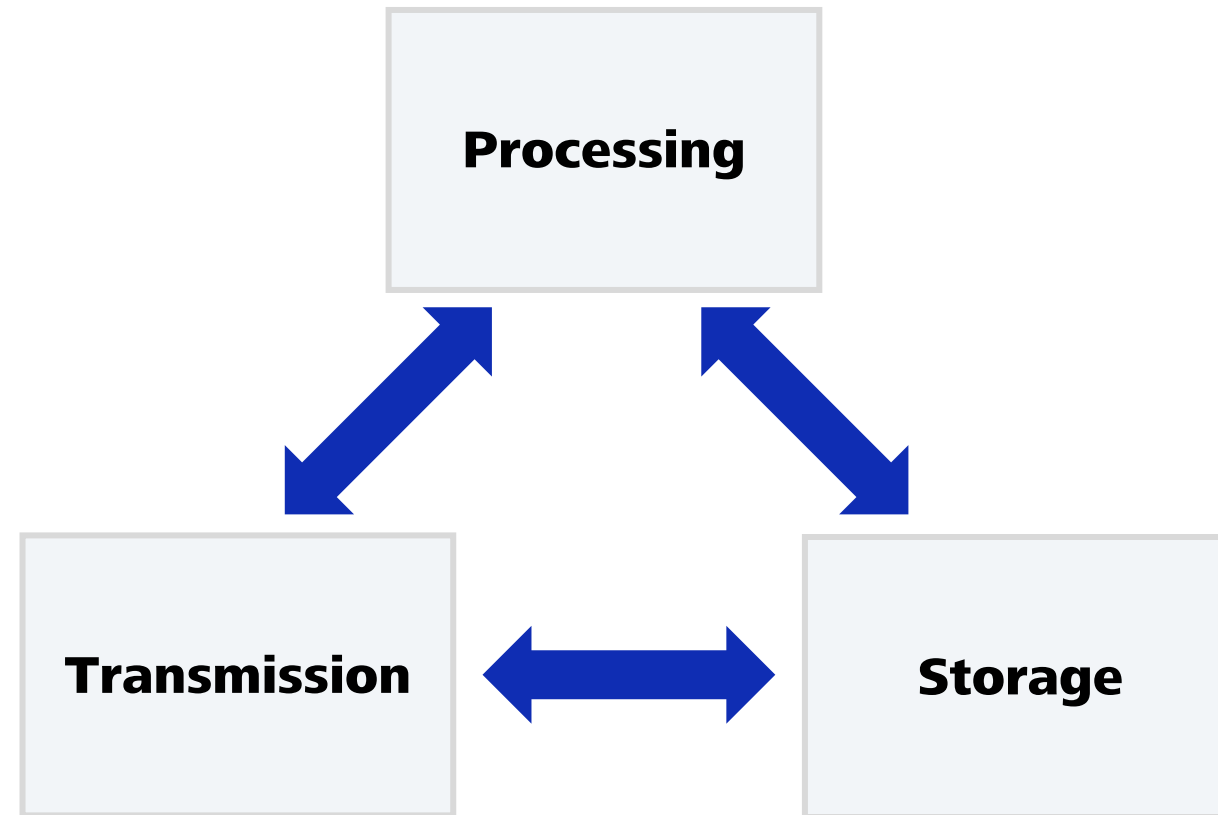
involves leveraging software to promote sustainable practices and reduce environmental impact, which can help organizations reduce their environmental footprint and promote responsible business practices.

Sustainability in Software

involves using sustainable practices in the design and development of software, such as using energy-efficient hardware or adopting agile development methodologies, to reduce the environmental impact of software development and promote responsible business practices.

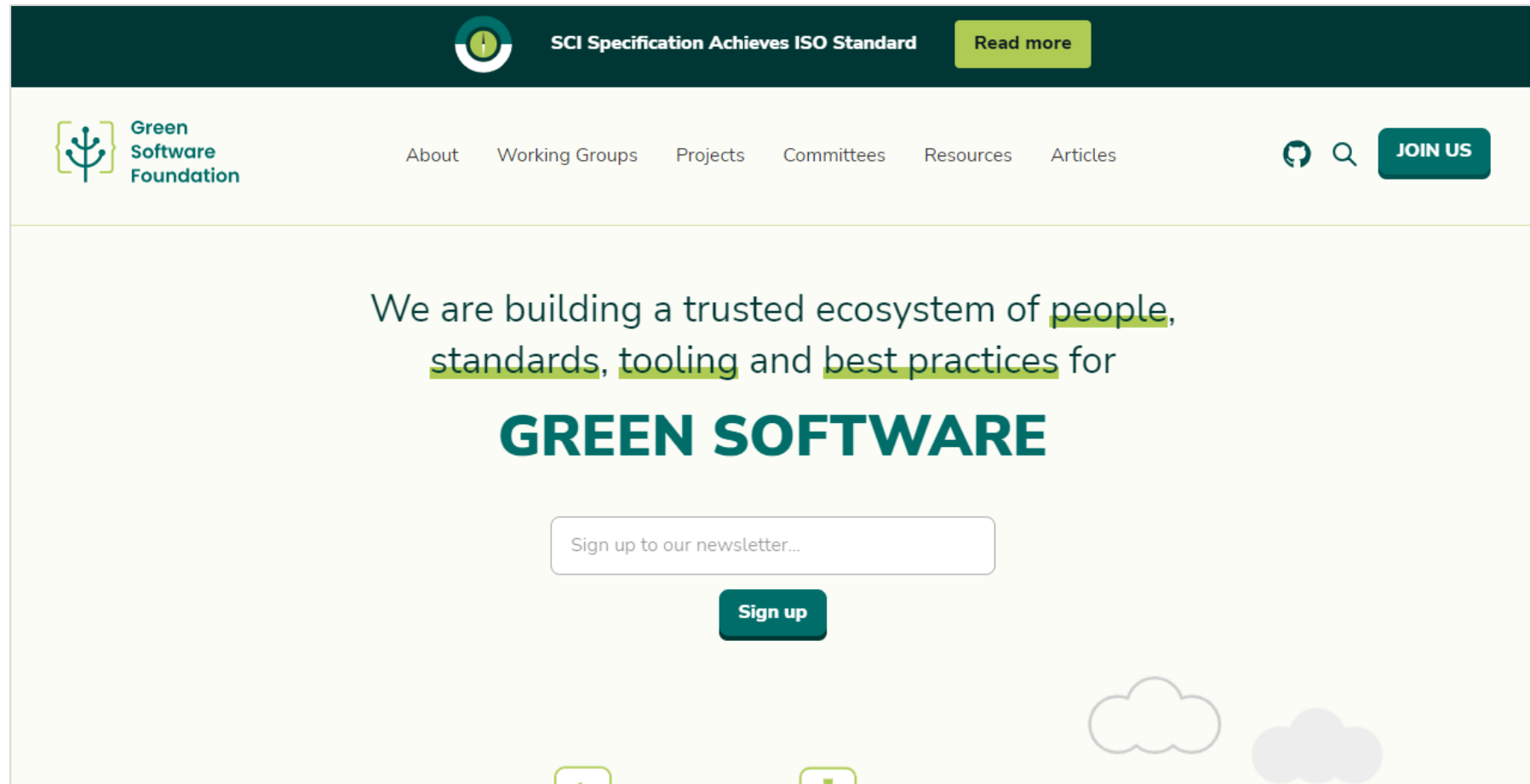
The Role of Software Development

Areas of effect



Existing Ideas

Green Software Foundation



<https://greensoftware.foundation/>

Existing Ideas

Information technology – Software Carbon Intensity (SCI) specification



- SCI is a methodology for calculating the rate of carbon emissions for a software system
- purpose is to help users and developers make informed choices about which tools, approaches, architectures, and services they use in the future

Energy Efficiency

Actions taken to make software use less electricity to perform the same function

Hardware Efficiency

Actions taken to make software use fewer physical resources to perform the same function

Carbon Awareness

Actions taken to time- or region shift software computation to take advantage of cleaner, more renewable or lower carbon sources of electricity

Operational Emission

based on the emissions caused by energy consumption

$$O = (E * I)$$

E= Energy consumed by a software system

I = Location-based marginal carbon intensity

Embodied Carbon

amount of carbon emitted during the creation and disposal of a hardware device

$$M = TE * TS * RS$$

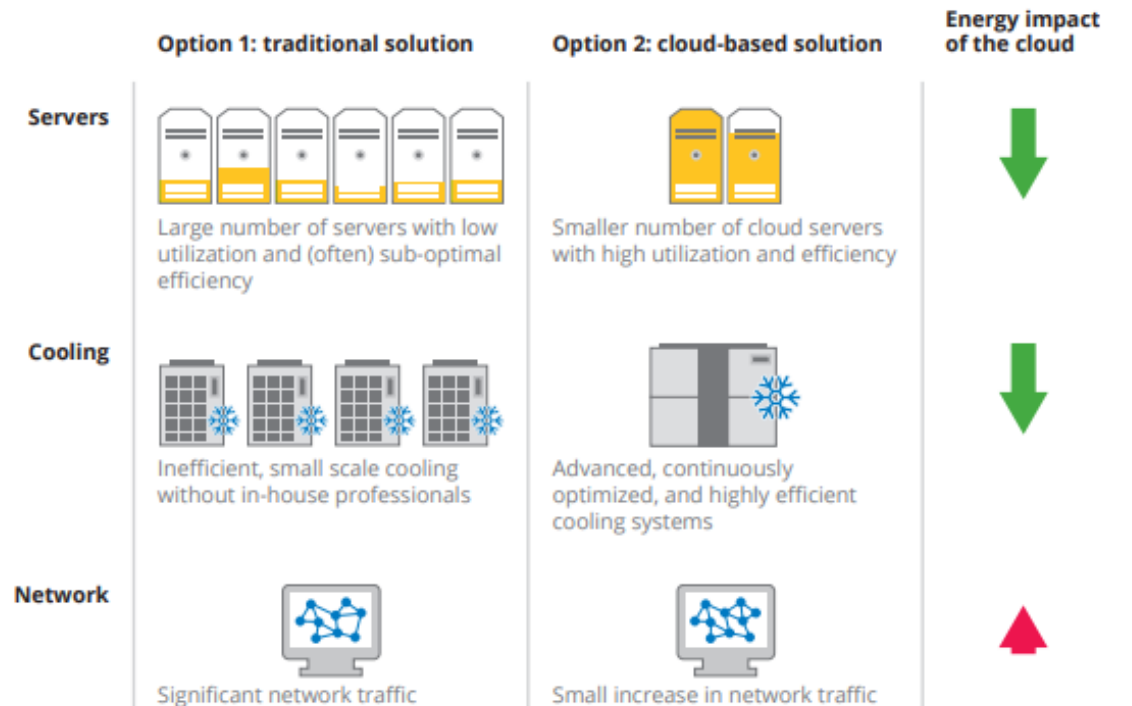
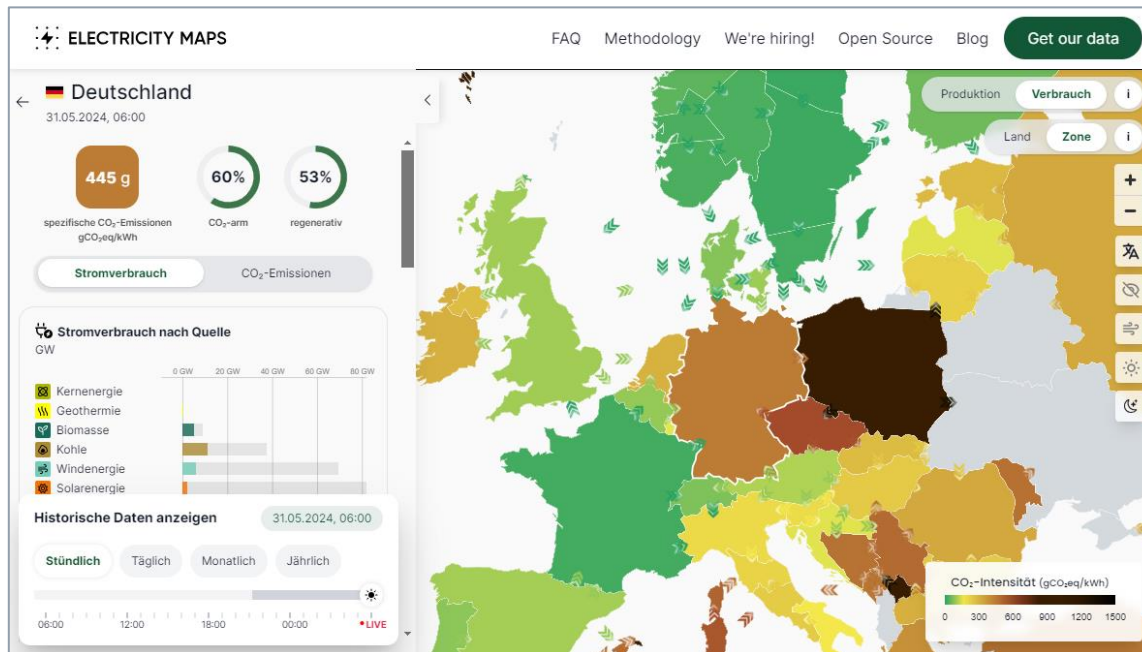
TE = Total Embodied Emissions

TS = Time-share

RS = Resource-share

The Role of Software Development

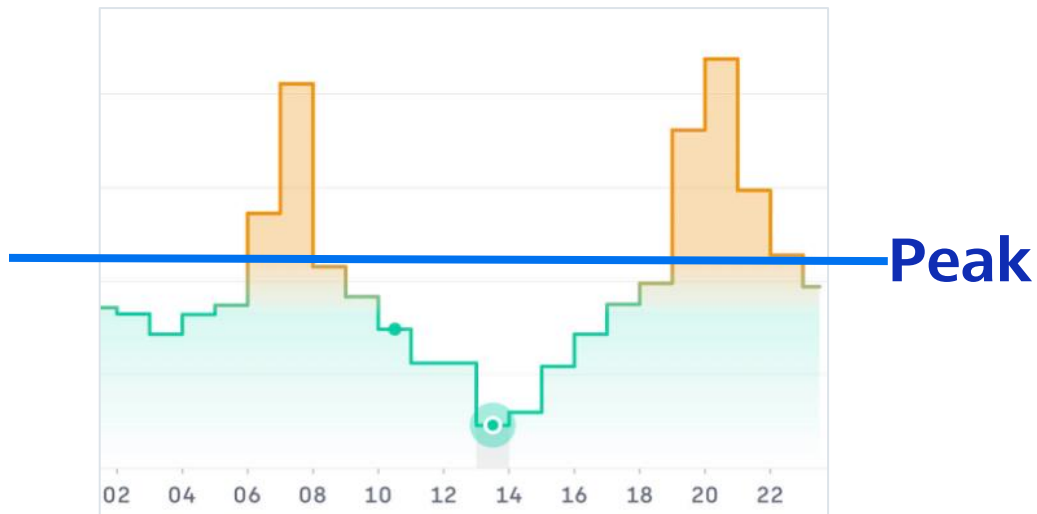
Advantages of the Cloud



[google-apps.pdf \(googleusercontent.com\)](https://google-apps.pdf.googleusercontent.com)

Existing Ideas

Load Shifting & Peak Shaving



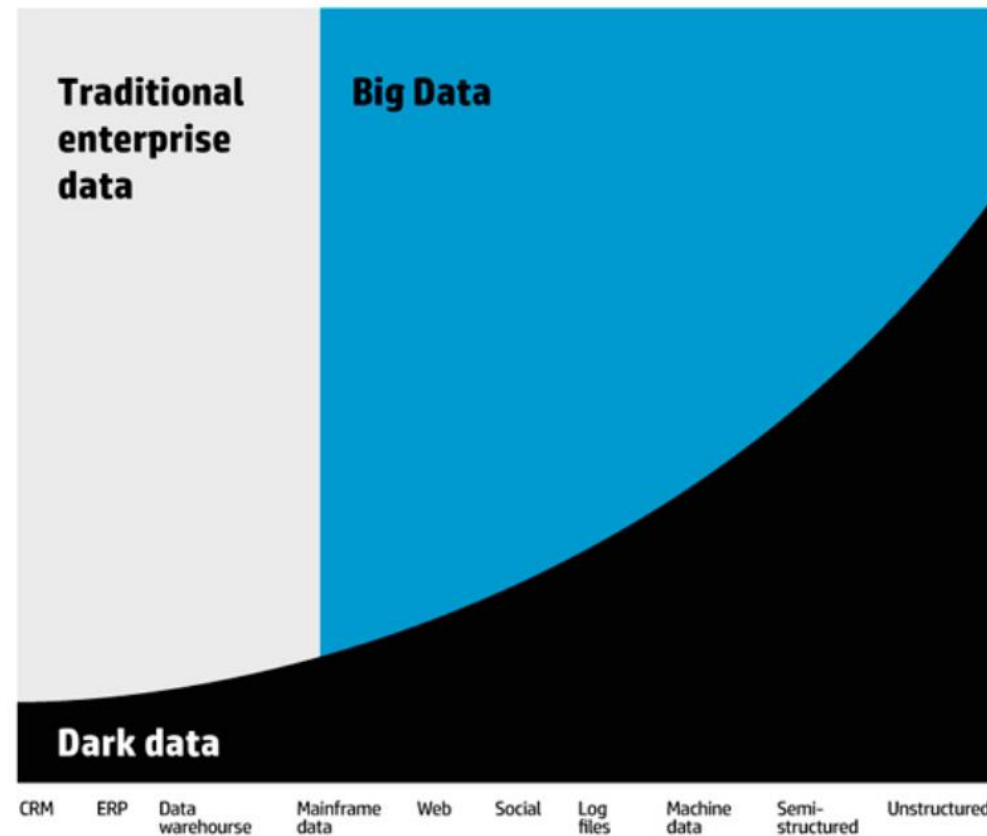
Peak shaving is a strategy used to reduce the maximum amount of energy consumed during peak hours, while load shifting is the practice of moving energy consumption from peak demand periods to off-peak hours.

Existing Ideas

Dark Data

Gartner defines **dark data** as the information assets organizations collect, process and store as part of regular business activities, but generally fail to use for other purposes.

No idea where these numbers come from....



The Role of Software Development

Green Software Patterns



AI

- Optimize the size of AI/ML models
- Run AI Models at the edge
- Select energy efficient Frameworks
- Leverage pre-trained models
- Adopt serverless architectures
- ...

Cloud

- Cache static data
- Choose regions closest to the users
- Reduce transmitted data
- Compress transmitted data
- Delete unused data
- Implement stateless design
- ...

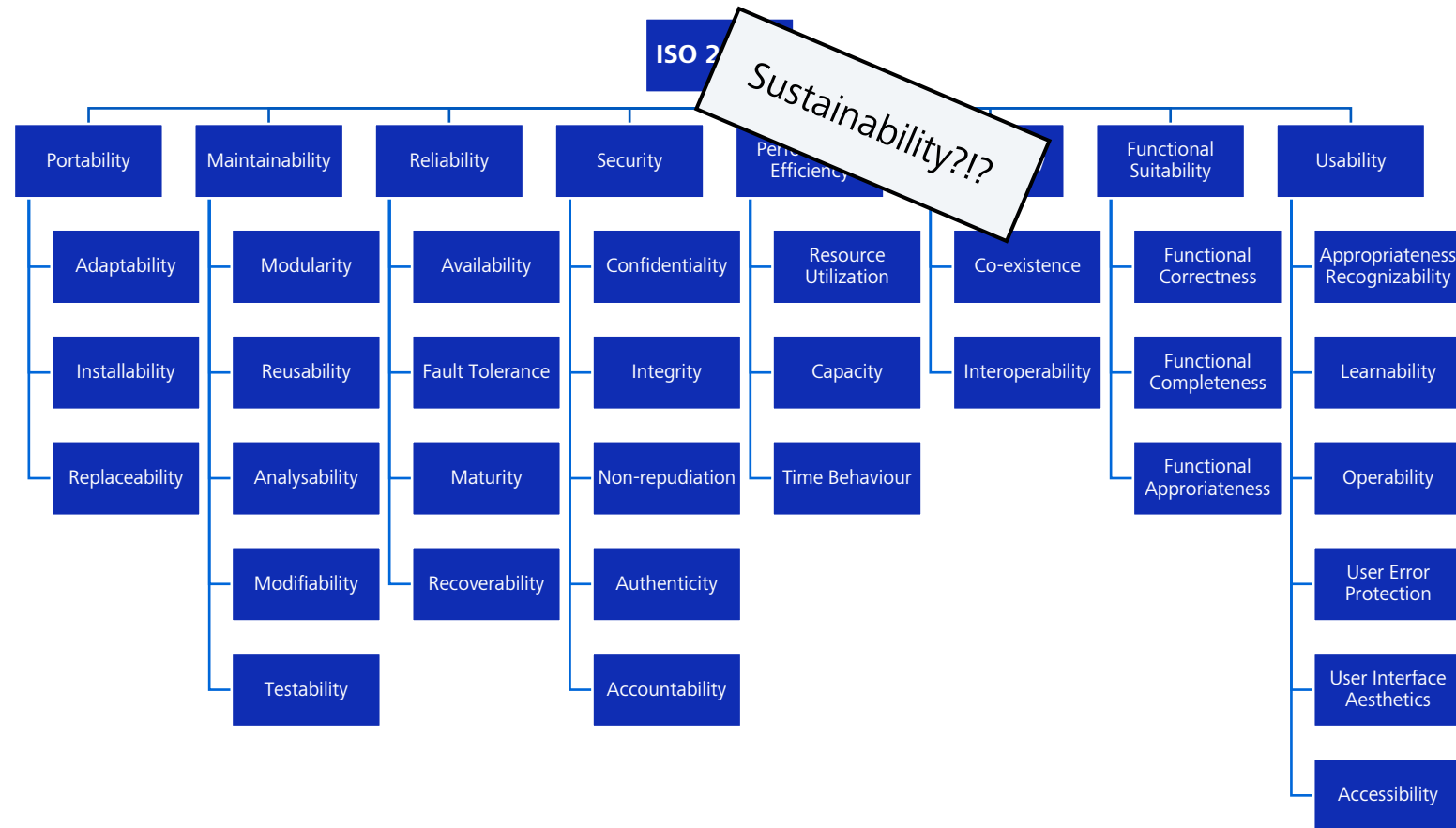
Web

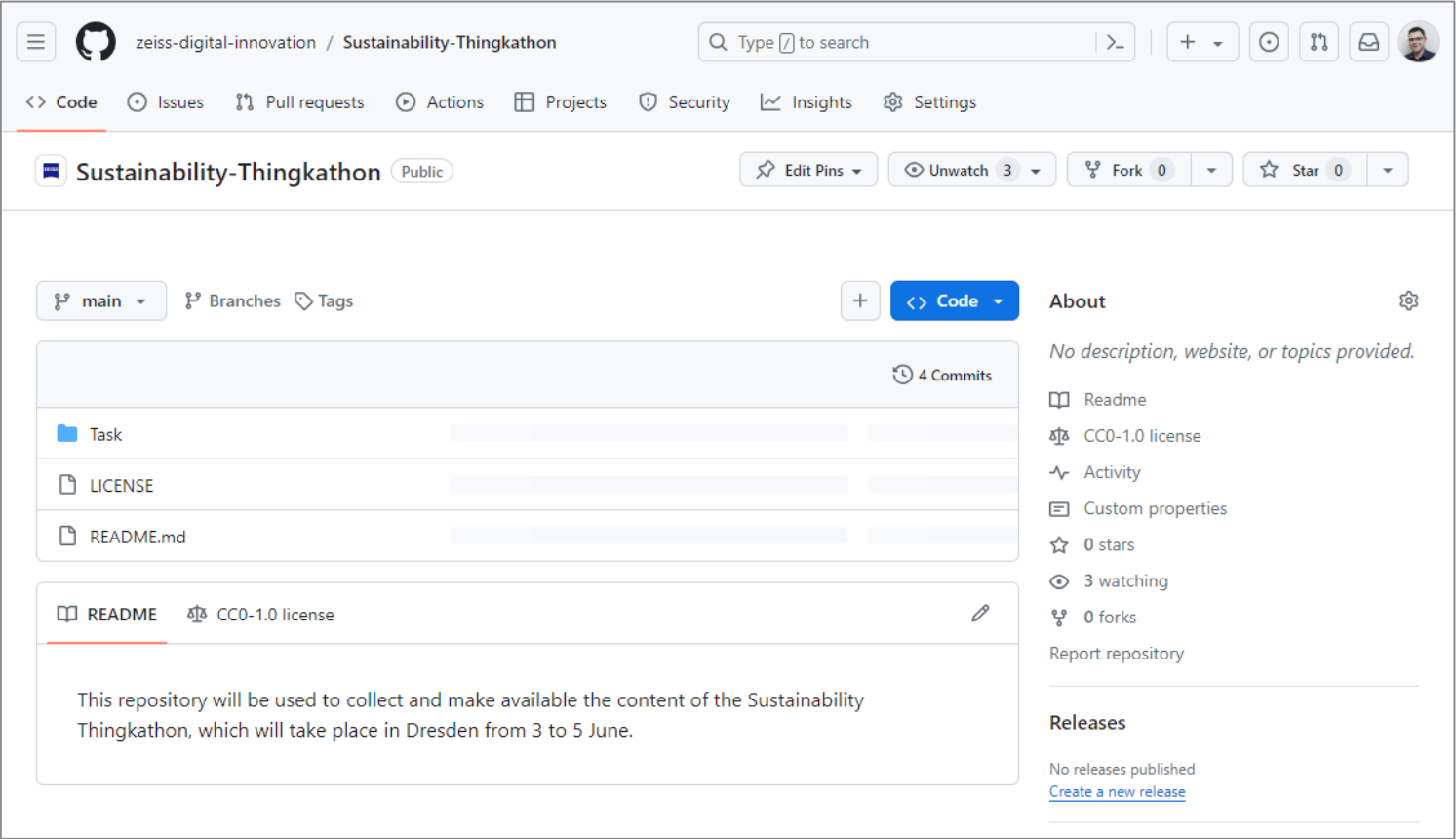
- Minify assets
- Remove unused CSS definitions
- Optimize images sizes
- Avoid Gifs for animations
- Avoid tracking unnecessary data
- Defer offscreen images
- ...

Conclusion

Sustainability as a quality metric

Consider resource efficiency in every requirement and architectural decision.





<https://github.com/zeiss-digital-innovation/Sustainability-Thingkathon>

Scenario

ZEISS is special...



Computational Systems

Google
facebook
NETFLIX

Cyber Physical Systems



Physical Systems



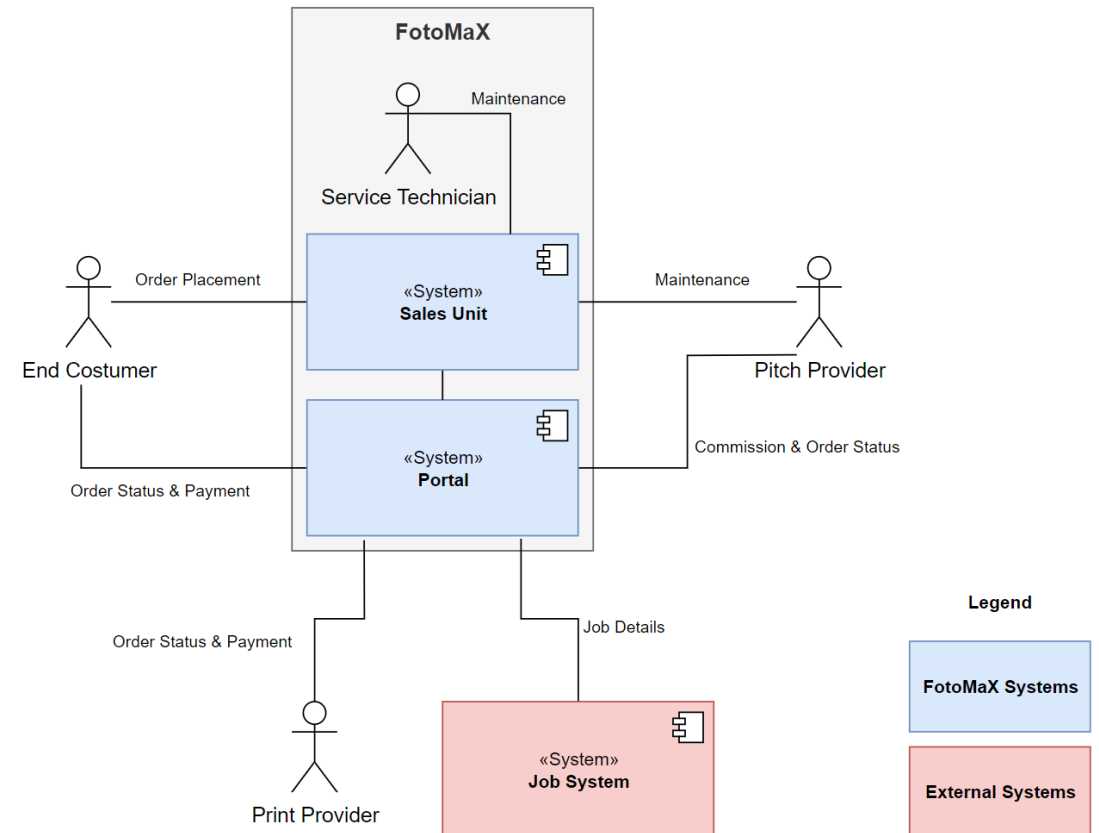
Scenario

Business Context



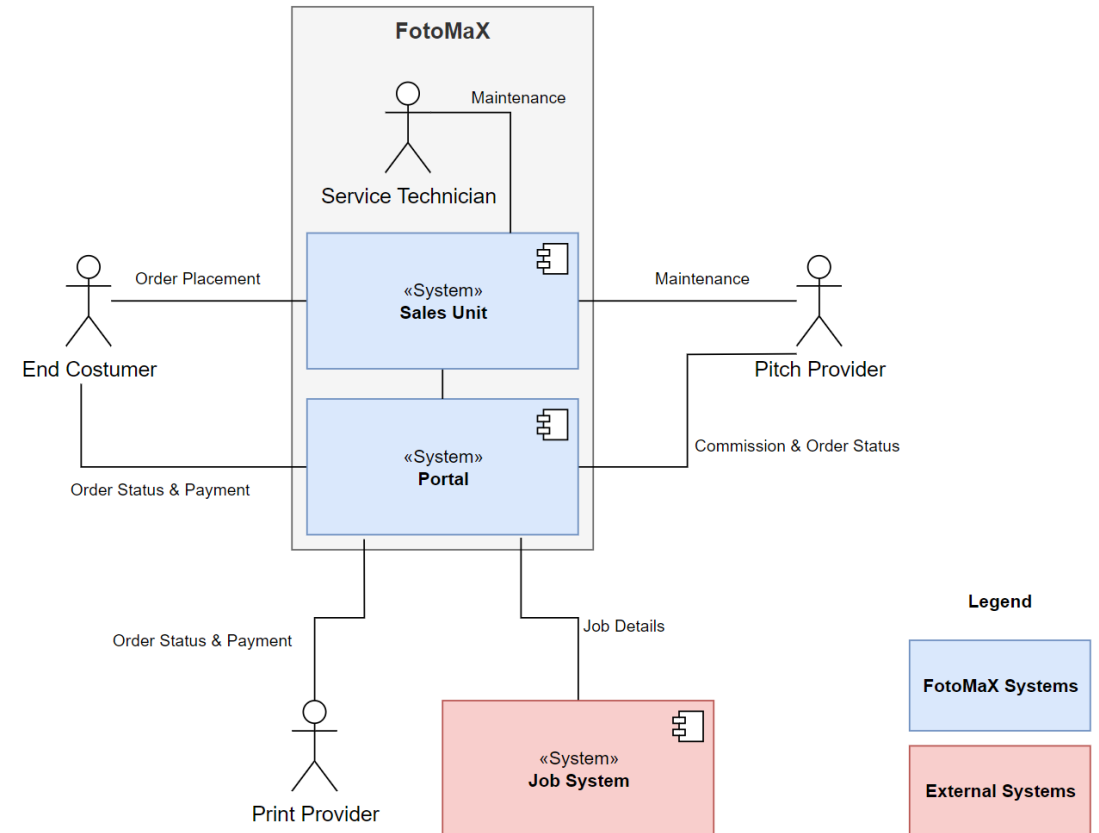
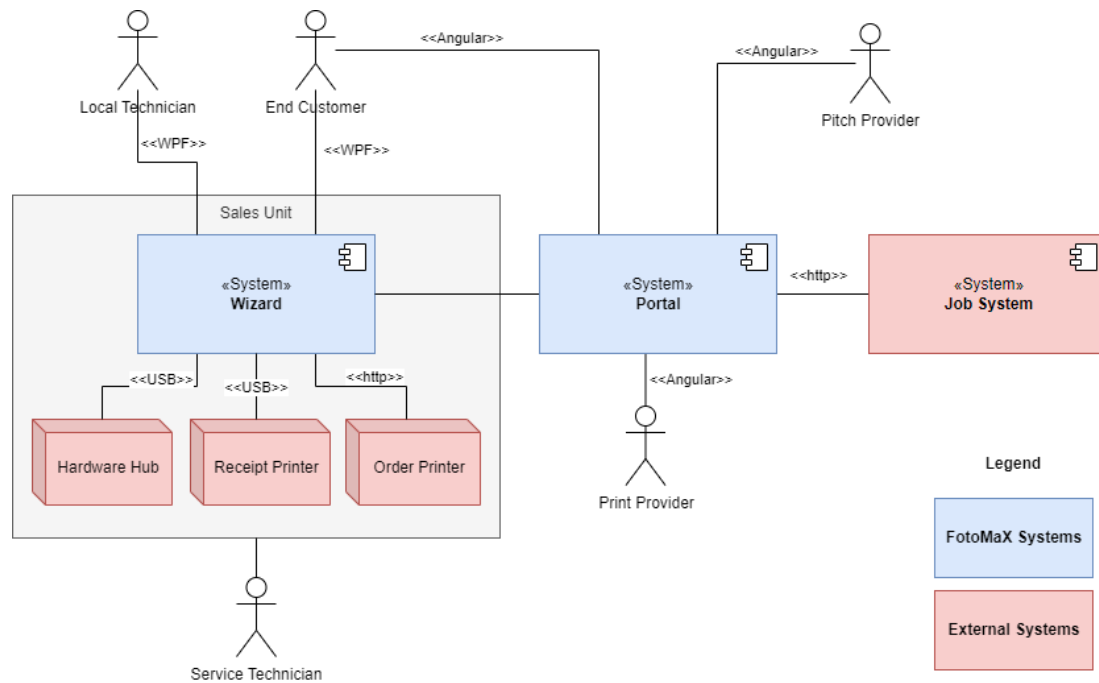
© CEWE

Standalone Solution → No Internet, thus no portal.
Connected Solution → Internet, thus the portal is available.



Scenario

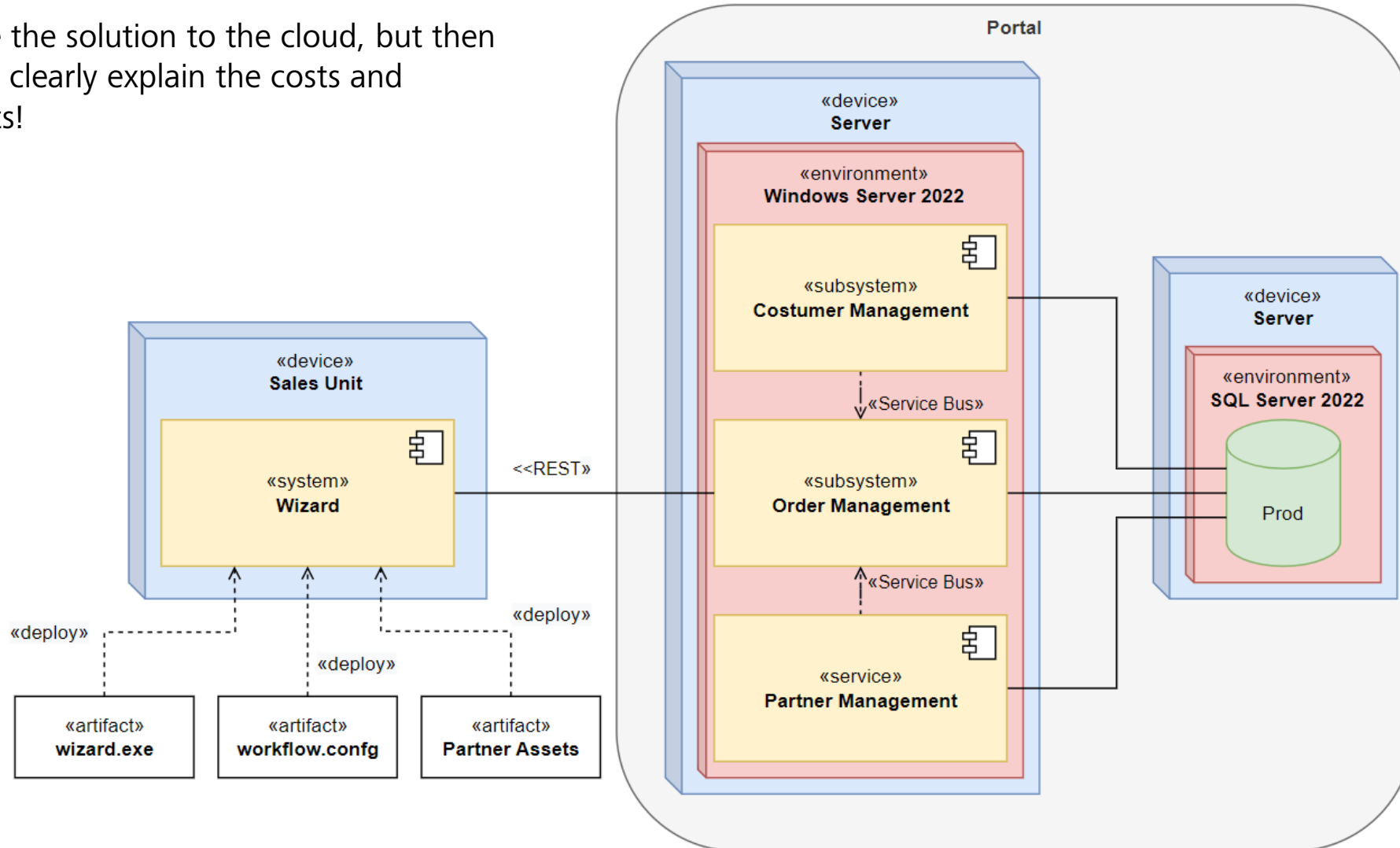
Technical Context



Scenario

Deployment

You can migrate the solution to the cloud, but then you also have to clearly explain the costs and potential benefits!



Scenario

Constraints



This is fix

Start of development	Wizard: 07.2010 Portal: 03.2018
Team Wizard	Five members, responsible for the implementation, adaptation and customizing of the software for the end-customer approach on the sales units.
Team Connect	Four members, responsible for processing, forwarding and accounting of orders.
Team Portal	Eight members, responsible for the portal solution where customers can view their orders and partners can view their commissions.
Team Data	Two members, responsible for the analysis and preparation of the accruing data for partners and for product maintenance.
Wizard Installations	Approx. 250 in different versions
Customers	Approx. 60 different pitch providers, approx. five different print providers, approx. 12 000 registered end users (December 2023), 20% of the users order approx. 30 images per month.

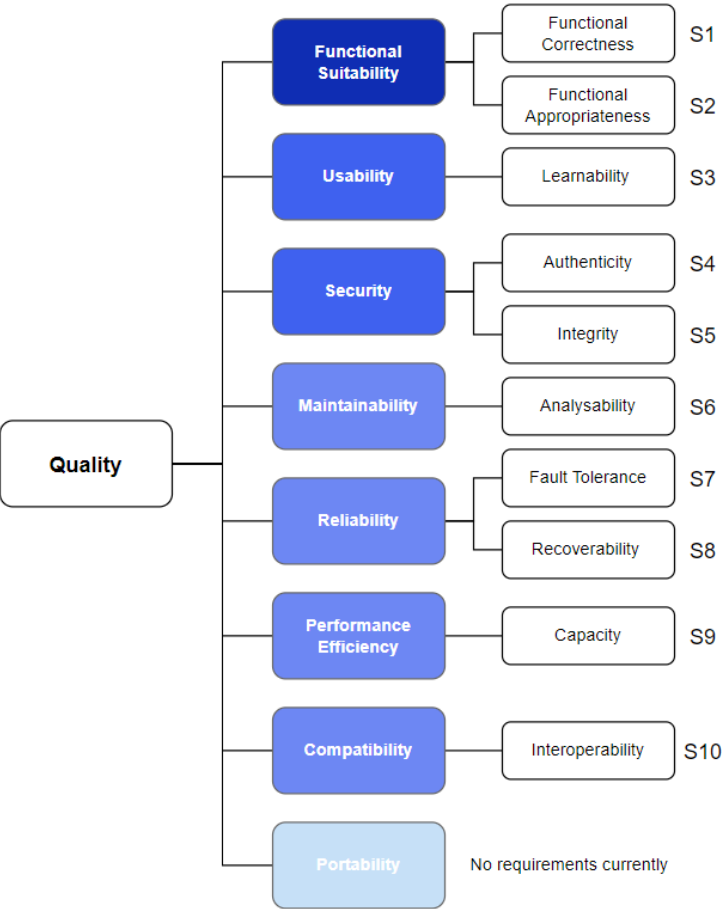
Technical Constraints

This is not fix, but please keep the idea.

- **Technologies Used:**
 - **Wizard:** .NET 4.8, C#, WPF
 - **Portal:** .NET 6, C#, Angular 11, NServiceBus for internal communication between services
- **Runtime Environment:**
 - **Wizard:** Windows 10, SQLite,
 - **Portal:** Windows Server 2022, SQL Server 2022,
- **Release Cycles:**
 - **Wizard:** About once every two to six months, depending on the partner, over the air.
 - **Portal:** Approx. every two weeks
- **Dev Environment:**
 - **Notebook:** Dell Latitude 5540 (65W @ 100% - 40W @ 60%)
 - **Monitor:** Dell S2725DS (21,4W when active)
 - **Server:** Dell Smart Selection PowerEdge R250 Rack Server (115W)
 - **Test Systems:** Dell Optiplex 7050 (75W), Beetronics 22" Touch screen (18.5W)
- **Production Environment:**
 - **Wizard:** DELL OptiPlex 7050 i5-6500T (75 W)
 - **Portal:** Dell Smart Selection PowerEdge R350 Rack Server (175W – 240W)

Scenario

Quality Goals

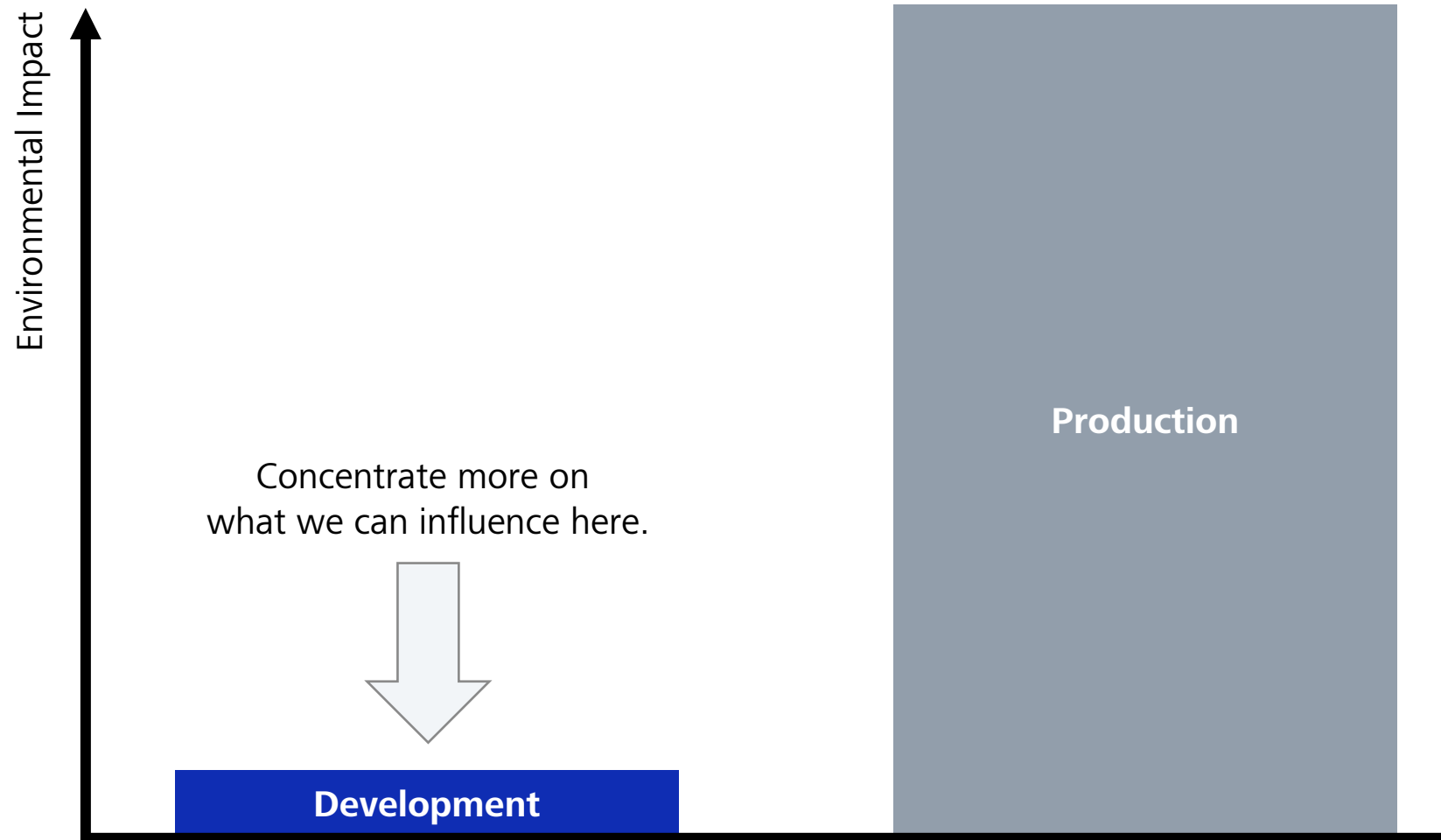


- 1 Very important
- 2 Important
- 3 Significant
- 4 Negligible

Prio	Attribute	Explanation
1	Functional Suitability	The functional correctness and completeness of the software has top priority; as no logical errors may occur during operation and all workflows or processes must be implemented in a way that leads to a successful order.
2	Usability	The software must be easy to use by people with different levels of technical knowledge and be perceived as appealing. It must be possible to place an order as quickly and conveniently as possible to attract walk-in customers.
2	Security	The sales units are located in a public space and offers various possibilities for data transmission.
3	Maintainability	The software system is comparatively extensive and must be able to be redesigned for different partners, so it should be modular and easily testable for different configurations.
3	Availability	If the service is not available, it does not generate any revenue. Therefore, it must always be possible to place orders locally on sales units. The actual transfer of orders to the central services can take place with a certain delay.
3	Efficiency	The expected load on the units is comparatively low, since they can only be used by one person at the same time. When implementing the system, consideration must be given to the manufacturing and hardware costs.
3	Compatibility	The software is primarily used for ordering photo products, so there should be compatibility with common image formats. It should also be possible to retrieve data from common capture devices without much effort.
4	Portability	The runtime environment, including both hardware and software, rarely changes and thus the system does not need to be portable at all.
NEW 2	Sustainability	The software system and development processes must be designed to minimize its environmental impact by reducing resource consumption and optimizing energy efficiency

Scenario

Development vs. Operations



Scenario

The Task



The questions that must be answered are:

- What is our current status regarding our sustainability goal? (Please use the given template for this)
- What changes do we need to achieve it?

Describe the changes and factor these into a second version of the given template which can and should be extended by your team.

Scenario "FotoMaX"

Scenario "FotoMax"

Time period:

2 week sprint ~ 10 working days

													Location-based		Market-based	
Category	Activity	Count	Days	Hours	Time Assumption [h/cycle]	Energy Consumption [W/h]	Data Usage Assumption [GB/h]	Energy Consumption Per GB [Wh/GB]	Total Energy Consumption [kWh]	Emission Factor [kgCO2e/kWh]	CO2e [kgCO2e/cycle]	Emission Factor [kgCO2e/kWh]	CO2e [kgCO2e/cycle]			
Staff - Devices	Team Wizard - Notebook		10	8		0	40	--	--	0	0,4	-	0,4			
Staff - Devices	Team Wizard - Monitor		10	8		0	21,4	--	--	0	0,4	-	0,4			
Staff - Devices	Team Connect - Notebook		10	8		0	40	--	--	0	0,4	-	0,4			
Staff - Devices	Team Connect - Monitor		10	8		0	21,4	--	--	0	0,4	-	0,4			
Staff - Devices	Team Portal - Notebook		10	8		0	40	--	--	0	0,4	-	0,4			
Staff - Devices	Team Portal - Monitor		10	8		0	21,4	--	--	0	0,4	-	0,4			
Staff - Devices	Team Data - Notebook		10	8		0	40	--	--	0	0,4	-	0,4			
Staff - Devices	Team Data - Monitor		10	8		0	21,4	--	--	0	0,4	-	0,4			
Staff - Devices Total									0		-		-			
Server	Production - Windows Server		14	24		0	240	--	--	0	0,4	-	0,4			
Server	Production - SQL Server		14	24		0	240	--	--	0	0,4	-	0,4			
Server	Testing - Mirrored Windows Server		14	24		0	175	--	--	0	0,4	-	0,4			
Server	Testing - Mirrored SQL Server (Test Data & Anonymized Snapshot)		14	24		0	175	--	--	0	0,4	-	0,4			
Server	Wizard - Mini PC		14	24		0	75	--	--	0	0,4	-	0,4			
Server	Wizard - Touchscreen		10	10		0	18,5	--	--	0	0,4	-	0,4			
Server	Dev / Staging - Windows Server		14	24		0	115	--	--	0	0,4	-	0,4			
Server	Dev / Staging - SQL Server		14	24		0	115	--	--	0	0,4	-	0,4			
Server Total									0		-		-			
Internet Usage	Daily Meetings ~ 15 min	19	10	0,25		47,5	--	2,4	60	6,84	0,478	3,27	0,478			
Internet Usage	Longer Meetings ~ 60 min (Planning, Refinement, Review, Retro)	19	4	1		76	--	2,4	60	10,944	0,478	5,23	0,478			
Internet Usage	Picture Upload (2.400 User order 30 images per sprint)	36000	1	1		36000	--	0,003	60	6,48	0,478	3,10	0,478			
Internet Usage Total										24,264		11,60				
Total										48,528		23,20				

Please see this as additional ideas and information but don't take it too seriously.

27

23

10

23,20

Please see this as additional ideas and information but don't take it too seriously.

Let's find ideas to achieve measurable success *and have fun ;)*



Seeing beyond