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Digital Management

University of Hohenheim

Faculty of Business, Economics and Social Sciences

Institute of Marketing and Management

Chair for Digital Management

Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 1: Introduction to Sustainability
2022

Research Center Finance & Information Management

Fraunhofer FIT
Project Group Business & Information Systems Engineering

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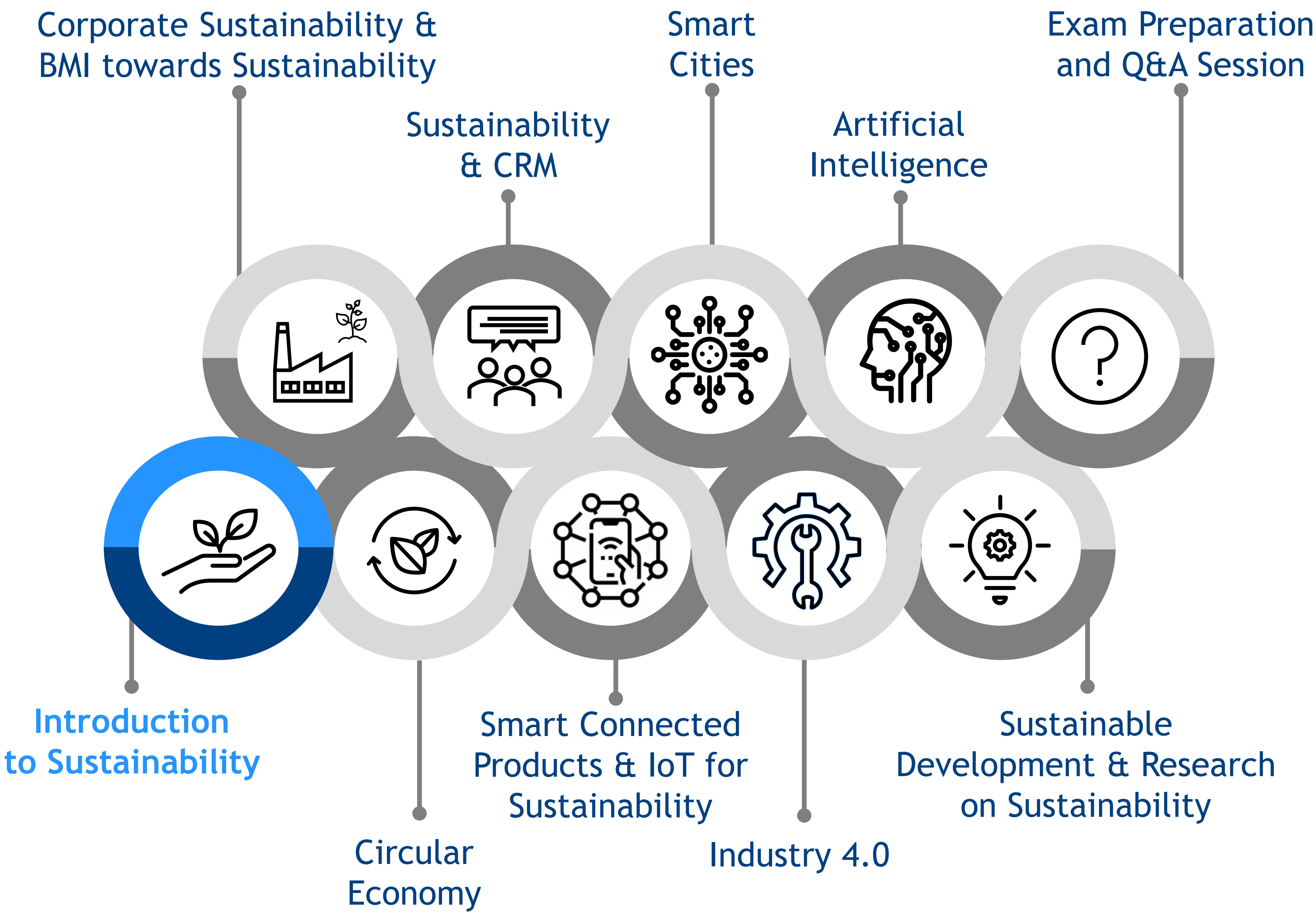
Overview Smart Sustainability



Agenda - Introduction to Sustainability

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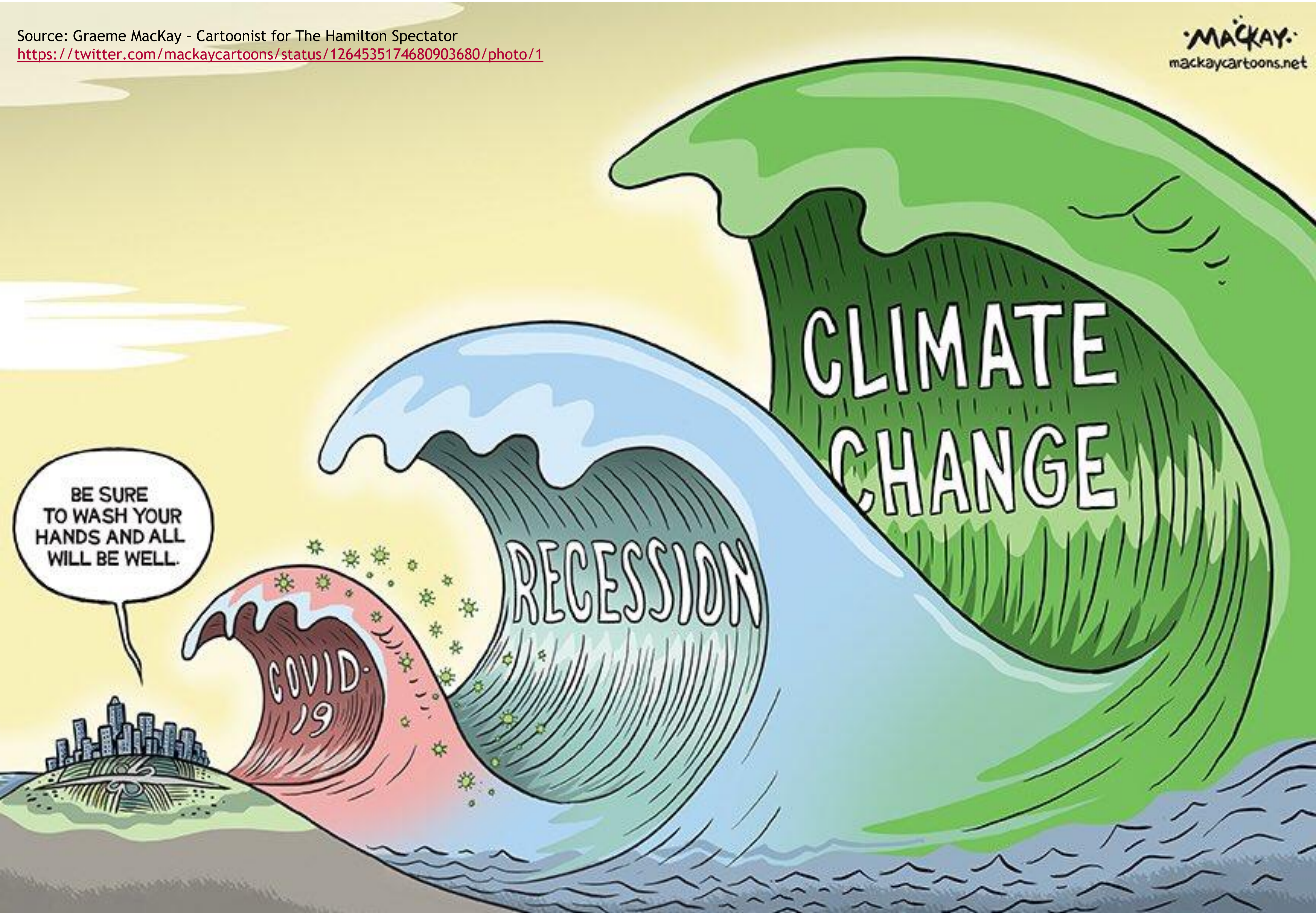
1. Why does sustain-ability matter?
2. Origin and definition of the term “sustain-ability”
3. Smart starting points for sustain-ability

Why does sustainability matter?

Source: Graeme MacKay – Cartoonist for The Hamilton Spectator
https://twitter.com/mackaycartoons/status/1264535174680903680/photo/1



The climate crisis increases the probability of extreme events (I)

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Lightning strikes at the North Pole

> **Meteorologists register a record number of lightning strikes in the Arctic.**
> SZ, August 19, 2019

- Lightning strikes around the geographic North Pole are extremely rare because the warm air masses necessary for them are usually missing
- Researchers recorded around 50 strikes in one day (previous record 6!)
- Presumed reason: Strong warming of the Arctic!

Iceland

> **Iceland declares a glacier a victim of climate change.**
> SZ, August 19, 2019

- Okjökull-glacier shrinks from 16 km^2 to less than 4 km^2 in recent years and is no longer moving
- It loses its glacier status and is declared "dead ice" (the ice no longer flows or breaks)
- Researchers predict the disappearance of all (approx. 300) Icelandic glaciers

The climate crisis increases the probability of extreme events (II)

"The Siberian cold is still not letting go of Europe: schools remain closed in many countries, and snow and ice continue to cause traffic chaos. The number of cold deaths (hypothermia) since Friday rose to more than 45 - in Poland alone there were 18 deaths."

Spiegel Online, February 28, 2018

"It is expected to take 100 years for the forest to recover. […] Forest fires so close to the Arctic Circle accelerate the thawing of permafrost soils, which, according to Greenpeace Russia, contain gigantic amounts of frozen biomass. If they thaw, they release greenhouse gases into the atmosphere."

Die Zeit, August 3, 2019

"Snow, arctic wind and ice: winter has Europe firmly in its grip. Record sub-zero temperatures were measured on the Zugspitze. In Poland, at least eight people died in freezing temperatures."

Tagesschau, February 26, 2018

"July 2019 was the hottest month worldwide since measurements began. This is the result of an analysis by the EU's own Copernicus service [sic!] for monitoring climate change."

Focus Online, August 5, 2019

The climate crisis increases the probability of extreme events (III)

Dramatic floods in Germany

> Fallen trees, flooded streets, damaged roofs: In several regions, the fire department had to be called out after rain and thunderstorms. In Saxony, a man died while trying to pump out his flooded cellar.
>
> **Spiegel Online, July 26, 2021**

> The flooding on the Ahr River was exacerbated by damage to the forest - and will harm nature along the river. A district forester calls for a rethink.
>
> **Spiegel Online, July 07, 2021**

> The German Weather Service expects further heavy rainfall in the coming months. The Interior Minister of Rhineland-Palatinate is concerned about the threat of thunderstorms. And the number of fatalities continues to rise.
>
> **Spiegel Online, July 25, 2021**

Origin and definition of the term “sustainability”

Origin and Development of Sustainability Concepts

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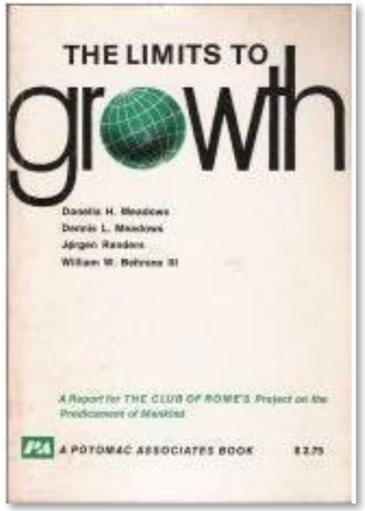
Forestry principle – Hans Carl von Carlowitz, 1713

[Picture: public domain]

Only as much wood may be felled as can grow back again.

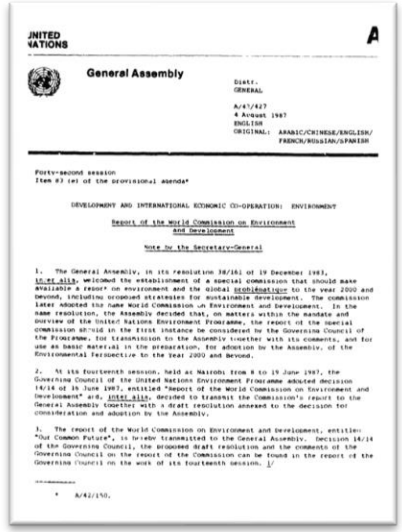
The limits to growth – Club of Rome, 1972



[Meadows 1972]

If growth remains unchanged, the limits of growth on Earth will be reached by 2072.

Brundtland report – 1980s



[WCED 1987]

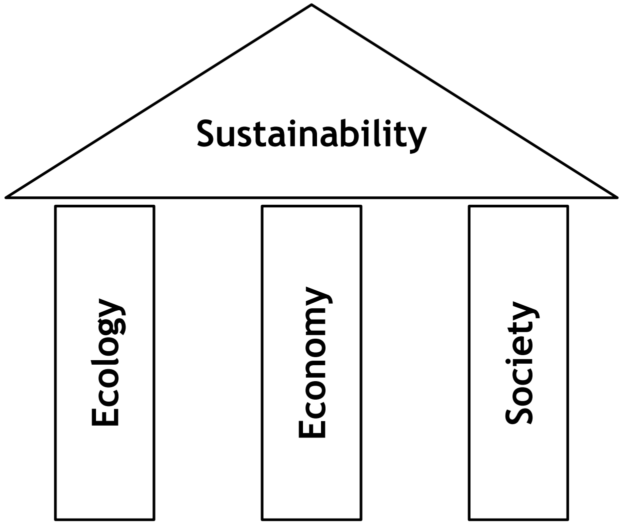
- 1983 Foundation of WCED
- Major influence on development and environmental policy debate

---

- Interdisciplinary approaches to solve sustainability related problems efficiently
- Connecting economic, ecologic and social sustainability
  - → Use of Information Systems (IS) to support sustainable development
  - → Potential in IS to accelerate sustainable development

Graf-Drasch (2020)

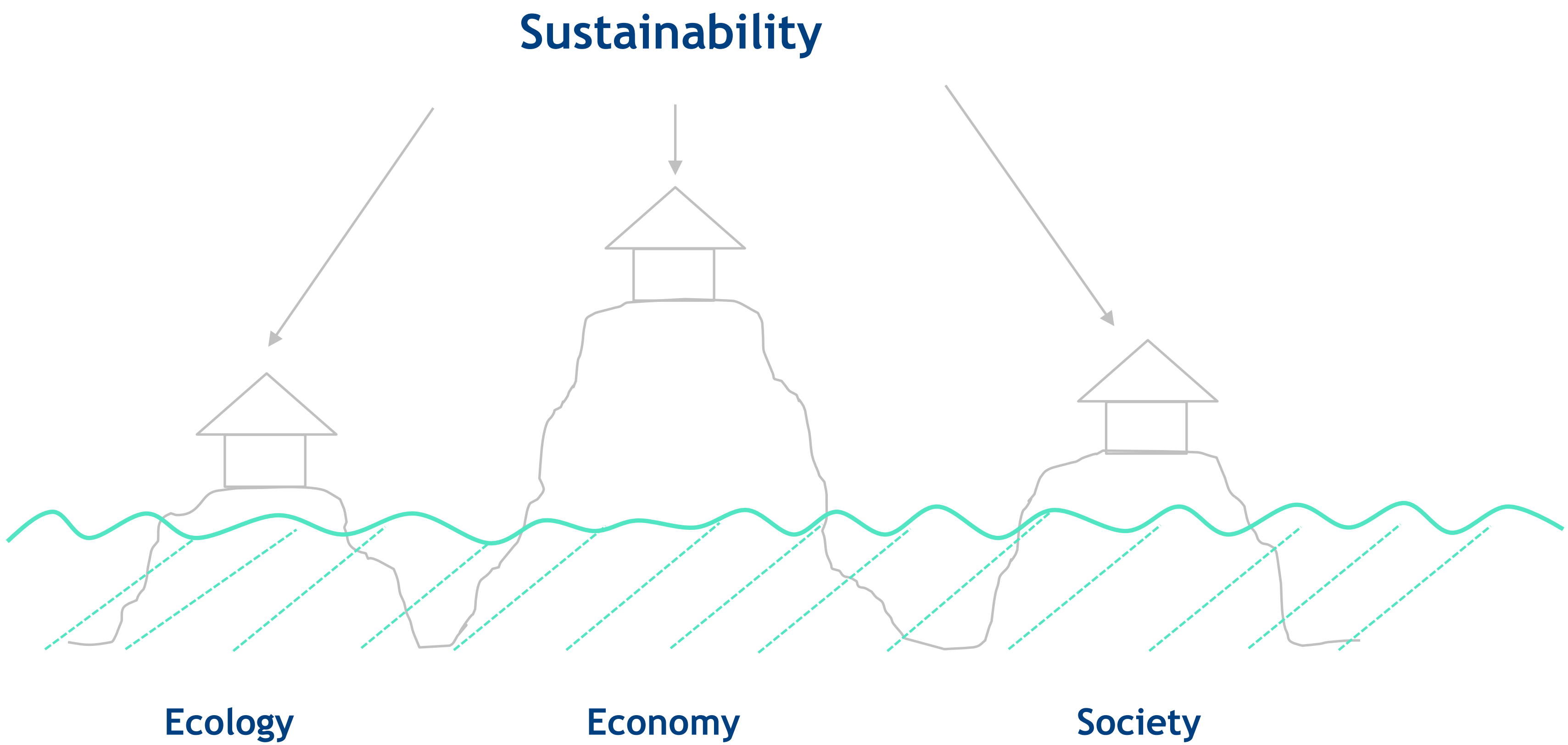
Interpretations of Sustainability



! **The pillars and goals are equally important!**

Ruhwinkel (2013); Dyllick und Hockerts (2002); https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

The minimum dimension must not be undercut



!

- A minimum level must be met in all three sustainability objectives
- **Not pure maximization of individual goals: Not "either - or"**
- **Target balance: „as well as".**

Sustainability - definition

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Sustaina|bi|li|ty

Principle, according to which not more may be consumed, than can be regrown, regenerated, and made available again in the future.

[Translated out of Duden - Deutsches Universalwörterbuch]

„Smart“

Application of information systems to model, control, and improve sustainable approaches.

Sustainable Development

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

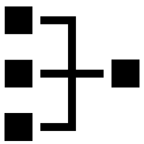
[WCED 1987, chapter 2, p. 1]

Sustainability

sustain, lat. sustinere [uphold, carry, preserve or retain]

Sustainable structures that have sufficient regenerative reserves for the future (sustainability in the context of this event).

Green IS/IT and ICT4D

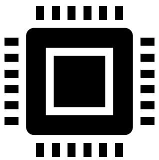


Green IS

"[Information System-enabled] practices and processes improving environmental and economic performance"

"Green IS focus on individuals', groups', organizations', and society's IS usage to support environmentally sustainable practices."

comprises



Green IT

Green Information Technology

"[…] hardware and infrastructures that can be better managed and designed from an environmental perspective."

ICT4D

"Information and Communication Technology for Development (ICT4D), summarizes research linking the potentials of ICT to international and societal development goals, such as those of the United Nations"

Graf-Drasch (2020), p.3; Melville (2010); Watson et al. (2010)

Smart starting points for sustainability

Smart Starting Points for Sustainability

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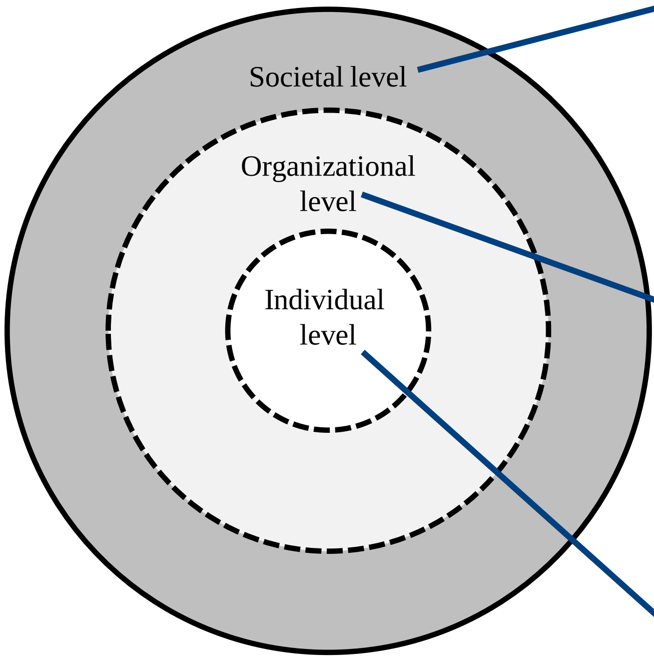
Three levels of action



Description	Example
- Collective realization of the importance of smart sustainability	- Collective activities addressing sustainability issues relevant to local, national, and international societies
- Mitigate negative environmental impacts - Aligning core strategy with environmental sustainability objectives - Developing concrete solutions	- Triggering more sustainable organizational practices and processes - Green IS, Green IT - Crowdsourcing
- Public acceptance of IS-supported solutions	- E-Books - E-Cars - Carbon capture and storage technologies - Smart meter technology

Graf-Drasch (2020)

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Slide deck 2: Corporate Sustainability & Business Model Innovation (BMI) towards Sustainability

2022

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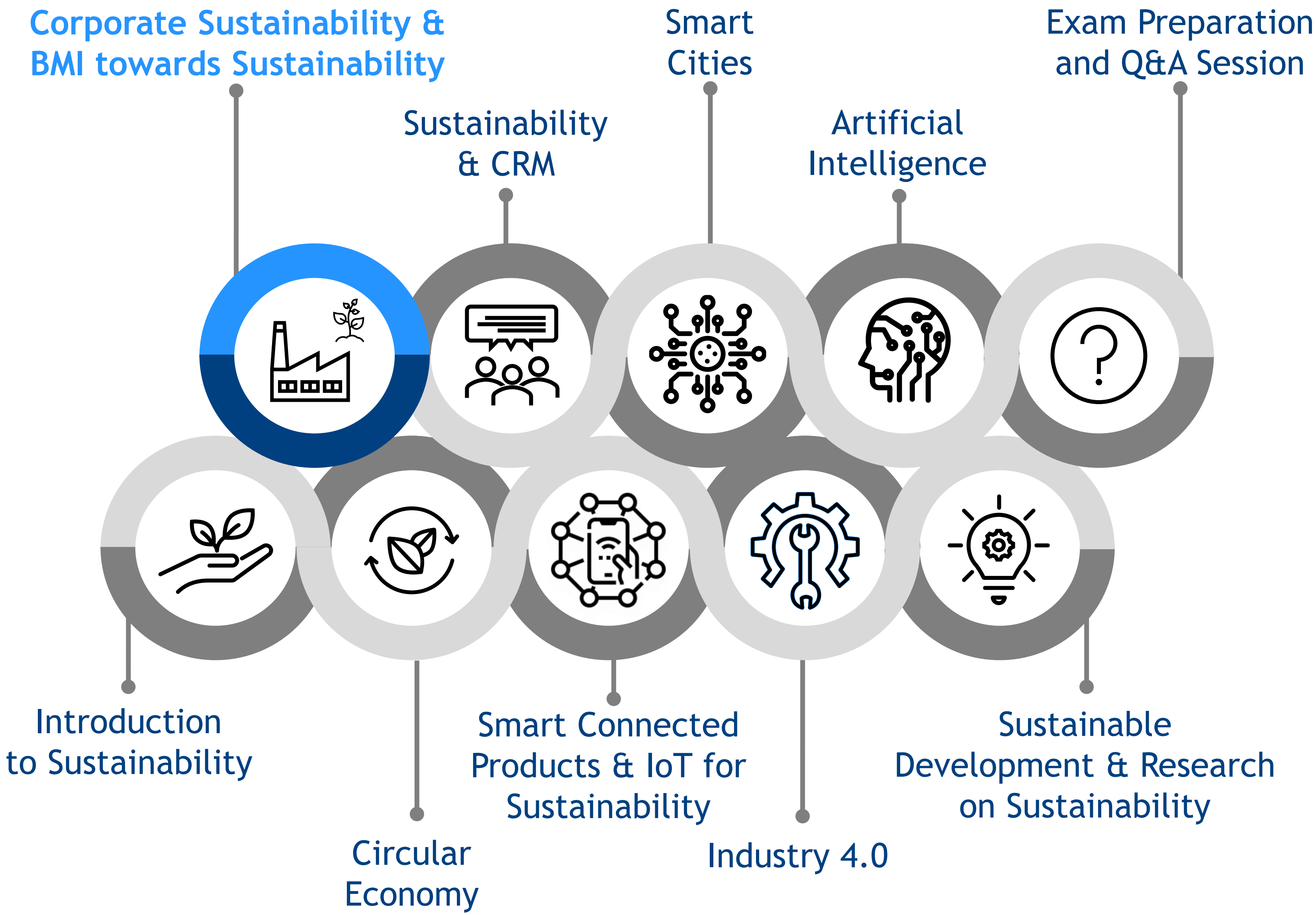
Overview Smart Sustainability



Agenda – Corporate Sustainability & Business Model Innovation (BMI) towards Sustainability

General Insight: Sustainability in Organizational Contexts

Sustainability - a major issue also for companies

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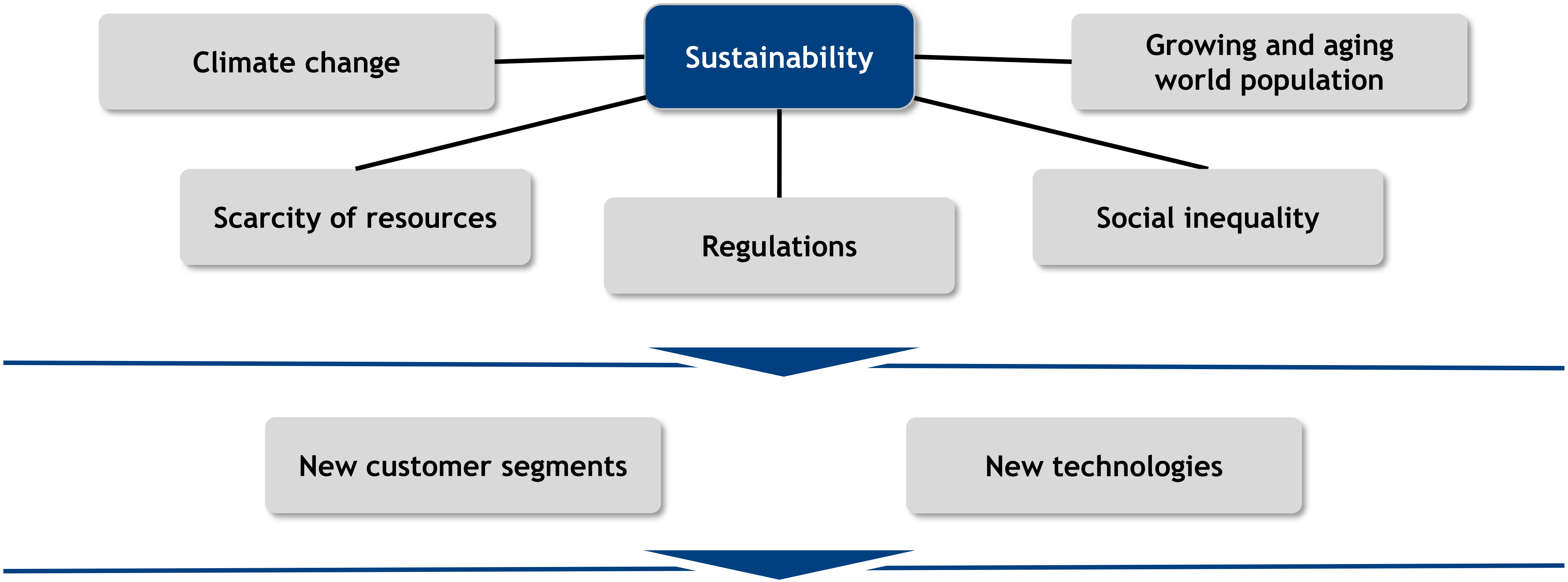

? How can companies approach the transformation towards sustainability and realize it in accordance with value-based corporate governance?

Corporate Social Responsibility

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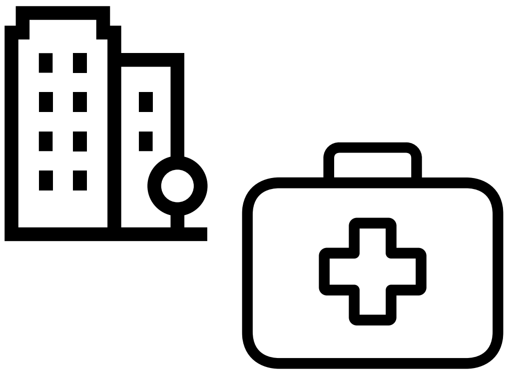
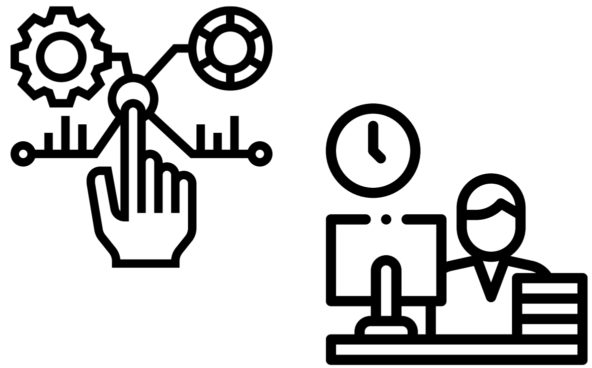


1953 first definition of the term



First approaches at the end of the 19th / beginning of the 20th century:

- Health programs for employees
- Housing for employees

Today's challenges and drivers:

- Digitalization and innovation as drivers and challenges for CSR
- Workplace quality
- Refugees and business integration

Corporate Social Responsibility is a concept for companies to integrate their social responsibility towards society and their own employees into company activities.

Bassen et al. (2005), Bundesministerium für Arbeit und Soziales (2018, 2019), Icons von Freepik, Good Ware u. Eucalyp von flaticon.com

The Operationalization of Sustainability in Organizational Contexts

How is sustainability implemented in companies?

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SIEMENS

At Siemens, we define sustainable development as the means to achieve profitable and long-term growth […] and internally strive for a balance along the dimensions of people, environment and profit.

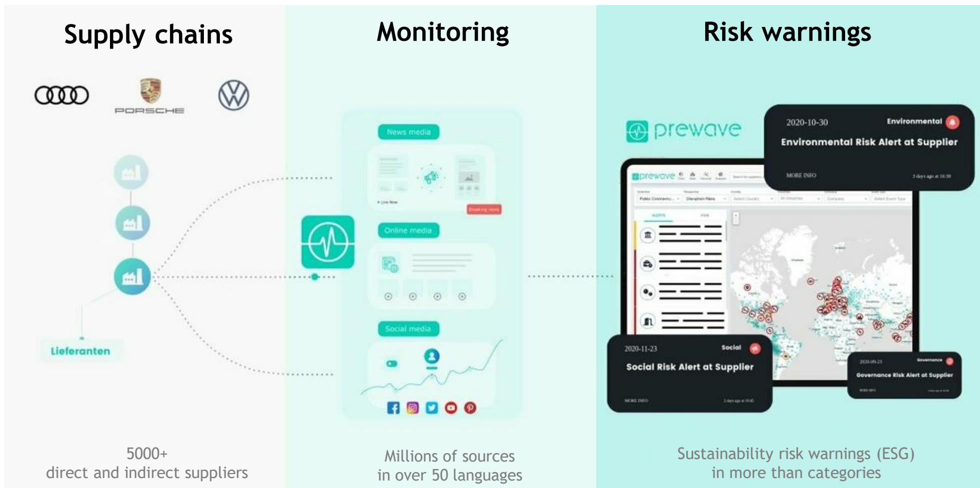
Siemens (2021)

SAP

Our focus on sustainability and social responsibility stems from our vision to improve the operations of businesses and the lives of people around the world. We know that social, environmental and economic activities and performance influence each other and have tangible interactions. Our efforts are therefore aimed at a future for our company, our customers and society that is shaped by sustainability.

SAP (2021)

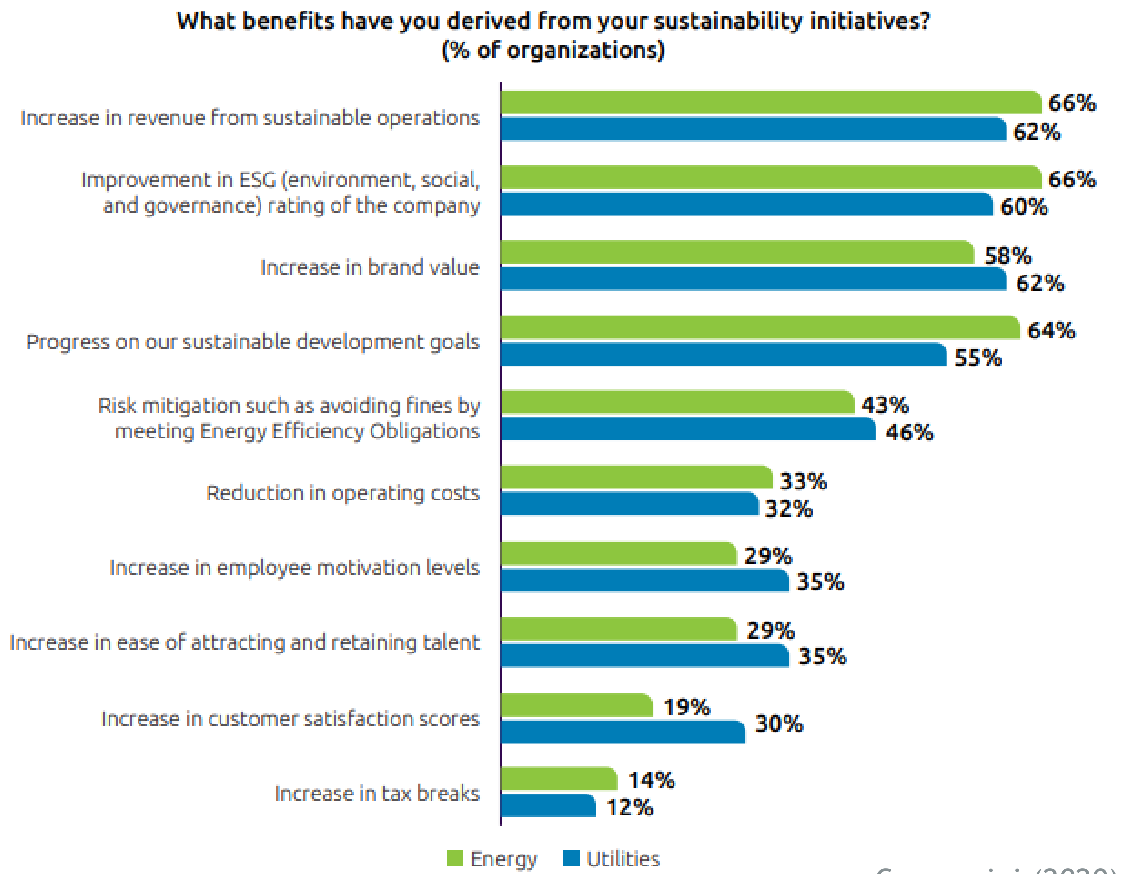
The digital early warning system for sustainability risks used by Audi together with Volkswagen and Porsche collects publicly available news in more than 50 languages and from around 150 countries. Since the AI developed by Austrian start-up Prewave uses automatic speech recognition to understand the meaning of the respective messages, potential sustainability violations can be identified flawlessly.



Umweltdialog (2021)

Logos are the intellectual property of the individual companies.

Why is sustainability relevant for companies? Opportunities



Capgemini (2020)

Sustainability has become a central field of action for companies, also because many stakeholders such as consumers or investors demand transparency regarding sustainable engagement.

Stechele (2016)

Why is sustainability relevant for companies?
Risks

Cobalt Lawsuit Against Tech Giants Over Child Labour A 'Global Flashpoint Of Corporate Social Responsibility'

"The shocking state of child labourers mining for cobalt in Africa has been thrust into the global spotlight after tech giants Apple, Google, Microsoft, Tesla and Dell were sued this week for their role in how this essential element ended up in their products."

"There is significant potential impact for these firms. […] not nearly as expensive as class action lawsuits they may face in many jurisdictions in future, along with massive reputational damage.'"

"The most obvious route is to apply the 'blood diamonds' principle to cobalt, thereby 'ensuring that provenance of is traced to ensure only ethically-mined minerals are purchased. Oracle and a partner company, Circulor, has developed a blockchain specifically to track cobalt.'"

"Apple has demonstrated the dangers of being seen to be complicit in child abuse. Organisations ranging from labour rights to human rights groups are becoming increasingly engaged in the issue, and it will probably lead to an entirely new approach to ensure ethical supply chains."

Forbes (2019)

Greenwashing as a threat to sustainable management

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Greenwashing

Greenwashing refers to the deliberate advertising of actually non-existent ecological efforts in a company, or when a company spends more money advertising the company as "green" than is actually invested in ecological measures.

Olsen und Potucek (2013)

Image: https://www.flickr.com/photos/hikingartist/5727271982

Greenwashing increases customers' general skepticism about companies' claims related to sustainability.

This harms not only the "greenwashing" company, but also those that are genuinely concerned with sustainability and ultimately reduce the incentive for companies to develop sustainably or advertise sustainable measures.

Polonsky et al. (1998)

Organizations' Sustainability Management and Goals

Three pillars of sustainability: optimization model

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! Sustainable management means maximizing a target function under constraints of long-term resource availability.

Possible target function:

$$\max \sum_{\substack{i.\epsilon.\{economical,\\ ecological, social\}}} w_i \cdot t_i(\overrightarrow{PF})$$

Under the constraints:

$$V\ (Knowledge) \leq reg\ (Knowledge)$$

$$V\ (Work) \leq reg\ (Work)$$

$$V\ (Raw\ materials) \leq reg\ (Raw\ materials)$$

$$V\ (Capital) \leq reg\ (Capital)$$

$$V\ (Environment) \leq reg\ (Environment)$$

...

Possible target function:

$$\max \quad t_{i=economical}(\overrightarrow{PF})$$

? Is it sustainable management if only economic success is maximized?

Notation	Explanation
w_i	Weighting factor of output
t_i	Transformation function of the production factors (PF)
$\overrightarrow{PF}$	Vector of production factors (e.g., knowledge, labor…)
$V(PF_j)$	Consumption of production factor j (PF_j)
$reg\ (PF_j)$	Regeneration of production factor j (PF_j)

Possible sustainability goals

Sustainability

	Ecological responsibility	Economic responsibility	Social Responsibility
Social sustainability	• Climate protection • Landscape protection • Preservation of biodiversity • Efficient use of resources • …	• Creation of long-term prosperity • Promotion of education • Creation of favorable economic policy conditions • …	• Creation of a sustainable and livable society • Individual development • Participation in the community • …
Corporate sustainability	• Low pollutant emissions • Reduced resource consumption • Recycling • Closed loop supply chain • …	• Profit maximization • Return on investment • Market share • Growth • Efficiency • …	• Good and enough jobs • Employee satisfaction • Safe workplaces • Tax payments • Social commitment • Labor protection • …

based on Ernst und Sailer (2013, S. 27)

How can an Organization be aligned with Sustainability?

Possible steps to align a company towards sustainability

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Steps towards corporate sustainability	Explanation
1 Clear target system	• A clear picture of corporate sustainability as a prerequisite for alignment / transformation
2 Decision model	• Development of a transparent multi-criteria decision-making model for evaluating the measures within the field of action • Decisions in the context of sustainable management are multi-criteria due to the three pillars / dimensions / spheres. • No simple optimization to an integrated (financial) key figure is possible.
3 Operationalization / implementation	• Prerequisites for operationalization of the issue • Difficulties in implementation
4 Reporting	• Guidelines for reporting quality (GRI standards) • Transparency and comparability

Business model innovation (towards sustainability)

Innovation: Definitions and perspectives

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1. The introduction of something **new** (an activity)
2. A **new** idea, method, or device (a novelty)

merriam-webster.com

Realization of a novel, advanced solution to a particular problem, …
…in particular the introduction of a **new product** or the application of a **new process**.

duden.de

Innovation is a process that is initiated irregularly and with different objectives. Important distinguishing features from routine tasks are novelty, the associated **uncertainty**, **complexity** and **interdisciplinarity** as well as potential **conflict**.

Granig, Perusch (2012)

Innovation is the implementation of **new technical, economic, organizational and social solutions** to problems in a company.
It is aimed at fulfilling corporate goals in a new way.

Pleschak, Sabisch (1996)

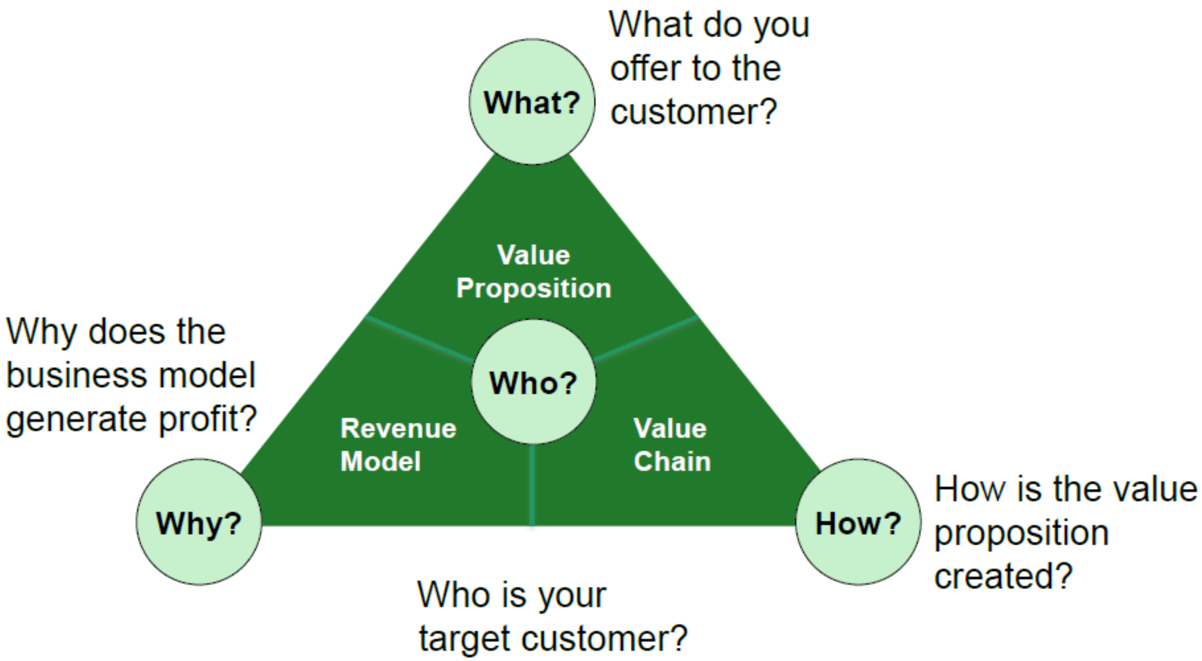
Novel means-end combinations: Technology opens up new means, the demand wants to fulfil new purposes/ends.

- Marginal innovation through market penetration (novelty lies in improved target-means ratio)
- Technical innovation: New technology for unchanged purpose
- Market innovation: New purpose satisfied with known means
- Radical innovation: fulfilling new purposes with new means

Technological innovation often creates **temporary monopolies**, allowing **abnormal profits** that can be competed away by rivals and imitators. These temporary monopolies are necessary to provide the incentive for firms to innovate.

Schumpeter (1926)

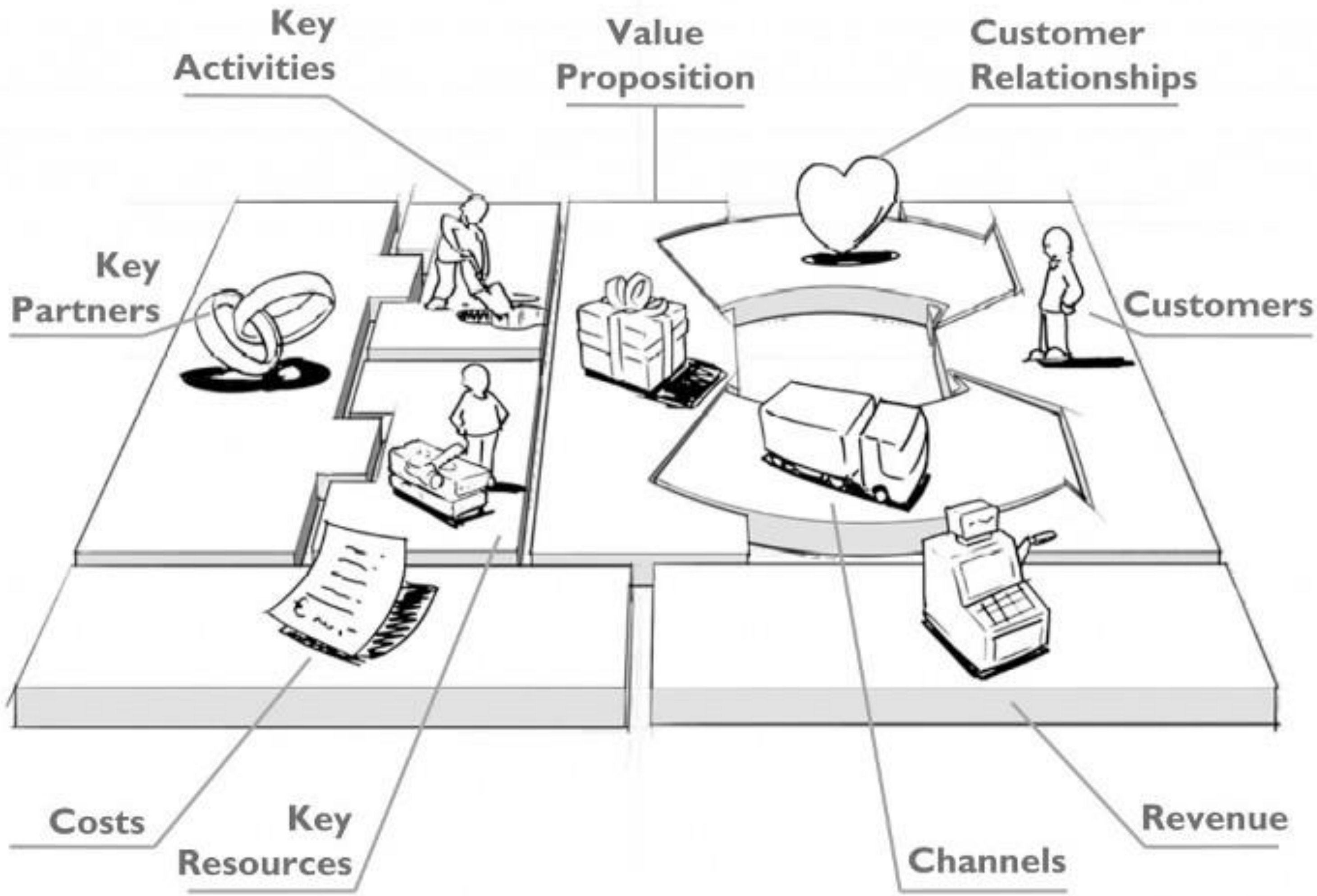
The Business Model Triangle



Business model innovation means changing at least two of a business model's dimensions

Gassmann, Frankenberger, Csik (2013)

The Business Model Canvas



Drawing by JAM, Structure by Osterwalder, Pigneur (2010)

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Slide deck 3: Circular Economy
2022

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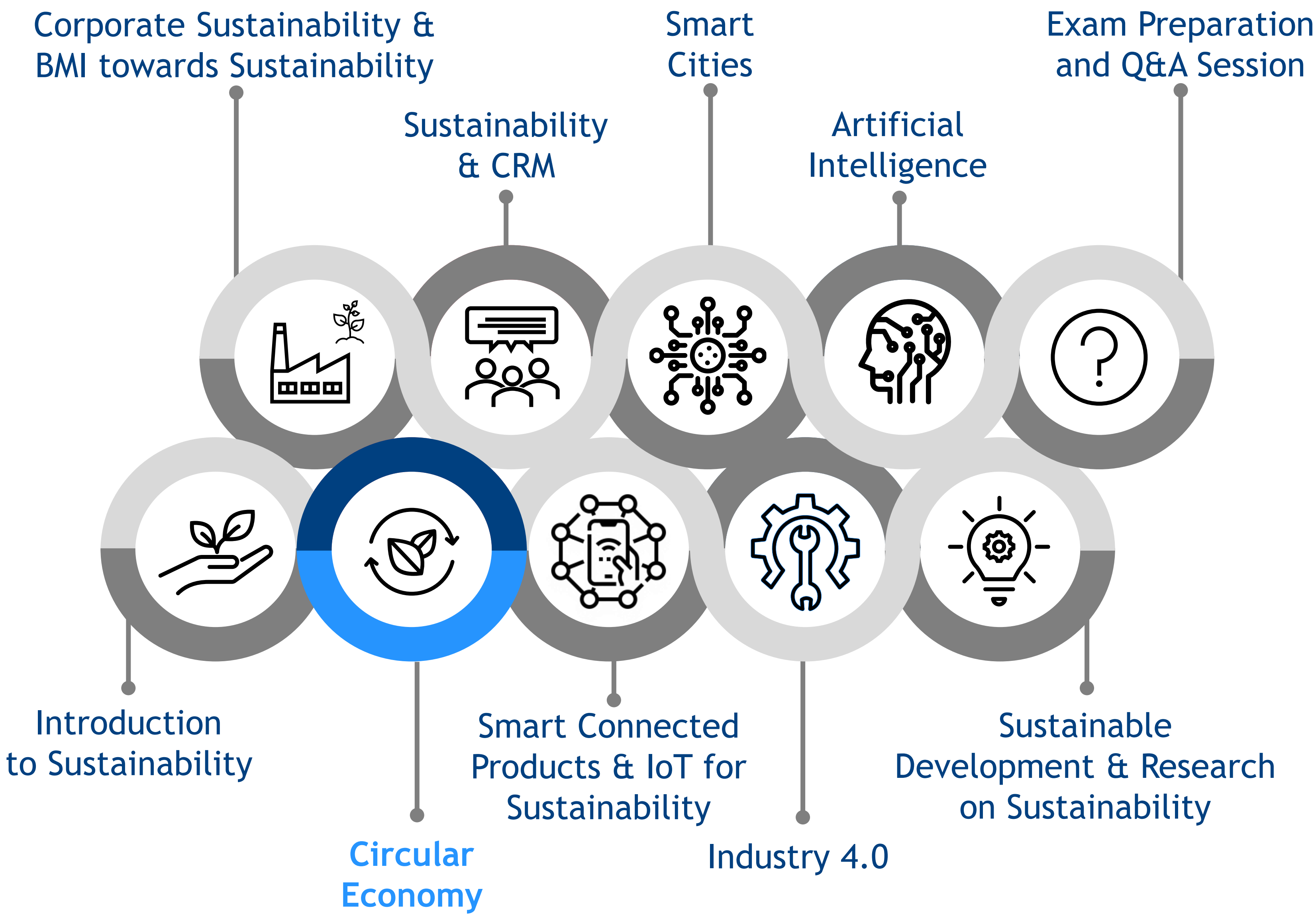
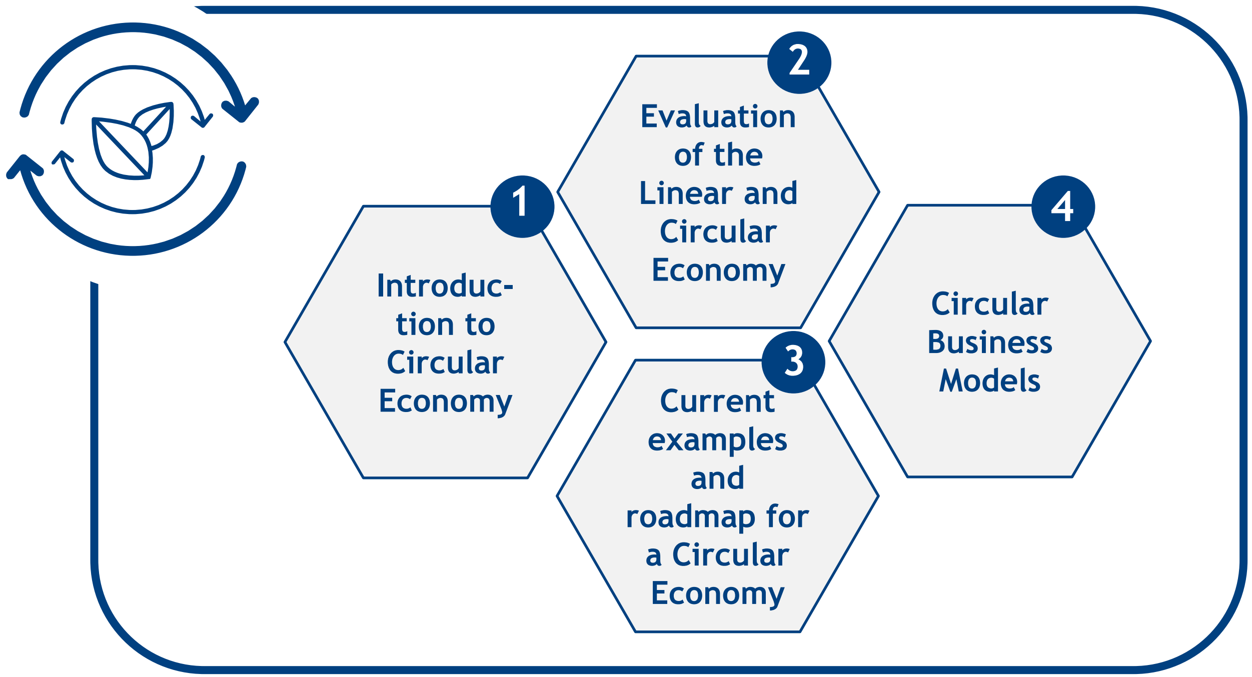
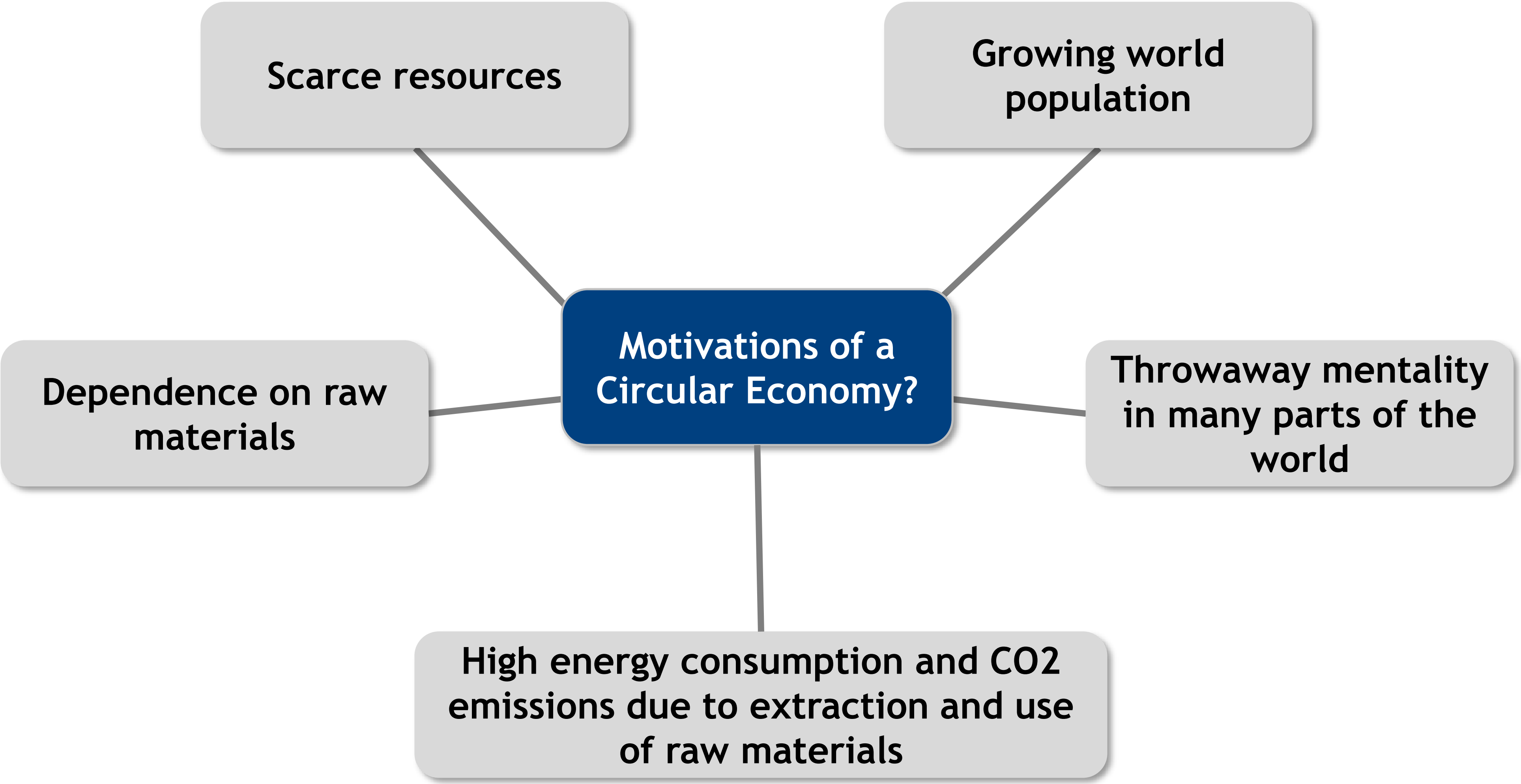


Agenda - Circular Economy



Introduction to Circular Economy

What is the motivation of a Circular Economy?



europa.eu (2021a)

The three key principles of the Circular Economy

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Circulate products and materials

Design products to be reused, repaired, or remanufactured. When it comes to products like food or packaging, get the materials back so they don't end up in landfill.

Eliminate waste and pollution

Waste and pollution are the consequences of decisions made at the design stage. Harness new materials and technology, to ensure waste and pollution are not created in the first place.

Regenerate nature

There is no concept of waste in nature. Instead of trying to do less harm, return valuable nutrients to the soil and other ecosystems to enhance the natural resources.

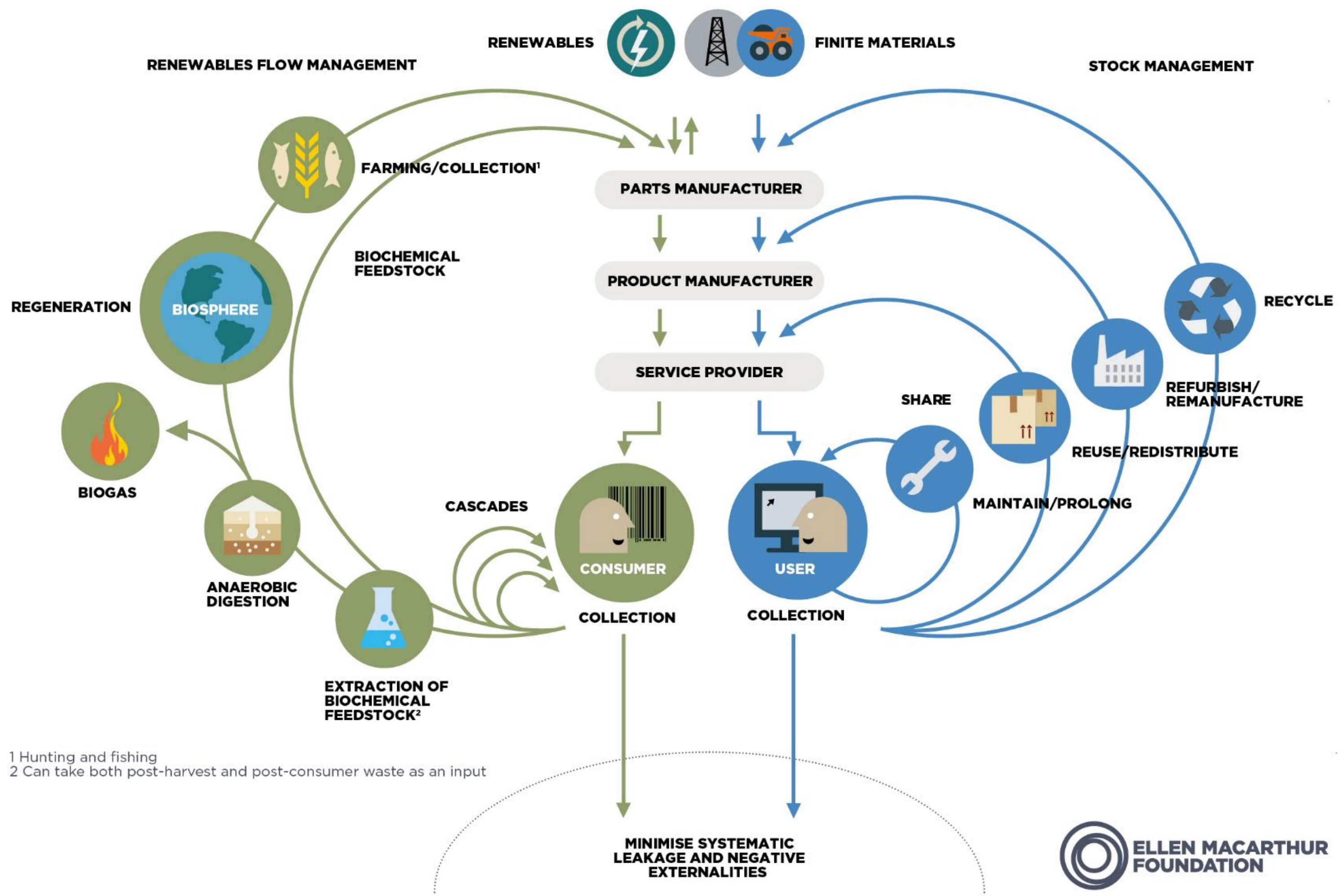
ellenmacarthurfoundation.org (2021a)

Native® Produtos da natureza

"The Balbo Group grows organic sugar. […] The Group developed a harvester with low pressure tyres to avoid harmful compaction. It cuts cane and shreds by-products at the same time to return 20 tonnes of previously unused organic material per hectare each year."

ellenmacarthurfoundation.org (2021b)

The circularity of renewable and finite materials



ellenmacarthurfoundation.org (2019)

Reuse

The repeated use of a product or component for its intended purpose without significant modification.

Refurbish

Return a product to good working order. This can include repairing or replacing components and improving cosmetic appearance.

Remanufacture

Re-engineer products and components to as-new condition with the same, or improved, level of performance as a newly manufactured one.

Recycle

Transform a product or component into its basic materials or substances and reprocessing them into new materials.

ellenmacarthurfoundation.org (2021c)

Sources of value creation in a Circular Economy

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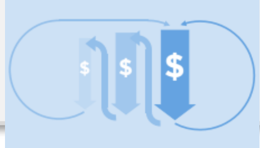
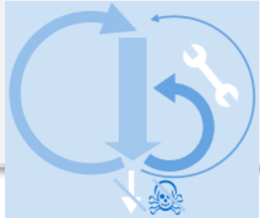
Inner circles > outer circles:
The tighter the circles, the larger the savings of a Circular Economy (in terms of ,e.g., material, labor, energy and capital, as well as greenhouse gas emissions or toxic substances)

Circling longer:
Keeping products, components, and materials in use longer within the Circular Economy (by more consecutive cycles (e.g., multiple consecutive refurbishments of an engine core) or by spending more time within a cycle (e.g., extending the use of a washing machine from 1,000 to 10,000 cycles)

Cascaded use and inbound material substitution:
Opportunity in the cascading of products, components or materials across different product categories (e.g., transforming cotton-based clothing into fiberfill for furniture and later into insulation material)



Non-toxic and easier-to-separate designs:
Improvements in the original design of products (e.g., ease of separation and material substitution to enable lower scrap rates during reprocessing and reduced contamination of material streams during and after collection)



Ellen MacArthur Foundation (2013)

Evaluation of the Linear and Circular Economy

Difference between a Linear and Circular Economy

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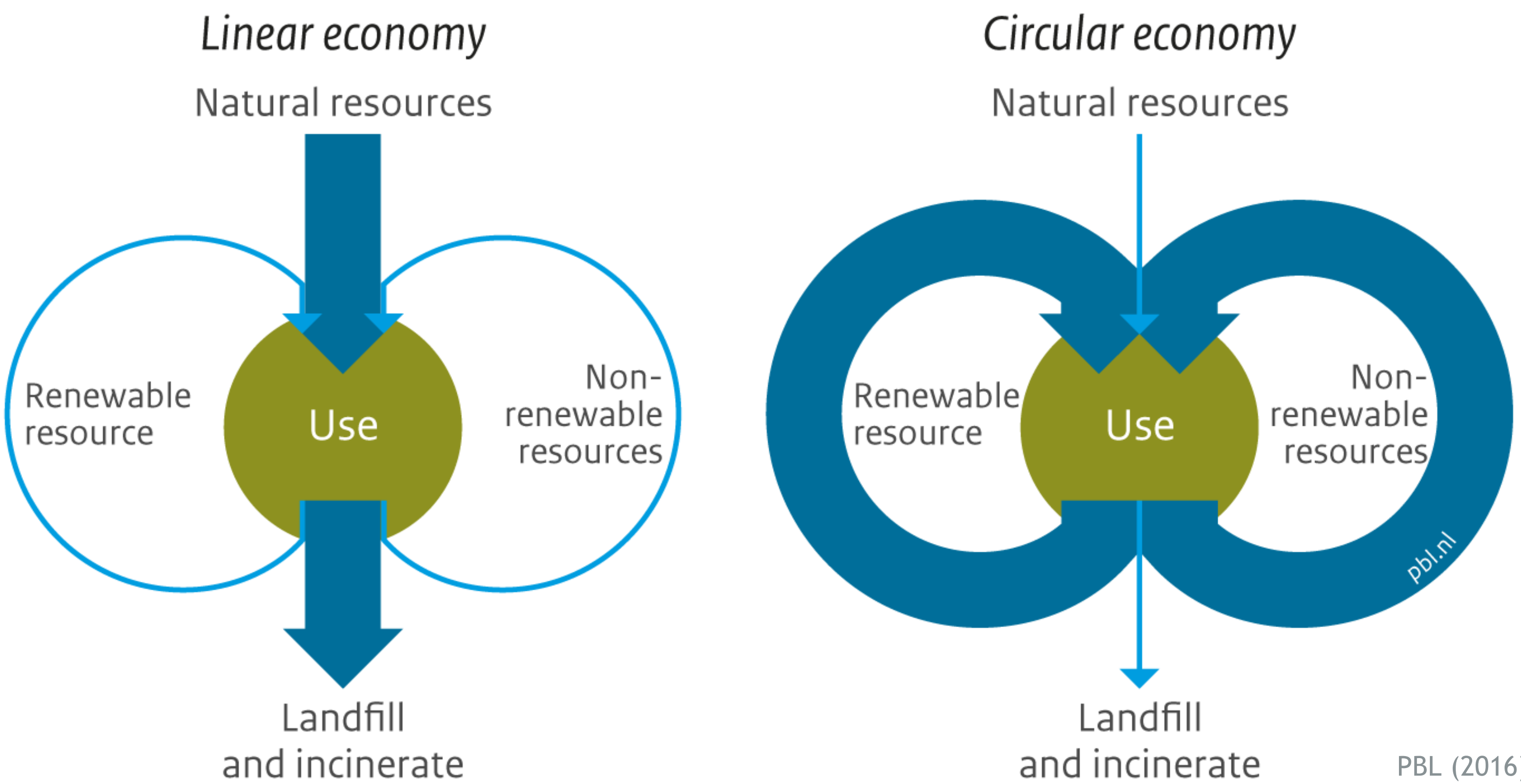

PBL (2016)

!

"The circular economy is seen as a logical alternative to a linear economy. In a linear economy, natural resources are **extracted** for producing materials that are **manufactured** in products to be **incinerated or landfilled after use**. The essence of a circular economy is to preserve natural resources by **retaining the quality and value** of products and their parts, and the materials."

PBL (2017)

Disadvantages of the Linear Economy

Ecological disadvantages

Take-make-dispose mentality

- High energy and water consumption, emission of toxins and destruction of natural capital such as forest and lakes due to **extraction of raw materials**
- Often high energy and water consumption and emissions of pollutants during **manufacturing** of products
- Space-consuming and pollutant emitting **disposal**

Economic disadvantages

Uncertainty in supply of materials

- **Increase in level and fluctuation** of raw material prices
- **Limited availability** of critical materials used in various industries
- Geopolitical **dependence** on materials
- **Increase in material demand** due to population and welfare growth

bmz.de (2019)

"Electronic and electrical waste, or e-waste, covers a variety of different products that are thrown away after use. […] **Less than 40%** of all e-waste in the EU is **recycled**. […] Discarded electronic and electrical equipment contains potentially harmful materials that pollute the environment and increase the risks for people involved in recycling e-waste."

europa.eu (2020a)

kenniskaarten.hetgroenebrein.nl (2021)

Advantages of a Circular Economy

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Ecological advantages

- **Conservation** of resources
- **Reduction** of pollutant and greenhouse gas emissions

Maga et al. (2018)

Social advantages

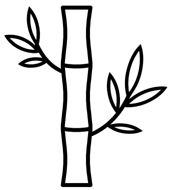
- **Reduced consumer costs** through Circular Economic Model in the electronics and electrical sector
- **More jobs** in the Circular Economy created through new business models and e-waste entrepreneurs

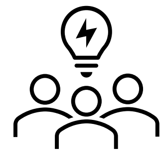
World Economic Forum (2019)

Economic advantages

- Increased raw material supply **security**
- Increased **competitiveness**
- Fostered **innovation**, **growth** and **employment**

europa.eu (2021a)





European Commission

"The circular economy will have net positive benefits in terms of GDP growth and jobs' creation, since applying ambitious circular economy measures in Europe can **increase the EU's GDP** by an additional **0.5%** by 2030 **creating around 700,000 new jobs**."

europa.eu (2020b)

Challenges and criticism

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Achievability and desirability

- **No infinite** reusing, remanufacturing and recycling of materials
- Possibly, high recycling rate **more expensive** than value of the recovered material
- In some cases, a lot of **produced waste** and **high energy consumption** through recycling, remanufacturing, etc.
- **Rebound effects**, so that increased consumption diminishes environmental gains

Missing social sustainability

- **More human labor** needed for additional processes such as refurbishing or recycling, but jobs may **not be created locally**
- Created jobs possibly under **inadequate conditions** (e.g., toxins in the textile industry)

Lack of strategic guidelines

- **Difficult to provide general guidelines** for implementation of a Circular Economy because of need for individualized or sectoral approaches
- Environmental **advantages of not fully recyclable materials** (e.g., lightweight components) could outweigh the disadvantage of non-recyclability

Korhonen et al. (2018), circular.academy (2019)

Current examples and roadmap for a Circular Economy

Examples for Circular Economy

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Gerrard Street

Subscription service for modular headphones: **Extended lifetime** because of easy order of module, disassembly and reparation

- **Recovery** and **recycling** of headphones at the end of their life through a subscription model
- **Reuse** of 85% of components

ellenmacarthurfoundation.org (2021d)

BioPak

It doesn't cost the earth

Compostable foodservice packaging made from **renewable** plant-based materials

- Circular model through **collection** and **composting service**
- Contribution of the compost to the **preservation** of **healthy soils**

ellenmacarthurfoundation.org (2021e)

Hilti

"Our first steps to improving our ecological footprint are: placing focus on reducing CO2 emissions and introducing the ideas of a **circular economy**. [...]

- We already consider the ability to **recycle** the materials we use in the development stage of our products.
- During production, we **minimize the use of water and energy** and continuously reduce the amount of **production waste**.
- The quality, **durability** and **repairability** of our products are central to this.
- The "**use instead of own**" approach for a wide range of Hilti equipment is becoming increasingly popular with our customers."

hilti.group (2021)

Logos are the intellectual property of the individual organizations.

Current regulations in Europe

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European Green Deal

Set of policy initiatives presented from 2019 regarding the transformation of the EU to a **modern**, **resource-efficient** and **competitive economy** that

- emits **zero net greenhouse gases** by 2050,
- **decouples** its growth from **resource use**,
- **leaves no one**, human or region, **behind**.

europa.eu (2021b)

international.tum.de (2020)

Circular Economy Action Plan

One of the main building blocks of the European Green Deal

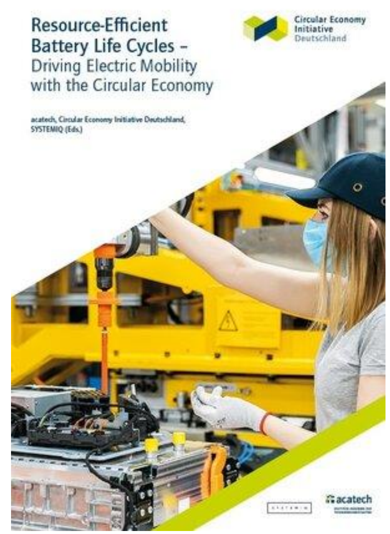
- **Make sustainable products the norm**: Products designed to last longer, easier to reuse, repair and recycle, and use of as much as possible recycled material
- **Ensure less waste**: Avoidance of waste, transforming it into high-quality secondary resources
- **Focus on sectors using the most resources and where the potential for circularity is high**: Electronics and ICT, batteries and vehicles, packaging, plastics etc.
- **Empower consumers**: Access to reliable information regarding the reparability and durability of products for environmentally sustainable choices

europa.eu (2020c)

Current action in Germany

Circular Economy Initiative Germany

- Initiative established in 2019 with funding from the Federal Ministry of Education and Research
- More than 50 institutions from business, science and civil society involved
- Development of a **Circular Economy Roadmap** including concrete recommendations for action focusing on:
  - Circular business models and **digital technologies as innovation drivers**
  - New value networks for traction batteries
  - New value networks for packaging



circular-economy-initiative.de (2021)

The role of digital technologies

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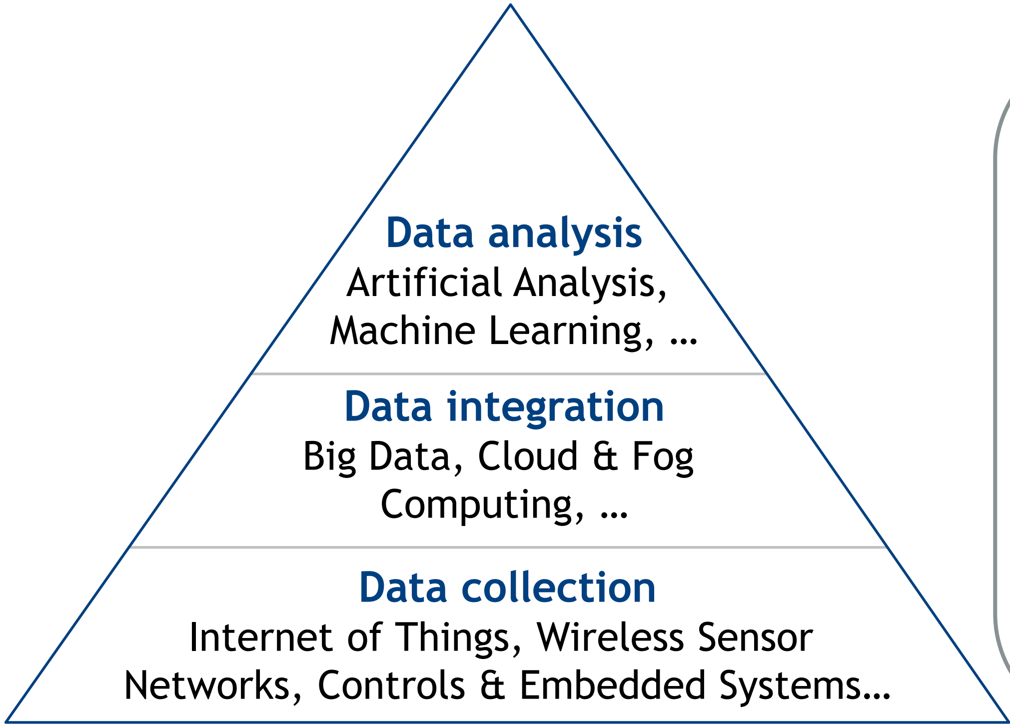
Digital Circular Economy

- Based on **strong integration** and **connection** of the value chain
- High degrees of **transparency** and **information** required



Smart Circular Economy framework

Different levels of **implementing digital technologies** for decoupling value creation from the consumption of finite resources

- **Data collection** to describe use of material resources or status of product
- **Data integration** (aggregation and contextualization) to provide concise overview ("What happened to the resource?")
- **Data analysis** to set up predictive or prescriptive management of materials and products ("How can use of the resource be optimized?")

▶ **Digital technologies as enabler** for the upscaling of the Circular Economy

Kristoffersen et al. (2020), European Circular Economy Research Alliance (2020)

Examples for the use of digital technologies

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impact vision

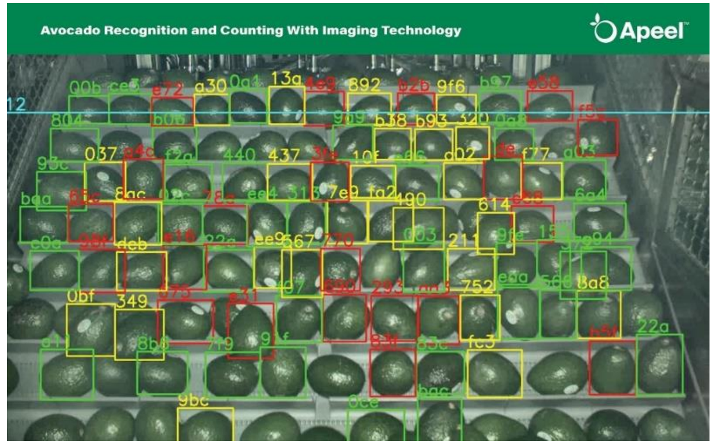
Startup ImpactVision

- Use of **machine learning** and **hyperspectral imaging**
- Automatic **assessment of the quality** of food (ripeness, freshness, nutritional density)
- **Information of the suppliers** about the ripening window, enabling the according sorting and shipping

→ **Reduction** of post-harvest **loss**, optimized distribution, and **lengthened shelf-life**

→ **Waste reduction** and **increased quality** and safety for consumers

agfundernews.com (2018), venturebeat.com (2021)



freshfruitportal.com (2021)

agrarheute.com (2021)

suez

Suez

- Sludge from wastewater treatment **reused** as **fertilizer material** in agriculture
- Use of **blockchain** for **secure traceability** of fertilizer materials
- Better **control** of the quality of agricultural inputs

→ Enabling the agricultural sector to **reduce** its **consumption of chemical** of **fossil inputs** (pesticides, fertilizers, phytosanitary products, etc.)

→ **Reuse of sludge** from wastewater treatment plants

suez.com (2021)

Circular Business Models

Strategies for circularity

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Retain product ownership (RPO)

- **Lease or rental** of the product instead of sale
- **Producer's responsibility** for the product at the end of customer's use
- Companies required to invest in **after-sales** and **maintenance** capabilities

BOSCH

Refurbishment of used tools, enabling to compete with low-cost producers

bosch-professional.com (2021)

Design for recycling (DFR)

- **Redesign** of products and manufacturing processes
- Maximization of **recoverability** of involved materials
- Partnership with company with **technological expertise** to use recovered materials

xerox

Lease and full service rental of printers and photocopiers to corporate customers

xerox-leasing.de (2021)

Product life extension (PLE)

- Design of products to **last longer**
- **Durability** as a key competitive differentiator justifying premium pricing
- Opening **secondary markets** (for used products)

adidas PARLEY

Use of reworked plastic waste to manufacture shoes and clothes

adidas.de (2021)

hbr.org (2021)

Choosing the right strategy

Assessment of feasibility of the circularity strategy by answering two questions

1 How easy is it to get my product back?

- **Willingness** of customers as well as **infrastructure** to return product (e.g., plastic bottles)
- Existence of **secondary markets**: Difficulty to get back products that have a high resale value

→ **Leasing** as a possibility to recover products more easily

2 How easy is it to recover value from my product?

- Difficulty to move and recondition **heavy or bulky products** (e.g., washing machines)
- Difficulty to recover value of products with a **complex design** (e.g., small components of smartphones)
- Availability of **cost-effective** solutions for reformulating products

hbr.org (2021)

The Circularity Matrix

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TWO central questions before transformation toward circularity:

1. Access: How easy can I get my product back?
2. Process: How easy can I retrieve value from my product (regarding effort, costs, infrastructure, …)?

ONE additional question:

3. What is the embedded value of my products?

(= The value that can be **economically** recovered from the product once it was used)

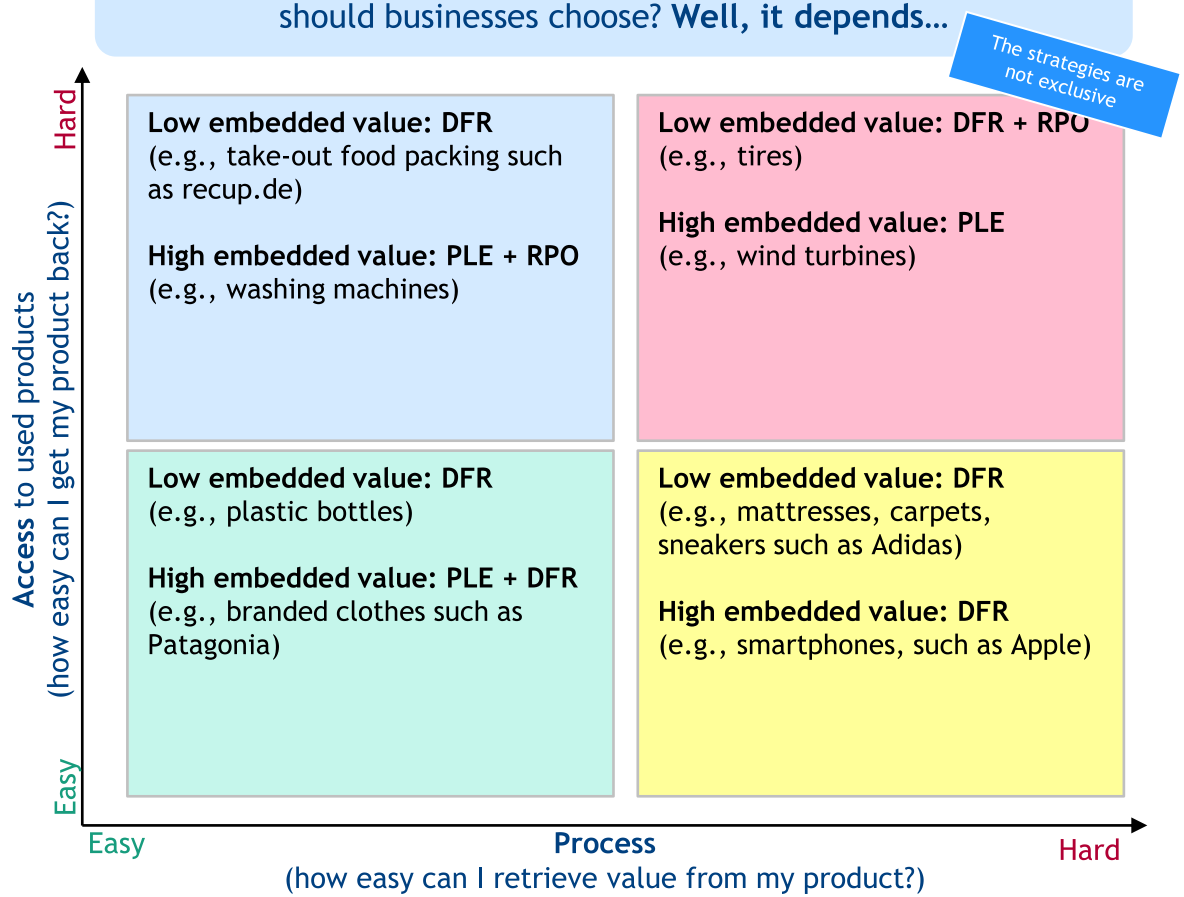
Three dominant (non-exclusive) strategies for creating a circular business model are:

RPO: Retain product ownership

DFR: Design for recycling

PLE: Product life extension

Which strategic option for creating a circular business model should businesses choose? **Well, it depends…**



Link for further optional & voluntary further reading: https://hbr.org/2021/07/the-circular-business-model

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Digital Management

University of Hohenheim

Faculty of Business, Economics and Social Sciences

Institute of Marketing and Management

Chair for Digital Management

Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 4: Sustainability and CRM (I)
2022

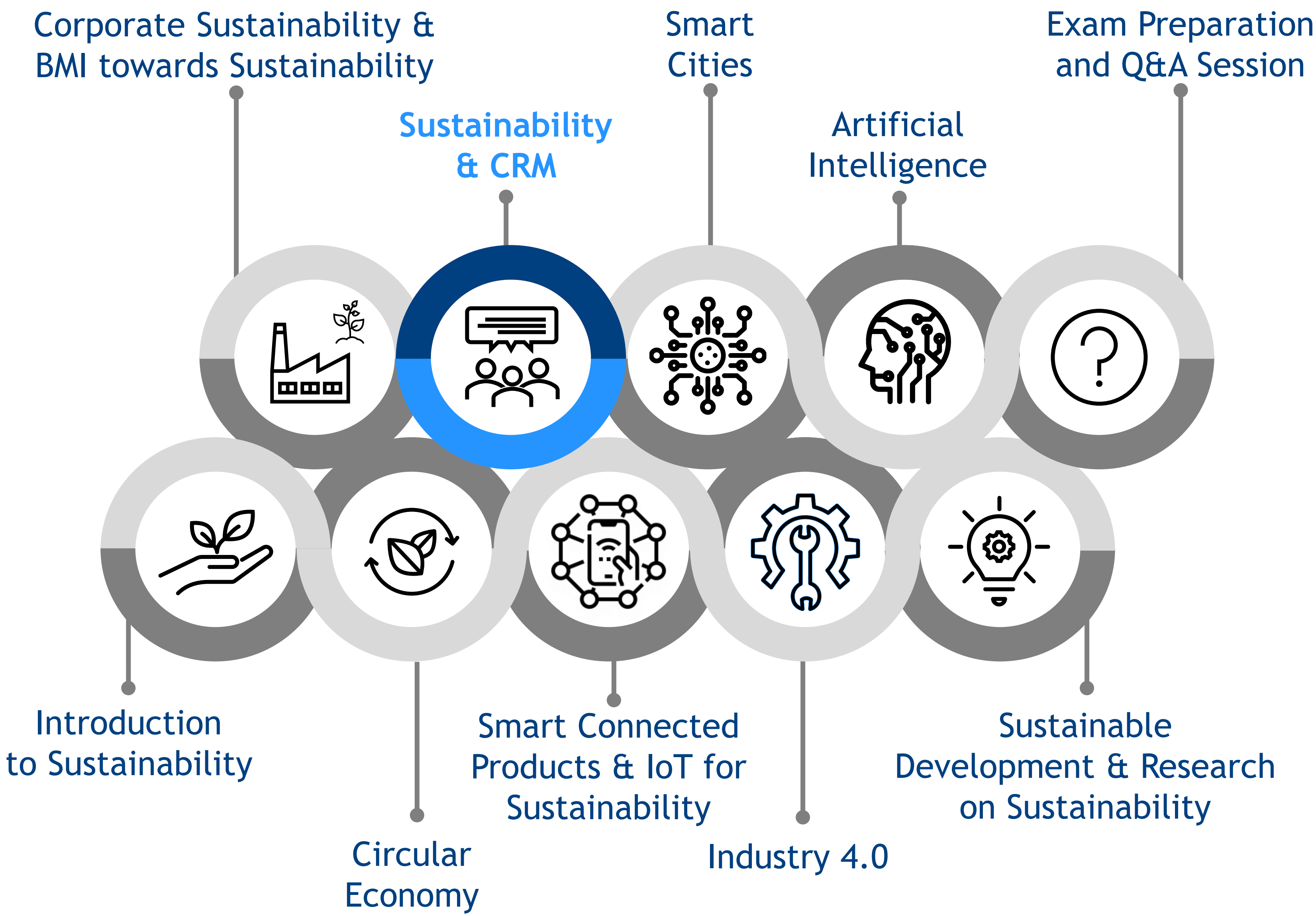
Research Center Finance & Information Management

Fraunhofer FIT
Project Group Business & Information Systems Engineering

DLA | DIGITAL LEADERSHIP ACADEMY

https://digital.uni-hohenheim.de/

Overview Smart Sustainability



Agenda - Sustainability and CRM (I)

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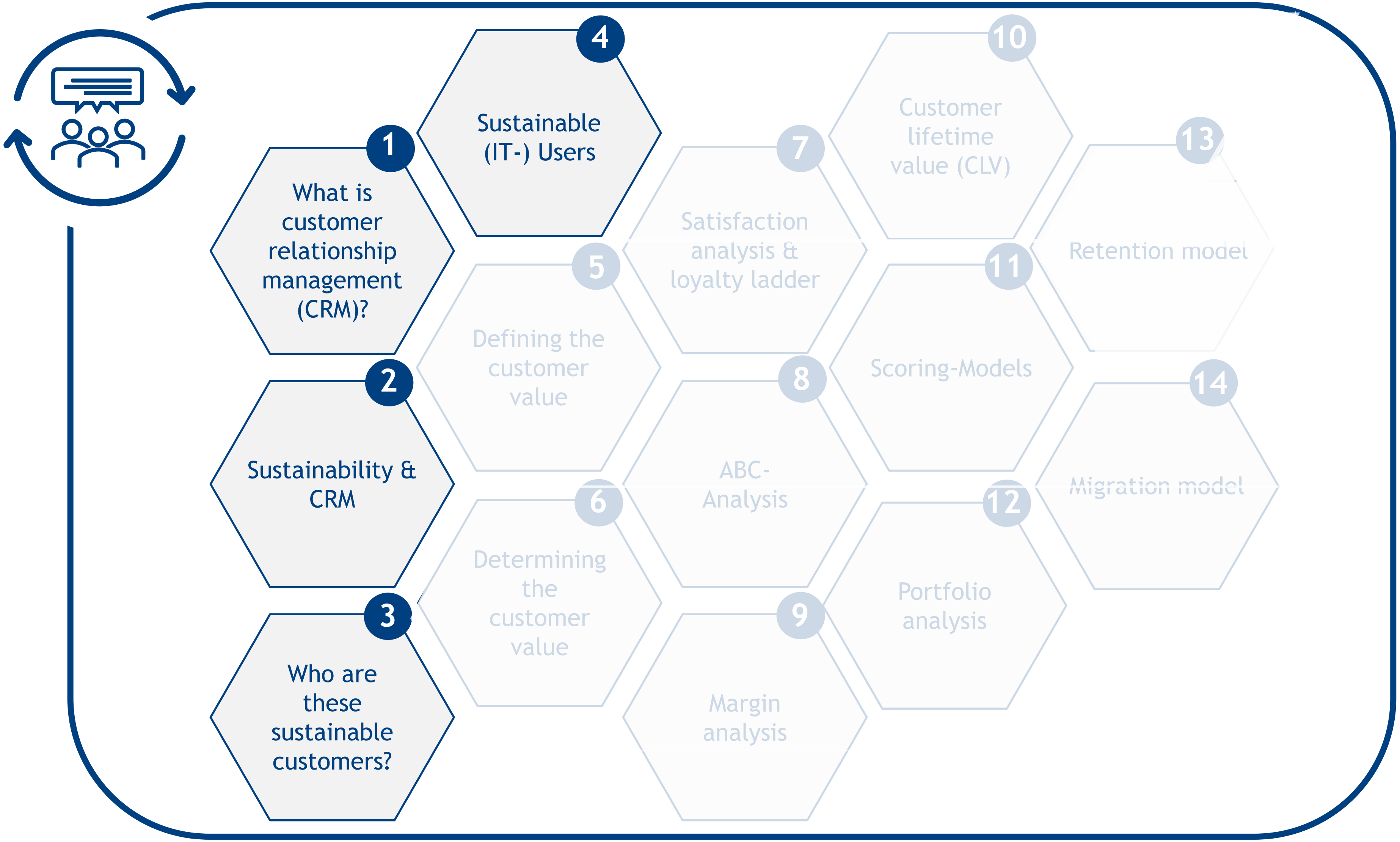

What is customer relationship management (CRM)?

Customer Relationship Management (CRM) and how it unfolds in the layered model of organization

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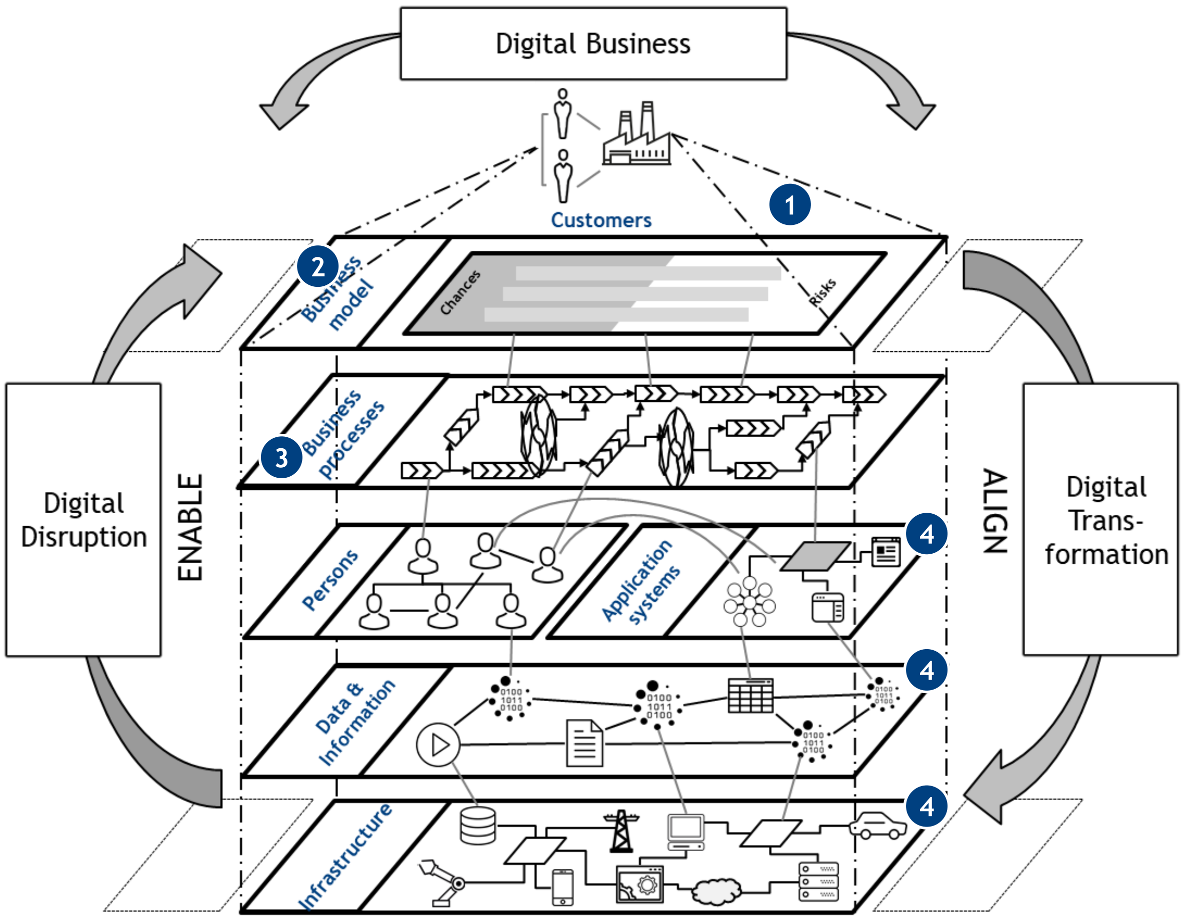


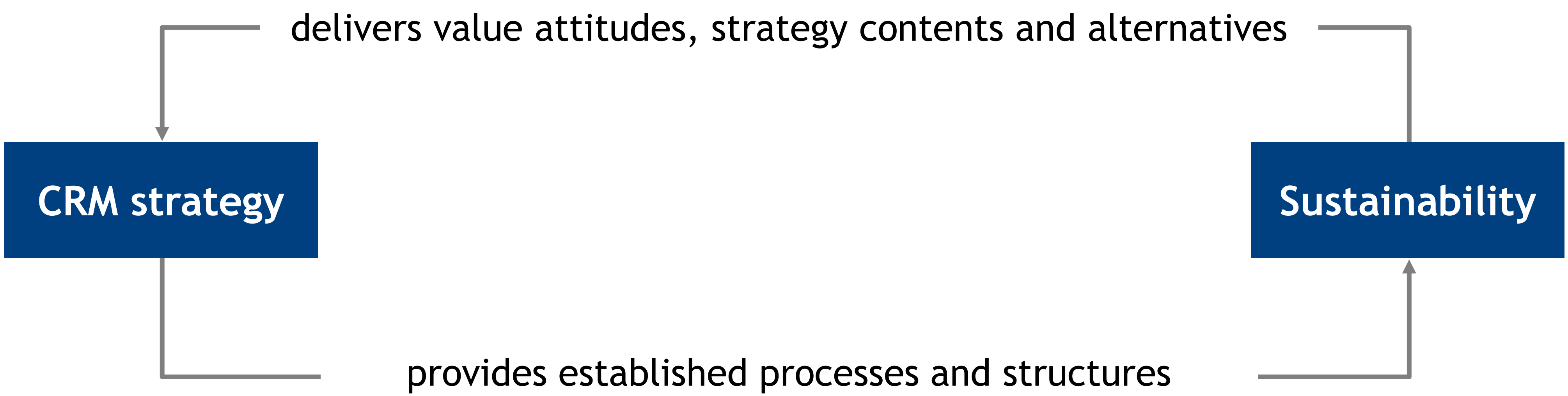
Definition

1. CRM is a customer-oriented **corporate strategy**
2. which tries to establish and **consolidate long-term profitable** customer relationships
3. through coordinated and individual **marketing, sales and service concepts**
4. with the help of **modern information technology (IT).**

Gimpel and Röglinger (2017), Leußer et al. (2011)

Sustainability & CRM

Sustainability oriented CRM



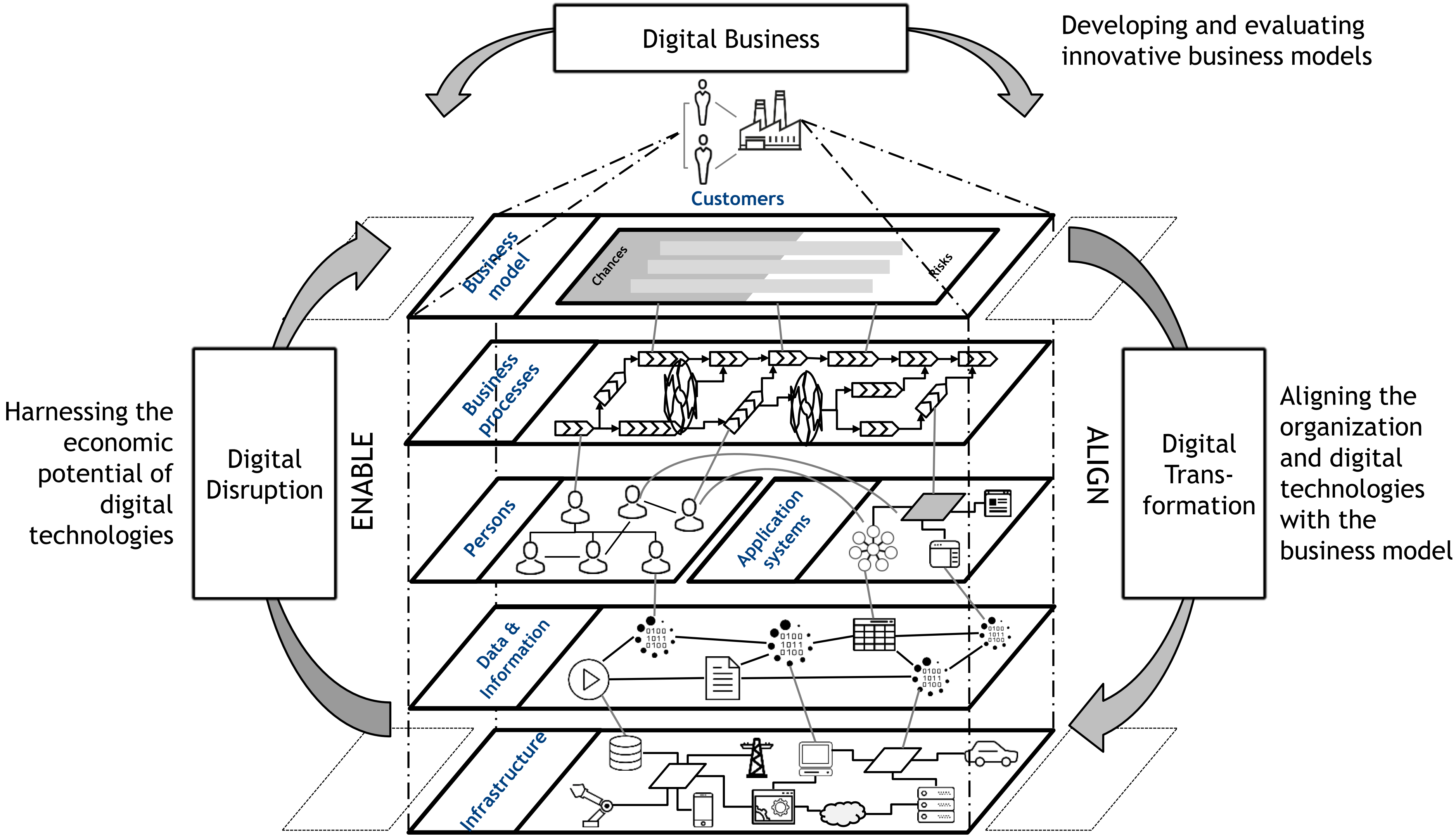
Definition

Sustainability oriented CRM is a **customer-oriented corporate strategy** which uses modern information and communication technologies, **taking into account ecological, economic and social goals,** to ensure the establishment and maintenance of long-term profitable customer relationships through coordinated marketing, sales and service concepts.

Ruhwinkel (2013)

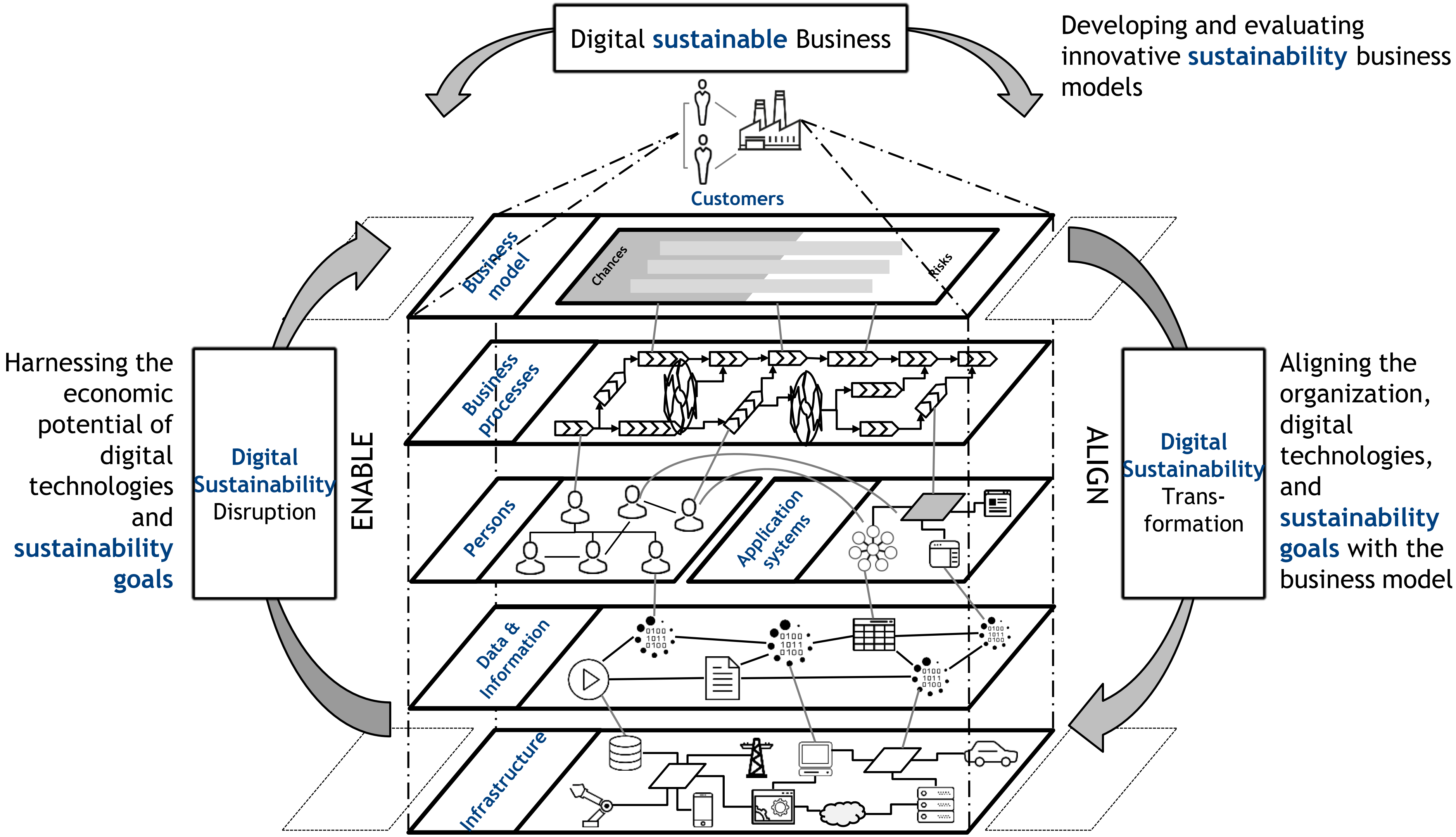
A layered model of an organization

Reminder



Gimpel and Röglinger (2017)

A layered model of a sustainable organization



Gimpel and Röglinger (2017)

Who are these sustainable customers?

Changing consumer behavior

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Green consumer

A green consumer is a consumer whose purchasing behavior is also influenced by environmental and social factors.

Shrum et al. (1995)

Green consumption

Green consumption considers purchasing decisions made on also the basis of ecological and social criteria.

Peattie (1995)

Image: Clker-Free-Vector-Images on pixabay.com

LOHAS

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LOHAS (Lifestyles of Health and Sustainability)

LOHAS refers to a market segment that endorses and promotes a variety of products, services and corporate activities that are environmentally conscious, socially responsible and sustainable for people and the planet

Lowitt et al. (2009)

LOHAS core values	LOHAS goals	LOHAS properties
Authenticity Honesty Naturalness Responsibility Engagement Activism Holistic approach Harmony Autonomy	Fair society Truth, reality Justice Healthy environment Shaping Participation Community Body, mind and soul in harmony Self-knowledge Self-realization Personal development	Critical Scrutinizing Questioning Authentic Actively engaged Social Curious Idealistic Holistic Ecological Confident Creative Ambitious Harmonious Multi-optional

based on Glöckner et al. (2010)

In addition to LOHAS, further sustainability movements and generations are forming

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Fridays for Future 25.01.2018 Berlin by fridaysforfuture CC BY 2.0

Sustainable (IT-) Users

Research Question

What factors influence individuals to behave in an environmentally sustainable manner across the different life cycle stages of information technology (IT)?

Baumbach et al. (2018)

Life Cycle of IT

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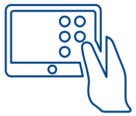
Manufacturing / Buy of IT	Use of IT	Disposal of IT

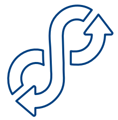
A consumer's attention to the production of IT, which can be considered within the IT purchase process.

The stage captures an individual's behavioral intention to buy sustainably manufactured IT.



Concerns an individual's behavioral intention to use IT with the aim of increasing sustainability.

An increased sustainability can either be due to adjusting energy-saving settings of IT or to buying "Green-IT".



Focuses on the way IT is disposed.

Intention is described as the behavioral intention to dispose IT sustainably.

Baumbach et al. (2018)

Where in this lifecycle does sustainability play a role from a customer's perspective?

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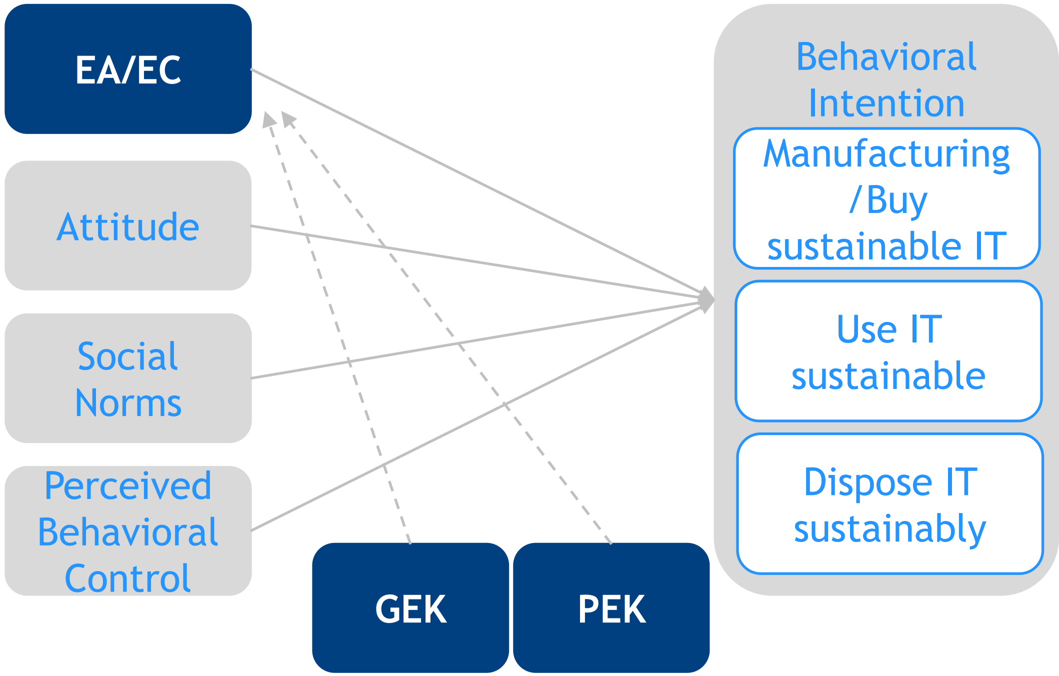

Traditional theoretical constructs (Theory of Planned Behavior)

Newly developed constructs

Life cycle stages of IT

EA/EC

ENVIRONMENTAL AWARENESS / ENVIRONMENTAL CONCERN: Concern about the environment.

When I think of the consequences of IT on the climate, I am very worried.

General EK

GENERAL ENVIRONMENTAL KNOWLEDGE: Common understanding of environmental related issues.

Fossil fuels produce carbon dioxide in the atmosphere when burned.

Personal EK

PERSONAL ENVIRONMENTAL KNOWLEDGE: Specific personal environmental knowledge and understanding

I know the meaning of the labels affixed on the sustainable technologies (e.g., energy-efficient devices).

Analysis

- Development of questionnaire
- Conduction of Online Survey >300 participants
- Application of Structural Equation Modeling

Ajzen (1985); Ajzen and Fishbein (1980); Baumbach et al. (2018)

Results and Implications

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Results

"Environmental Factors are positively related to the intention of environmentally sustainable behavior across the life cycle of IT"

Managerial Implications

Managerial Implications

1. Individuals prefer to buy IT which is sustainably produced → sustainable manufacturing and marketing campaigns
2. Individual's use IT to behave sustainable → IT may be designed to offer sustainability attributes during usage (e.g., improving carbon footprint)
3. Individuals pay attention to the disposal of IT → IT should be designed to offer simple and sustainable way of recycling

Baumbach et al. (2018)

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Digital Management

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Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 5: CRM and Sustainability (II)
2022

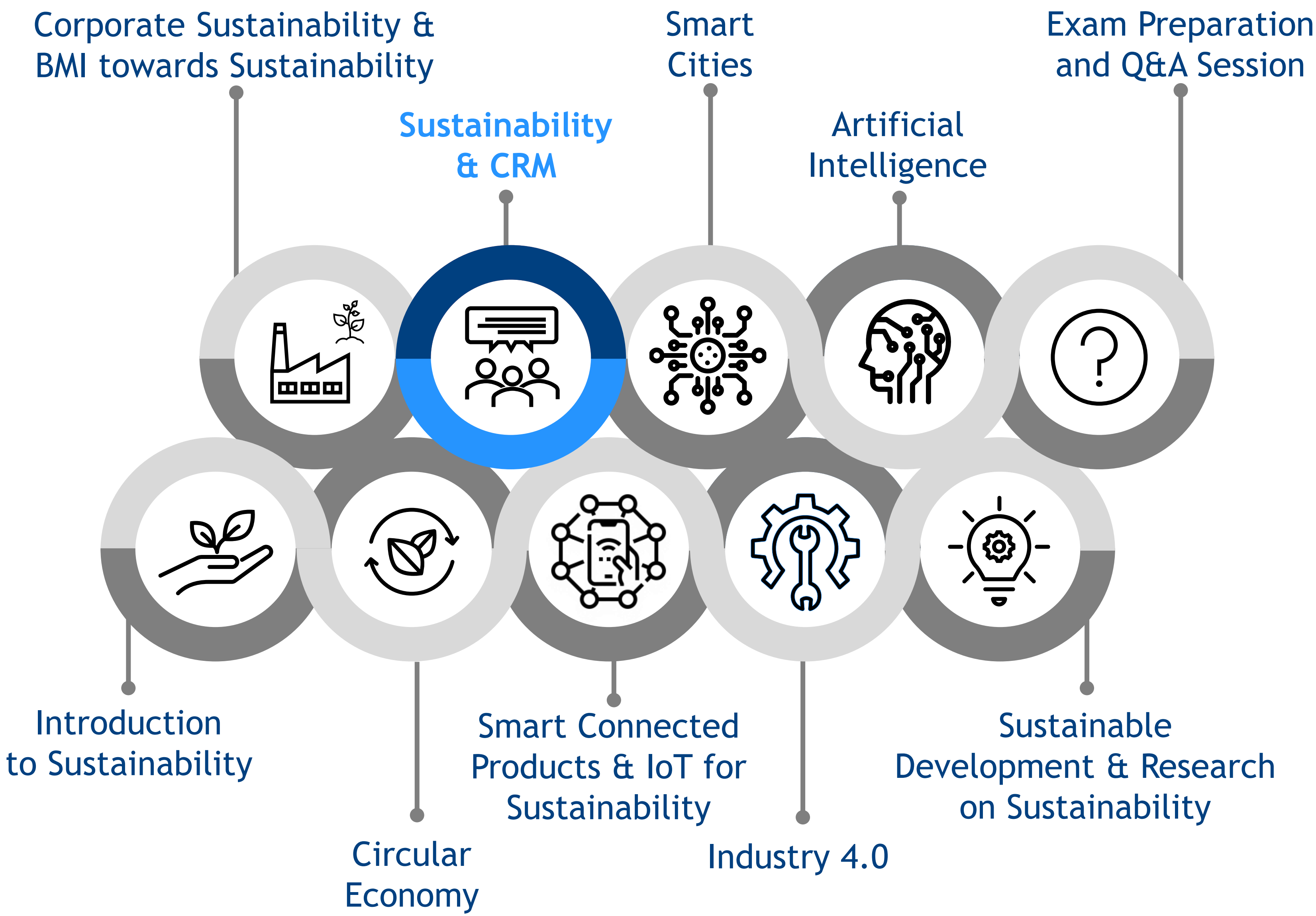
Research Center Finance & Information Management

Fraunhofer FIT Project Group Business & Information Systems Engineering

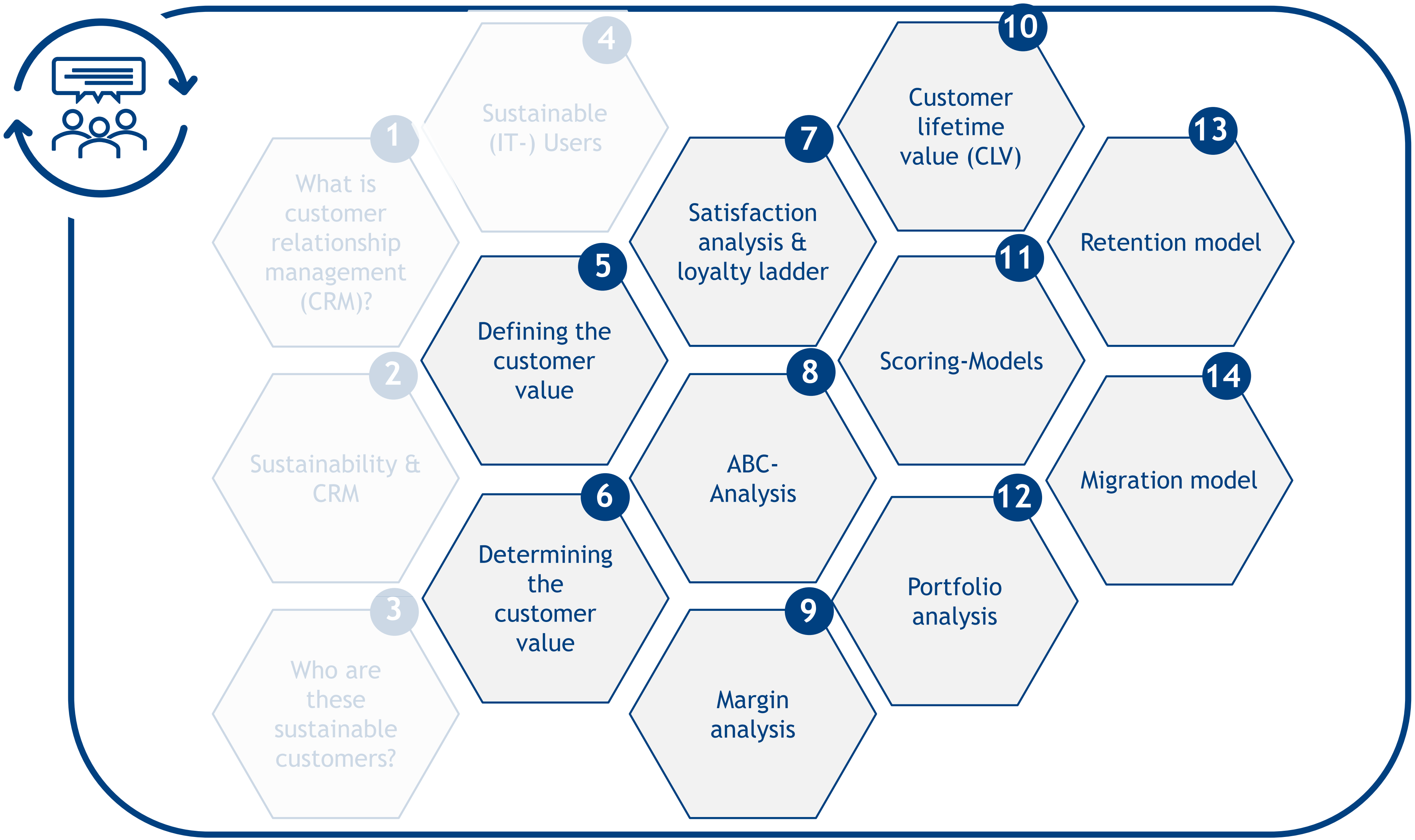
DIGITAL LEADERSHIP ACADEMY

https://digital.uni-hohenheim.de/

Overview Smart Sustainability

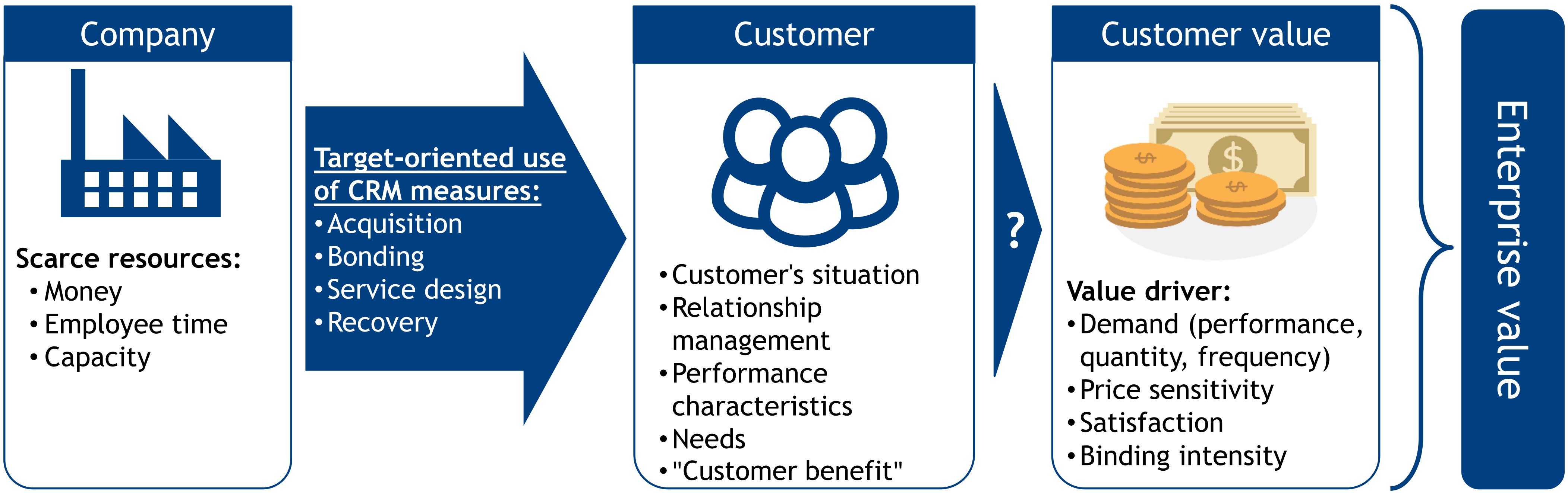


Agenda - Sustainability and CRM (II)



Defining the customer value

Customer value: control parameter for achieving the goal of “Increasing the Company's Value”



Based on Bruhn et al. (2000) resp. Cornelsen (2000)

The customer evaluation

– represents an **interrelationship** between the use of scarce resources for CRM measures and the goal of increasing company value,

– enables an **evaluation / prioritization** of CRM measures.

Customer value definition

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Definition – Cornelsen (2000)

The customer value […] is the indicator of the extent to which a customer contributes to meeting the **monetary** and **non-monetary goals** of the respective supplier.

Definition – Rudolf-Sipötz and Tomczak (2001)

In general terms, the customer value can be described as the customer-specific ranking on a company-specific measuring scale for the **overall economic importance** of a customer, i.e., their direct and indirect contribution to the goal achievement of a supplier company.

Definition – Diller (2002)

The customer value can generally be defined as the **sum of the target contributions** of a customer for the business.

Customer Value vs. Value for the Customer

"***[…] without customer value there can be no shareholder value.***"

Rappaport (1986)

Customer value

The contribution of a customer or a group of customers to the achievement of the company's objectives.

Value of the customer relationship from the company's perspective

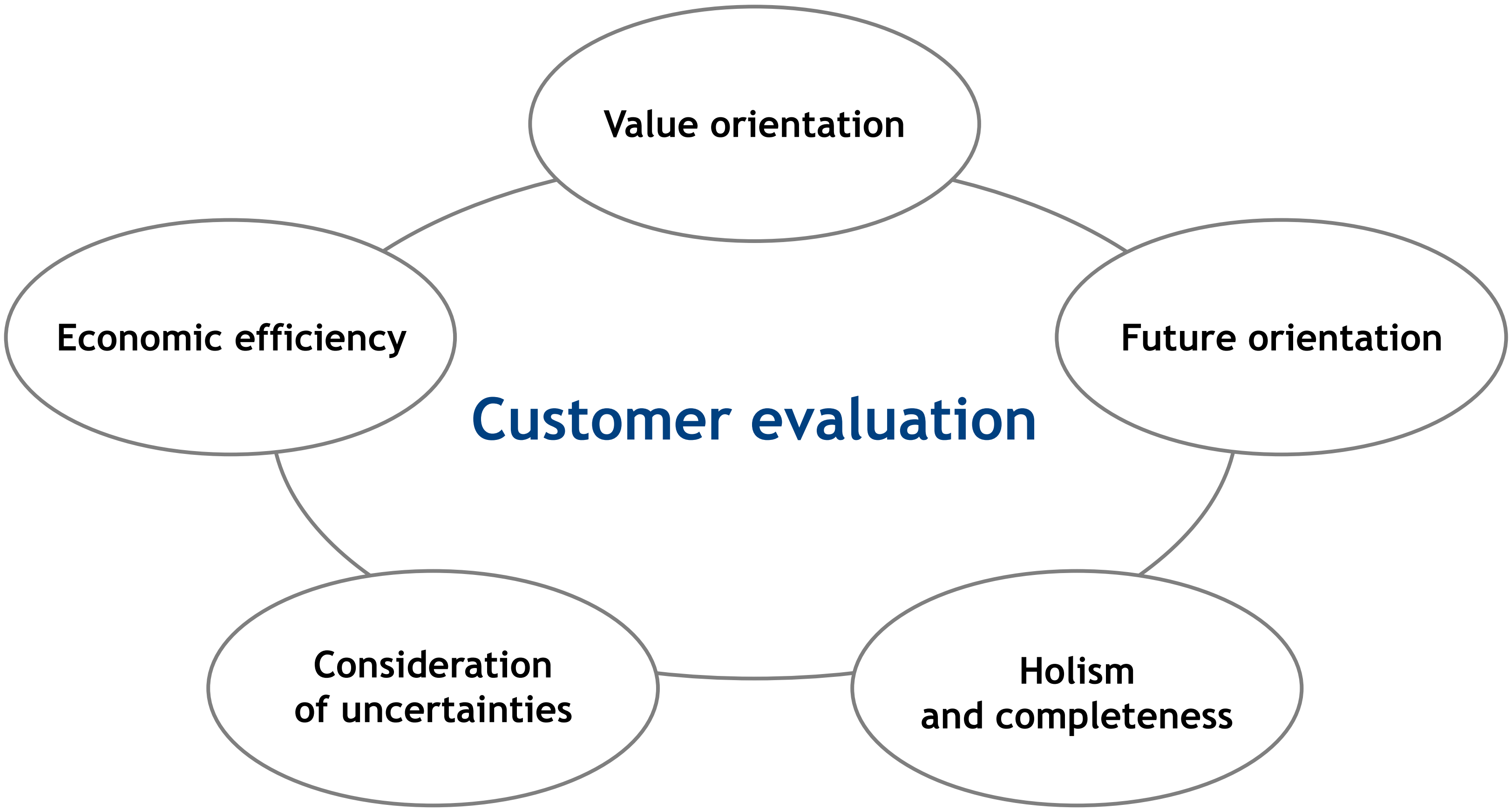
Value for the customer

The expected benefit estimated by the customer from the services or the customer relationship compared to the "costs" (net benefit) incurred by the customer.

Value of the customer relationship from the customer's perspective

Determining the customer value

Requirements for customer evaluation methods



Based on Schröder (2006)

Dimensions of customer value

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Customer value

Type

Monetary, e.g.:
- Acquisition costs
- Cross- / up-selling potential
- Cost savings

Non-monetary, e.g.:
- Increase in product acceptance due to sustainability
- Information potential
- Recommendation potential

Temporal dimension

Historical, e.g.:
- Customer value assessment carried out in the past

Future-oriented, e.g.:
- Customer value assessment extrapolated for the future

Overview of customer evaluation methods

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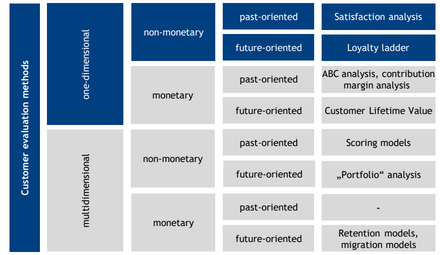
Customer evaluation methods		Type	Temp. dimension	Chosen methods
	one-dimensional	non-monetary	past-oriented	Satisfaction analysis
			future-oriented	Loyalty ladder
		monetary	past-oriented	ABC analysis, contribution margin analysis
			future-oriented	Customer Lifetime Value (+ extensions)
	multidimensional	non-monetary	past-oriented	Scoring models
			future-oriented	"Portfolio" analysis
		monetary	past-oriented	-
			future-oriented	Retention models, migration models

Based on Günter and Helm (2011)

Satisfaction analysis & loyalty ladder

Satisfaction analysis & loyalty ladder



Satisfaction analysis

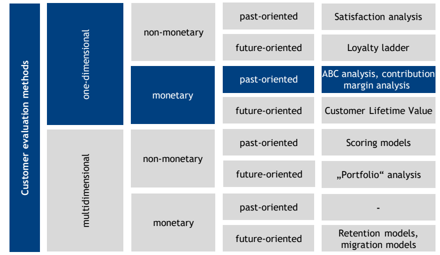
The customer rating results from the customer's satisfaction with the service delivery and interaction with the company.

Loyalty ladder

- The customer is categorized on the basis of his loyalty to the company.
- The loyalty level serves as an expression of the probability of repurchase.
- The customer is expected to climb the loyalty ladder over time.
- The type and intensity of addressing the customer strongly depend on the level of loyalty.

Link (1997)

ABC-Analysis



ABC analysis

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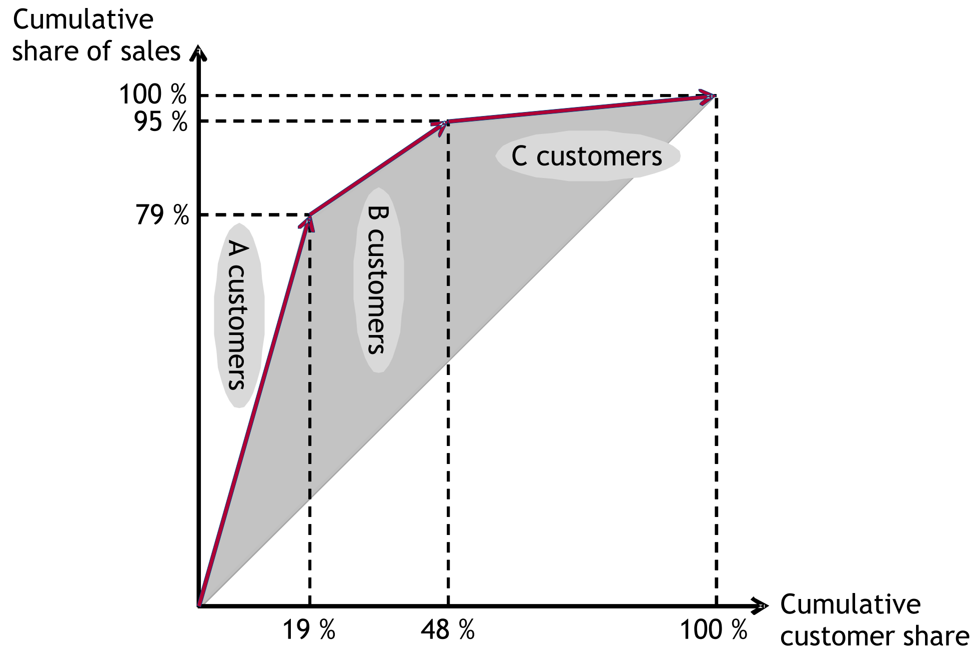
Definition

The ABC analysis is an instrument for identifying the customers with the greatest economic importance by forming three classes of customers (A, B, C) according to the relationship between the use of funds (volume) and the achievement of objectives (value).

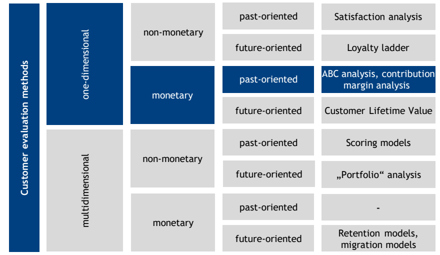


Strong demand from large customers and resulting discounts / special services can also lead to negative value contributions for A / B customers.

Günter and Helm (2011)

Margin analysis

Contribution margin analysis



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Customer gross revenues per period
- Sales deductions *(e.g., instant discounts, volume discounts, customer discounts, bonuses)*
= Customer net revenues per period
- Cost of the products purchased by the customer *(variable unit costs according to product costing, multiplied by the purchase quantities)*
= Customer contribution margin I per period
- Clearly customer-related order costs *(e.g., fixtures, shipping costs)*
= Customer contribution margin II per period
- Clearly customer-related visit costs (e.g., costs of travel to the customer) - Other relative direct customer costs per period *(e.g., salary of a specifically responsible key account manager; engineering support; mailing costs; interest on outstanding accounts receivable;* for customers at the commercial level: *advertising allowances, listing fees, and similar compensations)*
= Customer contribution margin III per period

Based on Günter and Helm (2011)

Customer lifetime value (CLV)

CLV basic model
A customer's life cycle determines long-term profitability

Customer evaluation methods	one-dimensional	non-monetary	past-oriented	Satisfaction analysis
			future-oriented	Loyalty ladder
		monetary	past-oriented	ABC analysis, contribution margin analysis
			future-oriented	Customer Lifetime Value
	multidimensional	non-monetary	past-oriented	Scoring models
			future-oriented	„Portfolio“ analysis
		monetary	past-oriented	-
			future-oriented	Retention models, migration models

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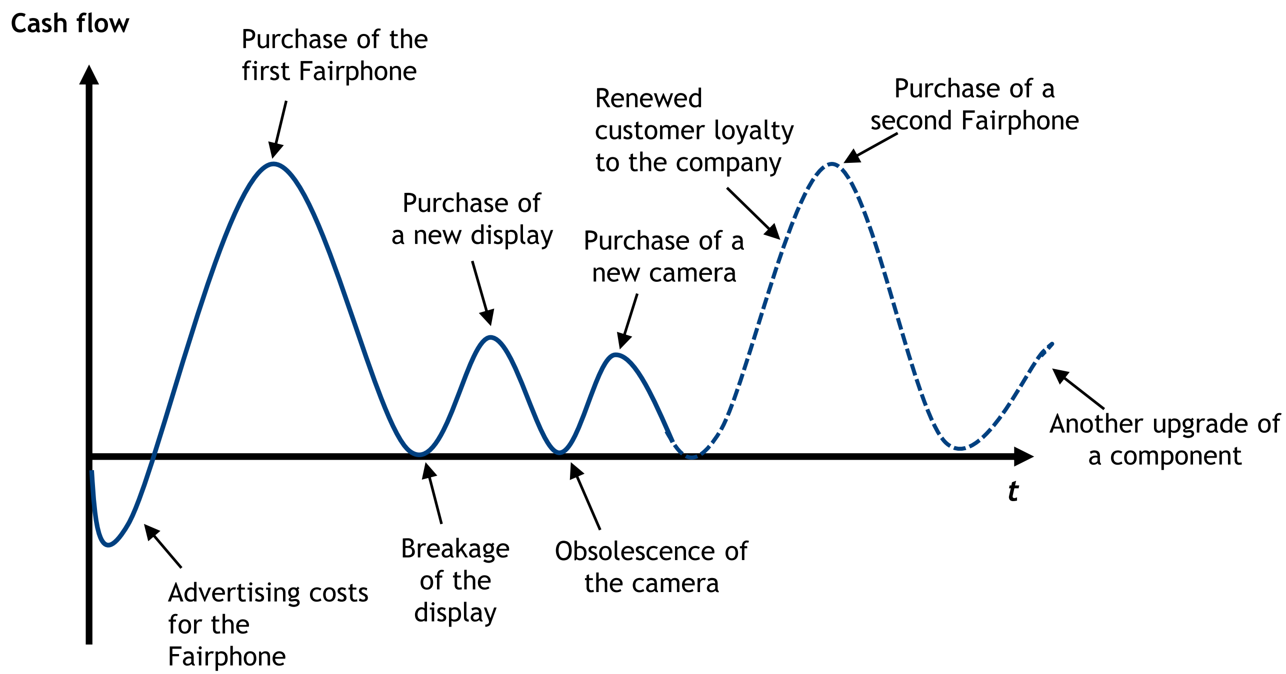
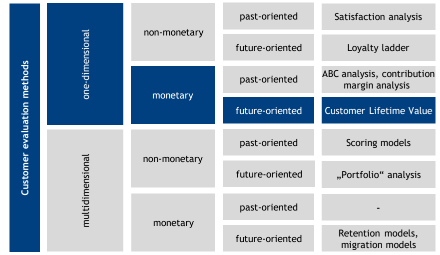
Cash flow progression over an exemplary customer life cycle in the context of the Fairphone company



Bach and Österle (2000)

Early customer acquisition can pay off in the long term.

Customer Lifetime Value (CLV)
The basic model



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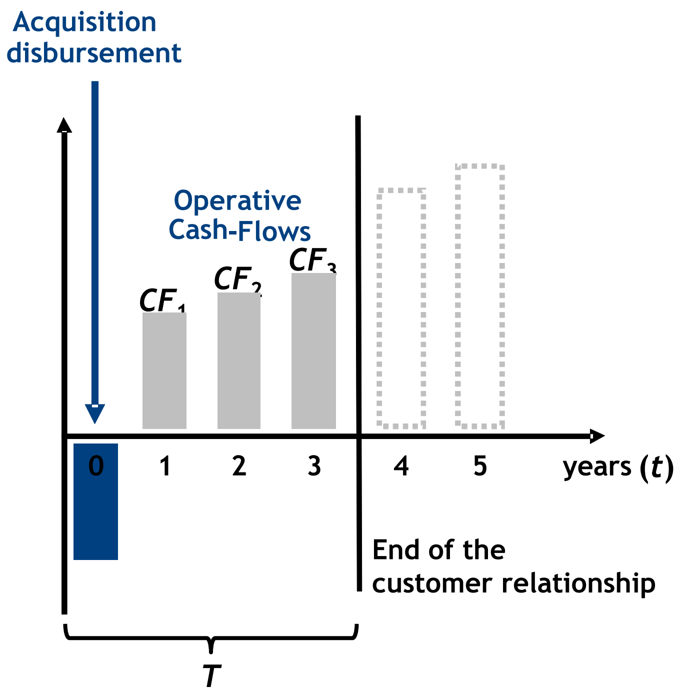
! **The CLV is determined from the present value of all cash flows with a customer over the duration of the customer relationship.**

cf. Gupta and Lehmann (2003)



$$CLV = -A + \sum_{t=1}^{T} \frac{E_t - A_t}{(1+k)^t} = \sum_{t=0}^{T} \frac{CF_t}{(1+k)^t}$$

***CLV*:** Customer Lifetime Value

***A*:** Acquisition disbursement at time $t = 0$

***t*:** period ($t = 1, 2, \ldots, T$)

***T*:** Remaining duration of the customer relationship

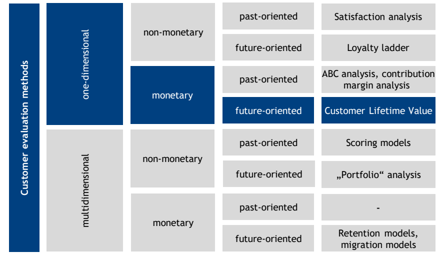
***k*:** Calculated interest rate (e.g., WACC)

E_t: (Expected) payments from the customer relationship in t

A_t: (Expected) disbursements from the customer relationship in t

CF_t: Cash-Flow at time t

CLV basic model
Example: Customers of Fairphone



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Details of the example

Social media marketing payouts	€15,000
Number of clicks generated on the homepage of the internet shop	10,000
Number of customers registering in this way	500
Order volumes per customer in periods 1/2/3	€400 / €80 / €120
Payouts per customer in the periods 1/2/3	€296 / €65 / €99
Calculation interest rate per period	5 %

Calculation of the CLV

A	€15,000 / 500 = €30
E_1-A_1	€400 - €296 = €104
E_2-A_2	€80 - €65 = €15
E_3-A_3	€120 - €99 = €21

$$CLV = -A + \sum_{t=1}^{3} \frac{E_t - A_t}{(1+k)^t} =$$

$$-30€ + \frac{104€}{(1{,}05)^1} + \frac{15€}{(1{,}05)^2} + \frac{21€}{(1{,}05)^3} = 100{,}79$$

Scoring-Models

Scoring models

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Scoring models

Mathematically simply structured, yet adaptable evaluation procedures, which assign a "scoring value" to the customer:

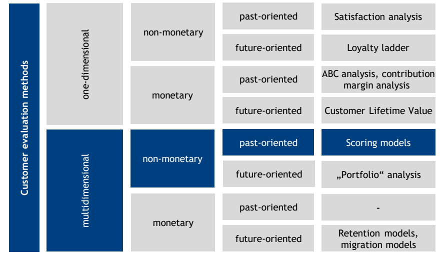
1. Listing of all customer characteristics relevant from the provider's point of view
2. Assignment of weighting factors to individual customer characteristics
3. Evaluation of the customer base on the basis of each individual criterion

Example: RFMR scoring model

Scoring model with the following criteria:

- **R** **"Recency"**, i.e., the period between the last purchase and today
- **F** **"Frequency"**, i.e., purchase frequency or number of transactions
- **MR** **"Monetary Ratio"**, i.e., contribution margin

Scoring models
RFMR model



Data base			
Customer ID	Recency (day)	Frequency (number)	Monetary Ratio (€)
1	3	6	540
2	6	10	940
3	45	1	30
4	21	2	64
5	14	4	169
6	32	2	55
7	5	3	130
8	50	1	950
9	33	15	2430
10	10	5	190

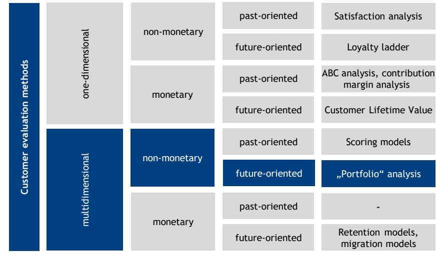
Sorting according to criteria			
Recency (day)	Frequeny (number)	Monetary Ratio (€)	
3	15	2430	Top 20% ≙ Score 5
5	10	950	
6	6	940	
10	5	540	
14	4	190	
21	3	169	
32	2	130	
33	2	64	
45	1	55	Lower 20% ≙ Score 1
50	1	30	

Result	
Cu ID	RMFR Score
1	5-4-4
2	4-5-4
3	1-1-1
4	3-2-2
5	3-3-3
6	2-2-1
7	5-3-2
8	1-1-5
9	2-5-5
10	4-4-3

! The RFMR score (composite customer score) enables a targeted assignment of CRM measures.

Portfolio analysis

Portfolio analysis



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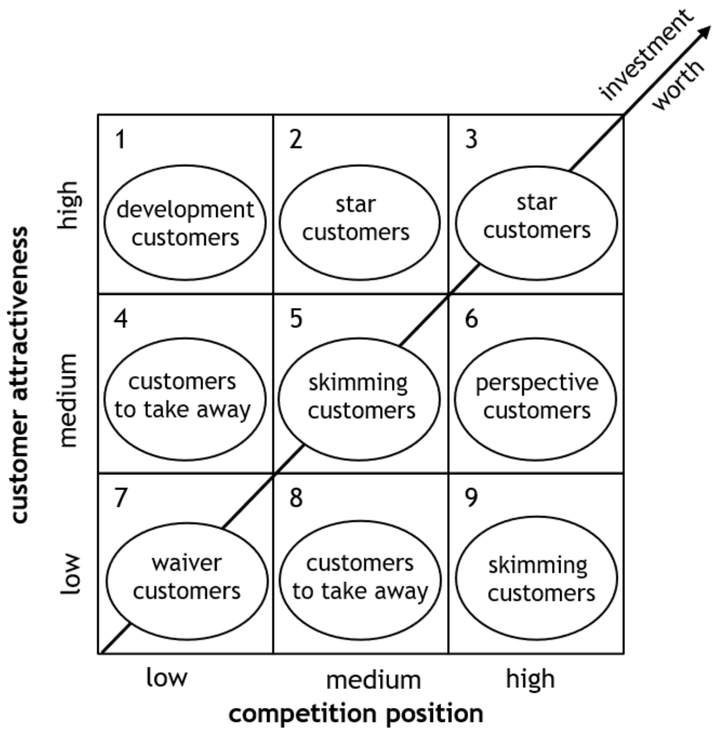
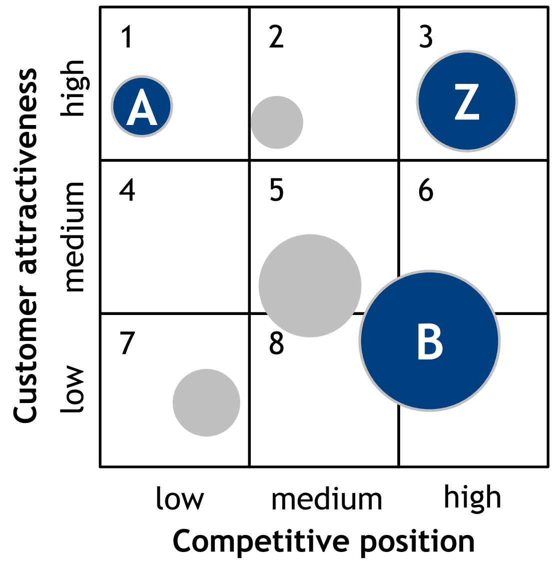
Define criteria → **Rate customers** → **Derive recommendations***



Link and Hildebrand (1997)

	Attracti-veness	Competitive position	Scope of delivery
Customer A	8	1	2
Customer B	3	7	6
…			
Customer Z	8	8	4



Based on Günter and Helm (2011)

A Invest in customer to expand business with them (e.g., customer workshops)

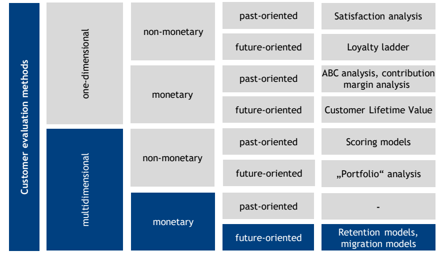
B Maintain existing relationship to secure current good sales (e.g., customer loyalty program)

Z Maintain and develop good relationship (e.g., strategic planning of customer relationships)

*An isolated portfolio analysis does not substantiate the derivation of recommendations, but only supports.

Retention model

Extension of the basic CLV model
The retention model



Retention models

Designed for a "**lost-for-good**" scenario of a customer relationship, i.e., if the customer changes the provider, he is subsequently treated as a new customer

Suitable model for contract goods and durable consumer goods (e.g., mobile phone contract or car purchase)

Extension of the basic CLV model: Retention Rate

$$CLV = -A + \sum_{t=1}^{T} \frac{(E_t - A_t) \cdot \prod_{j=1}^{t} r_j}{(1+k)^t}$$

***CLV*:** Customer Lifetime Value

***A*:** Acquisition disbursement at time $t = 0$

***t*:** Period ($t = 1, 2, \ldots, T$)

***T*:** Remaining duration of the customer relationship

***k*:** Calculated interest rate (e.g., WACC)

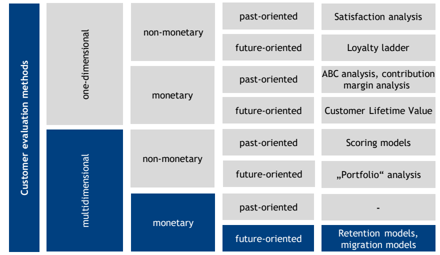
E_t: (Expected) payments from the customer relationship in t

A_t: (Expected) disbursements from the customer relationship in t

r_j: Retention Rate for period j, i.e., conditional probability that the customer is still a customer in period j if he was still a customer in period j-1

Based on Dwyer (1989)

Extension of the basic CLV model
Example for the retention model (1/2)



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Details of the example

Social media marketing payouts	15.000€
Number of clicks generated on the homepage of the internet shop	10.000
Number of customers registering in this way	500
Order volumes per customer in periods 1/2/3	150€/120€/80€
Payouts per customer in the periods 1/2/3	123€/99€/65€
Calculation interest rate per period	5%

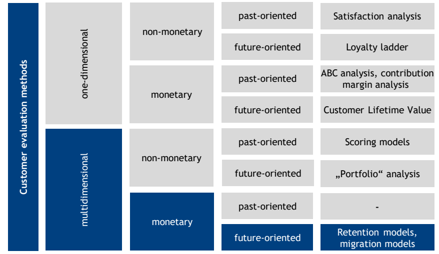
Calculation of the CLV

A	15.000€/500 = 30€
E_1-A_1	150€ - 123€ = 27€
E_2-A_2	120€ - 99€ = 21€
E_3-A_3	80€ - 65€ = 15€

$$CLV = -A + \sum_{t=1}^{3} \frac{E_t - A_t}{(1+k)^t} =$$

$$-30€ + \frac{27€}{(1{,}05)^1} + \frac{21€}{(1{,}05)^2} + \frac{15€}{(1{,}05)^3} = 27{,}72€$$

Extension of the basic CLV model
Example for the retention model (2/2)



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Details of the example for the retention model

Case I: CLV calculation using basic model	See previous slide
Case II: Customer retention rate in periods 1/2/3	90 % / 30 % / 20 %
Case III: Customer retention rate in periods 1/2/3	80 % / 70 % / 60 %

Calculation of the CLV

Case I : $$CLV = -A + \sum_{t=1}^{3} \frac{E_t - A_t}{(1+k)^t} = -30€ + \frac{27€}{(1{,}05)^1} + \frac{21€}{(1{,}05)^2} + \frac{15€}{(1{,}05)^3} = 27{,}72€$$

Case II: $$CLV = -A + \sum_{t=1}^{3} \frac{(E_t - A_t) \cdot \prod_{j=1}^{t} r_j}{(1+k)^t} = -30€ + \frac{27€ \cdot 0{,}9}{(1{,}05)^1} + \frac{21€ \cdot 0{,}9 \cdot 0{,}3}{(1{,}05)^2} + \frac{15€ \cdot 0{,}9 \cdot 0{,}3 \cdot 0{,}2}{(1{,}05)^3} = -1{,}01€$$

Case III: $$CLV = -A + \sum_{t=1}^{3} \frac{(E_t - A_t) \cdot \prod_{j=1}^{t} r_j}{(1+k)^t} = -30€ + \frac{27€ \cdot 0{,}8}{(1{,}05)^1} + \frac{21€ \cdot 0{,}8 \cdot 0{,}7}{(1{,}05)^2} + \frac{15€ \cdot 0{,}8 \cdot 0{,}7 \cdot 0{,}6}{(1{,}05)^3} = 5{,}59€$$

Migration model

Extension of the basic CLV model
The migration model

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Migration models

Designed for an "**always-a-share**" scenario of a customer relationship, i.e., a customer can buy from several companies at the same time

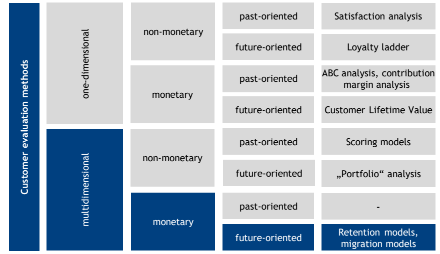
Suitable model for short-lived goods and services (with very short or no contractual commitment; e.g., grocery shopping)

Extension of basic CLV model: purchasing probability

Assumptions

- A1 Customer can switch between companies and be a customer of several companies at the same time.
- A2 The longer since the last purchase, the lower the purchase probability.
- A3 The customer base is divided into so-called "recency cells" depending on the time of the last purchase.

Based on Dwyer (1989)



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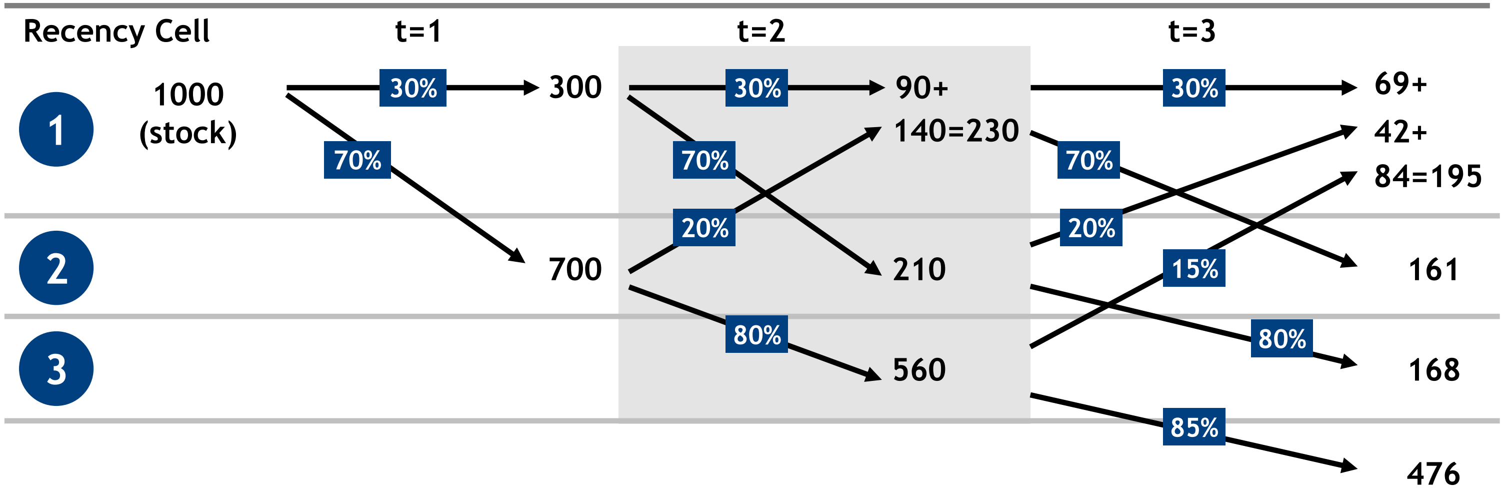
Extension of the basic CLV model
Example for the migration model (I)

Details of the migration model example (consideration of a customer segment with 1000 customers)

Recency Cell	Last purchase in period	Purchase probability (in period *t* + 1)	Payments per buyer in € (in priod *t* + 1)	Payouts per customer in € (in period *t* + 1)
1	*t*	30%	40	3,60
2	*t* - 1	20%	32	3,10
3	*t* - 2	15%	24	1,80

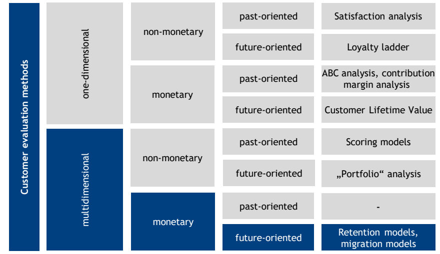
Customer migration between the Recency Cells



Logic:
- No purchase = Recency increases by 1 in t+1
- Purchase = Recency is 1 again in t+1
- Number of customers with recency 1 = Number of customers who bought in t-1

Extension of the basic CLV model

Example for the migration model (II)



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Details of the migration model example (consideration of a customer segment with 1000 customers)

Recency cell	Last purchase in period	Purchase probability (in period *t* + 1)	Payments per buyer in € (in priod *t* + 1)	Payouts per customer in € (in period *t* + 1)
1	*t*	30%	40	3,60
2	*t* - 1	20%	32	3,10
3	*t* - 2	15%	24	1,80

Number of customers per recency cell in the periods t = 1 to t = 3

Recency cell	*t* = 1	*t* = 2	*t* = 3
1	300	90 + 140 = 230	69 + 42 + 84 = 195
2	700	210	161
3	-	560	168

Calculation of the cash flows in the periods *t* = 1 to *t* = 3

$$CF_1 = 40€ \cdot 300 - 3{,}60€ \cdot 1000 = 8400€$$

$$CF_2 = (40€ \cdot 90 + 32€ \cdot 140) - (3{,}60€ \cdot 300 + 3{,}10€ \cdot 700) = 4830€$$

$$CF_3 = (40€ \cdot 69 + 32€ \cdot 42 + 24€ \cdot 84) - (3{,}60€ \cdot 230 + 3{,}10€ \cdot 210 + 1{,}80€ \cdot 560) = 3633€$$

Attention:

The recency of t-1 is used for the determination of the **disbursements** in t, because for example marketing expenses can be planned at the beginning of the period on which the value of the preperiod is based.

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Digital Management

University of Hohenheim

Faculty of Business, Economics and Social Sciences

Institute of Marketing and Management

Chair for Digital Management

Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 6: Smart Connected Products & IoT for Sustainability
2022

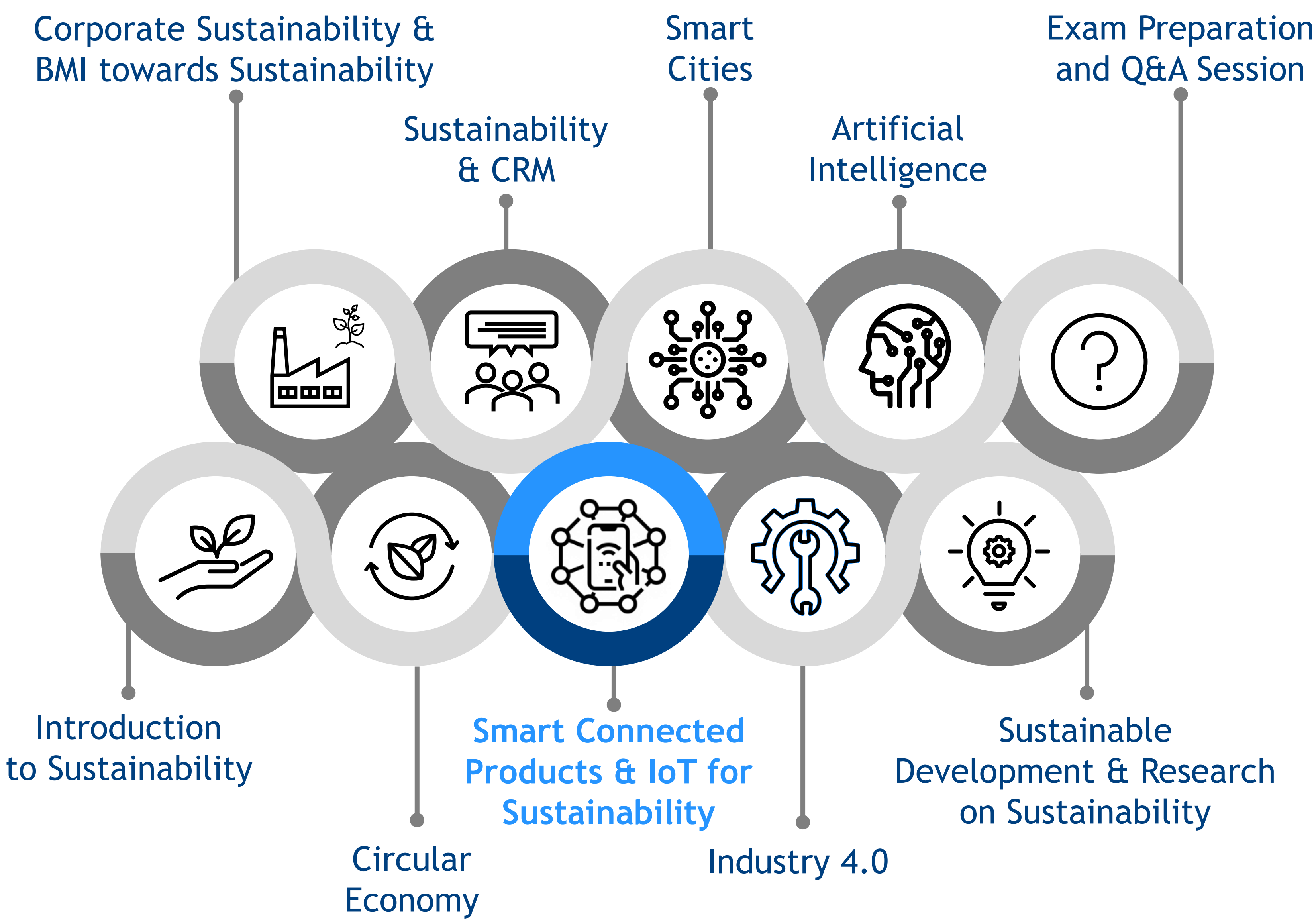
Research Center Finance & Information Management

Fraunhofer FIT Project Group Business & Information Systems Engineering

DLA Digital Leadership Academy

https://digital.uni-hohenheim.de/

Overview Smart Sustainability



Agenda – Smart Connected Products & IoT for Sustainability

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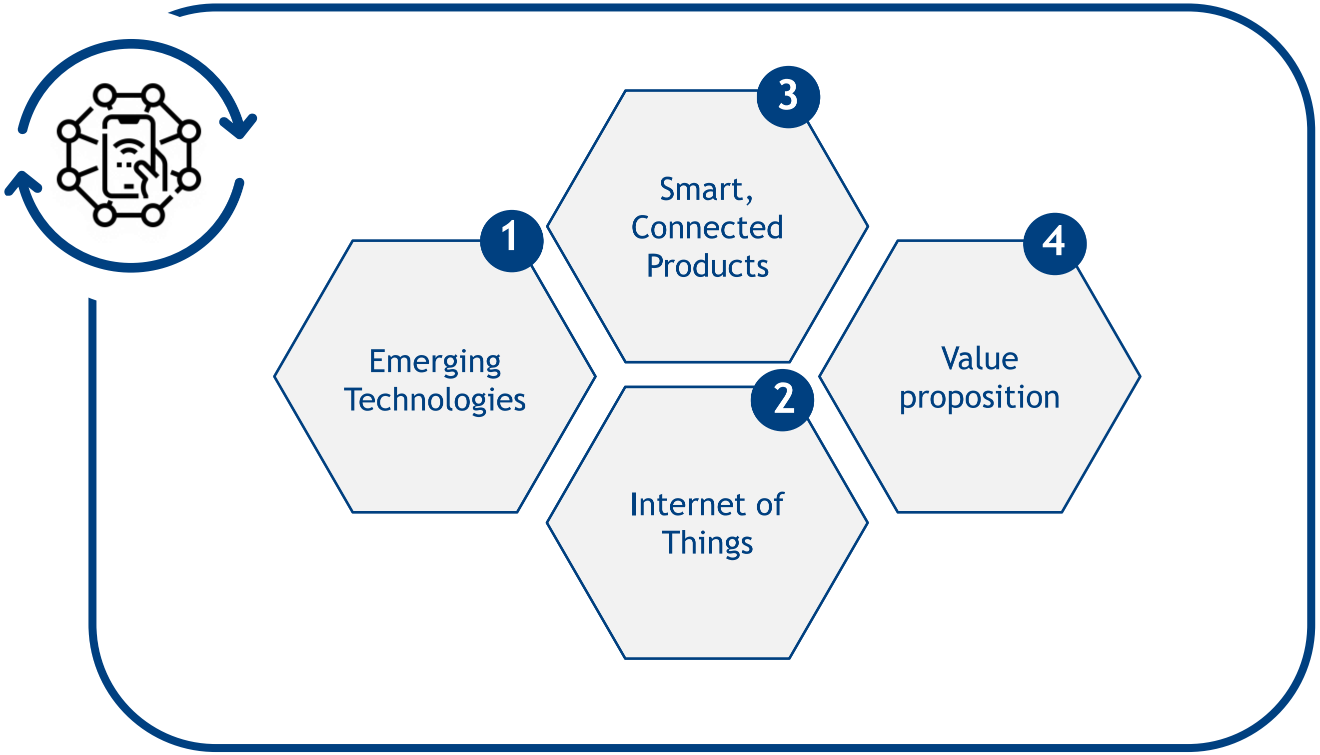

Emerging Technologies

New technologies are changing existing business rules and forcing established companies to rethink...

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From the cassette to Spotify

From TV to YouTube

From the typewriter to MS Word

From the telephone to Whatsapp

Link to the used images: https://www.behance.net/gallery/97103975/Once-Appon-a-Time

What is meant by “digital technologies”?

Definitions

Digitalization

Digitalization describes the increasingly accelerating **penetration** of **digital technologies** into the economy and society as well as the associated changes with regard to the **networking** of individuals, companies and things.

Digital technology

Digital technologies comprise emergent technologies such as the Internet of Things (IoT) or blockchain, as well as more established technologies such as cloud computing or social media.

Gartner Inc. (2017)

What are "Emerging Technologies"?

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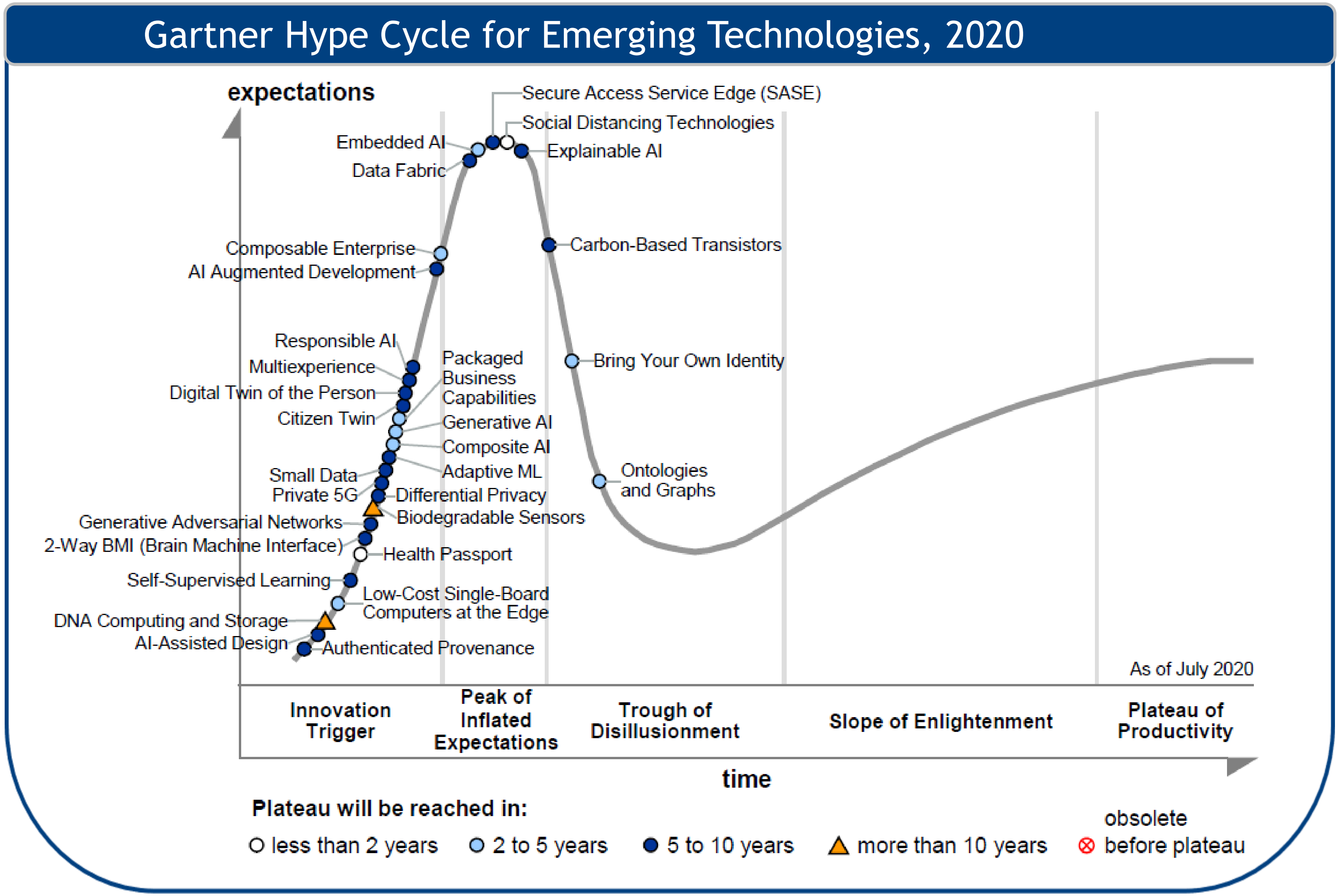

Gartner (2020)

Research Insight - Unblackboxing Digital Technologies - A Multi-Layer Taxonomy and Archetypes

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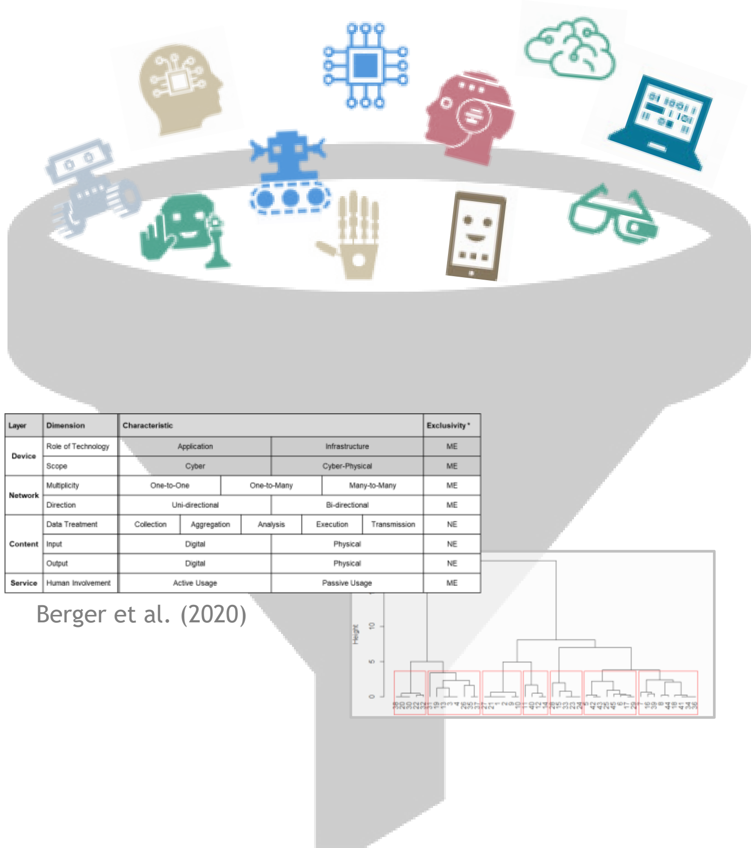
Sample of 92 digital technologies
from the Gartner Hype Cycle
for Emerging Technologies



Layer	Dimension	Characteristic					Exclusivity *
Device	Role of Technology	Application		Infrastructure			ME
	Scope	Cyber		Cyber-Physical			ME
Network	Multiplicity	One-to-One	One-to-Many	Many-to-Many			ME
	Direction	Uni-directional		Bi-directional			ME
Content	Data Treatment	Collection	Aggregation	Analysis	Execution	Transmission	NE
	Input	Digital		Physical			NE
	Output	Digital		Physical			NE
Service	Human Involvement	Active Usage		Passive Usage			ME

Berger et al. (2020)

Archetype	Examples
Connectivity & Computation	▪ 802.11ax ▪ Quantum Computing
Platform Provision	▪ (Mobile) Application Store ▪ Cloud/Web Platform
Mobile Device	▪ E-Book Reader ▪ Media Tablet
Sensor-based Data Collection	▪ Gesture Recognition ▪ Smart Dust
Actor-based Data Execution	▪ 3D Printing ▪ 4D Printing
Analytical Insight Generation	▪ In-memory Analytics ▪ Machine Learning
Self-dependent Material Agency	▪ Autonomous Vehicle
Augmented Interaction	▪ Augmented Data Discovery ▪ Virtual Personal Assistant
Natural Interaction	▪ Conversational UI ▪ Natural-languag Q-A

Berger et al. (2020)

Digitalization as a trigger for change

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Technology trends

Smart (Mobile) Devices

Social Media

Cloud Computing

Advanced Analytics

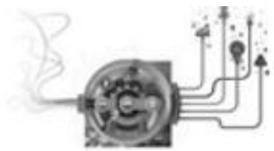
Internet of Things

Intelligent systems

Business implications

New business models

New markets



Value-added innovations

Productivity improvements

Enhanced interaction with the customer

Job flexibility

▶ Technology trends in combination with dynamically changing social conditions and customer requirements lead to massive implications for business models.

Emerging technologies are changing current business and value creation models

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Emerging Technolgies

Exemplarisch

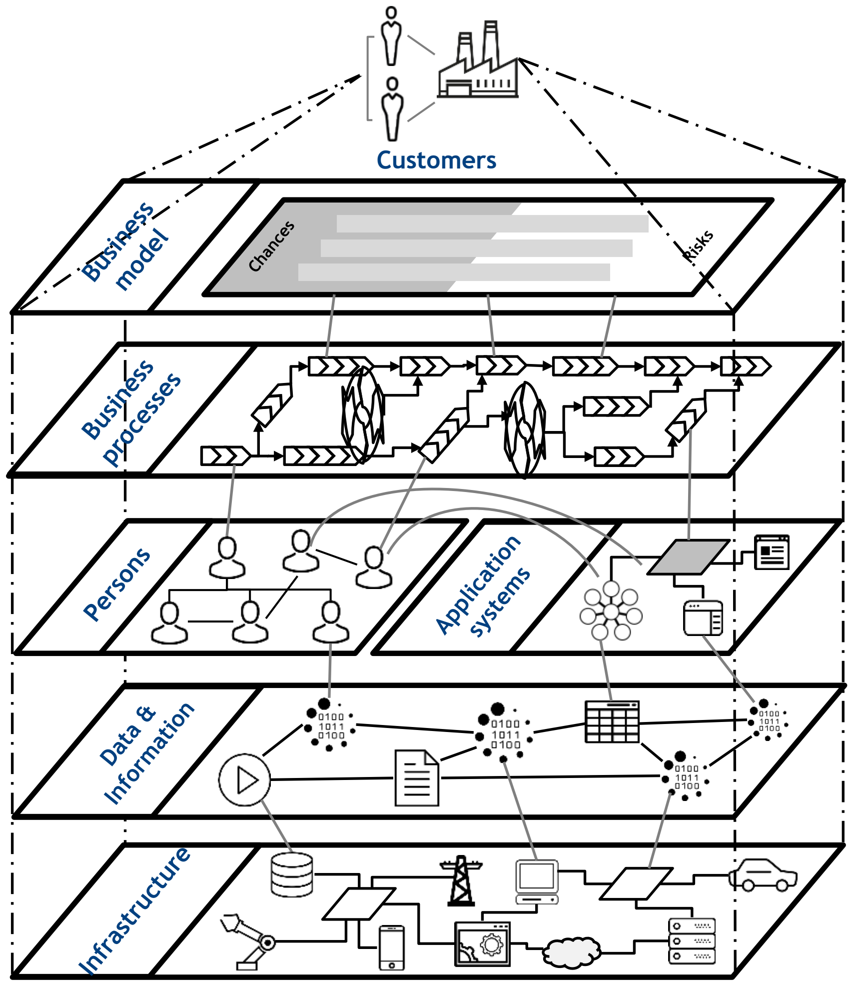
Social Media

Cloud Computing

Internet of Things

Artificial Intelligence

Blockchain



Gimpel and Röglinger (2017)

Internet of Things

What is the Internet of Things?

Definition

Internet of Things (IoT)

The Internet of Things refers to the internetworking via the Internet medium of everyday physical objects, which are equipped with smart sensors, actuators, controllers and computational logic. This networking enables new interactions between things, companies and individuals.

Oberländer et al. (2018)

Internet of Things is a key technology for smart products and services

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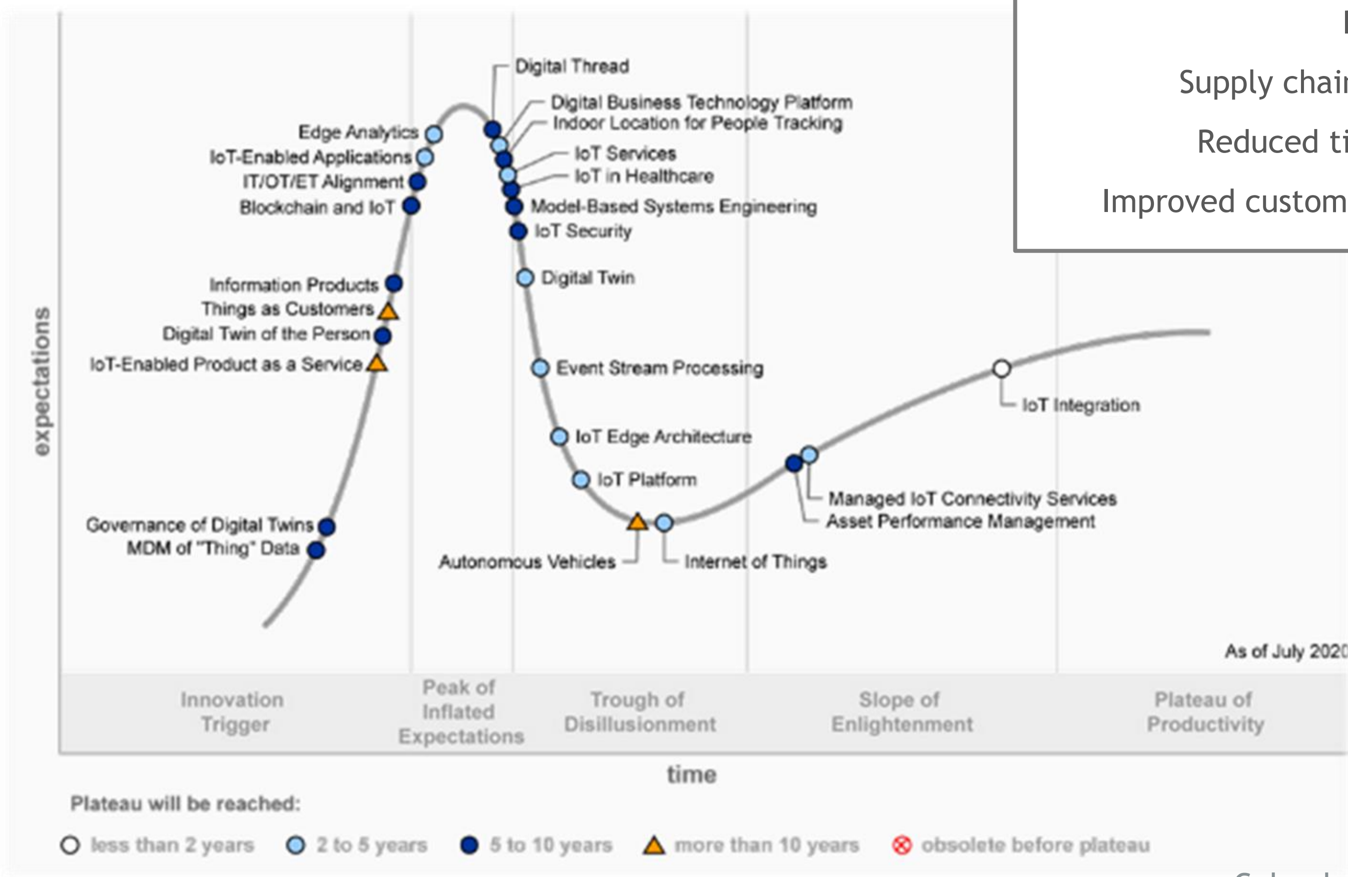
Internet of Things got its own hype cycle in 2020



Internet of Things: Added value $14.4 billion by 2022

Number of connected devices

2015	2025
approx. 15.4 billion	approx. 75.4 billion

Columbus (2015, 2018), Gartner (2020), Statista (2019)

Internet of Things (IoT) - Opportunities and effects

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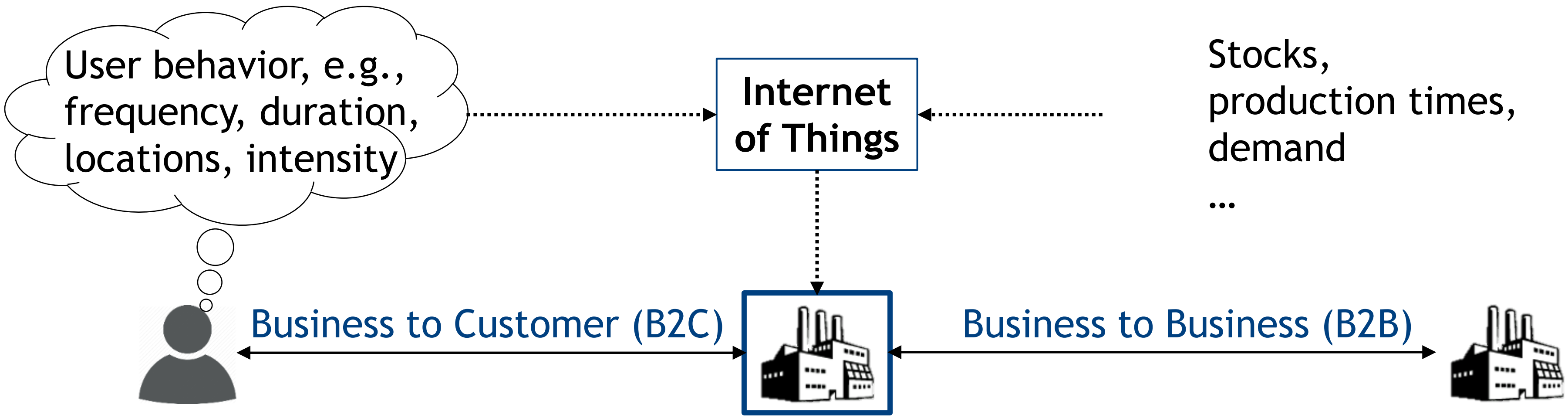


Opportunities in B2C

- Acceleration of business processes and their transformation
- New business models (Product as a Service)
- User orientation

Effects

- Emergence of new business models
- Data-driven decision making

Opportunities in B2B

- Time saving
- Increased quality
- Continuously optimized processes and products

Thanks to the Internet of Things, data collection is no longer performed just for control, but for forecasting and optimization.

The Internet of Things still poses numerous challenges

Image: https://svgsilh.com/png-512/33063.png

Technology

- Processing large amounts of data to enable Big Data analytics
- Industrial standardization und compatibility between smart things from different manufacturers
- …

Society

- Legal framework for data and consumer protection
- …

Operation

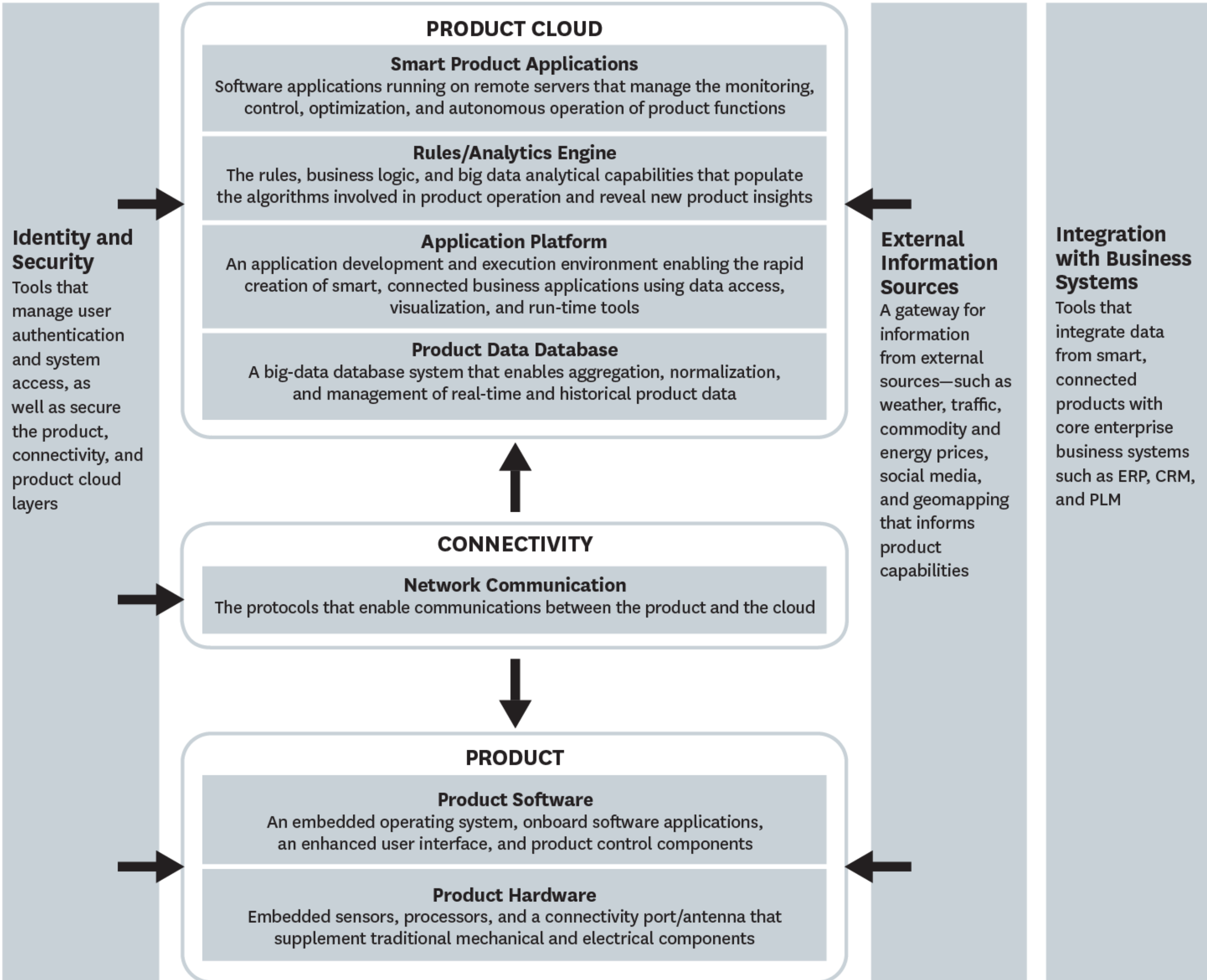
- Integrate smart components and technologies into existing processes and products
- Familiarize and train employees with smart things
- Adapt IT security to smart things
- …

Individual

- Responsible and sustainable use of smart things
- Responsible handling of data
- …

Smart, Connected Products

The new technology stack



Porter and Heppelmann (2014)

Capabilities of Smart, Connected Products
What can smart, connected products do?

The capabilities of smart, connected products can be grouped into four areas: monitoring, control, optimization, and autonomy. Each builds on the preceding one; to have control capability, for example, a product must have monitoring capability.

1 Monitoring

Sensors and external data sources enable the comprehensive monitoring of:

- the product's condition
- the external environment
- the product's operation and usage

Monitoring also enables alerts and notifications of changes

2 Control

Software embedded in the product or in the product cloud enables:

- Control of product functions
- Personalization of the user experience

3 Optimization

Monitoring and control capabilities enable algorithms that optimize product operation and use in order to:

- Enhance product performance
- Allow predictive diagnostics, service, and repair

4 Autonomy

Combining monitoring, control, and optimization allows:

- Autonomous product operation
- Self-coordination of operation with other products and systems
- Autonomous product enhancement and personalization
- Self-diagnosis and service

Porter and Heppelmann (2014)

Value Proposition

Smart Products & Services

Challenges	Possible Approach

Create or adjust value propositions in light of digitalization

- Boundaries between products and services blur
- Customers demand integrated and intuitive solutions anytime and anywhere
- Traditional competitive advantages erode
- Low entry barriers grant competitors easy access
- Customers have low switching costs

Journey towards servitization

- Products enriched with digital technologies
- Additional hybrid product-service bundles
- Independent service solutions
- Development of configurable product/service modules
- Extension of value chain activities (e.g. from mere B2B to B2C and B2T business)

Servitization: From product manufacturers to service providers

Car

Internet in the Car

Car in the Internet

Additional services

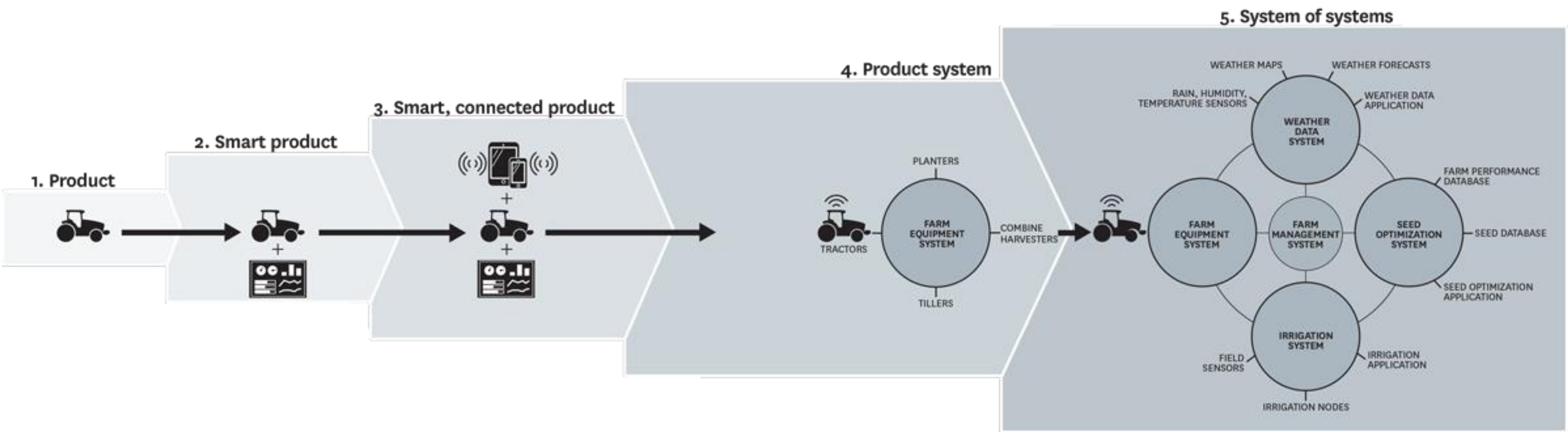
The five forces that shape industry competition

Smart, connected products will have a transformative effect on industry structure. The five forces that shape competition provide the framework necessary for understanding the significance of these changes.

Porter and Heppelmann (2014)

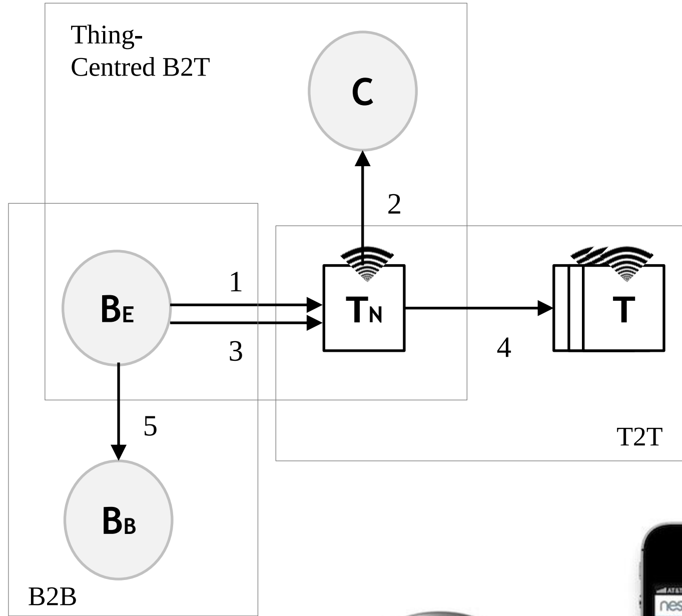
Redefining industry boundaries

The increasing capabilities of smart, connected products not only reshape competition within industries but expand industry boundaries. This occurs as the basis of competition shifts from discrete products, to product systems consisting of closely related products, to systems of systems that link an array of product systems together. A tractor company, for example, may find itself competing in a broader farm automation industry.



Porter and Heppelmann (2014)

Complex application of the B2T interaction patterns
Example: Google Nest



Kees et al. (2015), nest-thermostat.com

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Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 7: Smart Cities (I)
2022

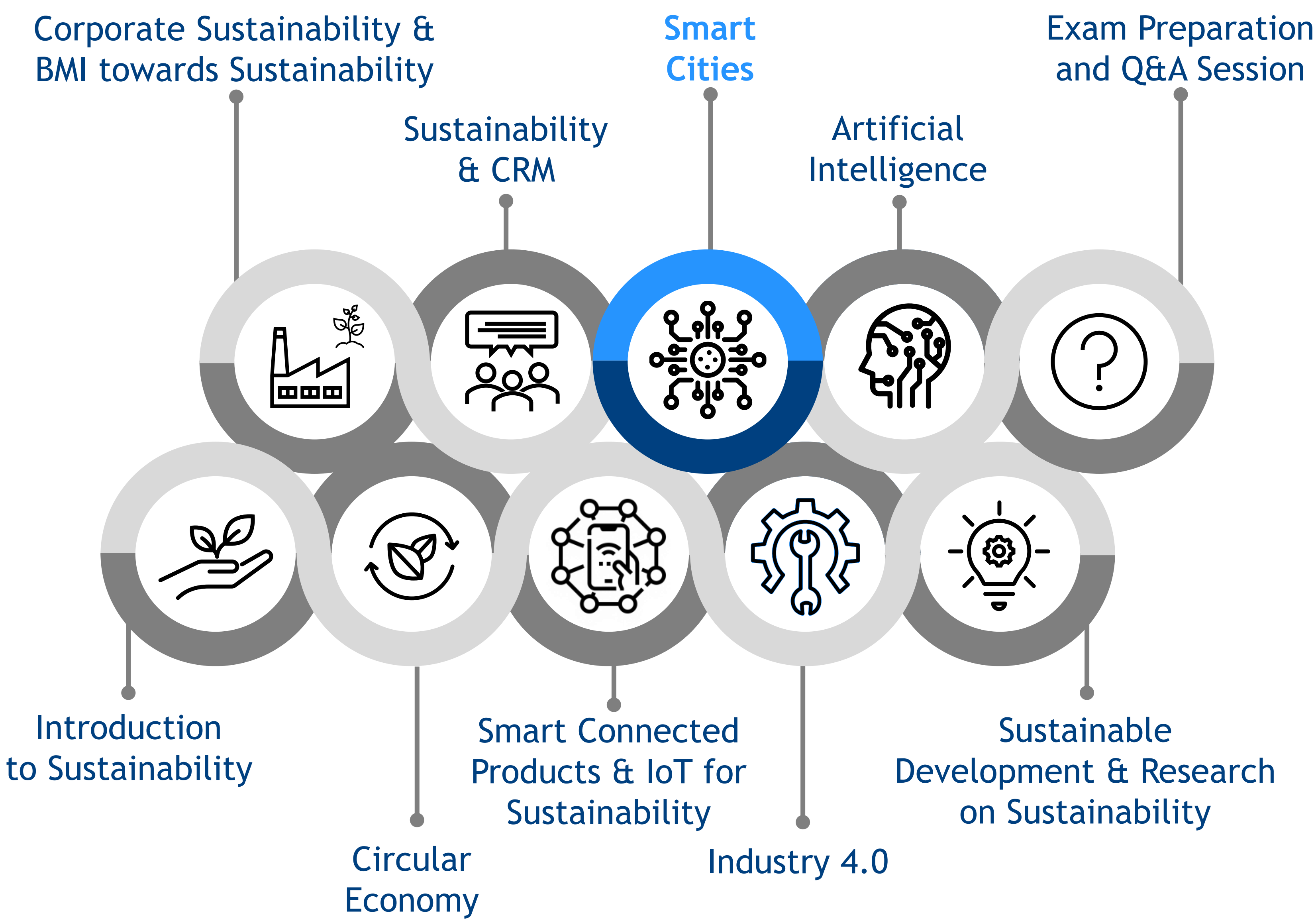
Research Center Finance & Information Management

Fraunhofer FIT
Project Group Business & Information Systems Engineering

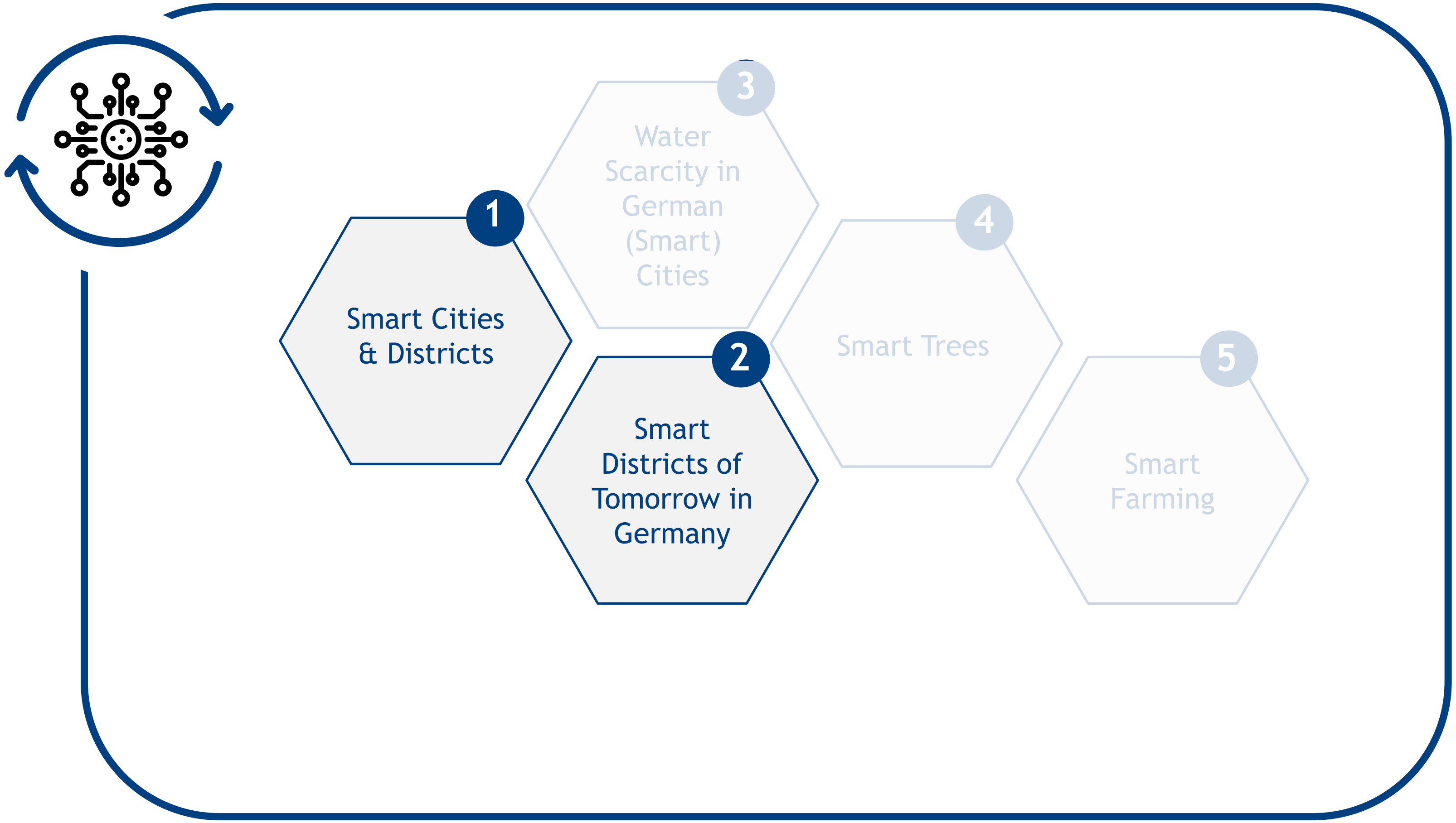
DLA DIGITAL LEADERSHIP ACADEMY

https://digital.uni-hohenheim.de/

Overview Smart Sustainability



Agenda - Smart Cities (I)



Smart Cities & Districts

Urbanization is a major driver of climate change which makes cities one focal point for counteraction

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Consequences of climate change

- Since **1880s,** the globe's **surface temperature** has risen by about **1 degree Celsius**
- According to weather records, the years from **2015-2019** have been the **warmest of** the **last 140 years**
- This **warming trend** contributes to the "**tipping point**" beyond which we **cannot reverse** the **effects** of **global warming** and other massive environmental shifts

Urbanization as a driver of climate change

Half of the **global** human **population** lives in **cities**

By **2050**, the proportion of city-dwellers will have increased to **two-thirds**

~75% of global **energy consumption** in **cities**

Cities produce **~80%** of **carbon emissions**

Mitigate the environmental downsides of urbanization

11 SUSTAINABLE CITIES AND COMMUNITIES

Source: https://sustainabledevelopment.un.org/?menu=1300

Sources: Von Borries (2019); Gholami et al. (2016); Harjanne and Kohrhonnen (2019); Hollands (2015); NASA (2020); Sengupta (2019); The World Bank Group (2014a, 2014b); United Nations (2018); United Nations (UN) Department of Economic and Social Affairs (2018).

Smart cities are a focal concept for addressing climate related problems

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History

Dates back to **early 1990s**

Silicon Valley put advanced information systems in place

Transformation of local communities, governments, businesses

First smart city "**Smart Valley**"

Definition

"***Development and use of digital technologies in almost all areas at the municipal level***" (Bundesministerium des Innern, für Bau und Heimat 2020)

Smart city **comprised of 6 central components**, whereas recent **literature** particularly **stresses** its role in tackling **environmental degradation**

1. Smart Economy
2. Smart Governance
3. Smart Mobility
4. Smart Living
5. Smart People
6. **Smart Environment**

Smart Energy Technologies

Use of technologies to serve at least one of two system goals:

1. Increasing energy efficiency
2. Increasing the integration of renewable energy sources

Sources: (Bundesministerium des Innern, für Bau und Heimat 2020); Goebel et al. (2014); Hosseini et al. (2018); Lombardi et al. (2012).

Sustainable intelligent urban district

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"A sustainable smart quarter comprises a subarea of a city in which forward-looking solutions are applied for the areas of economy, society, administration, mobility, the environment, energy and habitation. These solutions are based on an intelligent ICT infrastructure* that ensures benefits for all stakeholders and, in particular, enables a high quality of life for every citizen/resident."

based on Keller et al. (2019)

Image: Jude Joshua on pixabay.com

Smart Districts of Tomorrow in Germany

Presentation of a working paper

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How to design German Smart Districts?

Research Question 1	Research Question 2	Research Question 3
What preferences do citizens have for different technologies and IS-based services in smart districts?	Into what cluster groups can citizens be classified using the best-worst scores of the technologies and services?	How can each cluster be described in terms of preferences and affinity for technologies and services and socio demography of citizens?

How the survey was structured

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Socio-demographic factors

Housing conditions

Sustainability values

Affinity for technology

Mobility behavior

Services/technologies considered
(energy supply, smart home applications, smart mobility solutions, …)

Information-Systems based technologies and services that were considered

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Natural resources & energy generation

- Local energy storage
- Photovoltaic system
- District and local heating system
- Heat pump
- Combinded heat and power plant

I would like to receive energy for heating and water heating from the environment (e.g. from the ground).

Energy supply & smart consumption tracking

- Consumption monitoring and feedback
- Green electricity
- Demand-flexible control of household appliances
- Local energy trading platform

I would like to monitor my electricity and heat consumption in real time as well as information about potential savings.

Smart Home

- Smart thermostat
- Smart window shading
- Smart lighting
- Smart plugs

I want unused devices (stand-by mode) to be automatically detected and disconnected from the power supply.

People mobility

- Carsharing
- Bike & scooter sharing
- Charging stations for electric vehicles

I would like to be able to use a bicycle, e-scooter or scooter for a limited period of time paying a fee (bicycle and scooter sharing in the immediate proximity).

Key facts about the survey

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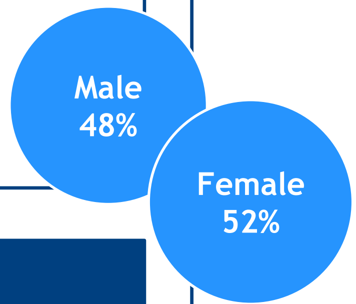
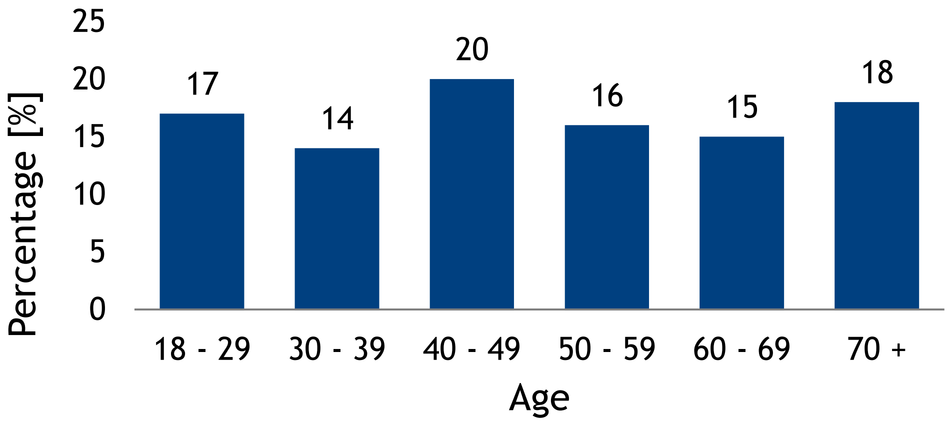
Conducting the survey

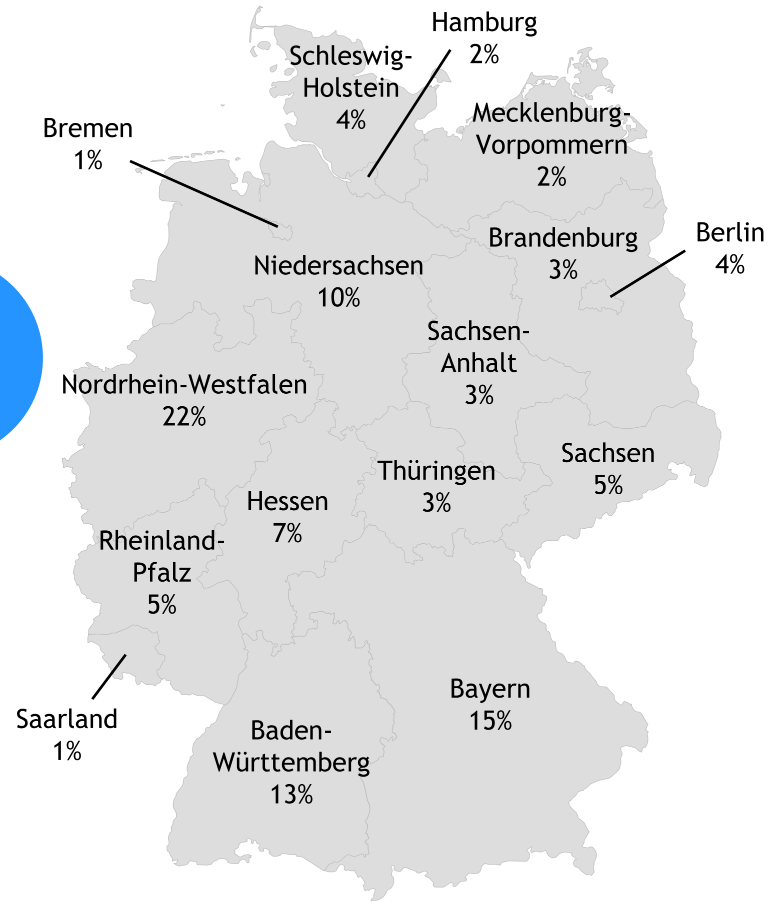
- Germany-wide
- Representative about age, gender and regional distribution
- 3.500 Respondents, about 2.900 usable questionnaires
- 47 Questions



Distribution of age



Regional distribution



Method and Results (1/3)

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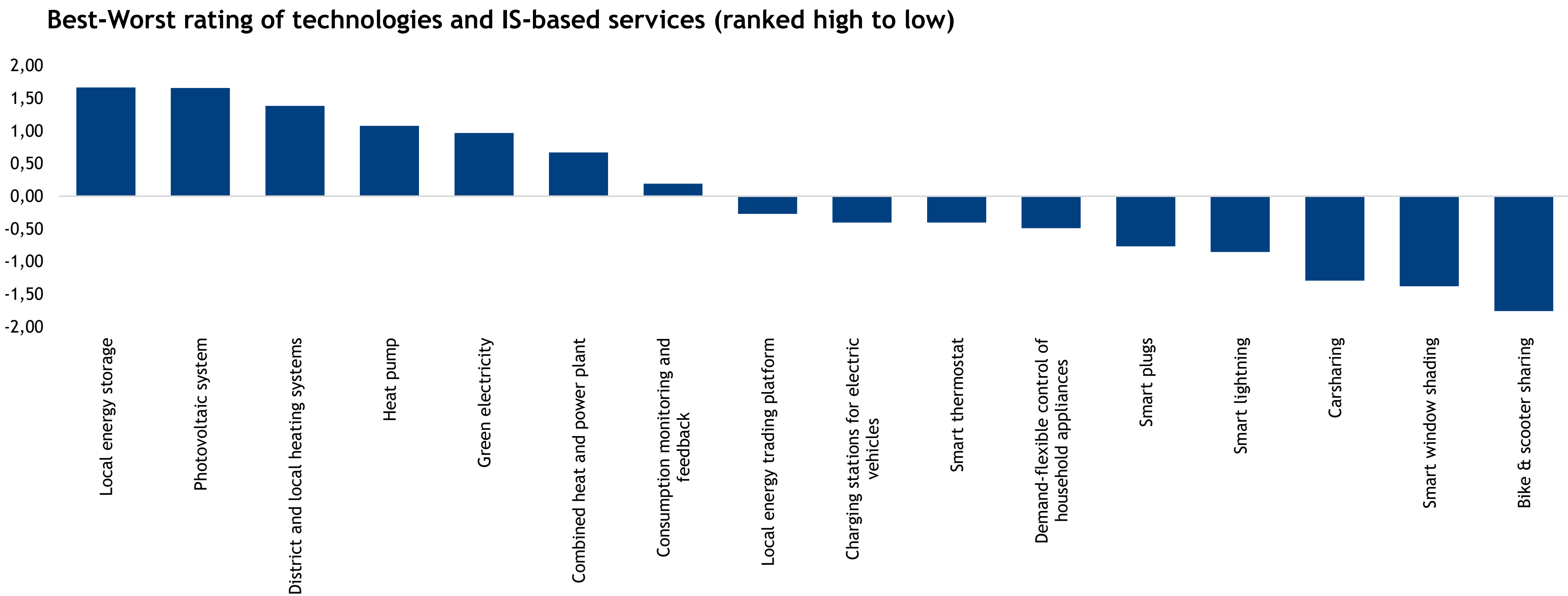
1 What preferences do citizens have for different technologies and IS-based services in smart districts?



Three technologies are rated overall very positive (Local energy storage, Photovoltaic system, and District and local heating system), while three services are rated overall very negative (Carsharing, Smart window shading, Bike & scooter sharing)

Method and Results (2/3)

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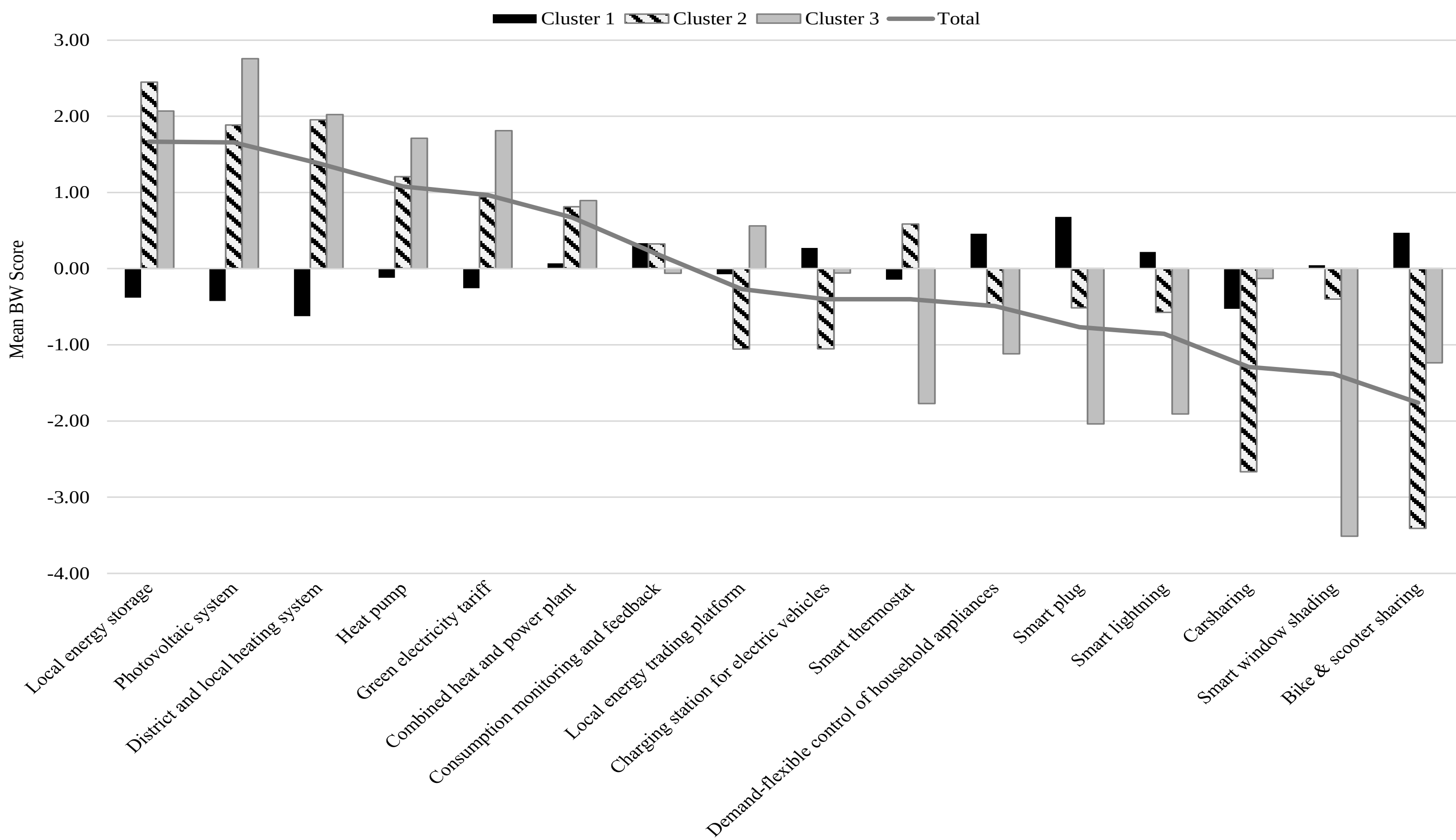
2 Into what cluster groups can citizens be classified using the best-worst scores of the technologies and IS-based services?



Cluster analysis enables us to evaluate how the technologies and IS-based services were rated by different groups. This analysis shows significant differences between the identified clusters (e.g., opposing trend of cluster 1).

Method and Results (3/3)

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2 How can each cluster be described in terms of preferences and affinity for technologies and IS-based services and socio demography of citizens?

Sociodemographic

Table 9. Cluster groups and descriptive statistics

	Age (mean)	Gender (% female)	Education (% univ. educated)	Marital status (% married)	Household income (mean / year, $000)
Cluster 1	42.0	48.6	36.7	53.9	55.7
Cluster 2	51.6	53.2	28.6	55.5	51.4
Cluster 3	52.8	51.5	31.0	45.1	41.1
X^2		3.64	13.39***	18.05***	
H	213.4***				4.16**

***p<0.01

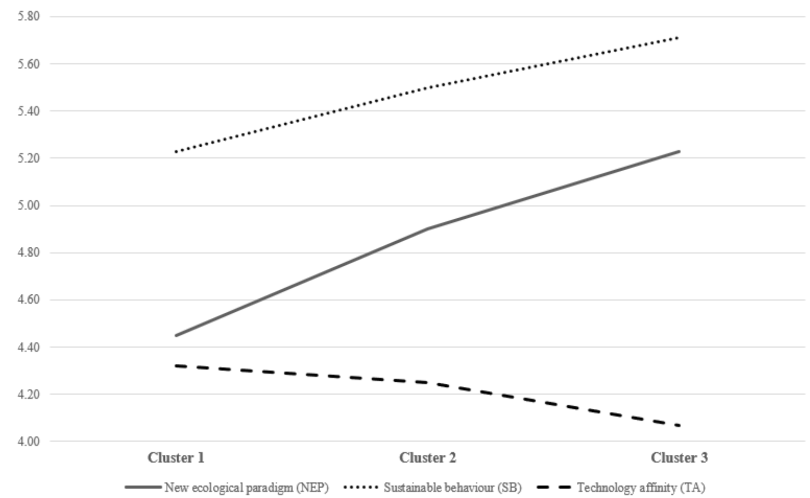
Living situation

Table 10. Results of contingency analysis

Categorical Variables		Adjusted C	p-value	effect-size
Housing	(Single or duplex houses; apartments)	0.122	0.000 ***	0.089
Home ownership	(yes ; no)	0.106	0.000 ***	0.075
Period of residency	(<5 years ; ≥5 years)	0.233	0.000 ***	0.167
Neighbourhood	(urban ; semi-urban ; rural)	0.121	0.000 ***	0.089
Living standard	(high ; average ; low)	0.145	0.000 ***	0.119

*** p < 0.01

Sustainability attitude and technology affinity



All clusters differ significantly with regard to their sociodemographics, living situation, sustainability attitude, and technology affinity

Discussion

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1

Preferences for different technologies and IS-based services in smart districts:

- Natural resources & energy generation are ranked best
- Smart home and People mobility are ranked worst

2

Building clusters, 3 types of citizens can be identified, significant difference with regard to their socio demographics, living situation, sustainability attitude, and technology affinity

- Implication: A better understanding of citizens

3

Different preferences about technologies and IS-based services

- Implication: Planning a district it is important to consider the different groups of citizens and their preferences

4

Overall implications

- Understanding the cluster characteristics and their preferences strategies can be developed for a targeted addressing of citizens
- Developing new business models or aligning them according to the citizens' preferences to ensure the economic viability of districts
- Better understanding of the citizens' willingness to pay according their preferences
- Creating acceptance, e.g. for renovation work, by focusing on the desired technologies and services → Increasing the needed renovation rate

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Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 8: Smart Cities (II)
2022

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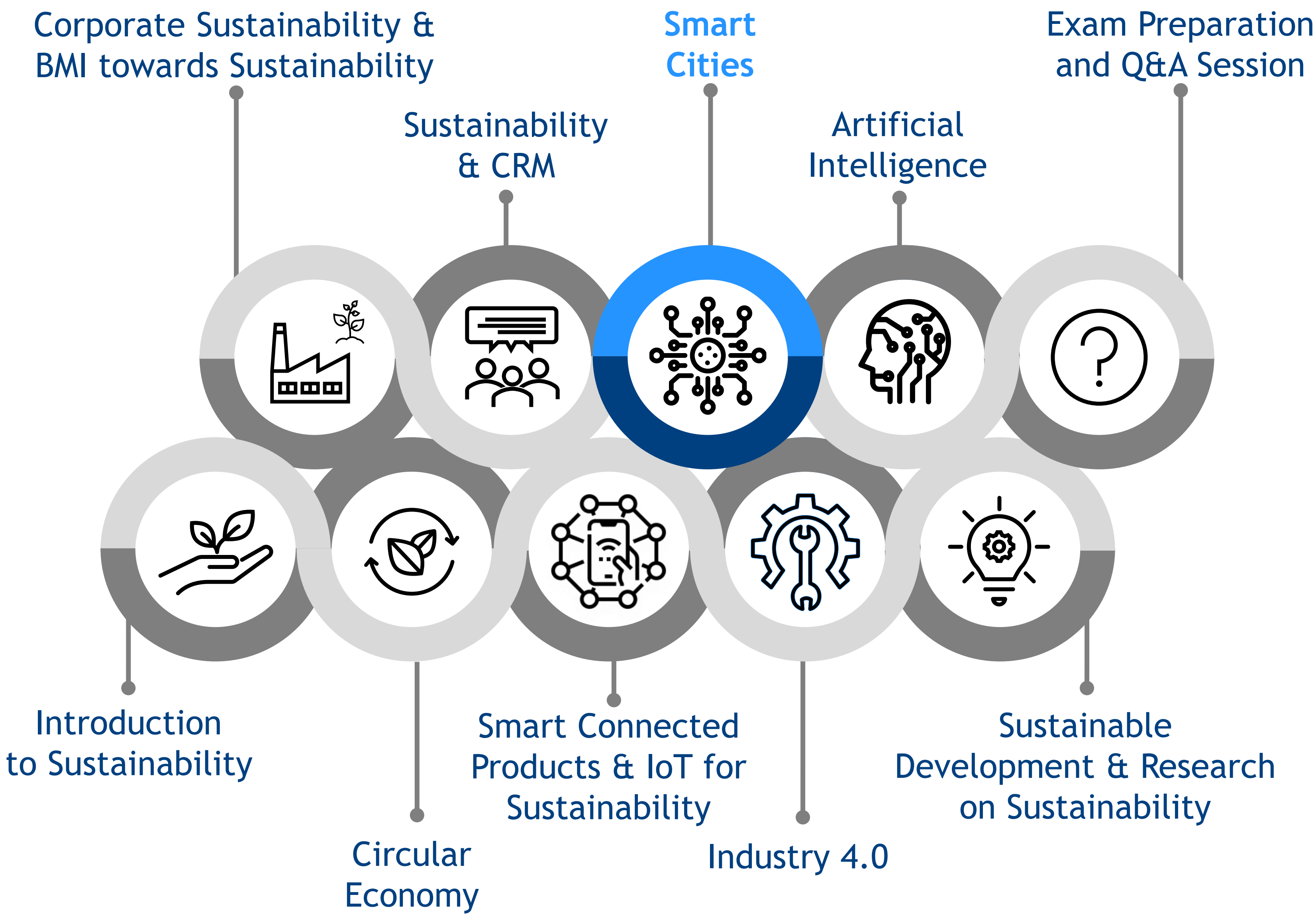
Overview Smart Sustainability



Agenda - Smart Cities (I)

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1 Smart Cities & Districts

2 Smart Districts of Tomorrow in Germany

3 Water Scarcity in German (Smart) Cities

4 Smart Trees

5 Smart Farming

Water Scarcity in German (Smart) Cities

Water scarcity is becoming a major challenge in Germany

Drought corn by CarneStation CC BY 2.0, https://www.dw.com/de/wassernotstand-in-deutschland/a-54668837, https://www.msn.com/de-de/wetter/topgeschichten/d%C3%BCrre-und-verschmutzung-experten-bef%C3%BCrchten-dass-trinkwasser-in-deutschland-um-45-prozent-teurer-werden-k%C3%B6nnte/ar-BB19pgqx, https://www.msn.com/de-de/finanzen/top-stories/das-wasser-wird-knapp-%E2%80%93-ein-ganz-neues-problem-f%C3%BCr-den-standort-deutschland/ar-BB18qdtg, https://www.tagesspiegel.de/berlin/stadtgruen-und-trockenheit-berlins-stadtbaeume-muessen-gegossen-werden-aber-von-wem/25807526.html

Factors contributing to water scarcity in Germany

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Urban water supply systems are currently stressed in particular by the following three factors

1. Population growth
2. Increasing urbanization
3. Climate change

Implications for water resources

(1) Population growth and (2) Urbanization harbor enormous imbalances for the global structure and lead to an increase of needed water resources

(3) Climate change reduces the available water resources.

This leads to challenges for water supply systems in a city like e.g. Frankfurt, which draws water primarily from two main sources: Hessisches Ried and Vogelsberg.

Emerging need and solution approach

- Development of alternative water resources for particular applications (e.g., irrigating urban green spaces) is necessary in order to increase the security of water supply
- Rainwater as a freely available water source as a solution approach
  - Possibility to replenish existing water supplies by using a water resource that would otherwise not be used

Smart Trees

Smart Irrigation for Trees: A maturity model

> Perhaps the most damaging modern challenge for city trees is drought
>
> Somidh Saha (urban forest ecologist at the KIT in Germany)

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	Status Quo: No information	Stage I: Monitoring and adaptation	Stage III: Predictive optimization	Stage IV: Automation
Description	No smart irrigation system in place.	Irrigation system allows monitoring of soil parameters and enables experts to adapt the amount of irrigation according to established thresholds.	Irrigation system makes recommendations based on predicted water potential from various data sources (e.g., historic water potential values and predicted weather)	Irrigation system controls the automated allocation and distribution of water via flow networks.
Application	Trees are irrigated with a lump amount of 200 liters ~ every two weeks.	No changes regarding the irrigation process: Adapt the irrigation amount for each tree for given irrigation assignments.	Adaptation of processes: Adapt scheduling and route planning of service providers.	Automatization of processes: Automated control of flow networks without manual intervention.

Gimpel, H. Graf-Drasch, V. Hawlitschek, F. Neumeier, K.(2021)

Smart Farming

Urban agriculture has moved from an issue at the edge of public discourse to its center

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Futuristic vision of the Smart City Paris, source: Inhabitat.com

- **Cities** are **growing** steadily (impressive figures available)
- Currently: More than **half** of **global population** lives in cities, by **2050** increase to **two thirds**

- Negative effects: **Particularly 2 problems** arise
  - Cities account for ~ $\frac{2}{3}$ of global energy demand & 70% of global carbon emissions → key lever
  - Questions of how to feed masses of people = central

- **Urban agriculture as a promising avenue** addressing both problems & on top serves cities' goals

- Benefits of urban agriculture:
  - Reduction of energy demand through shortened supply chains
  - Reduction logistic costs
  - Reduction waste
  - Enhanced food security
  - Takes pressure from farmland, recovery

Cities are hostile for plants, jeopardizing the availability of important primary resources, such as air, water, or soil

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Forest city in Mexico, Source: dezeen.com

- Urban agriculture is not easy
- Cities as hostile environment for nature
  - Sealed surfaces, limited light, pavements limiting rooting, and dwindling groundwater levels triggering heat stress
  - IS/ Smart technologies as “enabler”?
- Turning to traditional agricultural contexts:
  - Advanced technologies and IoT approaches → put in place and flourished
  - Drones, satellites, sensors
  - Farmers, data scientists, engineers → better decisions
- **According to literature:** Core rationale can be transferred to city context
- **Notable differences** (think of autonomous tractors, weeding robots, underground infrastructure with sensors, satellites offering analysis from the air)
- **No direct application**, no “**one size fits all**” approach
  - Too many variables across the two fields
- **To leverage opportunities:** Understanding of smart technologies’ characteristics & implementation strategies

Little research can be found on smart urban agriculture

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Urban Agriculture

- an industry that **produces, processes, and markets food**, largely in response to the daily demand of consumers within a city
- differentiation to rural agriculture on traditional farms: its **embedment into local urban economic, social, and ecological systems**
- Ranges from private or community gardens to commercially oriented (indoor) farms

Smart Farming

- **modern information and communication technologies** enhance agricultural production
- extension of precision agriculture: based on **specific location data** and on context and **situation awareness data** that is triggered by real-time events
- Key technologies used: big data, cloud computing, IoT, machine learning, AI, digital twins, robotics

Smart Urban Agriculture: Usage of digital technologies in urban food production

- Supporter of traditional cultivation techniques (e.g., intelligent irrigation)
- Enabler for new, innovative cultivation (e.g., vertical farming)

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Slide deck 9: Industry 4.0

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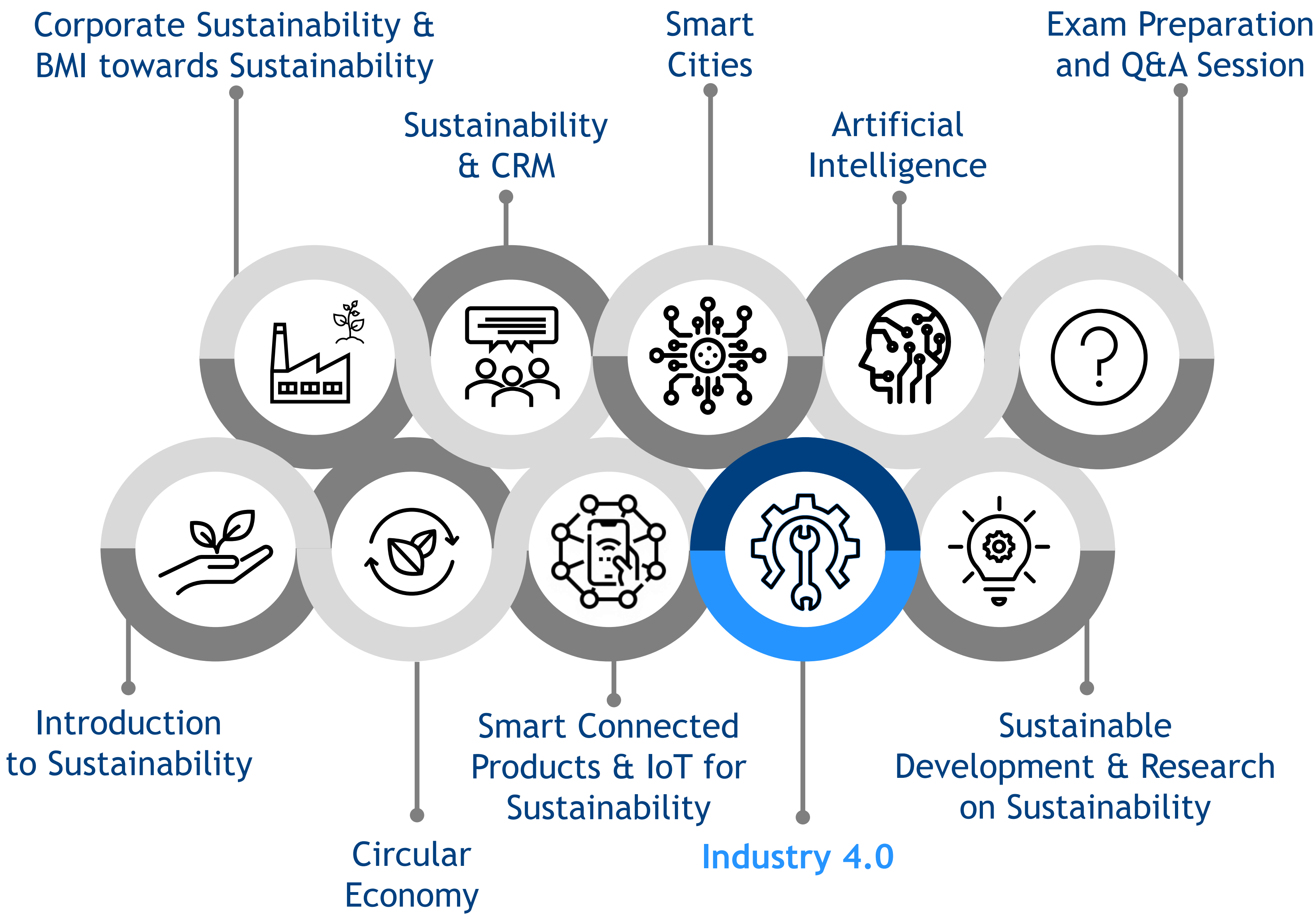
Overview Smart Sustainability



Agenda - Industry 4.0

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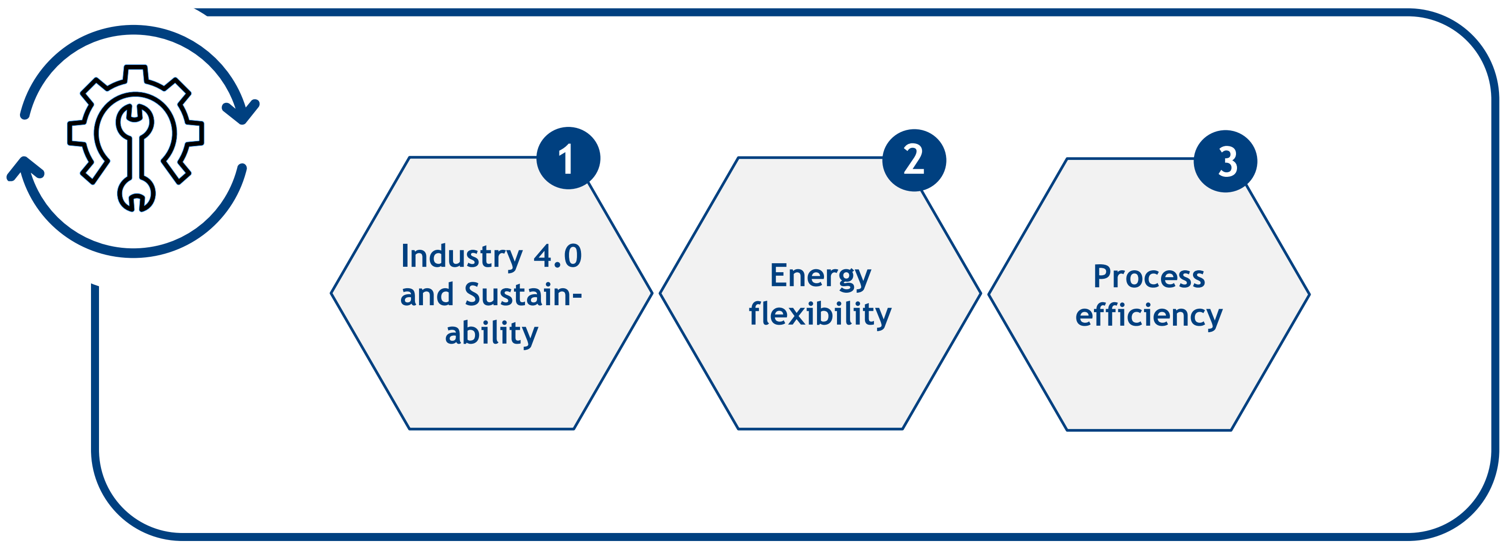


Industry 4.0 and Sustainability

What is Industry 4.0?

Industry 4.0 refers to the intelligent networking of industrial machines and processes with the aid of information and communication technologies.

PLATTFORM INDUSTRIE 4.0

[BMWI 2019]

The availability of information in real time through the networking and interconnection of all parties involved in the entire value creation process leads to dynamic, real-time-optimizing and self-organizing cross-company value creation networks.

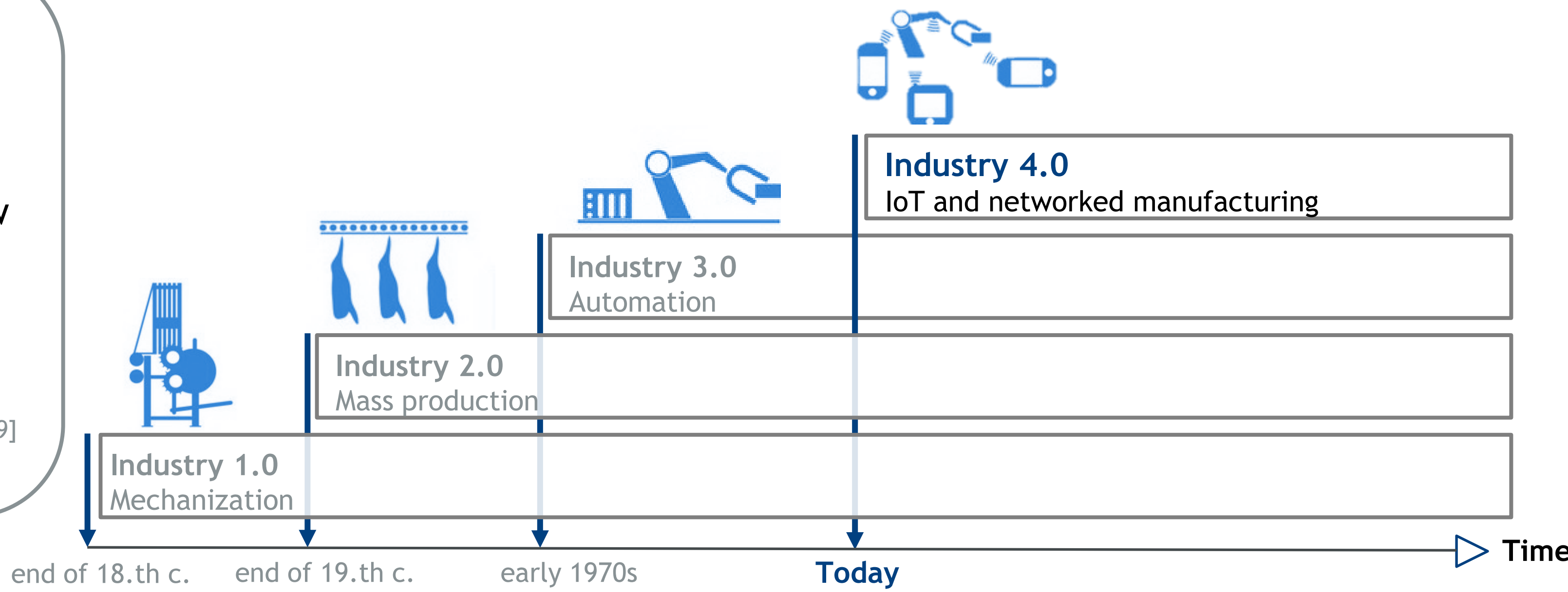
VDMA

[VDMA 2019]

bitkom

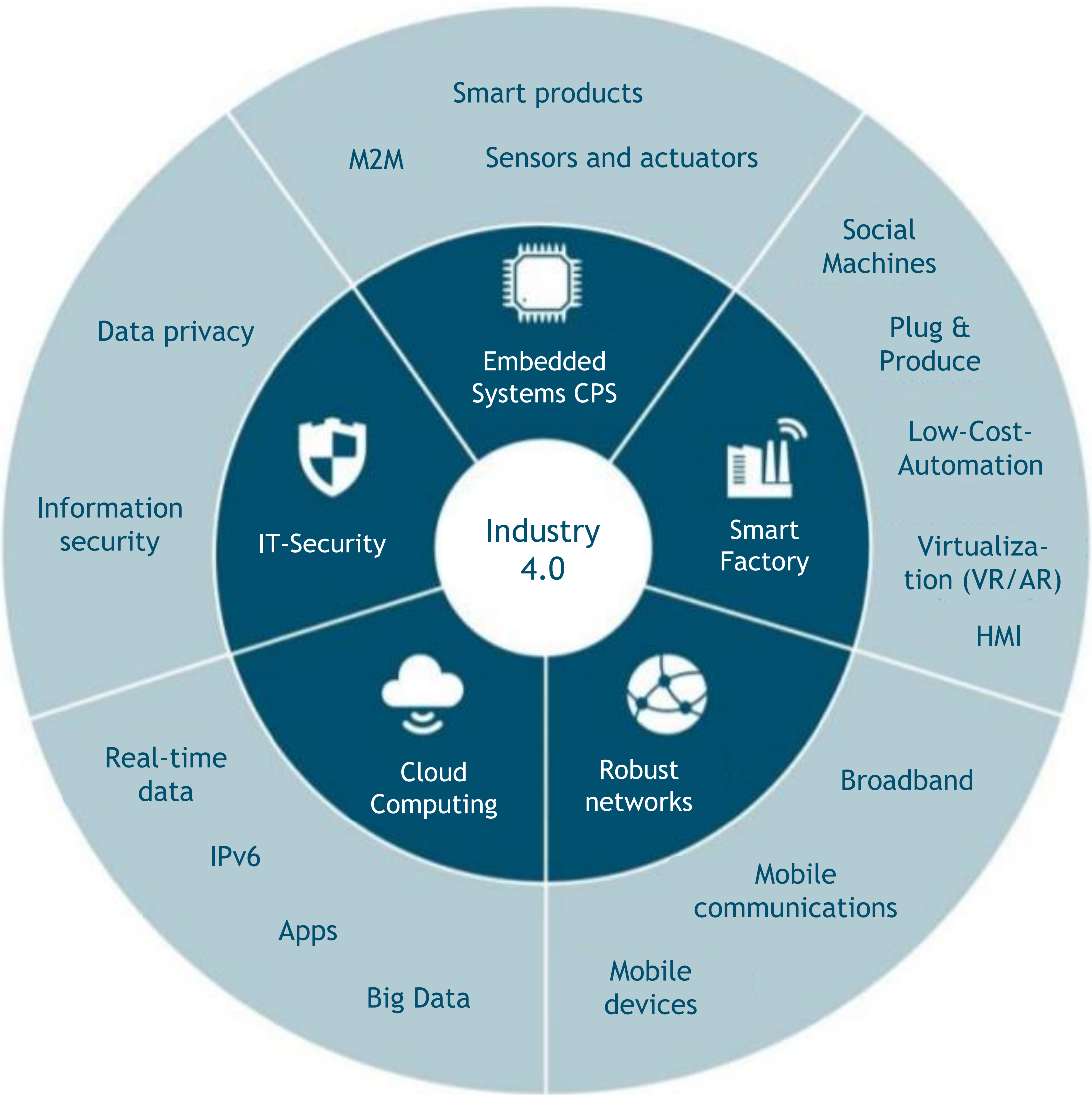
The term Industry 4.0 stands for the fourth industrial revolution, a new level of organization and control of the entire value chain over the life cycle of products.

[BITKOM, 2019]



Logos are intellectual property of individual organizations

What is Industry 4.0?

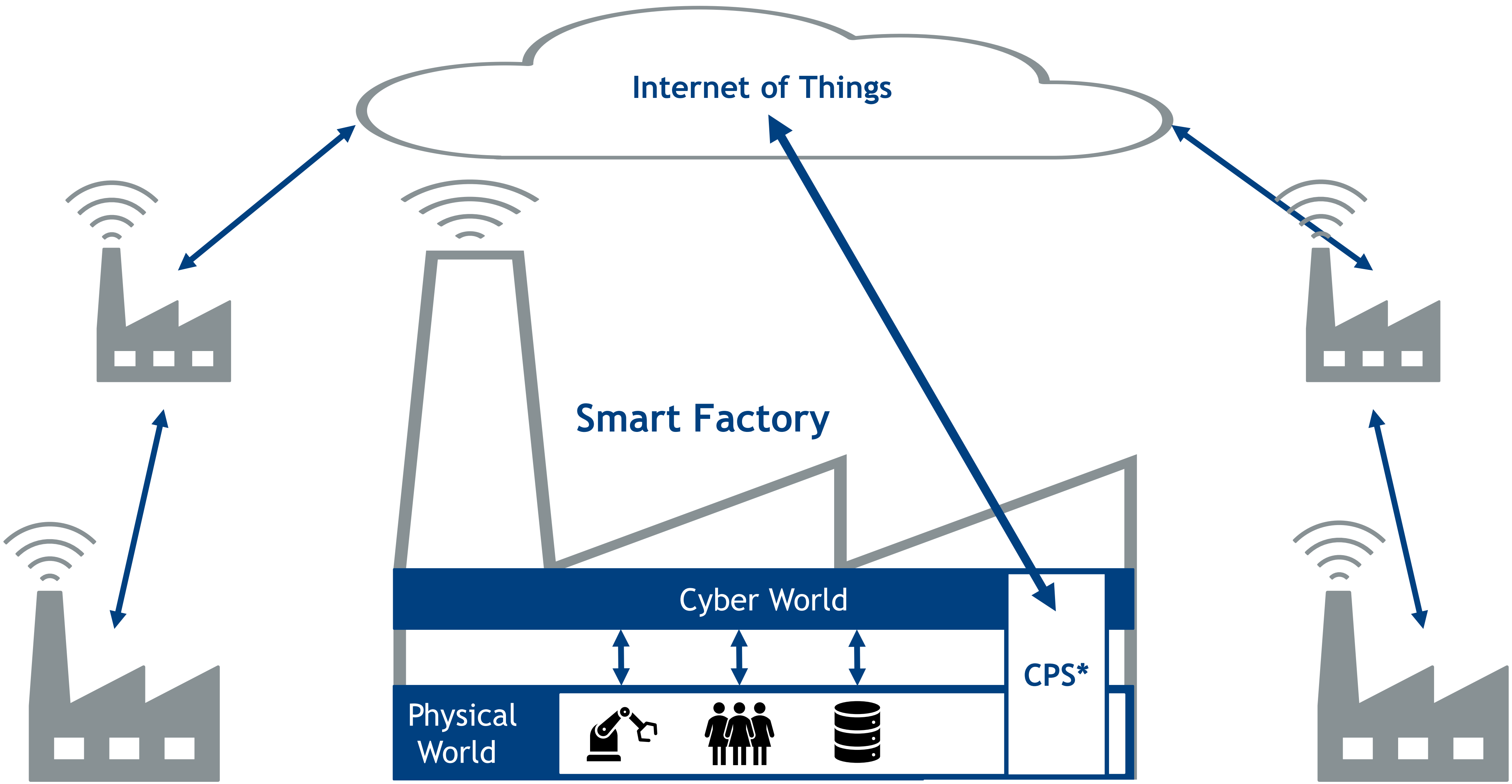


Source: Fraunhofer IAO/ Bitkom

Key features of Industry 4.0

- Automation of value creation
- Facilitated establishment of value chains and value networks across company boundaries
- Intelligent and decentralized processes
- Integrated all-digital engineering
- Networking of machines, products and processes
- Highly flexible and configurable production systems

Industry 4.0: The Smart Factory



*Cyber-Physical System

Future vision of the Smart Factory: Example Adidas

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Speedfactory in Ansbach (Bavaria) - Pilot Factory

- Series production of sports shoes, produced with intelligent robot technology and innovative production processes such as 3D printing.
- In the medium term, 500,000 pairs of shoes per year are to be produced largely automatically.
- Goal: Bring products to market quickly (time-to-market) through customer-oriented, urban production and respond flexibly to customer wishes (mass customization)
- The concept will also be extended to other consumer goods such as sportswear as part of the STOREFACTORY project.

"The speedfactories have been instrumental in furthering our manufacturing innovation and capabilities. Through shortened development and production lead times, we've provided select customers with hyper-relevant product for moments that matter. [...] We are now able to couple these learnings with other advancements made with our suppliers, leveraging the totality of these technologies to be more flexible and economic while simultaneously expanding the range of products available."
Martin Shankland, Member of the executive board of Adidas AG

Energy flexibility

Industry 4.0 and sustainability

Industry 4.0 contributions to sustainability in production

Energy flexibility

Process efficiency	
Cross-company	intra-company

How is flexibility defined in the context of energy?

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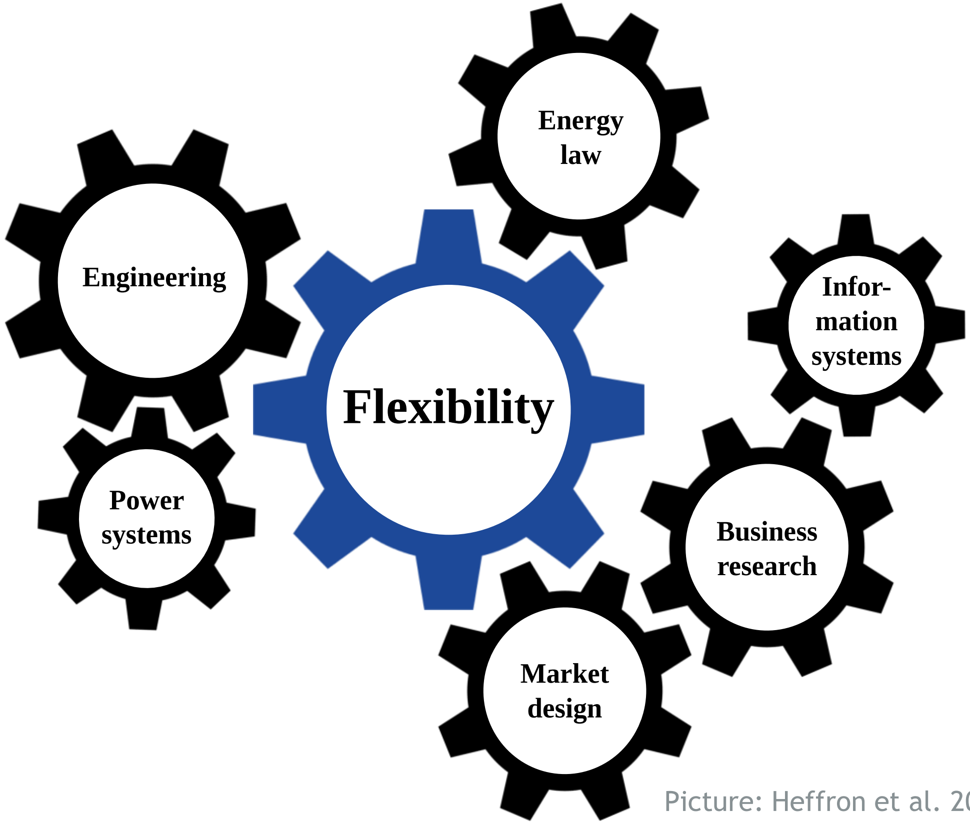

Picture: Heffron et al. 2020a

> Flexibility refers to the ability to compensate unexpected short-term imbalances between electricity supply and demand.
>
> Schöpf et al., 2018

Fluctuation of renewable energies and the need for flexibility in the system

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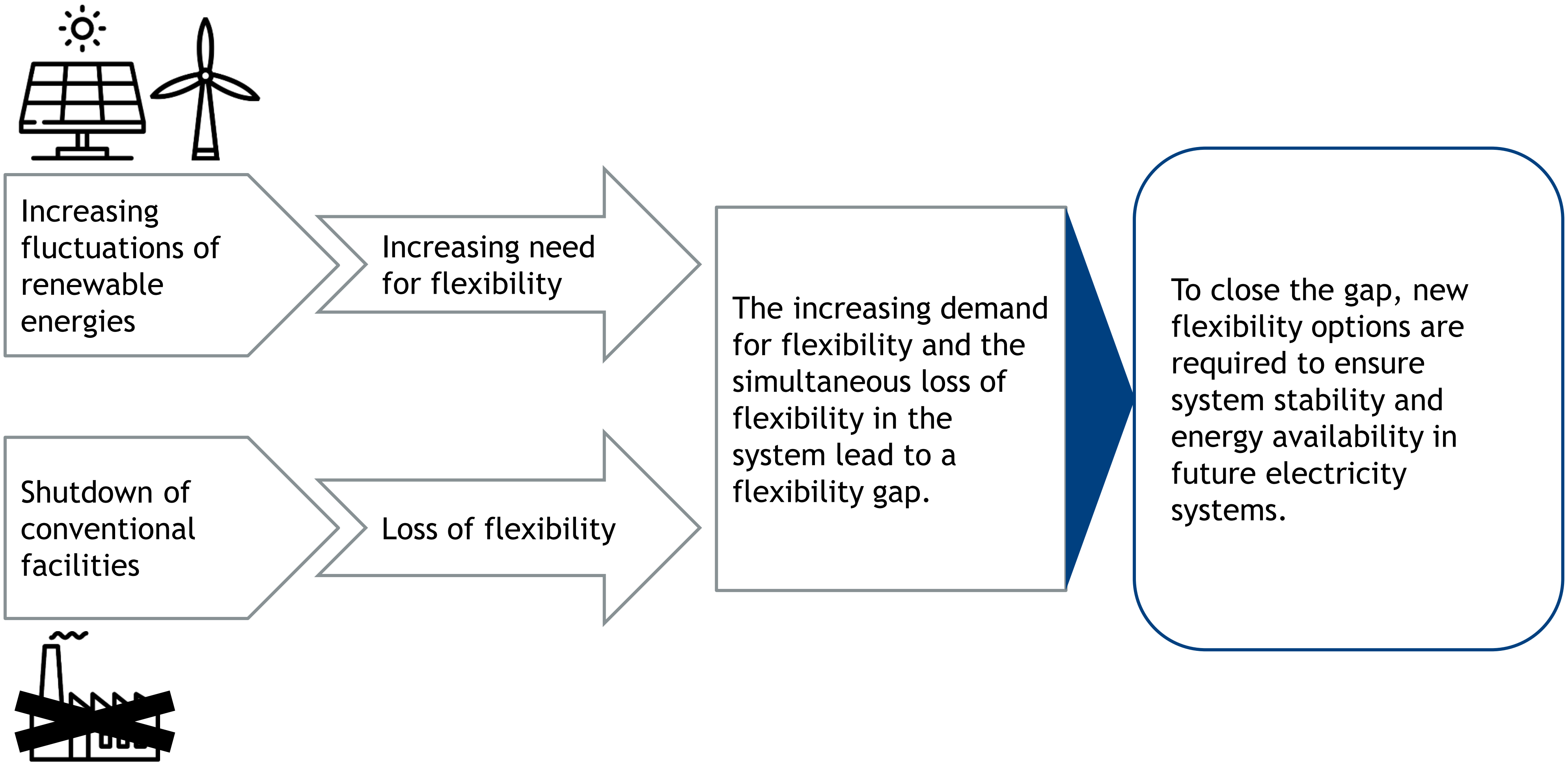
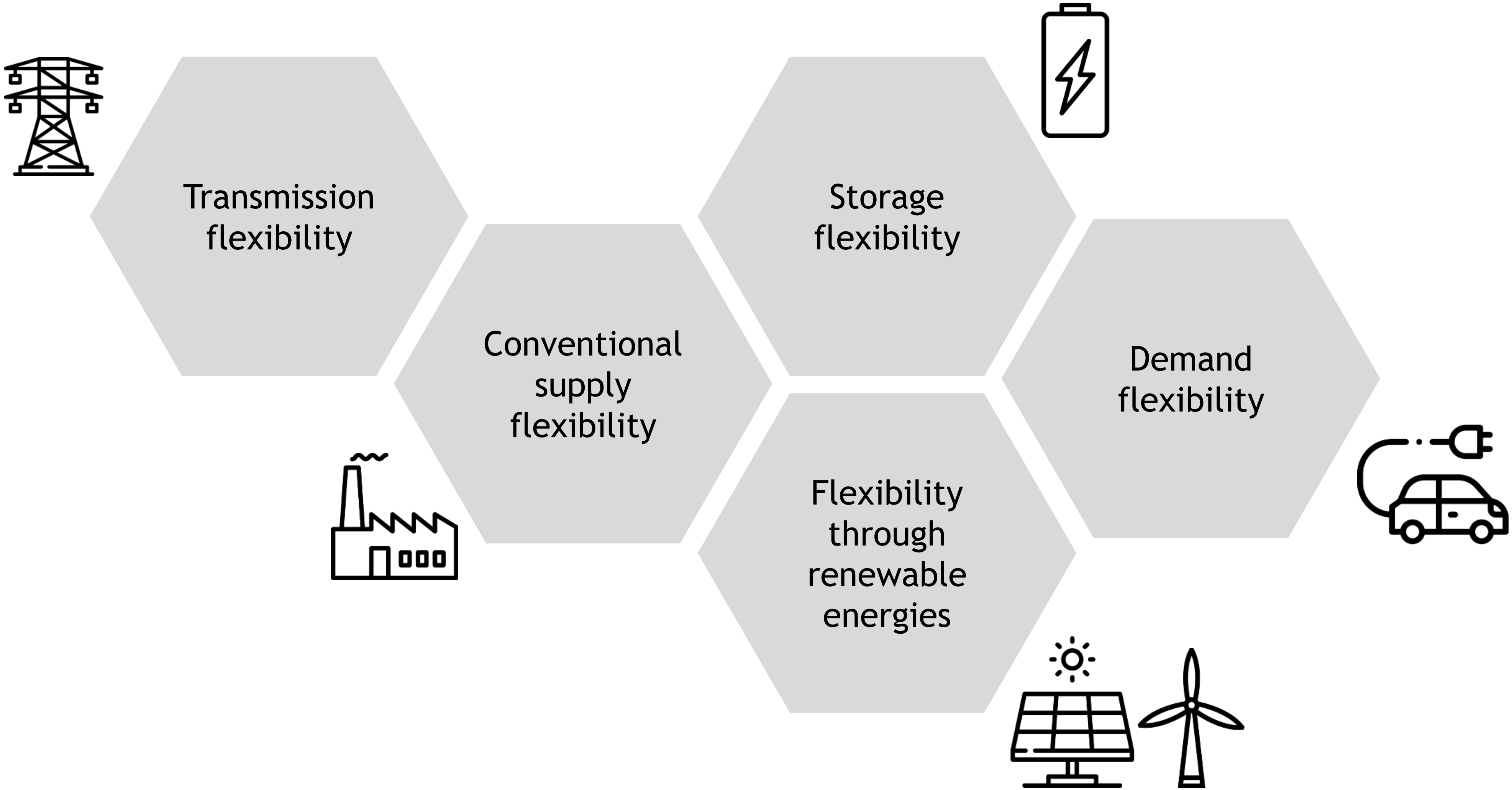


Heffron et al. 2020b; Icons: flaticon.com

Flexibility options



Icons: flaticon.com

Exemplary and possible advantages & disadvantages of the flexibility options (I)

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Flexibility option	Advantages	Disadvantages
Transmission flexibility	• Better use of renewable production • Low emissions (including pollutants) during operation	• Transmission losses, especially at very long distances across national borders • Landscape consumption and negative environmental impacts: emissions during construction phase, mining, processing of raw materials, and operation (thermal radiation leads to drought)
Conventional supply flexibility	• Use of renewable fuels such as eco-gas possible • Use or upgrading of existing facilities avoids additional land consumption and the need to build new infrastructure.	• CO2 emissions from conventional plants • Typically not compliant with the general objective of decarbonizing the electricity sector
Flexibility through renewable energies	• Low emissions (including pollutants) during operation • Typically easy removal of facilities at the end of their service life	• Landscape consumption and negative environmental impacts: emissions during construction phase, mining, processing of raw materials, and production of ,e.g., PV cells • Possible negative impacts on food production, e.g., biomass

Heffron et al. 2020b

Exemplary and possible advantages & disadvantages of the flexibility options (II)

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Flexibility option	Advantages	Disadvantages
Storage flexibility	• Typically low land use • Easy removal of facilities at the end of their service life	• Storage losses and inefficiencies • Negative environmental impacts, e.g., pollution during processing of raw materials • Problematic battery disposal, especially in developing countries
Demand flexibility	• Use of synergies with existing production infrastructure • Low emissions (including noise or pollutants) during operation • Typically no acceptance problems in the population	• Loss of production efficiency with increased CO2 emissions • Increased mechanical wear and maintenance costs due to flexible equipment operation

Heffron et al. 2020b

The flexibility of industrial demand, in particular, offers great potential for a successful energy system transformation.

Demand flexibility

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Challange:
Neither the energy system itself nor the current regulatory framework are designed to transform the energy system and take advantage of demand flexibility.

Potential:
System operation reliability can be increased by balancing power generation volatility with demand flexibility.

Heffron et al. 2020b

Initial situation:
Industrial companies have a consistently high electricity consumption

For economic reasons, companies often decide against using their flexibility potential, since the costs for providing flexibility, including lost grid fee reductions, significantly exceed the revenues generated on corresponding flexibility markets. Ländner et al. 2019

„The use of decentralized flexibility is made possible by advancing digitalization, which enables intelligent, timely high-resolved and fast control of many resources, even very small ones." Galus et al. 2018

Process efficiency

Industry 4.0 and sustainability

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Industry 4.0 contributions to sustainability in production

Energy flexibility

Process efficiency

- **Cross-company**
- **intra-company**

Process efficiency and sustainability

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Process efficiency through data exchange and transparency (cross-company)

Data on the production process and the condition of a product are brought together and evaluated. The data analysis provides information on how a product can be manufactured more efficiently.

BSP

Research project MAI ILQ 2020 – Inline production and quality control for milling in metallic and CFRP production applications

CAMPUS CARBON 4.0

Aim

- Inline process control for finishing operations to reduce costs
- AI model for process analysis and prognosis
- Concepts and methods for cross-company data exchange

CAMPUS CARBON 4.0

Process efficiency through smart products and services (intra-company)

Algorithms calculate ideal delivery routes; machines independently report when they need new material – smart networking enables an optimal flow of goods.

BSP

Research project Hospital 4.0 – ensuring inventory transparency, removal safety and automated reordering.

Hospital 4.0

Aim

- **Innovative logistics systems** in hospitals through the **use of digital technologies**.
- **Meaningful digitalization of hospital logistics** for improved transparency, security and efficiency of logistics processes

Hospital 4.0

What does this have to do with sustainability?

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Slide deck 10: Artificial Intelligence
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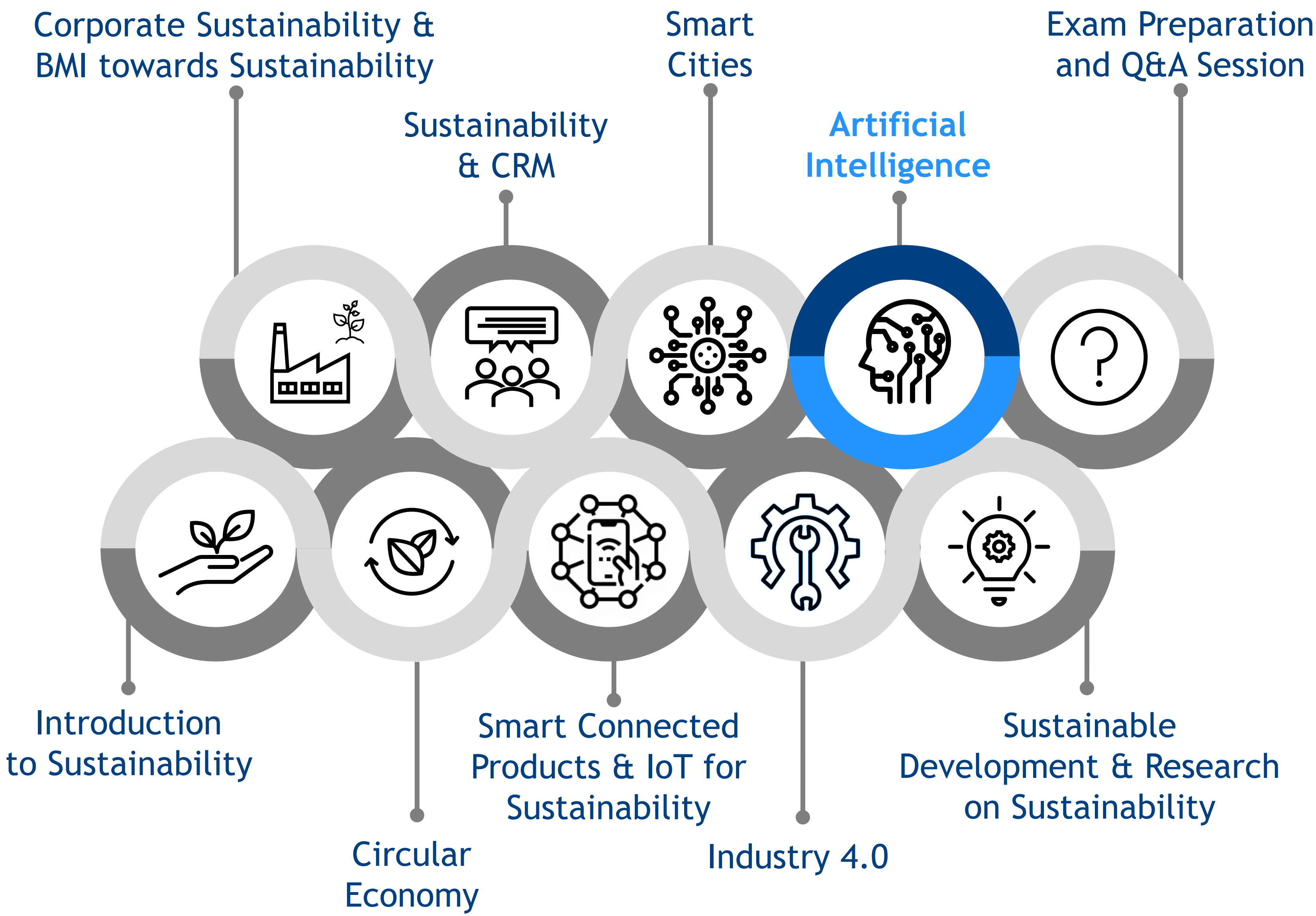

Agenda - Sustainable Development & Research on Sustainability

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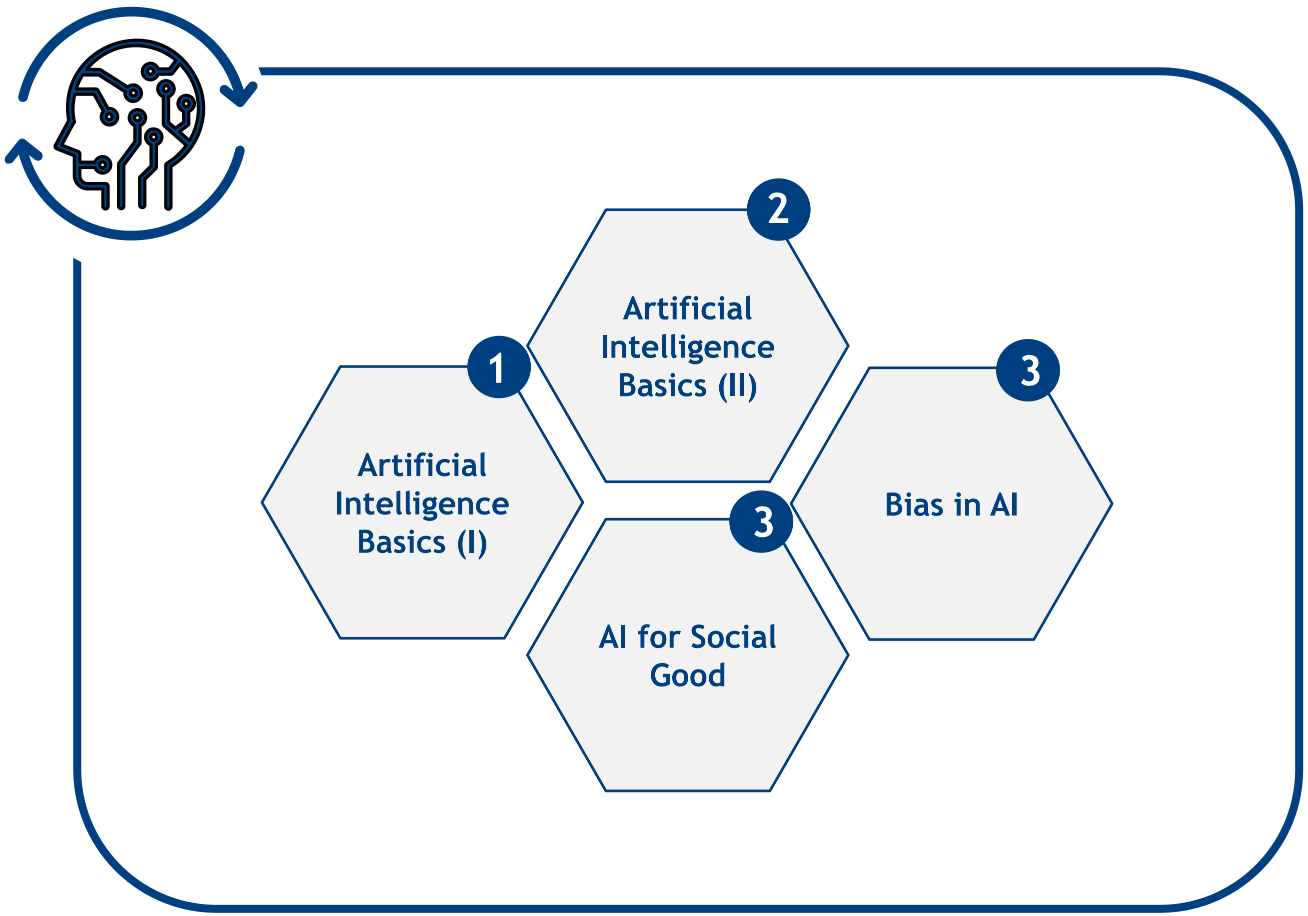
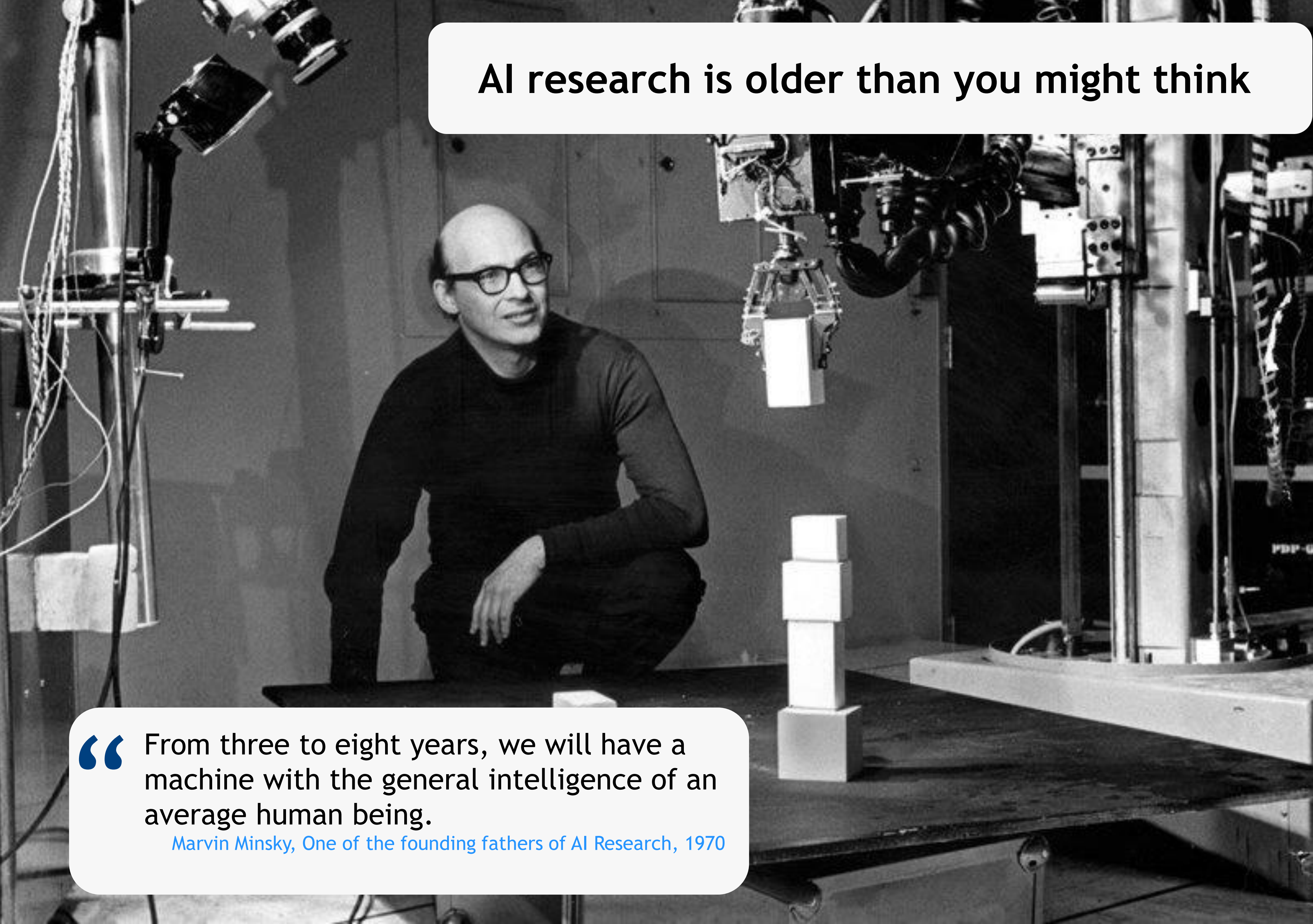


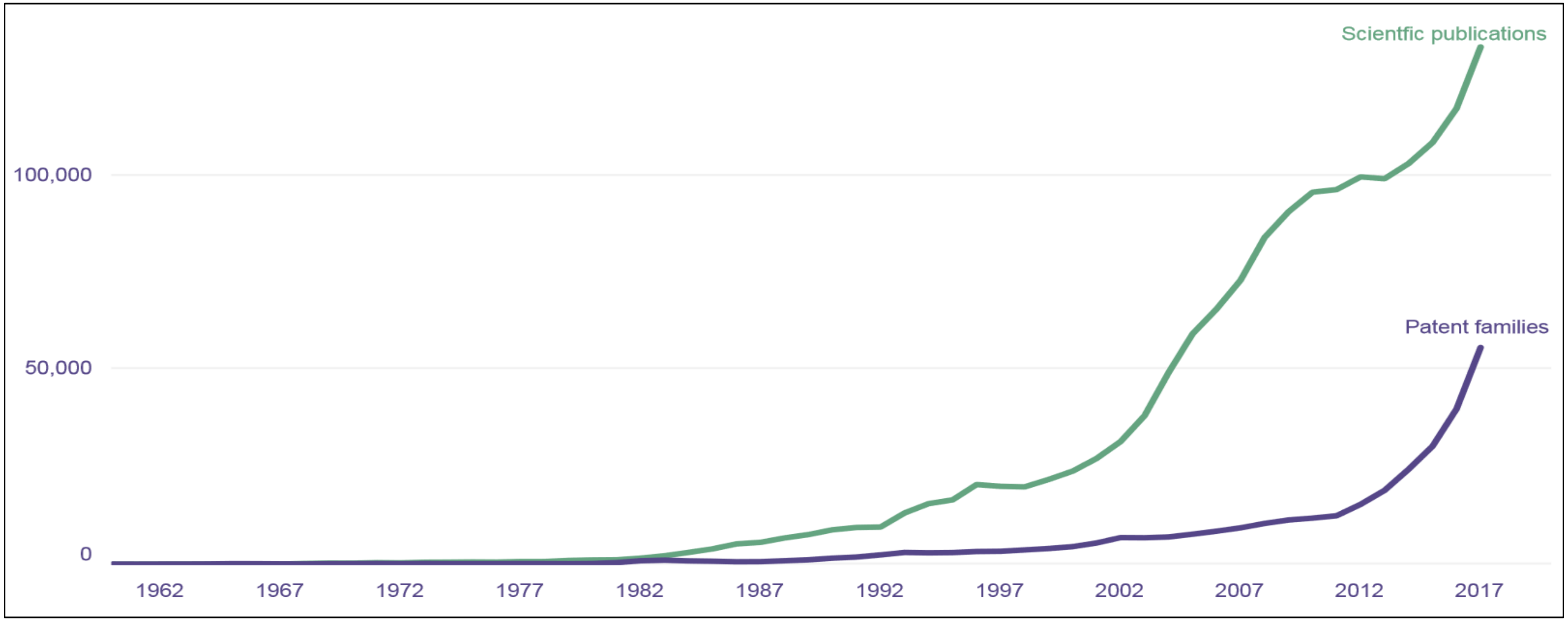
Artificial Intelligence Basics (I)

AI research is older than you might think



> “From three to eight years, we will have a machine with the general intelligence of an average human being.
>
> Marvin Minsky, One of the founding fathers of AI Research, 1970

Artificial intelligence finds its way into science and patents



Between 1960 and early 2018, nearly 340,000 patent families and more than 1.6 million scientific papers related to artificial intelligence were published.

WIPO (2019)

The long history of artificial intelligence in fast forward

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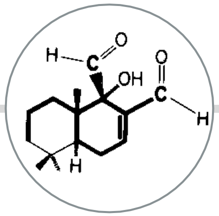
1950 – Turing test

1966 – ELIZA: 1. Chatbot

1972 – MYCIN: Expert system



1978 – R1: Expert system

1997 – Deep Blue wins at chess

2011 – IBM Watson wins Jeopardy

2016 – Alpha Go wins Go

2020 – AI warns about Corona

> In its long history, artificial intelligence has not had only triumphs.

Pictures: Turning Test https://anthrowiki.at/Alan_Turing; Eliza https://upload.wikimedia.org/wikipedia/commons/4/4e/ELIZA_conversation.jpg; Mycin https://www.semanticscholar.org/paper/The-Dendral-Project-%3A-Computational-Aids-to-Natural-Djerassi-Smith/3eea6a3e780e6177fb14fe13732995a6a2c1c93d; R1 https://en.wikipedia.org/wiki/Expert_system#/media/File:Symbolics3640_Modified.JPG; Deep Blue https://www.ichess.net/blog/deep-blue-vs-kasparov-1997-rematch/; IBM Watson https://www.jeopardy.com/sites/default/files/styles/article_image_960_/public/files/image//Assets/jeopardy/images/jbuzz/video-migration/jp_vid_watson_ibm.jpg?itok=nrOdqJ9u; Alpha Go https://www.lesnumeriques.com/vie-du-net/deepmind-domine-par-l-ia-le-champion-de-jeu-de-go-lee-se-dol-abandonne-n144195.html; Corona https://www.ionos.de/digitalguide/websites/web-entwicklung/code-editoren/

Definitions of artificial intelligence

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"The goal of AI is to develop machines that behave as if they possess intelligence" (McCarthy 1956)

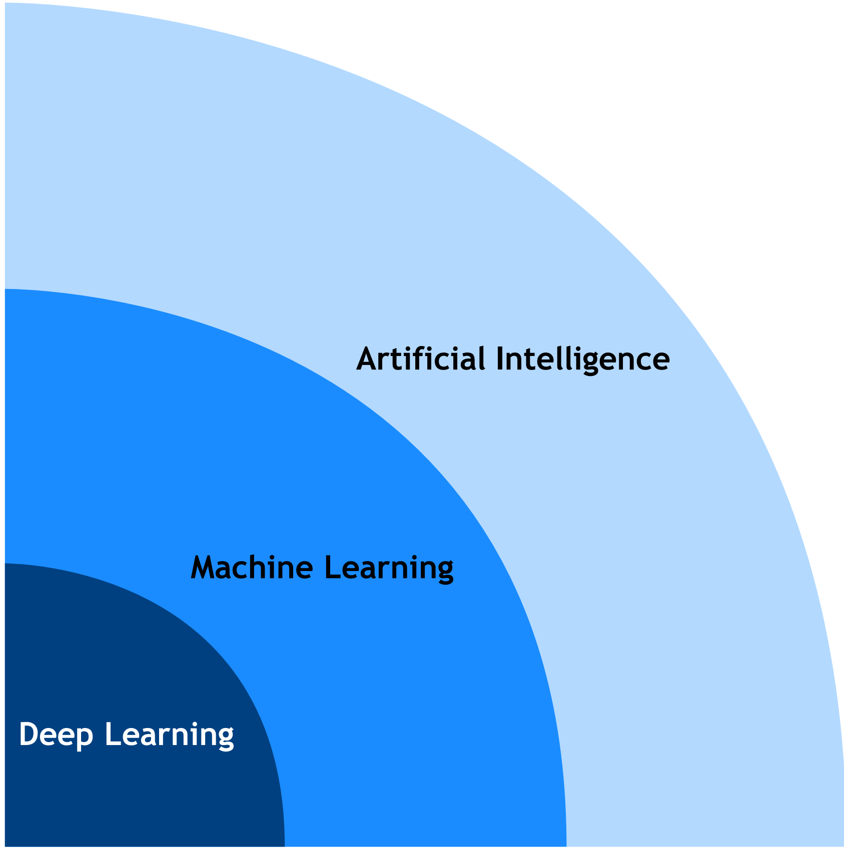
"Artificial Intelligence is the study of how to make computers do things at which, at the moment, people are better" (Rich 1983)

"Artificial intelligence is the ability of a computer or computer-controlled robot to solve tasks that are usually done by intelligent beings" (Copeland 2019)

"Artificial intelligence (AI) refers to the property of technical systems to solve tasks whose solution by a human requires intelligence" (Gabler Wirtschaftslexikon)

There is no single all-encompassing definition of AI.

Distinction between AI, Machine Learning, & Deep Learning



Artificial Intelligence can be based on programmed processes or generated by machine learning or deep learning algorithms.

Machine Learning: Methods of learning processes that can be used to identify relationships (or patterns) in existing data sets in order to make predictions based on them (Murphy 2012).

Deep Learning: Extract useful patterns and features from raw data using neutral networks (Amini 2022).

Artificial Intelligence Basics (II)

AI in action in the Covid-19 pandemic

AI is instrumentalized in the fight against the Corona virus

Support in the search for a vaccine

- AI examines compounds and matches them with a parameter database
- Shortening the period until the first tests of the vaccine

Prediction of the pandemic

- Early detection of the virus, through analysis of data sets such as news, airline ticket sales, demographic data, and climate data
- Forecasting Corona hotspots

Quick diagnoses

- AI exchanges data with CT scanners in hospitals
- AI analyzes CT images of the lungs, identifies the signs of coronavirus and evaluates the changes

In addition, AI supports the nursing staff, controls citizens, evaluates policies and measurements.

Wayback Archive (2021), Council of Europe (2021), Intel (2021)

Four key developments enable and accelerate the application of AI nowadays

Necessary data are available and usable

Digitalization creates data that can be used for AI applications through Big Data technologies

The machine learning algorithms have been improved

In recent years, significant progress has been made, especially through deep learning algorithms

Cloud services provide the required computing power

Cloud services enable fast, flexible and affordable use of computing resources without major investments

The application of AI is not rocket science

High-performance (open source) toolkits and libraries are available

Identifying AI use cases comes with new challenges

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General purpose of technology

Similar to fire or electricity, AI can be used in a variety of ways

More than copy & paste

AI use cases must be aligned with the business context

Data moves into focus

The success of an AI use case depends largely on the data at hand

More than a problem solver

AI applications can also create new competitive advantages independent of an existing problem

Lack of experience in using AI puts companies at risk of overlooking innovative AI use cases or focusing on less value-added AI use cases.

Hofmann et al. 2020a, Hofmann et al. 2020b

Classification of exemplary areas of application according to risks and opportunities of AI

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	Exemplary opportunities	Exemplary risks
Individual	• Better health care • Safer transportation • **Better/tailored products** • Easier access to education and information	• Use of AI to track individuals leads to privacy cuts • **Creation of "bubbles" can encourage radicalization of individuals** • Deepfakes
Organizational levels	• Development of new products and services • **Improvement/optimization of existing processes** • Use of robots in dangerous work steps • AI will create new jobs	• **Underutilization of AI leads to competitive disadvantages** • Overutilization or focus on applications that prove not to be useful can lead to major disadvantages • AI will cost jobs • Distortion of competition is possible
Societal levels	• **Sustainability of products can be increased** • Disinformation and cyber attacks can be better prevented • Decisions can be made in a value-neutral way • Security in the network and also in reality can be improved	• **Legal situation hard to get right:** Too many regulations stop development, too few previous to inadequate products

European Parliament (2022)

AI for Social Good (AI4SG)

AI for Social Good: The benefits of AI applications are not just about commerce

Picture: https://sdgs.un.org/goals

AI for Social Good (AI4SG)

- AI for Social Good – a relatively new research field at the intersection of AI and several other fields.
- Advanced research topics in artificial intelligence that contribute to solving global problems, particularly in the context of the Sustainable Development Goals.

> "Social" in AI4SG does not only cover social sustainability but refers to all three pillars of sustainability or all 17 SDGs.

Picture: https://aiforgood.itu.int/

AI4SG example of ecological sustainability

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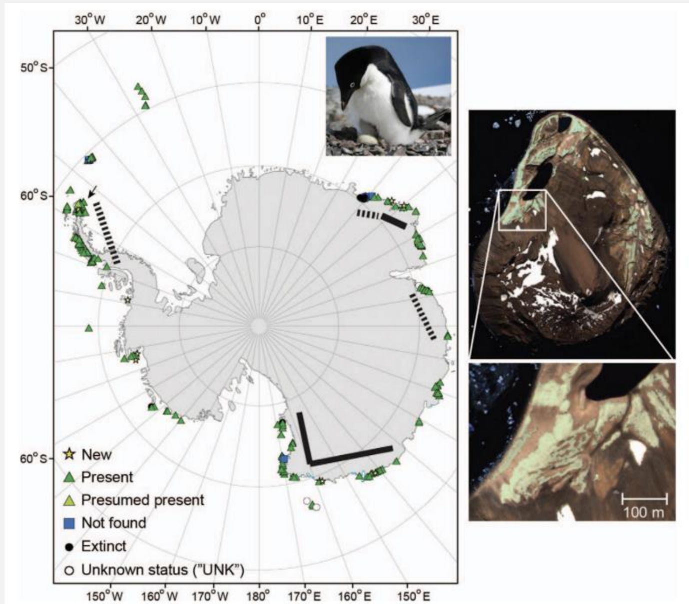
Description

- The excrements of penguins are light pink color and thus easily visible via satellite.
- **AI-based image recognition** can determine **where and how many colonies of various penguin species exist** as well as their **migration patterns.**

Impressions



Counting penguins from space because their excrements are visible via satellite.

Adressed SDGs

Pictures: https://sdgs.un.org/goals; https://towardsdatascience.com/introduction-to-ai-for-social-good-875a8260c60f

Lynch & LaRue 2014, Steward (2022)

AI4SG example of economic sustainability

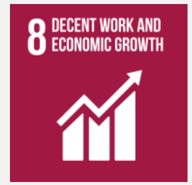
Description

- After closing time, the scanning robot drives autonomously through the store.
- **AI-based image recognition** captures data on store and shelf layout, merchandise locations and availability.
- The generated data can **increase efficiency and productivity in business processes.**

Impressions

Every night, the robot records the store layout, the exact location of the products and the inventory.

Adressed SDGs



Pictures: https://sdgs.un.org/goals, https://bremen.ai/usecase/nachts-allein-im-supermarkt/

AI4SG example of social sustainability

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Description

- The "Child Growth Monitor" app diagnoses the nutritional situation of children.
- Using an **AI-based video recording**, it measures a child's weight and height.
- Data is **more reliable and available faster** compared to handwritten measurements.

Impressions

Standing children can be measured from a safe distance of 1.5 meters without the need to touch the child.

Adressed SDGs

Pictures: www.sdgs.un.org/goals, www.welthungerhilfe.de
Source: www.childgrowthmonitor.org

Criteria required for AI4SG applications

Significance of the problem

The social impact problem considered is **significant** and **not addressed by the AI community** thus far.

Novelty of approach

Introduces a **new model or improves existing models** regarding data collection and analysis techniques or algorithms.

Scope and promise for social impact

High likelihood of **social impact of the solution** (instant or possible use in practice required).

Reliance upon and/or advancement of cutting-edge AI techniques

Introduces **novel or state-of-the-art AI techniques** suitable to the problem.

Not every AI application is automatically an AI4SG application, for this, four criteria must be met.

The Association for the Advancement of Artificial Intelligence (AAAI) (2022)

Bias in Artificial Intelligence

The case of Apple

Apple came under criticism because an algorithm responsible for deciding on customers' credits discriminated against women.

Picture: https://unsplash.com/photos/zFOm6KzA-7g
Source: ODSC - Open Data Science (2019)

The case of Amazon

Amazon came under criticism because their AI-based recruiting tool discriminated women.

Picture: https://unsplash.com/photos/LDcC7aCWVlo
Source: Zeit Online (2021)

There are various reasons for biases

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Problem

- AI is usually not malicious. However, even "good" **AI can have very negative effects** on our lives.
- **An AI cannot reflect on its actions.**

Reasons for biases

- Decisions are made by **input data and basic programming.**
- If this programming contains **errors** or if there are **unwanted patterns** in the data sets, then these **decisions can quickly go in unwanted or wrong directions**.
- These "errors" **cannot be found by the AI** itself. Programmers would have to find these errors.
- If the cause of the "errors" is not in the data, then every **programmer is responsible** for it through his or her code.
- It does **not** concern a **conscious manipulating** of the code, but through various characteristics that each person brings with them (unconscious bias).

Dilmegani (2022)

The potential of AI to address bias

Diverse team

By ensuring that the team that develops the solutions is diverse, multiple perspectives are represented.

Representative data

The training data should be representative, and the team needs to reflect on whether something is missing from the dataset.

Test for possible bias

It is also of importance to identify processes to test and monitor for possible bias during the development and use of the solution.

Reflect the impact on the users

The team needs to reflect on the AI solution's impact on the users and whether there may be users disproportionately affected by negative consequences.

AI4SG does not arise automatically, various criteria and possible negative effects must be considered.

Dilmegani (2022), Sentance (2022)

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Digital Management

University of Hohenheim

Faculty of Business, Economics and Social Sciences

Institute of Marketing and Management

Chair for Digital Management

Smart Sustainability

Dr. Valerie Graf-Drasch

Slide deck 11: Sustainable Development and Research on Sustainability
2022

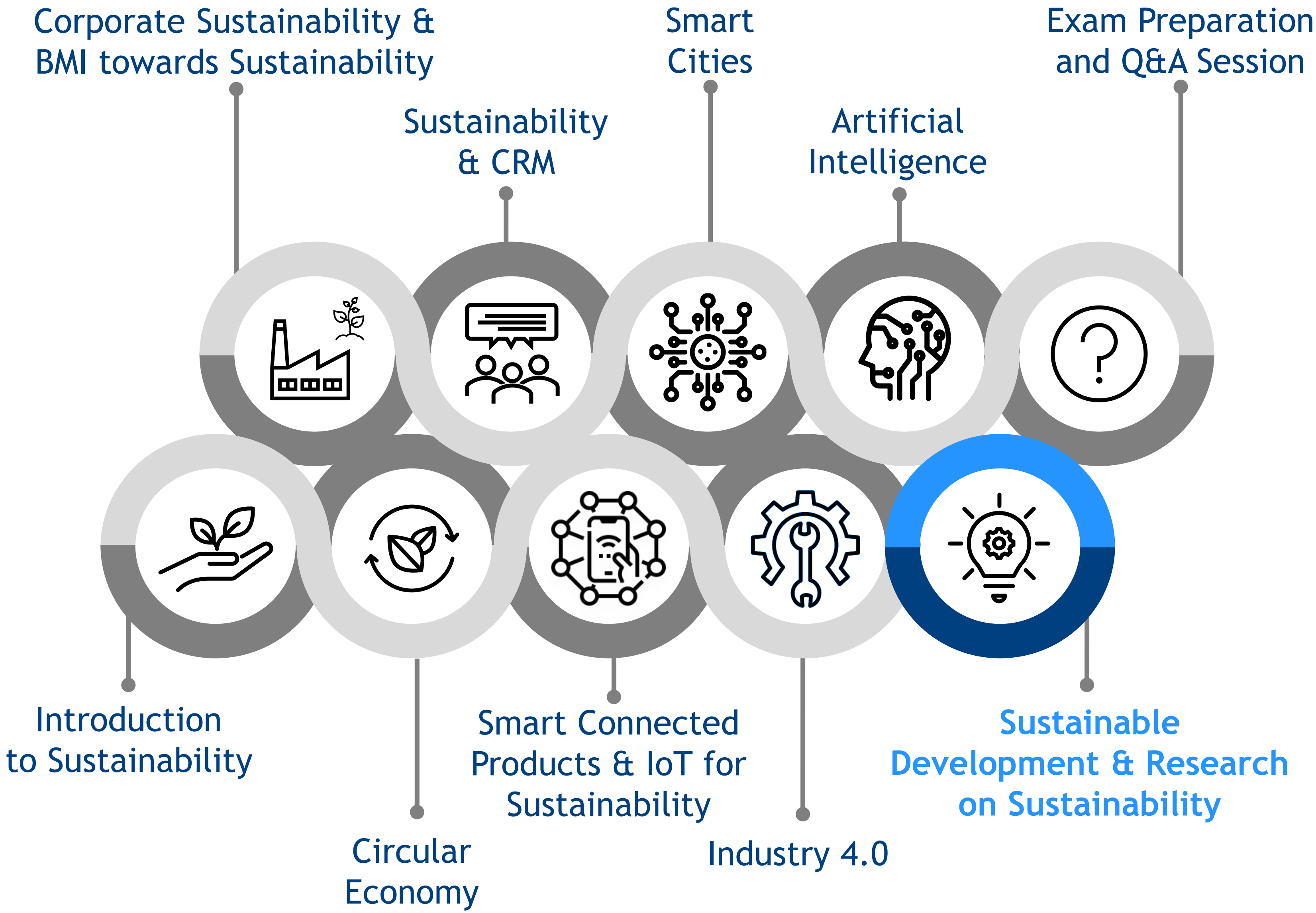
Research Center Finance & Information Management

Fraunhofer FIT Project Group Business & Information Systems Engineering

DIGITAL LEADERSHIP ACADEMY

https://digital.uni-hohenheim.de/

Overview Smart Sustainability



Agenda - Sustainable Development & Research on Sustainability

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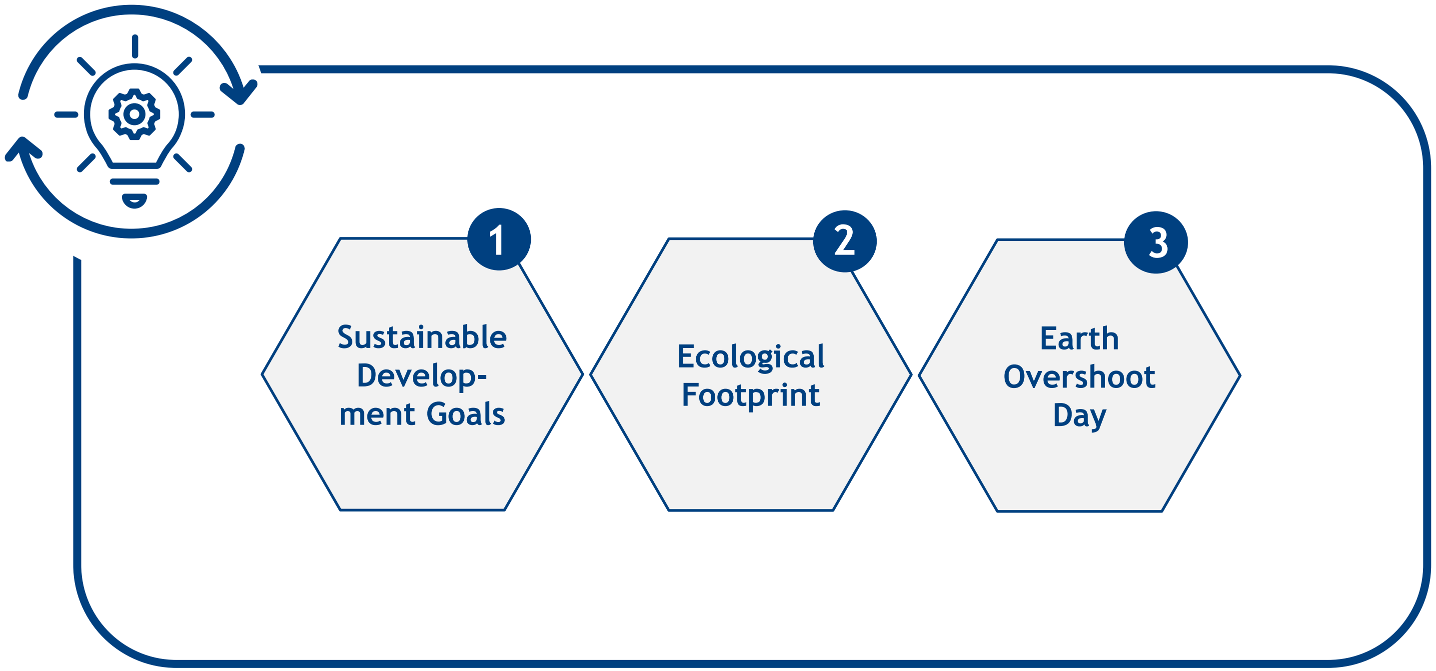
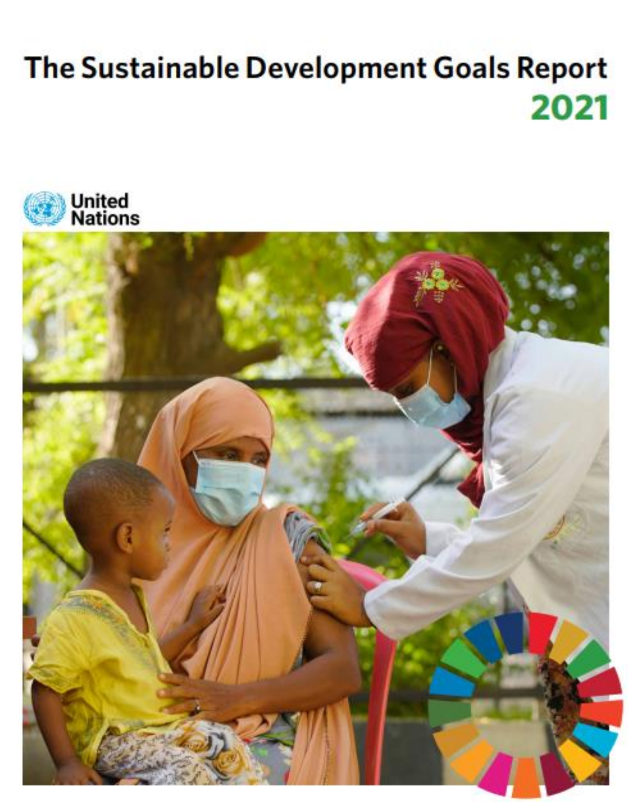


Sustainable Development Goals

What are the SDG?

Source: www.un.org/sustainabledevelopment/wp-content/uploads/2019/01/SDG_Guidelines_AUG_2019_Final.pdf

Where does Germany stand?



The 2021 SDG Index Scores

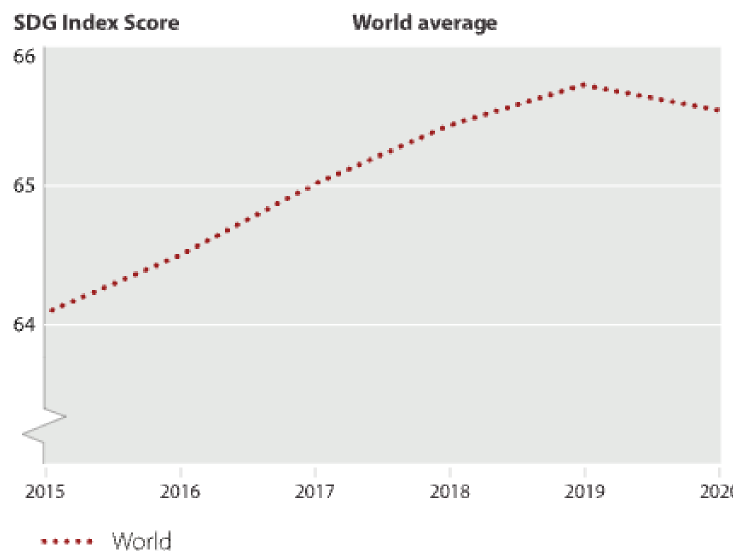
Rank	Country	Score
1	Finland	85.9
2	Sweden	85.6
3	Denmark	84.9
4	Germany	82.5
5	Belgium	82.2
6	Austria	82.1
7	Norway	82.0
8	France	81.7
9	Slovenia	81.6
10	Estonia	81.6
11	Netherlands	81.6
12	Czech Republic	81.4
13	Ireland	81.0
14	Croatia	80.4
15	Poland	80.2

„The COVID-19 pandemic is a setback for sustainable development everywhere.“

Sustainable Development goals report 2021, Jeffrey Sachs et. al.

„The pandemic has impacted all three dimensions of sustainable development: Economic, social and environmental.“

Sustainable Development goals report 2021, Jeffrey Sachs et. al.



While being 5th place in 2020 with a score of 80.8, in this years SDG Index Germany reaches **a score of 82.5**, which puts it in **4th place worldwide**. This indicates that Germany is among the ten most sustainable countries and further advances in its progression to reach the goals.

Source: unstats.un.org/sdgs/report/2021/; dashboards.sdgindex.org/chapters/part-2-the-sdg-index-and-dashboards

Where does Germany stand?

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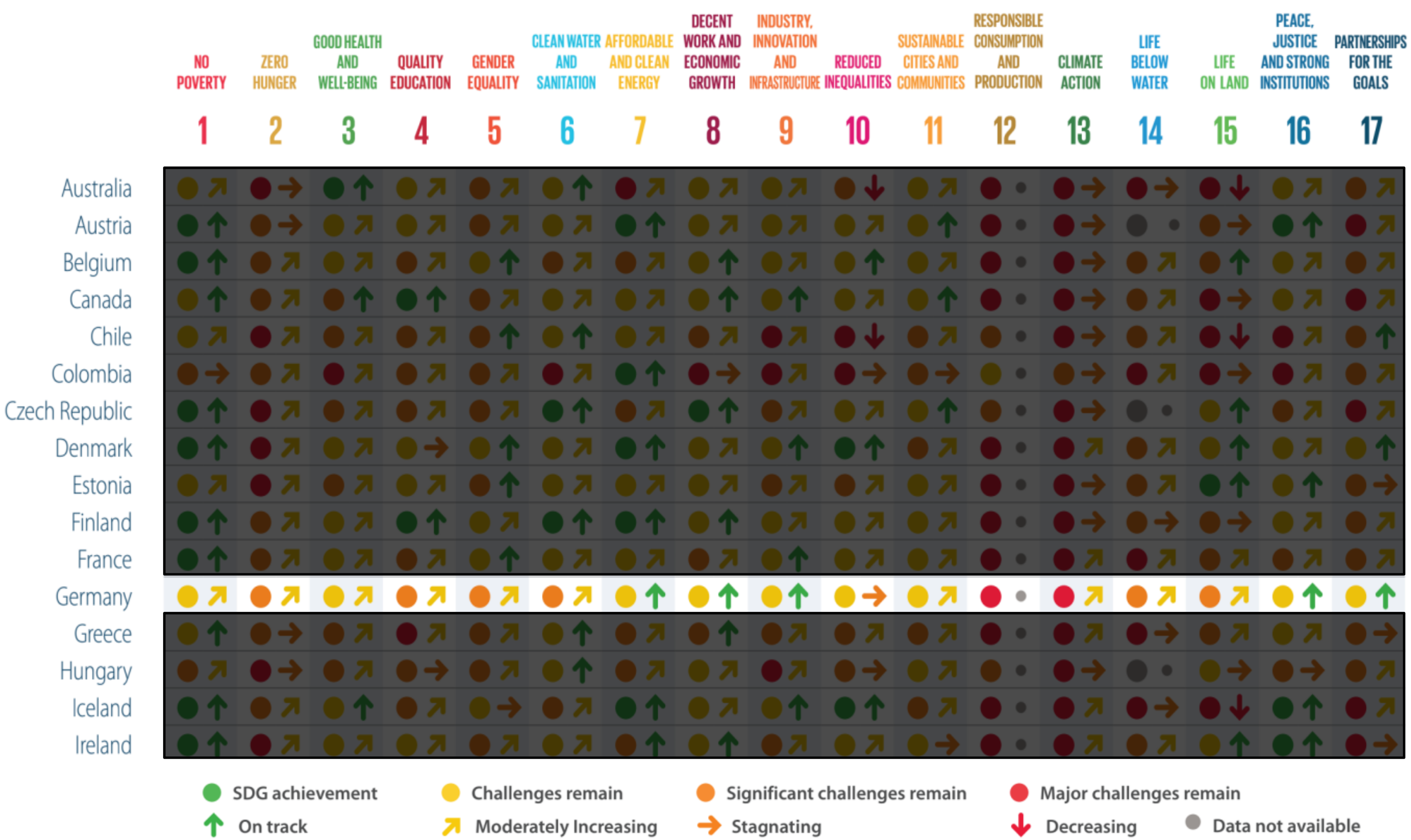
2021 SDG dashboards (levels and trends) for OECD countries



Source: www.un.org/sustainabledevelopment/wp-content/uploads/2019/01/SDG_Guidelines_AUG_2019_Final.pdf; dashboards.sdgindex.org/chapters/part-2-the-sdg-index-and-dashboards

Ecological Footprint

The Ecological Footprint and Biocapacity

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The **Ecological Footprint** measures, how much productive land and water an individual, a city, a country, or humanity requires to produce the resources it consumes and to absorb the waste it generates, using prevailing technology.

Afterwards, the required land is compared to the actual available biocapacity. When humanity's footprint is smaller than global biocapacity it is considered sustainable, otherwise it is engaging ecological overshot.

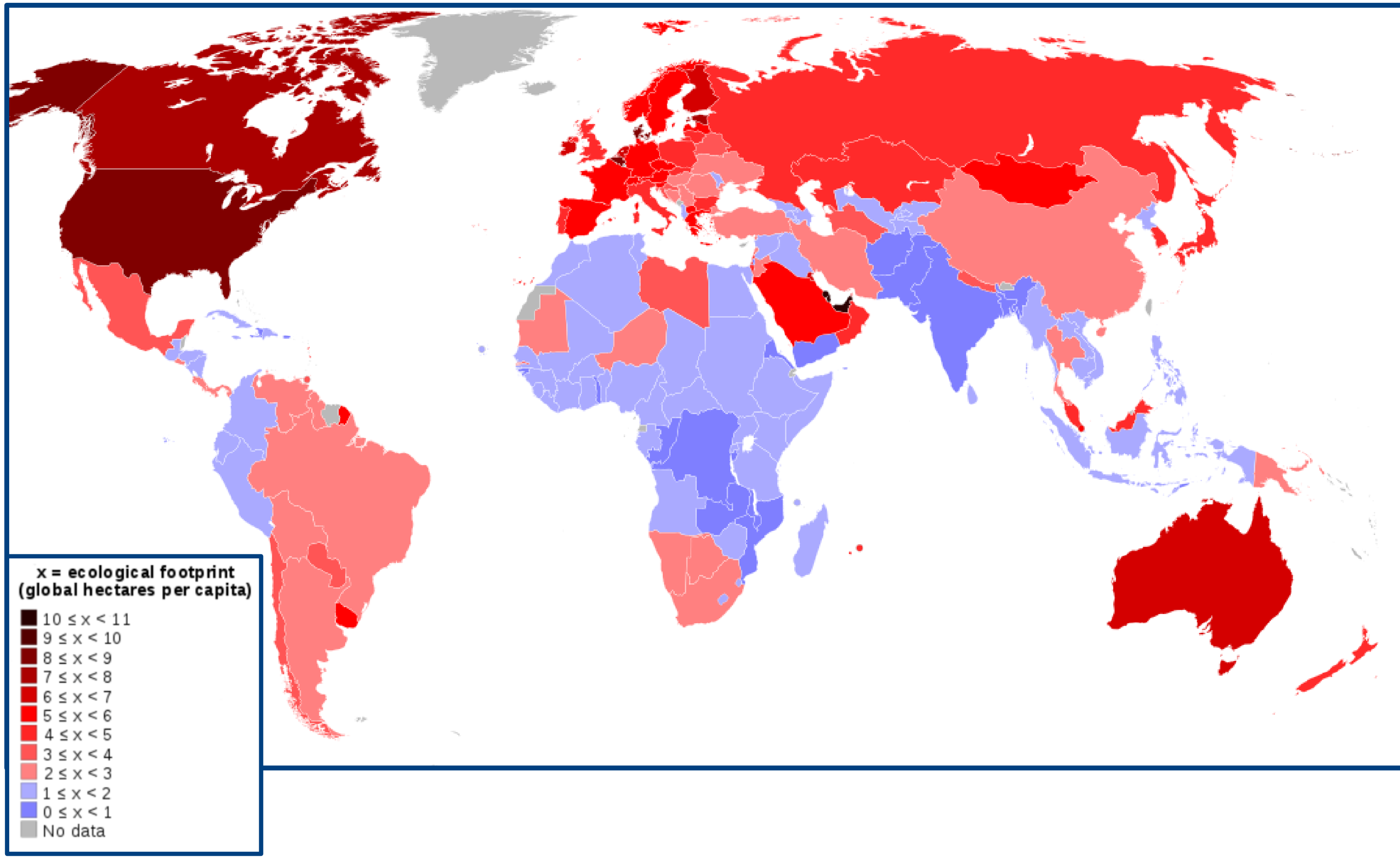
Source: www.mite.gov.it/sites/default/files/archivio/allegati/rio_20/forum_rio20_ruini_barilla2.pdf

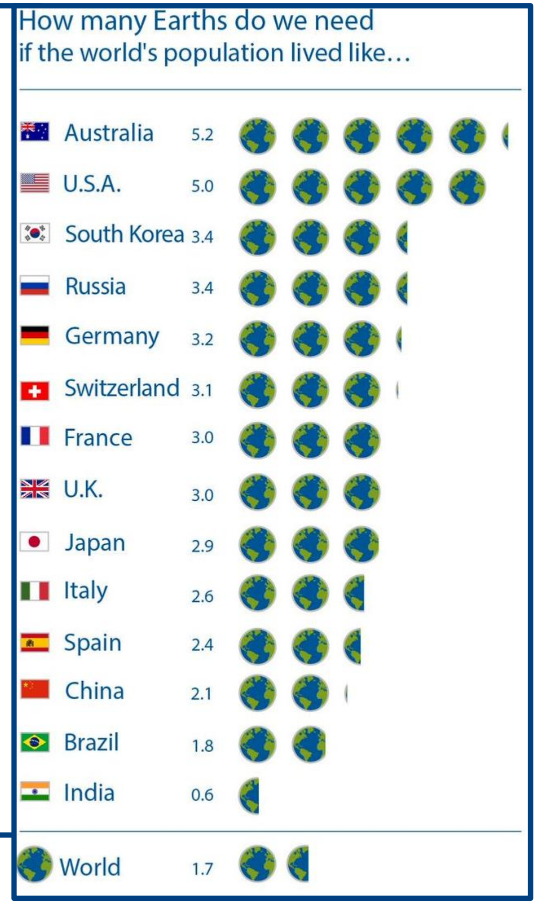
Biocapacity is the biologically productive area that provides renewable biological capacity including the replenishment of resources and the absorption of waste such as carbon dioxide from burning fossil fuel. It contains grazing and crop land, energy and built-up land, fishing ground and forest.

The **measuring unit** of the ecological footprint is the global hectare (**gha**). To enable the comparability between different countries, the global hectare represents an average unit, to take different soils, fertilities and the associated productivity into account.

Kitzes et al. (2007), utopia.de (2019), Meinhold (2011)

Ecological Footprint worldwide





Picture source: commons.wikimedia.org/wiki/File:World_map_of_countries_by_ecological_footprint_(2007).svg statistic: https://www.overshootday.org/newsroom/infographics/

We use resources during one year, the earth can only regenerate in one year and eight month

Interrelationship between prosperity and consumption

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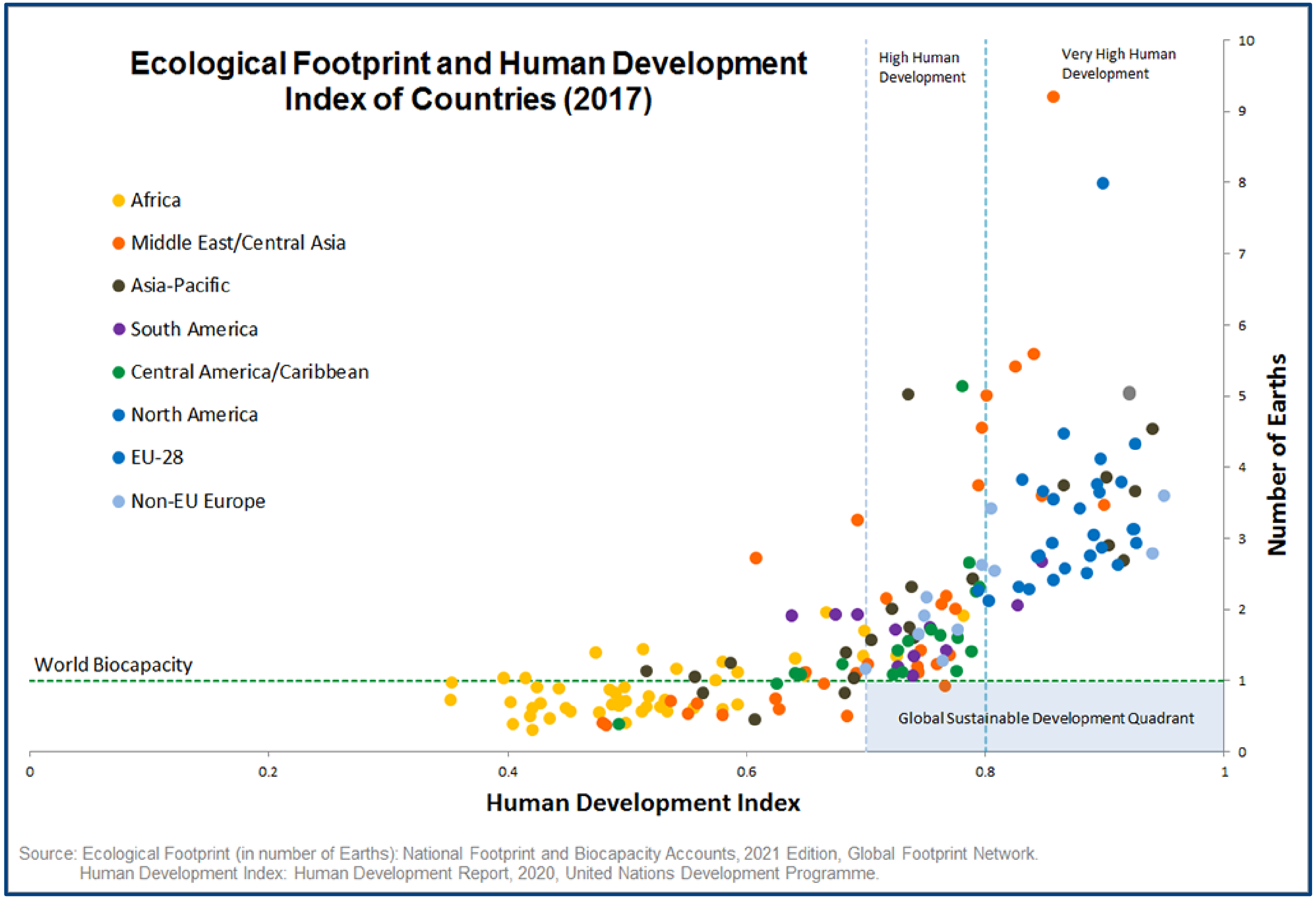
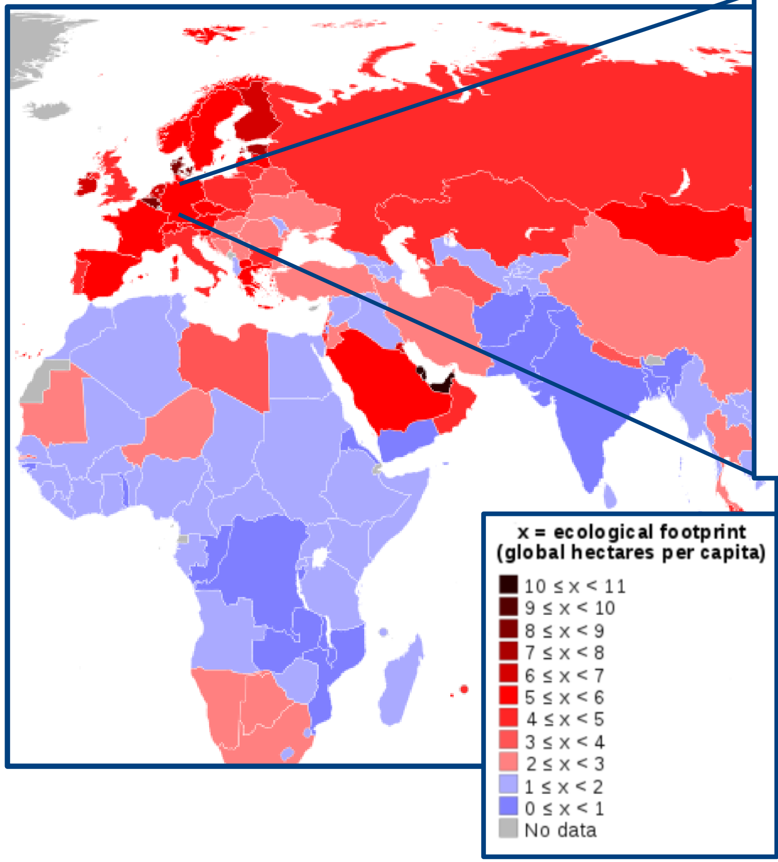
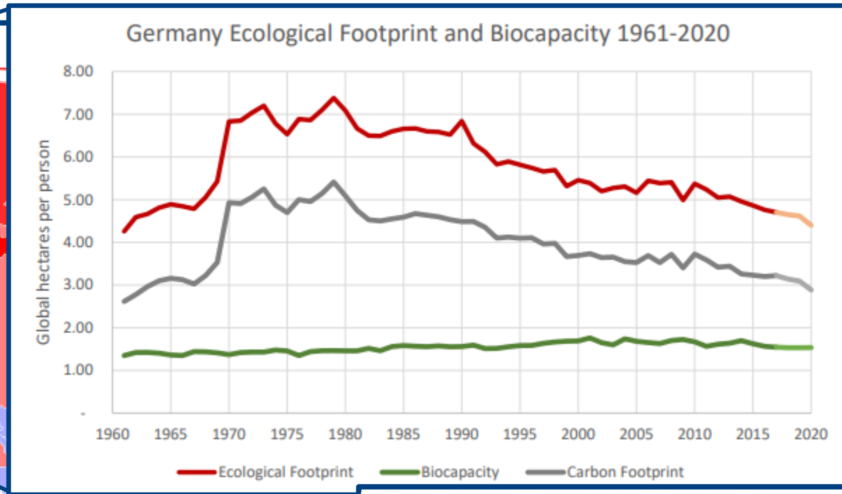


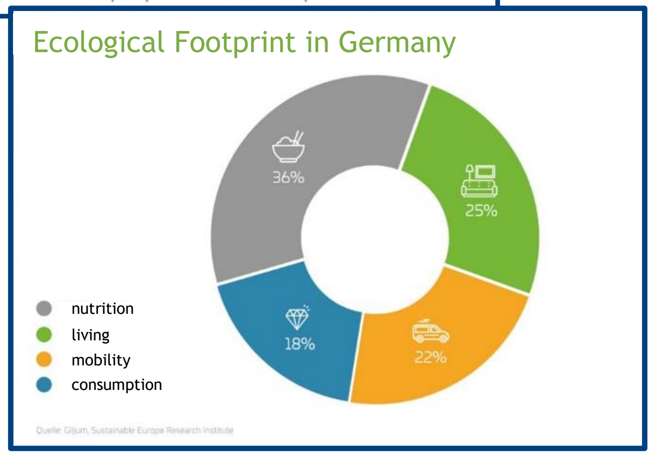
The higher the level of development, the bigger the consumption and the ecological footprint

Picture source: www.footprintnetwork.org/our-work/sustainable-development/

Ecological Footprint in Germany







Picture source: www.overshootday.org/content/uploads/2021/04/germany_nowcast_2020_final.pdf; www.swd-ag.de/magazin/oekologischer-fussabdruck/;

Politics and society still have to adapt to a more sustainably lifestyle regarding these 4 areas

Umwelt Bundesamt (2007), Meinhold (2011)

Calculation of the Ecological Footprint

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$$EF_C = EF_P + (EF_I - EF_E)$$

Ecological Footprint of Consumption | Ecological Footprint of Production | Net Ecological Footprint of Trade

The Ecological footprint of consumption is used to assess the total domestic demand for resources and ecological services of a population. It accounts for both the export of national resources and ecological services for use in other countries, and the import of resources and ecological services for domestic consumption.

=

It is the sum of all the bioproductive areas within a country necessary for supporting the actual harvest of primary products (cropland, grazing land and fishing grounds), the country‘s built-up area (roads, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the country.

+

Embedded in trade between countries is a use of biocapacity, the net Ecological Footprint of trade (the Ecological Footprint of imports minus the Ecological Footprint of exports). If the Ecological Footprint embodied in exports is higher than that of imports, then a country is a net exporter of renewable resources and ecological services.

After the production and the balance from import and export of a country has been calculated, it is converted into global hectare

Source: https://www.footprintnetwork.org/resources/data/

Earth Overshoot Day

Earth Overshoot Day

How the Date of Earth Overshoot Day 2021 was Calculated:

Ecological overshoot occurs when human demand exceeds the regenerative capacity of a natural ecosystem. Global overshoot occurs when humanity demands more than what the biosphere can renew. In other words, when humanity's Ecological Footprint exceeds what the planet can regenerate.

Earth Overshoot Day marks the date when humanity's demand for ecological resources (fish and forests, for instance) and services in a given year exceeds what Earth can regenerate in that year. We maintain this deficit by liquidating stocks of resources and accumulating waste, primarily carbon dioxide in the atmosphere. Andrew Simms originally conceived the concept of Earth Overshoot Day while working at the UK think tank New Economics Foundation.

Source: www.overshootday.org; **Picture source:** www.overshootday.org/newsroom/country-overshoot-days/

Germany and the Earth Overshoot Day

In Germany, we are far above the national average: this year's #overshootday was already on 05 May 2021 in our country. The date is determined every year by Global Footprint Network and illustrates that we in Germany consume almost 3 Earths with our current way of life!

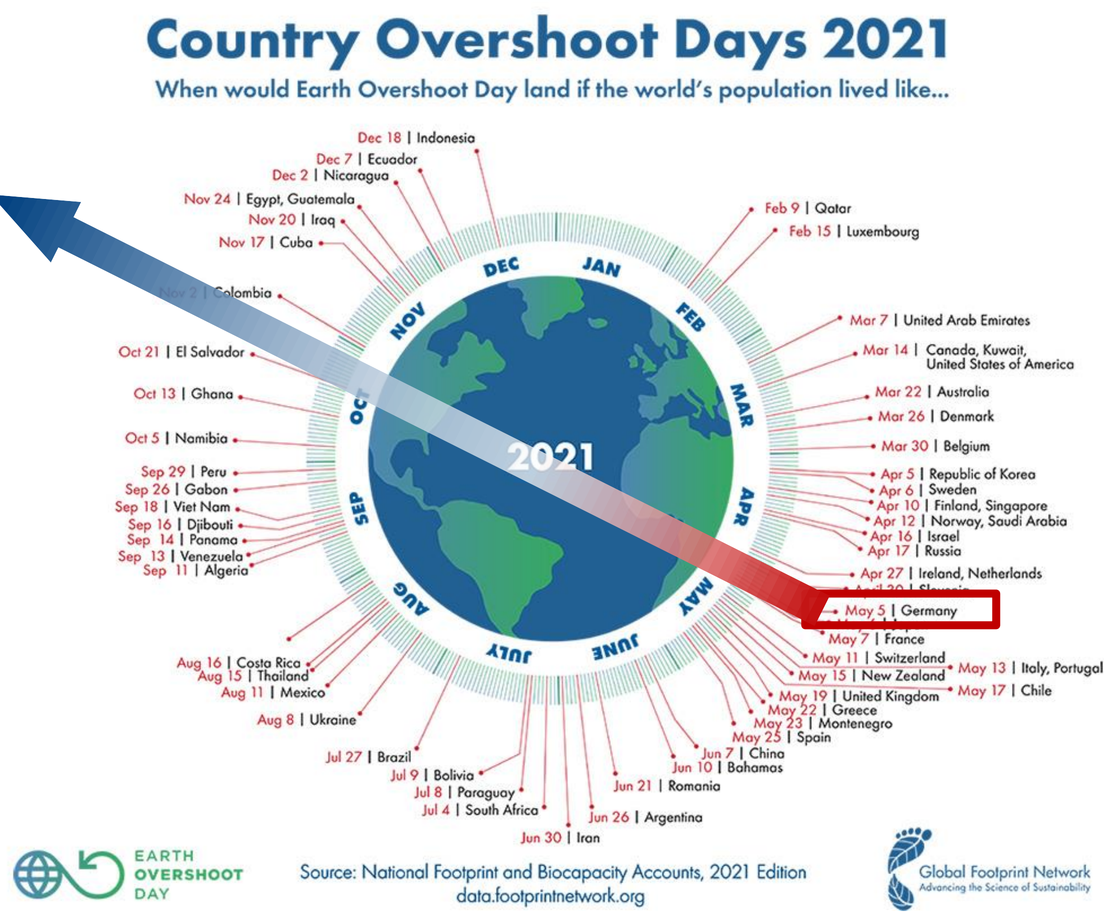
Translated from German; www.almalovis.de/s/earth-overshoot-day/

This year, Earth Overshoot Day falls on July 29, 2021.

Translated from German; www.almalovis.de/s/earth-overshoot-day/

The conclusion is clear: We must consume significantly less, differently and more consciously!

Translated from German; www.almalovis.de/s/earth-overshoot-day/



Picture source: www.overshootday.org/newsroom/country-overshoot-days/

Solutions to #MoveTheDate

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PLANET
How we help nature thrive

CITIES
How we design and manage cities

ENERGY
How we power ourselves

FOOD
How we produce, distribute, and consume food

POPULATION
How many of us there are

Examples in Germany

Picture source: www.overshootday.org/solutions/; https://www.overshootday.org/movethedate-deutschland/

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