IZES
Institut für ZukunftsEnergie- und Stoffstromsysteme

WATER PROOF

Creating synergies

A psychological perspective on stakeholder motivations, needs & challenges in Industrial-Urban Symbiosis

WaterProof Workshop: From Waste(water) CO_2 to Formic Acid

Alena Jahns, IZES gGmbH

22 October 2026 10:00–15:30 CET

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Creating synergies

A psychological perspective on stakeholder motivations, needs & challenges in Industrial-Urban Symbiosis

IZES & the multilevel approach in WaterProof

Industrial Symbiosis in the context of Circular Economy

- Industrial Symbiosis as a mechanism to achieve circular economy goals
- Key terms
- Practical examples
- I-US advantages

I-US in WaterProof

- WaterProof concept as an example of industrial-urban symbiosis
- IZES activities embedded in multi-level approach
- Research questions
- Insights into in-person I-US workshop, webinar and expert interviews

Conclusions:

- Environmental psychology perspective on key factors in I-US
- Stakeholder roles & perspectives in industrial (-urban) symbiosis

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Interdisciplinary approach

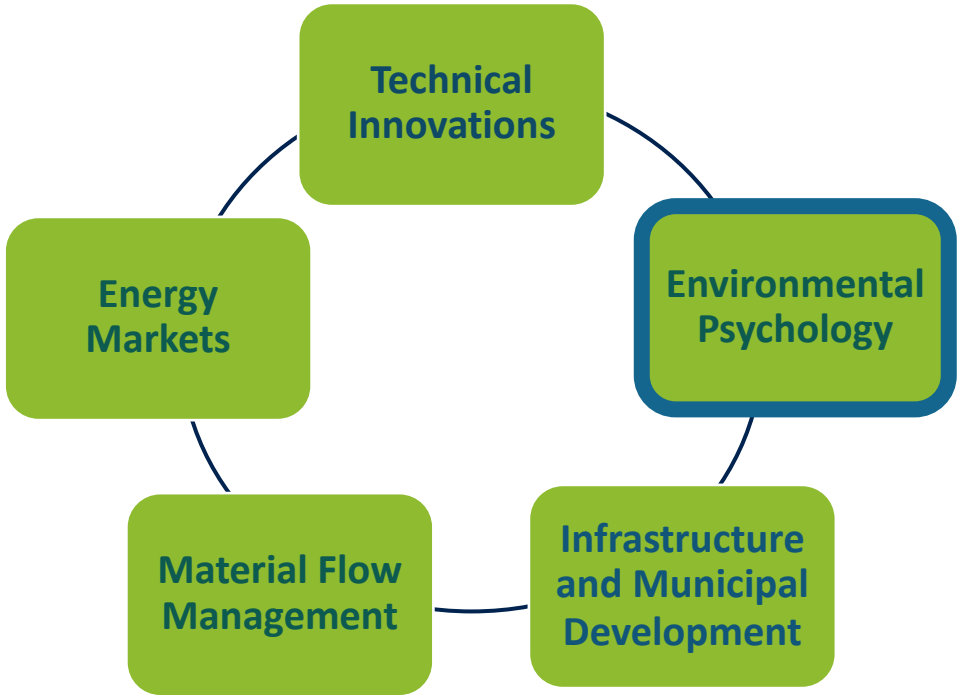


Figure 1: Interdisciplinary approach at IZES (Source: IZES)

Multi-level research approach in WaterProof

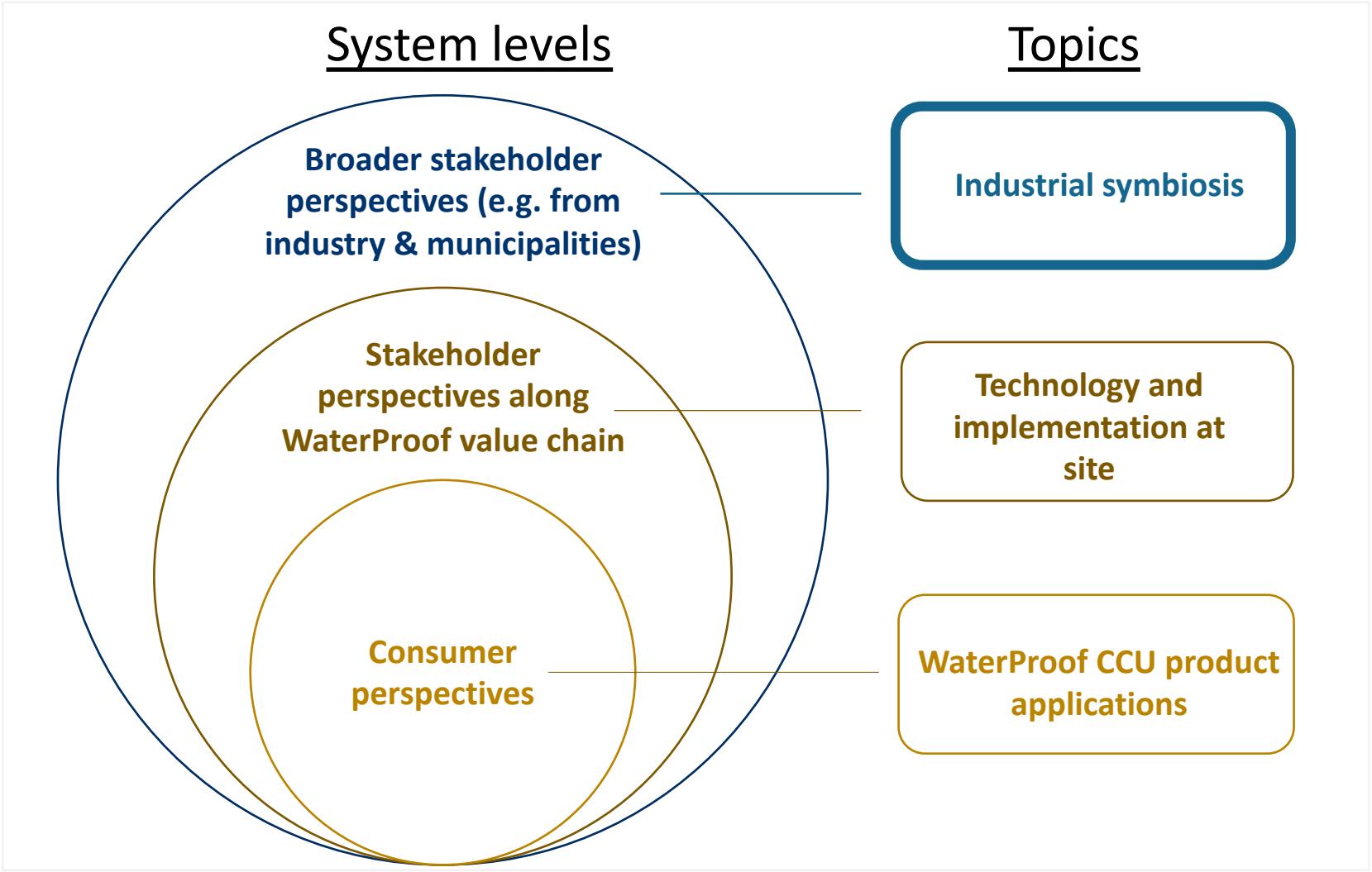


Figure 2: Multi-level research approach in WaterProof (Source: IZES)

Industrial Symbiosis in the context of Circular Economy

Industrial Symbiosis as a mechanism to achieve circular economy goals

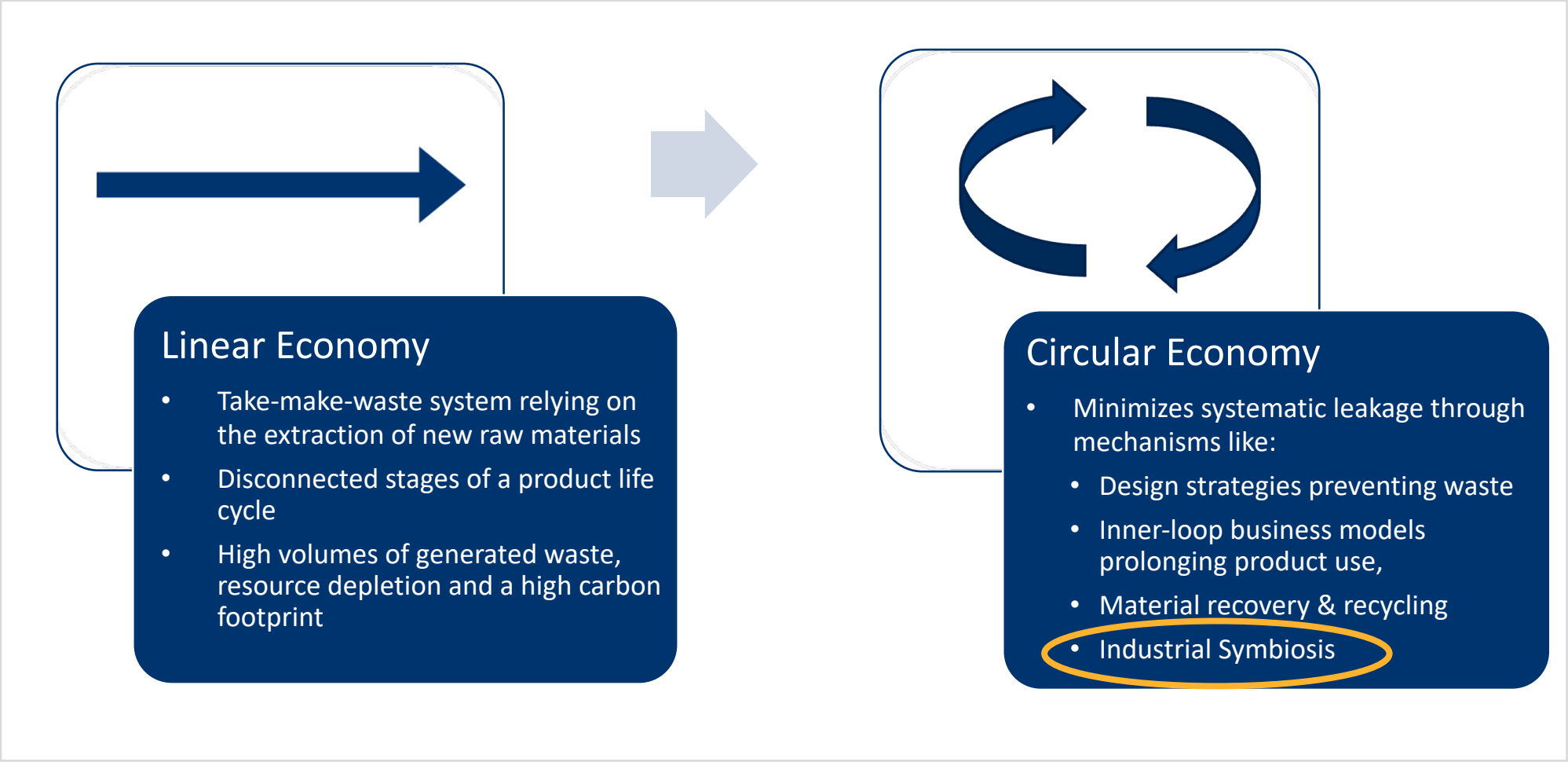


Figure 3: Industrial Symbiosis as a mechanism to achieve circular economy goals (Source: IZES)

Industrial Symbiosis as a mechanism to achieve circular economy goals

Circular Economy (CE)

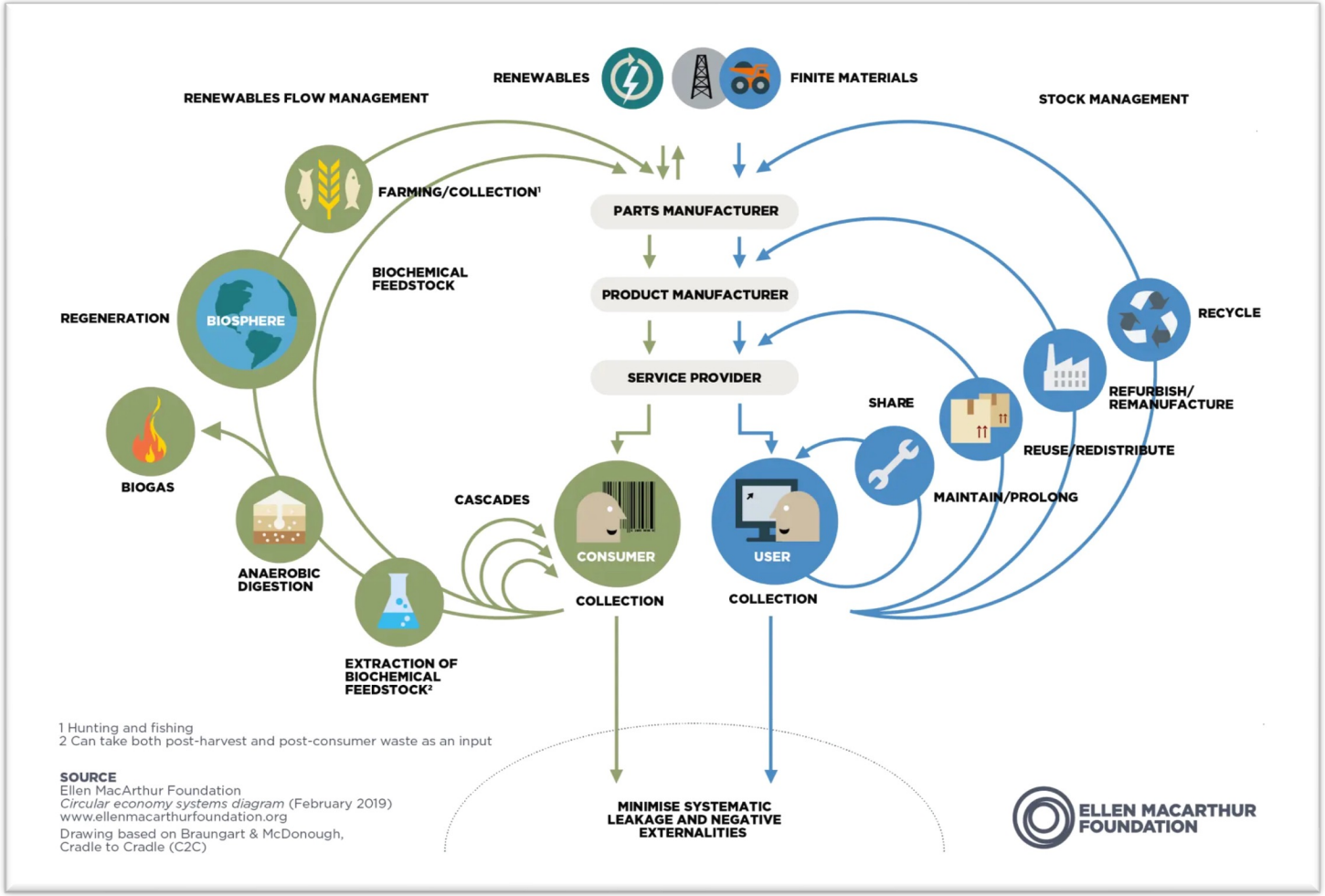


Figure 4: Circular economy systems diagram (Source: Ellen MacArthur Foundation, drawing based on Braungart & McDonough, Cradle to Cradle (C2C))

Industrial Symbiosis

"systems approach to a more sustainable and integrated industrial economy that identifies business opportunities to improve resource utilisation and productivity" (CEN Workshop Agreement – CEN 2018 CWA 17354, p. 7)

- uses „waste" as valuable input



Image 1:
Rijal – stock.adobe.com
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Image 2:
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Industrial Symbiosis – key terms

- **„Synergies“:** “transactions where one organisation acquires underutilised resources [...] from the organisation generating them, and integrates them as inputs into their own production process” (CEN Workshop Agreement – CEN 2018 CWA 17354, p. 12)
- **Ressources:** e.g. “by-products, waste, materials, energy, water, equipment or other resources that are not the primary output of the production process” (CEN Workshop Agreement – CEN 2018 CWA 17354, p. 12)
- **I-US:** Urban material flows (e.g. municipal waste or household wastewater) are integrated as raw materials, public and private organizations can take part
- **Models**: selforganized, facilitated, ICT-supported & strategic (CEN Workshop Agreement – CEN 2018 CWA 17354, p. 5-6)

Industrial(-Urban) Symbiosis – practical examples and projects



Image 3:
TanyaK – stock.adobe.com



Image 2:
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CO_2

Utilization of wastewater from the meat processing industry for biogas production (**Symsites project**, Ecosite in Austria)

Use of ash (e.g., from incineration plants) in applications like concrete production (**Ash Cycle project**)

Optimization of energy, waste & by-product utilization, & knowledge transfer etc. in industrial parks (**Industrial park Höchst**, Germany)

Conversion of captured CO_2 from waste(water) treatment into formic acid (**WaterProof project** with pilot installation in the Netherlands)



Image 4:
Anis Studio – stock.adobe.com
(generated with AI)



Image 5:
santona – stock.adobe.com
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AshCycle (2026); Symsites (2026); WaterProof Project (2026); Utikal, H. (2026, May 27)

Industrial(-Urban) Symbiosis – practical examples and projects

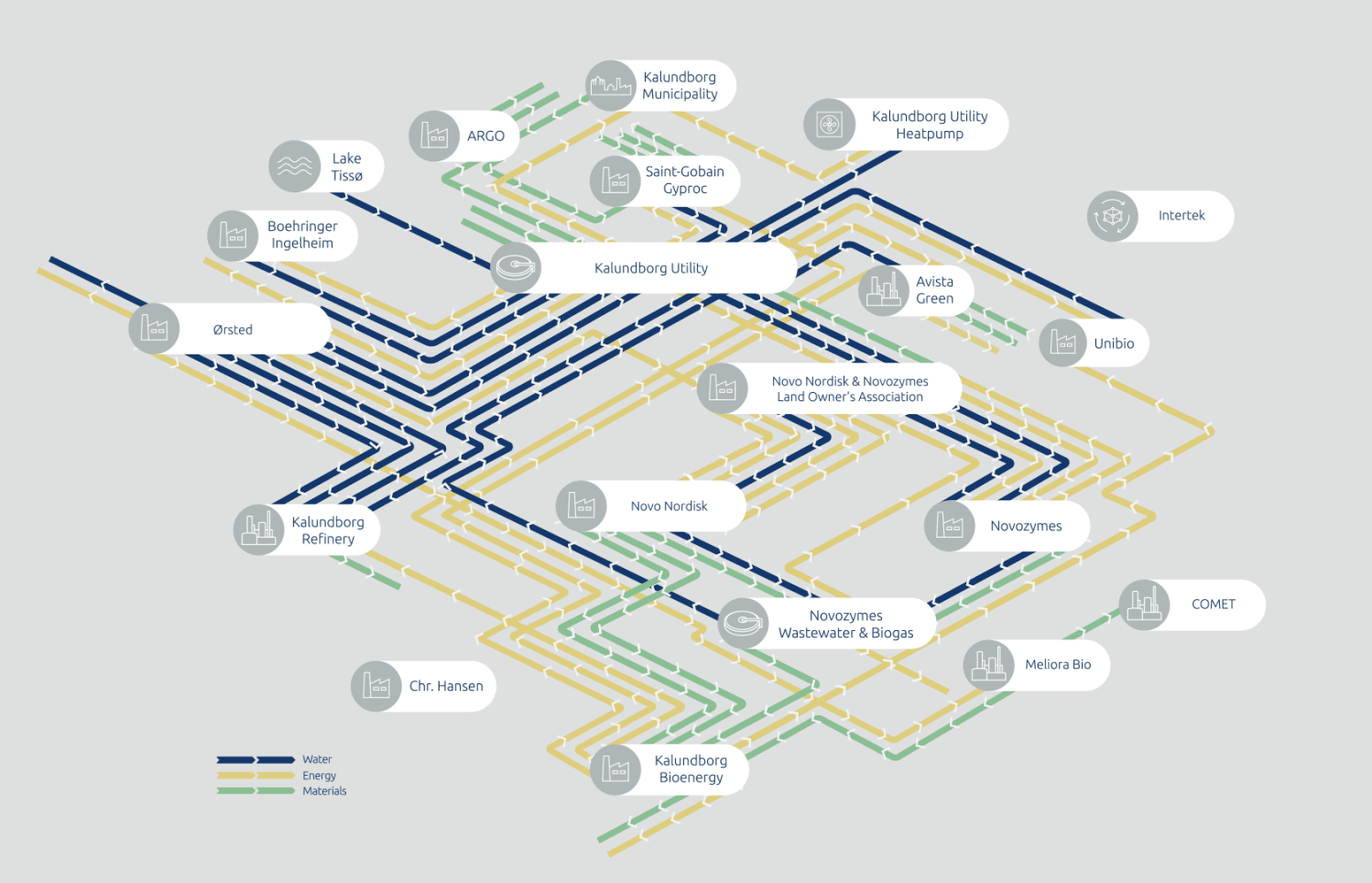


Figure 5: Infographic with symbiosis flows (Source: Kalundborg Symbiosis, retrieved from symbiosis.dk)

Kalundborg SYMBIOSIS

- A model for industrial symbiosis – established since the 1970s
- symbiotic network of 17 partners (public & private)
- 20 different resource flows: water, materials & energy

(Kalundborg Symbiosis, 2026; Symbiosis Center Denmark, 2022)

Advantages of Industrial(-Urban) Symbiosis

- Resilience and resource independence
- Sustainability & industrial tranfromation towards a circular eocnomy
- Economic value creation

Industrial-Urban Symbiosis in WaterProof

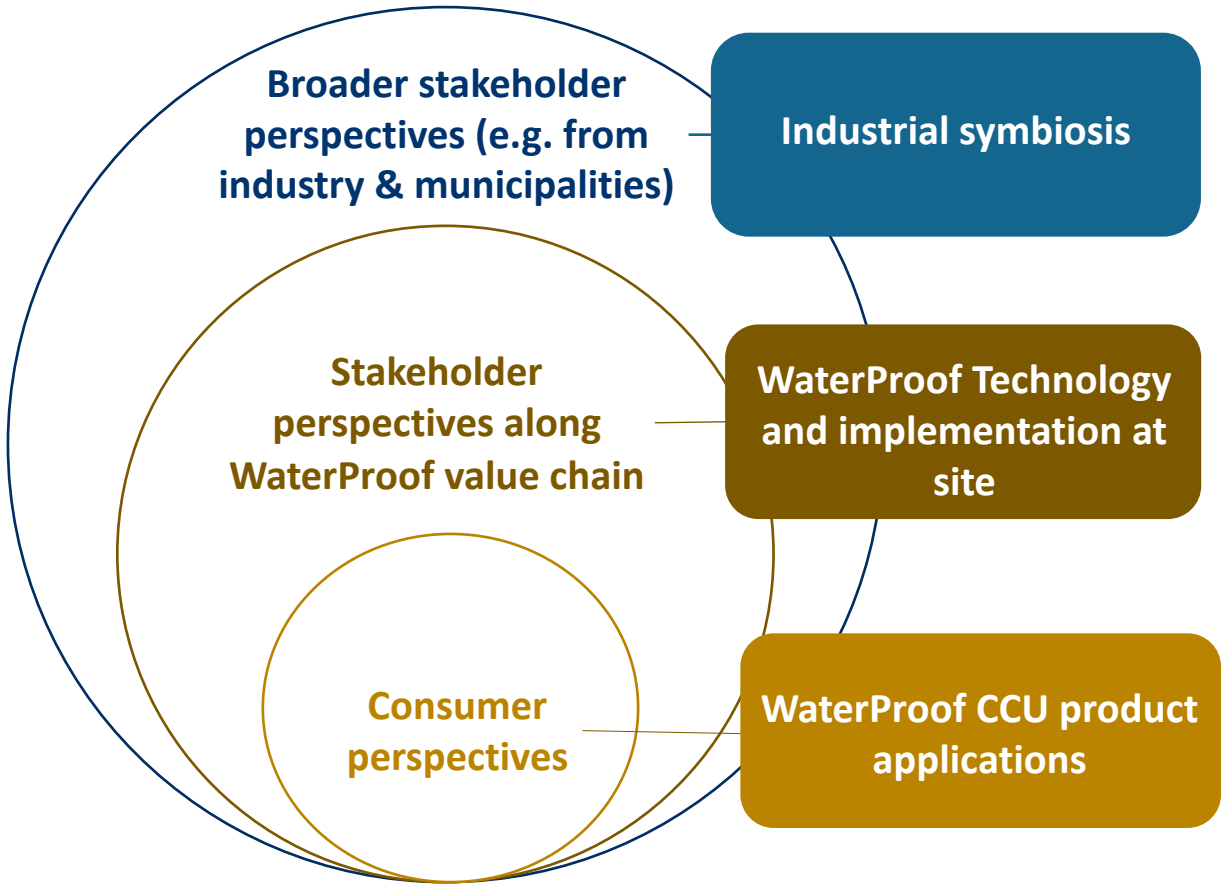
WaterProof concept as an example of Industrial-Urban Symbiosis

- **Synergies** captured and electrochemically converted CO_2 serves as an alternative carbon feedstock for chemical applications
- **Urban material flows** (e.g., municipal waste or household wastewater) can play an essential part in the symbiosis
- **Different actors**, such as public (e.g. public wastewater treatment companies) and private organizations (e.g. companies producing cleaning or leather products) can be part of the symbiosis network



Figure 6: WaterProof concept as example of I-US (Source: IZES)

IZES activities embedded in the multi-level approach



Educational & research activities

Informational factsheet

Expert interviews

Events & networking: Participation at and organisation of webinars and workshops

Stakeholder interviews with actors from the WaterProof value chain

Interviews and focus groups with consumers, &with environmental & consumer organisations

Online consumer survey

Image 6: (Photo: Carsten Simon | IZES, UdS: CircularSaar)





Image 7: (fizkes – stock.adobe.com)



Image 8 (Johnnii – stock.adobe.com (generated with AI))

Research questions

- **Roles :** What distinct roles do different stakeholder groups (e.g. like public authorities & industry) play within I-US?
- **Perception of I-US :** How do they percieve I-US initiatives like the WaterProof concept?
- **Drivers & Barriers:** What drives or deters these stakeholders when bringing I-US forward?
- **Needs:** What do these stakeholders need to successfully advance I-US initiatives?

Insights into in-person workshop

Setting

Title: *Industrial Symbiosis as a Building Block of Circular Economy in Saarland*

Collaboration with Circular Saar project, part of the Circular Economy Congress 16/09/26 in Saarbrücken, Germany

38 registrants, participating stakeholde groups: Research | Politics and administration | Private sector and industry| Public companies | Chambers and associations



Image 6: Photo: Carsten Simon | IZES, UdS: CircularSaar



Image 9: Photo: Carsten Simon | IZES, UdS: CircularSaar

Results

What do participants associate with industrial symbiosis?

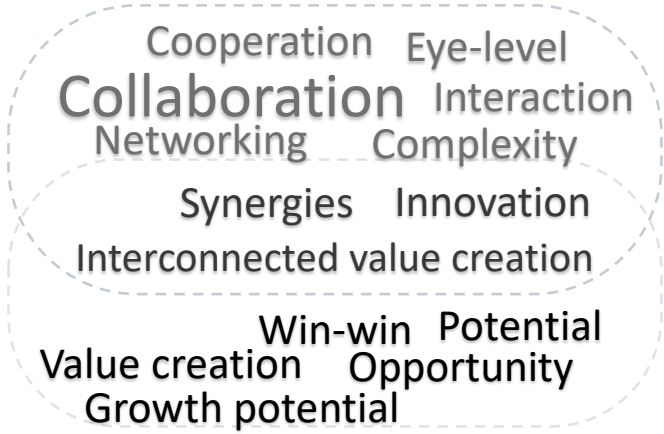


Figure 7: Workshop results - Associations with Industrial Symbiosis (Source: IZES)

IZES (2026) Circular Economy Congress. https://izes.eu/events/2-circular-economy-kongress/

Insights into WaterProof webinar

Setting

Title: Industrial-Urban Symbiosis: Business, Funding and Practical Insight

Agenda

Introduction to Industrial Symbiosis	IZES
Business cases and funding	International Synergies
Pratical insights: I-US collaboration	Provadis School Höchst
CCU/volta technology in I-US context	Avantium

Participants: 44 participants from Research & academia | Industry | Public organisations and administrations | Consulting & I-US facilitators

WaterProof Project (2026) Webinars. https://waterproof-project.eu/webinars/

Key-takeaways

- Facilitation governance models as well as a combination of models can takle I-US barriers if they fit to the local context.
- Performance measurement with strong I-US KPIs
- Industrial parks are ideal hubs but face double-challenge: remaining competitive while becoming climate neutral
- Barriers for I-US projcts: grid dependency and policy fragmentation

→ Needed: political planning certainty, green market creation and funding for higher TRLs are needed.

Insights from expert interviews with municipalities



Image 7 (fizkes – stock.adobe.com)

Setting

Two interviews with municipalities

<u>Focusing on the perspective of facilitators of I-US</u>

- Key role of cities' as facilitators & local resource managers, hotspots with a large density of industrial facilities highly suitable for synergies

<u>Selection of cities in the Netherlands & Germany</u>

- Amsterdam as one of the high performing Dutch cities regarding climate policies (den Exter et al., 2015)
- Munich as one of the climate policy leaders in Germany (Otto et al., 2021, 2025)

Key-takeaways

- <u>Motivations:</u> Environmental, climate & circularity goals & strategies, enhancing the sustainability of local industries
- <u>Needs:</u> Industry engagement & trust, external expertise & integration of internal knowledge
- <u>Challenges:</u>

  Allocating financial & staff resources – range of responsibilities

  Regulatory boundaries in permitting

  Balancing I-US goals with economic viability in industrial area recruitment

  Complex resource flows
- <u>Current municipal approaches:</u> Enhancing awareness, trust building and prioritization of essential resource flows

Insights from consumer studies on CCU products in WaterProof

Consumer survey

Online survey in May 2024 – July 2025 in the Netherlands (N=54), Germany (N=127) & Colombia (N=66) about consumer perspective on CCU cleaning product applications

- Environmental (especially climate) benefits associated with CCU cleaning products
- Rather low risk perception concerning CCU cleaning products
- Rather high purchase intentions for CCU cleaning products

Consumer focus group

In-person focus group in May 2026 in Germany (n=19) about consumer perspective on CCU cleaning & leather product applications

- Associated benefits (approaching waste-related emissions), concerns about energy consumption
- Prioritized product applications: daily life necessities
- Expectations towards manufacturers:
  - Credibility & transparency (e.g. about energy source & technological processes)
  - Quality assurance and reasonable costs
  - e.g. on packaging or via digitally accessible information with visualisations illustrating environmental impact or energy use

(Insights into consumer pre-study in D4.2; further insights into consumer online survey and focus groups in upcoming deliverable on recommendations for consumer communication)

Insights into interviews & focus groups with organisations

Setting

- Online, September 2026 with organisations in Germany
- 4 organisations in the area of consumer protection
- 6 organisations in the area of environmental protection and energy

Results

- Limited official statements on CCU by organisations
- General critique of CCU related to energy consumption
- Priorities:
  - renewable energy & optimized transport routes in CCU
  - Critically assessing CCU's environmental leverage of CCU ingredients in final product
  - Maintainance of core product criteria (e.g. safety & affordability)
- Product communication
  - Holistic communication on product circularity (looking at the product as a whole) and use of established multi-criteria eco-labels
  - Relevance of product circularity varies between products

Conclusions: Environmental psychology perspective on key factors in I-US on different systemic levels

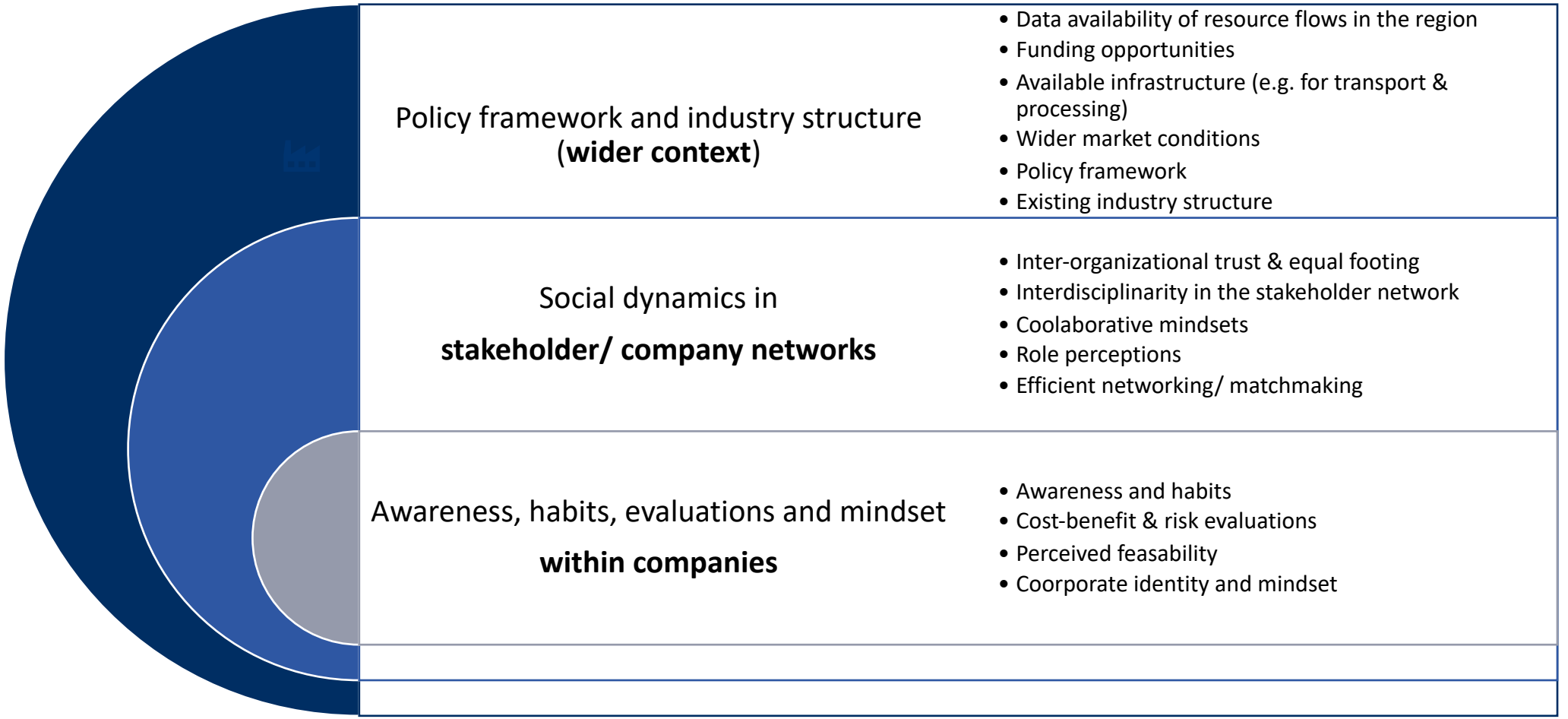
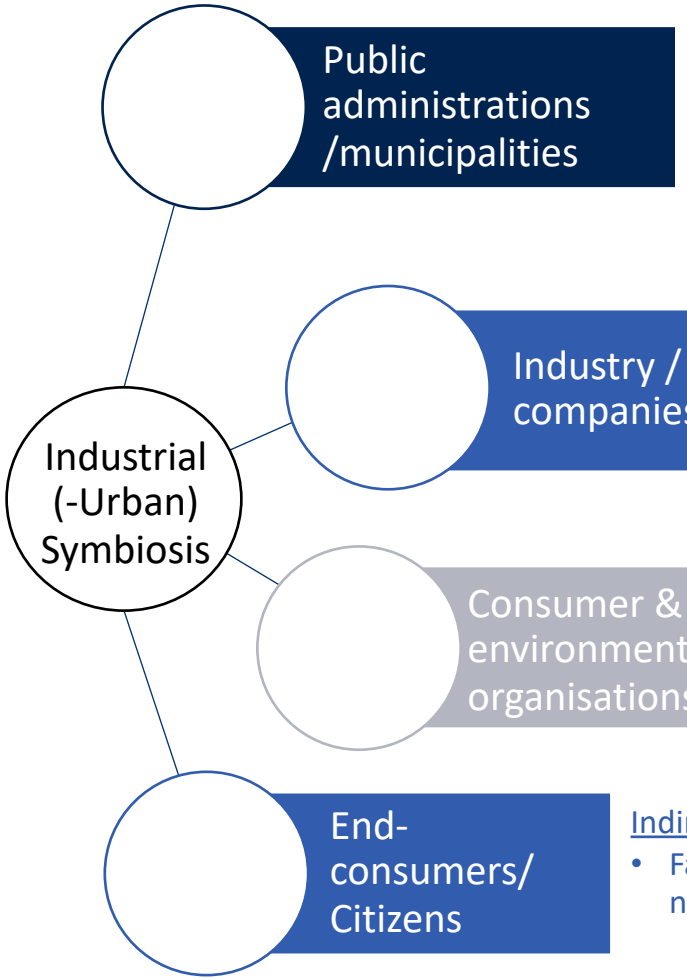


Figure 8: Key factors in I-US on different systemic levels (Source: IZES)

Conclusions: Stakeholder roles & perspectives in industrial (-urban) symbiosis



Coordinators, matchmakers, facilitators (funders, infra-providers, advisors) & offtakers
- Motivation: fit with environmental & CE strategies
- Need: industry trust & engagement, external expertise & integrated internal knowledge
- Challenges: prioritization & resource allocation, regulatory boundaries, balancing economic & I-US goals

Shareholders e.g. of public waste treatment & infrastructure companies

Synergy implementers, resource providers & offtakers
- Motivation: circular corporate identity and economic value
- Need: Ressources; interorganizational trust & equal footing, planning safety & matchmaking possibility
- Challenges: breaking old disposal routines, evaluating costs, risks & benefits

Critical evaluation of CE measures; advocacy for environment & consumer interests
- Wish for transparent LCAs, adequate product prices & using established multi-criteria labels
- Relevance for consumers depending on their active role in product circularity

Indirect links (e.g. waste providers); occasional direct links (local residents & end-consumers)
- Factors in consumer acceptance: environmental benefits, credibility & transparency, perceived product necessity, quality & prices & product safety

Figure 9: Examples of stakeholder roles & perspectives in I-US (Source: IZES)

Beyond Industrial Symbiosis: Psychological Drivers in Industrial Transformation - Insights from IZES Research

Credibility & Transparency in information

Trust & equal footing

Motivation knowledge, interests

Openness to coorperation

Habits

cost-risk & benefit evaluation

Perceived feasabiltiy

Strategic fit coorporate identity

Hydrogen transformation

Flagship Project TransHyDE

Hydrogen Flagship Projects
Green. Great. Global.

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NextGenerationEU

Waste heat utilization

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Energy sharing networks

MODELL EEGe
ENERGIE IN GEMEINSCHAFT

Supported by:

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Power-to-X

With funding from the:

KOPERNIKUS PROJEKTE
P2X
Die Zukunft unserer Energie

Federal Ministry of Research, Technology and Space

Thank you

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Environmental Psychology

https://izes.eu/

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Further reading:

Read our factsheet on I-US or our *Report on qualitative societal research (D4.2)*, watch the WaterProof webinar (*Industrial-Urban Symbiosis: Business, Funding, and Practical Insights*) or discover our upcoming deliverable on I-US:

https://waterproof-project.eu/

Sources & References

References & Literature

- AshCycle (2026). ashcycle.eu
- CEN (2018)- CWA 17354 Industrial Symbiosis: Core elements and implementation approaches
- den Exter, R., Lenhart, J., & Kern, K. (2015). Governing climate change in Dutch cities: anchoring local climate strategies in organisation, policy and practical implementation. Local Environment, 20(9), 1062–1080. https://doi.org/10.1080/13549839.2014.892919
- IZES (2026). Circular Economy Congress. https://izes.eu/events/2-circular-economy-kongress/
- Kalundborg Symbiosis. (2026). Surplus from circular production. https://www.symbiosis.dk/en/
- Otto, A., Haupt, W., Eckersley, P., Kern, K., & Thieken, A. H. (2025). Dynamism and stasis in the climate policies of German cities between 2018 and 2022. Mitigation and Adaptation Strategies for Global Change, 30(5), 30.
- Otto, A., Kern, K., Haupt, W., Eckersley, P., & Thieken, A. H. (2021). Ranking local climate policy: assessing the mitigation and adaptation activities of 104 German cities. *Climatic Change*, *167*(1), 5.
- Symbiosis Center Denmark. (2022, 25. 01). Kalundborg Symbiose 2022 [Video]. YouTube. https://youtu.be/Ism7NdQe94I?si=ATWLtdNRQTBgsQyJ
- Symsites (2026). symsites.eu
- Utikal, H. (2026, May 27). Industrial-Urban-Symbiosis Practical examples from the Industrial Park Höchst[PowerPoint slides]. Final Conference of Hubs4Circularity Community of Practice, Brussels, Belgium. https://www.h4c-community.eu/event/save-the-date-final-conference-of-hubs4circularity-community-of-practice/
- WaterProof Deliverable D4.2 Report on qualitative societal research– data collection and consumer insights
- WaterProof Project (2026) WaterProof: urban WAste and water Treatment Emission Reduction by utilizing CO2 for the PROduction Of Formate derived chemicals. https://waterproof-project.eu/
- WaterProof Project (2026) Webinars. https://waterproof-project.eu/webinars/

Figures & Diagrams

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Image & Photo Sources

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