



Welcome to GreenLab Summit Research Session

Ebbe Kruse Vestergaard, Research Director

May 20th, 2022



From idea to large scale

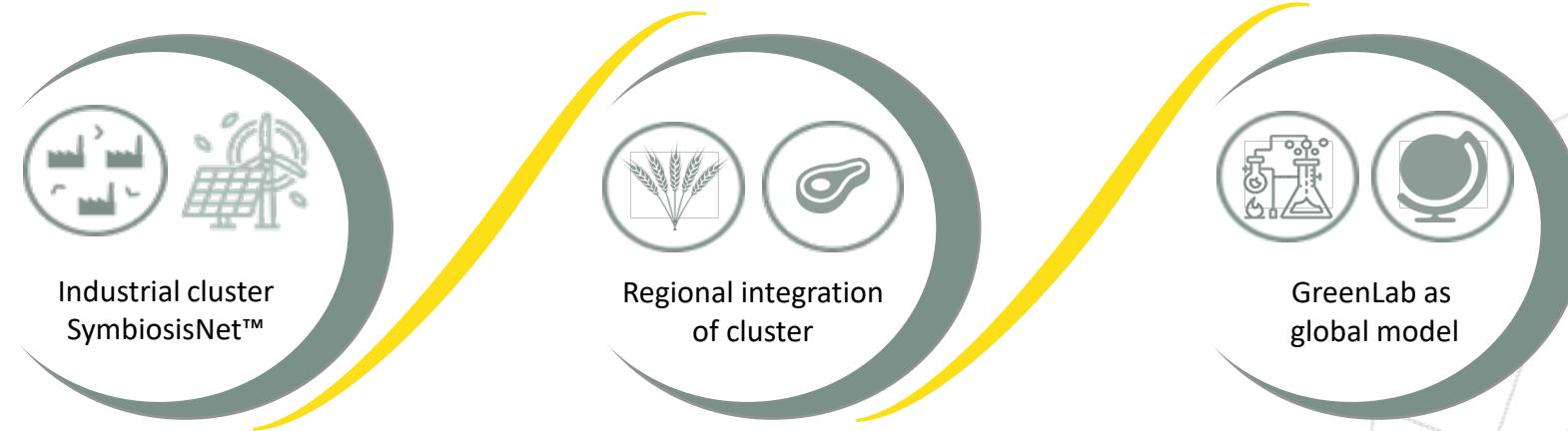
GreenLab



VILLUM FONDEN



Research at GreenLab



The GreenLab Research Call



GreenLab Skive and DTU have joined forces to add a dedicated research layer to the GreenLab Skive platform. The Villum Foundation has supported this endeavour with a grant including ~10 M DKK to be used for smaller, flexible, mission-driven research projects.

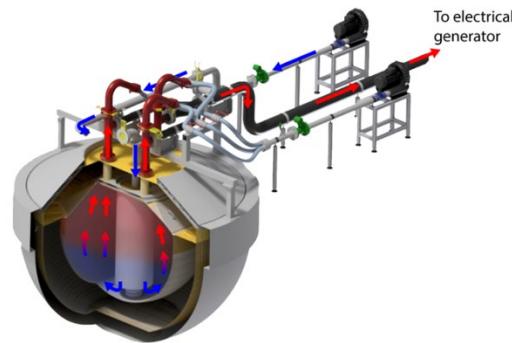
Next deadline is on the 14th of June 2022



THE VELUX FOUNDATIONS
VILLUM FONDEN ✪ VELUX FONDEN

GreenLab

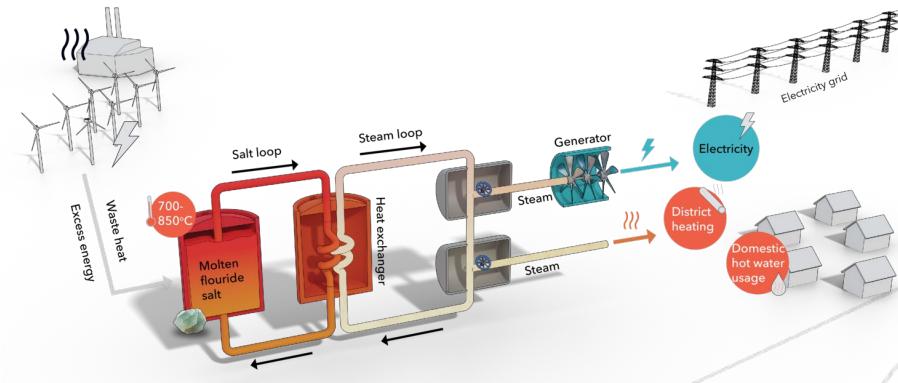
First round of Villum-funded research projects



Energy Rocks – DTU



FlexPTX – SDU



Molten Salt Storage – AAU, Hyme and Alfa Laval



GreenLab Designer Lite - SDU

GreenLab

GreenLab Research Missions

- »»» Developing the design principles for curated eco-industrial clusters for the future of Green Industry
- »»» Operating an eco-industrial cluster with optimized matching of RE fluctuations, demand side flexibility and infrastructure storage and conversion investments
- »»» Demonstrating the value of sector coupling and leading the way with scalable initiatives to bring value for national and international level green transition of industry



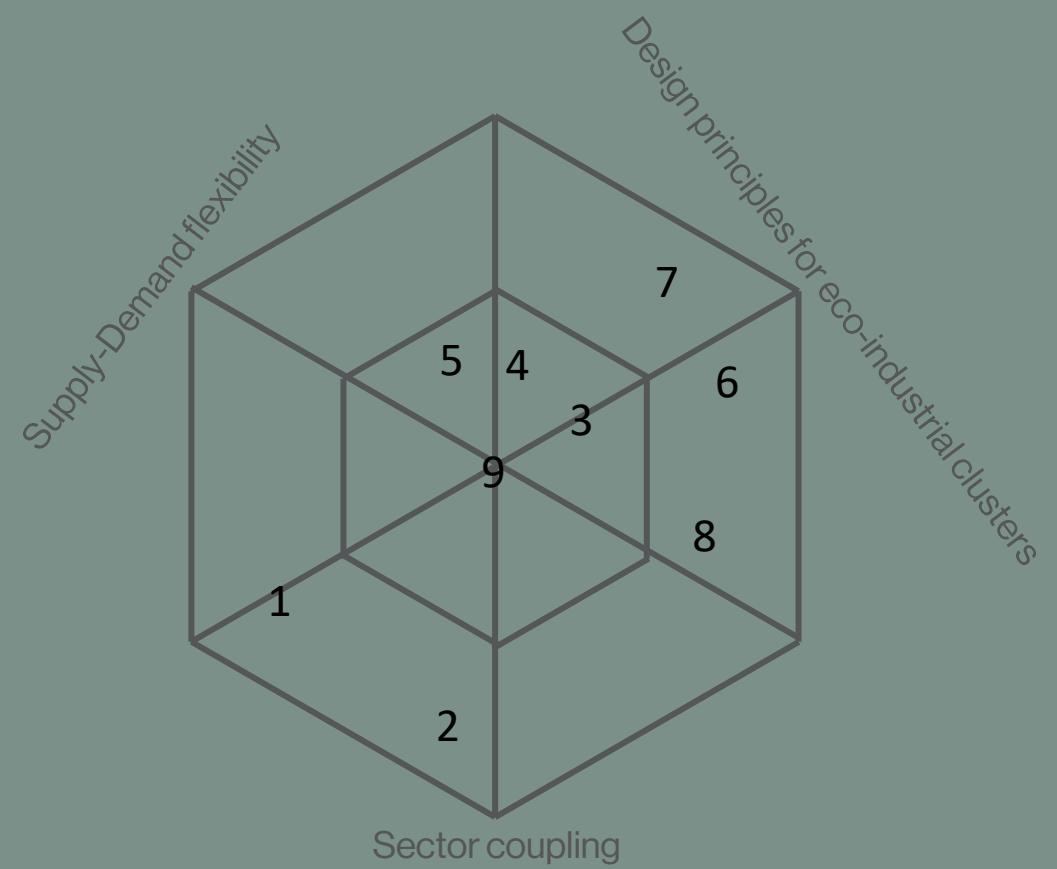
GreenLab

Mission-driven Research Challenges

- »» Multilateral, multi-market optimization of industries connected through a heat symbiosis
- »» Cross-sectoral sweet-spot of operation for electrolysis. The trade-off curve between water quality and electrolysis efficiency
- »» From meta studies of curated designs of eco-industrial clusters to actionable decision tools for cluster design (with multilateral revenue streams / business models)
- »» Customer segmentation tool through sustainability preferences. Mapping the trade off between sustainability and cost in industrial clusters
- »» Design guide for active power distribution networks in industrial clusters with large pro-sumers – building the power grid for a national research lab
- »» Socio-economic impact studies of local effects and acceptance of industrial clusters
- »» Absolute sustainability – targets for green industry
- »» Mapping the opportunities and expectations for interactions of stakeholders on a virtual GreenLab platform
- »» Open challenge

Research Roadmap

- »» The research challenges in GreenLab are continuously being developed along with the mission journey for GreenLab and the green transition of industry in society
- »» New challenges in society or technological roadblocks or breakthroughs may change the priorities over time, but the spiderchart shows a here and now illustration of the flow of challenges, with the inner area being next upcoming call for project proposals and outer area being future calls



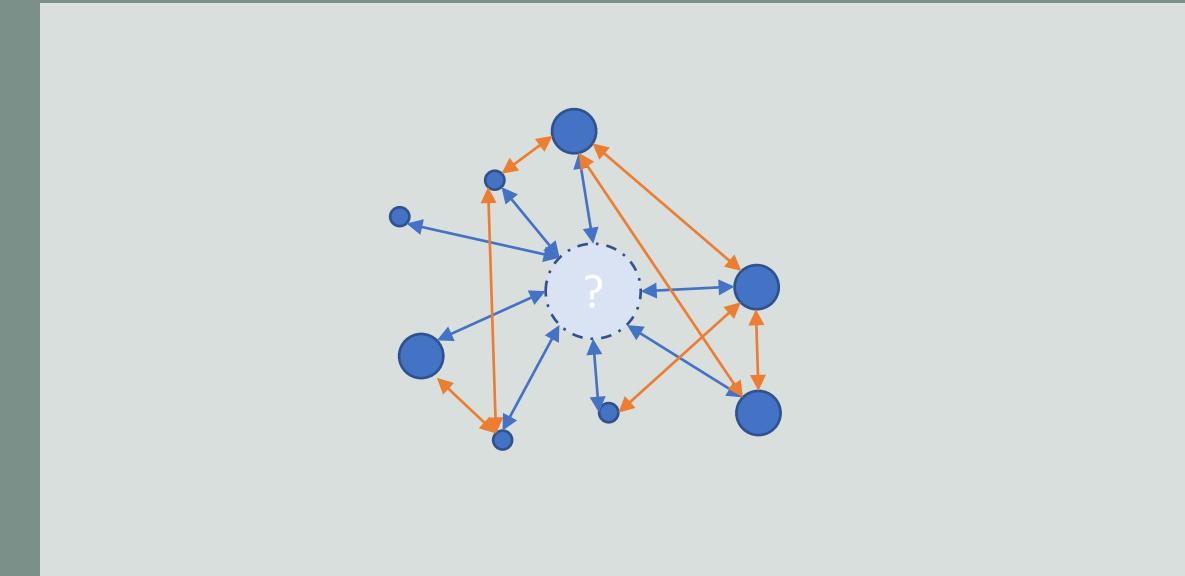
Challenge 3 – Clusters

- From meta studies of curated designs of eco-industrial clusters to actionable decision tools for cluster design

- » In GreenLab we see circular economy as one of the fundamental and necessary shifts in industry to enable a green transition in society. Eco-industrial clusters and industrial symbiosis are obvious ways to facilitate such shifts in economy and production.
- » Scientific meta-studies of industrial clusters and industrial symbiosis outline some challenges in centrally governed cluster design from "green field". However, there is a lack of concrete actionable guidelines drawing upon such scientific studies
- » With this challenge we invite for sociologically oriented study of mechanisms and incentives for cluster collaborations where guidelines and pitfalls from previous initiatives are identified.

Missions related to challenge:

- Design principles for eco-industrial clusters



Challenge 4 – Green vs cost

- Customer segmentation tool through sustainability preferences

Mapping the trade off between sustainability and cost

» In GreenLab the incentive for industries to become site-partners is often a green choice. However, we also see a need for increased understanding of the spectrum of industry operation from "all green" to "strict profit" focus. Most companies and potential site partners will be somewhere in the middle between the extremes

» With this challenge we invite for a value stream mapping at cluster level which can foster a data-based discussion of customer categories with respect to sustainability vs profit/cost. The mapping tool should facilitate a coupling between customer preferences and overall cluster/park sustainability gains

Missions related to challenge:

- Design principles for eco-industrial clusters
- Supply-Demand flexibility



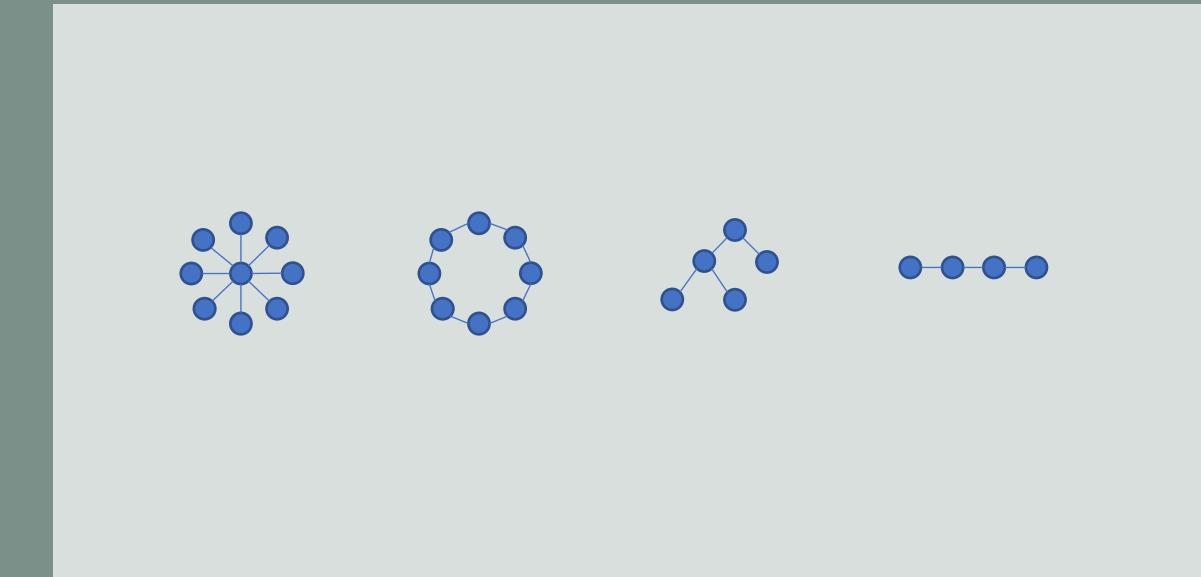
Challenge 5 – Topology

- Design guide for active power distribution networks in industrial clusters with large pro-sumers

- »» In GreenLab a mix of large energy consumers and green energy production constitute a novel setting where standard distribution networks may be challenged.
- »» The network topology as well as enabled service features should be reconsidered for such industrial clusters enabling both flexible operation and balance between availability and buffering as well as aggregated network services to the external DSO/TSO
- »» With this challenge we invite for ideation and co-creation to design the optimal internal power network. The network design should both be optimized towards operation as well as being an interesting test and demonstration facility for large scale power research

Missions related to challenge:

- Design principles for eco-industrial clusters
- Supply-Demand flexibility



Challenge 9 – Open Challenge

- Your ideas are welcome!

- »» In GreenLab we continuously identify new challenges and see the research activities targetting the challenges as stepping stones on the mission journey. This is our way of doing mission-driven research
- »» Our ideas for new challenges are almost always founded in dialogues with partners, researchers and other guests at GreenLabs, and we therefore also welcome ideas falling outside the existing challenges. If an idea is well-justified and supports our missions we may choose to initiate a research project directly for the idea, or we may otherwise define a new challenge based on the idea for one of the next call for project proposals

Missions related to challenge:

- All



FUTURE CHALLENGES



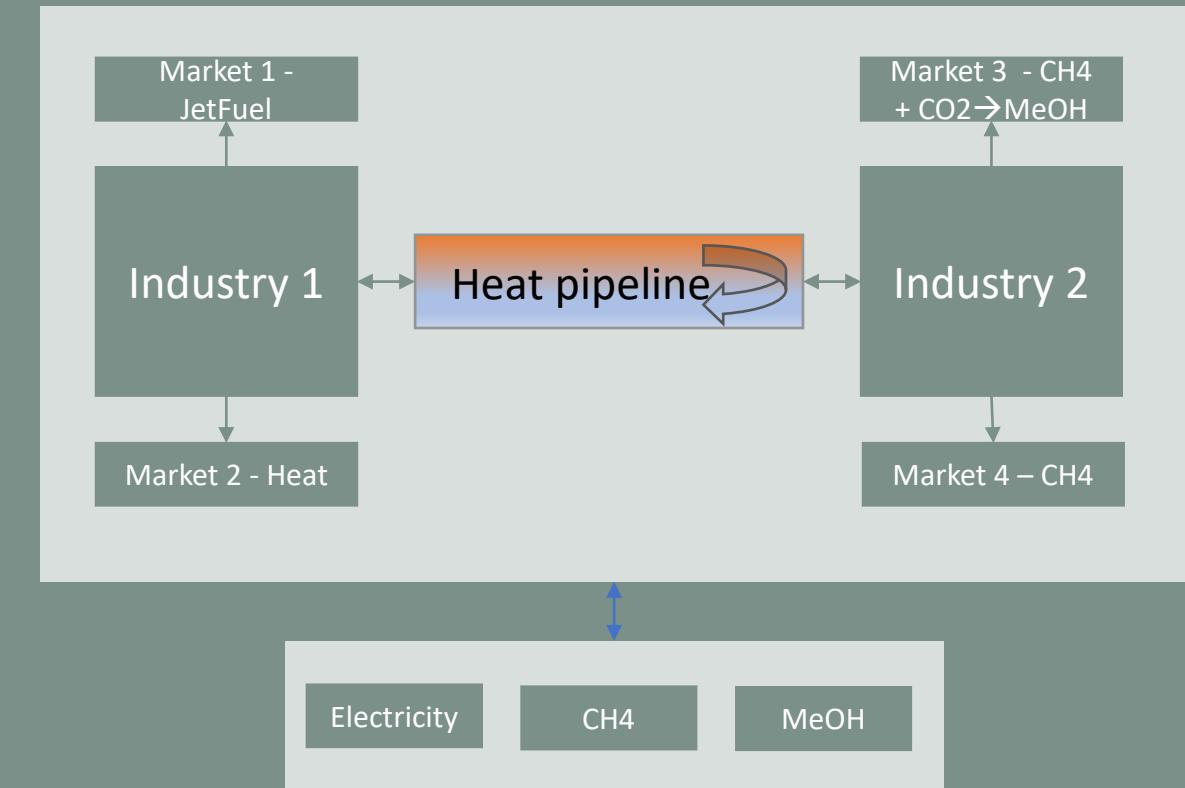
Challenge 1 – SymbiosisNet

- Multilateral, multi-market optimization of industries connected through a heat symbiosis

- » In GreenLab we see a need for advanced control algorithms facilitating a fair and transparent pricing of the trading of heat on an internal GreenLab market
- » The challenge consist of a real-time optimization problem with connections to multiple (cross-sectoral) external markets: Electricity, natural gas and liquid fuel (MeOH)
- » The GreenLab heat symbiosis will be initiated as a heat transfer between two specific industries, but the control will also influence other indirectly connected industries

Missions related to challenge:

- Supply-Demand flexibility
- Sector coupling



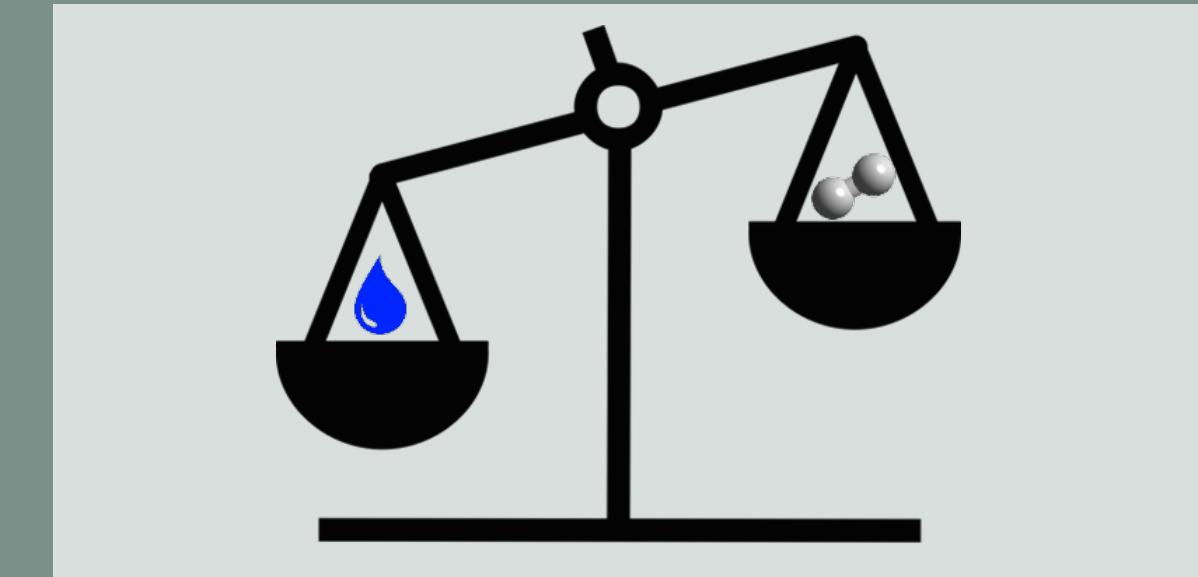
Challenge 2 – H₂O₄H₂

- Cross-sectoral sweet-spot of operation for electrolysis. The trade-off curve between water quality and electrolysis efficiency

- » In GreenLab we are facing a need to supply ultra-clean water for our 18MW H₂ electrolysis ultimo 2022 and +100MW subsequently.
- » We see a potential trade-off between
 - The scarcity of clean water, the urge to use secondary water sources, and the need to avoid excessive energy and resources in cleaning
 - The efficiency loss and degradation of electrode materials in the electrolysis stacks due to reactions with impurities from the water
- » With this challenge we invite for an interdisciplinary approach to enhance the understanding of the influence of the water quality parameters and advice on best practice for water purification for the green H₂ production

Missions related to challenge:

- Sector coupling



Challenge 6 – Local impact

- Socio-economic impact studies of local effects and acceptance of industrial clusters

- »» In GreenLab we experience a very strong local support for the growth of the eco-industrial cluster. There are significant benefits to the municipal and local region in the job creation and derived business. However there are also local nuisances such as increased heavy traffic, noise, odour issues and more.
- »» With this challenge we invite for studies of the positive as well as the negative impacts on the local municipal and region by having an expanding eco-industrial cluster. We strongly encourage quantified studies and also science based suggestions of improvements to the local impact

Missions related to challenge:

- Design principles for eco-industrial clusters



Challenge 7 – Sustainability

- Absolute sustainability – targets for green industry

- »» In GreenLab we strongly believe in the benefits of eco-industrial clusters with symbiosis both for the individual industries being site-partners in clusters and for the overall green transition in society. But how large a transition is needed for industry to become absolute sustainable in the future
- »» With this challenge we invite for quantitative studies of impacts on the operation of industries within an eco-industrial cluster and comparison to individually located industries. We encourage the use of absolute sustainability metrics routed in the SDGs and in planetary boundaries. The studies should help quantifying and setting ambitious targets for circular economy within eco-industrial clusters and for the rest of industry in society

Missions related to challenge:

- Design principles for eco-industrial clusters



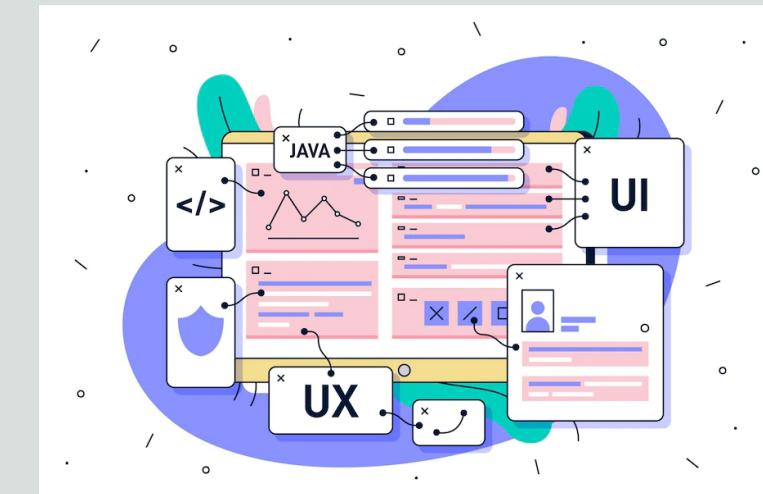
Challenge 8 – UX for digital GreenLab

- Mapping the opportunities and expectations for interactions of stakeholders on a virtual GreenLab platform

- »» In GreenLab we see a strong need for an interactive and dynamic virtual/digital platform which will help facilitating the circular economy collaborations in Industrial Clusters during all parts of its lifecycle.
- »» With this challenge we invite for studies of UX/UI needs and expectations at the various stakeholder groups for a future digital green cluster platform, which should be created in a way that enable future replicability for GreenLab. Stakeholders could include public administration, RE asset owners, large production companies, operators (DBO), local GreenLab site operators, companies/site partners at clusters

Missions related to challenge:

- Design principles for eco-industrial clusters



UPCOMING CALL



Upcoming call

- Three specific challenges and one open challenge

»» Deadline: June 14th

»» Duration up to one year

»» Funding for universities: 100k-1M DKK

We are looking forward to collaborating with you on the future research for a powershift in industry!

