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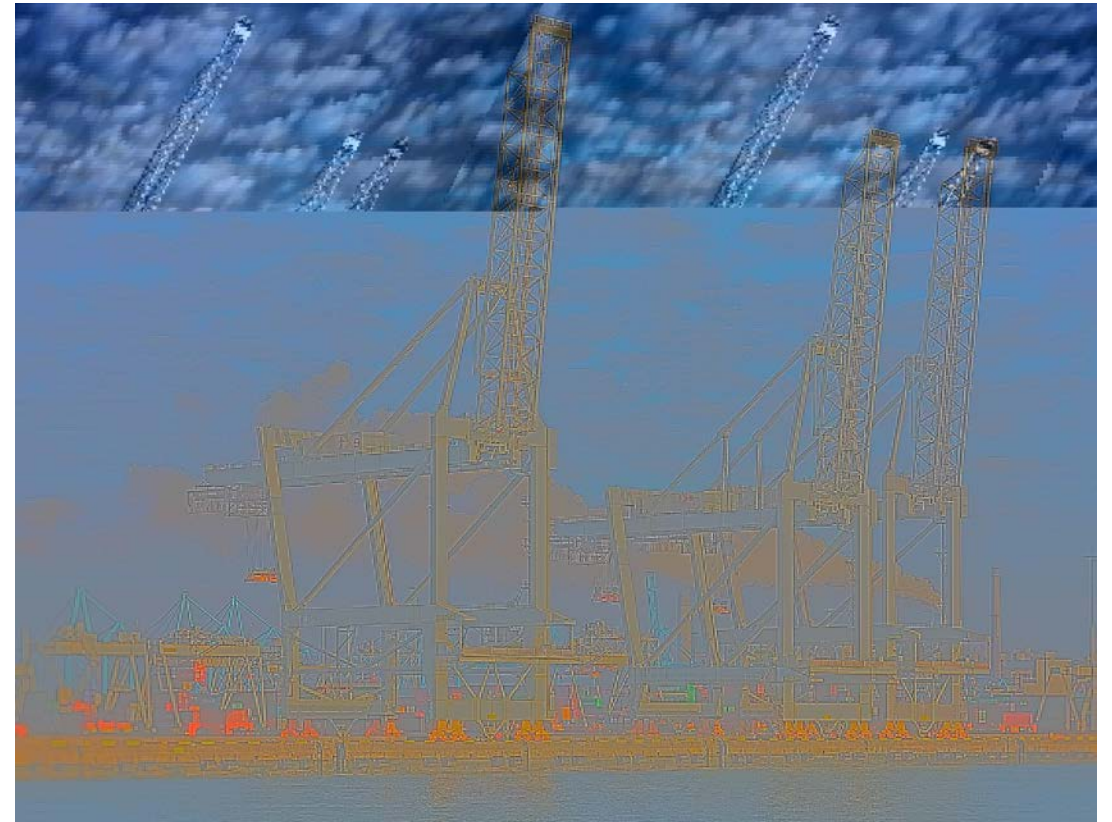
## **Intermediating multi-system interactions – exploring the activities that foster complementarities in technology value chains**

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# Project: ACES – Accelerating Energy- and Sustainability Transitions in Ports: from national vision to co-constructed transition

- **Project owner:** SINTEF Community
- **Research partners:** SINTEF Digital (dep. Technology Management), Norwegian University of Science and Technology (dep. Interdisciplinary Studies of Culture), Dutch Research Institute for Transitions (DRIFT)
- **Various industry and public partners**
- **Projektperiode:** 2021-2025
- **Financing:** Research Council of Norway (~80%) + industry partners





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# Introduction

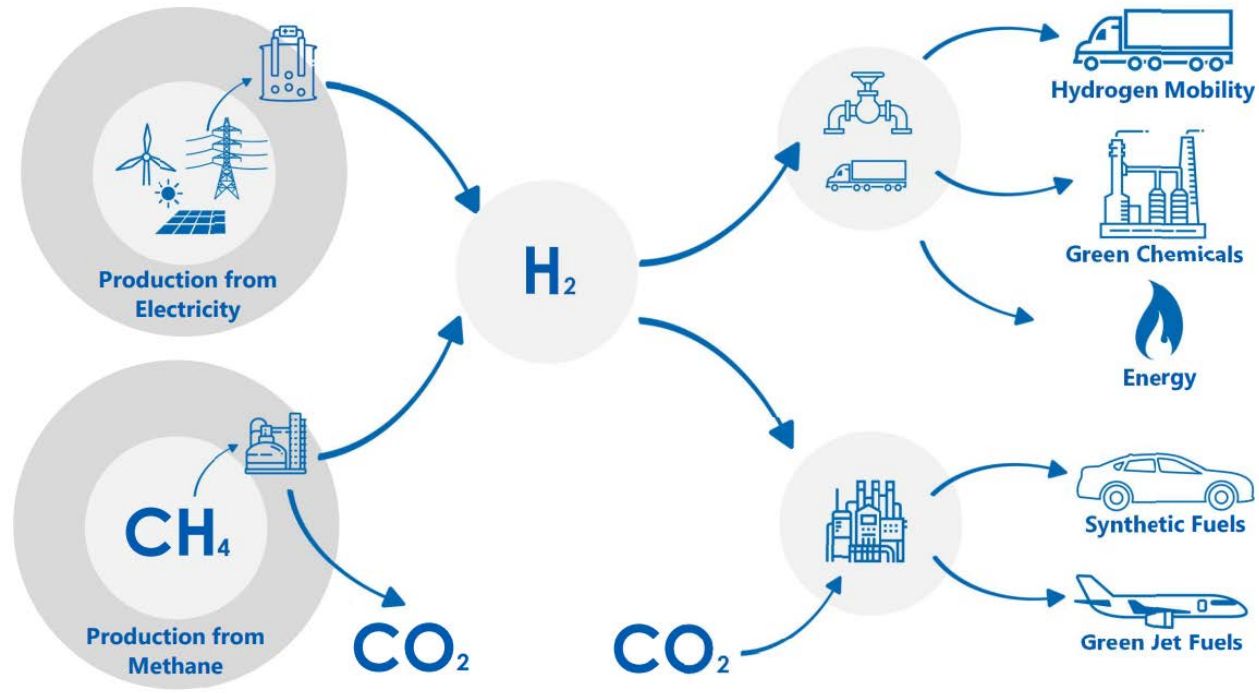
- Joint work with **Lillian Hansen** (SINTEF), **Susanne Jørgensen** (NTNU), **Marianne Ryghaug** (NTNU), **Tomas Moe Skjølsvold** (NTNU), **Markus Steen** (SINTEF), **Mari Wardeberg** (SINTEF)
- **Multi-system interactions** important for understanding transitions, especially in an acceleration phase
- One perspective to this analysis: emergence of novel/more sustainable **technology value chains** creating new couplings between systems (e.g. Stephan et al, 2017; Malhotra et al, 2019; Andersen & Markard 2020)
- Yet little attention to how **actors** may foster the emergence of novel/more sustainable technology value chains
- We study the types of **intermediation activities by port authorities** that may foster the **formation of multi-system interactions along technology value chains**
- **Multiple case study of five North European ports** and how they have **intermediated between actors from different systems** along technology value chains in the context of sustainability transitions
- **Work in progress!**



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# Technology value chains

- Sectors involved in the development and use of a technology = technology value chain (cf. Stephan et al., 2017)
- Technologies as **complex systems** where developments in one part of the value chain may affect the rest of the value chain (Rosenberg, 1976; Arthur, 2009)
- Complementarities between socio-technical systems central to transitions (Rosenberg, 1979, Markard and Hoffman, 2016, Andersen & Markard, 2020, Mäkitie et al., 2022)
- **Complementarities:** "Value of a combination of specific elements or assets is greater than the sum of the value of each individual element" (Markard & Hoffmann, 2016)
- Complementarities within and across technology value chains may form through (Mäkitie et al., 2022):
  - *Synchronization:* **co-development** of technology value chain segments
  - *Amplification:* technology value chain's **ability to expand**
  - *Integration:* **convergence** across technology value chains





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# Intermediation

- **Intermediaries** contribute to transitions through brokering between actors and systems (Kivimaa et al, 2019)
  - Connect transition vision and demands of networks of actors
  - Create momentum for systemic change
  - Create new collaborations
  - Disrupt unsustainable socio-technical configurations
- Yet little elaboration on **intermediation in multi-system interactions/technology value chains**
  - Different knowledge, different regimes and task and institutional environments potentially creating lack of alignment, unfamiliarity
- **Ports** as an interesting case study for this (Damman & Steen, 2021, Bjerkan et al, 2021)



Figure: Dreamstime



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# Multiple case study

- Five qualitative case studies (sixth coming) of **frontrunner port authorities** in sustainability topics
- Data
  - 11 semi-structured interviews (until now)
  - Ports websites
  - Reports, scientific literature
- Gathered data of sustainability activities of ports
- Identified activities that intermediate interactions across technology value chains

Port organization	Port of Gothenburg (PoG)	Port of Aalborg (PoA)	Port of Oslo (PoO)	Port of Bergen (PoB)	Coast Center Base (CCB)
Location	Next to the city of Gothenburg, Sweden	Outside the city of Aalborg, Denmark	Inside the city of Oslo, Norway	Inside the city of Bergen, Norway	Outside the city of Bergen, Norway
Ownership	City of Gothenburg	City of Aalborg	City of Oslo	Intermunicipal	Private
Type of shipping	Cargo Passenger	Cargo	Cargo Passenger	Cargo Passenger Offshore	Offshore
Main activities in the port area	Land and sea transport Industrial production	Industrial production Land and sea transport	Land and sea transport	Land and sea transport	Sea transport
Main sustainability activities	Alternative fuels	Industrial symbiosis	Shore-power	Shore-power	Shore-power
Size	Very large	Medium	Large	Large	Small





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# Intermediation activity 1: Building physical infrastructure

- New **physical infrastructure** required to couple together value chain segments, acting as a medium of multi-system interactions
- Ports in key role in (facilitating the) building of **shore-power and charging stations** required to electrify transport
  - Many ports developing power supply for shipping and trucks
- Ports **facilitating the future power needs** of transport companies
  - Port of Gothenburg **coordinating with the grid company** regarding needed investments in grid capacity
    - "Make friends with your grid company!"
  - Almost everybody **building renewable energy**
- Seeking to **avoid the chicken and egg problem**
  - Port of Gothenburg **building hydrogen supply** despite lack of users



Figure: Zinus



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# Intermediation activity 2: Cross-system network building

- Facilitation the formation of social and collaboration **networks between actors from previously unrelated socio-technical systems**
  - **Reducing uncertainty** and unfamiliarity, building **shared institutions** such as visions
- Ports have **broad networks, established collaborations** with a wide variety of actors
  - Port of Aalborg using its connections to **facilitating** the formation of a regional **industrial symbiosis** network
  - Port of Gothenburg established **cross-system consortia** for decarbonizing transport
- Ports **gathering information** about potential new couplings
  - Port of Gothenburg **gathering data of transport routes** that are feasible to decarbonize
  - Port of Aalborg **mapping the local industrial resource flows** of regional industries to allow
- Establishing new actors
  - Port of Bergen **co-founded an organization** that develops shore-connector projects

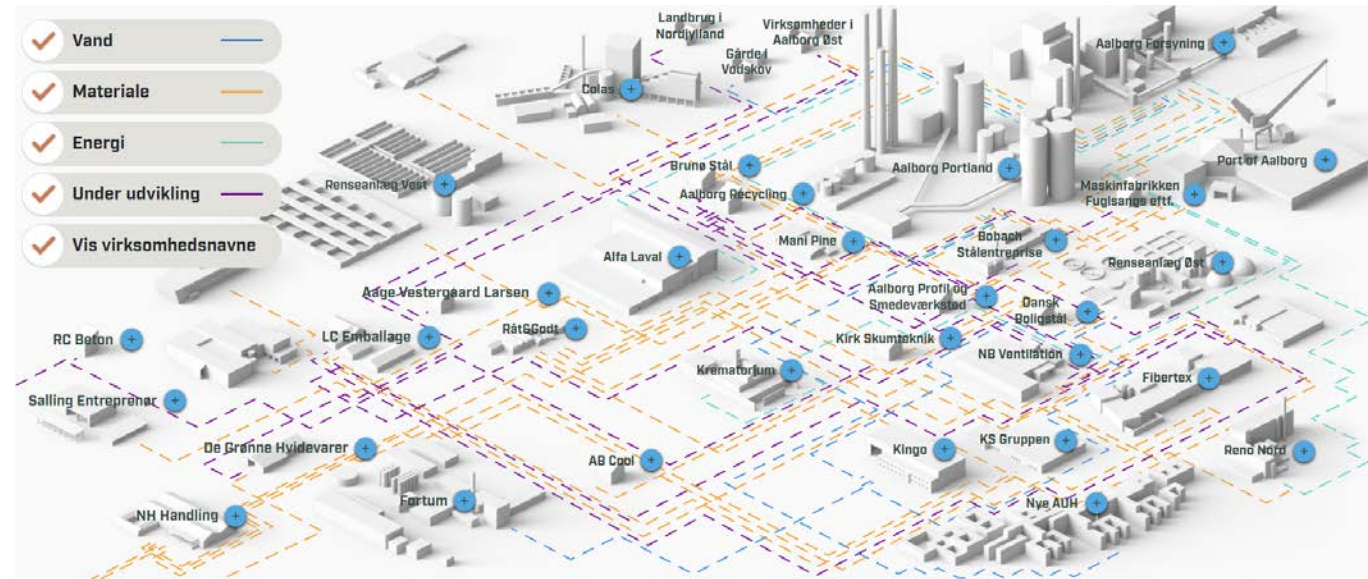


Figure: Industriel Symbiose Nord



# Intermediation activity 3: Coordination of sustainability activities across systems

- Public pressure towards more sustainability requires **coordinated activities across value chains**
- Publicly owned ports as a tool to **implement policies** – mandate to pursue sustainability
- Reduction of local emissions (NO<sub>x</sub>, SO<sub>x</sub>, VOC, etc.) a priority for several cities – responses require **coordination across the value chain**
  - City ports (Bergen, Oslo, Gothenburg) **coordinating responses between actors**
- Building green **industrial clusters**
  - Port of Aalborg with a goal of contributing to the creation of new green jobs in the region
  - Port of Oslo encouraging nearby concrete producers to switch to locally produced biogas



Figure: TV2



# Discussion and conclusion

- Port authorities can engage in **intermediary activities** contributing to formation of **multi-system interactions** in sustainability transition context
- Moreover, multi-system intermediation can **contribute to formation of complementarities** in technology value chains (Mäkitie et al., 2022)
  - Infrastructure building contributes to *synchronization* by reducing uncertainty regarding alternative fuels, encouraging transport companies to invest in e.g. electric vessels and trucks
  - Building renewable energy production and ensuring adequate grid expansion contributes to *amplification* in e.g. electrification of transport
  - Fostering network formation contributes to *integration* between different technology value chains
- Next steps:
  - Gather more data and include the sixth case study
  - Continue analyzing the data
  - Develop our conceptual anchoring and discussion

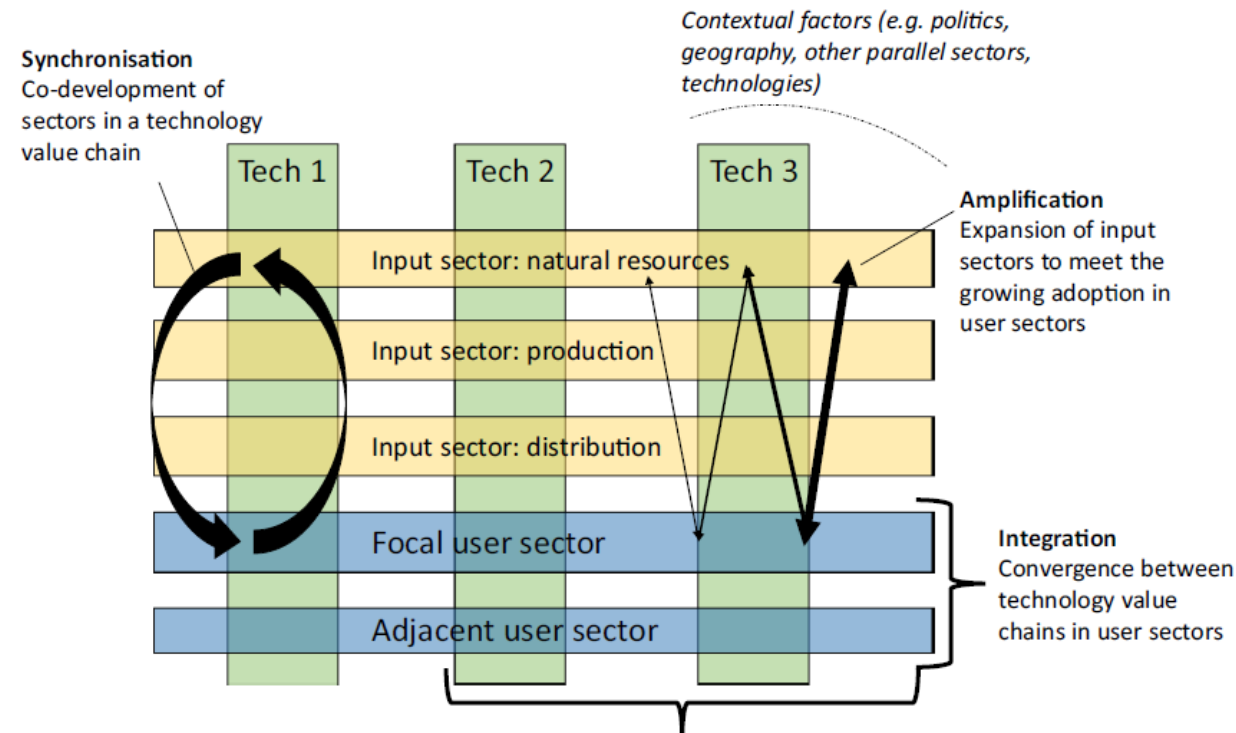


Figure: Mäkitie, T., Hanson, J., Steen, M., Hansen, T. & Andersen, A. D., 2022. Complementarity formation mechanisms in technology value chains. *Research Policy*, 51, 104559.



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