### Decarbonizing energy-intensive processing industries: stylized facts and research agenda

*J.H.* Wesseling<sup>1</sup>, S. Lechtenböhmer<sup>2,3</sup>, M. Åhman<sup>3</sup>, L.J. Nilsson<sup>3</sup>, E. Worrell<sup>4</sup> and L. Coenen<sup>1</sup>

1 CIRCLE, Lund University

- 2 Future Energy and Mobility Structures, Wuppertal Institute
- 3 Environmental and energy systems studies, Lund University
- 4 Copernicus Institute of Sustainable Development, Utrecht University



### Why *Deep* Decarbonisation ?

In accordance with "well-below 2 C" and CBDR (Paris Agreement):

- Industry in the EU have to reduce emissions with at least 80-95% by 2050
- This will be not the end, further reductions will have to follow (down to zero...)
- "Classic Energy Efficiency" can reduce industrial emissions with 20 to 35% (IPCC 2014)
  - » Wider definitions (*user-eff, prod.eff.e.t.c*) can potentially reduce emissions further
- Reductions > 50% requires systemic shifts in production routes



# Energy Intensive Processing Industries (EPIs) – some basics

- Metals (e.g., copper and steel), minerals (e.g., lime and silicon) and various organic compounds (e.g., cellulose fibers and plastics)
- <u>Technology</u>: Options for deep decarbonisation in EII:
  - Carbon Capture and Storage (CCS)
  - Biobased feedstock and fuels (biogas, charcoal, wood chips, bioplastics etc.)
  - Electricity and hydrogen/hydrocarbons for fuel and feedstock
- <u>Costs:</u> Few, if any, co-benefits but more expensive (from 30 % for bulk steel to 300 % for plastics)
- Not well-understood from a transition perspective



### Aim and method of paper

- 1. Characterize innovation system of EPIs: patterns of innovation
- 2. Explore transition dynamics: patterns of transformational problems (lock-in)
- 3. Research agenda
- Position paper data collection:
  - 4 experts (senior EPI researchers)
    - » 2 questionnaires;
    - » 3 workshops;
    - » 4 rounds of editing paper
  - Collective literature review



### Industry characteristics and innovation systems



- Industry structure: capital intensive, investment cycles, scale economies
- Innovation strategies: incremental process improvements, some products
- Markets: bulk commodities, cyclic, small margins (but some nichés)
- Public policy: safety, pollution, efficiency and shelter against disadvantages
- Systemic lock-in: incumbents, no markets, no push-pull, CO2-leakage



Source: Wesseling, et al (2016) submitted manuscript

### Policy and governance implications

- What transition research knows so far......

#### Direction

• Roadmaps, strategies, policies etc.

#### System innovation

• Technology push and market pull, co-evolution w. infrastructure

#### Role of government

- Risk sharing, financing and coordination
- Institutional capacity
  - Responsible agencies, expertise, "triple-helix" ?



### **Transitions research for EPIs**

- Research needed! Some high-lights of questions
- Government: How can directionality be created and supported without "picking wrong winners" ?
- *Business*: Can incumbents transform (avoiding lock-in)?
- All: How can we test and scale-up (NER400?)?
- Market: What are the nichés and what drives green buyers (e.g., LEGO)?
- *Government/market*: How can policies be designed for demand pull ?
- *Global policies:* How govern transitions in a global context?





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