Webinar: NAS Study Chapter on DAC

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Example Case: Capture **300 million tons of CO$_2$** per year

- 1% of global emissions or 1 ton per American citizen
- 750'000 40-ft shipping containers with Climeworks CO$_2$ Collectors
  - Amount of containers that pass through Shanghai harbor in 2 weeks
  - Small compared to global industry output
- Required investments (once for above capacity): US$ 100 .. 300 B
  - US federal budget: US$ 3’000 B
  - World-wide investments in renewables 2016: US$ 240 B
  - considerable
- Energy consumption: 300 .. 600 TWh/y heat/electricity
  - World, total: ~ 140’000 TWh/y
  - World, total, renewable: ~ 30’000 TWh/y
  - World, power, renewable : ~ 5’000 TWh/y
  - medium
LIMITATIONS & UNKNOWNS

- Potential limitations and unknowns: political/economical
  - Markets/price on carbon for commercial DAC
  - Market conditions for renewable fuels and materials from CO$_2$
  - Base-load renewable energy without jeopardizing other mitigation efforts (can be a limit but also an opportunity to boost renewable energy growth)
  - Moral hazard: discussion still present

- Potential limitations and unknowns: technical
  - Time-line of cost reduction
  - Long-term field data as input for scale-up
Our estimation on total, technically feasible DAC deployment (in commercial operation):

- **2017:** 1’000 t/y (already in operation)
- **2018:** > 5’000 t/y
- **2020:** > 50’000 t/y
- **2025:** > 10’000’000 t/y

Our estimation on DAC costs (as realized in commercial plants):

- **2017:** US$ 600 / t CO₂
- **2020:** US$ 200 – 300 / t CO₂ (for > 5’000 t/y scale)
- Mid-term target: < US$ 100 / t CO₂
RESEARCH NEEDS (1)

• Theoretical:
  ▪ Life cycle analyses

• Lab-scale:
  ▪ Sorbents and solvents, optimized for DAC
    – Regeneration energy
    – Production costs
    – CO₂ vs. H₂O uptake
    – Performance optimization not for theoretical record values but for practical DAC processes
    – Stability, Longevity
• Large-scale:
  
  - **Deployment of plants in the field with operation periods of several years**
  
  - Manufacturing planning on a large scale, based on real designs
    (We know the theoretical limits quite well but need to better understand the required steps for implementation.)
  
  - CO\textsubscript{2} depletion of atmosphere around DAC plants
RESOURCE REQUIREMENTS OF DAC

• Rating from 1 (no limitation) to 5 (potentially limiting)

  ▪ Land requirements 2
  ▪ Water requirements 1 (for Climeworks technology)
  ▪ Energy requirements 4
  ▪ Raw materials requirements 2
  ▪ Financial requirements 5