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Tiller CO₂ capture plant - The role of pilot plants in technology development

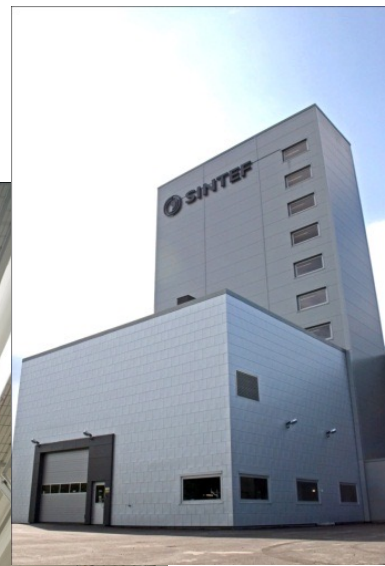
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US-Norway bilateral meeting, Washington DC,
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Full height pilot plant

- Qualification of solvents
 - Exhaust gas (4-20% CO₂)
 - Industrial conditions.
 - Demonstration of 90% CO₂ capture
 - Long term operation
- Development/piloting of advanced process configurations for low energy CO₂ capture
- Dynamic operation of CO₂ capture with Model Predictive Control
- Piloting and simulation models closely integrated
 - Analysis of the capture process
 - Process design and optimization – full scale

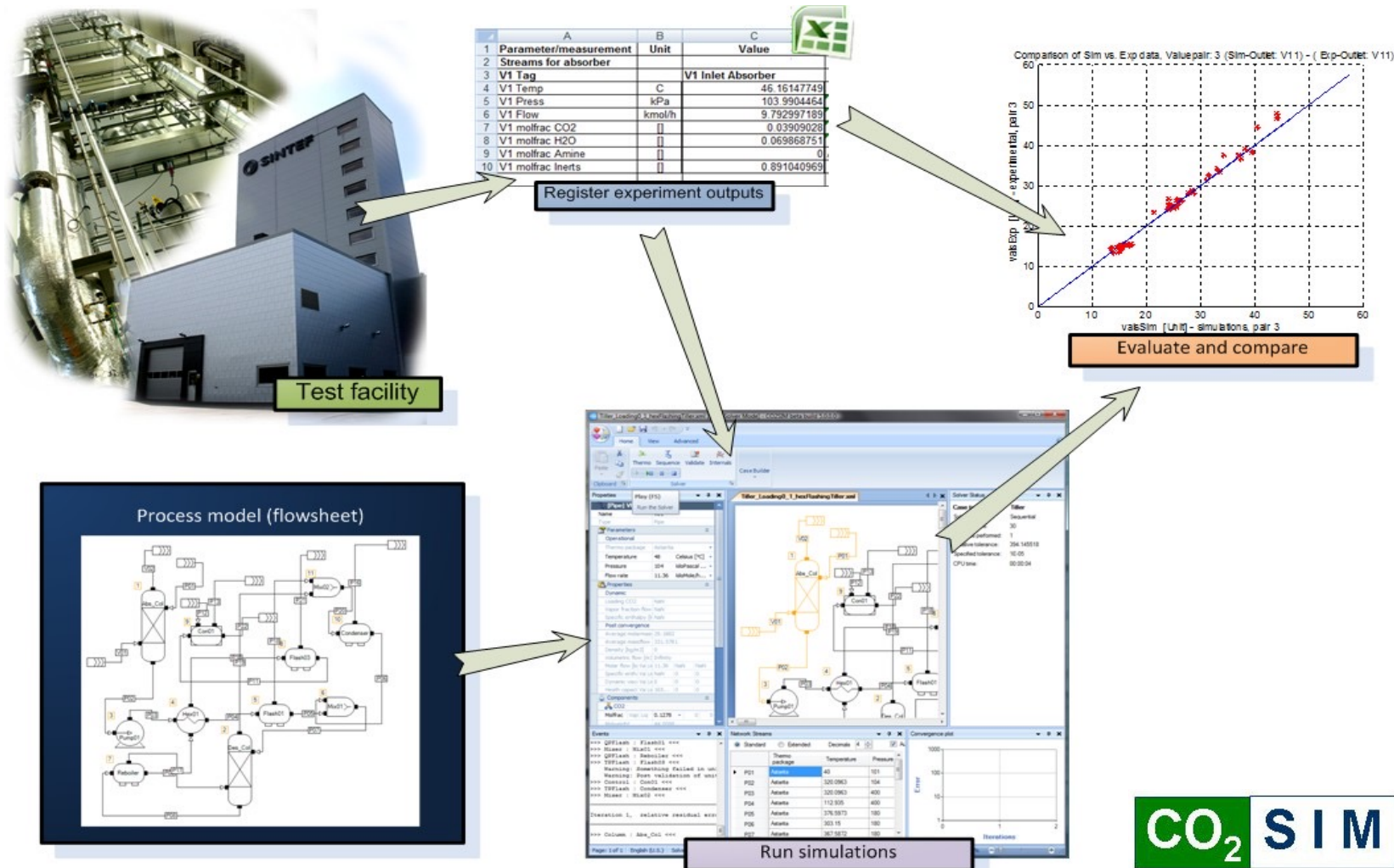




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Process modelling and simulations

Development of in-house process simulator for CO₂ capture with validation by in-house pilot plants





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Important scientific achievements within the field of amine-based, reactive absorption CO₂ capture -from the Tiller pilot plant

- 1. Improvements in Efficiency, understanding thermodynamic constraints:**
- 2. New Solvent Formulations, fundamentals of solvents performance:** Developing solvents systems for industrial application.
- 3. Improved understanding of oxidative and thermal amine degradation in operational environment**
- 4. Dynamic operation, process control and integration with industrial processes**
- 5. Understanding amine emissions, monitoring and mitigation.**
- 6. Evaluating third generation solvent systems**

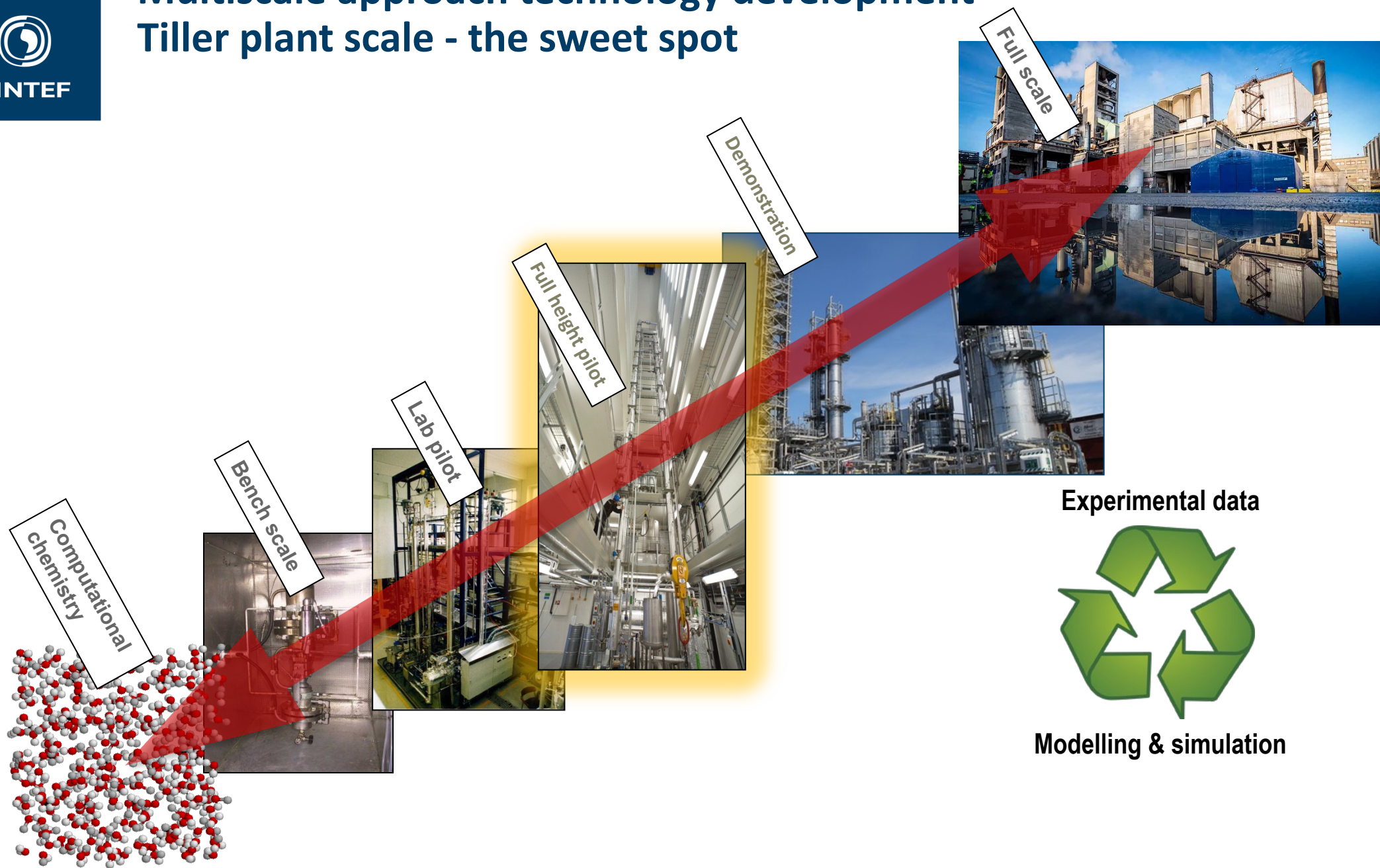




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Multiscale approach technology development

Tiller plant scale - the sweet spot



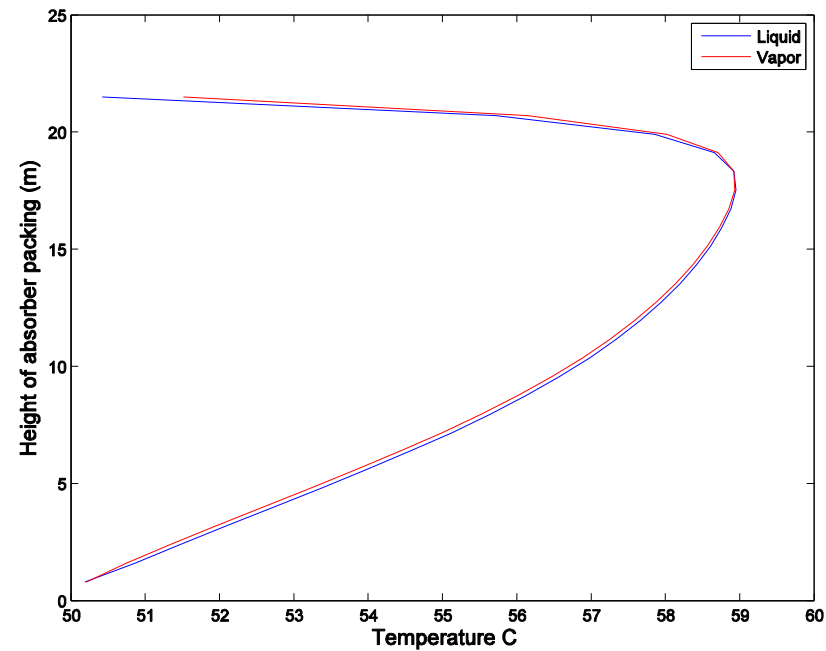
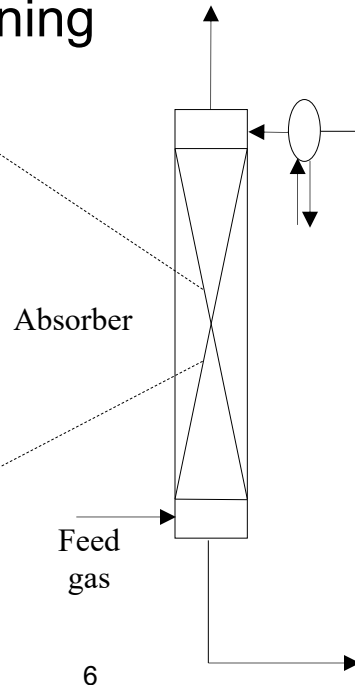


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Scaling of absorber and desorber

- Assumed good distribution of gas and liquid over the cross section area:
 - Scaling up is in principle only an increase in diameter.
 - Equal temperature and concentration at a given packing height.
- Heat loss from the column walls must be taken into consideration

Structured packing



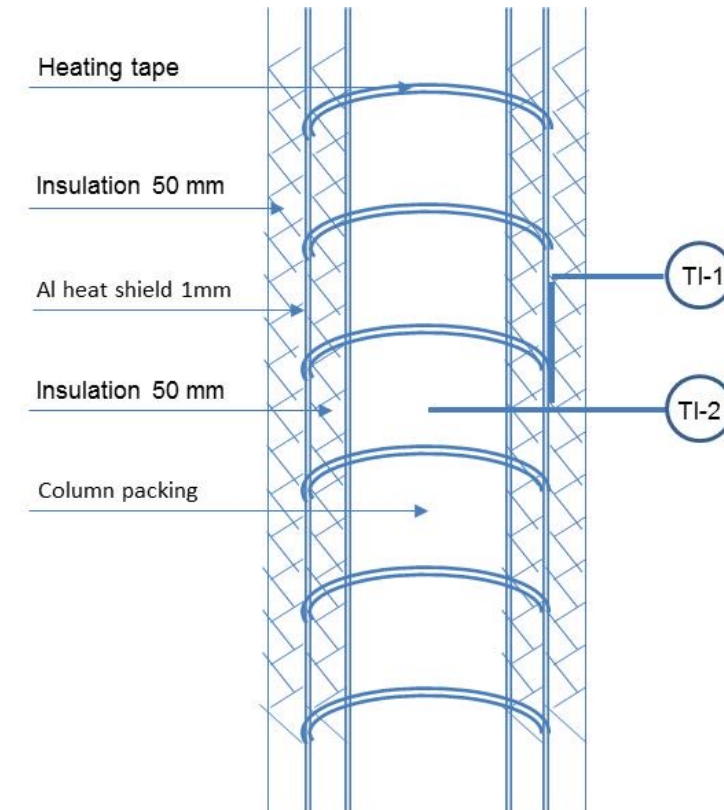


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Heat tracing

- Less than 1°C over the insulation
- Very close to adiabatic conditions.

- Correction for heat loss to surroundings essential for small pilots
- Risk of overcompensating heat loss by allocating all loss to Reboiler.
- Heat tracing of warm parts reduces heat loss



PT-100 element bøyes 90 grader.
Monteres i lomme på Al-mantel

Temperature control :
 $\Delta T = T_{I(1)} - T_{I(2)} = 0$



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Summary

- Tiller Pilot celebrated, in June 2023, 100 000 hours of operation, R & D on CO₂ capture since 2010
- Played a significant role in developing Aker Carbon Capture solvent technology towards full scale
- Small scale, full height pilot plants provide highly valuable scientific and engineering insights
 - Feedback to bench scale
 - Feed in to modeling, simulation and full scale design
 - Input to design studies
 - Flexibility in adapting process configuration and design for the purpose of specific solvents, exemplified by the significant cooperation with RTI on the NAS technology
- Standardisation – important topics
 - Heat loss to surroundings vs. SRD measurement
 - Gas/liquid velocity in pilots vs. full scale





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Further work...

- Utilize the unique flexibility, investigate specific solvent systems and process configurations
- Solvent management, long term operation
- Further work on process control in new industries, dynamic operation
- >95% capture rate
- CO₂ liquefaction, part of capture system

CCLU, CO₂ Compression and Liquefaction Unit (2023-)





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Thank you for your attention!

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