MTR / CCSI2 PILOT TEST COLLABORATION EXPERIENCE

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150 TPD Large Pilot at WITC

MTR Carbon Capture Development Timeline

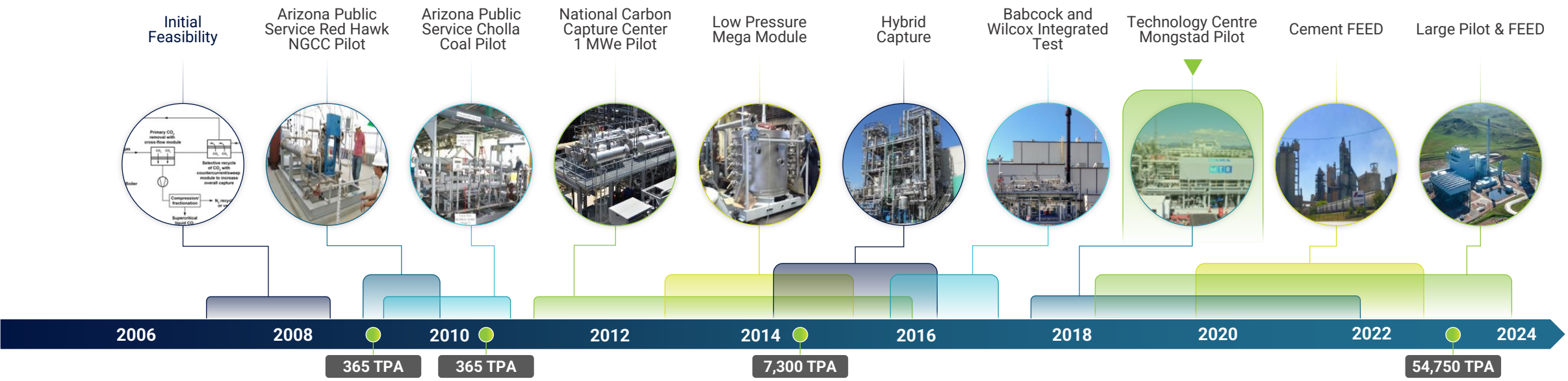
15 Year
Development History

20+
DOE Awards Won

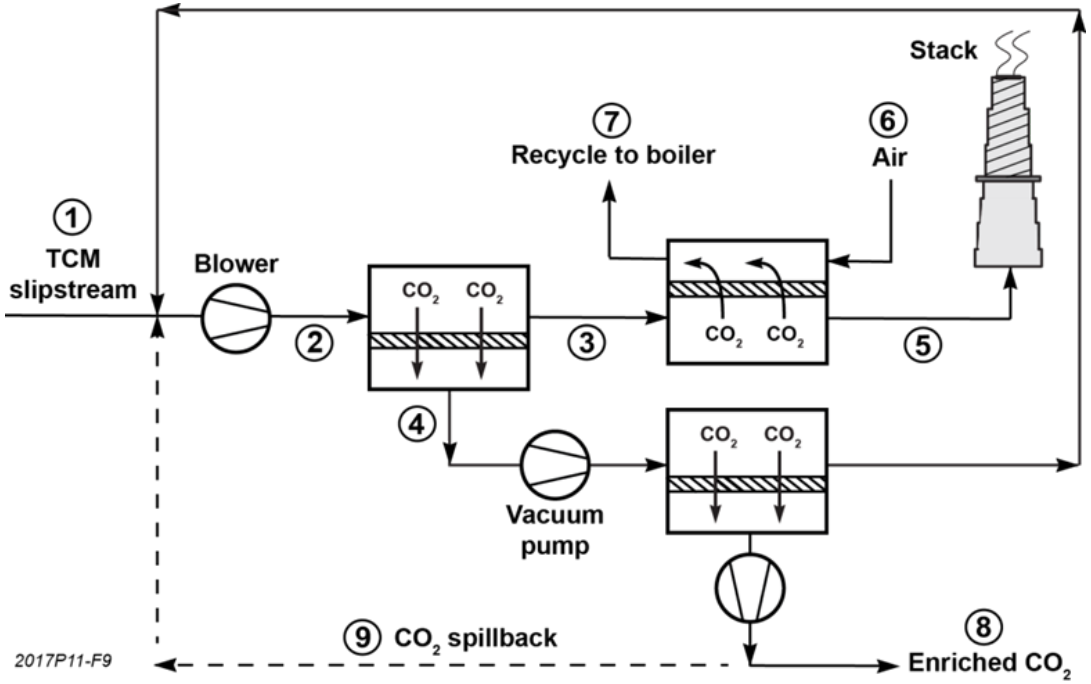
>$140mm
Total Funding Received from DOE

- Support from the DOE through many competitive awards has helped MTR bring membrane carbon capture technology from early concept to near commercialization
- This support was key to developing a technology for an emerging market where large scale-up was required

MTR / DOE Development Timeline



Pilot Testing at TCM (DE-FE0031591)



- 2 stage membrane system with input variables including feed flow rate, CO_2 content, sweep flowrate, temperature
- KPIs included capture rate, CO_2 purity and pressure drops

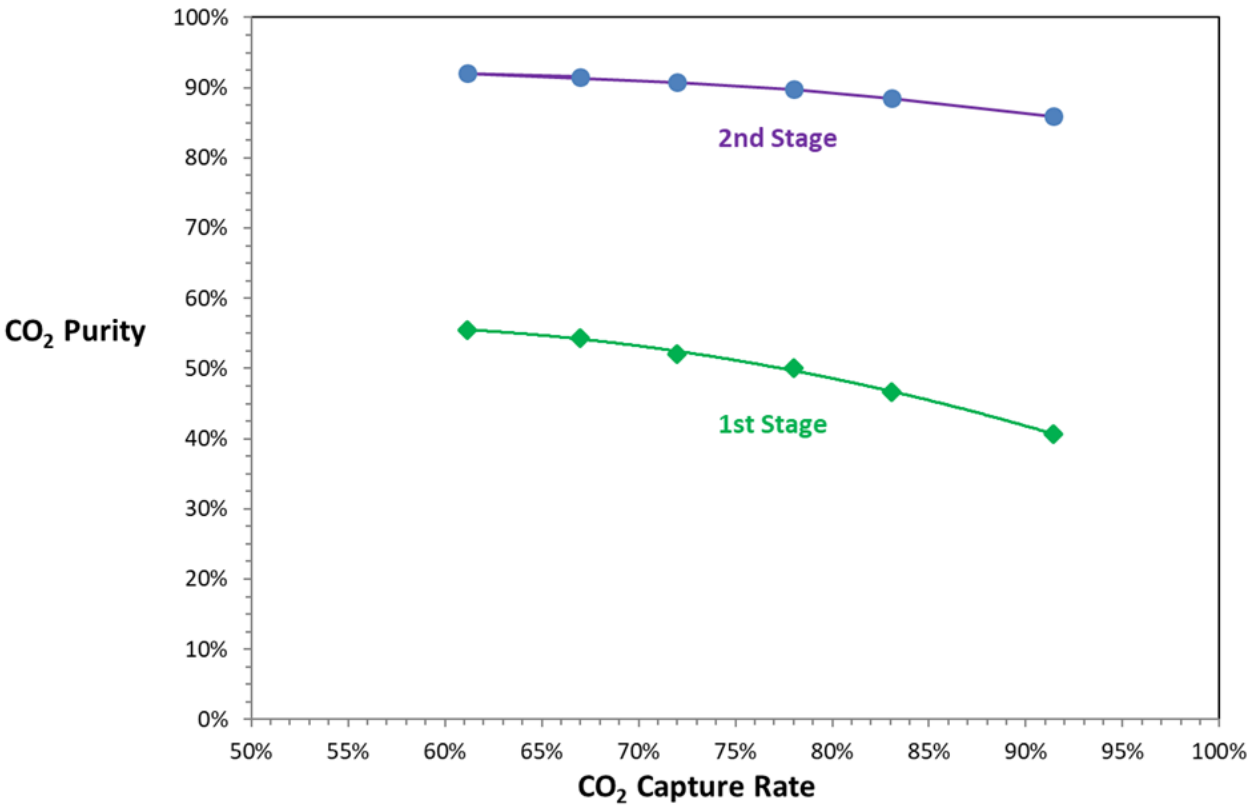
- ~6 month, 10 TPD field test at Technology Centre Mongstad (TCM) in Norway to validate new “containerized” membrane modules and Gen 2 Polaris membrane

Test Plan Development

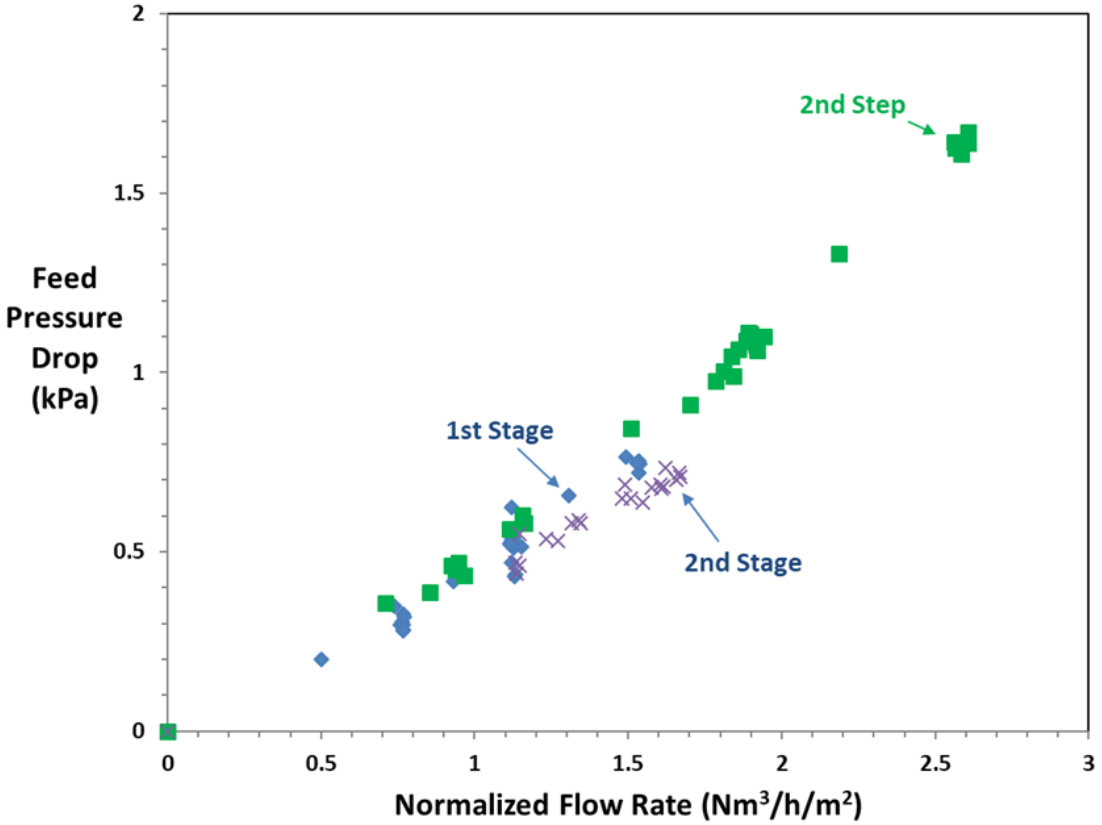
- MTR worked with CCSI2 team to develop a TCM test plan
- For simplicity, MTR initially proposed a one-factor-at-a-time approach
- However, with limited time/budget (~25 test conditions), it would be difficult to cover a broad range of possible operating conditions with this approach
- CCSI2 team used sDoE tools to develop an optimized test plan that would provide data used to tune model predictions for future designs
- After initial pilot startup, equipment issues further reduced the useful test time/conditions
- CCSI2 team quickly revised test plan to account for shorter test duration/less variables

Pilot Test Validated Performance of New Membranes

CO_2 purity and recovery



Module pressure-drop



- Used CCSI2 sDoE test plan to confirm/quantify performance over a broad range of possible operating conditions
- Data was incorporated into MTR's process model to design larger 150 TPD WITC system

Ongoing Activities with CCSI2

- MTR is currently working with CCSI2 team to finalize test plan for 150 TPD WITC Large Pilot (DE-FE0031587) → commissioning starts next month
- Challenges include that at this large scale there is less flexibility (due to cost and equipment limitations) for parametric testing
- Nevertheless, plan will attempt to efficiently sample possible input parameters to make sure we understand system response and thus minimize risk for future performance guarantees
- In a recently awarded project, we plan to collaborate on a small pilot test (3 TPD) at a cement plant; this size offers operational flexibility and is probably best suited/cost effective for model development
- Key areas to investigate will be the impact of industry specific contaminants and dynamic response to intermittent operation