



BIGCCS Centre

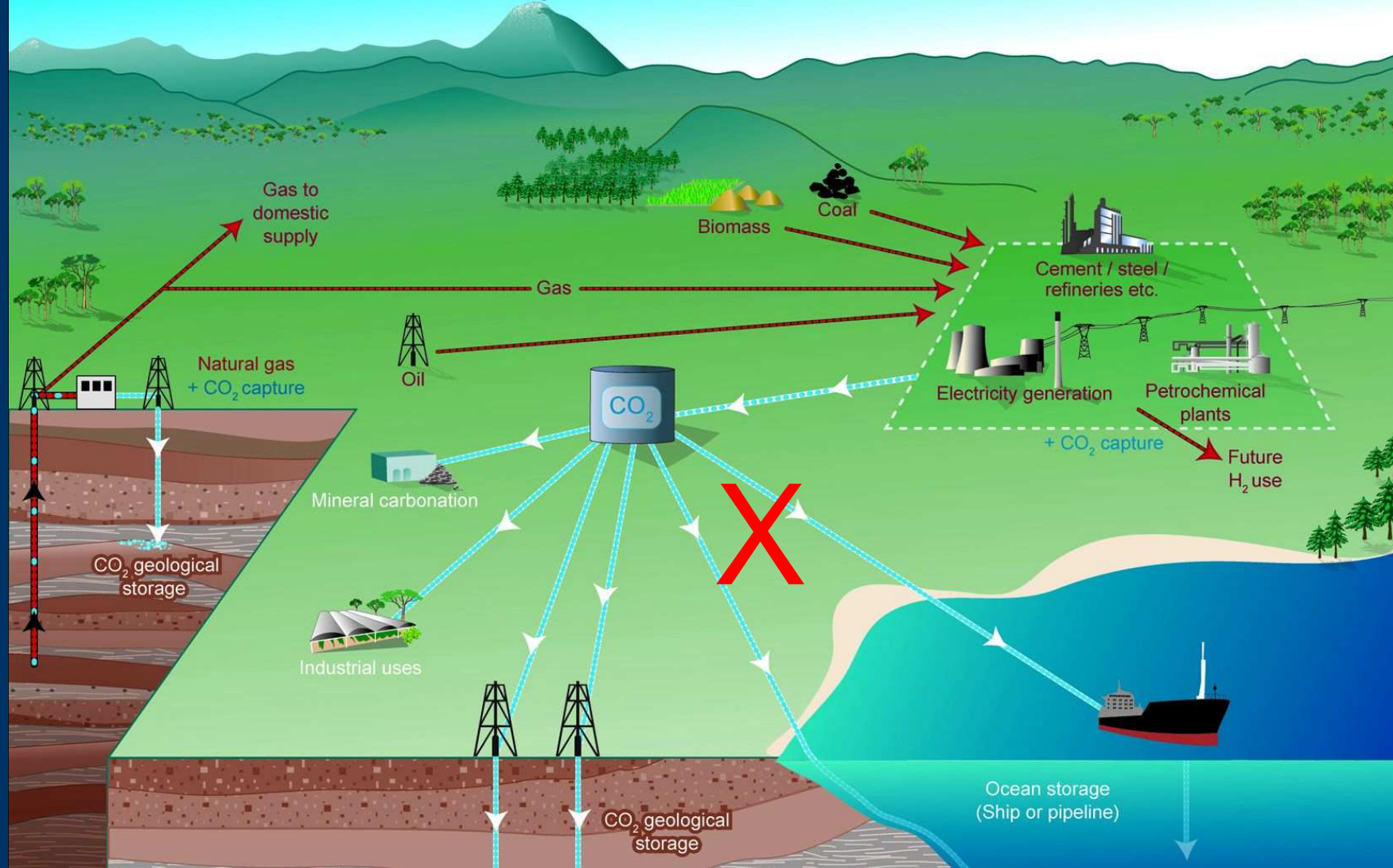
International CCS Research Centre

Science Week Minneapolis

Nils A. Røkke, Centre Director
VP Climate Change Technologies SINTEF
Minneapolis, 2009-09-29

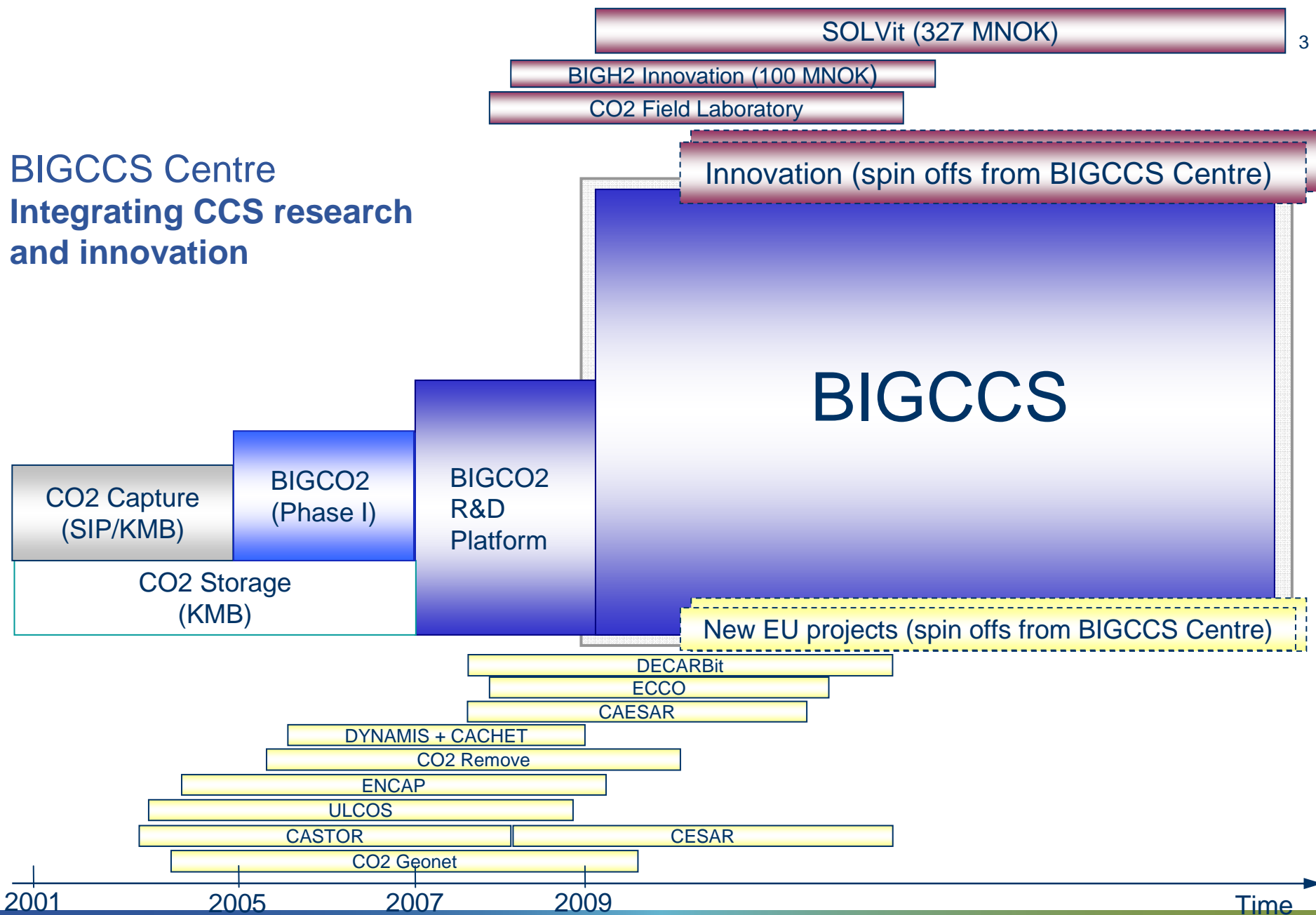


Schematic diagram of possible CCS systems



SRCCS Figure TS-1

BIGCCS Centre Integrating CCS research and innovation



CCS in SINTEF and NTNU

► Keywords

■ BIG.....

- CO2
- CLC
- H2
- CCS – CEER

90M€

■ ECCSEL

- European CCS Labs

82M€

■ SOLVIt

- Aker Clean Carbon

40M€

■ EU FP6&FP7

- Largest R&D provider within CCS in FP6 and FP7

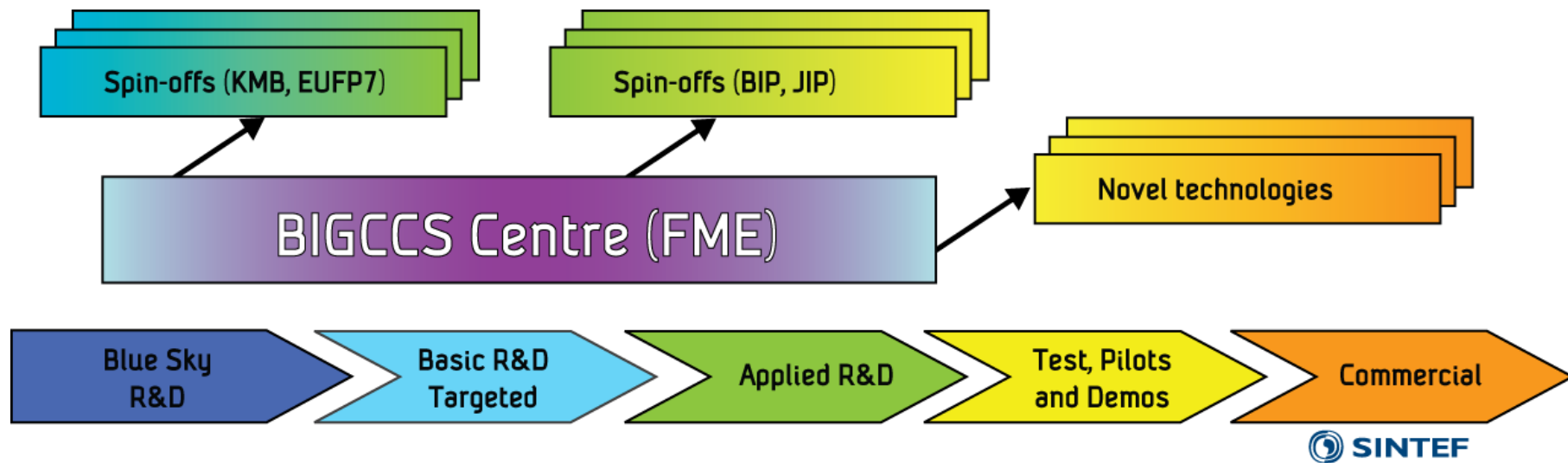
24M€



BIGCCS Centre Objectives

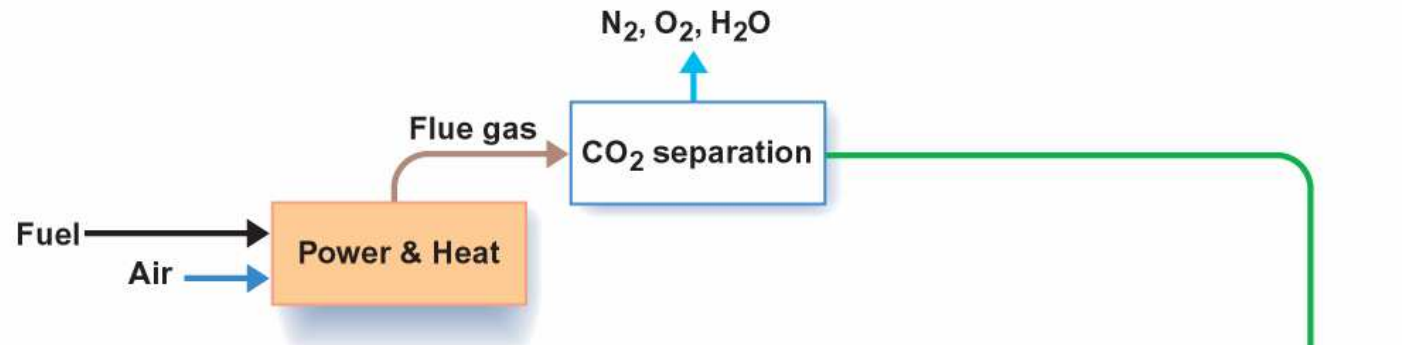
- ▶ The BIGCCS Centre will **enable sustainable power generation from fossil fuels based on cost-effective CO₂ capture, and safe transport and underground storage of CO₂.**
- ▶ This will be achieved by **building expertise and closing critical knowledge gaps of the CO₂ chain, and developing novel technologies in an extensive collaborative research effort.**
- ▶ **International co-operation, global CCS R&D provider and partner**

BIGCCS in the innovation chain

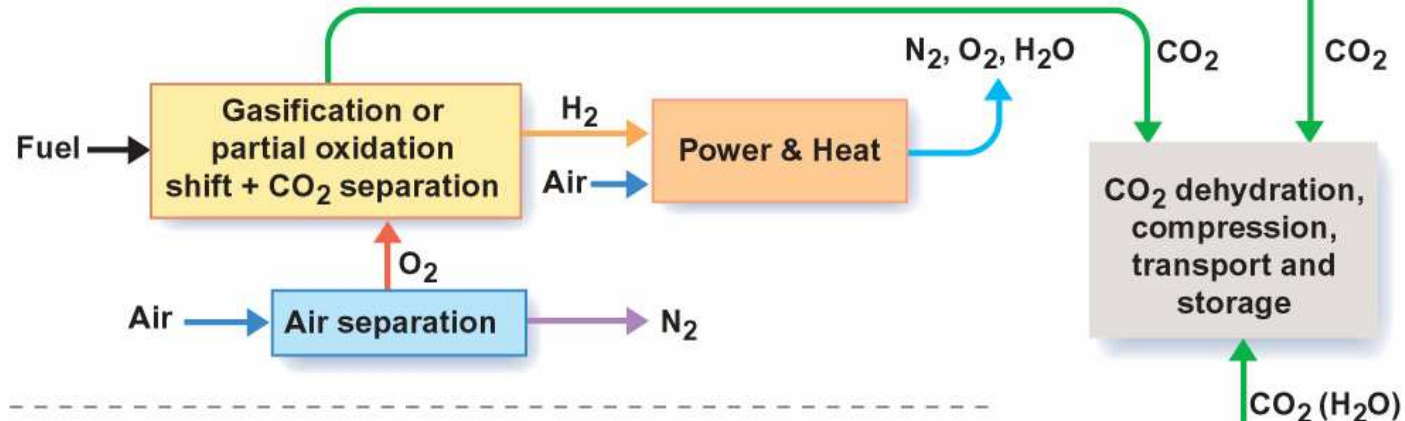


CO₂ capture routes

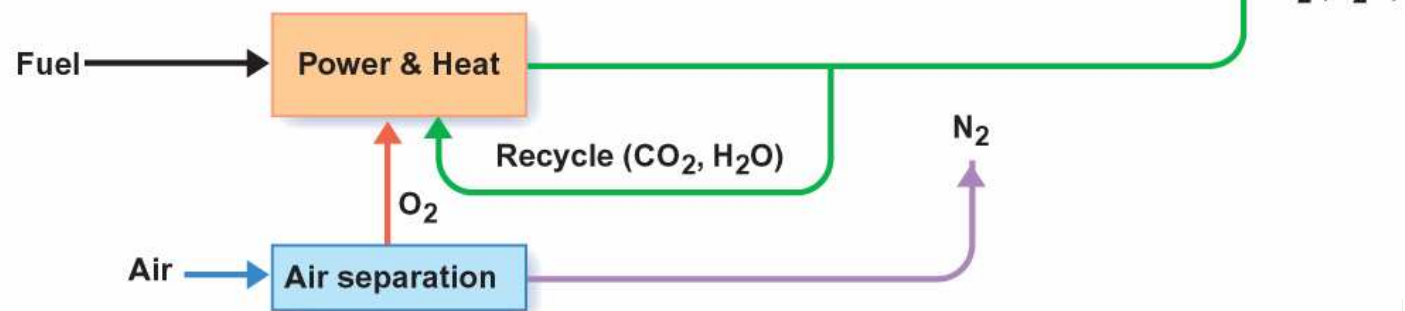
Post-combustion capture



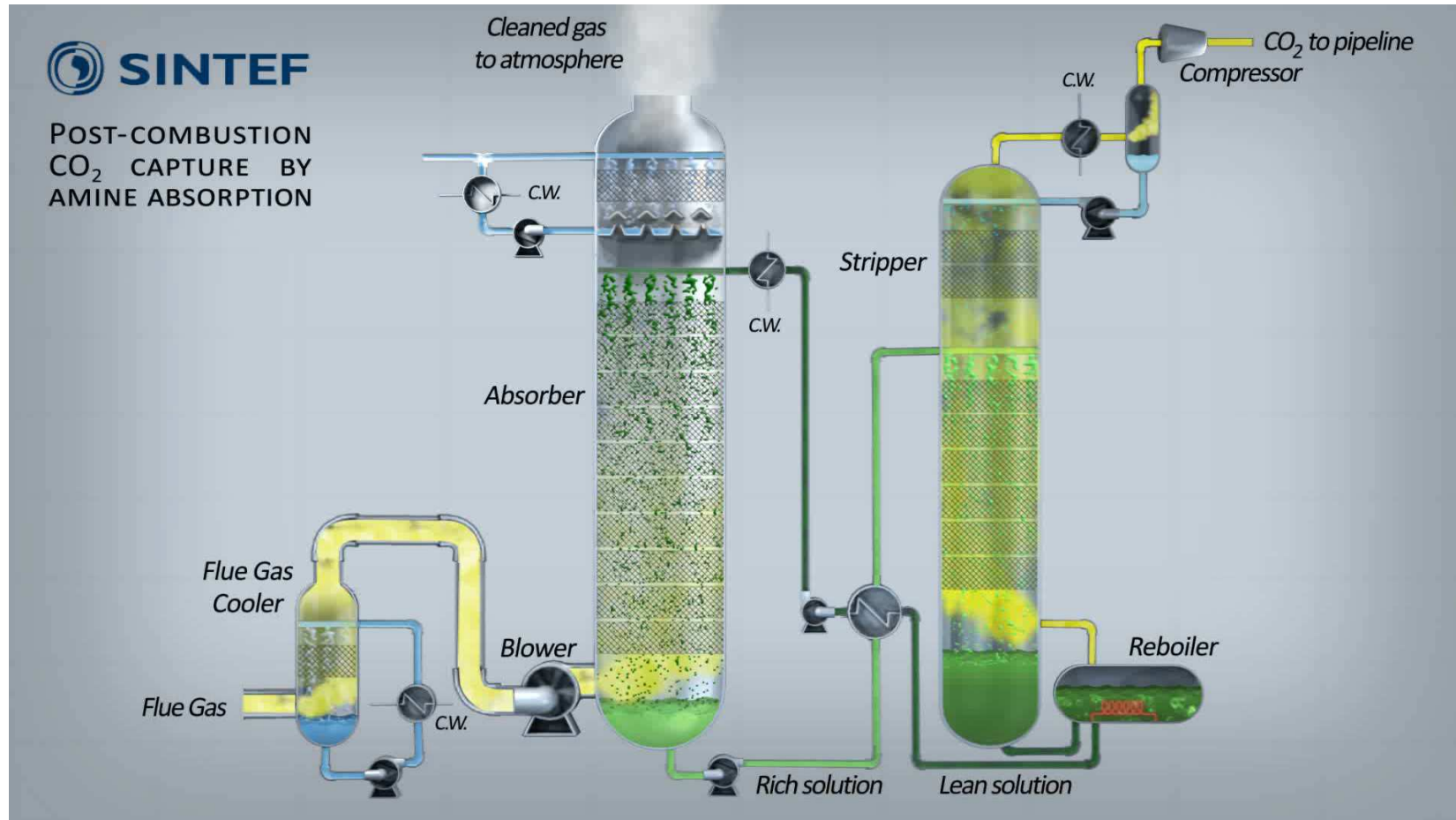
Pre-combustion capture



O₂/CO₂ recycle (oxyfuel) combustion capture



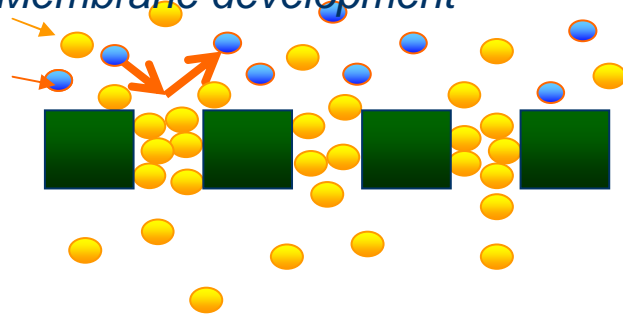
Post-combustion capture



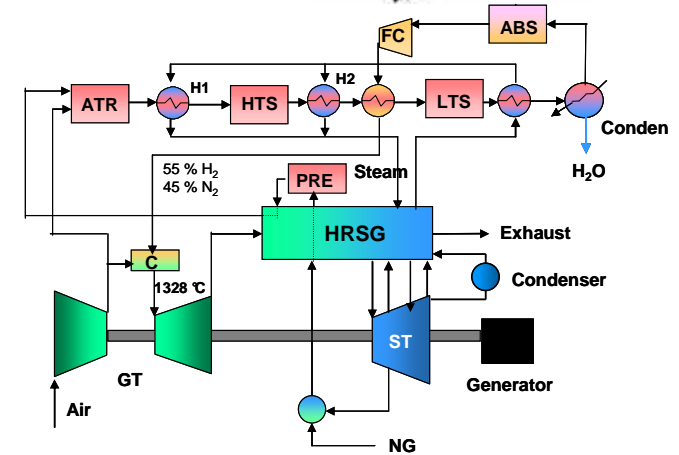


Areas of R&D

Membrane development

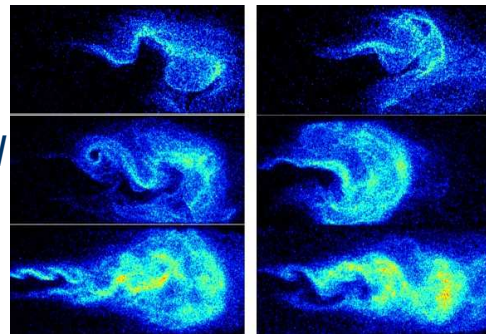


Absorption and desorption studies

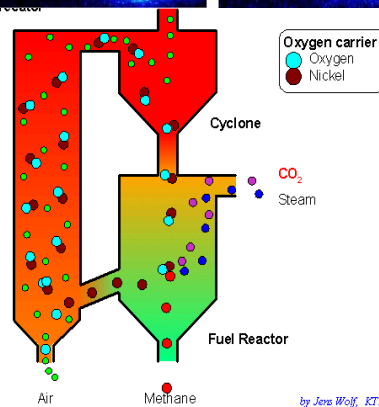


Power cycle and CO₂ chain analysis

H₂ and Oxy-fuel combustion



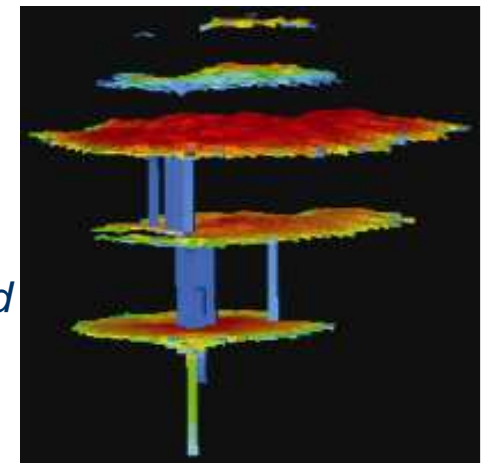
Chemical Looping Combustion



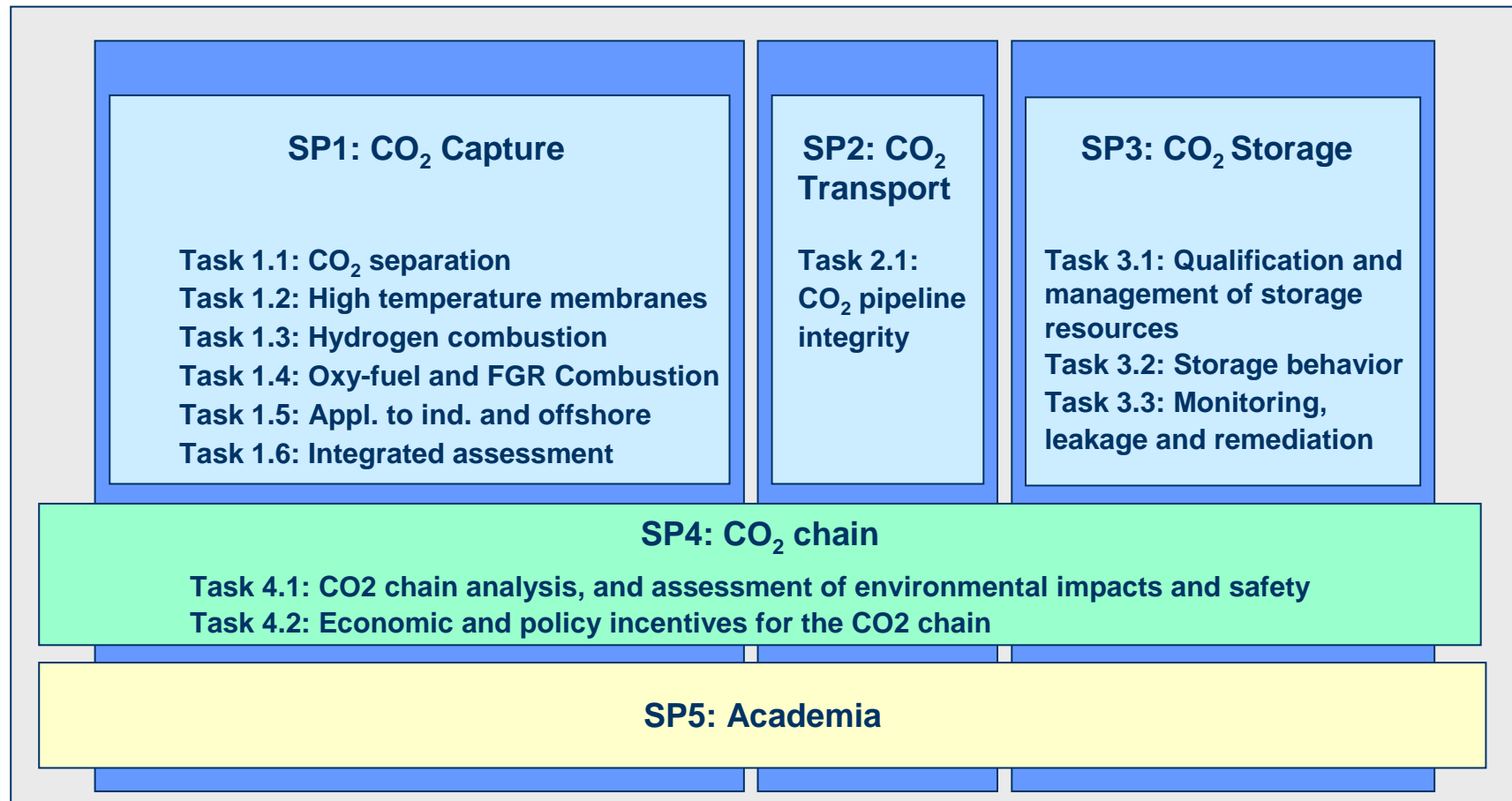
Safe CO₂ transport



Geological storage and EOR



BIGCCS Centre structure



BIGCCS Centre	Phase 1			Phase 2		Phase 3			Title - short
	2009	2010	2011	2012	2013	2014	2015	2016	
SP1 CO2 Capture									
Task 1.1 CO2 separation									
			PhD PhD						Absorption in precipitating systems, Prof. J-P Andreassen Dyn. mod. of the absorption process, Prof. M. Hillestad
Task 1.2 High temperature membranes									
			PhD PhD						Char. of mixed proton conducting materials, Prof. T. Norby (UiO) Membrane materials stability in relevant proc. cond., Prof. T. Grande
Task 1.3 Hydrogen combustion									
			PhD						Efficient chemistry implementation in hybrid combustion model, Prof. I. Gran Val. hybrid model against hydrogen flames, Prof. I. Gran/Dr. M.Ditaranto Prevention of flame stabilization at syngas fuel injectors, Prof. Th. Sattelmayer Prevention of flame stabilization at syngas fuel injectors, Prof. Th. Sattelmayer
			PhD		Post-doc				
Task 1									
Task 1									Gran
Task 1									M-B Hägg
Task 1									Jakobsen/O. Bolland
SP2 CO2 Transport									
Task 2.1 CO2 pipeline integrity									
			PhD						Thermo- and fluid dynamical modeling of CO2 decompression, Prof. I. Gran Modelling of fracture resistance in pipelines, Prof. C. Thaulow Coupled structural-fluid models for crack arrest, Prof. C.Thaulow/Dr. S.Munkejord
					PhD				
							Post-doc		
SP3 CO2 Storage									
Task 3.1 Q&M of storage resources									
			PhD						Numerical screening tool for analysis of fracture initiation, Prof. R.M. Holt
Task 3.2 Storage behaviour									
					PhD				Basic mechanisms for behaviour of CO2 in porous media, Prof. O. Torsæter CO2 displ. and storage in a water-saturated por. form., Prof. D. W-Berg/J. Kleppe Optimal design of CO2 injection operations (reservoir engineering), Prof. J. Kleppe
							PhD Post-doc		
Task 3.3 Monitoring, leakage and remediation									
			PhD PhD						Geophysical meth. for CO2 storage and early detection of leakage, Prof. M. Landrø Detailed imaging of gas chimneys and various leakage paths, Prof. B. Arntsen Advanced geophysical monitoring methods, Prof. M. Landrø Rock-physical properties for monitoring of CO2 in the subsurface, Prof. R.M. Holt Acoustic core measurements of two-phase flow of CO2 and water
								PhD Post-doc	
SP4 value chain									
Task 4.1 CO2 chain analysis									
								Post-doc	Calue chain analysis of CCS based energy systems, Prof. I.Gran/Dr. J.P. Jakobsen
Task 4.2 Economic and policy incentives									

Comprehensive PhD and Post Doc Programme

18 PhD's

8 Post Doc positions

BIGCCS Partners and Funding – 8 year programme ¹²

► Co-ordinator SINTEF Energy Research

► R&D providers

- SINTEF, NTNU
- CICERO
- University of Oslo
- Technische Universität München-TUM
- DLR (Deutsche Zentrum für Luft und Raumfahrt)
- British Geological Survey
- GEUS
- NGU
- RFF



NTNU



CICERO



GEUS



UNIVERSITY OF OSLO



► Funding

- 20 mill NOK/year – The Research Council of Norway
- 15 mill NOK/year – Industry
- 10 mill NOK/year – R&D providers



► Industrial consortium

- Aker Solutions
- Statkraft
- StatoilHydro
- SHELL
- ConocoPhillips
- TOTAL
- Gassco
- DNV



AkerSolutions™



Statkraft

StatoilHydro



ConocoPhillips



Labs

- ▶ Already secured approx 2M€ additional funding for strengthening key areas (combustion, membranes, storage)
- ▶ Will make use of new extensive lab infrastructure that is under construction – Tiller Labs – 5M€
- ▶ Extend to a Pan-European CCS Lab Infrastructure through the ECCSEL initiative (European CCS Labs) – 81M€
 - Key partners in Denmark, Germany, France and Netherlands
 - ECCSEL is lead by NTNU in co-operation with SINTEF
 - Will be operational by 2013
 - Open access for researchers to ECCSEL labs, defragment lab infrastructure
 - 81M€ envisaged investment, www.ntnu.no/eccsel

Tiller CCS Labs



International Orientation

- ▶ Through our partners
 - USA, Germany, Denmark, Uk, Switzerland, France
- ▶ By liasing with key CCS stakeholder bodies
 - GCCSI (Aus)
 - ZEP
- ▶ Open minded for extended international co-operation
- ▶ Use BIGCCS for spawning new projects on the international scene
- ▶ BIGCCS will seek to develop a designated international Sub project to make true our ambitions of international presence
- ▶ BIGCCS is open for new partners during the operation of the centre

Summary

- ▶ BIGCCS will contribute to **close critical knowledge gaps of the CO₂ chain**, and developing **novel technologies** in an **extensive collaborative research effort**.
- ▶ BIGCCS is among the largest CCS R&D centres on a global scale
- ▶ It covers the whole CO₂ value chain
- ▶ BIGCCS targets to be a global player in CCS issues
- ▶ We welcome more international co-operation actions and would like to liase with other major R&D programmes and industrial partners
- ▶ **BIG is beautiful**