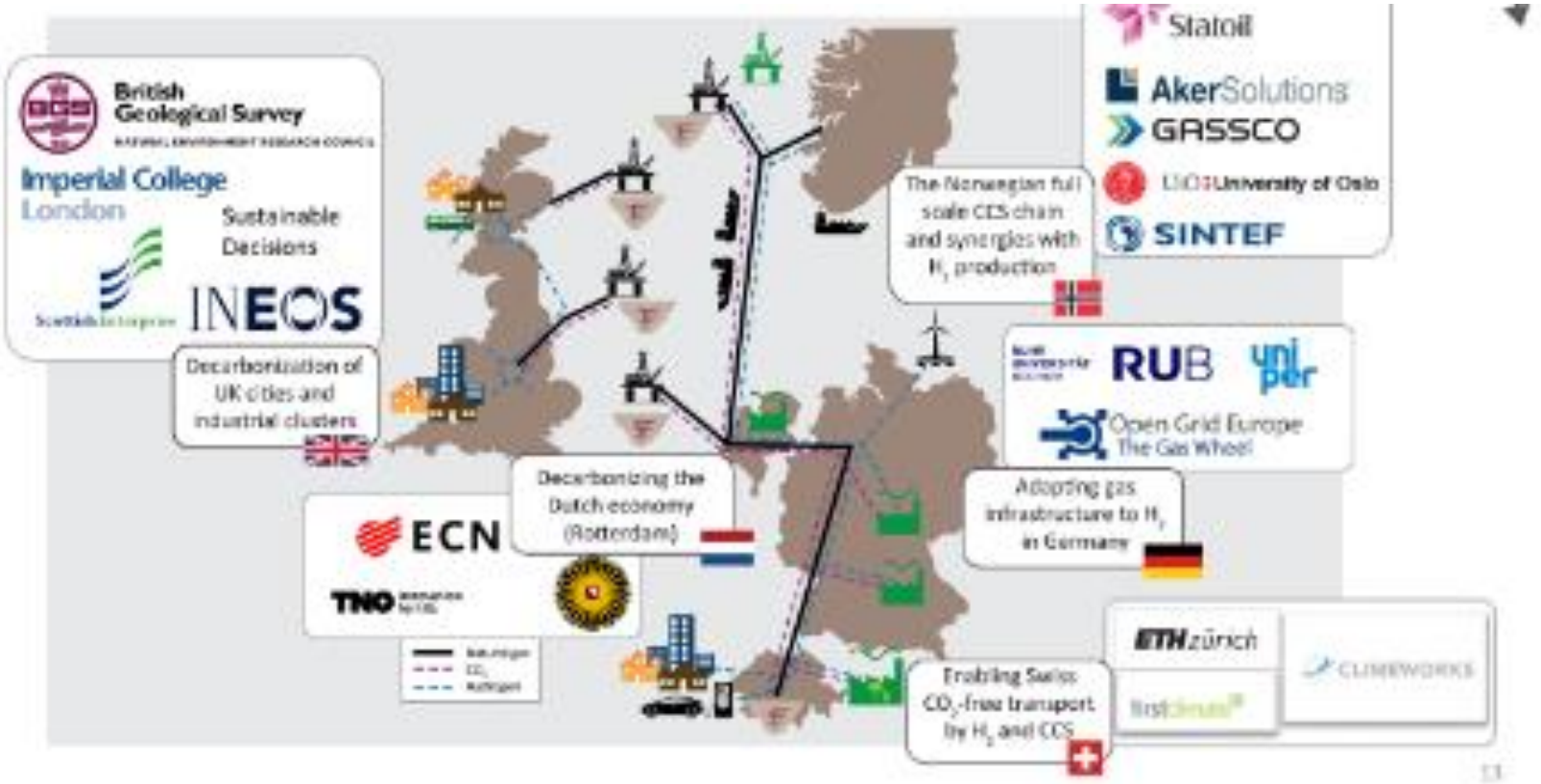
Hydrogen, Carbon Capture and Storage

Future proofing the fossil fuel sectors or an Achilles' heel?



Objectives of the course: to describe CCS, the role it is and could be playing in the energy transition. To illustrate how it could be an Achilles' heel for the fossil fuel sector. This course is to be as interactive as possible for the participants.

	Structure / hypotheses	Topics
1.	Introduction	a. CO2 emissions classification b. CO2 emissions by sector c. Netzero target setting d. Importance of CCS
2.	CCS – what it is	a. Carbon Capture (by emission sources) a. Fundamental approaches: pre- and post-combustion, oxyfuel, industrial processes b. Power plants (coal / NG combined cycle) c. Industrial sectors (cement, iron and steel, refineries – in particular blue hydrogen) b. Transport (pipelines, example: US CO2 pipeline infrastructure, compression, shipping) c. Carbon Storage a. CO2 / CCUS hazards. Safe CO2 operations b. Compression c. Subsurface sequestration (EOR, depleted reservoirs, saline aquifers, monitoring systems, risks) d. Storage capacity e. Other forms of sequestration (NL greenhouses, turquoise hydrogen)
3.	A brief history of CCS	a. How CCS emerged, when, trailblazers? b. Early pilot projects (Callide (AUS), Ciuden (ES), Schwarze Pumpe (D) c. Ramp up CCUS d. Impact of fluctuating CO2 pricing (crisis after 2011 and – recently – European rebound) e. Successful projects during the crisis (Boundary Dam, Petra Nova)
4.	CCS technologies	a. Overview of current technologies applied (how to remove the CO2 from process streams, solvents, amines) b. Evaluation of technologies: techno-commercial (including licensors) c. Modeling of subsurface aspects of CO2 d. Cost structure, learning curves: challenges and opportunities e. Operations and maintenance. For example: store monitoring systems. f. Future technology outlook: opportunities and challenges (include start-ups by TRL status)

5.	CCS business models	a. How CCS makes money (or not)? Subject to technology applied. CO2 pricing, negative emissions b. CCS clusters: Liverpool Bay, Net Zero Teesside, Net Minus Humber, Ravenna Hub (Italy), Northern Lights (Norway, FID'd), Acorn (UK), US (GoM, onshore) and Canada examples, Gorgon (AUS), Deep Purple (Nordic), Tomakomai (Hokkaido, Japan) c. Other supply chain requirements to make CCS happen d. Strategic partnerships focusing on CCS: overview, vision / objectives of each e. Thermal hydrogen
6.	CCS projects – overview and discussion, deep dives into case studies	a. Description / discussion of plants currently in operation b. Operations and maintenance, employment opportunities c. Plants and schemes under development / planning process (consenting, implementation, construction) d. Lessons learnt from plants / projects with x years of operation e. Project pipeline / future outlook
7.	Policy and regulatory perspectives – global initiatives and national nuances	a. the IPPC perspective b. United Nations perspective c. EU CCS directive d. National nuances: Canada, UK, US, Australia, Saudi Arabia (?), UAE (?), China, Japan, Korea
8.	Key stakeholder perspectives	a. Independent oil and gas companies. Discuss Shell, BP, Equinor, ENI b. National oil and gas companies. Discuss Aramco, Gazprom, Petronas. c. IEA d. NGO's and local community engagement (related to pilot projects, e.g. Barendrecht – Shell Netherlands, Kingsnorth) e. Investors f. Irena
9.	CCS and other paths in the energy transition (wind, solar, hydrogen etc.)	a. Synergies b. Clashes c. Dilemma's
10.	10 points to consider when investigating a CCS project	Issues to address (e.g. permitting, operational requirements, HSE)
11.	Summary, wrap up, final questions	