AFRY Carbon Capture and Storage Services

JANUARY 2022

Agenda

ABOUT AFRY

ÅF and Pöyry joined forces in 2019 under the new brand AFRY to become a leading international engineering, design and advisory company

The AFRY story

- ÅF was founded in 1895 and Pöyry in 1958
- In February 2019, ÅF and Pöyry merged to become an international engineering, design and advisory company which is listed on the stock market in Stockholm
- The new common brand AFRY was launched in November 2019
- Annual revenue in 2019: ~1.9 bnEUR (~20 bnSEK)
- 16,000 employees worldwide
- Locally present, globally connected: 50+ countries
- Projects in more than 100 countries
- Serving 25% of Fortune 500

AFRY divisions

Engineering & Solutions | Consulting

Energy	Infrastructure	Process Industries	Industrial & Digital Solutions	Management Consulting
– Networks – Renewable energies & hydro – Nuclear – Thermal generation – Desalination – Hydrogen	– Transport – Buildings – Water – Environment	– Chemistry – Stationery & packaging – Mining & metals – Biotechnology	– Advanced automation & IoT – Artificial intelligence – Software – Automotive R&D	– Market analysis – Strategic advice – Transaction services – Operational excellence

AFRY Global network consists of ~16,000 devoted experts with offices in ~50 countries within the fields of infrastructure, industry and energy

OFFICE NETWORK

Algeria
Armenia
Austria
Bangladesh
Brazil
Canada
Chile
China
Czech Republic
Denmark
Estonia
Faroe Islands
Finland
France
Georgia
Germany
Guinea
Hungary
India
Indonesia
Italy
Ivory Coast
Jordan
Kazakhstan
Saudi Arabia
Lithuania
Malaysia
Mexico
Myanmar
Nepal
Norway
Peru
Philippines
Poland
Russia
Rwanda
Senegal
Slovakia
Spain
Sweden
Switzerland
Thailand
Turkey
Ukraine
UAE
United Kingdom
United States
Uruguay
Uzbekistan
Vietnam

AFRY services in CCUS available from three divisions spanning a wide range of engineering and consulting disciplines

Energy

- Pre-feasibility / feasibility studies
- Engineering procurement and construction management services
- Detail engineering, delivery supervision
- Technical due diligence
- EIA procedure / Environmental licensing
- Project, site and commissioning management
- Owner's engineer services (OE)
- Measurement and testing services
- Operation/maintenance advisory services
- Studies of alternative fuel policies and of fuel supply and handling

Process Industries

- Technology assessment
- Technical expert and second opinion services
- Technical due diligences
- Project, Engineering and Construction management
- Procurement
- Project control incl. scheduling, cost control
- CO_2 and water footprint calculations
- Process safety consulting services
- Project deliveries
- Health and safety
- Environmental sustainability

Management Consulting

- Market entry & investment strategy
- Business model development
- Competitor analysis
- Financial modelling
- Commercial/ contractual support and tariff setting
- Technology assessment
- Future trends & technologies
- Scenario modelling and future foresight
- Market design and regulatory advice
- Commercial & regulatory due diligence
- Bid & transaction support
- Asset valuation

Why AFRY for Carbon Capture and Storage?

1

Detailed engineering and management consulting teams
AFRY Process Industry and Energy engineering experts work seamlessly with our management consulting team to deliver CCUS projects globally. Interdisciplinary teams have expert understanding of technology, policy, business models and economics

2

Strong track record in CCUS
>15 years of experience including designing one of world's first CO_2 capture test sites in Norway, techno-economic study of retro-fitting biomass with carbon capture to a coal pant in Oregon USA and macro-economic modelling of CCUS on UK and Middle East in 2021

3

Experienced team
AFRY team have combined CCUS experience of >100 years in engineering and consulting around CCUS – team experience includes regional CCUS strategy studies, CCUS project development, detailed design and engineering and techno-economic modelling

4

Global capabilities with a local team
From a Nordic base, AFRY's has a strong global present and an office network in >50 countries, with local engineering and consulting that covers Europe, Asia, North America and South America

Agenda

Economic consultancy: sample project reference timeline for CCUS shows extensive experience across major players in the energy/CCUS industry

2006	2007	2008	2009	2010	2012	2013
dti	OMV GAS dti	ieaghg SCCS nationalgrid	devon BG GROUP	North Sea Basin Task Force Committee on Climate Change	DEPARTMENT OF ENERGY & CLIMATE CHANGE THE CROWN ESTATE CCS	THE CROWN ESTATE Committee on Climate Change

2014	2015	2016	2017	2018	2020	2021
energy technologies institute	energy technologies institute Committee on Climate Change	GASSNOVA Committee on Climate Change	GASSNOVA TEES VALLEY COMBINED AUTHORITY	ervia	STATE OF OREGON 1859 nationalgrid ventures	CCSA OGCI OIL AND GAS CLIMATE INITIATIVE Silk Road Fund 丝路基金 ENEOS

AFRY ÅF PÖYRY

Technical / engineering CCUS consultancy project reference – a long history with projects rapidly increasing in last 2-3 years

2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013

VATTENFALL

VATTENFALL VATTENFALL

AFRY (prev. Pöyry) acquired Vattenfall internal power consulting team in May 2011

NORWEGIAN MINISTRY OF PETROLEUM AND ENERGY

Fortum Fortum

2014 | 2015 | 2017 | 2018 | 2019 | 2020 | 2021

NORCEM HEIDELBERGCEMENT Group

NORCEM HEIDELBERGCEMENT Group

NORCEM HEIDELBERGCEMENT Group

NORCEM HEIDELBERGCEMENT Group

NORCEM HEIDELBERGCEMENT Group

ÖRESUNDS KRAFT

ÖRESUNDS KRAFT

WESTENERGY

STATE OF OREGON 1859

Wentworth Clean Power

AFRY ÅF PÖYRY

AFRY selected CCUS Clients include a wide range of major global energy and industry players

Common themes in our economic CCUS work show broad themes across five key areas

AFRY CCS experience

Feasibility /concept studies

- OMV 2007
- BG Group 2008
- Devon Oil 2009
- Karachaganak, 2008
- Tees Valley Combined Authority 2017
- Swedish Pulp Mill
- Teesside EfW project 2020
- CCS / CO_2 Transport Options Review, 2021
- BECCS retrofit to a US coal power plant 2021

Detailed asset development support

- Technology Centre Mongstad (TCM) for Norwegian Ministry, 2007
- Meri Pori Coal Power Finland, FEED for large scale demo of CO_2 capture retrofit
- Norcem Cement (Heidleberg), 2017-2020
- Öresundskraft AB, 2020-2021
- Norcem Cement, 2021-
- Wentworth Clean Power, 2021 -
- Note that many AFRY detailed asset support assignments remain confidential

Business model development

- Scottish CCS Consortium 2008
- Energy Technology Institute 2015
- Committee on Climate Change 2010
- The Crown Estate 2013
- Committee on Climate Change 2016
- Gassnova 2016
- Tees Valley Combined Authority 2017
- Gassnova 2016, 2017
- Ervia 2018
- Confidential 2020
- OGCI 2021
- CCSA 2021

Cost reduction and Commercial DD

- Cost Reduction Task Force (DECC, TCE, CCSA) 2012
- Committee on Climate Change 2013
- The Crown Estate 2013
- Committee on Climate Change 2015
- Gassnova 2016
- CCSA macroeconomic impact of CCS in UK, 2021
- Silk Road Fund 2021/22
- OGCI 2021

Technology studies and scenario building

- IEAGHG 2008
- North Sea Basin Task Force 2010
- Committee on Climate Change 2010
- Energy Technologies Institute 2014
- Committee on Climate Change 2015
- OGCI 2021

Agenda

Technical and economic study for adding CCUS into a ~300MW biomass-fired district heating project in the Nordics

Project Metrics

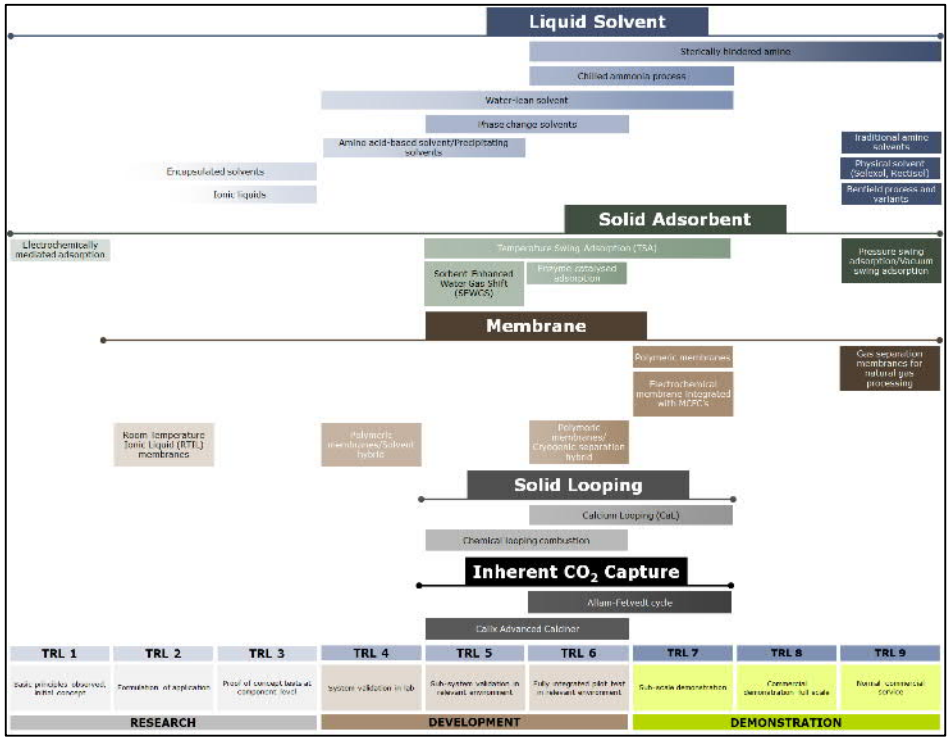
- AFRY Management Consulting, Helsinki, Stockholm, London, Oxford Offices
- 2022-

Client(s)

- Confidential Nordic utility company

Situation and Challenge

- Client was developing a major biomass-fired district heating project in the Nordics
- Interested in understanding the opportunity to include carbon capture in the project and the routes for the CO_2 use and storage



Service and Approach

- Techno-economic study for the inclusion of CCUS on the biomass-fired district energy project
- Detailed technical energy balance modelling of the plant under various technical routes
- Workshops with client to share understanding and assist in taking decision making on routes for CO2 capture, use and storage

Client Impact and Value Added

- Helping to increase team understanding and provide a model for CCUS understanding and decision making
- Assistance in strategic question on funding applications, risk and overall project timings

Technical and economic support for Energy from Waste (EfW) CCUS application to UK government CCUS cluster sequencing process

Project Metrics

- AFRY Management Consulting, Oxford, Horsham Offices
- 2021-2022

Client(s)

- Confidential EfW investor

Situation and Challenge

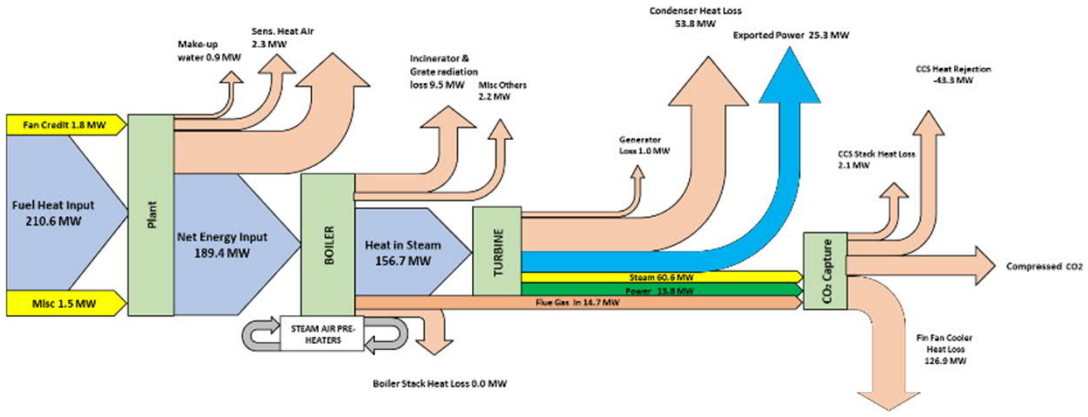
- Client had a requirement to submit a short-notice application to the UK government CCUS support mechanism
- As plant was currently under development required to parallel process the CCUS application with project development

Service and Approach

- AFRY provided direct application support for our Client, including drafting sections of the application forms, numerical inputs and technical reports
- Technical reports on post-combustion capture to be fitted to the EfW plant
- Review of global market for CCUS and innovative elements of project development
- Review of government scoring criteria and recommendations of additional actions

Client Impact and Value Added

- Delivered required inputs to allow client to submit major funding application to the UK government in a highly compressed timescale



CCUS Strategy and Roadmap development for Middle East including engagement with major National Oil Companies and governments

Project Metrics

- AFRY Management Consulting, Oxford, London, Dubai offices
- Gaffney Cline as subsurface sub-consultants
- 2021-2022

Client(s)

- Oil and Gas Climate Initiative (OGCI)

Service and Approach

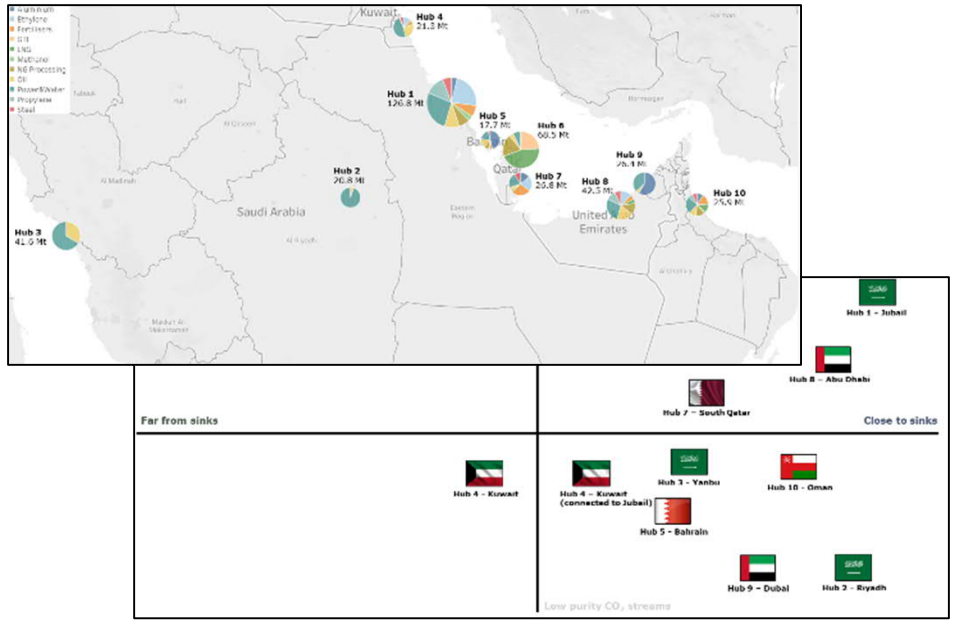
- Market opportunity workstreams delivering insight into CO_2 emission sources and sub-surface storage
- Analysis of routes to progress CCUS in the GCC through clustering, business model development and cost reduction
- A deep dive into the macroeconomic impacts of CCUS and the opportunities in hydrogen and negative emissions

Client Impact and Value Added

- Delivery of major technical report to input into the larger CCUS work programme of the OGCI
- Workshops and major engagement programme with key regional stakeholders
- Helped to galvanise range of GCC stakeholders on the opportunity for GCC CUS

Situation and Challenge

- Client required a thorough and broad analysis of the challenges and opportunity for CCUS in the Gulf Cooperation Council (GCC) countries



UK economic benefits of CCUS development scenarios, business case modelling and policy gap analysis for input into government spending review

Project Metrics

- AFRY Management Consulting, Oxford Office
- 2021

Client(s)

- Carbon Capture and Storage Association (UK)

Situation and Challenge

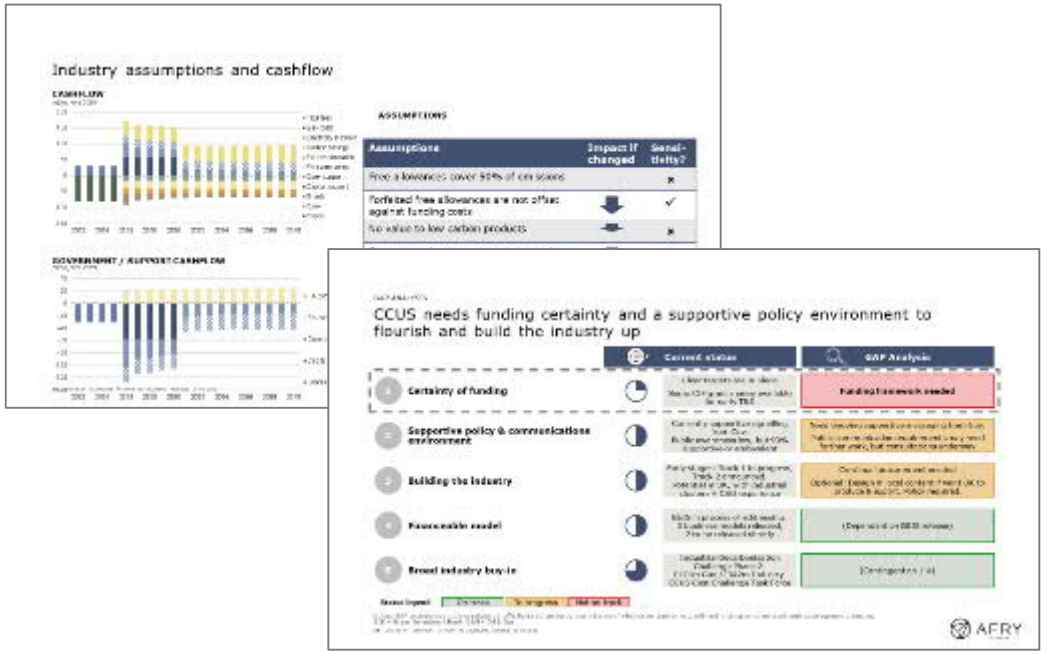
- UK Government had committed to supporting CCUS but the scale was highly unclear
- Business models and competition planning were being rolled out "just-in-time"

Service and Approach

- Analysed the economic impacts to the UK of two CCUS scenarios, in line with announced government ambition and the Climate Change Committee recommendations
- Assessed required funding in line with latest and expected business models and costs
- Performed a gap analysis against measures taken to support offshore wind to highlight some of the missing steps needed to support CCUS.
- Public report issued to publicise results

Client Impact and Value Added

- Public report used for messaging by the client to support their push for a funding framework
- Direct presentations to Treasury, ministers and the department for Business, Energy and Industrial Strategy to communicate the results to government



Comparison of alternative business models for developing a national transport and storage network

Project Metrics

- AFRY Management Consulting, Oxford Office
- 2019-2020

Client(s)

- Confidential

Situation and Challenge

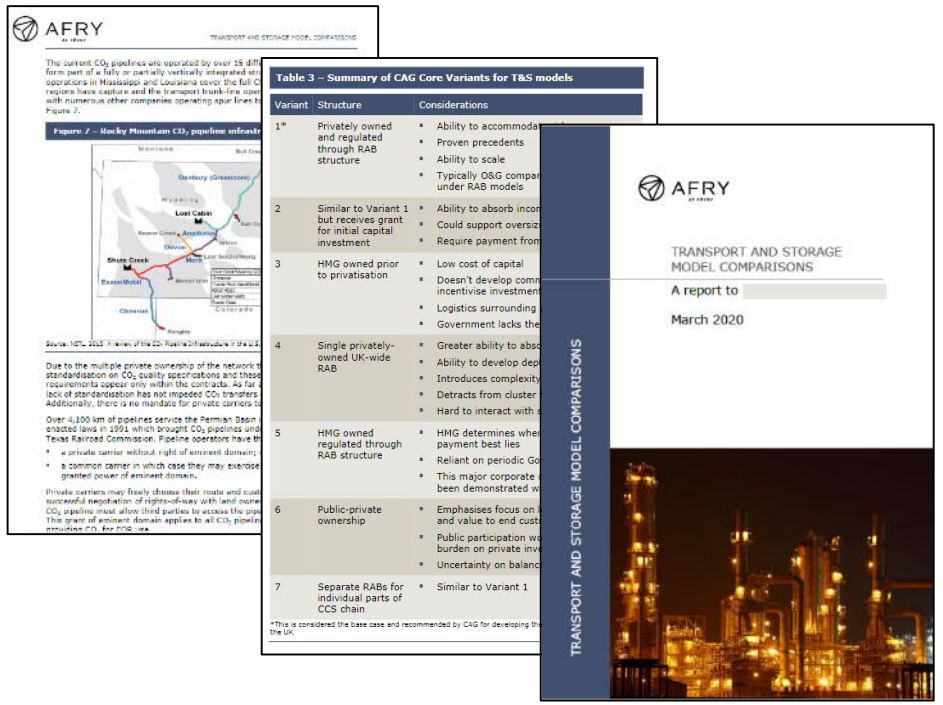
- Broad acceptance that a new support model will be required to bring forward CO2 T&S in Country A, but questions remain as to what the ideal model should look like
- Client was already involved in T&S and was looking for a review of the benefits of different model options

Service and Approach

- Analysed the current business model in country A and alternatives that had been considered previously
- Comparison of Country A approach to that used in other countries for CO2 transport and to other industries such as water and heat
- Provided detailed independent arguments for the advantages and disadvantages of certain models
- Made strategic recommendations as to a route forward

Client Impact and Value Added

- Supported client in creating a position for advocacy purposes on the future preferred business model and avoiding the need for a large public consultation
- Presentations of report and conclusions to disseminate report findings in organisation



Major multi-client study considering the challenges and technology options for fully decarbonising Europe's energy system by 2050

Project Metrics

- AFRY Management Consulting, Oxford, London, and Oslo Offices
- 2017 – 2018

Client(s)

- Major Europen utilities, Network companies, Upstream and midstream companies, and Government ministries

Situation and Challenge

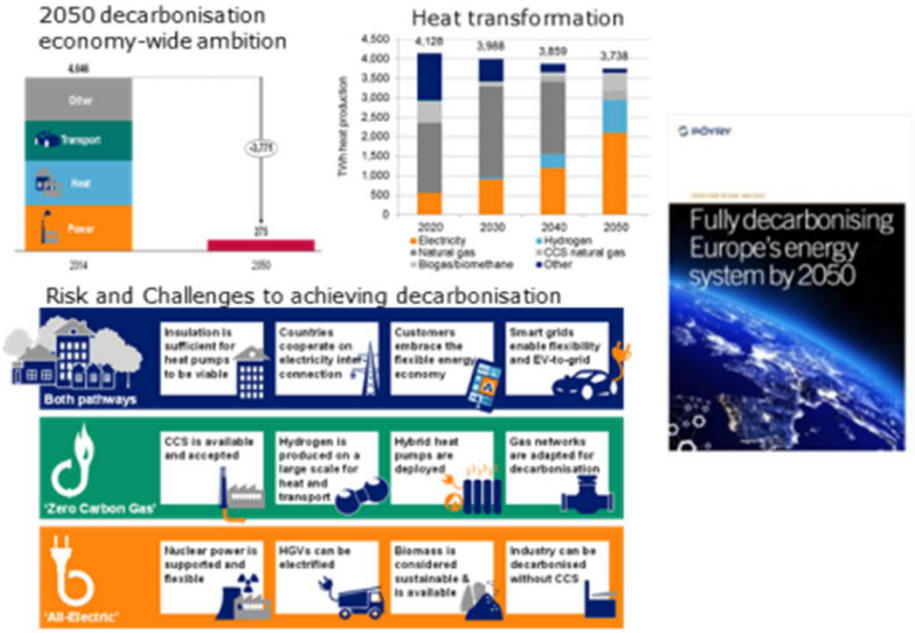
- Paris Agreement ambitions for a 1.5°C temperature limit means Europe will be decarbonising the whole economy by 95%
- Energy (power, heat & transport) will be fully decarbonised
- Many expect that decarbonisation will be achieved via electrification – what is the impact of excluding zero-carbon gas (e.g. biomethane, CCS, hydrogen)

Service and Approach

- Created two alternative pathways:
  - 'Zero Carbon Gas': where biomethane, hydrogen and CCS are allowed to compete as part of the solution on an economic basis
  - 'All-Electric': where only electrification of all transport and heat and new nuclear and biomass are required
- Afry extended its modelling suite to include the heat and transport sectors

Client Impact and Value Added

- Flexible demand from electric vehicles and heat balances intermittent supply, challenging future batteries and power-to-gas technologies
- Utilising Zero Carbon Gas as part of the energy mix could save €1,150bn by 2050 compared to an 'All-Electric' world, especially in transforming heat
- Policy recommendations of keeping all options open critical to managing the risk
- Publicly available article



Development of a business model for the Teesside CCS cluster and CBA for a European Union PCI submission

Project Metrics

- AFRY Management Consulting, Oxford Office
- 2017

Client

- Teesside Collective

Situation and Challenge

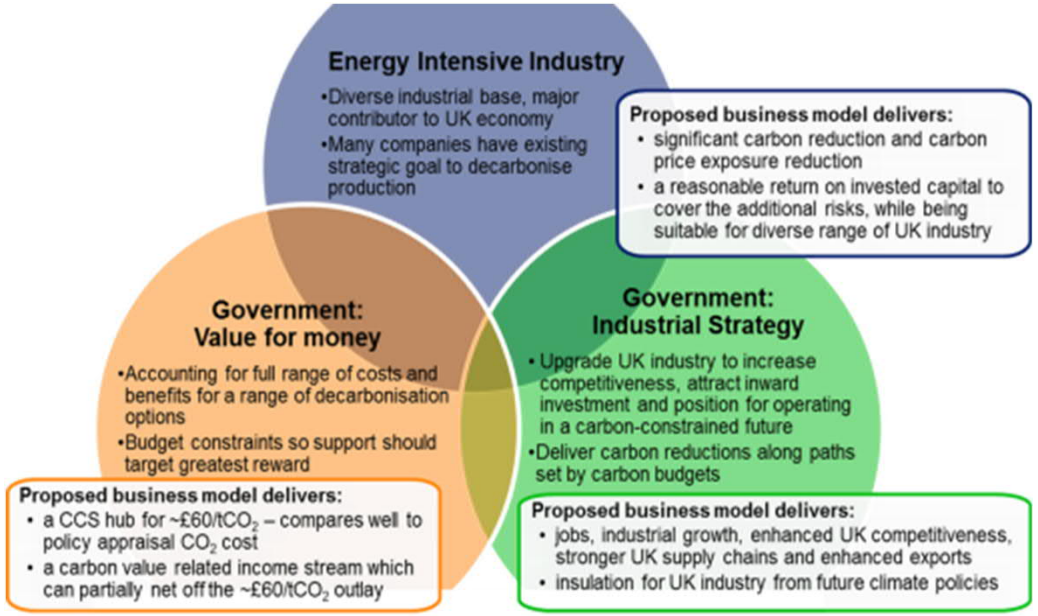
- Many industry sectors involved in collective with fundamentally different views on energy, carbon and investments
- Creating a report that achieved a consensus combined with a meaningful movement forward of the dialogue on industrial CCS

Service and Approach

- We were appointed to develop an industrial business model to present to government in early 2017, with consultation with disparate Teesside industries
- Discussed requirements for a UK funding model with industry, BEIS and Treasury
- Designed a business model structure with negotiable parameters to satisfy three distinct viewpoints
- Economic cost modelling to understand the cashflows for business model variations and cost @ Tessside
- Discussed allocation methods to synchronise timing and balance first project risks

Client Impact and Value Added

- Co-branded report launched in London (and available online) as part of the push for supporting industrial CCS
- Key elements of market mechanism adopted into the UK government support mechanism for industrial CCUS
- We subsequently supported Teesside in their successful Project of Common Interest application



TEESSIDE CO2 LLECTIVE
A NEW INDUSTRIAL FUTURE FOR THE UK

AFRY
ÅF PÖYRY

Four projects for the UK Committee on Climate Change, two each in 2015 and 2016, to make recommendations for CCS in the fifth carbon budget

Project Metrics

- AFRY Management Consulting, Oxford Office
- 2015, 2016

Client

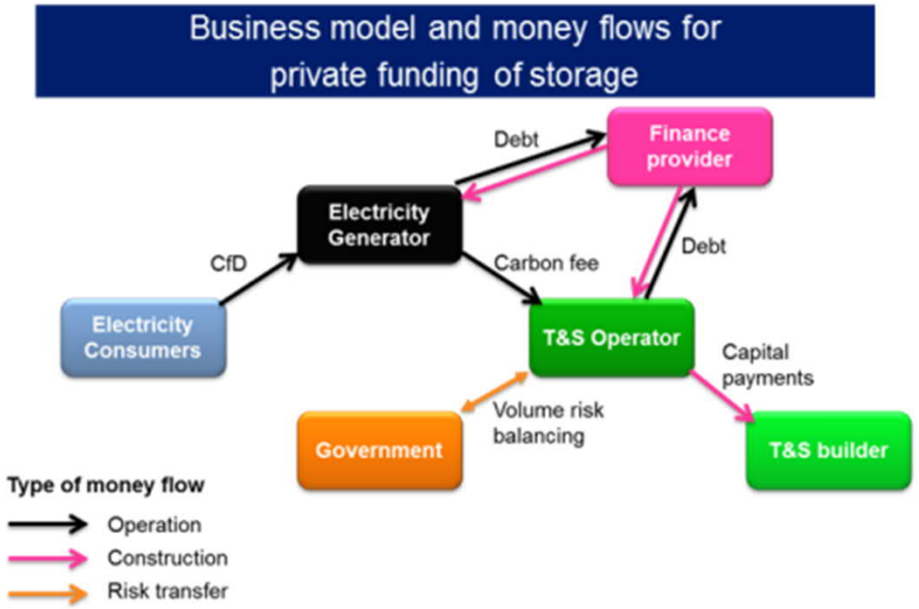
- Committee on Climate Change

Situation and Challenge

- Engaged to assist with recommendations for fifth carbon budget
- Engaged to provide a short report exploring the options for commercialising CCS in the UK
- Explored mechanisms and drivers for cost reductions following the competition projects
- Explored impact of alternative deployment options

Service and Approach

- Assisted the CCC in developing a CCS strategy after the failure of the competition
- Liaised with a steering group of experts from industry and academia
- Explored key steps to get CCS back on track, as well as possible new funding and risk sharing models
- Led to public report and a letter from CCC to the Energy Minister



Client Impact and Value Added

- Our work fed into the Committee's recommendations in the fifth carbon budget period
- Our final report was published by the Committee on Climate Change.

Examination of CCS development pathways in the UK beyond initial demonstration for the Energy Technologies Institute

Project Metrics

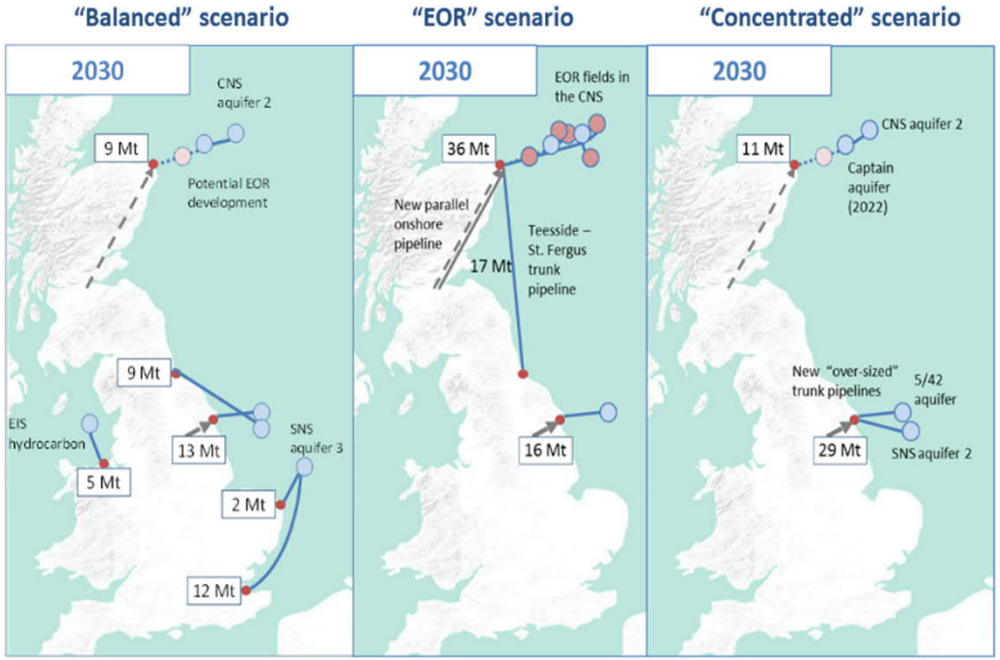
- AFRY Management Consulting Oxford, London offices Office
- Jul – Nov 2014

Client

- Energy Technologies Institute

Situation and Challenge

- Following the work of the UK CCS Cost Reduction Task Force the industry and government required an understanding of potential development pathways beyond the planned demonstration projects
- Pathways required to build expectations and plans around 7 UK capture hubs



Service and Approach

- AFRY in partnership with Element Energy, created a suite of CCS development pathways for the UK to understand key cost drivers in the rolling out of the transportation and storage infrastructure towards 2030 goals with some consideration of post 2030 continuation.
- The work also created a tangible expectation of possible geographic, infrastructural and technical development paths.

Client Impact and Value Added

- Report helped ETI to articulate potential futures for CCUS in the UK
- Report used to provide policymakers with the information necessary to consider policy beyond the initial two CCS demonstration projects
- Helped to broaden the thinking of industry stakeholders.

We led a large stakeholder group in 2012 for The Crown Estate, DECC & CCSA to examine possible cost reduction pathways for CCS

Project Metrics

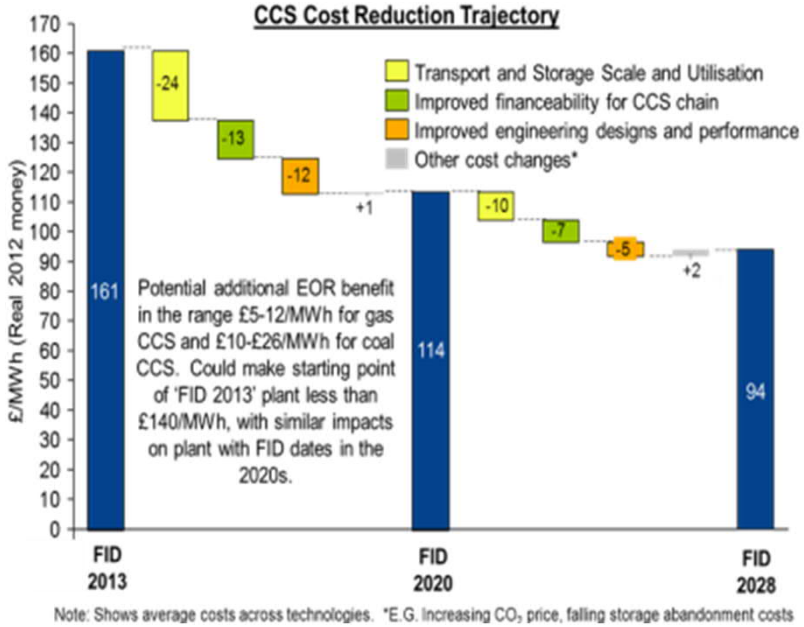
- AFRY Management Consulting, Oxford Office
- 2012

Client

- Department of Energy and Climate Change
- The Crown Estate
- The CCSA

Situation and Challenge

- AFRY was engaged by the Department of Energy and Climate Change, The Crown Estate, and the CCSA to drive the work of the CCS Cost Reduction Task Force.
- Many organisations from quite different industry sectors are involved and have fundamentally different views on energy
- Achieving a balance between robust analysis and detail, with the need to communicate to a lay audience



Service and Approach

- We brought together the views, opinions and analysis of almost thirty international industry stakeholders
- Developed a major report which objectively assessed cost reduction opportunities for CCS and made recommendations for actions to realise those reductions

Client Impact and Value Added

- The final report was presented to the Secretary of State and has been widely adopted by the industry as a robust view of the outlook for the economics of CCS in the UK and elsewhere.

Major report to examine deployment barriers and options to incentivise UK CO_2 transport and storage for The Crown Estate

Project Metrics

- AFRY Management Consulting, Oxford Office
- 2012, 2013

Client

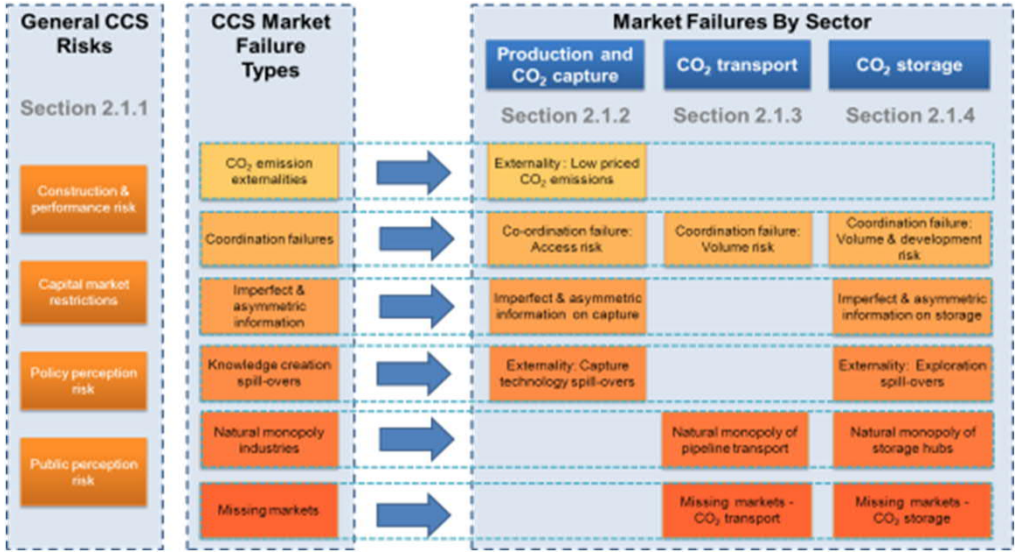
- The Crown Estate

Situation and Challenge

- Engaged (2012-13) to deliver extensive research and economic modelling on options for incentivising transport and storage elements of the CCS chain

Service and Approach

- Deep analysis of barriers and market failures to the development of CCS
- Investigated business model solutions and the potential value available
- Created a clear reference system for each element of cost reduction, including a model which reflects the underlying drivers of cost



Client Impact and Value Added

- Report to investigate barriers and market inertia to the development of Carbon Dioxide Transport and Storage (CTS) infrastructure, to recommend business model solutions and fully understand the potential value that such actions can realise.

Norcem Brevik: Full-scale carbon capture project development study on Norwegian cement CCUS project providing a wide range of engineering services

CLIENT: Norcem AS/ HeidelbergCement

DATES: 2017-2020

DESCRIPTION:
The Norwegian government has the ambition to develop a full-scale CCS value chain in Norway by 2024. The full-scale project includes capture of CO_2 from industrial sources at Norcem cement plant in Brevik and from the waste-to-energy plant in Oslo. Liquid CO_2 will be shipped from the industrial sites to an onshore terminal and then transported in pipeline to an offshore storage location subsea in the North Sea, for permanent storage. Equinor, Total and Shell are responsible for the transport and infrastructure project as part of the “Northern Light” project.

The project is owned and financed by the Norwegian Petroleum and Energy Department (OED) and governed by Gassnova; the national body accelerating the development of CCS in Norway.

AFRY ROLE:
AFRY has been an integral part of Norcem's project management in both the concept and FEED study. The project is matured to a AACE Class 3 estimate, decision basis for realization decision by the Authorities by the end of 2020. With positive investment decision, the CCS value chain will be completed by spring 2024.

Capture technology: Aker Carbon Capture amine-based CO2-capture technology

AFRY SCOPE: CONCEPT STUDY

Project Management, Project Management, Planning, Cost Estimation, Risk Management, Interface Coordination, Quality Management, Document Control, HSE and technical safety. Contract sum concept study: MNOK 5, Period: 2017

AFRY SCOPE: FEED STUDY

Design Management, Quality and Risk Management, Planning, Interface coordination, Document control, HSE and technical security, Contract and Implementation Strategy, CO2 Footprint (LCA/ LCC), Profit Realization, Technology Qualification, Lessons Learned, Cost Estimation. Contract sum preliminary study: 11 MNOK, Period: 2018-2019.

AFRY SCOPE: INTERIM PHASE (

Detail engineering and contract preparations for execution phase. Site preparations.
Period: 2019-2020

Norcem Brevik: Full-scale carbon capture project management for Norwegian cement CCUS project and wide-ranging delivery assistance

CLIENT: Norcem AS/ HeidelbergCement

DATES: 2021 - ongoing

DESCRIPTION:

The Government has decided to support the realization of a Norwegian full-scale CCS project that comprises capture of 400kt CO2 from the cement plant at Norcem in Brevik, and transport and storage of liquid CO_2 to the Northern Lights storage site. The full-scale CCS project is named ‘Langskip’, in English 'Longship’.

Longship will demonstrate that carbon capture and storage is safe and feasible, and it will facilitate learning and cost reductions for subsequent projects. It establishes an infrastructure with surplus capacity that other projects can use. Hence, the threshold for establishing new carbon capture projects will be lowered. Longship can also facilitate business development through preserving, restructuring, and creating new industry and business activities in Norway.

The total project costs are estimated at NOK 25.1 billion. This includes both the investment and ten years of operation. The state’s part of these costs are estimated at NOK 16.8 billion, which means that the state expects to cover approximately two-thirds of the project’s cost.

AFRY ROLE:

AFRY has a framework agreement with Norcem (2021-2024) to deliver the 400,000t capture site. The framework includes on Project Management/ Project Engineering Management, Planning, Document Handling and Project Assistance.

Study on BECCS (Bio-Energy with Carbon Capture and Storage) Installation at a Swedish Pulp Mill

Client	Confidential, Sweden
Plant description	Pulp and Paper
Project	Study regarding Bio-Energy with Carbon Capture and Storage Installation
Handprint target	Annual Capture of 700 kton/y

Client Need

— BECCS has been identified at EU level and by the Swedish Government as an efficient method for reducing CO_2 into the atmosphere and there are suggested plans for governmental support of such systems at the most CO_2 emitting sources in Sweden.

— The client wants to study the feasibility of a BECCS installation at their mill in Sweden for transport of liquefied CO_2 to Norway or elsewhere for storage.

Objective and Approach

— Identify available and suitable techniques for CO_2 capture.
— Identify mill consequences due to CO_2 capture, need of additional heat capacity, cooling water requirement etc.
— Preparation of a budgetary investment cost estimate.

AFRY's role in the project

— Project management
— Technical process concept
— Determination of mill balances
— Preparation of cost estimates
— Permit overview
— Time schedule for implementation

Pre-feasibility study on BECCS retrofit to existing large coal power plant

Client	Confidential, USA
Plant description	Coal fired
Project	Study regarding Bio-Energy with Carbon Capture and Storage Installation
Handprint target	Annual Capture of 3.8 Mton/y
Dates	2020-2021

Client's Objectives

- The most feasible pathways that could enable coal to biomass conversions of an existing coal power plant to achieve the lowest power generation cost.
- Potential to retrofit CCS for existing coal plant after biomass conversion.
- Required CAPEX and OPEX costs to implement CCS post coal to biomass conversion.

Study Approach

- Identify available and suitable techniques for CO_2 capture and potential CO_2 storage site.
- Produce a preliminary thermal model using Thermoflex software to generate overall heat and mass balance in order to assess the impact on the power plant performance.
- Estimate heat and power requirements for the CCS.
- Estimate CAPEX, OPEX and footprint requirements for CCS.
- Desktop review of potential CO_2 storage sites close to power plant.
- Study technical feasibility of transporting captured CO_2 to the potential storage site.

AFRY's role in the project

- Technical process concept
- Determination of heat and mass balances
- Preparation of cost estimates
- Time schedule for implementation

Carbon capture study for an energy from waste project at Teesside

Client	Wentworth Clean Power Ltd, Teesside, UK
Plant description	Energy from waste
Project	300 kton/y EfW project
CO_2 capture	Annual capture rate of 300 kton/y
Dates:	2020-2021

Client's Objectives

— Potential to retrofit CCS in the future to the proposed EfW plant at Teesside.

Study Approach

— Identify available and suitable techniques for CO_2 capture.
— Produce a preliminary thermal model using Thermoflex software to generate overall heat and mass balance in order to assess the impact on the power plant performance.
— Estimate heat and power requirements for the CCS.
— Estimate CAPEX, OPEX and footprint requirements for CCS.

AFRY's role in the project

— Technical process concept
— Determination of heat and mass balances
— Preparation of cost estimates

Post Combustion capture for Waste to Energy – A techno economic study

Client	Westenergy, Finland
Plant description	Waste to Energy – 200,000 ton/y
Project	Techno-Economic assessment of four Carbon Capture technologies
Handprint target	Annual Capture of 210 kton/y
Dates	2020

Client Need

— Assessing the impact in power and heat sales.

— Understanding of the technologies, their features, risks and matureness.

Objective and Approach

— Power Plant model developed created in Thermoflex.
— Simulation of generalized capture models for each technology and assessment of plant impact.
— Budget enquires to process licensors and generation of models with their KPI´s (Key Performance Indicators).
— CAPEX and OPEX estimates and levelized cost of capture.
— Preparation of evaluation model to rank the technologies.

AFRY's role in the project

— Project management
— Technical process concepts and simulations
— Power Plant balances with and without Capture
— Preparation of cost estimates – Levelized cost of Capture
— Evaluation Criteria

Post Combustion Capture technical Review

Client	Fortum, Finland
Plant description	Meri Pori Coal Fired Power Plant
Project	FEED FOR EU large scale demonstration retrofit CO2 capture
Handprint target	565 MW Annual 2.5 MT/y CO2

Client Need:

- An expert evaluation of 5 FEED tender proposals with different capture processes based on post-combustion capture.
- Evaluation of offered engineering services and project execution approach.
- Process evaluation from the offers.

AFRY's role in the project

- Process evaluation for Post-Combustion Capture technologies from the FEED tenders.
- The process review was focused mainly in
  - the heat and mass balances,
  - main equipment sizing,
  - Guarantees given by the licensors,
  - Plant availability,
  - Impact on current Plant performance,
  - Chemicals consumption,
  - Guaranteed emissions and,
  - Cycle modifications.

Agenda

Senior expert in North American and European energy markets specialised in asset valuation, market fundamentals and CCUS economics

Stuart Murray
Senior Principal
New York, US / London, UK
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AFRY Management Consulting

>15 years of consulting experience, specialising in energy market modelling and energy asset valuation – advising on >$40bn of renewable and conventional power asset transactions across North America, Europe and Asia. Clients range from major international utilities and financial institutions, to government departments including the Prime Minister's Office in the UK.

EDUCATION AND SPECIALITY

- From 2017-21 held responsibility for continued development of AFRY energy management consulting services in North America
- Specialist in electricity market modelling for renewable and thermal generation asset valuation.
- Recognised expert in CCS economics presenting papers at conferences and seminars in Europe and N America 2008-20
- 1st Class Honours BSc. in Economics, University College London and Executive Certificate in Business Strategy from Cornell SC Johnson College of Business
- Languages: English

SELECTED PROJECT REFERENCES

- Supporting lenders and investors from concept and market entry through to financial close for numerous project-financed thermal and renewable asset transactions and DD processes from 2006-2021
- Subject Matter Expert on CCS business models for 2021 strategic study on Middle East CCS for the Oil and Gas Climate Initiative
- Project supervisor for 2021 support for the UK Carbon Capture and Storage Association examining the economic benefits of a faster CCS roll-out on the UK economy, in consultation with the CCS industry and UK government departments;
- Project manager for 2017 industrial CCS work for Tees Valley CCS including funding model design, stakeholder (capture project) engagement and PCI application support
- Project supervisor for 2017 business model design support for Gassnova in the 2nd phase CCS project roll-out of the Northern Lights / Longship project
- Project manager for the modelling of CCS development pathways for the UK Committee on Climate Change and the ETI in projects from 2014-2016.
- Project manager for UK CCS Cost Reduction Task Force in 2012/13 – UK government sponsored cross CCS industry group including workshops, facilitation, cost modelling and lead report writer.
- 2008 Scottish CCS study examining the possible roll-out scenarios and costs for the expansion of CCS at various capture and storage sites across Scotland
- Work with a major international oil company on a concept study for developing a CCS project with EOR at a large Central Asian gas condensate field

Dr John Kelly, Senior Consultant in Hydrogen and CCUS with extensive experience in technology analysis and development of industrial decarbonization projects

Dr. John Kelly

Senior Consultant – Hydrogen and CCS

Oxford, UK

john.kelly@afry.com

AFRY Management Consulting,

John Kelly joined AFRY in 2021, and has over 15 years of energy industry experience. His main areas of work have been development of the hydrogen economy, technical due diligence, strategy, Carbon Capture Utilisation and Storage, and Capital Projects. His main role is to assist in the development of our hydrogen advisory services, with a particular focus on the UK. Before joining AFRY, John worked for IPA on large capital projects globally, and in upstream oil and gas for both Shell and Sasol.

EDUCATION AND SPECIALITY

- MBA Energy Leadership, Texas A&M University
- PhD Geoscience, University of Birmingham
- MSci. Geology and Astrophysics, Keele University
- Specialising in:
  - Hydrogen and decarbonisation
  - CCUS
  - Project Analysis
  - Strategy advisory
  - Competitive Intelligence
  - Due Diligence

- Languages: English (Fluent)

SELECTED PROJECT REFERENCES

- Project Manager for major study on defining a strategy for developing CCUS in the Middle East for a club of major global oil firms
- Subject matter expert for CCS technology evolution as part of a major buy-side DD transaction in the Middle East
- Analysis of pre-FEED project readiness for a CCUS and Blue Hydrogen project in the UK
- Managed several projects involving blue and green hydrogen as well as standalone CCUS in the Middle East and Europe
- Evaluation of a hydrogen for transport project in Germany
- Technical assessment of CCUS storage locations in the UK and Norway
- Hydrogen from natural gas pathway for a project in South Africa
- Assessment of decarbonization projects in Russia, identifying potential pathways and potential project partners
- Analysis of decarbonization options for upstream oil and gas projects in the North Sea
- Decarbonization pathway and strategy for a city in Texas, USA, identifying infrastructure opportunities and no-regret investments for local industry
- Assessment of methane reformation technologies for a UK participant in an industrial cluster
- Technical due diligence on a range of upstream projects and Enhanced Oil Recovery projects utilizing carbon dioxide

Expert in market modelling, asset valuation and market analysis including techno-economic analysis of CCUS and renewable technologies

Lara Tarasewicz
Senior Consultant
Oxford, United Kingdom
lara.tarasewicz@afry.com
AFRY Management Consulting

Lara has been with AFRY for 5 years where she has specialised in electricity market modelling and market analysis. She works across a range of specialisms and countries to conduct analysis, including carbon capture and storage, hydrogen, commercial due diligence and valuation of assets.

EDUCATION AND SPECIALITY

- MA in Natural Sciences, Geology, from the University of Cambridge.
- MSc in Sustainable Energy Futures at Imperial College London (thesis on hurdles to energy efficiency retrofits in commercial buildings, including stakeholder interviews and cost-benefit analysis).
- Languages: English (native), German (advanced), French (proficient)
- Specialities: Energy market analysis and electricity market modelling; scenario development; offshore wind market advisory; economics of renewable and other low carbon technologies; commercial due diligence.

SELECTED PROJECT REFERENCES

- Subject Matter Expert for CCUS policy gap analysis for a project UK Carbon Capture and Storage Association examining the economic benefits of a faster CCS roll-out on the UK economy, in consultation with the CCS industry and UK government departments;
- Developed report and workshop as part of CCUS knowledge building for Ervia
- Supported the CCS Project of Common Interest application by the Teesside Collective through the development of a cost-benefit analysis.
- Advisory work for Dutch offshore wind tender submissions over several auctions by various (confidential) clients, including sensitivity quantitative analysis.
- Evaluation of offshore wind business case for the Dutch Ministry of Economic Affairs and Climate Policy. Lead Modeller, working closely with the Ministry and steering committee. Set up modelling and ran several sensitivities to provide quantitative basis for analysis to determine whether systematic changes will be required to ensure the business case for merchant offshore wind is viable in the long term.
- Solar due diligence work for (undisclosed) M&A transactions.
- Onshore wind assessment of the market in the Netherlands.
- PM for AFRY's Independent Market (AIM) report for the Netherlands.
- CCGT (gas-fired plant) asset modelling to understand gross margins across day ahead and ancillary service markets to feed into decision whether to come out of mothball and timeline.
- Due Diligence project associated with commodity imports to the Port of Rotterdam to determine red flag analysis.

AFRY CCUS EXPERTS

Senior expert and AFRY Associate in energy market analysis, decarbonisation and carbon capture and storage

Dr. Phil Hare

Senior Associate

Oxford, UK office

phil.hare@afry.com

AFRY Management Consulting

Phil Hare is a Senior Associate of AFRY and was until recently a Director at AFRY Management Consulting and the head of it's Energy Market Analysis Global Consulting Practice. He joined AFRY in 2004 and has over thirty years' experience in the energy industry

EDUCATION AND SPECIALITY

— Phil is the Deputy Chairman of the Balancing & Settlement Code Panel, the industry body that governs the UK's electricity market arrangements.
— He was a member of Lord Oxburgh's CCS Parliamentary Advisory Group which was formed to advise the UK Government on its policy following cancellation of the CCS Demonstration Competition –its findings were launched in September 2016.
— Phil has a BA (Hons) and Doctorate from Oxford University

SELECTED PROJECT REFERENCES

— Senior industry figure serving as an adviser to companies at board level on strategy, decarbonisation and technical market operations

— He led AFRY's market analysis & market design global consultancy practice and also led the company's Carbon Capture and Storage practice

— He has worked on CCUS projects for ~20 years advising private companies, regulators and Government departments

— He has submitted evidence and spoken at government committees on energy matters, as well as authoring influential reports

Expert in process engineering in power and industry including technical lead on a range of CCS techo-economic studies

Alejandro Nocito
Principal Engineer
Finland
alejandro.nocito@afry.com
AFRY Energy Division, Finland

Alejandro Nocito (M.Sc., Chemical Engineering) joined AFRY in 2007 with over 25 years of experience in the power and industrial sectors. He has worked project phases such as feasibility, conceptual, FEED and detail engineering. He has also carried out owners engineering, contractor supervision, site work during construction commissioning and start-up of CCGT plants, BoP, water treatment and pipelines.

EDUCATION AND SPECIALITY

- M.Sc. degree in Chemical Engineering from Buenos Aires Engineering University (1990)
- Master degree in Energy and Environmental Economics at Enrico Mattei Institute, Milan, Italy (1993-1994)
- Languages: Spanish (native), Italian (fluent), English (fluent), Portuguese (limited working proficiency), Finnish (elementary), French (elementary)
- Specialities: Power and CHP plants, upstream and downstream O&G, boilers, flue gas treatment, bio fuels (torrefied & steam exploded pellets, bio ethanol plants), CCS and large district cooling plants

SELECTED PROJECT REFERENCES

- Technical lead, carbon capture techno-economic feasibility study (2020) – Study and simulation of 4 different post combustion options for a WtE plant in Western Finland. Activities performed: Budget inquiries for FEED packages and technology review. Modelling for process integration of the plant with the capture facility
- Carbon capture expert, carbon capture implementation study (2020) Responsible for Carbon Capture simulations with Post combustion technology. Basic Cost and plot area estimates. Activities performed: Simulations and review of current technical options for Post Combustion Capture, Carbon Capture applied to Recovery Boiler flue gas
- Senior Consultant, Meri Pori CCS (2008) – Two studies: Pre-feasibility study of CO2 transport, intermediate storage and final injection and storage in Northern European countries. Post combustion proposals and technology evaluation for a full scale demonstration project (FEED)Carbon capture Post combustion proposals and technology evaluation for a full scale demonstration project (FEED)
- Process Engineer, District Cooling advisor (2019) – Responsible for District cooling plant and network in the Red Sea Project and Qiddiya projects. Activities performed: Technical support to Client - review technical and commercial proposals from DC Supplier companies
- Senior Consultant for Boiler and EPC, MGT 300 MWe Power Plant (2015 to 2019) – Biomass Power plant in UK. Assistance to Local office in preparation of Contract documents for an EPC Contract - later the owners engineer for the Boiler plant

Expert in process engineering in both power and industry with particular focus on CCS applied to industrial processes in the US, UK and Norway

Indran Aandi

Senior Process Engineer,

Horsham, UK office

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AFRY Thermal and Renewable Energy Division

Indran has 20 years' of process engineering experience including 5 years at site on a coal-fired power plant project during construction, commissioning and operations and 15 years in consultancy. He has carried out project management, study works, basic design, thermal modelling, design review, written technical specifications, supervised contractors at site and covered commissioning tests, plant operations, particularly those involving energy from waste (EfW), biomass combustion, coal fired boilers, material handling, ESP and FGD systems.

Indran has broad knowledge on post-combustion and pre-combustion CO_2 capture and storage (CCS) technologies gained from his previous involvement in the two UK CCS demo competitions and other CCS studies.

EDUCATION AND SPECIALITY

- Indran has bachelors' degree in Chemical Engineering from the University of Birmingham, UK.

SELECTED PROJECT REFERENCES

- Recently, Indran has been involved in two pre-feasibility studies for retrofitting CCS to a coal to biomass combustion plant and a new EfW power plant.
- UK CCS Competition No. 2, Technical advisory services to the UK Government, the Department of Energy and Climate Change (DECC)
- Norway CCS project. Provided technical advisory support to Gassnova to identify potential large CO2 emission sources from existing and new planned process plants in Norway which are suitable to implement full CCS chain.
- Project manager for a pre-feasibility study on conceptual carbon capture readiness (CCR) to South Hook CHP plant developed jointly by ExxonMobil and Total.
- Feasibility Study on Carbon Capture for Gas-fired Power Plants for IEA GHG UK.
- Pre–feasibility Study on Conceptual CCR, Wyre Power, UK.
- CO2 Capture Ready Plant Design Support, Reliance Energy, India.
- CCS Demonstration Project No. 1 , UK. Owner's engineer to Scottish Power for submission to the UK Government's as part of the UK post-combustion CCS demonstration competition.

Liv Bjerge is a group manager in the Industry and Sustainability group in Norway responsible for AFRY‘s extensive work on Norcem Brevik cement CCS

Liv Bjerge
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AFRY PID - Advansia

>30 years of dedicated industrial experience and many years in CCS. Liv is Group Manager at AFRY Advansia Process & Energy, stationed in Oslo and part of AFRY’s Sustainability Expert Group Previously delivered major concept and FEED studies at Heidelberg Cement. Currently managing the Execution phase for the Norcem Brevik CCS project.

EDUCATION AND SPECIALITY

- Responsible for maturing CCS on cement industry through technology screening, pilot-testing in real conditions.

SELECTED PROJECT REFERENCES

- Responsible for maturing CCS on cement industry through technology screening, pilot-testing in real conditions, Concept and FEED studies at Heidelberg Cement.
- Currently managing the Execution phase for the Norcem Brevik CCS project.

Illka Rantanen is a Director in AFRY's Process Industry Division with around 15 years of experience in CCUS technical studies and bioenergy

Ilkka Rantanen
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Mr. Rantanen has 20 years of experience in process engineering in advanced biofuels, oil refining and chemicals production and leads various projects in feasibility, basic and detail engineering phases for carbon capture and storage. Currently, he is working as Director for Process Engineering Department at Chemicals & Biorefining department.

EDUCATION AND SPECIALITY

- 1993 - 2000 Helsinki University of Technology
- Major in chemical engineering, minors in chemical plant design and water supply technology

- Languages
  - Finnish Native or bilingual proficiency
  - Swedish Full professional proficiency
  - English Full professional proficiency
  - French Professional working proficiency
  - German Limited working proficiency

SELECTED PROJECT REFERENCES

- Confidential Nordic utility, 2022-01 -, Biomass with Carbon Capture and Usage Concept Study, Technical Lead
- Colabitoil, 2020-06 - 2020-12, Biorefinery Concept Study, Technical Adviser
- SGI, 2020-09 - 2020-11, Technical assessment of NG gas network for hydrogen, Technical Lead
- Confidential, 2017-04 - 2020-10, Phosphorous recovery plant , Project Manager
- Confidential, 2020-02 - 2020-05, Concept Study for Carbon Capture, Technology Advisor
- Confidential, 2018-08 - 2018-12, Bioethanol plant feasibility study, Process Lead
- Silva Green Fuels, 2015-08 - 2015-11, Biofuels Production Plant, Technology Lead on a Feasibility study for a biofuels production plant.
- Confidential, 2014-12 - 2015-03, Biofuels Production Plant, Project Manager, Feasibility study for a biofuels production plant.
- Gassnova, 2008-02 - 2009-01, CO2 Kårstö, Multinational, Process Specialist, Technology evaluation of basic engineering for carbon capture from power plant flue gases

Davide Durante is a Chartered process engineer under-taking CCUS technical studies at AFRY with significant experience from the O&G industry

Davide Durante

TECHNOLOGY MANAGER, CHEMICALS

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Davide is a Chartered process engineer (IChemE, UK Eng. Council) with significant work experience from the O&G industry. Davide graduated with honors in Process & Chemical Engineering at the University of Padua and has a Postgraduate Master in Oil & Gas Engineering from the University of Bologna. Davide worked both as lead engineer, coordinating the process design work for small and medium scope studies and projects, and as unit responsible engineer, part of a wider team for larger scale projects. Since joining AFRY, Davide has been actively involved in green hydrogen and power-to-X studies and projects.

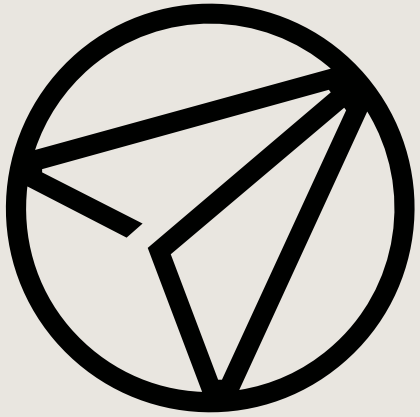
EDUCATION AND SPECIALITY

- 2021 - Aalto University Executive Education, MBA (part-time)
- 2011-12 Alma Mater Studiorum Bologna University (Italia) Postgraduate Taught Master Degree in "Oil & Gas Engineering
- 2008-11 University of Padova Master Degree in Process and Chemical Engineering, Master
- 2005-08 University of Padova Bachelor Degree in Chemical Engineering, Bachelor

- Languages: Italian, English

SELECTED PROJECT REFERENCES

- Confidential Nordic utility, 2022-01 -, Biomass with Carbon Capture and Usage Concept Study, Technical Specialist
- HYBRIT Development AB, 2021-09, demonstration Plant Pre-Feasibility Study, Process Lead Hydrogen Generation Plant
- Confidential German Client, 2021-09 – 2021-12, CCU for Waste-to-Energy Plant New Combustion Line, Simulation Specialist in HYSYS and Promax
- RISE, 2021-05 - 2021-10, Power-to-X Conceptual Study: Recovery Boiler Flue Gas CO2 Capture & Utilization with Electrolytic H2, Senior process Engineer
- Eolus Vind AB, 2021-05 - 2021-08, Techno-economic study for hydrogen production at a wind park in Sweden, Snr Process Engineer
- ACWA Power, 2021-04 - 2021-08, Green Ammonia production in the Kingdom of Saudi Arabia, using Renewable Power generated from Solar PV and Wind Power Plant, Senior Process Engineer
- Samsung/Hyundai Heavy Ind, 2018-10 - 2019-07, Very Large Ethane Carriers (VLEC) Cargo Handling and Fuel Gas Supply Systems project, Senior Process Consultant
- Neste, 2016-05 - 2017-01,Naantali Refinery Revamping project - Feasibility studies for the revamping of Thermal Catalytic Cracking fractionation unit, Process Engineer (Oil & Gas)



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