Interdisciplinary Research Collegium in Advanced Maritime Systems Design

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Summary

- The education of naval architects, marine engineers and others who are the active contributors to the ship design processes is heavily focussed on engineering fundamentals, often aligned with traditional university course constraints.
- The concept of a research collegium is described whose aim is to provide an environment where young people in their formative post-graduate years can learn and work in a small, mixed discipline group drawn from the **worldwide** maritime community to develop their skills whilst completing a project in advanced ship design.
- The brief that initiates each project sets challenging user requirements which encourage each team to develop an imaginative solution, using their individual knowledge and experience, together with learning derived from teaching which form a common element of the early part of the collegium.

Contents of talk

- Concept of The LRET research collegium
- Carbon capture and storage (CCS)
- Ideas emerging from the research collegium

1.

LRET RESEARCH COLLEGUIM CONCEPT

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Motivation behind the collegium concept

- Successful ship and maritime systems design depends on the collaborative application of a broad range of engineering competences as the drive for improved efficiency and environmental performance places greater demand on the design community.

- The education of naval architects, marine engineers and others who are the active contributors to the ship design processes needs to be broadened from a focus purely on engineering fundamentals to other disciplines in sciences, social sciences, human sciences, humanities, etc.

- The LRET Research Collegium addresses this latter aspect.

Aim

•The aim of the research programme is to provide an environment where scholarly young people in their formative post-graduate years can learn and work in a small, mixed discipline group drawn from the maritime community to develop their skills whilst completing a project in advanced maritime systems design

•The project brief will set challenging user requirements which will encourage each team of Scholars to develop an imaginative solution, using their individual knowledge and experience, together with learning derived from teaching which will form a common element of the early part of the programme.

Format

- The programme format provides adequate time for Scholars to enhance their knowledge through a structured programme of taught modules which will focus on the design process, advanced technologies, emerging technologies and novel marine solutions, regulatory and commercial issues, design challenges (such as environmental performance and climate change mitigation and adaptation) and engineering systems integration.

- Guest Lecturers are drawn from academic research and industry to provide a mind-broadening opportunity for the Scholars, whatever their original specialisation.

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Outputs

- A scholarly report for free circulation
- A technical paper from each group suitable for publishing in a reputable, peer reviewed forum
- A group presentation to an invited audience of academics, industrialists, young engineers and students, in Southampton
- Individual presentations by attendees in their respective institutions and countries
- An article written for the man-on-the-street.

Outcomes

- Promotion of the collegium subject as widely as possible
- Recognition of the achievements of the young scholars
- Contribution to and influencing policy making/forming forums
- Acknowledgement of The LRET's charitable contributions to education

An old idea revisited…

- Following 1980 Finniston report, Southampton part of first wave (1981) of UK integrated Master of Engineering (MENG 2+2)
- Novel feature was emphasis on group working with 50% of final year assessment based on a
  - Group Design (and build) Project
  - Multidisciplinary Project (MDP)
- LRET Colleguim took MDP and structured for a worldwide group of scholars to work towards a common goal over an extended period with support from leading thinkers in that area

Educational Aims

- Gaining experience of working as part of a team with different experiences and skills
- Tackling a new subject and finding a solution to a problem within a time-, human resource- and finance-constrained situation
- Tackling a real need/problem with industrial and commercial links
- Learning to meet both personal and group objectives
- Working and dealing with people from different cultural, social and educational skills backgrounds
- Handling organisation and administration for a project
- Developing communications and presentation skills

Project Brief 2011 Carbon Capture & Storage

(a) quantification of the environmental challenge;

(b) understanding of the geo-political legal-social context;

(c) possible techniques for sequestration;

(d) one engineering system to achieve CCS;

(e) economics and logistics challenges.

While all the groups/teams examined items (a) to (c), each team focused on just one (engineering) system in dealing with items (d) and (e).

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The 2011 Collegium

- From 11 July till 2 September

- 19 scholars from universities in Yokohama, Harbin, Seoul, Pusan, Singapore (NUS and NTU), Aberdeen, Cardiff, UCL, Steven Institute of Technology and Southampton and Lloyd's Register attended

- Scholars split into three teams of five and one team of four

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Project Supervisors and Student Mentors

Project Supervisors

Group A	Professor Philip Wilson and Professor Stephen Turnock
Group B	Dr. Dominic Hudson and Professor Philip Wilson
Group C	Professor Ajit Shenoi and Dr. Dominic Hudson
Group D	Professor Stephen Turnock and Professor Ajit Shenoi

Student Mentors

Messrs. Jonathan Gravina, Tom Lloyd and Matt Streeter

Week 1 - Timetable: 11/07/11-15/07/11

University of Southampton

	Monday, 11/07/11	Tuesday, 12/07/11	Wednesday, 13/07/11	Thursday, 14/07/11	Friday, 15/07/11
0900-0950	Welcome LRET	Lecture, Reeve&Melin Overview, LR	Library familiarisation	LectureTsimplis	Lecture Wu
1000-1050	Group introductions	Lecture, Reeve&Melin Overview, LR	Library familiarisation	Lecture Tsimplis	Lecture Wu
1110-1200	Group introductions	Lecture, Reeve&Melin Overview, LR	Computing familiarisation	Library search and reading (Individual)	Project Discussion (groups + mentors)
1210-1300	Introduction to Collegium	Lecture, Reeve&Melin Overview, LR	Computing familiarisation	Library search and reading (Individual)	Project Discussion (groups + mentors)
1300-1400	Lunch	Lunch	Lunch	Lunch	Lunch
1400-1450	Introduction to mentors	Project Discussion (groups + mentors)	Library search and reading (Individual)	Project Discussion (groups)	Presentations of progress (group wise)
1500-1550	Registration formalities	Project Discussion (groups + mentors)	Library search and reading (Individual)	Project Discussion (groups)	Presentations of progress (group wise)
1610-1700	Registration formalities	Project Discussion (groups)	Library search and reading (Individual)	Project Discussion (groups)	Presentations of progress (group wise)
1710-1800	Meet with FSI (wine and nibbles)	Project Discussion (groups)	Library search and reading (Individual)	Project Discussion (groups)	Presentations of progress (group wise)

Week 4 - Timetable: 01/08/11-05/08/11

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	Monday, 01/08/11	Tuesday, 02/08/11	Wednesday, 03/08/11	Thursday, 04/08/11	Friday, 05/08/11
0900-0950	Lecture Paik	Lecture Arai	Lecture Bruno	Lecture Bucknall	Private study and reading (Individual)
1000-1050	Lecture Paik	Lecture Arai	Lecture Bruno	Lecture Bucknall	Private study and reading (Individual)
1110-1200	Private study and reading (Individual)	Private study and reading (Individual)	Private study and reading (Individual)	Private study and reading (Individual)	Project Discussion (groups + mentors)
1210-1300	Private study and reading (Individual)	Private study and reading (Individual)	Private study and reading (Individual)	Private study and reading (Individual)	Project Discussion (groups + mentors)
1300-1400	Lunch	Lunch	Lunch	Lunch	Lunch
1400-1450	Private study and reading (Individual)	Library search and reading (Individual)	Industry visit	Project Discussion (groups + mentors)	Presentations of progress (group wise)
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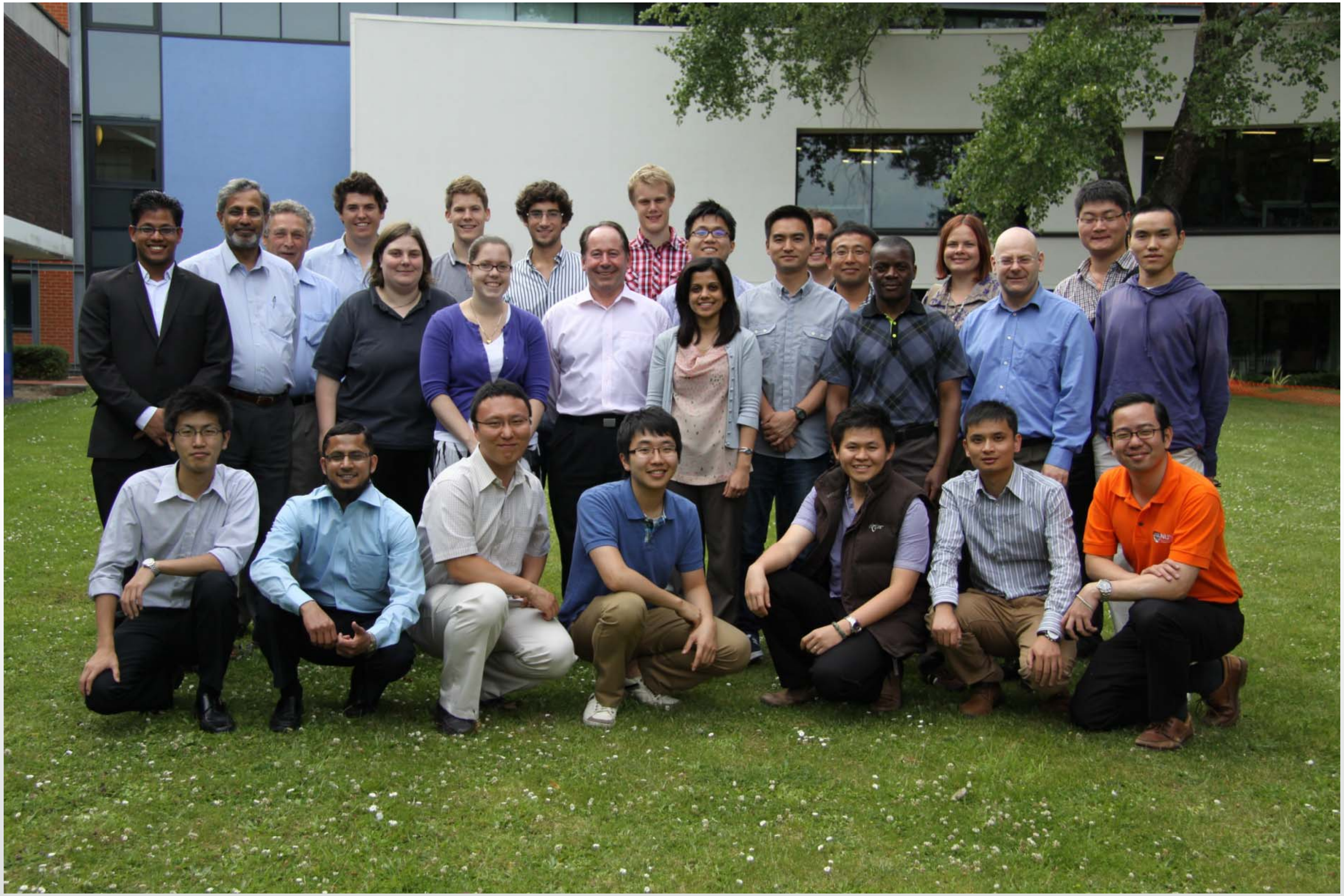

2

CLIMATE CHANGE

Climate change

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years – sometimes used to refer specifically to climate change caused by human activity, as opposed to changes in climate that may have resulted as part of Earth's natural processes

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Consequences of climate change

- Over the last 100 years, the average air temperature near the Earth's surface has risen by a little less than 1°C
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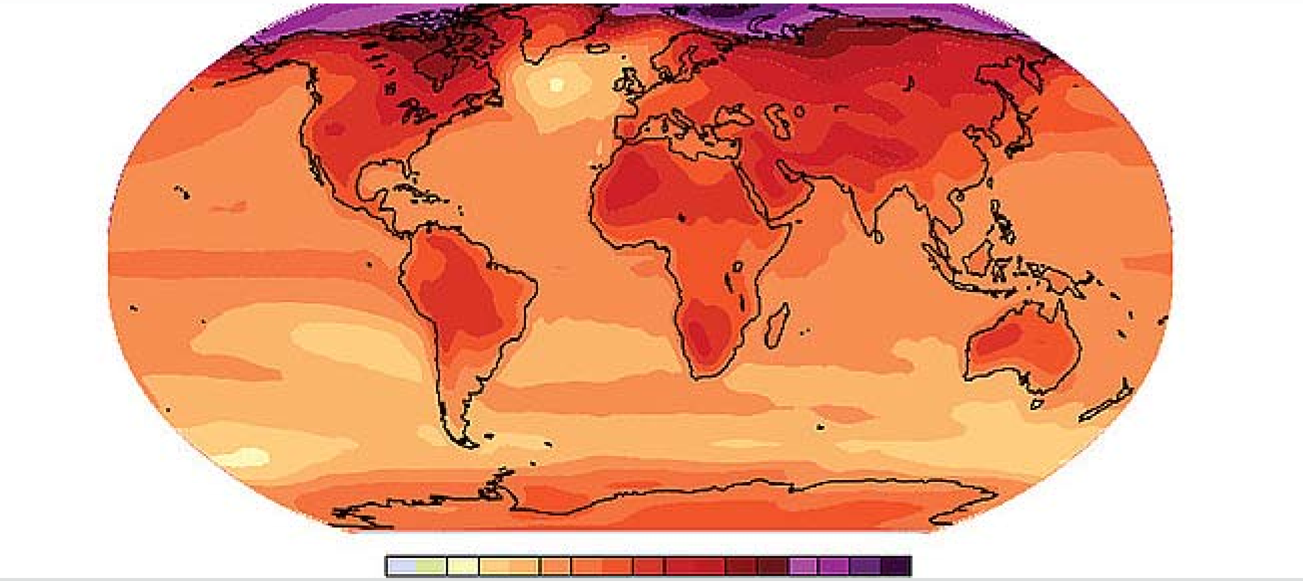
- Projections from IPCC indicate that global surface temperature will probably rise a further 1.1° - 6.4°C during the 21st century



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1.1° - 6.4°C does not seem to be much!

Consider this: at the end of the last ice age, when the northern part of American continent was covered by more than 3,000 feet of ice, average temperatures were only 5 to 9 degrees cooler than today.

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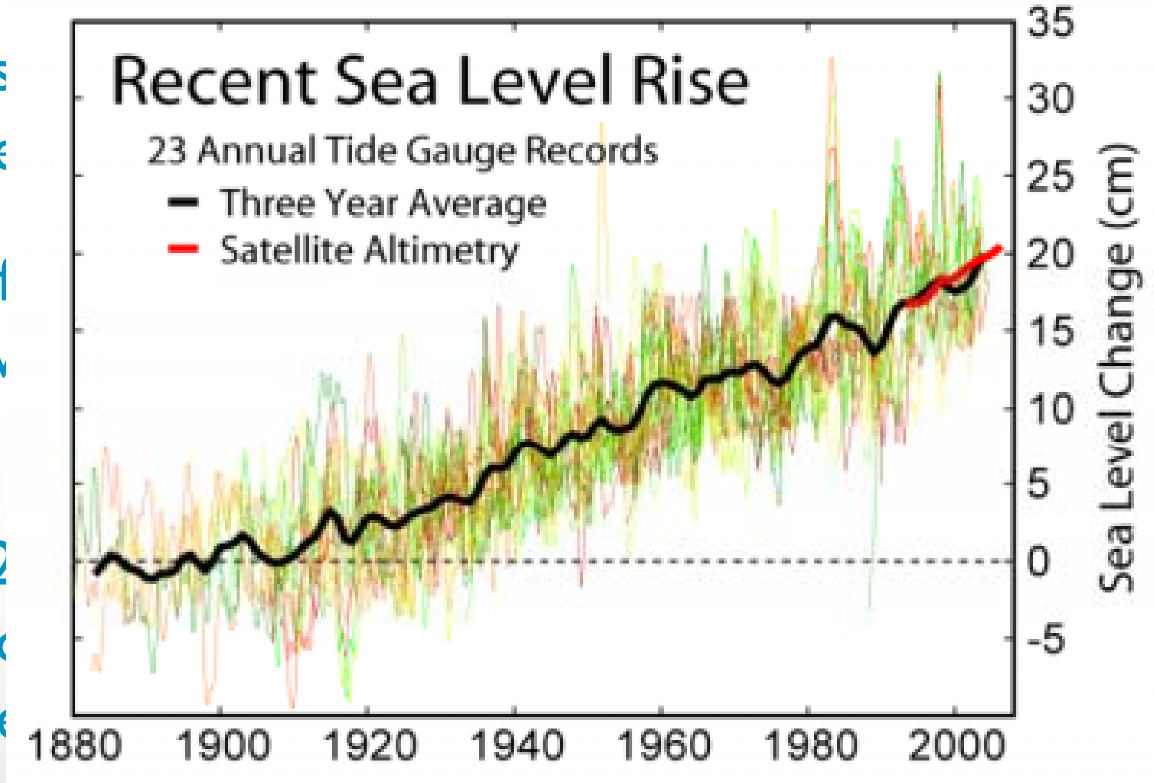
- Projections from IPCC indicate that global surface temperature will probably rise a further 1.1° - 6.4°C during the 21st century

- During the 20th century, sea level rose about 15-20 cm (roughly 1.5 to 2.0 mm/year), with the rate at the end of the century greater than over the early part of the century

Consequences of climate change

• Over the las r the Earth's surface



• Projections f temperature v g the 21st century

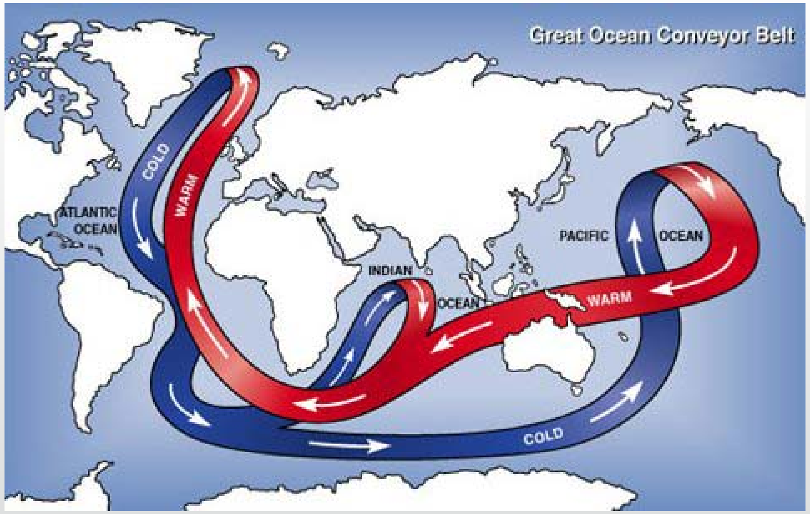
• During the 2 (roughly 1.5 to ne century great

• Over the 21st century, the IPCC's Fourth Assessment projected that thermal expansion will lead to sea level rise of about 17-28 cm (± 50%).

Consequences of climate change 2

- Melting of Glaciers and Ice Sheets
- Ocean Acidification
- Thermohaline Circulation
- ……………………………………………

Boulder Glacier in Nth America retreated 450m between 1987 -2005



Historically, ocean pH has averaged around 8.17, meaning that ocean waters are slightly basic. But with the rising CO_2 concentration causing acidification, today the pH levels are around 8.09, edging the waters closer to neutral (i.e. 7)

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Causes of climate change

- According to DirectGov (a UK government website): *There is very strong evidence that people are changing the climate with actions that create emissions of greenhouse gases like water vapour, carbon dioxide , methane, SOx, NOx, etc.*

- The greenhouse gases trap heat near the Earth's surface.

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- The greenhouse gases trap heat near the Earth's surface.

Collegium focus was on mitigation of one facet, namely CO_2

CO_2 in atmosphere

- The concentration of CO_2 in the Earth's atmosphere is approximately 391 ppm by volume as of 2011and rose by 2.0 ppm/yr during 2000–2009.

- 40 years earlier, the rise was only 0.9 ppm/yr, showing not only increasing concentrations, but also a rapid acceleration of concentrations. The increase of concentration from pre-industrial concentrations has again doubled in just the last 31 years

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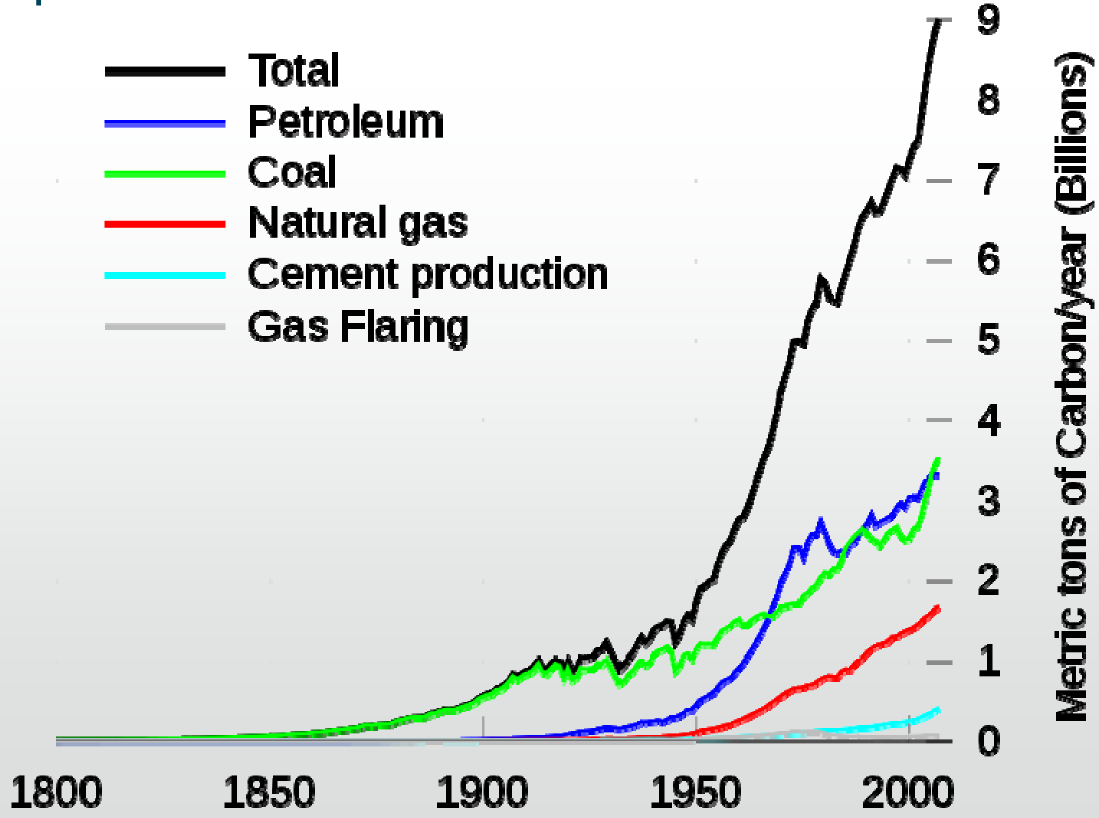
Sources of atmospheric CO_2

Burning fossil fuels such as coal and petroleum is the leading cause of increased anthropogenic CO_2.

8.67 GT of carbon (or 31.8 GT of CO_2) were released from fossil fuels worldwide in 2008, compared to 6.14 GT in 1990



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CCS – the topic

Carbon capture and storage (CCS), alternatively referred to as carbon capture and sequestration, is a means of mitigating the contribution of fossil fuel emissions to global warming. The process is based on capturing CO_2 from large point sources, such as fossil fuel power plants, and storing it in such a way that it does not enter the atmosphere.

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CCS in ocean space was chosen as the topic for the 2011 research collegium

3

LRET COLLEGUIM OUTPUTS SUMMER 2011

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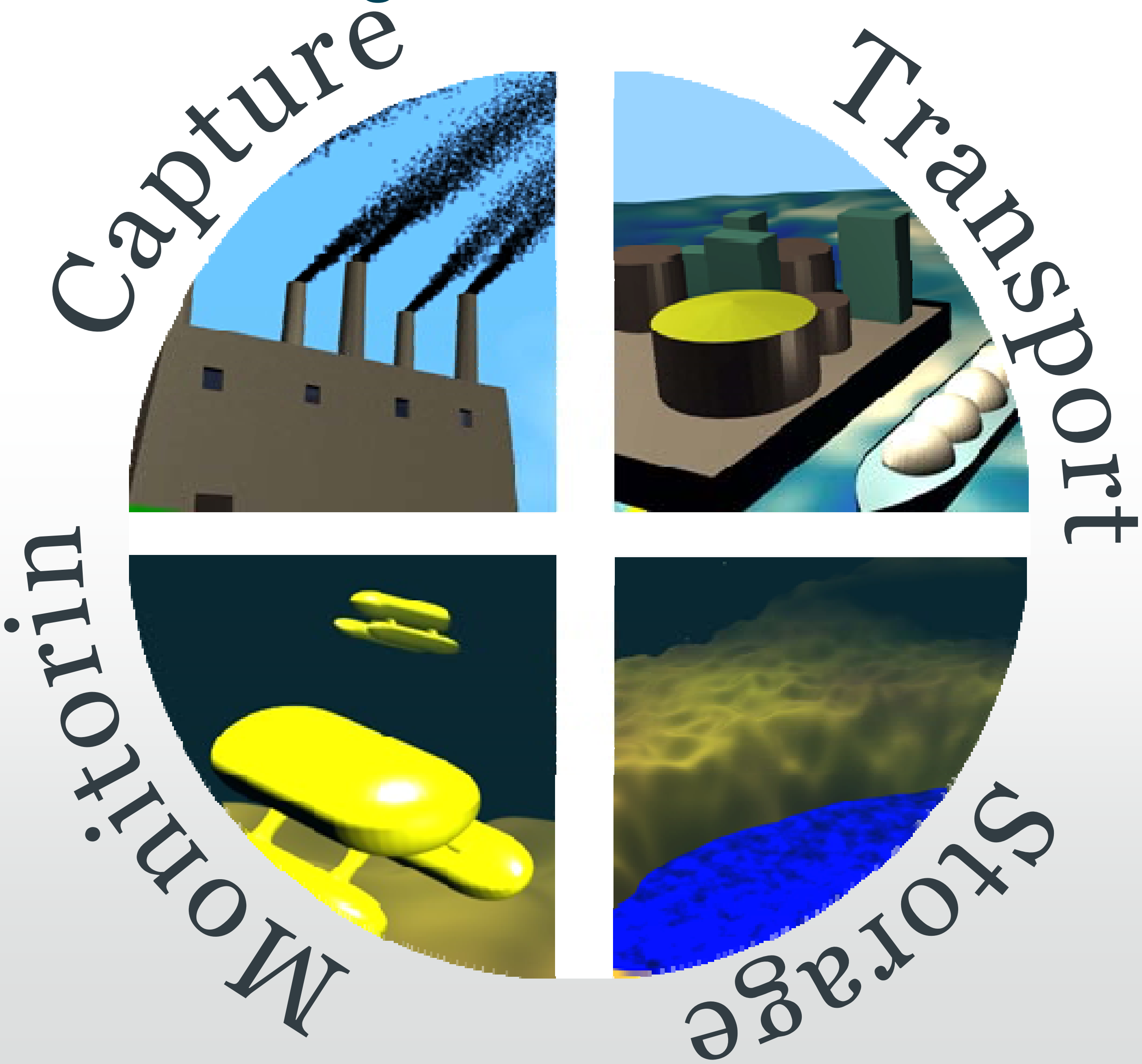
CCS – the coverage

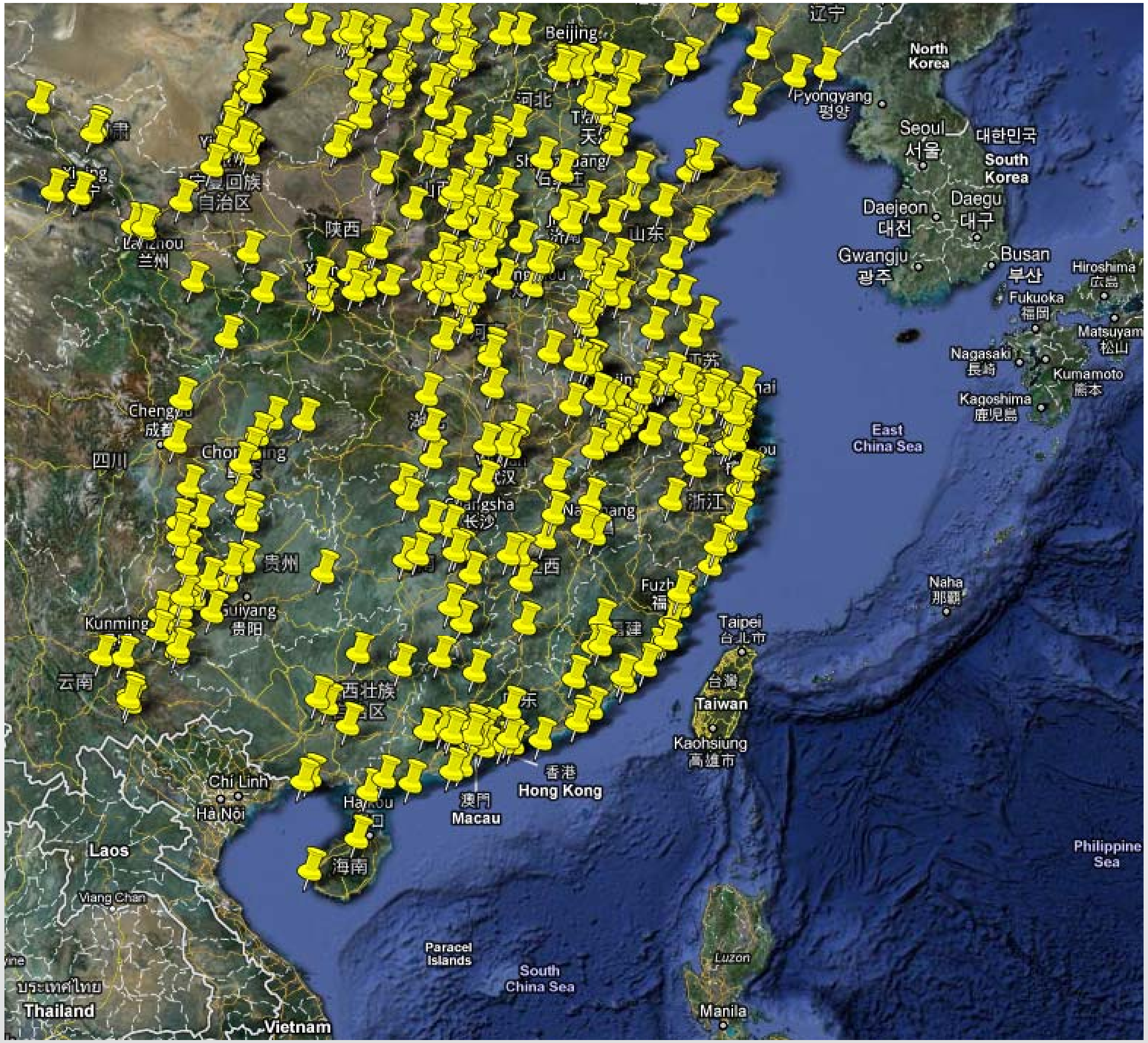


Group A – Guidelines for implementing CCS in China I

Largest emitter of CO_2 and projected to continue growing

Relatively new technology in China

Government is proactive in green energy & sustainable planning

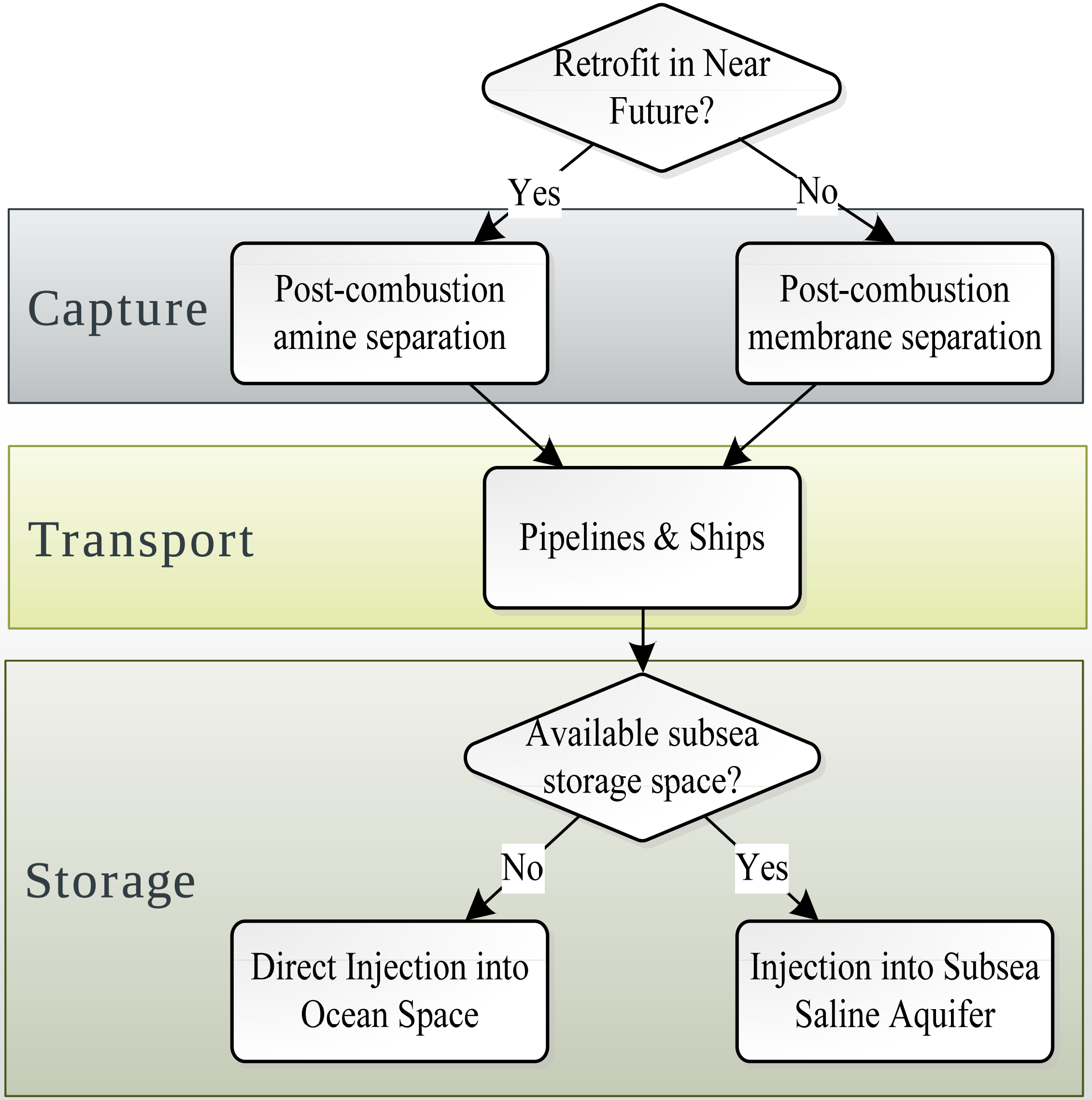


Group A – Guidelines for implementing CCS in China II

Capture
- Amines
- Membranes

Transport
- Onshore Pipeline
- Offshore Ships

Ocean Storage
- Subsea Geological
- Direct Injection



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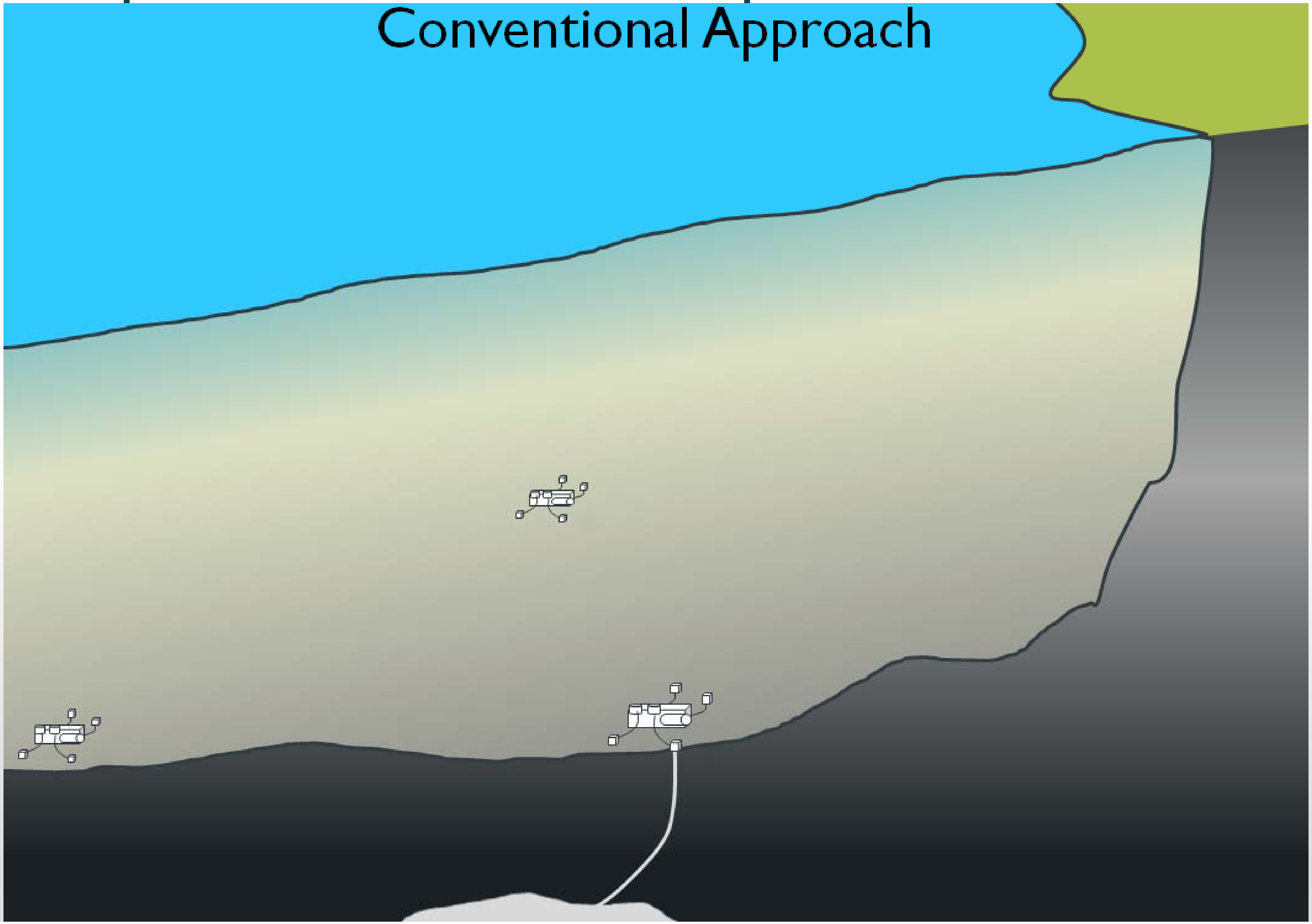
Group B – Offshore thermal power with CCS

Conventional Approach



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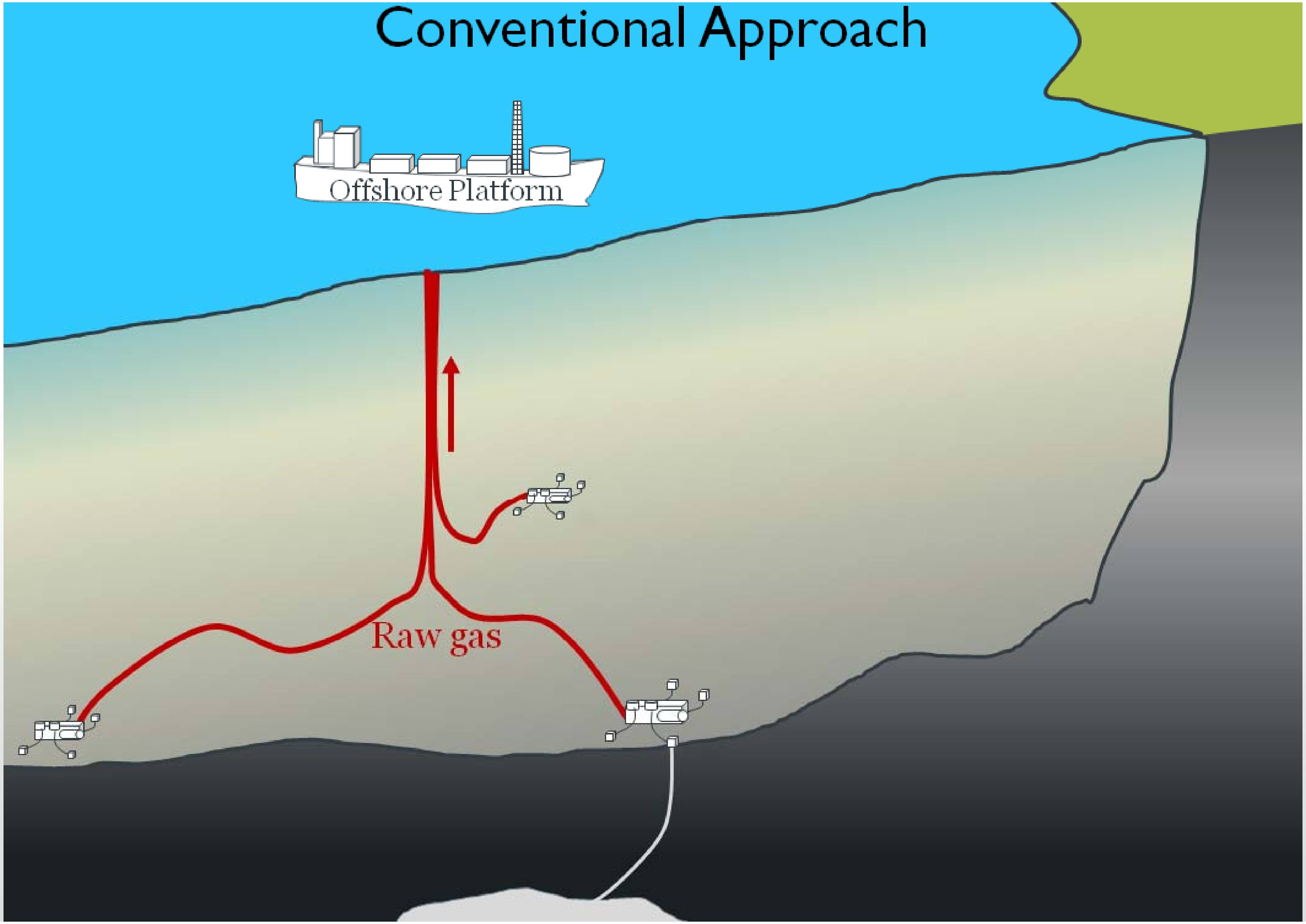

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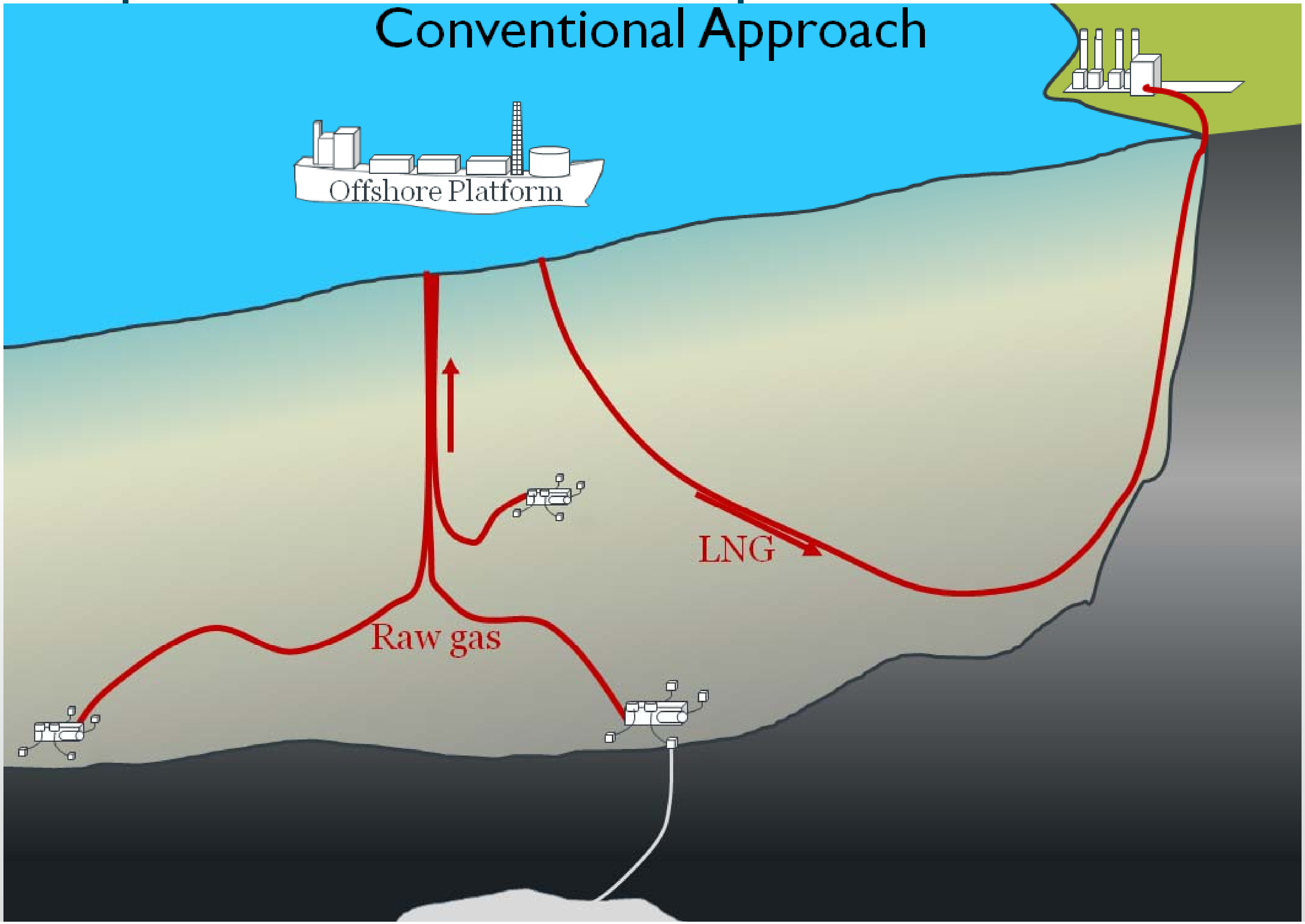

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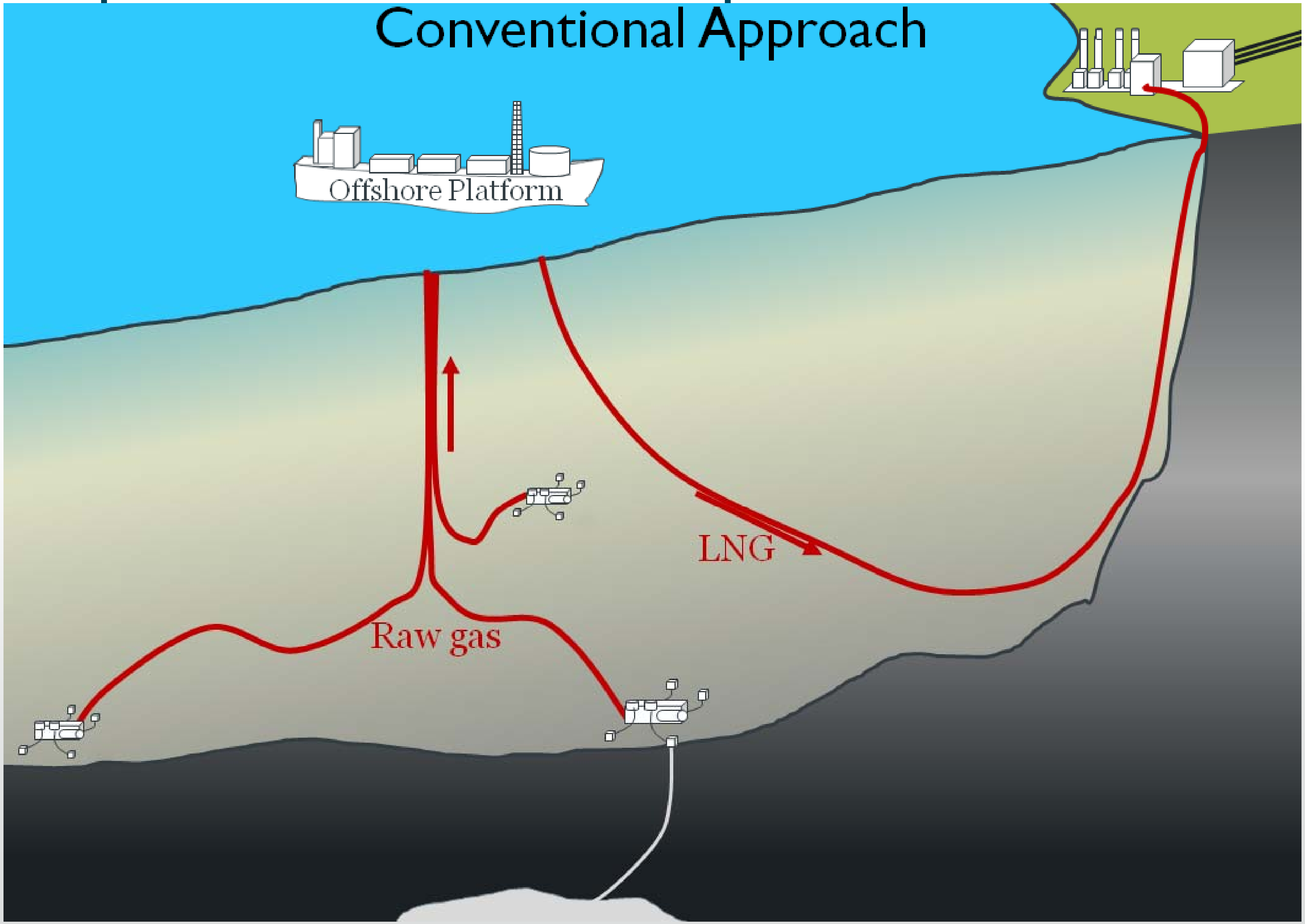

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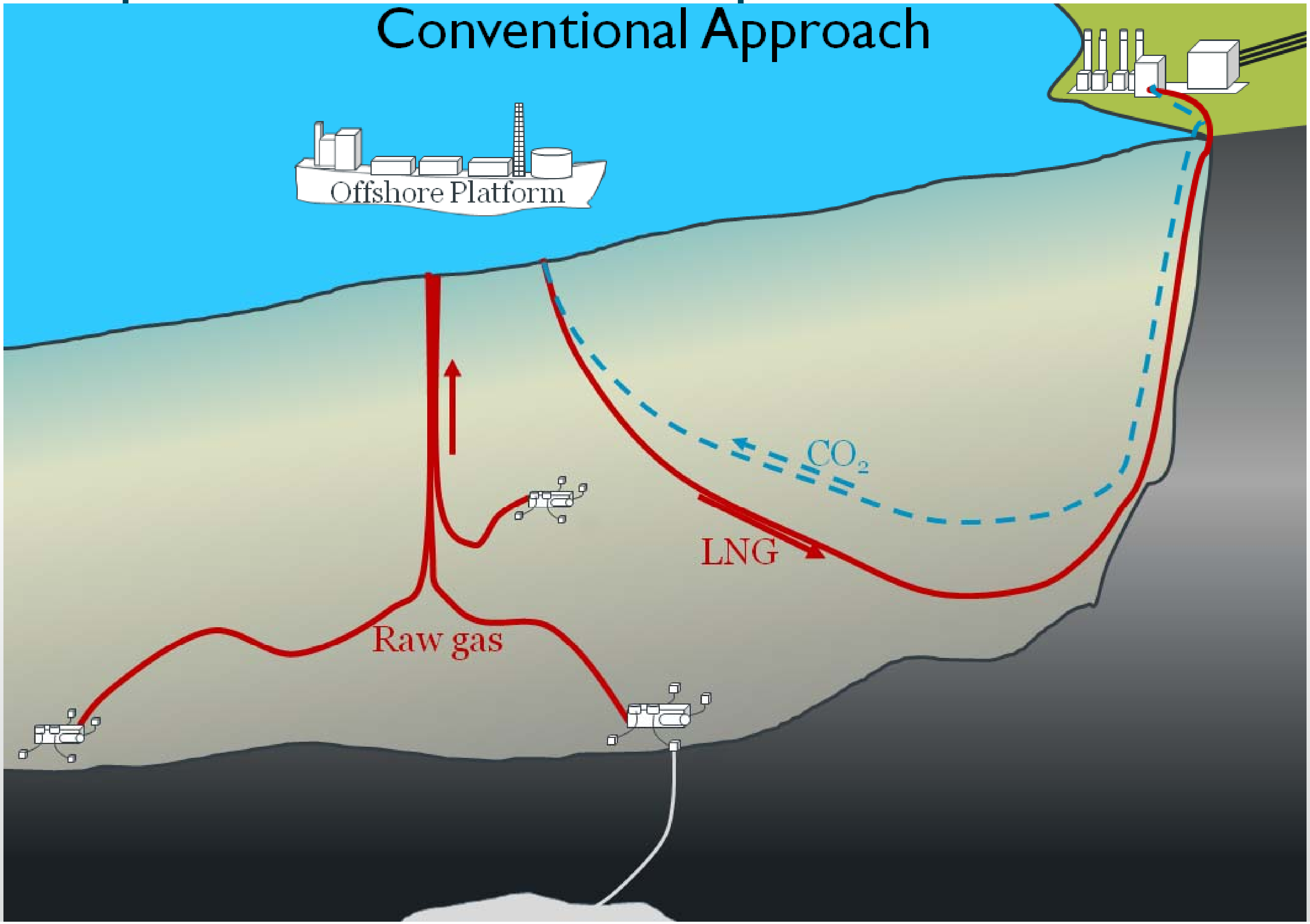

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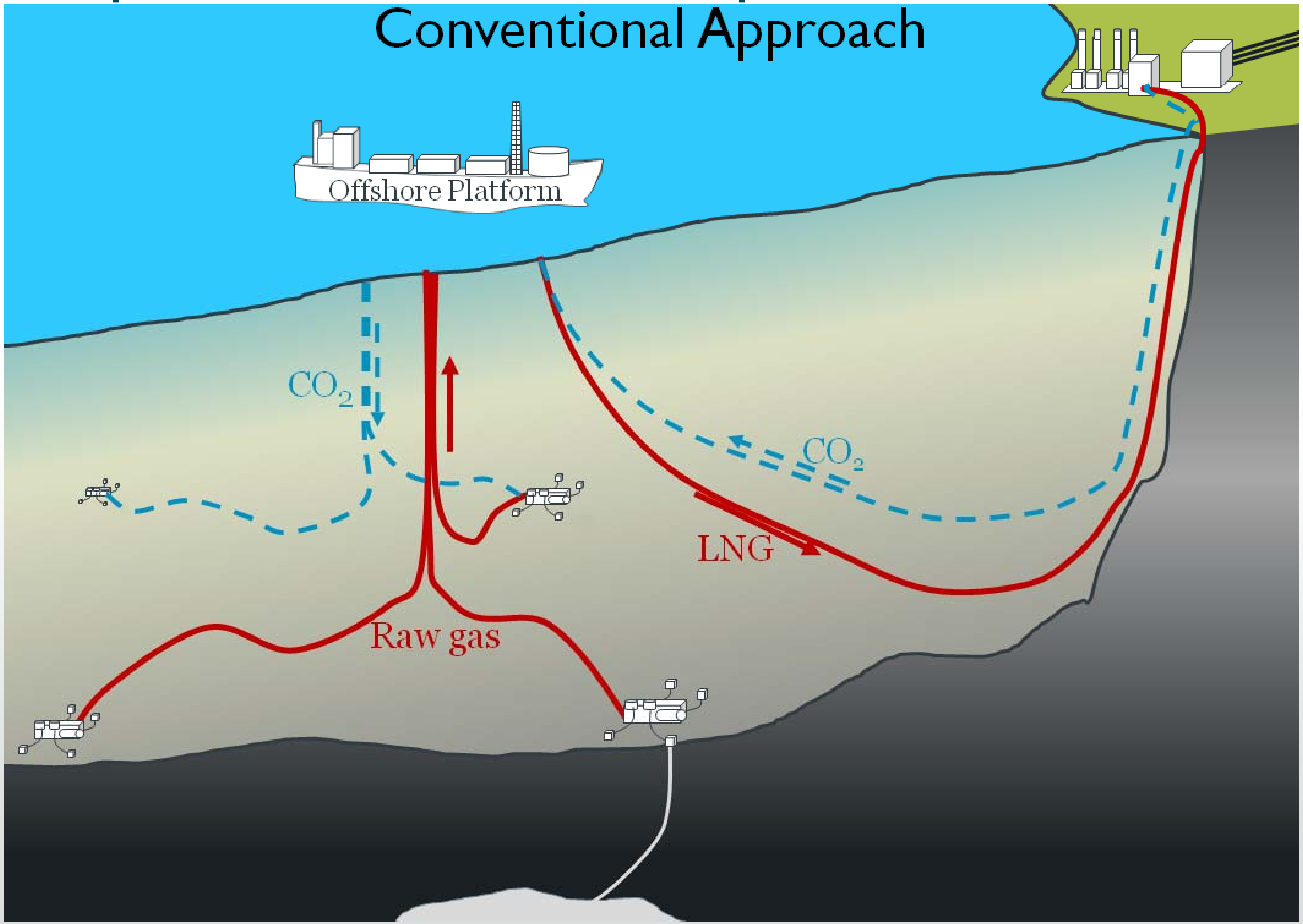

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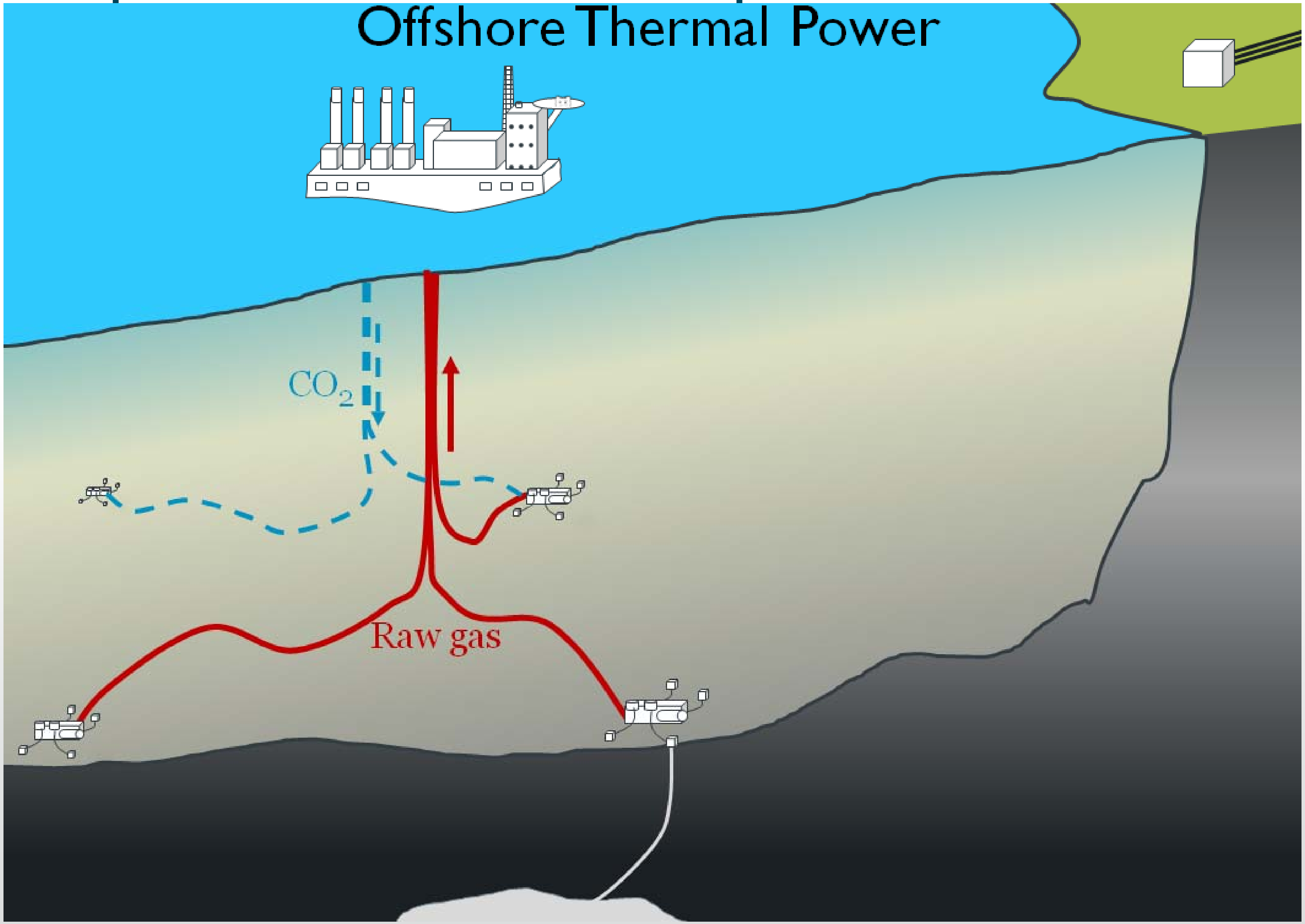

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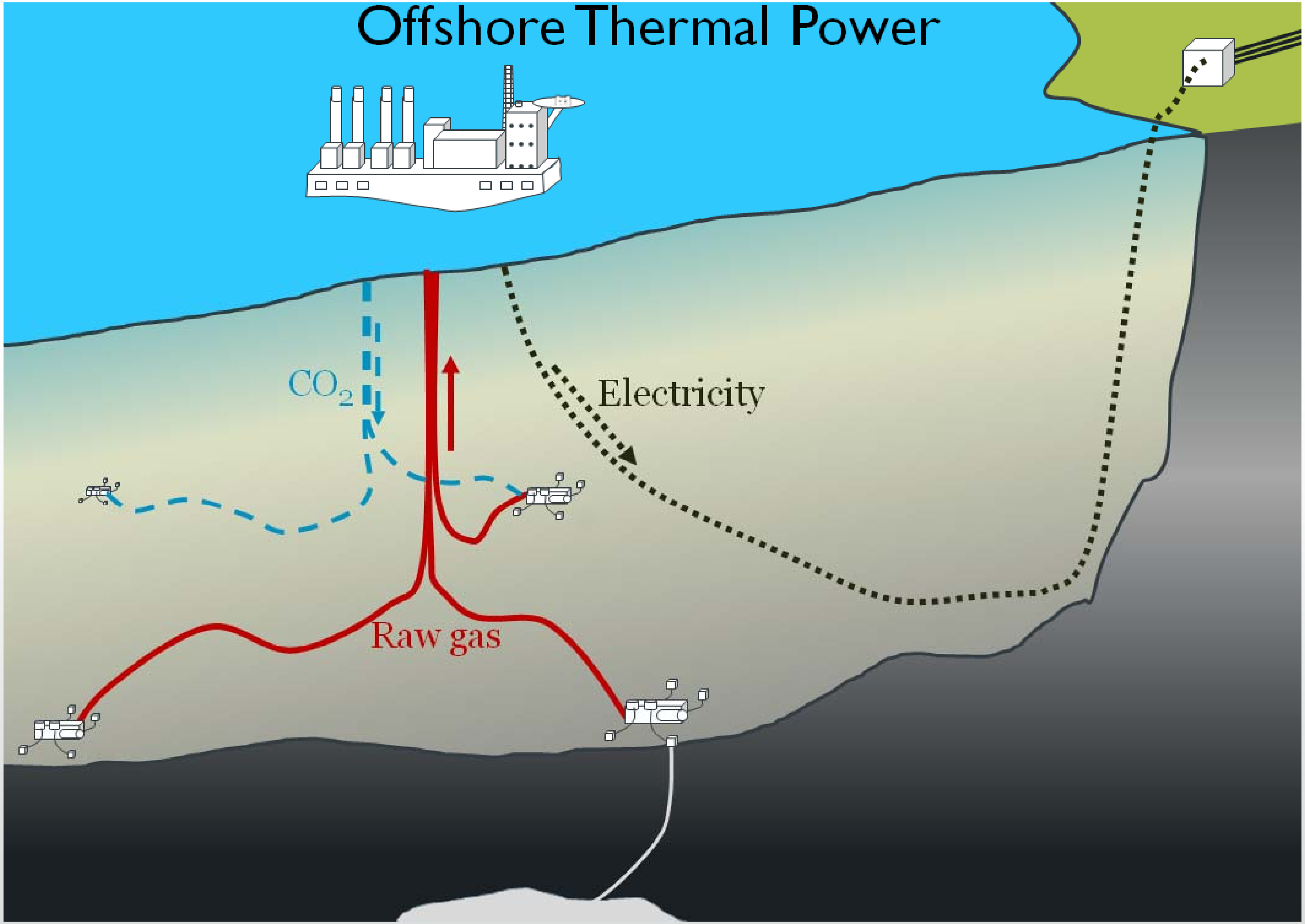

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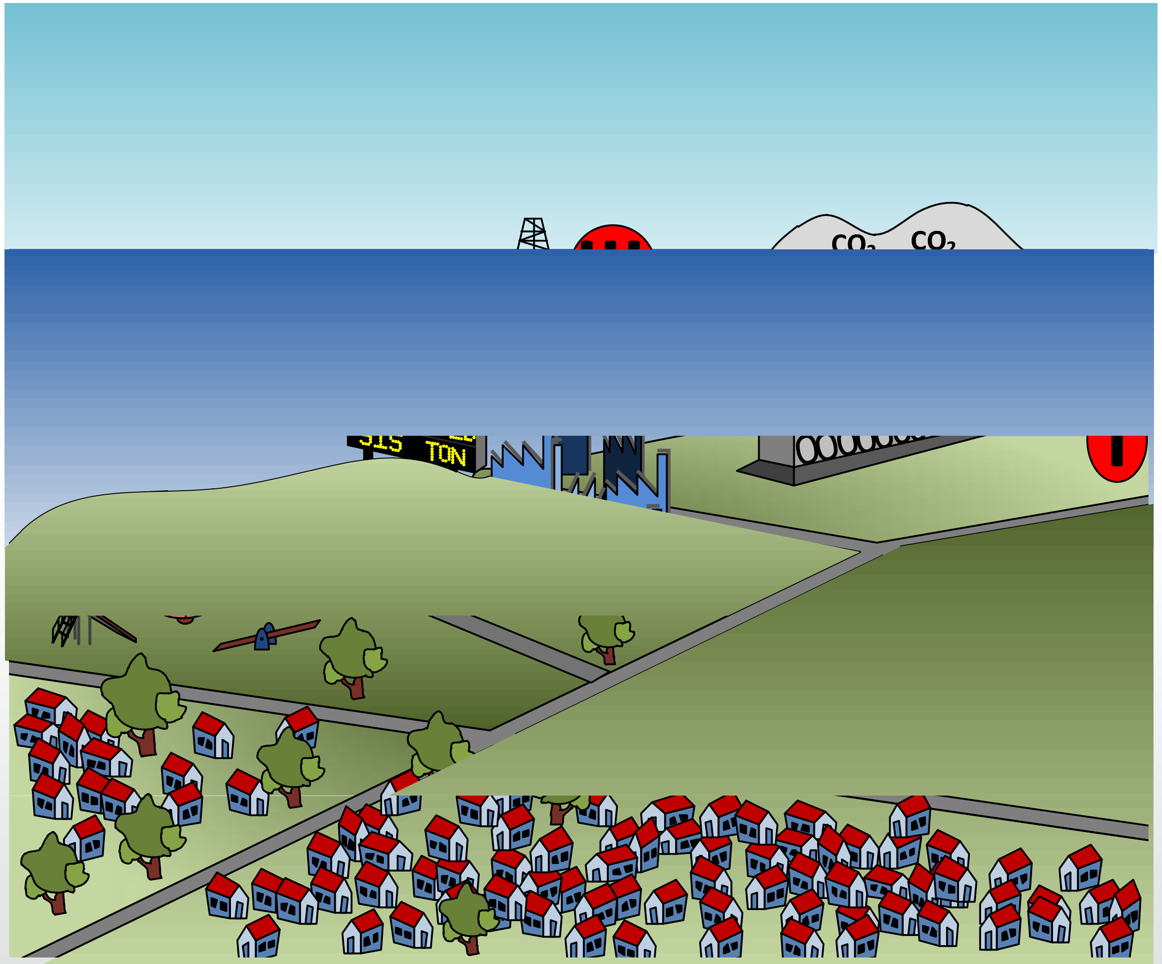
Group C – Key to successful CCS; engaging the public I

Green Town Concept

I. Air capturing facility to remove CO_2 from air

II. Captured CO_2 is transported by pipelines

III. CO_2 is stored in geological formation



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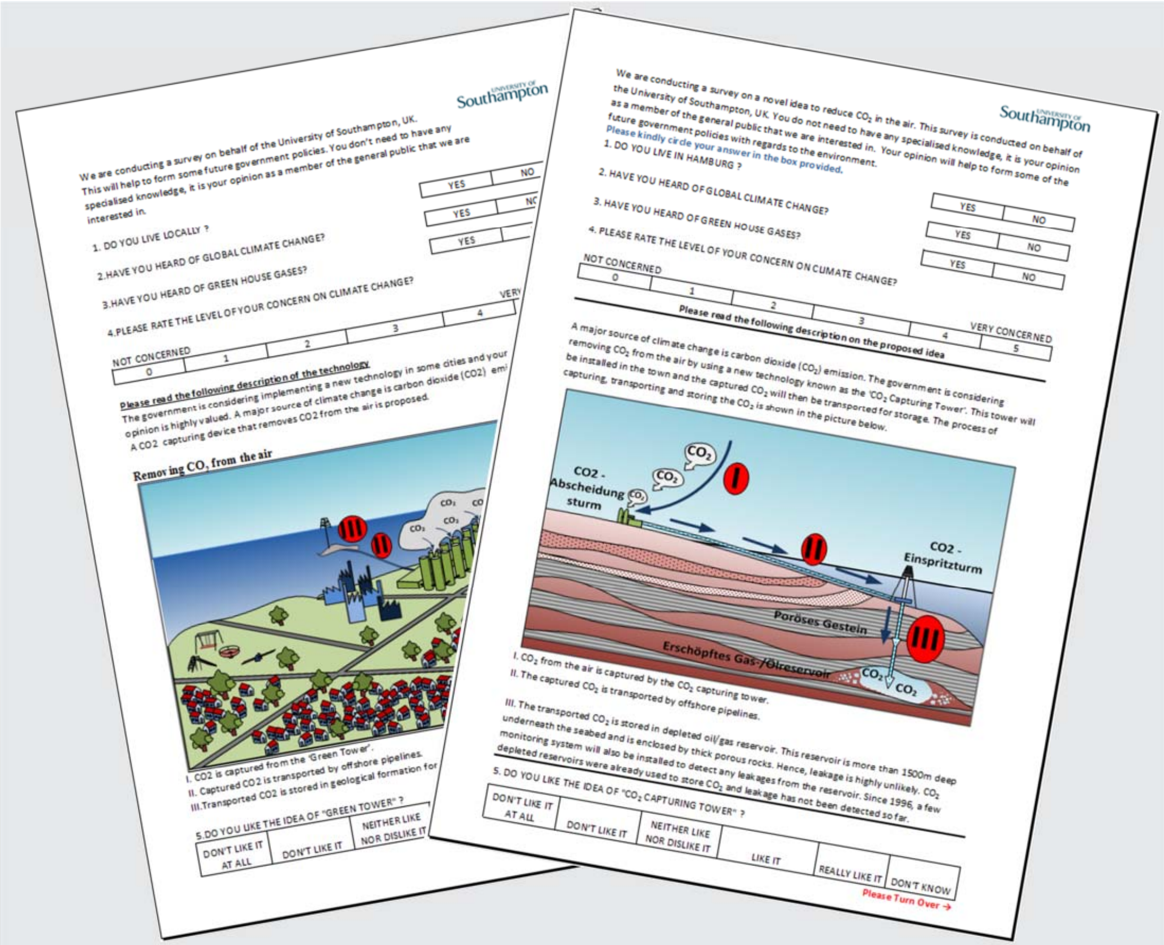
Group C – Key to successful CCS; engaging the public II

How can we prove "Green Town" is a good idea?



Group C – Key to successful CCS; engaging the public III

Surveys

Objectives:

- Is "Green Town" popular?
- Does "Green Town" help to promote CCS?
- What are the best methods to promote CCS?

Table Samples Collected in Southampton and Hamburg

	Total Samples	Locals	Confidence Level	Confidence Intervals
Southampton	158	100	95%	9.8%
Hamburg	366	248	95%	6.3%

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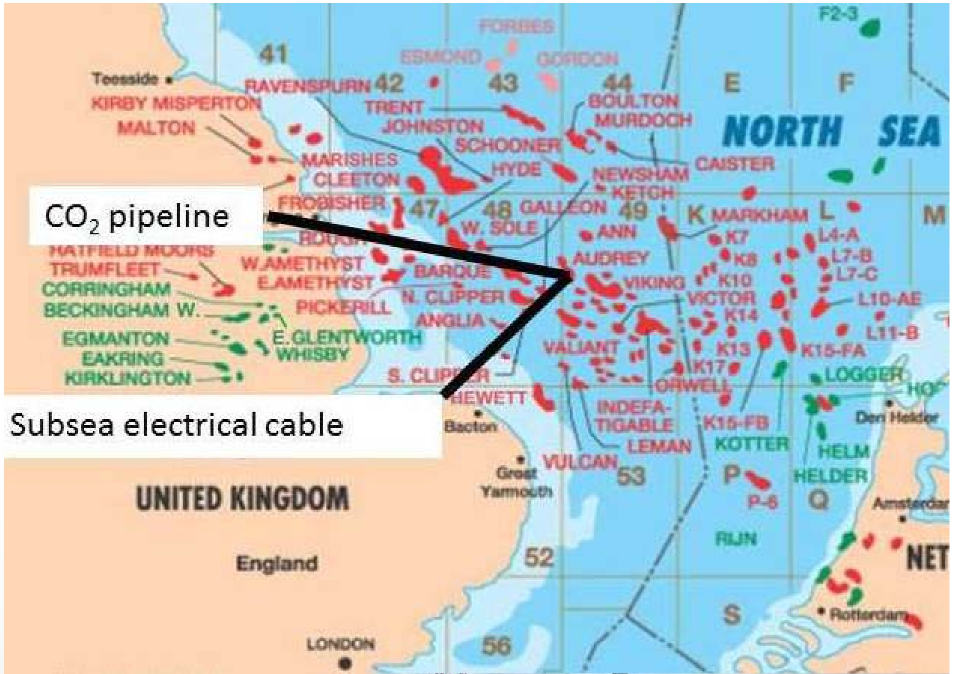
Group D – Offshore Renewable Energy Powered CO_2 Injection; concept



- Pipe CO_2 gas from Drax power plant to offshore field (Audrey) in Southern North Sea gas basin

- Lay subsea electrical cable from Sheringham Shoal wind farm to platform for power supply

- Retrofit the existing Audrey platform & reconfigure for CO_2 injection

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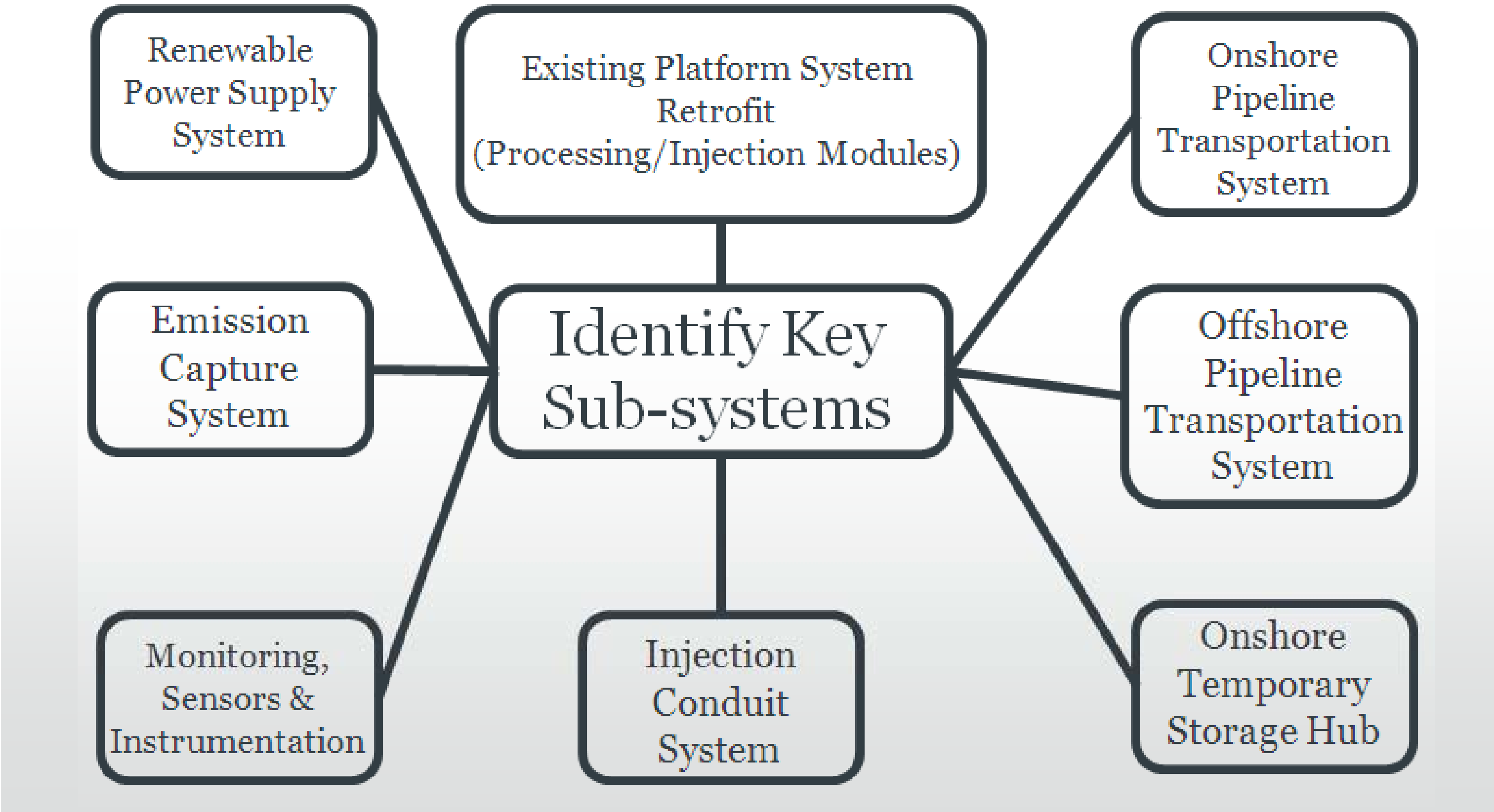
Group D – Offshore Renewable Energy Powered CO_2 Injection; systems approach



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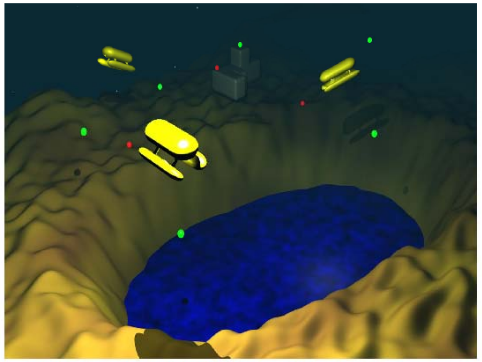
Reports

Carbon Capture & Sequestration in Ocean Space | The LRET Collegium 2011 Series, Volume 1

Carbon Capture and Storage in Deep Ocean Space for the 21st Century

Guidelines for Implementation in China



ELIZABETH A. LIVERMONT, YONGJIE KOH, TAURAI MLAMBO, MAHESA BHAWANIN, BINBIN ZHAO

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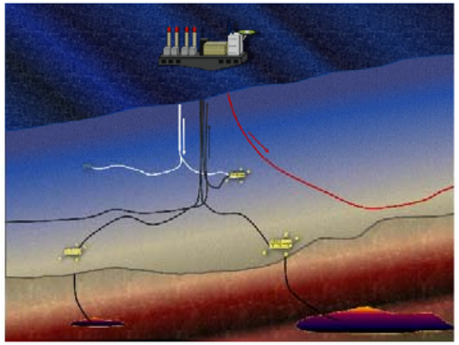
Carbon Capture & Sequestration in Ocean Space | The LRET Collegium 2011 Series, Volume 2

Offshore Thermal Power with CCS

An Alternative to CO_2 Transportation



BJÖRN WINDÉN, MINGSHENG CHEN, NAOYA OKAMOTO, DO KYUN KIM & ELIZABETH MCCAIG

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Carbon Capture & Sequestration in Ocean Space | The LRET Collegium 2011 Series, Volume 3

The Key to Successful Carbon Capture and Storage

Engaging the Public

NING CHENG, MIRJAM FÜRTH
MICHAEL CHARLES JOHNSON & ZHI YUNG TAY

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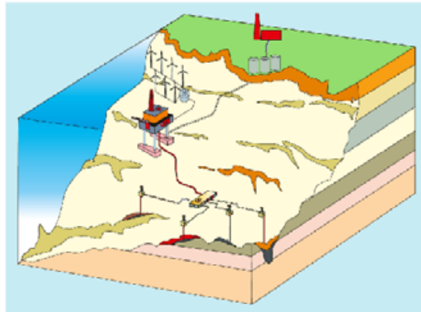
Carbon Capture & Sequestration in Ocean Space | The LRET Collegium 2011 Series, Volume 4

Offshore Renewable Energy Powered CO_2 Injection

A Small Carbon Footprint Solution



AICHUN FENG, TAEYOUNG KIM, XIAOJUN LI, ZEESHAN RIAZ & JUSTIN WEE

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Closure

- The LRET Collegium 2011 successfully achieved two the three outputs, namely the report and layman article, with the third output, the technical article, being work in progress
- Tangible steps are underway to achieve the stated outcomes: of generating interest in CCS and influencing people in policy directions; of celebrating the success of young scholars from around the world; and of widening and deepening awareness of The LRET's activities and its aims.

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The Future

- Two more summer programmes are proposed in Southampton in 2012 and 2013
- Full scholarships provided via LRET for all students attending
- Applications sought worldwide encouraging both industry and academic participants. Seeking ‘the best’ and the likely next generation leaders in maritime sector. Network of LRET UTC provided many links.
- Generous support of LRET and its vision for future maritime education very gratefully acknowledged

Was it all hard work (ctrl-shift H)?

- Justin's travels