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Pilot Case Definition

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Abstract

The idea of the GATEWAY project is to develop a comprehensive model Pilot Case which, intentionally, will pave the ground for CCS deployment in Europe. It will result from the examination of, and agreement on, technical, commercial, judicial and societal issues pertaining to a future CO_2 transport infrastructure. The Pilot Case derived on this basis, will emphasise a gateway for CO_2 transport in the North Sea Basin.

This Deliverable describes the basis for proposing candidate Pilot Cases and carrying out a selection process for the chosen Case, based on a set of criteria.

So as to maximise the impact of the proposed project, the GATEWAY project intends that the Pilot Case will be developed as a European "project of common interest" (PCI), obtaining the PCI label which will benefit from faster and more efficient permit-granting procedures and improved regulatory treatment. These projects may also have access to financial support from the European Union. The required criteria for a PCI project are set out in the report and candidate projects devised to meet them.

The GATEWAY project has also proposed additional criteria for the chosen Pilot Case to make sure the case is commercially sound, meets technical, regulatory and legal hurdles and has Member State and project partner support.

The four candidate Cases, which were proposed by the partners after consultation with interested parties, are set out and their merits discussed. The Cases cover a wide range of geography around the North Sea basin and serve defined clusters of CO_2 emissions of differing scale. The selection process is also described, taking into account each of the key criteria and the evaluation of the candidate Cases against them.

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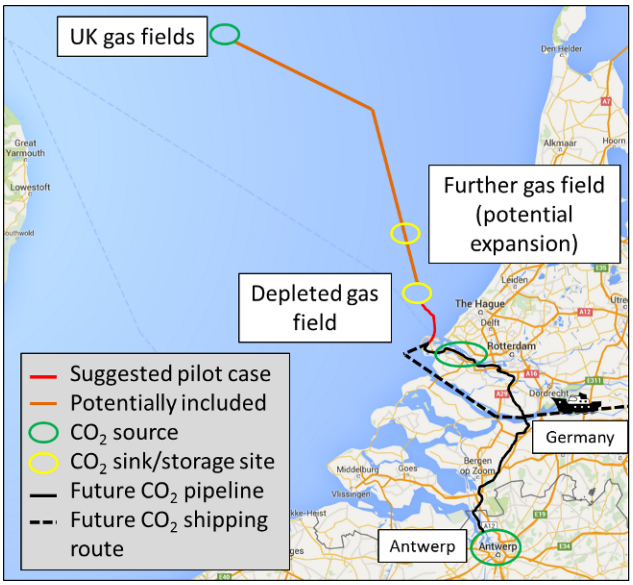

The chosen Pilot Case (Rotterdam Nucleus, shown in outline in the figure) is described in some detail. The Case is based on the development of Rotterdam as a southern North Sea hub with CO_2 capture being funneled through the port to off-shore depleted gas fields and further links using the CCS infrastructure to facilitate the processing of undeveloped gas fields. There are significant further expansion opportunities beyond the specific project, increasing the capture clusters through additional pipelines, expanding to further gas fields and using the port of Rotterdam for CO_2 shipping.

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1 INTRODUCTION

The stated objectives of GATEWAY are as follows:

a) to define an initiative, referred to as the Pilot Case, providing a model for establishing a European CO_2 infrastructure project, targeting a gateway transferring CO_2 from source to sink. The gateway is intended to form the first leg of a cross-border network, allowing multiple sources and multiple sinks.

b) to make profound assessments of the substantial funding needs and available resources.

c) to solicit strong actions by the partners involved (member states of the EU and other countries).

The idea is to develop a comprehensive model case which, intentionally, will pave the ground for CCS deployment in Europe. It will result from the examination of, and agreement on, technical, commercial, judicial and societal issues pertaining to a future CO_2 transport infrastructure. The Pilot Case derived on this basis, will emphasise a gateway for CO_2 transport in the North Sea Basin.

Necessary and important elements are the possible arrangements for a super-national legal entity responsible for the planning, construction, commissioning, operations, future extension, and eventually the decommissioning of the infrastructure. Additional to innovation and technological refinements, a detailed understanding is required of the legal and statutory framework, ownership arrangements, commercial aspects including synchronised funding from multiple sources, and the sharing of risk and liability.

1.1 Pilot Case Requirements

In order to define the basis for proposing candidate Pilot Cases and to carry out an unbiased selection process for the chosen Case, it is necessary to first set out the requirements for a suitable Pilot Case.

So as to maximise the impact of the proposed project, the GATEWAY project intends that the Pilot Case will be developed as a European “project of common interest”, obtaining the PCI label. The European Commission is maintaining a list of key energy infrastructure projects which have obtained the PCI label and will benefit from faster and more efficient permit-granting procedures and improved regulatory treatment. These projects may also have access to financial support from the European Union. In order for a project to be included in the list, it has to meet the minimum requirements to be eligible. These criteria are discussed in Section 2.

The GATEWAY project has also proposed additional requirements for a suitable Case to make sure the case is commercially sound, meets technical, regulatory and legal hurdles and has Member State and project partner support. The initial ideas for axes of such requirements are shown conceptually in Figure 1.1 and these are also discussed and developed in more detail in Section 2.

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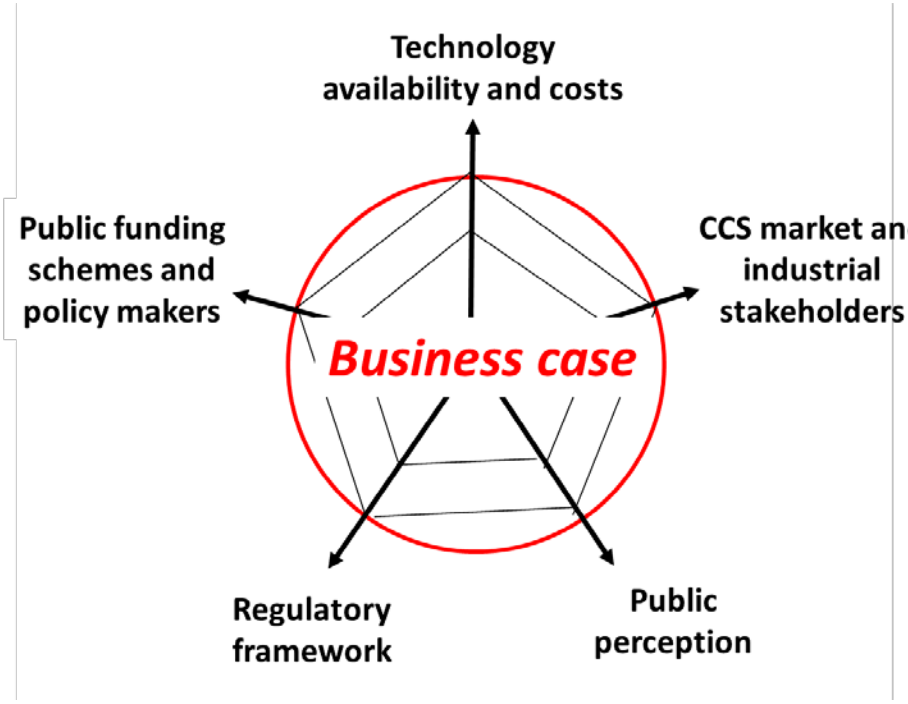

Figure 1.1 Axes forming the Business Case for a candidate Pilot Case

2 PCI CRITERIA

The requirement for eligibility of projects to be a Project of Common Interest (PCI) are key to the GATEWAY project and it is useful to list the key criteria here as they form a key stage in the Decision Gate process for agreeing and defining the Case Study. A more detailed examination of the criteria and the EC legislation is given in Appendix 1.

The criteria set out by the European Parliament1 for PCIs are as follows (words in brackets are interpretation for clarity). PCIs must:

- involve at least two Member States and cross a MS border [the possible alternative of a "significant cross-border impact" is not defined for CO_2];
- involve a pipeline linking more than one source to more than one storage location [shipping itself would appear to be excluded, although port infrastructure may not be];
- show potential overall benefits which outweigh its costs, including in the longer term [possibly defined in Annex 5 as 20yrs];
- contribute significantly to the avoidance of carbon dioxide emissions while maintaining security of energy supply;
- contribute significantly to increasing the resilience and security of carbon dioxide transport;
- contribute significantly to the efficient use of resources, by enabling the connection of multiple carbon dioxide sources and storage sites via common infrastructure and minimizing environmental burden and risks.

Each of the candidate cases discussed in the following sections has been designed to meet these minimum requirements.

In addition to meeting the PCI criteria above, further important aspects of candidate Cases were established in a project workshop. These included:

,

- Serve key CO_2 areas of Europe, particularly by key clusters of potential sources and availability of storage;
- Provide the seed for further European CCS development; see discussion of ZEP development phases below;
- Have financial and political support from stakeholders, sponsors and Member States;
- Absence of legal or public opinion "showstoppers";
- Facilitate routes to seed further CCS projects
- Commercial drivers – the economics of the Case look plausible from the outset.

The ZEP (Zero Emissions Platform) have produced a document[2] called "An Executable Plan for enabling CCS in Europe" which describes, inter alia, three phases of development of CCS projects which is a relevant vision for the GATEWAY Pilot Case (See Figure 2.1). The three phases can be summarised as follows:

[1] Regulation (EU) No 347/2013 of the European Parliament

[2] An Executable Plan for enabling CCS in Europe, ZEP, September 2015.

Phase 1: Deliver existing single source/ sink CCS demonstration projects in prime locations which can be expanded into strategic European CO_2 hubs;
Phase 2: Start sourcing CO_2 from nearby emitters to create CCS hubs, i.e. clustering additional CCS projects near the ground-breaking CO_2 transport infrastructure. Ensure that the storage is appraised well in advance of its need, driven by hub expansion;
Phase 3: Expand the hub over a wider region and potentially across neighbouring countries.

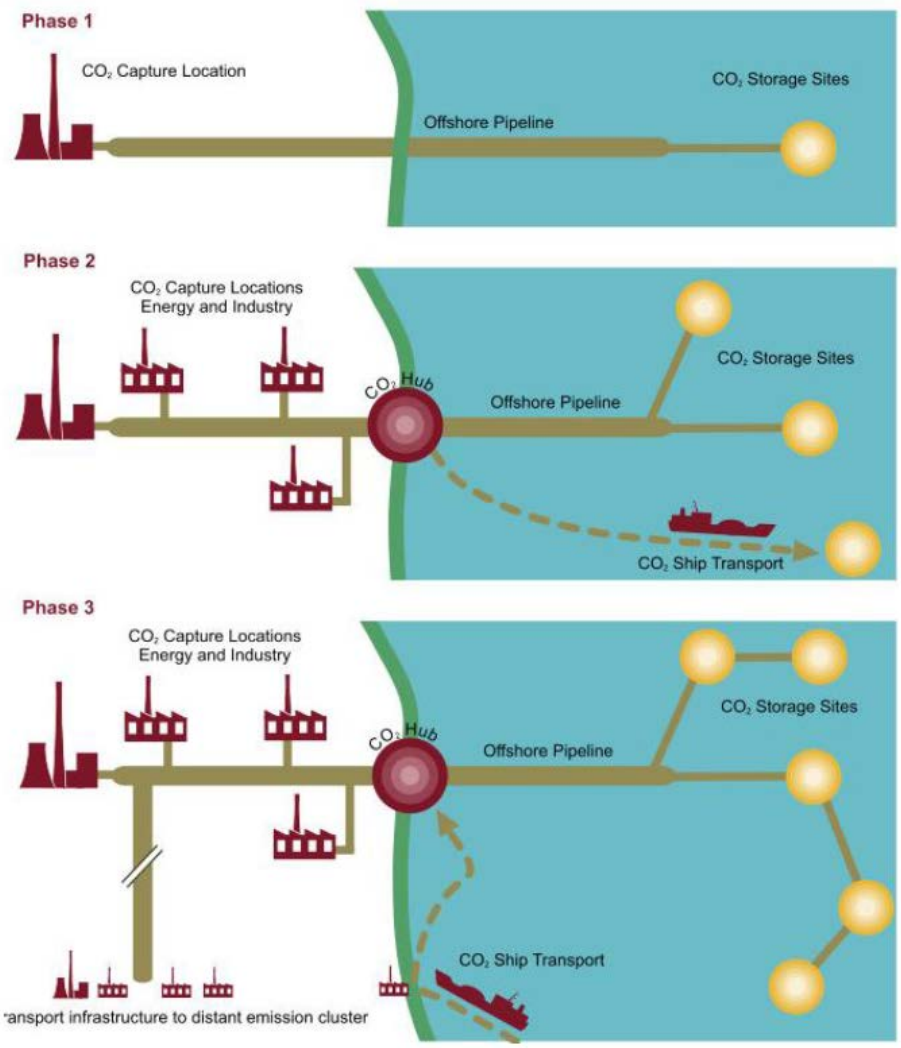

Figure 2.1: Phases of development of a CCS project (ZEP)

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3 EUROPEAN SOURCES AND STORAGE LOCATIONS

Many European projects have looked at the types, sizes and locations of CO_2 sources and possible storage locations, including Geocapacity, ECCO and CO_2Europipe. The following Figure 3.1 is from CO_2Europipe, showing sources of CO_2 plotted across the geography of Western Europe.

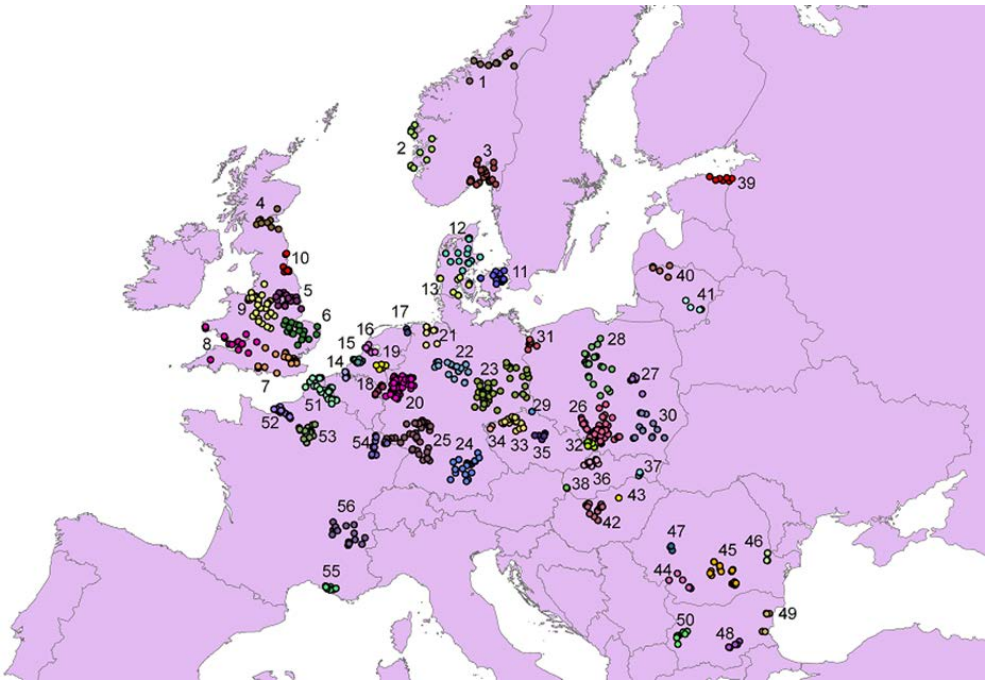

Figure 3.1: CO_2Europipe – Major CO_2 sources in Western Europe

GATEWAY has updated some of the data from these projects in order to make use of it both to inform the possibilities for candidate cases and for specific information for those cases chosen to investigate and support their merits in more detail.

The main focus of interest for possible CO_2 sources is clusters of larger industrial and power sector emitters which are sufficiently new to have a projected lifetime long enough to support investment in transport and storage infrastructure. These clusters need also to be co-located sufficiently closely to allow relatively cost-effective joint collection and geographically within a sensible range of storage opportunities.

Whilst on-shore storage is less expensive, it remains fraught with legal and public opinion problems and suitable sites of sufficient capacity seem unlikely for GATEWAY. Hence the initial focus of a search for candidate storage locations should take place in the North Sea where there is plenty of off-shore storage capacity in both aquifers and depleted hydrocarbon fields.

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3.1 Sources

The following table summarises some of the main clusters of emission sources of CO_2 in Western Europe which are located reasonably close to the North Sea. Cluster size is an important factor which can justify the installation of CCS infrastructure; the age of the relevant emitters is also relevant as more modern plant are likely to provide emissions which are more readily captured, but the plant is also likely to remain in service longer to provide economic support to the CCS capital investment.

Type	Location	Size of cluster Mt/y CO_2	Typical age years
Power	Nordrhein Westfalen (D)	120	33
Power	Niedersachsen (D)	22	25
Power	South Netherlands (NL)	31	18
Power	Belgium (B)	15	12
Power	UK Northeast (UK)	44	32
Power	Norway	2	9
Steel	Nordrhein Westfalen (D)	17	
Steel	Niedersachsen (D)	8	
Industry	UK Northeast (UK)	5	
Industry	South Norway	1	

Table 3.1: Main clusters of CO_2 emissions in Northwest Europe

It is clear that the most significant clusters are located in the western part of Germany, in the regions of Nordrhein Westfalen and Niedersachsen. The vast majority of the German power plants are owned by RWE with a minority in the hands of EoN. Many of these fossil-fuelled plants are long-established, but there are more modern plants in the mix which might be expected to provide easier capture opportunities. In the south of The Netherlands and in Belgium there are also significant clusters with more modern plants on average. There are also a number of sizeable clusters down the east coast of the UK, notably in the northeast at Teesside.

More details of the relevant plant in each chosen cluster are given with the individual case descriptions in Section 4.2.

3.2 Storage

Storage locations for CO_2 are plentiful across Western Europe, although when examined more closely many of the potential storage locations have drawbacks of various sorts. The storage locations fall into three main categories as follows:

- Depleted hydrocarbon fields, with two types:
  - Oil fields (and Condensate fields)
  - Gas fields
- Saline aquifer formations

Oil and gas fields have several potential advantages:

- a proven seal (for hydrocarbons),
- considerable existing topographical knowledge and modelling,
- existing infrastructure for both drilling and gas processing,
- the potential for enhanced oil/gas recovery (EOR/EGR).

EOR and EGR can make a very significant contribution to the economics of a storage opportunity and this is discussed further in Section 5. The downside of all explored fields is that they suffer from the problem of old wells, the capping of which may be of unknown quality and condition.

Saline aquifers, on the other hand, are usually relatively unmapped with seismic surveys and have unknown qualities in terms of the available seal and any fissures.

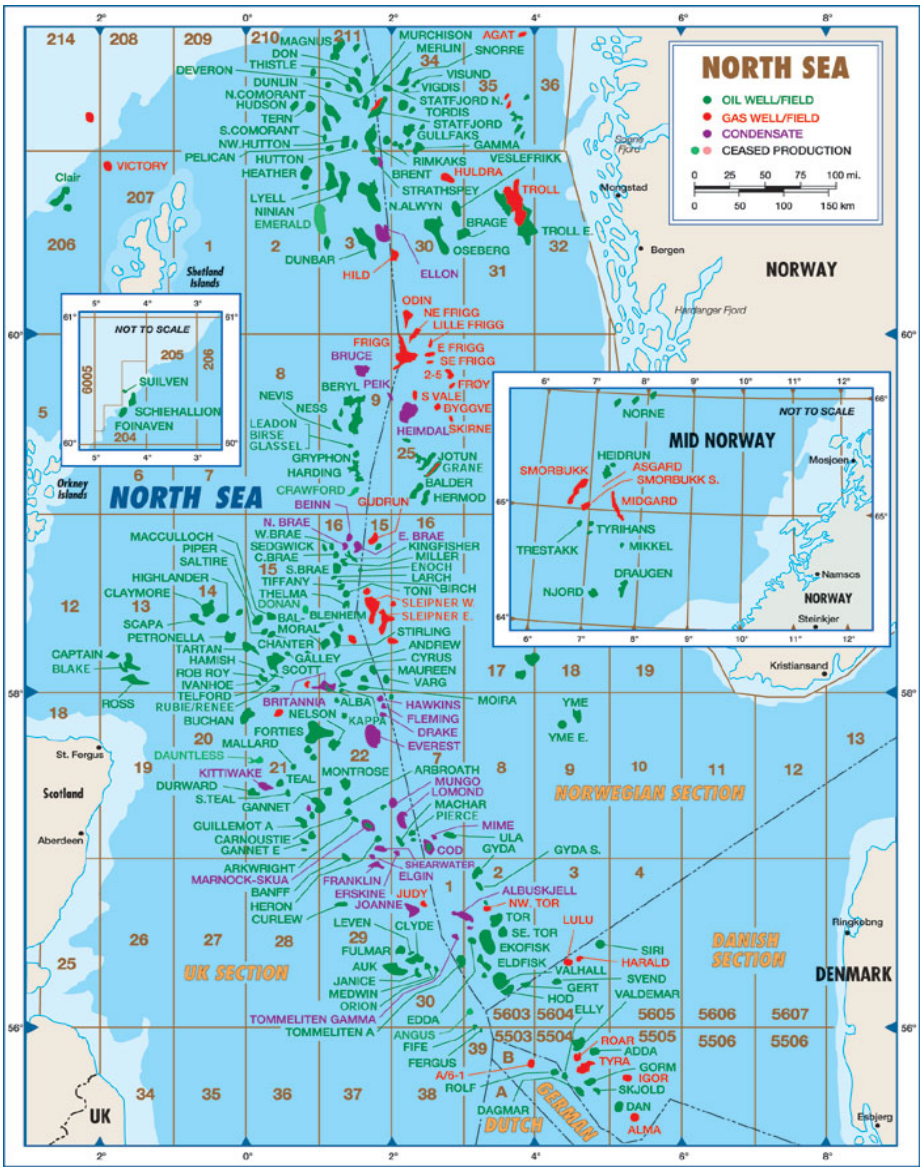
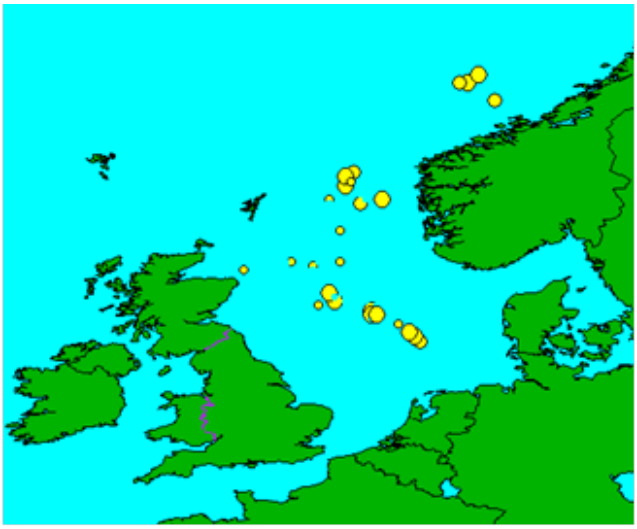


Figure 3.2: Oil and Gas fields in the Central and Northern regions of the North Sea

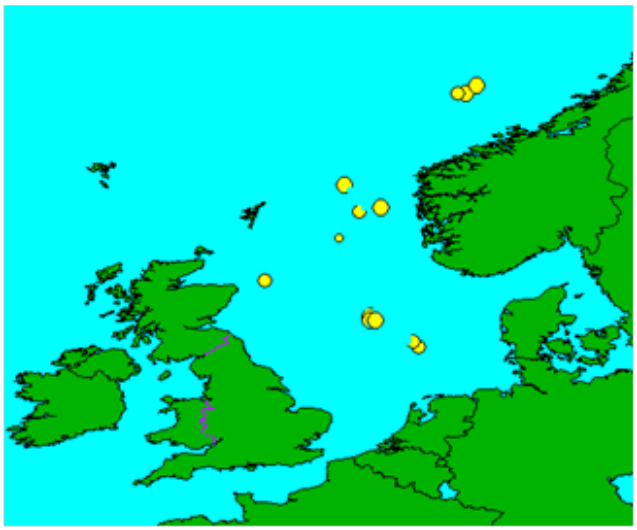
The vast majority of the accessible oil field capacity is located in the Central or Northern regions of the North Sea, generally clustering along the central graben and divided between the UK and

Norwegian sectors. There are a set of oil fields in the Danish sector, but the majority are chalk-based fields which are inherently difficult for CO_2 storage.

The FP7-funded ECCO project undertook a significant analysis[3] of the availability of depleted oil fields in the central and northern North Sea to find the likely sizes and period of maturity for possible Enhanced Oil Recovery (EOR) and storage of CO_2. Oil fields "mature" in this sense when they are economically depleted (this depends on the prevailing oil price and operational costs) but are then usually abandoned within a few years making them a much more expensive proposition to re-open. Hence they have a period of maturity when they are potentially good for CO_2 injection.



(a) Fields maturing by 2020



(b) Fields maturing by 2025

Figure 3.3: Availability of depleted oil fields in North Sea

The findings from ECCO for 2020 and 2025 are shown in Figure 3.3. The larger the dot, the greater the CO_2 capacity. It can be seen that there are quite a number of potential fields in the

[3] ECCO project Deliverable D2.2.1

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UK and Norwegian sectors in 2020, but these are dwindling and becoming further north by 2025 (reflecting later-developed fields).

Turning to the accessible depleted gas fields, the majority of these are located in the relatively shallow water of the Southern North Sea between the UK and The Netherlands.

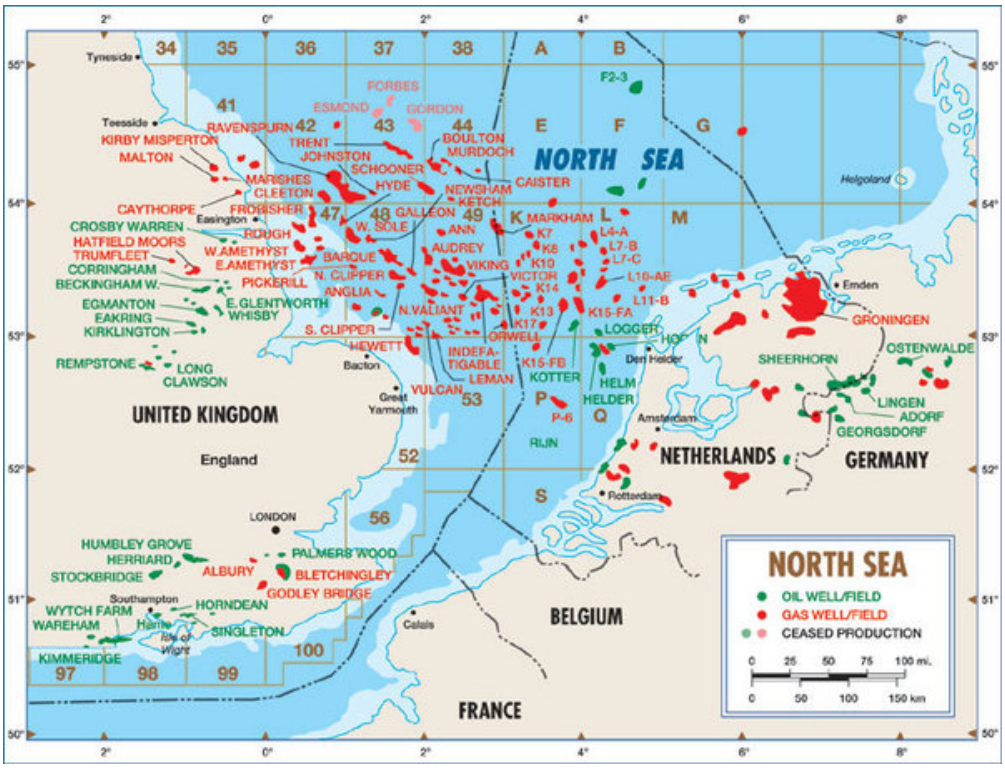

Figure 3.4: Oil and gas fields in the Southern North Sea

Hence in considering the possible Candidate Cases for GATEWAY, the availability and location of these potential storage areas have been taken into account, not only for the initial projects themselves, but also in estimating each Case's potential for seeding future development of CCS.

4 CANDIDATE PILOT CASES

In defining the Pilot Case to meet the requirements for the GATEWAY project, it was considered important to consider a range of possible cases which reflect different types of possible configurations, both in terms of technical aspects (eg overall size, types of sources and storage, pipeline length etc.) and also in terms of some of the key criteria, such as legal issues, public acceptability and structure of business case.

To this end, discussions amongst the project partners took place in order to come up with initial ideas. These were then refined through a workshop where some of the key criteria were rehearsed for each of the forthcoming ideas. Further refinement of possible cases took place by involving a range of other interested parties and presenting suggestions to a meeting of key players in Brussels.

After this process the possible cases were reduced to four key candidates and these were then subjected to an analysis of their merits against the key criteria at a further workshop.

4.1 Important Criteria

In considering how and where to identify candidate cases, the most important criteria have been identified and then projects devised which take them into account as much as possible. Apart from the necessary PCI criteria (see Section 2 above) which are clearly essential aspects of any proposal, other key criteria can be taken to be:

- Volume of CO_2 available to be (readily) captured in a defined area and follow-on projects
- Absence of legal or public opinion “showstoppers”
- Supportive Member State(s) and business partners
- Plausible route to storage
- Viable Commercial Plan

The largest clusters of CO_2 production both in the power and industrial sectors in Western Europe within reach of the North Sea are in the Ruhr (Nordrhein Westfalen) in Western Germany, so a case involving a maximum impact large collaborative pipeline project would have to seriously consider this region as at least part of its capture base. An additional capture prospect for this case could be the new coal plant at Eemshaven in The Netherlands. However, this whole project has to be set against the significant legal and public opinion obstacles in Germany and the lack of existing Member State-sponsored projects in Germany.

Looking at Member States which are actively supportive of CCS and existing planned / under-construction projects, the ROAD project based on Rotterdam and the CAR pipeline from Antwerp to Rotterdam are promising examples. An extension to this emerging hub could be possible to make it suitable by including Belgium (Antwerp) as an additional Member State and possibly storage in the UK sector of the SNS as well would fit with many of the key criteria.

An alternative supportive Member State is the UK, even though government funding for a CCS competition was withdrawn in 2015. At that time, two CCS projects were at an advanced stage of development; these projects have since been abandoned. There is an opportunity here to explore a candidate focusing on Industrial CO_2 and a good business case, based on the

development of the use of CO_2 for EOR in the Central North Sea. The industrial cluster in the Northeast of England (Teesside) represents one of the best combinations of size and proximity to relevant oil fields. This case should also include a cross border store in one of the depleted oil or gas fields in the Norwegian Sector of the North Sea as a means of opening up this rich storage target area.

4.2 Possible Cases

The four different possible cases arising from the process discussed above are shown graphically in the following Figure 4.1 and then summarized in the following tables. Orange dots portray sources of CO_2, while blue dots signify storage locations with black lines showing pipeline routes.

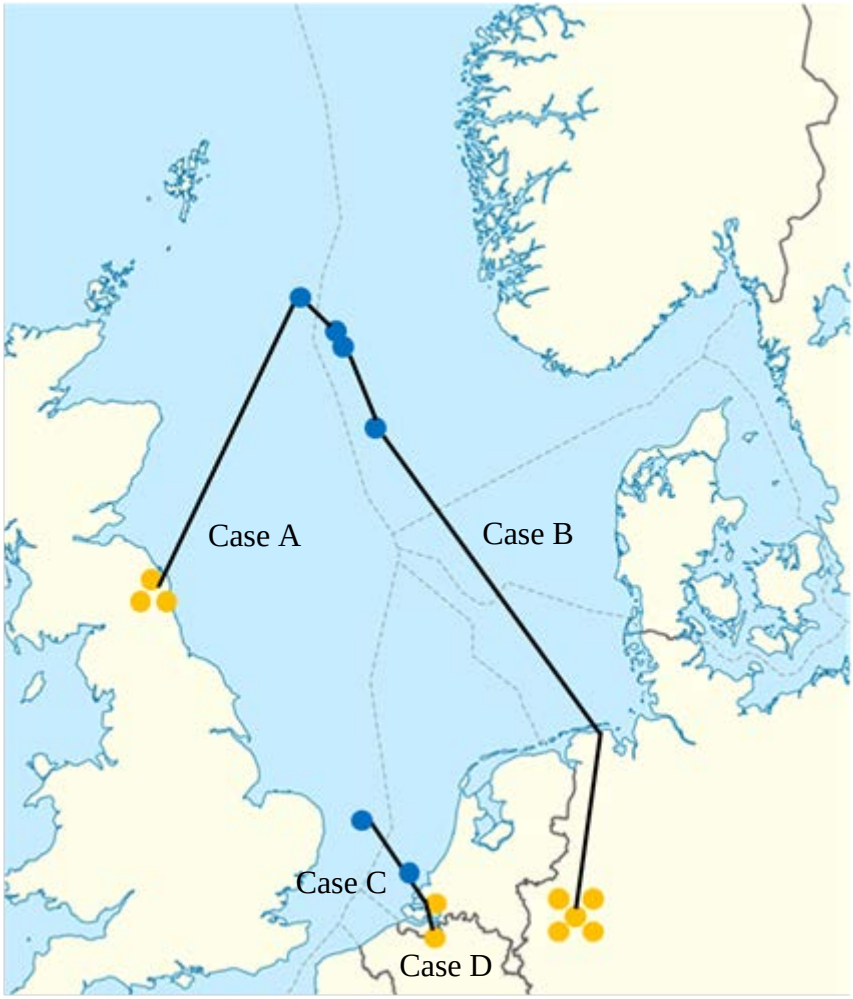

Figure 4.1 Diagram illustrating the location of possible candidate cases

Case A UK – Norway EOR

This project proposes a pipeline linking a varied cluster of CO_2 sources in the North East of England to Enhanced Oil Recovery (EOR) opportunities in the UK and Norwegian sectors of the Central North Sea (CNS).
There is a huge but fleeting opportunity to use CO_2 to produce significant additional levels of oil from existing CNS fields. This could amount to a further 30% of all CNS historical production with a total value of €100s bn, but the economic window for exploiting this opportunity is during the fields' decline which is from now for a further 10 years or so.

Outline:

The CO_2 source is the Teesside Collective, a mixed cluster of sources including industry (agriculture), power and gas reformation. Capture already existing for some, others projected to use standard absorption technology. Formed from members of the existing industrial cluster and with the involvement of the public sector, Teesside Collective is a local initiative with a shared vision of the Tees Valley as a leading hub of clean industrial production, assisting the UK to meet its targets for greenhouse gas reduction.

An initial CO_2 capture rate of 5Mt/a is envisaged and the proposed transport infrastructure is a high pressure, long (500km), oversized (28inch) pipeline from NE England to the CNS oil fields with no intermediate booster, operating at 210 bar. A fully-scoped route for the pipeline to the Central North Sea already exists, following some existing lines and away from any populated areas. The target CNS oil fields are high CO_2 fields [such as Brae (100Mt), T block (60Mt) in the UK sector and Jotun, Ula and Oseberg (100sMt) in the Norwegian sector]. These are all strategically closely located to Sleipner which could be used as a suitable buffer store for the storage cluster as shown in Figure 4.2.

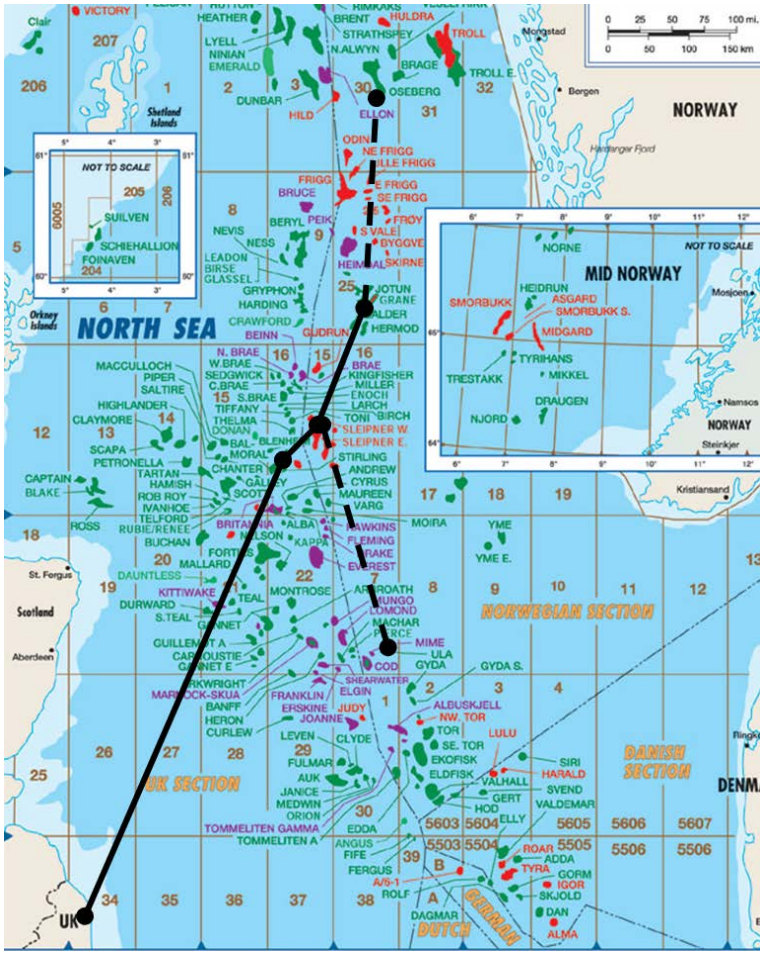

Figure 4.2: Diagram of Case A pipeline routing to CNS fields

Benefits of this case:

- Industrial and power CO_2 sources with extension possibilities
- Uses EOR to provide good business case and legal clearance for transboundary
- Supportive MS capture with transfer of some CO_2 to other MS for storage
- Lower cost way of accessing CNS

Key Issues

- Relies partially on new plant development
- Deliberately over-sized pipeline to seed further regional CCS development

There is considerable stakeholder interest and support for the project as follows:

- specific support / interest from UK government and regional agency support
- local Teesside Collective has been formed with CCS specifically in mind
- several local industries have expressed support and some CO_2 (0.5Mt/a) is captured already
- several strategic reports on the CCS opportunity at Teesside exist from bodies including Teesside Valley Unlimited (TVU), Cambridge Econometrics, Amec Foster Wheeler.

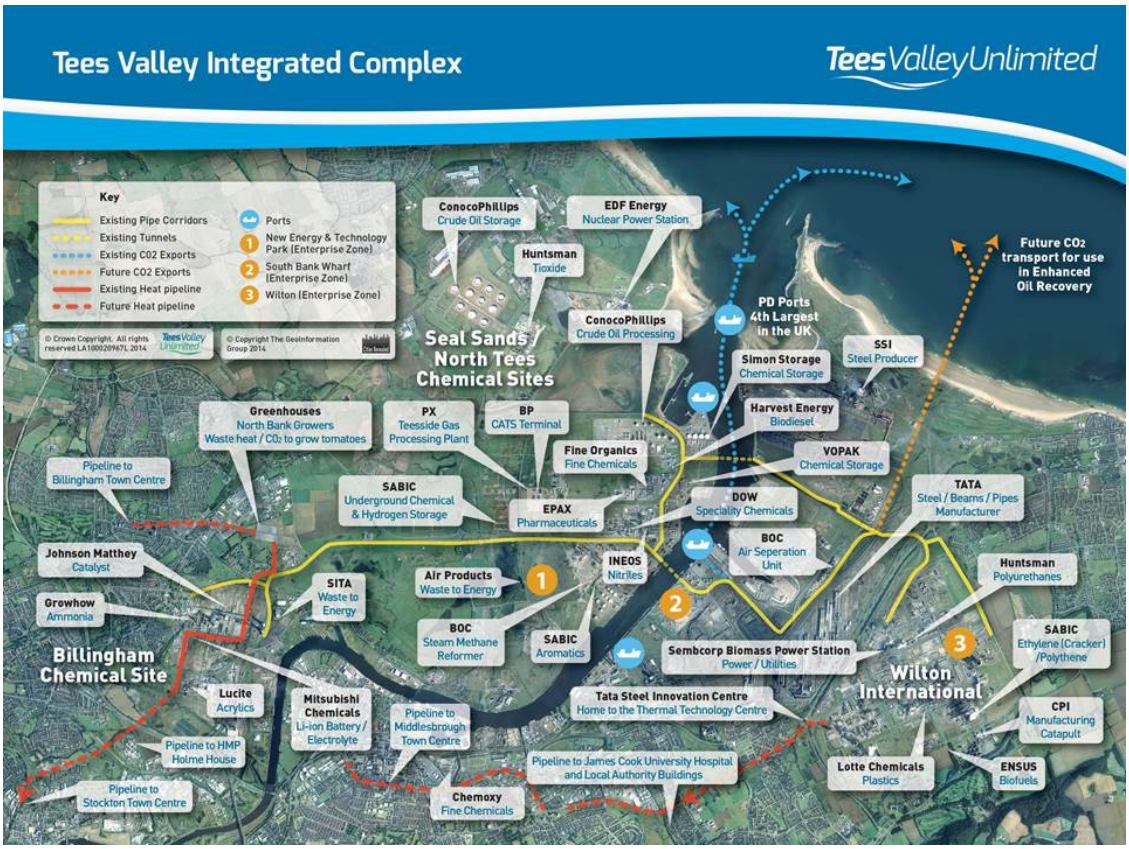

Figure 4.3: CO_2 sources in the Tees valley area

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Development potential
Additional EOR income stream facilitates oversizing
Backbone to seed significant uptake of CCS in Europe's densest CO_2 emissions areas
Encourages additional EU oil supplies and storage operators

Phase 1: Multi-source / one sink; Oversized strategic pipeline, supported due to EOR potential
Phase 2: Developing cluster and further storage areas
Phase 3: Further expansion opportunity with additional capture clusters.
Shipping hub facility from Europe's southern N Sea basin, 20Mt/a achievable

Case B: German Backbone

The proposed project is to link the major concentration of CO_2 emissions in Western Europe which are in the Ruhr valley in Germany to the main North Sea oil fields in the Central North Sea. This is a major CO_2 pipeline project to serve as a backbone for the development of a full CCS network around Western Europe and the North Sea area.

Outline:

The initial CO_2 source is the coal / lignite power stations of RWE and EON in the Ruhr valley in Germany using standard post-combustion absorption technology. An initial CO_2 capture rate of 8Mt/a is envisaged from a selection of the most likely power stations. Industrial companies (steel, cement) in same location can also be included to complement the cluster.

The proposed transport infrastructure is a high pressure, long (900km), oversized (44inch) pipeline running through western Germany near the Netherlands border to the North Sea coast at Wilhelmshaven from whence it will follow the offshore route of EuropipeI to the Central North Sea around the Sleipner area of the Norwegian sector – see Figure 4.4.

This can be used as a buffer store and a hub for further radial distribution to a variety of suitable CNS oil fields. There is the opportunity for EOR at many of these fields.

Figure 4.4: Diagram of Case B pipeline routing

Sources- power	Size (MW / Mt/a)	Age (years)	Owner (MS)
Neurath F – lignite	1100 / 9.4	3	RWE (D)
Neurath G - lignite	1100 / 9.4	3	RWE (D)
Niederraussem K - lignite	944 / 8.1	13	RWE (D)
Dattein 4 - coal	1100 / 5.4	New	EoN (D)
Eemshaven - Coal	1600 / 7.9	New	RWE (NL)

Table 4.1: Identified potential power station CO_2 sources for German Backbone

Benefits of this case:

- Provides a large "backbone" pipeline to encourage additional projects (such as Eemshaven)
- Originates in densest CO_2 emissions in Western Europe
- Single MS capture transfers CO_2 to other MS for storage

Key issues

- Pre-investment in high capital cost pipeline
- Legal obstacles in Germany
- Problems with onshore pipeline public opinion
- Lack of clear MS incentive framework for capture
- Use for EOR clears some transboundary legal issues

Key stakeholders / drivers

- Power operators RWE and EON
- CNS depleted field operators
- Industrial companies in same location to complement cluster
- $4billion/a potential income from oil

Development potential

Additional EOR income stream facilitates oversizing
Backbone to seed significant uptake of CCS in Europe's densest CO_2 emissions areas
Encourages additional EU oil supplies and storage operators

Phase 1: One source / one sink; Oversized strategic pipeline, supported due to EOR potential
Phase 2: Developing cluster and second storage
Phase 3: High expansion opportunity involving further clusters and extension pipelines
Shipping facility also possible at Wilhelmshaven - 50Mt/a achievable

Case C **Rotterdam Nucleus**

The proposed project is based on the developing nucleus of Rotterdam, with the RCI initiative, existing ROAD project and potential additional cluster connections (see CAR project Case D). The CO_2 network is extended out to gas field "Fizzy" in UK SNS sector 50 to facilitate gas production with CO_2 separation and storage. By doing this, 3.7 bcm natural gas can be produced (current value $800m) with potential for considerable further similar extensions. The importance of CCS in this context is its ability to facilitate the development of a further significant gas field. This project also has the potential to demonstrate a valid income stream for CCS infrastructure which can enable and encourage international CO_2 infrastructure.

The Fizzy field has been evaluated as having 4.5bcm of natural gas in place with a similar volume of CO_2 content at around 50% of the total field. So the main obstacle to development of the field is the relatively high CO_2 content. This is a common characteristic of undeveloped fields in this area of the Southern North Sea (SNS), both in the UK and also in the Dutch sector.

Hence the project is to provide platform facilities with a Central Processing Unit for the high CO_2 fields in the vicinity. This would be a shallow water processing platform and there are a number of possible locations / options for its realization which are to be explored.

The storage options for the separated CO_2 in the existing proposed storage locations (P18 which is licensed with around 8Mt capacity and extension plans to P15 with a much larger capacity). Further CO_2 arising from the Rotterdam area (and potentially from the CAR pipeline) will be added to the storage volume. An over-sized 457mm pipeline is envisaged to link to the fields over a distance of 100km. CO_2 flows from Fizzy would rise to 2.5Mt/a/ and be complemented by flows out of Rotterdam growing from 1Mt/a.

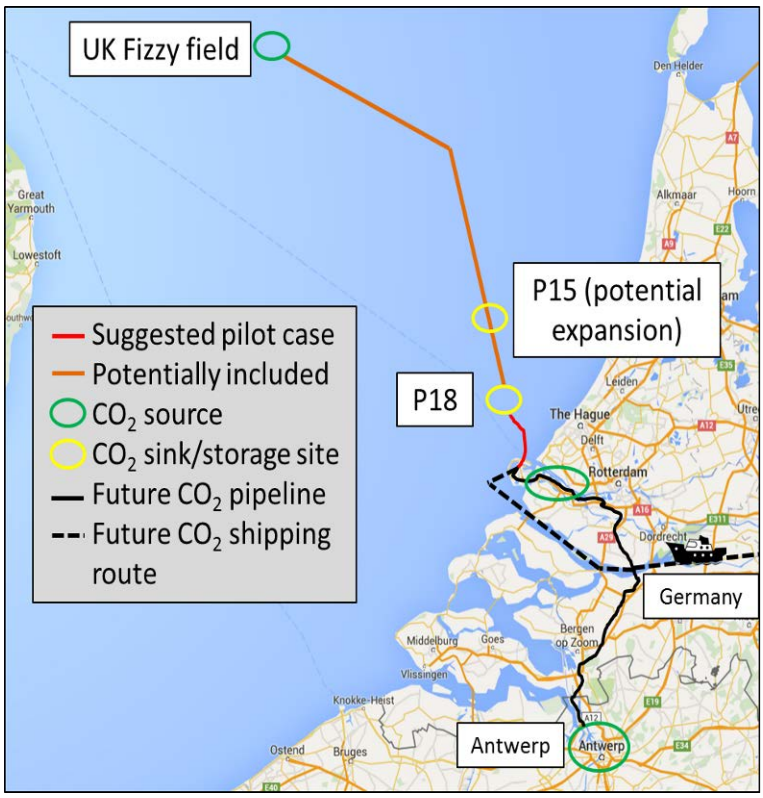

Figure 4.5: Diagram of pipeline routes and fields for Case C

Sources- power	Size (MW / Mt/a)	Age (years)	Owner (MS)
Maasvlakte 3 - Coal	1070 / 1.5	New	EON / GDF (NL)
BASF Industrial, Ammonia – NG	NA / 1.0	12	
Maasvlakte 1 & 2 - Coal	1042 / 1.5	27	EON (NL)

Table 4.2: Identified potential CO_2 sources in Rotterdam area

Benefits of this case:

- Existing Rotterdam project with explored pipeline routes
- Extension to other sources and further MS
- Supportive MS capture with transfer of some CO_2 to other MS for storage
- Extensive previous work done on CO_2 pipeline design and routing

Key Issues

- Unlocks ability to develop high-CO_2 gas fields in region
- Provides strategic CO_2 infrastructure linking storage facilities
- Growth potential for CCS projects

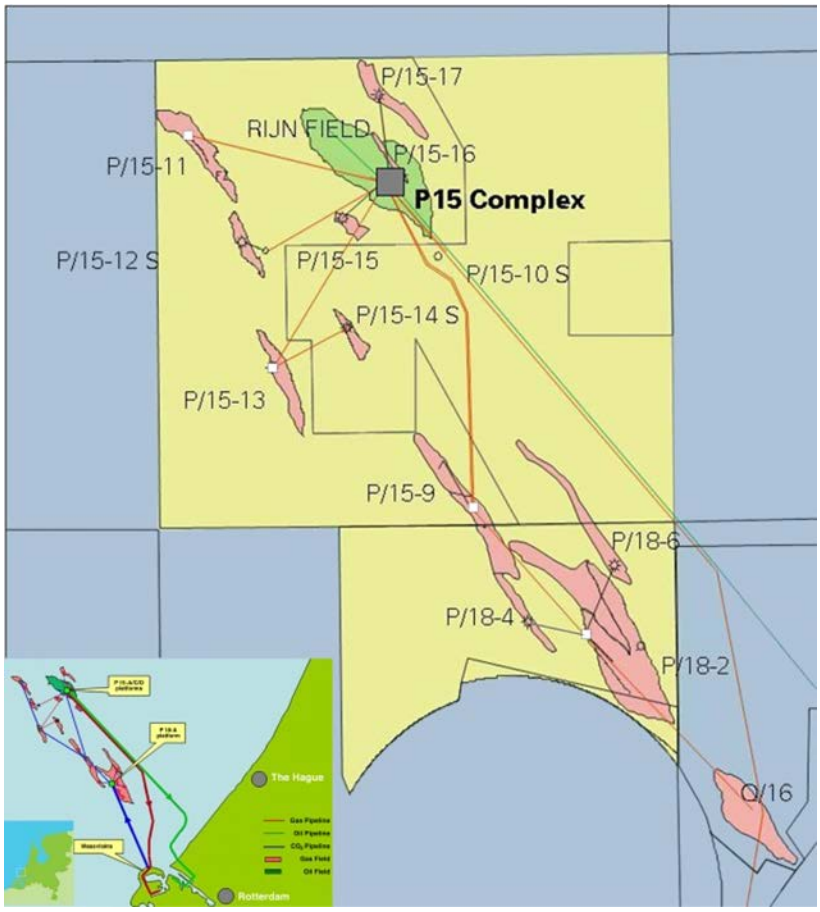

Figure 4.6: Storage locations in North Sea for Case C

Development potential
Additional gas production income stream facilitates processing and oversizing;
Creates CO_2 infrastructure to seed further CCS in greater Rotterdam region;
Facilitates additional EU gas supply development.

Phase 1: One source / one sink; Oversized strategic pipeline, supported due to gas potential
Phase 2: Developing cluster with second route to storage
Phase 3: High expansion opportunity involving further undeveloped gas fields;
Development of Rotterdam as CO_2 hub with shipping facility from the Rhur area.

Case D CAR Pipeline

The CO_2 PCI project proposal involves the development of a CO_2 pipeline, with the necessary compression and monitoring equipment, to transport CO_2 from a centralized location in the Antwerp region through the Port of Rotterdam (PoR) and then to gas fields in the P18 block of the Dutch continental shelf for complex for storage. The total length of the pipeline is approximately 140km, split into three sections with different pipeline capacities and pressure operation regimes. For ease of management and operation, the 3 sections have been given individual titles, but should be considered as an individual PCI known as the CAR Pipeline.

The CO_2 Antwerp-Rotterdam (CAR) Pipeline would follow and suitable pipeline corridor between the ports which already approved in regional spatial plans, so permitting the proposed pipeline should be able to be completed efficiently. The route between the ports involves multiple canal, river, road and rail crossings and is about 80km long. The route of the CAR pipeline crosses beneath Hollands Diep, Oude Maas, 3 canals, 8 motorways, 2 railways and more than 80 minor and provincial roads along a pre-zoned pipeline route. The initial proposed capacity of the CAR pipeline is 5 $MtCO_2$ per annum, operating at a pressure of 110 bar.

The CAR pipeline would arrive in the eastern section of the PoR, near the industrial complex of Pernis, where it would join another section of pipeline with a larger diameter. The ‘Multicore 2’ pipeline would traverse the PoR and would enable larger emitters in the PoR region to feed into the pipeline. There is already an existing ‘Multicore’ pipeline which transports refinery products across part of the PoR, and the new CO_2 pipeline could potentially follow the same route.

At the Maasvlakte 2, which is the western most part of the PoR, the pipeline travels offshore to the Multicore 2 Extension after the CO_2 is further compressed from 100 to 140 bar, a figure which is dependent on the injection profile of the initial storage location.

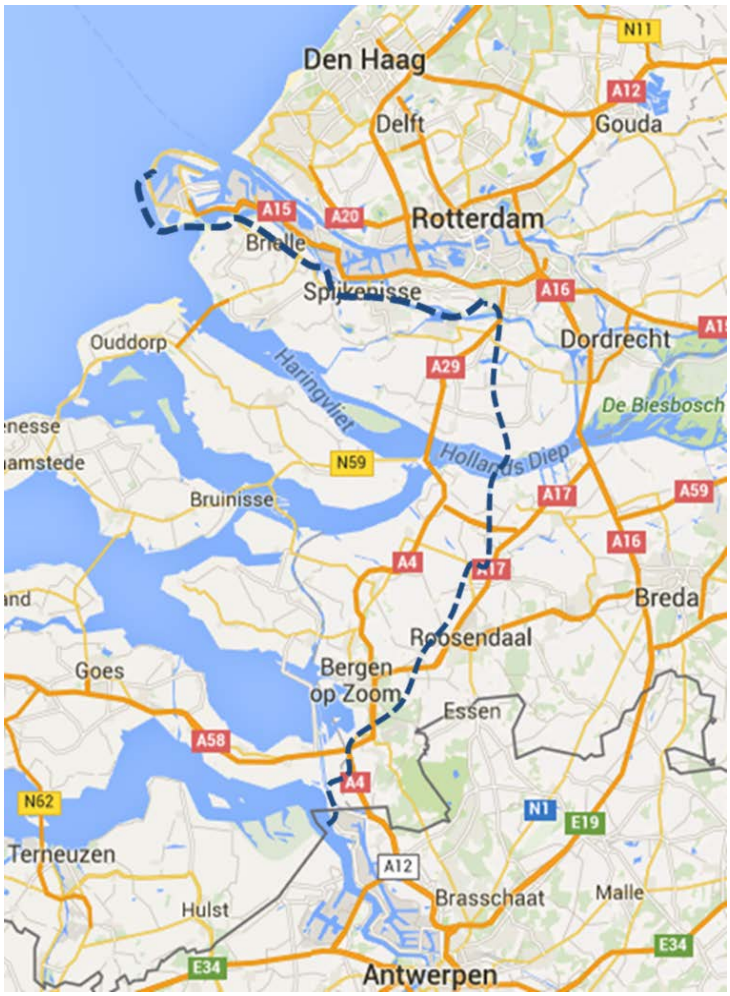

Figure 4.7: Proposed CAR pipeline route

Pipeline section	Pipeline Name	Route	Length (km)	Capacity Mt/a	Input pressure (bar)	Output pressure (bar)
1	CAR pipeline	PoA – PoR	80	5	20	110
2	Multicore 2	Pernis – Maasvlakte 2	40	10	99	110
3	Multicore 2 Ext.	Maasvlakte – P18 block	18	10	105	140

Table 4.3: Details of the CAR pipeline three sections

Port of Rotterdam	
Emission source	**MtCO2/yr**
E.On Benelux NV (coal power)	7.2
Shell Nederland Refinery	4.3
Esso Nederland BV Refinery	2.0
BP Rotterdam Refinery	1,9
AVR NV (waste incinerator)	1.5
Pergen VOF (gas power)	1.3
Air Liquide (chemicals)	0.8
Air Products (chemicals)	0.5
Eurogen CV (gas power)	0.5

Port of Antwerp	
Emission source	**MtCO2/yr**
Total Refinery	3.6
BASF Refinery	3.1
Exxon Refinery Antwerp	1.7
Zandvliet Power (gas power)	1.0
Indaver Sleco (waste incinerator)	0.97
Total Olefins (chemicals)	0.96
Air Liquide (chemicals)	0.55
Independent Belgium Refinery	0.54
Evonik Industries (chemicals)	0.50

Table 4.4: Emission point sources in the Ports of Rotterdam and Antwerp

Benefits of this case:

- Existing Rotterdam hub with CO_2 infrastructure
- Extension to other sources and further MS
- Supportive MS capture with transfer of some CO_2 to other MS for storage

Key Issues

- Public acceptance of on-shore pipeline?
- Established supportive stakeholders

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Development potential
Links two important Southern North Sea port areas
Facilitates development of Rotterdam as a CO_2 hub.

Phase 1: One cluster / one storage;
Phase 2: Developing further cluster and second storage
Phase 3: Some expansion opportunity involving further clusters linked to Rotterdam

5 KEY CRITERIA

The key criteria for evaluating the candidate Cases are described in Section 4. The important aspects of each of these criteria were discussed at a special partner workshop and the four Cases were then evaluated for their merits against each distinct criterion. Some of the issues arising from key criteria during the workshop are included in the following sections from the workshop notes, and the scoring for the Cases is reported in section 5.7.

5.1 Technical Risk Profile

The key test here is whether the technology associated with the CCS project is proven and deliverable or whether there are elements which are novel or unproven at scale or which represent a complexity which is significant. Also included is an assessment of the synchronization / matching of source(s) and sink(s) and the availability of CO_2 to the project.

Workshop comments were as follows:

- Plausible transport route
  - CAR high since pipeline there (existing route)
  - German Backbone insufficient info, but not technically implausible
  - Rotterdam Nucleus and UK-Norway also plausible
- Is low-cost CO_2 available?
  - Cheap and available in UK-Norway, Rotterdam Nucleus and CAR
  - German CO_2 would not be cheap
- Technical complexity
  - UK-Norway don't need recompression over the 400 km
  - German backbone is quite far so gets complex
  - Rotterdam Nucleus and CAR are fairly simple
- Matching of sources/sinks over time frame
  - Perfect with German Backbone and EOR in N. Sea
  - Good match with Teesside (UK-Norway) and major oil fields with EOR
  - Lots of storage available in Dutch shelf, but maybe not over time

5.2 PCI Criteria and Seed for CCS growth

The candidate Cases had all been chosen with their strategic location and expansion potential in mind, so all are able to meet the minimum criteria for the PCI eligibility. The German Backbone is the boldest with the greatest development potential whilst the CAR project can be seen as the most local with perhaps the lowest further development potential.

Workshop comments were as follows:

- Helps ongoing CCS projects
  - Nothing ongoing in Germany, ROAD is more advanced than Teesside, amount from CO_2 CAR pipeline is relatively small
- Initiates new CCS projects
  - Potential clustering with each of the projects
- Engage member state on their stated emission reduction plans

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  - UK-Norway directly in line with both MS's policies
  - Rotterdam Nucleus is in line with both MS's policies, but not as much for the Dutch policy
  - CAR doesn't help Netherlands, but does Belgium (which doesn't have the policy yet for it)
  - German policies are renewables rather than CCS
- Maximizes strategic CCS deployment
  - German backbone is boldest and largest
  - CAR is rather locally focused

5.3 Stakeholders

The assessment of the candidate Cases in this category was not necessarily for existing supportive stakeholders (as in the acse of the CAR pipeline) but rather for the potential for MS support and for the ability to find supporting commercial stakeholders for the outline project.

Workshop points raised:

- UK-Norway – despite withdraw of funds, still support from local authorities and businesses and in principle from MS.
- German – low local assessment, slightly higher political support than local and commercial.
- Rotterdam Nucleus– similar to UK-Norway. More of in the future rather than current assessment.
- CAR – existing stakeholders in this project; harder because of what is going on in Belgium.

5.4 Business Case

The candidate Cases have been compared against a number of economic criteria, including their revenue prospects, their appetite for capital funds, the perceived project risk/reward balance and any commercial obstacles that are foreseen.

The comments from the workshop were as follows:

- Revenue prospects (public and private funding sources) – includes the Opex
  - Ranked those with EOR high
- Capital requirement – question about whether this is necessary since the funding might be proportional to this capital cost
  - Scored according to least capital required (mostly based on pipeline length)
- Risk/reward balance – all similar risks, but the reward varies between the different projects
  - Liabilities and difficulties in arrangements
  - How proven the storage, prospects for achieving the project
- Commercial obstacles – things preventing commercial groups to take on project, or negative aspects from commercial prospective
  - Ranked on commercial agreements, number of partners, etc.

This initial assessment was followed up by the development of an initial GATEWAY economic model which allowed the Cases to be compared on any standard economic parameters (such as NPV or project return). This model was designed with the following key features:

- Standard financial model with cash flow sheet for each Case
- Set of common scenario parameters for all cases – eg oil and carbon prices, inflation, discount rate, project duration, debt interest rate etc.
- Ability to produce "what-if" comparisons across all cases for given parameters.

Typical results from the model are shown in Table 5.1 and Figure 5.1.

		German Backbone	UK-Norway EOR	Rotterdam Nucleus	CAR
Project IRR (Real)	%	12%	16%	47%	0%
Project NPV (Real)	€M	333	875	586	20
Project NPV/Capital		0.10	0.46	1.89	0.08

Table 5.1: Typical economic comparator output from GATEWAY financial model

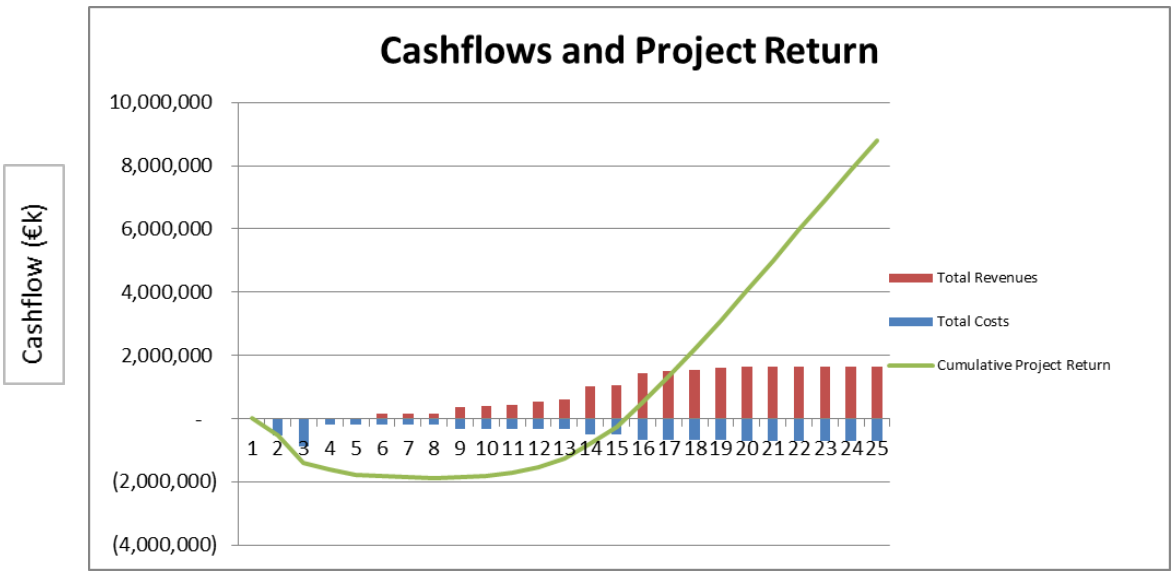

Figure 5.1: Typical graphical output from GATEWAY economic comparator

The results from a range of runs of the model were used to inform the assessments of each of the Cases.

5.5 Legal Issues

This topic encompasses a range of legal issues which could provide obstacles or show-stoppers for certain projects. Issues considered include International participation, the London Protocol, National Law & Policy, Commercial Law and Planning law and Permitting Issues. Liability issues have also been discussed but this point is recognized to be a continuing issue for all countries.

Comments from workshop:

- Belgium and Germany not signed amendment to London Protocol
- Liability – storage operator
- Planning and permitting – fine in most countries (and most likely improving)
    - Concern in Belgium – undecided on whether CO_2 transport is federal or regional issue
- Netherlands, UK, Norway look similar regarding legal obstacles, while Germany and Belgium are similar

5.6 Public Acceptance

Each of the outline candidate cases was assessed by Jülich for the anticipated public perception issues. The following is a short summary of the key points which were raised by Case letter:

A. **No significant problem**: It can be assumed that the short onshore pipeline itself would not give rise to very much public protest, particularly because it is running through an industrial area and along an established pipeline corridor. However, the compression station might give rise to protests from environmental activists or environmental organizations, because of its proximity to the Teesmouth National Nature Reserve.

B. **Very Negative**: From empirical studies, we can assume that such a high pressure, 600 km long pipeline running through western Germany would be perceived very negatively by the German public. Also, the perception of CO_2 onshore storage, CO_2 offshore storage and CO_2 transport via pipeline is considerably more negative in the German coastal regions than in the "rest of Germany". Further, the pipeline would be used for transporting CO_2 from the coal and lignite power stations in the Ruhr area and in Germany the majority of the public is opposed to the use of coal for energy production.

C. **No expected problem**: Since the ROAD extension to UK SNS pipeline will have no impact on any populated areas it seems that citizens in the UK or in the Netherlands will not be directly affected by the pipeline and so no public reaction is expected.

D. **Needs careful handling**: The perception of the Dutch public will be crucial for the realization of the project, because the largest part (70 km) of the pipeline route would be located in the Netherlands. In general, the perceived risks, perceived benefits and trust are the most important predictors of public perception of CCS. It may happen that the Dutch public feel they are carrying the burden whereas the Belgians gain the benefits of reducing their CO_2 emissions. A CO_2 storage demonstration project which included the CO_2 storage in two depleted natural gas fields located in nearby Barendrecht was cancelled and this decision was partly motivated by a lack of support for the project among the local public. Also 80 % of the respondents of a representative survey of the adult population of Barendrecht carried out in 2010 perceived the transport of CO_2 by pipeline as unsafe. However, with respect to the applicability of the assumptions regarding public perception of the CAR pipeline, one should be aware, that public perception is generally highly context-dependent and would need careful planning and handling.

5.7 Pilot Case Decision

The four candidate Cases were scored by the partners against the main criteria as discussed above. The result of the scoring is shown in Table 5.2.

Case Total Score	28.6	19.6	28.8	22.2
	Pilot Case alternatives			
Criteria	**UK-Norway**	**German Backbone**	**Rotterdam Nucleus**	**CAR**
1. Reflects ZEP strategic plan	**4**	**3**	**3.5**	**3**
Helps ongoing CCS projects	3	1	4	3
Initiates new CCS projects	4	4	2	4
Engage memeberstate	5	2	4	3
Maximizes strategic CCS deployment	4	5	4	2
2. Technical risk profile	**4.75**	**3**	**4.5**	**4.5**
Plausible transport route	5	3	5	5
Is low cost CO2 available for the project	5	2	5	5
Technical complexity	4	2	5	5
Matching of sources and sinks over time frame	5	5	3	3
3. Meets PCI criteria	**4.0**	**5.0**	**3.5**	**1.5**
Serve key CO_2 areas of Europe	4	5	4	2
Provide the seed for further European CCS	4	5	3	1
4.Stakeholder support	**4.3**	**1.3**	**4.3**	**3.7**
commercial support	4	1	4	4
political support	4	2	4	3
support by local authorities	5	1	5	4
5. Is financially viable	**3.5**	**3.25**	**4**	**3.5**
Revenue prospects (public and private funding)	**5**	**5**	**4**	**2**
Capital requirement	2	1	4	5
Risk/reward balance	4	4	4	2
Commercial obstacles	3	3	4	5
6. No legal obstacles	**4**	**2**	**4**	**3**
7. potential public acceptance	**4**	**2**	**5**	**3**

Table 5.2: Scoring of candidate Pilot Cases

General points raised at the scoring discussion included:

- The project most likely to be successful in going forward is that which is the least ambitious and hence presents the fewest major challenges.
- The most ambitious candidate case is also best suited for the PCI criteria (German Backbone)
- The high capital cost of a long pipeline would be main commercial barrier (eg UK-Norway) – this can be beneficially offset by PCI support.
- Scoring is a snapshot and may well change with time.

After discussion, it was decided to pursue the Rotterdam Nucleus project as the GATEWAY Pilot Case.

The overall scores in the main categories are also shown diagrammatically in Figure5.2.

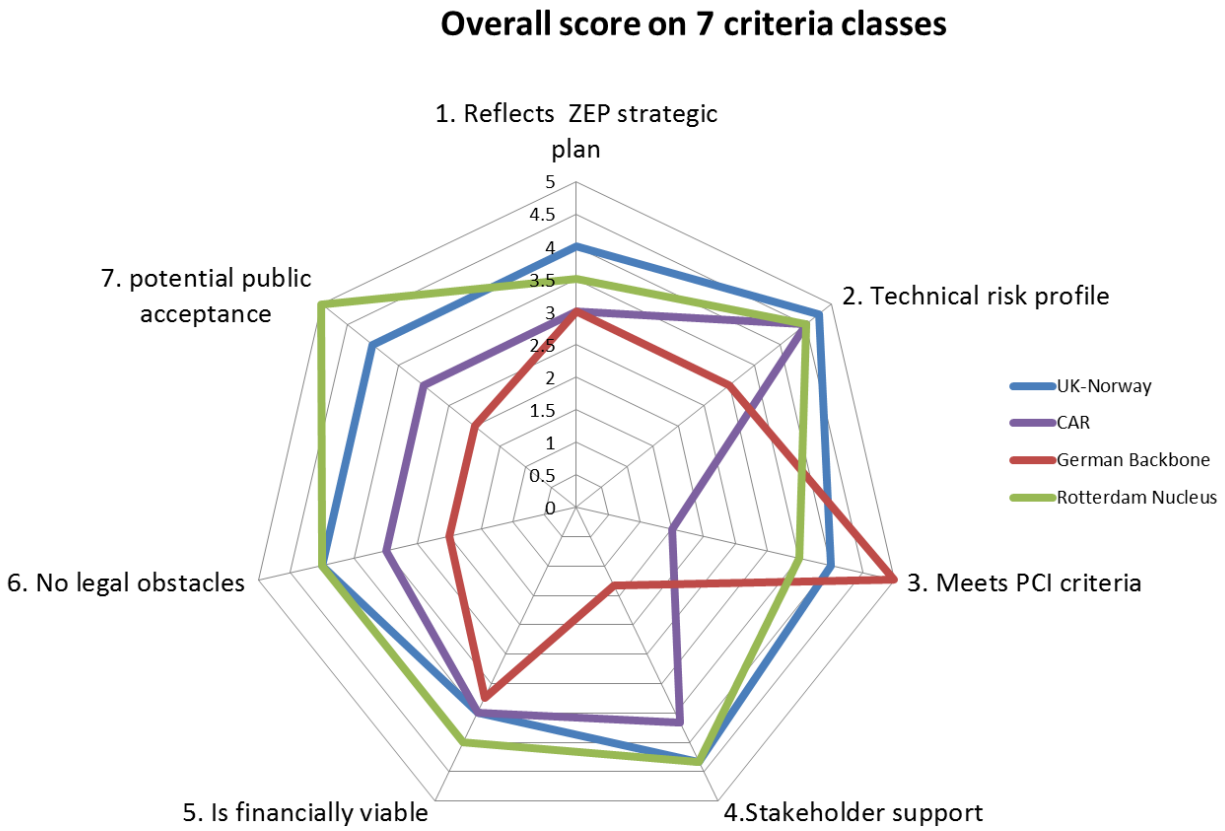

Figure 5.2: Diagrammatic representation of the four Cases in seven criteria.

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6 PILOT CASE DEFINITION

The Rotterdam Nucleus project will be refined and developed during the remaining period of the GAETWAY project, with the key technologies assessed in Deliverable D2.2 and the final proposed definition of the project along with the Business Case will be presented in Deliverable D4.3.

Prior to that, some further details of the agreed Pilot Case are set out below; all of the detailed specification of the Case is still being discussed, so some of the information given may be subject to amendment or change.

6.1 Fizzy Gas Field

The Natural gas field “Fizzy” is in UK SNS sector 50, evaluated as having 4.5bcm of natural gas in place

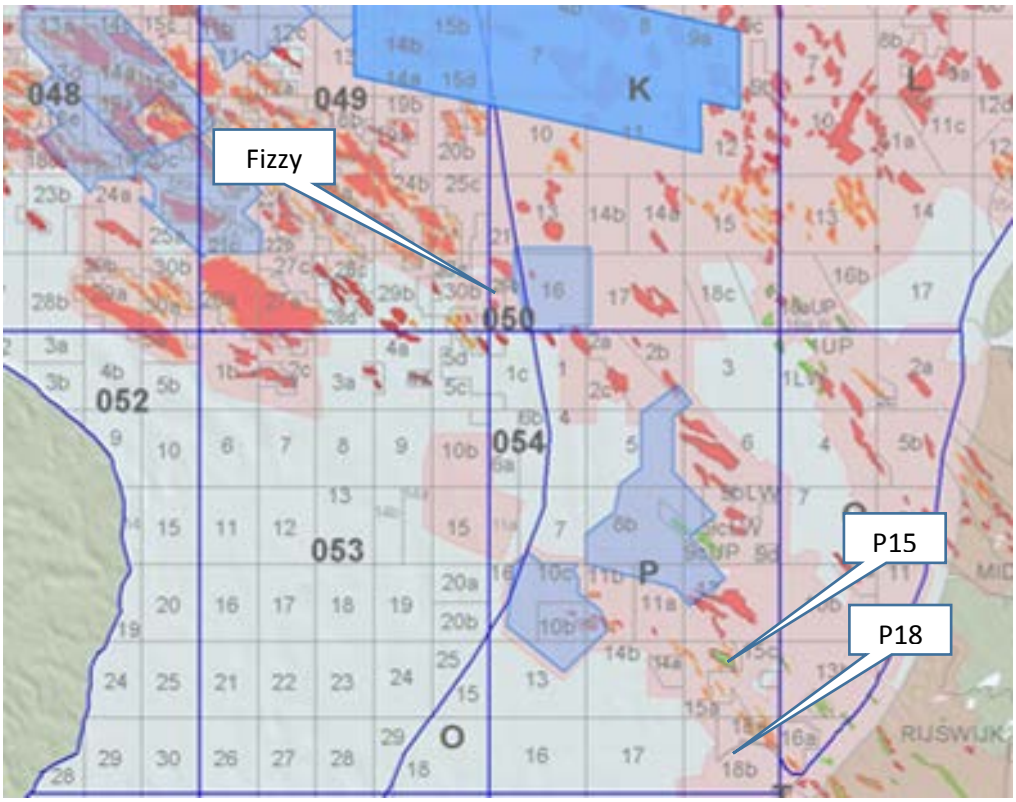

Figure 6.1: Location of Fizzy and P18, P15 in the UK and Dutch sectors

The Fizzy gas field is described by Volantis in their 2009 licence relinquishment report as follows: “The main Rotliegendes prospect is the Fizzy Discovery on the Fizzy horst block, which is defined by good quality 3D [seismic survey], two gas-bearing wells and a dry well just down dip of a well-defined gas-water contact (GWC). However, it has high CO_2 and N_2 gas contents, which make it uncommercial at this stage”.

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6.2 Central Processing Unit (CPU)

The CPU will process the gas arising from Fizzy (and follow-on fields) in order to produce two primary product flows:

- Natural gas of sufficient quality to meet standards for entry into the UK (NL) gas collection systems, perhaps with some additional blending;
- A CO_2 stream of storable quality.

The main separation will be achieved using a multi-stage Cynara filter which will operate at fairly low pressure. A by-product of the two product streams will be a nitrogen-rich GT fuel stream which can be utilized to power the necessary compression of both the natural gas and the CO_2.

The storage locations are depleted gas fields at low pressure (see section 6.4 below). Since the pipeline is only 100km it would not make economic sense to re-pressurise the CO_2 along the route, so the CO_2 stream will have to be tailored to meet the storage entry requirements. Initially it is envisaged that the pipeline will be used at low pressure (30bar) with the CO2 in gaseous phase, rising to dense phase pressure (eg 80+bar) when required. The gas field might be expected to re-pressurise at a rate of around 40bar/Mt CO_2 towards its original pressure of 350bar.

The CPU will require a shallow-water platform of some sort, the details and location of which are being considered.

6.3 Pipeline

The pipeline from P18 via P15 to UK field Fizzy is around 100km, depending on the exact route identified. An 18inch (457mm) diameter pipeline has been initially identified in order to provide sufficient capacity to facilitate further development of some of the high-CO_2 fields in the same vicinity of Fizzy while Fizzy is being exploited. This larger diameter also helps with initial operation at lower pressure (see section 6.2 above).

6.4 Storage Locations

The identified CO_2 storage locations are both in the Southern North Sea, close to the Netherlands coast, north of Rotterdam.

P18/4 is a depleted natural gas field off the Netherland coast (see Figure 4.6) for which TAQA holds a storage licence. It is located at around 3500m depth with a capacity of around 8Mt CO_2, but currently pressurized at only around 20bar. Other fields in the P18 cluster represent storage capacity of about 30 Mt of CO_2. The nearby cluster of fields in the P15 offshore block has an estimated storage capacity of about 40 Mt. A CO_2 storage feasibility study has been performed only for the P18-4 field and the operator TAQA holds the only storage permit issued under the EU CCS Directive in Europe.

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The other fields in the P18 cluster and the fields in the neighbouring P15 cluster are similar in setting (e.g., depth, reservoir formation, caprock) to the P18-4 field and permitting them for CO_2 storage is expected to be straightforward, assuming no showstoppers are found.

The production of all P18 and P15 fields is expected to cease in the period 2020 – 2030. All fields can be reached from a small number of existing platforms.

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APPENDIX 1

TNO report: GATEWAY – PCI Prerequisites and Application Procedures

Date September 2016

Author(s) Logan Brunner

Contents

1 Background of PCIs

Projects of Common Interest (PCIs) are a development of Regulation (EU) No 347/2013 of the European Parliament and of the Council, often referred to as the new TEN-E Regulation, which provides guidelines for trans-European energy infrastructure. Within this regulation, twelve strategic priority corridors and geographic areas were defined, dealing with infrastructure in electricity, gas, and oil, as well as electricity highways, smart grids, and CO_2 transportation networks. PCIs were established in 2013 to support these developments between 2014 and 2020 and beyond. The first pool of PCIs contained 248 projects, none of which dealt with the strategic priority corridor related to the development of a CO_2 transportation network. The list is revised every two years, allowing new projects to apply to obtain the PCI status, and requiring prior PCIs to re-apply to maintain their PCI status. These projects are permitted to seek funding from the Connecting Europe Facility (CEF), a source of funding totalling €4.7 billion meant to encourage public and private funding of trans-European networks. Aside from the CEF financial support, PCIs may also benefit from more efficient permitting procedures, including a single national competent authority (the one-stop-shop) for permitting, set time limits for permitting procedures, more transparency and better public participation, and a more streamlined environmental assessment procedure.

There are certain criteria to be considered as a PCI, as shown in Table A1. The table shows the topics concerning CO_2 transport projects in the new TEN-E Regulation. A more thorough description and details on the nuances of the criteria can be found in Identification of future CO2 infrastructure networks by Milieu Ltd (2016).

Table A1. Information concerning CO_2 transportation networks in the new TEN-E Regulation (European Commission Regulation 2013).

Article 4: Criteria for projects of common interest
1. Projects of common interest shall meet the following general criteria: (a) the project is necessary for at least one of the energy infrastructure priority corridors and areas; (b) the potential overall benefits of the project, assessed according to the respective specific criteria in paragraph 2, outweigh its costs, including in the longer term; and (c) the project meets any of the following criteria: (i) involves at least two Member States by directly crossing the border of two or more Member States; (ii) is located on the territory of one Member State and has a significant cross-border impact as set out in Annex IV.1; (iii) crosses the border of at least one Member State and a European Economic Area country. 2. The following specific criteria shall apply to projects of common interest falling within specific energy infrastructure categories: (e) for carbon dioxide transport projects falling under the energy infrastructure categories set out in Annex II.4, the project is contribute significantly to all of the following specific criteria: (i) the avoidance of carbon dioxide emissions while maintaining security of energy supply; (ii) increasing the resilience and security of carbon dioxide transport; (iii) the efficient use of resources, by enabling the connection of multiple carbon dioxide sources and storage sites via common infrastructure and minimizing environmental burden and risks.

Annex II: Energy infrastructure categories
The energy infrastructure categories to be developed in order to implement the energy infrastructure priorities listed in Annex I are the following: (4) concerning carbon dioxide: (a) dedicated pipelines, other than upstream pipeline network, used to transport anthropogenic carbon dioxide from more than one source, i.e. industrial installations (including power plants) that produce carbon dioxide gas from combustion or other chemical reactions involving fossil or non-fossil carbon-containing compounds, for the purpose of permanent geological storage of carbon dioxide pursuant to Directive 2009/31/EC of the European Parliament and of the Council (1); (b) facilities for liquefaction and buffer storage of carbon dioxide in view of its further transportation. This does not include infrastructure within a geological formation used for the permanent geological storage of carbon dioxide pursuant to Directive 2009/31/EC and associated surface and injection facilities; (c) any equipment or installation essential for the system in question to operate properly, securely and efficiently, including protection, monitoring and control systems.
Annex III: Regional lists of projects of common interest
2. Process for establishing regional lists (6) Proposed carbon dioxide transport projects falling under the category set out in Annex II.4 shall be presented as part of a plan, developed by at least two Member States, for the development of cross-border carbon dioxide transport and storage infrastructure, to be presented by the Member States concerned or entities designated by those Member States to the Commission.

2 Timeframe

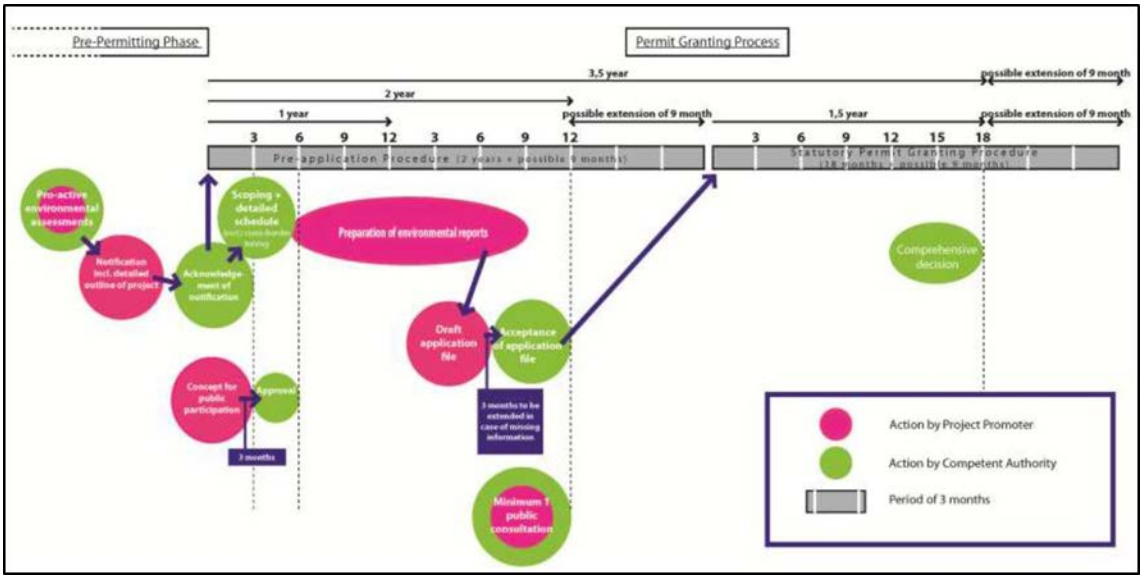
The overall timing for the approval of a PCI is constrained to 3 years and 6 months, with the possibility of a 9-month extension if necessary. The permit-granting process includes two phases:

(1) Pre-application phase – up to 2 years. This phase begins once the national competent authority informs the project promoter that their project notification has been submitted. This phase lasts until the application for the PCI is submitted. The project promoter ought to include an environmental report with their submission in this phase.
(2) Statutory permit granting procedure – up to 1 year and 6 months, with possibility of an extension of 9 months. This process begins with the acceptance of the PCI application and continues until the comprehensive decision.

These two phases do not include preparatory work that might be needed before the first phase, including environmental assessments. Figure 1 shows the timeline process of applying for a PCI.

The first call of PCIs took place in October 2013 with 248 projects. The submission of interest for the following round for existing and new PCIs was required by September 2014, while the updated list of 195 projects was available in November 2015. The next call will be available in 2017, though notification of interest should be submitted before then.

Figure A1. Timeline showing the permit-granting process for PCIs (European Commission Streamlining 2013).



3 Funding opportunities

The main funding pool available to PCIs is from the CEF, which has set aside €4.7 billion to support PCIs from 2014 until 2020. Once the PCI status has been achieved, the project promoter must then undergo an application process to obtain CEF funding. Previous calls for proposals have been from May to August 2014 (with a budget of €750 million), March to April 2015 (with a budget of €100 million), and June to October 2015 (with a budget of €550 million). See Annex II for more information on the CEF process.

4 Authorities involved

Each Member State has designated by November 2013 a national competent authority who will serve as the one-stop-shop to facilitate the permitting process for PCIs. If multiple Member States are involved in a project, the national competent authorities of those Member States shall coordinate the necessary cooperation. This authority will be to whom the project promoter submits all documents and information.

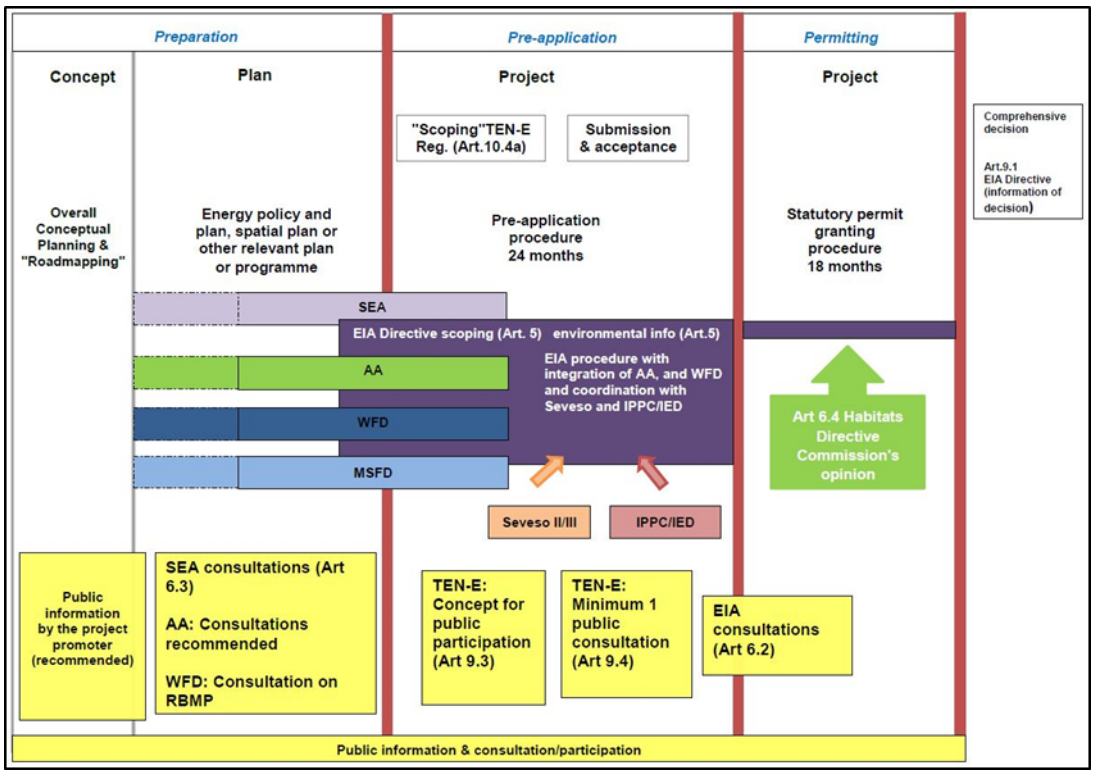
5 Evaluation process

In May 2014, each national competent authority published a manual of procedures to achieve the PCI label, which has been updated as necessary. Aside from those procedures, the new TEN-E Regulation has set out general requirements and directives to implement before the granting of a PCI.

The list below is the material asked of the project promoter regarding the PCI (a table view of the list is provided in Annex I). The directives listed under 5.2.3 through 5.2.7 are Sectoral Directives. The expected time frame of the procedure is displayed in Figure A2, from the European Commission's Streamlining environmental assessment procedures for energy

infrastructure Projects of Common Interest (PCIs) (European Commission Streamlining 2013). Out of these, they highlight that the Environmental Impact Assessment (EIA) and the Appropriate Assessment of the Habitats Directive (AA) as the two main procedures required.

Figure A2. Overview of the PCI granting procedure and materials required (European Commission Streamlining 2013).



5.1 Public participation

- Purpose: Complex infrastructure projects require public participation and transparency to be approved in a smooth manner.
- Requirements:
  - Within 3 months of the start of permit-granting process – Develop and submit a concept for public participation to be approved by the national competent authority (Article 9(3)).
  - Before submission of application – project promoter or national competent authority must have at least one public consultation (Article 9(5) and (6)).
  - Project promoter or national competent authority should have and update a website about the PCI (Article 9(7)).

5.2 Environmental assessment – 7 potential directives

5.2.1 Environmental Impact Assessment (EIA) Directive regarding CO2 projects:

- Directive: 2011/92/EU
- Purpose: Assess projects likely to have significant effects on the environment.
- Requirements:
  - An EIA will be required if one of the following conditions are met:

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- The pipelines have a diameter greater than 800 mm and a length of over 40 km for transport of CO_2.
- The pipelines for the transport of CO_2 for geological storage are screened and determined that they will have significant effects on the environment.
- Procedure
- Developer can ask the national competent authority for information the EIA should cover.
- Developer must create the EIA report on the environmental impact.
- Environmental authorities and public must be consulted.
- National competent authority decides and the public is notified of the decision.
- Public participation details (from EIA Directive and Aarhus Convention)
- Public shall be given early opportunity to participate in the decision-making of the project.
- Public shall be informed of the project, the request for an EIA, manner in which to submit comments and questions, decision-making timeline, decision possibilities, and the draft decision.

5.2.2 Strategic Environmental Assessment (SEA) Directive

- Directive: 2001/42/EC
- Purpose: Deals with energy, town and country planning, and land use projects. This assessment considers the environmental impact and reasonable alternatives to the plan.
- Requirements: A screening must take place to determine if the project will result in significant impacts. If so, then an SEA is required.

5.2.3 Appropriate Assessment (AA) of the Habitats Directive

- Directive: 92/43/EEC, Article 6(3)
- Purpose: Intends to determine the extent of negative impacts on Natura 2000 sites.
- Requirements:
  - The AA must be conducted if the project is likely to impact a Natura 2000 site (sites can be located at <natura2000.eea.europa.eu>).
  - If the AA concludes that the project will result in adverse effects to Natura 2000 sites, the project may be authorized if there is no alternative and the project is deemed necessary.

5.2.4 Water Framework Directive (WFD)

- Directive: 2000/60/EC
- Purpose: The WFD states that projects should not deteriorate good groundwater status, good surface water ecological status, or good ecological potential.
- Requirements:
  - This environmental assessment may be included within the EIA or SEA to streamline the process.
  - If surface or ground waters are affected, then the river basin authorities must include justification in their River Basin Management Plans (RBMP).
  - Even if an EIA or SEA are not conducted, conditions in WFD Article 4(7) – including taking all practical steps to prevent negative impacts on water, describing the reasons for making modifications that supersede public or environmental interest, and the benefits of such a project can’t be feasibly performed by a less impactful project – must be assessed and met.

5.2.5 Marine Strategy Framework Directive (MSFD)

- Directive: 2008/56/EC
- Purpose: Intends to reach Good Environmental Status (GES) in marine waters by 2020.
- Requirements: Projects must maintain GES, but there may be exceptional cases where GES is not achieved yet the project is allowed.

5.2.6 Seveso II and Seveso III Directives

- Directives: 96/82/EC and 2012/18/EU
- Purpose: These directives concern major-accident hazards involving dangerous substances, including liquefied natural gas and compressed natural gas.
- Requirements: A safety report that includes identification of any major accident hazards and preventative measures.

5.2.7 Industrial Emissions Directive (IED)

- Directive: 2010/75/EU
- Purpose: Concerns storage facilities for gas and oil and facilities for the liquefaction and buffer storage of carbon dioxide.
- Requirements: Application for an operating permit, which is potentially enveloped in the EIA procedures, depending on the Member State.

5.3 Planning, “roadmapping,” and scoping

- Purpose: To successfully streamline the assessment procedures, early planning and “roadmapping” are highly recommended. This topic also deals with other considerations to help the process of becoming a PCI.
- Requirements: The following are more tips to make the process run smoothly.
  - The roadmap should be planned and it should detail the type of assessment or environmental requirement and at what stage it should be conducted. This is to ensure comprehensiveness and avoid redundancy.
  - There should be an early scoping of the potential environmental effects, which should be updated to a detailed scoping during the pre-application phase or the EIA process.
  - Sensitivity and suitability maps that detail the project location help the permitting process.
  - Assessments should consider effects of climate change and those impacts on the PCI.
  - All environmental impacts should be considered throughout all of the EIA process, and other required environmental assessments should be aligned with the EIA process. This will ensure the consistency of information and prevent repetition.
  - Data collection should be started early in the preparation phase, since this information is important to prove no harmful effects as requested by the AA.
  - External experts and independent quality control will help to validate the environmental assessments.

6 References

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7 Annexes

Annex I: Table view of the material required for a PCI

	Directive	Purpose	Requirements
Public participation		Complex infrastructure projects require public participation and transparency to be approved in a smooth manner.	• Within 3 months of the start of permit-granting process – Develop and submit a concept for public participation to be approved by the national competent authority (Article 9(3)) • Before submission of application – project promoter or national competent authority must have at least one public consultation (Article 9(5) and (6)) • Project promoter or national competent authority should have and update a website about the PCI (Article 9(7))
1. Environmental Impact Assessment (EIA) Directive	2011/92/EU	Assess projects likely to have significant effects on the environment.	• An EIA will be required if one of the following are met: – The pipelines have a diameter greater than 800 mm and a length of over 40 km for transport of CO_2. – The pipelines for the transport of CO_2 for geological storage are screened and determined that they will have significant effects on the environment. • Submission of an EIA. Procedure:

			• Developer can ask the national competent authority for information the EIA should cover. • Developer must create the EIA report on the environmental impact. • Environmental authorities and public must be consulted. – National competent authority decides and the public is notified of the decision. • Public participation details (from EIA Directive and Aarhus Convention) – Public shall be given early opportunity to participate in the decision-making of the project. – Public shall be informed of the project, the request for an EIA, manner in which to submit comments and questions, decision-making timeline, decision possibilities, and the draft decision.
2. Strategic Environmental Assessment (SEA) Directive	2001/42/EC	Deals with energy, town and country planning, and landuse projects. This assessment considers the environmental impact and reasonable alternatives to the plan.	• This directive requires an SEA if the screening concludes that the project is likely to have significant environmental impacts.
3. Appropriate Assessment (AA) of the Habitats Directive	92/43/EEC, Article 6(3)	Intends to determine the extent of negative impacts on Natura 2000 sites.	• The AA must be conducted if the project is likely to impact a Natura 2000 site (sites can be seen at <natura2000.eea.europa.eu>). • If the AA concludes that the project will result in adverse effects to Natura 2000 sites, the project may be authorized if there is no alternative and the project is deemed necessary.
4. Water Framework Directive (WFD)	2000/60/EC	The WFD states that projects should not deteriorate good groundwater status, good	• This environmental assessment may be included in the EIA or SEA to streamline the process. • If surface or ground waters are affected, then the river basin authorities must include justification in their River Basin

		surface water ecological status, or good ecological potential.	Management Plans (RBMP). • Even if an EIA or SEA are not conducted, conditions in WFD Article 4(7) must be assessed and met.
5. Marine Strategy Framework Directive (MSFD)	2008/56/EC	Intends to reach Good Environmental Status (GES) in marine waters by 2020.	• Projects must maintain GES, but there are only exceptional cases where GES is not achieved.
6. Seveso II and Seveso III Directives	96/82/EC and 2012/18/EU	This directive concerns major-accident hazards involving dangerous substances, including liquefied natural gas and compressed natural gas.	• A safety report that includes identification of any major accident hazards and preventative measures.
7. Industrial Emissions Directive (IED)	2010/75/EU	Concerns storage facilities for gas and oil and facilities for the liquefaction and buffer storage of carbon dioxide.	• Application for an operating permit, which is potentially enveloped in the EIA procedures, depending on the Member State.
Planning, “roadmapping,” and scoping		To successfully streamline the assessment procedures, early planning and “roadmapping” are highly recommended. This topic also deals with other considerations to help the process of becoming a PCI.	These are more tips to make the process run smoothly. • The roadmap should be planned and it should detail the type of assessment or environmental requirement and at what stage it should be conducted. This is to ensure comprehensiveness and avoid redundancy. • There should be an early scoping of the potential environmental effects, which should be updated to a detailed scoping during the pre-application phase or the EIA process. • Sensitivity and suitability maps that detail the project location help the permitting process. • Assessments should consider effects of climate change and those impacts on the PCI.

			• All environmental impacts should be considered throughout all of the EIA process, and other required environmental assessments should be aligned with the EIA process. This will ensure the consistency of information and prevent repetition. • Data collection should be started early in the preparation phase, since this information is important to prove no harmful effects as requested by the AA. • External experts and independent quality control will help to validate the environmental assessments.

Annex II: Evaluation process of CEF

Eligibility committee:

- Proposal submitted on time, complete, signed by applicant, approved by Member State
- Proposal meets eligibility criteria
- Applicant has financial and technical capacity to carry out the action
- Proposal complies with EU legislation (environment, competition, public procurement)

Technical evaluation by external experts:

- Read proposals and rate
- Consensus meeting for each proposal
- Evaluate application against following award criteria:

	Weights (works)	Weights (studies)
Maturity of the action with regards to the developmental stage of the project, based on the implementation plan (Article 5(1) of the TEN-E Regulation)	20%	25%
Cross-border dimension of the action, area of impact and number of Member States involved in the action	10%	10%
Extent of the positive externality provided by the action involving works, impact of the action on solidarity	15%	NA
Need to overcome financial obstacles	15%	15%
Soundness of the implementation plan proposed for the action	10%	10%
Priority and urgency of the action, will the project remove bottlenecks, end energy isolation and contribute to the implementation of the internal energy market	15%	20%
Stimulating effect of the CEF financial assistance on the completion of the action	15%	20%

Figure AII-2. Detailed information on each of these award criteria can be found at the CEF Energy Info Day (Coda 2015).

Evaluation committee:

- Cuts costs/activities not eligible or not recommended
- Establishes a ranking list of actions proposed to receive CEF financial aid

Selection decision:

- Commission consults ranking list
- CEF Coordination Committee is consulted and European Parliament is informed
- Decision is adopted by the Commission

Grant agreement:

- Applicants invited to prepare individual grant agreement
- Grant agreements are signed between beneficiaries (applicants) and INEA

References

Coda, Beatrice (2015). CEF Energy Info Day. Available from: European Commission <https://ec.europa.eu/inea/sites/inea/files/download/events/2015/CEF_energy_march/3cef_award_criteria_for_distribution.pdf >. [14 December 2015].

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