

The East Irish Sea CCS Cluster: A Conceptual Design – Appendices to Technical Report

Hydrocarbon Resources Ltd and Peel Energy Ltd

Authors:

Andrew Coulthurst

Sam Taylor

Adam Baddeley

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Report for:

Hydrocarbon Resources Ltd and Peel Energy Ltd

Prepared by:

Andrew Coulthurst

Sam Taylor

Adam Baddeley

Approved by:



.....
Mike Brown

Contact Details

Eunomia Research & Consulting Ltd

37 Queen Square

Bristol

BS1 3QS

United Kingdom

Tel: +44 (0)117 9450100

Fax: +44 (0)8717 142942

Web: www.eunomia.co.uk

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A.1.0 Summary of Key UK CCS Consents

The development of CCS clusters will be amongst the largest and most complex infrastructure projects conceived in the UK. As such there will be a wide range of interest groups and a number of overlapping regulatory regimes. Whilst a regulatory framework for CCS is emerging in the UK (ahead of many other countries), there remain considerable uncertainties.

Table 1 summarises some of the key regulations relevant to all elements along the CCS chain, which developers will need to take into consideration. This should be viewed as high level guidance rather than as a definitive set of regulations given the emerging nature of CCS. It should also be noted that Table 1 summarises the regulations enacted by UK Government in Whitehall, and the variations from this under Scottish law. Regulations in the Republic of Ireland have been excluded.

Table 1: Summary of Key UK CCS Consents

Regulation	Consent/Licence	Part of CCS Chain Applicable	Granting Authority
Section 36 Electricity Act 1989 Town and Country Planning Act 1997	Section 36 Consent (and 'deemed' planning permission)	Power Station Capture Plant	Secretary of State / Scottish Ministers
Section 37 Electricity Act 1989	Section 37 Consent	Grid Connection	Secretary of State / Scottish Ministers
Grid Connection Agreement	Agreement	Grid	National Grid
Pollution Prevention and Control Act 1999	PPC Permit	Power Station (including capture plant)	Environment Agency / SEPA
Planning (Hazardous Substances) Regulations 1992 and The Control of Major Accident Hazards (COMAH) Regulations 1999	Hazardous Substances Consent (HSC)	Capture Plant (including any wider site storage)	Secretary of State / Scottish Ministers Health & Safety Executive is a statutory consultee
Marine and Coastal Access Act 2009	Marine License (covering removals from the seabed, construction and dredging as well as deposits)	Power Station Transport Storage	Marine Management Organisation (on behalf of Secretary of State)
Pipelines Act 1962 Pipeline Works Regs 2000	Construction Authorisation (and 'deemed' planning permission)	Pipeline	Secretary of State / Scottish Ministers HSE

Pipeline Safety Regs 1996			
Gas Act 1986	Consent for the disposal of regulatory asset	Pipeline	Ofgem
Energy Act 2008	Consent for connection to existing offshore pipelines	Pipeline	DECC
Section 17 Petroleum Act 1998	Consent for connection to existing offshore pipelines	Pipeline	DECC
CAR (The Water Environment (Controlled Activities)) Regs 2005	CAR Licence	Pipeline (crossing water courses)	Environment Agency / SEPA
Offshore Chemicals Regs 2002	Chemical Permit (for discharge of chemicals offshore)	Storage and Transport	DECC
Energy Act 2008 Petroleum Act 1998	Exploration Licence	Storage (non-intrusive exploration activities)	DECC
Energy Act 2008	Carbon Storage Licence (Offshore)	Storage (intrusive exploration and test injection activities)	DECC
Energy Act 2008	Agreement for Lease for Carbon Storage	Storage (lease)	Crown Estate
Energy Act 2008	Consent to cease injection and storage operations	Storage	DECC

Energy Act 2008	Consent to handover storage facilities	Storage	DECC
Section 29 Petroleum Act 1988	Approval of Decommissioning Programme	Storage (platform infrastructure)	DECC

A.2.0 List of Existing and Planned Emitters

Table 2: Summary of Existing Installations

Name	Mini-cluster	Type of Installation	Size (MWe)
Kilroot Power Station	Northern Ireland	Coal/Oil Power Station	520
Ballylumford Power Station	Northern Ireland	CCGT Power Station	1,316
Coolkeeragh Power Station	Northern Ireland	CCGT/Oil Power Station	400
Lafarge Cement UK	Northern Ireland	Industrial Process	N/A
DSM Dalry	Western Scotland	Industrial Process	N/A
Ardagh Glass (Irvine)	Western Scotland	Industrial Process	N/A
The Girvan Distillery	Western Scotland	Industrial Process	N/A
Edenderry Power Station	East Ireland	Peat Power Station	120
Huntstown Power Station	East Ireland	CCGT Power Station	747
Dublin Bay Power Station	East Ireland	CCGT Power Station	400
North Wall Power Station	East Ireland	CCGT Power Station	270
Poolbeg Power Station	East Ireland	CCGT Power Station	1,020
Lagan Cement	East Ireland	Industrial Process	N/A
Irish Cement (Drogheda)	East Ireland	Industrial Process	N/A
Premier Periclase (Drogheda)	East Ireland	Industrial Process	N/A
St. James Gate Brewery	East Ireland	Industrial Process	N/A
Roosecote Power Station	North West	CCGT Power Station	229
Port of Liverpool CHP	North West	CCGT Power Station	30
Rocksavage Power Station	North West	CCGT Power Station	748
Fiddler's Ferry Power Station	North West	Coal	1,989

Winnington CHP	North West	CCGT Power Station	130
Sandbach CHP	North West	CCGT Power Station	56
Lafarge Cement (Cauldon)	North West	Industrial Process	N/A
Pilkington Glass (Greengate)	North West	Industrial Process	N/A
Pilkington Glass (Cowley Hill)	North West	Industrial Process	N/A
Pilkington Glass (Watson Street)	North West	Industrial Process	N/A
Quinn Glass Elton	North West	Industrial Process	N/A
Stanlow Refinery	North West	Industrial Process	N/A
Eastham Refinery	North West	Industrial Process	N/A
Kemira (PAX Plant)	North West	Industrial Process	N/A
British Salt Ltd (Middlewich)	North West	Industrial Process	N/A
AstraZeneca (Macclesfield)	North West	Industrial Process	N/A
Manchester Sweeteners	North West	Industrial Process	N/A
Connah's Quay Power Station	North Wales	CCGT Power Station	1,420
Shotton CHP	North Wales	Industrial Process (CCGT)	210
Deeside Power Station	North Wales	CCGT Power Station	500
Padeswood Works	North Wales	Industrial Process	N/A
Baglan Bay Power Station	South Wales	CCGT Power Station	525
Aberthaw Power Station	South Wales	Coal Power Station	1,500
Dow Corning CHP	South Wales	CCGT Power Station	28
Barry Power Station	South Wales	CCGT Power Station	230
Uskmouth Power Plant	South Wales	Coal Power Station	363

Severn Power Station	South Wales	CCGT Power Station	824
Seabank Power Station	South Wales	CCGT Power Station	1,145
Wansbrough Paper Mill	South Wales	Industrial Process	N/A
Celsa Manufacturing	South Wales	Industrial Process	N/A
Lafarge Cement UK (Aberthaw)	South Wales	Industrial Process	N/A
Rockwool Bridgend	South Wales	Industrial Process	N/A
Port Talbot Steelworks	South Wales	Industrial Process	N/A
South Hook LNG Terminal	South Wales	Industrial Process	N/A
Milford Haven Refinery	South Wales	Industrial Process	N/A
Texaco Refinery	South Wales	Industrial Process	N/A

Table 3: Summary of Planned Installations

Name	Location	Type of Installation	Size (MWe)	Expected Year of Operation
Pembroke Power Station	Pembrokeshire, Wales	CCGT	2,000	2013
Carrington Power Station	Trafford, Greater Manchester	CCGT	860	2014
Trafford Power Station	Trafford, Greater Manchester	CCGT	1,520	2014
Hunterston Power Station ¹	Hunterston, Scotland	Clean Coal Power Station	1,852	2016
Notes:				
1. Hunterston has been included in this list, as although (unlike the other listed installations) it has not yet received planning consent, it is viewed as the catalyst project for the EIS cluster. See main Technical Report for related discussion				

A.3.0 Structure of CCS Mini-clusters

Sections A.3.1 to A.3.6 provide detailed information relating to each mini-cluster proposed as part of the wider EIS CCS Cluster. These mini-clusters have been modelled according to a range of assumptions, the rationales for which are provided in detail in the main Technical Report.

A.3.1 Western Scotland Mini-Cluster Development

The Western Scotland mini-cluster contains the planned Hunterston Power Station which is expected to be the catalyst project for the entire EIS CCS cluster. Following deployment of CCS at Hunterston from around 2016, it is expected that a small number of industrial installations (identified in

Table 4) will install CCS equipment between 2038 and 2042.

Due to the spatial location of these industrial emitters, it is likely that a single onshore pipeline would be required to link all of the emitters. Undoubtedly, the route of this pipeline will be dependent upon onshore constraints.

Figure 1: Phase 1-3 (2016-2050) Western Scotland Mini-Cluster

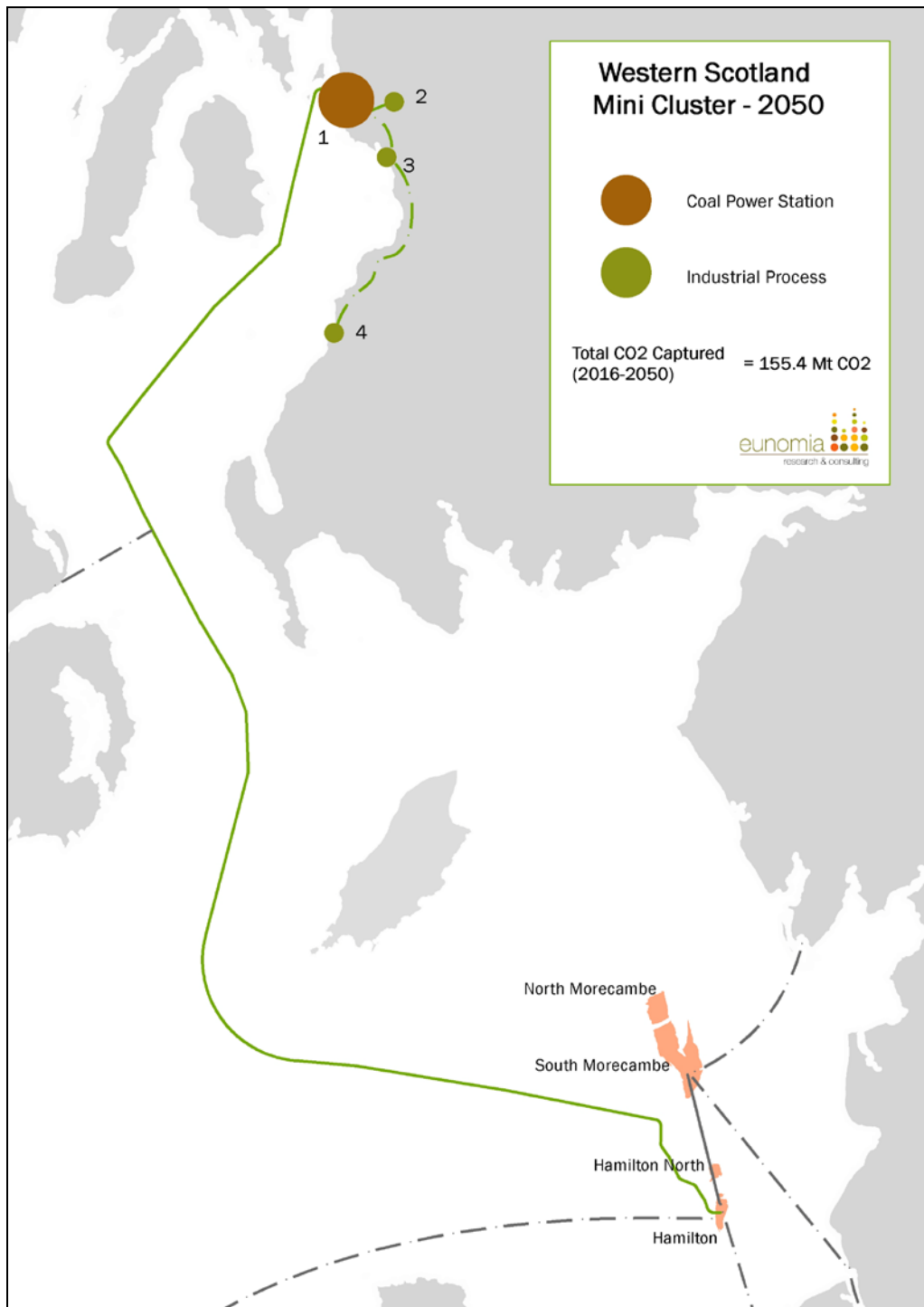


Table 4: Phase 1-3 (2016-2050) Western Scotland Mini-Cluster

ID	Name	Type of Installation	Cumulative CO ₂ Emissions Captured (MT)
1	Hunterston Power Station	Coal	152.7
2	DSM Dalry	Industrial Process	1.5
3	Ardagh Glass - Irvine	Industrial Process	0.7
4	The Girvan Distillery	Industrial Process	0.5
TOTAL			155.4

A.3.2 East Ireland Mini-Cluster Development

It is expected that the Eastern Ireland mini-cluster will be developed in two distinct phases. Initially, it is anticipated that CCS will be installed on the CCGT facilities surrounding the Dublin area, and potentially at the peat-fired power station at Edenderry. These retrofits have been modelled as taking place between 2028 and 2032, with a single pipeline connecting all of the facilities to one another. Once offshore, the pipeline could either be connected to EIS CO₂ storage sites directly, or alternatively join the pipeline from South Wales (as shown in Figure 2).

The final phase of deployment will see the four industrial facilities identified in Table 8: Phase 2-3 (2025-2050) North Wales Mini-Cluster

ID	Name	Type of Installation	Cumulative CO ₂ Emissions Captured (MT)
1	Connah's Quay Power Station	CCGT Power Station	60.7
2	Shotton CHP	Industrial Process (CCGT)	8.0
3	Deeside Power Station	CCGT Power Station	24.6
4	Padeswood Works	Industrial Process	4.4
TOTAL			97.7

Figure 5 retrofitting CCS equipment between 2038 and 2042. In order for the emitters at Drogheda to be included within the cluster, a separate pipeline would need to be constructed during this period. This pipeline would most likely join the two industrial emitters at Drogheda to Huntstown Power Station, where it would join up with the existing pipeline.

The routing of both of the pipelines within this mini-cluster would undoubtedly be subject to significant constraints. The city and county of Dublin is the most heavily populated area in Ireland, and thus the routing would need to be carefully planned so that sensitive receptors are avoided.

Figure 2: Phase 2-3 (2025-2050) East Ireland Mini-Cluster

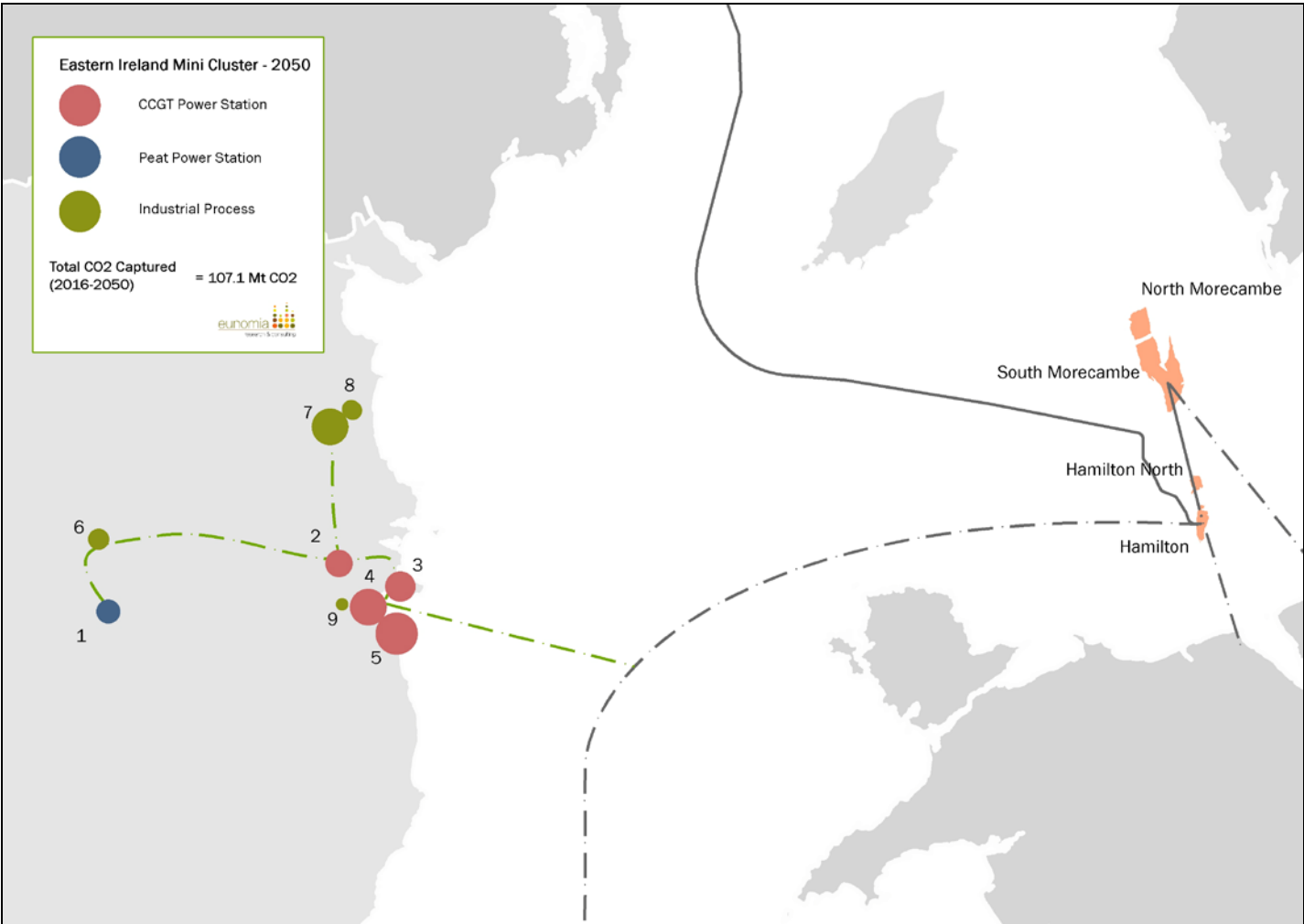


Table 5: Phase 2-3 (2025-2050) Eastern Ireland Mini-Cluster

ID	Name	Type of Installation ¹	Cumulative CO ₂ Emissions Captured (MT)
1	Edenderry Power Station	Peat-fired Power Station	16.4
2	Huntstown Power Station	CCGT Power Station	17.0
3	Dublin Bay Power Station	CCGT Power Station	19.8
4	North Wall Power Station	CCGT Power Station	2.5
5	Poolbeg Power Station	CCGT Power Station	33.6
6	Lagan Cement	Industrial Process	4.2
7	Irish Cement - Drogheda	Industrial Process	11.0
8	Premier Periclase - Drogheda	Industrial Process	2.0
9	St. James Gate Brewery	Industrial Process	0.6
TOTAL			107.1
Note:			
1. Assuming facilities are replaced at end of life, an alternative fuel may be employed by any new facility			

A.3.3 Northern Ireland Mini-Cluster Development

The deployment of CCS technologies in Northern Ireland has been modelled as taking place in two phases. The first phase of deployment would be the retrofit of CCS at Kilroot in 2025 and then at Ballylumford and Coolkeeragh between 2028 and 2032. A single pipeline would then be required to join all of the facilities together. Under this scenario it is most likely that a single pipeline would go offshore at Kilroot and join the Western Scotland mini-cluster pipeline in the North Channel.

The second phase of deployment modelled would see CCS retrofitted at the cement works at Cookstown between 2038 and 2042. In order to connect the facility with the existing pipeline, a new pipeline would be required to join up with the existing CO₂ pipeline.

Figure 3: Phase 2-3 (2025-2050) Northern Ireland Mini-Cluster

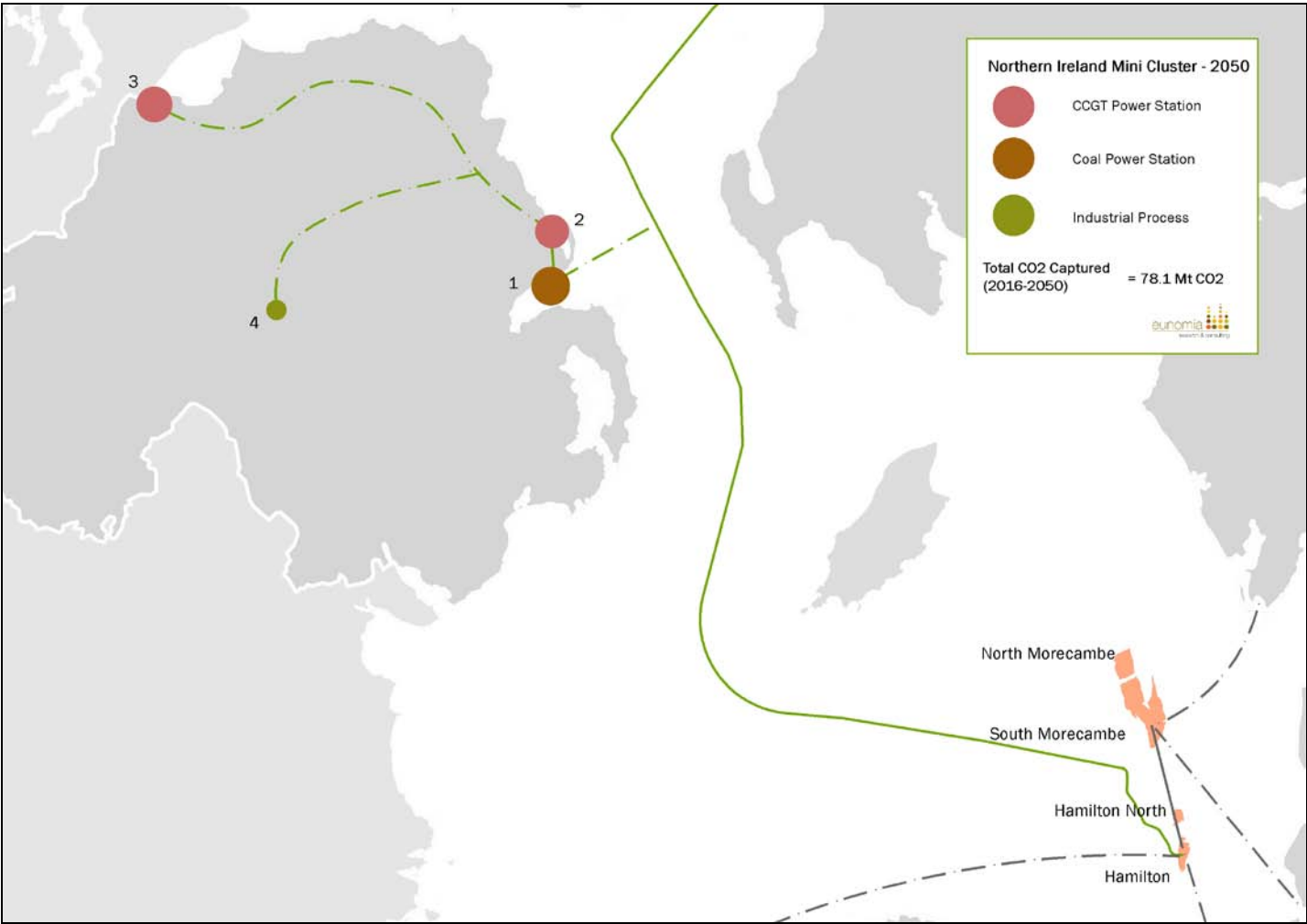


Table 6: Phase 2-3 (2025-2050) Northern Ireland Mini-Cluster

ID	Name	Type of Installation ¹	Cumulative CO ₂ Emissions Captured (MT)
1	Kilroot Power Station	Coal/Oil Power Station	30.4
2	Ballylumford Power Station	CCGT Power Station	25.0
3	Coolkeeragh Power Station	CCGT/Oil Power Station	20.0
4	Lafarge Cement UK	Industrial Process	2.7
TOTAL			78.1
Note:			
1. Assuming facilities are replaced at end of life, an alternative fuel may be employed by any new facility			

A.3.4 North West England Mini-Cluster Development

The North West England mini-cluster would most likely be the largest and most complex in development. As modelled for this study, the cluster would be developed in two phases. The first phase would be the retrofit of CCS at Fiddler's Ferry Power Station in 2025 and at the remaining CCGT power stations between 2028 and 2032. Due to the North West of England being a highly densely populated area, the routing of the pipeline would be challenging. As a result, it has been assumed that two spurs will initially be required. The first spur would link the CCGT power stations from Greater Manchester to the Rocksavage Power Station via Fiddler's Ferry Power Station. The second spur would link the Sandbach CHP Power Station with Rocksavage Power Station.

The pipeline route to reaching the offshore environment would also be challenging. One option, as shown in Figure 4, would be to route the pipeline offshore from Rocksavage Power Station, along the Mersey Estuary and then in to the EIS.

The second phase of CCS development would see the industrial facilities (as identified in Table 7) in the North West install CCS equipment between 2038 and 2042. Due to the location of these facilities, additional CO₂ pipelines would need to be installed. Again, routing of these pipelines would be challenging due to the high population density of the region.

Figure 4: Phase 2-3 (2025-2050) North West England Mini-Cluster

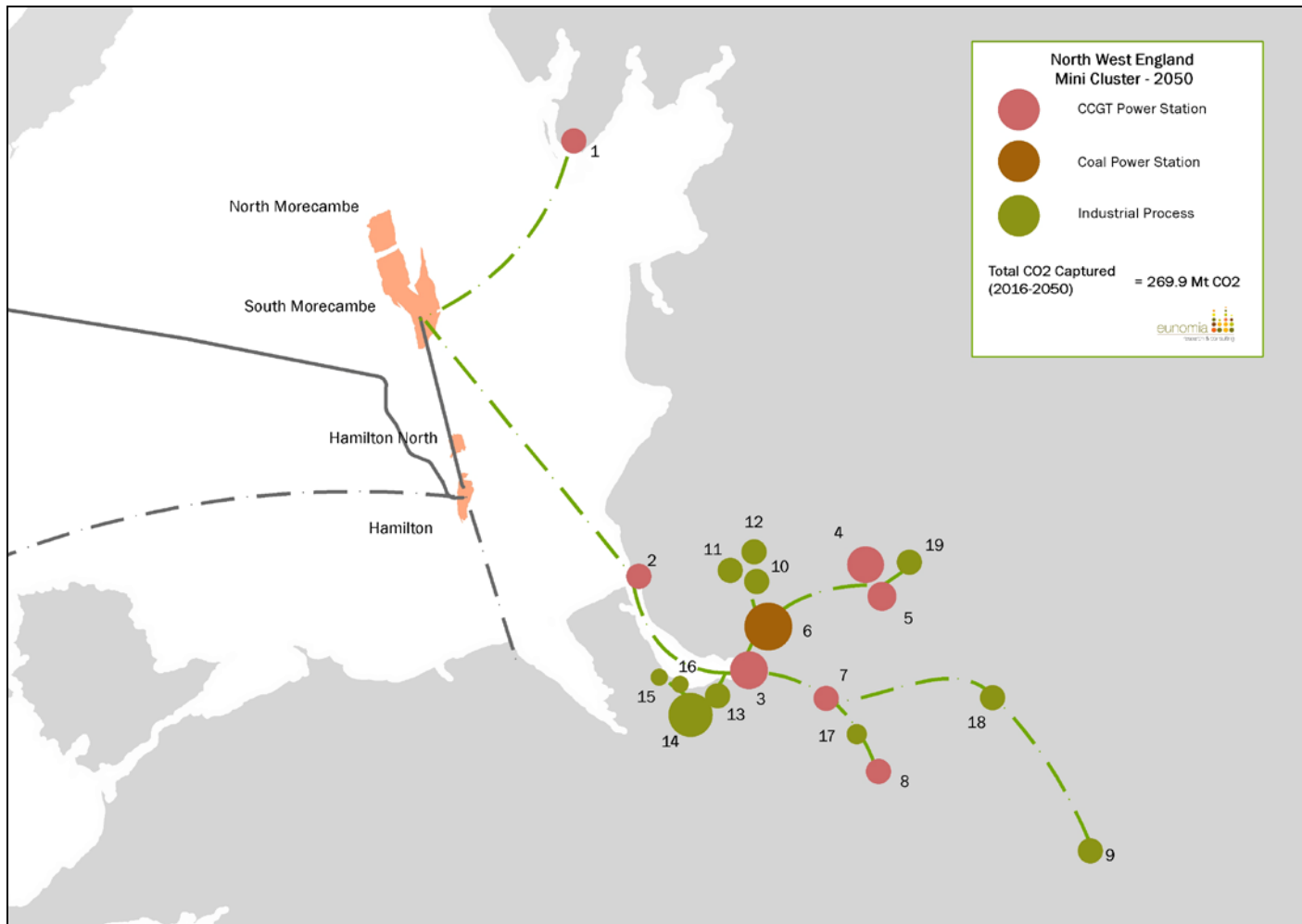


Table 7: Phase 2-3 (2025-2050) North West England Mini-Cluster

ID	Name	Type of Installation ¹	Cumulative CO ₂ Emissions Captured (MT)
1	Roosecote Power Station	CCGT Power Station	7.4
2	Port of Liverpool CHP	CCGT Power Station	2.5
3	Rocksavage Power Station	CCGT Power Station	33.6
4	Trafford Power Station	CCGT Power Station	51.6
5	Carrington Power Station	CCGT Power Station	29.2
6	Fiddler's Ferry Power Station	Coal	86.3
7	Winnington CHP	CCGT Power Station	13.2
8	Sandbach CHP	CCGT Power Station	2.7
9	Lafarge Cement - Cauldon	Industrial Process	6.5
10	Pilkington Glass - Greengate	Industrial Process	1.4
11	Pilkington Glass - Cowley Hill	Industrial Process	1.4
12	Pilkington Glass - Watson Street	Industrial Process	0.5
13	Quinn Glass Elton	Industrial Process	1.7
14	Stanlow Refinery	Industrial Process	28.2
15	Eastham Refinery	Industrial Process	0.5
16	Kemira (PAX Plant)	Industrial Process	0.6
17	British Salt Ltd. Middlewich Site	Industrial Process	0.6
18	AstraZeneca - Macclesfield	Industrial Process	0.6
19	Manchester Sweeteners	Industrial Process	1.5
TOTAL			269.9
Note:			
1. Assuming facilities are replaced at end of life, an alternative fuel may be employed by any new facility			

A.3.5 North Wales Mini-Cluster Development

The North Wales mini-cluster has been modelled as being developed in two phases. The first phase of development would be the installation of CCS infrastructure at the three CCGT power stations between 2028 and 2032. It is expected that the existing pipelines, both onshore and offshore currently used to deliver gas to the CCGT installations, will be adapted to transport CO₂. If such a retrofit is unfeasible, it would be expected that a similar route would be adopted for any new pipelines which would be required.

The second phase of deployment will see CCS installed at the Padeswood Works between 2038 and 2042. A new pipeline will be required to be installed between the works and Connah's Quay Power Station.

Table 8: Phase 2-3 (2025-2050) North Wales Mini-Cluster

ID	Name	Type of Installation	Cumulative CO ₂ Emissions Captured (MT)
1	Connah's Quay Power Station	CCGT Power Station	60.7
2	Shotton CHP	Industrial Process (CCGT)	8.0
3	Deeside Power Station	CCGT Power Station	24.6
4	Padeswood Works	Industrial Process	4.4
TOTAL			97.7

Figure 5: Phase 2-3 (2025-2050) North Wales Mini-Cluster



A.3.6 South Wales Mini-Cluster Development

As modelled, the South Wales CCS mini-cluster would capture the largest cumulative amount of CO₂ by 2050. The development of the cluster would most likely occur in two phases. The first phase of development would see the coal-fired power stations (Aberthaw and Uskmouth) retrofit CCS in 2025 and then the six CCGT plants install CCS between 2038 and 2042.

Due to the spatial variation between the emitters, it is expected that an offshore pipeline would need to be routed from the Seabank Power Station along the Bristol Channel. It is expected that emitters alongside the South Wales coast would require the installation of 'Tee' pieces in the trunk pipeline such that separate pipelines could subsequently link in.

The second phase of deployment would see the industrial facilities install CCS during 2038 to 2042. These facilities would require smaller onshore pipelines to join with the pipelines linking the power stations to the trunk pipeline.

Figure 6: Phase 2-3 (2025-2050) South Wales Mini-Cluster

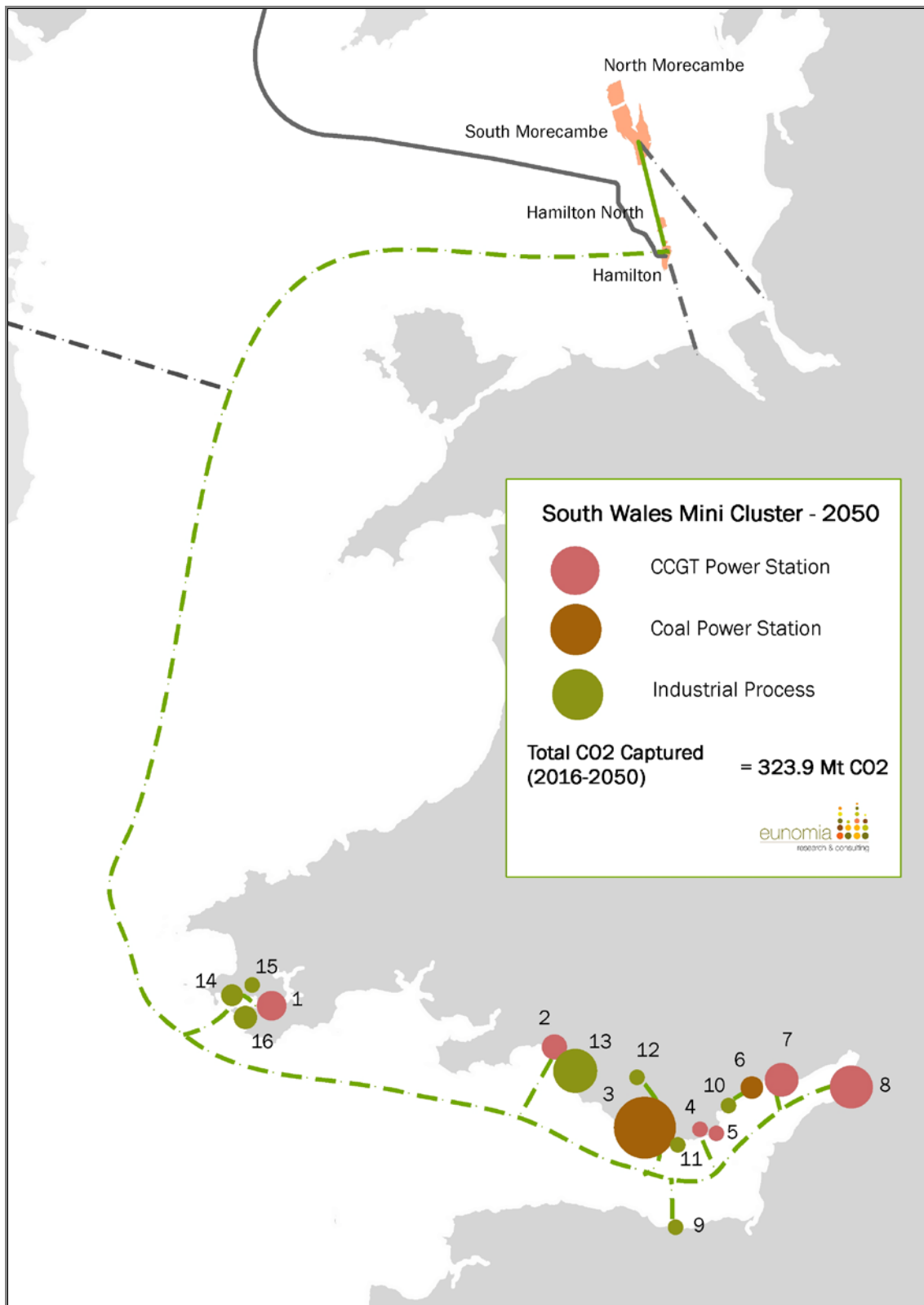


Table 9: Phase 2-3 (2025-2050) South Wales Mini-Cluster

ID	Name	Type of Installation	Cumulative CO ₂ Emissions Captured (MT)
1	Pembroke Power Station	CCGT Power Station	14.9
2	Baglan Bay Power Station	CCGT Power Station	15.3
3	Aberthaw Power Station	Coal Power Station	95.1
4	Dow Corning CHP	CCGT Power Station	2.8
5	Barry Power Station	CCGT Power Station	7.5
6	Uskmouth Power Plant	Coal Power Station	11.0
7	Severn Power Station (Uskmouth)	CCGT Power Station	27.8
8	Seabank Power Station	CCGT Power Station	44.0
9	Wansbrough Paper Mill	Industrial Process	0.6
10	Celsa Manufacturing	Industrial Process	0.6
11	Lafarge Cement UK - Aberthaw	Industrial Process	3.2
12	Rockwool Bridgend	Industrial Process	0.7
13	Port Talbot Steelworks	Industrial Process	64.8
14	South Hook LNG Terminal	Industrial Process	1.3
15	Milford Haven Refinery	Industrial Process	11.3
16	Texaco Refinery	Industrial Process	23.1
TOTAL			323.9
<p>Note:</p> <ol style="list-style-type: none"> 1. This refers to the current technology currently employed. 			