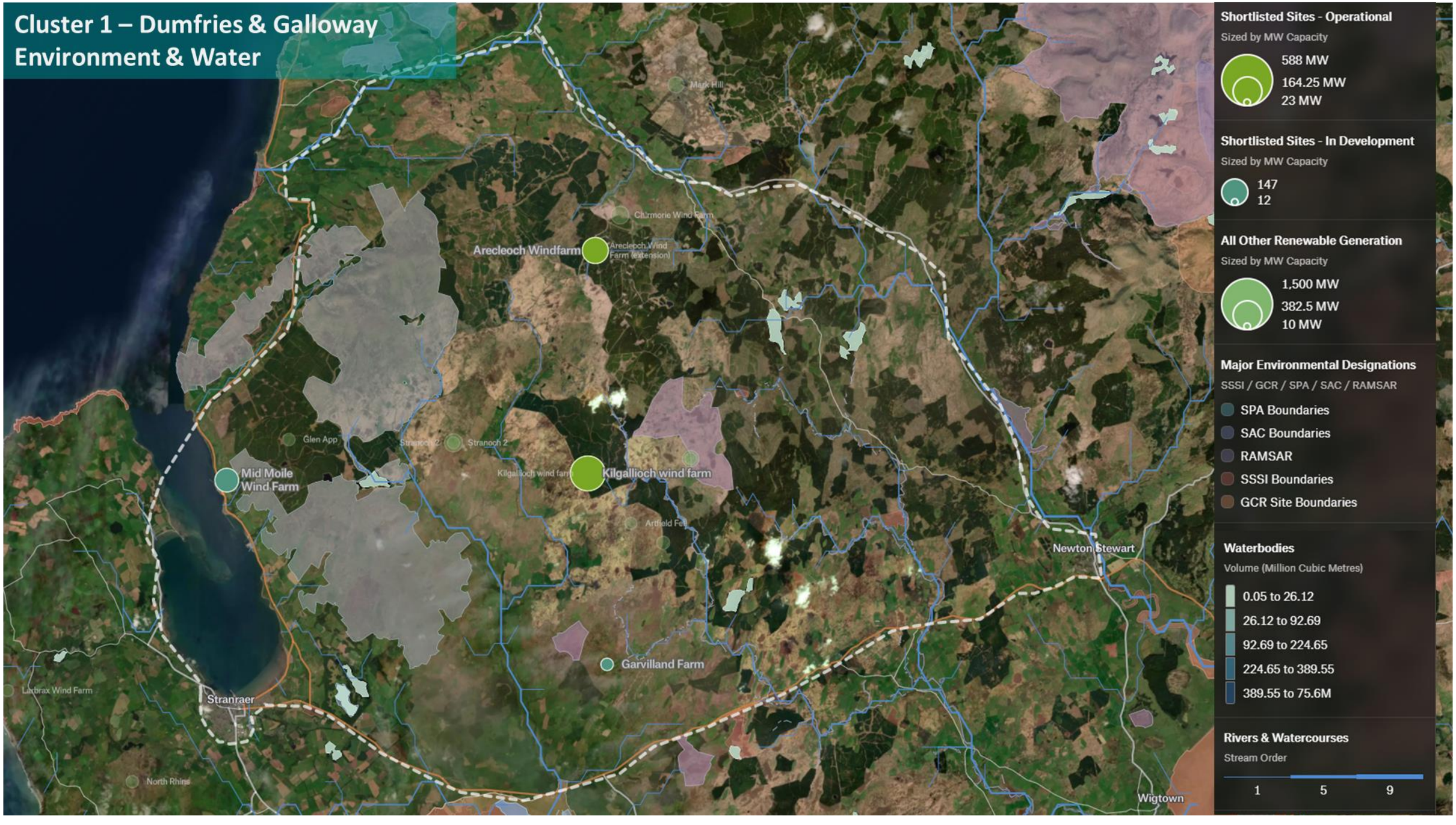
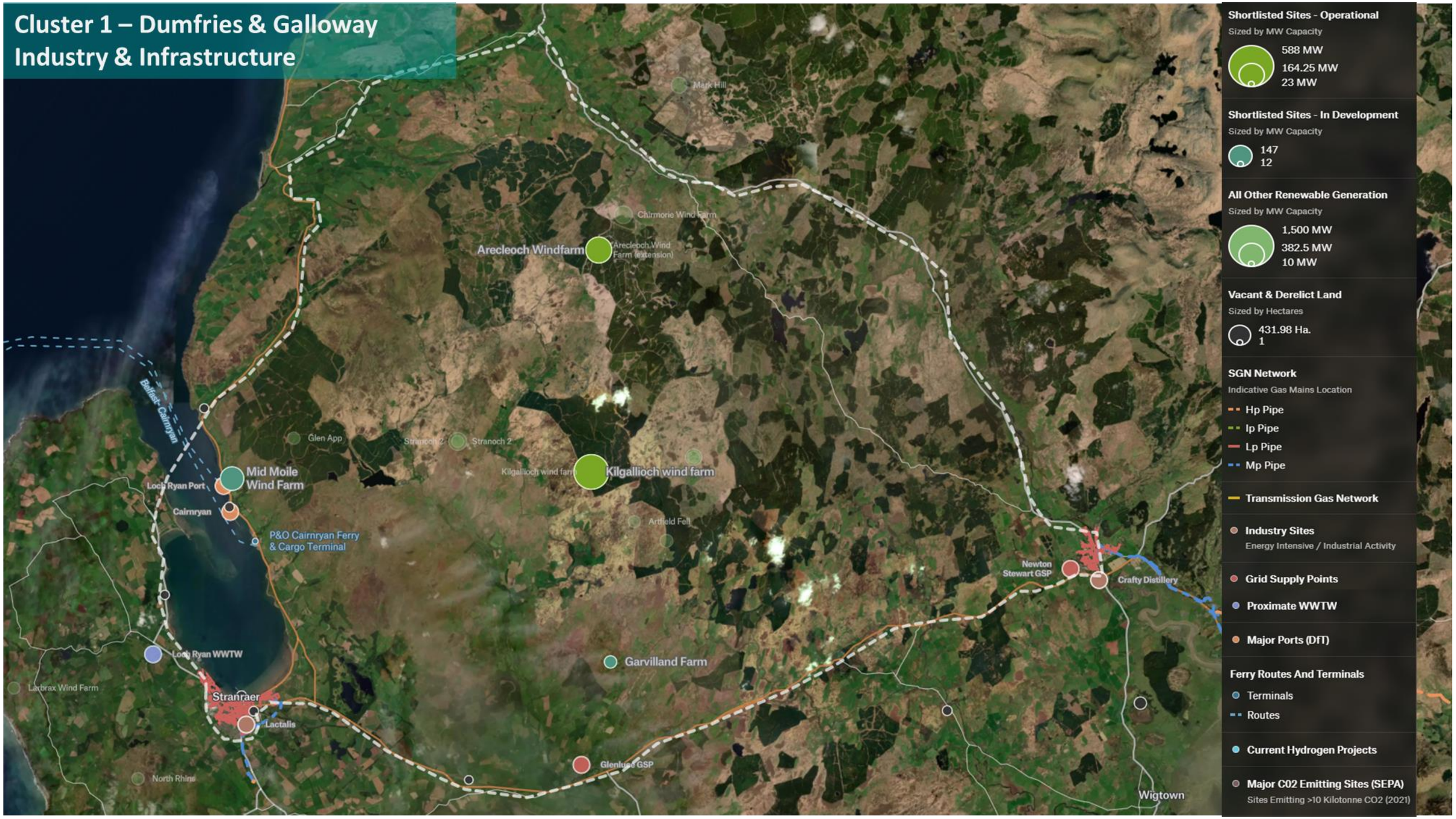
Cluster 1 – Dumfries & Galloway

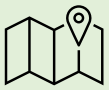


Cluster 1 – Dumfries & Galloway



CLUSTER 1: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Arecleoch Windfarm	Scottish Power Renewables	On-shore Wind	120	Operational since 2011	NG Balancing Mechanism (102 MWh/Day avg.) (£67 MWh avg)	Planned 73MW extension consented and awaiting construction (including 20MW battery storage)
Kilgallioch Wind Farm	Scottish Power Renewables	On-shore Wind	239	Operational since 2017	NG Balancing Mechanism (446 MWh/Day avg.) (£66 MWh avg)	Planned 62 MW extension consented and awaiting construction (including battery storage and solar PV)
Garvilland Wind Farm	Green Cat Renewables Ltd.	On-shore Wind	18	Planning App Submitted	Currently w/o grid connection	
Mid Moile Wind Farm	EnergieKontor UK Ltd.	On-shore Wind	99.4	Planning App Submitted	Currently w/o grid connection	Planned battery storage included as part of development.
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Glenchamber	Renewable Energy Systems	Onshore Wind	27.5 MW	Operational since 2016		
Artfield Fell	SSE Renewables	Onshore Wind	19.5MW	Operational since 2005		
Chirmorie	Corolis Energy	Onshore Wind	80MW	Planning granted		
Stranoch	EDF Energy	Onshore Wind	84 MW	Planning granted		

FACTSHEET: CLUSTER 1		
Key Details & Characteristics	**Local Authority**	Dumfries & Galloway Council / South Ayrshire
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	Key operators of known constrained renewable energy generation sites are: • Scottish Power Renewables (Arecleoch and Kilgallioch Windarms both of which are subject to planned expansion). They also operate Glen App Wind Farm (22MW) which is operational but not identified as subject to significant levels of constraint (from available data). • Energiekontor UK Ltd. • Green Cat Renewables Elsewhere within the Cluster there are operational wind farms which do not participate in NG Balancing Mechanism and/or have a Grid Connection. They may still be subject to constraint through network management by SPEN but there is limited available data on extent and nature of this. These include • Renewable Energy Systems (Glenchamber – 27.5MW) • SSE Renewables (Artfield Fell – 19.5MW) • Corolis Energy (Chirmorie – 80MW) • EDF Energy (Stranoch – 84MW)
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. The majority of constrained renewable energy generation in the Cluster relates to relatively large-scale sites Arecleoch and Kilgallioch currently operated by Scottish Power Renewables. There are plans to further expand these wind farms and incorporate battery energy storage which could be complementary to future hydrogen production.

	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, transport, grid and utilities infrastructures?	There is limited brownfield land or prior development of infrastructure in the area (except renewable energy). It is predominantly rural in character though towns of Stranrear and Newton Stewart have a level of commercial activity and associated infrastructure The rail line serving Stranraer and connecting it to the central belt runs through the centre of the Cluster. Loch Ryan and Cairnryan Ferry Ports are situated within the Cluster with ferry services running to/from Northern Ireland. Associated with the Ferry Terminal is marine and transport infrastructure, including dedicated areas for cargo and freight transport. Road infrastructure includes A77 and A75 Trunk Roads connecting to Stranrear and which form the boundaries of the Cluster to the West and South. There is local track and B-road access to wind-farm sites and other rural / agricultural uses across the area. Further detail on utilities infrastructure (gas, water, grid) is considered below.
Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	There is relatively limited brownfield land in the area, reflecting its rural character. Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The Dumfries & Galloway Council LDP recognises the potential of hybrid 'energy hubs' and different forms of storage (incl. hydrogen) to support decarbonisation across the region and make the most of its renewable capacity. It supports development of all renewable energy generation and storage where these are sited and designed appropriately, with regard to landscape, cumulative impacts, amenity, and natural and historic environment. Similarly, the South Ayrshire Council LDP supports proposals for generating and using renewable energy where they will not have a harmful impact on local amenity, landscape character, biodiversity, and the historic environment. The Glen App and Galloway Moors at the west of the cluster are subject to overlapping SSSI / SAC environmental designations, around which on-shore wind has been developed These are unlikely to pose a significant constraint to hydrogen production at 'de-centralised' scale. To the east of the Cluster the River Bladnoch (and associated tributaries)

		are designated as a Special Area of Conservation relating to the presence of Altantic Salmon. Noted pressures on the SAC include agriculture and forestry operations as well as water quality. The potential for abstraction from this source may be constrained. Specific development management considerations relating to access / transport, ground conditions / soils, visual impact, amenity (noise / vibration / odour), cultural heritage, archaeology have not been reviewed in detail but would need to be considered and assessed in detail for proposed production locations
Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. above Total renewable energy generation within the cluster is approximately 400 MW, with potential to rise to c. 680 MW though approved and currently planned sites. Battery storage is proposed to be developed within the Cluster at Arecleoch Wind Farm (20MW) and at Stranoch 2 (20MW) though in both cases awaiting construction to complement expansion of onshore wind. Subject to future feasibility and market conditions, battery storage could complement production of green hydrogen.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	The nearest Grid Supply Point (Glenluce) is noted as **RED** meaning at least one factor is close to operational limit and connection for most distributed generation is unlikely without reinforcement works. It is noted that future connections will be subject to Active Network Management. SPEN note that Dumfries & Galloway has among the UK's highest proportion of connected renewable generation relative to its demand for energy. A programme of Active Network Management has been developed and implemented to manage constraint at 11 Grid Supply Points across the area (including Glenluce), and will affect planned / future distributed connections within the Cluster. The project aims to manage transmission networks constraint by active monitoring and real-time management export from distributed generation, enabling new renewable connections in a heavily congested part of the network. The Project is due to complete in Q3 2023 (upon completion transmission reinforcement but may be subject to further review. • Project Fact Card • Innovation Roll-Out Mechanism Summary
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	The Transmission Gas Network does not cross through the Cluster.

		SGN Network Mapping indicates the nearest infrastructure is located around the settlements of Stranrear and Newton Stewart – where there are Medium Pressure gas mains linked to local industrial sites (eg. Lactalis) and Low Pressure mains serving communities and local infrastructure.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in South West Scotland from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture), as well as effluent as well as effluent from waste-water treatment. Within the Cluster itself, there are a number of local watercourses (Water of Luce) which could serve as a potential source of surface water abstraction subject to further review, as well as a reservoir which is proximate to Mid Moile Wind Farm though appears to still be in operation by Scottish Water. As noted above, abstraction potential from the River Bladnoch at the east of the cluster may be constrained by SAC designation. BGS Mapping indicates that groundwater abstraction yields are anticipated to be relatively limited, though there is a potentially productive aquifer at the south of the Cluster (south of Stranrear). There are no waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest waste-water treatment works (Loch Ryan WWTW) is located near Leswalt on the other side of the Loch. It does have effluent levels that could potentially satisfy demand, though would challenging for direct integration with green hydrogen production co-located to renewable generation.
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is some headroom capacity within the local potable water supply network, which could potentially support green hydrogen production at a small-medium scale (subject to future detailed review with SW). However, it has been highlighted that climate change will bring additional pressure on water supply in the area and future review of capacities.
Local Demand & Export	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be	Given the relatively remote and rural nature of land use within the Cluster, there is limited opportunities for off-take of hydrogen to local industrial activity or fulfilling demand for de-carbonisation from an energy intensive user.

	suitable for hydrogen integration as a source of demand?	Caledonian Cheese / Lactalis operate a large-scale production facility (creamery) in Stranrear that has previously been identified as part of an 'Energy Intensive Industry' with scope for industrial de-carbonisation. Hydrogen could form a part of this process subject to future feasibility and demand. Crafty Distillery (Newton Stewart) is located at the eastern edge of the Cluster and subject to future feasibility and demand could provide a potential off-take of hydrogen as part of future de-carbonisation.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	Loch Ryan Port and Ferry Terminal is situated at the western edge of the cluster – with ferry services operating to/from Northern Ireland. In a potential future scenario where hydrogen is utilised as fuel for shipping this could provide an off-take opportunity but subject to technical feasibility, demand, and may require a larger scale of hydrogen production than de-centralised opportunities produced from a single renewable energy source. Green Hydrogen production within the Cluster could serve freight / cargo vehicle movements moving to/from Scotland and Northern Ireland -with re-fuelling co-located to the Cairnryan terminal as a potential demand source.
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	There is no currently identified (public domain) hydrogen production / distribution / utilisation projects in the vicinity. However Scottish Power Renewables own and operate significant capacity of on-shore wind in the cluster and are actively exploring hydrogen production across a number of other Scottish sites.

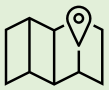
Cluster 2 – South & East Ayrshire

Cluster 2 – South & East Ayrshire

CLUSTER 2: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Hadyard Hill	SSE	Onshore Wind	120	Operational since 2006	NG Balancing Mechanism (70 MWh/Day avg.) (£71/ MWh avg)	
Craiginmoddie Wind Farm	Energiekontor UK Ltd	Onshore Wind	92	Planning App Submitted	Currently w/o grid connection	Co-located battery storage planned as part of development.
Dersalloch	Scottish Power Renewables	Onshore Wind	69	Operational since 2016	NG Balancing Mechanism (104 MWh/Day avg.) (£63/ MWh avg)	SP Renewables developing proposals for 50MW battery storage at Dersallaoch.
Sclenteuch	RES Limited	Onshore Wind	54	Planning App Submitted	Currently w/o grid connection	Co-located battery storage planned as part of development.
Polquhairn	Brookfield Renewable UK Ltd.	Onshore Wind	34	Planning App Submitted	Currently w/o grid connection	
Lethans Wind Farm Extension	Banks Renewables	Onshore Wind	66	Planning App Submitted	Currently w/o grid connection	Extension to consented Lethans Wind Farm (105 MW)
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Carrick Wind Farm	Scottish Power Renewables	Onshore Wind + BESS	86 MW + 20 MW BESS			
Knockcronal Wind Farm	Statkraft UK Ltd	Onshore Wind + BESS	59MW + BESS			
North Kyle Energy Project	Brockwell Energy	Onshore Wind	206MW			
Knockkippen	Falck Renewables	Onshore Wind / Solar / BESS	60 MW Wind / 20 MW Solar / 16 MW BESS			
Pencloe Wind Farm	Pencloe Renewables	Onshore Wind	85.5MW			

Enoch Hill Wind Farm	E.ON Renewables	Onshore Wind	53MW			
Over Hill Wind Farm	EnergieKontor	Onshore Wind	33MW			
Greenburn Wind Park	REG Power Management	Onshore Wind	67MW + 10MW BESS			

FACTSHEET: CLUSTER 2		
Key Details & Characteristics	**Local Authority**	South Ayrshire Council / East Ayrshire Council
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	As noted in the table above there are a range of renewable energy operators and developers active in the area that are subject to levels of constraint including: • Scottish Power Renewables • Energiekontor UK • SSE Renewables • RES • Banks Renewables • Brookfield Renewable UK Ltd. Elsewhere within the Cluster there is a significant number of proposed wind farms, which either do not participate in NG Balancing Mechanism and/or have a Grid Connection. They may still be subject to constraint through network management by SPEN but there is limited available data on extent and nature of this. These include: • Scottish Power Renewables - Carrick Wind Farm (86MW + 20MW Battery Storage) • Statkraft UK Ltd. – Knockcronal Wind Farm (59.4MW + Co-Located Battery) • Brockwell Energy – North Kyle Energy Project Wind Farm (206MW) • Falck Renewables – Knockkippen Wind, Solar, Battery Farm (60 MW Wind, 20 MW solar, 16MW battery) • Pencloe Wind Energy – Pencloe Wind Farm (85.5 MW) • E.ON Renewables – Enoch Hill Wind Farm (52.8 MW) • EnergieKontor – Over Hill Wind Farm (33 MW) • REG Power Management – Greenburn Wind Park (67MW Wind + 10MW Battery)

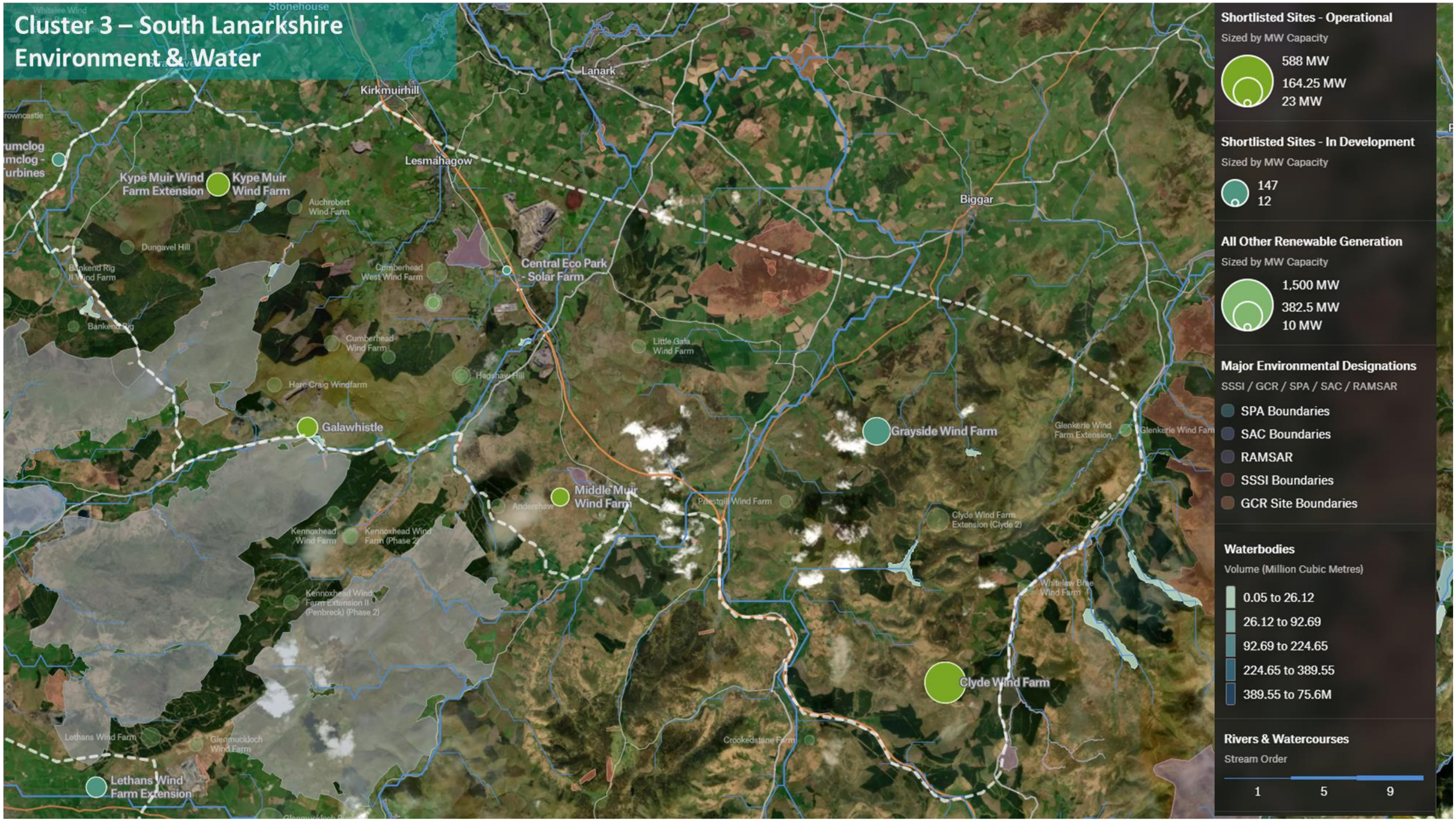
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. There is relatively large-scale operational sites at Hadyard Hill and Dersalloch which participate in the Balancing Mechanism and experience curtailment. Elsewhere within the Cluster there four sites with planning applications submitted – but yet to have a confirmed Grid Connection. These are mainly to the West of the Cluster.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, transport, grid and utilities infrastructures?	There is limited brownfield land or prior development of infrastructure in the area (except renewable energy). It is predominantly rural in character, though significant former mine workings in South Ayrshire are present in the north of the area which may present future opportunities for brownfield renewal, including renewable energy. The rail Stranrear rail crosses to the west of the Cluste, stopping at Ayr and Girvan. The 'Waterside' branch of the railway extends into the study area, with which there are former rail sidings and brownfield land at Dalmellington which may offer potential for hydrogen production in relative proximity to sources of water and renewables generation. Road infrastructure includes A77 which forms the western boundary of the Cluster and likely main connection to potential sources of demand beyond the locale. The A70 is also a short distance from the northern edge of the cluster. There is local track and B-road access to local settlements (eg. Dalmellington) and wind-farm sites and other rural / agricultural uses across the area. Further detail on utilities infrastructure (gas, water, grid) is considered below.
Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	Former East Ayrshire coalfield provides significant vacant and derelict land which could be utilised for hydrogen production and/or consolidation of storage and distribution infrastructure depending on the scale of future demand / capacity. It is particularly proximate to the planned Sclenteuch and Polquhairn Wind Farms, and Dersalloch (including planned battery facility). Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.

	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The South Ayrshire Council LDP supports proposals for generating and using renewable energy where they will not have a harmful impact on local amenity, landscape character, biodiversity, and the historic environment. Similarly, the proposed East Ayrshire LDP (currently under Independent Examination) supports a full range of renewable energy technologies across a range of scales. The Council is producing a regional Energy Masterplan to coordinate strategic planning of energy infrastructure across the region. The LDP refers to new and innovative approaches to supporting renewable energy development, and maximising the potential of renewable power generation and storage. There are relatively few environmental / planning designations which would constraint hydrogen production at de-centralised scale. Loch Doon is a SSSI noted for presence of Arctic Charr. This would require detailed review and assessment of any proposals for water abstraction.
Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to exceed 1GW. As noted above, a number of proposed wind farms in the Cluster are bringing forward co-located battery storage. This includes proposed sites at Carrick, Dersalloch, Greenburn, and Knockkippen all of which include battery storage of 10-20 MW which could complement hydrogen production, subject to future feasibility and market conditions.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	The nearest Grid Supply Points (Maybole / Kendon) are noted as **RED** meaning at least one factor is close to operational limit and connection for most distributed generation is unlikely without reinforcement works. It is noted that future connections will be subject to Active Network Management or Load Management Schemes. The above sub-stations are within the scope of SPEN's Actvie Network Management programme to manage constraint across Dumfries & Galloway and may be relevant to planned / future distributed connections within this Cluster.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	The Transmission Gas Network does not cross through the Cluster. SGN Network Mapping indicates that there are Intermediate Pressure and Medium Pressure gas main towards the centre of the Cluster, situated beneath the road linking to Dalmellington (close to the proposed Sclenteuch Wind Farm), with Low Pressure gas mains linked to communities – these mains are modernised polyethylene which is more capable of carrying Hydrogen. A High Pressure Gas Main (Steel) is located at the western edge of the Cluster, linked to Girvan and serving the Girvan Distillery and nearby industrial uses.

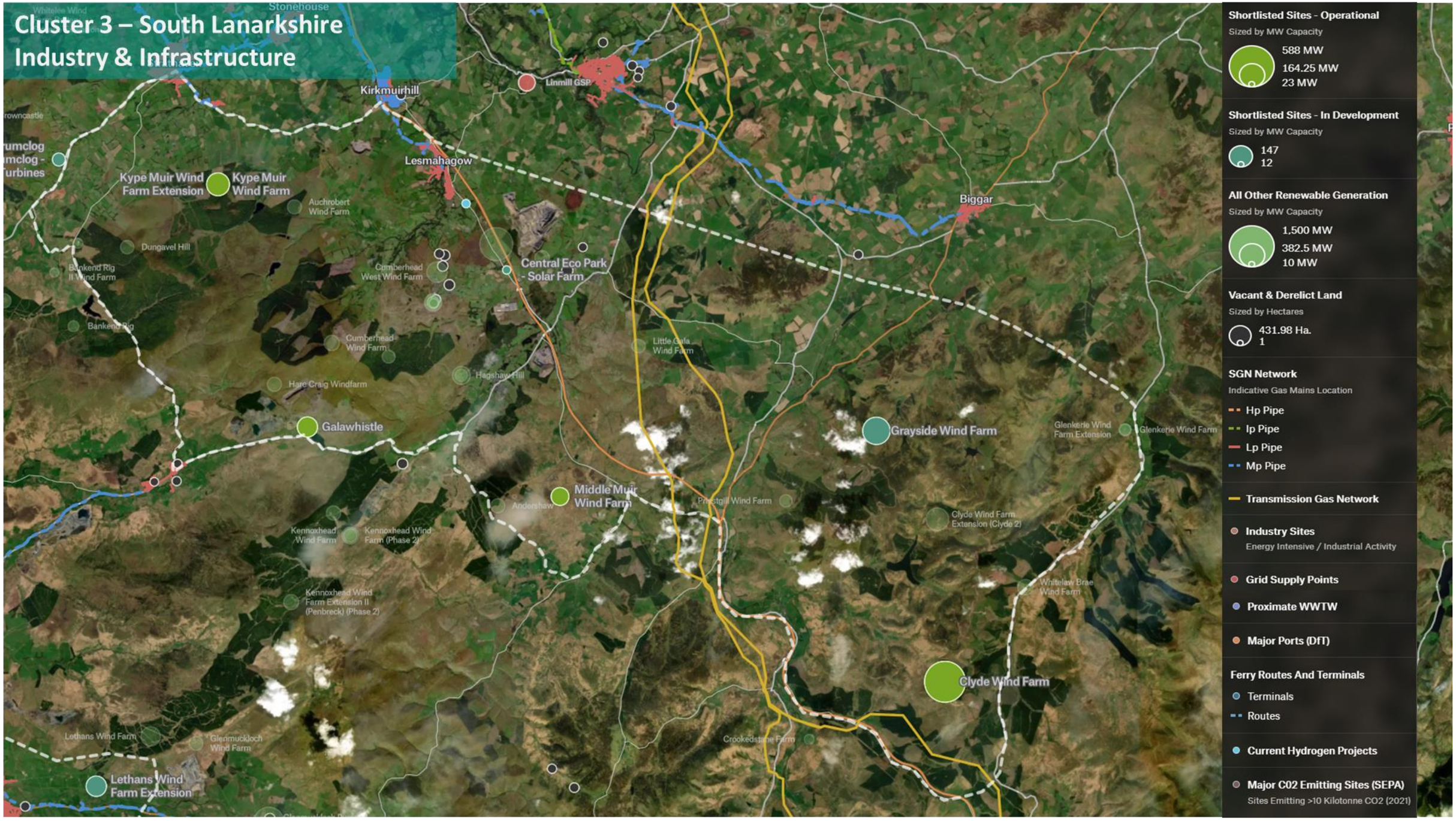
		Medium Pressure Gas Mains (polyethylene) are connected to New Cumnock at the north-east of the Cluster (close to the proposed Lethans Wind Farm extension).
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in this region of Scotland, from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture), as well as effluent from waste-water treatment. Within the Cluster itself, there are a number of local watercourses which could serve as a potential source of surface water abstraction subject to further review. The River Nith is proximate to the Lethans Wind Farm extension, while the River Doon runs through the centre of the Cluster and is proximate to Sclenteuch Wind Farm. Loch Doon and Loch Bradan is situated at the south of the cluster. It is a relatively large waterbody with an average discharge rate of 4.75 m3/s and therefore could be potentially capable of abstraction to support de-centralised green hydrogen production, subject to necessary SEPA consents and licenses and provision of infrastructure. As noted above, the Loch is designated as a SSSI which would require careful assessment and consideration for any water abstraction. It is owned by Scottish Power forming part of the Galloway hydro-electric power, with a dam and regular change in water levels as a result. There is an existing reservoir within the Cluster and is directly adjacent to Hadyard Hill – though is owned and operated by Scottish Water. BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are likely to be relatively high especially towards the east of the Cluster, with a potential average yield of 1m litres / day depending on locationally specific review. Groundwater abstraction could therefore provide a ready source of raw water supply for green hydrogen production. There are no waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest waste-water treatment works (Girvan STW) is located on the coast just north of Girvan.
	Mains Supply (SW) Availability	High-level review with Scottish Water has indicated there is some headroom capacity within the local potable water supply network, which could potentially support green hydrogen production at a small-medium scale (subject to future detailed review with SW)

	Is there headroom capacity at local water treatment works to provide a mains supply?	
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	While land use within the Cluster is predominantly low intensity and rural, there are potential opportunities in surrounding including: • Girvan Distillery (William Grant & Sons) is located at the western edge of the cluster. It is currently among Scotland's top C02 emitters and may seek to utilise hydrogen to support de-carbonisation of certain industrial / production processes. Around the distillery is a cluster of other production / industrial processes including Nestle UK and a wood pellet manufacturer. The site has been noted as an EII site within Scottish Government's 'Decarbonising Industrial Sectors and Sites' Discussion Paper (2019). • To the north of the cluster is Egger Paper and wood production processing plant, which is included on SEPA's pollutant release inventory. • Across South, East, North Ayrshire local industrial / activity and processes within Ayr, Irvine, Kilmarnock may provide a future source of demand subject to commercial and technical feasibility. Potentially complementary to planned advanced manufacturing development and/or existing energy intensive processes at GSK, Caledonian Paper Mill, and Ardagh Glass in Irvine.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	There is no major transport infrastructure within or around the cluster, other than local road network and relatively limited movement of large-scale freight / cargo through the area other than movements to/from Cairnryan Ferry Port to the south. There is likely to be relatively limited opportunities for green hydrogen production to supply local transport in the short-medium term.
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	There is no currently identified (public domain) hydrogen production / distribution / utilisation projects in the vicinity. However Scottish Power Renewables and SSE own and operate on-shore wind in the cluster and are actively exploring hydrogen production across a number of other Scottish sites.

Cluster 3 – South Lanarkshire



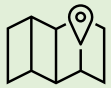
Cluster 3 – South Lanarkshire



CLUSTER 3: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Low Drumclog Farm	Clean Earth Energy Ltd.	Onshore Wind	20	Planning Submitted	Currently w/o Grid Connection	
Kype Muir Wind Farm & Extension	Banks Renewables	Onshore Wind	163 Total (75 MW Extension)	Operational site w/ extension under construction	Extension currently w/o grid connection.	
Galawhistle	Ventient (formerly Infinis)	Onshore Wind	66	Operational since 2017	NG Balancing Mechanism (56 MWh/Day avg.) (£71/ MWh avg.)	
Middle Muir	Banks Renewable	Onshore Wind	51	Operational since 2019	NG Balancing Mechanism (55 MWh/Day avg.) (£43/ MWh avg)	
Grayside	Grayside WR	Onshore Wind	147	Planning App Submitted	Currently w/o grid connection	Co-located battery storage (20MW) planned as part of development.
Clyde Wind Farm	SSE / Greencoat UK Wind	Onshore Wind	350	Operational since 2012	NG Balancing Mechanism (456 MWh/Day avg.) (£71/ MWh avg.)	
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Coalburn Energy Storage	Alcemi Storage Development Ltd.	BESS	500 MW	Planning App Submitted		
Broken Cross	BayWa UK Ltd	Onshore Wind	40MW	Planning Permission Granted		
Cumberhead West Wind Farm	**3R Renewables**	Onshore Wind	126MW	Planning permission granted		
Douglas West Extension	**3R Renewables**	Onshore Wind	78MW (+20 MW BESS)	Planning permission granted		
Hare Craig	EnergieKontor UK	Onshore Wind	36 MW	Planning App submitted		
Cumberhead Wind Farm	Cumberhead Wind Energy	Onshore Wind	48MW	Planning app submitted		

Hagshaw Hill (Re-powering)	Scottish Power Renewables	Onshore Wind	84MW (+20 MW BESS)	Planning permission granted		
Auchrobert Wind Farm	Falck Renewables	Onshore Wind	36MW	Operational since 2017.		

FACTSHEET: CLUSTER 3		
Key Details & Characteristics	**Local Authority**	Predominantly South Lanarkshire Council. Incorporating small areas of East Ayrshire and Scottish Borders where on-shore wind farms straddle boundaries.
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • Banks Renewables (operating major Kype Muir Wind Farm) • SSE (operating major Clyde Wind Farm) Elsewhere within the Cluster there are a number of proposed wind farms (and energy storage) which either do not yet participate in NG Balancing Mechanism and/or have a Grid Connection. These are predominantly clustered around the M74 corridor at the centre of the Cluster. They may still be subject to constraint through network management by SPEN but there is limited available data on extent and nature of this. • Alcemi Storage Development Ltd. (Coalburn Energy Storage -500MW stand-alone BESS system. Subject to planning). • BayWa UK Ltd. (Broken Cross Wind Farm – 40MW. Planning permission granted) • 3R Renewables (Cumberhead West Wind Farm – 126MW. Planning permission granted) (Douglas West Extension - 78 MW + 20MW Battery Storage) • EnergieKontor UK – Hare Craig Winfarm – 36MW. Planning Submitted. • Cumberhead Wind Energy – 48MW. Planning submitted. • Scottish Power Renewables – Hagshaw Hill repowering to provide 84MW wind farm and 20MW battery storage. • Falck Renewables – Auchrobert Wind Farm – 36MW. Operational.
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. There is very large-scale operational sites at Clyde Wind Farm, and at Galawhistle and Middle Muir which participate in the Balancing Mechanism and experience curtailment. Elsewhere within the Cluster there is a number of sites either with planning permission or progressing through the planning system. In particular Grayside Wind Farm and

		Kype Muir Extension at the western and eastern edges of the Cluster respectively would add significant generation capacity but do not yet appear to have a confirmed Grid Connection.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, grid and utilities infrastructures?	There is limited brownfield land or prior development of infrastructure in the area (except renewable energy). It is predominantly rural in character, though there is former coal workings / bings clustered around Coalburn at the centre of the Cluster and close to Douglas West Wind Farm, as well as the former surface mine of Broken Cross. The major arterial route M74 crosses through the centre of the cluster, including service stations at Cairn Lodge and 'Route 74' Truckstop at the northern edge of the cluster. The M74 provides connections to a range of potential demand sources (via tube trailer) and significant movement of freight / HGV which could also be a source of future deman. There is local track and B-road access to local settlements (eg. Lesmahagow) and wind-farm sites and other rural / agricultural uses across the area. The West Coast Main Line crosses through the cluster, though is a remote section of the line. The closest rail infrastructure is located at the Carstairs junction (approximately 9km north of the Cluster) where the WCML splits. Further detail on utilities infrastructure (gas, water, grid) is considered below.
Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	Limited brownfield land availability. Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The South Lanarkshire LDP supports development of renewable energy technologies, subject to detailed assessment against wider LDP policies and supplementary guidance. There are relatively few environmental / planning designations which would constraint hydrogen production at de-centralised scale. Tinto Hills SSSI, Coalburn Moss SSSI / SAC, and Muirkik and North Lowther Uplands SSSI / SAC are within the Cluster but largely separated from existing renewable energy generation.

Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to exceed 1GW, with major generation in particular at Clyde Wind Farm, Kype Muir (+Extension), and Cumberhead. Within the Cluster is the major 500MW Battery Storage development at Coalburn, being brought forward by Alcemi Storage Development Ltd. A planning application has been submitted and is currently under consideration.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	See Appended SPEN Heat Map. The nearest Grid Supply Points (Linmill) are noted as **RED** meaning at least one factor is close to operational limit and connection for most distributed generation is unlikely without reinforcement works. It is noted constraint comes from the wider transmission network, with no new capacity on GSP transformers a new GSP is required.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	National Grid Gas Transmission Network pipelines (900mm diameter) cross through the centre of the cluster – running north-south. Subject to future technical feasibility and legislation to allow for hydrogen blending, this could provide a robust export opportunity for green hydrogen production. The nearest interchange / compressor station is at the southern edge of the Cluster, close to Elvanfoot. SGN Network Mapping indicates there is limited other gas distribution infrastructure in the cluster. Medium Pressure Mains (polyethylene) are linked to Lesmahagow and Strathaven at the north-eastern edge, with Low Pressure Mains subsequently linked to communities in those towns.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in this region of Scotland, from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture), as well as effluent from waste-water treatment. Within the Cluster itself, there are a number of local watercourses which could serve as a potential source of surface water abstraction subject to further review. Douglas Water runs centrally through the Cluster, while the River Clyde is situated at the eastern end, close to Grayside Wind Farm.

		There are two existing reservoirs situated at the centre of the Cluster in relative proximity to Kype Muir Wind Farm, though both appear to remain operated by Scottish Water. BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are likely to be highest towards the west of the cluster, where there is a productive aquifer with a potential average yield of up to 1m litres / day depending on location specific review. Across the rest of the Cluster there appear moderately productive aquifers from which yields of around 750,000 litres/day could be achievable, thought dependent on more site specific investigation. Groundwater abstraction could therefore provide a ready source of raw water supply for green hydrogen production. There are no waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest waste-water treatment works are located in Glasgow (Dalmarnock) or Irvine (Meadowhead).
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is no current headroom capacity within the local potable water supply network that could support green hydrogen production. Water supply would therefore need to be taken from abstraction sources outlined above.
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	Relatively few opportunities for integration to local industry or meeting de-carbonisation need from energy intensive user within the cluster. The majority of opportunities for off-take from an industrial / energy intensive uses are likely to emerge from activity within the Central Belt. The Cluster is in an accessible location (via M74) so may be able to export hydrogen to the Central Belt or southward to England via tube trailers to a range of end-users (subject to demand and future feasibility).
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	The M74 motorway crosses through the centre of the cluster. It is a key arterial route for large-scale freight / cargo movements to/from the Central Belt and England. Subject to future technical feasibility and economics, hydrogen may emerge as a viable decarbonisation opportunity for vehicle freight movements. Green Hydrogen produced within the Cluster could serve re-fuelling infrastructure to meet this demand

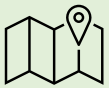
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	In recognition of the potential reference above, the HY2GO (M74 Hydrogen Hub) is being developed within the cluster – a collaboration between Hy2Go, Ryse, Siemens and Geopure. It is currently at detailed design stage for a site directly adjacent to the M74 (Jct 11) and would seek to provide a re-fuelling hub for HGV movement, using a combination of on-shore wind and solar. SSE own and operate major on-shore wind assets (Clyde) in the cluster and are actively exploring hydrogen production across a number of other Scottish sites.

Cluster 4 – East Lothian & Borders

Cluster 4 – East Lothian & Borders

CLUSTER 4: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Fallago Rig	EDF Energy Renewables	Onshore Wind	144	Operational since 2013	NG Balancing Mechanism (223 MWh/Day avg.) (£73/ MWh avg.)	
Aikengall	Community Windpower	Onshore Wind	48	Operational since 2008	Flexible Connection	
Aikengall II	Community Windpower	Onshore Wind	61	Operational since 2017	NG Balancing Mechanism (68 MWh/Day avg.) (71/ MWh avg.)	Co-located battery storage planned as part of development.
Aikengall III	Community Windpower	Onshore Wind	75.5	Operational since 2021	NG Balancing Mechanism (197 MWh/Day avg.) (48/ MWh avg.)	
Quixwood Moor	NTR PLC	Onshore Wind	30	Operational since 2017	Flexible Connection	
Penmanshiel	Renewable Energy Systems (RES)	Onshore Wind	28.7	Operational since 2016	Flexible Connection	
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Crystal Rig (all phases / extensions)	Fred Olsen Renewables	Onshore Wind	283 (all phases / extensions)	Operational since 2004		

FACTSHEET: CLUSTER 4		
Key Details & Characteristics	**Local Authority**	Predominantly Scottish Borders though a number of onshore wind sites straddle the border with East Lothian Council.
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • Banks Renewables (operating major Kype Muir Wind Farm) • SSE (operating major Clyde Wind Farm) Elsewhere within the Cluster Crystal Rig is a major wind farm operated by Fred Olsen Renewables. Crystal Rig participates in the NG Balancing Mechanism but to a smaller extent than other wind farms in the area. It may still be subject to constraint through other modes of network management but there is limited available data on extent and nature of this.
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. All of the renewable energy generation in the Cluster is operational reflecting the fact the area was an early site of development for onshore wind. Aikengall and its numerous extensions participate in the Balancing Mechanism, while other sites across the Cluster are subject to Flexible Connections through SPEN's Active Network Management in the area.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, grid and utilities infrastructures?	Pre-existing infrastructure and development assets are clustered around the A1 Corridor, at the eastern edge. Torness Nuclear Power Station is currently operational but due to be de-commissioned from 2028 onwards. The Tarmac Cement Plant and quarry works is also located within the Cluster and is a major emitter of CO2. Immediately adjacent is the Viridor Energy from Waste facility and landfill. Further inland within the Cluster (where renewable generation is sited), land use is predominantly rural in character, with patchwork of farms and small settlements. The A1(T) Road and East Coast Main Line are situated at the eastern edge of the cluster. There is also operational rail sidings / rail head associated with the Tarmac cement works and quarry facility. These have recently been subject to expansion and upgrade, following Freight Facilities Grant by Scottish Government with Tarmac seeking to expand its rail distribution to reduce carbon emissions and improve air quality. There is significant planned investment in grid infrastructure associated with offshore-wind substation / transmission infrastructure for Berwick Bank to be located at Branxton. On-shore infrastructure for NNG wind farm has already been delivered, connecting to existing infrastructure at Crystal Rig Wind Farm (10km inland). The HVDC 'Eastern Link' transmission reinforcement is also planned to make landfall at Torness – with the purpose of enabling large volume export

		of renewable energy. It is anticipated to be delivered by 2027/28 and may change future nature of constraint within the Cluster. Further detail on utilities infrastructure (gas, water, grid) is considered below.
Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	Limited brownfield land availability. Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	There are no relevant designations or constraints within the proposed Scottish Borders Local Development Plan (2021) which is currently subject to Independent Examination. The East Lothian LDP (2018) designates significant areas of the Cluster as a Special Landscape Area (Monynut to Blackcastle / Whiteadder / Lammermuir Woodland). Proposals for hydrogen production would need to have regard to local context and landscape, but at 'de-centralised' scale are unlikely to give rise to significant impacts and can be integrated with existing rural / renewable energy infrastructure. In both local authorities, development of renewable energy technologies is supported where they comply with other LDP policies and can be accommodated with unacceptable significant adverse impacts, giving regard to relevant environmental, community, and cumulative impact considerations. There are relatively few environmental / planning designations which would constrain hydrogen production at de-centralised scale. There are several SSSI designations in the area (Lammer Law, Rammer Cleugh, Lammermuir Deans) but largely separated from existing renewable energy generation and unlikely to pose a major constraint. The upper tributaries of the River Tweed (linked to Whiteadder Water) form part of a Special Area of Conservation designated for the presence of species including Otters, Altantic Salmon, and Sea Lamprey. Water management and quality is noted as a pressure on the SAC and would need to be carefully considered if surface water abstraction was required.

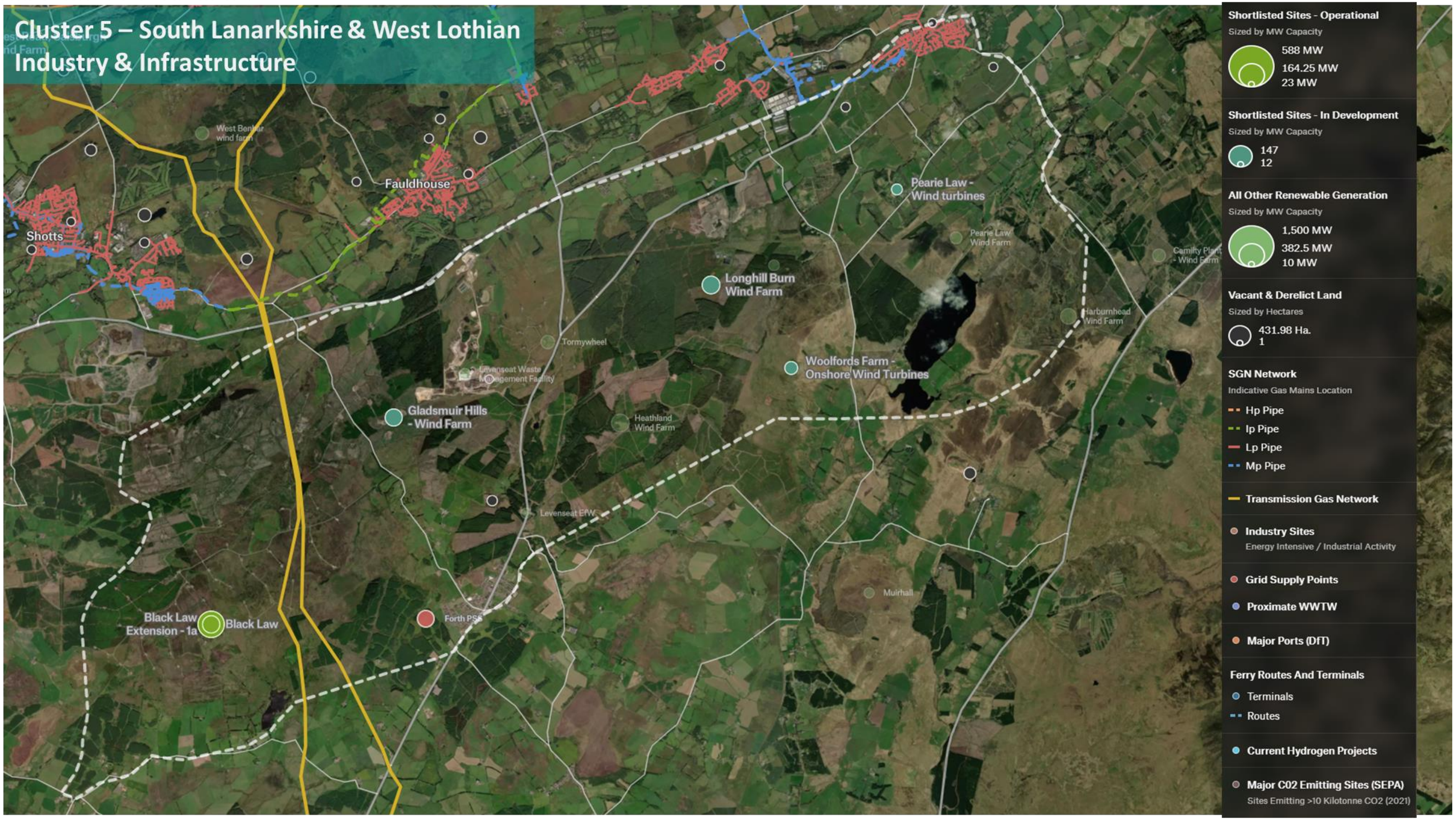
Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster currently exceeds 650MW, with a number of the operational wind farms subject to curtailment either through the Balancing Mechanism or Active Network Management.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	The nearest Grid Supply Points (Dunbar) is noted as **AMBER** meaning at least one factor is nearing its operational limit, and depending on the nature of application for a grid connection network reinforcement may be required. It is noted that the GSP Firm Capacity is full. SPEN have operated Active Network Management in East Lothian to manage constraint. As noted above, Torness in the on-shore landing site for Berwick Bank and NNG offshore wind farms, as well as the HVDC Eastern Link. The area will have significant quantity of renewable energy and is likely to be an area of interest for future hydrogen production and infrastructure, including at large scales.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	National Grid Gas Transmission Network pipelines (1050mm diameter) cross through the centre of the cluster – running north-south. Subject to future technical feasibility and legislation to allow for hydrogen blending, this could provide a robust export opportunity for green hydrogen production. The gas pipeline is located within the Lammermuir Hills, between an existing reservoir and Fallago Rig windfarm. SGN Network Mapping indicates that there is no other gas distribution infrastructure in the Cluster. The nearest distribution gas mains are Intermediate Pressure, Medium Pressure and Low Pressure (polyethylene) serving communities in East Lothian at Dunbar and Haddington.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Within the Cluster, there are relatively few watercourses / bodies which could serve as a potential source of surface water abstraction. An existing reservoir is situated in the Lammermuir Hill towards the western edge of the Cluster, though are still in use by Scottish Water and as an outdoor / water sports facility. It is in relative proximity to both Fallago Rig and Aikengall wind farms. As noted above, tributaries of the River Tweed are within an SAC designation and water abstraction would need to be carefully assessed. BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are classed as low and moderate – depending on specific locational factors. More productive abstraction is likely towards the coastline. There is

		likely to be limited potential for groundwater abstraction to provide a ready source of raw water supply for green hydrogen production. There are no major waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest major waste-water treatment works are located in Edinburgh (Leith)
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is no current headroom capacity within the local potable water supply network that could support green hydrogen production. Water supply would therefore need to be taken from abstraction sources outlined above.
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	The principal local industrial / energy intensive activity is the Tarmac Cement Works, located to the south of Dunbar. The site is listed as a major emitter of CO2 emissions on SEPA's Pollutant Release Inventory and as an energy intensive industry within Scottish Government's 'Decarbonising Industrial Sectors and Sites' Discussion Paper (2019). Subject to their future operation and technical feasibility, the potential of hydrogen to support de-carbonisation could emerge as a demand and off-take opportunity
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	There is no major transport infrastructure within or around the cluster, other than local road network. The A1 will provide a level of freight / cargo through the area which could provide an off-take opportunity in future scenario where de-carbonisation of vehicle freight via hydrogen emerges strongly, however other locations may be more competitive / frequented.
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	As noted, Torness is landing site for Berwick Bank offshore wind farm which will provide major quantity of renewable energy (up to 4.1GW) and may attract interest / opportunities around green hydrogen production at larger scales.

Cluster 4 – East Lothian & Borders

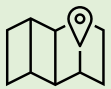
Cluster 5 – South Lanarkshire & West Lothian

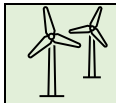
Cluster 5 – South Lanarkshire & West Lothian



CLUSTER 5: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Black Law	Scottish Power Renewables	Onshore Wind	124	Operational since 2004	NG Balancing Mechanism (59 MWh/Day avg.) (68/ MWh avg.)	
Black Law Extension 1A	Scottish Power Renewables	Onshore Wind	48.4	Operational since 2016	NG Balancing Mechanism (59 MWh/Day avg.) (64/ MWh avg.)	
Gladsmuir Hills	Wind Estate (UK) Ltd.	Onshore Wind	41	Planning Application Submitted	Currently w/o Grid Connection	
Longhill Burn	EnergieKontor UK	Onshore Wind	45.6	Planning Permission Granted	Flexible Connection	
Woolfords Farm	Woolfords Wind Energy Ltd.	Onshore Wind	19.8	Planning App Submitted	Flexible Connection	
Pearie Law	Wind Estate (UK) Ltd.	Onshore Wind	14.4	Planning Permission Granted	Flexible Connection	
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Heathland Wind Farm	EDF Energy Renewables	Onshore Wind	80MW + BESS	Planning permission granted		
Pearie Law	EDF Energy Renewables	Onshore Wind	19 MW	Operational since 2016.		
Harburnhead	Gresham House	Onshore Wind	51.7 MW	Operational since 2016		
Camilty Plantation	EDF Energy Renewables	Onshore Wind	26 MW	Planning permission granted		
Tormywheel	Blackrock	Onshore Wind	31MW	Operational since 2017		

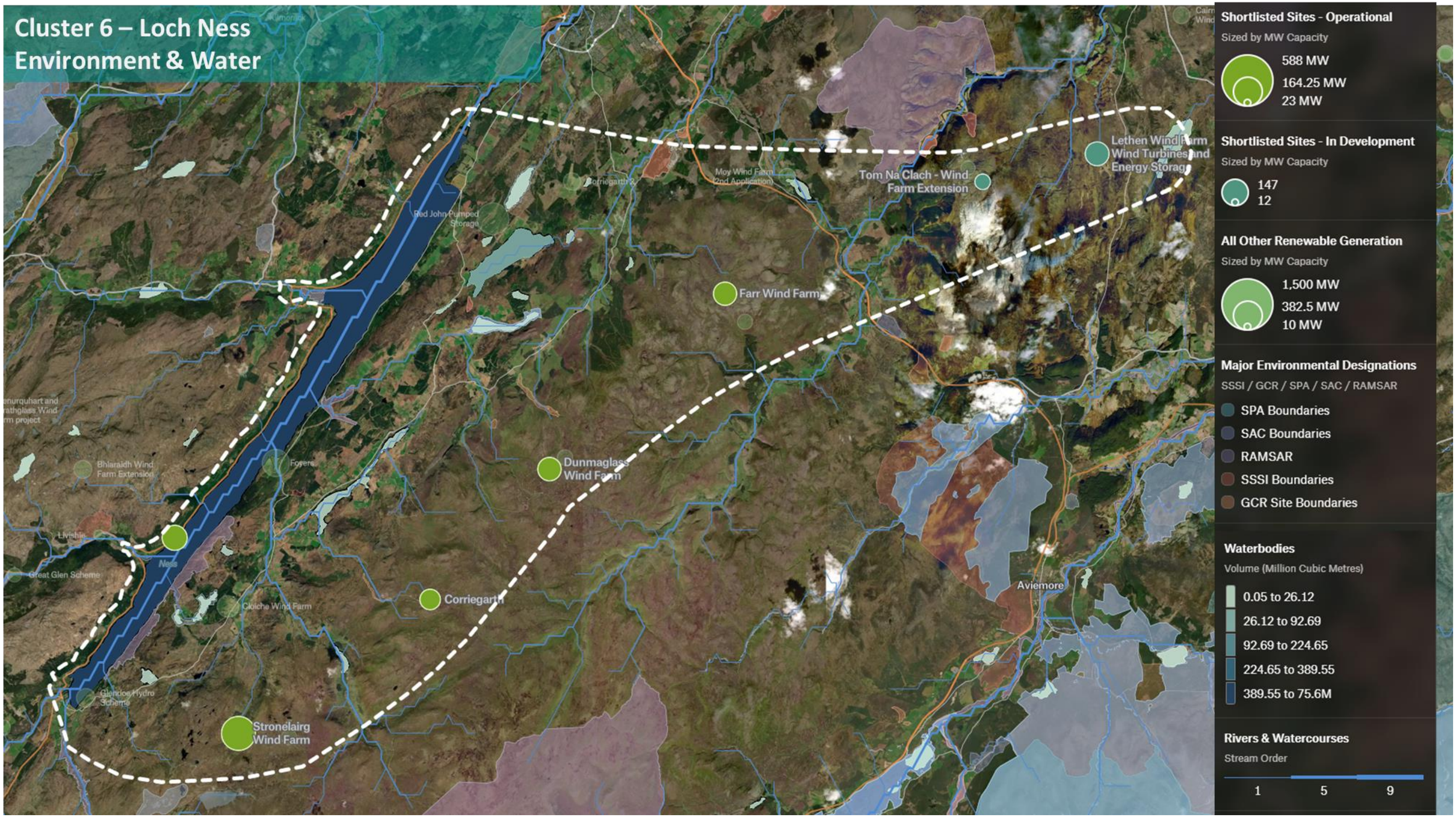
FACTSHEET: CLUSTER 5		
Key Details & Characteristics	**Local Authority**	South Lanarkshire / West Lothian
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • Scottish Power Renewables (Black Law Wind Farm) • Wind Estate (UK) Ltd. who have planning applications submitted / granted for development of Pearie Law and Gladsmuir Hills Wind Farms. Elsewhere within the Cluster there is a number of proposed wind farms, which either do not participate in NG Balancing Mechanism and/or have a Grid Connection. They may still be subject to constraint through network management by SPEN but there is limited available data on extent and nature of this. In particular EDF Energy Renewables operate Pearie Law Wind Farm (19MW) and have planning permission granted for a further two larger windfarms in the cluster (Heathland Wind Farm (80MW) and Camilty Plantation (26MW)).
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. Other than Black Law Wind Farm (operational since 2004) the renewable energy within the cluster is not yet operational but currently awaiting construction and/or progressing through the planning system.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, transport, grid and utilities infrastructures?	The area includes a number of former / restored mine workings, close to the railway line at the northern edge of the Cluster. Levenseat Waste Management Site is situated at the northern edge of the cluster undertaking significant groundworks operations. Elsewhere within the Cluster land use low-intensity farmland / forestry, situated amongst the numerous current and planned on-shore wind farms Road access through the area is predominantly local 'B' roads, and the M8 is located approximately 7km north. The Edinburgh-Glasgow (via Shotts) rail line runs parallel to the norther edge of the cluster, including Breich, Addiewell, and West Calder Stations, though there is no pre-existing rail / freight infrastructure. Further detail on utilities infrastructure (gas, water, grid) is considered below.

Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable. Brownfield land associated with former mine workings around Levenseat Waste Management facility and former Rusha surcace mine is proximate to planned wind farm development at Longhill Burn and Gladsmuir Hills and could present opportunities for co-location.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The South Lanarkshire LDP supports development of renewable energy technologies, subject to detailed assessment against wider LDP policies and supplementary guidance. West Lothian Council's LDP similarly supports development of new renewable energy technologies where these satisfy wider policy requirements around landscape character, the water environment, and soils, and do not have significant impacts on the natural or historic environment. The cluster is outside of any environmental / planning designations which would constrain hydrogen production at de-centralised scale. To the south-east of the Cluster is Cobbinshaw Moss SSSI designated as an open water transition fen and associated botanical interests. The moss habitat is hydrologically linked to the reservoir and proposals for abstraction (if sought) may need to consider potential for impacts on the SSSI. are relatively few environmental / planning designations which would constrain hydrogen production at de-centralised scale. There are several SSSI designations in the area (Lammer Law, Rammer Cleugh, Lammermuir Deans) but largely separated from existing renewable energy generation and unlikely to pose a major constraint.
Power & Utilities	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to be approximately 500MW if delivered in full.

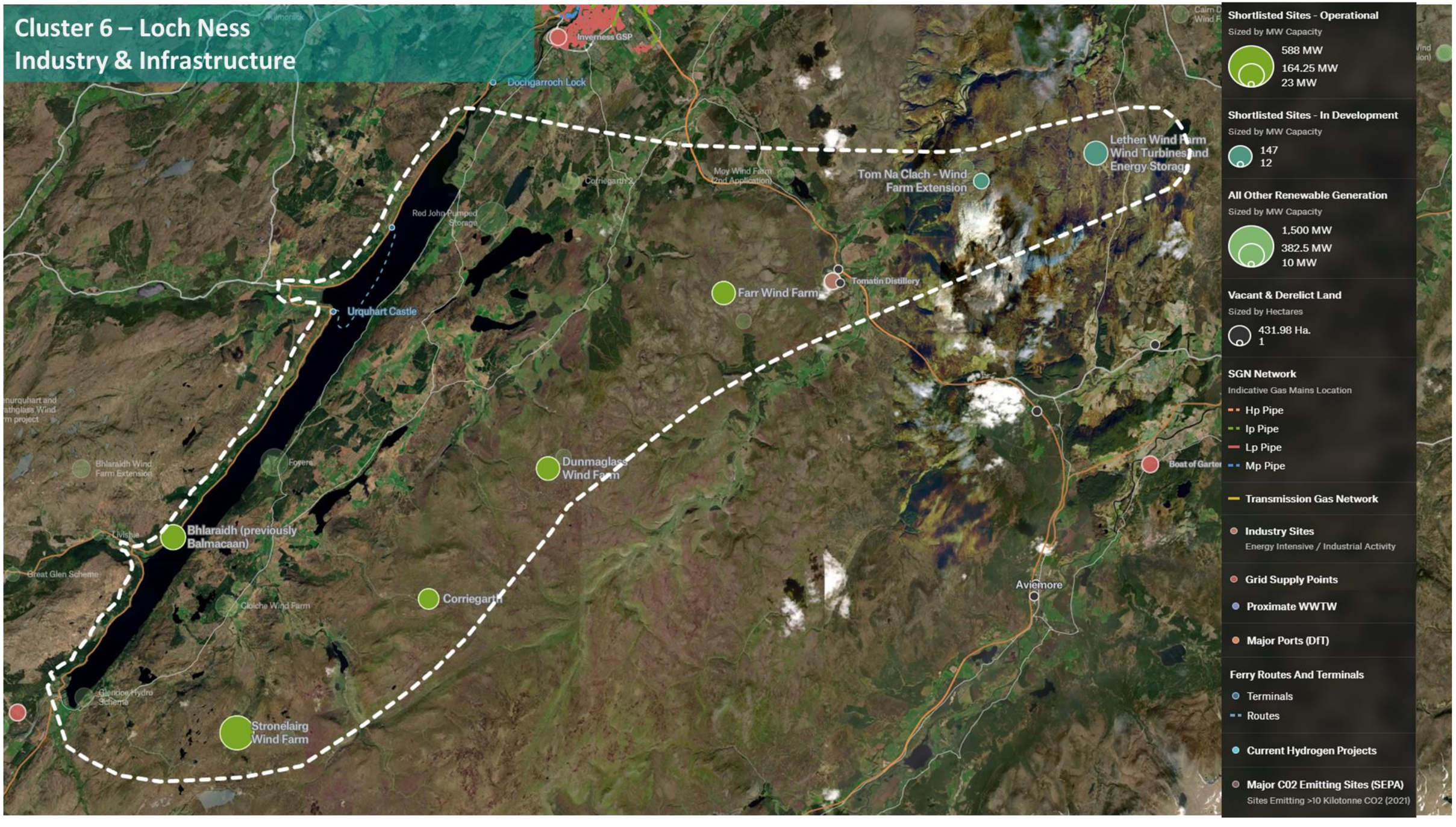
	**Grid Infrastructure** Is there other grid infrastructure present – GSP / PSS?	There are no Grid Supply Points within or in the close proximity of the Cluster. Primary sub-stations at Forth and Shotts are noted as **RED** meaning at least one factor is close to operational limit and connection for most distributed generation is unlikely without reinforcement works
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	2no. National Grid Gas Transmission Network pipelines cross through the cluster at its western edge– running north-south. Subject to future technical feasibility and legislation to allow for hydrogen blending, this could provide a robust export opportunity for green hydrogen production. The gas pipeline is located directly adjacent to Black Law Windfarm. SGN Network Mapping indicates there is limited other gas distribution infrastructure in the cluster. Serving communities (Shotts, Fauldhouse, West Calder) at the north of the Cluster are Medium Pressure and Low Pressure mains (polyethylene). An Intermediate Pressure main (steel) crosses to the north of Fauldhouse.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in this region of Scotland, from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture), as well as effluent from waste-water treatment. Within the Cluster itself, there are very few watercourses which could serve as a potential source of surface water abstraction. An existing reservoir is situated within the Cluster, with an average discharge of approximately 250 litres/second. It is in close proximity to planned wind farm development at Pearie Law, Woolfords Farm, and Longhill Burn that is subject to constraint. As noted above, the Reservoir is partially included within an SSSI noted for moss-land habitats which may require further assessment in the event of surface water abstraction. The reservoir was built to supply water to the Union Canal and appears to remain under the management of Scottish Canals. However, the reservoir is a SSSI and known as a Wildfowl habitat which may necessitate further assessment to determine feasibility. BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are likely to be moderately productive – with a potential average yield of up 10 litres/ second depending on location specific review. Groundwater abstraction could therefore provide a ready source of raw water supply for green hydrogen production.

		There are no waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest waste-water treatment works are located in Glasgow (Dalmarnock).
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is some headroom capacity within the local potable water supply network, which could potentially support green hydrogen production at a small-medium scale (subject to future detailed review with SW)
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	There is very limited immediate local demand for industrial de-carbonisation within the Cluster. However it is is situated within the Central Belt within a c.45 min-1hr drive from Edinburgh and Glasgow, and a 30 minute drive from Grangemouth. Hydrogen produced within the cluster could be distributed via tube trailer to a range of potential off-takers within the region, supporting industrial de-carbonisation and zero-carbon transport. For example local steel and metal fabricators based in North Lanarkshire (noted as EEI by Scottish Government) are relatively proximate and could provide a source of off-take subject to future feasibility and demand, or a range of other industrial / production processes based in the Central Belt.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	There is no major transport infrastructure within or around the cluster, other than local road network. The M8 is located approximately 7km north of the Cluster and would provide a potential location for re-fuelling infrastructure which could be supplied from production locations in the Cluster, though dependent on future decarbonisation of vehicle freight.
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	None known / currently identified. Scottish Power Renewables own and operate Black Law wind farm in the cluster and are actively exploring hydrogen production across other Scottish sites.

Cluster 6 – Loch Ness



Cluster 6 – Loch Ness



Cluster 6 – Loch Ness

CLUSTER 6: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Stronelairg	SSE	Onshore Wind	228	Operational since 2018	NG Balancing Mechanism (234 MWh/Day avg.) (£70/ MWh avg.)	
Blaraidh	SSE	Onshore Wind	110	Operational since 2017	NG Balancing Mechanism (270 MWh/Day avg.) (£67/ MWh avg.)	84MW extension also consented and currently awaiting construction.
Corriegarth	Greencoat Capital	Onshore Wind	69.5	Operational since 2016	NG Balancing Mechanism (91 MWh/Day avg.) (£68/ MWh avg.)	Planning application submitted in 2021 for 'Corriegarth 2' – a 76MW extension.
Dunmaglass	SSE	Onshore Wind	94	Operational since 2016	NG Balancing Mechanism (185 MWh/Day avg.) (£68/ MWh avg.)	
Farr	Innogy	Onshore Wind	92	Operational since 2005	NG Balancing Mechanism (68 MWh/Day avg.) (£80/ MWh avg.)	
Tom Nan Clach Extension	Infinergy Limited	Onshore Wind	31.5	Planning App Submitted	Currently w/o Grid Connection	Extension to existing 39MW Tom Nan Clach Windfarm (operational since 2019)
Lethen Wind Farm	Fred Olsen Renewables	Onshore Wind	102	Planning App Submitted	Currently w/o Grid Connection	10MW co-located battery storage planned as part of development.
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Cloiche Wind Farm	SSE Renewables	Onshore Wind	150 MW	Planning App Submitted		
Foyers	SSE Renewables	Pumped Storage	300 MW	Operational since 1974		
Aberarder Wind Farm	Renewable Energy Systems (RES)	Onshore Wind	49.9MW	Planning Permission Granted		
Glen Kyllachy Wind Farm	Greencoat UK Wind	Onshore Wind	48.5 MW	Operational since 2022		

Cairn Duhie Wind Farm	Renewable Energy Systems (RES)	Onshore Wind	67.2 MW	Planning app submitted		
Red John Pumped Storage	Intelligent Land Investments	Pumped Hydro Storage	450 MW	Planning permission granted		

FACTSHEET: CLUSTER 6

Key Details & Characteristics	**Local Authority**	Highland Council
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • SSE Renewables own and operate significant assets in the Cluster – which are subject to planned expansion. Elsewhere within the Cluster there are a number of proposed wind farms (and energy storage) which either do not yet participate in NG Balancing Mechanism and/or have a Grid Connection. They may still be subject to constraint through network management by SSEN but there is limited available data on extent and nature of this. These include additional SSE Renewables projects at Cloiche (150 MW planned wind farm) and Foyers (300MW operational pumped storage, planned RES projects at Aberarder (49MW) and Cairn Duhie (67MW.
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. To the north of the cluster is planned growth in the renewable energy generation capacity that is currently without a grid connection (Tom Nan Clach Extension and Lethen Wind Farm)

	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, transport, grid and utilities infrastructures?	There is limited brownfield land in the area, which is very rural in character. Settlements on Loch Ness (Fort Augustus, Lewiston, Dores) are small with very limited commercia activity or associated infrastructure. The A9 crosses through the Cluster at its north-eastern edge (near Tomatin) and would likely form the main route of distribution / access for hydrogen off-take, especially to potential distilleries in the Spey Valley. The Highland Main Line crosses through the same area, though on a remote section of the line with no stations / significant rail infrastructure. It should be noted that Coire Glaso pumped hydro-storage scheme is being developed to the south of the Cluster (by SSE Renewables). It will provide a major new source of grid infrastructure with potential capacity of up to 1,500 MW. Further detail on utilities infrastructure (gas, water, grid) is considered below.
Land & Planning	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	As noted above, there is limited available brownfield land or potential co-located sites Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable. The majority of on-shore wind in the Cluster is in remote, upland areas accessed via dedicated tracks. Subject to operational feasibility siting of production could be located in lower lying, more accessible sites closes to sources of water around Loch Ness and connected via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The Highland Council LDP designates land within the Cluster as predominantly ‘Wider Countryside’ and areas of ‘Local / Regional Importance’. Development is required to be sympathetic to local context and character, but at ‘de-centralised’ scale are unlikely to give rise to significant impacts and can be integrated with existing rural / renewable Renewable energy development is supported and potential economic and de-carbonisation benefits are to be taken into consideration. They are to be well related to the source of primary renewable resources needed for their generation, and be sited and designed to avoid detrimental impacts.

		There are relatively few environmental / planning designations which would constrain hydrogen production at de-centralised scale. Along the eastern shore-line of Loch Ness are Ness Woods SAC and Easter Ness Forest SSSI though largely separated from existing or planned renewable energy generation locations. Loch Ruthven is designated as an SSSI / SPA / SAC / Ramsar site and is an internationally important wetland supporting rare bird species and orchids.
Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to exceed 1GW if delivered in full.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	There are no Grid Supply Points in the Cluster or in immediate proximity. The Fort Augustus, Boat of Garten and Inverness GSPs are noted as **RED** on the SSEN Heat Map meaning they are constrained for new distributed generation.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	The Transmission Gas Network does not cross through the Cluster. SGN Network Mapping indicates there is no other gas mains within the Cluster, with the nearest gas network infrastructure located in Inverness.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in this region of Scotland, from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture, whisky distilling), as well as effluent from waste-water treatment. Within the Cluster itself, there are several watercourses and waterbodies which could serve as a potential source of surface water abstraction. Lochindorb is situated at the north-east of the Cluster proximate to planned Lethen Wind Farm and has a discharge rate of approximately 590 litres / second. Elsewhere Loch Duntelchaig, and Loch Mhor all provide significant quantities of water with potential for abstraction. As noted above, Loch Ruthven is designated (SSSI / Ramsar / SPA / SAC) as an important habitat which would likely constrain water abstraction compared to other potential sources. Most significantly, Loch Ness is situated within the Cluster and is the largest water body (by volume) in the UK. It is currently subject to relatively low levels of abstraction and could provide ready supply of raw water for hydrogen production at a range of scales.

		BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are likely to be low to moderate – especially low towards the south and east of the cluster . Groundwater abstraction is less likely to provide a source of raw water supply compared to the significant availability of surface water locally. There are no major waste water treatment works within the Cluster from which effluent could be utilised in hydrogen production. The nearest waste-water treatment works are located in Inverness (Allanfearn) or Fort William (Coal Spit).
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is some headroom capacity within the potable water supply network, though with some variability across the area and more remote locations potentially challenging to serve. Subject to location specific review with Scottish Water, potable supply could potentially support green hydrogen production at a small-medium scale
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	Given the relatively remote and rural nature of land use within the Cluster, there is limited opportunities for off-take of hydrogen to local industrial activity or fulfilling demand for de-carbonisation from an energy intensive user. However, the Cluster is proximate to the major cluster of Whisky Distilleries within the Spey Valley. Tomatin Distillery is within the Cluster and proximate to the operational Farr Wind Farm. A range of other distilleries are located within <90 min drive of the Cluster and could be supplied with green hydrogen via tube trailer distribution. Through a range of programmes and initiatives the Whisky Industry is progressing towards de-carbonisation and there several locations actively exploring integration of hydrogen. The Scotch Whisky Association has said hydrogen will play an important role in meeting net-zero emissions targets for the distilling sector.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen	There is no major transport infrastructure within or around the cluster, other than local road network. The A9 crosses through the cluster and would provide a potential location for re-fuelling infrastructure which could be supplied from production locations in the Cluster, though dependent on future decarbonisation of vehicle freight.

	could be integrated or provide a means of export?	
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	None currently in the public domain. Though, SSE own and operate major on-shore wind assets in the cluster and are actively exploring hydrogen production across a number of other Scottish sites. As noted above, there is active exploration within the distilling industry of integrating hydrogen to accelerate de-carbonisation.

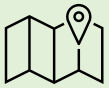
Cluster 7 – Invergordon & Ross-Shire

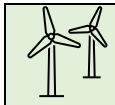
Cluster 7 – Invergordon & Ross-Shire

Cluster 7 – Invergordon & Ross-Shire

CLUSTER 7: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Lochluichart	Eneco	Onshore Wind	51	Operational since 2014	NG Balancing Mechanism (53 MWh/Day avg.) (£75/ MWh avg.)	
Lochluichart Wind Farm Extension 2	Infinergy Ltd.	Onshore Wind	24	Planning App Submitted	Currently w/o Grid Connection	
Kirkan Wind Farm	Coriolis Energy	Onshore Wind	81.6	Planning App Submitted	Currently w/o Grid Connection	
Torr Leathan	Energiekontor	Onshore Wind	36	Planning App Submitted	Currently w/o Grid Connection	5MW co-located battery storage planned as part of development.
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Corriemollie	EDF Energy Renewables	Onshore Wind	54.4	Operational since 2017		
Meall an Tuirc / Novar Wind	RWE NPower	Onshore Wind	53MW	Operational since 2012		
Coire Na Cloiche	RockbySea	Onshore Wind	29.9MW	Operational since 2020		
Beiin Tharsuinn	CRE Energy / Scottish Power	Onshore Wind	29.8	Operational since 2005		

FACTSHEET: CLUSTER 7		
Key Details & Characteristics	**Local Authority**	Highland Council
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • Energiekontor • Infinergy • Coriolis Energy • Eneco (operators of the currently operational Lochluichart Wind Farm) Elsewhere within the Cluster there are a number of operational wind farms which either do not yet participate in NG Balancing Mechanism and/or have a Grid Connection. They may still be subject to constraint through network management by SSEN but there is limited available data on extent and nature of this. These include projects by EDF Energy Renewables (Corriemollie), RWE Npower (Meall an Tuirc), Scottish Power (Beinn Tharsuinn), and Rockbysea (Coire Na Cloiche).
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. The majority of the constrained wind farm identified within the cluster is currently progressing through the planning system and awaiting grid connection. This will provide significant new quantity of on-shore wind in the area.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, grid, transport, and utilities infrastructures?	There is limited brownfield land in the area, principally associated with local industrial activity and processes in the A9 corridor / coastline. Technip FMC operate an oil & gas support service facility at Deephaven Industrial Estate. There is significant clustering of port infrastructure and associated industrial activity at Invergordon (Port of Cromarty Firth) and at Nigg (Global Energy Group) who are leading ports in energy transition activity and actively developing capabilities in hydrogen sector. A9 runs along the coast at the eastern edge of the cluster – and elsewhere the road network is predominantly local 'B' roads providing access to farmland, forestry, and renewable generation sites. The rail network (Far North Line) also crosses through the eastern edge of the cluster, stopping at Dingall, Alness, and Invergordon.

		Local utilities infrastructure (gas, water, grid) is considered below.
Land & Planning 	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users / sensitive receptors that may limit site suitability?	Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure. For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	The Highland Council LDP designates land within the Cluster as predominantly 'Wider Countryside' and areas of 'Local / Regional Importance'. Development is required to be sympathetic to local context and character, but at 'de-centralised' scale are unlikely to give rise to significant impacts and can be integrated with existing rural / renewable Renewable energy development is supported and potential economic and de-carbonisation benefits are to be taken into consideration. They are to be well related to the source of primary renewable resources needed for their generation, and be sited and designed to avoid detrimental impacts. Highland Council are also currently developed an Inner Moray Firth LDP, which recognises the potential around Cromarty and Nigg as renewables hubs, including for hydrogen. Aside from specific LDP allocations, Ben Wyvies Special Protection Area, Sites of Special Scientific Interest and National Nature Reserve at the centre of Cluster, but not likely to overlap with potential site opportunities or provide a significant constraint to production at decentralised scale. Novar and Morangie Forest SPA's are toward the east of the cluster designated for capercaillie breeding, but largely separated from renewable energy generation and unlikely to pose significant constraint.
Power & Utilities	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to exceed 350MW if delivered in full.

	**Grid Infrastructure** Is there other grid infrastructure present – GSP / PSS?	The Alness Grid Supply Point is situated within the Cluster area. It is noted on the SSEN Heat Map as **RED** meaning it is constrained for new distributed generation.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	The Transmission Gas Network does not cross through the Cluster. SGN Network Mapping indicates that there is an Intermediate Pressure Gas Main (steel) crossing through the eastern edge of the Cluster, predominantly following the alignment of the A9. This connects to the Whyte & Mackay Distillery in Invergordon. Low Pressure gas mains (predominantly polyethylene) are connected to communities in Dingwall, Evanton, Alness and Invergordon.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has broadly indicated that there is likely to be capacity in this region of Scotland, from a combination of sources including surface water and groundwater, though there may be competition from other sectors / users (agriculture, whisky distilling), as well as effluent from waste-water treatment. Within the Cluster itself, there are several watercourses and waterbodies which could serve as a potential source of surface water abstraction. Loch Luichart, Loch Glascarnoch, and Loch Glass are all in relative proximity to planned onshore wind development and have discharge rate in excess of 2,000 litres/second form which a level of abstraction could meet hydrogen production requirements. BGS Mapping / SGN Review indicated that groundwater abstraction yields within the Cluster are likely to be low to moderate – with higher yields towards the coastline and relatively low yields further inland . Groundwater abstraction is less likely to provide a source of raw water supply compared to the significant availability of surface water locally. The nearest major waste-water treatment works is located at Invergordon – and high-level review by Scottish Water has indicated that effluent levels could potentially support small-medium scale hydrogen production. Subject to future feasibility they could also provide an off-take for oxygen by-products from hydrogen production within the Cluster.
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is some headroom capacity within the local potable water supply network, which could potentially support green hydrogen production at a small-medium scale (subject to future detailed review with SW)

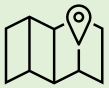
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	While land use within the Cluster is predominantly low intensity and rural, there are potential opportunities in surrounding area including: • Whisky distilleries in the Cromarty area, including GlenWyvis, Invergordon Distillery (Whyte & Mackay), Teaninich, Ardross, and Glenmorangie. Through the North of Scotland Hydrogen Programme (NOSH) there is 'live' development of hydrogen production to meet local demand from the distillery industry and support their de-carbonisation. Additional de-centralised hydrogen production opportunities within the Cluster could support / complement this programme and meet growing demand from local distillery sector.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	The Cluster includes major port and marine infrastructure located at Invergordon (Port of Cromarty Firth) and Nigg (Global Energy Group). This creates a range of potential opportunities and synergies for hydrogen production, either as a zero-carbon fuel source for marine transport (eg. Cromarty-Nigg Ferry), or as a means of transporting hydrogen to reach export markets. There is no significant road infrastructure within the cluster – though the A9 crosses through the cluster and would provide a potential location for re-fuelling infrastructure which could be supplied from production locations in the Cluster, though dependent on future decarbonisation of vehicle freight.
	Proximate H2 Projects / Initiatives Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	As noted above, NOSH Programme is currently in development centred around the distillery industry in Cromarty. It is a a partnership project between Scottish Power, Storegga, Diageo, Glenmorangie, Whyte & Mackay, and Port of Cromarty Firth. Including identified sites for 35MW hydrogen production within the Cluster as a first phase, with potential to grow to as much as 300MW. Early phase distribution of hydrogen to be off-takers via compressed tube trailers, serving local distilleries with potential for gas grid integration in future and serving a wider range of industrial / multi-modal transport users. Beyond the NOSH Programme, Opportunity Cromarty Firth has a 'Hydrogen Working Group' currently with 40 member organisations – seeking to develop a state-of-the-art Green Hydrogen Hub.

Cluster 8 – Orkney & Shetland

Cluster 8 – Orkney & Shetland

CLUSTER 8: RENEWABLE ENERGY GENERATION SITES CURRENTLY SUBJECT TO CURTAILMENT						
Site Name	**Operator**	**Technology**	**MW Capacity**	**Status**	**Nature / Form of Constraint**	**Note / Comment**
Nisthill Wind Farm	Nisthill Wind Farm Limited	Onshore Wind	26.4	Planning App Submitted	Currently w/o Grid Connection	
Other Existing / Planned Renewable Energy Development within the Cluster (>10MW)						
Viking Wind Farm (Shetland)	Viking Energy Wind Farm	Onshore Wind	443 MW	Under Construction	Linked to construction of Shetland HVDC.	
Yell Wind Farm (Shetland)	Energy Isles	Onshore Wind	126 MW	Planning Submitted	Direct NG Connection	
Beaw Field Wind Farm (Shetland)	Peel Wind Farms	Onshore Wind	59.5 MW	Planning granted	Direct NG Connection	
Mossy Hill (Shetland)	Peel Wind Farms	Onshore Wind	46.8 MW	Planning granted	Direct NG Connection	
Orkney Community Wind Farm – Hoy / Faray / Qantarness	Orkney Islands Council	Onshore Wind	28.8MW	Planning granted	Accepted to Connect	
Inner Sound Phase 1B/1C (MeyGen)	Altantis Resources	Tidal	86 MW	Planning Granted		Planning granted 2013. Demonstration array (6MW) operational.
Brims Tidal Array (Cantick Head)	DCNS Open Hydro / SSE Renewables	Tidal	200 MW	Planning submitted		Planning submitted 2016. Uncertainty over future delivery.
Billia Croo Wave Test Site (Extension)	EMEC	Shoreline Wave	20 MW	Planning submitted		Planning submitted 2019
Hesta Head (Orkney)	Hoolan Energy	Onshore Wind	20 MW	Planning granted	Direct NG Connection	

FACTSHEET: CLUSTER 8		
Key Details & Characteristics	**Local Authority**	Orkney Islands Council / Shetland Islands Council
	Site Operators & Owners Who are key operators / developers active in the cluster with potential for hydrogen production?	There are a range of renewable energy operators and developers active in the area including: • Viking Energy Wind Farm • Peel Wind Farms • Orkney Islands Council are developing several renewable energy generation assets.
	Development Status Are sites currently operational, under construction, consented, or currently in the planning process?	See summary above. The status and delivery of tidal and wave renewable generation from tidal is less certain, and dependent on more complex marine and protected species licensing processes though these are now largely complete. Preliminary sub-sea works for Phase 1B of the MeyGen project are complete and turbines are expected to be operating by 2027.
	Existing Assets & Infrastructures What assets and infrastructure are present in the area – eg. brownfield land, other land use activities, grid, transport, and utilities infrastructures?	The Cluster includes major port and marine infrastructure located around the Islands at Scapa Flow, Kirkwall (Hatston), and Lerwick. Major oil & gas terminals at Sullom Voe and Flotta include marine infrastructure and there a range of smaller ferry terminals, quays, ports across the Islands utilised for local transport. This creates a range of potential opportunities and synergies for hydrogen production. Local utilities infrastructure (gas, water, grid) is considered below.
Land & Planning	**Land Availability / Developable Sites** Where are principal developable areas? Are there other users /	Principal hydrogen production sites are likely to relate to land associated with and/or directly co-located to on-shore wind infrastructure and potentially integrated to offshore tidal / wave generation (if developed). For small-medium / de-centralised production land requirements this could include land adjacent to existing haul routes / access road, site sub-

	sensitive receptors that may limit site suitability?	stations, or previously developed land such as construction compounds / borrow pits which could be re-purposed as hydrogen production sites and connected to generation via sub-terrain cable.
	Planning Status / Constraints & Designations What LDP and other environmental / planning designations are present that may influence site suitability?	National Planning Framework 4 (2023) identifies a National Development for 'Energy Innovation Development on the Islands' – encompassing the Outer Hebrides, Orkney, and Shetland. It supports proposed developments for renewable energy generation, renewable hydrogen production, infrastructure and shipping, and associated opportunities in the supply chain for fabrication, research and development. It is noted that the use of low and zero emission fuels will play a crucial role in decarbonising island and mainland energy use, shipping, strengthening energy security overall and creating a low carbon energy economy for the islands and islanders. All development around production, storage, and transportation of hydrogen will have 'National Development' status.
Power & Utilities 	**Renewable Energy Generation** What is the total RE generation present in the area?	See summary table. Total renewable energy generation within the cluster, including currently planned sites, is likely to exceed 650MW if delivered in full, with the majority of generation from the large-scale Viking Wind Farm.
	Grid Infrastructure Is there other grid infrastructure present – GSP / PSS?	The Shetland Grid Supply Point is situated within the Cluster area. It is noted on the SSEN Heat Map as **RED** meaning it is constrained for new distributed generation. All SSEN distribution network sub-station across the Islands are also noted as constrained.
	Proximity to Gas Network Is there proximate gas network infrastructure? HP / IP Gas Mains?	The Transmission Gas Network does not cross through the Cluster. SGN Network Mapping confirms there is no gas main distribution network on the islands.
	Nearest Water Body / Abstraction Availability What is the local availability of water for abstraction – ground and surface water?	Prior SGN review of water availability for hydrogen production has indicated that there is relatively limited capacity of surface water and groundwater for abstraction across the Orkney and Shetland Islands. BGS Mapping similarly indicates that groundwater abstraction yields within the Cluster are likely to be low to moderate – with higher yields on Orkney. Groundwater / surface-water abstraction is less likely to provide a source of raw water supply compared to the significant availability of seawater, particularly given proximity of most renewable generation to coastline..

		High-level review by Scottish Water indicates that Water Treatment Works at Kirkwall and Lerwick have effluent levels which could potentially support small-medium scale green hydrogen production – though may be challenging for direct integration with green hydrogen production co-located to renewable generation.
	Mains Supply (SW) Availability Is there headroom capacity at local water treatment works to provide a mains supply?	High-level review with Scottish Water has indicated there is some headroom capacity within the local potable water supply network across the Orkney & Shetland Isles - which could potentially support green hydrogen production at a small-medium scale (subject to future detailed review with SW)
Local Demand & Export 	**Local Industrial Demand Opportunity** Are there local industrial / energy-intensive activities that may be suitable for hydrogen integration as a source of demand?	While land use within the Islands is predominantly low intensity and rural, there are potential opportunities for integration of Hydrogen surrounding area including Highland Park and Deerland Distilleries. The significant oil & gas industrial processing facilities at Flotta and Sullom Voe may also provide an opportunity for hydrogen integration as part of their long-term diversification and de-carbonisation programmes. Both sites are actively exploring hydrogen production, storage and distribution opportunities, making use of pre-existing marine infrastructure and skills base – to which de-centralised production could offer early test & demonstration / pilot, and/or complement future scaled-up production.
	Transport Integration Opportunity (Road / Rail / Marine) Is there local transport infrastructure to which hydrogen could be integrated or provide a means of export?	The Cluster includes major port and marine infrastructure located around the Islands at Scapa Flow, Kirkwall (Hatston), and Lerwick. Major oil & gas terminals at Sullom Voe and Flotta include marine infrastructure and there a range of smaller ferry terminals, quays, ports across the Islands utilised for local transport. This creates a range of potential opportunities and synergies for hydrogen production, either as a zero-carbon fuel source for local marine transport, or as a means of transporting hydrogen to reach export markets. Small-medium scale green hydrogen may also support local de-carbonisation of road transport across the Islands, subject to future development of re-fuelling infrastructure at key nodes / settlements. BIG HIT have demonstrated potential feasibility of this through hydrogen (fuel cell) re-fuelling in Kirkwall for Orkney Council's van fleet, and there may be opportunities to expand and diversify in future.
	Proximate H2 Projects / Initiatives	Orkney and Shetland have been active and early innovators in developing a Hydrogen economy and there are a range of projects and initiatives across the Islands to which future de-centralised production could be integrated / complementary:

	Are there other Hydrogen economy projects / initiatives in the vicinity which could support a 'cluster' and/or shared physical and skills infrastructure?	• Orkney 'Surf & Turf' / BIG HIT – wind and tidal power utilised for Green Hydrogen at local / small scale Producing c. 50 tonnes of hydrogen per year from constrained renewables for utilisation in local transport (ferry services) and in heating for local schools. • 'Flotta Hydrogen Hub' – linked to future development of Scotwind N1 site and utilisation of land / infrastructure at Flotta to support large-scale hydrogen production for continental export. • Shetland ORION Programme – Council-wide initiative of Blue and Green Hydrogen production and distribution, seeking to lead Shetland's transition from fossil fuels. Re-purposing and transition existing assets, infrastructure, supply-chain and skills including around Sullom Voe. Potential connection to planned offshore wind sites and opportunities for international export.