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Industrial Cluster Best Practice Analysis

Final Report
Scottish Enterprise
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Executive Summary

Industrial clusters can be defined as geographically concentrated and interconnected companies, and other organisations, that:

- Share infrastructure, such as utilities, waste treatment, pipelines and transport networks
- Demonstrate synergies, such as supply and value chains
- Demonstrate economic and operational efficiencies due to co-location and better resource usage
- Engage with local research and knowledge institutions
- Access a common pool of skilled labour

In the context of chemical clusters, this can mean that one or more chemical manufacturers is co-located with suppliers of feedstocks and services that are necessary to their operations, including analytical labs, logistics, research and development facilities and regulatory support.

The purpose of this research was to assess the structure, operations and strategy of chemical clusters across Europe that have demonstrated a transition towards sustainable chemical manufacture and integrated a number of different companies and other relevant organisations in value chains. For the most part, the origin of these clusters was in the petrochemicals industry. The outcome of this analysis is a comparison of the strengths and weaknesses of each cluster and the identification of best practice and lessons learned. These insights informed recommendations for the future development of the industrial cluster in Grangemouth.

A target list of seven clusters was selected for more in-depth review and comparison:

1. InfraLeuna GmbH (DE)
2. Chemiepark Knapsack (DE)
3. Chemical and Industrial Park of Zeitz (DE)
4. Chemparc Lacq (FR)
5. Bazancourt-Pomacle Biorefinery (FR)
6. Chemelot Industrial Park (NL)
7. Chemical Cluster Delfzijl (NL)

The more in-depth analysis involved reviewing cluster publications including services offered, investment, strategy, net zero activities and any collaboration or support from local, regional and national government and research and technology organisations.

Each cluster was scored across eight indicators with a weighting applied to each to reflect its relative importance compared with others. This comparative analysis is summarised in the following figure.

Cluster	Resources	Investment	Services	Infrastructure	Value Chains	Connections	Public Agencies	Future Strategy	Overall Score
Leuna Chemical Complex	30	30	30	45	45	20	15	0	215
Chemparc Lacq	15	20	45	45	15	20	45	0	205
Chemiepark Knapsack	30	20	30	45	45	20	15	5	210
Chemelot Industrial Park	30	20	45	45	45	0	45	15	245
Zeitz Chemical & Industrial Park	30	20	30	45	15	10	15	5	170
Bazancourt-Pomacle Biorefinery	15	20	30	30	45	20	45	5	210
Chemical Cluster Delfzijl	30	20	45	45	45	20	45	15	265

The colours highlight how clusters compare to each other overall and for each attribute. These are comparative rankings within each column of the table as follows:

Highest	Higher	Middle	Lower	Lowest

This shows that Chemical Cluster Delfzijl is consistently strong across all criteria, in particular the staff resources onsite to support tenants and access to significant infrastructure and services. It has a clear strategy for development towards sustainability and net zero.

From this analysis, the attributes of a successful cluster were identified

General business support - major attribute of successful clusters is the support they provide to tenant companies, includes access to utilities, infrastructure and waste treatment and can extend to support with gaining regulatory approval and accessing public and private finance

Local and regional government support - clusters that have strong connections with local and regional governments tend to perform better and are more highly rated than others

Industrial leadership - successful clusters are led by industry for industry

Investors - clusters that operate optimally, attract significant private investment, which allows larger companies to expand onsite infrastructure and younger companies to begin or grow their operations

Access to infrastructure and resources – including feedstocks, energy, water, waste treatment and, increasingly, CO2

Marketing - a distinct entity with clear messaging and marketing is essential for cluster impact

Access to innovation support - several clusters offer onsite innovation centres, either managed by the cluster itself or through a third party, which can be an academic or research and technology organisation

Strategy - Clusters (site owner, tenants and public sector) need a coherent, long-term strategy that demonstrates vision and how it will evolve over the coming years in response to new societal demands, new legislative requirements, and new opportunities

Local supply and value chains – these reduce both supply chain length and the amount of waste generated, while adding greater value to products and services

A number of key observations can be made:

- All of the other clusters began the transition to sustainability a long time ago – in some cases several decades
- In all cases there is a central organisation with resource that manages, supports and networks companies within the cluster. In the more successful clusters this is a substantial resource with business development and support to companies to access finance and secure the necessary permits to build manufacturing capability
- Infrastructure extends beyond utilities and wastewater treatment to include research and development and analytical support, and in some cases onsite technical training
- In several cases there are clear anchor companies, around which others have established a presence. This has led to the creation and evolution of value chains within the cluster
- There is clear public agency support in the form of local, regional and national government for these clusters, however, it is the cluster management organisation together with public sector and tenant organisations that drives development

While there has been significant investment in some clusters, this is perhaps not the most important aspect – it is how this investment is used to develop and integrate the cluster, rather than the size of the investment.

The situation at Grangemouth is rather different and development of Grangemouth manufacturing activity into a comparable cluster, in terms of scale and operation, will require significant time, investment and resources. There is, however, optimism within key stakeholder organisations that, with the right structure and support, there is potential for growth of industrial activity.

The overall recommendation is that steps should be taken to invest in the development of the Grangemouth manufacturing cluster, adopting and adapting best practice from other clusters. Specific recommendations are:

Establish an Independent Cluster Management Organisation	Develop a Unified Vision and Long-Term Strategy	Invest in Shared Infrastructure and Low-Carbon Utilities	Prioritise Sustainable Manufacturing	Accelerate Existing Initiatives and Build Cluster Capabilities
Create an independent, industry-led cluster organisation staffed with experts in business and industry. This organisation should collaborate with onsite companies, engage public sector agencies (e.g., government, regulatory bodies), and act as a liaison to ensure effective representation and coordination	Formulate an industry-led vision and strategy for the cluster, aligned with future developments. Ensure buy-in from all stakeholders, including private and public sectors, and set out clear actions to address current challenges and exploit future opportunities	Prioritise shared infrastructure development, such as waste treatment and utilities, as a foundational step to address current uncertainty at the Earls Gate site. Ensure these services are low-carbon to support the transition to net-zero operations. Facilitate private-public investment to achieve this	Focus strategically on production of sustainable chemicals, fuels and materials, leveraging hydrogen, captured carbon, and biomass as feedstocks. Identify and advance opportunities to progress net-zero operations, aligning with global market opportunities	Support and build upon existing initiatives (e.g., blue and green hydrogen projects by Ineos and RWE) while integrating additional supply and value chain actors. Expedite the development of the Sustainable Manufacturing Campus and related pilot projects, showcasing cluster capabilities to attract investment and innovation

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1 Introduction

1.1 Study Objectives

The purpose of this research was to assess the structure, operations and strategy of chemical clusters across Europe that have demonstrated a transition towards sustainable chemical manufacture and integrated a number of different companies and other relevant organisations in value chains. For the most part, the origin of these clusters was in the petrochemicals industry. The outcome of this analysis is a comparison of the strengths and weaknesses of each cluster and the identification of best practice and lessons learned. These insights informed recommendations for the future development of the industrial cluster in Grangemouth.

A literature review, entitled "Research Baseline" accompanies this report. This review summarises current research on the Grangemouth industrial cluster, to enable informed decisions, identify strategic opportunities and prioritise areas for further investigation. The key findings of this research, which are summarised here, also informed the recommendations set out in this report.

1.2 Definition of an Industrial Cluster

Industrial clusters can be defined as geographically concentrated and interconnected companies, and other organisations, that:

- Share infrastructure, such as utilities, waste treatment, pipelines and transport networks
- Demonstrate synergies, such as supply and value chains
- Demonstrate economic and operational efficiencies due to co-location and better resource usage
- Engage with local research and knowledge institutions
- Access a common pool of skilled labour

In the context of chemical clusters, this can mean that one or more chemical manufacturers is co-located with suppliers of feedstocks and services that are necessary to their operations, including analytical labs, logistics, research and development facilities and regulatory support.

1.3 Current Status of the Grangemouth Cluster

Based on the outputs of the baseline research activities, the current status of the Grangemouth manufacturing cluster can be summarised as follows:

- It is a strategic asset with a strong industrial heritage, but it is a geographical collection of a relatively small number of fragmented industrial activities rather than a cohesive industrial cluster with a collective, investable, long-term strategy
- Local company activities range from large volume bulk chemicals to small volume, high value speciality chemicals and pharmaceuticals. As such, there is a range of different business models pursued by companies based at Grangemouth rather than commonality of approach.
- There is no evidence of inter-company collaboration or sharing of infrastructure between companies in the cluster.

- Secure access to infrastructure, particularly waste treatment and, increasingly, green steam, is an important, if not critical, issue for some companies.
- Investment in net zero technologies and infrastructure is important for the future of key local companies and, also, to encourage inward investment.
- There is no industrially led organisation to catalyse collaboration and coordination or to act as the focal point for public sector engagement.
- There is a strong public sector commitment to supporting development of the cluster.
- The highly skilled local workforce, which should be a strong asset of the cluster, is dispersing to other areas / sectors. The image of Grangemouth as a declining industrial centre is strongly contributing to this situation.
- However, Forth Valley College is seen as a valuable asset for skills development and training and the future Sustainable Manufacturing Campus is expected to complement this as it becomes an important centre for innovation.

Its current position, therefore, suggests it needs a long term (30 year), commercially focused growth strategy that (a) provides stability and continuity, (b) offers a vision for leveraging key assets, such as port facilities and other infrastructure and (c) enables a successful transition to sustainable businesses. It is believed that a cohesive, well-supported approach to decarbonisation at Grangemouth could potentially transform the cluster into a model of industrial synergy and sustainability, but government support is required to leverage private sector investment.

2 Benchmarking Methodology

The European Chemical Site Promotion Platform (ECSPP) identifies 95 active chemical clusters in Europe. This was used as the initial resource for the identification and study of clusters that could offer relevant best practice and transferrable lessons for Grangemouth.

All cluster and other relevant websites were reviewed and individual clusters assessed on the basis of:

- Primary and secondary sector focus (chemicals, petrochemicals, polymers, pharmaceuticals, biobased chemicals, industrial biotechnology)
- Size
- Development history
- Activities
- Key companies

From this initial analysis, a long list of 47 clusters across 10 European member states was generated (see Appendix A), of which 10 were assessed as being most comparable with Grangemouth, in terms of size, activities, focus and development history. This long list was discussed with Scottish Enterprise and a target list of seven clusters was selected for more in-depth review:

8. InfraLeuna GmbH (DE)
9. Chemiepark Knapsack (DE)
10. Chemical and Industrial Park of Zeitz (DE)
11. Chemparc Lacq (FR)

12. Bazancourt-Pomacle Biorefinery (FR)
13. Chemelot Industrial Park (NL)
14. Chemical Cluster Delfzijl (NL)

The more in-depth analysis involved reviewing cluster publications including services offered, investment, strategy, net zero activities and any collaboration or support from local, regional and national government and research and technology organisations. During this phase, key individuals in management or business development positions in each cluster were identified for interview follow-up.

In parallel to the assessment of other clusters, additional stakeholders were identified for consultation as follows:

- Those with an existing involvement in Grangemouth: public agencies and companies located in the Grangemouth cluster. These included:
    - Ineos
    - Syngenta
    - Scottish Futures Trust (SFT)
    - Scottish Development International (SDI)
    - Scottish Government
- Companies that have previously shown an interest in establishing at Grangemouth or, based on their business focus, could reasonably be assumed to have potential interest in Grangemouth:
    - Storegga
    - Fulcrum BioEnergy
    - Velocys
    - SkyNRG
- Other organisations that could provide wider insight and context to Grangemouth:
    - Chemical Industries Association (CIA)
    - The Industrial Decarbonisation Research and Innovation Centre (IDRIC)
    - South Wales Industrial Cluster
    - University of Leeds

Each of these stakeholders was contacted by email to arrange a convenient time for interview. Appendix B provides the discussion topics used in these consultations. Appendix C provides a list of stakeholders contacted, and the outcome of these contacts.

The information generated from these consultations was combined with the desk research to produce a comparative analysis of the different clusters, including Grangemouth.

Each cluster was scored as follows, with a weighting applied to the score to reflect the relative importance of that indicator compared with others:

- Resources – dedicated staff available to support and develop the cluster
    - No staff (0)
    - <10 staff (5)
    - >10 staff (10)

  Weighting: 3
- Investment - from public and private sources

    - <€100M (5)
    - €100-1B (10)
    - >€1B (15)

  Weighting: 2
- Services – utilities, business, technical, logistics, training
    - Limited (5) – one or two of the above
    - Significant (10) – three or four of the above
    - Comprehensive (15) – all of the above

  Weighting: 3
- Infrastructure
    - Limited (5)
    - Significant (10)
    - Comprehensive (15)

  Weighting: 3
- Value Chains – between companies within the cluster
    - No evidence of cluster value chains (0)
    - Limited value chains (5)
    - Comprehensive value chains (10)

  Weighting: 3
- Connections – with other clusters and relevant organisations
    - No evidence (0)
    - Limited (5)
    - Extensive (10)

  Weighting: 2
- Public Agencies - engagement and support
    - No evidence of direct support (0)
    - Support in terms of investment and engagement (5)
    - Extensive support – clearly part of the regional strategy (15)

  Weighting: 3
- Future Strategy
    - No evidence (0)
    - Limited (5)
    - Comprehensive (10)

  Weighting: 1

3 Cluster Summaries

3.1 Leuna Chemical Complex

3.1.1 Summary

The Leuna Chemical Complex is 1,300 hectares in size and located in the east of Germany near Leipzig. There are more than 62 companies located onsite, the key ones being Arkema, BASF, Bilfinger, DOMO, Dow, Eastman Chemical Company, Innospec, Linde, Shell, TotalEnergies, and TUV Nord. In addition,

there are three research centres: the Fraunhofer Centre for Chemical & Biotechnological Processes, the Fraunhofer Institute for Wind Energy and Energy System Technology and the Helmoltz Centre for Environmental Research.

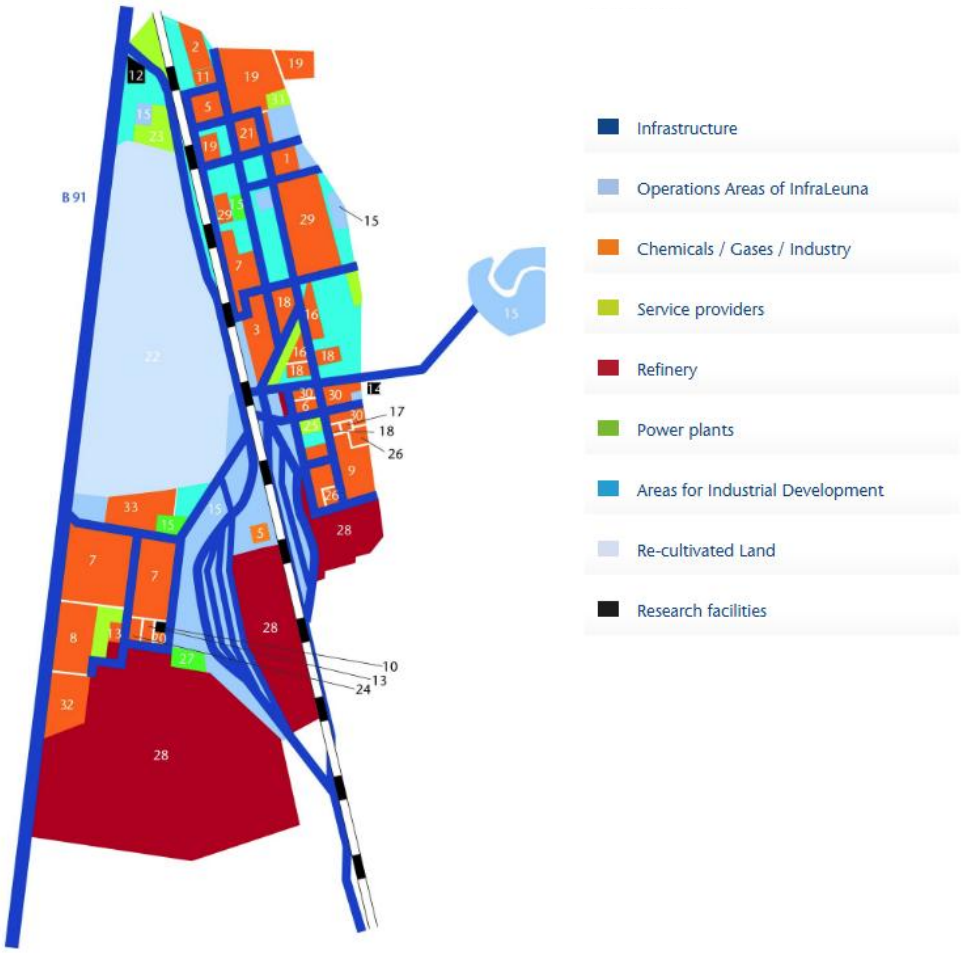

Figure 1: Overview of the Leuna Chemical Complex

3.1.2 Cluster Management / Leadership Structure

InfraLeuna are the owners and operators of the Leuna Chemical Complex. This private company has 48 employees and was founded in 1986.

3.1.3 Development Timelines

The origins of the site were in 1916 when Carl Bosch was commissioned by BASF to build an ammonia plant. This was followed in the 1920s by the production of methanol and then mineral oils and fuels from lignite hydrogenation. In the 1940s the site started producing polymers (beginning with nylon) and surfactants. Following the end of the Second World War, the site began refining oil and gas for Soviet bloc countries and used these as feedstocks to manufacture a range of petrochemicals. After German reunification, a number of Western (petro)chemical manufacturers established sites within the Leuna chemical cluster.

3.1.4 Focus

The cluster's focus is on petrochemical-based production, and it includes an onsite refinery (TotalEnergies) that produces fuels, oils, gases and methanol. Companies onsite manufacture a range of

speciality, fine and high-volume base/commodity chemicals, with more than 30 basic products, more than 30 interim products and more than 50 end products manufactured. Feedstocks come from imported oil, natural gas and ethylene, which are all delivered via pipelines.

The site is, however, moving towards net zero and it is stated that it has "*achieved a 95% reduction in environmental impact since 1989*". It follows ISO 9001, 14001, 45001 and 50001 standards, and is a member of the environmental alliance of the State of Saxony-Anhalt.

3.1.5 Investment

According to the site owners there has been a total of €9B invested since 1990 (by companies onsite as well as themselves), of which €500M has been invested in infrastructure by InfraLeuna in the last 20 years. The InfraLeuna Group had sales of €800M and assets of €820M in 2022.

3.1.6 Services Provided & Infrastructure Available

The site offers a number of services and infrastructure:

- **Water** (purified from the local river) which can be used for drinking, cooling and other processes (such as production of de-ionised water). This can be provided as a fully managed service or InfraLeuna can advise tenants on the best approaches to take themselves.
- **Wastewater treatment and disposal** of both production process wastewater and sewage. The company also offers management of tenants' systems and an analytical lab to ensure regulatory compliance.
- **Utilities** – combined heat and power plant providing electricity (various voltages), steam (different pressures) and hot water. Compressed air and natural gas are also provided. InfraLeuna works with tenants to understand their needs, advise and provide flexible connections. They can also provide consultancy support for automated engineering and data communication.
- **Engineering services** to support tenants' connections to the site's supply and disposal systems, and to road/rail links. InfraLeuna will also support tenants' applications to the necessary public authorities. This includes access to maps and GIS-based site information, as well as assistance with permits, coordinating tenders for construction and securing approval documents.
- **Logistics** - offer full supply management by road and rail (and indirectly via water and air) through working with external companies, securing best contracts and transferring materials from site to external transport as required. InfraLeuna operate their own public rail company to transfer products to national chemical centres – 70% of produced goods leave the site by rail and there are 90 km of railway lines within the cluster. They can advise on the best means of transportation, including of hazardous goods, as well as leasing and maintenance advice. They also offer storage facilities and tank cleaning.
- **Estates** provides rentable and furnished office space, workshops, production sheds, storage and archive space. Security, health and safety services (including medical services and a fire brigade) are also provided. In addition, there are some bridge and gantry cranes onsite. All sites are pre-approved for industrial builds and, at present, there are 40 Ha available for new development.
- **Business support** for tenants to access investment, and market their companies and products, including dedicated contacts.

In addition, there are 600 km of pipelines within the cluster transporting water, feedstocks, products and waste between different locations, including tenant sites.

3.1.7 Cluster Value Chains

The Leuna Chemical Cluster is Germany's largest closed chemical site. Linde provides industrial gases to the refinery and the polyamide manufacturer. The refinery provides a number of gases and feedstocks for the production of base chemicals and petrochemicals that are used to produce polymers and surfactants by others onsite. In addition, there are a number of technical, analytical, and engineering suppliers located onsite that provide services to manufacturers.

3.1.8 Connections with Other Clusters/Networks

The Leuna Chemical Cluster is connected with at least another seven chemical sites across the Saxony-Anhalt region, where there is purchase/supply of different feedstocks. The cluster is also connected with the Northeast Chemical Association through its Teaching Chemistry Campaign and with the local college (Merseburg) which provides a source of employees for the site as well as research services.

3.1.9 Public Sector Support

The public sector has supported the development of the Leuna chemical cluster through streamlining environmental permits (typically much shorter time to approval than elsewhere in Europe), as well as providing development grants to establish and grow companies onsite.

3.1.10 Future Strategy

No specific future strategy has been identified, apart from continuing to serve tenants well and secure new tenants as and when the opportunities arise.

3.1.11 SWOT Analysis

Strengths	**Weaknesses**
• Well established site • Comprehensive offering of services and infrastructure onsite • Significant ongoing investment • Links to other clusters/sites • Co-location of leading German research institutes • 48 members of staff that can support tenant companies onsite	• It is not clear how quickly it is migrating to net zero - perhaps only what is legally required
Opportunities	**Threats**
• The breadth of manufacturing onsite could better support the shift to sustainable feedstocks • Considerable space available for new tenants	• Still very much a petrochemicals complex - other sites have integrated biorefineries and have companies using sustainable feedstocks to make base and speciality chemicals

3.2 Chemparc Lacq

3.2.1 Summary

Chemparc Lacq is 680 hectares in size and located in the southwest of France (Pyrenees Atlantique) near Pau. There are more than 25 companies located onsite, the key ones being Air Liquide, Arkema, Lubrizol, Sanofi, Toray Carbon Fibers Europe, and TotalEnergies. The site also hosts several employee unions as well as part of the University of Pau and Pays de l'Adour, and offices of several public sector agencies.

Figure 2: Chemparc Lacq

3.2.2 Cluster Management / Leadership Structure

The site is operated by CHEMPARC, a non-profit public-private partnership (GIP in France) that was formed in 2003 with the purpose of stimulating regeneration of the Lacq Industrial Park and contributing to its economic development. There are three employees, all chemical industry experts, who proactively engage with industrial tenants and the public sector.

3.2.3 Development Timelines

Development of the Lacq Industrial site began in 1949 with discovery of oil and then natural gas fields in the region. Chem'pôle 64 was created in Mourenx in 1975 to support the local chemical industry, and this evolved into CHEMPARC in 2003.

3.2.4 Focus

Companies onsite manufacture a variety of chemicals. There is a commitment to waste reduction including industrial investment each year for safety and the environment and supporting a circular economy. This has successfully transformed chemical sites to clean energy production. There are also activities that regularly involve the local community.

3.2.5 Investment

According to the Chemparc Lacq website, more than €400M has been invested in the site since 2010. CHEMPARC itself had a €205k turnover in 2022.

3.2.6 Services Provided & Infrastructure Available

CHEMPARC offers the following services and infrastructure:

- **Shared services**: electricity, utilities (industrial gas, thermal energy), control and monitoring and secure access.
- **CHEMSTART'UP** to support new businesses in chemicals and materials. This was formed in response to a market need and supports companies in the pre-manufacturing stage. It offers high tech analytical equipment, pre-equipped labs, office units, the possibility of mini-pilot plants (6m high ceilings), and secure storage. There are 4 companies and 60 researchers engaged with CHEMSTART'UP at present.
- Risk prevention and safety.
- Connections to the scientific community through the Lacq Research Group (GRL) and the local universities.
- Access to a technical workforce trained via two technical colleges and three vocational colleges.
- **Permanent training facility** onsite for CPD as well as diplomas and baccalaureate courses (for chemicals and processing industries).
- Internal **rail network** and connection to mainline rail.
- **Chemical terminal** at the Port of Bayonne which is linked via rail and pipelines, enabling the supply of raw materials and export and storage of finished products.

3.2.7 Cluster Value Chains

All manufacturers share resources - electricity, utilities, the control and monitoring centre, and secure access. It is not clear whether any manufacturers purchase or supply products/feedstock to others.

3.2.8 Connections with Other Clusters/Networks

Chemparc has links with other regional clusters including: Lacq Plus (association of ~100 companies in the Lacq basin aimed at promoting opportunities), Pôle Avenia (cluster of companies and RTOs in subsurface industries, including TotalEnergies, in SW France) and Technopole Hélioparc (regional innovation park supporting startups and young businesses and linking with RTOs and more established companies).

3.2.9 Public Sector Support

CHEMPARC has had support from the French Government through the Territories d'Industrie programme which invests in the transition of industrial sites to achieving a more sustainable focus. Overall €1B will be invested across the whole of France in the coming 5 years, providing up to 50% match funding (from local authorities and the private sector), as well as equity investments and loans.

3.2.10 Future Strategy

No specific future strategy has been identified.

3.2.11 SWOT Analysis

Strengths	Weaknesses
• Established site • Internal infrastructure and connections outside site • Highly trained workforce and education and training establishments • Government - national and local investment and support	• Limited capacity within the organisation, only three employees. Suggesting more oversight than direct engagement and support for companies.
Opportunities	**Threats**
• Space available for expansion • Links with other clusters and expertise, which could better support the adoption of new technologies and industries.	• Other clusters have more substantial support teams in place and may be better able to coordinate with tenants.

3.3 Chemiepark Knapsack

3.3.1 Summary

Chemiepark Knapsack is 160 Ha in size and located in the west of Germany near Cologne. There are 14 companies onsite, the key ones being BASF, Bayer, Clariant, and LyondellBasell. The site also hosts the Rhein-Erft Academy, which is a certified vocational training and education institution, that provides training for the staff of companies onsite.

Figure 3: Chemiepark Knapsack

3.3.2 Cluster Management / Leadership Structure

The site is owned and operated by YNCORIS, a private company. YNCORIS is headquartered at the Knapsack site and has a total of 1,220 employees spread over 7 sites across the Rhine-Ruhr region in Germany.

3.3.3 Development Timelines

The Knapsack site was founded in 1907, initially to produce chemicals for fertilisers. During the subsequent period it expanded to become a major industrial site for the Hoechst Group. From 1960 onwards the focus shifted towards polymer production. The Hoechst Group merged with Rhone-Poulenc in 1997 and at that point its units at Knapsack became independent companies, one of which, InfraServ Knapsack (now YNCORIS), took over management of the site. This was the start of an open and collaborative chemical park. InfraServ Knapsack subsequently formed the Rhein-Erft Academy and new tenants including Bayer established sites in the park.

3.3.4 Focus

There is a significant agrochemical focus within the park, primarily due to the presence of Bayer Crop Science. There is also speciality chemicals, base chemicals, plastics, energy and utilities. There has been a consistent move towards circularity and sustainability over the past 15-20 years and the site is focused on reducing CO_2 emissions, water consumption and waste. It is gradually switching to renewable energies and also re-using water (coolant water is distributed via pipes within the park and can be re-used >20 times).

3.3.5 Investment

YNCORIS has continued to develop new sites adjacent to the park from its own resources. Other investment comes from companies that have established on the main Knapsack site. For example, LyondellBasell will open a new plastics recycling plant in Spring 2026 (LyondellBasell already has the world's largest polypropylene compounding facility onsite at >200kt p.a.); Bayer invested €60M onsite in 2009, and Westlake Vinnolit invested €330M in 2002. YNCORIS, as a whole, had sales of €209.62M and assets of €187.76M in 2022.

3.3.6 Services Provided & Infrastructure Available

YNCORIS aims to offer a 'plug & play' service:

- Provides **engineering, consultancy and construction services** to support companies to plan, build and/or expand within the park (for chemical, biotech and other process technologies). As part of this YNCORIS assists with gaining regulatory approval and site permits.
- Provides **process analysis technology** to help customers improve their process technologies.
- Provides **plant maintenance services** including repairs and authorised personnel.
- Supports tenants with their **logistics** needs.
- Has **pipeline connections** for raw materials and intermediate products, which also connect to regional pipelines for raw material supply.
- **Industrial and sewage waste disposal** via mechanical, chemical and biological treatment in two sewage plants, with storage of up to 30,000m^3 of untreated effluent.
- Has **solid waste disposal** via incineration or recycling of oils, chemicals, metals and electronic components.

The site is also connected to container terminals in Cologne, to ports on the Rhine, and from there to the North Sea.

3.3.7 Cluster Value Chains

There are opportunities to share raw materials, intermediates and end products with other companies onsite. For example, Westlake Vinnolit's PVC process produces H_2, Cl_2 and NaOH as by-products, which are used by CABB, Bayer and BASF in their process technologies.

3.3.8 Connections with Other Clusters/Networks

YNCORIS manages six other sites across the Rhine and Ruhr area and provides links to suppliers and processing companies across the region and beyond. There is also mention of links with universities and research institutions, and the fact that there are many educational institutions, as well as chemical companies, within the region indicates that there is a highly skilled workforce available.

3.3.9 Public Sector Support

The German federal government has committed up to €14B to facilitate structural transformation in the Rhenish mining area, in which Knapsack is located. In addition, the regional government of North Rhine-Westphalia (NRW) has worked directly with Chemiepark Knapsack and Bayer, amongst others, to further develop the site's infrastructure and research capabilities.

3.3.10 Future Strategy

The focus is on further developing the site as a location for sophisticated process industries and sustainable chemistry of the future.

3.3.11 SWOT Analysis

Strengths	**Weaknesses**
• Strong service offering – 'plug and play', facilitating tenant company activities • Comprehensive infrastructure onsite and to external sites • Training available onsite	• Not the same breadth of manufacturing as other clusters, which might limit future opportunities
Opportunities	**Threats**
• Already evidence of circularity with different companies using the (by-)products of others • This could possibly be expanded further in the future	• Other sites may have a greater critical mass

3.4 Chemelot Industrial Park

3.4.1 Summary

Chemelot Industrial Park is 800 hectares in size and located in the south of the Netherlands, near Maastricht. There are over 200 companies onsite, the key ones being Air Liquide, ARLANXEO, Aurorium, DSM Engineering Materials (now Envalior), Equans, RWE, and SABIC. The site also hosts Brightlands Chemelot Campus, an open innovation campus, which is one of the leading centres in the EU for enterprise, teaching, and research in chemistry and materials.

Figure 4: Chemelot Industrial Park

3.4.2 Cluster Management / Leadership Structure

The site is managed by the Chemelot organisation, which is a department of the Dutch multinational, DSM Nederland B.V. The Brightlands campus is a public private partnership with three shareholders: DSM, the Province of Limburg and Maastricht University.

3.4.3 Development Timelines

Operations at the site began in 1926, when DSM began the large-scale production of nitrogen fertilisers. Later it branched out into petrochemicals, plastics, hydrocarbons, and organic chemical products from naphtha and gasoil, and the production of specialty and fine chemicals from natural gas through ammonia. Until 2002, all plants and research facilities were part of DSM at which point it began divesting its activities at the site and sold off its plants. Chemelot then grew into a multi-user industrial complex with a large number of different companies but many of the industrial activities are still closely linked to one another. As a result, the various companies have developed a system of cooperation over the years, in which the umbrella environmental site permit for all companies within the complex plays a key role. This umbrella site permit ensures that the cooperation between relevant companies is not optional and gives the Chemelot Site Permit B.V. partnership (CSP) formal powers over the ensemble of companies regarding permit compliance. This is the only umbrella permit of its kind for a chemical cluster of this size in the Netherlands and, therefore, requires a tailored approach from regulators.

3.4.4 Focus

Companies onsite manufacture a range of petrochemicals, plastics, hydrocarbons, organic chemical products, specialty and fine chemicals, and performance materials. The site has the ambition to grow into the safest, most sustainable and most competitive chemical and materials site in Europe by 2025, and to become the first circular chemical and materials site in Europe by 2050 at the latest. In terms of revenue, Chemelot accounts for 20% of the chemical sector in the Netherlands.

3.4.5 Investment

No information on site investment has been identified, apart from general EU funding described in Section 3.4.9.

3.4.6 Services Provided & Infrastructure Available

Chemelot offers a range of services and infrastructure:

- An **umbrella permit**, including ~60 partial permits, provides more flexibility in the distribution of the available environmental space (such as emissions and noise) among the site users and makes it easy and attractive for companies to establish themselves and begin manufacturing operations. For the regulators, there is only one point of contact onsite.
- Utilities, fire brigade, maintenance, emergency organisation, infrastructure and regulations.
- Engages existing and potential tenants, local authorities and the local communities to **facilitate developments** by providing a single point of contact. Chemelot actively works to attract new business and to stimulate cooperation between companies.
- The **Brightlands Chemelot Campus** is a significant asset, providing a strong connection to DSM (production, research, and development) and its focus on performance materials. It offers pilot and demonstration scale facilities as well as RTD support. This has already resulted in showpiece innovations such as Dyneema (the strongest and lightest fibre in the world) and Kephricoat (super-transparent film for solar cells).

Chemelot is located directly on the European road network A2/E35 (Amsterdam-Rome) and has its own port and rail terminal. It is also connected by pipelines to the ports of Antwerp, Rotterdam and the Rhine-Ruhr area.

3.4.7 Cluster Value Chains

It is clear that the companies onsite mutually benefit from each other – supplying each other with different feedstocks, products and services

3.4.8 Connections with Other Clusters/Networks

Key connections are through the Brightlands Chemelot Campus that works together with Maastricht Health Campus, Campus Greenport Venlo and Smart Services Campus in Heerlen; the four campuses are located in the province of Limburg.

3.4.9 Public Sector Support

The Dutch government has designated Brightlands Chemelot Campus as a campus of national importance. The cluster has received a number of significant EU funds, including €108M in 2023 from the EU Innovation Fund to develop a waste-to-hydrogen project, that also includes carbon capture and storage (CCS). It also received a €2.6M subsidy in 2016 from the EU to the Chemelot Institute for Science & Technology (InSciTe) and Brightlands Chemelot Campus for research and development activities. In addition, the Brightlands Chemelot Campus is the coordinator of, and partner in, several EU and Dutch government funded projects.

3.4.10 Future Strategy

The Chemelot 2025 vision was announced with the ambition to grow the site into the safest, most sustainable and most competitive chemical and materials site in Europe. Chemelot is now working

towards a climate-neutral site in 2050. A key building block to realise this is the Chemelot 2030 Masterplan which describes the ambition and intended developments in the field of space and transport for the period up to 2030.

3.4.11 SWOT Analysis

Strengths	Weaknesses
• Scale • High degree of integration and synergy between companies • Activities cover entire technology readiness level (TRL) range; RTD centres, pilot and demonstration plants and large-scale (chemical) manufacturing industry • The knowledge and expertise within the Campus, the factories and the site services • Infrastructure	• Mutual dependency of companies, although a strength, it also makes Chemelot vulnerable - it can only remain competitive if none of the individual manufacturing sites close
Opportunities	**Threats**
• For the Province of Limburg, further development of Chemelot and of the Campus, in particular, is a key priority of economic policy	• None identified

3.5 Chemical and Industrial Park of Zeitz

3.5.1 Summary

The Chemical and Industrial Park of Zeitz is 232 Ha in size and located in the east of Germany, approximately 40 km south of Leipzig. There are around 50 companies onsite, the key ones being Remondis, Radici, PURAGLOBE, Interstarch, Münzing Micro Technologies, Jowat Klebstoffe, Deurex Micro Technologies, and Bioraffinerie Elsteraue GmbH. The site also hosts the Competence Centre for the industrial exploitation of biomass, the IfN Forschungs- und Technologie- Zentrum (FTZ), which focuses on chemical and environmental engineering processes, and the Helmholtz Centre for Environmental Research (UFZ).

Figure 5: Chemical and Industrial Park of Zeitz

3.5.2 Cluster Management / Leadership Structure

The site is managed by Infra-Zeitz Servicegesellschaft mbH, a private company, founded in 1993 with 44 employees, all located at this site. The company had sales of €5.85M and assets of €42.8M in 2022.

3.5.3 Development Timelines

The first activity onsite was between 1936-39 when a hydrogenation plant was built to produce fuels and lubricants from lignite. Following the Second World War, the site was rebuilt and expanded to encompass a refinery that produced a number of fuels and petrochemicals. It was redeveloped after 2010 into a modern chemical and industrial site, a process that involved local authorities.

3.5.4 Focus

The site has a focus on sustainable chemistry, with tenant companies producing a variety of basic chemicals, lubricants and speciality chemicals (waxes and adhesives).

Specifically, biobased chemicals are produced from the two biorefineries onsite. PURAGLOBE refines waste oils into biobased petroleum substitutes, while Elsteraue produces methane from various biomass sources that is fed into the grid. In addition, research centres onsite are actively investigating new biobased processes and more environmentally friendly chemical processes. Furthermore, Radici Chimica removes nitrous oxides from emissions resulting from its adipic acid (feedstock for polyester) production through a variety of abatement processes.

3.5.5 Investment

There has been significant investment in the site, €400M according to the regional government. This included €9.5M in 2010 to develop one of the biorefineries.

3.5.6 Services Provided & Infrastructure Available

The site provides the following services:

- **Gas and power** (there is a 5MW photovoltaic (PV) system onsite that also supplies electricity to the local grid), steam, industrial gases, water of different grades for industrial processes, heating and cooling, pre- and final treatment of industrial waste water.
- **Developed/service plots** - with planning consent.
- **Connections to public agencies** that can support inward investment (the site lies within an assisted development area).
- Assistance with **securing finance and necessary permits**.
- **Other services** provided onsite (including from other companies): R&D services, lab analysis, engineering and technical facility planning, maintenance and servicing, IT and software development, recruitment, catering and conference facilities.
- **Site and facility management**.
- **Start-up services** - offices, conference rooms, office services.

3.5.7 Cluster Value Chains

The site's focus is on expanding provision and value creation between established businesses and to create greater value from products already produced onsite.

3.5.8 Connections with Other Clusters/Networks

The Zeitz Chemical Park is part of the Central European Chemical Network (CeChemNet) which includes five other chemical sites in central Germany.

3.5.9 Public Sector Support

The regional government invested in the redevelopment of the park towards sustainable chemical and more environment-friendly processes.

3.5.10 Future Strategy

The bio-based strategy is probably the most recent, beginning with the investment in a biorefinery in 2010.

3.5.11 SWOT Analysis

Strengths	Weaknesses
• Offers comprehensive support and infrastructure • Company managing site has sufficient staff resources • Strong connection to local authorities, financial institutions and other networks/sites • Research institutions also onsite • International chemical manufacturers onsite	• Quite focused in types of output • Not as connected to external infrastructure as others
Opportunities	**Threats**
• Two biorefineries onsite - so already some expertise if additional biorefining was to take place • Other companies are looking at sustainability	• Other sites may be more attractive due to tenant companies (e.g. Bayer, BASF) and external infrastructure – there are sites with these companies in the wider region (part of CeChemNet)

3.6 Bazancourt-Pomacle Biorefinery

3.6.1 Summary

The Bazancourt-Pomacle Biorefinery is 713 Ha in size and located in the northeast of France in the Champagne-Ardenne (Grand Est) region near Reims. There are nine companies onsite: ADM, Cristal Union, Vivescia, Givaudan, Cristanol, Global Bioenergies, Air Liquide, Procethol 2G, and Wheatoleo. The site also hosts two RTD centres: ARD, which focuses on industrial research, and the European Centre for Biotechnology and the Bioeconomy (CEBB), a research facility that is a collaboration between AgroParisTech, CentralSupelec, NEOMA business school, and University of Reims Champagne-Ardenne.

Figure 6: Bazancourt-Pomacle Biorefinery

3.6.2 Cluster Management / Leadership Structure

This is a partnership between two farming cooperatives: Vivescia (focused on grain agriculture) and Cristal Union (focused on sugar beet agriculture). Each has its own processing sites and subsidiaries located at the Bazancourt-Pomacle site, however, it is unclear how many members of staff from each of these cooperatives are located onsite. The Jacques de Bohan Foundation was set up in 2011 to manage and market the site, but in 2018 it had only one member of staff, and it is unclear whether the Foundation is still operational. ARD, however, remains one of the main entry points for companies wishing to engage with the site.

3.6.3 Development Timelines

The origin of the site was in 1953 when the Bazancourt sugar factory was built. This was a result of the direct need of the cooperatives' members to diversify to ensure income for their farms. In 1989 ARD was formed to support value creation from biomass and optimisation for farming by-products. This was a joint venture between Vivescia and Cristal Union. In the 1990s new companies established onsite, some of them spun-out from ARD activity: Chamtor, which produces glucose, starch and proteins from wheat (and was later sold to ADM) Soliance, which develops active ingredients for cosmetics (and was later sold to Givaudan) and Wheatoleo, which produces surfactants, emulsifiers and soaps from wheat by-products. The biorefinery, Cristanol, was built in 2007 to produce bioethanol from sugar beet and wheat, via two separate fermentation and distillation systems. It is capable of producing 3.5 million hectolitres of bioethanol per year, for use in fuel blending, alcoholic drinks or other purposes (e.g., pharmaceuticals production). The CO_2 generated is captured by Air Liquide onsite and used in food and beverage applications. Procethol 2G, was another onsite development from the Futurol™ project. It produces bioethanol from fibrous biomass, such as hard and soft wood, soy stover, bamboo, and switch grass.

3.6.4 Focus

The focus of the site is on valorising biomass, mainly from agricultural but also some forestry sources. The bio-based chemicals that are produced are used in food, fuels, cosmetics, and plastics. While the initial focus was on supporting the cooperatives' members farms, it now clearly goes beyond this but is fundamentally about sustainability and net zero.

3.6.5 Investment

There has been significant investment from the site's owners including for ARD (around 30% of its annual budget, with the remainder from contract research and public grants, and significant capex investment including €22M for a demonstration scale facility). Other investment has come from the regional government, in total the Grand Est invested €500M in the regional bioeconomy over a period of 5 years, and from banks, Credit Agricole provided around 70% of the initial finance for the Cristanol biorefinery. This has all been focused on supporting the site to be a centre of innovation for the bioeconomy.

3.6.6 Services Provided & Infrastructure Available

The Bazancourt-Pomacle site offers:

- **Utilities**: water at various grades, wastewater treatment, industrial gases, steam and high voltage electrical connections.
- **Administrative support** to obtain necessary authorisations from authorities.
- **Rail links** and **internal pipelines**.
- Access to several different types of **biomass feedstocks**.
- Significant **RTD infrastructure**:
    - ARD offers capabilities across all TRLs: from lab-scale (1-30L) through pilot (150-2,000L) to demo-scale (180,000L), and can work with a variety of different micro-organisms. It has the capability to run several projects simultaneously and works with many different industrial companies. Other services include: designing facilities for clients and techno-economic analyses to support business cases.
    - CEBB has worked with some companies onsite, offering lower TRL research and analytical capabilities.

3.6.7 Cluster Value Chains

Cristal Union and Vivescia are investors in Global Bioenergies and Wheatoleo. ARD and CEBB offer R&D support to companies onsite, e.g. to scale up industrial processes. Several companies make use of the by-products of the bioethanol plant, the ethanol distillery and sugar and grain refining. There also appears to be distribution of by-products between some of the companies (e.g. Givaudan) and others for use in their production facilities. Overall, it can be seen as a good example of an integrated biorefinery.

3.6.8 Connections with Other Clusters/Networks

In 2005 the Industry and Agricultural Competitiveness (IAR) pole was formed, with the Bazancourt-Pomacle site and its constituent organisations a significant part of this. These competitiveness poles were an initiative of the French Government to bring together the research base and small and large companies to stimulate innovation in different sectors. The IAR has subsequently been renamed the Bioeconomy for Change (B4C) cluster, which has support from national and regional government.

3.6.9 Public Sector Support

As noted above, the site is part of the B4C cluster, a major initiative for the bioeconomy within the Grand Est region. Overall, €40M is invested each year in the bioeconomy, which represents ~8% of jobs in Grand Est.

3.6.10 Future Strategy

Overall, the strategy is to attract additional companies to the site that are focused on the bioeconomy and sustainability. The site retains significant space for expansion to enable this: an Industrial & RTD area of 260 Ha, a Bioeconomy Park of 193 Ha and an Experimental Farm of 240 Ha.

3.6.11 SWOT Analysis

Strengths • Globally recognised • Significant RTD capability • Integrated systems • Strong support from private, public and research sectors	**Weaknesses** • No real coordination/ leadership
Opportunities • Demand for all the products from the site are projected to increase and they are also highly diversified: fuels, foodstuffs, chemical feedstocks (to replace petrochemicals)	**Threats** • It has not grown or diversified as much as other sites and there are still limited numbers of companies

3.7 Chemical Cluster Delfzijl

3.7.1 Summary

The Chemical Cluster Delfzijl is 1,469 hectares in size and located in the north of the Netherlands on the Eems Delta near Groningen. There are 31 companies onsite, key ones being Avantium, Dow Benelux, Evonik, Lubrizol, Nouryon, OCI, PPG, Stork (Bilfinger), and Teijin Aramid. Nobian provides utilities and the Chemport Innovation Centre in Delfzijl works with scale-ups and innovative chemical companies to advance their sustainable ideas and technologies.

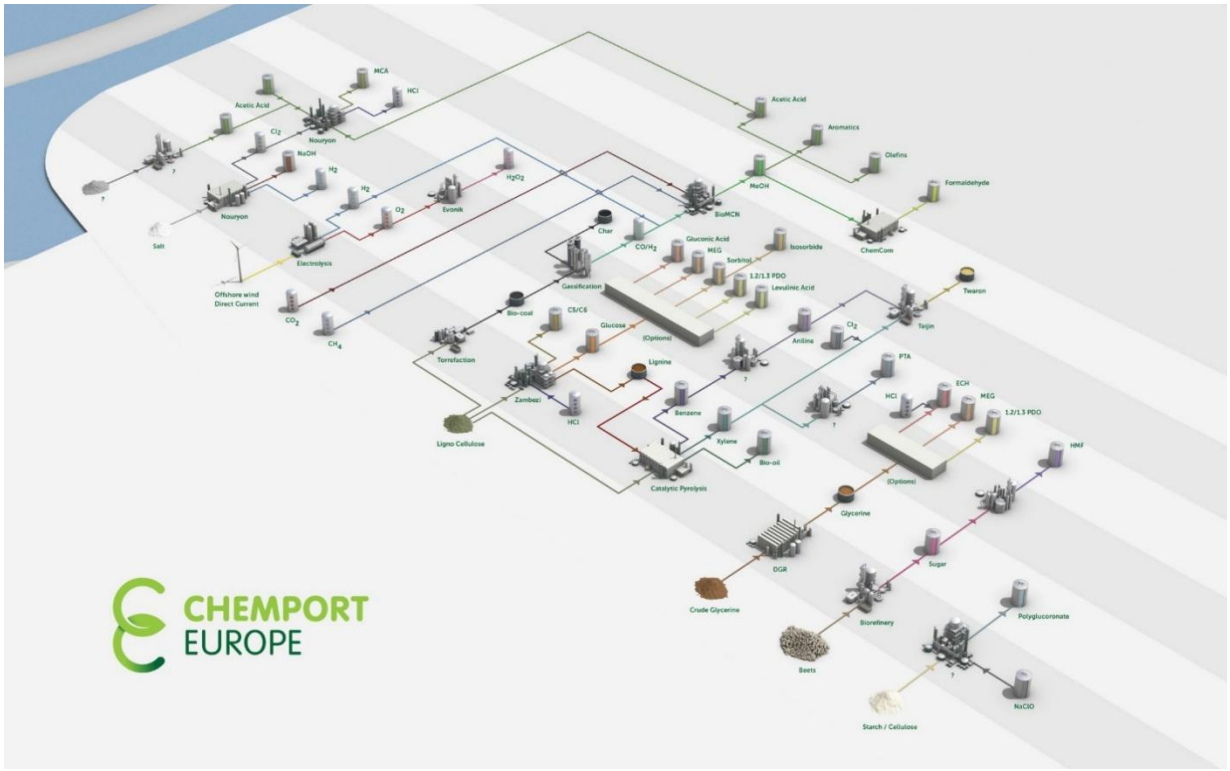

Figure 7: Overview of the Chemical Cluster Delfzijl

3.7.2 Cluster Management / Leadership Structure

Groningen Seaports owns, operates and develops the site. This is a public-sector owned company with around 100 employees onsite, of which ~20 are in business development and sales (engaging with existing and new customers), around 20-30 are in the technical services department that maintains infrastructure and around 30 are in the health and safety department. Chemport Europe (based in nearby Groningen) is key to the growth and development of the cluster. This is a non-profit, collaborative network of companies, government and RTOs focused on sustainable chemicals. There are three full time equivalents (FTEs) who are, essentially, employed by the organisations funding the network (mainly public sector such as the Province of Groningen).

3.7.3 Development Timelines

The cluster's origins were in 1839 when the W.A. Scholten company was extracting different biobased materials from potatoes: starch, protein, glue and dextrose. Salt mining began in the first half of the 20th Century followed by gas extraction from Europe's largest gas field in the 1950s. As a result, Delfzijl harbour expanded and became an industrial port with an associated chemical cluster, initially AkzoNobel (now Nobian) that focused on chlor-alkali production. Extraction of natural gas stopped around 10 years ago as it was causing earthquakes. This caused difficulties for some companies that relied on cheap gas, so, to a certain extent, this could have been one of the reasons the cluster transitioned to sustainability.

3.7.4 Focus

The cluster launched an ecosystem for green chemistry in 2017. This focuses on:

- Innovative circular polymer solutions – including chemical and mechanical recycling of plastics

- Utilising a variety of biomass, such as byproducts of sugar beet, wheat and potatoes that are grown in the region, as feedstock for the synthesis of different chemicals
- Development of green hydrogen production, through the offshore wind and onshore photovoltaic capacity in the region, both for energy and as a feedstock for chemical synthesis
- Capture and utilisation of CO_2, produced by many companies in the region, to make sustainable chemicals. For example, OCI operates Europe's largest bio-methanol plant which makes use of captured CO_2.

3.7.5 Investment

Groningen Seaports has invested in infrastructure development onsite in response to tenants' needs and new opportunities. This has included a pipeline that brings steam from the Nobian site to other tenants and also the conversion of a disused factory into the Chemport Innovation Centre. The owners have also leveraged funds from the Groningen Province to repurpose land for new tenants. Companies located at, or looking to establish a site at, Delfzijl have access to funds such as the Groningen Growth Fund, established by regional public authorities and which provides funding for SMEs, and the Investment and Development Company for the Northern Netherlands (NOM), which invests in companies over a period of 4 to 6 years.

3.7.6 Services Provided & Infrastructure Available

The cluster and wider Chemport Europe provide a number of services and infrastructure to support RTD and business development, including:

- Groningen Seaports, which has **~20 staff dedicated to business development** including account managers for its tenants. These individuals support new tenants and existing ones to secure permits and access funding. There is a staff member with considerable experience of the planning and permitting processes who can advise on these and the language to be used in application forms.
- Nobian Delesto's **cogeneration plant** that can provide up to 300 tonnes/hour of steam and 100 MW of electricity to the Delfzijl cluster. In addition, green electricity is provided by on and offshore wind, onshore photovoltaic and hydro power (total of 8 GW power available).
- In addition, the cluster provides access to natural gas and biogas, salt, chlorine, hydrogen, industrial water, nitrogen, compressed air and wastewater treatment.
- **Chemport Innovation Centre** is a shared facility that supports pilot and demonstration scale RTD. It offers licensed test areas to undertake the RTD, as well as lab and office facilities and access to the wider network. Companies can spend 4-5 years at the innovation centre to develop new technologies and can access public funding via the provincial government to support this.
- The site is **adjacent to the port** (fifth largest in the Netherlands) with access to the North Sea and has extensive road and rail connections to the rest of the Netherlands, Germany and other European countries.
- **Chemport Europe** provides support with business development, including help to secure necessary permits and access to public funding and private investment. It also offers 'Chemport Catalyser' a co-financing tool of up to €10k for SMEs that are developing green chemical processes.
- There are **several universities and applied research and training institutions** in the region, providing RTD support as well as access to a highly trained workforce. This includes a test centre

for hydrogen production, another for polymer development, a centre for energy innovations, and others for water technologies.

The site also has significant land (~400 Ha) still available for development by existing and new tenants.

3.7.7 Cluster Value Chains

There appears to be sharing of raw materials between companies that are required for others' process technologies, such as H_2, CO_2, and salts. Chlorine produced by Nobian is used by other companies in their processes (e.g. by Lubrizol to chlorinate PVC). By-products from different industries are used as inputs to other industrial processes, particularly bio-based feedstocks, much of which are sourced from regional agriculture. All of the organisations contribute to the success of Chemport Europe and also interact with each other via networking and use of shared RTD facilities.

3.7.8 Connections with Other Clusters/Networks

Chemport Europe is the key networking organisation, linking Chemical Cluster Delfzijl with the nearby Chemical Cluster Emmen (focusing on fibres, polymers and composites, as well as recycling), Campus Groningen (encompassing the University of Groningen, Hanze University and other research and knowledge institutions, collectively with over 70,000 students enrolled in technical and vocational studies), and R&D facilities (to support industrial scale-up, and specialisms in RTD for different sustainable chemicals). All are located within one hour's travel of each other. Through Chemport Europe, companies in the cluster have access to other networks across the Netherlands, and the important Amsterdam-Rotterdam-Antwerp (ARA) region.

3.7.9 Public Sector Support

The Province of Groningen and NOM are the most important public sector organisations supporting the cluster, either directly or through Chemport Europe. These provide networking, advice and access to various financial instruments.

3.7.10 Future Strategy

The overall ambition is to be the first chemical cluster in the Netherlands (and perhaps in Europe) with zero CO_2 emissions and minimum environmental impact. The entire Chemport Europe industry cluster will only use renewable energy and feedstocks by 2050. They believe that this distinguishes them from other chemical sites.

3.7.11 SWOT Analysis

Strengths	Weaknesses
• Sustainably developed industrial area for chemical related companies with strong inter-connections • Companies exchange raw materials, share supplies, and have a common focus on safety, people and the environment • The chemicals and recycling industry in Delfzijl is fully bio-based • 100 members of staff to support activities, 20 of which are dedicated to business development	• Some dependency between companies for materials • Limited linkages outside the cluster

Opportunities	Threats
• Access to a large amount of green electricity and green raw products which have been integrated into this chemical cluster • ~400Ha still available for new developments • By 2030, the Eems Delta will be the most important green seaport and industrial region of the northern Netherlands • The energy and data sector in the Eemshaven is of international significance	• No obvious threats

4 Analysis and Insights

4.1 Comparative Analysis

Each cluster was scored according to the methodology described in Section 2. This is summarised in the table below:

Cluster	Resources	Investment	Services	Infrastructure	Value Chains	Connections	Public Agencies	Future Strategy	Overall Score
Leuna Chemical Complex	30	30	30	45	45	20	15	0	215
Chemparc Lacq	15	20	45	45	15	20	45	0	205
Chemiepark Knapsack	30	20	30	45	45	20	15	5	210
Chemelot Industrial Park	30	20	45	45	45	0	45	15	245
Zeitz Chemical & Industrial Park	30	20	30	45	15	10	15	5	170
Bazancourt-Pomacle Biorefinery	15	20	30	30	45	20	45	5	210
Chemical Cluster Delfzijl	30	20	45	45	45	20	45	15	265

Table 1: Comparison of Different Chemical Clusters.

The colours highlight how clusters compare to each other overall and for each attribute. These are comparative rankings within each column of the table as follows:

Highest | Higher | Middle | Lower | Lowest

This provides the following, overall ranking for the assessed clusters, according to the criteria used:

1. Chemical Cluster Delfzijl – consistently strong across all criteria, in particular the staff resources onsite to support tenants and access to significant infrastructure and services. It has a clear strategy for development towards sustainability and net zero
2. Chemelot Industrial Park – also consistently strong across all criteria, and in particular the infrastructure and services available. It has a clear strategy for development towards sustainability and net zero

3. Leuna Chemical Complex – key strengths are in the infrastructure and services available. The site has seen the largest investment of all, >€9B since 1990
4. Bazancourt-Pomacle – key strengths are its focus on the bioeconomy, strong cluster value chain, access to significant RTD infrastructure and support from public agencies
5. Chemiepark Knapsack – key strengths are staff resources onsite as well as the infrastructure and services available
6. Chemparc Lacq – key strengths are infrastructure and services available as well as support from public agencies
7. Zeitz Chemical & Industrial Park - key strengths are staff resources onsite as well as the infrastructure available

4.2 The Attributes of a Successful Cluster

Based on the comparative analysis, together with key insights derived from the stakeholder consultations, the following summarises what makes a chemical cluster successful.

4.2.1 General Business Support

A major attribute of successful clusters is the support they provide to tenant companies. This includes access to utilities, infrastructure and waste treatment, and can extend to support with gaining regulatory approval and accessing public and private finance. This was highlighted by companies that have established at other sites and through the discussion with a European cluster organisation. The optimal solution for tenant companies is a site that offers plug and play capabilities, such that there is minimal effort required from the tenant to set up and operate at that site, for example, fully serviced and permitted plots of sufficient size. In general, these services are included within the rental agreement and function in the background, with minimal intervention from the tenant company.

4.2.2 Industrial Leadership

Successful clusters are led by industry for industry. The site manager/owner's income is based on the success of the tenant companies, the rent they pay and the payments they make for additional services provided. This requires a good understanding of the business needs of each tenant company, and having a system in place to ensure that the necessary support can be delivered and updated/adapted as needs evolve. In the best examples these are delivered by dedicated cluster staff, who act as account managers and are key contacts for tenant companies to facilitate their development at the site. Overall, this should bring about a cluster that is sufficiently agile to respond to new needs and opportunities, and has sufficient resource and authority (from the tenant companies) to deliver.

4.2.3 Access to Infrastructure and Resources

Companies that are developing sustainable, circular or net zero solutions require access to resources: feedstocks, energy and water being the basics. They also need sites that can remove and deal with waste streams. Increasingly, this also means CO_2, so sites that offer carbon capture and storage (CCS) solutions are more attractive to net zero emission manufacturers. These are facilitated by onsite infrastructure, such as pipelines, roads, railways and storage facilities, as well as external infrastructure, such as electricity grid connections, rail, shipping and road networks. Access to sufficient hydrogen, particularly green hydrogen, is becoming more important for manufacturers.

4.2.4 Access to Innovation Support

Several clusters offer onsite innovation centres, either managed by the cluster itself or through a third party, which can be an academic or research and technology organisation. These support the innovation and development activities of existing tenant companies and also the establishment of new companies, e.g., start-ups and spinouts, by providing access to lab and office facilities, and, in some cases, analytical services. Several also provide mentoring in the form of business accelerator programmes.

4.2.5 Local Supply and Value Chains

Clusters that include companies that can supply and add value to the business of others within the cluster rate more highly. When this is working optimally, it reduces both supply chain length and the amount of waste generated, while adding greater value to products and services. It can also deliver greater economic benefit in the local communities and, as a result, local support for the cluster.

4.2.6 Local and Regional Government

Clusters that have strong connections with local and regional governments tend to perform better and are more highly rated than others. This manifests as agencies that support the establishment and ongoing operations of different businesses onsite through, for example, simplified planning and permitting processes, providing funding, and access to investment. In all cases the public agencies facilitate these activities, rather than directing them.

4.2.7 Investors

Clusters that operate optimally, attract significant private investment. This allows larger companies to expand onsite infrastructure to take advantage of market opportunities and younger companies to begin or grow their operations. Public sector support is critical for this, to create the right legislative and regulatory environment that streamlines development and, therefore, investment processes.

4.2.8 Marketing

A distinct entity with clear messaging and marketing is essential for cluster impact. This effectively links any news that comes from cluster companies, reinforcing benefits, opportunities and outcomes from being part of it. In turn, this can leverage interest from other potential tenants and investors and can help build networks outside of the cluster.

4.2.9 Strategy

The cluster as a whole (site owner, tenants and public sector) needs a coherent long-term strategy that demonstrates vision and how it will evolve over the coming years in response to new societal demands, new legislative requirements, and new opportunities. Clusters that express this clearly are more attractive to both tenants and investors.

4.3 Views on Grangemouth

In addition to the observations of cluster best-practice above, stakeholders with knowledge of Grangemouth offered the following insights:

4.3.1 Key Attributes and Strengths:

- Grangemouth is in a strategic location, close to a major port that has the potential to enhance logistics capabilities for import and export. It is also close to major Scottish road networks. Together these provide access to regional, national and international markets
- The existing utility infrastructure, in particular electrical grid connections and grid capacity, could be a basis for further development. These could also offer the potential for blue and green hydrogen production
- Although the company base is small, Grangemouth is home to major industrial players (Ineos and Syngenta) focusing on both petrochemicals and fine chemicals production
- There is a highly skilled workforce with expertise in industrial processes and, increasingly, innovation and sustainability
- There are important supply chain companies that can support new, net zero, process development technologies
- The planned Sustainable Manufacturing Campus on which the Biotechnology Accelerator Pilot Plant (BAPP) and the Carbon Dioxide Utilisation (CDU) Centre will be located, could support Grangemouth to become a national innovation hub for the development and manufacture of sustainable fuels, chemicals and materials
- Links with RTD, education and training organisations (such as IBioIC, Forth Valley College and other colleges and universities) can support future innovation activities and ongoing skills development
- Whilst the availability of land has been limited in the past, this is changing due to the closure of some companies

4.3.2 Shortcomings, Limitations and Challenges:

- It is not a coherent cluster, rather two groupings of industrial activity: petrochemical operation in the East, centred around Ineos, and fine chemical/pharma and industrial biotechnology operations in the West at the Earls Gate site, with limited integration or interaction between the two
- There is no clear, industry-led entity to coordinate current industrial activities and to support future cluster development, which is leading to fragmented efforts and missed opportunities
- Currently there is no clear, long-term strategic plan to enable the development and growth of a more cohesive Grangemouth cluster
- There is insufficient collaboration on, or coordination between, utilities, waste treatment, and green energy solutions which creates inefficiencies and higher operational costs for companies operating at either end of Grangemouth
- There are uncertainties around carbon capture and storage (CCS) infrastructure and hydrogen production availability, which is limiting progress toward net-zero manufacturing. This is further compounded by the limited availability of key resources and feedstocks required for certain green processes, particularly those involving industrial biotechnology. Without cohesive strategies and leadership, Grangemouth risks being left behind in the transition to sustainable manufacturing
- There is a lack of streamlined, clear regulatory processes and a misalignment of policies between local, Scottish, and UK governments which can make it difficult for companies to secure the necessary regulatory permits. Regulatory and planning processes are perceived as being too

slow and misaligned with industry timescales. This delays critical infrastructure projects, limits expansion of existing businesses and deters inward investors

- Two distinct barriers to investment were identified:
    - Global company headquarters perceive Grangemouth as a risky investment due to political and economic uncertainties and limited government support
    - The cost and availability of energy, particularly green energy, pose significant barriers to inward investment and local operations. Insufficient green utility infrastructure (steam as well as energy) can make Grangemouth a less attractive location to companies for which sustainability is high on their agenda
- The more established clusters, including those reviewed as part of this study, offer strong incentives, better infrastructure, and cohesive governance models, which can make them significantly more attractive than Grangemouth
- Attrition and morale: skilled workers are leaving for more stable or competitive opportunities due to uncertainty in local industries
- Predominantly negative press about Grangemouth's industrial future can contribute to low workforce morale, resulting in challenges in retaining and attracting skills and talent. It could also hinder efforts to attract inward investors
- Community support for industrial operations in Grangemouth is limited due to concerns about environmental impact and insufficient engagement by industry players

4.3.3 Opportunities for Development

Whilst there are some significant and, in some cases, fundamental challenges to be addressed, stakeholders also highlighted that Grangemouth has the potential to evolve into a cohesive, sustainable and innovative industrial hub in the future. A number of opportunities were identified:

- Strengthen collaborative governance structures to coordinate development efforts and streamline decision-making
  It is important, however, that this is industry led
- Create a unified industrial cluster by connecting the petrochemical operations in the West and fine chemical/pharma operations in the East with shared infrastructure and utilities
- Invest in shared utilities, such as green energy, waste management, and a "utility corridor," to enhance efficiency and attract investment
- Fully integrate the port into industrial strategies to support logistics for new industries, such as sustainable aviation fuel production
- Position Grangemouth as a prime location for inward investment, particularly in sustainable industries, leveraging Freeport status and other incentives
- Develop and implement initiatives in carbon capture and storage (CCS) and green hydrogen production to align with net-zero goals
- Establish hubs for sustainable chemicals, materials innovation, and renewable energy research capitalising on the BAPP and CDU capabilities
- Leverage partnerships with academic institutions and innovation programmes
- Capitalise on the skilled local workforce by providing opportunities for transitioning to green and innovative industries

5 Conclusions

The key observations from the analysis of other clusters are:

- All of the other clusters began the transition to sustainability a long time ago – in some cases several decades
- In all cases there is a central organisation with resource that manages, supports and networks companies within the cluster. In the more successful clusters this is a substantial resource with business development and support to companies to access finance and secure the necessary permits to build manufacturing capability
- Infrastructure extends beyond utilities and wastewater treatment to include research and development and analytical support, and in some cases onsite technical training
- In several cases there are clear anchor companies, around which others have established a presence. This has led to the creation and evolution of value chains within the cluster
- There is clear public agency support in the form of local, regional and national government for these clusters, however, it is the cluster management organisation together with public sector and tenant organisations that drives development

While there has been significant investment in some clusters, this is perhaps not the most important aspect – it is how this investment is used to develop and integrate the cluster, rather than the size of the investment.

The situation at Grangemouth is rather different and development of Grangemouth manufacturing activity into a comparable cluster, in terms of scale and operation, will require significant time, investment and resources. There is, however, optimism within key stakeholder organisations that, with the right structure and support, there is potential for growth of industrial activity.

6 Recommendations

Our overall recommendation is that steps should be taken to invest in the development of the Grangemouth manufacturing cluster, adopting and adapting best practice from other clusters. Specific recommendations are:

1. Establish a cluster management organisation, comprised of individuals with industry and business expertise. This needs to be independent of any organisation onsite but have the capability to work with each one. It cannot be a public agency. It should also engage effectively with public sector organisations (e.g. government, planning, regulation, etc.) on behalf of cluster companies.
2. Develop a clear vision, strategy and action plan for the future development of the Grangemouth cluster, that has buy-in from all organisations. This must be industry led and supported by the public sector as appropriate. Further, it will need to take a long-term outlook to address the current issues within the cluster and to align with expected future developments (e.g. CCS infrastructure).

3. There should be an overt strategic focus on sustainable chemical manufacture. Potential opportunities include sustainable chemical manufacture using hydrogen, captured carbon and waste biomass (e.g., food and drink industry, municipal waste) as feedstocks.
4. Set out a timeframe for achieving different stages of the strategy and which organisations will be involved in ensuring their delivery.
5. Prioritise establishment of shared infrastructure / utilities as the first step in cluster development. This will address current issues (e.g. waste treatment, which has been identified as critical, especially for the Earls Gate site) and establish a common purpose/focus for cluster companies. Further, the shared infrastructure should offer zero carbon services to encourage net zero operations in companies. It is assumed that this will require both private and public sector investment.
6. Focus on supporting existing initiatives and partnerships, rather than taking a blanket approach. For example, the green hydrogen capability being developed by RWE. Consideration needs to be given as to how other supply and value chain actors could be brought into these, including those already onsite.
7. Expedite the construction of the Sustainable Manufacturing Campus, including the Forth Valley College training centre. This needs to be followed by pilot projects with those companies already onsite, that make use of the new capabilities. These can be used to promote cluster capabilities and attract inward investment.
8. Develop marketing and communications collateral for Grangemouth that highlights positive features, describes its future net zero profile and supports inward investment activities.

Appendices

Appendix A: Long List of Chemical Clusters

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
InfraLeuna GmbH	DE	chemicals	polymers	1,300Ha	InfraLeuna GmbH and its affiliated companies are the owners and operators of the infrastructure at the Leuna Chemical Complex. InfraLeuna works on a low profit principle. The shares in the company are owned by several companies located on-site. InfraLeuna GmbH operates and develops Germany's largest closed chemical site. The infrastructure and service concept, significant for the Leuna Chemical Complex, allows the investor to concentrate on its core competencies and enables suitable conditions for further expansions. Furthermore, InfraLeuna is also a site developer. Modern site management, marketing, assistance with location, and support with investment grant applications, are areas in which we have significant experience and expertise. Our acquired know-how, experience and a team of qualified and motivated employees have already convinced large international chemical groups to locate in Leuna.	ARKEMA, Dow Chemicals, Eastman, EW Biotech, Linde, Shell, Total, UPM	Good - although larger than Grangemouth it has a range of companies including Biotech and traditional chemical and polymers. Offers common / shared services	1
Chemiepark Knapsack	DE	chemicals	polymers	160Ha	The Chemiepark Knapsack near Cologne in Germany offers companies a scale-up platform and access to know-how for chemical production and integration into existing value chains. The innovative capacity of the Chemiepark Knapsack, solid infrastructure, plug&play services, as well as less bureaucracy and red tape all offer huge benefits for your company to commercialize your product. YNCORIS is the owner and operator of the Chemiepark Knapsack and places particular emphasis on the engineering of individual plants - from process development and conceptual design to basic and detailed engineering, regardless of whether we just carry out sub-services or take over the general planning for every stage. YNCORIS does not supply one-size-fits-all solutions. Instead, we adopt a flexible approach and gear ourselves towards the specific requirements of the current project stage - step-by-step. Thanks to a broad range of diverse engineering fields and an extensive selection of methods, we can guarantee the very highest degree of flexibility with regard to content.	Bayer, Clariant, EEW, LyondellBasell	Good - hosts a range of companies with similar sector focus as Grangemouth and also offers common / shared services	1

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Wolfgang Industrial Park	DE	pharma-ceuticals	chemicals	82Ha	Wolfgang Industrial Park is Europe's only high-tech site that is open to investors providing a complete materials science infrastructure. Health & Nutrition, Inorganic Materials, Advanced Intermediates, Coatings & Additives, and Consumer Specialties Business Units of Evonik Industries are established at the Wolfgang Industrial Park in Hanau, near Frankfurt am Main. The Industrial Park, which grew out of the Königlich-Preussische Pulverfabrik (Royal Prussian Powder Factory) established in 1875 and has undergone continual development ever since, has existed in its present form since 2001. The site is an innovative production and research centre for materials technology, chemicals, and pharmaceuticals that houses a total of ten companies.	Evonik, Fraunhofer, Umicore	Good - demonstrated adaptation, and incorporates innovation centre	1
Chemical and Industrial Park of Zeitz	DE	chemicals	industrial biotech	232Ha	Operated by Infra-Zeitz Servicegesellschaft mbH. Focus on sustainable chemistry. Has 5MW PV plant that also supplies the grid. Biorefinery operators onsite produce biomethane which is fed into the grid, as well as biobased petroleum substitutes from used oil. Also close connections with research and technology institutions such as IFN and UFZ.	Remondis, Radici	Good - range of similar industries and similar size	1
Industry Center Obernburg	DE	chemicals	polymers	176Ha	Owned and operated by Mainsite. Site has seen redevelopment over the years from being a textile production site to including a variety of polymer production as well as business support and analytical capabilities. Since 2010 the Technical University of Applied Sciences Aschaffenburg, together with the Bavarian State government, started the settlement of a research institute for industrial high-tech research in the fields of innovative materials, automotive, intelligent systems, knowledge management and structural transformation research.	Evonik	Good - demonstrated adaptation, and incorporates innovation centre	1
Kokkola Industrial Park	FI	chemicals		700Ha	Kokkola Industrial Park (KIP) is Northern Europe's largest chemical and metal processing industry ecosystem, where several top international companies operate. 16 production companies and around 60 service companies are located in the area to support the core operations of production companies. The companies directly employ 2,400 people. A strong cluster of the chemical industry and a group of global companies have grown in Kokkola. The know-how can be seen both in the process know-how of the industrial area and in the concentration of education and high-level research. Industrial circular economy is practised within the park.	Air Liquide, NESTE, UMICORE	Good fit - NESTE is refining waste into renewable fuels and feedstock for plastics. Park has circular economy ethos.	1

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Chemparc Lacq	FR	chemicals	pharma-ceuticals	680Ha	The Chemparc public-private partnership was created in 2003, in order to accompany the industrial regeneration of the Lacq Industrial Park and contribute to its economic development. All the manufacturers of the Park, the employee unions, the University of Pau and the Adour region, and offices for the public sector services, have premises here. Nowadays, CHEMPARC forms a team dedicated to detecting new manufacturing projects and accompanying potential investors. Together we are carried along by a single objective: bringing new manufacturers to the Lacq Industrial zone, project developers with high value-added. Provide start-up space, access to specialist knowledge and training.	Air Liquide, Arkema, Sanofi, Total	Good - hosts a range of companies with similar sector focus as Grangemouth and also offers common / shared services	1
Bazancourt-Pomacle Biorefinery	FR	industrial biotech	biobased chemicals	713Ha	The biorefinery was established by Cristal Union and Vivescia (French farming cooperatives). Its primary purpose is to produce bioethanol from sugar beet and wheat. It is also home to a number of companies that make use of bioresources as well as research facilities that support fundamental research and applied/commercial scale RTD. These include the European Centeer of Biotechnology and Bioeconomy (CEBB), ARD, Procethol 2G - Futurol.	ADM, Cristal Union, Vivescia, Givaudan, Cristanol	Good - different focus to Grangemouth, but this is a site that re-imagined its purpose to take advantage of local resources and has since integrated many different RTD capabilities.	1
EuraMaterials	FR	chemicals	biobased chemicals		EuraMaterials is a cluster serving the materials processing industries. It is a French competitiveness cluster, formed by the merger of various initiatives and with special recognition from the French Government. It supports companies and research players to enable them to find solutions, perform and grow. Always with a view to performance, our team informs, supports, creates links and encourages collaborations between entrepreneurs and researchers, enabling them to find solutions, innovate, open up new markets and grow. Our ambition is to be the European benchmark cluster for new materials processing industries. To achieve this, we rely on our network of member companies and innovation project partners – located in the Hauts-de-France region, throughout France, in Belgium, Germany, Austria, Japan, etc. Supports companies/members to access national and EU funding, connect with other partners, and provides technology assessment services.	Many different companies and research institutes - generally from the region and neighbouring regions in France and other countries.	Good - brings together public and private sectors to pro-actively build competitiveness in materials and the region. All French competitive clusters have a similar remit	1

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
AXELERA	FR	chemicals	biobased chemicals		AXELERA is the leading competitiveness cluster for chemistry, process industries and the environment. Since 2005, we have been accelerating the successes of our members involved in the controlled management of materials and environmental resources, by supporting innovation and the development of sustainable solutions, to respond to the climate and environmental emergency. Supports members in their innovation actions - helping to secure funding, building partnerships, monitoring and assessing progress, marketing innovations, etc	Many different companies and research institutes - generally from the region and neighbouring regions in France and other countries.	Good - brings together public and private sectors to pro-actively build competitiveness in materials and the region. All French competitive clusters have a similar remit	1
Chemelot Industrial Park	NL	chemicals	polymers	800Ha	Industrial site is managed by the Chemelot organisation. Integrates industrial production with R&D and training. >200 companies on site across a range of specialisms, with access to an innovation centre and pilot plant facilities. Focus on innovation and circularity - strategy is to be a circular, sustainable and fully climate-neutral chemical site in 2050.	SABIC, DSM, Arlanxeo	Good - larger than Grangemouth but demonstrating a good mix of established companies and innovative RTD	1
Chemical Cluster Delfzijl	NL	chemicals	biobased chemicals	1,469Ha	The Chemical Cluster Delfzijl is a unique co-operation between companies that exchange raw materials, share supplies, and with attention for safety, quality, people, and environment. The Chemical Cluster Delfzijl is a sustainably developed industrial area for chemical related companies, connected to each other like a chain. At the moment 18 companies are settled in the cluster. Includes SAF manufacturer, SKYNRG.	AkzoNobel, Dow Chemical, EVONIK, SKYNRG	Potential fit based on size, focus and capabilities	1
Catalisti	BE	biobased chemicals	industrial biotech	n.a.	Cluster for the chemical and plastics industries in Flanders. Connect different industrial and research partners together. These include local government, international companies, local companies and research facilities such as Biobased Europe, Sirris, Vito and various universities. No physical infrastructure, just a building - value add is the network.	Many companies are members including BASF, Bayer, Covestro, Dow, Ineos	Possible - in terms of cluster management and governance	2
GreenWin	BE	biobased chemicals	chemicals	n.a.	GreenWin is the Walloon innovation cluster that is dedicated to collaborative innovation projects in the three areas of green chemistry, innovative building materials and processes, and the environment. It is therefore the Cleantech Innovation Cluster in and for Wallonia. Established 2011. No physical infrastructure, just a building - value add is the network.	Mainly BE companies and research organisations	Possible - in terms of cluster management and governance	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Marl Chemical Park	DE	chemicals	polymers	650Ha	The Marl Chemical Park is the third largest integrated industrial site in Germany and also Evonik's largest production site. With Infracor as site operator and service provider, the Marl Chemical Park distinguishes by an excellent infrastructure and a customized service offer. Also has IB activity, common analytics facilities, good logistics and common purchasing.	Air Liquide, Dow Chemicals, Evonik, INEOS, Linde, SASOL	Possible - much larger than Grangemouth but has wide mix of tradiitonal chemical and IB companies, with recycling and waste treatment.	2
REMONDIS' Lippe Plant	DE	chemicals	biobased chemicals	280Ha	REMONDIS' Lippe Plant is not only the largest industrial recycling centre in Europe, it is also an excellent example of successful structural change. Originally an aluminium plant back in the 30s, the recycling park in Lünen is now home to a range of different facilities to recover a whole variety of recyclable substances as well as to produce high quality recycled raw materials. Today, over 1,600 employees work at the plant, where 1.4 million tonnes of residual materials are recycled annually, and approximately 0.9 million tonnes are returned to the industry as raw materials. The Lippe Plant plays a major role in helping to protect the environment and curb global warming – with various recycling activities at the site reducing carbon emissions by 488,000 tonnes each year. Additionally, a majority of the original aluminium plant buildings are still being used today and provide a perfect example of sustainability in action. The REMONDIS-Group is one of the world's leading recycling, service and water companies. Through branch offices and shares in other companies REMONDIS is present in over 30 countries on three continents and operates in a wide range of business fields: it recovers raw materials from waste, develops innovative recycled products, offers alternative fuels and plays an important role in the water management sector supplying water and treating wastewater.	Mainly REMONDIS group companies	Possible - more focused than Grangemouth but significant recycling capability and capability to produce alternative fuels.	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Krefeld-Uerdingen CHEMPARK	DE	polymers	chemicals	260Ha	Krefeld-Uerdingen CHEMPARK site has established itself as a leading location for polycarbonates and polyamides in Western Europe. At 260 hectares, it is also the world's largest production site for inorganic pigments. One of the Krefeld-Uerdingen site's best-known chemical products is the polycarbonate Makrolon®, one of whose many uses is as a substrate for DVD and CD production. In addition, the roughly 7,000 employees of the various CHEMAPRK tenants manufacture polyurethanes, polyamides, Durethan®, adipic acid and coatings, white and coloured pigments and intermediate products for crop protection products, odorants and flavourings. Companies at the site benefit from cutting-edge technical facilities, an excellent infrastructure and a wide range of services. The CHEMPARK is also one of the largest providers of training in the region. At CHEMPARK Krefeld-Uerdingen, school leavers can choose from a dozen different scientific, technical and commercial training courses. Students and graduates of chemistry and engineering can acquire in-depth specialist knowledge by taking courses at the ultramodern technical training center that involve both training and study. The focus is on combining theory and practice to provide highly qualified new recruits. Niederrhein University of Applied Sciences is also located in Krefeld. The chemical faculty provides one of the most comprehensive choices of specializations in Germany – for both Bachelors and Masters degrees.	Covestro, Lanxess	Possible - offers a range of services covering utilities, waste, analytics, training	2
CHEMPARK Dormagen	DE	chemicals	polymers	360Ha	Around 2,000 different chemical products are manufactured by a total workforce of 9,700 at CHEMPARK Dormagen, making it a site of some stature. Production activities at the largest CHEMPARK site focus on the development and manufacture of crop protection products, polymers, plastics and rubber. CHEMPARK Dormagen is one of the main providers of employment and training in the Rhineland district of Neuss. Around 150 young people start training here each year. They can choose from 17 different professions. In addition to the development and manufacture of crop protection products, other key activities include the production of polymers, plastics, rubber, isocyanates and organic intermediates. The CHEMAPARK sets standards throughout Europe with its research and development centre for polyurethanes. Environmental protection considerations play a key role in all processes. Over the past few years, emissions have been cut by over four-fifths despite rising production levels.	Air Liquide, ARLANXEO, Covestro, INEOS, Lanxess, Linde, Nouryon	Possible - offers a range of services covering utilities, waste, analytics, training	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Industriepark Höchst	DE	chemicals	biobased chemicals	460Ha	Frankfurt-Höchst Industrial Park: A licensed, fully developed site for researching, developing and producing chemical, pharmaceutical, biotechnology and related products. Plus, resident companies benefit from the central location, close proximity to Frankfurt Airport, excellent highway links, railroad connections, and the harbor facility. At the site Infraserv Höchst provides all services from A-Z: from standard site services – people, environment, rental buildings, plant and infrastructure- to supplying electricity, natural gas, cooling heat and water. From raw material and utilities supplies to waste and wastewater disposal, end to end logistics to communication networks the Frankfurt-Höchst Industrial Park has everything production and research companies need.	Air Liquide, BASF, BAYER, Cargill, Clariant, Daikin, LyondellBasell, Sanofi, Siemens	Possible - offers a range of services covering utilities, waste, analytics, training	2
Bitterfeld-Wolfen Chemical Park	DE	chemicals	polymers	1,200Ha	Significant chemical park in former East Germany with 360 companies. Provides good infrastructure for both industrial and commercial operations as well as connections to regional RTD centres. Can supply feedstocks as well as waste management, and offers technical and engineering support services.	AkzoNobel, Bayer, Clariant, Evonik, Nouryon	Possible - has re-invented itself several times from initially being a lignite mine	2
Schwarzheide Chemical Park	DE	polymers	chemicals	290Ha	Owned by BASF. Mainly plastics, polymers and agrochemical production. Storng connection with local technology institutes such as TU Darmstadt and Fraunhofer Institute for Applied Polymers. Site provides access to technical, analytical and logistics support	BASF, Air Liquide, Fraunhofer IAP, Huntsman	Possible - was also formerly a lignite mining region. BASF has invested significantly in site	2
GENDORF Chemical Park	DE	polymers	chemicals	197Ha	Managed by InfraServ. Largest chemical park in Bavaria. Supports circularity through shorter supply chains and reuse of waste products. Provides a number of support services - technical, engineering, logistics.	Clariant, Linde, 3M	Possible - similar size and range of companies	2
GreenTech Park FLUXUM Gernsheim	DE	pharma-ceuticals	industrial biotech		Site owned by Merck. Offers industrial and commercial space as well as incubator space for start-ups. PV plant producing up to 7GW p.a.	Merck	Possible - but is more a tech hub for smaller, early-stage companies	2
Industrial Park Wiesbaden	DE	chemicals	polymers	96Ha	The Industrial Park Wiesbaden (Kalle-Albert), operated by InfraServ Wiesbaden (ISW), offers innovative site management, industrial infrastructure and customer-oriented services. Competitive offerings and extensive synergies make the Industrial Park Wiesbaden a major global player. Our compound encompasses 96 hectares (237 acres) of space, equipped with all the necessary infrastructure to ensure successful business operations, especially for companies in the chemical industry. International companies produce a variety of products here, including: artificial resins, cellulose ether, detergent components, electronic materials, filtration membranes, plastic films, printing plates, sausage casings, and special adhesives.	Merck Performance Materials, Mitsubishi Polymer Film	Possible	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Veolia Industrial Park Heinsberg-Oberbruch	DE	chemicals	polymers	109Ha	Owned and operated by Veolia. Provides various services including water, heat and steam, energy, industrial gases, wastewater treatment. Offers technical support to companies, e.g., to improve resource efficiency. Home to various companies	Teijin Carbon, Mitsubishi Chemical Advanced Materials, Bilfinger	Possible - but operating more as a landlord. Some similarities to Calachem operated site at Grangemouth but on a larger scale	2
Chemical Park of Huelva	ES	petro-chemicals	chemicals		Recent investments by the main petrochemical company (Cepsa) to produce green methanol (Europe's largest plant), hydrogen and biofuels (including SAF) by 2026 at its La Rabida Energy Park in Huelva . Strong interaction with Andalusian government and Huelva City Council. Will make use of local agriwaste and solar PV.	Cepsa, C2X	Possible - re-invention of petrochemical facility as significant hydrogen and biofuel hub. Unclear what other companies are involved - mainly a Cepsa site	2
Port of Rouen	FR	chemicals	biobased chemicals	n.a.	Located along the Seine, Rouen gathers major industrials of base and specialty chemicals with direct access to the multimodal connexions and easy access to utility networks. With good inland access to the port, Rouen provides savings by offering a choice of modern dedicated terminals. The Port is located close to major centres of production and consumption in the Paris area. 50% of the nation's wealth is concentrated within a 190-mile radius from the City of Rouen.	Air Liquide, BASF, TOTAL	Potential fit based on size, focus and capabilities	2
Bioeconomy for Change	FR	biobased chemicals	industrial biotech		French cluster dedicated to the bioeconomy that covers a wide geography and includes smaller clusters such as Bazancourt-Pomacle Biorefinery.	Many different companies and RTOs from across France and further afield	Possible - much larger than Grangemouth in terms of geographic spread, but useful systems put in place to support, connect and help develop companies and other organisations.	2
Valuepark Terneuzen	NL	chemicals	petro-chemicals	n.a.	Valuepark Terneuzen is a joint venture of Dow Benelux and Zeeland Seaports Port Authority. As part of North Sea port it is situated in the south west of the Netherlands and ideal located for chemical production and distribution; it is the perfect base for entry or expansion into today`s European market. Centrally located on the estuary of the Westernscheldt River, between the main ports of Rotterdam and Antwerp, Valuepark Terneuzen offers the chemical producer and distributor cost effective facilities and direct access via road, rail, pipeline, inland waterway and deep sea port, to the world`s most crucial markets and sources of supply. Valuepark Terneuzen is ideally placed to become a major European hub for the chemical industry and offers tremendous partnership potentials.	Dow Chemical	Potential fit based on size, focus and capabilities	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
GETEC PARK. EMMEN	NL	chemicals	polymers	1,000Ha	GETEC PARK.EMMEN as part of Chemical Cluster Emmen, is dedicated to manufacturing and chemical enterprises with production processes up to environmental category 6 - heavy industry. The site has excellent facilities for companies active in the fibres, polymers and composites markets and is the largest of its kind in NW Europe. New developments towards biobased chemicals find a favorable home at site supported by its location in the Chemport Europe region.	BASF, Lanxess, Teijin	Potential fit based on size, focus and capabilities	2
Płock Industrial and Technological Park (PPPT)	PL	chemicals	petro-chemicals	60Ha	Joint venture between the City of Płock and PKN ORLEN SA. PPPT provides its partners and investors with a wide range of development services to support and stimulate entrepreneurship. Through cooperation with universities, research institutes, entrepreneurs, public administration, business environment institutions and international organizations, the Park builds a strong network of cooperation and supports and initiates R & D. Brings together companies from the chemical industry is keenly interested in promoting the closed loop economy among its stakeholders. Changes to the circular economy regulations will shape the future of the chemical industry in a significant way.	Orlen	Possible - started as petrochemicals refinery complex, now broadened to include other chemicals and tech companies in the local cluster	2
ZILS	PT	petro-chemicals	polymers	2,375Ha	ZILS is the largest area for the location of industrial and logistic units in the Iberian Peninsula. It offers over 23,750,000 m2 of space dedicated to industrial, logistics and service activities. It is expandable up to a total area of 41,570,000 m2. Largest refinery in the country	Air Liquide, ENERFUEL, REPSOL	Potential fit based on size, focus and capabilities	2
Stenungsund	SE	petro-chemicals	chemicals		Largest chemical cluster in Sweden, centered around a steam cracker that produces ethylene and various fuel gases, which are then used by a range of companies for the production of polyethylene, polyvinyl chloride (PVC), amines, detergents, and various other chemicals. Adesso Bioproducts received investment from the Swedish Government in 2023 for green ethylene production (aim to build pilot plant by end 2025).	Borealis, INEOS ChlorVinyls, AkzoNobel, Nouryon	Potential fit based on size, focus and capabilities and shift towards green manufacturing.	2
Venice Porto Marghera	IT	petro-chemicals	biobased chemicals	1,447Ha	Has been subject to upgrades and refocus on sustainability since 2014. Eni is main company operating refinery. Now has biorefinery for HVO biofuels and plans for SAF production. Has significant PV installation (3.55MW and 2.7MW) as well as hydrogen production (probably blue).	eni, Versalis	Much larger than Grangemouth, but appears to have managed to reimagine its future in terms of biorefining and production of biofuels	2

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Port of Antwerp	BE	petro-chemicals	chemicals		The Port of Antwerp is the leading European oil and chemical cluster in Europe (considered second largest global cluster). Home to both base chemicals and fine chemicals production, the Antwerp oil and chemical cluster can offer great integration possibilities. More than 7 million m3 of third-party liquid storage solutions, 2 top 10 refineries, 4 steam crackers and no fewer than 30 companies operating in the oil and chemical sector, including at least 10 top world players, are located in the port area. They are followed by world players in the contracting and logistics sectors. - Largest integrated European oil and chemical cluster - Guarantee of stable supply of feedstock, raw materials and intermediates - Opportunities for integration of products and energy create mutual beneficial synergies - Outstanding pipeline connectivity, tank storage and product handling - Green, brownfield and co-siting sites available	Air Liquide, ARKEMA, BASF, COVESTRO, EASTMAN, EVONIK, ExxonMobil, INEOS, Solvay	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3
INEOS Antwerp	BE	chemicals	polymers	n.a.	INEOS offers services to chemical companies located on the INEOS Antwerp site. These range from full operational responsibility for the assets to the supply of raw materials as well as a comprehensive range of specialities and intermediate chemicals and a range of cost effective services including site infrastructure. By acting as a host company, the guest company can benefit from the location in the heart of the Chemical Park of Antwerp, providing on site direct access to all transport means (sea, waterway, railroad, highway) and infrastructure (seaport, extensive pipeline network of various feedstock & industrial gasses). A new Cogeneration plant offers reliable and energy efficient access to a range of utilities.	INEOS	Poor fit - single company acting as host	3
Chempark Leverkusen Currenta	DE	chemicals	pharma-ceuticals	480Ha	Leverkusen is one of the word's most versatile locations for the chemical industry. More than 5,000 chemicals are manufactured here and, if necessary, disposed of safely. Contaminated hazardous waste is handled expertly at our Bürrig waste management plant, which is far from being just a regional facility. The 470-hectare Leverkusen site offers excellent opportunities for all kinds of companies – from the chemical and pharmaceutical industries to the high-tech sector. More than 5,000 chemicals and pharmaceuticals are manufactured at CHEMPARK in Leverkusen, mainly nitration and chlorination products, aromatics, fine chemicals and silicon chemicals. Around 30,000 people work here, ensuring that the CHEMPARK skills centre keeps on developing. Know-how, efficiency and responsibility are key to the success of this Chemical site.	Bayer, Covestro, Evonik, Lanxess, Nouryon	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
BASF Ludwigshafen	DE	chemicals	petro-chemicals	1,000Ha	With an area of approximately ten square kilometres the Ludwigshafen Verbund site is the world's largest integrated chemical complex. As the headquarters of BASF, it is also the cradle of the Verbund concept, where production facilities, energy flows and logistics are networked together intelligently. This integration leads to efficient value-adding chains from basic chemicals to highly sophisticated products. The backbone of the Ludwigshafen production Verbund is a dense network of around 200 production plants that are connected to each other by over 2,850 kilometres of pipelines and more than 230 kilometres of rail track. At BASF's Ludwigshafen site, some 8,000 sales products are produced with a total volume of 8.5 million metric tons per year from just a few raw materials, such as naphtha, rock salt and sulphur. The site also serves as a technology platform and the centre of corporate research.	BASF, Air Liquide, Basell Polyolefine, INEOS Styrolution	Huge compared with Grangemouth with a focus on BASF. Thus a poor fit for best practice learning.	3
Bayer Chemiepark Bergkamen	DE	pharma-ceuticals		110Ha	The Bergkamen Supply Centre is Bayer AG's largest site for the production of active pharmaceutical ingredients. Around 1,800 employees, including trainees from 32 nations, produce steroid hormones, contrast agents and active ingredients for innovative therapeutics of the highest purity.	Bayer, LANXESS, Huntsman, Linde	Probably not - focus on pharmaceuticals	3
Düsseldorf-Holthausen	DE	chemicals		143Ha	The vision for the industrial park is to become a leading example of sustainable industrial development, integrating cutting-edge technologies and innovative solutions to drive progress. Committed to a long-term strategic framework focused on "Purposeful Growth", the park aims to create exceptional value for customers and consumers. The overall goal is to exceed market growth and strengthen leadership in sustainability. By fostering a collaborative environment and prioritizing responsible practices, the park will contribute to a livable future for upcoming generations, enhancing the quality of life through its products, services, and industrial advancements. Emphasizing innovation, sustainability, digitalization, and future-proof business processes, the industrial park is built on a strong corporate culture of collaboration and empowerment.	Henkel, BASF	Probably not due to size and focus on Henkel/BASF	3
Industrial Park Stade	DE	chemicals		550Ha	Today, four chemical companies and a number of logistics and utilities partners are located in the Stade industrial park which is operated by Dow. More than 1.200 employees and a few hundred contractors manufacture in the production plants on a surface of approximately 550 hectares almost 4 millon tons of basic and specialty chemicals per year – altogether more than 20 different product families. Stade's Industrial Park concept focuses on the creation of synergies between a potential investor and the Stade site. The Stade location offers a variety of opportunities to potential investors - access to highly integrated chemical site infrastructure and to efficient shared services creating a solid base for a long-term cost-efficient operation.	Dow Chemical	Probably not due to size and focus on Dow	3

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
BASF Tarragona	ES	chemicals		112Ha	Located in the largest chemical complex in southern Europe, BASF Tarragona is one of the company's main production centres. In an area of more than 100 hectares , it houses four production plants operated by BASF, a joint venture with SONATRACH and five third-party company plants.	BASF, LyondellBasell	Poor fit - mainly BASF activities	3
Chemmed Cluster Tarragona	ES	chemicals	polymers	1,200Ha	Tarragona houses the largest chemical hub in southern Europe with annual production of 20 million tons. The Port of Tarragona plays a key role in the competitiveness of this hub. It is one of the deepest ports in the Mediterranean and a major logistics platform for Catalonia with a total annual through put in excess of 31 million tons, 19 million tons of which are petrochemicals. Chemical cluster in Tarragona consists of the south and north poles, which are linked to the nearby port via road and pipeline. The main raw material –crude oil and natural gas- are all imported. Natural gas is imported in the form of LNG and then processed in several gasification facilities along the coast around Barcelona and Cartagena. Natural gas is also provided via the Trans Pyrenean pipeline link Calahorra from Lacq in France, and from the Maghreb-Europe Gas pipeline from Argelia to Spain. Crude oil is provided by ship from various sources to several terminals. The Tarragona cluster is linked to the Spanish natural gas distribution network.	BASF, CEPSA, Clariant, Covestro, Dow chemical, LyondellBasel, REPSOL, Shell,	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3
Port of Le Havre	FR	petro-chemicals	chemicals	10,000Ha	Located in the deep-sea port, this integrated chemical platform gathers major industrials of base and specialty chemicals. Thus, it is a major refining and chemical complex in Europe. This area is strategic for the supply chain with direct access to the multimodal connexions (sea, rail, barge, pipe, road) and easy access to utility networks.	Air Liquide, ARKEMA, BASF, CABOT, CHEVRON, TOTAL	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3
Porte Jérôme	FR	petro-chemicals	chemicals	n.a.	Located along the Seine, near the platform of Le Havre, this integrated chemical platform gathers major industrials of base and specialty chemicals. Thus, it is a major refining and chemical complex in Europe. This area is strategic for the supply chain with direct access to the multimodal connexions and easy access to utility networks. ExxonMobil refinery has its own petroleum handling and storage facilities. It is the largest integrated platform of ExxonMobil in Europe with a lubricants plant and several petrochemical units. Tereos produces 400kt bioethanol p.a. Several other chemical and petrochemical plants have their own facilities as well, such as ethylene handling and storage facilities	Air Liquide, CABOT, ExxonMobil	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3

Cluster Name	Location	Primary Sector	Secondary Sector	Area	Summary of Activities	Key Companies	Assessment	Initial Ranking
Port of Rotterdam	NL	petro-chemicals	chemicals	n.a.	Rotterdam has been one of the world's major centres for oil and chemicals for some decades now (considered second largest chemical cluster in Europe). Its strategic location and unrivalled access to markets all over Europe have led to the establishment of a modern and diverse cluster of oil and chemical activities. The most prominent companies in the field of liquid bulk have set up operations in Rotterdam. There are 4 world-scale oil refineries, more than 40 (petro)chemical companies, 3 industrial gas producers and 13 major tank storage and distribution companies in the port area. All of these companies are interconnected via a network of pipelines that in total covers more than 1,500 kilometres. Through this network, liquid bulk can quickly, safely and environment-friendly be moved to destinations in Belgium, Germany and the Netherlands itself. The reasons why so many companies active in this field have opted for Rotterdam are obvious. Rotterdam offers: - Unrivalled facilities in the fields of logistics and transport; - A full range of chemical feedstock; - A high degree of operational integration between the various chemical plants and tank storage terminals.	Air Liquide, AkzoNobel, BP, COVESTRO, DuPont, ExxonMobil, Huntsman, Linde, Neste, Shell,	Much larger than Grangemouth with greater range of MNCs and sector activities. Infrastructure also significantly greater. Thus a poor fit for best practice learning.	3
Behringwerke	DE	pharma-ceuticals	industrial biotech	67.4Ha	The Behringwerke site in Marburg is an industrial park specialising in companies from the pharmaceutical and biotechnology sectors. Site operator Pharmaserv not only provides them with buildings for research and production, but also comprehensive services in the areas of site management, technology and logistics.	CSL Behring GmbH, GSK Vaccines GmbH, BioNTech Manufacturing Marburg GmbH, Siemens Healthcare Diagnostics Products GmbH, Nexelis Marburg GmbH	Poor fit - focus on pharma	3

Appendix B: Stakeholder Discussion Topics

Scottish Stakeholders

1. Current situation
    a. What, in your opinion, is the current Grangemouth cluster?
    b. Key strengths and weaknesses of Grangemouth cluster
    c. Current policies to support the cluster
    d. Role of local, regional, national government now?
    e. What is the role/involvement of industry?
2. Cluster dynamics
    a. Is there is a clear leader or not?
    b. Is there a cluster organisation?
    c. If so, what services are offered by the cluster
    d. Engagement and collaboration between companies
    e. Engagement and collaboration between companies and support organisations (academia / skills provision, etc.)
    f. Impacts of current situation on individual companies
3. Future of the Grangemouth Cluster
    a. Is there a clear market need rationale for the cluster?
    b. What the nature of that need (e.g. products, technology focus, anything else)?
    c. Future direction of the cluster
    d. What gaps need to be filled or improvements made?
    e. Timelines for cluster development and critical events
    f. Who should take the lead on this?
    g. Barriers to the cluster development
    h. Best ways in which national, regional and local government can support the cluster

Inward Investors

1. What encouraged you to establish at your existing site(s)?
2. What has been of most benefit to you at your existing site(s) and why?
3. Your knowledge of Grangemouth and whether you have considered it as a potential operational site.
4. What would you need to see in place at Grangemouth to attract you to establishing an operational presence there?

European Clusters

1. What have been the key factors in the development of the cluster?
2. Has the site/cluster strategy changed in recent years?
3. Does the site/cluster offer any new services as a result?
4. Is the site management reactive or pro-active in engaging with tenants, in terms of supporting their business needs?
5. Are there governance/leadership structures, involving tenant companies, that feed into site/cluster strategy? If so, how do these operate?

6. What is the evidence for site tenants / cluster members engaging in B2B relationships with each other?
7. Which, would you say, are the anchor companies at the site / in the cluster?
8. What has local/regional/national government done to specifically support the site/cluster?
9. Have any other organisations been important to site/cluster development?
10. What is the site/cluster's future vision? How much investment will this require?

Appendix C: Stakeholders Consulted

Scottish Government

Scottish Futures Trust (SFT)

Scottish Development International (SDI)

Ineos

Syngenta

Storegga

SkyNRG

Fulcrum BioEnergy

Velocys

Chemical Industries Association (CIA)

The Industrial Decarbonisation Research and Innovation Centre (IDRIC)

Chemical Cluster Delfzijl

University of Leeds

South Wales Industrial Cluster

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