Transitioning Industrial Clusters towards Net Zero

JANUARY 2023

In collaboration with Accenture and EPRI
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Collaboration is the new leadership.

Only 14 months ago at COP26, our teams launched the Transitioning Industrial Clusters towards Net Zero initiative with four clusters representing a collective CO₂ emissions reduction profile of approximately 30 million tonnes. Today, with 13 signatory clusters, that metric is 14 times increased at 417 megatonnes – equivalent to that of Mexico – with $188 billion gross domestic product (GDP) contribution and 2.59 million jobs protected or created.

At the heart of this initiative is our mission to bring together a cohort of global doers from diverse sectoral and geographic landscapes who are not hesitant to explore the hardest technical, environmental and social justice questions we are discovering as we advance in the energy transition. Our community shares, pushes, refines and operationalizes through cross-sectoral, hands-on workshops and roundtables. It is one which – most powerfully – is willing and eager to bring their stories into the public view to accelerate holistic industrial decarbonization.

We are thrilled to present in this document a review of 11 of our signatory industrial clusters onboarded to our initiative ahead of COP27 and, in complement, our Accelerating Industrial Clusters Playbook. This strategy aggregates the best of these clusters’ experiential learnings to provide a roadmap by which other corporates, non-government organizations, public entities and so on can anchor decarbonization in the hardest-to-abate sectors within their geographies with immediate next steps.

Thank you to all of the cluster leaders, policy-makers and community representatives for their time and contributions to this report and the continued development of a roadmap to decarbonize industry.
Executive summary

Technology development to support cross-industry decarbonization has sped up in recent years to bring into reach critical milestones set forth by the Paris Agreement, regional policy drivers and corporate sustainability goals. Still, with the industrial sector representing 30% of global greenhouse gas emissions, a complex, variable strategy (of which technological advancements are only one driving factor) must be developed to ensure communities, policy-makers and broader economies are ready for rapid, sustainable clean resource adoption.

In this report, the Transitioning Industrial Clusters towards Net Zero initiative presents the experiences and perspectives of 11 signatory industrial clusters who have developed holistic strategies to accelerate their decarbonization journeys. Each cluster represents vastly different geographical, infrastructure, policy and sectoral characterizations and constraints. Still, even at widely varying stages of development, these clusters have adopted a balanced set of environmental, social and economic benefit targets and strategies to engage communities, corporates and the public sector to ensure this transition is not only rapid, but equitable.

The approach these clusters and the Transitioning Industrial Clusters initiative take centres around four strategic approach areas seen throughout the Accelerating Industrial Clusters Playbook and in the assessment methodology of Signatory Cluster Profiles. The manifestation of these integrated elements – partnership, policy, financing and technology – will evolve uniquely over the life of each cluster, but from the start must be grounded in the goals of a common business model that provides sustainability both economically and to the community.

Partnerships
How to build trust between competing companies both on supply and demand side?

Policy
Have enabling policies been developed to accelerate the decarbonization of industrial clusters?

Financing
What innovative options exist for financing?

Technology
While the initiative is technology neutral, there is a logical pathway to consider which applies to all clusters.
For the purpose of this report, these elements have been laid over the development cycle of an industrial cluster based on the aggregated experiences of the cluster community and its associated corporate partners. On the following page in summary, the Accelerating Industrial Clusters Playbook proposes, at the intersection of each development phase and strategy element, key actions, questions and mindset shifts to guide leaders across contributing sectors of the transition. Each of these anchor back to the foundational responsibilities of a collaborative decarbonization leader:

1. **Collaborating to drive competition, not limit it.**

The timescale for decarbonization is much too limited to move forward without the benefit of lessons learned, still-developing insights and success (as well as failure) stories from the global community. Leaders should advocate for full participation in forums where policy enablers, financing models and technology use cases are explored and co-planning of infrastructure, supply chains, etc. take place. This does not limit competitive advantage but rather accelerates the horizontal timeline for the most compelling, cutting-edge assets.

2. **Rooting in system value, not one technology’s finite value.**

While many industrial clusters are formed at the impetus of federal funding or market demand for a specific technology or resource, successful leaders should not limit the collaboration scope to serve only a subset of technology use cases at the expense of leaving economic, social and environmental value untapped. “Technology optionality” is needed to decarbonize the hardest to abate sectors affordably and reliably, but none will scale without a strong workforce, an aligned value chain, an informed community and a plan for sustainable expansion.

3. **Designing financially-sustainable operating models from stage zero, not once scale is achieved.**

It is critical that each decarbonization opportunity – whether at the corporate, joint venture or cluster level – begins with leaders’ careful consideration of how the project financing model will mature as the opportunity scales. Reflection on stacking public and private mechanisms, proactive identification of useful levers at various maturities (e.g. seeding grants, contracts for difference) and frequent reevaluation of the opportunity’s maturity directly enable this.
This guiding framework outlays the actions, mindsets and questions that have demonstrated themselves as critical in the success of highly diverse, global industrial cluster developments.

While this guide – like all elements of the energy transition – must be localized per cluster, and not all components will occur in the order presented, a view of the end-to-end industrial cluster decarbonization journey is paramount when stacking partnership, policy, financing and technology strategies over time.

1. Cluster initiation
2. Cluster formalization
3. Net-zero strategy development
4. Net-zero strategy implementation: anchor projects
5. Net-zero strategy implementation: full scale

**Partnership**
Who are the right corporate, non-governmental organization and public sector partners to launch this industrial cluster, and what are their decarbonization priorities?

**Policy**

**Technology**
What are the existing decarbonization technology interests and pursuits among stakeholders, and how do these mutually align?
The Transitioning Industrial Clusters towards Net Zero initiative is building a variety of supporting assets, resources and forums that are focused on accelerating cluster development wherever they are in their journey. These assets span workshop series that facilitate early collaborative visioning and ambition development, structured roundtables with global policy-makers and tactical, use case-level technology enablement discussions. This programme’s support foundation is based upon its technology-agnostic, holistic system value approach to partner with industrial clusters from cluster initiation through to ongoing net-zero strategy implementation at full scale.

This model – and the continued shaping of the Transitioning Industrial Clusters initiative – is guided by the tested examples of the signatory industrial clusters profiled in this report. Each has emerged in vastly different industrial contexts, by various means, in diverse policy environments, but all with the same purpose: to accelerate decarbonization in the hardest-to-abate sectors while creating jobs and increasing local economic competitiveness.

This report will serve as a stage-by-stage journey map aggregating a selection of the initiative’s signatory industrial clusters’ experiences and lessons learned on their paths to achieving sustainable, dynamic and competitive decarbonized industry.
Eleven of the initiative’s global signatory industrial clusters profiled in this report represent vastly diverse collaboration methodologies/models across industries, policy environments and geological features – to name a few – but commonly prioritize the creation and maintenance of environmental, social and economic value.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>CO₂ emissions metric</th>
<th>Net-zero ambition</th>
<th>GDP impact</th>
<th>Jobs metric</th>
<th>Country net-zero commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightlands Circular Space</td>
<td>5.8 Mt CO₂ emissions per year emitted by industry</td>
<td></td>
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<tr>
<td>H2Houston Hub</td>
<td>220 Mt CO₂ emissions per year emitted by industry</td>
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<tr>
<td>HyNet North West</td>
<td>10 Mt CO₂ emissions per year emitted by industry</td>
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<tr>
<td>Jababeka Net-Zero Industrial Cluster</td>
<td>0.7 Mt CO₂ emissions per year emitted by grid-supplied electricity</td>
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<tr>
<td>Kwinana Industries Council</td>
<td>8.2 Mt CO₂ emissions per year emitted by industry</td>
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<tr>
<td>National Capital Hydrogen Center</td>
<td>2.7 Mt CO₂ emissions per year emitted by industry</td>
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<tr>
<td>Net Zero Basque Industrial Super Cluster</td>
<td>7.2 Mt CO₂ emissions per year emitted by industry</td>
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<td>Ohio Clean Hydrogen Hub Alliance</td>
<td>[Forthcoming]</td>
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<tr>
<td>Ordos-Envision Net Zero Industrial Park</td>
<td>12.4 Mt cumulative CO₂ avoidance through new operations, inserviced at net zero by 2025</td>
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<tr>
<td>Port of Antwerp-Bruges</td>
<td>16 Mt CO₂ emissions per year emitted by industry</td>
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<tr>
<td>Zero Carbon Humber</td>
<td>19.8 Mt CO₂ emissions per year emitted by industry</td>
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</tbody>
</table>
1. Accelerating industrial clusters playbook
Challenge

The industrial sector is today responsible for 30% of global CO₂ emissions.

This share has continued to tick up over the last twenty years, with overall sector emissions increasing more than 200%; now, action must be decisive to make a timely impact on these hard to abate emissions.

The global energy transition continues to gain momentum as pathways are created to green every nation’s society, regardless of current energy mix or developmental status. More than 130 countries have pledged to be net zero by 2050, but pledges will not be enough. The massive upgrades, retrofits and net new equipment required for this change is estimated to cost society more than $100 trillion to meet that same 2050 goal.

Within the global industrial profile, six hard-to-abate sectors are responsible for 80% of these emissions.

<table>
<thead>
<tr>
<th>Global GHG emissions by sector (scope 1 and 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>~80% of industrial emissions</td>
</tr>
</tbody>
</table>

- Oil
- Natural gas
- Steel
- Cement
- Aluminium
- Ammonia
- Other industries
- Agriculture
- Others
- Transport
- Buildings

Note: 1 Other industries include petrochemicals, coal mining, paper and pulp, ceramics and others.


Additional detail on these sectors’ challenges and readiness to change can be explored in the 2022 Net-Zero Industry Tracker published by the World Economic Forum and Accenture.

Many decarbonization programmes and acceleration initiatives have been developed by the research community, the public sector and private corporations to facilitate the reduction of a single industry’s emissions. The industry must move more quickly – and think more economically, environmentally, and socially sustainably – than such single industry approaches allow.

Advocating for an integrated approach across sectors and stakeholders is necessary where collaboration and distinct characteristics of the local context underline every action. Needs and opportunities driven by geographic components like access to renewables or CO₂ geological storage – as well as sociopolitical elements like national and regional enabling policy frameworks and workforce access – must bring together industry players to decrease cost, risk and speed timelines to scale.

Any region’s approach must be multi-technology and dynamic to hedge against the increasing instability with time. Looking through the current macroeconomic turbulence and geopolitical developments, regions and corporations need a balanced approach that delivers on the imperatives of sustainability, energy affordability and energy security and access – in essence, driving a resilient energy transition.
Opportunity

In all of this, there is a great and urgent opportunity to match today’s strong demand for clean resources by industry with developing and varied supply sources at the regional level.

In these co-located group of industries – generally defined by this initiative as industrial clusters – there is immediate opportunity to balance existing markets and lay the collaborative groundwork for the infrastructure, assets and support (financing, workforce, etc.), which will soon be crucial to continuing operations. Open dialogues between supply and demand providers, cross-sectoral peers and wider, non-industrial stakeholders, like government and the financial sector, cannot be put off where new market developments and material decarbonization is to occur.

The public sector bears a pressing “right now” role in seeding investment in domestic, decarbonized energy systems. Nations must first secure affordable and reliable energy before companies can adopt low-carbon technologies and energy-efficient processes that do not curtail operations. More information on how the public sector is doing this can be found in the Enabling Policy white paper.

The risks of traditional fossil fuel reliance with today’s price and global supply instability have already driven a quantifiable shift as cross-sectoral stakeholders have moved to harden their clean energy commitments and speed deployment of investment capital. Globally, $2.3 trillion has already been deployed and, the UN reports, is making a material impact, but that is approximately 2% of the estimated capital required to facilitate this transition. There are immediate needs to invest in – and rapidly scale – energy efficiency and electrification programmes, that are expected to drive 40%+ of energy sector greenhouse gas (GHG) reductions through 2040, alongside longer-term market developments for circularity, hydrogen, carbon capture utilization and sequestration, and other impactful technologies.


$100 trillion by 2050

$100 trillion in global investment is required to achieve net zero by 2050, with $32 trillion deployed by the end of the decade if the world hopes to effectively fight climate change.

~83%

Including China and the United States, more than 130 countries have set net-zero targets covering about 83% of global emissions.

1.6 billion tonnes CO₂

The initiative’s 100 industrial clusters goal has the potential to abate 1.6 billion tonnes of CO₂, protect and create 17 million jobs and contribute $2.5 trillion to global GDP.

90%

By 2050, almost 90% of the electricity produced globally will need to come from renewable sources – with 70% from solar and wind.

91%

Over 800 companies globally have committed to net zero, representing 91% of global GDP.
Five key actions can help give impetus and steady long-term momentum to the energy transition and make it more likely to withstand economic disruptions:

- **Enforce climate commitments**
  Anchoring climate commitments in legally binding frameworks that can endure political cycles and enforce the long-term implementation of national transition objectives.

- **Build an investment landscape**
  Building an attractive investment landscape for private capital, both foreign and domestic, to finance energy transition projects (policy and legal frameworks, currency and institutional stability, infrastructure quality and technology availability).

- **Decarbonize national energy system structures**
  Taking and holding long-term decisions with regard to the decarbonization of the national energy system structure (energy mix, power generation mix, energy efficiency and fossil fuel dependency).

- **Promote consumer participation**
  Promoting consumer participation (awareness of climate change and carbon footprints, individual responsibility for action and incentives for consumer behavioural change) and building the local workforce required for the transition, paying particular attention to the livelihoods of vulnerable populations.

- **Balancing local industrial supply chains**
  Enabling competing and cross-industry stakeholders to collaborate to de-risk investment, share infrastructure, and save resources and energy, resulting in environmental, economic and social benefits.

Transitioning Industrial Clusters towards Net Zero
A just and managed transition

A just transition is defined as a shift to more sustainable economies whereby workers and communities do not bear an inordinate cost or burden.

A sustainable transition will not only hinge on the right and rapid deployment of technologies; economic, environmental and social sustainability requires a holistic approach to engage all stakeholders, especially those disenfranchised by technological revolutions in the twentieth century. This left entire sectors and communities without employment, access to support or a clear path forward.

Specific opportunities that should be investigated in the Transitioning Industrial Clusters approach include the following:

- How will traditionally disadvantaged communities benefit from the transitional approach of the cluster? How are they included in the planning process?
- How can the environmental, economic and job benefits of the clusters approach be quantified and communicated to key stakeholder groups? Are they equitably distributed within the community?
- How will the approach impact affordability of key services in the region? Will those impacts be fairly distributed?

Industrial clusters

Industrial clusters are geographic areas where co-located companies, representing either a single or multiple industries, provide opportunities for scale, sharing of risk/resources, aggregation and optimization of demand.

A holistic and collective approach is required to optimize emissions solutions and create an integrated energy system that maximizes system value outcomes across economic, social and environmental aspects.
Industrial Clusters initiative mission and ambition

The Transitioning Industrial Clusters towards Net Zero initiative aims to build a community of one hundred industrial clusters, which balance economic, social and environmental impact through strong and expeditious support of developing clean energy markets and maturing decarbonization technologies.

Those 100 industrial clusters will represent 1.6 billion tonnes of CO₂ emissions per year or 15% of global CO₂ emissions. Through their decarbonization journey, these 100 clusters are expected to generate approximately 17 million jobs and contribute $2.5 trillion to the global GDP.

In support of these industrial clusters, the initiative has built an array of support mechanisms based on the feedback and lived experiences of signatory industrial clusters. These will be explored in more detail in chapter 2: Working together towards net zero.

How the initiative teams with signatory and prospective industrial clusters

- Best practices exchange between clusters located in various regions
- Global recognition through initiative partners’ and signatories’ media outlets and initiative publications
- Opportunities to showcase progress and liaise with signatories through in-person community meetings
- Environmental justice support to build and execute strategies to holistically benefit region

Partnerships

- Partnership development models, resources and assets
- Facilitated workshops to develop global partnerships
- Connections to initiative’s global network to develop balanced economic, environmental and social outcomes

Policy

- In-depth, country-specific policy and public funding analyses
- Roundtables with policy-makers and financial sector leaders
- Exchange of best practices and tools to build public-private engagement

Financing

- Country-specific financial analyses to catalyse funding opportunities and investment structure
- Experts’ guidance on financing nascent technologies

Technology

- Technology expertise and provisioned support to develop an integrated technology strategy and roadmap
- Technology supply and demand matchmaking
Accelerating industrial cluster playbook

Leveraging collaborative insights along the pathway

Through the workshops, roundtables and bilaterals in collaboration with initiative signatories, the Transitioning Industrial Clusters initiative has aggregated the accelerating industrial clusters playbook presented in the following pages. This guiding framework outlays the actions, mindsets and questions critical in the development of the initiative’s highly diverse global industrial clusters. While this guide – like all elements of the energy transition – must be localized per cluster and not all components will occur in the order presented, a view of the end-to-end industrial cluster decarbonization journey is paramount when stacking policy, financing, technology and partnership strategies over time.

1. Cluster initiation

2. Cluster formalization

3. Net-zero strategy development

4. Net-zero strategy implementation: anchor projects

5. Net-zero strategy implementation: full scale

Partnership
Convene local stakeholders with shared decarbonization ambitions to define and champion collaborative initiatives

Policy

Technology
Build the regional vision for joint technology and infrastructure development: use as basis for workforce, environmental and social impact targets

Financing

Contents
Accelerating industrial cluster playbook

Cluster initiation

KEY QUESTION
Who are the right corporate, non-governmental organization and public sector partners to launch this industrial cluster and what are their decarbonization priorities?

KEY ACTION
Convene local stakeholders with shared decarbonization ambitions to define and champion collaborative initiatives

1. Cluster initiation
2. Cluster formalization
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5. Net-zero strategy implementation: full scale

Case study

- Earliest efforts to convene cross-sectoral corporates to work together towards a shared decarbonization goal should prioritize including stakeholders that have publicly demonstrated decarbonization as a priority. Further, from the start, corporate leadership should be well informed on the corporate culture change that will be required to successfully transition business models, the workforce and operational enablers to clean technologies.

- Within this dynamic stakeholder group, the cluster – or anchor aggregators – will be required to appoint champions to advocate and bring in potential partners, build an early operating structure, define milestones and push stakeholders towards them. The nature of this collaborative working process will require participants to adopt a holistic approach that balances social, environmental and economic benefits at the earliest stages. This is necessary to understand and communicate not only the impacts that the industrial cluster will have on corporations but also the impacts and benefits for the broader community.

- Before any technology roadmap development begins, stakeholders should define the system value elements of greatest mutual priority based on demonstrated regional initiatives and needs; this will guide the collaborative identification of priority KPIs for the cluster, rooting the vision in measurable value. Technology strategies as well as those for the policy, financing or collaboration levers will be built around these elements; based on cluster characterization and barriers/enablers across partners.
Collaborators started with a goal to use Infrastructure Investment and Jobs Act (IIJA) funds to accelerate the development of common decarbonization infrastructure in the region and, in doing so, build an industrial cluster from the ground up:

1. Ameren, the founding champion for the cluster, initiated the conversation through outreach to their regional network of more than 20 industrial, community, research and government organizations.

2. Following initial conversations with this regional network of interested parties, a broad set of potential industrial partners were identified from the steel, manufacturing, chemical and energy sectors.

3. Clusters leaders held a series of facilitated bi-monthly workshops over six months to define a common vision and to develop commitments from potential partners. A vision statement was produced as well as a schematic of the cluster’s decarbonization ecosystem.

4. Committed collaborators aligned on a press release with a common vision and stated partners (press release supporters were Ameren, Burns McDonnell, MPLX (and its sponsor, Marathon Petroleum), Marquis Industrial Complex, Alton Steel, The Urban League of Metropolitan St. Louis, Walmart, Mitsubishi Power, Plug Power, Spire, Washington University in St. Louis, Missouri University of Science and Technology, Greater St. Louis and the Leadership Council of Southwestern Illinois).
Accelerating industrial cluster playbook

Cluster formalization

**KEY QUESTION**  
What will the cluster aim to achieve among stakeholders’ great mutual priorities and how must these stakeholders’ teams to do it?

**KEY ACTION**  
Align on cluster-wide, time-bound decarbonization goal for public release; execution of a multi-lateral memorandum of understanding (MoU) between cluster stakeholders in industry, research/academia, government, community organizations, etc.

- Formalization efforts must begin with the definition of a cluster’s ongoing structure and scope of collaboration among – at least three – partners. To ensure momentum is gained and maintained, it is paramount to appoint a “prime” or anchoring body to lead definition and execution of the cluster’s priorities, scope of work and timeline. If appropriate, cluster leaders should also guide appointment of cluster sub-committee chairs to own these elements within specific workstreams or initiatives. As this structure develops, the cluster should also consider whether it will self-govern or if a coordinating third-party should be introduced to centralize activities and certify outcomes.

- In parallel, the cluster should begin a workshop series with all partners to identify mutual decarbonization priorities and define its launching vision statement. This vision statement should include a high-level technology prioritization and deployment strategy (common anchors include hydrogen, carbon capture, electrification and/or energy efficiency) aligned to the priority system value framework focus areas and corresponding KPIs (often CO₂ abated, incremental GDP contribution, jobs created/maintained).

- Drawing these components together, the cluster should draft a MoU and prepare non-disclosure agreements (NDAs) for collaborators describing the anchoring cross-sectoral stakeholders, the highest priorities of the industrial cluster, and the overarching, collaborative vision for the region.

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**Case study**
Accelerating industrial cluster playbook

Cluster formalization

CASE STUDY

During cluster formalization at the Jababeka Industrial Estate in Cikarang, Indonesia

- Before public announcement of cluster formation, Jababeka Infrastruktur led closed door sessions with energy companies and its industrial estate tenants to identify decarbonization solutions that are being implemented or planned and explore potential areas of collaboration.

- Four corporations emerged from these conversations committed to collaborate and support deployment of clean electrification infrastructure within the industrial cluster alongside other sustainability initiatives, such as waste circularity, on top of each partner's individual initiatives. The energy partner is Pertamina New and Renewable Energy (PNRE), a subsidiary of Indonesia’s state oil company, and tenant partners include Unilever Indonesia, L’Oreal Indonesia and Hitachi Astemo Bekasi Manufacturing (together with Jababeka Infrastruktur, the launching partners).

- Launching partners convened at the B20 side event “Policy and Partnerships for Indonesia’s Decarbonisation” where the industrial cluster was announced with a live, televised signing to the Transitioning Industrial Clusters initiative and the collaborative decarbonization MoU was made public.
Accelerating industrial cluster playbook

Net-zero strategy development

**KEY QUESTION**
Where does the cluster need to develop focused depth and engage external expertise to achieve its goals?

**KEY ACTION**
Establish a scalable governance structure to integrate, develop and manage cross-organizational action plans for technology, workforce and community engagement initiatives.

- Post-MoU, the cluster should put focus on defining decarbonization goals and developing subcommittees to champion and lead holistic roadmap development. Artefacts should be developed both at the aggregate level and within sub-committees and should include quantified mid-point development targets. Further, all road mapping should highlight short- and long-term incentives to lock in corporate and ecosystem engagement.

- Decarbonization goals should be contextualized within the holistic approach and vision for the cluster and integrate cross-organizational action plans for partnership, policy, financing and technology (including workforce and community engagement) initiatives. Sub-committees and champions should be appointed to drive these on an ongoing basis throughout the life of the cluster.

- At this strategy development stage, the industrial cluster’s governance structure and anchoring body should be able to effectively manage the deployment of efforts across financing, policy and technology coordination as well as community engagement to attract new collaborators and educate on opportunities and benefits. As the stakeholder community continues to grow, onboarding processes must be developed for new stakeholders to plug into existing efforts.

1. Cluster initiation
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3. Net-zero strategy development
4. Net-zero strategy implementation: anchor projects
5. Net-zero strategy implementation: full scale

Case study
The cluster is led by SPRI (Basque Government), Petronor-Repsol and Iberdrola; both energy companies have long histories and strong commitments with business and social development in the Basque Country.

The Basque Net Zero Industrial Super Cluster aims to accelerate the path to net-zero emissions in the Basque Country, creating energy supply decarbonization and energy efficiency in the industrial sectors and creating market opportunities based on the scale-up of the new technologies and innovative services.

The Basque Industrial Clusters Associations play a key role in driving the development of decarbonization projects, ensuring coordination and maximizing synergies among their partners. The Super Cluster initiative is also aiming to create market opportunities based on these new technologies and services in the Basque Energy value chain, and therefore work very closely with the Basque Energy Cluster Association to deliver change.
Accelerating industrial cluster playbook

Net-zero strategy implementation: anchor projects

KEY QUESTION
How must industrial cluster partners engage with internal and external stakeholders to ensure planned operations are sustainable?

KEY ACTION
To support shared infrastructure, clusters must develop external workforce transformation and community education programmes as well as internally shape agreements and IT infrastructure for necessary KPI reporting, project management and internet of things-based collaboration.

Clusters should centralize work across the value chain to develop new skilling and workforce transformation support programmes to anticipate and prepare for green economy talent needs. This should include collaborating with policymakers to design mechanisms that support existing workers during the transition between fossil-fuel and green jobs. On top of this, engagement programmes targeting the wider community must be deployed to outlay the holistic benefits and sustainable hope of the energy transition.

As stakeholders build their own projects and collaborate on cluster-level initiatives, a robust, integrated project management approach, data-sharing strategy and appropriate legal agreements (commercial contracts, offtake agreements, NDAs) must be put in place. Early in the development of a cluster, project management platforms should be instituted to provide a central source of truth for all planning, coordinated execution and holistic KPI tracking. This tool – often described as a digital twin – should be adaptive to accommodate increasingly complex cluster composition, secure data sharing for operations and reporting, clean resource market balancing and internet of things system monitoring and control.

The earliest priority within this development should be to standardize data-sharing methodologies and KPI reporting exercises particularly focused on regulatory and financial levers.

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Transitioning Industrial Clusters towards Net Zero
CASE STUDY
During net-zero strategy implementation: anchor projects
at HyNet North West in North West and North Wales, UK

- Cluster leaders, appointed on a rotational basis to complement the permanent role of carbon capture and storage (CCS) infrastructure owner and operator Eni, teamed closely with the UK’s Department for Business, Energy and Industrial Strategy (BEIS) to workshop regulatory and financing hurdles, adjust business models for cluster-wide projects and discuss emerging opportunities and challenges.

- Community engagement and education programmes rolled out as precursors to scaled workforce transformation programmes to educate the community on the immediate and sustainable benefits of driving the region’s energy transition.

- Within the cluster – enabled by successful community engagement – offtake agreements in advance of full infrastructure installation continued expansion beyond initial cluster members. HyNet today has over 40 offtake agreements between hydrogen and carbon capture and sequestration use cases.
Accelerating industrial cluster playbook

**Net-zero strategy implementation: full scale**

**KEY QUESTION**
How can the decarbonization progress of the industrial cluster expand to drive accelerated regional emissions reduction and community uplift?

**KEY ACTION**
Implement cultural transition tools so that cluster members can draw messaging from a consolidated reporting resource to shape a public, quantitative impact story (environmental, social, economic)

- The cluster should expand its remit beyond the focus of the industrial community to support the broader regional energy transition by building a holistic, data-driven story for community consumption. This should encapsulate the positive environmental, social and economic benefits already and still to be realized through progress towards the clusters’ decarbonization target. Activating workforce transformation programmes and regional just transition roadmaps, credentialed by this narrative, should be a central focus of cluster partners.

- As the cluster’s impact expands and matures, the organizational structure and operating model should do the same. While the central body should still provide consolidated reporting, integrated project management, cluster-level resource balancing, and coordinated community and workforce uplift, it should stay agile to adopt new funding support models, geographic expansion and close collaboration with global developing and mature industrial clusters.
CASE STUDY

During net-zero strategy implementation: full scale at Brightlands Circular Space in South Limburg, Netherlands

- Following the Circular Economy Action Plan, a 2020-2030 Investment Agenda was developed to support four strategic pillars:
  1. Circular investments, innovations and applications
  2. Circular competencies
  3. Circular foundation
  4. Circular society

- Within the industrial cluster, 21 projects are in progress or in preparation, which include a broad range of themes from the realization of sustainable circular raw material flows to the electrification of processes. Strong links to programmes and investment funds on a national and European scale are being explored.

- A chairman for the regional board championing the action plan was appointed, who also acts as ambassador in The Hague and Brussels for the Chemelot Circular Hub.

- Additionally, through the Circular Academy, new circular knowledge and skills are delivered to the teaching staff and fed into a broader educational system.
Working together towards net zero
Transitioning Industrial Clusters towards Net Zero initiative

Once we unlock [clean industrial] techniques, we can spread them all around the world—giving industry everywhere a boost as our nations look to move faster towards our net-zero goals, and securing a place in the clean energy economy for their workers. As with so much of our transition, success will depend on collaboration.

Jennifer Granholm, Secretary, US Department of Energy at the 2022 Global Clean Energy Action Forum Opening Ceremony

The Transitioning Industrial Clusters towards Net Zero initiative was created with the aim to accelerate industrial decarbonization through a holistic approach, involving cross-industry stakeholders with a technology-neutral focus.

The programme is built on the belief that four foundational components are required to launch sustainable, cross-sectoral decarbonization in any geography:

- Balanced emphasis on driving economic, social and environmental value – informed by the system value framework.

- Inclusive consideration of all technologies and processes that support industrial decarbonization – as described in the initiative’s pre-launch report.

- Cross-sectoral collaboration within and across industry, public sector, financiers, labour and community stakeholders.

- Coordinated, agile strategies between partnership, policy, financing and technology enablement and deployment.

Within this approach, the Transitioning Industrial Clusters towards Net Zero initiative is building a variety of supporting assets, resources and forums, which are focused on accelerating cluster development from cluster initiation through to ongoing net zero strategy implementation at full scale.

These range from publicly accessible resources from the initiative and its collaborators (the World Economic Forum, Accenture and EPRI) to closed workshops, roundtables and multilaterals hosted for community members or signatory industrial clusters, wherein the initiative curates expert opinions, coaching and lessons learned from policy-makers, industrials, financiers, the non-profit sector and others.
A total of 139 countries, representing 91% of the global GDP have committed to net zero by 2050, but industrial emissions are considered some of the most difficult to abate on the path to net zero.

Both public and private sectors understand the need for policy and financing enablers and mechanisms to accelerate the energy transition; 84% of global companies have committed to increasing investment in sustainability initiatives and putting sustainability at the core of their future priorities. Policy-makers are scaling up programmes to provide seeding and bridge funding for scaled private investment to come into play.

One of the foremost challenges that industry is facing, however, is not isolated to one enabling lever but rather bringing together cross-industry stakeholders to scale technology deployment, scale investments and work together to find collaborations to best support the energy transition.

The global, cross-sectoral community

The Transitioning Industrial Clusters towards Net Zero initiative has created a growing platform of signatory industrial clusters with diverse industrial composition, infrastructure and technology approaches to the energy transition. Signatory companies within the clusters represent roles across the value chain, keeping a balanced supply and off-take technology structure to ensure the success of the investments and technology deployed.
Empowering and accelerating

As a neutral body with a technology-impartial approach, the Transitioning Industrial Clusters initiative sits as an aggregator and connector between global industrial clusters, media outlets, environmental justice programmes and cross-value chain stakeholders. A four-pronged strategic approach ensures balance between sustainable environmental, economic and social value creation.

How the initiative supports

In support of formalizing partnerships across the value chain to facilitate financial and operational risk sharing, the initiative has developed tested partnership structures and collaboration models, facilitates workshops series to build a unified vision and cluster structure, and brokers global connections to build balanced economic, environmental and social outcomes.

Work in practice

Transitioning Industrial Cluster’s April 2022 Community Meeting on Developing Partnerships in Bilbao, Spain, dove into the key components of sustainable, scalable partnership through the experiences of global market developers.

Materials are available upon request.
3 Signatory cluster community
Initiative signatory clusters

Of the initiative’s 13 signatory industrial clusters, the 11 profiled in this report today represent annual emissions greater than the United Kingdom, spanning a diversity of industries across North America, Europe and Asia Pacific.

Signatory profile approach

Signatory industrial clusters are profiled in the following pages for all clusters which joined before 15 November 2022 – 11 global clusters representing eight nations across North America, Europe and Asia Pacific. These profiles have been developed in line with the Transitioning Industrial Cluster’s initiative approach: balancing system value (primarily economic, social and environmental benefit) in a technology-neutral, collaborative format.

Aligned to the strategic development priorities of the initiative, each cluster is represented through its partnership, policy, financing and technology positioning.

Partnership profiles have been standardized through the lens of the Fostering Effective Energy Transition: 2022 Edition insight report’s model for assessing net zero collaboration between customers and suppliers.

The federal policy enablement foundation has been used from the initiative’s October 2022 National Policy Enablement for Industrial Decarbonization white paper.

The technology consideration model from Accenture in collaboration with the World Economic Forum’s March 2021 Achieving net-zero future with industrial clusters report, which has been adopted as core to the initiative.

Each profile has been developed in close coordination with signatory clusters based on the current stage of their decarbonization journey and thus, available information. The profiles will be updated on an annual basis.

417 Mt CO₂ abated emissions represented
2.59 million direct/indirect jobs represented
$188 billion GDP contribution represented
Maturity status

Industrial clusters have been categorized into three general maturity groups for the purpose of standardizing the type and style of attributes depicted in the following profiles:

Planning: Public announcement has been issued, but no collaborative physical asset improvements or construction has begun.

Developing: Collaborative physical asset improvements or construction has begun but is not yet facilitating decreased- or avoided-emissions operations.

Scaling: Decreased- or avoided-emissions operations are occurring as a result of clean technology integration through collaborative measures.
3.1 Brightlands Circular Space
Brightlands Circular Space is a flagship initiative of Chemelot Circular Hub, an alliance of companies, institutes and government agencies in the region of Sittard-Geleen (Netherlands) at the heart of the circular chemical industry (ARRRA region). A place to be for talented researchers, engineers and entrepreneurs who realize circular innovations and scale up circular processes and products. Brightlands Circular Space aims to become the ultimate growth accelerator for a circular society. In addition to the emission reduction goals of Chemelot Circular Hub stated above, Brightlands Circular Space aims to recycle 50% of the cluster’s plastics by 2030 through collaboration with the hub’s industrial partners in new sustainable business models that promote reuse and circularity.

**Key highlights**

- **Industries represented**
  - Chemicals
  - Energy (oil and gas)
  - Materials and manufacturing
  - Power generation

**Status**

- Planning
- Developing
- Scaling

**5.8 Mt CO₂**

- Annual emissions (2019)

**8,100**

- Jobs across 150+ companies

**20%**

- Of the region’s GVA (2019)

**Decarbonization roadmap**

- Current annual emissions (2019)
- 5.8 Mt CO₂

**2030 target emissions reduction**

- ↓ 50%

**Net zero by 2050**
The core partners of Brightlands Circular Space are Brightlands Chemelot Campus (Chair), the Netherlands Organization for Applied Scientific Research (TNO), Maastricht University and SABIC. Core parties invest a fixed amount per year into the Brightlands Circular Space, which is also funded by the European Union and the Dutch government via the Groeifonds.

There are no additional governance layers within the industrial cluster beyond the founding partners, but rather individual sustainability initiatives are developed through Brightlands Circular Space, each with unique governance structures developed by the respective investing corporates and R&D groups from small- and mid-sized Dutch businesses to multinationals.

As a platform, Brightlands Circular Space provides manufacturing equipment, lab and office space, and support services to more than 150 co-located corporates within the campus. It also provides knowledge sharing with partners of the ARRRA cluster as well as partners of the Forum.

Shared infrastructure within the cluster is owned by Brightlands Chemelot Campus and exists to catalyse innovation across industries housed in Brightlands Chemelot Campus with the input of surrounding government and society, research and innovation, and education and competence building.

Lia Voermans, Director, Circular Economy, Brightlands Chemelot Campus

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### Energy transition index collaboration model

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<th>Collaboration type existing in cluster</th>
<th>Partner types</th>
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<tbody>
<tr>
<td><strong>Shared infrastructure development</strong></td>
<td>- Researchers - Cross-industry partners - Entrepreneurs - Students - Designers</td>
<td>TNO, Maastricht University, Chemelot Industrial partners, CHILL, Brightlands</td>
</tr>
<tr>
<td><strong>Industrial cluster infrastructure planning</strong></td>
<td>- Public-private partners</td>
<td></td>
</tr>
<tr>
<td><strong>Shared commercial projects</strong></td>
<td>- Cross-industry peers - Public private institutions - Brand owners - Entrepreneurs</td>
<td>Chemelot Circular Hub Network, TNO</td>
</tr>
<tr>
<td><strong>Cross-industry funding</strong></td>
<td>- Public authorities - Private investors - Regional, national and EU level partners - Venture partners</td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge sharing</strong></td>
<td>- Researchers - Cross-industry partners - Entrepreneurs - Students</td>
<td>BMC, AMIBM, CHILL, Maastricht University, TNO</td>
</tr>
<tr>
<td><strong>Reskilling the workforce</strong></td>
<td>- Schools - Applied and academic institutions - Regional authorities</td>
<td>Maastricht University, Zuyd, CHILL, labour consultancies</td>
</tr>
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</table>
Brightlands Circular Space Policy

- Public-private financing of Brightlands Circular Space is enabled by partnerships with companies and supported by the public through the National Growth Plan as well as various subsidies issued at the national, provincial and municipal levels. Enabling policy support is generally considered at the sustainability initiative level as each programme is responsible for securing its own support and funding.

- The provincial government of Limburg and the involved cities were the initiating parties of the cluster and remain involved supporters without operating responsibilities. Neighbouring provinces have also pursued involvement with the industrial cluster, but corporates and research institutions remain primary in strategic and operational management.

- The European Green Deal has effectively incentivized cluster participation as the legislation’s policies pressure companies to change rapidly rather than the traditional incremental approach. This has driven companies towards Brightlands Circular Space to explore and integrate CO₂ emission reduction solutions, primarily at the stage of testing new technologies and processes before scaled investment.

Enabling policies available

- Climate and Energy Innovation Demonstration Scheme (DEI+) provides €76 million to support pilot and demonstration projects that contribute to the cost-effective reduction of CO₂ emissions by 2030, including circular use of materials.

- Mission-driven Research, Development and Innovation (MROI) scheme provides €25,000 minimum subsidy to each of the three participants for research and feasibility studies for renewable energy, decarbonization of industry and circularity.

How these policies are being leveraged

- Brightlands’ commitment to circularity closely aligns to Netherland’s Ministry of Economic Affairs and Climate’s Circular Plastics – a guiding piece of legislation promoting plastics circularity – which boasts the same goal.

- Brightlands is leading the Syschemiq consortium. An EU Horizon project with 16 EU parties involved focusing on the R&D of plastic recycling, including new models for cooperation and business.
Brightlands Circular Space Financing

- The industrial cluster relies on public financing legislated by both the European Union and Dutch government (Groeifonds), private financing of founding members and earned income by making R&D infrastructure available and additional services based on specific challenges of companies and institutes.

- Project-level financing must be secured by the network of stakeholders collaborating on the initiative. That same group must arrange among themselves any necessary contracting to cover investments, control and benefit/risk sharing.

- Supplementary public-private financing of the Brightlands Circular Space is enabled by the National Growth Plan and various subsidies issued at the national, provincial and municipal levels. Subsidies have and will continue to play an important role in bringing Brightlands Circular Space through economic reforms or crises.

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Planned funding deployment by technology readiness level

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Brightlands Circular Space Technology

Brightlands Circular Space anchors on the promise of “design for and design from” to promote circularity and reuse at the heart of all industrial cluster initiatives. Systemic efficiency and circularity, direct electrification, and renewable heat best capture most of the industrial cluster’s technical pursuits regarding the path towards industrial decarbonization. Besides the initiatives below, the Brightlands ecosystem counts many start-ups, scale-ups and multinational companies working on new technologies in these four categories.

Selected technology initiative matrix

- Systemic efficiency and circularity
  - Leaders within Brightlands Circular Space seek to recycle 50% of the cluster’s plastics by 2030 and create a plastic refinery for the future through the industrialization of plastic recycling and designing circular plastics. Pyrolysis oil from plastic waste is being produced by SABIC’s facility to fuel its own operations as part of the “TRUCIRCLE” programme.

- Direct electrification and renewable heat
  - Brightlands Circular Space supports sustainability initiatives at Brightsite Plasma Lab to eliminate CO₂ emissions in chemical processes, at Coolbrook to sustainably produce “olefins” components in plastic, textiles, packaging, etc. and the development of circular materials of Brightlands Materials Center and at the Aachen Maastricht Institute for Biobased Materials.

- Carbon capture, utilization and storage (CCUS)

- Hydrogen

Digital foundations of the cluster

With 60-70% of the industrial cluster’s focus going towards resource feedstock transition, Brightlands Circular Space’s primary goal is developing and scaling the right technologies and materials for achieving circularity. One example of success in this area is through digital twin research at Syscemic where the team maps resource streams through the PRISM model, uses blockchain and AI, and tests outcomes through a quality recycle model.
3.2
H2Houston Hub
The industrial cluster in Houston, Texas, intends to use hydrogen to become a global leader in low carbon energy. Large clusters of Houston’s corporates and industrials own trillions of dollars in assets across the Gulf Coast and already represent approximately one third of national hydrogen production, creating a nationally unique positioning to accelerate clean hydrogen market growth. While there is growing support among Texan politicians for speeding the energy transition, the state will rely heavily on clean resource markets to shape its hydrogen opportunity development. The NGO Center for Houston’s Future (CHF) was created to advocate for social, environmental and economic promise in the city and is set to play an integral role in this process as facilitator of cross-sectoral collaboration.

H2Houston Hub

Key highlights

Houston, Texas, USA

The industrial cluster in Houston, Texas, intends to use hydrogen to become a global leader in low carbon energy. Large clusters of Houston’s corporates and industrials own trillions of dollars in assets across the Gulf Coast and already represent approximately one third of national hydrogen production, creating a nationally unique positioning to accelerate clean hydrogen market growth. While there is growing support among Texan politicians for speeding the energy transition, the state will rely heavily on clean resource markets to shape its hydrogen opportunity development. The NGO Center for Houston’s Future (CHF) was created to advocate for social, environmental and economic promise in the city and is set to play an integral role in this process as facilitator of cross-sectoral collaboration.

Decarbonization roadmap

Current annual emissions (2019)

220 Mt CO₂

global abatement potential from 21Mt of hydrogen (4 times Houston’s 2019 emissions)

180,000

potential direct, indirect and induced jobs to be created by hydrogen by 2050

$100 billion

potential addition to Texas GDP (6% of Texas 2019 GDP) by 2050
Center for Houston’s Future is facilitating the development of the over 100 corporate partners’ H2Houston Hub vision to meet the opportunity posed by US Department of Energy funding for hydrogen hubs.

H2Houston Hub’s programmes and initiatives are strongly driven by industry with stakeholder feedback collected and integrated at every stage in hub planning. In the Department of Energy’s recent ROI for hydrogen hub funding programme design, the cluster submitted a response aggregated through seven stakeholder meetings and 25 industrials’ contributing comments.

Sustainable partnerships will be structured upon policy levers that mimic incentive systems established during the build out of transmission in the late 2000s; the cluster has already brought together a diversity of stakeholders incentivized to collaborate on capital-intensive infrastructure for hydrogen and CCUS as a means of de-risking.

Paula A. Gant, President and Chief Executive Officer, GTI Energy

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We have a tremendous opportunity to accelerate the creation of a clean hydrogen market at the pace needed to meet aggressive decarbonization goals for communities in our nation and around the globe. We need hydrogen deployment at scale, and this hub will lay the foundation with complete end-to-end demonstrations of an integrated network, match supply and demand regionally or locally, and leverage existing infrastructure to deliver resilient, reliable, and sustainable clean energy.

Paula A. Gant, President and Chief Executive Officer, GTI Energy
H2Houston Hub Financing

While private capital exists to fund development of clean hydrogen projects, the lack of secured, scaled demand pushes risk levels higher than private capital will tolerate. In cases where offtake is secured, H2Houston Hub has been successful in deploying early funding for small to mid-scale projects.

Today there exists more than adequate hydrogen supply as well as transmission and distribution infrastructure to meet current demand, alleviating what is often otherwise a barrier to investment in clean hydrogen projects.

Through cross-sectoral collaboration and education, cluster stakeholders have not faced barriers in raising capital for projects, which promote balance supply and demand through existing transmission infrastructure.

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H2Houston is focused on enabling the expansive natural gas infrastructure in the region to produce and distribute low carbon hydrogen, as well as to deploy CCUS capabilities throughout the region. Another key pillar is the deployment of the vast wind resources in the region to produce clean hydrogen.

Selected technology initiative matrix

- Waste-to-hydrogen pilot for hydrogen production in major cities such as Houston, Dallas, and San Antonio

Direct electrification and renewable heat

Carbon capture, utilization and storage (CCUS)

Hydrogen

Digital foundations of the cluster

H2Houston is using several digital tools to develop their deployment strategy, including the McKinsey Power Model, which projects capacity additions in the power sector and simulates dispatching decisions based on system-cost optimization; the McKinsey CO₂ Emissions Database, which supports the examination of potential CCUS clusters, testing of CO₂ pipeline networks, and understanding of regional abatement costs; as well as the McKinsey CCUS Cost Model, which takes an end-to-end approach to model carbon capture, compression, transport, and storage.
3.3 HyNet North West
HyNet is a consortium comprised of eight founding organizations: Eni, Progressive Energy, Cadent, Essar, Vertex Hydrogen, Hanson, INOVYN and University of Chester. HyNet has grown to involve more than forty partners, across public and private sectors. UK’s Government has designated HyNet as one of the two leading industrial decarbonization clusters. It will provide the infrastructure to produce, transport and store low carbon hydrogen across the UK’s North West to enable industry to switch away from natural gas. In addition, it will develop infrastructure to transport and lock away carbon dioxide emissions from industry which is unable to fuel switch. HyNet will both upgrade significant existing infrastructure, as well as develop and construct underground pipelines, hydrogen production plants and storage facilities. The project will bring significant economic benefits into this industrial heartland – creating new roles, safeguarding existing jobs and attracting inward investment, positioning it at the heart of the UK’s hydrogen and CCS economy.

**HyNet North West**

**Key highlights**

- Energy (hydrogen)
- Energy (oil and gas)
- Power generation

**Status**

- Planning
- Developing
- Scaling

**Industries represented**

- Energy (hydrogen)
- Energy (oil and gas)
- Power generation

**10 Mt CO₂**

per year from 2030

**6,000**

permanent new jobs created annually until 2030; 350,000 manufacturing jobs in region

**£2.8 billion**

UK gross value added 2022-2030

**Decarbonization roadmap**

Current annual emissions (2019)

40 Mt CO₂ across all sources of emissions within the North West

**10 Mt CO₂**

Target reduction each year from 2030

Net zero by 2040
HyNet is a hydrogen and CCS-focused industrial cluster led by Progressive Energy, Eni, Essar Cadent, Vertex Hydrogen, Hanson, INOVYN and University of Chester. HyNet’s geographic area is home to many energy intensive industrial emitters and dispatchable power generators, and has agreements.

HyNet’s geographic area is home to ~20 existing emitters and has ~40 future customers for low carbon and hydrogen production plants applying through bids.

HyNet is also engaged with alliances who share a common vision for decarbonization, including the North West Hydrogen Alliance, Net Zero North West and the Mersey Dee Alliance. Engagement with these groups allows HyNet to elevate their voice for decarbonization, work with leading engineers, landowners, academics and other entities in the region in the mission of decarbonization.

Partners within HyNet can use shared hydrogen and CCS infrastructure and complement each others individual purposes.

### Energy transition index collaboration model

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<tr>
<td>Cross-industry funding</td>
<td>- Public authorities</td>
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<tr>
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<td>- Financiers (public and private)</td>
<td>- Private funding from HyNet partners</td>
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<tr>
<td>Knowledge sharing</td>
<td>- Cross-industry peers</td>
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HyNet is the UK’s most advanced industrial decarbonisation cluster. It will include UK’s first large scale, low carbon hydrogen production plant, the UK’s first large scale hydrogen distribution network, carbon capture and storage facilities and a large amount of hydrogen storage.

The project will act as a blue-print which can be replicated across the UK to enable large scale industrial decarbonisation, quickly. It will bolster the UK’s hydrogen and CCS economies, whilst generating and safeguarding jobs, attracting inward investment and providing support for the UK’s energy security.

HyNet’s founding consortium, and project partners, work closely together to ensure that HyNet is well designed and developed as the infrastructure moves forward to planning consent and construction.

David Parkin, Director at Progressive Energy and Project Director, HyNet
- HyNet was successful in UK Research and Innovation’s (UKRI) Industrial Decarbonisation Challenge (IDC) competition through which they were awarded funding to develop early-phase projects on CCS and low-carbon hydrogen.

- HyNet has had an open dialogue with the UK Government since it was formed with Progressive Energy, HyNet’s lead partner, collaborating with UK government on different policies and guidelines.

- The UK government continues to provide active support to HyNet in supply/demand matchmaking, permitting enablement, public messaging, business model refinement and more.

- Both UKRI and UK Governments’ Department for Business, Energy & Industrial Strategy (BEIS) have provided continuous engagement and funding for the completion of the engineering studies through the Industrial Decarbonisation Challenge (IDC) and the Hydrogen Supply Competition.

- Eni has had a long history working with UK regulators for HyNet, when it was a hydrocarbon extraction area. In 2014 Eni became the sole operator of the Liverpool Bay oil and gas fields and, in 2020, the UK Oil and Gas Authority (now NSTA) awarded Eni a six-year storage appraisal license to use offshore fields as permanent storage for CO₂.

<table>
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<th>Direct electrification and renewable heat</th>
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<th>Hydrogen</th>
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### Enabling policies available

- £1 billion through the Carbon Capture and Storage Infrastructure Fund to support four industrial clusters.

- £100 million for industry and CCUS from the Energy Innovation Programme.

- £37.5 million to fund the largest government programme of greenhouse gas removal methods for cement (innovation and scaling projects).

- £100 million of new research and development funding to help develop direct air capture technologies in the UK.

### How these policies are being leveraged

- HyNet was placed within the first phase of CCS deployment projects in the UK through the UK BEIS CCUS cluster sequencing process, enabling infrastructure development and bilateral government discussions on business support model requirements.

- UKRI funding from the IDC, is allowing HyNet to develop the project, through its eight consortium partners, to financial investment decision (FID).

- The UK’s Levelling Up agenda, and its associated funds, support the development of “green skills” and the creation of jobs for the workforce of the future.
HyNet North West Technology

HyNet is delivering mature decarbonization technology and infrastructure solutions, using the region’s expertise, establishing a hotspot of innovation and economic growth, anchored in infrastructure for low carbon hydrogen and CCS ecosystem enablement. The cluster will build a low carbon hydrogen production plant which will be used to power the region’s industry, transport, homes, and businesses. It will also develop infrastructure to capture CO₂ emissions from energy-intensive processes, transport and safely store these emissions underground.

Selected technology initiative matrix

- **Systemic efficiency and circularity**
  - HyNet is using CCS to capture and transport carbon emissions from local industry. The cluster has the capacity to support the ambition both on the surface and subsurface sections, leveraging its existing supply chain and its optimal geological composition. The usage of this proven technology is estimated to remove the carbon equivalent to 4 million cars by 2030.

- **Direct electrification and renewable heat**
  - Eni are developing a carbon dioxide pipeline, which will transport CO₂ emissions from local industry, such as the Hanson Cement Plant at Padeswood, Flintshire and from the new Vertex hydrogen production plant at Stanlow Manufacturing Complex in Cheshire, to be stored safely in depleted gas reservoirs under Liverpool Bay.

- **Carbon capture, utilization and storage (CCUS)**

- **Hydrogen**

Digital foundations of the cluster

In order to realize the project vision of a decarbonized industrial cluster, HyNet is building a hydrogen and CCS sectors across the region. This involves the design, development, integration and construction of hydrogen and carbon capture and storage technologies. HyNet will both upgrade existing infrastructure, as well as develop new infrastructure including underground pipelines, hydrogen production plants and storage facilities. The project will use best-in-class technology to produce low carbon hydrogen at scale.

HyNet partners are committed to sharing knowledge, when relevant, to support the progression of industrial decarbonization clusters within the UK, and further afield.
3.4 Jababeka Net-Zero Industrial Cluster
The Jababeka Net-Zero Industrial Cluster plans to collectively develop decarbonization solutions at Jababeka Industrial Estate with the goal of achieving net-zero carbon emissions before 2050, supporting Indonesia’s national net-zero target by 2060. Other key areas include enhancing operational efficiency and circularity and transitioning to solar-powered electricity and other renewable sources.

Jababeka Industrial Estate in Cikarang is managed by Jababeka Infrastruktur – a subsidiary of PT Jababeka Tbk that spans an area of approximately 5,600 hectares. It is the largest industrial estate at South-East Asia with more than 2,000 companies from 30 countries, including major international and local brands.

**Jababeka Net-Zero Industrial Cluster**

**Key highlights**
- Chemicals
- Materials and manufacturing
- Metals
- Power generation

**Status**
- Planning
- Developing
- Scaling

**Industries represented**
- Chemicals
- Materials and manufacturing
- Metals
- Power generation

**709 kilotons CO₂**
annual emissions (2022)*

**1.7 million**
jobs protected

The partners for Jababeka Net-Zero Industrial Cluster are Jababeka Infrastruktur, Pertamina New & Renewable Energy (PNRE), Hitachi Astemo, L'Oreal, and Unilever. While the governance structure is still being developed, partnerships are recognized as a core value creation driver within Jababeka Net-Zero Industrial Cluster.

It is envisioned that the tenant partners L'Oreal Unilever and Hitachi Astemo will bring on board their global experience in decarbonizing their manufacturing operations while PNRE, as the energy partner, contributes deep technical expertise and capabilities for clean energy deployment in the cluster. Jababeka Infrastruktur would anchor the partnerships in the role of the cluster chair, using its plans for Correctio (Jababeka's plan for a digital ecosystem at the industrial estate) to cultivate partnerships within the industrial estate.

Correctio is focused on the three pillars of Industry 4.0, Society 5.0, and Transit-Oriented-Development to create a hub for technology and innovation in the region. Correctio features Jababeka's FabLab initiative that aims to encourage the development of Industry 4.0 skills, solutions and is a collaboration between Jababeka and President University, a leading private university in Indonesia.

Jababeka Net-Zero Industrial Cluster will build on the groundwork Jababeka's founders – especially Mr S.D. Darmono and Mr H. Rahardja – have laid at the industrial estate over 30 years to transform for the future, using operational and digital technologies. As the first South East Asian industrial cluster transitioning towards net zero from the emerging markets, we will take a leading role as the largest industrial park in the region to help address rising consumer demand for sustainable products and responsible business practices with support of the cluster partners, Pertamina New & Renewable Energy in its role as an energy company, and Hitachi Astemo, L'Oreal and Unilever as committed tenants. Collectively, we seek to aggregate the voices of industry to key stakeholders and drive impactful changes to the industrial ecosystem, enabled by cross-industry collaborations together with the larger global signatory community for the sake of future generations.

Agung Wicaksono, Managing Director, Jababeka Infrastruktur

### Energy transition index collaboration model

<table>
<thead>
<tr>
<th>Collaboration type existing in cluster</th>
<th>Partner types</th>
<th>Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared infrastructure development</td>
<td></td>
<td>Jababeka Infrastruktur, in collaboration with Pertamina New &amp; Renewable Energy</td>
</tr>
<tr>
<td>Industrial cluster infrastructure planning</td>
<td>Workplan to be developed</td>
<td></td>
</tr>
<tr>
<td>Shared commercial projects</td>
<td>Workplan to be developed</td>
<td></td>
</tr>
<tr>
<td>Cross-industry funding</td>
<td>Workplan to be developed</td>
<td></td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td>Jababeka Infrastruktur via FabLab Jababeka, a collaboration with President University</td>
<td></td>
</tr>
<tr>
<td>Reskilling the workforce</td>
<td>Jababeka Infrastruktur via FabLab Jababeka, a collaboration with President University</td>
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</table>
The formation of Jababeka Net-Zero Industrial Cluster emerged as a concrete response to the work of the B20 2022 Energy, Sustainability and Climate Change Task Force (ESC-TF), in particular, the B20 ESC-TF’s policy recommendation for energy efficiency and decarbonization for the industrial sector.

Policy is seen as an important enabler in order for the industrial cluster to scale the expansion of renewables. With the formalization of the Jababeka Net-Zero Industrial Cluster, the partners plan to actively engage with key government stakeholders and entities to support the work of decarbonizing Jababeka Industrial Estate, making use of relevant policies.

The collective nature of an industrial cluster encourages tenants’ participation in industrial forums that could influence policy aspects that are supportive of decarbonization efforts at Jababeka Industrial Estate.

Enabling policies available

- National Strategy on Managing Domestic Waste and Similar Waste (Presidential Regulation 97/2017)

- Management of Domestic Waste and Similar Waste (Regulation 81/2012)


How these policies are being leveraged

- On top of the fiscal and non-fiscal incentives from establishing business in industrial parks and special economic zones (SEZs) formed by the government, electricity generation assets from renewable energy (i.e. solar, biomass or biomass co-firing, hydrogen, etc.) can now supply end consumers within business areas despite being outside such business areas.

Sources: Reuters; Pertamina; New Energy and Industrial Technology Development Organization
### Jababeka Net-Zero Industrial Cluster Financing

- Current initiatives, such as rooftop solar photovoltaics (PV), are privately funded by each individual company pursuing their own sustainability targets.

- The group led by Jababeka Infrastruktur is exploring the potential for public funding to develop plans for scaling up decarbonization initiatives following the formation of the Jababeka Net-Zero Industrial Cluster.

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<th>Development stage</th>
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<td>Proof-of-concept validation</td>
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<tr>
<td><strong>Pilot projects and early development</strong></td>
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<td></td>
<td>Wide-scale commercial deployment</td>
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</table>
The initial focus would be on expanding clean electrification in the industrial estate, such as the deployment of rooftop solar PV, and electrification technologies, such as electric mobility. The group also intends to collaborate to enhance systemic efficiency and circularity at the cluster, such as the implementation of innovative circular organic waste management solutions. In the longer term, the group would explore other solutions that could help meet the decarbonization goals of the cluster, such as hydrogen and CCUS.

Jababeka Infrastruktur is piloting innovative organic waste management solutions at Jababeka Industrial Estate. The pilot initiative utilizes Black Soldier Fly (BSF) maggots to produce fertilizer from food waste generated by tenants. The plan is to scale up from 72 tons to 2,500 tons processed annually and expand the products produced, such as bioethanol, animal feed, fertilizer and distilled water.

Jababeka Industrial Estate has a robust foundation for digital communications and data infrastructure with the availability of estate-wide fibre optic coverage and tier-three data centre that cater to the needs of tenants. In addition, Jababeka recently launched Correctio in September 2022, announcing plans for the development of a digital ecosystem over the next five years. Correctio, with its three pillars of Industry 4.0, Society 5.0 and Transit-Oriented-Development, would support technology companies with ambitions to create a hub for technology and innovation for the region.
3.5

Kwinana Industries Council
The members of the Kwinana Industries Council (KIC), an industry association, view the decarbonization challenge of the Kwinana Industrial Area in Perth, Australia (KIA) from the perspective of an ecosystem of collaborative partners. KIC anchors the clusters as the collaboration leader with a mission to organize and advise the sharing of resources, knowledge and best practices that support the individual and collective carbon reduction efforts of participating corporates. Active full member corporates collaboratively pursuing decarbonization goals within the KIC include Alcoa, Avertas Energy, BHP, BP, Cockburn Cement, Coogee, Covalent Lithium, Wesfarmers Chemicals, Energy and Fertilisers (CSBP), Kleenheat, Synergy, Tianqi Lithium, Tronox, Water Corporation, Fremantle Ports and Woodside Energy.

### Key highlights

- **Cement**
- **Chemicals**
- **Energy** (oil and gas)
- **Materials and manufacturing**
- **Metals**
- **Power generation**

#### Status

<table>
<thead>
<tr>
<th>Planning</th>
<th>Developing</th>
<th>Scaling</th>
</tr>
</thead>
</table>

#### Industries represented

- Cement
- Chemicals
- Energy (oil and gas)
- Materials and manufacturing
- Metals
- Power generation

#### 8.2 Mt CO₂

Per year (2021)

#### 30,000

Jobs across the precinct

#### AUD 16 billion

GDP

#### Decarbonization roadmap

**Current annual emissions (2021)**

8.2 Mt CO₂

**Net Zero by 2050**

**Impact on roadmap towards decarbonization**

- **Hydrogen**
  - Supporting
- **CCUS**
  - Primary
- **Direct electrification and renewable heat**
  - Secondary
- **Systemic efficiency and circularity**
  - Primary

According to the Carbon Reduction Kwinana Industrial Area (CRKIA) project, and each corporate has their own individual targets.
 Corporations participate through the KIC board, which includes both full (major) and associated members, to support their enablement of international competition and resiliency.

 The KIC board and its members initiated a flagship carbon reduction project for the Kwinana Industrial Area (CRKIA) in 2020 to formalize collective efforts toward carbon reduction and achieve net zero by 2050.

 KIC’s work is carried out by its four specialist committees: Infrastructure and Planning, Environment (including CRKIA working group), Kwinana Industries Public Safety, Public Affairs and Communications Advisory Group.

 Three government trading enterprises (GTEs) supply uses directly to consumers on commercial terms – Water Corporation, Synergy and Fremantle Ports – and manage shared infrastructure and assets.

 KIC works with several public agencies to create an environment that is supportive of carbon reduction intentions and actions of industry.

### Energy transition index collaboration model

<table>
<thead>
<tr>
<th>Collaboration type existing in cluster</th>
<th>Partner types</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Shared infrastructure development</td>
<td>– Public authorities</td>
<td>Water Corporation, Synergy and Fremantle Ports</td>
</tr>
<tr>
<td>Industrial cluster infrastructure planning</td>
<td>Single firms collaborating under the KIC banner, and also collaboration with government</td>
<td></td>
</tr>
<tr>
<td>Shared commercial projects</td>
<td>A range of technology providers is in discussion with several industry partners. Memoranda of understanding agreements underpinning these discussions.</td>
<td></td>
</tr>
<tr>
<td>Cross-industry funding</td>
<td>Via KIC membership fees for full and associate members. Government identifying sectors and individual sector corporates for financial assistance.</td>
<td></td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td>Public authorities: the Australian government Department of Jobs, Tourism, Science and Innovation (JTSI) KIC: specialist committee established for knowledge sharing and project potential evaluation</td>
<td></td>
</tr>
<tr>
<td>Reskilling the workforce</td>
<td>Re-skilling is not needed, so the KIC focus is to run programmes that engage senior high school students with industry and the careers on offer. KIC runs a pre-apprenticeship course in partnership with the national training agency.</td>
<td></td>
</tr>
</tbody>
</table>

It continues to be an honour to lead Kwinana Industries Council (KIC) on behalf of the members along the decarbonization journey. I remain very proud of their courage and foresight in embracing the journey as a collegiate of companies co-located within a heavy industry sector and individually to set and take the appropriate actions to meet their own targets.

As we progress towards fine-tuning the technologies most likely to be adopted, I’m noticing a trend where over the past three years, individual company carbon reduction targets are changing. Self-imposed emission reduction percentages are getting revised upwards, and the time in which to achieve them is reducing.

The imperative is becoming less about slowing down climate change and more about corporate financial sustainability.

Chris Oughton, Chief Executive Officer, Kwinana Industries Council
The Kwinana Industrial Area (KIA) is nearly 70 years old and has developed despite a lack of broad policy support at the regional and federal levels. The Australian government has supported the development of the cluster through the provision of common user infrastructures like roads, rail and ports, and the provision of industrial land.

The designation of KIA as a strategic industrial area (SIA) has elevated the attention received at the state level, though this has not yet materially increased the financial or enabling-policy support of cluster operations.

In spite of clear policy direction for decarbonization and net zero industry transition, participants in KIC’s CRKIA report noted that international supply and demand forces will likely drive the pace of carbon reduction.

Enabling policies available

- Achieving 80% average recovery rate from all waste streams by 2030 and increase use of recycled content by governments and industry.
- AUD 43 million to assist large energy users to undertake studies to identify opportunities to lower energy costs and reduce emissions.

How these policies are being leveraged

The sustainability initiatives of the Kwinana Industries Council do not, at this time, benefit from public funding.
Kwinana Industries Council

Financing

- The provision of funds is managed on an individual corporate basis through capital- and private equity-raising efforts from publicly- and privately-listed companies.

- Federal grants have been allocated to corporates with a focus on modern industry manufacturing as opposed to infrastructure development within the cluster.

- Federal grants from the Australian government have provided support for individual companies. For example:
  
  - Alcoa received over AUD 10.3 million in federal funding to support their pilot carbon-reducing electric calcination technology for alumina refining.
  
  - To date, BP has received more than AUD 70 million in federal funds from the Western Australian Government Renewable Hydrogen Fund and Australian Clean Hydrogen Industrial Hubs Program to support the repurposing of part of BP Australia’s Kwinana site into a green hydrogen hub.

<table>
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<td></td>
<td>Exploratory research transitioning basic science into laboratory applications</td>
<td>Now: ✅</td>
</tr>
<tr>
<td></td>
<td>Technology concepts and/or application formulated</td>
<td>By 2025: ✅</td>
</tr>
<tr>
<td></td>
<td>Proof-of-concept validation</td>
<td>By 2030: ✅</td>
</tr>
<tr>
<td></td>
<td>Subsystem or component validation in a laboratory environment to simulate service conditions</td>
<td>Now: ✅</td>
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<td></td>
<td>Early system validation demonstrated in a laboratory or limited field application</td>
<td>By 2025: ✅</td>
</tr>
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</tbody>
</table>
Kwinana Industries Council Technology

In order for its industry members to achieve net zero by 2050, Kwinana Industrial Council is continuously evolving its search for new technologies, specifically around CCUS and collective infrastructure, to support cluster and individual goals. To best facilitate the removal of technology barriers, KIC focuses on its relationships with new technology providers and large enterprises to reach into the technology innovation space and to learn from the examples of US and UK CCUS infrastructure and develop well-informed, locally-suited decarbonization opportunities.

Selected technology initiative matrix

- Systemic efficiency and circularity
- Direct electrification and renewable heat
- Carbon capture, utilization and storage (CCUS)
- Hydrogen

KIC recognizes that the route to decarbonization is industry-specific and targets the implementation of systemic efficiency measures once clear, compelling data is collected to inform the development of a diversity of technologies and sector-fit decarbonization levers. For example, a carbon capture and re-use technology developed in a small-scale industrial “shed” is now partnering with a major CO₂-producing industrial to co-locate a larger pilot plant and thinking beyond that, the start-up is working with KIC and members to secure a site for the next stage, which is a carbon re-use installation on a major scale, once the technology is proven. The use of the captured carbon is for it to be sent back into the local industry as input into the production of fertilizer for the agricultural industry. The gathering of data is central to the planned expansion process.

Digital foundations of the cluster

The decarbonization of the Kwinana cluster sits atop the digital systems of each of the KIC’s member companies. Their own systems technology development is driven by their need for economic and commercial sustainability, for gathering and interpreting systems data, and for its collation in preparation for formal emissions reporting to Australia’s federal government. It seems unlikely that there will be a future where individual company data is aggregated across the precinct for it to be reported at that level. The pressure for emissions reduction is really coming from shareholders and boards, so the drive for emissions data reporting requires significant investment in IT systems and data-gathering processes.
3.6 National Capital Hydrogen Center
The National Capital Hydrogen Center is anchored by a non-profit “do-tank”, Connected DMV, and a diverse industrial, commercial and non-profit steering committee that has entered the competition for IIJA Clean Hydrogen Hub funding not to secure their own market share but to convene hydrogen use cases across the region without commercial conflict inhibiting. Connected DMV has built a consortium of commercial, industrial, governmental and community organizations across the region that will collaborate in the bid for government funding. The industrial cluster targets abating 2.7 MtCO₂ by 2030.

### Key highlights

<table>
<thead>
<tr>
<th>Status</th>
<th>Planning</th>
<th>Developing</th>
<th>Scaling</th>
</tr>
</thead>
</table>

- **Industries represented**
  - Aviation
  - Energy (hydrogen)
  - Heavy transport
  - Maritime

- **180 Mt CO₂** annually
- **8,900** jobs created
- **$1.7 billion** gross value added in the region by 2030

### Decarbonization roadmap

**Current annual emissions**

- **2.7 Mt CO₂**

**2030 target emissions reduction**

- **↓ 1.5%**

**Net zero goal forthcoming**

**Impact on roadmap towards decarbonization**

- **Hydrogen**
  - Primary
  - Direct electrification and renewable heat
  - Secondary

**Transitioning Industrial Clusters towards Net Zero**

Washington DC, Maryland, Virginia, USA

The industrial cluster’s anchor, Connected DMV, is actively aligning supply/offtake and facilitating MoUs among participants to open access to de-risked financing, as well as substantiating the case for federal investment for hydrogen in the region.

The steering committee works primarily to create a collaborative environment by engaging vendors, suppliers, policy-makers, community groups and universities with tailored opportunities to contribute to and mutually benefit from research, urban and suburban planning.

We are pleased that our Hydrogen Greenprint work, which began over 18 months ago, directly aligns with the federal government priorities ... Through the 2021 bipartisan Infrastructure Investment and Jobs Act and the Department of Energy’s (DOE) Energy Earthshots Initiative, we have a once-in-a-lifetime opportunity to transform existing infrastructure that has served us well into a cleaner, more modern network. The Mid-Atlantic Hydrogen Hub coalition comprises the diverse and industrial strength set of leading partners required to drive a clean energy transition that also serves our region’s broader community and economic interests.

Stu Solomon, President and Chief Executive Officer, Connected DMV

Energy transition index collaboration model

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<tr>
<th>Collaboration type existing in cluster</th>
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</table>
| Shared infrastructure development     | – Industry peers  
– Non-profit and think tanks  
– Researchers  
– Public authorities | The National Capital Hydrogen Center Steering Committee, the Mid-Atlantic Hydrogen Hub |
| Industrial cluster infrastructure planning | – Non-profit and think tanks | |
| Shared commercial projects            | – Non-profit and think tanks  
– Academia | Environmental and social equity groups leading regional colleges and universities |
| Cross-industry funding                | – Non-profit and think tanks | |
| Knowledge sharing                     | – Non-profit and think tanks  
– Academia | |
| Reskilling the workforce              | – Non-profit and think tanks | |
National Capital Hydrogen Center

Financing

- The National Capital Hydrogen Center plans to continue a balanced model of philanthropic government and private funding with the anticipated addition of federal funds through the MAHH application for DOE H2 Hubs regional hub funding.

- The cluster is leaning into the foundational role that investment and production tax credits (expanded via the 2022 Inflation Reduction Act) must play in incentivizing private participation ahead of major capital infusions.

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</table>
## National Capital Hydrogen Center Technology

The National Capital Hydrogen Center sees the future of clean hydrogen much akin to today's natural gas markets. The development of hubs and spot prices in the industrial cluster's region will come through carefully facilitated local markets and, eventually, central coordination with bodies like PJM – the geography's regional transmission organization.

### Selected technology initiative matrix

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic efficiency and circularity</td>
<td>The National Capital Hydrogen Center is working to accelerate commercial-scale clean hydrogen deployment in the region to support decarbonization of hard-to-abate sectors, including transport (aviation, public transit, surface transport, maritime) and commercial heating.</td>
</tr>
<tr>
<td>Direct electrification and renewable heat</td>
<td></td>
</tr>
<tr>
<td>Carbon capture, utilization and storage (CCUS)</td>
<td></td>
</tr>
<tr>
<td>Hydrogen</td>
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</tbody>
</table>

### Digital foundations of the cluster

The National Capital Hydrogen Center claims a leadership role in developing a Mid-Atlantic US balanced hydrogen market and sees a future as a digital steward when this market has matured. Parallel initiatives from industrial cluster anchor, Connected DMV, like the Potomac Quantum Innovation Center, are already exploring the potential of mining aggregated data across industrial cluster participants. The non-profit status of the cluster anchor ensures that the centralized data will not be used for commercial ventures but rather for the benefit of a cross-industrial hydrogen platform.
3.7 Net Zero Basque Industrial Super Cluster
The Net Zero Basque Industrial Super Cluster (NZBIS) initiative, launched in late 2021 at COP26, aims to accelerate the path to net zero emissions in Spain’s Basque Country, fostering energy supply decarbonization and energy efficiency in the industrial sectors and creating market opportunities based on the scale-up of the new technologies and innovative services. This initiative has been launched by Basque Government (SPRI), with the two primary energy companies in the Basque Country, Iberdrola and Petronor-Repsol, and with the collaboration of the industrial cluster associations (representing stakeholders by industry: energy cluster, foundry cluster, iron and steel cluster, pulp and paper cluster and concrete cluster).

**Key highlights**

- **Industries represented**
  - Cement
  - Energy (hydrogen)
  - Energy (oil and gas)
  - Metals
  - Power generation
  - Pulp and paper

- **7.2 Mt CO₂**
  - Annual emissions (2019)

- **20,000-30,000**
  - Jobs created by 2030 (2-3% of jobs in 2021)

- **€2-3 billion**
  - Economic impact in 2030 (3%-5% of GDP in 2021)

**Status**

- Planning
- Developing
- Scaling

**Decarbonization roadmap**

- Current annual emissions (2019)
- 7.2 Mt CO₂

- 2030 target emissions reduction
  - 30%

- Net zero by 2050
Net Zero Basque Industrial Super Cluster Partnership

The Net-Zero Basque Industrial Super Cluster aims to accelerate the path to Net-Zero Emissions in the Basque Country, fostering energy supply decarbonization and energy supply in the industrial sectors and creating market opportunities based in the scale up of new technologies and innovative services.

Arantxa Tapia, Minister of Economic Development, Sustainability and Environment, Basque Government

Basque energy companies are committed to the decarbonization of the economy, as well as of its own processes, through further electrification and the use of renewables and decarbonized fuels such as green hydrogen, based on technological neutrality and competitiveness.

Petronor-Repsol and Iberdrola, Basque Energy Companies

- The Basque region has a longstanding history of public-private collaboration and NZBIS’s launch with the objective to support Basque economies in the long-term is a natural extension of this culture.

- The name “Super Cluster” represents the participation of cross-sectoral industrials, government and community stakeholders and industrial cluster associations in NZBIS; the current composition of the governance model which brings this region together leans on three types of active industrial engagement to facilitate discussions and decision-making, represented as the strategic, executive and operating levels.

- This governance model’s clear delineation of responsibilities allow different stakeholders to confidently own the dialogues between industrials, industry alliances and public entities in priority areas across levels. From the establishment of the cluster, these dialogues have anchored in international perspectives to consciously define and strengthen the strategic positioning of the cluster.

Energy transition index collaboration model

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<tr>
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</tr>
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<td>Public authorities, Cross-industry peers</td>
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</tr>
<tr>
<td>Shared commercial projects</td>
<td>Public authorities, Financiers (public and private)</td>
<td>SPRI, Iberdrola, Petronor-Repsol</td>
</tr>
<tr>
<td>Cross-industry funding</td>
<td>Public authorities, Cross-industry peers, Researchers</td>
<td>SPRI, Iberdrola, Petronor-Repsol, energy cluster, foundry cluster, iron and steel cluster, pulp and paper cluster and concrete cluster, EPRI</td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td></td>
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<tr>
<td>Reskilling the workforce</td>
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</table>
Net Zero Basque Industrial Super Cluster Policy

- From its inception, NZBIS has worked to accelerate the cluster’s collaboration-driven decarbonization strategy. In addition to regional, national and EU-level policies described here, the SPRI (Basque Government) continues to team with the partners to develop policies that creatively enable the cluster and other regional decarbonization initiatives.

- Regionally, the 2021 Basque Climate & Energy Transition Law (LTCCE) was passed to enforce and support public and private initiatives – like NZBIS – to achieve the region’s target of climate neutrality by 2050.

- To leverage maximum public support, the cluster benefits from the support of several funding programmes at European, Spanish and Basque level, for Industrial strategic R&D projects and for knowledge acquisition by RTOs.

- SPRI and the Basque Government, through its Science, Technology, and Innovation Plan 2030 (PCTI 2030) and the Intelligent Industry Strategy, is committed to the implementation of digital technologies and considers the use of data analytics and digital technologies as one of the keys to decarbonizing energy consumption.

- These policies have laid the foundation, and seeded the funding, for the Basque Country and NZBIS to remain on track towards its net zero commitments and align with the European Green Deal and the Agenda of Objectives for Sustainable Development.

Enabling policies available

- The EU’s Circular Economy Action Plan (CEAP)
- Develop a consumption system based on dynamic pricing.
- Energy Strategy of Euskadi 2030
- Develop a consumption system based on dynamic pricing; implementing a legal framework and eliminating bureaucratic barriers.
- €1.36 billion public investment towards the digitalization of the energy grid to meet future distribution requirements.
- €929 million public investment for agricultural machinery efficiency improvement.
- €3.9 billion public investment for industrial heat efficiency improvement.

How these policies are being leveraged

- €1.36 billion public investment towards the digitalization of the energy grid to meet future distribution requirements.
- €3.9 billion public investment for industrial heat efficiency improvement.
- Support programmes of the Basque Energy Agency for energy efficiency projects and investments in industrial plants.
- Exploring public funding opportunities to digitalize the grid, improve industrial heat efficiency, and support broader efficiency projects in the cluster’s industrial plants.

Sources: EU Commission; Ministry for the Ecological Transition, Spanish government; Basque government
Net Zero Basque Industrial Super Cluster Financing

- Financing and policy for NZBIS have stayed closely tied since seed funding was provided as a public initiative led by SPRI (Basque Government). SPRI has taken a driving role in facilitating the transition to private funding through the definition of new technology and collaborative pilots.

- With regional government positioned as an anchor within the industrial cluster, the larger regional landscape benefits greatly from initiatives of SPRI aimed directly to empower the cluster. The programmes with wide-reaching impact most notably include funding packages to support R&D and infrastructure deployment as well as operational technology and digital development.

- The technological focus of the cluster enables secure financing, both short-term and long-term. R&D funds from different European, national and regional sources are available for this purpose.

- Especially relevant R&D funds are the European programmes for the Recovery and Transformation of the Economy (PERTE), that were launched by the Spanish government to mobilize European funds to improve the Spanish position in the areas of energy transition, such as: renewable energies, power electronics, storage and renewable hydrogen.

### Planned funding deployment by technology readiness level

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<tr>
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<th>Funding allocation</th>
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</tr>
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</table>
The NZBIS initiative aims at developing a robust, innovative industrial landscape where technology innovations serve as key driver of the energy transition and decarbonization. To do so, NZBIS will act as enabling mechanism by prioritizing those technologies with potential to transform the Basque industries not only by looking at the decarbonization profile, but especially focusing on their capacity to activate the entire value chain within the region.

### Selected technology initiative matrix

**Systemic efficiency and circularity**

- For the circularity of pulp and paper subsector, the recycling of side products will be promoted to valorize their use as materials or energy carriers.
- In the case of the steel subsector, the recycling of steel that can be processed directly through electric arc furnaces should be promoted, which implies further electrification of the industry.

**Direct electrification and renewable heat**

- Replacement of fossil fuels by net zero emission fuels, such as, synthetic fuels, biogas and biofuels, with no investment for the user (use of efficient technologies in furnaces) in foundry, steel and cement subsectors.
- Energy efficiency and decarbonization of refining process will be carried out applying best available technologies and optimizing industrial processes, products and services, and work tools to increase global efficiency of the company.

**Carbon capture, utilization and storage (CCUS)**

**Hydrogen**

Digital foundations of the cluster

In addition to the investment of corporations across the industry associations, the Net Zero Basque Industrial Super Cluster is investing in digital technologies that accelerate collaborative initiative prioritization and actions. Most notably, the BIDERATU project is developing a tool for modelling regional energy systems, especially focused on characterizing measures and solutions to decarbonize energy consumptions. This tool focuses in industrial sectors and processes, assessing the suitability of a selection of decarbonization strategies, their action plans, investments needs and business models.
3.8 Ohio Clean Hydrogen Hub Alliance
OH2Hub’s primary goal is to meet the social and economic needs of Ohio, the seventh most populous state in the US. Decades of de-industrialization have fundamentally reshaped the state’s economy. This cluster of more than 150 signatory parties formed to explore hydrogen’s potential to supercharge economic growth within Ohio’s industrial core (chemicals, power generation, steel production and heavy-duty transport). Anchored by Dominion Energy, Cleveland State University, SARTA, the Midwest Hydrogen Center of Excellence and Battelle, the cluster is seeking US DOE hydrogen hub funding to seed an inclusive and empowering clean energy transition that brings significant economic and social uplift, with open doors to neighbouring states.

Ohio Clean Hydrogen Hub Alliance

Key highlights

- Chemicals
- Heavy transport
- Materials and manufacturing
- Metals
- Power generation

170 Mt CO₂

Emission reduction in Electric Power, Transportation, and Industry Economic Sectors by 2025

Decarbonization roadmap

Current annual emissions (2020)

2030 target emissions reduction

↓ 25%

Net zero goal forthcoming

Ohio, USA

Transitioning Industrial Clusters towards Net Zero
Ohio Clean Hydrogen Hub Alliance Partnership

We formed the alliance to ensure that Ohio will have the opportunity to reap the economic and environmental benefits flowing from the federal government’s investment in clean hydrogen technology. Our region is an ideal location for a clean hydrogen hub, possessing a critical mass of abundant natural gas feedstock, end-user demand, energy infrastructure, highly skilled workforce and carbon storage potential, enabling it to submit the strongest possible proposal to the DOE. We believe that Ohio and its neighboring states are ideal locations for a clean hydrogen hub. Clean hydrogen is now an integral part of America’s long-term energy strategy and our alliance will enable Ohio to assume a leadership position in the zero-emission economy of the 21st century.

Kirt Conrad, CEO Stark Area Regional Transit Authority

- The industrial clusters’ anchors (Dominion Energy, Cleveland State University, SARTA, Midwest Hydrogen Center of Excellence, and Battelle) are supported by a membership of 150+ businesses, public bodies, and NGOs interested in securing IIJA Hydrogen Hub funding to catalyze the development of the OH2Hub.
- As an Industrial Cluster in its early development stage, OH2Hub has not yet formalized an oversight committee or board but rather continues to work ad hoc with corporates, NGOs and government in the region to onboard and shape the region’s hydrogen vision with industrials from a diversity of sectors.
- Battelle, a private research organization focused on science and technology development for the betterment of society and the economy, will lead the cluster as the aggregator and author of application for Department of Energy Hydrogen Hub funding with support from a developing community of producers, intermediaries, and offtakers across the state.

### Energy transition index collaboration model

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<td>– Cross-industry peers&lt;br&gt;– Researchers&lt;br&gt;– Non-profit and think tanks</td>
<td>Dominion Energy, Cleveland State University, SARTA, Midwest Hydrogen Center of Excellence</td>
</tr>
<tr>
<td>Industrial cluster infrastructure planning</td>
<td>– Researchers</td>
<td>Battelle</td>
</tr>
<tr>
<td>Shared commercial projects</td>
<td>– Researchers</td>
<td>Battelle</td>
</tr>
<tr>
<td>Cross-industry funding</td>
<td>– Researchers</td>
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</tr>
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<td>Knowledge sharing</td>
<td>– Researchers</td>
<td>Battelle</td>
</tr>
<tr>
<td>Reskilling the workforce</td>
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</table>
Ohio Clean Hydrogen Hub Alliance Financing

- The industrial cluster’s aim is to seed development of the regional infrastructure and detail-level value chain planning with the funding provided through the IIJA’s Hydrogen Hub program; to this point all activities have been privately self-funded through OH2Hub collaborators.

- In considering complementary public financial support to the IIJA, the cluster is exploring the value of Green Bonds: SmartColumbus, an Ohio based innovation lab and member of the clusters, has successfully employed Green Bonds and is informing the collaborative’s perspective on how, when and where to apply this mechanisms during cluster development.

- It is the aim for the cluster – as a collaborative, cross-sectoral body – to help de-risk investment and create a more attractive landscape for federal and national funding. The cluster continues to facilitate roundtables with companies that have clear sustainability mandates to define the value of cluster participation and the opportunity in collaboration.

### Planned funding deployment by technology readiness level

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<td></td>
<td>Technology concepts and/or application formulated</td>
<td>By 2025</td>
</tr>
<tr>
<td></td>
<td>Proof-of-concept validation</td>
<td>By 2030</td>
</tr>
<tr>
<td>Research and development</td>
<td>Subsystem or component validation in a laboratory environment to simulate service conditions</td>
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</table>
Ohio Clean Hydrogen Hub Alliance Technology

The OH2Hub is centered around the creation of an Ohioan hydrogen supply chain, including storage infrastructure, which uplifts all communities’ health, employment and economic outcomes. The cluster envisions a blue to green hydrogen transition over the next ~30 years with 100% replacement by 2050, made possible by significant scaling of renewable energy generation and a highly localized value chain.

## Selected technology initiative matrix

<table>
<thead>
<tr>
<th>Initiative</th>
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<tbody>
<tr>
<td>Systemic efficiency and circularity</td>
</tr>
<tr>
<td>Direct electrification and renewable heat</td>
</tr>
<tr>
<td>Carbon capture, utilization and storage (CCUS)</td>
</tr>
<tr>
<td>Hydrogen</td>
</tr>
</tbody>
</table>

- OH2Hub leaders anticipate that energy from biomass and renewable gas will play a strong role in making scaled hydrogen production possible (alongside solar); opportunities in this space are still in exploration.
3.9

Ordos-Envision Net Zero Industrial Park
The Ordos-Envision Net Zero Industrial Park will integrate the supply chains of several industries, such as battery manufacturing and energy storage, electric vehicle, photovoltaic, manufacturing of hydrogen fuel cells and green hydrogen equipment. It will feature a comprehensive clean energy solution, powered by the latest wind, solar and hydrogen power technologies, ensuring 100% green power supply through cooperation with the power grid. It is intelligently managed by Envision Digital’s AIoT operating system, EnOS, and will help build a fully-electric truck transportation system. By creating a diverse industrial ecosystem, the Ordos-Envision Net Zero Park is the ideal incubator for cross-industry innovation.
As a net-zero technology partner for companies, governments and organizations worldwide, we aim to define a system of new industries that will create the foundation for a sustainable future. Wind power and energy storage will become the new coal. Batteries and hydrogen will become the new oil. AI and the internet of things will enable the new grid, and net-zero industrial parks will become the new infrastructure. Zhang Lei, CEO Envision Group

The Ordos-Envision Net Zero Industrial Park cluster is co-led by the Ordos Government and Envision Group in collaboration with the cluster’s three main governing bodies: the Cluster Strategy Committee, Cluster Administration Committee, and the Electric Distribution and Sales Company.

The Cluster Strategy Committee, made up of the Mayor of Ordos, representatives of Envision and other companies, provides political incentives and guidance for cluster planning and connects all parties together.

The Cluster Administration Committee administrates Cluster’s planning, construction, financing, and attracting investments.

The Electric Distribution and Sales Company provides green power for the companies in the Cluster.

Other companies also play an important role to accelerate the development of the Cluster. For example, Envision attracts upstream and downstream companies as supply chain partners and establishes the Zero-carbon Intelligent Digital System based on EnOS that serves the whole industrial park. At the same time, Envision participates in Cluster planning and helps coordinate construction. Other companies, such as Sequoia, participate and contribute to planning and investment/company attraction.

Zhang Lei, CEO Envision Group

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### Energy transition index collaboration model

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<td>Ordos Government</td>
</tr>
<tr>
<td>Industrial cluster infrastructure planning</td>
<td>- Public authorities, Cross-industry peers</td>
<td>Mayor of Ordos, representatives of Envision and other companies, and Cluster Administration Committee</td>
</tr>
<tr>
<td>Shared commercial projects</td>
<td>- Cross-industry peers</td>
<td>Partnering with green industrial leaders including LONGi, Huayou, SAIC Hongyan</td>
</tr>
<tr>
<td>Cross-industry funding</td>
<td></td>
<td>$16 billion in attracted investment across industry partners</td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td></td>
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<td>Reskilling the workforce</td>
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Transitioning Industrial Clusters towards Net Zero
Ordos-Envision
Net Zero
Industrial Park
Policy

- The Inner Mongolia Government and Ordos Government are working closely together with private sector industrials to establish the industrial cluster’s leadership team and to write public policies which augment national support for the development of the green industrial park.

- The Inner Mongolia Government, Energy Bureau and Ministry of Industry and Information Technology have signed a document to announce that the industrial cluster has been designated as an exemplary demonstration of Zero-Carbon Industrial Cluster and the first of its kind in Inner Mongolia.

- The federal and regional policy support for Ordos-Envision primarily supports three areas: Green Industry, Distribution and Sales of Green Power, and Circular Economy

Enabling policies available

- As required by guidelines on the establishment of low-carbon circular economy systems, all clusters at the provincial level and above must modify operations to fit criteria of “circularity clusters”.

- Under guidance from the National Energy Bureau (NEB), more than CNY 100 million are funded to assist in clusters’ circularity transformations in more than 20 provinces nationwide.

- Tax exemptions for 15-30% of CapEx may be granted to clusters that have gone through circularity transformations.

How these policies are being leveraged

- The Ordos Government identifies energy efficiency as a key lever for reducing carbon emissions.

- Ordos is decommissioning high-emitting plants and supporting cleaner alternatives.
## Ordos-Envision

### Net Zero Industrial Park

#### Financing

- Ordos Envision is funded by both public and private sectors. Some investments include but are not limited to: Sequoia and other joint ventures co-founded with the Cluster attracts external investments for the finances of the Cluster, national special bonds, and local financial expenditures.

- Sequoia Capital brings together its invested companies in the new technology sector to the park, introducing an innovation center to seek potential opportunities in new industries.

- All finances for the Ordos-Envision Net Zero Industrial Park are processed through a dedicated bank secured by the Cluster Administration Committee.

- Industrial partners including LONGi, Huayou, and SAIC Hongyan, have already made commitments to invest and build production capacity within the Net Zero Industrial Park.

### Planned funding deployment by technology readiness level

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Envision Net Zero Industrial Park aims to be the first zero-carbon industrial cluster in the world by transforming operations into a ‘green circle’ where all energy and output products from the clusters are carbon neutral. This vision will be supported by green hydrogen islands, renewable energy (primarily wind and solar), and digital infrastructure technologies like the Net-zero Code and One Chart.

**Systemic efficiency and circularity**

- As the primary focus of the cluster (enabled by the other technology levers), efficiency and circularity be achieved by building the entire clean value chain within the Cluster, minimizing dependance on external organizations.

- This value chain will feature Inner Mongolia generated wind and solar power (replacing previously fossil fuel produced energy) used to manufacture green energy equipment and final products (e.g., EVs) which will run on green power. This will form positive green circularity within the Cluster and reduce emissions within the broader region.

**Direct electrification and renewable heat**

- The Ordos-Envision Industrial Cluster has prioritized building a digital foundation to optimize decarbonization efforts beginning with EnOS platforms “Net-zero Code” and “Electricity & Carbon on One Chart”. Net-zero Code gathers data across products’ full lifecycle (energy mix during manufacturing, supply chain carbon emission, etc.), which can be used to accelerate the production and verification of zero-carbon products. Electricity and Carbon on One Chart uses new computing technology to track and calculate real-time green power grid operation metrics and monitor carbon emissions from power usage.

**Carbon capture, utilization and storage (CCUS)**

**Hydrogen**
3.10

Port of Antwerp-Bruges
With an overall throughput of 289 million tonnes per year, Port of Antwerp-Bruges is a critical hub in worldwide trade and industry. The port is a crucial link for the handling of containers, breakbulk and for the throughput of vehicles. Port of Antwerp-Bruges is home to 1,400 companies and accommodates the largest integrated chemical cluster in Europe. The ambition is clear – to become the world’s first port that reconciles economy, people and climate. As well as growing in a sustainable way, the Port also aims to focus on its unique position as a logistics, maritime and industrial centre and to take the lead in the transition to a circular and low-carbon economy. Together with the port community, customers and other partners, the port is actively seeking innovative solutions for a sustainable future. High on the agenda is its responsibility for the environment and the surrounding society.

### Key highlights

- **City of Antwerp and City of Bruges**
- **Status**
  - Planning
  - Developing
  - Scaling
- **Industries represented**
  - Chemicals
  - Energy (oil and gas)
  - Maritime
  - Power generation
- **16 Mtpa CO₂**
  - annual emissions (2019)
- **164,000**
  - jobs (direct and indirect)
- **€20.8 billion**
  - added economic value impact metric
- **Decarbonization roadmap**
  - Current annual emissions (2019)
  - 16 Mtpa CO₂ (Industry related)
  - 2030 target emissions reduction
  - ↓ 50%
  - Net Zero by 2050
Partnerships are in Port of Antwerp-Bruges’ DNA. In support of the SDGs, the port authority teams up with business frontrunners in order to implement its business plan for sustainable growth and transition. These tailor-made business coalitions are designed to boost the future competitiveness of both port platforms. Dedicated teams for sustainable energy, sustainable industry and sustainable shipping have developed a balanced portfolio of showcase projects, addressing the different businesses on the diverse port platform. The portfolio includes projects for green hydrogen, carbon capture and utilization, circular economy, waste heat and alternative shipping fuels.

The growing list of projects and coalitions include: the Hydrogen Import Coalition, Power-to-Methanol Antwerp, Antwerp@C, the SDG-based chair at the Antwerp Management School, value-based collaboration with CIFAL Flanders, the UN training centre. In addition, non-governmental organizations are actively approached in order to share information and look for a common agenda.

Port of Antwerp-Bruges has been committed from the very start in the Antwerp@C project in order to reduce the CO₂ emissions on the Antwerp port platform by 50% in 2030. The fact that we have been awarded €500 million in EU funding means we can now start building a joint CO₂ infrastructure. It strengthens us in our conviction that as a port authority we must continue to fully assume our role as community builder in order to achieve a climate impact that reaches far beyond the boundaries of the port platform.

Jacques Vandermeiren, Chief Executive Officer, Port of Antwerp-Bruges

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<td>– Cross industry peers</td>
<td>Air Liquide, Fluxys Belgium</td>
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<tr>
<td></td>
<td>– Public authorities</td>
<td></td>
</tr>
<tr>
<td><strong>Industrial cluster infrastructure planning</strong></td>
<td>– Cross industry peers</td>
<td>Air Liquide, BASF</td>
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<tr>
<td></td>
<td>– Public authorities</td>
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<tr>
<td><strong>Shared commercial projects</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Cross-industry funding</strong></td>
<td>– Public authorities</td>
<td>EU Funding</td>
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<td></td>
<td>– Project partners</td>
<td>Project Partners</td>
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<td></td>
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<tr>
<td></td>
<td>– Cross industry peers</td>
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</tr>
<tr>
<td><strong>Reskilling the workforce</strong></td>
<td></td>
<td>– Customers</td>
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</tbody>
</table>

Port of Antwerp-Bruges Partnership
The Port of Antwerp Bruges is a limited liability company under public law, in which the City of Antwerp and the City of Bruges are the sole shareholders. Because of its specific statute and directive role within the cluster, the port takes up the role of enabling partner, within a growing number of coalitions with national and international governments, authorities and agencies in pursuit of its strategic goal of becoming a climate neutral port by 2050.

Policy, at different legislative levels, is a key driver for the types of projects being prioritized in the cluster. The port’s Funding Desk has a pivotal role in connecting policy initiatives such as the EU Innovation Call, which was the key driver for the set up of Antwerp@C, leading to the granted EU funding for this innovative CO₂ reduction initiative.

While the current European energy crisis threatens to impact the speed and direction of clean technology decisions across the continent, PoAB will continue to pursue the on-site production and import of green molecules and engages with relevant policy levels in support of the development of the required enabling policy frameworks.

Belgium is divided in semi-autonomous regions Flanders, Wallonia and Brussels that act as enablers of the European level.

Enabling policies available

Flanders
- The Energy Policy Agreement (EPA): Voluntary commitment to energy audits and energy-saving measures adoption. In exchange, access to a support measures, e.g. rebates on energy taxes, no additional burdens
- INTERREG: €200 million for Flemish-Dutch cooperation
- Circular Flanders: the hub and the inspiration for the Flemish circular economy

Brussels
- BeCircular Project Call, Brucircle, Greenlab Sustainale Accelerator, Village Finance

Wallonia has several financial support initiatives ongoing

Belgium’s Recovery and Resilience Plan
- €1 billion in energy efficient renovation of buildings

How these policies are being leveraged

- NextGen District demo side, Power to Methanol
## Port of Antwerp-Bruges Financing

- Port of Antwerp-Bruges is responsible for the management of the port platforms Antwerp and Zeebrugge. It is a limited liability company of public law between the City of Antwerp and the City of Bruges and plays an important role in the day-to-day operation of Port of Antwerp-Bruges. Around 1,800 employees provide customer-oriented services, guarantee optimal infrastructure, develop innovative projects and promote the port at home and abroad. Together, they are committed to strengthening the role of Port of Antwerp-Bruges as the world’s first port to reconcile people, economy and climate.

- Port of Antwerp-Bruges acts as landlord for 1400 companies operating inside the 143 km² port area. Together with the revenue of the port dues, these concessionaries are fundamental for the port’s financial results. Allowing the organization to invest in state-of-the-art infrastructure, innovation and sustainable transition. The world’s first tugboats running on methanol and hydrogen will be deployed in Q1 2023.

- The Antwerp-Bruges Port Authority has a dedicated funding desk to support financing of large transition projects and has a strong focus on EU funding mechanisms. The Port Authority act as an enabling partner between private companies, governments and agencies.

### Planned funding deployment by technology readiness level

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Port of Antwerp-Bruges Technology

The Port of Antwerp-Bruges, in collaboration with actively decarbonizing tenants, has prioritized a selection of initiatives to be developed on the Port’s platform which will play a strong role in enabling scaled decarbonization across the cluster. The climate transition mission of POAB is to assure the supply and competitiveness of renewable energy and feedstock for the port platform and for the European hinterland. There is a strong focus on infrastructure (waste heat network, CO₂ infrastructure, hydrogen infrastructure) as well as cross-sectoral circularity and efficiency improvements (chemical recycling enablers). The shift to renewable energy (solar/wind) as main energy source with three pillars: local renewable production, green electrons from offshore wind via high voltage grid, import of renewables via ship (green molecules).

Selected technology initiative matrix

- **Systemic efficiency and circularity**

- **Direct electrification and renewable heat**

- **Carbon capture, utilization and storage (CCUS)**

- **Hydrogen**

- **NextGen District** will be the future circular economy hotspot in the port of Antwerp, on the former 88 hectares of General Motors. Port of Antwerp consciously chose to set aside this large area close to Europe’s largest chemical cluster for the circular economy. Innovative players in the circular process and manufacturing industry will give end-of-life products a second or third life, explore circular carbon solutions and carry out experiments with renewable energy.

Digital foundations of the cluster

Port of Antwerp-Bruges has developed a digital twin of the port called: Antwerp Port Information and Control Assistant (APICA). The system combines the data streams generated by cameras, sensors (including i-noses) and means of communication and allows to monitor what is happening in the port including movements and incidents of all sorts. The combination of these data with real time information on weather conditions is accumulated and analysed. The deductive reasoning prepared by artificial intelligence is then published through several channels to be used by port operators.
Zero Carbon Humber (ZCH) is a consortium of 14 partners who share a vision for decarbonization of the UK’s east coast cluster (ECC) and are using hydrogen and shared CCUS infrastructure to deliver a net-zero future. This cluster aims to remove 50% of the UK’s industrial cluster carbon emissions and is centralizing the development of offshore transmission pipelines and a carbon storage facility network to be shared by ZCH and other industrial clusters in the area. ZCH is ensuring grid resiliency and energy security in the east coast region and catalysing economic prosperity by protecting 55,000 energy jobs in the region and securing the sustainable success of the low-carbon industry and infrastructure stakeholders across the value chain.

### Status
- **Planning**
- **Developing**
- **Scaling**

### Industries represented
- Chemicals
- Energy (hydrogen)
- Maritime
- Metals
- Ports
- Power generation

### 2040
- **Net zero goal**

### $2 billion
- GVA up to 2050 (Humber and Teeside)

### Decarbonization roadmap
- **Current annual emissions (2017)**
- **19.8 Mt CO₂**

### Key highlights
- **Hydrogen**
- **CCUS**
- **Direct electrification and renewable heat**
- **Systemic efficiency and circularity**

### Net Zero by 2040

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**Impact on roadmap towards decarbonization**

**Transitioning Industrial Clusters towards Net Zero**
The Zero Carbon Humber cluster was created to develop shared infrastructure to enable decarbonization for 14 partners as well as the greater ECC, which includes Net Zero Teesside and the Northern Endurance Partnership.

Each ZCH partner has autonomy over their own projects. Collaboration concentrates on lobbying and securing funding for the region’s shared industrial infrastructure. Government stakeholders that work closely with the industrial cluster leadership serve as consulting conduits to accessing public programs and funding.

The development of the shared carbon infrastructure is managed through the UK’s Department for Business, Energy, and Industrial Strategy (BEIS) carbon capture and storage cluster sequencing process, which has already designated the ECC to be among the UK’s first scaled CCUS deployments.

Phase two of the BEIS CCUS cluster sequencing process has shortlisted several ZCH projects to move into a due diligence process to move towards confirmed capacity in the shared system and access to business support models.

In September 2022 Equinor and SSE Thermal jointly acquired Triton Power. The key plant included in the purchase of Triton Power is the Saltend Power Station with an installed capacity of 1.2 GW. This is a conventional combined cycle gas turbine (CCGT) that uses natural gas. The main role of this power plant today is to provide electricity during periods of low output from solar and wind. Equinor and SSE Thermal are now starting work on preparing the power plant to use up to 30 percent hydrogen from 2027, with an ambition to eventually increase to 100 percent hydrogen operation. The acquisition of Triton Power strengthens Equinor and SSE Thermal’s portfolio of low carbon solutions in the UK and leverages the work done in Zero Carbon Humber to secure vital low-carbon infrastructure.

Ian Livingston, Project Manager, Equinor

**Energy transition index collaboration model**

<table>
<thead>
<tr>
<th>Collaboration type existing in cluster</th>
<th>Partner types</th>
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<tbody>
<tr>
<td>Shared infrastructure development</td>
<td>Industry peers</td>
<td>National Grid Ventures, Equinor, BP, Uniper, SSE, Drax</td>
</tr>
<tr>
<td>Industrial cluster infrastructure planning</td>
<td>Public authorities</td>
<td>BEIS, National Grid Ventures and Equinor</td>
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<tr>
<td>Shared commercial projects</td>
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<td>Equinor and SSE (Keadby Post Combustion Power Station, Triton Power Acquisition, Aldbrough Hydrogen Storage, Keadby Hydrogen Power Station)</td>
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<td>Cross-industry funding</td>
<td>Public authorities</td>
<td>UK BEIS, UK Research and Innovation</td>
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<tr>
<td>Knowledge sharing</td>
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<td></td>
</tr>
<tr>
<td>Reskilling the workforce</td>
<td>Industry peers</td>
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Zero Carbon Humber Policy

- Zero Carbon Humber was successful in the UK Research and Innovation’s (UKRI) Industrial Decarbonization Challenge competition through which they were awarded funding to develop early-phase projects on CCS and low-carbon hydrogen. The decarbonization target set by the UKRI was to get one cluster to net zero by 2040 and at least four to be significantly decarbonized by 2030. ZCH is targeting net zero by 2040.

- Notably, all projects vying for this UKRI funding and continued support from BEIS and UKRI in scaling clean hydrogen and CCUS projects are required to demonstrate structured collaboration of cross-sectoral industrials and detailed community engagement models.

- The close collaboration between ZCH, regional governments and the UK government has opened the door to bilateral discussions about the future of decarbonization technologies in the country and, valuably to Humber, the role of optimal business models for low-carbon hydrogen and CCS.

- The UK’s Levelling Up agenda and its associated funds support the development of “green skills” and the creation of jobs for the workforce of the future. This programme has guided ZCH in identifying the broader green economy needs for the region.

Enabling policies available

- £315 million Industrial Energy Transformation Fund (IETF) supports energy intensive business investing in efficiency technology.

- The resources and waste strategy sets out circularity goals. This included a £30 million UK Research and Innovation circular economy research programme.

- £200-300 million per annum climate change agreements supporting industrial businesses to achieve energy and carbon savings through energy efficiency improvements.

- £66 million funds under the transforming foundation industries challenge, aiming to bring businesses together to work on common resource and energy efficiency opportunities.

How these policies are being leveraged

N/A
Zero Carbon Humber Financing

- Zero Carbon Humber has greatly benefited from government fiscal support, having secured thus far £21.5 million from the UKRI’s Industrial Decarbonization Challenge (IDC) fund. This funding package will support ZCH to final investment decision – the tipping point during project planning at which major capital investment is required.

- The structured deployment timeline of this federal funding package provokes ZCH’s partners to work together rapidly to deliver on their decarbonization commitments and achieve net zero within the next 18 years.

- Within the cluster, there are established multinationals who continue to contribute internal funds to the larger initiative; the involvement of firms like Equinor, SSE and Drax provide security and assurance for the smaller companies who are more reliant on public short- and long-term funding.

- It is not yet defined in detail how funding will transition from public to private sources. The process may echo the successful example of UK offshore wind where public sector contributions decrease as operational costs fall.

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The cluster anchors on the decarbonization of industry and power through the deployment of carbon capture and storage and low-carbon hydrogen, which will complement one another and build upon the Humber’s successful deployment of scaled offshore wind generation. Outside of the wider industrial development plan, each cluster member has their own decarbonization strategy, mutually benefitting from the cluster’s overarching goals and individualized approach to technology and digital tools.

Zero Carbon Humber Technology

Selected technology initiative matrix

- Systemic efficiency and circularity
- Direct electrification and renewable heat
- Carbon capture, utilization and storage (CCUS)
- Hydrogen

Outside of the wider industrial development plan, each partner company has their own individual strategy and approach to technology and digital tools. This is predominantly driven by the partners’ different use cases for hydrogen and CCUS, the technology selection process and the company philosophy.

Transitioning Industrial Clusters towards Net Zero
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