

In collaboration with  
Accenture and EPRI

# Transitioning Industrial Clusters towards Net Zero

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# Foreword



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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 CO<sub>2</sub> 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.



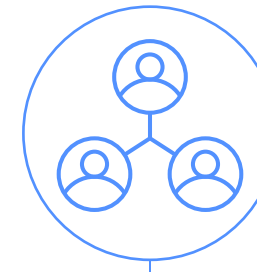


# Executive summary

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?



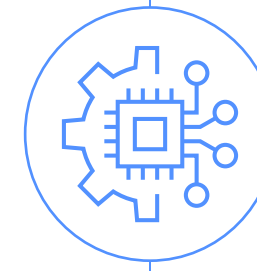
## Policy

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.



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.



1

# Accelerating industrial clusters playbook





# Challenge

The industrial sector is today responsible for 30% of global CO<sub>2</sub> 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.

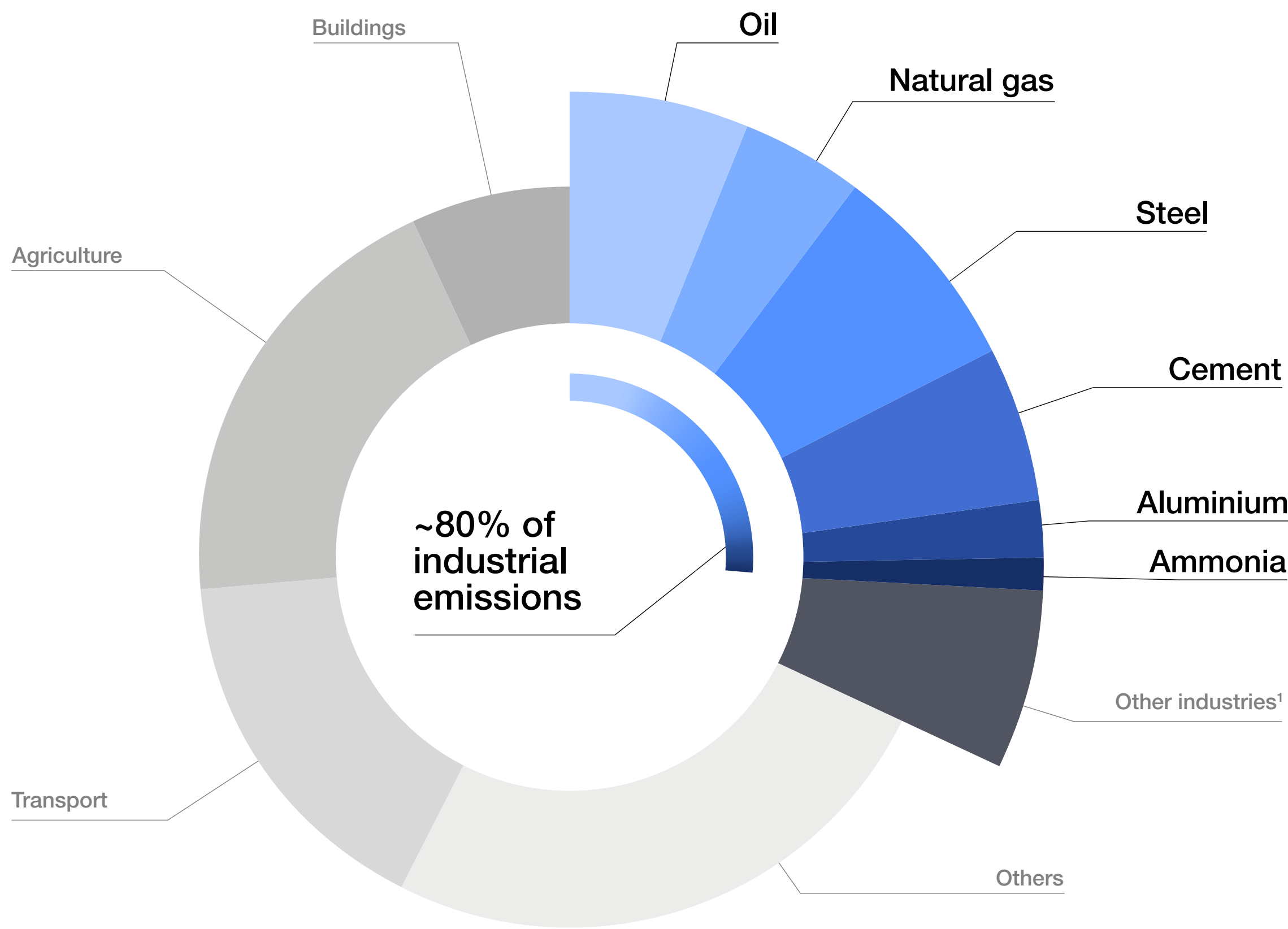
The global energy transition continues to gain momentum as pathways are created to green every nation’s society, regardless of current energy mix or developmental status. More than 130 countries have pledged to be net zero by 2050, but pledges will not be enough. The massive upgrades, retrofits and net 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.

**Source:** “Decarbonizing industry: If Industrial Clusters win, we all win”, *Accenture*, 21 June 2022; World Economic Forum, *Net-Zero Industry Tracker*, 2022; Ritchie, Hannah and Max Rose, “Emissions by sector”, *Our World in Data*, 2020.

## Global GHG emissions by sector (scope 1 and 2)

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.



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

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 CO<sub>2</sub> 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](#).*

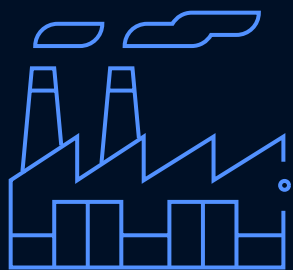
The risks of traditional fossil fuel reliance with today’s price and global supply instability have already driven a quantifiable shift as cross-sectoral stakeholders have moved to harden their clean energy commitments and speed deployment of investment capital. Globally, \$2.3 trillion has already been 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.

**Sources:** “Net Zero Tracker”, *Net Zero Tracker*, n.d., <https://zerotracker.net/>; “Are net zero emissions by 2050 possible? Yes, says IEA”, *World Economic Forum*, 26 May 2021, <https://www.weforum.org/agenda/2021/05/net-zero-emissions-2050-iea>; World Economic Forum, *Fostering Effective Energy Transition: 2021 Edition*, 2021; Transitioning Industrial Clusters towards Net Zero initiative analysis; “Why financial institutions are banking on sustainability”, *UNEP*, 21 April 2022; Accenture, *Investing in industrial clusters*, 2022, <https://www.accenture.com/content/dam/accenture/final/industry/utilities/document/Accenture-Financing-US-Industrial-Clusters-POV.pdf>



## \$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.



## 1.6 billion tonnes CO<sub>2</sub>

The initiative’s 100 industrial clusters goal has the potential to abate 1.6 billion tonnes of CO<sub>2</sub>, protect and create 17 million jobs and contribute \$2.5 trillion to global GDP.



## ~83%

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



## 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.





# 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.

The Transitioning Industrial Clusters towards Net Zero initiative approach advocates for cross-sectoral, global collaboration and frequent reassessment of impact versus intent of locally-prioritized system value framework metrics. By bringing together direct representatives of the entire industrial landscape – from regulators to industry and community members – regions can move more decisively with lessened concerns of stalled progress from regulatory, funding or community intervention. Without full ecosystem inclusion and education, these risks are significant.

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.



**Industry composition**



**Geography**



**Existing infrastructure**



**Energy costs and policy**

A hollistic 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 CO<sub>2</sub> emissions per year or 15% of global CO<sub>2</sub> 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



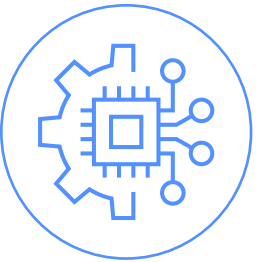
### Policy

- 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.



# Accelerating industrial cluster playbook

## Cluster initiation



Policy



Financing

- 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

Case study





# Accelerating industrial cluster playbook

## Cluster initiation

- 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

Case study

X

### CASE STUDY

## During cluster initiation at the Greater St. Louis and Illinois Regional Clean Hydrogen Hub Industrial Cluster in the Midwest United States

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

- 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

Case study







# Accelerating industrial cluster playbook

## Cluster formalization

- 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

Case study

X

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

- 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

Case study





# Accelerating industrial cluster playbook

## Net-zero strategy development

- 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

Case study

### CASE STUDY

#### During net-zero strategy development at the Net Zero Basque Industrial Super Cluster in Spain’s Basque Country

- 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

- 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

Case study





# Accelerating industrial cluster playbook

## Net-zero strategy implementation: anchor projects

- 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

Case study

### 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

- 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**

Case study





# Accelerating industrial cluster playbook

## Net-zero strategy implementation: full scale

- 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**

Case study

### 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.





2

# 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

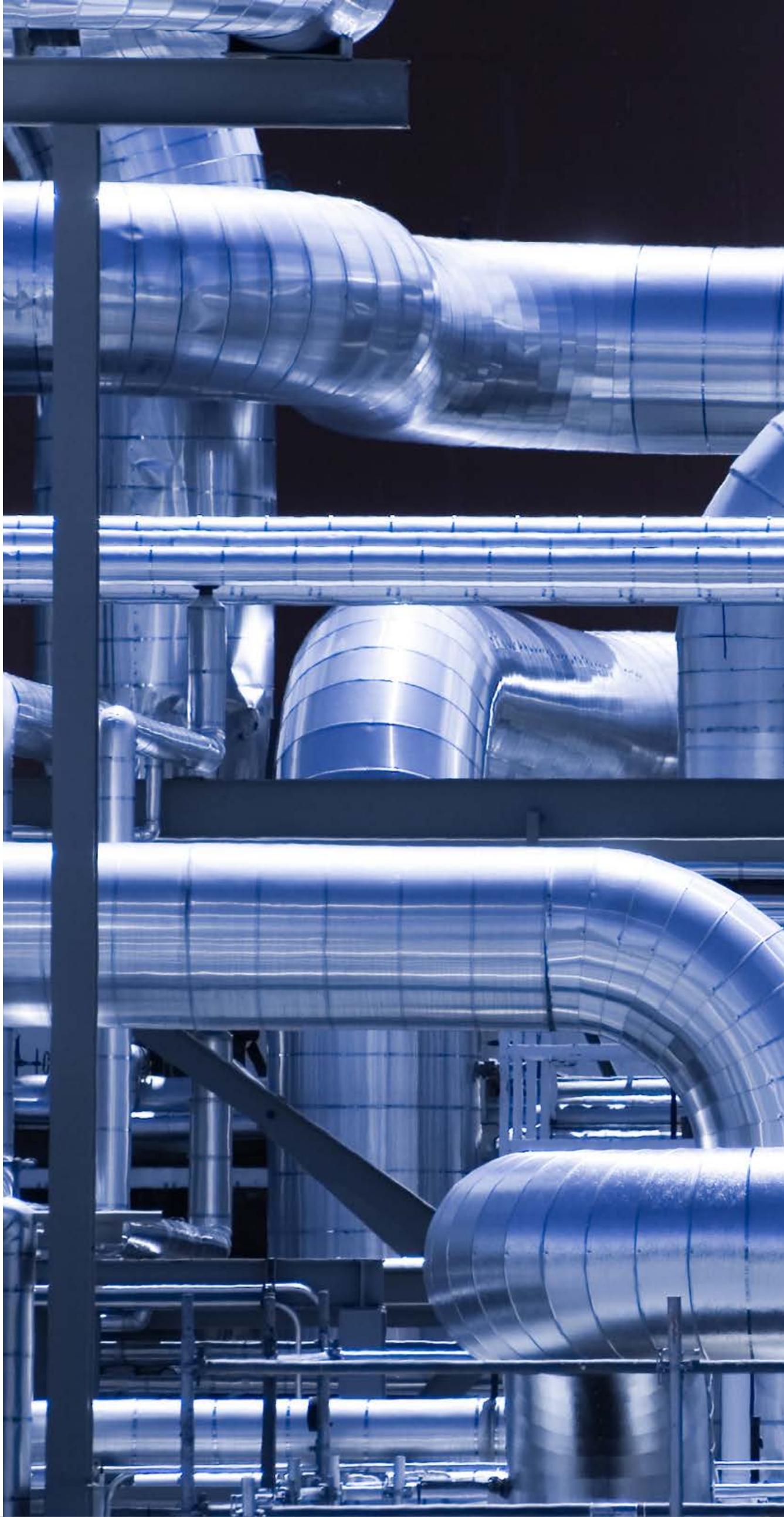
The Transitioning Industrial Clusters towards Net Zero initiative was created with the aim to accelerate industrial decarbonization through a holistic approach, involving cross-industry stakeholders with a technology-neutral focus.

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.









# The global, cross-sectoral community

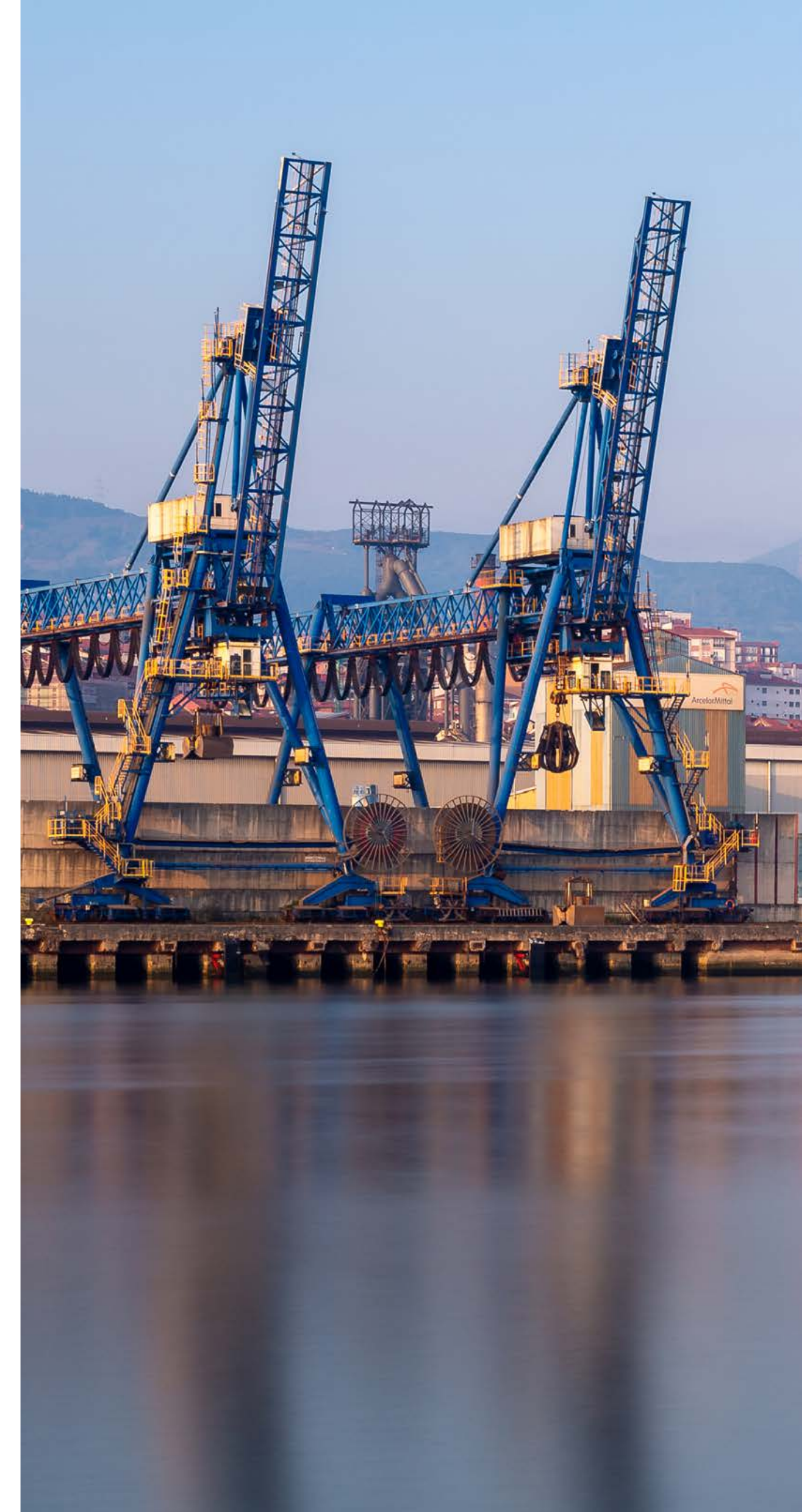
The Transitioning Industrial Clusters towards Net Zero initiative has created a growing platform of signatory industrial clusters with diverse industrial composition, infrastructure and technology approaches to the energy transition. Signatory companies within the clusters represent roles across the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

[Click here to switch between views](#)



# 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.





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.

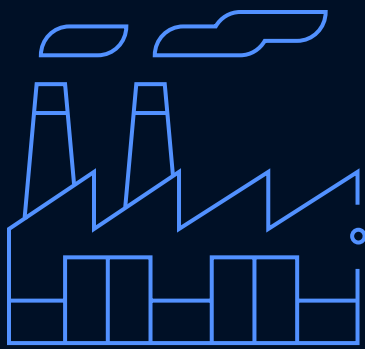
Aligned to the strategic development priorities of the initiative, each cluster is represented through its partnership, policy, financing and technology positioning.

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 CO<sub>2</sub>  
abated emissions represented

2.59 million  
direct/indirect jobs represented



\$188 billion  
GDP contribution represented



# Initiative signatory clusters

## 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.

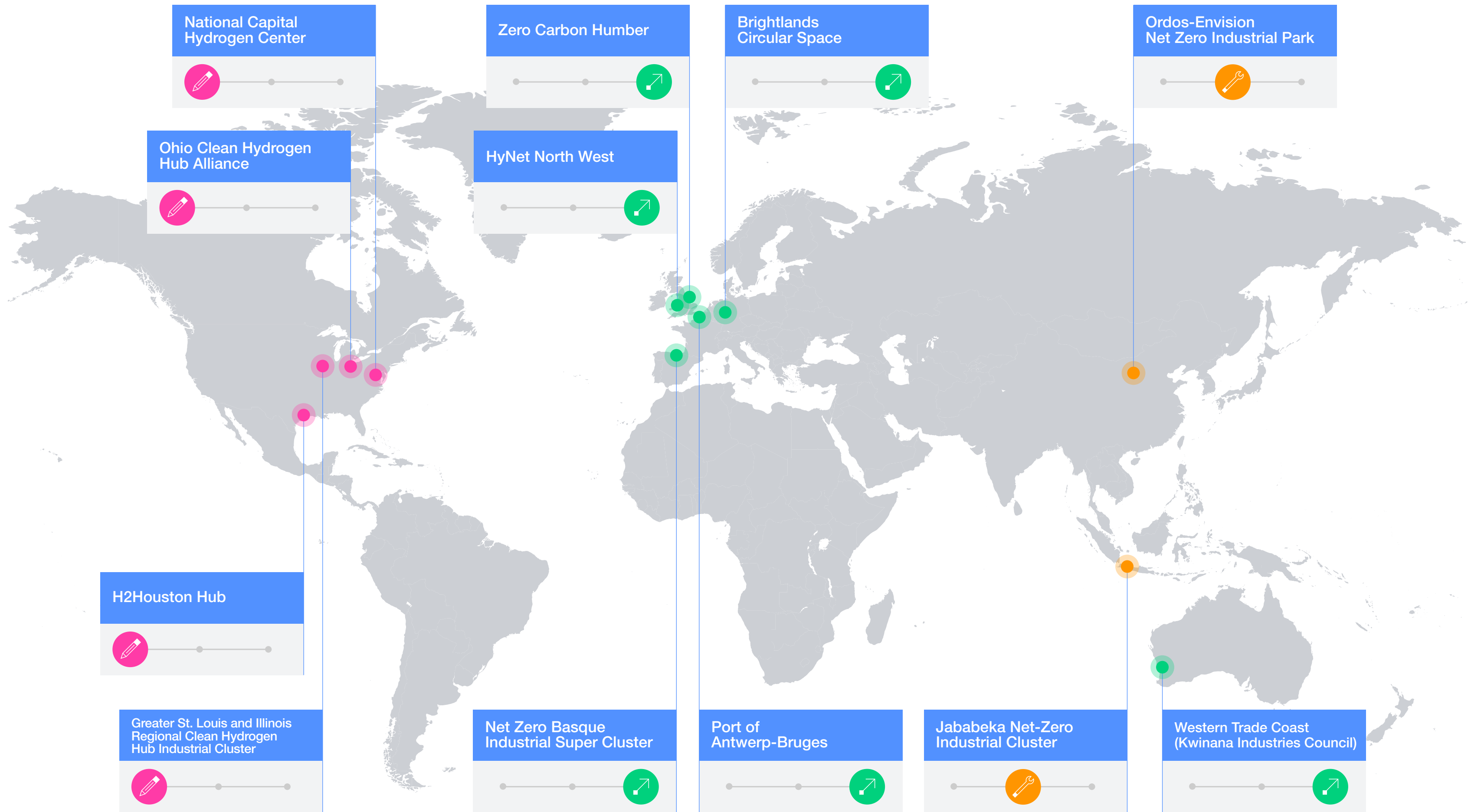


**Developing:** Collaborative physical asset improvements or construction has begun but is not yet facilitating decreased- or avoided-emissions operations.



**Scaling:** Decreased- or avoided-emissions operations are occurring as a result of clean technology integration through collaborative measures.

## Maturity status







3.1

# Brightlands Circular Space



# Brightlands Circular Space

## Key highlights



Sittard-Geleen,  
Netherlands

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 to be 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.

### Status



### Industries represented

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

5.8 Mt CO<sub>2</sub>

annual emissions (2019)

8,100

jobs across 150+ companies

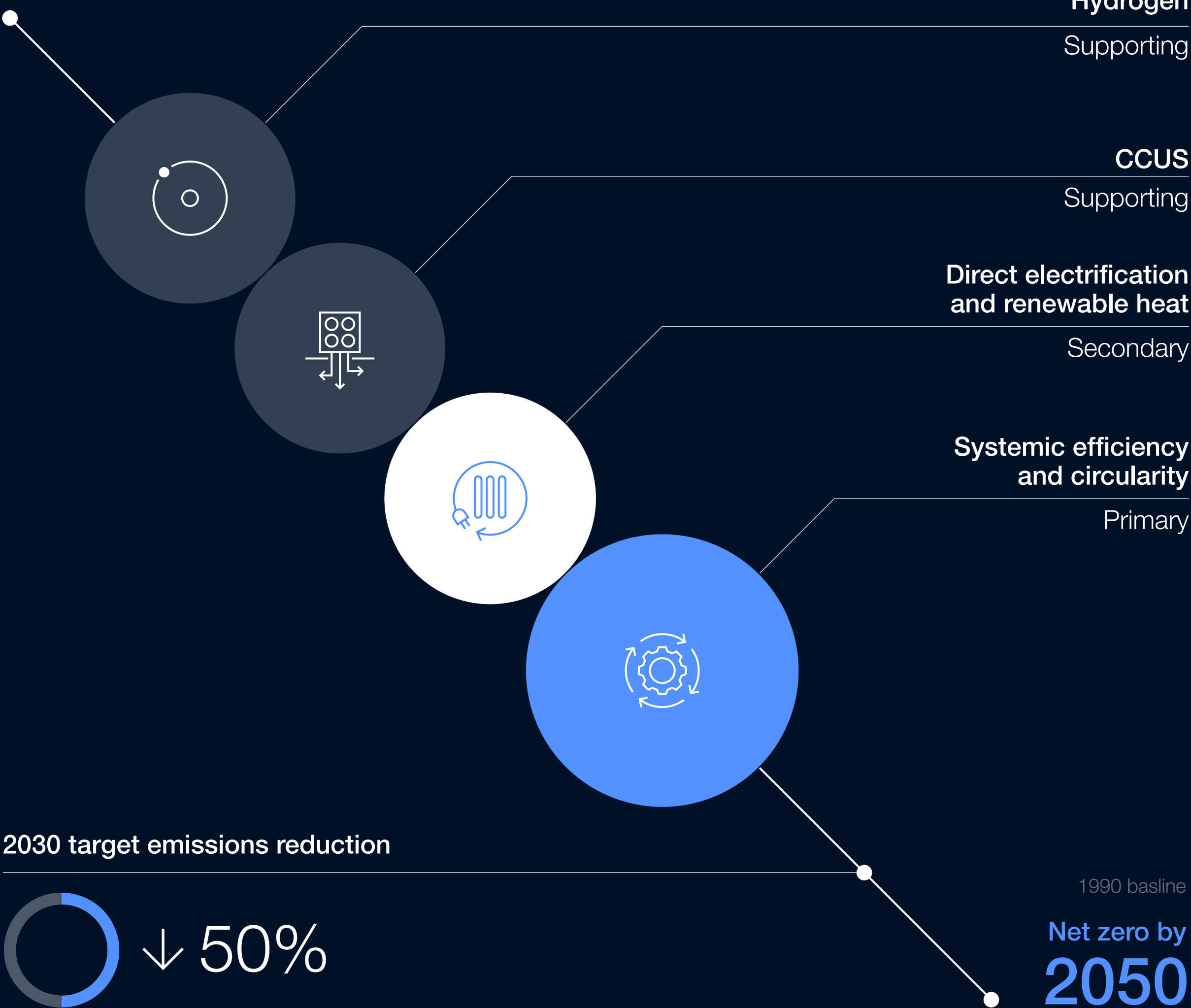
20%

of the regions GVA (2019)

### Decarbonization roadmap

Current annual emissions (2019)

5.8 Mt CO<sub>2</sub>





# Brightlands Circular Space Partnership



The transformation in energy and raw materials and cooperation is one of the greatest challenges for the future. Replacing fossil raw materials with waste and recycling products form the foundation for the development of the circular economy. In this regard it is not only new technology that is important, but also new business models, new forms of cooperation and the development of new competencies. Therefore, we set the goal to develop blueprints for a plastic waste refinery. We do this in an open space environment, making use of our estimated state-of-the-art infrastructure, aimed at scaling up innovative circular technology and the application of innovative processes and/or other forms of cooperation. For us the Forum’s Net Zero initiative fits seamlessly into our journey. I believe only cooperation on this level makes the change we are looking for in tomorrow’s life.

Lia Voermans, Director, Circular Economy, Brightlands Chemelot Campus

- 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.

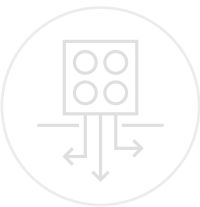
## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	<ul style="list-style-type: none"><li>– Researchers</li><li>– Cross-industry partners</li><li>– Entrepreneurs</li><li>– Students</li><li>– Designers</li></ul>	TNO, Maastricht University, Chemelot Industrial partners, CHILL, Brightlands
Industrial cluster infrastructure planning	<ul style="list-style-type: none"><li>– Public-private partners</li></ul>	
Shared commercial projects	<ul style="list-style-type: none"><li>– Cross-industry peers</li><li>– Public private institutions</li><li>– Brand owners</li><li>– Entrepreneurs</li></ul>	Chemelot Circular Hub Network, TNO
Cross-industry funding	<ul style="list-style-type: none"><li>– Public authorities</li><li>– Private investors</li><li>– Regional, national and EU level partners</li><li>– Venture partners</li></ul>	
Knowledge sharing	<ul style="list-style-type: none"><li>– Researchers</li><li>– Cross-industry partners</li><li>– Entrepreneurs</li><li>– Students</li></ul>	BMC, AMIBM, CHILL, Maastricht University, TNO
Reskilling the workforce	<ul style="list-style-type: none"><li>– Schools</li><li>– Applied and academic institutions</li><li>– Regional authorities</li></ul>	Maastricht University, Zuyd, CHILL, labour consultancies



# 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 CO<sub>2</sub> emission reduction solutions, primarily at the stage of testing new technologies and processes before scaled investment.



CCUS



Hydrogen



# 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.

## Planned funding deployment by technology readiness level

Development stage	Technology readiness level	Funding allocation		
		Now	In 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	✓	✓	✓
	Technology concepts and/or application formulated	✓	✓	✓
	Proof-of-concept validation	✓	✓	✓
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	✓	✓	✓
	Early system validation demonstrated in a laboratory or limited field application	✓	✓	✓
	Early field demonstration and system refinements completed	✓	✓	✓
	Complete system demonstration in an operational environment	✓	✓	✓
At scale commercial deployment	Early commercial deployment	✓	✓	✓
	Wide-scale commercial deployment	○	○	✓



# 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

## 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 Syschemic 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



# H2Houston Hub

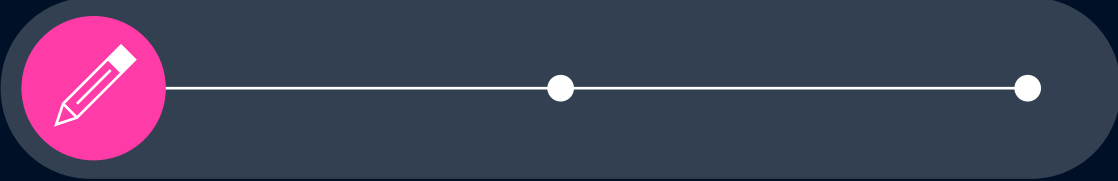
## Key highlights



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.

### Status



Planning      Developing      Scaling

### Industries represented

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

## 220 Mt CO<sub>2</sub>

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

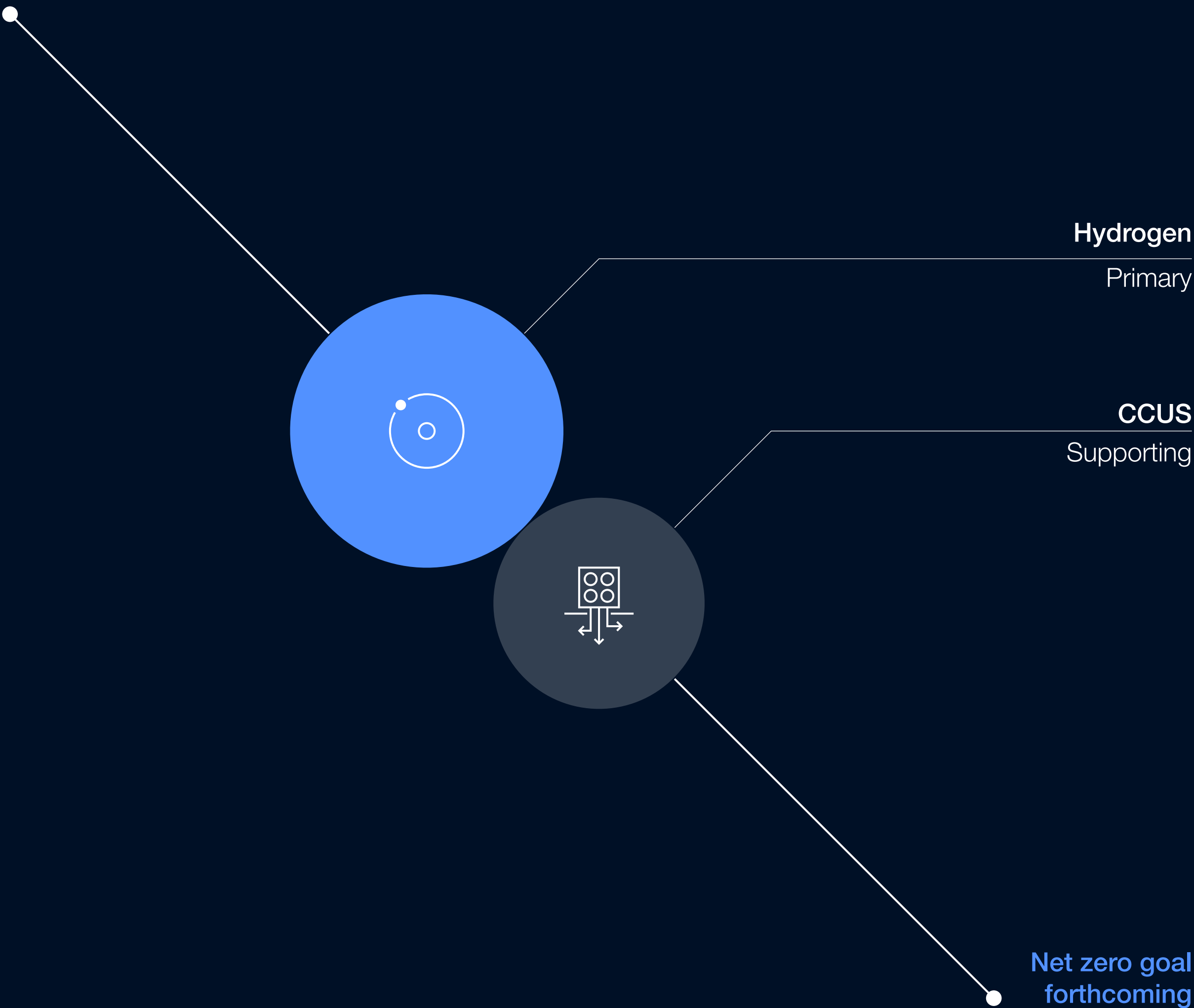
## \$100 billion

potential addition to Texas GDP (6% of Texas 2019 GDP) by 2050

### Decarbonization roadmap

Current annual emissions (2019)

## 220 Mt CO<sub>2</sub>





# H2Houston Hub Partnership



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

- 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.

## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	<div>– Suppliers</div> <div>– Industry peers</div>	
Industrial cluster infrastructure planning	<div>– Researchers ———&gt; University of Texas, Texas A&amp;M</div> <div>– Non-profits ———&gt; Center for Houston’s Future, GTI Energy</div>	
Shared commercial projects	<div>– Cross-industry peers</div>	
Cross-industry funding		
Knowledge sharing	<div>– Researchers ———&gt; University of Texas, Texas A&amp;M</div> <div>– Non-profits ———&gt; Center for Houston’s Future, GTI Energy</div>	
Reskilling the workforce	<div>– Researchers ———&gt; University of Texas, Texas A&amp;M</div> <div>– Non-profits ———&gt; Center for Houston’s Future, GTI Energy, HARC</div>	



# 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.

### Planned funding deployment by technology readiness level

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications			
	Technology concepts and/or application formulated			
	Proof-of-concept validation			
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions			
	Early system validation demonstrated in a laboratory or limited field application			
	Early field demonstration and system refinements completed			
	Complete system demonstration in an operational environment			
At scale commercial deployment	Early commercial deployment			
	Wide-scale commercial deployment			



# H2Houston Hub Technology

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

## 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 CO<sub>2</sub> Emissions Database, which supports the examination of potential CCUS clusters, testing of CO<sub>2</sub> 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 North West

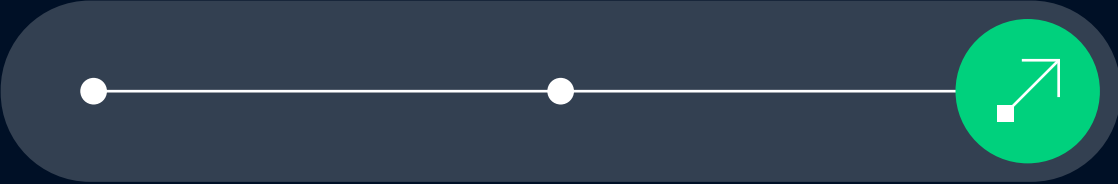
## Key highlights



North West  
England and  
North East Wales,  
United Kingdom

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.

### Status



Planning      Developing      **Scaling**

### Industries represented

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

# 10 Mt CO<sub>2</sub>

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

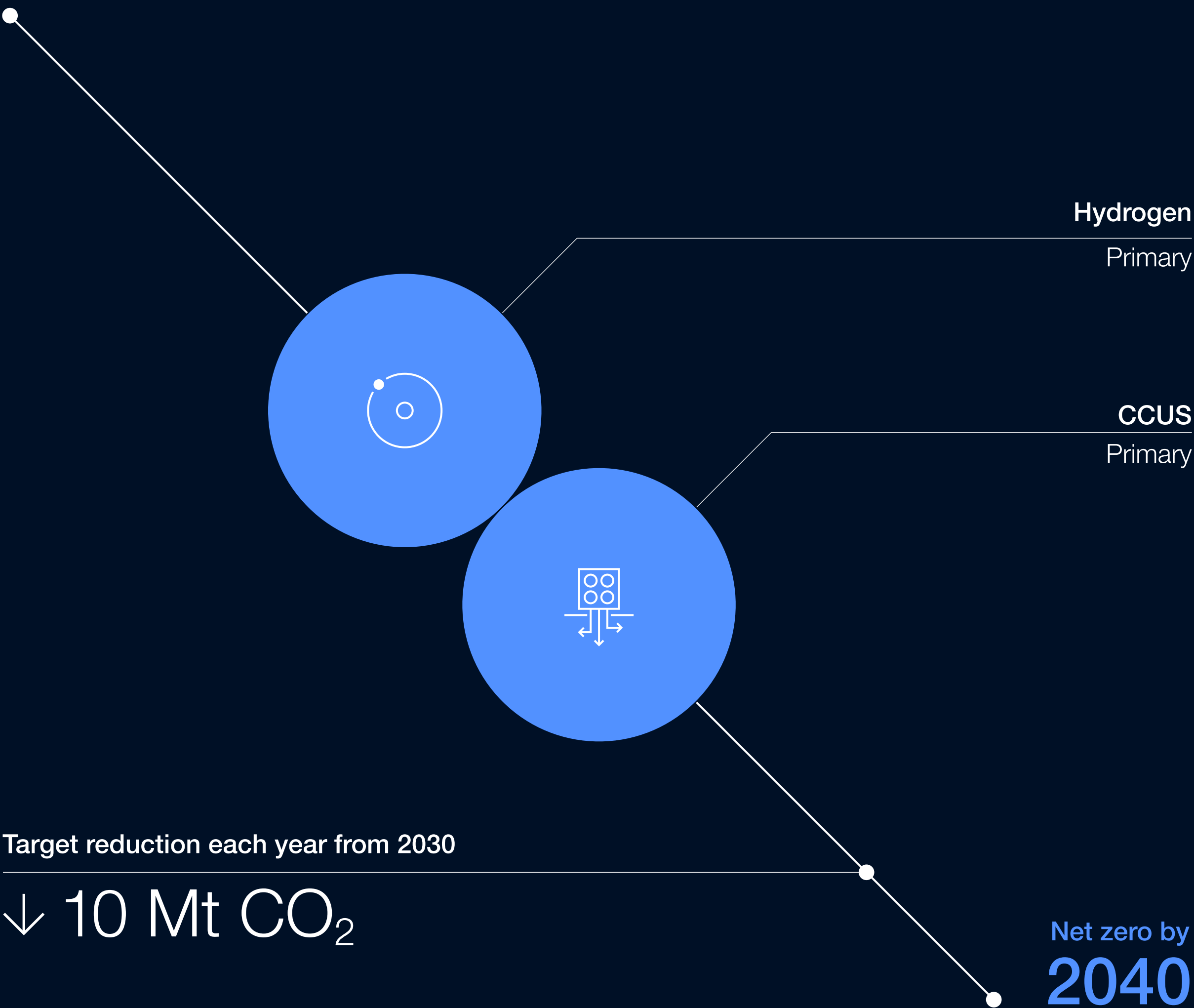
### Decarbonization roadmap

Current annual emissions (2019)

# 40 Mt CO<sub>2</sub>

across all sources of emissions within the North West

Impact on roadmap  
towards decarbonization





# HyNet North West Partnership



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 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.

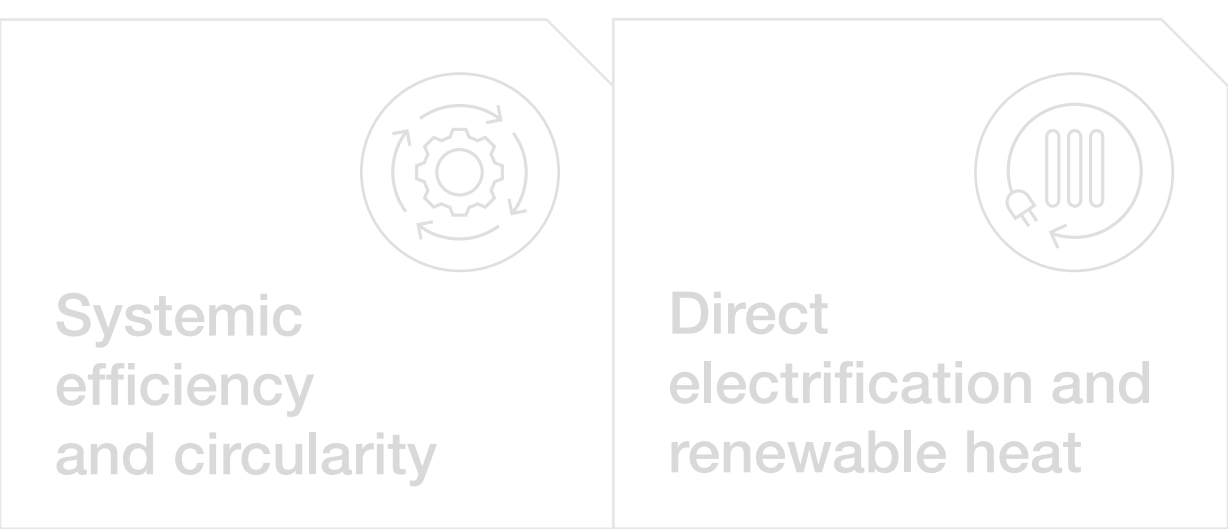
## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	– Industry peers	Eni, Cadent, Vertex Hydrogen, INOVYN
Industrial cluster infrastructure planning	– Cross-industry peers	Eni, Cadent, Vertex Hydrogen, INOVYN, Hanson, Viridor and hydrogen off-takers
Shared commercial projects	– Industry peers	Progressive Energy, Eni, Cadent, Vertex Hydrogen
Cross-industry funding	– Public authorities – Financiers (public and private)	– Government Funding from BEIS and UKRI – Private funding from HyNet partners
Knowledge sharing	– Cross-industry peers – Researchers	Eni, Progressive Energy, Cadent, Essar, Vertex Hydrogen, Hanson, INOVYN and University of Chester
Reskilling the workforce	– Industry types	Eni, Progressive Energy, Cadent, Essar, Vertex Hydrogen, Hanson, INOVYN and University of Chester



# HyNet North West Policy

- 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 CO<sub>2</sub>.







# 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 CO<sub>2</sub> emissions from energy-intensive processes, transport and safely store these emissions underground.

## Selected technology initiative matrix

	<b>Systemic efficiency and circularity</b>
	<b>Direct electrification and renewable heat</b>

## 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 the 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



# Jababeka Net-Zero Industrial Cluster

## Key highlights



Cikarang, West Java, Indonesia

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.

### Status



### Industries represented

- Chemicals
- Materials and manufacturing
- Metals
- Power generation

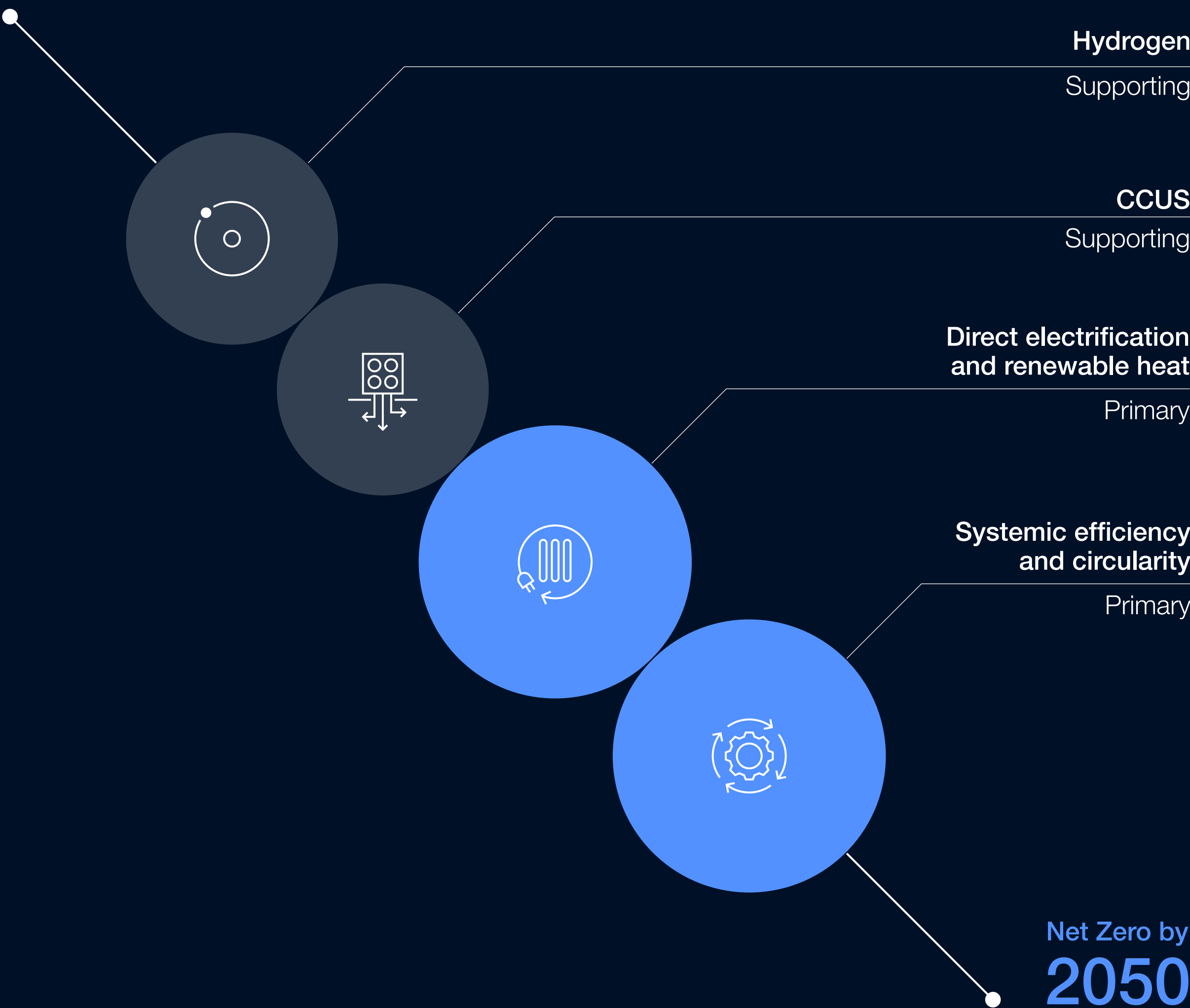
709 kilotons CO<sub>2</sub>  
annual emissions (2022)\*

1.7 million  
jobs protected

\* Estimated 2022 carbon emissions associated with grid-supplied electricity. Preliminary analysis by Accenture.

### Decarbonization roadmap

Current annual emissions (2022)  
709 kilotons CO<sub>2</sub>\*





# Jababeka Net-Zero Industrial Cluster Partnership



The 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

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.

## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	Jababeka Infrastruktur, in collaboration with Pertamina New & Renewable Energy	
Industrial cluster infrastructure planning	Workplan to be developed	
Shared commercial projects	Workplan to be developed	
Cross-industry funding	Workplan to be developed	
Knowledge sharing	Jababeka Infrastruktur via FabLab Jababeka, a collaboration with President University	
Reskilling the workforce	Jababeka Infrastruktur via FabLab Jababeka, a collaboration with President University	



# Jababeka Net-Zero Industrial Cluster Policy

- 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.



# 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.

## Planned funding deployment by technology readiness level

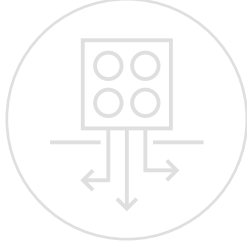

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	<input type="radio"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Technology concepts and/or application formulated	<input type="radio"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Proof-of-concept validation	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	<input type="radio"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Early system validation demonstrated in a laboratory or limited field application	<input type="radio"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Early field demonstration and system refinements completed	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Complete system demonstration in an operational environment	<input type="radio"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
At scale commercial deployment	Early commercial deployment	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>
	Wide-scale commercial deployment	<input type="radio"/>	<input type="radio"/>	<input checked="" type="checkbox"/>



# Jababeka Net-Zero Industrial Cluster Technology

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.

## Selected technology initiative matrix

	Carbon capture, utilization and storage (CCUS)
	Hydrogen

## Digital foundations of the cluster

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



# Kwinana Industries Council

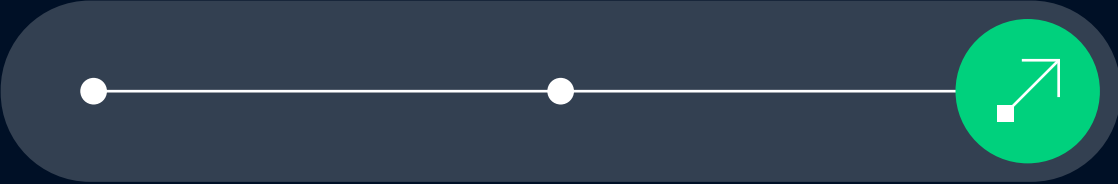
## Key highlights



Kwinana, Perth, Australia

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.

### Status



Planning      Developing      Scaling

### Industries represented

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

8.2 Mt CO<sub>2</sub>

per year (2021)

30,000

jobs across the precinct

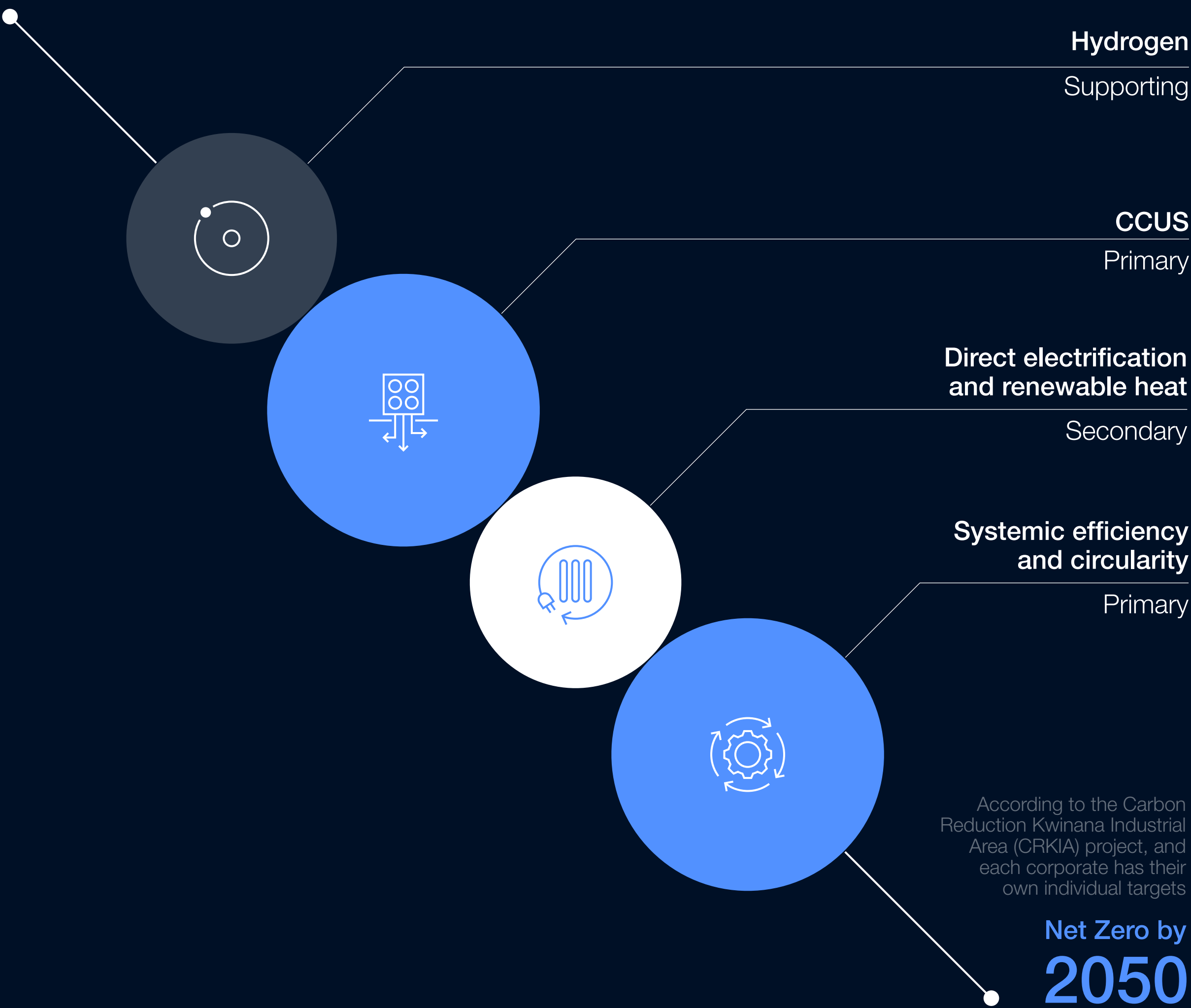
AUD 16 billion

GDP

### Decarbonization roadmap

Current annual emissions (2021)

8.2 Mt CO<sub>2</sub>





# Kwinana Industries Council Partnership



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

- 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

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	– Public authorities	Water Corporation, Synergy and Fremantle Ports
Industrial cluster infrastructure planning	Single firms collaborating under the KIC banner, and also collaboration with government	
Shared commercial projects	A range of technology providers is in discussion with several industry partners. Memoranda of understanding agreements underpinning these discussions.	
Cross-industry funding	Via KIC membership fees for full and associate members. Government identifying sectors and individual sector corporates for financial assistance.	
Knowledge sharing	<b>Public authorities:</b> the Australian government Department of Jobs, Tourism, Science and Innovation (JTSI) <b>KIC:</b> specialist committee established for knowledge sharing and project potential evaluation	
Reskilling the workforce	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.	



# Kwinana Industries Council Policy

- 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.



# 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.

### Planned funding deployment by technology readiness level

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	✓	✓	✓
	Technology concepts and/or application formulated	✓	✓	✓
	Proof-of-concept validation	✓	✓	✓
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	✓	✓	✓
	Early system validation demonstrated in a laboratory or limited field application	✓	✓	✓
	Early field demonstration and system refinements completed	✓	✓	✓
	Complete system demonstration in an operational environment	○	✓	✓
At scale commercial deployment	Early commercial deployment	○	✓	✓
	Wide-scale commercial deployment	○	✓	✓



# 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

## 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



# National Capital Hydrogen Center

## Key highlights



Washington DC,  
Maryland, Virginia,  
USA

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 MtCO<sub>2</sub> by 2030.

### Status



Planning

Developing

Scaling

### Industries represented

- Aviation
- Heavy transport
- Energy (hydrogen)
- Maritime

180 Mt CO<sub>2</sub>

annually

8,900

jobs created

\$1.7 billion

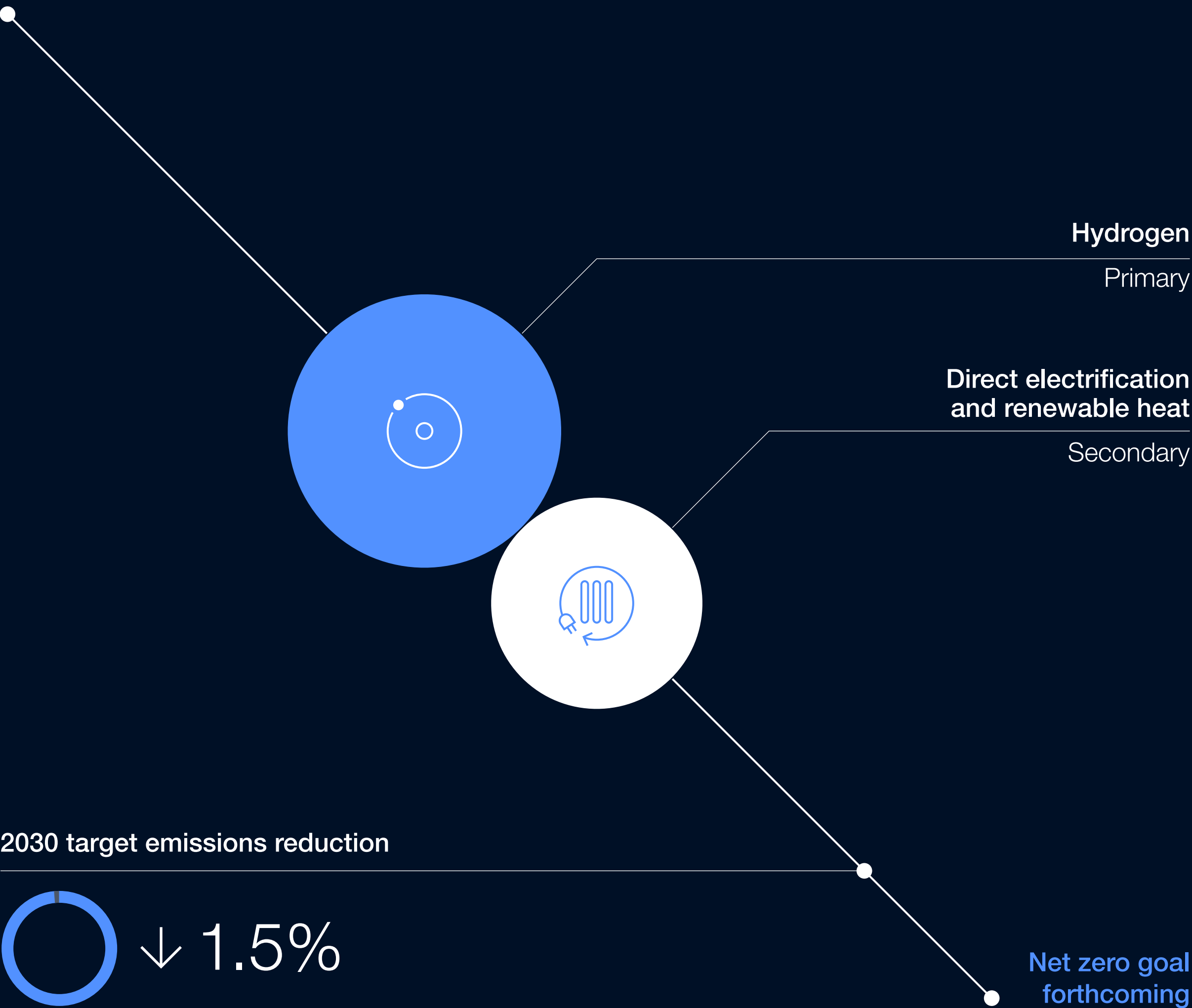
gross value added in the region by 2030

### Decarbonization roadmap

Current annual emissions

2.7 Mt CO<sub>2</sub>

Impact on roadmap  
towards decarbonization





# National Capital Hydrogen Center Partnership



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

- The National Capital Hydrogen Center is led by a non-profit “do-tank”, Connected DMV, and managed by an independent steering committee of public and private organizations pursuing the DOE’s Clean Hydrogen Hub funding: A selection of steering committee members includes Washington Gas, Constellation Energy, Exelon, Dominion Energy, Universal Hydrogen, US Department of Defense, US Department of Transportation, Accenture, Plug Power, Virginia Tech, DOE and Connected DMV.
- 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.

## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	<ul style="list-style-type: none"><li>– Industry peers</li><li>– Non-profit and think tanks</li><li>– Researchers</li><li>– Public authorities</li></ul>	
Industrial cluster infrastructure planning	<ul style="list-style-type: none"><li>– Non-profit and think tanks</li></ul>	The National Capital Hydrogen Center Steering Committee, the Mid-Atlantic Hydrogen Hub
Shared commercial projects		
Cross-industry funding		
Knowledge sharing	<ul style="list-style-type: none"><li>– Non-profit and think tanks</li><li>– Academia</li></ul>	Environmental and social equity groups leading regional colleges and universities
Reskilling the workforce	<ul style="list-style-type: none"><li>– Non-profit and think tanks</li></ul>	



# 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.

## Planned funding deployment by technology readiness level

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Technology concepts and/or application formulated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Proof-of-concept validation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early system validation demonstrated in a laboratory or limited field application	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early field demonstration and system refinements completed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Complete system demonstration in an operational environment	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
At scale commercial deployment	Early commercial deployment	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
	Wide-scale commercial deployment	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>



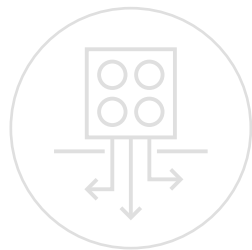
# National Capital Hydrogen Center Technology

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



Systemic efficiency and circularity



Carbon capture, utilization and storage (CCUS)

## 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



# Net Zero Basque Industrial Super Cluster

## Key highlights



Basque Country,  
Spain

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).

### Status



### Industries represented

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

7.2 Mt CO<sub>2</sub>

annual emissions (2019)

20,000-30,000

jobs created by 2030 (2-3% of jobs in 2021)

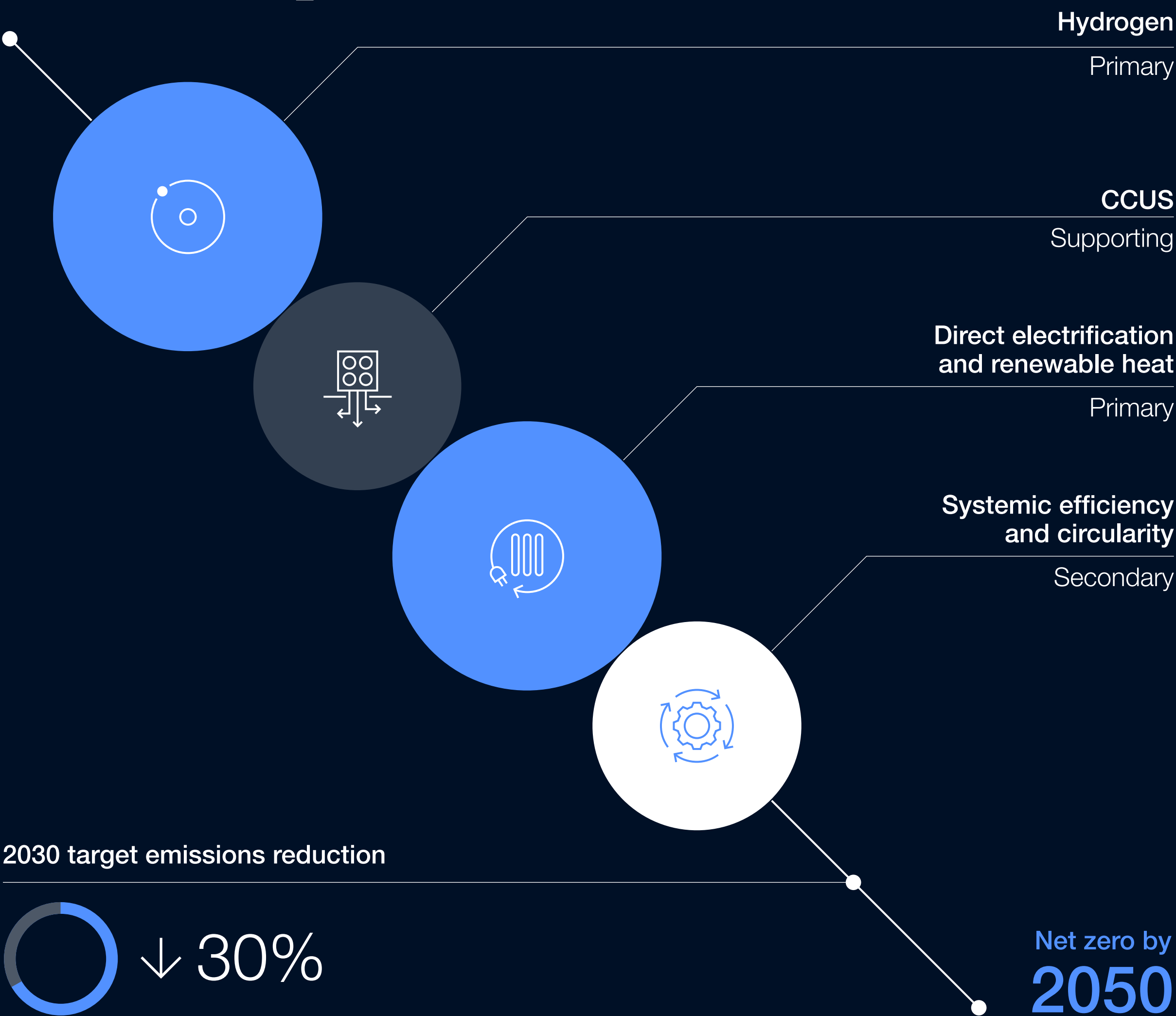
€2-3 billion

economic impact in 2030  
(3%-5% of GDP in 2021)

### Decarbonization roadmap

Current annual emissions (2019)

7.2 Mt CO<sub>2</sub>





# 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.

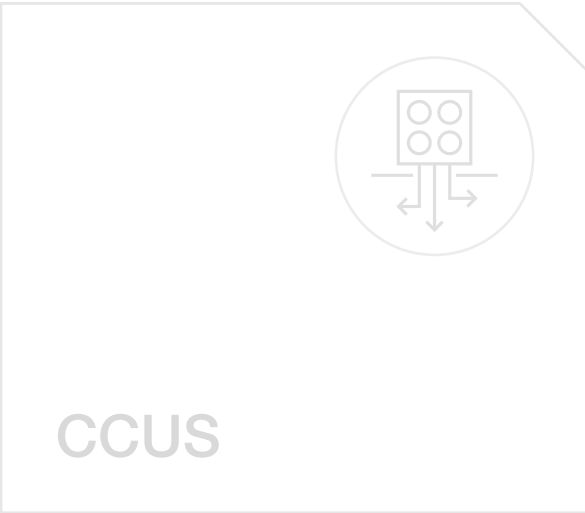
## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development		
Industrial cluster infrastructure planning	<div>– Public authorities</div> <div>– Cross-industry peers</div>	SPRI, Iberdrola, Petronor-Repsol, Basque industry associations
Shared commercial projects		
Cross-industry funding	<div>– Public authorities</div> <div>– Financiers (public and private)</div>	SPRI, Iberdrola, Petronor-Repsol
Knowledge sharing	<div>– Public authorities</div> <div>– Cross-industry peers</div> <div>– Researchers</div>	SPRI, Iberdrola, Petronor-Repsol, energy cluster, foundry cluster, iron and steel cluster, pulp and paper cluster and concrete cluster, EPRI
Reskilling the workforce		



# 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.





# 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

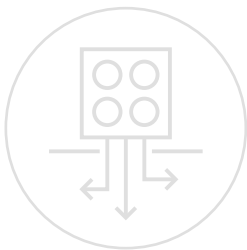
Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	✓	✓	✓
	Technology concepts and/or application formulated	✓	✓	✓
	Proof-of-concept validation	✓	✓	✓
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	✓	✓	✓
	Early system validation demonstrated in a laboratory or limited field application	✓	✓	✓
	Early field demonstration and system refinements completed	✓	✓	✓
	Complete system demonstration in an operational environment	✓	✓	✓
At scale commercial deployment	Early commercial deployment	○	✓	✓
	Wide-scale commercial deployment	○	✓	✓



# Net Zero Basque Industrial Super Cluster Technology

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



Carbon capture,  
utilization and  
storage (CCUS)

## 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



# Ohio Clean Hydrogen Hub Alliance

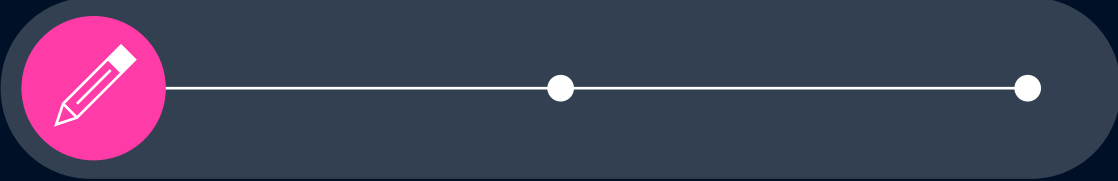
## Key highlights



Ohio, USA

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.

### Status



Planning      Developing      Scaling

### Industries represented

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

## 170 Mt CO<sub>2</sub>

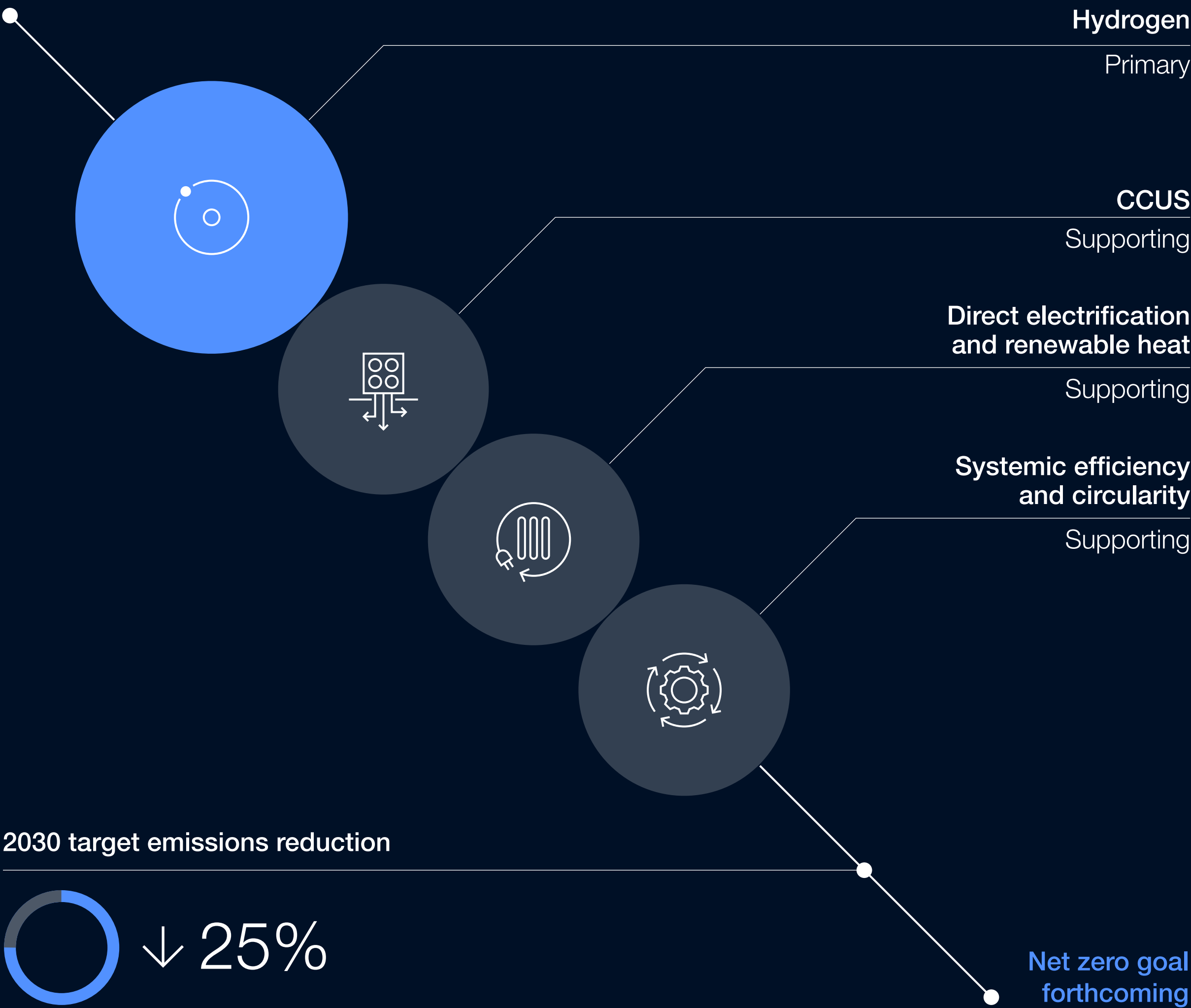
Emission reduction in Electric Power, Transportation, and Industry Economic Sectors by 2025

### Decarbonization roadmap

Current annual emissions (2020)

## 170 Mt CO<sub>2</sub>

Impact on roadmap towards decarbonization



2030 target emissions reduction



Net zero goal forthcoming



# 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 feed stock, 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

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development		
Industrial cluster infrastructure planning	<ul style="list-style-type: none"><li>– Cross-industry peers</li><li>– Researchers</li><li>– Non-profit and think tanks</li></ul>	Dominion Energy, Cleveland State University, SARTA, Midwest Hydrogen Center of Excellence
Shared commercial projects		
Cross-industry funding	<ul style="list-style-type: none"><li>– Researchers</li></ul>	Battelle
Knowledge sharing	<ul style="list-style-type: none"><li>– Researchers</li></ul>	Battelle
Reskilling the workforce		



# 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

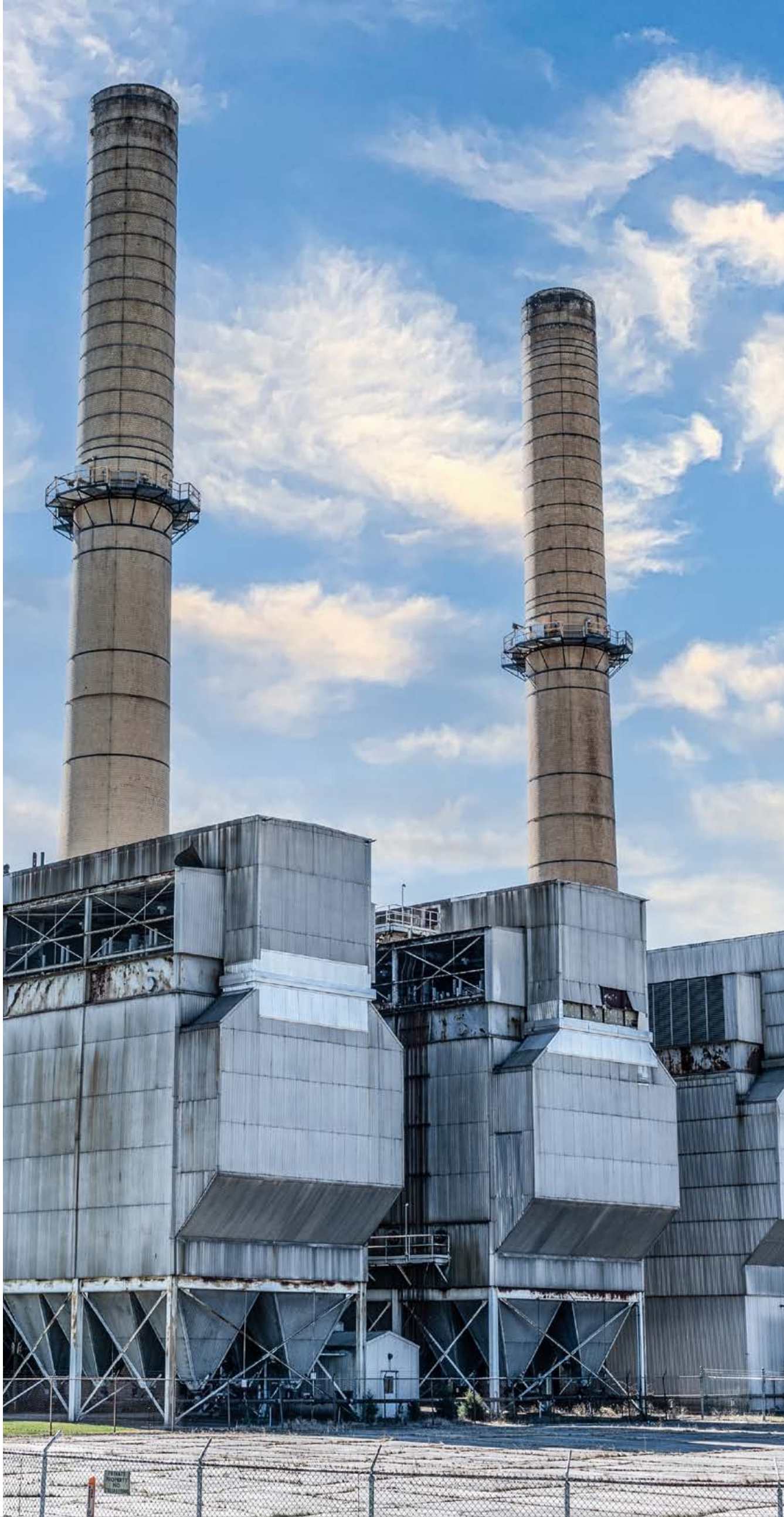
Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	✓	✓	✓
	Technology concepts and/or application formulated	✓	✓	✓
	Proof-of-concept validation	✓	✓	✓
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	✓	✓	✓
	Early system validation demonstrated in a laboratory or limited field application	✓	✓	✓
	Early field demonstration and system refinements completed	✓	✓	✓
	Complete system demonstration in an operational environment	✓	✓	✓
At scale commercial deployment	Early commercial deployment	✓	✓	✓
	Wide-scale commercial deployment	○	○	✓



# 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







3.9

# Ordos-Envision Net Zero Industrial Park



# Ordos-Envision Net Zero Industrial Park

## Key highlights



Ordos,  
Inner Mongolia

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.

### Status



### Industries represented

- Chemicals
- Energy (hydrogen)
- Materials and manufacturing
- Power generation

12.4 Mt CO<sub>2</sub>

Emission reduction by 2025

100,000

green high-tech jobs by 2025

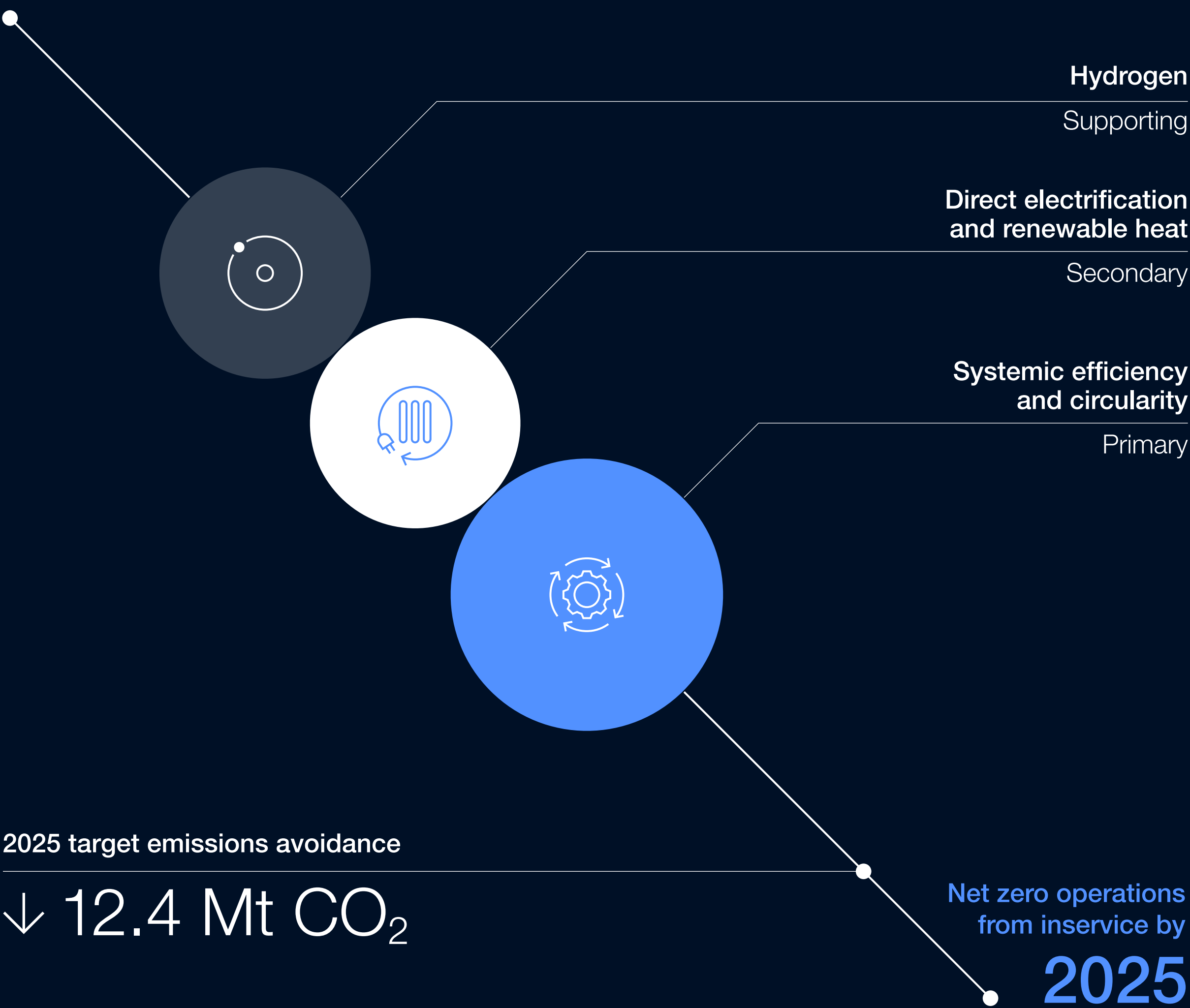
\$45 billion

in new green industry by 2025

### Decarbonization roadmap

Current annual emissions

N/A





# Ordos-Envision Net Zero Industrial Park Partnership



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 clusters 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.

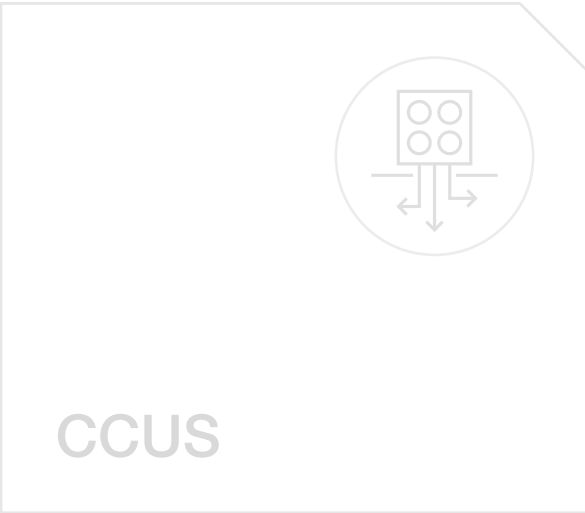
## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	– Public authorities	Ordos Government
Industrial cluster infrastructure planning	– Public authorities – Cross-industry peers	Mayor of Ordos, representatives of Envision and other companies, and Cluster Administration Committee
Shared commercial projects	– Cross-industry peers	Partnering with green industrial leaders including LONGi, Huayou, SAIC Hongyan
Cross-industry funding		\$16 billion in attracted investment across industry partners
Knowledge sharing		
Reskilling the workforce		



# Ordos-Envision Net Zero Industrial Park Policy

- 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





# 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

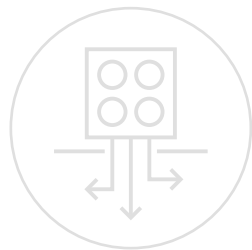
Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	✓	✓	✓
	Technology concepts and/or application formulated	✓	✓	✓
	Proof-of-concept validation	✓	✓	✓
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	✓	✓	✓
	Early system validation demonstrated in a laboratory or limited field application	✓	✓	✓
	Early field demonstration and system refinements completed	✓	✓	✓
	Complete system demonstration in an operational environment	✓	✓	✓
At scale commercial deployment	Early commercial deployment	○	✓	✓
	Wide-scale commercial deployment	○	✓	✓



# Ordos-Envision Net Zero Industrial Park Technology

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.

## Selected technology initiative matrix



Carbon capture,  
utilization and  
storage (CCUS)

## Digital foundations of the cluster

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.





3.10

# Port of Antwerp-Bruges



# Port of Antwerp-Bruges

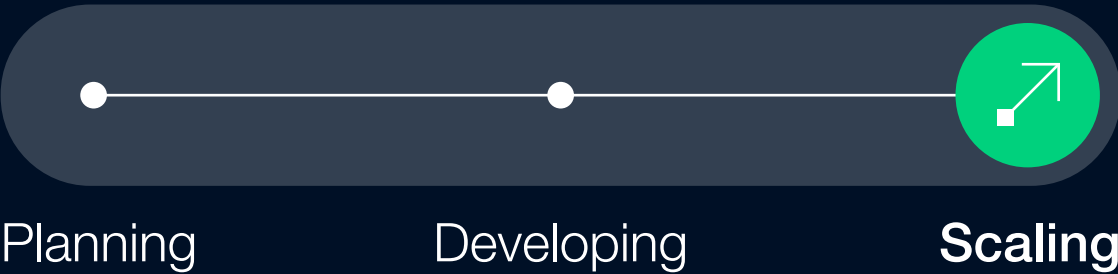
## Key highlights



City of Antwerp and  
City of 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.

### Status



### Industries represented

- Chemicals
- Maritime
- Energy (oil and gas)
- Power generation

# 16 Mtpa CO<sub>2</sub>

annual emissions (2019)

# 164,000

jobs (direct and indirect)

# €20.8 billion

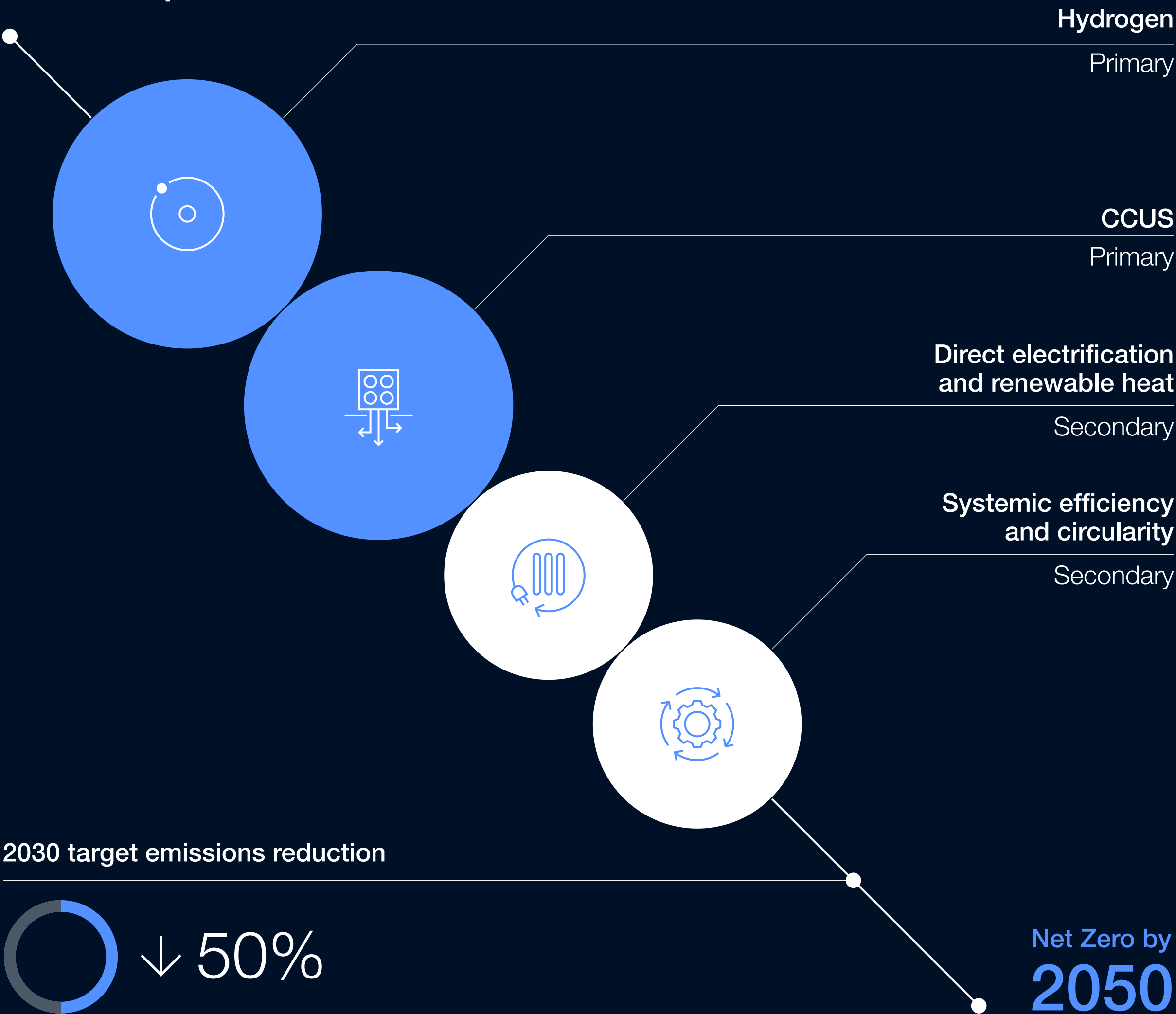
added economic value impact metric

### Decarbonization roadmap

Current annual emissions (2019)

# 16 Mtpa CO<sub>2</sub>

(Industry related)





# Port of Antwerp-Bruges Partnership



Port of Antwerp-Bruges has been committed from the very start in the Antwerp@C project in order to reduce the CO<sub>2</sub> 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 CO<sub>2</sub> 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

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.

## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	<div><div>– Cross industry peers</div><div>– Public authorities</div></div>	Air Liquide, Fluxys Belgium
Industrial cluster infrastructure planning	<div><div>– Cross industry peers</div><div>– Public authorities</div></div>	Air Liquide, BASF
Shared commercial projects		
Cross-industry funding	<div><div>– Public authorities</div><div>– Project partners</div></div>	<div><div>EU Funding</div><div>Project Partners</div></div>
Knowledge sharing	<div><div>– Cross industry peers</div></div>	Project partners
Reskilling the workforce	<div><div>– Customers</div></div>	



# Port of Antwerp-Bruges Policy

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 CO<sub>2</sub> 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.*



# 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

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Technology concepts and/or application formulated	<input checked="" type="radio"/>	<input checked="" type="radio"/>	Not yet decided
	Proof-of-concept validation	<input checked="" type="radio"/>	<input checked="" type="radio"/>	Not yet decided
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early system validation demonstrated in a laboratory or limited field application	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early field demonstration and system refinements completed	<input checked="" type="radio"/>	<input checked="" type="radio"/>	Not yet decided
	Complete system demonstration in an operational environment	<input checked="" type="radio"/>	<input checked="" type="radio"/>	Not yet decided
At scale commercial deployment	Early commercial deployment	<input checked="" type="radio"/>	<input checked="" type="radio"/>	Not yet decided
	Wide-scale commercial deployment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



# 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, CO<sub>2</sub> 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

## 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.





3.11

# Zero Carbon Humber



# Zero Carbon Humber

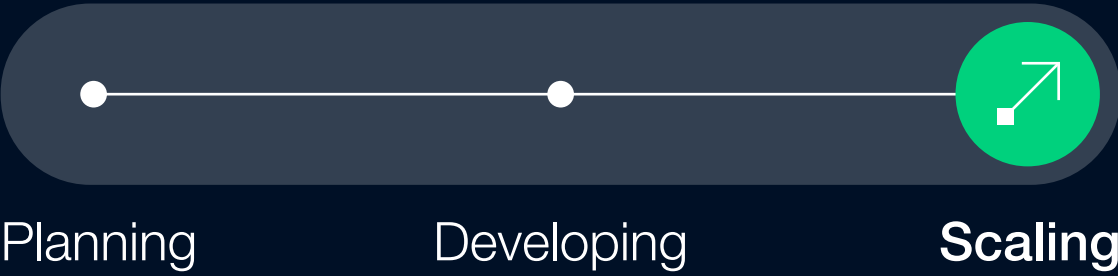
## Key highlights



Humber,  
United Kingdom

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



### Industries represented

- Chemicals
- Energy (hydrogen)
- Maritime
- Metals
- Ports
- Power generation

2040

Net zero goal

25,000

jobs per year out to 2050 with  
a peak of 41,000 in 2026

\$2 billion

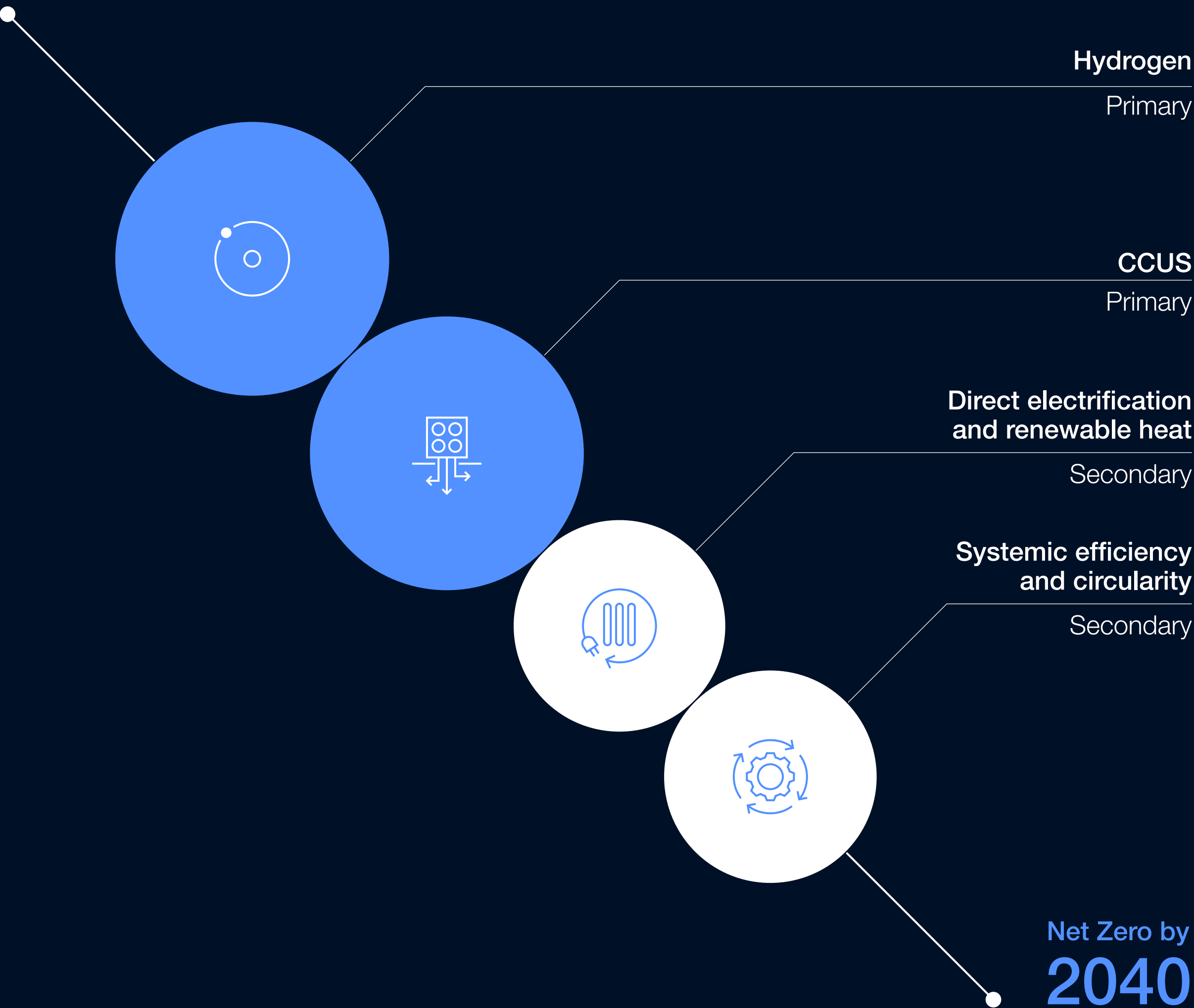
GVA up to 2050 (Humber and Teeside)

### Decarbonization roadmap

Current annual emissions (2017)

19.8 Mt CO<sub>2</sub>

Impact on roadmap  
towards decarbonization





# Zero Carbon Humber Partnership



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

- 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.

## Energy transition index collaboration model

Collaboration type existing in cluster	Partner types	Partners
Shared infrastructure development	– Industry peers	National Grid Ventures, Equinor, BP, Uniper, SSE, Drax
Industrial cluster infrastructure planning	– Public authorities	BEIS, National Grid Ventures and Equinor
Shared commercial projects	– Industry peers	Equinor and SSE (Keadby Post Combustion Power Station, Triton Power Acquisition, Aldbrough Hydrogen Storage, Keadby Hydrogen Power Station)
Cross-industry funding	– Public authorities – Industry peers	UK BEIS, UK Research and Innovation
Knowledge sharing		
Reskilling the workforce		



# 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.



Direct  
electrification and  
renewable heat



# 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.

### Planned funding deployment by technology readiness level

Development stage	Technology readiness level	Funding allocation		
		Now	By 2025	By 2030
Research and development	Exploratory research transitioning basic science into laboratory applications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Technology concepts and/or application formulated	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Proof-of-concept validation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pilot projects and early development	Subsystem or component validation in a laboratory environment to simulate service conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early system validation demonstrated in a laboratory or limited field application	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Early field demonstration and system refinements completed	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
At scale commercial deployment	Complete system demonstration in an operational environment	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
	Early commercial deployment	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>
	Wide-scale commercial deployment	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>



# Zero Carbon Humber Technology

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.

## Selected technology initiative matrix

## Digital foundations of the cluster

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.



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