# Unlocking First-of-a-Kind Projects through Clean Industrial Hubs

Lessons learned from California and Texas

Report / May 2025

## About RMI

Rocky Mountain Institute (RMI) is an independent, nonpartisan nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to secure a prosperous, resilient, clean energy future for all. In collaboration with businesses, policymakers, funders, communities, and other partners, RMI drives investment to scale clean energy solutions, reduce energy waste, and boost access to affordable clean energy in ways that enhance security, strengthen the economy, and improve people's livelihoods. RMI is active in over 60 countries.

## About Mission Possible Partnership

Mission Possible Partnership (MPP) is an independent non-profit organisation advancing global clean industry transformation. Since 2019, we have been working with some of the most energy-intensive industries – aluminium, cement, chemicals, shipping, aviation and steel – to cut their global GHG emissions. We mobilise business, finance, government, and civil society leaders to speed up the shift to clean materials, chemicals and fuels. Having charted sectoral pathways to net-zero, we continue to forge new territory, lifting the barriers to enable a critical mass of clean industrial projects to break ground by 2030. Mission Possible Partnership has people and partners on the ground in North America, Brazil, Europe, the Middle East, North Africa, India and Australia.

# Authors and Acknowledgments

This report was prepared by Mission Possible Partnership and RMI.

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BEZOS EARTH FUND

## Acknowledgments

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# Foreword from Faustine Delasalle, CEO, Mission Possible Partnership

**A new clean industrial revolution is underway, and it is happening in major industrial hubs.** Over the last decade, I've witnessed significant change in my exchanges with industry leaders across some of the most energy-intensive value chains, like steel, cement, and chemicals: we've gone from disbelief that a clean transformation of heavy industry is possible to industry-endorsed decarbonization plans to commercial-scale clean industrial plants being built and operational.

This new clean industry is one that can underpin a flourishing global society, one where clean materials, chemicals, and fuels can support quality of life for the world's population in a sustainable and resilient way.

Mission Possible Partnership's Global Project Tracker shows that the pipeline of clean industrial plants globally is growing. That's because companies understand that clean industry is an economic opportunity as well as a sustainability imperative. For industry players that are thinking about industrial asset investments with a 20-year lifespan, taking the long view, building clean technology leadership, and anticipating inevitable government actions in the wake of worsening impacts of climate breakdown are surer ways to futureproof a company and build its competitive edge.

But pioneering new industrial processes is a challenging journey. First-of-a-kind (FOAK) projects are rarely bankable. At Mission Possible Partnership, we pride ourselves on lifting barriers to action and, in an ever-changing world, finding routes forward. In 2022, we saw an opportunity to leverage the power of industrial hubs to fast-track FOAK projects. Our hypothesis then, which is now supported by direct observation, was that collaboration among companies colocated in industrial hubs could address critical barriers to investment. The US federal policy impulse created a favorable business environment to stress test this approach.

By partnering with the Bezos Earth Fund, RMI, and local partners like the Houston Energy Transition Initiative and the Port of Los Angeles, we were able to gain the trust of big and small project developers in two key globally connected industrial hubs, in the Gulf Coast and California. We uncovered the specific barriers to clean industry investment on the ground and fostered collaborations among corporate, finance, and policy players to effectively address these barriers. The result is that 50% of the projects we worked with have reached final investment decisions — meaning construction has started or is about to start.

This report reveals a wealth of learnings from three years of work on the ground, working shoulder to shoulder with project developers. Among the portfolio of actions we've pursued, three stick out as issues that can uniquely be addressed through collaboration at the level of an industrial hub:

- The development of a shared ambition across a local business community that can embolden corporate leaders and galvanize support from local and state policymakers
- The planning and buildup of a clean energy infrastructure commensurate to the aggregated needs of all local industry players
- The engagement of the local community to boost the benefits of the clean transformation of industrial activities for the people who live and work in the area

It has been an honor and pleasure to have worked with such tremendous people and partners who stood with us boldly and bravely on the cusp of a new era in industry. The collective momentum enabled individual companies to take big strides, which open the way for others to follow.

Now in 2025, we find ourselves at a different juncture. Momentum in the clean industrial revolution is shifting; new entrants are joining the race to global clean industrial leadership from emerging and developing countries across the Sunbelt of the world, as is borne out by Mission Possible Partnership's Global Project Tracker data. For those who want to secure an early-mover advantage, the development of clean industrial hubs is an effective way to start. As I look forward to the new partnerships we are forming, from Brazil to Australia, I am confident that we can take learnings from the US clean industrial hubs and adapt them to diverse geographies. I hope that, with our blueprint, other stakeholders around the world are spurred on to mobilize companies in their local industrial hubs to advance clean industrial transformation.

**Faustine Delasalle,**
CEO of Mission Possible Partnership

# Executive Summary

Heavy industry is on the brink of a major transformation. Developing low-emissions products and decarbonizing existing industrial facilities can increase domestic and global economies, protect energy security and resilience, create hundreds of thousands of jobs, and improve the quality of life for people across the planet by reducing pollution and supporting global climate goals.

Enabling the triple bottom line of economy, community, and environment requires a tremendous investment in new projects this decade. Trillions of dollars of capital will be needed in industry and transportation. But financing alone is not enough. Building these projects requires a collaborative ecosystem of project developers, policymakers, community organizations, and financiers to support innovation, sustainability, and economic growth.

Heavy industry and transportation sectors — cement, steel, aluminum, chemical production, aviation, shipping, and trucking — together generate more than 30% of global greenhouse gas (GHG) emissions. Meeting global climate goals will require building more than 700 net-zero industrial projects and deploying 7 million zero-emissions trucks by 2030.[1] So far, just 12% of these projects are operational. Most will be in regional industrial hubs, or clusters, where there is a concentration of existing industrial activity and where the physical, social, regulatory, and economic infrastructure is in place to support rapid scale-up. Today, first-of-a-kind (FOAK) and nth-of-a-kind (NOAK) decarbonization projects face tremendous hurdles, but our on-the-ground experience and research show there is a key to unlocking them.

From August 2022 to December 2024, Mission Possible Partnership and RMI, with support from the Bezos Earth Fund, accelerated the development of clean industrial hubs in California and Texas, directly partnering with 18 FOAK clean industrial projects to grow regional economies, strengthen local workforces, and protect energy security while reducing industry's environmental impacts.

Clean industrial hubs bring together project developers, policymakers, financial institutions, and community-based organizations to advance regional clusters of clean energy and industrial decarbonization projects. These stakeholders work together to benefit the local economy by sharing infrastructure, creating demand for low-emissions fuels and materials, and implementing innovative technology while minimizing environmental impact. Clean industrial hubs help spur economic growth, create employment opportunities, and unlock new technologies.

**Clean industrial hubs bring together project developers, policymakers, financial institutions, and community-based organizations to advance regional clusters of clean energy and industrial decarbonization projects.**

Their impact can be significant: 50% of the 18 projects we supported reached a final investment decision (FID), compared with 20% globally. Once built, these projects will additionally mobilize $34 billion of public and private investment and reduce emissions by half a billion tons of carbon dioxide equivalent

($CO_2e$) by 2050.[i] A successful clean industrial hub includes three main components: a supportive ecosystem, a variety of decarbonization and clean energy projects, and reliable connective infrastructure (see Exhibit ES1).

This report shares insights from the development of these clean industrial hubs and demonstrates how participating in a hub enhances outcomes for projects, the climate, and communities. It details how creating an enabling ecosystem of private finance, public policy, and community engagement is essential to de-risk projects and help innovative first movers. It also documents steps to take to successfully develop a clean industrial hub (see Exhibit ES2, next page).

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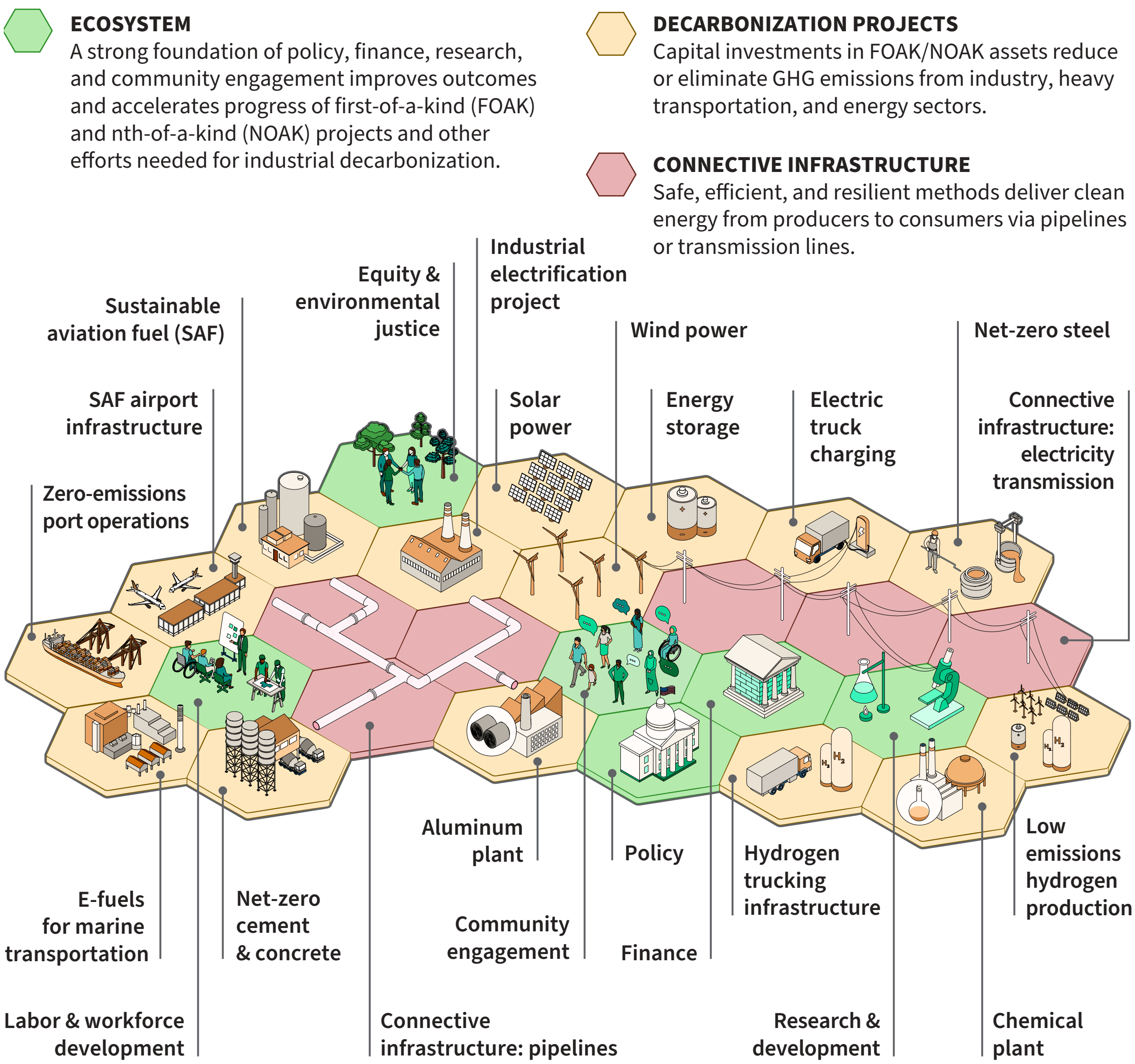
## Exhibit ES1 **Model of a clean industrial hub**




RMI Graphic. Source: Mission Possible Partnership and RMI

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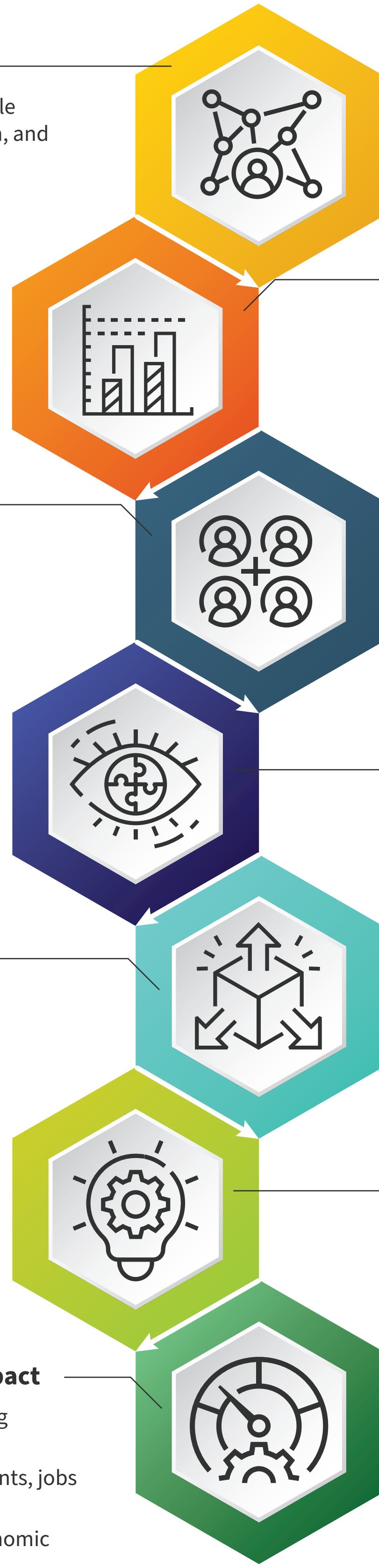
i These estimates assume that all projects become operational.

## Exhibit ES2 **Steps to create a clean industrial hub**



STEP 1

### Identify Hub Region

- High potential to produce renewable electricity, low-emissions hydrogen, and low-emissions fuels.
- Sufficient scale of project announcements.
- Engaged policymakers, financial institutions, utilities, community organizations, and NGOs.

STEP 2

### Conduct Foundational Analysis

- Conduct economic and project feasibility evaluation.
- Greenhouse gas emissions baseline.
- Decarbonization pathways for existing industries.
- Potential to develop new net-zero industries.
- Clean energy (electricity and hydrogen) needed.
- Air pollution baseline.

STEP 3

### Mobilize the Ecosystem/ Stakeholders

- Identify and map key stakeholders.
- Hold bilateral meetings and needs assessments with project developers, financial institutions, policymakers, and community organizations/EJ groups.
- Bring together ecosystem actors in convenings.

STEP 4

### Develop a Shared Vision

- Based on foundational analysis and convenings, set targets for decarbonization, clean energy production, capital expenditures, jobs created, and community benefits.
- This work will be ongoing and will need to be updated.

STEP 5

### Support Stakeholders to Advance Foundational Hub Success Factors

- Support enabling policies at the local, state, and federal level.
- Work with financial institutions to mobilize capital.
- Build capacity with community-based organizations.
- Plan for renewable energy and infrastructure.

STEP 6

### Provide Technical Assistance to FOAK and NOAK Projects

- Pick, scope, and launch FOAK/NOAK projects.
- Balance large enterprises with startups and small/medium-sized developers.
- Balance technology types and reduction pathways.

STEP 7

### Track, Monitor, Document Impact

- Projects reaching FID and becoming operational.
- Direct impacts on GHGs, air pollutants, jobs created, and money invested.
- Indirect impacts to health and economic development.

RMI Graphic. Source: Mission Possible Partnership and RMI

To scale projects to new geographies around the world, the second half of this report includes lessons learned and case studies from FOAK and NOAK projects in six key sectors: low-emissions hydrogen, sustainable aviation fuel, electrolytic methanol and electrolytic ammonia, concrete and cement, low-emissions steel, and zero-emissions trucking.

The goal of this report is to catalyze stakeholders in other geographies to take the lessons shared in this report and advance clean industrial hubs — and the FOAK and NOAK projects at their core — in new geographies (see Exhibit ES3).

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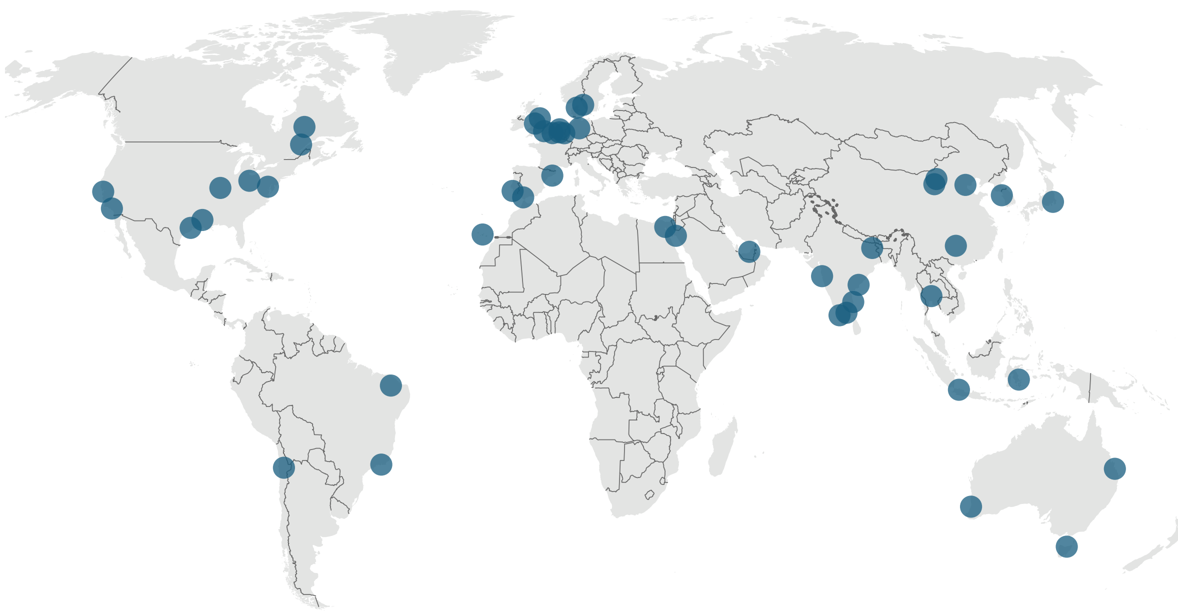
## Exhibit ES3 **Current and potential locations for clean industrial clusters**



RMI Graphic. Source: Mission Possible Partnership, RMI, and the World Economic Forum

# Introduction

Decarbonizing industry and heavy transportation sectors presents an opportunity to achieve economic and job growth, create more resilient communities, and meet climate and environmental goals. Globally, there is a need to invest trillions of dollars in decarbonization projects. These investments in decarbonization technologies can create hundreds of thousands of jobs and provide benefits to communities that are close to projects while dramatically reducing carbon emissions.

Heavy industry and transportation together generate 23% of US greenhouse gas (GHG) emissions and 30% of global emissions.[2] This includes emissions from cement, steel, aluminum, and chemical production, as well as aviation, shipping, and trucking. Meeting global climate goals will require building more than 700 net-zero industrial projects and deploying 7 million zero-emissions trucks by 2030.[3]

Most of these low- to zero-carbon projects will be built in regional industrial hubs, or clusters, where the physical, social, regulatory, and economic infrastructure is in place to support rapid scale-up. Although hundreds of net zero–aligned projects have been announced globally since 2022, as of November 2024, only 83 projects were online and another 53 projects had reached a final investment decision (FID).[4] That means there are only five years left to finance and construct more than 600 clean industrial projects.

That's why Mission Possible Partnership and RMI, in collaboration with the Bezos Earth Fund, are working to create clean industrial hubs (see Exhibit 1, next page). Clean industrial hubs bring together project developers, policymakers, financial institutions, and community-based organizations to support regional clusters of industrial decarbonization projects.

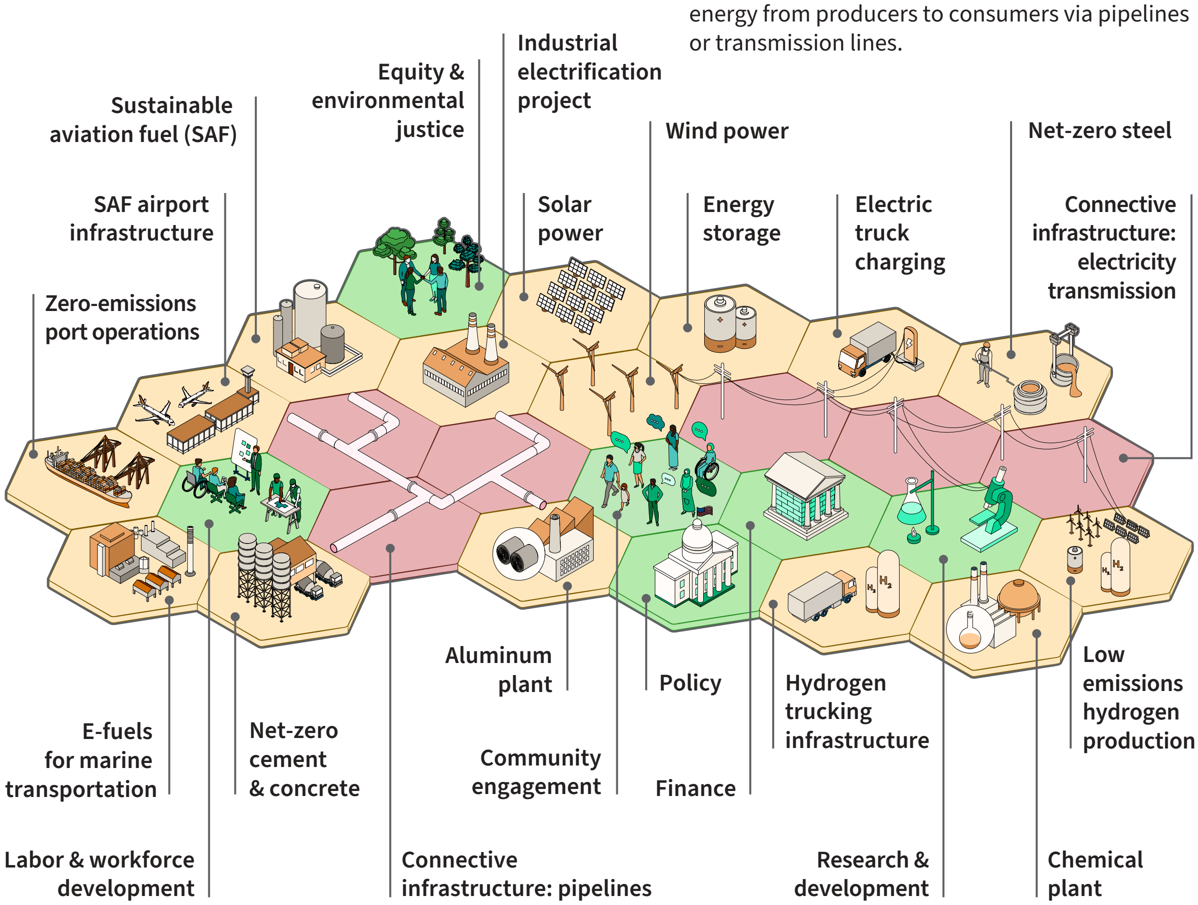
Our regional-based approach brings together industrial assets with social infrastructure — a hub — leveraging first-of-a-kind (FOAK) and other cutting-edge projects to achieve economies of scale and tipping points for decarbonization. Our hubs-support model concentrates efforts in a defined geographical region through a two-pronged approach of (1) providing technical assistance to specific industrial and clean energy projects combined with (2) building an overall ecosystem of policies, finance, shared infrastructure, and community engagement to improve outcomes and accelerate progress.

## Exhibit 1 **Model of a clean industrial hub**

**ECOSYSTEM**
A strong foundation of policy, finance, research, and community engagement improves outcomes and accelerates progress of first-of-a-kind (FOAK) and nth-of-a-kind (NOAK) projects and other efforts needed for industrial decarbonization.

**DECARBONIZATION PROJECTS**
Capital investments in FOAK/NOAK assets reduce or eliminate GHG emissions from industry, heavy transportation, and energy sectors.

**CONNECTIVE INFRASTRUCTURE**
Safe, efficient, and resilient methods deliver clean energy from producers to consumers via pipelines or transmission lines.




RMI Graphic. Source: Mission Possible Partnership and RMI

Participating in a clean industrial hub can help individual projects by reducing technology risk, lowering project costs, pooling demand, increasing availability of clean energy supply for industrial decarbonization projects, setting market standards for clean products (e.g., level of emissions), and establishing willingness to pay. Clean industrial hubs also help overcome the remaining hurdles for the clean energy transition by developing an ecosystem that supports project development. They can facilitate community engagement, develop local workforces, create a supportive policy environment, reduce risk for private finance, help developers access low-cost public capital (grants and loans), and establish a shared vision for success.

To establish the framework for a clean industrial hub and explore opportunities and challenges, Mission Possible Partnership and RMI, in collaboration with the Bezos Earth Fund, supported the acceleration of clean industrial hub development in Southern California and the Texas Gulf Coast.

## California clean industrial hub

California is a national leader in climate action with state mandates to achieve carbon neutrality by 2045. It is also the nation's largest state economy, contributing more than $3.9 trillion to the gross domestic product (GDP) in 2023.[5] Yet California is the third-largest industrial emitter in the United States, driven by the state's refineries, heavy-duty trucks, airports, and ports. In 2022, industrial facilities in California released more than 80 million tons of $CO_2$, 6% of all industrial emissions in the United States.[6]

Investments to transition and build new clean facilities and vehicles will reduce pollution and help the state reach its climate policy targets while creating a green economy for California workers. State analysis has shown climate-aligned investments can support more than 75,600 jobs, demonstrating the potential of climate investments in spurring economic growth in the region.[7]

In Southern California, our team advanced heavy transportation and port decarbonization, low-emissions cement production, low-emissions hydrogen, and industrial electrification by providing technical assistance to 10 proposed FOAK decarbonization projects (see Exhibit 2, page 13). This included identifying and advancing decarbonization pathways for two major ports, the heavy-duty trucking sector, and existing industrial facilities, with a focus on cement. We also worked on accelerating production and adoption of sustainable aviation fuel (SAF) and low-emissions hydrogen to enable decarbonization in the aviation, shipping, and trucking sectors.

In California, the team also worked to strengthen the stakeholder ecosystem by engaging with policymakers to streamline the permitting process, financial institutions to increase investments in SAF and low-emissions hydrogen, community-based organizations to understand what is needed for a successful community benefits plan (CBP) and community benefits agreement (CBA),[ii] and utilities and infrastructure providers to increase availability of electricity and low-emissions hydrogen for projects.

**ii** CBPs are nonbinding agreements that are typically developed by community organizations and developers. They outline the community's priorities for a development project and the developer's commitments to those priorities, which can include things such as affordable housing, job creation, and local hiring preferences. CBPs are not legally enforceable. CBAs, on the other hand, are legally binding agreements that are negotiated between community organizations and developers. They outline the specific benefits that the developer will provide to the community in exchange for the community's support of the project. CBAs are enforceable in court, which gives communities a stronger guarantee that the developer will follow through on its commitments.

## Texas clean industrial hub

Texas has the largest industrial and energy economy in the United States. It produces 25% of US domestic energy,[8] is home to 25% of the country's publicly traded oil and gas exploration and production companies, and supports 15% of the nation's total refining capacity and 44% of the nation's petrochemical manufacturing capacity.[9] The state's 640 industrial facilities emit 291 million tons of carbon dioxide equivalent ($MtCO_2e$) per year, 23% of industrial emissions in the United States.

Texas is also making strides to become a clean energy leader.[10] Since 2013, Texas power provider the Electric Reliability Council of Texas (ERCOT), has reduced the carbon intensity of power generation by 11% while increasing power generation capacity by 26%. Wind and solar production in Texas have grown significantly, leading the United States in 2023 by producing 108,000 gigawatt hours (GWh) of wind power and 32,000 GWh of solar power.

Mission Possible Partnership and RMI leveraged Houston's acumen in clean energy, manufacturing, and heavy industry to focus on accelerating the production and adoption of low-emissions hydrogen and its derivatives to enable decarbonization in the cement, shipping, steel, and aviation sectors (see Exhibit 2). The team analyzed future decarbonization pathways for heavy industry in metro Houston and forecast the power needs of the regional electric grid to meet net-zero ambitions. This work showed that decarbonization efforts in the region are projected to drive significant economic growth, potentially creating nearly 530,000 new jobs by 2050 while simultaneously reducing emissions.[11]

The team provided technical assistance to eight proposed FOAK decarbonization projects in Texas. This work included identifying and advancing detailed decarbonization pathways for cement and steel plants, and accelerating production and adoption of SAF and low-emissions hydrogen and its derivatives to enable decarbonization in the aviation, shipping, steel, and trucking sectors.

In Texas, the team created a supportive ecosystem for these projects by connecting policy, finance, infrastructure, and community organizations to define and help overcome barriers that slow progress. Our work provided practical tools and insights that help stakeholders navigate the complex path to cleaner industrial processes, making ambitious decarbonization goals more achievable.

## How clean industrial hubs create impact

Clean industrial hubs help unlock FOAK decarbonization and clean energy projects and help create tipping points to enable scaling to nth-of-a-kind (NOAK) projects. Projects that participated in the hub and received technical assistance reached the front-end engineering design (FEED) and FID stages of project development with greater success than projects that did not participate in the hub. In fact, 50% of the projects supported by Mission Possible Partnership and RMI reached FID, compared with 20% globally.

Clean industrial hubs leverage shared infrastructure, resources, and technologies to reduce emissions more efficiently than individual efforts. They also drive regional economic growth. As seen in Exhibit 3 (next page), industrial decarbonization efforts bolstered by hubs can unlock private capital investment and public funding, strengthening local economies. In both their capacity to reduce climate pollution and promote economic expansion, clean industrial hubs strive to be greater than the sum of their parts.

## Exhibit 2 **California and Texas clean industrial hubs**

| | California Hub | Texas Hub |
|---|---|---|
| **Focus Sectors** | Aviation, cement, shipping, trucking | Hydrogen, shipping, aviation, cement, steel |
| **Number of Announced Low-Carbon Industrial Projects in the State** (Pilot and Commercial Size) | 70 | 100 |
| **Number of Projects Receiving Dedicated Technical Assistance** | 10 | 8 |
| **State Industrial GHG Baseline** | 81 $MtCO_2e$ | 334 $MtCO_2e$ |
| **State GHG Reduction Goal** | Net zero by 2045 with 80% emissions reductions | Not applicable |

Note: The state industrial GHG baselines came from the Environmental Protection Agency's (EPA's) Greenhouse Gas Inventory Data Explorer, **https://cfpub.epa.gov/ghgdata/inventoryexplorer/#industry/entiresector/allgas/category/current**.

## Exhibit 3 **Impact from California and Texas clean industrial hubs**

| | California Hub | Texas Hub | Total |
|---|---|---|---|
| **Number of Projects Supported** | 10 | 8 | 18 |
| **Number of Projects Reaching FEED** | 9 (90%) | 6 (75%) | 15 (83%) |
| **Number of Projects Reaching FID** | 7 (70%) | 2 (25%) | 9 (50%) |
| **Public Funding Potential through 2050** (pre-Trump Administration) | $4 billion | $10 billion | $14 billion |
| **Total Capital Investment** | $9 billion | $25 billion | $34 billion |
| **Potential Emissions Reduced or Avoided Annually from Participating Projects** (Starting in 2030) | 8 million tons $CO_2$ | 13 million tons $CO_2$ | 25 million tons $CO_2$ |
| **Potential Emissions Reduced or Avoided Cumulatively by 2050** | 200 million tons $CO_2$ | 340 million tons $CO_2$ | 540 million tons $CO_2$ |

Note: All impacts are estimates, assuming that projects are successfully developed and become operational.

RMI Graphics

# Creating Successful Clean Industrial Hubs

When evaluating where to launch the first clean industrial hubs, Mission Possible Partnership and RMI chose California and Texas because each had a large baseline of industrial activity, high demand for industrial products, a sufficient number of announced projects, organizations to drive the work on the ground, and in the case of California, an enabling policy environment.

Below are eight key ingredients identified through our work in California and Texas for a successful clean industrial hub.

- **Renewable energy base and natural resources** (e.g., hydrogen and carbon storage resources) or in a location with a high potential to develop renewable energy to support industrial electrification, hydrogen electrolysis, and development of SAF and other electrolytic fuels (e-fuels).
- **Enabling policy environment** with the right balance between carrots (incentives, grants, loans, permit streamlining) and sticks (regulations, mandates, carbon markets).
- **Anchor assets (FOAK/NOAK projects)** across the value chain from supply to demand to catalyze action. Locations need enough announced projects to warrant the attention of the broader ecosystem and achieve economies of scale.
- **Coalition of stakeholders**, led by a local organization (e.g., an economic development organization; state, local, or regional government; a utility; university; a consortium; or a port), to develop and implement the shared vision over the short and medium term alongside a technical partner (e.g., RMI or Mission Possible Partnership) to advise on implementation.
- **Shared vision** of what it will take to decarbonize the hub, why it is important, and what success will look like (including impact criteria, such as dollars invested, energy produced, offtake, emissions reduction, number of jobs, and capacity of workforce).
- **Engaged community-based organizations, labor unions, and environmental justice (EJ) nongovernmental organizations (NGOs)** to support workforce development and creation of CBPs and CBAs.
- **Connective infrastructure** that enables a robust marketplace with diverse actors to produce and consume clean energy (electricity, hydrogen).
- **Financial ecosystem** of different types of investors ready to fund multiple types of companies and projects (startups, incumbents, new technology), and lawyers ready to support the transactions.

**Clean industrial hubs help unlock FOAK decarbonization and clean energy projects and help create tipping points to enable scaling to nth-of-a-kind (NOAK) projects. Projects that participated in the hub and received technical assistance reached the front-end engineering design (FEED) and FID stages of project development with greater success than projects that did not participate in the hub.**

Using these criteria, the clean industrial hub model can be adopted in other locations to scale industrial decarbonization projects around the world. A preliminary analysis by Mission Possible Partnership and RMI identified 46 locations that are most promising to be clean industrial hubs. Some of these locations are supply hubs with the right conditions to provide low-emissions hydrogen, alternative fuels, and industrial production. In contrast, demand hubs have the right conditions and purchasing power to import significant sustainable products, clean fuels, and hydrogen. Some locations possess the conditions for both (see Exhibit 4).

Organizations wanting to coordinate a clean industrial hub or cluster can follow best practices for starting and running a clean industrial hub, as shown in Exhibit 5 (next page).

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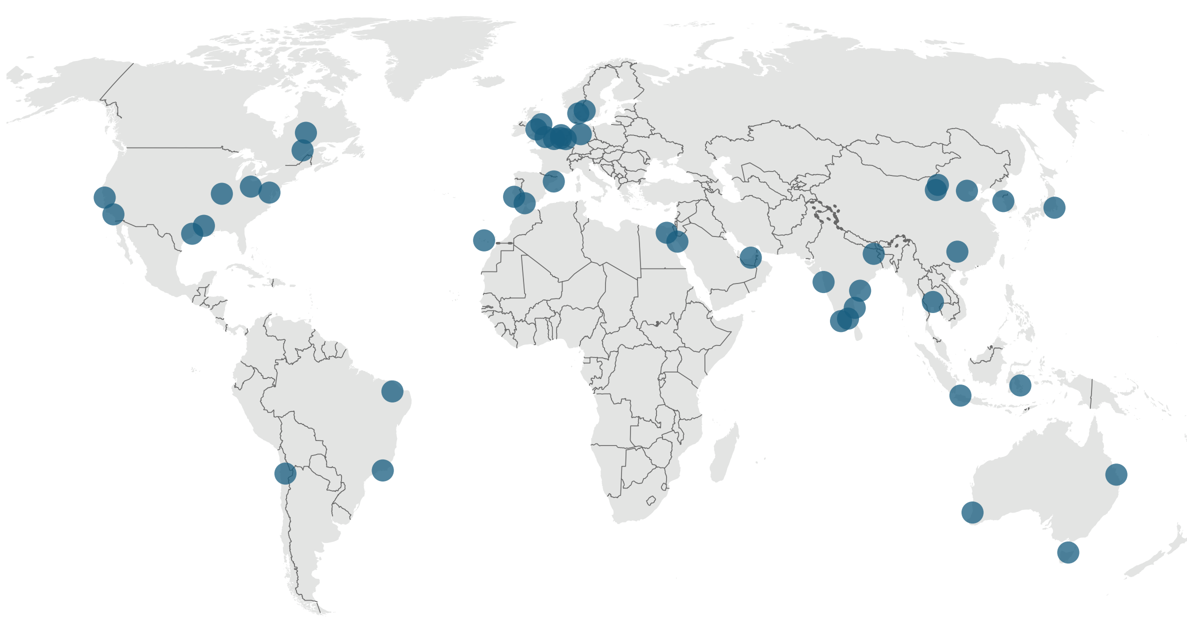
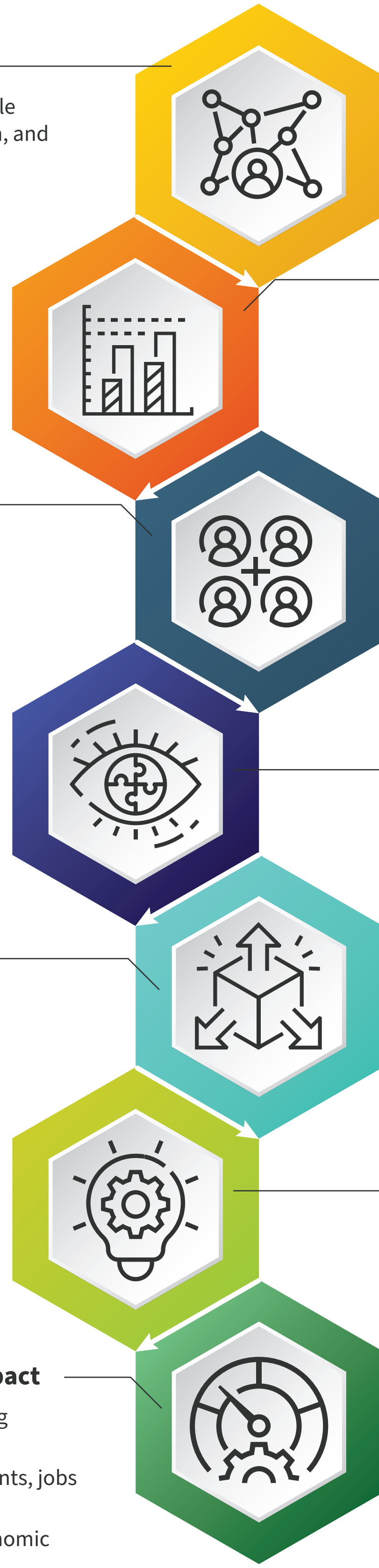
Exhibit 4 **Current and potential locations for clean industrial clusters**



RMI Graphic. Source: Mission Possible Partnership, RMI, and the World Economic Forum

## Exhibit 5 Steps to create a clean industrial hub



STEP 1

### Identify Hub Region

- High potential to produce renewable electricity, low-emissions hydrogen, and low-emissions fuels.
- Sufficient scale of project announcements.
- Engaged policymakers, financial institutions, utilities, community organizations, and NGOs.

STEP 2

### Conduct Foundational Analysis

- Conduct economic and project feasibility evaluation.
- Greenhouse gas emissions baseline.
- Decarbonization pathways for existing industries.
- Potential to develop new net-zero industries.
- Clean energy (electricity and hydrogen) needed.
- Air pollution baseline.

STEP 3

### Mobilize the Ecosystem/ Stakeholders

- Identify and map key stakeholders.
- Hold bilateral meetings and needs assessments with project developers, financial institutions, policymakers, and community organizations/EJ groups.
- Bring together ecosystem actors in convenings.

STEP 4

### Develop a Shared Vision

- Based on foundational analysis and convenings, set targets for decarbonization, clean energy production, capital expenditures, jobs created, and community benefits.
- This work will be ongoing and will need to be updated.

STEP 5

### Support Stakeholders to Advance Foundational Hub Success Factors

- Support enabling policies at the local, state, and federal level.
- Work with financial institutions to mobilize capital.
- Build capacity with community-based organizations.
- Plan for renewable energy and infrastructure.

STEP 6

### Provide Technical Assistance to FOAK and NOAK Projects

- Pick, scope, and launch FOAK/NOAK projects.
- Balance large enterprises with startups and small/medium-sized developers.
- Balance technology types and reduction pathways.

STEP 7

### Track, Monitor, Document Impact

- Projects reaching FID and becoming operational.
- Direct impacts on GHGs, air pollutants, jobs created, and money invested.
- Indirect impacts to health and economic development.

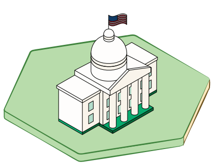
RMI Graphic. Source: Mission Possible Partnership and RMI

# Building the Industrial Decarbonization Ecosystem

Successfully decarbonizing existing industry and developing new clean industries require securing broad stakeholder support and effectively integrating finance, enabling policy, and community benefits within regional hubs. It also requires a foundation of connective infrastructure to enable industrial projects to access renewable electricity, low-emissions hydrogen, and carbon storage. Collaboration with research and development institutions, universities, and national labs is another important part of the industrial decarbonization ecosystem that helps drive innovation. Such collaboration leverages a broad range of technical expertise and accelerates the transition from research to commercial deployment while using the most cost-effective and cutting-edge solutions.

Mission Possible Partnership and RMI played a crucial role in this process by facilitating convenings with stakeholders, conducting needs assessments to understand challenges and barriers, and developing practical tools to enhance project efficiency and outcomes. By concentrating efforts in strategic regions and supporting decarbonization projects while simultaneously developing necessary financial structures, policy frameworks, and community partnerships, the ecosystem approach developed and tested in the clean industrial hubs in California and Texas has proved effective, as reflected in a higher percentage of projects reaching FID compared with overall state and global industrial decarbonization progress.

This section shares lessons learned from our work advancing policies for industrial decarbonization, community engagement and social impact, connective infrastructure in clean industrial hubs, and financing for clean industry. Although every hub is different, the lessons learned about the role of a convenor for a hub's success could be applied while establishing a hub in another region.



## Policies for industrial decarbonization

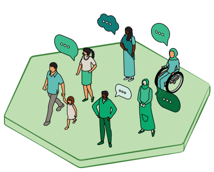
FOAK industrial decarbonization projects rely on policies that create incentives, strengthen market signals, and reduce barriers to cleaner industrial operations. A combination of emissions standards, financial incentives, and streamlined regulations levels the playing field for industries to transition to low-carbon alternatives while maintaining competitiveness.

Regulatory frameworks such as California's Low Carbon Fuel Standard (LCFS), the EU's Industrial Emissions Directive and its Clean Industrial Deal, and Japan's Act of Sophisticated Methods of Energy Supply Structures push industries to adopt cleaner technologies through emissions limits and performance-based standards. These policies provide long-term certainty, encouraging investment in energy efficiency, electrification, alternative fuels, and carbon capture. Financial incentives help offset the cost of decarbonization. Federal tax credits such as 45Q for carbon capture, 48C for advanced energy projects, 45V for low-emissions hydrogen production, and 45Z for SAF reduce capital costs, while grants support early-stage projects in hydrogen, industrial electrification, and carbon management.

The Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) provided unprecedented funding, ensuring that clean industrial technologies scale efficiently. Although the IRA and IIJA have accelerated industrial decarbonization, additional policy intervention is still needed in several areas.

For instance, project permitting remains a major bottleneck, often delaying critical projects such as SAF production, carbon capture and storage (CCS) facilities, and hydrogen infrastructure. Addressing these challenges through streamlined permitting, expanded market mechanisms, and continued financial incentives will be essential to achieving deep industrial emissions reductions.

**Mission Possible Partnership and RMI** worked to identify existing policy gaps, support regulatory improvements, and develop tools that help industrial projects navigate incentives. For this, we supported regional coordination and market development with meetings of policymakers and project developers and conducted targeted regulatory analysis published online for stakeholders to use. We also created the Decarbonizing Industry Resources Tool (D.I.R.T.) to enable project developers to identify and access state and federal funding.[12] Developers not only in Texas and California, but in nine additional US states that could potentially house clean industrial hubs can use this tool. By improving permitting efficiency, advancing carbon capture and hydrogen infrastructure, and strengthening market frameworks, these efforts help translate policy into real-world decarbonization success stories.



## Community engagement and social impact

Meaningful inclusion of all stakeholders, particularly communities historically burdened by industrial pollution, is essential for successful decarbonization projects. Beyond reducing emissions, decarbonization efforts can generate local economic opportunities, improve health outcomes, and build long-term community resilience. To achieve this, community engagement and workforce development must be integrated into project planning from the outset. Tools including CBPs, CBAs, project labor agreements (PLAs), and EJ frameworks help ensure that industrial decarbonization delivers shared value instead of reinforcing existing inequities. Early, inclusive, and meaningful engagement with host communities over the full life cycle of projects from conception to decommissioning is also a critical de-risking strategy to minimize community opposition and lawsuits that can lead to expensive delays and project cancellations.

Mission Possible Partnership and RMI worked to improve project outcomes and facilitate open, transparent communication between developers and local communities. These efforts focused on providing technical assistance to project developers on how to conduct early engagement, inclusive decision-making, and proactive impact mitigation, with the goal of leading to greater public support, fewer permitting delays, and stronger long-term partnerships.

To identify local needs, we held listening tours with 38 community-based organizations and labor groups and hosted 12 capacity-building workshops with project developers, community-based organizations, federal and state policymakers, regulators, and investors to strengthen partnerships and enhance the social license to operate. We also provided technical assistance to project developers on incorporating CBPs, CBAs, and PLAs into state and national funding proposals.

Through these engagements, we identified two foundational challenges. First, traditional stakeholder analysis and mapping options (think spreadsheets or Venn diagrams) can be time-consuming, tedious, and limited in functionality. Commercially available tools are not tailored for analyzing and mapping the typical stakeholders in energy project landscapes. This deficiency makes effective stakeholder management challenging for project developers. Second, there is not a public repository of potential community benefits and burdens of industrial decarbonization projects or a way to assess the cumulative impact of changes to common air pollutants, including sulfur oxide (SOx), nitrogen oxide (NOx), and fine inhalable particles (PM2.5[iii]).

Mission Possible Partnership and RMI addressed these gaps by developing tools, databases, and maps that empower project developers, policymakers, and other decision makers to properly assess environmental and economic impacts of industrial projects in their region and visualize stakeholder relationships in their community. By evolving traditional industry practices, supporting local workforce development, and prioritizing EJ, these initiatives drive equitable decarbonization with lasting community benefits.

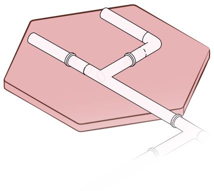
Mission Possible Partnership and RMI created the **Stakeholder Analysis and Mapping (S.A.M.) Tool** (beta) to simplify and digitize the process of analyzing power dynamics and mapping interrelationships among all types of stakeholders. S.A.M. allows project developers to create clear and actionable visuals of any project's stakeholder landscape. This digital tool has a broad range of interdisciplinary applications across energy, sustainability, finance, policymaking, public health, academia, and nonprofit sectors. Although much of the stakeholder mapping work for California and Texas was done manually, clean industrial hubs and individual projects globally can use the S.A.M. Tool for more effective and inclusive stakeholder engagement and management.

Replicable learnings and recommendations for future clean energy project developers were documented in a report on best practices for developing inclusive, two-way community engagement strategies and responsive benefits to secure the essential buy-in and local support for FOAK and NOAK clean industrial, energy, and infrastructure projects.[13] An additional five deep-dive cross-sectoral case studies were conducted via 45 stakeholder interviews to capture how developers adhering to recommended best practices are de-risking their ongoing projects. These can be used to help clean industrial hubs and projects in other geographies learn from best practices.

We also created a database and a map that shows socioeconomic (jobs, housing values, and exposure to wildfire and flood risks), health (asthma and heart disease), and air pollution (PM2.5 and diesel particulate matter) data in California and Texas. The tool is designed to help policymakers, industry stakeholders, and the public understand the baseline where industrial projects are being proposed and to monitor their effects on EJ, health, and economic outcomes in different counties. The tool can help the decision-making process by aggregating relevant data from multiple sources to assess the economic, environmental, and health impacts of industrial decarbonization projects.

**Meaningful inclusion of all stakeholders, particularly communities historically burdened by industrial pollution, is essential for successful decarbonization projects. Decarbonization efforts can generate local economic opportunities, improve health outcomes, and build long-term community resilience.**

**iii** PM2.5 refers to particulate matter with a diameter of 2.5 micrometers or less, small enough to penetrate the respiratory tract and enter the lungs or bloodstream.



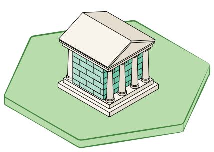
## Connective infrastructure

Connective infrastructure, including transmission and pipeline infrastructure, plays a critical role in supporting industrial decarbonization by enabling reliable, efficient delivery of clean energy to industrial facilities. Robust electricity transmission networks ensure renewable power from wind and solar can reach energy-intensive industries, facilitating electrification and reducing fossil fuel dependence.

Similarly, pipeline systems are essential for transporting low-emissions hydrogen and captured $CO_2$. These networks enable industrial facilities to implement hydrogen-based processes, carbon capture utilization and storage, and other emerging technologies at scale and usually with lower costs compared with the cost of other modes of transportation.

Without strategic investment and consideration of these infrastructures, industries may face significant barriers, such as insufficient clean energy supply, grid congestion, higher operating costs, and limited pathways for feedstock delivery.

Mission Possible Partnership and RMI worked to address these challenges in three ways: analyzing the infrastructure requirements for net-zero industries, identifying policy and permitting gaps that need to be addressed for the safe development of hydrogen and carbon infrastructure, and convening key stakeholders in each hub geography to identify next steps for infrastructure development. Because it can often take 5–10 years to site, permit, and build transmission lines, pipelines, and storage infrastructure, our work played a key role in uniting stakeholders behind an action plan.



## Financing clean industry

Securing adequate financial resources is critical for industrial decarbonization projects, given high up-front capital costs, long investment horizons, and market uncertainty. Without strong financial backing, projects using early-stage technologies struggle to move past the pilot and demonstration stages. For commercial-scale projects, access to finance allows scaling and expanding operations, which in turn enables further cost reductions, increases market competitiveness, and reduces emissions.

Mission Possible Partnership and RMI worked with financial institutions, including banks, private equity, strategic investors, financial advisers, and venture capital, to overcome barriers to investing in industrial decarbonization projects.

This work sought to increase capital supply in each clean industrial hub by widening and deepening investor engagement in emerging markets such as hydrogen and SAF, and to stimulate capital demand by sharing financial institution insights with project sponsors to improve asset-level bankability.

We also created a feedback loop between project developers and financiers to ensure early engagement, helping align projects' financial models to maximize the use of existing incentives, thereby de-risking clean industrial projects and improving their bankability.

Through tailored financial research, strategic multistakeholder meetings, and innovative webinars and workshops, Mission Possible Partnership and RMI facilitated communication between project developers and financial institutions and created pathways for financing the substantial up-front investments required for industrial transformation, accelerating the flow of capital into decarbonization projects.

To further help project developers across sectors secure financing, we developed the Industrial Decarbonization Investor Database, which identifies 200 financial institutions that have actively engaged in industrial decarbonization transactions in 2023 and 2024.[14] Through comprehensive analysis of public announcements, we identified 40 private equity firms, 40 venture capital investors, 60 strategic corporate investors, and dozens of financial advisers, engineering procurement and construction firms, commercial banks, and export credit agencies positioned to finance FOAK clean industrial projects, particularly in low-emissions hydrogen and derivative sectors.

# Unlocking FOAK and NOAK Projects

Since 2022, nearly 700 industrial decarbonization projects have been announced globally. Yet only 136 projects (20%) have reached FID,[15] and over half of those announced have been waiting for financing for at least two years. By comparison, 50% of projects that participated in the California or Texas clean industrial hub reached FID for at least one major component (i.e., hydrogen or alternative fuels, electrification, or carbon-capture unit).

Participating in a clean industrial hub can help FOAK and NOAK projects reach FID faster than when pursued alone. Additionally, participating in a hub can enhance outcomes by helping companies set a higher level of ambition, increase the speed and scale of investment, ensure environmental integrity of the product, conduct inclusive two-way community engagement, and ultimately create sector tipping points through project learnings.

Through our work advancing FOAK and NOAK projects in the United States, we identified eight critical factors that, regardless of sector or location, projects need to reach FID and become operational.

**Demand for product and offtake contracts:** Demand for lower carbon products and long-term offtake contracts are needed for projects to get financing and proceed to FID.

**Project financing:** Private-sector funding plays a central role in enabling industrial decarbonization projects. Although financial institutions are starting to invest in clean industrial projects, challenges remain related to perceived technology risk, longevity and stability of incentive structures, uncertain financial returns, and longer payback periods than conventional alternatives. The cost of capital can make or break project economics, particularly for capital-intensive technologies such as hydrogen production or carbon-capture systems.

**Public-sector support:** Favorable policies and regulations set the course to meet mid-century goals. Additionally, many clean industrial projects need a mix of private and public funding to be cost-competitive with conventional products. Public-sector support in the form of grants, loans, and incentives is one way to help close the green premium, offset high capital expenditures, and make these projects financeable. Public sector support can also take the form of public-private partnerships to aid in research and technology development and deployment.

**Access to reliable clean energy resources at competitive prices:** Industrial facilities need renewable energy resources to meet emissions-reduction targets. Electrification can replace fuel use and reduce emissions in industrial facilities and heavy transportation but requires access to clean power. Carbon-free electricity also provides a necessary input for producing low-emissions hydrogen, SAF, and e-fuels for marine shipping.

**Corporate commitment and organizational structure:** Projects are successful when the companies leading them have a long-term, high-level commitment to and support for decarbonization. Additionally, successful projects often require collaboration across multiple departments and decision makers. Companies need skillful project managers who can manage costs, mitigate risks, and move projects through the development pipeline.

**Technology readiness of individual tech components:** To be commercially viable, projects must have a technology readiness level (TRL) above 7 or 8, even if there is some stacked technology risk.[16] Reaching 2030 targets for building new commercial-scale low- and zero-carbon plants requires a rapid deployment of new technologies.

**Community support:** Inclusive two-way engagement to seek feedback from host communities on project design and potential benefits early in the process helps de-risk critical clean energy and infrastructure projects from opposition, lawsuits, or expensive permitting delays in the long run.

**Workforce availability and capability:** Workers with specialized skills are often needed to build, operate and maintain, and decommission clean industrial and transportation projects. Developers can also leverage local and state incentives to create jobs for unemployed, underemployed, and underrepresented workers.

## Low-emissions hydrogen plants

Low-emissions hydrogen will play a key role in the energy future. Hydrogen can be used directly by industry and for transportation and can be used to make derivative fuels and chemicals such as SAF, e-ammonia, and e-methanol. By 2050, 660 tons of low-emissions hydrogen could be used each year, meeting 22% of global energy demand. Using low-emissions hydrogen could enable 7 gigatons of emissions abatement, 20% of the total needed, while also improving energy security and air quality.[17]

Hydrogen production is currently responsible for approximately 2% of global CO2 emissions, with conventional production methods releasing 8–12 kg of $CO_2$ per kg of hydrogen produced.[18,19] Low-emissions hydrogen can be produced using several production pathways, including electrolytic hydrogen made from renewable energy and water, hydrogen produced from natural gas (which is made up mostly of methane, a warming gas about 80 times more powerful than $CO_2$) with CCS technology, and innovative approaches such as biomass gasification with carbon capture. Global electrolyzer capacity surged to 1.4 gigawatt (GW) by the end of 2023, nearly doubling from 2022 levels. Electrolyzer manufacturing capacity similarly expanded twofold during this period, reaching 25 GW annually.[20] If all the announced projects materialize, installed capacity could reach 230–520 GW by 2030; however, most projects are stuck in early development stages, with only about 20 GW having reached FID. A significant acceleration is needed to install 560 GW of electrolyzer capacity by 2030.[21] Transitioning to low-emissions hydrogen production will require mobilizing $150 billion to $300 billion in capital by 2030, with the cost of an individual plant ranging from $300 million to $800 million for commercial-scale facilities.[22,23]

Because low-emissions hydrogen does not yet have an established market, project success depends on the integration of stakeholders across the entire value chain — from feedstock suppliers to financiers to offtakers. This coordination can be facilitated through clean industrial hubs, which provide a structured ecosystem for collaboration. Clean industrial hubs can also benefit low-emissions hydrogen production by pooling demand across end uses; sharing critical infrastructure for hydrogen pipelines, carbon capture, storage, and transportation, and resilient, renewable energy; and buying down additional feedstock prices for hydrogen derivative fuels, such as e-methanol, e-ammonia, and SAF.

## Critical factors for reaching FID

**Demand for product and offtake contracts:** Emerging markets for low-emissions hydrogen in industrial applications, transportation, and energy storage are creating new demand signals, though many remain in early stages.[24] Long-term offtake agreements are critical to secure project financing, with potential buyers including derivatives producers, industrial facilities, and truck refueling facilities.[25]

**Technology readiness of individual tech components:** Low-emissions hydrogen production technologies vary in maturity, with electrolyzers advancing rapidly, currently ranging from TRL 6 for anion exchange membranes to TRL 9 for proton exchange membranes.[26] Biomass gasification with carbon capture represents a more novel approach and is currently largely limited to pilot and demonstration projects.[27] Carbon storage infrastructure remains a critical bottleneck in many regions, requiring accelerated development to support hydrogen decarbonization pathways.

**Public-sector support:** Low-emissions hydrogen projects have a significant green premium compared with conventional hydrogen production methods. Public funding through programs such as LCFS credits in California and federal 45V production tax credits, which can reduce costs by up to $3/kg, are essential to bridge cost gaps, while regulatory uncertainty around permitting, infrastructure development, and carbon management can significantly slow investment decisions.[28]

**Access to reliable clean energy resources at competitive prices:** Hydrogen development is highly reliant on grid connectivity and regional energy sources, as these factors shape its feasibility, cost, and sustainability. Electricity accounts for up to 70% of green hydrogen production costs, making access to affordable clean power a critical determinant of competitiveness. Additionally, these factors influence the applicability of incentives such as tax credits and subsidies, which are often tied to renewable energy integration and regional energy policies. A successful low-emissions hydrogen market will also need access to long-duration storage and pipeline infrastructure.

## Project Spotlight: Mote

Based in California, Mote is a startup developing an innovative biomass-to-hydrogen facility in the state's Central Valley. The company's process primarily uses woody residues, such as dead branches from forestry management or agricultural waste, and explicitly excludes virgin forest materials. Mote's facility is designed to produce approximately 20,000 tons of low-emissions hydrogen annually while removing and sequestering 350,000 tons of $CO_2$ per year.[29] Once built, it would be one of the country's first commercial deployments of carbon-negative hydrogen-production technology, with the hydrogen achieving a CI score of -189 $gCO_2$/MJ.

Mote worked with Mission Possible Partnership and RMI to validate its technical approach, secure project financing, and navigate the complex regulatory landscape, particularly regarding how to stack various incentives for hydrogen production.[30]

With our technical assistance, Mote secured grant funding to develop its low-emissions hydrogen and carbon capture process from forest residues. The company received $1.2 million in grant funding from the US Forest Service, United States Department of Agriculture - United States Forest Service (USDA USFS), and California Department of Forestry and Fire Protection (Cal Fire) for the development of its second biomass-to-hydrogen and carbon-sequestration plant.[31] Mote also secured $100 million in additional funding through the US Department of Energy's Regional Clean Hydrogen Hubs program as part of the Alliance for Renewable Clean Hydrogen Energy Systems consortium, which was awarded $1.2 billion to develop California's hydrogen economy and $7 million from the Department of Energy's Office of Fossil Energy and Carbon Management department to develop a pilot plant through the Carbon Negative Shot Pilot program.[32]

Innovative startups such as Mote benefit from being in a clean industrial hub. Joshuah Stolaroff, Mote founder and CEO, said: "The momentum behind the energy transition and carbon removal is enormous. It's coming from private industry and in a huge way from federal and state governments, so it's fantastic to have this push for something that is fundamentally hard. For the most part, we see other companies doing similar things not so much as competitors: The potential is so big — if we can build the market together — that everybody wins."

California's commitment to climate leadership, through policies such as Senate Bill 1075, created a supportive environment for innovative hydrogen projects.[33] California's hydrogen demand is expected to reach approximately 4 million tons per year by 2050, requiring a rapid scale-up to 48 GW of installed hydrogen production capacity.[34] Meeting this demand will require scaling innovative low-emissions hydrogen projects, including projects such as Mote.

> **"The momentum behind the energy transition and carbon removal is enormous. It's coming from private industry and in a huge way from federal and state governments, so it's fantastic to have this push for something that is fundamentally hard. For the most part, we see other companies doing similar things not so much as competitors: The potential is so big — if we can build the market together — that everybody wins."**

**Joshuah Stolaroff, Mote founder and CEO**

## Sustainable aviation fuel plants

Aviation is one of the world's fastest growing industries. By the mid-2030s, the industry is predicted to operate 200,000 flights per day, contribute $1.5 trillion to the world's GDP, and directly employ 15.5 million people.[35]

Aviation is also responsible for 2.5% of the world's annual carbon emissions and 4% of the earth's warming to date.[36] Aviation emissions are growing faster than other sectors as air travel increases around the world. To reduce emissions from flying and meet climate goals, 300 commercial-scale SAF plants will need to be built by 2030 globally.[37] These plants will need to produce 40 million tons of SAF per year and replace 10%–15% of aviation fuel supply. Although 193 SAF plant proposals have been announced, just 40 of these are in operation and another 10 have reached FID, or 17% of the number needed by 2030.[38] Closing this gap requires mobilizing an investment of $40 billion to $50 billion this decade.[39]

SAF is a drop-in fuel that replaces jet fuel produced from fossil fuels and therefore can be used in commercial aircraft today, without any modifications to equipment or infrastructure. SAF is produced from a variety of renewable and waste feedstocks and technologies and can reduce life-cycle emissions 50%–90% compared with fossil jet fuel. Most SAF produced today is made from bio-based feedstocks or waste fats, greases, and oils. Depending on production technology used, SAF producers can use significant amounts of renewable electricity and hydrogen. SAF producers benefit from being a part of a clean industrial hub because they can improve sourcing of feedstocks, including hydrogen, and connect with diverse offtakers for SAF and co-products such as renewable diesel and renewable naphtha. This local offtake can drive regional economic growth and support more than 1,400 ongoing jobs at a commercial-scale SAF plant producing 50 million gallons per year.[40]

### Critical factors for reaching FID

**Demand for product and offtake contracts:** SAF benefits from relatively high offtake certainty compared with other hydrogen-based products because it can be blended with fossil jet fuel and used in commercial aircraft without any change to technology or infrastructure. Contracts for SAF and SAF certificates, the environmental attributes of SAF, are increasing in number and length. The ability to secure long-term offtake is critical for SAF projects to secure project financing and reach FID.[41]

**Public-sector support:** Public policy support has been a catalyst for the SAF market in the United States. These include the Biden administration SAF Grand Challenge to produce 3 billion gallons of SAF by 2030,[42] the Federal Aviation Administration's Fueling Aviation's Sustainable Transition (FAST) $300 million grant program,[43] an SAF tax credit, and funding available from other federal and state grant and loan programs. These have catalyzed 37 proposals for new commercial SAF plants, whereas only three are operating today.

**Technology readiness of individual tech components:** Different SAF production pathways have a range of TRLs. The hydroprocessed esters and fatty acids (HEFA) pathway has the highest TRL, meaning it has strong financing and market readiness. The TRL for the power-to-liquid (PtL) varies and is less mature, yet momentum for its development continues because of the potential for lower carbon intensity.

**Community support:** Community opposition can slow down development of new SAF plants and SAF refinery conversions. Conversely, community support built through strong relationship with local government, businesses and resident can help efforts.

**Workforce availability and capability:** SAF refineries can benefit from the ease of transitioning the specialized workforce from existing liquid-fuel industries and refineries to SAF production facilities.

## Project Spotlight: World Energy

World Energy was the world's first commercial-scale producer of SAF.[44] The company has committed to mobilizing $15 billion in California, Texas, and beyond on projects with SAF, renewable diesel, green hydrogen, and more.

In 2018, World Energy acquired a former petroleum refinery in Paramount, California, and began converting the site into a 100% renewable energy facility to produce SAF, renewable diesel, and renewable naptha.[45] During the conversion, the company started operating a 2,500-gallon demonstration facility selling small amounts of SAF delivered by truck to Los Angeles International Airport (LAX). At the same time, World Energy began planning to develop a commercial scale production unit at the site. When complete, the facility will produce 350 million gallons of renewable fuels annually, including 250 million gallons of SAF,[46] a 700% increase.

Mission Possible Partnership and RMI provided technical assistance to World Energy to evaluate five different SAF production pathways based on feedstock choice, life-cycle assessment of carbon intensity, and techno-economic analysis of production costs to support the company as it moved from pre-feasibility to FID and construction. We explored various production scenarios, including HEFA with gray, blue, and green hydrogen as well as PtL technologies. The project emphasized reducing carbon intensity by optimizing hydrogen sourcing and leveraging renewable energy.

The team from Mission Possible Partnership, RMI, and the Bezos Earth Fund also helped World Energy explore federal funding to help de-risk the project. In 2024, the company reached FID and began construction on its second production unit at the plant. The SAF produced at the plant will reduce life-cycle carbon emissions by up to 85% compared with conventional jet fuel and will reduce particulate emissions up to 30% and SOx emissions up to 100%.

World Energy also won a Federal Aviation Administration FAST SAF award to convert a former petroleum pipeline to be used for continuous delivery of SAF to LAX.

World Energy's FOAK SAF plant sets the market for future SAF plants in the United States and globally. Our work shows that it is possible to optimize production costs, carbon intensity, and purchase price for SAF that enables faster adoption by airlines of drop-in clean fuels.

## E-methanol and E-ammonia plants

Shipping is critical to our modern economy, responsible for over 80% of global trade. In the United States, alone, it contributes $476.2 billion to the GDP and supports 21.8 million jobs.[47] It is also responsible for 3% of emissions globally, most of which are from fuel.[48] E-ammonia and e-methanol are two fuels that can be used for low-carbon marine shipping. Methanol and ammonia already play an important role in our daily lives because they are used in the production of up to 96% of manufactured goods.[49]

In addition to serving as shipping fuels, methanol is used to make chemicals and ammonia is used in fertilizer. When made with renewable energy, they can decarbonize supply chains and create a lower emissions shipping fuel. By 2030, 100 low-emissions shipping-fuel plants will need to be operating to achieve global climate goals.[50] As of November 2024, none are operational and only four have reached FID.[51] Achieving a net-zero shipping sector will require up to $1.7 trillion in capital investments by 2050.[52] Because it can take years to develop zero-emissions fuel plants and purchase ships that use them, industrial leaders must accelerate plans now for low-carbon shipping fuel plants across the globe.

An e-ammonia or e-methanol plant combines renewable energy, alternative feedstocks such as green hydrogen, and advanced processes to reduce emissions from production, compared with ammonia and methanol made from fossil fuels at legacy plants. These innovations enable the creation of essential shipping fuels and other materials with a significantly smaller carbon footprint, supporting broader industrial decarbonization goals.

Demand for e-methanol and e-ammonia in the shipping sector is significant, with the International Maritime Organization mandating the shipping sector reach 100% net zero–fueled ships by 2050.[53] Up to 30% of marine fuel usage could be fueled by e-methanol in 2050 and another 25% could be fueled by e-ammonia.[54] Clean industrial hubs benefit e-ammonia and e-methanol plants by pooling demand from anchor assets, such as ports, and aggregating competitively priced supply for feedstocks critical to producing these low-carbon shipping fuels.

Clean industrial hubs with ports also stand to benefit from cleaner shipping operations, leveraging best practices from across heavy-industry value chains incorporating proper safety and reliability procedures.[55] Shipping emissions not only exacerbate warming, but contribute to air pollution in coastal areas, posing serious health risks to coastal communities and maritime workers.

### Critical factors for reaching FID

**Demand for product and offtake contracts:** E-ammonia and e-methanol projects rely heavily on securing buyer agreements to ensure financial viability and risk-sharing among stakeholders. Without these contracts, the projects face significant uncertainty and potential financial instability. Additionally, shipping lines are purchasing dual-fuel ships that can run on both diesel and e-fuels, with over 250 containerships expected to be in the water running on these fuels by 2028.[56] Securing contracts for e-ammonia and e-methanol is essential for these ships to run with zero emissions.

**Access to reliable clean energy resources at competitive prices:** E-ammonia and e-methanol projects need to source significant amounts of renewable energy for the electrolytic hydrogen required to make these zero-emissions fuels. Sixty percent of the production cost is from purchasing renewable energy. Without affordable renewable energy, the overall production cost can become prohibitive, hindering project viability.

**Community support:** The success of e-ammonia and e-methanol projects hinges on local support, particularly because of safety concerns in port communities, where securing public buy-in can mitigate risks of lawsuits and permitting denials. Ensuring community approval for site locations, operational safety, management of energy and water intensity, and minimization and mitigation of any emissions and potentially hazardous waste products is critical for smooth project execution and long-term viability.

## Project Spotlight: E-Ammonia and E-Methanol Production

Low-carbon shipping fuel is a nascent market. Major shipping companies, such as Maersk and Hapag-Lloyd, are putting in orders for ships that run on low-carbon shipping fuel,[57] but most ships still use fossil fuels. As companies begin to explore the opportunity to capitalize on this nascent market, questions remain as to what demand and supply of these fuels will look like in the coming decades.

The FuelEU Maritime initiative, which came into force in January 2025, and the EU Emissions Trading System are shaping global demand for low-carbon shipping fuels. These policies apply penalties to 50% of emissions from routes that begin or end at an EU port and 100% of intra-EU shipping emissions.[58] Given shipping's inherently global nature, these regulations have broad implications for supply chains worldwide. European markets now prioritize low-carbon fuels, creating a ripple effect that extends to potential producers and suppliers in the United States.

Mission Possible Partnership and RMI supported the development of the e-methanol and e-ammonia market in the United States by working with first-mover projects. We did this through technical analysis of supply and demand out to 2050 and by working with companies considering producing these shipping fuels and feedstocks to assess their price competitiveness. We then developed short- and medium-term supply and demand roadmaps to assess price competitiveness for e-methanol and e-ammonia under multiple production pathways and policy scenarios. The study considered subsidized and unsubsidized fuels, with the goal of de-risking low-carbon fuel production.

Our analysis found that low-carbon fuels differ from traditional energy commodities in fundamental ways. Beyond their energy content, these fuels also derive value from measurable climate attributes, making them multidimensional products in a decarbonizing economy.

We found that the cost of e-methanol is highly sensitive to the electricity price for producing electrolytic hydrogen. For e-ammonia, there is significant circularity potential when integrated into decarbonized-polyol supply chain, low emissions–carbon polyurethane products.[iv] Additionally, many polyurethane feedstocks originate from fossil fuel inputs, which are subject to geopolitical and market-driven price swings. We helped potential producers of low-carbon fuel advance fixed-price contracts for low-carbon feedstocks, because the fixed price mitigates exposure to fossil fuel price volatility and enhances cash flow predictability.

This analysis highlights the opportunity for low-carbon fuel producers to capitalize on the growing demand in not only the shipping sector, but also for fertilizer and chemicals. As regulatory pressures and corporate sustainability goals drive investment in low-carbon fuels, producers with strategic foresight and supply chain integration can position themselves competitively in this evolving market.

## Low-emissions concrete and cement plants

Cement and concrete are essential building materials used in everyday life. Cement manufacturing also emits 8% of global carbon emissions each year.[59] By 2030, 45 cement plants will need to reach net zero for the cement sector to align with global climate goals.[60] Thousands will need to reach net zero by mid-century. Today, there are no commercial-scale net-zero cement plants in operation and only four net-zero cement plants have reached FID, just 9% of the number needed in the next five years.[61] Transitioning the global cement industry to net zero will mobilize $27 billion to $54 billion in capital by 2030 and up to $1.4 trillion by 2050, with investments of $600 million to $1.2 billion per commercial-sized cement plant.[62]

Cement plants eliminate carbon emissions through four primary levers: innovations in clinker chemistry, supplementary cementitious materials (SCMs), alternative fuels, and commercial-scale CCS. Cement plants can benefit from being in a clean industrial hub by sharing carbon capture, storage, and transportation infrastructure with other projects. A clean industrial hub can also help concentrate and pool demand for net-zero concrete and cement.

### Critical factors for reaching FID

**Demand for product and offtake contracts:** Traditional and new buyers are showing stronger demand for low-emissions cement and concrete products, which can help cover cost premiums. The cement industry is responsive to demand for different types of cement and concrete, creating an opportunity for buyers to influence production.

**Corporate commitment and organizational structure:** Achieving net-zero cement and concrete requires multiple departments and decision makers to work together to implement multiple projects across several geographies over a long time. A company-wide goal supported by leadership and a coordinated structure will smooth the process to reach FID for each lever.

**iv** The decarbonized-polyol supply chain refers to making polyols, which are key ingredients in polyurethane, using methods that produce little to no carbon emissions. This is part of creating low-emission polyurethane products, which are designed to be more environmentally friendly by reducing the carbon impact during production.

**Technology readiness of individual tech components:** Net-zero traditional cement production relies on carbon capture to eliminate residual emissions. Carbon-capture technologies for the cement industry are new and expensive, and carbon-storage facilities are nascent or nonexistent, depending on geography. Carbon capture needs to be rapidly deployed to meet decarbonization targets, and improving energy efficiencies of the capture technologies will be critical to reducing green premiums.

**Public-sector support:** Achieving net-zero emissions for the cement industry relies on carbon capture to eliminate process emissions. CCS technologies rely on public funding to bring down costs. Additionally, regulations are still being developed for moving and storing carbon, which a cement plant will rely on to eliminate captured emissions. Until those regulations are finalized, cement companies may hesitate to invest in, and private finance may hesitate to commit to, expensive carbon-capture systems.

## Project Spotlight: CalPortland

CalPortland is the largest building materials company in the western United States. The company operates three of California's seven cement plants: Mojave, Oro Grande, and Redding. Together these produce more than 3.1 million tons of cement per year, 35% of the cement produced in the state.[63] California Senate Bill 596, passed in 2021, regulates the cement industry in California to reduce emissions 40% by 2035 and transition to net zero by 2045.[64] CalPortland was looking for ways to meet state regulations while continuing to run a profitable business and create premium products for its customers. At the start of the project, the company already had reduced emissions by 10% on a per-ton basis at Mojave by integrating limestone and exploring other SCMs, such as pozzolans.[65] The company was also seeking public funding to cover the initial investments of major capital projects that reduce emissions.

To support these efforts, Mission Possible Partnership and RMI developed comprehensive, plant-level decarbonization roadmaps in partnership with CalPortland, helping inform an overall net-zero strategy with clear targets by decade. Our technical assistance identified and prioritized decarbonization pathways, project timelines, financial analysis, community benefits, and government incentives to reach net zero at CalPortland's Oro Grande and Mojave plants. We found that SCMs and alternative fuels can be deployed in the near term with greater cost competitiveness than other levers and reduce nearly two-thirds of a cement plant's GHG emissions. Carbon capture is needed to eliminate remaining emissions. Full decarbonization to net zero at both plants will reduce 2.2 million tons of $CO_2$ per year.

With our support, CalPortland won multiple grants, including a $4 million US Department of Energy grant for $CO_2$ mineralization and a $500,000 grant from Cal Fire for wood biomass integration, reaching FID for the projects. CalPortland has also demonstrated further commitment to reaching net zero by creating a carbon reduction team "dedicated to science-driven research and analysis to develop projects that lead to meaningful and innovative carbon reduction for the cement and concrete industries." [66] CalPortland's climate leadership has potential to affect the rest of the cement industry in California. A similar approach could scale solutions at California's other cement plants, which would reduce an additional 5 million tons of $CO_2$ per year[67]— and demonstrate the commercial and technical feasibility of profitable net-zero cement to companies in the United States and beyond.

## Low-emissions steel plants

Steel is an essential building material used in almost every industry, from automobiles to buildings.[68] Globally, the steel industry employs 2 million people. The steel industry also accounts for 11% of total global $CO_2$ emissions.[69] Low-emissions steel — also called green steel, near-zero steel, or low-carbon steel — can reduce $CO_2$ emissions by up to 95% compared with traditional steelmaking processes.[70] By 2030, more than 70 low-emissions steel plants need to be operational with a total 190 million tons of low-emissions, primary steel–production capacity per year.[71]

Although the steel industry has made strides to develop low-emissions steel, the industry saw an increase in carbon emissions in 2019–23.[72] The sector needs to meet rising demand while reducing hundreds of millions of tons of carbon emissions per year to align with mid-century climate goals. Transitioning the steel industry to align with climate goals will require over $129 billion in annual investments by 2050.[73]

Traditionally, primary steel is produced in large integrated facilities that use coal and natural gas to make iron and steel. The steel sector can take advantage of cleaner primary ironmaking technologies as well as renewable energy in steel production to eliminate up to 95% of carbon emissions. Direct reduced iron (DRI) is an alternative to the blast furnace used in primary iron production. Traditionally, the DRI pathway has used natural gas to reduce iron ore. However, transitioning the feedstock to low-emissions hydrogen or installing CCS can achieve the same iron production with minimal GHG emissions. This low-emissions iron can then be fed into electric arc furnaces (EAFs) powered by renewable energy to make low-emissions steel.

Clean industrial hubs benefit primary steel facilities by easing access to low-emissions hydrogen for DRI processes, low-cost renewable power for EAFs, and CCS technology and infrastructure. This reduces costs to decarbonize steel facilities and mitigates the risk of deploying clean energy sources and technologies. Steel facilities also deliver substantial economic benefits to local communities, maintaining clusters of on-site and upstream jobs, co-located downstream supply chain assets, and associated infrastructure investments.

### Critical factors for reaching FID

**Demand for product and offtake contracts:** Demand and offtake contracts are critical for any commodity sector, including steel. Companies can send a strong demand signal by signing offtake agreements for low-emissions iron and steel. Additionally, by pooling low-emissions steel demand into specific, joint procurement efforts, such as the Sustainable Steel Buyers Platform, buyers can signal to steel producers sufficient market demand to de-risk the necessary deep decarbonization investments at scale.[74]

**Corporate commitment and organizational structure:** Producing low-emissions steel requires multiple departments and decision makers to work together to implement multiple projects over a long time. A company-wide goal supported by leadership and a coordinated structure will smooth the process to reach FID for each lever. This is especially important for incumbents transitioning existing assets that are competing with newer entrants making investments in FOAK low-emissions steel production.

**Technology readiness of individual tech components:** Low-emissions steel relies on increased use of DRI, with low-emissions hydrogen or CCS technologies for primary production. DRI is a commercial process that traditionally uses natural gas. Hydrogen deployment is commercially feasible today and is being invested in globally by ambitious first movers. Steel producers face risks in scaling and integrating GW-scale renewable electricity and hydrogen or CCS into existing processes but are not limited by the TRLs of individual components.

**Public-sector support:** Public incentives and other funding can enable clean steel to achieve cost parity with traditional steelmaking.[75] Additionally, the US Office of Clean Energy Demonstrations awarded $1.5 billion to six steel projects to advance novel technologies for the steel industry.[76] Low-emissions hydrogen and CCS technologies also rely on public funding to bring down costs.

## Project Spotlight: Low-Emissions Steel

There are 121 iron and steel plants in the United States that together emit 64 million tons of carbon each year.[77] Many of these are working to shift their assets to use hydrogen, CCS, and other emissions-reductions levers.

Mission Possible Partnership and RMI worked with a steel producer, not named for commercial confidentiality, to model potential decarbonization pathways using renewable hydrogen and CCS and evaluated them for cost-effectiveness and emissions reductions.

We found that green hydrogen and carbon-capture pathways can be cost-competitive in the next decade. However, green hydrogen prices must decline significantly to be a viable route. CCS is more competitive in the near term, but DRI made with green hydrogen is more likely to meet market demand thresholds for low-emissions iron and steel. DRI made with CCS has a harder time reaching the same level of emissions reductions and requires additional upstream improvements such as certified very-low-leakage methane and mining decarbonization to achieve the same emissions reductions.

Our technical assistance helped the company identify that blending hydrogen into existing operations is a viable option to reduce emissions while it expands its site. If transitioned to 100% hydrogen in 2025, the company could reduce carbon emissions by over 25 $MtCO_2e$ by 2050 while producing 2 million metric tons of iron per year.

Mission Possible Partnership and RMI also evaluated the risks, benefits, trade-offs, and maturity of green hydrogen and CCS in the region as it relates to their asset. DRI and steel plants need a large, consistent, and cost-competitive hydrogen supply that can be reliably produced and transported to the plant, which remains a challenge in the absence of a hydrogen infrastructure network in the United States. Overcoming low-emissions hydrogen sourcing and delivery challenges is essential to enable DRI and steel plants to reach FID on hydrogen projects. Using low-emissions hydrogen in low-emissions steel production can be scaled to other iron and steel plants in the United States.

## Truck charging depot and hydrogen refueling stations

Trucks play an essential role in our modern economy, delivering goods every day. More than 278 million heavy-duty trucks are on the road globally.[78] The vast majority are internal combustion engine (ICE) trucks that run on diesel, resulting in more than 2.2 billion tons of $CO_2$e emitted each year,[79] 35% of global emissions from road transportation.[80] To align with global climate goals, by 2030 7 million zero-emissions trucks need to be in use. Although there have been announcements to purchase 1 million zero-emissions trucks, only 110,000 zero-emissions trucks are operating today.[81]

Zero-emissions truck adoption also requires a major infrastructure investment in electric truck charging depots and hydrogen refueling stations. By 2030 about 1.4 million to 1.8 million overnight depot chargers and 400,000 to 700,000 public high-speed chargers will be needed for battery-electric trucks, and 1,000 to 19,000 hydrogen refueling stations will be needed for hydrogen trucks.[82] Closing this gap requires mobilizing nearly $1 trillion for battery-electric trucks, hydrogen trucks, and charging and refueling infrastructure.[83]

Battery-electric and hydrogen trucks have zero on-road carbon emissions. Fully eliminating emissions from trucking requires powering zero-emissions trucks with renewable electricity and low-emissions hydrogen. Clean industrial hubs support the transition to zero-emissions trucks by improving access to electric power and low-emissions hydrogen for charging depots and refueling stations. A hubs approach can also bring together the different stakeholders that need to work together to enable this transition, including ports, terminal operators, utilities, hydrogen companies, truck producers, and fleets.

Moreover, communities surrounding clean industrial hubs stand to greatly benefit. The trucking industry is a significant contributor to air pollution, with diesel vehicle emissions linked to myriad negative health and environmental outcomes. Transitioning to zero-emissions trucking will not only reduce carbon pollution but also improve overall air quality and health outcomes for millions of residents.

### Critical factors for reaching FID

**Access to reliable clean energy resources at competitive prices:** Truck charging depots require reliable, competitive clean energy and grid interconnection, both of which can be slow because of utility processes. Hydrogen refueling stations need to be able to purchase cost-competitive low-emissions hydrogen.

**Project financing:** Enabling the transition to zero-emissions trucks requires fleets and independent truck owner–operators to be able to finance the up-front purchase costs of vehicles, and for infrastructure providers to finance charging and refueling stations. Although future operating savings of zero-emission trucks brings the total cost of ownership to below that of ICE trucks, financing can be needed to cover up-front costs.[84]

**Public-sector support:** National, state, and local grants, tax incentives, vehicle voucher programs, and other subsidies can bring down the up-front costs of zero-emissions trucks and reduce the costs of capital for charging and refueling stations. Federal investment and production tax credits for renewable electricity and low-emissions hydrogen reduce the costs of zero-emission energy sources, further reducing emissions from the trucking sector.

**Workforce availability and capability:** ICE truck drivers are exposed to PM2.5, SOx, NOx, and other pollutants while driving. Drivers of electric and hydrogen trucks benefit from reduced exposure to pollutants. Truck drivers generally prefer driving electric trucks once they have personally used them, and successful depots may incorporate worker rest areas with amenities.

## Project Spotlight: Advancing Zero-Emissions Drayage Trucking at the Ports of Los Angeles and Long Beach

California has ambitious state and local policy targets to reduce emissions from road transportation. By 2045, all trucks sold in California must be zero-emissions vehicles.[85] This is especially important in Southern California because the Port of Los Angeles and the Port of Long Beach are the combined largest cargo-handling port in the United States.

More than 25,000 trucks are registered to operate at the ports and together take more than 10.5 million trips per year.[v] About 94% are diesel trucks, and another 5% burn natural gas.[86] This freight activity is a cornerstone of Los Angeles's industrial ecosystem but also contributes significant emissions, making the region one of the most polluted in the nation.[87]

Because current electric truck models can already run many short- and regional-haul operations and hydrogen trucks are well-suited for long-haul routes, some of the primary barriers to zero-emissions truck adoption in Southern California are financial and fuel-based.

To enable the transition to zero-emissions trucks, multiple state and local agencies created vehicle voucher programs and grant programs for charging depots and refueling stations. However, there was still a financial premium that some companies and independent fleet owner–operators were not able to overcome to afford the up-front costs of electric and hydrogen zero-emissions trucks. Additionally, there were only pilot- and demonstration-scale charging and refueling stations near the port and along key trucking routes, making fleets and drivers unsure where they would be able to reliably charge or refuel.

Mission Possible Partnership and RMI developed a transition pathway to zero-emissions trucking in Southern California by evaluating the total cost of ownership of electric and hydrogen trucks, working with ports and local governments to increase financial incentives to reduce the cost premium of purchasing zero-emissions trucks, and identifying pathways to scale up charging infrastructure for electric trucks.

We analyzed multiple local funding pools and voucher programs and found that they could be used together to create a stacked local fund of $300 million, enough to create tipping points for vehicle purchases and initial commercial-scale charging depots.

We also located charging demand throughout Los Angeles County to help governments, utilities, and private companies identify where to install charging depots. Our analysis considered drayage-specific charging needs as well as broader medium- and heavy-duty truck electrification across Los Angeles. Exhibit 6 displays these results, with drayage truck activity on the left and all medium- and heavy-duty truck activity on the right, showing how drayage trucks could use a variety of off-port charging locations throughout Los Angeles County and how general truck activity is greatest near the ports, LAX, downtown Los Angeles, and San Fernando. We found that just 40 public truck charging depots can support the entire drayage fleet serving the Ports of Los Angeles and Long Beach. These findings were made public and shared on a website, through a public webinar, and in meetings with local utilities and electric charging depot developers to accelerate development of stations in areas of peak demand.

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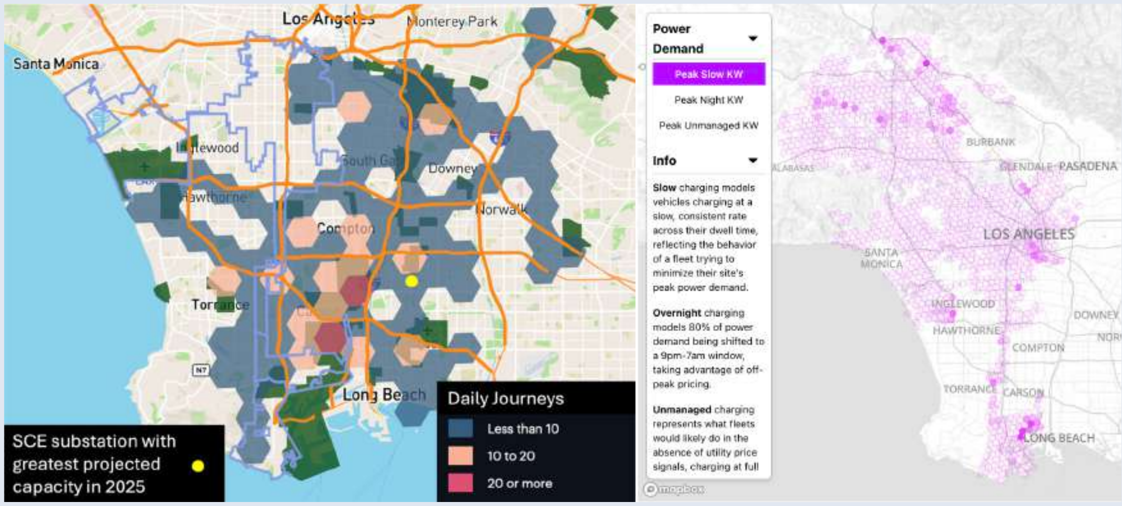
**v** Based on an RMI analysis of Port of Los Angeles data, **https://kentico.portoflosangeles.org/getmedia/452bad8c-4e16-490f-bab6-155b061866bb/POLA-Monthly-Gate-Move-Analysis**.

## Exhibit 6 **Truck charging stops and potential power demand in Los Angeles County**




RMI Graphic. Source:

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These findings are especially important to local stakeholders such as the Ports of Los Angeles and Long Beach, which have ambitious goals to reduce emissions from drayage trucks but limited land availability to provide on-site charging or hydrogen refueling. Our geospatial research showed the ports that they do not have to provide charging to enable the transition if public charging depots are made available along key corridors frequented by drayage trucks coming and going to the port. These findings can also be used by charging depot developers and electric utilities to prioritize building depots in areas with high demand and available power, and to help utilities identify where additional future capacity is needed as trucks electrify.

Stakeholders in Southern California are advancing zero-emissions trucking. The Ports of Los Angeles and Long Beach won an $412 million EPA Clean Ports grant to install zero-emissions equipment at the port, including installing 300 new charger ports and deploying 250 zero-emissions trucks.[88]

# Conclusion

The world is on the brink of a clean industrial revolution that can create jobs and support economies while meeting climate and other environmental goals.

The urgency of aligning economic development with global climate goals is growing. At present, the world has warmed an average of 1.5°C and is experiencing a documented increase in extreme weather, including an increase in life-threatening multibillion-dollar events, such as the recent wildfires, hurricanes, and winter storms in California and Texas. At the same time, emissions across many industrial and heavy-transportation sectors continue to rise because of ever-growing demand for the steel, cement, and chemicals critical to our modern way of life, and the trucks, planes, and ships used to transport them. Linking the pace of industrial growth with that of net-zero project development is essential.

Additionally, because large capital projects can take multiple years to site, permit, and finance, they must get started now to catalyze the wave of clean industrial development needed by 2030.

Enabling the pipeline of announced projects, 600 as of publication, to reach FID and become operational requires a multistakeholder mobilization in which industry leaders commit to FOAK and NOAK projects, governments create enabling policy environments, financial institutions develop specialized financing products, and community organizations are engaged early in the development of clean industrial hubs and projects.

Decarbonizing existing industries and creating markets for new clean industries are an opportunity to invest in the triple bottom line of economic growth, community benefits, and environmental improvement.

The communities and companies that are the first to act can capture a first-mover advantage, create vibrant local economies, and help industries reach tipping points. The clean industrial hubs model gives a blueprint to pursue their ambitions, and as regions successfully deploy projects, they can in turn serve as an inspiration for neighboring communities and those across the globe.

It will take a herculean effort to address the environmental impacts we have had on our planet since the Industrial Revolution. By capitalizing on the strengths of industrial regions, leveraging new technologies, and ensuring communities benefit from economic growth, this next industrial transformation can create a thriving, resilient, and prosperous future for all.

# Abbreviations

| | |
|---|---|
| **Cal Fire** | California Department of Forestry and Fire Protection |
| **CBA** | community benefits agreement |
| **CBP** | community benefits plan |
| **CCS** | carbon capture and storage |
| **CO2e** | carbon dioxide equivalent |
| **D.I.R.T.** | Decarbonizing Industry Resources Tool |
| **DRI** | direct reduced iron |
| **EAF** | electric arc furnaces |
| **E-ammonia** | electrolytic ammonia |
| **E-fuels** | electrolytic fuels |
| **EJ** | environmental justice |
| **E-methanol** | electrolytic methanol |
| **EPA** | Environmental Protection Agency |
| **ERCOT** | Electric Reliability Council of Texas |
| **FAST** | Fueling Aviation's Sustainable Transition |
| **FEED** | front-end engineering design |
| **FID** | final investment decision |
| **FOAK** | first-of-a-kind |
| **GDP** | gross domestic product |
| **GHG** | greenhouse gas |
| **GW** | Gigawatt |
| **GWh** | Gigawatt hours |
| **HEFA** | hydroprocessed esters and fatty acids |
| **ICE** | internal combustion engine |
| **IIJA** | Infrastructure Investment and Jobs Act |
| **IRA** | Inflation Reduction Act |
| **LAX** | Los Angeles International Airport |
| **LCFS** | Low Carbon Fuel Standard |
| **MtCO2e** | million tons of carbon dioxide equivalent |
| **NGO** | nongovernmental organization |
| **NOAK** | nth-of-a-kind |
| **NOx** | nitrogen oxide |
| **PLA** | project labor agreements |
| **PM2.5** | fine inhalable particles with diameters generally 2.5 micrometers and smaller |
| **PtL** | power to liquid |
| **RMI** | Rocky Mountain Institute |
| **SAF** | sustainable aviation fuel |
| **S.A.M. Tool** | Stakeholder Analysis and Mapping Tool |
| **SCMs** | supplementary cementitious materials |
| **SOx** | sulfur oxide |
| **TRL** | technology readiness level |

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