Building the cornerstones of a future-proof and competitive industry and energy system for the Netherlands

With a focus on the industry cluster in the Port of Rotterdam

POWER2X
LEADING IN ENERGY

Introduction

This paper provides a sketch of the opportunity that the Dutch Energy and Chemical industry has to lead and grow in the coming decades. It is the result of observations, modelling and real technology advancements that have been observed in the (global) industry, and understanding of the specific Dutch context. It is intended as a contribution to the ongoing discussions around the Dutch industrial agenda and, specifically, as input to the Dutch Government's competitiveness efforts. It draws on inputs from industry parties, advisors and associations as well as deep experience gained over five years of developing industrial projects in Western Europe in places such Spain, Portugal, UK, Estonia, Sweden, Germany and of course the Netherlands, as well as closely monitoring other projects outside of Europe in various end products and markets. It sketches how the Netherlands, with a lead role for the industrial cluster in the Port of Rotterdam, can shape a world-class, future-proof clean energy hub through an integrated, well-planned system approach. It is directional, not prescriptive; mapping out a vision of a secure and competitive industrial complex supporting the Dutch economy. The numbers used are based on Power2X analysis, market insights, using real current market data, projected future costs and estimates.

Power2X is a clean fuels and chemicals company, committed to creating new industrial assets that enable large-scale future proofing and decarbonization of the aviation, heavy industry and maritime sectors. The company is currently developing industrial-sized projects in blue and green hydrogen, e-methanol, and synthetic sustainable aviation fuels (e-SAF).

Shaping a positive vision for Rotterdam and beyond

For decades, the Netherlands has punched above its weight in global energy and industrial markets. The Dutch TTF sets the benchmark gas price for Europe, and Rotterdam's port has long been the continent's energy engine, handling most of Europe's oil, fuels, and petrochemical flows. Together with the wider Amsterdam-Rotterdam-Antwerp (ARA) industrial corridor, it forms the heart of Europe's chemicals and refining industry, connecting global energy trade with the continent's industrial heartland.

Now, the country stands at the start of a new chapter. In a world where speed, scale, and focus define who wins, the Netherlands has the chance to lead again, this time in clean energy and sustainable industry. By building an integrated system that couples electrification with clean molecules such as hydrogen, methanol, and CO_2 reuse, the Netherlands can strengthen its economy, secure its energy and chemicals future, and set new global standard for industrial innovation.

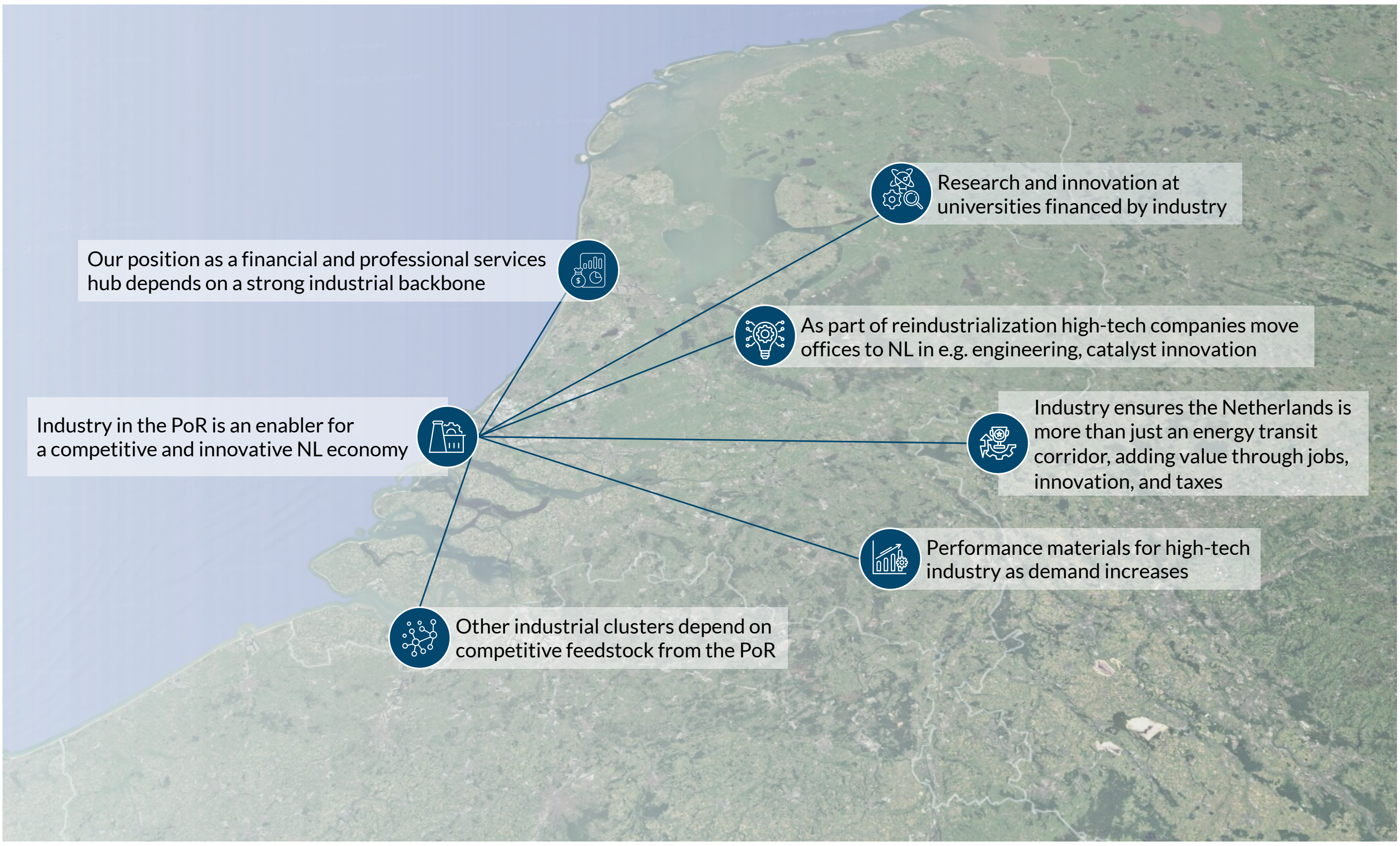
The opportunity is enormous: tens of billions of euros in new investments, thousands of jobs, and significant GDP growth as clean fuels and circular chemistry-scale. The Netherlands has all the ingredients to fulfil this opportunity: world-sized ports and industrial infrastructure, a rich history of innovation, a skilled labor force, and access to markets. Bringing the individual ingredients together into a coherent and action orientated strategy will deliver the vision. The Netherlands has led Europe's industrial energy and chemical story for a century. With the right choices, it can power the next one; clean, connected, and competitive.

The case for integration: Electrons and molecules as one system

Electrification continues to be the key in the energy transition, there where it can. However, electricity alone cannot deliver the necessary speed, scale, or reliability. To get a sense of the scale, electricity delivers around only 20% of our energy. In areas such as road transport, it provides a logical solution where it also provides a boost to efficiency. However, in most high energy industrial processes, electrification proofs more challenging, and the sheer amount of power to fuel a full transition would simplify not be feasible in the coming decades. Not in the Netherlands, not anywhere. Relocating heavy industry to other countries or regions would simply move emissions, not remove them. By keeping heavy industry, the Netherlands not only protects a critical pillar of the economy and autonomy, it also can shape its emissions. Thus supporting the heavy industry to produce in a carbon efficient way. Energy dense liquid fuels and gasses such as hydrogen, methanol, olefins, ammonia including carbon capture have long been recognized as a critical and credible solutions for these hard to abate sectors. So, while grid reinforcement and power storage solutions are essential, alone these won't deliver the transition that is needed. And, despite huge leaps in battery storage, the country is still a long way from being able to store electricity in the volumes required to address grid intermittency caused by moving to a grid powered by renewables. Molecules are chemistry's answer to power storage: they act as energy carriers, just as crude oil, coal and natural gas in today's system.

The next wave of Dutch energy leadership depends on treating power and clean molecules as one system. Electricity from offshore wind and other sources provide a source, while hydrogen, methanol, and captured CO_2 store and deliver that energy where it's needed most: powering industry, chemicals, and strategic sectors like semiconductors. An integrated system, where molecules act as a storage as well as energy, will balance supply and demand, ease grid congestion, anchor offshore wind with reliable industrial offtake, lower energy costs for hundreds of users in Rotterdam and strengthen energy security and autonomy for the Netherlands and Europe.

An integrated approach transforms fragmentation into a coordinated engine of innovation, investment, and growth.



A new system Approach: Re-energizing Dutch Competitiveness

Electrification remains central. But as renewable penetration grows beyond 50%, clean molecules become the enabler of deeper electrification, providing the flexibility, storage, and industrial inputs that pure electricity systems cannot.

The Netherlands has made major strides in renewables, CCS, and hydrogen infrastructure, but industrial competitiveness still depends on better coordination and scale. As the recent EU competitiveness review (the Draghi report) highlighted, structural pressures remain: high power costs, growing import dependence, and intense global competition for clean investment.

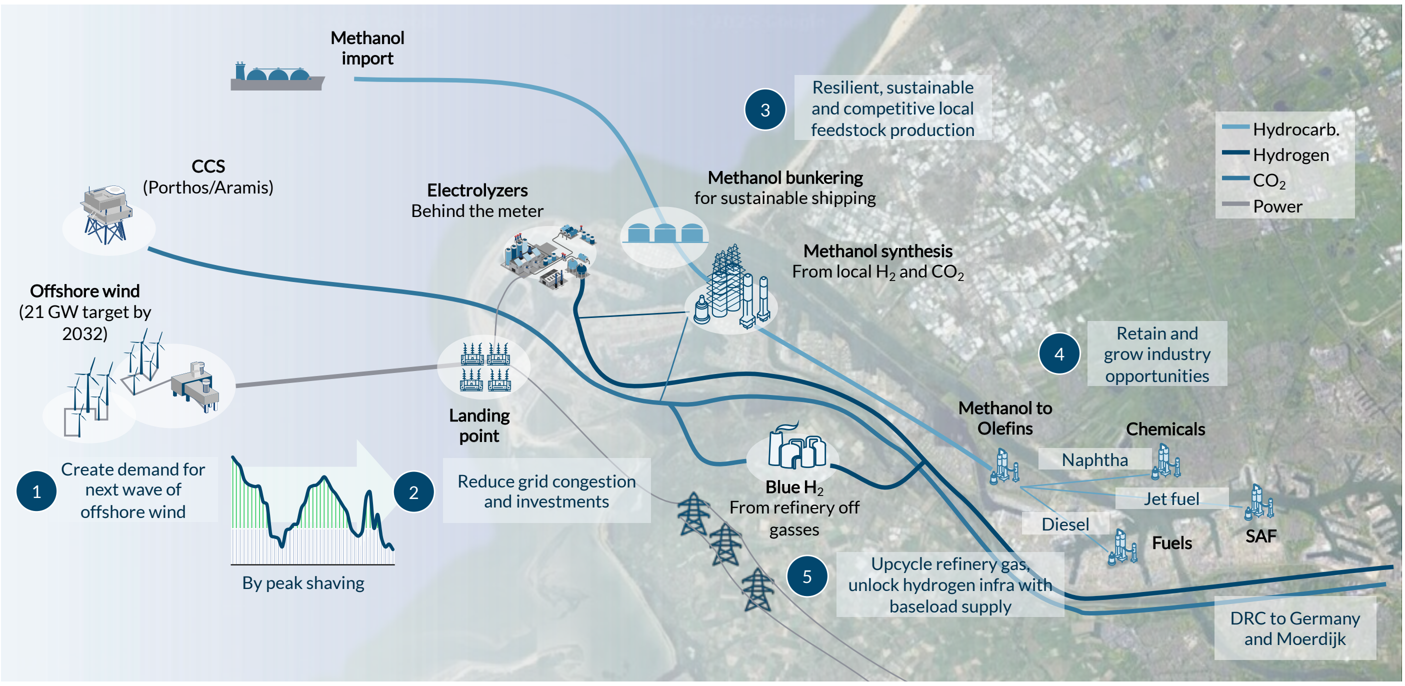
These structural challenges are not going away. In order to stay ahead, the Netherlands must move from stand-alone projects to an integrated, system-based strategy. This should be built on open-access infrastructure for CO_2 and hydrogen, utility-scale financing combining low-cost public capital with private investment, shared standards for contracts and certification to create reliable, investable demand, and long-term capital which can anchor industry for decades to come.

The Netherlands already has open-access assets, including the GATE LNG regasification terminal in Rotterdam.

The Netherlands has a proven track record with shared, tariffed infrastructure, such as LNG terminals, gas networks, and CO_2 storage (e.g., Porthos, Aramis). Building on this approach, and applying this experience to a system which integrates electrons and molecules will allow the Netherlands to maximise the opportunity.

The Port of Rotterdam: A Case Study in Integrated Energy and Industry

The Port of Rotterdam (PoR) offers a practical model for this integrated approach. As Europe's largest energy and industrial hub, Rotterdam is not only the logistical heart of the continent but also one of the world's most important petrochemical centers. The wider ARA region forms the industrial backbone of Europe's economy, hosting over 40% of the EU's refining and chemicals capacity and linking directly to the German industrial heartland. Few places in the world combine such scale, infrastructure, and expertise, making Rotterdam uniquely positioned to lead the shift to clean energy and sustainable molecules.



The port already brings together conversion capacity, logistics, and certification with a deep base of industrial users, including chemicals. Molecules are well established in the Netherlands and in Rotterdam: grey hydrogen is used widely in industry, and the development of Holland Hydrogen 1, Europe's largest green-hydrogen facility, demonstrates how these molecules can be progressively greened. Methanol, a globally traded and easy-to-handle molecule, can be imported cost-effectively today, converted into jet fuel, shipping fuel, and chemical feedstocks, and produced domestically from renewable power in the future.

Early investments are already turning this vision into reality. For example, the Porthos and Aramis projects as well as several green hydrogen projects are providing the first wave of projects. A new wave of projects is emerging. Such projects include Power2X eFuels Rotterdam project, Europe's largest synthetic-fuels initiative, which would produce over 250,000 tonnes of e-SAF annually. Other such projects include recent announcements of Ammonia imports and cracking, clean olefins projects and several initiative to produce so called blue hydrogen. These projects also unlock new opportunities for the chemical industry, as green methanol and hydrogen can be converted into olefins, aromatics, and other key building blocks, creating circular, low-carbon feedstocks for plastics and advanced materials.

Together, these projects anchor new clean value chains, attract billions in private investment, and position Rotterdam, and the Netherlands, as Europe's green engine for sustainable fuels and chemicals; a global hub at the crossroads of energy, innovation, and industry. Unlocking the opportunity requires decisive leadership and a practical, phased, roadmap.

Phase 1 – Investment decisions in 2026 – 2032: Large-scale imports of clean feedstocks, decarbonization of local fuel gases into hydrogen, and development of the first major facilities for low-carbon fuels and chemical production

In the first phase, Rotterdam could use imports of clean feedstocks and use local fuel gases, focussing on four areas:

- **Methanol import hub:** The port already has a large methanol storage capacity, which could be further scaled by upgrading tankage, jetties, safety systems and certification, enabling delivery of renewable and low-carbon methanol to maritime bunkers and the chemical cluster as a fuel and feedstock. Methanol could be biogenic (for example from areas with large excess capacity of biogas) or synthetic (e-methanol). Over time clean methanol could be considered, including as a backup power fuel source for long duration storage.
- **Methanol-conversion plants:** Building on imported feedstock, Rotterdam could develop a first generation of methanol-to-X facilities: one to two SAF plants (~ 250 kt each), one to two methanol-to-olefins units, and a first integrated methanol-synthesis unit combining captured CO_2 and hydrogen. These facilities could supply mandate-backed markets such as aviation and shipping while providing low-carbon feedstocks for downstream chemical users. Together they would demonstrate large-scale conversion of clean molecules into finished fuels and chemical intermediates, creating a domestic product base and securing early offtake.
- **Low-carbon hydrogen** could be produced, using a tolling model to reduce costs for individual projects, from refinery and industrial off-gases that today serve as fuel. In this approach, the fuel gases themselves are converted into hydrogen, effectively decarbonizing the system at its source. Together with captured CO_2, this hydrogen could be transported to Porthos/

Aramis for storage or reused as feedstock for methanol synthesis. Investing at this stage could allow Rotterdam to phase out all grey-hydrogen production and convert almost all local fuel gases into low-carbon hydrogen, turning an emission source into a circular feedstock stream. Low-carbon or “blue” hydrogen is not the end-state; it provides the reliable, lower-cost supply that enables the early clean-fuel market, supports new users, and justifies investment in open-access hydrogen and CO_2 backbones that de-risk the wider system.

- **Green hydrogen** could be developed with modular electrolyzers at landing points for offshore windfarms, absorbing imbalances and supporting the grid, without being relied upon for baseload at this stage. This early green capacity complements the converted-fuel-gas hydrogen system, providing flexibility and a pathway to full decarbonization. The combination works because blue hydrogen provides a stabilizing service, imported methanol provides liquidity and scale, and methanol-to-X converts that liquidity into durable offtake, together establishing the competitive market platform into which green molecules can later grow.

Indicative outcomes for Phase 1 (2026– 2032)[1]

Investment Decision	Key Deliverable by 2032	Indicative Capacity	Investment (€ bn)	CO_2 Abatement (Mt / yr)	Share of NL Emissions Abated
Fuel-gas conversion / Blue H_2	ATR of refinery off-gases + CCS (Porthos / Aramis)	≈ 300 kt H_2 / yr	≈ 2	≈ 2.0	~1.2 %
Green H_2 (electrolysis)	≈ 1 GW electrolyser linked to offshore wind	100 kt H_2 / yr (~1 GW)	≈ 2	0.5	~0.3 %
Methanol import hub	Upgraded terminal & logistics for renewable / low-carbon MeOH	≈ 2 Mt / yr throughput	≈ 1	0.5	~0.3 %
Clean-molecule plants (SAF, olefins, MeOH synthesis)	1–2 SAF, 1–2 MtO, 1 MeOH synthesis plant	≈ 1 Mt / yr output	≈ 3-5	≈ 1.5	~1.0 %
Hydrogen & CO_2 infrastructure	Port backbones + first corridor to Germany	–	≈ 5	≈ 1.0	~0.5 %
Total (Phase 1)	**Grey H_2 eliminated; first wave of clean-molecule plants operational**	–	**10–15**	**≈ 5.5**	**≈ 3 % of national emissions**
Macroeconomic Impact					
Employment impact (2030s)	4 200 – 12 500 structural FTE				
Added value	€ 3 – 5 billion / year (≈ 0.5 % GDP)				
Broader effect	Anchors early clean-molecule market and regional supply chains				

[1] Note: The system sizing is purely indicative. The investment tickets are based on Power2X internal views for these asset types based on our engagements with equipment suppliers and engineering partners. Abatement benefits are calculated based on assumed replacement of fossil equivalents based on open source literature. FTE and GDP benefits are taken from CE Delfts projections on the NL hydrogen economy.

Several key assets unlock the system

A phased approach can help unlock the opportunity.

Phase 2 – Investment decisions in 2032- 2040: Large-scale local and green hydrogen production, and at scale circularity of CO_2

The second phase could move the Rotterdam industrial system toward a **fully green, large-scale integrated network** anchored in offshore wind, domestic e-methanol production, and expanded methanol conversion to products. By 2040, the port could have replaced roughly **25 percent of current naphtha and kerosene volumes** with sustainable alternatives, supported by large-scale hydrogen, methanol, and CO_2 integration.

- **First, industrial-scale methanol-to-X** could be expanded into olefins, naphtha and other chemicals, providing drop-in feedstocks to well over a hundred companies across the port and beyond. This locks in durable downstream markets for hydrogen and CO_2 conversion and gives industry the confidence to reinvest off the back of a competitive domestic supply of clean feedstocks. A new generation of MtX plants – three to five units producing more than two million tonnes per year of clean olefins, aromatics and naphtha – could substitute around a quarter of current Dutch naphtha consumption.
- **Second, large-scale green-hydrogen production** could grow in line with secured demand, linked directly to offshore wind and supported by hybrid PPAs, storage and demand response to maintain high utilization. Roughly 1.5 million tonnes per year of green hydrogen could provide reliable domestic supply and system flexibility. At this scale, hydrogen becomes the connecting element between renewable power, CO_2 reuse and clean-molecule conversion.

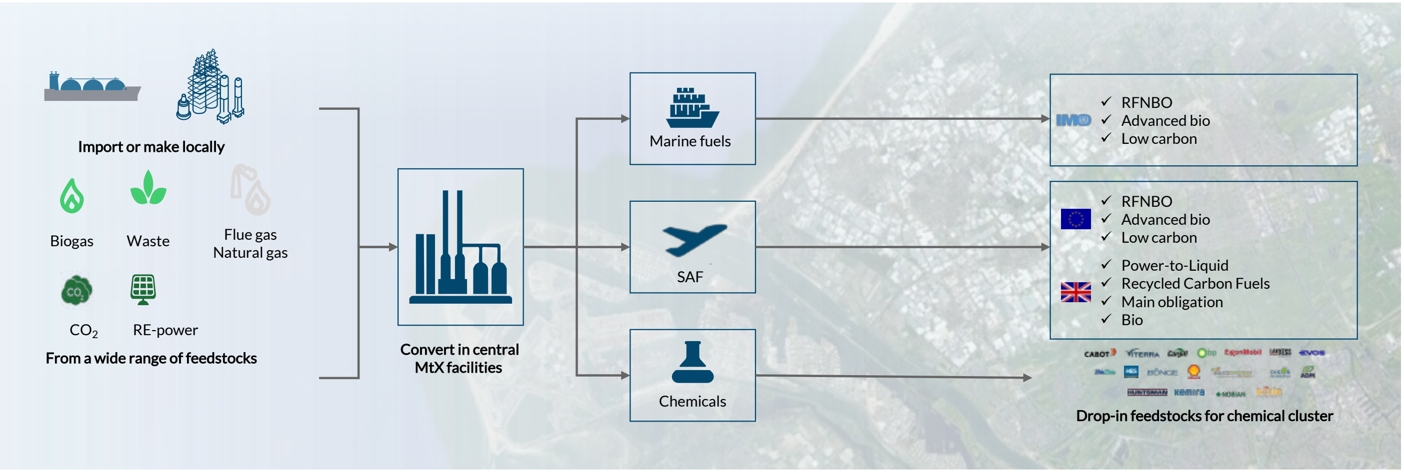
- **Third, domestic e-/bio-methanol production** could be added and co-located with hydrogen and CO_2 hubs. Where appropriate, CO_2 from clean-hydrogen plants could be included, so that volumes feed directly into methanol-to-X and close the loop from offshore wind to industrial demand. Methanol in this phase becomes both a feedstock and a trading molecule, enabling balanced flows between domestic production and imports. The system works because methanol provides durable offtake that makes green molecules bankable, blue hydrogen continues to provide reliability as a tolling service, and open-access infrastructure keeps costs down, risks manageable and private capital engaged.

Indicative outcomes for Phase 2 (2032 – 2040)[2]

Technology / Focus Area	Key Deliverable by 2040	Indicative Capacity / Volume	Investment (€ bn)	CO_2 Abated (Mt / yr)	Fossil Replacement (% of current volumes)
Offshore wind	Renewable-power for green-molecule production	+25 GW (~110 TWh / yr)	50	≈ 5.5	New demand for electrons
Green hydrogen	Domestic production linked to offshore wind	≈ 1.5 Mt H_2 / yr	15	≈ 12.0	(Phase 1 already replaced ~400 kt grey; this is new demand)
Methanol-to-X (MtX)	Expanded olefins / aromatics plants	> 2 Mt clean products / yr (3–5 plants)	12	≈ 8.0	≈ 20 % of current naphtha feedstock
e-SAF / e-fuels	Additional synthetic-jet-fuel plants	> 1 Mt / 1-2 new plants at scale	10	≈ 3.0	≈ 30 % of current kerosene use
e- / bio-methanol	Domestic renewable-methanol production co-located with H_2 / CO_2 hubs	3–4 Mt / yr	10	≈ 3.0	≈ all of current methanol trade volumes + additional demand
Infrastructure & backbones	Extended H_2, CO_2 & methanol networks; NL–DE corridor	–	8–10	≈ 0.5	Enabling (no direct fossil equivalent)
Total (Phase 2)	Fully integrated green industrial system		≈ 150	≈30–35	–
Macroeconomic Impact (whole phase)					
Employment impact (2040s)	≈ 30 000 – 40 000 high-quality FTE				
Added value	€ 20 – 25 billion / year (≈ 2.5–3 % GDP)				
Broader effect	Replaces ≈ 25 % of naphtha & kerosene; revitalises Dutch industrial base				

[2] Note: The system sizing is purely indicative. The investment tickets are based on Power2X internal views for these asset types based on our engagements with equipment suppliers and engineering partners. Abatement benefits are calculated based on assumed replacement of fossil equivalents based on open source literature. FTE and GDP benefits are taken from CE Delfts projections on the NL hydrogen economy.

Together, these Phase 2 investments could scale Rotterdam's clean-molecule system from early deployment to full maturity. The combination of large-scale offshore wind, domestic hydrogen, methanol production and open-access infrastructure can turn today's low-carbon initiatives into a fully circular, globally competitive industrial base. With reliable green feedstocks and connected markets in place, downstream reinvestments in refineries, crackers and chemical complexes become viable, consolidating Rotterdam's role as Europe's green engine for sustainable fuels and materials.



What It Takes to Compete Globally

To secure private investment and global competitiveness, the Netherlands must align industrial and energy policy around five levers:

1. Integrated Policy & Planning - Align hydrogen, CO_2, and methanol infrastructure with offshore wind planning.
2. Scale Efficiency - Build large, coordinated plants to halve electrolyser and conversion costs.
3. System Efficiency - Co-locate power and molecules to absorb peaks and reduce grid costs.
4. Risk-Sharing Infrastructure - De-risk shared pipelines and storage with public guarantees and open access.
5. Affordable Finance & Predictable Signals - Use a National Investment Bank, step-down co-funding, and CO_2-abatement Contracts for Difference (CfDs) to attract private capital and ensure stable returns.

By following this approach, Rotterdam can compete head-to-head with global energy hubs and retain industrial value within the Netherlands, rather than importing clean molecules from abroad.

Indicative numbers on business cases and the importance of integration, technology development and global competitiveness

The above quoted numbers on investments, GDP impact and volumes of production for sure look exciting and a prize worth pursuing. However, in order to make such a roadmap viable, we need to make aggressive assumptions on things like cost of capital, technology learning curves, cost of construction and especially on the full system integration. For example, charging current network tariffs for large-scale green hydrogen production is a non-starter and would make any project immediately non-competitive at a global scale. Examples of the types of assumptions that would be needed for this type of large-scale system to work and be globally competitive in the coming decade:

1. Aggressive public private funding, either in the form of guarantees or project loans/co-investment would bring project cost of capital down from around 12% to 7% or even less. This is broadly in line with observed capital cost reductions in different sectors of the energy industry like wind energy. This type of optimized financing can take out as much as 30-50% of final product cost.
2. Full power-to-chemicals integration, for example allowing electrolyzers to truly act as balancers in an overloaded power grid. Assuming for example only 35-40% utilization of green hydrogen production at zero network tariffs and at power prices in the low teens (as this power would otherwise be curtailed).
3. Low cost of plants due to scale and technology. Getting on a curve towards building hydrogen plants at scale at levels of 1000eur/kW installed, down from the current 3-5,000. This is in line with broader industry curves, but clearly ambitious.
4. Seamless CO_2 system integration and simplified carbon accounting. For example, creating a simple, volume based setup that allows companies to inject and take out CO_2 on a pure volumetric basis, and allowing monthly mass balancing and ticketing for grey and biogenic CO_2.
5. Radical simplification (with the EU) on rules and regulations for RFNBO, green and clean fuels etc. The current frameworks are adding enormous cost to the EU producers.

In first assessments and modelling work, one could see that such a system would actually be able to produce competitively priced feedstocks and products versus other regions in the world. The density and network effect, the excellent infrastructure in such a system would be THE differentiating factor. Without these measures, competition from several countries in Asia and the Americas would be gaining an enormous competitive advantage in this next frontier of the energy and industry system.

Conclusion

The Dutch industrial and energy sector can secure an exciting economic and impactful future by building an integrated energy and chemical industrial system that unites electrons and molecules. Through shared infrastructure, coordinated investment, and pragmatic sequencing, the Port of Rotterdam can anchor Europe's next generation of industrial competitiveness.

This is not a distant moonshot. It is a practical, phased vision that keeps the Netherlands at the forefront of global clean-industry innovation, and there is already action underway. The time to accelerate the action and deliver a coordinated approach is now: Whoever builds the first major green molecules hub will lock in industrial and financial leadership for decades. The Netherlands has the base assets, but needs government support, with clear policy signals, funding, and faster permitting, to stay ahead of for example China, North America, India and Brazil . This is a global race. If the Netherlands acts now, it can become the world's green fuel leader, or at least one of them.