



Final version - MARCH 2026

Syngas value chain in Rotterdam HIC

Deliverable 4: Decision-Based Roadmap

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TEKENKAMER VAN
DE INDUSTRIE

Transparantie in complexiteit

Deliverable version review history

Title	Syngas value chain in Rotterdam HIC Deliverable 4: Decision-Based Roadmap
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Tvdi Internal review and versions	Full draft version release to client for review – v1.0 – March 20 2026 Internal review of V1.0 – March 20 2026
External review	V1.0 review – Els Boesveld – Provincie Zuid Holland – March 2026
Status	Final
Publication status	Internal PZH and Tvdi and partners



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Introduction – A strategic syngas value chain assessment

As the chemical industry transitions toward circular and renewable carbon, syngas emerges as a uniquely versatile building block for what comes next. Produced from waste, biomass, or CO₂, and convertible into chemicals, fuels, and other hydrocarbon products, syngas connects diverse feedstocks to a wide range of valuable outputs — making it a natural focal point for large-scale circular carbon development.

The Rotterdam Harbor Industrial Cluster (HIC) is uniquely positioned to lead this development. Its logistical reach across roads, rails and waterways, its access to large volumes of renewable power, and its role as a hub for international trade flows of feedstocks and products give the Rotterdam HIC the foundations to develop syngas value chains at meaningful scale — supplying both chemicals and fuels to the Antwerp-Rotterdam-Rhein-Ruhr Area (ARRRA) super-cluster and the greater Western European hinterland.

This study was initiated by the Province of Zuid-Holland (PZH), team Sustainable Harbor, Industry and Maritime Industry. PZH asked itself: "What can we do to stimulate the development of circular and renewable carbon investments in the Rotterdam Harbor Industrial Cluster?" To answer this, PZH commissioned Tekenkamer van de Industrie (TvdI) and Sproule ERCE to conduct a strategic exploration of how the transition toward circular carbon can move forward — assessing what syngas value chain development in the Rotterdam HIC could look like at different scales, what it requires, and what it means for the existing industrial ecosystem, infrastructure, and investment climate.

To structure this exploration, first archetypes of syngas value chains were developed to understand value chain requirements and conversion efficiency. Based on these archetypes three versions were made of development pathways for a syngas value chain with the aim to increase scale and allow the Rotterdam HIC to continue to play its critical role. These versions are deliberately polarized to surface the impact of starting with a different approach. For all three versions, as scale increases the complexities grow: from the challenge of supporting many independent projects, to coordinating the large-scale systemic transformation of the industrial cluster itself. The nature of the assets, the infrastructure demands, and critically, the focus of leadership all shift — from individual project developers to regional and ultimately national governance. And they differ markedly in their contribution to sustainability and strategic autonomy, making scale a strategic choice.

The exploration is structured across four deliverables and summarized in a whitepaper. Together they take the reader from the fundamentals of syngas value chains, through a scaling assessment, to a stakeholder landscape and a decision-based roadmap — building a coherent picture of what it takes to go from ambition to action. At its core, the study asks which scale is needed, and what it would take for the Rotterdam HIC to supply the hinterland and achieve our goals of CO₂ neutrality, circularity and strategic autonomy — creating a diversified circular carbon portfolio that secures the region's long-term industrial position.



Introduction – Contextual Driving Forces with Strategic Implications (1)

The development of a syngas value chain in the Harbor Industrial Complex (HIC) of the Port of Rotterdam does not take place in isolation. It is shaped by global geopolitical developments, the accelerating energy transition, and the internal dynamics of the European Union. These forces interact in complex and uncertain ways outside our control and will influence the performance of the HIC as a whole and the syngas value chains within it. As such they create both opportunities and constraints for industrial clusters. In the following slides we'll introduce these driving forces, why they matter, what makes them uncertain, and what is inevitable.

Driving Force 1: Multipolarity and Struggling Superpowers

The global political and economic order has shifted from a predominantly US-led system toward a multipolar world with several competing superpowers including the United States, China, the European Union and large emerging economies. Geopolitical competition increasingly shapes trade flows, technology development, and access to resources. Security of supply and supply-chain resilience increasingly compete with economic efficiency and sustainability ambitions. An important nuance is that all these superpowers are internally struggling under sustained stress from climate impacts, economic volatility, demographic aging, technological disruption, and geopolitical fragmentation forcing all governance models to evolve.

This matters to Dutch base industries and the HIC in Rotterdam as it is deeply embedded in global trade networks. Feedstocks, energy carriers, technologies, and markets depend on international flows. Changes in the geopolitical system influence access to feedstocks and energy carriers, availability and cost of critical technologies, market access for chemical and energy products, and investment confidence in industrial infrastructure.

- **Critical uncertainties** include the degree of fragmentation versus cooperation between blocs, the reliability and price of international trade in energy and feedstocks, and the EU's willingness to prioritize strategic autonomy over economic efficiency.
- **Inevitable truths** and surprises include geopolitical shocks, sudden export restrictions on critical materials, and rapid shifts in alliance structures especially over the course of the 2020s and early 2030s driving towards a new balance between global powers.



Introduction – Contextual Driving Forces with Strategic Implications (2)

Driving Force 2: Climate Change impact on transitions

Climate change and environmental degradation are structural and accelerating forces shaping the global economy. Governments are responding with policies aimed at reducing emissions, improving energy efficiency, and transforming industrial systems. The resulting transition involves large-scale technological, economic, and societal change.

This matters to Dutch base industries and the HIC in Rotterdam as they are energy- and carbon-intensive, placing them at the center of the transition challenge. They face carbon pricing, regulatory pressure, changing energy costs, demand shifts toward low-carbon products, and growing expectations around circularity and resource efficiency.

- **Critical uncertainties** include the speed and stringency of regulation, the pace of technology scale-up (renewable power, hydrogen, CCS, circular feedstocks), and market willingness to pay for low-carbon products.
- **Inevitable truths** and surprises include extreme climate events, technology breakthroughs or failures and shifts in public and political attention following climate shocks.

Driving Force 3: EU internal dynamic

The European Union has ambitious goals for industrial transformation and decarbonisation but translating these ambitions into implementation remains challenging. Diverse national interests, ageing populations, and complex regulatory processes shape the speed of change.

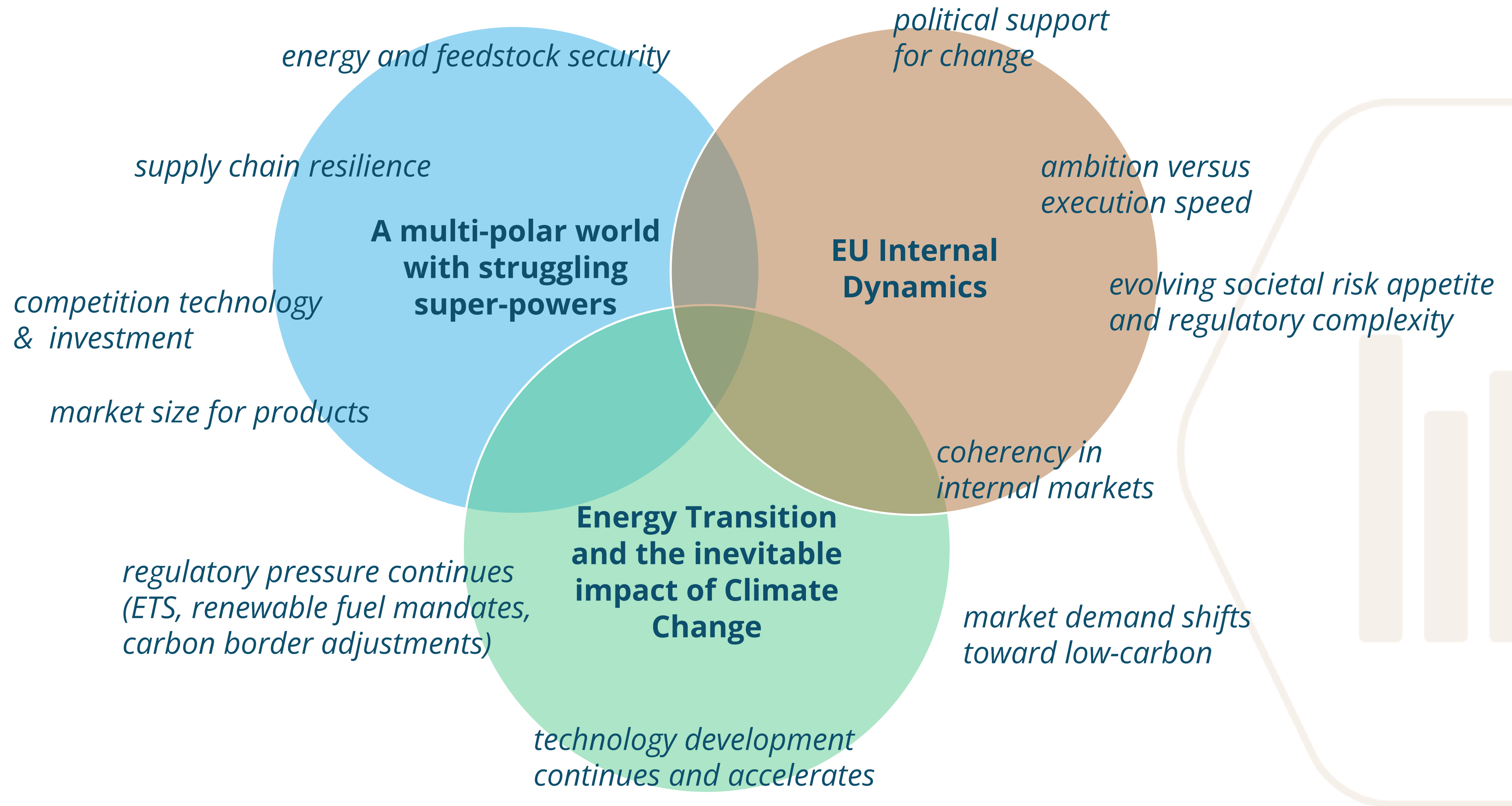
This matters to Dutch base industries and the HIC in Rotterdam as EU policy strongly shapes the investment environment through instruments such as the EU Emissions Trading System (ETS), renewable mandates, the Carbon Border Adjustment Mechanism (CBAM), and circular economy policies. These create incentives for transformation but also regulatory complexity.

- **Critical uncertainties** include the stability of political and societal support, the speed of permitting and infrastructure delivery, and coherence of internal markets.
- **Inevitable truths** and surprises include political backlash against energy costs, labor and space constraints, and crisis-driven policy accelerations.

Together, these driving forces define the uncertainty space within which the future of Dutch base industries will unfold. In the remainder of this document, we examine what decisions need to be made to grow a syngas value chain in the HIC and how these forces shape context within which these decisions will have to be made.



Introduction – Contextual Driving Forces with Strategic Implications (3)

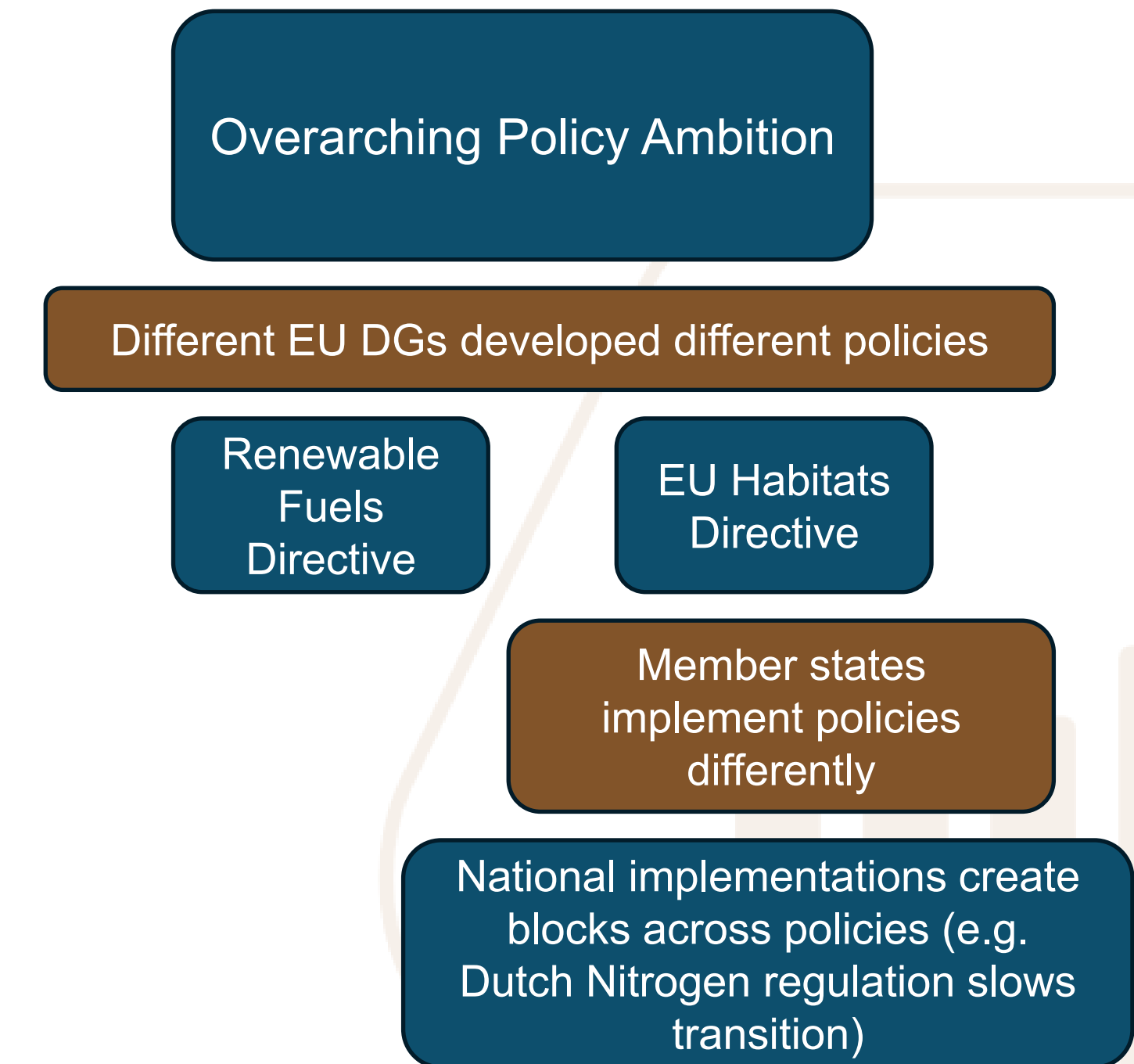


Policy framework driven by contextual driving forces (1)

European policies are rooted in a set of core shared societal values such as solidarity, fairness, respect for people and the rule of law. These values translate into societal ambitions, for example climate neutrality, circular use of resources, autonomy, resilience and a level playing field, which are implemented through policy instruments (e.g. carbon trade, market incentives and regulatory standards).

The European Union pursues its goals across many policy domains simultaneously which is a response to the strong set of contextual driving forces described above. As a consequence, the EU policy landscape is dense and filled with interacting policy tools. Implicitly, this approach assumes that economic and industrial systems can be reshaped without constraint and individual policy measures operate independently. In practice, real-world systems are constrained by, among other things, physical infrastructure, natural and human resources, investment cycles, institutional capacity; causing policy instruments to interact with each other in complex ways. As a result, the landscape becomes very hard to navigate for individual organizations and the combined effect of push, pull and regulatory measures regularly produces outcomes that differ from, or even counteract, the original policy intentions.

The finite world requires a holistic approach that combines policy goals within the context of a finite system. Priorities need to be weighed against the capacity for change and resources taking our governance from perfectionistic to realistic. A pragmatic approach integrating the multiple levels of ambition and governance is needed.



An illustration of how overarching policy ambitions, create horizontal policy silos that fragment along the vertical axis as different jurisdictions implement regulations. Bottom-up policies or adjusted targets (like advanced nitrogen policy in The Netherlands) may even further increase fragmentation.

Policy framework driven by contextual driving forces (2)

The regulatory landscape is split into horizontal silos and vertical transpositions. It is these transpositions that create the mechanics of how this landscape interacts with a future syngas value chain. Looking at the policy interactions within the conceptual framework we define push, pull and barrier mechanisms, where

- **push mechanisms (sticks)** move investment and technology away from undesirable states through levy, taxes and more.
- **pull mechanisms (carrots)** use incentives to create market demand which draws towards the desired investment and state, and
- **barriers** act as additional aspects that block a transition

The next slide, shows an illustrative overview of some of the main policies and their main working mechanism(s) on the archetype syngas value chain.

The stakeholders interviewed in the HIC syngas project unanimously identified that the fragmented policy framework is a topic of particular relevance. The combination of many of push and barrier policies, as well as uncertain pull mechanisms, lead to a lack of clarity on how to realistically meet all ambitions together. This forms a major barrier for project execution and investment. Ironically, there are also areas where ambitions have already been defined but where comprehensive policy packages are still evolving such as the transition towards a circular carbon system by 2050 or future expansion of carbon border adjustment mechanisms to cover broader carbon-based value chains. Understanding

the impact of these gaps is essential to unlock investment decisions today on assets with a full life cycle of multiple decades.

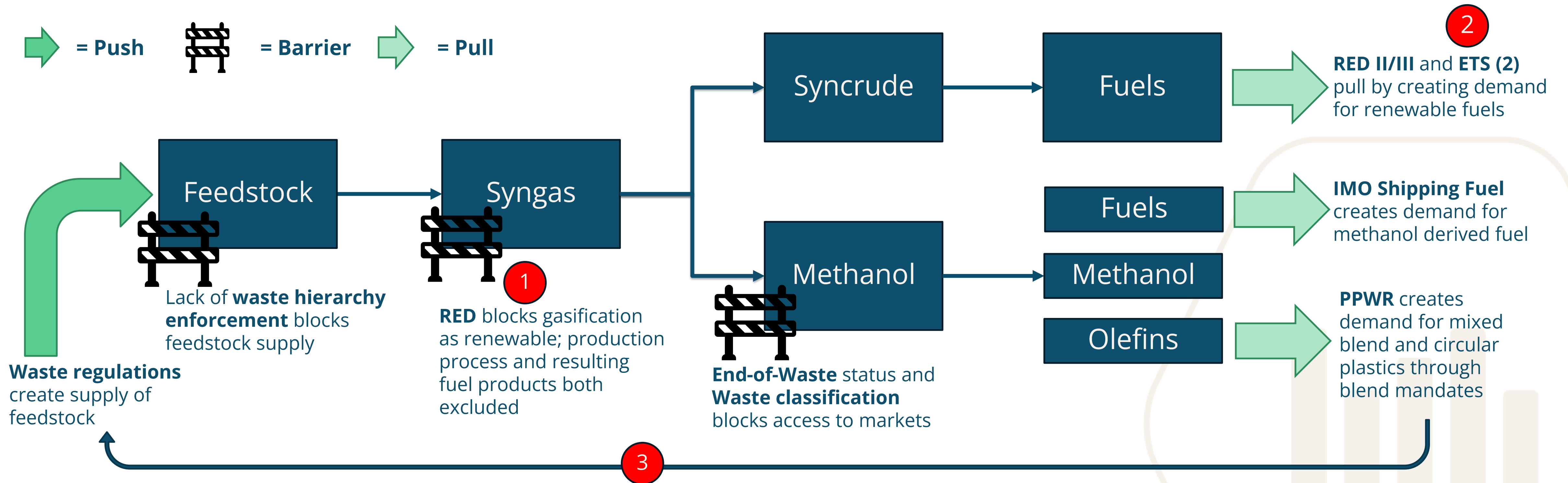
Designing effective policy for the transition of energy and material systems requires matching policy instruments to the different phases of the transition. This can be approached in two complementary ways. A backward-looking perspective starts from long-term objectives, such as climate neutrality and circular resource use by 2050, and works back to determine what technologies, infrastructure and market conditions must be in place at earlier milestones. A forward-looking perspective instead begins with the practical constraints of the present system, assessing what can realistically be developed and deployed over time and phasing ambitions accordingly. This second approach requires:

- (1) internally consistent views of the future against which policy roll-out can be planned,
- (2) an integrated plan across investment climate, infrastructure and assets and
- (3) continuous monitoring of progress and tools to manage emerging constraints.

The coming slides will work out some of these topics in more detail to show the effects of a fragmented back-ward looking policy framework in practice.



Policy framework Overview



This slide highlights the most mentioned policy bottlenecks and the mechanism through which they interact with a future syngas value chain. There are three main regulatory conclusions that are further explored on the next few slides. In the picture it is shown where these three have an impact in the value chain.

1 The **Renewable Energy Directive (RED)** simultaneously pulls on the syngas value chain through stimulation of the demand for renewable fuels and acts as the largest barrier, as gasification does not qualify for renewable fuels certification despite the main intent being to stimulate renewable fuels.

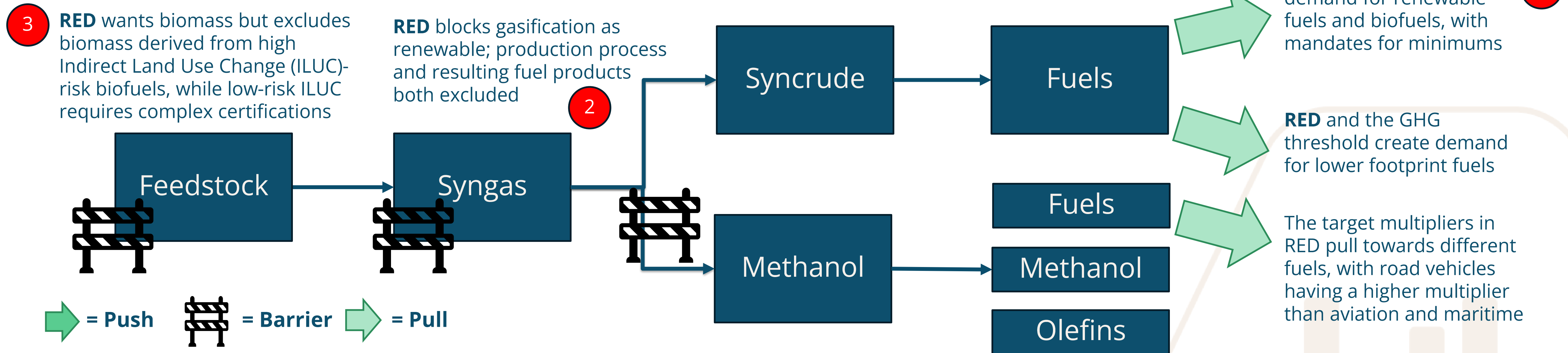
2 **ETS** is fundamentally a push instrument for industries as it raises the cost of emitting CO₂ and therefore increases pressure on fossil-intensive activities. The extension to transport emissions (to ETS2) could also be a pull on the syngas value chain as it creates new markets for low carbon fuels. But it does not specifically create a market for syngas based renewable fuels.

3 There are feedstock policies working on both sides of the value chain, but neither are effective. The push of the feedstocks into a syngas value chain through **waste hierarchy regulations** is not enforced and the pull of the Plastic and Packaging Waste Regulation (**PPWR**) and blended mandates are not actually a pull due to lack of

clear criteria on what constitutes blended. Together they create a situation in which syngas feedstocks are also claimed by multiple other uses, while the market signal for circular chemicals remains unclear.

There are other detailed policies that interact and influence the investment climate: **nitrogen permits** are mentioned as blocking investment decisions, project progress and delaying permitting processes and **unclear carbon accounting** (specifically: unresolved GHG allocation for co-production processes, biogenic/fossil attribution in mixed feedstocks, and uncertain chain-of-custody for carbon certificates) is a frequently mentioned barrier with direct impact on project bankability.

Policy framework Exhibit 1: Renewable Energy Directives (RED)



RED is simultaneously the strongest pull mechanism *and* the largest barrier for waste-based syngas value chains. It creates demand for renewable fuels through blend mandates and GHG thresholds, while excluding the most scalable circular carbon production pathway from qualifying. This contradiction runs through every layer of the directive: feedstock rules, pathway definitions, biomass restrictions, and GHG accounting all interact to fragment what should be a coherent market signal.

MSW/RDF feedstocks, breaks the traceability chain between carbon origin and end product. Because RED has no established methodology for attributing biogenic fractions through a co-produced intermediate, neither the production process nor the resulting fuel can be certified as RED-compliant.

Even where biomass gasification could qualify, certification schemes are inconsistently recognized across member states and Annex IX eligibility interpretations vary between certification bodies. This is an independent barrier and adds audit exposure and investment risk on top of it.

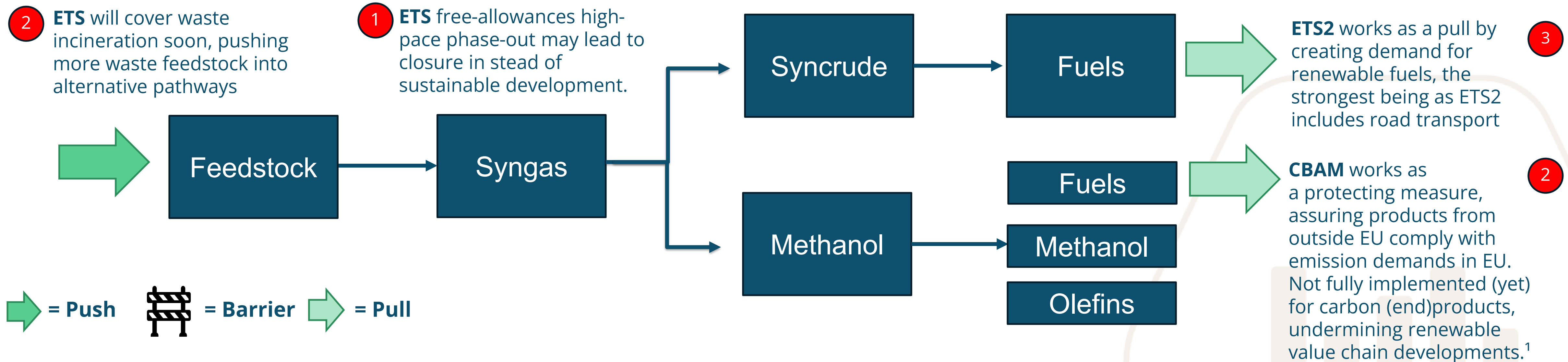
1 The RED pulls towards renewable fuel production through demand mandates for, a 29% renewable share in transport (or 14.5% GHG intensity reduction) and a 5.5% advanced biofuel/RFNBO sub-target by 2030, and through establishing demand for lower footprint fuels.

3 As a result, RED pulls primarily on biomass-based feeds and production pathways, but this is not a straightforward alternative. Sustainable biomass is a scarce and contested feedstock, with competing demand from bioenergy, BECCS, and construction materials. RED further restricts high-ILUC-risk biomass outright, and exemptions for low-ILUC biomass require complex, ongoing certification with no guarantee of long-term compliance. Together, these constraints create supply chain uncertainty that directly undermines the investment case for any production pathway built around them.

The implication is that RED compliant feedstocks and production processes will struggle with reaching the required scale for system-level transition.

The complexity of RED also creates a GHG accounting gap that further compounds the above. Co-production processes in gasification — where mixed feedstocks yield multiple outputs — have no clear allocation methodology under RED's Annex V and VI, meaning even biomass-based routes face audit risk and certification uncertainty. As a result, the lower GHG mandates that should drive market demand do not translate into bankable market pull.

Policy framework Exhibit 2: ETS, CBAM and ETS2 — pressure and volatility without perspective



The EU reduces industrial CO₂ emissions through **ETS**, **CBAM**, and **ETS2**, targeting production emissions, import competition, and transport fuel demand. They increase the cost of emitting carbon, at different rates and through different mechanisms.

1 The **ETS** free allowances phase out by 2039, requiring carbon neutrality within 15 years. For heavy industry, new plants cost billions, development takes years, and the infrastructure (e.g. for H₂ and CO₂) also takes time to build. When free allowances are phased out, credits must be purchased through the open market, leading to sharp price peaking in a structurally inelastic market. The rational response is closure and assets that could anchor a circular value chain risk being retired before that chain is ready, losing the scale and pace the transition

requires.

2 **ETS** and **CBAM** raise the cost of fossil methanol, potentially makes waste available as a feedstock, supporting the relative business case for bio-methanol from gasification. But closing the merit order gap requires solid protection and a high carbon price and even then, is insufficient alone. Complementary instruments and the ETS price are subject to political pressure, and investors face uncertainty on both.

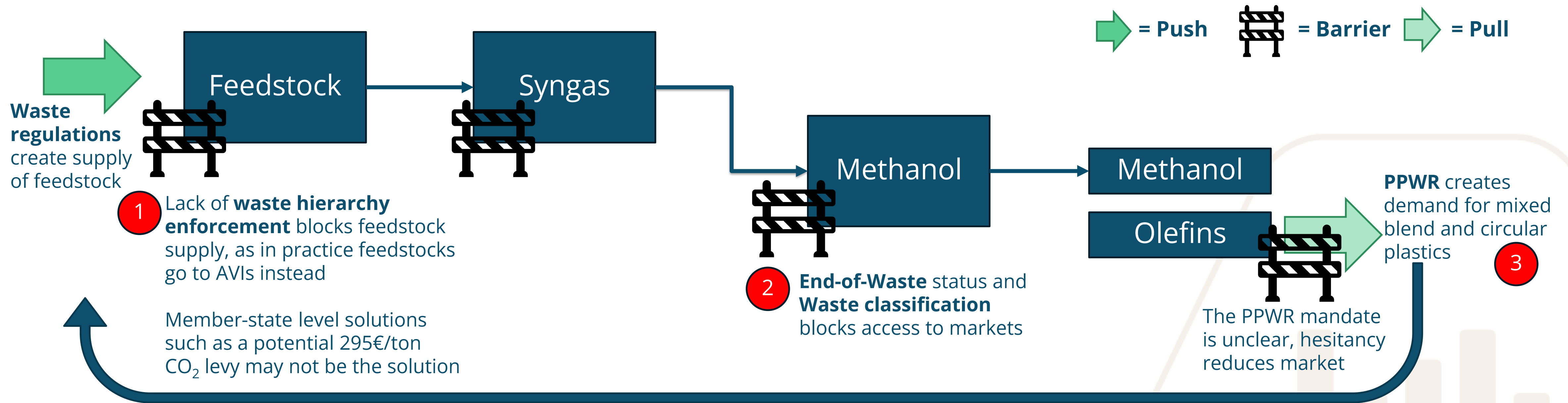
3 **ETS2** extends carbon pricing to transport fuels and heating from 2028. This adds a potential demand signal for low-carbon products, but implementation remains uncertain. ETS2 is intended as a separate market, but there is a risk of ETS2 competing for credits in complex

industries or in circular systems (where “heavy industry” is a fuel supplier). This needs to be explored further, to see how specific articles and industries interact under the two trading systems.

For syngas value chain development, the instruments are directionally correct, but not stable or coordinated enough to anchor the investment decisions needed at the scale we are after. The combined effects in a politically uncertain landscape leaves little room to make financially sound investments on time. The uncertainty results in pressure and volatility without perspective.

1.) EgoLibrium (2026). Van Keten naar Kringloop: Transitieagenda voor de Nederlandse koolstofchemie. Invest-NL, January 2026.

Policy framework Exhibit 3: Plastic gasification blocked by rules meant to enable it



Turning plastic into products sounds straightforward – collect, recycle, reuse. But only roughly 27% can be mechanically recycled. The remainder is incinerated. Gasification can convert it to circular chemicals, but conflicting regulations block this route:

1 The **waste hierarchy (WFD, 2008/98/EC, Article 4)** aims to push feedstock to higher value recycling prior to applying incineration. However, under **Article 3 (17)**, producing fuels is classified as "**other recovery**", which is the same tier as incineration. Stakeholder interviews indicated that in the Netherlands **AVIs** capture feedstock that could flow to circular projects. A proposed Dutch levy of **€295/ton CO₂** would likely displace waste to neighboring countries rather than redirect it to circular feedstock application. Coordination at **EU level** is needed.

2 Under the **WFD (Article 6)**, waste only becomes product when **end-of-waste criteria** are met. For plastics, no EU-wide criteria exist yet (a draft implementing act entered public consultation in December 2025). Until then, circular products keep their waste classification, blocking market access despite being chemically identical to virgin material. The **EC's** December 2025 draft proposal addresses this but gasification remains out of scope.

3 The **PPWR (Regulation (EU) 2025/40)**, in force since February 2025, sets mandated recycled content targets for packaging. Circular chemicals from gasification can count towards these targets, making **PPWR**, unlike **RED**, a pull mechanism for waste-based chemicals. However, the implementing act on recycled content calculation is not due until **31 December 2026**, and recyclability criteria not until

2028. The stakeholder interviews explicitly identified clarity on **PPWR** as a precondition for **FIDs**. Without it, the demand signal is real, yet unbankable.

These three failures block the circular value chain at every stage: feedstock does not flow, products cannot re-enter the market, and demand is unbankable. The core trade-off, rules strict enough to prevent greenwashing versus pragmatism to allow transition-phase solutions to scale, has not been resolved. Until then, long-cycle **FIDs** on circular carbon value chains cannot proceed.

Decisions (1)

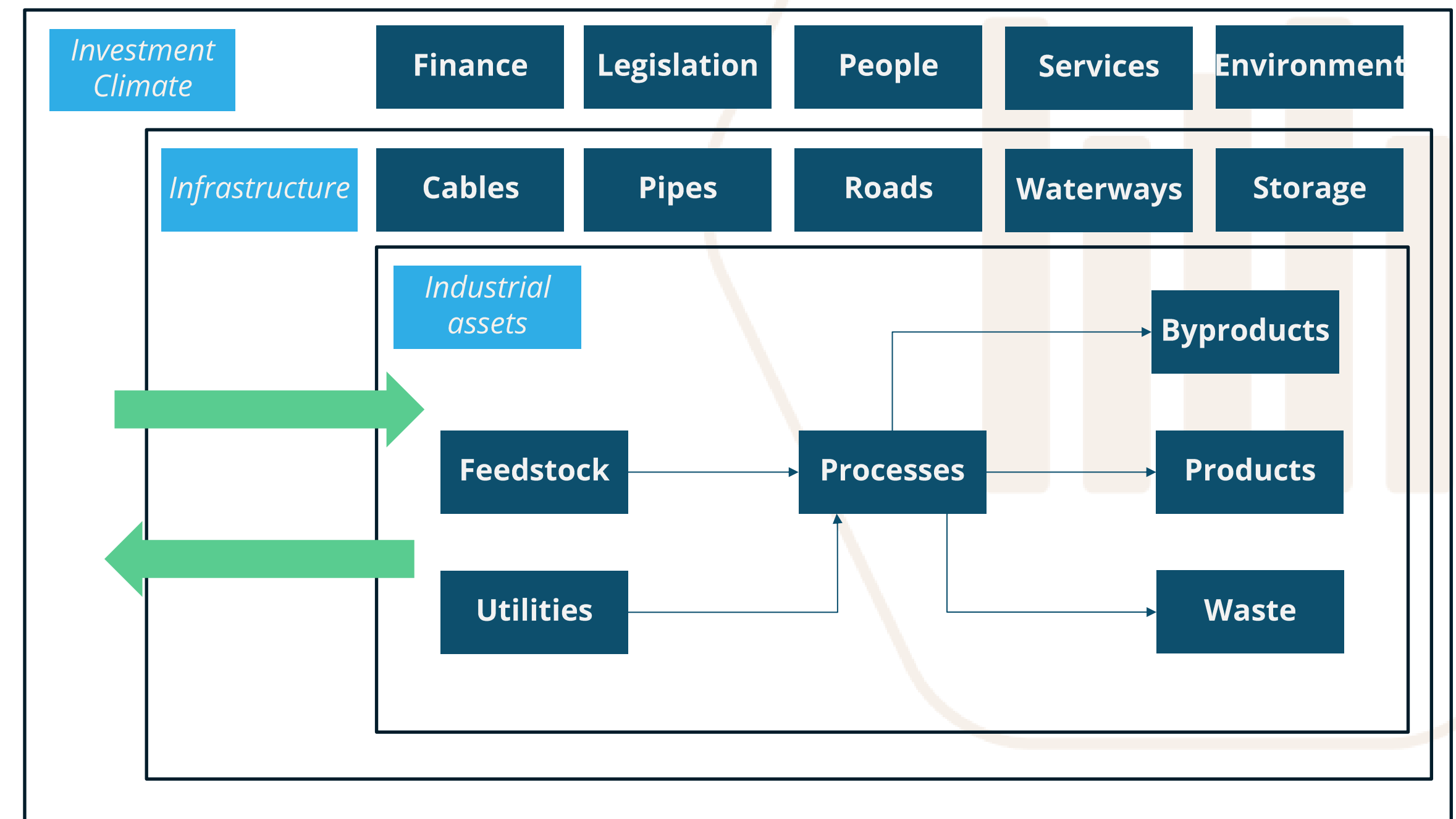
Implementation of new circular carbon processes will require the execution of large capital projects. These projects move through typical front-end phases to decide on specific elements before taking a final investment decision.

To understand how these projects fit into an industrial carbon conversion system, we first need to develop the frame within which each version delivers its projects. This frame starts with setting how green, how circular and how independent Northwest Europe and the Netherlands wants to be. What could demand look like in the future? How much of the national demand do we want to produce from locally converted circular sources? Only then we can look at the more detailed project level decisions required to establish the required projects. These decisions and related actors, are split in 3 parts, schematically shown in figure 1 and elaborated on the next page:

- **Decisions on an Asset level:** Where will a plant reside? How can we create the required space? What type of feedstock to use? How will feedstock be supplied? What products to produce? How to integrate with and re-use existing assets for a circular carbon industry?
- **Decision on an Infrastructural (physical Ecosystem) level:** How to transport feedstock and products? How to connect to these networks? How to distribute hydrogen, power, heat and other utilities? How do old, new or transformed assets work together?

- **Decisions on Investment Climate level:** How to create and sustain a circular carbon market? How to access funds from investors? How to obtain government support? What adjustments are needed in regulations or permitting? How to bring different parties together, within Rotterdam HIC but also internationally? How to protect new and emerging value chains during that growth path? And, how to structure and connect the business models of all the value chain elements?

Figure 1: Typical decision topics across the Asset, Infrastructure and Investment Climate levels. A long list of typical decisions is shown on the next page.



Decisions (2)

By comparing versions of the syngas value chain at increasing scale we explore how we can reach our goals, and what risk exposure they give. But no matter what size the Version or project is, decisions must always be taken at all three levels (Asset, Industrial or Investment Climate) and they influence each other in all cases. Per version however, decisions are taken in a specific order, and by specific decision owners. When placed in order, accounting for dependencies, the decisions form a Decision-Based Roadmap. If decisions are not taken at all, taken in the wrong order, not by the ultimate decision owner or not with recognition of all the options, risks and stakeholders, there is a large chance of getting stuck, getting delays or ending up with failure later on.

Relatively small projects may be locally organized by a developer that sees opportunities, for example in using a local waste stream, and starts at the Asset level. Additional Infrastructure could be required, and the Asset Owner must secure finance, largely taking the Investment Climate as is.

Industry scale projects the size of a refinery or even the transformation of the HIC itself, starts with direction setting and facilitation at cluster or national level. A decision must be made to push for circular carbon conversion at scale into a set of products. They may need to organize EU legislation and re-structure an entire area in the HIC with all existing Assets and stakeholders in it. Only then infrastructure network decisions can be taken, and Asset owners can decide how to play their role in the HIC transformation. All decision owners must be aligned to enable success.

This makes clear that different Versions require key decisions to be taken by **different decision owners**; Owners and also stakeholders change from one version to the next. The smaller the scale of the envisaged Version, the more ownership with the Asset owner or developer. For small-scale projects, most of the Asset and Infrastructure decisions can be taken by the Asset Owner, with support from (local) authorities. This does not immediately make decisions easier as influencing the system around such a project is more difficult for these smaller organizations.

When the number of small-scale projects increases, space becomes progressively scarcer. Access to power and hydrogen becomes a concern and takes time. The first movers may still find a voluntary circular carbon market, but for a larger number, it becomes important to have a regulatory framework that predictably supports market creation for at least The Netherlands, ideally at EU level. The Asset owners may be innovative smaller companies, or larger industry players.

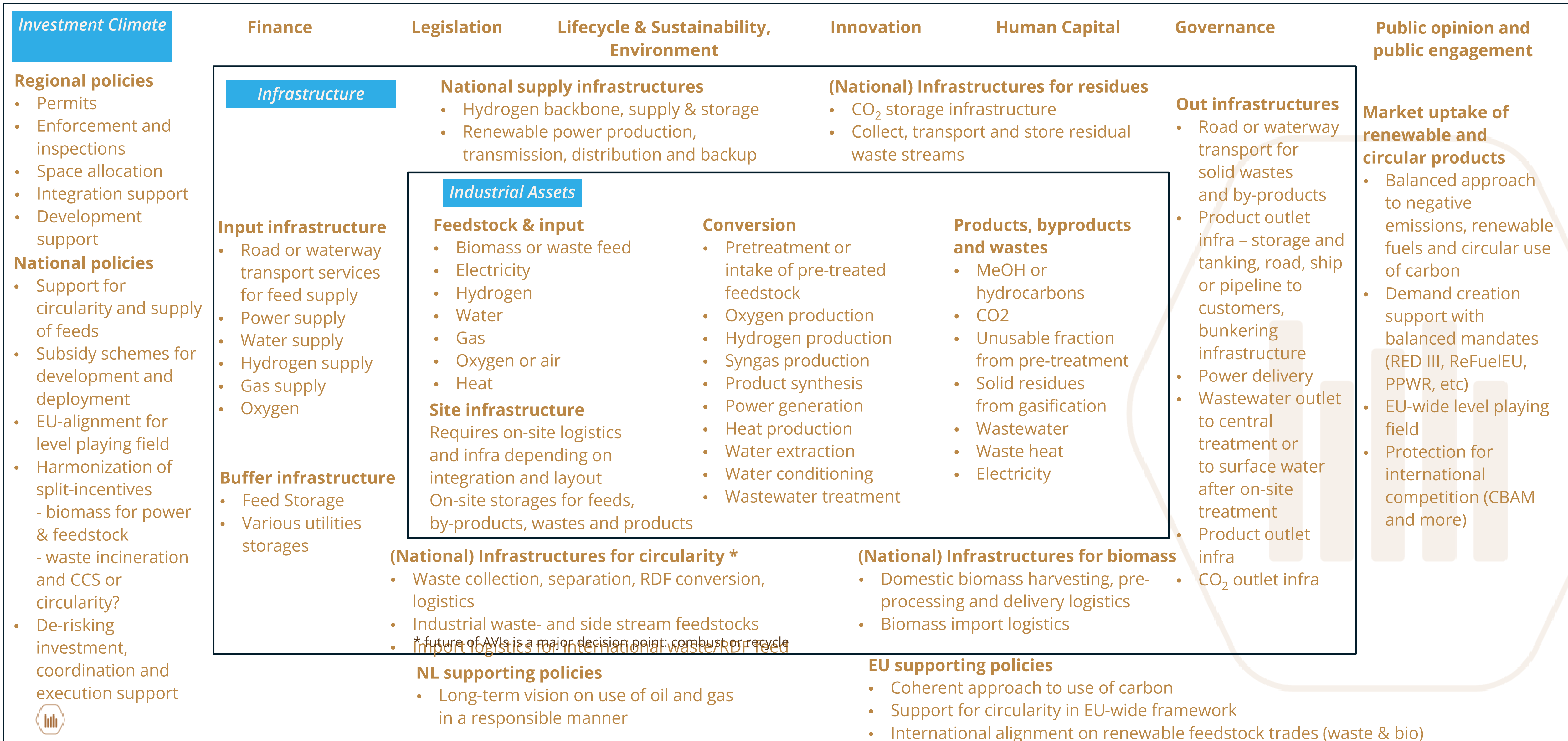
For larger projects, decisions about allocation of space, infrastructure and transport must be made on an ecosystem level, in this case between large asset owners and together with the Rotterdam HIC. The circular carbon market may already require European regulation to protect the more expensive production.

A full transition can only be done with decision making on a national level for space and physical integration. Investments must have a commercial perspective on the market they aim for, and this requires protection within at least the European market. Cooperation between countries will be needed for securing all types of feedstock.



Typical decisions across Asset, Infrastructure and Investment Climate topics

Figure 2: Long list of typical decision topics across the Asset, Infrastructure and Investment Climate levels



The Decision Based Roadmaps for Versions 1, 2 and 3

Throughout this project three versions of the syngas value chain system are considered, each representing an increasing level of complexity and scale. These versions are described in detail in Deliverable 2. For each version, a dedicated roadmap and Gantt chart are presented.

A decision-based roadmap differs from a conventional planning document in that it does not primarily describe what will be done but rather identifies which decisions must be made to advance the project, and what work is required to be able to take those decisions.

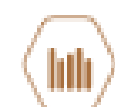
The roadmaps in the following slides show grey rectangles that illustrate the different phases of a project, the colored rectangles indicate the decisions with the color of the box indicating the decision owner, and the diamonds represent key decision milestones such as FID with the colors again representing the decision owner of this key decision.

Each roadmap illustrates which decision maker decides what and how this links to other decisions, but the roadmap does not provide chronological project milestones. Not all decisions are sequential, as some of the decisions must be taken simultaneously by different parties. For instance, an asset owner can only take an investment decision if the investment decision for the infrastructure is also taken. Different decisions fall under the authority of different stakeholders. These stakeholders range from

industrial asset owners and project developers to the Port of Rotterdam Authority and provincial or national regulators. The decision maker for each decision varies across the different versions as the scale of the projects increase. Versions of a larger scale syngas system (2 and 3) include front-end loading, allowing market strategies, feedstock strategies, and financing to be resolved at a very early stage in project development.

After each roadmap, a Gantt chart adds a temporal dimension to the decision structure. Where the roadmap illustrates how decisions are logically connected and depend on one another, the Gantt chart provides an indication of when these activities can take place per project. To reach the target volume of a version, multiple projects are required, with the Gantt chart providing an indication what the timing would look like for each project of a version.

Please note, both the decision-based roadmap and the Gantt chart only provide a schematic and indicative illustration of the decision needed and how they would play out over time. In no way can these be used to decide on the do-ability of different versions in practice. For that more work is needed.



The impact of the different versions

As the carbon gateway to Europe, the HIC is critically important in meeting a wide set of Dutch and European transition ambitions especially those associated to the carbon value chain and other associated base chemicals.

We are currently in a phase of maturing technology and deploying these through Version 1 type projects. We must move to mass deployment to transition the current fossil-based system to a mature sustainable one that meets our ambitions. Figure 6 illustrates how this inevitably leads to a shift from making changes to an existing system to changing the system itself. The system we end with depends on the choices we make today. The roadmaps show that each version builds out differently, leading to fundamentally different systemic transformations.

We have assessed the ability of the three versions to grow, change the system and contribute meaningfully to meeting our ambitions. In Deliverable 2 project level indicative costs, time, space and constraints, infrastructure were assessed. The value lenses assessed are:

- Climate change – CO₂ emissions reduction
- Contribution to circular economy
- Role of the R-HIC in the Dutch economy
- Activity of process industries in the HIC (investments)
- Strategic autonomy NL and EU

This gives an indication of a versions potential for meeting our ambitions, but we need to also assess the associated risks and trade-offs, or difficult choices. The identified risk themes are:

- Policy uncertainty or indecisiveness
- Level playing field (local to global competition)
- Transition system risk (continuity and stability)
- Execution risk (permits, contractors, resources, space)

Together the value and risk assessments are the starting point for defining the pathway to aim for, identify inevitable trade-offs and possible mitigation actions to minimize the associated regrets.

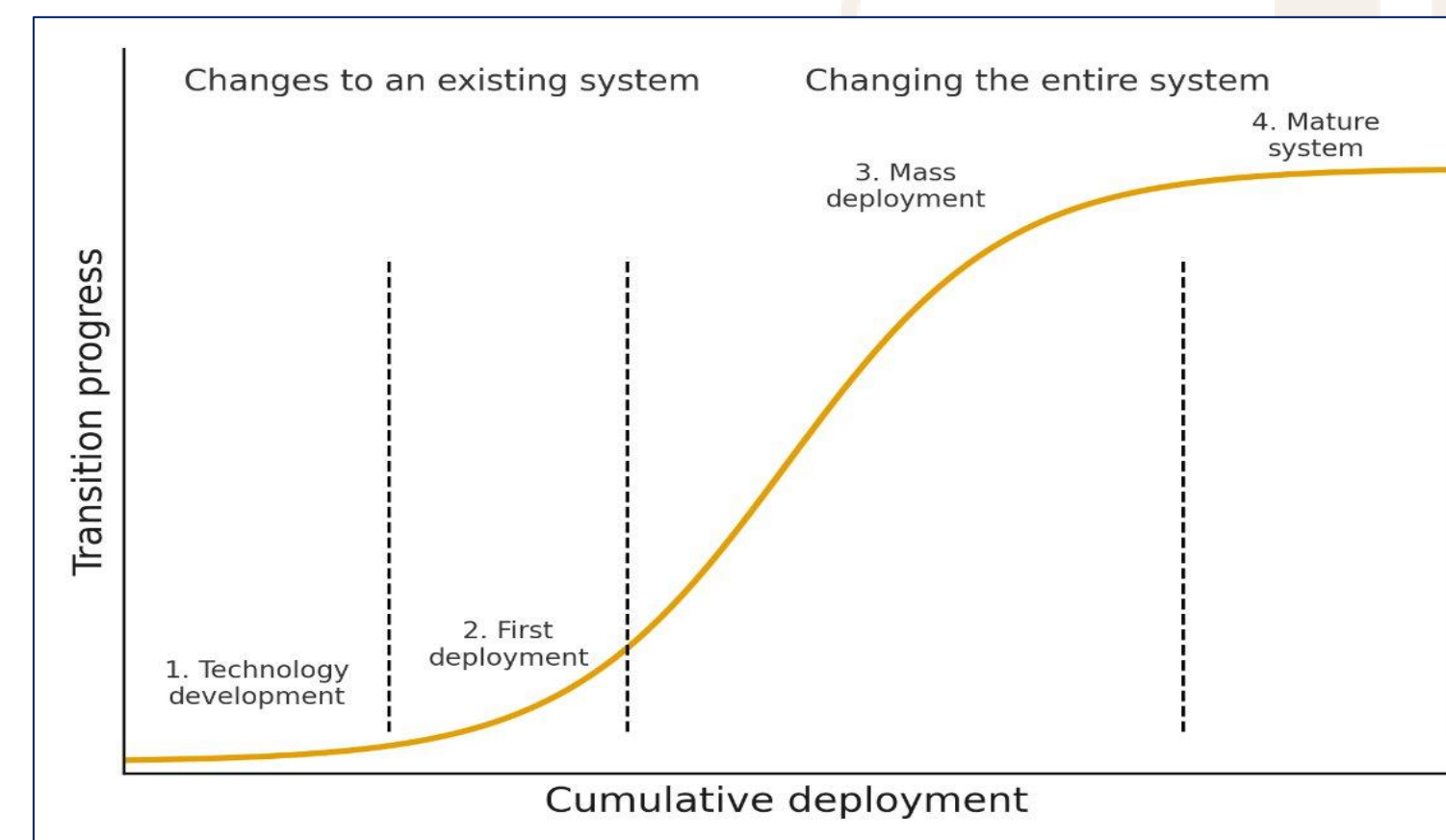
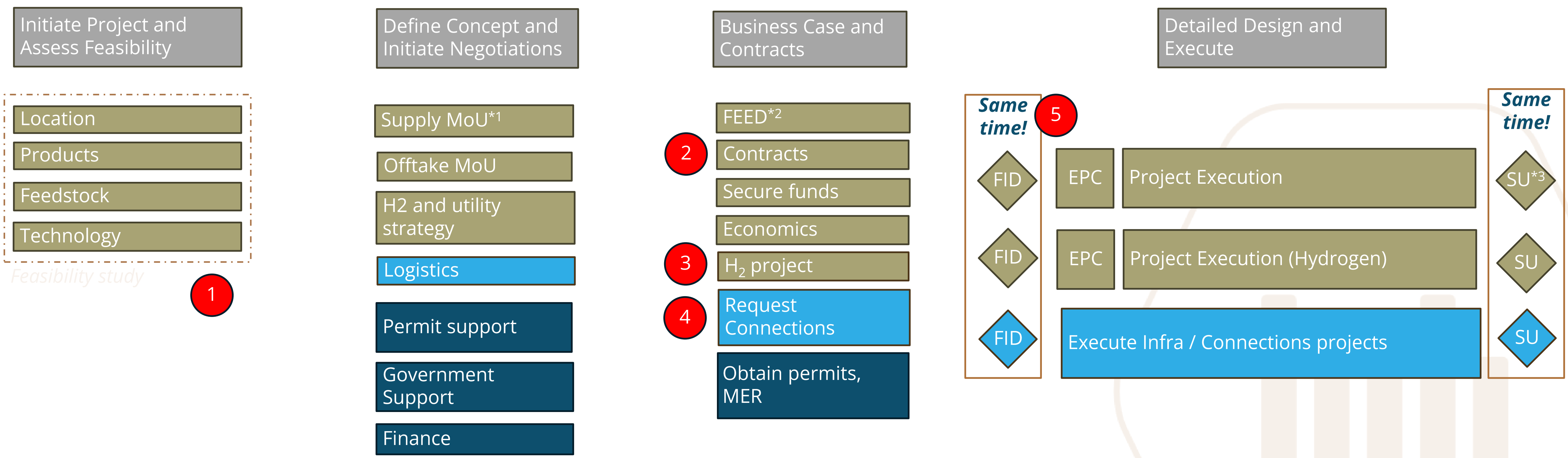
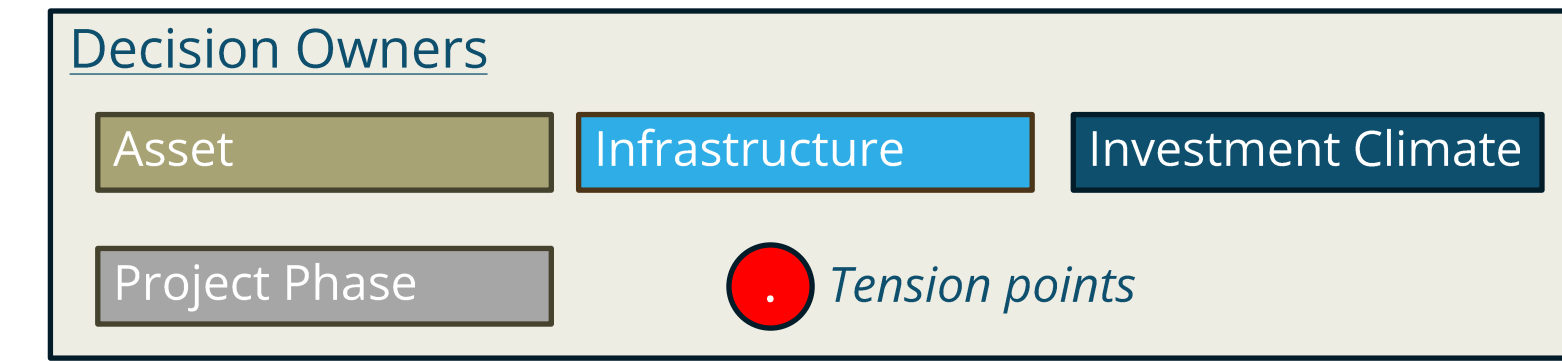


Figure 6: The curve of transition indicates how over time deployment of new technology leads to system transformation.

Version 1 – Indicative Decision Based Roadmap



- 1** Decisions on technology, feedstocks and products are linked to location selection. There are constraints to what is possible at a any specific location, especially if co-location with feedstock or offtake is part of the concept.
 - 2** Landing supply-offtake contracts and funding are often connected. Neither of them can commit without the other as the project would not be bankable.
 - 3** Access to reliable and affordable utilities is key. Especially hydrogen is difficult as this is also a newly developing market with the same development, contracting and financing challenges.
 - 4** Infrastructure connections require commitment and are often on the critical path especially when the system is full.
 - 5** Three simultaneous investment decisions (FID) to unlock capital also need to lead to simultaneous start up (SU) dates to unlock revenues. Execution delays could still result in disconnects.
- *1) MoU – Memorandum of Understanding
 *2) FEED – Front-End Engineering Design
 *3) SU – Start-Up

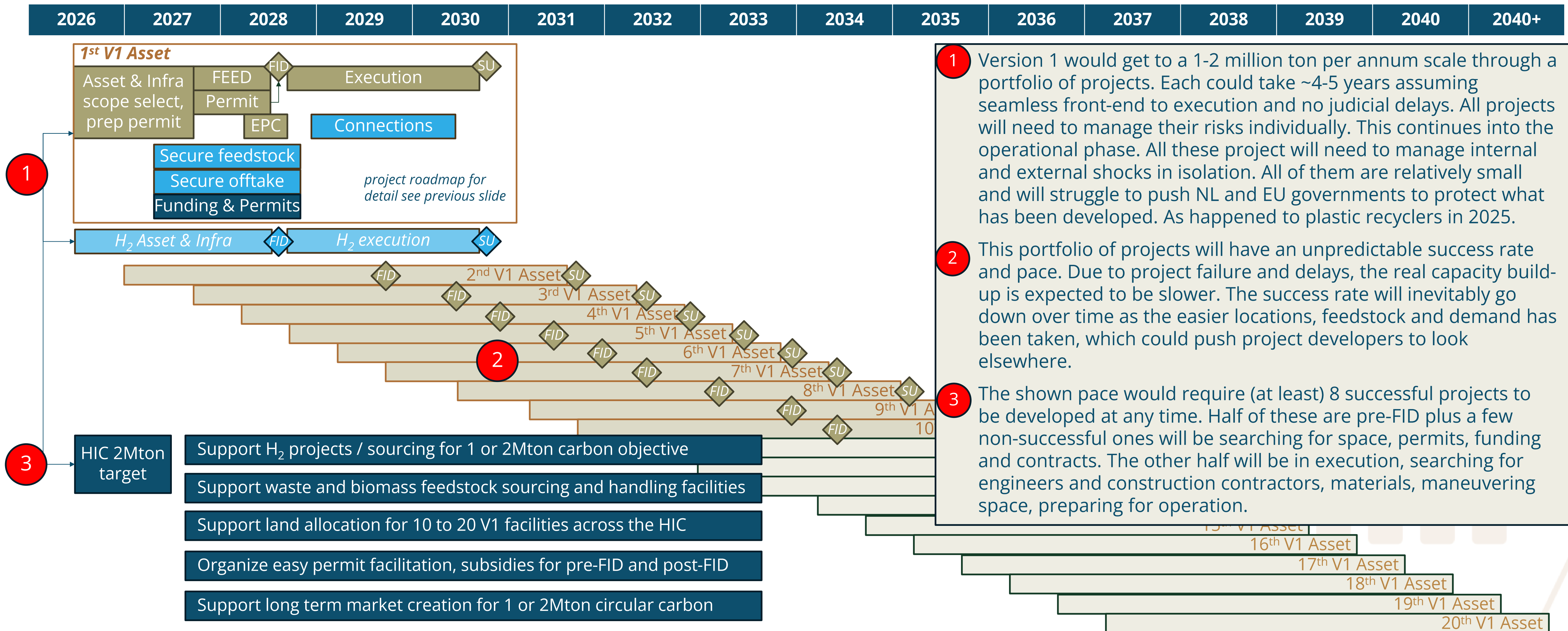


Version 1 – Indicative Gant chart

Decision Owners

Asset Infrastructure Investment Climate

Project Phase ● Tension points



- Version 1 would get to a 1-2 million ton per annum scale through a portfolio of projects. Each could take ~4-5 years assuming seamless front-end to execution and no judicial delays. All projects will need to manage their risks individually. This continues into the operational phase. All these project will need to manage internal and external shocks in isolation. All of them are relatively small and will struggle to push NL and EU governments to protect what has been developed. As happened to plastic recyclers in 2025.
- This portfolio of projects will have an unpredictable success rate and pace. Due to project failure and delays, the real capacity build-up is expected to be slower. The success rate will inevitably go down over time as the easier locations, feedstock and demand has been taken, which could push project developers to look elsewhere.
- The shown pace would require (at least) 8 successful projects to be developed at any time. Half of these are pre-FID plus a few non-successful ones will be searching for space, permits, funding and contracts. The other half will be in execution, searching for engineers and construction contractors, materials, maneuvering space, preparing for operation.



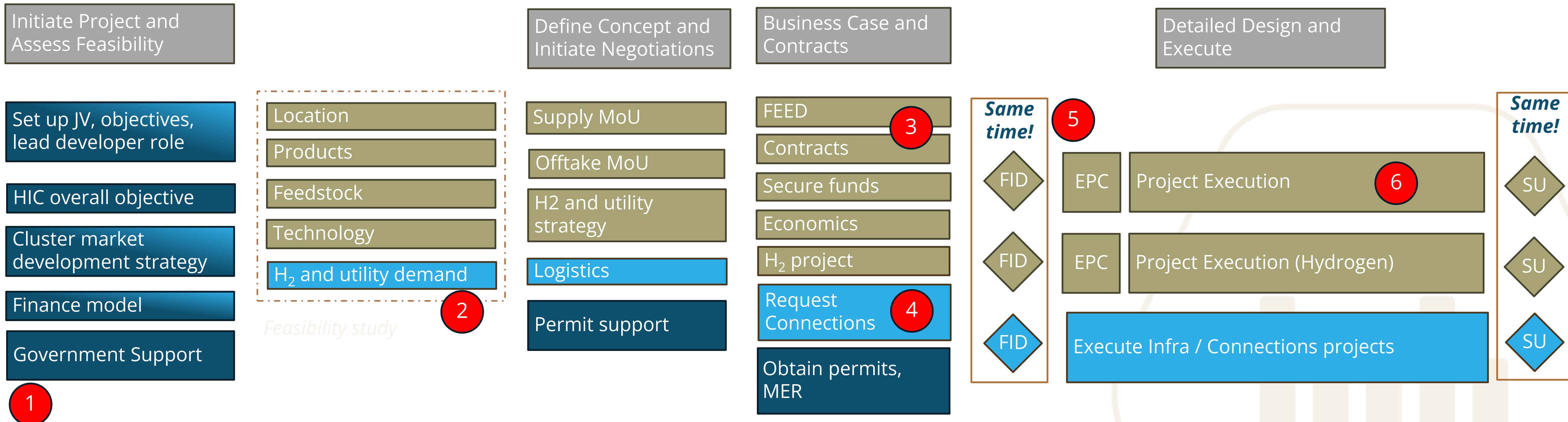
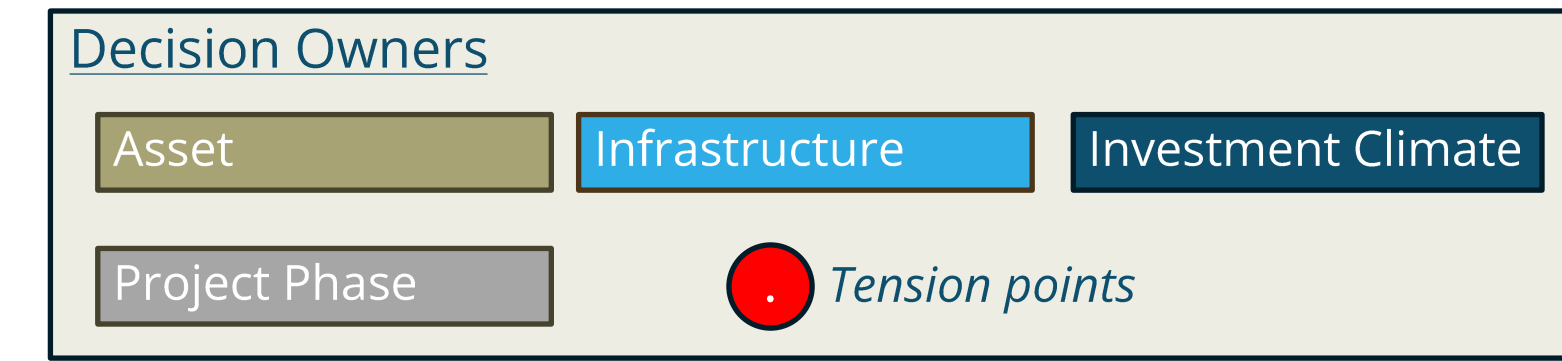
Version 1 – Assessment of ability to meet Ambitions and manage Risks

		Version 1 - Circular Carbon Niche							
		Builds 1–2 Mt scale through small, independent projects. Flexible and faster to start, but coordination is limited: infrastructure follows projects and hydrogen demand remains fragmented. Over time, fragmentation, policy vulnerability and declining success rates increase exposure. Total volume growth forces increased import dependency to fulfil clean carbon demand							
		Specifics		Energy Transition & Climate Change		EU Internal Dynamics		Multipolarity & struggling superpowers	
		1 plant	10 plants	CO ₂ / climate ambitions (strict enforcement / pragmatic adaptation / policy drift) This affects things like: • Regulatory pressure continues (ETS, renewable fuel mandates, carbon border adjustments) • Technology development accelerates • Market demand shifts toward low-carbon products • Time urgency for 2030-2040 targets		EU policy coherence and decisiveness (tight / adaptive / unraveling) This affects things like: • Low societal risk appetite, wavering political support for change, regulatory complexity, slow permitting • Tension between ambition and execution speed • Development of coherent internal markets, financing and lending		Geopolitical forces / security of supply (conflict and escalation/ multipolar blocks /global aligned alliances) This affects things like: • Multi-lateralism, democracy, and security • Where feedstocks come from and at what price • Energy security and supply chain resilience • Market share and market access for products • Competition for technology and investment	
Ambitions	Climate change - CO2 emission reduction	Minimal	Some	Does not address port emissions, sustainability or circularity in a meaningful way.		Lack of addressing systemic change implies anticipating EU policy drift on climate goals and ETS due to economic stress. Consequently, policy drift is very likely as ambitions meet deadlines.		This version implies substantial product imports, making reaching goals highly dependent on global geopolitical development.	
	Contribution to circular economy	Minimal	Some						
	Role of R-HIC in the Dutch economy	Minimal	Some	A market based approach to attracting investments in new value chains combined with little coordination on the future of the HIC leads to stalling investments and over time uncontrolled shrinking of the HIC. This affects the manufacturing industry in the entire hinterland and exposes the region to increasing imports.					
	Activity of process industries in the HIC (investments)	Minimal	Some						
	Strategic autonomy NL & EU	None	Minimal						
Risk Themes	Policy uncertainty or indecisiveness	Lobbying for support on a project level.		Individual projects lack leverage over NL & EU policy development, and are vulnerable if rules change mid-development. However, at a system level the exposure is small.					
	Level playing field (local to global competition)	Small isolated value chains with little to no hedging options.		Small-scale projects struggle to compete in the market and unable to ensure protection measures. Inevitable system volatility will impact them but the wider system is unaffected.					
	Transition system risk (continuity and stability)	Small isolated value chains with little to no integration to wider system.		Fragmented build-out risks' uncontrolled decline of HIC and limits growth of new sub-systems (hydrogen, CO2)					
	Execution risk (permits, contractors, resources, space)	Multiple parallel projects increase coordination burden, competition for permits and pressure on contractors.		Multiple parallel projects increase coordination burden, competition for permits and pressure on contractors.					
Overall evaluation	Highest Value	Potential for deployment of up to 10 isolated syngas value chains							
	Largest Risk	No long-term continuity and stability in NLD and ARRRR hydrocarbon supply, uncontrolled decline of R-HIC industry.							
	Trade offs between value and risk	Version 1 will not get us much closer to meeting our ambitions and creates exposures to geopolitical tension as it implicitly assumes large-scale renewable imports. It implicitly assumes that the EU will drift on its ambitions and policy which is likely. As little investments are done financial, exposure is low. Investments run risk of bankruptcy if supporting policies are not held up.							

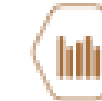
Rating scale:	Low	Medium	High
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Version 2 – Indicative Decision Based Roadmap



- 1 Version 2 projects start with the creation of a Joint Venture that requires NL government support and a lead developer to come to clear JV objectives. This takes time but enables front-end loading of market and feedstock strategies starting with the JV partners itself. This in turns opens the route to early financing discussion going beyond project finance.
- 2 Large immediate hydrogen demand unlocks faster build up of an electrolyzer park which can be combined with SMR with CCS initially.
- 3 Signing contracts, securing funds and developing a business case that balances risk and value is easier due to the JV Set Up and front-end loading .
- 4 This also creates the opportunity to create clarity on requirements from infrastructure and utility providers (power, water, port logistics, gas).
- 5 The overarching clarity also makes it easier to align simultaneous investment decisions but these are bigger decisions creating larger exposure.
- 6 Bigger decisions come with a longer and more complex project execution phase and associated execution and system continuity risks.



Version 2 – Indicative Gant chart

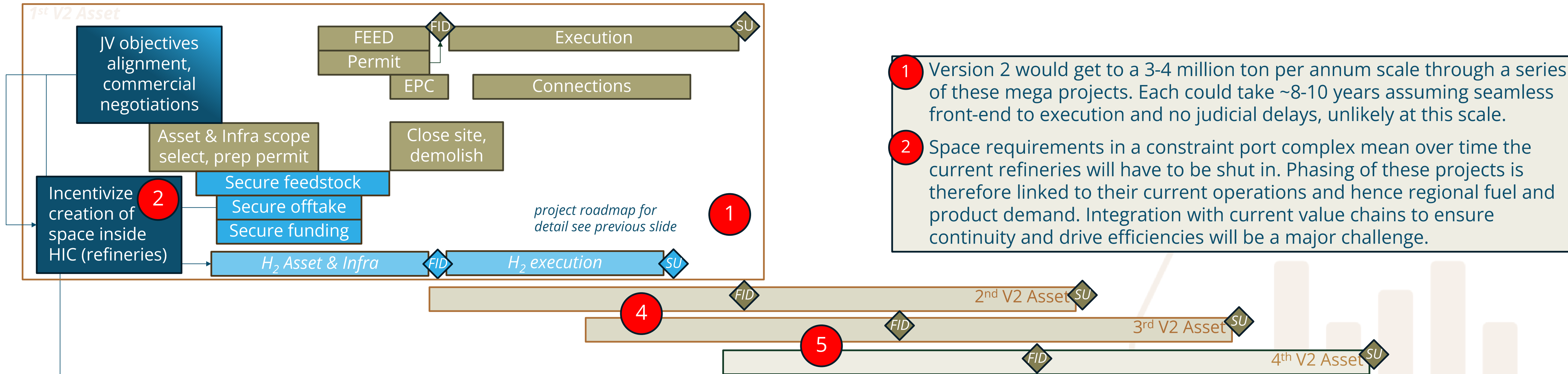
Decision Owners

- Asset
- Infrastructure
- Investment Climate

Project Phase

Tension points

2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2040+
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1 Version 2 would get to a 3-4 million ton per annum scale through a series of these mega projects. Each could take ~8-10 years assuming seamless front-end to execution and no judicial delays, unlikely at this scale.

2 Space requirements in a constraint port complex mean over time the current refineries will have to be shut in. Phasing of these projects is therefore linked to their current operations and hence regional fuel and product demand. Integration with current value chains to ensure continuity and drive efficiencies will be a major challenge.

- 3 HIC 4Mton target
- Support H₂ projects / sourcing for 3 or 4Mton carbon objective
 - Support waste and biomass feedstock sourcing and handling facilities
 - Support land allocation for 3 to 4 V2 facilities and infra across the HIC
 - Organize easy permit facilitation, subsidies for post-FID
 - Support long term market creation for 3 or 4Mton circular carbon
 - Ensure HIC continuity and stability during execution phase

3 Project and execution risks will need to be manage at a JV level. This changes going into the operational phase. These projects have real impact on the total Harbor Industrial Complex making it more difficult to foresee how the total system manages internal and external shocks with these kinds of activity levels. On the other, these investment would ensure attention from NL and EU governments.

4 The shown scope and pace can only be delivered by 2040 when three active mega projects to be developed in parallel searching for space, permits, funding and contracts in pre-FID and searching for engineers, construction contractors, materials, maneuvering space, preparing for operation during execution.

5 The 3rd and 4th projects will be more difficult to decide on as these JV's will be in competition. It is natural for all the JVs to want to be second in line. Being 3rd or 4th is inevitably less attractive.



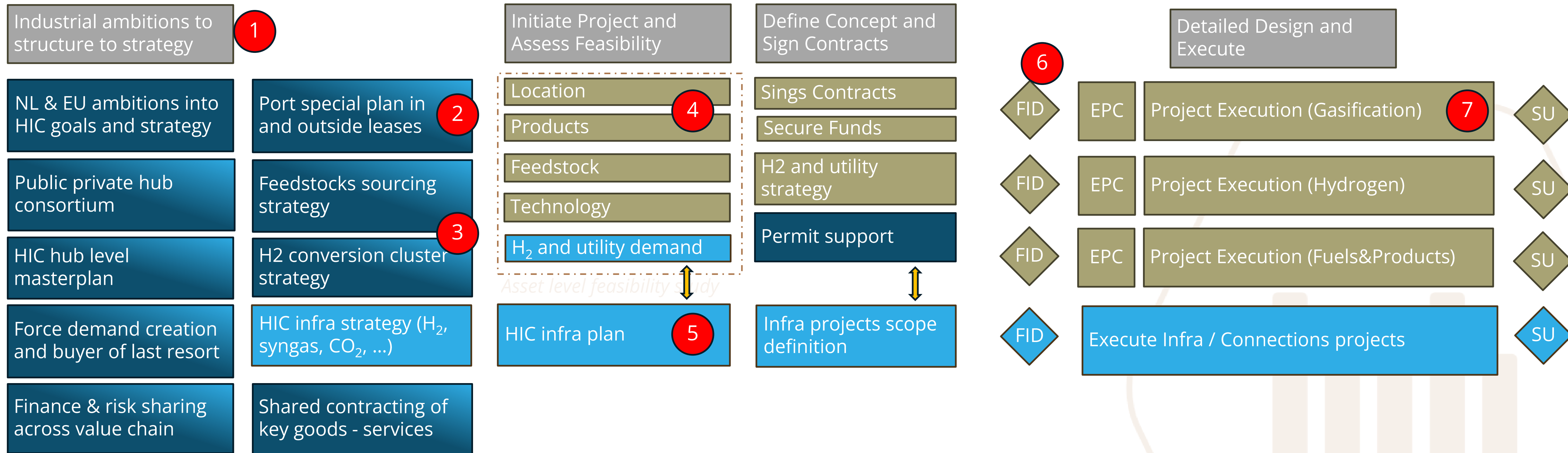
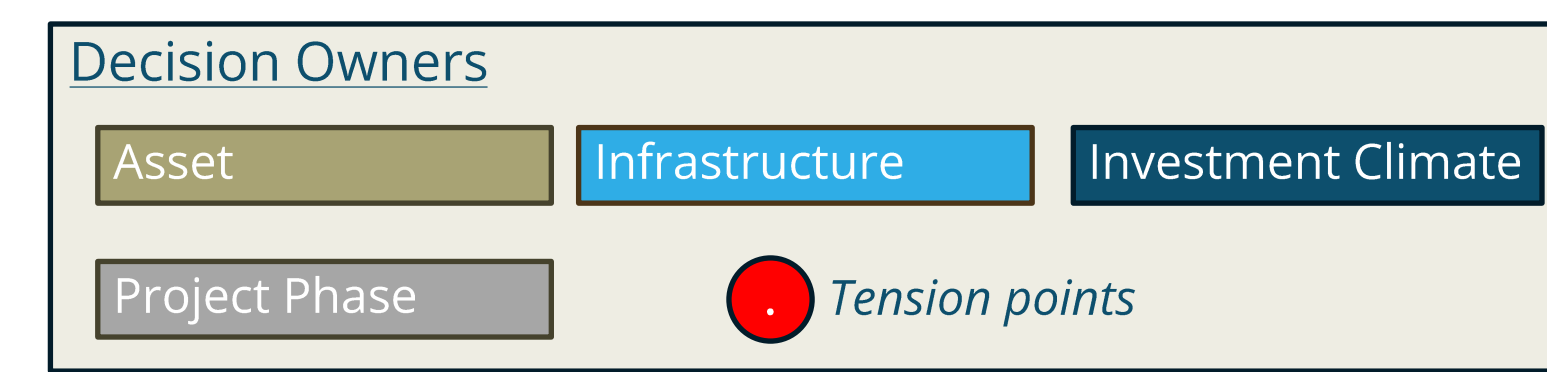
Version 2 – Assessment of ability to meet Ambitions and manage Risks

		Version 2 - Industrial Scale					
		Builds 3–4 Mt through a few large Joint Ventures with strong front-end loading. Creates clearer hydrogen and infrastructure signals and stronger policy leverage, but concentrates execution and continuity risk into long, complex mega-project cycles.					
		Specifics		Energy Transition & Climate Change		EU Internal Dynamics	
		1 plant	3-4 plants	CO ₂ / climate ambitions (strict enforcement / pragmatic adaptation / policy drift) This affects things like: • Regulatory pressure continues (ETS, renewable fuel mandates, carbon border adjustments) • Technology development accelerates	EU policy coherence and decisiveness (tight / adaptive / unraveling) This affects things like: • Low societal risk appetite, wavering political support for change, regulatory complexity, slow permitting • Tension between ambition and execution speed • Development of coherent internal markets, financing and lending	Geopolitical forces / security of supply (conflict and escalation/ multipolar blocks /global aligned alliances) This affects things like: • Multi-lateralism, democracy, and security • Where feedstocks come from and at what price • Energy security and supply chain resilience	
Ambitions	Climate change - CO ₂ emission reduction	Relevant	Significant	Significant impact on industrial emissions and circularity but unlikely to get us to our ambition levels for 2030, 2040 and 2050.	This version's large scale investments are susceptible to policy drift. A lack of protection and upholding of policy may hamper progress.	This version creates a future for the HIC that is smaller and driven by a small group of large JV's but could become low to zero emissions and highly circular. It will leave a large demand for carbon based materials and fuels that is not met and is unlikely to be fully covered by other industrial clusters in the hinterland. Demand for import of base products will grow which is more difficult to diversify than imported feedstocks. The manufacturing industry in the hinterland will be affected by this change.	
	Contribution to circular economy	Relevant	Significant				
	Role of R-HIC in the Dutch economy	Significant	Most				
	Activity of process industries in the HIC (investments)	Some	Relevant				
	Strategic autonomy NL & EU	Minimal	Some				
Risk Themes	Policy uncertainty or indecisiveness	Industrial Joint Ventures engage with Dutch policy makers.		Large projects attract policy focus and political attention, but long development cycles creates exposure to shifts. At system level this creates significant exposure for NLD.			
	Level playing field (local to global competition)	Industrial scale new value chains create economies of scale between competing JV's and an innovation environment.				Larger scale improves competitiveness, but projects remain exposed to global commodity cycles and price volatility. JV's will also compete with each other making it harder to get them going beyond a certain point.	
	Transition system risk (continuity and stability)	Multiple industry scale projects requiring industry scale space means taking down multiple sites around the same time.				Multiple large simultaneous changes and phase-outs increase continuity risks and make shock absorption more difficult.	
	Execution risk (permits, contractors, resources, space)	Multiple industry scale projects in the same cluster, looking for the same permits, resources, space.				Mega-project complexity amplifies judicial risk, contractor scarcity and supply-chain exposure especially with multiple projects ongoing at the same time.	
Overall evaluation	Highest Value			Potential for up to 4 new JV's creating a significant step towards meeting our climate and circularity ambitions.			
	Largest Risk			A growing dependence on product imports and 10-15 years of development of competing mega-projects results in major resilience and autonomy risks. At system level this creates significant exposure for NLD as a country and NW Europe as a region.			
	Trade offs between value and risk			Version 2 creates a possible future for the HIC as a smaller cluster with significantly lower emissions and high-levels of circularity. Demand for carbon based products and fuels will still remain resulting in exposures to geopolitical tension as it implicitly assumes large-scale renewable imports. It implicitly assumes that the EU will drift on its ambitions and policy which is likely. Huge investments will require huge incentives creating financial exposure to NLD. The JV's could become too big to fail requiring continuous policy support to prevent bankruptcy.			

Rating scale:	Low	Medium	High
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Version 3 – Indicative Decision Based Roadmap



- 1** In Version 3 coordination and risk management of the HIC transformation is improved by translating our ambition into an integrated HIC strategy and forming a public private consortium to execute on this strategy. This demands leadership from the NL & EU and will take time. It unlocks further front-end loading of market, feedstock and financing.
- 2** This consortium will oversee the allocation of available space (inc. inside battery limits) similar to the tendering of blocks for offshore wind projects.
- 3** The consortium can also act as a market maker for feedstocks, hydrogen, fuels & products and possibly coordinate contracting of key goods and services.
- 4** All these foundational elements derisk project development across the value chain to a point where feasibility assessment and concept selection can be fast-tracked to signing contracts, securing funds and developing a business case.
- 5** They also derisk infrastructure build out by creating clarity on requirements from infrastructure and utility providers (power, water, port logistics, gas) and open the door to much needed anticipatory build out.
- 6** Aligning FIDs for asset and infrastructure investments along the value chain do not have to be taken together as overarching masterplans ensure alignment.
- 7** Space allocation is integrated allowing for smaller individual investments. This will still mean a set of projects in execution, but associated execution and system continuity risks are better managed.

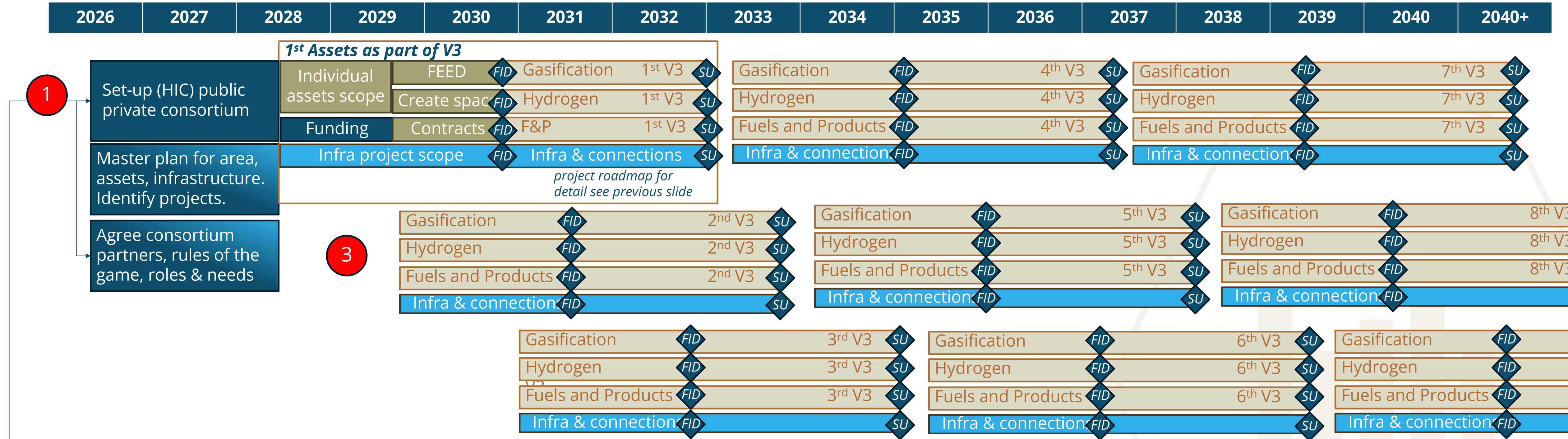
Version 3 – Indicative Gant chart

Decision Owners

- Asset
- Infrastructure
- Investment Climate

Project Phase

Tension points



1 Set-up (HIC) public private consortium

Master plan for area, assets, infrastructure. Identify projects.

Agree consortium partners, rules of the game, roles & needs

2 HIC 10Mton target

- Domestic, EU and international feedstock sourcing
- Land allocation including inside battery limits
- Market maker hydrogen, fuels and products
- Drive permit facilitation and incentives
- Central contracting of key goods and services

1 Version 3 would get to a 10 million ton per annum scale through a tender process along multiple swim lanes of coordinated projects across the value chain. Individual project would take ~4-5 years assuming seamless front-end to execution and no judicial delays, delays on individual projects are manageable.

2 Central coordination of available space inside the HIC opens up flexibility in phasing of investments. Allowing for a measured approach to internal-external shocks and ensuring continuity of a constraint port complex. Project execution risks are managed by the individual project owners but remain manageable through the role of the hub level consortium. The consortium receives direct steer from NL and EU governments.

3 Delivered scope and pace by 2040 is driven by the number of active execution swim lanes. There is no hard target but a pragmatic adaptive approach that allows for a transformation that is as fast as possible. The number of active swim lanes and projects can be scaled up and down according to feedstock availability, space inside the HIC or demand for new and current fuels and products.

Version 3 – Assessment of ability to meet Ambitions and manage Risks

		Version 3 - Circular Carbon Hub				
		Builds up to ~10 Mt through coordinated project lanes under a public-private consortium. Infrastructure, space, supply-demand and pacing are centrally aligned, reducing fragmentation and concentration risk. Depends on shift change in governance and pragmatism.				
		Specifics		Energy Transition & Climate Change	EU Internal Dynamics	Multipolarity & struggling superpowers
		R-HIC - 1 swimlane	R-HIC full deployment	CO ₂ / climate ambitions (strict enforcement / pragmatic adaptation / policy drift) This affects things like: • Regulatory pressure continues (ETS, renewable fuel mandates, carbon border adjustments) • Technology development accelerates	EU policy coherence and decisiveness (tight / adaptive / unraveling) This affects things like: • Low societal risk appetite, wavering political support for change, regulatory complexity, slow permitting • Tension between ambition and execution speed • Development of coherent internal markets, financing and lending	Geopolitical forces / security of supply (conflict and escalation/ multipolar blocks / global aligned alliances) This affects things like: • Multi-lateralism, democracy, and security • Where feedstocks come from and at what price • Energy security and supply chain resilience
Ambitions	Climate change - CO2 emission reduction	Late	Relevant	Significant impact on industrial emissions and circularity. Unlikely to fully get us to our ambition levels for 2030, 2040 and 2050 but could get us close.	Anticipated policy drift in the 2030s poses risks to version 3, but due to the modular and adaptive approach of long-term planning can to some extent be managed .	
	Contribution to circular economy	High	Very high			
	Role of R-HIC in the Dutch economy	Most	All	This version creates a future for the HIC that could see it continue its current role while over time transitioning to a low emissions and circular system. When properly governed, it would be able to act at current levels, supported by early identification of bottlenecks and continuity management. While imports will likely be a part of the HIC, it's easier to diversify importing feedstocks. This version opens the door to a system that can absorb internal / external shocks and volatility. The manufacturing industry in the hinterland will be supported making it easier for the EU to remain a key manufacturing hub globally.		
	Activity of process industries in the HIC (investments)	Significant	High			
	Strategic autonomy NL & EU	Some	Significant			
Risk Themes	Policy uncertainty or indecisiveness	A full cluster approach centrally governed through a set of public private consortia		New governance structures to govern the public-private consortium and create a bridge to the multi-level governance system reduces the risk of indecisiveness. Sustained political commitment and institutional alignment remains important.		
	Level playing field (local to global competition)	Focused gasification and hydrogen hubs allow creating economy of scale and an innovation ecosystem		Aggregated demand and market-making functions improve resilience and bargaining power, but exposure to market dynamics will still require protection against especially external driving forces.		
	Transition system risk (continuity and stability)	Central coordination in blocks and swimlanes. Accelerating when possible and pausing when needed.		Coordination secures a phased development improving continuity and progress in a constrained port.		
	Execution risk (permits, contractors, resources, space)	Multiple execution swimlanes in parallel create huge activity levels over a long period.		Execution remains distributed, but hub-level coordination helps manage delays, space allocation and smooth contractor demand. Nevertheless this will be a decades long execution pipeline that should not be underestimated.		
Overall evaluation	Highest Value	A balanced approach between managing our climate and circularity ambitions with economic resilience and stability creates a path to a new future for the HIC.				
	Largest Risk	A long transition path requires sustained societal and governance commitment combined with solid leadership in coordinating the execution of the transformation.				
	Trade offs between value and risk	Delivering real value while minimizing the associated risks can only be done through full commitment and a cluster wide approach but is in no way a guarantee for success. Managing the execution of the transformation comes with a sense of chronic unease and requires a pragmatic constructive mindset.				

Rating scale:	Low	Medium	High
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Comparison of versions (1) - overview of ambitions and risks

All versions have different impact with a different success rate and timelines. An important lesson out of historic mega projects is : **Go slow to go fast!**

			Version 0 - No Development	Version 1 - Circular Carbon Niche		Version 2 - Industrial Scale		Version 3 - Circular Carbon Hub	
			Uncertainty and indecisiveness leads to stagnation, uncontrolled turndown and de-industrialization.	Builds 1-2 Mt scale through small, independent projects. Flexible and faster to start, but coordination is limited: infrastructure follows projects and hydrogen demand remains fragmented. Over time, fragmentation, policy vulnerability and declining success rates increase exposure. Total volume growth forces increased import dependency to fulfil clean carbon demand		Builds 3-4 Mt through a few large Joint Ventures with strong front-end loading. Creates clearer hydrogen and infrastructure signals and stronger policy leverage, but concentrates execution and continuity risk into long, complex mega-project cycles.		Builds up to ~10 Mt through coordinated project lanes under a public-private consortium. Infrastructure, space, supply-demand and pacing are centrally aligned, reducing fragmentation and concentration risk. Depends on shift change in governance and pragmatism.	
		Description	No development	1 plant	10 plants	1 plant	3-4 plants	R-HIC - 1 swimlane	R-HIC full deployment
Ambitions How do versions support reaching our R-HIC, national and EU ambitions?	Climate change - CO2 emission reduction	How much does the Version contribute to achieving CO2 emission reduction by scope 1, 2 and 3? EU targets are 55% emission reduction in 2030 and effectively net-zero by 2040.	None	Minimal	Some	Relevant	Significant	Late	Relevant
	Contribution to circular economy	How much does the Version contribute to achieving circularity of carbon-based products (chemicals, plastics, etc) by feedstock replacement with waste and biomass? NL government target is 55% circular by 2035 and 100% in 2050.	None	Minimal	Some	Relevant	Significant	High	Very high
	Role of R-HIC in the Dutch economy	How much does the Version contribute to the economic development of the Rotterdam HIC industrial activity, supporting it's contribution to the NLD economy as well as securing its position in the ARRRR cluster?	None	Minimal	Some	Significant	Most	Most	All
	Activity of process industries in the HIC (investments)	How much does the Version contribute to the ongoing development of industrial activity in the Rotterdam HIC? Based on rough estimates for investments in conversion capacity, infrastructure, and need for hydrogen and related renewable electricity demand	None	Minimal	Some	Some	Relevant	Significant	High
	Strategic autonomy NL & EU	How much does the Version contribute to strengthening the strategic autonomy of NLD and NW-EU? Factors are contribution to reducing crude oil dependency, increasing feedstock diversification, and increasing feedstock sourcing hedge (combining domestic, EU and RotW carbon feedstock supply)	None	None	Minimal	Minimal	Some	Some	Significant
Risk Themes What risk-exposure give the versions to R-HIC?	Policy uncertainty or indecisiveness	Conflicting and constantly changing policies with mixed signals are a prime risk for capital-intensive industry development.	No investments due to constant policy unclarity and long-term global uncertainty with lacking policy response to create stable investment climate.	Lobbying for support on a project level.		Industrial Joint Ventures engage with Dutch policy makers.		A full cluster approach centrally governed through a set of public private consortia	
	Level playing field (local to global competition)	Uncertainty of market position and ROI due to competition risks in immature markets. Risks of unfair competition with conventional oil-based routes or state-supported dumping.	No new syngas value chains, lack of expansion to scale of alternative routes, long-term risks of uncontrolled break-down of conventional value chains.	Small isolated value chains with little to no hedging options.		Industrial scale new value chains create economies of scale between competing JV's and an innovation environment.		Focused gasification and hydrogen hubs allow creating economy of scale and an innovation ecosystem	
	Transition system risk (continuity and stability)	Risks associated with systemic transformation of industrial cluster structure and development of large multi-party value chains. Needs balancing with controled turn-down of conventional routes and build-up of alternative uses like electrification and SAF.	No significant systemic transformation.	Small isolated value chains with little to no integration to wider system.		Multiple industry scale projects requiring industry scale space means taking down multiple sites around the same time.		Central coordination in blocks and swimlanes. Accelerating when possible and pausing when needed.	
	Execution risk (permits, contractors, resources, space)	Risk of load pressure on full support system for large-scale building process (coordination, use of space, manpower, financial means, public support, supply of goods and services). Overload leads to delays, stagnation, costs.	No execution leads to risk of losing execution-at-scale competences for process industry support.	Multiple parallel projects increase coordination burden, competition for permits and pressure on contractors.		Multiple industry scale projects in the same cluster, looking for the same permits, resources, space.		Multiple execution swimlanes in parallel create huge activity levels over a long period.	

Scale
None
Minimal
Some
Relevant
Significant
High
Very high



Comparison of versions (2) – assessing key trade-offs

All versions have different impact with a different success rate and timelines. An important lesson out of historic mega projects is : **Go slow to go fast!**

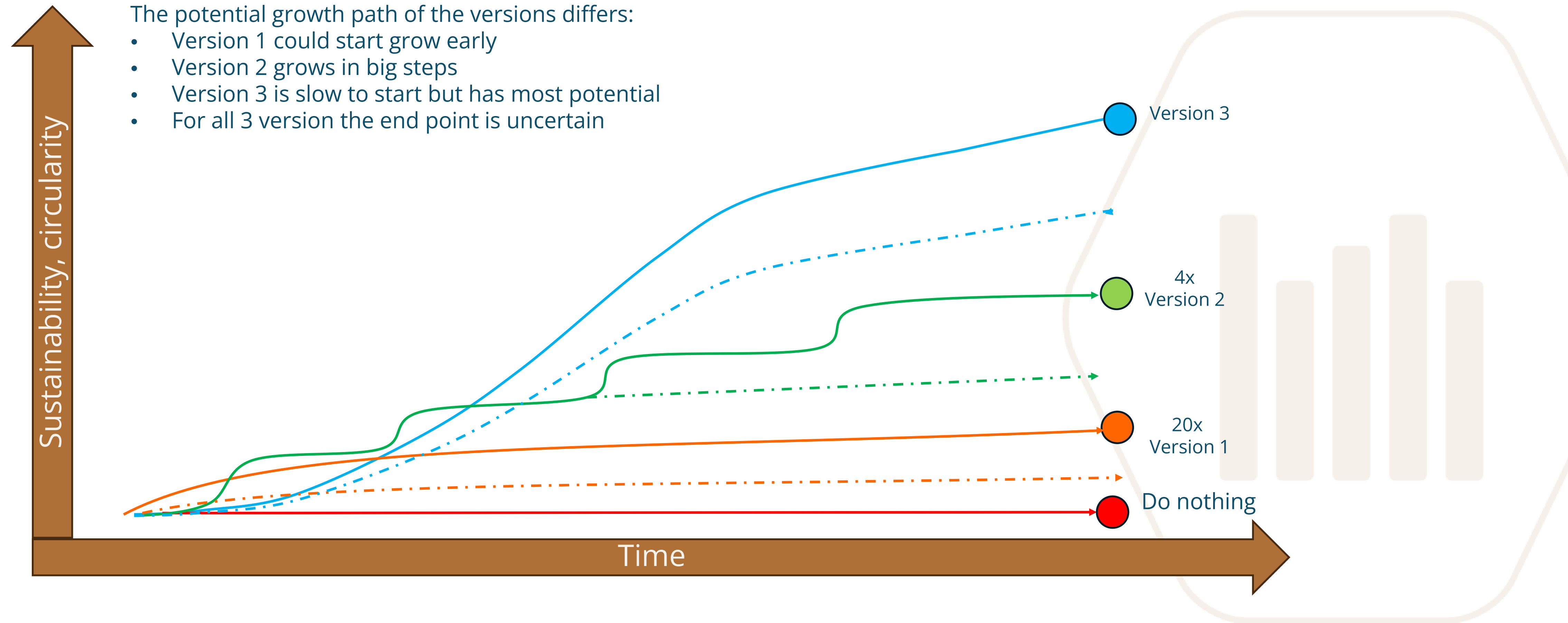
			Version 0 - No Development	Version 1 - Circular Carbon Niche	Version 2 - Industrial Scale	Version 3 - Circular Carbon Hub
			Uncertainty and indecisiveness leads to stagnation, uncontrolled turnaround and de-industrialization.	Builds 1–2 Mt scale through small, independent projects. Flexible and faster to start, but coordination is limited: infrastructure follows projects and hydrogen demand remains fragmented. Over time, fragmentation, policy vulnerability and declining success rates increase exposure. Total volume growth forces increased import dependency to fulfil clean carbon demand	Builds 3–4 Mt through a few large Joint Ventures with strong front-end loading. Creates clearer hydrogen and infrastructure signals and stronger policy leverage, but concentrates execution and continuity risk into long, complex mega-project cycles.	Builds up to ~10 Mt through coordinated project lanes under a public-private consortium. Infrastructure, space, supply-demand and pacing are centrally aligned, reducing fragmentation and concentration risk. Depends on shift change in governance and pragmatism.
			No development	1 - 10 isolated projects	3-4 large JV's	R-HIC swimlanes
Description						
Ambitions How do versions support reaching our R-HIC, national and EU ambitions?	Climate change - CO2 emission reduction	How much does the Version contribute to achieving CO2 emission reduction by scope 1, 2 and 3? EU targets are 55% emission reduction in 2030 and effectively net-zero by 2040.	Industrial decay without new syngas value chains; uncontrolled emissions decline; no circularity progress.	Limited impact on port emissions, sustainability or circularity; implicitly assumes EU policy drift in the 2030s.	Significant emissions and circularity improvements; unlikely to meet 2030–2050 ambitions; exposed to policy drift.	Strong emissions and circularity improvements; close to ambition levels; modular approach partly mitigates policy drift.
	Contribution to circular economy	How much does the Version contribute to achieving circularity of carbon-based products (chemicals, plastics, etc) by feedstock replacement with waste and biomass? NL government target is 55% circular by 2035 and 100% in 2050.				
	Role of R-HIC in the Dutch economy	How much does the Version contribute to the economic development of the Rotterdam HIC industrial activity, supporting it's contribution to the NLD economy as well as securing its position in the ARRA cluster?	A HIC in decline affects the manufacturing industry in the hinterland exposing the region to increasing imports.	A market based approach to attracting investments with little coordination still leads to stalling investments and over time uncontrolled shrinking.	A smaller HIC driven by a group of large JV's but potentially low to zero emissions and highly circular. Growing imports of fuels and base products creates new dependencies and affects the hinterland.	A HIC that continues its current role while transitioning to a low emissions and circular system with strong governance to ensure resilience and feedstock imports that can be diversified opens the door to a system that can absorb shocks and volatility supporting a strong manufacturing industry in the hinterland.
	Activity of process industries in the HIC (investments)	How much does the Version contribute to the ongoing development of industrial activity in the Rotterdam HIC? Based on rough estimates for investments in conversion capacity, infrastructure, and need for hydrogen and related renewable electricity demand				
	Strategic autonomy NL & EU	How much does the Version contribute to strengthening the strategic autonomy of NLD and NW-EU? Factors are contribution to reducing crude oil dependency, increasing feedstock diversification, and increasing feedstock sourcing hedge (combining domestic, EU and RotW carbon feedstock supply)				
Risk Themes What risk-exposure give the versions to R-HIC?	Policy uncertainty or indecisiveness	Conflicting and constantly changing policies with mixed signals are a prime risk for capital-intensive industry development.	Not a risk but a certain outcome.	Limited leverage over NL/EU policy; exposure to regulatory change; system exposure remains limited.	Strong political attention but long project cycles increase exposure to policy shifts; significant system-level exposure for the Netherlands.	Consortium governance reduces policy indecision; sustained political commitment and institutional alignment remain essential.
	Level playing field (local to global competition)	Uncertainty of market position and ROI due to competition risks in immature markets. Risks of unfair competition with conventional oil-based routes or state-supported dumping.	Shrinking market position.	Small projects struggle to compete and secure protection; volatility mainly affects projects while the wider system remains unchanged.	Larger scale improves competitiveness but exposure to global commodity cycles remains; JV competition may slow further development.	Aggregated demand and market-making improve resilience and bargaining power; exposure to global markets remains and requires protection.
	Transition system risk (continuity and stability)	Risks associated with systemic transformation of industrial cluster structure and development of large multi-party value chains. Needs balancing with controlled turn-down of conventional routes and build-up of alternative uses like electrification and SAF.	Uncontrolled decline and shocks in oil and oil-product supply to the Netherlands and Northwest Europe.	Fragmented development risks decline of the HIC and slows growth of new systems such as hydrogen and CO₂ infrastructure.	Multiple large simultaneous investments continuity risks and reduce the system's ability to absorb shocks.	Coordinated and phased transformation improves continuity and stability in a spatially constrained port system.
	Execution risk (permits, contractors, resources, space)	Risk of load pressure on full support system for large-scale building process (coordination, use of space, manpower, financial means, public support, supply of goods and services). Overload leads to delays, stagnation, costs.	Not applicable	Multiple small projects increase coordination burden, permit competition and contractor pressure.	Mega-project complexity increases judicial risk, contractor scarcity and supply chain exposure.	Distributed execution with hub coordination manages delays, space allocation and contractor demand; transformation remains a multi-decade complex path with inevitable bumps along the way.
Trade-offs What is the maximum regret against what value?	How are value and risk balanced against global drivers?	We aim for minimizing maximum regret. For each version a sensitivity analysis reveals the overarching trade-off between value created and the maximum regret enclosed in a specific version.	Waiting for certainty in an uncertain world and changing system; worst strategic option.	Limited progress toward ambitions; rising import dependence; low financial exposure but project failure risk if policies weaken.	Smaller low-emissions HIC possible but large investments create financial exposure and potential 'too-big-to-fail' dynamics.	Highest potential value but requires full commitment and cluster-wide coordination; success depends on sustained governance and execution discipline.

Rating scale: Low Medium High



Comparison of versions (3) – impact timeline

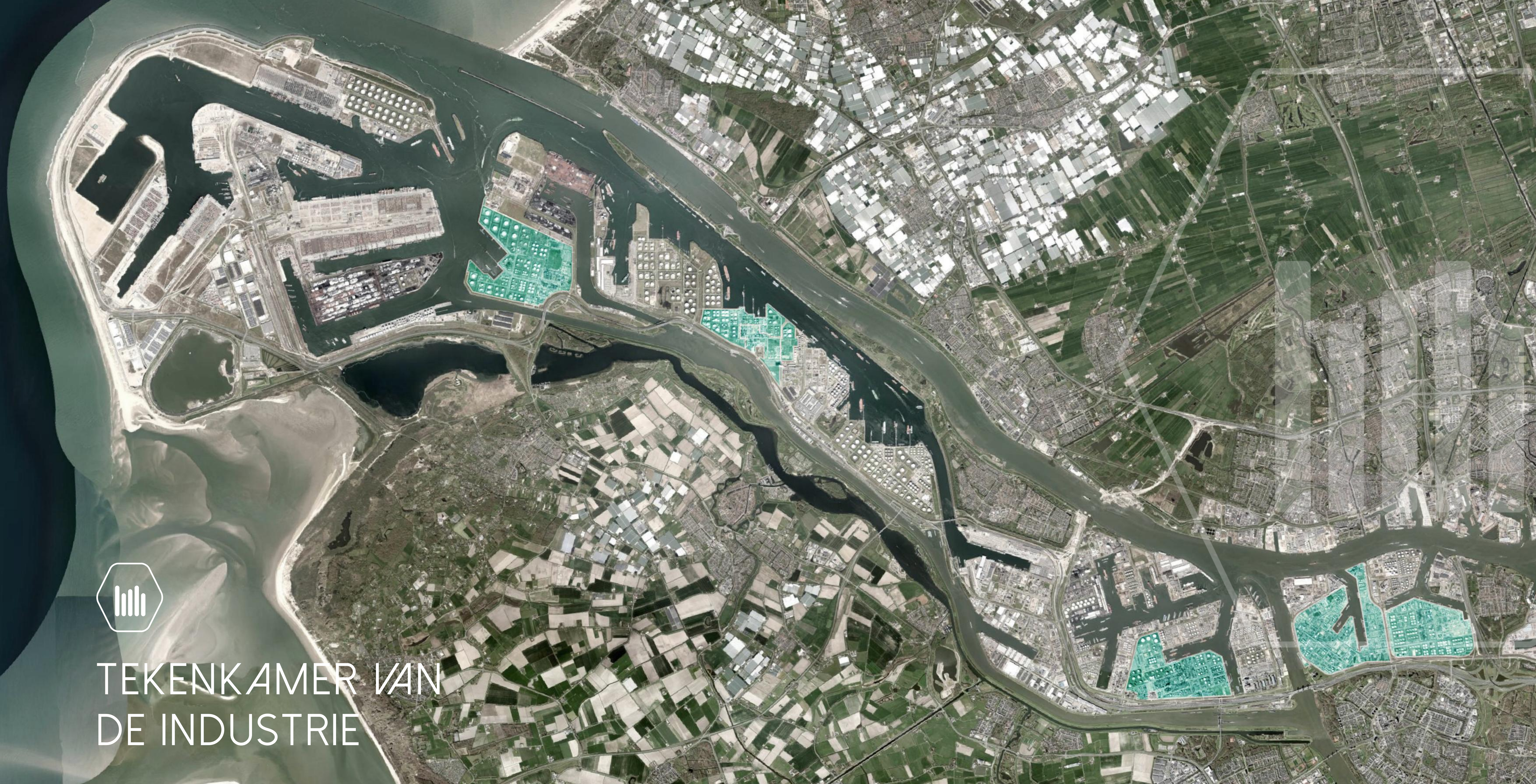
All versions have different impact with a different success rate and timelines. An important lesson out of historic mega projects is : **Go slow to go fast!**



Colophon

Title	Syngas value chain in Rotterdam HIC Deliverable 4: Decision-Based Roadmap
Publication date	March 2026
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Assignment	This document is a deliverable of the project “Ontwikkeling Synthesegasketen HIC”, assigned by Provincie Zuid Holland, registered under number PNR20085654. The project is carried out by Tekenkamer van de Industrie and Sproule ERCE. The project ran from October 2025 to March 2026.
Cover image	Generated using OpenAI ChatGPT (DALL·E)
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Published by	Tekenkamer van de Industrie (TvdI) on behalf of the Province of South Holland.
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Website	tekenkamer-industrie.nl // industrys-drawing-room.com
Suggested citation	Beek, T., Hassing, T., Stevens, M. & Ten Cate, A. (2026). <i>Syngas value chain in Rotterdam HIC – Deliverable 4: Decision-Based Roadmap</i> . Tekenkamer van de Industrie / Sproule ERCE, commissioned by Provincie Zuid-Holland. Available at: industrys-drawing-room.com/syngas-rotterdam





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