KICK-STARTING THE HYDROGEN ECONOMY OF THE NETHERLANDS

Shell Holland Hydrogen 1
Renewable hydrogen will play a pivotal role in the energy system of the future, and the Holland Hydrogen 1 factory is an important step in helping hydrogen fulfil that potential.

Anna Mascolo, Executive Vice President Shell Emerging Energy Solutions

Shell, together with contractors and vendors, is building the first big renewable hydrogen plant of Europe, in the 200-MW range. Once operational in the second half of this decade, it will produce up to 60 tons of hydrogen per day, powered by offshore wind from the North Sea.

Hello Holland Hydrogen 1

Where wind, water and sand meet, a step towards a cleaner energy future is in the making. The Holland Hydrogen 1 factory rises behind the dunes of the Dutch coast, on land reclaimed from the sea. At the Tweede Maasvlakte plains near Rotterdam, Europe’s largest renewable hydrogen plant will be ready to produce in the second half of this decade. This is a significant Shell investment and an endeavour involving more than 150 contractors and vendors.
The Holland Hydrogen 1 (HH1) factory provides an answer to the need for cleaner energy in heavy-duty cargo and industries, sectors that have limited options for other renewable solutions. Powered by wind coming from the offshore wind farm Hollandse Kust Noord, the 200-megawatts HH1 plant will be the first step meeting the needs of the hard-to-abate sectors.

The design incorporates circular materials wherever possible. The plant itself will be oval shaped, with plot space around the HH1 turned into green retreats for birds and other small animals. This to showcase how factories can be, and should be, built.

The HH1 project kickstarts the hydrogen economy of the Netherlands, primarily in the Port of Rotterdam. The HH1 will speed up society on its path to net-zero emissions by 2050 or earlier, including Shell’s own operations and that of our clients and partner companies.

**Who will benefit from the Holland Hydrogen 1 plant?**
The HH1 will help the factories of Shell Energy and Chemicals Park Rotterdam (Pernis) to become more sustainable. The hydrogen will be used as a raw material in Pernis. A dedicated hydrogen pipeline will connect the plant with the Port of Rotterdam, and its hydrogen customers.
Heavy-duty road vehicles will also benefit from the HH1 production. The 60,000 kilograms of hydrogen that the HH1 factory will produce daily, are enough to keep 2,300 hydrogen trucks rolling daily. However, by the time the plant is operational, there probably will not be many hydrogen trucks on the road yet. That is why the renewable hydrogen initially will be used at Shell Energy and Chemicals Park Rotterdam in Pernis, which is currently using so-called grey hydrogen.

**How does making renewable hydrogen work?**

**Splitting water**
At the Holland Hydrogen 1 factory, Shell will use green electricity to split the water molecule $\text{H}_2\text{O}$ into hydrogen ($\text{H}_2$) and oxygen ($\text{O}_2$). The splitting will be done by 10 parallel connected electrolyser of 20 megawatts each, 200 megawatts in total. The electrolyser modules are state of the art and optimised for hydrogen manufacturing. It is a process already in use by industries worldwide after William Nicholson and Anthony Carlisle invented water electrolysis in the year 1800. For each litre of renewable hydrogen, about 9 litres of water are used.
Electricity
The electricity for the Holland Hydrogen 1 plant comes from the offshore wind farm Hollandse Kust Noord (HKN). This wind turbine plot is run by both Shell and Eneco in their joint-venture CrossWind and comprises 69 wind turbines (759 MW installed capacity) located 18 kilometres (11 miles) off the coast of Egmond aan Zee, the Netherlands. CrossWind will deliver its annual production of 3.3 TWh, or about 2.8% of the current electricity demand of the Netherlands, to the grid. The Holland Hydrogen 1 systems will tap into the grid to extract the wind power, for which it will use about a third of the HKN production. The construction of HKN started in October 2022 and is expected to be fully operational by the end of 2023.

Solar
Shell is implementing the use of solar power as an additional electricity source for the Holland Hydrogen 1 factory. Solar panels with a combined size equal to 20 basketball courts will be incorporated in the design of the installation. The electricity produced by them will initially power non-essential installations and processes at the Holland Hydrogen 1.

Power electronics
Unlike conventional oil and gas installations, where electronics and other digital solutions make up 15% of an installation, power electronics are about 40% of the Holland Hydrogen 1 factory. With today’s technologies, power engineering will ensure that operations run smoothly for decades to come – not only to provide a constant flow of wind electricity to the electrolysers, but also for the electrolysis process itself, and to guarantee a smooth delivery of hydrogen to its users.

“We are writing history. Worldwide, there are 300 megawatts of electrolysers for renewable hydrogen production. On 6 July 2022, Shell and partners announced to add another 200 megawatts. So, this is big!”

Lydia Boktor, Shell’s core team Holland Hydrogen 1
What happens to the waste products?
Making renewable hydrogen is sustainable; the waste produced by the Holland Hydrogen 1 installations is oxygen and heat. Shell and industrial partners are looking into the economic and technical feasibility to deliver the oxygen and heat to industrial processes or to re-use it in another circular way.

How will the Holland Hydrogen 1 building itself be sustainable?
Embedded in the landscape of the Tweede Maasvlakte plains, the aim of the Holland Hydrogen 1 project is to have as little impact on the environment as possible. For example, circular materials are used in the construction, like sustainable wood, eco-flax wool and plant-based paint.

Why isn’t there more of renewable hydrogen already?
Shell is one of the early pioneers of large-scale production of renewable hydrogen. The electrolyser modules come from Thyssenkrupp, one of the very few companies that has the technology to deliver 20 times the size of what currently exists. The HH1 project will use the lessons learned from a small demonstration plant in Rheinland, Germany.
## Factsheet Holland Hydrogen 1

<table>
<thead>
<tr>
<th>What is it?</th>
<th>A 200-megawatt factory that will produce 60 tons of renewable hydrogen a day, using a series of electrolyser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For whom?</td>
<td>Initially the renewable hydrogen will replace grey hydrogen as a feedstock at Shell Chemicals and Energy Park Rotterdam in Pernis. The annually produced 24.8 kilotons of renewable hydrogen represents approximately 5% of the total annual use of hydrogen in the Port of Rotterdam. Later, the hydrogen will be delivered to heavy-duty trucks once hydrogen trucks are more widely available and a hydrogen filling network is in place.</td>
</tr>
<tr>
<td>Where is it?</td>
<td>Just behind the beach of the Tweede Maasvlakte, about 35 kilometres (21 miles) west of the centre of Rotterdam, the Netherlands.</td>
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<tr>
<td>CO₂ reduction</td>
<td>2.4 megatons in the first 10 years of operations is projected. This equals to 75,000 cars driving 20,000 kilometres each year in the same decade.</td>
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<tr>
<td>Power needed</td>
<td>The indirect, clean power source is the offshore wind farm Hollandse Kust Noord, located 18 kilometres of the Dutch coast near Egmond aan Zee and run by the joint-venture CrossWind of Shell and Eneco. The HH1 installations will tap into the national grid to get their power. Non-critical systems on site will use electricity from the plant’s own solar panels.</td>
</tr>
<tr>
<td>Water needed</td>
<td>700 m³ of demineralized water a day, sourced from the surface water of lake Briel (Brielse meer). The lake is fed by the rivers Rhine and Maas. Rainwater will be collected on site, for sanitary use and cleaning.</td>
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<tr>
<td>Transport</td>
<td>The renewable hydrogen from the HH1 factory will be transported by a new high-capacity pipeline throughout the Port of Rotterdam and Shell’s Energy and Chemicals Park in Pernis. The pipeline infrastructure is called HyNetwork Services.</td>
</tr>
<tr>
<td>Storage</td>
<td>No hydrogen storage on site.</td>
</tr>
<tr>
<td>Commitment to the United Nations goals (SDG)</td>
<td>Enabling affordable and clean energy (UN GDP Goal 7). Provisioning and innovating towards sustainable industry and infrastructure (Goal 9). Proactive measures towards climate action (Goal 13).</td>
</tr>
<tr>
<td>Design &amp; Engineering</td>
<td>Worley Engineering Contractor, Kraaijvanger Architects and landscape experts of Stijlgroep.</td>
</tr>
<tr>
<td>Construction materials</td>
<td>Non-toxic and recyclable, compliant with the EU circularity passport standards. Aim to have 85% of the concrete used recyclable at the end of its life.</td>
</tr>
<tr>
<td>Surrounding landscape</td>
<td>Bio-based materials and/or cradle-to-cradle certified materials will be used in the surrounding landscape. The landscape will include dune and wetlands habitats to support biodiversity and the local ecology.</td>
</tr>
<tr>
<td>Area</td>
<td>4 hectares for the entire plot, including visitor experience centre and green zones to support local flora and fauna.</td>
</tr>
<tr>
<td>Construction started</td>
<td>September 2022.</td>
</tr>
<tr>
<td>Planned start of operations</td>
<td>Second half of the 2020s.</td>
</tr>
</tbody>
</table>
Cautionary Note

The companies in which Shell plc directly and indirectly owns investments are separate legal entities. In this brochure “Shell”, “Shell Group” and “Group” are sometimes used for convenience where references are made to Shell plc and its subsidiaries in general. Likewise, the words “we”, “us” and “our” are also used to refer to Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. “Subsidiaries”, “Shell subsidiaries” and “Shell companies” as used in this brochure refer to entities over which Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as “joint ventures” and “joint operations”, respectively. “Joint ventures” and “joint operations” are collectively referred to as “joint arrangements”. Entities over which Shell has significant influence but neither control nor joint control are referred to as “associates”. The term “Shell interest” is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

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Shell’s net carbon intensity

Also, in this brochure we may refer to Shell’s “Net Carbon Intensity”, which include Shell’s carbon emissions from the production of our energy products, our suppliers’ carbon emissions in supplying energy for that production and our customers’ carbon emissions associated with their use of the energy products we sell. Shell only controls its own emissions. The use of the term Shell’s “Net Carbon Intensity” is for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell’s net-Zero Emissions Target

Shell’s operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, they reflect our Scope 1, Scope 2 and Net Carbon Intensity (NCI) targets over the next ten years. However, Shell’s operating plans cannot reflect our 2050 net-zero emissions target and 2035 NCI target, as these targets are currently outside our planning period. In the future, as society moves towards net-zero emissions, we expect Shell’s operating plans to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

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This brochure may contain certain forward-looking non-GAAP measures such as cash capital expenditure and divestments. We are unable to provide a reconciliation of these forward-looking Non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those Non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures are calculated in a manner which is consistent with the accounting policies applied in Shell plc’s consolidated financial statements.

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