Green hydrogen: Ras Duqm

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Hydrogen is the most abundant element in the universe. It has the chemical symbol H and is composed of a single proton and a single electron. It makes up roughly 90% of all the atoms in the universe.

Friday, June 20, 2025

Learning Goals

1. Know what hydrogen is.
2. Understand the different types of hydrogen and extraction feasibility.
3. To be able to describe the social costs and benefits, and implications for the carbon cycle.

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1. Using the sentences below, create a timeline on the evolution of hydrogen as a form of energy on your worksheet.

Hydrogen was first produced in the 1920s through the process of coal gasification (when coal is heated with limited oxygen or steam to produce syngas).

This approach was succeeded by steam methane reforming from the 1930s onwards.

Initially, hydrogen was used in ammonia production, beginning in the early 20th century. This remains a critical component in the production of fertilisers, to enhance crop yields and food production.

Later in the mid-20th century hydrogen was used for petroleum refining.

In 1954, the first hydrogen fuel cell capable of generating electricity was invented by General Electric. This was a pivotal moment in its energy history.

Throughout the 1960s hydrogen was increasingly used as rocket fuel, in NASA's Apollo program.

By the 21st century, its potential as a form of clean energy became increasingly recognised, with green hydrogen production emerging in the 2010s as renewable energy technologies advanced.

The first commercially viable hydrogen car was the Toyota Mirai, released in 2014. It is hoped that hydrogen cars will replace combustion engines (which burn petrol or diesel). Combustion engine cars release carbon dioxide. Hydrogen cars only produce one harmless gas – water vapour.

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2. Watch the BBC video How is hydrogen used? to answer the question on your sheet.

Sources of hydrogen

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It is possible to produce hydrogen in several different ways.

- Natural gas reforming is the most common method for producing hydrogen. Currently it involves reacting natural gas with steam to produce hydrogen and carbon dioxide. This is referred to as grey hydrogen, or blue hydrogen if the carbon emissions are captured and stored.
- Water electrolysis is a growing alternative. Electricity splits water (H_2O) into hydrogen (H_2) and oxygen (O_2). When renewable energy (like solar or wind) is used for this process, the hydrogen produced is called green hydrogen.
- Coal gasification describes the process of extracting hydrogen from coal through gasification. It produces significant carbon emissions. This method is less environmentally friendly.
- Other opinions include biomass processing (hydrogen is produced from organic materials, such as agricultural and forestry waste), photocatalysis (an experimental method which uses direct sunlight), and industrial byproducts (from a certain processes like chlorine production).

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Types of hydrogen

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There are several types of hydrogen (8 in total). Each type serves different purposes and offers varying degrees of sustainability. The main 3 main types are grey, blue and green.

Using the image and your own knowledge. Write out a definition for the main types of hydrogen on your worksheet.

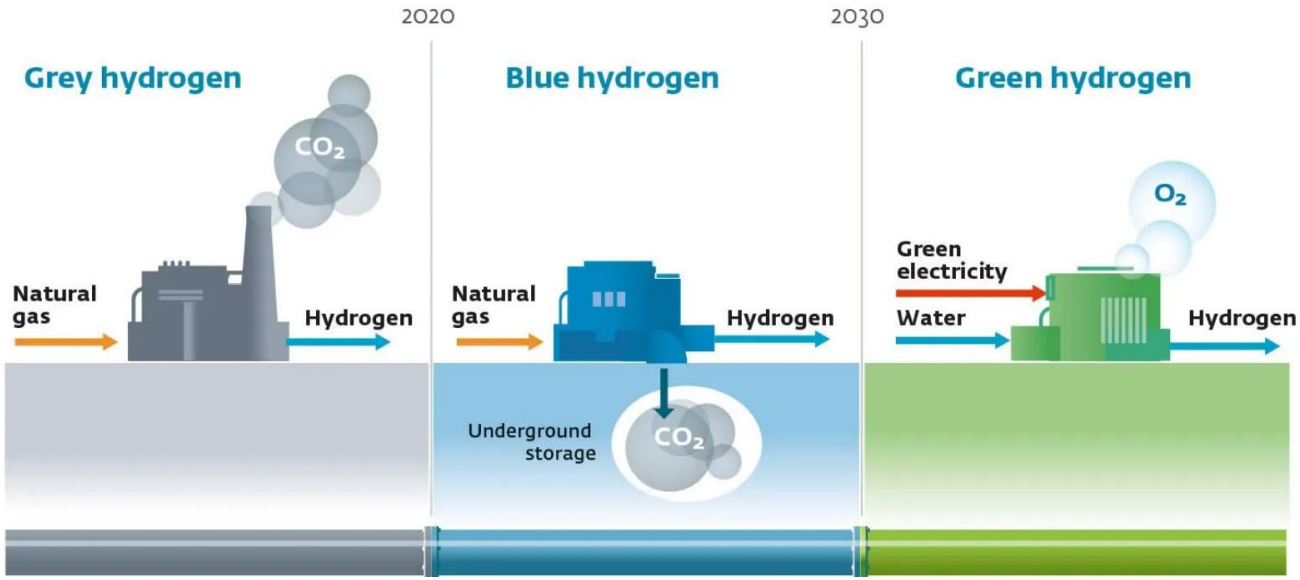

Image source: The different types of hydrogen © The World of Hydrogen Gasunie

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Types of Hydrogen

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Brown hydrogen is derived from coal through gasification. It is highly polluting due to significant carbon emissions during the process.

Blue hydrogen is like grey hydrogen as both are produced from natural gas. However, the blue hydrogen process captures and stores carbon emissions.

Green hydrogen is produced using renewable energy sources to split water into hydrogen and oxygen via electrolysis. This is the cleanest type, with no carbon emissions.

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Green hydrogen infographic

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Make an infographic on green hydrogen, following the steps below.

1. Go to Canva.com
2. Canva is an online graphic design tool. It has a free account option for infographics
3. When you access the website select Student and then High school
4. When you have the Canva home screen click + Create a design
5. You will be offered several options. Select Infographic (Portrait)
6. Experiment by using the Design search function, to look for different premade Templates
7. Start designing!
8. Remember an infographic should be visually appealing, clear, and packed with information.

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Ras Duqm

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The Special Economic Zone (SEZ) of Duqm in Oman, called Ras Duqm. This area is known as the Special Economic Zone at Duqm (SEZAD). It consists of 2,000km² of land, an airport, industrial zones, housing, a major oil refinery and petrochemicals complex, port and dry dock.

Using the two images opposite, describe the location and connectivity of Duqm in Oman. Add any further key facts from the text to your description.

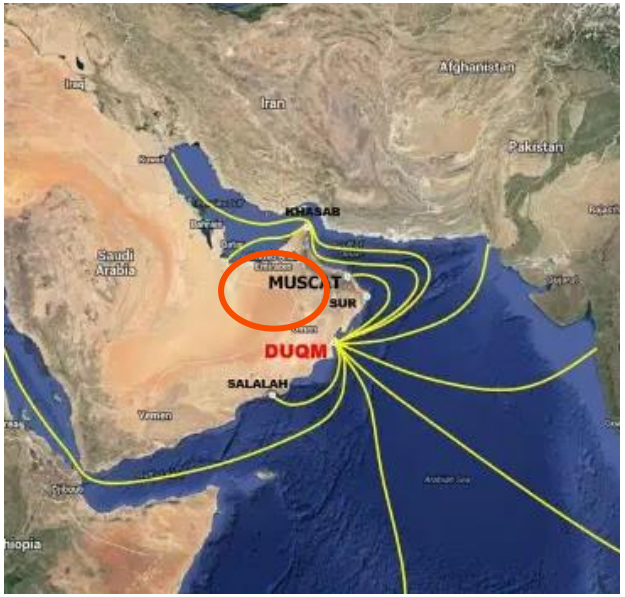

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Image source: The location of Duqm © Springer Nature Oman and map SEZAD Duqm-Oman

Sectors in Ras Duqm

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Look at the images to help identify the industries present in the SEZAD.

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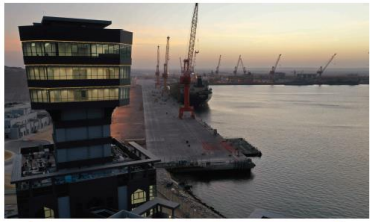
Duqm Refinary - مصفاة الدقم

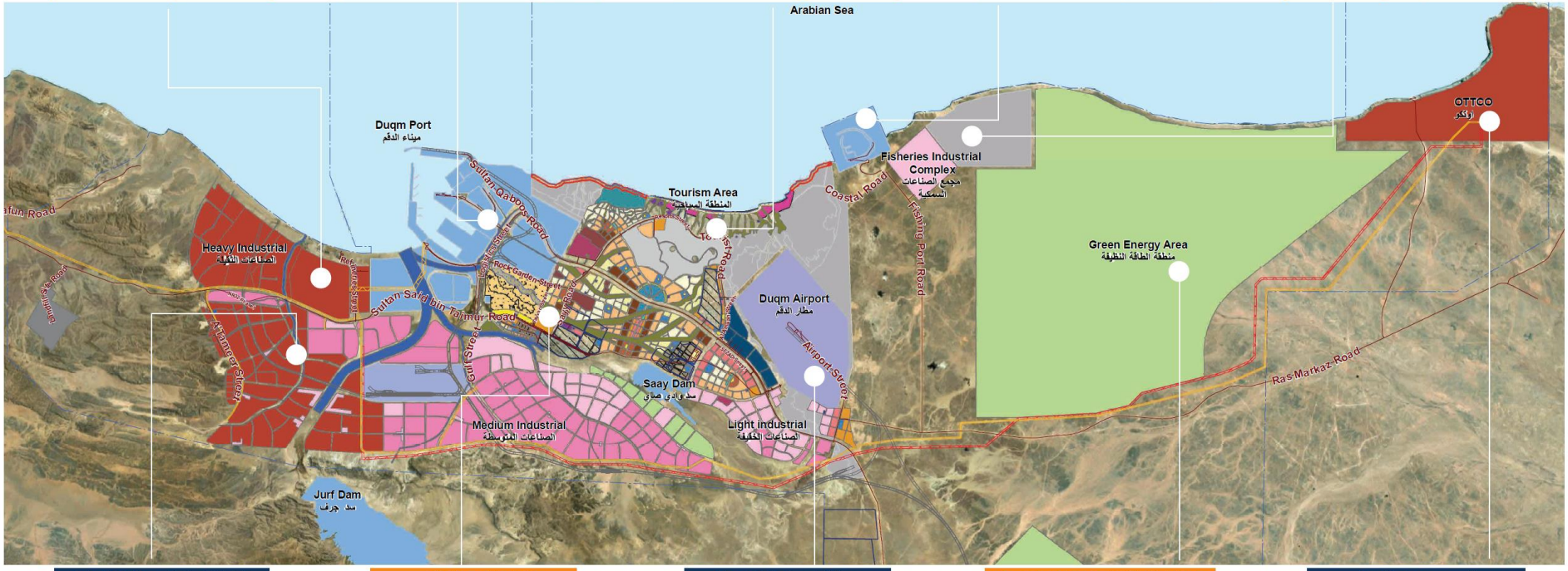


Duqm Port Dry dock - ميناء الدقم والحوض الجاف

Tourism Area - المنطقة السياحية

Fishary Port - ميناء الصيد البحري (متعدد الأغراض)

Al Aera - منطقة الذكاء الإصطناعي



Industiryal Aera - المنطقة الصناعية

City Aera - مركز المدينة

Duqm Air Port - مطار الدقم

Green Energy Aera - منطقة الطاقة النظيفة

Ras Markaz - رأس مركز

Image source: Connsect

Duqm Port SEZ

Hydrogen at HYPORT Duqm

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Ras Duqm in Oman is involved in both blue and green hydrogen projects. Green hydrogen is developed in HYPORT Duqm. HYPORT reflects the project focus on Hydrogen and its location in the PORT of Duqm. The intention is to produce and export green hydrogen and its derivatives (such as ammonia) to the global market.

Task

Read the article HYPORT Duqm set to be among world's first green hydrogen projects to answer the following questions.

1. Where will the project rank among the world's large-scale ventures in green hydrogen?
2. What will HYPORT Duqm be the first in the world to do?
3. What will the production of green hydrogen and green ammonia be powered by?
4. How many green hydrogen projects have been signed by the Sultan of Oman?
5. What is the goal of these projects?

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Costs and benefits

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Hydrogen can be delivered in existing natural gas pipes or pure hydrogen pipelines
Green hydrogen production is expensive due to the need for advanced technology
Green hydrogen can power fuel cell-based vehicles, with zero-emissions
The process of producing green hydrogen is energy-intensive, potentially straining electricity supply
HYPORT leverages Oman's abundant solar and wind resources
Developing the necessary infrastructure is complex and expensive
Duqm Port is an ideal hub for exporting green hydrogen and green ammonia
Electrolysis requires large amounts of water, a concern for Oman with limited freshwater resources
HYPORT aligns with Oman's Vision 2040 by promoting renewable energy and reducing carbon emissions

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Identify the socioeconomic and environmental costs(+) and benefits(-) in the speech bubbles on your sheet. Which comments do you agree with? Challenge: Are there any other ideas you would add?