# Chapter 10
# Green Hydrogen:
## The Pillar of the Sustainable Energy Transition

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## ABSTRACT

*Energy transition policy now places a strong emphasis on green hydrogen because of its enormous potential to cut greenhouse gas emissions and its substantial commercial potential. Renewable energy sources like wind and solar power are used to manufacture this eco-friendly substitute. A novel technique uses chlorophyll-rich microalgae, which produce hydrogen as a byproduct of photosynthesis, the process by which sunlight is converted into chemical energy.Converting renewable energy into forms that may be used, like green hydrogen, requires the development of production circuits for renewable PtX (Power-to-X). Water electrolysis, which separates water into oxygen and hydrogen using power from renewable sources, is the technique involved in this procedure. Continuous and dependable manufacturing necessitates a strong infrastructure, which includes effective electrolyzers.Since it is the basis for the production of numerous synthetic fuels and other energy products, green hydrogen is an essential part of PtX.*

## 1. INTRODUCTION

The demand for energy is continual due to population expansion, technological advancements, and ongoing economic issues. Actually, a measure of a nation's political, social, and economic growth may be found in its energy sector (Brodny et al., 2020). the generation of energy is still largely dependent on fossil fuels and that annual growth in energy consumption is 2% (Nam et al., 2020 ; Khan et al., 2022). Policies and actions to reduce reliance on fossil fuels, greenhouse gas emissions, and carbon emissions

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are required. One such approach is energy management via the use of sustainable and renewable energy systems (Yu et al., 2019; Li et al., 2019).

Integrating renewable energy sources such as biomass, solar, wind, hydroelectric power, and hydroelectricity into current energy systems is known as renewable energy integration (Papadis & Tsatsaronis, 2020). By providing a greener, more sustainable fuel substitute, these sources help to lower greenhouse gas emissions and slow down the effects of climate change (Mahapatra et al., 2021). Conversely, climate resilience pertains to the ability of individuals, communities, and systems to predict, adjust, and recuperate from the consequences of climate-related risks (de Graaf-van Dinther & Ovink, 2021). Through diversifying their energy sources, lowering their susceptibility to energy disruptions, and advancing sustainable development, societies can strengthen their resilience to climate change by utilizing renewable energy resources (Ghorbani et al., 2023). Building resilience against the effects of climate change and addressing it urgently have grown more and more important in recent decades. Integration of renewable energy has become an important tactic in this effort, providing a mechanism to reduce the negative consequences of climate change and decarbonize energy systems (Arent et al., 2022). Examining the opportunities, tactics, and difficulties related to this crucial component of sustainable development, this thorough review aims to investigate the complex relationship between climate resilience and the integration of renewable energy (Ajayi & Udeh, 2024 ; Familoni et al., 2024).

In order to achieve sustainable growth, the majority of countries in the world today have looked into the development of renewable energy sources. Solar and wind power generating is one of the most technologically advanced forms of renewable energy. The electrical grid's balance is one of the major obstacles to rising renewable resource penetration, however there are other obstacles as well (Shabani & Kalantar, 2021a ; Shabani et al., 2021b). Potential energy storage solutions to this problem are "Power-to-X (PtX)" technology, where "X" can stand for heat, power, gas, or liquid fuels. With the help of this technology, excess power can be transformed into other types of energy or energy carriers (Cui et al., 2022). Because water is the only feedstock used in the electrolysis process to make hydrogen, this fuel may be deployed almost anywhere. When employed as fuel in properly engineered fuel cell or combustion systems, hydrogen can be used directly as fuel for stationary energy generation or transportation, leaving only water as a byproduct. In this light, hydrogen as a renewable energy carrier will be essential in numerous ways to decarbonize energy systems throughout the entire energy value chain (Sorrenti et al., 2022).

This chapter's goal is to draw attention to how crucial green hydrogen is to the energy transition as a way to lower greenhouse gas emissions and promote the advancement of Power-to-X (PtX) technologies. It also seeks to address the difficulties associated with green hydrogen generation, transportation, storage, and sustainability, highlighting the necessity of appropriate infrastructure and stringent environmental regulations.

## 2. THE CONCEPT OF POWER-TO-X

The technology known as "Power to X," or "PtX," works by converting electricity into a different kind of energy. In order to feed heating networks or meet industrial needs, this "X-vector" could be heat (Power to Heat). It might also be a synthesis gas (Power to Gas), such methane, which can be injected into the gas network for industrial, heating, or mobility demands, or hydrogen for mobility (Ait Almouh, 2019). We need to quickly transition our economy to operate emission-free in order to achieve climate