

# Integrated Renewables and H<sub>2</sub>/NH<sub>3</sub> Production, Storage, and Utilization System Toward Carbon Neutrality Scenario

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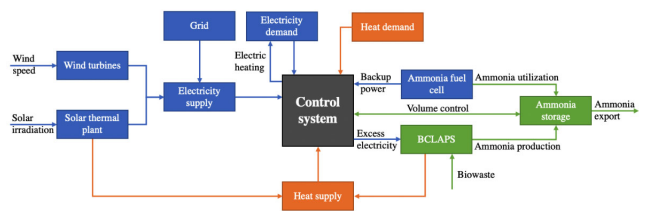
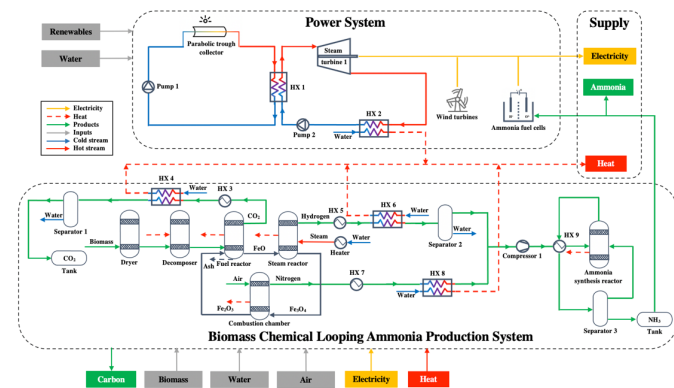
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Climate resilience has been put on the agenda as many countries have proposed their carbon neutrality plan. Increasing the penetration of renewables, mainly solar and wind, is the primary pathway to achieving this goal. In order to widely use renewables, energy storage that is to store excess renewable energy in the forms of mechanical, electrical, chemical, and thermal is a well-developed technology of which hydrogen is a good energy storage medium. It can be used in many different applications like power generation, industrial production, etc. However, hydrogen storage faces several problems of efficiency, safety, and transportation. Thus, ammonia is chosen as the substitute of energy storage medium.

## Multi-Generation Energy System

Green hydrogen is using renewable water electrolysis to produce hydrogen, which is regarded as a promising pathway to achieve carbon neutrality. Considering the storage and transportation of hydrogen, green ammonia which is using green hydrogen to produce ammonia can be seen as a more reliable method. Because ammonia has a high volumetric density and more stable physical characteristics that can be stored as liquid form at ambient temperature and moderate pressure. Besides, ammonia production is energy intensive, high carbon emission, and there are many real-made ammonia plants need to be transformed.

A combined renewables and ammonia production, storage, and utilization system (CRAS) is proposed for the targets: (1) increasing the penetration of renewables; (2) satisfying electricity and heat demand, meanwhile decreasing the curtailments; (3) fixing ambient carbon dioxide through biomass chemical looping process; (4) setting up ammonia economy where ammonia serves as fuel and feedstock. It contains 2 systems. The power system integrates solar and wind energy to provide electricity, while the direct ammonia fuel cell is seen as the backup power activated when there is a supply shortage or demand surge. Heat is the secondary product that is used indirectly by means of heating up water for district heating. The biomass chemical looping ammonia production system (BCLAPS) can be seen as an energy storage method.



## Expected Results and Future Prospects

The performance of the system is evaluated on the hourly data of supply and demand sides. The results show the technological aspect of the system. In the future, the economic and environmental aspects of the system will be assessed.

