Acting now — Qatar's Efforts Towards Sustainable Aviation Fuels

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Introduction

In 2021, the State of Qatar has launched its National Climate Change Action Plan (NCCAP) that aimed at achieving a 25% reduction in greenhouse gas emissions by 2030. Under this umbrella, in the civil aviation sector, Qatar Civil Aviation Authority (QCAA) is working closely with all the stakeholders in the aviation industry to fully do its part in achieving the State's NCCAP objective, and to abide by Qatar's National Vision 2030 (QNV 2030) which contains four pillars, namely: Human, Social, Economic and Environmental Development. Specifically, QNV 2030 indicates that:

> *"Economic development and protection of the environment are two demands neither of which should be sacrificed for the sake of the other"*; and
>
> *"Environment Development: management of the environment such that there is harmony between economic growth, social development and environmental protection"*

Among the initiatives that were taken, recently, to tackle climate change in the National Aviation Industry, we can mention:

> *Improve Hamad International Airport's carbon efficiency per passenger by 30% by 2030 against a 2015 baseline*; and
>
> *Commitment, by the national carrier, to net zero carbon emissions by 2050.*

The State of Qatar is pursuing the implementation of ICAO (International Civil Aviation Organization) comprehensive strategy to progress all elements of the "basket of measures", namely: Aircraft-related modern technology; Improved Air Traffic Management; More efficient operations - Infrastructure improvements; Market-based measures; and CORSIA Eligible Fuels (CEF) including the Sustainable Aviation Fuels (SAFs) and the Lower Carbon Aviation fuels (LCAF).

One especially essential element of the stated above basket of measures, is SAF which, according to recent analysis, is aimed to enable the global civil aviation industry to reach the goal of net zero carbon emission. The State of Qatar as per its strategy, continues to support research, development, and demonstration of CORSIA Eligible Fuels in collaboration with different Stakeholders. This includes the discussion of the potential for, benefits of, and barriers to CEFs production and use in Qatar. With regards to SAFs, the main object of the joint synergies in Qatar is to find alternative sources of feedstock to produce biomass to liquid (BTL) fuels. In the following polarographs, two projects are presented as examples.

1. Algal Technologies Program: Towards Sustainable Aviation Fuel

An example of Qatar's efforts is the Qatar University Biofuel Project which is taking advantage of Qatar's resources and climatic conditions for growing marine microalgae as feedstock. Specifically, lipid-rich marine microalgae that could be grown using seawater on non-arable land. Qatar's abundant sunlight throughout the year, easy access to vast non-arable lands, and seawater, make Qatar a suitable location for producing lipid-rich marine microalgae as a potential feedstock to commercially produce SAFs.

FIGURE 1: Lipid rich marine microalgae cultivated in 25,000 L outdoor open raceway ponds

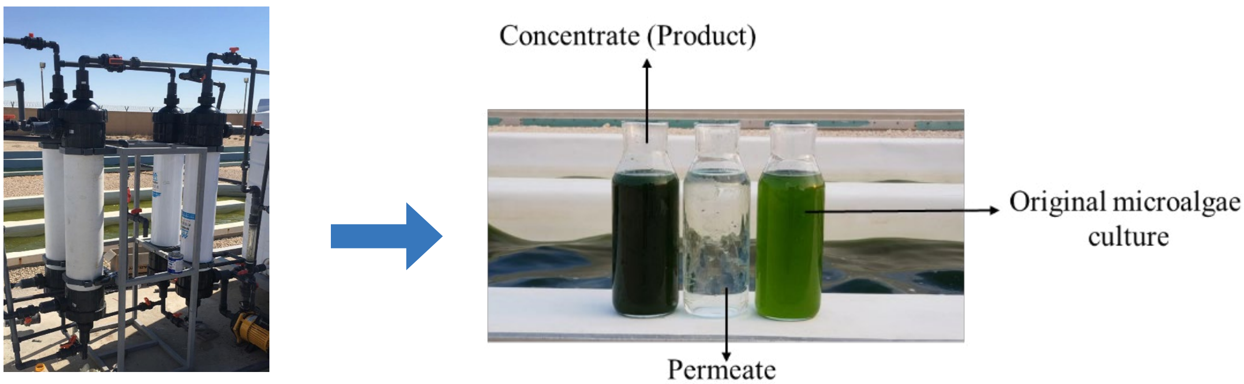

FIGURE 2: Tangential flow filtration system developed by algal technologies program (ATP)-Qatar University

Presently, the Algal Technologies Program (ATP) research group at Qatar University has successfully cultivated lipid-rich marine microalgae in 25 m^3 – 100 m^3 outdoor open raceway ponds, as shown below. The research group has also developed a tangential flow filtration system for harvesting microalgae – capable of processing 1300 L/hr microalgae culture at 0.2 – 0.3 kWhr/m^3. The filtration unit can concentrate marine microalgae cultures to biomass densities ranging from 25 to 30 g/L as shown below.

For this project, researchers used a high-pressure Parr reactor for producing biocrude oil from microalgae; the hydrothermal liquefaction (HTL) reactions were conducted at temperatures ranging from 275 – 400 °C and 200 bar pressure. A similar reactor setup will be used for the hydroprocessing of marine microalgae lipids to SAFs or bio-jet fuels. ATP is working on biocrude oil production from various marine microalgae strains.

A biorefinery process was developed to extract pigment and lipid efficiently at a large scale. More than 40 % lipid has been successfully extracted from sundried marine microalgae by using a pilot-scale soxhlet extractor.

Future steps for the ATPs biofuel project would focus on the scale-up of microalgae production facility. Additionally, the hydroprocessing reaction parameters will be optimized for obtaining higher SAF yields from marine microalgae lipids. The results from optimization studies would then assist in developing continuous SAF production systems.

2. Sustainable Solar-Driven Biofuel Generation from Industrial Wastewaters without External Bias

Hydrogen is considered by many experts, a promising alternative fuel. It is characterized by easy storage, high energy density, and a clean combustion process which produces water. Hydrogen can be generated from various sources such as reforming fossil fuels such as coal and natural gas, water electrolysis, biological sources such as dark fermentation process, and solar-driven methods such as photo-electrochemical.

Qatar University, in collaboration with the Environmental and Municipal Studies Center at the Ministry of Environment, Korea Maritime, and Ocean University, is working on a project that can be considered as an added value for converting industrial wastewater into hydrogen. This project can break the limitations of traditional Microbial Electrolysis Cell (MEC) and rely on coupling of solar energy with bioenergy. The project design, photo-assisted microbial electrolysis cell (PA-MEC), can deliver sustainable hydrogen fuel together with efficient degradation of organic contaminants without the use of external power as shown below.

The project work has reached an advanced level, where researchers will calculate the amount of the produced Hydrogen and then evaluate the process performance in terms of system design and materials used, cost, and efficiency to pave the way for commercialization of PA-MEC technology as a practical alternative approach for biofuel production in the State of Qatar. The State of Qatar is making huge efforts in enabling diversification of renewable energy resources and in the heart of it the sustainable aviation fuels a major element of the ICAO basket of measures in the coming decades.

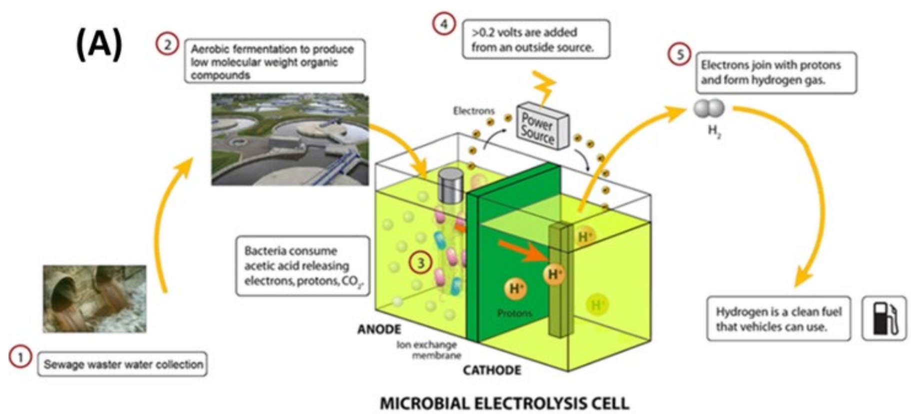

FIGURE 3: Schematic diagram for the microbial electrolysis cell

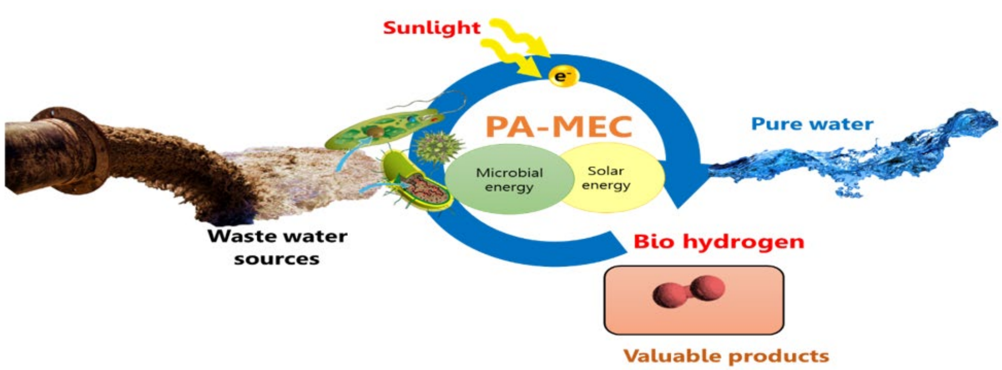

FIGURE 4: Schematic diagram of (PA-MEC) hybrid system coupling solar energy with bioenergy