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EXECUTIVE COMMITTEE

Agenda Item 17: Environmental Protection – International Aviation and Climate Change

ENVIRONMENTAL SUSTAINABILITY - LOW EMISSION TECHNOLOGIES

(Presented by Saudi Arabia)

EXECUTIVE SUMMARY

This paper provides an overview on low emissions refuelling technology options and on the feasibility of generating electricity through solar at the King Abdulaziz International Airport in Jeddah Airport.

The paper is a collaboration between the Arabian Petroleum Supply Company (APSCO) and the General Authority of Civil Aviation (GACA) of Saudi Arabia.

Supporting Saudi Arabia's growth, advancing capabilities, results, and aligning with the Saudi Arabia Vision 2030, the analysis and information presented in this paper supports the General Civil Aviation Authority (GACA) Environmental Sustainability Programme and the aspirational goals of ICAO through ongoing technological advancements and associated sustainable option implementation.

<i>Strategic Objectives:</i>	This information paper relates to the Environmental Protection Strategic Objective.
<i>Financial implications:</i>	Without any financial obligations.
<i>References:</i>	Annex 16 – <i>Environmental Protection</i> , Volume IV – <i>Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)</i> Doc 10013, <i>Operational Opportunities to Reduce Fuel Burn and Emissions</i> Doc 9889, <i>Airport Air Quality Manual</i> Doc 9184, <i>Airport Planning Manual – Part 2, Land Use and Environmental Management</i>

1. INTRODUCTION

1.1 The Kingdom of Saudi Arabia is undergoing a significant transformation through the implementation of the Saudi Vision 2030 which is built around three primary themes: a vibrant society, a thriving economy, and an ambitious nation. The landscape of the sector in KSA consists of 29 airports (public and private) (domestic, regional and international).

1.2 APSCO are one of the world's leading aviation fuel suppliers, lubricants and grease manufacturers, and a prime facilitator for Saudi Arabia's growth and diversification towards Vision 2030.

1.3 APSCO operate across the majority of the value chain, through a network of fully integrated businesses, with interests ranging from blending, aviation, storage, manufacturing, retail and distribution.

1.4 Aligned with the Saudi Vision, and international commitments including those defined at the ICAO level, the General Authority of Civil Aviation (GACA) Saudi Arabia is developing an Environmental Sustainability Programme, which will outline environmental policy and regulation for its aviation sector and define a roadmap to manage and minimise potential environmental impacts and collaborate with local and international stakeholders and partners to identify and analyse sustainable solutions.

1.5 Through partnership and collaboration, APSCO and GACA are working on challenges and solutions in relation to low emission technologies.

2. BACKGROUND

2.1 The King Abdulaziz International Airport in Jeddah is an important international gateway for the Kingdom of Saudi Arabia, being the country's second-largest city as well as the closest international airport for the holy mosques of the world's 2 billion Muslims. The airport is the busiest in Saudi Arabia. It received over 41 million passengers in 2018 and passenger numbers are expected to rise sharply under the Kingdom's plan to triple annual passenger traffic to 330 million by 2030.

2.2 Refuelling operations at the airport, which are currently on the order of 90,000 movements per year, are performed by diesel trucks. CO₂ emissions from the combustion of diesel fuel associated with refuelling are on the order of 1688 tonnes per year. Electrification using solar power generated on-site at the airport offers a low-carbon alternative to conventional diesel fuel.

2.3 The evolving landscape of the aviation sector in KSA provides a unique opportunity to consider and support (where feasible) sustainable measures in design, and construction whilst focusing on innovative solutions for operations. Balancing the Kingdom's Global Reputation and approach with the economic and operational requirements will be key to the Environmental Sustainability journey whilst ensuring the avoidance of accidental risk transfer and future-proofing technology options.

3. PROJECT DETAILS

3.1 The project started with an analysis of low emissions refuelling technology options including the feasibility of generating the needed electricity with solar panels installed on-site at the airport.

3.2 Multiple data sources have been used to determine the feasibility of these proposed solutions and the costs and benefits of a low carbon refuelling system are identified. Challenges facing the implementation are also identified, which provides national policymakers with the tools needed to develop strategies for the decarbonisation of refuelling operations. The proposed sustainable solutions may be shared at regional and global levels.

4. RESULTS

4.1 Given that Saudi Arabia's national electricity production is currently derived from fossil fuels (mainly natural gas and petroleum derivatives), an independent solar grid solution was investigated to achieve a low-carbon result. The solar power generation potential of the land area open to the refuelling company at King Abdulaziz International airport was analysed. The company occupies 50,000 m² of land at the airport, which is leased from the airport operator. The roof area of buildings on the site is 14,000 m². Potential rooftop solar power capacity was estimated at 2,142 kW, assuming 85% of the available roof area was used for solar power systems with an estimated efficiency of 180 W/m² and an 85% derating of DC power to AC electricity production.

4.2 Utilising an analysis tool, the annual electricity production by this installation was estimated to be 3,888,221 kWh. Capital costs (Capex) for the rooftop solar panels were estimated to be USD 1.4 per Watt of installed capacity, or USD 2.99 million. The cost of installing 0.64 km of electricity transmission lines to connect the panels to airport grids was estimated at USD 150,000 taking total capital costs to USD 3.14 million. Annual operating costs (Opex) for the solar power system were estimated at 0.7% of Capex, using 70% of US operating cost assumptions to account for lower costs of materials and labour in Saudi Arabia.

4.3 Furthermore, phase 1 of the project started the deployment of solar panels as shown in the below photograph:

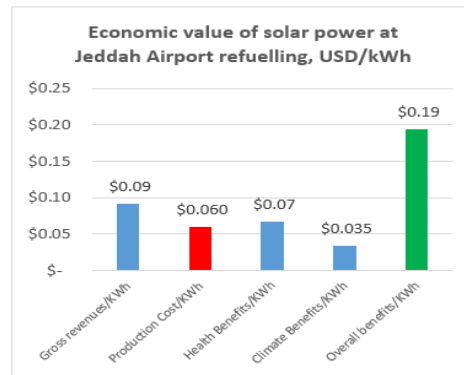
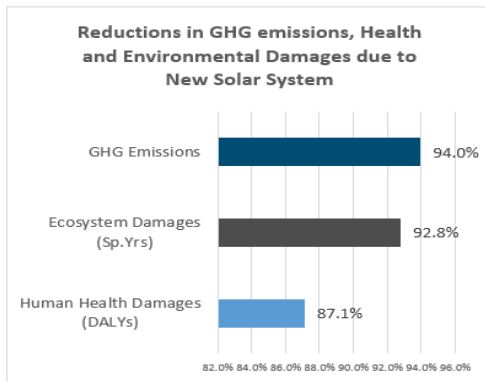


4.4 Using a 3% annual interest rate and a 20-year amortisation yielded an annual capital cost of USD 211,649 resulting in a production cost of USD 0.06/kWh, which compares favourably with the USD 0.092/kWh price of electricity in Saudi Arabia. A discounted cash flow analysis was performed to determine net present value and internal rate of return over the 25-year lifespan of the project. Assuming a 0.7% annual degradation of the solar power system, a 2.5% annual rate of inflation for Opex and the 2.5% Zakat tax on net operating income levied on Saudi firms, the project's forecast cash flows showed a positive NPV at 6% and 4%. As the IRR of 6% exceeded the project's 3% cost of capital, it is considered to be viable.

4.5 Two truck-based refuelling solutions have been considered: battery-electric trucks and fuel cell hydrogen trucks. However, although hydrogen trucks offer some advantages including a faster refuelling time than what is needed to recharge batteries, hydrogen fuel cell vehicles were discarded as a solution owing to their inability to tolerate ambient temperatures on airport aprons exceeding 50°C.

4.6 As a result, an electric truck solution will be required until operating tolerances for fuel cell hydrogen vehicles improves. On average 246.6 daily refuelling operations are performed every year at the airport and each refuelling operation consists of a round trip of approximately 20 km. This level of operations would require a fleet of 30 trucks, each performing approximately 8.2 refuelling operations per day.

4.7 An electric truck has a 540-kWh nameplate battery capacity and consumes approximately 1.1 kWh/km. As such, battery capacity should be sufficient for daily operations. Moreover, the stable lithium battery is suited to operations in areas with high ambient temperatures. The high capital cost of Electric Vehicles (EV) trucks is a barrier, though the cost premium is expected to decline. At the time of writing, the cost of EV trucks and mobile fuelling systems is almost higher than a diesel-powered truck with a fuelling system by almost 30%. EV trucks would save USD 7000 per year per truck in maintenance and lubricant costs.



4.8 A key challenge remains the duration of charging, which is estimated at 2.5h using a 250 kW DC charging station, or 9.5h with a 43 kW AC station. Moreover, due to the relatively low number of minimum irradiation hours in some months of the year, between eight and ten 220 kW DC charging stations would need to be installed to ensure uninterrupted operations. The charging facility Capex is estimated at USD 175,000 per truck.

4.9 However, given that annual electricity consumption by the truck fleet is expected to be approximately 1,980,000 kWh, considerable emissions savings are possible if solar power produced on-site can be used. The current diesel-fuelled fleet consumes 0.35 litres of fuel per km travelled, resulting in annual diesel consumption of 630,000 litres and the emission of 1,688.4 tonnes of CO₂ to the atmosphere.

4.10 Moreover, using onsite-generated solar energy offers the opportunity to avoid the emissions associated with grid-sourced power. Using grid power to recharge electric trucks would cause the emission of 3,059.8 tonnes of CO₂ equivalent since approximately 58.8% of the electricity available on the Saudi grid is generated from natural gas and the remaining 41% is supplied by oil-fired power plants.

4.11 Using solar power delivers additional health benefits in the form of reduced particulate emissions and airborne pollution that translates into a benefit equivalent to USD 0.07/kWh from reduced deaths from cardiovascular disease. Attributing a USD 47/tCO_{2e} carbon price adds a further USD 0.035/kWh benefit to shifting to solar energy. Finally, utilizing rooftop parking and buildings for installing a solar system inside airport premises is considered a positive initiative toward achieving high sustainable standards.

5. DISCUSSION

5.1 The Saudi government has laid out its Vision 2030 plan to shift the economy away from its heavy reliance on oil through investments in renewable energy, tourism and new urban developments centred around sustainability concepts.

5.2 The study clearly shows there are considerable societal benefits from implementing an electrified aircraft refuelling system at the King Abdulaziz International Airport. However, the key challenge for project developers remains capturing some of these economic benefits to overcome the high Capex required to implement the project.

6. CONCLUSION

6.1 The benefits of analysing the Low Emissions Technology options can be summarized as follows:

- a) supports the Saudi Arabia 2030 vision and international commitments, goals and targets;
- b) promotes technological advancements; and
- c) promotes collaboration.

6.2 The Assembly is invited to take note of the information provided in this paper and encourage States to exchange information on the development and implementation of environmental sustainability programmes, including challenges and benefits.