2016 International Conference on Power, Energy Engineering and Management (PEEM 2016)
ISBN: 978-1-60595-324-3

Aerospace Technology Green Energy System Perspectives

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Keywords: Aircraft fuel burn, Aircraft green fuel, Green aircraft technology, Space environmental observation, Green energy, Green space technology spin-off.

Abstract. Aerospace Technology comprises a broad spectrum of technologies, mostly based on the higher end of technology, human capacity, investment and vision. With global concern and vision on the need of global climate and resources conservation and efficiency, these efforts have also been focused on concerted, proactive and actions addressing urgent global climate change and resources conservation imperatives. Among these broad spectrums, two earth oriented aspects and activities will be focused and reviewed: Atmospheric flight technology based Green Technology and Space flight technology based energy technology associated with climate change monitoring and mitigation. Space flight technology based Earth monitoring has gained importance as useful tools in sustainable agricultural management and development. Relevant aspects of the contribution of space technology and integrated use of space based Earth monitoring system and technology for sustainable development will exemplified.

Introduction

Aerospace Technology is a subject of a very broad spectrum and reflects one of mankind efforts to improve mankind quality of life. Without delving to a precise and all-inclusive definition of quality of life, it can be interpreted as mankind holistic and integrated opportunities, subjective needs, resourcefulness, wellbeing and efforts (physical and emotional). Perhaps it may be related to the most commonly used Human Development Index (HDI), an international measure of development which combines measures of life expectancy, education, and standard of living, in an attempt to quantify the options available to individuals within a given society. As illustration, HDI is related to electrical usage, one form of energy. Therefore, attention is focused on their individual contribution to green energy, although proceeding to the elaboration, the discussion and proposed ideas may only touch upon a selected view of issues. On a broader scope, the analysis of different global energy scenarios indicates that the exploitation of energy efficiency potentials and the use of renewable energies play a key role in reaching global CO2 reduction targets [1].

The agro-based environment-friendly technology or Green Technology (GT) comprises a group of methods or materials which are continuously evolving, from techniques for generating energy to non-toxic cleaning products. GT reduces environmental damages created by the products and technologies and incorporates innovation which reduces waste by changing patterns of production and consumption. Aeronautics and air transport is a vital sector of many industrial as well as developing societies and economies. It is also of sovereign importance for major industrialized countries, for which the public and private stakeholders provide world leadership and helps to meet society's needs by ensuring suitable and sustainable mobility of passengers and freight, significantly contributing to competitiveness and trade balance, wealth generation and economic growth, provision of jobs and innovation, fostering knowledge economy through R&D investment, and contributing to security, global safety, and self-reliance. Hence aeronautics and air transport is a catalyst for growth. For example, Aviation's economic and societal contribution for the European Union is generating around €220 billion and providing 4.5 million jobs [3]. The European aeronautic industry, through collective efforts encompassing public and private sectors, major companies, thousands of small and medium enterprises (SMEs), academia and research laboratories, has successfully risen from a niche sector to a world leading industry. Europe has supported 751 million passengers in 2009. Aerospace Technology Vision then has to transcend the needs of mankind and the dynamics of socio-economic development. These in part can be differentiated into various elements, such as extensive, holistic, highly ambitious and built on the parallel objectives of providing the best products and associated services in aeronautics and air transport, are significant for economic contribution. In addition, Aeronautics and Aerospace Technology involve SMEs and based on cutting-edge research and education catalytically by providing the connectivity needed by other globalized industries and trade by meeting societal and market needs for affordable, sustainable, reliable and seamless connectivity for passengers and freight with sufficient capacity and providing opportunities for highly qualified and skilled jobs [2].

Renewable and Environmentally Friendly ("Green") Aviation Fuel Technology

To enable future growth in the aerospace industry, industrialized countries, particularly those that house significant share of the global aerospace industry and commercial air transportation, there is a need to develop sustainable alternative fuels and technologies that improve energy efficiency in order to mitigate the environmental impact of aviation systems. The aviation industry worldwide consumes 1.5–1.7 billion barrels of traditional jet fuel annually and contributes to 2–5% of anthropogenic greenhouse gases [3]. The rapid growth of the commercial aviation in the few decades to come will cause increasing fuel consumption. As an illustration, from 1978 to 1990 alone the number of passengers-km has doubled, from 1.10^{12} passenger-km to 2.10^{12} passengers-km, respectively, and has been forecasted to continue to increase until the year 2075, when it is expected to stabilize at around five times the 1990 level at 1.10^{13} passengers-km [4][5]. Even so, the aviation sector only represents about 2.5% of the global energy consumption [6][7]. For a N+2 (2020 time frame) generation aircraft (300 passengers and 7500 nautical mile range) flying at cruise Mach of 0.85, 40% fuel burn saving relative to baseline B777-200ER aircraft and GE90 engine can be realized by a combination of hybrid wing-body configuration with all composite fuselage, advanced engine and airframe technologies, embedded engines with Boundary Layer Ingestion (BLI) inlets and laminar flow [8][9]. For such baseline aircraft, the fuel consumption is 237,000 lbs. Figure 1 is an example of anthropogenic contribution of greenhouse gases which constitutes Radiative Forcing in the atmosphere; the aviation contribution is identified with + sign on the right hand side of the figure [4]. Results depend on scenario and individual RF (Radiation Forcing)-values. Both have large uncertainties.

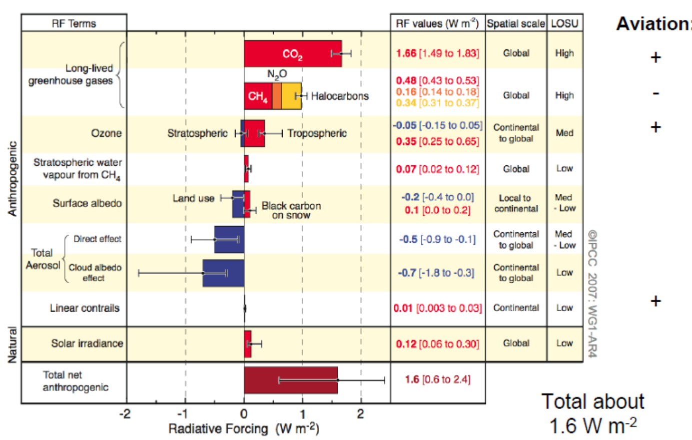


Figure 1. Anthropogenic contribution to radiative forcing (Lee et al, 2009).

It is with such perspectives that efforts are taking place to search for appropriate alternative fuels, aircraft and propulsion system technologies. An integrated, holistic approach to advance not only component efficiencies, but also the efficiency of the entire aviation system has to be taken. New architectures, technologies, materials, and operational procedures to improve overall system efficiency should be assessed and developed. Research at Imperial College [10] stipulated that methanol, ethanol and biogas are unsuitable for jet aircraft, while nuclear power is not a suitable alternative either. Having low energy densities, low flash points, ethanol and methanol have been ruled out for producing formaldehyde and acetaldehyde at low power settings. Hydrogen, Fischer-Tropsch synthetic kerosene [10] and biodiesel, however, all have the potential to bring savings in the sector's use of non-renewable energy and emissions of greenhouse gases. It should be noted that hydrogen aircraft would require new engines and airframes. Such technologies are unlikely to be available for at least several decades. With such background, three fuel options considered as favored options for Renewable Aviation Fuels require further detailed analysis. Synthetic Fischer-Tropsch (FT) kerosene can be produced from biomass. FTkerosene could be blended with or used as a substitute for conventional kerosene. Biodiesel has the potential to be used as a "kerosene extender" by blending it with conventional kerosene up to a maximum of approximately 10% - 20% by volume.

Energy and Climate Change

In recent years, progress has been made in developing cleaner, more efficient energy technologies. Economic growth and energy-related emissions, which have historically moved in the same direction, have started to decouple. The energy intensity of the global economy continued to decline in 2014 despite economic growth of over 3%, although the Global energy intensity increased 1.35 percent in 2010, reversing a broader trend of decline over the last 30 years. Adoption of measures that would achieve a near-term peak in global energy-related emissions while maintaining momentum for stronger national efforts have been proposed.

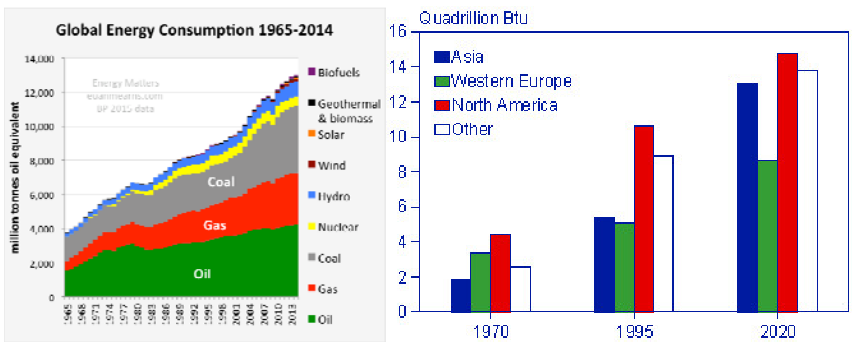
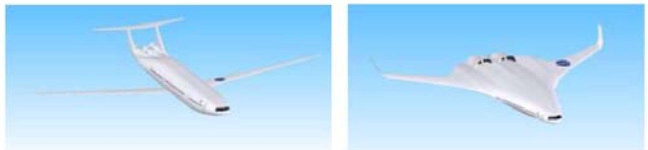


Figure 2. (a) Global Fossil Fuel consumption in million tons of oil equivalent (TOE); note the slowing down of growth of oil, gas and coal. (b) Renewable Energy Consumption by continent, 1970-2020. Source: http://www.google.co.id/imgres?imgurl=http://www.all-creatures.org/hope/gw/renewable_energy _consumption_by_continent_1970-2020.jpg.

Energy production and use account for two-thirds of the world's greenhouse-gas (GHG) emissions mean that these emissions should be deeply cut, while maintaining the economic growth, boosting energy security and bringing modern energy around the world. The trend in the slowing down of growth of oil, gas and coal, as illustrated in Figure 2a, and the increase of global consumption on renewable energy, as illustrated in Figure 2b, is one of the some encouraging signs.

Environmentally Friendly ("Green") Aircraft Technology

Addressing Aircraft Technology Solutions destined for 2050 time frame, which, among others, incorporate Green Aircraft imperatives, Drela [8] and Greitzer [9] reported development of the conceptual design of two advanced civil aircraft for the 2030-2035 time period, as well as trade studies relating aircraft performance (fuel burn, field length requirement), noise, and emissions for the defined mission to each of the identified advanced technologies, and specific steps needed to advance these technologies.



(a) (b)

Figure 3. (a) Double-bubble (D8 Series) and (b) hybrid wing body (H3 Series) conceptual aircraft [8][9].

(a) (b) (c)

Figure 4. (a) Hybrid wing body concept aircraft [10]. (b) A blended wing body concept by the Royal Aeronautical Society [5]; c. Silent aircraft SAX – 40: (joint MIT/Cambridge University design).

Two aircrafts studied for Aircraft Technology Solutions are illustrated in Figure 3. Two other aircrafts, one developed by the Royal Aeronautical Society and one jointly by MIT and Cambridge University are exhibited in Figure 4 (b) and (c), along with a general concept (a). The capabilities of the two aircrafts illustrated in Figure 8 are given in Tables 1a and 1b, which show the NASA Aircraft Performance metrics, the baseline aircraft, the N+3 goals and the calculated performance. The items in italics in the fourth column are those in which the N+3 goals were met or exceeded. The D8 Series (double-bubble) [8] can be seen to achieve three of the NASA N+3 metrics and nearly achieves the fourth (noise). The H3 (hybrid wing body) meets only one of the goals (emissions), although there are substantial gains towards the other three aggressive targets. The potential of the hybrid wing body configuration has been recognized by NASA and others, but the D8 Series is a new configuration whose design was developed as a direct result of the N+3 Phase 1 program.

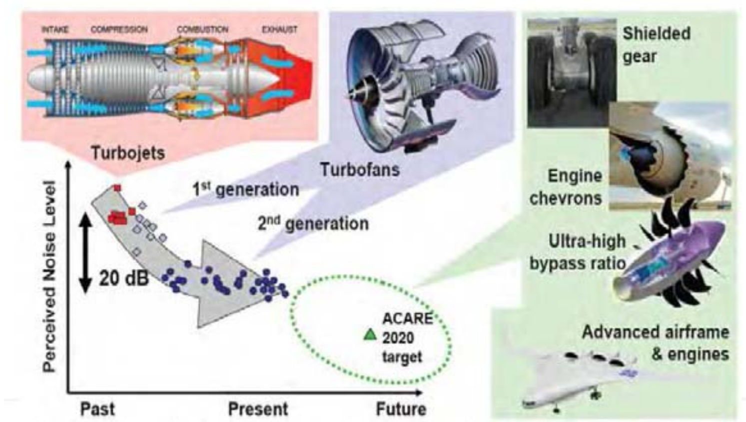


Figure 5. Evolution of noise reduction technologies [6] [7].

The performance levels achieved by the two configurations like the aircraft weight reduction is one of the most powerful means of reducing the fuel burn. Boeing and Airbus, as well as other Business and General Aviation aircraft manufacturers are investing in advanced composites which have the prospects of being lighter and stronger than the present carbon fiber composites (CFC). The replacement of structural aluminium alloy with carbon fiber composite is the most powerful weight reducing option. The Boeing B787 and Airbus A350 have both taken this step, having wings and fuselage made with CFC, and is likely be utilized by most new designs. More efficient turbofans have been produced to achieve greater engine efficiency by employing gas-turbine driven fan for additional thrust. Unducted fan has also been developed for better engine efficiency, as schematically illustrated in Figure 5 [6].

Space Technology Spin-Off: Energy and Environment

Spaced based observation on climate change provide relevant and significant information to avoid a catastrophic impact on ecosystems and creative effort for better prosperity, security and well-being of all humankind to come. The potential consequences extend to virtually all aspects of sustainable development, from food, energy and water security to broader economic and political stability [11].

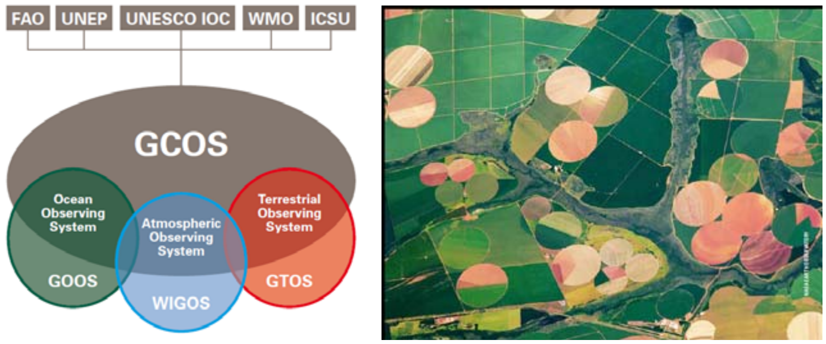


Figure 6. (a) Schematic of United Nations sponsors and the component observing systems, includes the Global Climate Observing System, the Global Ocean Observing System, the Global Terrestrial Observing System and the WMO Integrated Global Observing System. (b) Space observation based image which illustrates the diverse agricultural landscape including areas of centre-pivot irrigation in the western part of Minas Gerais state in Brazil, which is also a large agricultural producer for Brazil [11].

Figure 6(a) exhibits a Schematic of United Nations sponsors and the component observing systems, includes the Global Climate Observing System, the Global Ocean Observing System, the Global Terrestrial Observing System and the WMO Integrated Global Observing System while Fig. 6(b) illustrates Space observation based image of the diverse agricultural landscape including areas of centre-pivot irrigation in the western part of Minas Gerais state in Brazil, which is also a large agricultural producer for Brazil [11].

Concluding Remarks

Associated with Aerospace Technology Vision for Green Energy, various anthropogenic endeavour has been elaborated to emphasize how and the extent aviation or aircraft and aviation technology, as well as space technology, translate that vision to anthropogenic endeavour to improve mankind quality of life. For effective efforts, such endeavour also covers climate change monitoring and mitigation initiatives.

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