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## Prospect of biofuels as an alternative transport fuel in Australia



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## ABSTRACT

The prospect of biofuels as a transport alternative fuel in Australia is reviewed and discussed in this paper. The Australian transport sector is the second largest energy consuming sector which consumes about 24% of total energy consumption. A part of this energy demand can be met by ecofriendly biofuels. A wide array of different biofuels feedstocks including Australian native species, their distributions, oil content, traditional uses are reviewed and listed in the descending order of their oil content. The world biofuel scenario as well as the 20 largest biofuel production countries and their mandates on biofuels blending with petroleum diesel are presented. Australia's biofuel production, consumption, production facilities and future investment projects are also reviewed and discussed. The study developed a biofuel supply chain for Australia and found that the second generation biofuels have better prospects as a future alternative transport fuel in Australia. These biofuel feedstocks are readily available and can overcome the shortcomings of the first generation biofuels, such as socio-economic, environmental and food versus land use challenges. Although some research is in progress, further study is needed on the process development of second generation biofuel production at commercial scale in Australia and abroad.

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## 1. Introduction

Energy is available in different forms such as thermal energy, chemical energy, electrical energy, mechanical energy etc. which

can be transferred from one form to another through energy conversion processes [1]. The energy demand, which is increasing day-by-day, should be met by ecofriendly and cost effective sources of energy because energy, economy and environment (EEE's) are the multidisciplinary concern now-a-days. Energy available in the universe is broadly categorised in two groups, namely renewable energy and non-renewable energy. Renewable

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energies are clean sources of energy that are freely available in nature. About 16% of global energy consumption comes from renewable resources [2–4]. Coal, crude oil, natural gas etc. are the main sources of non-renewable energy which meets more than 80% of the total energy demand worldwide [5–7]. Due to increased demand and consumption, the amounts of non-renewable energies are gradually depleting. This energy is mainly consumed by the transport, industrial and electricity generation sectors [8] which causes serious environmental pollutions [9]. Therefore, the world is moving towards energy sources which are renewable, biodegradable, cost effective, freely available in nature and friendly for environment. According to the United States Energy Information Administration (USEIA), the world's total energy consumption projected to 2040 shows an increasing trend towards renewable energy consumption [10]. This form of energy is clean and produces low emissions [11]. The classification of energy resources is shown in Fig. 1. In that classification, renewable energy can be divided into two groups, firstly clean energy such as, solar, wind, hydroelectric, wave and rain energy and secondly bioenergy such as biomass, and biofuel.

The most effective and efficient form of renewable energy is biofuel. These can serve as a substitute for petroleum-derived gasoline and diesel fuel in the transport sector as reported by USEIA. Biofuel is a liquid fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils, animal fats and other non-edible oil sources and meeting the standard requirements of ASTM D6751 [12–16]. The available types of biofuels are bioethanol [17,18], renewable methanol [19], biodiesel, biogas [20], biobutanol [20] and biohydrogen [21]. They are low emission, non-toxic, safer and environmentally acceptable sources of energy [22]. The biofuels are usually classified as first generation (1G) [23,24], second generation (2G) [23,24], third generation (3G) [23,25–27] and fourth generation (4G) biofuel. Research on biofuel is ongoing worldwide for technological development to use of this eco-fuel in the transport sector. Literatures reported that sustainable energy development strategies typically involve three major technical changes such as energy savings on the demand side [28,29], efficiency improvements in the energy production [30,31] and replacement of fossil fuels by various sources of renewable energy [32,33]. Renewables are the world's fastest growing energy classification of which biofuels are the most rapidly growing

segment [34]. This paper reviews and discusses the prospect of biofuels as an alternative transport fuel in Australia. Logistically, the review follows the path indicated by the arrows in Fig. 1. Initially, Australia's energy scenario by sector and fuel types is introduced to identify the significance and importance of both the transport sector and biofuels. Then, the biofuel sources, availability, production, yield, consumption, generation (such as 1G, 2G, 3G and 4G), scenarios, etc. are presented and discussed. Finally, the study developed a biofuel supply chain showing the nexus between primary resources and end users for Australia which can be applied to any country in the world.

## 2. Australia's energy scenario by sector and fuel types

Australia is the 6th largest developed country having the world's 12th largest economy [35]. The Australian economy is dependent on energy use now and in the future. The world energy statistics shows that Australia is 9th largest energy producer, 17th largest consumer of non-renewable energy resources and ranks 19th on an energy consumption per person basis [2,36]. Australia's is primarily consumed 96% of total energy consumption from coal, oil, gas and related products [37]. Account for the remaining 4% consumption from renewable resources like bioenergy. Australia has one-third world's uranium resources, one-tenth of black coal resources and almost 2% of world conventional gas resources [36]. It has only a small proportion of world crude oil resources. Australia is a member of Commonwealth of Nations, Organization for Economic Co-operation and Development (OECD), United Nations, G20, Australia, New Zealand, United States Security Treaty (ANZUST), World Trade Organization, Asia-Pacific Economic Cooperation and Pacific Islands Forum. Australia is gifted with abundant, high quality and diverse renewable and non-renewable energy resources.

Australia's energy consumption by sectors is presented in Fig. 2 which shows that the highest energy consuming sector is electricity generation (36%), followed by the transport sector (24%). According to Bureau of Resources and Energy Economics (BREE) estimation, energy consumption in the transport sector has increased by an average of 2.4% per year during 2000–2001 to 2011–2012 [38]. This sector consumes mostly petroleum fuels and

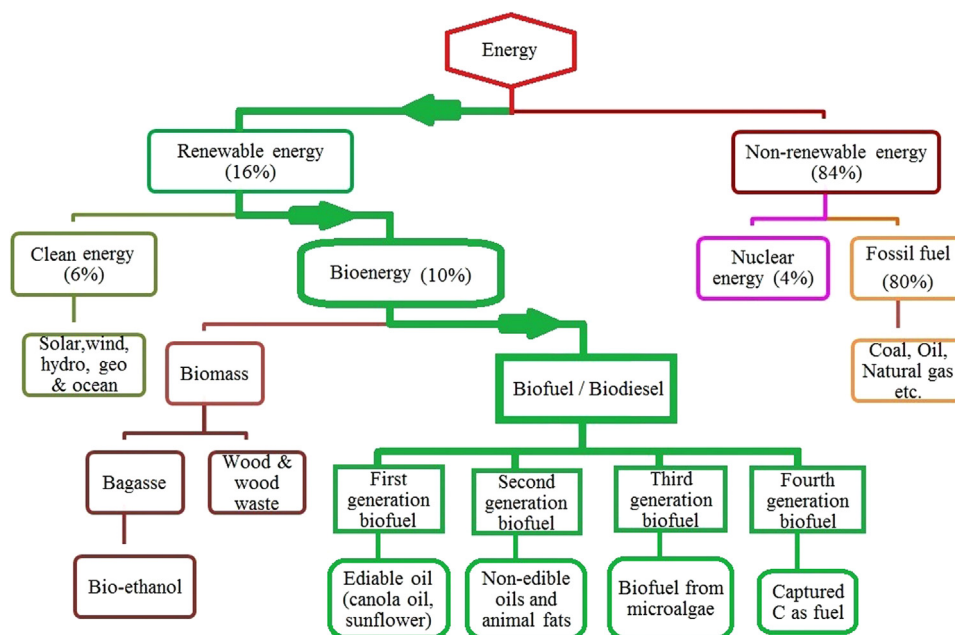


Fig. 1. Classification of energy by source types and its contribution to global energy consumption.

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