ShARE
GROWING
CHANGE
MAKERS

November 2022

How Can Biomass Utilization Impact Movement Towards a Cleaner and More Sustainable Mobility?

Consulting Presentation

Shulha
Junior member
Institut Teknologi Bandung
L.U. Mobility

Executive Summary

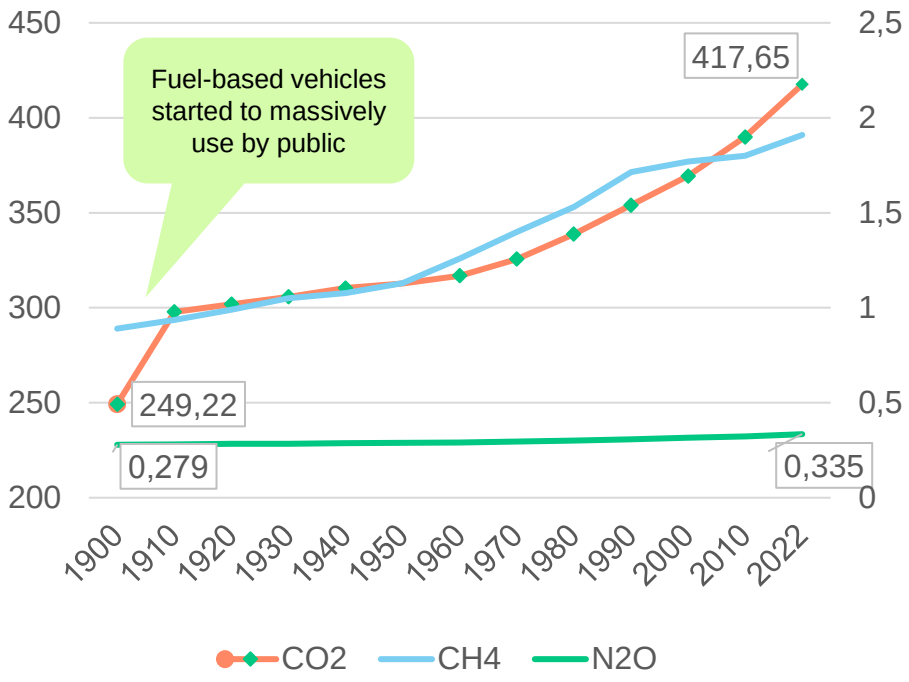
- **Background**
  - The transportation sector is one of the largest GHG emitters
  - Biomass produces less carbon emission than the burning of fossil-derived, an alternative to reduce GHG emissions from the mobility sector
- **Production of Biomass-based fuel**
  - There are 3 types of biofuel based on the feedstock used to generate it: food-crop feedstock, non-food feedstock, and algae.
  - The generation of biofuel considered many things into account: the input (cost, feedstock, etc.), process, and output (desired and undesired)
  - Among many types of feedstock and methods to generate biofuel, many of them are calculated as 'efficient'
- **Current Usage of Biomass-based Fuel**
  - Many countries have set regulation/policy/mandate to optimize biofuel use
  - Global biofuel demand has constantly been increasing during the past decade. Countries should increase the demand for biofuel more to meet the Net Zero Emission Scenario
  - Different types of vehicles need different types of biofuel, such as bioethanol, biodiesel, and SAF
- **Optimization of Biomass-based Fuel Production and Utilization**
  - Consider the best feedstock and method to generate biofuel, those which generate the least emission
  - Biofuel utilization should be implemented globally. Countries could help each other in this global issue
  - Sustainable Air Fuel (SAF) could have a competitive price in the future with optimization of production and usage
  - All levels of society altogether could help optimization of biofuel usage

Over decades, the emission of greenhouse gases has been rising, with mobility sector being one of the major contributors

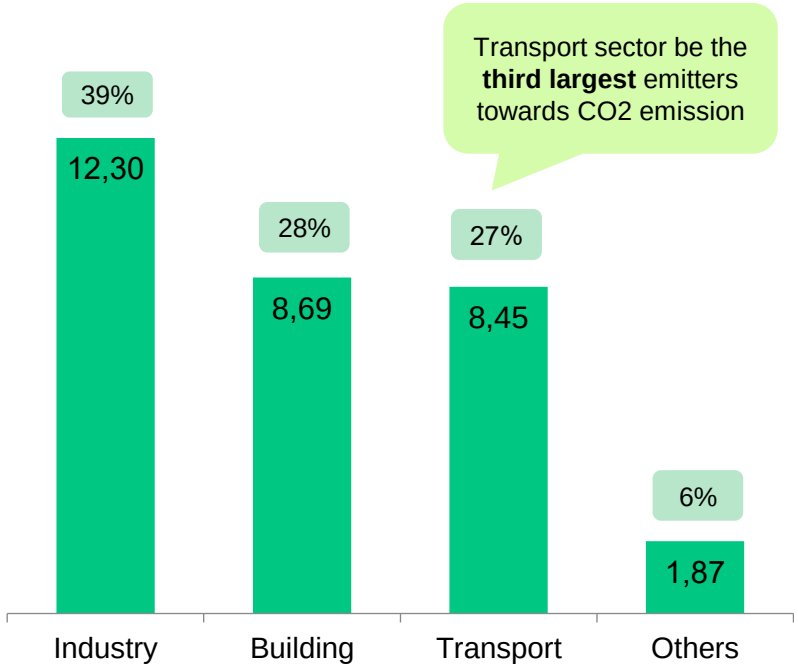
Green house gases emission is rapidly increasing over years…

…with transportation sector being one of the biggest contributors towards the emission.

Green House Gases Emission 1990 to 2022
in parts per million (ppm)



CO_2 Emission From Fuel by Sectors
(in BtCo2e unit)

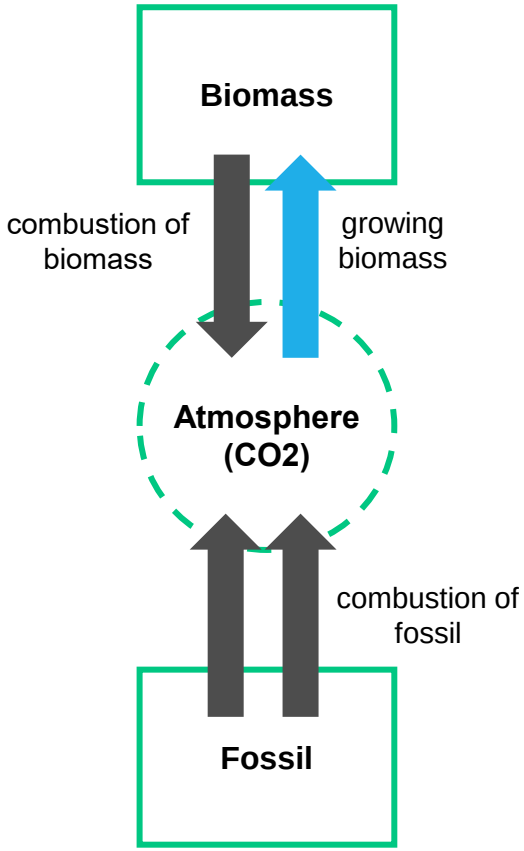


CAGR of CO_2 in 1900-1910 reaching **2%,** it is the **era** when **fuel-based vehicles** started to massively use by public

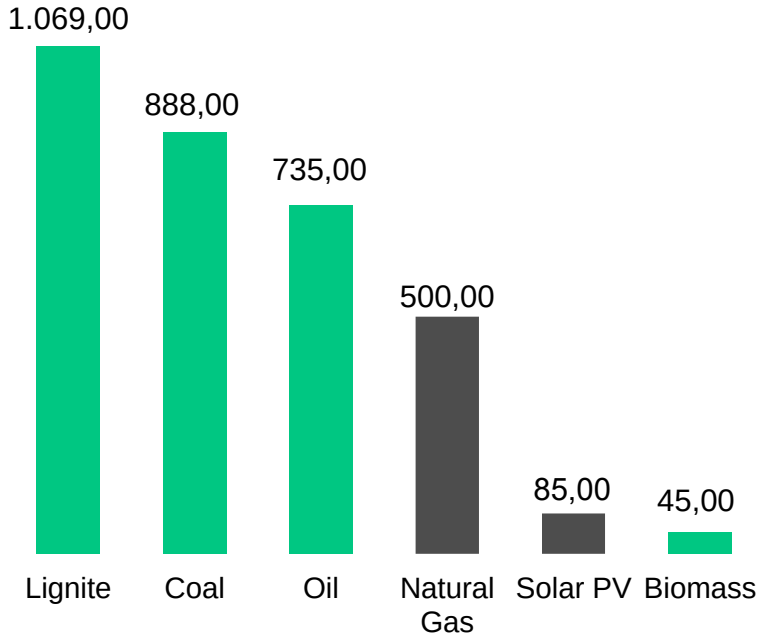
Source: National Oceanic and Atmospheric Administration (NOAA), International Energy Agency (IEA)

The burning of fossil-based sources causes more than 20 times lifecycle greenhouse gases emission compared to biomass

Lifecycle of CO2 Overview



Lifecycle Greenhouse Gases Intensity of Electricity Generation Method (Tonnes CO_2e/GWh)



Comments

Although the burning of biomass causes GHG emissions, **plants** that are used to make biofuels **absorb CO2** as they grow and **may offset the CO2 emissions** when biofuels are produced and burned.

Key Takeaway

Biomass considered to be a cleaner energy source in the long run.

Source: World Nuclear Agency (WNA)

Biofuels are divided into few categories according to their origin and its production takes several factors into account

Biofuels today divided into few types based on generation

First-Generation Biofuels

produced from dedicated cultivation of bioenergy crops (i.e. **food-crop feedstock)**. Mainly made from **sugar**, **starch** and **vegetable oil**.

Second-Generation Biofuels

bio-based products that come from **non-food** feedstock. Include **lignocellulosic feedstocks** (such as agricultural and forestry feedstock) to **municipal solid wastes.**

Third-Generation Biofuels

biofuels produced from **aquatic** cultivated **feedstock** (i.e. **algae**)

The making of biofuels considered many things into account

Input

Cost	Land	Materials	Energy	Water

Process

Farming	Transport	Conversion	Combustion

Output

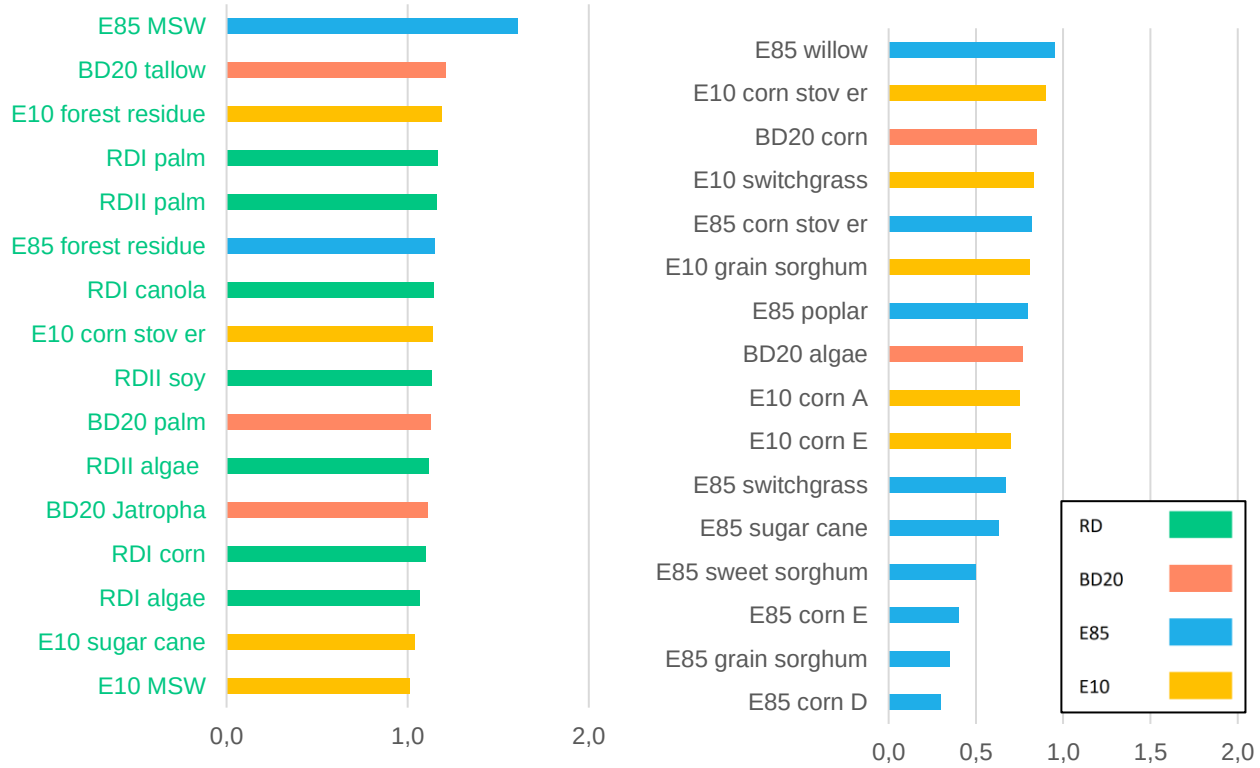
Greenhouse Gases	Ecotoxicity	Eutrophication	**Distance** km.passenger

undesired — **desired**

Source: R. Cabrera-Jim´enez et al. (2022)

About 48% of 72 biofuels types are calculated “efficient”, providing a wide range of biofuels choice

Efficiency of Several Biofuels Type and Generation*



Comments

- The **highest efficiency** score, achieved by the blend using 85% of ethanol from **municipal waste**
- About **48%** of the biofuels routes analyzed are **efficient**, meaning that there is no other biofuel showing superior performance in all the sustainability indicators simultaneously.

* Several efficient biofuel types labeled green (more than 1.0 nominal efficiency score), account all sustainability factor including costs, materials, GHG output and more.

1. RD: Renewable Diesel
2. BD20: Diesel fuel with up to 20 %v/v FAME content
3. E85: Gasoline fuel with up to 85 %v/v bioethanol content
4. E10: Gasoline fuel with up to 10 %v/v bioethanol content
5. By research on 72 types of biofuels (not all shown)

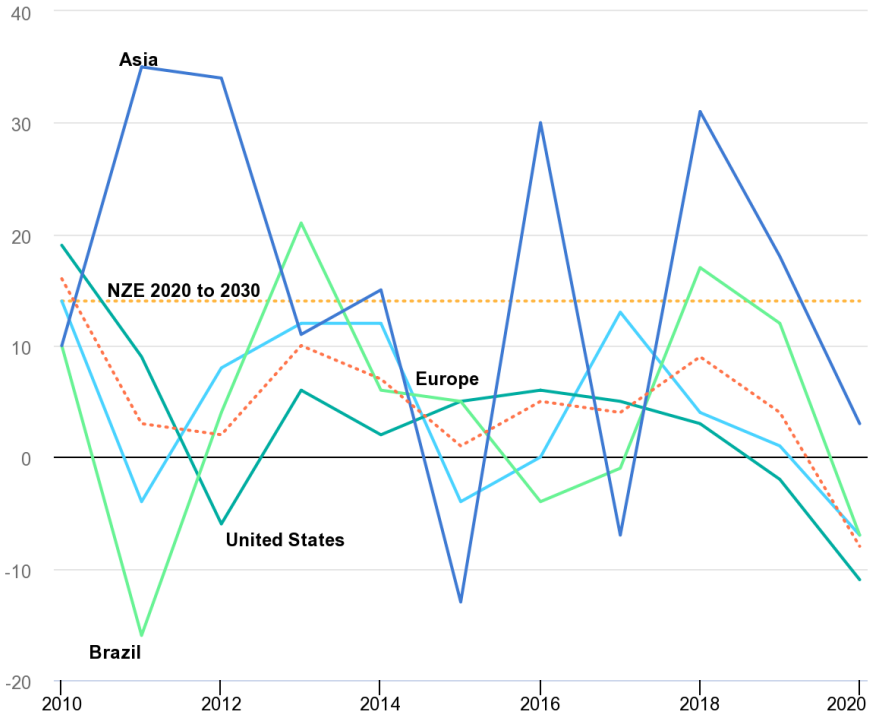
Key Takeaway

There are many range of biofuels type that could be promoted, according to regional context (land availability, farmer preferences, etc.)

Source: R. Cabrera-Jim´enez et al. (2022)

Global biofuel demand shown 5% CAGR from 2010 to 2019, countries in the world have shown seriousness in developing and increasing the utilization of biofuel in transportation sector

Annual Biofuel Demand growth, 2010-2020 vs. Net Zero Scenario



Global biofuel demand grew **5% per year** on average between **2010 and 2019**. However, Net Zero Emissions by 2050 Scenario **requires** average growth of **14% per year to 2030.**

Many countries in the world has set regulation to utilize biomass based fuels

Europe

Fit for 55 targets by 2030:

- **13% decline in GHG** intensity of transport fuels
- **28%** share of **renewables** in transport **fuels** by 2030 (estimation)

North America

US:

- Renewable Fuel Standards (expected 2023)
- Sustainable Aviation Fuel Challenge targeting **11 billion litres of sustainable aviation fuel** by 2030.

Canada's Clean Fuel Standard targets by 2030:

- Reduce the GHG intensity of transport fuels to 13% below the 2016 level.
- **Double biofuel demand** in the country (estimation).

Asia

India's 20% ethanol blending mandate proposes to more than double its ethanol production capacity.

China's 14th Five Year Plan plans to peak GHG emissions before 2030.

Source: International Energy Agency (IEA)

Biofuel has been used in various types of vehicles, depends on the vehicle engine type

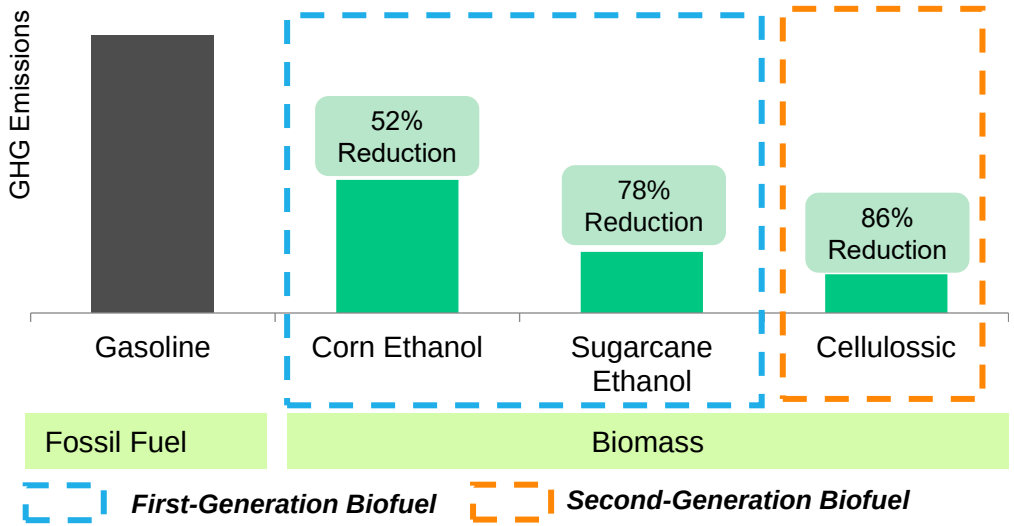
Vehicle	Fuels Used	Insights
Light-duty Vehicle (Sedan, SUV, Van)	• E10 • E85	• **Almost all** (95%) petrol-powered vehicles on the road today **can use E10**. • **E85 can be used in flex fuel vehicles (FFVs)** which have a fuel delivery system and engine that are designed to use it. • E85 generates more torque and horsepower than gasoline, burns cleaner, and has cheaper price per gallon (in the US)
Heavy-duty Vehicle (Bus, Truck, Tractor)	• BD20 • RD/B100	• B20 and lower-level blends can be used in many diesel vehicles without any engine modification. • **Biodiesel raises** the **cetane number** of the fuel and improves fuel lubricity. • Life cycle analysis completed by Argonne National Laboratory found that **emissions for 100% biodiesel (B100) are 74% lower than those from petroleum diesel**. • B100 and other high-level biodiesel blends are less commonly used directly as a transportation fuel than B20 and lower blends due to a lack of regulatory incentives and pricing. • Pure biodiesel contains less energy on a volumetric basis than petroleum diesel. • B100 requires special handling and may require equipment modifications.
Aviation	**SAF** (Sustainable Aviation Fuel)	• Advanced liquid biofuels are the only low-CO2 option for substituting kerosene, since a high specific energy content is required. • Globally, a number of airlines have **signed biofuel offtake agreements** • More than 250,000 commercial flights have flown on SAF blends • Currently, **5 to 50% blend of biofuel in SAF** are approved by the standard (ASTM-certified) • High production cost be one of the greatest barrier to promote massive use of SAF

Source: US Department of Energy, ETIP

To ensure a much cleaner and more sustainable mobility, good types of biofuel should be used

Despite cleaner than fossil-based fuel, **some types** of biofuel **still emitting a considerable amount of GHG**

GHG Emission of Fuels Vary By Feedstock and Type Energy Used



Challenges in generating first-generation biofuel

Land Use

Land use issues leads to the loss of ecosystems preservation and the homes of indigenous people.

Food Security

Massive use of food crops has the potential to alter the world's access to affordable food.

More GHG*

Despite being cleaner than fossil fuel, first-gen biofuel emits more GHG than several second-gen biofuel

Recommendation

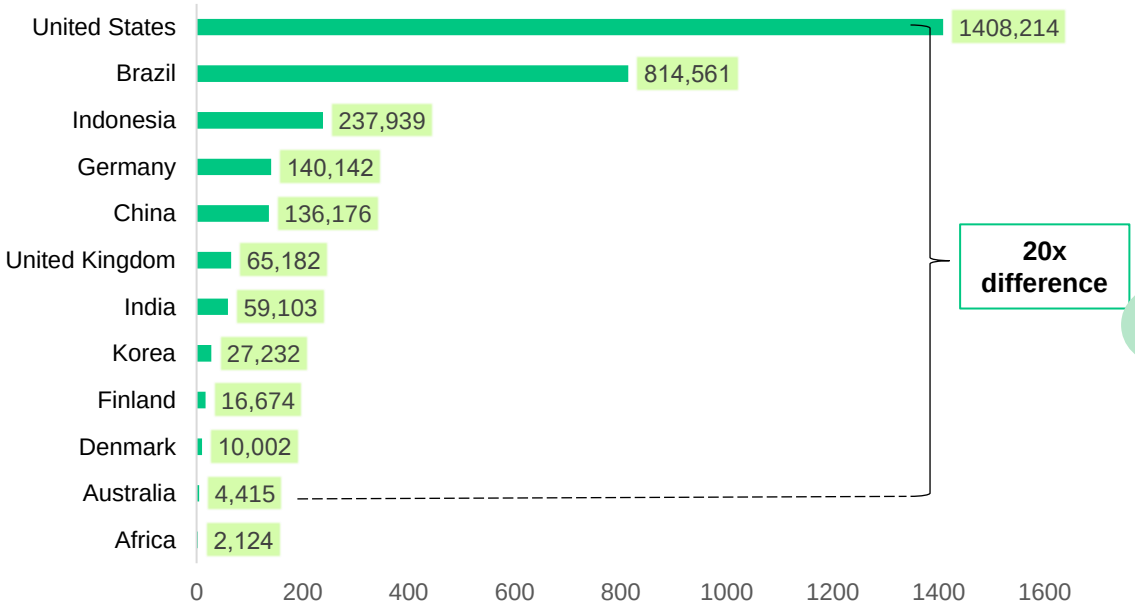
Choose the **best type of feedstock** to generate biofuel. Consider **second-generation biofuel**, especially which **do not consume** much **land** and **affordable** in cost, like municipal solid waste (**MSW**).

Source: US Department of Energy, EUBIA

To ensure a much cleaner and more sustainable mobility, utilization of biomass should be implemented globally

Several countries have massively **utilize biomass** in transport sector, while **many others lack behind**

Renewable Energy Transport Balance
in PetaJoules (PJ)



Comments

- Despite having a **huge land**, usage of renewable energy for transportation is still **very low in Australia**
- While most countries in **Africa is underdeveloped**, its utilization of renewable energy for transportation is still **low**

Source: IEA

Recommendations

Strong targeted regulation

- All countries must contribute to reach the Net Zero Goal by **making a strong targeted regulation.**
- It could be in the form of **policy**, **law, mandates,** or others.
- The target could be adjusted according to **local availability of feedstock** and **capability** to generate biofuel

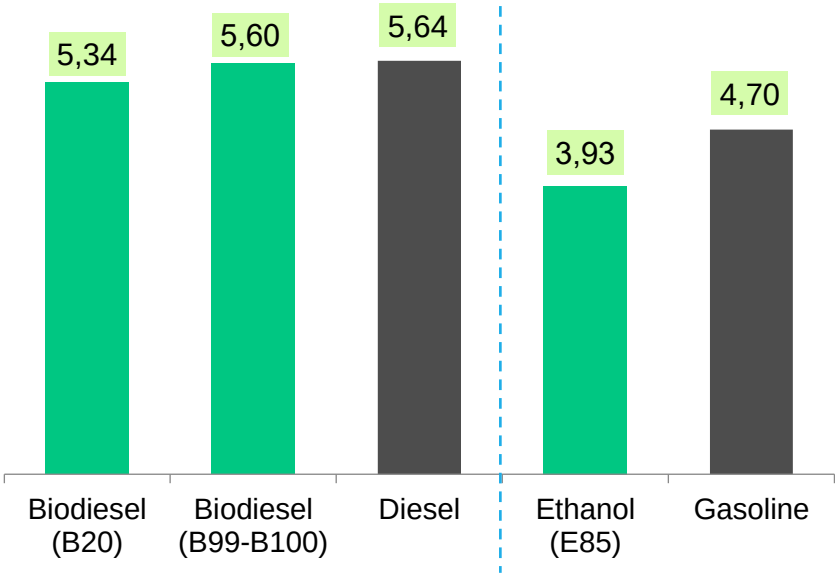
Support each other

Developed country should also **support developing and underdeveloped country** in the form of **fundings, equipment, and technologies.**

Road vehicle biofuels have competitive price, while air biofuel price could be much cheaper in the future, showing an economically sustainable mobility

As the price of fossil-based fuel increasing, road vehicle fuel generated from **biomass offer a competitive price**

US National Average Price
Between July 1 and July 15, 2022
(USD/Gallon)



Key Takeaways

- There should be no hesitation to shift to biofuel, since price is no more be the issue
- US huge production of biofuel resulting a competitive price, it should be followed by another countries

Cost of Sustainable Air Fuel

IATA estimates the **cost of SAF** is between **two and four times higher than fossil fuels**

Annual Escalation Factor

of Conventional Jet Fuel	for CO2 Compliance Cost
1%	3.5%

Forecast

Average Efficiency Factor For SAF **2.25%** in **2037**

SAF PRICE = JET FUEL + CO^2 EMISSION COST

Recommendation

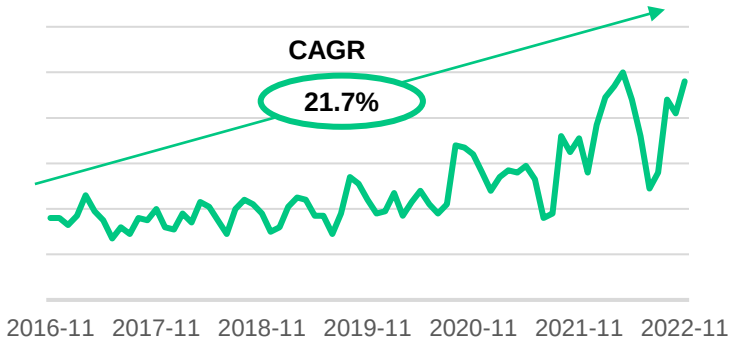
SAF Surcharges
Raising flight ticket price to counter the increased cost due to utilization of SAF

Government Incentives
Investment in production could increase supply and drive down cost

Source: US Department of Energy, IATA, OAG,

To achieve cleaner and more sustainable mobility, all level of society (government, private sector, regular citizens) should work hand-in-hand in optimizing the utilization of biofuel

Environment Issue Interest
(based on the number of searches about environmental issue)



Year to year, **people are more aware towards environmental issue**, this is an **opportunity** to help maximize the utilization of biofuel

Recommendations
to optimize utilization of biofuel

Promotion of Biofuel and Its Impact

Government, private sectors, NGO, influencers, and regular citizens could promote utilization of biofuel in many ways

Biofuel Price Subsidy

Government could implement a price subsidy for biofuel, so citizens will shift from fossil fuel

Biofuel-Providing Gas Station

Biofuel should be widely and easily accessible. They could use existing gas station, despite building a new one

Production and Advertisement of FFVs

FFVs should be available worldwide with a competitive price. While advertising FFVs, company could also promoting biofuel

Source: Google Trend