Climate change mitigation through carbon dioxide conversion to biofuels for replacement of fossil fuel

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Further Reading:

- Ireland's Greenhouse Gas Emissions Projections (2018-2040)
- Ireland's Greenhouse Gas and Air Pollutant Emissions Inventories 1990-2016 Presentation
- Greenhouse Gas Emission Projections 2017-2035 Presentation
- SEAI Energy Projections 2017-2030 Presentation
- EPA 2018 GHG Emissions Projections Summary Report
- EPA Research Report-National Preparedness to Adapt to Climate Change: Analysis of State of Play (2016-CCRP-FS.30)
- Industrial Emissions Directive 2010/75/EU

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BACKGROUND

The ever-increasing emissions worldwide of the greenhouse gas carbon dioxide (CO_2) cause global warming and climate change. Ireland's target for the year 2020 is to achieve a 20% reduction in emissions of the non-Emissions Trading Scheme (non-ETS) sector from the 2005 levels, with annual binding limits set for each year over the period 2013-2020. However, the latest projections indicate that Ireland will exceed the carbon budget over the period 2021-2030 by 52-67 Mt CO_2 (Figure 1).

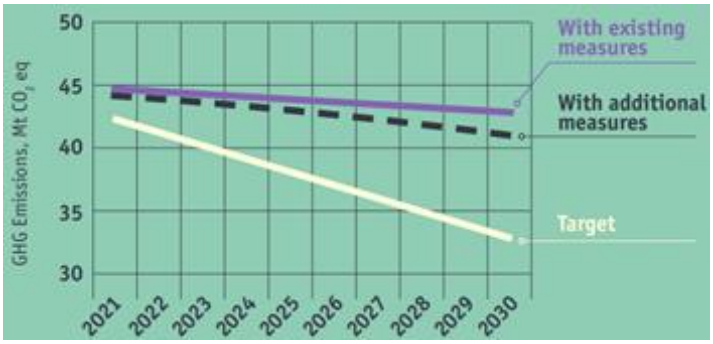


Fig.1 Greenhouse gas emissions target and predicted trends from 2012 to 2030 (Source: https://www.epa.ie)

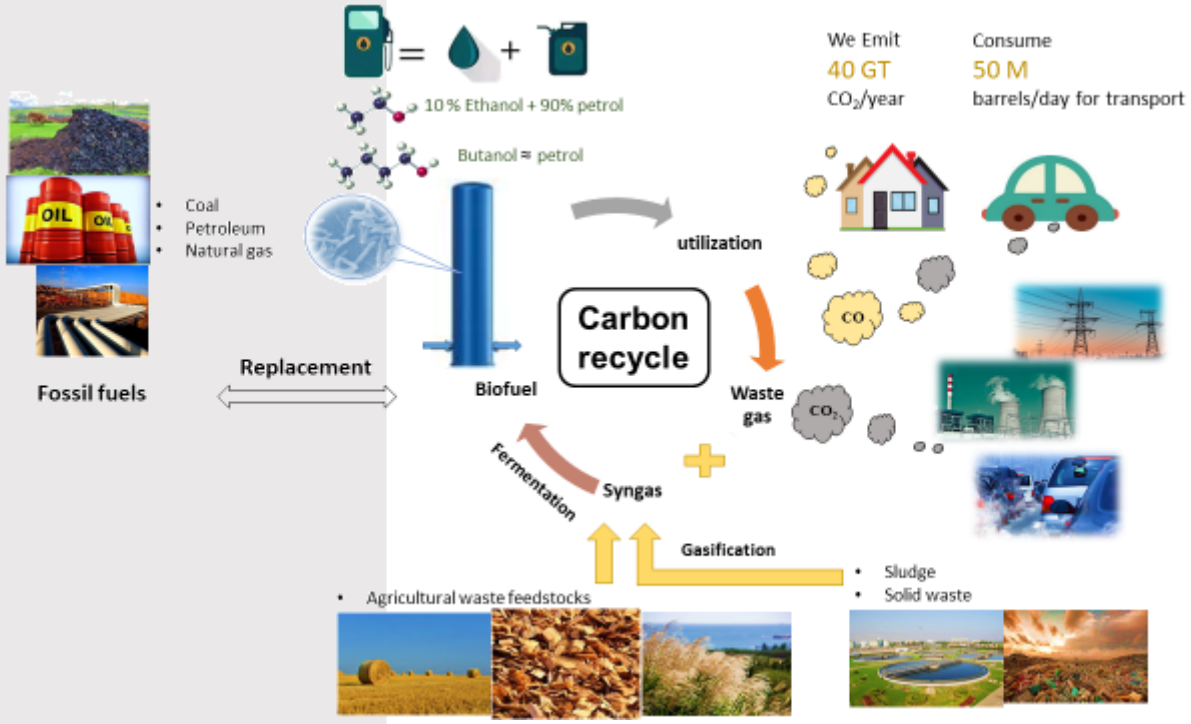
CARBON DIOXIDE CONVERSION TO BIOFUELS

It is imperative to adopt a sustainable way to achieve the reduced carbon emission goal. The increasing demand for fuels and rapidly depleting fossil fuel reserves necessitate the development of new technologies for alternative fuel production, such as biofuels. Biofuels such as ethanol, butanol and hydrogen can be produced from carbon dioxide using microorganisms, either directly or indirectly, thereby simultaneous mitigating climate change and generating valuable bioenergy products.

A huge amount of organic solid wastes is generated annually from agricultural farms in Ireland with an estimated abatement potential of more than 18 Mt CO_2eq emission between 2021 and 2030. A significant portion of biomass sources like straw and wood is poorly degradable, thus making it difficult for conversion to biofuels by microorganisms. Gasification of such recalcitrant biomass and other solid wastes like sludge from wastewater treatment plant produces a mixture of gases, including CO, CO_2 and H_2, referred to as syngas. This syngas could offer a solution to reduce carbon emission, as some microorganisms can convert it to biofuels and other valuable products.

CARBON RECYCLE AND SUSTAINABLE BIOFUEL PRODUCTION FOR THE FUTURE

Carbon dioxide and carbon monoxide can be effectively converted to biofuels using microorganisms, particularly by using bacteria belonging to *Clostridium* species that are widely found in sludge as well as animal and poultry manures. This is being applied at industrial trials demonstrating conversion of flue gas containing a mixture of carbon dioxide, carbon monoxide and hydrogen from a steel mill to ethanol. Biofuels produced from carbon dioxide and carbon monoxide will undoubtedly become a contributing factor in future solutions for relieving the Irish greenhouse gas emission and energy shortages in the future as shown in the scheme below.



Scheme: *Carbon recycle from waste gas for climate change mitigation biofuel production*

Images used for the scheme are based on fair usage policy. Reference links for each image can be found below:

- https://www.epa.ie/
- https://www.epa.ie/pubs/reports/air/airemissions/ghgprojections2018-2040/EPA_greenhouse_gas_emissions_Infographic.pdf *
- https://www.epa.ie/pubs/reports/air/airemissions/ghgprojections2018-2040/Greenhouse_Gas_Projections.pdf
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- https://www.extension.iastate.edu/agdm/articles/others/TakApr08.html

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