



Green House Gas Emissions and Climate Change: Options to Mitigate Climate Change

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ABSTRACT

Increasing levels of greenhouse gas emissions are cause of global concern. The Kyoto Protocol shares the ultimate objective of the Convention to stabilize atmospheric concentrations of Green House Gases at a level that will prevent dangerous interference with the climate system. . Current biomass use, although not sustainable in some cases, replaces fossil fuel consumption and results in avoided CO₂ emissions, representing about 2.7 to 8.8 % of 1998 anthropogenic CO₂ emissions. The global biomass energy potential is large, estimated at about 104 EJ/a. hence, biomass has the potential to avoid significant fossil fuel consumption, potentially between 17 and 36 % of the current level and CO₂ emissions potentially between 12 and 44 % of the 1998 level. There is significant scope then to integrate biomass energy with agriculture, forestry and climate change policies. Improved agronomic practices of well managed biomass plantations will also provide a basis for environmental improvement by helping to stabilize certain soils, avoiding desertification which is already occurring rapidly in tropical countries.

Keywords: Kyoto protocol, greenhouse emissions, fossil fuel, plantations, biofuels. Climate change.

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Received 04 January 2015, Accepted 13 January 2015

INTRODUCTION

Increased unregulated emission of exhaust gases from automobile has taken us towards global warming. Fossil fuels, smog, carbon monoxide, particulates, free radicals and toxic chlorofuloro carbons have contributed to the greenhouse gas emissions (GHE) and resultant climate change. Biofuels offer the potential of both decreased greenhouse gas (GHG) emissions and energy security. Familiarity with the principles of measuring GHG emissions will allow plant scientists to contribute actively to this growing practice. Recently Kumar¹ and Kazamia and Smith² reviewed, the quantifiable aspects of the environmental sustainability of biofuels, focusing on GHG emissions. Fuels produced from harvested biomass (biofuels) can be either solid, gas, or liquid^{3,4}. Biosolids, such as woodpellets or forestry waste, and biogas, produced by anaerobic digestion of biomass, are used primarily for electricity generation and heating, whereas liquid biofuels provide drop-in fuels that can be used directly in the transport sector, without a change in infrastructure. In theory, it is possible to convert any biomass feedstock into a liquid or gas fuel using appropriate chemical engineering techniques, but the efficiency of conversion, cost, and scale of demand/ supply have led to preferred practices.

Climate Change Is a Global Problem

Kyoto Protocol

“The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. It provides framework to stabilize emissions and future reductions of greenhouse gases to check global warming¹³ (Source: http://unfccc.int/resource/docs/publications/08_unfccc_kp_ref_manual.pdf). Kyoto protocol was adopted in Kyoto, Japan, in December 1997 and entered into force on 16 February 2005. Its first commitment period started in 2008 and ended in 2012.

Targets for the first commitment period

The targets for the first commitment period of the Kyoto Protocol cover emissions of the six main greenhouse gases, namely:

Carbon dioxide (CO₂); Methane (CH₄); Nitrous oxide (N₂O); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulphur hexafluoride (SF₆).

During the first commitment period, 37 industrialized countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18

percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first².

In Doha, Qatar, on 8 December 2012, the “Doha Amendments to the Kyoto Protocol”:

- New commitments for Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

In Durban, the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) was established to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention, applicable to all Parties. The ADP is to complete its work as early as possible, but no later than 2015, in order to adopt this protocol, legal instrument or agreed outcome with legal force at the twenty-first session of the Conference of the Parties and for it to come into effect and be implemented from 2020.

Biomass

Biofuels offer one of the best alternative options as they have much lower life cycle GHG emissions compared to fossil fuels. These are liquid fuels derived from renewable biological sources^{3,5}. Biomass can be defined as the collection of all organic matter composing biological organisms, but the main components utilized for biofuel production are sugars (starch, simple sugars, and lignocelluloses) and lipids^{3,6}. One of the directives of European Union (2009/28/CE)⁷ imposes a quota of 10 % for biofuels on all traffic fuel until 2020⁸. The most common renewable fuel is ethanol, which is produced from direct fermentation of sugars (e.g. from sucrose of sugar cane or sugar beet) or poly saccharides e.g. starch from corn and wheat grains⁹. Recent biotechnical advances made it possible to utilize Biomass as a source for fuel molecules which can be divided into two phases: carbon chain elongation and functional modification. In addition to natural fatty acid and isoprenoid chain elongation pathways, keto acid-based chain elongation followed by decarboxylation and reduction has been explored for higher alcohol production¹⁰.

Biofuels

First generation biofuel:

It included sugar cane, starch seeds, oil seeds and salt and drought resistant hydrocarbon yielding plants for growing in wastelands. Second and third generation biofuels: It included

lignocellulosic biomass agricultural waste and conversation technologies and altering host material and /or developing new enzyme systems¹¹. Second-generation biofuel production from lignocellulosic feedstocks (e.g., waste biomass and municipal solid waste) has been suggested to satisfy future EEC requirement for biofuels⁷. Currently, cellulosic biofuels and algal biodiesels are prominent biological approaches to sequester and convert CO₂. Nowadays, there is little commercial production of ethanol and ethanol derivatives from cellulosic biomass, but R&D is ongoing not only in Canada and USA, but also in Europe. Presently in addition to current 200 biorefineries operating in the USA in 2009, over the last year at least 28 advanced biofuel companies have started or planned cellulosic ethanol plants¹².

Metabolic engineering for entire product

Industrial application of biofuel inclusive of related bio products of commercial value from fourth generation products.

Use of genetically engineered *Synechococcus elongatus* Global PCC7942 to produce isobutyraldehyde and isobutanol directly from CO₂¹⁰.

Next generation bio-fuels

Next generation bio-fuels shall involve technical components (1) Biological sciences: Plant biotechnology, Cellular and molecular biology, microbial /industrial biotechnology. (2) Chemical technology sciences: catalysis, reaction engineering and separations.

- Hydrogen or lipid production by cyanobacteria or algae.

Biomass contributes a significant share of global primary energy consumption and its importance is likely to increase in future world energy scenarios. Modern biomass energy use can contribute to controlling CO₂ emissions to the atmosphere while fostering local and regional development. Further the advantages from utilization of biomass include: liquid fuels produced from biomass contain no sulfur, thus avoiding SO₂ emissions and also reducing emission of NO_x. The production of compost as a soil conditioner avoids deterioration of soil.

Land Use, Land-Use Change and Forestry

Human-induced, afforestation, reforestation and deforestation activities and forest land management, cropland management, grazing land management and/or revegetation have great positive and negative impacts on the greenhouse gas emissions. Kyoto protocols has set rules for these activities.

The clean development mechanism (cdm)

The CDM is also a project-based mechanism. CDM credits may be generated from emission reduction projects or from afforestation and reforestation projects in different countries. CDM

projects must meet detailed requirements and follow exact procedures and steps for the validation and registration of projects and the verification and certification of emission reductions and removals. These steps, largely carried out by designated operational entities (DOEs), ensure that reductions or removals associated with projects are additional to what would otherwise occur in the absence of the projects. Additional rules apply to afforestation and reforestation projects. CDM projects result in three types of Kyoto units. Certified emission reductions (CERs) are issued for projects that reduce emissions, while temporary CERs (tCERs) and long-term CERs (lCERs) may be issued for projects that enhance removals through afforestation and reforestation projects². However, from an environmental perspective, comparing biofuels based on the feedstock from which they originated is not sufficient to infer a sustainability benefit. Instead, a Quantitative assessment, known as environmental life cycle assessment (LCA) can be used.

CONCLUSION

Life cycle assessment provides quantitative assessment on the net impact of measures taken to regulate green house gases control. A benchmark of 35% GHG emission savings compared with fossil fuels, estimated through a standard LCA, has been set, which will increase to a minimum of 50% savings on 1 January 2017¹³

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