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# Future biodiesel policy designs and consumption patterns in Latvia: a system dynamics model

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ABSTRACT

Decarbonisation of transport has become central to European Union policy. Biofuels are expected to represent a substantial part of the overall strategy towards diversifying Europe's energy supplies and curbing greenhouse gas emissions in a cost-effective way.

This research deals with the dynamic simulation modeling of a biodiesel market as a part of transportation fuel market and analyses of various policy support instruments on increasing the proportion of biofuel in total transport fuel demand. The study is carried out for Latvia's road transport sector. After it had experienced generous financial support from the government allowing the industry to develop, support was abruptly stopped creating stagnation in both biodiesel supply and demand. This threatened the national transport policy goals. The goal of this research is to find the most effective policy strategies for achieving the national transport policy goals by applying system dynamics modeling to the current market conditions of transport fuels. . Specifically, the primary focus of this paper is an attempt to gain insight into the long-term dynamic behavior of the biodiesel market in Latvia. The principal policy tools and mechanisms implemented can be summarized as: i) state subsidies at different levels and stages (i.e. the biodiesel production sector, the agricultural sector, and the end consumer sectors), ii) increasing the excise taxes on fossil fuels, iii) increasing the share of the biodiesel in the transportation fuel blend. The results obtained from model simulations confirm that promoting biofuel acceptance among end-users is the primary key issue.



## 1. Introduction

First generation biofuels are a widely discussed topic in the European Union. On the one hand, biofuel policies to date have been driven by concerns about climate change, energy security and rural development (Linares and Perez-Arriaga, 2013). In the short term, biofuels are considered to be the only renewable resource that can address the transportation sector's heavy dependence on foreign oil without replacing the vehicle fleet (DOE/EE, 2013). On the other hand, there is the question of the sustainability of the first generation biofuels. The Directive 2009/28/EC on renewable energy specifies a minimum 35% reduction in greenhouse gas (GHG) emissions to be achieved by biofuels during their life cycle, a target that is meant to increase to at least 50% beginning 2017. Taking into account the increasing concerns of food vs fuel and land availability issues, as well as the environmental impact and indirect effects associated with the development of biofuels, the EU proposed in 2013 limiting first generation biofuels to 6% of the final energy consumption in transport by 2020 (Mahony, 2013). It means that despite the increasing concerns of sustainability, first generation biofuels will maintain their leading role in the EU's way towards 10% renewable energy consumption in the transport sector.

In fact, if on the one hand, biofuel production routes are supposed to have a primary role among the renewable energy alternatives, it must be kept in mind that their sustainability is still open to question by scientists (Blengini et al., 2011). This view is mostly related to the use of food crops as feedstock and, involves as well competition among the different end-users for both raw materials and land. Potential shortages of fossil fuel for use in transportation are an increasing national security concern. This provides an important impetus to improving the management of bio-based fuels as well as a need to strengthen the rural sector (Buonocore et al., 2012).

Within the overall transport sector, that account for a 30% of the total consumed energy, biofuels can represent a promising option

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for decreasing dependency on oil imports (Markevicius et al., 2010). In this context, EU energy policies aiming to boost biofuel production have been strengthened with different policy tools such as regulations and public incentive schemes (Blengini et al., 2011). Moreover it has been found that biofuel production schemes must be re-directed from their multi-disciplinary and interconnected perspectives among different economic sectors, and the industrial processes placed at different economical scales (i.e. micro-economic and macro-economic) which are mutually connected and subject to human decisions and control (Blengini et al., 2011). This issue has raised a great deal of interest from people concerned about environmental, economic and social issues, i.e. scientific, governmental, non-governmental, international vs local (Mangoyana et al., 2013).

From the literature, one discerns that the sustainability of biofuels is mainly associated with: 1) their carbon neutrality (i.e. the $CO_2$ amount emitted during the combustion phase is balanced by the carbon subtracted while the biomass was growing), 2) avoiding the production of hazardous wastes, 3) the use of local resources avoiding long distance transportation of the feedstock (Lora et al., 2011).

From a technical and economic perspective, liquid biofuels in the short term can represent an opportunity for reducing transportation sector fossil fuels dependency (Buonocore et al., 2012). Even though in connection to this perceived advantage, biofuel sensitive problems come up as, for example: the sustainable use of feedstock, the increase of food prices mostly in connection with the use of first generation biofuels (Buonocore et al., 2012) and the increase in negative effects in connection with climate change (i.e. decrease in biodiversity, deforestation, increasing use of fertilizers, increasing use of water theoretically allocated for human purposes).

Moreover, from an economics point of view the potential decrease in subsidies for biofuels production in the long run, together with other constraints could negatively affect the industrial competitiveness of the biofuels sector (Buonocore et al., 2012).

Looking again from a long-term perspective, biofuels can turn into global commodities. Even though this is a partial solution for transportation, in fact, in the near future biofuels themselves would expand their scale of transportation to a more global level with potential negative impacts at a regional scale (Buonocore et al., 2012).

Within this context the production capacity of the biofuel industry in the European Union has experienced an exponential growth over the past decade. It has increased more than tenfold from 1.9 million tons in 2002 up to 16.4 million tons in 2010 (followed by a 16% decrease in 2011) (Eurostat, 2013). From Nanaki and Koroneos (2012), it is generally perceived that the biofuels industry in Europe will lead to a constant increase in the blending share within the whole structure, and that consequently this will become a crucial factor for decision-makers in the transport sector. Finding effective and feasible policies for promoting biofuels has become an important issue for national governments.

The transition from current oil-based transport to alternate fuel sources involves a great challenge due to the social dilemma it reflects. Khachatryan et al. (2013) discuss the biofuels vs. gasoline question within a three-dimensional social dilemma framework recognizing a social conflict (individual vs. collective interests), a temporal conflict (immediate vs. future interests) and a biospheric conflict (human vs. biospheric interests). Opting for biofuels instead of fossil fuels is essentially a public good game (Turrentine and Sperling, 1992), where the goal is to avoid tragic natural and cultural consequences. As an environmental decision it requires that we abandon some personal luxuries for the greater good (Chen et al., 2012). However, because of biofuels' limited availability and potential price premium, consumers are deterred from adopting them (Khachatryan et al., 2013). As the tragedy is more likely to emerge in a situation where restraining access to the resource is costly, impractical or impossible (Feeny et al., 1990), the desired goal of long-term transport sustainability fails in the face of more short term benefits.

From a systems perspective the conflict between individual and collective interests and situations in which short-term self-interest is at odds with long-term collective interest has been well described by Peter Senge (Senge, 1990). His "shifting the burden" systems archetype (Fig.1) describes the political willingness to address the long-term energy dependency problem with a symptomatic solution – fuel imports.

Incurring action now for future benefits is always a political challenge. It creates a moral social dilemma whether to go along with the tragedy of the commons or take deliberate action to make changes.

The current study uses a dynamic model of the Latvian biodiesel sector to evaluate the potential increases in the use of biofuel in Latvia and to find the most effective policy strategies for achieving the national transport policy goals by applying system dynamics modeling given the current conditions of transport fuels' market situation. The model incorporates specifications designed to examine the dynamics of biofuel demand and supply market interactions. The paper starts with the background information about Latvia's biodiesel market and gives an overview of recent system dynamics models in the biofuel sector. Section 3 provides an overview of the model. Section 4 discusses the biofuel use results of several biofuel policy simulation scenarios, and the paper ends with a summary and conclusions.

## 2. Background information

### 2.1. Biofuel market in Latvia

Latvia is located in North Eastern Europe. It has land borders with Estonia, Lithuania, the Russian Federation and Belarus. The territory of Latvia is mostly forested (around 47% of the total land surface) and 37% of the total land is agricultural (CSB, 2013). At the beginning of the year 2013 the total population of Latvia was around 2 million.

Regarding the distribution by economic activity, most employees work in service and retail – 17.1%; as well, 13.7% work in manufacturing; 11.6% in education; 6.6% in construction and 2.5% in agriculture (Ministry of Economics, 2013a).

Latvia joined the European Union in 2004. With this act, the common energy policy of the EU became binding for Latvia, also in relation to the use of biofuels in transportation. Directive 2003/30/EC on the promotion of the use of biofuels and other renewable

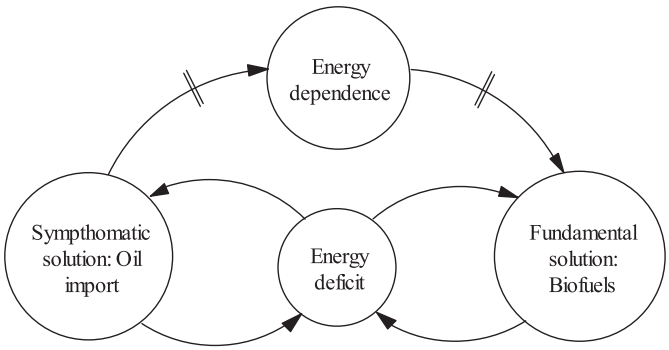


**Fig. 1.** Senge's "shifting the burden" systems archetype applied to the transport energy dependency problem.