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## Model aided policy development for the market penetration of natural gas vehicles in Switzerland

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### Abstract

Introduction of alternative fuels in the passenger car fleet is widely discussed in the light of emission reductions. Worldwide experiences show that the market introduction depends on the actions of many stakeholders, like car industry, fuel companies and consumers. The process demands well-timed actions and investments, whilst economic chances and risks are distributed highly unequally. Policy makers set the framework conditions, although the influence of the height and timing of subsidies, tax reductions and other stimulation policies are not well understood yet.

The market introduction of alternative fuel vehicles was studied with the example of natural gas cars in Switzerland. Stakeholder analysis and system dynamics modeling techniques were used to characterize the system. Analyses identify difficulties and chances in the market penetration process of natural gas cars. For example, a critical balance between fueling station upgrade investments and natural gas car sales is needed. Further, it is found that large time delays exist between strategic policy actions and frequently used market penetration indicators (e.g. car sales and infrastructure expansion), limiting the ability of policy makers to assess the performance of their strategy. Referring to elements of the *Balanced Scorecard* approach, a set of five alternative indicators is proposed to better measure the performance of the implemented strategy.

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## 1. Introduction

The market introduction of alternative fuel vehicles has gained worldwide interest over the past decade. Ongoing improvements in fuel efficiency of gasoline and diesel cars have shown unable to totally solve local pollution problems or reduce CO<sub>2</sub> emissions far enough. The anticipated scarcity of oil has put extra momentum to the search of alternatives. Though hydrogen fueled cars are widely thought to be the long-term solution, with its large scale market penetration estimated after 2030, several viable short and middle term options exist. One of these options is formed by natural gas vehicles.

Modern natural gas vehicles (NGVs) are directly available from car manufacturers. They exhibit very low emissions, in best cases even in compliance with California's very strict emission standard for super-ultra-low-emission-vehicles, SULEV (Bach et al., 2004). The major advantage of NGV is the reduced CO<sub>2</sub> emission by 20–30% at comparable performance, mainly because methane is less carbon-intensive than gasoline. An important add-on is the CO<sub>2</sub>-neutral operation by using renewable methane (biogas) from wood or organic waste. First biogas production plants in Switzerland show its potential.

NGVs are also seen as having a bridge function for the market introduction of fuel cell vehicles: As hydrogen can be efficiently reformed from methane, the NGV refueling infrastructure and its operation would need only modular extensions to enable hydrogen distribution and refueling. Besides, NGVs give customers the chance to get familiar with the concept of gaseous fuels. Most car types are *bivalent*, i.e. they can drive on compressed natural gas (CNG) and gasoline. This enables operation in regions with less developed refueling infrastructure. In Switzerland, simple conversions of gasoline cars to natural gas cars are not considered as an option since only NGVs from serial production (OEMs) fulfill high technological standards, especially environmental benchmarks.

In Switzerland, efforts for the market penetration of NGVs have started recently. The fuel infrastructure is still widely absent, and less than 1000 NGVs are presently operated in Switzerland. However, several stakeholders have demonstrated interest in a substantial market share of NGVs. The gas industry, running their business mainly on distributing gas for households, would like to establish a market share in the transportation sector to increase natural gas sales. The Swiss national and regional governments see NGVs as one option to achieve their ambitious goals to reduce local pollution and the traffic-related CO<sub>2</sub> emissions, especially when renewable methane can contribute significantly.

The Swiss gas industry recently communicated their ambitious goals of 30,000 NGVs in 2010 and 300,000 NGVs in 2020 (i.e. almost 10% of the Swiss car fleet). Overall, more than 50 million Swiss Francs (≈30 million Euros) will be invested over the coming years to fuel the market introduction of NGVs. Investments include significant subsidies to the approximately first 100 filling facilities for compressed natural gas (CNG). Full investment costs for a normal CNG filling facility range from 350,000 to 500,000 Swiss Francs. The government, in reaction, is working on reduction of fuel tax for natural gas and skipping taxes for renewable methane.

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