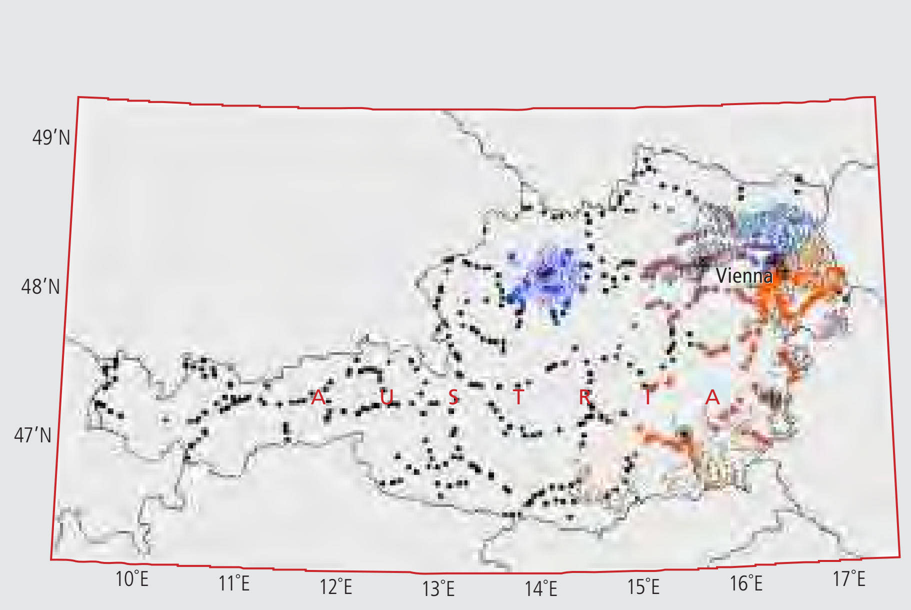
BIOFUELS

Running cars on methanol

Could methanol prove to be the answer to some of the world's energy woes? A new study by Sylvain Leduc of IIASA's Forestry Program indicates that the biofuel methanol offers huge potential as an alternative to traditional energy sources. In his research, methanol emerges as an economically plausible and environmentally sound alternative to gasoline.

Biofuels, such as methanol, are—in simple terms—produced from plants. Among other uses, they are capable of powering motor vehicles ranging from cars to trucks. Generating energy from plants clearly offers potential solutions to a host of seemingly intractable global problems.

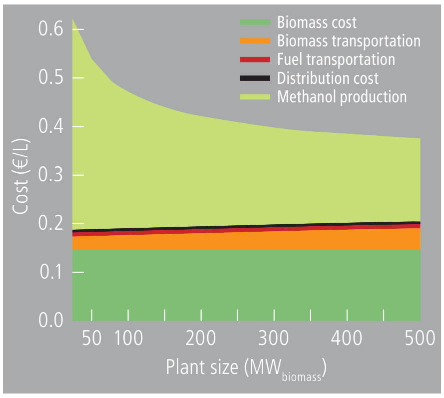
High on the list of thorny international issues, for example, is climate change. As motor vehicles are among the largest contributors to air pollution, biofuel use offers the means to dramatically cut net greenhouse gas emissions to the atmosphere. The gasoline-run car returns carbon to the atmosphere that was absorbed millions of years ago by plankton before it decayed, was buried, and turned to oil. A car running on methanol, which is produced from trees that absorb carbon from the atmosphere while they are growing, returns carbon that has only recently been absorbed. Thus, although the greenhouse gas emissions from a methanol-run car are very similar to those from a gasoline-run car, methanol fuel is markedly less harmful to the atmosphere because the carbon dioxide released is offset by the amount of gas absorbed by the trees when they grew. In other words, it is carbon neutral.



Distribution of seven methanol plants in Austria A star with a black circle represents the methanol plants; the colored dots represent the biomass for the closest plant; the larger colored dots represent the cities that are supplied with methanol from the plant of the same color; the remaining black dots are the cities that are not supplied with methanol.

In his study, Leduc examines the sustainability and economic consequences of using methanol as an alternative to fossil fuels for the transport sector. Unlike the more widely used biofuel ethanol, methanol is not fermented but rather produced from wood through a process of gasification, the result of which is a gas with a high energy content. Methanol is just one example of a biofuel that is produced by the gasification of biomass. Other second-generation biofuels that can be substituted for diesel and gasoline include Fischer Tropsch liquids and diesel DME (dimethyl ether).

After gasification, the gas is processed and cleaned to make liquid methanol which is then usually mixed with 15 percent gasoline. The rationale behind adding gasoline is that pure methanol flames are nearly invisible in daylight. Gasoline is thus added as a safety precaution to provide color to the flame. It is also easier to start an engine at low temperatures with gasoline in the mix.



A breakdown of the cost of methanol (in euros per liter) by the size of the biofuel plant (in MW).

Leduc modeled the estimated costs for each part of the methanol-for-fuel chain from harvesting and transporting the wood, through methanol production and transportation, to distribution to the consumer. He applied his bioenergy model to the state of Baden-Württemberg in Germany before extending it to Austria.

His calculations show that planting 20 percent of Austria's existing arable land with poplar trees (which can be harvested every four to five years) would provide sufficient methanol for almost half of Austria's 1,990 gas stations at a price that is competitive with current pump prices. Leduc's research shows that a 200 MW plant could produce methanol at a price between 0.3 €/L (euros per liter) and 0.5 €/L, or between 0.6 €/L and 1 €/L in gasoline price equivalent, as twice as much methanol as gasoline is needed to drive the same distance using today's standard engine technology. As a comparison, unleaded gasoline fuel cost 1.02 €/L in October 2006 in Austria.

To assess the economic viability of the use of methanol fuel, Leduc made a detailed breakdown of the costs involved in producing it (see graph). As percentages of the total cost, biomass (i.e., trees) represents 36 percent, biomass transport 17 percent, methanol transport 3 percent, methanol distribution 1 percent, and methanol production 43 percent.

Using sensitivity analysis, the study identified the three specific aspects of the methanol fuel process with the greatest impact on the fuel's final cost. It found that the efficiency of the biomass conversion plant has the strongest influence on the methanol price. Indeed, differences in technology can increase the price of methanol by a factor of two. Leduc's cost analysis is based on current technology. Production costs are likely to continue falling as the technology develops, which will make the price of methanol even more competitive.

Wood costs are the next most influential factor, with variations in wood costs influencing the variability of the final price by 70 percent. The running hours of the methanol production plant also have a major impact on price. For example, running a plant for 8,000 hours, as opposed to 6,500 hours, can mean savings on the total methanol production cost of 20 per cent.

For methanol fuel to be competitive, Leduc concludes, particular attention must be paid to building the most efficient production plants in the best geographic locations in terms of biomass supply and fuel distribution. Applying this model to Austria reveals that seven methanol plants of similar technology and size (250 MW) would produce optimal results in terms of a competitive methanol price (see map). In view of such promising results based on one European country, Leduc believes that now is the time to extend this model more widely to Europe as a whole. ■

Further information Leduc's research project, "Spatially explicit analysis of bioenergy systems," was part of the IIASA-coordinated network , "Integrated Sink Enhancement Assessment." See www.insea-eu.info.

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Methanol: A few facts

- First discovered in 1823, methanol is a colorless, odorless, slightly inflammable liquid, also called methyl alcohol or wood alcohol. Liquid methanol can be produced from just about anything, including trees, that contains carbon. Methanol has been used for more than 100 years as a solvent and to make products such as plastics, plywood, and paint.
- Pure methanol (M100) has been used to power heavy-duty trucks and transit buses equipped with compression-ignition diesel engines. Since 1965, M100 has been the official race fuel for Indianapolis 500 race cars. In 1964, the last time gasoline was used in the Indianapolis 500, a pile-up of cars resulted in a gasoline fire and deaths. And while pouring water on to gasoline spreads a fire, M100 fuel can be extinguished with water if an accident occurs.
- A blend of 85 percent methanol and 15 percent gasoline (M85) is typically used in cars and light trucks. Power and acceleration using M85 are comparable with those of other fuels in equivalent internal combustion engines. M85 has a high octane rating of 102, compared with 87 for regular unleaded gasoline. Methanol can be dispensed from pumps in the same way as gasoline or diesel. As methanol is corrosive, however, fuel storage tanks and dispensing equipment must be corrosion-resistant. ■