

Will methanol, produced from renewable energies, substitute oil as a source of energy in future?

## Tackling the Energy Turnaround with Methanol

**Fossil and non-renewable energy sources such as oil, natural gas and coal as well as nuclear power should gradually be replaced by renewable energies. Silent-Power AG has developed a system to ensure the future supply of energy with methanol.**

### Andreas Walker, Peter Warthmann

Silent-Power AG, headed by the CEO Urs A. Weidmann, has developed an energy concept to solve both electricity production and storage by means of a methanol cycle. Today the electricity is usually generated by large power plants before it is supplied to the end user. Electricity is therefore not produced where consumed and not always whenever needed. Hence, the approach used is based on energy storage. Silent-Power AG relies on storing energy in liquefied, chemical form using methanol. Storage and transport are thus particularly cost-effective and environmentally friendly.

### Production of methanol from renewable energy sources

The electrical energy for the fully synthetic production of methanol should originate from renewable energy sources. Good examples are cheap off-peak electricity from wind farms, geothermal power plants and wave power plants in places where several metres high waves occur throughout the year, such as in the New Hebrides or Tierra del Fuego. This is electrical energy that has no ready customers where it originates, since it is generated far away from the civilized world. Photovoltaic systems in desert regions or on floating islands in the sea are other future sources of electricity.

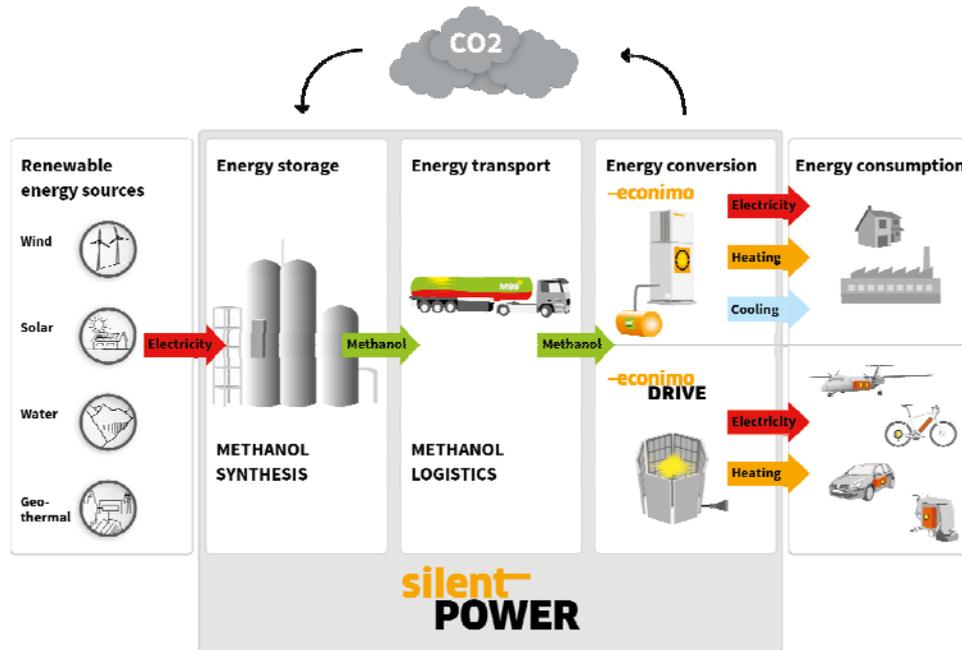
Iceland plays a leading role in this sector. It has built five large geothermal power plants producing methanol with low-cost electricity, water and CO<sub>2</sub>. Iceland is the first country in the world, requiring virtually no fossil heating and automotive fuel. The entire mobility of the island (with the exception of air traffic) is driven by the self-generated methanol. The sector with the largest energy consumption, i.e. heating of buildings (like in our country), has always been covered by geothermal energy.



**Urs A. Weidmann, CEO of Silent-Power AG, with the mini power plant "Econimo".**

## Thermophotovoltaic converter

Conversion of methanol into electricity occurs via the innovative Econimo converters. Econimo is the abbreviation for “Energy Converter Integral Module”. In this process, the fuel methanol is catalytically decomposed and the resulting infrared radiation is converted into electricity in special infrared photocells.



### CO<sub>2</sub>-neutral energy cycle with methanol.

Silent-Power AG in Cham, Canton of Zug, is currently developing a marketable thermophotovoltaic converter. Heat and electricity are generated simultaneously in the Econimo modules. The heat is used for heating and cooling of buildings (via absorption system). The electricity is fed to the grid or directly drives electric motors in appliances, machinery and motor vehicles. Silent-Power first developed mini power plants to ensure a decentralised supply of energy to residential buildings.

Several energy problems can be solved with this concept. Since the existing structures can be used, this new technology can be rapidly applied. Germany, Switzerland and Sweden are the first countries to agree to a nuclear phase-out. To compensate for the loss of nuclear power, new feasible and financially viable solutions are required in the foreseeable future.

### The methanol economy cycle

Currently, methanol (CH<sub>3</sub>OH) is mainly produced from methane (natural gas, CH<sub>4</sub>). If this methanol is burnt, the same amount of CO<sub>2</sub> is generated as if natural gas was burnt directly. In the future, however, if methanol were produced entirely synthetically from renewable energy, CO<sub>2</sub> and water, it would significantly counteract global warming. Methanol does not occur in nature as it is rapidly degraded by bacteria in the soil. This is why methanol cannot cause serious environmental disasters as from oil drilling. In 1994, after Prof. George Olah was awarded the Nobel Prize in Chemistry for the fully synthetic production of methanol with electricity, water and CO<sub>2</sub>, methanol is regarded as a source of environmentally friendly chemical energy. It is considered to be a CO<sub>2</sub>-neutral fuel, as it decomposes back into the original components CO<sub>2</sub> and H<sub>2</sub>O during the release of energy.

Silent-Power proposes to close the electricity gap with 30 000 Econimos across Switzerland, to compensate for the decommissioning of our nuclear power plants for reasons of age. Silent-Power is currently setting up three mini power plants. One of these is being commercially tested for one year at the Waterworks Zug AG ([www.wwz.ch](http://www.wwz.ch)).



**The methanol mini power plant “Econimo” supplies electricity (25kW) and heat for heating (70 kW) or cold water for cooling (40 kW).**

### **Decentralised energy supply**

The standard model of the Econimo power plants has an overall height of less than 2.5 metres. It has an electrical capacity of 25 kW and concomitantly 70 kW heating or 40 kW cooling output. It can typically supply a ten-to-fifteen apartment block, a school building, a supermarket, a nursing home, etc. It runs at full capacity within a few seconds and thus produces valuable peak energy. It can be operated inside or outside buildings, it functions silently, it is maintenance-free and odourless.

The Econimos can be remotely monitored and operated via the Internet. Thanks to the integrated intelligent systems, the Econimos normally determine independently whether there is too little electrical energy in the neighbourhood (e.g. overcast skies reduce the photovoltaic production). The Silent-Power control centre monitors automatically the methanol level in the units and the tanks are refilled in time by a tanker truck fleet. Thus, property owners or property management companies do not have to worry about maintenance or refuelling logistics. The Econimos ensure a high degree of autonomy as they store the energy inherent in methanol at the consumer.

The developed thermophotovoltaic converter (TPV converter) is always used, regardless whether a mini power station, a car or an airplane is operated with methanol. Naturally, one could also run a car with a piston engine or an aircraft gas turbine with methanol.

However, use of a thermophotovoltaic converter requires much less maintenance (similar to the fuel cell, e.g. no oil change) and provides a vibration-free and silent operation. In the future, the efficiency of this drive will also exceed many times over the performance of a petrol engine.

### Properties of methanol CH<sub>3</sub>OH

Synthetically manufactured **methanol** (molecular formula CH<sub>4</sub>O) is currently the second most widely traded liquid in the world after crude oil, and used in many products, such as cosmetics. Methanol is the alcohol with the simplest molecular structure. The next more complicated is **ethanol** (C<sub>2</sub>H<sub>6</sub>O), the ordinary drinking alcohol. Qatar, followed by Trinidad are the largest methanol manufacturers. Synthetic methanol can be produced from water, CO<sub>2</sub> from the atmosphere and electricity. Unlike the fossil fuels (oil, natural gas or coal), these elements are available in unlimited quantities. Methanol can be produced entirely synthetically. Since the production of methanol does not require agricultural cropland, its manufacture does not compete with food production. Silent Power's methanol is called "M99", i.e. at least 99% purity. M99 has combustion properties similar to those of petrol, diesel or kerosene, but burns residue-free with an almost colourless flame, is biodegradable and far less toxic than petrol. During the combustion process it is again broken down into CO<sub>2</sub> and water. Like methylated spirits, methanol is a colourless liquid that can also be easily stored and transported over a long period without signs of decomposition or loss.



Methanol can be used for heating, driving cars, powering agricultural and construction machinery, lawn mowers, etc., or aircraft turbines, as with petrol, diesel, kerosene, and heating oil. Moreover, methanol can also be converted into electricity and heat in fuel cells or thermophotovoltaic converters (in future Econimos) silently and with a high degree of efficiency.

### Methanol can be easily transported

Methanol is currently the second most traded liquid in the world after crude oil. However, the large chemical companies use practically all the methanol to produce plastic granulates, as well as pharmaceutical and cosmetic products. Silent-Power AG allows to convert electricity into methanol and methanol back into electricity. This methanol fuel "M99" (technical term for methanol with 99% purity) is transported with tankers to the consumers via the usual transport channels. Since methanol is non-explosive and the loss caused by possible leaks in the soil is rapidly degraded by bacteria, storage and transport are extremely easy. In addition to pipelines, quite ordinary oil tanks once cleaned are suitable transport vehicles. Overpressure or cooling is not required, such as with liquefied natural gas (LNG). Since methanol can be loaded and unloaded very quickly thanks to its favourable liquid state, transport costs will thus be cheaper. In the event of a tanker accident, spilled methanol evaporates within a short time. In contrast to crude oil, a methanol accident contaminating beaches with residual tar remains a thing of the past.



**The first commercially operating Econimo unit for the WWZ AG.**

Comparison of storage media for an energy amount of 7 kWh							
Storage media	Bituminous coal	Methanol	Petrol	Heating oil	Wood pellets	Hydrogen H2	Li-Ion battery
Volume or mass for 7 kWh	0.72 kg	1.4 l (=liter)	0.73 l	0.67 l	1.35 kg	10 l	14 l
Cost for 7 kWh without storage	CHF 0.22	CHF 0.50	CHF 0.58	CHF 0.48	CHF 0.50	CHF 1.54	CHF 1.40
Energy density/ Calorific value	9.7 kWh/kg	5.0 kWh/l	9.6 kWh/l	10.5 kWh/l	5.2 kWh/kg	0.0035 kWh/l	0.5 kWh/l
End user price	CHF 0.032/ kWh	CHF 0.071/ kWh	CHF 0.07/ kWh	CHF 0.069/ kWh	CHF 0.071/ kWh	CHF 0.22/ kWh	CHF 0.20/ kWh
Investment per kWh storage capacity	CHF 0.09/ kWh	CHF 0.60/ kWh	CHF 0.65/ kWh	CHF 0.24/ kWh	CHF 0.27/ kWh	CHF 70.00/ kWh	CHF 1000.00/ kWh



**Comparison of storage media/energy sources: On the left: cooking pot with 80 litres of water to be heated from 20 to 100 °C boiling point. The energy required: 7 kWh. This amount is contained in each of the lined up energy sources or energy storage media. Red markings on the left side of the 2-litre bottles show the corresponding fill level.**

## The energy concept of Silent-Power

The energy concept of Silent-Power AG has significant advantages over the conventional methods. The fuel used is methanol, an alcohol obtained directly from electricity, water and CO<sub>2</sub>, but also from renewable raw materials such as biomass or household waste (the City of Toronto produces methanol from household waste containing many plastics such as PET bottles, yogurt cups, etc.).



**Project Engineer Stefan Bernsdorf describing the individual components of the Econimo.**

Conversion of electricity into methanol and vice versa is CO<sub>2</sub>-neutral. Environmentally harmful processes do not occur at any time. The fuel M99 can be easily stored and transported over long distances with the existing infrastructure. The electricity in the Econimo converters is finally supplied directly to the consumer at the desired time. In terms of mobility, an electric car is for example powered with M99 instead of a battery. In the Tesla, the heavy lithium battery is thus replaced by a 50-litre methanol tank and the Econimo converter. Thus, the electric vehicle provides the following advantages: silent and easy to maintain, no toxic car exhaust gases, no fine dust, no gearbox, no catalytic system, etc., and those of the conventional system: refuelling in 5 minutes for a distance of 500 km. So far, electricity was supplied to the end user via grids, petrol over filling stations, and fuel oil and natural gas via other channels. A single logistics system is required if methanol is used. This will improve the overall cost balance and reduce losses through storage, conversion and transport.

## Methanol cycle:

### Efficiency levels and costs

The production efficiency of methanol with electricity ranges from 60 to 85% (high-pressure electrolysis); up to 90% is expected in future production. The current overall efficiency for conversion and reconversion of electricity via methanol production and back to electricity amounts to 20%; for future optimised processes 50% is expected.

The largest existing plant set up in Iceland produces in the start-up phase 50 million litres of CO<sub>2</sub>-neutral methanol per year. Larger plants could also be installed, but many small plants with e.g. 20 MW output have significant advantages in terms of decentralised and autonomous supply as well as cost reduction due to mass production.

Today the production of one litre of methanol costs about one Swiss franc (CHF). Current prices for electricity production from methanol are about twice as high as from conventional sources.

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An information video and a schematic diagram of the methanol cycle with a detailed description of the individual process steps are available in the online article of HK-Gebäudetechnik via [www.hk-gt.ch](http://www.hk-gt.ch), Find: methanol.