Sooner or later, we will run out of oil. But we do not have to look far for the alternative, as nature produces lots of energy. If we can find out how it breaks down waste, creates crude oil, and utilizes solar energy, scientists can produce the fuels of the future.

**IN 2050 NATURE SUPPLIES OUR OIL**

- Enzymes convert waste into oil
- Reactor brews crude oil in 0.5 hour
- Nanoforest turns sunlight into fuel
WASTE IN – FUEL OUT

Pilot plants in Copenhagen convert household waste into an energy-rich liquid by means of enzymes. The principle of the reactor is the same as when waste and plants decay out in the open.

1. Waste goes in

A household waste into a silo.

2. The waste is heated

Water is added to the waste, and both are pre-heated to a temperature of up to 50-70 degrees. All paper is converted into a thick mass.

3. Enzymes attack

Enzymes are added to the mass, and the former react with the organic components. In 18-20 hours, the waste is broken down, and 90-95% of the biomass is utilized.

4. Two products come out

The result is an energy-rich liquid, which resembles diesel oil and can be used for biogas extraction or refined. Waste, which cannot be broken down, such as tires and plastic, can be recycled.

5. Liquid

Two products come out: an energy-rich liquid and a thick mass.

6. Plastic and metal

Waste, which cannot be broken down, such as tires and plastic, can be recycled.
Reactor brews crude oil in 0.5 hour

FAST OIL MACHINE

A sophisticated pressure cooker copies the natural way of producing oil.

In nature, the process takes millions of years – scientists do it in half an hour.

1. Biomass is fine-ground. The test plant can handle straw, wood, rice, husk, chipped bark, oil seed husk, or the like.
2. In a feed barrel, the ground biomass is mixed with recoved water from the previous load, and catalysts such as calcium carbonate are added.
3. The mixture is heated and pressurized, so the waste becomes supercritical. The biomass is broken down into small molecules. Oxygen is converted into CO₂ and water-driven out.
4. Hydrogen and carbon molecules remain. In the reactor itself, the small molecules get together, forming long chains hydrocarbon molecules, a combination which resembles fossil crude oil.
5. A barrel collects oil, process water with water-soluble components, plus solid substances. Outside the plant, less crude oil and water are separated.
6. The mixture is heated in a process named thermal upgrading, making it homogenous, so it resembles fossil crude oil completely.
7. By evaporating the crude oil and sending it up through a distillation tower, components like petrol and diesel are extracted.

technology, which can convert even plastic into crude oil, and the metals are easy to reuse, so 100% recycling could be within reach.

Production takes millions of years

In nature, where the biological breakdown is not disturbed by engineers and chemists, organic waste such as algae, collapsed trees, and dead animals are left to themselves, and after millions of years, they have turned into oil, gas, and coal captured deep in the ground. The process is a tough one, but nature can convert almost anything into pure energy.

So what if we did not have to wait for millions of years? What if we were able to produce oil from our waste right now? Another Danish team of scientists has managed to do this. In a test plant at the Aalborg University, scientists have copied natural oil production on a small scale. One of the main elements of the so-called HTL (Hydrothermal Liquefaction) process is water, which is otherwise a byproduct of biomass treatment. By heating the water to 400 degrees and increasing the pressure to 250–350 ATM (corresponding to the pressure approx. 3 km below the ocean surface), the liquid enters a supercritical state.

Under such conditions, the water becomes extremely reactive and is converted into a strong dissolving agent. Straw, wood, and rice and oil seed husk, which are otherwise not

NATURE USES MILLIONS OF YEARS

Crude oil is produced from organic material deposits such as algae, pollen, fungi, microorganisms, and plant debris. Over time, the substances become part of a so-called source rock and buried still deeper beneath new sediments. The temperature increases by 1 degree for every 30–40 metres, so the source rock is subjected to increasing pressure and temperatures. The generation of oil and gas begins at approx. 60 degrees, but is optimum at 90–120 degrees. The majority of the oil will move upwards and evaporate in connection with the next load of biomass.
In May, they published their preliminary results. The scientists have built a nanos- version of a forest, in which microscopic structures split water into oxygen, hydrogen ions, and electrons. The electrons and the hydrogen subsequently convert the CO₂ into hydrocarbon, which is what scientists are after, as hydrocarbons are so to speak the building blocks of our fuels.

But so far, the outcome has been nothing to write home about, as only 0.12% of the sunlight is turned into energy. If the same were true for crude oil, we would get 1 litre of fuel per 834 litres of crude oil.

One big challenge consists in finding the right catalysts. Nature uses manganese, but that is not necessarily the most efficient, according to scientists. Even plants do not utilize more than 2-5% of the solar energy. With the right catalyst, artificial photosynthesis could become much more efficient.

The head of research, Peidong Yang, is sure that the team will soon manage to multiply the production. If so, the perspectives are promising. In just one hour, Earth receives enough energy from the Sun to cover our needs for a whole year. However, most experts agree that commercial utilization is well into the future. But until then, the more earth-bound alternatives are ready to take over, so the world does not stop, the day the oil supplies run out.

Microbe converts CO₂ into fuel

Scientists of the University of Georgia in the US have found a microbe named Pyrococcus furiosus, which lives in the deep sea. It converts carbon dioxide into a chemical, which can easily be used as fuel. By means of gene modification, scientists hope that the microorganism can extract CO₂ from the air and convert it into fuel.