Energy
National Research Programmes 70 and 71

Project

Energy recovery in waste management

Energy from waste: how as much as possible can be recovered

NRP **Energy**
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Energy from waste: how as much as possible can be recovered

Less energy is recovered from waste than would be possible. This is the conclusion drawn by an investigation conducted by researchers at ETH Zurich. In a sub-project of the joint project "Waste management to support the energy turnaround", they scrutinised the recovery of municipal waste. On the basis of the results, they are proposing specific improvements.

This plastic waste will be recycled into new raw materials, for example for the manufacturing of packaging products. Picture taken at Innorecycling AG in Eschlikon in the canton of Thurgau. *Source:* Maja Wiprächtiger, ETH Zürich

At a glance

- Waste from Swiss private households contains a great deal of energy that is already partially recovered – on the one hand, through the use of heat from incineration plants for heating or electricity production and, on the other, through the recycling of materials.
- Environmental engineers from ETH Zurich have now scrutinised all existing waste recovery processes and identified where energy is lost.
- The researchers pinpointed potential for improvement both with respect to the processing of recycling materials such as paper and glass as well as at incineration plants. They are proposing various measures that could more than double the amount of energy recovered from waste.

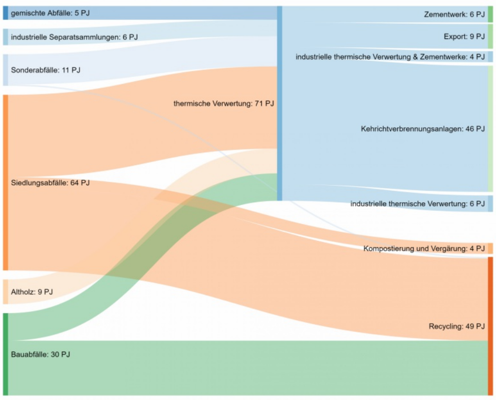
Every person in Switzerland causes around 700 kilograms of waste a year. Some of this is recycled, while some is incinerated. Both processes recover energy from the waste: the thermal energy from the incineration plants is partially used in industrial processes, for the heating of housing or for the production of electricity. And in the case of recycling, the reused materials replace new raw materials and thus indirectly yield an energy gain. However, a large share of the energy contained in waste is still lost. This is shown by an investigation conducted by environmental engineers at ETH Zurich.

As part of the joint project “Waste management to support the energy turnaround”, the scientists analysed how much energy is contained in waste from private households as well as in waste with a similar composition from the industrial sector and how much of this has not been recovered until now. Based on the results, they are proposing measures in order to ensure the better recovery of waste in future.

To this end, the Zurich-based researchers created a material flow analysis and an energy flow analysis for the waste: from the front door to the waste’s ultimate recovery following recycling or the depositing of ash from waste incineration plants, all collection, sorting and transport processes were recorded and all energy flows along the entire recovery chain were calculated. The researchers also modelled all recycling and incineration processes using computers. In doing so, they likewise included the waste that is incinerated in industrial furnaces (e.g. for cement production) as well as waste that is exported abroad. Furthermore, they investigated materials that are sent for recycling: paper, cardboard, glass, metal, PET and other plastic. Using life cycle analyses, the environmental engineers also determined the overall environmental impact of the various waste types and their recovery processes – 190 individual processes were analysed to this end.

Enormous amounts of energy

Based on their analyses, the researchers initially determined the amount of energy contained in all waste from private households and similar waste from the industrial sector – referred to as municipal waste in technical jargon: this waste contains a total of 64 petajoules. One petajoule equates to a quadrillion joules or, put another way, a million billion joules. 64 petajoules corresponds to the calorific value of more than 1.5 million tonnes of crude oil – an immense amount of energy.



The scheme shows the composition of Swiss waste and how much energy it provides: the most energy is contained in so-called municipal waste, i.e. waste from private households including similar waste from the industrial sector. Melanie Haupt, ETH Zürich

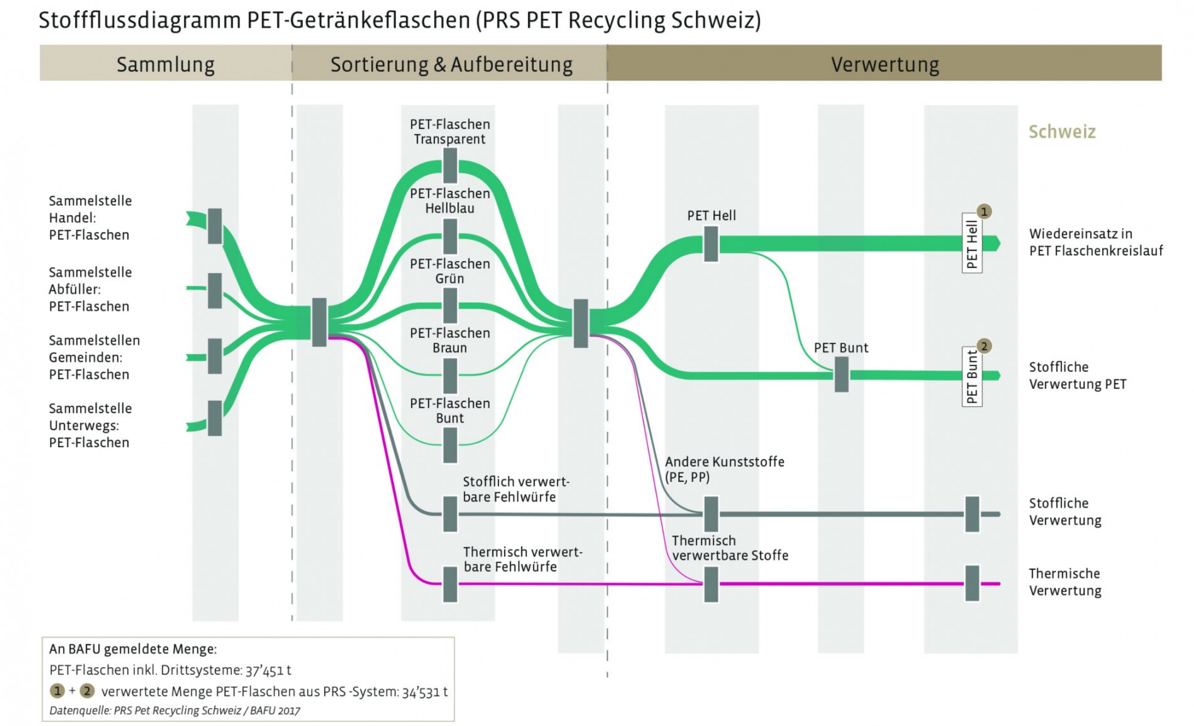
Of these 64 petajoules, more than half, namely 37 petajoules, end up in waste incineration plants. However, a large share of this energy is lost during incineration. Only 10 petajoules of energy is recovered in the form of heat, with 6.3 petajoules recovered as electricity. This energy can be reused and thus replaces so-called primary energy, i.e. energy that would otherwise have to be generated as new. There are also losses, however, during the generation of primary energy: to be able to use a petajoule, almost two petajoules have to be expended. If this is taken into account, this results in a total of 30 petajoules of energy gained from the incinerated waste.

There is also the energy gained from the recovery of organic waste as well as the recycling of materials. This recycling indirectly leads to a positive energy balance: although recycling itself also requires energy, this replaces the greater amount of energy that would have to be expended in order to reprocess the raw materials. It results in a further energy plus of 45 petajoules.

Avoiding losses

The ETH researchers subsequently examined the various recovery chains in detail in order to identify potential for improvement. An initial important measure was identified for the waste incineration plants. “If energy efficiency was improved here with technical expansions and the waste heat was utilised consistently at all plants, significantly more energy could be obtained from the same amount of waste”, says project manager Stefanie Hellweg. The environmental engineers are also recommending various improvements for recycling.

In principle, there are two different kinds of recycling, namely open and closed loops. In an open loop, the recycled materials give rise to new raw materials – these are not used to produce the starting product, however, but rather something different on an irreversible basis. In the case of PET bottles, for example, a large share is recycled into new packaging in an open loop. In a closed loop, on the other hand, the materials are reused to manufacture the same product. As is often the case, for example, with the recycling of cardboard or packaging glass.



What happens with the PET bottles collected in Switzerland: some is used to produce new bottles, while some is utilised for completely different packaging. Swiss Recycling

The researchers scrutinised these loops in more detail and examined their quality. For example, for each recycling material, they compared the collected volume with the volume actually used to make recycled products. This difference between the quantity of materials collected and the quantity recovered arises due to the fact that it is not only recyclable material that ends up in the collection and the material is sometimes contaminated. “With improved collection systems and processing procedures, more can be recovered”, says Hellweg. Improvements would be worthwhile, in particular, for the recycling of paper, cardboard and glass. According to the results, these materials have the biggest impact on the environment. This is because enormous quantities of these materials are collected and transported. Paper and cardboard alone are responsible for 72 % of the energy recovered from recycling.

Improvements for the future

Finally, the ETH environmental engineers calculated how great the impact of their recommendations would be. To do so, they recreated the waste recovery processes in a mathematical model. Here, they also incorporated the use of new technological possibilities – they had identified these beforehand together with experts from the recycling industry. “In particular, for the recycling of plastic, a process that is still relatively young, we expect technological progress”, explains Hellweg. The research team then applied the computer model to three future scenarios: in the first, the volume of waste remains at the current annual level of 700 kilograms per person. In the second, the researchers anticipate a decline in the volume of waste to 400 kilograms per person and year. And in the third, they work on the assumption of an increase to 900 kilograms.

Result: even from the smallest volume of waste, 10 % more energy could be extracted than today. If the amount of waste remains the same, this figure rises to around 100 % – i.e. twice as much as at present – and with a waste volume of 900 kilograms per person 130 % more energy could even be yielded than is currently the case. Strong facts that are likely to help decision-makers at companies and politicians to in future contribute to the energy turnaround with waste management.

Produkte aus diesem Projekt

- Do We Have the Right Performance Indicators for the Circular Economy? Insight into the Swiss Waste Management System
  Date of publication: 01.01.18
- Life cycle inventories of waste management processes
  Date of publication: 01.01.18
- Environmental Assessment of Resource and Energy Recovery in Waste Management Systems
  Date of publication: 01.01.18
- wastEturn – Abfall als Teil der Energiewirtschaft
  Date of publication: 01.01.18
- Environmental optimization of biomass use for energy under alternative future energy scenarios for Switzerland
  Date of publication: 01.01.18
- Ein Leben ohne Abfall
  Date of publication: 01.01.18
- Managing waste for an efficient and clean circular economy: Indicators and tools
  Date of publication: 01.01.18
- Material and Energy Flow Analysis of the Swiss Waste Management System
  Date of publication: 01.01.18
- Manejo de residuos en Suiza
  Date of publication: 01.01.18
- Quality-dependent impact of steel recycling: scrap from MSWI bottom ash vs. common scrap grades
  Date of publication: 01.01.18
- Combining MFA, LCA and optimization techniques to improve MSW management in Switzerland
- Environmental optimization of Swiss municipal solid waste management to support the energy turn-around
  Date of publication: 01.01.18
- Waste management indicators for Circular Economy: Comparison of collection and recycling rates
  Date of publication: 01.01.18
- Is there an environmentally optimal separate collection rate?
  Date of publication: 01.01.18
- Material flow analysis of Swiss waste management
  Date of publication: 01.01.18
- Influence of scrap quality on operational parameters in steel recycling
  Date of publication: 01.01.18
- Optimizing Swiss waste management to support the energy-turnaround: wastEturn
  Date of publication: 01.01.18
- Is there an environmentally optimal separate collection rate?
  Date of publication: 01.01.18
- Geschichten lesen im Abfall
  Date of publication: 01.01.18
- Alter Schrott wird neuer Stahl
  Date of publication: 01.01.18
- Sammeln ist noch kein Recycling
  Date of publication: 01.01.18
- Es besteht viel Potential, mehr zurückzugewinnen
  Date of publication: 01.01.18

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- Life Cycle Assessment of Swiss Municipal Solid Waste Management
  Date of publication: 01.01.18

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