

Integrated Bioenergy RES Hybrids

Flexible renewable energy solutions

Authors: Ilkka Hannula, Elina Hakkarainen

SUMMARY

The report surveys the status of integrated bioenergy RES hybrids, defined as energy conversion processes that have at least two renewable energy inputs, one of which is bioenergy. The survey covered Finland, Germany and Austria, and found that elements for the deployment of RES hybrids are already in place in many sectors. In addition, several region-specific characteristics were also identified.

Currently, most hybrid systems are found in the heating sector, particularly in detached houses outside the district heating network. This is mainly due to simple and robust integration of different heat sources and the natural flexibility offered by the integrated system. In **domestic heating systems**, bioenergy and ground-source heat are typically considered as alternative options for base load production. Depending on the heating behaviour of the household, bioenergy can be used either as a base load producer, or to complement other heat source(s) during peak demand.

District heating and cooling networks can be considered as large-scale hybrid applications, and bioenergy offers a quick way to increase the share of RES in heat production through these networks. Solar thermal is not yet a widely applied technology for district heat production in the surveyed countries, although a large project is currently underway in the city of Graz, Austria. In general, solar thermal could make a significant contribution to the production of district heat during summer periods. Waste heat recovery is a growing trend, which reduces the need for investments in new energy generation capacity.

At **farm-scale** the availability of and experience with bioenergy offers good preconditions for hybrid systems. Besides increasing the level of self-sufficiency in energy supply and reducing energy related costs, hybrid systems might also allow additional revenue streams for the farms.

In the **power sector**, the role of hybrid systems varies depending on the market conditions. In Finland, their role and potential is currently limited due to the clean and reliable Nordic electricity market, and the abundance of flexibility options due to access to hydro. In Germany, virtual power plants are an interesting topic, and coupling of biogas and biomethane with hydrogen from wind is currently being demonstrated. In general, bioenergy can have a significant role as a flexible component in a VRE (variable renewable energy) dominated energy system.

Energy storage encompasses a family of diverse technologies, but in the context of bioenergy hybrids, two main concepts were identified: 1) biomass drying with VRE and 2) chemical storage of electricity in biofuels via hydrogen. They can be used to complement VRE variability by creating demand during periods of abundance. Chemical storage of electricity in biofuels has also the unique feature among storage technologies that it never fills up. However, due to its comparably high costs, it is likely to be among options that are deployed only after the potential of more cost-effective solutions has been exhausted.

KEY FINDINGS

- Bioenergy can have a significant role as a flexible component in a low emission energy system dominated by VRE (variable renewable energy) generation.
- The motivation for integrated bioenergy hybrids depends on the application, but usually relates to
 - efficiency improvements (e.g. preheating of process feeds with other renewable energy sources before biomass conversion),
 - lower cost through equipment sharing (e.g. common steam system),
 - improved resource efficiency (e.g. hydrogen enhanced biofuels)
- The technical potential for integrated bioenergy hybrids is considerable; no major significant limitations have been identified.
- The market potential for integrated bioenergy hybrids is difficult to estimate as there is **no universal way to assess the economic value of flexibility** in isolation from the energy system. So the economic feasibility is always specific to the case in question.
- The majority of hybrid concepts currently in the markets of the surveyed countries are focused on domestic heating applications. However, in Germany there has also been notable interest in virtual power plants and power-to-gas concepts.
- Integrated bioenergy hybrids can provide flexible resources for both energy supply and energy storage.
- The role of bioenergy in a hybrid system depends on the application. Either other renewable energy sources are used to support bioenergy, or bioenergy is used to support other renewable energy sources.
- District heating and cooling networks offer great potential for an efficient utilisation of renewable energy and waste heat sources.
- There is a lack of standardised interfaces between technologies, which leads to the need for multiple control systems and thus added costs for hybrid systems.
- Using VRE for drying biomass or storing it chemically in biofuels via hydrogen are potential future hybrid concepts that can be applied at large scale.

For additional information, please refer to the main report and related presentations on the project website: <http://task41project7.ieabioenergy.com/iea-publications/>