WEEG NEWSLETTER June-July 2018

The newsletter is published monthly by the University of Southampton's Water and Environmental Engineering Group WEEG, and reports things of interest in this field worldwide, as well as ongoing undergraduate student and research work in WEEG itself.

We believe that water and energy are the most important topics worldwide for the next decades. Our work covers river and coastal engineering, water and wastewater and energy related to water.

Editorial: The main topics of our WEEG group are water and energy. Renewable energy that is. One major problem generated by the increasing renewables input into our grids is the grid regulation, i.e. balancing energy generation if there is e.g. a sudden drop or increase in renewables generation. Today, we will look at how bio-based technologies developed in the context of sewage treatment can contribute to the solution for this problem.

Hydraulic Engineering International: *Biotechnology for methane generation*

The increasing use of renewable energy sources is making regulation of the power grid more difficult due to the unpredictable nature of wind and solar irradiance. Supply and demand in the electricity grid need to be precisely balanced, and overload must be avoided. The surplus electricity produced from solar or wind plants at peak periods must be consumed, otherwise it will be lost or will cause grid instability. Fig. 1 shows a typical situation with high renewables input, the balance is negative in morning and afternoon (i.e. additional energy is required), and positive – i.e. surplus energy – during the day.

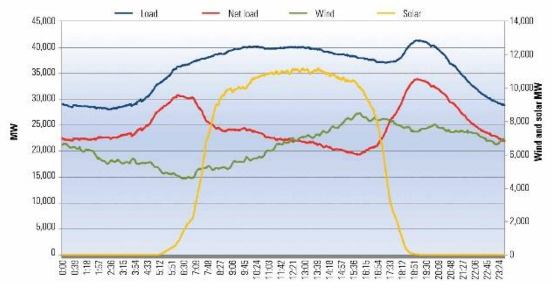

Fig. 1: Load and renewables input

Short-term electricity surpluses already occur quite frequently in some EU countries (e.g. Denmark, Germany, UK), and are likely to become more common in future, since many countries are promoting the installation of renewables as part of their energy policies. In Denmark, for example, a huge expansion in wind energy is in progress: the 'Green Energy' Agreement launched in March 2012 gave a national target of 40% renewable energy by 2025 and 100% by 2050. The situation can be exacerbated by seasonal factors. Sometimes, in cases of excess supply, generating companies have to pay the grid managers to take their electricity (i.e. the electricity price is negative).

Battery technology is developing rapidly, but is not cost-effective, and presents challenges in terms of raw materials and disposal. Currently, only two methods have a realistic capability of storing surplus electricity: pumped storage hydroelectric power, and production of hydrogen. Pumped storage hydropower plants are technologically mature solutions, with efficiencies as high as 80%. Examples include the Dinorwig power station in Snowdonia, which was commissioned in 1984 and at times of low electricity demand pumps water up to the Marchlyn Mawr reservoir, releasing it through turbines at a rate of 390 $m^3 s^{-1}$ at peak demand. Unfortunately, the initial capital cost for construction of these systems is high, most of the best locations for such installations have already been used, and the overall capacity stored is small compared with e.g. wind energy surplus input.

The second method is to store the surplus energy in the form of hydrogen, produced from the electrolysis of water. Although this is feasible, hydrogen is difficult to store (low volumetric energy density explosive properties).

An alternative to storing hydrogen is to convert it to methane, which has a higher energy density. Methane can be stored and distributed in the gas grid, as compressed natural gas (CNG) in cylinders, or as liquefied natural gas (LNG). The UK, for example, has 280,000 km of gas pipelines that are never fully charged, giving a huge storage potential without additional infrastructure costs. This far exceeds the capacity of the pumped storage hydro plants.

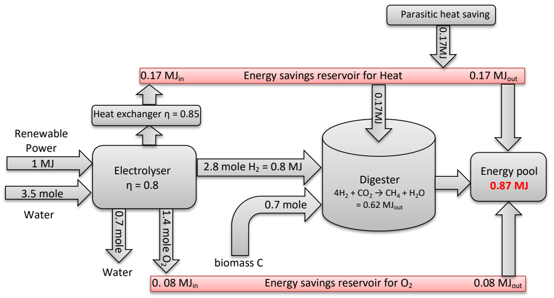

Fig. 2: Biomethanisation using surplus grid energy

To date the main method used for CO_2 conversion has been the Sabatier reaction, a thermo-catalytic reduction that takes place in pressurised reactors at 350 oC. This process has been known for 90 years. Recently, however, there has been rapid growth in interest in microbially-mediated processes where biomethanation is carried out at low temperature and atmospheric pressure without the need for catalysts. In the last 10 years these systems have gone from scientific concepts through pilot and demonstration-scale plants to market availability, though there is still a great deal of scope for engineering and process optimisation.

Fig. 3: AD plant - without conventional biogas upgrading or biomethanation

Our Bioenergy and Organic Resources Research Group is working on these biomethanisation systems in the IB Catalyst H2AD project, and this will form the topic of another editorial.

WEEG GDP: *Design Excellence award for WEEG GDP 2018*

Against very strong competition, this year's Design Excellence Award for the best Group Design Project of the Faculty of Engineering and the Environment went to the WEEG group, pictured below with their certificates.

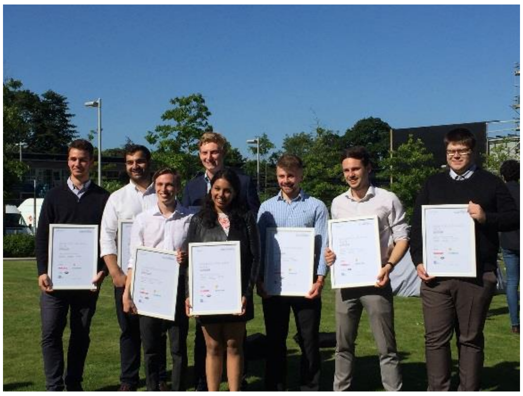

Fig. 3: The GDP design team

They designed, built and tested an ultra low-head hydropower system for water purification and water saving irrigation: see Fig. 4, and for more details of the project see e.g. posts 166, 172, 178 and 183 on the Hydraulics Lab Facebook page.

Fig. 4: The 0.1 =- 0.2 m head, 180 Watt prototype

With a little bit of luck, we will build a full scale version in an irrigation system in Spain, based on the model tests next year. In the upcoming academic year, our group is offering a GDP to generate more hydropower in a supercritical flow channel.

Jobs in water engineering:

This gives you an idea of the type of work you can do when working in industry.

Advert: An interesting example of an opportunity to apply engineering knowledge and judgement in identification of solutions

Infrastructure Solutions Engineer Southern Water

https://www.southernwater.co.uk/current-vacancies

Civil and Environmental Engineering at Southampton University:

WEEG: the Civil and Environmental Engineering pathway offers the chance to deepen your knowledge in water-related areas, and gives you a better preparation for environmental engineering projects.

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Further information:

We have two Facebook pages, which provide a logbook of our laboratory activities:

www.facebook.com/Hydraulicslaboratory/

www.facebook.com/environmental.lab.university.of.southampton/

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