



# AT THE NEXUS OF WATER AND ENERGY SECTORS: FLEXIBLE ELECTRICITY GENERATION FROM ANAEROBIC DIGESTION OF SEWAGE SLUDGE



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## The need for flexible electricity generation

The contribution of the energy sector to decarbonisation is crucial to achieve a net-zero carbon emissions system. Energy production, and specifically electricity generation, is a major contributor to global carbon emissions.

Given the large potential contribution of renewable sources (such as wind and solar power generation), the electricity sector is considered easy to decarbonise. However, security of electricity supply is threatened by a large use of such intermittent renewable energy sources. Therefore, other technologies, preferably renewable, are needed to provide flexible electricity generation.

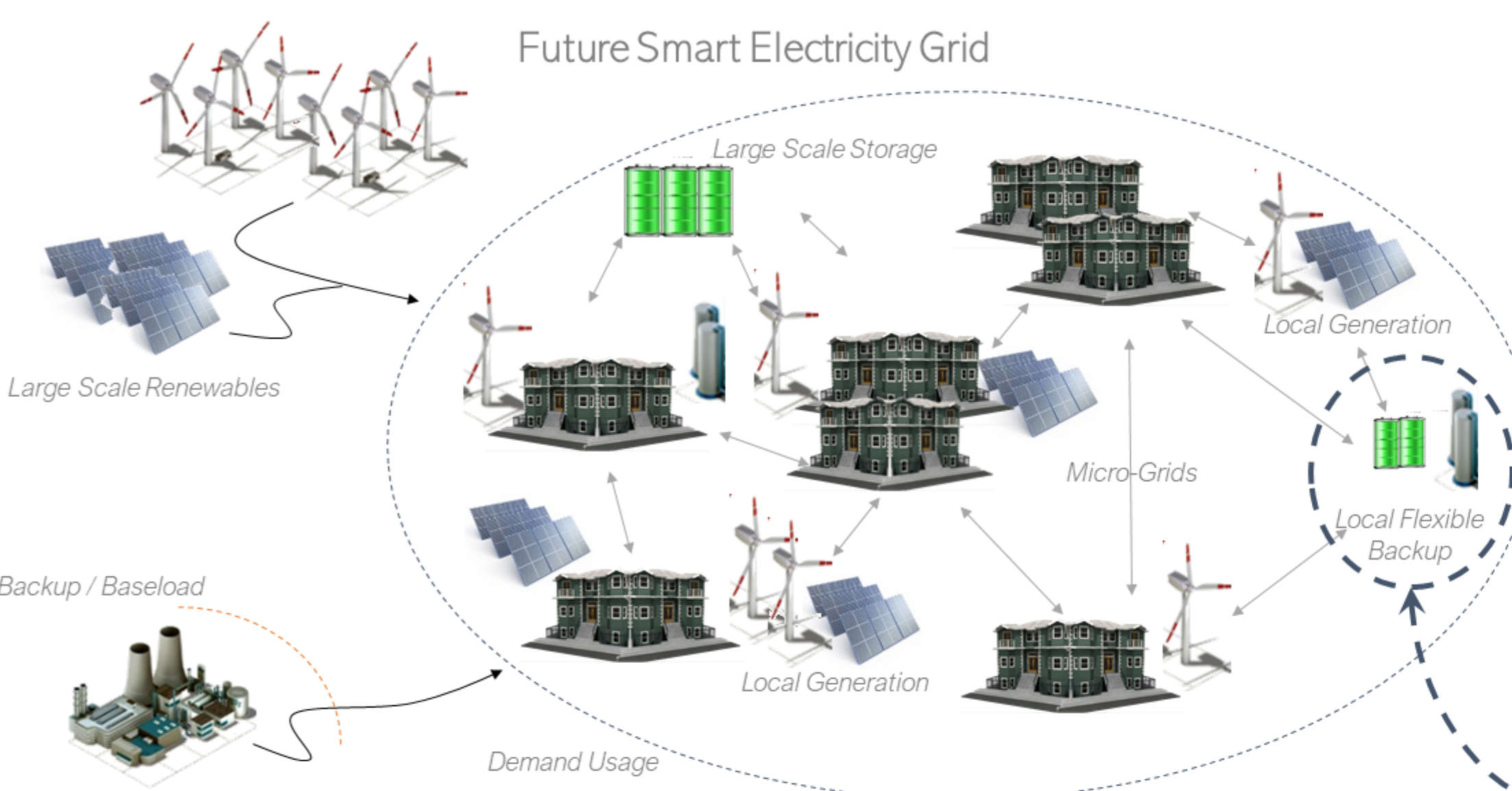


Fig.1: Future smart electricity grid: local (distributed) generation and storage/backup balance the smart grid.

## Electricity generation in the water industry

Water supply and wastewater collection and treatment are electricity-intensive services: the electricity consumption of the water industry represents the 3% of the national total. In UK, the whole of Northern Ireland uses a similar amount.

The water industry is also a large generator of renewable electricity. Anaerobic Digestion (AD) is extensively used as process to sustainably treat sewage sludge in centralised Sewage Treatment Works (STW). AD allows the recovery of resources and to self-generate energy and electricity needed on-site. Excess electricity is also exported to the grid.

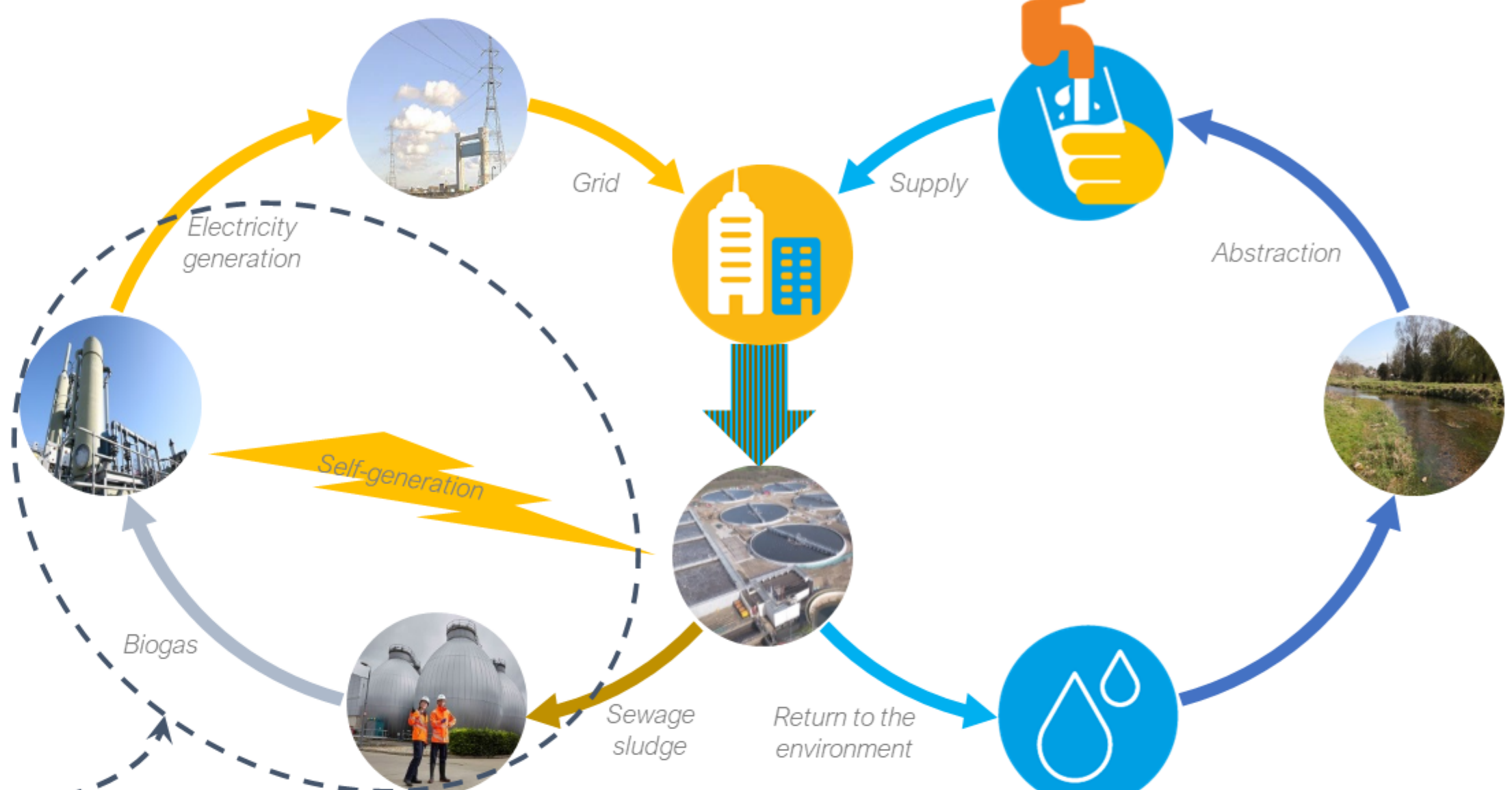


Fig.2: Urban water cycle (right) and energy recovery from sewage sludge (left) for electricity generation

## On-demand biogas production from anaerobic digestion

Whilst the operational common practice is to use the process as baseload provider of electricity, AD is able to produce energy (in the form of biogas) that can be used for on-demand electricity generation. Research [1] shows that AD of sewage sludge has flexibilization capability in conventional and advanced configurations. In all scenarios, the value of the biogas converted into electricity is higher than with a steady operational regime, increasing by 3.6% on average (up to 5.0%) in conventional and by 4.8% on average (up to 7.1%) in advanced AD.

Additionally, flexible renewable generation is expected to reduce the Carbon Intensity of the grid at peak time [2].

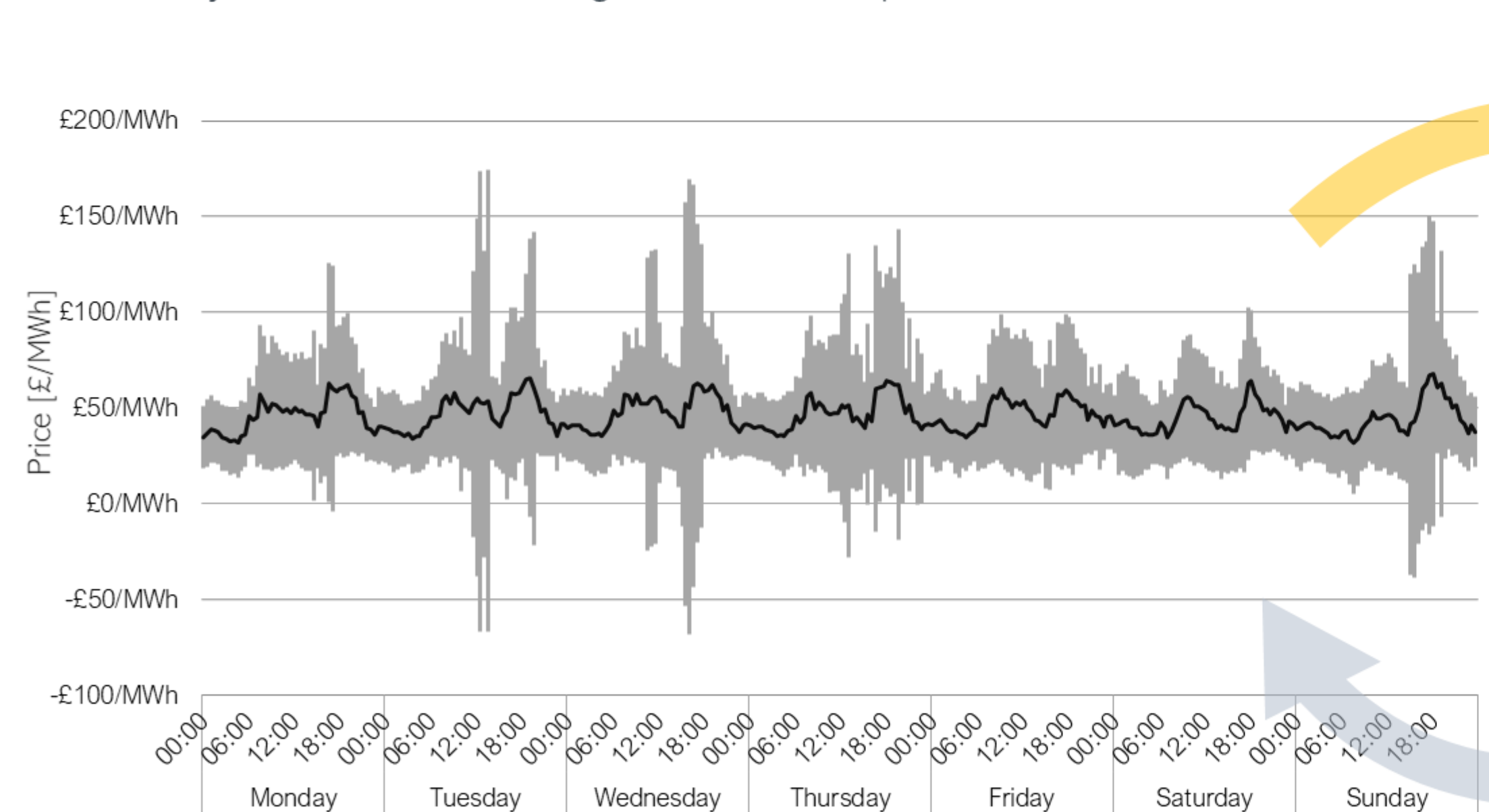


Fig.3: The demand for flexible generation in the UK electricity balancing mechanism, adapted from [1]

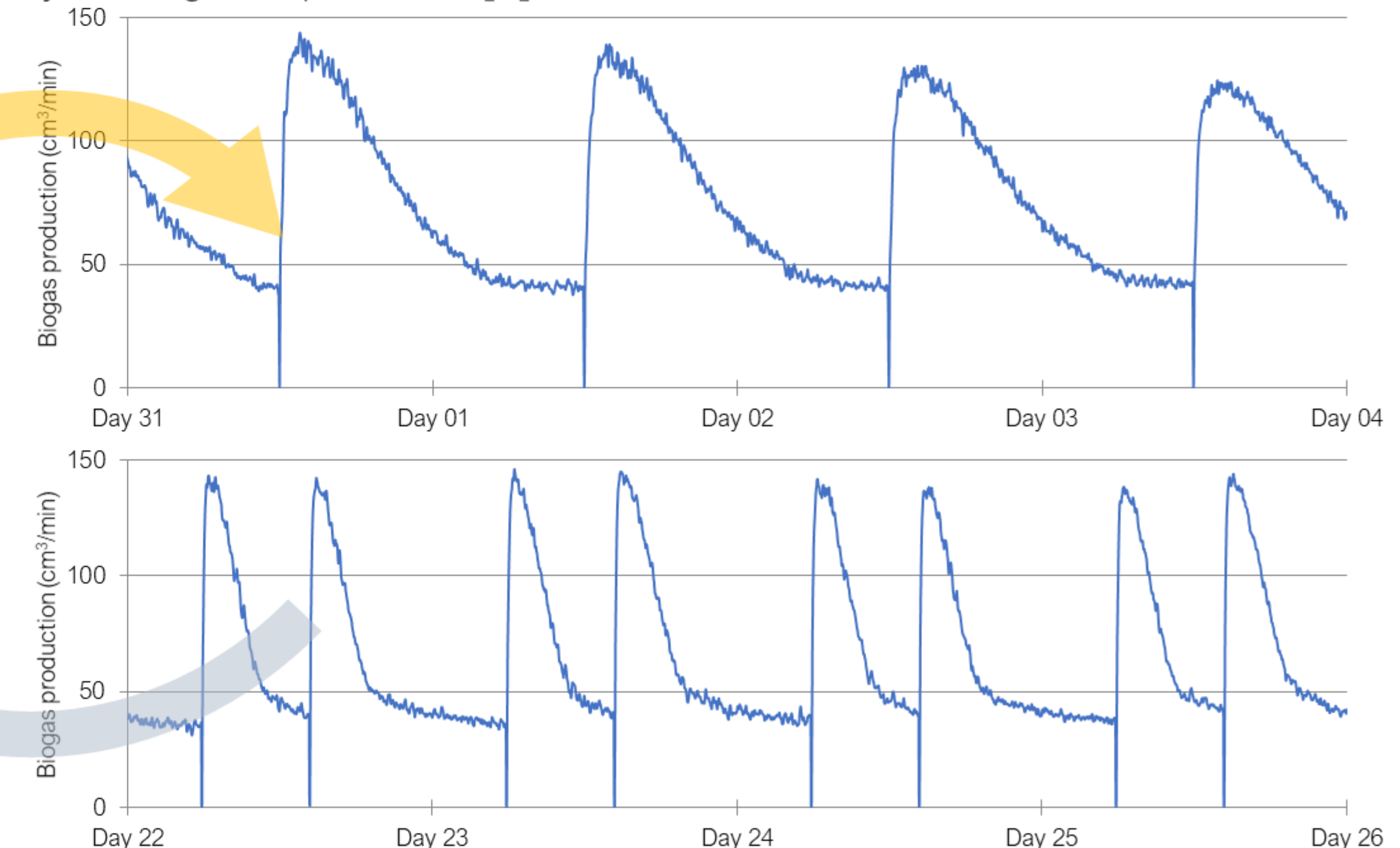


Fig.4 Biogas production rate obtained by experimental activities presented in [1]. The feeding regimes are designed to match the peaks of the electricity market.

## Conclusions

In the research for innovative flexible renewable generators to achieve a net-zero emission economy, AD of sewage sludge appears to be a viable operational process to provide on-demand electricity to unlock the full decarbonisation of the power system.

As the water industry is a large user and generator of electricity, the nexus between the water and energy sectors is very close. The water industry might significantly contribute to the development of a decarbonised energy sector, and adapt its own development also according to the one of the energy sector.

## References

- [1] Lafratta, M., Thorpe, R.B., Ouki, S.K., Shana, A., Germain, E., Willcocks, M. and Lee, J., 2020. Dynamic biogas production from anaerobic digestion of sewage sludge for on-demand electricity generation. *Bioresource Technology*. <https://doi.org/10.1016/j.biortech.2020.123415>
- [2] Lafratta, M., Thorpe, R.B., Ouki, S.K., Rus Perez, E. and Lee, J., 2018. On the potential environmental benefit of flexible electricity generation from sewage sludge in the UK Water Industry. *Proceedings of Sludge Management in the Circular Economy*, CNR Edizioni, Rome.

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