Policy Briefing Paper

Bioenergy in the Dairy Industry in South Africa

SUMMARY

South Africa has the most dynamic and successful commercial dairy sector in Sub-Saharan Africa (SSA), with just under 1,200 medium-to-large-scale dairy farms in operation.

There is good potential for these farms to utilise their livestock waste as bioenergy feedstock for anaerobic digestion (AD), to generate biogas for the supply of both heat and electricity. Given the continued concentration of dairy farming into a smaller number of ever-larger concerns, the economic and technical potential for using cattle manure and dairy wash water for AD-based biogas heat and power production is growing quickly.

A small number of South African technology developers are also developing technology. As a result, good quality, locally-produced AD systems and biogas electricity generators are increasingly available. Uilenkraal Dairy, in West Cape Province, South Africa (Figure 1) is an excellent example of that approach of a large dairy using local technology.

However, most dairy farms have limited onsite demand for heat and/or power, and, until April 2021, South Africa's renewable electricity framework did not favour licensing small-scale (≤1 MWe) renewable electricity supplies to the Eskom grid. Consequently, there is currently limited scope for investment in small-scale dairy livestock residue AD cogeneration due to limited scope to sell surplus electricity to Eskom, which controls electricity supply to over 90% of South African consumers.

The **Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)**[1] commenced in 2011 to promote extensive investment in renewable electricity generation. It has stimulated significant renewable electricity investment from less than 700 MW capacity in 2010 to nearly 6 GW today, with a projected 13 GW by 2022. However, the REIPPPP targets large (>5 MW) projects eligible to bid for long-term power purchase agreements (PPAs) for renewable electricity supply to the national grid run by Eskom, the state-owned power utility, at preferential tariffs.[2] There is currently no scope for small-scale (<1MW) renewable electricity to meet the REIPPPP's requirements and with little interest in bioenergy (other than sugar bagasse or landfill gas generation).

However, under certain conditions, producers with electricity generation capacity of ≤1 MW, with a MV (medium voltage) connector and a bi-directional meter, can 'wheel' their surplus electricity to other willing buyers using the Eskom grid, if Eskom permits such a contract.

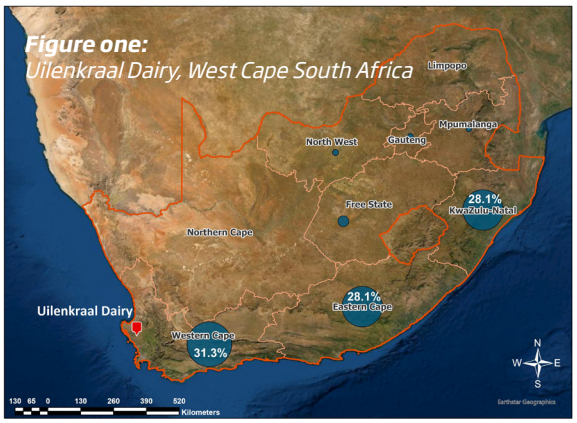


Figure one:
Uilenkraal Dairy, West Cape South Africa

Regulator of South Africa (NERSA) as an IPP registered for 'commercial purposes' with ≤1 MW generation to sell to a willing buyer. Eskom's requirements for wheeling are far more complicated and onerous on a small-scale electricity generator (SSEG) than NERSA.[3] While NERSA makes it relatively easy for bioenergy electricity generators to 'wheel' their surplus electricity to willing customers, Eskom's requirements, grid utilisation charges, and required reporting and monitoring information pose excessive burdens on SSEGs such that there has been no utilisation of grid wheeling from rural renewable SSEGs.

Additionally, generators with capacity of ≤1 MW are not eligible to bid for PPAs with tariffs higher than Eskom's under the REIPPP. However, under new legislation grid access and sale requirement for electricity suppliers from 100 kW to 1 MW have been opened. Still, at present, small generators are only allowed to sell electricity to the grid at Eskom's normal tariffs through a wheeling agreement that incurs additional administrative, technical requirements and financial charges that that are onerous for small-scale producers wishing to sell/wheel on the Eskom grid.

However, things are changing fast in South Africa. In October 2020, the Minister of the Department of Mineral Resources and Energy (DMRE) gazetted a new law that encourages municipalities, industrial and commercial parks, among others who have their own non-Eskom electricity grids (257 municipalities) to purchase electricity from SSEGS, which includes those with less than 1 MWe, for their own supplies. This is potentially a game-changer for encouraging small-scale bioenergy producers, like Uilenkraal to negotiate contract directly with municipalities, industrial estates, residential estates, for selling electricity as 'willing buyer-willing seller' contracts. NERSA is required to promote this.

This policy briefing paper explores the current landscape for biogas use in the dairy industry in South Africa, to identify the potential for further adoption for commercial-scale heat and power production.

[1] https://www.ipp-renewables.co.za/
[2] One REIPPP call for proposals targeted projects in the 1 to 5 MW range. All others have been for >5 MW.
[3] Eskom requires a NERSA registration from a producer to wheel based upon the Electricity Regulation Act (ERA) of 2006 that identifies the supplier ('non-utility generator') and the buyer ('load'). Eskom has a schedule of payments that must be made by the small-scale generator ranging from connection, use-of-system agreement, an amendment to Eskom's supply agreement, among others that are onerous for small-scale producers. Various charges are associated with each step of a wheeling arrangement that make the contract with Eskom quite onerous.

SECTOR OVERVIEW

South Africa is SSA's largest dairy producer and has the largest, most commercialised, dairy processing industries on the continent.

Figure two:
Dairy cattle waste biogas AD electricity generators at Uilenkraal Dairy Farm 2021

Source: Author's own photograph

South Africa's national cattle herd is just below 13 million head, of which 20% are dairy cows. Most of the country's milk supply comes from the Eastern and Western Cape, Free State and KwaZulu-Natal Provinces. The industry is very well-organised, with several national industry bodies, sophisticated commercial marketing and adherence to international quality, hygiene, animal health and husbandry standards. This enables South African farmers to export their dairy products all over the world and sell to an increasingly at higher prices to an increasingly discerning local consumer base. The dairy industry has seen considerable consolidation over the past two decades, with the number of dairy farms dropping from 50,000 in 1997 to just under 1,400 in 2019. At the same time, average dairy herd size has increased to 350, with some 250 farms now having more than 1,000 head of dairy cattle.

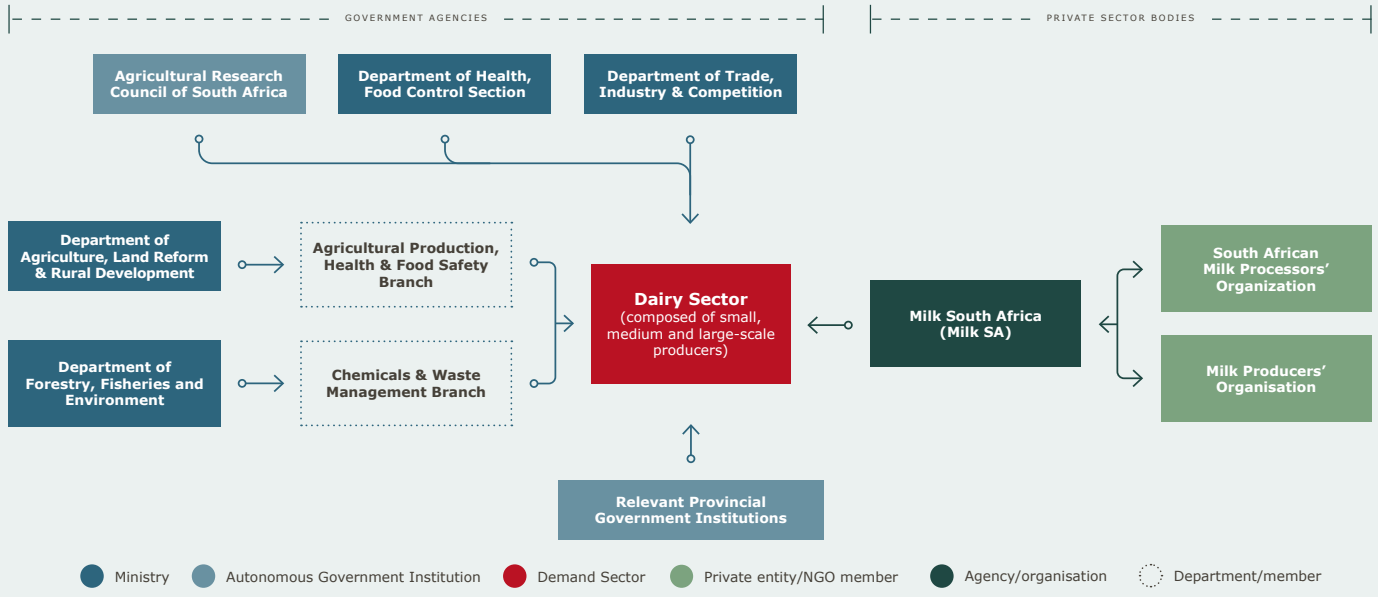
While South Africa is seen as a leader in promoting commercial-scale renewable energy in SSA, there is currently only one known dairy farm that has invested in AD-based cattle waste for independent power generation from this renewable source of bioenergy.[4]

One of South Africa's largest dairy farms, Uilenkraal Farms, located in West Cape Province, has the country's only diary livestock waste AD systems with two biogas generators each generating 330 kW from a large cow manure biogas digester (photo left). The electricity serves the entire dairy system from milking some 1000 dairy cattle to cooling the milk. However, its biggest load is the cattle feed production plant on the farm. The biogas system generates, on average, 75% of Uilenkraal's electricity consumed, while importing, on average, over the year some 25% of its electricity from Eskom. Half of its expenditures on electricity are for the 25% consumed from Eskom because the Eskom tariffs (peak and ordinary) are nearly double the biogas cost. This shows how financially important the biogas supply for electricity generation on-site is to the viability of the farm.

INSTITUTIONAL FRAMEWORK FOR DAIRY SECTOR

The Agricultural Production, Health & Food Safety Branch of the newly-created (2019) Department of Agriculture, Land Reform and Rural Development (DLR&RD), is the main support and regulatory body for South Africa's dairy sector.

Figure three: *Institutional framework for dairy sector in South Africa*



[4] The plant is at the Uilenkraal dairy farm in the Western Cape, which has been using cattle manure as feedstock for heat and electricity generation since 2014.

The Agricultural Research Council (ARC) provides development and capacity-building support for dairy cattle farmers and for dairy products.

The Chemicals and Waste Management Branch of the Department of Environment, Forestry and Fisheries is responsible for regulating dairy cattle waste management, disposal and utilisation, as well as dairy product waste management. The Food Control Section in the Department of Health is responsible for dairy product quality, standards and hygiene. The Department of Trade, Industry & Competition (DTI&C) is the primary body for regulating the commercial aspects of the dairy sector. The sector is very well-organised and represented by Milk South Africa (MilkSA), the Milk Processors' Organisation (SAMPRO), and the Milk Producers' Organisation (MPO), who work together both domestically and internationally to promote South Africa's dairy producers, processors and exporters. They work actively with government to set standards to support farmers to expand domestic and exported products. Further, these organisations work to assist the sector in diversifying products, improving quality and marketing, and increasing their members' revenues.

INSTITUTIONAL FRAMEWORK FOR ELECTRICITY SECTOR

On the energy side, Eskom is South Africa's near-monopoly national electricity utility, owning over 90% of the country's generation capacity, its electricity transmission, and supplying approximately 60% of South Africa's distribution networks.

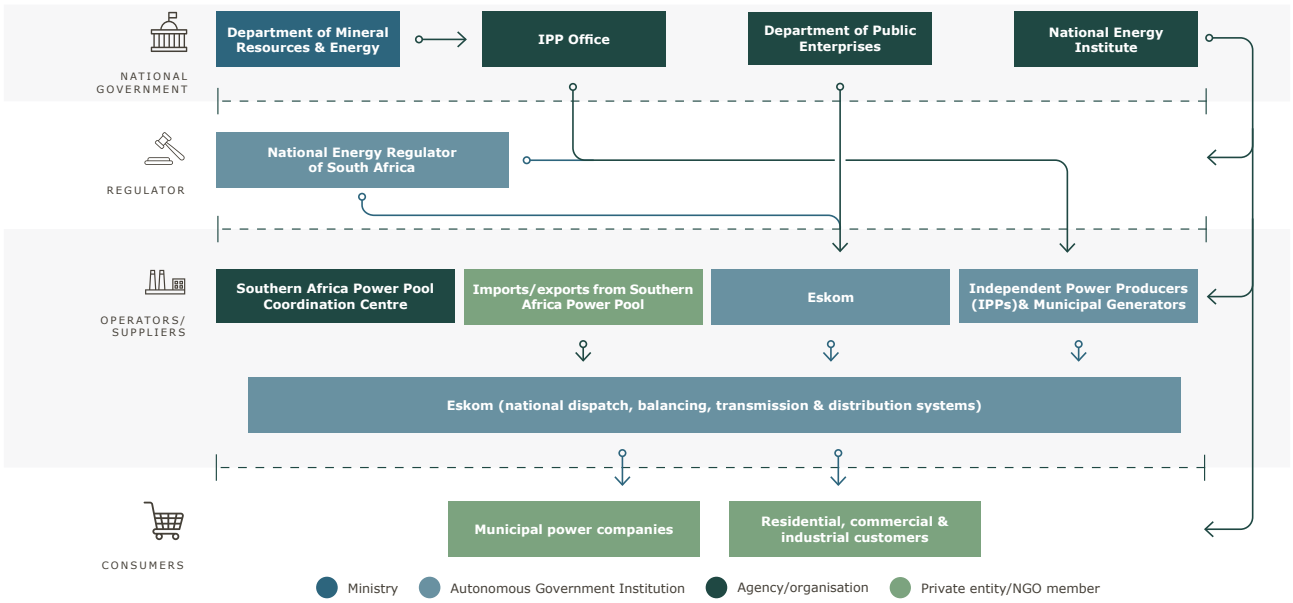
Eskom has shown little interest in diversifying generation from large-scale coal-fired and nuclear facilities to renewable sources. It suffers major problems with obtaining investment in its aging transmission and distribution systems, and rapidly aging coal-fired generation stock. Electricity shortages from Eskom have increased significantly since 2005.

The Department of Mineral Resources and Energy (DMRE) oversees South Africa's electricity sector. Its The Department of Public Enterprises is responsible for Eskom. The DMRE's predecessor, the Department of Energy, created the REIPPPP in 2011 to promote investment in renewable electricity from various sources, including bioenergy.

The REIPPP is run in conjunction with the National Treasury and the Development Bank of Southern Africa (DBSAT). The Programme is designed to stimulate innovative, commercially viable renewable energy investments, both to meet South Africa's rapidly growing electricity demand and to contribute to South Africa's aggressive climate change reduction targets by replacing coal-based power generation.

The Programme is operated by the IPP Office (under the DMRE). The IPP Office runs a bidding process consisting of a series of tenders (six rounds since 2011) targeting specific renewable energy resources and technologies. The IPP Office prepares tenders, manages tender reviews, and negotiates PPAs, working in conjunction NERSA, for successful project proposals. Winning bidders propose projects that best meet the most competitive proposed capacity, resource and power purchase prices for each bid. The REIPPPP has succeeded in securing investment in over 7.8 GW of renewable electricity since its inception – this compares to less than 700 MW of renewable electricity generating capacity in 2010, almost all of which was hydropower.

Figure four: *Institutional framework for electricity sector in South Africa*



The Electricity Department of NERSA works closely with the IPP Office in tendering and contract awards. Notwithstanding some delays during the process, REIPPPP has been a success due to clarity and certainty in procurement requirements, well-defined selection criteria, specific targets and knowledge that procurement offers through the REIPPPP are commercially bankable. These factors reduce risks to developers, financial institutions, local authorities and other stakeholders.

As noted, the REIPPPP sets an eligibility threshold of >1 MW generation capacity. All rounds, except for one round that targeted the 1-5 MW range, have set a threshold of 5 MW generation capacity or more. As such, small-scale power producers who generate ≤1 MW of electricity are not eligible to participate. The REIPPP is currently about to close its Bid Window 5 Request for Proposal (RFP) Including 1 600 MW from onshore wind energy and 1 000 MW from Solar Photovoltaic (Solar PV) power plants. Thus, while the REIPPPP has been very successful in massively increasing renewable electricity generation capacity over the past decade, it has squeezed out small-scale renewable electricity producers, particularly those using bioenergy, including dairy waste.[5]

On the consumer level, increasing numbers of large users are starting to buy from non-Eskom suppliers, or at least limit their exposure to Eskom through **(SSEGs).** The framework for SSEGs has been set up within Eskom and many municipalities (including City of Cape Town, Ekurhuleni and City of Johannesburg). SSEGs are typically <1MW and do not export power except in special cases of net metering, or banking of energy. South Africa's Integrated Resource Plan (IRP) which has a strong focus on reducing carbon emissions, has major targets for solar and wind, but nothing for bioenergy.

REGULATIONS AFFECTING WASTE DISPOSAL IN THE DAIRY SECTOR

Several regulatory bodies govern the disposal and use of dairy waste, including its treatment, disposal and use for gas or electricity production.

Manure, milk processing wastes and effluents associated with cleaning and disposing of those wastes are covered by both national and provincial laws and regulations under the **Agricultural Production, Health & Food Safety Branch; Food Control Section, Department of Forestry, Fisheries and Environment's (DFFE's) Chemicals and Waste Management Branch,** and the **Department of Health.**

There are no national or provincial regulations governing the spreading of manure on fields. Similarly, no permits or licences are required if a farm gives waste away, according to the **Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947** (amended in 1980). However, if a farm sells digestate, it needs to register with the above-mentioned bodies. This implies that a farm can spread its cattle manure as it wishes, but if it is upgraded (e.g. using AD) then a licence is needed if it seeks to sell it.

Generating **biogas for self-consumption or sale to other parties (i.e. as compressed gas)** requires a NERSA licence under the **Gas Act (No. 48 of 2001).** However, exemptions are granted for: i) any person engaged in the transmission of gas for own exclusive use; ii) small biogas projects in rural communities not connected to the national gas pipeline grid; and; iii) gas reticulation and any trading activity incidental thereto. **Producing bio-fuels (e.g. biogas) for transport, cooking or other uses for own use or sale** has no supportive legal framework or policy support although NERSA is responsible for registering and setting standards for gas (natural gas, biogas, etc.). The **Gas Act** only covers small-scale rural self-use. There are no effective standards for the installation of pipes and appliances for biogas use, and no standards for sale and quality use of biogas.

South Africa does not have an internal carbon trading system, although the DFFE is designing a **Climate Change Mitigation System** which could allow for such trading. The **Carbon Tax Act** was enacted in 2019, but its framework for carbon offsets has not been finalised. The Act allows the use of emissions offsets to reduce a qualifying entity's carbon tax liability by up to 10%. DFFE has proposed an initial carbon tax of ZAR 120/tCO2e, with up to 95% rebates, pegged to the consumer price inflation rate. This would cover direct emissions from within South Africa and only allow carbon offsets created within the country to reduce the carbon tax liability of a qualifying facility (e.g. factory, milk processor, etc.). This means that the Carbon Tax Act provides an incentive for dairy farms to use their residues for bioenergy.

[5] Small-scale (e.g. household) solar PV is an exception – by December 2019, over 250 MW of small-scale solar PV had been installed in South Africa.

REGULATIONS AFFECTING BIOENERGY IN THE DAIRY SECTOR

Until April 2021, any generation of electricity ≤1 MW required NERSA registration. If a dairy facility with ≤1 MW capacity wished to sell electricity to another party, all NERSA requires is the standard registration indicating that some or all its electricity will be for 'commercial use' – NERSA's approval process is the same as registering electricity generation for own-use. Since April 2021, the threshold for NERSA registration has dropped from 1 MW to 100 kW.

The costs and administrative issues for **wheeling** electricity from a small-scale producer to consumer lies with Eskom, effectively South Africa's electricity monopoly, as almost all electricity is transported over the Eskom grid from any **net energy generator (NEG)** to a consumer who purchases the electricity from the NEG at an agreed tariff. For a small-scale generator to sell to any customer, both the seller and the buyer must pay wheeling charges to Eskom for use of the grid (see introduction, above).

Eskom also permits **electricity offsetting** and **electricity banking**.[6] Under energy offsetting, a supplier with its own electricity generation exports any electricity not consumed on its premises to the Eskom grid by means of bi-directional meter (i.e. net metering). The surplus electricity exported to the grid is credited to the supplier's Eskom account. **Electricity banking** refers to the carrying over of electricity generated surplus to own use to the Eskom grid, which is 'banked' in the supplier's account. This is accounted for within a specific **time of use (TOU)** period, which corresponds to a billing month, and the surplus kWh are offset against the electricity consumed in the following month. However, any **banked electricity is 'retired' at the end of the Eskom electricity year** with no compensation to the supplier. In other words, Eskom always comes out on top financially for any wheeling, offsetting or banking contract, thereby discouraging small-scale generators to engage in selling electricity.

IMPACT OF REGULATIONS ON ADOPTION OF BIOENERGY IN THE DAIRY SECTOR

The environmental, institutional and regulatory setup does not encourage dairy farms to use their livestock wastes for electricity generation.

The environmental regulations provide minimal oversight for treatment of animal wastes on farms, so such waste can be spread on the land without regulatory constraint. This means there is no regulatory incentive to avoid this practice, by, for example, processing cattle manure through an AD system.

Power generation >1 MW can be eligible for support under the REIPPPP, although no tenders in the 1-5 MW range have been held for several years. Policies also exist that allow power producers ≤1 MW to use Eskom's grid for wheeling and for electricity offset and electricity banking. While Eskom's wheeling charges are fair by international standards, energy offsetting and banking offer few financial incentives for electricity generation for any small-scale renewable electricity producer. Customers can only benefit from electricity banking if their exports to Eskom are higher than their consumption. As noted, they must also forfeit any banked energy to Eskom at the end of the Eskom's financial (billing) year.

Moreover, the total banked energy per TOU period (one month) may not exceed the total energy consumed per TOU period in that banking year, i.e. a supplier cannot bank more than they have consumed in the banking year, known as 'the banked energy limit'. Thus, while banking allows a producer to levelise costs and revenues, it does not allow them to achieve a net gain. Eskom therefore always gains from a 'banking' arrangement with a supplier.

Finally, while the banked/offset electricity credit is valued at the same rate the customer pays Eskom, for each kWh consumed, imposes several charges for the use of the grid, including administrative and ancillary charges for wheeling, banking and offsets. Therefore, the compensation that the customer receives for each kWh of electricity exported Eskom's system is always less than the amount paid to Eskom for each kWh consumed. Again, the only reason for banking or generating offsets is to levelise electricity expenditures. For a farmer generating electricity, whose power production and demands may fluctuate seasonally, this can provide a business benefit, but, from a cash point of view, Eskom always gains the most.

Thus, until recently, South Africa has had a sophisticated system for selling electricity to the grid. Until April 2021, there was **no institutional, market or regulatory framework that specifically supports bioenergy development in the dairy industry for electricity producers using livestock wastes generating ≤1 MW**. This has now changed, although the details are to be worked out for any dairy producer wishing to generate electricity from biogas using cattle waste at sub-5 MW scale. Certainly, as in the past, surplus electricity may be wheeled to a third party via the grid but the details for such transactions are to be worked out.

[6] Generator use of system charges, Wheeling of energy, Offset (net billing) of energy, Banking of excess energy, Eskom, January 2020

NERSA, as the primary national body for regulating gas, is generally silent about the sale of biogas (e.g. as compressed biogas). Given that dairy sector biogas production is limited to very few players, and that biogas generation from all sources is still relatively limited in South Africa, there is little impetus for developing a more supportive institutional and regulatory framework to support biogas as an energy resource. It is only in the electricity sector that this framework is set out most clearly. If AD from dairy sector waste (and from other sources) is to progress and expand, changes, such as significantly reducing transaction costs to the supplier (and consumer, in the case of wheeling) to the grid, will be required in the electricity sector to make it more financially attractive.

RECOMMENDATIONS

Since mid-2020, the framework for electricity generation, wheeling on the grid, sales to third parties (including municipalities and companies) has changed significantly, and is in a major period of change and clarification of commercial and institutional arrangement. The following changes would make the regulatory and market environment more conducive to the production of electricity using AD from dairy farm wastes:

- Renewable electricity producers ≤1 MW should be permitted to participate in the REIPPPP or some other system to qualify for renewable electricity PPAs at favourable power purchase prices, with the support of the DMRE, Energy Department, the REIPPPP's IPP Office and NERSA; and
- Eskom needs to develop procedures and a framework for setting its transaction costs for small (≤1 MW) producers, and liberalise, reduce costs and administrative requires to promote wheeling of electricity on its grid to enable dairy biogas electricity generators to sell their surplus electricity to willing third parties.the DMRE, Energy Department, the REIPPPP's IPP Office

As noted, the IRP of October 2019 set targets and frameworks for the electricity sector that were both ambitious and favourable to small-scale bioenergy producers. Several Government Acts have already set this in motion. The modalities need to be worked out, but there is the potential to see revolution in small-scale renewable electricity, including biogas electricity from dairy farms, over the coming years. This is good news for small-and-medium-scale renewable electricity producers, not just in the dairy AD sector but elsewhere. This is one of those unique moments where the adage of 'watch this space' is particularly relevant for mall- to-medium scale dairy and other renewable energy AD electricity generation.

UKaid Transforming Energy Access

This material has been funded by UK aid from the UK government via the Transforming Energy Access programme; however, the views expressed do not necessarily reflect the UK government's official policies