METHANE CAPTURE AT LANDFILLS AND WASTE DUMPS FOR ENERGY PRODUCTION

TECHNOLOGY DESCRIPTION

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All solid waste disposal sites are the sources of landfill gas (LFG) emission. LFG is the mixture of methane and carbon dioxide with some minor additions. Methane can be used as alternative energy source. If not recovering, it is a significant source of GHG emissions. Thus, approximately 2.4 % of total amount of GHG emissions in Ukraine is caused by MSW disposal at landfills and waste dumps.

Methane capture from landfills is implemented using a series of wells and a blower/flare system. This system directs the collected gas to a central point where it can be processed and treated depending upon the ultimate use of gas. From this point, gas can be simply flared (thereby converting methane into CO_2) or used to generate electricity and/or heat, replace fossil fuels in industrial and manufacturing operations, or fuel greenhouse operations. Gas could also be upgraded (purified) to natural gas standards (biomethane).

Ukrainian technical standard DBN V.2.4-2-2005 "Solid waste landfills" includes such main provision as the utilization of landfill gas formed by the anaerobic decomposition of the organic component of solid waste. Landfill gas could be used as fuel for power plants (boiler units, industrial furnaces, stationary generators) or for refuelling in fuel tanks. The method of landfill gas utilization is determined during the technical specification development for the design of a landfill gas recovery system.

It is considered that the recovery and energy utilization of landfill gas makes sense with an average thickness of waste layer of at least 10 meters and one million tons of accumulated solid waste. Great importance is given to the time of accumulation for the required amount of waste. Typically, these conditions are met at landfills that accept waste from settlements with the total population of 200,000 inhabitants or more.

CURRENT TECHNOLOGY READINESS LEVEL OR COMMERCIAL READINESS INDEX

The technology is under reasonable development in Ukraine. Between 2008-2012, during the first commitment period of the Kyoto protocol, Ukrainian methane capture systems were implemented within joint implementation projects. The introduction of a "green" tariff for electricity produced from biogas and landfill gas resulted in a significant part of the energy potential of landfill gas being implemented by private companies. There were almost 30 MW_{el} of total installed capacity at 26 Ukrainian landfills and waste dumps by end of 2020. The total economic potential of existing Ukrainian landfills is evaluated as 40-50 MW in term of the installed electrical capacity.

Thus, technology readiness level for methane capture technologies in Ukraine is considered as an actual system proven in operational environment, commercial readiness as multiple commercial applications.

CLIMATE RATIONALE OF THE TECHNOLOGY

Landfill gas recovery is an effective environmental measure. As a result of landfill gas combustion (in power unit or by flare), GHG emissions are reduced, organic volatile compounds responsible for unpleasant odours are destroyed and the probability of fire events is reduced or eliminated. In addition, landfill gas is a local and renewable energy source that can be used as a substitute for any kind of fossil fuel like coal, oil and natural gas.

The combustion of landfill gas for the production of energy contributes to the reduction of GHG emissions (and therefore to climate change mitigation) in two ways. Firstly, landfill gas capture prevents the release of methane into the atmosphere and secondly, the electricity subsequently produced by landfill gas combustion produces less CO_2 emissions than conventional fossil fuel combustion. Total potential for the reduction of GHG emissions is evaluated as 1.7 Mt CO_2-eq./yr for present Ukrainian conditions.

According to the Updated Nationally Determined Contribution of Ukraine[1] to the Paris Agreement (NDC2), landfill gas capture with the purpose of energy production is one of the key measures to be introduced in the national municipal solid waste (MSW) management system to achieve the target on GHG emission reduction in the Waste sector by 2030.

AMBITION OF THE TECHNOLOGY

SCALE FOR IMPLEMENTATION AND TIME-LINE

In spite of the fact that technologies of mechanical biological treatment of waste with biogas production will probably, in future, be developed in specialized reactors, a certain part of landfill gas potential may be related to the construction of regional sanitary landfills in the framework of the waste management strategy by 2030 and beyond. The role of landfilling will remain significant in Ukraine for at least several decades. The concentration of waste resources on a large scale and in strict compliance with operation rules for sanitary landfills would allow a recovery of up to 75-85% of the generated landfill gas and even the total amount of landfill gas will be reduced due to avoiding direct landfilling of biodegradable waste.

The number of landfills equipped with LFG recovery with energy production have to gradually reach 50 units in 2040 to ensure that the waste sectoral goal stated in the NDC2 is achieved as well as the National Waste Management Strategy of Ukraine is fully implemented with ten-year postponement. Thus, the countrywide scale for LFG recovery technology with energy production is to be equipped at 50 largest landfills by 2040.

EXPECTED IMPACTS OF THE TECHNOLOGY

The process of LFG projects development creates jobs associated with the design, construction and the operation of energy recovery systems. LFG projects involve engineers, construction firms, equipment vendors and utilities or end-users of the power produced. Many of these costs are spent locally for drilling, piping, construction and operational personnel, helping communities to realize economic benefits from the increased employment and local sales. By linking communities with innovative ways to deal with their LFG, it helps them to enjoy the increased environmental protection, better waste management and responsible community planning. In some cases, there is additional payment by the project sponsor to support community programmes for stakeholders, including support for people living nearby the sites and who are affected by the project

LFG projects improve groundwater quality as the management of the site could relatively easily be combined with leachate collection and disposal action. The improvement of local air and safety (fewer emissions of SOx, NOx, and particulates) is achieved through the reduction of landfill gas released into the air and burning less fossil fuel (coal, natural gas) for electricity generation.

LFG projects are also reduce the risk of dangerous methane gas concentrations in landfills and reduce the exposure of residential areas to odour.

[1] Published in 2021, available at: https://bit.ly/3ik1wMQ

EXISTING POLICIES IN RELATION TO THE TECHNOLOGY

The feed-in tariff (FiT "green tariff") for power from biomass/biogas/landfill gas is the main driver for the technology development. The FiT for electricity produced from biomass/biogas/landfill gas is fixed in euros until 2030 (0.1239 EUR/kWh without VAT). The tariff is converted into national currency on a quarterly basis.

In order to facilitate transformation processes on the basis of the EU principles and practices, the National Waste Management Strategy up to 2030 was approved by the Cabinet of Ministers of Ukraine in 2017 as well as National Waste Management Plan up to 2030 in 2019. These documents consider that 50 new regional sanitary MSW landfills would be constructed by 2030. It's expected that all of them would be equipped with landfill gas recovery technology. However, it is possible that the National Waste Management Strategy up to 2030 will not be fully implemented by 2030 in part of development of modern MSW landfill infrastructure.

PROPOSED POLICIES/MEASURES TO ENHANCE TECHNOLOGY IMPLEMENTATION

In order to achieve the GHG emission target in the Waste sector, which was set up in the NDC2, the following main policies and measures are proposed to be implemented for dissemination of technologies for methane capture at landfills and dumps for energy production:

1. The creation of necessary infrastructure:

1.1. Monitoring of existing disposal sites conditions by means of created MSW disposal sites inventory (2022-2024).
1.2. Implementation of waste disposal sites phase out plan by means of development and adoption of list of MSW disposal sites, which operation has to be stopped (2024-2025).
1.3. To ensure simplified access conditions to the existing infrastructure for the landfill gas (LFG-to-E) projects (2025-2040).

2. The creation of economic and financial conditions for regional landfill construction and old waste dumps closure:

2.1. To introduce high gate fee/tax for waste disposal and CO_2 emission (2022-2024).
2.2. To develop economic and financial conditions for the use of landfill gas not only for electricity, but also for heat and upgrading to biomethane quality (2022-2024).

3. The provision of long-term and low-interest loans or grants through state funds, private sources and international funds:

3.1. To support access to the funding to the LFG energy recovery projects by means of low-interest loans (national and international agencies) (2021-2022).
3.2. To promote training in development of proposals for funding (2022-2024).
3.3. To create granting mechanism for successfully prepared and approved proposals on new LFG energy recovery projects (2024-2030).

4. The creation of the stakeholder and technical expert networks for technology development and transfer:

4.1. To promote cooperation between the stakeholders by means of the platform creation for national technical experts and stakeholders based on governed or non-government organizations (2022-2024).
4.2. To promote exchange of information and lessons learned by means of organizing info campaigns, workshops and conferences (2024-2030).

COSTS RELATED TO THE IMPLEMENTATION OF POLICIES

Capital expenditure for landfill gas recovery and utilization system depends on size and physical conditions at landfills and solid waste dumps. The specific cost of the project, which involves the production of electricity from landfill gas, usually ranges from 1500 to 2500 €/kW_{el} of the installed electrical capacity. The lower value is mostly associated with controlled landfills, and the upper one with waste dumps. There are at least two reasons for that. At uncontrolled waste dumps, it is possible to collect less landfill gas per unit of accumulated waste. In addition, the construction of recovery system at waste dumps involves additional costs because of the complex geometry of the waste body and the requirement to form the upper airtight layer covering the waste.

USEFUL INFORMATION

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LINKS TO TNA REPORTS

Reports prepared within the TNA Project:

- Technology Needs Assessment
- Barriers Analysis and Enabling Frameworks
- Technology Action Plan

Full texts of the TNA reports are available at: https://tech-action.unepdtu.org/country/ukraine/

TNA Project page at the web-site of the Ministry of Environment and Natural Resources of Ukraine: https://menr.gov.ua/news/33450.html