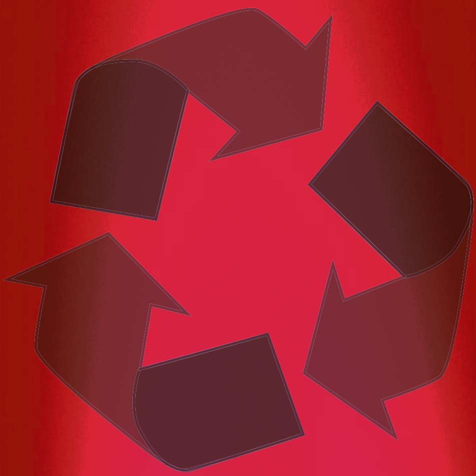

Turning a Liability into an Asset: the Importance of Policy in Fostering Landfill Gas Use Worldwide

January 2009

International Energy Agency

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- To maintain and improve systems for coping with oil supply disruptions.
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations.
- To operate a permanent information system on the international oil market.
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Introduction

Solid waste disposal sites are not often seen as opportunities for energy solutions. Landfill gas (LFG) – a mixture of methane, carbon dioxide and trace constituents – is typically viewed as a liability because of concerns about explosions, odours, and increasingly, climate change. However, LFG can be turned into an asset. Many countries regularly capture LFG as a strategy to improve landfill safety, reduce odours, generate electricity, reduce greenhouse gas (GHG) emissions, and to earn GHG reduction credits. Developed countries have addressed growing concerns about climate change while making a profit from energy projects using landfill gas; while projects in developing countries are taking advantage of the United Nations Framework Convention on Climate Change (UNFCCC) Clean Development Mechanism (CDM) to earn GHG credits by capturing and combusting methane. These landfill gas-to-energy (LFGE) projects provide a valuable service to the environment and a potentially profitable business venture, while contributing a new energy resource to local and regional communities.

As part of its work to develop strategies for a clean energy future, the International Energy Agency (IEA) is undertaking a strategic initiative to highlight methane energy recovery opportunities. This is one of a series of papers meant to highlight opportunities for cost-effective reductions from oil and natural gas facilities, coal mines, agriculture, and landfills. This report can be used by energy, environment, waste management, and climate change experts and policy makers to make LFG utilisation a part of clean energy production, sanitary waste disposal, and greenhouse gas reduction policies.

The purpose of this document is to identify and examine global policies, measures, and incentives that appear to be stimulating LFG use. As certain countries have made great advances in LFGE development through effective policies, the intention of this report is to use information from the IEA's Global Renewable Energy and Energy Efficiency Measures and Policies Databases to identify and discuss policies. By consolidating this information and categorising it according to policy type, the attributes that are most appealing or applicable to the circumstances of a particular country or area – technology demonstration, financial incentives, awareness campaigns, etc. – are more easily identified.

The report begins with background information on LFG and sanitary landfill practices, including a discussion of regional disparities, followed by a description of LFG mitigation technologies. Barriers to LFGE projects are then outlined. An explanation of the importance and effectiveness of policy measures leads into a discussion of types and examples of measures that are being used to overcome these barriers and encourage LFGE development. The report concludes with lessons learned, recommendations for further study, and resources where more information can be found.

Background

Methane as a Greenhouse Gas

Methane, the major component of natural gas, is also a potent greenhouse gas. It is 21 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year time period.[1] Methane is the second-most significant GHG after CO_2, accounting for 16% of global GHG emissions (Figure 1). The chemical lifetime of methane in the atmosphere is approximately 12 years. This relatively short atmospheric lifetime makes it an important candidate for mitigating global warming in the near term. Several studies (Fisher, et al, 2007) have assessed the importance of mitigating methane emissions early, due to the immediate climate impacts that are realised.

The detrimental impacts of uncontrolled landfill gas are not confined to its climate change impact. It has odorous, toxic, and carcinogenic trace components. LFG is potentially flammable and explosive when concentrated in confined spaces. Long-term exposure may have harmful health effects; and it can damage vegetation.[2]

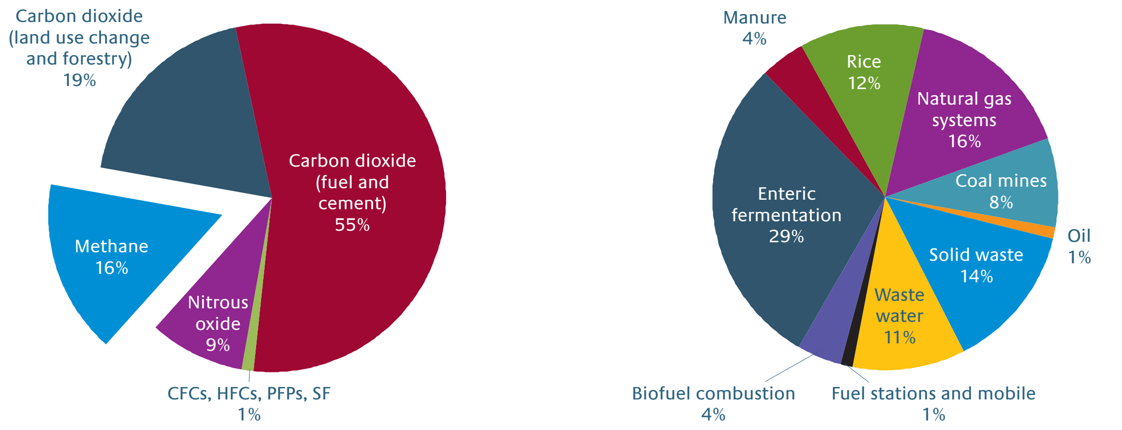
Sources of Anthropogenic Methane

Methane is emitted from a variety of human-related (anthropogenic) and natural sources. Slightly over half of the total emissions results from human activity (UNEP, 2002). Anthropogenic sources include fossil fuel production, agriculture (enteric fermentation in livestock, manure management, and rice cultivation), biomass burning, and waste management. Methane emissions vary significantly from one country or region to another, depending on factors such as climate, industrial and agricultural production, energy resources and usage, and waste management practices. Methane emissions from energy- and waste-related activities comprised approximately 36% of the global anthropogenic methane emissions in 2000.

Since the mid-1700s, global average atmospheric concentrations of methane have increased 150%, from approximately 700 to 1 745 parts per billion by volume (ppbv) (IPCC, 2001). Although methane concentrations have continued to increase, the overall rate of growth during the past decade has slowed, largely due to mitigation efforts in several nations, including the European Union, the United States, Canada, and Japan (EPA, 2006). In the late 1970s, the growth rate was approximately 20 ppbv per year. In the 1980s, growth slowed to between 9 ppbv and 13 ppbv per year. From 1990 to 1998, methane grew by up to 13 ppbv per year (IPCC, 2001). The rise from 2006 to 2007 is the highest annual increase observed since 1998, although it is unclear whether this represents the start of a new upward trend (WMO, 2008).

1. The global warming potential of methane in the IPCC's Fourth Assessment Report (2007) is 25 over 100 years.
2. See "Key Issue: Management of Landfill Gas," International Solid Waste Association (ISWA), http://www.iswa.org/c/portal/layout?p_l_id=PUB.1.33.

FIGURE 1: GLOBAL GREENHOUSE GAS EMISSIONS IN 2000 AND ANTHROPOGENIC METHANE SOURCES



Source: *Energy Technology Perspectives 2008*, IEA.

Municipal solid waste (MSW) management contributes 14% of total global methane emissions, as shown in Figure 1. Methane is produced through the natural process of the bacterial decomposition of organic waste under anaerobic conditions in sanitary landfills and open dumps. Methane makes up approximately 50% of landfill gas, the balance being mostly CO_2 mixed with small quantities of other gases. If LFG is not actively collected, it escapes into the atmosphere.

Landfill Gas and Waste Disposal

The amount of LFG generated has a great deal to do with the type of waste disposal site. There are different classifications for waste disposal sites, depending on management practices: open dump, controlled or managed dump, or sanitary landfill. Open dumps are characterised by widely spread uncovered waste, periodic fires, no recording or inspection of incoming waste, no control of waste placement or compaction of waste, no or minimal cover, and unmanaged leachate and landfill gas. Managed dumps are somewhat better maintained than open dumps; typically with features like rainwater management, simple cover materials and improved inspection of incoming waste. Open and controlled dumps are less conducive to landfill gas production because of aerobic conditions, shallow layers, and unconsolidated disposal.[3]

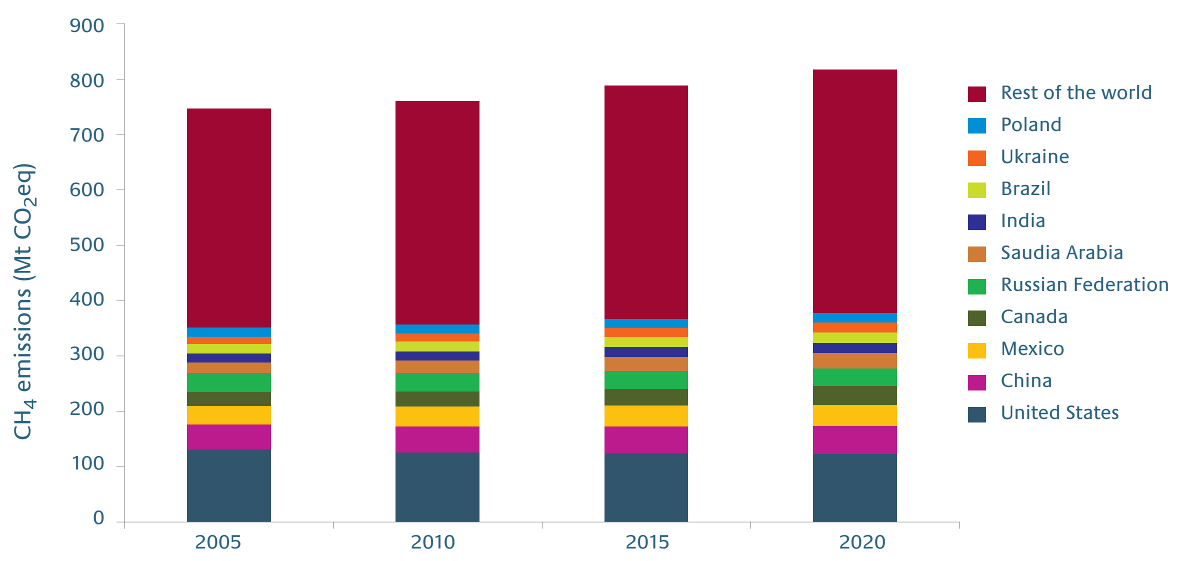
Sanitary landfills use waste management practices such as mechanical waste compacting and the use of liners, daily cover, and a final cap; and produce more LFG than open dumps because of the anaerobic conditions they facilitate. Sanitary landfills are more likely to be located in developed countries, where LFG regulation and utilisation decreases the overall emissions. Developing countries are far more likely to have open and managed dumps – some may have a mix of all three types, with sanitary landfills in large cities, managed dumps in larger townships, and open dumps in rural and some urban sites (EPA, 2006). The costs of closing an open dump are often seen as prohibitive in developing countries where investments in other basic

3. "Key Issue: Closing of Open Dumps," ISWA, http://www.iswa.org/c/portal/layout?p_l_id=PUB.1.33.

infrastructure improvements (such as wastewater treatment) are generally made a higher priority. In the long term, however, the costs related to impact of an unmanaged waste site on the health of the public and the environment may be much greater than the cost of closure. For this reason, the goal should be to make waste disposal as controlled and as sanitary as possible.[4]

The United States, China, Russia, Mexico, Canada, and Southeast Asia are the main contributors of methane emissions from solid waste management (Figure 2). Methane emissions from landfills are expected to decrease in industrialised countries and increase in developing countries. Industrialised countries' emissions are expected to decline as the result of expanded recycling and composting programmes, increased regulatory requirements to capture and combust LFG, and improved LFG recovery technologies. Developing countries' LFG emissions are expected to increase due to expanding populations, combined with a trend away from open dumps to sanitary landfills with increased anaerobic conditions.

FIGURE 2: METHANE EMISSIONS FROM SOLID WASTE MANAGEMENT



Source: *Energy Technology Perspectives 2008*, IEA.

Regional Differences and Waste Disposal Hierarchy

It is important to note the regional differences in landfill practices and the importance of slow advancement toward the use of sanitary landfills, with possible leachate treatment and LFG capture and combustion or use. As noted previously, developing countries are more likely to dispose of waste in open or minimally managed dumps. Before these regions can consider managing leachate and landfill gas, they will need to begin upgrading waste management practices. The importance of proper solid waste management as a foundation for LFG recovery and use cannot be understated; the following summary is provided to aid in better understanding regional solid waste practices (UNEP, 2005).

4. Ibid.

Africa

The vast majority of waste disposal sites in Africa are open dumps. While statutory or regulatory requirements for the construction of sanitary landfills may exist, a lack of financial and human resources leads to a failure of compliance. Landfill siting is usually decided based upon factors like access to collection vehicles rather than environmental and public safety considerations. Site construction seldom includes liners, fences, or the application of a daily cover; leachate or LFG management are also rare due to their higher costs and the need for technically trained personnel. Some countries have recently made improvements to landfill practices, including Egypt, Tunisia, and South Africa.

East Asia and the Pacific

In the developed areas of East Asia and the Pacific, sanitary landfills are the most common method of waste disposal. Costs of landfilling have risen as disposal sites are exhausted and stricter environmental regulations are imposed. Countries like Japan and Australia classify their landfills according to the presence of hazardous waste, and implement leachate and gas control measures.

In the developing countries in this region, open dumping is the main disposal method. While some sites use clay liners, little consideration is paid to leachate or gas control. Because of the high percentage of organics and plastics that are conducive to anaerobic digestion, landfill gas builds up quickly and has led to fires in cities such as Bangkok and Manila.

While some cities in the developing countries of this region, including Bandung, Jakarta, and Manila, have had success in designing and operating sanitary landfills; overall, the open dumps that predominate have led to environmental and health problems.

South and West Asia

Open dumps are the most prevalent waste disposal method in this region. Most areas have crude dumping practices with little or no cover. Some metropolitan areas designate sites as landfills, but these operations lack most of the conditions of a sanitary landfill such as covers, leachate collection/treatment, compaction and proper site design. LFG capture has been tried on an experimental basis. Throughout the region, fires are common.

Europe

Europe has made great advances in landfill practices over the last 20 years, going from mainly small, minimally controlled municipal landfills to regional systems with a number of safety and pollution control features such as LFG and leachate management systems. As more environmental requirements have been implemented, economies of scale are improved, leading to large, capital-intensive landfill construction. European landfills commonly flare or utilise LFG to minimise pollution and greenhouse gas emissions. There are also a number of bioreactor landfills, where moisture – sometimes leachate – is recirculated to stabilise the landfill sooner than under usual conditions.

Latin America and the Caribbean

Improved solid waste management is becoming an increasingly common practice in Latin America and the Caribbean. Many of these landfills would be more accurately described as managed dumps. There is often some type of daily cover, but no liner, leachate collection, and environmental monitoring. In some larger cities, liners and leachate management systems may be put in place. LFG is produced quickly because of the high organic content of the waste. However, only a few landfills have instituted gas collection systems.

North America

Landfills store 60-70% of North America's municipal solid waste. The fraction of MSW that is landfilled has declined recently, but the total amount generated has increased. Landfills in North America typically have liners, leachate collection systems, final covers, and other features designed to minimise environmental hazards. Landfill gas recovery for energy production is proven and commercially available. There are approximately 460 operational LFG energy projects in the United States. In addition, about 60 projects are currently under construction or are exploring development options and opportunities.[5]

Landfill Regulation and Enforcement Challenges

A number or developing and newly industrialised countries have recently begun to pass regulations on waste disposal and landfill gas capture and flaring. These countries face unique challenges in the enforcement and monitoring of regulations, as they must replace the existing disposal routines and ensure that the new practices are consistently and properly enforced.

India's organic dumping ban illustrates some of the potential difficulties. In 2000, recognising the environmental problems associated with MSW, the Ministry of Environment and Forests notified a new set of rules under the Environment Protection Act of 1986, (the Municipal Solid Waste Rules 2000) governing MSW collection, transport, processing, and disposal. The rules require a major restructuring of waste collection and processing. Specifically, they require that all organic waste be sorted and processed separately and not be dumped into landfills, with the goal of reducing methane production in landfills. To date, few municipalities have made significant progress in implementing the new rules (GOI, 2000).

Further, the experience from other similar countries shows that even with advanced MSW collection and processing, considerable amounts of biodegradable material continue to be dumped into landfills.[6] Recognising the difficulties in monitoring and enforcing this ban, the Ministry is considering revising the rule. Even if future MSW is less rich in organic material, current landfills sites rich in organic material will continue to generate LFG for considerably longer (10-30 years), although production decreases significantly with time, meaning the potential for landfill gas capture will remain for at least one or two decades. Capturing and utilising this LFG could help fund the transformation of India's waste disposal sites from open and managed dumps to sanitary landfills.

Eligibility for CDM projects is another complicating factor for countries that regulate LFG capture and use. See text box on page 14 for more information.

SOURCE: *TURNING A LIABILITY INTO AN ASSET: LANDFILL METHANE UTILISATION POTENTIAL IN INDIA*, IEA 2008.

5. See http://www.epa.gov/lmop/accomplish.htm for more details.
6. See methanetomarkets.org for more information.

Landfill Gas Mitigation Technologies

The technology for LFG extraction is mature and widely available, and there are a number of options for LFG use. LFG can be extracted from landfills using a series of wells and a vacuum system that directs the collected gas to a point to be processed. To effectively manage landfill gas, an active extraction system is necessary. This would include some or all of the following: vertical gas extraction wells; horizontal gas collection trenches; collection piping to move the gas to a central location for processing; condensate-handling equipment; blowers/compressors; water knockout tanks, dehydrators, or other scrubbers; flares and flame arrestors; and/or engine-generator sets or other energy recovery facilities. These various components work to extract the LFG and to prevent water condensation that would cause blockages in the system.[7]

Once the gas is collected, it may be flared, used for electricity production, used directly, or upgraded to pipeline-quality natural gas. Historically, flaring has been the most common manner of removing the landfill methane from the atmosphere (Figure 3 depicts a landfill gas flare). The main benefit of flaring is the improvement to the environment and public health through the removal of harmful emissions. Additionally, flaring reduces volatile organic compounds and mitigates odour (EPA, 2006).

FIGURE 3: LANDFILL GAS ENERGY SYSTEM

Source: Landfill Methane Outreach Program, EPA.

7. "Key Issue: Management of Landfill Gas," ISWA, http://www.iswa.org/c/portal/layout?p_l_id=PUB.1.33.

While flaring has proven effective in reducing methane emissions that contribute to global warming, it misses an opportunity to turn LFG into an asset. Where economically viable, it is preferable to use LFG as an energy source. Landfill gas can be used for a variety of purposes, for example, to produce electricity or as an alternative fuel for local industrial customers or other organisations that need a constant fuel supply. Such "direct use" of LFG is reliable and requires minimal processing and minor modifications to existing combustion equipment. Although annual benefits and savings change depending on the market price of natural gas, and the quantity and quality of the LFG, an estimate based on the 2004 price of natural gas in the U.S. indicates that the annual benefits can be up to 10 times as great as annual costs (EPA, 2006).

One application for the direct use of LFG is leachate treatment. Methane is not the only harmful substance that landfills produce if left unchecked – as rainwater infiltrates a landfill, wastewater accumulates, forming leachate. Leachate contains dissolved organic matter and other compounds that can degrade the environment by polluting groundwater and surface water (Kjeldsen, et al, 2002). To avoid costly treatment and disposal options, LFG can be used as a fuel to evaporate leachate on-site. In the United States, nearly 20 projects of this type are already operational.[8]

Other direct-use projects range from the most fundamental to the quite inventive. LFG can replace natural gas, coal, or fuel oil in boiler applications, reducing the need for fossil fuels. Combined heat and power and district heating systems are another type of application. LFG can be harnessed for direct thermal uses, including dryers, infrared heaters, and pottery kilns. It can also fuel greenhouse and aquaculture (fish farming) operations (LMOP, 2008a).

A third, emerging option is to create pipeline-quality gas or alternative vehicle fuel. There are over 20 projects of this type worldwide. Upgrading the landfill gas involves a large investment in purification. As such, conditions for the production of pipeline-quality natural gas from LFG are more economically advantageous in countries like the Netherlands where requirements for natural gas are not as stringent as, for example, the United States (Willumsen).

8. See http://www.epa.gov/landfill/docs/distributiondirect.pdf.

Barriers to Increased Use of Landfill Gas

While the technology is mature and there are many options for landfill gas use, there are some barriers faced by LFGE projects, including higher capital costs, regulatory issues, lack of awareness, and interconnection challenges.

Capital Costs

As noted in the background section, it is difficult for some solid waste management sites to make the investment needed for basic safety and environmental measures, let alone more advanced practices like LFG capture and use. However, as referenced in the India text box above, LFG sales offer the potential for a new revenue source that may offset the cost of capital. In developed countries, where it is more feasible to install LFGE systems, costs may still pose a barrier to installation. When the alternative of not installing any system or simply flaring the LFG exists, investors are unlikely to put forth the capital needed for a landfill gas capture and utilisation scheme unless it will be sufficiently profitable to justify the setup and maintenance costs. For this reason, some countries have enacted subsidies and other schemes to support LFGE.

Lack of Awareness among Industry and Policy Makers

Another challenge for the future development of LFGE projects is to increase awareness of the existence of LFG emissions and the value of the lost fuel, especially in countries such as China, Ukraine, India, and Russia, which have rapidly growing energy and waste sectors. Policy makers may not understand the full extent of the harmful effects of LFG, particularly with regard to climate change. They may also not realise how LFG can be used for electricity production or the range of direct use possibilities. Solid waste site owners also lack clear, unbiased information about costs and performance of various LFG use options.

Electrical System Interconnection and Other Policy Issues

Another potential barrier is inconsistent, complicated, or poorly devised standards for connecting LFG power projects to the grid. Because there is typically very low electricity consumption at solid waste sites, LFGE projects need to sell power to make a project viable. While it is important to establish interconnection conditions that smaller-scale generators must meet – such as safeguards, grid upgrades, operating restrictions, and application procedures – these standards can be an obstacle to smaller-scale systems if they are subjected to the same expensive, lengthy processes as large power generators. Greater regulatory oversight and attention is needed to provide safe, effective, yet reasonable interconnection standards for LFGE and other smaller-scale generators (EPA, 2006). This is one example of how policy inconsistencies can pose a problem for LFGE investment. Uncertainties in the regulatory environment can dissuade investors from supporting LFGE projects. In the absence of laws governing landfills and LFG, there are no requirements or incentives to motivate developers.[9]

9. See http://methanetomarkets.org/resources/factsheets/landfill_eng.pdf.

The Importance of Policy

These barriers can and have been addressed in individual countries, using targeted policies. Analyses from the IEA and other experts demonstrate the advances that can be made through effective biogas and LFG policy making.

The International Energy Agency's examination of renewable energy policies of major countries in its Deploying Renewables report highlights the countries with the most effective policies for encouraging electricity production from biogas. Biogas includes the anaerobic digestion of organic materials producing biogas (agricultural biogas), sewage gas, and landfill gas. In the period analysed, 2000-05, the highest growth of biogas generation took place in Germany, the UK, and Luxembourg. Germany and Luxembourg achieved their growth rates through feed-in tariffs, while the UK's success is attributed to a quota obligation system with tradable green certificates (TGCs). Italy's quota obligation system with TGCs also demonstrated a high degree of effectiveness. The study finds that the growth in the UK and Italy is based on expansion of LFG capacity, which can produce methane more cheaply than other biogas feedstocks. In addition to the proven policies of Germany, the UK, and Luxembourg, new feed-in tariffs in the Czech Republic and Portugal proved to be highly effective in 2004-05 (IEA, 2008a).

A number of experts have asserted that developed countries' initiatives to reduce methane emissions from landfills have contributed to the slower growth of atmospheric methane concentrations. The U.S. Environmental Protection Agency (EPA) attributes the decline in baseline methane emissions in the United States to a portion of the Clean Air Act dubbed the "Landfill Rule," as well as increased LFG usage in general.[10] In the United States, the number of LFG utilisation projects more than tripled between 1990 and 2008, from 130 projects to 460 as of December 2008 (LMOP, 2008b).

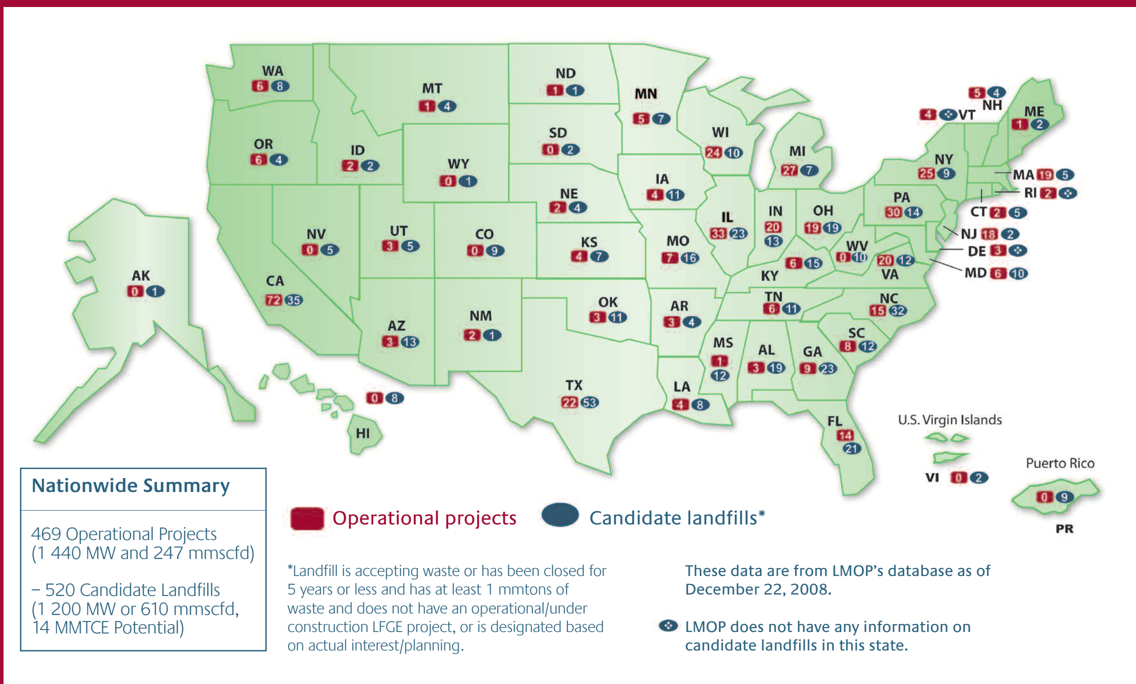
10. The Landfill Rule requires all landfills that have a capacity greater than 2.5 million metric tonnes (Mt) and 2.5 million cubic metres to collect and control LFG through flaring or utilising for energy (EPA, 2006).

U.S. State-Level LFG Policies

A number of Federal policies have had an influence on landfill gas projects, including Clean Air Act regulations, Clean Renewable Energy Bonds (CREBs), and Section 45 of the Internal Revenue Code of 1986, which has been amended several times (LMOP, 2008a). Yet the number of LFGE projects varies greatly from state to state. To a large degree, this is due to disparities in resource availability. The other major factor is state-level policy.

California, New York, Illinois, Michigan, and Texas comprise 60% of the solid waste in landfills that use gas collection. However, approximately 50% of the total area devoted to landfill gas recovery is located in California, New York, Illinois, Michigan, and Pennsylvania. What places Pennsylvania in this category rather than Texas are its strong policy measures. EPA's Landfill Methane Outreach Programme (LMOP) lists four programmes in Pennsylvania in its inventory of state incentive programmes for LFG: The Alternative Fuels Incentive Grant Programme; Energy Harvest Grants; Pennsylvania Energy Development Authority Grants, Loans, and Loan Guarantees; and Sustainable Energy Funds (LMOP, 2008c). No incentives are recorded for Texas. Similarly, while California has substantial resources for LFG utilisation, it has the most landfill gas facilities in the U.S. at least partly because of state and local requirements for collecting and controlling gas (Themelis and Ulloa, 2007).

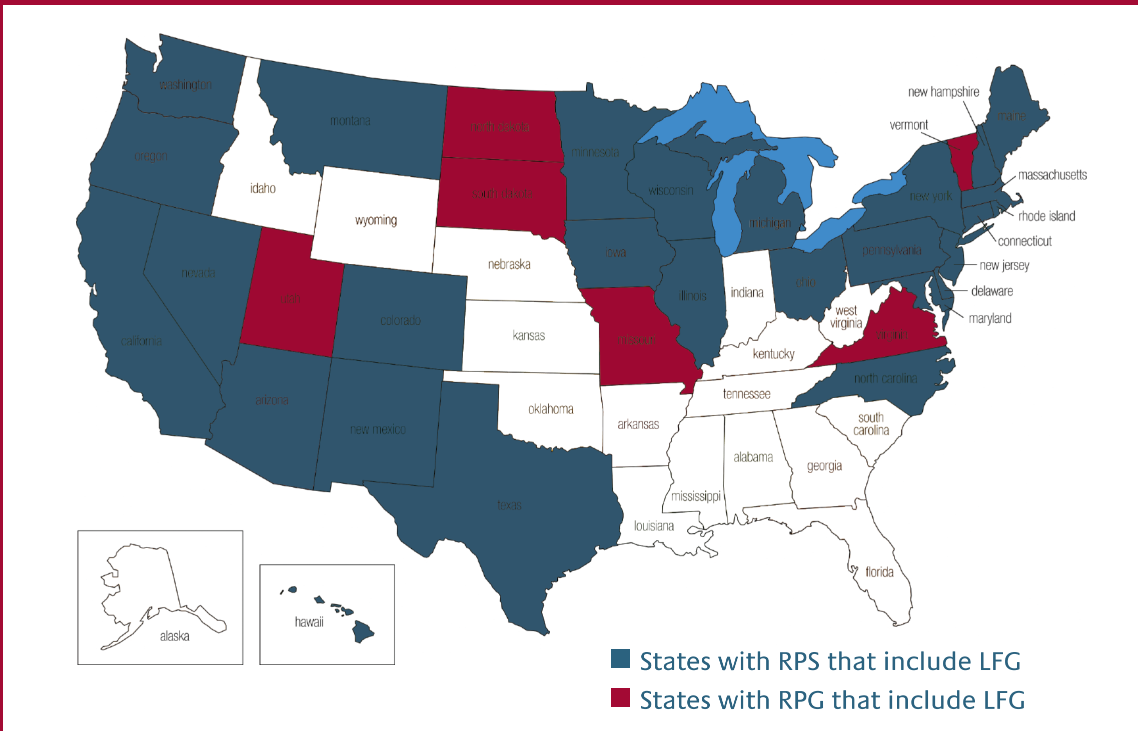
FIGURE 1: LANDFILL GAS ENERGY PROJECTS AND CANDIDATE LANDFILLS



SOURCE: LMOP, EPA, HTTP://WWW.EPA.GOV/LANDFILL/DOCS/MAP.PDF.

In the United States, a national Renewable Portfolio Standard (RPS) has not been enacted. However, many states have used this policy, with benefits for LFGE. As of October 2008, 32 states and the District of Columbia have enacted an RPS or Renewable Portfolio Goal (RPG; i.e.,non-mandated goal). All of these standards/goals include LFG as an eligible renewable energy source.

FIGURE 2: STATE-LEVEL RENEWABLE PORTFOLIO STANDARDS/GOALS IN THE U.S.



Source: LMOP, EPA, http://www.epa.gov/landfill/res/guide/state_rps.htm.

Aside from an RPS or RPG, state incentives for LFGE projects include grants, loans, production incentives, and tax credits and exemptions (M2M, 2005). For more information on state-level LFG policies in the United States, see LMOP's database of state, federal, and foundation resources for landfill gas energy projects at http://www.epa.gov/lmop/res/guide/state_resources.htm.

This evidence suggests that favourable policies can have a significant effect on LFG utilisation and corresponding greenhouse gas mitigation, and there is vast potential that remains to be tapped. Success stories in biogas and LFG use for energy and electricity production are evidence of the potential for LFG to decrease emissions that contribute to climate change and reduce the need for fossil fuel energy. The following section lists more detail on specific policies that have been designed to overcome specific LFGE barriers. As this assumes that the fundamentals of sanitary landfill practices are in place, the list is mainly comprised of policy examples from developed nations.

Policy Tools

Policy tools encourage LFGE projects through providing financial incentives, clear and consistent regulatory signals, education and awareness campaigns, and support for technology development and demonstration.

Financial Incentives

The driver behind LFG recovery system installations in developed countries is usually regulation. In developing countries, on the other hand, the decision to capture and use landfill gas is generally financially motivated (Spokas, 2007). For this reason in particular, it is important to examine the financial setting (e.g., prevailing electricity and gas rates) and the mechanisms that make landfill gas capture and use economically feasible such as GHG sales revenue, feed-in tariffs, tax relief, and mandates for the purchase of LFG energy.

GHG sales revenue

A significant financial incentive for running emission reduction projects in developing countries is the possibility of receiving Certified Emission Reductions (CERs) certificates under the Clean Development Mechanism (CDM) for GHG reductions associated with LFGE projects. The CERs can be purchased by Annex I countries to make up for shortfalls in reaching targets in emission reductions under the Kyoto Protocol targets. They can then be traded on carbon credit markets (e.g., the European Climate Exchange). A landfill site such as India's Deonar Landfill Site capturing and combusting around 7 000 m^3 of LFG per day will save around 18 000 tonnes CO_2 eq per year, worth approximately 180 000 USD per year as CERs, assuming 50% methane content (IEA, 2008d).

There are currently 76 registered CDM projects to capture LFG for flaring or electricity generation. The projects range from small (18 000 tonnes of CO_2 eq avoided per year) to very large (1.2 million tonnes CO_2 eq avoided per year). Small projects that generate electricity produce around 1 to 2 megawatts (MW) of capacity, while the largest is a power plant in the Republic of Korea, handling 19 000 tonnes of MSW that is projected to generate up to 50 MW of electricity.[11] Other examples include the Bandeirantes Landfill in Brazil and the Nanjing Tianjingwa Landfill in China.

To be eligible for CERs, a project must demonstrate that it would not otherwise proceed, i.e., there are no laws enforcing the capture and combustion of landfill gas. It must also establish a baseline for future emissions if the project were not to exist. The baseline can be estimated using LFG production models, and can be verified by the actual amount capture and combusted.[12]

China is an example of a country where LFGE CDM project development has been promising. At the end of 2005, China had over 370 landfill sites, and is the world's second-largest emitter of landfill methane, at around 46 Mt CO_2 eq per year, forecast to rise by 8% by 2020 (IEA, 2008d). The LFGE sector is emerging, with 12 CDM projects currently registered on the UNFCCC's CDM website. To date, China has earned 220 000 CERs with a much larger number of CERs expected to be awarded into the future (over 2 million per year based on the CDM project design documents). The biggest LFGE CDM project is in Guangzhou, which will process 6 800

11. For more information, see http://cdm.unfccc.int/index.html.
12. It should be noted that some of the CDM LFGE projects have overestimated the amount of LFG production and have earned fewer CERs than expected. It may be that in the early stages of these projects, gas flow is lower than the projected average for the lifetime of the projects. Therefore, it is important to be conservative in LFG generation estimates to avoid overly optimistic gas flow estimations and therefore underestimation of financial returns (IEA, 2008d).

tonnes of MSW a day and produce up to 19 MW of electricity capacity, avoiding almost 1 million tonnes of CO_2 eq per year. There are several landfill sites that have been evaluated for LFGE potential using the EPA Land GEM model and pump tests, and are seeking investors to fund the projects.

Landfill Gas Regulation and CDM in China

China has made significant improvements in waste management since the mid-1990s, with most large cities developing sanitary landfills as their main method of waste disposal method (World Bank, 2005). China passed its first comprehensive law on solid waste in 1995, laying the framework for solid waste storage and disposal (Jones, 2007). In April 2008, the Ministry of Environmental Protection released the policy "Standard for Pollution Control on the Landfill Site of Municipal Solid Waste." As a result, LFG capture and flaring is now required as part of landfill management (Ministry of Environmental Protection of the PRC, 2008).

These regulations are designed to remove air pollution and safety hazards caused by uncontrolled LFG venting. However, they also make future (and possibly existing) Chinese LFGE projects questionable under the CDM, as they fail to satisfy the "additionality" test. To qualify for CERs, a project developer must demonstrate that the project would not have occurred otherwise. It remains to be seen how these requirements for LFG capture and use will affect Chinese LFGE projects.

Generation incentives

Generation incentives are financial incentives that encourage power generation from alternative energy sources such as LFG by making it economically viable through subsidies or other measures. By offering the incentive consistently over a designated number of years, policy makers can encourage large renewable energy investments that would otherwise prove too costly. Tying the incentive directly to generation rather than the construction of a plant ensures that the motivation is to produce power in a timely, efficient manner.

Feed-in tariffs (FITs) are a proven method of incentivising generation of energy from LFG. FITs require utility companies to allow renewable energy producers access to the grid and to purchase renewable energy at above-market prices. Different rates are typically set for individual technologies like solar, wind, geothermal, and biomass/biogas. The costs of paying higher rates for renewables is usually passed onto the consumer; but the increase in electricity bills is hardly perceptible, perhaps a few dollars per month. FITs are set for a certain number of years to ensure long-term predictability for investors. Each year, the rates are lowered as more projects are built and their economic competitiveness increases. The goal is that by the end of the FIT time period the industries will be able to stand on their own in the market. Encouraging renewable energy production also has the potential to stimulate local economies by creating jobs. As noted above, the IEA found that Germany and Luxembourg achieved among the highest growth rates of biogas electricity generation; this was mainly due to their feed-in tariff schemes. A number of other countries, including Ireland, the Republic of Korea, France, Switzerland, Austria, and Portugal, use different variations on feed-in tariffs to encourage new capacity development of LFG (see Table 1 below).

The **German Renewable Energy Sources Act of 2004** prescribes fixed tariffs that grid operators must pay for the feed-in of electricity generated from a number of sources, including landfill gas. In principle, the guaranteed payment period is 20 calendar years. The fees that the Act designates for electricity from landfill gas, sewage treatment plant gas, and mine gas are at least 7.67 cents/kilowatt-hour (kWh) up to and including a capacity of 500 kW, and at least 6.65 cents/kWh up to and including a capacity of 5 MW (IEA, 2008c; BMU, 2004). The German Bundestag decided in June 2008 that beginning in 2009, the tariff for landfill gas facilities would be revised to 9 cents/kWh up to and incl. 500 kW capacity, and 6.16 cents/kWh for plants between 500 kW and 5 MW (BMU, 2008). Many attribute Germany's success in expanding its renewable energy industry, creating hundreds of thousands of green jobs, and reducing GHG emissions ahead of its targeted schedule to its effective FIT policy (Barber, 2008).

TABLE 1: FEED-IN TARIFF AND RELATED POLICY EXAMPLES FOR LFGE

Country	Name	Year	Details
Austria	Green Electricity Act – 2006 Amendment	2005	The Green Electricity Act of 2002 was amended in 2006, leading to revised subsidy conditions for new green power plants. For landfill gas, sewage gas, and biogas, there is a feed-in tariff combined with a purchase obligation. For landfill and sewage gas, the feed-in tariff for generating stations up to 1MW is 6 cents/kWh, and for over 1MW it is 3 cents/kWh.
France	Renewable Energy Feed-In Tariffs (I)	2001	Feed-in tariffs were established under the Electricity Law of 2000. All sites benefiting from the mandatory buyback rates must be under 12 MW of nominal capacity. For biogas from landfills: production sites built after the publication of the law are guaranteed, in metropolitan France, rates up to 0.0572/kWh for small installations, up to 0.0450/kWh for large installations and linear interpolation for medium-sized installations.
France	Renewable Energy Feed-In Tariffs (III)	2006	Under the Electricity Law 2000, further feed-in tariffs were introduced on 10 July 2005. These apply for contracts of 15 years. For biogas and methanisation: between 7.5 and 9 Eur cents/kWh, with an energy efficiency bonus of between 0 and 3 Eur cents and a methanisation bonus of 2 Eur cents/kWh.
Ireland	Renewable Energy Feed-In Tariff (REFIT)	2005	The REFIT programme provides a financial incentive in the form of long-term feed-in tariffs designed specifically to encourage new capacity development in individual categories of proven technologies. The fixed price tariffs for proven technologies are indexed to the annual change in the national consumer price index. The price as published in 2005 for landfill gas is 7.0 Eur cent per kilowatt hour.
Korea, Republic of	Feed-In Tariff for Renewables (Electricity Business Law)	2001	The government guarantees standard feed-in tariff prices for 15 years for wind, small hydropower, bioenergy (LFG, biogas, biomass), fuel cells, tidal energy, and waste incineration (including RDF). The renewable energy power producer can choose the standard price between fixed price and floating price. The feed-in- tariff varies by technology - for landfill gas, 68.07 KRW/KWh or System Marginal Price (SMP) +5 KRW/KWh (20MW≤ LFG plant ≤50MW), 74.99 KRW/KWh or SMP+ 10 KRW/KWh (LFG plant <20MW). The feed-in tariff is not applicable to LFG plants with over 50MW of capacity. If the government subsidy ratio is over 30%, the FIT program cannot be applied.

TABLE 1 (CONTINUED)

Country	Name	Year	Details
Luxembourg	Feed-In Tariffs for Renewable Energy and Cogeneration: Law of 14 October 2005	2005	The regulation of 14 October 2005 amends the Grand Decal regulation of 30 May 1994, establishing feed-in tariffs for electricity produced from renewable energy sources and cogeneration as of 1 January 2005. For biomass, which includes biomass, biogas, sewage, and landfill gas, the feed-in tariffs are (in EUR/MWh): 1kW to 500kW - 102.6; 0.5MW to 3MW - decreasing from 102.6 to 87.8; 3MW to 10MW - decreasing from 87.8 to 79.1.
Portugal	Modified Feed-In Tariffs for Renewables	2007	Decree Law No. 225.2007 revised the feed-in tariffs established by the previous Decree Law No. 33 A/2005. Different tariffs are provided for small and large installations. For landfill gas, the tariffs are: EUR 104/MWh up to 5 MW, EUR 102/MWh above 5 MW.
Switzerland	Feed-In Tariffs of New Electricity Supply Act	2008	On 14 March 2008, the Swiss Federal Council adopted an ordinance on electricity supply, establishing a system of feed-in tariffs, applicable as of 1 January 2009. The system provides feed-in tariffs differentiated by technology, size and application. The payments are made for periods of 20 to 25 years, depending upon the technology. They will apply to new installations (built after 1 January 2006), as well as expanded and renovated installations. For sewage and waste gas, the tariff is calculated based on a specific formula, with a maximum tariff of CHF 0.24/kWh for sewage gas and CHF 0.20/kWh for waste gas.
Italy	Finance Act 2008: Renewable Energy Provisions	2008	The Finance Act 2008 includes new measures relating to the production of electricity from renewable energy sources, in two areas: a review of the green certificates system, applying to power plants producing 1MW or more, and the introduction of feed-in tariffs for plants producing up to 1MW. The revisions concerning green certificates are twofold. First, the incentive period is raised to 15 years. Second, the number of certificates issued varies depending on the type of renewable source, according to a coefficient multiplicative energy produced. This coefficient is 0.8 for biogas. Small renewable energy power plants, producing up to 1 MW, can choose feed-in tariffs (that include the selling value) differentiated by source and supported for 15 years. Relevant feed-in tariffs are: EUR cents 30/kWh for biomass from short chain, EUR cents 22/kWh for other biomass, EUR cents 18/kWh for biogas.
Czech Republic	Act on the Promotion of the Use of Renewable Energy Sources	2005	The Act regulates the rights and obligations of participants in the renewable electricity market and conditions of support for the purchase and registration of electricity production from renewable sources. The purpose of the Act is to support the use of renewable sources of energy, i.e. wind energy, solar energy, geothermal energy, water energy, soil energy, air energy, biomass energy, landfill gas energy, sewage gas energy and biogas energy. Electricity from landfill gas and sewage gas will be bought out for 77 Euro/MWh, while the feed-in tariff for biogas has been set at 103 Euro/MWh. Green bonuses range from 45 to 67 Euro/MWh.

Sources: Renewable Database, IEA 2008; German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety data; Korean Energy Management Corporation data.

Tax relief

Tax relief is another financial incentive for LFG energy generation. Tax relief in its many forms (deductions, credits, exemptions, exclusions and favourable rates) promotes a given activity, such as producing energy from renewable sources, by reducing the tax burden (Lazzari, 2008). Canada's Capital Cost Allowance, Spain's corporate tax deductions for renewable energy investment, and the production tax credit in the United States are all examples of tax relief to encourage renewable energy, including LFG (see Table 2).

The tax code in the **United States** contains production tax incentives that apply to LFG. The Section 45 Production Tax Credit (PTC) was enacted as part of the Energy Policy Act of 1992, but applied to only wind and some biomass. The American Jobs Creation Act of 2004 expanded the Section 45 tax credit to include LFG electricity-generating facilities. An extension of the tax credit for landfill gas and several other eligible energy sources through January 2011 was included in the Energy Improvement and Extension Act of 2008 (H.R. 1424, 2008). The PTC has a two-tiered system for energy sources. Wind, solar, closed-loop biomass, and geothermal resources receive a tax credit of 1.5 cents/kWh. Open-loop biomass, small irrigation hydroelectric, landfill gas, municipal solid waste resources, and hydropower currently receive 1.0 cents/kWh. For landfill gas facilities placed into service after August 2005 and before January 2009, the credit period is 10 years (LMOP, 2008d).

The PTC has provided both financial and regulatory incentives for renewable energy in the United States. It makes alternative energy competitive with fossil sources, and provides a predictable policy environment for investors to make decisions about which technologies to support.

TABLE 2: TAX POLICY EXAMPLES FOR LFGE

Country	Name	Year	Details
Belgium	Subsidies for Renewable Energy Investment – Wallonia	2005	The Walloon Region awards an investment subsidy and an exemption from real estate taxes to companies that carry out an investment programme aiming at a sustainable use of energy (hydroelectric energy, wind energy, solar energy, geothermal energy, biogas, organic products and waste from agriculture and forestry arboriculture, biodegradable organic part of waste), a quality cogeneration and energy savings during the manufacturing process.
United States	Energy Policy Act of 2005	2005	Among other provisions, the bill extends and expands the scope of Section 45 of the Code, which provides a tax credit for the production of electricity from wind, closed-loop biomass, open-loop biomass, geothermal energy, solar energy, small irrigation power, municipal solid waste and refined coal. Electricity from landfill gas and municipal solid waste resources and receives 1.0¢/kWh.
Spain	Law on Fiscal, Administrative, and Social Measures	2001	The Law offers corporate tax deductions for investments in renewable energy sources. Eligible investments entitle firms to a 10% tax deduction in the case of investments in installations or equipment using solar power, biomass from agricultural or forestry waste, solid municipal waste and biofuels.
Finland	Energy Tax Overhaul	2003	Parliament decided to raise all energy taxes by approximately 5% as of January 2003. In keeping with the National Climate Strategy, the scope of energy tax subsidies in electricity generation was expanded to include electricity produced from recycled fuels and biogas.
Canada	Income Tax Act – Accelerated Capital Cost Allowance	2007	The accelerated Capital Cost Allowance (CCA) allows investors an accelerated write-off of certain equipment used to produce energy in a more efficient way or to produce energy from alternative renewable sources. Specifically, a 50% accelerated CCA is provided for eligible equipment that generates electricity from waste fuel such as landfill gas.

Source: Renewable Database, IEA 2008.

LFG capture, conversion, and energy purchase requirements

The cost structure of a LFGE project changes dramatically when there is a requirement to produce or purchase energy from LFG. With the installation of a LFG capture and flaring system a cost of doing business, the energy utilization portion of the project becomes much less expensive.[13] Some schemes have components that not only require the purchase of LFG and but also ensure that it will be profitable. The United Kingdom has measures in place that require the conversion of LFG to energy and the purchase of energy output from LFGE projects.

The **United Kingdom** put in place laws in 1994 to ensure the capture and processing of landfill gas. All new non-hazardous landfill sites in the UK must be built with LFG capture and conversion to energy. Due to new laws relating to the sorting of waste and increased use of bioreactors, LFG production from fresh waste deposits is expected to decrease over the next few decades. However, gas collection and use is expected to continue for decades more as previously deposited waste is a major source of LFG (Rosevear, 2005).

The UK Government's main support mechanism for renewables is the Renewables Obligation (RO), which was introduced in 2002 and is the successor to the Non Fossil Fuels Obligation. The RO, which will remain in place until 2027, is a market-based mechanism designed to support technologies that are close to the market, including landfill gas energy. Renewable Obligation Certificates mean that electricity generated from LFGE projects can be sold onto the national grid at three times the price of fossil fuels, meaning that the process is cost-effective and profitable. The cost of the RO is expected to be equivalent to an increase of some five percent in electricity prices by 2010 over actual 1999 prices (IEA, 2008c).

Similarly, in Hungary, the Electricity Law of 2002 required the national electricity transmission company (MAVIR) and electricity distribution companies to purchase electricity produced from renewable sources and from small scale CHP at minimum guaranteed prices, or market prices above the given limits. Targeted activities include use of renewable energy sources such as biomass, biogas, gas from waste deposits, and gas from sewage water treating facilities (IEA, 2008b).

Interconnection Standards and LFGE

Regulatory issues such as interconnection issues have been a barrier to some LFG projects, but difficulties can be avoided by developing standardised interconnection requirements. For smaller systems, net metering rules can be established to regulate interconnection to the grid. Net metering credits customers when they generate more power than needed for their own consumption, allowing customers to offset electricity from the grid with their own excess power. Well-planned standards make connecting to the grid an attractive option for LFGE systems while still maintaining safety and reliability.

Standard interconnection requirements help level the playing field between central power generation and distributed generation. This improves the likelihood of realising the power system benefits of smaller-scale systems, including enhanced economic development, reduced peak electrical demand, reduced grid constraints, reduced environmental impact of power generation, and increased success of clean energy

13. However, as noted above, in the case of CDM CER generation, mandates requiring the capture and combustion of LFGE will remove the additionality for methane reductions from LFGE projects in non-Annex I countries to the UNFCCC.

initiatives that are enacted in tandem with interconnection standards. Furthermore, the application of smaller-scale generation in targeted areas can reduce grid congestion, potentially deferring or precluding more expensive transmission and distribution infrastructure investments.

To design effective interconnection standards, a number of factors should be considered to address the needs and concerns of all stakeholders. These include promoting broad participation during standards development, addressing a range of technology types and sizes, and taking into consideration existing barriers to interconnection. Another factor to consider is current regulations or policies that may have an influence on standards development. Standards should also take into account the large range of project sizes, from several kW to tens of MW. Some states in the U.S., noting the disparity in system sizes, have designed multi-tiered application processes to address systems of varying capacity. Multi-tiered screening processes can allow smaller systems to make it through the process faster and pay less in fees, commensurate with their size. For a system of any capacity, establishing clearly defined categories of technologies and generation systems can streamline the application process for customers and reduce the administrative time and resources required to review applications (EPA, 2006).

Massachusetts is an example of a state in the U.S. that has established a clear, transparent process for interconnection applications. In 2002, the Massachusetts Department of Telecommunications and Energy (DTE) initiated a rulemaking for interconnection standards development. DTE engaged stakeholders by establishing a Distributed Generation (DG) Collaborative to jointly develop a model interconnection tariff. The application process that resulted uses consistent criteria to determine the fees and timelines for DG systems of various sizes. A "simplified process" category allows most inverter-based systems of 10 kW or less to be processed without an application fee in under 15 days. For larger DG systems, the "standard process" can take up to 150 days and include a USD2,500 application fee because of the greater impact that these producers will have on the utility system. Although many DG producers have successfully applied using the existing standards, the DG Collaborative has reviewed the process and determined that it can be improved upon further. The state's commitment to reviewing and revising the application process is an indication that it will continually improve for all involved.[14]

Awareness/Education Efforts for LFGE

Educating stakeholders about the value of LFGE is an important strategy that can help support all of the other policy approaches by ensuring that the policies achieve their goals. Further, in developing countries, educational campaigns are critical, as there are a number of informational and training needs among local personnel, including analysis of LFG generation, optimizing system design, system operation, and economic analysis of potential LFGE schemes. Developing country policy makers also need assistance in understanding the environmental and economic benefits of LFGE projects.

The **United Kingdom**'s Biomass Task Force recommends the use of biomass as a renewable fuel to reduce overall carbon emissions. Its 2005 report proposed government funding for heat and power generated from a range of biomass feedstocks, including waste and sewage sludge. In 2006, the Task Force published a Biomass Action Plan, with funding of £10 to 15 million over the first two years. The plan includes a Biomass Energy Centre to provide expert information and advice (IEA, 2008c).

14. For more information, see http://www.mass.gov/dte/restruct/competition/distributed_generation.htm, http://www.masstech.org/policy/dgcollab/.

An example from the **United States** is the EPA's Landfill Methane Outreach Programme (LMOP), a voluntary assistance programme that helps to reduce methane emissions from landfills by encouraging LFG recovery and use. LMOP forms partnerships with stakeholders to overcome barriers to project development by helping them assess project feasibility, find financing, and market the benefits of project development to the community. EPA launched LMOP in 1994 to encourage productive use of this resource as part of the U.S. commitment to reduce GHG emissions under the UNFCCC. LMOP provides services such as technical assistance, guidance materials, and software to assess a potential project's economic feasibility; assistance in creating partnerships and locating financing for projects; informational materials to help educate the community and the local media about the benefits of landfill gas energy; and networking opportunities with peers and LFGE experts to allow communities to share challenges and successes.

Technology Development and Demonstration Policies for LFGE

Policies that encourage innovation and technology development can improve processes, lower costs, and potentially lead to breakthroughs that could transform the industry. Several countries have programmes that facilitate technology development and demonstration of waste gas, including LFG. Hungary promotes projects in energy efficiency and renewable energy through subsidies. In France, grants are available for demonstration projects in the renewable energy sector. Finland's well-known technology innovation agency has a programme dedicated to waste-related projects including biogas from landfills.

Finland's Funding Agency for Technology and Innovation, or Tekes, is a governmental financing and expert organisation for research and technological development. Tekes finances industrial R&D projects as well as projects in universities and research institutes, and especially promotes innovative, risk-intensive projects. STREAMS is a technology programme initiated by Tekes to develop new, internationally competitive technology and business opportunities related to municipal waste streams. STREAMS is partly financed by Tekes and partly by the participating enterprises. Biogas and biowaste from landfills are part of ongoing projects (IEA, 2008c).

TABLE 4: LFGE TECHNOLOGY DEVELOPMENT SUPPORT EXAMPLES

Country	Name	Year	Details
Hungary	Structural Funds for Environment Protection and Infrastructure Operative Programme (EPIOP)	2006	The EPIOP of Hungary's National Development Plan specifies measures to promote energy efficiency and renewable energy sources. In 2006, the EPIOP provided 280 million HUF in subsidies to three types of energy efficiency projects: the modernisation of buildings and institutions, the development of district heating systems, and the promotion of cogeneration. The rate of funding granted in the case of all projects is equivalent to 75% of eligible public expenditure. The budget or local governments (in the case of projects where local governments are the beneficiaries) contribute the remaining 25%. Since its inception, one of the programme's focuses has been district heating systems using biomass or geothermal energy or waste deposit gases, including landfill gas.
France	Renewable Energy Market Development (Support for Demonstration and Diffusion)	1999	ADEME provides support for demonstration projects and diffusion in the renewable energy sector. Grants for demonstration projects can go up to 30 to 40% of project costs depending on the energy source and targeted sector. Assistance can also be provided for market diffusion of demonstrated technologies/projects, grants can reach 15 to 30% of the costs depending on sector they can also be calculated on the basis of avoided CO2-equivalent emissions (up to 400 Euro/t avoided carbon). Support is also available to increase market diffusion of mature and validated innovative technologies which still need to overcome cost barriers. The programme covers biogas recovery for energy production.

Source: Renewable Database, IEA 2008.

Lessons Learned

The countries that have made the most progress in landfill gas utilisation have instituted policies that recognise LFG as an asset, provide consistent regulatory signals, make energy derived from LFG economically competitive with fossil fuel energy, and encourage further improvement and innovation. Feed-in tariffs, tax relief, and requirements for environmental controls on landfills are some of the measures that have been successfully used.

The immediate steps that a country can take to advance sound environmental landfill practices (including LFG capture and use) will depend on its current situation. The first step for a developing country with lesser-developed solid waste management practices is to analyse the potential for upgrading existing dump sites through simple, proven practices, such as enclosing the premises, instituting rules and procedures for waste disposal, and applying a daily or semi-regular cover. With the proper planning, landfill gas utilisation can contribute toward financing the transition from open dumps to sanitary landfills. Landfill gas-to-energy projects can also earn Carbon Emission Reduction certificates under the Clean Development Mechanism, a promising option for developing countries.

Countries that have more stringent landfill practices already in place can implement measures that facilitate LFG projects such as standard interconnection regulations and renewable portfolio standards that include landfill gas as an eligible energy source. As is the case with any alternative energy source, a favourable and predictable tax incentive structure can also encourage investment in LFG energy production. Additionally, while the technology for landfill gas capture and utilisation is mature and available, further improvements can be made through technology development and demonstration projects.

Recommendation for Further Study

Data from developed countries with established policies promoting sanitary landfill practices and LFGE utilisation is widely available. Information on policies from countries that have more recently passed regulations is not as easily obtained. Further study in regions where regulations to improve waste disposal methods and promote LFGE projects are more recent would be useful to those countries that are considering implementing LFG policies and face similar challenges. Of particular value would be studies of policies in Latin America, the Middle East, and China.

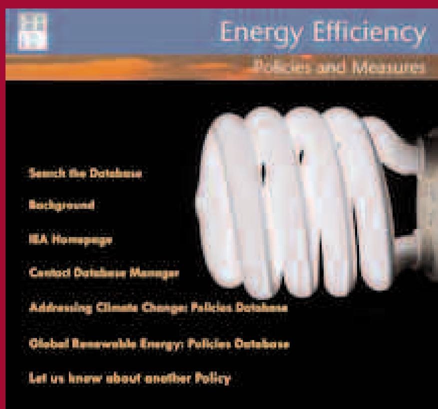
For More Information

For more information on methane recovery and usage, the Methane to Markets Partnership is a useful source. The Methane to Markets Partnership is an international initiative that advances cost-effective, near-term methane recovery and use as a clean energy source. The goal of the partnership is to reduce global methane emissions in order to enhance economic growth, strengthen energy security, improve air quality, improve industrial safety, and reduce emissions of greenhouse gases. The partnership currently focuses on four sources of methane emissions: agriculture, coal mines, landfills, and the oil and gas industry. The partnership includes

27 countries with large sources of methane or special expertise and interest in developing methane projects. Partner countries account for approximately 60% of global methane emissions from the targeted sources. The partnership includes over 800 project network members. These are public and private organisations with experience or an interest in projects concerning methane recovery and use. In October 2007, Methane to Markets hosted the first International Project Expo in Beijing, China, which featured 91 new methane projects seeking investors.[15]

IEA Global Renewable Energy and Energy Efficiency Databases

Many of the specific policy examples included in this report are from the IEA's Global Renewable Energy and Energy Efficiency Databases. The databases provide summaries of policies and measures that are being used by various jurisdictions to encourage the uptake of renewable energy and energy efficiency/waste fuels utilisation. Where available, the database entries provide a link to websites with further information. The Renewable Energy database, the main tool used, covers over 1 000 records on policy measures in IEA member countries, together with members of the Johannesburg Renewable Energy Coalition (mostly African nations) as well as Brazil, China, the European Union, India, Mexico, Russia, and South Africa.



The databases can be accessed at http://www.iea.org/textbase/pm/grindex.aspx (Renewable Energy) and http://www.iea.org/textbase/pm/index_effi.asp (Energy Efficiency).

15. See methanetomarkets.org for more information.

Appendices

The following table contains a list of policies that do not expressly fall under the rubric of the types of policies discussed in this report, but also affect LFGE projects.

TABLE 5: OTHER GLOBAL POLICIES RELATED TO LFGE

Type of incentive	Country	Name	Year	Details
Action Plan	Germany	Integrated Climate Change and Energy Programme	2007	The Energy and Climate Change Programme sums up the discussions of various energy summits held in 2006/2007 and has as its guiding principles security of supply, economic efficiency, and environmental protection. The programme aims to cut greenhouse emissions by 40% to 2020 compared with 1990 levels and includes goal of feeding biogas into the natural gas grid to a greater extent: 10 percent by 2030.
Government Support	Czech Republic	State Programme to Support Energy Savings and Use of Renewable Energy and Secondary Sources	1991	Targets of the State Programme include the implementation of savings measures in the area of generation, transmission, distribution and consumption of energy; and higher use of renewable and secondary sources of energy and the development of cogeneration of heat, cooling and electricity. Support for energy planning and certification of buildings includes plans for construction of centres for use of municipal waste for energy purposes.
Grant	United States	Energy Independence and Security Act of 2007 (EISA)	2007	Law authorises 50% matching grants for the construction of small renewable energy projects that will have commercial electrical generation capacity of less than 15 megawatts - landfill gas is an eligible source.
Grant	United States	Energy Efficiency and Conservation Block Grant Programme	2008	The Energy Efficiency and Conservation Block Grant Programme aims to help reduce energy use and emissions at the local and regional level. The programme will assist eligible entities in implementing strategies that will improve energy efficiency in the transportation, building, and other appropriate sectors, and reduce fossil fuel emissions and total energy use in an environmentally sustainable manner. Eligible entities include cities, counties, states and Indian tribes. Activities that may use grant funds include technologies to reduce, capture, and use methane and other GHGs from landfills or similar sources.

TABLE 5 (CONTINUED)

Type of incentive	Country	Name	Year	Details
Long-Term Agreement	France	Agreement between waste management company and state-owned utility	1999	A waste management company and the state-owned utility, Electricité de France (EdF), signed an agreement to develop renewable energy from landfill methane. The waste management company, which operates the landfill, invested FRF 200 million in the infrastructure to capture the methane gas and burn it to produce 10 MW of electricity. EdF agreed to buy all the electricity production for a term of 12 years at a guaranteed price.
Subsidy	China	Shandong Province Village Renewable Energy Regulations	2008	The Shandong Province Village Renewable Energy Regulations took effect on 1 January 2008, providing subsidies for specified renewable energy technologies in farming villages. The regulations require that governments at the county level and higher incorporate special funds into their yearly budgets, which will be used to subsidise renewable energy facility construction in farming villages. Projects eligible for subsidies include production of methane gas from animal and agricultural waste, as well as garbage. The methane can be used to produce power directly.
Subsidy	Hungary	New Hungary Development Plan (NHDP) and Environment and Energy Operative Programme (KEOP)	2006	The programmes use EU and Hungarian government funds to provide subsidies for energy efficiency and renewable energy investments. Various sectors are targeted, including energy production, transport, distribution and end-use, with a special focus on public buildings. Small- and medium-sized enterprises, public institutions and non-profit organisations can apply for the subsidy. The programmes support biomass utilisation, waste utilisation, and biological waste based biogas production and utilisation. The subsidies can cover between 10-50% of the investment cost.
Task Force, Action Plan	United Kingdom	Biomass Task Force	2005	The Biomass Task Force recommended the use of biomass as a renewable fuel to reduce overall carbon emissions. Its 2005 report proposed government funding for heat and power generated from a range of biomass feedstocks, including straw, wood chips, waste, energy crops and sewage sludge. The report also urged the UK Government to reduce emissions from decomposing agricultural waste by converting it, via anaerobic digestion, into biogas for burning as a renewable fuel. In 2006, the Task Force published the Biomass Action Plan, outlining a 5-year capital grant scheme for biomass boilers, with funding of 10 to 15 million pounds over the first 2 years. The plan includes a Biomass Energy Centre to provide expert information and advice.

Sources: Renewable and Energy Efficiency Databases, IEA 2008.

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Acronyms

BMU: German Federal Ministry for Environment, Nature Conservation, and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)
BRIC: Brazil, Russia, India, China
CDM: Clean Development Mechanism (of the UNFCCC)
CER: Certified Emissions Reduction
CHP: Combined Heat and Power
CREB: Clean Renewable Energy Bond
DG: Distributed Generation
EPA: Environmental Protection Agency
EUA: European Union Allowances
FIT: Feed-In Tariff
GHG: Greenhouse Gas
GOI: Government of India
IEA: International Energy Agency
IPCC: Intergovernmental Panel on Climate Change
LFG: Landfill Gas
LFGE: Landfill Gas-to-Energy
LMOP: Landfill Methane Outreach Programme
M2M: Methane to Markets
MSW: Municipal Solid Waste
OECD: Organisation for Economic Co-operation and Development
PTC: Production Tax Credit
RDF: Refuse-Derived Fuel
RO: Renewables Obligation
RPG: Renewable Portfolio Goal
RPS: Renewable Portfolio Standard
TGC: Tradable Green Certificates
UNEP: United Nations Environment Programme
UNFCCC: United Nations Framework Convention on Climate Change

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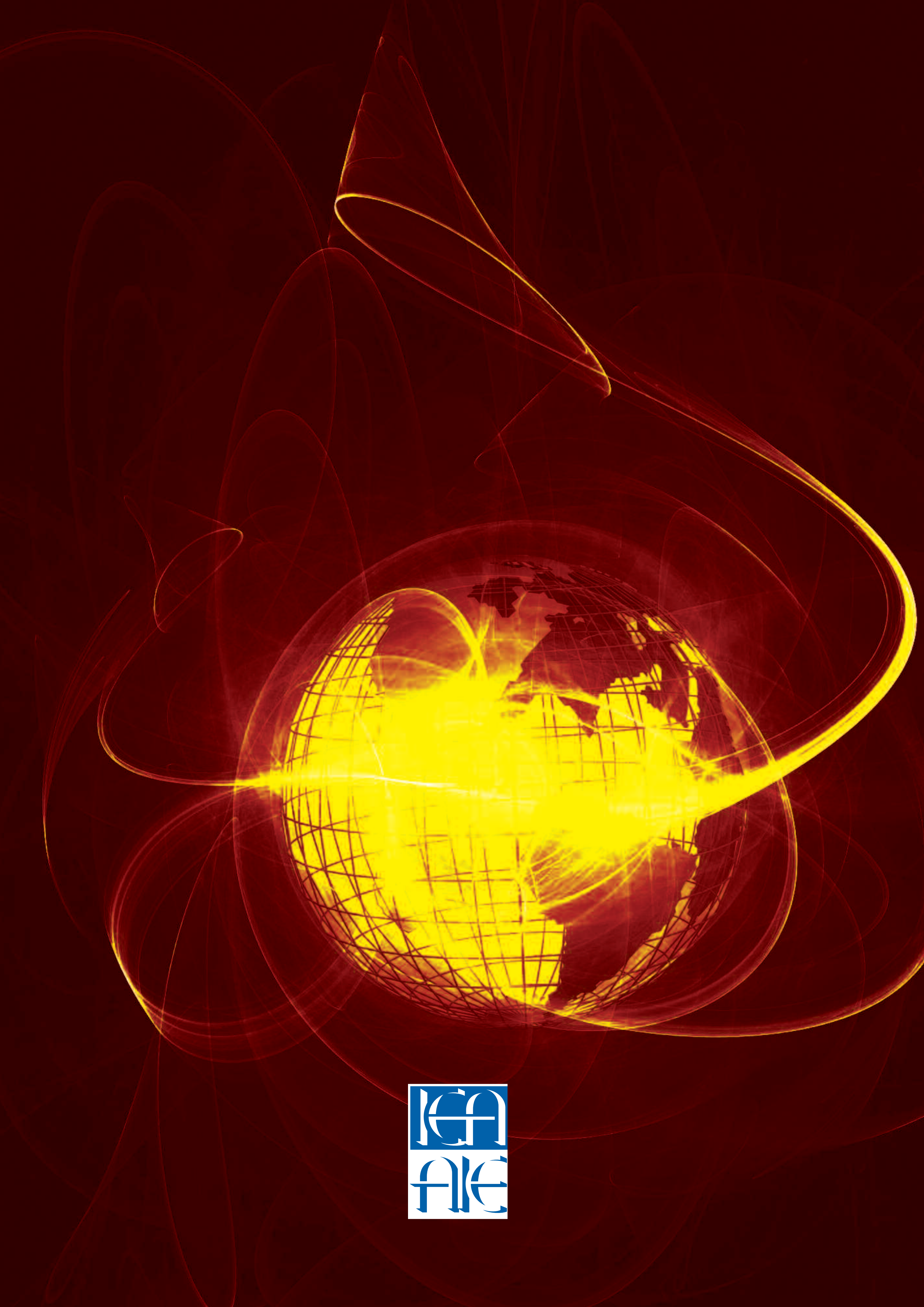

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