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ANAEROBIC DIGESTION: MARKET ANALYSIS

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INTRODUCTION

Anaerobic digestion (AD) is a technology for managing waste. Anaerobic digestion is the process of conversion of biodegradable organic material into biogas, which can be used as source of energy by converting it into heat and electricity. Biogas consists of 55-70% methane, 30-45% carbon dioxide and 1% nitrogen (DEFRA, 2011a). The Government made a commitment to work towards a 'zero waste' economy in the Coalition Programme for Government of 20 May 2010. In the view of low carbon green economy, Government is supporting and encouraging the initiatives to increase the energy recovery from waste such as heat, electricity and fuels through anaerobic digestion. (DEFRA, 2011b)

Anaerobic digestion is also helpful in reaching the EU targets and key national targets. This would also help the organisations in reaching the legal limits of the climate change act for reducing CO_2 emissions by minimum 26% by 2020 and reducing greenhouse emission by minimum 80% by 2050. It would also be instrumental to achieve the UK's share in the overall EU target of renewable energy, which is at the moment proposed to be around 15% by 2020. Also, Landfill directive which sets landfill waste to 35% of 1995 level for municipal biodegradable waste by 2020 (DEFRA, 2009a)

This report will highlight the anaerobic digestion current market in UK. It will examine how the political, legal, social and technological factor can impact the industry in future. It will also analyse industry growth in future and how competition from other energy from waste technologies could influence the market.

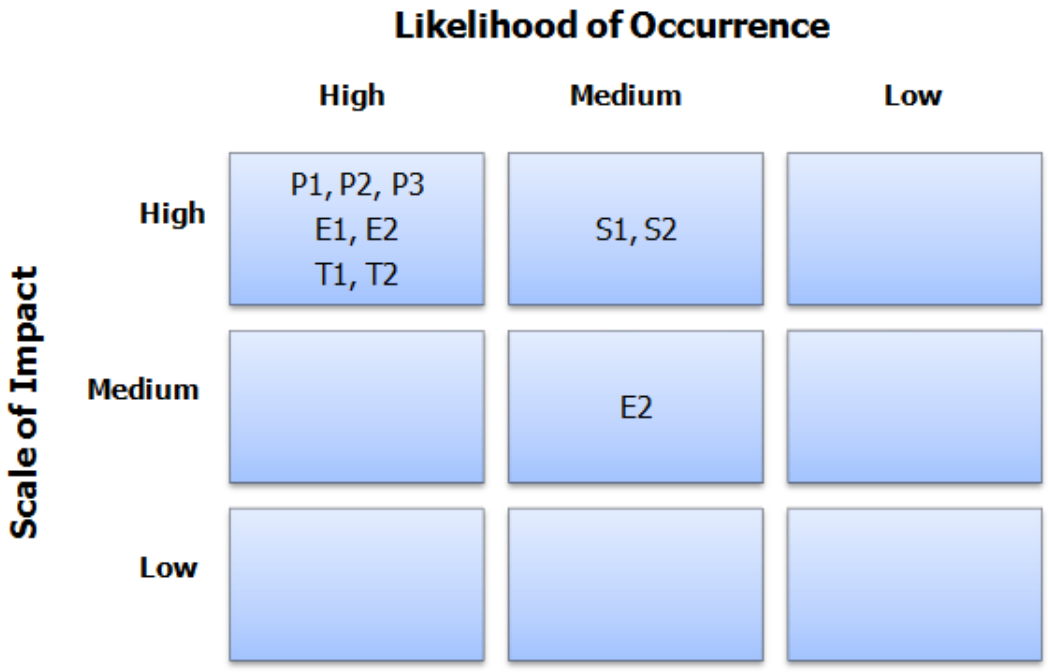
ENVIRONMENTAL ANALYSIS – MACRO

PEST is used to analyse the external macro environment factor. It analyses the potential impact of external factors on the organisation and can help to prepare strategic decision, which could give the competitive advantage. Anaerobic digestion market is relatively new in UK; therefore each factor is weighed on its scale of impact and likelihood of occurrence.

Category	Factor	Scale of Impact	Likelihood of Occurrence
Political	• **P1**: EU has proposed to source 20% of total energy from renewable sources by 2020. In order to achieve this, UK target should increase from around 1.5% in 2006 to 15% by 2020 (DEFRA, d, 2011). There is a political drive towards achieving low carbon agenda and energy security. This will push UK government to encourage AD industry.	**High**	**High**
	• **P2**: EU target for diverting waste sent to landfill, i.e. 35% reduction in waste sent to landfill by 2020 (DEFRA, c , 2009), will ensure that the organisations adopt more sustainable options which do not pollute the environment as a whole.	**High**	**High**
	• **P3**: The UK government is providing incentive such as Renewable Obligation Certificates and Feed-in tariff to promote AD plants. Also, additional financial support is provided by WRAP and Green investment bank to encourage project developers.	**High**	**High**

Economical	• **E1**: UK has just started to come out of recession hence there is considerable pressure to meet the EU 2020 and national targets. • **E2**: Employment, local investment and infrastructure reply on large industrial plant in UK. • **E3**: Financial pressure to avoid penalties for not meeting the targets and to avoid landfill tax escalator.	**High** **Medium** **High**	**High** **Medium** **High**
Social	• **S1**: People are also taking interest in environmental issues. Their view towards suitability has changed which promoted the image of clean technologies and green industries. • **S2**: Growth in population and industrial composition will increase the amount of waste generated.	**High** **High**	**Medium** **Medium**
Technological	• **T1**: AD technology is widely accepted in UK as best solution for waste disposal. Innovation in Energy to waste market is leading to development of clean and sustainable technology. • **T2:** Success of new technology worldwide, results in its adoption on large scale. Many new entrants in the energy from waste industry are from European market.	**High** **High**	**High** **High**

Prioritisation matrix



Aspects which could have high Impact on the energy to waste sector are

- Commitment to have sustainable and low carbon industry across UK. Drive to achieve the target of 20% energy from renewable sources.
- Huge investment in sustainable technology such as AD which would help in achieving EU and national targets.
- High innovation rate worldwide especially from Europe creates pressure to become leader in sustainable technologies.
- Reduce the waste diverted to the landfill.

ANAEROBIC DIGESTION MARKET IN UK

Anaerobic digestion is a technology which has been proven successful so far. It is currently being used in a lot of developed and developing countries. A well established system of anaerobic digestion plants has been successfully established in UK, and treats 66% of its sewage by means of anaerobic digestion (DEFRA, 2009b).

AD has more benefits than any other waste treatment alternatives. AD benefits government, environment, investor, food processing sector, local community. AD growth and development depends on various government policies such as Renewable Transport Fuel Obligation and Excise Duty reduction for Bio fuels, Renewable Obligation, Landfill Tax, and Landfill Allowance Trading Scheme (DEFRA, 2007).

The process is widely used for sewage waste treatment within UK. Now, there is a shift in feedstock and organisations are looking for alternative feedstocks such as food waste, farm waste, and crops. Anaerobic digestion technology is old but it has not been used extensively for food waste, manure, dairy waste, crops. Despite of having the established technology the growth in the AD plant development is slow as compared to EU states (e.g. Germany, Austria, Sweden) (DEFRA, 2011a).

As of now (April 2011) there are 54 AD plants operating in UK (32 on farm and 22 off farm), which doesn't include sludge treatment plants. As Biogas generated from AD plants is used for CHP generation and transport fuels. Currently 50 new plants have received the planning consent, which creates an extra capacity of 70 Megawatt electrical (MWe) (DEFRA, 2011c)

At the moment approximately 145 MWe (1.08 TWh) of installed capacity for AD exists in UK. As per the DEFRA report, Electricity generated from AD plants in UK has potential to reach 3–5 TWh by 2020 (DEFRA, 2011b). There is certain prediction of the capacity for this to grow due to less availability of feed stocks. To aid this new development, the government authorities decided that WRAP would bring in a new loan fund to ensure investment in this sector. Over 10 million pounds has been sanctioned to provide debt finance over the last 4 years to increase the investment in the new AD capacity (carbonlowemissions.co.uk, 2011)

Anaerobic digestion industry capacity in UK

Input Capacity of 54 existing plants (includes food waste and farm manure treatment plant)	534,200 tonnes of commercial waste 382,000 tonnes from food and drink manufacture 136,156 tonnes in farm-based plants
Output capacity of 54 plants	35 megawatts
Input of 146 sewage based AD plants producing energy	1,100,000 dry tonnes of sewage sludge
Output capacity of 146 plants	110 megawatts
Output capacity of 50 Planned AD plants	70 megawatts

Source: (Defra, 2011c)

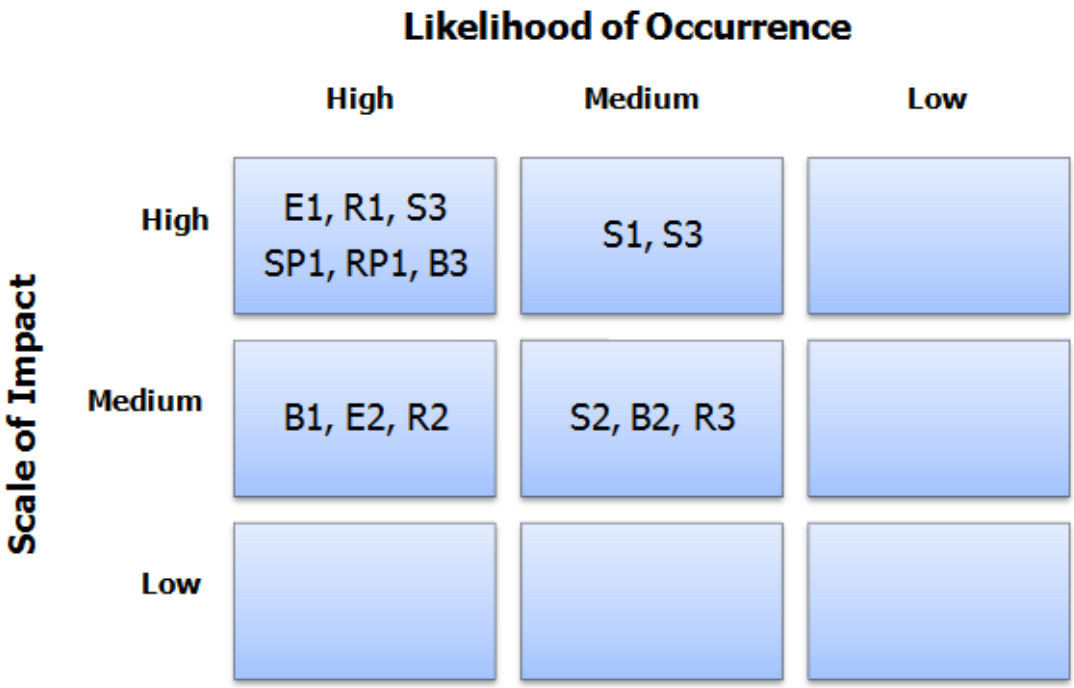
AD INDUSTRY ENVIRONMENT ANALYSIS

Category	Factor	Scale of Impact	Likelihood of Occurrence
The threat of entry	• **E1**: There is significant barrier to entry into anaerobic digestion plant industry due to high investment and to obtain economies of scale.	**High**	**High**
	• **E2**: To explore the potential of the AD market it is important to enhance the knowledge of the technology. AD industry requires extensive operation knowledge and experience.	**Medium**	**High**
The threat of substitutes	• **S1**: There is a threat from other technologies for energy from waste such as composting, paralysis, incineration.	**High**	**Medium**
	• **S2**: Currently nuclear power plants are an interesting avenue for generating electricity as they do not have any issues of environmental pollution, having said that there definitely are other concerns with it like the radioactive toxic wastes that these produce.	**Medium**	**Medium**
	• **S3**: With the increasing costs of handling air pollution due to the tough legislations, the economic and financial benefits of investing in cleaner technologies are plenty. There are increasing numbers of sustainable clean technologies in the electricity generating industry.	**High**	**High**
The power of buyers	• **B1**: National Grid will be the key customer for the electricity generated by anaerobic digestion plant.	**Medium**	**High**
	B2: The electricity generated is always sold at a pre decided price set		

	in a contract, but during times of high demand during which extra electricity is bought at the wholesale spot price. This helps in reaping further profits by selling electricity. • **B3**: Ability to sell digestate as soil amendment/ fertilizer. With many AD plants and huge landfills cost, farmers will have the power of negotiating price.	**Medium** **High**	**Medium** **High**
The power of suppliers	• **Sp1**: Gate fees vary by region and depend on the duration of the contracts and size of facility. Gate fees for AD range from £36-64 (Matthew Aylott, 2011) **Sp2**: Also, various qualities of products would be provided by different suppliers • **Sp3:** Rising charges of landfill and gate fees will force the waste suppliers to look for Energy from waste alternatives.	**High** **Medium** **High**	**High** **Medium** **High**
Rivalry amongst existing firms	**R1**: Rivalry in AD market. The present AD plants are sources of cheap and trusted electricity and hence there would be price war between them. • **R2**: The organisations supplying electricity have a fierce competition due to same buyer of them, the same supplier, similar substitutes, and equally harmful new market entrants. • **R3**: Since the cost of starting electricity plant is very high and also running an electric plant is very costly, so this creates barriers to exit from this sector.	**High** **Medium** **Medium**	**High** **High** **Medium**

Porter's five forces help to understand industry structure which will help to determine competition and profitability. Each factor is prioritised with respect to its impact and likelihood of occurrence.

Prioritization Matrix



The high impact and high likelihood of occurrence aspects are:

• Deterrent to enter in to AD industry due to high investment unless equity funding is not provided.

• Threat of rivalry from other energy to waste options such as composting, incineration.

• Fluctuation in energy prices and rivalry will reduce the profit margins.

• In future, the competition in energy sector would tremendously increase due to other renewable and clean energy sources especially as more money is pumped into this innovative sector.

Threat of entry into the industry is low due to huge investment, so as such the big players in this sector are safe from external intrusions. Threat of substitute is medium as AD has proved to be most clean and sustainable technology but still faces the competition from other industry such as In-vessel composting and hence has to maintain its high standards of being cheap and environment friendly. Power of buyers is medium as the clean electricity produce is mainly sent to national grid on

pre-agreed contracts. The Power of suppliers will reduce with increase in the concentration of the suppliers, so this is another danger to the existing companies in this sector. Rivalry in the industry will increase with development of the market as it's an attractive avenue especially in future so existing players have to gauge this and act accordingly.

However, Forces are not very intense as the industry is in nascent stage, so companies have the opportunity to earn attractive returns on the investment. Even though rivalry could be immense but it will not limit the profitability. But eventually these forces will affect the industry profitability. Companies entering this industry should gain competitive advantage in due course of time to sustain in the industry.

FUTURE POTENTIAL OF AD MARKET

Over the next few years and next decade as a whole, the anaerobic digestion plants are expected to grow exceptionally in England and Wales. As per latest Defra policy, there is a target of at least one thousand new anaerobic digesters to be constructed in the next five years in UK, mathematically this equates to about three new digesters built every week. This would help the environment by reducing landfill as the main feedstock to be supplied in these digesters would be mostly food wastes and organic part of the municipal garbage, which would otherwise be land filled (Nigel Horan et al, 2011).

Though when we deeply analyse this target, it looks quiet unachievable going by the past track records i.e. only 80 anaerobic digesters were constructed over the last 5 years in England and Wales. Though in the last 5 years, over 4000 anaerobic digesters were constructed in Germany (Nigel Horan et al, 2011). This definitely questions the trivial achievement by UK in last 5 years, though it definitely shows that this is an achievable target. The amount of waste generated will increase in coming years due to increase in populations and number of households which will drive to increase the waste treatment capacity. Now also it is observed that there

is a capacity gap between the food waste availability and amount of food waste treated.

Table below shows the current waste treatment capacity and total capacity region wise in tonnes per annum

Region	AD (tpa)	IVC (tpa)[1]	Total Capacity (tpa)
East Midlands	125,000	42,000	167,000
East of England	18,500	96,600	115,100
London	0	64,500	64,500
North East	0	27,000	27,000
North West	0	68,325	68,325
Scotland	165,000	45,000	210,000
South East	45,000	49,800	94,800
South West	191,000	128,100	319,100
Wales	18,000	45,300	63,300
West Midlands	125,000	24,300	149,300
Yorkshire & Humber	105,000	94,500	199,500
Total	**792,500**	**685,425**	**1,477,925**

Source: Eunomia (2011)

As per the Eunomia report, food waste available in UK is 7.97 million tonnes per annum. With existing capacity 1.47 million tonnes per annum is being treated by AD and composting. There is huge gap of 6.5 million tonnes per annum between food waste availability and treatment capacity (Eunomia, 2011). Capacity gap clearly indicated that there is huge opportunity for growth in waste from energy market. The landfill tax is increasing every year by £8 per tonne up to 2013 (IntertradeIreland.com, 2009). Suppliers of food waste might be finding alternative was of disposal. With the research done and study undertaken, most sustainable way to treat food waste is anaerobic digestion process.

ECONOMIC OPPORTUNITIES AND CONSTRAINTS

A research study conducted in 2007 by AEA technology stated that centralised AD plants eventually become financially unviable. At times they don't even reach the break-even point, if at all they do, at most they do not give good financial returns (Butler Allan et al, 2008).

This study asserts that most of the profit is achieved from gate fees and renewable obligation certificates (ROC's) instead of the main purpose i.e. selling heat and electricity. Hence eventually the AD plants cannot create profits without government's active help and support.

There are many AD technologies that operate on various configurations and feed stocks. Feed stocks on which AD operates determine the plant complexity, capital cost and operational cost (Austermann et al, 2007). A challenge for organisations generating renewable energy is that they need to operate at full capacity throughout the year, any possible curtail in operating time would quickly cut into the profits. Currently feed stock supply chain is not providing sufficient waste to meet the full capacity or to increase the existing capacity (DECC, 2011).

AD has two major components involved in setting it up; those are associated to finance and feedstock. The high investment required in setting up an AD plant means that revenue can be generated only in the long term, the more the number of years for which the plant operates, the more is its overall return. Though there still are good enough companies to finance well established AD businesses and a government scheme, Enhanced Capital Allowance scheme is created to ensure that the investment on combined heat and power (CHP) generator in the first year of operation is offset.

It is academically debated that excessive public awareness and their perception towards AD might act as a barrier (Defra, 2007b). Due to less public knowledge, the general acceptance of CAD plants will be difficult

and would limit a particular government's attempt to increase renewable energy in the country.

The main legislations that will *impact* the AD industry and *promote* the industry are:

The Renewables Obligation – this scheme rewards the electricity created by using clean biomass wastes and CHP from all biomass wastes.

Renewable Transport Fuels obligation – this will generate market opportunities for renewable transport fuels.

Future heat incentives – this scheme rewards heat generation from CHP from renewable waste.

The Landfill Directive – this sets legal limits and targets for uses alternate means than land filling organic material.

MSW – this policy imposes financial penalty for non compliance.

Waste Framework Directive – this policy concentrates on carbon efficient resource recovery essentially concentrating on bio-waste fraction of MSW for separate collection enabling composting and digestion (NNFCC, 2009)

Generating green electricity is supported by the Renewables Obligation (RO) and the climate change levy. Landfill tax and the Landfill Allowance Trading Scheme are created to help in reduction of total organic wasted which gets land filled. Currently the Feed-In Traffic will be supplied only to renewable electricity generators of less than 5MW (currently all non-water owned AD plants are of a capacity less than 3MW) and this price will be fixed for next 20 years. A Renewable Heat Incentive policy would be created by the government to ensure that renewable heat sector grows.

Digestate, heat, electricity and policy incentives and gate fees are sources from where revenues for AD can be generated. Eventually AD would also grow due to these schemes (NNFCC, 2009).

COMPETITION IN WASTE TREATMENT INDUSTRY

This section of report will analyze the alternatives in the waste management industry which could give threat to the anaerobic digestion industry and could impact the potential future growth of the industry.

There is intense competition in the waste management industry. Earlier this industry has been regarded as competitive by the industry representatives and in the recent years competition has increased due to government regulations. Waste management Industry is made up of small number of local authorities, small number of large private organisations and many small to medium sized enterprises (SMEs) (euskills.co.uk, 2010)

UK is seeing major change in the waste management in the recent year's mainly after the Government announce the plans for zero waste economy. All industrial and municipal waste is being utilised to produce useful product that will help economy grow and achieve the EU 2020 targets rather than disposed of into landfill (euskills.co.uk, 2010)

Currently UK is facing pressure due to rise in the landfill tax; disposal of waste to a level has become commercially unviable. As a result, there has been a drive to use the alternative waste treatment process such as *composting, incineration and anaerobic digestion*.

Incineration

Incineration is not acceptable due to adverse environmental and health effect. Incineration which produces electricity and heat (i.e. used in combined heat and power plants CHP) are source of green electricity but they produce greenhouse gas. There have been many refusals of such projects from planning authority. Incineration that operate in combined heat and power mode is only supported by renewables obligations (DECC, 2011). In the view of climate change pact, recycling is better option than incineration.

In the next two decades, these incinerators would pollute the environment with CO_2 emissions as much as new or retrofitted coal powered power stations do, due to better technology and recycling. It is thus senseless to invest in this out-dated technology especially when there is access to far better waste management options (Warhurst and Watson, 2006).

Recently Environmental Protection Agency (EPA) has approved licenses for building incineration plant in UK. Also, many such more plant will be in planning phase in year 2011 (Hai, 2011). The Coalition government is planning to roll out £10 billion pounds for these new projects. To oppose this, many environmentalists has argued that this decision will do more harm than good and will be hinder nation to meet EU directive by discouraging from meeting recycling and GHS emission goal (Brown, 2010)

There are many arguments against incineration given by environmental groups such as Herts WithOut Waste, Transition Town Movements, and Friends of the Earth. They said there is not enough non recyclable waste in coming 10 - 20 years. With the advancement in the technologies, most of the waste will be recycled or treated.

Alternative to incineration is AD and composting, which can process most of the materials. Remaining non-reprocessed material will be sent to landfill but that will not carry heavy penalty (Hai, 2011)

Environmental Protection Agency said that this will prevent organisations filling up landfill fines. EU, UK and Wales have set the target to reduce the landfill by imposing the levy and fines if the targets are not achieved. These targets can be easily meet by incinerating the waste. These plants have to confirm to the strict regulations of Waste Incineration Directive as they are regulated by Environmental agencies (letsrecycle.com, n.d.)

Conditions imposed by environment agency on incineration plants are

1. Only those materials in the waste will be burnt, which cannot be reuse or recycled. Before burning, the reusable waste should be removed.
2. Treatment of waste flue gases that release into the environment by a 5 stage process; strict management policies and continuous monitoring and statistical reporting.
3. Dioxins should not be more than 0.1 nanograms per cubic metre.
4. There are specific limits on emission of acidic gases and heavy metals as directed by Waste Incineration Directive.
5. Complete closure of that particular incineration plant in case of a breakdown. (Walsh, 2011)

The assertion that there is hardly any hope of UK meeting its landfill directive targets in near or future with excessive growth in recycling or composting is supported by the consultation draft waste strategy. Since the overall cost of establishing an incineration plant including the start-up cost and the amount of time taken to establish is excessively large, any chances of sudden increase in the number of such plants in next five years looks highly improbable (Hogg, 2006).

Composting

About 40% of the organisations operating in this sector are said to be specialist in composting (Wrap.org.uk, 2008).

There has been a huge increase in the growth of composting sector in U.K., though this has been primarily driven by the garden waste (open air window) composting. In the days to come, the policy makers are paying more attention to food wastes, which aided to growth of its collections and processing capabilities over the last few years (Wrap.org.uk, 2008)

The UK governments waste management strategy is implementing composting as a new strategic move and major targets have been identified which aim at improving the current capacity of large scale composting plants. The composting industry is predicted to grow by three

to four folds in line with meeting the stringent European Landfill directive aiding the growth of various composting technologies (WRC, n.d.)

As per current statistics, by 2012/13 about 5 million tonnes of municipal organic waste will be processed which comprises of about a million ton of food waste.

Organisations supplying compost know that demand for compost will increase and they are affirmative that they could produce about two million tonnes of compost across the next five years, provided they have apt economic environment for growth (wrap.org.uk, 2008)

Anaerobic digestion plants are not as common in UK as composting plants because composting apart from being cheaper is also easier to implement and operationalize. The output formed by process of composting is often a superior quality soil conditioner than the output from anaerobic digestion, also given the fact that composting has a far more established market in UK. But this might change in the coming years especially due to the publication of PAS 110 and Quality Protocol (Bailey R. et al, 2011).

AD Market faces intense competition from composting industry. Both the industries are currently in an unsaturated state. Both the industry has huge scope of business development (intertradeIreland.com, 2009). In Europe, there is revamping of composting plants by integrating with AD digesters to meet the EU directives (Biocycle, 2011). The same trend, i.e. complimentary infrastructure of composting and AD, has been seen in UK as well. Drivers for AD make it cost competitive with other alternative waste management option such as composting (IVC). At one hand AD stack up with composting on incentives other hand getting financial aid for AD fades the picture (Eunomia, 2011)

Various recycling options are available today. Few of these are on site-composting, in vessel composting, waste to energy and anaerobic digestion (AD). Amongst all these, the anaerobic digestion has been promoted as the future of food waste recycling by the environment

minister Hilary Benn. Now days a lot of organisations in UK are separating their food wastes to form site waste management systems (letsrecycle.com, 2010).

Anaerobic Digestion has far more environmental benefits as compared to other food waste disposal techniques, as suggested by environmental agencies. It would be cheap and cost effective especially if waste is segregated while collecting it, because of these advantages, its use is strongly recommended for local business and authorities (Bailey R. et al, 2011).

LIMITATIONS

Reports published by environmental, government agency like DEFRA and WRAP were used for market analysis. These were credible reports but they were not up to date. Latest data was collected from the published news and articles. Verification of veracity of these data required considerable amount of time which was not feasible due to time constraint.

CONCLUSION

Anaerobic Digestion will aid the UK economy and environment in number of ways: reduction in GHG emission thereby reducing pollution, waste sent to landfill hence reducing environmental damage, use of digestate as fertilizer so multiple use of the by product, combined heat and power essential providing multiple sources of energy, creating green job opportunity which is so very important in maintaining good economy. With so many advantages, this is the most sustainable option for disposal of waste.

Porter's five force analysis conducted on the AD industry depicts the attractiveness of the industry. There are many technologies for waste treatment and hence intense competition in the waste management industry. Competition has increased in recent years due to drive towards zero waste and low carbon economy. There are many incineration plants

being set up this year but all those plant will process the non-recyclable and non-reusable waste. There is little prospect of incineration in future. AD has competition from In-vessel composting industry as both the industries are seeing significant growth. However, AD is more clean technology.

In next few years, AD will be well established industry for various feedstocks. At the moment there are many challenges faced by the AD projects. Main concern is to get fund from equity investors, who have short term investment view, which creates a major problem because AD requires high investment which would be returnable and thereby profitable only in a long run spread across the years. Another is to secure the feed stock supply so that plant can operate on its full capacity, as keeping the plant shut for a while renders huge losses due to the high fixed cost. To maintain uninterrupted supply of input and outflow of the output, strong supply chain should be established.

Future profitability and expansion of the industry depends on many factors. Particularly, economic factors such as scale of operation, expected market for Combined Heat and Power, ability to increase gate fees and market development of digestate at the end of the process.

AD market is attractive and booming. LoGen should use their strengths to gain the market share and should also reflect on their weaknesses which could turn into threats. They should turn these threats into opportunities with proper internal analysis. They should develop strong supply chain with supplier and with end market owners. Gaining competitive advantage in this new market is essential for local generation to establish themselves as a big player in the market. As this industry is in infancy and growing rapidly, local generation should gain competitive advantage in coming years to sustain the competition.

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