EN

COUNTRY SPECIFIC CONDITIONS

Denmark

BIO-METHANE REGIONS

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BIO-METHANE REGIONS

Promotion of biomethane and its market development through local and regional partnerships

A project under the Intelligent Energy – Europe programme

Contract Number: IEE/10/130
Deliverable Reference: 2.1.2
Date of Preparation: August 2011

Country Specific Conditions and Barriers to Implementation for Anaerobic Digestion Plants in Denmark

Knowledge Centre for Agriculture

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Introduction

This document is designed to fulfil several functions:

- It will provide information on the key decisions to be made and the conditions to be met for anyone considering the development of a biogas (anaerobic digestion – AD) plant in Denmark. It is quite a detailed examination of the issues and would, therefore, not be appropriate to someone in the early stages of decision-making in respect of biogas.
- It will provide the core information necessary for the development of a regional strategy for the area of Denmark covered by the "Biomethane Regions" project.

It is important to note that legislation and policy surrounding anaerobic digestion in Denmark is changing quickly and some of the information in this report will quickly become out-of-date. Users will have to check for updated information.

1. Corporate structure (legal form) of Plant Owners

1.1 Ownership of the biogas plant usually consists of more categories: Plants will vary, but there are likely to be four broad categories:

- Groups of farmers creating a cooperative and 20-60 farmers are delivering slurry and animal manure and running an industrial biogas plant – approx. 23 of these are implemented in Denmark. The farmers are normally tied up by contracts in order to secure the biomas supply. Also, co-fermentation is carried out at these plants as they often process industrial waste products, however, this source seems to be drying out or declining rapidly.

- Power plants own the biogas plant at a few locations.

- Single farmers owning their own biogas plant in order to process own slurry and agricultural waste products usually producing electricity and utilizing the heat production for farm purposes, e.g. heating pig houses, etc.

- Wastewater operations often own a biogas plant for treatment of domestic waste disposal and in the pre-treatment of bio-degradable waste prior to final disposal to land.

1.2 The barriers for biogas plants are the ownership and capital requirement (equity) which is very difficult to provide due to the current financial situation and debt crisis that also affect farm operations in Denmark. Only a very few plants have been established during the past 10 years. Also, the profitability is considered to be low and uncertain.

1.3 Lack of standardised biogas plants and extended operational services are other barriers, as only a very few existing plants are standardised rather than individually built and expanded.

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2. Availability of trained operators or specialised training programmes

2.1 The availability of trained and experienced biogas technicians in Denmark is very limited indeed, and the opportunities for training activities are currently hardly existing. However, many AD plant manufacturers offer training on the running and maintenance of their installations.

2.2 Especially, the operating of 23 industrial scale biogas plants (some of these being among the world's largest plants) has provided skilled labourers, and some of these are servicing new biogas plants or plants that need to be optimized in order to become profitable or in order to sort out specific technical or biological problems. There is therefore expertise and experience in closely related technology, and the transfer to the sort of digesters to be encouraged under Biogas Regions is relatively easy.

2.3 At this stage, Denmark has no practical and theoretical training centre. If biomethane production is to be developed in the future, training courses would be necessary.

2.4 Technical support in terms of laboratory analyses and studies is available from a number of organisations, including Aarhus University and AgroTech, and a group of companies in the private sector provide technical support and consultancy services on a commercial basis. The suppliers' directory being developed as part of the IEE Biomethane Regions project will improve developers' knowledge of companies offering such services.

3. Site constraints

3.1 The regulatory processing of the local council

The regulatory processing of the biogas project is rather comprehensive. This section covers the processing, to which the local council is responsible. In addition are described the necessary objectives for approval of a plant according to the Danish Planning Act and the regulations of the Danish Environmental Law.

3.1.1 Land-use planning

Today, most local councils have not designated particular areas for the establishment of joint biogas plants in their town planning activities. In cases where farmers/biogas participants want to establish a biogas plant in the open land and outside the generally designated occupational fields, this requires planning and building regulations by the local council before lauching the plant.

In cases, where the local council has designated areas for joint biogas plants in their town planning and possibly have a local development plan, the originators of the project only "need" to have the EIA process and the environmental administration procedure implemented.

Plants being an integrated part of a farm unit will be placed according to a rural zone permit instead of a local development plan.

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3.1.2 Time schedules

The difference may be considerable between time schedules for farm biogas plants being more simple and small plants for animal production, and large joint biogas plants being in many ways more complicated plants to plan in uncultivated fields.

The time frame is often approx. three years from the first application till start of the project. A thorough preparatory work together with a close dialogue with the participants and an openness in the process would often reduce objections and secure a better accept of the plant.

It is possible to reduce the time schedules considerably, if the biogas plant can be placed within the areas, in which the local council has already resolved a town plan and local development plan with the possibility of establishing a biogas plant. In such cases, deadlines for EIA and the environmental approval of the plant should be approx. 12 months. Generally speaking, the decision-making may be considerably reduced, if the application material for the local council has been carefully planned and is complete. A constructive dialogue with the local council may also contribute to an uncomplicated and efficient process.

3.1.3 EIA notification and environmental approval

To start the EIA process, the project group has to forward a notifiction of the plant in accordance with the EIA statutes. When the project has to be considered according to the EIA statutes, the environmental conditions apply in a wide sense and not only within the cadastral plot for the biogas plant. The notification would therefore comprise the biogas plant and the areas for sprearing, which would be necessary to attach to the plant in order to secure the handling of the degassed biomass.

The EIA notification and application for environmental approval procedure requires a report on traffic, odour, emissions for air, soil and water, adaptation to the landscape and restrictions for the surroundings, if any, for the placement of the plant. Details on effects, possible risks and preventive measures, considerations for co-residents, school children, etc. should be presented, including:

- Number of extra transports with heavy vehicles
- Handling of odour problems from the plant
  - Plans for an odour control unit?
  - Plans for a closed loading/unloading department with negative pressure and exhaustion?
- Visualization of adaptation into the landscape by use of plants, bank of earth, low reactor tanks, etc.
- Report on the influence, if any, by the intended placing on environmentally sensitive areas and possibly vulnerable ground water.
- Statements on environmentally correct handling of the degassed biomass.

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3.1.4 Building notification

Filing of the projected building activities is effected according to the building regulations. The local councils have developed a website with a form for this notification.

The public opinion is an important aspect of the regulatory process. From a social viewpoint, a project may be very useful, however, if the public mind puts pressure on local politicians to have diverging opinions instead of strictly rational opinions, the project might fail. Therefore, the process concerning communication and involvement by the local society during the consultation periods is very important and not to be neglected.

SMALLER SCALE “THERMAL” POWER UNITS

Developments for the generation of energy (heat and/or electricity) from combustion processes, at a relatively small-scale (20-30 MW or below of electrical capacity).

1. The fuel is from a demonstrably local source (usually from within a radius of 15km) and should not have been diverted from a more environmentally valuable use.
2. The proposal would not prejudice highway safety and would have a vehicular access and access route that is of a standard appropriate for the volume and character of traffic to be generated.
3. The proposal would not lead to any significant impact upon the amenities of local residential or other sensitive uses by reason of noise, dust, smell or fumes.
4. The development would not significantly detract from the landscape or townscape within which it is situated.
5. Emissions to the atmosphere and ground (including water) are such as to not lead to unacceptable levels of pollution, and
6. The proposal would not destroy or significantly damage a site of importance in archaeological, historic, ecological or conservation terms.

3.2 Adjoining landowners and neighbours

3.2.1 Adjoining landowners and neighbours do have rights and could conceivably challenge the proposal directly through private action, but by far the most likely way in which they might influence the proposal is via the representations that they make during the consenting procedure.

3.2.2 It is clearly of considerable importance that neighbours are kept fully informed as the development concept progresses. If it is practicable, neighbours might be offered site visits to existing, well-operated AD plant of a similar type to that planned. Assurances must be given in respect of the questions that are likely to arise, e.g. smell and safety. Planning officers and elected members are likely to be sympathetic to the concerns of neighbours unless they can be satisfied that they are unwarranted.

3.3 The avoidance of nuisance (odour and noise)

3.3.1 There may be a risk of odour nuisance around the biogas plant. This would particularly come from the unload hall and the pre-load tank, in which different smelly biomasses are added and

mixed. New biogas plants will have requirements as to maximum number of odour units in e.g. a distance of 1,000 m, which may be detected in housing areas and rural areas, and typically the plants will have airfilters installed. Consideration should also be given to the direction of the prevailing wind in the locality – for the vast majority of cases in Denmark, this will be from the south-west.

A large part of odour particles in the slurry is decomposed in the biogas reactor. However, slurry odour consists of maybe 300 different particles, and the odour from degassed slurry is different. Odour is measurable objectively in so-called odour units (OU), and the amount of odour from raw gas is almost the same as from degassed slurry. The limits are normally fixed according to the guidelines for contamination of the surrounding environment set by the Danish Environmental Protection Agency. Limits for housing areas is 5-10 OU/m3. In industrial districts and proper rural areas values of 10-30 OU/m3 are acceptable. But during spreading of the slurry and, as mentioned, when it sinks into the ground more quickly, the odour from the spreading definitely becomes slighter and is only smelly for a short period of time.

In case the degassed slurry contains more ammonium, this will increase the risk of evaporation of the ammonium in the field. However, since the degassed slurry is more fluid than raw slurry, the degassed slurry will sink into the ground more quickly, and thus, this will reduce the loss of ammonium compared with the loss by spreading of raw slurry. In practice, the possible evaporation of ammonium from spreading of raw and degassed slurry, resp., is somewhat the same.

3.3.2 Noise can be reduced through the construction of suitably located and designed earth baffle mounds or acoustic barriers (fences or walls made of dense material such as concrete, hardwood or glass). It would also be good practice to visually screen operations from neighbours as much as possible, preferably through the judicious use of topographical features (natural or man-made) and/or existing or newly planted vegetation. A receptor of (lower levels of) noise or odours may well not perceive them as being so serious an issue if their source cannot be seen.

4. The authorisation procedures

4.1 Country planning legislation

Biogas in relation to the Danish Planning Act and subject to approval by the Danish Environmental Law

The legal framework on the regulatory processing of large biogas plants is quite comprehensive and not to be mentioned here. Only the most essential laws and directives are mentioned, which the planning affects.

- The Danish Planning Act, Council Regulation 85/337/ from 27 June 1985
- The Danish Environmental Law, Council Regulation 85/337/ from 27 June 1985
- The Danish Nature Protection Law, Council Regulation 92/43/ from 21 May 1992
- Animal By-Products (Animal By-Product Regulations) Council Regulation 1069/2009 from 21 October 2009
- The Danish Tender Act, Council Regulation

- The Public Procurement Act, Council Regulation 2004/18 and 2004/17

The regulatory processing by the local councils of the biogas project has to fulfil the objects of the Danish Planning Act and the Danish Environmental Law.

This means that the biogas plants are subject to approval by the Danish Planning Act and the Danish Nature Protection Law.

When establishing a large stock of gas (more than 10 t consisting of methane and carbon dioxide, i.e. 8,700 m3 stock), the plant will be subject to Council Regulation 96/82/EØF, Council Directive on the control of major-accident hazards involving dangerous substances.

4.2 Location of biogas plant

The location of biogas plants are regulated by the Danish Planning Act. This means establishment of a local development plan to ensure comments by surrounding citizens and professional bodies. In cases with establishment of biogas plants in farms in connection with animal husbandry, and if the plant only treats slurry from this particular farm, a rural area permit may be enough.

The optimal location of biogas plants would often be in the open land (rural area) in the centre of the “slurry area” and close to an energy purchaser. It is of vital importance to asses the potential localities compared to a high number of location criteria, in which transport and infrastructure, distance to neighbours and fitting into the landscape are key factors.

To assist the local councils, The Biogas Secretariat of the Danish Ministry of the Environment has made a list of criteria to for the assessment of possible locations. The purpose of the geographical analysis is to place biogas plants appropriately in respect of the existing physical planning. The geographical analysis visualizes to the extent possible the relevant applicable considerations for location. The analysis shows by colour codes in a map how to influence biogas planning on the existing planning

By the end of 2013, the local councils must designate the rural areas, which are suitable for placement of large biogas plants in the town plans.

4.3 Rural area permit

The rural area permit grants permission for the establishment of small-scale plants in connection with farm buildings. Procedure of application for rural area permits will take place in conformity with the Danish Planning Act.

The application should include a brief description of the impact of the development on the environment and a specific description of the elements of the plant, i.e. heights of building, materials, traffic conditions, etc. Developers should ensure a discussion on the content of the application with a local government employee in charge of rural area issues.

4.4 EIA screening

All biogas plants are subject to screening according to the EIA rules issued by the authorities, and

all planning and building regulations for municipality/local authorities are subject to environmental assessment according to the environmental rules.

The biogas group/the operators will register the project for screening.

Subsequently, the local council determines if the establishment of the plant would require an EIA assessment or if building the plant should be effected solely in accordance with a local development plan. Biogas plants and the spreading areas hereof are comprised by the EIA screening rules.

The procedure:

- A plant is subject to AIE screening by the local council
  - As a minimum, the screening should be based on the relevant criteria of the EIA regulation
  - Often, the council will apply a screening form enclosed in the EIR application instructions.

- Based on the AIE screening, the council will decide if the plant would be subject to AIE screening, i.e. an AIE statement should be prepared.
  - If the council decides otherwise, the next step will be a local development plan and possibly an addendum to the town plan.

4.5 An AIE statement

If a plant, based on the AIE screening, is considered having a considerable environmental impact, this requires an AIE statement. The preparation of this would normally lie with the biogas project group.

The project group would normally prepare the statement, however, as the council is responsible for the content, they will also prepare the statement. It is important, in the first instance, that the operator and the local council will agree on the content of the statement and the procedure of implementation, including coordination with the local planning authorities.

Afterwards, as an enclosure for the AIE statement, the draft application for environmental approval should be submitted.

4.5.1 Information for the AIE statement

The information that is more specific to a biogas operation and likely to be required to satisfactorily negotiate a planning permission is:

A non-technical resumé:

Introduction

Project description and delimitation

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- A detailed site plan clearly showing the development site, all other land in the applicant's control and all neighbouring dwellings or other sensitive building/uses
- A full description of the processes to be employed – e.g. waste reception, processing, digestion, energy generation
- Description of the feedstock to be utilised, its origins, transport routes, delivery vehicles tobe employed, etc.
- Estimated energy output and its utilisation
- Description of the solid and liquid digestate and the strategy for utilisation/disposal.

Alternatives

Land-use conditions
- Plans, elevations and sections of the development that clearly set out the proposed appearance
- Details of any off-site equipment that would be required as a result of the development (e.g. electricity lines or substation).

Landscape and surroundings

Visualization

Nature plans

Traffic

Noise

- Noise minimisation technology and measures

Odour
- Measures to avoid the release of odours

Other environmental conditions
- Environmental advantages of AD – carbon emissions offset

Socio-economics
- Economic advantages to the area

Cumulative effects
Mitigation procedures and surveillance programme

Environmental impacts of the project
- Details of all emissions, even under worst-case conditions
- Measures to avoid pollution to the air, ground and watercourses, even under worst-case conditions

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Environmental assessment restrictions

References

Appendices to the report
Enclosure 1. Charts
Enclosure 2. Nature plans

4.6 Environmental assessment of plans

If the establishment of a plant requires a change in the local town plan, i.e. an addendum, which would break with the existing town plan framework, this would require an environmental assessment. By and large, an environmental assessment is like an AIE statement, however, it is less detailed and directed towards the plan, not the specific plant.

4.7 Addendum to the town plan

Whether localization is already included in the town plan or not, a town plan addendum must be drawn up. This independent town plan addendum with guidelines for the town plan and the appurtenant AIE statement is the final and approved document, according to the AIE rules. An addendum normally includes a brief statement and the specific guidelines and framework of the council.

4.8 The local development plan

According to the Danish Planning Act procurement of a local development plan is obligatory before introducing large parcellization or large-scale building or construction work, by example a biogas plant.

The local development plan lays down guidelines for the establishment of the plant, such as plot ratio, building area, height of buildings, choice of materials, plantation, access roads, etc. Odour and noise guidelines are subject to adjustments in the environmental approval, however, may also be included in the local development plan. The local councils normally have a framework for their local development plans, which should be applied in the process.

4.9 Environmental permit

Biogas plants with a capacity exceeding 30 t biomass/day and/or with a gas production of more than 1MW are subject to the Danish Nature Protection Law and require an environmental permit. An environmental permit is a part quantity of the EIA statement.

5. Components of the Plant

5.1 There are a number of components to any AD operation and each will require to comply with relevant standards and regulations. Of critical importance, however, is the full integration of the component parts in order that the system works efficiently, safely and as a reasonable “neighbour”.

5.2 The feedstock reception and processing facilities will depend very much upon the nature of the operation and the type of materials under consideration. Most biogas feedstocks have the potential to cause odour nuisances and it is critical that feedstock deliveries are handled correctly, probably happen within an enclosed space and often under “negative pressure”. The sooner the feedstock is contained within an airtight receptacle such as a mixing or fermenting tank, the less the chance that nuisance will be created.

5.3 The digester (usually a twin-walled steel or concrete tank) is clearly the defining component of a biogas installation. It is also one of the physically largest components.
It is critical that the digester is setup properly, maintained well and fed according to its design parameters and feedstock currently in use.
Feedstock will often vary from one time of year to another and it is important that the processes within the digester are monitored and managed as necessary.

5.4 The biogas is drawn off from the digester and, again, it is vital that this process is well-managed. There is a theoretical potential for explosion because of an undue build up of gas/pressure as well as the ignition of the flammable gases, but safety systems are put in place to ensure that this does not happen.
Gas collection, control, storage and utilisation systems are designed in accordance with good engineering practice and, where appropriate, the technical and safety standards issued by the Danish Managing Regulative for Gasses (Gasregulativet), especially part B-4 (Bigger Gas fired Plants and B-41 Gas engines).
Good plant manufacturer’s designs are reviewed by a Chartered Gas Engineer.

5.5 Where a significant quantity of Hydrogen Sulphide is anticipated to be produced within the digestion process, it is normal for the biogas to be cleaned prior to its combustion in a boiler, engine or turbine.

5.6 Once the biogas reaches this stage in the process it is regulated and controlled very much like any gas combusting equipment. It is possible the gas is, indeed, piped to a remote location for utilisation elsewhere.

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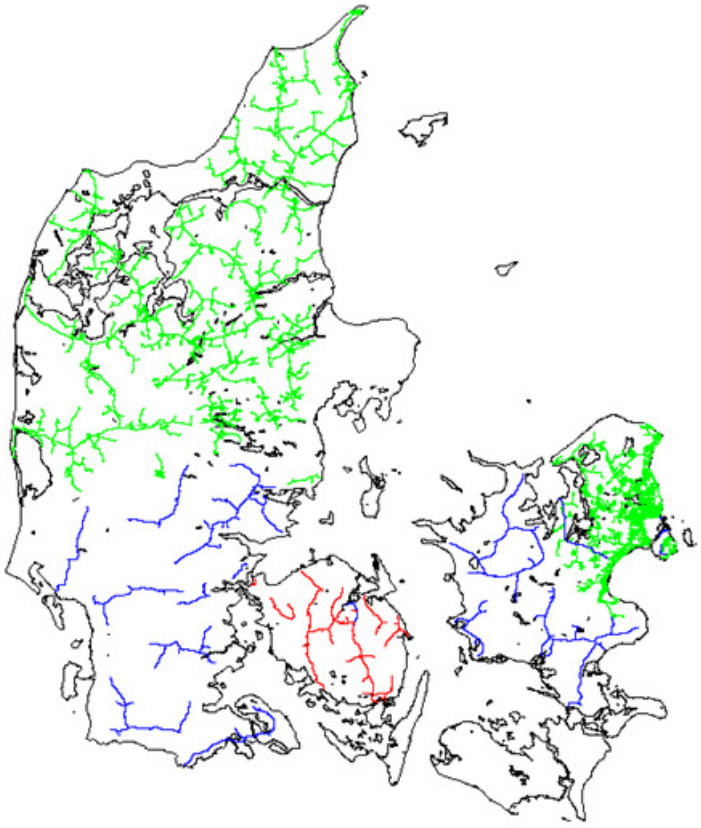

Maps: Gas mains in Denmark over 4bar

5.7 If the gas is to be injected into the gas mains then the cooperation of the gas distribution network operator is required and early contact with the relevant organisation is recommended. There are exacting standards for bio-methane into the gas grid with only very low concentrations of gases other than methane allowed. The Department for Energy and Energinet.dk has produced a guide for producers of bio-methane into the gas network.

5.8 Should the gas be used to generate electricity then there are clearly important safety issues that need to be addressed with the generator itself and with the connections to the public network. Connections to the public network have to be undertaken by and through negotiation with the Energinet.dk

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6. Feedstock to be Utilized

6.1 Household waste

6.1.1 In Denmark, the municipalities' responsibility to ensure that household waste from private households is collected and processed in the most environmentally friendly way. The goal is to reduce waste volumes that as much waste as possible is recycled, the less will be burned and that as little as possible deposited in landfills.

In Denmark all food waste is segregated. Private companies have a contract whit the municipalities to collect the food waste and drive it to CHP where the heat is used in the district heating network. The price is about € 350 per year for each private household. Restaurants, canteens, schools, hospitals, care homes are paying much more.

Kilde: Næstved municipality, http://www.naestved-affald.dk/index.php?ID=6&lang=da

Some waste can be sort from and compost, so it becomes topsoil. Some municipalities have special bins for food waste. Then scavengers run this for composting or anaerobic digestion instead of burning it.
There are not yet any food waste AD plants in Denmark.

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6.2 Waste from Food Processing (including Abattoirs)

6.2.1 Category 1 and Category 2 (except Digestive Tract Content) material from abattoirs cannot be processed via an AD plant and must be sent for high temperature processing but some of the material (Low Risk Category 3) is available.
The waste from food processing including abattoirs waste is send to DAKA there produce bio-ethanol.

6.2.2 There are a number of other food processing operations that have the potential to provide significant feedstock for AD plants and, indeed, some of them now have operational AD plants of their own.
There are a number of food processing operations, e.g. organic operations, that have enough potential feedstock to justify the construction of an AD plant but there are many more that could either cooperate with others or provide material to a third party facility.

6.3 Animal Slurries

6.3.1 The density of livestock across the project country varies quite significantly. For much of the upland region e.g. of Jutland the predominant form of agriculture is cow and pigs rearing. All the pigs slurry are collected and about 80 pct. of the dairy farming slutty or manure are collected. The collection of slurries from housed animals is relatively restricted. The opportunities for collecting more slutty and manure will be very difficult.

6.3.2 AD plants utilising only animal slurries are not in the future economic profitable.
Most AD plants will use mixed feedstocks e.g. slutty, maize, grass and waster from food industry.
In Denmark it is necessary to cooperate or make contracts with a number of slurry and/or waste and/or crop feedstocks producers to make the biogas production economic profitable.

6.4 Especially Grown Crops and Crop Residues

6.4.1 Energy crops as maize and grass are used in small AD plant in Germany. In Denmark we use the grass in organic plant as part of a mix with other feedstock such as animal slurry and manure. The big AD plants are using sugar beet and straw which is really good and give a lot of methane.
In 2011 and 2012 grass from roadside verges has been trialled at a small AD plant as a research trial.

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7. Gas Utilisation

7.1 Electricity production

7.1.1 The usual and, in many ways, the easiest means of productively utilising biogas from AD plant and sewage is the generation of electricity via a gas engine or turbine.
It is quite easy to assign the electricity production to the electricity distribution network and make an economic agreement with the distributor how the electricity is settled.

7.1.2 The Danish government has since 2008 market supported mechanism for larger renewable electricity production from AD plants. The support is 0.77 DKK per Kwh in 2009. The grant is index linked each year and in 2012 the price is 0.79 DKK per Kwh with an engine power of 35 %. The grant is paid to the AD plants.
The price guarantee to the AD plants provides significant comfort to both the lender and the borrower when it comes to securing a loan.

7.2 Heat Production

7.2.1 There is some requirement for heat in the digestion process itself and this is best supplied by utilising some of the biogas.

7.2.2 The remainder of the gas will be utilised to produce heat for buildings and hot water to the householders via district heating plants.
Given the difficulties and expense involved in storing large quantities of gas, it is best to have a heat and/or cooling load that are near constant and well-matched to the gas output. The demand for heat is greatest in the winter in Denmark leading to a need for large storage facilities for slurry, maize and grass resulting in that the AD plants up costs are quite large.

7.2.3 Whilst it is clearly better when the demand for the heat energy is sited close to the biogas facility it is certainly possible to transfer gas by pipelines at a reasonable cost even if there should be an upgrade of the biogas. This cost would be very much less than the cost of a heat main (insulated pipes carrying hot water).

7.2.4 Should the gas pipeline or heat main from the AD plant options be considered, then it would clearly be necessary to come to an early agreement with the owners of any “third party” land to be crossed. Most of the gas pipelines in Denmark are owned by the Danish state/DONG Energy, Energinet.dk or private gas companies as Naturgas Fyn and HMN, which is a company owner by 27 municipalities.

7.3 Combined Heat and Power

7.3.1 Combined heat and power (CHP) is an attractive option in that it combines the production of renewable electricity, and thereby income from marked support from the Danish state, with the productive use of the heat that is an inevitable by-product of the power generation process.
The key, however, is the identification of an appropriate heating/cooling load and therefore the ability to attract additional income from energy sales.

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A good, efficient CHP system is designed to meet the heat load with electricity generation following. A "good" heat load will be 24 hours a day and all year round.
A combination of users, for example residential, office, leisure may provide just such a load with the summer requirement for cooling providing the year round demand.

7.3.2 As with the heat only option, consideration needs to be given to reducing to an optimum the length of required heat main and thus consideration should be given to piping biogas from the AD plant to the CHP unit.

7.4 Feeding (Bio) Methane into the Gas Grid

7.4.1 Upgrading biogas is stripping out the gases other than methane (i.e. mostly carbon dioxide) in order to match mains gas. But this might not be enough: In the Danish case the natural gas that is supplied from the north has a very high quality and heating level, so propane might have to be added to biogas in order to maintain the same quality and heating level as in natural gas. This adds further to the cost injecting biogas into the grid.

7.4.2 This option has only been implemented in one case in Denmark, but might be a future option if subsidies are provided for this logistic and use of biogas. The Danish self-supply from natural gas resources has just ceased and the decline has started, but it is very difficult to predict the production for the coming years.

7.4.3 Government revenues/charges are high from the national gas sale and this revenue is maybe the most significant barrier for biogas distribution throughout the country. It seems not to be an option politically to remove taxation of biogas.

7.4.4 The parliament has not yet decisided to support upgrading and injection into the grid.

7.4.5 It is not necessary to be within few kilometres from the gas main thus extension of the main with a biogas collection grid is an option. Early discussions with the gas network operator are recommended which is Energinet.dk as the national operator and HMN Naturgas, Naturgas Fyn and DONG Energy as regional gas operators are relevant in the central and north region of Denmark.

7.5 Utilisation as Transport Fuel

7.5.1 Denmark does not use methane as transport fuel but many other counties (Germany, Sweden and so on) use methane as a transport fuel in the form of CNG (compressed natural gas) and rather more usually LNG (liquefied natural gas). Utilising a cleaning process similar to that required for injection into the gas main, biogas can be converted to a transport fuel. In the 70s there were many cars in Denmark using methane gas as fuel but settled slowly and completely disappeared in the early 1980s. In 2012 a municipality in Fyn started using methane as fuel to 14 of their cars.

7.5.2 By far the most likely scenario for this utilisation would be where there is a captive fleet of vehicles or possibly a public bus fleet e.g. in Sweden today. The big cars companies are producing cars using gas as fuel.

In the future it would be important that the projected output of the AD plant matched reasonably well with the demand for fuel.

7.5.3 Storage of the bio-methane is very expensive but it is equally important that there is always sufficient fuel available to the captive fleet. This would be a difficult balance to achieve unless the transport fuel option is run in parallel to a main gas operation.

8. Utilisation of the Digestate

8.1 Use as a Bio Fertilizer

8.1.1 Both the liquid and solid digestate (biomasse) has potential value as a bio-fertilizer, displacing the use of mineral fertilizers. For every ton of mineral nitrogen displaced there is a potential reduction in carbon dioxide emissions of 2.3 tons with the equivalent figure for phosphate fertilizers being 1.1 ton. The majority of the phosphate content is usually within the solid fraction of the digestate (biomasse). The carbon reduction arguments are supplemented with cost savings to the agriculturalist – the cost of mineral fertilizer is souring.

8.1.2 In Denmark the digestate is regulated in connection with the total VVM screening (Impact on the Environment) that the Municipality has to make to give the permission for each AD plant. Digestate in Denmark always contains waste and is therefore to be treated and disposed as waste.
8.1.3 Great care will always need to be taken in the timing, methodology, practice and spreading rates when applying the fertilizer/digestate. In Denmark you must have at least storage capacity for 6 months production of digestate, but even if not required by license or legislation, digestate should only be applied when weather and soil conditions are appropriate. Spreading digestate when plants are not in a position to take up the applied nutrients immediately is wasteful and potentially polluting.

8.1.4 Digestate must not be agitated (e.g. by spraying) during application, and thus it is best applied by either direct injection into the soil or by trickling it onto the surface. To do otherwise, would see the release of compounds of nitrogen, such as ammonia, into the atmosphere, seeing a loss of nutrient value to the soil, odour nuisance and atmospheric pollution. Within Nitrate Vulnerable Zones the limits for the spreading of organic manure (which would include digestate) are 170kg of nitrogen per hectare for arable land according to the EU Directive.

8.1.5 Digestate from AD plant that is treating residual or contaminated wastes will not be allowed to be disposed of to agricultural land. Under some circumstances it may be possible to use it as a fertiliser to non-food crops.

8.2 Soil Conditioner

8.2.1 The solid digestate from AD installations can also provide a soil conditioner benefits due to the residual organic carbon content. Where the feedstocks can be demonstrated to be free of con-

taminants this product can be utilised in circumstances where food-crops are involved. Lightly contaminated feedstocks will give rise to a solid digestate that would be suitable for use in the cultivation of non-food crops. Some feedstocks will only provide a digestate suitable for daily cover on a landfill site or combustion. In some circumstances it may well be necessary to provide a further period of aerobic composting in order to comply with "Landfill Directive" requirements for the treatment of bio-degradable waste.

9. Avoidance of Hazards

9.1 Construction Design & Management Regulations.
The contractor constructing the plant will have to comply with these regulations, which fall under the Danish "Arbejdstilsynet – vejledning D.2.7." The purpose of the regulations is to ensure the safety of those involved in constructing the plant.

9.2 Dangerous Substances and Explosive Atmosphere Regulations.
These regulations (DSEAR) require a formal risk assessment be carried out and a suitable strategy implemented to minimise the risk of explosion. They implement in Danish law the "Gasreglement" and the Directive of the EU. They are clearly relevant to biogas plant and require extensive planning and strategy implementation particularly in respect of potential sources of ignition in key areas.

10. Conclusion

10.1 There are a number of barriers to the development of biogas plants in Denmark with the difficulty - one of the greatest, seemingly - VVM and country planning consent. On the other hand it does appear that the market conditions are changing and that good quality AD developments based on the processing of waste products from farmers and food industry production (i.e. attracting a gate fee) are now economically attractive if the settlement prices for electricity and biogas is about 1.15 DKK/kwh and 5.00 DKK m3 methane. The Danish parliament will spring 2012 present a new energy agreement. The agreement will also indicate how large the subsidy to the AD plants will be the next 8 years.

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