
Summary Report

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PREPARATION OF A BUSINESS PLAN FOR IMPROVING MANURE MANAGEMENT IN POULTRY FACTORIES IN THE LENINGRAD REGION, RUSSIA

SUMMARY REPORT

Volume I: Main Report

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SUMMARY REPORT

Volume I: Main Report

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PREPARATION OF A BUSINESS PLAN FOR IMPROVING MANURE MANAGEMENT IN POULTRY FACTORIES IN THE LENINGRAD REGION, RUSSIA

SUMMARY REPORT

EXECUTIVE SUMMARY

This Summary Report combines all reports of the Preparation of a Business Plan for Improving Manure Management in Poultry Factories in the Leningrad Region, Russia assignment with the Business Plans being included to the extent possible without disclosing confidential information.

The report also attaches as Appendices (in Volume II)¹ the Task Reports (Tasks 1 to 6) which were developed and submitted to NEFCO prior to the elaboration of the Interim Report of the Business Plans.

The Terms of Reference of the assignment make up Volume III.

During the course of the study the following issues, which are summarised in this Summary Report, were addressed:

- Market survey on the potential of fertilisers processed from poultry manure
- Analysis of technology alternatives
- Analysis and update in respect of legislative requirements and related environmental concerns, as well as other relevant manufacturing or exporting costs
- Analysis and update of the investment capacity of poultry factories
- Identification and analysis of relevant funding options
- Assessment of potential joint investments

The main results of the **market survey** were as follows:

- The fertiliser market may be divided into three areas:
 - *Mineral fertilisers*: highly consolidated in Russia, well established and growing market; widely exported product. Russian producers enjoy share of 11% in global production, while consumption in Russia represents some 2% of global consumption (9,5 and 1,5 billion EUR respectively in 2008). Entering this market segment would require a partner.
 - *"Branded" organic and mineral-organic fertilisers*: low consolidation; low volumes (turnover under 200 million EUR in Russia in 2008); growing market; B2C mostly – small packaging. Entering the market requires heavy involvement in marketing of the product. This is a regional niche market but export to other regions/countries could be considered on a relatively small scale.

¹ Volume II, the Task Reports, is available only in the English language , and only upon request.

- *Bulk organic fertilisers* production: consolidation is low while integration (farm+field) is not uncommon; locally traded product; bulk transportation. Cost of transportation limits the export potential to other regions/countries. However this is a growing market segment in Europe, and globally, such that exports to other regions/countries could be an attractive possibility despite the transport issue. This will be addressed in more detail in connection with the preparation of the business plans.
- The organic fertilisers market in Russia shows the first signs of revival after over 15 years of decline. However, the market in Leningrad region is small so that export to other regions/countries will be needed, as will strong marketing efforts in those export destinations. The most promising export destinations are the UK, France, Portugal and Spain, as well as Southern Russia. However the logistical and competition conditions might be a problem if the whole volume of poultry manure produced in Leningrad region is to be disposed of in this way. The total market in Russia in 2008 was approximately 1,3 billion EUR. The total net-import of the UK, France, Portugal and Spain in 2008 was nearly 80 million EUR.
- Industrial production of fertilisers in Russia requires certification. The biggest poultry farms in the Leningrad region (Oredez, Udarnik, Roskar, Severnaya and Sinyavinskaya farms) have been, or are now proceeding through, a end-product certification process. No significant problems have been reported

From the point of view of the **analysis of the technology alternatives**, the following general conclusions can be presented:

- The larger producers, which typically produced 90 000 t/a of manure, would benefit considerably from the reductions in mass that would result from one or another thermal treatment. They would then be left with potentially commercially interesting ash, biogas, bio-oil, biochar or manure pellets. However the commercial interest in these products is limited, as long as mineral fertilizers continue to receive subsidies from the Russian state.
- Smaller producers, typically 20 000 – 40 000 t/a of manure, are able to choose between two established technologies, viz composting or anaerobic digestion. The problem here however, even with the smaller farms, is that the resulting fertilizer or biogas quantities produced with these methods would be very large. An answer must be found as to what to do with the outputs of these processes.

It can be concluded that while there are gaps in the **legislation currently in force**, overall legislation is appropriate and pertinent for prevailing conditions. However gaps also exist in the application of legislation, and in particular with respect to incentives meant to encourage environmentally sensitive behaviour. These are not always sufficient.

Thus the legal and regulatory framework under which poultry farms dispose of their manure, from the point of view of a creditor to the farms in this specific area, may be more feeble than such a creditor would like.

The conclusions on the **investment capacity of poultry farms** are that altogether four farms were identified which expressed an initial interest in proceeding further with

investigating the feasibility of possible future investment and which have better potential for such investment. These are:

- Severnaya,
- Roskar,
- Primorskaya, and
- Lagolovo.

Severnaya and Roskar are among the biggest sources of nutrient load, and Primorskaya and Lagolovo have demonstrated the most interest to proceed with business plans and investments in the near future. (*Note – for the Summary Report this condition has changed. PF Lagolovo has since expressed its lack of interest in proceeding with an investment. PF Lagolovo’s main interest, it seems to the consultant, is to find a technology partner to resolve the manure issue for it. NEFCO is not in a position to be that partner.*)

One of the tasks of the assignment was to identify and assess other, non-NEFCO, **sources of financing for possible investments**. The need for this arises because NEFCO, by its own mandate, is not permitted to finance more than 50% of any given investment, and is limited to financings of a maximum of €5 million in size. There are several potential sources of complementary financing which can be classified by type, as follows:

Concessional external financing partners, such as:

Multilateral Sources: International Finance Corporation of the World Bank group, European Investment Bank, Nordic Investment Bank, EBRD

Bilateral Sources: FINNFUND (Finland), SWEDFUND (Sweden), IØE (Denmark), Kredifanstalt für Wiederaufbau (Germany)

Non-concessional external financing partners

Financial Intermediaries: Nordea Bank (Finland)

Non-financial Intermediaries: Various Finnish firms active in the sector, technology firms or others, were contacted to assess their willingness to undertake financial risk in Russia.

Concessional domestic financing partners

In Russia domestic sources of concessional financing are available from entities related to the state, at one or another level. Entities connected to the Leningrad Region Administration, or the Russian Federation Administration active in rural or agricultural finance were contacted.

The conclusions of the **potential joint investment analysis**, undertaken in a most generic fashion and without any attention to the details of each farm, suggested that the financial viability of the investments (as stand alone investments) must be questioned especially if the treated poultry manure is delivered or sold in the vicinity of poultry farms with relatively low prices.

Similarly, only domestic Russian demand for the outputs of the investments was considered in Phase I. In fact in certain circumstances there also exists a possible export trade for the outputs of the investment, particularly composted product. This will also be examined in detail in the Business Plans.

The three **Business Plans** are developed around the following technical solutions:

- A composting solution;
- A pelletized fertiliser solution;
- Digestion and incineration solutions in various combinations.

The business plans are summarised in section 4, below.

1 INTRODUCTION

1.1 Background

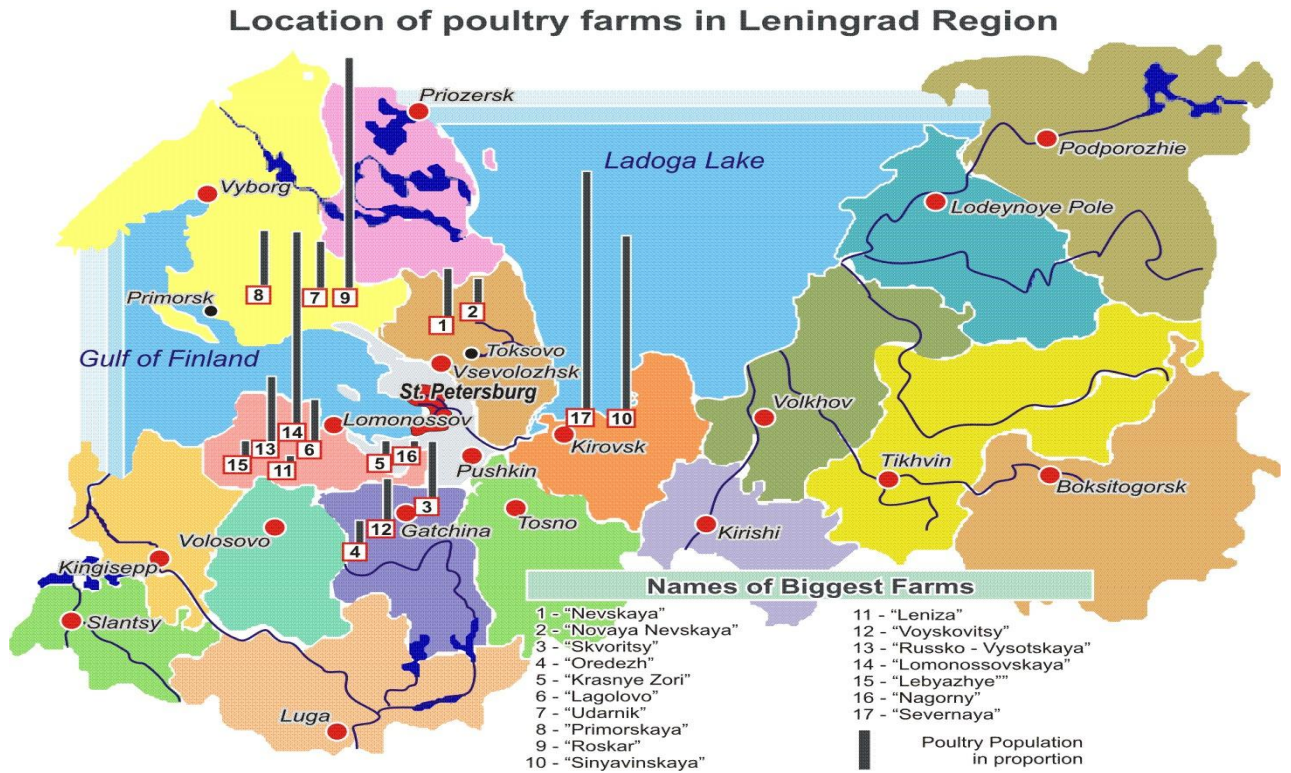
As stated in the Terms of Reference (TOR), and also in several earlier reports regarding the issue, animal manure handling and nutrient loading constitute a major outstanding water pollution risk of the Baltic Sea. The share of poultry farming – as we show below in section 2 – is a big part of the overall animal farming, i.e. the potential nutrient loading to the Baltic Sea of poultry manure is about 60 % of phosphorus loading and about 50 % of the nitrogen loading of all animal farms in Leningrad region (c.f. estimates in section 2.1.). Hence, there is no doubt that this issue is significant, not only from the perspective of the individual poultry farms but also from the point of view of the protection of the Baltic Sea - and especially from the point of view of the loading of the Gulf of Finland.

Several earlier studies on this topic have been conducted in the last 4-5 years, and they are briefly referred to in section 1.2 of this report. The environmental risks, potential corrective measures, and financing of investments have been addressed in these studies. On the other hand less attention has been paid in these studies to the markets for end-products of manure handling, or to the availability of Russian technology for manure management, which would lower the investment and operating costs of manure treatment. These two issues have been paid special attention in the current study project, as have been other essential legal and financial issues which are relevant for the elaboration of 2-3 business plans and for preliminary commitments of the companies participating in their preparation – i.e. the resulting final outputs of this project. The investment capacity of the industry as a whole, as well as the current interests of the most motivated poultry farms, have been estimated and updated in the course of this study.

In order to get an initial idea of the geographical distribution of the poultry farms, their location is presented in Figure 1-1. This map shows not only the locations of the farms, but also the relative loading of these farms, which is expressed as number of animals in each farm. From the Figure 1-1 we can observe that the poultry farms are concentrated in Primorskiy, Lomonovski, Gatschinskiy, Viborgskiy and Kirovskiy districts. Some major farms are located closer to the Baltic Sea, with shorter pollution pathways to the

Baltic Sea, whereas with some other farms there are lakes or short chain of smaller lakes in between the farm and the Baltic Sea. This pollution potential and risk has been addressed in the most important farms in a study report of the BALTHAZAR project in spring 2010. The section 1.3 of this report includes a summary of the loading inventory, risk assessment and prioritization of the pollution of the most important farms from environmental protection point-of-view.

Figure 1-1. Poultry farms in Leningrad Region



1.2 Former and on-going parallel studies

We have reviewed the earlier studies and project reports referred to in the TOR. We find that they contain a considerable amount of useful information, to which we have made references as appropriate, especially in sections 1 and 2 of this Summary Report. In section 2, and later in this report, we have updated and summarized the macro-scale numbers and issues and combined and compared them with information collected and analyzed in this study project. We have done this, for example, regarding information on estimates and nutrient contents of animal feed (fodder) in order to update an overview of the nutrient inputs and nutrient balance of the Leningrad region.

Also the investment cost and operating cost estimates of previous studies have been compared to such costs acquired for this study, when preparing the costs estimates in section 3.2. The investment and operating cost estimates of this study rely to a greater extent to the information received from Russian technology suppliers and Russian civil works and operating cost levels than in earlier studies, where the estimates were based mainly on the Finnish costs levels and represented thus more conservative cost estimate levels.

In addition to the previous studies, there has been a parallel project financed by HELCOM as part of the pilot – i.e., projects related to their BALTHAZAR-initiative. This project has focused on two pre-selected poultry farms (especially Primorskaya farm but also Udarnik farm) and has addressed the possibilities of applying a new Russian poultry manure drying and pelletising technology called Bioklad. The study team of current project and the HELCOM-project have exchanged information and met various times in autumn 2010 in order to coordinate the works and to ensure the availability of relevant information for both study teams.

1.3 Poultry farms as one major source of nutrients from animal farms in Leningrad region

The poultry farms (listed in Table 1.1.) were selected to be interviewed by comparing their earlier activities in manure treatment development, their potential environmental risks assessed in the former projects BaltHazAR and PRIMER, as well as their location and willingness for cooperation. In connection with this project most farms – but not all of them – have been willing to meet and discuss with the project team and to participate in the two workshops which have been arranged. Therefore, the farms included in this report are influenced by their willingness to discuss their investment capacity and to describe their earlier experiences of investment plans in manure management.

According to the report of the PRIMER project (2009), the potential nutrient load (nitrogen and phosphorus) from poultry farms to the environment in the Leningrad Region is largest in the Lomonosovskiy district, where the poultry farms Lomonosovskaya, Lagolovo, and Rusko-Vysotskaya are located. The second largest potential nutrient load comes from the Vyborgskiy district, where the poultry farms Roskar, Udarnik and Primorskaya are located. Kirovskiy district provides the third largest potential load. The companies Sinyavinskaya and Severnaya are located in this district. Other districts of the Leningrad region do not represent very significant potential of nutrient load reduction from poultry farms.

Table 1.1. The poultry farms in the Leningrad Region, their main products, current manure treatment and their ranking of potential phosphorus and nitrogen amounts in manure

Poultry farm	District	Ranking: P in manure	Ranking: N in manure	Current manure treatment	Main Products
PF Lomonosovskaya	Lomonov.	1	1	Composting, stockpiling	Meat
PF Severnaya	Kirovsk.	2	2	Stockpiling	Meat
PF Roskar	Vyborg.	3	3	Land spreading granulation, stockpiling	Eggs
PF Sinyavinskaya	Kirovsk.	4	4	Stockpiling, granulation, land spreading	Eggs
PF Russko-Vysotskaya	Lomonov.	8	8	Composting	Meat
PF Voyskovitsy	Gatchin.	11	11	Stockpiling	Meat
PF Lenoblptitseprom	Gatchin.	6	6	Stockpiling	Eggs
PF Primorskaya	Vyborg.	10	10	Storage in lagoons, partly stockpiling	Eggs
PF Udarnik	Vyborg.	13	13	Stockpiling, composting	Eggs, meat
PF Oredezh	Gatchin.	9	9	Composting	Eggs
PF Lagolovo	Lomonov.	16	16	Composting	Eggs
PF Nevskaya	Vsevolozh.	12	12	Stockpiling	Eggs, meat
PF Lebyazhye	Lomonov.	-	-	Composting	Eggs
PF Skvoritsy	Gatchin.	-	-	Composting	Eggs

N.B. (i) Ranking of phosphorus and nitrogen amounts in manure is presented according to Russian nutrient excretion coefficients for phosphorus and nitrogen in the project BaltHazAR (2010, Table 10 which includes also information about other than poultry farms) ; (ii) Current manure treatment is based on the interviews conducted in the course of this project or on information of the project BaltHazAR (2010).

Lomonosovski district: two farms were selected to be interviewed: Lagolovo and Russko-Vysotskaya. Lagolovo does not present a big potential environmental load, but the company is actively developing manure treatment, and might have cooperative actions with other farms nearby. Some information was collected from Russko-Vysotskaya and Lebyazhye, especially about their interest in co-operation

Vyborgskiy district: three farms were selected: Roskar, Primorskaya and Udarnik. These three companies are relatively close to each other. They were selected to be addressed because they might have interest to make investments together, or to use joint treatment unit. They have been active in searching manure treatment opportunities as well. Udarnik and Primorskaya are not ranked very high in potential environmental load, but Roskar is ranked as third in potential risk of nitrogen and phosphorus.

Kirovskiy district: company Severnaya was selected. It has been ranked a source of very high potential risk of nitrogen and phosphorus. The company has investments plans for expanding and it is interested in improving manure treatment. Sinyavinskaya is located near Severnaya. Its potential environmental load was ranked high both in nitrogen and phosphorus. It has not shown remarkable activity during this project or earlier.

Gatchinskiy district: poultry farms Skvoritsy and Oredesh were selected. The farm Skvoritsy is a part of the Lenoblptitseprom complex, which is ranked on 6th position by the potential environmental load. Oredesh has not been ranked high, but it might have cooperative actions

Because two of the farms, Primorskaya and Udarnik, are familiar to the team and there is an ongoing project funded by HELCOM, regarding the pilot project in Primorskaya and partly Udarnik, these companies were not interviewed with face-to-face meetings but contacted by phone. The information produced in the on-going HELCOM project is made available to NEFCO-project team.

1.4 Objectives and focus of this study project

According to the ToR the Project Purpose was to prepare Business Plans for manure management for typical poultry factories in the Leningrad Region. The work was divided into two phases: (1) Study of the possibilities for joint processing of manure into relevant products; and (2) Depending on the feasibility, preparation of Business Plans(s). Based on the findings of the Phase I, a decision on whether the actual Business Plan(s) were to be prepared was made. The detailed scope of the Business Plan(s) was defined consequently.

The main objectives and principles of the technical approach to the Phases I and II of the project were as follows:

PHASE I

- Market survey on the potential of fertilisers processed from poultry manure
- Analysis of technology alternatives
- Analysis and update of the legislative requirements and related environmental and other relevant manufacturing or exporting costs
- Analysis and update of the investment capacity of poultry factories
- Identification and analysis of relevant funding options
- Assessment of potential joint investments

PHASE II

- The project resulted in the development of three Business Plans which have been developed together with NEFCO and with those poultry farms and their co-investors which are most interested, and which have the best investment capacity to carry out the investments.

2 OVERALL NUTRIENT LOADS AND PRINCIPAL WAYS OF DEALING WITH THEM

2.1 Manure amounts and nutrient loads of poultry manure

Estimates of nutrient loads in manure and manure amounts

In the BALTHAZAR project (2010) there were the most recent calculations of nutrient amounts of animal farming at the Leningrad region. The share of poultry farming can be estimated based on the number of hens and their specific loading coefficients presented e.g. in the reports issued by the BALTHAZAR project. Based on 20 million hens and specific phosphorus and nitrogen excretion of 0,25 and 1,0 kg/hen/a respectively, the annual loads of main nutrients in Leningrad region are estimated to be as follows:

- Phosphorus: 5 000 t/a
- Nitrogen: 20 000 t/a

These estimates are even somewhat higher than the earlier estimates mentioned in previous studies and in the TOR of this project (these being 3 000 t/a phosphorus and 14 000 t/a nitrogen). When also the amount of pig and cattle manure in Leningrad region are calculated, (assuming that 50 % of the cattle produces meat and the other 50 % milk as was the case in 2007 according to the Ramboll (2008) report), the total nutrient amounts of all animal farms is approximately

- Phosphorus: 8 000 t/a
- Nitrogen: 38 000 t/a

These estimates based on information of specific loadings and animal numbers of the BaltHazar project (2010) are higher than the earlier estimates of PRIMER project, which were 4 600 t/a phosphorus and 18 600 t/a nitrogen. These differences are probably caused by the differences of Finnish and Russian methodologies and their animal specific loadings. However they can also reflect the real increase of animals as the animal farming capacity has increased to some extent since 2007. For example according to a Ramboll (2008) report for the Finnish Ministry of Environment (referred to in the TOR and submitted by NEFCO as baseline material for tendering in June 2010), the total number of pigs in Leningrad region was 66 000 animals, whereas in the latest inventory of the BaltHazar project (2010) had increased to 157 000 animal. The number of animals in poultry and cattle farms were essentially at the same level in both study reports.

Furthermore, the annual amount of poultry manure can be estimated from the nutrient loads and share of main nutrients in manure. In addition, the water content of manure has a big influence on the estimates of manure amounts, which can vary between 600 000 – 1 000 000 t/a taking into account all poultry farms in the region. As the real

gross amounts of manure are depending very much of the water content of the manure, the range mentioned immediately above is relatively big as there is no information of the water contents of the poultry manure of each farm. Therefore the estimates above are based on the earlier information included in the reports of FCG (2008) from four major poultry farms (Primorskaya, Roskar, Severnaya and Skuoritsy). The total amount of poultry manure can be compared to the earlier estimates of total animal manure, which according to the TOR (and referring to the PRIMER project (2009)), is 660 000 tonnes per annum.

Comparison of nutrients in animal manure and use of fertilizers in the region

According to an earlier report by Ramboll (2008), the total area of Leningrad region is 84 500 km². There are 6 457 km² of agricultural land and 3 972 km² of arable land. The consumption of chemical fertilizers was in the year 2007 as follows:

- Phosphorus: 1 350 t/a
- Nitrogen: 6 340 t/a

These numbers represent about 30 % of the nutrient amounts which are included in the total amount of poultry manure. When considering also the nutrient contents of other manure from cattle and pig farms, then fertilizer consumption is only about 17 % of the nutrient content of all animal farms with phosphorus and nitrogen. Hence this rough calculation shows a nutrient surplus of 83 % in the Leningrad region, when using the numbers of the year 2007. After the financial crisis started in 2008, farming companies and cooperatives have been less able to pay for their fertilizers, and therefore the interest to use manure based organic fertilizers has been increased with those farms, particularly those that are located near to the animal farms and where the manure is supplied free-of-charge. Even when considering this recent trend, the order of magnitude of excess manure is at least 70 – 75 %.

If we then compare manures from different animal farms, the water content of cattle and especially pig manure is so much higher than the water content of poultry manure, that the possibilities to deliver manure outside the typical 30 – 50 km range from the animal farm are best with poultry manure. This is because a significant part of poultry manure is drier than cattle and pig manure. This material is also easier to dewater and dry than the other two types of manure.

Feed amounts in the region

The nutrient amounts presented above can also be compared to the total use of animal feed (fodder) in the Leningrad region, because it is the main source of nutrients. According to the information collected in this study, in 2009 the overall number of domestic animals in the Leningrad region was 183 100 head of cattle (of which 84 700 dairy cows), 163 000 pigs and 20.8 million birds. The total area under forage crops in the region is 193 600 ha. Ninety-two percent of this area is grassland and only 8% forage grain, mostly barley. This 8% include also fields used for whole grain silage production.

Annual feed consumption in the region is estimated to be follows, expressed first as (billion feed units):

- Dairy cows 0,4
- Young cattle 0,2
- Pigs 0,1
- Poultry (egg-laying hens) 0,3
- Poultry (broilers) 0,4
- **TOTAL 1,4 billion feed units (N.B. 1 feed unit equals 1 kg of grain)**

Average fodder crop yield in the region is estimated as 2 000 feed units per hectare. Thus, 700 000 ha of arable land should be used for fodder production in order to meet the needs of the livestock in the region. Currently less than one third of the calculative amount of animal feed needed is produced in the Leningrad region and most of it is cattle feed. Thus, more than two thirds of feed raw material is imported from other regions, including practically all poultry feed. This results in substantial nutrient surplus in the region.

In Russia the share of industrial mixed-feeds in animal feeding is: poultry 57%, pigs 26% and cattle 15%, respectively. However, in the Leningrad region mixed-feed usage is much above the national average due to modernized production technologies and dominance of large-scale production. Especially pigs and poultry are fed with industrially produced feed.

Leningrad region is among the main mixed-feed producers in Russia, the others being Belgorod and Moscow regions and Krasnodar district. In 2008 the share of Leningrad region of all mixed-feed production in Russia was 7.3%.

In the Leningrad region there are a number of feed producers, five of which are among the largest in Russia. One of these is the poultry farm “Severnaya”, which produces poultry feed exclusively. Main producers of cattle and pig feed are Luga, Gatchina, Tosno and Volosovo feed factories.

The possibilities for making feed components of poultry manure have been studied in Russia (Salnikov et al. 1997) and there exists at least one Russian patent (Biofom 2139667) for such a product. Some Russian companies (Topgran, Biocomplex) selling technologies for poultry manure utilization do mention options for producing feed components, but this line of production has not been developed much further. Production of protein feed with the help of earthworms and using poultry manure in fish farming have gained some attention in Russia, too.

The mixed-feed market in Russia has been growing quickly in recent years due to the modernisation of production technologies and to the creation of feed production units within large farms or other forms of cooperation between major animal husbandry units and feed producers. In the case of the Leningrad region, the fast growth of poultry farming sector has also increased demand for industrial feed products. According to an estimate based on targets set by the national development programs for animal husbandry, mixed-feed demand may grow as much as five-fold by 2020.

The feed market in Russia is dominated by domestic producers, since only 1% of all mixed-feed is imported from abroad. Within this, Leningrad region is one of the main producers of different sorts of animal feed.

Russia's mixed-feed products differ from their West European products with very high concentration of grain (above 70%), whereas the amount of different food industry residues such as groats and oilcakes is 3-4 times smaller. Feed producers may become interested in finding less expensive alternatives for raw material in the future. This goal has been expressed also in the national program "Development of mixed-feed production in the Russian Federation 2010-2012", published on April 16th 2010.

If the production of feed components of poultry manure is to be developed, potential partners may be found within the Leningrad region. Because poultry manure is best suitable for cattle and pig feed production, the first options to look at would be local factories producing feed for cattle and pigs (Luga, Gatchina, Tosno and Volosovo).

However, all sanitary regulations and possible hindrances for using manure in feed production may have to be carefully examined. Since the practice would be new for all market actors, it is expected that gaining acceptance for this kind of production will take time and effort. Based on the information presented above, the production of feed from poultry manure in Leningrad region cannot be considered as a short – term solution and it would be too early to include this alternative in the business plans in Phase II. However, this recycling of poultry manure could be developed further within the next 3-5 years, including the necessary certification of feed products, and it can become one feasible alternative to recycle nutrient within the poultry industry.

Since the overall nutrient balance shows a major surplus of both phosphorus and nitrogen, it is important to consider also other possibilities of beneficial use of the excess amounts of nutrients. At present the surplus of nutrients in the region results in their accumulation in the immediate vicinities of poultry farms, and only a very small part (less than 5%) of the nutrients is recycled back to beneficial use in local agriculture. The rest is accumulated in disposal sites of manure. There is also clearly room for improvement in the disposal of manure in order to reduce phosphorus and nitrogen loading to the Baltic Sea and nitrogen /nitrate loading of ground waters. However the main focus of this study is to come up with concrete investment proposal and business plans to increase the beneficial use of nutrients inside or outside Leningrad region.

2.2 Principal alternative solutions to deal with the excess nutrients

Firstly, it should be stated that due to the production type (eggs versus meat) and volumes, the financial capacities of the farms, the composition and water content of the manure, the current manure handling and disposal practices of the farms, as well as several other farm-specific features, it is highly likely that different types of solutions will be feasible for different farms. If a relatively modern and big farm is planning an extension of production capacity, the prerequisites for also improving the manure management are better than for farms where the production capacity is relatively small and/or the production technology is approaching the end of its technical lifetime. In addition, considering only the farms that have the best preconditions to carry out investments also in manure management, the following should be borne in mind:

- A combination of 2-3 different technologies targeted to 2-3 different market segments would be a better strategy than focusing (and being dependent) on only one market segment. The local agriculture in the immediate vicinity of a farm is often an existing solution and natural starting point to develop solutions, more so than more remote markets and respective technical solutions for them would be.

- The investments – especially with different technological solutions and eventually with different co-investors – could be implemented step – by- step and avoiding, for the time being, investing in the entire manure handling problematic.

The principal alternative solutions can be characterized and initially ranked based on their cost-efficiency and sustainability as follows:

- The first and best solution for all poultry farms is to have to nearby agricultural fields to dispose of their treated poultry manure. This would be because it would support the local and regional economies, minimizes the need for treatment costs, and results in shortest transportation distances from generation of manure to its beneficial user. However, there are a few farms which cannot practically rely on this solution because of a lack of own fields or other nearby fields (e.g. Primorskaya farm).
- The second-best solution is the use of treated poultry manure in other applications where there is demand for organic fertilizers in Leningrad region. From the quality point-of-view, the recycling of nutrients to landscaping of roads, fertilizing city parks and corresponding applications in St Petersburg, Vyborg or other cities of Leningrad region, is not as demanding as recycling to fast-growth greenhouse production of vegetables or garden fertilizers. For the landscaping use, etc, the maturity, homogeneity or physical and chemical properties of end-products are not so important. In all these solutions, the recycling of nutrients of manure which takes place within Leningrad region, or in St Petersburg, will have beneficial impacts on the regional economy as it will save costs of importing fertilizers from outside this area. It is worth mentioning here that there have already been several attempts at these types of solutions, and there are a couple of Russian technologies which have been certified for this type of operation. The main additional resources and competence is needed in marketing and sales of the finished products. This would usually favour co-operation between poultry farms and companies possessing earlier competences and track records in the marketing on Business – to – Business (B to B) or Business-to- Consumers (B to C) bases. Considering the large volumes of excess poultry manure and the currently relatively undeveloped B to C markets in the region, the main emphasis should be paid on bulk products and B to B solutions.
- Unless all excess manure and nutrients cannot be recycled within the region, the surplus should be exported to markets outside the region. There are two principal ways of carrying out this export to other regions of Russia or abroad:
 - Concentration of phosphorus by its incineration to ash, whereas nitrogen would be converted to elemental nitrogen in this process and lost to the atmosphere. The ash could be used as one additional feedstock of mineral fertilizers, where there is increasing shortage of inexpensive phosphorus raw material.
 - Processing of the manure by reducing the water content to facilitate and reduce costs of long-haul transportation. This requires typically drying of manure. The sales price is usually better if the material is also pelletized to correspond to the size and hardness of other commercial fertilizer pellets so that they can be spread on fields with the same equipment.

Both solutions require bigger investments than investments in composting and, therefore, the markets of end-products should be secured and business partners identified. Preferably also such investments should be carried out jointly with companies taking care of marketing, sales and shipping of the end-products. Due to the proximity to the ports of Primorsk, Vyborg, and St Petersburg of several poultry farms and therefore to the international “chicken guano” market, the export possibilities abroad appear to be better than inside Russia, where the organic fertilizer market is currently manifested mainly on a regional basis. Organic farming (without using mineral fertilizers or pesticides) is at the moment also more developed and faster growing in the EU than Russia. The markets and the most feasible export countries in Western Europe are described in more detail in section 3.1 of this report.

- If in the end, all poultry manure cannot be disposed of with one or another of the ways described immediately above, the final solution is a safe disposal of manure with modern landfills, where the leaching of nutrients can be minimized with applying modern technical standards and construction methods. In practice this would mean sealing of the landfill bottom with clay or other soil materials with low water permeability or geotextiles, as well as minimizing the production of leachate water by capping the surface of the landfill. This alternative can be as expensive, or even more expensive, than the low-cost composting solutions, and therefore it is recommended only if none of the recycling alternatives can be applied.

3 RESULTS OF THE PHASE I

3.1 Market review

The market analyses was carried out by analysing statistical information available in Russia as well as conducting interviews with chemical fertiliser producers and organic fertilisers users in Russia.

The results of market review can be summarised as follows:

- **The fertiliser market** may be divided into three components:
 - *Mineral fertilisers*: highly consolidated, well established and growing market; widely exported product. Russian producers enjoy a share of 11% of global production, while consumption in Russia represents some 2% of global consumption (9.5 and 1.5 billion EUR respectively in 2008). Entering this market segment would require a partner.
 - *"Branded" organic and mineral-organic fertilisers*: low consolidation; low volumes (turnover under 0.2 billion EUR in Russia in 2008); growing market; B2C mostly – small packaging. Entering the market requires heavy involvement into marketing of the product. This is a regional niche market and in addition export to other regions/countries could be considered in a relatively small scale.
 - *Bulk organic fertilisers* production: consolidation is low while integration (farm+field) is not uncommon; locally traded product; bulk transportation. Cost of transportation puts limits on export possibilities to other regions/countries. However there is a growing market segment in Europe and globally such that

export to other regions/countries would be an attractive possibility despite the transportation issues..

- **The organic fertilisers market** in Russia shows first signs of a revival after over 15 years of decline. However, the market in Leningrad region is small so that export to other regions/countries will be needed, as will strong marketing efforts in those export destinations. The most promising export destinations are the UK, France, Portugal and Spain, as well as Southern Russia.

However the logistical and competition conditions might be a problem if the whole volume of poultry manure produced in Leningrad region is to be disposed of in this way. The total market in Russia in 2008 was approximately 1.3 billion EUR. The total net-import of the UK, France, Portugal and Spain in 2008 was nearly 80 million EUR, which is negligible compared to the domestic market.

- Industrial production of fertilisers in Russia requires **certification**. The biggest poultry farms in the Leningrad region (Oredez, Udarnik, Roskar, Severnaya and Sinyavinskaya farms) have been, or are now proceeding through, a end-product certification process. No significant problems have been reported.
- Total **production of electricity** in the Leningrad region in 2008 was app. 55 TWh/a, while consumption was app. 37 TWh/a. If all fresh chicken manure is used to produce electricity, it would add only some 0.3 TWh/a. The project is small, barely profitable and hardly welcome in the highly consolidated market. The market is in a transitional phase (from regulated to open). And more to the point, electricity production requires cooperation of almost all poultry farms and after the production process there will be still waste to get rid of.

It should be noted that green feed in tariffs for renewable energy sources are becoming more of a possibility in the Russian Federation. Legislation since 2007 (*Federal Law No 35 "On electroenergetics" of 26.03.2993 (as ammended 4.11.2007) / Федеральный закон N35 "Об электроэнергетике" (с поправками от 4 ноября 2007 г.)*) permits the applying of green tariffs in certain conditions, including for the generation of power from biofuels.

However the regulations of the legislation have not yet been fully promulgated such that green tariffs are not yet fully defined, and so not implemented.

3.2 Analysis of technology alternatives

The analysis of technology alternatives focuses on assessing the various possible technologies available for managing the poultry manure which is produced. The aim is to identify technologies which manage the manure in a manner which is environmentally sensitive and within prevailing legislation, and which at the same time embodies appropriate incentives to interest poultry producers.

The analysis of the technology alternatives is based on:

- Review of earlier studies provided by, or referred to, by NEFCO.
- A complementary review of scientific literature and technologies commercially available.

- Interviews and discussions with most poultry farms about current or earlier technology on manure management utilised. This occurred at the workshops of current assignment and/or during the visits to farms.
- Brainstorming and cross-checking of the alternatives based on the earlier experiences of the team members.

The technical alternatives reviewed consisted of:

- Composting, using various composting approaches.
- Anaerobic digestion both wet and dry.
- Thermal treatment processes, including incineration, pyrolysis and bioklad (to produce pellets).

With respect to the applicability of these technologies for inclusion in Phase II of the assignment, the following conclusions were reached:

- The various composting alternatives considered (windrow and tunnel) are both proven and mature technologies which should, without doubt, be able at reasonable cost to meet appropriate environmental objectives for the investments. The drawbacks with these technologies, however, are two:
 - The high phosphorous content of the resulting fertilizer limits its usefulness;
 - Because of the amount of poultry manure produced, the amount of organic fertilizer to be produced will be well in excess of what is required in Leningrad region. Therefore the fertilizer would have to be transported – to other regions of Russia and/or abroad. This will affect the competitive pricing of the fertilizer.
- Biogas technology is also considered to be proven and mature. Furthermore there is sufficient experience from elsewhere to suggest that in Leningrad region this could be a viable solution to the issue of final disposal of poultry manure.

Problems, however, arise regarding the use of the resulting biogases. The quantities of biogas produced will be such that the poultry producers will not themselves be able to consume it all themselves. Therefore the gas will need to be distributed to other users, either as gas or in a state converted to another type of energy – such as electricity. However there are transport issues to consider in this case, and/or issues of licensing and permitting. Biogas producers may have to be transformed into different types of companies, electricity generators for example, if the gas is to be distributed as energy in a different form. Legislation will have to be reviewed in these cases.

Another possibility is to liquefy the biogas for sea borne export, most likely to Western Europe. However much infrastructure development costs would need to be incurred in this case – including port terminals for ship loading, etc.

Finally, natural gas and electricity in Russia are otherwise currently very cheap. As an energy source, biogas would have to compete with these.

- Incineration reduces the volume of manure much more efficiently than composting or biogas production, which is an advantage over these other alternatives.

However incineration requires that pricey infrastructure investment and operating costs be incurred, and the recovery of such costs by the poultry producers has not up to now been assured.

While pyrolysis is considered a possibly viable future technology, with respect to poultry manure the pyrolysis technology is still in an emerging stage and will require more in-depth testing or piloting work. There is a promising Swedish development going on, and it will potentially be feasible within a period of 3 - 5 years.

- There is another emerging technology developed in Russia which merits further development, testing, and a demonstration plant. The Bioklad process has been proposed very concretely for Primorskaya and Udarnik poultry farms, but unfortunately this technology is not yet ready for full-scale application.

Otherwise the following general conclusions have been reached:

- The larger producers, which typically produced 90 000 t/a of manure, or a joint treatment approach for several farms, would benefit considerably from the reductions in mass that would result from one or another thermal treatment. They would then be left with potentially commercially interesting ash, biogas, bio-oil, biochar or manure pellets. However the commercial interest in these products is limited, as long as mineral fertilizers continue to receive subsidies from the Russian state.
- Smaller producers, typically 20 000 – 40 000 t/a of manure, are able to choose between two established technologies, viz composting or anaerobic digestion. The problem here however, even with the smaller farms, is that the resulting fertilizer or compost quantities produced with these methods would be very large. An answer must be found as to what to do with the outputs of these processes.

3.3 Review of relevant legislation and other regulations

The Russian federal and regional legislation regarding waste disposal and treatment of poultry manure on one hand, and legislation regarding utilization of manure as organic fertilizers on the other hand, are evaluated. Special attention is paid to the transfer and trade of manure from one farm to another, or to some other actor, for use as a raw material, or as a source of such material, in Leningrad region.

The basic question addressed is, what kind of legislative requirements and restrictions have to be regarded in business planning on manure utilization. The focus of the evaluation is mainly on the economical use of manure in a way which could be profitable for the poultry farm who produces the manure, or which could at least cover the costs it causes. Possibilities of the poultry farm to avoid payments and fees are described and discussed. The economic incentives for the poultry farms as provided by current legislation are described. Conditions and opportunities to export manure as a raw material from Russia to other countries are briefly discussed as well.

The following conclusions are arrived at in the report:

- **Environmental requirements for management of poultry manure, and its processing for use as fertilizer: permitting and regulation, producer liability,**

categorization of manure: In the business plan attention is paid to these matters as there are ambiguities and some lack of clarity in the legislation regarding descriptions of actions that are permissible. Thus sound legal advice is necessary. On the other hand the requirements for permits, licensing, training, etc. are clearly stated and so should be relatively easy to comply with.

- **Licensing of manure management operations on farms:** Specific legal requirements about what kind of buildings, equipment, etc. should be used on farms, and how and how often the operating personnel should be trained, etc. Operators of the poultry manure treatment plants are required to carry out self-monitoring and prepare relevant documents on monitoring results for the competent regional environmental authorities.
- **Treatment of fertilizers and other agricultural chemicals:** Regulations for pesticides and agrochemicals include a registration procedure for commercial organic and inorganic fertilizers. Regulations include requirements concerning the chemical composition and toxicity of compounds, safety issues and the principles governing testing of the fertilizers.
- **Legislation governing the production of organic food:** The legislation governing the production of organic food, and thus use of organic fertilizers from poultry manure in that production, is very recent. Its real affect is still to be understood.
- **Current and planned future environmental fines on poultry producers:** Penalties for not disposing of manure in an environmentally sensitive manner are applied, but they are not high enough to deter the disposing of manure in a non-environmentally sensitive manner. Future Business Plans must keep this in mind. The possibility the fines and penalties will be substantially increased so as to act as a deterrent, while not currently under discussion, exists in a latent fashion.
- **Requirements for fertilizer exports:** Export to the EU, because of its proximity to Leningrad region, is possible. The attainment by Leningrad region poultry producers of the composition and hygiene standards required for such export should not be a problem for most farms.
- **Green tariff legislation** in respect of alternernate energy sources is not yet fully formed. The applicable statutes are in place, but regulations of the law establishing certification and permitting regulations, tariff premiums, durations of the premiums, etc., are not yet all in place. However it is expected that they will be soon.

It can be concluded that while there are gaps in the legislation in force, on the whole legislation is appropriate and pertinent for prevailing conditions. However gaps also exist in the enforcement of legislation, and the incentives towards environmentally sensitive behaviour are not always sufficient. Thus the legal and regulatory framework under which poultry farms dispose of their manure, from the point of view of a creditor to the farms in this specific area, may be a bit more feeble than such a creditor would like.

3.4 Investment capacity of poultry farms

The possibilities for, and willingness of, large poultry farms in Leningrad region to develop more environmentally friendly and cost-effective treatment and use of the manure they produce has been evaluated.

A total of eight (8) poultry farms from the districts of Lomonosovski, Kirovskiy, Vyborgski and Gatsinskiy were chosen for evaluation. These farms cover approximately half of the poultry farms in the Leningrad region. Within the evaluated group there are several farms which have previously been identified as causing severe environmental risk to the Baltic Sea.

The evaluation mainly focused on identifying the most economical use of the manure. However the uses of the manure must be such that it will be profitable for the farm, or at least cover the costs involved in manure disposal.

Information on farm ownership, production, location, current manure management and potential environmental load were mainly taken from previous studies. The managements of the farms chosen were interviewed in order to verify the information and to determine investment options. In addition a general willingness to investigate and implement different possible technologies, and in respect of different possible markets, was assessed. Different technologies and reuse options for manure, such as bioenergy and combined heat and power production, composting and production of organic fertilizers, were assessed from farm specific points-of-view.

The results of the investment capacity investigation of the poultry farms are that altogether four farms were originally identified which are interested in proceeding in further investigation the feasibility of possible future investment, and which have better potential for such investment. These four are:

- Severnaya,
- Roskar,
- Primorskaya and
- Lagolovo.

Severnaya and Roskar are among the biggest sources of nutrient load, and Primorskaya and Lagolovo had, up to that time in the implementation of the study, demonstrated the most interest to proceed with business plans and investments in the near future.

3.5 Review of funding alternatives

One of the tasks of the assignment was to identify and assess other, non-NEFCO, sources of financing for possible investments. The need for this arises because NEFCO, by its own mandate, is not permitted to finance more than 50% of any given investment, and is otherwise limited to financings of a maximum of €5 million in size.

The investigation of possible partner financing sources was limited by two factors:

- a) The assignment TOR, the consultant's proposal, and the Inception Report, all assumed that there exist only four channels for possible partner financing. As a result these four channels were the only ones investigated. The four channels are:

- Concessional external financing, i.e. from tax payer supported financing entities abroad, either bilateral or multilateral;
 - Non-concessional external financing, i.e. from private financing sources abroad;
 - Concessional domestic financing, i.e. from Russian state sources derived from any level of the Russian state administration;
 - Non-concessional domestic financing; i.e. from private Russian sources.
- b) The fact that no investments had been defined at the time discussions with potential partners were held, i.e. at the stage in the implementation of the study when this assessment was carried out. As a result the discussions were of a highly hypothetical nature, a condition that was somewhat unsatisfactory for the potential partners involved.

A summary of the discussions with potential partners of the four types indicated above is as follows:

Concessional external financing partners

Discussions were held with the following organisations:

Multilateral Sources: International Finance Corporation of the World Bank group, European Investment Bank, Nordic Investment Bank, EBRD

Bilateral Sources: FINNFUND (Finland), SWEDFUND (Sweden), IØE (Denmark), KfW (Germany)

Non-concessional external financing partners

Financial Intermediaries: Nordea Bank (Finland)

Non-financial Intermediaries: Various Finnish firms active in the sector, technology firms or others, were contacted to assess their willingness to undertake financial risk in Russia.

Concessional domestic financing partners

In Russia domestic sources of concessional financing are available from entities related to the state, at one or another level. Entities connected to the Leningrad Region Administration, or the Russian Federation Administration active in rural or agricultural finance were contacted.

Non-concessional domestic financing partners

Discussions with the Agricultural Bank of Russia were held.

Conclusions of the review of funding alternatives

The following was concluded:

- In order of the likelihood of financing partners being identified for the investment(s), we would suggest that the ranking of potential partners, ranked by type of possible partner from least likely to most likely to agree to partnership, should be as follows:

- *Least likely* are **Non - Concessional External Financing** organisations, either financial intermediaries or non-financial intermediaries. For these the risks of the Russian market still outweigh the possible benefits of activity in that market, except where there is highly credible, high quality security. Usually this means state guarantees or guarantees from credible Russian banks.

However if such guarantees are available then the more rational and efficient option would be for local financiers to take up this business – not foreign ones. We suggest that it is likely that such ironclad guarantees are not readily available in Russia, which is why local financing entities are not so interested in the business, and which is why foreign entities enter into the discussion at all.

We do not, in fact, expect that foreign financing entities will be able to play a partnering role in future investments arising from the current study.

- *Next least likely* are **Non - Concessional Domestic Financing** organisations. As with their foreign counterparts, these organisations will require highly credible security. There is at present no indication that such security will be made available, except perhaps in the case of liens or claims on assets.

It is in this way, the possibility of security being provided by liens or claims on assets, that domestic entities differ from the foreign entities. If financing entities have legal presence in Russia they can become owners of property, i.e. they can exercise their claims over the assets in the event of default by, or liquidation of, the beneficiary. It is more difficult for foreign entities, which have more tenuous legal establishment in Russia, to do this.

However the use of liens or claims on assets as sufficient security will depend on the nature of the assets involved and the timing of the financing of the assets, etc. It is not at this moment a given that such liens or claims would be sufficient security. But as noted above, it will be worth discussing with these organisations again once the investment(s) are better understood.

- *Next least likely* are **Concessional External Financing** organisations, particularly the bilateral organisations.

The possible multilateral organisations require, on the whole, projects which are likely to be much larger than the investments likely to arise from the present assignment. However if the foreseen investments begin to approach the sizes which IFIs need in order to optimise their own efficiency, then it would be very worthwhile returning to discuss with them. The IFC would be the first to approach, we would suggest.

- *Most likely* are **Concessional Domestic Financing** organisations, which means the Russian state budget. The place to start in this respect is with a more detailed investigation of the possibilities through the Leningrad Oblast Committee Agro-industry and Fisheries Complex.

3.6 Assessment of joint investments

During the course of the study three general technical solutions were identified as being, realistically, the most plausible and technically proven, or the most likely to be possible given the conditions prevailing in Leningrad region's poultry production sector. These probable technical solutions are: composting of manure; capture of biogas from decomposing manure; and manure incineration.

Given that at the time of writing no specific technical solution has been uniquely identified for any specific farm's circumstances, the assessment of joint investments was made in a very generic fashion. Thus in all assessments certain common factors were considered for all cases, and certain unique factors to each case were considered.

Common factors are:

- Investment costs considered for composting and biogas solutions are generic (and consequently not site-specific to any farm), based on Russian price levels. Annual O&M costs are similarly calculated, as they are based upon an assumed percentage of investment costs. Russian price levels are used as the technology involved is, it is assumed, likely to be sourced in Russia.
- Investment and O&M costs for incineration are also generic, but based on Western European price levels. This is because it is assumed likely that the technology will be sourced in this case from abroad.
- For revenue assumptions Russian price levels are used, as it was assumed that the revenues will be generated in the Russian market.
- For each technical solution two assessments were made, with one assuming installed capacity to deal with 40 000 t/a of manure, and one assuming installed capacity to deal with 90 000 t/a. The exception to this is the incineration solution, for which a single 24 000 t/a capacity installation was assessed. However the Generic Business Plan (see section 4.3, below) is developed on the assumption that 200 000 t/a of manure will be treated.

Unique factors to each technical solution were:

- O&M costs differ for each technical solution based upon a general understanding of such costs as a percentage of investment costs. This is rather arbitrary and is based upon a well developed understanding of how these solutions function in Finland.
- The relative weighting of civil works and technology (plant and equipment) in the investments differs within the total investment cost of each technical solution.
- The assumed revenues arise from the commercialising of the final products of the technical solutions as follows: compost in the case of the composting solution; biogas or methane in the case of the biogas solutions, as well as the solid bulk material generated by the process (the latter corresponding to the revenues of composting products); no directly sellable product in the case of the incineration solution, but a preliminary fertiliser equivalent value based on the phosphorus content has been estimated on a very preliminary basis.

Each technical solution therefore attracts its own unique cash flow.

- Because the investment costs to deal with the different types of material (wet or dry) are very different, the biogas technical solution is further sub-divided into a dry manure biogas solution and a wet manure biogas solution.

The conclusions of the preliminary joint investment analysis, undertaken in a most generic fashion and without any attention to the details of each farm, suggest that the financial viability of the investments (as stand alone investments) must be questioned, especially if the treated poultry manure is delivered or sold in the vicinity of poultry farms for relatively low prices.

4 SUMMARY OF THE BUSINESS PLANS DEVELOPED FOR THE ASSIGNMENT

As per the Terms of Reference for the assignment, three Business Plans (BPs) were developed for the purpose assessing the technical and financial implications of applying differing technical solutions under differing operational conditions. These are summaries in this section.

Two of the business plans incorporated (one each) real, existing oblast poultry farms combined with one each potential external partners (in addition to NEFCO). Real actual discussions were held between the two respective farms and their two respective putative partners. In both cases NEFCO was assumed to be one of the sources of finance capital for the identified investments. The third business plan, designated the Generic BP, did not identify a specific poultry farm, nor specific partners for it. The Generic BP assesses various technological alternatives available to the farms, including incineration, digestion and biogas liquefaction.

All three BPs are summarised here. However, for reasons of commercial confidentiality, for the two non-generic BPs the respective farms and their respective putative partners are anonymous. The three business plans are:

- The composting solution;
- The pelletized fertiliser solution;
- The generic business plan (digestion and incineration solutions in various combinations are addressed).

4.1 Composting Solution

Investment Project

The composting solution assumes that approximately 40 000 – 50 000 tonnes of manure will be composted.

Added to the manure raw material will be very small amounts of peat and wood chip. This mixture will sit in windrows for up to two years and be turned on a regular basis. At the end of two years an amount of compost material equal to the manure input will be available for commercialisation.

The fixed assets to be procured for the operation will be the following:

- Asphalted space to create the windrows;

- A building to house the offices of the installations as well as mechanical equipment consisting of pumps, piping, electrification, process control and a small leachate water treatment plant.

The turning of the material in the windrows will be done mechanically. This equipment will not be procured, but this service would be procured from a contractor on an as need basis. Therefore it is not included in the project's investment plan.

Capital costs are estimated to be about 1.6 million EUR including also planning, engineering and project and construction management costs.

In order to develop, implement and operate the project, a joint stock company (JSC) will be formed on an equal partnership basis between one of the poultry farms and a technology supplier. Shareholdings of the two partners will be based on an agreement between the parties, and both will, in addition to paying in their share capital, further capitalise the JSC by advancing it equally sized shareholder's loans. In addition NEFCO will advance a loan to the JSC. The investment will require approximately two years to implement.

Market Conditions

The market for the compost product produced as a result of the investment is divided into two basic segments:

- Agricultural producers, probably of a large scale, who use compost products on their fields – as the minor part of the demand;
- Contractors and otherwise developers of land who use compost products for landscaping, etc. in the vicinity of their developments – as the larger part of the demand. Much of this demand is in St Petersburg, where continuous urban development includes the creation of parks, green spaces, road sides, etc. Compost products are used in the creation of such spaces.

In both cases, the assumption made in the business plan is that customers will purchase the product in bulk terms (truck loads) and do so at their own installation. Therefore the investment is not required to support the costs associated with bagging lines for small parcels of compost.

The selling price for purchasers of compost product will be CIF at the customers' own locations. Transport service, however, can be purchased in the market. Therefore the JSC will not need to purchase a transport capacity. The hiring of transport services is calculated into the selling price.

The business plan assumes that all of the compost produced will find a buyer.

The JSC will have revenues from two streams:

- A gate fee charged to the producer of the manure (the poultry farm)
- A selling price for the compost.

Business Prospects

The major weakness in the business plan is in the demand for compost product. Chemical fertilizer is highly subsidised in Russia such that projected volume sales are not by any means presently confirmable. This will be a very difficult commercial environment for the JSC, which itself will not be subsidised.

On the other hand the manure volumes to be disposed of in this business plan are relatively small, when compared to the volumes produced in Leningrad Oblast as a whole. They represent approximately the manure production of one medium sized farm only. Thus, if composting cannot possibly be the solution for all of the poultry manure produced, for one farm it may be a viable option.

And, of course, the assumptions made in the business plan in respect of O&M costs, sales volumes and revenues suggest that this could be a viable business.

4.2 Pelletized Fertiliser Solution

Investment Project

The pelletized fertiliser solution assumes that up to 20 000 tonnes of manure will be pelletized. No other raw material inputs will be needed except chemicals to use as a binding agent.

The fixed assets to be procured for the operation will be the following:

- Poultry manure drying unit
- Pelletising unit
- Packaging equipment for packaging of pellets into big bags for farms and consumer packages
- Building for the above mentioned operations and product storage

Capital costs are estimated to be approximately 8.7 million EUR, including both tangible and non-tangible costs.

In order to develop, implement and operate the project, a joint stock company (JSC) will be formed on an equal partnership basis between one of the poultry farms and a technology supplier. Shareholdings of the two partners will be based on an agreement between the parties, and both will, in addition to paying in their share capital, further capitalise the JSC by advancing it equally sized shareholder's loans. In addition NEFCO will advance a loan to the JSC. The investment will require approximately two years to implement.

Market Conditions

The client groups deemed as the most important consumers in the region are for pelletized fertilizer are:

- Business to Business: farms growing grain, vegetables, berries and root crop;

- Business to Consumers: individual persons practising small scale farming for their own use.

In both cases these are not bulk purchasers of fertilizer, but rather are retail purchasers. Thus packaging operations will be needed.

The project does not envision that a marketing effort for retail sales will be needed by the JSC. Retailers are assumed to be available and interested in the product

The business plan assumes that the selling price for pelletized fertilizer is FOT at the factory gate of the JSC. Therefore the JSC will not be responsible for transporting the product to market. Customers/retailers will support the costs of collecting the pellets at the production facilities and delivering them to final consumers.

The JSC's revenues will be derived from the sale of pelletized fertilizer only. For the purposes of this study, gate fees are deemed to be equal to the transport costs that poultry produces will incur transporting their manure to the treatment facility, although it is understood that this is not consistent with the polluter pays principle.

Business Prospects

As with the compost solution business plan, the major weakness in pelletized fertilizer business plan is in the demand for product. Chemical fertilizer is highly subsidised in Russia such that projected volume sales of pelletized fertilizer are not by any means presently confirmable. This will be a very difficult commercial environment for the JSC, which itself will not be subsidised.

On the other hand, also in common with the compost solution business plan, the manure volumes to be disposed of in this business plan are relatively small when compared to the volumes produced in Leningrad Oblast as a whole. They represent approximately the manure production of one small to medium sized farm only. Thus if the production of pelletized fertilizer cannot possibly be the solution for all of the poultry manure produced, for one farm it may be a viable option.

4.3 Generic Business Plan

Investment Project

The generic business plan contemplates four separate possible investment projects:

1. Incineration of manure;
2. Digestion and commercialisation of the resultant biogas – via the existing pipeline to Finland;
3. Digestion and liquefaction of the resultant biogas for export to Sweden;
4. Digestion and commercialisation of liquefied biogas in Sweden, with the incineration of the remaining digestate.

In each case an amount of 200 000 t/a of manure is assumed to be treated. Investment costs, in addition to the cost of the actual treatment installations and technology, are also assumed to include relevant transport related costs. This means the inclusion in the investment project of a connection to the existing natural gas pipeline in the case of project 2, and of a liquefied biogas port terminal in the cases of projects 3 and 4.

Capital costs, for both the tangible and non-tangible investment costs, are estimated to be the following:

1. Incineration of manure - € 78 million
2. Digestion and bio gas sales to Finland – € 103 million
3. Digestion and liquefied bio gas sales to Sweden - € 107
4. Digestion, liquefied bio gas sales to Sweden, incineration of the digestate - € 185 millions

In order to develop, implement and operate any of these investment projects, a joint stock company (JSC) will be formed on a partnership basis between one or more of the poultry farms and a technology supplier. Shareholdings of the partners will be based on an agreement between the parties, and shareholders will, in addition to paying in their share capital, further capitalise the JSC by advancing it equally sized shareholder's loans. It is, in addition, assumed that concessional financing on a credit basis will be sourced from abroad – from international financing institutions such as the IFC, EBRD, NEFCO, etc.

Market Conditions

- **Incineration of manure** Mineral fertilisers, to which manure ash is added: highly consolidated, well established and growing market; widely exported product. Russian producers enjoy an 11% share of global production, while consumption in Russia represents some 2% of global consumption (9.5 and 1.5 BEURO respectively in 2008).
- **Incineration of manure** "Branded" organic and mineral-organic fertilisers: low consolidation; low volumes (turnover under 0.2 BEURO in Russia in 2008); growing market; business to consumer mostly, in small sized packaging. Entering the market requires a heavy commitment to marketing of the product. Export to other regions/countries would be highly desirable.
- **Incineration of manure** Bulk organic fertiliser production, of which ash: consolidation is low while integration (farm+field) is not uncommon; locally traded product; bulk transportation. Cost of transportation puts limits to export to other regions/countries. Growing market in Europe.
- **Digestion and bio gas sales to Finland** Biogas, when sufficiently cleaned and purified, has properties similar to natural gas. Therefore the propose investment project will link the biogas production to the existing gas pipeline to Finland for sale in that country.

- **Liquefied bio gas sales to Sweden** Liquefied biogas will be exported to Sweden – to the terminal at Nynäshamn. It is expected that the total production, of approximately 15 000 tonnes of liquefied biogas per annum will be absorbed completely by the Swedish market. Ash resulting from the incineration of digestate will be treated as per the incineration points above.

Business Prospects

The major concern with respect to the implementation of any of these proposed investment projects will be the initial investment cost.

1. Incineration of Manure. Thermal treatment is very attractive technically as it reduces the mass of organic waste by a factor of up to 10. The resulting quantities of waste are much easier to deal with. At the same time incineration produces a final product, ash, which has some commercial value.

However the commercial value of the ash is far from sufficient to provide a viable business model for the investment owner. The investment cost of an incinerator with the capacity to treat 200 000 t/a of manure is very high.

Rather than being viewed as investment in a viable business, the thermal solution should more properly be seen as an investment made to ensure compliance with environmental legislation. Such an investment will not produce positive returns for its owner. It will, rather, mitigate any financial harm done to the poultry producers from inappropriately disposing of their manure.

2. Digestion and commercialisation of the resultant biogas. This possible solution is viable only if the biogas is sold at world market prices for gas. That is in Finland. There are, however, some obstacles arising in this possible market solution.

The first of these is the investment cost. The costs of the digestion facilities are not terribly onerous. However for the resulting biogas to be added to a pipeline for transport to Finland, the biogas must be of a technical quality exactly similar to natural gas already being transported in the pipeline. As biogas is dirtier than natural gas, the cleaning of the gas will be more expensive than with natural gas. This becomes an important investment costs.

In addition the (now cleaned) biogas will need to be transported by local pipeline to connect to the trunk pipeline which feeds Finland. An investment cost in the biogas feeder pipeline will cost something on the order of € 50 000 per kilometre, in addition to compressors, etc. Depending on the distance from the digestion facilities to the trunk pipeline, this can be a significant amount.

The second possible obstacle arises with the trunk pipeline owner/operator. Will the owner of this investment project be required to sell its biogas to the trunk pipeline owner/operator, and thereby realise domestic Russian wholesale gas sales prices? Or will the owner of the investment be able to sell gas directly to a consumer in Finland (and treat thus the trunk pipeline owner/operator simply as the provider of transportation services) and so realise Finnish retail gas sales prices?

This is unclear, although it will be an important consideration for the viability of the investment. Finnish retail gas prices, less transportation costs, will be much higher than Russian wholesale prices.

3. Digestion and liquefied bio gas sales to Sweden. Again the major consideration in this possible investment project will be the investment cost.

In this alternative it is primarily assumed that the produced biogas will be cleaned and liquefied at or near a port. A liquefied biogas terminal will need to be constructed, however, so that the investment cost for the port terminal is included in the project. The liquefied biogas will then be sold to Sweden, and delivered to the Nynäshamn facility near Stockholm.

The digestate arising from the digestion process would not be commercialised. Rather it would be landfilled or provide free of charge to local agricultural producers – if they collect it. It would not incur any costs, and would not generate any revenues for the gas producer.

This investment will not, under these conditions, be able to sustain itself. The need to develop and operate a port to allow the storing and loading of liquefied biogas, which more than doubles the investment cost, is debilitating.

4. Digestion and liquefied bio gas sales to Sweden, incineration of the digestate. This proposal is similar to proposal number 3, above. However it also includes a € 78 million incinerator to reduce the digestate amounts.

This alternative also suffers from the enormously debilitating need to construct a port terminal to store and load the liquefied biogas. However, the relatively positive nature of the incineration process mitigates this problem somewhat. (The incineration alone alternative has been found to have a relatively better prospect of viability.)

The mitigating effect of the incineration notwithstanding the relatively enormous port development costs will not be recouped even with the relatively positive effect of incinerating and commercialising the digestate.