LIFE Project Number

LIFE09 ENV/EE/000227

FINAL Report
Covering the project activities from 01/09/2010 to 15/08/2016

Reporting Date
15/11/2016

LIFE+ PROJECT NAME or Acronym

OSAMAT

Project Data

Project location	
Project start date:	01/09/2010
Project end date:	31/12/2014 **Extension date:** 15/08/2016
Total Project duration (in months)	<71,5> months (including **Extension of** 19,5 **months**)
Total budget	2 379 280 €
Total eligible budget	2 379 280 €
EU contribution:	1 142 490 €
(%) of total costs	50
(%) of eligible costs	50

Beneficiary Data

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2. Executive Summary

Over 90% of the basic power supply in Estonia is provided by oil-shale firing thermal power plants. Oil shale mining and processing generate vast amounts of by-products that are mostly deposited coursing environmental impacts. Estonian oil shale (OSA) is characterized by a high mineral matter. After combustion 45–48% of the oil shale is left over as ash, producing about 5–7 Mt of OSA annually. Despite numerous studies only a small amount of OSA is currently recycled - around 3% of the annual amount produced. Eesti Energia (EE) concern moving towards to environmental sound production set a goal to find solutions to maximise the utilisation of OSA and minimise the deposition at the landfill.

Due to its chemical content OSA could be considered as a valuable binder material, which could be used to improve stabilization and strength of civil-engineering structures. Based on these assumptions in the year 2010 the OSAMAT project was initiated. The project aimed at introducing, testing and promoting advanced methods of using OSA as a valuable material in road construction. The project results are intended to serve as basic data for the European policies and local regulation concerning waste recovery to promote sustainable recycling with a focus on life thinking and development of recyclables market.

OSA was tested in construction of the two pilot sites in two construction technologies: road base courses layer stabilization and mass stabilization of peat. The demonstration started with the geotechnical and environmental laboratory testing in order to ascertain appropriate materials based on OSA for different pilot applications and to demonstrate the required test procedures to ascertain the quality of OSA materials. This was followed by the pilot sites construction design compilation and piloting construction. During construction the quality measurements were conducted to assure stability of the processes within the constructed structure. The demonstrations also included verification of OSA feasibility as construction material with respect to the environmental, technical and economic criteria. Verification actions included technical, environmental monitoring and LCA/LCC assessments to prove that the methods, materials and applications based on OSA are environmentally safe and technically and economically feasible. The project results were widely disseminated in Estonia and in Europe. Due to the dissemination actions the OSA and its usage methods as construction materials were presented to the wide audience including different authorities, constructors, civil-engineering experts and others. Project results and dissemination actions helped to change the perception to OSA from waste to a valuable construction material.

The project was managed by coordinating beneficiary Eesti Energia AS – the largest company in the world producing energy from the oil shale. EE as a Project Coordinator was responsible for the general coordination of the project, the project’s general accountancy and communication with the Commission (reports, amendments submission and processing).

Associated beneficiaries were EE daughter company Eesti Energia Narva Elektrijaamad AS (EE NEJ) and construction company Nordecon AS (NC). EE NEJ was mainly responsible for OSA supply, but also for the implementation of project researches and compilation of progress reports. NC was responsible for the pilot sites construction.

The project was co-financed by Estonian Road Administration.

The project implementation was done by the means of 7 action: 1 Preparations; 2 Materials; 3 Application; 4 Piloting; 5 Verification; 6 Dissemination and 7 Management. The key deliverables and main outputs of the project action are presented in the Table 1.

Table 1. OSAMAT project key deliverables and the main outputs.

Year	Project actions and key deliverables	Outcomes
2010-2011	Preparation, Materials and Dissemination actions : 1) partnership and co-financing agreements conclusion, 2) 2 pilot sites location choice, 3) pilot sites' geological investigations and environmental background information gathering, materials laboratory testing, recipes with OSA development, 4) compilation of pilot sites construction design projects, 5) information dissemination	1) conclusion of partnership agreements with Nordecon AS, EE NEJ and ERA, 2) two pilot sites: Narva-Mustjõe and Simuna -Vaiatu , 3) Materials Report: 3 recipes for N-M and 5 recipes for S-V peat stabilisation and 1 for the road upper layer at S-V, 4) pilot sites construction design projects, 6) OSAMAT project goals were presented through 16 media sources, launch of the project web page www.osamat.ee.
2011-2012	Application, Piloting and Dissemination actions: 1) pilot sites written construction instructions and quality control instructions compilation, 2) construction of Narva-Mustajõe pilot site (2 sections), 3) information dissemination	1) production of instructions for construction and quality control at the pilot sites, 2) 900 m of N-M pilot section constructed (layer stabilisation) and quality control done, 3) notice board at the pilot sites installed, participation at the conferences presenting the project, articles issuing 4) start of technical and environmental monitoring (follow-up) at N-M pilot site.
2013	Piloting, Verification and Dissemination actions: 1) construction of the 3 (final) section at N-M pilot site, 2) mass-stabilisation of peat and quality control at S-V pilot site, 3) follow-up at N-M pilot site, 4) information dissemination	1) 1,6 km N-M pilot site constructed 2) 500m (10 000m3) of peat section is stabilised and construction quality controlled 3) follow up activities at N-M pilot continued 4) booklet issuing and dissemination, OSAMAT film production and dissemination, participation in conferences, 2 local public events organisation.
2014	Piloting, Verification and Dissemination actions: 1) layer stabilisation onto stabilised peat at S-V pilot site, construction quality control, 2) follow-up at the pilot sites, 3) information dissemination.	1) 900 m of S-V pilot section upper layer constructed, construction quality controlled 2)start of technical and environmental monitoring (follow-up) at S-V, 3) N-m and S-V Pilot Reports compiled, results of the pilot construction at the different conferences presented
2015	Verification and Dissemination actions: 1) Technical and environmental monitoring at N-M and S-V pilot sites, 2) information dissemination.	1) Technical and environmental monitoring finished and final reports submitted, 2) participation in the conferences.
2016	Dissemination actions: 1) International Conference and Workshop organisation, 2) project outcomes documentation compilation	1) International Conference and Workshop was organised on 2-3 of June 2016, 2) project results dissemination through the 15 channels, 3) Guidelines for European practice issued. Project reports 4) Verification report 5) Layman's report 6) Dissemination report 7) After -LIFE Communication Plan 8) Audit report 9) OSAMAT final report with payment request 10) Carbon Footprint report 11) LCA/LCC report 12) Technical monitoring report 13) Environmental monitoring report 14) After-LIFE slide presentation 14) OSAMAT film

The project actions implementation took 6 year (2010-2016 years). The project had to be extended by 19,5 months due to unpredictable and unforeseen situations (that faced most of the projects that test new equipment and new materials) and other different reasons that caused 3 project modification. Despite the modification, the overall project management was effective and successful in fulfilling the intended goals. We are thankful to the project External Monitoring Team (EMT) that was always ready to give an advice in the project management during the whole period.

The product of the project management action was a Carbon Footprint (CF). The aim of CF report was to present the results of the emissions created by the different project actions. The report can be found as Annex 7.2.2.

In the year 2010 the project Steering Group was formed. It consisted from the members of project partners, ERA, Ministry of Environment and Ramboll Eesti AS.

At the first SG members kick-off meeting the two sections at Narva-Mustajõe (basic state road 13109 km 14,470 – 16,150) and Simuna -Vaiatu (state road nr 17192, km 2,5-5) roads were approved for conducting the project pilot activities. The chosen construction technologies were cold in place recycling with cement (traditional, but done with OSA instead of cement within the frame of the project) and mass-stabilisation technology correspondently.

To develop the recipes with OSA firstly the materials were tested for the properties specification in the laboratory. Based on the tests results OSA recipes were developed: 3 recipes to be used in N-M section layer stabilisation, 5 recipes for peat mass-stabilisation in S-V pilot site and 1 for construction of upper layer onto the mass-stabilised peat at S-V pilot site. The mixtures for the pilot construction in N-M section consisted of mining waste aggregates, cement, OSA and old paving. The mixtures for the pilot construction in S-V section consisted of peat, cement and OSA.

Laboratory investigations included leaching tests to control the heavy metals and some anions (chlorides, sulphates) concentrations in leachates of construction mixture made with OSA. The results were compared with Finnish regulation for road construction (as there is no such a regulation in Estonia). The results showed that there are no exceeding of limit values of the regulation for design road mixtures.

The first demonstrations started in the year 2011 and continued until the year 2014. N-M first 2 pilot section were constructed in 2011 year the last third section in 2012. S-V pilot section construction began in the year 2013 and was finished in 2014.

The pilot constructions were done according to written instructions, quality control instructions and country legislation. N-M and S-V pilot reports describe the construction method applied in the pilot sites construction with OSA, the everyday construction details and quality control actions.

The construction was followed by environmental and technical monitoring to assure the technical results of the pilot construction and to control if there were any impacts on the environment.

The technical monitoring results showed that all types of OSA can be used in tested applications for road construction.

N-M pilot site technical monitoring results in details as follows:

- The load bearing capacity of the pilot section was twice or more higher (400-600 MPa) comparing to design value (260 MPa) in case of all 3 types of OSA (Cycl, EF PF, EF CFB) and tested recipes.

- Section constructed with Cycl ash has lower bearing capacity comparing to the section constructed with EF PF and EF CFB.
- Compression strength of the drilled samples were high (7-16 MPa). Such a compression strength is considered as too high, that might provoke cracks. So, in the future it is recommended to try different recipe (less cement or less ash etc.)
- During the first year after construction the cracks emerged on the asphalt of the constructed sections. However, after conducted defect analysis (that was not foreseen in the project) it was concluded, that the cracks most likely were caused by reflection from the old base course onto which the new layer was constructed. There were no cracks at all in the section constructed onto the new base course.

S-V pilot site technical monitoring results in details as follows:

- Between 3 types of OSA tested in mass-stabilisation of the peat in S-V pilot section, Cycl ash was the type that didn't suit the requirements of the machinery (Cycle ash is coarser that cement and needs probably thicker tubes and stronger pumps to flow through the tubes), so only one section (from 5) was done with Cycl ash. However, technical parameters measurements showed that it is technically suitable for mass-stabilisation.
- Vane shear strength measured during quality assessment was higher (65-120 kPa) than the target (60 kPa) in case of all the ashes.
- Compression strength of the drilled samples was similar for the all types of the ashes (around 0,4 MPa, that is ok for such type of the structure).
- The pavement constructed onto the stabilised structure was done with only CFB ash without cement addition. For comparison, one part of the pavement was done by traditional method with cement. The section done with CFB ash gave the best results of load bearing capacity (300MPa) that was twice higher than designed(170 MPa).

It could be concluded that pilot testing of OSA was successful and OSA proves itself as technically suitable aggregate.

The environmental monitoring included sampling of soil and surface water (from the ditches next to the pilot sections) and flora observation. The background data (water and soil samples from the pilot sites) for environmental impacts analysis were collected before the construction to compare with the measurements results after the piloting.

From the results of the environmental monitoring we could see the fluctuation in concentrations of some metals and anions in the samples of surface water and soils during several years of monitoring (at both pilot sites), but none of the concentrations exceeded the target values of the environmental legislation. Special attention should be paid to the OSA from pulverized firing regarding sulphates, as this anions concentration might exceed some EU country legislation (for example if soils or waters are sensible to sulphates).

There was no influence on the flora around the pilot site. Instead, it was a bloom of vegetation. It is might be explained by the influence of OSA, as it contains valuable nutrients for the plants. OSA is used in Estonia officially as a fertiliser.

In general it can be concluded that there are no impacts to the environment coming from OSA use in road construction and it proves itself as environmentally safe aggregate.

The LCA and LCC sturdies supported the project action results.

The aim of the LCA study was to determine and compare the potential environmental impacts of 4 different alternatives (with OSA and without) of constructing a specific road structure. Primary attention in OSAMAT was paid to the depletion of natural resources and the global warming potential. According to the LCA made for the N-M and S-V pilots, the environmental load can be decreased by using oil shale ash as a construction material for road construction.

The purpose of the LCC was to compare the relevant investment costs of the alternatives and find out if OSA use was cost-effective. The LCC results showed that the discounted annual cost per 1 kilometer of road was lower for structures with alternative construction materials like OSA.

Through all the period of the project implementation the dissemination actions went along with demonstration activities from the start of the project in 2010 until the end of the project in 2016, including after-LIFE period. We can state with certainty that the project improved public awareness about OSA and its use significantly and let to make very important decisions regarding OSA use in road construction on the local authorities' level. Dissemination of technical and environmental monitoring results helped us to convince public and authorities that OSA is valuable construction material and doesn't have impacts on nature. As the result the very important decisions were done on the country level 1) OSA was standardised as product for using in cement, concrete and gas concrete production (OSAMAT technical and environmental monitoring results played an important role in decision making) 2) OSA will be tested in 2017 for using in mass-stabilisation of soils in Rail Baltic railway construction (the biggest construction in Estonia in the coming years), 3) Estonian Road Administration has been testing OSA to use in construction of Tallinn –Tartu highway, 4) EE considers the possibility of OSA use in mass-stabilisation of soil in construction of Tootsi wind park. We started collaboration with ECOBA, big cement producers and civil-engineering companies in Finland, Sweden, and Lithuania.

Dissemination actions included the production of the main outcome of the project – "Guidelines for the European Practice" (attached as Annex 28 of DR). The guidelines give instruction for the constructor how to use OSA in road construction (tested applications).

The project actions have proved OSA suitability as a construction material technically, environmentally and economically. The utilisation of OSA brings environmental, economic and social benefits for the local and EU public. OSA utilisation as a binder in road construction means reduction of CO_2 emissions and in depletion of natural resources. The potential for OSA usage in Europe is around 900 000 t/year thus around 630 000 t/year of CO_2 emissions could be eliminated.

The project costs amounted as 2 430 710, 50 € which is a bit higher (51 430, 50 €) than the planned project budget (2 379 280 €). The exceeding of the budget was connected mainly to the project prolongation and the need to make additional technical and environmental monitoring to verify pilot construction and project action results.

Despite the project prolongation and amendments the overall project implementation can be assessed as successful and helpful in promotion carbon free alternative materials like OSA in new construction technologies.

3. Introduction

Every year around 6 mln tones of OSA is generated in Estonia. OSA removed from the boilers is transported to the plateaus through a pipe system as water slurry. OSA is rich in free lime. Contacting free lime with water leads to pH values above 13. The highly alkaline leachates from the ash deposits pose an environmental risk, and the ash plateaus are considered as major pollution sources.

In earlier decades, OSA has been extensively studied, that has made OSA available for usage in production of construction materials and cement, in road construction and in liming of acid soils. Despite numerous studies only a small amount of oil shale ash is currently recycled, a little more than 3% of the annual amount produced. Use of OSA road construction is considered as alternative to landfilling that helps to reduce the ash amounts to be deposited as well as reduce its environmental impact.

Due to its chemical content OSA is considered as a valuable binder material, which could be used to improve stabilization and strength of civil-engineering structures. Based on these assumptions the OSAMAT project was initiated. The scope of the project include three different applications at the two pilot sites: layer stabilization of existing road base courses with binders based on OSA, mass stabilization of peat with binders based on OSA, structural road base course by mixing different types of fractions of oil shale mining waste with OSA and verification of OSA feasibility as construction material with respect to the environmental, technical and economic criteria.

The results of the project prove that cement can be substituted by OSA partly or fully. According to the project result the technically suitable ash types for road construction refer to the fly ash, meaning the annual potential for usage altogether ~2 700 000 t.

OSA has similar properties to cement. To prove OSA technical suitability was very important as it directly influences on getting environmental benefits from OSA use in two directions: firstly, the use of OSA instead of cement means lesser deposition on the landfill, thus improving ecological situation in the region. Secondly, OSA production doesn't produce airborne greenhouse emissions and other environmental impacts comparing to natural aggregates production (incl raw materials withdrawal, transportation). Consequently the more OSA is used the bigger environmental benefits are received.

Due to OSAMAT project experience there are 3 potential road construction projects in Estonia under discussion where OSA might be used. We discuss also OSA use in road construction in Lithuania and abundant soil stabilisation in Finland (around 4 mln m3/year of abundant soils are generated only in Helsinki region during construction works). Calculating the total amount of OSA required for the projects that are under discussions with the partners and to be implemented in the nearest 1-10 year, the required amount might be around 900 000 t annually. Reaching 900 000 t of OSA use annually around 630 000 t/year of CO2 emissions could be eliminated.

The OSAMAT project results proved that utilisation of OSA can bring environmental, economic, social benefits and propose alternative construction material for the local and EU public.

4 Administrative part

4.1 Description of the management system

The OSAMAT project was held in Estonia. Eesti Energia AS (EE) was the coordinating beneficiary of OSAMAT project. There were two associated beneficiaries: Eesti Energia Narva Elektrijaamad AS and Nordecon AS. The co-financer was Estonia Road Administration.

Eesti Energia role in the management of the project

EE is the leading energy company in the Baltic states and the largest company in the world working with oil shale. During oil shale processing around 6 mln tons of OSA per year is generated in Estonia that is mostly landfilled at the moment. EE is looking for the environmentally sound solution to promote OSA as valuable material that could be used in different applications.

EE as a Project Coordinator was responsible for the general coordination of the project, the project's general accountancy and communication with the Commission (reports, amendments submission and processing).

In particularly EE was responsible for the implementation of the "Preparations", "Materials", "Verification", partly "Dissemination" and "Management" actions. In connection with the tasks of the actions the Project Coordinator was responsible for the:

- Conclusion of Partnership Agreements and sharing LIFE financial support according to the contribution of the beneficiary (incl accepting the work done and payments).
- Communication with Commission: progress reports and final report with payment request submission, amendments submission, answering the Commissions letters.
- Organising procurements for consultations and research (materials laboratory research, geological research, pilot sections design projects, Materials Report, Pilot Reports, LCA/LCC, Carbon Footprint, Verification Report, Layman's Report, Guidelines for European Practice-OSA use in road construction, Quality Control Report), equipment rent, pilot sections owner supervision, technical and environmental monitoring.
- Decisions on pilot sites locations and on mixture recipes for the piloting.
- Communication with the Environmental Board on EIA initiation/not initiation and on getting expert opinion from the local authorities and independent experts for Verification Report.
- Accepting the consultant's work and researches results (incl checking, negotiations, acceptance and payments).
- Moderating OSAMAT International Conference 2016 and managing the preparations.

Eesti Energia Narva Elektirjaamad AS role in the management of the project.

Eesti Energia Narva Elektrijaamad AS is a daughter company of EE. EE NEJ manages the production of electricity at two power plants (Balti and Eesti Power Plants). The company supplies electrical energy to Estonian consumers and heat to the town of Narva, and it exports electricity to the Baltic States and supplies electricity to the Nordic power market through the Estlink undersea cable. Every year about 6 mln tonnes of oil shale ash are produced at the two power plants. All the actions connected to OSA producing, storing, selling and landfilling are under EE NEJ jurisdiction.

EE NEJ was mainly responsible for OSA supply, but also for the implementation of project researches and compilation of progress reports.

In particularly EE NEJ was responsible for the implementation of the “Applications”, “Piloting”, and partly “Dissemination” actions. In connection with the tasks of the actions the EE NEJ Project Manager was responsible for the:

- Organising OSA supply for the laboratory researches and pilot sites construction.
- Organising purchase of the materials and transport to the pilot sites (procurements, contracts, work acceptance, payments).
- Implementation of the projects researches: communication with the executers, materials supply, control and acceptance of the actions during research, results acceptance and reports final version submission to the Project Coordinator.
- Control of the actions of the consultant (Ramboll Finland and Ramboll Eesti): communication with the consultant, control and acceptance of the repots made by consultant (pilot sections design projects, Materials Report, Pilot Reports, LCA/LCC, Carbon Footprint, Verification Report, Layman’s Report, Guidelines for European Practice- OSA use in road construction, environmental survey and Quality Control Report at the pilot sites) and submission of the reports final version to the Project Coordinator.
- Communication with Estonian Road Administration, incl preliminary EIA compilation and submission to ERA for decision making; communications on project designs; processing construction permit procedure; organising pilot sites acceptance procedure.
- Managing OSAMAT web page in collaboration with consultant. Project Manager was responsible for the informative part (news, documents, photo etc) and consultant for the technical part – information upload, allocation and design at the webpage.
- Compilation of the progress reports and submission of the final versions to the Project Coordinator, including compilation of the EE NEJ financial tables, time sheets and project documentation and submission to the Project Coordinator.
- Compilation of the dissemination materials and sharing, incl writing articles or organising articles writing and project video compilation in collaboration with consultant.
- Performing the OSAMAT project results at the conferences.
- Organising OSAMAT International Conference 2016, conducting Workshop.
- Compilation of the final repot with payment request, After –Life communication plan, slides and submission of the final versions to the Project Coordinator.

<u>Nordecon AS role in the management of the project.</u>

Nordecon is one of the largest construction groups in Estonia that acts in nearly all segments of the construction market, including road construction. The Nordecon Group's development strategy is to improve operating efficiency and to sustain internationalisation. In order to develop the range of know-how and markets Nordecon AS is very keen to test new cost efficient methods, materials and technology for the road construction.

NC was responsible for the pilot sites construction.

In particularly NC was responsible for the implementation of the “Applications”, “Piloting”, and partly “Dissemination” actions. In connection with the tasks of the actions the NC Project Manager was responsible for the:

- Coordination of the pilot sections design compilation.
- Calculation of the materials volumes for construction according to the mixture recipes;
- Construction of the pilot sections: materials supply and transport, necessary equipment rent, construction according to the instruction and in accordance with legislation, completed sections delivery for the acceptance to ERA.
- Compilation of the NC financial tables, time sheets and project documentation and submission to the Project Coordinator.
- Introducing OSAMAT project at the conferences.

Estonian Road Administration had a role of co-financier, but it was also responsible for pilot sites designs approval, EIA initiation/not initiation decision, construction permit issuing and construction work acceptance.

According to the results of the procurement for providing consultation services for the OSMAT project the winner was Ramboll Finland and Ramboll Eesti AS (starting from 23.07.2015 all the right and obligation (including the consultation agreement between EE NEJ and Ramboll Eesti AS) have been transferred to the company Skepast&Puhkim AS). They have conducted most of the researches and compiled most of the report.

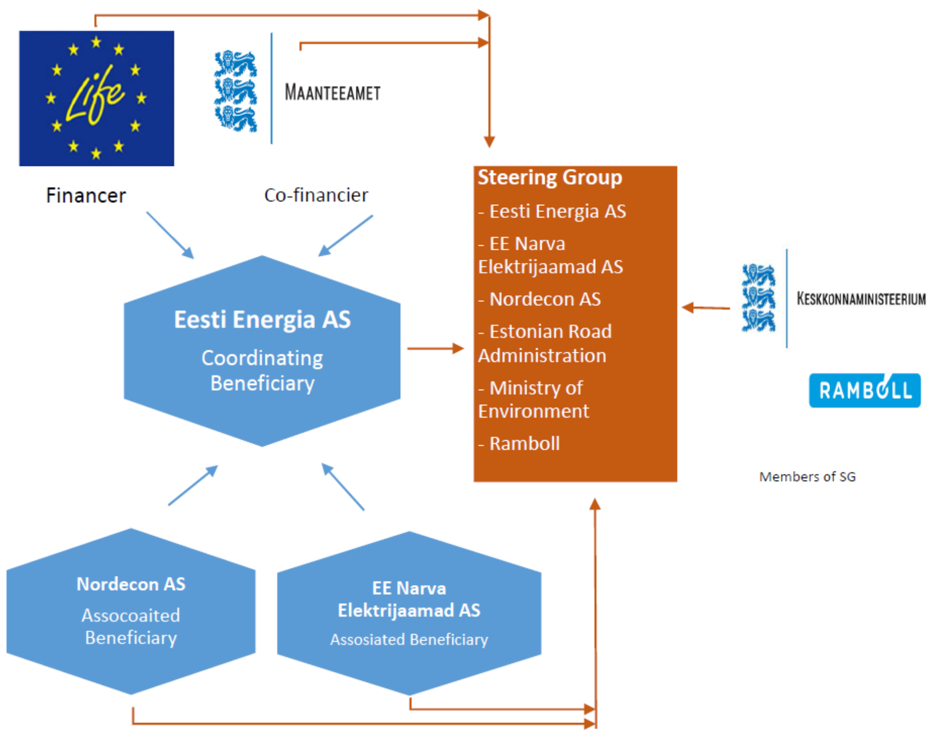


Figure 1. General Organigramme of the OSAMAT project

The project had one steering committee, consisting of the member from EE, EE NEJ, NC, ERA, ME and Ramboll (Figure 1).

The SG- group had regularly meetings (SG- meetings) once a year (usually before progress report submission to Commission to approve the progress).
The beneficiaries of the project had work meetings depending on the necessity. The meetings were held most frequently during construction works.

<u>Description of changes due to amendments to the Grant Agreement.</u>

There have been 3 amendments of the Grant Agreement during the project life.

1. Amendment nr 1 signed on 12 of September 2012.
   The Grant Agreement was modified as follows:
- A new associated beneficiary Eesti Energia Narva Elektrijaamad AS was included in the project with effect from 11/11/2011;
- The associated beneficiary name and legal status had changed. Nordecon Infra AS withdrawn and was replaced by Nordecon AS from 11/11/2011;
- The provisional budget was modified (changes in forms FA, FB, FC, F1, F3, F4b, F6, F7)

- New beneficiary approval and Nordecon legal name change caused modifications in forms A1, A2, A3, A4, A5, A7, C1/1, C1/2, C1/7, C1/9, C1/10, C1/14, C1/16.

2. Amendment nr 2:

   The Grant Agreement was modified as follows:

- The modification of the name and legal status of Nordecon AS, which was the object of the Amendment nr 1 to the Grant Agreement is effective from 01/01/2011.

3. Amendment nr 3 signed on 4 of December 2013:

   The Grant Agreement was modified as follows:

- The project was extended and should run for 71,5 month from 01/09/2010 to 15/08/2016

The partnership agreements was delivered as follows:

- EE and NC partnership agreement - with the Progress Report nr 1 and supplement agreement with Progress Report nr 3.
- EE and EE NEJ partnership agreement – with Progress Report nr 3.

4.2 Evaluation of the management system

The project's management system assured the planning, organisation and implementation of the project actions. Despite unexpected technical problems that caused the project prolongation all the objectives of the project were fulfilled, expected results received and the project can be assessed as successful.

The cooperation between the partners can be also assessed in general as good. During unexpected situations (technical problems) the partners tried to be flexible, bearing in mind that such a pilot construction project was done for the first time and the results depended on the common efforts. Such an approach let the pilot section constructed and results received. However, it should be noticed that there were differences of opinion in understanding common provisions regarding financial issues. It wasn't understood that the Commission prepayment should be divided between the partners according to the partner's contribution. This has led to a situation (through the concluded contracts) that one partner has all its costs already covered by today, although the final payment hasn't been done yet. Consequently, the Project Coordinator has covered most part of the costs (that should be covered from the prepayment) from the own budget.

We had to do three amendments to the Grant Agreement during the project life not to jeopardize the project results. The success of the project proves that those amendments were necessary to fulfil the project goals.

Briefly, the problems encountered (that lead to the amendments) were as follows:

1. Eesti Energia Narva Elektrijaamad AS adding as a new OSAMAT project associated beneficiary (Amendment nr 1).

   In OSAMAT application phase in autumn 2009, all activities connected to OSA selling services were carried out by Department of Business Development under Eesti Energia AS. However, in December 2009 due to structural changes a new Ash Sales Service under Eesti Energia Narva Elektrijaamad AS was formed and all the actions with ash storing, selling and ash R&D projects were transferred to the jurisdiction of the EE NEJ as a daughter company of the EE. To guarantee OSA deliveries and researches EE NEJ should become a beneficiary of the project.

2. On 31 of December 2010 Nordecon Infra AS changed the legal name to Nordecon AS. According to the common provisions clause 15.2 the legal name change is a substantial change that required Grant Agreement amendment (Amendment nr 2).

3. Mass-stabilisation equipment rent instead of purchasing (Amendment nr 1).

   During application phase it was assumed that equipment could be used for similar projects, but in the beginning of the project the market perspective for further usage of the equipment was not covered with concrete projects due to overall economic situation; also we faced with the gaps in country legislation referring to implementation of mass-stabilisation technology using OSA. EE and NC came into a conclusion that at that stage it was economically efficient and reasonable to rent mass-stabilization equipment with qualified personnel instead of purchasing.

4. Changes in the provisional budget (Amendment nr 1).

   The budget was reallocated in total amount of 696 625 € (528 493 € from Durable goods to external assistance 190 000€, to consumables 278 493€ and to other costs 60 000€; 168 132 € from personnel to external assistance) between the categories to ensure the successful completion of the construction and monitoring.

   Initially both pilot sections should be constructed in one road. During project implementation and different researches it came out that two different technologies couldn't be tested at one pilot sections. To fulfil technical and geological criteria and not compromise research targets it was decided to use two different locations. This created additional costs connected to transportation, materials and services. In N-M pilot section two layers of asphalt should be put instead of planned one and according to the ERA decision EE should make an owner supervision of the pilot sections. This also created an additional cost and demand to allocate the project budget.

5. The project prolongation (Amendment nr 3).

   The postponement of the end day of the project were connected to CFB ash handling system construction. According to the laboratory research the CFB ash showed the best results in strength development. The laboratory proposed recipes with only CFB ash (without cement addition like to other Cycl and EF PF ashes). CFB ash hadn't been tested before and we couldn't foresee such a result. So, from one side that was a good news, but from the other side that meant that quite big amounts of the ash would be required. There was no CFB ash handling equipment at that moment at the plant to issue big amounts of the ash. EE Member Board decided to install special equipment to the combustion block to take out the ash. This caused the delays in construction of the 3 section of N-M pilot section (was moved from the year 2011 to 2012) and construction of S-V pilot section (moved from the year 2011 to 2012).

   Unfortunately a force-major situation repeated once again: CFB block where ash loading equipment was installed broke and wasn't in exploitation until the end of December 2012. S-V pilot construction were moved again to the year 2013. From this moment it was obvious that with later construction it was not possible to make pilot sites environmental and technical monitoring and disseminate the project results. The project was postponed for 19,5 months. Prolongation of the project let us to finish the project, to fulfil the objectives and to get successful results.

6. Recipes change during S-V pilot construction (Progress Report nr 4).

   During S-V construction we faced with some technical problems. According to initial plans 3 types of the ashes in different ash to cement ratio should be applied. In practice (during the site construction) Cycl ash stacked the tubes of the machinery and it was impossible to continue with this type of ash as planned. We did only 1/3 of the planned length of the pilot section with Cycl ash. As technically we couldn't use Cycl ash anymore, there was a decision to make left 2/3 of the pilot section with EF CFB and EF PF ashes. In collaboration with laboratory experts from Ramboll the recipes for the sections were worked out and applied at the site. The new recipes are given in chapter 5.1.2 of the report. All the recipes proved their reliability according to the results of the technical monitoring.

It can be concluded that despite unpredictable and unforeseen situations (that faced most of the projects that test new equipment and new materials) and other different reasons that caused project modification, the overall project management was effective and successful in fulfilling intended goals.

All the Progress Report that have been sent to the Commission could be found at OSAMAT project webpage.

Communication with the Commission and Monitoring team

Each year, regularly before a Progress Report submission in September there was a meeting with the EMT. EE Project Coordinator, EE NEJ Project Manager and NC Project Manager gave an overview of the project and actions, project progress, modifications. There were also several visits to the pilot sites.

We answered all the Commission's questions on time (usually with the following report). It was a very constructive cooperation with the Commission and EMT throughout the entire project. We always received prompt and sufficient answers from EMT on various issues (project modifications, interpreting the rules correctly, etc).

Carbon Footprint

Carbon Footprint (CF) analysis was a part of the management action of the project and monitoring was done once during each project year. The aim of CF report was to present the results of the emissions created by the different project actions. Carbon footprint calculations show which activities gave the biggest CO2 emission. The CF calculations included deskwork, travelling and piloting activities. The OSAMAT total CO2 emissions (from 2010 Sept-Jun 2016) consisted of 921.4 tons CO2 ekv.

The result of OSAMAT carbon footprint can be useful base material for comparison with other road construction projects. Carbon Footprint report is attached as Annex 7.2.2.

5 Technical part

5.1 Technical progress

The technical progress is composed by 5 actions (Preparations, Materials, Applications, Piloting, Verification). The detailed information regarding implementation and results obtained for each action is given in the following sections.

5.1.1 Action 1: Preparations

Preparations action included preliminary activities, which assured a smooth start of the project prior to pilot activities.

Deliverables	**Deadline**	**Status 15/08/2016**
Decisions of new equipment for the project	1.09.2010	Completed. The equipment was rented (Commission letter 04/06/2012). Progress Report nr 1.
Preparations Action report	15.12.2010	Completed, December 2010 attached as Annex to Inception Report.
Compilation (report) of technical, environmental and economic criteria for materials and applications and test procedures	28.02.2011	Completed, February 2011 attached as Annex to Inception Report.
Environmental permits	31.05.2011	Completed, February 2012. The environmental authorities have confirmed that the licence for handling hazardous waste is not required as OSA (letter from Viru Region Environmental Board to EE on 22.02.2012 nr V 8-2/12/3980-2). Progress Report nr 2.
Milestones		
Consortium agreement conclusion	1.09.2010	Completed, March 2011-November 2012. Mid-term Report and Progress Report nr 3.
Completion of Steering Group	1.09.2010	Completed, October 2010. Inception Report.
Decisions on pilot sites location	1.09.2010	Completed, October 2010. Inception Report

The consortium agreements included:

- Co-financing agreement with Estonian Road Administration (signed in March 2011);
- Partnership Agreement between EE and NC (signed on 31.05.2011);
- Partnership Agreement between EE and EE NEJ (signed on 25.10.2012).

The Steering Group was formed from the members of project partners, ERA, Ministry of Environment and Ramboll Eesti AS on the first project kick-off meeting organised on 21.10.2010.

At the kick –of meeting the two sections at Narva-Mustajõe (basic state road 13109 km 14,470 – 16,150) and Simuna -Vaiatu (state road nr 17192, km 2,5-5) roads were approved for conducting the project pilot activities. The chosen construction technologies were cold in place recycling with cement (traditional, but done with OSA instead of cement within the frame of the project) and mass-stabilisation technology correspondently. There was a decision to rent a mass-stabilisation equipment to construct Simuna-Vaiatu pilot section.

The acceptance criteria for materials and applications were based on the relevant guidelines available in Estonia and on the criteria of end of waste (Waste framework directive 2008/98/EC, Article 6), CPD (construction products directive 89/106/EEC and the potential Construction Products Regulation in 2011), and on the available and appropriate European Technical Approvals and CEN-standards. Based on the criteria the detailed test program was compiled. The tests started in the Ramboll Finland OY Luopioinen'i laboratory on 28 of February 2011.

Based on the preliminary environmental impact assessment (EIAS) screening results ERA decided not to not to initiate full EIA. The environmental authorities confirmed that the licence for handling hazardous waste was not required as OSA was considered as material and not a waste (Environmental Board to EE on 22.02.2012 nr V 8-2/12/3980-2). Progress Report nr 2).

The mass-stabilisation equipment rental agreement was signed with Lemminkäinen Infra Oy on 13 of May 2013. The delay in obtaining the equipment was connected to the delays in the project pilot activities. Due to the technical problems with OSA handling system, (it was not possible to take the ash out) the construction was postponed twice to the year 2013 and 2014.

5.1.2 Action 2: Materials

Materials Action was carried out with the help of geotechnical and chemical laboratories in order to ascertain appropriate materials based on OSA for the different pilot applications. Material tests started in 2011 and performed until the year 2013.

Deliverables	**Deadline**	**Status 15/08/2016**
Technical report compiling all the activities and results of the Materials Action during the project years 2010 – 2012	28.02.2013	Completed, November 2012, Material Report is attached as Annex 7 to Progress Report nr 3
Milestones		
Choice of the laboratory for chemical analysis, materials testing start	30.09.2010	Completed, September 2010, Inception Report.
Tests for N-M pilot finish	31.05.2011	Completed, May 2011, attached as annex 6.7 to Progress Report nr 1
Tests for S-V pilot finish	31.05.2012	Completed, May 2012, Annex 7 to Progress Report nr 3

At a first stage of the testing program 4 different types of OSA, mining waste and the peat (from S-V pilot section) properties were examined. The measurements included water content, pH, loss on ignition, density, grain size distribution, Niton and leaching characteristics.

After materials properties specification, different recipes for road construction mixtures were composed and tested in the laboratory.

OSA should be tested in two different construction technologies at the pilot sites and in three different applications:

1. Layer stabilisation of existing road base
2. Mass stabilisation of peat
3. Structural base course of road by stabilising oil-shale mining waste with OSA.

The first and third applications referred to the layer stabilisation technology and the second application – to mass-stabilisation technology.

During geological investigation it was detected that exiting road old materials amount would not be enough to make the 1 first application fully, so it was decided to combine 1 and 3 application to one. As a result the layer stabilisation in N-M section was done mixing existing road old materials (1 application) and mining waste (3 application) with OSA (and cement in some recipes). So, actually all 3 applications were tested as planned.

The mixtures for the pilot construction in N-M section consisted of mining waste aggregates, cement, OSA and old paving. Several test specimens with different constituents ratio were examined to define unconfined compression strength and freeze-thaw durability of the mixtures. The test results showed that the bottom ash couldn't be used in construction because of poor compression strength, EF PF and Cyclone ash should be used with some cement addition and EF CFB ash could be used without cement addition.

The mixtures for the pilot construction in S-V section consisted of peat, cement and OSA Several test specimens with different constituent ratio were examined to define unconfined compression strength and freeze-thaw durability of the mixtures. The results showed that only OSA use for peat stabilisation gave poor compression strength and cement had to be used together with OSA. The laboratory proposed the recipes with Cyclone and EF CFB ash.

However, during the pilot construction the technical problems with Cyclone ash pumping occurred and the recipes were rapidly switched (additional tests) to EF PF.

Changes in the recipe's plan in no means jeopardized the project goals. On the contrary the addition of the new recipes gave an opportunity also for EF PF and EF CFB ashes that are produced in big amount at the Narva plants to find the way of application in stabilisation of soft soils.

Finally, based on the testing results the following recipes were proposed to use in N-M and S-V pilot sections construction (Table 2).

Table 2. The recipes applied at N-M and S-V pilot sections.

Recipe number	Recipes
Layer and road base stabilisation, Narva- Mustajõe pilot section	
1	EF PF 6 % + KS 3 %+aggregates
2	Cycl 5 % + KS 5 %+ aggregates
3	EF CFB, 9%+aggregates
Mass-stabilisation, Simuna-Vaiatu pilot section	
4	CYCL 200 kg/m3 + KS 60 kg/m3
5	EF PF 190 kg/m3 + KS 90 kg/m3
6	EF PF 170 kg/m3 +KS 110 kg/m3
7	EF PF 180 kg/m3+ KS 100 kg/m3
8	EF CFB 200 kg/m3+ KS 80 kg/m3
Upper layer stabilisation, Simuna-Vaiatu pilot section	
9	EF CFB 9%

KS- cement, aggregates - mixture of MWA (mining waste aggregate) and MAC (milled asphalt concrete), Cycl - cyclone oil shale ash, EF PF - electrostatic precipitator oil shale ash from pulverised firing, EF CFB - electrostatic precipitator ash from circulating fluidised bed combustion.

OSA quality (mainly CaO_{free}, Cl and specific surface) was fixed during the laboratory testing and later controlled before the each delivery to the pilot sites.

OSA and all the construction mixtures were tested according to the EN 12457-2 to fix the range of leaching of the components from the mixtures and pure materials to predict the possible impacts to the nature. Stabilised construction mixtures testing results were compared with Finnish regulation on ashes use in road construction (as Estonia doesn't have such). The laboratory results showed that there were no exceeding of the values stated in Finnish regulation.

The testing program was carried out by Ramboll Finland Oy Luopioinen laboratory.

The description of the measurements procedures, tests results and analysis are presented in the technical report "Material report".

5.1.3 Action 3: Applications

The activities of the action were concentrated on the production of pilot sections design and construction instructions.

Deliverables	Deadline	Status 15/08/2016
Report of civil-engineering (pilot sections design) and environmental survey program	28.02.2011	Completed, March – August 2011, July 2012. Progress Report nr 2 and Mid-term Report.
Written instruction for the implementation of pilot applications 2011 (N-M pilot)	31.05.2011	Completed, June 2011, Annex 6.9 to Progress Report nr 1.
Written instructions for the quality control (N-M pilot)	31.05.2011	Completed, June 2011, Annex 6.9 to Progress Report nr 1.
Written instruction for the implementation of pilot applications 2012 (S-V pilot)	31.05.2012	Completed, July 2012, Annex 6.4 to Mid Term Report.
Written instructions for the quality control and follow-up of pilot applications 2012 (N-M and S-V pilot)	31.05.2012	Completed, August 2012

In the year 2011 geological and environmental investigations were carried out at the pilot sites (by Ramboll Eesti OÜ) to determine the soil and environmental background conditions. Based on the results and outcomes of the geological and laboratory research the pilot sections designs requirements were issued by ERA in March 2011. The pilot section designs were ready in August 2011 for the construction of N-M pilot and in July 2012 for the construction of S-V pilot and third section of N-M pilot site. The environmental investigations ended in the end of the year 2010 and the results and outcomes were used for the compilation of the environmental survey program (ready in April 2011) and environmental impact assessment screening report (ready in March 2011), sent to ERA for EIA initiation/ not initiation decision making. Based on the preliminary environmental impact assessment there was a decision not to initiate EIA.

Written instruction for construction on N-M pilot site was issued in July 2011. Written instruction for S-V pilot site construction was issued in July 2012. Written instruction included the detailed information about exaction of the pilot construction works with OSA: materials delivery, equipment, machinery, materials spreading, mixing and quality assessment.

During the pilot sites construction the samples of the mixtures from the pilot sites were delivered to the laboratory for the quality control (according to the written instruction issued in August 2011) to provide the initial technical and environmental information for further monitoring and outcomes. The following measurements were conducted with the samples: unconfined compression strength, freeze-thaw durability, water content and hazardous substances leaching.

The pilot sites further technical and environmental monitoring were done in accordance with written instruction on follow-up (issued in August 2012). The follow-up instructions included the detailed program of measurements that had to be done after the construction to assess the results of piloting action: strength measurements in technical monitoring; water and soil samples for leachate assessments in environmental monitoring.

5.1.4 Action 4: Piloting

Piloting Action demonstrated the practical implementation of different types of civil-engineering applications with materials based on OSA.

Deliverables	Deadline	Status 15/08/2016
Pilot Report including descriptions of applications	15.11.2014	Completed, January 2014 (N-M Report), April 2015 (S-V Report). Attached as Annexes 6.1 and 6.6 to Progress Report nr 6.
Milestones		
Final securing of the timetable, materials and equipment for pilot 2011	31.05.2011	Completed, May 2011. Progress Report nr 1.
Piloting 2011 starts 01/08/2011 and is finished	15.12.2011	Completed, August –October 2011. Progress Report nr 1
Final securing of the timetable, materials and equipment for pilot 2012	31.01.2012	Completed, January 2013, Progress Report nr 3
Piloting 2012 starts 01/04/2012 and is finished	15.10.2012	Completed, August –October 2012, Progress Report nr 3
Piloting 2013 starts 01.05.2013 and finishes	30.06.2014	Completed, June 2013-August 2014. Progress Report nr 4, 5.

OSA was tested in two different construction technologies as a binder (substitution of cement) at N-M and S-V pilot sites.

According to the laboratory results three types of OSA were suitable for piloting: Cyclone, EF PF and EF CFB.

EF CFB ash showed the best results in strength development. According to the Narva-Mustajõe and Simuna-Vaiatu sites' construction designs EF CFB ash was supposed to be used alone as a binder, without cement addition. After recipes compilation it became clear that the amount of EF CFB ash needed for piloting at Narva-Mustajõe and Simuna-Vaiatu sites couldn't be taken out from combustion block by 2011 piloting action start for technical reasons.

In September 2011 only two sections at Narva-Mustajõe site were constructed with using Cycl and EF PF ashes as a binder. To provide the amount of EF CFB ash needed for piloting there was a decision done by Eesti Energia AS Board Member to install additional equipment to the combustion block to take out the ash (not financed from the OSAMAT project). That's why construction of the 3 section at Narva-Mustajõe site and construction of the Simuna-Vaiatu site were postponed to the year 2012.

2012 year piloting actions were planned to be started in September. Unfortunately force-major situation repeated once again: CFB block where ash loading equipment was installed broke and wasn't in exploitation until the end of December 2012.

Engineers of Eesti Energia proposed a temporary solution for loading ash in small amounts and in quite long periods of time from another CFB block (company owns 2 CFB blocks). Hot ash had to be cooled down prior to loading to the track for transporting the ash to the site, so loading was foreseen to take a lot of time. This solution let to construct at Narva-Mustajõe site only, because it was located right near the CFB block (so long-time loading wasn't a big problem) and the amounts needed satisfied the demands of the engineers.

Simuna-Vaiatu site construction had to be postponed further again (to the year 2013). It was not possible to provide the ash for the site under the proposed temporary technical solution because of the distance between the CFB block and the site (150 km) and the amounts of the ash needed (twice more than in Narva-Mustajõe case).

Narva-Mustajõe pilot site construction

Three types of OSA were tested in stabilization of layer by cold in place recycling method at N-M.

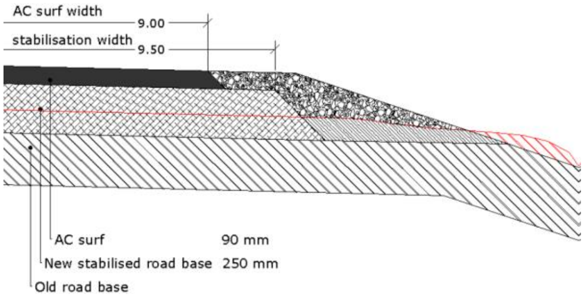


Figure 2.Narva-Mustajõe pilot site construction.

Layer stabilisation with binders based on OSA started in autumn 2011 (first and second sections) and finished in autumn 2012 (third section) at the pilot site. The layer stabilisation (new layer with OSA) was mostly done onto the old concrete layer. As mentioned in the chapter 2 the demolition of the old layer was expensive and senseless, so the new layer was mostly constructed onto the old layer. Only in one place the old layer was taken out and completely new 300 m section was constructed.

The lengths of experimental sections and OSA type used were the following:

OSA	**Total length of the sections with OSA type used, m**
Cyclone	780
EF PF	650
EF CFB	200

Simuna-Vaiatu pilot site construction

At the second pilot site OSA was tested in mass-stabilisation of peat. Three types of OSA (EF PF, Cycl, EF CFB) in different ash to cement ratio (all together 5 recipes) were tested in mass-stabilisation of peat at the site. Initially 4 recipes consisted of Cycl ash. However, technical problems occurred during piloting restricted testing of Cycl ash at the site: the ash stacked the tubes of the machinery and it was impossible to continue with this type of ash as planned. So, the initial recipes plan had to be changed. Only 1/3 of the planned length of the pilot section was done with Cycl ash.

As technically we couldn't use Cycl ash anymore, there was a decision to make left 2/3 of the pilot section with EF CFB and EF PF ashes. In collaboration with laboratory experts from Ramboll the recipes for the sections were worked out and applied at the site.

The changes in initial recipes plan hadn't stopped the piloting activities - the mass-stabilisation works were finished in September 2013 as planned. The total length of the stabilised structure was 500 m.

Onto the stabilised structure the new layer with EF CFB ash were constructed (490 m) in August 2014 (Figure 2, LS-BOS). The rest of the pilot section (410 m) was constructed by complex stabilisation method using traditional construction materials for the experimental reasons (Figure 3, LS-CB).

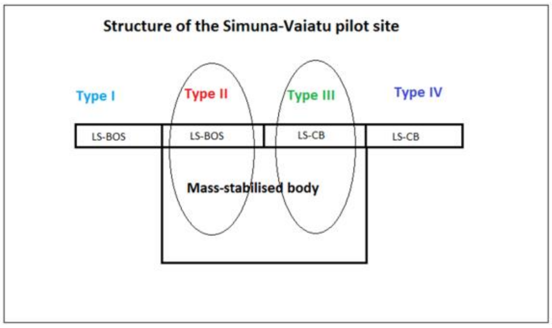


Figure 3. Simuna-Vaiatu pilot site construction.

The pilot section construction was successfully finished at Simuna-Vaiatu road in August 2014.

The description of the piloting actions is given in two separate reports: Narva-Mustajõe Pilot Report (attached as Annex 6.1 to Progress Report nr 6) and Simuna-Vaiatu Pilot Report (attached as Annex 6.6 to Progress Report nr 6). The Pilot Reports give the information about the pilot sites, pilot sites design principles, construction details, environmental studies and follow –up program, quality control and technical follow-up procedures.

5.1.5 Action 5: Verification.

Verification Action activities aimed to control and monitor the quality of the pilot sites construction, the follow-up activities and results of environmental and technical monitoring and impacts on the surrounding nature. The data received during verification activities was foreseen to prove that the methods, materials and applications based on OSA were environmentally safe and technically and economically feasible.

Deliverables	**Deadline**	**Status 15/08/2016**
Final Verification Report	15.07.2016	Completed, Annex 7.2.3
Milestones		
Quality Control at pilot site 2011 finished	15.12.2011	Completed, N-M Pilot Report, attached as Annex 6.1 to Progress Report nr 6.
Environmental background values: start by sampling and finished with results	15.06.2011	Completed, final version of Environmental Survey is attached as Annex 6.2 to Progress Report nr 6
Quality control at pilot site 2012 finished	15.10.2012	Completed, N-M quality control data in N-M Pilot Report, attached as Annex 6.1 to Progress Report nr 6.
Quality Control at pilot site 2013 finished	30.06.2014	Completed, S-V quality control data attached as Annex 6.5 to Progress Report nr 6.
Follow-up studies of LIFE-period at pilot sites finished	30.05.2016	Completed, technical monitoring report in Annex 7.2.4, environmental monitoring report in Annex 7.2.5
LCA and LCC studies finished	30.05.2016	Completed, attached as Annex 6.7 to Progress Report nr 6.
Statements from External Experts received	30.05.2016	Completed, attached to Verification Report (Annex 7.2.3)

The verification actions (including quality control activities during construction, long term follow-up procedures (technical and environmental monitoring), LCA/LCC) and results have been analysed through all the period of construction and monitoring by different experts to get a better understanding of the processes and outcomes. The analysis of the actions is presented in Verification Report attached as Annex 7.2.3. The Report includes expert opinions given by the representatives of Estonian Road Administration, Ministry of Environment and Tallinn University of Technology. It is also available on the project website (including the opinions by the experts).

5.1.5.1 Quality control procedures during the pilot sites

2011 and 2012 year piloting at Narva-Mustajõe was accompanied by quality control actions. They included measurements and recoding of the depth, width and cross fall of the stabilisation layer, construction mixture water content measurement during construction and unconfined compressing strength measurements (UCS), materials and volumes control used in construction and load bearing capacity measurements.

Construction mixture (used in pilot construction) samples were delivered from the pilot site to the laboratory to follow 7 and 28 d unconfined compression strength development. According to the results the one month average UCS was 3 MPa (2 MPa is considered as enough initial strength). The samples were also tested for freeze-thaw (FT) weathering comparison. The strength loss between normal UCS result and FT weathered result was measured to be only around 15 %, which points to successful stabilisation (the loss until 30% is considered as successful).

Quality control actions at Simuna-Vaiatu pilot site included column penetration soundings (vane shear strength measurements), construction mixture XRF analysis and five settlement plates instalment and measurements.

Settlement

After the mass stabilisation took place, five settlement plates were installed, their initial height was recorded and then during the next months the height measurements were taken again to see the difference in time. The results showed that the settlement of the stabilised peat layer was between 1-4 centimetres. This corresponds to the experience in Finland when mass-stabilisation is carried out on existing road, where the stabilized soil has been already compressed. On completely new area settlement can be around 30-40 cm. Settlement time highly depends on local conditions. It is recommended to monitor about 6 months.

XRF analysis

The purpose of the XRF-analysis was to ensure the success of the stabilisation by measuring the amount of calcium in the samples taken on-site. The calcium contents measured in the laboratory and with the Niton analyser in the field were very much alike. There were some minor variation but the mixing level in the field was fulfilled and the stabilisation work has succeeded well.

Column penetration sounding

According to the penetrometer soundings the stabilised sections have achieved the shear strength of 50 - 160 kPa in two to three months. The target shear strength was 50 kPa. The highest strength level was achieved in section 4 with EF PF + KS 180 + 100 kg/m3 binder mixture.

In the second quality control soundings the stabilised sections have achieved shear strength of 60…> 200 kPa at the age of ten months. In all stabilised blocks the shear strength has increased or remained constant between the first and the second quality control soundings. In the second soundings the highest strength level of over 200 kPa was achieved in section 1 with CYCL + KS 200 + 60 kg/m3 binding mixture.

The detailed information about quality control procedures can be found in N-M Pilot Report, S-V Pilot Report and S-V quality control report.

5.1.5.2 Long-term follow-up procedures

5.1.5.2.1 Pilot sites environmental monitoring

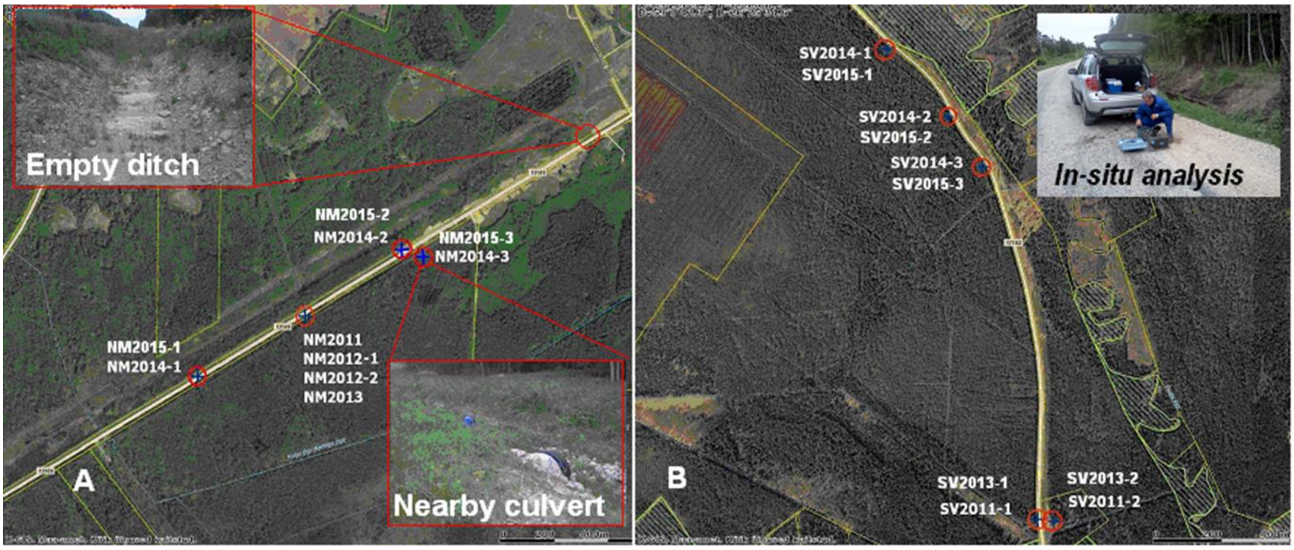
Environmental monitoring program at the both pilot sites included sampling of surface water and soil, analysis and compilation of the results. The environmental monitoring was done by Ramboll Eesti AS (the years 2011-2013) and KBFI (the years 2014-2015).

The environmental targets for the surface water were to monitor the values of the following parameters:

- Electrical conductivity, chloride, sulphate Mo, Sb and V content (not regulated for the surface water in Estonia)
- pH (has to be in a range of 6-9)

- Priority hazardous metals: Hg, Cd, Pb and Ni (under MAC-EQS)
- Hazardous substances: F-, As, Ba, Cr, Cu, Zn (under MAC-EQC)

The environmental targets for the soils were to monitor the heavy metals concentration to check if the results satisfy the requirements of the Regulation No 38 of the Estonian Ministry of Environment (adopted in 11.08.2010), Ohtlike ainete sisalduse piirväärtused pinnases (Concentration limits of hazardous substances in the soil).



Picture 1. Surface water sampling sites (N-M on the left and S-V on the right).

During the follow-up monitoring program of the OSAMAT pilot road sections the following conclusions was made:

- The content of all selected trace elements in soil samples was below national environmental quality limits during the follow-up monitoring and the road construction has not affected the soil quality when compared with the results of previous monitoring campaigns (including background data).
- The content of priority hazardous metals, Hg and Cd was below limit of detection (LOQ) in all water samples taken in 2014 and 2015 (Hg and Cd were not measured in the previous campaign 2011-2013).
- Among priority substances the content of lead was below LOQ in all water samples and traces of nickel were found close to detection limits in both pilot sections. Such a content of nickel in water samples can be considered as a natural background and is not caused by road construction.
- Among hazardous substances following anions and elements were detected: fluoride, arsenic, barium, copper and zinc. Barium content in N- M pilot section was found above national environmental quality standard (0.1 mg/L). At the same time the natural level of barium in Estonian surface water ranges between 0.02-0.22 mg/L. E.g. in groundwater close to N- M section (at Eesti Power Plant) the content of barium has been found at level 4.4-5.2 mg/L.
- The natural level of barium in surface and groundwater in East-Estonia is well over national environmental quality standards and is most probably not affected by the use of OSA

in road construction. National environmental quality level of barium is under amendment at the moment.

- The concentration of chloride ions in surface water is many times higher in N- M pilot section compared to S-V. Latter affects also the content of water-soluble barium chloride concentration in N- M section. Source for chloride ions could be for example the use of de-icing salt in road maintenance during winter period in N- M road. In S-V the barium is mainly bonded to insoluble salts ($BaSO_4$ or $BaCO_3$).

- The road construction has not affected the natural level of pH or electric conductivity of surrounding surface water. Electric conductivity of water is directly connected to dissolved solids or salts. Also content of chlorides and fluoride is similar to natural background level or with the observations made before road construction.

- The results in sulfate content (hat is not regulated in Estonia) in surface water samples in comparison with observations made in pre-construction monitoring leave us believe that the road construction has raised the sulfate content in surrounding surface water in N- M but not in S-V pilot section. The EF CFB ash is more environmentally friendly alternative comparing to OSA coming from pulverized firing.

The Environmental monitoring final report is attached as Annex 7.2.5.

5.1.5.2.2 Pilot sites technical monitoring

The aim of the technical research was to monitor and analyse the performance of two pilot sections with planned and designed subsections with structural alterations to find out, how OSA performs as a binder.
Technical monitoring program at the both pilot sites includes sampling of stabilised structures for strength, moister susceptibility and frost resistance measurements, paving quality measurements (damage assessment at N-M pilot site), analysis and compilation of the results.

Narva-Mustajõe pilot site monitoring results

In Narva-Mustajõe it was found that all stabilisation layers have good compressive strength and FWD bearing capacity, including the option with ash as a binder alone, without cement.

The road bearing capacity can be considered as a very good overall bearing capacity: it remains predominantly above 300, typically between 400 and 600 MPa in all sections. Those results are above the targeted 260 MPa value. The only relatively weaker spot can be found in Narva -> Mustajõe direction, with bearing capacity of 234 MPa. The deeper research referred to the problems in constructed pavement layers. This is a sub-section where the cyclone ash (with cement) was used (Figure 4).

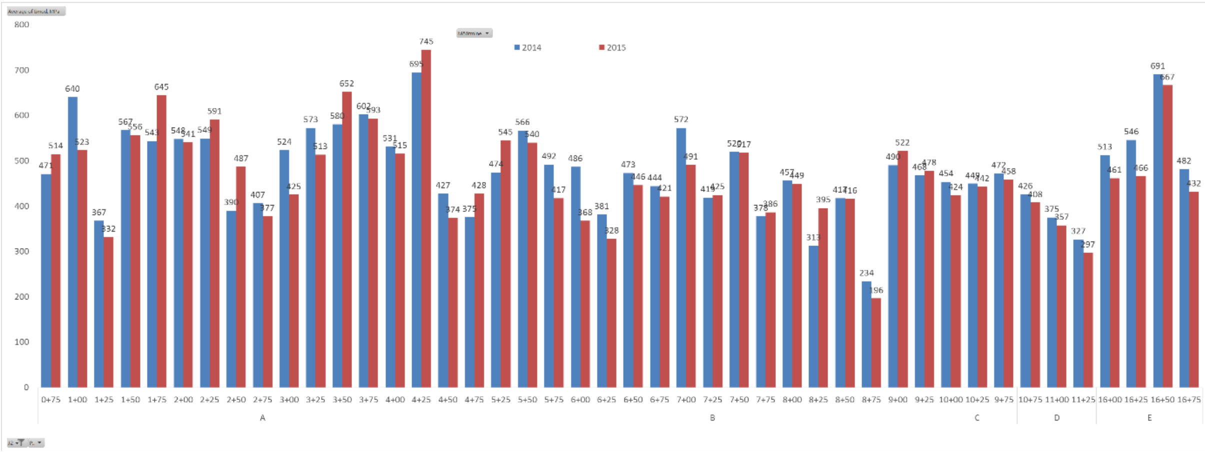


Figure 4. E- modulus values from the single measurements in N-M.

Compression strength of layer stabilisation specimens ranged from 7,2 ... 16,4 MPa. Compression strength of samples from sections with binder EF PF 6% + cement 3%) was in the range of 11,4 to 16,4 and the rest were in the range of 6,8 ... 9,2 MPa. The compression strength measurements of the road samples are not officially required by legislation. Road construction experts in Finland and in Estonia considered the value of 3 MPa as very good strength; values over 12 MPa might indicate to the possibility of cracks emergence (as the structure becomes too hard).

Picture 2. Core drilling of samples for compression strength measurements in N-M.

In 2015, decreasing of compression strength was found in all sections between 13% and 54%. In sections A and B, decrease in compression strength was 18%, in section E about 20%, in section D about 26% and in section C about 54% (Figure 5).

It needs to be said that the amount of core-samples was limited, so it is not possible to draw conclusions for type of binder to affect the compression strength.

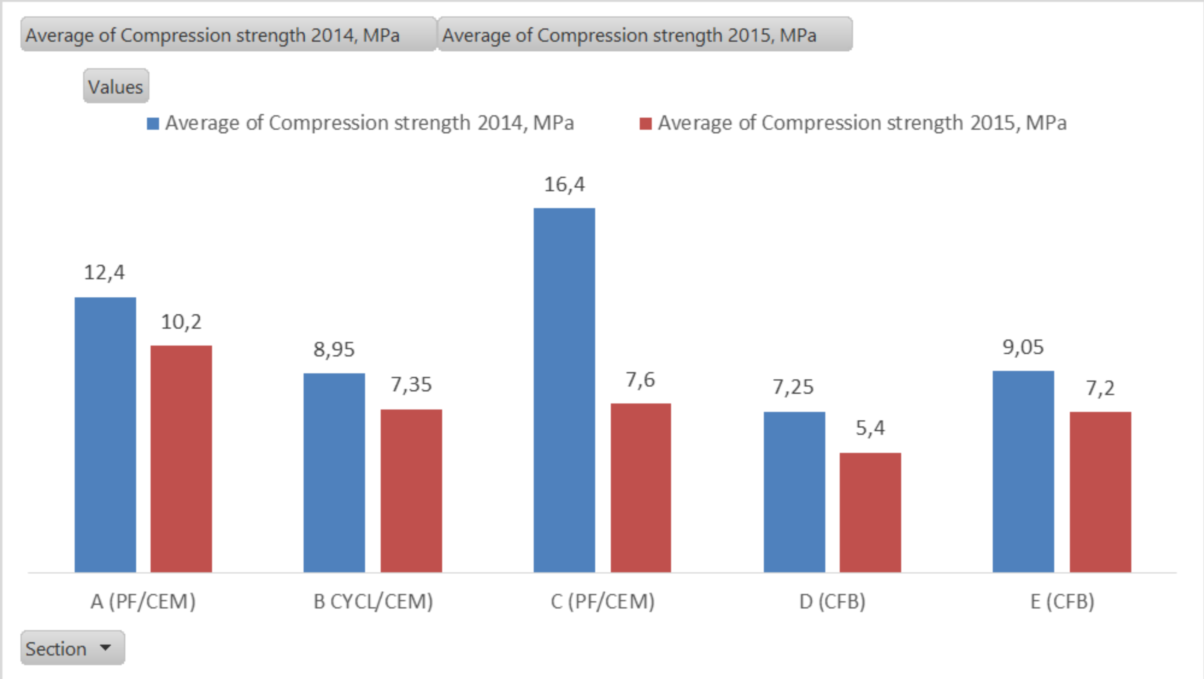


Figure 5. Compression strength in 2014 and 2015 (sections averages) in N-M.

Generally said the compression strength is in the good range in all sections varying between 5,4 and 10,2 MPa in 2015. Core-drilling is suggested to continue to understand the long-term dynamics of ash stabilisation. According to the after –LIFE monitoring program the next measurements will be done in the year 2018 and 2020.

Pavement defect analysis (damage assessment at N-M pilot site).

The defect analysis has shown the emergence of the cracks in the section constructed in the year 2011 with EF PF and Cyclone ashes. The number of the cracks in the section constructed with EF PF OSA hasn’t changed since the first measurements in year 2012. Inspection of the cracks has pointed out that the main reason is probably reflection of the old layer cracks on the surface of the newly constructed layer. The big amount of the ash in the mixture is also possible as a reason – as it is mentioned in the previous clause - „too hard“ (with high strength) structure might cause cracks emergence. As to the section constructed with Cycl OSA then the number of the cracks tripled with the year. Reflection is one reason for that as in the case with EF PF, but the main reason is probably the chemical composition and properties of the Cycl ash that differs significantly from EF PF and EF CFB ashes. This type of the ash behaves as an air-binder type in connection with water and this explains the emergence of the cracks.

To understand the reasons of the cracks emergence the deeper analysis was made. In August 2015 EE made an additional agreement with Teede Tehnokeskus AS.

After the research it came out that the cracks have appeared only in the sections with old stabilised pavement remained under new construction (without any treatment). In sections where old stabilised layer was removed, no transverse cracks have appeared (Figure 6,7).

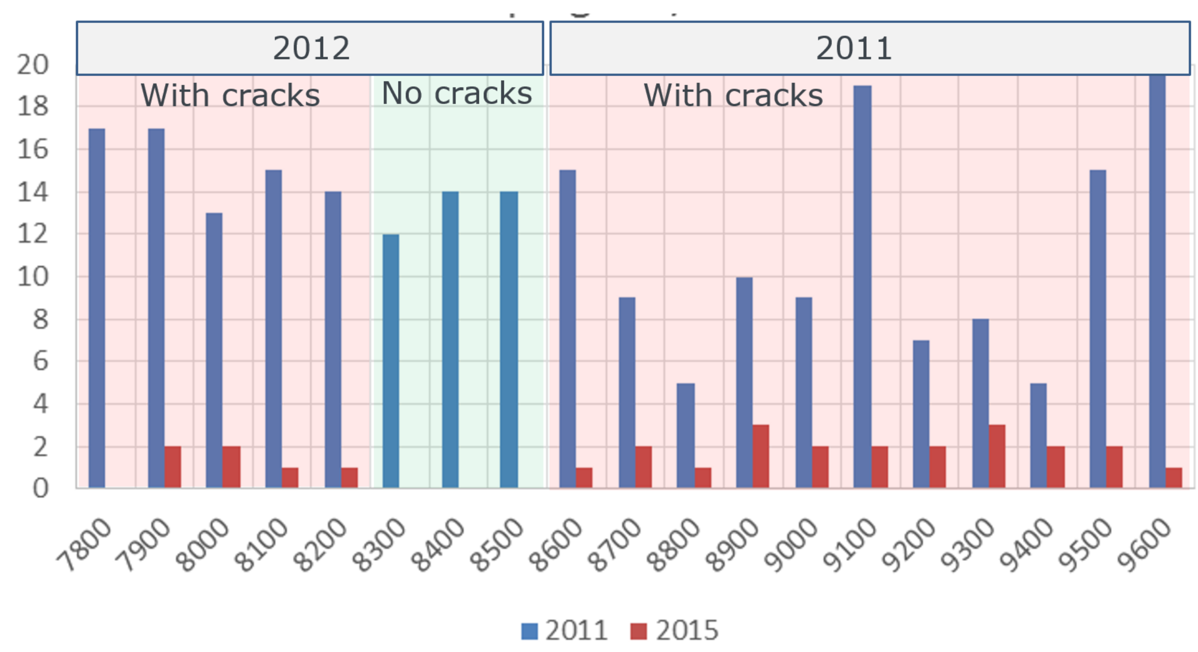


Figure 6. Number of cracks in 100 m sections in 2011 and 2015.

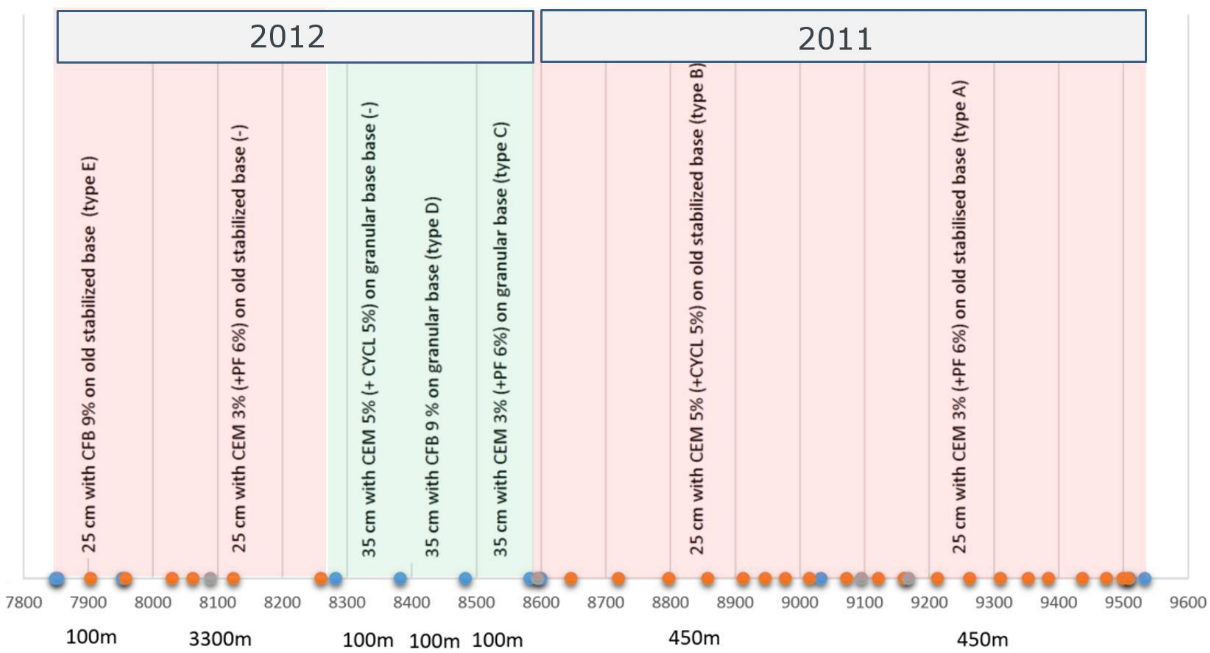


Figure 7. Location of cracks 2015 (orange dots).

The research showed that main reason for crack emergence was reflection of the old crack to the new surface, but not the usage of OSA in construction.

The detailed information could be found in the "Technical monitoring and scientific analysis of data from OSAMAT project pilot sections" attached as Annex 7.2.4.

Simuna –Vaiatu pilot site monitoring results

Mass-stabilisation with OSA and cement was been carried out in September 2013. Depth of stabilisation was ca 1…3 m (ca 4 m from surface of pavement). In July 2014, two different pavement structures were built on Simuna-Vaiatu section onto the stabilized peat: layer stabilisation with limestone mineral aggregate and OSA as a binder (LS-OSA) constructed in 490 m section and layer stabilisation with limestone mineral aggregate, milled asphalt concrete and cement and bitumen (LS-CB) as binder constructed in 410 m section. Surface-dressing has been used as protective treatment in both cases. Schematically the constructed sections could be presented as follows (Figure 8):

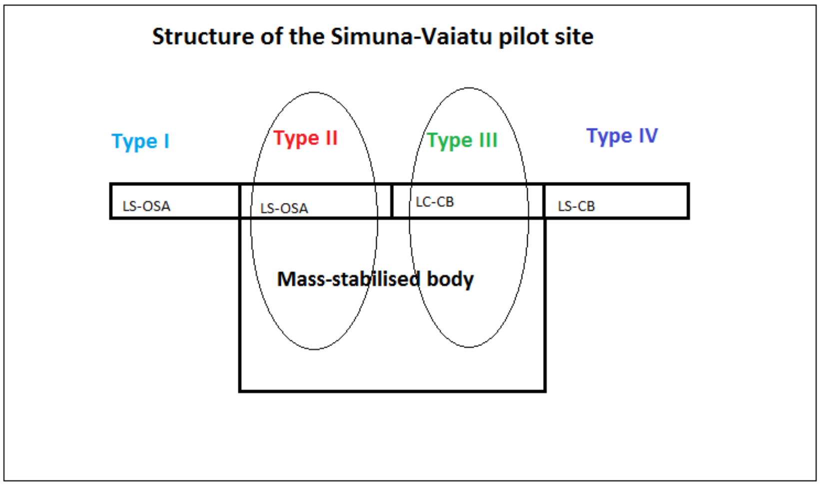


Figure 8. Simuna-Vaiatu pilot site construciton scheme.

According to the design documentation the bearing capacity of the pilot (E-modulus) of 169 MPa was required. From the figure below, one can see that sufficient bearing capacity is achieved only with structure type II comprising mass-stabilisation and layer stabilisation with OSA. It can also be seen that even with this type of structure, E-modulus in spring thaw period can fall below required one. Initial bearing capacity was achieved back only in structure type II (LS-OSA). Structure types I and III, although very different, perform fairly similarly, close to the required E-modulus. The structure type IV, differing from the type I theoretically (according to the design documentation) only by stabilisation type, performs very poorly. The initial bearing capacity was only 66 MPa after 1 week and reached only 77 MPa in average by week 5 and have had maximum of 81 MPa within one year.

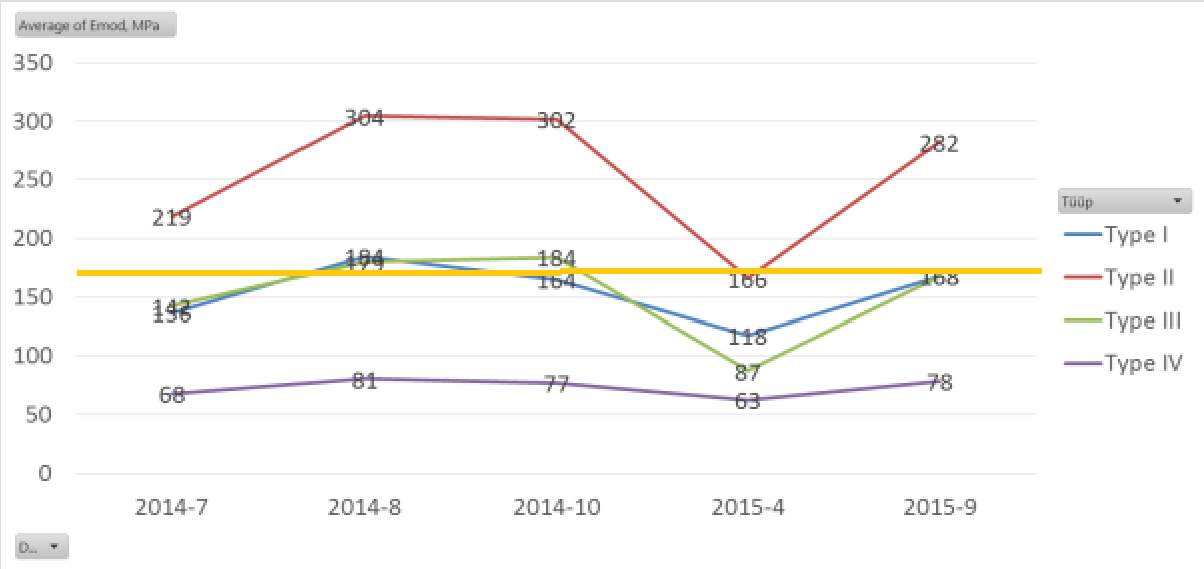


Figure 9. FWD measurement average results by section in Simuna-Vaiatu. Design capacity is 169 MPa (yellow line).

In order to determine compression strength of MS-OSA in Simuna-Vaiatu, core samples with geological drilling device were taken in September 2014. In total, 5 geological drillings were carried out. Generally it can be seen that water content in samples ranges from high 68 to 278% and the compression strength in comparison with usual stabilized materials used in road construction, is much lower, between 0,0 and 0,40 MPa. Compressive strength measurements of the road samples are not regulated and not usually measured. In the frames of the study we did those measurements for the first time to accumulate the knowledge's about behavior of the mass-stabilized structure constructed with OSA. These data will serve as a background for further researches. The strength received might be considered as enough as the bearing capacity of the road constructed onto the mass-stabilized body was high and above the target value (see Figure 9).

In general, it could be concluded so far that mass-stabilisation (stabilized structure) clearly performs better than dense peat (existing structure). Also it was found that the stabilisation homogeneity varied in wide range, it seems that the bearing capacity is good to support ca 1 m of road structure and traffic.

Layer stabilisation with oil-shale ash (LS-OSA) seems to perform better than stabilisation with cement and bitumen (LS-CB) in these conditions.

LS-OSA also showed better compressive strength than LS-CB (layer stabilization with cement). Corresponding 7 day strengths were 2,4 and 0,2 MPa, 28 day strengths 4,5 and 1,3 MPa (based on laboratory samples) and 1 year core-drilled samples strengths were 8,1 and 1,5 MPa in average. It must be noted that initial strength based in 7 days was about 10 times better for LS-OSA (Figure 10).

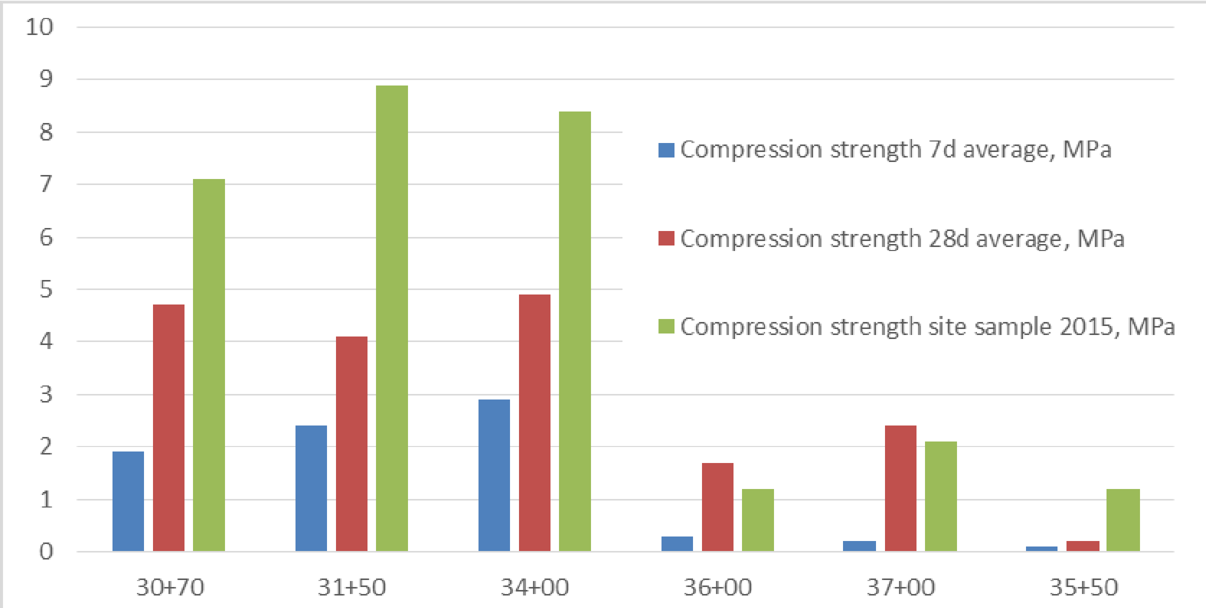


Figure 10. Compressive strength development MPa (7, 28 days curing samples and 1 year core-drilling samples).

9% of EF CFB was used in layer stabilisation. Based on latest compression strength data it may be needed to reduce the binder content to 5-6% to avoid too high strengths.

The detailed information is presented in "Technical monitoring and scientific analysis of data from OSAMAT project pilot sections" and attached as Annex 7.2.4.

5.1.5.3 Environmental life-cycle assessment and life-cycle costing of the pilot applications

The LCA/LCC report introduces the results of the verification action carried out in the framework of the OSAMAT project.

The aim of the LCA study was to determine and compare the potential environmental impacts of different alternatives of constructing a specific road structure. Primary attention in OSAMAT was paid to the depletion of natural resources and the global warming potential.

The purpose of the LCC was to compare the relevant investment costs of the alternatives and to show that the use of oil shale ash can be cost-effective.

The LCA and LCC are executed using the results from the laboratory tests, and quality control and follow-up studies at the pilot construction sites. The product system for the LCI and LCC calculations has been divided into the following processes:

- material production
- material transportation
- construction

The Functional Unit (FU) for the LCA and LCC calculations is 1000 meters of a road structure. The amounts of the materials per FU are given in the chapters 3.1.2.1 (table 5) for N-M and 3.2.2.1(table 13) for S-V of the LCA/LCC report.

The analyzed alternatives for N-M pilot site included:

Alt 1: layer stabilisation using a binder mixture of cement and oil shale ash (EF PF)
Alt 2: layer stabilisation using a binder mixture of cement and oil shale ash as a binder (CYCLON)
Alt 3: layer stabilisation using cement as a binder
Alt 4: complex recycling using a mixture of cement and bitumen as a binder

The analyzed alternatives for S-V pilot site included:

Alt 1: The bottom of the construction is mass stabilised with OSA (EF CFB) and cement and the top of the construction is layer stabilised with OSA (EF CFB)
Alt 2: The bottom of the construction is mass stabilised with OSA and cement and the top of the construction is complex stabilised with bitumen and cement
Alt 3: The bottom of the construction is mass stabilised with cement and the top of the construction is complex stabilised with bitumen and cement
Alt 4: At the bottom of the construction mass exchanged is applied: peat is replaced with natural aggregates and the top of the construction is complex stabilised with bitumen and cement.

Summary for LCA.

According to the life cycle analyses made for the Narva-Mustajõe and Simuna-Vaiatu pilots, by using oil shale ash as a construction material for road construction the environmental load can be decreased. Most clearly the effect can be seen when the stabilisation alternatives are examined – when cement is substituted in the stabilisation structures (in the cases when it is technically feasible and possible) – the environmental loads diminish clearly. The manufacturing of cement consumes a lot of energy and considerably depletes natural resources. Therefore, by replacing part of cement with oil shale ash - which as a by-product of an energy production can be regarded as a “zero impact factor” - all the studied environmental loads are smaller. Also, the technical and environmental follow-up tests showed that OSA can be utilised in a technically and environmentally feasible way.
As the sensitivity analysis shows, the amount of cement used has a very big impact on the final results. Although the results in S-V case were not exactly as expected, the results indicate that OSA can play the role of an environmentally and technically feasible element substituting cement and natural aggregates.

Summary for LCC.

The assessment is based on the investment calculations of costs of certain product or functional unit during a life-cycle. The general elements of the LCC calculations are provided on the picture below (Figure 11).

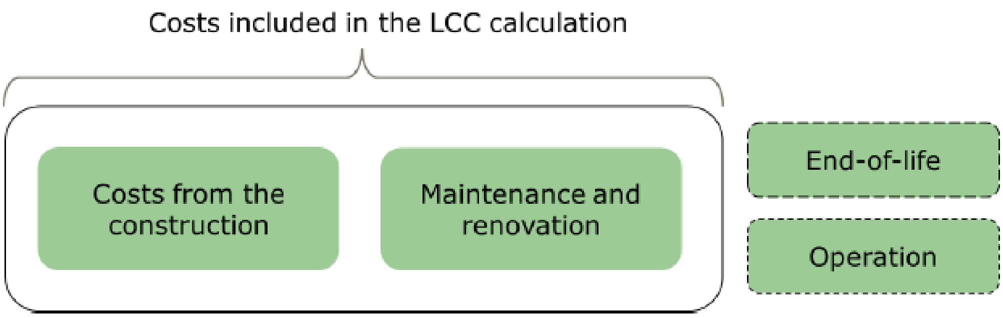


Figure 11. Costs included in the LCC calculations.

The operation costs are neglected since they are considered insignificant or identical and therefore they do not bring about variation to the calculation. The maintenance costs include repair and structural renovation costs which are discounted into net present values.

LCC results for N-M pilot site.

It was made an assumption that during the 40 years time horizon, the structure is repaired and renovated many times. The paving methods REP and U-REP are used many times for these structures. However, the structural renovation is done once during the 40 year time horizon. The time point of this renovation varies in Scenarios 1 – 3. The time point has an impact on the overall calculation. The calculation contains 3 scenarios where the first has the shortest life-time for structural renovation (Scenario 1 – 20-28 years; Scenario 2- 24-36 years; Scenario 3 – 28-40 years). The third scenario has the longest life-time until structural renovation. The annuity factor for the calculation was chosen to be 40 years. By postponing the renovation time, lower lifecycle costing is achieved.

The LCC results showed that the discounted annual cost per 1 kilometer of road (9.5 m wide) is lower for structures with alternative construction materials like OSA (Alt1 and Alt2 on the Figure 12) postponed structural renovation time horizons.

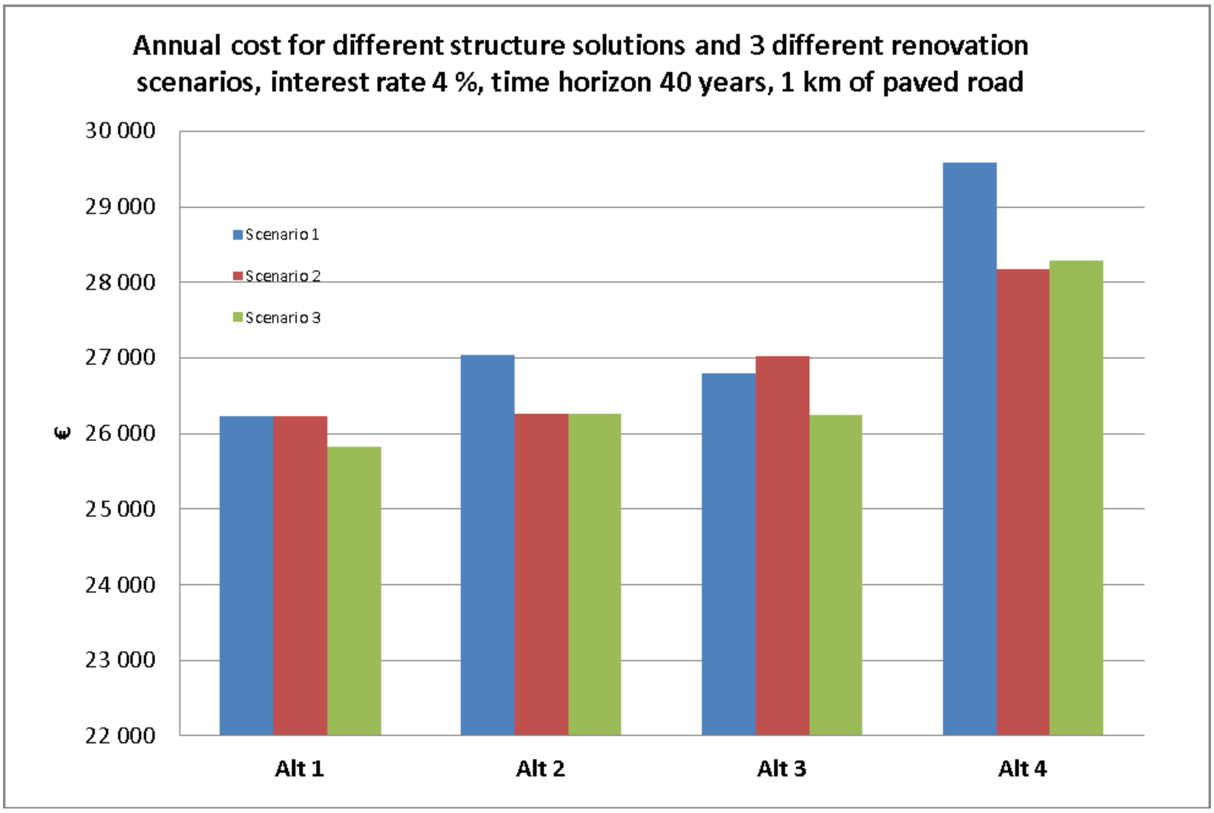


Figure 12. Annual cost (NPV) in euros (€) for structures Alt 1–4 with scenarios 1–3.

LCC results for S-V pilot site.

The calculations were made for a total time horizon of 40 years. In Scenario 1, the structural renovation time periods were 25 years after the construction. In scenario 2, the structural renovation time periods were between 28-30 years after construction. In scenario 3, the structural renovation time periods are done between 31-35 years after construction.

According to the results, it can be concluded that the life cycle costing with Alt1 (mass stabilisation with OSA and cement + layer stabilisation with OSA) and Alt2 (mass stabilisation with OSA and cement + complex stabilisation) is lower (Figure 13).

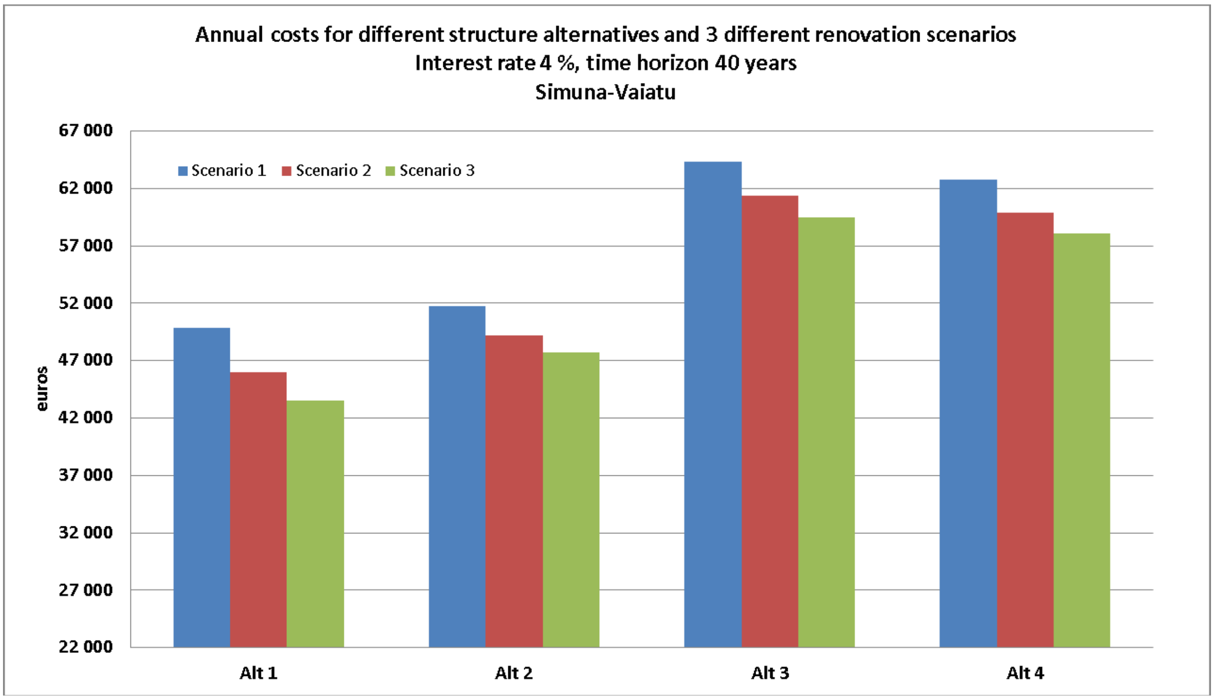


Figure 13. Annual cost (NPV) in euros (€) for structures Alt 1–4 with scenarios 1–3.

Summary and conclusions for LCA/LCC

According to the results achieved in the OSAMAT LCA and LCC analysis, the structure alternatives implemented in the OSAMAT pilots (Narva-Mustajõe and Simuna-Vaiatu) may cause less environmental harm than if stabilisation is carried out using only cement or if the structure is built exclusively with natural aggregates. However, it has to be pointed out that the LCA was performed as a Streamlined LCA which is not a complete one. Although the data used for the calculations originates from reliable sources, there are still uncertainties as the results and the conclusions are based only on the studied environmental impacts, depletion of natural resources and global warming potential.

Based on the data available LCA/LCC report demonstrates that OSA and the implemented methods can be environmentally and financially feasible for civil engineering purposes. Utilization of OSA in road construction proves to be feasible technically and environmentally.

Verification Report summarizes the methods and results of the verification actions (quality control at the pilot sites, follow-up programs and LCA/LCC studies). We have turned to the experts twice: 1) during the project implementation in order to have a variety of the opinions from different experts to enhance the quality of the data interpretation and results 2) in the end of the project to get an evaluation of the project results from Estonian Road Administration and Ministry of Environmental.

While the first opinions served as additional information to work on some nuances in data interpretation and reporting, then the final opinions have given an evaluation of the overall project results.

ERA considers, that the project results proved the successfulness of the project and give an opportunity for OSA to be used in road construction projects further. ERA weighs the mass-stabilisation technology with OSA implementation in Tallinn-Tartu highway construction.

5.2 Dissemination actions

5.2.1 Objectives

The objective of the dissemination program was to disseminate know-how of the methods and the results demonstrated during the project implementation to the target groups like municipalities, road administrators, contractors, politicians, legislative authorities, scientists, and other professionals and specialists in Estonia as well as in Europe.

5.2.2 Dissemination: overview per activity

The dissemination and communication is carried out with the following tools: the project webpage, created in the beginning of the project and containing all reports and information produced during the project, LIFE notice boards the piloting sites, Guidelines for European practice for OSA usage in civil-engineering applications, DVD-presentation, a booklet, Layman's Report, Dissemination Report, International Conference and Workshop, articles in national newspapers and professional magazines, oral presentations at the conferences, press releases, public events during the piloting, slides about the project and After-LIFE Communication Plan for After-LIFE communication.

Deliverables	**Deadline**	**Status 15/08/2016**
Press release about the project and piloting	1.07.2011	May 2011, Progress Report nr 1, Dissemination Report Annex 1.
Conference papers and posters submitted for Oil Shale symposium in Estonia 2012	31.03.2012	The event did not take place, instead OSAMAT was presented at Jordan International Oil Shale Symposium, Progress Report nr 2, Dissemination Report Annex 4.
Conference papers and posters submitted for Wascon Conference in Sweden 2012	31.03.2012	30.05-1.06.2012 Wascon Conference in Sweden, Progress Report nr 2, Dissemination Report Annex 5.
Conference papers for International Baltic Road Conference in Lithuania 2013	31.03.2013	6-28 August 2013 BRC in Vilnius Lithuania, Progress Report nr 4, Dissemination Report Annex 11.
Conference papers and posters submitted for Oil Shale symposium in Estonia 2013	31.03.2013	10-13 June 2013 in Tallinn, Estonia, Progress Report nr 4, Dissemination Report Annex 10.
Conference papers and posters submitted for Oil Shale symposium in Estonia 2014	30.06.2014	The event did not take place. Instead OSAMAT was presented at other conferences, period September 2013-September 2014, Progress report nr 5, Dissemination Report.
Conference papers and posters submitted for Oil Shale symposium in Estonia 2015	15.03.2015	The event did not take place. Instead OSAMAT was presented at International Conference Ash Trade Europe 2015, 22-23 of April 2015, Frankfurt, Germany, Progress report nr 6, Dissemination Report annex 18.

DVD presentation about the project, its methods and results	1.03.2016	2 video: shorter version in 3 languages and longer version on 2 languages (period 2011-2013), Progress report nr 5, Dissemination Report DVD.
Press release about the International Workshop	30.01.2016	March-May 2016, Dissemination report annex 20, 20-1.
Completed slide presentations in Estonian and in English for After-LIFE presentations (based on presentations for Roadshows, workshops and conferences)	15.07.2016	August 2016, Annex 27-1 and 27-2 of DR
Guidelines for European Practice	15.07.2016	August 2016, Annex 28 of DR
Layman's report	15.07.2016	August 2016 Annex 26-1 and 26-2 of DR
Dissemination Report	15.07.2016	August 2016 Annex 7.3
Milestones		
Webpage ready for use	31.10.2010	September 2010, www.osamat.ee, Inception report, Dissemination Report.
Arrangement of LIFE notice boards for pilots 2011 and 2012	30.04.2011	2 notice boards: N-M in 2011, S-V in 2013, Progress report nr 1, Dissemination Report.
Local events at piloting site	30.06.2013	2 events: 6 of August 2013 and 4 of September 2013, Progress report nr 4, Dissemination Report.
International Conference, Roadshows for specified target groups in Scandinavia, Baltic Countries and Central Europe and Workshop	30.05.2016	2-3 of June 2016 (Final report and Dissemination report)

Press release about the project and piloting.

OSAMAT project was introduced firstly in 2010 in Estonian newspaper "Põhjarannik" and in Estonian national broadcasting company. On 27 of May 2011 the press conference took place in Nordic Hotel Forum the press release about OSAMAT project in general, pilot sites, pilot construction technologies and materials was delivered to the wide audience. The media coverage after the press conference was good and articles about OSAMAT project were published in on-line media and also in Estonian national television news.
All together the press release was covered by 16 media sources. The links to OSAMAT media broadcasts in web and other media were added to the project webpage. The list of the media sources can be found in Dissemination Report (*further DR*), Annex 7.3.

Webpage ready for use.

The homepage is located at www.osamat.ee and it is in Estonian, Russian and English languages. The project homepage provides an overview of the project actions and objectives. The separate sections are for the news, project reports, publication and other documents, gallery and media. It features information on project beneficiaries along with links to their homepages. The project homepage was updated constantly according to the project progress.

Arrangement of LIFE notice boards for pilots 2011 and 2012.

The notice bards were prepared and installed at the Narva-Mustajõe pilot site in 2011 before construction and at Simuna-Vaiatu pilot site in 2013 before construction.

Picture 3. Notice boards with OSAMAT project identification and LIFE logo.

Conference papers and posters submitted for Oil Shale symposium in Estonia 2012.

Oil Shale Symposium didn’t take place in 2012 and the OSAMAT project was presented in Jordan Oil Shale Symposium by Tõnis Meriste (Jordan International Oil Shale Symposium, Dead Sea, Jordan, 7-9 May, 2012.). Attached as Annex 4 of the DR.

Overview of the OSAMAT project activities was also given in the year 2011 at "20th International Symposium on Mine Planning and Equipment Selection" Almaty, Kazakhstan 12 of October 2011.

In the same year (meeting on 28 of October 2011) the overview of OSAMAT project activities was given to the collegium of scientists from Tallinn University of Technology, Estonia for further collaboration.

Conference papers and posters submitted for Wascon Conference in Sweden 2012.

There were two oral presentation by Marjo Ronkainen and Arina Koroljova on Wascon conference 2012 (Annex 6 of the DR) A scientific article “OSAMAT - Utilisation of oil shale ashes in road Construction” was issued in Conference Proceedings (Annex 5 of the DR).

Ronkainen, M.; Koroljova, A.; Pototski, A.; Puhkim, H.; Lahtinen, P.; Kiviniemi, O. (2012). OSAMAT - Utilisation of oil shale ashes in road construction. In: WASCON 2012. Towards effective, durable and sustainable production and use of alternative materials in construction. 30 May–1 June 2012. Gothenburg, Sweden: (Toim.) Arm, M.; Vandecasteele, C.; Heynen, J.; Suer, P.; Lind, B.. The Swedish Geotechnical Institute, 2012, 1 - 10.

Beides Wascon conference the OSAMAT acitivities were presented on Nordic Geotechnical Meeting in Copenhagen, held on 9-12.05.2012**.** The result received so far were analysed in the scientific article "Utilisation of oil shale ashes in road construction” published in Conference proceedings (Annex 7 of the DR).

Ronkainen, M.; Lahtinen, P.; Kiviniemi, O. ; Susanna, O.; Puhkim, H.; Koroljova, A.; Pototski, A. (2012). "Utilisation of oil shale ashes in road construction". In: Dansk Geoteknisk Forening, DGF Bulletin 27 / Nordic Geotechnical Meeting, NGM 2012, 16, 9-12 May, 2012. Article in Conference

Proceedings, vol. 2: NGM 2012 - 16th Nordic Geotechnical Meeting. Dansk Geoteknisk Forening, DGF Bulletin 27 , 2012, (2), 811 - 820.

We also took part in the “Ash “Ash utilisation 2012” conference held in Stockholm, Sweden on 24-27 of January 2012 with the poster “Oil shale fly ash use opportunities” (Annex 2 of the DR).
Results (laboratory) of stabilisation of peat were presented (Annex 3 of the DR) at „Winter Academy 2012“organised by Tallinn University of Technology, Estonia on 12 of March 2012 and in 12th International Symposium "Topical Problems in the Field of Electrical and Power Engineering", Doctoral Scholl of Energy and Geotechnology, Kuressaare, Estonia, 11-16.06.2012 (173 - 175). Tallinn: Elektriajam. The results of OSAMAT researches were issued in a scientific article “Use of Oil Shale Fly Ash as a Binder Material in Stabilization of Soft Soils” (Annex 8 of the DR).

Koroljova, A.; Pototski, A. (2012). Use of Oil Shale Fly Ash as a Binder Material in Stabilization of Soft Soils. Lahtmets, R. (Toim.). 12th International Symposium "Topical Problems in the Field of Electrical and Power Engineering", Doctoral Scholl of Energy and Geotechnology, Kuressaare, Estonia, 11-16.06.2012 (173 - 175). Tallinn: Elektriajam.

Conference papers for International Baltic Road Conference in Lithuania 2013.

A scientific article “OSAMAT – utilisation of oil shale ash in road construction” were published (Annex 11 of the DR) and presented orally (presentation in Annex 12 of the DR) by Marjo Ronkainen (Ramboll Finland) in the XXVIII International Baltic Road Conference, Vilnius, Lithuania, 26.-28. August 2013.

Marjo Ronkainen, Aleksander Pototski, Hendrik Puhkim, Pentti Lahtinen, Tarja Niemelin. “OSAMAT – utilisation of oil shale ash in road construction” , The XXVIII International Baltic Road Conference, Vilnius, Lithuania, 26.-28. August 2013. Article in Conference Proceedings.

Conference papers and posters submitted for Oil Shale symposium in Estonia 2013.

The first OSAMAT project field test results were presented by Arina Koroljova at Oil shale Symposium 2013 held in Tallinn in oral presentation “Oil shale ash use in road construction: field application analysis within OSAMAT project”(slides are attached as Annex 10 of the DR). The abstract “Oil shale ash use in road construction: field application analysis within OSAMAT project” was issued in Conference Proceedings (Annex 10 of the DR).

Local events at piloting site.

Two public events were arranged along with the progress of pilot sites construction works to present OSAMAT pilot activities.
The first event was organised at Simuna-Vaiatu pilot site on 6 of August 2013. The representatives of Road Administration, Estonian Asphalt Pavement Association and different construction and consulting companies took part in the event. Three presentations at the beginning of the day gave the information to the event participants about OSAMAT project goal and activities, about quality control measurements and follow-up activities at the pilot sites and about mass-stabilisation technology (EE presentation in Annex 13 of the DR). After the presentations part the participants went to Simuna-Vaiatu pilot site to see the work going on at the site. It was a good chance to see and to ask how the mass-stabilisation technology was applied.

The second event went at the Balti power plant on 4 of September 2013. In the frames of "Eesti Energia Environmental day" the presentation "Oil shale ash use in road construction" with video material about mass-stabilisation works at Simuna-Vaiatu pilot site were showed. To the event the booklet about OSAMAT project and ashes used at the pilot sites was issued at three languages (Annexes 15-1, 15-2, and 15-3 of the DR). There was also demonstration of ashes organised at the event: the glass boxes was filled with the ashes and provided the information about the ashes, so that everybody could "touch" the material. The event including OSAMAT project activities, goals and importance was discussed widely in Estonian newspapers and radio (media list in Annex 16 of the DR).

DVD presentation about the project, its methods and results.

Filming of Narva-Mustajõe stabilisation works was carried out in autumn 2011. Filming at Simuna-Vaiatu pilot site was done in August 2013.
One part of the video material (mass stabilisation works) was prepared separately for the public event held on 4 of September 2013 (shorter version ~4 min). The movie shows the way how mass-stabilisation of peat is done at Simuna-Vaiatu pilot site. The movie is accompanied by the voice that explains the nuances of mass-stabilisation technology, quality control measures at the site and gives a short overview about the project. This video version was translated additionally to Estonian and Russian languages. The video is available at the project website.
During the period (15.09.2013-15.09.2014) the final version of the OSAMAT video have been created (longer version ~8 min). The final version gives the general information about the project and piloting idea, inform about the environmental problems connected to the oil shale ash and the possibility of using it in environmentally sound way. It includes also the short video fragments of Narva-Mustajõe and Simuna-Vaiatu pilot site construction and describes the way quality control and follow-up activities have been done. The video is available on two languages: English and Estonian and could be seen on the project website.
The film was demonstrated at different conferences. The DVD with videos is attached to the DR.

Conference papers and posters submitted for Oil Shale symposium in Estonia 2014.

The event did not take place. Instead OSAMAT was presented at other conferences.
Dissemination actions during the period September 2013-2014 included:

- OSAMAT film (mass stabilisation part) demonstration and OSAMAT booklet dissemination at the XX Jubilee International conference "Ashes from the Power Plants", 23-25 of November 2013, Warsaw, Poland.
- OSAMAT film (mass stabilisation part) demonstration and OSAMAT booklet dissemination at the South Baltic Conference on Dredge Materials in Dike Construction, 10-11 of April 2014, Rostock, Germany.
- OSAMAT film (mass stabilisation part) demonstration and OSAMAT booklet dissemination at the International Conference Ash Trade Europe 2014, 22-23 of May 2014, Dusseldorf, Germany.
- OSAMAT booklet dissemination at the LIFE Green Week 2014, 3-5 of June 2014, Brussels, Belgium.
- Oral presentation "OSA use in road construction" (Annex 17) and OSAMAT film demonstration at LIFE project ABSOILS conference, 11-12 September 2014, Helsinki, Finland.

Conference papers and posters submitted for Oil Shale symposium in Estonia 2015.

The event did not take place. Instead OSAMAT was presented at International Conference Ash Trade Europe 2015, 22-23 of April 2015, Frankfurt, Germany. Arina Koroljova made an oral presentation “OSA use in road construction” and demonstrated OSAMAT film (final version).

Picture 4. Presentation of OSAMAT project at the International Conference Ash Trade Europe 2015, 22-23 of April 2015, Frankfurt, Germany.

Press release about the Conference and International Workshop.

The International OSAMAT Conference 2016 and Workshop were organised on 2 and 3 of June 2016 (Conference on 2 of June and Workshop on 3 of June). Around 200 invitations were send personally to people from different target groups: politicians, scientists, contractors, country authorities (Estonian Road Administration, Ministry of Environment, Ministry of Economic Affairs and Communication), partners.
The press release about coming event was posted all together to 6 different media channels (the list in Annex 21, 21-1 of the DR) including LIFE program website.

International Conference and International Workshop

OSAMAT International Conference and Workshop were arranged on 2 and 3 of June 2016. The Conference was held in Tallinn in KUMU museum.
The objectives of the events were to deliver the OSAMAT project results and in particularly:

- to present the oil shale ash in a new perspective: as material for road construction (based on the project results),

- to provide technical information about road construction with OSA on a example of the pilot sites construction (Narva-Mustajõe and Simuna-Vaiatu pilot sites), quality control and monitoring,
- to present pilot sites environmental monitoring results and discuss on environmental issues,
- to open discussion about OSA further standardisation and conformation as a product
- to foster international networking and present experiences from Finland, Germany and Greek.

Picture 5. OSAMAT International Conference 2016 in Tallinn.

The first day of the conference was targeted to the wide auditorium: politician, transport authorities, road managers, contactors and scientists. For better information delivery the conference was conducted in such a way that firstly the general information about the OSAMAT project and project activities and results were presented. Then the floor was given to Estonian Road Administration and Ministry of Environment to get an assessment of the project actions and support in further steps to legalise OSA use in road construction. Finally the experience of Finish, Germany and Greek experts in utilisation of by-products in road construction were presented and discussed. The program is attached as Annex 22 of the DR.

The conference ended with the panel discussion. It was emphasized the value of the experience and data got during the OSAMAT project, as the need for “carbon free” materials is growing with the growing demand of binder material in general. The expert from Finland brought an example of Helsinki city: every year million tons of sub-soil is generated. Instead of landfilling it might be stabilised with environmentally friendly materials as OSA and give environmental and economic savings for all the parties.

All together 104 persons took part in the conference. The conference ended with a common dinner with potential partners (transport authorities, road managers, contractors).

The aim of the second day of the conference was to foster the communication between interested parties: Eesti Energia as a producer of oil shale ash and authorities, contractors and scientists as a consumers of the material. The program included the visiting of the pilot site and discussions at the place and a Workshop where the practical issues as OSA production volumes, storage and loading capacities, transportation, legal status of OSA and new developments were discussed. Additionally LIFE program opportunities were presented by the representative of Ministry of Environment.

As an output of the Workshop (and conference in general) EE:

- continues collaboration with the biggest construction company who has an experience in mass-stabilisation in other countries and who gives us a great help in promoting OSA and mass-stabilisation in Estonia.
- continues collaboration with Finnish company who research the binder production in an alternative way (ash goes to combustion together with the fuel). The OSA is going to be research (samples will be sent in September 2016).
- takes part in international project RECIPE (HORIZON 2020 program), where
    - the new approach in transportation of OSA will be tested,
    - OSA will be tested in stabilisation of port contaminated sediments
    - OSA will be tested for conformation to European standards

The conference presentations and pictures could be found at OSAMAT project website (www.osamat.ee, documents folder, “aasta 2016 dokumendid” and Gallery).

Presentation of the OSAMAT project on the LIFE program Information Day, Tallinn 2016.

On 16 of June 2016 an oral presentation about OSAMAT project management was made by Arina Koroljova at LIFE program Information Day (slides are attached as Annex 25 of the DR). Arina presented the project activities and delivered the LIFE project management details as project planning, partnership agreements conclusion, reports compilation, project amendments and communication with Commission.

Completed slide presentations in Estonian and in English for After-LIFE presentations (based on presentations for workshop and conferences).

Slides presentations give the overview of the project, results and After-LIFE activities. The slides in two languages are attached as Annex 27-1 and Annex 27-2 of the DR.

Guidelines for European Practice

The Guidelines are based on the project results and intended to serve as a practical instructions for the contractors about OSA use in some particular project.
The Guidelines is a basic document for the compilation legislative acts at the country level regarding OSA use in construction. The documents is attached as Annex 28 of the DR.

Layman’s report

The Layman’s Report was prepared, designed and printed in 2016. The report provides a general information about the project, background and importance of project initiation, aims and objective, brief overview of the pilot activities, methods and results, environmental benefits and dissemination activities.
Layman´s report is made on two languages and is available on the project website.
The Layman’s report is attached as Annex 26-1 and 26-2.

Dissemination report

The project information is planned to be disseminated also after the OSAMAT project completion. After –LIFE Commutation Plan (Annex 29 of the DR) envisages the

dissemination activities regarding project results presentation at least for two year to promote OSA use in road construction. The dissemination and marketing are going to be part of the normal strategic and marketing business operations in the future.
The overview of the project dissemination action is given in Table 2 of the DR.
All together during the project period the information about OSAMAT project and results was disseminated at 17 different conferences in Estonia, Kazakhstan, Jordan, Sweden, Denmark, Belgium, Germany, Poland, Finland, and Lithuania.
The OSAMAT booklet was disseminated at different conferences and meetings in total amount of 365 items.
The OSAMAT is presented in 2 video films and After-LIFE slides.
The project results are presented in different reports including Guidelines for European Practice that gives a practical instruction to the constructors about OSA use in road construction.

5.3 Evaluation of Project Implementation

The overall project objectives were to prove OSA suitability as a construction material technically, environmentally and economically to be used in road construction and dissemination the know-how of the methods applied.

The methodology for reaching the goals included several steps, starting from preparation actions followed by material tests, recipes compilation, piloting, results verification, analysis and know-how dissemination. All the actions were divided between the 7 project actions: 1 Preparations; 2 Materials; 3 Application; 4 Piloting; 5 Verification; 6 Dissemination and 7 Management. Every action has their own goals to fulfil the objectives of the project.

The chosen methodology was correct and let us step by step to come closer to the main objectives. The first actions (from 1 to 5) were linked in such a way that the previous action results served as data for the following action. During preparation phase (1 Preparations) the pilot sites locations and necessary permits got to let the start of materials testing. The researches of the materials and mixtures quality, properties and based on that recipes compilation during Material action (2 Materials), gave the input data for the pilot road sections design and preparations for the construction in Application action (3 Application). The previous actions information let the pilot construction start (4 Piloting). During and after piloting the quality of the pilot constructions were measured and assessed by the monitoring programs envisaged in Verification action (5 Verification). Actions 6 Dissemination and 7 Management went along with the project actions implementation. To provide the cost-efficiency of the actions the price quotation or tenders were arranged according to the rules of LIFE program and partners organisations.

Objective: to provide technically, environmentally and economically feasible civil-engineering aggregates and additives based on OSA for appropriate applications like for the construction of base courses of roads and fields.

Foreseen in the project

1) Pilot site locations choice
2) EIA screening report
3) Environmental permit
4) Pilot sites background information gathering
5) Materials report: materials sampling, recipes compilation and mixtures testing to control mixture durability and substances leaching to start pilot construction
6) Three application to be tested
    1. layer stabilisation of existing road base courses with binders based on OSA
    2. mass stabilisation of peat with binders based on OSA
    3. structural road base course by mixing different types of fractions of oil-shale mining waste with OSA
7) Pilot sites design
8) Written instructions for the implementation of each pilot application (report)
9) Technical quality control actions during piloting at the pilot sites (report)

10) Narva –Mustjõe pilot sit construction and N-M Pilot Report production

11) Simuna-Vaiatu pilot site construction and S-V Pilot Report production

12) Environmental monitoring (before, during and after construction) at N-M and S-V pilot sites (report)

13) Technical monitoring (follow-up after construction) at N-M and S-V pilot sites (report)

14) LCA/LCC analysis conduction (report)

15) Verification Report including analysis of technical and environmental monitoring results and LCA/LCC results

16) Guidelines for European Practice that give practical instruction how to use OSA in road construction (tested applications)

Achieved

All the foreseen actions have been and reports submitted. The evaluation of the actions implementation is done below.

Evaluation

1) Pilot site locations choice

The initial idea was to conduct demonstrations at one pilot site. However, suitable for mass-stabilisation technology place (soft deep soils) was found quite far from the OSA production place. From the cost-efficiency point of view it was decided to conduct mass-stabilisation applications at that founded place, but layer stabilisation applications conduct closer to the OSA production Plant to save on the materials transportation costs. Mass-stabilisation was done at Simuna-Vaiatu place and layer stabilisation at Narva-Mustajõe place.

2) EIA screening report

According to the report, there were no reasons to initiate a full EIA. The proposal was done to the decision maker (Estonian Road Administration). The full EIA wasn't initiated.

3) Environmental permit

According to the letter of Ministry of the Environment there was a right not to get environmental permission for this particular project.

4) Pilot sites background information gathering

Two different researches were done: geological – to provide data for pilot sites design and environmental – to provide background data for further possible environmental impacts assessment.

5) Materials report: materials sampling, recipes compilation and mixtures testing to control mixture durability and substances leaching characteristics to start pilot construction.

To provide technically durable construction mixtures all the materials quality and properties were researched in the laboratory first: 4 types of different OSA and soils from the pilot sites. Then several mixtures with different OSA/soil/cement/mining waste ratio were done and tested to suit the requirements for road construction mixture. Finally 3 recipes were proposed to be tested in N-M pilot site and 4 recipes in S-V pilot site. Because of technical problems (Cycl ash wasn't possible to pump through the machinery tubes), the recipes for testing in S-V pilot site were changed. 3 additional recipes were added and all together 5 recipes were tested in S-V.

Laboratory leaching tests controlled the heavy metals and some anions (chlorides, sulphates) concentrations in leachates of construction mixture made with OSA. The results were compared with Finnish regulation for road construction (as there is no such a regulation in Estonia). The results showed that there are no exceeding of limit values of the regulation for design road mixtures.

The details of materials research see in chapter 5.1.2 Action 2: Materials or in Materials Report.

6) Three application to be tested
    1 layer stabilisation of existing road base courses with binders based on OSA
    2 mass stabilisation of peat with binders based on OSA
    3 structural road base course by mixing different types of fractions of oil-shale mining waste with OSA

OSA was tested in two different construction technologies at the pilot sites: in layer stabilisation and in mass-stabilisation. 1 and 3 application referred both to layer stabilisation. During geological investigation it was detected that exiting road old materials amount would not be enough to make the 1 first application fully, so it was decided to combine 1 and 3 application to one. As a result the layer stabilisation in N-M section was done mixing existing road old materials (1 application) and mining waste (3 application) with OSA (and cement in some recipes). So, actually all 3 applications were tested as planned.

7) Pilot sites design

The pilot section designs were ready in August 2011 for the construction of N-M pilot and in July 2012 for the construction of S-V pilot.

8) Written instructions for the implementation of each pilot application (report).

Separate piloting instructions (reports) were issued in July 2011 for construction of N-M pilot site and in July 2012 for S-V pilot site construction.

9) Technical quality control actions during piloting at the pilot sites (report).

Quality control instructions for construction on N-M pilot site was issued in July 2011. Quality control instructions for S-V pilot site construction was issued in July 2012.

10) Narva –Mustjõe pilot sit construction and N-M Pilot Report production

The pilot construction was done according to written instructions, quality control instructions and country legislation. The pilot report describes the construction method applied in the pilot sites construction with OSA, the everyday construction details and quality control actions. The final Pilot Report was presented in January 2014.

11) Simuna-Vaiatu pilot site construction and S-V Pilot Report production.

The pilot construction was done according to written instructions, quality control instructions and country legislation. The pilot report describes the construction method applied in the pilot site construction with OSA, the everyday construction details and quality control actions. The final Pilot Report was presented in April 2015.

12) Environmental monitoring (before, during and after construction) at N-M and S-V

pilot sites (report)

The environmental monitoring included sampling of soil and surface water (from the ditches next to the pilot sections) and flora observation. It was initially planned to take samples of ground water, but after the meeting with experts it was clear that such kind of assessment was not reasonable in this particular project for several reasons: it was expensive (and not foreseen in the budget), because we had to drill a separate holes for the project, secondly we had to have a permission for drilling (takes around a year and also costs) and thirdly the results of the measurement couldn’t be interpreted for the particular pilot sites, because it was impossible to define exactly what coursed the presence of this or that substances in the ground water (N-M is very close to oil shale landfill, S-V is located in the farm and agricultural area, so we could have the result of the contaminations from the landfill or farms).

The background data (water and soil samples from the pilot sites) for environmental impacts analysis were collected before the construction to compare with the measurements results after the piloting.

From the results of the environmental monitoring we can see the fluctuation in concentrations of some metals and anions in the samples of surface water and soils during several years of monitoring (at both pilot sites), but none of the concentrations exceeded the target values of the environmental legislation. Special attention should be paid to the OSA from pulverized firing regarding sulphates, as this anions concentration might exceed some EU country legislation (for example if soils or waters are sensible to sulphates).

There was no influence on the flora around the pilot site. Instead, it was a bloom of vegetation. It is might be explained by the influence of OSA, as it contains valuable nutrients for the plants. OSA is used in Estonia officially as a fertiliser.

Environmental Monitoring Report was submitted in December 2015.

In general it can be concluded that there are no impacts to the environment coming from OSA use in road construction and it proves itself as environmentally safe aggregate.

13) Technical monitoring (follow-up after construction) at N-M and S-V pilot sites (report).

The technical monitoring results showed that all types of OSA can be used in tested applications for road construction.

N-M pilot site technical monitoring results in details as follows:

- The load bearing capacity of the pilot section was twice or more higher (400-600 MPa) comparing to design value (260 MPa) in case of all 3 types of OSA (Cycl, EF PF, EF CFB) and tested recipes.
- Section constructed with Cycl ash has lower bearing capacity comparing to the section constructed with EF PF and EF CFB.
- Compression strength of the drilled samples were high (7-16 MPa). Such a compression strength is considered as too high, that might provoke cracks. So, in the future it is recommended to try different recipe (less cement or less ash etc.)
- During the first year after construction the cracks emerged on the asphalt of the constructed sections. However, after conducted defect analysis (that was not foreseen in the project) it was concluded, that the cracks most likely were caused by reflection from the old base course onto which the new layer was constructed.

There were no cracks at all in the section constructed onto the new base course.

S-V pilot site technical monitoring results in details as follows:

- Between 3 types of OSA tested in mass-stabilisation of the peat in S-V pilot section, Cycl ash was the type that didn't suit the requirements of the machinery (Cycle ash is coarser that cement and needs probably thicker tubes and stronger pumps to flow through the tubes), so only one section (from 5) was done with Cycl ash. However, technical parameters measurements showed that it is technically suitable for mass-stabilisation.
- Vane shear strength measured during quality assessment was higher (65-120 kPa) than the target (60 kPa) in case of all the ashes.
- Compression strength of the drilled samples was similar for the all types of the ashes (around 0,4 MPa, that is ok for such type of the structure).
- The pavement constructed onto the stabilised structure was done with only CFB ash without cement addition. For comparison, one part of the pavement was done by traditional method with cement. The section done with CFB ash gave the best results of load bearing capacity (300MPa) that was twice higher than designed(170 MPa).

The technical monitoring report was submitted in December 2015.

It could be concluded that pilot testing of OSA was successful and OSA proves itself as technically suitable aggregate.

14) LCA/LCC analysis conduction (report).

The aim of the LCA study was to determine and compare the potential environmental impacts of 4 different alternatives (with OSA and without) of constructing a specific road structure. Primary attention in OSAMAT was paid to the depletion of natural resources and the global warming potential. According to the LCA made for the Narva-Mustajõe and Simuna-Vaiatu pilots, the environmental load can be decreased by using oil shale ash as a construction material for road construction.

The purpose of the LCC was to compare the relevant investment costs of the alternatives and find out if OSA use was cost-effective. The LCC results showed that the discounted annual cost per 1 kilometer of road was lower for structures with alternative construction materials like OSA.

The report was submitted in April 2015. It can be concluded that OSA is cost-effective alternative to traditional construction materials like cement.

15) Verification Report including analysis of technical and environmental monitoring results and LCA/LCC results

Verification Report is a document where the main conclusion regarding project goals fulfilment are done. Based on the 5 year research work done it can be concluded that OSA is technically, environmentally and economically feasible civil-engineering aggregate and additive that can be used in road construction.

16) Guidelines for European Practice that give practical instruction how to use OSA in road construction (tested applications).

The Guidelines give practical instructions to the constructor how to use OSA in road construction based on experience got during piloting action at N-M and S-V pilot sites.

The report is available at the project webpage and will be disseminated and used in further steps for OSA usage promotion in road construction.

Objective: to disseminate know-how of the methods and the results demonstrated in the project to the target groups like municipalities, road administrations, contractors, politicians, legislative authorities, scientists and other professionals and specialists in Europe as well as in Estonia.

Foreseen in the project and achieved

The quantitative indicator of the actions foreseen and results achieved is given in the table below. It was an opportunity to dissemination information about the project more that planned through media and speeches at the different conferences in Estonia as well as in Europe.

Grant Agreement LIFE09 ENV/EE/000227 OSAMAT deliverables	**Planned**	**OSAMAT project**
Outputs of the dissemination action	**amount, it**	**amount, it**
Press releases	4	38
Articles in a professional and national magazines	4	4
Conference posters and papers	4	17
Slides-presentations After-LIFE	2	2
After-LIFE Communication Plan	1	1
Layman's report	1	1
Dissemination report	1	1
Guidelines for European Practice	1	1
DVD presentation about the project, its methods and results	1	2
International Conference and Workshop	1	1
Webpage	1	1
Notice boards	2	2
Total	**23**	**71**

Evaluation

We can state with certainty that the project improved public awareness about OSA and its use significantly and let to make very important decisions regarding OSA use in road construction on the local authorities' level.

In the beginning of the project, going to disseminate the information about OSA and OSAMAT project it was noticed that European public as a rule didn't know or heard anything about OSA, let alone the use of OSA. Estonian public had a stable perception that OSA is a hazardous waste and its use had a severe impact on nature and health. It became clear that we faced with serious obstacles in OSA promotion. So, OSAMAT project and its dissemination actions was a real tool and chance to help to introduce OSA to the society as a valuable, environmentally friendly material and brake the myth about its hazardousness.

The dissemination actions went along with demonstration activities from the start of the project in 2010 until the end of the project in 2016, including after-LIFE period.

OSAMAT project dissemination concept was based on two strategies: creation the project identity and stimulation of the awareness about the project and dissemination of the project activities and results.

In the end of the project it could be evaluated that the chosen strategy and tools were correct and successful. The dissemination actions in Europe helped to introduce OSA and its use as construction material in road construction. We started collaboration with European Coal Association (ECOBA) and the biggest cement producers in Europe. OSA was tested for suitability in road construction in Lithuania and for mass-stabilisation of the contaminated sediments in Finland. Due to the participation in different conferences in Europe we have reached the level after 5 years of dissemination work when European public didn't ask about OSA anymore, but started to focus on OSA implementation and use. The very possible projects in Europe are mass-stabilisation with OSA in Finland.

After getting first OSAMAT project piloting results we started actively to disseminate the information not only in Europe but also in Estonia. Dissemination of technical and environmental monitoring results helped us to convince public and authorities that OSA is valuable construction material and doesn't have impacts on nature. As the result the very important decisions were done on the country level 1) OSA was standardised as product for using in cement, concrete and gas concrete production (OSAMAT technical and environmental monitoring results played an important role in decision making) 2) OSA will be tested in 2017 for using in mass-stabilisation of soils in Rail Baltic railway construction (the biggest construction in Estonia in coming years), 3) Estonian Road Administration has been testing OSA to use in construction of Tallinn –Tartu highway, 4) EE considers the possibility of OSA use in mass-stabilisation of soil in construction of Tootsi wind park.

Due to OSAMAT project dissemination actions we have done a big step further in promotion of OSA use. It has also helped to change the perception to OSA as to waste and made such important decisions at the country level. We also continue to collaborate with the partners in Europe and expect OSA use also in European countries.

Objective: to give proof of the environmental benefits of civil-engineering materials and applications based on OSA with help of environmental life-cycle assessments, for example: reduced need for conventional civil engineering based on high volumes of natural non-renewable aggregates will bring about much less atmospheric CO2 releases and other environmental harms.

Foreseen in the project

Conduct LCA studies.

The aim of the LCA study was to determine and compare the potential environmental impacts of 4 different alternatives (with OSA and without) of constructing a specific road structure.

Achieved

According to the LCA made for the Narva-Mustajõe and Simuna-Vaiatu pilots, the environmental load can be decreased by using oil shale ash as a construction material for road construction.

Evaluation

The LCA/LCC report introduces the results of the verification action carried out in the framework of the OSAMAT project. The LCA was carried out according to the principles of available standard procedures EN ISO 14040:2006. The LCA and LCC studies were carried out as simplified versions or as Streamlined LCA and LCC, which is an acceptable procedure

when there is a shortage of time, money and resources for completing such studies. Primary attention in LCA was paid to the depletion of natural resources and the global warming potential. The consumption of energy in the studied processes was the major reason for the global warming potential and the choice of materials for the depletion of natural resources. According to the results of OSAMAT LCA, the structure alternatives implemented in the OSAMAT pilots (Narva-Mustajõe and Simuna-Vaiatu) may cause less environmental harm than if stabilization is carried out using only cement or if the structure is built exclusively with natural aggregates. However, it has to be pointed out that the LCA was performed as a Streamlined LCA which is not a complete one. Although the data used for the calculations originates from reliable sources, there are still uncertainties as the results and the conclusions are based only on the studied environmental impacts, depletion of natural resources and global warming potential. Based on the data available LCA/LCC report demonstrates that OSA and the implemented methods can be environmentally and financially feasible for civil engineering purposes. Utilization of OSA in road construction proves to be feasible technically and environmentally.

Objective: to give proof of the economic benefits European societies will achieve when approving the use of OSA as additive material in appropriate stabilised civil engineering applications instead of using conventional methods with high aggregate volumes.

Foreseen in the project
Conduct LCC studies. The purpose of the LCC was to compare the relevant investment costs of the alternatives and find out if OSA use was cost-effective.
Achieved
The LCC results showed that the discounted annual cost per 1 kilometre of road was lower for structures with alternative construction materials like OSA.
Evaluation
The LCA/LCC report introduces the results of the verification action carried out in the framework of the OSAMAT project. The model for the LCC was the available standard procedure described in EN ISO-15686-5:2008. The LCA and LCC studies were carried out as simplified versions or as Streamlined LCA and LCC, which is an acceptable procedure when there is a shortage of time, money and resources for completing such studies. The purpose of the LCC was to compare the relevant investment costs of the alternatives and to show that the use of oil shale ash can be cost-effective. The LCC results for Narva-Mustajõe showed that the discounted annual cost per 1 kilometre of road (9.5 m wide) was lower for structures with alternative construction materials like OSA. According to the Simuna-Vaiatu LCC results, it can be concluded that the life cycle costing with Alt1 (mass stabilisation with OSA and cement + layer stabilisation with OSA) and Alt2 (mass stabilisation with OSA and cement + complex stabilisation) was lower comparing to the alternatives where natural aggregates were used. Based on the data available LCA/LCC report demonstrates that OSA and the implemented methods can be environmentally and financially feasible for civil engineering purposes.

Immediately visible results

OSAMAT project aimed to introduce oil shale ash as technically, environmentally and economically feasible construction material to EU public and demonstrate the methods of OSA use in road construction.

The visible results of introduction and demonstration are:

- Construction mixtures recipes with OSA to use OSA in road layer construction (layer stabilisation) and in road embankment construction (mass-stabilisation).
- Guidelines for European Practice – instruction for the constructor how to use OSA in road construction (tested applications).
- Laboratory and field test results of environmental monitoring have proved OSA safety to environment and human health (in tested applications). Documentation (results, reports) is a valuable input data for further OSA projects and standardisation.
- Laboratory and field test results of technical monitoring have proved OSA suitability and availability of cement substitution as binder material for road construction. Documentation (results, reports) is a valuable input data for further OSA projects and standardisation.
- OSA was standardised as a product for cement, concrete and gasconcrete production in Estonia standard EVS 927:2015 "Burnt shale for building materials. Specification, performance and conformity". Available at www.evs.ee.
- Due to dissemination actions the OSA was introduced as binder material for road construction in Europe. As a result important collaboration with Europe ECOBA and big cement producers has been started. OSA has been testing in Lithuania, Finland and Sweden to use in mass-stabilisation.
- Due to dissemination actions the perception in Estonia to OSA has been changed. OSA is considered to be used in 3 project in Estonia (Rail Baltic railway construction, Tallinn-Tartu highway construction and Tootsi wind park).
- LCC studies and later calculation (for Estonian projects – see the previous clause) seems to show that OSA use can bring economic benefits.

Results that can be assessed in the future

The OSAMAT project was a very important starting point in promotion of OSA as a construction material. Due to the project we've got the background information about OSA properties and possibilities of use. This information opens a door to a very big niche for a by-product like OSA for use. The OSAMAT project data and outcomes will be used to get the following results in the future:

- Standardisation/certification of OSA as a hydraulic road binder. We are going to conduct testing of OSA to comply with EU standard EN 13282-2:2015 or create a new Estonian standard.
- Available OSA amount increase for the client. Due to OSAMAT project OSA is considered to be used in several Estonian and European projects. To provide the amount of OSA needed for the projects, the additional combustion block producing OSA will be connected with silo in 2017 to increase the loading capacity and guarantee (by appropriate storage) the quality of OSA to clients.

- Initiation of laboratory (and probably pilot later) testing of OSA for use in Rail Baltic railway, Tallinn –Tartu highway and Tootsi wind park construction.
- OSA use in mass-stabilisation in EU countries (Finland, Sweden, Lithuania).
- Participation in other similar to OSAMAT projects (EE is applying as a partner of RECIPE project to get financing from HOIZON 2020 program to test OSA in combination with different by-products (gypsum, crushed bricks etc)).

Projects amendments evaluation.

There have been 3 amendments of the Grant Agreement during the project life.

Amendment nr 1 signed on 12 of September 2012.	
Amendments	**Influence on project results**
Eesti Energia Narva Elektrijaamad AS addition as a new OSAMAT project associated beneficiary	Due to structural changes in EE the ash storing, selling and ash R&D actions and corresponding costs went to EE NEJ. If this amendment had not been agreed, EE couldn't continue the participation in the project and we would never had the project results and important outcomes we got.
Mass-stabilisation equipment rent instead of purchasing	The decision didn't influence directly on the project results as there was no difference for construction works if you rent or purchase the equipment. But there was a risk for the partners due to the market situation (at that time) that the machinery wouldn't be in demand and covered by similar projects. That meant additional costs for the equipment outage. In case the amendment had not been agreed, there was a slight risks that some of the partners might change their mind and quit the project.
Changes in the provisional budget	Initially both pilot sections should be constructed in test section near the some traffic road. During the project implementation and different researches it came out that two different technologies couldn't be tested at one pilot sections. To fulfil technical and geological criteria and not compromise research targets it was decided to use two different locations and in real traffic roads. This created additional costs connected to transportation, materials and services. The foreseen budget costs should be reallocated between the categories to cover additional costs emerged. The amendment allowed to finish the pilot construction and cover the costs from the project budget. If

	the amendment had not been agreed the share of ineligible costs would be quite big and this could create a risk that some of the partner might quit the project. In this case most likely the project would stop and results never achieved.
<u>Amendment nr 2</u>	
Nordecon Infra AS changed the legal name to Nordecon AS.	The change of the legal name hadn't disturbed the achievement of the project results, but if the amendment hadn't been agreed then the partner would quit the project as its costs wouldn't be eligible. This meant the project prolongation for longer period to find a new partner or project finish. In both cases we haven't probably had project results in the year 2016.
<u>Amendment nr 3 signed on 4 of December 2013</u>	
The project prolongation	The postponement of the end day of the project was connected to CFB ash handling system construction. The construction with CFB ash was delayed twice because of technical reasons. It was very important to test CFB ash as in longer term perspective (over 10 years) it is the only type of OSA produced at the power plants (other old blocks will be closed). The technical monitoring showed that this type of ash gives the best strength results and is popular between the clients. By prolongation the end date the opportunity to CFB ash use (incl longer -term) was given. In case of amendment had not been agreed the project goals couldn't be fully achieved as the most perspective ash hadn't been tested.

Effectiveness of dissemination

The effectiveness of the dissemination is discussed in details in the chapter above (evaluation of the project implementation), but it should be underlined once again that due to OSAMAT project dissemination actions we have done a big step further in promotion of OSA use. It has also helped to change the perception to OSA as to waste and made important decisions at the country level. We also continue to collaborate with partners in Europe and expect OSA use also in European countries.

All together during the project period the information about OSAMAT project and results was disseminated at 17 different conferences in Estonia, Kazakhstan, Jordan, Sweden, Denmark, Belgium, Germany, Poland, Finland, and Lithuania.

The OSAMAT booklet was disseminated at different conferences and meetings in total amount of 365 items.

The OSAMAT is presented in 2 video films and After-LIFE slides.

The project results are presented in different reports including Guidelines for European Practice that gives a practical instruction to the constructors about OSA use in road construction.
Effective dissemination helped to change the perception of public to OSA as to waste and made important decisions at the country level. The visible results included:

- On authorities level:
    1. OSA standardization in Estonia (EVS 927:2015 "“Burnt shale for building materials. Specification, performance and conformity”. Available at www.evs.ee.
    2. Estonian Road Administration decided to design Tallinn-Tartu highway swamp area by mass-stabilization technology with OSA.
    3. OSA testing in Lithuania at Road Administration laboratory.
    4. OSA testing and results presentation to the local authorities in Finland and Sweden. There have been several meeting with Finnish and Swedish authorities to present OSA.
- Contractors, constructors, civil-engineering experts, consultants, industries:
    1. Start of collaboration with Estonia Rail Baltic OÜ (RB). Rail Baltic railway construction is one of the biggest construction in Baltic States in the nearest future. Together with RB the OSA testing with RB railway soils will be started in 2017.
    2. Start of collaboration with Ramboll Finland. OSA has been tested and considered as valuable construction material for stabilisation of contaminated sea sediments and soft clays.
    3. Start of collaboration with Cowi AB. OSA is been testing in stabilization of the contaminated sediments in Sweden.
    4. Start of collaboration with the companies (Renotech Oy, Fatec Oy) that researched the treatment of OSA to give the specific properties to the final material based on OSA.
    5. Start of collaboration with ECOBA and OSA (and brown coals ashes) promotion at European level.
    6. Start of collaboration with other companies with whom the potential of OSA is under discussion at the moment.
- Scientists and educational organizations:
    1. Continued the collaboration with Tallinn University of Technology, National Institute of Chemical Physics and Biophysics, Tartu University. As a result several scientific articles have been issued during the project time and some are planned to be written in the future based on project results.

5.4 Analysis of long-term benefits

5.4.1 Environmental benefits

There are several environmental benefits from the use of OSA both direct and indirect ones. Direct benefits are connected with the OSA transportation to the storage area and long term storage/landfilling. Mentioned process has been the subject of long research, optimization and development work. Due to the long term operation experience, closed and optimized hydro transportation loop, effective anti-dusting measures and extensive monitoring of the whole process, the overall environmental impact of the OSA transportation and storage activities has reduced to minimal level. Therefore, main direct environmental benefits of the use of OSA as raw material are mainly connected to the longer lifetime of existing safe storage area and reduced energy consumption that are difficult to express in direct numbers or values as the algorithm between volume of OSA used as raw material and gained environmental benefits is not simple.

More important are actually so called indirect benefits from the OSA use as raw materials, that reduces the air emissions and GHG emissions, improves the resource use efficiency and reduce need for primary new mineral resources.

Namely OSA have remarkable binding properties and can be used as cement replacement in certain applications. Mass stabilization and layer stabilization in the road construction are one of those possible usage areas where the binding material cement can be partly or fully replace. Therefore, every ton of OSA used in the large applications as replacement reduces at least 0.7 tons of GHG emissions, but also certain amount of other air pollutants (exact numbers are not possible to bring out here, as those depend on production technology of specific cement factory). As OSA is the one by-product of the energy production, the fossil fuel as energy source has already burnt and therefore the use of OSA as binding material gives both the reduction of emissions of GHG and reduced need for the fossil fuels to produce clinker. Due to the different properties of different OSA fractions, there are more reuse options from building materials industry to the agriculture. Mostly we see here the long term effects to the environment and not so much quick effects, although some of the benefits and effects can be seen rather directly.

The use of OSA as raw material will reduce the need of mineral raw materials extracted from the nature. Mainly this is applicable for the limestone, but also it saves raw materials that are needed for the clinker production. Processed and due to that neutral OSA can be used as filling materials and therefore it can also partly reduce gravel or sand use volumes. Exact volumes and quantitative wins cannot be generalized as every different solution gives a different size and type of benefit. OSAMAT project also targets not only the Estonian market, but also surrounding areas as long as the transportation length is still environmentally and also economically viable and sound.

Both 6^{th} and 7^{th} EU EAP mentioned reuse of the waste materials or by-products and improved resource efficiency as one of the main topics. It is defined in both EAP-s as gaining better efficiency of resource use paired with the reduced environmental impacts from the waste management. The same idea is at the moment in the EU level developed further on in the frames of Circular Economy Strategy. Although OSAMAT project was initiated much earlier than EU introduced its Circular Economy Strategy main principles and actions, are OSAMAT project goals and targets in line with EU strategic coals and targets.

5.4.2 Long-term benefits and sustainability

Every year around 6 mln tons of OSA is generated in Narva Power Plants during combustion of oil shale for energy production. Around 96% of OSA is landfilled at the moment. The OSAMAT project goal was to convert OSA into valuable construction material by project actions to reach environmental, economic and social benefits in Estonia and other Europe in short and longer term perspectives.
According to the project result the technically suitable ash types for road construction refer to the fly ash. They are Cycl, EF PF, EF CFB. The annual production, thus annual potential for usage of the mention types is altogether ~2 700 000 t.

OSA has similar properties to cement. The results of the project prove that cement can be substituted by OSA partly or fully. The technical suitability is very important as it directly influences on getting environmental benefits from OSA use in two directions: firstly, the use of OSA means lesser deposition on the landfill, thus improving ecological situation in the region. Secondly, OSA production doesn't produce airborne greenhouse emissions and other environmental impacts comparing to natural aggregates production (incl raw materials withdrawal, transportation). Consequently the more OSA is used the bigger environmental benefits are received.

Between two tested technologies the mass-stabilisation becomes more and more popular as it proposes cheaper solutions than other methods for stabilisation of soft soils. Moreover, mass-stabilisation is used not only in road construction but also for stabilisation of contaminated sediments, soils for park areas, abundant soils stabilisation for different purposes etc. So, the projects results can be used much wider than only in road construction. The project results show that mass-stabilisation projects require big amounts of binder (because of technology type), where OSA could be utilised.

<u>OSA use in stabilisation of sediments (incl contaminated sediments)</u>

According to the SMOCS project (Baltic Sea Region Program 2007-2013) survey "Sediments and Dredging in the Baltic Sea Region Ports" about 5-8 million m3 of contaminated sediments could be expected to be dredged the upcoming years (1-10 years) in 125 Baltic Sea Region ports. OSAMAT project technical results state that in average 180 kg of OSA is needed to stabiles 1 m3 of soft soil. The simple indication might be done: to stabilise 5 mln m3 of sediments 900 000 t of OSA is required. Mass-stabilisation of dredge sediments is considered as environmental friendly and quite cheap solution (comparing to landfilling). OSA use might bring additional environmental and economic benefits in such projects.

In parallel with OSAMAT project actions (and due to dissemination actions) we started collaboration with several partners from Finland and Sweden to research the potential of OSA in stabilisation of sea sediments. OSA was tested in the laboratory for suitability to stabilise sediments of different qualities and in all the cases it proved its technical and environmental suitability (leaching tests). Based on these results we continued collaboration with the partners and several projects (with OSA amounts given in the table 3) are under discussion:

Table 3. Prognosis of annual OSA demand in Finland and Sweden (mass-stabilisation of dredge sediments).

Country of sediments mass-stabilisation project	Amount of OSA required annually, t
Finland	30 000
Sweden	25 000

The projects in Finland and Sweden are the first steps in using OSA for stabilisation of sea sediments. They will serve as reference for similar projects that will help to present and promote OSA faster for other port projects (dredge materials utilisation) in Europe in longer – term perspective.

OSA use in stabilisation of soft soils.

OSAMAT project results gave an impulse for considering mass-stabilisation technology with OSA in construction of road embankments and utilisation of abundant soils for different purposes (parks, noise barriers etc.). In Estonia there are 3 potential road construction projects where OSA might be use. We discuss also OSA use in road construction in Lithuania and abundant soil stabilisation in Finland (around 4 mln m^3/year of abundant soils are generated only in Helsinki region during construction works). The demand for OSA in those projects is presented in the table 4 below:

Table 4. Prognosis of OSA demand in Europe for road construction and soft soils stabilisation.

Country of sediments mass-stabilisation project	Amount of OSA required annually, t
Finland Helsinki region (4 mln m^3/y)	720 000
Lithuania	100 000
	Amount of OSA 7 year perspective
Estonia	300 000

Calculating the total amount of OSA required for the projects that are under discussions with the partners and to be implemented in the nearest 1-10 year, the required amount will be around 900 000 t annually. Only several projects opportunities show us how big the potential of OSA utilisation in mass-stabilisation projects is.

The utilisation of OSA brings environmental, economic and social benefits for the local and EU public. OSA utilisation as a binder in road construction means reduction of CO_2 emissions and in depletion of natural resources. Comparing to OSA the production of 1 t of cement produces around 0,7 t of CO_2. Reaching 900 000 t of OSA use annually around 630 000 t/year of CO_2 emissions could be eliminated.
Production of cement needs also different types of materials from natural non-renewable resources. Using OSA instead of cement the environmental impacts caused by raw materials withdrawal, transportation will be also eliminated.

As it was already mentioned we have had strong collaboration with several partners who are interested to use OSA as a binder in stabilisation projects. Besides technical suitability the cost-effectiveness of the new material is not less important to promote OSA use further. OSAMAT project LCC analysis has showed that the construction with OSA could be cheaper depending of the project. The crucial role in the calculations of the costs referring to the OSA use in stabilisation projects plays the distance between the Narva Power Plant and the place of destination. To have an indication of OSA transportation costs for the potential projects (mentioned above) EE started to cooperate with logistical companies to find the way of OSA transportation and costs by different means of transport including sea transportation. It came out that OSA can be proposed to the clients (actually almost 100% is transportation costs) 30-50% cheaper depending on the project. This proves again that OSA is a cost-effective material and its use brings economic benefits promoting the stabilisation technologies on the market as reliable and cost-effective. The cost-effective project has more chances to be implemented.

This has a positive social impact as it influences directly to the employment and contribute to the involvement of big and also small and medium enterprises who serves the project.

Due to OSAMAT project the perception of local public to OSA is changing to the understanding that OSA is a valuable construction material. Three types of OSA have been standardised and one type (EF CFB) is going to be standardised in 2017. The acceptance of the material on the country level clearly indicates the success of OSAMAT project. With authorities support it will be easier to increase also public acceptance of OSA as valuable material and not waste.

EE is going to continue researches and demonstrations of OSA use in mass-stabilisation technology in other similar to OSAMAT projects. EE is a partner of HORIZON 2020 program project RECIPE. The project is under evaluation at the moment. In the frames of the project OSA will be tested in combination with other waste materials.

Replicability, demonstration, transferability, cooperation.

Initially the OSAMAT project was targeted to provide Estonia as well as European countries with new alternative binder material that propose reduction of costs and negative carbon emissions. Replicability and transferability of OSAMAT project actions and results went along with all the activities during the project implementation. OSAMAT project reports and the guidelines compiled on the basis of research results and know-how acquired by implementing project actions can be used in different countries. The execution of any stabilisation project consist of certain steps: testing of the materials, recipes compilation, construction and quality control. All the steps during OSAMAT project demonstration actions implementation were made in conformity with European standards and legislations. The differences between the projects will be in different recipes resulting in different OSA amounts for a particular project as every country raw material qualities are different. But, the methodology of testing and construction with OSA will be the same for every project. OSAMAT project provides road construction with OSA detail information in “Guidelines for European Practice”. Additionally, the detail information regarding materials testing, quality control and monitoring are described in different OSAMAT project materials. All the reports and guidelines are available at the website or can be asked from the OSAMAT project contact persons.

The mass-stabilisation method is becoming popular because of cheaper solution for stabilisation of deep soft soil comparing to traditional methods. Traditionally, to construct a road embankment, the natural soils should be replaced by more stable aggregates. If the road goes through a deep 8 m swamp, then the replacement methods changes to very expensive. Moreover, such a construction requires a lot of natural aggregates meaning the depletion of natural resources and carbon emissions. The mass-stabilisation with by-product like OSA propose cheaper and environmentally sound solution for road construction – these are the main two drivers for the mass-stabilisation method implementation. These drivers are also true for layer stabilisation, as cement is substituted by OSA partly or fully.

It should be also mentioned once again that mass-stabilisation methods is universal and suits not only for roads construction. The results of OSAMAT projects is also transferable to contaminated sediments stabilisation projects, construction of park areas, noise barriers and other similar constructions.

The cooperation with partners from Finland, Sweden and Lithuania started during the project implementation has proved that OSAMAT project results are transferable. Additionally, any construction project owners can always get comments and advice regarding stabilisation experience with OSA from OSAMAT project coordinator.

The obstacles that might face the constructor, contractor in European countries is the perception of local authorities to unknown material that is moreover defined as a waste according to the legislation. It might be that a constructor has to make some procedures or organise additional laboratory testing in a particular country to show OSA suitability for local conditions. However, the OSAMAT project demonstration data (monitoring program measurements done in real environment) will always support any additional testing, as the laboratory results could be correlated with demonstration results of the OSAMAT project and give an interpretation of this laboratory results.

Another obstacle that might occur is a distance to a place of construction and transportation costs connected to this. The transportation costs are almost 100 % cost of OSA. So, the far the construction object, the higher the transportation costs might be. However, it is very specific for a particular project. For example, the transportation might be cheaper for the project located in the intersection of the transport routes, but more farthest from the power plants comparing to an object located closer to production of OSA, but away from transportation routes. Consistently, an individual approach to every project might be needed to calculate the costs. EE has taken into account this possible obstacle and started to work out different transportation solutions (by car, by railway and by sea) solutions for the client to ease the promotion of OSA in different European projects.

It can be concluded that OSAMAT projects actions are replicable, results are transferable and suitable for further cooperation with potential clients in Europe.

Best Practice lessons.

The sequence of the planned actions is very important with any project. Applying the structure of preparatory work and data collection, followed by data analysis and then the implementation of actions based on the gained information ensured high-quality results.

In OSAMAT project the methodology for reaching the goals included several steps, starting from preparation actions followed by material tests, recipes compilation, piloting, results verification, analysis and know-how dissemination.

The chosen methodology was correct and let us step by step to come closer to the main objectives. The first actions (from 1 to 5) were linked in such a way that the previous action results served as data for the following action. Actions 6 Dissemination and 7 Management went along with the project actions implementation.

Assessing the 5 year work within the project and project results, we can conclude that the chosen approach were completely justified.

Innovation and demonstration value.

OSA has been tested, demonstrated in road construction and demonstration results properly monitored for the first time in Europe. So, it could be without doubt declared that the whole OSAMAT project actions were innovative at national and international level.

Two road construction technologies have been tested in the frames of OSAMAT project: layer stabilisation with OSA and mass-stabilisation with OSA.

N-M pilot site layer stabilisation has been done with “cold in place recycling” method. This a traditional method for road layer stabilisation. However, the substitution of cement by OSA was an innovative idea. To switch from ideas to the implementation the OSA was tested in demonstration of the N-M pilot site construction within the OSAMAT project. During the construction we faced with some situations, details that made construction with OSA a bit different comparing to cement. The nuances referred to OSA spreading, mixing and others.

The innovations was fixed and given as instructions in “Guidelines for European Practice” (Annex 28 of DR). The guidelines give instructions for a constructor how to use OSA in road layer construction. The guidelines are appropriate for use in construction in any conditions and any country.

The mass-stabilisation is quite new technology in road construction. It is primarily used in Finland and Sweden and not widely known and used in Europe. OSAMAT mass-stabilised pilot section was the first road section (located at the functioning transport route) constructed by mass-stabilisation technology in Estonia. Every step of the construction was innovative for the local constructor (Nordecon) as mass-stabilisation had never been done before in Estonia. In this demonstration two innovations could be distinguished. The first is testing of new technology and the second is testing of OSA in this new technology. The OSAMAT project results show that both innovations have value for further road construction development: firstly, the new (for deeper swaps) mass-stabilisation technology has been proved itself to be cost-effective and environmentally sound and secondly the sustainability of the construction project rises with OSA use in mass-stabilisation projects.

All the details of the mass-stabilisation construction process et S-V pilot site were fixed and given as instructions in “Guidelines for European Practice”. The guidelines give instructions for a constructor how to use OSA in mass-stabilisation projects. The guidelines are appropriate for use in construction in any conditions and any country.

It was extremely important to go through the real construction process with OSA to assess logistics, storage, unloading and spreading of OSA at the site, the behaviour of the mixture with OSA during the first hours, quality assurance procedures, the results of stabilisation (if the construction was strong enough) and possible impacts to the nature. Only the demonstration gives realistic data that can guarantee to the target groups the material suitability for the construction. We could observe during the project implementation how the demonstration results (piloting results at N-M and S-V pilot site) changed the perception of the authorities and constructors to the material. There is a real demand for the reliable, environmentally sound and cost-effective material as OSA, but the interested parties needed proves to guarantee the quality of the construction. These guarantees can give only a demonstration. That’s why the value of the demonstration data got within the OSAMAT project couldn’t be overestimated. OSAMAT demonstration data are the starting point for the future OSA utilisation projects in road construction.

EU funding of the projects through the LIFE program has given the opportunity for OSA to become a valuable construction material on the market through a demonstration character of the OSAMAT project. Due to the fact that LIFE program pays much attention to the dissemination, the OSAMAT project demonstration results were disseminated throughout the Europe. The programme naturally fostered (through funding) the international cooperation, because we had an opportunity to meet with different experts, visit other construction sites, visit conferences and disseminate the project results in different European countries and start discussions with potential clients.

Long term indicators of the project success.

OSA is a by-product of energy production. Every year around 6 mln. tons of OSA is generated. At the moment 97% is landfilled at the ash plateaus. EE manages different researches to show the value and suitability of OSA as material in different applications to decrease the load to the environment, causing by OSA landfilling. OSAMAT project has given an opportunity to prove OSA suitability as a binder for road construction, thus giving a chance for utilisation of OSA in quite big amounts (especially mass-stabilisation projects). So, the main indicator of the project success in a long-term perspective will be the amount of utilised OSA in different projects. Due to the OSAMAT project results we expect the decrease in landfilling and increase in utilisation of OSA starting from 2018 year. It is very hard to predict the quantity of OSA utilised in the long-term perspective, as we are in the very beginning of OSA promotion at the moment. Relying on the numbers mentioned in discussion with our partners (who is considering OSA use in their projects, see chapter "long-term benefits and sustainability"), we can predict the increase of OSA use around 15% from the total OSA amount and around 30% from the amount of the fly ash (as bottom ash didn't suit for the construction purposes).

After –LIFE follow program

The program of after-LIFE follow –up activities includes technical and environmental monitoring in the years 2018 and 2020. The detailed follow program is given in the table below:

After-LIFE action	Details of the action	Period
Webpage update www.osamat.ee	**1)** server hold, **2)** webpage update	2017-2020
Pilot sites (N-M and S-V) technical and environmental monitoring	**1)Environmental monitoring:** surface water sampling and soil sampling 2 a year	2018;2020
	2)Technical monitoring: defects analysis; load bearing capacity, samples compression strength measurements	2018;2020
Dissemination	**1)** Participation in the conferences (at least in 2 for four year period)	2017-2020
	2) Layman's report and booklet dissemination at conferences, meetings	2017;2018
	3) Articles production: at least 1 science articles and 1 at a magazine	2017-2020
EF CFB ash testing for standardisation	**1)** EF CFB ash conformity control with European standard	2017
	2) EF CFB ash standardisation or certification	2017
EF CFB ash amounts availability increse	**1)** CFB combustion block connection to silo	2017
Collaboration with ERA and partners for OSA use in stabilisation of soft soils	**1)** OSA tests, logistics solutions work out for the transportation in Estonia and over the sea	2017+
	2) OSA lab tests and logistic for Rail Baltic project	2017
	3) OSA pilot test in Rail Baltic railway area	2020
	4) Collaboration with authorities of Europe countries for OSA import as a product	2016+
Participation in other pilot projects	**1)** Participation in RECIPE project via HORIZON 2020 program (stabilisation of soft soil in combination with other by-products)	2017-2020

6 Comments on the financial report

6.1. Summary of Costs Incurred

PROJECT COSTS INCURRED				
	Cost category	Budget according to the grant agreement*	Costs incurred within the project duration	%**
1.	Personnel	609 655	644 771,85	105,8
2.	Travel	20 500	12 050,44	58,8
3.	External assistance	832 132	929 207,81	111,7
4.	Durables: total non-depreciated cost	0	0	0
	- Infrastructure sub-tot.	0	0	0
	- Equipment sub-tot.	0	0	0
	- Prototypes sub-tot.	0	0	0
5.	Consumables	641 993	616 793,31	96,1
6.	Other costs	123 000	78 285,02	63,6
7.	Overheads	152 000	149 602,07	98,4
	TOTAL	**2 379 280**	**2 430 710,50**	102,2

The column "%" indicates the percent difference between the project's actual costs and the project's revised budget (Amendment No 1 to Grant Agreement for project OSAMAT, signed on 12 of September 2012).

The costs in the "Personnel" category exceeded (105,8 %) the planned budget because of the higher costs emerged during pilot construction (Nordecon costs). Construction piloting is always under the risk of unpredictable situations emergence as the construction faces with new materials, new technologies and weather conditions. In case of OSAMAT project the mass-stabilisation at S-V pilot site took more time and forces comparing to initially planned. During stabilisation works it came out that the handling of ashes was different comparing to cement (details in the chapter 4.2 clauses 5 and 6). This created prolongation in construction and a need for additional labour force.

"Travel and subsistence" category budget money was planned to support mostly dissemination and pilot activities (according to the budget fixed in the Grant Agreement). The participation in the conferences was cheaper than planned, some conferences took place in Estonia. It gave savings in this category covering only 58,8 % of the budget.

External assistance costs have exceeded the budget (111,7 %) due to the costs connected with the necessity of carrying out additional technical and environmental monitoring at the pilot sites. In the years 2012 and 2013 the technical problems with the ash taking out and delivery appeared. This moved the construction for the next years and the project was prolonged for 19.5 months (details in the chapter 4.2 clauses 5). Because of unforeseeable technical problems and late construction at the pilot sites the period of monitoring had to be moved in time until the end of 2015 year. It was extremely important to finish the project monitoring program as it has given data and a basis for producing new legislation and OSA standardisation as a valuable product, giving an opportunity of OSA utilisation instead of landfilling. A new procurement was organised and technical and environmental monitoring done. This created an exceeding and discrepancies with the initial budget of the project.

There were no big costs discrepancies in the "consumables" category.

Costs in "other costs" category covered 63, 6 % of the budget, that is lower percentage as it was planned. The reason for that is mainly due to cheaper transportation and materials price comparing to the expected.

The costs of the "overheads" category made up 6.5% of the project costs.

6.2. Accounting system

The accounting systems of all beneficiaries allowed for separating project expenses from other expenses. This was done using codes, which were associated with corresponding expenses (receipts) when registering expense receipts in the organisations' accounting. All beneficiaries adopted project-based cost accounting as of the beginning of the project.

Invoices and expense receipts were submitted to the project manager, who checked their accuracy and conformity with project requirements and agreements. The accounting department attached the project code to the document and the project accountant submitted the document for payment.

EE and EE NEJ had a project code KA0055.
Nordecon had a project code 02.11.027A.

All beneficiaries used the standard LIFE manually completed timesheets for registering working time. They filled out timesheets according to the work done, registering project and other working hours separately. The timesheets were checked, approved and signed on a monthly basis by immediate supervisors.

All timesheets were sent to the project manager, who checked their compliance with the rules of completing timesheets.

We used two options for adding project references to the project's expense receipts. Either the issuer of an invoice provided a clear reference to the OSAMAT project or, the invoice was stamped with the project stamp.

6.3. Partnership arrangements

The coordinating beneficiary concluded agreements with the associated beneficiaries, which also stipulated the conditions of transaction of the Commission contribution. After the receipt of the first and second payment from the Commission, the amounts established in the agreements were transferred to the associated beneficiaries. The last payment will be transferred to the associated beneficiaries after the receipt of the final payment and in the amount declared eligible. While the payments are based on agreements, the actual payments are made after the associated beneficiaries have submitted their requests for payment.

The beneficiaries completed the tables by theirselves and forwarded them, along with the documentation, to the coordinating beneficiary. During final report compilation the project manager corrected, consolidated, complemented and finalised the tables.

6.4. Auditor's report/declaration

The project was audited by:

Name: KPMG Baltics OÜ
Address: Narva mnt. 5
Tallinn 10117
Estonia

Contact person: Risto Viirg
Contacts: phone +372 6 268 700, fax +372 6 268 777,
www.kpmg.ee

6.5 Summary of costs per action

Action no.	Short name of action	1. Personnel	2. Travel and subsistence	3. External assistance	4.a Infra-structure	4.b Equip-ment	4.c Prototype	5. Purchase or lease of land	6. Consumables	7. Other costs	TOTAL
1	Preparations	9950,00	0	28000,00	0	0	0	0	0,00	0	37950,00
2	Materials	7150,00	0	105000,00	0	0	0	0	0	0	112150,00
3	Applications	17675,00	500,00	72000,00	0	0	0	0	0	0	90175,00
4	Piloting	405981,41	2039,06	365703,77	0	0	0	0	616793,31	73694,30	1464211,85
5	Verification	50897,58	0,00	230904,70	0	0	0	0	0,00	0,00	281802,28
6	Dissemination	62886,89	9259,77	50000,00	0	0	0	0	0,00	4590,72	126737,38
7	Management	90230,97	251,61	77599,34	0	0	0	0			168081,92
Over-heads											149602,07
	TOTAL	644771,85	12050,44	929207,81	0	0	0	0	605581,47	89496,86	2430710,50

The major discrepancies emerged due to technical problems connected with ash delivery and piloting and project prolongation. So, the major discrepancies are seen in "Piloting" and "Verification" actions.

"Preparations" and "Materials" actions costs are in accordance with the planned budget.

There are some savings of personnel cost in "Application" actions. The actual costs changed from 27 475 € to 17 675 € due to less work time required during project implementation and cheaper daily rates in some cases comparing to daily rates foreseen in the budget.

"Piloting" costs exceeded the planned budget mainly because of technical problems during S-V pilot site construction. There was a need for more labour force and this created exceeding of the personnel costs foreseen in the budget. The budget changed from 377 830 € to 405 981,41 €. There were savings in all other categories of the "Piloting" action. External assistance costs changed from 378 132 € to 365 703, 77 € due to cheaper road construction owner supervision service got (25 000 € instead of planned 70 000 €). Consumables costs changed from 640 993 € to 616 793,31 € as materials transportation and materials prices were cheaper than expected (76 €/t cement costs instead of 80 € foreseen; 7,6 €/t crushed gravel costs for N-M construction and 16 €/t crushed gravel costs for S-V construction instead of 20 €/t foreseen). "Other costs" changed from 120 000 € to 73 694,30 € due to cheaper transportation costs comparing to the planned budget.

The major discrepancy with the project budget of "Verification" action occurred in external assistance category. The costs changed from 120 000 € to 230 904,70 €. The main reason for that was a need to conduct additional technical and environmental monitoring because of the pilot sites later construction (construction was finished in the year 2014 instead of planned 2012 year). The first contract for environmental and technical monitoring ended in the beginning of 2014. However, the construction works were still going on. It was impossible to leave the sections without monitoring as the monitoring data were of the major goals of the project and not doing the monitoring meant that the overall project objectives would be altered.

There were not big discrepancies of the costs in “Dissemination” action. Travel category costs changed from 17 000 € to 9 259,77 € due to cheaper conference costs comparing to expected.

7. Annexes

7.1 Administrative annexes

The partnership agreements were concluded and presented with the following Progress Report to Commission

- Partnership Agreement between EE and NC (signed on 31.05.2011);Progress Report nr 1;
- EE and NC Supplement Agreement (signed on 2.01.2013); Progress Report nr 3
- Partnership Agreement between EE and EE NEJ (signed on 25.10.2012): Progress Report nr 3

7.2 Technical annexes

7.2.1 List of keywords and abbreviations used

OSA – oil shale ash

LCA – life cycle assessment

LCC – life cycle costing

CF – Carbon Footprint

EE – Eesti Energia AS

EE NEJ – Eesti Energia Narva Elektrijaamad AS

NC – Nordecon AS

ERA – Estonian Road Administration

EMT – External Monitoring Team

SG- Steering Group

N-M – Narva-Mustajõe pilot site

S-V – Simuna-Vaiatu pilot site

Cycl PF – cyclone ash from the pulverized firing

EF PF – bag filter ash from pulverized firing

EF CFB – electric precipitator ash from circulating fluidised bed combustion

ECOBA – European Coal

EIA – Environmental Impact Assessment

DR- Dissemination Report

UCS - unconfined compressing strength

FT - freeze-thaw

LS-OSA – layer stabilisation with OSA

LS- CB – layer stabilisation by complex stabilisation with cement

KBFI- Keemilise Biloloogilise Keemia Institute (National Institute of Chemical Physics and Biophysics)

REP - (Repaving) method includes grinding of the old road pavement surface and constructing a new one

U-REP - is a method where only the worn off tire track areas of the road surface are paved for the width of about 1 meter.

7.2.2 Carbon Footprint Report

7.2.3 Verification Report

7.2.4 Pilot sites Technical Monitoring

7.2.5 Pilot sites Environmental Monitoring Report

7.3 Dissemination annexes

7.3.1 Dissemination Report

- includes all the brochures, scientific articles, guideline and other dissemination materials
- includes DVD with videos and photographs
- includes After –LIFE slide presentation
- includes Guidelines for European Practice
- After-LIFE Communication plan
- Layman's report

7.4 Final table of indicators

LIFE+ Environmental Policy and Governance output indicators

OUTPUTS

Part 1 - Preparatory actions

Table 1

Types of preparatory actions	No.	Incurred cost (€)
Feasibility studies		
Legislative reviews		
Cost-benefit studies		
Market analysis		
Permit studies	2	3230
Permit applications	2	0
Permits obtained	2	0
Environmental impact assessment studies	2	0
Scientific studies		
Detailed engineering studies		
Monitoring actions		
Action plans	1	0
Management plans		
Inventories & Studies	2	0
Ex ante environmental monitoring	2	4113
Ex post environmental monitoring		
Other (please specify)		
Total budgeted cost (€)		7 343

OUTPUTS

Part 2 - Concrete actions

Table 2 - Main project deliverables (project implementation phase)

Deliverable	No.	Budgeted cost (€)
Prototypes		
Pilot plants	2	0
Techniques/Methodologies developed	3	113 113
Software		
Successful implementation of demonstration actions	10	1 433 357
Monitoring techniques developed		
Monitoring performed	4	180903
Guidelines		
Manuals		
Others (please specify): Co-ord. & management		75 000
Total budgeted cost (€)		2 379 280

Table 3 - Training activities

No. of training sessions	Total no. of persons trained	Budgeted cost (€)
0	0	0

OUTPUTS

Part 3 – Awareness-raising and communication

Table 4 - Workshops, seminars and conferences

Target audience:	General public			Specialised audience (e.g. decision-makers)			Very specialised audience (e.g. experts, academics)		
Number of participants:	Local/ Regional	National	EU/ International	Local/ Regional	National	EU/ International	Local/ Regional	National	EU/ International
0-25 participants	2								
25-75 participants									
75-100 participants									
More than 100 participants						1			
Total budgeted cost (€)	10 000								

Table 5 - Media and other communication and dissemination work

Type of media	No.
Project website: average number of visitors per month	50
Press releases made by the project	38
General public article in national press	17
General public article in local press	-
Specialised press article	4
Internet article	10
TV news/reportage	3
Radio news/reportage	5
Film produced	2
Film played on TV	-
Film presented in events/festivals	2
Exhibitions attended	-
Booklet (Estonian, English, Russian)	1
Project notice boards	2
Other (please specify): conf. presentations, poster	17
Total budgeted cost (€)	25 000

Table 6 - Publications

Type of publication	No. published	No. of copies	Languages
Layman's report	1	450	en, ee
Manuals			
Leaflets			
Brochures	1	600	en, ee, rus
Posters	1	10	en
Books			
Technical publications	1	10	en
Other (please specify) conf.papers			
Total budgeted cost (€)	1 000		

Table 7 - Educational activities

Establishment involved	No. of students
Kindergartens/Primary schools	0
Secondary schools	0
Higher education establishments	0
Total budgeted cost (€)	0

8. Financial report and annexes

8.1 Standard Payment Request and Beneficiary's Certificate
8.2 Consolidated Cost Statement for the Project
8.3 Financial Statement of Eesti Energia AS
8.3a OSA own costs calculation
8.4 Financial Statement of Eesti Energia Narva Elektrijaamad AS
8.5 Financial Statement of Nordecon AS

8.6 The answers and comments to the European Commission letters nr Ares (2013) 2593795 – 9/07/2013, Ares (2014) 3127839 - 23/09/2014, Ares (2015)5025439 concerning the final report.

8.6.1 European Commission letter nr Ares (2013) 2593795 – 9/07/2013.

1. Personnel Costs.

Question 1

a. Nordecon AS - I note that most of the project staff appear to be on part-time contracts. Please explain how the annual working hours are established.

Answer 1

Whether a person is employed on a temporary or exclusive basis is set out in their contract. Employees with temporary or site-based contracts are paid hourly wages, with time sheets kept in relation to their working hours. Furthermore, employees on contracts with indefinite duration have time sheets. Employees' working hours are recorded monthly. The annual volume of hours worked are taken from the person's annual record, available as a statement from the payroll component of the HR programme. The programme provides a personalised statement for every employee, reflecting the period worked by the employee and the costs on a monthly basis over the course of a year.

Question 2

b. Nordecon AS
Please provide timesheets, contracts, salary slips showing the annual salary, or invoices and proofs of payment for the following persons: Jaanus Taro, Ain Pähkel, Roland Kirsipuu.

Answer 2

The documents are attached as Annex 8.6.1.2 in electronic version of the report.

Question 3

c. Eesti Energia Narva Elektrijaamad AS
Please provide timesheets, a contract, salary slips showing the annual salary, or invoices and proofs of payment for Aleksander Pototski.

Answer 3

The documents are attached as Annex 8.6.1.3 in electronic version of the report.

5. External Assistance

Question 4:

Please provide the contract, all invoices and proofs of payment for Ramboll Eesti AS. In addition, please describe in detail the procurement procedure.

Answer 4

The tender "Management of environmentally sound recycling of oil-shale ashes into road construction products. Demonstration in Estonia"

The tender documentation, the list of tenderers, kind of tender procedure were confirmed with the ordering party (A. Pototski), the chef of procurement department, lawyer, the chief of ash sales department (A. Pototski) and confirmed by the board Eesti Energia Narva Elektrijaamad AS.

The following tenderers were defined by the ordering party and the chief of ash sales department: K-Projekt AS, Ramboll Eesti AS, Telora-E AS. The tender documents were sent to the tenderers on 08.09.2010 by email.

The deadline for tender was fixed on 15.09.2010. One joint offer was received on Eesti Energia Narva Elektrijaamad AS email from the companies Ramboll Eesti AS и Ramboll Finland OY. The offer amount was 470 000.00 EUR. By the official record (protocol) dated on 16.09.2010 the tender commission decided to confirm the offer from Ramboll Eesti AS и Ramboll Finland OY successful.

The documents are attached as Annex 8.6.1 4 in electronic version of the report.

6. Consumables.

Question 5

Nordecon AS

a. Nordecon AS has reported several consumable costs which are not foreseen in the amended project proposal such as e.g. traffic signs (line 6; € 4.525), pipes (lines 9 and 10; respectively € 8.352 and € 3.600), etc. Please justify these costs in terms of project needs or remove them from the financial report.

Answer 5

The original application stipulated stabilisation works for three different applications in two construction technologies; however, there was no specific information on the location and nature of the test section. The budget was prepared on the assumption that it would be possible to carry out all of the desired applications of stabilisation on a single test section (area closed to traffic). After the approval of the project by the LIFE+ committee, the search for a suitable section began. Since the project was also co-funded by the Road Administration, and the interest of the Road Administration was to obtain adequate feedback on the utilisation of oil shale ash in road construction, in order to obtain the best final result the test section had to be built on a road directly subject to traffic, entailing also other works part of regular road construction (the works were needed precisely in order to achieve point of comparison with respect to works carried out with oil shale ash using the regular VS method, in an equal environment).

In order to ensure the achievement of the ultimate objective of the project and the requirements of the Road Administration, it was inevitable to disregard the attendant works needed for the accomplishment of the project. Accordingly, also water drains (culverts, pipes) had to be constructed based on the approved design solution. In addition, the works were carried out on roads subject to traffic, which necessitated the installation of traffic management equipment (to ensure the safety of the road users and employees). These costs could not have been foreseen in the original application; however, these costs were needed for the achievement of the objective of the project.

Question 6

b. Please explain the legal relationship between Nordecon AS subcontractors: Eesti Energia Kaevandused AS, Aidu Karjäär and Eesti Energia AS.

Answer 6

Nordecon AS has no relations with Eesti Energia Kaevandused AS, Aidu Karjäärid or Eesti Energia.

Question 7

d. Please provide contract, all invoices and proofs of payment for TREF AS.

Answer 7

The documents are attached as Annex 8.6.1.5 in electronic version of the report.

7. Other direct costs.

Question 8

Nordecon AS

a. Some of the costs reported under this heading have not been foreseen in the provisional budget (costs for leasing cars, communication (mobile phone), winter tyre etc.). Please justify these costs in terms of project needs or remove them from the financial report.

b. several internal invoices for the total value of €1.400,64 have been reported. These should be removed from the final report.

Answer 8

Please see the Answer 5.

8.6.2 European Commission letter Ares (2014) 3127839 - 23/09/2014.

Question 9:

1. Financial issues.

High daily rates

It has been brought to my attention that some employees report significantly higher daily rates than foreseen in the Grant Agreement. Please note that in such cases an explanation should be included in the Final Report for each employee regarding the added value they brought to the project. Please be reminded that the Commission reserves the right to only accept the daily rates from the Grant Agreement + 10%.

Answer 9 EE, EE NEJ:

Three employees had higher daily rates than foreseen in the GA: Aleksander Pototski, Tõnis Meriste and Arina Koroljova (starting from the year 2015).

Tõnis Meriste became EE Project Coordinator in the year 2012 because of the amendments in the project management due to the new partner EE NEJ inclusion. Aleksander Pototski continued the work in the project as EE NEJ Project Manager. Tõnis had an agreement with EE from the year 2004 and his daily rate came from his salary established in the EE agreement. Tõnis and Aleksander worked at the company departments' head positions that were rated higher in the company than in the budget foreseen. Aleksander had an agreement from the year 2009.

In the year 2014 Aleksander and Arina left EE NEJ and started to work in EE.
EE NEJ concluded agreements with both on a fix monthly rates to work part time in the project. Aleksander daily rate was higher than in the budget foreseen because during the project implementation period (4 year) the economic situation changes as well as salary rates. Aleksander and Arina were the best candidates as they managed the project before and were very professional and deep in the details of the project. After Aleksander left the company Arina Koroljova became EE NEJ Project Manager. Arina's higher daily rate was justified by the increased load.

Tõnis as EE Project Coordinator was responsible for the general coordination of the project, the project's general accountancy and communication with the Commission (reports, amendments submission and processing) (details in chapter 4.1). Due to his previous experience (the Head of Environmental Department in EE) he had useful contact and effective, good – working communication on the level on the country authorities that helped to promote the project activities and disseminate the information about the project value for the country and European Union.

EE NEJ Project Coordinators (Aleksander and Arina) were mainly responsible for OSA supply, but also for the implementation of project researches and compilation of progress reports (details in chapter 4.) It could be said that Aleksander was the first person in the company who started to deal "with the end-of-waste" issue for the oil shale ash. Due to his knowledge's about OSA, his vision and strategy the OSAMAT project came into life. In the beginning of the project implementation he was the only person who understood the quality of the material, its potential, value of usage and management.

Arina came as Project Assistance in the year 2011. During several years together with Aleksander she managed the project and strengthen the knowledges about OSA. After Aleksander left the company she was the only person (from EE NEJ side) who was very deep with all the details of the project and competent to promote the material.

Due to the specific material (OSA) the project required the labour force who were experienced and competent to manage such a specific project. Tõnis, Aleksander and Arina were without a rival at the time of making decision on labour force. Without their experience, knowledges and efforts the project couldn't be finished. We understood, that the project implementation was of a very high importance for the company, country and European Union and we preferred to put under the risk the personnel costs financing and pay higher daily rates rather than fail the project.

We hope fully for your understanding and acceptance of the higher daily rates for those key three persons who made the project, struggled for the project implementation and successful results.

Answer 9 Nordecon AS

The original application provides the average pay information for the positions, since as at the time of the submission of the application there was no specific team for the accomplishment of the project. This is also evident from the budget, where Eesti Energia and Nordecon have identical daily rates. On a project with such a long duration, it makes sense to provide averages for positions, since there is employee turnover and different employees have different rates of pay, whilst the averages should be in place. In implementing the project, we have adhered to the Grant Agreement (GA), to ensure that the costs in the cost category (staff costs) do not go over by more than 10% or 30 000 euros. In the cost category of staff costs, differences in payroll costs from row to row are both lower and higher than the budget. At the moment, the average hourly cost is lower than in the budget: 164 vs. 135 euros. Accordingly, in our own opinion, in implementing the project we have adhered to the GA and have not exceeded the budget in terms of the cost category (going over the budget has resulted from the longer period of the accomplishment of the project, that is, more hours have been spent on the site than originally calculated). We hereby confirm that all the costs have been necessary for achieving the objective of the project. Highly qualified employees with extensive experience have been engaged for the successful accomplishment of the project. All the contracts, time sheets, annual records, pay statements and the like are available and may be presented on request.

Question 10

2. Calculation of the annual personnel cost

I understand that the associated beneficiary Nordecon AS has a salary system where employees receive a basic salary and an extra salary which is called "salary based on results" or "performance fee". Since, it is taxed as salary, it has been included in the calculation of the annual personnel cost. As a result, the daily rates have become very high and exceed what is foreseen in the Grant Agreement. Please be reminded than in order for these costs to be included in the calculation of the annual personnel cost, they have to be applicable to all employees and have to be included in the collective agreement. However, please be reminded that the Commission reserves the right to only accept the daily rates from the Grant Agreement + 10%.

Answer 10

Please see the Answer 1.

8.6.3 European Commission letter Ares (2014) 3127839 - 23/09/2014.

Technical issues

Question 11

2. Environmental monitoring

Thank you for the clarifications regarding ground water monitoring. However, I consider the potential impact of using oil-shale ash in road construction on ground water a significant issue. Therefore, in the Verification report, please include a clear conclusion about the impact of the piloting activities on ground water, in terms of the contaminants which are present in oil-shale ash in noteworthy amounts, and which might pose a risk for the environment. Moreover, as the draft Verification report will be given to independent experts for comments and evaluation, the statement of the independent external experts should include a comment on the ground water issue.

Answer 11

The environmental monitoring included sampling of soil and surface water (from the ditches next to the pilot sections) and flora observation. It was initially planned to take samples of ground water, but after the meeting with experts it was clear that such kind of assessment was not reasonable in this particular project for several reasons: it was expensive (and not foreseen in the budget), because we had to drill a separate holes for the project, secondly we had to have a permission for drilling (takes around a year and also costs) and thirdly the results of the measurement couldn’t be interpreted for the particular pilot sites, because it was impossible to define exactly what coursed the presence of this or that substances in the ground water (N-M is very close to oil shale landfill, S-V is located in the farm and agricultural area, so we could have the result of the contaminations from the landfill or farms).

Question 12

3. Articles

According to the approved project proposal, a second article in a professional magazine was due by 15 January 2015. However, no information on this milestone is provided in your report. Please attach the second article published in a professional magazine to the Final Report. Additionally, please be reminded to ensure that all deliverables, not yet submitted to the Commission, are sent with the Final Report both in paper copy as well as electronically.

Answer 12

The detailed list of dissemination products, including article list is given in Dissemination Report table 2. All the planned articles have been issued.

8.7 Auditor's report

Auditor’s report is attached as Annex 8.7.1.