

Pro-environmental Product Planning in a Dynamic Operational Environment Now and in Future - Methods and Tools (ProDOE)

Report Year 2009

1 The Research consortium members

At Helsinki University of Technology (TKK)

The Institute of Law: LL.D Ari Ekroos (University of Helsinki, April 2009), M.Sc. Mari Pajunen, D.Sc. Matias Warsta (Until July 2009), LL.M. Jaakko Kanerva

The Laboratory of Environmental Protection: D.Sc. Olli Salmi

TKK Laboratory of Environmental Technology: D.Sc. Olli Dahl, M.Sc. Gary Watkins, Lic.Tech. Helena Mälkki, Diploma worker Mikko Mäkelä

TKK Laboratory of Energy Engineering and Environmental Protection: Lic.tech. Carl-Johan Fogelholm, Lic.Tech. Sanni Eloneva, M.Sc. Laura Kainiemi

TKK Laboratory of Mechanical Process Technology and Recycling: D.Sc. Kari Heiskanen, M.Sc. Maaria Wierink

At University of Helsinki (HY)

The Research group in Environmental policy: PhD Janne Hukkinen, M.Sc. Jarkko Levänen

The Department of Private law, Environmental and Energy law: LL.D Ari Ekroos, LL.M. Eeva-Maija Pusa, LL.M. Inga-Liisa Paavola, LL.stud. Iida Huhtanen

At the Oulu University (OY)

The Laboratory of Process metallurgy at the Department of The Department of Process and Environmental Engineering: D.Sc. Jouko Härkki, PhD Jyrki Heino, Mikko Angerman (Executive Manager of CIRU), University teacher Eetu Heikkinen

2 Objectives and Hypotheses

The group will research the complex interactions between the setting of regulatory objectives and the choice of scale of the engineered industrial ecosystems to be regulated and managed as well as the complex interconnections, dynamics and relevant cycle specific boundary conditions. This will require research on eco-efficiency indicators to understand their variability and how the policies chosen interact with these variations. It will also need research on the physical and chemical possibilities for utilization of different streams in the ecological web.

Our research hypotheses are:

- (1) The closure (including optimisation) of resource cycles can only be achieved if all the chemical, physical, technical, economic, legal, administrative, environmental, and social issues are considered together in a systemic way.
- (2) The policy must be discussed from the perspective of all actors.
- (3) We need to understand the implication of the metrics and procedures used.

The general objectives of the project are:

- (1) To produce a position paper of the research group of the existing situation concerning the metal and fibre cycles and the interconnected energy cycle. We will assess the current policies, their spatial and temporal effectiveness and outline existing boundary conditions.
- (2) To identify legislative and regulatory development needs in order to promote sustainable use of resources and the closure of material cycles. We will try to propose some effective policies and legal instruments related to material cycles (legal, technical and economic means to control the material flow).
- (3) To provide new insights into the metrics of industrial ecology by developing further the deterministic indicators so as to better understand the temporal and spatial scales of ecological efficiency.
- (4) To intensify the utilisation rate of side-streams or rejects in the three industrial ecosystems, while taking into account the aspects rising from legislation, management, economy, ecology, material properties and processing. The possibilities for cross-linking the cycles will also be explored.

(5) To develop a first generation systemic model (generically a model framework) for the chosen material cycles in terms of system interconnectedness and dynamics and use the developed model in conjunction with the results of all the groups to generate dynamic estimates for the effectiveness of the chosen environmental policy instruments.

3 Expected research results

- A general assessment publication of the current policies, their spatial and temporal effectiveness and boundary conditions.
- Analytical tools for investigating the influence of temporal and spatial scale on ecological efficiency.
- Multidimensional indicators of ecological efficiency and effectiveness.
- Improved utilisation rates of wastes and by-products in the three cases.
- Recommendations for environmental regulation or de-regulation promoting resource cycle closure.
- Systemic model for test cases for estimating effectiveness of environmental regulation.

3.1 Third year results

Publications:

Dahl, Olli; Nurmesniemi, Hannu; Pöykiö, Risto; Watkins, Gary. Comparison of the characteristics of bottom ash and fly ash from a medium-size (32 MW) municipal district heating plant incinerating forest residues and peat in a fluidized-bed boiler. *Fuel Processing Technology* (2009), 90(7-8), 871-878. CODEN: FPTEDY ISSN:0378-3820. CAN 151:250098 AN 2009:687970

Eloneva, S., Teir S., Revitzer, H., Salminen, J., Said, A., Fogelholm, C.-J., Zevenhoven, R., 2009. Reduction of CO₂ emissions from steel plants by using steelmaking slags for production of marketable calcium carbonate. *Steel Research International*, 80 (6), 415-421.

Ekroos, A., Ympäristölainsäädännön ja -hallinnon kehityksestä. *Vesitalous* 5/2009, s. 11-15.

Heino, J., Outokumpu Tornio steel works from the environmental point of view. Intermediate report of ProDOE – project. Oulu 2009, 6 pp.

Heino, J., Harjavalta industrial ecopark – A success story of the industrial ecology in the area of metallurgical industry to increase regional and global sustainability. Esitelmä UUMA Metallinjalosta-jien seminaarissa Torniossa 28.4.2009.

Heino, J. & Dahl, O., Industrial ecology applied to metallurgical, chemical and pulp and paper industries around Bothnian arc. Esitelmä UUMA Metallinjalostajien seminaarissa Torniossa 28.4.2009.

Heino J.; Leinonen, V.; Koskenkari, T.; Mälkki, H. & Pajunen, N., Harjavalta industrial ecopark – A success story of the industrial ecology in the area of metallurgical industry. 17 pp. (The article ready but it is waiting for the contribution and feedback of Harjavalta industrial ecopark representatives)

Heino J., Harjavalta industrial ecopark – A success story of the industrial ecology in the area of metallurgical industry to increase regional and global sustainability. Environmental management in net-networks course. University of Jyväskylä 7.4.2009. 25 pp.

Heino, J., Kuparin ja nikkelin valmistuksen ympäristökuormitus ja ympäristökuormituksen hallinta. Luento ja luentomateriaali Prosessiteollisuuden ympäristökuormitusten hallinta -kurssilla. Oulu 2009, Oulun yliopisto, Prosessi- ja ympäristötekniikan osasto.

Heino, J., Nikkelin valmistus. Luento ja kirjallinen luentomateriaali Hapetus- ja pelkistys -kurssilla. Oulu 2009, Oulun yliopisto, Prosessi- ja ympäristötekniikan osasto.

Heino, J., Kuparin, nikkelin ja sinkin valmistuksessa vapautuvien raskametalli- ja rikkidioksidipitoisten kaasujen puhdistaminen ja talteenotto sekä hyötykäyttö tai loppusijoittaminen. Luento ja kirjallinen luentomateriaali Ilmansuojelutekniikat -kurssilla. Oulu 2009, Oulun yliopisto, Prosessi- ja ympäristötekniikan osasto.

Hukkinen, J., K.G. Hansen, R. Langlais, R.O. Rasmussen, S. Jeppson, J. Levänen, F. Lund Sørensen, P. Schmitt, S. Lange (2009) Knowledge-based tools for sustainable governance of energy and climate adaptation in the Nordic

periphery (K-Base). Nordic Council of Ministers Research Programme Report 2009:7. Stockholm: Nordregio (<http://www.nordregio.se/inc/openitem.asp?id=88737&nid=2112>).

Hukkinen, J. (2009) Kohti uusia ydinvoimakiistoja (Toward new conflicts over nuclear power) in Finnish, Helsingin Sanomat, OpEd, 21 August, p. C8.

Hukkinen, J. (2009) Hot topic: Nuclear heaven—part 2, European Society for Ecological Economics Newsletter, July, p. 3 (<http://www.euroecolecon.org/pdf/ESEE2009.pdf>).

Huutoniemi, K., J. Thompson Klein, H. Bruun and J. Hukkinen (2009) Analyzing interdisciplinarity: Typology and indicators, Research Policy, doi:10.1016/j.respol.2009.09.011

Härkki, J., Recycling questions of steel. Presentation in ProDOE seminar in Lahti 29.-30.1.2009.

Kettunen, P., Diploma thesis: The flow balance of the RAP5 line and the metal contents of the process solutions and process dregs. Oulu 2009. 128 pp. (In Finnish)

Kievari, T.; Warsta, M.; Ekroos, A., Jätehuollon vakuusvaatimukset ympäristönsuojelussa. Ongelmat ja kehittämistarpeet. Ympäristöministeriön raportteja 1/2009. (<http://www.ymparisto.fi/download.asp?contentid=97839&lan=fi>)

Leinonen, V. Heino, J. & Makkonen H., Towards eco-efficiency: granulated nickel slag's transformation into a product. Progress in Industrial Ecology, Vol. 6, No. 1, 2009. Pp. 29 - 43.

Mälkki, H. Poster presentation and participation in SETAC (Society of Environmental Toxicology and Chemistry) Europe 19th Annual Meeting, 31 May–4 June 2009, Göteborg, Sweden.

Mälkki, H. Ohjeita ympäristön huomioon ottavaan suunnitteluun. SFS-tiedotuslehti 5/2009. ISSN 0356-1089.

Mälkki, H. Yhtenäiset periaatteet ekotehokkuuden arviointiin. SFS-tiedotuslehti 5/2009. ISSN 0356-1089.

Pajunen, M., Mälkki, H., Watkins, G. Poster presentation "Sustainable production - Environmental Policies, Legislation and Incentive-based Economic Policy instruments" in ISIE 2009 "International Conference on Industrial Ecology: Transitions towards Sustainability", 21-24 June 2009, Lisbon, Portugal

Polet, J., Bachelor's work: The use of secondary and primary raw materials in blast furnace briquettes. 39 pp. (In Finnish)

Pusa, Eeva-Maija; Ekroos, Ari, Ilmastonmuutos ja hevosenslanta – uusiutuvan energian hyödyntämistä koskevan lainsäädännön lähempää tarkastelua. Ympäristöjuridiikka 3-4/2009, s. 10-27.

Salmi Olli: Environmental Management Systems - A Comparative Study. Paper presented at the SME Annual Meeting and Exhibit & CMA 111th National Western Mining Conference. Denver, Colorado, February 22 - 25, 2009.

Salmi Olli, Heino Jyrki, Hukkinen Janne, Pajunen Mari and Wierink Maaria: Interplay between industrial ecosystems and environmental governance at different spatial scales. Paper presented at the 5th International Conference on Industrial Ecology "Transitions towards Sustainability", 21-24 June 2009, Lisbon, Portugal.

Salomaa, E., Watkins, G., Environmental performance and compliance costs for industrial wastewater treatment – an international comparison. Sustainable Development (2009). Published on line in Wiley InterScience www.interscience.wiley.com DOI: 10.1002/sd.440, Accepted article received 13 Oct 2009, 2 - Proofs sent 9 Nov 2009, 3 - Corrections received 17 Nov 2009, 3 - EarlyView 26 Nov 2009 (published online)

Sarkimo A., 2009. Ammoniumsuolaliuosten vaikutus teräskonvertterikuonan laatuun. Metropolia Ammattikorkeakoulu.

Tuominen L, Heiskanen K, Mälkki H, Penttinen I. 2009. Primary Copper Flows in Scandinavia. SETAC Europe 19th Annual Meeting, 31 May–4 June 2009, Göteborg, Sweden. Poster presentation.

Wierink, M; Pajunen, M. and Heiskanen, K., Analysis of procedures and drivers for industrial waste management, Submitted to XXV International Mineral Processing Congress Brisbane, Australia

Wierink, M., Jansen, M. and Heiskanen, K., oral presentation. Mass balance compilation for WEEE scrap, Resource Conservation and Recycling (SRCR) 09 in Cape Town, South Africa 4.-5.2010

4 Activities of The Research Project

Seminars:

ProDOE Seminar in Lahti 29. – 30.1.2009

ProDOE Seminar in Kokkola 17. – 18.12.2009

Visits:

Heino's participation in "Window of Opportunity for Real Change" conference at Turku 14. – 15.12.2009 arranged by The Finnish Society for Industrial Ecology

Salmi's and Pajunen's participation in "International Conference on Industrial Ecology: Transitions towards Sustainability", 21-24 June 2009, Lisbon, Portugal

Wierink's and Heiskanen's participation in "Sustainability through Resource Conservation and Recycling (SRCR) 09" in Cape Town, South Africa 4.-5.2010

Other activities:

Eloneva, S. as an invited speaker in Helsingin Ekonomit ry – HEKO's Climate Change seminar, 5.11.2009

Hukkinen, J. organized workshop on "Knowledge technologies and changing institutions" at the 9th Nordic Environmental Social Science Conference (NESS) - Knowledge, learning and action for sustainability, University College London, UK, 10.-12.6.2009.

Hukkinen, J. organized workshop on "Climate change versus financial crisis: What makes quick action possible?" at European Society for Ecological Economics (ESEE) Conference, Ljubljana, Slovenia, 29.6.-2.7.2009.

Mälkki, H. participation in International Organization for Standardization ISO/TC 207 Environmental Management 16th Plenary Meetings from June 21 to 27, 2009 in Cairo, Egypt. An expert member of Finnish SFS delegation in ISO TC 207/SC 1/WG 4 Environmental Management Systems – Guidance on eco-design, ISO/TC 207/SC5 Life Cycle Assessment and ISO/TC 207/SC 5/WG 7 Eco-efficiency.

Salmi, O. as a member of the organizing committee, Finnish Society for Environmental Social Science (YHYS) Fall Colloquium 2009: Environmental governance of natural resources, the economy, and consumption, November 26–27, 2009, Finnish Environment Institute, Helsinki

Salmi, O. as an invited chairman in seminar session "Ympäristö" in Lahden tiedepäivä – Lahti Science Day 2009: Tiedettä – tutkimusta, tuotekehitystä, 24.11.2009.

Watkins, G. as an invited speaker in PaPSAT Conference, Oulu, 24-26 August 2009

5 Progress of The Research Project

Progress according to research plan.

5.1 Professor. Dahl's research group

Identification and investigation of industrial residue streams for innovative use/reuse

Concerning research on industrial residue streams concentrating on the fibre and metals industries. Achieve advances through the identification of specific candidate material streams for further investigation:

- Identification of the limiting factors hindering the current utilization of significant material streams identified, including characterizing stream impurities and quality stability.
- Investigation of the technical feasibility of innovative uses and ways to overcome utilization issues presented by impurities or residue characteristics.
- Development of new ideas for new processes and new ways of connecting existing processes, especially in the fibre cycle (and also with the steel industry), through investigating ways of reducing impurities, changing compositions or finding new ways of combining material streams.

Progress outline:

- Stora Enso Oyj- pulp and paper mills located in and around Oulu and Kemi, and Ruukki Oy steelworks at Raahe – Ground blast furnace slag, converter slag, desulphurisation slag, ladle slag, green liquor dregs, slaker grits, fibre clay, lime wastes and ashes all sampled and lab formulations carried out to determine potential for use of alkaline and other mill residues as activators and fillers for fibre reinforced blast furnace slag cement based concrete products and cementitious matrices.
- Main residue testing and analysis work (feasibility) was completed in December 2009 by MSc student M. Mäkelä.
- 3 publications produced in 2009. One MSc thesis due early 2010.
- Formulation, mechanical testing and leaching results in preparation. papers in production.
- At least 6 academic papers are in preparation for 2010. See below.
- Agricultural fertiliser potential of novel products to be progressed with Yara Oy
- Tuli (Otaniemi International Innovation Centre) support being sought to assist evaluation of the initial commercial potential of novel product ideas and scope for patenting.

Papers accepted for publication:

Nurmesniemi, Hannu; Pöykiö, Risto; Watkins, Gary, Dahl, Olli, Total and extractable heavy metal, phosphorous and sulfur concentrations in slaker grits from a causticizing process at a pulp mill used as a soil amendment, accepted for publication in the journal of the Chemical Speciation and Bioavailability.

Mill visits: Stora Enso Oulu and Ruukki Raahe completed to carry out sampling or secure residue sampling arrangements, handling and shipping to Otaniemi for the investigation of residue qualities, identification of current utilization issues.

Materials Analysis - Mill residue testing and product formulation tests - Chemical and physical analysis work undertaken as well as consideration of options for intra-industry utilization/intensification options.

Planned work for 2010:

Papers submitted:

- G., Watkins, O., Dahl, M., Mäkelä, Innovative Use Potential of Industrial Residues from the Steel, Paper and Pulp Industries – A Preliminary Study. Submitted to the Journal Progress in Industrial Ecology in Jan 2010.

Papers planned:

- Winter 2010 - O. Dahl, H. Nurmesniemi, R. Pöykiö, G. Watkins, Distribution of heavy metal and nutrient concentrations between the bottom ash and fly ash fractions from a large-size (246 MW) fluidized bed boiler at a power plant of a pulp and paper mill complex. In this article, we will present e.g. the differences in the physical and chemical properties of the bottom ash and two fly ash fractions obtained from the power plant of Stora Enso. Total heavy metal concentrations as a function of size fraction – for submission to the journal of the Chemical Speciation and Bioavailability.
- Winter 2010 - G. Watkins, M., Wierink, Industrial Ecology as trans-disciplinary science, a general theory paper on the IE metaphor and Bothnian Arc situation for submission to the journal Progress in Industrial Ecology.
- Winter 2010 - Mäkelä, M., Watkins, G, An integrated approach in the beneficial utilisation of steel, pulp and paper industry residues in soil amendment, we present the results of formulation trials, mechanical testing and leaching results. Abstract submitted to the Journal of Cleaner Production, Jan 2010.
- Spring 2010 – Ekroos, A., Husgafvel, R., Warsta, M., Watkins, G., A., N., Other, The renewal of the Waste Framework Directive: Implications for recycling of industrial residues – Does it really become simpler? Target journal not yet agreed.
- Spring 2010 – Mälkki, H, Pajunen, M., Watkins, G., Sustainable production – Environmental Policies, Legislation and Management Systems, Target journal not yet agreed.

- Summer 2010 – Mäkelä, M., Watkins, G, Novel symbiotic product development, opportunities and barriers to beneficial utilisation of steel, pulp and paper industry residues in soil amendment, we present an overview of the position wrt novel product development.

Other planned activities in 2010:

- MSc graduation - M Mäkelä
- Nordic Recycling Day, Oulu , 2-4 February 2010 – 2 Conference papers
- Yara Oy visit – Agricultural testing facility at Ojakkala near Vihti, G. Watkins and M. Mäkelä.
- Participation in all ProDoe initiated events, plant visits and any other TKK partner laboratory initiatives. i.e. ProDOE Summer Symposium on Sustainable Systems in Sannäs, Finland on June 15-17, 2010
- Licentiate of Science in Technology (Lic.Sc. (Tech)) graduation - G Watkins
- Conference papers to be prepared for 2nd International Conference on "Hazardous and Industrial Waste Management"- Hania, Crete, Greece Oct 2010.
- Tuli (Otaniemi International Innovation Centre) support being sought to assist evaluation of the initial commercial potential of novel product ideas and scope for patenting.

5.2 Professor Ekroos' research group

Professor Ekroos moved on to University of Helsinki. He is now working there as a professor of the environmental and energy law. Researcher Nani Pajunen continues her PhD studies in TKK (Aalto University) in environmental law and management and her new supervisors in her thesis are professor Erja Werdi and consortium leader professor Kari Heiskanen. In the new position professor Ekroos has three new researcher in his team: Eeva-Maija Pusa (LL.M.), Inga-Liisa Paavola (LL.M.) and student Iida Huhtanen.

Professor Ekroos's research is focused on material efficiency, energy and climate issues in legal point of view.

5.3 Professor Fogelholm's research group

1 journal article (Eloneva et al., 2009), 1 graduate thesis (Sarkimo, 2009)

The focus of our part of the research project is upon developing recycling processes for alkaline industrial residues for producing calcium-, magnesium- and iron oxides, -hydroxides and -carbonates. The objective is to refine slag products and simultaneously reduce CO₂ emissions by carbonation or by avoiding calcination of carbonates. The work consists of:

- Mapping of alkaline industrial residues in Finland (industrial infrastructure, characterization of residues and CO₂ emission reduction potential by utilization)
- Investigate and develop methods for carbonation of steelmaking slag and other slag products rich in calcium (e.g. paper process and recycling ashes)
- Investigate and develop methods for carbonation of copper and nickel slag
- Investigate and study methods for production of hydroxides or oxides from silicate-based slag products.
- Optimization of carbonation processes and integration with the paper and metal industry in order to save energy and raw material, close the material loops, and reduce CO₂ emissions
- Study the cycle of trace elements in the alkaline waste producing processes and the new carbonate processes being developed

Results and impacts 2009:

- Visits to Myllykoski Paper, Specialty Minerals (Myllykoski) and Vattenfall Myllykoski
- Feasibility of the invented a method, where aqueous solution of ammonium salt is used to extract calcium selectively from the steel converter slag, followed by precipitation of pure calcium carbonate by bubbling CO₂ through the formed solution was investigated. The method was calculated to have economical potential and clearly negative CO₂ emissions. Paper of the results was submitted to ICAE 2010 conference (Eloneva, Said, Fogelholm, and Zevenhoven: "Feasibility Study of a Method Utilizing Carbon Dioxide and Steelmaking Slags to Produce Precipitated Calcium Carbonate (PCC)")
- Quality of the residual slag from the CO₂ storage method utilizing steelmaking slags and ammonium salt solvents to produce CaCO₃ was investigated. Results were published in (Sarkimo, 2009) and journal article manuscript dedicated to this is also under work.
- Potential of soda ash waste stream from paper industry to capture CO₂ by bubbling CO₂ through the soda ash & water slurry was investigated. Unfortunately, this did not work in the tested conditions.

5.4 Professor Heiskanen's research group

The research work has focused on the survey of the material streams of selected industrial ecosystems, industrial waste management procedures within the area of Kokkola industrial park and possibilities on linking the by-product streams with other industrial ecosystems within the area, such as Boliden Rönnskär plant (Sweden) and Outokumpu Tornio stainless steel factory.

The group is responsible for organizing the Summer Symposium on Sustainable Systems (4S) which is a 3 day event for PhD and junior post doc students. The aim of the symposium is to bring together motivated young researchers with an interest in multidisciplinary systemic approaches to complex issues under the theme of closed-loop sustainable systems of materials ecology. The aim is that this new forum will create novel, innovative and interdisciplinary insights into the steps needed to move towards sustainable use of resources. Within this scope behavioral, cultural, economical, environmental, ethical, legal, managerial, regulatory, social, and technical issues are studied and discussed. This joint work will form the initial steps to chart the systemic nature of materials ecology and its complex interconnectedness. The central issues of the discussion will be the effects of systemic temporal and spatial boundaries, and scales on the metrics used to evaluate the effects of decisions leading to progress towards sustainable systems and closed-loop economy.

The symposium will provide you with concrete opportunity for active international networking, academic exchange and access to state of the art academic expertise. This Symposium is the first of its kind in Finland and is the first in a series of yearly symposia; we believe that growth towards sustainability requires development of an international research community. The 4S symposia form a professional basis for this key international co-operation.

Researcher Nani Pajunen moved into the Kari Heiskanen's team in the autumn.

International post- graduate training (M. Wierink)

- WISE- Waste in Social Environment Training Course, Madrid, Spain 8th- 13th October 2009

Acted as mentor. Theme: Human

- WISE- Waste in Social Environment Training Course, Linz, Austria, 10th- 15th May 2009

Acted as Team Leader. Theme: Biogas, Energy Supply

These programs are 100% funded by Marie Curie Actions of EC

Other (M. Wierink)

- Organizing 5 Innovative Material Stream (IMS) meetings for ProDOE researchers

- Supporting organization of ProDOE Kokkola Industrial Park Seminar 17.-18.12.2009

- Co-coordinator for Summer Symposium for Sustainable Systems, which will be arranged in Sannäs 14.-16. June 2010

Phd studies (N.Pajunen)

- Finished her last PhD courses

Visits

- Participation and poster presentation in "International Conference on Industrial Ecology: Transitions towards Sustainability", 21-24 June 2009, Lisbon, Portugal

Other (N.Pajunen)

- Reporting ProDOE Year 2008 to Finnish Academy

- Organizing ProDOE seminar in Lahti 29.-30.1.2009

- Organizing 4 Meetings for ProDOE

- Organizing 2 ProDOE teamdays

- Co-coordinator for Summer Symposium for Sustainable Systems, which will be arranged in Sannäs 14.-16. June 2010

5.5 Professor Hukkinen's research group

Impact of the research (visits, interviews, other activities)

Hukkinen, J.

- Reviewer of scientific articles: Ecological Economics (twice), Environmental Policy and Governance (once), Journal of Environmental Management (once).

- Member of Review Panel of Finnish Environmental Cluster Programme.

- Reviewer of application for Docentship in Forest and Environmental Policy, University of Joensuu, Finland.

- Visit by doctoral researcher Miklós Antal (Budapest University of Technology and Economics) to University of Helsinki, research on “Sustainability in governance networks”, 15.3.-15.10.2009.
- Visit by prof Jouni Paavola, University of Leeds, UK, lecture in the summer school of Graduate School of Science and Technology Studies, 26.-27.5.2009.
- Lecture at Rotary Club of Karjaa, Finland on “Unexpected environmental threats in the Baltic Sea”, 24.3.2009.
- Radio interview for Finnish Radio, YLE:n Aikainen on “Sustainable consumption”, 11.11.2009.

Salmi, O.

- Review-assignment (one/journal): Ecological Economics (Elsevier), Environmental Science and Technology (ACS Publications), Journal of Cleaner Production (Elsevier)
- External evaluator in Estonian Science Foundationin, research financing

5.6 Professor Härkki's research group

1 journal article (Leinonen, V.; Heino, J. & Makkonen H.), 1 diploma thesis (Kettunen, P.), 1 bachelor's work (Polet, J.)

According to research plan the researcher has with the help of many mutual meetings acquainted the research group of ProDOE and especially in the Innovative use of material streams (IMS) sub-project to utilize to the joint expertise in research group maximally. It has been made a very ambitious already partly fulfilled publication plan concerning both Bothnian arc industrial ecology enterprise within IMS and new feasible utilisation possibilities beyond the conventional usage of copper and nickel slags. Also information and networking from other ongoing projects in the Laboratory of Process metallurgy has been utilized.

As promised in original ProDOE application to get additional funding it has been made a very big and innovative application to EU Life+ concerning Bothnian arc industrial ecology enterprise, where the main target is to improve material and energy efficiency through both intra and inter company development work utilizing the unutilised energy and material residues from Finnish and Swedish metallurgical, chemical, and pulp and paper industries around the Bothnian Arc region.

As promised in the original plan seminars are planned for the discussion of obtained results with in-vited speakers present and contribution. The Nordic Recycling Day V in the beginning of the February 2010 will be very multidisciplinary academic seminar arranged together with ProDOE team and the Laboratory of Process Metallurgy in the Luleå University of Technology.

Other activities:

Started diploma thesis: Hulkkonen, J. Secondary iron raw materials and their effective utilisation from different Ruukki company place of business in Finland. (In Finnish)

Started bachelor's works: Hyvönen, H. The waste manganese from Boliden Kokkola Oy as raw material in the Outokumpu Tornio stainless steel making process; Salo, A. The reduction of iron oxide in nickel slag and Alila, M. The utilisation of fibre sludge from pulp and paper industry in the point of industrial ecology view. (In Finnish)

Heino's and Härkki's planning, arranging and contacting ProDOE team, the staff of the Laboratory of Process metallurgy in the Luleå University of Technology and representatives of the Oulu University when planning Nordic Recycling Day V seminar in Oulu 3th – 4th of February, 2010.