Developing knowledge and strategies for enabling and governing transitions to a low carbon society

Most of the research on low carbon society in Denmark has hitherto focused on developing scenarios and analyzing possible policy instruments, including market mechanisms, costs and impacts in relation to known options and impacts. The Danish Council of Strategic Research funds the four year research alliance “Enabling and governing transitions to a low carbon society” during 2010-2013. The aim of this alliance is to conceptualize the dynamics of transition processes towards a low carbon society by involving the diverse set of actors from consumers to governmental agencies, companies and organizations. Transition of the path-dependent, socio-technical regimes in the energy system is a governance challenge, since transitions need to occur simultaneously in different arenas without necessarily having a specific „centre” of co-ordination. Changes of regimes require innovative breakthroughs in technology, changes of institutional frames and changes in social practices, but also increased utilisation of well known solutions is important. The research alliance focuses in a number of inter-linked projects on five overall transition arenas in society: standards and certifications, households, companies, cities, and national and international policy. Theoretically the research alliance builds upon a combination of theories including social practice theory, innovation economy, institutional theory, actor-network theory and governance theory. Through a combination of historical analysis, case studies and action research, the research alliance analyses the roles of socio-technical experiments, creation and utilisation of „windows of opportunity” and stabilisation of changes in societal niches into regime transformation. The results of the alliance will comprise of: Methods which enable stakeholders to make continuous adjustments of objectives and means in unavoidably conflict ridden transition processes. Analyses of how key measures and institutions at different societal levels might contribute to transition processes. Characterisation of 4-6 typical sustainable transition set-ups as complex contexts, which are identifiable to actors in similar situations.
Sustainable transition of electronic products through waste policy

The European Union's Waste Electrical and Electronic Equipment (WEEE) directive makes a challenging case for transition theory and its different aspects, as it represents an ongoing and still open-ended case. At present the objectives of the directive are not met: the amount of electronic waste is increasing, and the resulting waste is poorly managed. With its starting point in the multi-level perspective of transition theory, this case study analyzes how the outcome of the WEEE directive is constituted in the interplay between the somewhat detached regimes of electronics and waste management. The two regimes are described and analyzed together with the underlying regulatory principle of extended producer responsibility, which has guided the design of the directive. Conflicting interpretations of sustainability, in combination with a simplistic understanding and agency introduced from the top-down, has eliminated waste minimization as the main outcome of the directive. The concluding discussions raise the issues of the role of sustainable niche initiatives in electronics compared to multi-regime interaction. Guiding visions may need to be supplemented with other alignment devices in order to support co-evolution of regimes and coherent actions within transition processes.

Reflections on product/service-system (PSS) conceptualisation in a course setting

Product/service-system (PSS) approaches have over the past decade received considerable attention as possible sustainable innovation strategies. This paper presents and reflects upon the background, rationale and experiences behind a PSS design methodology applied with engineering students in a project course for the past five years. The methodology proposes four complementary dimensions of PSS: value proposition, product life cycle, activity modelling
cycle and actor network, that all seem to comprehensively describe the essential conceptual design perspectives. Each of these dimensions represents an expansion of the traditional degrees of freedom for designers. It has been observed that the most promising PSS solutions seem to be those where the perspectives in all four dimensions are coherent and mutually support each other.

**General information**
Publication status: Published
Organisations: Engineering Design and Product Development, Department of Management Engineering, Innovation and Sustainability
Contributors: Tan, A., McAloone, T. C., Lauridsen, E. H.
Publication date: 2009
Peer-reviewed: Yes

**Publication information**
Journal: International Journal of Design Engineering
ISSN (Print): 1751-5874
Original language: English
Keywords: design teaching, PSS, service-oriented design, product life cycle, product/service-system design, design for sustainability, Product life, Design, Product and service development, Product life cycle, Product life cycle design, Product Service System, Product/Service-Systems, Product/Service-Systems (PSS), Service design
Source: orbit
Source-ID: 232786
Research output: Contribution to journal › Journal article – Annual report year: 2009 › Research › peer-review

**Appropriation of EMS standards in Thailand**

**General information**
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Lauridsen, E. H., Jørgensen, U.
Number of pages: 244
Pages: 130-152
Publication date: 2007

**Host publication information**
Title of host publication: New horizons in Asian management : Emerging issues and critical perspectives
Publisher: Palgrave
ISBN (Print): 978-0-230-01365-0
Source: orbit
Source-ID: 233028
Research output: Chapter in Book/Report/Conference proceeding › Book chapter – Annual report year: 2007 › Research › peer-review

**Kan miljøpolitik stimulere dynamisk teknologiudvikling?**

**General information**
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Jørgensen, U., Lauridsen, E. H.
Pages: 319-348
Publication date: 2007

**Host publication information**
Title of host publication: Økologisk modernisering på dansk : Brud og bevægelser i miljøindsatsen
Place of publication: København
Publisher: Frydenlund Academic
ISBN (Print): 978-87-7887-549-5
Source: orbit
Source-ID: 195428
Research output: Chapter in Book/Report/Conference proceeding › Book chapter – Annual report year: 2007 › Research › peer-review

**Sustainable transition of electronics products: WEEE and RoHS linking innovation to governance policies on electronics waste**
General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Jørgensen, U., Lauridsen, E. H.
Publication date: 2007

Host publication information
Title of host publication: Politics and governance in sustainable socio-technical transitions
Source: orbit
Source-ID: 233040

Waste prevention, waste policy and innovation
General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering, Danish Centre for Environment and Energy, Regional Environmental Center for Central and Eastern Europe, Danish Topic Centre on Waste
Number of pages: 228
Publication date: 2006

Publication information
Place of publication: Electronic
Publisher: IPL
Original language: English
Keywords: recycling, life cycle analysis, prevention, waste policy, innovation
Electronic versions:
ESTO waste final report - v4 - 5 October 2006-til-ipl-9.pdf
Source: orbit
Source-ID: 195353

Appropriation of EMS standards in Thailand
The implementation of ISO 14001 in Thai companies.

General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Jørgensen, U., Lauridsen, E. H.
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Asian Business and Management Journal
Original language: English
Keywords: environmental management
Source: orbit
Source-ID: 187330

Environmental Impact of the use of natural Resources (EIRES)
Executive summary Background The European Commission is preparing a "Thematic Strategy for the Sustainable Use of Natural Resources", the so-called "resources strategy". A first Communication on this was adopted by the Commission in October 2003 (COM 527, 2003), and the strategy is planned to be completed in 2005. The general aim of the resources strategy is "to develop a framework and measures that allow resources to be used in a sustainable way without further harming the environment". Objectives and scope The present report aims to support the development of the resources strategy by extracting and assessing the science-based evidence from eight recent studies that have been identified as relevant for understanding the environmental implications of resource use: *Labouze E, Monier V, Puyou J-B (2003). Study on external environmental effects related to the life cycle of products and services. BIO Intelligence Service and O2 France for the European Commission, Directorate General Environment. *Moll S, Acosta J, Villanueva A (2004). Environmental implications of resource use - insights from input-output analyses. Copenhagen: European Topic Centre on Waste and Material Flows. Draft manuscript, January 2004. *van der Voet E, van Oers L, Nikolic I (2004).
Dematerialisation: not just a matter of weight - Development and application of a methodology to rank materials based on their environmental impacts. Leiden: Centre for Environmental Studies at Leiden University. CML report no. 160.


(Arbejdssrapport 13). In Danish. Nijdam DS, Witting H (2003). Milieudruk consumptie in beeld (A view on environmental pressures on consumption) RIVM report 771404004). In Dutch. Rixt K, Falkena H-J, Bender G, Mol HC, Noorman KJ (2003). Household metabolism in European countries and cities - Comparing and evaluating the results of the cities of Fredrikstad (Norway), Groningen (The Netherlands), Guilford (UK), and Stockholm (Sweden). Toolsust Deliverable No. 9. Groningen: Center for Energy and Environmental Studies, University of Groningen. The objectives of the present study were to analyse and evaluate this existing body of research with a view to identifying those materials and resources whose use has the greatest environmental impacts. This should result in Conclusions on the present state of knowledge about the relationships between resource use, material flows and environmental impacts; and Proposals on how to approach future research in support of developing the environmental aspects of an EU resources strategy. Nature of the studies The common feature of the eight considered studies is that they aim at determining the driving forces behind environmental impacts and resource consumption in the European Union or parts of it. The considered studies cover a range of methodological approaches, ranging from top-down-approaches where impacts are determined from National Accounts Matrix extended by Environmental Accounts (NAMEA) to bottom-up-approaches where environmental impacts are determined from Life Cycle Assessments (LCAs). While all studies have been made with other purposes than supporting the EU's resources strategy, it has been analysed in the present study to what extent the results of the studies can be applied in the EU's resources strategy. It turns out that all of the considered studies do contribute to our understanding of what are the environmentally most relevant types of resource use, through identifying relationships between environmental impacts and specific material flows or product groups within the production and consumption realms. The immediate possibilities the studies offer to establish direct links between indicators of resource use and indicators of environmental impact are more limited and additional research would be required to explore such links. Types of environmental impacts considered Environmental impacts are typically classified in a number of impact categories of which the following are covered by most of the considered studies: Acidification Climate change (global warming) Ecotoxicity Human toxicity Nutrient enrichment (eutrophication) Photochemical ozone formation (smog) Stratospheric ozone depletion This set of well-established impact categories is commonly used and spans the main part of the environmental concerns that are presently generally considered important. Core activities at the origin of environmental impacts From analysing the data and models applied in the considered studies, it has been found that the by far largest share of the major environmental pressures affecting those environmental impact categories originate from a limited number of human activities referred to as core activities: Combustion processes Solvent use Agriculture Metal extraction and refining Dissipative uses of heavy metals Housing and infrastructure Marine activities Chemical industry Second order driving forces of environmental impacts The core activities can be seen as first order driving forces for the environmental impacts, themselves driven by second order driving forces largely in the form of market forces, ultimately reflecting human demands. The second order driving forces are the main focus of the considered studies, which look at products or product groups, sometimes aggregated in need groups, or material flows induced by these products. Due to the great variation in applied methods and scopes, the results show a complex picture at the detailed level. However, at the more general level the studies reinforce each other in pointing to housing (construction and temperature regulation), transportation and food consumption as covering a large part of the most important consumption domains driving the environmental impacts and resource use in Europe. Correlation and causal relationships between resource use and environmental impacts With the exception of Møll et al. (2004), the considered studies do not analyse explicitly the correlation or causal relationships between indicators of resource use and indicators of environmental impact. However, from the underlying data and models it appears that, apart from environmental impacts directly related to resource extraction, there are only few instances where the relationship between resource use and environmental impacts are straightforward, and thus a more obvious target for policies aiming to reduce the environmental impacts from resource use: The use of fossil fuels and "global warming potential" and "potential acidifying effect". Use of specific metals, where there is a clear and linear relationship to environmental impacts from metal extraction and refining. A reduction in use of these metals will lead to a direct reduction in the associated impacts. Area occupation, where it is the resource use itself that is of environmental concern. A reduction in area occupation will reduce the pressure on biodiversity. Construction materials, where the resource use drives the waste stream, albeit mostly with a significant delay corresponding to the lifetime of the constructions. This list is, however, only indicative at this stage, and further systematic analysis would be needed to consolidate it (see below). It should be noted, furthermore, that even in those cases where causal relationships may be established it is unlikely that these relationships will be linear, especially at the aggregated level. Methodological alternatives Two main approaches have been applied in the studies considered: bottom-up and top-down, each with specific advantages and disadvantages. The main advantage of the process-based bottom-up approach is its ability to treat each product or material separately in great detail. However, at the same time, it is notoriously incomplete when it comes to covering all activities involved in the production processes. In contrast, the main advantage of the input-output based top-down approach is its completeness. Since it takes its starting point in the national accounting matrices, it includes by definition all activities, materials and products in the economy. Its main disadvantage is the implicit assumption of homogeneity of the industries, i.e. that all products from an industry are assigned the same environmental impact per monetary unit. Methodological aspects are addressed in further detail in a following ESTO project: Evaluation of the
Environmental Impact of Products (EIPRO). Knowledge gaps

Based on the information and experience gathered from the eight studies and the critical assessment hereof, the following knowledge gaps with respect to development of the resources strategy have been identified:

1. **Lack of systematic insights into the causal relationships between resource use and environmental impacts, and therefore of possibilities to give consolidated advice on priority needs in policy development.**
2. **Persisting weaknesses in environmental impact assessment models.** Proposals to develop further the scientific input concerning the environmental aspects of the resources strategy.

Three different strategies for closing the knowledge gaps and developing further the scientific input to the resources strategy are proposed.

1. **Exploit more thoroughly the models behind the existing studies with a focus on the relation between resources and environmental impacts.**
2. **Make a selection of the resources a priori seen as most relevant, and perform for each of them Substance Flow Analyses or other adequate resource-specific analyses.**
3. **Set up and use for the analysis a detailed European NAMEA (National Accounts Matrix extended by Environmental Accounts), specified from the outset in a way that takes into account the information needs of the EU's resources strategy (European top-down approach).**

The first strategy can probably be realised for a limited investment of 100,000+ Euros. It gives, however, not a structural information basis that can be easily updated. The investment in the last two strategies is probably of a similar order of magnitude (some two million Euros each alternative). Strategy 3 actually covers similar research as Strategy 2, but it is more systematic with the advantage that a structure is built that lasts and allows for regular and relatively cost-effective upgrading and updating. If a major investment will be made, the authors express a clear preference for Strategy 3. Improved and more comprehensive scientific input to the resources strategy following such lines is clearly recommended, but for effective policy development, it should be provided in close relation to parallel research and dialogue on:

* A precaution-based approach to a resources strategy building on existing knowledge.
* An approach based on the scarcity of resources in Europe and globally.
* An approach building on equality among the different parts of the world.
* The requirements of different methods of linking the state of the environment to resource consumption (through materials, product groups, consumption areas etc.).
* The abatement strategies used in cases of resources where policies are already in place.

General information

Publication status: Published
Organisations: Department of Management Engineering, Innovation and Sustainability, Netherlands Organisation for Applied Scientific Research - TNO, 2.-O LCA Consultants APS
Contributors: Nielsen, P. H., Tukker, A., Weidema, B., Lauridsen, E. H., Notten, P.
Number of pages: 89
Publication date: 2005

Publication information

Publisher: European Commission
ISBN (Print): 92-894-8801-8
Original language: English
Keywords: Material flows, Environmental regulation
Source: orbit
Source-ID: 187332
Research output: Book/Report › Report – Annual report year: 2005 › Research

Environmental professional competence - the role of communities of practice and spaces for reflexive learning.

General information

Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Jørgensen, U., Lauridsen, E. H.
Pages: 57-67
Publication date: 2005
Peer-reviewed: Yes

Publication information

Journal: Greener Management International
Issue number: 49
ISSN (Print): 0966-9671
Ratings:
Scopus rating (2005): SJR 0.166 SNIP 0.331
Web of Science (2005): Indexed yes
Original language: English
Source: orbit
Source-ID: 187876
Research output: Contribution to journal › Journal article – Annual report year: 2005 › Research › peer-review
Catalyzing alignment processes
This paper describes how environmental management systems (EMS) spur the circulation of processes that support the
collection of environmental issues as specific environmental objects and objectives. EMS catalyzes
alignment processes that produce coherence among the different elements involved in societal and industrial
environmental awareness and improvements. The coordination of these elements – covered by the notion of coherence –
is seen as the most important mechanism for bringing about a change in environmental impact. The elements comprise of
regulatory regimes and available technology, the networks of environmental professionals that work in the environmental
organisation, in consulting and regulatory enforcement, and dominating business cultures. These have previously been
identified in the literature as individually significant in relation to the evolving environmental agendas. They are here used
to describe the context in which environmental management is implemented. Based on findings from contributions to a
research program studying the implementation and impact of EMS in different settings, we highlight the diverse roles that
these systems play in the Thai context. EMS may over time and in combination with other social processes establish more
aligned and standardized environmental performance between countries. However, examples of the introduction of
environmental management suggests that EMS' only plays a minor role in developing the actual environmental objectives
and following this also in setting the agenda for companies’ environmental focus. The paper develops this argument
through a number of empirical examples supported by a theoretical framework focusing on the complex interactions
involved. This framework stresses how the EMS are dependent of the context they are implemented in and how the
changing context is reflected in the environmental objectives that are established and prioritised. Our argument is, that the
ability of the standard to achieve an impact is dependant on the constitution of 'coherent' environmental issues in the
context, where the management system is applied.
Disciplinary Fragmentation in Comprehensive Issues

The geographical and spatial proximity of the activities in the Songkhla Lake Basin ties the region together through the common use of the lake waters as a resource or a discharge media as well as a regional economy, the capacities of a common workforce, local demographic features and the social welfare of the population at large. This paper suggests that the Lake Basin must be described and analyzed as a comprehensive issue which integrates an understanding of the uplands of the lake as more than watersheds. A literature survey was performed searching major international research databases for all English language references to Songkhla and Southern Thailand. The survey shows that the existing literature can provide a quite detailed picture of the pollution of the lake and rivers as natural phenomena. The chemical and biological characteristics of the waters are described, as well as some of the immediate sources of pollution. Other but more remote sources that are also located in the watersheds of the Songkhla Lake Basin are not described in relation to the Songkhla lakes; agroindustries as palm oil and rubber. Also the more indirect effects of the present development with regards to social and economic factors are not subjects of specific analysis in the literature. They can to some extent be derived from the assumptions of the articles on environmental planning. Socio-economic data are available as statistics for the area, but they are not related to the concrete sources of environmental degradation of the lakes. Articles on environmental planning contain a more integrated understanding of the environmental degradation as a result of social activities. But also here the scope of the studies tend to be limited to the water related issues. The results of the literature survey indicates, that the existing research suffer from disciplinary fragmentation. Most of the literature appear to focus on specific and very detailed descriptions of specific issues in different scientific fields of investigation rather than clarify the complex relationships between socio-economic factors and environmental degradation.

General information

Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Lauridsen, E. H.
Publication date: 2004

Host publication information

Title of host publication: Integrated Lake Management
Place of publication: Hat Yai
Publisher: Prince of Songkla University
Source: orbit
Source-ID: 178090
Research output: Chapter in Book/Report/Conference proceeding → Article in proceedings → Annual report year: 2004 → Research → peer-review

Industrial developments challenging planning and research endeavours around Songkhla Lake

The unique character of the Songkhla Lake Basin (SLB) and its regional status as the southern region of Thailand has brought this area into attention both in the national and international policies for regional development. SLB has matched the international planning interests in managing water resources to counter environmental degradation as well as the focus on regional developments including the variety of aspects involved in building a sustainable future including economic development, cultural diversity, natural resources and environmental protection. Besides from a national strategy for energy supplies and industrial development in the SLB developed in relation to the central role of the SLB in the Thai Malaysian ‘southern growth triangle’. Two major studies have focused on the coupling of economic and environmental developments leading to major plans for SLB. The Thai government has had several broad committees engaged in supporting these planning issues and resolve the conflicts between different stakeholder interests in the regions development. The paper gives an overview over the types of problems that have been addressed in these major plans and studies and the types of managerial and technical solutions that have been suggested in relation to the pool of available scientific knowledge on these issues. In both scientific practice and in regional planning there is an implicit anticipation of an acting body and a coherent object of study and control. The acting body is seen as a political subject (e.g. in the form of a government or an agency) that can take on the task of changing the course of development while the body to be managed is considered available for investigation and manipulation. In relation to the SLB a series of large committees have been established, but the specific outcomes of the planning and the scientific result seem to be rather limited. In an attempt to find an explanation to this gap between planning and advice on one hand and the implementation on the other, it is important not only to look for policy answers. These would typically be ‘lack of political will’, ‘lack of stakeholder participation’, ‘no coherent and coordinated plan’, ‘lack of institutional capacity’ and ‘too diverse interests’. These may have certain relevance but the basic multitude of scientific contribution each focusing on single aspects of the problem and the complex character of the problems raises the need for a much more diverse set of actions. Where the big planning
The third case story describes the environment, which is constituted in the context of the voluntary self-organised procedures and practices, is a stronger representation of the environment than the comparative representation of smell, which is managed and regulated, and not smell because noise through its embedding in measuring instruments, concrete problem of noise is established as one of the most pronounced results of the formal regulation, even though the is successful in limiting the consequences of the formal regulation of smell imposed by the authorities. At the same time a used by the company to establish a wide interpretative flexibility of the representation of smell. By doing this, the company stabilised by delegating authority to a number of norms, so that they are empowered to select and specify the essential conditions of the environmental area by neighbours, the nature conservation society, civil servants and local politicians. In this situation, the authority of the local administration fails to keep the existing regulation of the factory as a stable construction. The regulation is re-enrolled and translated through a crucial scientific network in order to take part in the 'political' negotiation processes. The theoretical discussion has two main lines. The one is a discussion of how representations of the environment function as mediators, i.e. as knowledge transfer agents inside science as well as between science and politics. The other is a discussion of how this boundary between science and politics contributes to the constitution of the environment, so that this appears as characterized by partly pre-structured domains, called environmental regulatory arenas. The empirical basis of the thesis is a case study of how the concrete environment is constituted in and around the mineralwool factory of Rockwool A/S in Hedehusene south of Copenhagen. The thesis presents three case stories using the case company as a point of departure, each reflecting the constitution of concrete environmental problems on a specific environmental regulatory arena. The first case story is on how the EU classification norm determining potential cancerous effects from mineral wool fibres, is set up. This case story describes how environmental problems become concrete on the 'norm-regulation arena'. The classification norms are constituted as heterogeneous elements, when themes of the public environmental discourse and standard scientific practice are mobilised, enrolled and translated through a crucial scientific network in order to take part in the 'political' negotiation processes. The mineralwool fibre is at the centre of a 'scientific' construction, where it is also the fibre itself that is translated, (re)defined and becoming an entity. The concrete fibre does not appear as a product of an open-minded scientist uncovering the secrets of nature, but rather as a product of meticulous negotiation processes, where 'political' conflicts of interest are incorporated into a scientific procedure. The second case story is on how the case factory is awarded an environmental permit by the local environmental authorities. This case story describes how environmental problems become concrete as specific conditions on the 'administration arena'. The environment constituted with the conditions of the environmental permit, is a product of interpretation and juxtaposition of a number of relations of production, as the case company has to account for the environmental problems caused by different production processes. The case describes how in particular two environmental problems are developed through this process: an 'original' smell problem, and a 'new' noise problem. The smell problem contributes to a large extent to the factory being conceived as an environmental nuisance in the local area by neighbours, the nature conservation society, civil servants and local politicians. In this situation, the authority of the local administration fails to keep the existing regulation of the factory as a stable construction. The regulation is re-stabilised by delegating authority to a number of norms, so that they are empowered to select and specify the essential environmental problems. However, in the concretizing of the smell problem the lack of precise smell measurements is used by the company to establish a wide interpretative flexibility of the representation of smell. By doing this, the company is successful in limiting the consequences of the formal regulation of smell imposed by the authorities. At the same time a concrete problem of noise is established as one of the most pronounced results of the formal regulation, even though the noise problem hardly existed as a general concern before the development of the environmental permit. Thus, it is noise which is managed and regulated, and not smell because noise through its embedding in measuring instruments, procedures and practices, is a stronger representation of the environment than the comparative representation of smell. The third case story describes the environment, which is constituted in the context of the voluntary self-organised
environmental efforts of the company, as an ISO 14000 environmental management system is implemented. The case describes the conception of the environment prescribed with the DEPA’s ‘product-oriented environmental initiative’, and how this conception is incorporated into the process of concretizing the environment as part of the case company’s environmental accounting and established priorities. These efforts in the company to establish well functioning concrete environmental problems are juxtaposed with the standardised prescriptions of how the self-organised environmental effort shall uncover an environment, which has already been made an attribute of nature. The environmental priorities of the company were made by a pragmatic combination of especially technical possibilities and economic considerations. The management, which established the priorities, characterises the result as established on ‘common sense’. However, in the public environmental account the significant environmental aspects of the company are not presented as a result of practical consideration, but rather through the categories of the scientific life-cycle assessment methodology. The prescriptions for the self-organised environmental efforts are thus incorporated into the company’s environmental efforts through a scientific account of the company’s “significant environmental aspects”, but the prescriptions are not contributing to the concrete development of the company’s specific environmental priorities and goals. At the end of the thesis there is a thematic discussion based on the case stories. The recurrent theme is how the concrete environmental problems are developed in parallel with and as a part of the environmental regulation. The concrete environmental problems are a result of a meeting between the administrations continuous attempts to develop essential descriptions and the complex and heterogeneous networks that in practice constitute the environmental problems as manageable identities.

General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Lauridsen, E. H.
Number of pages: 282
Publication date: Oct 2003

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
ISBN (Print): 87-91-03554-6
Original language: Danish

Changing settings - changing roles - The different conditions of EMS in Thailand and Europe
The context for implementing environmental management systems is crucial for how they work and which impact they can provide.

General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering, Chiang Mai University
Contributors: Jørgensen, U., Lauridsen, E. H., Koottatep, S.
Publication date: 2003

Host publication information
Title of host publication: Papers for GIN2003
Keywords: environmental management, ISO 14001, cross-cultural
Source: orbit
Source-ID: 63685
Research output: Chapter in Book/Report/Conference proceeding – Annual report year: 2003 – Research

Coherence in Industrial Transformation
The notion of coherence is used to illustrate the general finding, that the impact of environmental management systems and environmental policy is highly dependent of the context and interrelatedness of the systems, procedures and regimes established in society.

General information
Publication status: Published
Organisations: Innovation and Sustainability, Department of Management Engineering
Contributors: Jørgensen, U., Lauridsen, E. H.
Publication date: 2003
Gud er død - bestemmer ekspertene miljøet?

General information
Publication status: Published
Organisations: Department of Technology and Social Sciences
Contributors: Lauridsen, E. H.
Pages: 45-48
Publication date: 1999
Peer-reviewed: No

Publication information
Journal: Ernærings- og husholdningsøkonomen
Issue number: 2
Original language: Danish
Source: orbit
Source-ID: 172363
Research output: Contribution to journal › Journal article – Annual report year: 1999 › Research

Projects:

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01/02/1997 → 02/12/2003
Award relations: Tekniske miljøvurderingsværktøjer
Project: PhD

ESTO-WASTE: Waste prevention, waste policy and innovation
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Forsk. EU - Andre EU-midler: DKK1,500,000.00
01/11/2005 → 30/08/2006
Award relations: Waste prevention, waste policy and innovation
Project: Research