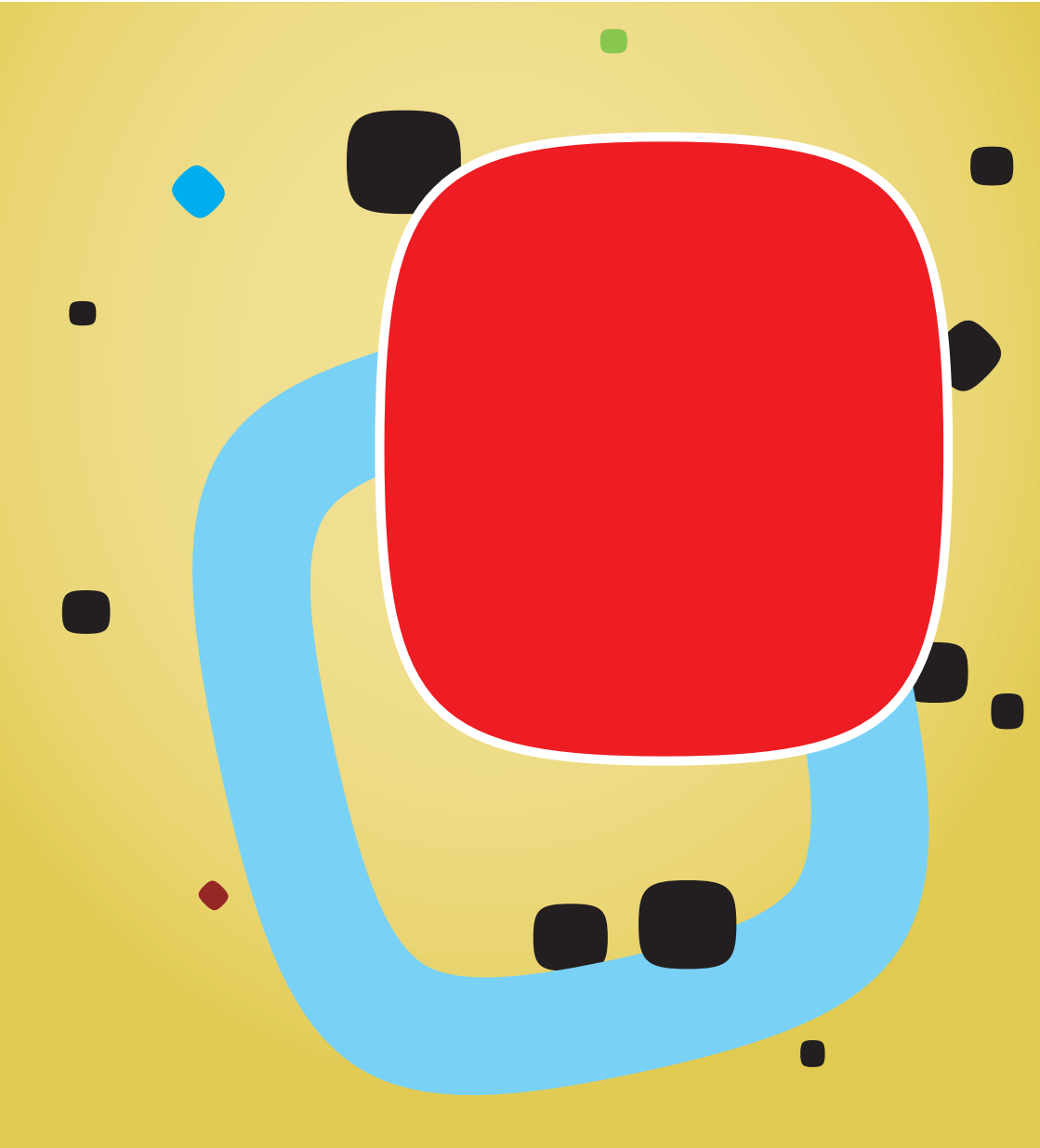


“Pathways to our common future”

Proceedings of The Alliance for Global Sustainability
Annual Meeting 2007
18-21 March, Barcelona, Spain



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**Editors:
Sebastien Rauch
Greg Morrison
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Preface

Pathways – a common theme for The AGS Annual Meeting 2007

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The AGS annual meeting

The AGS annual meeting has been given the title “pathways to our common future” to remind us that it is now two decades since the Brundtland report (after which the term sustainable development became widely known, debated and for many, accepted), but more importantly to reflect the emphasis on developing The AGS pathways concept. This annual meeting will focus on pathways for energy and food/water systems in carefully planned forums. Here I will guide you through the annual meeting after a short introduction to the pathways concept and to the energy and food/water flagship programs.

The pathways concept

We have a clear aim for the pathways concept; to investigate and present alternative pathways into the future (usually near and medium term) for social and technical systems. These alternative pathways are to be made available both to society and academia.

Tools for investigating pathways cover the range of systems approaches that attempt to look into the future and include scenarios, adaptive strategies, trend analysis etc.

The logo consists of a red rounded square containing the text "Energy Pathways Flagship Program" in white, stacked vertically.

Energy flagship program

At the 2005 annual meeting The AGS inaugurated the first of its “flagship” research, education and outreach programs with a focus on the transition to more sustainable energy systems. Entitled, “Near-Term Pathways to a Sustainable Energy Future” the Energy Flagship Program recognizes that “sustainable energy” refers not just to individual clean technologies, but how such technologies can collectively transform regional energy infrastructures over time. Such transitions or “pathways” are a long-term process, where near-term actions related to the development, deployment and use of sustainable energy technologies determine how fast a path, once found, can be followed. Identifying such robust, technologically grounded infrastructure pathways - and the policies that encourage their implementation - is a key element of the AGS Energy Flagship

Food and water flagship program

The AGS Food and Water Flagship program on “Secure ecosystem services for a nourished world” was launched at the annual meeting 2006. It will identify development paths for social and technical systems which aim for a nourished world in balance with the provisioning ecosystems. The heart of the program is data and knowledge bases that reflect requirements of the AGS integrated model system, the latter including biophysical, economic and geographic models. Models of the complex and dynamic nature of food and water systems will provide a solid foundation for descriptions of the future, a future which we will foresee through social and technical system pathways. Pathways will be tracked by combining stakeholder dialogue with the modeling results to provide a combined actor-modeling procedure.

About the meeting

As a basis for the meeting we have invited a limited number of guest speakers to provide inspiration to the delegates and to provide ideas for the forums. Guest speakers will present in plenary on the morning of days 1 and 2. Additionally supporting papers which are considered cross-cutting have been assigned to the day 2 plenary.

We have selected 64 supporting papers and 34 poster abstracts which provide valuable information for developing the alternative pathways. These are printed in this proceedings and are both numbered and in first author alphabetical order for your convenience.

The poster session is on Monday evening with a significant number of contributions looking at approaches and advances in education for sustainable development. The AGS considers learning as an integral part of the pathways concept.

The forums are divided into three working sessions

1. The first forum sessions (Monday afternoon) are termed pathseeker and aim to provide a state-of-the-art in the following four areas
 - Energy - technologies and systems
 - Energy - policies for changing course
 - Energy – biomass and biorefineries
 - Food and water – aspects of water systems

Each forum session has been assigned up to 10 supporting papers for discussion. Presenters are asked to respect the 5-10 minute time-frame and follow the instructions on the website (which states three slides and details what is expected to be presented on each).

2. The second forum sessions (Tuesday morning) are termed pathfinder and aim to bring the pathways systems approach into the forum discussions. The supporting papers have been placed into three areas
 - Energy – policies and pathways
 - Education – advances in support of the pathways approach
 - Food and water – aspects of water systems, policy and pathways
3. The third forum sessions (Tuesday afternoon) are termed pathmaker and will be devoted to discussions on alternative pathways in two areas
 - Energy
 - Food and water

Each forum session will be chaired by one or more persons from the team of four moderators. These moderators will in turn be backed up by facilitators and by students taking notes of the discussions. The moderator team will be involved through the forums and present the alternative pathway findings at the final forum panel sessions (pathwalker) on the Wednesday morning.

Results of the meeting

The alternative pathway findings will be collated in a written form after the final panel and communicated to all delegates of the annual meeting. The results will also be fed into the AGS flagship programs and used to provide a common platform for the intensive research being carried out. We also encourage delegates to continue to engage with the AGS and find ways to fund mutually beneficial activities in support of the flagship programs.

Biography of keynote speakers

Eiichi Abe

General Director of the Nissan Science Foundation

Mr. Eiichi Abe is Managing Director of Nissan Science Foundation. He is an authority on vehicle, specifically on hybrid electric vehicle and fuel cell vehicle for solving environmental problems. The aim of NSF (Nissan Science Foundation) is to “Create Solutions for Social Progress” and its priority fields are environment, automobiles, and education. NSF is the sponsor of AGS education program “NISSAN Workshop in IPoS.”

Christian Azar

Researcher and advisor to the Swedish government on climate affairs

Christian Azar’s background is in physics and he is currently a professor of energy and environment at Chalmers University of Technology, Sweden. His research focuses on climate change mitigation strategies (including energy systems modeling, technology assessment and policy analysis). He is on the editorial board of several international scientific journals and has been a lead author of the Intergovernmental Panel on Climate Change. He has offered more than hundred lectures to policy makers, business leaders, environmental organizations and the general public on energy, sustainability and climate change. He is a member of the Swedish government’s scientific council on climate change, and he was a member of the former Swedish Prime Minister’s oil commission (2006), and he has been an advisor to Margot Wallström in her capacity as EU Commissioner on the environment.

Alan AtKisson

Founder the AtKisson Group and Executive Director of Earth Charter International

Alan AtKisson’s professional career has been dedicated to advancing global sustainability for nearly twenty years. From 1988-92 he edited the pioneering journal *In Context*, which covered sustainability and innovation from a systems perspective. In 1991, he and several colleagues founded Sustainable Seattle, a civic initiative that created the first comprehensive set of indicators for urban sustainability. The initiative was recognized with local and international awards and was copied around the world.

In 1992, Alan founded the AtKisson Group, now a global network of affiliates who provide leaders in sustainability with training, planning, assessment, and strategic planning support. Alan has personally consulted to over one hundred

cities, companies and public sector agencies around the world. Alan now serves as Executive Director of Earth Charter International, which coordinates the global Earth Charter Initiative. The Charter is an international declaration developed during the 1990s and released by an independent global Commission initiated by Maurice Strong and Mikhail Gorbachev.

Dennis L. Meadows

The great author of Limits to growth

In 1972 Dennis Meadows led the research team at MIT that produced one of the ten most important environmental texts of the 20th century. Limits to Growth was translated into over 30 languages, and it prompted many people to start considering the longer-term implications of popular policies governing economic growth. Dennis Meadows has been working on that issue for over three decades. He has been a professor and institute director at three universities over that period. He has lectured in over 40 nations. His ten books and numerous environmental management games have advanced the application of competent systems science to many global issues. His work has earned him many awards - three honorary doctorates from European universities, the Order of the Hungarian Republic from the President of Hungary, a Fulbright Fellowship to the USSR, to mention just a few.

Manuel Ángel Soriano Baeza

Sustainable Development Manager Holcim España

Manuel Soriano Baeza is a chemical engineer, degree achieved at the “Escuela Técnica Superior de Ingenieros Industriales” in Seville. He also has a Master in Business Management and Administration from the ICADE. He has developed a wide professional activity in the manufacturing and services sectors in large group companies such as Air Products, Dragør, ABB, and as an independent consultant.

He has been working for Holcim España since 1997, where, after an initial stage as General Manager of the waste management company, he has become the Director of the Sustainable Development Department, likewise, President of Flacema (Labor Andalusian Foundation of the Cement and the Environment) and Member of the Management Council of ASEGRE (Special Spanish Waste Management Association).

Mathis Wackernagel

Founder and Executive Director of Global Footprint Network

Mathis Wackernagel created, with William Rees, the 'Ecological Footprint' - a widely-used measure of sustainability. He is a founder and Executive Director of Global Footprint Network. This organization supports the creation of a sustainable economy by advancing the policy-utility of the Ecological Footprint. The goal is to make ecological limits central to decision-making everywhere. Mathis has lectured at over 100 universities and worked on sustainability issues for organizations on all continents but Antarctica. Mathis has authored or contributed to over fifty peer-reviewed papers, numerous articles and reports, and various books on sustainability that focus on the question of embracing limits and developing metrics for sustainability, including *Our Ecological Footprint: Reducing Human Impact on the Earth*, *Sharing Nature's Interest*, and WWF International's *Living Planet Report*.

He has advised governments, companies, and civil society organizations on all continents on the possibility of living well, within the limits of one finite planet.

Frederic Ximeno i Roca

General Director of Environmental Policies and Sustainability, Catalan Autonomous Government

Frederic Ximeno (Barcelona, 1967), is General Director for Environmental Policies and Sustainability of the Government of Catalonia since december 2006. His background is in biology (UB), with an MSc in Regional and Urban Studies (UPC-UPF-EAPC).

His professional career, in the private sector, has been dedicated to environmental, regional and urban planning, and to the definition of local strategies from a sustainability perspective. He has been working in Estudi Ramon Folch, ERF (2003-2006), a GFE-SOCINTEC (1997-2003) and CEP-Centre d'Estudis de Planificació (1993-1997).

supporting papers

1. PROSPECTS OF URBAN SUSTAINABLE ENERGY IN IRAN

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Key words: *renewable energy, sustainability, Iran*

1. Introduction

A significant increase in global energy consumption is likely to happen in the forthcoming decade. This increase can not be met in the long run by fossil fuel based power supply, without very serious consequences for the global environment. Moreover, Socio-political transformation, technological innovation, economic restructuring and global net working have influenced the positions of our cities and regions in the world by make them keep changing now days. This also holds for the cities in developing countries; they faced with the urgent need to solve the problems such as poverty, housing and unemployment. On the other hand, they are also facing the need to generate competitive advantages in order to be sustainable and pull through in the vicious national or international competition [4], [5].

Strategies towards sustainable energy

An environmentally sustainable energy system of a city can only be gained by initiating suitable policy strategies which rely on three major schemes.

- A reduction of the use of scarce energy through e.g. behavioural change
- An increase in technical energy efficiency through improving the insulation, using heat pumps and district heating
- A common introduction of new sustainable technologies such as photovoltaic systems, hydropower and wind energy

2. Sustainable energy development obstacles in Iranian urban areas

The shift of population from rural areas to large urban areas in Iran is the major reason for socio-economical change in this country. This is mainly because of the attraction of living in urban areas due to the lack of educational and health care services as well as the proper job market in rural areas. This has faced Iran with highly populated urban areas in a state of flux.

3. Renewable energy development in Iran

The per capita electricity consumption in Iran has increased from 156 KWh in the year 1966 to 2015 KWh in the year 2001[1]. During the recent years environmental pollution, population increase, per capita electricity consumption and rapidly growing capital investment for conventional energy supply systems, have made the ministry of power of Iran to invest on utilization of renewable energy resources to produce electricity [2].

Hydroelectric power plant

Water power has been utilized to generate electricity for more than half a century and it accounts for 8% of total electricity production in Iran [1]. Hydroelectric power plant has additional advantages such as flood control and a mean for regulation irrigation and drinking water supplies. Moreover, due to the fact that Iran has a considerable potential for developing hydroelectric power, all have lead to a substantial effort and investment on hydroelectric power plants in recent years.

Wind power

Iran enjoys a moderate supply of wind power. The potential energy form wind is estimated about 6500 MW in Iran. Regarding the fact that some regions in the country have a good potential for generating the electricity from wind, some initial steps has been taken to make use of this potential by making two wind farm with the capacity of 25 MW and 60 MW in Manjil [3].

However, considering the potential the investment is insignificant. Wind farms demand extensive use of land surface and create environmental/sociological problems related to birds, noise and electro magnetic interference. Moreover, comparing the other energy sources they don't have competitive price and price facilitation is not sufficient to repay the initial expenses. Hence, wind farms development is suffering from unpopularity in most part of the world.

Solar Power

Generally, climate conditions can act as major bottleneck to the actual continuation of concrete public initiatives. This is true about European countries where long and foggy winter occurs. However, Iran is potentially one of the best regions for utilization of solar photovoltaic systems. The average sunlight hours are exceeded to average 3200 hours in city of Yazd[2].

Geothermal energy

The geothermal energy has been estimated to provide 1400 MW of power in Iran. Ministry of energy has initiated a project to utilize this source of energy in the region of Ardebil with the capacity of 100 MW [2].

4. Conclusion

Based on total energy production in Iran in 2001, only 8.9% of total amount of energy production was generated from renewable resources which hydro power account for 90% of it and the rest was the share of wind power, solar, and other renewable energy sources [1]. Iran has a considerable potential for the utilization of renewable energy especially hydro power and solar energy. However, the level of development of such energy sources is rather small. Proper distribution of subsidies, utilization of resources, and adaptation of new laws would have a significant effect on the future sustainable energy growth in Iran.

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2. KEY TECHNOLOGY OF WIND TURBINES FOR SUSTAINABLE SOCIETY STRESSING ON JAPAN AND ASIAN AREA

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Key words: *wind turbines, typhoon, prediction of electric power, offshore*

1. Introduction

The total amount of wind turbines exceeds 70GW now in the world and the potential is the largest among the new renewable energy. But it is very slow to introduce it in Japan and Asian countries comparing with Europe and USA because the weather conditions in Japan are different from others. The detailed observation of wind and new technology development of turbines are so important that one Japanese project of NEDO (New Energy and Industrial Technology Development Organization) is organized to propose the new guidelines of wind turbines technology in Japan which is also available for other Asian countries. In parallel, the precise prediction of electric power with wind turbines is required for increasing the penetration in the grid of electricity. The complex terrain of mountain area and complicated motion of typhoon suppress the reliability of previously developed simulation method in Europe. The another NEDO project aims to develop new simulation technique for accurate prediction of electric power from wind turbines in these complicated area of weather. Furthermore offshore wind farms can increase the total amount of wind turbines because the area of ocean is extraordinary large in Japan and Asian countries. But the new concepts of turbines and platforms should be developed such as huge size of turbines and floating system which are now in the process of the detailed investigations as the third project in Japan. These new key technologies are essential to the growth of penetration in wind turbines for Japan as well as Asian countries including China and India where they will have the lack of energy in near future and strong impacts for global sustainability.

2. New guideline for wind turbines in Japan and Asian area

Typhoon is a key element for Japanese weather and its strong wind prevents ones from installing wind turbines.

The most important method is that a map of maximum wind speed for every 20 or 50 years is produced and turbines to put up with these wind speeds should be installed. The second point is that a new class of wind turbines for stronger wind is designed for special area with fail-safe system for accident. The guideline for the map of wind speed and the new design of wind turbines will surely play important role in its penetration in Japan as well as Asian area. Of course this guideline will be available in other monsoon area of the world and extend the possibility of

sustainable society with wind power.

3. Precise forecast of electric power with wind turbines in Japan

The difficulty for wind turbine penetration in Japan is that Japanese electric companies request developers of wind farm to produce electricity of good quality and to forecast the amount of wind power generation one day ahead precisely. The forecasting system was originally developed in Europe, but it is not available in Japan and some countries where there are complex terrain such as mountains. The next generation of forecasting system is being developed in Japan and will be applied for other countries in future, which makes it possible to easily cooperate with other generation systems.

4. Proposal of offshore wind farms with new technology

The new type of offshore wind farms is required in Japan because the depth of sea in the offshore becomes larger. The floating system is a good candidate for deep water as well as a so-called jacket type for bottom basin system. If these systems are introduced, the total amount of capacity will increase to ten times as large as that of onshore wind farms. The turbines should grow up to 10MW of 150m diameter where the new design and material will be required. For example, the carbon fiber composite is a key technology for rotating blade because the weight becomes one-tenth comparing with the ordinary system. The authors have already used it for the new design of small size of wind turbines named as “Airdorphin” shown in Fig. 1. The potential of offshore winds is so large that the wind power can support the sustainable society in the world.

5. Conclusions

These new technologies and ideas lead the pathways to sustainable society in the framework of new renewable energy. Although the technology of wind turbines looks mature for a glance, the new ideas in all fields of science and engineering can be easily combined for their improvement and further penetration so that the system of wind turbines continues to develop. The research and development for Japanese type of turbines described in this paper will be surely a common sense especially for the area of monsoon climate in the world.



Figure 1: Wind turbine of new materials for high performance

3. A TECHNICAL AND ECONOMIC ASSESSMENT OF THE POTENTIAL OF UTILISING RICE HUSK FOR HEAT AND POWER PRODUCTION IN VIETNAM

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Key words: *rice husk, biomass, clean development mechanism*

1. Introduction

The use of agricultural residues as fuel for heat and power production can play an important role as a bridging technology towards a sustainable energy system. Rice husk is a residue from rice milling and is produced in large amounts in Vietnam, the second largest rice exporter in the world. Approximately 20% of the paddy grain weight is made up of rice husks which have a lower heating value of 13.9 MJ/kg. Today, large amounts of rice husks are dumped in the Mekong River Delta (MRD) every year. Therefore, by using rice husk as a fuel in the energy sector of Vietnam, dual environmental benefits can be achieved. Since rice husk is a carbon neutral fuel it can, with the application of appropriate energy conversion technologies, contribute to lowering the global CO₂-emissions and reducing local environmental problems.

Rice husk can be combusted or gasified for heat and power production. This is done in several countries around the world on different scales. Energy demand within the rice milling industry can in this way be met through the use of their own process residuals. At the moment, there are no operating plants of this kind in Vietnam. Some of the reasons are the low electricity price, lack of successful domestic projects for the promotion of the technology and lack of sufficient incentives for renewable energy, which makes it difficult to compete with traditional power production technologies. At present, independent power producers are paid approximately 4 US¢/kWh. With the introduction of the Clean Development Mechanism (CDM) of the Kyoto Protocol, the economy of rice husk energy projects can be improved by the generation and sales of Certified Emission Reductions (CERs). Furthermore, rice husk ash also has an economic value, primarily within the steel and the cement industry, and can bring additional revenues to the project. The impacts of CDM funding and rice husk ash sales on the economy of a rice husk energy project are investigated in this study. The overall aim is to assess the economic potential of utilising rice husk for heat and power production in Vietnam.

2. Methodology

Given that there are varying sizes of plants with different technologies operating in the world today, the size and configuration of a suitable plant was unknown. Thus, in order to investigate how rice husk can be used to produce heat and power in an

economical way, three different sizes of power plants are studied. The electricity generated will be supplied to the rice milling industry or delivered to the national grid. The different options assessed in the study represent power plants of sizes 300 kW_{el}, 3 MW_{el}, and 20 MW_{el}. Energy conversion technologies are either gasification or combustion, based on steam turbine technology. Both power only plants and combined heat and power plants are included in the study.

A field study was carried out in the Mekong River Delta. The aim was to assess local conditions at three different sites to further investigate the feasibility of the three options. For each of the three options an analysis is made to identify technical systems suitable for power, and possibly, heat production. Parameters of significance are size, power and/or heat technology, energy product distribution and fuel supply situation. The economic performances of the options were compared with each other, with other projects and to assess the commercial viability of them within the particular setting of Vietnam. The economic analysis includes benefits from CDM funding and ash sales and contains an investment analysis and electricity production cost calculations. It also comprises of a sensitivity analysis of important parameters.

3. Results and Discussion

The analysis shows that for the reference case, including the electricity distribution system but excluding CDM and ash, it is very difficult to reach a competitive production cost. As expected, the unit cost of production is decreasing with size, due to economies of scale. However, the alternative cost of production is dependent on whether the electricity is sold directly to rice mills or to the national grid. This implies that a direct comparison of production costs is not possible. With the additional revenues of CDM and ash, all options are well below their respective alternative costs of electricity. The influence of CDM and ash sales on the cost of production gives a reduction of about 30%, assuming an ash revenue of 50 US\$/ton and a CER price from 5-7 EUR/CER. The ash revenues improve the economics of the options to a larger extent than the CDM. By applying only ash revenues all options can produce to a lower cost than the alternative cost, but the future development of the ash market is uncertain. The influence of CDM, albeit more modest, will still render all but the small scale option economically viable.

If production cost is lower than the alternative cost of electricity the project is economically competitive, but when evaluating the options with each other, several aspects must be reviewed, not just the cost of producing electricity. Examples of important aspects in the Vietnamese setting are purpose of the project and access to funds. Purposes could be to add more electricity to the national system or to enhance the economic viability of the rice mill(s) by reducing the electricity cost or eliminating disposal problems. It should be emphasized that the options are not mutually exclusive and an optimal solution could contain more than one of these options.

4. INTERNATIONAL BIOENERGY TRADE - THE PROSPECTS FOR LARGE-SCALE IMPORT OF BIOMASS AND BIOFUELS TO SWEDEN

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Key words: *Biomass potential, Biofuels, International bioenergy trade, Sweden*

1. Introduction

Traditionally, biofuels have been used mainly in the region where they are produced. However, it has been indicated that large-scale intercontinental trade in biofuel or bulk transport of wood for energy could be economically feasible. International trade in energy from biomass has also been envisaged as a feature of the future global energy system and should thus be considered one important aspect for pathways to sustainable energy systems. Sweden is one of the biggest consumers of biofuels in the EU. It could be expected that the use of bioenergy would be based on domestic biomass resources. However, at present, Sweden is one of the largest importers of biofuels in Europe and imports approximately 18-32 PJ of biofuels annually. Policy development in Sweden and other regions (not least EU) will determine the direction of future biomass/bioenergy flows. A study of bioenergy trade from a Swedish perspective can –besides giving insights about the Swedish case- provide information about aspects that may influence how the international biofuel trade will develop.

2. Aim

The use of biofuels in Sweden is projected to increase and the future demand can be met by production based on domestic resources, import of solid and liquid biofuels, and import of biofuel feedstock for subsequent conversion to biofuels in Sweden. There are many factors influencing the balance between these supply options. In a prospective situation with an early establishment of a Swedish industry for the production of lignocellulose-based biofuels, large-scale import of biofuel feedstock may become a prerequisite for the competitiveness of this industry. This motivates an evaluation of the prospects for a large-scale import of biofuels to Sweden. This has been done by assessing selected issues that are judged crucial for the development of Swedish biofuel use and trade.

3. Main findings

Based on the survey of critical issues linked to large-scale Swedish biomass and biofuel imports, we draw the following conclusions:

High prospects for Swedish and global biofuel supply

Swedish biofuel resources allow for a substantial increase in domestic bioenergy supply. But Sweden will have to import biofuel feedstock to support a biofuel industry capable of exporting substantial volumes of biofuels, for instance, to Europe. Global assessments indicate that available biofuel resources could support an international biofuel trade of the order of hundreds of exajoules (EJ). However, this would require plantation establishment at rates much higher than at present. It must also be emphasized that the assessed potentials are based on the present understanding of prospects for agricultural development, land use change, and –not least– climate change. There are also assessments arriving at more conservative estimates of the bioenergy potential (less than 100 EJ)

Attractive transport cost

The estimated cost of ship transport (including handling) is low enough to make long-distance biofuel transport economically attractive. However, the cost is dependent on future competition for transport and port capacity. In a situation of scarcity, freight rates may become higher than those indicated by the cost estimates.

Global freight capacity can accommodate global biofuel trade

The future potential of global biofuel trade is small but not insignificant in relation to global freight capacity. Compared to the estimated growth of freight capacity, the increase in biofuel trade flows required for reaching its estimated potential appear to be large enough to influence seaborne trade patterns in the world. Current specialization in Swedish ports might in the short term (perhaps 5-15 years) act as a barrier to a rapid increase in biofuel import. There are also limitations related to the infrastructure and storage capacity linked to ports.

Low environmental impact

The energy input in long-distance biofuel transport, as well as the environmental impact, is estimated to be low. To make large-scale biofuel trade flows acceptable, special attention must be paid to factors such as the impact on biodiversity and socioeconomic conditions in the exporting countries.

5. SUSTAINABILITY SCIENCE: COMPLEXITY AND RISK

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Key words: *Risk, complexity, dynamic systems*

1. Introduction

From the requirement to ensure that the needs of future generations are not compromised has evolved the science of sustainability – basically the dynamics of multiple, complex and interrelated systems over time and space. Such a science must consider system boundaries, limits and resilience, time-delayed feedback mechanisms, integrated social, environmental, economic and technical factors, non-linear relationships over short, medium to long term timeframes and risks to systems^{1,2,3,4}. This paper discusses some of the issues to be considered in assessing sustainability, using water as an example.

2. Human Needs

The provision of human needs first requires an understanding of those needs and the systems which supply them. Engineers and planners usually undertake demand rather than needs analyses when designing or upgrading an infrastructure system, particularly for water and energy. Thus, what originally is a demand becomes a need once the delivery system allows the use to meet that demand capacity. For example, the requirement for residential water could be reduced to the need for drinking, cooking and bathing/washing (with reuse of washing water for small crop production). However, because a wastewater treatment system is often included in the urban infrastructure, significant volumes of water are then needed to shift wastewater to a central treatment plant. The movement of such water volumes and the operation of the treatment system require energy and thus this system now included ‘engineered needs’ for water, energy and infrastructure. Our current economic structure contributes to increasing demand as increasing profits promotes selling increasing volumes of water and energy. There is a notable lack of research on basic needs, those required for ‘quality of life’ and the resources we should be maintaining for the future. Research into ‘needs’ has ignored the quantitative, material requirements to fulfill those needs. A better understanding of the key material needs is essential.

3. Systems

The provision of needs, e.g. food and water, is based on a complex interaction of environmental, social, governmental, technical and business systems. The provision of food often focuses on the production of crops, yet the failure of any of the aforementioned systems will result in an inability to supply food. For sustainability, the function of those systems which fulfill needs must be effective and sustained.

Thus an understanding of the systems, their key functionalities and dynamics and the interactions of the various systems which supply the needs is essential. It is likely that most such systems are complex rather than chaotic or linear. The provision of food and water requires that the production, transportation and delivery systems must be maintained. Each system is both spatially and temporarily located and may also be dynamic over both space and time; crops and productivity will change from year to year in a specific location so that food may be sourced from a variety of locations and affording resilience to the system. Current piped delivery systems limit water sources though, which decreases resilience, increases risk and thus jeopardises sustainability of the water supply.

Another factor to consider is that once a community builds infrastructure to supply a specific need, e.g. building pipelines to supply water from a distant source, then future generations become reliant on the infrastructure, source and system function. This places an economic, social and technical burden on future generations to maintain and upgrade that infrastructure. The risk to the community increases if the source system is under control of another governing body which may not consider the interests of the community as paramount in the system's management.

4. Risk

The probability of system failure to provide needs is the basis for sustainability as this is the only means to assess the ability to provide for needs for future generations. The risk is that of multiple interactions affecting system function and capability to supply the need. Assessing complex risk requires development of a model which shows the critical linkages, system boundaries, feedback mechanisms and relevant weak points of the systems. This means that the relevant systems must be mapped as is done for life cycle inventories and the major influencing factors on the overall system are then identified. The criticalities of the overall, integrated system can then be identified and managed.

5. Managing criticalities

Current managing of criticalities often entails increasing complexity through technology or management. Both of these can result in an increase in 'engineered needs', thus increasing the burden on resources and society. At the same time, redundancy also assists in providing system resilience. Research is required to provide some guidance as to the balance between increasing redundancy and hence resilience vs increasing complexity and the probability of system failure. For example, by requiring water tanks be installed on all buildings, the number of sources increases, thus increasing the resilience but not necessarily the technical or administrative complexity.

Overall, sustainability can only be assessed using risk. The system in question must be scoped to determine the factors which influence its function, including system interactions, boundaries, limitations, resilience and dynamics. The risk to that function must then be assessed to identify and manage criticalities. Significant

research is needed to better understand the function of complex, dynamic systems in order to develop sustainable strategies for food and water management. It must be noted that the science of sustainability is highly complex and the specific system dynamics are usually localized; yet a wide range of professionals and the public want simple solutions to sustainability, particularly for supplying basic needs for water, food and energy.

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6. A THREE PART STRATEGY FOR ACHIEVING CLEAN, RELIABLE ENERGY SERVICES

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Key words: *energy pathways, energy security*

1. Combined Solutions to Energy Security and Environmental Performance

Two major energy challenges face modern society: the reliable cost-effective supply of energy services, and providing those services in an environmentally responsible manner. The popular press reports on these issues as global phenomena—international energy markets and climate change’s global commons of the atmosphere.

However, when we look at the energy solution space, how to transform our demand for energy services, and the future energy infrastructures that link renewable resources to responsible consumption, much happens at the national, regional and local level. Below are the three key recommendations our group at MIT and Cambridge University made to the UK’s Department of Trade and Industry in their Spring 2006 Energy Review. [1] They apply equally well to all net-energy importing countries, developed and less developed, and probably energy-rich countries as well.

2. Aggressive Energy Efficiency

Strategies which radically reduce an economy’s energy use and intensity go a long way to meeting the combined energy security and environmental goals. If they can be crafted to reduce imported and/or high carbon content fuels first, then a strategy with an aggressive energy efficiency component can make substantial, early gains in increasing energy security and reducing greenhouse gas emissions. Reduced energy consumption has both technology investment and utilization dynamics. Fossil fuel use can be reduced in personal transportation by promoting more fuel efficient vehicles, by “diluting” fossil fuel consumption with ethanol or biodiesel, by reducing distances commonly traveled from home to work, by reducing traffic congestion, and by improving the quality and frequency of public transportation. Such a strategy *requires a detailed understanding of energy use patterns*, and how those consumption patterns can be modified, or met with advanced technologies—including information technologies.

The technological responses will be a *combination of improved energy conversion/ consumption efficiency* (more efficient lamps, motors, etc.), *energy utilization efficiency* (smart buildings that turn lights off and temperatures down, hybrid vehicles where engines turn off at signals, etc.), and *integrated energy efficiency* (cogeneration).

3. Diversify Domestically

Diversifying the energy mix through the increased and responsible use of domestic energy resources, further reduces the nation's exposure to tightening global markets for petroleum and natural gas. While some of these energy options are large centralized facilities (nuclear, coal with carbon capture), many are more geographically distributed, with significant daily, seasonal and inter-annual variability in both space and time. Tapping a much greater proportion of renewable resources, whether for power generation, or as a feedstock for alternative fuels (ethanol, biodiesel, hydrogen), *requires a detailed understanding of the size, temporal and spatial variability*, as well as quality of each renewable resource. Such dynamics may compensate or compound when different portfolios of renewables are examined. For example, a portfolio reliant on hydropower and bioenergy (fuel crops) will be vulnerable to droughts. Are wind-hydro, or solar-hydro portfolios equally vulnerable? These dynamics need to be well understood, and then factored into the design of energy policies.

4. Modernise the Network

The third component connects the first two, and focuses on upgrading the energy delivery network, on both an energy delivery and information basis, to handle the combined dynamics of efficient and responsive energy demands, and diverse and changeable supplies of energy. The degree to which the energy infrastructure requires modernization is directly linked to our understanding of the quantity, quality and location of domestic energy supplies, and opportunities presented by making energy services, including microgeneration, more responsive to “system state” and “market conditions”. The transformation of the energy sector to one more reliant on local energy resources will require an upgrading of energy delivery systems to handle the regionalization of renewable energy resources, inter-regional transfer of centralized nuclear generation and remote and/or offshore wind to load centers, and the collection and transportation of diverse, voluminous biomass energy feedstocks to “biorefineries”. Intelligent expansion of energy networks should enhance, not degrade, the overall operational reliability and robustness of fuel and power networks.

5. Transforming Energy Infrastructures

These three components of an integrated energy pathway identify a need for strong governmental action encouraging investments in the fuel and power delivery networks, as well as increased innovation in energy markets for the development, deployment, and use of novel energy services, on both the demand and supply side.

There are no “low investment” energy strategies. All energy infrastructure investments are large, it is just that some like end-use efficiency improvements, non-fuel renewable facility development, and energy network investments tend to have greater up-front costs. Governments need to encourage these activities, now.

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7. ATRAZINE DISPERSION IN THE YAMASKA WATERSHED, QUÉBEC (CANADA)

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Key words: *Pesticides, Modelling, Yamaska watershed, Fugacity, Agriculture, Quebec*

1. Introduction

Nowadays, progress done in the protection of plants and fields with chemicals has undoubtedly contributed to crop yields increase and production regularity. However, the use of pesticides in agriculture has become an important issue due to their toxicity [1]. As a consequence, agencies in both governmental and non-governmental levels have agreed on making their environmental impact assessment a priority. In Québec, very agricultural area (1 638 450 ha), the average application rates are estimated at 1,3 kilograms of active ingredients per hectare annually whereas the Yamaska watershed (478 400 ha, agriculture dominated by corn and soya) experienced rates up to 1,8 kilograms [2;3]. Rivers are particularly vulnerable to pesticide pollution. As an example, atrazine shows a very long residence time in aqueous phase, with negative impacts on water quality and animal health. For many years, researchers have noticed the presence of this chemical in every sample they collected and analyzed [4]. Almost 30 tons of atrazine were applied by agricultural practice in 2004. Although it shows a weak tendency to volatilization, concentrations up to 1900 pg/m³ have been found in air samples around that time in Baie St-François, North-west Yamaska region. Such observations of atrazine concentrations in the atmosphere result in significant loads to the Yamaska watershed.

2. Aim and methodology

A first modelling impact assessment has been carried out in the framework of National Agro-Environmental Standards Initiative demonstration program (NAESI), aiming at implementing standards for good agricultural practice concerning pesticides. The dispersion of a chemical emitted in the environment depends in the most part on its physico-chemical properties as well as its rate of emission and the environmental properties of the media. Therefore we used ChemCAN for the study, a level III fugacity model specifically designed for use in Canada. According to the systemic approach, ChemCAN represents the environment as a four compartments open system in which the contaminant evolves, using the fugacity concept as means to quantify inter-media exchanges and advective inflows from the outside as well as concentrations at equilibrium state [5]. The model was run to understand and evaluate the fate of atrazine under the regional conditions. The characteristics

of atrazine were in the model data to which we adapted its half-life degradation time to agricultural soils [6]. Environmental data (e.g. weather conditions, average temperature, soil characteristics etc...) were gathered to set the model to the specific watershed of study.

3. Results and discussion

The results from the modelling (see figure 1) shows that inter-media exchange after atrazine application is mainly from soil to water via runoff. Air pollution is due to advective inflows from neighbouring regions via wind added to erosion effects and mid-day applications (leading to higher volatilization). A scenario that would reduce the quantity of atrazine applied by 25% does not lead to high decrease in water concentration but if assuming an extra 80% decrease in runoff, the model shows a reduction around 37% (figure2).

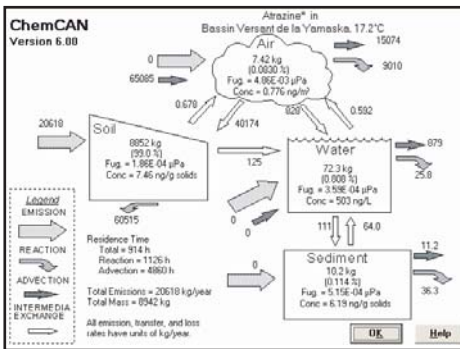


Figure 1: Atrazine concentrations with a business as usual scenario

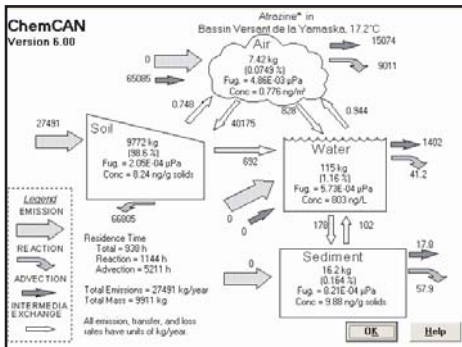


Figure 2: Scenario with 25% reduction of atrazine and 80% runoff reduction

Numerous simulations were carried out to analyze which parameters had the most influential effects given the context. Results clearly present runoff and advective inflows as the most influential parameters on concentrations in water: 55% of the atrazine found in water results from direct air-water exchange or atrazine deposition. Indeed, the Yamaska watershed receives high flows of atrazine from upwind regions. We can assume this comes partly from erosion factors but running the model for higher daily temperatures (around 25°C) results in significant increase in

volatilization and explains why air concentrations turn out to be so high. Therefore, although emissions from farmers, mostly transmitted into water by runoff, have a great influence at local scales, they only represent 18,5% of the total concentration of atrazine found in water samples at regional scale. Thus considering the overall trend of the wet and dry depositions, it appears that rural fittings, that prevent excessive runoff, will only be able to lower concentrations of atrazine up to 45% in the aquatic media. Overall, considering the air inflows of atrazine by advection from rural areas, efforts must be made both in the everyday application and rural fittings. That is, change the time of spraying, avoid windy conditions for spraying, use direct sowing, convincing farmers into respecting three meters strip etc... And the National Agro-Environmental Standards has a role to play for implementing these good agricultural practices.

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8. FOOD AND WATER AS A CLAIM FOR HUMAN SECURITY

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Key words: *human security, human development, quality of life*

1. Which social and technical innovations can promote pathways to a nourished world?

Climate and land use change, ecosystem service depletion, poverty, power inequality, among others are factors that will most likely increase the number of people at risk of hunger in the coming decades. Their impacts will most likely depend on the level of economic development and poverty reduction strategies applied in those countries where all these elements affect many areas of life including human welfare, domestic and international policies, trading patterns and resources use.

Food production is high on the list of human activities and ecosystem services under threat from dangerous anthropogenic interference in Earth's climate and other elements¹. Therefore in the analysis of impacts, other cross-cutting questions to respond will be hence to enquire specifically: Where do measures matter most? And how much will impacts be reduced through innovative social and technical means?. Availability of food and water is a concern in all countries but integrating sustainable development policies could be a way to improve the prospects to achieve long-term environmental goals meeting development needs of the least-developed countries. The demand for ecosystem services is now so important that trade-offs among services have become the rule. The problem though, is now posed by the growing demand for ecosystem services, compounded by increasingly serious degradation in the capability of ecosystems to provide these services.

Water is a key example of the latter statement. Overcoming the crisis in water and sanitation is one of the great Human Development challenges of the early 21st century. Water, a basic human right, is at the heart of a daily crisis faced by countless millions of the world's most vulnerable people. Indeed it is a crisis that threatens life and destroys livelihoods on a devastating scale. Unlike wars and other global casualties, crisis in water does not make media headlines. Nor does it galvanize concerted international action. Like hunger, deprivation in access to water is a silent crisis experienced by the poor. Therefore it characterizes a type of crisis that is holding back human progress, consigning large segments of humanity to lives of poverty, vulnerability and insecurity.

Certainly water problems are not acutely felt by everyone in the same way. As the global Human Development Report 2006 depicts:

“The availability of water is a concern for some countries. But the scarcity at the heart of the global water crisis is rooted in power, poverty and inequality, not in physical availability. Nowhere is this more apparent than in the area of water for life. Today, some 1.1 billion people in developing countries have inadequate access to water, and 2.6 billion lack basic sanitation. Those twin deficits are rooted in institutions and political choices, not in water’s availability.”²

All this brings about a new challenge to institutions and civil society to democratize access to both; food and water as a claim for Human Security. This type of defense denotes human protection of peoples’ vital freedoms from critical and pervasive threats and situations building on their strengths and aspirations. It also means creating systems that give people the building blocks of survival, dignity and livelihood. Human security connects different types of freedoms - freedom from want, freedom from fear, and freedom to take action on one’s own behalf. Therefore outcomes for the poorest and most vulnerable people in society will be determined by the way institutions and governments put equity concerns at the centre of national policies.³

We finally fall under the well-being and quality of life discussions.⁴ Whether it is a Techno Garden (a globally connected world relying strongly on environmentally sound technology), a Global Orchestration (a globally connected society reactive to approach ecosystem problems but also takes strong steps to reduce poverty and inequality), a view of the Order from Strength (a world concerned with security and protection); or an Adapting Mosaic (where local ecosystem management strategies are supported) according to the Millennium Ecosystem Assessment; these pathways represent viable socio-political scenarios to strengthen and enhance for a sustainable nourished world.

Other initiatives suggest that in general, privatization is not the answer, because most ecosystem services are public goods. But we do need to adjust market incentives to send the right signals to the market. These methods include: Ecological tax reforms (taxing *bads* not goods, remove perverse subsidies), full cost pricing (i.e. www.trucost.org) linked to investment fund management and ecosystem service payments scheme, remove environmental and labor externalities to allow sustainable trade to occur⁵ among many other related innovative socio-economic measures.

Human Security (HS) is overall a concern with human life and dignity and its four existential characteristic include; that it is a universal concern, that the components of Human Security are interdependent (pollution, climate change, biodiversity loss, terrorism, etc; are no longer isolated events); that HS is easier to endure with early prevention than later intervention and that it entails a *people-centered* approach. After all when people have the opportunity to fulfill their most essential human needs this will ensure “their full contribution to development – their own development and that of their communities, their countries and their world.”⁶

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9. UPCO₂: A PROGRAM TO REDUCE THE GHG EMISSIONS IN THE UNIVERSITY

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Key words: *GHG emissions, energy efficiency in buildings.*

In the middle of 19th century, an outstanding Argentinean wondered how it was possible for the British men to pay the highest price for taking away the Argentinean wool and at the same time to import the cheapest coats in Argentina. Where was the trick? Now we know it: the British productivity that made this miracle possible was based on a system that released carbon from the lithosphere into the atmosphere. The secret was to externalize some costs for which all of us have to pay now.

The Kyoto Protocol has transformed the greenhouse gas (GHG) emissions in an aim of the economic activity. First of all because the emissions are limited. Then property titles are handed out by giving emission rights to the countries. And finally a market to exchange these emission rights would be created.

The development of any activity requires utilities which are provided by the consumption of different products. And these products are made by processes generating GHG emissions, normally due to the use of energy from fossil fuels. This means that any activity has associated GHG emissions and therefore it will be affected by the Protocol.

The manufacturer of the products and the supplier of the services will need to improve their production processes in terms of GHG emissions, reducing them per every unit of product or service provided. The Kyoto Protocol will force these agents to find new processes considering the new costs of emissions.

Taking this context into account the whole Technical University of Catalonia (UPC) as an institution considers that it should adapt to the Kyoto Protocol new frame. As a result, the UPCO₂ program has been created to reduce the GHG emissions associated to the UPC. It has the following objectives:

- to evaluate the emissions associated to the UPC activity
- to design the most efficient strategies to reduce them (kg saved CO₂ / invest €)
- to implement and to evaluate the strategies
- to introduce the emission reduction as a new value into the UPC
- to spread the results and the experience to the society

Basically, the sources of GHG emissions in the UPC are:

- the obligated mobility of its near 40.000 members (students, professors, administrative and service staff)
- the consumption of the necessary resources to carry out the activities of education and research, especially, the necessary energy for the buildings (near a hundred in 400.000 m²)
- the emissions due to material manufacture of the new constructions and equipment in the UPC

There are several reasons for UPCO₂'s first activities to specially focus on the emissions due to building:

- in the UPC Sustainable Plan 2015 arranging the environmental actions in the University, there is a preferential line about building and climate change, - in the field of the emissions arisen by building, the UPC has an own know-how with large possibilities of development, there is the opportunity to get aids to invest in energy efficiency in buildings

UPCO₂ activities related to construction consist of analyzing which are the factors that affect the GHG emissions, which is their importance, which strategies would be possible to apply to reduce them and to reduce their cost. The factors that affect the emissions are:

- energy demand of the building. It includes energy demand for air conditioning, artificial lighting and services.
- emissions efficiency of energy installations: efficiency of the systems and emissions depending on the kind of energy.
- use and management. Differences between occupancy rate designed and real. Management of energy resources by users and staff.

Specific assessment tools have to be developed in each area, and also the relations between them. Tools for the said demand and energy factors are already quite developed, while those for use and management still need to be found. There is no point in considering GHG prediction and evaluation separately, since management determines them. The final result should articulate new global points of view, letting us to understand a building as an efficient product according to GHG emissions needed to obtain building's main utility: habitability.

Gaining experience in definition and use of prediction and measure systems for GHG in buildings and its standardization inside the Kyoto Protocol frame are some of the expected benefits from UPCO₂ actuations in buildings. They could be used as clean development mechanisms (CDM) or any other saving measures considered inside the Protocol.

Design of buildings should be understood from the new GHG emissions efficiency points of view. This knowledge could be therefore applied to other areas outside UPC.

10. DISPATCH MODELING OF A REGIONAL POWER SYSTEM - INTEGRATING INTERMITTENT POWER GENERATION

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Key words: *wind power, power system modeling*

1. Summary

The past decade has seen a significant growth in wind power in Europe, and wind power is by many considered to be a key technology in a sustainable power generation system. However, in order to make possible a large scale integration of wind power, while safeguarding a high security of supply, economically acceptable ways to handle the variations in wind power production need to be identified. This paper presents a model, which has been developed to study the effect of large-scale integration of variable wind power in a power generation system which includes base load plants.

The model optimizes the power production of each power plant in the system so that the electricity demand is met at the lowest systems cost. As more wind power is introduced to a power generation system, periods during which other power plants are uneconomical to run become more frequent. Whether it is economically advantageous to shut down these plants in such a situation, or to keep them running, depends on the length of these periods. The model is designed to evaluate which alternative that is favorable from a systems perspective. Under the assumptions given, the model results suggest that power plants with low start-up costs or high load turn down ratio will maintain their production as the wind power production increases, while units with low load turn down ratio and high start-up costs have to decrease production.

2. Background

Since wind power production is subject to uncontrollable variations, wind power plants must be combined with other plant types to achieve an economically and socially acceptable power generation system. The result of the introduction of wind power in a typical power generation system can be seen as a bridging system, i.e. a system which typically is dominated by thermal units. When constructing the model an effort has thus been made to include the ability/inability of thermal power plants to respond to the wind power variations. The questions in focus have been; How should thermal units be run to balance the wind power variations in the most cost effective way and how will this way of running thermal units influence power system properties such as emissions and marginal costs? The work is a first step in finding a methodology to study integration of variable RES based power generation in the AGS project “Pathways to Sustainable European Energy Systems”.

3. Model

A mixed integer programming approach has been used to model the alternative ways that the power plants can choose to handle variations in wind power production and power demand. The model assigns each thermal power plant with a minimum power production level and a start-up cost. In order to identify occasions of a startup an integer variable is introduced, which indicates whether the plant is running/ready to run or not. As long as the power plant is running/ready to run, the minimum power production level assures that the production does not take values lower than the physical limitations of the plant (i.e. corresponding to the load turn down performance of the plant). The possible increase in power production of a running unit is available to the system as reserve capacity.

The reserve capacity answers to production variations within 15 minutes. The more wind power that is

introduced to a power system the more reserve capacity has to be set aside. In this model the relation between reserve capacity and wind power developed in previous studies have been used, and each time step it is required that a sufficient amount of capacity is set aside to form a reserve. A 15 minute time resolution can thus be avoided. The time resolution of the model is instead set to one hour in order to be able to consider the start-ups of the power plants. Western Denmark has been used as a case study for the work, i.e. the model simulations have been carried out for the power system of this region and with data from 2005.

4. Results

Initially wind power was assumed to be prioritized, as wind power producers in Western Denmark are guaranteed to sell the power they produce. Simulations suggest that in a situation where wind power is sold on the market the wind power plants would still be profitable to run at all times that power production is possible. This is explained by the low running costs of wind power plants compared to fuel consuming plants. In both the prioritized case and the market case it is thus up to the fuel consuming units to compensate for variations, both in wind power production and power demand.

Three scenarios have been applied to the region; one scenario without wind power, one with the present wind power capacity and one with a 50% increase in wind power capacity. Simulations suggest that the number of start-ups of the thermal units will increase with installed wind power capacity. Simulations also indicate that the utilization of units with low start-up costs or low minimum production levels is marginally affected by the wind power production, whereas the utilization of units with high start up costs and high minimum production levels will decrease as the wind power production increases.

In the study, units with high start-up costs and high minimum production levels (low load turn down performance) are large coal fired plants designed for base load

production. These units have low running costs, whereas gas fired units have lower start-up costs but higher running costs. In the simulations, as described previously, the units with low start-up costs, and high running costs, were used to the same extent in a system with wind power as in a system without wind power. The marginal cost of electricity therefore did not decrease as the wind power capacity increased, despite the low running costs of wind power.

The model can also be used to visualize to what extent the wind power replaces domestic power production and to which extent it is exported. In the case of Western Denmark the simulations suggest that a 50% increase in wind power capacity would increase the amount of replaced domestic power production per unit of installed wind power (under the assumption that the transmission capacity remains unchanged). This would result in a larger decrease of carbon dioxide emissions per unit of installed wind power than today, despite the increased number of plant start-ups. Western Denmark can thus install wind power to get closer to its Kyoto undertakings also in the future.

5. Conclusions

A dispatch model of a regional power generation system has been developed and applied to Western Denmark. The model results suggest that wind power variations introduce aspects that influence the competitiveness of the thermal units in the power system relative one another. The influence of large scale wind power grid penetration can only be revealed if the power production of the system is optimized on an hour-to-hour basis, taking flexibility aspects, such as start-up costs and minimum power production levels, into consideration. It is therefore suggested that models of this type is utilized when investigating bridging systems including large-scale wind power.

11. SUSTAINABLE DEVELOPMENT INDICATORS (SDIS) FOR URBAN WATER SYSTEMS: CASE STUDIES EVALUATION OF THE THOHoyANDOU AND MAKHADO (LOIUS TRICHARDT) MUNICIPALITIES, SOUTH AFRICA

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Key Words: *SDIs, Urban Water Systems*

Sustainable urban water systems is defined as one which over a long time perspective provides required services while protecting human health and the environment, with a minimum use of resources. 20 SDIs were proposed and categorized in terms of four environmental and technical systems: freshwater, drinking water, wastewater and sewage sludge. Each system was represented by a number of dimensions broken down into indicators, selected on the basis of five criteria, which are: move towards or away from sustainability, availability of data of sufficient quantity and quality to provide spatial and temporal trends, non-overlap of the indicators, ready existence of goals and objectives and the ease of understanding the information to be relayed by the indicator.

The 20 SDIs were evaluated for water systems of Thohoyandou and Makhado (Louis Trichardt) Municipalities using benchmarks to assess the performance of each indicator in the two municipalities;

- (i) to assess water and waste water systems in each of the two municipalities based on the performances of the indicators if they are moving towards sustainability;
- (ii) to make recommendations to water services authorities in the municipalities on measures that would move their systems towards sustainability if they are currently running non-sustainability.

16 SDIs were found to be useful for the current situation in the study area and were recommended for future studies (Table I). Some SDIs like raw water withdrawal, drinking water quality, drinking water consumption, drinking water quality, waste production loads to receiving waters, access to drinking water, sanitation and development indicators were easy to apply in the study areas as data were easily available. Some of the SDIs like access to water and sanitation, water quality and affordability of services (economic indicator) were similar to the Key Performance Indicators of the South African Department of Water Affairs & Forestry. The current situation for many of the indicators studied for the water and wastewater systems is not moving towards sustainability and some improvements are necessary in the operation of the systems to make them sustainable.

Table I: Summary of data availability, relevance/suitability, awareness and scores for applied SDIs in the study areas

SDI	Data Availability	Awareness	Relevance/ Suitability	Score
Category: Freshwater Resources				
Protection	3	3	4	3
Raw water quality	4	4	5	4
Withdrawal	2	2	4	1
Category: Drinking Water				
Water consumption	3	4	5	3
Drinking water quality	4	4	4	4
Chemical use and energy use for drinking water	2	2	4	1
Leakage	0	4	4	0
Water reuse	0	2	4	0
Category: Wastewater				
Wastewater production	3	3	5	2
Combined sewers	0	0	0	0
Treatment performance	3	3	4	3
Loads to receiving waters	3	4	4	3
Chemicals and energy use for wastewater	2	2	5	0
Resource use per removal of nutrient	0	2	5	0
Recycling of nutrients	2	2	4	2
Quality of sludge	0	1	4	0
Energy recovery	0	1	0	0
Category: Development				
Access to clean drinking water	4	4	5	5
Access to adequate sanitation	4	4	5	4
Affordability of services	3	4	4	4

** - Grading: 5, very high; 4, high; 3, moderate; 2, low; 1, extremely low, 0, no grade.

Personal reflections on annual meeting key questions

The key questions within the Energy and Food and Water flagships are very relevant and important to growth and development and social well being of people especially in the developing world where energy capacity, food production and access to good portable water are still poor. It is my opinion that AGS should foster better cooperation with researchers in the developing world especially in Africa where the problem is most acute.

12. TOWARDS MORE SUSTAINABLE ENERGY SYSTEMS

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Key words: *sustainability, energy, environment, multi-objective optimisation*

1. Introduction

The paper summarizes the content of a recent movie made at EPFL describing some of the motives, objectives, results and prospects of an existing collaboration within AGS to develop new methodological tools for designing and planning more sustainable energy systems. Concerns about the environmental pressure linked to population growth, energy consumption trends and global warming emissions are briefly reminded. The film illustrates the trend towards more advanced technologies for improving the energy supplies to large cities with reference to the so-called Tokyo half project and the integrated computer design and planning platform which is developed by a team from MIT, UT and EPFL.

2. The important role of information structuring

Among the many factors embedded in the concept of sustainability, environomics (a contraction of energy, economic and environment) plays an important role. Rather than considering these factors sequentially modern design and planning approaches should as much as possible account for them simultaneously as could be done using a holistic computer platform. Keywords for such a platform are model sharing, web based communication, and optimization.

Data and model structuring is not only important for engineers but it is also a vital part of communication between stakeholders including decision makers.

Among the tools demonstrated in the movie is an advanced multi-objective optimizer developed thanks to AGS, which allows to represent optimum solutions of complex integrated systems along Pareto curves. For example, in a pollution versus overall cost diagram, best solutions of integrated energy systems to satisfy a given demand of heat and cold can be represented from the cheapest and usually most polluting to the most expensive but cleanest solution. The slope of this optimum boundary provides information on specific cost of pollutant reduction like the specific cost of GHG emission reductions.

The multi-objective optimizer is only a part of the tools included in a more global holistic and web based platform developed at MIT called DOME and adapted at UT for the project Tokyo half aiming at comparing measures to reduce by half the GHG emissions of Tokyo (hence the project name Tokyo half). The overall platform includes among others a land use aggregation tool (geographic information package)

to structure the actual demand curves of a given part of a megacity, integrated technology design and energy integration techniques, dispatching models, semantic model representations, encapsulated databases, air circulation and traffic flow model and an input-output synthesis model.

3. The importance of integrated energy systems

Combinations of technologies described include high speed directly driven electrical heat pumps, Solid Oxide fuel cells or hybrid fuel cell-gas turbine cogeneration systems. Examples of result include the satisfaction of heat and cold in a part of Tokyo with multimodal optimization results showing that future hybrid fuel cell –GT systems combined with a district heating compression heat pump could reduce by half the emissions and at a reduced cost. Alternatives including a hybrid fuel cell-GT cogeneration system with an absorption heat pump or importing electricity and satisfying the needs by compression heat pumps alone are discussed. Examples of hybrid natural gas cars, biofuels, solar tower power plants, energy services to an isolated village in an oasis are also presented.

4. Conclusions

Efforts towards more sustainable energy solutions are not only dependant on technology development or blind social awareness but they depend on a proper information structuring from the engineer or designer to the planner and the decision makers. Information structuring and the use of sophistication optimization techniques is a major challenge depending on the setup of appropriate platforms for sharing scientific models and hopefully sharing values.

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13. ABOUT INFORMATION SYSTEMS AS A KEY FOR THE SUSTAINABILITY STRATEGY. A CASE ON ENERGY EFFICIENCY OF UPC BUILDINGS

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Key words: *Information systems, Energy efficiency, Sustainability, Buildings*

1. Introduction

Definition of strategies and pathways towards sustainable models of resources use requires trustworthy and dynamic support of information. Without good information to start from it is impossible to establish diagnostics, to fix objectives, and in the future to evaluate its fulfilment and to reframe the defined strategies.

Information as simple registration and compilation of data is useless if it is not possible to analyze it in a suitable form. This requires it to be integrated in a structure that allows comparing historical data with value trends and standards in order to define behaviour models and to predict future evolutions. When energy efficiency targets are raised it is fundamental to have information systems that bring data with respect to, in one side, the needs to cover, and in the other, the resources that are used for it. This is the only manner to evaluate whether the system can be optimised or not.

2. UPC experience and SIRENA System

UPC is currently working on the implementation of an information system for energy and water resources (called “SIRENA”), based on a recent PhD work (“About the environmental impact of buildings: Analysis of buildings use incidence in the energy consumption”[1]), which used the university buildings as the research field. This work focused on the analysis of the energy efficiency by analysing the effect of various factors on the consumption. The developed methodology gave a central role to the information gathered about the building characteristics, their actual use and energy consumption. This information was classified in two types. On one side, ‘static’ information, related to architectural characteristics, use typology, energy sources and devices used.

On the other side, ‘dynamic’ information related to the use follow-up and the energy consumption (on-line registers).

From the results obtained, and based on the analysis of the data collected, it was possible to identify the factors that determine the consumption and their relative weight for each building category. Among the conclusions of this work, the authors underline the need of integrating a dynamic information system for monitoring the resources consumption of the buildings of the organization (the university in this

particular case). This allows an easy and permanent assessment and converts it into a basic tool for targets definition and energy efficiency policy implementation.

This research project has inspired the current information system (Fig. 1), a platform that integrates today various types of energy and water information related to UPC campuses buildings, and aims to go further and include other kinds of information relevant to sustainability. Up to now, this system is not only used for management purposes but also for research and educational matters also.



Figure 1. Two screens of the SIRENA system (<http://www.upc.edu/sirena>)

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14. ANAEROBIC DIGESTION AS A KEY PROCESS FOR SUSTAINABLE ORGANIC WASTE MANAGEMENT AND ENERGY PRODUCTION

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Key words: *Anaerobic digestion, biogas, energy, waste management*

1. What is anaerobic digestion?

Anaerobic digestion (AD) is a microbiological process that occurs naturally in the environment, for example in lagoons or in the stomach of ruminants. Under anaerobic conditions, organic materials are biodegraded through a complex microbiological process leading to the production of a more stabilized organic material and biogas with high methane content.

The technological application of this process in bioreactors gives an appropriate solution for the treatment of organic wastes and by-products. The effluent of bioreactors can be used as an organic fertiliser as long as it meets current legislation for land application. Methane content in biogas depends on the composition of the raw materials treated and operational conditions (reactor design, process temperature, residence time, etc.), being typical values 60-70%. As methane energetic value is 10 kWh/m³, it can be used for heating and/or electricity production, giving an energetic valorisation of the organic materials treated. Hence, technological strategies based on AD may allow for both sustainable waste management and renewable energy production.

2. Is it environmentally friendly?

If we take into account the main features of the process, one could think of anaerobic digestion, also known as biomethanation, as an environmentally friendly technology. Its major advantage compared to alternative biological treatment technologies (like composting) is the production of renewable energy, with an overall positive energy balance, i.e. substitution of fossil fuels or wood, which could help decrease deforestation rates in certain areas. Moreover, as the process takes place in a controlled and enclosed reactor, the digester, it helps reducing offensive odors and CH₄ uncontrolled emissions mitigation. Additionally, there is a reduction of CO₂ emissions (from the substituted fossil fuels), with an overall reduction of greenhouse gases emissions. The partial stabilization or mineralization of the organic materials makes it appropriate for land application, i.e. agriculture, gardening or land reclamation, closing the organic matter cycle. In this sense, the performance of AD followed by a composting stage should provide a better quality end-product.

3. Which wastes or by-products can be digested?

Theoretically, any easily biodegradable organic waste or by-product could be treated in anaerobic digesters. Currently, the major sources include animal manure or slurries, sewage sludge, organic fraction of municipal solid wastes (OFMSW), and wastes from agro-industries, depending on the geographical location and the corresponding regulations (if any). Their mixture is particularly interesting, because it provides more equilibrate substrates for microorganisms, improving process performance, through the so called co-digestion. Unfortunately, the application of this practice tends to be more complicated, as it usually involves different stakeholders, and in many countries there is a need for supporting legislation.

4. What about the technological application?

The application of AD is usually described as complex and expensive when compared to composting. Hence, it has been commonly reduced to the treatment of semi-liquid wastes, which cannot be composted without prior dewatering (i.e. treatment of pig slurries and sewage sludge, but not manure or OFMSW), or when energy production is accounted for. However, one strength of AD is that it is indeed a natural process that can be performed in both high-tech heated and expensive bioreactors, or in very simple and inexpensive systems operated at environmental temperatures. This allows for its application in a wide range of realities, from industrialized and densely populated areas, where big digesters operated at 35 or 55°C should cope with relentless accumulations solid wastes, to isolated communities, where the treatment of animal manure can provide a source of energy for cooking in substitution of wood, as well as an organic fertilizer.

5. Current situation and perspectives

A growing interest in AD started early in the seventies, as a result of the 1973 energy crisis. However, after a sudden rise, there was a progressive decrease in the implementation of these systems mainly due the economical constraints. Nowadays, with the increasing awareness of the necessity for environment protection, stringent environmental legislation is to apply in all countries, and all sectors (local authorities, private industries, farmers, etc.) will have to cope with their wastes and emissions in the near future. Some authorities even offer some subsidies with the aim of promoting the implementation of treatment technologies, in countries like Denmark, Germany or Austria. Together with this, there is an urgent need for increasing renewable energy production.

Bearing in mind the above described scenario, it seems the time to give another chance to anaerobic digestion systems has arrived. For this to happen, however, some considerations are required. First of all, the cost of waste treatment should be internalized in the production function, thus in the final prize of all products. Secondly, energy production from biogas should be subsidized, and grid connection (electrical and gas) facilitated, in order to allow its introduction in the energy market. In developing countries, the promotion of this technology may help reducing the lack of energy supply in many areas.

15. BIOREFINERY APPROACH TO EFFICIENT UTILIZATION OF WASTE USING HYDROTHERMAL METHODS

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Key words: *hydrothermal, biorefinery, biomaterial, waste*

1. Biomass as resource base - waste is an opportunity

A society based mainly on renewable resources and biomaterials present us with several challenges. The amount of biomaterial that can totally be harvested from ecosystems is limited. Intense biomaterial production and harvesting can, also within the production limits, be done in ways harmful to the environment. It is also important to consider nutrient cycles. Material streams today considered waste are thus of interest, since these streams includes materials that has already been processed. However, when utilizing such materials it is very important to consider the risk of contamination, both microbial and chemical, that often exists and can be further spread when handling streams inappropriate. Proposed process solutions handling such waste streams should preferably give us valuable products (including both energy and materials), enable nutrient recycling, destroy harmful micro pollutants and disease vectors, and not generate large negative impacts outside the actual process site. Evaluation using environmental systems perspective is thus necessary also for processes proposed with the best intentions. It should be remembered that chemical processes and products will not fit the criteria of sustainability solely because they are based on biomass, or even biowaste. All proposed processes should be evaluated from an environmental systems perspective to establish their environmental performance as well as identify possible improvements to the processes.

2. Hydrothermal processing in biorefineries

Hydrothermal processes are possible attractive components for biorefinery application as they could be used to convert a variety of wet biomass streams into a range of products without need of drying. An example of a wet biomass feedstock is food industry waste. Large flows of material processed by the food industry are not converted into marketable food products. Two benefits of using hydrothermal conversion of food industry waste can be identified immediately: fewer odors from open processing and transport of non-processed organic waste and sterilized process outputs minimizing risks for spreading of pathogens. However, for development towards sustainability we can never omit assessment of the environmental systems performance, even if a process seems promising in many of its aspects.

3. Case study of a small biorefinery

One example of hydrothermal processing used in a biorefinery is an industrial process plant in Carthage, Missouri, developed by Changing World Technologies (CWT)¹. The plant converts the refuse from Butterball Turkey production into diesel oil, fertilizer products and carbon. The CWT process is essentially a closed system with few emissions, avoiding odor problems from the handling and giving products free from pathogens. Recovered from the two stage process are a solid phase (inorganic nutrients) and a liquid phase (nitrogen containing), both possible to use for fertilizing purposes, fuel gas, carbon and diesel oil. The fuel gas is used for the internal heat needs; the other streams are all marketable products. The process comes out beneficial in ascreening life cycle assessment. Benefits come from the possibility to replace fossil diesel oil with renewable fuel, but also from the recovered nutrients. The results underline the benefits of efficient recovery of both energy and material resources from waste, and not only one of these as are often the case, thus advocating the concept of biorefineries. Studies of supercritical water oxidation (another hydrothermal method) of wet biomass waste have shown similar result, the process is beneficial especially when both energy and material resources that are recovered from the biomaterial².

4. Conclusion

The idea of bio refineries, to optimally recover energy and materials, is promising for sustainability. To utilize waste can help us avoid unnecessary disturb or overtax ecosystems, but we must make sure that such waste utilization is done in a way addressing the problems of contamination. Nutrients' recycling is essential with increasing use of biomass, and also here the contamination problem must be addressed. Hydrothermal processing of wet biomass and waste streams can help in these respects.

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16. ARSENIC IN SOIL, WATER AND AIR

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Key words: *arsenic, volatile arsenic, methanogenic bacteria*

1. Introduction and objectives

Arsenic is a ubiquitous element and is assumed to be the 20th most abundant element in the biosphere. It is mostly naturally occurring and is mainly distributed in the environment as a consequence of weathering of rocks, volcanic activity, evaporation of water, anthropogenic input and biological activity. Being a metalloid arsenic can present in soil, water, air and all living matter in any of the form of solid, liquid and gas. Arsenic, primarily in the inorganic form, is present in the earth's crust at an average of 2-5 mg/kg. However, arsenic contamination has become a common problem in many parts of the world. Arsenic leaching has occurred from mine tailings in Australia, Canada, Japan, Mexico, Thailand, the United Kingdom and the United States. Arsenic contamination in natural aquifers has occurred in Argentina, Bangladesh, Cambodia, Chile, China, Ghana, Hungary, India, Mexico, Nepal, New Zealand, the Philippines, Taiwan, the United States and Vietnam.

Arsenic pollution has occurred most severely in Bangladesh and India (West Bengal). It is estimated that more than 35 million people are consuming arsenic-polluted groundwater alone in Bangladesh where underground water is used mainly for drinking and cooking. So far, lot of effort has been devoted to find safe drinking water there but no suitable measure has been established yet. In addition to the drinking water problem, continued irrigation with arsenic contaminated water increases the extent of arsenic contamination in agricultural land soil in Bangladesh. Objective of this paper is to review information on the arsenic concentration in soil of Bangladesh, where contaminated water is used for irrigation and also to provide information on subsequent effect on plant growing on contaminated soil. In addition, this study overviews the literatures, which focus on the biological remediation of arsenic from soil and proposes a novel biological remediation process for soil cleanup.

2. Results and conclusions

There is no regulatory guideline for soil or plant arsenic concentration in Bangladesh. Some developed countries provide such guideline, for example, the regulatory limit of arsenic for agricultural soil is set for environmental health investigation in Australia is 20 mg-As/kg. This suggests that in case of exceeding this level requires soil clean up. Considering increasing concentration in agricultural soil and its subsequent effect on plants, establishment of such a guideline is

necessary and as a result some soil may require cleanup of arsenic. Biological cleanup could be fruitful solution for a developing country like Bangladesh. The feasibility of biological removal of arsenic from soil has already been established by the authors. The application of biological removal as a novel process can be introduced after investigation of the fate of volatile arsenic compound in the environment, which is hitherto unknown. In addition to the proposal of biological gasification of arsenic as a tool for environmental cleanup, the natural cycle of arsenic around the contaminated area was proposed in Figure 1. Survey of natural emission of gaseous arsenic is being conducted by the authors' research group.

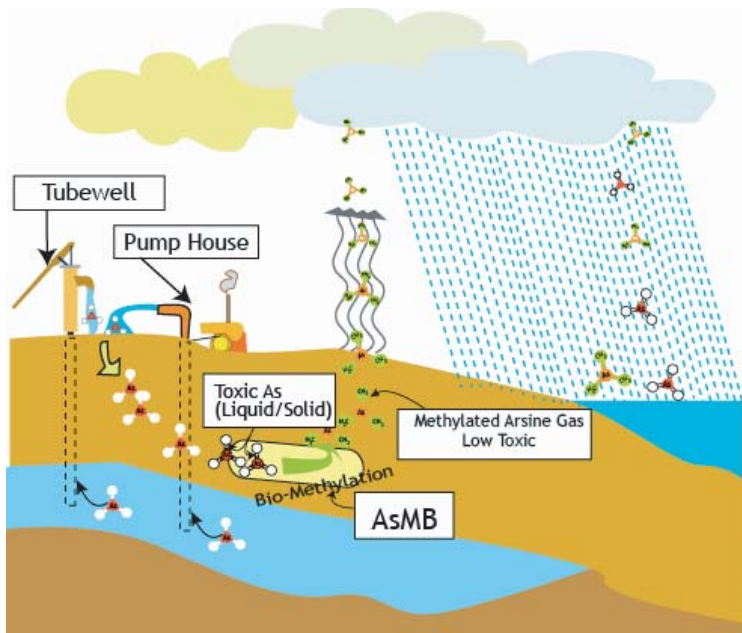


Figure 1. Conceptual figure of natural arsenic cycle.

17. KEY QUESTION E2 – KYOTO PROTOCOL DEVELOPMENT?

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Key words: *KYOTO PROTOCOL, GHG BURDEN SHARING, EQUITY*

1. Preliminary remarks

Burden sharing efforts and agreements in order to achieve specific GHG emission reduction objectives have been widely discussed in last years. Kyoto protocol sets an “equity principle” but, however, it is differently understood when defining methodologies to reach specific reduction goals among countries, regions or activity sectors. This paper deals on some reflexions to the meaning and possibilities of “equity” in environmental issues.

2. Equity principle

Equity may have different meanings according to the intention to focus on:

- **EQUALITY** – We all have the same rights to make use of environment – Equal per capita emissions.
- **SOVEREIGNTY** – Present emissions stand for status quo – We all reduce in the same amount / proportion.
- **HORIZONTAL** – Equal efforts according to similar economic circumstances – Reduction efforts in proportion to GDP.
- **VERTICAL** – Reduction efforts proportional to per capita GDP.
- **POLLUTER PAYS** – Reduction efforts proportional to past emissions record.

Major consensus is agreed when considering equality principle provided that atmosphere is supposed to be a common good that acts as a GHG drain. This specially means that all mankind has same rights to make use of it. However, there are two major obstacles when considering previous definition:

- Some countries may state that their individual needs are greater in comparison to others due to different natural conditions (for instance, average temperature) or different cultural conditions (for instance, life models based on intensive transport, leisure time, a.s.o.). This obstacle may be overcome when developing multicriteria methodologies.
- Present per capita emissions achieved in some countries are high enough so as to make it difficult (or even impossible) to reach those emissions by other

countries. This obstacle may be overcome when developing emission trading mechanisms among all countries.

3. Equity Burden Sharing components

Taking into consideration previous remarks, it can be agreed that there are three main components to be included in any methodology to share GHG emission burdens:

- Responsibility : Reduction efforts (emission permits or roofs) shall be proportional to past contribution to the problem. Need :
- Need: Reduction efforts shall be considered in terms of poverty eradication and shall help achieving reasonable living level to all humankind.
- Possibility / Opportunity : Reduction efforts shall be proportional to the capacity to make contributions in solving the problem.

How shall previous components be weighted or included in specific burden sharing methodologies is an open discussion at international level that will increase its interest in present and next years and, for this reason, is aimed for inclusion in AGS annual meeting 2007 in Barcelona.

18. DIALOGUE FOR FUTURE WATER MANAGEMENT

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Key words: *dialogue, stakeholder, sustainable, water management*

1. A challenge to solve complex environmental problems

Despite the enormous sums of money that have been invested in both research and measures to promote good water quality in the world, we have still not managed to solve the problems of exploitation, eutrophication, and pollution of lakes, rivers, groundwater, and seas.

In the Swedish Environmental Objectives Council's latest evaluation of Sweden's 15 environmental objectives, four environmental quality objectives that focus on water are judged to be very difficult to attain. The consequences of this unsustainable attitude to water as a resource can be seen today in the form of polluted drinking water and algal bloom. In the long term, however, what we are facing is the collapse of ecosystems, reductions in fish stocks, a declining ability to meet our own needs, and negative impacts on people's health and their prerequisites for a good life.

2. Is Science - Stakeholder Dialogues a way forward?

Over the years, we have built up a substantial knowledge base, yet in spite of this and despite the fact that the major players have been meeting regularly for decades, we have still not managed to secure the communication of knowledge between the players or the development of common problem descriptions and effective strategies. The need for ecosystem based adaptive management is often put forward as a way to handle these complex environmental issues but what are the conditions for this kind of approach to be able to work in practise? What is the role of research in this process? The complexity and uncertainty of the problems at hand, and the vast numbers of actors involved urges us to look for better ways of communicating and building knowledge to promote a long-term sustainable management of our common water resources.

To explore ways of communicating between various water-related stakeholders and researchers the project "Dialogue on future water resource management", was initiated. The aim was to produce a synthesis of knowledge of Sweden's water-related problems and to clarify for the players concerned what we know today and what we must do if we are to be able to solve our existing problems and ensure

sustainable water resource management for the future. The management of water resources requires not only knowledge of cause and effect and what practical measures can be applied. It is no less important to clarify how such knowledge can be used and how different players together can be persuaded to take action or change their behaviour.

This project differs from earlier, similar initiatives on several points. What we wish to emphasise is the form of the project. We have chosen an active, process-oriented dialogue between researchers and practitioners as a method for synthesising available knowledge. A group of 25-30 people with key positions in the Swedish water management sector including local, regional and national authorities, industry and NGOs were invited to participate in the four dialogue workshops. The group also included researchers from the field of social, natural and engineering sciences. The group was diverse in respect to age, sex and place of living.

The main activities in the project consisted of a series of dialogues conducted in four stages (D1-4). The project has also interviewed a number of Swedish long time water managers and researchers and compiled a database with most Swedish water related projects financed during the last five-year period.

The results from the dialogue workshops are a form of knowledge synthesis where the project has identified research needs and the need for further actions to be taken. The results from the process have been communicated to Swedish decision makers and the experience gained of the dialogue process itself as a work method has also been evaluated in terms of potential for learning and communication.

3. Visions for the future

Our vision is that this project will inspire future dialogues of this kind. We believe that the dialogue model is an appropriate work method for complex environmental issues in general. We also hope that the knowledge synthesis will be used as the starting point for a debate on how we can create the prerequisites for achieving sustainable water resource management.

This project has been drawn up in collaboration between people responsible for water resource issues at the Swedish National Environmental Protection Agency and researchers who have taken part in three of MISTRA's water programmes. The project has been financed by MISTRA (<http://www.mistra.org>).

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19. GOING GLOBAL: INTERNATIONAL WORKING SESSIONS ON SUSTAINABILITY IN HIGHER EDUCATION

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Key words: *education, networks, global, collaboration*

1. The Challenge

Higher education institutions in several major regions of the world are working actively to incorporate sustainability into undergraduate and graduate education and research. These academic ventures have included in-depth explorations of sustainability as a discipline in its own right, or integration of sustainability concepts or projects into various disciplinary subjects. Yet rarely have the disciplinary, pedagogical, regional, and cultural differences in these efforts been explicitly examined at a global level for insights that could be shared. How can educators in engineering, social sciences, and humanities collaborate to design integrated curricula and teaching assignments to encourage sustainable development? Can lessons learned from participatory and experiential approaches be shared among regions? How could higher education in all corners of the world benefit from examining specific examples of bridging the research/education gap?

2. The “Going Global” Initiative

“Going Global: International Working Sessions on Sustainability in Higher Education” will focus the efforts of invited sustainability educators and researchers from Europe, North America and Asia on this cluster of questions. Through two intensive working sessions – Session I on March 17, 2007 in Barcelona, just prior to the AGS 2007 Annual Meeting, and Session II in July 2007 in Cambridge, Massachusetts – we aim to advance the capacity of the global higher education community to recognize and address opportunities for collaboration and pedagogical innovation. The “Going Global” sessions will help sustainability educators, students, and researchers span gaps of region, culture, and discipline and will spark new energy and new insights for participants to share with the greater global learning community.

A critical feature of both Sessions is intensive discussion of specific pedagogical successes and challenges shared by participants. The group will examine these specific examples to identify significant areas of disciplinary, regional, and cultural differences and similarities. These conversations will be informed by two brief keynote presentations. Professor Walter Leal Filho, editor of the *International Journal of Sustainability in Higher Education*, will review international trends in sustainability in higher education. Professor Roland Scholz, head of the Natural

and Social Science Interface Transdisciplinary Lab at ETH-Zürich, will discuss the scholarship and practical reality of cross-disciplinary work. True to the term “working sessions,” most of the time will be devoted to

intensive interaction to identify distinctive regional, cultural, and disciplinary contributions to education propose enhanced strategies for global collaboration.

Desired results of the “Going Global” initiative are an enhanced capacity for global, cross-cultural, multi-disciplinary collaboration; regionally and empirically robust recommendations for best practices in on-the-ground planning and implementation of sustainability education curricula and lessons; and an expanded network of sustainability education professionals at colleges and universities around the world. The nature, form, extent, and duration of the resulting activities will be shaped by event participants, to assure that future activities are directly responsive to issues identified by the community of educators involved. Possible activities include publications, further formal and informal networking, projects, and efforts to include other sustainability education leaders from around the world.

Following Session I on March 17th, session leaders and, as feasible, participants will discuss results at the 2007 AGS Annual Meeting. We will invite comments and suggestions from the AGS community regarding follow-up activities of the initiative, including a request for papers, a two-and-a-half day working session at MIT in July 2007, and further dissemination of findings and insights. The Going Global Working Sessions are coordinated by the Education Program at the Laboratory for Energy and the Environment at MIT with funding provided by the Knut and Alice Wallenberg Foundation of Sweden.

20. TEACHING ENERGY AND CLIMATE TO DIVERSE AUDIENCES IN A SHORT COURSE FORMAT

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Key words: *sustainability education, short course format, energy, cognitive map*

1. Project History

Energy and climate are emerging as perhaps the pre-eminent environmental challenges in the 21st Century. As such, they are a critical component of any serious effort to develop an effective curriculum for teaching sustainability. Actions and decisions at the local, national, and international levels will reflect the degree of understanding of these issues on the part of diverse audiences. Absent such understanding, there are likely to be serious obstacles to society's acceptance of pathways to sustainable energy and climate futures, especially when such pathways may entail increased personal effort and economic costs. Last year, the AGS decided to support a set of independent but coordinated one-week short courses on "Teaching Energy and Climate" (TEC) to diverse educational audiences of high importance at each partner's university. While each partner's educational team was to be fully responsible for the design, implementation, and evaluation of their own activity, the goal was to generate robust comparative case studies of how to convey critical information to targeted audiences in a short, intensive course.

2. Short Course Implementation

MIT and UT

The MIT course in June 2006 involved 14 advanced undergraduate students from eastern and mid-western U.S. colleges and universities. Titled "Toward Sustainable Energy Systems," the five-day course began with an overview approach to the energy and climate topic. A wide range of MIT faculty shared presentations on scientific and policy basics of energy and climate during the first two days. On days 3 and 4, students were introduced to the science and technology of interior lighting and then carried out a hands-on team project to identify and propose energy lighting efficient solutions for locations around MIT. Day 5 consisted of presentations to MIT Facilities staff and Architecture faculty, and course evaluation.

The University of Tokyo (UT) course took place in December 2006, building on the Intensive Program on Sustainability (IPoS) in August 2006. The workshop involved 20 graduate students primarily from Asian universities in one very

important aspect of the energy and climate issue: sustainable mobility. The workshop focused on the small Japanese tourist city of Kamakura for an intensive case study asking the main question “How to accommodate cars in an Asian historical city like Kamakura?” The different components in the program (lectures on travel behavior, sustainable mobility, energy, and innovation; a Kamakura city walk; and visits to Japan Hydrogen Fuel Park (JHFC), a city traffic control center, and a Nissan factory) provided students with hints for group work developing proposals for future cities in response to the main question.

The MIT and UT courses shared a common methodology used for both pedagogical and formative evaluation purposes. At the beginning and end of each course, students completed a “cognitive map” displaying their understanding of the main theme of the course (“energy and climate” at MIT; “sustainable mobility” at UT). MIT and UT plan to analyze these data collaboratively and compare both methods and findings.

Chalmers and ETH

Chalmers University is developing their course, to be held during 2007, in consultation with industry partners. The course will be targeted at young and mid-career professionals. The ETH Zürich climate and energy course for pre-college students is under development.

3. Findings

At the 2007 AGS Annual Meeting, the AGS Education Team will report on the outcomes of the TEC programs that have been completed to date, compare lessons learned on developing and presenting the courses, and identify those aspects that can be shared with the international sustainability education community with regard to communicating key energy and climate concepts in an intensive instructional format.

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21. FLEXIBLE MICROGRIDS – A KEY POINT FOR INTEGRATE INTO THE GRID DISTRIBUTED GENERATION BASED ON RENEWABLE ENERGY RESOURCES

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Key words: *Microgrids, Renewable Energy, Droop Control, Distributed Generation*

1. Introduction

The future electric network could be formed by a number of small electrical grids interconnected between them, also named microgrids. Hence, the conventional concept in which the generation areas are separated from the consumption areas could be replaced by a novel concept called distributed generation (DG). This concept is based on the principle that the electrical power can be generated near the consumption points, and, hence, the final consumers are also responsible for generate: in fact they form part of the grid. The advantages of using microgrids are: avoid the transmission power losses, improve the system efficiency, and increase the reliability, since the microgrid can be disconnected to the grid when an important fault occurs.

2. The Flexible Microgrid

A microgrid is a part of the grid, including small generators, storage devices, and local critical and non-critical loads, which can operate both connected to the grid or autonomously in island mode^{1,2}. This flexible microgrid has to be able to import/export energy to from/to the grid, control the active and reactive power flows and manage of the storage energy. Fig. 1 shows a microgrid, which is a part of the grid, including small generators, storage devices, and local critical and non-critical loads, which can operate both connected to the grid or autonomously in island mode. This flexible microgrid has to be able to import/export energy to from/to the grid, control the active and reactive power flows and manage of the storage energy. This way, the power sources (photovoltaic arrays, small wind turbines, or fuel cells) or storage devices (flywheels, superconductor inductors, or compressed air systems), uses electronic interfaces between them and the microgrid. Usually these interfaces are ac/ac or dc/ac power electronic converters, also called inverters. The inverters have two separate operation modes, acting as a current source if they are connected to the grid and as a voltage source if they work autonomously. In this last case, if there is a fault in the grid, it must be disconnected for security reasons, avoiding the islanding mode.

However, if we want to impulse the use of decentralized generation of electrical power, the distributed generation, and the implantation of the microgrids, islanding operation should be accepted, if the user is completely disconnected to the grid. In such a case, the microgrid could operate as a grid, using three control levels:

- 1) *Primary control.* The inverters are programmed to act as generators by including virtual inertias through the droop method. The droop method consists of decrease frequency or amplitude output voltage when the active or the reactive power increases. This way, the active and the reactive powers can be properly shared between the inverters³.
- 2) *Secondary control.* The primary control achieves power sharing by sacrificing frequency and amplitude regulation. In order to restore the microgrid voltage to nominal values, the supervisor sends proper signals by using low bandwidth communications. This control also can be used for synchronize the microgrid to the main grid before they have to be interconnected, transiting from islanded to grid-connected mode.
- 3) *Tertiary control.* The set points of the microgrid inverters can be adjusted, in order to control the power flow, in global (the microgrid imports/exports energy) or local terms (hierarchy of spending energy). Normally, the power flow depends on economic issues. Economic data must be processed and used to take decisions in the microgrid.

The flexible microgrid is proposed for the new b_TEC Technological University Campus of Barcelona (<http://www.btec.org>) in order to be implemented together with a pilot plant of residual wasted water, as a global laboratory for a next Master degree on Energy.

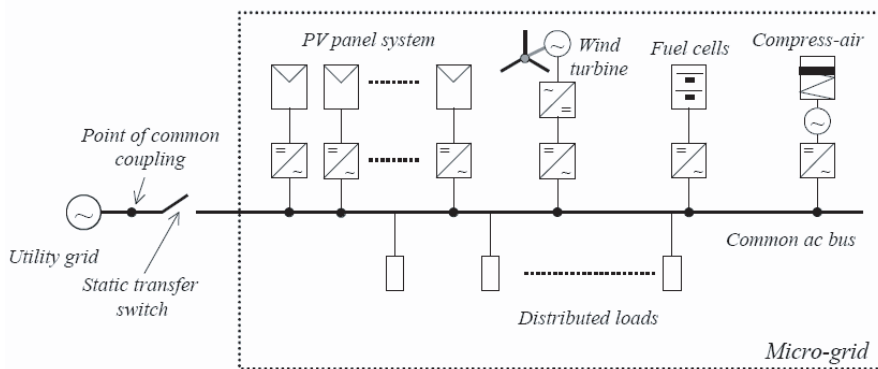


Figure 1: Scheme of a flexible microgrid.

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22. FUTURE OPPORTUNITIES FOR IMPLEMENTING BIOREFINERY CONCEPTS IN THE SWEDISH PULPING INDUSTRY

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Key words: *pulp mills, biorefineries*

1. Introduction

Pulp production is an important industry in Sweden, based on renewable and CO₂ neutral forest wood feedstock. Most of the pulp is used for paper production. However, a number of drivers have combined to provide incentive to find new highly refined products to complement existing products. New technologies under development open opportunities for refining almost all of the incoming wood feedstock into high-value products. The major challenge is to convert new scientific knowledge into industrial practice.

A biorefinery integrated with a pulp mill can be characterized by full utilization of the incoming biomass and other raw materials for simultaneous and economically optimized production of fibres, chemicals and energy. Examples of products from a pulp mill biorefinery include: (1) Chemicals and Materials (Phenols, adhesives, carbon fibres, activated carbon, binders, barriers, adhesives, antioxidants, surfactants, chelants, solvents, adhesives surfactants, descaling agents, specialty polymers, pharmaceuticals, nutraceuticals, cosmetics etc); (2) Biofuels (pellets, lignin fuel, methanol, DME, ethanol etc); (3) Electricity. These upgraded products can be made from internal and/or external biomass. Three different cases can be identified:

- A high degree of energy saving in future mills, especially chemical pulp mills, results in large amounts of excess internal biomass which can be upgraded to more valuable products;
- Components in e.g. the black liquor, forest logging residues and bark can be upgraded to more valuable products. The mill energy balance is maintained through fuel import (biomass or other types);
- External (imported) biomass (in some cases together with excess internal biomass) can be upgraded at the mill site, benefiting from synergy effects of integrating the upgrading with pulp mill operations.

The main reasons for the current interest for biorefineries in Sweden are as follows:

- Increasing wood feedstock costs and decreasing pulp and paper product market prices;

- Increasing competition from low cost producers of pulp and paper in South America and Asia;
- Increasing energy efficiency and hence excess of biomass in pulp mills;
- Increasing energy prices and new policy instruments that promote renewable and non petroleum based chemicals and materials.

A pulp mill integrated biorefinery can use both internal and external (imported) biomass. The three major parts of wood are cellulose (40-50 %), hemicelluloses (30-35 %) and lignin (20-30 %). In a typical chemical mill, pulp wood is used to produce fibres (cellulose and some hemicellulose) and electricity/steam (hemicellulose and lignin). In a biorefinery some of the lignin and/or hemicellulose must be available to produce other products. The energy balance of such a mill must therefore enable an excess of internal biofuel. Modern Swedish chemical pulp mills have a slight excess of biofuel and no fossil fuel except for the lime kiln. There is a high potential to create a significant excess of biofuels in future greenfield market pulp mills compared to current mills. This has been shown in the energy system oriented studies within the Swedish KAM (Ecocyclic Pulp Mill) and FRAM (Future Resource Adapted Pulp Mill) programs. This can be accomplished by a mixture of measures: New energy efficient components and/or sub-processes, new energy technologies, more advanced process integration and new system solutions (e.g. process integrated evaporation).

2. Visions and need for further Pulp Mill Biorefinery R&D in Sweden

Export of high-grade energy products from the pulp and paper industry

The Swedish lead in several key areas connected to export of high-grade energy products should be used for establishing Sweden as a foremost biorefinery Country. Examples of such lead areas are:

- Process integration in pulp mills (Chalmers)
- Pressurized gasification of black liquor and conversion into electricity or motor fuels (ChemRec, Nykomb, ETC)
- Separation of high-quality lignin from black liquor through the LignoBoost process and further upgrading of the lignin (STFI-Packforsk)
- Chip, bark, etc leaching kidney technology (STFI-Packforsk, Chalmers)

Future R&D in this area should focus on the following:

- Identify opportunities for energy savings in chemical pulp mills in order to identify potentials for upgrading of internal biomass to high-grade energy products such as electricity, lignin, motor biofuels, etc
- Identify opportunities for mill energy savings in connection with implementation of black liquor gasification technology
- Increase knowledge of most suitable end products for export under different future energy market scenarios

Biofuel polygeneration concepts

Integrated biofuel polygeneration concepts for upgrading of biofuel in connection with pulp and paper mills is an area of high interest in Sweden. R&D needs include the following:

- Investigation of possible synergy effects in connection with implementation of new technologies, e.g. low-temperature drying
- Identification of technical and economic opportunities for production of high-grade biofuels through upgrading of e.g. forest residues and bark via leaching of metals and other elements. This could be a highly interesting way to produce high-quality biofuel in Sweden
- Investigation of synergy effects for ethanol production integrated with a pulp or pulp and paper mill that could improve economic performance for this type of biofuel. Future conditions necessary for profitable production of ethanol in this type of integrated biorefinery should be identified.

Separation of CO₂ from the process

In this area Sweden could be a leading nation due to the ongoing research, the number of potential pulp mill implementation sites, and good storage capacity (e.g. in Skåne). Although most R&D efforts in this area are focussed on CO₂ sequestration in coal and natural gas systems, removal of CO₂ from pulp and paper mills through CO₂ sequestration from recovery boiler flue gases, black liquor gasification systems, lime kiln gases, etc should be of high interest for Sweden and create a win-win situation, i.e. CO₂ mitigation with comparatively low cost for society and good profitability for industry

Further R&D is needed to explore different aspects of this technology/system solution, with emphasis on:

- Investment cost/system solutions and operability aspects for MEA systems
- Pilot plant testing of the technology using real pulp mill flues gases
- New absorption media that can operate at higher temperature levels than existing MEA systems
- Infrastructure issues for transportation of CO₂

Production of chemicals and new fibre materials

Future chemical pulp mills have a large potential to supply chemicals and materials, in addition to the present fibre products. Sweden has several competitive advantages that motivate further R&D for development of pulp mill biorefinery concepts for production of chemicals and new materials.

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This supporting paper is based upon the following report:

T. Berntsson, P. Axegård, B. Backlund, Å. Samuelsson, N. Berglin, and K. Lindgren. *Swedish Pulp Mill Biorefineries – A Vision of Future Possibilities*. Report commissioned by the Swedish Energy Agency, 2006. Publication forthcoming.

23. ANTICIPATION OF WATER POLLUTION IN DEVELOPING RURAL AREAS FROM LAND-USE PATTERNS

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Key words: *water pollution, developing rural area, land-use patterns*

1. Introduction

Measures often fall behind problem. Water pollution is not an exception. It usually becomes serious in developing rural areas where population grows and residences increase. We suggest a new pathway to sustain water environment in such rural areas in developing stage (Figure 1) and discuss about factors that determine location patterns of pollution sources from example cases in Thailand and Indonesia to achieve precaution and the new pathway.

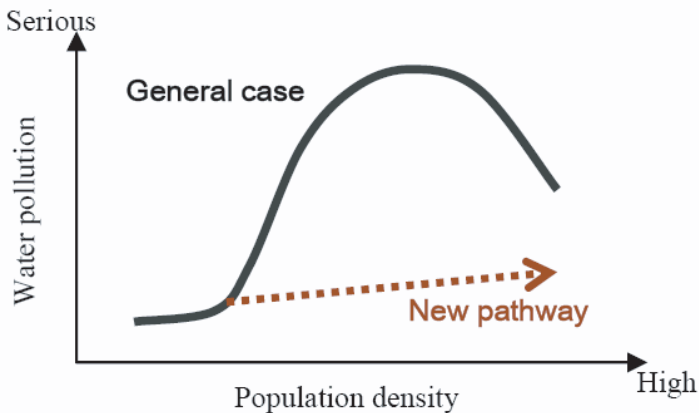


Figure 1 : Schematic diagram of relationship between population density and water pollution

2. Location patterns of pollution sources

Location patterns of pollution sources are essential to decide measures to prevent water pollution. We can see typical location patterns of pollution source from cases in Thailand and Indonesia. In the both cases, population growth and increase of sewage discharge causes water pollution of river and canals in the area. In Bangyai district in Nonthaburi, Thailand, residences of new habitants, which are the main pollution source, are located in a mosaic-pattern, while they are located in a linear pattern along a river in Taruma Jaya village, West Java, Indonesia (Figure 2).

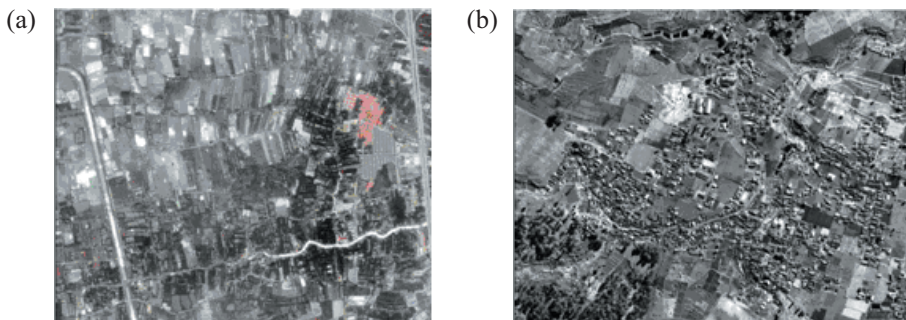


Figure 2 : Location patterns of pollution sources. (a) Bangyai district, Nonthaburi, Thailand; (b) Taruma Jaya village, West Java, Indonesia

3. Factors to determine the patterns

There should be various physical and social factors that determine the location patterns of pollution sources. However, in the above cases in Thailand and Indonesia, three factors were essential to determine the location patterns: (i) ownership of land and intention of the owner; (ii) business of new habitants and/or immigrants (cropping, livestock, commuter, etc.); and (iii) characteristics of river/water channel (flow velocity, flow rate, etc.).

In the case of Bangyai district, new habitants are immigrants whose workplace is in/near Bangkok. Their residences were developed on the land where old habitants owned as farmland. One reason to form the mosaic pattern location is because old habitants usually sell only a part of their land to continue farming. On the other hand, in the case of Taruma Jaya village, many new habitants occupy their residential place illegally and live on livestock because they don't own their land. The reason to form the linear-pattern location is because they tend to live along a river or canals, where it is easy to treat livestock excrement. That makes water pollution of the river and canals very serious.

4. Anticipation of the location patterns

It should be quite difficult to predict the future land-use patterns before the development starts. However, it should be possible to classify the development patterns in several cases. If we could clarify the important factors that may determine the pattern, it possibly enables the prediction of location patterns of pollution sources in very early stage of development. That makes the new pathway possible by taking precaution against the pollution before it becomes serious. Now the factors mentioned above are probably a part of the factors. We need to study more cases to collect possible factors and to define how they define the pattern. (a) (b)

24. DEMANDING SUPPLY AND SUPPLYING DEMAND. EXPLORING THE ROLE OF AND ACCESS TO INSTITUTIONS IN (UN) SUCCESSFUL CASES OF FOOD AND WATER SUPPLY.

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Key words: *Institutions, resources, efficiency, human needs*

1. Introduction

This paper provides reflections on the key questions in the AGS food and water flagship research program. We emphasize the importance of understanding both the supply- and the demand-related challenges encountered on the pathway to secure ecosystem services for a nourished world. First, the developing world in particular face tremendous supply-side challenges when it comes to food security and secure access to water. Equally important, however, there is a need to manage demand and curb excessive use of scarce natural resources so that efficiency improvements benefit those most in need¹. Innovations and technology transfers are here acknowledged as crucial for both increasing supply and efficiently managing demand. But such progress (or lack thereof) can to a large extent be ascribed to institutions and institutional performance². Institutional reform has in recent years been put forward as a key component in extending supply of ecosystem services to poorer segments. Institutions also constitute the constraints and incentive structure facing societal actors and by such shape demand for ecosystem services. But, importantly, it is not enough to acknowledge that institutions are important. One also have to take into account the problems inherent in the supply and demand for institutions.

2. A Combination of Supply- and Demand-related challenges

Across the developing world, there is great demand for more efficient, equitable and ecologically sound supply of ecosystem services such as food and water. Globally, 1.2 billion people lack access to safe drinking water, and lack of water in turn jeopardizes food security, economic development and human health. In order to safeguard secure ecosystem services for a nourished world, as well as general social and political stability, one thus has to focus on increasing supply for the poorest segments of society. However, managing demand is equally important. To start with, for example in the water sector, supply-side solutions are giving way to a demand oriented view where it is emphasized that the best way of creating a new supply is not through expanding supply in a traditional way (i.e., by extracting additional water), but through using existing water more efficiently³. The focus on this form of

efficiency, however, needs to be complemented with an equal emphasis on the other pillars of sustainability, i.e., social development, equity and ecological integrity. A crucial aspect when implementing demand management is thus to make sure that the benefits from more efficient resource use accrue to the individuals and groups lacking access today. Economic incentives and regulations must therefore make sure that technological progress such as increased irrigation efficiency, reductions in, e.g., un-accounted for water is not merely used to fill more swimming pools, for golf course irrigation or for millions more meat-rich diets.

3. Institutional Supply and Demand

Institutions are generally defined as the rules of the game in society and as such define the constraints and incentive structure facing societal actors⁴. Clear from the above section, investments in water efficiency and conservation is generally regarded to yield more usable water per dollar than what investments in conventional water supply projects do. In urban areas in many African countries up to 60 percent of all water in city pipes is for example lost due to leakages⁵. *But the improvements will not materialize until policies, laws and institutions begin to foster such measures rather than hinder them.* And this is where the problem of institutional demand and supply becomes crucial. In the research field commonly termed “institutional theory”⁶ it was for long assumed that institutions arise, spontaneously or deliberately, when there is a demand for the services provided by the institutions. But this ‘naïve’ theory of institutional formation has been proven futile as history by no account has been shown to be efficient, in terms of resource demand and supply. It can thus be argued that even if there is a demand for high performing institutions that could increase the securing of ecosystem services; these institutions are not likely to arise spontaneously. In fact, *institutions are by definition themselves public goods and are therefore subject to the very problems they set out to solve*: everyone is to benefit from a highperforming institutional framework but this gives rise to a free-rider problem where each individual has an incentive to free-ride on others’ efforts and not participating in the joint effort of producing the public good. This reasoning is commonly referred to ‘the logic of collective action’⁷ and rests on the fact that an individual who will receive the benefits of a collective good once the good exists, has no incentive to put any effort into actually producing the good. A theoretically well-grounded investigation of institutions must thus take heed of the now well-established notion that institutions will not be established simply because there is a demand for them. In conclusion, apart from acknowledging that institutions are important for ensuring secure ecosystem services and balancing supply and demand of such services – it is also important to focus on the supply and demand of institutions, and hence the underlying political conditions that enable high performing institutions to arise in the first place. We thus suggest that - apart from the important task of tackling matters of demand- and supplyrelated solutions and challenges in regard to individuals and different socio-economic groups - variants of the following two research questions are crucial within the food and water flagship program: What kind of (high quality) institutions contribute to X?

What is the primary factors (e.g., historical, political, psychological, economical) causing the establishment of high quality institutions?

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25. BRIDGING TO A SUSTAINABLE ENERGY FUTURE - EXAMPLES FROM THE STATIONARY ENERGY SYSTEM

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Key words: *Sustainable development, Energy, Bridging, Technology options*

1. Introduction

It is clear that mankind lives far from what can be considered sustainable with respect to the ecological constraints provided by our planet (e.g. Limits to Growth [1]). Climate change has put this in focus and a key question is if we over the next decades will be able to divert enough capital and resources to change direction to a pathway which ultimately leads us to a sustainable society. However, such change in course will most likely require considerably less resource than the environmental cost we have to bear if we continue on the present pathway, as recently concluded in the Stern report with respect to fighting climate change [2]. Yet, the change in course cannot be too abrupt and a reasonably smooth change is one which paves the way towards a sustainable society maintaining environmental, economical and social sustainability. A problem is that we do not know which choices of technologies, measures and institutional frameworks (e.g. policy measures) might lead us towards a sustainable society (since we cannot in detail describe the sustainable society). However, what we can do is to change course and use bridging systems. Bridging systems are technologies and options which may not be sustainable in themselves, but which significantly improve the present system and therefore can change course towards a more sustainable system. This is of great importance when it comes to climate change where drastic cuts in CO₂ emissions are required over the next few decades. Below are some examples of bridging systems for the stationary energy system.

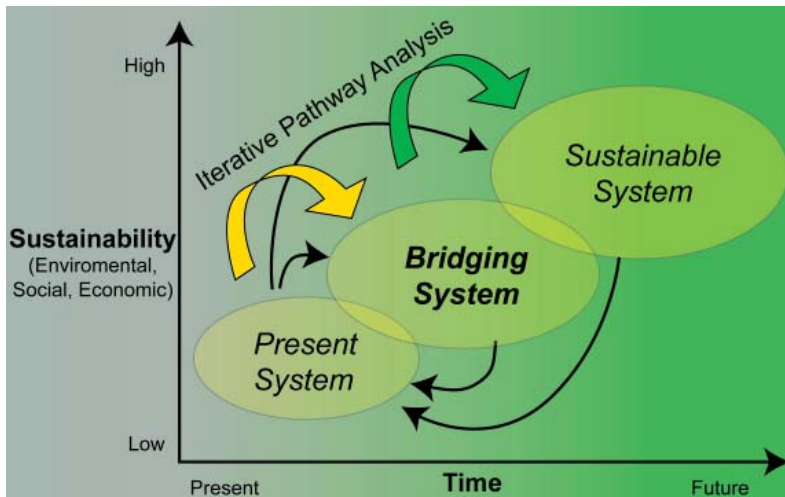
2. Bridging to a sustainable energy future

The energy system in its present form has been developed over the last 100 years or so, and has seen a tremendous expansion post 1945. The “energy infrastructure” consists of various sub-systems, such as the system for power generation (power plants, grid etc), the transportation system and residential and industrial heating systems (including district heating). These systems were typically developed separately from each other and under regulated market conditions. This has at least two implications: First, the energy is not utilized in an optimal way. There are for instance large amounts of low temperature heat which are now not used. Second, it is not obvious to what extent the present deregulated energy markets are suitable to facilitate a development towards a sustainable energy system. Here, only some examples of technology options which can serve as part of a bridging system are given, and the focus is on the climate change problem, i.e. ways to reduce CO₂ emissions.

The figure below illustrates the problem in analysing various pathways towards a sustainable energy system. The present system contains both the capital stock (power plants, transportation system etc) and various institutional frameworks. Depending on how much we are willing to pay for the transformation the present system must be part of the solution and, over the next decades probably to a rather large extent, considering the time and costs that will be required to change the energy infrastructure. Part of the bridging system is therefore to improve and develop present systems and to find synergies between these, such as links between the stationary energy system and the transportation system. Bridging systems can also be systems which are explicitly developed to change course but which in themselves are not sustainable, although they may seem to be over a certain time horizon such as over the next 50 years. An example of the latter is CO₂ Capture and Storage (CCS) from fossil fuel power generation, which has the potential to substantially reduce CO₂ emissions at a reasonable cost, thus allowing more time for parallel development of more long term solutions, i.e. technologies which are more sustainable (or truly sustainable). In the case of the European Union (EU), successful application of CCS would also lower dependency on natural gas (allow for more coal to be used) and thereby enhance security of supply. This fits with the goal of EU which at present has a strategy promoting a development which is sustainable, competitive and ensures secure energy [3]. Another example is hydrogen from fossil fuel with CCS which can pave the way towards hydrogen produced from renewables (RES) by facilitating development of a hydrogen infrastructure. Other bridging systems are those which can help boost the market for energy from RES. Such systems can be polygeneration of transportation fuel and power with the split adjusted to meet variations in intermittent power generation such as wind. Co-firing of biomass with coal can help establishing a biomass market without the need to build an entirely new energy infrastructure. Plug-in hybrid vehicles can contribute to improving the overall energy efficiency and lower CO₂ emissions from both the power generation system and the transportation system. As for the demand side, energy efficiency improvement of the existing building stock is an example of what could be seen as a bridging technology.

Little is expected to happen without the right policy measures. With respect to climate change, the above examples are likely to be implemented already at costs of around 20€/ton of CO₂ emitted, a figure sometimes mentioned as being a near term cost as a result of the EU emission trading system.

The above mentioned technologies are examples of bridging systems which are analysed in a new AGS project “Pathways to Sustainable European Energy Systems” and examples from this project are given in this meeting.



Conceptual presentation of the move from a non-sustainable energy system (e.g. carbon intensive) to a sustainable energy system. The AGS project “Pathways to Sustainable European Energy Systems” studies options and pathways leading through the bridging system.

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26. REFLECTION ON FOOD AND WATER ECOSYSTEM SERVICES FOR A NOURISHED WORLD; FROM PADDY RICE EXAMPLES

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Key words: *decision making, locality, multi-functionality, rice (Oryza sativa L.)*

1. Global demand for water for food production

Global community became increasingly aware of the vulnerability of fresh water resources after United Nations Conference on Environment and Development at Rio de Janeiro in 1992, because of the population increases (6,5 billion in 2007 and estimated about 9,1 billion in 2050 by United Nations) and increasing demands for food, and consequently for agricultural water. Geographical regions with higher risks of water scarcity in future have been pointed such as north Africa, south India, north China¹. Agricultural sector, which is a major water user (ca. 70%), also started discussion and research on efficient agricultural water use².

2. Local perspectives; example cases of China, Japan, Indochina

Water is no doubt essential for everybody but its physical distribution is uneven among continents, countries, and regions. Socio-economics of water also differs among countries, as is the case of large variation in agricultural water price. Therefore, “food and water ecosystem services” should be better considered as location specific. For example, in China, one of the most risky regions for future water scarcity, new water-saving rice production technologies have been studied and now being introduced to change some of the traditional flooded lowland rice production system. Not only the accumulation of technical research (e.g. aerobic rice breeding), but also the water pricing policy helped the society to adopt the new technology². In contrast in Japan water scarcity has not yet been as seriously considered, which can be explained because Japan has more average annual rainfall (ca. 1700 mm) than China. The in-depth socio-economic reason would be that a lot of food import is taken as granted in Japanese agriculture; as long as the country can rely imported food (and associated importation of “virtual water”) there is no urgent needs to efficiently utilize domestic fresh water resources for agriculture. However, if Japan chooses the alternatives to dramatically increase food self-sufficiency rate from the current level of only 40% as original calorie basis, water-saving rice production in Japan will become more urgent social and technical concerns. The third example is Indochina peninsula of dominant tropical rainfed agriculture. Rainfall in the region is higher during rainy season compared with arid climate regions, but is erratic, which limits yield of rice low (2.1 t/ha) compared with irrigated rice (5.7 t/ha)³. Yield improvement through better crop management based on scientific knowledge is very much needed. In dry season with scarce rainfall, water-saving production technology should be developed to maximize utilization of limited available irrigation water.

3. Multicriteria decisions including water for non-agricultural services

“Water ecosystem services” include non-agricultural services, such as environment conservation, maintenance of biodiversity, creating landscapes. Therefore, land and water utilization should be determined based on multi-criteria by the stakeholders. As an example, Japanese paddy fields dramatically changed in terms of hydrology for the last 50 years from ill-drained paddies to well-drained paddies by establishing drainage systems, in order to easily introduce big agricultural machineries. While it contributed to increase both land and labor productivity of rice, biodiversity in the agro-ecosystem in paddy fields have declined; habitation of fish from creek to paddy was prevented by drainage system, and wetland area was reduced for the bird and aquatic creatures. Ecologists and environmental groups have proposed to increase biodiversity in paddy fields, for example, by making a “fish tunnel” in irrigation/drainage system, or by flooding paddy fields in winter after rice harvest. The proportion of agro-ecosystems with such adapted management is still small. Other example is whether to develop or maintain floating rice fields in Thailand and Cambodia, based on multi-criteria of ecosystem services.

4. Pathways

(1) Scientists can accumulate correct information and propose to the public future scenario on global fresh water resources and food production. (2) Not only global but also local aspects should be addressed including multifunctional roles of water. (3) Research for technological innovation should be continued on improved water management for agriculture and crop improvement under water scarcity⁴. (4) Spirit of scholars can be fostered through education with modest evaluation of human power in terms of attainable technical and social improvement with the sense of community with different regions in the world; during my postdoctoral research in Philippines based International Rice Research Institute, a pastor questioned me, “Small Philippine farmers in Culion Island do farming with prayer heart for rain, because they do not have irrigation facility and often suffer from water scarcity. With what heart do you work as an agricultural scientist?” The pastor’s question of “my heart” implies a spiritual dimension to consider global sustainability of water and food ecosystem services.

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27. LINKING MOBILE AND STATIONARY SYSTEMS – PLUG-IN HYBRID ELECTRIC VEHICLES

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Key words: *plug-in hybrids, cost-efficiency, Chalmers research*

1. Linking mobile and stationary energy systems

The energy system for transport, heavily dependent on fossil oil, has in the 20-th century developed decoupled from the stationary parts of the energy system. Though not changed to any substantial degree yet, there are several factors, when facing dwindling oil resources and insistence on CO₂ mitigation and enhanced efficiency, pointing towards an increased future integration, although not all in the same direction: Several routes for non-oil transport fuel production (i.e., liquid fuels via biomass gasification) will be less efficient than refinery processing and produce a lot more of waste heat. Another possible route, fermentation, may utilize large amounts of low temperature heat in the processing¹. Reliance on large-scale utilization of intermittent resources such as solar energy will depend on efficient ways of adjusting electricity supply and demand, maybe through hydrogen or electricity storage and utilization systems including transportation². Increasing requirements for energy efficiency in transportation as well as development within electric conversion, control and storage have led towards an electrification of the car (hybrid electric vehicles, HEV), making possible transportation energy supplied from grid electricity (plug-in HEV). We have investigated the economic viability in a European context of the plug-in cars option for personal transportation. We will also point to some initiatives taken at Chalmers to strengthen research within a broader field centered around the electrification of the car.

2. The viability of plug-ins a European context

So far hybrids drivelines have mainly been utilised in Japan and US, where also the plug-in option is most actively discussed and evaluated. Less so in Europe, where reliance on diesel vehicles has been the favoured efficiency option so far for car transportation. However, generally the high pump prices should favour hybrid drivelines and plug-in options. Here we investigate under what circumstances, in a European context, plug-in extensions of hybrid electric vehicles with different all-electric range are cost-effective options from an owners perspective. The base case vehicle specifications and cost functions are derived from US studies, at EPRI defining different all-electric range vehicles³, and at NREL quantifying vehicles with blended operation⁴. We have used Swedish condition for energy prices and driving patterns.

The study shows that the cost-effectiveness is dependent on vehicle specification and applied cost methods. It is shown that a plug-in designed with a reasonably

small all-electric range (30-40 km) for a wide range of circumstances could become an economically viable option in comparison to both conventional and hybrid vehicles. The most important factor for the economic outcome is the fuel price. It is also shown that a downsizing of the car is favourable for the plug-in vehicles. The blended operation vehicles have worse economics due to less use of the efficient electric drive as well as in this case a design with less favourable trade-offs and also the applied cost functions. The applied strategy in design and marketing may thus be important for the success of plug-ins.

The carbon intensity of the marginal electricity system is important not only for the overall CO₂ effects of PHEVs but also for effects of blended operation vs. all-electric modes. With coal condensing power for electricity generation the total CO₂ emission may well increase with plug-in vehicles. However the ability to pay for the electricity may be so high that these vehicles are not on the margin.

3. Chalmers initiatives centered around hybrid and plug-in vehicles

Chalmers has identified plug-in electric vehicles as a strategic research area. In all parts in Figure 1 strong research activities can be found at Chalmers, and recently a national hybrid center has been located to Chalmers. There is also a regional interest in testing the plug-in system in the Göteborg area.

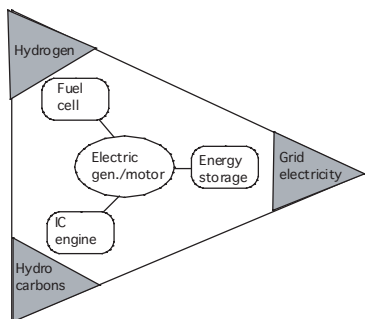


Figure 1. The future electrified vehicle may be supplied along three main routes.

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28. BRIDGING TO A SUSTAINABLE ENERGY FUTURE – EU ENERGY POLICY

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Key words: *Sustainability, SoS, Transition, Options*

1. Key objectives for EU energy policy

In March 2006 the EU commission published the Green Paper on “A European strategy for sustainable, competitive and secure energy” and thereby highlighting the importance of sustainable development (SD) and Security of Supply (SoS) within the European energy sector. The Green paper identifies mitigation of climate change and reduction of greenhouse gas (GHG) emissions as key objectives in reaching a sustainable energy system within the Union. As part of the Kyoto agreement EU-15 is committed to reduce average annual GHG emissions between 2008 and 2012 by 8% relative to the base year emissions which, in most cases, refers to 1990. However, current emission trends indicate that the EU will not comply with their commitments. EU-15 GHG emissions in 2004 were only 0.9% below the base year level and applying existing domestic policies and measures imply that EU-15 GHG emissions will only be around 0.6% below base year emissions in 2010. Additional domestic policies and measures by individual member states are expected to reduce emissions by around 4.6% according to the European Environmental Agency (EEA) [1]. The EU council of environment has suggested further emission reductions of 15 to 20% by 2020 and 60 to 80% by 2050, in both cases relative to 1990. At the same time, total EU energy import dependency is projected to grow to nearly 70% in 2030 (e.g. according to European Energy and Transport Trends to 2030 [2]) with most of the imported oil and gas coming from Russia and the Middle East, simply because these two regions possess the largest resource base of both fuels. In order to enhance SoS and reduce import dependency the EU has several options; a) to reduce demand for energy, b) to increase the share of renewables, c) to maximize indigenous recovery of oil and gas, d) to utilize indigenous coal and lignite resources and e) to increase the number of primary fuels, suppliers and transport routes for external supply including continued use of nuclear power. While options a) and b) also fit within the concept of SD, options c) and d) do not, at least not in the way they are currently being utilized. Also, it is unclear how nuclear energy fits within the concept of SD, but the Green Paper nevertheless recognizes the importance of nuclear power as a carbon-free technology within the EU energy sector. Taking the objectives and the time perspective into consideration it seems evident that the EU will have to utilize all available options in a bridging system towards a sustainable energy system, where the bridging system is to be used for at least some 50 to 100 years.

2. Options for bridging to a sustainable energy future

The energy efficiency action plan was announced by the EU commission in October 2006 targeting a reduction in primary energy consumption of 20% by 2020 and thereby to achieve savings of up to € 100 billions per year and reductions in annual CO₂ emissions of up to 780 million tons. Although it is unclear to what extent energy savings may accumulate to macro-economic level because of the so-called rebound effects, the commission claims that they have accounted for such effects when they set the above mentioned target. The advantages from any reduction in energy use are obvious also with regard to enhancing SoS.

In principle, the potential for renewable energy sources (RES) are huge and development of RES will further reduce the need for imported fuels. EEA estimates that biomass and waste as a primary fuel within the union could reach between 2,200 and 3,400 TWh in 2030 [3] while the European Wind Energy Association claims that wind energy could supply 12% of Europe's electricity needs by 2010 and in excess of 20% by 2030 [4]. Additionally, emerging technologies like solar power could contribute significantly in the long-term while a re-evaluation of hydropower could lead to a production of up to 480 TWh, up 140 TWh from 2004, according to a previous study by Eurelectric [5]. In 2004, renewables accounted for 6% of gross primary consumption while wind accounted for a little less than 2% of total electricity generation [6].

According to the Chalmers Power Plant Database (PP db) some 100 GW existing coal plants will pass 40 years lifetime by 2020. Assuming an average conversion efficiency of 35% for the existing plant stock will reduce CO₂ emissions by some 22% if the plant is being replaced with a state of the art new coal plant with a conversion efficiency of 45%. Replacing the old coal plant with a state of the art gas combined cycle with a conversion efficiency of 58% would reduce emissions by nearly 66% [7]. However, a continued rapid expansion in gas based power generation will contradict the concept of SoS by raising import dependency. Instead, coal based power generation could be utilized together with subsurface storage of CO₂. Europe has a large subsurface storage potential although the bulk of the potential is located in five countries situated around the North Sea, i.e. in Denmark, Germany, Netherlands, UK and the non-EU member state Norway. The EU targets some 10 large-scale CO₂ capture demonstration plants up and running by 2015-2020, but it is not believed that capture and storage of CO₂ will have any profound impact on GHG emission levels until after 2020.

Nuclear power has been recognized as an important zero-carbon technology by the European Union. In 2004, nuclear power accounted for 31% of total gross electricity generation within the union, generating 986 TWh [6]. Three countries have decided to phase out in total some 36 GW gross nuclear capacity generating 292 TWh (gross) in 2004, namely Belgium, Germany and Sweden. Most other member states that already have nuclear power have announced their intentions to

either keep or expand nuclear generation while at least one member state currently without nuclear power has announced plans to construct nuclear plants (Poland).

In summary, it can be concluded that although renewable energy sources (a) and reduction in demand (b) are likely to contribute significantly to both SoS and SD, nuclear power and fossil based generation in combination with CCS will not only contribute to SoS but may also act as a bridging technology to reduce CO₂ emissions in the near- and medium-term. With respect to the large investment need in power generation over the next decades a key question is the role of conventional fossil fuel power plants over these decades until CCS has reached a commercial level and the role of nuclear power has been settled.

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29. GLOBAL LIMITATIONS AND LOCAL SOLUTIONS

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1. Introduction

Global limitations can not addressed by global solutions. In this paper new methods are presented to describe local societies in terms of population and culture. Local solutions for air and energy are discussed shortly.

2. Population model

The population of a society is classified using a logarithmic distribution. The population is put equal to 2^N with a N an integer and a class width of 2 allowing in each class the population to vary from between the limits $2^{N-\frac{1}{2}}$ and $2^{N+\frac{1}{2}}$. Figure 1 gives the distribution of the world population over the 236 countries (nations, dependent areas and other entities) listed in the CIA World Factbook. The world population has $N=33$. The largest countries China and India are in class $N=30$ to be followed by the USA and Indonesia with $N=28$ and the smallest one are the Pitcairn Islands with a population of 46 with $N=6$.

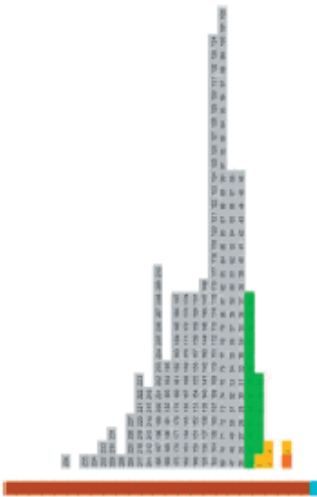


Figure 1: The world population distributed over 236 countries in terms of N .

The population model describes a society top-down taking into account only the class of the largest sub-societies and the next two smaller classes satisfying the equation,

$$2^N = h \cdot 2^{N-m} + k \cdot 2^{N-m-1} + l \cdot 2^{N-m-2}$$

top-down hence from left to right. The population model gives then the following description of the world in terms of countries; $N=33$, $m=3$, $h=2$ (China and India), $k=0$ and $l=24$ (USA, Indonesia and the rest of the world in 22 entities to satisfy the equation). The population model can be used for the description of a society in terms

of subsocieties: countries, provinces, cities, neighbourhoods, etc. But of course it may be applied to other more volatile gatherings: soccer teams, parliaments.

3. Culture model

Hofstede recognizes five cultural dimensions or indexes: Long Term View Index (A), Power Distance Index (B), Uncertainty Avoidance Index (C), Individualism Index (D) and Masculinity Index (E). In this novel Culture model the sequence of the scores is considered only and dimensions A and E are disregarded as coming late in evolution of species on Earth. (The Bb,C,D sequence is therefore not restricted to humans 0. This gives rise to $3!=6$ cultures, In Table 1 the culture sequence of B,C and D of 88 countries is given. In a few countries the score of indexes is the same and all sequences of these countries are listed.

Table 1: B,C,D-sequence of 88 countries with established indexes.

nr	BCD	CBD	CDB	DCB	DBC	BDC
1	Albania	Argentina	Austria	Australia	Sweden	Bhutan
2	Bangladesh	Brazil	Belgium	Canada		India
3	Burkino Faso	Bulgaria	Czech Republic	Denmark		Jamaica
4	China	Chile	France	Finland		Singapore
5	Dominican Republic	Colombia	Hungary	Germany		Slovakia
6	Ecuador	Costa Rica	Israel	Ireland		
7	Ethiopia	Croatia	Luxembourg	Italy		
8	Fiji	Egypt	Malta	Netherlands		
9	Ghana	El Salvador		Norway		
10	Hong Kong	Greece		New Zealand		
11	Indonesia	Guatemala		Switzerland		
12	Iraq	Iran		United States		
13	Jordan	Japan				
14	Kenya	Korea South				
15	Lebanon	Mexico				
16	Malawi	Pakistan				
17	Malaysia	Peru				
18	Morocco	Poland				
19	Namibia	Portugal				
20	Nepal	Russia				
21	Nigeria	Slovenia				
22	Panama	Spain				
23	Philippines	Surinam				
24	Saudi Arabia	Taiwan				
25	Sierra Leone	Turkey				
26	Sri Lanka	Uruguay				
27	Syria					
28	Tanzania					
29	Venezuela					
30	Vietnam					
31	Zambia					

nr	BCD	CBD	CDB	DCB	DBC	BDC
1	Romania	Romania				
2	Thailand	Thailand				
3			Estonia	Estonia		
4				South Africa	South Africa	
5				United Kingdom	United Kingdom	

It can be seen that there are major cultural differences between countries. The most dense populated countries for each sequence are: BCD (China, Indonesia), CBD (Brazil, Pakistan), CDB (France, Belgium), DCB (USA, Germany), DBC (Sweden) and BDC (India, Slovakia)

4. Limitations and Needs

The concept of a Sustainable Technological World leads to limitations in a material sense. See Table 2.

Table 2: Properties Sustainable Technological World.

Basic properties		
Mass STW	110	Gton
Power STW	8800	GW
Life-span artifacts, average	25	yr
Benchmarks		
Annual production of artifacts	4.4	Gton/yr
Specific energy consumption producing artifacts	64	MJ/kg
Specific power consumption STW	80	W/kg
Air and water flows		
Air	375	Gton/yr
Water	100	Gton/yr

With global limitations known, the question is how population characteristics (size, culture) affect needs. Societal diversity will safeguard global sustainability.

5. Sustainable Air sharing

The technological air budget of 375 Gton/yr is shared by 6.45 billion people living on planet Earth nowadays according to the CIA World Factbook. For a city like The Hague in the Netherlands this implies that, assuming stagnant air, the air budget is consumed in less than 30 years. Local culture will play a leading role in plans and actions to change this figure of 30 years (less technology, other energy, more area).

30. COMPOSTING AND ORGANIC FARMING FOR ISOLATED COMMUNITIES- A CASE STUDY OF ALDERNEY

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Key words: *composting, organic farming, landfilling*

1. Introduction

Alderney, an Island which lies about 8 miles off the Normandy coast, is the third largest of the Channel Islands. It has a total population of about 2,400, and is about 5km long and 3km at its widest point. This small community is an independent state with its own judicial system, and it is not part of the EU. From the STAR report (2005)¹, the current per capital waste generation for Alderney is estimated at about 1.95kg, comparable with many urban centres. The total cost of refuse collection and landfill disposal is put at €579,239.62 per annum. Landfill site requirements constitute considerable loss of the natural environment, including the land space. Tipping fee for annually landfilling 385.66 tonnes of waste, at the rate of €150.3/tonne for an uncontaminated load, is €57,999.11 annum. In addition, biodegradable waste in disposal sites decomposes to form leachate, a highly polluting liquid. Further, organic waste decompose to produce methane and carbon dioxide, both of which are major contributors to global warming as they break down the ozone layer and cause dramatic climate changes. Solid waste composting presents a strategic integrated approach for the management of the biodegradable part of the waste streams, not least in the fact that the resulting composts can be used for soil conditioning and crop production at household and municipal levels. In addition to this green waste which could be composted, household wastes, currently being land filled, contains substantial organic waste that could be composted and marketed on the Island.

2. Current waste disposal practice

Waste distribution in Alderney (Table 1) shows that black bag waste, 37% of which is organic, (718 tonnes) constitutes the largest percentage of the total waste generated by the island annually. 22.97% or 385.66 tonnes of the total waste profile can be composted but is presently incinerated in the island using open quarries.

Table 1. Waste fraction in Alderney (STAR Report, 2005)

Fraction	Bbw	Bhw	Cboard	Paper	Plastic	Cans	Glass	Tyres	Ac	C&D
Tonnes/yr	718	252	103	115	14	4	182	18	30	100
Disposal route	Landfill	Landfill	Recycled	Recycled	Recycled	Recycled	Recycled*	Recycled	Incinerated	Landfill

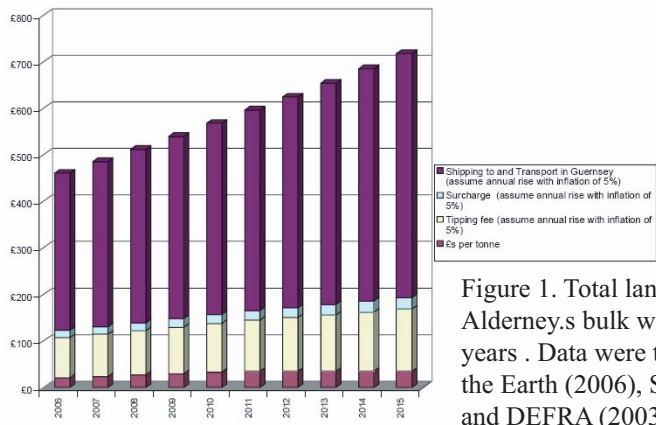
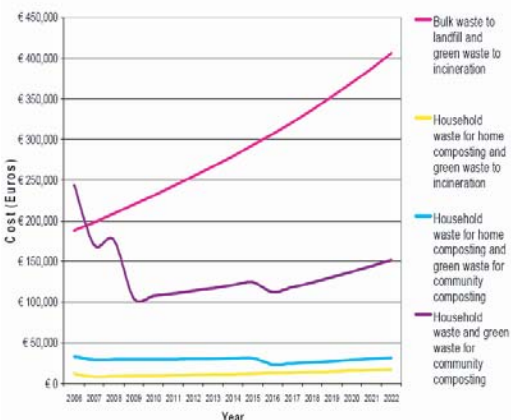


Figure 1. Total landfill cost of managing Alderney's bulk waste over the next 10 years . Data were taken from Friends of the Earth (2006), STAR report (2005) and DEFRA (2003)

As shown in Figure 1, the total cost of land-filling, which includes shipping cost to Guernsey, and surcharge and tipping fees, will steadily increase from €503 in 2006 to €779.75 in 2015 considering a 5% annual inflation rate. Thus the total cost of managing the Island's organic waste therefore, will steadily increase from €153,940 in 2006 to €332,599 in 2022. The income deficits incurred per person over this period will increase from €64.14 to €138.58.

3. Composting options for Alderney

The first management option considers composting the organic component of black bag waste at household levels, and incinerating the green waste. The total cost of managing the organic waste of the island using this scheme will be reduced to €17,328 from €154,176 within a 15-year period (Figure 2). The annual income savings for Alderney significantly increases from €180, 825 in 2006 to €372, 227 in 2022.



The second option involves the installation of a centralized in-vessel composting facility with a 0.4 -0.8 t day⁻¹ capacity for the green waste of the island whilst organic black bag waste is composted at household levels. The annual cost will be effectively reduced to €31,756 from €117,467 over a 15-year period. The final option involves composting all organic wastes of the island in a centralised composting facility. The annual cost of composting begins at a high point of €244,370 and reduces steadily to €151,819 in 2022.

4. Potentials for organic farming

The application of compost for soil conditioning and agricultural production is a principal attraction of solid waste composting for isolated communities like Alderney. Currently Alderney imports consumer goods, including some food crops for local consumption. Since the climate is favourable and land requirement is not a hindrance, composting is not only environmentally desirable but also a viable means of crop production for the Island. Several studies have been carried out on the viability of composting for crop production. In a trial in South East England², the application of MSW compost at 50 and 100 t ha⁻¹ (f.m.) on a loamy clay soil, produced grain yields comparable to those which received 75 or 150 kg ha⁻¹ mineral N fertilizer. Organic manure is known to perform well with vegetable crops, and this is particularly suitable for Alderney. In a study by Kolade O.O. et al³, palm kernel waste was converted into compost using goat manure and poultry droppings as nitrogen supplements. The results of the greenhouse experiment using green amaranth (*Amaranthus* spp) indicate that the composts can be applied to a 4 t ha⁻¹ capacity to obtain yields comparable to those of commercial chemical fertilizers.

5. Conclusion

This study has shown that Alderney as whole and individual householders stand a lot to benefit economically and environmentally from adopting the option of composting rather than land-filling or incinerating organic wastes. It is recommended that, in addition to awareness campaigns emphasizing both the economic and environmental incentives for home composting, there should be adequate policy commitment and necessary legislation by the local authority.

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31. SUSTAINABILITY OF THE GLOBAL ENVIRONMENT BY THE TOKAIDO SHINKANSEN

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Key words: *energy efficiency, CO₂ emissions, Tokaido Shinkansen, Series N700*

Abstract.

Railway is a mode of transportation that is considered to give a minimal impact on the global environment in comparison with other modes of transportation. The Tokaido Shinkansen, a high-speed railway system linking three metropolitan areas in Japan, Tokyo, Nagoya and Osaka, can especially exhibit the special performance by acting as an important mass transport system in our country.

Central Japan Railway Company (JR Central) has developed and introduced rolling stock with still higher energy efficiency, aiming at further improvement of the superior characteristics of the Tokaido Shinkansen, and also has made the transportation system more fascinating so that it can be used by still more and more people. In addition, We currently have been making preparations for the introduction of the next generation Shinkansen N700 with outstanding energy conservation performance.

Among the people traveling between two large metropolitan areas, Tokyo and Osaka, 80 percent of them are carried by the Tokaido Shinkansen, and the rest by airplanes. According to our investigation on the transportation between the two areas, the transportation volume is actually found to have increased since 1990; however the increasing rate of CO₂ emissions is found to be still more significant than that of transportation volume. Our calculation has revealed that taking full advantage of the the Tokaido Shinkansen between the two areas may lead to the great deal of reduction in CO₂ emissions.

In this paper, it is described that an appropriate allocation of each transportation mode taking into account the advantages of each system may contribute to a sustainable society. Our efforts that have been made for improvement of energy efficiency of the Tokaido Shinkansen are also introduced.

Railway is a means of transportation that has superior environmental performance to air plane and automobile, thanks to its higher energy efficiency, lower CO₂ emissions and other factors. In Japan, mass transportaton by railway has been realized owing to the development of intercity network among the areas with dense population, where railway is expected to be able to demonstrate its high energy saving performance. The Tokaido Shinkansen, daily used by as many as

approximately 390 thousand passengers, can especially be regarded as a quite environmentally superior system.

JR Central has positively invested for the development and introduction of energy conserving rolling-stock aiming at further improvement of the superior characteristics. When the performance of the Tokaido Shinkansen (Series 700"Nozomi") and an airplane (B777-200) are compared, the CO₂ emissions calculated per seat on a single trip from Tokyo to Osaka by Shinkansen is approximately one-tenth of that by air.

These days the number of people traveling between Tokyo and Osaka area is over 40 million every year, approximately 80 percent of whom are carried by the Tokaido Shinkansen and the rest by airplanes. The time required for the trip is approximately the same for both transportations cases. According to data concerned with the transportation between the two areas, the transportation volume and CO₂ emissions of the Tokaido Shinkansen has not been unchanged significantly since 1990, while the both have almost been doubled in the cases of airplanes, accompanied by the increase in the flight numbers. As a result, the total transportation volume by both systems between the two areas rose approximately by 7% from FY1990 to FY2004; however CO₂ emissions showed a remarkable increase of around 36%. Our calculations have revealed that if the Tokaido Shinkansen was to be in charge of all the transportation between the two areas, it would lead to a significant reduction in total CO₂ emissions.

Every transportation mode has its own distinctive characteristic. For instance, airplane is considered to be suitable for long distance transport, such as transport overseas. However, when a transportation with a distance of several hundred miles such as that between Tokyo and Osaka is concerned, the Tokaido Shinkansen, with a high environmental characteristic, is expected to exhibit its special performance most significantly. In this case, shifting passenger from airplanes to the Shinkansen would lead to the reduction in CO₂ emissions. We believe that an establishment of a transportation system by which each transportation mode is allocated an appropriate role, taking into account such advantages as each unique transportation capacity, travel distance, or travel time, will be desirable for a sustainable society.

JR Central has been making progress in enhancing the competitiveness of the Tokaido Shinkansen so that many customers will select our services. Preparations are currently being made for the introduction of next generation Shinkansen Series N700, which is to be launched in the summer 2007, with still more excellent energy efficiency as well as greatly improved services.

JR Central will continue to contribute to a sustainable society through the efforts of further improving the environmental characteristics of the Tokaido Shinkansen and through the promotion of the transportation system, polishing the service quality.

32. SATISFYING THE DEMAND FOR HIGH QUALITY ELECTRIC POWER SERVICE FROM CLEAN ELECTRICITY SUPPLIES

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Keywords: *Utility power, Clean Energy, Electronic Loads, Uninterruptible Power Systems*

High-quality electric power can be provided by clean electricity supplies by employing converters and dc power systems. Use of lead acid batteries for energy storage and their disposal can be reduced by use of fuel cells and flywheel motor generator sets.

Among the consequences of the growing service economy and the computer-dependent society in the United States and elsewhere in the world is the demand for high-quality electric power service. Where power supplied by utilities is subject to random interruptions of 6 cycles (100 ms) or longer, electronic equipment such as computers and servers will fail to operate properly under interruptions of 1 cycle (16 ms) or less. To avoid the problem, the demand for high-quality power is being satisfied today by the installation of UPS (uninterruptible power supplies) using battery or flywheel energy storage, at extra cost and power losses¹. For example, the total UPS capacity in units ranging from 100W to systems of 10,000 kW in the United States is estimated to be at least 3000 MW. For longer interruptions, including blackouts, the UPSs are backed up by E/G sets (engine generators) using gasoline, diesel or natural gas fuels. Clean electricity supplies can reduce the power losses and environmental effects of this equipment.

Electric utility systems are designed to generate, transmit, and distribute power at least cost. Transmission lines and distribution circuits are constructed primarily overhead, exposed to the weather, lightning, and accidents. Protection from faults, switching of lines and equipment, is carried out by circuit breakers and fuses. The resultant power service with random 6-cycle interruptions is adequate to energize motors, lights, heaters, and other insensitive equipment. This service is sufficient for the bulk of the industrial, commercial and residential load, but not for the small percentage of the load for electronic equipment that must be high quality and is critical to today's society. Of the clean electricity supplies, such as solar, wind, hydropower or biomass, none offer the required reliability to supply electronic equipment loads directly without the addition of energy-storage means and electronic converters. Suggested ways to utilize clean electricity supplies for electronic loads include the following:

1. Transmit the clean energy into the utility power system. Supply the electronic loads by UPS with E/G set back up, as is done today.

- For a facility housing electronic loads and equipped with solar panels, utilize a dc distribution system supported by batteries and with the electronic loads supplied with dc power or ac power by inverters.
- Reduce the size of the lead-acid and other battery banks in UPSs by installing flywheel-motor generator units. This will reduce the environmental problems of end-of-life battery disposal.
- Utilize hydrogen-powered fuel cells for back up service to reduce the dependence on E/G sets. This will reduce fuel requirements and exhaust emissions. Even though the operation of clean electricity supplies such as solar and wind is variable in power delivery, and the requirement for electronic loads is steady, there are efficient ways to combine their operation.

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33. ESTIMATED COSTS OF VARIABLE PRODUCTION TAX CREDITS TO ENCOURAGE INVESTMENT IN RENEWABLE FUELS¹

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Key words: *tax credit, ethanol, oil volatility*

1. Introduction

renewable fuels by reducing the investment and production risks associated with a drop in oil prices.² A VPTC can raise investor confidence and stimulate the commercialization of renewable fuels production, thereby increasing learning and lowering production costs. If oil prices are low, the credit is large enough to protect investors. As oil prices increase, a VPTC decreases in direct proportion to the increase in the oil price. Above some established baseline, there is no tax credit.

An important consideration in the use of a VPTC is the cost to the Treasury, and ultimately, to taxpayers. Two methods are used in estimating the cost of a VPTC for cellulosic ethanol³. The first method assumes that oil prices will follow the U.S. Energy Information Administration's (EIA) low-, reference-, or high-price projections shown in its Annual Energy Outlook 2006 (AEO) [1], i.e., there is no volatility in projected oil prices. The second method uses the historical distribution of oil prices to simulate their volatility in calculating the VPTC. The analysis reflects maximum production levels of cellulosic ethanol that are technologically feasible (to provide conservative estimates of tax credits) and limits the number of plants that would be eligible to receive the tax credit.

2. Cellulosic Ethanol Production

The production of cellulosic ethanol is still in a developmental stage and no commercial cellulosic ethanol plants are in operation. Because of this, production costs are uncertain and pose a high risk to investors. For the purposes of estimating VPTC costs, we assume that cellulosic ethanol plants will be producing at commercial- scale levels by 2012, consistent with the AEO high oil price scenario. Pilot production is not expected to begin until 2009 with a small-scale plant,

¹ The views expressed herein are solely those of the individual authors and do not necessarily represent the position of the U.S. Department of Energy.

² Production costs for sustainable fuels, like cellulosic ethanol, are generally higher than conventional fossil fuels and are not economically competitive when oil prices are very low.

³ Cellulosic ethanol will be further after referred to as "ethanol" in this paper.

producing about 20 million gallons of ethanol per year. Production is expected to exceed 250 million gallons per year by 2012, as called for in the U.S. Energy Policy Act of 2005, and up to two billion gallons by 2030.

3. Method

The VPTC costs are estimated using two methods.⁴ The first assumes that oil prices will follow EIA price projections [1], i.e., no volatility in projected oil prices; and, the second calculates the VPTC using simulations of oil price volatility.⁵ We further assume that there would be a production cap limiting the number of plants receiving the tax credit to twenty, each producing 70 million gallons of ethanol per year, and reach a production level of 22 MMbbl gasoline-equivalents per year.

For the first method, the VPTC costs are simply equal to the difference between the forecast price of crude oil⁶ and the VPTC floor price for crude oil, multiplied by the production volume.⁷ Tax credits are in effect only when the forecast price of crude oil falls below the floor price for crude oil. To simulate volatile oil prices in the second method, first, a cubic spline interpolation of AEO annual oil price (nominal \$) was used to estimate forecasted monthly oil price. An empirical distribution of monthly percentage change in oil price from historical data (1986-2006) was used to simulate oil price volatility [2]. One thousand iterations or simulations were used in computing a distribution of possible VPTC costs.

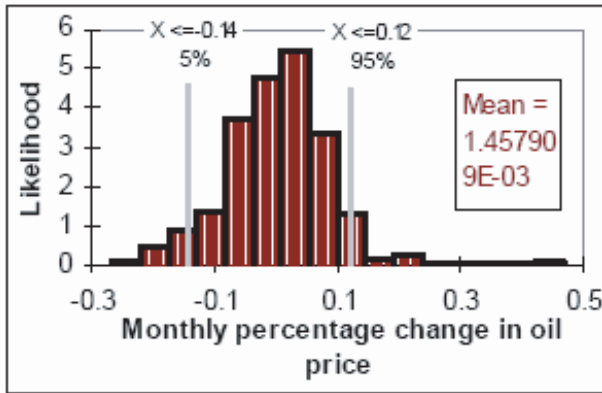


Figure 1: Empirical Distribution of Monthly Percentage Change in Oil Price from Historical Data (January 1986 - June 2006) [2]

⁴ A 10-year horizon, from January 2007 to December 2016, is used for estimating costs. The crude oil price floor is in nominal dollars.

⁵ Simulated monthly price = forecasted monthly price * (random percentage change). Distribution of monthly percent change is based on an empirical probability distribution of historical data for refinery acquisition imported crude costs, 1986-2006. The forecasted monthly price is obtained through cubic spline interpolations of the AEO yearly forecasts.

⁶ The forecast price is based on the EIA reference-, high-, and low-price projections, which describe imported low sulfur light crude oil [1]. All estimates are in 2004 U.S. dollars, unless otherwise noted as nominal U.S. dollars.

⁷ The analysis was done in nominal dollars and converted to 2004 dollars.

4. VPTC Cost Estimates

Table 1 shows the relationship between various floor prices for oil and the cost of a VPTC for ethanol based on the AEO reference-, high-, and low-price scenarios. Crude oil floor prices are assumed to be \$45/bbl, \$50/bbl, and \$55/bbl (nominal \$). The VPTC cost estimates range from zero up to \$535 million over the next ten years. As the floor price is lowered, the tax credits decrease because the projected crude oil price is more likely to remain above the floor price where no credit is distributed.

Table 1: Cost estimates (in 2004\$MM) for ten-year cellulosic ethanol VPTC modeled with annual oil price forecast and monthly oil price volatility at three EIA oil price projections and three floor prices (in nominal\$)

Cost estimates	EIA Oil Price Projection Scenarios									
	Reference-Price			High-Price			Low-Price			
Floor Price (\$/bbl oil)	\$45	\$50	\$55	\$45	\$50	\$55	\$45	\$50	\$55	
with annual oil price forecast (2004\$MM)	-	-	3	-	-	-	44	250	457	
with monthly oil price volatility (2004\$MM)	5%	-	1.06	15.3	-	-	-	64.9	247	474
	mean	0.39	4.65	26.5	-	-	0.02	85.8	276	505
	95%	1.59	9.57	40.2	-	-	0.23	110	308	535

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34. THE ROLE OF NATURAL WASTEWATER TREATMENT SYSTEMS IN THE PROTECTION OF WATER RESOURCES

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Key words: *constructed wetlands, natural systems, wastewater treatment, water resources*

1. The importance of water management for sustainable development

Water is a precious and essential good, indispensable to all forms of life. This is one of the principles that constitute the European Charter on Water Resources of the European Council of 2001 (based on the European Water Charter of 1968), aimed to remark the importance of water management. According to this Charter, water management should be based on three basic ideas: solidarity, subsidiary and participation. As well as being essential, drinkable water is also scarce in many areas of our Planet Earth. Moreover, it is extremely fragile towards pollution, much more than another precious resource like soil. Therefore, adequate water management is a key issue for sustainable development in all scales, from small communities to whole countries and continents.

Focus on wastewater treatment

Decontamination of water is one of the main pieces of the great jigsaw. Following the principle of pollution prevention, the best way to protect and preserve water resources is to prevent their pollution. The relentless increase in the amount of wastewater produced in our society, especially since tap water is easily available and cheap, makes evident the necessity of wastewater treatment systems to decontaminate water prior to its discharge in natural water bodies. This practice is nowadays widely spread in most of the so-called developed countries, at least in major cities and towns. It is less common in small villages, and in most of the so-called developing countries, wastewater treatment is still very scarce, particularly where even drinkable water treatment is very scarce. Two major reasons for this are the high cost of wastewater treatment plants construction and operation, and the technological dependence that cause mechanical intensive processes like activated sludge systems. Alternative wastewater treatment techniques, known as natural systems, are presented in this paper as bridging systems which could help sustainable water management in near-term future.

3. Natural wastewater treatment systems

Over the last few decades, natural wastewater treatment systems have been set up all over the world as a good alternative to conventional systems for the sanitation of small communities (< 2000 population equivalent) , where, generally, land availability and costs are not limiting factors. Low energy requirements,

straightforward operation and maintenance work are some of the most attractive advantages of these technologies.

Constructed wetlands

Among all natural systems, constructed wetlands (CW) are one of the most common types. CW are passive wastewater treatment systems, constituted by shallow ponds or channels with macrophytes, where water treatment processes take place by means of physical, chemical and biological phenomena simultaneously. They may be used either as a single process, treating domestic, industrial or mine wastewaters, or in combination with conventional treatments. According to water circulation within the system, CW can be divided into two groups: surface and subsurface flow systems. Figure 1 A shows a diagram of a surface flow CW, in which water treatment mostly occurs as water flows through the stems emergent aquatic plants. Figure 1B shows a subsurface flow CW in which water flows through a gravel bed and by the roots and rhizomes emergent aquatic plants. Both types of CW are mainly characterized by a simple operation, low or null energy consumption, low waste production, low noise environmental impact, low operation and maintenance costs, operation reliability, and good integration on rural environment.

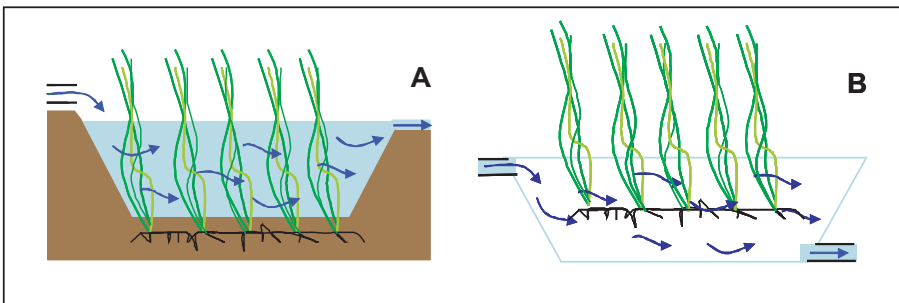


Figure 1. Types of constructed wetlands: surface flow constructed wetland (A) and subsurface flow constructed wetland (B).

3. The potential role of constructed wetlands

The number of CW facilities in some European countries like Germany, Denmark, the UK, Belgium, France, the Czech Republic or Spain has increased considerably over the last few years. A reason for this could be that inherent characteristics of CW make them an appropriate technology for the treatment of wastewaters in small communities. In this sense, natural wastewater treatment systems, and particularly CW, could possibly be one of the most feasible options to cover the needs of small communities, rural villages and isolated populations, both in the so-called developed and developing countries, which urgently need small and decentralized treatment facilities. Major constraints for their implementation could be land availability (surface requirements are between 20-80 times higher than those of conventional systems) and cost, especially if land movements are required. As their tuning time can be rather long, due to the complexity of processes involved in pollutants removal, and because there is little operational control, accurate design and construction are crucial to ensure a good performance.

35. CISOL: INTEGRATION, RESEARCH AND EDUCATION IN PHOTOVOLTAICS AS KEY TECHNOLOGY TOWARDS THE SUSTAINABLE ENERGY SYSTEM “BUILDING”

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Key words: *photovoltaic, building integration, integrated energy design, sustainable architecture*

1. Photovoltaic as key technology in sustainable buildings

CISOL is the Solar Research Centre of the Faculty of Architecture ETSAV of the Polytechnic University of Catalonia (UPC). Within its research activities it develops innovative building skins for the architectural integration of solar technologies, with a special focus on photovoltaic.

CISOL has realized in 2005 an innovative PV façade in Barcelona based on colored, semitransparent thin film modules, within the energetic refurbishment of the SCHOTT Ibérica office building. (Figures 1,2,3)

Thermal measurements have been realized and advanced simulation tools have been used to optimize the combination of façade materials, the natural ventilation, sun shading, daylight use, electricity production and the overall architectural quality and energy performance of the building. [1]



Figure 1: Façade exterior

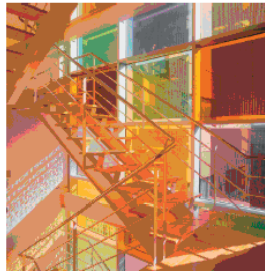


Figure 2: Façade interior

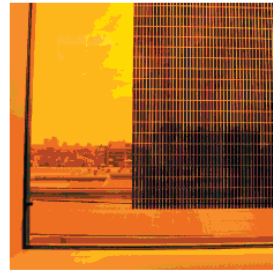


Figure 3: Module detail

For the applied research and innovation in renewable energies in this project CISOL received different prizes like the Environmental Prize of Catalonia 2006 and the EUROSOLAR Solar Prize 2006.

For a second project, a kinder garden in the city of Sant Celoni (Barcelona), a colored, semitransparent PV-panel with polycrystalline silicon cells has been developed for the architectural integration as a south oriented sunscreen in front of the building. The installation will function as a colored filter of the natural sunlight

creating a unique interior atmosphere for the children's rooms and the office areas. First prototypes with colored glass-glass modules have been realized and evaluated. Thermal performance measurements will be evaluated.

A row of design studies shows the variety of possible colored PV module configurations for this project, understanding photovoltaic modules integrated in the building skin as a natural material and design resource for architects.

2. Integrated Energy Design

Integrated Energy Design or Climate Design must be the key issue for understanding buildings as potential energy generating systems. The building skin plays a mayor role in this.

Approximately 50 % of all consumed energy world wide is used in the building sector, related to the extraction, transport and transformation of materials, the construction process, the use of buildings through their life span and finally their reutilization, recycling or demolition.

This role of buildings as a main energy consumer has to be inverted. Buildings as net-energy producers are no longer utopia. They already exist as shown with the "Plus Energy Houses" by Rolf Disch in Freiburg, Germany. This buildings proof their efficiency in an annual positive energy balance due to electricity generating solar roofs and a very efficient passive solar architecture.

These kinds of buildings need a careful design process with an energy optimization in every stage. This can only be done by the so-called *integrated energy design* with a close collaboration of architects, engineers and simulation experts. Only this multidisciplinary approach allows the energy optimization of a whole project, the early implementation of the right energy system and the best use of existing resources for bioclimatic architecture like sun, wind and microclimate.

3. Political actions and decisions – obstacles and possibilities

New building legislations in the field of improvement of energy efficiency in buildings, ranging from local solar legislations up to the new national building code are implemented in Spain and most European countries, but far to weak in their requirements.

The building sector, dominated by big companies is not interested in energy efficiency, being low building costs and high profits their main objectives. This will only change when there is a demand for this kind of architecture in the market.

Awareness raising, education and dissemination of environmental and also economic advantages of energy efficient architecture must create this demand.

The introduction of an energy pass for buildings and the direct relation between building standards and energy costs will help in this field and incite society

to demand for low energy architecture. An active tax policy would also be an important instrument to compensate the slightly higher building costs of sustainable buildings.

4. Education

CISOL is focused in his research and educational activities on low energy architecture and renewable energy systems as key factors for a sustainable building culture. Applied research and consultancy on innovative solar technologies for building integration and the optimization of the building skin are main issues of our work (Figure 4). The CISOL - Solar Workshops focus on the integrated energy design as tool towards sustainable architecture. (Figure 5)



Figure 4: CISOL – Research and Consultancy



Figure 5: CISOL-Solar Workshop 2007

This type of planning procedure should be implemented as a general methodology in architectural and urban design to enhance the synergies between renewable energy systems and the complexity of architectural and urban planning parameters like function, form, density, materiality and esthetics. As another educational project a participated PV installation, the “ESTAV Solar garden” will be realized by CISOL at the Campus Sant Cugat.

5. Conclusion

Energy efficiency and renewable energy technologies have to be seen together as the most important parameters in sustainable architecture and urban planning. Integrated solar technologies within multifunctional building envelopes will play a key role in buildings understood as renewable energy systems, which generate more energy than they consume. An outstanding concept in our search for pathways to a sustainable energy future.

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36. AN ALTERNATIVE EMISSION TRADING INCLUDING TECHNOLOGICAL PRODUCTS

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Key words: *Post Kyoto Protocol, Emissions Trading, Technologies, Policies*

1. Abstract

This paper discusses an alternative pathway to sustainable GHG emission reduction on Kyoto regime. The Kyoto doesn't count outside credits, or emission reduction that cannot be attributable to JI/CDM projects, but may offset fraction of GHG reduction out of foreign investment and sales of products and goods distributed through market by private sectors. Then, the authors postulate that the Kyoto regime should be extended to the level of products and goods, or technologies and services so that such latent credits can be tradable. Although the Kyoto Protocol is practically in place with JI/CDM, which is project or production-based and points direct sources of gas emission such as power plants/factories, the GHG reduction through consumer market is set aside. Such objects includes, for example, automobiles, aircraft, or even ITs with highly energyefficient, low GHG polluting technologies. Although project-based approach is effective to some extent, it requires massive investments to construct and replace infrastructure, and the cost of the investment decision will soon outweigh the benefits in the near future. As a result, the authors propose that outside credits should be considered for emission trading in post Kyoto Protocol as an alternative tradable window to seek long-term goal of GHG reduction.

2. Supporting Analysis

In our study, the second author analyzed potential emission reduction based on information published by public bodies. In Figure.1, JI/CDM projects approved by Japanese Government [1] are put in order of their emission reduction. The horizontal axis represents cumulative number of projects, and the curved line then shows the rapid decline in emission reduction. This means that JI/CDM is efficient to some degree, however, it is assumed the efficiency yields rapidly diminishing number of effective projects since JI/CDM projects are generally costly,.

On the other hand, emission reduction by consumption of products and goods are generally small. Figure.2 shows comparison of gas emission between traditional cars and hybridcars [2]. The difference in gas emission between them may be approximately 150g-CO₂/km. Returning to Figure.1, individual emission reduction obtained from consuming products and goods is nominal, however, their total consumption reflects dominant numbers. For example, there are approximately 850 million automobiles running around world today. Suppose that energy efficient technology such as hybrid car replaces traditional one, its impact cannot be ignored.

3. Summary

Under the current scheme of Kyoto Scheme, major focus is put on project-based, or production-based approach such as JI/CDM. This paper developed that the scope of Kyoto should be also extend to consumption-based, focusing on the reduction out of products and goods using effective technologies and services. As an example, this paper has shown potential emission reduction in the case of automobile reduction in comparison between traditional cars and hybrid. The application, however, includes other sectors such as aircraft, electricity, etc. Considering *outside credits* as referred here may be also one of key aspects in research and education relating to technology transfer, CSR, etc., as well as issues of technological policies.

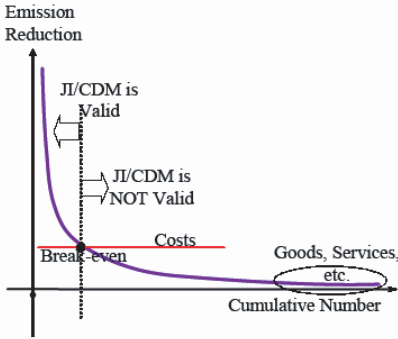


Figure 1 : Potential of Emission Reduction

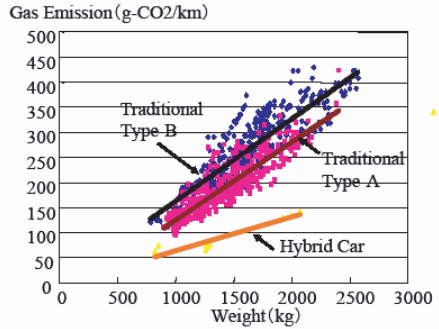


Figure 2 : Comparison of CO2 Emission

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37. PATHWAYS RESEARCH FOR A ROBUST, SAFE AND SECURE PROVISIONING OF FOOD AND WATER

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Key words: *future studies, learning processes, scenarios, landscape*

The concept of “pathways” is very frequent among researchers and policy-makers approaching complex and multidimensional problems with a more or less clear connection to future studies. This contribution wants to explore the concept and its implications when applied to one of the future challenges - the provisioning of food and water to a growing world population. The Alliance for Global Sustainability (AGS) has dedicated a flagship programme to collaboration around these pressing issues. “Pathways” is the concept used to structure our communications during the AGS-meeting. But what are “pathways” and which are the limitations of “pathways”?

“Pathways” is understood among researchers and the general public in many different ways, and as all metaphors it is enriched with associations. It is not difficult to imagine the small hiking party finding its way under trees and between hedge rows experiencing a mild breeze, engaged in a pleasant conversation and with a nice pub within reach. However pathways may also lead to unwanted destinations, with unforeseen consequences. Without pressing the metaphor it is possible to see many pathways followed by different larger or smaller groups, which starts at different locations and lead forward to different goals.

Pathways are found in the landscape at particular positions due to irregularities of the landscape. The pathways are related to the passability of the terrain. In old times mountain ridges and deep forests prevented contacts between populated areas. Understanding the landscape is to understand where pathways are to be found, and which terrain that is to be avoided. Seldom pathways changes the landscape, but it might happen when pathways of people and water coincide.

The ease of following a pathway, compared to traversing of pathless land is a conspicuous aspect of hiking known to all wanderers. Following well-used pathways can be alluring, but they can lead in wrong directions. Maybe the smaller and more difficult track is the one to be followed. However, one can be sure that pathways in the landscape will be used, and therefore widened. There are places in the landscape where we want to be - and places we don't want to be - human preferences matters and there is a clear interaction between humans and nature.

Within academic disciplines the concept of “pathways” has been approached in history (Mahoney 2000), sociology of technology (Hughes 1983; Bijker et al. 1987) and in cognition research. In all instances the use of the metaphor tells us that it is easier to follow a path. Or that we cannot choose another point of departure than where we are right now. “Pathways” is also a way to approach the making of scenarios (Swart et al. 2004) and that is the concern for dealing with “pathways” for energy, food and water.

There are many possible goals and therefore many possible pathways into the future. There are also many possible ways to apprehend the landscape since many possible positions can be imagined. Sustainability science (Kates et al 2000) must therefore be a post-normal science (Funtowicz and Ravetz 1993) accepting multiple legitimate and parallel perspectives which poses challenges for future studies and emphasize the boundary work (Cash et al. 2003) as a necessary precondition for the communication between science and politics.

Saying that pathways are different for different groups (or even individuals) is in a way easy to comprehend. Different groups may follow different paths to different goals. However, there is only one single world that we share (Danermark et al. 2001) and the overall constraints are the same, the landscape is the same.

The findings of the Millennium Assessment (Millennium Ecosystem Assessment 2005) indicate a need for transition. That is to move from one general direction to another, changing into another pathway. Therefore “pathways” is also about change, about learning processes. Changing cognitive pathways on a societal level is related to resilience and adaptive governance (Folke et al. 2005; Folke 2006). This will then rise some questions - who, what and how to learn?

Who are the actors? Influence or power is not an easy thing to understand or handle and we don't know who the ones are that need to learn. It is easy to point out politicians, CEOs and some influential journalists, academics - but also the ordinary, individual citizen does possess power as consumer or as voter. Large transitions may need many to learn a lot. Change of behaviour is also a learning process. And we all know how difficult it can be change an old habit. Restrictions on learning are seldom pointed out as a problem - how come?

What need to be learnt? Restrictions and possibilities related to food and water issues can easily be pointed out. For instance water is unevenly distributed, both on a global and on a local scale. On global scale weather systems, which are formed by the uneven distribution of solar energy and continents, causes precipitation to fall predominantly where monsoons or cyclones coincide with mountains causing air to cool and water to precipitate. The further fate of water is a guided by topography and, to a lesser extent, the distribution of vegetation. But how to handle distribution and restrictions - who is going to have water enough for what crop? Which crops should be grown, and for what purposes? Is it OK that purchasing power should

guide agricultural systems into bioenergy production instead of food production? A food production that might save the last forests to those without purchasing power - orang-utans, gorillas and tigers? Discovering and quantifying relationships between different sectors and perspectives is one of the important challenges for “pathways” research, and very much remain to be discovered in the interfaces between energy systems, agricultural systems and urban systems. Old sector approaches need to be complemented by new approaches for understanding and learning that cuts across disciplines.

We think that integrated mediated modelling using participative scenario-making processes that open up the boundary work is what the pathway-concept should be about.

38. WHICH SOCIAL AND TECHNICAL INNOVATIONS CAN PROMOTE PATHWAYS TO A NOURISHED WORLD?

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Key words: integrated approach, environmental flows

1. An integrated approach to land and water resource management

This abstract comments on and summarises some of the major findings of a chapter of the forthcoming Comprehensive Assessment of Water Management in Agriculture. The chapter, entitled *Agriculture, water and ecosystems: Avoiding the costs of going too far*, outlines the trends and impacts of agriculture on ecosystems over the last 50 years, sets out the future challenges facing humankind, and proposes societal responses to these challenges. Two key responses highlighted here are the need for an integrated approach and an example of a tool to be used in the decision making process: environmental flow assessment.

An integrated approach to land and water management is essential for developing a sustainable pathway towards feeding an additional 3 billion people by 2050 while preventing further degradation of ecosystems. Integrated approaches have received much attention over the last two decades, and are referred to in many different ways: integrated land and water resource management, ecosystem approach, integrated river basin management, systems approach, etc. The general aims of all approaches are (1) to integrate all benefits and costs of land and water management decisions, (2) to involve key stakeholders and cross-institutional levels, and (3) to cross relevant biophysical scales, addressing interconnectedness across sub-basin, river basin and landscape scales. Despite the efforts in developing and understanding integrated approaches, very few examples exist today where successful implementation has occurred. Given the difficulties in putting integrated approaches into practice, two critical questions remain to be asked: Is an integrated approach still the most appropriate strategy for dealing with the immense challenge ahead for feeding the world without undermining ecological resilience? If so, what does it take to successfully establish and implement an integrated approach?

Integrated approaches help water managers and decision makers to deal with the competing interests in water resources. By putting on the table all benefits and costs generated across a river basin, decision makers can identify opportunities for the sharing of these multiple benefits, costs and responsibilities.

In the past, decisions and management practices have focussed on one or a small number of services, such as food production. Either intentionally or unintentionally, other services have been neglected in the decision making process. These services commonly have no or unrecognised market values, yet many play essential roles

in livelihood support and ecosystem health. With the increased recognition of the adverse impacts on ecosystems and social systems from these sectoral approaches of the past, we realise that the best response options will involve managing landscapes, including agriculture, for a broader array of services.

2. Environmental flow assessment

One of the tools available to water managers and decision makers for assessing the multiple services provided within a river basin is environmental flow assessment. Environmental flows refers to the water regime provided within a river, wetland or estuary to maintain or restore ecosystems and the benefits they provide to people. The water regime in this context is defined as the pattern of delivery of both the quantity and quality of water needed by a river, wetland or estuary, in space and time. Determining how much water can be allocated to consumptive human uses without the loss of ecosystems services is becoming a more common component of efforts to maintain and rehabilitate rivers, wetlands and coastal zones. Environmental Flow Assessments (EFAs) are undertaken through a variety of methods and often involve a range of stakeholders and experts. The research and science behind the assessments is extensive and many examples of assessment can be found around the world, particularly in Australia, South Africa and USA. A gap, however, prevails between this research and actual on-the-ground implementation of the assessments and translation into policy and decision making processes.

The importance of this specific tool in promoting a pathway to a sustainable future can be seen in the growing recognition of the link between flows and human livelihood. It is often downstream poor rural communities that are most dependent on the goods and services provided by a river, wetland or coastal zone. Subsistence farming on the floodplains of rivers, local riverine and estuarine fisheries and smallscale irrigation are three examples of these goods and services that are intimately linked to the flow regime. These types of uses have also been historically ignored when water development plans have been developed upstream. The impacts from upstream dams, reservoirs, diversions and canals on ecosystems and the people dependent on these ecosystems downstream are often significant.

Evaluation of all the benefits and costs when planning these types of developments will identify this link between flows and livelihood, and ensure that these aspects are considered as part of an integrated approach to land and water management within a river basin. The Comprehensive Assessment of Water Management in Agriculture has been undertaken over the last 6 years to critically evaluate the current situation and to provide policy relevant recommendations on the way forward over the next 25 to 50 years. It aims to address the diverging views over choices about water, food and ecosystems, as well as inform people who make investment and policy decisions in the field of water management for agriculture as well as practitioners and researchers.¹

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39. HEAT IN THE CITY, PREVENTING THE NEXT EXPLOSION OF ENERGY CONSUMPTION IN EUROPE

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Key words: *energy consumption, urban heating, cooling technology, air-conditioning*

1. Introduction

Cities are warmer than the surrounding rural areas. This difference in temperature is largest under sunny conditions, and especially in the evening. At maximum, the difference is about 6°C (10°F). Higher temperatures cause increased mortality rates, hospitalization, decreased labor productivity and less feeling of well being. However, in winter, this ‘urban heat island effect’ keeps cities warmer and therefore saves energy. Recently, Europe has been suffering from unusually hot summers. Traditionally, buildings in Middle and Northern Europe were not air-conditioned. However, as a result of the hot summer, air-conditioning sales is growing rapidly. The central issue of this paper is to search for promising options that could prevent a strong increase in electricity consumption for air-conditioning in Northern and Middle European cities.

2. The problem

During the last six years, six heat waves were recorded in the Netherlands. This is remarkable as there were only 38 heat waves in 105 years of heat wave recording the KNMI [1]. In all North Western Europe, summers have been extremely warm. The number of victims is hard to estimate as these heat waves coincide with high smog and fine dust levels. [2]

City authorities take measures. Public health authorities started information campaigns to warn vulnerable groups such as elderly, children, patients, etc.

However, sales of air conditioners are sky rocketing. It is relatively cheap and effective for the individual. However, it will increase CO₂ emissions and local heat production

The construction sector has long been focused on conservation of heat. Many buildings and blocks have been constructed having passive solar energy in mind. Therefore, we should not just introduce efficient cooling technologies, but also rethink urban planning and the energy requirements for buildings.

3. Options

The paper will analyze various options that might lower temperatures in the city or in buildings:

- Intelligent management of buildings
- Vegetation
- Water
- City Planning
- Construction
- Converting solar radiation to useful energy
- Sustainable air-conditioning and cooling

The paper will make an assessment of these options based on their effectiveness, environmental impact and costs.

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40. WHAT SUSTAINABILITY MEANS FOR FOOD EXPORT AND AGRICULTURAL VALUE ADDITION?

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Key words: *Food export; Sustainability; Value addition; Interdisciplinary system integration*

Accelerating high doesn't necessarily reflect 'the only' tool for development. Faster growth, in any sector, may not last longer. This holds true even in case of food – which is one of the basic vital needs for human survival. Achieving the first and foremost millennium development goal of reducing by half the proportions of people living on less than a dollar a day and of people who suffer from hunger by 2015 – can be envisaged on the grounds of sustainability.

Advances in science and technology have led to new methodologies and techniques to strengthen most of the links in the food-chain. Production of food to the farm gate; processing to preservation; and handling to storage and distribution – the technology reflects the quantum of advancement we have gained over the years, recently. Growing world-population poses harder challenge to the engineers and scientists. Technical innovations in several sub-sectors of food-chain offer a significant buffer to cushion this impact. Efficiencies are likely to hike and losses are assumed to reduce – in order to fetch larger returns to each dollar input.

It is believed that balance and sustainability, through economic structure adjustment, can be induced by increasing economical competition capability. To accomplish such strategy, priority has to be given on the conformance of the production structure adjustment with trade. The key factors including human skill and knowledge, science and technology, management and upgrading of infrastructure must be emphasized in order to increase the efficient and quality of production process and market accessibility. Simultaneously, it has to consider the equilibrium of natural resource conservation and utilization as well as environmental quality protection under the sustainable development concept.

Such approach to sustainable development could be followed by several measures. One of them is research and development focusing on application, invention and innovation of technology. It is required to establish the technology roadmap toward research for industry by the mechanism on technology developer-user collaboration research. Accordingly, it would generate the output that meet the target of industrial development. However, the technology roadmap of any industries should be established on the principle of integration in order to develop the research for the industry that can reach to the competition market.

Technologies have their own limits, so does too in the food-chain. Natural resources are limited, (conventional) energy sources are depleting and in addition, numerous food-borne diseases have out broken – causing increased global awareness towards food-sufficiency, -safety, -security, and –sustainability. This guides the scientific community – engaged in food-chain – to critically examine sustainable ways of food production and processing. Organic farming, Good Agricultural Practices (GAP), Good Manufacturing Practice (GMP), Hazard analysis and Critical Control Point (HACCP), clean technology, functional food, and by-products and waste utilization are some prominent and proven examples of sustainable approach in food-chain. Functional food or medicinal food, for instance, serves dual purposes of health promotion and/or disease prevention. Similarly, cleaner technology not only aims at environment friendly processes, but also incorporates by-products or wastes generated at most of the production or processing stages – thereby offers a minimum disturbance to the ambience.

The integration of technology roadmap should be made on the value chain for food export industry. Each stage during the value addition- raw material-post harvesting/inbound logistics-production process/modification of product-packaging-logistics-marketing-export –should be integrated. It indicates that each unit process on the value chain consists of the principle technologies integrated with the supporting technologies of other industries including renewable energy, information technology and cleaner technology/waste management technology. For example, in food-export industry, the possible supporting processes could be Food information Technology, Traceability and Bio-polymer. While supporting technologies might be Geographic Information System (GIS) Radio Frequency Identification (RFID) from software-hardware computer industry, energy saving for farm machinery from energy industry, waste utilization from cleaner technology/waste management technology. In advanced stages, the integrated technology can be compiled toward drafting of a sustainable research plan on the value chain following the steps as below:

- identification of qualified and economical cost raw material;
- post harvest technology/inbound logistics;
- development of production and value added process, utilization of by products/ waste management, development of testing and efficacy method/consumer oriented new products/drug and cosmetic;
- packaging to maintain quality of product with safety to health and environment;
- development of knowledge that enhance for food and herbal food/medicine industry and food sa hain management.

The afore-mentioned examples are though in existence, yet there exists a tremendous scope of wide spreading the concept of sustainability worldwide, and also to identify newer methodologies for the purpose. The future is likely to depend on how we handle our ‘today’. As a rule of thumb, in nature, an isolated closely-looped cycle that accounts neither accumulation nor depletion – is sustainable.

41. OXYFUEL POWER PLANT WITH CO-PRODUCTION OF DME - A BRIDGING TECHNOLOGY

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Key words: *Oxyfuel, Co-production, Co-combustion, Simulation*

1. Introduction

Capture and storage of carbon dioxide (CCS) from fossil fuelled power plants is on its way to become an important part of the pathway to a sustainable energy system, i.e. to serve as a bridging technology. Bridging technologies using fossil fuels are required in order to meet emission targets (such as corresponding to limiting the temperature increase to 2°C in year 2100) at a cost which society seems willing to pay, considering security of supply and maintaining regional competitiveness. More specifically, current estimates and analysis yield that CCS has a large potential for reducing CO₂ emissions at an avoidance cost of no more than 20 €/ton CO₂ avoided. However, in order to make the bridging system flexible and minimizing lock-in effects, it is important to investigate integration possibilities between the power generation and the transportation sector and to see if CCS can help the biomass market to grow. One capture technology for which this may be possible is the so called oxyfuel process (or O₂/CO₂ recycle combustion process). An interesting possibility with this process would be to burn the fuel in an oxygen lean mode (i.e. slightly under stoichiometric conditions), yielding a process between combustion and gasification with co-production of synthesis gas, which can be used to synthesize different fuels or for power production. When the produced synthesis gas is used as fuel in the transportation sector the carbon present in the gas is emitted to the atmosphere. In order to compensate for these emissions a small fraction of biomass could be co-combusted in the proposed process, corresponding to the amount of carbon used for the synthesis gas production. At the same time co-combustion of biomass using a large coal power plant is an efficient way to utilize biomass. In this way the flexibility of the processes is increased and the expensive oxygen production for the oxyfuel process is minimized.

2. Method

In this work a 700 MW power plant with oxyfuel combustion with synthesis gas production is investigated. The synthesis gas is used in an integrated DME production unit. The process is simulated in Aspen Plus where the combustion, gas cleaning, DME synthesis and steam cycle is implemented. The outcomes from the various reactions are predicted with equilibrium calculations at given temperatures. The stoichiometrics of the combustion is varied from 1.15, i.e. normal combustion, down to 0.6. The amount of biomass in the combustion is adjusted to make up for the carbon dioxide emitted from the DME, so there is no increase in the net

emissions of carbon dioxide from the power plant. The efficiency for the power production is kept at a level corresponding to a state of the art oxyfuel combustion process (0.35 is applied which is comparable to literature data) when the resulting efficiency of the DME production is calculated.

3. Results

The resulting efficiency of the DME production as a function of the stoichiometrics of the combustion is presented in Figure 1. The efficiency reaches a maximum of around 0.6 at a stoichiometry of around 0.8. At higher stoichiometric ratios the DME process suffers due to the higher concentrations of inert gases in the reactor and at lower stoichiometrics the efficiency of the power production suffers. The need for extra equipment compared to the conventional oxyfuel process is limited and is basically only related to an enhanced separation of the carbon dioxide. The DME synthesis is well integrated with the flue gas treatment of the oxyfuel power plant and existing equipment for compression and CO₂ removal, which is normally required in both processes, are utilized in the DME process. Synergy effects can also be achieved with heat integration, the heat produced in the DME reactor is used for preheating of the feed water and the low value heat from the flue gas condensation can be used in the distillation column of the DME process.

4. Conclusion

The efficiency gained for the DME production, which is in line with efficiencies for alternative processes for DME production, together with a small need for extra

equipment and integration possibilities makes the proposed process an attractive alternative for DME production from biomass. Sub stoichiometric O₂/CO₂ combustion is also beneficial for the oxyfuel process due to the elimination of the over production of oxygen. The flexibility of the process is increased both through the use of multiple fuels and through coproduction of fuel for the transport sector. The major concern with the process is possible implications related to the substoichiometric combustion conditions, which should be investigated further.

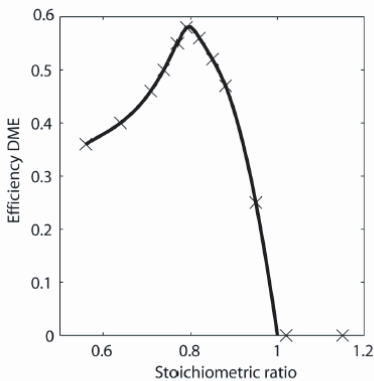


Figure 1 Resulting efficiency of the DME production from the proposed process as function of the stoichiometrics.

42. ENERGY USE IN EUROPEAN BUILDINGS - MONITORING THE PATHWAY TOWARDS A SUSTAINABLE BUILT ENVIRONMENT

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Key words: *Monitoring, Buildings, Data, Europe.*

1. Introduction

To contribute towards a reduction in demand side energy use in Europe over the coming decades, a key system that must be put in place, is a method of monitoring energy usage trends in buildings. A basic premise for such monitoring is, that, across the continent, mandatory building thermal efficiency standards have not lead to reductions in energy use in line with regulations. Germany, for example, has had building thermal regulations in place since the early 1970's. Theoretically there should have been a 60% reduction in residential sector energy use there over this time. The reduction has, however, been only 38%¹. A reoccurring problem is that, although applicants for building permits submit plans which include the thermal characteristics of the buildings they plan, compliance is rarely monitored afterwards by authorities. This has implications for the energy saving initiatives that have emanated from the EU in the last few years including the Environmental Performance of Buildings Directive (EPBD). In fact, and this certainly includes buildings, the IPCC SRES² states that there is an inadequate ability to capture the potential for efficiency improvement and the impacts of efficiency programs.

2. Measuring and Monitoring

Effective monitoring of building energy use trends requires two key components. First, time series measurements of building stock and corresponding energy end uses therein. Second, a descriptive method of displaying the collected data so as to accurately interpret root causes of changes in energy use. Ideally, those engaged in monitoring would have access to annual measurements of total building floor space and energy end use therein for space heating, space cooling, water heating, lighting, electric appliances, cooking and air conditioning. There are, however, currently gaps in the availability of such data all across Europe. Data is often not disaggregated. Energy for space and water heating can be given as one figure while the same can occur for lighting and appliances. Data for air conditioning or newer electrical appliances may not even be collected at all. At the same time however, there is no shortage of methods for displaying collected data. The Energy indicators work carried out by both the IEA and the Odyssee Project have left an adequate range of approaches for trend and cause analysis. Data deficiencies however, prevent the full use of these indicators, such as with the classic³, *useful energy use for space heating per metre squared of building space corrected with degree days*

for seasonal climate variation. In this case data for floor space in the services sector is often lacking.

3. Solution?

Recently a number of proxies have been suggested. Estate agents and State departments could have knowledge of floor spaces quantities in the service sector. Municipal authorities who charge rates to commercial buildings could have same. More concrete solutions such as the installation of advanced energy monitoring equipment in buildings or, the inclusion of questions relating to energy use in the next round of EU wide censuses in 2009/2010⁴, would help. Electrical monitoring equipment could be costly however depending on its complexity while some EU countries, no longer conduct a national census. A more straightforward solution would be to use existing marketing companies to conduct sample surveys to collect the required data by their appending energy related questions to their existing questionnaires. Such a solution has been proposed by Eichhammer⁵. He costed an adequate sample survey of both residential and service sectors buildings for the whole EU at €1.5 Million per year, which would be a drop in the ocean compared to the €700 Million⁶ tranche the IEE has been allocated for the next framework. To date, the Odyssee Project has been the best attempt at collecting the desired level of floor space and energy end use detail and presenting harmonised inter country comparisons. The project does not however have the authority to mandate national members to collect data in addition to that already collected. This level of authority is available at EU level and as such the commission could identify an organisation to coordinate an expanded demand side data collection service. The commission have already requested Eurostat to formulate a set of indicators for assessing the impact of the Energy end-use efficiency and energy services directive. In order for the commission to act however there may be a number of organizational matters that would have to be dealt with to make binding, the collection of data by member states. Action though would enhance the EPBD and allow effective monitoring of the pathway towards a sustainable built environment.

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43. THE DEVELOPMENT OF THE ELECTRICITY-SUPPLY SYSTEMS IN GERMANY, THE UK AND THE NORDIC COUNTRIES UNDER STRINGENT CO₂-REDUCTION COMMITMENTS

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Key words: *Electricity generation, system, Northern Europe, CO₂-abatement*

1. Key questions

When reflecting on the key questions given for the Energy flagship program it stands clear that the aim is not trying to identify and specify a future defining sustainability. Rather, the way forward lies in focusing on the direction of the development route. Thus, it should be important to include a detailed description of present energy systems to serve as a starting point for requested actions to act upon. Special attention within methodologies used should not only be on what to do to reach a certain target but also on the timing of these actions. Adding this extra dimension of timing to a target switches the focus from what to achieve on to how to get there, i.e. to identify pathways and to analyze these in relation to Security of Supply, Environment and Competitiveness. Using a pathways perspective enables work being carried out towards sustainability without having defined a final sustainable society. Instead, the focus lies in identifying technology and actions that can make transformation of present systems come about. In addition, timing issues enables identification of windows of opportunities and bridging technologies, which may play an important role avoiding locking in in old or suboptimal technology.

2. Put into practice

The purpose of this study is to evaluate the development of the electricity-supply systems in three important European regions, Germany, the UK and the Nordic countries. We assume that the three region's (as the rest of Europe's) electricity systems will face stringent CO₂-reduction commitments such as a 60 percent reduction target by 2050. Following this, we evaluate the different ways such reduction targets may be reached both separately within each region and jointly through a common reduction target.

The analysis is based on a highly detailed description of the existing power-generation stock. Together with new investments these plants represents a bridging system on the pathway towards a sustainable energy system. In the analysis, existing power plants are represented down to a block level (i.e. single boilers) in the three regions and included in terms of capacity, year of commissioning and fuel (from

the Chalmers power plant database). Assumptions on the remaining (technical) life time yield “phase-out” patterns of existing capacity over time in each region. Furthermore, assumptions are made on development of thermal efficiencies for thermal units, based on historical statistics and future projections, and on anticipated full load hours for intermittent RES. Thus, by assuming future electricity demand the need for new capacity investments over time is evaluated for each region. The most cost-efficient technology mix for new investments is modelled, considering stringent CO₂-reduction targets and the different national energy policies. Differences in the “phase-out” patterns and differences in investment strategies between the three regions are analyzed in detail. These differences explain some of the benefits a common strategy for reducing CO₂ emissions. Differences in “phase out” patterns are primarily explained by different age structure in the existing capacity. However, differences in energy policies between the regions, for instance concerning existing nuclear power, may also contribute to different “phase-out” patterns. The status of the existing capacity stock and national and international energy and environmental policies are also important factors when choosing strategies for investments in new capacity. One crucial question is whether it is likely that one region pursues an investment strategy that is significantly different from the other regions or if the regions will have more or less the same preferences for coming investments.

National studies on RES^{1,2} (Renewable Electricity Supply) from the UK and Germany show that these regions could obtain about 50 to 65 percent of total electricity generation from RES in 2050 if maximum realistic potentials are utilized. Yet, some technologies have generation costs far from competitive compared with conventional thermal technologies, e.g. geothermal electricity (Germany) and photovoltaics, which calls for stringent policy or subsidies. However, even with this high penetration of RES some additional generation capacities with near zero carbon emissions (Nuclear or CCS) are needed to enable mitigation levels of 60 percent. In addition, “bridging” systems can be seen in the ongoing fuel switch from coal to gas, which in the latter period studied is replaced with CCS technologies (then serving as a second “bridge”).

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44. WORLD WATER RESOURCES IN THE 21st CENTURY

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Key words: *global hydrological cycles, global warming, food and water*

1. Background

Water is a naturally circulating resource that is constantly recharged. Therefore, even though the stocks of water in natural and artificial reservoirs are helpful to increase the available water resources for human society, the flow of water should be the main focus in water resources assessments. The climate system puts an upper limit on the circulation rate of available renewable freshwater resources (RFWR).

2. Current Situation of Water Demand and Supply

Although only 10% of maximum available blue water and 30% of green water resources are used presently (Oki and Kanae, 2006) and current global withdrawals are well below the upper limit, more than two billion people live in highly water-stressed areas because of the uneven distribution of RFWR in time and space. This fact reminds that water resources development is how to stabilize the temporal variation by storing water and fill the water deficit by transporting water with reasonable cost.

3. Future Perspectives

Climate change is expected to accelerate water cycles and thereby increase the available RFWR. This would slow down the increase of people living under water stress (Figure 1). However changes in seasonal patterns and increasing probability of extreme events may offset this effect, and there are places where more water stressed situation is anticipated regionally, such as Middle East, Mediterranean, and Sub-Saharan Africa. The increases of numbers of people under “water stress” are mainly due to the demographic and economical growths.

4. How to tackle with current and future world water issues?

Nevertheless, it is certain that there are people who are already suffering from water shortage today and that any change in the hydrological cycle will demand changes in water resource management, whether the change is caused by global warming or cooling, or by anthropogenic or natural factors. If society is not well prepared for such changes and fails to monitor variations in the hydrological cycle, large numbers of people run the risk of living under water stress or seeing their livelihoods devastated by water-related hazards such as floods. Therefore reducing current vulnerability will be the first step to prepare for such anticipated changes. The ultimate objectives of future-oriented world water resource assessments are

to show the international community what will happen if we continue to manage our water resources as we do today and to indicate what actions may be needed to prevent undesirable outcomes. In that sense, studies of future world water resources are successful if their predictions based on business-as-usual are proven wrong. It is recommended for AGS to consider such long term perspectives of water and its relationships with food and energy even when thinking about near-term future in terms of developing sustainability in societies by technological developments.

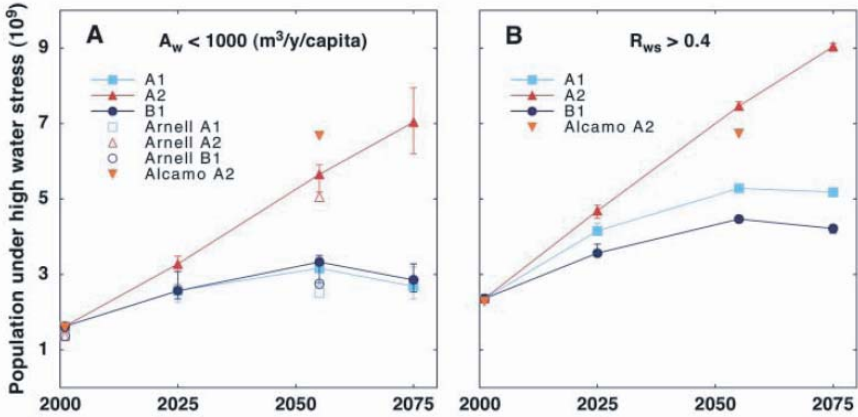


Figure 1: Current and future projections of population under high water stress under three business-as-usual scenarios of the Intergovernmental Panel on Climate Change’s Special Report on Emissions Scenarios. Threshold values are set to be (A) the water-crowding indicator $A_w = Q/C < 1000 \text{ m}^3\text{/year per capita}$ and (B) the water scarcity index $R_{ws} = (W - S)/Q > 0.4$, where Q , C , W , and S are renewable freshwater resources (RFWR), population, water withdrawal, and water generated by desalination, respectively. Error bars indicate the maximum and minimum population under high water stress corresponding to the RFWR projected by six climate models. Climatic conditions averaged for 30 years are used for the plots at 2025 (averaged for 2010 to 2039), 2055 (averaged for 2040 to 2069), and 2075 (averaged for 2060 to 2089). (Firstly appeared in Oki and Kanae, Science, 2006)

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45. LIFE CYCLE ASSESSMENT OF TUSCANY OLIVE OIL PRODUCTION

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Key words: *Life Cycle Assessment, Best Practice, Typical Production*

1. Introduction

Olive oil manufacture is one of the most typical and oldest Italian productions. A great variety of typologies, over 400 “cultivar”, are produced in this country, 68 of which only in Tuscany [1].

Territory preservation and biodiversity are key concepts on which both the agricultural and food production chain are based. Appropriate production techniques and respect of natural resources are fundamental aspects of a correct management system for companies involved in this field. Only recent studies have applied the LCA analysis on extra-virgin olive oil production [2]. This study attempts to underline the necessity to preserve typical agricultural and gastronomic traditions of this region, trying to demonstrate how these are still based on sustainable patterns. This analysis, following a preliminary calculation where the environmentally most significant activities were identified, wants to present a more detailed study that illustrates the importance of a co-generative use of waste materials. This evaluation shows how the recoveries from the phases of olive transformation, olive pulp allocation, waste water reuse and leaves and limbs reprocessing, represent an important gain in the total environmental assessment. The project involves OTA (Olivicoltori Toscani Associati, Florence, Italy), LCA-lab spin off ENEA and the University of Florence with the collaboration of the Industrial Ecology master at Chalmers Institute of Technology.

2, Methods

For the study the EPS 2000 method and the Sima Pro 5.0 code has been used for Life Cycle Impact Assessment (LCIA) phase, and the database Standard, Ivamlca3, Idemat, Eth-Esu, Data Archive, Ecoinvent for Life Cycle Inventory Analysis phase [3]. In EPS 2000 [4] method (Environmental Priority Strategies in product design) the impact categories are identified from five safe guard subjects: human health, ecosystem production capacity, abiotic stock resource, biodiversity and cultural and recreational values. The Human Health indicators are: Life expectancy expressed in years of life lost (person/year), Severe morbidity and suffering including starvation (person/year), Morbidity like cold or flue (person/year), Severe nuisance (person/year) and Nuisance which causes irritation, but not any direct reaction (person/year).

The impact categories of ecosystems production capacity are: Crop production capacity (kg of harvest), Wood production capacity (dry kg), Fish and Meat production capacity (entire weight of species in kg), Base cations capacity (H^s mole equivalents), Production capacity of water (kg) with respect to persistent toxic substances and Production capacity of drinking water (kg) fulfilling WHO's criteria on drinking water. Abiotic stock resource indicators are: Depletion of elemental or mineral reserves and Depletion of fossil reserves. The weight factors, which are another distinctive element of the EPS 2000 method, stand for the willingness to pay (WTP) to avoid any change that may cause damages to the environment and to human health. The willingness to pay is an economic concept and defines a method of evaluation meant to establish the maximal amount of money that a subject is willing to pay for a certain benefit.

3. Results and discussion

The goal of this LCA study is to determine the environmental damage due to the olive oil production in the conventional Tuscan company (OTA) [5]; the object of the analysis is the virgin olive oil production; the functional unit is 0,75l of 1 olive oil bottle; the system boundaries includes the olives transformation phases until bottling phase, including solid olive residue allocation, olive oil waste water reuse and leaves and limbs reprocessing. In figure 1 and table 1 the principal results of weighing analysis.

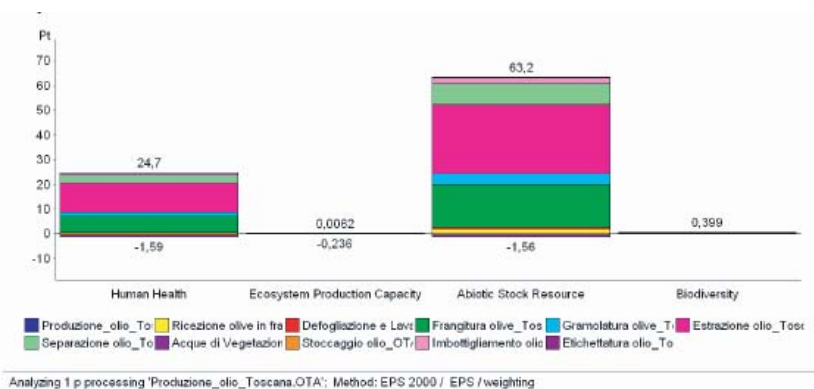


Figure 1: Diagram of weighing analyse of 1 bottle of Olive oil production

Table 1: The results % of weighing analyse of 1 bottle of Olive oil production

THE PROCESSES THAT PRODUCES THE MOST DAMAGE	% POINT OF DAMAGE
EXTRACTION	47
CRUSHING	27
SEPARATION	13
KNEADING	7
BOTTLING	4
THE PROCESSES THAT PRODUCES THE GAIN	% POINT OF DAMAGE
WASTE WATER REUSE	- 2
DEFOLIATION	- 0,13

The damages incurring in the olive oil production phases are a result of a large use of electricity. The -2% gain is consequent of olive oil waste water reuse for fertirrigation, which results in avoiding the use of fertilizing products. The -0, 13% gain is due to the reuse for fertirrigation of leaves and limbs in the defoliation phase.

4. Conclusion

LCA analysis can represent a valid tool to numerically quantify the environmental impact of a productive cycle in the agricultural food industry with the use of international indicators and specific software. This analysis' objective is to guarantee hygiene and to preserve quality through an accurate evaluation of the chemical, physical and biological risks of the entire olive oil weaving factory (from cultivation to oil retail).

The environmental impact analysis divided into productive phases wants to clarify the criticalities of each productive step and create a manual listing of the "Best Production Practices for Environmental Sustainability" for the sector.

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46. ENVIRONMENTAL CONSTRAINTS FOR AFFORESTATION AND REFORESTATION ACTIVITIES IN DIFFERENT AGRO-ECOLOGICAL ZONES OF SOUTHERN INDIA¹

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Key words: *afforestation, agro-ecological zones, carbon finance, India*

1. Background

India holds 20% of land classified as wasteland. Wastelands are degraded land, with the degradation process being defined as a decline in soil quality with an attendant reduction in biomass productivity¹. It is estimated that on average wastelands have a biomass productivity of less than 20% of their overall potential². Despite attempts from the Indian government to reforest the lands, with programmes such as Social Forestry Projects and Joint Forest Management, current rate of Afforestation and Reforestation (A/R) is inadequate³.

2. Afforestation and reforestation in India

Afforestation of India's wastelands is not only a possible action for environmental reasons, but also an economically beneficial action⁴. However, the implementation of A/R projects on wasteland is hampered by social, environmental and economical constraints. Soil degradation processes on wastelands have severely reduced the soil organic carbon, primarily induced by a combination of low biomass productivity and excessive crop residue removals. At the same time, the low soil productivity is together with financial difficulties, such as lack of funding and long investment period, in itself a barrier for A/R implementation^{5,6}.

3. Financial incentives

The introduction of carbon credits under the Clean Development Mechanism (CDM) or other financial systems, such as compensation for ecosystem services or voluntary carbon offsets^{7,8}, create opportunities and can potentially provide incentives to re-vegetate the wastelands, which in return can have an energy supply impact in terms of biomass for bioenergy. The mitigation potentials of

¹ The project is carried out as part of ongoing research at our departments exploring climate change mitigation and adaptation options in the energy sector and in land use. The group has been granted AGS financial support under the Flagship Project: Energy for development in India, China and Africa.

these financial systems, as well as the environmental and socio-economic factors that influence their realization, are not well known. Unrealistic expectations about the potential of wasteland risk hampering the implementation and might also lead to a false impression of CDM or other financial systems as a quick ride to land development and carbon credits for project developers. The definition and analysis of potentials and barriers for A/R projects on both a local and a regional level will help policy development to point out areas where the A/R process might need to be altered.

4. The scope

By looking at different land uses and various forest options in four different Agro-Ecological Zones (AEZs), the potential for wasteland development within CDM-like situations will be evaluated. A comparison of soil quality and vegetation cover for natural forests, plantations and wasteland will help define the impact that a potential forestry project could have on different land-use options. The aim of our study is to identify and analyze environmental and socio-economic constraints for A/R activities on both local and regional scale. The study intends to clarify whether A/R CDM could induce an increase in the A/R rate in Karnataka on land areas previously unsuitable or undeveloped for forestry purposes. Local physical differences and upscaling of local data to a regional level, in this case to AEZs, will be used to address the questions.

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47. TOWARDS CONSUMER-ORIENTED, DEMAND-DRIVEN AND PRO-POOR URBAN WATER DELIVERY

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The important role played by water in ensuring the sustenance of life puts it in the category of essential but public goods demanded by all in its safe and pleasant form. The changing urban population and pattern of consumption from simplicity to sophistication is observed in cities around the world where for instance consumer demand for and patronage in water and food is increasing and moving away from the 'raw' product state to value-added products. Generally, urban consumers would prefer value-added products such as aromatic or sweet-tasting water, processed vegetables, etc, than before. Like many other countries, it is not uncommon to observe an increased patronage in bottled water perceived to be hygienically pleasant to taste in Accra. According to Bonello (2002), bottled or mineral water use is on the increase in most countries, believed to result from a number of factors including water quality compromises. The changing pattern reflects a shift from consumption (especially drinking) of utility company-supplied treated water to packaged or bottled water.

In the water sector, an effective way to meeting this changing consumer demand and pattern of consumption is by instituting a more vibrant and efficiently managed utility company. A study in Accra by Lundeohn *et al* (2004) identified safe water quality, safe water access and affordable water as the top three criteria for a satisfying water supply. The study unearthed that consumers and stakeholders call for a more efficient and better managed Ghana Water Company limited (GWCL) and that people in general are quite positive toward private participation (PSP) in the urban water delivery, although tariffs are thought to increase. The PSP of GWCL in line with the World Bank's own water management orientation is expected to inject vibrancy and ensure sustainability in urban water delivery (WB, 2004), though in the view of Ruiz-Mier and Ginneken (2006), the key to success does not necessarily bother on the ownership structure in place, but also how different the ownership structures can adopt practices that allow them to overcome challenges. It is crucially vital that, the urgency and purpose of utility company's operations are guided by the expectation and the level of consumer demand. Consumer-centered water delivery and management system is very important to ensuring that water supply meets the expectations of consumers. Studies have shown that, consumers in Accra expect a lot of improvements to come with the shift to PSP management, in terms of the quality of water and supply services. Lundeohn *et al's* study (2004) confirms this. Also a study by PURC (2002), an opinion poll by GWCL (2004) and

a consumer trust study by Lundehn and Owusu (2006) indicate that Accra water consumers consider accessibility, water quality and service reliability as paramount issues in water delivery.

In Accra, increasing urbanisation has outpaced infrastructural development and reinforced the shortfall in water supply. A daily supply of 551000m³ against a demand of 939000m³ is estimated, which means that just a little over half of urban demand for water is currently met by the supplies. A Millennium Development Goal (MDG) target of 85% supply coverage by 2015 is only achievable with consumer-oriented services as well as a complementary socio-cultural environment. Owing to the critical shortfall in water delivery, the urban poor are most often than not disadvantaged and pay as much as ten times the approved tariff through secondary and tertiary water providers (PURC, 2005b).

Lundehn and Owusu's (2006) study, shows that urban consumers whose source of water is via small water enterprises and public standpipes most likely occupy the lower levels of the income distribution (between ₵599,000 (US\$65)¹ and ₵1,199,000 (US\$130) per month). The per capita cost of water for tanker-water, shared and private water consumers² is estimated to be ₵62,000 (US\$7), ₵36,900 (US\$4) and ₵28,400 (US\$3) respectively. Mean comparison test indicate significance (at 5%) for at least one of these values. Their results raise a critical question about targeting of pro-poor water pricing policies in urban water supply.

This paper concludes by highlighting the need for a consumer-oriented demand-driven urban water supply in view of the changing phase of urbanisation in Ghana and the MDG objective. This requires that water supply management is reconstituted to exhibit the needed proactiveness.

Also, there is the need for a strategic price-policy targeting to the urban poor consumer in a way as to facilitate their ability to access and use safe and quality pipe water as their right so dictates.

These are critical pathways for a sustainable water delivery system.

¹ The exchange rate is currently an average of GH₵9,200 to US\$1

² The study considered three categories of pipe water consumers: Those that have in-house water supply (private consumers), those that share their water source (shared consumers), and those that have access through tanker or small water enterprises (tanker-water consumers)

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48. WE DO NOT HAVE A SUSTAINABLE WATER MANAGEMENT MODEL TO EXPORT

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Key words: *sustainable water management*

Reflection

We do not have a sustainable model of water management to export to developing countries. By pretending that these countries will not follow the pattern get dirty - get rich - get green we are misleading ourselves and thus missing an occasion to prevent a major ecological damage. According to Systems Dynamics, ecological problems don't need a technical solution, but a social one. Think global, act local, says the word. Applying this sentence to water management could mean taking one small basin, analyzing its social, economic and environmental cycles and then applying its conclusions to bigger and more complex ones. Taking into account that the AGS is formed by four major universities from different parts of the world, a similar and parallel study could be engaged in the closest small river basin, simulating its feed backs and finding its often hidden leverage points. Only if we are able to offer a success case can we pretend to implement it in other parts of the world. Different system dynamics experts [1], often from different points of view, have reached surprisingly similar conclusions:

There are no technical reasons why socio and environmental problems couldn't be solved, it's only because of social and political structures. Actual policies only lead to actual solutions. It's only through a change in social, economical and political structures that we can hope for a better world, overcoming change resistances. These changes have to be carefully designed and implemented. The AGS is very well placed to provide this analysis and offer some innovative solutions, implement them at small scale and offer a success story. Only by example can we learn.

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49. A SUMMARY OF THE ‘ENGINEERING EDUCATION FOR SD TOOLKIT OF INFORMATION & TEACHING MATERIAL’

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This paper is based on ‘Smith, M., Hargroves, K. and Paten, C. (2007) Engineering Sustainable Solutions Program: Critical Literacies Portfolio, The Natural Edge Project, Australia. (TNEP)’

Key words: *Engineering, Education, Sustainable, Solutions*

1. Introduction - Global Challenges on the Pathway to a Sustainable Future

This paper reflects on the critical need for an urgent transformation of higher education curriculum globally, to equip society with professionals who can address our 21st Century sustainable living challenges. Specifically it discusses a toolkit called the ‘Engineering Sustainable Solutions Program’, which is a freely available, rigorously reviewed and robust content resource for higher education institutions to access content on innovations and opportunities in the process of evolving the curriculum. Access is via www.naturaledgeproject.net.

As identified by the Alliance for Global Sustainability, communication at all levels must be an integral part of the overall strategy in working towards the ultimate goal of Sustainable Development. In particular, the Scientific and Engineering profession has a duty of care to use our technical knowledge to communicate sustainable development challenges and opportunities to the community at large. In particular, it is critical that both this latest information about global systems and current and emerging endeavors to address sustainability challenges are translated into curriculum content efficiently and in a timely manner. Such a transition involves significant content and cultural adjustment within the teaching and research fraternity – and there is no time to waste. The call for a transformation of the way we equip graduates is coming from both industry and our future learners. The next generation understands the gravity of the situation and Industry around the globe is demanding that graduates be equipped with skills to innovate in this changing arena.

When AGS formed 10 years ago, it identified the issues around global sustainability – energy efficiency, clean water, fresh air, and sufficient food for an expanding population – as among the most challenging problems on earth today. Indeed, the two current AGS Flagship programs – “Energy”, and “Food and Water” – provide an opportunity to consider how we can equip the next generation of

leaders, across all sectors of society, with the knowledge and skills required to meet the challenges of sustainable development. In order to have meaningful discussions about pathways and innovations in key technologies and systems; about political actions and decisions nationally and internationally; about globally changing needs; and about implementation challenges and opportunities amongst society, it is critical that we are all equipped with the best information that we can find.

2. An Educational Toolkit – the Engineering Sustainable Solutions Program (ESSP)

The ‘Engineering Sustainable Solutions Program’ (ESSP) has been developed over the last three years in collaboration with academic, business and public service colleagues globally¹. It draws on knowledge and experiences of the network in addition to a recent publication *The Natural Advantage of Nations*² (Earthscan Press, 2005). The program provides an easily accessible robust and rigorously reviewed set of content that demonstrates the possibilities of achieving Factor 4-10 improvements³ in energy and resource consumption, through rethinking the way we design the built environment. Sponsored by UNESCO, TNEP and Engineers Australia (the peak professional body for Engineers in Australia), the package contains two portfolios that are modular in layout and structured according to commonly accepted pedagogical principles. The Critical Literacies Portfolio (CLP)⁴ comprises two levels of content on the topics of Greenhouse Solutions, Greening Industry, Built Environment, Urban Transport, Water – Nature’s Gold, and Zero Waste. For each of these topics, the material covers the four themes of Eco-Efficiency, Whole Systems, Biomimicry and Green Engineering. The Design Practices Portfolio (DPP) provides examples of calculations of technological innovations across these themes and topics. UNESCO, TNEP and Engineers Australia recently announced that the ‘Toolkit’ will be a free-access, open-source resource.

3. Exploring the Pathways – The Natural Edge Project

The Natural Edge Project (TNEP) is a not-for profit partnership for research and education on sustainable development, first hosted by the Institution of Engineers Australian and from 2007 hosted by the Centre for Environmental Systems Research at Griffith University, Queensland Australia. TNEP’s mission is to contribute and succinctly communicate leading research, case studies, tools and strategies for achieving sustainable prosperity across government, business and civil society. Driven by a team of early career Australians, the onprofit Project receives mentoring and support from a range of experts and leading organisations in Australia and internationally, through a generational exchange model. We believe that our generation has an obligation - and an exciting opportunity - to be part of the solution in restoring the balance. Imagine... if organisations could improve their bottom line while being planetary caretakers... Imagine... if national economies could grow more than business as usual and contribute positively to society and the environment... TNEP aims to be part of making these visions a reality. We rely on mentoring and

collaboration, using lessons from the last 30 years to ensure the next 30 make our children proud.

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50. RISK MANAGEMENT TO REDUCE THE GLOBAL RISKS FOR A TRAGEDY OF WATER

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Key words: *Risk assessment, Regional, Drinking water*

1. Background

During the last century the industry has constantly increased the discharge of environmental hostile contaminants leading to degradation of the world's ecosystems and diminishing the natural sources for drinking water production and supply. Over utilization of groundwater sources, e.g. bad irrigation management, have depleted many groundwater sources, which jeopardizes the future drinking water supply. It is also well known that the main limiting factor for the global food production is water, which further emphasizes the urgent need to preserve and remediate the water sources, e.g. the Water Framework Directive (WFD). World population is in many future scenarios expected to increase to about 8 billion people by 2025, where the increase in Asia and in several developing countries is especially pronounced and in many cases already struggle with the water supply [1]. Today, over one billion people are lacking enough safe water to meet a minimum level of health. United Nations has in one of the Millennium Development Goals appointed that this number of people should be halved before 2015. There is a matter of opinion among stakeholders about how this goal should be attained, e.g. the World Bank suggests large-scale solutions such as increased privatization which on one hand concern many NGO's and local populations since it is not clear for them how this would affect the poor people's access to water and the effects on the ecosystems. On the other hand water is normally considered as common goods and therefore not accounted for in economic models and in the national budget. Considering water as an economical resource and include it in national GDP (green GDP) is one suggested way to globally value scarce water resources. Regardless of which political ideology that nationally will rule the water sector there is an urgent need for increased consciousness within the society and among stakeholders to globally develop and implement new sustainable water policies promoting a globally sound water management practice avoiding the risks of a continued degradation of the world's water sources. Another global threat is the risk of international conflicts due to increased water scarcity, e.g. augmented water source degradation by effects from the foreseen climate changes.

This paper aims at discussing the potential an integrated risk assessment and risk management will have to reduce the risks and threats to the water supply from catchment to consumer and from local to regional/global systems.

2. Risk Assessment and Risk Management

One way of identifying and controlling the risks and threats within different areas of the society is to carry out a risk assessment of the system and apply adaptive strategies to manage the risks in economical, ecological and social-cultural safe manners, also termed risk management. In a recently started EU project, TECHNEAU, risk assessment and risk management strategies for local water utilities are being developed [2]. A generic framework and a set of tools applicable for the integrated risk management are developed and based on the basic risk management process and on the WHO's Water Safety Plans (WSP), see Figure 1. In the toolbox a hazard database with general hazards for the whole drinking water system sub-divided from catchment to consumer, including future hazards. Another tool developed is a matrix of different risk assessment methods that can be used in the risk analysis of the whole drinking water system (e.g. HACCP, HAZOP, fault tree analysis etc.). Finally a risk reduction option database tool is developed suggesting different measures and barriers to reduce or eliminate the identified risks in the drinking water system. The generic framework for integrated risk management together with the developed tools will form a decision support tool for optimization of costs for the risks and the suggested risk reduction options in the drinking water system. Risk management at this level of the system is not a new innovation, but an integrated fully quantitative risk management approach covering the whole local drinking water system is rather novel in the drinking water supply.

To adapt this approach up to a regional level assessing the risks and hazards for the drinking water system, valuing the risks and risk reduction options on a regional level is an interesting approach that has not been fully tested yet. Integrated risk management in a regionally water system will of course be a comprehensive work to carry out, and has been discussed previously [3], that certainly will create added value to decision makers nationally and internationally, including organizations such as WHO, UN, World Bank, etc.

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51. INTEGRATING BIOMASS IN NATURAL GAS FIRED COMBINED CYCLES AS A BRIDGE TO A SUSTAINABLE ENERGY SYSTEM - A METHOD FOR TECHNOLOGY ASSESSMENT

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Key words: *gasification, biomass, retrofitting*

1. Introduction

Co-firing biomass with fossil fuels in existing heat and power plants can serve as a near term bridging technology towards a more sustainable energy system. Although co-firing with coal offers a significant low cost carbon avoidance potential, an obvious prerequisite for its application is the availability of high efficiency coal fired power plants. Since the use of natural gas combined cycles (NGCC) is widespread in Europe and elsewhere, introducing biomass in such plants could offer an efficient use of biomass in terms of electricity per unit of biomass.

This study aims at identifying and comparing the technical options for retrofitting NGCCs for co-firing of biomass and to compare these options with respect to overall efficiency, level of technical maturity and associated risks. An aspect which is in focus is the connection between the level of biomass substitution and fuel efficiency. Theoretical results for a general case are compared to a few, more detailed case studies based on existing NGCC plants, to demonstrate the validity of the general calculations. Another goal is to develop a methodology to assess and compare different system alternatives as bases for energy systems analysis of pathways towards sustainable energy systems. At present, the study is limited to thermal processes for heat and power generation.

2. Methodology

2.1. Model requirements

To be able to compare different technical options with each one need to set the system boundaries for different energy conversion technology in a such a way that the result become as unbiased results as possible. Furthermore, it considers the main parameters which determines if, when and under what conditions the technology can be competitive. Parameters of obvious importance are the thermal efficiency and investments and running costs, but also technical maturity and associated risks are important in the overall assessment. The methodology must also handle the difficulty of comparing a commercial system with a non-commercial “future system”. An obvious problem is how to treat less mature technology only demonstrated at a small scale, where no experiences from commercial projects are

available with mature technologies with known problems and costs. However, it should be noted that this work is restricted to proven technologies. Here, proven technologies refer to technologies where the components exist and have been experimentally investigated, at least on lab scale, although not necessarily in the proposed configurations. With respect to providing input to energy systems analysis, the methodology aims at a more detailed description than what is obtained by so called learning curves.

2.2. Methodology

The proposed methodology is divided into four steps:

1. Identifying and describing the alternatives
2. Process evaluation
3. Technology assessment
4. Systems analysis

In the first step, the different possible alternatives for fuel substitution are determined and described schematically. The process evaluation in the second step yields the thermal efficiency for the processes considered and is used as an input when sorting out the least promising alternatives. For the more promising alternatives a more detailed analysis are conducted to evaluate the technology assessment. This analysis describes in a qualitative, but organized way, the technical maturity of the components of each process, environmental characteristics and associated risks with the process. Finally, the Systems Analysis describes and analyses the process in a larger perspective; the impacts of the process on a regional scale and the feasibility of the process to constitute a bridging technology.

3. General case

In the general case, the retrofitting alternatives are applied to a general and simplified NGCC base case, which is assumed representative to typical NGCC systems. The base case is based on data from a number of European plants built after 1995. Several alternatives for NG substitution are proposed and scrutinized, with focus on the process evaluation.

4. Case study

The Case Studies are based on “real” data for existing NGCC plants, confirming the results from the “general” case, but comprise technology assessments with a higher level of detail. Initial evaluations have shown an interesting option for partial substitution of natural gas by using biomass instead of natural gas for supplementary firing (in HRSG boiler). This could be a solution that does not include the troublesome, and in large scales unproven step of biomass gasification, which is the option often discussed today.

52. DEVELOPMENT OF PATHWAYS STRATEGIES FOR THE FOOD SUPPLY/DEMAND SYSTEM

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Key words: *Food, production, demand, pathways*

1. Prospect for food supply/demand (2030)

The global population is predicted to reach 8 billion by 2030 and global food consumption is expected to increase to over 3000 kcal person⁻¹ day⁻¹, raising concern over the secure availability of food. However, the UN Food and Water Organization (FAO) provides a positive outlook for 2030. Increasing demand for food is predicted to be outpaced by an increase in crop yields and livestock productivity. Unfortunately, there is no such thing as a free lunch and although the prospect for food supply appears to be generally (globally) positive, it is important to stress that current problems will persist or become more significant. These problems include over-consumption in the developed world, hunger and food security in the poorest countries (especially in Sub-Saharan Africa), dependence on cereal, milk and meat imports in developing countries, changes in land use, agricultural land degradation, nutrient leaching and the use of pesticides and chemicals. Increased vulnerability is also expected to result from climate change and subsequent water availability issues in some regions. These issues need to be solved to ensure that the increase in agricultural production does not jeopardize the secure, long-term (beyond 2030) provision of food.

The Food and Water Flagship Program aims at defining pathways that will ensure a balance between the secure provision of food and water (and other ecosystem services) and human needs and demands. The development of pathway strategies requires a comprehensive understanding of the system considered and the identification of the issues to be tackled.

2. Simplified description of the food supply/demand system

Considering the human actors (in contrast to Figure 1 in the Food and Water Flagship Program description 2), the food supply/demand system can be described as a 2-component system with providers (farmers) and consumers (general population) (Figure 1). The exchange between providers and consumers is performed by the food industry and the system is largely driven by demand from consumers; farmers produce what can be sold. In addition, governments have gained some control of the system by providing subsidies to farmers. Further governmental regulation occurs in the case of international trade. The food supply/demand system is part of the earth system and the use of agricultural land by the providers is an important interaction between man and its environment.

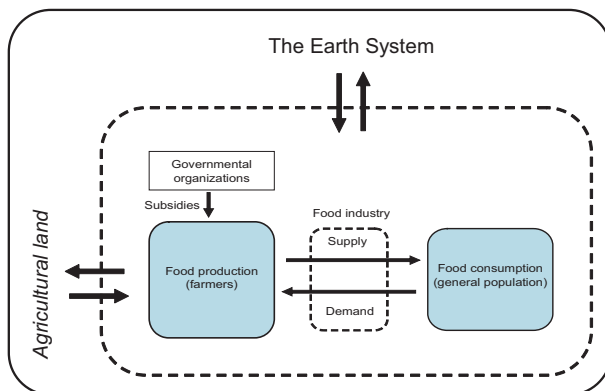


Figure 1. A simplified schematic description of the food supply/demand system.

3. Development of pathway strategies

Clearly, there are several ways to reach a balance between the secure provision of food and human needs and demands. For example, a simple solution could be to reduce consumption from present day demands to basic human needs. However, consumption patterns are difficult to change. It is therefore important to select a viable pathway and there is a need to develop a strategy for the identification of such pathways.

The focus of the AGS Food and Water Flagship Program needs to be further defined and a strategy needs to be identified. Where can an organization such as AGS bring changes? Considering the balance between supply and demand, it is possible to consider the following focuses for pathway identification:

- two- (or multi-) component focus: the identification of pathway strategies in a 2-component system would require the identification of win-win (or non-zero sum) situations for food producers and consumers.
- single-component focus: this approach requires the identification of a key component with low intrinsic inertia (or resistance to change) in the supply/demand system and focuses on improving this component to reach standards set by other components.

The most suitable pathway strategy is probably a single-component approach with a focus on food supply, possibly integrating the food industry into the producer component.

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53. GOOD CALCULATION: MAKING KNOWLEDGE COMPLETE, CLEAR AND VALUATED

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Key words: *Environmental Science, Teaching, Graphical Representation*

1. Presentation

An important obstacle for a new pathway to be accepted by society is that people is not confident about ideas they do not understand. My hypothesis is that all necessary knowledge should be available for the public (say, high school level public) and that national and international institutions have to cover this gap.

In certain debate points, it is important to understand, simultaneously, the whole problem and its different parts, including relations among these parts. From my point of view, this project consists on identifying and preparing the contents, procedures and results that should be transmitted following certain conditions and avoiding other conditions. As a general idea we can establish that, for complex systems, graphical representations are useful.

Positive conditions are: Completeness, Clarity and Disposal of values

Negative conditions are: Saturation and 'Physical Lies'

Table 1 : Conditions to fulfil and to avoid for good transmission systems

Fulfil	Avoid
Completeness	Saturation
Clarity	'Lies'
Disposal of values	

We have done this work for the general topic: Teaching Physics to Architecture Students^{1,2}

2. Environmental Science applications done

All environmental topics are complex ones. So work developed in other complex topics (like Architecture) is fully applicable. Even, the subjective part of architectural design can be mirrored with the each day necessity of addressing "new" topics (and from different perspectives) that is common in Environmental problems.

For this reason, I have decided to transmit a useful variable not very much known. I have chosen the variable Exergy³, mainly for its capability of considering together Energy and Material problems. I have presented different graphical possibilities⁴.

The common characteristic is representing different kinds of exergy with three different colours. Then, combinations can be seen in a straightforward graphical way.

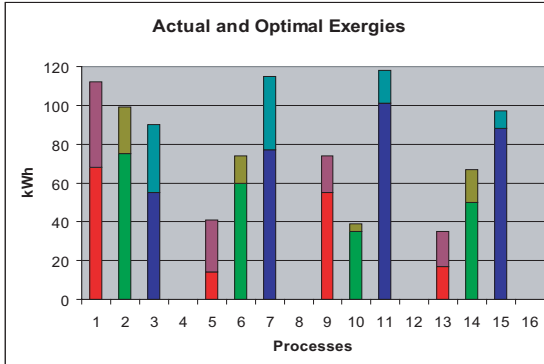


Figure 1 : Two different presentations of variable exergy where Red stands for Thermal Exergy, Green for Mechanical Exergy and Blue for Materials Exergy

3. Works on process

This work has been, until now, rather personal. But sustainable development items need collaborative work. So it is time for it to grow in people concerned and, also, in work to be done. I have thought this growing in three different directions:

- a) Measures: Make measuring available for people that does not have used. Organizing our own measures, preparing them for compatibility with other people measures and contrasting with validated software. UPC/Cities and Applied Physics Department provided some funds.
- b) Application to more elaborated projects with implication of groups of different disciplines and coming from Universities, Public Agencies, ... For example, a study about water and its cycle in buildings (coordinated by professor A.Cuchi).
- c) Exploration of other theoretical possibilities: A possible study about exergy of a quarter in a city scale distinguishing and valuating the three types of exergies.

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54. INVESTIGATION OF TECHNICAL SPECIFICATIONS OF REINFORCED GYPSUM BOARDS AND ITS EFFECTS ON ENERGY SAVING

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Key words: *Composites; Gypsum Board; Bending Strength; Energy Saving.*

Abstract

Effective heat conservation and saving energy have long been important considerations for those involved in the design and construction of houses and apartments. To satisfy these requirements, a growing number of architects and builders are switching to lightweight gypsum board area separation walls. Gypsum board systems are easy to erect and secure, meet all building code requirements, and provide economical thermal insulation and sound control and because of their lightness they are appropriate for regions that are prone to having earthquakes like Iran. The main construction material that is used in Iran is brick. Whereas the brick making is one of the most contaminating industries -especially near Tehran- the replacement of bricks with gypsum boards can reduce the environmental pollution. The main problem is that it's not accepted to use gypsum boards instead of the old materials because of their light and brittle look.

Gypsum boards may break during transportation and they are not suitable when using as bearing walls a research has done to increase their bending strength. Three kinds of fibers (Polypropylene, Fiberglass, Rough rice) were selected for reinforcing gypsum base. In one part of this research rough rice and polypropylene fiber were used to increase the bending strength but because of the discontinuity between fiber and matrix the result was not satisfying. But when long glass fiber was used, the bending strength of the boards was increased about 50 percent.

55. PEDAGOGICAL STRATEGIES FOR INTEGRATE SUSTAINABILITY IN TECHNOLOGICAL UNIVERSITIES CURRICULUM

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Key words: Education Sustainability Pedagogy

1. Teaching and learning processes on Sustainability.

The introduction of Sustainability culture in technological universities presents several challenges to be overcome. Although the importance of sustainability knowledge is becoming widely recognised within the core of engineering universities, there are still some educational barriers:

- (i) the structure of the curriculum tends to be very rigid and condensed, thus not allowing the introduction of new modules on Sustainable Development (SD).
- (ii) the splitting up in specialized areas of knowledge within the university departments, which makes difficult the introduction of transversal knowledge as Sustainability.
- (iii) the pedagogy used in most technological universities, where the courses are taught basically in a passive way as lecturing.

The importance of the pedagogical strategies in the teaching-learning process is crucial to facilitate the introduction of SD knowledge in the curriculum, both from the point of view of specific SD modules and also in embedding SD in “regular” modules.

This contribution presents the study carried out in 19 European technological universities where 50 experts in pedagogy, educational managers, teachers of SD modules and students have been interviewed.

2. Interviews of experts

Experts were asked about which pedagogical strategies were more suitable to teach courses on sustainable development and which were more permeable to the introduction of SD in “normal” courses.

From the interviews we would like to point out the following statements:

- Didactics are a tool, they are important in themselves but are used to achieve a certain learning objective, and the objective for SD is changing attitudes. Thus, one needs to create a situation where students can get confronted to the consequences of their decisions, where they can learn from their own experience
- The accent should be put on how to use a strategy more than on the strategy itself. One should create a more specific environment to make sure that the students are working in the direction and the areas that one desires them to work.
- Curriculum should be action orientated with real live situations and students not sitting in a room learning about SD, they should learn for o through SD by engagement to action oriented projects.
- Pedagogy should integrate the principles on SD (equity, futures orientation, participation, etc.), as those concepts have an implication not only for what has to be taught in the curriculum but also for pedagogical process. Thus, the learning process itself must be sustainable, participatory, etc., and involves the lecturer's role as a model role.

3. Results

The interviews show that about 90 % of interviewed experts propose Project Based Learning as the more permeable active learning strategy for the introduction of sustainability. Nevertheless Lecturing (71%) is also seen as very important in the very first steps of the learning processes where information needs to be given to the students before they start applying this knowledge in other active learning steps.

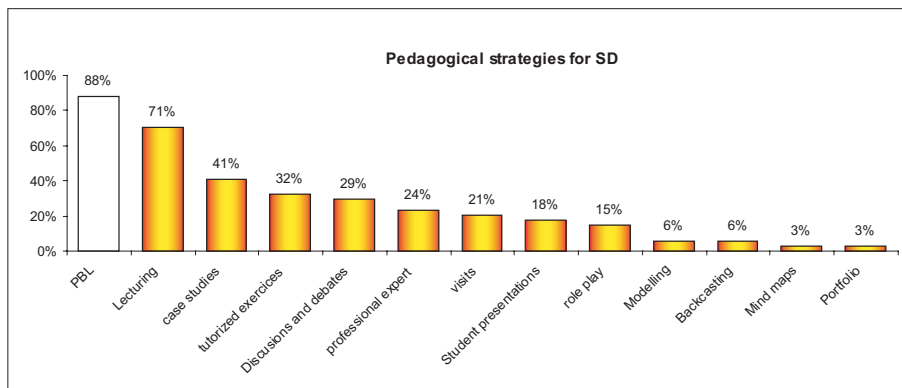


Figure 1. Percentage of experts who has highlighted the importance of different pedagogical strategies.

4. Conclusions.

Sustainability needs systemic thinking; a lot of pictures are still in a mechanistic mode, understanding divided in boxes, etc. According to the experts and practitioners interviewed, we need to create a pedagogical approach that optimizes the understanding of flows of relationships between concepts of all kind.

Sustainability is a clear multidisciplinary “potpourri” (Environmental, social, economic, values, future, culture, diversity, etc...). and thus, we need different ways of teaching to do that. However, we should not forget that these must be active learning processes.

“I hear, I know. I see, I remember. I do, I understand.” Confucius.

56. ECONOMIC ANALYSIS OF THE REUSE OF WATER RECLAMATION IN THE IRRIGATION OF VINEYARDS

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Determining the cost and the price of reclaimed water is important in the design and operation of a system for the reclamation and reuse of wastewater (SRRWW). Although a detailed SRRWW cost approach can certainly be obtained, this is not normally the case for the price of reclaimed water. This is basically conditioned by the absence of a reclaimed water market, which would allow the price to be determined. Therefore, the only reference value is usually the price of water from conventional sources. The main problem with this price is that it could not reflect all the impacts that a wastewater reclamation and reuse project might have.

In recent literature related to the reclamation and reuse of wastewater, there is no evidence of a methodology for an economic analysis of the SRRWW, that is, a methodology that relates technical and economic aspects. The methodologies associated with the SRRWW recognize that the economic variables significantly affect the planning model, but that the model does not affect the variables. The decision-making process is therefore affected by a problem whose origin is exogenous.

The specialized literature mentions and describes the existence of both positive and negative impacts in the implementation and operation of SRRWW. Nevertheless, so far no documented information brings together and organizes, in a methodological way, the identification and description of the most important impacts to be considered in installing and operating an SRRWW (Seguí, 2004). The methodology used for technical and economical analysis is based on a restricted connection between technical and economical areas, that is, from an interdisciplinary perspective, and it attempts to solve the exogenous problem that SRRWW planning methodologies already involve.

The analysis of the impacts in the project follows a series of steps: identification, periodicity, quantification and assessment, for a certain scope and related to a specific agent. These impacts are added to an evaluation that combines cost-efficiency analysis (CEA), cost-benefit analysis (CBA) and the net present value (NPV) technique to establish the economic feasibility of the technical alternatives proposed and which alternative provides the maximum benefit.

The goal is to identify the technological options for wastewater reclamation and reuse that allow the difference between the benefits and costs associated with the production of reclaimed water to be maximized. The agent who chooses between the technical options is the local water authority (CCB). This economic optimization criterion was selected because it can be interpreted intuitively and is applicable to

our study.

The objective function to be optimized is as follows:

$$MAX B_T = \sum_{n=0}^n \left[\underbrace{(VAR_n * PV_n)}_1 - \underbrace{(CI_n + CEM_n + CFin_n + IMP_n)}_2 + \underbrace{(EP_n - EN_n)}_3 - \underbrace{CO_n}_4 \right] \quad (1)$$

where 1 is for the total revenue; 2 is for total costs; 3 is for net externalities and 4 is for the opportunity cost. More particularly, BT is for total benefits; VAR is for annual volume of reclaimed water; PV is for price of sale of reclaimed water; CI is for investment costs; CEM is for costs of operation and maintenance; CFin is for financial costs; IMP is for taxes; EP is for positive externalities of impact; EN is for negative externalities of impact; CO is for the opportunity cost; and n = year.

Traditionally, an economic-financial analysis of an SRRWW focuses exclusively on the costs and private benefits. The methodology presented here considers the private impacts but also the project spillover that affects it, through an analysis of the external impacts, both positive and negative. The methodology used takes into account the SRRWW's characteristics, in such a way that it becomes a tool that allows the decision makers to express an opinion on whether it is appropriate to implement this kind of system, where the primary target is to determine the maximization of project benefits. This methodology evaluates the SRRWW from a multidisciplinary and interdisciplinary perspective.

The main conclusions of this study for a vineyard farm devoted to wine production in north Catalonia, (Castillo de Perelada), are as follows:

The sensitivity analysis shows that the MPS is highest when the SRRWW is working at a low capacity. Therefore, selling the regenerated water could be problematic and it may be difficult to recover the costs of the project.

The CCB supplies reclaimed water at a rate of 0.38€/m³, under the assumption that the capital invested does not have to be returned and the fixed operating costs do not vary. The price is fixed below its cost per cubic metre, which is 0.7033 €/m³. In this way, there is a subsidy of 46% with reference to its real cost. If the actual production level is sustained, then the cost rises to 3.0136€/m³ (production capacity of 13%), which involves an 87% subsidy.

Concerning the reuse system, the investment made by the Castillo Perelada company is highly profitable, because under present conditions it shows a benefit of 6.3089 €/m³ regarding the water used on the property.

Economic Policy Proposals

The CCB must reframe its pricing policy for reclaimed water, because current changes in the European Union mean that the funds are to be substantially reduced, making it necessary to ensure that the investments made can be recovered, at least

for uses for which a high economic benefit exists, as is this case in this study.

To continue to follow this policy, that is, to consider investments as non-returnable and to fail to take into account the environmental costs and opportunity costs involves the serious mistake of continuing to subsidize the sector and/or continuing to generate indirectly crossed subsidies. At the same time, there continues to be a distortion in the price of the water.

To recover the investments made and to set up finance rates according to the user would allow the CCB to ensure the viability of its water reclamation and reuse plans and programmes over time.

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57. RESOURCE RECOVERY FROM WET WASTE FLOWS WITH SUPERCRITICAL WATER OXIDATION

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Key words: *sludge, wastewater treatment, water treatment, de-inking*

1. The biorefinery concept

A series of supporting papers are presenting different technologies and processing solutions that fit into the biorefinery concept. A biorefinery is a processing plant that transforms biomass feedstocks into a variety of useful products, such as fuels, materials, chemicals, heat and power. The analogy to petroleum refineries is obvious and suggests that we need new technologies and process solutions that can handle the often more complex and varying composition of biomass feedstocks. The biorefinery concept can also be applied to biomass waste. This paper discusses the potential of supercritical water oxidation (SCWO) as a means to recover inorganic elements and energy from wet waste flows.

2. Supercritical water oxidation (SCWO) for different applications

In supercritical water oxidation (SCWO), water in its supercritical state ($>374^{\circ}\text{C}$ and >221 bars) is used as a reaction medium for oxidation of organic material. In a wet waste flow, water is often already present in sufficient amounts (5-20%DS) and organics are often mixed with inorganics. When an oxidant, e.g. oxygen, is present, the organics in the feed will rapidly oxidize, leaving the inorganics relatively unchanged due to the low temperature. This makes it possible to recover heat from the oxidation of all organic material, and it also creates an opportunity to recover useful parts of the inorganic solid rest. The aqueous effluent contains some acids and dissolved salts but no organic contaminants. The gaseous phase contains carbon dioxide with some water, nitrogen gas and excess oxidant. The technology has so far mainly been used for hazardous waste, but also for sewage sludge. Below, a few applications will be briefly described. In all processes, the heating value of the organic material in the wet waste feed can be fully recovered as heat, water can be recovered for some purposes and carbon dioxide from oxidation of organics can be collected from the gases.

Sewage sludge and water treatment sludge

All organic micropollutants and pathogens are destroyed during SCWO processing of sludges from water and wastewater treatment. The remaining inorganic solids contain mainly aluminates and silicates. Solids from sewage sludge processing also contain phosphorus and heavy metals that can be extracted in a subsequent recovery process involving acid or base digestion and precipitation. Heavy metals can be sent to a secure deposit and phosphorus can be safely used as a fertilizer on agricultural

soil. Solids from water treatment contain elements from the coagulant from water treatment, which can be extracted in a similar process and recycled.

De-inking sludge

Sludge from the paper recycling process contains fibers, ink and filler. After SCWO, pure filler remains which can be directly recycled into production of new paper without any changes of the optical properties of the paper. This is not possible with ashes from incineration of de-inking sludge since the high temperature then changes the surface properties of the filler.

3. Relevance for the AGS flagship programs

The use of SCWO in the described applications would increase the biofuel share in the energy system when appropriate heat sinks are present. It also makes possible cycling of nutrients and valuable materials without the risk of contamination of agricultural soil, decreased process performance or losses of product quality. SCWO can therefore be a key technology in the recovery of resources from wet waste flows.

The biorefinery concept connects the two flagship programs since these technologies and process solutions will be essential parts of both the energy system, water management and food production. Many other societal functions are also involved. The biorefinery is a relatively new and attractive concept that connects many strong research fields at Chalmers in the sustainable technologies and systems area. Figure 1 illustrates the use of biorefinery-type technical systems to increase the yield from productive ecosystems.

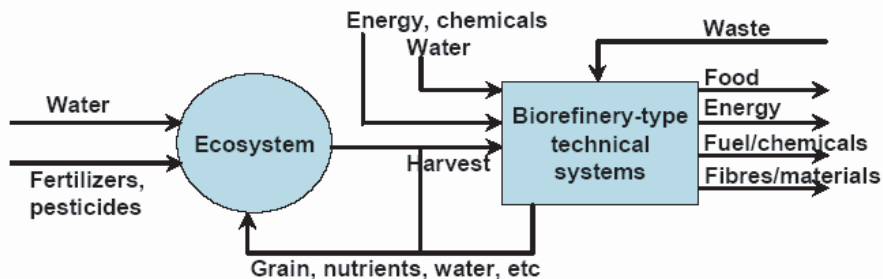


Figure 1: Biorefineries for a more sustainable society

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58. IMPLEMENTING GOALS FOR EDUCATION FOR SUSTAINABLE DEVELOPMENT AT CHALMERS UNIVERSITY OF TECHNOLOGY

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Key words: *education for sustainable development (ESD), higher education, course development*

1. Introduction

Chalmers University of Technology is actively promoting education for sustainable development (ESD) in its bachelor and master's programs. A compulsory part of the bachelor curriculum is five full-time weeks of studies focusing on environment and sustainable development. An inventory of the contents in these courses was made as a series of interviews with the course leaders. The interviews serve as an important part of a course development effort. The inventory also gives the basis for a self-evaluation of the courses and gives input both to the development of a document describing the desired content of the courses and to other projects connected to ESD.

2. Inventory results

Four of the 14 bachelor programs at Chalmers, have chosen to distribute the compulsory ESD into several different courses spread over the three years on the bachelor program. The other programs have chosen to give the compulsory ESD as one course of which two programs have the course in the first year, four in the second year and four in the third year. Not all programs can account for the required amount and a few programs can account for more than the required amount. An advantage of giving a course early on in the program is that the students are still open to new ideas and new ways of thinking. On the other hand, the students are still often quite unaware of their personal and professional identity and can therefore hardly reflect upon the impact of sustainable development on their lives and professional roles. Many teachers mention that integrating ESD into many different courses in the programs and in all three years would probably be the most effective method, but the efforts made so far to integrate ESD into other courses have often resulted in that the course is received by the students as consisting of two separate parts. An important conclusion of the inventory project is that teachers are not always aware that their course is partially counted as an ESD course and program directors (planning the programs and ordering the courses from the departments) are not always aware which courses that can be considered to fulfill the requirements.

Teachers in the area of environment and sustainable development at Chalmers regularly meet to share experiences. One outcome of these meetings is a document describing a desired content of the compulsory ESD in the bachelor programs. This document describes three different areas: 1) The concept of sustainable development, the different perspectives and communication, 2) Status and trends in the society and in natural systems, important problems and their reasons and potential measures (systemic perspective) and 3) Reflections on how sustainable development will change the professional role and the responsibility of individuals. The content of the courses were compared to the document with the desired content, bearing in mind that the document is not final and need improvements. Typically, courses tend to focus on problem areas and applications relevant for the specific discipline of a bachelor program which makes the courses appear to be very different at first sight. There is also often an emphasis on environmental issues while other areas of sustainable development are less well covered. It is relatively common that students do projects in these courses. The focus is on the second part of the document describing the desired content while the first and the third part do sometimes not appear in the courses. Very seldom are teachers involved in discussions in which students are asked to reflect upon their role as individuals and professional actors. Many courses focus mainly on the climate change issue and the changes needed in the energy system. A few courses focus only on this area.

3. Conclusions and perspectives

An important issue in the development of the document describing the desired content of the compulsory ESD will be to decide whether there is a minimum breadth in status and trends, problem areas, dimensions etc covered in these course that is necessary for a good enough understanding of sustainable development. A general conclusion of the inventory project is that in order for ESD to be effective, all teachers in a program need to be aware of how sustainable development can be communicated/taught to the students and how their topic relates to this. A project is now being started at Chalmers to motivate and help teachers in non-ESD courses to integrate ESD in their courses. The integration can be made in many different ways. One way is to have students focus on objects that are relevant for the understanding of sustainable development instead of traditional engineering objects, in e.g. calculations on a model or a system. Good examples can probably be created based on the research in the AGS flagship programs, which would also benefit communication of AGS flagship research results to public and industry

59. LIGNOBOOST: A NOVEL PROCESS FOR EXTRACTION OF LIGNIN AS BIOFUEL FROM THE KRAFT PAPER PULP PROCESS

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Key words: *biofuel, pulp mill*

1. Introduction

Wood has almost from the very beginning of mankind been used for various purposes. Even today wood is one of the most important renewable resource for mankind (e.g. fuel, paper, building material); only in the kraft paper pulp process more than 250 Mton of wood is used annually worldwide. The main components in wood are cellulose, hemicelluloses and lignin. The chemical composition of these components is different and thus also the properties are different. It is interesting to note that the heating value of cellulose and hemicelluloses is ~ 14 MJ/kg and for lignin it is ~ 26 MJ/kg for lignin. Thus, the heating value of lignin corresponds to approximately 1% of the heating value of all oil used worldwide. For effective use of the wood it is obvious that one should use the celluloses and hemicelluloses as construction material (e.g. paper or boxes) or for production of chemical (e.g. xylose). Lignin, however, may be used as both fuel and chemical (e.g. feed stock to the phenol based industry or carbon fibers). When the kraft paper pulp mill is considered it becomes obvious that this process actually is a separation process between cellulose (with some hemicelluloses) and lignin (with some hemicelluloses), see Figure 1.

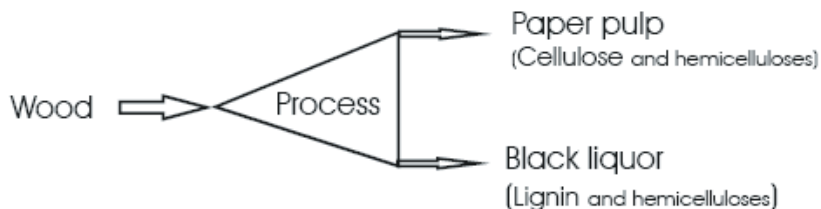


Figure 1. A schematic of the paper pulp process.

Today concentrated black liquor is combusted in the recovery boiler producing steam used for power production and heating purposes.

However, if the best available technique is used a huge energy surplus is obtained in the pulp mill. Furthermore, the recovery boiler is the most expensive equipment in the pulp mill. Consequently, if lignin can be extracted from the pulp mill it can be exported from the pulp mill as a biofuel (or feedstock for production of various

chemicals) and the recovery boiler can be downsized. The idea of extracting lignin is not new and very small amounts are today extracted in a few mills. However, the quality of this lignin is not high enough to be used as biofuel, the concentrations of alkali metals are far too high.

This presentation is about a novel process for extraction of lignin, this process is called LIGNOBOOST and how the lignin produced can be used.

2. The LIGNOBOOST process

The LIGNOBOOST process has jointly been developed by Chalmers University of Technology and STFIPackforsk within the research projects “The Ecocyclic Pulp Mill” and “Future Resource Adapted Pulp Mill”. Even if the process only has a few process steps, as can be seen in Figure 2, it is very efficient and a lignin product suitable as fuel in larger boilers can be produced.

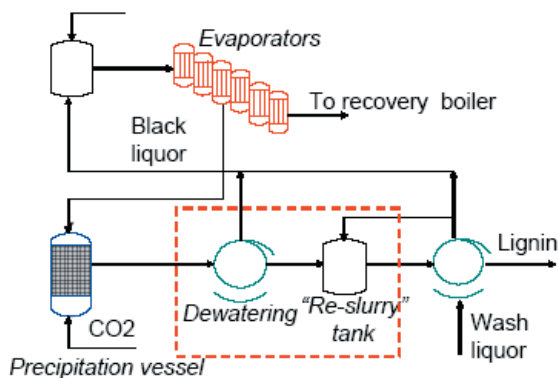


Figure 2. A schematic of the LIGNOBOOST process

In the LIGNOBOOST process a part of the black liquor is acidified by absorbing CO₂ and solid lignin precipitates. The lignin is filtered off in a first filter and is thereafter re-suspended in an acidic liquid (pH 2-4) and, finally, in a second filter it is washed and dewatered. This process has been thoroughly tested in lab, bench and pilot scale. In all these tests the results have been consistent showing that the process is feasible from a technical as well as an economical point of view. In February 2007 a demonstration plant designed for 4000 ton per year was inaugurated.

Typical data on the lignin from this process is: DS= 60-70%, HHV \approx 26MJ/kg, Sodium conc. \approx 0,02-0,2%-w and sulfur conc. \approx 1-3%-w. The relatively high sulfur content is a disadvantage in some cases; it can normally not be used in smaller combustion units. In some cases, however, it is an advantage with the high sulfur content; in cocombustion with other biofuels the sulfur will to some extent prevent corrosion in the boiler (today sulfur is added to biofuel in some cases). In other

applications, e.g. replacing part of the coal in large CHP, the sulfur content is of minor importance.

LIGNOBOOST is not only a process providing the kraft paper pulp mill with another product that can give an additional income, it is also a step towards the conversion of the pulp mill as being simply a fiber supplier to a combined fiber supplier and a biorefinery producing biofuel and/or biobased organic products that can be used as feed stock in the organic chemical industry. In a realistic scenario for the future 30-50% of the lignin ought to be possible to export from the pulp mills. This will, thus, correspond to 0,3-0,5 % of the total oil consumption worldwide.

60. Organic Wastes as Energy Resources and as a Means of Greenhouse Gas Reductions

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Key Words: *Biomass energy, Digestion, Greenhouse Gas Reductions; Agricultural Wastes*

Food production and processing are essential activities in every part of our world. Regardless of the level of technical sophistication of a nation, it is photosynthesis, the biochemical reaction that converts carbon dioxide and water to organic matter and oxygen. The organic matter produced becomes the feed and food that maintain animal and human life. But along with the energy-granting nutrients and calories, inevitably come organic by-products. Because they are not needed and have no immediate market value, are perceived as wastes.

Some of these waste by-products can be successfully applied to nearby farmlands as fertilizer or soil supplements, but there is a limit to the nutrient load that farmlands can effectively absorb. An excess of applied nutrients becomes a source of pollution of the local groundwater, and in times of heavy rains will also lead to pollution of rivers and streams.

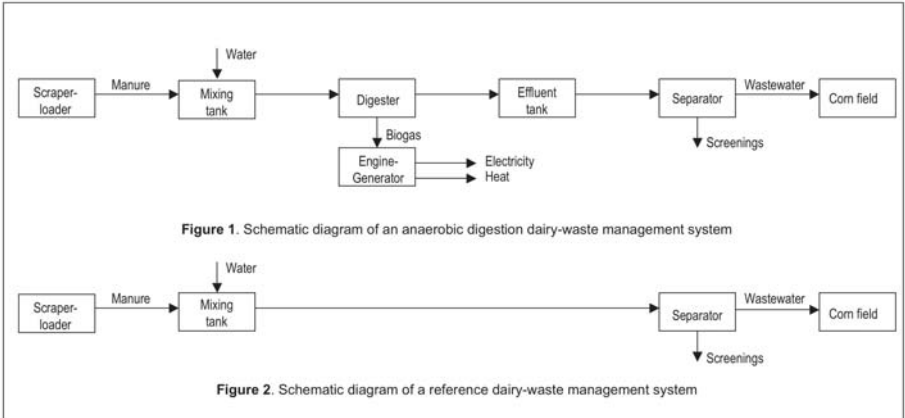
Increasingly, these residual organic materials are being put to beneficial use as feedstock for other marketable carbon-based products, or as an energy resource.

In some parts of the world agricultural and animal wastes have long been an important energy resource. In rural Nepal, dried yak dung remains a major fuel for heating and cooking. In China, people in rural communities anaerobically digest human and animal wastes to produce biogas for cooking and heating. In Denmark and Austria, centralized plants co-digest animal manure along with other organic wastes for combined heat and power production. In Tahiti, the government is currently considering the installation of an advanced digestion system to manage the green, food and other organic wastes that are beginning to overwhelm this island nation. Biomass power plants in many forested parts of the world use lumber wastes and forest thinnings as fuel. And recently renewable energy experts in Canada have been considering the use of pelletized perennial prairie grasses, grown to protect marginal and erodible land, as a fuel for combined heat and power in Saskatchewan.

Using organic wastes as an energy resource is an effective way to address mounting environmental pollution problems to diminish the current reliance on petroleum and natural gas, and to reduce greenhouse gas emissions. Most biomass feedstocks are considered to be “closed-loop” fuels. This means that the carbon dioxide released during combustion is taken up and used once again in the photosynthetic process. Thus, to the extent that these biomass/organic feedstocks displace fossil energy, they provide an offset to greenhouse gas emissions. The

amount of the offset can be calculated by means of a life cycle analysis of the particular system.

To present a specific example, the following schematic diagram presents a comparison of the manure management system using a digester as compared with a conventional system.



The anaerobic digester converts problematic wastes into biogas fuel with a methane concentration of about 60 percent; without the organic solids would undergo natural bacterial decomposition and release both methane and carbon dioxide into the atmosphere. Because methane has a global warming potential 21 times greater than carbon dioxide, the emissions reduction benefits attributable to the use of digestion are truly notable. In a case study prepared for Task 38 of the International Energy Agency¹, Wellam Kamthunzi and I concluded that by using anaerobic digestion the global warming potential associated with dairy manure management at a typical 400-cow dairy in northern California would be reduced by four-fifths. The average annual electricity output is about 320 MWh, and the average annual thermal energy output about 2.6×10^6 MJ. The dairy owner produces all the power he needs on site and is able to sell the excess power to the local utility for about \$20,000 (U.S.) per year.

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61. ENERGY REDUCTION IN BUILDINGS THROUGH EDUCATION OF DESIGNERS AND OCCUPANTS

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Key words: *buildings, energy, design, efficiency*

1. Building energy consumption

Operation of commercial and residential buildings is responsible for roughly 1/3 of the world's primary energy consumption. Heating, cooling, and lighting loads represent the largest portion of this consumption, and depend most heavily on climate, occupant behavior, and building design. Lacking any practical means of controlling outdoor climate, we had best focus our attention on adapting the latter two to move towards a sustainable energy future. A focus on the education of both designers and occupants is critical if a sustainable outcome is to be attained.

2. Designers and Occupants: societal obstacles

Building Designers

Designers must be educated to make better decisions when selecting building components, layout of spaces, and control schemes. Even when the desire is there to improve design, sometimes tools are not available to properly evaluate the options. Evaluating the payback of an energy-saving option is sometimes difficult or impossible. How much value can be placed on using better insulation, or high-performance windows? It depends on the context and the inter-play of a large number of variables. Quantitative tools must be made available to assist the designer in making these decisions. Some discussion of these tools is provided in section 3.

Occupants

Occupant behavior plays a large part in the consumption patterns. A cultural challenge exists to motivate endusers to perform simple energy-saving tasks. The most basic and obvious behavioral changes are often the ones that can have the greatest impact on a building's energy performance: using efficient bulbs, turning off computers at night, and setting back the thermostat. Shifting cultural norms and attitudes is not simple, but it must happen if we are to achieve the goals of reaching a sustainable outcome. Inhabitants must have a better awareness of the impacts of their behaviors. The average person must be able to internalize both the cost and impact of their consumption patterns. How much can I save by turning off the lights? How much difference does it make if I set the thermostat back at night? Education is crucial to imparting change on the user level, but equally important is motivating the user to care enough to pay attention. Whether that motivation comes in the form of monetary incentives (giving credit for curbing energy usage), or some other mechanism, it must come if a change is to happen at the user-level.

3. Educational tools and integrated design

Existing building simulation tools are many in number. Most are highly sophisticated, require expert-level training to use, and often take days or weeks to construct and analyze. While these complex tools may be useful for evaluating completed designs, they are of little help to the architect for modeling and improving a preliminary design. Early decisions (building orientation, for example) can have a great impact on the energy footprint of a building. Waiting until the design is finished to simulate performance is too late; an integrated approach is necessary at the very start of the design process to ensure a good design. To address this need, we have developed a software tool – The MIT Design Advisor – for predicting the energy use and occupant comfort of early-stage building designs. The software computes monthly- and yearly- heating, cooling, and lighting loads of basic preliminary designs. Simulations based on climate, building construction and geometry, occupancy schedules, and control systems (lights, blinds, and ventilation) are performed rapidly. Within minutes, users can graphically compare the expected energy usage of several designs and understand which options are most-responsible for energy reductions. Energy savings can be translated into economic- or carbon-savings, and the designer can make educated decisions about the design. The tool can be found at <http://designadvisor.mit.edu>.

4. Technology & policy in building design

The policy side of building design relies heavily on Energy Standards and Building Codes. While effective in setting a base-line for building construction, some of these standards are outdated and others are not enforced. Programs like the LEED standard provide a gentle push toward sustainable design, but the incentives are not always aligned with true sustainable design. More aggressive standards should be developed and enforced. Further, monitoring must take place once the buildings are constructed to ensure buildings perform as expected. Technology's role towards improving building performance is important but limited. When focusing on sustainability, a tendency exists to add highly-visible options: solar PV panels, green roofs, etc., even when these options are not the most appropriate in terms of efficiency or cost. In many cases, it is the 'invisible' options – like occupancy sensors and efficient windows – that produce the highest impact. Technology plays an important role in improving and reducing consumption, but only to the extent that it is used in the right context.

62. TECHNEAU, AN EUROPEAN COOPERATIVE RESEARCH PROJECT FOR WATER SUPPLIES

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In January 2006 the EU funded Integrated Project TECHNEAU was launched. TECHNEAU will run for 5 years and will address the tremendous challenges that face the water supply sector worldwide. New emerging contaminants, aging infrastructures being vulnerable to accidental and deliberate contamination, shortage of good quality and readily treatable resources and more demanding regulators and consumers are just a few examples.

TECHNEAU is addressing these challenges by bringing together more than 100 water supply researchers from across Europe and beyond. By joining forces the research is more efficient and innovative and more focused on the global challenges.

TECHNEAU will develop adaptive supply system options and new and improved treatment and monitoring technologies. Future system options to be studied are flexible, small scale and multi-source supplies, utilising non-conventional resources like brackish ground water, treated wastewater and urban groundwater. Treatment technologies include membrane and oxidation based multi-barrier schemes, providing safety against a broad spectrum of chemical and microbiological contaminants. Monitoring technologies to be developed will provide 'on-line' and 'at the site' information on water quality including parameters that relate to malicious contamination. The project will integrate and further develop current work on modelling with the purpose of controlling and optimising existing supply systems. A framework for risk assessment/risk management will assist in integrating the project output into the practice of the water companies.

The project will enable end-users to make informed choices, appropriate to their own circumstances and constraints, for cost-effective and sustainable source-to-tap solutions for the provision of safe high quality drinking water that has the trust of the consumer. Involvement of water suppliers, regulators, researchers and other stakeholders is an important part of the project.

The benefits of the integrated approach are already becoming apparent in the first year after the launch. To give an example: various platforms for water supply modeling exist in Europe, but researchers within TECHNEAU succeeded in agreeing on a common platform to be used for further model development within TECHNEAU. This platform will exceed the capabilities of the existing ones. The TECHNEAU 'rethink the system' team produced a draft report of their future trend analysis in Europe and other parts of the world. Other teams started working on advanced technologies at laboratories and in the field. E.g. the applicability of a UV probe for water quality fingerprinting is currently tested at the waterworks of Vienna and Amsterdam.

63. THE ROLE OF INNOVATION IN A SUSTAINABLE POWER SECTOR

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Key words: *innovation, sustainability, distributed generation, intelligent power networks*

1. Introduction

Europe is a clear example of a region which comprises both energy dependence on fossil fuels and growing apprehension of sustainable development. The region is one of the largest energy consumers depending heavily on foreign fossil fuel sources due to scarce sources of its own. The European Commission is aware that within 20-30 years, 70% of the EU's energy needs will be imported, compared to 50% today¹. Therefore, the energy issue has become a priority on the EU agenda and it promotes a common energy policy with the following long-term goals: sustainable development, security of energy supply and competition in energy markets². The Europe's case is not unique; similar trends can be found all over the world. But what are the key technologies and systems ensuring sustainable energy schemes? There are three main action areas:

Transport: more global the world becomes higher mobility it demands.

Transportation is the main petrol consumer and replacing petrol is a key. Not many alternatives are available at the moment, despite biofuels are there and research on hydrogen as energy carrier is carried out. These need to gain more trust from the public.

Domestic: buildings and housing conditioning also require a considerable amount of energy. The solution may be in designs corresponding to climate and environmental conditions (bioclimatic architecture) and the integration of renewable energy sources, such as solar, thermal or organic waste, boiler for heating and cooling water. However, the cost of these solutions is high and not many can afford it. Although it is difficult to control, some governmental initiatives may stimulate developments in this area.

Electrical sector: electricity generation is the other big fossil fuels consumers.

Initially, these were petrol and coal. Nowadays, gas is replacing them. Although gas is less contaminant, it is also a fossil fuel. However, besides fossil fuel consumption for electricity generation electric power systems comprise more issues and elements. What are those is described below.

2. Electric Power Systems

Current electrical networks have satisfactorily fulfilled their function to connect electric power generators and consumers, within a system based on large power plants fossil fuels or nuclear supplied that are placed remote from consumption areas. Nevertheless, this centralized and hierarchical model is changing to a decentralized system. The reason for that is an increasing demand for the integration of non-conventional generation units in the electrical power systems, most of which based on renewable resources, and distributed in the power network, called Distributed Generation (DG). The current integration level of DG in the EU is important³. In Denmark, DG (CHP plants and wind power) supplies 40% of the electricity demand. In Spain, DG is close to 25% of generation capacity. Other European countries, such as Germany, the Netherlands and Portugal, have approximately 20%. This means that the shift in the traditional power systems operation and control, from centralized to decentralized system is in place, and it represents some challenges that need to be tackled.

3. Challenges

Future power systems will be more competitive, sustainable, efficient and secure because intelligent solutions will be introduced in power systems in order to make them: *Flexible and open to all the stakeholders*, to accommodate any kind of DG technologies and to balance their uncertain power production with consumer's requirements; *Reliable*, to ensure and increase the security and the quality of power supply, to avoid situations like recent originating in Germany blackout Europe experienced on the 4th of November 2006; and *Economical*, to provide better, innovative, efficient management and regulation according to stakeholders' capabilities. In addition, developing Intelligent Networks needs answers to the following questions:

What is it needed? It is needed to promote and invest in R+D+i in: *Power electronics* to excellent energy processing within networks and integration of generators; *Energy storage strategies* for balancing renewable generation and demand; *Information and Communication Technologies (ICT)* for making possible a distributed control and demand-side management; *New tools and methods* for analyzing and operating power systems.

Who is it needed? Current power systems were developed in the middle of the last century. Current digital society requires a new power supply concept, hence new engineering education is needed to educate new engineers who will be able to deal with these new framework and requirements.

How? All stakeholders must take part and collaborate to develop future power systems. Governments, utilities, universities and research centers, and consumers have to be involved in this new energy era.

When? We must start now or we will be late. Innovation is the only way to ensure the sustainability and efficiency in future power systems.

To conclude, we would like to point out one more question, non-technical in this case: Is it possible to match both spatial and energetic planning? The world is moving towards centralization in large urban areas and it is desired to decentralize power generation.

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64. SECURING FOOD SAFETY AND ENVIRONMENTAL PROTECTION:A PROPOSAL FOR SUSTAINABLE SHRIMP FARMING IN VIETNAM

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Key words: *Area Management, Information Commons, Extended Consumer Responsibility*

1. Food Safety and Environmental Protection in Shrimp Farming

As the demands for consuming shrimp have been expanding in the world, shrimp farming has been developing rapidly in Asia and is facing a number of challenges regarding negative social, economic, and environmental impacts as well as volatile international markets and anti-dumping issues¹. In particular, a serious concern has been raised with regard to the contamination of shrimp with chemicals including antibiotics. At the same time, wide-spread intensive shrimp farming has been creating grave environmental destructions in Southeast Asian countries including Vietnam.

2. Proposal for Sustainable Shrimp Farming in Vietnam

We are currently making a project proposal for a business model in a broad sense which will promote environmental protection and food safety, so that both producers in Vietnam and consumers in Japan can obtain benefits. In particular, based on appropriate technologies and techniques ensuring the quality of water and shrimp through area management, we are interested in establishing a system for information commons which could channel information effectively with regard to environmental situation in Vietnam and food quality to consumers in Japan.

As this kind of information is clearly communicated to Japanese consumers, we expect that they are also responsible for environmental burden through shrimp farming, consequently encouraging them to become willing to pay a price premium on shrimp for the efforts in Vietnam to protect the environment and ensure food safety. Through the established information and charge system, the Japanese consumers could also send feedbacks to the shrimp producers in Vietnam, with regard to their satisfaction and suggestions for the future.

We would call that “extended consumer responsibility” (ECR), in a similar way to “extended producer responsibility” (EPR) in the case of manufactured products. The concept of EPR basically says that the producers of manufactured products should be responsible for their products not only before they sell them, but also after they are used and discarded by consumers. The concept of ECR means that consumers should be responsible for the storage and dealing with the products, but also the environmental and social conditions in the producing countries before they purchase them. In addition, we could argue that consumers should also be responsible for feedbacking their care for the conditions in the producing countries and willingness to pay for the efforts of the producers as a price premium.

To develop a more detailed project proposal, we plan to visit Vietnam. First we visit Da Nang, near Hue, to see a shrimp farming site. As one of our team members has been involved in a different project in Da Nang, we have picked up this place for a site visit. Then we plan to have a meeting in Hanoi to make a presentation of our proposal for comments and information exchange with relevant stakeholders, including researchers, companies, and policy makers. This is still a preliminary idea, and we would like to brush up our proposal through discussions and information exchange with relevant stakeholders in Vietnam as well as experts and researchers participating in the AGS annual meeting. With a good proposal, we hope to be able to apply for further funding.

Acknowledgement

We would like to thank Program Director of Nissan LPIE, Professor TAKEUCHI Sawako of Kyoto University, and Supervisors, Professor UEDA Kanji of the University of Tokyo, Professor NISHIMOTO Seiichi of Kyoto University, and Mr. ABE Eiichi of the Nissan Science Foundation, for their helpful advices, comments, and encouragement throughout the program. The dedicated support from the program secretariat, Mr. YAGUCHI Eiichi, Ms. HANANO Midori, and Mr. KOMATSU Hiroshi of the Nissan Science Foundation, is very much appreciated. We learned greatly from stimulating discussions with other members participating in the program.

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poster
abstracts

A COURSE IN THE DISSEMINATION OF INNOVATIONS FOR THE COMMON GOOD

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Key words: *development, dissemination, education, innovation*

Abstract

For several years, MIT has offered hands-on courses that challenge students to learn about the role of technology in sustainable international development. The courses have inspired a variety of design projects, theses, and even careers and new organizations, but the greatest challenge has been to increase the worldwide impact of appropriate innovations. To address this need, a new course was introduced in 2006 to address technology dissemination, and in specific, the large-scale implementation of innovations for the common good. In its first year, the course attracted projects as diverse as solar micro-generators for Lesotho and an organization to provide affordable temporary housing and skills training to Filipino migrants. Topics include refinement of vision and strategy, sustainable implementation models and mechanics, social entrepreneurship, microfinancing, monitoring and evaluation, and the challenges of knowledge and technology transfer in under-developed regions. The course methodology mixes theory, guest speakers, and student-developed case studies to support team development of implementation plans for the students' continuing projects. The students then use the dissemination course materials as a foundation for expanding the success of their innovation and its impact on real-world communities; approximately half of last year's students are now pursuing their projects full-time.

The presentation at AGS 2007 AM will include the course content outline, case studies developed for and by the class, examples of 2006 projects now at large, and reflections on changes for 2007 and beyond. [The course will be mid-way through its second offering at the time of the Annual Meeting.]

ECONOMIC ASSESSMENT OF ENHANCED COALBED METHANE RECOVERY IN CHINA

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Keywords: *coalbed methane (CBM), economic assessment, carbon credit, methane price, China, horizontal well*

Abstract:

Coalbed methane (CBM) is regarded one of the new natural gas resources. And its development is booming in the world. About 9% of domestic natural gas production is supplied by CBM in the USA. In China, CBM production is estimated to be 1.5-2.0 billion m³ in 2010 and 5.0-10.0 billion m³ in 2015. Enhanced recovery of CBM (ECBMR) by injecting CO₂ and /or N₂ into coal seam has been carried out in the USA, Canada, Poland, China and Japan. There are many options to enhance the gas production other than injecting gases. They are stimulation (hydraulic fracturing, cavity completion), use of horizontal wells and multilateral wells. ECBMR simulator ECOMERS was used for the methane production estimates and CO₂ storage capacity in coal seam. The economic assessment was made for ECBMR projects with different geological conditions using vertical wells and horizontal wells. Economics in these well patterns were calculated for the different permeability of coal seam, methane selling price and value of carbon credit. Horizontal wells are economically effective for the low permeable coal seams, when the methane price is high or value of carbon credit is high. Finally the case study of economic assessment for Chinese geological conditions, for major coal basins, East Taihang coal basin and Qinshui coal basin, were made.

OPTIMAL DESIGN METHOD FOR BUILDINGS & URBAN ENERGY SYSTEMS USING GENETIC ALGORITHMS

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Key words: *Optimal Design, Genetic Algorithms, Energy Systems*

Abstract

Energy conservation in the building sector is now in great demand given the increased attention throughout the world to environmental preservation of the Earth. Thanks to advances in technology for building facilities, many choices are available when designing an energy system in a building or in an urban area, such as cogeneration systems, triple-effect absorption refrigerators, air source heat pumps, etc. However, because so many choices exist, it is difficult to make a quantitative evaluation about which energy system is the best, i.e. the lowest cost or the minimum environmental impact.

In this study, a new optimal design method for buildings and urban energy systems is proposed. This method designs the most efficient energy system by optimizing operation of available systems with consideration of optimal capacity size of each equipment in the systems. Optimization algorithms called “Genetic Algorithms (GA)” which could deal with nonlinear optimization problems are adopted for this optimization analysis.

This optimal design method has two optimization steps, equipment capacity planning and system operation planning. These optimization problems cannot be solved separately due to the strong relation between the capacity size and operation efficiency of equipment. To cope with this problem, proposed method calculates these two optimization steps simultaneously.

Also its applicability is analyzed through a case study. The result shows that the proposed method has enough capability of optimal designing and has the potential to be applied to very complex energy systems with appropriate improvement.

SOCIAL PERCEPTION OF A RESEARCH CENTRE ON CLEAN COAL COMBUSTION: THE IMPORTANCE OF THE LOCAL CONTEXT

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Key words: *Social perception, sitting, clean coal combustion, local context*

Abstract

Although there are new energy technologies for improving global sustainability (such as carbon storage technology), there is still a clear “implementation gap”. The obstacles for implementing these technologies are not only to be found at the level of the basic political and economical setting, but rather in social phenomena such as NUMBY (“not in my back yard”) or LULU (“locally unacceptable land use”).

This study analyses the factors that influence public acceptance of a new and unknown Advanced Research Centre of Energy Technology dealing with research on clean, efficient coal combustion. We consider different variables as information and knowledge about the technological research centre, perceived risks and problems associated to the centre, trust, desire of participation in the decision-making process and wider attitudes towards technology and its benefits. Data from semi-structured interviews (n=15), a questionnaire survey (n=400) and focus group sessions (2) are drawn together. The results of this study underline the importance of carrying out psychosocial studies in the implementation of energy technologies which may generate NIMBY phenomenon and to improve the environmental efficiency of energy technologies.

PUBLIC ATTITUDES TOWARD ENERGY POLICY AND CLIMATE CHANGE

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Key words: *social perception, public attitudes, climate change, carbon capture and storage*

Abstract

Public attitudes toward climate change and mitigation policies may have a significant influence on public support of political programs as well as on individual behavioral intentions to address climate change. Understanding public perception of climate change and energy policy may be useful in the design of suitable communication strategies and in the efficient implementation of climate change mitigation and adaptation strategies.

Based on a survey to the Spanish population, we analyze different issues such as the level of concern about climate change, the existing knowledge about the contribution of different energy technologies to global warming, the attitudes toward energy technologies and the beliefs about potential adaptation strategies. Comparisons with other countries based on similar public opinion surveys are established to obtain a broader view of policy preferences and attitudes regarding climate change.

PHOTOSYNTHETIC SOLAR CELLS AND DIFFUSE SOLAR CONCENTRATORS

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Key words: *solar electricity*

Abstract

We aim to reduce the cost per watt of solar power by developing technology based on 1) biological and molecular semiconductors and 2) concentrator systems, which replace expensive solar cells with passive light redirection elements. Scalable, inexpensive systems to convert solar power provide a pathway to ubiquitous, clean energy.

The structures and processes of photosynthesis are evolved, highly efficient, robust, and possess high power density. We attempt to leverage these characteristics in solar cells by direct integration of photosynthetic structures and the incorporation of photosynthetic architectural motifs. We have demonstrated the integration of bacterial reaction centers into solid state photovoltaics; initial devices are limited in their ability to absorb enough light. We adapt the organization of processes in photosynthesis and introduce a synthetic light harvesting structure into organic semiconductor solar cells which couple to the active device area by near field energy transfer. External light absorbing structures are a general way to increase power conversion efficiencies in absorption-limited solar cells.

Diffuse solar concentration is an inexpensive method to concentrate light that does not require solar tracking. The luminescent solar concentrator is a diffuse concentrator that redirects light absorbed over a large area to a smaller area through guided energy transfer via an optical waveguide. Photovoltaic elements are situated over the smaller area and receive the concentrated light. Recent improvements in chromophores and photonic crystals provide a route towards high efficiency systems.

A NOVEL BIOLOGICAL TREATMENT PROCESS FOR SUSTAINABLE GROUNDWATER MANAGEMENT IN AGRICULTURAL AREAS

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Key words: *Groundwater contamination, biological treatment*

Abstract

The global population has grown tremendously in the past 50 years, and is projected to continue to grow in coming years. This has led to a need for efficient food production, which has been accomplished by increased use of fertilizers and pesticides in agriculture. Nitrate and pesticide contaminated ground- and surface waters have been found around the world as a result of the increased use of these chemicals in agriculture.

Treatment of nitrate and pesticide contaminated groundwater using physical or chemical methods such as reverse osmosis or ion exchange is costly and will produce a waste product which then has to be treated. This is especially unfortunate in underdeveloped parts of the world where pollution may be severe but the economical and technical means to provide proper water treatment are inadequate.

For this reason we have explored a biological treatment method for nitrate and pesticide contaminated groundwater using methane-supported microbial consortia grown on the surface of hollow-fiber membranes. This method has the advantages of being relatively simple and inexpensive.

Biological treatment of groundwater generally requires the addition of a substrate for the microbial population. Using methane for this purpose is advantageous since methane is an inexpensive, non-toxic, and widely available gas. Being a gas, methane is unlikely to remain in solution and contaminate the effluent. In addition, methane-oxidizing microorganisms are well-known for their ability to cometabolize a wide range of organic pollutants. Nearly 100% utilization of the supplied gas could be obtained by supplying it through hollow-fiber membrane to microorganisms growing on the membrane surface.

BEFORE A TRANSITION TO HYDROGEN

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Key words: *Light-duty vehicles, Alternative fuels, Powertrains, Petroleum*

Abstract

Since 1986, fuel consumption in the US light-duty fleet has remained constant while vehicle weight and power-to-weight ratio have both increased by over 25%. If current trends persist, fuel use and greenhouse gas (GHG) emissions will increase by 31% over present-day numbers in the 2025 US light-duty fleet. This study evaluates near- and mid-term options for mitigating this growth in petroleum use and CO₂ emissions. Approaches under consideration include improving the efficiency of traditional powertrains, such as diesel or internal combustion engines; transitioning to new powertrains (such as hybrid, plug-in hybrid, or fuel cell vehicles), to lighter weight vehicles, or to new fuels; or implementing demand-side measures that change how vehicles and vehicle technology is used. Demand-side measures include, for example, efforts to translate increasing fractions of technological improvement into improving fuel efficiency or to moderate growth in vehicle kilometers traveled.

Initial characterization of the US automotive fleet indicated that directing even half of technological improvements towards improved fuel efficiency while leaving other variables unchanged reduces fuel consumption by 7%. Using the results of this reference scenario, mitigation options were then evaluated according to the magnitude of change required to reduce fuel consumption and GHG emissions by an additional 5%. The results suggest that, due to the inertia associated with effecting change in the automotive sector, measures that impact the entire in-use fleet quickly, such as demand-side changes, provide the greatest leverage. Conversely, radical paradigm shifts require more drastic effort to have a macroscopic effect in the near-term. In addition, the results show that although moderating fuel use is a manageable problem, reducing GHG reductions is a far greater challenge.

LONG-TERM ESTIMATION OF UTILIZATION POTENTIAL FOR UNUSED BIOMASS IN A REGIONAL SCALE

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Key words: *unused biomass, utilization potential, long-term estimation, regional scale*

Abstract

Unused biomass, such as organic wastes including municipal, industrial and agricultural wastes, is considered as a prospective resource in terms of energy and regional nutrient cycle. There are many types of biomass in each region, and several technological options to convert them to a useful form are available. For efficient use of unused biomass, a long-term estimation of its potential in each region is very important.

In this poster, methodologies of long-term estimation for utilization potential of different types of biomass in regional scale are discussed. Food wastes, wooden wastes and organic sludge are target biomass in the analysis, and energy crop and rapid-growing tree are also considered as future options for efficient biomass use. Utilization potential of wooden wastes to bio-fuel in the prefectural scale of Japan are shown as a case study. Amount of wooden wastes from demolishing buildings are projected under several social scenarios, and the potential of bio-ethanol production is estimated in each prefecture. Then the mitigation of CO₂ emission is discussed with maximum use of wooden wastes to bio-ethanol.

ENHANCING PLANNING FOR LOCAL ENERGY SYSTEMS BY BACKCASTING FROM SUSTAINABILITY PRINCIPLES

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Key words: energy, backcasting, strategic sustainable development

Abstract

The world is facing energy supply challenges. Rising prices and finite reserves of fossil fuels, combined with necessary reductions in their use in order to mitigate anthropogenic climate change, will dramatically reshape a complex energy supply. The twenty-seven countries within the European Union (EU) contribute to a significant portion of global greenhouse gas emissions. Among the greatest contributors to these emissions are the energy systems that power transportation, heating and cooling, and industrial processes. Due to the implications of not addressing climate change, it is imperative that EU energy planning is sustainable, sufficient and effectively implemented. As the European Commission promotes the energy independence of its regions, our focus is on energy planning at a local level and envisioning a local sustainable energy system. In this study, we advocate strategic planning, specifically ‘backcasting from principles of sustainability’. Backcasting consists of starting a planning initiative from the point of a successful end state. This method is valuable in complex systems because, rather than attempting to agree on detailed future scenarios, decision-makers agree on basic principles of success, allowing for creativity within constraints. It also allows agreement on initial concrete steps that can serve as flexible stepping-stones in the right direction. The sustainability principles are based on scientific consensus. These concise ecological and social principles are both sufficient and necessary to achieve sustainability. Our research suggests that backcasting from principles of sustainability provides structure to indicate strategic and critical insights for decision-makers.

WASTE PREVENTION AND SUSTAINABILITY

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Key words: *waste management, decoupling, local project*

Abstract

Waste prevention is a relevant subject to global sustainability. This poster will present my research during my internship in the French engineering company Trivalor. The amount of waste has increased continuously on the Earth. Today a European produce more than 1 kg of waste per day. Government and company has implemented waste management policy to act with this problem. To begin a efficiency waste management, the first step is waste prevention. Two main parameters are to reduce the amount of waste or to reduce the toxicity of waste.

A waste not produced is even better than all new technologies of treatment, as "end of pipe" solution. The 4 basic approaches to waste reduction are:

1. Reuse products
2. Increase product durability
3. Reduce the amount of material per product
4. Decrease consumption (repair instead of replace).

The poster will present the waste prevention policy in different country. My study will show how can we deal with waste prevention, which indicator of performance can we use and how to apply new action in a local waste management project. One of the goal is the decoupling between the gross domestic product and the increase of waste. To reach a sustainable development we need to reduce as much as possible anthropogenic impacts due to waste.

INDUSTRIAL ECOLOGY IN GÖTEBORG: MAPPING AND EVALUATING LOCAL EXCHANGE OF RESOURCES

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Key words: *industrial ecology, resource optimization, energy cascading.*

Abstract

This poster maps local exchange of resources (material, energy) that is based on industrial ecology principles between 8 companies and the municipality in Göteborg (Sweden). Companies were chosen according to their size, environmental awareness, production capacity, location and business area in order to have a representative number of flows. The analysis of flows between companies reveals a network of more than 20 projects of resource exchange implemented until 2004. Projects related not only to water and energy conservation, but also to waste valorization and pollution prevention. Although these collaborations mostly promote environmental, social and economic benefits at local level, they also help to reach national and global objectives. Example of benefits are reduction in consumption of fossil fuels, reduction in thermal pollution, extension in time frame between intake and final discharge of resources, use of cleaner energy, direct and indirect economic savings related to up or downstream activities, facilitation of the development of new products and their markets, etc. Initially, the industrial environmental development in Göteborg surged to deal with pollution issues, as the right path to follow without a previous strategic plan. Local governments today promote proactive environmental regulations in which industries are challenged to improve their environmental performance with research and development focused on a large number of different environmental issues. Some of the region's environmental projects have arisen through cooperation initiatives between research institutions like Chalmers University of Technology, companies and authorities in the region.

A BOTTOM UP AND HYBRID EDUCATIONAL DYNAMICS :TOWARD SOCIO-TECHNICAL ECO-DESIGNED INNOVATIONS

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Key words: *life cycle thinking, eco-design, socio-technical innovation, education*

Abstract

This poster aims at accounting for an ongoing - and we believe original - experience of setting up an educational project and dynamics on sustainable development & technology in a university of engineering in France. The originality of this project dynamics – at the humble stage of a Minor diploma, for time being– is double: first, it was “demand pulled” or, more precisely, mostly carried out by user-innovators (Von Hippel, 2005). In a context where the university was quite “passive” concerning sustainable development (SD) educational issues, with dispersed initiatives in partitioned departments, some students, involved in associative and political organizations, decided in 2003 to form a group in order to “mobilize” some professors and researchers of the university on the project of building up a diploma on SD. The second originality of the project rests on its hybrid composition (Callon & al., 2001). Were part of the conception group “Profanes” – i.e. students - and also representatives of heterogeneous but complementary fields of knowledge and level of expertise : professors and researchers from both engineering and humanities departments were mixed; last but not least, no member could pretend to the status of real expert in SD. But each could contribute to give a different light from its discipline.

We like to believe that this original “unforeseen” organization of an educational project on sustainable development – user-pulled and hybrid-managed – will impulse an original innovation dynamics at the university. We aim at going beyond the traditional approach of “social acceptability” of new technology under environmental constraints towards a socio-technical eco-designed innovation approach. This would be based on global performance & wealth indicators (UNEP HDI, A. Sen 1999) and life cycle thinking (Jolliet, 2005), both integrating environmental, social and economic aspects. Emerging projects seem to confirm this expectation.

FOSTERING INTERDISCIPLINARY LEARNING IN ENERGY AND THE ENVIRONMENT

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Key words: *education, interdisciplinary, project-based learning, campus-based projects*

Abstract

The Education Program at the Laboratory for Energy and the Environment is engaged in developing educational programs which address energy, environment, and sustainability and integrate multiple disciplines and stakeholders. We provide resources to the MIT community about relevant opportunities, including:

- The EnviroClasses and EnergyClasses websites, which filter the MIT catalog into searchable databases of classes on energy and the environment.
- The Martin Family Fellowships in Sustainability, funding graduate students from many departments who are engaged in sustainability-related research. A related program matches undergraduates with Fellows for research and mentoring.
- Environmental Fellows Networking Events, a series of events including Martin Fellows and recipients of other relevant fellowships for networking and sharing research.
- The Student Group Network, bringing together the leadership of energy, environmental, and sustainability related student groups for discussion, collaboration, and updates on campuswide initiatives.

We are also undertaking several interdisciplinary educational initiatives emphasizing energy and environmental goals, including:

- Connecting academic and administrative departments for collaboration on campus projects, including biodiesel use, laboratory fume hood efficiency, and facilitating student projects on campus sustainability through student groups and undergraduate research.
- The “Energy, Environment, and Society” seminar, a new, experimental subject for first-year students to provide them with a systems perspective of energy through campus and community-based energy projects.

We look forward to integrating these efforts with MIT's larger initiatives on energy, environment, and sustainability, now receiving serious attention from students, faculty, and administration. These efforts work in partnership with the AGS Energy Flagship projects and help to speed new programs on campus. We look forward to participating in a new movement for interdisciplinary learning in energy and the environment at MIT.

AGRONOMIC RESEARCH ON EFFECTIVE WATER USE FOR RICE PRODUCTION AS A PATHWAY TO A NOURISHED WORLD

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Key words: *agronomy, food self-sufficiency, rice (Oryza sativa L.), water-saving*

Abstract

Attaining reasonably high levels of food self-sufficiency rate within a country is important not only for food security but also for efficient use of natural resources inside the country. Japanese food self-sufficiency rate is exceptionally low among developed countries, with only 40% at original calorie basis (2002). This implies importation of “virtual water” from abroad (estimated 40 billion tons per year) without fully utilizing domestic agricultural water (58 billion tons per year). Japan chose to import food and export industrial products during 1960s of rapid economic growth, but alternative decision making would be possible and may be more relevant at present and in future, as the society matures to prioritize operation of sustainable natural resource management and food production. We have conducted agronomic study from 2001 to 2006 to assess alternative rice production technology in relation to fresh water resources. This study involved participation of students in the discipline of plant science; as the educational goal, rice crop responses to different water regimes were analyzed either field or plant levels, while the research goal was to invent new or modified rice production technology adapted to water scarce situations. We chose 3 subprojects; (1) increasing yield for upland rice, (2) developing water-saving lowland rice production, (3) stabilizing rice production in rainfed lowland in northeast Thailand and Cambodia. The first and the second are water-saving rice production technology in Japan, because rice production is by far the largest water consumer in Japan, and saved water can be utilized for possible other crop production. The reason to include the third subproject is to broaden the perspectives of Japanese scholars for sustainable food production under rainfed fragile ecosystems. The study found several unique rice responses to different water regimes and showed with quantitative data both possibilities and limitations of different crop management (e.g. water-saving irrigation, cultivars, planting method) at each location. Our study explored pathways to a nourished world through technical innovation of effective water use for rice production.

STUDENTS LEADING “SUSTAINABLE CAMPUS” PROJECT!

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Key words: Student activities, University, Multidisciplinary, Education,

Abstract

With the century of environment, University of Tokyo has been challenging to create new and innovative “Studies for Sustainability”. It has made alliances and partnerships for ”Sustainability” internationally and multidisciplinary. For global sustainability, not only domestic but also international and intercultural discussions should be done, and structured knowledge and visions based on it is need to be proposed. As research and education institute, universities are expected to play an important role and take actions locally toward “Sustainability”. We, students from diverse backgrounds, also gather and bring our concerns into actions to realize “Sustainability”.

Taking actions not just discussing is essential to realize “Sustainability”. To do so in university, collaboration between administrations, professors and students is definitely necessary. However, it does not easily happen because actors are so divided. The project “Sustainable Campus” has been started by student community, which is expected to work as a catalyst for the collaboration. Although actions for “Sustainability” by universities have been “Think global and act global” and research oriented, “Think local and act local” and actual actions should be given much importance.

To start the project “Sustainable Campus”, we, AGS UTSC, form a group of students who are willing to take actions. The group proposes action plans to make university campuses sustainable and carries them out with support by universities.

We see several good aspect of implementing this project. Through actions, students can learn how to realize “Sustainability” and grow up as future leaders, which can be a new form of education. It makes it possible for universities to fulfill the responsibilities in leading “Sustainable Society”. Here, we would like to introduce the action plans for “Sustainable Campus” proposed by students.

STUDENT SUMMIT FOR SUSTAINABILITY

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Key words: Student Network Will Action

Abstract

Student Summit for Sustainability is the Annual Meeting of the World Student Community (WSC-SD) organized by University of Tokyo Student Community. It was held in March 2007 in Tokyo and about 100 students from all over the world stayed together for 5 days discussing about Sustainability. The theme this year was “Taking Action for Global Sustainability”. It is aimed for students to become a Change Maker for the future and think about what we can do now as a student. We encouraged the collaboration and value creation by sharing ideas, wills , and making friendship among students.

It is 20 years in 2007 since the publication of “Our Common Future,” in which the definition of the word “sustainable development”(SD) was presented. Since then, the discussions on “sustainability” have gradually changed and progressed, but the situation has only worsened. The need for immediate action toward SD from various fields has only intensified. One of the major gaps in confronting issues internationally and locally is lack of sufficient academic and international network and communication.

Facing this reality, students who are close to the academic research and community, hold some key roles in activating this needed network. Understanding our responsibilities as future leaders and decision makers, students can bring bright hopes in connecting currently still sectorized actors.

We also made “Seeds for Sustainability” as an online database gathering actions, which we call “seeds”, to learn a lesson from it. Our ultimate goal is to contribute to many students in the world who face similar problems when they try to take action.

During the Summit, we learned to take better actions from forerunners in the world, who already have taken the successful action. Also we, students, tried to make our action plan learning from “seeds” and the projects each Student Community in WSC-SD have done.

ENGINEERING EDUCATION FOR SUSTAINABLE DEVELOPMENT- A TOOLKIT OF INFORMATION AND TEACHING MATERIAL

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This poster is based on 'Smith, M., Hargroves, K. and Paten, C. (2007) Engineering Sustainable Solutions Program: Critical Literacies Portfolio, The Natural Edge Project, Australia. (TNEP)'

Key words: *Engineering, Education, Sustainable, Solutions*

Abstract

As identified by the Alliance for Global Sustainability in its formation 10 years ago, the issues around global sustainability – energy efficiency, clean water, fresh air, and sufficient food for an expanding population – are among the most challenging problems on earth today. Indeed, the two current AGS Flagship programs – “Energy”, and “Food and Water” – provide opportunities to consider how we can equip the next generation of leaders, across all sectors of society, with the knowledge and skills required to meet the challenges of sustainable development. This poster graphically presents a summary of the educational material prepared by The Natural Edge Project (TNEP) over the last three years in collaboration with academic, business and public service colleagues globally. Sponsored by UNESCO and Engineers Australia (the peak professional body for Engineers in Australia), the package is referred to as the ‘Engineering Sustainable Solutions Program’ (ESSP). It currently contains two portfolios: The Critical Literacies Portfolio (CLP) and the Design Principles Portfolio (DPP). Both portfolios focus on the topics of Greenhouse Solutions, Greening Industry, Built Environment, Urban Transport, Water – Nature’s Gold, and Zero Waste. The material also covers the four themes of Eco-Efficiency, Whole Systems, Biomimicry and Green Engineering. The CLP covers the base knowledge and the DPP provides examples of calculations of technological innovations across these themes and topics. The Natural Edge Project, UNESCO & Engineers Australia are pleased to announce that the ‘Toolkit’ will be a Free Access – Open Source resource online.

The Natural Edge Project, is a not-for profit collaboration for research and innovation in sustainable prosperity, hosted by the Centre for Environmental Systems Research at Griffith University, Queensland Australia (TNEP, www.naturaledgeproject.net).

YOUNG ACADEMICS SPEAK UP! AGS-UTSC OVERSEA PROJECTS

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Key words: *Student activities, International conferences, COP, UNESCO*

Abstract

The AGS-UTSC is a community of students concerned about global sustainability inside the University of Tokyo. Other than the daily campus activities of its working groups (i.e. study meetings, symposiums), the AGS-UTSC promotes dispatching its members to international conferences. The purpose of this is the following; to create international networks for further partnerships, maximizing the chances for its members and their research, and to make the presence of young academics heard as stakeholders in the attempt for global sustainability.

The dispatches made in the year 2006 were to “The COP12-COP/MOP2 Nairobi Conference”, by the Climate Change Working Group (CCWG) in November, and to “The 10th APEID International Conference”, by the Sustainability Education Working Group (Sus-Ed WG) in December.

The detachment to the COP12-COP/MOP2 Nairobi Conference was carried out as a part of a CCWG project analyzing the Kyoto Protocol framework since 2003. Participation is done through observing the main negotiations, but also as valuable are the exhibitions and side events held by governments, corporations, research institutes, and NGOs. Through this project the CCWG was able to conclude its findings in a report to be distributed, and create a negotiation simulation game to help people experience the complexities of such international negotiations.

The Sus-edu WG is a group dedicated to exploring new methods and partnerships enhancing education for global sustainability. Detachment to the 10th Annual APEID Conference “Learning Together for Tomorrow: Education for Sustainable Development” in Bangkok was carried out under the aims to understand the present situation of ESD in the Asia-Pacific region and to create new networks that would lead into future partnerships. Presentations by the members, of their activities and researches, were well received.

AGS UNIVERSITY OF TOKYO STUDENT COMMUNITY

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Key words: *Student Platform Future Collaboration*

Abstract

AGS-UTSC (University of Tokyo Student Community) is one of the student communities in the World Student Community (WSC-SD). We consist of about 200 students, mainly postgraduate students.

The Vision is to be a platform for future collaboration for global sustainability. To achieve this vision, we promote open exchanges and spontaneous activities by the students who are interested in global sustainability.

We have three working groups: Climate Change Working Group, Water Environment Working Group, and Sustainability Education Working Group. These three working groups often hold events, promoting open exchanges for global sustainability. And we welcome new working groups to be created.

We also organize many projects in addition to the activities of three working groups. For example we held Student Summit for Sustainability in March 2007 in Tokyo Next, we are going to take action to change the campus of the University of Tokyo to the sustainable campus.

OPTIMAL PROCESS DESIGN FOR THERMOCHEMICAL BIOFUEL PRODUCTION PLANTS

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Key words: *biofuels, modelling, optimisation*

Abstract

Transport applications are a major global source of greenhouse gas emissions and the production of fuels that are renewable and neutral in CO₂ is an important issue in chemical process research and development. Contrary to the biological routes that produce bioethanol and -diesel on industrial scale through fermentation or esterification, 2nd generation biofuels obtained through thermochemical processing of lignocellulosic and waste biomass by means of gasification and fuel reforming are expected to be truly sustainable since high conversion efficiencies and a decidedly positive environmental balance are achieved.

The poster addresses the optimal design of such thermochemical fuel production processes with respect to its environomic (energetic, economic and environmental) performance. Thereby, the challenge is to develop design methodologies that allow the identification of the most promising conversion routes in a specific environmental and economical context. Thermo-economic process modelling and integration techniques are coupled with a multi-objective optimisation algorithm to target the best process technology and operating conditions for the trigeneration of fuels, heat and power. The approach is demonstrated on the production of synthetic natural gas from wood considering different gasification technologies and the possibility to increase the fuel yield from biomass and electrical power by integrating an electrolyser in the system.

CONSUMER TRUST IN ACCRA DRINKING WATER SUPPLY

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Key words: urban water supply, consumer survey, public involvement

Abstract

The entirety of Accra water system and management of Ghana Water Company Limited (GWCL) is under reformation towards Private Sector Participation (PSP), in the quest to inject vibrancy and efficiency in water supply as well as expand supply coverage.

Consumer participation and involvement in decision-making and regulatory policies is crucial for sustainability and vibrancy of the water sector. The study sought to understand consumer attitude and trust in water supply by understanding the consumer perspective of water policies and legislations; identifying consumer criteria of trust in water supply; assessing consumer attitudes, perceptions, experiences in water supply; understanding the level of consumer satisfaction; and ascertaining the level of consumer trust in water supply.

Consumer criteria for trust that were identified include access to water, water supply reliability, willingness and ability to pay, cost of water, level of service and enforcement of consumer-oriented policies. Perceived consumer responsibilities include wise use of pipe water, problems reporting to utility provider, timely payment of water bills and consumer inquiry of bills if not submitted by the utility company. Private water consumers, rate their satisfaction of overall service from good to excellent, while shared and tanker water consumers rate satisfaction from moderate to bad. Most private consumers rate their trust in water supply from moderate to very high while a considerable majority of shared and tanker water consumers rate their trust from moderate to very low.

The study identifies the need for GWCL to institute a water services interruption management plan to tackle holistically, service interruptions. Concessionary water pricing (extension of lifeline tariff) specially tailored for tanker water and shared water consumers should be enforced. Regulation of the entire role of Small Water Enterprises (SWEs) is extremely warranted for hygienic water delivery and cost-effective patronage by consumers.

HIGH YIELD METHANE GENERATION FROM WET BIOMASS AND WASTE

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Key words: *Supercritical Water Gasification, Biomass to methane, Process development, LCA*

Abstract

Fuels from biomass and especially waste biomass are interesting options from a sustainability perspective. Methane as an energy carrier is interesting since there is an already existing distribution infrastructure in many countries. In addition, when used as a fuel, methane has high efficiency in the energy conversion process. Methane conversion via catalytic supercritical water gasification (SCWG) shows significantly higher methane yields compared to traditional methods such as anaerobic digestion and does not require its feed to be dried, which is an advantage compared to traditional gasification. This method has been proven to work for salt free substrates (i.e. wood chips) and processes adapted for other, salt-containing feed stocks (manure, sewage sludge etc.) are under development. These developments include the revalorization of the mineral byproduct as a fertilizer. Before implementation, the environmental systems implication of using this proposed process should be investigated. Several industrial size scenarios are constructed using a combination of process and life cycle modeling. This permits to assess the technical and economical feasibility of such scenarios as well as their associated environmental impacts. The scenarios are constructed for different Swiss feed stocks and different scales depending on different logistic options. A large (90 MW) and a small (3MW) methane production facility are modeled for a manure feedstock and one scale (50MW) is modeled for a wood feedstock. Process modelling is done using Aspen plus™ and the minimum energy requirement is determined using combined heat and power integration models. Life cycle modeling is integrated to the process models and the logistics options. The results are benchmarked toward life cycle models of concurrent methane production technologies such as anaerobic digestion and wood gasification at atmospheric pressure followed by catalytic methanation. The environmental impacts of the scenarios are determined and compared using the Ecoinvent life cycle inventories and life cycle impact assessment methods (Eco-indicator 99 and Eco-scarcity) but also Green House Gas assessment methods such as applying the IPCC 2001 radiative forcing values to the different emissions.

ENERGY FOR SUSTAINABILITY: AN INITIATIVE OF THE UNIVERSITY OF COIMBRA

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Key words: *academic programs, post-graduate, buildings, systems*

Abstract

The Energy for Sustainability (EfS) program at the University of Coimbra (UC), Portugal, is an initiative that configures an interdisciplinary grouping of faculty, resources and research units with the objective of promoting cross-fertilization of research and educational activities in the area of energy resources for sustainable development. The scope of EfS encompasses modeling of physical systems (e.g., buildings and equipment), analysis and control of large-scale systems (e.g., electric power distribution networks, life cycle management), energy-environment-economy interactions and industrial ecology models, analysis of liberalization processes and electricity markets, and support to decision processes using multi-objective optimization and multi-criteria analysis. EfS aims to transfer knowledge directly to policy and decision makers in industry and government, including educational activities for MSc and PhD students and for working professionals in life-long learning programs. This poster describes the EfS competencies, the portfolio of post-graduate courses, and structure of the post-graduate programs which are grouped into two areas: i) Buildings and Urban Environments, which focuses on energy management, environment, climate and comfort in buildings and cities; ii) Energy Systems and Policy, which addresses energy systems (electrical, renewable, etc.), industrial energy management, environmental impacts of energy production, and energy markets. Both areas share a common core in energy planning, sustainable development, operations research, and industrial ecology.

AUTONOMOUS ELECTRICITY SUPPLYING SYSTEM BY RENEWABLE ENERGY AND NATURAL GAS

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Keywords: Autonomy, Photovoltaics, Wind electricity, Natural gas

Abstract

The gas that is called a hydrosoluble gas is produced in Japan. We studied the electricity supplying system that combines gas, the photovoltaics and the wind electricity.

The time series variation of the amount of photovoltaic and wind power generation is calculated from the weather statistics data of the region where this electricity supplying system is introduced. Then we analyze the electricity demand, and fix the ratio of the capacity of the photovoltaics and the gas engine. Because the ratio of the capacity of wind electricity is not uniquely decided, we simulate the power production, and evaluate the results. We evaluate the electricity cost, effect of CO₂ exhaust amount reduction and of gas use amount reduction calculated based on the capacity of wind electricity. 1) The electricity cost is not too higher than the case that wind power generation is not introduced. 2) An enough effect of the gas use amount reduction is achieved. 3) The effect of the reduction of the amount of the CO₂ exhaust is also high. From these criteria, the preferable range of the capacity of wind electricity is

TRADITIONAL ENERGY SAVING METHODS FOR ARCHITECTURAL DESIGN

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Key words: *Sustainable building, climatic design*

ABSTRACT

The building and construction sector contributes to a large proportion of world GDP; this sector is widely responsible for resource depletion, waste generation and greenhouse gas emission. Therefore, for achieving the Millennium Development Goals, addressing sustainability in this sector is one of the prerequisite. Climatic design is an approach to reduce the energy consumption of a building comprehensively. In all different climates, buildings designed according to climatic design principles, reduce the need for mechanical heating and cooling, by using natural energy available from the climate at the building site. In most countries, in contrary to modern cities growing fast without considering local architectural characters, or climatic conditions, Traditional architecture has been the designer's response to climate. Looking to Iranian history of building design and traditional architecture, having the variety of climatic conditions, quite good collection of climatic design techniques are observed around the country. Unfortunately further study of the building designs of new cities at the same region proves that these useful techniques are mostly forgotten or missing. Some of These techniques are introduced, natural convection and shadings, orientation of building and windows considering sunlight and wind direction, use of local materials, shape of the roof, and natural ventilators for cooling and ventilation .have been considered as samples of these methods. These climatic techniques in different regions of the world form the knowledge that can be very useful for planners of future sustainable cities. Although Traditional methods, in their original form, may not be used for design of modern cities, further analysis of these methods will result in better designs and improvement of their modern techniques for sustainable design.

BIOMASS USE STRATEGY IN SUBURBAN AREA: CASE STUDY IN SAITAMA PREFECTURE, JAPAN

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Key words: *organic waste, demand-and-supply balance, agriculture, composting*

Abstract

Unique biomass use activity has been practiced in SAITAMA prefecture for long years. The SANTOME, southern district in SAITAMA, is characterized by traditional biomass use. The homestead woodland is placed at the edge of each homesite and the fallen leaves are composted for fertilizer use. This activities started in late 1600's and still continues. The place is defined as the origin of biomass use activity in this prefecture, but now many other biomass-use projects are also conducted in SAITAMA. One of the unique activities is "Recycle Factory" project. The old landfill area was developed, nine recycling companies were selected and started their business from 2003. This project was carried out by PFI (Private Finance Initiative). Two companies are dealing with organic waste for making compost.

Based on the background, we first estimated the potential of biomass supply in SAITAMA prefecture using statistical data and evaluated the balance with demand of fertilizer. Then two scenarios (A & B) relating to the management strategy for the Recycle Factory were evaluated from the view point of CO₂.

It was estimated that almost 70% of the total biomass production was derived by livestock waste. Available nitrogen supply by livestock waste was estimated as 111,000 tN/y, which was almost 10 times greater than the estimated nitrogen demand (11,300 tN/y). Almost 20 % of CO₂ would be cut, if the factory collects the biomass from closer areas (Scenario A). In the case of Scenario B, the exchange from chemical fertilizer to compost was assumed. It was estimated as potential that almost half of the current CO₂ emission from the factory could be cut by this exchange.

SUSTAINABLE DEVELOPMENT OF ECONOMICS AND SOCIETY IN URBAN AND RURAL AREAS IN TIANJIN OF CHINA

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Key words: *biomass recycle, high quality rice, saline soil, water treatment*

Abstract

The University of Tokyo would like to cooperate with Asian countries including China and opened the university office in Beijing. As the first step for collaboration with China, the joint-project with Tianjin city on sustainable development of economics and society in both urban and rural areas has now been on going based on the memorandum on collaboration on exchanging technology as well as researchers and students between the University of Tokyo and Tianjin city.

The economical difference between urban and rural areas is rapidly increasing to be quite serious in China. The final objective of the joint-project is to establish sustainable development of both urban and rural areas based on harmonization between them, which must show a fruitful model to Asian countries with similar problems as in China.

Members of the joint-project with different background have visited each other between Japan and China to open seminars and symposia to understand their background and to propose research on possible subjects including improvement of rice quality, rehabilitation of saline soil, usages of biomass, water treatment and economics and society of urban and rural areas.

Last year, for example, Japan-China joint symposium on quality and taste of rice was opened in Tianjin, which shows the potential needs of consumers for high quality rice with good taste. At present we are breeding new cultivars and improving growing method with less amount of nitrogen fertilizer. We will be able to introduce new cultivars with improved growing method in a few years.

IMPACT OF VEHICLE WEIGHT REDUCTION ON FLEET FUEL USE

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Key words: *vehicle weight reduction, fleet*

Abstract

Vehicle weight reduction is a known strategy to improve fuel economy in vehicles, and presents a good opportunity to reduce energy consumption in the transportation sector. Vehicle weight can be reduced by a combination of downsizing and substitution of steel with alternative lightweight materials, like aluminum. Our aim is to model and demonstrate the potential fuel-saving benefit of incremental vehicle weight reduction over time at a vehicle fleet level. The study focuses on the light-duty vehicle fleet in the U.S., which includes cars, SUVs, vans and pickups weighing less than 3,850 kg. The reference case scenario assumes that new vehicles sold in 2035 will weigh 1,710 kg on average, 10% less than those sold today. Through year 2035, the total fuel consumed by the vehicle fleet is tracked on an annual basis. If the goal is to achieve a 5% reduction in fleet fuel use in 2035, we find that the average new vehicle weight must decline by an additional 4% to 1,600 kg by 2035. Fuel use in 2035 would then decline from 680 to 645 billion liters, and the cumulative fuel savings from 2007-2035 would amount to 430 billion liters, three-quarters the amount of fuel used by the fleet in year 2005. In general, every additional 10% reduction in new vehicle weight by 2035 will result in a 7% reduction in the 2035 fleet fuel use. The fleet dampens the fuel-saving potential of weight reduction, due to the time taken for new lightweight vehicles entering the fleet to gradually replace older, heavier vehicles retiring from the fleet. The authors conclude that weight reduction is an effective way to conserve fuel, but aggressive weight reduction is necessary to achieve significant fuel savings over time. Even with more fuel-efficient technologies and vehicle options, reducing fleet fuel use in the short-term is a challenge with a slow vehicle turnover rate.

NEW EDUCATIONAL PROGRAM FOR “HUMAN SUSTAINABILITY” TO 3,000 STUDENTS OF THE UNIVERSITY OF TOKYO -“SELF DISCOVERY” OF THE HUMAN BODY AS NATURE ITSELF AND ITS CONNECTION TO THE MIND-

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Key words: *self recognition human sustainability autonomy physical exercise*

Abstract

Thanks to the advances in scientific research, the human genome has been sequenced. However we cannot learn the real abilities of human beings through genome research alone. Life (cells) can adapt to the environment by responding to stress/signal. If we can use this stress well, our cells and bodies can also be strengthened, both physically and mentally. Humans have evolved through the process of dynamic communication between our own cells and the environment, other life forms and human beings that surround us. We will discuss this new symbiotic relationship from the point of view of principles of life activity. Especially, Human beings then evolved their huge brains. But how much do we know about our life, brain and our inner/outer environment? Physical exercise is often promoted only for its physical values -- but the impact of movement on the mind and brain is far more important, since a dynamic body gives us the foundation for a dynamic brain and also contributes to understand body-brain and body-environment communications. For understanding myself, we started new programs titled by “Five common scientific practices for self discovery” for 3,000 students of 1st year students from 2006 as essential general education; to know 1) disagreement of reality and will, 2) basic principles of human movement and posture, 3) phase-transition evaluated from rhythms of respiration and heart-beating during running and cardio-respiratory health, 4) autonomous property of beating heart cell on

cultured cell and cell system as a unit of life, 5) practice of resuscitation and electric property realizing autonomous property of heart. By self discovery through these programs, peoples will be able to understand and utilize recent scientific data in the area of mind-body, body-environment interconnection, and highlight why this is so important in alliance for global sustainability.

COMPETITION

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Key words: *Competition, Education, International Development*

Abstract

CSS (Chalmers Students for Sustainability) initiated an International Projects Competition for SD. The Competition can be seen as an educational tool aimed at engaging students for SD at an early stage of their education, mostly in the Bachelor phase. This is achieved in an active way by actually developing and implementing projects for SD. Internationally, the Competition could take place in different regions with different rounds and a final with winners of each region. At the local the Competition is supported by a lecture series so that students learn from best practice projects presented by researchers. Students can earn credits by following the lecture series as an elective course. Student teams work on practical action projects that improve the community environment in an industrialized or developing country. These are the categories:

- 1) Energy: how can you help reduce energy use or make it more sustainable;
- 2) Food and Water: deals with social and technical innovations that promotes a nourished world;
- 3) Biodiversity: how can you help animals and plants live in the aimed community;
- 4) Waste: what can you do to reduce waste, reuse and recycle more;
- 5) Social Economic: how can you improve the social economic context in the aimed community;
- 6) Education: deals with educational aspects for SD

Companies and other organizations can support the Competition financially. AGS and CSS can be partners of the Competition. At a later stage centres for international development can be founded at the local similar to the MIT International Development Initiative, see: <http://web.mit.edu/idi/> In conclusion: to reach a more sustainable world, students should be engaged at a very early stage by undertaking international projects and thus actually contributing to SD. We will then achieve that more students are interested in SD both for education and research.

GREENING EVENTS AS A CONTRIBUTION TO SUSTAINABILITY

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Key words: *green event, sustainability, good environmental practices*

Abstract

The celebration of events always entails the consumption of natural resources, the generation of waste and, therefore, environmental impacts. However, if sustainability criteria are introduced within event design, it can become a great chance to raise awareness, to learn and to create a new culture of caring for natural, social and financial resources. An event can be considered “green” if it is designed, organized and staged in accordance with sustainability principles, with a special focus on environmental, health and social concerns.

The Universitat Autònoma de Barcelona (UAB) has been working in greening events since 1998. UAB, in collaboration with Barcelona City Council, has designed a theoretical framework for sustainable events, and has published documents like the guide “More Sustainable Celebrations” (2001) and the document “Large festive events; analysis and experiences for sustainability” (2004).

According to UAB theoretical framework, green event planning should always include active participation of all stakeholders, and should start at the very beginning of the event design. It should be implanted during the different stages and should be monitored from the start to the end. The main goals of a green event are to use as few natural resources as possible, to minimize waste, to reduce pollution generation and to raise environmental awareness among participants.

UAB has actively worked on introducing sustainability criteria in several events such as festivals, conferences or conventions. Some of the most remarkable initiatives carried out are: waste minimization, use of reusable cutlery, serving ecological and fair trade products, public transport promotion among participants, making green procurement and calculating and offsetting CO₂ emissions from venue consumptions and delegates journeys. Some practical examples will be described in the poster.

TEACHERS PERCEPTION OF SUSTAINABLE DEVELOPMENT A STUDY OF ENGINEERING COURSES

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Key words: *Education for sustainable development, teachers' perspective, curriculum development*

Abstract

This study investigates the effect of faculty perspective of sustainable development on curriculum development in engineering education at Chalmers University of Technology (Chalmers). Chalmers has been developing the area of sustainable development for engineering students during the past decade. A decision has been made that engineering and architecture programs should provide students with 5 weeks of compulsory courses about sustainable development. To achieve this goal, a standard core curriculum has been set as a guide for creating or integrating courses (a common faculty model curriculum). However, because each faculty member has been teaching and researching based on their own traditional disciplines, the perspectives for sustainable development differ between faculties.

To reveal the teachers' perspective for sustainable development, open-ended and semi-structured interviews have been carried out with faculty. Further, the course "Sustainable Development" in the Master's Programme Industrial Ecology was followed and observed.

We identify both similarities in the view for sustainable development and differences in the approach of individual faculty within and between courses, which reflect both disciplinary backgrounds and settings, and personal perspectives. We find various basic approaches; systems thinking, environmental science in local context and understanding for global sustainability. We also consider issues not identified by faculty that could reasonably be expected for engineers to know or use in their working life.

The study is in progress and the final results will help guide and raise awareness for faculty covering which aspects of sustainable development they should consider, or not consider, in their courses.

PATHWAYS TO A SUSTAINABLE CONFERENCE

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Key words: *sustainability, conference, emissions, waste*

Abstract

Could the annual meeting of the Alliance for Global Sustainability in Barcelona ever be sustainable? Isn't this international conferences itself a risk to the climate, the fresh water or the clean air? Are there ways out of this dilemma? When planning the AM 2007, the organization committee tried to consider as many aspects of sustainability as possible. But are we really sustainable ?

The biggest issue is perhaps transportation. Most of us come to the meeting by plane, bus or car, thereby producing emissions of greenhouse gases and other pollutants. At the conference we use a lot of energy for heating, PowerPoint presentations and other electronic equipment. All participants eat, drink, use paper and produce waste of various kinds. How could improvements be made to reduce the negative environmental, social and economical impacts of the conference?

This poster shows some of the things done and point out possible actions for future annual meetings. For example, all the food at the meeting is catered from an EMAS- and ISO14001 certified restaurant, and participants are offered emission compensation for their travels. There are various possibilities on the market today that provide emission neutralization through different mechanisms. The poster will present some of them. Also, the conference fee is lower for students, to make it possible for people with different economical limits to attend. Other aspects of sustainability are also presented, such as public transportation, use of recycled paper and waste minimization.

THE CENTER FOR SUSTAINABLE ENGINEERING

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Key words: *engineering education, workshops, electronic library, educational assessment*

Abstract

The Center for Sustainable Engineering is a three-way partnership among Carnegie Mellon University, Arizona State University, and the University of Texas at Austin, with the assistance of the U.S. Environmental Protection Agency (EPA). It is supported by the National Science Foundation and EPA. The goal of the Center is to develop and implement activities to enhance education in Sustainable Engineering at colleges and universities around the U.S. and around the world. A number of specific activities are in progress:

1. Workshops (two days each) are intended to assist faculty members who are adding Sustainable Engineering content to their courses.
2. A website is being developed with peer-reviewed educational materials on Sustainable Engineering.
3. An assessment of Sustainable Engineering programs and courses around the U.S. is being conducted to benchmark the status of education in this emerging discipline.

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