REPORT

Research, Development and Demonstration Strategies on Environmental Technology

Suggested foundations for a Formas-Vinnova strategy

Pontus Cerin Ulrik Axelsson Östen Ekengren

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This IVL report constitutes Appendix C in the suggested common Research Strategy for Environmental Technology of Formas and Vinnova sent by them to the Ministry of Enterprise, Energy and Communications as of February 1st, 2007.
The suggested research strategy provides an account on the assignment by the Government to the agencies Formas and Vinnova.

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IVL Swedish Environmental Research Institute

IVL Swedish Environmental Research Institute

Organization

IVL Swedish Environmental Research Institute Ltd.

Address

P.O. Box 21060
SE-100 31 Stockholm

Telephone

+46 (0)8-598 563 00

Report Summary

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Author

Pontus Cerin, Ulrik Axelsson, Östen Ekengren

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Research, Development and Demonstration Strategies on Environmental Technology. Suggested foundations for a Formas-Vinnova strategy

Summary

The aim of this report is to provide information for Formas and Vinnova to utilise in their development of a common strategy for their forthcoming environmentally adopted collaborative program. The structure of this report follows the assignment given by Formas and Vinnova to explore how three different aspects can and should influence the design of their forthcoming program. The three parts of the study, that each could constitute a report of its own, are: *Definitions of environmental technology*, *Development trends in the world's vast latecoming economies* and *Comparative study on environmental policy-making processes for environmentally adopted solutions and technology transformation.*

When considering the size of the coming Formas-Vinnova programme for environmental technology the recommendation is to make the programme focused on e.g. technology development or demonstration projects. To gain greatest leverage it is vital to figure out how the programme can fit into the landscape of programs that support environmental technology in Sweden and thereby fill the gaps in support that Swedish environmental technology actors are experiencing today.

Keyword

Formas, Vinnova, Strategy on Environmental Technology, Environmental Infrastructure, Environmental Infrastructure Components (EIC), Environmental Infrastructure Systems (EIS), Definitions, Global Development Trends, Population Trends, Urbanisation, Latecoming Economies, Trade Barriers, East Asian Corporatism, State Corporatism, Neo-Corporatism, Environmental Policy Development, Technology Transformation

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Lars-Gunnar Lindfors
Scientific Director

Executive Summary

The aim of this report is to provide information for Formas and Vinnova to utilise in their development of a common strategy for their forthcoming environmentally adopted collaborative program. The structure of this report follows the assignment given by Formas and Vinnova to explore how three different aspects can and should influence the design of their forthcoming program. The three parts of the study, that each could constitute a report of its own, are: *Definitions of environmental technology*, *Development trends in the world's vast latecoming economies* and *Comparative study on environmental policy-making processes for environmentally adopted solutions and technology transformation*.

The conclusions from the first part of the study are that there exist numerous definitions on environmental technology and on the concept often used in association to it: sustainable development. The wide definitions used in statistics make the picture of the importance of environmental technology erroneous since it is too inclusive, but for the purpose of the Formas-Vinnova research program a wide definition should be applied, merely focusing on whether the suggested technology will improve environmental performance compared to alternatives. Formas-Vinnova should not engage in developing a new definition on environmental technology of its own.

The conclusions from the second part of the study are that the need in the world's large latecoming economies for environmental technology is – by far – to solve the obstacles that arise from A) the huge internal migrations from rural areas to urban areas where some of the largest cities in the world will be created. Access to infrastructures like running water and sewage, waste disposal system, electricity, communications and transport systems will be of outmost importance. Also the rural population needs access to e.g. water and energy which can be solved by stand alone systems where the costs are to high for constructing entire networks. The other important problem that needs to be solved is that B) the resource scarcities will become even more severe when the buying power increases in the most populous nations of the world which will require product and service solutions that are considerably more resource efficient that currently today, in some cases radical innovations will be required.

The conclusions from the third part of the study are Swedish policy processes have not always provided Swedish industry with competitive advantage. In the case studies included in the third part of this study, on the contrary, the Swedish policy process has been rather lax. The interesting comparison is made to the policy processes in Japan and their culture of collaborating between government and industry through industry associations that play a central role in the process. Seemingly the Japanese proactiveness in establishing environmental policies has been followed by Japanese firms making use of their competitive advantage on other world markets. Another finding from the study is that when trying to learn from the policy processes from other nations it is vital that an understanding about the environmental conditions and constraints (resource availability), the size and power relations between the involved actors as well as understanding society structures in which government and industry interact. Japan could e.g. be characterised by East Asian corporatism while small open economies in Europe are neo-corporativistic countries. Without such awareness the risk of making simplistic and faulty conclusions when learning from other policy measures will be higher. The third part of the study has, moreover, detected that a prerequisite for the international trade in the very nearby future may be the environmental requirements, standards and technical legislation implemented in China and India, as with the fargoing Chinese RoHS legislation to enter into force during 2007.

When considering the size of the coming Formas-Vinnova programme for environmental technology the recommendation is to make the programme focused on e.g. technology development or demonstration projects. To gain greatest leverage it is vital to figure out how the programme can fit into the landscape of programs that support environmental technology in Sweden and thereby fill the gaps in support that Swedish environmental technology actors are experiencing today.

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Content

A. Introduction

Environmental technology has increasingly become a core interest in political, economic and scientific discourses during the early years of this millennium. The reasons are obvious: in a period when people in the already industrialised countries are facing challenges as regards resource depletion and environmental pollution, growth processes are taking off in several, primarily Asian, countries thus speeding up the environmental degradation processes. At the same time the obvious need for enormous efforts as regards environmental conservation creates opportunities for new industries and technologies that can contribute to solving the anthropogenic environmental problems now reaching heights never seen before on a global scale. There is, thus, a hope that the old countries (industrialisation wise) – drawing on the experiences of environmental conservation policies and strong environmental quality demands – may have a well-built position in this structural change towards sustainability which is ahead globally. In short, that is the background for many recent policy related activities in Sweden and other OECD and EU countries within the environmental technology area (cf. e.g. Swedish Trade Council, 2005; EC, 2002; EC, 2003; EC, 2004; Nutek, 2003 and Vinnova, 2003).

A.1. The assignment to Formas and Vinnova

The aim of the programme assigned to Formas and Vinnova by the Swedish government is to create a jointly financed research program on environmental technology in collaboration with Swedish industry and other affected actors. There are two documents that set the foundation for the program design. The first document is a proposition made by the government Mach 2005 on how to create improved life through research – *Forskning för bättre liv* (Regeringen, 2005a). The other document is the decision from the Swedish Government, Ministry of Industry, Employment and Communications, to Vinnova providing directives for the budget year 2006 (Regeringen, 2005b), concretising the outlines drawn in the government proposition made in early 2005.

The directive states that Formas and Vinnova shall together develop a research strategy on environmental technology in collaboration with industry and other affected actors. The research program shall be co-financed by the government and industry and other prerequisites for research shall be illuminated by Formas and Vinnova as well as how to make the participation of small and mid sized enterprises easier. The strategy shall consider the priorities made within ETAP as well as the potentials for collaboration with Swentec and Nutek's program for environmentally driven business development. The research strategy is to be presented November 1st, 2006.

A.2. The assignment by Formas and Vinnova – essence and structure

As described above in this report the task of this study is to provide information for Formas and Vinnova to develop a common strategy on their forthcoming environmentally adopted collaborative program. The work description by Formas and Vinnova is divided into three distinct segments which each can be viewed as a project of its own. Even though the three parts of the assignment can be framed as separate stand alone studies and could constitute the foundation for making three individual reports some of the results retrieved will, when combined, provide

knowledge areas where the findings of the three studies can reinforce each other in the suggestions made to Formas and Vinnova as well as providing a more holistic picture of the outcomes of the individual sub-projects.

The report has consequently been divided into three main sections, dealing with one task each in accordance with the assignment from Formas and Vinnova. The three parts of the Formas and Vinnova are:

Part I – Definitions of environmental technology: The first part of the project is to study the definitions of environmental technology, both wide and narrow, that is applied by actors for different purposes. The chose scope of environmental technology in e.g. a policy instrument, statistics or funding program will influence their outcomes. Definitions of special concern in this sub-project are those made by ETAP and Nutek.

Part II – Development trends in the world's vast latecoming economies: The second part of the project is to forecast future societal conditions especially in the vast rapidly transforming latecoming economies. By applying the perspective one to a few decades from present an economic, social and environmental forecast of these markets shall be carried out. What is the demand for goods and services in these markets and how large is the purchasing power behind these demands compared to the OECD countries? The social and environmental severities of these countries will affect their legislation. Will the regulations develop in sync with corresponding OECD legislation or even ahead to address environmental problems that are more severe? Will there also be elements of impeding foreign competition in the environmental policies of these markets? No matter which, there will be implications on Swedish and European environmental policymaking. Countries of special concern in this sub-project are Brazil, China and India.

Part III – Comparative study on environmental policy-making processes for environmentally adopted solutions and technology transformation: The third and last part of the project is to compare the environmental policy processes in Sweden to competitors that are seen as being on the frontier within the OECD in creating beneficial policies for its industry that may provide respective industries with competitive advantages in the domestic and global markets. Which actors are e.g. included in the national policy processes? Countries of special concern in this sub-project are Germany, Japan and Sweden.

On request by Formas and Vinnova this report, suggests the basic strategies for Formas and Vinnova and positions as regards research and research funding on environmental technology. The report does not provide a full national perspective; the aim is as limited as the Formas-Vinnova programme which hopefully will benefit from the policy recommendations made in this study.

A.3. Report content

The core structure of the report follows the structure described in the assignment by Formas and Vinnova, also describe in the section above. The report consists of three major parts, individual studies, and the results from each and one of them will be discussed in the concluding part of the report.

The report is, thus, structured as follows. The first section of the report contains the introduction where the assignment to Formas and Vinnova from the government is described, followed by the description of the assignment that Formas and Vinnova have made for the creation of this report and the introduction section ends with this outlining of report content. Part I of the report deals

with environmental technology definitions and relates it to the concept of sustainable development and discusses whether it is suitable to apply a definition to this program. Following Part II of the report describes the status and development trends of the three latecoming economies Brazil, China and India that increasingly will constitute the world lead players in tomorrow's global economy. What conditions are people, environment and industry experiences today as well as tomorrow and how will this change affect global resources, environment and the need for infrastructures as well as adopted products? In the last subsequent Part III of the report is the policy processes of especially Japan, but also Germany and Sweden investigated. Which actors take an active role in the policy context and in which government-industry networks do collaborative atmospheres take place? The report is, thereafter, concluded in the synthesis and recommendations section that provides condensed information of the finding that ought to be taken into account in the development of the strategy for the Formas and Vinnova program for environmental technology.

Part I:
Definitions of environmental technology

PI. Definitions of environmental technology

Although the expression environmental technology *a prima vista* seems easy to grasp that is far from the case. To illustrate that we may mention the fact that much of our recent economic history has consisted of making resource utilization more efficient, that is using less inputs for a given output - but including all those efforts may contribute to a too broad and loose definition. In addition the meaning of "environmental" as well as how to evaluate the utilisation of non renewable resources in various technologies may be argued. Limiting the concept environmental technology to the technology of cleaning up what others pollute is e.g. a reactive rather than pro-active approach, obviously lacking long run visions of transforming society into sustainability. In order not to end up too narrow the discussion below is commenced from a more broad perspective, i.e. with the sustainability concept (sub section 2.1) which has become the "dominant concept" of this discourse. Arguing in that sub section for a new focus on the ecological dimension of the sustainability concept we then proceed by analysing the concept of environmental technology (sub section 2.2) which is in focus for the Formas-Vinnova task but nevertheless far from clearly defined. That analysis is followed by some short reflections (in sub section 2.4) on what could be a reasonable policy from Formas-Vinnova as regards their R&D support to environmental technology as asked for in the recent R&D bill from the government.

PI.1. The concept of sustainability and its implications

The need for environmental technology has long been interrelated with the concept of sustainable development by many actors in society ranging from local NGO' to municipalities, governments and on the global level by UN. The concept of sustainble development has also been embraced by the business community, both internationally and nationally by larger domestic companies. The term sustainable development, for which environmental technological solutions are one prerequisite, along side with social wellbeing and stability, is however seen upon very differently by different actors. This diverging and incoherent view on sustainable development may affect the view on environmental technologies. Therefore, is a thorough discussion on the matter taking place in Appendix 1.

The sustainable development agenda is not entirely a concept for global development used by the developed nations and the transnational corporations based there, even though it might appear so at times. China's GDP as of 2006 is exceeding US$ 1,200 and is expected to reach US$ 1,700 per capita by 2010 (and US$ 3,200 per capita by 2020) according to senior researcher at the State Council Development Research Centre Zhang Xiaoji (China Daily, 2006). When the Chinese Premier Wen Jiabao explained the 11th Five-Year Plan (FYP) proposal for the Central committee of the Communist Party of China in October 8th 2005 he also stated that the country will experience an enormous GDP per capita growth from 2006 to 20010 and during the same time cut energy costs per unit GDP by 20 percent. These two goals, according to Wen, *"...reflects the requirements for the building of an energy-saving and environmental friendly society and sustainable development,..."* (Chinese Government's Official Web Portal, 2006). This is, according to Chinese predictions, partly achieved by putting 562 coal-fired plants into operation – corresponding to nearly half the world's total at present. The Premier Wen, however, warns that the Chinese economic development excessively rides on increasing material output and sees a huge need for more efficient growth patterns that moves away from dichotomising economic development and the environment that can no longer continue. In short, the FYP may be interpreted as illustrating the strong contradictory forces

between demands on increasing material wealth, on the one hand, and social inequalities and preserving the eco system, on the other hand, for avoiding social unrests and well as ensuring resources for human survival in the long term. The FYP aims, thus, for a more robust society where social inequalities are decreased and employment, education, healthcare, infrastructures as well as environmental protection are given high priority. The denomination for this goal is *the harmonious society* and it is supported by the concept of development.

Like China, India has also indicated a concern for the economic growth being first, supported by environmental and social matters. E.g. the Indian critique on the draft Programme of Implementation at the *World Summit on Sustainable Development* Johannesburg, South Africa 2002 (UN, 2006): *"Because we focus on sustainable development, we underplay the fact that the real problem is unsustainable consumption and the pressure it generates on the earth's finite resources. It is this attachment to unsustainable consumption patterns, and a determination to preserve and raise levels of prosperity at any cost, that breeds resistance to any meaningful reform in the financial and economic structures that underpin global society today, and results in the neglect of the development agenda. The poor are not the biggest consumers of the world's resources; the rich are. The concept of sustainable development puts an unequal burden on developing countries as their developmental aspirations are considered potentially threatening to the prosperity of the developing countries and come under close scrutiny."*

The notion of sustainable development has, as illustrated above, opened up for new discourses in analysis, politics and business related to our environment in a broad sense. Although the conceptual process is far from clearly defined it allows for other alternatives to environmental degradation – i.e. pollution and resource depletion – than economic stagnation and continued social inequalities.

Actors may perceive the notion of sustainable development differently and there exist actually more than 70 definitions on sustainability (Holmberg and Sandbrook, 1992). The definitions that evolve may, however, be troublesome in another way as Welford (2000) puts it: *"There exists a strange and fruitless search for a single definition of sustainable development among people who do not fully understand that we are really talking here of a process rather than a tangible outcome."* Welford's statement goes inline with the sustainable development strategy of Sweden (Swedish Ministry of Sustainable Development, 2002): *"Sustainable development is not a clearly defined objective, the important thing is the process of change.".*

Kofi Annan's, UN Secretary General, is quite concerned with the fact that so many people in the world live in non-sustainable environments of which far too many under sever conditions: *"Our biggest challenge in this new century is to take an idea that seems abstract – Sustainable Development – and turn it into a reality for all the world's people."* (UNEP, 2006). But also here, even though not stressed, is the process an underlying force. Another way of looking at Sustainable development is to point at factors that are restraining its process. *Our Common Future* (1987) has extracted the essentials as being relative limitations on the environment that relate to human organisation and technological advances: *"The concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources..."*

The sustainability concept is, thus, far from clear, but it is not obvious that a clear and unambiguous definition is needed or wanted. "Sustainability" may, at best, serve as a tool for mobilising actors towards complex (policy) strategies containing goal conflicts; e.g. between employment and pollution. The problem, however, is whether this loosely defined and partly contradictory sustainability concept in many, most or all policy situations should be allowed to invade the individual pillars of the sustainability concept.

The position of this report is that this should not be the case. Even if sustainability is a useful concept for high-level declarations it is - on some levels at least - necessary to restore the individual

ecological pillar or dimension in concrete policy situations. The technological choices have an imperative impact on the stress that humanity is posing on its life-supporting milieu. Following this argument, UNEP (2004) uses Trindale's (1991) wordings when explaining the imperative need to adopt well-informed choices in and transfer of technologies, techniques, know-how and institutions for facilitating a more sustainable development:

> *"To a large extent, the state of the environment today is the result of technological choices of yesterday. The state of the environment in the 21st century will be determined largely by the technologies we choose today."*
>
> (Trindale, 1991)

In short we argue that in an R&D programme as this Formas-Vinnova case the ecological dimension only should be in focus. This is a stronger position than it superficially seems to be and we will come back to it below in this section. It is possible to stick to a reasonably clear understanding of the ecological dimension even within the framework of a vague sustainability umbrella. In fact this may be necessary in order not to end up including every phenomenon as environmentally important. What we mean here is e.g. that the ranking of technologies – or artefacts – according their potential in solving ecological problems should not be influenced by their potential as employment providers. But, and that is the topic of the sub section below, also the more narrow ecological – or environmental dimension – has to be identified properly.

PI.2. The Environmental Technology concept

Environmental technology is supposed to serve, as one of several approaches, for sustainable development which is reflected in the name given to the European Commission report on environmental technology: *"Environmental technology for sustainable development"* (European Commission, 2002). There exists, however, more than one definition of environmental technology and the concept is used by organisations for different purposes and their applicability continues to be a topic for further discussions (cf. NIC, 2006). There is also, as we will se, some confusion as regards how the concept "technology" is related to concepts like "firm", "industry" etc; a phenomenon to which we will return later in this sub section.

In 1995 OECD and Eurostat retained an informal working group (OECD, 1996) that agreed on an interim definition of environmental goods and services industry which goes as follows:

> *"The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use."*
>
> (OECD, 1996; OECD, 2005)

The working group added that: *"For cleaner technologies, products and services, despite their importance, there is currently no agreed methodology which allows their contribution to be measured in a satisfactory way."* The European Commission also stated in their Communication that statistics on environmental technology is not available, but there is for the European ecoindustry (European Commission, 2002) and in a Communication from the Commission the following year European Commission, 2003) they wrote that the data they *"have only captures a narrow range of environmental technologies, and includes only those that are driven purely by environmental requirements."* Also, environmental products and

services are not defined satisfactory and this poses an important challenge (OECD, 2005a). The European Commission (2002) has, however, stated the purpose of environmental technology is to serve, as one of several approaches, for a more sustainable development which is also reflected in the name given to the report on environmental technology: *"Environmental technology for sustainable development."*

There is - in this policy world – not always a clear border line drawn between "technology", "industry", "good" etc. As now, when WTO ministers failed to agree on a common term, countries have created their own lists of what they regard being environmental goods. These lists usually contain goods that manage environmental pollution and or harvest renewable energy while lists from some nations also contain environmentally preferable products for consumption – i.e. bicycles and natural biodegradable materials. Also the definition of environmental services has created problems.

In short, and leaving the detailed analysis to others, it may be argued that the process of identifying environmental technologies, products, services and industries as well as relating them to an overall sustainability umbrella is highly influenced by the perceived advantages and disadvantages various countries face in the WTO negotiations. Inclusion/exclusion may impact trade conditions since environmental products are to be treated differently for tariff purposes, according to OECD (2005b). Products that are related to processes, production methods and life-cycle impacts may not be addressed and, thus, omitted in lists from these countries (i.e. the APEC list) although included in the OECD list which is based on the wide interim definition by OECD and Eurostat 1995 (OECD, 2005b). The wider environmental goods and services classification of OECD/Eurostat has only received support from Canada, EU, Japan and US. These countries regard current GATS classification being narrow and given their competitive advantage in environmental services they have interests in broadening the scope of the environmental services definition (Chaytor, 2002).

Based on the definition work by the OECD/Eurostat informal working group and in the absence of any internationally agreed product list of environmental goods OECD created a list for the purposes of studying trade and trade barriers (OECD, 1999). The list of environmental goods was divided into three main categories; A) *Pollution Management*, B) *Cleaner Technologies and Products* and C) *Resources Management*. A fourth group, D) *Environmentally Preferred Products*, was added from the United Nations Conference on Trade and Development – UNCTAD (OECD, 2005a). However, the OECD report of 2005 (OECD, 2005b) states clearly that its *"list was only meant to be illustrative rather than definite, and particularly for use in analysing levels of tariff protection."*

It is also difficult to retrieve a clear definition paragraph on environmental technology within the web portal of the European commission's Environmental Technology Action Plan that states something like: *"ETAP's definition of environmental technology:"* that is followed by a clearly distinct definition (cf. ETAP, 2006). What can be read on ETAP's Technologies page, however, is this:

> *Environmental Technologies are all around us: wind turbines and solar panels, cleaner cars, biofuels and certain washing powders, recycling systems for waste or water, etc. These are basically any technology that are designed to prevent of*[1] *reduce the environmental impacts, at any stage of the life cycle of the products and activities.*
>
> (ETAP, 2006)

[1] Probably a misspelling or typing error by ETAP at the European Commission. It should, most likely, be an "or" there instead of the "of".

Condensed, by extracting the examples, the resulting ETAP definition of environmental technology would be: "*Environmental Technologies are basically any technology that are designed to prevent or reduce the environmental impacts, at any stage of the life cycle of the products and activities."* which is a very broad description that could encompass a wide variety of products and services that may not be appropriate for defining environmental goods in national or EU statistics. In Sweden we have the example with the water pumps and fluid handling technology of ITT Flygt that all are counted for as environmental technology products in Swedish statistics which results in an erroneous picture of the size of Swedish environmental technology sector (cf. Bråsjö & Blomkvist, 2006). It would likewise be misguiding if the Swedish statistics accounted all Volvo trucks that are equipped with Euro4 and Euro5 engines instead of Euro3 (current legal minimum requirements) as environmental technology products.

The report from the European commission 2002 on *"Environmental technology for sustainable development"* states, furthermore, very clearly – in italics – that it *"takes a broad view of environmental technology, to include all technologies whose use is less environmentally harmful than relevant alternatives."* (European Commission, 2002). Both integrated technologies that prevent pollutions from being generated in production processes as well as end-of-pipe solutions that reduce the emissions of pollutions that are created are exemplified as environmental technologies. The report also positions new materials, energy and resource-efficient production processes and know-how, and new ways of working as being environmental technologies. Environmental technology, furthermore, includes both low and high-tech applications and the commission report addresses the importance of high-tech since: *"that in a knowledge-based economy,* ***technology is increasingly about our skills and know-how*** *rather than the simple presence of industrial processes or high capital spending per employee."* (European Commission, 2002). These strong beliefs in high-tech solutions are in the Communication from the Commission in 2003 on *"Developing an action plan for environmental technology"* given some less emphasis where the report states that the concept of environmental technology *"...includes both low and high-tech applications as well as skills and know-how. For instance, relatively modest adaptations in industrial processes by means of piping, screens, filters, tanks etc, can be just as important – and more accessible - as high-tech applications."* (European Commission, 2003)

This *Report from the Commission* 2002 constitutes the foundation for the *Communication from the Commission* 2003 which has set out the broad mandate in e.g. choice of environmental issues and stakeholders when developing its action plan for environmental technologies. The high-tech focus is, however, seen as a bridge between the European Council strategy of Lisbon (2000) to make the European Union *"the most competitive and dynamic knowledge-based economy in the world."* and the environmental dimension of European strategy of Gothenburg (2001) to create a sustainable society (European Commission, 2002; 2003; 2004).

Although different appellations of environmental technology have been applied in the European Commission documents, one in 2002 and 2003 documents and another one in the 2004 document[2], their inward sense is similar. Both apply a wide scope on environmental technology that embraces all technologies that are less environmentally harmful than alternatives, in a cost effective manner. The appellations, hence, work better as concepts for creating a common worldview where the introduced have a more or less coherent holistic picture than as definitions for scientific or statistical work and follow-up and steering in detail.

Also at the *"Workshop on Nordic Environmental Technology – Innovation and Export"*, arranged by the Nordic Innovation Centre (residing under the Nordic Council of Ministers) March 2006, it was agreed not to create another definition of environmental technology but to advocate a holistic view that comprises both hardware technology as well as software such as education, know-how and competence. The workshop came to the decision to recommend the application of the definitions used by ETAP or OECD or both (cf. Nordic Innovation Centre, 2006).

Nutek – the Swedish Agency for Economic and Regional Growth – has, based on the European Commission's (2002) definition on environmental technology (for sustainable development), created the term *environmentally adopted products and services*. This term to define the market of environmentally adopted products and services has received vast impact in Sweden. Nutek has divided the term *environmentally adopted products and services* into three categories:

1 *Pure environmental technology*
Goods, services and systems aimed for dealing with discharges, pollutions and wastes. Central application areas are water and wastewater treatment, abatement solutions for air, recycling, handling residual wastes, energy technology, emission monitoring and analysis services.

[2] In the *Communication to the Council and the EU Parliament* 2004 on how to stimulate sustainable development through the EU Environment Technologies Action Plan the Commission leans towards the documents described above from 2002 and 2003, but applies the definition on technologies dealing with environmental matters from UN Agenda 21. The tree first clauses of chapter 34 – dealing with the transfer of environmentally sound technology, cooperation and capacity-building – are quoted in the Communication from the European Commission (2004).
The three clauses quoted from UN Agenda in the European Commission (2004) for defining Environmentally Sound Technologies are:
34.1 Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes.
34.2 Environmentally sound technologies in the context of pollution are "process and product technologies" that generate low or no waste, for the prevention of pollution. They also cover "end of the pipe" technologies for treatment of pollution after it has been generated.
34.3 Environmentally sound technologies are not just individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organizational and managerial procedures.
The entire UN Agenda 21 definition on Environmentally Sound Technologies is available in the Agenda 21 web portal (UN Agenda 21, 2006)
The Agenda definition refers to *sound* environmental technologies whereas the concepts of the two European Commission (2002; 2003) documents referred to above deals with the shorter phrase environmental technologies. UNEP's division of Technology, Industry and Economics use the Agenda 21 definition when linking sustainable development to one enabler, namely, environmentally sound technologies which have the potential to significantly improve the relative environmental performance of other technologies (UNEP, 2004).

2 *Environmentally efficient products and services*
Technologies, systems and methods that reduce the risks for the creation of environmental burdens such as through minimized resource consumption, minimised waste generation, increased use of environmentally adopted substances and materials in processes as well as products that incorporate environmentally improving characteristics (SOU, 1998:118:p. 22). Goods and services with an energy efficiency and energy economising alignment as well as gradual improvements of environmental efficiency of goods and services.

3 *Innovative environmental solutions*
Major changeovers and system swifts that involve several stages in the value chain or markets (cf. system innovations in VINNOVA, 2003). Innovations breaking free from the prevailing path-dependence are a prerequisite which often requires a collaboration of actors and often distinguished by a technology leap. Such examples are renewable energy systems, functional sales as well as dematerialisation.

Also this definition, with the ambition to gasp over all forms of reducing environmental degradation and resource depletion, however has the problem of identifying technologies with products (and, in the extension, with industries). This may, in many everyday occasions, be a small problem. For analysts it makes sense, however, to identify the distinction. Technologies may be more or less generic and, thus, more or less applied in different industries. Environmental technologies may well be applied in firms not classified into environmental industries. And there may well be industries which are ecologically sound although they use very little "environmental technologies"[3]. Therefore, our position is that Formas-Vinnova in their allocating of money should avoid mistakes related to this blurring of concepts.

In a recent study Bråsjö & Blomkvist (2006) have organized firms in the environmental primary and secondary sectors following Statistics Sweden (2005) according to the business logic model (Giertz, 1999) instead of the traditional industry classification. This undertaking reveals a somewhat modified picture on the character of the environmental industry. 57% of total turnover relates to infrastructure services, e.g. solid waste management, waste water management, renewable energy production etc. These infrastructures are in this report referred to as ***environmental infrastructures***. In short the lion part of these services is related to the municipal sector and extremely important but not necessarily related to frontier technologies. Usually the municipalities in Sweden assemblies the systems and posses the know-how of ***environmental infrastructure systems*** while the components are oftentimes procured from small and mid-sized enterprises posses knowledge about certain ***environmental infrastructure components***. In fact to a large extent these technologies may be labelled mature and well-known among those who use them. The gap to bridge for these actors may for many be the internationalisation step. Increasing the international activities and transferring the technologies of these firms may, however, well be an institutional problem beyond the R&D focus of the present Formas-Vinnova programme (cf. Regeringen, 2005b:10).

[3] Increasingly, the term *cleantech* is being used as something completely new and very lucrative for investments. Oftentimes it is referred to as en US phenomena. Googling the terms *cleantech* and *environmental technology* does, however, not indicate any of this yet. In fact, relatively speaking, *environmental technology* is stronger in the US than in Europe compared to the other term. The same thing goes indeed for the terms when speaking about investments. It seems difficult for most actors to tell these two terms apart. SWENTEC (Swedish Environmental Technology Council) e.g. has started to the term *cleantech* in their new web pages, even though they use ETAP's definition on *environmental technology* for describing the term *cleantech*. Their Swedish pages on the web still use the term environmental technology where it has been altered in the English version. In this report we defy the hyped term and stick to *environmental technology*.

PI.3. Summing up Part I

- There exist several definitions on environmental technology and environmentally sound technology. Some definitions have a narrow focus on recycling of products and processes and handling of residual wastes. Others apply a wider scope that also includes technologies that generate low wastes and pollution. Environmental technologies may also be seen as innovative solutions that takes technology leaps and changes entire systems.

- One common definition on environmental technology is ETAPs (European Commission's wide definitions. Another definition on environmental technologies that is useful is the three scope developed by Nutek pure environmental technology, environmentally efficient products and services and innovative environmental solutions.

- Wide definitions on environmental technologies may have the problematic implication that whole industries and companies become in national statistics accounted for as environmental technology, such as water pumps, which results in erroneous statistics.

- For this Formas-Vinnova program, however, the wide definition on environmental technology is suitable. Technologies that qualify into the program should be those where potentials exist for environmental, health and ecological improvements.

- A new definition on environmental technologies should not, within the scope of the Formas-Vinnova program, be developed.

Part II:
Development trends in the world's vast latecoming economies

PII. Development trends in the world's vast latecoming economies

There are two major aspects that will determine humanity's impact on the environment and due to the reciprocity – since humans are dependent on the environment – these two areas where humanity impacts the environment may in turn backfire by affecting the health of humans in return. Impacts on the environment and human health are related to the demographic and economic developments, especially in the vast latecoming economies. The two most important demographic issues regards population growth and migrations, often intranational flows, from rural areas to urban densely populated areas. This huge reallocation of people requires enormous investments i.e. infrastructures in piped water and sewage water and waste treatment systems as well as investments in electricity, transport and telecommunication infrastructures. The economic development of the populous countries will increase the need for resources worldwide. This will have impacts on products and services (that can) produced for all markets in the world. There will, hence, also be a huge need for more resource efficient products as well as possible alternative services, that have the ability to replace the current resource consuming alternatives.

PII.1. Population Trends

Population estimates for the work within United Nations is carried out by the UN Population Division of Economic and Social Affairs. They have for the firs time, in their *"2002 Revision"* (UNESD/PD, 2003), projected future fertility levels in the majority of developing countries to fall below 2.1 children per woman by 2050. In other words: 3 out of 4 less developed countries will in the mid-twenty-first century face fertility rates that are below the replacement fertility level (2.1). However, currently the global population is increasing by almost 80 million people annually. Six countries accounts for half of that annual increment. India and China belongs to this group and constitute 21 and 12 per cent of world annual population increase respectively. The only developed country in this group, USA, accounts for 4 per cent of global population increase. The developing country China has, however, already reached below its replacement levels today.

PII.1.1. Urbanisation puts huge demands on new infrastructure

The world population is increasingly living in *Urbania* and huge migrations from rural areas feed the urban areas with new inhabitants, that seek for better living conditions. These new citizens of *Urbania*, however, due to their numbers put a lot of pressure to improve and expand the city infrastructures such as transports, piped drinking water and sewage and waste handling, just to mention a few. According to UNESD/PD (2005a) 30 percent of the global population lived in urban areas as of 1950. By 2007 it is estimated that half of the world's population will be urban-dwellers and in 2030 the urban population is projected to constitute a good 60 percent of the global population.

Table 1: Urbanisation trends globally, in Brazil, in China and in India (Data Source: UNESD/PD, 2006; cf. 2005a).

	World		**Brazil**		**China**		**India**	
	Urban population		Urban population		Urban population		Urban population	
	Thousands	% of Tot	Thousands	% of Tot	Thousands	% of Tot	Thousands	% of Tot
2005	3,150,451	48.7	157,010	84.2	531,817	40.4	316,942	28.7
2030	4,912,553	59.9	214,603	91.1	872,671	60.3	589,957	40.7

As seen in table 1 there is a strong urbanisation trend in the world currently, making the urban populations of Brazil, China and India outgrow their respective rural populations. The most remarkable growth-differences between urban and rural areas can be found in China. The rural population has already started to decrease as of 1990-1995, but the urban population will growth by more than 340 million inhabitants as of 2005-2030, that is a 20 percent-unit increase of the share that urban area inhabitants constitute of China's total population. The urban population in India will increase by 273 million people and despite the general population increase in India will the urban population increase its share of the total population by 12 percent-units. Brazil is compared to the other two countries – China and India – a much urbanised country where almost half the population lives in urban areas. There is also here an ongoing flow of migrants into the cities and the share of urban population will increase by some 7 percent-units until 2030. Between 1990 and 2025, the number of people living in urban areas around the world is, thus, projected to double to more than 5 billion, see figure 1.

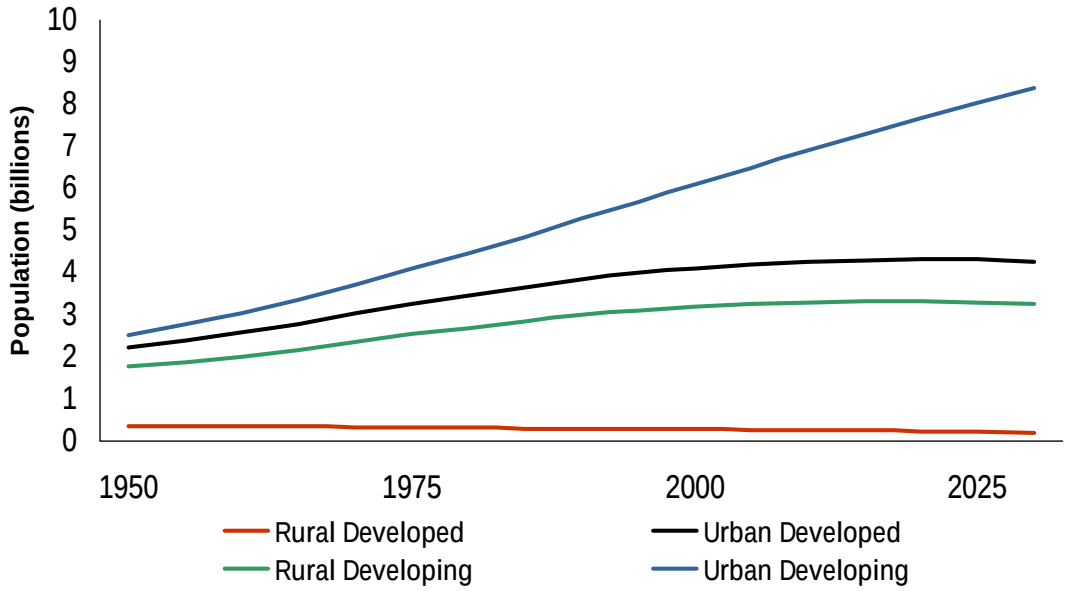

Figure 1: Urban population growth outgrowths rural growth as of 1950-2025 (Sources: WRI et al., 2002; and UNESD/PD, 2005b).

The mega-cities with populations exceeding 10 million inhabitants will in Brazil, China and India increase their populations between 2005 and 2015 by 3,5 million, 15,2 million and 9,9 million in Brazil, China and India respectively – see appendix 2. Not only do these people need new infrastructures such as transports, water, sewage and waste – but all these people and the

infrastructures aiding them may cause even worse environmental and health problems to the inhabitants of the mega-cities. Other infrastructures in combination with increased purchasing power and the following increase of vehicles will give rise to escalating traffic problems that are likely to pose severe problems in the largest cities. In India e.g. by 2016 urban transports are estimated tot increase by 2.6 times in large and mid sized cities and the increase of two- and three-wheelers is seen as truly troublesome (Nagdeve, 2002).

One very important demographic factor in both China and India are the huge internal movements of labour from rural areas to the rapidly growing major cities. The mamothian intranational migrations will create some of the largest megacities – i.e. populous cities having more than 10 million inhabitants each – in the world. The largest city is predicted encompass a population on about 27 million inhabitants by 2015 (National Intelligence Council, 2000). This will pose immense demand on constructing new *environmental infrastructures* for traffic, electricity and telecommunications but also for infrastructures that include treatment of water and wastewater as well as the treatment of household and industrial wastes. According to the National Intelligence Council (2004) the internal number of migrators in China is currently 100 millions which is a low estimate compared to some other estimates done.

All these new city dwellers are going to need access to piped drinking water and sewage. The Chinese Ministry of Construction has accounted that the domestic cities that in total lack sewage systems and sewage treatment plants to as many as 278 cities. In China as of 2006-2010 alone the Ministry of Construction and the 11th FYP have set aside US$41.3 billion for constructing and extending the access to sewage treatment and recycling facilities. By 2010, the aim is that 70 percent of the urban population shall have access to sewage disposal (WRI, 2006).

PII.1.2. Population severities that influence population trends, stability and economic development

There exists, moreover, huge challenges of social and demographic character that can alter the predictions of the development in foremost China and India illustrated above. That is the huge surplus of men that evolves in China and India as a consequence of the practice of favouring male children. The male surplus may lead to civil unrest in these countries among other negative side effects and then there is the issue of HIV/AIDS infections in Asia and Latin America that may impact coming population figures – compare with those illustrated in appendix 3.

PII.1.3. The growing middle class in latecoming economies

Not only will the number of people moving into the cities increase the need for these infrastructures and the need for managing environmental waste but also the rapid economic development with the consumption patterns that follow. The Chinese middle class is expected to by 2020 constitute 40 percent of the country's total population. The middleclass is, consequently, currently a good 250 million people in China and India's middleclass is estimated to be 300 million people. The GDP per capita for these persons are not as high as in the west, but good enough for spurring car purchases for the middleclass households (National Intelligence Council, 2004). In Brazil the corresponding middle-class constitute one third of the population, i.e. a good 60 million inhabitants living on a European living standard (IBGE, 2007).

The GDP of China has according to some calculations already surpassed the UK GDP and the Chinese economy is projected to be the second largest in the world by 2020 after the USA (Goldman Sachs, 2003). India's and Brazil's GDP development's are close behind with India at

echelon with the major countries of Europe and Brazil right beneath the GDP of the largest European economies as of 2020.

PII.2. Consumption Trends

The great increase in economic wealth currently taking place in the world's vast and populous nations – of foremost concern are the economic development trends in China and India – that rapidly turns into increased consumption of goods demanding increased resource use of energy and materials. Food consumption increases and the transport and energy content per produced food as well. The consumption patterns will also profoundly turn towards home appliances, electronic goods, apparel, furniture and automobiles. As described above, the middle class in China and India currently number 250 and 300 million people, respectively, and as estimated below the number of cars in China and India by 2030 will together account 540 million vehicles which is close to the total number of vehicles (630 million) on the earth today. This huge increase in car usage and car replacement (when buying new cars) will put some immense pressure on global resources in terms of availability (available high quality ores to mine) and extraction capacity. Oil, aluminium, plastics and platinum-group metals are some resources that will be considerably affected by the increased vehicle usage in the world as of 2030. These severities will have to be met by some radical innovations in the transport sector. The impact on resources, other industries (i.e. electronic goods), recycling practices and radical innovation system innovations by future vehicle fleet is discussed in the case study below.

PII.2.1. CASE: The arising Automotive Economies and the Decreasing Resource Availability

According to the WRI et al. (2002) the number of vehicles – cars, busses and trucks – in the world as of 1995 was 630 million. If we assume that for most nations the number of cars per 1,000 inhabitants at the same national GDP per capita level[4] would be somewhat similar and that the current number of cars in South Korea is 250/1,000 inhabitants[5] (OECD, 2006c; STEPS, 2005) we will get a rough estimate of the size of the car park in tomorrow's China. By 2030 China's per capita income will be as large as Korea's is today (Goldman Sachs, 2003) and the number of inhabitants in China exceeding 1.44 billion. Applying the car rate in Korea as shown above is 250/1,000 inhabitants then the number of cars in China would be some 360 million cars by 2030 when the Chinese population exceeds 1.44 billion inhabitants (se appendix 2).

STEPS (2005) shows that the car ownership rate versus GDP per capita is currently similar between China and India. The estimates on future rate of ownerships is, however, according to STEPS (2005) very diverting between the studies e.g. made by IEA/WEO, WEC and EU. Taking the average ratios between China and India for 2020 in the STEPS reports the car ownership rate in India by 2030 will be about 50% (47.9%) of that in China[6]. By 2030 both countries are estimated to each have populations exceeding 1.44 billion inhabitants. The number of cars in India would, then,

[4] As shown by STEPS (2005).
[5] In Japan with a higher GDP/capita the corresponding car ownership rate vs. GDP per capita number is above 550 vehicles per 1,000 inhabitants.
[6] In comparison: STEPS (2005) estimates that the car park of India will be half the size of China's by 2050 mainly due to two facts: *one* the economy of India will not be as large as China's and *two* the railway networks measured in number of passengers is much higher in India which can serve as a route for decreasing the need for high-way solutions.

approximately be 180 millions as of 2030 and in China about 360 million cars. Together these two countries will encompass some 540 million cars. Then we have an increased car usage in many other regions of the world, especially in countries i.e. Brazil, Indonesia, Iran among many others. So, by 2030 the number of cars in the world would if these estimates are not too erroneous be far more than doubled compared to 1995[7]. This enormous expansion in vehicle ownership has already begun in China where during 2002 three vehicle groups – busses, trucks and cars – all reached and passed 1 million units sold each and the number of cars sold during 2015 will be almost 6 million cars and the annual vehicle sales is estimated to have reached 9 million units (KPMG, 2003).

How will a global car park – as of 2030 – twice as large as current global numbers impact the resource demand of some core means of modern society i.e. iron, aluminum, plastics and special metals? As stated above the global auto numbers will by 2030 count somewhere around 1.2 billion, low estimation, and the current figure 630 million cars (WRI, 2003). If applying an fictive usage phase of ten years[8] we get an replacement rate on one tenth a year for the global car stock which for 2030 will be correspond to a production of 120 million vehicles. Assuming that the vehicles (compact class) have a weight on a metric ton a piece and that the steel content is approximately 70 weight percent (Schmidt *et al.*, 2004) then the total demand for steel from the auto industry as of 2030 will be 84 million ton/year. The production of autos during 2005 has been estimated to 54.5 million vehicles (Autoparts Report, 2001) which corresponds to a steel demand on 38 million ton/year. The aluminum content of standard cars is currently 3 percent, but some brands like Audi and Mercedes have cars in the product portfolio with considerably higher aluminum shares and lesser content of steel. Light weight cars of tomorrow are assumed to have aluminum content somewhere in the range of 11 to 49 percent. There is, thus, two scenarios for aluminum demand from the auto sector as of 2030. A) 120 million vehicles times 1 ton/car times 3 percent aluminum content equals 3.6 million ton/year and B) 120 million vehicles times estimated 0.75 ton/car times (e.g.) 40 percent aluminum content equals 36 million tons. The plastic content is assumed to as much as double in light cars but in current cars the plastics content is approximately 19 percent (Daimler-Chrysler, 2006). That would make the demand for plastics in the auto sector to 22.8 tons/year. If each car is assumed to be equipped with some kind of catalytic converter by 2030 with an average platinum-group metal[9] weight on 1.5 gram (USGS, 1998) the demand from the auto sector will then be 180.000 tons on a yearly bases as of 2030. These figures that are dealt with in this paragraph on the auto industry demand for resources, current and by 2030, as well as current annual production is shown in table 2, below.

[7] For example STEPS (2005) have estimated, by using OECD data, that motor vehicle kilometres travelled by 2020 will increase by 86% worldwide and 40% in the OECD compared to 1995 figures.
[8] On average, according to Eurostat figures, the average age of passenger cars in Europe was 7.3 years as of 1998, which is an increase by one year since 1990 (STEPS, 2005).
[9] The platinum-group metals consist of platinum, palladium, rhodium, ruthenium, iridium and osmium and they tend to have similar physical and chemical characteristics. Converters contain several different he metals, although having different efficiencies, in catalytic converters are sometimes substituted for each other (USGS, 2006).

Table 2: The estimated increase in global auto sector resource demand as of today and 2030 to current resource production figures. (Sources: Autoparts Report, 2001; Schmidt, 2004; Daimler-Chrysler, 2006; Plastics New Zealand, 2006; STEPS, 2005; Swedish Recycling Industries' Association, 2006; USGS, 1998; 2004; 2006a; 2006b; 2006c).

Resource (Data in million tons)	**Current Annual Production**	**Current Annual Auto Sector Demand**	**Auto Sector Demand as of 2030**	**Auto Sector Demand Increase to Current Production**
Steel	1090	38	84	4.2 %
Aluminum (low estimate)	31	1.6	3.6	6.5 %
Aluminum (high estimate)	31	1.6	36	111 %
Plastics	155	10.3	22.8	8.1 %
Platinum-Group Metals	0.43	0.06*	0.18	28 %

* A rough estimation is made here, assuming that 75 percent of global vehicle production is currently equipped with catalytic converters.

Grayish shaded areas represent current annual resource production that currently is close to/facing global yearend capacity.

Black shaded area concerns the resource extraction of PGMs. The mining of these metals is currently expanding due to the vanishing availability of higher grade ores.

As seen in table 2 above the future demand increase on resources from the auto industry is considerable compared to current global production/extraction of resources. The increases in aluminium and plastics demand for the vehicle industry are, furthermore, faced with the severity of already having reached annual production capacity today (cf. Swedish Recycling Industries' Association, 2006; cf. 2006a). A study by the US Department of Energy (Wall *et al.*, 2006) assessed two alternatives for steel, concerning weight and recyclability, in the Toyota Prius, one aluminium and one composite alternative. The composite body alternatives will solve the worst case aluminium scenario above with an increase in auto industry demand surpassing current annual production, but since composites are made of carbon fibers and a mix containing a wide range of various plastics today's global production capacity has also to be expanded considerably. There is, consequently, room for and, importantly, an enormous need for innovation in creating lightweight vehicles for the very nearby future to solve the resource and recycling issues facing the world economy due to the rapidly increasing middle class in the latecoming economies.

Lightweight vehicles are also a prerequisite for solving the auto fuel problem. Another technology for dealing with finite fossil fuels in transports is the development of fuel cell automobiles that will require considerable amounts of Platinum, constituting the catalyst in the fuel cell engine that converts hydrogen and oxygen to electricity. Palladium is, also used in the actual fuel cells (USGS, 2006c). The demand for Platinum-Group Metals will increase considerably if the use of fuel cell technology becomes widespread and there will be a great need for recycling. Recycling of these PGMs is a rather easy task to solve, since they are so precious already today (increasingly valuable cf. Harler, 2005), but all anthropogenic substances going into the economy can never be one

hundred recycled, fractions end up in the environment or even into the biosphere[10]. There is, thus, even here regarding engine technologies a vast need for innovation solutions that are not only solving the fossil fuel problem, but also importantly solving the problematic aspect of the increasing demand for precious metals resources.

According to the calculations of McKillop (2005) the oil need for the future car fleets are immense. When China and India reaches OECD levels in car rate ownerships these two countries alone will together consume some 10 billion barrels of oil per annum and this is equal to the yearly production of oil of the entire OPEC countries and more than a third of total oil production worldwide as of 2003 (EIA, 2006). The struggle for produced oil is, hence, going to be much more severe that it has been to date where the current oil demand for road traffic from China and India has without exaggeration been very moderate, especially if considering the fact that the car owner rate is in China is just above 5 cars per 1,000 inhabitants (WRI *et al.*, 2002; KPMG, 2004; STEPS, 2005). Some 25-30 years from now these vehicle markets will by far outnumber the big markets in the old OECD region and have a competitive buying power to retain resources for transports. If returning back to McKillop, the vastly increased demand for oil and the limited resources and production capabilities may, except for environmental degradation, be a source for international instability.

As one possible solution to the oil dependency that China increasingly experiences is to explore the abundance of coal that China is in possession of. The Chinese coal reserves will last another 200 years which in comparison with the oil alternative may be perceived as an intermediate solution in the transition towards renewable energy sources. A council chaired by the Chinese Premier, Wen Jiabao, has developed coal gasification strategies for the Chinese government that will enable increased efficiency in electricity generation, decreased environmental costs (both SO_2 and carbon emissions are reduced) and more application areas compared to the traditional coal combustion (technology) plants. Interestingly, the syngas from the gasification process is the basis for synthesizing high quality liquid fuels i.e. methanol and DME (among other outputs) that can be used for transportation and agriculture. According to Farinelli's (2003) predictions the coal gasification production in 2050 could be as large as or larger than the total primary energy supply of China as of 2005.

[10] Currently three-way catalytic converters disperse PGM in the environment, especially close to high-ways, but only Pt is taken up by plants. The abundance – relatively speaking to their economic value – of PGM on road shoulders and nearby areas has made it economically viable to recover these metals lying along the European and North American roadsides (Ely *et al.*, 2001).

PII.3. Brazil

In many aspects Brazil cannot be classified as a poor country if considering the fact that two thirds of the worlds nations and 77 percent of the world population has a per capita income that is lower than Brazil's on US$ 3,580 as of 2002. But if considering that one third of its population – i.e. more than 50 million people – are living below the poverty line in Brazil which is far worse than the case in comparable GDP per capita countries where the below poverty line share of the population is only 10%. Poverty has been persistent in the country for some decades but the extreme poverty was reduced by 5 percent during the 1990s down to just above 14% of the population (OVE, 2004).

PII.3.1. In Brief

The Federative Republic of Brazil is the fifth largest country in the world both area and population wise. The country also constitutes half of South America's area and population. Brazil is a federation of 26 states and the federal district of Brasilia is its capitol. Being a former Portuguese colony the language is Portuguese, the strong cultural legacy is Roman Catholic and the legal system is based on Roman Law. The executive power of the state is held by the government lead by the president and the legislative power is held by the bicameral National Congress, one proportional representation – Chamber of Deputies and one house of Federal Senate. The President may veto and the Supreme Court tests laws against the constitution.

The individual states have significant autonomy and have jurisdiction over considerable law making, social and environmental issues and taxation. Each Brazilian state is headed by a Governor and a legislative assembly. The states are in their turn divided into municipalities headed by a Mayor and a legislative body. The municipalities' autonomy is large and the organisation of them varies. This organisational divide may influence and affect the success of e.g. ambitious federal environmental policies.

Brazil's economy is advanced and the country's industry is well advanced encompassing aircrafts, automobiles, computers, consumer durables, medicines, petrochemicals and steel. The country is also blessed with enormous assets of resources that has contributed to a successful agriculture, forest and mining sectors. The country has also a huge resource of labour. Tourism is also an important sector to the nation's economy. These factors combined make the Brazilian economy strong and less vulnerable to changes in industry sectors. Brazil is now considered to be a stable democracy with controlled inflation (the estimated figures for 2006 are less than 4) but a GDP growth a good two percent which is low for an emerging economy.

The International Monetary Foundation (IMF) has considered Brazil to have the world's ninth largest economy considering its purchasing power. The challenges for Brazil to face are, however, serious. The country is suffering from poor infrastructure, asymmetric income distribution – between population groups and regions – low quality public services, corruption and social unrest. The public debt is, moreover considerable and GDP growth is lower than the growth of comparable Latin American economics and of China and India.

Health and environmental problems are that water and sewage pipes coverage is low and rivers and bays receive toxic residuals and legal and illegal logging endager much of Amazonas. The President of Brazil since 2002, Luiz Inácio Lula da Silva, has put considerable efforts into decreasing the social inequalities and improving the living standards of the poorest by terminate hunger, provide

schooling incentives to families and to provide households with infrastructure commodities like piped drinkable water, electricity. These, projects are long-term that takes time to accomplish.

PII.3.2. Poverty and inequalities

The inequalities in Brazil have, however, remained constant and the country is one of the world's most unequal nations and the Gini coefficient has remained at above 0.57 since the beginning of the 1990's. As a consequence, the group under extreme poverty is more sensitive to income distribution than growth in GDP, according to simulations. For the extreme poverty a ten percent decrease in poverty would be similar to 25 years of 3 percent annual growth. Wealth is also asymmetrically distributed among the regions, states and municipalities. In the wealthier Southeast 18 percent of the population is living with half the minimum wage or less while the corresponding figure in the poorer Northeast is 51 percent. Another asymmetric distribution of wealth is along race, which create impediments of exclusion among groups. These inequalities in wealth and exclusion of individuals from the society are potential risks for social unrest, but already today Brazil's larger cities are *"known"* for their problems with violence. According the Inter-American Development Bank (OVE, 2004) considerable amount of money is spent on social sectors and Brazil "is certainly a country with an active social policy." So, according to the report the amount the country is spending is more than needed for satisfying the basic needs of the poor the challenge is not to mobilising resources but to improve the targeting, tracking and monitoring of the programs. A too large share of the population belongs to the informal economy with no contribution to the tax system and this population receives little securities made by the government in return. Overcoming the inequalities is, hence, still an imperative task for Brazilian policy makers and the President da Silva. The success in doing so, however, is a prerequisite for being able to solve the environmental problems of Brazil.

PII.3.3. Natural resources and environmental issues

Brazil has a troublesome historic burden of pollution from the second half of the last century, starting with almost unrestricted industrial pollution and untreated household waste that came with the industrialisation and urbanisation in the 1950s and 1960s. Major clean-up efforts started in the 1980s and 1990s, but much of the decontamination is still to be carried out. Toxic residues cover some important rivers and bays, like the bay of Rio de Janeiro and during the 1990s the eutrophication and biochemical oxygen was not reduced either. Vital rivers through densely populated areas still carry significant amounts of pollutants and phosphorus, nitrogen and heavy metals will be released into the water for many years to come (OVE, 2004).

PII.3.4. Water and wastewater

Also the access to potable water varies greatly in Brazil between regions, by income and along population density. As of 2001 more than 90 percent of the country's urban population was covered by the drinking water supply, but the sanitation coverage was much lower. For the lowest decile 70 percent in urban areas had access to piped water while the lowest decile in rural areas only 8 percent had access to piped water. The progress in rural pipe water coverage is, according to OVE (2004) incremental. The coverage to sewage pipes is less developed than to fresh water. As of 2001 45 percent of the lowest decile in urban areas hade sanitation coverage and virtually no progress had been made in rural sanitation coverage since the early 1980s. Several projects have been undertaken since the turn of the millennium to address the shortage in access to piped water and sewage pipes in poor urban homes as a response to federal government directives aiming for coverage for all.

PII.3.5. Sustainable development

Brazil faces immense challenges in making the individual goals of economic development, poverty reduction – on the hand – compatible with preservation of the environment – on the other. There exists, conflicting aims in the huge needs for land of the vast mega-cities in the Southeast and preserving costal areas. Other conflicting resource usages are harvesting forests for fuel, wood, cattle ranching and soybean fields (such as in the Amazon region), exploiting the lands of indigenous people by establishing road networks into their dominions, human activities that intensify desertification and draughts, and activities that causes contamination of soils and waters.

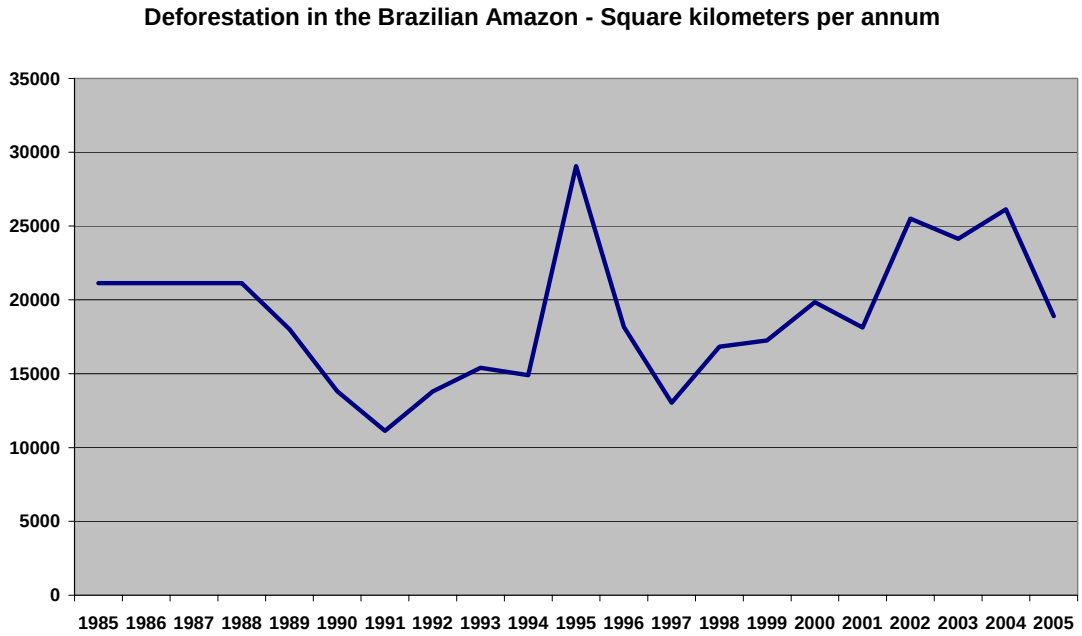

Figure 2: Annual Deforestation in the Brazilian Amazon, 1988-96 (Sources: INPE, 1998; WRI, 2003; Timber Hunt, 2006; Mongabay, 2006).

Only during the 1990s did an area corresponding to twice the size of Portugal become deforested (CIFOR, 2004) and between 2000-2005 a jungle area larger than Greece disappeared for the benefit of soybean fields and cattle pastures and, thus, the Amazon jungle will be completely vanished by 2050 if the rapid pace of deforestation does not decline. The CIFOR article stresses that one of the major contributors to this deforestation is the beef exports. As shown in figure 2 the rate of deforestation did not decline during the 1990s but rather increase and according to WWF (World Wildlife Fund)(WWF, 2006) is now 10-12% of the Amazon forever gone and according to WWF some of the consequences may be modified global climate, droughts in Brazil's agricultural region and of course loss of biodiversity and habitats in the Amazon region. The Brazilians that will be most severely struck are the poorest and the indigenous peoples still living in the Amazon jungles.

As the CIFOR and WWF references above indicate; also the GIS (Geographical Information System) study by Laurance *et al.* (2002) points out large-scale cattle ranching and slash-and-burn farming to be the greatest threats to the rainforest and this in the Eastern basin which are most easily reached by the large population areas.

The OVE (2004) report claims – unlike the findings of Laurance *et al.* (2002) – that at federal levels, however, "Brazil has been a leader and innovator" in integrating environmental aspects and development issues, but the obstacles lie in the limited institutional capacity to handle environmental issues at the state and local level authorities, especially when weighting them to economic and employment aspects. Since, Brazil is a federation the implementation of responsibilities such as environmental do often come into the dominion of the individual state. The challenge of the federal government is to support the environmental agenda (among others) in the face of very heterogeneous needs of the different Brazilian regions. This institutional battlefield is also a field of multidisciplinary research to reveal – describing the potential salients and reverse salients.

Financial support is an institution that is imperative for change. As an indication of the importance of financial aid the Inter-American Development Bank has invested in many projects for improving the environmental conditions in bays and rivers in urban areas covered by toxic sludge. By decontaminating the bays and rivers local living conditions can be improved. But the success requires the execution of civil works in a coordinated manner which in the described case by OVE (2004) did not happen despite the finance of treatment plants, household connections and water meters, solid waste collection and municipal waste information system among other financed initiatives in the program.

PII.3.6. Transports

After the oil crises in 1973 Brazil, lead by its military junta, developed the nation-wide alcohol program for exchanging imported petrol to own generated ethanol sugarcanes, which at the time experienced low market prices. The sugar cane is an efficient source of fermentable carbohydrates that rather easily can be processed to ethanol fuel. The sugar canes also yields sugar and alcoholic beverages but is also used for generating electricity. Sugar cane farming requires little labour and the huge offsets for the product has made sugar cane the main crop in Brazil today. Today, gasoline fuel is replaced in 40% of the transports and ethanol is being exported to other markets.

The positive environmental side from ethanol is the improved air qualities in the cities resulting from the lesser use of gasoline. One of the negative sides of ethanol fuel for Brazil is that vast plantations with monoculture fields of sugar canes have taken over small farms with varied production. The need for new sugar cane fields has also lead to deforestation of forests, leading to decreased biodiversity.

Other crops grown for industrial purposes are eucalyptuses and pines. These are successfully grown in plantations and the cycle from sowing to harvesting is seven years. The Brazilian eucalyptuses and pines works fine and are internationally very competitive for pulp and paper production. These monocultures of species alien to Brazil may pose further pressure on the remaining domestic forests.

PII.3.7. Summing up on Brazil

- Agriculture is in need of improvements concerning the droughts, especially in the Northeast, and the erosion of soil is another severity of Brazilian farming.

- The hunt for new land for agriculture is one of the main causes of deforestation in the Amazonas. Rainforests have to give away for pastures for beef cattle, soybeans and sugarcanes that is used for producing ethanol formerly primarily for the domestic market, but exports to other markets, like Europe, are increasing fast.

- Rivers and bays, especially in densely populated areas have received considerable amounts of toxic sludge, disposal residues and eutrophication. Emissions causing these severities in rural area do still occur.

- A large part of the lowest decile of the urban population lacks access to piped drinkable and sewage water that is contaminating.

- The country is one of the most unequal countries in the world with an Gini coefficient exceeding 0.5.

PII.4. China

China experiences a rapid economic development that reshapes the entire global trade environment. As of 2005 China's trade surplus with the rest of the world reached new record $ 104 billion which is a tripling of Chinese surplus figures from 2004. In total the Chinese export reached $762 billion and total foreign trade topped $ 1.4 trillion making China the third largest trade nation in the world, beaten only by the USA and Germany (Morrison, 2006; People's Daily Online, 2006a). China is currently 4th largest economy when sorting countries according to nominal GDP and 2nd largest economy if sorted by purchase power (IMF, 2006).

PII.4.1. In Brief

Since the Chinese Civil War succeeding WWII China may be interpreted as a region divided into two separate states: the People's Republic of China (PRC) and the Republic of China (ROF) of which the former governs the mainland China and the latter Taiwan. Both states are claiming to be the sole ruler of all China. Since the 1970's, however, the PRC has gained increasing international recognition and is the only of these two that have representation in the United Nations. The China referred to in this report is the PRC in control of mainland China as well as Hong Kong and Macau. The PRC will in the report often be referred to as just China.

The People's Republic of Chinas is the fourth largest country in the world by area but without comparison the largest country in the world population wise, encompassing some 1.3 billion inhabitants. China is a one party-state led by the Communist Party of China (CPC). The country's economy has been partly privatised since the 1980's which have resulted in an economic upswing, bringing down poverty rates from 33 percent to 12 percent of the population and the country is now the third largest economy in the world. China is the second largest country in the world if seen to purchasing power, only beaten by the USA, but the GDP per capita is only a sixth of the corresponding US figures. This economic development is, however, also associated with some asymmetries in wealth distributions and rate of employment between e.g. rural and urban China.

The economic expansion and the increased military spending have influenced the power relations in the area. China has currently territorial disputes with India, Japan and the Republic of China that is in control of the Island Taiwan. The People's Republic of China regards the government of ROC (Taiwan) as being illegitimate and strives for a reunified one single China under its one-China policy.

The economic reforms, in combination with loosened authority controls of private lives started in 1982. By giving peasants a stake in the land incentives for improved agricultural production was provided and during the 1990's, in the post-Tiananmen China, the economic growth has been exceptional that have pulled out some 150 million peasants form severe poverty and enabled the unprecedented growth on an 11.2 percent in annual GDP growth per year (People's Daily Online, 2000).

Politically China is regarded as being a communist state of strict authoritarian character closely related to the strong centralised monarchies that have played a central role in Chine for most of the preceding 2,000 years. The economic system is, however, increasingly characterised by capitalistic decentralised decision-making among the economic actors in society. The communistic central planning in detail has been loosened up, but restrictions of thought are still significant in media, internet and the right to demonstrate.

The single Communist Party of China is divided into sub-parties, so-called democratic parties. It is claimed that there are some political freedom in the elections for local village governance, but in higher levels the CPC holds total control since there are no contested national elections carried out. Other attempts to keep the opposition in place is by oppressive force on those engaged in alternative views (to the CPC) and to improve the economy and, thus, the living conditions of people.

The People's Republic of China is divided into 22 provinces that it governs, but the regime, furthermore, considers Taiwan to be its 23rd province. There are also 5 autonomous regions within China – characterised by large minority groups such as in the Tibet and Xinjiang regions – and 4 municipalities as well as the 2 special administrative regions of Hong Kong and Macau. There are also 5 Special economic zones in China that have investment incentive laws to attract foreign capital and trade.

There are some resemblances to the human rights in Western democracies in the constitution of the People's Republic of China, at a first glance, stating with the rights for free speech, free trial, freedom of religion and also property rights and even the freedom of the press. The implementation and practice of these rights is, however, not always close to the writings of the constitution. Also public punishment in China is a delicate issue to deal with if considering that the country accounts for a large majority of the world's death penalties. Since the corruption in lower and regional levels of government is considered to pose a serious problem, media has been allowed to illuminate social problems and expose corruption.

International pressure is put on China, especially from the US, for China to create a more "fair" foundation for international trade. US industry has large problems to compete with Chinese industry, but also low cost regions such as Latin America and other parts of Asia. Predominantly two issues are at stake here that are unfavourable to foreign industry: A) the set value of Chinese Yuan is to low compared to US dollars and B) the tax incentives that is provided Chinese industry both for competing on the internal and the international markets and the duties imposed on foreign imports to the Chinese market.

President Ho Jintao declared in early 2006 that the aim is to transform Chinese economy from resource and manufacturing based one to an innovation based one (Einhorn, 2006) and the long-term goal is to increase the R&D spending from currently 1.2 percent of GDP to 2 percent by 2010 and 2.5 percent by 2020. By 2050, the intention is that, China shall be the largest research nation in the world surpassing the capacity of USA. The Chinese regime dislikes being dependent on foreign key technologies and would also like to retain the picture of China as the nation of great inventions which within the country is synonym with medieval time China. Being a populous country with vast resources China takes on a broad range of sectors in its technology research approach, including ethically sensitive areas – gene therapy, genetically modified crops and stem cells – in US dominated areas – semiconductors, software, space explorations – but also in emerging renewable energy areas – solar, hydro, wind power and (renewable depending on fuel) fuel cells (Einhorn, 2006). As means for enabling a hydrogen-based economy is the development of the country's nuclear power.

Infrastructure investments are enormous in China such as in road transports and between 2001 and 2005 the highway network in the country has more than doubled and is currently the world's next largest, only beaten by the size of the US highway system. The highway network supporting the cities of Beijing and Shanghai are massive in size. In Beijing the progress of the 6th ring of circular highways is under construction to lead traffic around the inner city area. The total amount of roads also grew considerable – 13 percent in just five years between 1993 and 1997 since proper paved roads are needed for numerous villages in rural China too. To China the massive road and highway

construction to erect a dense transportation network is a keystone in its efforts to fight poverty in the nation.

China is, already today, the world's largest telecom market with close to 350 million cellular phone users and just above 200 million fixed telecom subscribers. The internet users have already reached some 90 million people. The adoption of information and communication technologies (ICT) currently taking place in China is unprecedented. In 1978 there where only 2 million fix telecom subscribers in China (Sandklef and Kiesow, 2006). Today the increase in number of mobile phone subscribers accounts some 7 million people each month. The Chinese telecom market has surpassed USA as the most important telecom market for the ICT Corporation Ericsson. The competition from Chinese counterparts has increased both in China – sometimes supported by Chinese technology standards – and globally. The new technology which is promoted by Chinese leaders is also seen as an obstacle when aiming for controlling the information flow within the country.

PII.4.2. The 11th Five Year Plan – Designing a harmonious society

Key concepts in the newly adopted 11th Five Year Plan (FYP) is the aim to A) build a harmonious society that is B) founded on a scientific concept of development. As no other preceding FYP the high focus on environmental and social issues in the 11th FYP is an indication of the imperative need for the government to diminish the social inequalities within in the country in order to diminish the risks for social unrest. The sustainable development concept is used to avoid overheating in the rapidly expanding city regions in Eastern China. The official *China Through a Lens* (China Internet Information Center, 2005) summarises the 11th FYP similarly:

> *"Build new socialist rural areas, optimize and upgrade industrial structures, promote concordant development of regions, build a conservation-minded and environment-friendly society, further system reform and enhance opening-up, efficiently practice strategies to invigorate China through science and education and through human resource development, and give impetus to constructing a socialist harmonious society."*
>
> (China Internet Information Center, 2005)

The Central Committee of the Communist Party of China (CPC) have, moreover, decided that the 11th FYP will realise a doubling of China's per capita gross domestic product of year 2000 by 2010 and this aim will be fulfilled by improving economic structure, increased efficiency and reduced energy consumption. The energy consumption is to be decreased radically by some 20 percent per unit GDP (Chinese Governments Official Web Portal, 2005; People's Daily Online, 2005).

The 11th FYP encompasses, furthermore, the industrial aim, not on expansion in scale but to upgrade the Chinese industry structure e.g. towards the value-chain phases with higher revenue that will make the Chinese industry to a global industrial powerhouse. The resources put into research and development (R&D) will increase to 1.5 percent of GDP to create an innovative a position on the global technological frontier in the industries of attention. Related to this aim is a whole chapter dedicated to the shaping of the nation's service sector. In the strategies to rejuvenating the country through science and education and strengthening the concept of a nation of talented people China will increase the expenditures for education to 4 percent of GDP. A compulsory 9-year education will be introduced also in the rural areas of China that will be free of charge for poor people (Chinese Governments Official Web Portal, 2005; 2006a; 2006b; 2006c; China Internet Information Center, 2006; People's Daily Online, 2006c).

The regional aspect is core in the FYP where support is given to geographical areas of the country with fewer investments. A regional development strategy is developed steering investments to pinpointed areas and away from overheated ones according to the classification optimized, prioritized, limited and banned exploitation. The FYP aims at saving the resources and protecting the environment. The plan puts great emphasis in building an innovation-oriented country and China is also to develop a strategy that will produce a country of talents. During the five year period 45 million urban jobs will be created and the same number of farmers will be trained to take on chores in industry. It is, moreover, estimated that 15 million farmers will lose their lands. People's quality of life will be improved by safer food, convenient transportation, and public services to help people in an equitable manner. The medical healthcare system will cover 80 percent of the population in rural areas and 70 percent of the people in urban areas will have access to sewage treatment systems. People will also enjoy a better environment where the severe pollutions will be cut by 10 percent as of 2010 compared to year 2000 and the forest coverage will increase by 20 percent. An additional 100 million people will have access to safe drinking water (Chinese Governments Official Web Portal, 2005; 2006a; 2006b; 2006c; China Internet Information Center, 2006; People's Daily Online, 2006c).

Summing up the communique on the 11th FYP people's standards of living will be much higher both in rural and urban areas concerning housing, transportation, education culture, health and environmental conditions. On top of that there will also be some progress made in democracy and legal system as well as the culture and ethics in the general public, building on to the harmonious society.

PII.4.3. Population demographics and urbanisation

The initiation of China's one child program in the 1970's to decrease the population growth as well as improving the quality of life. Authorities have advocated late marriage, late childbearing and "one couple, one child". Since the implementation of the family planning program some 300 million births have been averted and today the fertility rate of Chinese women has gone below the replacement rate. The population is, however, still increasing and is estimated to reach 1.4 billion 2010, reaching its peak by mid-21st century at 1.6 billion inhabitants. Thereafter, the population will gradually start to decrease.

There is a strong, unprecedented in man's history, urbanisation currently taking place in China. The urban share of the population was over 40% in 2005 which is a huge increase since 1978 when the urban share only constituted some 17% of the Chinese population. By 2030 the urbanised population is estimated to constitute 60% of the total population (UNESD/PD, 2006; cf. Table 1). This means that the increase of the number of city dwellers in China will be 340 millions between 2005 and 2030. The internal number of migrators in China is, moreover, ranges between 80-120 million people who work part-time in the major Chinese cities, only periodically returning to their rural areas of origin (National Intelligence Council, 2004; CBC, 2004).

The huge influx of people to the rural areas and mega-cities of China is putting a lot of pressure on Chinese authorities to create new infrastructures for traffic, electricity, telecommunications, drinkable and sewage water and wastes from households and industries. On top of the influx issue is another aspect that creates increased need for development of infrastructures and that is the increased economic wealth in China that is spreading among people, especially the urban middle class. Their increased use of resources and changed consumption patterns will pose an additional challenge to resource use, roads, piped water and facilities for waste disposals. By 2020 the Chinese middle-class is estimated to account for 40 percent of the population which means that there are about 250 million people in China having a living standard that drives consumption. The middle

class in China is wealthy enough for car ownership and car purchases are currently spurring (National Intelligence Council, 2004).

The control of population is a prerequisite for socioeconomic development, natural resources and natural protection or as the *Office of the State Council* describes the relevance of the program: *"This has alleviated the pressure of the excessive population growth on the natural resources and environment, thus contributing to the economic development and the improvement of the people's living standards."* (People's Daily Online, 2006b).

Now, when the population growth of China is restrained there are three demographics and socioeconomic developments of great concern. *One* is the vast migration of young labour within China from rural areas to major city areas, *two* is the surplus of men and *three* is the rapidly improving GDP per capita. The needs for environmental technologies are especially linked to the internal migration flows and the tremendous increase in people's buying power and standard of living. Aspects of male surplus are mainly of social order which could lead to social unrest, crimes, prostitution, trafficking, HIV infections and even aggression from the militia. If such a scenario occurs then the environment surely becomes severely affected. The internal migrations have also considerable social impacts. Such as together with the effects of the one child policy the migrations of young labour to the city regions may affect elderly people in rural areas.

The major need for environmental technologies will arise from A) internal migration patterns, creating highly densely populated areas in Eastern China, and B) the explosion in economic wealth with an expected doubling of the middleclass by 2020, reaching 40 per cent of the population, that can consume cars, white goods, electronics and other resource demanding gadgets currently unachievable for large portions of the population.

PII.4.4. Economy, Equality and the Environment

Goldman Sachs (2003) predicted that the Chinese economy would pass the UK in terms of nominal GDP already in 2005 and this has already happened. Just within a few years the German economy will be surpassed as well and Japan by 2015. The US GDP figures will not be passed until 2039. Even though China's total GDP will surpass the size of the USA, the Chinese GDP per capita will still be considerably smaller than the US. The per capita figures will, however, not be insignificant since by 2030 the estimated Chinese income per capita will roughly correspond to current income per capita levels in South Korea. So, the rough estimation is that the environmental loads per GDP/capita are not going to be all that different in China compared to e.g. today's Korea, but times 1.44 billion people as of 2030 and thus considerable impacts on world economy, resources and environmental conditions[11].

Some fundamental problems of the Chinese economy that may impact the long-term economic development of the country are related to state-owned companies, the banking system, public concerns over pollution, corruption and income inequalities as well as the lack of rule of law (Morrison, 2006). Many of the state owned companies are mismanaged and more than half of them are loosing money. Poor management leads, however, not only to lousy economic statements but also results in inferior quality and severe environmental conditions. The inefficiency of these state-owned enterprises (SOE) makes it difficult for Chinese authorities to lower the trade barriers to

[11] Considering that South Korea currently has about 250 vehicle per capita (OECD, 2006c; STEPS, 2005) and that China by 2030 will have an economy/capita that resembles the Korean the resulting number of vehicles in China will then be – if following the car ownership rate versus GDP/capita relationships in STEPS – some 362 million cars on Chinese roads.

foreign competition. The problems of SOE spills over to the banking system which has to put economic rationality aside to finance the operations of inefficient companies with low-interest rate loans of which a large share is not likely to be paid back to the creditor.

The rapid economic development of China has also a dimension of overheating the Chinese society, in general, but the costal areas in particular. Inflation is and will increasingly be a very important issue to control and keep low. The uneven development has created problems for less fortunate regions to transfer taxation revenues to the central government which has lead to the practice of unfair taxation among some regional officials. Industrial actors in the rapidly expansive costal areas are increasingly experiencing competition among employers (which affects salaries and working conditions) and higher costs such as for properties and facilities. These labour and landed property shortages have lead production using unskilled labour to increasingly locate their plants in rural areas in the interior of China or to countries in Sothern Asia. UNDP (2005) shows in its report on China's human development that the national income inequalities has risen from previously low levels (Gini Coefficient 0.3 as of 1978) to considerable inequalities today (Gini coefficient 0.45 as of 2002).

Morrison (2006) continues to claim that the Chinese government disregards its own environmental laws in order to promote the country's economic development. Nonetheless, Morrison illuminates issues of concern for the people's health and the economic development and refers to the World Bank figures showing that 16 out of the 20 most polluted cities in the World are located in China and over 300 million of the rural population drink unsafe contaminated water. The water table is continuously lowered, especially in Northern China. These severities lead to health problems and water shortages. If this was not enough there are also considerable arable lands lost every year due to soil erosion and due to economic development, where god fertile soil has to make way for constructions – i.e. buildings and highways. Wheat crops have, moreover fallen to lower levels since 1997. Chinese authorities aim at further expand agro production tough improved plants, fertilisers and other technological innovations that boost yields. China is already today yielding considerable crops on its agriculture fields and according to the UN World Food Programme China supplies 20% of the world's population with food by using merely 7% of the world's arable land (BBC, 2006).

Also the UN World Health Organization has stated in a study, which includes almost 300 cities, that Chinese cities dominated the top ten positions when the cities with most severe air conditions were rated. Air quality in China is generally bad and two-third of the Chinese cities were considered air-polluted. The situation is not better when it comes to the rivers where almost all rivers in China are considered polluted. Almost 50 percent of the Chinese population lacks access to clean water. The northern parts of China have a deficient amount of water and the demand from cities, agriculture and industries continuously lowers the water table. To solve these severities Chinese authorities at national level attempts to retrieve water from the south of China, from the Yangtze River, to the Northern cities of China i.e. Beijing and Tianjin. This mammothian scaled project may, however, result in huge impacts on the environment, living conditions and on the regional economy in the areas surrounding the Yangtze River from were the water is to be retried.

Another grandiose project in China, also affecting the environment and local communities, is the Three Gorges Dam project. The intention with the large scale dam is to make the region less dependent on coal and to diminish the air pollutions but the construction of it has forced over 1 million people to move from their farms, villages and cities due to the increased water levels up-streams from the dam construction. The local biotopes are affected and the habitats of species i.e. the river dolphin living there are endangered.

The Chinese State Environmental Protection Agency (SEPA) has, however, received a stronger position to ministry level and the annual amount spent on environmental protection now exceeds 1% of GDP. In both the 10th and 11th Five Year Plans have the air conditions been improved and special concerns are paid to the Beijing area as one of the commitments for becoming the host of the 2008 Olympic Games.

PII.4.5. Standards as trade barriers to foreign competition

Chinese standards are increasingly accused of being a tool for delimit foreign competition on the Chinese market, favouring domestic competitors. According to the US Government Export Portal (2004) US industry has shown significant concern with China and its development and promotion of domestic Chinese standards since the development processes of them lacks transparency, especially for foreign competitors. The US Government Export Portal and US General Accounting Office have retrieved the picture from industry that standards and certification issues pose the most significant trade barrier for importers to the Chinese market, being more significant obstacles to trade than Chinese customs procedures, tariffs and deficient property rights.

The Office of United States Trade Representative (2005; 2006a)[12] confirms the above picture claiming the severity in how standards are applied in China. The complaints of many US industries is, accordingly, that China should manipulate technical regulations and standards to favour domestic industries. This procedure of using standards for providing domestic industries with a competitive advantage has increased in importance since China attempts to adopt WTO agreements on custom procedures and tariffs. In its WTO agreement, however, China has also committed itself to ensure that its regulatory authorities apply the same standards, technical regulations and conformity assessment procedures for both domestic and foreign goods and industries (US Trade Representative, 2006a). The US report continues to argue that foreign industries often are not allowed to participate in the standard development processes as domestic firms are. Foreign competitors are then faced with changed rules of the game adjusted to the prerequisites of domestic industry. Another concern that importers to China have is the discrepancy between China's WTO agreement and the implementation of these at local level officials where there might be a combination of not understanding the national WTO agreements as well as striving for to protect local industries.

The US Trade Representative (2006a) further claims that SAC issued a strategy report where China's development of standards and technical regulation should be used as means of favouring domestic industries as tariff rates fall. In a number of industry sectors – i.e. autos, telecommunications (td-scdma instead of wcdma), wireless local area networks (WAPI instead of WLAN), radio frequency tags, audio-video coding, whiskey – China has developed its own set of unique standards even though there exists well-established international standards. These domestic standards seem to lack sound foundation according to the US Trade Representative (2006a) and may pose a barrier to foreign imports. These standards, however, also serves as source of enhancing national pride by showing the lead that China possesses in technical development. The standard

[12] It should be mentioned that these documents from the Office of United States Trade Representative, may not always provide an objective picture of non-US countries' work with custom procedures, tariffs, standards and technical regulations. The agency is more concerned with promoting the view of US industry to enable US officials to put pressure on foreign nations. Brazil, China, India and EU are e.g. claimed to use standards based on vague or questionable scientific bases when they do not accept the sanitary and phytosanitary standards used in US agriculture industry. However, compared to the criticism of Brazil (US Trade Representative, 2006b) and India (US Trade Representative, 2006c) that are much lighter than the severe criticism that is given China (US Trade Representative, 2006a) where it is stated that US industry is concerned about: *"China's manipulation of technical regulations and standards to favor domestic industries."*

initiatives by the Chinese authorities may be seen as a mean to successfully lock out Western wireless telecom system providers by developing its own version of the internationally accepted WCDMA standard in a process where foreign competitors did not manage to adapt to the new requirements in the procurement procedures of telecommunications system in China. The Chinese offensive in these areas may, however, also be evaluated against the background that after joining the WTO it became obvious that the largest market for – as well as in producing – ICT products is faced with a new set of barriers, namely IPR (Intellectual Property Rights) fences and thickets. This has created enormous efforts as regards innovative activitites among Chines actors, strongly supported by the Chinese government. This may be illustrated by the development of a third international standard for the third generation of mobile telephony, TD-SCDMA. Irrespective of its advantages/disadvantages compared to the other two standards – as illuminated by Long and Laestadius (Laestadius, 2006) – the very existence of this standard may have impact on the license agreements of Chinese operators when they upgrade their existing mobile networks.

In early 2003 two EU directives, the Waste Electrical and Electronic Equipment Directive (WEEE) and Restriction of Hazardous Substances Directive (RoHS), went into effect for implementation in 2005 and 2006. The EU RoHS Directive has gone into effect and it became implemented in mid-2006 in most of the EU membership countries. The WEEE/RoHS requirements have inspired policy development of similar legislation around the world as in China, Korea, Japan and some US states, however, EU may still be considered to be in the lead. But, China has unexpectedly taken up forceful actions in its policy development process and the country has adopted the strictest forms of RoHS not allowing any exceptions and phase-in periods as is done Europe which has drained some effectiveness out of the European legislation (STR, 2006). Moreover, as shown two paragraphs above, there exists a dichotomy between the Chinese official national policies and regulation, on the one side, and the local implementation, on the other, where the understanding for international agreements might be lesser, but not the strive for protecting domestic and local industry. According to the Specialized Technology Resources (2006) the strict adherence to RoHS that China has taken may *"pose a major problem in the coming years for companies that export RoHS-targeted goods to China. There is growing concern in the electronics industry that China may be using these Directives for its own market share purposes."* This has been a concern of one hearing before the Subcommittee on Environment, Technology, and Standards; Committee on science (US) House of Representatives that took place in 2005 (House of Representatives, 2005). Also the report by Martin Charter and Clark (2006) is somewhat sceptical about the intention of the far going Chinese RoHS Directive, not seeing a clear motive. To them the concern about of the health of people may be one reason for going beyond the EU RoHS Directive and the other reason may be of strategic character to ensure the competitiveness of domestic industry.

There is, hence, a rapid development of environmental policy initiatives in China seemingly for the sake of protecting people's health and the common environment in accordance with the 11th Five Year Plan, and possibly, as some resources indicate, for ensuring a competitive advantage of Chinese industry. Western industries and policy makers, ought therefore, to incorporate the Chinese development of standards and technological legislation where environmental aspects and the technological solutions to address them may to a larger extent become a question of having the possibility of exporting Western/Swedish products at all to some the largest markets in the world of tomorrow.

PII.4.6. Industry structure

Today, there is an eruption of Chinese products on the global markets. The Chinese industry is, currently, experiencing an enormous development overflowing the global market with *Made in China* products and the domestic Chinese industry covers today most types of production, from

having been primary low-tech oriented ten years ago. Today, Chinese exports include goods such as electrical machinery and equipment, computers, power tools and appliances, apparel, furniture, medical equipment, footwear and Toys & games. The imports are mainly electronic integrated circuits and sub-assemblies, electrical machinery, power generation equipment, mineral fuel & oil, liquid crystal display panels, steel products and plastics. Chinese imports are, thus, characterised by input needs for its industry production (Morrison, 2006). The industry product groups that grew the most during 2004 was handsets for telecom and radio and data processing equipment which experienced an almost 50% and 30% increase in exports, respectively. The imports to China that rose the most as of 2004 were crude oil and integrated circuits and electronic sub-assemblies with an increase on a good 40% and good 30%, respectively.

The Chinese state encourages foreign direct investments in prioritised sectors and regions and it produces an industry catalogue in which the degree of foreign involvement is set. Since 1990 the Chinese government allows foreign partners to chair in joint ventures. The government supports investments in prioritised industries and regions by various tax instruments but also in state prioritised projects such as energy, communications and transports – all which can contain elements of environmental concerns. Corporations that has received foreign investments constitute almost half of China's exports and these foreign invested firms are one important contributor to the fact that China's foreign exchange reserves more than doubled between 2003 and 2005, making China the holder of the world's largest foreign reserves. There is, thus, a significant financial strength in China's economy that provides the country the opportunity to invest in prioritised areas.

PII.4.7. Resource scarcity

The rapid economic development of China has led the country to become an important power in the fight over resources – i.e. oil and metals. A recently published report for the US Congress (Morrison, 2006) clearly states the new world order where China is vacuuming the globe for precious resources, of which many have not earlier been regarded as precious.

> *China's rapid economic growth and continued expansion of its manufacturing base are fueling a sharp demand for energy and raw materials, which is becoming an increasingly important factor in determining world prices for such commodities. China is now the world's second largest consumer of oil products (after the United States) at 6.7 million barrels per day, and that level is projected to double to 13.4 million barrels per day by 2025. According to the U.S. Energy Information Administration, around 40% of world oil demand growth over the past four years came from China and this demand is "a very significant factor in world oil markets." China has also reportedly become the largest consumer of steel, cement, and copper.*
>
> (Morrison, 2006)

Plastics have become a renewable resource which in many respects previously was of no value other than for energy recovery. Now it is worth while to recover the material since the production capacities in the world have reached and exceeds the production limits. The way we treat and view what was previously seen as waste has now to be treated as a limited resource to be implemented in resource efficient design and in design for material recycling (cf. Swedish Recycling Industries' Association, 2006).

According to OECD (2006a), see figure 3 below, many economists internationally put the blame on China – and to a somewhat lesser extent on India and other emerging economies as well – for the currently broken trend where decreasing prices have been changed to escalating price levels on commodities. The price for raw materials, according to the OECD, has increased by 70 percent, see

figure 3. Already today, as stated above, China is vacuuming the world market for resources needed to keep its economic machinery running, see figure 4. But, what will happen to the world's resources and the commodity prices as well as environmental consequences from mining, emissions and disposal within a few years from now when China's economy has passed all other economies in size – as of 2039? Are we facing a global bonanza or a world threat? China's policy makers see these huge obstacles arriving at unprecedented speed and have in the 11th FYP set out a route for creating a less resource dependent economy – production wise – that to a larger extent relies on developing software, intellectual properties and creating an innovative society.

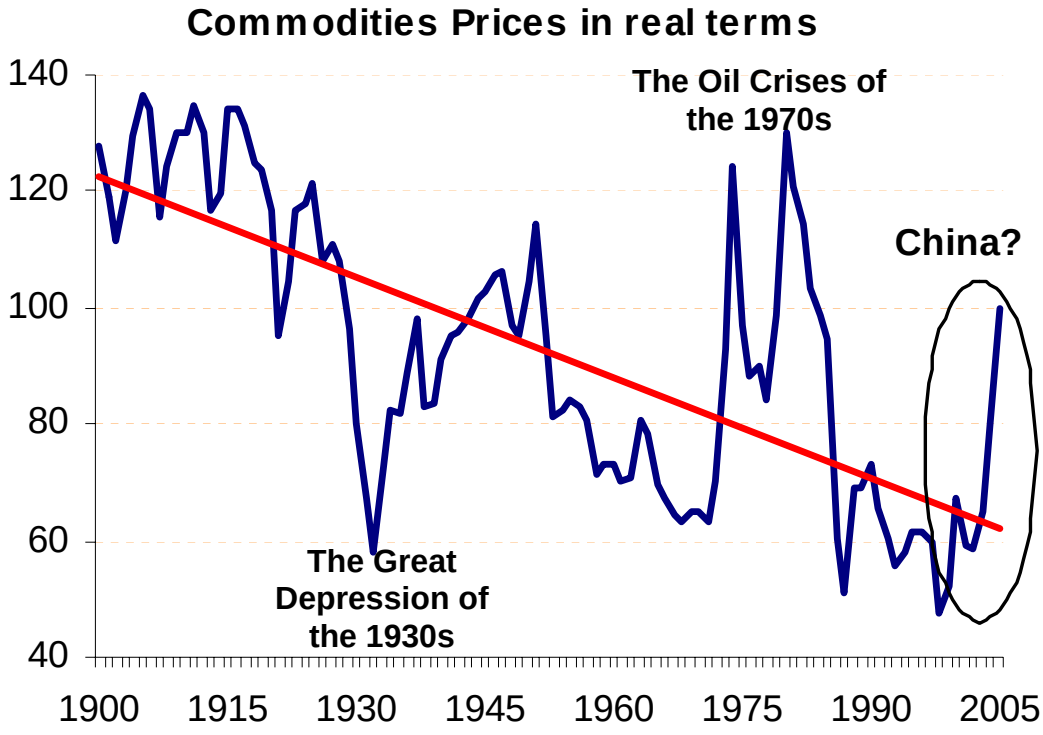

Figure 3: Has China's economic expansion lead to souring prices on commodities? (Sources: OECD, 2006a; University of Oxford).

Even though China manage to steer its economy, production wise, towards less resource dependencies the economic boom in China is currently creating a society of consumerism where the increased buying power is going for consumption patters similar to other industrialised countries of the world, let us say Japan and South Korea. So even though the Chinese industry will become much less dependent on resources in the future, let us say moving such production elsewhere in the world, the buying power of the Chinese will put a similar resource demand on the globe. If we take this new buying power and add to that the increased buying power of India, whose economy will have passed today's second largest economy, Japan, as of early 2030s (cf. Goldman Sachs, 2003) the combined demand for products will be considerably increased compared to today.

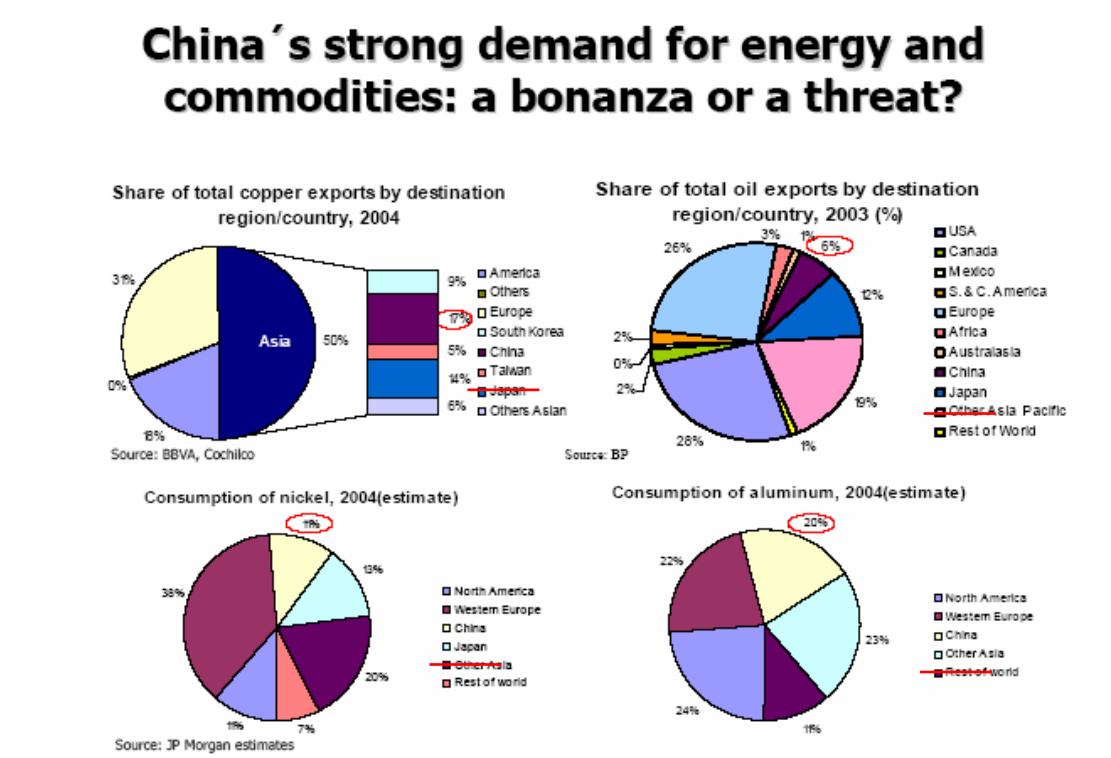

Figure 4: The size of China's demand for energy and commodities is currently in many respects similar to North America's. (Source: OECD, 2006a).

The *Commission for Africa* set out by UK Prime Minister Tony Blair (Commission for Africa, 2005) recognises that trade between Africa and China has increased dramatically over the last couple of years. During 2004 the trade reached over US$ 20 billion which is more that a 50 percent increase compared to previous year. The report on Africa identified some of the increased Chinese (and Indian) interactions with Africa, but China and India are in the report mostly referred to as developing countries that have succeeded in a number of economic and social issues.

So, in the report China is used for comparisons, comparing one developing country to an African counterpart, but China is also acting successfully in Africa where Western based corporations have pulled out for ethical reasons. E.g. when Western based corporations disinvested in countries ruled by oppressive regimes, like Zimbabwe and Sudan, China quickly took their place, buying minerals and oil as well as investing in the countries. Consequently, in the fight for resources there are other global actors that compete over natural and Economic resources such as in Africa and Latin America, setting new rules of the game. That could have been reflected to a greater extent in the Commission for Africa, which primarily was addressed to the G8 countries. If including the new powers in Africa like China then also theses countries could be admitted to participate in discussions on social and environmental responsibility in trade and investments.

This development of increased exports to China and India from Africa and direct investments from Chinese and Indian corporations into the African continent is, however, according to an OECD (2006b) study overall a positive development for Africa even though room for improvements exists with respect to exploitation of African natural resources in a sustainable manner. Other aspects of these new trade routes is that A) African trade moves away from OECD towards China and India, B) world prices on commodities like oil and minerals rise, C) commodities that could have been

used for Africa's economic diversification are now being used for the expansion of Asian competitors and C) as claimed by the European Investment Bank (EIB, 2005), due to the increased competition the EIB may have to apply other – read lower – environmental and social standards in some African investments in order to be competitive to Chinese contestants. The Swedish Daily Business Newspaper DI (DI, 2006) describes the Chinese proactviness as something that is seen as positive in Africa but that there is an inherent risk that these countries put themselves in a dependent situation characterised by huge debts to China. Huge debts from African nations have been revoked by China and the country constructs railway networks throughout (almost) the African continent. China imports cupper and oil which constitute 2/3 of China's oil imports predominantly from Angola and Sudan.

The rapid increase of car usage in China will, furthermore, greatly impact some key global resources in terms of size of availability and production capacities i.e. oil, aluminium, plastics and platinum-group materials. As shown in section PII.2.1. above the rapid economic increase in China will lead to an auto rate per capita in 2030 that is similar to today's ownership rates in South Korea. This will, besides consuming the global oil resources, give us some 360 million cars in the Chinese vehicle park as of 2030. This will require some drastic innovation to take place in the auto industry of tomorrow. One approach by Chinese authorities to solve the energy problem in the transportation sector is to create methanol and DME fuels from coal via efficient coal power plants that applies coal gasification. From that process is syngas retrieved which is the foundation for synthesising the methanol and DME. Another way of using coal as energy in the transport sector is to create hydrogen fuel for fuel cell engines, described below.

PII.4.8. Hydrogenised Transport Systems

The conclusion from the case of the future vehicle and transport scenario of the world – section PII.2.1. – is that the vehicle sector of the future will become fundamentally altered by the economic rapid development of China and India. The auto industry has, thus, to seriously address resource, environmental and health issues in their product strategies if they are to gain/keep market share in tomorrow's car market. Auto industry worldwide – design and assembly companies and auto-part firms – ought, hence, to consider following aspects: Decrease energy consumption of vehicles, decrease resource consumption put into vehicles, increase the resource efficiency in production-use-recycling, exchange materials in vehicles, develop new fuels, innovate new engine technologies, create new infrastructures of new fuels. Improving the resource efficiency in China's energy system, especially considering its energy imports is a prerequisite for maintaining the country's growth rate (Sandklef and Kiesow, 2006). These issues will demand fuel and engine developments, but importantly also the holistic perspectives of e.g. developing infrastructures, as well as supply chains, for new fuel such as hydrogen, which is really the paramount salient that has to be solved. The engine and fuel are only aspects in the new technological system and overcoming the social and economic barriers of energy supply to fuel cell powered cars will make the huge problem of switching between GSM and 3G look really insignificant (Cerin, 2006b)[13]. Also STEPS (2005) illuminates these huge obstacles in introducing fuel cells technology as *The Chicken and Egg Problem*,

[13] One cannot sell hydrogen powered cars when there is no supply network hydrogen fuel and it is immensely difficult to build a hydrogen supply network if there are no cars (market) that can be run on the fuel. Here technologies that are not as efficient i.e. the hydrogen internal combustion engine of BMW can bridge the fuel infrastructure problem since it can run on both hydrogen and petrol. The technology can then gain a competitive advantage by being first and alone when the energy supply network is not fully covering the transport system in which the resulting path-dependence may make it impossible for the competing technology (i.e. the more efficient hydrogen fuel cell engines) to gain access to the market (Cerin, 2006b).

where the major problems are about where to start from, who takes the first step and where the funding shall come from.

China has taken interest into fuel cell applications within the transport sector and is currently making its first steps in this direction by the use of fuel cell busses in Beijing, starting off at the Olympics 2008. The country is also to start series production of busses equipped with hydrogen fuel cell engines (STEPS, 2005). The prerequisites working for a Chinese system of hydrogen based road transports are:

A) the capability to enforce strict policies that steer the Chinese society into considerable changes as in the five year plans,

B) that the country and its major cities are experiencing some severe air pollution, causing health problems, from road traffic and coal combustion plants that need to be addressed,

C) the fact that most infrastructure in China, and India, needs to be created which provide room and incentives to go for new technologies and

D) the great abundance of coal that China has and the country is investigating how it can switch its oil dependence to produce hydrogen from coal.

Seemingly, there is a sizeable initiative taken in China to obtain a lead in innovating a hydrogen based transportation system – to solve foreign oil dependence, health and environmental problems and to create a competitive advantage for its industry. This development in China could also spillover, creating opportunities for other nation's with hydrogen transport related edge technological and system know-how, something for policy makers, e.g. Swedish and EU, to keep an eye on.

PII.4.9. Summing up on China

- The population of China just passed the 1 billion mark 1981 and will increase to 1.45 billion inhabitants by 2030 according to estimates. The largest impact on the environment and need for environmental technologies will, however, during the same time period be driven by A) the huge flux of people moving into the cities and B) the expanding economy that rapidly increases the buying power of the Chinese population.

- The internal migrations within China will increase the urban share of the population from 36 percent 2000 to 60 percent in 2030. The huge flux of internal migrators in China from rural (especially from the interior parts of China) to urban areas (especially the costal parts of China) will put huge demand on new infrastructures on piped water and sewage and treatment of wastes. The number of city-dwellers will increase by 340 million people as of 2005-2030.

- Other infrastructures that need to be invested in are the transportation systems in the cities. Currently, there are immense highway construction activities taking place in China. Between 2001 and 2005 the highway network of China more than doubled and Chinese authorities sees a future dense transportation network to be a keystone in its efforts to fight poverty in the nation. There will be enormous need to hamper the environmental effects that is associated with highway construction and heavy traffic emissions, especially in the cities containing several million inhabitants.

- According to Chinese officials some two-thirds of Chinese cities are considered air polluted and in an international comparison Chinese cities dominated the top ten positions of the most air polluted cities in the world. Half of the population lacks, furthermore access to clean water.

- In order to make China less dependent on oil imports for supporting the rapidly increasing road traffic system China is developing gasification strategies to produce synthesised liquid fuels i.e. methanol and DME for its vehicle fleet. Another strategy is to develop a hydrogen fuel cell vehicle park that is also based on coal as the primary resource of energy. The route that China eventually chooses will e.g. be important for the success of the alternative energy solutions that is under development in Sweden.

- The water scarcity especially in Northern China is a severe aspect for the supply to the major cities as well as the agriculture. Enormous efforts will be needed in e.g. how to reuse water resources and how to close industrial processes. Water scarcity in Chinese agriculture is of outmost importance. Chinese fields constitute only some 7% of global total but feed 20% of global population. The water scarcity problems of these high yielding fields are a prioritised area that needs to be addressed. Another threat is urbanisation leading to the destruction of farm land by city and infrastructure construction.

- Environmental concerns are rising in China and considered an important issue for the country's future development and prosperity as stated in e.g. the 11th FYP. The annual amount spent on environmental protection currently exceeds 1 percent of GDP.

- There are indications that China will be developing environmental standards and technical legislation on environmental issues that are ahead of corresponding initiatives within the OECD region. There are two main reasons indicated :

    - Aim #1: There are numerous severe environmental issues that China has to address relating to the historic environmental disorders that has to be repaired, but also the huge migrations to the urban areas and the economic boom of the country's inhabitants will put enormous pressure on resources, agriculture, infrastructure, pollution and residuals as well as human health. There are, thus, issues that need to be dealt with in China, that requires a standard and technological legislation that goes further than corresponding OECD policy approaches.

    - Aim #2: China is increasingly using standards and technical legislation for the purpose of putting barriers to foreign trade and competition since the Chinese adoption of the WTO agreements has made it difficult to utilise protective custom procedures and tariffs. There are claims that the soon to be implemented Chinese RoHS directive which goes further than EU's RoHS may not only be a case of concern for the environment but a strategic tool for ensuring Chinese competitiveness, both on the domestic market and abroad.

    - Outcome of aims: Whether Chinese officials are influenced by aim #1 or #2 or a combination Western policy makers ought to pay attention to the environmental policy and standard developments in China, since what ever the main aim is, Chinese environmental policy development may become a prerequisite for the competitiveness of many Western based companies in the nearby future both

within the Chinese market but also to markets being influenced by Chinese standards.

- China has a rather complete industry structure ranging from resource extraction of many important minerals and energy inputs, production of low –tech goods (i.e. apparel and toys), and increasingly during the last decade a producer of high-tech appliances (i.e. electronic equipment and vehicles). The expansion of the industrial production has increasingly become dependent on imports of input materials and with increased production comes a greater need for environmental protection measures. China is to create A) an innovation based economy that will make the country less dependent on industrious production, which then to a larger extent can be outsourced and B) a society with increased internal demand for goods and services. These circumstances will result in:
    - More severe resource scarcities in the world. To a greater extent recyclable and also much more resource efficient products and services have to be introduced on the world market since prices on resources will sour and some inputs that currently are considered readily available as will become scarce as some plastics already today.
    - Increased need for production technology process solutions in China as well as in the future outsourced production facilities outside China.
- In conclusion the major need for environmental technologies will arise from
    - internal migration patterns, creating highly densely populated areas in Eastern China, adding some 340 million to the urban population, and
    - the explosion in economic wealth with an expected doubling of the middleclass by 2020, reaching 40 per cent of the population, that can consume cars, white goods, electronics and other resource demanding gadgets currently unachievable for large portions of the population.

PII.5. India

India is experiencing a rapid economic growth, but the impact on global economy is not as significant as that of China. The reason is not only a lower economic growth (which in itself is considerable: a tenth of global economic growth) but India is relatively more closed economy with considerable non-trade tariffs trade restrictions to foreign competition. Despite this both India's exports and imports increased by one third as of 2004 and there are attempts to lower the trade barriers to the average level in South Asia (STC, 2006). According to the Swedish Trade Council the IMF estimates the Indian economy to play a dominant role in world economy ahead.

PII.5.1. In Brief

The Republic of India is the seventh largest country in the world in size but is currently the second largest country in the world population wise with a population on 1.1 billion inhabitants, only surpassed by China, but with a fertility rate above 3 India will encompass the largest population in the world before 2050. India is, however, already today the world's largest democracy. Having played a dominant part in entire historic time and being a subcontinent itself India encompasses cultural traces all the way back from the cradle of civilisation. Many religions have seen their birth here and e.g. Hinduism, Sikhism, Buddhism and Jainism but also Judaism, Islam and Christianity have long been a part of the Indian heritage. In fact, the influence of the Islamic leaders that conquered India prior to the era of European trading companies makes today's India the nation with the world's second largest Islamic population, after Indonesia.

India has a Westminster-style parliament. The Prime Minister is de-facto head of state, but the President holds the ceremonial role. The real power of the President is being the Supreme Commander of the armed forces. The President and the vice-President and the Prime Minister and his/her Cabinet of Ministers constitute the executive power. The legislating parliament is bicameral, consisting of an upper house and a lower house where the members of the former are elected by state legislative bodies and the latter by direct elections. The Supreme Court tests if the laws are in conflict with the constitution.

The country is divided into 29 states and 6 territories of the union. Each state has its own government while most of the territories have an administrator that is appointed by the central government. The judicial powers of the state government covers a wide range of tasks such as sales taxes, industry policy, rural development, employment, environment et cetera. India's economy is the 12th largest economy of the world in nominal GDP. If rating the purchasing power the country's economy takes the 4th place (IMF, 2006). The nation is the second fastest growing economy of the world with a GDP growth at almost 10% a year. The inequalities in India are huge with the top 10% of the population receiving one third of all income.

The governmental control over industry has traditionally been quite large resembling a blend economy of capitalistic and socialistic influences. Since the beginning of the 1990s markets have gradually been opened up for competition. More than half of India's working force (60%) is occupied in the agrarian industries which constitute only 22 percent of India's GDP. Less than every fifth person works in industry – i.e. steel, transportation equipment, cement, mining petroleum and mining – and a barely more every fifth person works in the service sector. The considerable Anglophone middle class of India constitute the foundation for the country's software industry selling research and programming to international corporations in both North America

and Europe. The software industry's expansion has led the service sector to constitute for about half of India's economy.

PII.5.2. Population trends of India

India has experienced an enormous growth in population since its independence for the British Empire. In 1947 India had some 342 million inhabitants, in 1991 the number of inhabitants had grown to 846 million and in 2001 the population of India had well passed 1 billion, namely, 1027 million inhabitants (Nagdeve, 2002). By 2025 there will be 1395 million and by 2050 India's population will total at 1593 million inhabitants, according to estimates (FT, 2005). The share of the Indian population living in urban areas was 1951 a good 17 percent and had increased to 28 percent in 2001 (Nagdeve, 2002) and the predicted share of developing countries' population to live in urban areas by 2010 is 40% which would be a doubling since 1950 when the share was below 20% (WRI *et al.*, 2002).

The urbanisation where humans are gathered in megacities containing more than 10 million inhabitants will lead to health problems due to an increase in the pollution levels and the intensified exposure to them that can lead to premature deaths (Nagdeve, 2002). Housing problems will lead to pollution related diseases like respiratory disorders, water borne pathogenics, and tuberculosis among others. Globally urban air pollution may result in 830,000 annual deaths due to particles and SO_2 (WRI *et al.*, 2002). The need for supporting infrastructure for these new urban settlers is, hence, enormous. But it is not only the flux of people moving into the mega cities that needs support. Water infrastructure has already today a deficient coverage in Indian cities where poor people often lack piped drinking water and sewage, forcing them to collect drinking water from the same waters that people are "forced" to use for releasing the sewage and industrial affluence. There exist, thus, severe health risks associated to these shortcomings of the evolving Indian megacities. Currently, tap water is available only to 35% of the urban population and sewage pipe coverage reaches only 18% of the urban population. Even though this coverage of urban population numbers seem low the situation is even worse in rural areas. As claimed by WRI *et al.* (2002) the e.g. lower access to adequate sanitation, better quality drinking water, health services and jobs in rural areas makes it worth moving into the cities. "The rural neglect" within the developing countries makes it attractive to seek for the better services in the city and even though the poorest inhabitants in the cities cannot access those *environmental infrastructures* (of safe piped water and sewage and waste treatment systems) the chances of getting access is better than in the rural areas.

India is, by the UN World Food Programme (WFP) displayed as, one of the World Hunger countries (UNWFP, 2006). According to them more than one third of the Indian population are food-insecure, that is consuming less than 80 percent of minimum energy requirements. A horrifying number of pregnant women, almost 90 percent, suffer from malnutrition and anaemia. Pregnant women that suffer from anaemia alone experience an infant mortality rate on 20 percent. To fight these food deficiencies the WFP has a number of objective to be carried out as: immediate food security for selected groups, ensure participation of women, advocate joint forest management, strengthen distribution channels for locally produced grains and increasing the agricultural production as well as creating employment.

PII.5.3. Deforestation and land degradation

Only about 5 percent of India's area is covered by dense forests and the protection of those is lax and forests are vanishing which has brought the condition in India closer to an ecological crisis (Nagdeve, 2002) if considering the unique wildlife in these habitats with e.g. elephants and big cats.

The modern agricultural methods have lead to over usage of both land and water resources as well as of pesticides and fertilisers which have increased considerably. The pesticides and fertilisers severely affect the water streams and rivers going through agricultural land. The extensive use of irrigation salinates the soil. Today's practices also contribute to soil erosion and loss of nutrients.

PII.5.4. Transports and urban areas

Transports have increased considerably in India and are nowadays the major source of air pollution in the country's mega cities. The air conditions get worsened by congestions, poor housing, poor drainage and garbage. The cars in the vehicle fleet are with almost no exception run on oil or gasoline. Combined, taken all together, these aspects create respiratory difficulties among people. The main pollutants from the road traffic are carbon monoxide (CO), oxides of nitrogen (NO_X), hydrocarbons (HC) and suspended particulate matters (SPM) and sulphur dioxide SO_2. The air related problems increases since the vehicle park constantly growths and especially fast is the growth in number of two-wheelers – in fifty years the numbers has risen from 0.27 million as of 1951 to 231 million as of 2001 (Nagdeve, 2002). Having the roads populated by two-wheelers may seem more resource efficient than having large cars clogging up the streets[14]. These small two-wheelers do, thus, pollute considerably more CO, NO_X, HC as well as suspended and particular matters, but also may also – to a varying degree depending on the fuel applied – emit sulphur dioxide (SO_2) and lead (Pb).

These two-stroke two-wheelers have created an enormous health and environmental problem that Indian officials have started to address by implementing stricter emission standards that can be met by the more expensive four-stroke engines. This move in emission requirements is not appreciated by the US agency that promotes US exports. It claims that the procedure for establishment of emissions standards was vague and lacked transparency, but the biggest concern is that *even* the US manufacturers and their applied technologies fail to meet India's requirements, thus, seeing it as a trade barrier to US industry (cf. US Trade Representative, 2006c).

> *The emissions standards seem to favor small displacement four-stroke motorcycles that are primarily manufactured by Indian producers. Even the latest low-emission technology used by U.S. manufacturers fails to meet India's requirements.*
>
> (US Trade Representative, 2006c)

The internal migrations towards the mega cities combined with the rapidly growing population is, hence, putting sever pressure on India's urban transport system. The health problems arising from air are most severe in the largest mega-cities. Today, there are 3 mega cities in India, i.e. really populous cities that each have a population exceeding 10 million inhabitants. There are currently about 35 metro cities in India, that is cities with more than 1 million inhabitants. In 2001 the corresponding number was 31 and it is estimated that by 2015 India will encompass 43 metro cities and by 2020 the country will have 51 metro cities (UNESD/PD, 2006; Nagdeve, 2002). According to the World Bank there will be about 30,000 pre-mature deaths each year, 17 million respiratory hospital admissions and some 17 million respiratory hospital admissions, not to mention all working days lost for all these people, due to the poor quality in the Indian cities. Some air quality problems are suspended particulate matters and dust-load. In fact, the dust-load in Indian cities is

[14] The two-wheeler fleet in India is, however, more polluting than the auto fleet since most of the two-wheelers are still driven by two-stroke engines and due to the fact that there are only two strokes in a full circle the exhaust has to go out of the cylinder at the same time as the cylinder is being filled with new gas and, naturally, some new unburned gas goes directly out together with the residuals from the former.

the highest in the world (The Tribune, 2005). The cause is seen to be traffic conditions but also deficient coverage of piped water and sewage as well as waste.

As in Mumbai, the slum-dwellers constitute 55 percent of the city's total population and half the population lacks running water or electricity. The emissions from the huge amount of two-stroke vehicles together with the smoke from several hundred thousands of open cooking fires, diesel buses and coal-fired plants have resulted in inversion-trapped air. Breathing this air of Mumbai is the equivalent of smoking a package of cigarettes a day (Abhat *et al.*, 2002).

PII.5.5. Pollutions from Energy

India is experiencing increased environmental effects from its amplified usage of energy. A major source of this pollution is from the combustion of coal, lignite and oil. Nationally the production of energy has increased from 5 billion kWh around 1950 to 380 billion kWh around 1995. At the same time thermal power has increased in importance while hydropower has dropped from constituting half of India's electricity supply to only contribute with one fifth of the total electricity produced around 1995. The size of nuclear power is only nominal compared to India's total energy production. The production of coal and lignite has increased more than 9 times between 1950 and 1995 to 292 million tons. The production of petrol has increased 22 times between 1950 and 1995 to 75 million tons. Per capita the commercial energy use has increased from 137 kg of oil equivalent in 1980 to 248 in 1994 and in 1996 the oil equivalent increased to 476 kg according to the World Bank's World Development Indicators (Nagdeve, 2002).

PII.5.6. Water Pollution

The rapid urbanisation will also demand more water for both industrial and domestic purposes. According to the WHO (1996) the Indian water pollution comes from three major sources and if adding one important source indicated by (Nagdeve, 2002) the four main sources of pollution to water in India is: A) domestic sewage, B) industrial effluents, C) leaking waste disposals and D) run offs from agriculture. The chemicals from agriculture that runs off the fields is estimated to poison more than 2 million people which results in some 20.000 deaths annually (WHO, 1996). Also religious practices are a source that contaminates the rivers. In India, shocking 70% of the available water is polluted and five states lack waste water treatment facilities. The city of Delhi, e.g. dumps 200 million of untreated sewage from its pipes into the nearby river, Yamuna, which has become one of the world's most polluted rivers (Nagdeve, 2002). There are numerous diseases that can be associated with water pollution. If taking diarrhoea and other gastrointestinal disorders as an example: it is estimated that more than 1 million children during the 1990's died from those diseases. But to increase the urban populations' access to sewage treatment to let 70% are investments that will cost the nation many tens of billion US dollars (cf. the China report by WRI, 2006).

PII.5.7. Summing up on India

- The population of India just passed the 1 billion mark 2001 and will increase to 1.45 billion inhabitants by 2030 according to estimates. The largest impact on the environment and need for environmental will, however, during the same time period be the huge flux of people moving into the cities and the expanding economy that rapidly increases the buying power of the Indian population.

- The internal migrations within India will increase the urban share of the population from 28 percent 2001 to 40 percent in 2030. The vast flux of internal migrators in India from

rural to urban areas will put huge demand on new infrastructures on piped water and sewage and treatment of wastes.

- Other infrastructures that need to be invested in are the transportation systems in the cities. Today, the numerous two-wheelers, foremost two-stroke engine equipped, that dominate the streets severely pollute the city air.

- As much as 70% of Indian water is polluted and some huge cities do not treat the sewage water before realising it. Water problems arise primarily from domestic sewage, industrial effluents, leaking waste disposals and run offs from agriculture.

- The dust-load in the Indian cities is the highest in the world and the estimated annual premature deaths in India are 30,000 due to poor air quality in the Indian cities and 20,000 people die from contaminated water each year.

- In Mumbai alone over half the population lack running water and electricity. Even though the coverage of these commodities is low in the cities it is even lower in the Indian country side. Therefore, huge efforts are needed to also supply the rural population with water, sanitation, electricity and telecommunications. For such applications both infrastructure developments and stand alone solutions will be needed.

- Agriculture and population expansion in combination with lax regulation decreases the few forests areas left India, encompassing some rare wildlife such as elephants and big cats.

Part III:
Comparative study on environmental policy-making processes for environmentally adopted solutions and technology transformation

PIII. Comparative study on environmental policy-making processes for environmentally adapted solutions and technology transformation

There are considerable differences in national approaches and corporate responses to environmental legislation and regulatory initiatives that may impact national competitiveness which is illustrated by Porter and van der Linde (1995a; 1995b). In short the Porter and van der Linde articles argue that industries in countries with innovation-friendly, but strict, environmental legislation may receive competitive advantages internationally. The writing can also be seen as a critical petition to the legislation processes in the US which is, according to them, characterised by harsh antagonistic behaviour between regulators and firms compared to the legislation process in Germany and the Scandinavian countries. Even though the legislative processes in Germany and the Scandinavian countries were to a larger extent characterised by collaboration between government and industry Porter and van der Linde saw that legislation requirements went further in these countries than it did in the US. The other result that the authors detected is that despite further going environmental legislation the German and Scandinavian firms seemed to gain a competitive advantage over the US firms.

These examples on European legislations are, according to this view, more cleverly designed, seeking innovative stimulus through flexible and long-term instruments. Porter and van der Linde (1995a; 1995b), moreover, provide the argument for a win-win situation for business to encompass environmental concerns. The basic notion is that any waste in production or throughout the value chain of the product should be regarded as economic waste. You do not want to use more resources or create more waste than absolutely necessary for selling one product or service.

> *In short, firms can actually benefit from properly crafted environmental regulations that are more stringent (or are imposed earlier) than those faced by their competitors in other countries. By stimulating innovation, strict environmental regulations can actually enhance competitiveness.*
>
> (Porter and van der Linde 1995b, pp. 97-98)

The last part of the quote is the essence of the Porter hypothesis (Porter, 1991; Porter and van der Linde, 1995a; 1995b)[15], also known as the Porter-van der Linde thesis (1995a; 1995b)[16], which states that well designed regulation (in the US) can increase competitiveness and encourage innovation. There is, thus, a win-win situation for firms to reduce economic waste and simultaneously improving its environmental efficiency of its activities. Legislation may, therefore, act not only as a force that goes against firm rationale and delimit company revenues. On the contrary, by applying this viewpoint environmental legislation is rather an institution that informs corporations on the unforeseen corporate benefits of caring for the environment especially by delinking A) resource use and pollution generation from B) profits. The role of legislation is, hence, in this contest a catalyst for innovation.

[15] A tem used by Ambec and Barla (2002).
[16] A term used by Palmer *et al.* (1995).

Environmental regulation that stimulates environmental innovations can, according to Porter and van der Linde be characterised by a number of principles. The eleven design factors for innovation-friendly environmental legislation are (Porter and van der Linde, 1995a):

- Focus on outcomes, not technologies;
- Enact strict rather than lax regulation;
- Regulate as close the end user as practical, while encouraging upstream solutions;
- Employ phase-in period;
- Use market incentives;
- Harmonise or converge regulations in associated fields;
- Develop regulations in sync with other countries or slightly ahead of them;
- Make the regulatory process more stable and predictable;
- Require industry participation in setting standards from the beginning;
- Develop strong technical capabilities among regulators;
- Minimise the time and resources consumed in the regulatory process itself.

Many of the features in the list above can be seen as a critique to the legislative process in the US at the time where industry and regulators acted as antagonists, resulting in stiff legislation not opting for industry's innovative capacities. The authors claim, as stated above, that the costs the regulative process in developing new regulations is more expensive in the US due to juridical struggles between governmental and corporate lawyers trying cut up-front costs while some legislative processes in Europe are claimed to be characterised by environmental and process experts trying to find solutions in a more collaborative way.

So, the North European legislation is to a larger extent influenced by long term goals that is designed more competently. It is taking the business cycles of industry into account, striving for long-term outcomes instead of aiming at strict short-term goals. Thereby, North European industry can make long-term plans that influence the technology choice when investing in new production method or developing new products. The argument follows as with the earlier writings of Porter that industry in a nation that faces harder conditions have a competitive advantage when competing on the international market. This would, hence, also be the case with stricter environmental legislation that is, as Porter and van der Linde put it, slightly ahead of other nations' legislation. This argument constitutes a good reason for studying the competitive advantage industries of some pro-active countries may experience due to well-designed legislation.

But, before going to specific proactive countries and their environmental legislative procedures there exists some critique that is worth mentioning. Massive critique has been raised on the theoretical arguments and the empirical soundness or a lack of thereof by Palmer *et al.* (1995), Jaffe *et al.*, (1995), Faucheux and Nicolaï, 1998, US EPA website (2003) and Swedish EPA report (Cerin, 2005). The critique involves another front as well, namely, the danger of indulging industry and the public into the beliefs that environmental improvements are not costly which may prevent expensive environmental measures from taking place. The empirical evidences supporting the arguments of Porter and van der Linde (1995b) have been criticised already from the beginning, in the same number of the journal, by Palmer *et al.* (1995). They surveyed firms that had been affected by environmental legislation and found increased costs for most of them even those that had been

referred to by Porter and van der Linde as success cases. Also the report by the Swedish EPA (Cerin, 2005) criticised the theoretical discussion of Porter and van der Linde as being to thin, not considering asymmetric information, transactions cost and property rights of agents over the value chain to satisfactory, which had led to over simplification in reasoning and generalisations in conclusions.

However, despite the critic on these seminal articles by Porter and van der Linde, many critics show some support to the work. Especially the aspects of the articles concerning incentive schemes for spurring innovations and gaining a competitive advantage on the international market have won receptive ears among companies, legislators and NGO's, even though some regards the costless claims of environmental legislation to be built on lose grounds.

Dobers (1997) describes the actual policy process as a market a pre-market where actors compete to get the best roles of the game, that is the game to come. According to Dobers these markets drive technological change and work as means of diffusion. Taking this line of reasoning one step further: Being successful in the legislative process then the process itself ends up as the disseminator of technologies. If an actor is able to steer – influence – the legislative process into a direction that fits the abilities of the actor it will provide a competitive advantage for the actor. If the actor is extremely successful then the actor has created a regulatory supported path-dependence that encompasses the offerings and specific know-how of the actor itself.

Since, in the beginning of a policy creation process there is limited reliable information about the different technological choices possible the decisions by involved actors may be characterised by bounded rationality, using simplistic decision models to cope with a complex environment (cf. Simon, 1955), which gives the actor that has information advantage some opportunities. Establishing a path-dependence creates an enormous competitive advantage for the actors whose technology is dominating the market segments even though other solutions may be better technically, economically and environmentally (cf. Nelson and Winter, 1982). So, if following these thoughts on industry evolution the industry adoption process – starting point as well as noise from unintended occurrences – is vital for the final outcome in the market and as Dobers has shown, which too often is overseen, is that this struggle over path dependence s, especially for environmental and health matters, may start early in the regulatory design processes. On top on this in this section of the report, discussions are also made on C) the policy making process that takes place aside from authorities in Japanese conglomerates and D) examples provided on policy measures taken on renewable energy power generation around the world.

Now, after this theoretical discussion let's take a closer look at the policy-making processes for environmentally adopted solutions and technology transformation by examining two cases A) the introduction of the three-way catalytic converter (in California, Japan, USA, Chile, EU, Germany and Sweden) and B) the collaboration between ministries, industry associations and telecom industry (operators and manufacturers in Japan) to see how the theories connect to the cases described. Both cases have a strong Japanese focus.

PIII.1. Environmental Policy Making Processes in Japan – A case of East Asian corporatism

The rapid economic development in Japan has evolved the country from severe poverty levels since the end of the post-war occupation – as of 1952 – to an economic world power. Japan has the highest average post-war (WWII) GDP growth counting from WWII until today. One drastic slowdown in economic growth occurred during the aftermaths of the oil crises in the mid 70's. The otherwise huge economic growths in the 60's, 70's and 80's slowed down remarkably again in the 1990's and turned into economic recession by the turn of the millennium. Recently, the economy recovered and the economic expansion in Japan is now once again surpassing the GDP growths in many other industrialised countries. Japan is a predominant trade country and its largest export markets are USA and China followed by, but at considerably lower levels, South Korea, Taiwan and Hong Kong. Japan's largest import partners are China and the USA.

Japan, one of the world's leading industrialised countries in the world, is a dominant player in international trade and one of the most advanced producers of products of motor vehicles, electronic equipment, machine tools and chemicals among many other sectors. The automotive and electronics industries are often considered the largest sectors in Japan and constitute a major driving force in Japan's industrial sector. Some other industries worth mentioning of importance are service sectors like banking, transports and telecommunications.

The successes of these industries are, thus, of great importance for Japan and it is therefore, interesting to see how the Japanese policy making process works. How are the policy makers a developing policies that delimit environmental harm without intruding on the success of Japanese exports?

As detected by research, e.g. Bauner (2004), Broadbent (2003), Edman (2003), Japanese policy makers include and collaborate closely with its domestic industry in the policy process, often through industry associations. In this, one could find support from the Porter and van der Linde arguments concerning industry participation. However, when comparing the situation of one country to another; one should pay sincere attention to the cultural and natural (i.e. ecological, resource and pollution) conditions since these may be paramount in detecting the causes of human interaction and resulting activities.

One characterisation of Japan's society is its corporatism[17]. The country's East Asian type of corporatism is to a much higher extent integrated by social networks even compared to the

[17] The term corporativism can be interpreted in various ways, either as A) a holistic term for different sorts of corporatism or B) a label for the historic view on corporativism which is a society form where the legislative powers belongs to assemblies constituted by various civic groups such as economic, industrial or other types of groups. In this case, however, it is the East Asian state corporatism that is of greatest relevance in order to understand the society structures and the interactions between actors. The East Asian model is characterised by governments that use organisations that have a somewhat semi-official status as means for industry and society interaction. In the case of Japan there is some culture – in society in general and particulary in the contracts between state, industy associations and individual industry firms – of obeying state officials as a relic from the period (pre-1945) when the state official was a servant of god – i.e. the Japanese Emperor – whose directives he handled down. However, this tradition seems to weaken slowly over time (Broadbent, 1998). The political system or societal arrangements of small northern and western European countries can be termed neo-corporatism which is characterised by negotiations between three parties: the government, industry associations and labour unions but serves merely as a mean for dividing capital among them.

European varieties that exist in Austria and Germany[18] (cf. Broadbent, 2003). According to Broadbent and Ishio (1998) Japanese business sectors do merely have quasi-autonomy from Japanese ministries and the industry sectors cannot be viewed as a class of entirely own self-interests. This so-called business-state integration is one reason for swiftly turning around Japan in the 1970's from a country with severe environmental problems to become a proactive nation in managing environmental aspects. Calder (1988) has a similar description of Japanese policy development during crises where pro-environmental agencies provide necessary policy suggestions.

Accordingly, the Japanese policy process may not just be copied by Western economies without paying large concern to cultural differences such as the natural hierarchy and the loyalty to personal and organisational networks as well as the conformity in these networks to accept the official form (Lebra, 1976) which makes the implementation of environmental policies from government to businesses a more straightforward process (cf, Nankane, 1970). It is, moreover, shown by Bauner (2004) that the Japanese legislators consulted Japanese auto industry and adjusted phase-in periods as well as technology solutions to the needs and capabilities of the domestic industry. Edman (2003) illustrated, furthermore, that Japanese ministries collaborated with the industry associations of cellular phone producers and telecom providers to establish a take back system for recovery of used terminals.

Another aspect that differ countries in their environmental policy development processes – such as how the participating actors behave – is the influence of natural and social intensities of pollution (Broadbent, 1998). This can be seen in the policy processes where initiatives to diminish air pollution from road traffic is driven by areas of severe air conditions like the regulations to improve the air qualities of the Los Angeles, Santiago and Tokyo areas. So, comparing policy processes of different nations have to include both cultural and environmental perspectives.

PIII.2. CASE: Policy Processes in Vehicle industry – Introducing the Catalytic Converter

PII.2.1. The Budding of Japanese Environmentalism

Due to the economic post-war boast in Japan the domestic standard of living rose rapidly and reached levels similar to those in Europe and USA. As a result, vehicle fleets, distances travelled and the congestions intensity increased considerably as well as the associated environmental problems, but so did also the environmental effects from industrial activities. Between 1955 and 1970 the demand for energy more than fivefold and the sulphur dioxide emissions consequently did so too in 1968 (Bauner, 2004). As a result, environmental awareness and public support for stricter environmental regulation grew which resulted in the creation of the Japanese Environmental Protection Agency in 1971. The first task of the agency was to implement stricter regulations for abating emissions from vehicles and industry.

[18] Another type of policy process struggle: As described by Böcher and Töller (2003), there are other actors than those fighting for dominance (e.g. establishing technological path-dependence) in the environmental policy landscape, but fighting for creating new policy mindsets. In Germany, identified as the environmental policy pioneer in Europe (cf. OECD, 2001), drastic changes in policy ideas was permeated into policy instruments during the 1980s and 90s moving regulatory instruments from command-and-control towards eco-taxes and voluntary agreements. A prominent name in the push for this alteration was von Weizäcker and such agent are in the paper labelled the *Policy-entrepreneur* which is an actor that is devoted to a policy idea and place in vital role in altering the policy process.

The Swedish expert on the introduction of vehicle catalytic converters, David Bauner (at Industrial Economics and Management, Royal Institute of Technology), has studied how the Japanese policy development followed the US, and especially the Californian, regulative initiatives closely but, in interaction with the of Japan's auto industry to incorporate domestic industry prerequisites (cf. Bauner, 2004). His research has followed the private and public dependencies in creating emission abatement systems for the automotive industry.

PII.2.2. Policy Developments in California, Japan, USA and elsewhere

The American Muskie Act, denominated after Senator Muskie whose bill was passed by US Congress in 1968, for delimiting vehicle emissions greatly influenced the goals of the newly established Japanese Environmental Protection Agency. In fact, Japanese regulators closely followed the US vehicle policy development for vehicle emission control systems and especial concerns were paid to the Californian regulatory initiatives. The Japanese Environmental Protection Agency arranged hearings on the three-way catalytic converter with domestic Japanese car manufacturers and Japanese university professors to get a clear picture on the state of vehicle emission control technology in the country as of early 1975.

When governmental officials in 1975 realised that the domestic vehicle producers were not going to be able to meet the stringent NO_X emission targets – requiring a 90% reduction of NO_X emissions – for 1976, the bill became postponed another two years until 1978. The Japanese regulators realised, consequently, that the NO_X abatement targets would be out of reach in the short time span without the three-way catalytic converter solutions.

By 1978 these solutions would be accessible to most Japanese vehicle manufacturers, however, not industrialised by all. This delay can be seen as an attempt to incorporate the investment cycles in industry, taking into account that the, at the time, current catalyse technologies available just could not do the work. The Japanese requirements on three-way catalytic converters were implemented one year after corresponding Californian requirements, but well ahead of corresponding US national emission standards coming into effect as late as 1983.

The US legislation was, thus, implemented after a decade of negotiations between governmental bodies, industry and NGOs (Bauner, 2004). The policy process was trichotomised between federal authorities, vehicle manufactures and NGO's communicating partly through legal processes (Grad *et al.*, 1975). The Japanese firms, however, saw the potentials for rapidly increasing exports and recognised the growing public concern in the US for the increasing emission levels arising from traffic. This concern became legislated in California which was closely followed by Japanese legislators. In fact, by following the Californian regulative initiatives for introducing three-way converters Japan got a go-ahead start internationally, also compared to the big three automakers in Detroit. Californian legislators put the local environmental concern foremost, whose air pollutions was more severe than elsewhere in the US, and had less concern for the US (domestic) auto industry. The arguments and concerns of the big three automakers, being based in a city faraway in the American so-called Rust Belt, did not have the same closeness to the Californian public concerns as the urban air conditions of the state's major cities worsened.

The antagonistic process between federal legislators and the US auto industry, shown above, links rather well with the American policy process criticised by Porter and van der Linde (1995a; 1995b), seemingly leaving the US industry and public authorities with considerable legal process costs, but even more burdensome a competitive disadvantage compared to its Japanese contenders. The legislative advantage for Japanese auto industry for competing in the international arena is well

illustrated in the table of three-way catalytic converter introduction by markets below (table 3), based on Bauner and Laestadius (2005) and Bauner (2004):

Table 3: Ascending chronological order of policy supported introductions of the three-way catalytic converter in selected world markets.

Regulative Area	**Year**
California	1977
Japan	1978
USA	1983
Germany	1989
Sweden	1989
Chile	1993
EU	1995

If looking globally at the introduction of the three-way catalytic converter we see that Japanese legislators quickly followed the Californian lead. Japan did not only follow the Californian legislation on catalytic converters, but was also on the cutting edge on reducing emissions from passenger cars by adopting and adjusting the *Muskie act* adopted by US Congress 1968. This adherence to the development of US policy measures has an explanation in the expansion of Japanese domestic demand for vehicles as well as the expansion of its auto industry production (cf. Bauner and Laestadius, 2005). At the time Japanese auto industry export was restricted to Asian markets but the country saw the potentials in penetrating the North American passenger car market.

Except for the resistance of the US auto industry the introduction of three-way catalytic converters the introduction of the new technology was also stalled by an unresolved gas issue. Until recently lead has been added to gasoline for lubrication purposes as well as for superior octane figures, but Japan pioneered in phasing out the lead content in petrol for environmental reasons during the early 70's and the toxic metal was phased out already in 1974 (Bauner and Laestadius, 2005). The public opinion was supportive to these measures, although the refinery industry manufacturing gasoline was somewhat more reluctant. The collaboration between legislators, industry (i.e. gasoline producers and distributors and vehicle manufacturers) and other stakeholders was, accordingly, of cooperative nature and information was traded among the involved actors.

The early de-leading of petrol that took place in Japan is in fact a removal of one important reverse salient that obstructs the introduction of a technology. As described by Hughes (1992) the change of a new technology may be hindered by conditions that reside outside the thought of application that is to be introduced. These, reverse salients – in this case the supply of un-leaded fuel for three-way catalytic converters – that are a part of the wider system has to be identified and addressed if a change is to take place. Even though they may at first sights appear insignificant their presence can constitute the critical problem that stalls changes of greater magnitude. So, the introduction of the three-way catalytic converter was dependent not only on government initiatives and vehicle manufactures, but also the solutions enabled by the automotive component manufacturers (like catalytic converters), oil refiners and fuel distributors.

PIII.2.3. The Chilean Context

When looking at how the Japanese and US automakers and governments dealt with the introduction of the three-way catalytic converter in South America the process in Chile constitutes a good example how different approaches to environmental technology may affect tomorrow's

market shares. Besides, Chile is the South American market that first enforced policies on three-way catalytic converters and, consequently, also on unleaded fuel. In fact, when the first democratically elected government took over the Pinochet junta in December 1989 the new civilian Minister of Transport found a signed document of its predecessor and Pinochet. The proposal applied the emission requirements on vehicles. The newly elected Chilean government, however, had to rework the proposal for legitimacy reasons (since it could not officially use a proposal from the former undemocratic regime). Because, the foundation for the proposal was already done the work with implementing the new proposal went fast, although obstacles existed.

The Chilean authorities applied a remarkably short phase-in period for the three-way catalytic converters, and the authorities could draw on the experiences from markets already having introduced catalytic converter requirements. By 1992 new cars in the capital Santiago and other heavily populated areas in central Chile were equipped with the catalytic converters. In 1994 it became mandatory for new cars nationwide to be equipped with three-way catalytic converters.

There where no domestic Chilean car manufacturing industry in the country at the time, but the policy process got resistance from France and the USA since their auto industry have auto plants in Argentina and Brazil, seeing the Chilean market as an output for their production. Consequently, the Ambassadors of France and USA paid visits to the Chilean presidential palace, explaining the need to halt the process of introducing the catalytic converter in Chile (with requirements similar to those in the US and some European countries.). The reason for their objection is that the auto plants of e.g. GM and Renault was producing cars exclusively for the South American market where no such restrictions were in place. It would thus be expensive for these manufacturers to change the production lines in these factories only for the Chilean market. The policy process in Chile should hence be slowed down (Bauner and Laestadius, 2003).

The Chilean policy process was despite these attempts not stalled. This can be illustrated by the number one selling car on the Chilean market 1991, Chevrolet Chevette, which was withdrawn from the Chilean market the following year due to inability to change production in time (Bauner and Laestadius, 2003). It was difficult for them to ad the cost of a catalyst to the end consumer. The situation was completely different for Japanese auto manufacturers. They did not have any production in South America adjusted for a non-catalytic vehicle market. Before the stricter emission standards in Chile, it was expensive for Japanese car manufacturers to sell vehicles to Chile since – due to the lead content in gasoline sold in Chile – Japanese auto makers had to make modifications backwards by taking away the catalytic components. As a result from the introduced emission standards in Chile Japanese auto makers quickly gained a large share of the rapidly growing Chilean vehicle market. Linking back to Porter and van der Linde (1995a) the phase-in period of the three-way catalytic converter policy process was long enough for Japanese firms to quickly supply the market with products fulfilling the needs. The US counterparts, however, needed more time for adjusting their production processes and lost considerable market shares. Some of the valuable phase-in period was, instead, spent in opposing the Chilean legislative process.

PIII.2.4. The European Context

Swedish three-way catalytic converter legislation was, heavily, influenced by the developments in the EC and by German initiatives. The process towards unleaded fuel and three-way catalytic converters was slow in Europe where nations tried to block tightened emission standards to defend their own domestic auto manufacturers. When Germany threatened to introduce unleaded fuel and catalyst requirements unilaterally 1983, the European Commission agreed on a directive the following year.

So, in 1985 Germany announced the directive that will require all new gasoline-driven vehicles had to comply with the US EPA-83 regulation. In Sweden, the fear of going ahead of other European countries and introducing petrol not available on the European continent was now relieved, and unleaded petrol was made available on the market (Bauner and Laestadius, 2005). In order to support domestic car manufacture interests the three-way catalytic converter on new cars was not made mandatory until 1989, but rebates on car price tags were awarded those that bought a car with catalytic converters during the phase in period between 1986 and 1989. Germany introduced a program for tax rebates, both for new cars and for simpler catalytic converters to be installed on cars already in use.

PIII.2.5. Behaviour of Industrial Actors

In the Californian policy process the US automakers declared the demands in producing such cars to be unrealistic. Volvo was then a small player in the Californian market and saw, thus, an opportunity to gain market share as well as improving its reputation as a European luxury car maker taking social responsibility. Together with German based mechatronic company Bosch and US based catalytic converter company Engelhard, Volvo developed the three-way catalytic converter. Volvo then demonstrated, to the US Senate that – unlike the claims of US auto makers – it was possible to produce such a cleaning solution. In the Swedish market, however, Volvo did not make use of such a proactive strategy. On the contrary, later during a similar legislative process in Sweden Volvo took a position comparable to the one that the American car producers took in California. Volvo, thus, opposed the converter requirements on cars in Sweden which delayed the implementation of the requirements for a few years (Cerin, 2005).

Why this apparent inconsistency in approaching the comparable regulatory process in different markets? Well, as described in a Swedish EPA report (Cerin 2005), in the Californian market, Volvo was a small premium player, being able to pass on the extra costs for catalytic converters to the customer and even earn an extra premium on its new exclusive environmental image. Sales can boost (still residing within a distinctive niche of the market) with increased premium appeal. In Sweden Volvo was the dominant player with a share on about one fifth of the total market and could not pass on the costs to a large mass of not so concerned customers. Volvo had, therefore, in Sweden to compete in (mass) segments with generally lower prices and the customers prepared to pay extra for a better environment represented a relatively small group compared to Volvo's existing market share.

Looking back at the Porter and van der Linde (1995a; 1995b) view that lax legislation would hamper environmental technological solutions seems not always to be the case. Volvo placed itself on the technological frontier in the anticipated US and Japanese markets that had much stricter regulations implemented. The Swedish car manufacturer engaged small technology companies for catalytic converter system development, held several patents and got well ahead of many competitors several times larger than Volvo (Bauner and Laestadius, 2005).

So, the corporate strategic evaluation of the future conditions of anticipated future regulation and restrictions in the company's (potential) markets seems to be decisive for the environmental business proactiveness of the company. The aspect whether domestic environmental regulation supports large companies in this undertaking may not be equally important. In this exploration of market potentials in foreign markets as well as incentives for technological innovation Japanese firms had benefited from the domestic regulation process while the Swedish manufacturers had not the same early support from environmental regulations. The support from the Swedish policy process was a late and silky introduction of catalytic converters on the home market by during the

first years using tax relieves instead of mandatory requirements on consumers buying new passenger cars, but not really supporting innovations for a competitive advantage abroad[19].

PIII.3. CASE: The Policy Making Process in Telecommunications industry – Japan

The communication between individual companies and policy makers is rare according to Edman (2003). Industry's views are represented by industry associations instead. These associations work as intermediates negotiating with policy makers at governmental bodies. If the government wants to retrieve the views of certain companies then the contacts, according to Edman, go through the industry association requesting it to extract answers for the respondents from the government. Edman, moreover, found that the associations themselves believe they retrieve not enough feedback from this process.

If looking specifically at the policy process to develop regulations for recycling terminals, phone units, within the Japanese cellular phone industry there are two key industry associations that negotiate with authorities. One of them is the association of manufacturers, CIAJ, and the other one is the association of operators, TCA. These industry associations also, apart from policy development discussions, are also keeping track on international standards and regulations for harmonisation purposes (Ashford, 1993; Edman, 2003). These information bridges (cf. Cerin, 2005) also enable the collection of information for the actors in the policy process such as collection and recycling data of cellular phones.

Besides being an information bridge between government and industry sector the industry associations may take an active role in establishing environmental programs such as in the case of recycling of cellular phones in the telecom industries where the associations of operators and manufacturers worked together (Edman, 2003). Also the Japanese Ministry of Economy, Trade and Industry (METI) expressed in the strength of the collaborative nature between ministries and industry associations. According to METI itself it does not communicate directly with manufactures and operators. Instead the ministry communicates with industry association that also provide the ministry with company stances in return.

Fiscal support to individual companies is not common but Japan has semi-governmental banks where SME's can apply for funding. The aim is to maximise public utility and interest through investments in production facilities or technology. Also this process, according to Edman's interviews (2003), is carried out in collaboration with industry associations. The ministry (in this case METI) believes the industry associations collect a better picture and constitute a superior

[19] Relating to this case for lax Swedish environmental policy development in the auto-industry is the case of chlorine free bleaching in the Swedish pulp and paper industry. For a decade Swedish pulp and paper industry apposed strong public opinion against using chlorine bleaching, since it would both be costly and of lesser whiteness. In the small European neo-classic corporatism both industry and unions were against the creation of policies restricting the use of chlorine and the Swedish EPA was not supportive to chlorine-free paper. An NGO, however, got the association of municipalities in Sweden to influence its members to only procure copy paper that was no-chlorine bleached. One producer took the bate, changed production technology and received huge market shares of premium character on top of that. Consequently, after one year all major producers of copy paper that had claimed the impossibility of producing chlorine-free paper had such *environmental* products on the market. This process provided the Swedish pulp and paper industry a competitive advantage. Porter and van der Linde (1995a), however, erroneously claim that this is a case of clever and flexible Swedish legislation (cf. Cerin, 2005).

devise for permeating the view of the ministry. Industry associations are in general good followers of government directives. The ministry sets up councils compromised by authorities, industry representatives, and so-called talented people. The ministry does, however, in practice tend to supply the committee with guideline drafts to be processed in an authoritative manner.

The experience among the interview corporations in Edman's study, on the collaboration between industry and government, support the view of ministries and industry associations displayed above. NEC for instance is a member of many industry associations and competitors share information with each other at these meetings and NEC too discloses information about their environmental aspects. Not only companies attend the meetings, as shown above, but government attends and shares information regarding coming legislation proposals. According to NEC, government and companies cooperate to find room to establish new technological solutions as well as finding market opportunities for those. SonyEricsson's experience is that they do not receive feedback from government directly but the association of Communications and Information Networks provides a forum for retrieving information from governmental bodies. The industry association also requests SonyEricsson to write reports as input for the association's communication with the government.

Despite this collaborative environment among ministry, industry association and companies, the environmental proactiveness varied among Japanese telecom providers. The NTT DoCoMo is a well recognised leader for its environmental proactiveness globally and the second largest player, J-Phone, is increasingly taking a proactive stance, but other operators in Japan have not reached as far. This could, however, be more a reflection of company size since the other operators are small compared to NTT DoCoMo (58% market share) and J-Phone (18%) market share, leaving the rest with small pieces of the pie. Company size is, as the Swedish EPA report (Cerin, 2005) explains, decisive for likeliness for a company to be able to engage proactively in many environmental issues.

PIII.3.1. Recycling of electronics

Considerable amount of Japanese electronics firms of which some produce cellular phones have been recognised for their work with environmental issues such as Sony and SonyEricsson by Greenpeace (Greenpeace, 2006) and NEC by Technology Forecasters (Gordon, 2006) even though the Japanese consumer electronics firms were still behind their European counterparts, on for example recycling, a couple of years ago which was considered a problem that needed to be resolved due to the limited availability of landfills in Japan (cf. Edman, 2003). Estimates indicate that Japan will run out of landfills by 2008 and this obstacle has now been aggressively addressed in Japan both in the design of electronic goods, home appliances among several other products – design for environment – as well as recycling facilities – recycling technologies. Today, Europeans go to Japan to study recycling facilities (Gordon, 2006). Examples on innovative solutions where Japan is several years ahead of competitors on the global market are gas-electric hybrid vehicles, unleaded and unbromided electronics and circuit boards without bromide and recycling technologies, all belonging to product groups that constitute a significant share of world trade figures. According to Gordon this aggressive greenness strategy of Japan and its companies will give and already have given them a competitive position in the increasing market for products and services that enable a more environmentally sound solutions.

PIII.4. The Policy Making Process in a Japanese Conglomerate

Top management commitment is a prerequisite for company engagement in evolving new technological solutions as well as being proactive in the legislative processes. The pro-activeness in policy processes is also depending on company market capitalisation size and, of course, the size of its revenues. A blue-chip multinational company whose top management is committed to environmental issues has an advantage over competitors in retrieving of good picture of the future international needs of people (consumers) and environment as well as going from there to explore new solutions both to services offered and to policy makers. These companies influence both competitors in the industry – horizontally – and upstream in the supply chain – vertically. Through horizontal competition and vertical pressure the advancing company may, thus, create an upstream change that involves firms of considerably smaller size on the global scene. The advanced company may also play the role as providing the legislator with possible solutions.

One company, being the forerunner in many environmental aspects is Toyota i.e. on three-way catalytic converter, hybrid engines and fuel cells. Toyota has also created a research institute – Toyota Genesis Research Institute established 1997 – to collaborate with research institutes world-wide to serve the long-term interests of humanity. The institute makes global social forecasting and the results are used for carrying out research together with universities research institutions as well as with Toyota Technological Institute and Toyota central laboratories. The outcome shall contribute to the world in a broad range of fields and projects that the Toyota group is facilitating. Questions that the Genesis Research Institute is working with are "Will cars run on gasoline in the 22nd century? How much of the Earth's forests will be left? What will be the average life expectancy? Will Japanese people still be eating rice? Will any of us still be wearing cotton clothing? Will the sun still be shining brightly above us?" (Genesis Research Institute, 2006). Such questions could then permeate e.g. through facilitation projects, into the product strategy of Toyota.

PIII.5. The impact of Company Size when Comparing Policy Processes

Japan is often referred to when it comes to big leaps in environmental technology such as the development of alternative engines for vehicles like the hybrid and fuel cell engines. An ITPS report (Andersson and Tanaka, 2006) describes the successful environmental strategies in Japan where the applied broad definition of environmental technology is seen to have lead to innovations of greater magnitude. It is, however, important to consider the size of these Japanese conglomerates and their access to capital for research, before expecting similar scope and results from the Formas-Vinnova programme with an annual budget on SEK 30 million that is to be matched with industry funding.

Large corporations may have the strengths to develop strategies ahead of national legislation, but this does not appear to be common practice in the domestic markets where the large corporation is the dominant player. One such case is Volvo which took a lead internationally on the three-way catalytic converters. The pulp and paper case shows that a small player in a domestic market – like Volvo in a foreign market where it is a niche player – can be the actors that go ahead of legislation. In Sweden Munkedal was a niche player in its domestic market, but saw the potentials of first mover advantage in supplying the market with non-chlorine bleached paper. The common issue in the two cases is that legislation did provide the support for retrieving a competitive advantage on important markets.

As shown in the catalytic converter policy cases above, however, the Japanese policy process was characterised by close cooperation between government and industry through industry associations where the legislators worked for retrieving a good picture of Japanese technology and their status compared to international initiatives. The Japanese legislators quickly adopted the Californian emission requirements and implemented similar standards just a year after and Japanese car manufacturers have gained competitive advantage in many markets worldwide.

Two aspects that policy needs to deal with and to create an understanding about is

- seeking export opportunities of environmental technology
- the institutional picture – power relations, asymmetric information, cultures of actors, institutions and society structures of different nations.

Even though a critique is brought forward so far in Part III on Swedish legislation, there are of course positive sides as well but the greatest leaps forward can be achieved by highlighting some aspects that can be improved for increasing Swedish competitiveness in the international scene of environmental technology.

PIII.6. Renewable energy and power generation policies

About 17 percent of the world's primary energy is constituted by renewable energy sources. Large scale hydro plants, traditional biomass plants as well as newer supplements i.e. small hydro, modern biomass, wind, solar, geothermal and biofuels.

Internationally the most renewable energy policies were created during the late 1990's and early 2000's and these measures have generally exerted significant influence on the creation of renewable energy markets. As also shown above in the report policies for addressing environmental aspects have significant impact on the development and dissemination of renewable energies (cf. also REN21, 2005). However, most analysts do not recognise the magnitude of governmental support for renewable energy in many OECD countries. Countries and markets with strong solar power policies are Germany, Japan, South Korea, Italy, Spain, but also China and California (cf. Stauffer, 2005). One example, provided by Stauffer, on such is Germany where utilities have got a price on 70 cents/kWh for photovoltaic generated solar power which well exceeds the estimated 40-50 cents/kWh costs for producing it.

The International Energy Agency (IEA) has, however, stressed that a single policy will not make a change but a set of policies are often required (Sellers, 2004). Having set overall policy targets are seen as important for the assurance of longevity and predictability of policy support and by 2005 some 43 countries had national targets for renewable energy supply (REN21, 2005). Notably all EU-25 countries had set targets but neither the USA nor Canada had come up with something similar, nationally. However, some 18 US states and 3 Canadian provinces in have taken the lead in North America with set renewable portfolio targets.

Most renewable energy targets are set for the 2010 or 2012 and some countries have goals for 2020 as well. Among the 43 countries around the world that have Renewable energy targets 10 are developing world nation, encompassing the vast spurring economies of Brazil, China and India. The targets for these latecoming economies, the EU and the USA are (REN21, 2005):

- **Brazil:** As of 2006 shall 3.3 GW be from wind, biomass and small hydro be added.

- **China:** As of 2010 shall 10% of electricity (of expected 60 GW) originate from renewable energy, and 5% of primary energy originate from renewable sources. By 2020 shall 10% 5% of primary energy originate from renewable sources

- **EU-25:** As of 2010 shall 21% of electricity originate from renewable energy, and 12% of primary energy originate from renewable sources

- **India:** As of 2003-2012 shall 10% of all added electricity (of expected 10 GW)

- **USA:** No national targets, but 20 states have targets ranging between a 5-30% renewable energy share of electricity.

So, this little exposé of the economic superpowers of today as well as tomorrow indicates that there is a global market for renewable technologies with huge growth potentials. A few EU-countries Germany, Spain and Denmark have, moreover, implemented feed-in policies that have really spurred innovations and investment activities, according to REN21 (2005) as well as raised the attention and interests towards renewable energy generation. In Germany, for instance, renewable energy generation have under the feed-in policies more than doubled in merely four years from 14 TWh (in 2000) to 37 TWh (in 2004). The USA was actually the first country to adopt feed-in policies for renewable energy in 1978, but those policies were terminated in the 1990's. Unlike Germany, Spain and Denmark, Sweden has not been a forerunner in this policy area and adopted its first feed-in policy 1998. These national feed-in tariffs differ are differently designed, varying from country to country, but they usually last for a 15-20 year period with varying decline of support during phase out. A law was passed in January 2006 in China requires the access to the electricity grid from renewable energy sources. The Chinese legislation is a result of benchmarking against the German incentives policies that lowers the barriers for introducing renewable energy sources into the German grid (DAKS *et al.*, 2006).

Renewable Portfolio Standards (RPS) policies are another policy way to promote renewable energy supply that has been introduced in a number of countries. Also this policy area is an American invention where the first regulations in the world have been implemented in a large number of states in the USA, dating back to 1997. The USA has, however, not yet a national RPS policy and Germany too is lacking such an instrument. Japan and Sweden both introduced Renewable Portfolio Standards during 2003 (cf. REN21, 2005). In Japan the percentage renewable energy required from utilities is 1.35 percent by 2010. This is a rather low figure compared to e.g. some European countries i.e. Poland that requires 7.5% of its electricity to be constituted by renewable energies and Sweden that starts off (2003) with a renewable energy quote on the same level as the Polish goal for 2010. As of 2010 Swedish RPS will reach 16.9%. The Swedish system is designed accordingly: the electricity producers (utilities) receive one electricity certificate for each MWh electricity that is produced with renewable resources. These certificates follow "the MWh" down to the customer. The utility customers have to, in their turn, acquire a quote of electricity that will give them electricity certificates corresponding to 16.9 percent of total electricity purchased (STEM, 2005; EMMA, 2006).

The electricity certificate system provides the producers of renewable energy with a market price that fairly well covers the extra costs for generating renewable energy. Previously in Sweden, some utilities received financial support from the government but the intention with the new policy is to

provide the production for renewable electricity with more stable conditions and less dependent on the fluctuations in the state budget (EMMA, 2006).

Few countries have policies that promote rooftop solar photovoltaic applications for easy access to the electricity the grid. These policies have, according to REN21 (2005), spurred the rapid growth of the grid-connected market in recent years. In Germany guarantied feed-in tariffs have been applied in combination with low-interest loans until 2003 when the interest subsidies were terminated. The support programs in Germany have contributed to more than 160,000 rooftop solar homes with a total installation on 700 MW. In Japan they had rooftop solar policies between 1994 and 2005 where capital subsidies initially covered 50% of the costs, but declining to only constitute 4% as of 2005. Japan has today more than 200,000 homes equipped with rooftop photovoltaic solar applications. During a similar period – as of 1992-2003 – the average annual price drop for photovoltaic panels for residential customers is 7 percent (Stauffer, 2005).

A small number of countries have created net metering policies. Net metering allows for two-way flows between the grid and customers (electricity consumers) with their own electricity generation. At times when the self-generation exceeds the consumption the electricity meter runs backwards. The customer pays for net consumption and if there is a surplus in the energy going out to the grid that surplus can then e.g. be transferred to the next billing period, benefiting the end customer (REN, 2005). As of 2005 the REN21 global status report had identified seven nations that had applied the net metering laws. In Japan a net metering system is implemented in the energy industry, based upon a voluntary arrangement. Net metering laws are also implemented in a majority of the states and provinces in North America and in 2005 a US federal law was passed requiring all US electricity utilities to provide net metering systems until 2008.

This policy how to get access to the electricity grid is a very important step to take since most companies that develop photovoltaic solar applications are small or mid sized and the property owners are in many cases private family house owners, associations of family houses, condominium associations or smaller landlords (of apartment houses). These actors usually are not in possession of massive bargain power and without legal support it can be very expensive for them to get access the grid for selling surplus energy – even thought they are already hooked up to the grid as consumers receiving electricity for consumption. It is in Sweden, for example rather costly for such small electricity producers to get access to the grid for supplying excessive energy since the oligopoly like situation on the Swedish electricity market dominated by just a few energy suppliers has lead to high fees for metering the energy being supplied to the grid. Not being able to benefit from the excessive energy that is generated will of course be a reverse salient in the implementation of small family house yard placed wind mills and roof mounted photovoltaic solar cells.

PIII.7. Summarising the section on environmental policy making

We see clearly from this exposition on environmental policy processes as means for driving innovation and enforcing technological change that strict legislation does not necessarily lead to innovation and business offsets that provides the domestic industry a competitive advantage which is quite in line with the Jaffe *et al.* (1995) study, comparing US legislation with foreign. We do also, however, see that the policy process have the ability to provide business with a competitive advantage if the process is focused on A) taking the advantage of domestic business investments cycles, B) exploring the space for business opportunities, domestic or global, by being on the environmental technological solution frontiers, and C) developing a strong marketing research to

understand and influence the trends in policy processes (e.g. in nations that are environmental frontiers and those catching up in need of technology) and stakeholder engagements around the world.

So far these suggestions go in line with Porter and van der Linde (1995a; 1995b) as well and as the claim that regulators must be competent knowing the technical abilities of the industry. This knowledge is vital but is, however, still far from providing the legislators with the holistic picture, since it leaves out structural lock-ins that may be imperative to the likeliness of a successful policy that drives innovation – technological and social – that has the potentials to contribute to decreased environmental impacts and at the same time creating a foundation for domestic competitive advantage.

Consequently, as the *Ecological Economics* article by Cerin (2006a) describes – when applying the theorem by the Nobel Prize Laureate, Coase (cf. 1937; cf. 1960; cf Stigler, 1966) – that the theoretical discussion of Porter and van der Linde is too thin, not considering asymmetric information, transactions cost and property rights of agents over the value chain to satisfactory, which has led to over simplification in reasoning and generalisations in conclusions. As also concluded by Brännlund (2007), no strong evidences of the Porter hypothesis seem to exist. Therefore, we ought to retain a better understanding of the actual policy process – the incentives of actors, the struggle for path-dependence and attempts lock-out – for estimating the market potentials for the solutions on the domestic arena, but also very crucially globally on the vast growing markets

As Dobers (1997) has shown the so often overseen struggle over path dependence is an important market, *pre-market*, where ideas and technologies compete over supremacy in the subsequent market, *the real market*. Especially for environmental and health matters the market life-cycle starts early in the regulatory design processes. It is, moreover, not as simple as to just copy the interaction model of the policy process in another country since the structures in society go much deeper than that (cf. Broadbent, 1998; 2003; Broadbent and Ishio, 1998). The policy process involving the government-industry-NGO structures of a nation has to bee understood in order to adopt them to own domestic conditions. How does the influence from state-corporatism and neo-corporatism affect the policy processes of Japan and small open economies of Northern and Western Europe?

Continuing the discussion, vital for success (innovations) as we have seen in Part III of the report is to understand the institutional context that the nation provide for environmental technologies to evolve in. Even though Swedish policies to support e.g. solar cells may appear similar to those in let us say Germany and Denmark in some respects (like energy certificates or feed in tariffs) that is no guaranty for a similar development. The development of solar power is also heavily dependent on the organisations playing on the energy market. In Sweden a few multinational energy utility corporations keep a very high fee for linking solar energy on to the electricity grid. Much higher than the actual cost which is possible to enforce since there is in this area of business a market situation in Sweden that strongly resembles oligopoly.

Some large corporations have well adopted strategies for future global environmental technologies such as Toyota and Volvo has had. The interesting case with Volvo is that it reached its international success with the three-way catalytic converter with little help from the Swedish legislative process. Volvo saw the potentials with the new technology and took a proactive role in the Californian market where it realised that the catalytic approach will give them good image and increased market shares and since Volvo was a niche player on the Californian market it could pass on the additional costs for the converter to the end customers. But, more than a decade later in

Sweden Volvo was (and still is) the dominant player and could together with the industry stall the legislative process for a few years in a Swedish neo-corporativistic manner (cf. Cerin, 2005).

Another case of Swedish corporatism is the pulp and paper case where industry and labour unions worked against non-chlorine bleaching policies for a good decade. Even the EPA was not pushing the issue. Then these structures were altered since, due to the influence of a persistent NGO and public green procurement, a small player on the Swedish market saw the potentials for growth and excessive revenues – and got rewarded big time in return. Within a year the large players followed suit. The close *"cooperation between the public administration and industry was regarded as something completely natural"* (de Vylder-UNDP, 1996) and constitute one cornerstone in the *"Swedish Model"* (cf. de Vylder-UNDP, 1996), hence, the case of Swedish neo-corporativism.

Although some critique have been brought forward here on Swedish legislation process, there are of course positive sides as well, but the greatest leaps forward can be achieved by bringing forward some aspects that can be improved for increase Swedish competitiveness in the international scene of environmental technology. Actors in the environmental policy making process, especially regulators, should have an aim of looking ahead detecting the coming trends globally, especially what is taking place in vast markets such as the spurring latecoming economies where the need for environmentally adopted solutions soon will rapidly increase. There is, thus, if we are to better understand how to stimulate environmental innovation processes, from invention to market penetration, we need more multidisciplinary research that understands the interactions between actors in society based upon their power relationships, information asymmetries, self-interests et cetera.

Two aspects that policy needs to deal with – to create an understanding about

- seeking export opportunities of environmental technology, influencing the actors in the legislative process to strive for that goal.
- the institutional picture and power relations, asymmetric information, cultures of the actors, institutions and structures of society at different nations.

Consequently, the imperatives of multidisciplinary research – even thought it is often neglected in the field of environmental policies – is the understanding of actor behaviour, power and information asymmetries as well as an understanding of society structures covering both government and industry. In order to be successful, an understanding of these aspects should not only be restricted to the conditions in the own country or to the country/countries targeted for exports, but also knowing the strategies and capabilities of competing field – nations and corporations.

One current and interesting case of policy development is the creation of an ethanol market for road vehicles. The Swedish government has supported the development of ethanol in Sweden – i.e. to Domsjö in Örnsköldsvik to build up a domestic industry. This is also pointed out by the former Swedish Prime Ministers to the researcher in the *"Commission against Oil Dependency"* that made an objection to import tariffs on Brazilian ethanol. The PM criticised the stand on just low prices for the consumers and stressed the importance of building up an own industry and knowledge (Kommissionen mot oljeberoende, 2006).

This is an important task that policies can play which shall not be overseen. Much of Sweden's stock of large firms has been created in development-pairs between state owned firms and domestic private firms where engineers from both sides collaborated in the technology development (cf.

Fridlund, 1994; Fridlund, 1999). Here, by building up the domestic ethanol production in Sweden the future actually looks somewhat brighter for Swedish forest based industry since it will have a very difficult time to compete with fast growing areas in the tropical regions of the world, risking a considerable phasing out of Swedish produce (of e.g. pulp and paper) to merely deal with niche products. The environmental technology pursuit may in this case actually work as one enabler of Sweden's forest industry of tomorrow (cf. Larsson, 2006; cf. Novotny 2006a; cf. Novotny, 2006b). Environmental policies should, hence, not be looked upon only as side activities that improve the environmental conditions but also seen as a true industry enabler if the policy creation processes are played right.

PIII.8. Summing up Part III

- The cases in this part of the report show that the included Swedish policy processes has not provided Swedish industry with a competitive advantage on the international market. Instead, once again in these cases, lax regulation has been adopted[20]. This is the situation with the three-catalytic catalytic converter legislation as well as the fight to ban chlorine bleaching in Swedish pulp and paper industry.

    - In the three-way catalytic converter case the big player Volvo together with other actors, like Bosch, took the lead in Californian legislation showing that it indeed was possible to manufacture cars with the catalytic technology, contrary to the claims of the big three auto manufacturers in Detroit. In Sweden though it took another 8 years for similar legislation to be introduced.

    - In the Swedish pulp and paper case did industry and labour unions together work against attempts to make the bleaching of paper chlorine free. It was not the initiatives alone from the Swedish EPA that tilted the pulp and paper industry over towards non-chlorinated paper, but thanks to a persistent NGO green procurement solved the knot and soon, after 10 years rejection of the idea, the whole pulp and paper industry could produce chlorine free paper and won market shares internationally. In this case industry needed help in understanding the market and access to public customer that could ensure an initial market for the investments into chlorine free bleaching. This could also be the task of environmental regulations, helping industry actors understand the (international) market.

- In the often foreseen pre-markets takes the first struggle over path dependence place and it is here where ideas and technologies can gain supremacy in the subsequent real market. These pre-markets, the policy processes, are often the important starting points for markets dealing with environmental and social concerns.

20 We would like to emphasise that lax regulation is not particularly representative for the outcome of the work of Swedish EPA. The EPA of Sweden has, on the contrary, been really successful in many other cases such as abating CFCs and VOCs as well as in developing and promoting analysing methods, managerial tools and holistic thinking and incentives such as through LCA (Life-Cycle Assessment) and IPP (Integrated Product Policy).

- There are numerous factors that influence the proactiveness in national environmental policy processes which should be understood if the aim is to successfully implement foreign policy methods with similar outcome at home.

    - One important factor for the establishment of successful environmental policy processes is determined by the economic conditions in the country, but also the severity of environmental aspects and resource scarcities play an important role.

    - When comparing environmental policy processes it is important not to compare apples with oranges. When the policy processes of Japan are discussed the market capitalisation size of the involved Japanese conglomerates tends to be neglected when comparing with the Swedish policy processes where most concerned companies are considerably smaller.

- When analysing the policy process of another country it is vital to understand the underlying society culture. Without such understanding the copy of policy processes may not lead to successful outcomes.

    - In Japan the underlying culture affecting business life is often referred to as East Asian Corporativism where state and industry associations form network for collaboration. There is a higher degree of obeying state officials in industry organisations perhaps since formerly (pre-1945), these officials where servants of god (the Emperor).

    - In small open European economies the underlying culture in business life is often referred to as Neo-Corporativism where a collaborative culture between government, industry and labour unions exists. As an example, the corporation between industry and public administration has been viewed as natural in the *"Swedish Model"*.

- When comparing the environmental policy processes of Japan to Sweden it is imperative to recognise the prominent role played by industry associations where industry and government meet. According to the cases in this report the joint efforts is to seek business opportunities from domestic industry's know-how and technological solutions.

- The environmental policy process in Sweden ought to be seeking export opportunities for the domestic industry and not lock the industry into rendering endemic solutions. Such process requires the collaboration from both industry and government, where industry associations are proactive, not only seek the solution that fit the laggards of the industry sector.

- Consequently, to better understand the policy processes and retrieve the necessarily holistic picture for successful implementation of policy variants applied to domestic conditions. To increase the Swedish policy capability extensive multidisciplinary research – e.g. into asymmetric information, power relationships, societal culture, economic, technical, resource and environmental conditions of the country – have to be applied.

Synthesis and Implications for the Formas-Vinnova Programme

B. Synthesis and implications for the Formas-Vinnova Programme

As described above in this report the task is to provide information for supporting Formas and Vinnova in their development of a common strategy on their forthcoming collaborative environmentally adopted program. The programme is assigned to Formas and Vinnova by the Swedish government and the aim is to create a jointly financed research program on environmental technology that will constitute a foundation for collaboration between firms and public research from various disciplines. Small and mid sized enterprise shall be prioritised in the program. Important outcomes are to support knowledge and competence on environmental matters.

B.1. Synthesis

The assignment from Formas and Vinnova is to create a report that is divided into three rather distinct areas. The report is, consequently, divided into three main sections, dealing with one task each. The first one deals with environmental technology, the second provides a picture of developments in the spurring latecoming economies Brazil, China and India and the third task is to compare the environmental policy processes of different countries such as Japan, Germany and Sweden. The following discussion will be divided into the three distinctive segments of the report and a common discussion and recommendations takes place in the last section of this report: *Recommendations to the Formas-Vinnova Programme.*

Definitions of environmental technology

- *Use a wide definition on environmental technology*
  There are several definitions on environmental technology applied today, but the most interesting definitions from a Formas-Vinnova programme perspective is the wide scope that ETAP has adopted – encompassing any technology that is designed to prevent or reduce the environmental impacts – and the categorising of environmental adopted products and services that Nutek has created into 1) Pure environmental technology, 2) Environmentally efficient products and 3) services and Innovative environmental solutions. This categorisation can be used for explanatory reasons, while the ETAP should set the limits for the technologies considered in the programme.

- *Implications for research:*
  Formas and Vinnova should preferably not try to develop their own definition on environmental technology for the program, but to focus on supporting projects that can contribute to decrease or prevent environmental impacts.

Trends in latecoming economies that will have major impacts on the environment

- *Urbanisation*
  The vast internal migration of people within China and India will increase the urban population in these two countries alone by some 614 million city-dwellers while the rural population will decrease by some 138 million people as of 2005-2030. This new urban population will need access to safe piped water and sewage as well as to waste disposal systems in order to protect the environment and public health. In China as of 2006-2010

alone the Ministry of Construction and the 11th FYP have set aside US$41.3 billion for constructing and extending the access to sewage treatment and recycling facilities. By 2010, the aim is that 70 percent of the urban population shall have access to sewage disposal. The demand for *environmental infrastructures* is, hence, enormous but also the demand for low polluting transportation infrastructures. The cities and rivers of China, India as well as Brazil suffer, furthermore, already today from low air qualities and contaminated water, respectively. The access to piped water and sewage is too low, especially in China and India, leading to premature deaths. The situation is severe in the cities but the access rate to *environmental infrastructure* is even lower in rural areas. There is, therefore, a vast demand for stand alone water and sewage solution that in cases require stand alone energy supply.

- *Consumerism*
  The enormous economic growth and industrial development of foremost China and India is the alteration of the way the population is living. The consumption patterns will change towards more energy and transport content in food, more home appliances, electronic goods, apparel and furniture will be demanded not to speak of the increased use of vehicles. Already by 2030 the number of cars in the world will be more than doubled and the number of cars in China and India will surpass more than half a billion. This rapid increase will put extra strengths on global resources like iron, copper and oil which require new more resource efficient solutions such as lighter vehicles, more efficient engines and alternative fuels to be developed. Vehicles and the enormous future demand for electronic goods will, furthermore, consume precious metals making high yields in recycling a prerequisite. The estimated future demand 2030 form the auto industry on e.g. aluminium, plastics and platinum-group metals is seriously making world demand surpassing current production limits. The innovation pressure – for more environmentally adopted solutions – in this sector and other industries competing for the same resources will be gargantuan.

- *Implications for research:*
  Both the environmental concerns arising from the urbanisation process in China and India and the escalating force in Brazil, China and India's consumption patterns are two major trends that significantly will affect human health, environment and resources scarcity. The needs arising from urbanisation is largely associated with access to environmental infrastructures such as piped drinking and sewage water and waste disposal systems. Another need related to urbanisation but also to the shift towards a consumerist society is the need for a transport infrastructure that is less polluting when the Chinese and, to somewhat lesser extent, Indian vehicle parks explode in size. The economic buying power of the vast latecoming economies will demand much more resource efficient solutions (less and greater reuse of materials) spilling over to the solutions available for the rest of the world.
  Both the environmental infrastructures and the innovative solutions to the resource scarcity problematic ought to become an aspect of Formas and Vinnova's joint research strategy on environmental technology. The limited resources to Formas and Vinnova's joint research program may, however, make it less practical to focus on and striving for implementing radical innovations and system changes of greater magnitude. The development of environmental infrastructure solutions, a knowledge well advanced in Sweden, may therefore pose a more realistic technology area to focus on. The character improvements in environmental infrastructure can oftentimes be closer to (incremental) technological development than (radical) innovations and since the firms in the Swedish environmental infrastructure industry are mostly SMEs this is an area in need of support is to demonstrate technologies to potential customers abroad.

Environmental policy developments to be considered in Swedish policy processes

- *Policy processes in Japan, EU and USA.*
  Especially in markets for environmental and social goods the game for market dominance start early in – sometimes even initiating – the policy process where the player behind the dominant technology may gain path dependence by influencing the rules of the coming market. In Japan, the case studies (e.g. on vehicles, telecom and recycling) indicate the practice of, government and industry collaborates through industry associations throughout the policy process that is characterised by a consensus of searching for domestic industry competitiveness which in the observed cases have been realised by Japanese industry. The US policy processes are to a higher degree characterised by less collaboration and later inclusion of industry actors into the talks and negotiations. Policy measures taken by individual states – e.g. on energy and transports – may, however, be on the front edge internationally even in areas where the federate level of the USA is considered to be lagging behind. In Europe the nation being on the environmental policy frontier could be consider to be Germany whose initiatives (e.g. on vehicles, energy and recycling) also influences the stand taken by other EU member states.

- *Policy processes in China and India*
  There are plausible indications that important prerequisites for international trade in various areas may in the very nearby future be set by the environmental requirements, standards and technical legislation – concerning environmental aspects – implemented by the vast economies of China and India that are on the frontier compared to those discussed in the traditional OECD countries. Two major reasons for the proactiveness is seen as a response to more severe environmental conditions – e.g. concerning health, toxicity, resource scarcity and local biotopes – compared to Western countries but claims are also made that the proactive environmental policy measures taken could be a sign of supporting domestic industries against foreign competitors, foremost nationally but gradually when the economic power grows stronger also internationally.

- *Implications for research:*
  If the Swedish environmental policy process is to support not only improved domestic environmental conditions but also provide a competitive advantage of the nation's industries the process should also focus on taking the advantage of domestic business investments cycles, exploring the space for business opportunities – domestic or global – by being on the environmental technological solution frontiers, and developing a strong marketing research to understand and influence the international trends in policy processes and stakeholder engagements around the world. In doing so, the regulators need to have the ability to create an understanding among the involved industry actors about seeking export opportunities of environmental technology. The regulators also need to understand the institutional picture i.e. power relations, asymmetric information, cultures of the actors, institutions and structures of society, both domestic and internationally.
  In order to provide better input to environmental policy processes it is imperative to apply multidisciplinary research to understand the holistic picture actor interaction in the play over technological superiority. This aspect of research ought, hence, to become an aspect of Formas and Vinnova's joint research strategy on environmental technology. The limited resources to Formas and Vinnova's joint research program may, however, call for an exclusion of these aspects, for the benefit of direct technology investments.

Tomorrow's demand for environmental technology in the key latecoming economies is, consequently, chiefly:

- *Environmental Infrastructures*
  The great influx of people to the urbanised areas, especially within China and India, require enormous investments into environmental infrastructures i.e. access to piped drinking and sewage water, waste disposal and treatment systems. The general access today in Brazil, China and India to these infrastructures is deficient, leading to premature deaths and loss of working days due to illnesses. The access to clean water and systems for treatment of sewage and disposals is even lower in the rural areas outside the city regions that can be solved with stand alone solutions supported by local energy production if electricity grid is not present.

- *Transportation infrastructures*
  The rapid expansion of the transport infrastructures in the larger cities causes premature deaths due to inferior air qualities. There is, hence, a need for lighter vehicles, less polluting engines and fuels as well as looking into the possibilities for substituting individual travels by car to public transportation and telecommunications.

- *Industry processes*
  The expansion of industrial production require solutions of both integral process and end-of-pipe character. In latecoming economies demands from local subsidies of Western companies based or Western based companies procuring goods on documented environmental work will push facilities in e.g. Brazil, China and India towards greater environmental concerns, but also governmental policy actions such as in China are increasingly addressing environmental measures to be taken.

- *Agriculture – forestry*
  The agriculture is in several areas of Brazil, China and India experiences droughts and decreasing water tables due to too extensive irrigation. The harsh exploitation of agricultural land in China and India is supporting a huge number of humans considering the size of farm land which may lead to increased sensitivity and increased risks for decreased crop yields in the nearby future and in Brazil newly established farm land only endure a few seasons of agriculture before new rain forest areas have to be cleared. Agricultural land is also threatened by land loss by erosion, road and urban construction. Agriculture affects, moreover, the surrounding environment with run offs – of pesticides and fertilisers – and decreased biodiversity due to deforestation to give way for new farm land.

- *Resource scarcity*
  The increased wealth in the latecoming economies will make many resources that currently may be considered abundant scarce, leading to a great need for innovations to exchange materials, make products weight less and increase recycling. Products active during use should also consume less energy.

B.2. Recommendations to the Formas-Vinnova Programme

Formas and Vinnova have received a relative small amount of money for a task that is to operate in a domain which is enormous. In 2003 total Swedish expenditure on R&D (GERD – Gross Expenditure on R&D) was approximately SEK 70,000 (or USD 10,000) million of which approximately 65% was financed and 74% was performed within the business sector while 35 and 26% respectively within universities and government bodies (OECD, 2005c). The total budget for the Formas-Vinnova programme on environmental technology is SEK 15 million during 2007 and thereafter SEK 30 millions annually. This is just a fraction of a percent of Swedish research. In addition the Swedish export of products related to environmental technology (as defined by Swedish Trade Council) is approximately SEK 25,000 million. Also in relation to environmental export figures the allocated money to be permeated through the Formas-Vinnova programme is just a fraction of a percent (0.12%). This fraction is still more reduced if related to the total turnover (2003) of the primary environmental sector (as defined by Statistics Sweden, 2005) which was SEK 131,000 million. One conclusion from this observation is that the funds in question will – if handled in isolation - have no immediate impact on the behaviour and performance, at large, of Swedish industrial competitiveness in the environmental technology field. To be useful the money should be allocated to qualified projects of potential strategic interest and with a *"catalytic"* character. In the following we argue for what could be included in – and should be excluded from – such a policy.

First of all, and following our arguments mentioned above, we are of the opinion that Formas-Vinnova should focus on technologies. The focus on "technology" rather than on "products", "firms" or "industry" is important. This distinction is in fact far from upheld in official documents we have consulted. (cf. e.g. Swedish Trade Council, 2005 and the above quoted Nutek definition). For Formas-Vinnova it is essential to be clear on this topic. What should be supported – according to our view – is technological development which often takes place through various forms of R&D and related activities. The technologies may potentially be more or less connected to ("embodied" in) various products and processes and it is not even necessary to exactly identify what is a product and what is a process. In addition, some of the "products" may be intangible in character, i.e. "services" – not even this distinction is of primary importance to identify and to evaluate their environmental impact.

A strong focus on technologies has the advantage of creating a clear division of labour between Formas-Vinnova, on the one hand, Nutek, Swedish Trade Council and Swentec, on the other. The more commercial parts of the environmentally driven SME-related (business development process) topics as regards products and services of ecological significance may be dealt with by e.g. Nutek and Swedish Trade Council can continue or rather expand its important support activities for firms with environmentally related exports (however defined). As shown by an ITPS report (Schwaag Serger and Widman, 2005) Swedish SMEs have difficulties accessing the Chinese market and breakthroughs are made by larger companies in Swedish vehicles, power, heavy industry and telecom sectors. Possibly, other actors, as well, could support international demonstration and implementation projects i.e. IVL Swedish Environmental Research Institute and Swentec.

Although the government bill is strongly focused on collaborating with actors that focus on business development aspects (Regeringen, 2005a:60) it is also important that at least one actor in the network for supporting Swedish environmental technology argues for frontier technologies in the environmental field. ITPS (Schwaag Serger and Widman, 2005) sees great potentials for reducing the increasing resource use in China such as in energy production, products and

technologies. One example is innovating resource efficient vehicles and vehicle technologies in which advanced research currently is taking place in Sweden. The same report also recognises the potentials of demonstration projects like the "Sustainable City" carried out by a collaboration of Swedish actors i.e. firms and municipalities to market Swedish environmental solutions in city planning. These undertakings by various organisations – including municipalities, IVL Swedish Environmental Research Institute and Swentec – to promote and demonstrate Swedish environmental technology are of outmost importance in overcoming the barriers for creating a market presence on the Chinese market for Swedish Environmental technologies. These actors and actions can be seen as locomotive organisations and are an important institutional solution that may be the engine in getting products from a local community out on the global market as described by Mascanzoni and Novotny (2000) concerning the role of locomotive fair sized firms in Italy with a global presence that provide smaller suppliers with access to the global market.

The very (small) size of the funds in question supports our discussion above on narrowing the scope of what may be included in the technological R&D work which should be supported in this programme. Allowing all – or most – forms of resource savings to be included makes the programme meaningless. There may, hence, also be strong practical reasons supporting the academic interest in using a "narrow" definition of Environmental Technology.

Consequently, as we see it, there is no reason to adopt any of the definitions discussed in sub section PI.2. above, which in various degrees have been developed in political processes related to trade policy and industry consideration. Turning the definition problem upside down *we suggest that instead of trying to identify an "environmental technology" or a set of environmental technologies the Formas-Vinnova programme may focus on all technologies which potentially may have a substantial impact in the ambition to reduce environmental damage; be they - global or local – as well as considering the market potentials, primarily from an international perspective.* The technology must not necessarily be radical from non-ecological perspectives – the important thing is its potential from an ecological perspective, compared to existing state of the art technology, to contribute to reduced resource depletion and to pollution generation as well as to ensure sustained biodiversity.

Focusing on technologies we still have the problem of whether the Formas-Vinnova programme should explicitly address specific areas like *"wastewater treatment"*, *"air treatment"*, *"energy saving"*, *"process/control technologies"* etc. Even in this case we are of the opinion that Formas-Vinnova should have an open minded policy and leave to the applicants to argue why their suggested technological R&D work qualify as having potential ecological significance. And even small reductions (incremental innovations) may be important if they relate to large scale processes/systems. In our opinion Formas-Vinnova should also aim for supporting initiatives where *environmental infrastructure system* actors, like municipalities, support *environmental infrastructure component* actors, like SMEs, to gain access to *hard-to-fetch* markets abroad.

The government bill on the task given to Formas and Vinnova assumes that the research programme in environmental technology should be co-financed from the government (through Formas and Vinnova) and the industry beneficiaries (Regeringen, 2005:159f.). This is an often used means with the intention to expand R&D resources for a certain end. This report is not the place to analyse the advantages and disadvantages with that model in detail. However, it should be remembered that even if the allocated government money is expanded with such a model the total amount thus made available is still very limited and it may be argued that its relevance for business development in the short term, in general, will be low.

This elimination of compulsory co-finance for each individual project may contribute to a more long term vision in the programme than would otherwise be the case. It would also open the

funding for academic research of significant ecological potential although not necessarily profitable in the short run – an approach which has been advocated by some academics at Formas-Vinnova workshops in strong opposition to the stand taken by the participating SMEs. Another important flaw with the argument is that it represents the dichotomy to the intention written by the Government in their bill explicitly stating co-funding as a prerequisite for participation in the program. The argument given by the Government, in its bill, and by the participating SMEs indicate that there have to be a real stake in the project funding to ensure commitment from the participating laureates – a paradigm of thought shared with prominent person's like Aristotle, Jefferson and Smith.

Consequently, the non co-financed approach neglects the strong emphasis on environmental business development in the government bill. As indicated – although not analysed in depth – in sub section PI.2. above it may well be the case that short term (Swedish) business development in the environmental areas is more of an institutional problem than a question of R&D. The focus of the Formas-Vinnova strategy may focus on the long-term and multidisciplinary research similar to funding bodies like Mistra, but the company focus in the bill set the Formas-Vinnova program out to be more short-termish providing increased opportunities for enterprises to realise environmental technology undertakings.

Summarising our arguments in this sub section and thus in the report as a whole we may say that within the framework of the tasks given not only to Formas and Vinnova but also to actors like Nutek, Swentec and Swedish Trade Council we argue that Formas-Vinnova should focus on the vertical axis in figure 5 below, i.e. technology development thus leaving the horizontal task of environmentally driven business development to the other actors on the scene. In fact we have no problems to identify other actors outside those already mentioned in the Swedish landscape which can support this horizontal activity; e.g. Swedfund is one example. And, as is the message in the recent Bråsjö & Blomkvist report (2006), the potential competitive advantage of Swedish environmental industry also has this non-technological dimension worth to develop. There are advantages – analytically as well as from a policy perspective – not to blur concepts or to use vague or unclear definitions of them on all levels of policy formation as well as it may be wise to establish some division of labour between government bodies as regards different policy instruments. As we have shown the unclear definitions of sustainability and environmental technology in the general policy discourse must not necessarily spill over on those actors which have to implement policy.

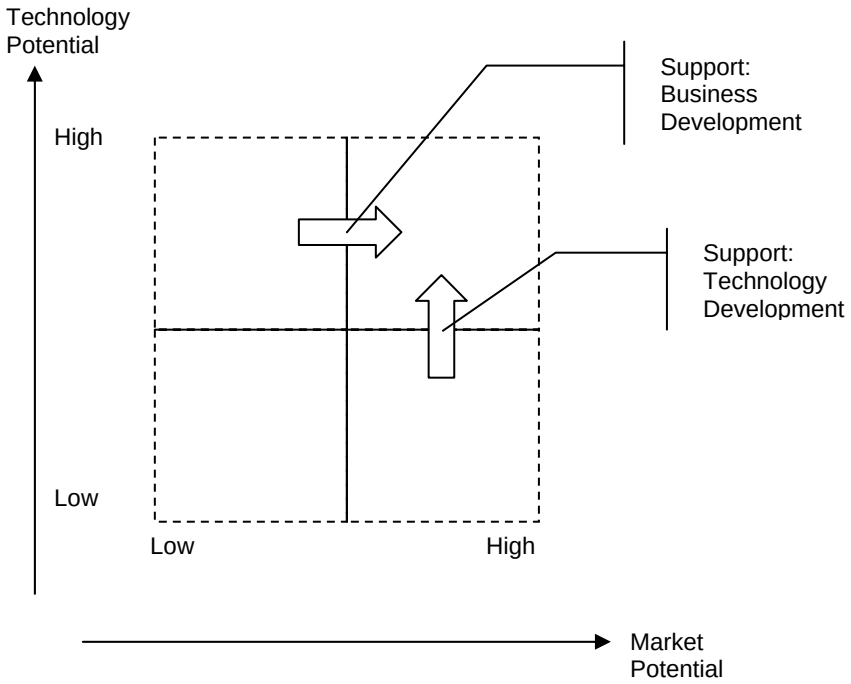

Figure 5. The four-fielder of Technology Potentials and Market Potentials of Application.

Even if Formas and Vinnova choose to focus its investments on the suggested areas above there exist numerous fields where there is a *"Technology Potential"*. The program should, hence, make a heavy selection if the financial assets available shall have the potentials to make a significant impact. Our firm opinion is that the Formas-Vinnova program shall have clear distinctive selection criteria presented in the call for applications, making the applicants argue for why the *Technology Potential*'s within the field addressed by the application is worth supporting.

Here it is suitable to separate short and long term project. Possible selection criteria for projects with a short time frame are today known market potentials, potentials arising from legislation as well as the competitive situation in the segment among other things. Concerning projects of the longer time-frame the market potentials and the prerequisite for those should be the foundation for selection as well as known development efforts in other countries that are related to the proposed project.

Applying such procedures will improve export potentials for Swedish environmental technology as well as growth capabilities for Swedish companies to establish a niche on foreign markets as means for further international expansion.

If Formas-Vinnova bridge the gap between technology and market development by collaborating with other domestic actors that put efforts into to the horizontal plane of the technology-market four-fielder (see figure 5) there will be fine prerequisites for lifting the field of environmental technology potentials and refraining it from being merely potentials to realising the immense growth in environmental solutions demand that currently is budding in the vast late-coming economies of the world today and tomorrow.

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Appendix 1 – The budding of environmental and social concerns

Environmental problems have been a policy concern since the beginning of the industrial revolution. The modern discourse, however, has its origin primarily in the 1960's, then concerning phenomena such as lead in biocides, and controlling emissions from point sources – i.e. chimneys, public and industry wastewaters. Two books of very different character, and selected from a long list, may illustrate the take off of a new environmental awareness. The first was *Silent Spring* (Carson, 1962) focusing on the consequences of using pesticides. The second was a small study by Erik Dahmén on the overuse of natural resources and suggesting models for pricing the environment (Dahmén, 1968). The by then dominant mindset of seemingly unrestricted growth got further questioned by the *Club of Rome* reports by Forrester (1971) and *Limits to Growth*, by Meadows *et al.* (1972) which laid the ground for a long lasting debate on whether growth was possible, was wanted and, if so, what the long term conditions for growth were. A detailed review of that discourse falls outside this report.

Of importance, however, is the official attempt to solve (some of) the controversies regarding *Our Common Future* (WCED, 1987), a study which emanated from the limits to growth discourse. The report, oftentimes referred to as *the Brundland Report,* introduced a concept of sustainable development (sustainability) consisting of a balance between natural systems (eco-systems) and the human (social and economic) systems. Environmental degradation must, it is argued, be overcome but without bowing out the needs for economic development, social equity and justice. Such a development – if met – is a process that *"meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED, 1987) and puts the equality concept not only in a traditional intra-generational setting – between North and South – but in an inter-generational setting – striving for equality between generations. The in the 1960's and 70's dominant non-growth – zero-growth and steady state – advocators were, it may be argued, increasingly pushed aside when the notion of sustainable development came into play during the 1980's and 90's (cf. Welford, 1996; cf. Kågeson, 1998).

The Brundtland sustainability concept thus rests on three pillars; economic development, preserving the environment and social equality. It is, as e.g. interpreted by Welford (2002), probably not sustainable to attempt to solve environmental problems without solving today's social inequalities. So, we are dealing with a trinity in the bottom line – economic, environmental and social – and duality in the time line – present and future.

There are, however, risks associated with the application of this sustainability concept as e.g. a report from the Swedish EPA states (Cerin, 2005): *"By jointly applying economic, environmental and social issues – constituting the commonly used triple bottom line in the sustainability discourse – environmental issues can be given a lesser importance by being disrupted and put against the others, and of course visa versa when needed."* The Swedish EPA report also states the interdependency of the three dimensions of sustainable development that has to be embraced and taken into account not to fall into too narrow thinking – environmental problems cannot be solved unless solving sever social inequalities[21].

[21] One example on leaving out one or two components of sustainable development is the Swedish Agency for Economic and Regional Growth – Nutek (NUTEK, 2003) that left out the social dimension of their sustainable development perspective where the focus is on defining environmental technology as an enabler for sustainable development. Also Nutek recognises that the social dimension cannot be disregarded since all dimensions of sustainable development interacts and reinforces each other.

The concept of sustainable development has won large terrain in the political agenda internationally in the UN – e.g. Rio de Janeiro, 1992; Johannesburg, 2002 (UN DESA, 2006) – and from there permeated down to national levels. The concept has found its way into national statements, strategies and visions (see e.g. Swedish Ministry of Sustainable Development, 2002; UK Department for Environment, Food and Rural Affairs (Defra, 2006). It is stated in the Swedish text that sustainable development is the overall goal for Swedish government policy, nationally as well as internationally, where the vision is solidarity between countries and generations. The environment is condensed to aspects in a long-term horizon as well as in natural resource perspective. In the British sustainable development strategy – for securing the future – pressing issues like loss of biodiversity in rainforests, over fishing resulting from consumption patterns as well as the devastating loss of infants and juveniles due to severe poverty are given a more prominent role.

Also the international business community has embraced the concept of sustainable development by e.g. engaging in the organisation World Business Council for Sustainable Development (WBCSD) which is supported by some 180 transnational corporations. Although sustainable development is part of the organisation's name it is not easy to find their definition on the concept but the concept shows up in the organisation's mission, which *"...is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate..."*. Furthermore, the United Nations has since the World Economic Forum, January 1999, in collaboration with industry and other organisations developed the 10 principles that constitute the core of the Global Compact (GC). GC sees itself as a mean for *"producing practical solutions to contemporary problems related to globalisation, sustainable development and corporate responsibility in a multi-stakeholder context."* The indicator may here be seen as a means of operationalising the concept of sustainable development into ten value areas of which one is to *"encourage the development and diffusion of environmentally friendly technologies."*

Appendix 2 – Demographic Developments as of 1950-2030

World

Indicator	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Rural population (thousands)	1 787 705	1 906 963	2 031 459	2 180 259	2 367 741	2 557 870	2 705 993	2 860 273	3 008 650	3 140 989	3 240 771	3 314 299	3 368 353	3 400 408	3 400 783	3 362 873	3 286 551
Urban population (thousands)	731 765	850 436	992 353	1 157 715	1 328 847	1 515 870	1 736 302	1 983 674	2 270 869	2 551 364	2 844 802	3 150 451	3 474 571	3 819 023	4 177 106	4 542 366	4 912 553
Percentage urban (%)	29.0	30.8	32.8	34.7	35.9	37.2	39.1	41.0	43.0	44.8	46.7	48.7	50.8	52.9	55.1	57.5	59.9

Size class	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
10 million or more														
Number of agglomerations	2	2	2	2	2	3	4	7	10	13	17	20	21	22
Population (thousands)	23 613	26 932	30 842	35 461	39 489	53 185	69 249	104 507	144 875	183 795	239 655	292 593	326 655	359 238
Percentage of urban population	3	3	3	3	3	4	4	5	6	7	8	9	9	9

Brazil

Indicator	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Rural population (thousands)	34 457	37 438	40 061	41 886	42 468	41 371	39 640	39 090	37 639	35 877	32 699	29 395	26 740	24 616	23 012	21 896	20 902
Urban population (thousands)	19 517	25 448	32 681	42 443	53 521	66 753	81 975	96 973	111 756	125 499	141 159	157 010	171 757	184 785	196 182	206 033	214 603
Percentage urban (%)	36.2	40.5	44.9	50.3	55.8	61.7	67.4	71.3	74.8	77.8	81.2	84.2	86.5	88.2	89.5	90.4	91.1

Size class	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
10 million or more														
Number of agglomerations	0	0	0	0	0	0	1	1	1	2	2	2	2	2
Population (thousands)	0	0	0	0	0	0	12 089	13 395	14 776	26 122	27 902	29 802	31 752	33 304
Percentage of urban population	0	0	0	0	0	0	15	14	13	21	20	19	18	18

China

Indicator	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Rural population (thousands)	482 641	522 642	552 246	601 097	686 138	766 369	802 657	824 101	838 752	837 023	818 180	784 026	745 945	707 351	666 173	621 694	573 781
Urban population (thousands)	72 119	86 363	105 246	128 093	144 537	161 439	196 220	246 074	316 554	382 308	455 800	531 817	608 587	685 630	757 766	819 732	872 671
Percentage urban (%)	13.0	14.2	16.0	17.6	17.4	17.4	19.6	23.0	27.4	31.4	35.8	40.4	44.9	49.2	53.2	56.9	60.3

Size class	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
10 million or more														
Number of agglomerations	0	0	0	0	0	0	0	0	0	1	1	2	2	3
Population (thousands)	0	0	0	0	0	0	0	0	0	10 423	13 243	25 220	27 531	40 495
Percentage of urban population	0	0	0	0	0	0	0	0	0	3	3	5	5	6

India

Indicator	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Rural population (thousands)	296 625	325 629	363 058	402 141	445 259	488 295	529 745	579 533	632 411	686 773	738 604	786 428	826 904	857 271	874 413	875 338	859 121
Urban population (thousands)	60 936	69 467	79 287	93 016	109 652	132 406	159 111	186 520	217 004	248 799	282 480	316 942	356 388	403 096	457 619	520 158	589 957
Percentage urban (%)	17.0	17.6	17.9	18.8	19.8	21.3	23.1	24.3	25.5	26.6	27.7	28.7	30.1	32.0	34.4	37.3	40.7

Size class	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
10 million or more														
Number of agglomerations	0	0	0	0	0	0	0	1	2	3	3	3	3	3
Population (thousands)	0	0	0	0	0	0	0	10 341	23 197	36 128	41 585	47 521	52 567	57 453
Percentage of urban population	0	0	0	0	0	0	0	6	11	15	15	15	15	14

Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2005 Revision, http://esa.un.org/unup, 03 October 2006; 11:59:50 AM.

Appendix 3 – Social conditions that may threaten stability

One major problem facing China and India is the rapidly increasing number of males being born compared to females which will create a surplus of men not being able to marry and danger of violence, prostitution, trafficking and HIV infections. One short-term benefit for China, according to the BBC (BBC, 2004) is the flux of spare male labour from the countryside into the cities of China that is one part of *China's economic miracle*. Each year there are 2 million surplus males in China which will result in a female deficit around 50 million individuals (NBC, 2004). The sex imbalance situation is as extreme in India as in China with similar numbers. The Nobel Prize laureate Dr. Amartya Sen has described the sex imbalance problem and some the problems connected to it in *"More Than 100 Million Women Are Missing"* (Sen, 1990). The great deficit of women – leading to large groups of young men finding themselves without spouses – in both China and India, as well as other Asian states, may lead to instability in these nations and diminishes the possibilities for meaningful democracy and peaceful foreign policy (den Boer, 2004; Hudson V and den Boer, 2004). According to them are young men with little chance of forming families much more prune to coalitional aggression, both within and outside the militia.

The *"2002 Revision"* (UNESD/PD. 2003; cf. UNESD/PD. 2005b) has also found that the HIV/AIDS epidemic will considerably decrease the pace of global population growth. The most severely affected countries are, however, the sub-Saharan countries in Africa where the current HIV prevalence on 20 to 30 per cent of adult population hugely impacting population growths. The impact of the HIV/AIDS epidemic is in Asia and Latin America is, compared to Africa, still low. The projected effect on population numbers is projected to be a decrease on 1 per cent while the decrease in the most affected African countries is a 10 per cent decrease. However, due to the large populations of Brazil, China and India the death numbers will be quite substantial. The number of deaths in India alone is estimated to have been 2.3 between 2000 and 2003 while the corresponding numbers for entire Asia is 3.5 and for Latin America including the Caribbean is 0.7 million. The development of the spread of HIV in Asia and Latin America requires careful monitoring since the numbers in Asia is projected to peak at 17 million excess deaths in 2020-2025