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Innovation for Sustainability in a Changing World

Proceedings of the 2nd South African-German Dialogue on Science for Sustainability

RESEARCH

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Innovation for Sustainability in a Changing World – The South African-German Dialogue on Science for Sustainability

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I. South Africa and Germany in Dialogue

The South African-German Dialogue on Science for Sustainability (D4S) between the South African Department of Science and Technology (DST) and the German Federal Ministry of Education and Research (BMBF) was initiated in December 2007 in Pretoria, South Africa.

A hundred South African and German scientists, policy makers and representatives of industries and non-governmental organizations participated in the course of the dialogue. The initiative intends to define common areas between South Africa and Germany in the field of research and development for sustainability, build future networks between the scientists and industries in both countries, initiate new research and development cooperations and contribute to the dissemination of scientific and technological knowledge. Importantly, the dialogue aims to provide a forum for the two parties to share knowledge and have focused discussions on a range of mutual policy and strategy challenges.
Based on a Joint Declaration of Intent signed by Mr. Mosibudi Mangena, Minister of Science and Technology, Republic of South Africa and

The 2nd dialogue session in Pretoria, 26 and 27 October 2009 aimed at deepening joint understanding of a selected number of policy and strategy issues and agreeing on the next steps for the dialogue and identifying specific areas for enhanced cooperation between the two countries

Prof. Dr. Annette Schavan, Minister of Science and Technology, Federal Republic of Germany in February 2008 two conferences were held so far. The 1st session in Bonn, Germany, was a first stocktaking exercise of the bilateral cooperation lines in Science and Technology, Development and Environment. Five priorities were identified for future cooperation. The 2nd dialogue session in Pretoria, 26 and 27 October 2009 aimed at deepening joint understanding of a selected number of policy and strategy issues of interest to players in the national systems of innovation of both countries, refining the dialogue framework developed during the 1st dialogue session as a basis for identifying new areas of cooperation and agreeing on the next steps for the dialogue and identifying specific areas for enhanced cooperation between the two countries.

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In the dialogue, the participants exchanged experiences and scientific knowledge in organizing national systems of innovation to support sustainable development, decoupling economic development and environmental degradation, and the role of international science and technology cooperation towards innovation for sustainability.

Both parties agreed to keep the dialogue on the strategic level especially in the cross cutting fields of environmental economy and policy research and innovation for sustainability research. BMBF and DST will discuss possibilities for funding of new joint R&D projects, e.g. in water and environmental technologies, and to continue the dialogue for another three years (2010-2012) under the Agreement on Cooperation in Science, Research and Technology (1996).

II. Background: The Role of the Science Policy Dialogue

Science and technology play a crucial role in meeting the pressing challenges of sustainable development. Having recognised the considerable potential for collaboration in developing cost-effective and innovative technologies, South Africa and Germany entered into a policy dialogue process that aims to strengthen bilateral science and technology cooperation. The dialogue rests on an assessment that both countries face a challenge in combining economic growth with sustainability and agree that the time is ripe for a partnership based on mutual interests in a sustainable future nationally and globally. The dialogue should lead to joint research and sustainability strategies as well as contribute to the development of strong linkages between research, the private sector, civil society and the government, both within and between the countries. Finally, it should assist both countries in not only strengthening the contribution of National Systems of Innovation to support sustainability but also the emerging Global System of Innovation. Both Germany and South Africa are playing leading roles in an OECD project looking at how to strengthen international cooperation to address global challenges such as environmental sustainability.

The partnership draws from the ongoing collaborative projects in the fields of environmental science and sustainable technologies within the existing political framework for scientific and technological cooperation between the Republic of South Africa and the Federal Republic of Germany (See Intergovernmental Agreement on Cooperation in Science, Research and Technology, 1996).

The dialogue creates links between bilateral and multilateral cooperation lines. A significant milestone was the signature of a Joint Declaration of Intent on Cooperation in the Area of Science for Sustainability by the German Federal Minister of Education and Research Prof. Dr. Annette Schavan and the South African Minister of Science and Technology Mosibudi Mangena in February 2008. The Declaration confirms the countries' support for the G8+5 call for an internationally coordinated research agenda as part of the Heiligendamm Dialogue Process and in accordance with the results of the G8 Strategy Meeting on Africa's Science and Technology Consolidated Plan of Action. In the framework of the UN Earth Summit in Rio de Janeiro (1992) over 170 signatory states committed to translate the vision of sustainable development into practice by adopting Agenda 21, a global action programme designed to achieve sustainable development worldwide. Both countries, the Federal Republic of Germany and the Republic of South Africa, signed Agenda 21 and designed national strategies to promote fundamental political, social, economic and industrial change towards sustainability. Research for sustainability is one of the pillars in these national strategies.

Along the National Strategy for Sustainable Development the South African government adopted the 10-year Innovation Plan in 2007 which identifies five key grand challenges for its National System of Innovation. The need to contribute to sustainable development is reflected in all of the five grand challenges identified in the plan. Three of them play especially prominent roles. Firstly, Energy Security identifies the need for developing and deploying new energy technologies, including renewable energies and energy sources with a lower carbon footprint. Secondly, Human and Social Development identifies the need for new approaches to the challenge of change. Thirdly, the Global Change grand challenge has a major focus on innovation for sustainability.

A comprehensive 10-year Research Plan acknowledges that "the ways in which human societies engage with their environment to satisfy basic needs, stabilise and grow their economies, and improve their quality of life, affect and are affected by the natural cycles that regulate the land, water, and air. Changes are occurring so rapidly, however, that greater understanding of the Earth's natural processes, the human influence on these processes, and the interactions between the two, has become a global priority – as has the need to find ways to mitigate these changes where possible, and to adapt to them.

Work is also underway to accelerate the development of other environmental technologies and innovations that would support

Accelerating the development of environmental technologies and innovations that a minimum amount of energy for every resident is one of the bilateral goals

adaptation and resilience. These include water, agriculture, built environment, coastal protection, environmental monitoring, and environmental rehabilitation. This is located within a broader framework of developing the Environmental Goods and Services sector in South Africa.

Germany has placed sustainability at the core of its economic and social development agenda. Specifically, the German Research for Sustainability is aimed towards:

- **Developing strategies for social action with the goal of meeting fundamental needs while minimizing the risks for the long-term stability of nature and society;**
- **Gearing globalised value chains and production systems to sustainability while simultaneously securing the long-term competitiveness of the German economy;**
- **Shaping regional development with the goal of improving the quality of human life and at the same**

View of Downtown Johannesburg

time stabilizing the natural, social and economic bases of this quality of life on a long-term basis;

- **Managing natural resources with the goal of maintaining their functions on a long-term basis and concurrently preserving and fostering their regeneration capacity as much as possible.**

There are important overlaps between these focus areas and three of the four knowledge themes identified in the South African 10-year Global Change Research Plan. These are:

- **Reducing the human footprint;**
- **Adapting the way we live;**
- **Innovation for sustainability.**

III. Linking Sustainable Development and Innovation Policy

As we have seen above, sustainable development is one of the guiding principles in both countries' policies and science and technology play a significant role in meeting the pressing challenges of sustainable development. Beyond technology transfer and adaptation to local needs new technologies and services are required. Economic, environmental and social aspects are equally important when looking for sustainable solutions. The lack of attention to sustainability research by top policy-makers and the lack of acceptance of such research by mainstream science need to be addressed.

Germany's experience in sustainability science was shared and the paradigm shift noted from knowledge-oriented to interdisciplinary, solution-oriented research. Germany's 1st framework programme "Research for Sustainability" (2004-2009) had four thematic fields of action:

- **Concepts for sustainability in industry and business;**
- **Sustainable concepts for regions;**
- **Concepts for sustainable use of natural resources; and**
- **Societal action geared for sustainability.**

The second framework programme "Research for Sustainable Developments", commencing in 2010, will focus on:

- **Global responsibility – international networking;**
- **Earth system and geo technologies;**
- **Climate and energy;**
- **Sustainable economy and resources;**
- **Societal developments.**

As sustainable solutions require a concerted effort and an international coordination of research agendas, BMBF launched a series of dialogues on Science for Sustainability with key emerging economies. The initiative aims to establish the foundations for long-term, strategic partnerships in sustainability research, to increase bilateral cooperation in sustainability-related research, and to develop projects for the dissemination of already existing results.

The South African "Ten Year Innovation Plan" and the plans of South Africa encourage sustainable development, but in linking innovation and sustainable development three issues have to be taken into consideration: firstly, sustainable development strategies need to acknowledge political realities and is not value-free. Sustainable development pathways may differ between developing and developed countries. However, taking into account the strong influence of international governance on national strategies, strategic dialogues between developing and developed countries provides an important policy learning opportunity that can support the development of international policy environments that can support more fair and just outcomes.

Secondly, in many instances supporting the development of green or environmental technologies experience the same challenges and problems as any other technology. In addition, South Africa wants to ensure that the wave of interest in sustainability leads to long-term economic and social benefits for South Africa. As such, a key focus for South Africa remains the building of its National System of Innovation including the introduction of new institutional arrangements that better support commercialisation and R&D-led industrial development. This includes the establishment of a Technology Innovation Agency (TIA) and the development of specialised institutions called Centres of Competence to take forward specific commercialisation opportunities.

Finally, achieving sustainable development cannot happen through technological solutions only. Although it is easier to galvanise business and government interest on the development of new industries and jobs through technology-led approaches, the nature of the sustainable development requires innovations across a broad range of fronts including a better understanding of human and social dynamics and through a range of policy innovations. As such, these areas of research feature strongly in the 10-year Global Change Research Plan that will be implemented. Coupled to the research work, South Africa will be implementing specific mechanisms

The nature of the sustainable development requires innovations across a broad range of fronts, including a better understanding of human and social dynamics and through a range of policy innovations.

that enable the science that is generated to inform policy and decision-making. The South African-German Dialogue on Science for Sustainability is one such mechanism aimed at building the science-policy interface.

IV. The State of the South African–German Bilateral Cooperation in Science for Sustainability

South African-German bilateral relations in the field of science and technology embrace various projects in manufacturing, technology, innovation systems, biodiversity, and so forth. They are aimed primarily towards generating sustainable innovative technologies and services, and contributing to human capacity development. Apart from sixteen bilateral cooperation formats, there are bilateral and trilateral cooperation modalities. Trilateral and multilateral cooperation can involve several countries. In this case, cooperation draws on the strength of several countries by pulling together financial and human resources. This is a popular form of enhancing cooperation. Other platforms are workshops and seminars. There is also institutional collaboration, or know-how exchange. If these modalities are to be successful in a meaningful way, partners need to identify the objectives and assess the availability of funds.

Research for sustainability has increased in the context of the existing bilateral S&T agreement. The 1st German-South African Dialogue on Science for Sustainability in 2008 identified five topics for cooperation: environmental technologies and services, global change, sustainable energy use, sustainable resource management and sustainability innovation system analysis. These topics were incorporated into the 2009 call for proposals and three topics of mutual interest were added: biotechnology, nanotechnology and advanced manufacturing. Thus, the proportion of sustainability research proposals under the bilateral science and technology agreement increased from 25 % in 2008 to 51 % in 2009. Sustainability topics are also already part of the bilateral lighthouse projects funded on a large scale by research organisations, private sector, DST and BMBF – “Inkaba ye Africa”, “Biota”, “EnerKey”, “Communal Waterhouse”, “Integrated Water Management Olifants”, “GENUS” – as well as about 20 % of about eighty known independent projects.

The overall context for the future sustainability topics are COP-15, green jobs, and the South African REFIT that will also trigger research and development and applied sciences oriented projects in the context of climate change and renewable energy. Furthermore, a German-South African Memorandum of Understanding on (renewable) energy cooperation is currently being elaborated. On the environmental side, there is the international climate change initiative by the German Government with eight projects addressing climate change issues in South Africa. On the political level, the Dialogue on Science for Sustainability (D4S) and the meeting of the joint committee which took place at the beginning of 2010 will focus on sustainability projects and programmes. In the future, there will be projects focusing on: earth system sciences, sustainable land management, regional science services centres on climate change and others. One suggestion is to open up the dialogue to the industrial sector, particularly the participation of SMEs in projects under the S&T agreement in form of a joint research call. Consideration could be given to set up a cluster initiative on solar technologies. Similar to the European Union (EU), there could be a technology platform incorporating German and South African research organisations as well as the public and private sector.

V. The Way Forward

The partnership between Germany and South Africa has been mutually beneficial and needs to be continued and made more effective. However, two things need to be addressed. First, as there is a set of challenges that have a historical basis, also regarding conceptions of growth, we need to address how we do development and find solutions in an interdependent and resource-limited world. We need to see what is it what we require and what is it that we face. Thus, it is important to get the principles and objectives right. Secondly, both countries have very dynamic systems of innovations and although each party has different objectives, there is a need to strengthen the interaction between the two systems, especially when talking about sustainability. The dialogue should be a real partnership and there should be a full acceptance of ownership. A social approach, project orientation and the integration of industry is crucial for the dialogue that will be continued in the period 2010-2012.

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Welcome Address

Ambassador Dieter Haller
Embassy of the Federal Republic of Germany, Pretoria, South Africa

Ladies and Gentlemen,
Dear participants from Germany and South Africa,

It gives me great pleasure to welcome you on behalf of the German Federal Government to the second dialogue event on "Science for Sustainability". This discussion brings together both expertise and strong commitment from Germany and South Africa. I am honoured to be associated with this dialogue, as it truly is a distinguished gathering of leading sustainability experts from our two countries.

I would like to thank the representatives of the South African Department of Science and Technology, as well as the German Ministry of Education and Research for making this event possible.

The importance of "sustainable development" has gathered momentum throughout recent years in both Germany and South Africa – especially in the context of ongoing debates on global challenges, such as "climate change" and "energy security".

The Federal Government of Germany is strongly committed to its share of global responsibility regarding the principle of sustainable development. The dialogue for sustainability supports the implementation of the priority

Participants of the 2nd South African-German Dialogue on Science for Sustainability, "Innovation for Sustainability in a Changing World", 26-27 October 2009, CSIR Campus, Pretoria, South Africa

objectives of the Federal Government's Internationalization Strategy for Science and Research, as well as its High-Tech-Strategy.

We also witness the South African side establishing a solid foundation, and developing an awareness to the growing potential of "sustainable development approaches". Such measures and plans as the 10-Year Innovation Plan, the Global Change Research Plan or the feed-in-tariff for renewable energies underline these developments.

The dialogue builds upon these mutual scientific and technological interests in South Africa and Germany. I must say I am quite impressed by the momentum of it. The Joint Declaration of Intent on Cooperation in this area was signed by the Ministers in February 2008 in Bonn. The first dialogue event took place in June 2008, and now we are already in the midst of the second discussion. In Bonn, four thematic areas of cooperation were identified as highly relevant and interlinked topics: Environmental Technologies, Global Change, Sustainable Energy and Sustainable Resource Utilization are highly relevant topics.

Environmental technologies, such as renewable energies, recycling technologies or wastewater treatment technologies are already considered success stories for a better environment. So-called "green jobs" accompany this development both nationally and internationally. Global change has become one of the major topics on the international agenda, as the impact of climate change affects us all. Renewable energies and clean technologies are also closely linked to the necessary reduction of emissions. We need innovative concepts and strategies for sustainable resource utilization, such as sustainable land management, or dealing with mining impacts in order to be able to face the challenges of regional and global change.

Science plays a major role in this context. Without science, there is no basis to tackle these present and future challenges.

I would like to point out that "sustainable development" initiatives and measures are not only relevant for politicians, scientists and intellectuals, but for the men and women out on the street as well. We are all affected by the impact of climate change. Green jobs are not only possibilities but already realities. We care for our children so our well-being should not be a cost to future generations. In this respect, science and technologies, as well as educational and awareness-raising measures for society are vital.

Translating science into products and services has always been a major challenge. Thus, I am all the more delighted to see that entrepreneurs are also participating in this dialogue.

I would like to encourage and invite all participants to make the most out of this special event and to use this great opportunity to lay a strong foundation for future collaborations between Germany and South Africa in this highly relevant area.

I wish all of you a very fruitful and successful dialogue and all the best for the already existing and the forthcoming German-South African partnerships.

Thank you for your attention!

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Decoupling and Sustainable Resource Management – A South African Perspective

Prof. Mark Swilling
School of Management and Planning, University of Stellenbosch, South Africa

Although the South African Government has systematically increased financial support for scientific research because it is believed that scientific knowledge reinforces development, this self-same community of scientists is generating research that raises very serious doubts about whether South Africa's resource-intensive economic growth path can continue in light of the rapid depletion and degradation of the country's natural resources (see Burns & Weaver 2008).

Global Context

There is a broad global consensus that we face the unprecedented twin challenge created by inter-linked economic and environmental crises. As the economic and environmental crises mutually reinforce one another, decision-makers across the public, private and non-profit sectors in both the developed and developing world intensify demands for practical solutions. A succession of global mainstream assessments over the past decade have together raised very serious questions about the sustainability of a global economic growth model that depends on material flows that have reached – or soon will reach – their natural limits (Barbier 2009; Gleick 2006; Intergovernmental Panel on Climate Change 2007; United Nations Environment Programme 2007; United Nations 2005; Watson et al 2008;

Prof. Mark Swilling answering a question from the audience

World Resources Institute 2002; World Wildlife Fund 2008). The crisis of resource depletion and the negative economic implications of climate change have even been be recognised by mainstream reviews such as the Stern Report (Stern 2007) which estimated the economic costs of climate change and the International Energy Agency, which finally acknowledged in 2008 that the “era of cheap oil is over” (International Energy Agency 2008).

The International Panel for Sustainable Resource Management (IPSRM) has highlighted the crucial role that material resource flows and associated environmental impacts (see http://www.unep.fr/scp/rpanel/biofuels.htm). By resource flows, we mean primarily the metabolic flow of fossil fuels, biomass, minerals and metals through the global economy. The focus is on extraction and domestic use of materials quantified in tons. The aim is to analyze the relationship between economic growth and resource use. Material Flow Analysis (MFA) is the methodological tool that is used to conduct this analysis. MFA has matured over the past five years and has become an established method for assessing the sustainability of local, national and global economies (Bringezu & Schutz 2001; Bringezu & Bleischwitz 2009; Bringezu et al 2004; Fischer-Kowalski 1998; Fischer-Kowalski 1999; Haberl et al 2004; Krausman et al 2008; see Krausmann et al forthcoming).

Policy and strategic decisions can be made that foster the relative/absolute decoupling of both resource use and impacts in contextually specific ways that reduce the significance of resource limits as a constraint to growth (Swilling et al 2010).

Limits of Resource–Intensive Growth[1]

It is becoming increasingly apparent that key ecological thresholds in South Africa are being breached by its prevailing approach to growth and development, and that this is resulting in dysfunctional economic costs. This condition of rising costs caused by a new set of material, ecologically driven constraints sets the context for new ways of thinking about the country's economic growth model and poverty reduction strategies.

Since the first democratic elections in 1994, South Africa has experienced an unprecedented growth period that came to an end towards the end of 2008. As a resource-rich resource exporting country, South Africa benefited from the rise in commodity prices over the past decade, but suffered as they collapsed temporarily during 2008 as a result of the global financial crisis.

[1] This section is based primarily, but not exclusively, on background research materials commissioned to inform the writing of the National Framework for Sustainable Development that was adopted by Cabinet in June 2008. The materials were circulated publicly and most are available on www.deat.gov.za. The commissioned research papers are referenced in the subheadings that follow, and additional research integrated where necessary. Because this section relies quite heavily on these papers, they are not specifically referenced in detail. The supporting research and backup references can be found in these commissioned papers.

In short, South Africa is a good example of an economy caught up in the financialization of a globalised economy, with debt-driven consumption as the key driver of growth. This has undermined manufacturing as tariff barriers have been lowered and cheap imports from Asia have risen. It has also resulted in debt-financed consumption spending, and increased dependence on revenues from exported primary resources at low prices. The unsustainability of this growth strategy is partially recognised by the Government and key stakeholders, and various interventions are being considered by a wide range of state institutions, including the Department of Environmental Affairs, National Treasury, Department of Trade and Industry, Department of Human Settlements, Department of Energy, Department of Water Affairs, Department of Transport and key financial institutions such as the IDC and DBSA. However, South Africa is a robust constitutional democracy with three layers of Government (National, Regional, Local) that are, in turn, relatively independent from one another. This has resulted in very low levels of intra-governmental co-ordination. Each sector responds to the sustainability challenges in their own way. What is lacking is a government-wide approach that connects industrial policy, resource management strategies and protection of eco-system services. However, 2010 is slated as a key year for consolidating the Green Economy policy framework, which could become the focus of the newly established National Planning Commission. In February 2010, the Cabinet approved a Department of Environmental Affairs document entitled Proposals on Green Jobs – A South African Transition. This will be followed up by a comprehensive strategy document called National Green Economy Strategy which will be considered at the Cabinet Legotla in July 2010 which is fairly soon after the Green Economy Summit planned for 19-21 May. Both the IDC and DBSA are working together with the Department of Environmental Affairs to work out detailed financial plans for implementing the Green Economy Strategy. In the meantime, the Gauteng Government has adopted what it calls a "Developmental Green Economy Strategy" that is heavily focussed on decoupling by targeting investments in renewable energy, water efficiency, recycling of solid and liquid wastes, moving people into public transport and massively increasing locally produced food to improve food security and create jobs.

Conclusion

The dominant economic paradigm in post-apartheid South Africa has to date failed to address a wide range of underlying resource constraints that will almost certainly undermine many preconditions for growth and development. The body of evidence that has emerged over the past decade at both the global level and within South Africa clearly demonstrates that there are very serious material resource and ecological limits to the type of growth and poverty eradication policies that are proposed by economic policy think-tanks such as the Growth and Development Commission (that the Minister of Finance so admires). With significant exceptions, growth models have not emphasised the need for decoupling growth rates from rates of resource consumption and associated declining quality of the environmental systems that we depend on for things like clean air, productive soils, and clean water. Reversing this trend will require policy frameworks and interventions that are currently absent from national economic policy documents but which are slowly starting to emerge, with 2010 clearly set to be a watershed year. However, it is one thing to formulate policy; it is a very different matter when it comes to implementation through inter-institutional coordination, budget reform and regulatory interventions. Like many other policy realms, the South African state's capacity to formulate policies is not matched by its capacity to implement these policies.

There is broad consensus around two economic and social challenges for South Africa's second decade of democracy:

- **How to boost growth to 6% and ensure a more equitable distribution of wealth;**
- **How to eradicate poverty, with special reference to the Millennium Development Goals.**

The sustainability perspective means there now is a third challenge, and due to the adoption of the NFSD and LTMS, this is being recognised:

- **How to decouple growth rates and poverty eradication from rising levels of natural resource use and waste.**

Many of South Africa's leading scientists have been saying for some time that economic growth policies are premised on incorrect assumptions about the health and durability of our natural resources and eco-system services. Aligning economic policy with Section 24 (b) of the Constitution is not simply about preserving the environment. As other countries have experienced, it is also about preventing wasteful expenditures on avoidable system failures. But above all, it can also be about the creation of new opportunities for driving non-material forms of growth that improve quality of life for all, forever.

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Sustainable Development – Some Lessons on Governance

Prof. Dr. Reimund Schwarze
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South Africa is about to implement its National Strategy for Sustainable Development (NSSD) in 2010[1]. Germany's NSSD is moving into its second phase, re-adjusting its NSSD of 2002[2]. What lessons can be drawn from Germany's first phase on how to govern sustainable development as a national strategy?

While the concrete meaning of sustainable development (SD) in Germany and in South Africa is fairly different, the lessons in governing SD in Germany, specifically regarding the changes from 2002 to 2008, may be of importance for South Africa in implementing its own NSSD.

The German NSSD and its Review

The German NSSD is guided by four principles of sustainability:

- **Generational Justice;**
- **Quality of Life;**

[1] Sustainable Development. South Africa's National Strategy for Sustainable Development (2006)
[2] Perspektiven für Deutschland. Unsere Strategie für eine Nachhaltige Entwicklung (2002). http://www.nachhaltigkeitsrat.de/en/home/

- **Social Cohesion;**
- **International Responsibility.**

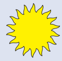
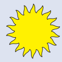
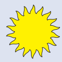
These principles are based on indicators, i. e. a set of quantified targets, to allow for a regular, biannual monitoring of success. The process of monitoring is undertaken by the German statistical office in Wiesbaden. The synthesis of this monitoring and the reporting of results are controlled by a roundtable of under-secretaries of the chancellery. A board of advisors, consisting of well-known and respected public figures, e. g. representatives from the Church, reaches out to all actors in society, not just government.

The German NSSD was reviewed in 2008[3]. Lessons from this review may be of importance for South Africa when implementing their own NSSD. Success or failure of the NSSD is judged in this review on a four grade (weather-based) scale:

- **Sunshine: Target can be achieved;**
- **Partly cloudy: Could be missed by 5-20 %;**
- **Cloudy: Could be missed by more than 20 %;**
- **Heavy rain: Development goes into the wrong direction.**

The German NSSD consists of 21 indicators. Two thirds (14 of 21) of the indicators are social or economic indicators. This demonstrates the great importance given to the social and economic dimension of sustainability in Germany. In contrast to this dominant approach, I have selected eight indicators for this short review (in the table) with a relative bias towards environmental indicators because of the special interest of today's participants in this conference.

[3] Björn Stigson (Chair of the Peer) (2009), Sustainable Development in Germany - Conclusions from the Peer Review of Sustainable Development policies in Germany, 9th Annual Conference of the German Council for Sustainable Development, Berlin 11/23/2009.

Goal (Indicator)	Development (2002-2008)	Grade
Steady moderate growth (Per capita income)	Per capita income has been rising in real terms from 1991 to 2007 at about 23.8 %, on average nearly 2 % per annum. This can be called a steady, moderate growth. It was non-destructive in as much it was accompanied by progress in many environmental indicators.	
Kyoto-targets for climate protection	Emission of greenhouse gases decreased by more than 20 % (20.4 %) compared to 1990. The Kyoto-Targets for the 2008-2012 period will be achieved.	
Doubling the share of renewables	The share of renewables rose from 2002 to 2007 from 2.1 % to 6.7 %. The target of 2002 – to double the share of renewables in both primary energy use and electricity production - has been surpassed.	
Doubling resource productivity	Resource productivity – a measure of usage of all non-biotic material, including imported goods – did not constantly move into the right direction and is far from being in line with the projected goal of doubling by 2020 if no additional measures are taken.	
Increasing ODA to 0.51 % of GNP in 2010 and 0.7 % in 2015	Official development assistance did increase from 0.31 % of Gross National Product (GNP) to 0.37 % (by almost 20 %) but is not on the way to reach the interim target of 0.51 % in next year and 0.7 % in 2015. Additional measures will have to be taken.	
Balanced budget	The national budget deficit seems on track after a hefty break out following the German reunification (and the consequent period of high unemployment in the mid-nineties, and then again in the early 2000s). 2007 was the first year to have a positive balance of public finance, i. e. cutting back on debt, but this could not be sustained during the last two years in the face of the financial crisis.	
Full-time schooling	Full-time schooling is an important measure to increase chances for women to participate in formal employment and seen as a key to also change the current trend of a decreasing birth rate. It should achieve 60% by 2020, while preschool and nurseries should reach 35% in 2020. The kindergarten goal has been grossly missed mainly due to the fact that the enforcement of pertinent policies lie at the communal level where they face serious difficulties in implementation.	
Limiting the usage of virgin land for urban development to 30 ha/ day by 2020	Similarly, the enforcement of the 30ha-Goal was left to the local and regional level, and failed because of this split responsibility between different levels of governance. The daily "land consumption" did not significantly decrease in the last decade, and is far from meeting the target level (106 ha/day in 2008).	

Newly built houses in Johannesburg are provided with solar geysers to produce hot water in an eco-friendly way

Some Lessons on Governance

Overall, the results of the 2002 strategy are mixed with relative success on the side of energy and climate protection and relative disappointment in the field of social sustainability and developments which are enforced at the sub-national level. These deficits were acknowledged in the 2008 audit of the sustainability strategy. A major recommendation from this review is to strengthen the “management of sustainability” through legal and organizational measures, and to enact additional policies and measures where target failure was indicated. A major innovation in regulation is the introduction of Sustainability Impact Assessment (SIA) for federal laws and regulations. Additional policies and measures were introduced in fields where targets seemed too relaxed (i. e., in the cases of climate protection and the desired share of renewable energy). Cornerstone new regulation is the so-called 20-20-20 rule – the EU’s integrated energy and climate policy programme towards 2020. It demands:

- **A reduction of climate gases minimally by 20 % (in fact, 30 % are promised if all major economies agree to cut greenhouses gases by 2050 in half at COP15 in Copenhagen);**
- **A 20 % share of renewables in primary energy and electricity production;**
- **A 20 % increase in energy efficiency, mainly achieved by new rules for buildings and products, the so-called eco-design directive.**

To meet the targets for ODA, new ODA programmes of 3 billion Euros per year were released, and Germany played a constructive role in G8 negotiations on international debt relief in Gleneagles and Heiligendamm. To decrease land consumption, sustainability impact assessment is made mandatory in communal land zoning and regional planning. Federal tax incentives for building new homes (on "greenfields") were cut to zero. Other measures were enacted to counteract stated deficits, but their list is too extensive to elaborate upon here.

These examples reveal that reporting of failures to meet quantified goals resulted in concrete legal and economic responses by the federal government under the German NSSD. My conclusion in looking at the results from six years of NSSD in Germany is as follows: effective national sustainable development policy needs quantified targets, appropriate economic framework conditions (undistorted prices insomuch as they are feasible), stronger "management tools" (such as SIAs at varied levels), coherent multi-level governance and powerful, central institutionalisation – best located at the chancellery.

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Concept and Implementation of Ecological Industrial Policy in Germany and Relevant European Strategies

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The discourse on the costs and benefits of environmental policies has changed fundamentally. Studies like the Stern Report (Stern 2006) or the study on the Economics of Biodiversity (TEEB 2009) have pointed out that environmental degradation inevitably leads to tremendous economic losses. Other studies demonstrate the economic potentials of environmental technologies and services (e.g. Roland Berger 2007, BMU 2009, Jaeger et al 2009). A number of national and European policies have been developed to exploit the potentials of the fast growing markets and to further stimulate environmental technologies.

It is difficult to delineate environmental technologies from other mainstream technologies. Official statistics focus on technologies with the main purpose of cleaning the environment or preventing further pollution. The investments in these technologies have been in decline in most countries for several years. The picture is different for technologies with other purposes, e.g. the provision of energy, mobility, housing, etc., but with a lower environmental impact compared to other mainstream technologies. The markets for such technologies are growing at a fast pace worldwide. The global turnover for such technologies is estimated for 2007 at 1.400 bln EUR and expected to rise to 3.100 bln EUR until 2020.

Environmental technologies have evolved for Germany into a major economic activity. The share of the GDP is estimated as high as 8 % and

The capacity of photovoltaics has risen rapidly over the last years

expected to rise to 14 % in 2020. Germany holds a favourable position in the world markets. However, other economies, mainly Japan, China and the US are catching up and developing large and ambitious programmes. The new Obama administration has announced that it will invest $150 bln over 10 years in R&D in climate-friendly technologies. Japan will spend $30 bln in the coming five years. South Korea spent 80 % of its stimulus package in green technologies, while China spent 1/3 of its package (the largest of the world). Both are farther ahead of German efforts.

The strategy for Ecological Industrial Policy (EIP) is defined as the core German policy in this international green race. It is mentioned in several studies and policy documents (Jacob 2009). There is no specific instrument assigned to EIP. Rather, it employs a multitude of approaches. The focus is not only on the development of technologies, but also on their market introduction, the broad diffusion and support for the export. Although there are many different instruments possible (see Rennings and Jacob 2008), the focus is on spending programmes in support of green technologies throughout the phases of the business cycle. Demand side instruments such as regulations to enforce private investments have not been fully utilised.

In the European Union, several policies in various domains are relevant for the promotion of green technologies. The promotion of green technology

Renewable energies, such as wind power or renewable fuel, are driving economic modernisation

is not fully integrated within the meta strategies, such as: the Lisbon Strategy, the Strategy for Sustainable Development or the Better Regulation Strategy, all of which aim to provide guidance for the development of sectoral policies. Comparing European R&D policies with environmental policies and economic policies, R&D policies score best in terms of potentials and the actual orientation towards the promotion of green technologies. Environmental policies are ranked second and economic policies, third. In the latter, there are still counteracting policies, which emphasise the support of existing, conventional technologies (Hertin et al. 2008). Overall, there is a lack of mainstreaming. The implementation in concrete policies and in the Member States falls short. The focus is often limited to climate issues, the potentials of global diffusion are not utilised, and there are few efforts made to increase the demand for green technologies.

Industrial policies to promote industrial sectors and to transform industry as a whole have a transformative potential beyond the technologies, the resources and the forms of energy usage. Historically, the replacement of energy sources was linked to new production models, new core technologies and industries, and new institutions (Jänicke and Jacob

2009). The phases of transition are phases of redistribution between firms, sectors, regions and revaluation of capital and qualifications. It is open to debate regarding which regions of the world will be successful in leading the development towards more sustainable industrialisation. It will be a transformation that is not only market-driven, but requires active and helpful governmental policies.

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Linkages of Sustainability and Environmental Management Accounting

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The aim of this paper is to provoke thought leadership and challenge the implementation of Environmental Management Accounting (EMA) in South Africa as a tool for sustainability by investigating how companies in South Africa account for and manage environmental costs. EMA practice is still in its beginning stages in developing countries, compared to developed countries where research and implementation of EMA has steadily increased over the last two decades, involving universities, industries and governments (Ambe, 2007).

Sustainability is defined as "forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs". Meeting the needs of the future generation depends on how well interconnected economic, social, and environmental objectives of sustainability are balanced during current decision-making process. Environmental Management Accounting (EMA) incorporates and integrates two of the three building blocks of sustainability - environment and economics - as they relate to an organization's internal decision-making, and EMA provides the economic rationale for organisational involvement in sustainable development (Burrit, 2004; Schaltegger & Wagner, 2006).

EMA is broadly defined as the identification, collection, analysis, and use of two types of information for internal decision-making:

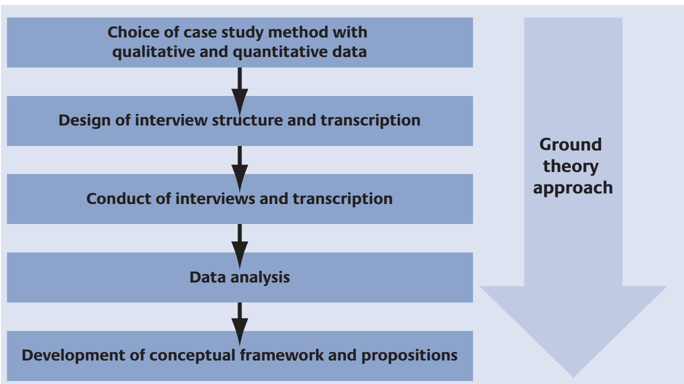
- **Physical information on the use, flows, and fates of energy, water, and materials (including wastes); and**
- **Monetary information on environment-related costs, earnings, and savings (Jasch, 2008:7).**

In line with the above definition, the he following research questions were used for this study:

- **Research question 1: To what extent do South African companies identify, collect and analyse; (i) physical information on the use, flows and destinies of energy, water and materials?**
- **Research question 2: To what extent do South African companies identify, collect and analyse; (ii) monetary information on environment-related costs, earnings and savings?**

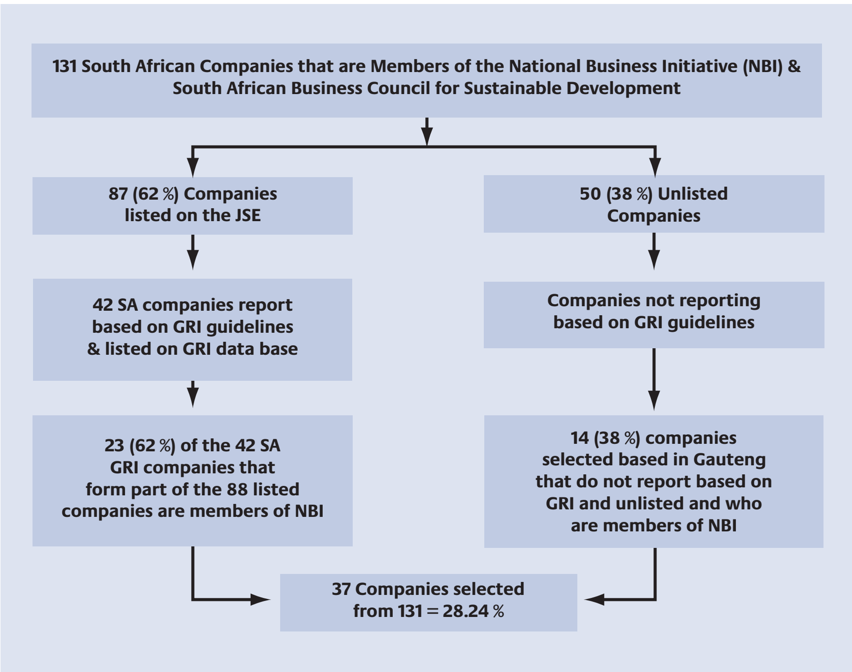
Methodological Framework:

A grounded theory approach employing an exploratory qualitative technique was used for this study. Grounded theory is a qualitative research analysis technique whereby theory is generated from the collected data (Locke, 2001), as illustrated in the figure below.



Overview of research method

Thirty-seven personal interviews were conducted with environmental managers, SHE managers and financial personnel from three industry sectors (mining and petrochemicals; manufacturing and industrial; and services sectors). Interview data was triangulated with an examination of sustainable development (annual reports) and other documentation of the case companies and industry data to validate the findings. The sample for the case study (as depicted in the figure below) was made up by 62 % of companies listed in the Johannesburg Securities Exchange (JSE) and producing sustainability reports based on the Global Reporting Initiative (GRI). 38 % were composed of companies not listed (on the JSE) and who do not report based on GRI guidelines.



Selection of Samples for the case study

Findings

The study demonstrates strong evidence of physical information on environmental management accounting (high to extremely high) as reflected in the summary table 1 below, by companies in the case study. The extent of generation and recording of physical quantities of material and energy input, material flows, products, waste and emissions for internal decision-making are driven by legislative conventions and the drive towards sustainability reporting. Conversely, monetary information of environmental management accounting detailing environment-related costs, earnings and savings are found to be mixed (low to somewhat high – see Table 2 below). Monetary environmental management accounting (MEMA) especially in the mining and petrochemicals industry is driven by legislative requirements with respect to environmental rehabilitation provision, decommissioning costs, restoration costs and producer environmental trust. While there is some significant evidence of environmental cost being accumulated and recorded, there is little evidence of an established monetary environmental management accounting system.

Table 1: The generation and recording of physical environmental information;
where, (1) is extremely low, (2) low, (3) somewhat high, (4) high and (5) extremely high.

	1	2	3	4	5	6	Total	Total %
Raw and Auxiliary Materials	11.1%	8.3%	16.7%	19.4%	44.4%	0%	36	100%
Packaging Materials	13.9%	19.4%	11.1%	30.6%	22.2%	2.8%	36	100%
Merchandise	16.7%	19.4%	19.4%	22.2%	16.7%	5.6%	36	100%
Operating Materials	5.6%	2.8%	36.1%	27.7%	27.7%	0%	36	100%
Water	2.8%	2.8%	16.7%	36.1%	41.7%	0%	36	100%
Energy	0%	2.8%	8.3%	30.6%	58.3%	0%	36	100%
Products	11.1%	11.1%	22.2%	22.2%	33.3%	0%	36	100%
By-products	16.7%	19.4%	30.6%	16.7%	13.9%	2.8%	36	100%
Solid Waste	8.3%	13.9%	36.1%	16.7%	24.3%	0%	36	100%
Hazardous Waste	19.4%	8.3%	33.3%	13.9%	22.2%	2.9%	36	100%
Wastewater	19.4%	8.3%	27.7%	19.5%	22.3%	2.8%	36	100%
Air Emissions	16.7%	19.4%	24.3%	13.9%	22.2%	2.8%	36	100%

Note: One respondent was unsure of the facts of his company on these questions; (Difference in the total column is due to statistical and rounding off error).

Table 2: generation, record and accounting for monetary environmental information; where, (1) is extremely low, (2) low, (3) somewhat high, (4) high and (5) extremely high.

	1	2	3	4	5	6	Total	Total %
Material Costs of Product Outputs	8.1%	21.6%	16.2%	24.3%	24.3%	5.4%	37	100%
Material Costs of Non-Product Outputs	8.1%	35.1%	18.9%	13.5%	18.9%	5.4%	37	100%
Waste and Emission Control Costs	18.9%	24.3%	16.2%	8.1%	24.3%	8.1%	37	100%
Prevention and other Environmental Management Costs	16.2%	27.0%	21.6%	10.8%	21.6%	2.7%	37	100%
Research and Development Costs	16.2%	13.5%	40.5%	8.1%	21.6%	0%	37	100%
Less Tangible Costs	35.1%	21.6%	16.2%	5.4%	16.2%	2.7%	37	100%
Environmental operating expenditures independently of other operating expenditures	13.5%	32.4%	16.2%	10.8%	18.9%	8.1%	37	100%
Environmental capital expenditures tracked independently of capital expenditures	5.4%	35.1%	21.6%	13.5%	13.5%	10.8%	37	100%

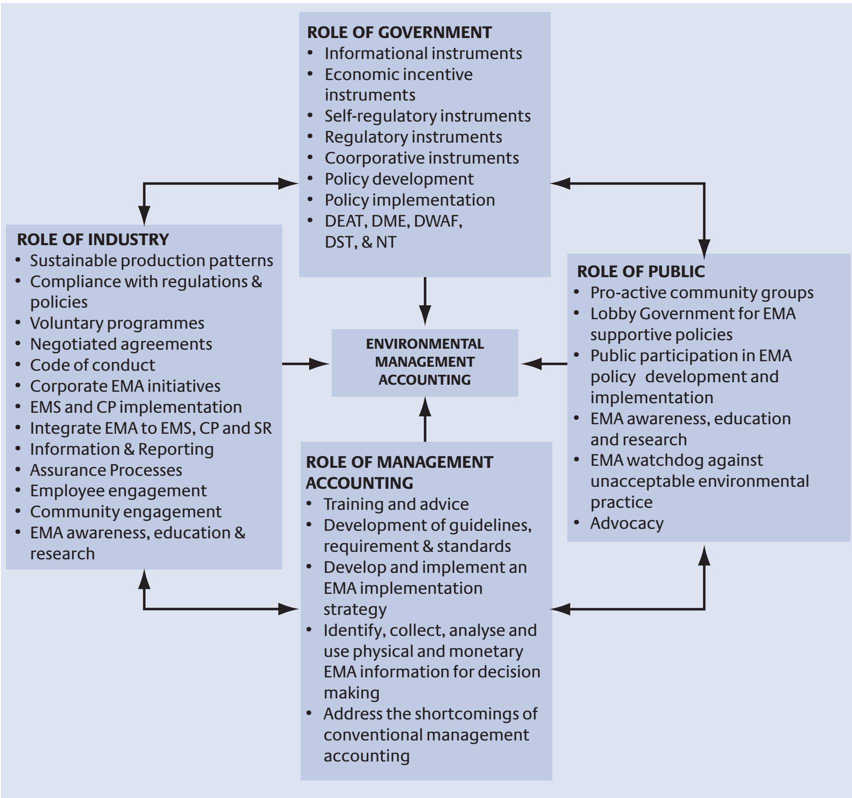
Note: Difference in the total column is due to statistical and rounding up error

Based on the above findings, the figure on p. 41 presents a conceptual framework for the implementation of environmental management accounting in South Africa to attain sustainability.

The EMA framework is developed around four background frameworks:

- **Framework 1-Developing vs. developed country: South Africa has large world class companies with developed country characteristics including environmental impacts that the developing country cannot cope with;**
- **Framework 2-Government: There are various world class environmental legislations and initiatives but with little capacity and resources for enforcement;**

- **Framework 3-Industry: Because of poor enforcement of legislation, companies take the easy way out (such as litigation) for short term gains that undermine sustainable environmental practices;**
- **Framework 4-Public: Civil society is unaware of environmental or EMA issues and can not advocate against unacceptable environmental practices, and they do not have the resources to buy environmentally friendly products.**



EMA Implementaion framework for South Africa

Cosmas M. Ambe from the Environmental Management Accounting Network, University of Limpopo shared information on the links between sustainability and environmental management accounting

The framework depicts that any successful implementation of EMA will require: government, industry, accountants and the public playing important roles. This model provides additional guidelines and action plans for implementation for each of the role players for the implementation of EMA in South Africa. The paper further suggests a greater integration of EMA to other environmental management systems, enforcement of legislations, training and the introduction of tax and other incentives to promote EMA to achieve sustainability.

Conclusion

Based on the findings in Section 3, the following propositions can be stated in relation to the practice of EMA in South Africa:

- **South African companies identify, collect and analyse physical information on the use, flows and destinations of energy, water and materials. However, these may be due to the application of other sustainability management tools, and not from an EMA system;**
- **The extent of identification, collection and analysis of monetary information on environment-related costs, earnings and savings is mixed (low to somewhat high) with high environmental sensitive industry MEMA being driven by legislative requirements on environmental rehabilitation provision, decommissioning costs, restoration costs and producer's environmental trust;**
- **A framework for the implementation of environmental management accounting in South Africa will enhance the practice of EMA within an integrated approach with other environmental tools.**

While the study included only thirty-seven companies, it consisted of the full population of companies that subscribe to the South African Business Council for Sustainable Development and also reported based on the GRI guidelines, and are sensitive to environmental issues. Therefore, the study, while not generally conclusive on the South African situation provides an indication of the direction of the practice of EMA in South Africa and the suggested framework and action plans are applicable and can be adapted by all sectors and industries in South Africa and other developing countries.

The findings of the study increase our understanding of environmental management accounting issues in South Africa and the extent of EMA applications. The conceptual framework for EMA implementation will inform policy pathways for the promotion of EMA and hence sustainability.

When applied correctly, EMA can lead to environmental cost savings, cost avoidance, liability reductions and other significant financial benefits. EMA will produce the most benefits when it is integrated with other environmental management tools. In particular, EMA will increase the advantages that a company may gain through the implementation of environmental management systems (EMS). Linking EMA with cleaner production and environmental reporting will show the financial gain that can be achieved by applying these tools, since contingent liabilities represent major environmental, business and financial risks for companies. EMA is also excellent for supplementing risk management programmes.

Corporate sustainability requires responsible management decisions and action (CSR). Management decisions supporting corporate sustainability require good a information basis (including relevant environmental and social information).The company's central information system is accounting (management accounting). The core question is: What kind of information does management need to improve corporate sustainability?

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Science for the Future: The Potential of Inter- and Transdisciplinary Sustainability Research

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Sustainability research is aimed at meeting the challenge of dealing with important societal problems related to the "metabolic" processes between society and nature in a global context. Besides generating knowledge about the characteristics and dynamics of the complex processes involved (e. g. climate change, loss of biodiversity, the degradation of soils and forests and increasing poverty and hunger), it should generate normative knowledge regarding the evaluation of these processes, and develop strategies for social change towards sustainability.

The complexity and the character of the problems sustainability research is confronted with can only be handled by an interdisciplinary research team. Additionally, normative questions and the need for decisions in situations of uncertainty require a transdisciplinary research design involving actors from life world as equal partners.

Challenges of Inter- and Transdisciplinary Research

Interdisciplinary research is facing the challenge of integration for theoretical and methodological approaches from different disciplines.

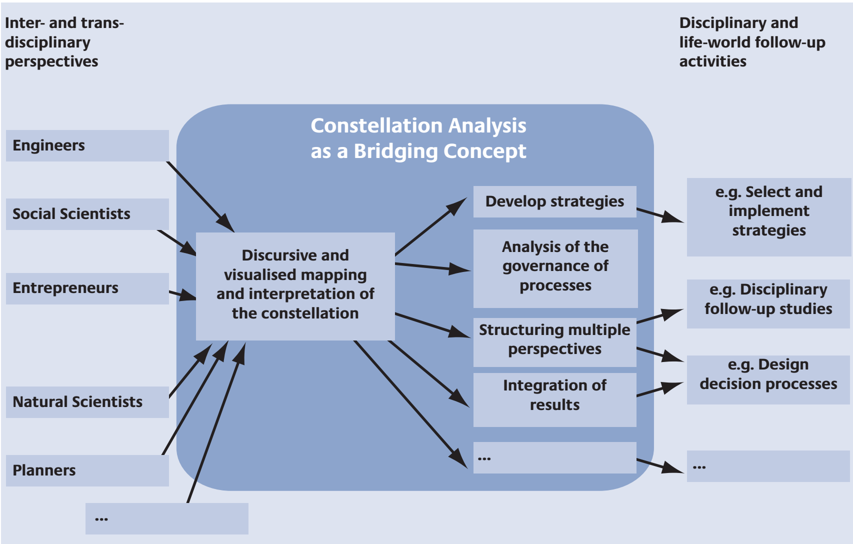
Scientists have to agree on a common definition for the research problem. If life world actors are included in the process, the problem of speaking "different languages" and acting with different rationalities is even greater. While scientists aim at a thorough understanding, and have to apply their methods according to scientific standards, decision makers in politics or business often are obliged to make decisions under the pressure of time.

Achieving a mutual understanding in inter- and transdisciplinary research teams, and ensuring subsequent success from this cooperation, is therefore a demanding process, which should be supported by adequate cooperation management.

The Center of Technology and Society at the Technische Universität Berlin has a lot of experience in carrying out inter- and transdisciplinary research (Schäfer 2007a/ 2007b; Schäfer and Boeckmann, 2004). To integrate practitioners in the research process, it is applying innovative participation methods such as citizen juries and exhibitions. It has published several handbooks on inter- and transdisciplinary cooperation management (von Blanckenburg et al., 2005; Schophaus et al., 2004,) and developed a tool for inter- and transdisciplinary discourse: the constellation analysis (Schön et al., 2007).

The Constellation Analysis: A Tool for Inter- and Transdisciplinary Discourse

The constellation analysis has been applied in several projects in the field of innovation or sustainability research (e. g. Kruse, 2008; Ohlhorst, 2009; Schön et al., 2007, Meister et al., 2005). It begins with a collective and iterative graphical mapping of the relevant elements and relations of the issue under investigation. In the mapping process, differences between social actors, technical elements, natural elements and systems of signs are highlighted. However, there is no a priori decision about their relevance for the issue under consideration. Including these elements on equal terms and visualizing the constellation allows the different disciplines, as well as the practitioners to contribute with their specific perspective.

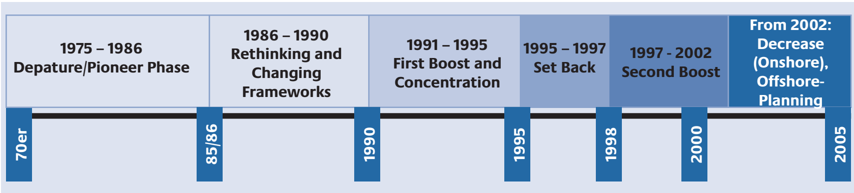


Constellation Analysis as a Bridging Concept (Source: translation from Schön et al., 2007)

By identifying the dominant actors and relations, the constellation analysis facilitates discourse about the status quo of a problem, and creates transparency about different perspectives. It can be used for mapping different stages of a certain process (e. g. an environmental conflict or an "innovation biography"). It can also be applied to mapping possible future developments, anticipating a change in elements or in their relations. Furthermore, it can be helpful by integrating the results of different disciplines.

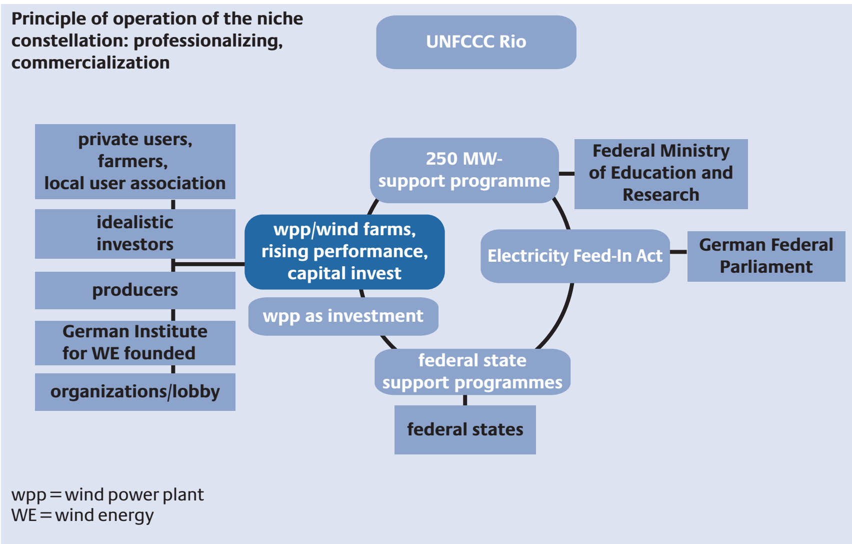
Innovation Biography of the German Wind Energy Sector: One Example of Applying the Constellation Analysis

The German wind energy sector has seen rapid growth during the last 40 years and was marked by a dynamic process of innovation. Germany has

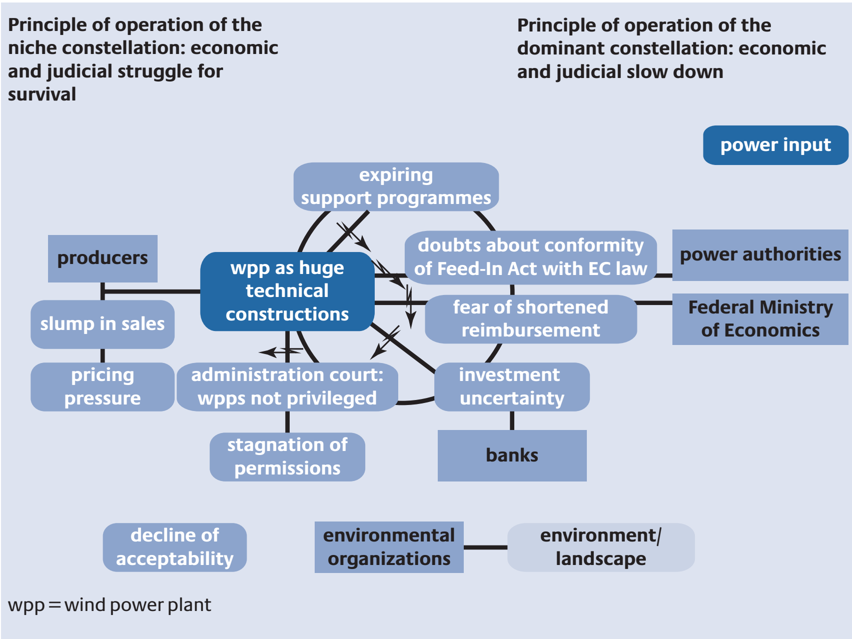


Phases of the development of the German wind sector (source: Ohlhorst 2009)

become the world's leading wind energy producer. The research project "Innovation Biography of Wind Energy" (Ohlhorst, 2009), proceeded from the hypotheses that in the course of the innovation of wind energy, both the network structure of decision makers and the application of technology shifted. It was assumed that the technical and natural elements are closely linked to institutional and social developments, and that this



1991-1995 First Boost and Concentration (source: Ohlhorst 2009)



1995-1997/98 Set Back (source: Ohlhorst 2009)

heterogeneous constellation is permanently reorganised. To be able to understand the dynamics of this innovation process, the constellation of the wind energy sector was mapped in different phases. In an inter- and transdisciplinary research process, the relations between the main elements and the impact of regulation measures could be understood. This process allowed the actors of the wind energy sector to learn from the history of the sector for future developments. Furthermore, it is possible to transfer knowledge about the innovation history of one sector for understanding commonalities and differences in other sectors (solar energy, energy from biomass). The picture on p. 48 (above) summarises the development of the German wind energy sector in different phases, the pictures on p. 48 (below) and on p. 49 show examples of the constellation in two phases.

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An Innovation Systems Approach to Sustainable Development

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The orthodox theory of economics implicitly places the issue of sustainable development within the category of externalities, which are due to "market failure". This is one of the few areas where neoclassical welfare theory allows for public sector intervention in the economy. The reasoning behind this is that the price mechanism, which is normally seen as the perfect allocation mechanism, fails to recognise the costs imposed by the production activities of one party on another party. Thus, in the case of negative externalities, e. g. in the case of pollution, market determined costs underestimate the total cost of a certain line of production to society as a whole. This is also seen as an estimation failure of private cost-benefit analysis.

The chief reason, which is usually quoted for the existence of such externalities, is a deficiency in the allocation of property rights, which prevent those parties on whom external costs have been imposed from exercising their rights in demanding compensation. The consequent underestimation of the total cost to society therefore leads to production levels, and associated levels of environmental degradation, which exceed those that would be "optimal" from a marginalised perspective. In such cases, state intervention in the form of the allocation of property rights, and of the imposition of taxes, quotas and even perhaps outright bans are deemed as justifiable interventions in an otherwise perfect resource allocation mechanism. However, what was originally seen as an exception

Prof. Mario Scerri (IERI) presents on "Innovation Systems Approaches to Sustainable Development"

to the orthodox welfare maximisation criteria has relatively recently come close to dominating the centre ground of economic discourse as a rapidly accelerating rate of global environmental degradation is now generally accepted as the main overall medium to long term binding constraint on global economic growth and development. The current deficiency in addressing these externalities is generally attributed to a deficit in political will and inadequate legal provisions at national and global levels.

The evolution of legal frameworks is closely tied to theory. In the case of economic laws, we should perhaps re-examine their foundation in economic theory if we hope to understand the current failure to address the sustainability problem with the required efficiency. Mainstream economics has largely detached itself from the social sciences in its quest to emulate the hard sciences through the adoption of mathematics as the sole language of the discipline. In the process, the engagement with other disciplines in the social sciences, with their tendency to introduce analyses that are often not quantifiable, has mostly been abandoned. This is best seen in the shift from political economy to (neoclassical) economics as the orthodoxy in economic theory. One of the consequences of this shift has been to introduce a sharp dichotomy between the two constructs of the "private" and the "public" which has come to be accepted as a non-questionable, self-evident reality. This development and the strengthening of the truth effect of this posited dichotomy has been cumulative and path dependent, not only within the discipline itself, but also because of the mutually reinforcing relationship with the evolution of legal frameworks.

A "systems of innovation" approach to economics may, through its firm grounding in political economic theory, provide a viable alternative theoretical basis for a novel approach to the problem of sustainability. This approach emerges from evolutionary economics and its origin may be traced back to Friedrich List's (2005) refutation of Adam Smith's advocacy of the welfare benefits of free trade. This approach views economic systems as webs of linked institutions within an inescapably dynamic context, where innovation is the driving force of economic change. Innovation is nowadays defined to extend far beyond technology to encompass all alterations in economic organisation, which are seen to be an improvement on a previous state. Institutions are defined to include formal and informal institutions in the form of established routines and practices. This approach in its popular articulation of "national systems of innovation" has until now been confined to the empirical and conceptual perimeters of the nation state. However, it also applies to more localised systems at the sub-national level and broad systems at the regional and even global levels.

The relevance of this approach to the sustainability debate lies in its conceptualisation of complex systems where the range of institutions and their various modes of interrelatedness blur the sharp distinction between the public and the private spheres. As a consequence, it erodes the theoretical foundation of the concept of externalities, which is premised on the compartmentalisation of economic agents. From within this body of theory we can start thinking of cost from the basis of total economic cost, which includes the valuation of those costs (and benefits) which neoclassical theory relegates to the category of externalities. In shifting the conceptual base of value away from that of exchange to a broad one within which exchange values determined by market transactions are a subset, we lay the foundation for an approach to economic cost-benefit analysis, which from the start incorporates considerations of sustainability in its economic calculus. Thus, we would have an analytical framework, which would no longer have to "add-on" the analysis of environmental costs to its theoretical core. Instead, such costs would already be incorporated in theory. The shift to this alternative economic paradigm would also carry implications for a reformulation of policy and of the associated legal structure. This, however, is where the power/knowledge complexities have to be considered. All three interlinked breaks in theory, policy and law are simultaneously subject to the interplay among diverse power bases, including the vested interests of the various fractions of capital in all of the variations of capitalism, to civil organisations and to governments. In terms of advocacy for a concerted effective approach to sustainability, all three fronts have to be addressed simultaneously by a combination of academics from the social and the hard sciences, civil organisations, international bodies and national governments. The implications of the sustainability debate thus provide what is possibly a historically unprecedented study in the link between theory and praxis at the global level.

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Green Markets of the Future – An Economic Opportunity also for Newly Industrializing Countries?

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Competences for green development and leapfrogging in Newly Industrializing Countries (NICs) are becoming increasingly urgent from a global perspective. The integration of these innovations into the development process of the rapidly growing economies requires knowledge build-up and technology cooperation. The prospect of exporting sustainability technologies can add an incentive for NICs to move towards sustainability technologies.

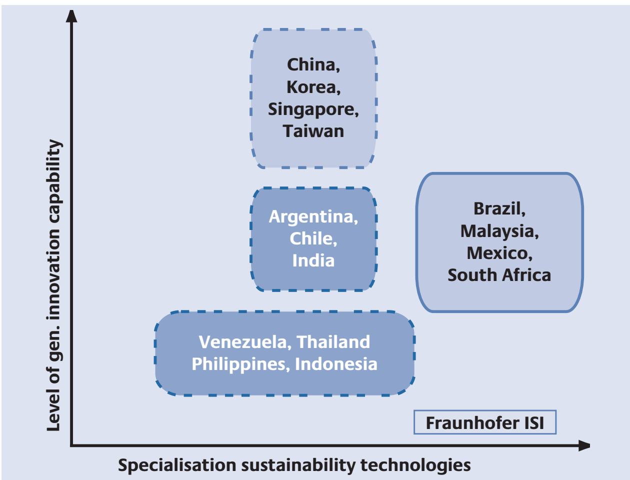
Methodology

The competences for green development are analysed with an innovation indicator approach. The general innovation capabilities are evaluated using R&D indicators and survey results regarding general innovation capabilities. Technological competences in the sustainability fields are a key indicator for the absorptive capacity of sustainability technologies and for the ability to export them. International patents and publications, and successes in foreign trade indicate to what extent a country is already able to participate in global technology markets (see Walz et al. 2008; Walz 2009).

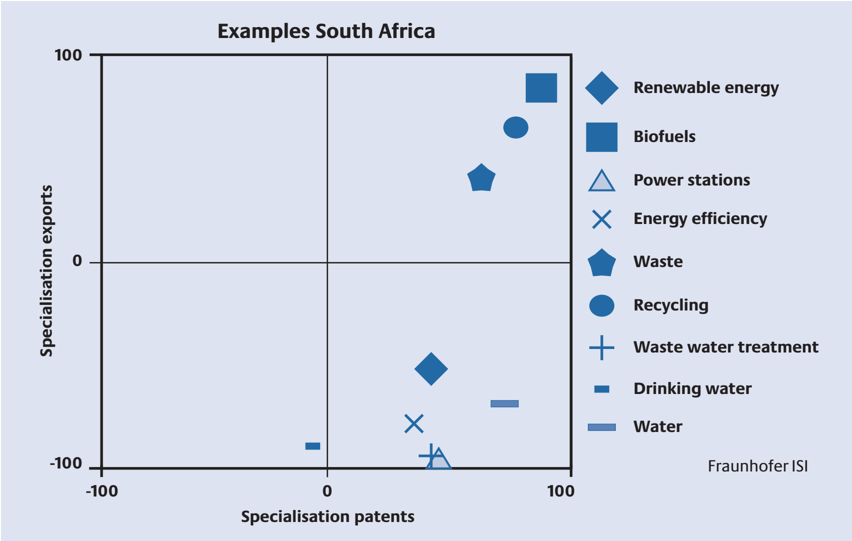
Results

The resulting pattern shows various strengths and weaknesses of the analyzed countries. In some fields, e. g. material efficiency, the knowledge build-up is above average for the Newly Industrializing Countries. There is a strong need for strategic positioning of the countries, and for coordination of the various policy fields involved.

However, the capabilities for supplying green markets are quite different between each NIC. Some NICs have already obtained a substantial level of general innovation capability. However, this is achieved without specialization on sustainability technologies (e. g. China, see Walz/Ostertag 2009). Other countries have somewhat lower general innovation capabilities, but are specializing on sustainability related technologies. Countries in both clusters are likely to have good opportunities to participate in green markets of the future. This is more unlikely to happen in the near future for the NICs that show neither strong general innovation capability nor specialization on sustainability technologies.



Country clusters of NICs capabilities for green technologies



Specialisation of South Africa for selected sustainability technologies

A disaggregated analysis of South Africa reveals significant differences between the technological fields. In some areas such as biofuels, South Africa is already showing strengths in both increase of the knowledge base and success in export markets. In other fields, it is necessary to transfer the strong knowledge base into products that can be marketed.

However, moving towards a greater role in supplying green markets of the future also requires additional efforts. First of all, higher attention must be paid to sustainability technologies within the national research priorities. This calls for research programmes specifically targeted towards sustainability. Second, the supply oriented R&D policies have to be augmented with a demand oriented innovation policy. The demand for the green technologies is strongly influenced by the (environmental) regulatory system. Thus, the latter must be tailored to enhance further innovations. Strengthening environmental regulation must be seen not as a trade-off

PD Dr. Rainer Walz during his talk

between environmental protection and economic development within the NICs, but as an instrument of demand-side driven innovation policy in one of the most dynamic growing economic sectors. This also calls for integration of the traditional R&D policies with the demand-side oriented policies, which are typically performed by different actors – a challenge which is not unique to NICs, but which can be found in almost every OECD country, too.

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Success Factors of Eco-Innovation and Lead Market Strategies

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We ask for the opportunities and potentials for an international diffusion of environmental innovations. It is most often pioneering states that effectively push for both advances in global environmental policy and development of environmental innovations. These phenomena might be analysed as lead markets for environmental innovations.

Lead markets are geographic markets which have the characteristic that produce or process innovations. These are designed to fit local demand preferences and local conditions, and can subsequently be introduced successfully into other geographical markets or commercialised worldwide without many modifications. In the model of international diffusion of innovations, a lead market is the core of the world market where local users are the early adopters of an innovation on an international scale. Examples for lead markets include the facsimile machine in Japan, the Internet in the USA and the cellular phone in Scandinavia. Innovation economics ascribes the emergence of lead markets to five groups of factors that lead countries might have advantages over: prices, demand, transfer of innovations, export, and market structure.

We understand lead-markets for environmental technologies as regional or national markets that were stimulated by higher preferences for environmental goods in a given country, by specific supporting measures, or policy interventions, which are able to influence the markets in

The solar industry has become a revelant economic sector in lead countries

other regions effectively, trigger reactions of adjustment and lead to an international diffusion of the new technologies. Through this, we take into account that environmental innovations have to be largely ascribed to governmental (or NGO) activities. Furthermore, environmental innovations provide marketable solutions for environmental problems, which are encountered worldwide or at least in many countries.

The emergence of international markets for environmental technologies is supported by the diffusion of appropriate policies. Standard solutions in certain pioneer countries diffuse worldwide, causing a substantial convergence in policy formulation at national level – often irrespective of extremely different capacities for action. The diffusion of policy innovations depends on the characteristics of the innovation and the underlying problem, capacity for environmental policy in the adopting country, and support by international organizations.

For our purposes, it is crucial to understand why countries forge ahead in their environmental policy regulations, and under which circumstances that policy is successful in terms of increasing the share of domestic companies in international markets and thus, increasing employment and incomes at home. Modern, game-theoretically founded environmental economics supports the view that a stricter environmental policy ahead of other countries, despite increases in costs of regulated firms, can, under certain conditions, improve the competitiveness of domestic enterprises.

Finally, it is necessary to analyse the behaviour of companies, in particular multinationals. They are potentially agents of diffusion of technologies and standards. Two approaches of management sciences may be utilised here: on the one side, Porter's strategic positioning school, and on the other side, the resource-based view on firms.

The emergence of lead markets for environmental innovations cannot be explained by one single disciplinary approach. All of the distinct theoretical approaches defined by their methodologies and their respective objects of research contribute to the analysis of this phenomena. An integrated framework of analysis is developed here.

The challenge for most eco technologies is the upscaling from pilot to mass markets

The wind market is mainly driven by regulation

The concept of our research is as follows: Asking (1) for a description of the innovation design, the lead market, the regulatory measures which were taken in the pioneering country, and the actors involved, (2) an analysis of the lead market factors of the country, (3) the lead market factors of the innovation, and (4) the lead market factors of the policies supporting innovation and diffusion.

Conclusions can be drawn regarding the types of innovations which successfully diffused on the world market, the properties of the leading countries and of the policies supporting the innovation and diffusion.

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Involving Industry: Key Challenges of Bilateral Research and Development Cooperation between South Africa and Germany

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Society, in particular well-developed countries such as Germany, is driven by increasing wealth. This also means an increase in the use of all types of resources. Emerging countries such as South Africa are significantly growing in population and economic power and rapidly closing in the gap on highly developed countries. Thus, responsibilities of the developed countries emerge: supporting and fostering the development and implementation of sustainable approaches to growth in South Africa and other less developed countries, allowing for peaceful living worldwide. Significant research and development (R&D) efforts are necessary to attain this goal.

Competitiveness – Innovation – Cooperation

Securing and expanding competitiveness is the goal that countries, regions, enterprises and research organisations aim for. Competitiveness is the basis for wealth and well-being. Worldwide, it is recognised that innovation is a key to securing and increasing competitiveness.

Co-operation with South Africa offers prospects of expanding markets as energy efficiency in industrial processes, public and private buildings and installations

Examining the areas where innovation takes place, it can be noted that the intelligent combination of known technology, the exploration of the borders and limits of known technology, and the consideration of different viewpoints merge into a melting pot for the initiation of innovation. Thus, cooperation ensuring this integration of various knowledge and viewpoints is a driver for innovation.

Innovation means, “exploring something new”. R&D therefore is an important issue since R&D generates new knowledge. Often the R&D is only carried out in dedicated R&D institutions, with weak ties to industry.

Industry on the other side is constantly seeking out new opportunities and solutions for securing and expanding their competitive edge. Therefore, R&D carried out in industry in cooperation with dedicated R&D institutions and in particular the industrial exploitation of the R&/D results must be the aim of measures supporting innovation in a region or a country. Stimulating the cooperation and strengthening the link between R&D institutions and industry will increase innovation.

Key Challenge: Involving Industry in R&D for Sustainability

The governmental and public sectors face the important tasks of demonstrating the opportunities for industry to shift its business focus to areas relevant for sustainable development. They can achieve this by initiating and implementing certain related social, legal and fiscal boundary conditions. In addition, incentives provided to the private sector are important for supporting this transition to a sustainable economy. The public sector will never dispose of the necessary financial resources to be able to single-handedly support this paradigm change towards such a sustainable economy and related sustainable growth.

Therefore, the challenge is to arrive towards a common understanding, create competitively-oriented strategies and to integrate the global challenge of sustainable development. The necessary R&D efforts might be stimulated by governmental sources, but in the end, the private sector has to adopt this strategy to maintain its competitive edge and to create wealth in its micro environment. If the private sector fully adopts the paradigm change, nearly unlimited resources for R&D will be mobilised, new economies will emerge and society as a whole will benefit.

As the most important part of the private sector, industry is very focused on its technology, products, processes, and existing and potential markets. R&D for sustainability as an aim for governments, on the other hand, is a very broad issue. A transformation of these broad aims into focused thematic priorities is necessary in order to meet the industrial understanding of sustainability R&D. A specific purpose out of a set of focused thematic priorities for sustainability R&D might then be adopted by industry, leading to the desired significant involvement of industry in sustainability R&D.

Proposed Thematic Priorities of Sustainability R&D of Industrial Interest

The strategy of identifying sectors for sustainability R&D of industrial interest is based on identifying industrial sectors where the German industry has a very good or leading competitive position in the world market, and where cooperation with South Africa offers prospects of expanding markets, or of exploring new technological paths. A few sectors are obvious:

- **Renewable Energy: Solar and wind energy in particular;**
- **Energy Efficiency: Industrial processes, public**

The strategy of identifying sectors for sustainability R&D of industrial interest is based on identifying industrial sectors, e.g. the recycling sector with monitoring of waste streams and the waste origin, waste treatment technology, planning and development of regional waste management structures.

and private buildings and installations;
- **Recycling: Monitoring of waste streams and the waste origin, waste treatment technology, planning and development of regional waste management structures;**
- **Water Technology: Waste water treatment technology, securing drinking quality and quantity;**
- **Health: Introduction and implementation of mobile diagnostics for doctors in rural areas.**

Programmatic Requirements for Fostering German-South African Bilateral Sustainability R&D

Existing public support schemes for bilateral and/or international R&D cooperation for German stakeholders to cooperate with foreign countries outside the European Union are (if existing at all) not matching the interest and need of the industry. Therefore, it would significantly advance the mutual efforts for sustainability R&D if a dedicated funding programme, attractive for industry, co-financing bilateral industrial collaborative R&D&I projects with pre-defined priorities relevant to industries, would be initiated and implemented in South Africa and Germany in a harmonised manner.

If through these means the involvement of industry in sustainability R&D within bilateral cooperation can be achieved and increased, R&D efforts executed at the level of R&D institutes are complemented. The overall significant activity level will lead to achieving critical masses of efforts in sustainability R&D.

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Global Solutions to Global Challenges

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The most recent global financial crisis served as yet another reminder of the extent of globalization in the first decade of the 21st century. The worldwide climate change and global warming dialogue, combined with discussions on the rate of progress with the Millennium Development Goals, have all served to emphasise the old African concept of "Ubuntu". Ubuntu dictates that the state of health of an individual or an individual country is interdependent with the health of the community or in the case of a country, the international community. This creates further impetus for the development of collaborative global knowledge partnerships to address global and local challenges. The South Africa-Germany partnership represents important opportunities in this regard. This partnership already contributes to the development of the African Science and Technology platform through regional projects and has great potential to contribute to global solutions to such issues as global climate change.

Collaborative partnerships are generally organised into one of three levels. The first is a classic bilateral country-to-country or institution-to–institution partnership. This describes the nature of the South Africa – Germany Science and Technology Bilateral Cooperation Agreement, and the supporting Programme of cooperation.

Dhesigen Naidoo (University of Pretoria) discusses global solutions to global challenges

The second partnership is based on both countries' memberships within a larger consortium constructed around more players with mutual interests. This is defined by the author as a polylateral collaboration modality. In the context of Africa, this modality is utilised as an opportunity to contribute to a broader global sustainable development agenda. This could be in the form of a tripartite project between South Africa, Germany and an African Least Developed Country (LDC). In this scenario, South Africa and Germany carry the costs of their participation, and a German Development Agency funds the participation of the LDC.

The third level consists of two partners who are members of a multilateral platform developing and implementing decisions and work programmes. The global platforms that will demand science for sustainability cooperation include the World Summit on Sustainable Development (WSSD) and the supporting Johannesburg Plan of Implementation, the UN Framework Convention on Climate Change and all other Multilateral Environmental Agreements (MEAs) to which South Africa and Germany are both signatories and active parties. In this context, both countries have the opportunity to lead the implementation of these agreements through science for sustainability partnership projects. A subset of this category is the African multilaterals. In particular, the AU/NEPAD platform for both Science and Technology as well as Environment is the form of cooperation that takes forward the sustainable implementation of the Africa Science and Technology Consolidated Plan of Action and the AU/NEPAD Environment Plan.

These relationships and actions have to be established in a nesting that organises the bilateral activities to add value to the achievement of the multilateral goals and that the multilateral projects strengthen the bilateral relationship. Furthermore, these two sets of activities should actively seek opportunities for the third modality of polylateral projects.

It is through these collaborative efforts that we will be able to afford partners in both countries, the benefit of critical mass development, multidisciplinary and diverse teams, access to the global laboratory, as well as the opportunity to develop solutions for local, regional and global conditions in a manner that adds value and capacity to the locality of the challenges.

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Towards Innovation Systems for Sustainability - The Role of International Cooperation

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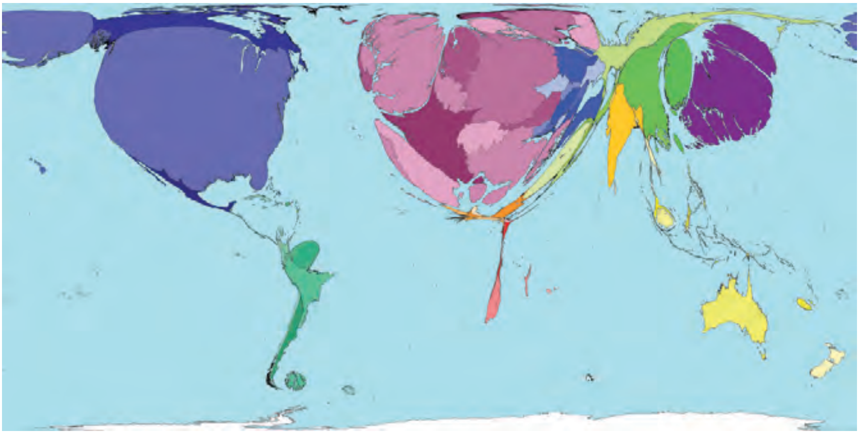
How can Science, Technology and Innovation (STI) contribute to achieving the Millennium Development Goals (MDGs)? Goal 1, reducing poverty, and Goal 7, ensuring environmental sustainability, are particularly relevant for the policy dialogue on Sustainability Sciences.

Stocktaking exercises, such as the MDG report 2009, show that the global objectives are unlikely to be met. However, international science and technology policies will be crucial in aiding these objectives up to the extent that they can be satisfied (UN 2009). To expand scientific and technological capabilities is crucial for economic growth in most developing economies, particularly in those countries that have established a domestic scientific basis.

In the implementation strategies so far, the MDG reports show, it is remarkable to note that developing technological capabilities in developing countries and S&T cooperation are not explicitly addressed. The main debate around the MDG focuses on the allocation of ODA and leaves scientific and technological cooperation aside.

Linking Science and Technology Cooperation with Development

Robust cooperation lines have evolved over the last decades between South Africa and Germany with regard to both development and science



Territory size shows the proportion of all scientific papers published in 2001 written by authors living there. There is more scientific research and publications of results, in wealthier territories. This locational bias is such that roughly three times as many scientific papers per person living there are published in Western Europe, North America, and Japan, than in any other region.

and technology. Some dynamics of the last few years may open important opportunities to use synergies between both forms of cooperation.

Science, technology and innovation has lost significance on the agenda of policy makers in the field of development cooperation since the 1960s. None of the focal areas for development cooperation within the German lead ministry refer explicitly to STI or to higher education. Most activities in the focal area related to education refer only to basic education and vocational training.

The same tendency can be observed along the cooperation lines of Science and Technology. They tend to focus on co-funded partnerships with other industrialised countries. The German government rarely funded STI cooperation with developing countries - except for reasons of infrastructure or interesting natural research topics, e.g. native flora and fauna. As opposed to scientists and policy makers in the developing countries, “Science and Technology” and “Development Cooperation” were not designed together.

All governmental cooperation effort is supposed to be committed to the Millennium Development Goals, approved by the global community in 2000. Unfortunately, this does not necessarily make it easier to advocate for a stronger role of STI or higher education in development cooperation.

Official German Development Cooperation has been channelling significant resources that may contribute to the building-up of scientific and technological capabilities, e.g. through a broad range of activities conducted by the German Academic Exchange Service. However, for decades there was no strategic focus placed on this field of activity. In recent years, the role of knowledge has been re-acknowledged in discourses on development. This shift has led to the approval of a BMZ concept paper “Knowledge for Development” in May 2009 (BMZ 2009).

Territory size shows the proportion of the world population in poverty living there (calculated by multiplying population by one of two poverty indices). The highest human poverty index scores are in Central Africa, the lowest are in Japan.

This paper reflects a commitment of German development cooperation to strengthening knowledge and innovation systems in partner countries. It reflects an increasing awareness that strong knowledge and innovation systems are necessary for sustained economic growth, and especially for a transition towards ecologically more sustainable growth patterns.

Another important framework paper, "The Strategy for Internationalisation of Science and Research", developed initially by BMBF, and adopted by the German cabinet in February 2008, is particularly important for two reasons. First, it recognises the need to enhance STI cooperation with developing countries. Secondly, it stresses the role of STI in addressing global challenges (BMBF 2008).

Finally, mitigation of – and adaptation to – climate change is a topic that is given high priority within German development policy. Whatever the concrete outcome of the Copenhagen Summit will be, the topic of technology and innovation in response to climate change will heavily influence the debate from 2010 onwards.

Scientific and technological cooperation, as well as development cooperation can clearly be complementary to each other in their effort to strengthen innovation systems in the partner countries.

The way forward: creating strategic STI – fostering Sustainability oriented Innovation Systems (SoIS)

How can cooperation in STI best be organised to address the global challenge of sustainable development? A useful approach to explain the determinants and dynamics of technological innovation is the innovation systems approach that focuses on the interaction of firms, governmental actors and researchers. Thus far, sustainability and environmental conflict has not been systematically integrated into this approach. Sustainability oriented innovation systems can be defined as networks of private and public actors who produce market innovations that reduce pressures on the environment (Stamm et al. 2009). Following the assumption that (global) public goods are under-supplied, SoIS differ from conventional innovation systems by attributing a more important role to policy (Fischer and Rennkamp 2009). Two reasons explain this. First, a private company will usually not exploit all of the benefits from investment in innovation activities (non-appropriability). Secondly, environmental costs continue to be largely externalised.

As a result, three policy types are necessary:

- **Demand side policies that help to create markets. These can be regulations that obligate the use of a certain environmental technology i.e. solar water heaters;**
- **Supply side policies are important to create the infrastructures for public science, research and development and human resources. These are necessary to build the knowledge and technological capability to create and adapt innovations. They differ in their explicit focus on the creation of environmentally relevant scientific knowledge and engineering capacity;**
- **Closely coordinated international cooperation to enhance the effects of both demand side policies and supply side policies. While STI cooperation focuses primarily on the creation of new knowledge, it can also contribute to strengthening technological capability and the demand side. Development cooperation is also usually applied on the demand side, assuming a strong role in education and capacity building. However, it can also be useful in strengthening the supply side. Such examples include: feasibility and foresight studies, policy consultancy to the formulation of regulation mechanisms, as well as initial funding for the introduction of new technological solutions to bridge the long way from an invention into market innovation.**

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Multilateral Approaches to Science and Technology Cooperation for Sustainability

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South Africa is a particularly apt place to talk about multilateral approaches to Science and Technology (S&T) cooperation as the Johannesburg World Summit on Sustainable Development remains a watershed moment. It was the Science and Technology Forum on Sustainable Development – part of the World Summit – that stressed the essential role played by Science and Technology for generating possible solutions to environmental and developmental issues, and emphasised that international cooperation is an effective tool for building upon scientific and technological capacities. In this article, we will examine different types of multilateral approaches to S&T cooperation, a number of examples of currently utilised strategies and, finally, the challenges that need to be addressed in order to increase the success of multilateral cooperation.

Overview of Existing Approaches

As there is a vast amount of approaches, initiatives, partnerships and organizations devoted to multilateral S&T cooperation for sustainability, it is important to structure them. A basic structure could be organised by:

- **The number of parties involved, ranging from two for the bilateral cooperation to many in classic multilateral approaches;**
- **Scope and extent, from sub-regional to regional and global;**
- **Focused on one sector or encompassing a number of sectors;**
- **Whether the primary objective is scientific knowledge or immediate policy relevance;**
- **Whether or not the mechanism is linked to a formal intergovernmental process; and**
- **Participants (intergovernmental, hybrid or non-governmental).**

This paper will be structured along 3 categories: intergovernmental, hybrid, and non-governmental.

Intergovernmental

In this category, we will examine two traditional partnerships (G8 and OECD) and one recently founded organization (IRENA). With regards to G8, we will only look at two trends: a greater focus on research and innovation and a step-by-step transition to more inclusiveness.

In terms of focus on research, the Carnegie meetings of G8 research ministers are a significant milestone as they provided an important venue for informal discussion of research ministers in a setting traditionally focused on economic policy. In 2006, four African research ministers were invited to the Carnegie meeting.

The first meeting of the Group of 20 in 1999, at the time composed only of finance ministers, recognised that as financial markets had gone global, there was also a need to respond in a truly global manner. This meant including more emerging economies into the discussions of G8 finance ministers. This meeting appears to be a precursor of today's G20.

An important milestone both in terms of inclusiveness and focus on research was the Heiligendamm Summit in Germany: the launch of a long-

G8 Summit in Heiligendamm: German Chancellor Angela Merkel in G8 group photo with Africa Outreach representatives, June 2007

term research initiative focused on global challenges and an invitation to emerging economies to participate in discussions. The launch of the Heiligendamm Process was the first institutionalised dialogue between the G8 and G5. Interestingly, one of its four working groups focused on research and innovation.

Finally, the Pittsburgh Summit was where heads of state designated the G20 as the premier forum for international economic cooperation. In terms of our interest, the big question of today focuses on how multilateral S&T cooperation can be firmly anchored in the emerging G20 framework.

Within the OECD Member States, there is increasing interest in the role of S&T for innovation. This is reflected in the OECD's flagship project:

Pittsburgh Summit: At the summit, the heads of states designated the G20 as the premier forum for international economic cooperation. September 2009

The Development of an Innovation Strategy, which has two main goals: fostering economic growth and tackling major global and social challenges. A particular emphasis is placed on cooperation across government departments for innovation (whole-of-government approach). As always in OECD work, there is a strong focus on the creation of a common conceptual understanding and a joint language which would enable exercises such as objective reviews of national innovation systems. The innovation strategy will be completed in 2010. As with G8, we have seen that the recent history of the OECD has been marked by more inclusivity and cooperation with non-members through formal and informal mechanisms.

In 2008, OECD – through its Committee for Scientific and Technological Policy (CSTP) – concluded that the strengthening of multinational S&T

cooperation to address key global challenges is an important question for S&T policymakers. An important aspect in this regard, for example, is that six countries have observer status in CSTP: the three OECD applicant countries of Russia, Israel and Chile, as well as Brazil, China and South Africa. CSTP's new work will focus on identifying and promoting more effective approaches and governance mechanisms for multinational S&T cooperation. The first step in this work programme was the organization of a Workshop on International Cooperation to Address Global Challenges - New Approaches and Governance, organised jointly by Germany and the OECD. This workshop set the stage for a work programme that is expected to result in recommendations for a reform of the governance mechanisms of multinational research and technology cooperation. To sum it up, there are three important developments at OECD: 1.) higher emphasis on S&T as a key part of innovation strategies in OECD Member States; 2.) institutional opening of OECD through the enlargement of membership and observer status, and, 3.) specific work programme on effective approaches to multilateral S&T cooperation.

The International Renewable Energy Agency (IRENA) is an intergovernmental network. It was officially established in Bonn in January 2009. It is inclusive on a voluntary basis but thus far not entirely comprehensive. As of today, 143 states and the European Union signed the Statute of the Agency; amongst them are 48 African and 37 European states. IRENA aspires to become the main driving force for promoting a rapid transition towards the widespread and sustainable use of renewable energy on a global scale. It envisages providing practical advice and support for both industrialised and developing countries, thereby helping to improve frameworks and to build capacity. While the focus of IRENA is applied, it will rely on input from research, particularly through its centre of innovation and technology hosted by Bonn. IRENA plans to add value by regularly consulting and cooperating with organizations and networks in the field of renewable energy with a view of creating synergies.

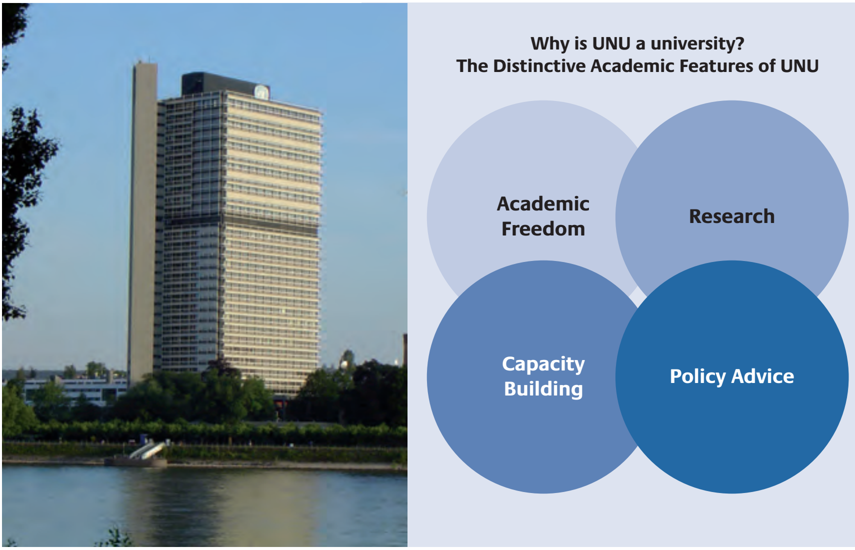
Hybrid

The International Panel on Climate Change (IPCC) is probably the most well-known mechanism for S&T cooperation and the scientific mechanism with the highest amount of media and political attention. There are several interesting aspects about it. First, the IPCC has a very narrow focus. Secondly, it does not conduct any research of its own. Instead, it focuses on a single purpose: to present a scientific consensus view on the current state of climate change and its potential environmental and socio-economic consequences. Reports can also incorporate varied views within a scientific community.

The results are widely accepted as neutral because of the mandate and the diversity of the IPCC contributors. One point is particularly important in the context of the South African-German Dialogue on Science for Sustainability: the IPCC has been a highly effective instrument in communicating scientific results to policymakers and society. One possible explanation for its success is that it attempts to present one consensus view. This is a stark contrast to the usual situation in science-policy interaction characterised by high complexity and an absence of a clear message or agreement. One possible explanation for this is that the IPCC was founded over two decades ago, and it required time for it to evolve. In addition, there are a confluence of other factors, including the Nobel Prize for Al Gore and the Stern Report.

Nevertheless, the IPCC recently came under attack for lack of scientific rigor related to an unsubstantiated estimate regarding the melting rate of Himalayan glaciers. In order to ensure confidence in the scientific process underpinning the assessments of the IPCC, UN Secretary General Ban Ki-moon and the IPCC Chairman, Dr. Rajendra Pachauri, have requested an independent review of the processes and procedures followed by the IPCC during the preparation of its Assessment Reports.

Another example of a hybrid mechanism is United Nations University (UNU). The UNU was founded in 1973 by the General Assembly as a decentralised scientific network of research institutions. Its mission is to



Established in 2007 as the first UNU Vice Rectorate outside Tokyo, the United Nations University Vice Rectorate in Europe (UNU-ViE) is dedicated to developing knowledge-based sustainable solutions to global problems

contribute, through research and capacity building, to efforts dedicated to resolving the pressing global problems that are of utmost concern to the United Nations, its Peoples and Member States. The UNU is an international community of scholars, a bridge between the UN and the academic world, a think-tank for the UN system, a developer of capacities and a platform for dialogue and ideas. Its distinctive academic feature is its academic freedom as the UNU receives no funding from the UN.

The University is comprised of the UNU Centre in Tokyo and a worldwide network of Research and Training Centers and Programmes assisted by numerous associated and cooperating institutions. These core units work in collaboration with each other as well as with a broader network of several designated UNU Associated Institutions and hundreds of cooperating institutions and individual scholars and researchers worldwide. The work of the UNU focuses on Global Sustainability including science, technology and society, climate, energy, economics. In 2007, the UNU established its Vice Rectorate in Europe, with a view of strengthening the UNU's presence in Europe and initiating, supporting and coordinating projects aimed towards developing intellectual capacity building and knowledge transfer, with a geographical focus on Europe, Russia, Central Asia and Africa. The Vice Rectorate also hosts the Secretariat of UNU-IHDP, which is part of the Earth System Science Partnership.

A recent strategy of the UNU is twinning. The goal of twinning is to intensify global research and teaching interaction. The idea is that each research institute in a developed country should have a twin in a developing country. Twins develop a joint research agenda and spend at least 50% of time on joint projects. An important point here is that the twinning instrument is meant to move away from ad-hoc research cooperation towards a long-term and equal partnership. One example is the twinning of UNU-MERIT in Maastricht, the Netherlands and Consortium for Economic and Social Research in Dakar, Senegal, which was initiated in April 2009. MERIT and CRES have similar research interests and complementary research portfolios.

Non-governmental

Some of the partnerships on the other end of the spectrum that are non-governmental in nature and focus on research, include the Earth System Science Partnership (ESSP) and the Consultative Group on International Agricultural Research (CGIAR).

The ESSP is a partnership for the integrated study of the Earth System, the ways that it is changing, and the implications for global and regional sustainability. Work is conducted through each of its four programmes which united after the Global Environmental Change Open Science Conference in Amsterdam in 2001. These programmes are:

- **DIVERSITAS (The International Programme of Biodiversity Science);**
- **IGBP (International Geosphere-Biosphere Programme);**
- **IHDP (International Human Dimensions Programme on Global Environmental Change);**
- **WCRP (World Climate Research Programme).**

The ESSP brings together researchers from diverse fields, and from around the globe, to undertake an integrated study of the Earth System. This is obviously a very complex and comprehensive structure and it is important that the four major programmes joined forces. Still, we need to ask how such a coalition and vast network can be organised in such a way that the whole is more than the sum of its parts.

CGIAR is a network of fifteen research centers with one common mission: to achieve sustainable food security and to reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy, and environment.

The primary institutions in the System are:

- **The Consultative Group on International Agricultural Research (CGIAR/the Group);**
- **An independent Science Council; and**
- **15 international agricultural research Centers.**

In 2006, the fifteen centers created the Alliance of CGIAR center to further strengthen collective efforts.

Challenges

There is a number of underlying challenges in multilateral S&T cooperation that need to be addressed if cooperation is to be effective and useful for all partners involved. First, there is a need to recognise tensions and tradeoffs on both sides, such as, for example, income growth and social cohesion vs.

international responsibility for Germany (see p. 27) and South Africa's need to meet development needs (job, quality of life) vs. decarbonization and biodiversity protection.

While dealing with the dimensions and determinants of frameworks for cooperation, we need to see whether we are dealing with the disciplinary or what some contributors call the real-life world (see p. 45), and question exactly what kind of science that implies. This is a source of ongoing tension in the CGIAR system, for example. Many of the researchers seek to make a contribution to better agriculture on the ground in southern countries; however their organizational performance is measured by the extent of their formal publications in northern journals.

In addition, we need to ask ourselves whether we are seeking to address policy, application or innovation. For example, in the area of water resource management, the kind of research required to establish policy on how to manage water is very different to that required to monitor trends in water resources or to develop new approaches to resource management. Yet, this could become extremely important in the choice of partners. Thus to partner with an organization committed to the implementation of Europe's Water Framework Directive would need to recognise that the Directive is seen, in many quarters, as a relatively extreme policy and indeed one with significant competitive implications for potential partners.

Therefore, it is useful to ask whether the proposed field of work would be potentially competitive, as for example would be the case in the cooperation between Denmark and China in the development of certain wind-based renewable energy systems; synergistic, as could be the case in cooperation on solar power between Germany, which has many of the technologies, and South Africa, which has many possibilities for the application and further development; or whether the area is one in which the potential for cooperation and competition is not yet clear, as for instance in the case of platinum based fuel cell technologies.

A more fundamental question is whether the values underpinning the societies concerned are shared. Thus, South Africa and Germany are agreed on the importance of promoting long-run sustainability and "decarbonizing" the global economy. However, in the field of hydropower, there are clear conflicts between the primacy of human development on the one hand and the protection of biodiversity on the other.

Once cooperation is established, it is also important to have monitoring systems that reflect the intent of such cooperation. Thus, if the sole intent is to generate research, mechanical indicators such as the number of peer reviewed papers published, or patents registered will be sufficient. But if the intent is to achieve changes in the real world, more subtle outcome-based measures will be required.

There are some tough, practical questions that need to be addressed. Is the framing of research in itself a mechanism for lobbying policy objectives? Are partnerships entered into solely in order to gain access to resources? Is the process one of promoting the partner's comparative advantages?

It is helpful to have these issues on the table as efforts proceed to establish partnerships because, by considering and addressing them, it is more likely that acceptable and mutually beneficial mechanisms will emerge. In the broader sense, the challenge for cooperation between Germany and South Africa in the area of sustainability research is to ensure that, in the language of UN negotiations, approaches emerge that reflect the "common but differentiated responsibility" context.

Conclusion

The variety of approaches reflects increased international attention to multilateral cooperation in Science and Technology for sustainability. There are no lack of initiatives, organizations and partnerships on different levels. There is a slow transition towards inclusiveness, even if this is often still on an ad-hoc basis. There is need for more effective architecture and better governance of multilateral cooperation in science and technology. There is a number of underlying challenges in multilateral S&T cooperation that need to be addressed if cooperation is to be effective and useful for all partners involved.

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Research for Sustainability and the Bilateral Science and Technology Agreement

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The 1st South African-German Dialogue on Science for Sustainability in 2008 identified important themes for D4S cooperation. Four crucial topics were addressed: 1.) environmental technologies and services; 2.) global change; 3.) sustainable energy use and 4.) sustainable resource management. The 2009 call for proposals built upon these four essential topics, and added three more themes of importance: biotechnology, nanotechnology and advanced manufacturing.

Results

With the successful incorporation of these focal points, the proportion of sustainability research proposals under the bilateral science and technology agreement increased from 25 % in 2008 to 51,5 % in 2009. A wide array of sustainability-related topics are already a part of bilateral lighthouse projects funded on a large scale by research organisations, private sector, DST and BMBF- Inkaba ye Africa, Biota, EnerKey, Communal Waterhouse, Integrated Water Management Olifants, GENUS-as well as about 20 % of roughly eighty known independent projects.

Future Developments

Currently, the overall context of future sustainability topics will include UNFCCC processes and results, green jobs and the South African REFIT that will also trigger further research and development and applied sciences-oriented projects in the context of climate change and renewable energy. Furthermore, a German-South African MoU on renewable energy cooperation is currently elaborated upon.

On the environmental front, there is an international climate change initiative by the German government with eight current projects addressing climate change issues in South Africa.

D4S and the envisaged joint committee panel will focus beginning in 2010 on sustainability projects and programmes. Future projects will address: regional science services centres on climate change (RSSC), earth system sciences (SPACES), sustainable land management, and other important issues.

Major emphasis is placed on the criticality of opening up the industrial sector (South Africa is currently weighing options which would allow open participation of SMEs in projects under the S&T agreement; joint research call). Consideration could be given to set up a cluster initiative on solar technologies. Similar to the EU, there could be a technology platform incorporating German and South African research organisations, as well as the public and private sectors.

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Titles of Presentations

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1. Decoupling and Sustainable Resource Management – South African Perspective
by Mark Swilling, Sustainability Institute, School of Public Management and Planning, South Africa
2. Sustainable Development - Some Lessons on Governance
by Reimund Schwarze, Helmholtz Centre for Environmental Research (UFZ), Germany
3. Concept and Implementation of Ecological Industrial Policy in Germany and Relevant European Strategies
by Klaus Jacob, Environmental Policy Center, Free University Berlin, Germany
4. Linkages of Sustainability and Environmental Management Accounting
by Cosmas M. Ambe, Environmental Management Accounting Network / University of Limpopo, South Africa
5. Science for the Future: The Potential of Inter- and Transdisciplinary Sustainability Research
by Martina Schäfer, Dr. Dörte Ohlhorst*, Dr. Susanne Schön***
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*** inter 3 - Institute for Ressourcemanagement, Berlin, Germany*

Session 2: Organising National Systems of Innovation to Support Sustainable Development

1. An Innovation Systems Approach to Sustainable Development
   by Mario Scerri, Institute for Economic Research on Innovation (IERI), Tshwane University of Technology, South Africa
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   by Rainer Walz, Fraunhofer Institute for Systems and Innovation Research, Germany
3. Success Factors of Eco-Innovation and Lead Market Strategies
   by Klaus Rennings, Center for European Economic Research (ZEW), Germany
4. Involving Industry - Key Challenge of (Bilateral ZA-DE) R&D Cooperation
   by Helmut Kergel, VDI/VDE Innovation + Technik GmbH, Germany

Session 3: Multilateral Science, Technology, and Innovation Cooperation to Address Global Challenges

1. Global Solutions to Global Challenges
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2. Towards Innovation Systems for Sustainability - The Role of International Cooperation
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3. Multilateral Approaches to Science and Technology Cooperation for Sustainability
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Session 4: Reflections on South African-German Science and Technology Cooperation for Sustainability

1. Research for Sustainability and the Bilateral Science and Technology Agreement
   by Tanja Fröhlich, Embassy of the Federal Republic of Germany in Pretoria, South Africa
2. Making it Happen: Sustainability in the Practice of German-South African Science Cooperation - Energy, Environment and Remote Sensing
   by Harold Annegarn, University of Johannesburg, South Africa
3. Experiences and Challenges in South African-German Cooperation in Renewable Energies
   by Hagen Späth, Trium Investments (Pty) Ltd., South Africa
4. Best Practices and Lessons Learned in Transferring Sustainable Technology from Science to the Market
   by Frank Aletter, Southern African-German Chamber of Commerce and Industry, South Africa
5. DAAD Support Programmes in Sustainability Research and Training
   by Ralf Hermann, DAAD Information Centre Johannesburg, South Africa

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Acronyms and Abbreviations

AU	African Union
Appr(ox).	Approximately
Bln	Billion
BMBF	German Federal Ministry for Education and Research
BMU	German Federal Ministry of Environment
BMZ	German Federal Ministry for Economic Cooperation and Development
COP15	Conference of Parties 15
CSR	Corporate Social Responsibility
D4S	International Dialogue "Sustainable Solutions-Science for Sustainability"
DBSA	Development Bank of South Africa
DIE	German Development Institute
DST	Department of Science and Technology
EIP	Ecological Industrial Policy
EMA	Environmental Management Accounting
EU	European Union
Fig.	Figure
GDP	Gross Domestic Product

GNP	Gross National Product
GRI	Global Reporting Initiative
IDC	Industrial Development Corporation
IERI	The Institute for Economic Research on Innovation
IPSRM	International Panel for Sustainable Resource Management
JSE	Johannesburg Securities Exchange
LDC	Least Developed Country
LTMS	Long Term Mitigation Scenarios
MDG	Millennium Development Goals
MEA	Multilateral Environmental Agreement
MEMA	Monetary Environmental Management Accounting
MFA	Material Flow Analysis
Mio.	Million
MoU	Memorandum of Understanding
NBI	National Business Initiative
NEPAD	The New Partnership for Africa's Development
NFSD	National Framework on Sustainable Development
NGO	Non-governmental Organization
NIC	Newly Industrializing Countries
NSSD	National Strategy for Sustainable Development
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
Prof.	Professor

R&D	Research and Development
R&D&I	Research and Development and Innovation
S&T	Science and Technology
SD	Sustainable Development
SHE	Safety, Health and Environment
SIA	Sustainability Impact Assessment
SMEs	Small and Medium Enterprises
SoIS	Sustainability-oriented Innovation Systems
STI	Science, Technology and Innovation
Tab.	Table
TEEB	The Economics of Ecosystems and Biodiversity
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UNU	United Nations University
USA	United States of America
VDI/VDE-IT	Association of German Engineers/ Association for Electrical, Electronic & Information Technologies-Innovation and Technology
WE	Wind Energy
WHO	World Health Organization
WPP	Wind Power Plant
WSSD	World Summit on Sustainable Development
ZEW	Centre for European Economic Research

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