Deutsches Institut für Entwicklungspolitik

German Development Institute

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Technological trajectories for climate change mitigation in China, the EU and India

Final report

The project was generously funded by Sweden's Riksbankens Jubileumsfond under the joint research programme "Europe and Global Challenges" with Volkswagen Foundation and Compagnia de San Paolo. The project ran from 2012 to 15th May 2015. It involved 16 researchers from four institutions: Deutsches Institut für Entwicklungspolitik/ German Development Institute as grant holder; the School of Public Policy and Management at Tsinghua University; the Institute of Development Studies at the University of Sussex; and the Indian Institute of Technology, Delhi (Annex 1). This final report summarises the research focus and main findings; it highlights the collaborative research management and discusses some challenges in implementation; finally, it provides an overview of research outputs and shows how the research project has triggered a range of secondary research activities and policy actions. The Annex lists publications and workshops.

1. Research focus

In order to halt global warming it is imperative to involve both old industrialised countries and emerging powers in the global search for solutions, in particular the development and diffusion of low carbon technologies. Against this background, the project analysed technological innovations for climate change mitigation in select European countries, China and India. We hypothesised that low carbon technologies in the three economies develop along different trajectories. Evolutionary innovation theory informs us about the cumulative, path-dependent evolution of technologies: location-specific initial conditions shape the technological choices taken at later stages and thereby give rise to the formation of specific technological trajectories. There are also levelling forces at work, e.g. through the globalisation of markets and the benefits of economies of scale. These tend to reduce, but not eliminate diversity. We further hypothesised that, on average, diversity in *low carbon* technologies is larger than in other technologies because (a) the former are strongly shaped by policy and thus depend to a high degree on specific societal preferences and political constellations and (b) few of them have reached the level of maturity where the levelling forces of globalization tend to kick.

The **main research** question driving the research was: ***"How and why do the emerging technological trajectories in Europe, China and India differ?"*** This is relevant because understanding the dynamics of low carbon technological trajectories has important implications for industrial development and climate mitigation. If low-carbon technologies tend to converge, we most likely will see a concentration of economic

benefits in a small number of technologically-advanced countries. Such concentration may imply large investments by key players in driving technological change, allowing the benefits of economies of scale for shared components and declining costs and therefore an accelerated diffusion of low carbon technologies; but it might discourage many national governments to engage in low-carbon innovations if they cannot reap co-benefits in terms of industrial development and job creation. If, in contrast, low-carbon technology pathways draw, or are dependent on, significant country-specific variation, more countries might be able to build competitive advantages that can help mobilise public support for such technologies. While economies of scale may not be reaped to the same extent, there likely would be more experimentation and competition, which may speed up innovation, depending on the local resources and capabilities to engage in, and build on, such activities. A better understanding of the drivers and interactions of innovation pathways within and across countries and how their co-benefits (and risks) are distributed is essential for defining the appropriate policy agendas and also international technology cooperation.

As a matter of fact, we explicitly addressed the implications for technology cooperation, asking a **secondary, more policy-oriented research question: "What are the implications for strategies of international competition and cooperation at the enterprise and government level?"**

Case studies were conducted in two domains of low carbon technology. In each case, Chinese and Indian trajectories were compared with those in two technologically leading European countries:

- *wind turbines* are a relatively mature and not overly complex low carbon technology, first developed in Denmark and Germany (our two European case studies) and later also mastered in China and India;
- *electromobility* relates to systemic innovations entailing automobile production and wider changes in the transport and energy systems. China and India as well as France and Germany embarked on major national electromobility programmes at roughly the same time, around 2009. The shift from combustion engines to hybrid and purely electric powertrains is slowly taking off, but policy frameworks and initial market conditions are very diverse, leading to different technological preferences in the four countries.

Once the case studies had brought out key elements of technological development in each country we started to compare, carve out differences between the two technologies and the country-specific pathways. Finally, lessons for international technology cooperation were derived from the comparison of national trends, and one practical case of technology collaboration between China and Germany on electromobility was analysed in detail.

2. Main findings

Main findings relate to the main and secondary research questions:

Regarding the question *how and why emerging technological trajectories differ*, the inter-country comparison revealed interesting insights into the drivers of technological convergence and divergence. Geography, income levels, capabilities, and policies have an influence on technological trajectories. This country specificity is strongest in the early stages. Over time, economies of scale become important and certain designs become dominant internationally. Also, the Asian latecomers are influenced by the European first movers from whom they license and learn, which leads to similar technology choices. Still, major country-specific differences remain. These are more pronounced in electromobility technologies than in wind turbines.

The wind turbine industry is in a relatively mature stage. Chinese and one Indian turbine manufacturer are now among the global top ten. All four economies offer substantial, but different, policy support. The European industry targets sophisticated high-end markets to escape cost pressure from Asian competitors. Overall, however, trajectories are converging around a small number of designs internationally, driven by the globalisation of the innovation process. At the same time, though, there is divergence among choice of designs among firms, even within a country, driven largely by firm strategy. Thus, international convergence on designs does not mean lack of competition between firms in Europe and Asia or within countries. On the contrary, there is strong competition between the lead firms in wind energy. But simultaneously, considerable cooperation across Europe-Asia has developed involving suppliers of equipment and knowledge intensive business services. Contrary to our expectations, clear Chinese or Indian pathways reflecting the needs of poor and remote regions have not emerged. Private innovation and government support for innovation remain weak for small-scale off-grid wind power. This is surprising because both countries continue to have many regions without access to grid-based power.

Inter-country comparisons in electromobility show much more divergence. Very different technological experiments are being undertaken in each of the countries, even though automobile and motorcycle production is a highly globalised industry in which big corporations organise production and innovation networks, often spanning major markets world-wide. The main reason is that innovations are still at an early stage, with no dominant pathways or designs having emerged as yet. Big automobile corporations are not yet decided how to shape new pathways because of two reasons: first, technological uncertainty is high as the auto industry still does not know which technological alternative – electric (and battery chemistry), fuel cell, hydrogen and different hybrid vehicle arrangements – will become dominant. Second, political uncertainty is high over the sticks and carrots wielded by governments in advancing electromobility. Established

carmakers are engaging in interesting new alliances e.g. with battery producer and energy utilities to prepare for different scenarios, but they are not (yet) willing to bet on the one new technological option. Some newcomers do fully bet on electromobility, but few (like Tesla) are big and successful. Country-specific conditions, both demand-conditions in the home market and the technological capabilities of local firms, also have a very strong influence on innovation paths in this early stage, in both Europe and Asia. The dominant picture is one of divergence: across the Europe – Asia divide, within Europe and within Asia. Interestingly, even within Europe, variation in demand conditions, policy frameworks as well as firm capabilities and strategies shape very different technological pathways. There is no latecomer effect pushing China and India into convergence with the European countries because Asian and European countries started the race into electromobility at the same time. There is no globalisation effect bending innovation towards convergence because the innovation process is not (yet) fully internationalised and the initial explorations are quite context dependent. Thus, the national factors can exercise their influence unencumbered. But this is likely to change in the future when global players start mass-manufacturing electric vehicles and pushing towards dominant designs – and some form of convergence.

Sectoral differences across the European and Asian countries studied thus seem substantial but care is needed in interpreting cross-sectoral findings because the nature of the two sectors is very different. First, cars need to be tailored to consumer tastes and have therefore always differed considerably across countries even though the underlying platforms may be shared; wind turbines produce energy, which is a homogeneous and interchangeable commodity, hence one would expect less variation in turbine technology. Second, electromobility refers to a complex new system which covers many technologies and requires simultaneous changes in related energy and mobility systems, whereas a wind turbine is a relatively simple technological product. Third, there are differences in the degree of maturity; wind power technology and deployment have reached a relatively mature stage whereas electrical vehicles are still in an early phase of technological experimentation where scale-intensive production has not yet kicked in.

With regard to the secondary research question about *implications for strategies of international competition and cooperation*, we explored the difficult trade-off between national interests in maintaining technological leadership and reaping innovation rents vs. the benefits of international technology cooperation from a global public goods (especially climate change mitigation) perspective. The competitive relationship between Europe and China in particular has triggered an intensive and controversial political debate: First, because China has in some cases been able to take market shares away from European market leaders, thereby eroding their early mover advantages and discouraging low carbon actions in Europe (as in the case of solar photovoltaic panels); second, because European investors accuse China`s policymakers and obligatory joint-venture partners to not fully respect intellectual property rights.

Our research confirmed fierce competition and conflicts over intellectual property rights enforcement, but also revealed many win-win situations. In the wind turbine industry, China and India clearly benefitted from technologies developed in Europe. At early stages, Asian newcomers licensed Western technologies but later increasingly accessed technology through acquisitions of European hi-tech service providers to the wind turbine industry. European firms had to share some technology but gained access to vast Asian markets as well as royalty payments. In contrast to the photovoltaic industry, Chinese (and Indian) firms have not (yet) been able to outcompete their European rivals.

In electromobility, China is putting pressure on foreign carmakers to develop electric vehicles and share the respective e technologies if they want to continue selling in China. This has triggered some interesting electric vehicles co-operations. German carmakers and Sino-German joint ventures are developing some specific electric vehicles for the local market, but so far they have been able to avoid major leakage of core competencies and Chinese catching up is still slow.

Public sector cooperation also played a key role in advancing low carbon technologies. In renewable energy technologies, German and Danish development cooperation has for decades promoted capacity-building in China and India. The more China and India are perceived as potential competitors, the more reluctant however are European governments and companies to continue supporting capacity building. In electromobility, we studied the case of a Sino-German partnership. So far, this partnership has not produced relevant results because both sides pursue different interests: China wants to access critical core technologies, Germany is interested in agreements on technological standards as well as environmental performance. Our research however identified areas where technology cooperation might benefit both sides. This includes e.g. collaborative research and monitoring of electromobility experiments ("Begleitforschung") in both countries. Still, the scope for bilateral technology cooperation is limited given the concerns about national competitiveness.

The team therefore also explored the role of multilateral technology cooperation and capacity building. Under the UNFCCC negotiations, developed countries have committed to share and assist developing countries in low carbon technology development, e.g. through the UNFCCC Technology Mechanism. However, little action has been taken so far. Additional efforts are needed to mobilise funds that can be used to pay for licenses; in parallel, low carbon innovation systems need to be strengthened at the national level.

3. Collaborative management of the research project

The research undertaken was truly collaborative: The international team, 16 actively participating researchers based in five countries (including Denmark), has jointly

developed the research design and conducted field research in China, India and Europe in mixed international groups. Even company visits in the different countries were done in cross-country teams, ensuring that team members had an opportunity to actually experience and jointly reflect on differences in company organisation and policy approaches. Also, most of the research papers (listed in Annex 3-6) were jointly designed, intensively discussed and finally co-authored by international teams.

Four project team meetings were held between 2011 and 2013, with each country team hosting one workshop in Bonn, Beijing, Delhi and Brighton, respectively. All four workshops were attended by the entire team of 16 researchers, with only very few exceptions.

A project steering group was formed consisting of one representative from each of the four main research partners (Tilman Altenburg for the German Development Institute; Ambuj Sagar for the Indian Institute of Technology, Delhi; Hubert Schmitz for the Institute of Development Studies at the University of Sussex; and Lan Xue for the School of Public Policy and Management at Tsinghua University). The steering group organised rigorous peer review processes for all core publications of the project (Special Issues and DIE Discussion Papers, Annex 3-5), again putting together review teams across different countries and cultures. Papers were reviewed internally by members of the trajectories project before being sent out for anonymous external reviews. These procedures provided detailed guidance, enabling team members to improve their papers, and where acknowledged as a unique opportunity especially by the younger researchers.

4. Challenges in implementation

While the cooperation proceeded smoothly and no major problems of implementation or conflicts arose, three issues created challenges:

First, while the complexity of the international network, the collaborative research design and the rigorous peer review process have been an outstanding experience for all participants, they resulted in a delay compared to the original schedule. While project closure was originally envisaged for December 2013, the project received permission from the funding agencies to extend project activities (without the need for additional funding) until May 15th 2015.

Second, in the course of the project, several younger researchers moved to other institutions because they were offered professorships or other attractive employment positions. Doris Fischer received a call as a Full Professor (W3) from University of Würzburg; Rasmus Lema became Associate Professor at Aalborg University; Frauke Urban became Associate Professor at the University of London, Shikha Bhasin was hired by the Energy Research Centre of the Netherlands. This made coordination more difficult, but we managed to keep all researchers committed to the project until the end.

Third, the leaders of the Chinese and Indian teams are high profile international innovation specialists in great demand at international policy and research fora and therefore with a heavy international travel schedule in addition to the considerable leadership roles in their own organizations. This shifted the main burden of coordination to DIE and IDS, making Bonn-Brighton the central collaborative axis of this project. In the spirit of the collaborative intention of the project, however, all country teams ultimately made their contributions to the writing and reviewing of papers and fulfilled the quality assurance criteria we had defined in the beginning of the project.

5. Research output

The research network already produced one **Special Issue** of an international peer reviewed journal ("**Innovation and Development**") in the first project year. It included seven papers of which 6 were written by (a total of nine) researchers from the trajectories project. While the publication mainly drew on previous research of these researchers on low carbon technologies in China and India (rather than new empirical research funded under the Riksbanken grant), it had an important positive effect on bringing the network closer together and exploring conceptual details. The Special Issue was later selected for a book publication by Routledge, London (Annex 4).

A series of eight detailed reports was then produced over the next two years, mostly analyzing the development of one of the two core technology areas in one of the countries (e.g. *wind turbine development in China* or *electromobility in Germany*). One dealt with lessons for international technology cooperation. Of these reports, so far six have been published as **DIE Discussion Papers** after going through meticulous peer review processes. Two reports are still in final review loops (Annex 5).

On the basis of the detailed case study reports we then started to work on country comparisons. This resulted in a **Special Issue** of another international journal, **Science and Public Policy.** Seven articles were submitted for internal and external peer reviews and five (plus an editorial introduction) were ultimately accepted. This Special Issue condenses the project's main contributions to the academic debate (Annex 3).

In addition to these core outputs of the project, the team members published **28 other research papers** using the findings of the research project. These range from journal articles (Climate Policy, Energy Policy, International Journal of Technology and Globalization, Journal of Current Chinese Affairs, Global Environmental Change, New Political Economy, Technological Forecasting and Social Change, Journal of Renewable and Sustainable Energy) to book chapters and Discussion Papers (See Annex 6).

6. Spillovers and network building

The project was also a major and successful investment in network building for all the four main institutional partners.

First (as one would expect from a research project of this kind), **networks with the international research community** were strengthened through a considerable number of presentations of team members at international conferences, including the special seminars and panels listed in Annex 2.

Second (and this is more specific to our network), the **links between research and policy** played an important role throughout the project. All four partner institutions are *policy* research institutes with close relationships to national ministries, implementing agencies as well as international organizations. Research findings were therefore used to inform policymakers and frame their debates at various levels. Some of the lead researchers of the project have high-level positions in advisory bodies, especially Xue Lan who is a member of the national expert committee for China's 13th five year plan and a member of the National Committee of Strategic Consultation and Comprehensive Evaluation which advises the Central Government on China's innovation strategies; Ambuj Sagar who is a member of the Indian Government's Expert Committee on Low-Carbon Strategies for Inclusive Growth, the US-India Track-II Dialogue on Climate Change, as well as other advisory groups in the Indian Government; and Dirk Messner who chairs the German Advisory Council on Global Change, represents Germany at the High Level China Council on International Cooperation on Environment and Development and co-authored an action plan to support the small island states in the UNFCCC negotiations. Also, Tilman Altenburg is coordinating a joint flagship report of several UN agencies on 'Green Industrial Policy'. Through these institutional linkages, project results could be channeled into policy processes. Policy briefs were produced e.g. for the UNFCCC Technology Mechanism and for the Indo-German Environmental Experts Group.

Third (and perhaps most strikingly), **many follow-up activities between the four partners** evolved. While DIE and IDS are looking back on a long history of research collaboration, cooperation between the European partners and Tsinghua University and IIT Delhi as well as between the two Asian partners only started with the 'Technological Trajectories' project. During the project time, links intensified and led to several high profile collaborations between the partners in *different constellations*, including:

- a research project between *IDS, Tsinghua University and IIT Delhi* on Drivers of Low Carbon Transformation;
- a Special Issue of Climate Policy with contributions from *IIT Delhi and Tsinghua University* which explored the implications of our research for international technology cooperation;

- joint advisory work for the the UNFCCC Technology Executive Committee at a workshop in Bonn with core contributions from *IIT Delhi and DIE*;
- joint contributions from *IDS and IIT Delhi* to the 'BRICS and the Green Transformation: Mutual Learning for Sustainability' Conference held in Rio de Janeiro in March 2014;
- a joint background paper of *DIE and IIT Delhi* for the establishment of the Indo-German Environmental Experts Group;
- During the life-span of the project, National Committees of the Sustainable Development Solutions Network led by Jeffrey Sachs were established. *DIE* became the National Hub for Germany and the School of Public Policy and Management at *Tsinghua University* the Hub for SDSN China. 'Technological Trajectories' project meetings were used to explore options to intensify collaboration between the two Hubs.

Overall, despite some delays and high transaction costs of coordinating such a complex international research network, all participants assessed this project as a unique opportunity for joint learning and network building. With an output of 20-25 peer reviewed journal articles and a similar number of (also intensively reviewed) Discussion Papers and book chapters as well as the mentioned inputs into policy processes, we also regard the academic harvest a success.

Bonn, 12 August 2015 Dirk Messner / Tilman Altenburg

Annex 1:
Research team

1. Tilman ALTENBURG, Deutsches Institut für Entwicklungspolitik/ German Development Institute (DIE), Bonn
2. Shikha BHASIN, Energy Research Centre of the Netherlands, Amsterdam (initially DIE)
3. Ankur CHAUDHARY, Indian Institute of Technology, Delhi
4. Ling CHEN, School of Public Policy and Management, Tsinghua University
5. Yixin DAI, School of Public Policy and Management, Tsinghua University
6. Doris FISCHER, University of Wuerzburg (initially DIE)
7. Rasmus LEMA, Aalborg University, Denmark (initially IDS)
8. Dirk MESSNER, DIE
9. Ankita NARAIN, Indian Institute of Technology, Delhi
10. Ambuj SAGAR, Indian Institute of Technology, Delhi
11. Eike SCHAMP, University of Frankfurt
12. Hubert SCHMITZ, Institute of Development Studies, University of Sussex
13. Qunhong SHEN, School of Public Policy and Management, Tsinghua University
14. Frauke URBAN, School of Oriental and African Studies, University of London (initially IDS)
15. Lan XUE, School of Public Policy and Management, Tsinghua University
16. Yuan ZHOU, School of Public Policy and Management, Tsinghua University

Annex 2:
Workshops, conference panels and final conferences

As planned in the project proposal **four workshops** where held in each of the home countries of the main institutional partners:

1. Bonn, Germany April 2011
2. Beijing, China November 2011
3. Delhi, India September 2012
4. Sussex, UK, May 2013

A **Final Conference** was held at Bonn on 7/8 April 2014: 'Technological Pathways to Low Carbon: Competition and Collaboration between Europe and Emerging Asia'. The conference was structured around the project's research topics and provided space for presenting our preliminary findings and complementary presentations from international researchers in related fields. The second day was dedicated to policy implications, with discussions involving international organizations such as IEA and IRENA, German Ministries and several implementing agencies. 24 conference presentations can be downloaded from the DIE website at: can be found at:

http://www.die-gdi.de/veranstaltungen/technological-pathways-to-low-carbon-competition-and-collaboration-between-europe-and-emerging-asia/

In addition, a number of special seminars and conference panels were held which were directly related the project and included several project team contributions. These included:

- Globelics Annual Conference, Hangzhou, 9-11. November 2012, Panel on Technological trajectories in China, Europe and India", convened by Tilman Altenburg
- Globelics Seminar on Low Carbon Development, 4-5 April 2013, Copenhagen, organized by Rasmus Lema
- Seminar on Wind Power Technology in China and Denmark, 20 April 2012, Copenhagen, organized by Rasmus Lema
- Workshop "Greening innovation for sustainable development: The role of lead markets and frugal innovations", DIE, Bonn, 21 May 2013
- Conference "Climate technology & development", DIE, Bonn, 25 June 2013
- 2nd Geography of Innovation International Conference, Utrecht University 24-25 January 2014, Panel on "Green technologies from emerging Asia: Changing the geography of innovation?", convened by Tilman Altenburg
- IDS/SPRU/STEPS seminar 'Low carbon innovation paths in Europe and Asia: Divergence or Convergence?' on 8 May 2015, organized by Hubert Schmitz

- 'BRICS and the Green Transformation: Mutual Learning for Sustainability' held in Rio de Janeiro in March 2014 at the time of the BRICS Academic Summit, convened by Hubert Schmitz and Ambuj Sagar

Finally, numerous individual paper contributions were made to other conferences which are not listed here.

Annex 3:
Special Issue of *Science and Public Policy:* Comparing Low Carbon Innovation Paths in Asia and Europe
Guest editors: Tilman Altenburg (German Development Institute, Bonn); Ambuj Sagar (Indian Institute of Technology, Delhi); Hubert Schmitz (Institute of Development Studies at the University of Sussex); Lan Xue (School of Public Policy and Management, Tsinghua University, Beijing).

Five papers, mostly written by teams of authors from two or three partner countries, were submitted. Each paper went through internal reviews of the project team first and was then peer-reviewed in a double-blind review by two or in some cases even four external reviewers. Five papers successfully passed the review and are currently being processed for publication. An online version will be published in early September and the print version soon afterwards. An introductory chapter was written by the four country team leaders:

0. Altenburg, T., A. Sagar, H. Schmitz, L. Xue, Editorial introduction.
1. H. Schmitz, H. and T. Altenburg, 'Low Carbon Pathways: Comparing Europe and Emerging Asia'
2. Lema, R., Y. Zhou, A. Sagar, 'Convergence or Divergence? Wind Power Innovation Paths in Europe and Asia'
3. Altenburg, T., E. Schamp, A. Chaudhary, 'The Emergence of Electromobility. Comparing technological trajectories in France, Germany, China and India'
4. Shen, Q., K. Feng, X. Zhang, 'Divergent Technological Strategies among Leading EV Firms in China and India: Multiplicity of Institutional Logics and Responses of Firms'
5. Zhou, Y, L. Xin, R. Lema, F. Urban, 'Comparing the knowledge bases of wind turbine firms in Asia and Europe: patent trajectories, networks, and globalization'

Annex 4:
Special Issue of *Innovation and Development:* Sustainability-oriented innovation systems in China and India (2012)

Guest editor: Tilman Altenburg

1. Altenburg, T. (2012): Introduction to the special issue.
2. Altenburg, T. / A. Pegels. : Sustainability-oriented innovation systems: managing the green transformation.
3. Lema, R. / A. Lema: Technology transfer? The rise of China and India in green technology sectors.
4. Chaudhary, A, / A. Sagar / A. Mathur: Innovating for energy efficiency: a perspective from India.
5. Altenburg, T, / S. Bhasin / D. Fischer: Sustainability-oriented innovation in the automobile industry: advancing electromobility in China, France, Germany and India.
6. Walz, R. / J. Novak Delgado: Different routes to technology acquisition and innovation system building? China's and India's wind turbine industries
7. Urban, F. / J. Nordensvärd / Y. Zhou: Key actors and their motives for wind energy innovation in China.
8. Fischer, D.: Challenges of low carbon technology diffusion: insights from shifts in China's photovoltaic industry development.

The Special Issue is currently being reprinted as a **book** by Routledge Publishers. The book is announced for September 2015:

Altenburg, Tilman (ed., 2015): Sustainability-oriented innovation systems in China and India, London: Routledge

Annex 5:
DIE Discussion Papers:

1. Altenburg, T. (2014): From combustion engines to electric vehicles: a study of technological path creation and disruption. Bonn: DIE (Discussion Paper)
2. Bhasin, S. (2014): Enhancing international technology cooperation for climate change mitigation: lessons from an electromobility case study. Bonn: DIE (Discussion Paper 26/2014)
3. Chaudhary, A. (2014): Electromobility in India: attempts at leadership by businesses in a scant policy space. Bonn: DIE (Discussion Paper 15/2014)
4. Lema, R. / J. Nordensvärd / F. Urban / W. Lütkenhorst (2014): Innovation paths in wind power: insights from Denmark and Germany. Bonn: DIE (Discussion Paper 17/2014)
5. Schamp, E.W. (2014): The formation of a new technological trajectory of electric propulsion in the French automobile industry. Bonn: DIE (Discussion Paper 12/2014)
6. Dai, Y. / Y. Zhou / D. Xia / M. Ding / L. Xue (2014): Innovation paths of the Chinese wind power industry. Bonn: DIE (Discussion Paper 32/2014)
7. Narain, A. / A. Chaudhary / C. Krishna (forthcoming): The wind power industry in India. Bonn: DIE (Discussion Paper)
8. Ling, C. / D. Fischer /Q. Shen / Y. Wenhui (forthcoming): Electric vehicles in China: bridging political and market logics. Bonn: DIE (Discussion Paper)

Annex 6:
Other project-related academic publications

1. Altenburg, T. / T. Engelmeier (2013): Boosting solar investment with limited subsidies: rent management and policy learning in India, in: Energy Policy 59 (8), 866–874
2. Berger, A. / D. Fischer / R. Lema / H. Schmitz / F. Urban (2013): China-Europe Relations in the Mitigation of Climate Change: A Conceptual Framework, in: Journal of Current Chinese Affairs, 42, 1, 71-97.
3. Chaudhary, A. / A. Narain / C. Krishna / A. Sagar (2014): Who Shapes Climate Action in India? Insights from the Wind and Solar Energy Sectors. IDS Evidence Report 56
4. Chaudhary, A. / C. Krishna / A.D. Sagar (2015) Policy Making for Renewable Energy in India: Lessons from Wind and Solar Power Sectors, in: Climate Policy, 15 (1): 58-87
5. Coninck, H. / A.D. Sagar (eds., 2015), Perspectives on Climate Technology Development and Transfer, special issue of Climate Policy, 15 (1)
6. Dai, Y. (2015): Who Drives Climate-relevant Policy Implementation in China? IDS Evidence Report 134 (2015)
7. Dai, Y. / L. Xue (2015): "China's policy initiatives for the development of wind energy technology," Climate Policy, 15(1): 30-57
8. Johnson, O. / T. Altenburg / H. Schmitz (2014) 'Rent Management Capabilities for the Green Transformation' in A. Pegels (ed.), Green Industrial Policy in Emerging Countries, Abingdon; Routledge
9. Lema, R. / A. Berger / H. Schmitz (2013): China's Impact on the Global Wind Power Industry, in: Journal of Current Chinese Affairs, 42, 1, 37–69.
10. Lema, R. / A. Berger / H. Schmitz / Hong Song (2011): Competition and Cooperation between Europe and China in the Wind Power Sector, IDS Working Paper 377, 1-45;
11. Lema, A. / R. Lema (2013): Technology transfer in the clean development mechanism: Insights from wind power. In: Global Environmental Change 23, 301–313
12. Messner, D. / T. Altenburg / A. Sagar (2014): Background paper: exploring pathways towards a green and inclusive transformation. Discussion Paper for the Indo-German Environmental Experts Group. Berlin.
13. Messner, D. / C. Leggewie (2012): The low-carbon transformation: a social science perspective, published on Journal of renewable and sustainable energy 4/2012
14. Messner, D. / N. Htun / Y. Jiang / D. Mahajan / R. Templer (eds.) (2012): Low-carbon society for a green economy, Special Issue on: Journal for Renewable and Sustainable Energy 4 (4)
15. Messner, D. / H.J. Schellnhuber / C. Leggewie / R. Leinfelder / N. Nakicenovic / S. Rahmstorf / S. Schlacke / J. Schmid / R. Schubert (2012): Financing the global energy-system transformation: WBGU, Berlin (Policy Paper 7)

16. Messner, D. (2014): The role of science and technology in the dynamics of global change and the significance of international knowledge cooperation in the post-western world in: Maximilian Meyer / Miriana Carpes / Ruth Knoblich (eds.), The global politics of science and technology vol.1, Berlin: Springer, 267-276
17. Messner, D. (2015): Dirk Messner on the dynamics of global change and the significance of international science and technology cooperation in the post-Western world, Interview published on Theory talk #67, Friday, 30 January 2015
18. Messner, D. (2015): Deutschland als Gestaltungsmacht in der globalen Nachhaltigkeitspolitik: Chancen und Herausforderungen unter den Bedingungen „umfassender Globalisierung“, in: Gunther Hellmann / Daniel Jacobi / Ursula Stark Urrestarazu (Hrsg.), "Früher, entschiedener und substanzieller"? Die neue Debatte über Deutschlands Außenpolitik (Zeitschrift für Außen- und Sicherheits-politik 8(1) Sonderheft 6), 379-394, DOI 10.1007/s12399-014-0463-3
19. Messner, D. (2015): A social contract for low carbon and sustainable development: reflections on non-linear dynamics of social realignments and technological innovations in transformation processes, in: Technological Forecasting and Social Change,doi:10.1016/j.techfore.2015.05.013
20. Schmitz, H. (2015): How does China’s rise affect the Green Transformation?, in: International Journal of Technology and Globalization’ forthcoming
21. Schmitz, H. (2015), ‘How Does China’s Rise Affect the Green Transformation?’, International Journal of Technology and Globalisation, 2015, forthcoming
22. Schmitz, H. (2015): Green Transformation – Is There a Fast Track?’, in I. Scoones / M. Leach / P. Newell (eds), The Politics of Green Transformations, Earthscan/Routledge
23. Schmitz, H. / O. Johnson / T. Altenburg (2013): Rent Management – The Heart of Green Industrial Policy. IDS Working Paper 418, Brighton.
24. Schmitz, H. / O. Johnson / T. Altenburg (2015), ‘Rent management: the heart of green industrial policy’, New Political Economy, forthcoming
25. Schmitz, H. / R. Lema (2015): The Global Green Economy: Competition or Cooperation between Europe and China?, in J. Fagerberg, S. Laestadius and B. Martin (eds.), The Triple Challenge: Europe in a New Age, Oxford University Press, forthcoming
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